SPECIAL PROJECT PROGRESS REPORT

Progress 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 year	2014
Project Title:	Sensitivity of decadal forecast to atmospheric resolution and physics
Computer Project Account:	spfrguer
Principal Investigator(s):	Jean-François Guérémy
Affiliation:	CNRM-GAME/GMGEC
Name of ECMWF scientist(s) collaborating to the project (if applicable)	
Start date of the project:	01 January 2013
Expected end date:	31 December 2015

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)	15950000	15950000	14500000	0
Data storage capacity	(Gbytes)	40000	40000 (on frtodcli)	30000	0

Summary of project objectives

(10 lines max)

The main objective of the project is to investigate the sensitivity of decadal predictability to atmospheric resolution and physics. Two earlier projects dealing with decadal forecasts (i.e., CMIP5 and EPIDOM) made use of our present model CNRM-CM5 with different atmospheric spatial resolutions, Tl127l31 for the former and Tl63l62 together with Tl63l91 (including for the latter. In the present project, we will use a more recent version of the CNRM-CM model including a new atmospheric physical package (non orographic gravity wave drag, turbulence, convection and microphysics). In the last year of the project, prognostic aerosols might be included in the model to perform the decadal forecasts. Moreover, different atmospheric spatial resolutions will be considered in the course of the project, all including the stratosphere to take advantage of our simulated QBO, starting from Tl159l91.

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

As mentioned in the summary of plans from our last report, during the second part of the first year we performed a first set of decadal hindcasts using CNRM-CM5+ with a resolution of Tl159l91, running on the IBM c2a of ECMWF. CNRM-CM5+ is an upgraded version of CNRM-CM5 (Voldoire et al., 2012), using cycle 37t1 of ARPERGE-IFS (and NEMO 1° as in CNRM-CM5) and a new atmospheric physical package: turbulence (Cuxart et al., 2000), microphysics (Lopez, 2002), convection (Guérémy, 2011 and Piriou, 2012, personal communication for the prognostic convective microphysics following Lopez, 2002) and a new non orographic gravity wave drag parameterization (Lott, 2012). 11 start dates from 1980 to 2005 every 3 or 2 years (1980, 1983, 1985, ...) have been considered. The hindcasts have been started from the first of November of the previous year. Each decadal hindcasts is an ensemble of 10 members over a range of 10 years. The initial conditions come from a coupled simulation nudged toward NEMOVAR in the ocean and toward the rotational dynamics (stream function) of ERA-Interim in the stratosphere (as already done in the frame of the French project EPIDOM with CNRM-CM5 Tl63).

Table 1 presents global T2m ACCs for the years 2-5, computed with ERA-Interim data. The performance is rather good at the beginning of the 80's, weak in the 90's and firmly increasing again during the first half of the first decade of 2000. Interestingly, this behaviour might be related to the AMO seesaw of the mid 90's. Moreover, the weakest skill obtained in 1990 is further explained by the fact that the actual volcanic aerosols (Pinatubo eruption in 1991) are not included in the hindcasts (a climatological back ground is indeed taken into account).

Year	1980	1983	1985	1988	1990	1993	1995	1998	2000	2003	2005
ACC	0.28	0.50	0.30	0.14	0.05	0.13	0.12	0.15	0.32	0.62	0.58

Table 1. Global T2m ACCs for the years 2-5.

Figure 1 shows the Z500 plumes for 1983, 1990 and 2000 start dates. CNRM-CM5+ presents a quasi null drift, whereas CNRM-CM5 was producing a negative drift corresponding to decrease of 0.6K of the temperature at 2m.

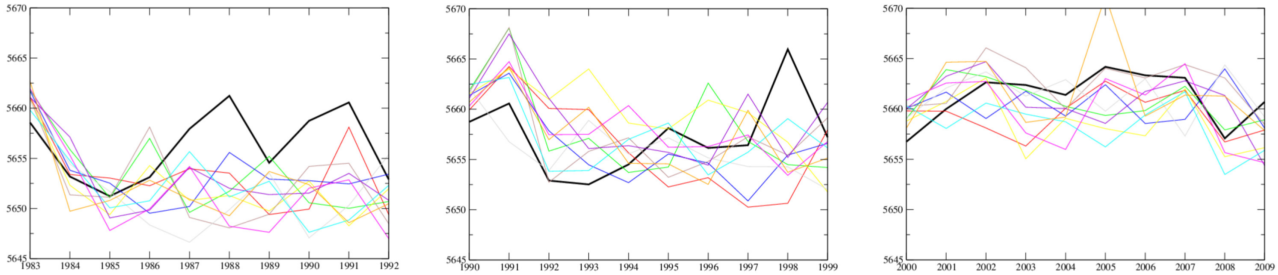


Fig. 1. Z500 plumes for 1983, 1990 and 2000 start dates (ERA-Interim in black, members in colour).

Figure 2 is depicting the spatial maps of temporal correlation (computed over the start dates) for the temperature at 2m averaged over the first year, CNRM-CM5+ on the left and CNRM-CM5 on the right. The skill over the equatorial Pacific (ENSO), Atlantic and Indian Oceans is significantly larger for CNRM-CM5+ compared to the earlier version (used for CMIP5), while being of the same order elsewhere.

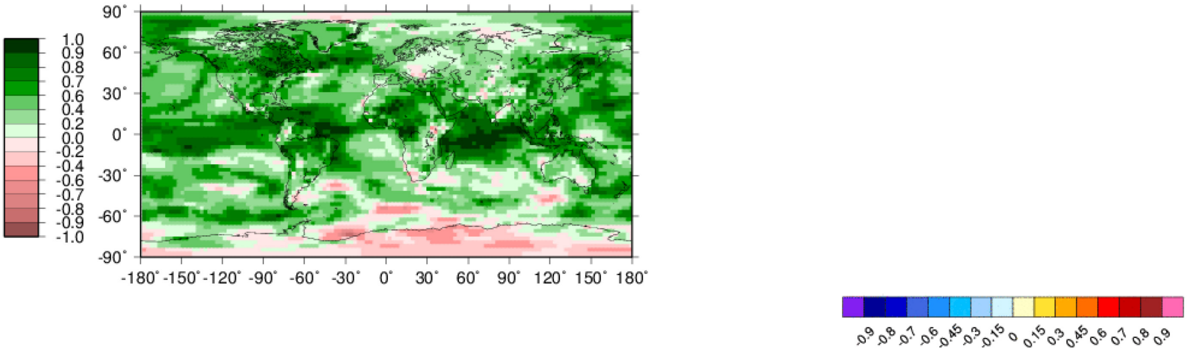
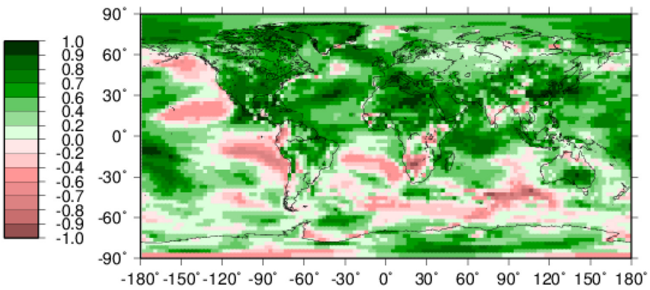


Fig. 2. T2m correlation for the 1st year (CNRM-CM5+ left and CNRM-CM5 right).

The spatial maps of temporal correlation (computed over the start dates) for the temperature at 2m averaged over the years 2 to 5 are shown in Fig. 3. In the first row CNRM-CM5+ (left) and CNRM-CM5 (right) are depicted; in the second row, this the results from IFS model (Corti et al., 2011), and in the third row, the results from the French project EPIDOM (5 start dates only from the same period) are shown, raw data on the left and detrended data in the right. Overall, the regions of good skill are common in all experiments, that is the equatorial Indian Ocean together with the equatorial western Pacific, the northern Atlantic Ocean and the Euro-Asian continent. Going deeper into regional differences, it is worth to notice that the skill obtained by CNRM-CM5+ over the tropical western is the best. Moreover, it is noteworthy that CNRM-CM5+ is providing the best performance in the north Atlantic just south of Iceland, a region where the decadal signal is large. Furthermore, over the continents, all experiments are showing the same type of performance over the Euro-Asian region, part of it due to the climate trend and another part from the decadal signal. Over the western part of northern America, CNRM-CM is showing larger skill than IFS, skill due here also to the climate trend and to the decadal signal.



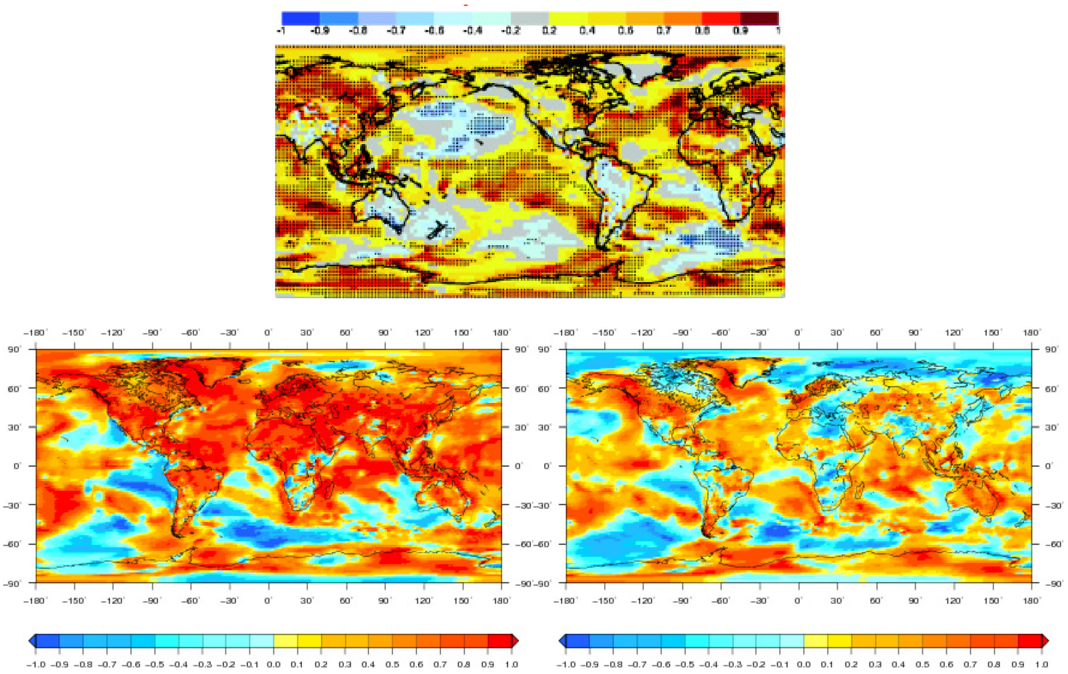


Fig. 3. T2m correlation for the years 2-5: 1st row: CNRM-CM5+ left and CNRM-CM5 right, 2nd row: IFS, and 3rd row CNRM-CM5 Tl63 from EPIDOM (raw data left and detrended data right).

During the first part of the second year, the main part of the activity has been devoted to some improvements, correction and re-tuning of CNRM-CM5+, and to the implementation of higher horizontal resolutions, i.e. tl255 and tl359. Both 10 year coupled simulations and seasonal forecasts have been carried out using these higher resolutions. These simulations have been performed on Meteo-France Bull, the objective being to install CNRM-CM5+ on the ECMWF Cray (sharing a common architecture with the Bull HPC) this July to run the new high resolution simulations.
The simulated mean climates produced by the 3 resolutions (tl159, tl255 and tl359) are very close. The main difference is coming from the precipitation bias which is weaker in the tropical western Pacific with tl255 and tl359 versus tl159, as shown in Fig.4 for summer and fall seasons.

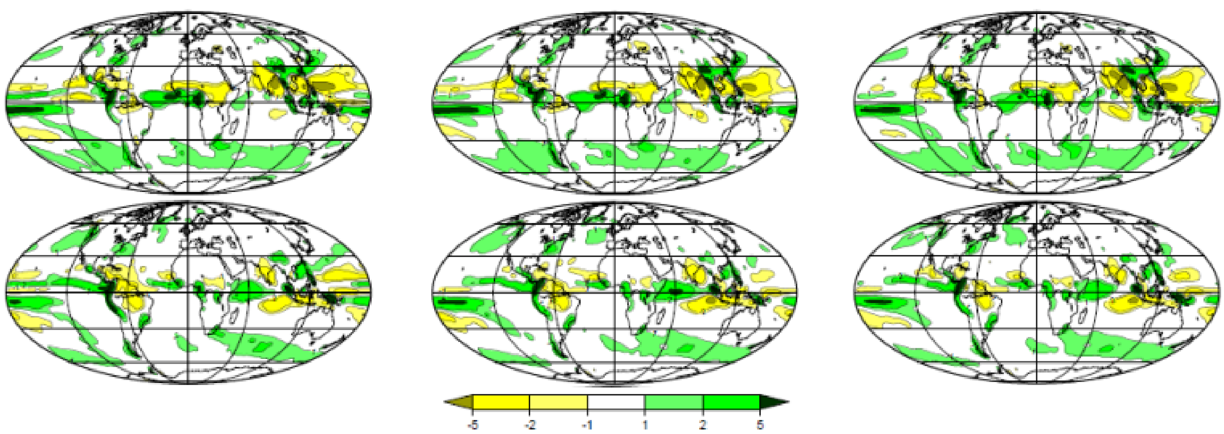


Fig. 4. Precipitation bias (mm/day): 1st row summer (JJA) and 2nd row fall (SON), tl159 left, tl255 middle and tl359 right.

In terms of seasonal forecast skill, a comparison has been performed between tl159l91 and tl255l91 using this latest release of CNRM-CM5+. Ensembles of 15 seasonal hindcasts have been carried out over 4 months starting the first of November during a 32 year period (1979 to 2010). tl255l91 shows a slight but significant better skill (taking a bootstrap interval into account) over the tropics for T2m and precipitation. Moreover, concerning the extra-tropics, it is noteworthy that the time correlation of Z500 is larger over Europe with tl255l91 compared to tl159l91, as presented in Fig. 5.

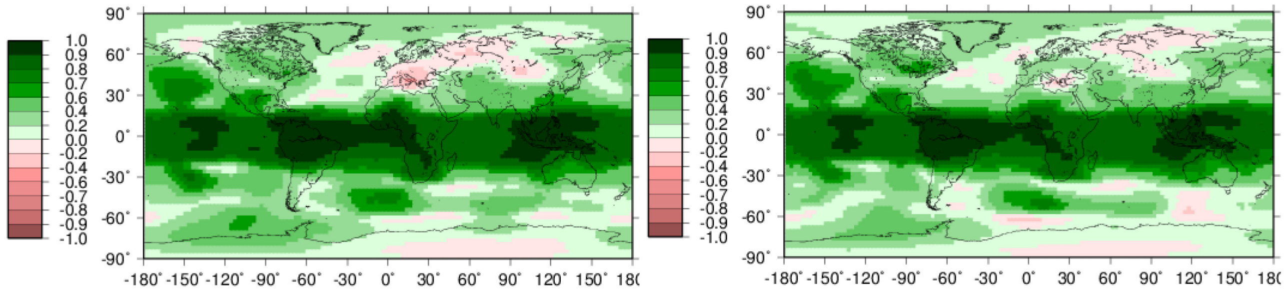


Fig. 5. Time correlation of Z500 for DJF over the 1979-2010 period; tl159l91 left, tl255l91 right.

List of publications/reports from the project with complete references

Summary of plans for the continuation of the project

(10 lines max)

In the second part of the first year, we intend to perform a second set of decadal hindcasts using CNRM-CM5+ with a resolution of Tl255l91. The plan is to consider the same 11 start dates from 1980 to 2005 every 3 or 2 years (1980, 1983, 1985, ...), as the firs set performed with tl159l91. The hindcasts will start from the first of November of the previous year. Each decadal hindcasts will be an ensemble of 10 members over a range of 10 years. The initial conditions will come from a coupled simulation nudged toward NEMOVAR in the ocean and toward the rotational dynamics of ERA-Interim in the stratosphere. During the third year, it is expected to redo the same set of decadal hindcasts, but using up-to-date aerosol climatology and hopefully improved soil model.