Earth System Science (ESS)
FY2013 Information Sheet

Program Overview and Goals

The Earth System Science (ESS) program aims to provide a process-level understanding of the climate system through observation, modeling, research, analysis, and field studies to support the development of improved climate models and predictions.

ESS-sponsored activities are carried out at NOAA and other federal laboratories, NOAA Cooperative Institutes, private research companies, and academic institutions. Research supported by ESS advances understanding of: 1) the behavior and predictability of land-atmosphere-ocean-cryosphere system interactions giving rise to climate variability and change on multiple timescales, 2) the location and quantification of global carbon sources and sinks, and 3) the role of aerosols and chemically-active greenhouse gases in the global climate system. Research supported by ESS is coordinated with major national and international scientific bodies including the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), and the U.S. Global Change Research Program (USGCRP).

In FY2013, the ESS program will accept proposals in three main areas: 1) Understanding and Improving Prediction of Tropical Convection using results from the DYNAMO (Dynamics of the Madden-Julian Oscillation) Field Campaign, 2) Atlantic Meridional Overturning Circulation (AMOC) - Mechanisms and Decadal Predictability, and 3) Atmospheric Chemistry, Carbon Cycle, and Climate. Each of these areas directly contributes to the *"Improved Scientific Understanding of the Changing Climate System and its Impacts"* objective in NOAA's Next-Generation Strategic Plan available at: http://www.ppi.noaa.gov/ngsp/ as well as the newly released document, "*The National Global Change Research Plan 2012-2021: A Strategic Plan for the U.S. Global Change Research Program available at:* http://library.globalchange.gov/u-s-global-change-research-program-strategic-plan-2012-2021

1) Understanding and Improving Prediction of Tropical Convection using Results from the DYNAMO (Dynamics of the Madden-Julian Oscillation) Field Campaign

The Dynamics of the Madden-Julian Oscillation (DYNAMO) was an international research field campaign (http://www.eol.ucar.edu/projects/dynamo/) motivated by two outstanding problems: (i) Current prediction skill for the Madden-Julian Oscillation (MJO) is very limited and is lowest for the MJO initiation phase over the Indian Ocean, and (ii) The inability of state-of-the-art global models to produce the MJO degrades their seasonal to interannual predictions and weakens our confidence in their ability to project future climate.

The goal of DYNAMO is to expedite the understanding of processes key to the MJO, especially its initiation, in the Indian Ocean region and our ability to simulate/predict the MJO. DYNAMO consists of four integrated components: field observations, data analysis, modeling, and forecasting. The DYNAMO field campaign was proposed as the U.S. component of CINDY2011 (Cooperative Indian Ocean Experiment on Intraseasonal Variability in Year 2011), an international field program that ran from October 2011 – early February 2012 over the equatorial central Indian Ocean. Four countries (France, India, Japan, and the United States) participated. The DYNAMO campaign was augmented by other field programs (AMIE, HARIMAU, PAC3E-SA, ONR Air-Sea Interaction) also taking place in late 2011 - early 2012.

In FY2013, the ESS program invites modeling and analysis proposals using data collected during the DYNAMO field campaign. It is expected that these data will be freely available in late March 2013. Proposals should focus on improving the understanding of one or more of the three aspects of physical processes deemed to be critical to the MJO initiation and its representation in models: interaction between convection and environmental moisture, the dynamic evolution of the cloud population, and air-sea interaction. DYNAMO hypotheses target critical, but poorly observed processes in MJO initiation: shallow cloud moistening, convective sensitivity to environmental moisture, low- vs. upper-level diabatic heating, large-scale moisture advection and convergence, surface evaporation, the ocean barrier layer, upper-ocean mixing and entrainment, among others. A better understanding of these processes is an essential step toward improving their representations in numerical models and improving MJO simulation and prediction. Proposals will be considered that either focus on model analysis of events during this time period or direct analysis of data collected during the campaign, or a combination of both of these activities. Interactions with NOAA laboratories and centers are encouraged.

2) Atlantic Meridional Overturning Circulation (AMOC) - Mechanisms and Decadal Predictability

The Joint Subcommittee on Ocean Science and Technology (JSOST) identified the improved understanding of the mechanisms behind fluctuations of the Atlantic Meridional Overturning Circulation (AMOC) as a near-term priority in the *Ocean Research Priorities Plan*. As highlighted in the recent *Fourth Annual Progress Report for a SOST Near-Term Priority: Assessing Meridional Overturning Circulation Variability: Implications for Rapid Climate Change*, much progress has been made on the main objectives identified in the *Ocean Research Priorities Plan*. Further effort is needed, however, in understanding AMOC variability mechanisms and the model dependencies of those mechanisms, especially in examining how these mechanisms affect decadal predictability.

In FY2013, the ESS program invites focused multi-model analyses and experimentation that seek to better understand the mechanisms of AMOC variability and predictability in different models. The use of model ensembles developed for the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5) is highly encouraged. Successful principal investigators will become members of the U.S. AMOC Science Team.

3) Atmospheric Chemistry, Carbon Cycle, and Climate (AC4)

Recognizing the many connections linking research into greenhouse gases, aerosols, and climate, ESS is integrating its previous efforts in these areas in the hope of stimulating a more holistic approach to studies of atmospheric chemistry and carbon cycle as they relate to climate. In FY2013, Atmospheric Chemistry, Carbon Cycle, and Climate (AC4) will concentrate on three focus areas. Preference will be given to proposals illustrating a direct link with the priorities listed below. Please note that these research focus areas are not necessarily independent; proposals that aim to address more than one focus area will be considered of higher relevance.

a. Observational constraints on emissions of greenhouse gases

Accurate estimates of greenhouse gas and aerosol precursor emissions are at the core of climate forcing calculations. Both anthropogenic and natural emission estimates, however, remain very uncertain. Terrestrial emission estimates, particularly of biogenic aerosol precursors and of agricultural ammonia, nitrous oxide, and methane, represent a gap in knowledge, and they would benefit from additional observations and from analysis of recent and future NOAA field measurements (e.g. CalNex, SENEX). Emissions from megacities and other metropolitan areas, both in the U.S. and abroad, are projected to grow in coming decades, and their estimates require targeted measurements (such as CalNex and INFLUX) and analysis of multi-species and/or isotopic data sets. Recent increases in emissions from oil and gas extraction are only beginning to be measured, and additional observations and analysis are needed to confirm uncertain inventory estimates for this source sector.

In FY2013, research is solicited that aims to put observational constraints on emission estimates from terrestrial sources, metropolitan areas, and oil-gas extraction. Projects in collaboration with NOAA scientists that quantify emissions via modeling and analysis of existing and future NOAA and related data are encouraged.

b. Improvements to CarbonTracker

Policy makers, industry, scientists, and the public need accurate carbon dioxide flux information to make informed decisions related to atmospheric greenhouse gas levels. NOAA/ESRL/GMD's CarbonTracker, a system that produces quantitative estimates of atmospheric carbon uptake and release for North America and the rest of the world that are consistent with observed patterns of CO_2 in the atmosphere, is designed to supply that information. The new release of CarbonTracker ("CT2011") uses multiple models to explicitly estimate the influence of first-guess fluxes on the final result. CarbonTracker is intended to be a tool for the community, and feedback and collaboration from anyone interested are welcome.

In FY2013, research is solicited that focuses on the analysis and modeling of terrestrial, atmospheric, and oceanic observations and processes in collaboration with CarbonTracker (http://www.esrl.noaa.gov/gmd/ccgg/carbontracker/) team members to incorporate alternative models of atmospheric transport and surface CO_2 exchange in the CarbonTracker analysis framework. In addition, research into assimilation methods for using carbon dioxide mole fraction estimates from aircraft measurements and satellite retrievals in CarbonTracker is solicited.

c. Improved understanding of nitrogen cycle

Human activities have vastly perturbed the nitrogen cycle, which has resulted in emissions and deposition of climate-relevant atmospheric constituents. While N_2O is a major greenhouse gas and ozone depleting substance, other nitrogen containing species contribute to ozone production and aerosol formation, with a resulting mix of uncertain positive and negative radiative forcing. Extensive measurements have been made of various nitrogen containing species (e.g. SOS99, CalNex, NACHTT), including aerosols and aerosol precursors.

In FY2013, modeling and analysis proposals are solicited that employ multiple NOAA data sets (as well as complementary data collected by others) to focus on the elements of the nitrogen cycle that are relevant to stratospheric ozone and/or climate, including interactions between the nitrogen and carbon cycles.

Program Contact information:
For additional information, investigators should contact the following program managers:

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Letters of Intent should be submitted directly to the program manager(s) of the competition of interest with a cc: to Kendra Hammond (kendra.hammond@noaa.gov, 301-734-1223)