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	2018
Project Title:	Simulating the green Sahara with EC-Earth 3.2
Computer Project Account:	SPSEZHAN
Principal Investigator(s):	Qiong Zhang
Affiliation:	Department of Physical Geography Stockholm University
Name of ECMWF scientist(s) collaborating to the project (if applicable)	
Start date of the project:	2019-01-01
Expected end date:	2021-12-31

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	9885401	15.000.000	564506
Data storage capacity	(Gbytes)	5000	4500	5000	1000

Summary of project objectives (10 lines max)

We aim to run transient simulations to investigate the termination of Green Sahara. The planned transient simulation will be about 3500 years long from 8000 BP to 4500 BP. This simulation will provide a comprehensive understanding of the vegetation feedbacks in the transition phases together with the possibility of having multiple equilibria in Northern Africa. Besides the transient simulations, different sensitivity simulations will be also performed to understand the climate response and feedbacks, such as offline dynamical vegetation model simulations to determine how much precipitation would be needed to initiate a green Sahara. We also test the impact of the aerosol direct and indirect effect through a few sensitivity experiments.

Summary of problems encountered (10 lines max)

The long transient simulation demand huge computation, while which such a heave earth system model EC-Earth, with the low resolution T159, approximately we can run10 simulation years per day (SYPD). It indicates that a planned 3500 years simulation will need more than one year to complete, ideally when everything goes on well. It would be great if technically we can improve the computation efficiency. Since from 2019 we have finished the setup and enter the production stage, we request 5,000,000 SBU more for 2020, that will increase the granted 15,000,000 SBU to 20,000,000 SBU. The need for 2021 will be according to the simulation progress and report in 2020.

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

From 2018 to 2019, we have done sensitivity experiments with the dynamical vegetation model LPJ-GUESS, and have coupled the LPJG to EC-Earth. We have adopted the external forcing (GHG and solar irradiance) from the paoelcimate reconstructions to EC-Earth forcing file. Now we have started the spinup run for the starting year 8ka BP. Once the 8ka simulation reaches the equilibrium (usually needs 200-300 years), we can start the transient run from 8k with time varied external forcing (orbital, GHG and solar).

List of publications/reports from the project with complete references

The publications listed below during project year 2019 have acknowledged the HPC and data support from ECMWF. Some works may have done during the previous years.

Ljungqvist, F. C., Q. Zhang, G. Brattström, P. J. Krusic, A. Seim, Q. Li, Q. Zhang and A. Moberg, 2019: Centennial-scale temperature change in last millennium simulations and proxy-based reconstructions. Journal of Climate. https://doi.org/10.1175/JCLI-D-18-0525.1.

Messori, G., M. Gaetani, Q. Zhang, Q. Zhang and F. S. R. Pausata, 2019: The water cycle of the mid-Holocene West African monsoon: The role of vegetation and dust emission changes. *International Journal of Climatology*, **39**(4): 1927-1939.

Zheng, J., Q. Zhang, Q. Li, Q. Zhang, and M. Cai, 2019: Contribution of sea ice albedo and insulation effects to Arctic amplification in the EC-Earth Pliocene simulation, *Clim. Past*, 15, 291-305, https://doi.org/10.5194/cp-15-291-2019.

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.

In the first half year of 2019, most work have been done for the model experiment setup and now the simulations are running, no scientific results have been analysed yet. We expect that the first results will be obtained by November, when we will present the results in our project meeting. Detailed scientific results will be reported in 2020.