Ensemble Activities at Institute of Meteorology and Water Management – National Research Institute

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Operational setup

- EPS operational since January, 2016
- Perturbation of *c_soil* – surface-area index of the evaporating fraction of gridpoints over land, perturbation amplitude depends on type of soil (clay, sand, peat etc.).
- 4 runs per day, 36 h forecasts, 20 members/4 groups (Time Lagged ICs/BCs)
- Forecasts of T2M, TD2M, PS, U10M, TOT_PREC
- Immediate post-processing (probabilities, charts and plots…)
- Results stored for further studies (spread-skill relation etc.)

Research activities – lower boundary perturbation

- Soil surface temperature (analysis) – perturbed with an amplitude related to the soil type. An average perturbation over the entire domain is set to zero via normalization of perturbation values.
- Collection efficiency coefficient E_c – the efficiency with which a drop intercepts/unites with the smaller drops it overtakes (perturbation effective only for non-zero precipitation). E_c is largely determined by the relative airflow around the falling drop.
- Combinations of all perturbations (including operational) also examined.

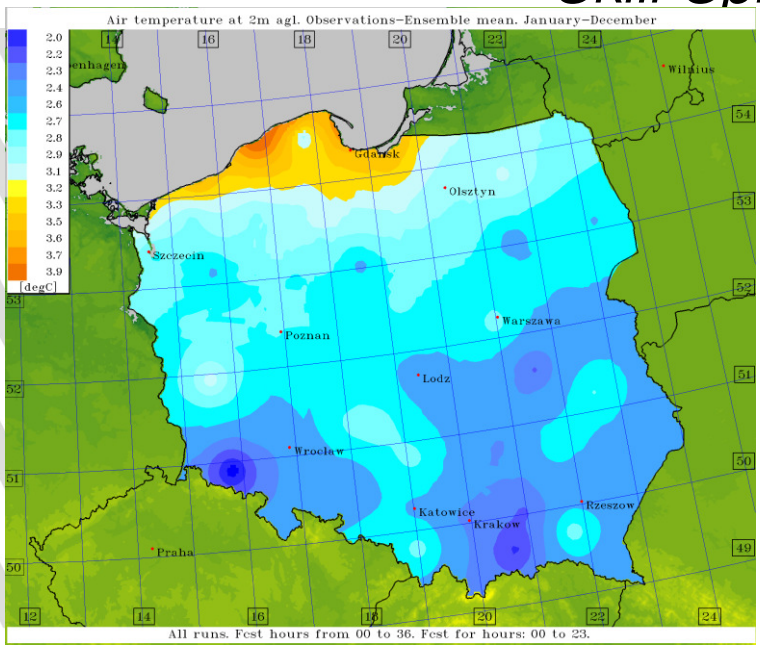
Research activities – ensemble post-processing & calibration

- Two basic methods – multilinear regression and ANN approach
- Predictors – values from member forecast, spatial and temporal information (coordinates, terrain elevation, lead time of forecasts etc.)
- Up to 24 predictors taken into account.

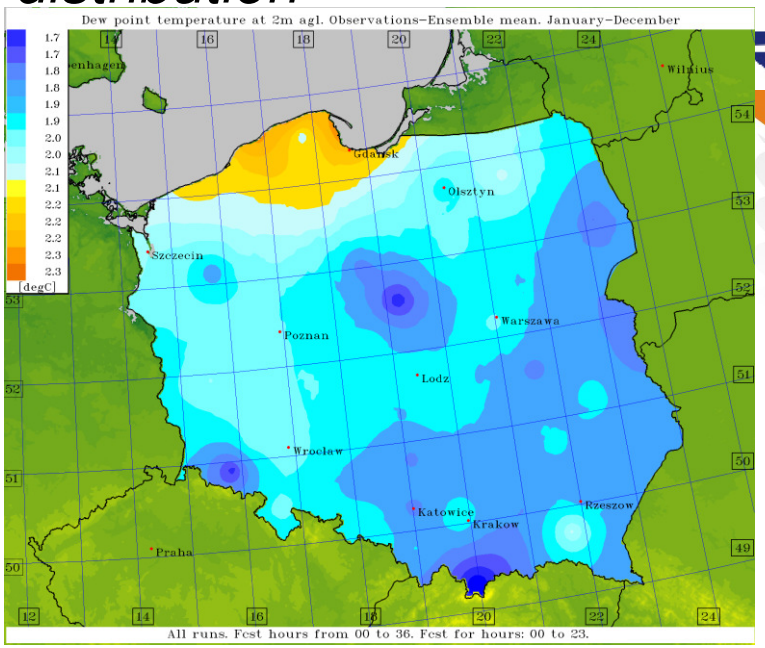
Spread/skill relation study

Skill-Spread spatial distribution

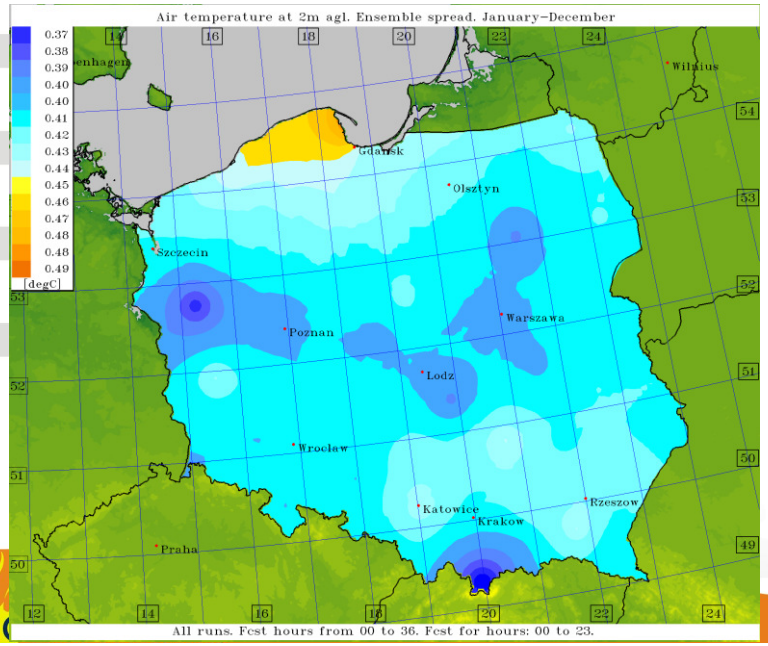
(a)



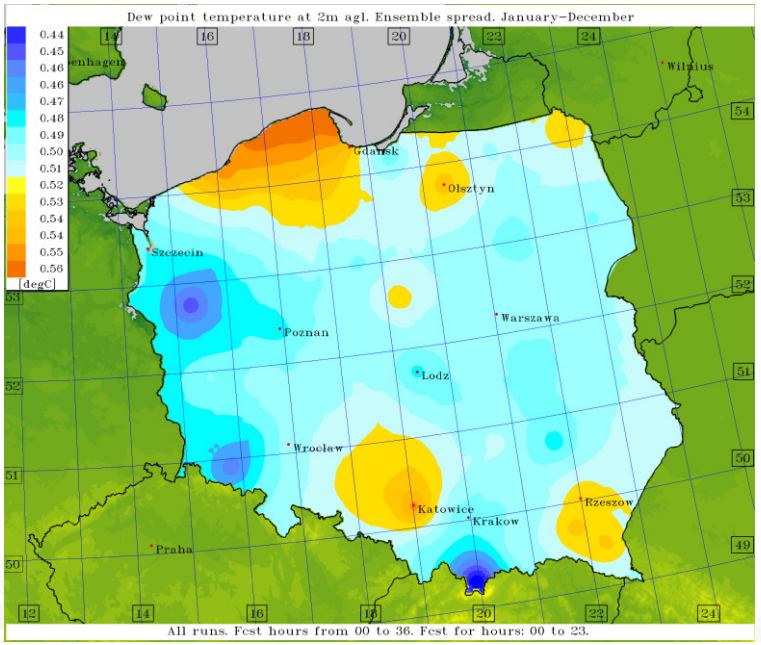
(b)



(c)



(d)



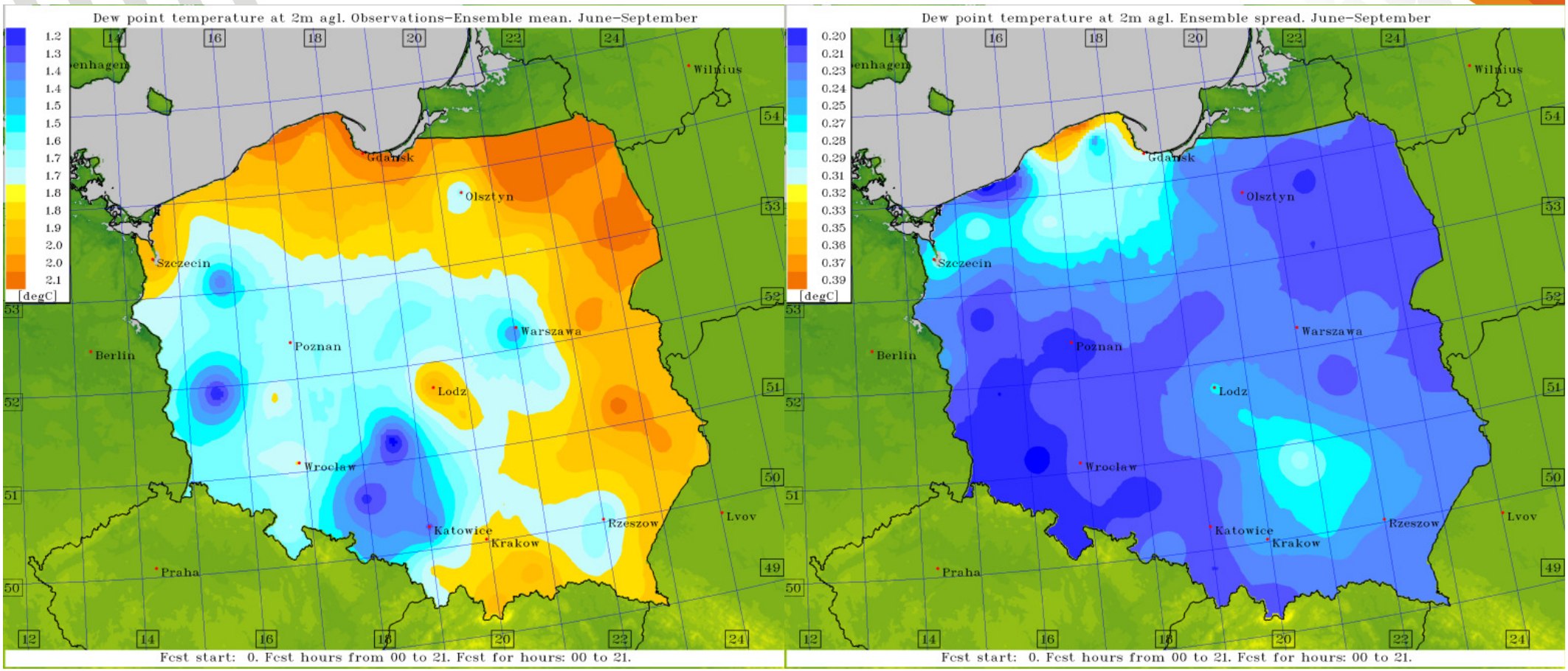
Avg. skill (up)/spread (down); T2M(left) , TD2M (right). All runs, all fcst hours, Jan-Dec 2016

Conclusions – operational activities

- Skill/spread – considered for months/seasons/year, for runs (00, 06, 12, 18), lead times (0-36) and hours (0-23).
- Average spread – 2x to 10x lower than skill measured as MAE.
- In Poland – skill is ”better” (i.e., smaller) for central and southern part.
- Spread is bigger in central and northern part of Poland.
- Skill and spread are ”better” (i.e., smaller/bigger, resp.) for warm months.

Research activities – lower boundary perturbation

Spatial distribution of MAE (left) and spread (right) for TD2M, June-September (*c-soil* – operational – combined with surface temperature perturbation).



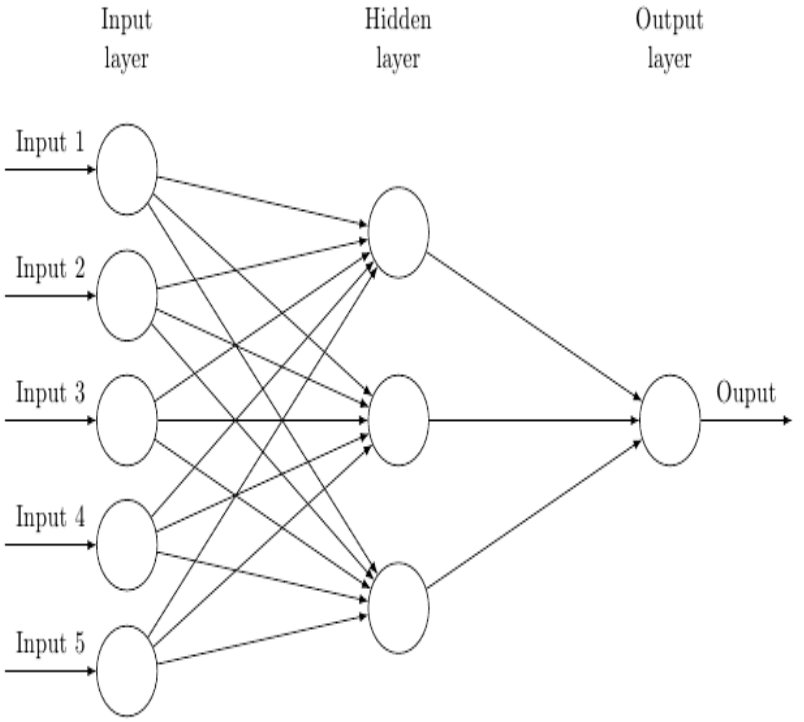
Most effective perturbation schemes (combinations) in terms of MAE vs. spread, avg. for Jun-Sep, 2013 are presented in the poster

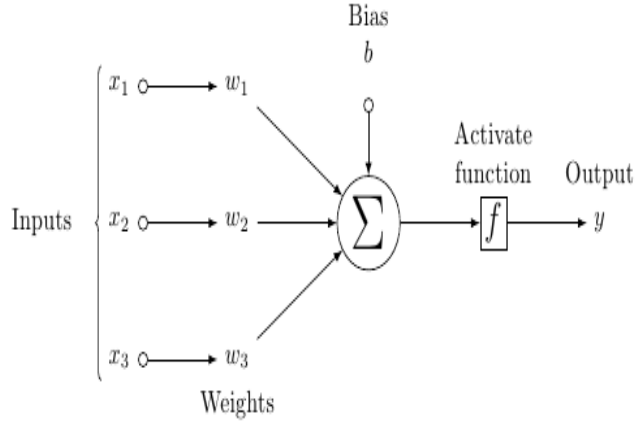
Ensemble calibration and post-processing

(Multi)Linear regression vs. ANN approach – compute weights for ensemble members.

$$\begin{pmatrix} y_1 \\ y_2 \\ \dots \\ y_n \end{pmatrix} = \begin{pmatrix} x_{11} & \dots & x_{1p} \\ x_{21} & \dots & x_{2p} \\ \dots & \dots & \dots \\ x_{n1} & \dots & x_{np} \end{pmatrix} \cdot \begin{pmatrix} \beta_1 \\ \beta_2 \\ \dots \\ \beta_p \end{pmatrix}$$

y – corrected forecasts, X – matrix of input forecasts, β – weights.
Alternatively: 24/22/20 inp. neurons, 5 neurons in a hidden layer (1 for precipitation).
Activation function: hyperbolic tangent. Training method: backward propagation of errors (back-prop). Optimization: gradient descent.





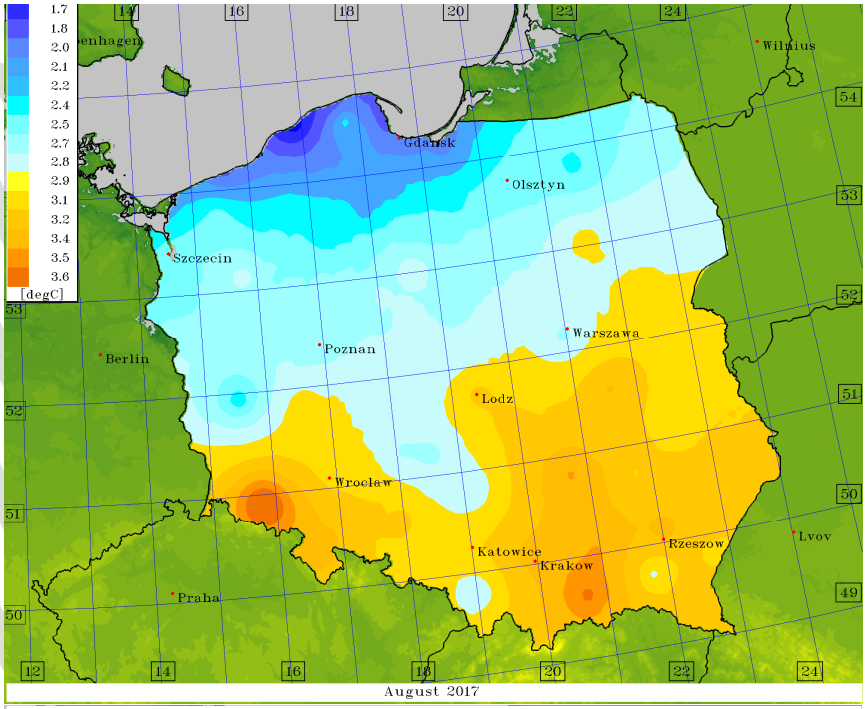
Ensemble calibration and post-processing

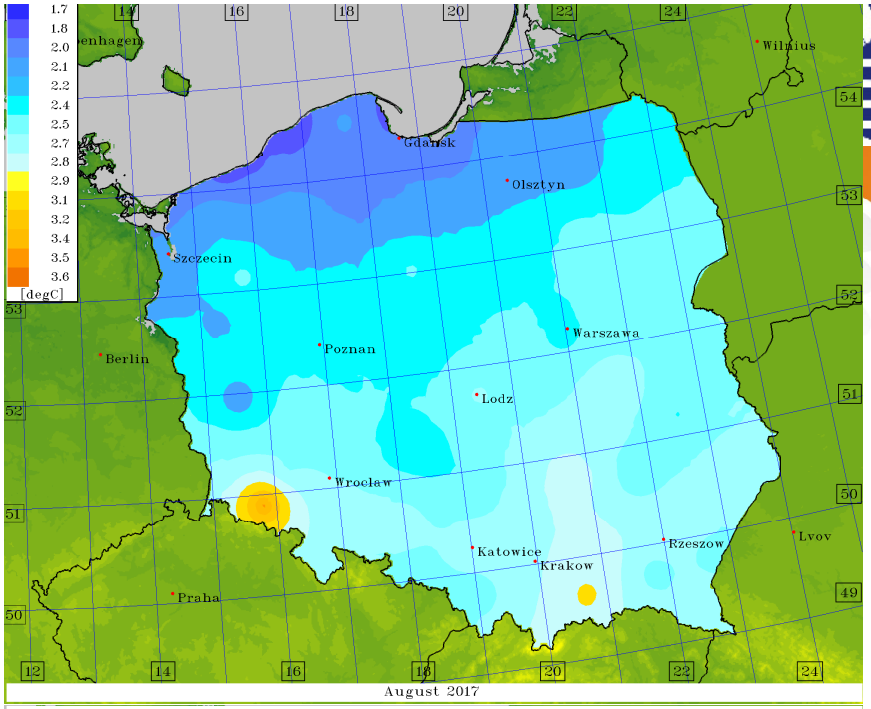
(Multi)Linear regression vs. ANN approach – results.

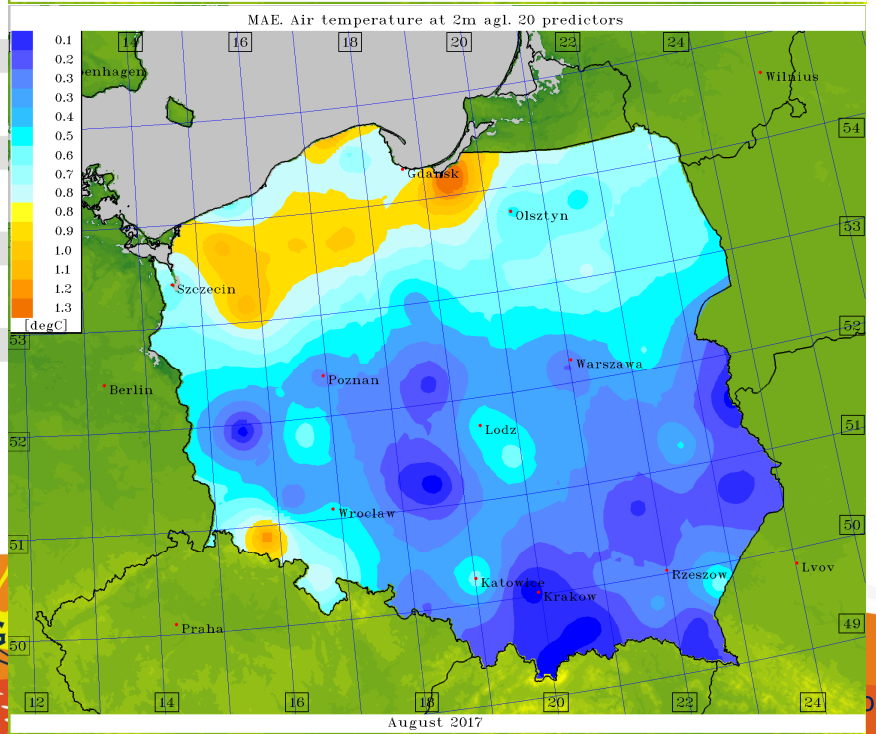
Fields	→ Predictors/neurons ↓ MAE	Simple Avg.	M-Linear regression			ANN		
		20	24	22	20	24	22	20
U10M	Avg.	1.373	1.168	1.182	1.187	0.409	0.416	0.430
	Max	2.519	1.748	1.754	1.783	1.324	1.361	1.538
T2M	Avg.	2.606	2.327	2.481	2.483	0.266	0.275	0.451
	Max	3.628	3.173	3.466	3.475	0.924	1.144	1.302
TD2M	Avg.	1.736	1.634	1.646	1.651	0.268	0.305	0.365
	Max	2.006	1.957	1.993	1.989	0.906	0.999	1.238
PS	Avg.	2.864	2.725	2.727	2.785	2.398	2.405	2.595
	Max	11.786	11.284	11.286	10.589	11.683	11.464	9.708
TOT_PREC	Avg.	0.808	0.967	0.972	0.973	0.131	0.127	0.219
	Max	1.514	1.677	1.679	1.693	0.739	0.741	0.505

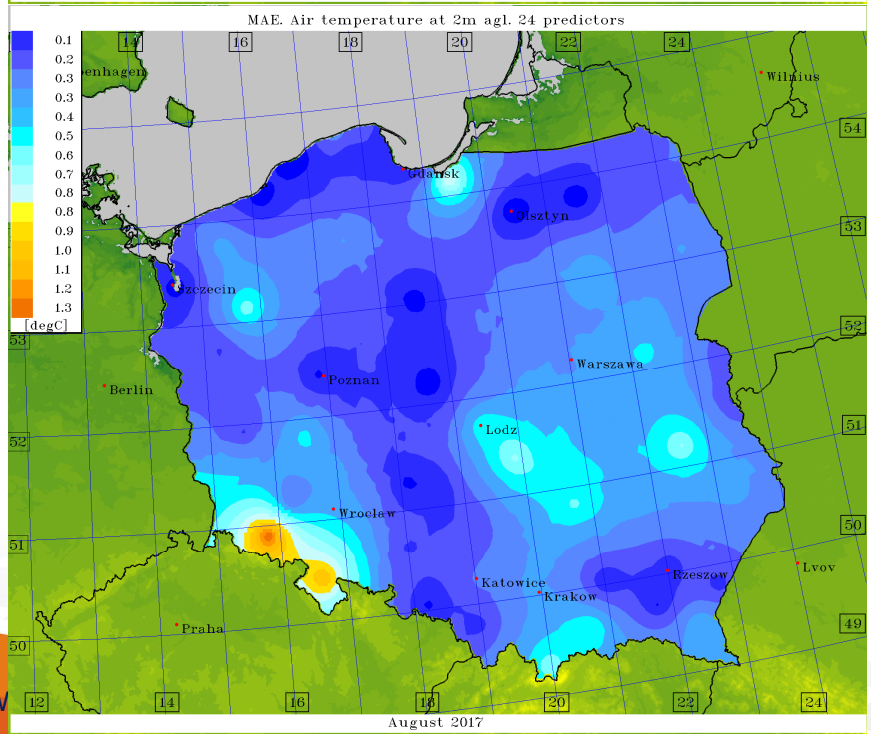
Training period – July 2016 to July 2017. Test period – August 2017.
Operational results (members' forecasts) were used for training and testing.

Ensemble calibration and post-processing









Temperature

Conclusions – research activities

- Most effective perturbation schemes (combinations) in terms of MAE and spread e.g. for T2m – efficiency coefficient, for TD2m – surface temperature combined with *c_soil*
- Significant improvement, esp. of ANN (perhaps due to sufficient learning period). ”More predictors” – in general – means ”better forecast”, but also ”longer calculations” – compromise to be established
- Some fields may be treated with ANN, others (pressure?) – linear regression