Field campaign and information resources of the FROST-2014 project

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EMS-2014, Prague
Winter Olympics challenges

- Steep orography
- Sharp weather contrasts and high spatial and temporal variability

Seamless approach

Olympics: from Vancouver to Sochi

WWRP projects: from SNOW-V10 to FROST-2014
WWRP FDP/RDP project FROST-2014
(Forecast and Research in the Olympic Sochi Testbed 2014)

Goals:

- To develop a comprehensive information resource of alpine winter weather observations;
- Improve and exploit forecasts in complex terrain
  - High-resolution forecasts
  - ensemble forecasts
  - Nowcasts of high impact weather phenomena
- Improve understanding of physics of high impact weather phenomena in the region
- Deliver forecasts in real time to Olympic forecasters and decision makers and assess benefits of forecast improvement

under supervision of the WWRP WGs on Nowcasting, Mesoscale Forecasting, Verification Research
FROST-2014 team

Participants from

• 10 countries (Austria, Canada, Finland, Germany, Italy, Korea, Norway, Russia, Switzerland, USA)

• 3 consortia (COSMO, HIRLAM, ALADIN)

The next meeting will be in Moscow on October 29-31, 2014
Observational network: automatic meteorological stations (AMS)

- More than 40 AMSs (different providers);
- Data control (T, humidity, wind, Pmsl)
  - Check of limits;
  - Spatial control - for observations at 00, 03, 06 ..21 UTC;
  - Temporal control – for 10-minute observations;
  - QC with respect to COSMO-Ru2 forecasts (works better for temperature than for humidity);
- Manual control (still continued)
The Olympic sport venues

- Each venue has one basic station and 1-4 supplementary stations
- Each basic station has a fixed set of sensors
- Supplementary stations have variable sets of sensors
Vaisala C-band Doppler radar WRM200 on Akhun mountain in Sochi operates continuously since October 2012

Altitude – 646 m
Location: 43°32’52,6 "N, 39°51’05,0"E.

- Max reflectivity;
- Horizontal sections of reflectivity at different altitudes from 1 to 12 km (CAPPI)
- Height of cloud tops
- Precip & wind
- Vertical velocity processing
- Map hazards

+ 2 Turkish and +2 Ukrainian dual-pol Doppler radars
Composite maps: usage of Turkish and Ukrainian data

Rain intensity/Reflectivity: Black Sea composite map (Akhun+Simferopol+Samsun +Trabzon+ Donetsk)

Environment Canada

Reflectivity: radar composite Akhun-Samsun-Trabzon-Simferopol

Central Aerological Observatory
Russia
Profilers
- Temperature/Humidity – HATPRO (RPG GmBh, Germany);
- Wind – Scintec-3000 Radar Wind Profiler (Scintec Corp, USA);
- Two METEK Micro Rain vertically pointing Radars (MRR-2)

+ 4 times/day upper air sounding in Sochi
**Video cameras**

**Sky conditions and development of the clouds**

**Surface conditions**

**Update rate – 10 min**

**Single cam** – 3 sites  
(2 at the seashore and one at 11 km from the sea)  
**Paired cam** – 4 sites, all within the valley at different altitude (560, 570, 980, 1400 m)

**fresh snow**
During snowfalls special snow measurements were carried out by the anti-avalanche service in the area of Krasnaya Polyana.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (Moscow)</th>
<th>Snowfall Intensity, cm</th>
<th>Snow Increase, cm</th>
<th>Fresh Snow Density, g/cm³</th>
<th>Type of crystals</th>
<th>Size of crystals, mm</th>
<th>Precipitation type</th>
<th>Wetness of precipitation</th>
<th>Precipitation Amount (mm)</th>
<th>Air Temperature</th>
<th>Wind Speed and Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.01.13</td>
<td>09.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Snow</td>
<td>Dry</td>
<td>-3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12.00</td>
<td></td>
<td>2</td>
<td>0.7</td>
<td>2</td>
<td>0.14</td>
<td>&gt;2</td>
<td>Snow</td>
<td>Dry</td>
<td>-2.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15.00</td>
<td></td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>0.12</td>
<td>1-2</td>
<td>Snow</td>
<td>Dry</td>
<td>-2.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18.00</td>
<td></td>
<td>6</td>
<td>0.3</td>
<td>1</td>
<td>0.12</td>
<td>2</td>
<td>Snow</td>
<td>Dry</td>
<td>3.7</td>
<td>-2.5</td>
<td>0</td>
</tr>
<tr>
<td>21.00</td>
<td></td>
<td>8</td>
<td>0.7</td>
<td>2</td>
<td>0.10</td>
<td>2</td>
<td>Snow</td>
<td>Dry</td>
<td>-1.9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>00.00</td>
<td></td>
<td>9.5</td>
<td>0.5</td>
<td>1.5</td>
<td>0.10</td>
<td>3</td>
<td>Snow</td>
<td>Dry</td>
<td>-2.5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5.01.13</td>
<td>3.00</td>
<td>19</td>
<td>3.2</td>
<td>9.5</td>
<td>0.8</td>
<td>3</td>
<td>Snow</td>
<td>Dry</td>
<td>-2.6</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Snowfall №1 started 4.01.13. 9:00
FROST-2014 forecast data

- Deterministic forecasts: 8 models, resolutions from 7 km to 250 m
  - 6 systems, resolutions from 11 to 2.2 km
- Ensemble forecasts:
- Nowcasts:

Point forecasts for all systems were presented on http://frost2014.meteoinfo.ru/forecast/multi-system-point-forecasts
## Deterministic forecasts in FROST-2014

<table>
<thead>
<tr>
<th>Country, Center</th>
<th>Model</th>
<th>Resolution, km</th>
<th>Forecast Length, h</th>
<th>Forecasts per Day (UTC)</th>
<th>Available since</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia, RHMC</td>
<td>COSMO-Ru</td>
<td>7; 2.2; 1.1</td>
<td>72(48); 42; 36</td>
<td>4 (00,06,12,18)</td>
<td>4.11.2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29.01.2014</td>
</tr>
<tr>
<td>Canada, EC</td>
<td>GEM</td>
<td>2.5; 1; 0.25</td>
<td>24</td>
<td>1 (21; 23; 00)</td>
<td>26.04.2013</td>
</tr>
<tr>
<td>Finland, FMI</td>
<td>Harmonie</td>
<td>1</td>
<td>36</td>
<td>4 (00,06,12,18)</td>
<td>09.12.2013</td>
</tr>
<tr>
<td>USA, NCEP</td>
<td>NMMB</td>
<td>1</td>
<td>24</td>
<td>2-4 (00,06,12,18)</td>
<td>04.04.2013</td>
</tr>
</tbody>
</table>

COSMO-Ru1

COSMO-Ru7

meteograms
Nowcasting project component:
INTW, CARDS, ABOM (Canada, EC), INCA (Austria, ZAMG), MeteoExpert (Russia, IRAM), Joint (Russia, RHMC)

Nowcasting systems on multimodel page of FROST-2014 site
<table>
<thead>
<tr>
<th>System Name / Origin</th>
<th>Forc ini time (UTC)</th>
<th>Forc length/ data freq</th>
<th>Spatial resolution and grid</th>
<th>Ens size</th>
<th>Period of data available</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSMO-S14-EPS / COSMO / ARPA-SIMC (Italy)</td>
<td>00 12</td>
<td>72 hr / 3 hr</td>
<td>7 km, native rotated model grid</td>
<td>10</td>
<td>21.12.2011-28.05.2014</td>
</tr>
<tr>
<td>GLAMEPS / HIRLAM-ALADIN / Metno (Norway)</td>
<td>06 18</td>
<td>54 hr / 3 hr</td>
<td>~ 11 km, native rotated model grid</td>
<td>54</td>
<td>22.10.2012 - 31.03.2014</td>
</tr>
<tr>
<td>LAEF / ALADIN/ ZAMG (Austria)</td>
<td>00 12</td>
<td>72 hr / 3 hr</td>
<td>interpolated from native ~11km grid to Lon-Lat 7 km grid</td>
<td>17</td>
<td>17.09.2013 - 09.04.2014</td>
</tr>
<tr>
<td>NMMB-EPS / NOAA / NCEP (USA)</td>
<td>00 12</td>
<td>72 hr / 3 hr</td>
<td>7 km, Lon-Lat grid</td>
<td>7</td>
<td>19.02.2013-9.06.2013 13.09.2013-25.03.2014</td>
</tr>
</tbody>
</table>
# FROST-2014 Ensemble Prediction systems: resolution 2-3 km

<table>
<thead>
<tr>
<th>System Name / Origin</th>
<th>Forcini time (UTC)</th>
<th>Forc length/data freq</th>
<th>Resolution and grid</th>
<th>Ens size</th>
<th>Period of data available</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSMO-RU2-EPS/COSMO/ RHMC (Russia)</td>
<td>00 12</td>
<td>48 hr / 1 hr</td>
<td>2.2 km, native rotated model grid</td>
<td>10</td>
<td>01.01.2013-28.02.2013 12.11.2013-27.05.2014</td>
</tr>
<tr>
<td>HARMON-EPS/HIRLAM-ALADIN/Metno (Norway)</td>
<td>06 18</td>
<td>36 hr / 3 hr</td>
<td>2.5 km, Lambert conformal projection</td>
<td>13</td>
<td>15.01.2014 - 31.03.2014</td>
</tr>
</tbody>
</table>

Forecast from 00Z10Mar2014. Valid from 20140311/18 to 20 3h cumulated precipitation probabilities

Total precipitation > 0.2mm

T2m. GLAMEPS forecast from 2013020718 UTC. Station: Kr_Pol

LAUF and GLAMEPS EPSgrams

COSMO-S14-EPS probability maps
## Observations and forecasts available at the FROST-2014 server - 1

<table>
<thead>
<tr>
<th>Data type</th>
<th>Format</th>
<th>Period of data availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS observations</td>
<td>xml</td>
<td>11.11.2011 – till mid May</td>
</tr>
<tr>
<td>Temperature/humidity profiler (up to 10 km), Temperature (up to 1 km), Wind profiler</td>
<td>Text files</td>
<td>Winter season 2013-2014</td>
</tr>
<tr>
<td>Vertical micro-rain radar profiles from 2 sensors (every 1 min)</td>
<td>Images</td>
<td>Winter season 2013-2014</td>
</tr>
<tr>
<td>High-resolution upper air sounding profiles (4 times per day) for Sochi</td>
<td>Text files</td>
<td>Dec 2013-March 2014</td>
</tr>
<tr>
<td>Special snow profile measurements</td>
<td>Text tables</td>
<td>2-3 seasons (depending on location)</td>
</tr>
<tr>
<td>Marine and meteorological data from the anchored sea buoy near the Sochi coast</td>
<td>Text tables</td>
<td>Winter season 2013-2014</td>
</tr>
<tr>
<td>Raw radar data from 5 radars (including 3 dual-pol Doppler radars) - every 10 min</td>
<td>Volume files</td>
<td>22.12.2012 – till mid May</td>
</tr>
<tr>
<td>Radar graphical products, including composite maps</td>
<td>Images</td>
<td>22.12.2012 – till mid May</td>
</tr>
</tbody>
</table>
### Observations and forecasts available at the FROST-2014 server -2

<table>
<thead>
<tr>
<th>Data type</th>
<th>Format</th>
<th>Period of data availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic forecasts</td>
<td>GRIB1 or GRIB2 GEM250 - binary</td>
<td>Depends on the model</td>
</tr>
<tr>
<td>Ensemble forecasts</td>
<td>GRIB1 or GRIB2 + graphical products</td>
<td>Depends on the system</td>
</tr>
<tr>
<td>Point forecasts</td>
<td>XML + graphical products</td>
<td>Depends on the model</td>
</tr>
<tr>
<td>Nowcasts</td>
<td>Pointwise –txt, graphical point nowcasting products, Fields (INCA)- GRIB1</td>
<td>Depends on the system</td>
</tr>
<tr>
<td>Shots of 7 cameras (every 10min)</td>
<td>jpg</td>
<td>Winter season 2013-2014</td>
</tr>
<tr>
<td>Series of official forecast bulletins for 5 sport venues</td>
<td>Text files</td>
<td>Winter season 2013-2014</td>
</tr>
</tbody>
</table>
FROST-2014 Web-site: Useful tools

- Export of point forecasts and observations in csv-format
- Online monitoring of forecast quality at points
- Valuable and successful blog
With the closure of the Olympics in March 2014 the project field campaign was mostly over. FROST-2014 provided a valuable information resource for mesoscale predictability studies.

But there is still a lot of work in FROST-2014 …

- Verification is in progress
- A list of interesting synoptic events in February-March in Sochi was prepared – We’re waiting for new case studies
- 4 reports at WWOSC-2014 in Montreal
- Many publications are being prepared
Thank you for your attention!

for more information and data