# 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.

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| **Reporting year** | 2013 |
| **Project Title:** | SNOWGLACE2 – Impact of snow initialisation on spring sub-seasonal forecasts |
| **Computer Project Account:** | spnoorso |
| **Principal Investigator(s):** | Dr. Yvan J. ORSOLINI |
| **Affiliation:** | NILU - Norwegian Institute for Air Research |
| **Name of ECMWF scientist(s) collaborating to the project** (if applicable) | Dr. A.Weisheimer, Dr. G. Balsamo, Dr. E. Dutra. Dr. F. Vitart<br>……………………………………………………….…… |
| **Start date of the project:** | 1st January 2013 |
| **Expected end date:** | 1st January 2014 |

## 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) | | | 1200000 | 0 |
| **Data storage capacity** | (Gbytes) | | | 1000 | |

## Summary of project objectives
(10 lines max)

The aim of this project is to investigate the impact of snow initialisation on spring-time seasonal forecast, using the methodology developed in SNOWGLACE (Orsolini et al., 2013) and GLACE2 (van den Hurk et al., 2010). In spring, the Eurasian/Himalayan snow cover exerts a strong influence on the land surface energy budget, and the importance of the springtime Eurasian/Himalayan snow cover for modulating the Indian summer monsoon intensity and onset has a long history and has been the subject of many observational and model studies. The SNOWGLACE set-up with twin ensembles of forecast with realistic or scrambled snow initialisation would be ideally suited to isolate the impact of snow initialization upon the Indian summer monsoon onset or variability.

## Summary of problems encountered (if any)
(20 lines max)

We have not encountered major problems per se, but we have some spent additional time investigating the snow/monsoon relation in various re-analyses datasets, such as ERAINT, ERAINT-land, JRA-25, incl. back to the late 1800 using also the 20th Century Re-analyses. We have started implementing the coupled model runs in June 2013.

## Summary of results of the current year (from July of previous year to June of current year)

The importance of the springtime Eurasian/Himalayan snow cover for modulating the Indian summer monsoon (ISM) intensity 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). This influence 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. We have some spent additional time investigating the snow/monsoon relation in various re-analyses datasets, such as ERAINT, ERAINT-land, JRA-25 and also 20th Century Re-analyses. In addition, we have made some effort to recover station snow data over the Himalaya/Tibet Plateau (HTP) region. These included Russian data and, most interestingly, snow observations from 47 Tibetan stations back to 1980. This allowed for a better comparison of the biases and the variability in the different re-analyses, and how they compared with in-situ observations.

In particular, we revisited the snow-monsoon relationship using the longest ever global reanalysis data set covering the period from1871 to 2010. In most studies, the ISM has been represented by the June to September mean rainfall over India. We rather used a thermodynamically based objective definition based on the meridional temperature gradient in the whole troposphere.

Cold anomalies at low levels were associated with high snow over the HTP in April, leading to a weakening of the advance of the monsoon over the Bay of Bengal and Arabian Sea branches in May, and a delayed onset of the monsoon and warm Indian sub-continent in June. Hence, the inverse relationship between ISM and snow over HTP in the composite analysis of the 20th CR re-analysis is consistent with the Blandford hypothesis (see. E.g. Turner and Slingo, 2011): heavy snow leading into spring over HTP contributes to a delayed onset of the monsoon and its evolution. This snow-monsoon relationship is not sensitive to ENSO. These results were presented at the International workshop on seasonal to decadal prediction held in Toulouse (France) in May 2013 (Senan et al., 2013), and a paper is to be submitted in the summer 2013.

The analysis of re-analysis and observational data has indicated that starting the simulations in April, when the snowpack is still present, would be adequate and allow to still capture the snow impact on the monsoon onset. It also indicated that the 20th CR re-analyses have a high snow bias, and might favour this snow-ISM connection over other influences.

This analysis of data and simulations is funded by the Research Council of Norway under the project NORINDIA - Climate Change and its Impacts on Selected Indian Hydrological Systems using Earth System and High-Resolution Modeling.

*Orsolini, Y.J., Senan, R., Balsamo, G., Doblas-Reyes, F., Vitart, D., Weisheimer, A., Carrasco, A., Benestad, R. (2013), Impact of snow initialization on sub-seasonal forecasts , Clim. Dyn., DOI: 10.1007/s00382-013-1782-0.*

*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.*

## List of publications/reports from the project with complete references

Senan, R., Orsolini Y.J. and F. Stordal, Influence of spring-time Eurasian-Himalayan snow on the evolution of the Indian summer monsoon, International workshop on seasonal to decadal prediction Toulouse, France, 13-16 May, 2013.

## Summary of plans for the continuation of the project

Our initial plan was to run the coupled seasonal forecast System 4.0 (IFS/NEMO, 38R1 at T255L91) with twin 10-member ensembles of two-month forecasts, launched at 4 monthly-spaced start dates from March to June, and covering over a decade (2000-2012). Our revised strategy –based on the above-mentioned analysis-, is to use only one start date (April) and run a larger ensemble of 40 members, for a better signal-to-noise ratio. The “scrambled” snow initial conditions for 40 members would be generated using ERAINT-land over the past 40 years. We would still be able to cover a decade of simulations, without changing our requirements for computing ressources. Work on the implementation of the runs has started in June 2013, with help from ECMWF scientists.