SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year …………………2019…………………………………….……

Project Title: Towards seamless development of land processes for Earth System prediction and projection
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Computer Project Account: …………spitales…………………………………….……

Principal Investigator(s): ……… Andrea Alessandri ………………………………..……
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Affiliation: ………ENEA……………………………………….……

Name of ECMWF scientist(s) collaborating to the project (if applicable) …………………………………………………………….……
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Start date of the project: …………2019……………………………………….……

Expected end date: …………2021……………………………………….……

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)			5.5 million	3985418.75
Data storage capacity	(Gbytes)			31250	15134

Summary of project objectives (10 lines max)

The objectives of this special project are (i) to include the representation of the Earth System processes and feedbacks over land (from the latest Earth System Model developments in the frame of CMIP6 and beyond) that can suitably contribute to the the short-term climate predictions performed using EC-Earth (Hazeleger et al., 2012), (ii) to evaluate the impact of including Earth System processes over land on the skill of the retrospective seasonal forecasts, (iii) to contribute towards new frontiers in the seamless development of Earth system predictions/projections across multiple time-scales.

Summary of problems encountered (10 lines max)

The control seasonal hindcasts (SEAS-CTRL) that were planned at BSC (in the framework of APPLICATE and other projects) and to be completed by mid 2019 have been delayed and now expected during the second half of 2019.

Summary of plans for the continuation of the project (10 lines max)

A set of retrospective seasonal forecasts (SEAS-EXP) with improved representation of the Earth System processes over land (from the latest Earth System Model developments in the frame of CMIP6 and beyond) will be incorporated in the seasonal hindcasts performed using EC-Earth. SEAS-EXP will be compared with control seasonal hindcasts (SEAS-CTRL) that are already planned at BSC (in the framework of APPLICATE and other projects) and expected to be completed in the second half of 2019.
The verification at the seasonal time scales will provide knowledge back to better constrain the land processes also for the longer projection time-scale, therefore allowing to better constrain the land processes for the climate-projection simulations to be performed in the subsequent stage of the project.

List of publications/reports from the project with complete references

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Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

Workflow manager configuration and setup

In collaboration with the colleagues at Barcelona Supercomputing Centre (BSC), the Autosubmit workflow manager has been employed in order to set-up a semi-automated procedure for the production of retrospective seasonal forecasts. The EC-Earth runtime scripts have been modified in order to perform parallel scheduling of the seasonal predictions and post-processing and by setting up the required running environment including preparation and transfer in the working directory of the initial and boundary conditions required by the model.

System set-up and implementation of the initialization strategy

In collaboration with the colleagues at BSC the initialization strategy to be shared by both SEAS-CTRL (control seasonal hindcasts that are already planned at BSC in the framework of APPLICATE and other projects) and SEAS-EXP is being implemented. It consists of initializing the coupled model on May 1st and November 1st of each considered year (in the period 1982-2015) from a known reference state. Initial conditions for IFS/HTESSEL (Molteni et al., 2011; van den Hurk et al., 2003; Balsamo et al. 2009) have been prepared from ERA-Interim/ERA-Land reanalysis (Dee et al., 2011; Balsamo et al., 2015). ICs for NEMO have been interpolated from ORAS5 Reanalysis, and sea-ice conditions for LIM3 have been produced by BSC.
The transient historical land cover/vegetation conditions for the SEAS-CTRL are those already prepared for the DECK-CMIP6 simulations (http://www.ec-earth.org/cmip6/ec-earth-in-cmip6/). These have been produced from one of the historical simulations performed with the EC-Earth-Veg version of the EC-Earth model, which includes the LPJ-GUESS dynamic vegetation model (Smith et al., 2014).
Consistent with the inclusion of the latest Earth System Model developments over land (in the frame of CMIP6 and beyond, i.e. also including the developments in the ongoing H2020 projects). the SEAS-EXP will represent the historical land cover/vegetation transition in a more realistic way: for each grid point the fraction of high and low vegetation as well as the dominant types for each tile will be derived from simulations with the offline dynamic vegetation model (LPJ-Guess) forced by ERA20C reanalysis and the Land-Use Harmonization (LUH2; http://luh.umd.edu/; Hurtt et al., 2011) dataset. Furthermore, the Leaf Area Index for each tile will be persisted or statistically predicted from available satellite derived LAI (GLCF; Xiao et al., 2013) data prior of the onset of the hindcasts.
Further consideration of representing water flux from irrigation will be optionally included over crop areas. The available historical reconstructions of irrigated fraction of crop areas that are available in the LUH2-CMIP6 forcing database will be tentatively used.

Study of the predictability of LAI at seasonal time-scale

The results reported in Alessandri et al (2017) show that when realistic interannual anomalies of Vegatation LAI are provided to the forecasts, significant improvements in the prediction of surface climate can be obtained regionally. It is therefore important to perform a preliminary evaluation of the actual predictability of LAI itself. Since we do know that vegetation can display quite long memory, the very first step could be to persist interannual anomalies of LAI at the start date of the forecasts for the entire length of the integration. A generalized approach (also including persistence as a particular case) is to apply seasonal autoregressive integrated moving average (SARIMA) models. For each grid point, the better SARIMA model is selected using a 10-years training and then used to predict LAI in the forthcoming months.

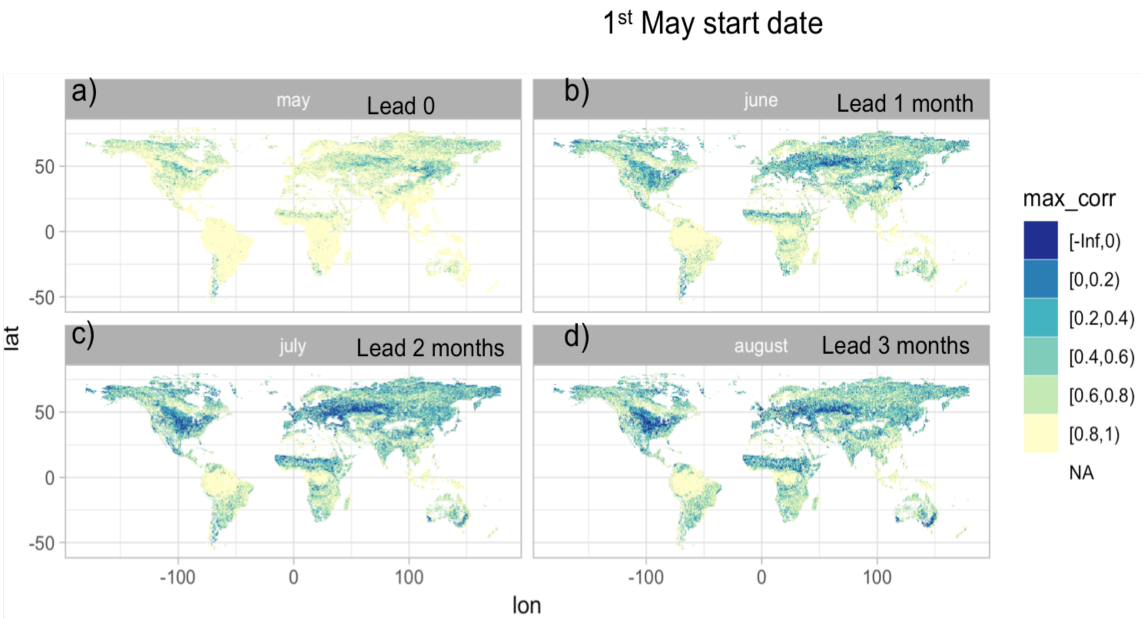

Figure 1: Anomaly correlations between monthly-mean predicted and observed LAI at reference start date 1st May and for a) 0-month, b) 1-month, c) 2-month and d) 3-month lead times.

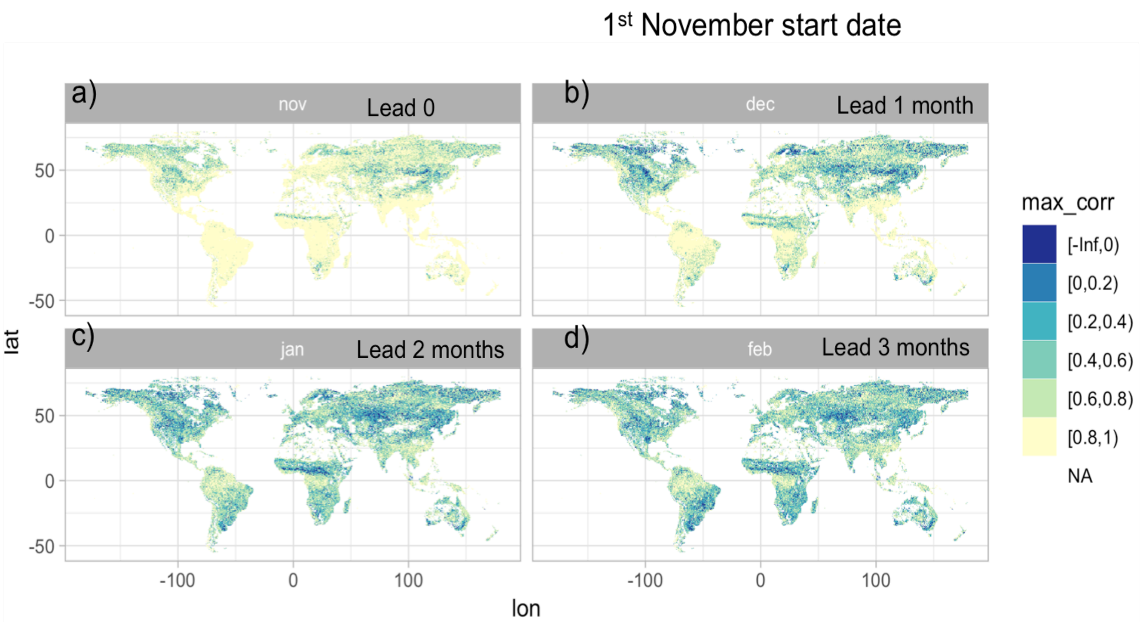

Figure 2: Same as Figure 1 but for reference start date 1st November.

Anomaly correlations between monthly-mean predicted and observed LAI are reported in Figure 1 (Figure 2) for 1st May (1st November) start dates for lead times from 0 to 3 months. It is shown LAI memory indeed persists until 3 month lead-time and with correlations that tend to be larger than 0.8 for the first month (lead 0) but still persisting with values mostly larger than 0.6 at 3-month lead time. As expected the only regions where anomaly correlations fall below these values are those dominated by grasses and annual vegetation, which typically tends to display shorter memory of the initial states because strategically adapted to be less resilient than forest tree vegetation.

References

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