Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Comparison of NWP based nowcasting (AROME) with classical system

Preliminary results

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Model Evaluation Tools (MET)

Goal

- to assess the AROME Nowcasting system skills to accurately predict the precipitation field

- Comparison of AROME Nowcasting vs INCA forecast → we can't expect AROME Nowcasting to outperform INCA forecast in the first 1-2 forecast hours, but the aim is to know when AROME starts to has more skill than INCA

↑

MET (Model Evaluation Tools)

- developed at NCAR, maintained and enhanced by the Developmental Testbed Center ***(http://www.dtcenter.org/)***

Compilation of the MET tools

External libraries

- netcdf library (if the versions V4.4.x are used then the libraries shoud be compiled with –disable-netcdf-4 option)
- GSL library (GSL-1.11)
- NCEP's BUFRLIB (MET is not compatible with the last version, V11.0.0, therefore the used version is V10.2.3)
- Cairo and FreeType libraries (for building MODE-Graphics tool)
- copygb utility for regriding GRIB data
- wgrib and wgrib2

In addition

- to enable grib2 files - the NCEP's GRIB2 C-Library compiled with JASPER, PNG and Z libraries

Short description of MET package
(http://www.dtcenter.org)

- ***Point-Stat*** - matches gridded forecast to point observations and supports several interpolation options

- ***Grid-Stat*** - matches gridded forecast to gridded analysis field

- Series-Analysis - perform a grid-to-grid comparison over a series of fields, most commonly a time-series

- ***Ensemble-Stat*** - compare an ensemble of gridded forecasts to point and/or gridded observations

- ***MODE*** - perform an object-based verification approach to a gridded forecast and gridded analysis field

- ***Wavelet-Stat*** - spatial decomposition method to investigate how forecast errors varies with the lenght scale (apply an intensity-scale decomposition verification approach to a gridded forecast and gridded analysis field)

Files transformation

1. The INCA analysis files transformation

- conversion from text-based data files into netCDF format

  \- NCAR Command Language (NCL), V6.1.2 software (https://www.ncl.ucar.edu) ←→ *asciiread* was used to read the hourly ASCII files (the 15 min precipitation files were hourly cumulated) into CF-compliant netCDF

Cressman interpolation method

interpolated into AROME grid using the *built-in function obj anal ic*

Files transformation

2. The INCA forecast files transformation

- files are written in *GRIB2* format, ***Lambert native projection***

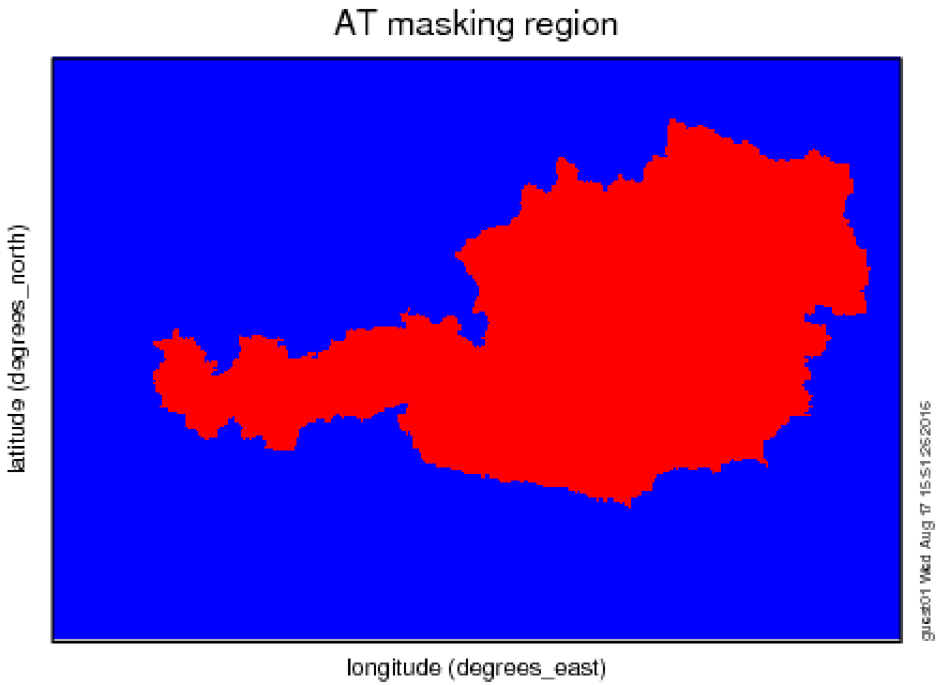
MET is not supporting this projection

- files - transformed in a regular latitude-longitude projection.

  - Grib_api tools – some keys were unrecognized
  - **CDO (Climate Data Operators) tool**

The masking verification region

Gen-Vx-Mask tool - to define the bitmapped masking region using as input a gridded model (AROME model) and one ASCII file.



Grid-Stat tool - the computation of statistics

- ***traditional and spatial verification (neighborhood methods)***
- to avoid the double penalty problem, new spatial methods are used, as **Fractions Skill Score - FSS** (Roberts, 2008, Mittermaier et al, 2013).

$$\mathrm{FSS} = 1 - \frac{\mathrm{FBS}}{\mathrm{FBS}_{\mathrm{worst}}}$$

$$FBS = \frac{1}{N}\sum_{i=1}^{N}(O_i - F_i)^2$$

- Fractions Brier Score

O_i and F_i - observed and forecast fractions

$$FBS_{worst} = \frac{1}{N}[\sum_{i=1}^{N} O_i^2 + \sum_{i=1}^{N} F_i^2]$$

- reference that gives the largest possible FBS that could be obtained from the observed and forecast fractions

- *Roberts, 2008: Assessing the spatial an temporal variation in the skill of precipitation forecasts from an NWP model*
- *M. Mittermaier, N. Roberts and S. Thompson, 2013: A long-term assessment of precipitation forecast skill using Fractions Skill Score*

Grid-Stat tool - the computation of statistics

- **Fractions Skill Score - FSS** (Roberts and Lean, 2007)

Two stages:

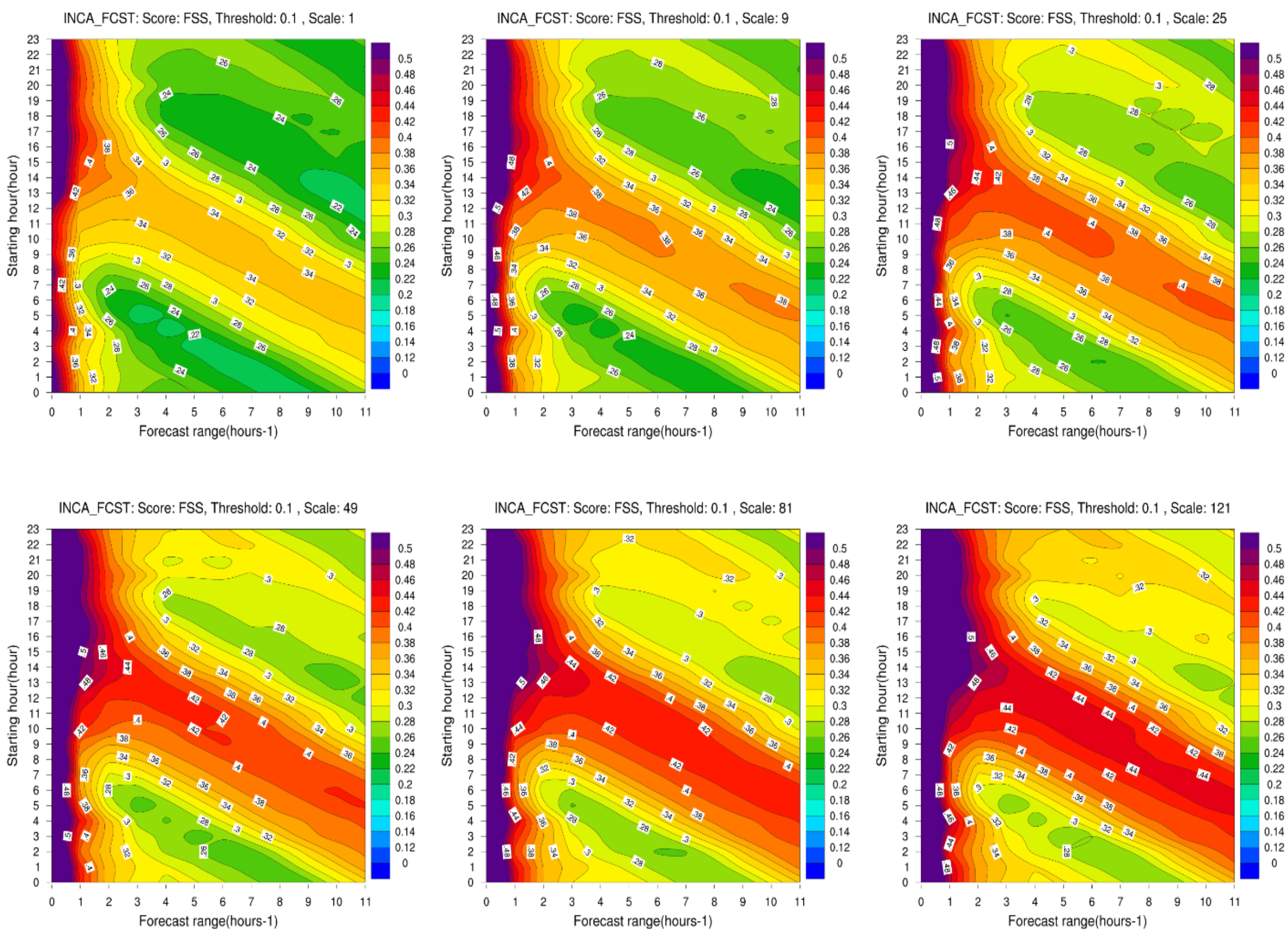
- a square neighborhood of a particular size is defined as 1x1, 3x3 ,5x5, 7x7, 9x9, 11x11 pixels centered around each pixel (Mittermaier, Roberts and Thompson, 2013)
- the fractions of occurence of 1h rainfall accumulations with different neighborhoods sizes (width) are computed for the forecasts and observations and then these fractions are compared

- the computation of FSS by applying bootstrap method is costly
- Thresh >=0.1, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32 l/mp

Preliminary results: July 2016

FSS - INCA forecast , THS >= 0.1 mm/h

- INCA has the highest skill in the first two forecast hours
- in the afternoon when convections starts to be active the skill is longer lasting than before midday
- the best forecasts for INCA: 16-17 UTC in the afternoon (peak of convection in summer).
- also, the best skill: 15 UTC + 1hr, 14 UTC + 2hr, 13 UTC + 3 hour, 12 UTC + 4 hour

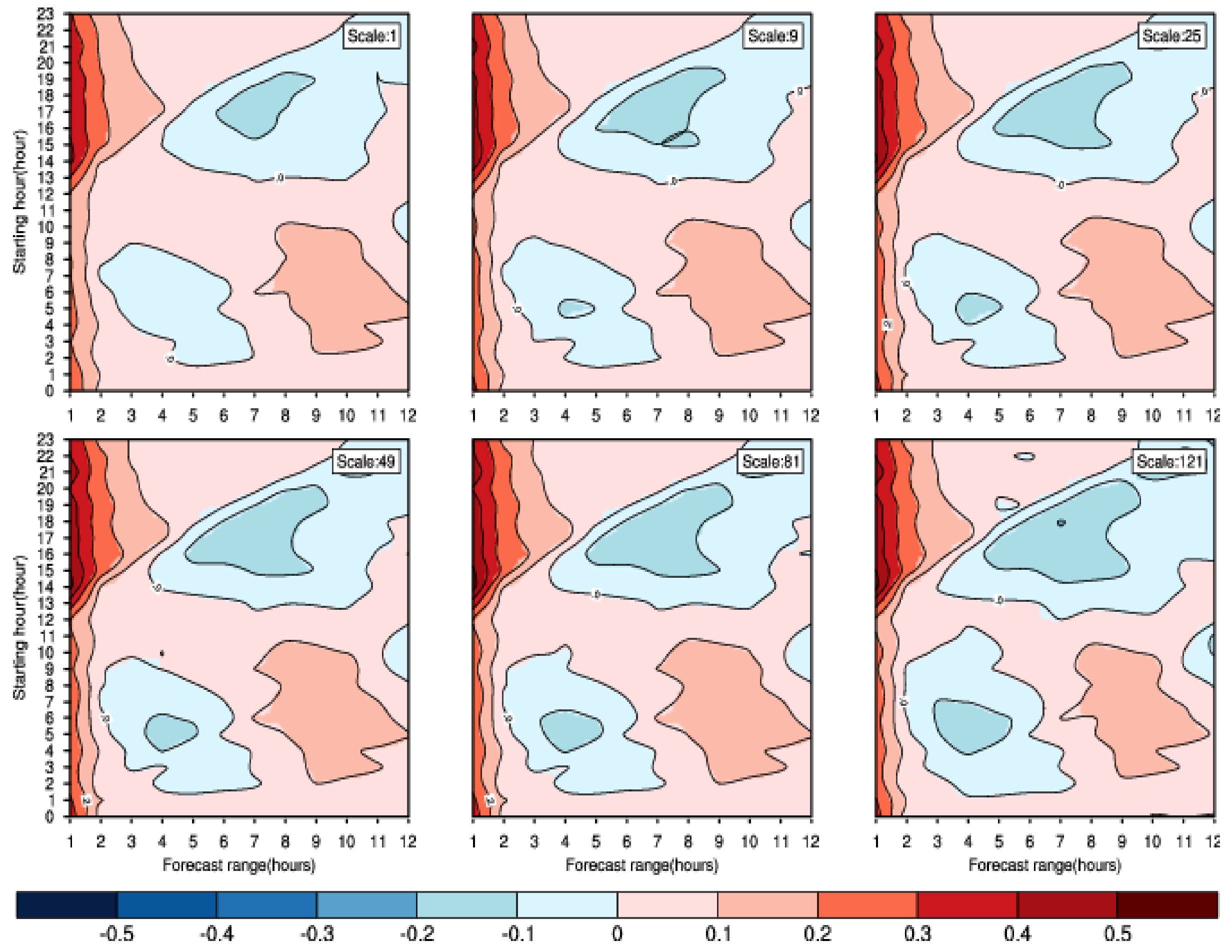


Preliminary results: July 2016

FSS difference INCA_FCST – AROME 2.5, THS >= 0.1 mm/h
Hourly precipitation

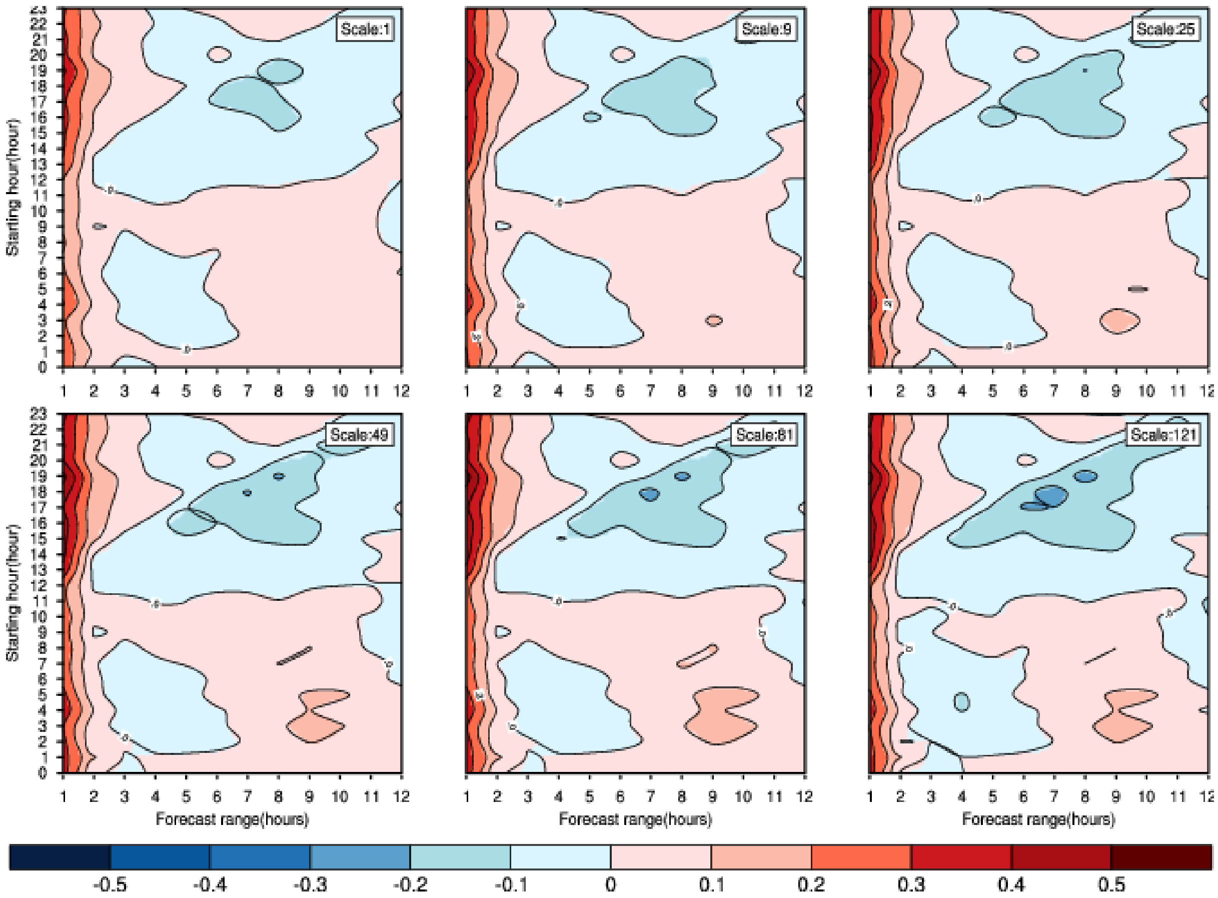
AROME has more skill than INCA in the afternoon (beyond the forecast lead time 3-4 hours)

INCA has no skill to predict the evolution of cells after 1-2 hours lead time



Preliminary results: July 2016

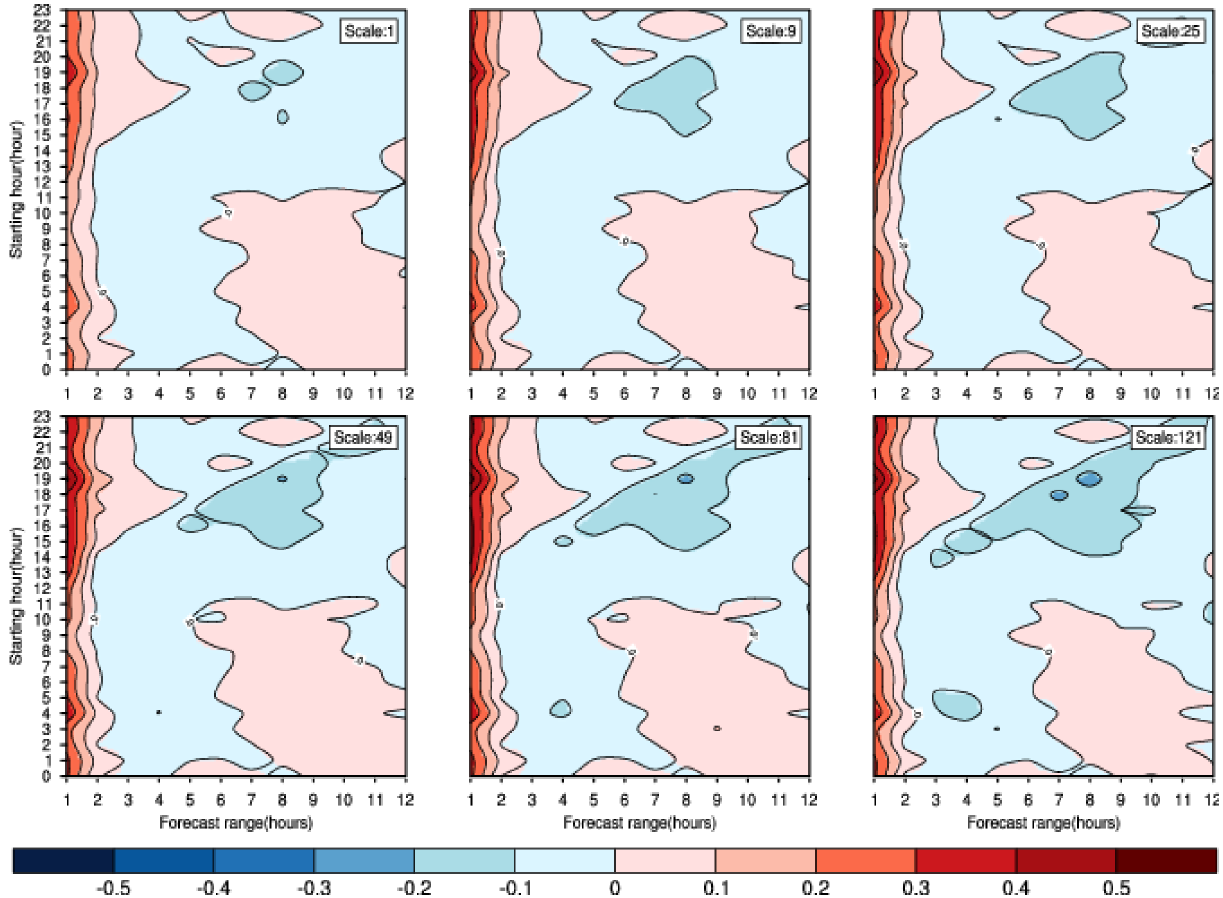
FSS difference INCA_FCST – AROME 2.5, THS >= 1 mm/h
Hourly precipitation



Preliminary results: July 2016

FSS difference INCA_FCST – AROME 2.5, THS >= 2 mm/h

Hourly precipitation



Conclusions

- AROME RUC results are preliminary

- the FSS approach can be used to evaluate the spatial and temporal variation in skill of both nowcasting systems (how the forecast skill varies with the neighborhood size)

- this verification approach can provide the scales where the data assimilation techniques adds most of the information (the benefits of data assimilation)

Thank you for your attention!