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	………………2018……………………………………………..……
Project Title:	Decadal climate predictions: exploit vegetation dynamics and improve fire risk assessment …………………………………………………………..……
Computer Project Account:	……………spnlales……………………………………………..……
Principal Investigator(s):	………… Alessandri Andrea………………………………… …………………………………………………………..……
Affiliation:	…… KNMI…........(other affiliation: ENEA, Italy)……………
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…………………………………………………………..…… …………………………………………………………..……
Start date of the project:	…………1 January 2018……………………………..……
Expected end date:	…………31 December 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)			9600000	37579
Data storage capacity	(Gbytes)			29000	0

Summary of project objectives

(10 lines max)

The objectives of this special project is (i) to verify the actual improvement of the decadal climate predictions due to improved land surface/vegetation and (ii) assess the related benefit for the prediction of fire risk. To this aim a set of sensitivity experiments will be performed with a modified version of EC-Earth that improves vegetation representation and variability by either prescribing or modeling the vegetation state and variability.

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Summary of problems encountered (if any)

(20 lines max)

The experiment planning of SPNLALES is based on the availability of the control DCPP hindcasts (DCPP-ctrl) that were originally scheduled to be completed by early 2018 as part of BSC's contribution to DCPP (DCPP - Component A1). However, realization of the DCPP-ctrl hindcasts has to wait until finalization of the EC-Earth ESM to be used for CMIP6 simulations, which has been considerably delayed and not yet completed. The delays are due to problems encountered with new Earth System components and related physical parameterizations and issues with the CMIP6 forcings and various technical problems within the code. In order to be fully comparable to the DCPP-ctrl experiments, the improved set of decadal hindcasts performed in this project (DCPP-vege), must be developed starting from the CMIP6 version of the EC-Earth model. It is expected that the final version of EC-Earth will be ready only after the summer (i.e. September 2018) therefore significantly affecting the realization of SPNLALES within the scheduled time in 2018.

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

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 the improved set of decadal hindcasts (DCPP-vege). The EC-Earth runtime scripts have been modified in order to perform parallel scheduling of the decadal 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 DCPP-ctrl and DCPP-vege has been implemented following the DCPP protocol. It consists of initializing the coupled model on November 1st of each considered year (in the period 1980-2010) from a known reference state. Initial conditions for IFS have been prepared from ERA-Interim and ERA-40 Reanalyses. ICs for NEMO have been interpolated from ORAS5 Reanalysis, and sea-ice conditions for LIM3 have been produced by BSC. The preparation of the necessary model output configurations and cmorization is in the final stages.
Transient vegetation conditions for the DCPP-ctrl will be the same ones prepared for the DECK simulations. These have been produced from simulations with the offline dynamic vegetation model (LPJ-Guess; Smith et al., 2014) and the Offline Surface Model (OSM, the off-line version of H-TESSEL which is part of IFS; Balsamo et al., 2009), forced by ERA-20C Reanalysis and the Land-Use Harmonization (LUH2) dataset.

Fire models and enhanced fire danger forecasting

As part of this Special Project, it is expected that better Earth System Predictions coming from improved land surface-vegetation parameterization will allow for better fire predictions. The strategy is to use the offline version of the LPJ-Guess model used in EC-Earth, forced by the output of the DCPP runs (accomplished with LPJ-Guess turned off, i.e. without simulation of an interactive dynamic vegetation). During the first 6 months of SPNLALES, the LPJ-Guess dynamic vegetation model has been configured to be used off-line from EC-Earth to conduct seasonal-to-decadal predictions of fire danger. This setup will allow to calibrate, test and refine the fire model that is included in LPJ-Guess. Currently the fire model within LPJ-Guess is the GlobFIRM model, but work is underway, in collaboration with Lund University, to add the SIMFIRE/BLAZE model as an additional option in LPJ-Guess, and it is further expected that another model, SPITFIRE, will be as well included in LPJ-Guess by the end of the summer 2018. Thus it will be possible to test and refine 3 different fire models and select the one that can provide the better performance..

Improved representation of vegetation cover/variability

Following the approach described in Alessandri et al. (2017), an improved representation of vegetation processes has been included in the latest version of EC-Earth (v3.2). The year-to-year variations in land use cover has been implemented in collaboration with the colleagues at Lund University and prescribed from the LUH2 dataset (Hurtt et al. 2011). Furthermore, the parameterization prescribing time-invariant blended albedo for each grid point has been replaced with an interactive albedo scheme discriminating between vegetation and soil. A new parameterization of the bare soil albedo has been developed that include the dependence on moisture content in the soil as detailed in the next subsection.

New process-based albedo scheme with dependence on soil moisture

A novel process-based parameterization of albedo has been developed in HTESSEL-IFS. The total albedo is obtained as the weighted average of the vegetation component (Aveg) and of the bare soil component (Asoil):

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\begin{aligned}
&Atot\ (t) = \\
&Aveg_{l,iveg}\ [iveg = T\ V\ L] * Ceff_l\ (t) + \\
&+ Aveg_{h,iveg}\ [iveg = T\ V\ H] * Ceff_h\ (t) + \\
&+ Asoil * [1 - Ceff_l\ (t) + Ceff_h\ (t)]
\end{aligned}
$$

where TVL and TVH are the dominant vegetation types and Ceffl,h is the effective vegetation cover for low and high vegetation, respectively. Vegetation albedo is computed from lookup table values estimated for each PFT from available observations. To obtain albedo component of the soil, we developed a parameterization which accounts for the dependence upon soil moisture (SM). The dependence of soil albedo on SM has been assessed by using the latest released global observational datasets of albedo from COPERNICUS global land service (https://land.copernicus.eu/global/) for the period 1999-2016. The dataset provides parallel and diffuse albedo for both visible and nearinfrared bands, as required by EC-Earth/IFS. In order to produce a snow-free albedo dataset from the COPERNICUS albedo data we used the snow extent dataset from NOAA (Brown and Robinson 2011) and filtered out all albedo points where snow is present in the timeseries. More than 50% of the grid-points of the global albedo land-domain (space-time) is identified as snow-free and used in the estimation. Soil moisture is based on the latest ESA product (Dorigo et al. 2017) while for the computation of effective vegetation covers we used the observational leaf area index (LAI) dataset from COPERNICUS. The above datasets have been used in the overlapping period 1999-2016, that is available for all the observational products.

To disentangle the soil albedo component (Asoil[t]) from the observed total albedo, a linear decomposition can be performeded using the vegetation-albedo maps from Otto et al. (2011) as follows:

$Asoil[t] = (Atot[t] - Aveg * Ceff[t]) / (1 - Ceff[t])$

Note that the points with Ceff > 0.8 are discarded from subsequent analysis to make sure that only the grid points that are representative of a significant amount of bare soil are retained.

The link between Asoil and SM depends mainly on two soil properties: (i) texture and (ii) color. Soil color map from Dickinson et al. (1993) considers 9 soil colors, from light (1) to dark (8) and one additional class (9) for deserts. HTESSEL soil texture map considers 7 soil types: coarse, medium, medium-fine, fine, very-fine, organic, tropical-organic. By combining soil color and texture information we divided the land areas into 9*7=63 soil classes. For each soil class (texture and color) we seek a robust (statistically significant) linear relation between albedo and soil moisture for the four albedo components:

$Asoil(i,j,t) = a_{tex,col} * SM(i,j,t) + b_{tex,col}$

Figure 4 shows the linear relation between the visible component of Asoil and SM, together with the linear regression considering all land points. It is clear from the figure how the scatterplot cloud tends to be clustered in the different color classes. As an example, Figure 5 shows the medium-fine/color 4 soil class with its statistically significant (1% significance level) linear relation well represented.

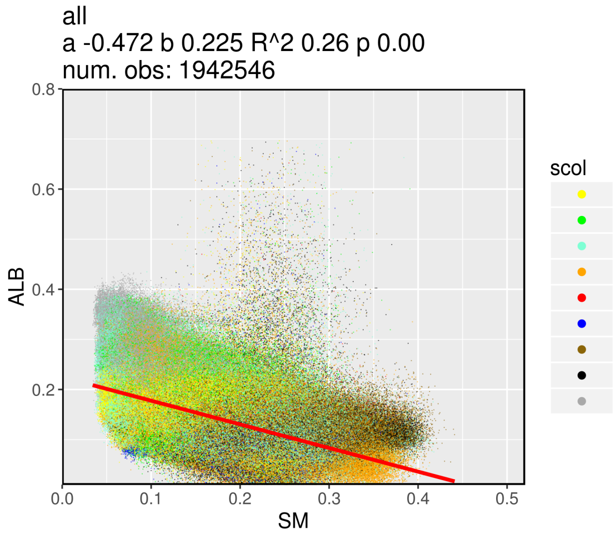

Fig. 4: *Scatterplot of the visible component of Asoil vs Soil Moisture, together with the linear regression considering all land points. Different colors stand for the 9 soil colors considered in the soil color map by Dickinson et al (1993).*

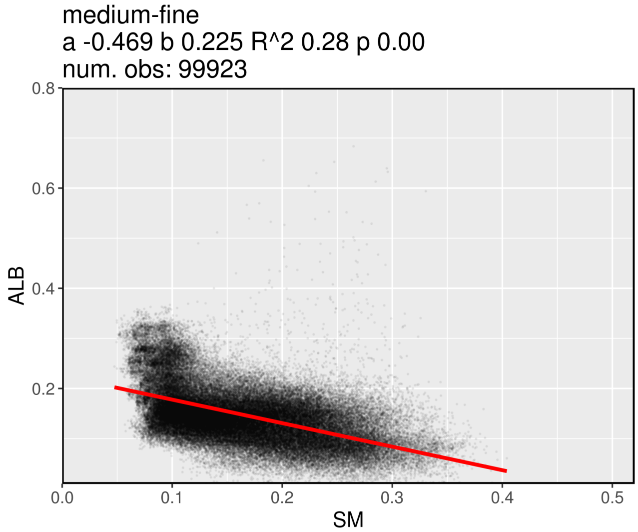

Fig. 5: *Scatterplot the of the visible component of Asoil vs Soil Moisture for the medium-fine/colour 4 soil class with its statistically significant (1% significance level) linear relation.*

References

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List of publications/reports from the project with complete references

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Summary of plans for the continuation of the project

(10 lines max)

As soon as the CMIP6 version of the EC-Earth model is released, a set of decadal hindcasts will be performed with the improved representation of the vegetation processes that has been already implemented during the first 6 months of the project. The vegetation density/cover will be obtained and prescribed from the available satellite observations. The finalization of the EC-Earth ESM to be used for CMIP6 has been delayed and not yet completed in the frame of the EC-Earth Consortium. It is expected that the final version of EC-Earth3.2 for CMIP6 will be ready only after the summer (most likely September 2018 instead of late 2017 as envisaged at the time of submission of this project) and this could jeopardize the realization of DCPP-vege for the scheduled time in 2018. Therefore it appears necessary to move resources (5 Million SBU) from the first (2018) to the second year of the project (2019) and an amendment request is being submitted at the same time of this report.