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 2017

Project Title: Impact of land surface and ocean initial conditions on sub-seasonal to seasonal forecasts

Computer Project Account: SPFRBATT

Principal Investigator(s): Lauriane Batté

Affiliation: CNRM (Météo-France)

Name of ECMWF scientist(s) collaborating to the project (if applicable) …………………………………………………………………
…………………………………………………………………

Start date of the project: 01/01/2016

Expected end date: 31/12/2018

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)	10,000,000	10,000,000	12,000,000	1,281,434
Data storage capacity	(Gbytes)	20,000	15,320	20,000	1,690

* Our user accounts are linked to frtodcli and output files are stored on this ECFS account

Summary of project objectives

(10 lines max)

The main objectives of this special project are to assess beyond conclusions from the FP7-SPECS project the impact of the initialization of land-surface and sea-ice components of the CNRM-CM model on sub-seasonal and seasonal predictability. Two main questions are addressed:

- What is the extent of initial condition information needed to properly initialize the sea ice and land-surface components of the model?
- Can improvement in model initialization impact the predictability of specific events?

The objective is to study these questions using land surface and sea ice initial conditions and climatologies built with the corresponding CNRM-CM components run in forced mode, and studying specific test cases with initial conditions representing extremes of the climatologies.

Summary of problems encountered (if any)

(20 lines max)

We originally intended to work with a more recent version of NEMO-GELATO but due to delays had to switch back to NEMO 3.2. As a consequence, the forced NEMO-GELATO runs initially planned were not run, and we resorted to using initial conditions for sea ice derived by Mercator-Ocean by nudging the NEMO-GELATO model towards the GLORYS2V4 reanalysis. This restricts the re-forecast period to 1993-2012 instead of 1979-2012.

The most recent version of the SURFEX interface enabling nudging of land surface towards reference data is not yet ported on the Cray. We therefore chose to work on land surface initial condition sensitivity using the ERA-Land reanalysis, and an offline SURFEX run.

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

a) Soil moisture conditions

The role of soil moisture initialization for JJA predictability in seasonal forecasts initialized in May was examined in a multi-model framework by Ardilouze et al. (2017). In the scope of this study, the authors found a confirmed role of dry soil moisture conditions over the Balkans in the forecasting of warm summer temperature anomalies.

For this project, two sets of 15-member ensemble re-forecasts were run with CNRM-CM from May to August each year over the 1993-2012 period, starting from ERA-Interim for the atmosphere and Mercator-Ocean upscaled ocean reanalysis PSY2G2V3 for the ocean. One ensemble called SCLI used climatological soil moisture conditions, the other (SINI) "realistic" conditions based on an offline SURFEXv7.2 run, forced by ERA-Interim with precipitations corrected by GPCC.

Figure 1 shows the impact of more realistic soil moisture conditions on correlation of maximum temperature with respect to CRUTS4 reference data for JJA 1993-2012. Results are consistent with those of Ardilouze et al. (2017): initialization of soil moisture provides additional skill in some areas including most of Europe, mid-latitudes in Asia and parts of continental United States. Other areas exhibit lower skill when soil moisture is initialized as in SINI. This requires further investigation into the mechanisms at play (possible initialization shocks).

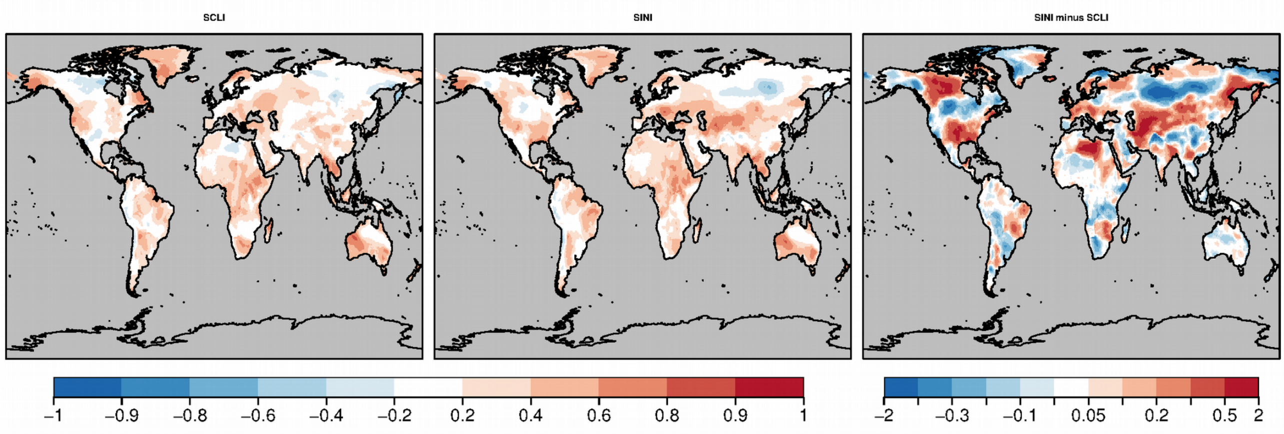

Figure 1: Correlation of seasonal mean maximum near-surface daily temperature (Tmax) with CRUTS4 for JJA 1993-2012 in re-forecast experiments SCLI (left) and SINI (center). The difference in correlation between both experiments is shown in the right panel.

Figure 2 focuses on similar results but over Europe, using EOBS reference data (as a way to estimate the possible influence of the reference used on the skill assessments shown). Results are quite similar between both reference datasets and confirm the improvement over Western and Central Europe.

As planned at the time of project submission, we then ran case study experiments, but focusing on the 2012 summer instead of 2003 which has been extensively studied in past works. In the SNEU case study run, we initialize CNRM-CM with neutral soil moisture conditions over Central Europe and Balkans corresponding to the 1st May 2009. We use 1st May 2006 as anomalously wet soil moisture conditions over the region. Corresponding root layer SWI anomalies for each land surface initial condition used are shown in figure 3 (see also figure 1 in the 2016 special project report for SWI anomalies averaged over the Balkans region). Note that the 2009 "neutral" conditions are in fact due to the area average between dryer and wetter conditions on a finer scale over the Balkans.

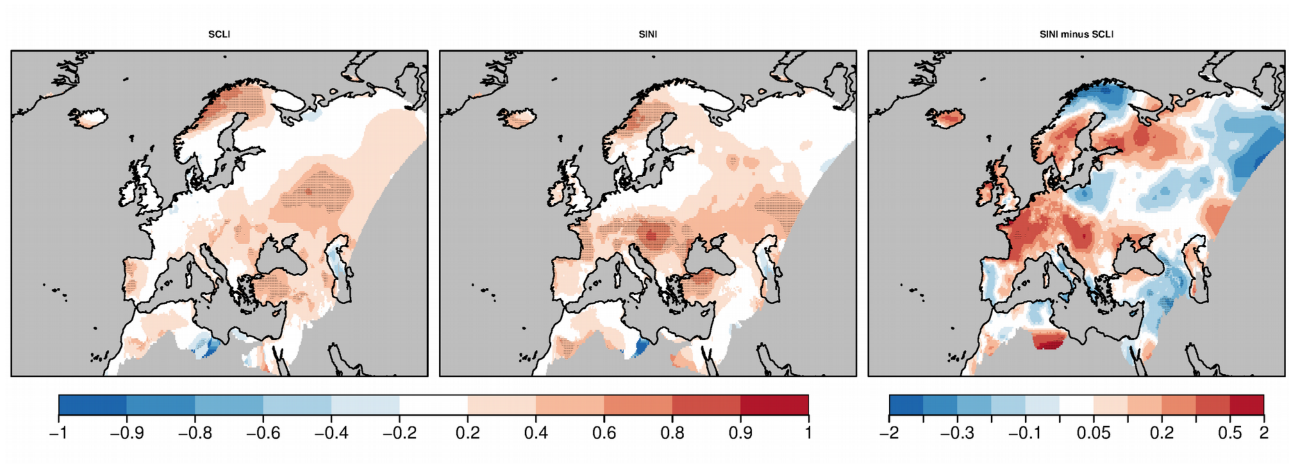

Figure 2: Same as figure 1 but for Tmax over Europe using EOBS data as reference.

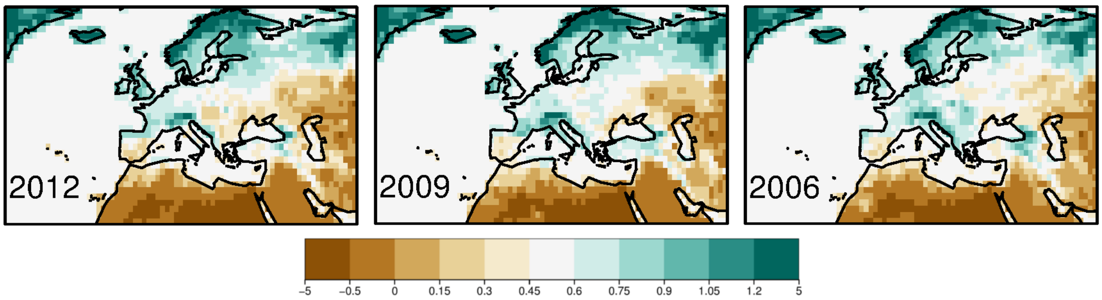

Figure 3: 1st May root layer soil wetness index (SWI) from an offline SURFEX run forced by ERA-Interim with corrected precipitation for 2012 (SINI – dry case), 2009 (SNEU) and 2006 (SWET)

Results for the different case study experiments and SCLI and SINI are shown in figure 4 in terms of JJA Tmax anomalies with respect to 1993-2011 in the SCLI experiment (SINI and SCLI climatologies are very similar). Results are surprising and partially in contradiction with conclusions from Ardilouze et al. (2017). SINI conditions correspond to the driest JJA season of the re-forecast period, but unlike most previous simulations the coupled model does not respond with a warm Tmax anomaly. The warm anomaly between the Black Sea and Caspian Sea present in each simulation suggests a role of other sources of forcing (such as SSTs) which remain unchanged in the different experiments. Over the Balkans area, the climatological initial conditions for land surface yield the best results for 2012, followed by neutral conditions used in SNEU. Due to limited skill and the high level of noise in midlatitudes regions, this could be by chance and further investigation is needed. Another possibility is that the coupled model biases cancel out the SWI anomalies in the first few days of the seasonal runs thus limiting the impact of soil moisture initialization on results. Daily outputs of soil and atmospheric variables have been saved for these experiments and their analysis is ongoing work.

b) Sea ice conditions

The second part of this special project focuses on the impact of sea ice initial conditions on seasonal prediction skill in boreal winter in DJF. As explained previously we have slightly changed plans due to model availability and compilation problems on the Cray supercomputer.

Figure 5 shows sea ice area (SIA) over the Arctic and different sectors over the re-forecast period for November 1st starts in the Mercator-Ocean initial conditions used for this project. As the main focus of the project is set on European climate, we decided to consider the East Atlantic sector in terms of sea ice conditions (namely, the Barents and Nordic seas). The case study will focus on the 2009/10 winter. When defining the extreme years (positive and negative SIA anomalies) we are faced with a strong negative trend in SIA. Removing the trend is tricky in itself, since the period is quite short. We therefore chose to select extreme years in the last decade of the base period. Based on values shown in figure 5, we select 2005 as a positive SIA extreme, and 2011 as a negative extreme.

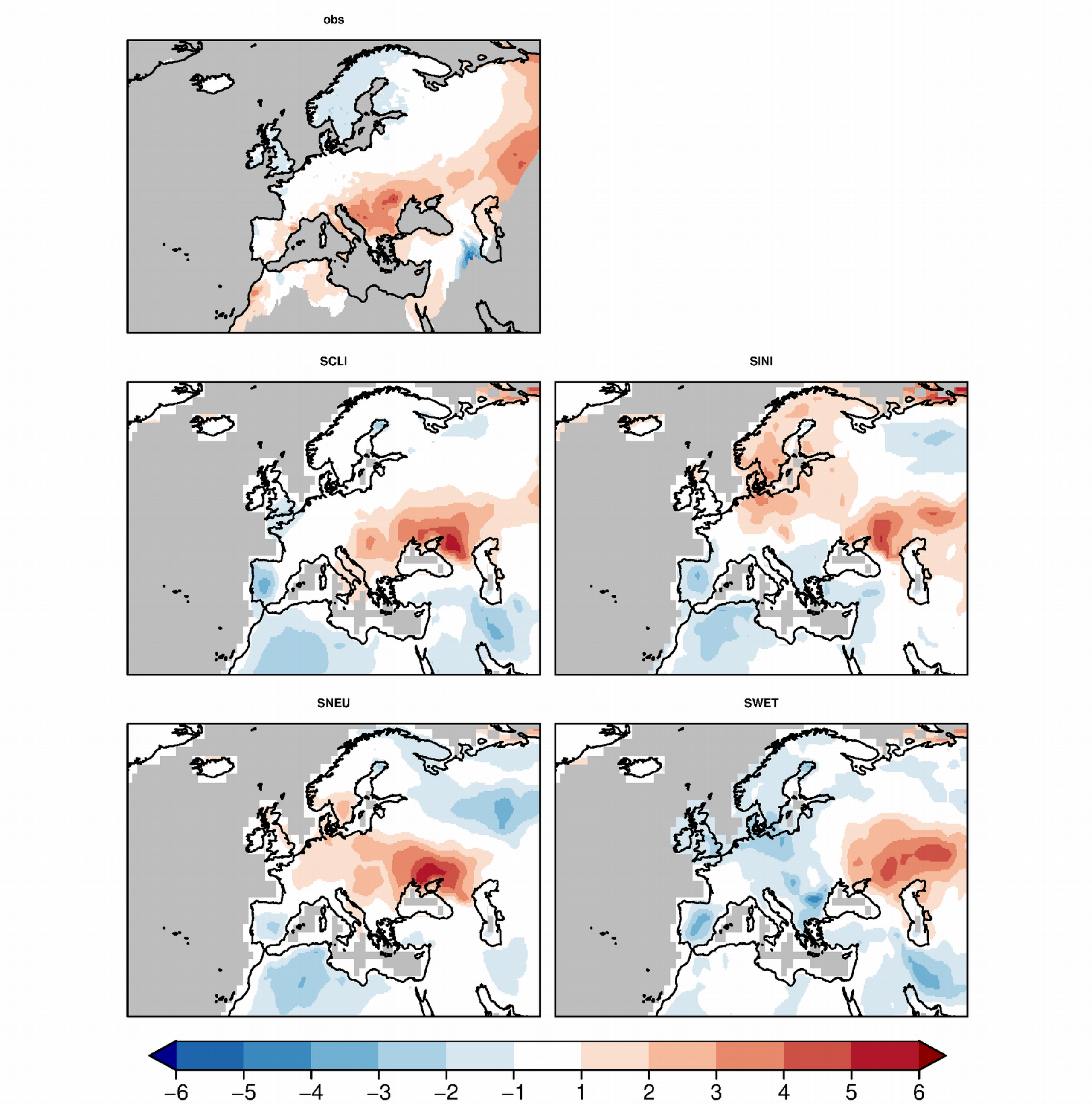

Figure 4: JJA Tmax anomaly for 2012 with respect to the 1993-2011 climatology from SCLI in EOBS (top) and re-forecasts (middle row to bottom, left to right) SCLI, SINI and case study re-forecasts SNEU and SWET.

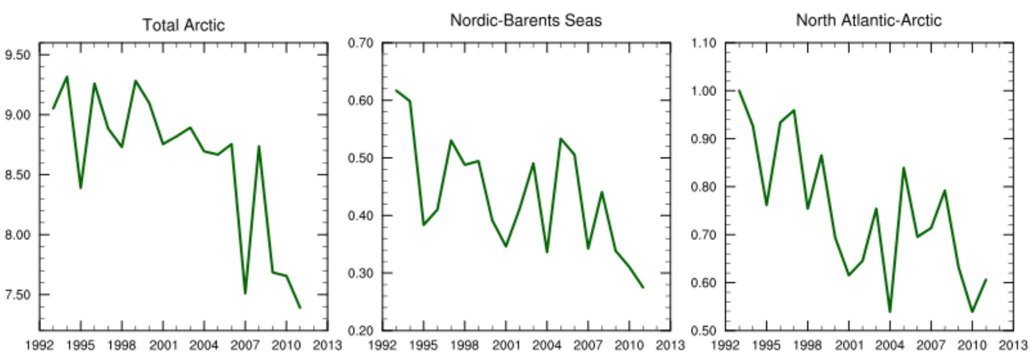

Figure 5: Sea ice area (in millions of km²) over the Arctic (left), the Nordic and Barents Seas (center) and all Arctic regions linked to the North Atlantic (Nordic, Barents and Labrador Seas, right) for November 1st 1993-2011 in the Mercator-Ocean initial conditions used for CNRM-CM DJF re-forecasts.

Simulations for the DJF IINI (sea ice initialization) re-forecasts are currently running on the Cray cca machine and will be evaluated once the full re-forecast is completed.

List of publications/reports from the project with complete references

Ardilouze, C., Batté, L., Bunzel, F., Decremer, D., Déqué, M., Doblas-Reyes, F. J., Douville, H., Fereday, D., Guemas, V., MacLachlan, C., Müller, W., and Prodhomme, C. (2017): Multi-model assessment of the impact of soil moisture initialization on mid-latitude summer predictability. Climate Dynamics, doi:10.1007/s00382-017-3555-7*, in press*.

Summary of plans for the continuation of the project

(10 lines max)

This summer, we intend to finish running the DJF re-forecasts initialized in November and analyze skill over Europe as in the summer season. We will then move on to the case studies with the selected years. Careful analysis will be needed to make sure that sea ice anomalies are properly imprinted onto the ocean conditions during the first days of the run.

Depending on leftover resources for the final year of the project, additional experiments could be added to the current set so as to test the robustness of results, or ensemble size increased to enhance skill assessments and separate signal from noise.