Appendix IV.

The Department
Of
Marine Earth and Atmospheric Sciences

Earth Systems Program

ESP

A Compact Plan

Submitted to: Dan Solomon, Dean
College of Physical and Mathematical Sciences

Submitted by: John Fountain, Head
Marine Earth and Atmospheric Sciences
November 15, 2006

Department of Marine Earth and Atmospheric Sciences
DRAFT DRAFT DRAFT DRAFT
Earth Systems Program

The Department of Marine Earth and Atmospheric Sciences (MEAS) proposes to develop a nationally prominent research program utilizing our distinctive breadth of disciplines that focuses on the coupled air and water systems of our planet.

The problems to be addressed, including natural hazards from severe storms, water resources, environmental effects of urbanization and global climate change, are of first order importance to society and involve fundamental science questions.

The current strengths of our department include quantitative modeling (prediction) of weather and climate and the study of anthropogenic forcings on the environment. We propose to build on these strengths to develop a program of integrated studies of the coupled atmospheric and hydrologic earth systems.

The problems are of global concern and are central to the issue of sustainability. Although the scope and significance of the problems are widely acknowledged, no long-term solutions are in sight. The proposed program supports the University Thrust Area "Environmental Sciences - study and research in interactions among the Earth's atmosphere, biosphere, hydrosphere, and lithosphere." (note: university thrust areas for 2006-2007 have not been finalized)

Due to the extensive coupling between the atmosphere and hydrosphere, it is necessary to consider the entire system in order to quantify the role of individual components. Thus the common approach of addressing specific issues as isolated factors is unlikely to lead to optimal long term strategies to preserve our air, water and soil resources and mitigate natural hazards. In view of the economic and social implications of changing either urban development or agriculture, the need for quantitative evaluation of the effects of proposed changes is evident. It is development of the ability to predict long term effects, and hence to quantitatively evaluate the consequences of various environmental policies, that is our objective. The Earth Systems Program (ESP) also directly addresses the current national interest in development of enhanced operational prediction/forecasting methods aimed at both natural hazard mitigation and homeland security issues.

ESP builds upon the central theme of MEAS: Prediction and Modeling of Earth Systems. All three program areas, atmospheric science, earth science and marine science are currently involved in this research. We have well-established climate, meteorology, air and water quality programs, which involve the majority of our faculty from all three program areas. This program will integrate these programs by adding strength to the areas of their interfaces.

The initiative will stimulate research in the program areas, will allow major expansion of graduate and undergraduate programs in these areas of high demand and will improve instructional quality by addressing gaps in the current program offerings. Existing collaborations with the agricultural colleges (CALS, CNR and CVM), and with nearby Federal facilities (EPA, NOAA, USGS, NCDC, NIEHS) provide support for the initiative and will be enhanced by it. The extensive land, sea and air monitoring systems being constructed by our various programs

(NC ECONet, RiverNet and Caro-COOPS) combined with other planned monitor systems (e.g. SEA COOS) will provide an infrastructure for calibration and validation of models that cannot readily be duplicated by other programs.

We propose to use a combination of departmental resources (3 faculty positions) and college/ university positions (2 additional faculty in our department). The resources required include start up funds for these faculty and rehab of existing lab space.

The Earth Systems Program (ESP) will:

1) Put NC State in the forefront of an area of critical local, national and international importance which is certain to be a major focus of science over the next several decades.
2) Allow expansion of our graduate and undergraduate programs in an area of high student demand.
3) Provide a substantive increase in program quality through integration of inherently multi-disciplinary programs, filling of existing gaps between the disciplines and reduction in the current overload of our faculty in this area.
4) Develop partnerships with other colleges, federal agencies and other Universities that are involved in parallel research in air and water quality.
5) Continue the planned development of MEAS in a manner which both strengthens and focuses our program.
6) Provide direct, immediate and continuing benefit to the citizens of North Carolina through research on severe storms, water quality, water resources, soil and beach erosion and effects of continuing development and future climate change on the estuarine and near-coastal environment.
7) Strengthen our efforts at building diversity in our student population through the emphasis on benefits to society – which has been shown to be an important criteria for attraction of women and minority to career paths.

Weather and Climate (including air quality, water quality and water supply), have a profound influence on the economy, on the environment, on public safety and health and on national security. National needs resulting from current concerns in these areas have raised the bar for climatological studies; a new class of predictive models for air and water quality is required that necessitates a more comprehensive and quantitative knowledge of the complex cycles involved. As a result, studies of the atmospheric, hydrologic and biogeochemical cycles involved will be a national priority for decades to come – as detailed in the funding section of this document. This initiative is designed to position NC State to be a national leader in environmental prediction and modeling.

The source terms that influence both climate and resources including urbanization and agricultural operations, the pollution pathways: air and water, and the effects on ecosystems each involve numerous disciplines and cross the boundaries of major regulatory and funding agencies. As a consequence, the problem of anthropogenic environmental degradation and climate change have historically been addressed in a piecemeal fashion; local concern over air pollution associated with swine operations, without consideration of potential water pollution and concern over surface water pollution from sewage treatment plants while ignoring the potentially large ground water component are current examples in North Carolina where only one small aspect of the overall problem is being addressed.

Components of the Initiative

The initiative is designed to provide the personnel and equipment necessary to successfully compete for large-scale sponsored research funding for integrated environmental, climatological and meteorological studies. Specifically, to undertake complete studies of the cycling of water, nitrogen, carbon and other environmentally important elements and compounds and to integrate the evidence of the geologic record into climatological studies. The effort would include fundamental and applied research including measuring of parameters such as fluxes, transport coefficients, and ecological indicators and model development using a total systems approach.

In order to develop research at the scale necessary for the initiative, 5 new faculty in MEAS are required; we propose to use two currently open lines and one projected near-term future retirement line to provide three of the hires, the other two would be new positions provided to the department.

1. **Data assimilation:** Assimilation of data into models is a characteristic of modern models, driven by the continual increase in available remotely sensed data. One position will be a specialist in the use of data assimilation in modeling. This position will support our modeling efforts in all three disciplines.

2. **Surface processes:** Erosion soil from urbanization and intensive agriculture, and of beaches near shore areas from severe storms and climate change are important components of the coupled system. A specialist in surface processes will address these components. This position will support our earth science and marine science areas.

3. **Hydrometeorology:** Hydrometeorology is one of the important intersection areas of the hydrologic and atmospheric cycles. It is vital in understanding flooding, droughts, the effect of climate change and water resources. This position will strengthen our meteorology and hydrology programs.

4. Remote Sensing: Remote sensing (including satellite and other platforms) provides increasingly valuable information on atmospheric, marine and land use parameters. It is a major source of real time data for models. This position will contribute to each of our program areas.

5. Instrumentation Developer: Models require data for calibration and validation. One of our department's specialties is monitoring in the air (e.g. NC EcoNet, sea (e.g. CaroCOOPs) and on land(e.g. RiverNet), developing a fully instrumented estuary system is a major objective of our department. An instrumentation specialist would help develop future instrumentation.

This plan is complementary to our long standing initiative (incorporated into all three previous compact plans) to develop a coastal ocean/estuarine monitoring network to complement our physical, chemical and biological estuarine research programs. It builds upon the existing strengths in the department by providing linkages between programs, a necessary step in developing an earth systems approach to the hydrologic and atmospheric systems.

Research in data assimilation is also taking place in the statistics department; our proposal to develop excellence in this area will also support statistics efforts at development in the same area. The associated problems of data assimilation, data mining and computation involving extremely large data sets also overlaps with interests in the mathematics department.