

SPECIAL PROJECT INTERIM REPORT

Interim Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year2009.....

Project Title: **Seasonal to interannual predictability of a coupled ocean-atmosphere model**

Computer Project Account: ...SPFROASP.....

Principal Investigator(s): ...Philippe Rogel.....
.....

Affiliation: ...CERFACS.....

Name of ECMWF scientist(s) collaborating to the project
(if applicable) The Seasonal Forecasting group and more precisely Paco Doblas-Reyes and Antje Weisheimer
.....

Start date of the project: ...2009.....

Expected end date: ...2011.....

Computer resources allocated/used for the current year and the previous one
(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	10000	5000	10000	1600
Data storage capacity	(Gbytes)				

Summary of project objectives

(10 lines max)

The aim of this Special Project is to investigate the seasonal to decadal climate predictability by using a coupled ocean-atmosphere model developed at Cerfacs. This work is currently carried out in the framework of the EC-FP6 ENSEMBLES project, and will be continued within COMBINE and the decadal prediction exercise for the IPCC AR5. The model uses the ARPEGE-Climat atmospheric model, the OPA ocean model, and the OASIS coupler. An assimilation system developed in collaboration with the SPFRVODA Special Project is used to assimilate several types of oceanic data, including in-situ and satellite-based (altimetry) and to produce ocean initial conditions.

Summary of problems encountered (if any)

(20 lines max)

Summary of results of the current year (from July of previous year to June of current year)

This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

During the last year, the SPFROASP Special Project has allowed Cerfacs to continue achievements in the framework of the ENSEMBLES project, and to :

- Archive ENSEMBLES Stream 2 decadal hindcast data;
- Access ocean reanalyses and decadal hindcast data from other groups;
- Continue validation studies of the ocean reanalyses issued by the project
- Begin some verification work of the decadal hindcasts.

Work done

Archiving of the ENSEMBLES Stream 2 decadal hindcast data

The storage of the decadal hindcasts produced for the Stream 2 of ENSEMBLES has been completed. It consisted of ocean model outputs defined commonly with other groups, and of atmosphere outputs from ARPEGE. For the ocean data, a specific tool had been developed and applied, and data have been archived in netcdf format on ECFS. For the atmosphere data, tools developed by CNRM have been adapted to our decadal hindcast output format, and have been used to archive data in grib format on MARS.

AVERAGED TEMPERATURE (0-300m) 1960-2005

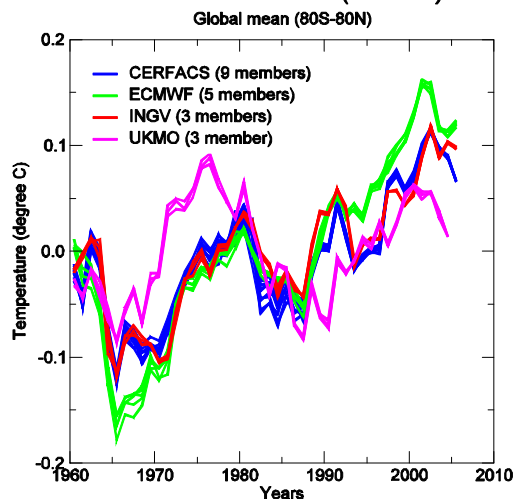


Figure 1: Global (80°S-80°N) annual mean upper (0-300 m) ocean averaged temperature anomalies (wrt the 46-year average) in 20 ENSEMBLES ocean reanalyses

Validation studies of the ENSEMBLES ocean reanalyses

A validation work of the ensembles of ocean reanalyses has been pursued, in the line of what had been done for the OPAVAR ensemble produced by CERFACS. The study consists mainly in comparing reanalyses with a truly independent data set, distributed over the globe, representative of decadal variations over the multi-decadal period of interest (1960-2005). This is of importance to assess the quality and signification of climate indicators such as the heat content (see Figure 1). A set of quality controlled tide gauge gauge, in about 100 sites, used elsewhere to reconstruct sea level variations (Llovel et al., 2009), has been used as an independent validation database. An example is given in Figure 2, and a quantitative comparison has been made, and will be presented in a paper in preparation.

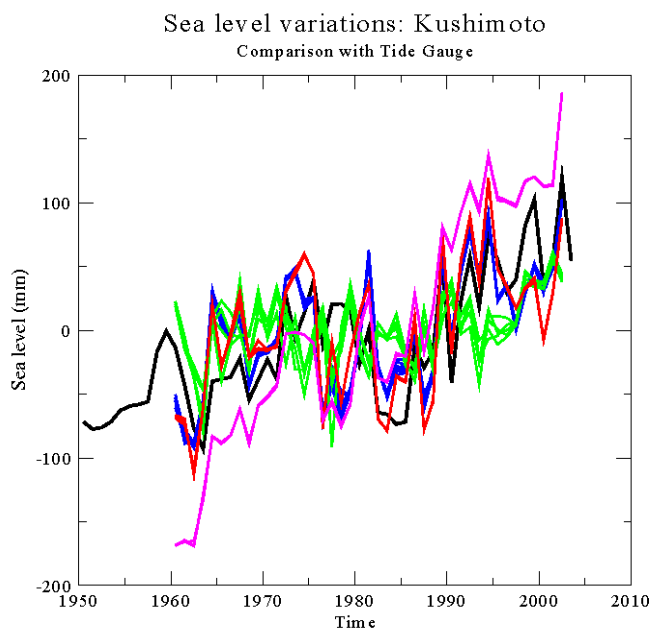


Figure 2: Annual mean sea level variations at Kushimoto (135°E, 33°N) of tide gauge measurements (black) and of 20 ENSEMBLES ocean reanalyses (same color code as figure 1).

Preliminary analyses of the ENSEMBLES Stream 2 decadal hindcasts

Cerfacs has produced decadal hindcasts, as part of the ENSEMBLES stream 2 multi-model seasonal-to-interannual hindcasts. An analysis of the large systematic error reported in the previous SPFROASP report has been done. The analysis of these decadal simulations has continued, and predictability of some global climate indices has been investigated (see Figure 3). Work is currently focusing on the tropical modes of variability and their predictability. The extension of these analyses to the whole ENSEMBLES decadal hindcasts multi model will also be carried.

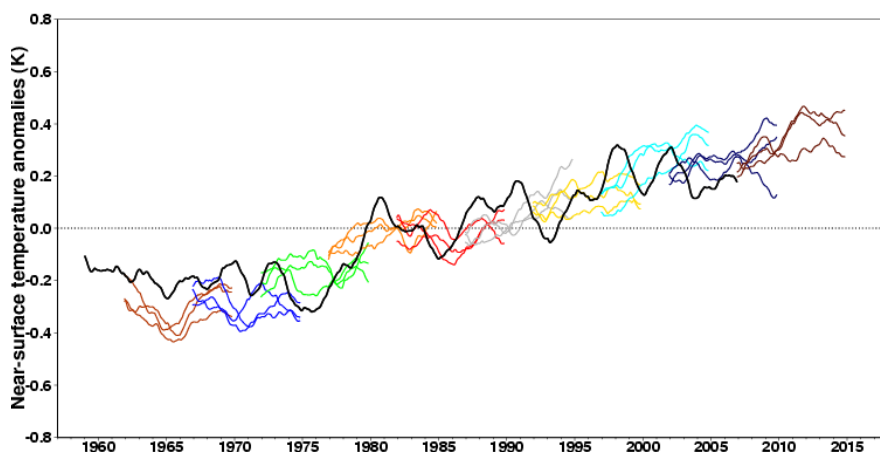


Figure 3: Decadal hindcasts of the global mean surface temperature anomalies in the ARPEGE/OPA Cerfacs model (colors) and verification (black). A systematic error has been subtracted.

List of publications/reports/proceedings from the project with complete references

- A. Weisheimer, F.J. Doblas-Reyes, T.N. Palmer, A. Alessandri, A. Arribas, M. Déqué, N. Keenlyside, M. McVean, P. Rogel, 2009: ENSEMBLES - a new multi-model ensemble for seasonal-to-annual predictions: Skill and progress beyond DEMETER in forecasting tropical Pacific SSTs *Geophys. Res. Letters*, submitted.
- F. J. Doblas-Reyes, A. Weisheimer, M. Déqué, N. Keenlyside, M. McVean, J. Murphy, P. Rogel, D. Smith, T. N. Palmer, Addressing model uncertainty in seasonal and annual dynamical ensemble forecasts, *Q. J. Roy. Meteor. Soc.*, 2009, In Press.
- Llovel W., Cazenave A., Rogel P., Bergé Nguyen M., 2009: 2-D reconstruction of past sea level (1950-2003) using tide gauges records and spatial patterns from a general ocean circulation model. *Climate of the Past*, In Press.
- Rogel, P, N. Daget, S. Masina, P. Di Pietro, A. Weaver, Report on the production of OPA/NEMO analyses and initial conditions for use in seasonal to decadal Stream 2 hindcasts, ENSEMBLES report (available at http://ensembles-eu.metoffice.com/project_reporting/year3reporting/publicly_completed_deliverables/D1.9_OPA_reanalyses_final.pdf).
- Weisheimer, A., F. Doblas-Reyes, P. Rogel, E. Da Costa, N. Keenlyside, M. Balmaseda, J. Murphy, D. Smith, M. Collins, B. Bhaskaran, and T. Palmer. Initialisation strategies for decadal hindcasts for the 1960-2005 period within the ENSEMBLES project. ECMWF Technical Memorandum No 521, 2007.
- Auger, P-A, Variabilité et prévisibilité décennale de l'état thermique des océans tropicaux atlantique et indien à partir de réanalyses océaniques et d'expériences couplées de prévision décennale, CERFACS Technical Report TR/CMGC/07/67, 2007.
- Rogel P., Y. M. Tourre, V. Benoit and L. Jarlan, 2006: Atlantic moisture availability and precipitation over West Africa: Application to DEMETER hindcasts *Geophys. Res. Letters*, 33, L21711.
- P. Rogel, C. Ubelmann, Use of global ocean reanalyses for reconstructing sea level variability patterns over the last 40 years, proceedings of the Symposium "15 years of progress in radar altimetry", Venice, Italy, 13-18 March 2006.
- Benoît, V., P. Rogel, Y. M. Tourre, et L. Jarlan, Convergence du flux d'humidité sur l'Atlantique tropical et prévision saisonnière des précipitations sur l'Afrique de l'Ouest, Poster presented at the AMMA International Conference, Dakar, Senegal, 28 November-2 December 2005.
- Rogel, P., A. T. Weaver, N. Daget, S. Ricci and E. Machu, Ensembles of global ocean analyses for seasonal climate prediction: impact of temperature assimilation, *Tellus* 57A, 375-386, 2005.
- Lazar, A., A. Vintzileos, F. Doblas-Reyes, P. Rogel, and P. Delecluse Seasonal forecast of tropical climate with coupled ocean-atmosphere GCMs: On the respective role of the atmosphere and the ocean model components in the drifting mean climate, *Tellus* 57A, 387-397, 2005.
- Ricci, S., A.T. Weaver, J. Vialard, and P. Rogel: Incorporating state-dependent temperature-salinity constraints in the background-error covariance of variational ocean data assimilation. *Mon. Wea. Rev.* 133, 317-338, 2005. Also available as ECMWF Tech Memo 441.
- André, J.C., M. Déqué, P. Rogel, S. Planton, La vague de chaleur de l'été 2003 et sa prévision saisonnière, *C. R. Géoscience*, 336, 491-503, 2004.

Summary of plans for the continuation of the project

(10 lines max)

The next plans are in the line of the onset of the COMBINE project and the production of decadal hindcasts for the next IPCC reassessment exercise :

- Finalise the analyses of decadal predictability, for both globally averaged quantities and decadal modes, and using the whole ENSEMBLES multi-model hindcasts;
- Prepare COMBINE and IPCC AR5 simulations by designing a new initialisation procedure based on coupled anomaly nudging;
- Produce some preliminary multi-decadal coupled experiments with nudging for initialisation.