

Potential for Regime Transitions in North Atlantic Climate

Extended abstract

The research envisaged for this project is to extend techniques for calculating optimal forcing perturbations developed for the ECMWF IFS model (Barkmeijer et al. 2003) to the ocean model OPA (version 8.2), and to investigate potential interactions between oceanic and atmospheric forcing patterns.

The available linear and adjoint versions of OPA will enable us to determine fast-growing perturbations of the initial state and to develop tools to determine optimal forcing patterns (Forcing Singular Vectors (FSV) and Forcing Sensitivities (FS)). Experience with the IFS model has shown that sustained tendency perturbations with FSVs can have a considerable and beneficial impact on the course of forecasts.

There are three types of major computer calculations that are planned to be performed at ECMWF's computers and with basic code from ECMWF. First we plan to investigate to what extent additional ocean forcing in certain model variables, for example forcing perturbations solely restricted to fresh-water flux, heat flux, or wind-stress, will have on certain aspects of the forecast, with special attention to the Atlantic-European area. Computation of these Forcing Sensitivities will involve stand-alone OPA model runs, supplemented with a simple statistical atmosphere to provide the necessary boundary conditions, over integration periods of the order of years. Second, we plan to calculate a wide range of atmospheric FSVs and FS with optimization intervals up to 10 days and different targeting at initial and final time to geographical areas and to selected atmospheric parameters, such as low-level temperature over the North Atlantic Ocean. Third, we plan to run several sets of coupled IFS-OPA runs in prognostic mode over time-horizons up to a few decades, in order to filter out those forcing perturbations that may interact positively and trigger abrupt regime changes. We also plan to study how sensible the linearly obtained forcing structures are in nonlinear integrations.

The project has strong links with the existing Special Project 'REGCLIM - *Optimal forcing perturbations for the atmosphere*' but this significant extension may provide mechanisms that have the potential to produce positive or negative feedback in coupled IFS-OPA runs. The work set out to do in this project will be performed in close collaboration with the Seasonal Forecasting Group at ECMWF.

Barkmeijer, J., T. Iversen and T.N. Palmer, 2003: Forcing singular vectors and other sensitive model perturbations. *Quart. J. Roy. Meteor. Soc.*, **129**, 2401-2424.