WG7 activities and APSU PP

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Outline

- WG7 activities:
  - APSU PP
  - COSMO-LEPS
  - CIAO PT
- Maintain the link with WG1 on KENDA/ICs for ensembles
  - Joint meetings at GM/ICCARUS
- Maintain the link with WG5 and WG4 on verification and post-processing of ensembles
  - Joint meeting on high impact weather verification on Tue afternoon

Outline

- APSU PP runs from Mar 2018 to Aug 2020
- Participation of: ARPA SIMC, COMET, DWD, IMGW, MeteoSwiss, RHM
- Aim: improving the spread/skill relation of the Convection Permitting ensembles
- Six Tasks:
  - Task 1: New model perturbation methods
  - Task 2: Revision of the Parameter Perturbation method
  - Task 3: Lower boundary perturbation
  - Task 4: Post-processing and interpretation of ensembles
  - Task 5: Initial and lateral boundary Conditions for the CP ensembles
  - Transition to ICON-LAM

Highlights from some Tasks

- Task 1: New model perturbation methods
  - Stochastic modeling of the model error (scheme of EM)
  - Stochastic Pattern Generator -> AMPT: Additive Model-error perturbations scaled by Physical Tendencies
  - Perturbations based on adapted Random Number Generator (RNG)
  - iSPPT (independent SPPT)
  - Model perturbation based on analysis increments
- Task 4: Post-processing and interpretation of ensembles
  - Calibration
  - Products from ensemble output
- Task 6: Transition to ICON-LAM -> better definition of the plans of the COSMO members for the transition of the ensembles (mainly, test of physics perturbations with the new model)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

EM-scheme *model for the model error (E. Machulskaya)*

➔ $$\frac{\partial\psi}{\partial t} = \left[\frac{\partial\psi}{\partial t}\right]_{\mathrm{det}} + \eta(t) \qquad \frac{\partial\eta}{\partial t} = -\gamma\eta + \gamma\nabla(\lambda^2\nabla\eta) + \sigma\xi(t)$$

ψ : prognostic variables (T, QV, U, V)

$\eta(t)$: noise field / model error, correlated in time and space

$\xi(t)$: Gaussian noise

σ, γ, λ: standard deviation and spatial and temporal correlation

γ, λ and σ are weather-dependent and are derived from past data

Potential predictors are $\left|\frac{\mathrm{d}T}{\mathrm{d}t}\right|$, $|U|$, cl.cover, $\left|\frac{\mathrm{d}q}{\mathrm{d}t}\right|$

Task 1

AMPT: Additive Model-error perturbations scaled by Physical Tendencies

Our empirical study of model error structures (by using a more sophisticated and hi-res version of COSMO as the truth) suggests that both an additive and a multiplicative error components should be present.

AMPT is the additive model-error-model component. It relies on the Stochastic Pattern Generator (SPG, Tsyrulnikov and Gayfulin 2017) as the spatio-temporal stochastic source.

The final model-error-model is a linear combination of AMPT and SPPT.

Task 1

AMPT: Additive Model-error perturbations scaled by Physical Tendencies

The **AMPT** model error perturbations:

1. are mutually uncorrelated spatio-temporal (SPG-generated) random fields.
2. are scaled as the *area averaged* (in the horizontal) $|\mathcal{P}|$.

iSPPT: independent SPPT

- SPPT does not distinguish between different parameterization schemes
- but they do not necessarily have the same error characteristics
- Christensen et al. (2017) suggest independent random pattern for each parametrization scheme
- improves ENS forecasts (but mainly in the Tropics)

Christensen, H. M., Lock, S.-J., Moroz, I. M., and Palmer, T. N., 2017, Introducing Independent Patterns into the Stochastically Perturbed Parametrisation Tendencies (SPPT) scheme. Q. J. Roy Meteor Soc., 143(706), 2168–2181. DOI: 10.1002/qj.3075

Task 1

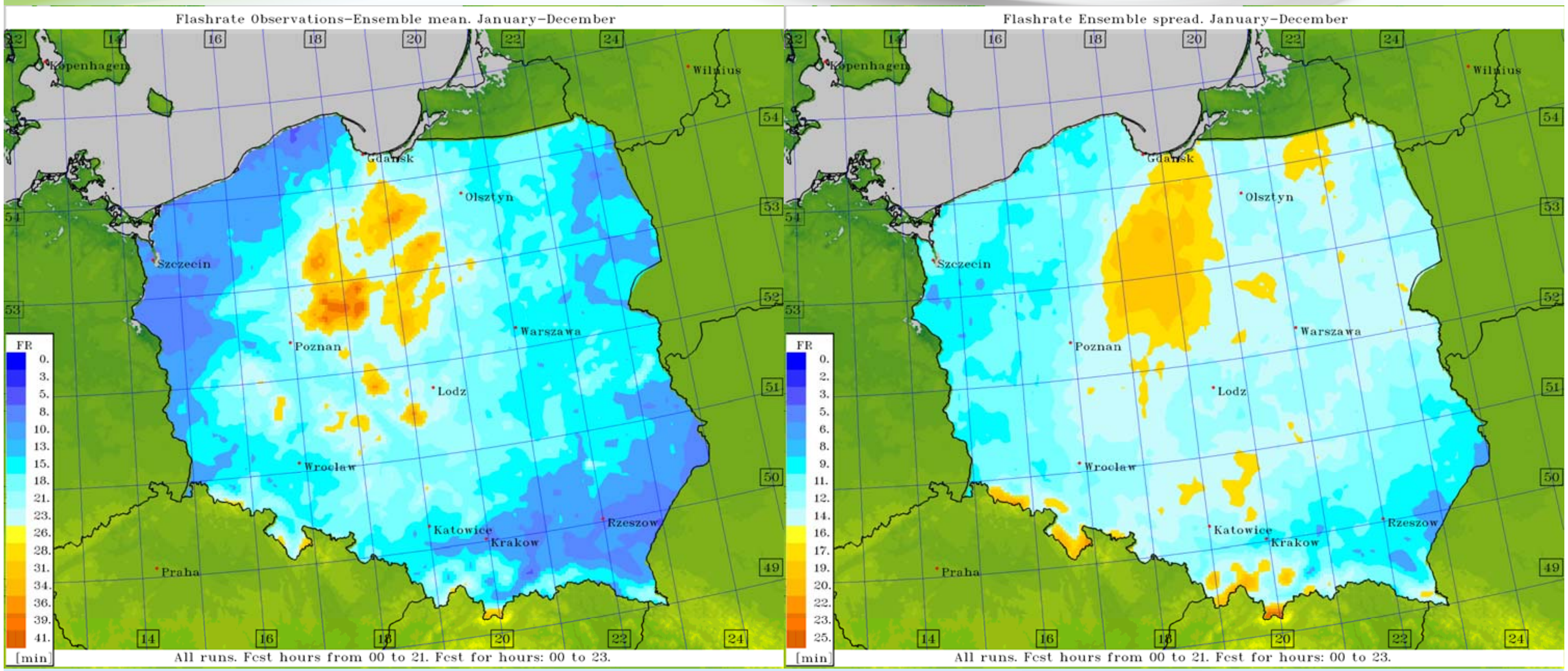
Model perturbations based on analysis increments (Piccolo et al. 2018)

- motivation: analysis increments (i.e. difference between analysis and first guess) can take into account more possible sources of model errors than SPPT
- random forcing terms are derived by sampling a dataset of historic analysis increments (same resolution and time of year)
- assumes that model error statistics are stationary (i.e., no dependence on current model state)
- applied for global ensemble forecasts so far
- promising approach for our ensembles…?

Piccolo, C., and M. Cullen, W. Tennant, A. Semple, 2018: Comparison of different representations of model error in ensemble forecasts. Quart. J. Roy. Meteor. Soc., accepted. doi: 10.1002/qj.3348

Institute of Meteorology and Water Management
National Research Institute

Ensemble post-processing - flashrate



Mean skill (left) and spread (right) of flashrate, c_soil (operational) perturbation, 2013

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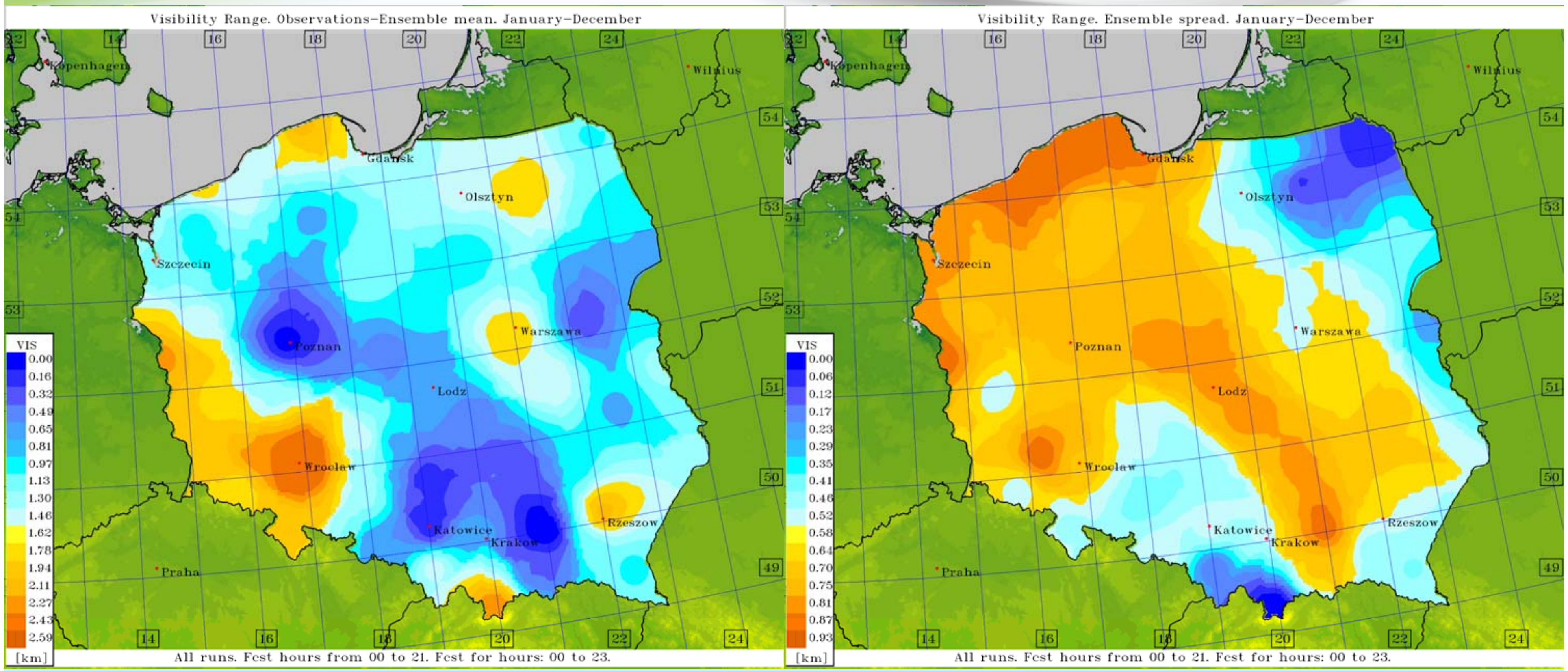
Task 4

Ensemble post-processing - visibility

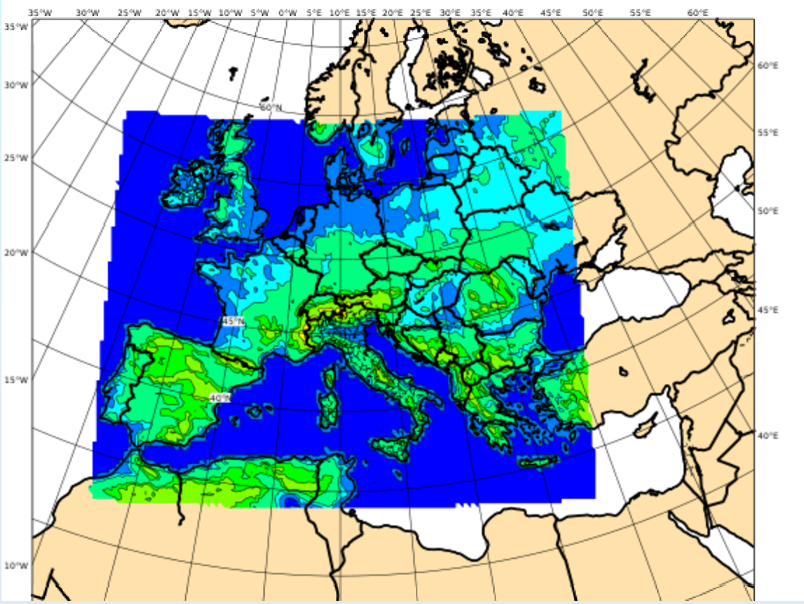


Mean skill (left) and spread (right) of VIS, c_soil (operational) perturbation, 2013

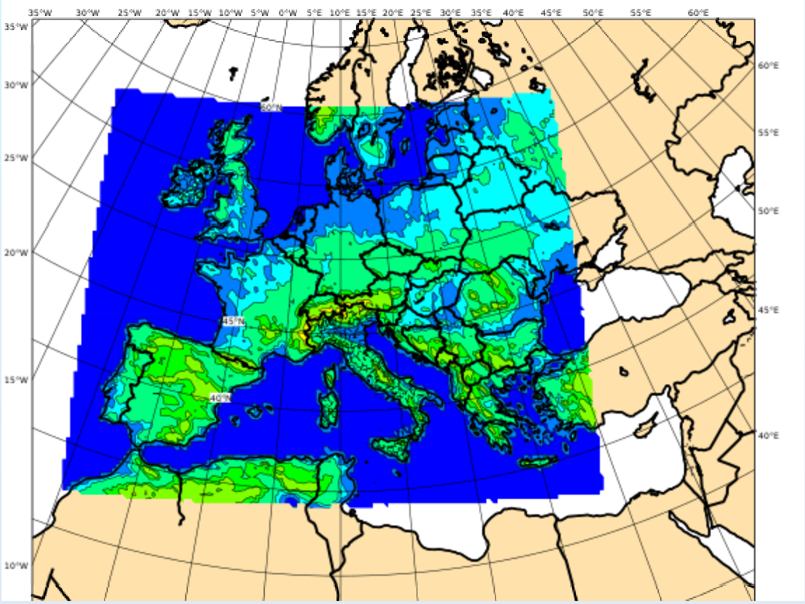
COSMO-LEPS 5-km upgrade

- In agreement with the Consortium strategies, we are assessing the sensitivity of COSMO-LEPS forecast skill to the use of different parameterisations of moist convection and to enhanced horizontal resolution.
- From 24/11 to 31/12/2017 and from 1/5 to 31/5/2018, in addition to **oper7** (COSMO-LEPS @ 7 km), we also ran a test configuration (only at 00UTC), denoted with **test5**.

oper7



test5



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CONSORTIUM FOR SMALL SCALE MODELING COSMO

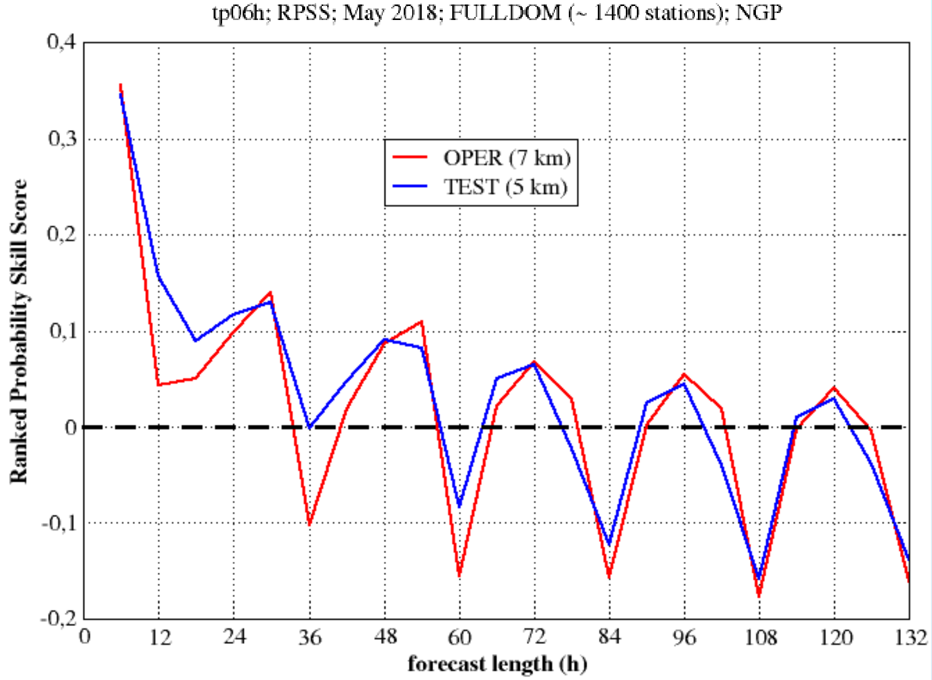
5-km upgrade

	oper7	test5
model version	5.03	5.05
convection scheme	Tiedtke	members 1-10 IFS-Bechtold members 11-20 Tiedtke
Perturbations to physical parameterisation	**“random”**	**none**
horizontal resolution	7 km	5 km
grid points	511 x 415 x 40 = 8.482.600	739 x 599 x 40 = 17.706.440
time step (s)	66	45
Billing Units for one single run (forecast length: 132h)	1750	5378
elapsed time (s)	542 (720 tasks)	1235 (972 tasks)

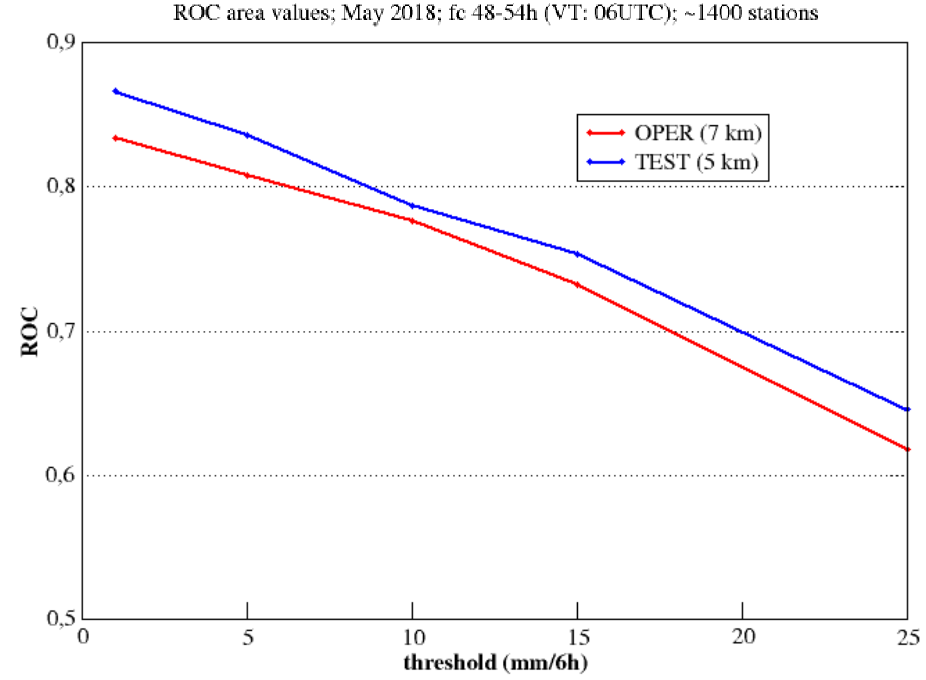
May 2018 experimentation: oper7 vs test5

- Variable: 6h cumulated precipitation (thresholds: 1, 5, 10, 15, 25, 50 mm).
- Scores: Ranked Probability Skill Score (RPSS), ROC area at fixed forecast range.

RPSS: tp06h



ROC: tp06h



- RPSS: clear daily cycle in the performance of the model; higher skill of **test5** in the short range for day-time precipitation; mixed results later on.
- ROC area: slight positive impact of enhanced resolution for all thresholds.

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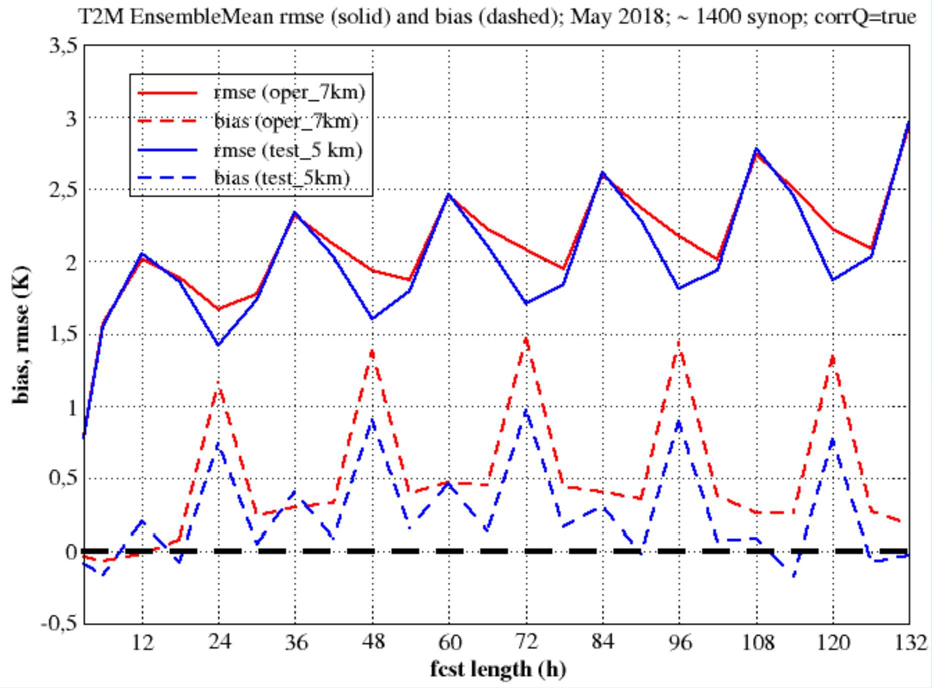
May 2018 experimentation: oper7 vs test5

- Variables: 2-metre temperature
- Scores: bias, and rmse of the ensemble mean (model forecast correct with station height difference)

t2m

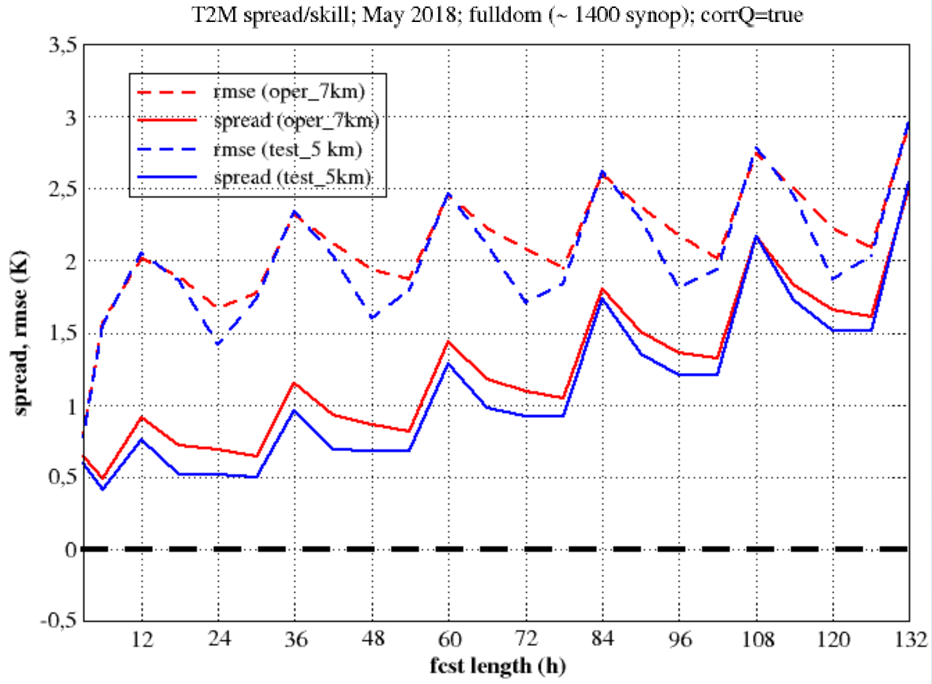


- Temperature: still positive bias at all forecast ranges (the model is too warm), but bias reduction, especially at night-time, in **test5**. Correspondingly, reduction of rmse.

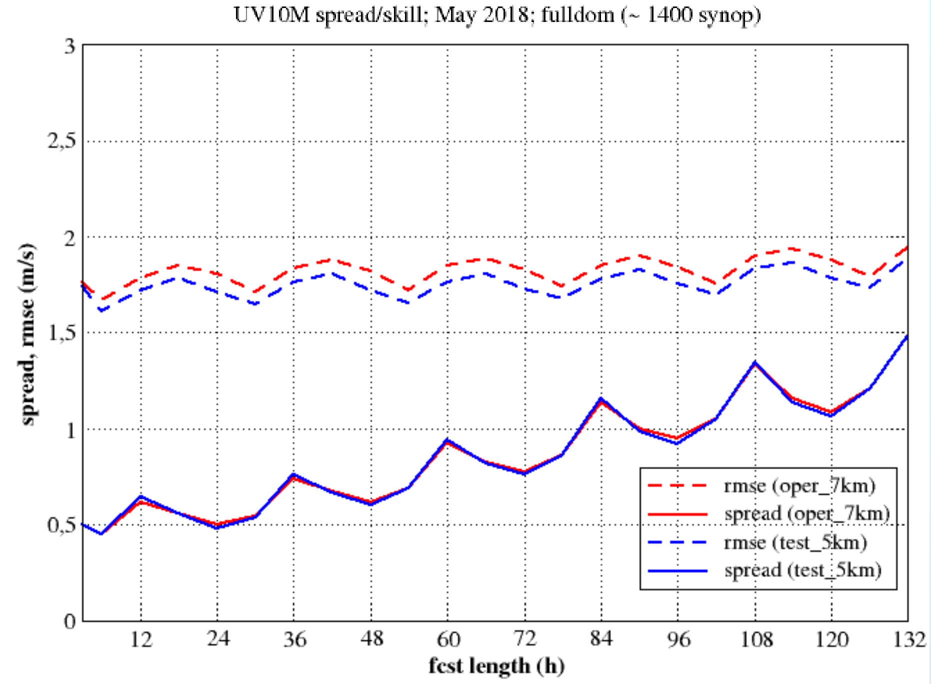
May 2018 experimentation: oper7 vs test5

- Variables: 2-metre temperature **and** 10-metre wind speed
- Scores: rmse of the ensemble mean, spread.

t2m



wspeed10m



- T2M: some reduction of rmse at night-time for **test5**; larger spread for **oper7** (effect of perturbed parameters, missing in test5?)
- WSPEED10M: no impact on spread by enhanced resolution; slight systematic reduction of rmse of the ensemble mean.

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CONSORTIUM FOR SMALL SCALE MODELING COSMO

Conclusions

- COSMO-LEPS: well established product
- Improved forecast skill of COSMO-LEPS throughout the years.
- Promising results by the increase of horizontal resolution (7 → 5 km).
- Probabilistic products are (at last!) considered and can support Civil Protection decisions.
- Keep on working with regional Civil Protection Agencies “to think ensemble” with them and develop customised products.

Next steps / open issues / frozen issue

- Upgrade model version to v5.05.
- Further tests with multi-physics approach and 5km resolution.
- What about model perturbations?
- Use also ENS06 and ENS18 for the provision of ICs and BCs.
- SPPT still not working in single precision.

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CONSORTIUM FOR SMALL SCALE MODELING COSMO