10th GIFS TIGGE WG meeting
Boulder
25-27 June 2012

TIGGE LAM Report
Tiziana Paccagnella

with contributions from
J. Hacker, J. Chen, C. Saulo, S. Landman
Regional reporting

Mike Bush
SRNWP Interoperability
Andrea Montani
LAM EPS in Hymex and Frost14
Chiara Marsigli
SRNWP EPS
and other colleagues
Content

- TIGGE LAM Plan & organization aspects
- TIGGE LAM archiving
- Regional reporting
- LAM- EPS in RDPs and FDPs
- Past Meeting Actions
- Future changes in TIGGE LAM
Content

- TIGGE LAM Plan & organization aspects
Finished and published on the WWRP web site

TIGGE LAM Plan

1. LIMITED AREA ENSEMBLE PREDICTION AND TIGGE-LAM

2. RELATIONSHIP BETWEEN THE GIFS-TIGGE WG AND TIGGE-LAM

3. RELATIONSHIP TO NORTH AMERICAN EFFORTS

4. BASIC SCIENTIFIC CHALLENGES
   4.1 Meso-scale predictability
   4.2 Meso-scale model inadequacy

5. ADDRESSING THE SCIENTIFIC CHALLENGES: LAM-EPS AND TIGGE-LAM
   5.1 Scale interactions for LAM embedded in global models
   5.2 Perturbations on LAM initial-conditions
   5.3 Representation of model errors
   5.4 Perturbations associated with soil/surface description
   5.5 LAM EPS and Data Assimilation
   5.6 Verification methods and research required to assess the added value/societal benefit of regional LAM EPS systems
   5.7 Biases and calibration
   5.8 Convection-allowing EPS
   5.9 Probabilistic forecasts for other modelling applications

6. ACTIONS AND ACTIVITIES
   6.1 Action 1: Maintain an appropriate structure and composition of the TIGGE-LAM Panel
   6.2 Action 2: Definition of the key issues in regional ensemble forecasting
   6.3 Action 3: Set up of TIGGE-LAM Databases to contribute to the TIGGE archive
   6.4 Action 4: Definition and adoption of the TIGGE-LAM data policy
   6.5 Action 5: Implementation of regional observations/analyses dataset for objective verification of mesoscale deterministic and ensemble forecasting
   6.6 Action 6: Interoperability Aspects - Define standards to exchange meteorological fields required as initial and boundary conditions
   6.7 Action 7: Development and provision of LAM EPS products in the GIFS perspectives
   6.8 Action 8: Set up of cross-working group discussion between TIGGE-LAM and the other WMO working groups with cross-cutting interests
   6.9 Action 9: Set up of specific cooperation initiatives, research projects, and demonstration project
   6.10 Action 10: Identification of possible funding opportunities to support the development and implementation of the regional activities
The TIGGE-LAM Panel was re-organized in regional sub-groups:

- Better coordination with the Thorpex Regional Committees
- Better link with regional initiatives
- Better focus on scientific issues, actions/activities

After last meeting:

- Stephanie Landman (South Africa) focal person for Africa
- Celeste Saulo (Argentina) focal person for South America

Australia/New Zealand: contacts through the TIGGE GIFS WG
North American TIGGE-LAM subcommittee

• Membership:
  – Primarily academic; limited representation from operational centers and the private sector
  – Primarily U.S., but includes Canada and Mexico
  – Mesoscale ensemble data assimilation well-represented

• Focus:
  – Identification of scientific challenges to underpin effective LAM-EPS development
  – Prioritization of challenges
TIGGE LAM archiving
LAM EPS contribution to the TIGGE archives

The sub-set of High Priority parameter from LAM EPS systems should be archived at their native full resolution at the three TIGGE archiving centres.

Biggest advancement:
The work to implement European LAM EPS systems @ ECMWF is just started thanks to the GEOWOW Project (presentation by David Richardson on GEOWOW)

- The person responsible for the implementation of the archive, Richard Mladeck, is already working at ECMWF.
- We are in contact since 10 days and we are defining a working procedure.
- TP contacted the different data providers to initiate the official procedure.
- TP sent to Tetsuo Nakasawa the draft of the letter to invite Data Providers.
- The work is ongoing ….
Regional reporting
Projects at CMA:

CMA support a research program on short range probability forecast technology for severe convective weather event. The main aim is to develop probability forecast technology for severe convective weather events based the CMA short-range REPS from 2012 to 2014.

Another research project is a project on LAM EPS technology for heavy rainfall event for forecast time range being 1 week to 2 weeks. This project is supported by the ministry of Science and technology of China. This program is from 2012 to 2016.

LAM EPS / REPS products will be used with more emphasis for severe weather prediction, local severe weather prediction and also for Hydrological Prediction.
North America EPS test Bed
(http://www.dtccenter.org)

Hydrometeorological Testbed (HMT) to design and support a series of field and numerical modelling experiments to better understand and forecast precipitation in the Central Valley of California.

The main role of the Forecast Application Branch (NOAA/ESRL/GSD) in HMT has been in supporting the real time numerical forecasts as well as research activities targeting better understanding and improvement of Quantitative Precipitation Forecasts (QPF).

For this purpose ensemble modelling system has been developed. The ensemble system consists of mixed dynamic cores, mixed physics and mixed lateral boundary conditions.
South-America: Super model ensemble system

- Now includes 54 model outputs, that combine GCMs, with regional models (mainly ETA-BRAMS, and WRF).
- Some models contribute with different members of their ensemble (CPTEC models, for example)
- Products are available at station points (not maps!)
- The web page is interactive, and the user can select any model, and any synoptic station and plot surface variables forecasts

http://www.master.ia...
Extracted from:
High resolution ensemble forecasts for applications predictions
Stephanie Landman
South African Weather Service

Aim
The principal aim of this study is to develop and determine the skill of a 7-day lead time high resolution ensemble forecasting system over the southern African domain. The second aim is to determine whether higher horizontal resolution sub-domains (nested domains) within the greater limiting area model will increase the skill of forecasts over areas of complex orography.

Objectives
The main objectives of this study are to:
1. Implement a statistical method by which the initial conditions are perturbed in order to create an ensemble of forecasts;
2. Create hindcasts of 7-days' horizon during an historical 5-year period, for each of the perturbed initial conditions and each of the horizontal resolutions;
3. Construct the probability forecasts for different meteorological variables, including temperature, humidity, wind speed and precipitation;
4. Verify the ensemble forecasts against observations;
5. Determine the optimal construction of the ensemble system from the available perturbed members and resolutions.

Figure 1: The southern African domain with the smaller squares indicating the nested domains at higher resolutions.
A new SRNWP Programme, EurEPS, has been submitted by the SRNWP Expert Team on Predictability and EPS. In the Roadmap for the Forecasting Capability Area of EUMETNET the creation of a EurEPS Programme is envisaged.

This Programme should support a major cooperative effort to develop a capability for convection-permitting ensembles in order to address prediction of severe or high-impact weather in a probabilistic framework.
By Chiara Marsigli
chair of the ET on Predictability and EPS

**SRNWP-EPS**

The project has been approved by the EUMETNET Assembly (May 2012)

- 18-month project (1 January 2013 – 30 June 2014): feasibility study for a long-term project
- The general aim is coordinating ensemble forecasting at European level. The first phase focuses on:
  - Identify common interests of participating members for the development of next generation km-scale ensemble → enable joint planning and the use of joint resources for challenging problems
  - Prepare an analysis/overview of the plans for ensemble development in the NMSs in Europe and identify common issues
  - **Make a proposal for a research plan** aiming to develop the next generation ensemble system
  - Prepare a shared and long-term SRNWP-EPS project proposal from 2014 onwards
LAM - EPS in RDPs and FDPs
FROST will include both FDP and RDP. Scientific activities will be focused on:

- mesoscale forecasts of meteorological conditions in complex terrain environment;
- regional EPS forecast products;
- nowcasts of high impact weather phenomena in complex terrain;
- Improve understanding of physics of high impact weather phenomena in the region;

Convective Scale (1km) multi-model ensemble (5 models at present) will be exploited during the RDP.

Both the MWFR WG and the Verification WG are strongly involved in the scientific planning of the project and TIGGE LAM is also contributing in cooperation with these WGs.
**List of ensemble systems for FROST-2014**

**Convective-parameterised ensembles**

<table>
<thead>
<tr>
<th>Name (organisation)</th>
<th>Hor. and vert. resolution</th>
<th>Ensemble size</th>
<th>Fcst range (h)</th>
<th>Emission time (UTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSMO-FROST-EPS (ARPA-SIMC for COSMO)</td>
<td>7 km; 40 ML</td>
<td>10</td>
<td>+72</td>
<td>00, 12</td>
</tr>
<tr>
<td>ALADIN-LAEF (ZAMG)</td>
<td>11 km; 45 ML</td>
<td>16+1</td>
<td>+ 72</td>
<td>00, 12</td>
</tr>
<tr>
<td>GLAMEPS (Hirlam)</td>
<td>~ 11 km; 37-40 ML</td>
<td>54</td>
<td>+ 54</td>
<td>06, 18</td>
</tr>
<tr>
<td>TIGGE (WMO)</td>
<td>~ 25 km; ~ 60 ML</td>
<td>&gt; 100</td>
<td>up to 384</td>
<td>00, 06, 12, 18</td>
</tr>
</tbody>
</table>

**Running on a daily basis**

**Experimental, pre-operational**

**Planned (Autumn 2012)**
### List of ensemble systems for FROST-2014

**Convective-resolving ensembles**

<table>
<thead>
<tr>
<th>Name (organisation)</th>
<th>Hor. and vert. resolution</th>
<th>Ensemble size</th>
<th>Fcst range (h)</th>
<th>Emission time (UTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSMO-RU-EPS (RHM for COSMO)</td>
<td>2.2 km; 50 ML</td>
<td>10</td>
<td>+48</td>
<td>00, 12</td>
</tr>
<tr>
<td>HarmonEPS (Hirlam)</td>
<td>~2.5 km; ~50 ML</td>
<td>20</td>
<td>+ 36</td>
<td>06, 18</td>
</tr>
</tbody>
</table>

*running on a daily basis*

*experimental, pre-operational*

*planned (tests in late 2012)*

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**Ensemble forecasting for FROST-2014**

Andrea Montani

ARPA Emilia-Romagna Servizio IdroMeteoClima, Bologna

(I)
Verification for the «Sochi area»
Actions and activities

Link with FROST-2014
LAM EPS system relocation.

Forecast Demonstration Project initiatives

A limited-area ensemble system based on COSMO
(“relocation” of COSMO-LEPS)

- Horizontal resolution: 7 km.
- Vertical resolution: 40 model levels.
- Forecast range: 72 hours.
- Starting time: 00 UTC, 12 UTC.
- Ensemble size: 10 members.
- Boundary conditions: from selected ECMWF EPS members.
- Initial conditions: interpolated from ECMWF EPS members.

Timetable
- Pre-trial: 2011/12 winter
- Trial: 2012/13 winter
### Operational LAEF domain and setup

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
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<tbody>
<tr>
<td>Ensemble size</td>
<td>16+1</td>
</tr>
<tr>
<td>Horizontal resolution</td>
<td>18 km</td>
</tr>
<tr>
<td>Vertical resolution</td>
<td>37 layer</td>
</tr>
<tr>
<td>Runs/Day</td>
<td>2 (00, 12 UTC)</td>
</tr>
<tr>
<td>Forecast range</td>
<td>60 h</td>
</tr>
<tr>
<td>Output-Frequency</td>
<td>1h</td>
</tr>
<tr>
<td>Model time step</td>
<td>720s</td>
</tr>
<tr>
<td>Coupling-Model (time-lagged)</td>
<td>ECMWF-EPS (SV Vectors, first 16 members)</td>
</tr>
<tr>
<td>Coupling-Update</td>
<td>6h</td>
</tr>
</tbody>
</table>
### LAEF for FROST-2014

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensemble size</td>
<td>16+1</td>
</tr>
<tr>
<td>Horizontal resolution</td>
<td>11 km</td>
</tr>
<tr>
<td>Vertical resolution</td>
<td>45 layer</td>
</tr>
<tr>
<td>Runs/Day</td>
<td>2 (00, 12 UTC)</td>
</tr>
<tr>
<td>Forecast range</td>
<td>72 h</td>
</tr>
<tr>
<td>Output-Frequency</td>
<td>1h</td>
</tr>
<tr>
<td>Model time step</td>
<td>450s</td>
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<td>Coupling-Update</td>
<td>6h</td>
</tr>
</tbody>
</table>
**COSMO-FROST-EPS vs ECMWF-EPS**

**Main features of verification:**

- **variable:** 12h cumulated precip (18-06, 06-18 UTC);
- **period:** from Jan 2012 to Mar 2012;
- **region:** 40-50N, 35-145 (SOCHIDOM);
- **method:** nearest grid point; no-weighted fcst;
- **obs:** synop reports (about 60 stations/day);
- **fcst ranges:** 6-18h, 18-30h, 30-42h, 42-54h, 54-66h;
- **thresholds:** 1, 5, 10, 15, 25, 50 mm/12h;
- **scores:** ROC area, BSS, RPSS, Outliers, …
- **systems:**
  - COSMO-FROST-EPS (10m, 7 km, 40 ML)
  - ECMWF-EPS (51m, 25 km, 62 ML)

“Large-scale” verification tends to smooth out differences between higher and lower resolution systems → ECMWF-EPS should be favoured.
Ranked Probability Skill Score

- BSS “cumulated” over all thresholds. RPSS is written as $1 - \text{RPS}/\text{RPS}_{\text{ref}}$. **Sample climate** is the reference system. RPS is the extension of the Brier Score to the multi-event situation.
- Useful forecast systems for \( \text{RPSS} > 0 \).
- RPSS depends on the ensemble size and penalises small ensemble sizes.
- Consider debiased RPSS: \( \text{RPSS}_{\text{D}} = 1 - \left(\frac{\text{RPS}}{\text{RPS}_{\text{ref}} + \frac{\text{RPS}_{\text{ref}}}{N}}\right)\)

In either case (RPSS or \( \text{RPSS}_{\text{D}} \)) COSMO-FROST-EPS has higher scores than ECMWF-EPS for all forecast ranges, despite the lower ensemble size.
### List of ensemble systems for HyMeX

<table>
<thead>
<tr>
<th>Name (organisation)</th>
<th>Hor. and vert. resolution</th>
<th>Ensemble size</th>
<th>Fcst range (h)</th>
<th>Emission time (UTC)</th>
<th>Type of convection</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSMO-LEPS (COSMO)</td>
<td>7 km; 40 ML</td>
<td>16</td>
<td>+132</td>
<td>00, 12</td>
<td>parameterised</td>
</tr>
<tr>
<td>AROME-EPS (Meteo-France)</td>
<td>2.5 km; 60 ML</td>
<td>8/16</td>
<td>+30</td>
<td>00, 12</td>
<td>resolved</td>
</tr>
<tr>
<td>UIB-ensemble (Uni. Balearic Islands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>resolved</td>
</tr>
<tr>
<td>??????COSMO-IT-EPS (ARPA-SIMC)</td>
<td>2.8 km 50 ML</td>
<td>10</td>
<td>18</td>
<td></td>
<td>resolved</td>
</tr>
<tr>
<td>WRF-WMED (Uni Hohenheim)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>resolved</td>
</tr>
</tbody>
</table>

**Link with HYMEX**
Another very relevant aspect of the HYMEX activity is the link between LAM EPS and Data Assimilation which will be developed through the implementation of a common testbed.
The WWRP Polar Prediction Project is currently under preparation and coordinated by Thomas Jung.

Trond Iversen is contributing to the planning of LAM EPS activity.
Past Meeting Actions
LAM EPS and TC intensity

The development of the GIFS concept comprises the development of ensemble based products tailored to optimize the forecasting of weather parameters associated to HIW. Tropical Cyclone tracks and intensity is the first of a list including precipitation and wind gusts in the second and third position respectively.

The original vision of a strongly interactive component of the GIFS, including on-demand LAM EPS runs, is now strongly scaled down.

The patchwork coverage of LAM EPS makes the inclusion of TIGGE LAM in the GIFS products development/dissemination more awkward. The focus should move more on exchange of experiences and research results and on cooperation during research projects, FDPs and RDPs.

Following the outcome of the 9th GIFS TIGGE WG meeting, the TIGGE-LAM panel is encouraged to start by assessing skill of TC intensity forecasts in high-resolution models. The investigation of LAM EPS impact to TC intensity forecasting, in particular as a contribution to the Typhoon Landfall FDP, was also recommended during the 6th meeting of the WG-MWFR (10-11 September 2011 in Berlin)

Some mail exchanges with colleagues from China and Japan.
Inform TIGGE and TIGGE LAM community about the final outcomes of the Programme.

Interoperability Aspects - Define standards to exchange meteorological fields required as initial and boundary conditions.

A link is established with the SRNWP Interoperability programme, a three-year EUMETNET programme started in September 2008 (ended at December 2012) and lead by the Met Office with the participation of the four European consortia. The deliverable of this Programme are:

- A report documenting the definition of a standard output format including a list of parameters for which the standard format will be applied.
- Four adaptors that transform the output from every LAM to the standard format and vice versa. Documentation will also be provided. Each consortium is responsible for provision of the software.
- Deliver enhancements to existing adaptors to enable LAMs to process data from the four global model providers. This includes documentation. In addition, deliver enhancements to existing adaptors to allow LAMs to process data from any other LAM. This work is the responsibility of each consortium.

The Programme was successful with just some delay due to GRIB2 coding extra work. EUMETNET approved a one year extension of the Programme which is currently running. During this extra year, the work will be completed and a plan for the maintenance of the Software adaptors will be delivered.

Tiziana Paccagnella will inform TIGGE and TIGGE LAM community about the final outcomes of the Programme.
The Programme Decision document for SRNWP-I has been updated with the new milestones and deliverables for 2012 and this document can be found on the EUMETNET portal.

There are six deliverables for this year, four of which are reports or documentation and the remaining two concern work on lateral boundary conditions and surface parameters.

The first deliverable to be completed in 2012 is a document entitled “SRNWP-I: Adaptor software maintenance regime” and this has been put on the EUMETNET portal.
SRNWP-I Progress as of March 2012

### LAM Initial and boundary conditions

<table>
<thead>
<tr>
<th></th>
<th>ALADIN &amp; HIRLAM</th>
<th>COSMO</th>
<th>UM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALADIN &amp; HIRLAM</td>
<td>Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COSMO</td>
<td></td>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>UM</td>
<td></td>
<td></td>
<td>Blue</td>
</tr>
</tbody>
</table>

#### Key:
- Blue – complete
- White – work in progress

### Global initial and boundary conditions

<table>
<thead>
<tr>
<th></th>
<th>ECMWF</th>
<th>ARPEGE</th>
<th>DWD ICON</th>
<th>UM</th>
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</tbody>
</table>

By Mike Bush – Met Office
Future changes in TIGGE LAM

3.5A Update on TIGGE-LAM Panel

3.5a.1 The main interests include perturbation of initial conditions, model perturbations, the surface, working towards convective permitting LAM EPSs and the area of LAM EPS and data assimilation combinations. The Panel was restructured into regional bodies e.g. Europe, North America etc., The TIGGE-LAM Plan was making progress but not very many comments had been received and more were welcome as efforts are made to finish the document. Some aspects needed further work – there is still a need to address some scientific issues. There needs to be more coordination of the research. The Plan contains a list of actions/activities which are being steadily addressed. It is hoped to have a final version of the Plan by the summer of 2011.

3.5a.2 Archiving has been discussed for some time and is now just beginning at CMA. Work at ECMWF has slowed up. It is now considered better to archive on the native grid. There is some prospect of obtaining funds for archiving if the GEOSS interoperability for Weather, Ocean and Water (GEOOWOW) proposal to the EC is successful. TiGGE is a major part of this proposal.

3.5a.3 Work is also proceeding on a high resolution observations data set e.g. precipitation analysis at ECMWF. Strong links are maintained with the EUMETNET Short Range Numerical Weather Prediction (SRNWP) project which addresses interoperability issues. Links are also in place to the "DISTRIBUTED RESEARCH INFRASTRUCTURE FOR HYDRO-METEOROLOGY STUDY" (DHRIMS) group and the evolving HyMeX plans.

3.5a.4 In discussions it was noted that:

- The JSC noted that the original emphasis on TIGGE-style data sets may not be appropriate in all regions and that, in general, the emphasis is shifting away from the original concept of interactive deployment of limited area models on demand and towards research on the design and utilization of regional ensembles. Several members of the JSC suggested that, in view of these issues and, since the project is not global, the group consider renaming the project to LAM EPS.

- The JSC urged comments on the Science Plan be sent as soon as possible and include comments on the noted shift in emphasis.

- The JSC suggested it was not necessary to change the organizational structure at this time, but noted that the evolution of this project was moving the effort closer to the Mesoscale Forecast Research Working Group and that the emphasis on implementation should take into account existing regional efforts.

Decision/Action WWRP/JSC4 (22): The JSC, noting that there were strong links between the TIGGE-LAM Panel and the Mesoscale Working Group, recommended that the TIGGE-LAM Panel be integrated into the Mesoscale Working and requested the Manager of the THORPEX IPO to convey this recommendation to the GIFS-TIGGE Working Group and the THORPEX ICSC with the view to getting agreement with this recommendation before the next JSC meeting.
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Participation of T. Paccagnella to the Sixth Meeting of the WWRP MWFR Working Group and to the Joint meeting of this WG with the JWGFVR held in Berlin in September 2010.

Contacts and cooperations within Projects (HYMEX, DTC Ensemble Test bed, Frost etc...)

Link with WWRP MWFR WG
Link with WWRP MWFR WG

- April 2012 JSC Recommendation:
  TIGGE LAM should move as LAM EPS to the Mesoscale Research WG

Next:
- June 2012 Boulder GIFS TIGGE Meeting
  Discussion about the JSC recommendation and further recommendations or comments
  - TP will be officially member of the Mesoscale Research WG but what about the TIGGE LAM Panel?
  - Which is the link with GIFS TIGGE?

- Autumn 2012. ICSC official final decision.
Thanks!