COSMO Activities for the Winter Olympic and Paralympic Games in Sochi, Russia, in February and March 2014

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COSMO Modeling System (NWP, ART, CLM)

- Nonhydrostatic, fully compressible dynamical core
- Runge-Kutta time stepping; higher order numerics
- Horizontal explicit, vertical implicit; splitting scheme
- NWP: Convection-permitting numerical weather prediction
- ART: Aerosols (dust, pollen, volcanic ash) and reactive trace gases
- CLM: Regional, high resolution climate simulation

- COSMO Modeling System is freely available to universities.
- Strong involvement of universities in R&D activities.
COSMO activities related to Sochi-2014 WWRP RDP/FDP

1. **Deterministic:** High resolution COSMO model (2.2 km grid spacing; forecast range up 24 hours; rapid update cycle) nested into the 7-km COSMO-RU model in Moscow. DWD will provide the 2.2 km topographical data set; the model runs should include data assimilation using all available data, hopefully even a Doppler radar on a mountain near Sochi which will be ready by the summer of 2012.

2. **Probabilistic:** A COSMO-LEPS (7-km grid spacing) centered around Sochi for a dynamical downscaling of the ECMWF EPS with a forecast range of up to 5 days. The idea is to run the COSMO-LEPS-Sochi at ECMWF for a test period during winter 2012/2013 and in production mode during winter 2013/2014. The products (GRIB fields) should be transferred to Moscow for visualization. See the following presentation by Andrea Montani!

3. **Postprocessing and product generation:** Implement and use FIELDEXTRA.

4. **Verification:** Implement and use VERSUS as platform for verification of deterministic and probabilistic forecasts.
End – to – End Deterministic FDP for Sochi

Observations: In-situ and remote sensing

Data assimilation including LHN of radar

Numerical model chain from global to local

Postprocessing, generation of products, visualisation, verification

Different user groups, e.g. forecasters, organisers, media, general public
Deterministic Numerical Weather Prediction for Sochi

**Global model GME**
- Grid spacing: 30 (20) km
- Layers: 60
- Forecast range:
  - 174 h at 00 and 12 UTC
  - 48 h at 06 and 18 UTC
- 1 grid element: 778 (346) km²

**COSMO-7**
- Grid spacing: 7 km
- Layers: 40
- Forecast range:
  - 78 h at 00 and 12 UTC
  - 48 h at 06 and 18 UTC
- 1 grid element: 49 km²

**COSMO-2**
- Grid spacing: 2.2 km
- Layers: 50
- Forecast range:
  - 21 h at 00, 03, 06, 09, 12, 15, 18, 21 UTC
- 1 grid element: 5 km²
Data Assimilation for GME and COSMO MODELS

GME: intermittent 3D-Var; COSMO: Nudging scheme

observations assigned to analysis times

GME

hourly boundary values

COSMO

(sub-) surface fields (snow)

(atmospheric fields)

data assimilation cycle

time critical 12-UTC forecast run

Observation (continuously at the model integration)

wanted: 12-UTC forecast run

→ required: 12-UTC analysis → start at 14:14 UTC

12-UTC: “main run” nudging ana.
“main run” snow analysis
main forecast run

ass. cycle nudging ana.
ass. cycle snow analysis

15-UTC: ass. cycle nudging ana.

18-UTC ...

00-UTC:
+ snow ana
+ SST ana
+ soil moisture ana
+ climatolog. fields

LM–Analysis (Nudging)
(Available at hourly intervals)
COSMO-7; Snow line (m above MSL) 13/02/11 12+24h
COSMO-2; Snow line (m above MSL) 13/02/11 12+24h
COSMO-2; Wind speed at 10m (m/s) 13/02/11 12+24h
FIELDEXTRA Overview, Part I

• *Postprocessing* program designed as a **generic tool** to manipulate NWP model data and gridded observations

• Simple **data extraction** & complex **data operations** are supported:
  • merge surface temperature from IFS over sea and from COSMO over land to produce a single field suited for the assimilation cycle;
  • interpolate Swiss radar composite onto the COSMO-2 grid for feeding the latent heat nudging process;
  • compute stability indices like CAPE and CIN;
  • compute the relative vorticity on pressure surfaces (approximation);
  • compute EPS probabilities from COSMO-LEPS;
  • compute neighbourhood probabilities from COSMO-7;
  • create a *single* XML file with time series of meteorological parameters from COSMO-2 / -7 / -EPS and IFS for a set of locations;
  • and much more ...
FIELDEXTRA Overview, Part II

- Primary focus is the **production environment**
  - high quality standard (code and functionality!)
  - robust handling of exceptions
  - comprehensive diagnostic (> 1700 messages)
  - optimized code:
    - input/output (**read model output once**, produce as many products as desired)
    - memory footprint
    - time criticality
  - comprehensive testing

- Supported **data formats**
  - input in **GRIB1** or **GRIB2** (WMO binary format for gridded data)
  - output in GRIB1, GRIB2, XML, CSV and other ASCII based format
MAIN Goal of the Versus project

Development of a common and unified verification “package” including a Conditional Verification (CV) tool.

METHOD

The typical approach to CV could consist of the selection of one or several forecast products and one or several mask variables or conditions, which would be used to define thresholds for the product verification (e.g. verification of T2M only for grid points with zero cloud cover in model and observations). After the selection of the desired conditions, a classical verification tool for statistical indexes can be used.

The more flexible way to perform a selection of forecasts and observations is to use an “ad hoc database”, planned and designed for this purpose, where the mask or filter could be simply or complex SQL statements.
Main DB Modules

- Relational Database (RDBMS) features:
  - OBS e FCS data
  - Data configuration to perform verification
  - Verification results, Scorse and images

- “daemon” process (Loader) to load data from different sources (e.g. MARS (ECMWF), local DB, File system): BUFR format for obs and GRIB format for fcs

- Processes performing verifications through specific requests (Integration with “R” statistic package) and storing of resulting data

- WEB GUI (server-client architecture)
VerSUS - Architectural Design

- OBS data
- Configuration data for verification
- Verification results (Scores and images)
- FCT data
- MARS
- ECMWF
- Local DB
- Loader
- Versus-DB
- Verification R
- User management
- Web GUI
Summary

• **COSMO** will be engaged in WWRP RDPs/FDPs for Sochi 2014.

• There are four components, namely deterministic, very high resolution NWP in rapid update cycle mode, probabilistic, high resolution downscaling of ECMWF EPS, user-oriented postprocessing, conditional verification scheme.

• **Russia, Germany, Switzerland** and **Italy** will contribute to the work.

• **Pre-operational trial of components should start by the end of 2011/2012.**
Extra slides
Bright band effects of radar observations

Miss-interpretation of melting snow leads to strong overestimation of observed precipitation at the surface

24-h precipitation sum of 19 November 2006

Radar observation

Rain gauges
No bright band detection is performed at the radar sites. Model-based detection is applied to improve assimilation.

**Source:** Wikipedia

**HZERO:** freezing level of model  
**HRADAR:** height of radar beam  
**RR_RAD:** hourly precipitation of radar observation

**Bright Band criteria:**

1. $ \text{HZERO} - \text{HRADAR} \in [-100;1000]$  
2. $\frac{\sum_{i=1}^{nrad} RR\_RAD(i)}{nrad} > 8.5$
Assimilation of bright band (BB) is detrimental:

Besides the effects of bright band assimilation of radar derived precipitation in winter is slightly positive (with respect when using LHN). The most impact is found on soil moisture, whereas most of the verification scores are almost neutral.
Diurnal cycle of 10m-wind, JJA 2009

Windgeschwindigkeit

Tagesgang der Beobachtungen und der Vorhersagen des GME, COSMO-EU und des COSMO-DE im Gebiet 7.00E – 10.00E 47.30N – 50.00N

Prognosen im Zeitraum vom 03.06.2009 00 UTC bis 31.08.2009 00 UTC Höhenbereich: 0 bis 800 m
Diurnal cycle of precipitation, JJA 2009

Niederschlag (eine Stunde)

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