REQUEST FOR A SPECIAL PROJECT 2015–2017

MEMBER STATE: Italy, Germany, Switzerland

Principal Investigator[1]: Montani Andrea (Italy)

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Project Title:

Investigation of case studies during Sochi Olympic Games using COSMO-based ensemble prediction systems.

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** COLEPS	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2015	
Would you accept support for 1 year only, if necessary?	YES ☐	NO ☒

Computer resources required for 2015-2017: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2017.)	**2015**	**2016**	**2017**
High Performance Computing Facility (units)	1.000.000	1.000.000	1.000.000
Data storage capacity (total archive volume) (gigabytes)	50	50	50

*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): 27 June 2014

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

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.

Introduction and aims

Past winter Olympics and Paralympic Games took place in Sochi, Russia, from 7 to 23 February 2014 and from 7 to 16 March 2014, respectively. In the framework of these events, WMO launched a dedicated WWRP FDP/RDP (Forecast Demonstration Project / Research and Development Project) initiative to improve understanding of nowcasting and short-range prediction processes over complex terrain. A new project named **FROST-2014** (**F**orecast and **R**esearch in the **O**lympic **S**ochi **T**estbed; http://frost2014.meteoinfo.ru) was set-up and four Working Groups (WGs) were established to deal with the various components of the project:

- ➔ WG1: observations and nowcasting;
- ➔ WG2: NWP, ensembles and assimilation;
- ➔ WG3: IT including graphical tools, formats, archiving and telecommunication;
- ➔ WG4: products, training, end user assessment and social impacts.

As for WG2, ensemble systems with resolution about 7 km or coarser were involved in the project in forecast and demonstration mode (FDP component), while systems with resolution about 2 km contributed to the project in research mode (RDP component). Within the former component, a new convection-parameterised limited-area ensemble prediction system based on COSMO model and targeted for Sochi-area (referred to as COSMO-S14-EPS) was set-up, generated, implemented and maintained in a quasi-operational way throughout the Olympic Games. As for the latter component, a convection-permitting ensemble (COSMO-RU2-EPS) was also implemented and maintained on an experimental basis. Both COSMO-S14-EPS and COSMO-RU2-EPS were used in real time by the operational forecasters during the Olympics and the performance of both systems is under investigation. The main features of the two systems, as run during the Olympics, are summarized in Table 1.

In the framework of this special project, it is planned to investigate the performance of these systems for a number of cases occurred during February and March 2014, varying the configurations of the ensembles. For cases of poor performance of COSMO-S14-EPS, the ensemble size will be increased to 20 and to 51 and the probabilistic predictability of the system will be assessed. It will be also investigated the added value of the higher resolution of COSMO-RU2-EPS with respect to COSMO-S14-EPS and we will also test the possibility to nest COSMO-RU2-EPS directly on ECMWF ENS in order to simplify the forecasting chain. It is worth pointing out that the model levels from ECMWF ENS needed to run COSMO model have already been saved on ecfs during the Olympic Games. Therefore, at the moment, it is not envisaged to rerun the full global ensemble system.

Table 1: Main features of the implementations of ECMWF-EPS, COSMO-S14-EPS and COSMO-RU2-EPS during the Olympic Games

	ECMWF-EPS	COSMO-S14-EPS	COSMO-RU2-EPS
Hor. res.	~ 31 km	7 km	2.2 km
Vert. res.	62 ML	40 ML	50 ML
Forecast length	240h	72h	48h
Ensemble size	50+1	10	10
Initial time	00/12 UTC	00/12 UTC	00/12 UTC
Convection	Parameterised	Parameterised	Resolved
Running at	ECMWF	ECMWF	Roshydromet
ICs and BCs	SV ini pert + EDA	from selected ECMWF-EPS members	from COSMO-S14-EPS members
Model perturbations	Stochastic physical tendencies + backscatter	Physical parameterizations	

Computer resources

The approximate costs of COSMO-S14-EPS and COSMO-RU2-EPS are based on the present architecture of ECMWF super-computers (IBM) and are quantified for the "72-hour range" and "48-hour range" configurations, respectively. The costs in terms of computer time can be estimated as follows:

- cost of one run at 7 km ~ 1000 BU;
- cost of one run at 2.2 km ~ 2000 BU;
- cost of 51-member COSMO-S14-EPS ~ 51.000 BU;
- cost of 51-member COSMO-RU2-EPS ~ 102.000 BU;
- cost of 6 case studies including pre- and post-processing ~ 950.000 BU.

Depending on the results, the set-up of the systems could be modified and the cost could change.

Technical characteristics of the codes

In the framework of this special project, the following F90 codes will be used:

- "int2lm", an interpolation program which performs the interpolation from coarse grid model data to COSMO initial and/or boundary data. The following coarse grid models are possible (at the moment): GME (the global German grid point model on a icosahedral grid), IFS (the global ECMWF spectral model), GFS (global US model), UM (UK Met Office Unified Model) and COSMO (when the COSMO model is nested into itself).
- "cosmo", the code performing the actual numerical weather prediction with the non-hydrostatic limited-area atmospheric prediction model COSMO. This code has been designed for both operational forecasts and various scientific applications on the meso-beta

(from 5 to 50 km) and meso-gamma (from 500 m to 5 km) scale. COSMO model is based on the primitive thermo-hydrodynamical equations describing compressible flow in a moist atmosphere. The model equations are formulated in rotated geographical coordinates and a generalized terrain following height coordinate. A variety of physical processes are taken into account by parameterisation schemes.

Since the very beginning of the code development, both “int2lm” and “cosmo” have been parallelised using the MPI library for message passing on distributed memory machines. With regard to the more demanding code “cosmo”, it has to be underlined that this code is portable and can run on any parallel machine providing MPI. At the moment, “cosmo” is implemented for both operational and research use on several platforms, including IBM SP pwr6 (the ECMWF machine where the COSMO-LEPS time-critical application runs, using 6 nodes for a total of 384 tasks), NEC SX8, INTEL/AMD Linux clusters, Cray XC30.