REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: NORWAY

Principal Investigator[1]: Dr. Yvan J. Orsolini

Affiliation: NILU- Norwegian Institute for Air Research

Address: Instituttveien 18, N-2027 Kjeller, Norway

E-mail: yvan.orsolini@nilu.no

Other researchers:

Drs. G. Balsamo, F. Vitart, A. Weisheimer (ECWMF)
Drs R. Senan (Univ. of Oslo), R. Benestad (Metno)

Project Title:

SNOWGLACE2 – Impact of snow initialisation on spring sub-seasonal forecasts

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** ________________	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2013	
Would you accept support for 1 year only, if necessary?	YES X☐	NO ☐

Computer resources required for 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	1 200 000		
Data storage capacity (total archive volume) (gigabytes)	1000		

An electronic copy of this form ***must be sent*** *via e-mail to:* *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date):

April 18, 2012

Continue overleaf

[1] The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

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Extended abstract

1.Background

Improving atmospheric forecast skill beyond the synoptic time scale requires further exploiting of the memory inherent to the slowly varying components of the climate system. There has been renewed interest in tapping on that potential with state-of-the-art, dynamical prediction systems. The question of whether realistic initialization of soil moisture could quantitatively improve dynamical forecasts of surface temperature and precipitation on the monthly to sub-seasonal time scale, was investigated in the coordinated, international numerical modeling experiment Global Land-Atmosphere Coupling Experiment (GLACE2) (e.g. Koster et al., 2010; Van den Hurk et al., 2010). Snow covered land is another slowly varying component of the climate system. Its importance stems from the snow remarkable insulating and reflecting properties and from the snowpack role in the hydrological cycle (Xu and Dirmeyer, 2011). These snow-related feedbacks are partly reproduced in models, and multi-layer snow schemes in forecast models lead to a more effective insulation, and hence a further cooling of the near-surface atmosphere (Dutra et al., 2011).

In addition to its effect on local meteorological conditions, many observational and model studies have indicated that the snowpack impacts large-scale circulation patterns. In autumn and winter, anomalies in the Eurasian snow cover influence the North Pacific and North Atlantic climate patterns (Orsolini and Kvamstø, 2009), and have been argued to condition the phase of the North Atlantic Oscillation (NAO) (Cohen et al., 2007). In spring, the Eurasian/Himalayan snow cover exerts a strong influence on the land surface energy budget over Eurasia, and its importance for modulating the Asian and Indian summer monsoons has a long history and has been the subject of many observational and model studies (e.g Peings and Douville, 2010; Turner and Slingo, 2011). Few studies have however assessed the contribution of snow initialization to actual seasonal predictability with state-of-the-art, coupled dynamical prediction models.

2. SNOWGLACE autumn forecasts

In a recent study, we have transposed the GLACE-2 methodology from its original, warm season soil moisture focus, to an autumn-early winter snowpack focus. Two parallel series of two-month retrospective ensemble forecasts, each comprising 11 members, were performed with the ECMWF coupled ocean-atmosphere seasonal prediction system. Forecasts were launched twice-monthly during the six autumns of 2004 to 2009, one with realistic snow initialization and one with "scrambled" snow initialization, providing a total of 24 ensemble forecasts. The cycle 36R1 with improved land surface module, a one-layer snow scheme (Dutra et al., 2010), new hydrology (H-TESSEL) was used at T255L62. Both series of forecasts anomalies are separately evaluated against corresponding anomalies derived from the ERAINT re-analyses.

The main findings were that, initially, in the first 15 days, the presence of a thick snowpack cools surface temperature over the continental land masses of Eurasia and North America, decoupling the atmosphere from the soil layer below (Dutra et al., 2010; 2011). The feedback hence operates at high latitudes in autumn, despite the short-wave albedo feedback being weak. At a 30-day lead, a remarkable, large forecast skill increment in surface temperature is found over the Arctic. The corresponding warming over the Arctic and Eurasian high latitudes and the cooling of Eurasian mid latitudes appear due to the intensification, and also westward expansion, of the Siberian High. In the Series1 simulations, initialized with a realistic snowpack, a cold model bias versus ERAINT re-analyses over the Arctic is alleviated. Hence, a realistic snow pack initialisation has potential to improve forecast skill in surface temperature over the Arctic, at monthly lead time.

These simulations were realized as a part of a special project (spnospar),, and were the result of a collaboration between the Norwegian Institute for Air Research, the Norwegian Meteorological Institute and ECMWF researchers. The project completed in 2011 led to two publications (Benestad et al., 2011; Orsolini et al., 2011) on the role of sea ice initialisation, while the role of snow initialisation forms the basis of a paper soon to be submitted (Orsolini et al., 2012).

3. SNOWGLACE spring forecasts

The aim of this application is to carry on the SNOWGLACE methodology to springtime forecasts. In spring, the physical processes are different due to the prominence of the short-wave albedo feedback. In addition to potentially affecting the circulation over northern Eurasia and the Arctic, the feedbacks could potentially affect Rossby wave-trains from the Atlantic to East Asia, and the inter-annual variability of the Asian and Indian summer monsoons. The *snowpack influence on monsoons remains controversial as major remaining issues concerns the masking effect of ENSO, the stationarity of the snow/monsoon relation over decades, and the differences found in identifying key coupling regions depending on whether snow cover or depth is considered, as discussed in Section 1. But, we aim to bring new insight into the role of Eurasian/Himalayan snow cover through the SNOWGLACE methodology, with forecasts specifically designed to isolate the impact of snow initialization upon the monsoon variability. Analyses of these simulations will be funded by a project recently approved by the Norwegian Research Council Climate Program, in the frame of a bilateral collaborative project with India.*

We aim to follow the same simulation design as in the autumn simulations mentioned above, with the coupled seasonal forecast System 4.0 (IFS/NEMO). We aim at using the cycle 38R1 at T255L91. Twin 10-member ensembles of two-month forecasts will be launched at 4 monthly-spaced start dates from March to June, covering over a decade (2000-2012). The requirements would hence be

*2 months * 10 members * 2 Series * 4 start dates * 12 years = 160 coupled model-years*

*7500 SUB * 160 = 1 200 000 SBU*

Bibliography

Benestad, R., R. Senan, M. Balmaseda, M., L. Ferranti, Y.J. Orsolini and A. Melsom, Sensitivity of T-2m to Arctic sea ice, Tellus, Ser. A, doi: 10.1111/j.1600-0870.2010.00488.x, 2011.

Cohen J., M. Barlow, P.J. Kushner and K. Saito, Stratosphere-Troposphere coupling and link with Eurasian Land-Surface variability, J. Clim., 20, 5335-5343, 2007.

Dutra E. et al., An improved snow scheme for the ECMWF land surface model: description and offline validation, J. Hydromet., 11, 899-916, doi:10.1175/2010JHM1249.1, 2010.

Dutra E. et al., Land-atmosphere coupling associated with snow cover, Geophys. Res. Lett, 38, L15707, doi:1.1029/2011GL048435, 2011.

Koster, R.D. et al., GLACE2: The Second Phase of the Global Land-Atmosphere Coupling Experiment: Soil Moisture Contributrion to Subseasonal Forecast Skill, J. Hydrometeor, in press, 2010.

Orsolini, Y. J., and N. Kvamstø, The role of the Eurasian snow cover upon the wintertime circulation: decadal simulations forced with satellite observations, J. Geophys. Res.,114, D19108,doi:10.1029/2009JD012253, 2009.

Orsolini, Y.J., R.Senan, R. Benestad and A. Melsom, Autumn atmospheric response to the 2007 low Arctic sea ice extent in coupled ocean-atmosphere hindcasts, Climate Dynamics, (DOI) 10.1007/s00382-011-1169-z, 2011.

Orsolini Y. J., Senan, R., Balsamo, G., Doblas-Reyes, F.J., Vitart, F., Weisheimer, A., Carrasco, A., and Benestad, R.E., Impact of snow initialization on sub-seasonal forecasts, to be submitted, March 2012

Peings, Y., Douville, H. (2010): Influence of the Eurasian snow cover on the Indian summer monsoon variability in observed climatologies and CMIP3 simulations, Clim. Dyn., 34, 643-660, DOI 10.1007/s00382-009-0565-0, 2010.

Turner, A. G. and Slingo, J. M. (2011): Using idealized snow forcing to test teleconnections with the Indian summer monsoon in the Hadley Centre GCM, Clim. Dyn., 36, 1717-1735, DOI 10.1007/s00382-010-0805-3.

van den Hurk B., F. Doblas-Reyes, G. Balsamo, R.D. Koster, S. I. Seneviratne, H. Camargo, Soil moisture effects on seasonal temperature and precipitation forecast scores in Europe, Clim. Dyn., DOI 10.1007/s00382-010-0956-2, 2010.

Xu, L. and P. Dirmeyer, Snow-atmosphere coupling strength in a global circulation model, Geophys. Res. Lett., 38, L13401, doi:10.1029/2011GL048049, 2011.