Florida Climate Change Education and Training: State University System Cooperative Plan

December 2011




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Front cover photo credits (clockwise from left): NASA, UF, FSU, USF

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List of Abbreviations and Acronyms

Abbreviation/Acronym	Description
CACCE	Coastal Areas Climate Change Education Partnership
CES	Center for Environmental Studies
COAPS	Center for Ocean-Atmospheric Prediction Studies
FAMU	Florida Agricultural and Mechanical University
FAU	Florida Atlantic University
FCI	Florida Climate Institute
FGCU	Florida Gulf Coast University
FIU	Florida International University
FSC	Florida Sea Grant
FSU	Florida State University
IPCC	Intergovernmental Panel on Climate Change
NAS	National Academy of Sciences
NCF	New College of Florida
SECC	Southeast Climate Consortium
SUS	State University System
UCF	University of Central Florida
UF	University of Florida
UM	University of Miami
UNF	University of North Florida
USF	University of South Florida
USGCRP	United States Global Change Research Program
UWF	University of West Florida

EXECUTIVE SUMMARY

Global climate changes are complex and challenging to communicate to society. As a consequence, society is not prepared to adapt and mitigate the impacts of climate change, remaining incapable of pushing for effective, efficient, and equitable policies and actions on the matter. This challenge is evident in the Southeastern United States, where broad sectors of the public remain unconvinced that climate change is a serious problem and scientists and educators in general lack sufficient capability to translate sciences to lay audiences, making it harder for people to understand climate change and how and when they should be concerned and take action. Therefore, it is important to identify existing educational opportunities that and others that are still needed to broadly educate and inform relevant audiences.

The overall goal of this paper is to provide information on university climate change programs (research and education), university climate change institutes and centers, and initiatives statewide in Florida. The specific objectives are:1) describe the current status of climate change education within Florida, b) assess the extent at which climate change educational needs are being addressed, and c) identify action items required to enhance climate literacy of the State's population.

Through a systematic statewide effort, 461 courses with varying degrees of climate change content were identified within 12 surveyed institutions of higher education. Almost 40% of these courses are taught in disciplines within the Earth and physical sciences, and both the life and social sciences have around 100 courses each. The rest of the courses were part of the curricula of interdisciplinary programs (43), and humanities (8). The courses were further classified based on the amount of climate change content that they included.

A set of educational needs were identified. The most important needs are: a) promote a stronger integration of climate change education with other sciences and disciplines; b) enhance students' access to current and future courses; c) develop the skills of scientists for translating scientific concepts to lay audiences; and d) strengthen the preparation of teaching and extension faculty and K-12 science teachers to incorporate climate change concepts in their courses. Two approaches are proposed by the authors based on these findings and on recent publications, such as the USGCRP Climate Literacy framework. The first one focuses on the development and delivery of training curricula to enhance the knowledge and skills of university faculty (both teaching and extension) and K-12 science teachers in two main areas: 1) the integration of climate change education into their courses/programs, and 2) the translation of scientific concepts to multiple audiences. The second approach is the establishment of a state-wide, inter-institutional, and multidisciplinary concentration or minor/certificate on climate change. This program would enhance the access of students to a variety of courses on climate change, improve the capacity of future scientists for translating sciences, and promote the integration of climate change education into a range of disciplines.

SECTION 1: INTRODUCTION

"If a man empties his purse into his head, no man can take it away from him. An investment in knowledge always pays the best interest."

Benjamin Franklin (1706-1790)

Society is not prepared to respond to climate change because the climate-related decisions and policies that need to be made over the next decades will require a citizenry that is better informed and more engaged than it is today (NRC, 2010a). History shows that society has successfully coped with and adapted to the existing relatively stable climate variability; the challenge now is to respond effectively to the threats presented by climate change (NRC, 2010b). All types of decision-makers (e.g. governments, businesses, and individuals) are already taking actions to respond to climate change (NRC, 2010c). However, large segments of society still remain unconvinced that climate change is real (Kohut et al., 2009) and, therefore, these segments remain inactive. Society as a whole must realize that climate change is happening and that human activity is playing a part in this change (NRC, 2011; Hassol, 2008).

Recent surveys show that the American public wants more information about climate change and the ways in which it may affect their lives; citizens also expect responsive action from the government and are willing to take action themselves (NRC, 2010a). The truth is that global climate changes are complex and challenging to communicate to society. An understanding of science is fundamental to appreciating the forces that produce climate change and the effect of changing climate on different regions of the world. However, science education is not available to everyone and scientists and educators, in general, lack sufficient capability to translate sciences to lay audiences. This situation makes it difficult for people to become informed or educated about climate science. As a consequence, society lacks the knowledge and skills to modify its behaviors to adapt to the effects, or mitigate, climate change.

Greater awareness or knowledge about climate change may lead to a more engaged citizenry (Kahlor and Rosenthal, 2009), but only if special attention is directed to the cultural diversity of our audiences when tailoring messages aimed at generating a sense of urgency and being a cue to act (Kahan et al., 2011). The sustainability of our society within an ever changing climate, regardless of the source of change, requires that we place climate science education, including education about climate change, on a level of education similar to that of the basic sciences, such as biology, chemistry, and physics. This is consistent with NRC's recommendation in its report on Informing and Effective Response to Climate Change (2010a), "*The federal government should establish a national task force that includes formal*

and informal educators, government agencies, policymakers, business leaders, and scientists, among others, to set national goals and objectives, and to develop a coordinated strategy to improve climate change education and communication."

Climate change is a global concern and may have significant negative effects on agriculture, ecosystems, and human health (IPCC, 2007). Scientists predict that the effects of climate change on human and natural systems will increase over the next several years (USGCRP, 2009). Taking action today to mitigate climate change impacts is costly (0.7 to 3.5% of GDP), however, these costs will double, or triple, for each decade that action is delayed (Stern, 2006). Even though this type of economic analysis has led policy makers to enact legislation to mitigate and adapt to climate change (e.g. 23 states in the U.S. have established targets to reduce greenhouse gas emissions; NRC, 2010a), public opinion is still widely divergent on climate change (Leiserowitz and Broad 2008; Leizerowitz et al. 2009).

Recent studies of society beliefs about climate change indicate that the public lacks a basic understanding of science and its methods (Kohut et al., 2009; Maibach et al., 2009). Additionally, public opinion about climate change is largely influenced by political preferences (Hamilton, 2009). Sometimes, it appears that political orientation is a stronger determinant of attitudes towards climate change than other demographic attributes. The politicization of the debate on climate change has led members of the public to perceive it more as a matter of personal opinion or a political ideology, distracting attention from the known facts about climate change and the basic causes of those changes (Furman et al. 2009). Consequently, there is an acute and demonstrable need to better educate and inform decision-makers and citizens in general on the most basic facts of climate change (Hassol, 2008), to develop a more climate science literate society. Numerous reports highlight the need for the public to better understand science and engineering (National Academies of Science, 2006; National Research Council, 2009; US Department of Education, 2002).

This challenge is evident in the Southeastern U.S., where broad sectors of the public remain unconvinced that climate change is a serious problem (Kohut et al., 2009). As a consequence of this deficiency of education and awareness, society lacks the means to adapt to and mitigate the impacts of climate change, remaining unable to enact effective, efficient, and equitable policies and actions on the matter. For example, in the U.S. policy-makers are limited in what they can do to address this issue, because even though some significant efforts to reduce greenhouse gas emissions are being implemented at the state and local levels, the country still lacks a set of national goals and polices to frame and coordinate the efforts of individuals, organizations, and governments (NRC, 2010d). A society with a comprehensive background in climate literacy is able to develop and implement effective risk-management strategies (NRC, 2010b). The connection between adaptation and risk assessment is evident in the case of hurricane preparedness. Coastal communities spend large sums of money on hurricane preparedness, but most will likely never get hit by a hurricane, however, the risk associated with it is communicated through governmental structures, so investment is

justified. Policy-makers will need to closely monitor the impacts of actions implemented to adapt or mitigate climate change to learn and improve the effectiveness of response options (NRC, 2010b).

Global Climate Change Education: a Synopsis

Educating citizens to develop a more climate literate society is currently a critical need. Climate science literacy is "the understanding of your influence on climate and climate's influence on you and society" (USGCRP, 2009), and a climate literate citizenry is crucial in order to make informed decisions that will influence one's own quality of life and sensible public policy. There is a need to advance climate science literacy across the spectrum of education, but one of the most important areas to target may be at the graduate and undergraduate levels of higher education, where future scientists as well as informed opinion leaders have the potential to disseminate their knowledge broadly through formal and non-formal education channels. However, in the case of climate change education, universities have generally responded in a "lethargic" way to their responsibility to educate about important societal issues (Lemons, 2011).

It has been proposed that, regardless of their major, university students should be environmentally aware and literate (McIntosh et al., 2001). According to Lemons (2011), institutions of higher education must recognize their responsibility in responding to the urgent need of global climate change. However, even though some universities have successfully implemented different education models to integrate environmental education into existing courses, this is an area in need of great improvement (Rowe, 2002). Rowe found that students using these models have a greater concern about the future of society, believe that they can make a difference, and are willing to participate in solving society's environmental problems. The full commitment of the higher education system will be required to make the needed changes to face this challenge; changes may include incorporating content on the underlying causes of climate change and strategies for its mitigation in courses across all disciplines (Lemons, 2011). Expanding climate change education into disciplines such as the social sciences is necessary to bring scholars that can contribute their expertise to promote public engagement and understanding through communication and to extend the discussion on the ethics of climate change (Mailbach and Priest, 2009).

There is a wide range of educational programs focusing on climate education around the world. Formal and non-formal education on the causes and consequences of climate change has been accelerating over the past decade. Leadership for this effort in the U.S. has come primarily from governmental institutions. These efforts are summarized in the latest edition of the U.S. Climate Action Report (United States Department of State, 2010). The current scientific consensus on climate change is summarized in (NRC Board on Atmospheric Sciences and Climate, 2010). Related documents have focused on the effects of climate

change in Florida and the Gulf Coast (Florida Fish and Wildlife Conservation Commission, 2008; Florida Oceans and Coastal Council, 2009; Sole, 2008; Twilley, et al., 2001).

Climate Change Education in Florida: a Brief Analysis

The Southeastern U.S. is particularly vulnerable to climate change due to its high inherent biodiversity and agricultural diversity, tenuous water resources, coastal topography, and high population growth (Climate Change Science program, 2008). Significant climate change may bring about serious agricultural, economic and environmental challenges to the region, creating an acute need to educate agricultural producers, public and policy makers to better understand, mitigate and/or adapt to future climate. The main issues facing this region in terms of climate variability and change are significant and are available in much more detail elsewhere (e.g. USGCRP 2009). In brief though, some of the main issues affecting this region include: a) changes in precipitation patterns; b) average annual temperatures are projected to rise, c) sea-level rise is projected to accelerate, increasing coastal inundation and shoreline retreat, and d) the frequency and intensity of tropical cyclones may change, thereby subjecting the region to more or less rainfall and possibly higher wind speeds. The 'Global Climate Change Impacts in the United States' report for the Southeastern region (Karl et al. 2009), explains that one of the ways in which the projected increases in air and water temperatures will affect the quality of life is by causing heat-related stresses for people, plants, and animals.

As noted by Lemons (2011), climate change education in the U.S. is at its "infancy", even though scientists have reported the severe and irreparable dangers of climate change for years. A real pressure exists on climate change education to develop and "mature" as soon as possible if society is going to respond on time and effectively to climate change challenges. This is specially urgent in Florida where most people do not consider climate change a relevant issue and do not identify the global rise of temperatures as a consequence of human activities (Kohut et al., 2009) and scientists and educators in general lack the capability to translate sciences to lay audiences, making it harder for people to become informed or educated about climate science. The higher education system has ignored its responsibility to educate society on climate change (Lemons, 2011) and today it is more urgent than ever to develop the required social and human capital necessary to broadly educate and inform relevant audiences with a view toward increasing the number of scientists, educators, and opinion leaders who understand the impacts, possess the means to adapt and mitigate these impacts, and have the capacity to teach and inform others.

Objectives

The overall goal of this paper is to provide information on university climate change programs (research and education), university climate change institutes and centers, and initiatives statewide in Florida. The specific objectives are:

- Describe the current status of climate change education within Florida.
- Assess the extent at which educational needs related with climate change are being addressed.
- Identify action items required to enhance climate literacy of the State's population.

Figure 1: Graduate and undergraduate courses are important areas to advance climate science literacy. Courtesy of UF/IFAS.

Scope of Paper

The main object of study of this document is the formal and non-formal educational curricula on climate change available in Florida. Therefore, an account of related graduate and undergraduate courses, outreach and professional development programs, and other educational initiatives sponsored, developed, and/or delivered by institutions of higher education, governmental agencies, non-governmental organizations, and the private sector is included. However, it is not possible to claim that the information presented in this document is an exhaustive account of the climate change education in Florida because there are multiple challenges to identifying all education programs on climate change. The main challenge is that climate change education is very diverse and approached from a variety of disciplines and philosophical perspectives (e.g. quantitative courses in Meteorology vs. qualitative courses in Anthropology). The instructors of these different courses/programs are dispersed and, in most cases, do not share other scholastic activities. This makes it very difficult to identify those who are teaching topics on climate change, how are they framing the issues, and what types of outcomes they expect from their learners.

SECTION 2: CLIMATE CHANGE EDUCATION ASSESSMENT IN FLORIDA: METHODS AND PROCEDURES

"The result of the educative process is capacity for further education."

John Dewey (1859-1952)

Setting

Eleven public universities distributed across the state form the State University System of Florida (SUS) and currently serve more than 300,000 students. These institutions are: Florida Agricultural and Mechanical University (FAMU), located in Tallahassee; Florida Atlantic University (FAU), located in Boca Raton; Florida Gulf Coast University (FGCU), located in Fort Myers; Florida International University (FIU), located in Miami; Florida State University (FSU), located in Tallahassee, New College of Florida (NCF), an autonomous honors college located in Sarasota; University of Central Florida (UCF), located in Orlando; University of Florida (UF), located in Gainesville; University of North Florida (UNF), located in Jacksonville; University of South Florida (USF), located in Tampa; and University of West Florida (UWF), located in Pensacola. The SUS is under the administration of the Florida Board of Governors. The higher education system in Florida is integrated by SUS and the Florida College System. This white paper presents an overview of the ongoing educational efforts related to climate change conducted within the SUS. In addition to these institutions, it was decided to include the efforts of the University of Miami (UM), which is a key player in the formation of human resources with strong foundations in the physical sciences connected to climate change.

Climate change education in Florida is not limited to higher education institutions that teach enrolled students. Multiple groups and audiences have a concern regarding the offering, accessibility, and scope of programs in this area. Among the key stakeholders interested in education on climate change, we found researchers from diverse disciplines in various state and regional agencies, the private sector, NGOs, policy-makers, and the general public.

Data Collection Methods

A systematic statewide effort was implemented to compile and classify a comprehensive list of climate change educational opportunities that are available through the SUS. This process began at the State University System Climate Change Task Force Workshop held in Boca Raton, FL on March 18, 2011. During that event, participants in the *Education and Training* break-out session completed a questionnaire asking what climate

change-related courses were offered at their universities (see Figure 2 and Appendix E). This initial list was later expanded using the procedure described below.

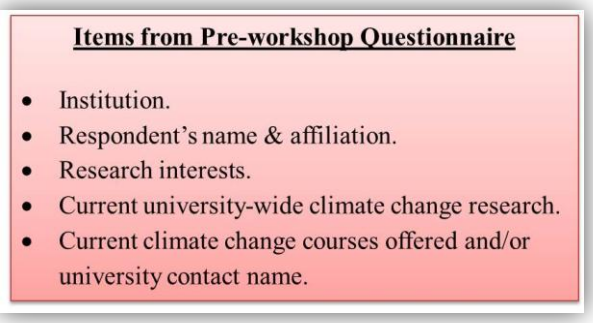

Figure 2: Items included in the pre-workshop questionnaire at the 1st Climate Change Task Force Workshop in Boca Raton, Fl. March 18, 2011.

Course Identification

Three steps were followed to standardize the process of collecting information regarding the climate change courses available within the SUS. These steps were: 1) Identify the courses available at each institution that contain climate change content, 2) Review and classify the identified courses, and 3) Organize and integrate the information. Each of these steps is described below.

Two main strategies were employed to identify the climate change education courses offered within the SUS; these strategies were sometimes modified and adapted to the particular conditions of the institution for which we were seeking to identify courses (e.g. available manpower, level of difficulty associated with searching the course catalog(s), etc.). The following key words were used for both strategies: *Atmospheric Dynamics, Bio-fuel, Climate Change, Climate Impacts, Climate Science, Climate Variability, Climatology, Environmental Chemistry, Environmental Sustainability, Geophysical, Global Environmental Change, Global Environmental Problems, Green Consciousness, Greenhouse Gases, Meteorology, Sea Level Rise, Sustainable Development, Urban Sustainability, Water Management Issues, Weather Analysis, Weather Forecasting, and Weathercasting*. This list of key words may need to be revised for future efforts to include other relevant words such as *Adaptation* and *Mitigation*.

In Strategy A, a search was performed on the course catalog(s) of the Universities to identify courses using the aforementioned key words. A list including the courses' names and instructors' contact information was made with the results from the search. The identified instructors were then contacted via email requesting them to submit the syllabi for their courses (see Appendix I). Strategy B consisted of gaining access to the All-Faculty (or equivalent) email lists of the universities for which we were seeking to identify the available courses. This was achieved through a contact person within each institution. An email was then sent to faculty in this list explaining the goal of our project, and asking them to submit syllabi for those courses with climate change content (see Appendix II). A second email was sent a week later, to thank those faculty members who had replied, and to encourage those who had not sent the requested information to do so (see Appendix III).

The collected course information was reviewed and classified using predefined criteria based on the course focus and its relationship to climate change. Because course syllabi were not always available, attempts were made to contact faculty or department chairs to at least gain feedback regarding the level of involvement of climate change information in the courses. Courses were assigned to one of four categories using primarily the criteria presented in Figure 3 as a guideline; alternatively, the feedback provided by instructors was used to assign a given course to one of the four categories. Level 4 courses were not evaluated for all the universities. The strategies used are indicated with each university description.

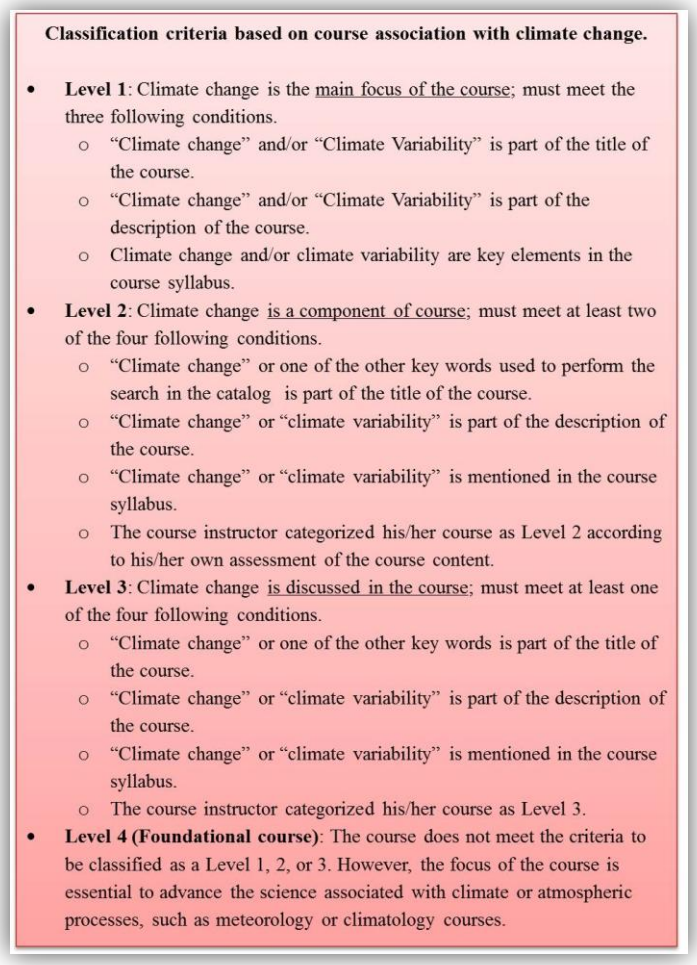

Figure 3: Suggested criteria to classify the identified courses based on their relationship to climate change.

Courses were further organized into groups, depending on the branch of science in which their general disciplines were rooted. For example, all the courses from disciplines such as meteorology, engineering, geology, physics, chemistry, and geography were grouped under the umbrella of Earth and Physical Sciences; this group combines those diverse disciplines organized as physical sciences and Earth/space sciences in the 1996 National Science Standards. The courses in other natural sciences' disciplines such as biology, ecology, medicine, and agriculture (with the exception of engineering) were assembled in the Life Sciences category. The Social Sciences included courses from disciplines such as education, sociology, anthropology, business, law, etc. Courses in disciplines such as religion, history, and philosophy were grouped within the Humanities. Finally, courses from interdisciplinary programs were classified as Interdisciplinary. It is important to mention that even though a few institutions have established programs in Interdisciplinary Studies, the allocation of courses to the Interdisciplinary group was mainly based on the course description and not on its prefix.

Identifying Other Educational Initiatives

In addition to implementing the strategies previously described to identify and organize climate change related courses, team members were assigned different tasks to detect other educational programs, research centers, and initiatives related with climate change education. These programs and initiatives were identified primarily through both informal interviews with key informants and archival research (Holstein and Gubrium, 2003; McCulloch, 2004). For example, information about a given program was provided by a stakeholder in that program, or collected directly from the program's website or other publications.

An attempt was also made to identify all science education faculty who are involved in teaching climate-related courses in the SUS and the University of Miami. We found 31 such faculty in the SUS, including three at UM. Emails were sent to all 31 on July 7 informing them of a planned Showcase and Symposium organized by the Coastal Areas Climate Change Education Partnership (CACCE), and asking them if they are involved in any climate change efforts, including any university or professional development courses. Fourteen responded to that email. A second email was sent on August 9 to all those who had not yet replied; an additional response was received in response to that second request.

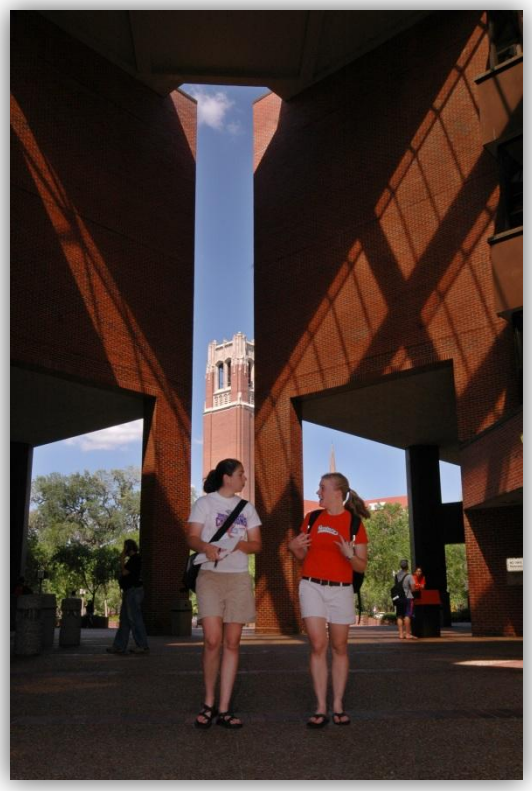

Figure 4: Students walking outside of UF's Marston Science Library. Courtesy of UF/IFAS.

Data Analysis Methods

Once classified, the course information was entered into a database to prepare it for analysis. The analysis consisted in describing the courses grouped by institution, level of relationship of their content with climate change (i.e. Level 1 – 4), and branch of science where they belonged. The content of the syllabi obtained from faculty was further analyzed to identify how the course was delivered, the teaching strategies employed by faculty (e.g. lecture, discussion, debate, etc.), and other characteristics of the courses. Data obtained from other sources (i.e. websites, informal interviews, and artifacts) were classified and analyzed in a similar manner.

The authors organized bi-weekly conference calls to discuss the advances made in data collection and analysis. Analytical decisions were discussed and approved by the group of authors, either during conference calls or through the revision of different drafts of the document.

SECTION 3: CLIMATE CHANGE EDUCATION CURRENTLY OFFERED IN THE SUS

"The principal goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done."

Jean Piaget (1896-1980)

Formal Education

The educational process that encompasses from primary school up to university and graduate/professional training is called formal education. This type of education is long-term and general in scope, characterized for taking place in a school or training institution where learners are usually full-time students.

Graduate and Undergraduate Programs and Courses (Organized by University)

Courses related to climate change vary widely within and between universities. Each university often has unique structuring of colleges and departments, making it difficult to compare similar programs. For this reason, it was decided to organize our analysis and synthesis of information beyond the disciplinary boundaries imposed by colleges and departments. Once the courses were categorized based on their level of association with climate change, we grouped them by the branch of science (e.g. physical sciences, life sciences, social sciences, and humanities). Despite these differences, one commonality that emerged relates to the course prefixes that tend to have a climate change component. A few of the most common of these are BSC (Biological Sciences), GEO (Geography), GLY (Geology), EVR (Environmental Sciences), and OCE (Oceanography). A brief description of course offerings by branch of science and level of relation with climate change for each university is presented below. Most of the courses described below highlight climate change and related societal responses with Florida, however, many of them include elements that extend the scholarship to national and international levels. Table 1 presents a summary of the educational offer related with climate change by institution.

Florida Agricultural and Mechanical University (FAMU)

Florida Agricultural and Mechanical University (FAMU), which is an 1890 land-grant institution serving nearly 12,000 students, offers eight courses containing climate change content. Two of these courses are designed for undergraduate students, and the rest are offered at the graduate level. Focused on topics such as nonpoint source pollution, conservation biology, and soil and the environment, all of these courses are grounded in the life sciences. Students in these courses learn about the relationships between soil fertility and

conservation, as well as the key role of climate in pollutant transport. With the exception of the undergraduate course Nonpoint Pollution which was categorized as Level 2 (CC is a component of the course), the remaining courses were categorized as Level 3 (CC is discussed in the course). Strategy B was used to identify FAMU's courses.

Figure 5: Campus of the Florida Agricultural and Mechanical University. Courtesy of FAMU.

Florida Atlantic University (FAU)

Serving 28,000 students, Florida Atlantic University (FAU) has 67 courses that relate to climate change. In general, 38 of the 67 courses are for undergraduates, and 29 are offered to graduate students. FAU courses span over seven colleges and are grounded in the Earth and physical, social, and life sciences, as seen in Table 1. Undergraduate courses are available in the colleges of Arts and Letters, Education, Engineering and Computer Science, Business, Science and Design and Social Inquiry, which includes urban planning. With the exception of the College of Arts and Letters, there is at least one graduate course in each of the remaining colleges plus courses offered concurrently (either undergraduate or graduate credit available) that include issues related to climate change. Concurrent courses generally require graduate students to perform additional assignments and more in-depth study than undergraduates.

Faculty at FAU teach 40 courses within the Earth and physical sciences, and most of these courses are categorized as Level 2 or 3. However, there are two graduate courses that are Level 1, focusing on global environmental change and coastal hazards. The Geosciences Department within the College of Science offers the largest share of the courses (24), from fundamental basic climate coursework to in-depth graduate courses. Twelve courses are offered in the College of Engineering and Computer Science, such as Sustainability Leadership for Engineers, Stormwater Modeling, and Dynamic Hydrology. Oceanography courses at FAU, such as Marine Global Change (a Level 1 course), are split between the College of Science and the College of Engineering and Computer Science for the Ocean Engineering program.

Issues related to climate change are included in a wide range of courses at FAU; for example, the Liberal Arts program raises awareness on the topic through a Green Consciousness course. A total of 15 courses are taught within the social sciences, including three Level 1 courses focusing on climate change education, global environmental politics, and the connections among climate, disaster, and society. The education courses would be useful for basic climate science, where pre-service teaching students learn to demonstrate melting ice and sea level rise processes. The social dimensions of climate change and sustainability can be further explored through eight Level 2 courses addressing issues such as the need for sustainable design concepts that factor in new technologies and relate to local climatic conditions in urban planning and architecture, the leadership of conservation, or global environmental management including policy and economic implications. The remaining courses within the social sciences are Level 3, focusing on water resources, ecosystem management, and environmental planning. Another four courses containing climate change concepts can be found in the life sciences, including marine biology, discussing relevant topics such as the connections between climate, ecosystems and health. In additional, six interdisciplinary studies delve into related topics across multiple programs, focusing on the interactions among climate, technology, and society. Overall, there is a very broad spectrum of coursework at FAU that includes issues related to climate change, sustainability and global systems. Strategy A was used to evaluate FAU coursework and many syllabi were received. Level 4 courses were not evaluated at FAU and were not included in course totals.

Figure 6: Campus of the Florida Atlantic University. Courtesy of FAU.

Florida Gulf Coast University (FGCU)

Serving over 12,000 students in Southwest Florida, Florida Gulf Coast University (FGCU) offers 33 courses that address climate change concepts. Three are graduate level courses in the social sciences, including Environmental Policy and Environmental Law. Two courses, Paleoclimatology (Level 1) and Biogeochemistry (Level 2) in the Earth and physical sciences are offered for both graduate and undergraduate study. The remaining 26 undergraduate courses are a mix of physical, social, and life sciences and interdisciplinary

studies. Several of these courses are available for students enrolled in the Climate Change Minor that is housed in the Department of Marine and Ecological Sciences at the College of Arts and Sciences. Six of these undergraduate courses are grounded on the Earth and physical sciences (Levels 1 through 3), covering subject matters such as basic geology, meteorology, and climatology, and expand into Environmental Chemistry and Sustainability in Engineering. Four courses that include climate change concepts in the life sciences teach students about environmental science, biogeography, marine and wetland ecology (Levels 2 and 3). Courses in the social sciences cover a wide spectrum from environmental policy to future conservation strategies (Levels 2 and 3). FGCU also has an interesting series of courses in environmental science and interdisciplinary studies that relate to the environmental history of different continental regions, such as sub-Saharan Africa, North America, Asia and the Caribbean. These Level 2 courses include a climate change component and study of human effects on the environment. Strategy A was used to identify courses at FGCU.

Florida International University (FIU)

In Miami, students at Florida International University (FIU) can enroll in four different academic programs with content on climate change and coastal impacts. These degree programs are BS, MS, and Ph.D. in Geosciences, and B.S. in Marine Biology. Twenty courses containing climate change content that cover a variety of topics at graduate and undergraduate levels are available to students in these programs. Most of these courses are connected with the Earth and physical sciences where a total of 11 courses are offered that are aimed at preparing students in areas such as climatology, geology, and hurricane meteorology. The level of integration of climate change concepts into these courses is variable. For example, an undergraduate Level 1 course on Earth's climate and global change promotes students' understanding of the interactions of Earth's crust, atmosphere, biosphere, and oceans effects on climate, while a Level 3 graduate course explains the formation, motion, and impacts of hurricanes. Four of the courses in the physical sciences are Level 4, most of them offered at the graduate level. FIU also offers seven courses in the life sciences dealing with ecology, coastal resource management, and integrated water resources management; five of these courses are Level 2. The academic offerings of this institution related to climate change also includes two undergraduate Level 1 courses; one has an interdisciplinary approach to the study of global climate change exploring the connections between science, society, and potential solutions, while the other is nested in the social science disciplines introducing students to policies governing climate change mitigation. FIU serves 46,000 students. A modified Strategy A was used to evaluate FIU coursework, in which key departments were contacted to gather course information.

Florida State University (FSU)

Figure 7: Campus of Florida State University. Courtesy of FSU.

The Florida State University (FSU) serves nearly 40,000 students and has 99 courses with some level of course material on climate change, covering topics as diverse as dynamic climatology, landscape ecology, and environmental conflict. Almost 60% of these courses are offered at the graduate level; however, some courses are open for both graduate and undergraduate students. Disciplines in the Earth and physical sciences house 49 of these related courses. The majority of these (31) are Level 4 courses that provide students with foundations in sciences, such as physics, geology, climatology, and meteorology, which are necessary to understand the underlying physical principles of climate change. Students become engaged in discussions of current ground-breaking research, environmental problems, and approaches to solving them, including the use of explanatory and predictive models of the earth's systems and environmental processes therein. Content in these courses also covers such areas as climate modeling, physical climatology, dynamic climatology, climate change, plus climate and the oceans. Five courses in the Earth and physical sciences can be categorized as Level 1 because they have a strong focus on climate change. These courses are mainly for graduate students and deal with the Earth system, the global climate system, paleoceanography, and climate science.

Faculty members in the social sciences at FSU also incorporate climate change concepts into their courses. A total of 33 courses are offered within these disciplines exploring how the phenomenon of climate change is occurring in today's world and how this change is experienced by individuals and societies around the world. Again, most social science courses (20) are Level 4, providing students with the required elements to understand the scientific and human dimensions of global environmental change and its implications for international public policy. A graduate seminar in climate change and an undergraduate course exploring the relationship between global-scale processes and local-scale experiences are two Level 1 courses offered in the social sciences. The seminar includes an overview of the causes and effects of global climate change and some of the methods available to mitigate and/or adapt to it. The rest of the courses in this group are mostly Level 3, with just two Level 2 courses, aiming to cultivate literacy in the principles of environmental science through course content on ecosystem management, environmental law, and sustainable development. Four Level 3 courses connected with the life sciences, particularly ecology and environmental science, and seven interdisciplinary courses complete the educational offerings of FSU related to climate change. Three of the interdisciplinary courses are Level 1 dealing

directly with global environmental change, global warming, and strategies for planning and mitigating the effects of climate change; two of these courses are available for both graduate and undergraduate students. The interdisciplinary courses are connected to geography, urban planning, ecology, and international studies; three Level 1 interdisciplinary courses are offered by faculty from the Department of Earth, Ocean, and Atmospheric Sciences. Strategy B was used to evaluate FSU courses.

New College of Florida (NCF)

New College of Florida (NCF) offers courses in two of their three undergraduate divisions: Division of Natural Sciences and Division of Social Sciences. Five courses are offered in each division, for a total of ten courses that relate to climate change, sustainability and related issues. Within the life sciences, NCF has one interdisciplinary Level 1 course looking at relationships between climate, ecosystems and society, three Level 2 courses dealing with issues in ecology and conservation, and one Level 3 course on environmental studies. In the social sciences, there is one Level 1 course focusing on the sociology of sustainable communities, two Level 2 courses concerned with policy–making, economy and environmental governance, and two Level 3 courses on cultural anthropology and urban sociology. The 800 students at NCF have the opportunity to learn not only about the many facets of climate and how ecosystems and society interact with these phenomena, but also of being exposed to a thought-provoking critique of contemporary environmentalism and current ideas about sustainability from a sociological perspective. Due to their unique system of course naming, the course names and course descriptions are better guides than the course numbers. There is no prefix. Courses that begin with the number "2" are taught in the spring and those that begin with "8" are taught in the fall, as shown in Appendix IV. NCF does not offer graduate level courses. Strategy A was the tool used to evaluate courses at NCF.

University of Central Florida (UCF)

Serving more than 50,000 students, the University of Central Florida (UCF) offers 29 courses that relate to climate change through its colleges of Biological Sciences, Engineering and Computer Science, Physical Science and Social Science. Four courses are graduate level, 23 are undergraduate and one is available to both (Environmental Philosophy). Unlike many other universities, the majority of these courses are in the social sciences (16), followed by 6 in the physical sciences. Level 2 undergraduate courses in the social sciences engage students on such issues that relate to environmental law and global environmental politics. Level 3 graduate and undergraduate courses cover a broad spectrum of study in natural resource economics, global political issues, urban and land use planning, environmental policy and ethics, and sustainability. A Level 1 course in the Earth and physical sciences aims to increase students' awareness of the potential impacts of climate change on hydrology and water resources systems; and Level 2 courses within these disciplines delve into studies in environmental chemistry and the earth's climate. Through a Level 1 course in the life

sciences, undergraduate students can increase their knowledge of current challenges that relate humanity with global environmental change. In three Level 3 courses in the life sciences, undergraduate students can learn about biogeochemical cycling of ecosystems, environmental factor interactions, and population dynamics, while graduate students address ecological questions in a course on landscape ecology. A modified Strategy A was used to evaluate UCF coursework, in which courses were evaluated almost solely from key word searches on course titles or descriptions from the course catalog. Level 4 courses were not evaluated.

University of Florida (UF)

The University of Florida (UF), an 1862 land-grant institution serving more than 51,000 students, is the oldest university in the state. UF teaches 74 courses that contain climate change content through its multiple colleges and degree programs. Most of these courses (41) are offered at the undergraduate level, but some courses accept both graduate and undergraduate students. Many of these courses are taught by faculty in the Earth and physical science disciplines. A total of 41 courses are offered through academic departments such as geological sciences, physics, and geography. Sixteen of these courses provide students with the basic notions to understand the science connected to climate change in areas such as climatology, hydrology, meteorology, weather and forecasting, oceanography, and water management engineering; these courses were categorized as Level 4. Another 16 courses in the Earth and physical sciences are categorized as Level 3 because they integrate concepts of climate change in the discussion of the different topics that are the foci of their study (e.g. earth science, energy and environment, sustainability, and green engineering design). There are six Level 2 courses, five of which are offered through the Department of Geography, through which students can learn about paleoclimatology, extreme weather, and environmental geology. The Department of Geological Sciences offers two Level 1 courses that explore the role of oceans in determining and regulating global climate, and the past, present and future of global climate change.

Figure 8: University of Florida's main entrance. Courtesy of UF/IFAS.

UF also has 14 courses with climate change content in the life sciences. Two of these are Level 1 courses that help undergraduate students understand key issues in sustainability and global environmental change from an ecological perspective; one focuses on case studies in climate change ecology and the other one on global change, ecology and sustainability. Three Level 2 courses focusing on ecology and advanced biogeochemistry enhance students' awareness of the relationship between climate change and global elemental cycles in terrestrial, wetland, and aquatic systems. The list of courses offered in disciplines within the life sciences is completed with nine Level 3 courses covering diverse topics such as wastewater microbiology, agricultural meteorology, and sustainable agriculture systems analysis.

In the social sciences, 10 courses are taught on human-environment relationships in connection with the conservation of resources and humankind's footprint on the landscape. Additionally, six climate-related courses exist within the humanities at UF. These Level 2 and Level 3 courses focus on exploring the connections among religion, ethics, nature, society, and sustainable agriculture. Finally, three interdisciplinary courses looking at the interactions among environment, food, and society, the connections between environmental science and humanity, and the fundamentals of environmental biogeography. Students in these courses learn about the relationships among technology, industrialization, the earth's resources, and the resultant effects on environmental quality by exploring global issues and trends in population growth, natural resource utilization, climate change and potential impacts of current trends on agriculture, natural resources, global food security and sustainability. A modified Strategy A was used to evaluate UF coursework.

University of Miami (UM)

The University of Miami (UM), serving more than 15,000 students, has 20 undergraduate and 26 graduate level courses with climate change content, for a total of 46 courses. Twenty four of the graduate level courses are part of their Master of Professional Science degree offered through the Rosenstiel School of Marine and Atmospheric Science. This program emphasizes the relationships among weather, climate, and societal impact with a strong focus on the roles of physical sciences in this relationship. Twenty three of the courses in this program are taught in disciplines such as oceanography, physical meteorology, climate dynamics, and large-scale ocean circulation. The majority of courses in this program are categorized as either Level 4 or Level 3, with just a couple of Level 2 courses. The undergraduate courses and the remaining graduate classes are part of the curricula in the colleges of Art & Sciences, Architecture, and Engineering. Among these, it is possible to find Introduction to the Earth's Ecosystem, Architecture and the Environment, Remote System and the Environment, etc. Strategy A was used to evaluate coursework at UM.

University of North Florida (UNF)

The University of North Florida (UNF) offers 37 courses with climate change course material to its more than 16,000 students. In addition to the 25 undergraduate and 10 graduate courses, two educational experiences are available for both graduate and undergraduate students. Students can study a broad range of environmental issues in the 12 climate-related courses offered within the life sciences. UNF's ecologically oriented and environmental classes, such as environmental physiology and marine biology, are Level 2 or 3, devoting a lecture or part of a lecture to global climate patterns, including modern concepts for the understanding of complex environmental issues and the interactions between human behavior and the natural environment. Another five courses with climate change content are offered within social sciences disciplines such as history, sociology, philosophy, and international studies, including environmental ethics, ecological philosophy, and social change and development. Most of these courses are Level 2, taking a sociological approach to the study of environmental problems from a global perspective, and exploring the conceptual foundations of the ways we relate to our environment and the social justice issues affecting this relationship. Thirteen undergraduate courses in the physical sciences are available to UNF's students. Unique to UNF is the Construction Management Department, which offers three Level 2 courses on green construction practices, sustainability and alternative energy practices. The Engineering Department is expanding to include a course on clean renewable energy, and has two related courses in development: Climate Cycles and Engineering Challenges, and Disasters, Causes and Issues. More civil engineering courses are planned, beginning in Spring 2012. The remaining courses in the physical sciences are categorized as Level 2 or 3; they teach students about the physical, chemical, and biological aspects of the ocean, including the role of the ocean in the global system. UNF also has one interdisciplinary course connecting the life, social, and physical science disciplines through a series of lectures on globalization and environmental degradation. Strategy A was used to evaluate UNF.

University of South Florida (USF)

The University of South Florida (USF) serves more than 46,000 students and offers eight graduate and 16 undergraduate courses related to climate change. The bulk of these courses is taught within Earth and physical sciences disciplines and consists of nine courses. Two of these are graduate courses teaching students the scientific principles underlying today's global environmental problems and their potential solutions through educational experiences in subjects such as earth systems science, energy and humanity, greenhouse-icehouse earth, and climatology. Among these disciplines, there are three Level 1 courses totally focused on climate change to provide USF's students with an understanding of the mechanisms causing the changes in climate and the human impacts on climate. Two Level 2 and one Level 3 courses, addressing the greenhouse effect and how human activities purportedly affect the global climate, aim to identify the differences between green and

icehouse climates. The remaining three courses in the physical sciences are Level 4 focused on guiding the application of basic earth system science analysis to environmental problems.

Figure 9: Marshall Student Center at the University of South Florida. Courtesy of USF.

Connecting the physical and social disciplines, USF had six Level 2 interdisciplinary courses emerging primarily from geography, environmental engineering, and environmental science and policy. Courses in these disciplines help students develop and practice skills related to global sustainability, broaden their knowledge and understanding of global determinants. Also, potential solutions to sustainability issues can be identified through the integration of issues related to science, policy and management in making decisions related to sustainability. To explore the effects of environmental factors on health and access to health care, undergraduate students have access to four courses within the life sciences dealing with these issues. Two of these are Level 2 courses related with human behavior and the environment, where students can learn the principles of behavior analysis applied to global environmental and social issues. The other two courses are Level 3 and place the foundations of public health in a global context to understand how environmental changes impact personal and global health and nutrition. Finally, three courses within the social sciences explore the societal impacts of weather as well as the human impact on weather and climate, examining global problems of economic growth and development, geopolitical relations among nations and states, food supply and hunger, and environmental change. Many of the courses identified at USF are part of the programs organized under the Patel School of Global Sustainability, a program based on integrated interdisciplinary research, scholarship and teaching. USF courses were evaluated using Strategy A.

University of West Florida (UWF)

The University of West Florida (UWF) offers 17 undergraduate and four graduate courses related with climate change for its almost 12,000 students. Most of these students are housed in the Department of Environmental Studies, which is grouped with the other science departments under the College of Arts and Sciences. Within this college are 14 courses in the physical sciences such as geography, environmental geology, climate, oceanography, coastal processes, and environmental science. Half of these courses are Level 2, where students learn about natural disasters, coastal and marine environments, basic hydrology, and physical geography. Global climate change is explored in a Level 1 undergraduate course in which students study the connections between oceans and the atmosphere. Within the Department of Environmental Studies is the Center for Environmental Diagnostics and Bioremediation.

This center places a fundamental emphasis on modern biological research as applied to environmental systems, providing research and training opportunities to graduate and undergraduate students, including activities to enrich science education at the K-12 levels. Students at UWF can also learn about climate change from a social science perspective through two Level 3 courses focusing on conservation of natural resources and the current local, state and federal laws relating to the environment. The marine biology and biological oceanography courses in the Biology Department also discuss climate change in relation to these subjects. These two undergraduate courses were categorized as Level 3. Courses at UWF were evaluated using Strategy A.

University-Based K-12 Education Programs

A number of academic units and institutions are engaged in science education programs for secondary science teachers who are teaching K-12 students. A total of 31 faculty members connected with science education programs were identified within the SUS and UM. The involved academic units and institutions are: a) Department of Secondary Education and Foundations (FAMU), b) Teaching and Learning (FAU), c) College of Education (FGCU), d) Department of Teaching and Learning Science Education (FSU), e) School of Teacher Education (FSU), f) College of Education Science Education Program (UCF), g) School of Teaching and Learning Science and Environmental Program (UF), h) Department of Teaching and Learning Area: Mathematics/Science Education (UM), i) Secondary Education and Foundations (UNF), j) Department of Secondary Education Science Education (USF), and k) School of Education/ Science Education (UWF).

After repeated contacts with faculty at each of the previously listed academic units, it was possible to identify that a group of instructors at four of these institutions (i.e. FAU, FIU, UF, and USF) incorporated concepts of climate change in their courses. These courses are Perspectives on Environmental Education (FAU), Special Topics: Global Climate Change Education (FAU), Global Studies Methods in Science (UF), Teaching Secondary School Physical & Earth Science (USF), Teaching Secondary School Biology (USF), and Communication Skills in the Science Classroom/Reading and Communication in Science Education (USF). These courses prepare secondary science teachers to teach literacy practices in science, enhancing their understanding of the physical and earth sciences commonly found in school curricula. Additionally, in the required research methods class at the FSU-Teach program (http://fsu-teach.fsu.edu/); FSU's adoption of the UTeach program from University of Texas (http://uteach.utexas.edu/), a typical inquiry problem that students have to work on is the science behind climate change (regardless of their particular teaching specialty).

Three of the science educators reported that they address climate change issues in their courses on methods for teaching physical science at the elementary and secondary levels.

Other courses, like the Global Studies Methods in Science taught at UF, address climate change issues as a key element in their curricula. Another instructor mentioned that the possibility of addressing climate change issues as part of a graduate certificate program in informal science education has been previously discussed. FAU and USF have three funded projects related with climate change education. These projects are:

Figure 10: College of Education at the University of South Florida. Courtesy of USF.

- Florida Atlantic University's Global Climate Change Education Grant (GCCE), *Using NASA Data to Improve Young Adults' Climate and Science Literacy* aims to improve students' understanding of climate science and strengthen their scientific inquiry skills, which will be useful to them in STEM-related careers and as global citizens. This two-year project (January 2011-2013) will develop a series of teaching modules that use NASA satellite and remote sensing data, climate models, and simulations to help young adults (high school and first-year undergraduate students) investigate the fundamentals of global climate change (GCC) and address the public's questions and commonly held misconceptions about GCC. The project also includes professional development activities for regional science teachers.
- Advancing Student Knowledge (ASK) is a project of the University of South Florida Coalition for Science Literacy (CSL) and The Florida State University Center for Ocean-Atmospheric Prediction Studies (COAPS). This three-year initiative is also funded by NASA's program on Global Climate Change Education (GCCE). The overall goals of this project are to: increase teacher content knowledge in global climate change, provide pedagogical training to enable teachers to stimulate student interest in learning about climate change, enable teachers to identify and practice using resources available through NASA and elsewhere to incorporate global climate change education in the classroom, and stimulate interest in climate change topics for teachers and students by including local and regional topics.
- USF's Coastal Areas Climate Change Education Partnership (CACCE; http:/cacce.net) is one of fifteen projects funded in 2010 by the National Science Foundation (NSF) as part of their Climate Change Education Partnership (CCEP) program. The CACCE Partnership is led by The University of South Florida (USF), the Florida Aquarium in Tampa, the Hillsborough County Public Schools (HCPS), and the University of Puerto Rico at Mayaguez (UPRM). This initiative will develop a comprehensive educational plan specific to the coastal areas of Florida and the Caribbean to improve climate change literacy, and competency in managing its impacts. Through its website, the

CACCE partnership grants educators, students, and professionals access to valuable information on climate change education; the information contained in their website was particularly useful to inform the development of this document.

Through the GLOBE program (http://www.globe.gov/), FSU has trained over 200 teachers in Florida over the past 10 years and also developed science protocols for the international program. GLOBE's latest effort, which is now underway and active internationally, is the Student Climate Change Campaign. FSU is still a data collection site (1998-present), but their training activities only ran from 2001-2010.

Last year FSU was invited to join the Earth System Science Education Alliance (ESSEA; http://essea.strategies.org/). ESSEA is a 10+ year-old consortium of college and university partners who prepare teachers from an earth systems perspective. FSU has now infused much of what they do in teacher training and preparation using ESSEA strategies and ESSEA modules. Their courses include the following, each of which will have been offered once during the life of the two-year commitment (through summer 2012): SCE 4835C - Teaching Earth and Space Science (Preservice), SCE 5836C - Teaching Earth and Space Science (Inservice), ESC 5211 - Earth System Science Education Alliance , and ESC 5215 - Geoscience Visualization.

Figure 11: Emerson Alumni Hall at the University of Florida. The 2nd Climate Change Task Force Workshop was held at this building on November 14-15, 2011. Courtesy of UF/IFAS

Table 1. Graduate (G) and undergraduate (U) courses offered by institution, organized by level of climate change content and branch of science.

Institution (courses)	Climate Change Course Content	Earth & Physical Sciences	Life Sciences	Social Sciences	Humanities	Interdisciplinary
FAMU (8)	Level 2		1U			
	Level 3		2G, 5U			
FAU (67)	Level 1	2G	2G	3G		
	Level 2	8G, 11U		4G, 4U	2U	2U
	Level 3	8G, 11 U	1G, 1U	1G, 3U		2G, 2U
FGCU (34)	Level 1	1 U		1U	1 G	2U
	Level 2	1 G, 6 U	2 U	2 G, 2 U		4 U
	Level 3	1 U	2 U	1G, 3 U		1 U
	Level 4			1U	1U	
FIU (20)	Level 1	1U		1U		1U
	Level 2		2G, 3U			
	Level 3	1G, 2U	1U			
	Level 4	3G, 4U	1U			
FSU (93)	Level 1	4G, 1U		1G, 1U		2G, 1U
	Level 2	4G, 4U		2G		1U
	Level 3	1G, 4U	3G, 2U	9G		1U
	Level 4	18G, 16U		11G, 11U		1G, 1U
NCF (10)	Level 1		1U	1U		
	Level 2		3U	2U		
	Level 3		1U	2U		
UCF (29)	Level 1	1G	1U			
	Level 2	2 U		3 U		
	Level 3	3 U	1G, 2U	2 G, 11 U	1 G	1 U
UF (74)	Level 1	1G, 1U	1G, 1U			
	Level 2	3G, 3U	2G, 1U	3G, 1U	2U	2U
	Level 3	4G, 14U	4G, 3U	5G, 1U	4U	1U
	Level 4	10G, 6U				
UM (46)	Level 2	2G, 4U		1G, 1U		7U
	Level 3	7G, 1U	1G	1G, 7U		
	Level 4	14G				
UNF (39)	Level 2	8U, 2G	5U	1U, 2 G	2U, 1G	
	Level 3	5U	1U, 5G	2U	2U	
USF (22)	Level 1	1G, 3U				
	Level 2	1G, 1U	2U	1G		4G, 2U
	Level 3	1U	2U	2U		
	Level 4	3U				
UWF (19)	Level 1	1U				
	Level 2	1G, 7U				
	Level 3	1G, 5U	2U			

Non-Formal Education

Any type of educational activity or program organized outside of the established system of formal education can be considered non-formal education. These are usually short-term programs targeted to address relevant needs of the learners. The U.S. Cooperative Extension Service is the largest non-formal educational system in the world.

Cooperative Extension Programs

The two land-grant institutions in the state, UF and FAMU, work together administering the Florida Cooperative Extension Service. Through the land-grant institutions, Extension is a partnership between state, federal, and county governments to provide research-based information to the general public with the purpose of empowering these audiences to solve their immediate problems. The Extension administration is housed at the University of Florida in the Institute of Food and Agricultural Sciences; it is commonly referred to as UF/IFAS Extension.

Through the work of thousands of faculty members, scientists, educators, administrators, and volunteers, Extension develops and implements educational programming required for achieving its institutional goals. One of Extension's goals is focused on Florida's Environment and contains an interdisciplinary Focus Area 5 dealing with *Climate Variability and Change*. This Focus Area aims to develop, validate, and disseminate, a variety of tools, tactics, and strategies effective for adapting to climate change variability and change. It provides in-service training to Extension faculty located at each of the local county offices in the state. The trained Extension faculty members incorporate their new tools, knowledge, and skills into their current and future community-based programs. For example, Extension agents may use seasonal climate forecasting to determine the type of program that would benefit their audiences, and the best time to offer it. In other words, they may look at climate normal information, translate that information into variables relevant for agriculture, and identify the implications for Extension's programming.

State and county faculty connected with Focus Area 5 also identify climate related concerns and connect these concerns with appropriate practices, technologies, or information. The development of effective solutions to respond to climate change and variability require the engagement of stakeholders, research and education institutions, policy makers, and governmental agencies. Focus Area 5 was created to provide these diverse stakeholders with trusted, useful, science-based information to aid them in making informed decisions. In this context, the Southeast Climate Consortium has developed a successful climate extension program focused on assisting producers to mitigate climate-associated risks and adapt to seasonal climate variability. A year ago, the leadership of Focus Area 5 received funding from USDA/NIFA to expand these extension efforts to address longer-term climate change.

Their purpose is to: 1) increase the climate literacy of Extension faculty and stakeholders including youth, 2) develop educational materials including regional handbooks on promising mitigation and adaptation strategies and interactive online modules, 3) use participatory approaches to promote effective engagement of stakeholders, including limited resource producers on the processes of developing adaptation and mitigation strategies, 4) review methodologies to estimate and reduce carbon, water, and nitrogen footprints, 5) map typical footprints of corn and wheat production systems in the southeastern USA, 6) develop web-based footprint calculators for producer use on the climate risk management information system, www.AgroClimate.org, and 7) communicate research needs and knowledge gaps to the research community.

UF also houses Florida Sea Grant Extension. The Florida Sea Grant College (FSG; http://www.flseagrant.org/) at the University of Florida is actively engaged in supporting research, extension and education programming related to climate change impacts and adaptations on Florida's coastal communities, economies and marine environments. FSG coordinates climate change programming activities with local governments and with state and federal agencies by drawing upon its statewide network of marine extension agents and specialists, and by acting as a conduit for expertise sourced throughout Florida's public university system and marine research laboratories. This programming is guided by a new strategic plan for 2009-2013 in which climate change is a primary area of focus. The plan, based on input from more than 2000 Floridians, program stakeholders, agency representatives, and academics, seeks to foster the widespread understanding of the processes of climate change and their effects on coastal ecosystems and human-built coastal communities. This plan is leading to the support and implementation of innovative strategies for adapting to change (e.g., planning protocols and policies). The Sea Grant College also works in collaboration with multiple organizations that have climate change as one of their focus areas. Some of these organizations are:

- The Florida Oceans Council and the Florida Oceans Alliance. In 2010, FSG worked with these organizations to develop user-friendly informational documents about climate change, sea level rise, and coastal and ocean opportunities planning – targeted primarily at the Florida Legislature, and together held events in the State Capitol to meet with Legislative staff on these important coastal issues.

- The Florida Fish and Wildlife Conservation Commission. In 2011, FSG entered into a partnership arrangement to hire an educational coordinator that will focus on sea-level rise issues affecting natural systems in state of Florida. This individual will be part of the FSG Climate Change Work Action Group that is developing extension and outreach programs throughout the state.

- The Gulf of Mexico Sea Grant Programs (Texas, Louisiana, Mississippi, Alabama), the NOAA Gulf of Mexico Regional Collaboration Team, and the NOAA Coastal

Services Center. In 2010 FSG led the effort to create a Climate Outreach Community of Practice (COP) to bring awareness and resources for action to coastal communities affected by climate change, in particular, by sea level rise. This partnership has included a face-to-face meeting in St. Petersburg attended by nearly 100 extension and outreach specialists from the Gulf of Mexico region. The COP also developed an interactive web site with a discussion forum and repository of documents related to outreach and education on the subject of climate change, and an ongoing process to develop tools and information tailored to the needs of particular Gulf communities.

- The Gulf of Mexico Coastal Ocean Observing System (GCOOS) Education and Outreach Council (EOC), which is an umbrella organization composed of educators from various educational institutions (universities, state aquariums, federal and state agencies) in the Gulf of Mexico that focus on ocean observing modeling and data sharing.

- The Southeast Coastal Ocean Observing Regional Association (SECOORA), which has an Educational and Outreach Committee that provides educational materials and programs that focus on ocean observing modeling and data collection.

Outreach & Continuing Education Programs

These programs have been selected because they exemplify the diverse methods for delivery of Climate Change Education and Outreach that can be utilized to reach a wide range of audiences.

The University of Miami's program, "*Empowering Capable Climate Communicators: Dr. Hal Wanless' Cooper Fellow Training Series*" seeks to provide fellows with the tools necessary to be able to educate others about the causes, severity & impacts of human-induced climate change emphasizing what must be done to stop and reverse the trend. The audience includes scientists, college students and professors, high school students and teachers, and leaders and representatives from informal science organizations, environmental groups, and the community at large.

Since 2005, Florida Atlantic University (FAU) organizes and runs the "*Scripps Howard Institute on the Environment"* (http://www.fau.edu/scrippsjournalism/), a continuing education program for Journalists that is focused on South Florida environmental content and issues including Climate Change. The target audience is professional journalists, writers, editors, and producers that feature environmental topics.

Florida Atlantic University's Center for Environmental Studies (CES) organizes and runs the "*Green Business Forum"* through a partnership with FAU's executive MBA

program. CES brings together business students, and local business executives with experts in sustainable business practices. The target audiences are business persons and students in the Executive Business Program.

The Federal Emergency Management Agency (FEMA) initiated the "*Emergency Management Higher Education Program*," which includes formal associates, undergraduate and graduate degrees, stand-alone Certifications and a variety of training courses for emergency managers across the country. An example of a course for professionals is a course titled, "Theory, Principles and Fundamentals of Hazards, Disasters, and U.S. Emergency Management: Disaster as a Growth Business". Partnering with FEMA, some universities offer certificate, training and degree programs in "*Emergency Management and Homeland Security*." The higher education institutions in Florida offering this training include: Broward College, Florida Atlantic University, Florida State University, Indian River State College, Palm Beach State College and University of Central Florida. Additionally, FEMA, the Department of Homeland Security, and Emergency Management Professionals collaborate to incorporate the relevance of climate change and its associated risks (e.g. flooding, droughts, potential storm events, etc.) as global and secondary hazards into industry management planning scenarios and training efforts (Blanchard and Wayne, 2008; Freitag, 2007). The target audience is professionals and students of emergency, disaster &/or risk management.

The Natural Resources Leadership Institute (NRLI; http://nrli.ifas.ufl.edu/) is an eight-month program at UF that was created to assist emerging leaders from different spheres of agriculture and natural resources (e.g. government, industry, NGOs, academia, etc.) in acquiring the required skills to effectively manage conflict arising from natural resources issues. The program includes seven three-day seminar and activity sessions, a practicum, and a graduation session. Fellows in this program have the opportunity to enhance their group leadership skills, communication skills, and conflict management techniques, while learning about environmental issues through tours of key natural resource sites throughout the state. NRLI's class of 2012-2013 will have a climate related theme.

Research Centers and Institutes

The Florida Climate Institute (FCI; http://floridaclimateinstitute.org/) was founded in 2010 by the University of Florida and the Florida State University, it is a multi-disciplinary network of national and international research and public organizations, scientists, and individuals concerned with achieving a better understanding of climate variability and change. Through its more than 200 affiliated members, the FCI brings together outstanding expertise from across disciplines, universities, organizations and industry to develop projects that integrate research, education, and outreach that will identify and evaluate potential societal responses to climate change and climate variability.

The Southeast Climate Consortium (SECC; http://seclimate.org/) is a multi-disciplinary, multi-institution research team that conducts research and outreach to help decision makers manage risks arising from seasonal climate variability and climate change. The SECC uses the advances in climate sciences, including improved capabilities to forecast seasonal climate and long-term climate change, to provide scientifically sound information and decision support tools for agricultural ecosystems, forests and other terrestrial ecosystems, and coastal ecosystems of the Southeastern USA. As a multidisciplinary, multi-institutional team, the SECC conducts research and outreach to a broad community of potential users and forms partnerships with extension and education organizations to ensure that SECC products are relevant and reliable. About 60 investigators participate in the SECC from eight universities in the southeast USA.

Figure 12: Dr. Eric Chassignet and Dr. James Jones, Co-Director and Director of the Florida Climate Institute. Courtesy of UF/IFAS.

Scientists at the Florida Climate Center, in collaboration with the Center for Ocean-Atmospheric Prediction Studies (COAPS) and the Southeast Climate Consortium, developed an interactive website with climate, agriculture, and forestry information. This website is called AgroClimate (www.agroclimate.org) and it helps farmers better manage their crops for maximum outcome under different climate conditions by means of crop simulation models that include historic and forecast climate data. A tab for AgroClimate Tools provides farmers with opportunities for pro-active adaptations to seasonal climate forecasts, including information for specific counties and regional overviews. http://www.agroclimate.org

The University of Florida, Florida State University, and Florida Atlantic University established the Florida Climate Change Task Force (http://floridaclimate.org/) because climate variability and change pose significant economic and environmental risks to Florida. This task force was developed to focus on: identifying current State University climate change expertise, research and curricula; enhancing cooperation with State and Federal agencies to bring science into climate change-related decision making; and developing a climate change information system and portal that will connect State University System (SUS) assets with these agencies, private industries, and other groups to facilitate communication.

The Florida Institute of Oceanography (FIO; http://fio.usf.edu/Home.aspx) was established by the State University System to support and enhance Florida's coastal marine science, oceanography and related management programs through education, research, and public outreach. The FIO facilitates the activities of educators, scientists, and agencies

responding to state, regional, national and international issues by providing centralized facilities and research vessels and coordinating an infrastructure to address the marine concerns of state and federal agencies, and the public.

The Environmental Science Institute at Florida A&M University (ESI; http://www.famu.edu/index.cfm?environmentalscience&ESIHome) was established in 1995. The ESI is a multidisciplinary unit that provides instruction, conducts research, engages in professional and community service on the local, national, and international levels, and facilitates technology transfer. The work of this institute results in protection of the environment and the development of remedies for existing environmental problems; the education of communities on environmental science and policy issues; and the scientific and intellectual preparation of students who are uniquely prepared to address present and future interdisciplinary environmental science and policy issues. There are two centers under the umbrella of the ESI. These centers are: Environmental Cooperative Science Center (http://www.ecsc.famu.edu/) and Center for Environmental Equity and Justice (http://www.famu.edu/index.cfm?environmentalscience&CEEJ).

The Florida Center for Environmental Studies (CES; http://www.ces.fau.edu/) is a state university research center that was established in 1994 and it is housed at Florida Atlantic University. Its mission is to collect, analyze, research, and promote the use of scientifically sound information concerning tropical and subtropical freshwater, estuarine and coastal ecosystems. It plays an active role in various programs related to climate change. CES Promotes and facilitates research on the natural processes of ecosystems and the human decision-making processes which affect these systems. The center also develops and coordinates environmental science and education programs that target teachers, students and the general public. A key component of CES is the Integrative Collaboration on Climate and Energy (ICCE), which is a cross-university program creating relevant linkages across disciplines and various stakeholder groups. The Center works in the broad field of the management of tropical and sub-tropical water-dominated ecosystems and in related information technology worldwide.

Within CES, the Integrative Collaborative on Climate & Energy (ICCE; http://www.ces.fau.edu/climate_change/icce) is a cross-university program creating relevant linkages across disciplines. The initiative was created in response to the realization that sea level rise and other climate changes were making South Florida one of the most vulnerable areas and that adaptive strategies were critically important. ICCE includes more than 80 faculty members in a multitude of climate change-related disciplines. Collectively, there are strong collaborative linkages with local, state and federal governmental and non-governmental organizations, the business community, and public. Other university collaborators include University of South Florida and Columbia University.

FAU also has two programs that study the health of coastal environments and the impacts of coastal pollution on key marine organisms through the Center for Marine Ecosystem Health (http://www.fau.edu/hboi/OceanHealth/index.php) housed in the Harbor Branch Oceanographic Institute. These programs are the Indian River Lagoon Research Initiative (http://www.fau.edu/hboi/OceanHealth/OHindianriverlagoonresearch.php), which focuses on the relationship of water quality in the Indian River Lagoon with seagrasses, macroalgae, and phytoplankton, and the Robertson Coral Reef Program that seeks to understand and prevent losses in coral communities that result from both natural and anthropogenic causes. Both of these programs address critical research needs with applications to major global issues affecting the health of our ocean and its future, so that scientists, students, resource managers, lawmakers, and the public can all better understand, protect, and improve the oceans, their resources, and functionality.

At Florida Gulf Coast University, the Center for Environmental and Sustainability Education (CESE; http://www.fgcu.edu/cese/) works toward a sustainable future for our planet through scholarship, education, and action. The Center advances understanding and achievement of the goals of environmental and sustainability education through innovative educational research methods, emergent eco-pedagogies, and educational philosophy and practice based on ethics of care and sustainability. The Center provides professional development opportunities for educators in environmental education and sustainability (mainly pre-service teachers), and faculty administrators, staff, and students across FGCU. The CESE strives to create an ecologically literate citizenry and to advance civic engagement in the critical environmental issues of the Western Everglades and Barrier Islands.

In addition to its coursework, FIU houses four research centers that focus on climate change and coastal impacts. These centers are: a) International Hurricane Center (http://www.ihc.fiu.edu/), conducting multidisciplinary research focused on mitigating hurricane damage to people, with an emphasis in Florida; b) Southeastern Environmental Research Center (http://casgroup.fiu.edu/serc/pages.php?id=1737), exploring climate change and coastal ecology impacts, also focused in Florida; c) NASA / Waterscapes (http://web.eng.fiu.edu/waterscapes/WaterSCAPES_web/WaterSCAPES.html), a center dedicated to the study of climate change and coastal geomorphology and ecological impacts in Florida and Mexico; and Global Water for Sustainability (GLOWS; http://www.globalwaters.net/), a USAID funded initiative working to provide sustainable clean water to people and ecosystems.

The FSU Coastal and Marine Laboratory (FSUCML; http://www.marinelab.fsu.edu/) has been in existence since 1949, and is a member of The Southern Association of Marine Laboratories (SAML) and The National Association of Marine Laboratories (NAML). Research is conducted by faculty in residence and from the departments of biological science, oceanography, geology, meteorology, and anthropology, as well as supporting postdoctoral,

graduate, and undergraduate research. Scientific diving activities are supported by the Academic Diving Program. It has developing research partnerships with a number of state and federal agencies, including the Florida Fish and Wildlife Conservation Commission, the NOAA Fisheries, the Apalachicola National Estuarine Research Reserve, and the St. Marks National Wildlife Refuge. In addition, it has close ties with a number of environmental organizations, including the Nature Conservancy. Facilities at the FSUCML include a fleet of boats, including the 48 ft. R/V Seminole, housing, information technology, classrooms, and laboratories to support the research, education, and outreach missions of the laboratory.

Also at FSU, the work of the Institute for Energy Systems, Economics, and Sustainability (IESES; http://www.ieses.fsu.edu/) dovetails both on the natural and social science sides of sustainability. The IESES conducts scholarly basic research and analysis in engineering, science, infrastructure, governance and the related social dimensions all designed to further a sustainable energy economy. It brings together researchers from multiple disciplines to address sustainability and alternative power issues in the context of global climate change.

The Center for Ocean-Atmospheric Prediction Studies (COAPS; http://coaps.fsu.edu/) is a center of excellence performing interdisciplinary research in ocean-atmosphere-land-ice interactions to increase our understanding of the physical, social, and economic consequences of climate variability. COAPS scientists and students come from a wide range of disciplines, including meteorology, physical oceanography, statistics, and the computer and information sciences. It provides an interdisciplinary research environment for scientists carrying out important cutting edge work in the following areas: Agricultural Forecasting, Air/Sea Interaction, Climate Change, Climate Variability, Ocean Modeling, Ocean Prediction, Risk Assessment, and Satellite Studies. In addition, COAPS serves the wider scientific community through provision of data from the following data centers and sources: Florida Climate Data, Geographic Information System (GIS) Applications, FSU Winds and Fluxes, Scatterometer Products, Research Vessel Data, HYCOM Data Products, and the JMA SST ENSO Index. COAPS is a NOAA Applied Research Center and is a partner in NOAA's Northern Gulf Institute for cooperative research.

The Florida Climate Center (http://coaps.fsu.edu/climate_center/index.shtml) is a public service unit of the Florida State University Institute of Science and Public Affairs. The Center is part of three-tiered system (in affiliation with the National Climatic Data Center [NCDC] in Asheville, NC and the Southeast Regional Climate Center [SERCC] in Columbia, SC) that aims to provide climate data, information, and services for the United States, as well as citizens, organizations, educational institutions and private businesses in the State of Florida. It warehouses Florida climate data, provides climate support services for research, education, and public outreach, and prepares monthly summaries. The Florida Climate Center maintains archives of observations dating back to the early 1900's. This Center conducts

outreach to inform and educate the people of Florida about current and emerging climate issues.

The Coastal Hydroscience Analysis, Modeling and Predictive Simulations (CHAMPS; http://champs.cecs.ucf.edu/) Laboratory at UCF educates and trains tomorrow's engineers, scientists and educators, while meeting the coastal hydroscience challenges of today. Their primary research goal is to incorporate the physical system and associated processes into their computer modeling and simulation approach "in order to better analyze and understand coastal hydroscience. This begins with the production of an accurate and efficient astronomic tidal model for the Western North Atlantic Tidal model domain that can be used as a basis for more localized models, or to simply provide tidal boundary conditions for a shelf-based model."

The UF Water Institute (http://waterinstitute.ufl.edu) brings together talent from throughout the University to address complex water issues through innovative interdisciplinary research, education, and public outreach programs. The Water Institute originated from a UF Faculty Task Force Proposal in 2004. However, it was not until 2006 that the Institute received a $1.2 Million endowment form Progress Energy, and the founding Director and Research Coordinators were hired. Through interdisciplinary teams, comprised of leading water researchers, educators and students, the Institute develops new scientific breakthroughs; creative engineering; policy and legal solutions; and pioneering educational programs that are renowned for addressing state, national, and global water resource problems. *'Water and Climate'* is one of the Institute's four focus areas and deals with extreme events (floods, droughts, hurricanes), climate variability (ENSO phase, MDO), climate forecasts, and climate change (global warming, sea level rise, rainfall redistribution). One of the current studies in this focus area examines the use of intra-seasonal and seasonal forecasts to reduce risk in regional public water supply management.

Within the UF Water Institute, the Public Water Supply Utilities Climate Impacts Working Group (PWSU-CIWG; http://waterinstitute.ufl.edu/workshops_panels/PWSU-CIWG.html) is a collaborative effort focused on increasing the relevance of climate change and variability data and tools to the planning and operations of Florida's public water supply utilities. The partners are interested in how climate variability/change and sea level rise may impact planning and operations of Florida's public water supply utilities. The working group "promotes shared knowledge, data, models and decision-making tools among public water suppliers, water resource managers, climate scientists and hydrologic scientists with partners through peninsular Florida."

The University of Florida is a founding member of The National Ecological Observatory Network (NEON; http://www.neoninc.org/about/overview) which will collect data across the United States to study the impacts of climate change, land use change and invasive species on natural resources and biodiversity. NEON is a project of the U.S. National

Science Foundation, with many other U.S. agencies and NGOs cooperating. NEON will be the first observatory network of its kind designed to detect and enable forecasting of ecological change at continental scales over multiple decades. The data NEON collects will be freely and openly available to all users. As the Florida partner of NEON, UF is monitoring natural communities at two study areas near Gainesville, FL.

The University of Miami's Cooperative Institute for Marine and Atmospheric Studies (http://cimas.rsmas.miami.edu/index.html; CIMAS) conducts research focused upon understanding oceanic and atmospheric processes associated with global and regional climate change on various temporal scales and the impacts of climate variability and change. Activities under this theme include research to determine effective regional adaptation strategies, and developing and studying new climate information products and tools appropriate for evolving user needs, particularly in the Southeast United States and the Caribbean."

Also at the University of Miami, the Rosenstiel School of Marine and Atmospheric Science (RSMAS; http://www.rsmas.miami.edu/about-rsmas/) has grown into one of the leading academic oceanographic and atmospheric research institutions in the world. The School's basic and applied research interests encompass virtually all marine-related sciences. RSMAS seeks to improve understanding and prediction of the Earth's geological, oceanic, and atmospheric systems in order to provide a sound scientific basis for managing natural resources and adapting impacts of natural disasters and global change. RSMAS focus areas include a multi-disciplinary assessment of the value of climate forecasting for agricultural production in North and South Americas; applications of satellite data to detect structures of active volcanoes in the Pacific, the water level in the Everglades, and man-made land subsidence in metropolitan areas; a Reefs of Hope project aims to understand how reefs in different parts of the world will respond to climate change; and a study of the Caribbean climate with a focus on the Mid-Summer Drought.

A third initiative at UM is the R.J. Dunlap Marine Conservation Program (http://rjd.miami.edu/) which fosters STEM (Science, Technology, Engineering and Math) literacy and advances marine conservation by conducting cutting edge scientific research and involving graduate, undergraduate and high school students through hands-on field and virtual learning experiences. Participants from many disciplines across the globe learn the importance of the ocean and terrestrial environments in their daily lives, the threats facing our oceans and coasts and solutions for conservation. Education opportunities are made for those in land-locked communities as well as those from underserved populations.

The Environmental Center (http://www.unf.edu/ecenter/) at the University of North Florida addresses environmental issues and problems in a multidisciplinary way. By establishing this center, UNF has adopted a cooperative and integrated approach to understanding the environment and managing resources wisely. The Center will respond to

the pressing need for research relevant to environmental issues, help design thoughtful planning processes, encourage responsible stewardship, and help prepare the next generation of environmentally literate society leaders.

Figure 13: Researchers from UF and UM collaborate in a variety of climate-related projects through the Southeast Climate Consortium. Courtesy of UF/IFAS.

In Tampa, the University of South Florida houses the Patel School of Global; Sustainability (http://sgs.usf.edu/ma-courses.php) that combines academic and research programs focused on sustainability. Within this school, the Patel Center for Global Solutions develops research that creates solutions for sustainability development in a rapidly-changing world. Its research is based upon USF's broad, interdisciplinary expertise in the areas of water, public health, energy, global security, and social equity. This interdisciplinary approach provides a fertile foundation for the development of unique solutions to emerging and existing problems. Focus areas for the center include challenges surrounding the development of resilient, livable, and healthy cities of the future, particularly in the developing world. The Patel Center for Sustainability houses the Office of Sustainability to advance university-wide initiatives to create a sustainable campus environment and "transform USF into a 'Green University' by sharing a sustainability ethic that promotes conserving resources."

Established in 1990, the Center for Environmental Diagnosis and Bioremediation (CEDB; http://uwf.edu/cedb/index.cfm) at the University of West Florida provides a vital program of research and education. The CEDB collaborates with affiliated academic departments and diverse external organizations, including the Florida Institute of Oceanography and NOAA, to enrich the research, teaching, and service functions of the University of West Florida. The center emphasizes the application of modern biological research to environmental systems, engaging in basic and applied research pertinent to the assessment and improvement of environmental health and providing research and training opportunities for graduate and undergraduate students. The CEDB engages in basic and applied research pertinent to the assessment and improvement of environmental health; provides research opportunities and academic programs in life and environmental sciences; and contributes to public service, including K-12 science education enrichment.

SECTION 4: OTHER SOURCES OF CLIMATE CHANGE EDUCATION IN FLORIDA

"We know very little, and yet it is astonishing that we know so much, and still more astonishing that so little knowledge can give us so much power."

Bertrand Russell (1872-1970)

There are many programs and partnerships that support research, public awareness and local efforts for water resource and sustainability as well as regional planning in the face of climate change impacts. Those highlighted below are some additional programs with Florida affiliations including out-of-state universities, governmental agencies (at all levels of government), NGOs, and private sector initiatives. Other programs may exist. Links to the main web page for each program are provided with a brief summary based on, or paraphrased from, online information as of November 2011.

Out-of-State Universities Working Locally

Massachusetts Institute of Technology (MIT)

The MIT Science Impact Collaborative (formerly known as MIT-USGS Science Impact Collaborative) has been experimenting with a field-based graduate training program. Students, faculty, and researchers developed spatially explicit climate change simulations for peninsular Florida to support long-term strategic conservation planning for the US Fish and Wildlife Service (FWS) and the US Geological Survey (USGS). Beta form interactive simulations of "the Everglades Project" are available online: http://geoadaptive.com/everglades/mitse/bin-release/mitse.html A video simulation can be viewed at: http://web.mit.edu/dusp/epp/music/ As of 2011, the team is working with the Florida Fish and Wildlife Conservation Commission (FWC) and the Defenders of Wildlife to assess the direct and indirect impacts of climate change on wildlife habitats and plan management responses with refuge managers and state officials by means of scenarios and simulations.

Nova Southeastern University

The National Coral Reef Institute (NCRI) identifies gaps and constraints in scientific knowledge of reef structure and function. Assessing and monitoring biodiversity is a priority,

especially as it affects and interacts with ecological processes, overall reef function, reef recovery, and restoration. http://www.nova.edu/ocean/ncri/aboutus/index.html NCRI scientists are currently conducting research at the Chagos Marine Protected Area to examine the relationship between climate change and coral reefs to help us better understand weather patterns and other natural disasters. http://nsunews.nova.edu/nova-southeastern-university-scientists-expand-climate-change-research-worlds-largest-marine-reserve/

Governmental Agencies

The Florida Fish and Wildlife Conservation Commission (FWC; http://myfwc.com/) has designed an internal climate change professional development program. The FWC "Climate Change Certification of Completion" (CCCC) is a ten-month program consisting of lectures, presentations, online discussions, reading assignments, and a final project. The 11 program goals and assignments are designed to augment and integrate the topic of climate change as a critical priority within the agency by fostering education, improving participants' leadership and communication skills on climate change topics, and providing an ongoing and dynamic forum for considering adaptation strategies within the agency. The purpose of the program is, "To develop climate change literacy among FWC employees to ensure FWC is a leader on managing the impacts of climate change to Florida's wildlife." This program enhances the professional development of its participants while strengthening the agency's overall ability to successfully incorporate and execute its mission. While not a requirement for employees, participation is encouraged and open to all employees who are willing to complete the objectives.

FWC in partnership with Florida Natural Areas Inventory (FNAI; http://www.fnai.org/), which is an initiative dedicated to collect, interpret, and disseminate ecological information for the conservation of Florida's ecological diversity, have developed an interactive tool to identify critically imperiled resources in Florida. The Critical Lands and Waters Identification Project (CLIP; http://www.fnai.org/clip.cfm) is a GIS database of statewide conservation priorities for a broad range of natural resources, including biodiversity, landscape function, surface water, groundwater, and marine resources.

The Florida Department of Environmental Protection (DEP; http://www.dep.state.fl.us/) oversees a variety of programs. One of these programs is the Florida Oceans and Coastal Council. The Council has members appointed from Florida Department of Agriculture and Consumer Services (FDACS; http://www.freshfromflorida.com/), and FWC that coordinate coastal research and provide tools, funding opportunities and materials for education and research. The program was developed to coordinate state-wide efforts and identity research gaps and provide funding in

coastal research including climate change. The target audience encompasses the broader research community, professional agencies and interested parties.

While the Florida DEP provides opportunities for continuing education and training to its staff, no program currently exists that is specifically geared towards Climate Change. Generally, DEP relies on web-based options and tele/video conferencing due to budget constraints of travel-related training. One of their challenges is to provide professional development opportunities for its staff given their budgetary constraints. The Florida DEP does invest resources in managing and maintaining a public education outreach website (http://www.dep.state.fl.us/mainpage/programs/ed.htm). The purpose is, "To provide resources for cultivating and supporting environmental citizenship: the awareness, understanding and appreciation of Florida's environment; and the capacity to think critically and participate constructively in its protection." (C. Llorens, DEP employee, Pers. Comm.).

Regional Planning Councils (http://ncfrpc.org/state.html) provide oversight and support to regions within the State. Many planning councils in the State provide climate change resources such as fact sheets, links to educational websites, and promotion of climate change workshops in the region. For example, the South Florida Regional Planning Council (http://www.sfrpc.com/), which is a planning and public policy agency whose mission is to identify the long-term challenges and opportunities facing Southeast Florida and assist leaders in the region to develop and implement creative strategies, offers "Climate Change Community Toolbox that includes factsheets on the impacts of climate change, a sea level rise map atlas, and a compendium of adaptation resources. The purpose is to provide education to communities as a feedback mechanism to build support for climate change planning and funding. The target audience includes citizens, policymakers and State agencies.

The Southeast Florida Regional Climate Change Compact represents a joint commitment of Broward, Miami-Dade, Palm Beach and Monroe Counties to partner in mitigating the causes and adapting to the consequences of climate change. Formed following the 2009 Southeast Florida Climate Leadership Summit, the Compact outlines a collaborative effort to participate in a Regional Climate Team toward the development of a Southeast Florida Regional Climate Change Action Plan. This Compact commits the counties to work on federal and state climate policies related to the shared challenges of climate change. Counties in the Compact pledge to promote public awareness about the causes and impacts of climate change as a member of the ICLEI Climate Resilient Communities Adaptation Program. The Compact received the 2010 International Council for Local Environmental Initiatives (ICLEI) Sustainability Leadership Award for process innovation in a large community.

Both the Florida Department of Transportation (FDOT; http://www.dot.state.fl.us/) and the Metropolitan Planning Organizations (MPO) are actively pursuing best practices for integrating climate change issues into outreach and education practices (Federal Highway

Administration, 2010). Their purpose is to inform citizens and engage policymakers on issues of climate change and its impact on activities such as transportation and urban planning. The target audience includes policymakers, interested partners and citizens.

The Water Management Districts in Florida (http://www.dep.state.fl.us/secretary/watman/) have historically been active participants in scientific workshops and symposia. No formal internal professional development currently exists. Many staff scientists and engineers have conducted research on climate change impacts of rising water levels and flooding to incorporate into technical publications that support necessary changes in infrastructure and management operations. At this point it is unknown to what extent the 2011 budget cuts may alter future monitoring and participation.

The National Oceanic and Atmospheric Administration (NOAA) has established through a federal-state collaboration six Regional Climate Centers (RCCs; http://www.ncdc.noaa.gov/oa/climate/regionalclimatecenters.html) engaged in the timely production and delivery of useful climate data, information and knowledge for decision makers and other users at the local, state, regional and national levels. The Southeast Regional Climate Center (SERCC; http://www.sercc.com/) is the one that covers Florida and is housed at the University of North Carolina in Chapel Hill, NC. NOAA also supports a variety of cooperative research centers and institute throughout the region, including the following:

Figure 14: The 2nd Climate Change Task Force Workshop on November 14-15, 2011 brought together representatives from academia, governmental agencies, NGOs, and private sector to discuss about cooperation in climate change. Courtesy of UF/IFAS.

- The Southeast Aquatic Resources Partnership (SARP; http://sarpaquatic.org/) is a regional collaborative of natural resource and science agencies, conservation organizations and private interests whose mission is to "protect, conserve and restore aquatic resources including habitats… for the continuing benefit, use and enjoyment of the American people." SARP was developed to strengthen the management and conservation of aquatic resources in the southeastern United States.

- The NOAA Coral Reef Conservation Program (CRCP; http://coralreef.noaa.gov/aboutcrcp/) supports effective management and sound science to preserve, sustain and restore valuable coral reef ecosystems for future generations. To make the most of limited resources and to have the largest impact to reverse general declines in coral reef health, the CRCP is narrowing the focus

of its U.S. domestic program on understanding and addressing the top three recognized global threats to coral reef ecosystems: climate change impacts, fishing impacts, and impacts from land-based sources of pollution.

- Atlantic Oceanographic and Meteorological Laboratory (AOML; http://www.aoml.noaa.gov/), a federal research laboratory, is part of NOAA's Office of Oceanic and Atmospheric Research , located in Miami, Florida. AOML's research spans hurricanes, coastal ecosystems, oceans and human health, climate studies, global carbon systems, and ocean observations.

- The Southeast Fisheries Science Center (SEFSC; http://www.sefsc.noaa.gov/about/) conducts multi-disciplinary research programs to provide management information to support national and regional programs of NOAA's National Marine Fisheries Service (NMFS). The SEFSC, headquartered in Miami, FL, is organized with divisions and labs across the southeast region of the U.S. including Miami, FL and Panama City, FL labs.

The *U.S. Army Corps of Engineers* (USACE; http://www.usace.army.mil/Pages/default.aspx) is involved in several efforts related to water management and climate change adaptation including Everglades restoration, wetlands permitting, and guidance for incorporating the direct and indirect physical effects of projected future sea level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects.

The *U.S. Geological Survey* (USGS; http://www.usgs.gov/) has several programs, some examples are as follows:

- The South Florida Ecosystem Program, one of several study areas within the USGS Ecosystem Program, is an intergovernmental effort to reestablish and maintain the ecosystem of south Florida. Through 3-5-year efforts, USGS provides an intense level of scientific information tailored to the specific management needs of that ecosystem. One element of the restoration effort is the development of a direct, significant and firm scientific basis for resource decision-making. The program, which began in 1995, provides multidisciplinary hydrologic, cartographic, and geologic data that relates to the mainland of south Florida, the Florida Bay, and the Florida Keys and Reef ecosystems. On a regional or sub-regional basis, it may focus on issues such as "water quality or water supply, environmental effects of mineral or energy use or extraction, effects of alterations in land use or land cover."

- South Florida Information Access (SOFIA) is an interdisciplinary service that provides coherent information access in support of research, decision making, and

resource management for the South Florida ecosystem restoration effort. Sponsored by the USGS Priority Ecosystems Science Initiative, SOFIA offers a suite of information systems and tools enabling the selection, organization, documentation, dissemination and storage of data and other information products. SOFIA focuses on the projects and products of the South Florida PES Initiative, as well as related projects and products from other information providers, including federal, state and local agencies; universities; and non-governmental organizations. SOFIA personnel include a cross-bureau team of scientists, information managers, and informatics specialists, working in close collaboration with partner and client agencies outside the USGS.

- The Land Remote Sensing Program (LRS) operates the Landsat satellites and provides the Nation's portal to the largest archive of remotely sensed land data in the world, supplying access to current and historical images. These images serve many purposes from assessing the impact of natural disasters to monitoring global agricultural production.

- The goal of the USGS Geographic Analysis and Monitoring (GAM) Program is to understand the patterns, processes, and consequences of changes in land use, land condition, and land cover at multiple spatial and temporal scales, resulting from the interactions between human activities and natural systems.

- The USGS Earth Resources Observation and Science Center (EROS) contributes to the Climate and Land Use Change Mission Area through research and operational activities that enable the understanding of local to global land change. The EROS multidisciplinary staff uses their unique expertise in remote sensing-based science and technologies to carry out basic and applied research, data acquisition, systems engineering, information access and management, and archive preservation to address the Nation’s most critical needs.

- USGS Florida Water Center supports the overall mission of the U.S. Department of the Interior and the U.S. Geological Survey, by providing the hydrologic information and understanding needed for the best use and management of the Nation's water resources for the benefit of the people of the United States. The USGS provides current ("real-time") stream stage and stream flow (558 sites), water-quality (143 sites), and groundwater levels for 222 sites in Florida.

Three federal agencies have come together to create the Partnership for Sustainable Communities: Housing and Urban Development (HUD), Department of Transportation (DOT), and Environmental Protection Agency (EPA). Because sustainable communities provide a variety of housing and transportation choices, with destinations close to home, they tend to have “lower transportation costs, reduce air pollution and stormwater runoff, decrease

infrastructure costs, preserve historic properties and sensitive lands, save people time in traffic, be more economically resilient and meet market demand for different types of housing at different prices points." The partnership helps communities develop in ways that are more environmentally and economically sustainable, in rural, suburban and urban areas with strategies tailored to the community's character, context and needs. The partnership provides grants and other assistance to make housing more accessible, affordable, and energy-efficient. http://www.sustainablecommunities.gov/

Non-Governmental Organizations

Non-governmental organizations (NGOs) play an increasing role in climate change education. For example, in May 2010 the National Academies convened the first meeting of the Climate Change Education Roundtable (NAS, 2010), a two-year dialog to develop an articulated national strategy for improving public understanding of climate science among federal agencies and in business, academic, nonprofit, and community sectors. Other NGOs, including the Pew Center for Global Climate Change, the National Wildlife Federation, Sigma Xi, the Sierra Club, and the Smithsonian Center for Education and Museum Studies, have begun similar initiatives with their respective stakeholder groups.

In addition, a growing number of educational efforts are dedicated to climate change education. For instance, the Alliance for Climate Education (2010) is a national nonprofit organization that deploys climate scientists to high schools throughout the U.S. to organize innovative multimedia assemblies, and then work with students to develop and implement climate change awareness projects in their communities. And the Association for the Advancement of Sustainability in Higher Education administers the American College and University Presidents' Climate Commitment (http://www.presidentsclimatecommitment.org/; 2009), signed by 685 institutions of higher education, which provides resources on climate change education for post-secondary audiences. In Florida, the University of Miami and the following SUS institutions have signed this commitment: Florida Atlantic University, Florida Gulf Coast University, Florida International University, New College of Florida, University of Central Florida, University of Florida, University of North Florida, and the University of South Florida. Numerous web resources have been created by various science education groups, such as Climate Change Education (http://www.climatechangeeducation.org), the Climate Change Collection (http://serc.carleton.edu/climatechange), and the Lawrence Hall of Science (http://lawrencehallofscience.org/gss/). To date, however, very few educational resources for climate change education have been developed specifically for Florida. Two good examples of efforts led by NGOs in Florida are highlighted below.

The Nature Conservancy (TNC) works on a global scope and focuses on incorporating the best science with the best practices in adaptive management strategies. The group funds the dissemination of resources and people to augment their own research, as well as their partners across the globe. The scope of their mission includes development and dissemination of knowledge-based reports and materials, conducting training of people in leadership roles relating to stewardship, conservation and management of natural resources, as well as, working to form partnerships across a wide range of stakeholders, organizations and community-level contacts that are charged with natural resource stewardship and conservation. Their overall purpose is to promote conservancy goals that include mitigating and adapting to climate change. Their target audience includes staff and partner scientists, public citizens, members, and the conservation community as a whole. A representative project is the "Coastal Resilience Project" in the Florida Keys that is aimed at assisting managers and planners with interactive decision tools to respond to climate change, storm events and sea level rise.

The United Nations Environment Programme Finance Initiative (UNEP FI) through the Climate Change Working Group offers consulting services and ongoing online courses, such as "Climate Change: Risks and Opportunities for the Finance Sector Online Course" (http://www.unepfi.org/training/climate_change/index.html). Their purpose is to provide education on the relevance of climate change within the context of financial industries such as banks, insurers, reinsurers and fund managers. The target audience is executives, managers from financial institutions, governments and citizens.

Figure 15. The Florida Center for Environmental Studies (CES) is housed at FAU's Jupiter campus. Courtesy of FAU.

Private Sector

Good examples of private sector initiatives are highlighted in this section. First, the Florida Aquarium, Inc (http://www.flaquarium.org/) is a grant recipient of the Climate Change Community Outreach Initiative funded by NOAA (http://www.oesd.noaa.gov/elg/elg_projects.html#aw11). The initiative benefits six Aquariums in the Gulf Region, including Florida, through funding on a 5-year NOAA grant. The NOAA funding is to promote climate change literacy through the development of

websites, exhibits, and programs for continued outreach and workshops. The target audience includes diverse audiences, non-formal educators and the public.

And second, the Ecosystem Based Management Tools Network (EBM; http://www.ebmtools.org) provides professional training online through a participatory network of partnerships. The network is "an alliance of EBM tool users, providers, and researchers to promote the use and development of tools for EBM in coastal and marine environments and the terrestrial environments that affect them (watersheds). Many of their online training sessions include climate change components as it relates to natural resource planning.

SECTION 5: UNMET CLIMATE EDUCATION NEEDS IN FLORIDA

"The claim of General Education is that the history of science is part of science. So are its philosophy, its great literature, and its social and intellectual context. The contribution of science instruction to the life of the university and to society should include these elements, since science includes them..."

Harvard Committee on General Education

State of Climate Change Education

The number of courses that were found with climate change science content seems low compared to the student population that is served at these institutions. The information collected showed that 461 courses with varying degrees of climate change content are available for the more than 330,000 students within the 12 surveyed institutions of higher education in Florida. This list of courses seems impressive, however, seeing how many different courses that include information on climate sciences and climate change impacts and societal responses demonstrates quite clearly how important the issue of climate change is to our society as a whole. Undergraduate students have access to almost 60% of these courses, and the other 40% are available for graduate students. About 40% of the 461 courses are taught in disciplines within the Earth and physical sciences, and both the life sciences and the social sciences disciplines have nearly a fifth each. The rest of the courses were in the curricula of interdisciplinary programs (43) and humanities (8). Table 2 shows that most institutions offer at least one Level 1 course of the 46 that were identified.

A closer look at this information indicates that most of the Level 1 courses are offered within the Earth and physical sciences (18) and are almost equally distributed between graduate and undergraduate programs. We found that the remaining courses belong to the social sciences (8), life sciences (13), humanities (1), and interdisciplinary programs (6). The bulk of the courses are concentrated at levels 2 and 3, where we find 329 of the 461 courses identified. Again, the majority of courses in these levels is offered either in the physical sciences (76 and 77 for Level 2 and Level 3, respectively) or for undergraduate students (99 and 114 for Level 2 and Level 3, respectively). Something relevant is that 32 of the 43 interdisciplinary courses that were identified are classified as either Level 2 or Level 3. This finding suggests that even though climate change is not the main focus of most of the identified courses (about 10% of the total number listed in Table 1 and in Appendix IV), this topic has become an important component in a number of courses, particularly those where faculty and students from different disciplines converge. As mentioned before, Level 4 courses were not identified for all institutions; most likely, if we perform a new search looking for this type of courses, we will find them in most institutions.

Table 2. Climate-related courses taught at each institution.

	Courses taught (% of Total)				
	Overall	**Level 1**	**Level 2**	**Level 3**	**Level 4**
FAMU	8 (1.7)		1 (0.7)	7 (4.0)	
FAU	67 (14.5)	8 (17.4)	32 (22.2)	27 (15.4)	
FGCU	34 (7.4)	5 (10.9)	17 (11.8)	10 (5.7)	2 (2.1)
FIU	20 (4.3)	3 (6.5)	5 (3.5)	4 (2.3)	8 (8.3)
FSU	93 (20.2)	10 (21.7)	11 (7.6)	19 (10.9)	53 (55.2)
NCF	10 (2.2)	2 (4.3)	5 (3.5)	3 (1.7)	
UCF	29 (6.3)	2 (4.3)	5 (3.5)	22 (12.6)	
UF	74 (16.1)	4 (8.7)	18 (12.5)	36 (20.6)	16 (16.7)
UM	46 (10.0)		15 (10.4)	17 (9.7)	14 (14.6)
UNF	39 (8.5)	8 (17.4)	16 (11.1)	15 (8.6)	
USF	22 (4.8)	3 (6.5)	11 (7.6)	5 (2.9)	3 (3.1)
UWF	19 (4.1)	1 (2.2)	8 (5.6)	10 (5.7)	
TOTAL	**461**	**46**	**144**	**175**	**96**

The courses utilized a variety of educational methods. However, most of them still rely on lectures mainly, with a limited time dedicated for student discussion. This is consistent with the cognitive categories at which most of the learning objectives are directed. The vast majority of syllabi that were reviewed have their learning objectives stated at the categories of knowledge and comprehension, which are the more basic cognitive levels (Bloom, 1956). In general, students are expected to be able to understand, appreciate, articulate, explain, or describe the content of the course after completing the educational experience. These objectives may be appropriate for many of the courses (particularly the Level 4 courses directed at providing students with the scientific foundations of climate change). Though, if the objective is to prepare a more engaged citizenry that can design and implement risk management strategies focused on climate change adaptation and mitigation, then it would be necessary to target other cognitive categories in the course objectives, and to adapt the teaching strategies accordingly. The few courses with learning objectives targeting

higher cognitive categories (i.e. application, analysis, synthesis, and evaluation) employed strategies such as debates and reflection papers that would allow students to appreciate the complexity and to think critically on climate change.

In addition, Florida possess more than 20 centers and institutes that conduct research focused on understanding the climate change, and develop strategies to both decelerate the change process and prepare for its impacts. These institutions foster the establishment and maintenance of national and regional multidisciplinary networks of scientists connecting them with a variety of stakeholders. Furthermore, multiple non-formal educational initiatives are developed and implemented by universities, governmental agencies, NGOs, and private entities. These initiatives aim to raise climate literacy across different segments of the population

Educational Needs

A set of educational needs emerged from the analysis of the collected information. These findings confirmed, and expanded, the initial list of needs that was generated at the State University System Climate Change Task Force Workshop held in Boca Raton, FL on March 18, 2011. The main needs that were identified included the promotion of a stronger integration of climate change education with other sciences and disciplines. We found that most of the courses related with climate change come from disciplines in the physical sciences. Considering the complexity and multidimensionality of climate change in regards to its causes and consequences, it is necessary, as Lemons (2011) proposed, to incorporate the discussion on climate change into the discourses of every discipline within the higher education system. Opening the study and discussion on climate change to more audiences, will, most likely, enrich the debate and strengthen the communication between scientists, policymakers, etc. This enhanced interaction among diverse stakeholders is desirable to promote an effective mitigation of climate change (Ockwell et al., 2009). Developing this collective multidisciplinary scholarship on climate change is required to generate new ideas on mitigation and adaptation that are relevant to more audiences. It will make it easier for society in general to understand the causes and effects of climate change, and to modify its behavior accordingly.

Enhancing the access of students to current and future courses is another identified need. Every institution has a mix of courses related with climate change, however, in most cases, the offering of courses within a particular institutions is concentrated within one, sometimes two, branches of science. For example, an institution may have a really strong set of courses on the scientific foundations behind climate change, but fail to offer courses where students can learn how climate change is affecting the lives of individuals around the world and apply the scientific knowledge to alleviate this situation. In a case like that, students may

possess a deep scientific knowledge of climate change but lack the broader perspective necessary to effectively communicate about climate change.

The need to strengthen the preparation of teaching and extension faculty and K-12 science teachers to incorporate climate change concepts in their courses was also identified. The training of extension faculty will help to expand the integration of climate change education into Extension/outreach programs, particularly beyond agriculture and natural resources. Providing training targeted to develop the skills of educators to understand and educate on climate change is likely to have a multiplicative effect raising the climate science literacy of learners in their courses or programs. It will be desirable to develop new professional development opportunities for educators and to incorporate climate change education into the curricula of current programs and courses for them.

Particular emphasis should be placed on the development and delivery of training programs for K-12 science teachers. It is during the stages of primary and secondary education that students acquire the knowledge, and develop the skills, required either to enroll and successfully complete climate-related undergraduate and graduate courses in the future, or to implement climate change mitigation and adaptation strategies. However, climate change education seems to be currently "under attack" in some places (Reardon, 2011); this situation has discouraged educators from taking advantage of valuable workshops and online resources offered by organizations such as the National Earth Science Teachers Association (NESTA; http://www.nestanet.org). A recent poll on climate change education conducted by the National Science Teachers Association (NSTA) with science educators showed that 82% of respondents have faced skepticism about climate change and climate change education from students, 54% have faced it from parents, and 26% faced the same skepticism from administrators. The survey is available at http://ncse.com/news/2011/11/nsta-poll-climate-change-education-006941.

SECTION 6: NEXT STEPS

"The great aim of education is not knowledge, but action."

Herbert Spencer (1820–1903)

Climate Change Education for the Future

The information presented in this document is by no means an exhaustive account of all of Florida's courses, initiatives, and research centers that provide courses and other education opportunities on climate change. The course information identified for the different universities may have gaps and not all courses may be represented. Furthermore, new courses continue to be added and others are replaced. However, review presents a good overview of what climate change education is available in in Florida's universities and highlights its main features. The education system is constantly changing, and it is important to include climate change education in universities' agendas to help society better understand and respond to those changes.

The information presented in this document provides a valuable resource to design strategies directed at enhancing Florida's capacity to broadly educate its citizenry on climate change, promoting the adoption of adaptation and mitigation behaviors. We propose two main approaches to initiate and direct the needed change process. Implementing these approaches will require stronger interactions among researchers from multiple branches of science, and an enhanced congruence of climate change research and education agendas to raise the literacy and preparedness of society regarding global climate change. This research needs to be continued and expanded. Additional time and resources are needed to refine and implement the proposed approaches.

Approach 1: Professional Development

This approach focuses on the development and delivery of training curricula to enhance the knowledge and skills of university faculty (both teaching and extension) and K-12 science teachers in two main areas: a) the integration of climate change education into their courses/programs, and b) the translation of scientific concepts to multiple audiences. Establishing statewide opportunities for students to obtain a climate change concentration or certificate, as proposed in Approach 2, will definitely yield significant benefits regarding climate change education. However, a concurrent investment on professional development for university faculty will be required. Furthermore, more educational options, in formal and

non-formal settings, need to be available to produce an educated society at a more rapid pace to respond in a timely manner to the challenges of climate change. This first approach is critical to develop the required human capital to expand and multiply the educational effect across society. Educators need to develop a deep understanding of the science behind climate change and the connections. According to Lee and Aurolyn (2006), when teachers are able to create their own understanding of science, they can easily identify potential difficulties for teaching the subject (e.g. student's misconceptions) and plan accordingly to deliver effective instruction. Educators should also learn how to integrate climate change education into their courses and programs, and the most effective methods to use to teach it.

An area of concern for some scholars is that both the lack of well-prepared science educators in physical and Earth sciences and the current treatment of climate change as a controversial issue in education (Reardon, 2011) are just parts of a larger problem. An additional layer of complexity for the integration of climate change education within the STEM framework is represented by current science requirements for high school students. For example, the average high school graduate in Florida has only three credits of science and no preparation on Earth and physical sciences (Ruscher, 2011). Educators, policy-makers, and other key stakeholders will need to work together to address these issues. For example, SUS can advocate with the state's K-12 leaders (e.g. Board of Education, Chancellor's office, legislators, etc.) for the establishment of a four years of high school science requirement for Bright Futures recipients; science units should come from the three recognized areas of science (i.e. Life, Physical, and Earth/space).

Reaching educators in formal (i.e. K-12, undergraduate, and graduate level) and non-formal (e.g. Florida Cooperative Extension Service and Sea Grant College) education programs will allow to have a greater impact in a shorter time, addressing both adaptation and mitigation tactics that involve different groups of society in a coordinated effort.

Approach 2: Inter-institutional Certificate on Climate Change

The second approach proposes the establishment of a state-wide, inter-institutional, and multidisciplinary degree concentration or a minor/certificate on climate change. Leadership for this effort should emerge from all the surveyed institutions of higher education. Faculty from these universities will need to come together based on their identified strengths on formal and non-formal climate change education.

Once established, this program would be offered to graduate and undergraduate students in Florida, providing them with interdisciplinary knowledge and technical skills related to understanding the science behind climate change and variability, its implications on different sectors of society, and on options for adaptation and mitigation responses by public and private institutions and its connection with other disciplines. This program should be

anchored by a core course dedicated to translating climate change by integrating education, communication, and public outreach methods.

This program would yield positive changes at three levels. First, it will enhance the access of students to a variety of courses on climate change. Current and future courses selected to be part of the certificate will need to be delivered, at least partially, online to enhance access across the state. Currently, many courses are only taught online, or at least have a section that is taught online. Furthermore, institutions have the infrastructure and know-how required to make this happen and students have already developed skills for online learning. Second, the capacity of future scientists for translating sciences will be improved. Students and faculty participating in this program will learn about translating and communicating science to different audiences. Developing this skill in scientists, and future scientists, may have a very positive effect on society's capacity to respond to climate change. Scientists will need to keep presenting the information in an objective way, but they will learn to do it in forms that are relevant and meaningful to different groups of society. That way, people will be able to adopt the discourse and engage in discussions directed to modify their realities. As Maibach and Priest (2009) state, "instigating public discussion may be more important than engineering public opinion." And third, it will promote the integration of climate change education into a variety of disciplines. Students and faculty participating in this program will develop the scholarship needed to transfer concepts and methods from one discipline to another.

A number of challenges and potential roadblocks to the implementation of this approach were identified. The generation of student credit hours and limits on courses that can be transferred are probably the bigger ones. Significant changes will be needed at the institutional level to create a favorable environment where students not only can take courses from other institutions in the state, but are encouraged to do so. A current mechanism exists that allow students to do it (see Appendix F), however, most students are not aware of this capability. A framework will need to be developed among all institutions to promote the change in behavior required to get this program offered. Institutional reform will be required to achieve a comprehensive approach to climate change education within the higher education system (Lemons, 2011). There are many layers of complexity (e.g. funding, logistics, etc.), but the potential benefits should motivate all the institutions to make their best attempt at addressing this challenge.

It is important to expand the efforts to identify what similar programs may already be available in the U.S. and abroad. For example the University Corporation for Atmospheric Research (UCAR; http://www2.ucar.edu/) and the National Center for Atmospheric Research (NCAR; http://ncar.ucar.edu/) are pushing an initiative to develop a curriculum for climate change education. The emphasis is at the level of good science background combined with education in more policy and sustainability. Identifying these types of programs will allow us to learn from them and maybe obtain access to some educational resources that may have already been developed.

Epilogue

Significant efforts on climate change education are being implemented in Florida to advance the science behind climate change and to prepare society for taking action through a wide range of mitigation and adaptation approaches. However, the educational needs are still numerous and need to be addressed quickly to enhance the state's capacity to effectively respond to climate change.

Figure 16: UF students work on their assignments in front of the Green Pond conservation area. Courtesy of UF/IFAS.

The implementation of the strategies proposed in this white paper will require the collective action of multiple stakeholders (e.g. university faculty, secondary teachers, policy-makers, etc.). Future collaborative opportunities will be abundant and must be productive, with a focus on situating climate change education (in all its different forms) at the center of the efforts to help society in the mitigation of climate change and in adapting to its current and future impacts. Leveraging existing educational resources available inside and outside of the state may help shortening the time and funds required for the development of effective programs.

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APPENDIXES

Appendix I – Message for Strategy A

Dear <Professor Name>,

<University Name that you represent> is working on an SUS white paper for education and we are trying to gather all of the <University Name for which you are seeking syllabi> syllabi for courses that relate in some way to Climate Change (CC). The categories are:

1 – CC or climate science is the main focus

2 – CC or climate science is a component

3 – CC or climate science comes up in discussion

I see in the course catalog that you taught <List course name(s)>. Would you mind sending me the syllabus for that course (those courses), and any others that relate to Climate Change so that we may include them in our paper? General course information will be referenced in an appendix of the white paper. Please be assured that the syllabi will not be included in the white paper. It is used only to categorize the level of climate change focus / discussion and to check online aspects of the course.

Thank you in advance for your prompt reply!

Sincerely,

<Your Name>

Appendix II. Message 1 for Strategy B

Dear Colleague,

<University Name that you represent> is working on an SUS white paper on climate change education and we are trying to gather all of the <University Name for which you are seeking syllabi> syllabi for courses dealing directly with Climate Change (CC), or with related topics such as: Climate Science, Climate Variability, Climate Impacts, Climate Change Adaptation, Mitigation, Greenhouse Gases, Climatology, Meteorology, Weather Analysis, Weather Forecasting, Atmospheric Dynamics, Weathercasting, Geophysical, Global Environmental Change, Sea Level Rise, Environmental Sustainability, Global Environmental Problems, Urban Sustainability, Sustainable Development, Environmental Chemistry, Green Consciousness, Bio-fueling, and Water Management Issues.

The identified courses will be organized into the following categories:

1 – CC or climate science is the main focus

2 – CC or climate science is a component

3 – CC or climate science comes up in discussion

Please ignore this request if it is not related to the courses that you teach. If you teach a course that fits into any of these categories, would you please send me the name, description and the syllabus for each course? General course information will be referenced in an appendix of the white paper. Please be assured that the syllabi will not be included in the white paper. It is used only to categorize the level of climate change focus / discussion and to check online aspects of the course.

Your input is instrumental for the success of this project. We sincerely appreciate your interest in CC and your willingness to take the time to help us with this process. Thank you in advance for your prompt reply!

Sincerely,

<Your Name>

Appendix III. Message 2 for Strategy B

Dear Colleague,

A few days ago, I sent an email asking you to send me the name, description, and syllabus of any course that you teach that is related in some way to climate change. The categories are:

1 – CC or climate science is the main focus

2 – CC or climate science is a component

3 – CC or climate science comes up in discussion

If you have already sent that information, I would like to take this opportunity to thank you! If you have not had a chance to address this request, I would like to encourage you to do so now. It will take very little of your time and it will allow us to identify all of <University Name for which you are seeking syllabi> courses related with CC.

Thanks for taking the time to help us! Please accept our apologies and ignore this request if it is not related with the courses that you teach.

Sincerely,

<Your Name>

Appendix IV. List of Courses by Institution

Florida Agricultural and Mechanical University		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	ABE 4224	Nonpoint Source Pollution
G	BSC 5865	Conservation Biology
U	SWS 3022	Nature and Properties of Soils - Lab
U	SWS 3022L	Nature and Properties of Soils - Lab
U	SWS 4131C	Soil Fertility and Fertilizers
U	SWS 3211C	Soil and Water Conservation
G	SWS 5217	Soil and the Environment
U	AGR 3210	Field Crop Science
Florida Atlantic University		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
G	ARC 6598	Sustainability and Tropical Architecture
G	URP 6930	Seminar in Cities and Climate Change Adaptation
U	URP 4403	Sustainable Cities
U	URP 4420	Environmental Planning Methods
U	SYA4930-01	Climate, Disaster and Society
U	WST 4349	Green Consciousness
U	INR 4081	The International System
U	INR 4932	Global Environmental Politics
G	MAN 6937	Global Environment of Management
U	MAN 4930	Sustainability Leadership for Entrepreneurs
G	MAN 6931	Sustainability Leadership for Entrepreneurs
G	GEB 6446	Management of Natural Systems
G	GEB 6448	Ecosystem Management and Operations Ecology
G	GEB 6445	Global Management of Air, Water, and Land
U	ECP 4302	Environmental Economics
G	EDG 5931	Climate Change Education
U	SCE 4350	Principles and Methods: Elementary and Middle School Science
G	CWR 6525	Dynamic Hydrology
G	CWR 6818	Water Resource System Engineering
G	EES 6025	Modeling Methods in Water Resources and Environmental Engineering
U	EGN 4070	Sustainability Leadership for Engineers
U	CWR 4307	Stormwater Modeling and Management
U	CGN 4930	Dynamic Hydrology
U	CWR 4202	Hydrologic Engineering
U	CGN 1500	Discoveries in Engineering: Innovative Materials for Infrastructure
U	OCE 2001	Introduction to Oceanography
U	OCE 3008	Oceanography
U	ENV 3001	Environmental Science and Engineering
U	EOC 4193	
G	BSC 6936	Special Topics - Climate, Ecosystem & Health
G	OCE 6019	Marine Global Change

G	BOT 6606	Coastal Plant Ecology
U	BOT 4404	Marine Botany
U	CHM 1020C	Contemporary Chemical Issues
G	CHS 6611	Chemistry for Environmental Scientists
U	CHM 3080	Environmental Chemistry
G	GEA 6277	Human-Environment Interactions in South Florida
G	GEO 6337	Culture, Conservation, and Land Use
G	GEO 6938	Seminar in Special Topics in Regional or Systematic Geography
U	ESC 3704	Environmental Issues in Atmospheric and Earth Science
U	MET 2010	Weather and Climate
U	EVR 2017	Environment and Society
U	GEA 4275	Human-Environment Interactions in South Florida
U	GEO 4280C	Water Resources
G	GLY 6746	Global Environmental Change
G	GLY 6888	Coastal Hazards
G	GLY 6745	Ancient Marine Environments
G	ESC 6206	Earth Science for Educators
G	ESC 6207	Earth Science for Educators
G	GLY 5243	Environmental Geochemistry
G	GLY 5575C	Shore Erosion and Protection
G	GLY 6737	Coastal Environments
G	GLY 5736C	Marine Geology
U	ESC 2070	The Blue Planet
U	GLY 4241	Environmental Geochemistry
U	GLY 4822	Hydrogeology
U	GLY 3730	Coastal and Marine Science
G	GLY 6707	Regolith Geology
U	GIS 4035C	Remote Sensing of the Environment
G	GIS 5038C	Remote Sensing of the Environment
U	CHM 1025C	Honors Contemporary Chemical Issues
U	CHM 3080	Honors Environmental Chemistry
U	PCB 3352	Honors Issues in Human Ecology
U	ENC 3362	Honors Environmental Writing and Rhetoric
U	EVR 2017	Honors Environment and Society
U	EVS 3403	Honors Global Environmental Issues
U	IDS 4933	Race, Gender, & Environmentalism

Florida Gulf Coast University		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	BSC 3303	Biogeography
U	CHM1084C	Environmental Chemistry
U	CPO 3002	Comparative Politics
U	ENC 2160	Introduction to Nature Writing
U	ENV3006C	Fundamentals of Environ Engineering
U	ENV 4612	Sustainability in Engineering
U	EVR 1001C	Intro. Environmental Science
U	EVR 2861	Intro to Environmental Policy
U	EVR 4326	Conservation Strategies Future

U	EVR 4872	Environmental Policy/Law
U	EVR 4930	Paleoclimatology
U	EVR 4930	Special topics: North American Environments
G	EVR 5039	Soc & Cult Dims of Env Movemts
G	EVR 6936	Paleoclimatology
G	EVR 6936	Biogeochemistry
G	EVS 6937	Environmental Policy
U	GLY 2030	Environmental Geology
U	GLY3603C	Geobiology
U	GLY4074C	Meteorology & Climatology
U	GLY4244C	Biogeochemistry
U	GLY4700C	Coastal & Watershed Geology
U	IDS 3143	Issues in Science and Technology
U	IDS 3304	Issues in Ecology & Environ.
U	IDS 3920	University Colloquium
U	ISC 3145C	Global Systems
U	ISC 4930	Current Topics Climate Change
U	OCB4633C	Marine Ecology
U	OCP 3002C	Physical Oceanography
G	PAD 5620	Environmental Law
U	PCB 4442C	Wetland Ecology
U	PUP 4206	International Environmental Policy
G	PAD 5356	Environmental Policy & Ethics
U	SPC 3543	Ecological Communication

Florida International University		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	IDS 3XXX	Global Climate Change: Science, Society and Solutions
U	GLY 2072	Earth's Climate and Global Change
U	MET 3102	Physical Climatology
U	EVR 4112	Climate Change Policy
G	MET5XXX	Advanced Physical Climatology
G	ESC 6XXX	Water Resources and Climate Systems
U	GLY 3039	Environmental Geology
U	GLY 3039L	Environmental Geology Lab
U	GLY 4990	Coastal Hazards
U	EVR 3013	Ecology of South Florida
U	EVR 3013L	Ecology of South Florida Lab
G	EVR 5061	South Florida Ecology: Field Studies
U	EVR 4023	Coastal Resource Management
U	EVR 4356	Coastal and Marine Environmental Policy
U	EVR 4594	Analysis of South Florida Ecosystems
G	EVR 5332	Integrated Solutions for Water in Environment and Development
U	GLY 3882	Environmental Geology Florida Keys Workshop
U	MET 4532	Hurricanes
G	MET 5530	Hurricane Meteorology and Impacts
G	OCC 6413	Biogeochemistry of Coasts and Estuaries

Florida State University		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	GLY1030	Environmental Issues in Geology
U	GLY1070	Living on the Water Planet
U	GLY 4730	Marine Geology
U	GLY4884	Environmental Geology
G	GLY 5135	Quaternary Geology
G	GLY 5267	Stable Isotopic Tracers in the Environment
G	GLY 5575	Coastal Geology
G	GLY 5736	Marine Geology
G	GLY 5757C	Fundamentals of Remote Sensing, Air Photo Interpretation and GIS for the Earth Sciences
G	GLY 5885	Geologic Hazards Assessment
G	GLY 5887	Environmental Geology
G	GLY 5577	Sedimentary Basin Analysis
U	OCE 1001	Elementary Oceanography
U	OCE 4008	Principles of Oceanography
U	OCE 4017	Issues in Env Science
U	EOC 4631	Marine Pollution
U	OCB 4631	Estuarine and Coastal Ecology
U	ISC 2003	Global Change
U	OCE 4930	Studies in Oceanography
G	OCE 5018	Current issues in Environmental Science
G	OCE 5554	Habitable Planet
G	OCG 5106	The Earth System
G	OCG 5664	Paleoceanography
G	OCC 5554	Atmospheric Chemistry
U	OCC 4060	Environmental Science Modeling
G	MET 5105	Global Climate System
G	MET 5135	Dynamic Climatology
U	MET 2101	Physical Climatology
U	MET 4450	Atmospheric Physics II
G	MET 5451	Advanced Physical Meteorology II
U	MET 2700	General Meteorology
U	MET 1010	Introduction to the Atmosphere
U	MET 4159	Selected Topics in Meteorology
U	MET 3103C	Climate Change Science
G	MET 6155	Advanced Topics in Climatology
U	SCE 4835C	Teaching Earth and Space Science
U	GEO 3200	Physical Geography
G	GEO 5934	Advanced Quantitative Geography
G	GEO 5934	Seminar on Bayesian Analysis and Modeling
G	GIS 5106	Advanced GIS
G	GEO 4114	Env Field Methods
U	GEO 2200C	Physical Geography
G	GEO 5118C	Geographic Research
G	GEO 5934	Seminar in Complexity Theory
U	GEO 4930	Complexity & Hazards

U	GEO 1331	Environmental Science
G	GEO 5934	Seminar in Global Warming
G	GEO 5118c	Geographic Research
B	GEO 4930	Environmental Conflict & Economic Development
U	GEA 1000	World Geography
B	GEO 4930	Global Resource Governance
U	GEO 4930	Public Affairs
G	GEO 5058	Geographic Thought
U	GEO 4403	Global Change, Local Places
B	GEO 4151	Geographic Information Systems
B	GEO 4930	Intermediate GIS
U	GEO 5157	GIS for Environmental Analysis and Modeling
B	GEO 4930	Landscape Ecology
G	GEO5934	Environmental Change Modeling
G	GEO5934	GIS Programming
B	GIS 4043	Introductory GIS
U	GEO 1330	Environmental Science
G		Climate Change Seminar
G		Coastal & Ocean Law
G		Ecosystem Management
G		Endangered Ecosystems Seminar
G		Endangered Species Law
G	LAW 7841	Energy Law & Policy
G	LAW 6470	Environmental Law
G		Environmental Certificate Seminar
G		Environmental Legal Research
G		Florida Environmental Law
G		Florida Water Law
G		International Energy Law
G	LAW 7268	International Environmental Law
G	LAW 6460	Land Use Regulation
G		Law of the Sea
G	LAW 6480	Natural Resources Law
G		Planned Communities
G		Public Rights in Water Law
G		Sustainable Development Seminar
G		Water Law
G	URP 5429	Planning for and Mitigating Climate Change
G	URP 5422	Coastal Planning
	URP 5421	Introduction to Environmental Planning and Natural Resource Management
U	PUP 4203	Environmental Politics and Policy
U	ANT2511	Introduction to Physical Anthropology
U	ANT4586	Human Evolution
U	ANT3141	World Prehistory
U	ANT4153	North American Archaeology
U	ANT4125	Paleonutrition
U	ANT4269	Economic and Ecological Approaches in Anthropology
U	EML 4450	Energy Conversion Systems for Sustainability

New College of Florida		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	20167	The Sociology of Sustainable Communities
U	20241	Environmental Governance and Policy-making
U	80256	The Political Economy of the Global Environment
U	80079	Introduction to Cultural Anthropology
U	80233	Urban Sociology
U	80263	Climate, Ecosystems and Society: A Climate Affairs Approach
U	80222	Coastal Ecology
U	20105	Coral Reef Ecology
U	20222	Bio Diversity and Conservation
U	80268	Introduction to Environmental Studies
University of Central Florida		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	ISC 3930H	Global Environmental Change
G	CWR 5937	Water Resources in a Changing Environment
U	CHS 4615	Environmental Chemistry
U	MET 2104	The Earth's Climate
U	INR 4350	Global Environmental Politics
U	INR 4351	International Environmental Law
U	PLA 4554	Environmental Law
U	BSC 1050	Biology and Environment
U	PCB 3044	Principles of Ecology
G	PCB 6328C	Landscape Ecology
U	BSC 4861L	Sustainability: Socially & Economically Viable Environmental Protection
U	CEG 3301	Engineering and Environmental Geology
U	ENV 3001	Introduction to Environmental Engineering
U	ECP 3302	Economics and the Environment
U	ECP 4303	Environmental and Natural Resource Economics
U	IDS 3150	Foundations of Environmental Studies
U	IDS 4156	Solving Environmental Problems
U	INR 3016	Global Political Issues
U	PAD 3330	Urban and Regional Planning
U	PAD 4351	Issues in Environmental Program Management
G	PAD 5338	Land Use and Planning Law
U	PHI 3640	Environmental Ethics
U	PUP 3203	Environmental Politics
U	PUP 4204	Sustainability
U	SYD 4510	Environment and Society
U	SYD 4514	Environmental Movement
G	SYD 5517	Environment and Society
U	PHM 4031	Environmental Philosophy
G	PHM 5035	Environmental Philosophy
University of Florida		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		

Level	Number	Title
G	ABE6252	Advanced Soil and Water Management Engineering
G	CPO 6796	Water Politics
G	CWR 6115	Surface Hydrology
G	CWR 6537	Contaminant Subsurface Hydrology
G	EES5105	Advanced Wastewater Microbiology
G	EES5207	Environmental Chemistry
G	EES5315	Ecology and the Environment
G	EES6136	Aquatic Autotrophs
G	EES6145	Environmental Meteorology and Oceanography
G	EES6225	Atmospheric Chemistry
G	ENV5105	Foundations of Air Pollution
G	ENV6146	Atmospheric Dispersion Modeling
G	FOR6005	Conservation Behavior
G	GEO 5305	Environmental Biogeography
G	GEO 5809	Geography of World Agriculture
G	GEO 5945C	Field Course in Geography
G	GEO 6118:	Contemporary Geographic Thought and Research
G	GEO 6255:	Climatology
G	GEO 6375:	Land Change Science Seminar
G	GEO 6495:	Environment and Behavior
G	GLY 6075:	Global Climate Change: Past, Present, and Future
G	GLY 6695	Topics in Paleoclimatology
G	HOS5616	Agricultural Meteorology
G	IND5428	Materials for Interior Design
G	MET 5504	Weather and Forecasting
G	MET 6530	Hurricanes
G	MET 6752	Atmospheric Data Analysis
G	SWS5406	Soil and Water Chemistry
G	SWS6136	Soil Fertility
G	SWS6456	Advanced Biogeochemistry
G	URP6421	Environmental Impact Statements
G	WIS6934	Species Distribution Modeling
G	WISXXXX	An undergraduate course on Case studies in Climate Change Ecology
U	BSC 2862	Global Change Ecology and Sustainability
U	AGG 3501	Environment, Food and Society
U	AGR 4212	Alternative Cropping Systems
U	AGR 4268C	Sustainable Agriculture Systems Analysis
U	EES 3000	Environmental Science and Humanity
U	EES 3008	Energy and Environment
U	EES 4021	Modeling Environmental Systems Dynamics
U	EES 4370	Environmental Meteorology and Oceanography
U	ENV 4612	Green Engineering Design and Sustainability
U	ESC 1000	Introduction to Earth Science
U	ESC 1000L	Introduction to Earth Science Laboratory
U	GEO 2242	Extreme Weather
U	GEO 3250	Climatology
U	GEO 3280	Principles of Geographic Hydrology
U	GEO 3315	Geography of Crop Plants

U	GEO 3341	Extreme Floods
U	GEO 3352	The Human Footprint on Landscape
U	GEO 3372	Conservation of Resources
U	GEO 4221	Coastal Morphology and Processes
U	GEO 4281	Fluvial Morphology and Processes
U	GEO 4285	Models in Geographic Hydrology
U	GEO 4300	Environmental Biogeography
U	GLY 1000	Exploring the Geological Sciences
U	GLY 1102	Age of Dinosaurs
U	GLY 1150L	Florida Geology Laboratory
U	GLY 1880	Earthquakes, Volcanoes and Other Hazards
U	GLY 2030C	Environmental and Engineering Geology
U	GLY 2080C	Introduction to Marine Science
U	GLY 3074	Oceans and Global Climate
U	GLY 4571	Fluvial Morphology and Processes
U	GLY 4734	Coastal Morphology and Processes
U	MET 3503	Weather and Forecasting
U	MET 4532	Hurricanes
U	MET 4750	Atmospheric Data Analysis
U	PCB 3034C	Introduction to Ecology
U	REL 2071	Sustainability and Religion
U	REL 2166	Religion and the Environmental Crisis
U	REL 3169	Religion and Environmental Movements of the Global South
U	REL 3492	Religion Ethics and Nature
U	REL 4168	Religion, Nature and Society
U	REL 4173	Religion, Ethics and Sustainable Agriculture
University of Miami		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	ECS 111	Introduction to the Earth's Ecosystem
U	ECS 113	Introduction to Environmental Policy
U	ECS 201	Seminar Series in Contemporary Environmental Issues I
U	ECS 372	Special Topics in Ecosystem Science and Policy—Reporting Global Environmental Issues
U	ECS 372	Special Topics in Ecosystem Science and Policy/INS 394—Energy Policies of the US and EU
U	ECS 372	Special Topics in Ecosystem Science and Policy—Transnational Social Movements and Global Transformation
U	ECS 372	Special Topics in Ecosystem Science and Policy/INS 311 Geopolitics of Natural Resources
U	INS 322	Economic Development and the Environment
U	GSC 101	Evolution of the Biosphere
U	GSC 103	Evolution of the Modern Earth Environment
U	GSC 111	Earth System History
U	GEG 303	Remote Sensing of the Environment
G	ARC 585	Contemporary Green Design
U	ECS 204	Environmental Statistics
U	ECS 301	Tools for Environmental Decision-Making: The Quantitative Perspective

U	ECS 372	Special Topics in Ecosystem Science and Policy—Tourism and Development in Latin America
U	ECS 372	Special Topics in Ecosystem Science and Policy—Environmental Filmmaking
U	ECS 372	Special Topics in Ecosystem Science and Policy—The Anthropology of Sustainability
G	INS 504	Alternative Global Futures
U	ARC 223	Architecture and the Environment
U	ECO 345	Economics of Natural Resources and the Environment
U	CAE 581	Energy Efficient Building Design
G	MPO 503	Principle of Physical Oceanography
G	MPO 511	Geophysical Fluid Dynamics I
G	MPO 518	Remote Sensing of the Atmosphere
G	MPO 521	Estuarine and Coastal Processes
G	MPO 531	Physical Meteorology
G	MPO 542	Physics of Remote Sensing
G	MPO 551	Introduction to Atmospheric Science
G	MPO 561	Tropical Meteorology
G	MPO 611	Geophysical Fluid Dynamics II
G	MPO 612	Large-Scale Ocean Circulation
G	MPO 615	Numerical Weather Prediction
G	MPO 621	Waves and Tides
G	MPO 623	Statistical Analysis of Geophysical Data
G	MPO 624	Statistical Modeling of Geophysical Fields
G	MPO 631	Air-Sea Interaction
G	MPO 632	Climate Dynamics
G	MPO 633	Marine Atmospheric Boundary Layer
G	MPO 650	Coastal Oceanography
G	MPO 661	Synoptic-Scale Meteorology
G	MPO 662	Compute Models of Fluid Dynamics
G	MPO 663	Convective and Mesoscale Meteorology
G	MPO 664	Atmospheric and Oceanic Turbulence
G	MPO 665	General Circulation of the Atmosphere
G	MPO 671	Advanced Studies
University of North Florida		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	ESC 2000C	Earth Science
U	GEO 2200	Physical Geography
U	GEO 3372	Conservation of Natural Resources
G	SYP 6447	Social Change and Development
U	BSC 3057	Introduction to Environmental Studies
U	BCN 4587C	Green Construction and Sustainability I
U	BCN 4594C	Green Construction and Sustainability II
G	BSC 6098C	Environmental Physiology
U	BSC 3263	Marine Biologoy
U	BSC 3052	Conservation Biology
U	BSC 4054	Environmental Toxicology
U	OCE 3008	Oceanography

U	INR 3016	Global Issues in Contemporary Politics
U	INR 3443	International Law and Organization
U	INR 4930	Capstone Seminar: International Studies
U	CHS 4610	Environmental Chemistry
U	HIS 3403	Nature, Power and Metropolis
U	ENV 3001C	Environmental Engineering
U	ENV 4012	Advanced Environmental Engineering
B	PCB 6446	Ecology of Wetlands
U	IDH 3352	Florida As Text: An Ecological Inquiry
G	PCB 5314C	Marine Ecology
G	PHI 5691	Environmental Ethics
G	PAD 5385	Public Policy Formation and Implementation
G	SYD 6515	Environment and Society
G	BCN 6595	Environmental Issues in Land Development and Construction
U	BSC 3053	Health Effects of Environmental Pollutants
U	PHI 3640	Environmental Ethics
U	PHM 2030	Ecological Philosophy
U	SYD 4510	Environment and Society
U	IDH 3652	Service Learning: Environmental Issues
U	BSC 1930	Current Applications in Biology
U	BSC 4930	Marine Mammals
U	BSC 4930	Coastal Management
G	BSC 6990	Aquatic Toxicology
U	HIS 4960	Environmental Oral History
U	HIS 4963	Global Environment History
G	PCB 6447	Community Ecology
U	PHI 3930	Justice/Gender/ & Environment
University of South Florida		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	BSC 2025	Food: Personal and Global Perspectives
U	BSC 2050	Environment
U	EDF 3228	Human Behavior and Environmental Selection
U	ENV 2073	Global Warming: Science and Politics of a Contemporary Issue
U	EVR 2002	Environmental Science: Regional and Global Issues
U	EVR 2217	Energy, Environment, and Sustainability
U	EVR 4114	Climate Change
B	EVR 4934	Global Climate Change
G	EVR 6922	ESP Capstone Seminar
U	GEO 2371	Introduction to Earth Systems Science
G	GEO 6255	Weather, Climate and Society
U	GLY 2010	Dynamic Earth: Introduction to Physical Geology
U	GLY 2073	Global Climate Change
G	GLY 6075	Greenhouse-Icehouse Earth
U	HSC 4001	Foundations of Global Health
U	IDS 2664	Social Science Perspectives I
G	IDS 6215	Seminar in Global Sustainability
G	IDS 6946	Sustainability Internship

U	MET4002C	Climatology
G	MET 6140	Weather, Climate and Society
U	PSC 2515	Energy and Humanity
U	WST 3225	Women, Environment and Gender

University of West Florida		
U=Undergraduate, G= Graduate, B=Both graduate and undergraduate		
Level	**Number**	**Title**
U	BSC 2311	Introduction to Oceanography and Marine Biology
U	BSC 4263	Biological Oceanography
U	GEO 1200	Physical Geography
U	GEO 3250	Weather and Climate
U	GEO 2330	Environmental Science
U	GEO 3372	Conservation of Natural Resources
B	GEO 4221	Coastal Morphology and Processes
U	GEO 4280	Basic Hydrology
B	GEO 4333	Seminar in Environmental Issues
U	GLY 3031C	Environmental Geology
B	GLY 4990	Natural Disasters
U	EVR 4023	Coastal and Marine Environments
U	EVR 4035	Environmental Law
G	EVS 6196C	Environmental Sampling and Analysis
U	OCE 3008	Oceanography
U	OCB 4550	Global Climate Change: Ocean/Atmospheric Interactions
U	OCC 4002	Chemical Oceanography
U	OCG 4050	Geological Oceanography

Appendix V. Guiding Questions from Breakout Session

Questions to guide breakout group discussions – Education and Training

1. What are the existing educational opportunities in the SUS regarding climate (climatology, meteorology, oceanography, etc.) and climate change in particular? *approximately 20 minutes*

2. What are existing educational opportunities in the SUS regarding interdisciplinary studies on climate change and societal responses? *approximately 20 minutes*

3. Are there gaps in undergraduate and graduate climate change related education programs that need to be filled? *approximately 30 minutes*

4. What mechanisms exist to allow any student in an SUS university to take courses that may exist in other universities, and how can this situation be improved? *approximately 20 minutes*

5. What SUS-organized continuing education and outreach programs currently exist? What sectors are being targeted (public, professional and business)? *approximately 15 minutes*

6. Are there opportunities to develop collaborative outreach and continuing education programs via a consortium of SUS universities? What programs or working groups currently exist? *approximately 30 minutes*

7. How might we improve communication between educational institutions to advance climate change learning? *approximately 30 minutes*

Appendix VI. Taking Courses across the Florida State University System

Taking Courses across the Florida State University System (SUS)

How can a student enrolled in one university take a course in another university within the Florida SUS? This question has been raised regarding climate change issues and courses offered by various universities throughout the state. The process already exists and is actually fairly simple. Here are the basic steps:

A. Students active in a state university, e.g., Florida Atlantic University (FAU). Note: this information is based on policies currently in effect at FAU and may vary at other institutions.

1. Complete a "Transient Student Form" for your university (see color coded sample form on page 2)

- The student completes the lines highlighted in yellow, i.e., Section A with their information, signature and date and the course information in Section B
- The student then takes it to their academic advisor who can check on FAU equivalency, verify that the course would count toward the students' degree and signs the form (green highlights) – a critical point. Sometimes there is no course equivalent (often the reason to take a course at a different university that may have different specialties, such as climate change).
- It then gets sent to the Registrar's office, who will sign, date and stamp the form (pink). This typically takes two to three days, but may take up to a week during very busy time (such as the Drop-Add period). Timing may vary between campuses and universities.

2. The student will be given the white and yellow copies of the multi-copy Transient Student Form. As stated at the bottom of the form, the student keeps the yellow form and provides the white copy to the Registrar of the receiving school.

3. At this time (Spring 2011) there is no fee for the Transient Student Form at FAU, but this may vary from one university to another.

4. Students should keep their copy with their permanent records, at least until it shows up on their permanent transcript.

B. Students enrolled in a private college or out-of-state college or university

1. Students enrolled in a private or out-of-state college or university need to complete a Non-Degree Seeking Student Application Form.

- There is a $30 application fee (e.g., FAU) but this is paid only once.
- This is good for as long as the student is active in the university system, i.e., taking at least one course per year. If a student does not take a course for three consecutive semesters, they will need to fill out a new application form with proof of residency, but should not need to pay a new fee (good to check).

2. Students would need to check with the academic advisor at their college or university to determine if they would receive credit for the transferred course upon completion.

C. Students enrolled at Florida's State Colleges. In general, students enrolled at a Florida State College would follow the steps using the Transient Student Form described above, however, they would need to check if they have the proper prerequisites or get permission to take the course.

Appendix VII. Additional Resources

Institutions & Websites	
Institution	**Website**
Coastal Areas Climate Change Education Partnership	http://cacce.net
AgroClimate	www.agroclimate.org
American College and University Presidents' Climate Commitment	http://www.presidentsclimatecommitment.org/
Center for Environmental and Sustainability Education	http://www.fgcu.edu/cese/
Center for Environmental Diagnosis and Bioremediation	http://uwf.edu/cedb/index.cfm
Center for Environmental Equity and Justice	http://www.famu.edu/index.cfm?environmentalscience&CEEJ
Center for Marine Ecosystem Health	http://www.fau.edu/hboi/OceanHealth/index.php
Center for Ocean-Atmospheric Prediction Studies	http://coaps.fsu.edu/
Coastal Hydroscience Analysis, Modeling and Predictive Simulations	http://champs.cecs.ucf.edu/
Cooperative Institute for Marine and Atmospheric Studies	http://cimas.rsmas.miami.edu/index.html
Earth System Science Education Alliance	http://essea.strategies.org/
Ecosystem Based Management Tools Network	http://www.ebmtools.org
Environmental Center	http://www.unf.edu/ecenter/
Environmental Cooperative Science Center	http://www.ecsc.famu.edu/
Environmental Science Institute at Florida A&M University	http://www.famu.edu/index.cfm?environmentalscience&ESIHome
Florida Aquarium, Inc	http://www.flaquarium.org/
Florida Center for Environmental Studies	http://www.ces.fau.edu/
Florida Climate Center	http://coaps.fsu.edu/climate_center/index.shtml
Florida Climate Change Task Force	http://floridaclimate.org/
Florida Climate Institute	http://floridaclimateinstitute.org/
Florida Department of Environmental Protection	http://www.dep.state.fl.us/
Florida Fish and Wildlife Conservation Commission	http://myfwc.com/
Florida Institute of Oceanography	http://fio.usf.edu/Home.aspx
FSU Coastal and Marine Laboratory	http://www.marinelab.fsu.edu/
Global Water for Sustainability	http://www.globalwaters.net/
GLOBE program	http://www.globe.gov/
Institute for Energy Systems, Economics, and Sustainability	http://www.ieses.fsu.edu/

Integrative Collaborative on Climate & Energy	http://www.ces.fau.edu/climate_change/icce
International Hurricane Center	http://www.ihc.fiu.edu/
NASA / Waterscapes	http://web.eng.fiu.edu/waterscapes/WaterSCAPES_web/WaterSCAPES.html
Patel School of Global; Sustainability	http://sgs.usf.edu/ma-courses.php
Public Water Supply Utilities Climate Impacts Working Group	http://waterinstitute.ufl.edu/workshops_panels/PWSU-CIWG.html
R.J. Dunlap Marine Conservation Program	http://rjd.miami.edu/
Regional Climate Centers	http://www.ncdc.noaa.gov/oa/climate/regionalclimatecenters.html
Regional Planning Councils	http://ncfrpc.org/state.html
Rosenstiel School of Marine and Atmospheric Science	http://www.rsmas.miami.edu/about-rsmas/
Scripps Howard Institute on the Environment	http://www.fau.edu/scrippsjournalism/
Southeast Climate Consortium	http://seclimate.org/
Southeastern Environmental Research Center	http://casgroup.fiu.edu/serc/pages.php?id=1737
The National Ecological Observatory Network	http://www.neoninc.org/about/overview
University of Florida Water Institute	http://waterinstitute.ufl.edu/