REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: Italy, Germany, Greece, Switzerland

Principal Investigator[1]: Montani Andrea(Italy)[1] , Majewski Detlev (Germany)[2], Steiner Philippe(Switzerland)[3]

Affiliation: [1]ARPA-SIMC , [2] Deutscher Wetterdienst, [3] MeteoSwiss

Address: [1] Servizio IdroMeteoClima, Viale Silvani 6, 40122 Bologna (Italy)
[2] Frankfurter Strasse 135 63067 Offenbach (Germany)
[3] Kraehbuehlstrasse 58, 8044 Zurich (Switzerland)

E-mail: [1] amontani@arpa.emr.it, [2] detlev.majewski@dwd.de, [3] Philippe.Steiner@meteoswiss.ch

Other researchers: Chiara Marsigli (ARPA-SIMC)

Project Title: Implementation of a limited-area ensemble prediction system for Sochi Olympic Games

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.)	2012	
Would you accept support for 1 year only, if necessary?	YES ☐	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)	6.200.000	2.000.000	500.000
Data storage capacity (total archive volume) (gigabytes)	70	60	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): 26/4/2012

Continue overleaf

Principal Investigator: Montani Andrea, Majewski Detlev, Steiner Philippe

Project Title: Implementation of limited-area ensemble forecasts for Sochi Olympic Games.

[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.

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

Next winter Olympics and Paralympic Games will take place in Sochi, Russia, in a region characterised by complex topography located in the vicinity of the Black Sea. The Olympic Games will take place from 7 to 23 February 2014, while the Paralympic Games from 7 to 16 March 2014. In the framework of these events, WMO launched two initiatives: a dedicated WWRP FDP (Forecast Demonstration Project) and a dedicated WWRP RDP Research and Development Project) to improve understanding of nowcasting and short-range prediction processes over complex terrain.

A new project, named **FROST-2014** (**F**orecast and **R**esearch: the **O**lympic **S**ochi **T**estbed) was endorsed by WWRP/WMO and the second meeting of the project took place in Moscow from 16 to 18 April 2012. The activity of the four Working Groups (WGs) was revised and suggestions for improvements were made. The WGs deal with the following 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, it was agreed that ensembles with resolution about 7 km or coarser could be involved in the project in forecast and demonstration mode (FDP component), while systems with resolution about 2 km would contribute to the project in research mode (RDP component). Within the former component, one of the main activities will deal with the set-up, generation, implementation and maintenance of a limited-area ensemble prediction system based on COSMO model and targeted for Sochi-area. During the fist part of 2012, steps were made to set-up the FDP component. More information about FROST can be found under the project web-page: http://frost2014.meteoinfo.ru/ .

Scientific plan

In the framework of the FDP, it is planned to "clone" COSMO-LEPS system and relocate it over Russia, centring the domain over the Sochi area, thus generating COSMO-FROST-EPS system. In the past years, COSMO-LEPS proved to be a valuable tool for the generation of probabilistic predictions of high-impact weather over complex topography and it is envisaged that COSMO-FROST-EPS can provide useful support to bench forecasters during the Olympic Games. Within FROST-2014, the attention will be focussed on those atmospheric variables which play a major role in the outdoor activities of the Olympic Games. More specifically, the probabilistic prediction of wind, wind-gust, precipitation (in various forms), temperature, humidity and visibility will be required for forecast ranges up to three-four days, depending on the variable.

Phase I: set-up of the system

This phase covers a large part of 2012. The first prototype of COSMO-FROST-EPS was set-up with a configuration partly similar to COSMO-LEPS application. In order to save computer time, the ensemble size was initially limited to 10 members and the forecast range to 72 hours. Therefore, the main characteristics can be summarised as follows:

- horizontal resolution: 7 km,

- vertical resolution: 40 model levels,
- number of grid points (NX x NY x NZ) ~ 365x307x40 = 4.482.200,
- forecast length: 72 hours,
- ensemble size: 10 members,
- initial conditions: interpolated from selected ECMWF EPS members,
- boundary conditions: interpolated from selected ECMWF EPS members,
- initial time of the run: 00UTC and 12UTC.

The EPS members providing initial and boundary conditions to COSMO-FROST-EPS integrations, are selected by means of a clustering analysis / selection of representative members similar to the one used in COSMO-LEPS time-critical application. COSMO-FROST-EPS produces a set of standard probabilistic products (e.g. probability maps, meteograms, ...) which are delivered in real time to the Met Ops room of the Hydrological and Meteorological Centre of Russia (hereafter, Roshydromet). The generation of the different types of non-graphical products takes advantage of "Fieldextra", the official COSMO post-processing software, developed at Meteoswiss.

In Phase I, as well as Phase II, the training of forecasters plays a key component. Forecasters are being "educated" to familiarise with ensemble products and to get in touch with the probabilistic approach.

Phase II: development of the system

This phase will cover late 2012: on the basis of the experience gained in Phase I and on the feedback provided by Roshydromet forecasters, the configuration of COSMO-FROST-EPS will be adapted accordingly; the same applies to the type of products to be generated and delivered. COSMO-FROST-EPS configuration is thought in a modular way and can be modified in terms of ensemble size, forecast range and other features with limited effort.

In this phase, the complete transition of the system towards the use of GRIB2 format for COSMO-FROST-EPS output files will probably take place. In addition to that, special needs of Roshydromet could be implemented in the Fieldextra software, already installed on ECMWF super-computers. The set of products to be delivered will have to be consolidated, as well as the procedures of transmission and visualisation.

Phase III: final implementation of the system

This crucial phase will cover 2013 and 2014, thus including the full length of Winter Olympic and Paralympic Games. COSMO-FROST-EPS should run continuously for the whole 2013 and up to March 2014 so that forecasters have enough time to familiarise and get used to probabilistic products at high resolution. Generation and transfer of products (forecast fields and/or plots) will have to be reliable and the timely delivery should be ensured.

Computer resources

The approximate costs of COSMO-FROST-EPS are based on the present architecture of ECMWF super-computers and are quantified for the "10-member, 72-hour forecast range, twice a day" configuration. The costs in terms of computer time can be estimated as follows:

- cost of one run ~ 800 BU;
- cost of 10-member COSMO-FROST-EPS ~ 17000 BU/day;
- cost of 3 months of COSMO-FROST-EPS activity ~ 1.550.000 BU;
- cost of 12 months of COSMO-FROST-EPS activity ~ 6.200.000 BU.

It is clear that, depending on the results of Phases I and II, the set-up of the system 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.
- "fieldextra" is a generic tool to manipulate NWP model data and gridded observations. Simple data processing and more complex data operations are supported, for example: selecting data satisfying some complex condition, comparing or merging multiple fields, horizontal and vertical re-gridding, computation of regional means, computation of stability indices, computation of neighbourhood and EPS probabilities. A rich set of output format is proposed, including GRIB1 and GRIB2. Fieldextra is an official COSMO postprocessing tool and is also one of the COSMO 'translator' for the SRNWP interoperability project.

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 and INTEL/AMD Linux clusters.