Accelerated Prediction of the Polar Ice and Global Ocean (APPIGO)

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Award #: N00014-13-1-0861
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LONG-TERM GOALS

Arctic change and reductions in sea ice are impacting Arctic communities and are leading to increased commercial activity in the Arctic. Improved forecasts will be needed at a variety of timescales to support Arctic operations and infrastructure decisions. Increased resolution and ensemble forecasts will require significant computational capability. At the same time, high performance computing architectures are changing in response to power and cooling limitations, adding more cores per chip and using Graphics Processing Units (GPUs) as computational accelerators. This project will improve Arctic forecast capability by modifying component models to better utilize new computational architectures. Specifically, we will focus on the Los Alamos Sea Ice Model (CICE), the HYbrid Coordinate Ocean Model (HYCOM) and the Wavewatch III models and optimize each model on both GPU-accelerated and MIC-based architectures. These codes form the ocean and sea ice components of the Navy's Arctic Cap Nowcast/Forecast System (ACNFS) and the Navy Global Ocean Forecasting System (GOFS), with the latter scheduled to include a coupled Wavewatch III by 2016. This work will contribute to improved Arctic forecasts and the Arctic ice prediction demonstration project for the Earth System Prediction Capability (ESPC).

OBJECTIVES

The objective of this effort is to create versions of the Los Alamos Sea Ice Model (CICE), the HYbrid Coordinate Ocean Model (HYCOM) and the Wavewatch III models that can perform optimally on both GPU-accelerated and MIC-based computer architectures. These codes form the ocean and sea ice components of the Navy's Arctic Cap Nowcast/Forecast System (ACNFS) and the Navy Global Ocean Forecasting System (GOFS), with the latter scheduled to include a coupled Wavewatch III by 2016. This work will contribute to improved Arctic forecasts and the Arctic ice prediction demonstration project for the Earth System Prediction Capability (ESPC).

APPROACH

We will utilize an incremental acceleration approach to ensure we maintain code fidelity while improving performance. We will begin by improving the performance of selected sections of each code and expanding those regions until we have accelerated the three application codes. Acceleration may start with directive-based mechanisms like OpenACC and OpenMP, but may also include targeted kernels written in CUDA or other lower-level accelerator libraries. This approach provides early successes and opportunities to test the changes as they are made. A second approach will redesign code

infrastructure to incorporate a multi-level parallelism by design. The modified codes will be validated both on a single component basis and within the forecast systems.

This work is part of a joint collaboration led by E. Chassignet (Florida State Univ.) that includes the Naval Research Lab – Stennis (A. Wallcraft, T. Campbell), Los Alamos National Lab (P. Jones, E. Hunke, R. Aulwes) and the University of Miami (M. Iskandarani, B. Kirtman).

WORK COMPLETED

As this project was started very late in the FY13, only some limited scoping work and planning for an initial kick-off meeting have taken place.

RESULTS

This project was initiated late in 2013, so no results are available at this time.

IMPACT/APPLICATIONS

If successful, this project will provide high-performance codes to enable future Arctic prediction.

RELATED PROJECTS

This project builds on the core model development activities taking place at the partner sites, including:

The Climate, Ocean and Sea Ice Modeling (COSIM) project that includes the primary development of the Los Alamos Sea Ice Model (CICE), funded by the US Department of Energy's Office of Science.

The ongoing development of the Arctic Cap Nowcast-Forecast System (ACNFS) and Global Ocean Forecast System (GOFS) at the Naval Research Lab – Stennis, funded by the US Navy.

Continued development of the Hybrid Coordinate Ocean Model (HYCOM) at Florida State University, funded by the National Science Foundation, Department of Energy and US Navy.