Initiating an Operational Canadian Global Assimilation and Prediction Capability for the Coupled Atmosphere-Ocean-Ice System

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Environment Canada (EC), the Department of Fisheries and Oceans (DFO), and the Department of National Defence (DND) all need the products that can be provided by an operational global coupled atmosphere-ocean-ice data assimilation and prediction system. With the availability of global sea level and surface temperature observations from satellites and upper-ocean water mass properties from Argo floats, and the existence of moored arrays in the tropics, the development of a data-assimilative global ocean model for Canada is now feasible (as demonstrated by initiatives in France, Japan, and the UK and US). The natural next step is to develop a data-assimilative coupled atmosphere-ocean-ice system that will take full advantage of these new data sets.

The atmospheric GEM model currently used by EC in operational weather forecasting has state-of-the-art dynamics and assimilative methodologies, but it needs to be coupled to active ocean and ice models to improve forecasting skill in some areas. DFO has been a major contributor to the Argo float program but it has made only a limited investment in the development of the modeling capacity required to make full use of the resulting data. EC has recognized the potential for improved short-, medium- and long-range weather forecasts, and both DFO and DND recognize that they would benefit greatly from the availability of improved oceanic and meteorological information. Although the opportunity and the potential benefits are obvious, the development, maintenance and continued improvement of the required technology are major tasks that are beyond the present capacity of any one department. The success of such an initiative will require significant long-term contributions from all three departments as well as input from the academic research community.

Here we report on initial steps for Canada to implement and improve an operational assimilation and prediction capability for the coupled global atmosphere-ocean-ice system, referred to as the Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS). The following paragraphs summarize the background developments and current status.

An Inter-agency Panel was formed in 2002 to make recommendations regarding the development of an operational coupled atmosphere-ocean-ice data assimilation and modelling capability. The Panel emphasized the following points in its report in January 2004:

1. A global system, with nested and coupled regional models dictated by scientific (e.g., tropical Pacific) and practical (northwest Atlantic, northeast Pacific) considerations, should be run

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operationally at the Canadian Meteorological Centre (CMC) as an increment to the existing infrastructure.

2. New long-term funding and permanent positions should be established to support this new activity.
3. There is an excellent opportunity to benefit from, and contribute to the international Global Ocean Data Assimilation Experiment (GODAE) activity.
4. Suggested products to be developed in the short term (within three years) include: basin scale analyses of ocean temperature, salinity and currents for DFO and DND needs; global wave forecasts for operational DND needs; and a prototype coupled sea ice system.
5. Suggested products to be developed in the medium term (within five years) include: daily to seasonal forecasts of SST for atmospheric models, three-dimensional initial ocean fields for climate simulations, and global forecasts of large scale ocean temperature, salinity and currents, with nested basin-scale models, for operational DFO and DND needs.
6. Suggested products to be developed in the longer term (beyond five years) include an operational model-assimilation system for forecasting changes in the coupled global ocean-atmosphere-ice system and re-analyses of marine environmental conditions (e.g., hydrographic conditions, extreme currents at the shelf break, mean circulation patterns).
7. A two-track approach was recommended: a "fast track" based possibly on an imported system installed at CMC and extended to meet short-term goals and demonstrate the utility of Argo data; and a parallel slow track enhancing research and development for a system tailored to Canadian needs and generating Canadian capacity. It was subsequently decided to add a products activity as mentioned below.

The panel recommendations have been accepted by senior departmental managers, resulting in the development of the new CONCEPTS inter-agency initiative. In the past year agreement-in-principle has been reached with the Mercator group (France) to install a version of their ocean data assimilation and prediction system at CMC, and collaborate in a number of core research projects directed towards improved capabilities for atmosphere-ocean-ice prediction at various scales. Initial resources have been put in place for the establishment of three major inter-related activities: 1) an operational activity based on coupling the Canadian atmospheric GEM model with the Mercator system; 2) a research and development (R&D) activity consisting of government and academic research networks to develop and maintain a system tailored to Canadian needs in the longer term; and 3) a products activity to identify, develop and disseminate relevant products and outputs. The operational activity is being built upon existing EC infrastructure and centres on the following core projects: 1) core CMC systems installation, coupling and support; 2) basin-to-global ocean reanalyses for prediction and validation studies; 3) demonstration of regional ocean prediction capability and applications; 4) sea ice modelling and data assimilation; 5) improved ocean data assimilation capabilities; and 6) physical-biological ocean modelling. The R&D activity will be enhanced through a new research network on "Prediction and Predictability of the Global Atmosphere-Ocean System from Days to Decades" funded by the Canadian Foundation for Climate and Atmospheric Sciences.