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	2020…………………………………………………….……
Project Title:	Land surface - climate interactions in the EC-Earth ESM: their role for climate variability and contribution to future climate…………………………………………………….……
	…………………………………………………….……
Computer Project Account:	spsemay…………………………………………….……
Principal Investigator(s):	Wilhelm May………………………………………….……
	…………………………………………………….……
Affiliation:	Centre of Environmental and Climate Research, Lund University, Sweden…………………………………….……
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…………………………………………………….……
	…………………………………………………….……
Start date of the project:	1.1.2020……………………………………………….……
Expected end date:	31.12.2022……………………………………………….……

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)			9,000,000	7,500,000
Data storage capacity	(Gbytes)			20,000	36,500

Summary of project objectives (10 lines max)

With the final version of the EC-Earth earth system model in place since mid-2019, the project activities started swiftly. In relation to the project description, one of the long simulations with EC-Earth (1900-2014; #1.3) has been performed. Instead of running the long simulations (#1.2, #1.3, #1.4 and #1.5) right away, I have run three shorter corresponding experiments for the late observational period (1979-2017), where the land-surface forcing, i.e. soil moisture and vegetation, was obtained from an offline simulation with H-TESSEl+LPJG forced with ERA5 (corresponding to #1.1). The results from these shorter simulations will give an indication of what to expect from the corresponding long experiments. Also, they can be compared with some of the originally planned long simulations, which use GSWP# as forcing instead of ERA5……………………………………………………………….

Summary of problems encountered (10 lines max)

No problems encountered, except when eccodes was replaced by grib_api, which caused several changes in the model environment and the code. However, I have considerably underestimated the data storage required and have now already almost used the quota for 2021. Therefore, I would like to mask you to set up the quota by about 20,000 GB for each year, giving 45,000 GB (2020), 65,000 GB (2021) and 85,000 GB (2022), respectively…………………………………... …………………….

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

There are computer resources for one of the long simulations left for this year. Depending on the results obtained from the shorter experiments that might be simulation #1.5 according to the model description…………………………………………………………………………………….……

List of publications/reports from the project with complete references

No publication yet…………………………………………………………………………………

Summary of results

In the following, some preliminary results from the four short simulations (1979-2017) with EC-Earth, with prescribed sea surface temperatures and sea ice, are presented. In particular, results for the skin temperature during boreal summer (June through August) are shown. The following four experiments are considered:
<u>ECE-V</u>; IFS coupled with LPJ-GUESS
<u>ECE-V+SM</u>; IFS coupled with LPJ-GUESS, with soil moisture nudged against the values from the offline simulation with HTESSEL+LPJG forced with ERA5
<u>ECE+VEG</u>; IFS, with vegetation prescribed from the offline simulation with HTESSEL+LPJG forced with ERA5
<u>ECE+SM+VEG</u>; IFS, with soil moisture nudged and vegetation prescribed from the offline simulation with HTESSEL+LPJG forced with ERA5

As indicated in Fig. 1, EC-Earth (ECE-V) is characterized by strong cold biases in many parts of the globe, i.e. in the high northern latitudes and most of Eurasia as well as in parts of South America, Africa and Australia. Considerable warm biases, on the other hand, are located in the United States, Amazonia, the Mediterranean region, Central Asia as well as in parts of Africa and Australia. Restricting the land surface conditions (ECE+SM+VEG) generally reduces the magnitudes of both the cold and the warm biases, but the geographical distributions of the biases are not really affected. It appears that most of the improvements are largely related to prescribed vegetation (ECE+VEG) and not as much to the nudged spoil moisture (ECE-V+SM). The latter, though, reduces the warm biases in the United States and Central Asia.

The deviations between the different experiments are illustrated in Fig. 2. In the three upper panels, the same types of colour (red or blue) as in the differences between ECE-V and ERA5 indicate improvements of the temperature biases when restricting the land surface conditions. In particular, the cold bias in the high northern latitudes and the warm bias in the tropics are improved when vegetation is prescribed. On the other hand, nudging of soil moisture markedly improves the warm bias in Central Asia. In the lower row of Fig. 2, the particular effects of nudging soil moisture (left panel) and prescribing vegetation (right panel) are separated. Again, the same types of colour as in the differences between ECE-V and ERA5 indicate improvements of the temperature biases when restricting the specific land surface conditions.

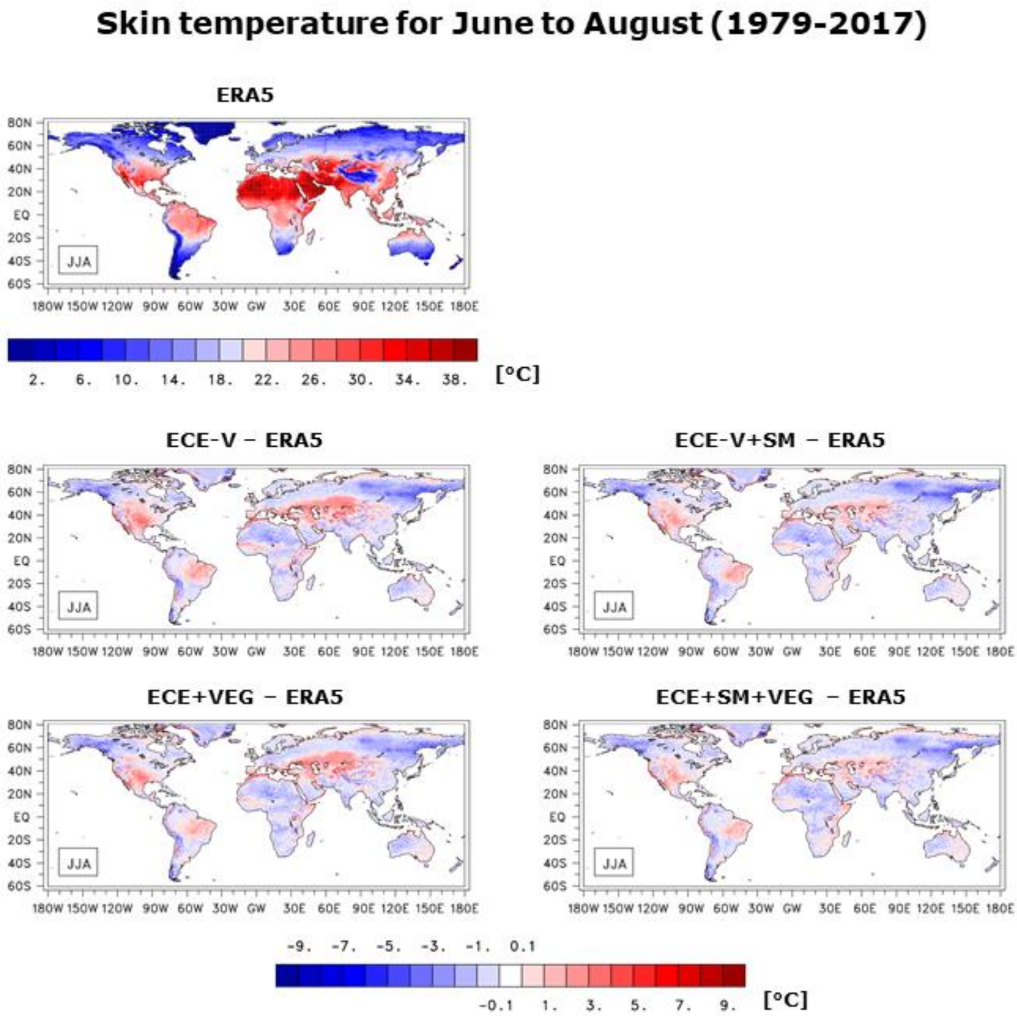
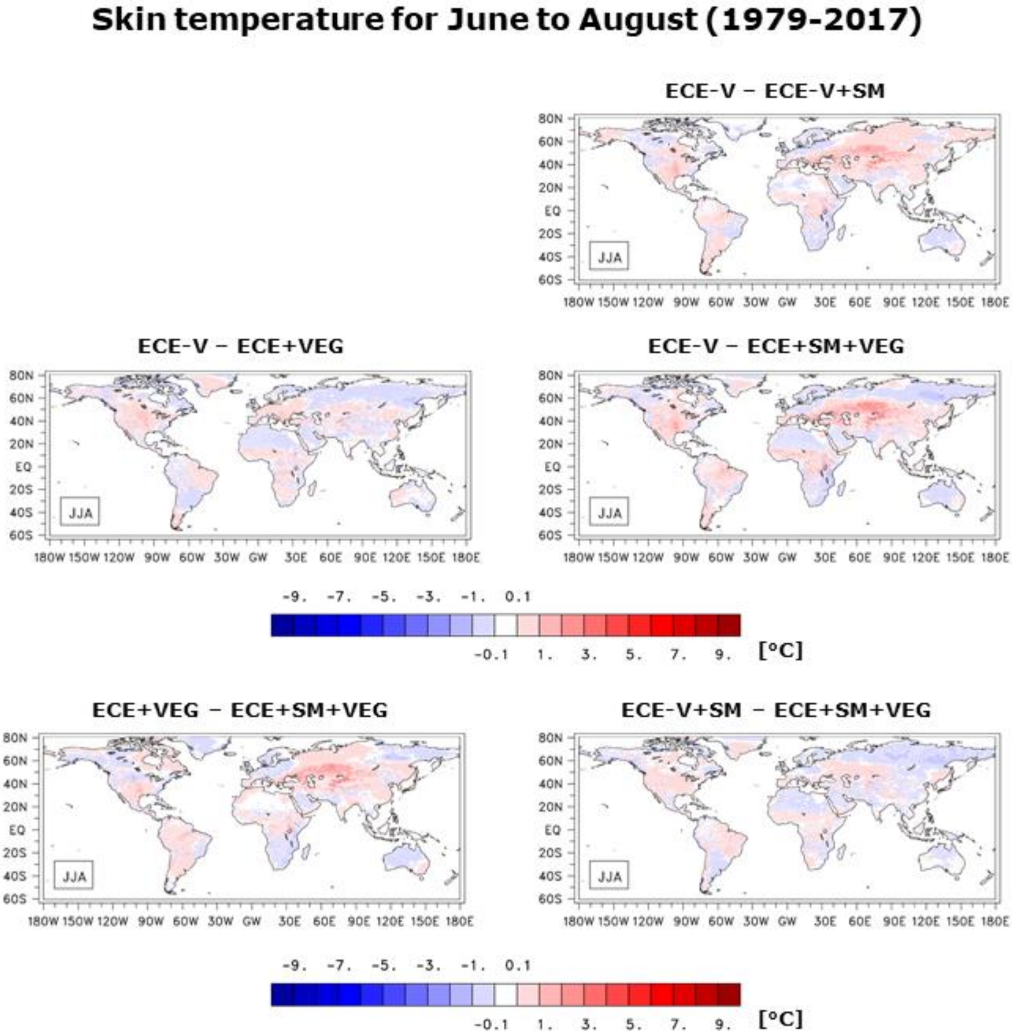


Fig. 1: Long-term seasonal mean of skin temperature from ERA5 (upper row) as well as the differences between the four simulations and ERA5 (middle and lower row). The significance of the differences at the 97.5% level is indicated by the white hatching.



<u>Fig. 2:</u> Differences of the long-term seasonal mean of skin temperature between the three simulations nudged or prescribed land surface conditions and the unrestricted simulation (ECE-V; upper and middle row) and the differences between the two simulations, where either soil moisture is nudged or vegetation prescribed, and the simulation, where both land surface conditions are restricted.