Task 3.6

Verification of precipitation objects from SINFONY-RUC simulations (ICON-D2-EPS Rapid Update Cycle) during summer 2021

AWARE progress report

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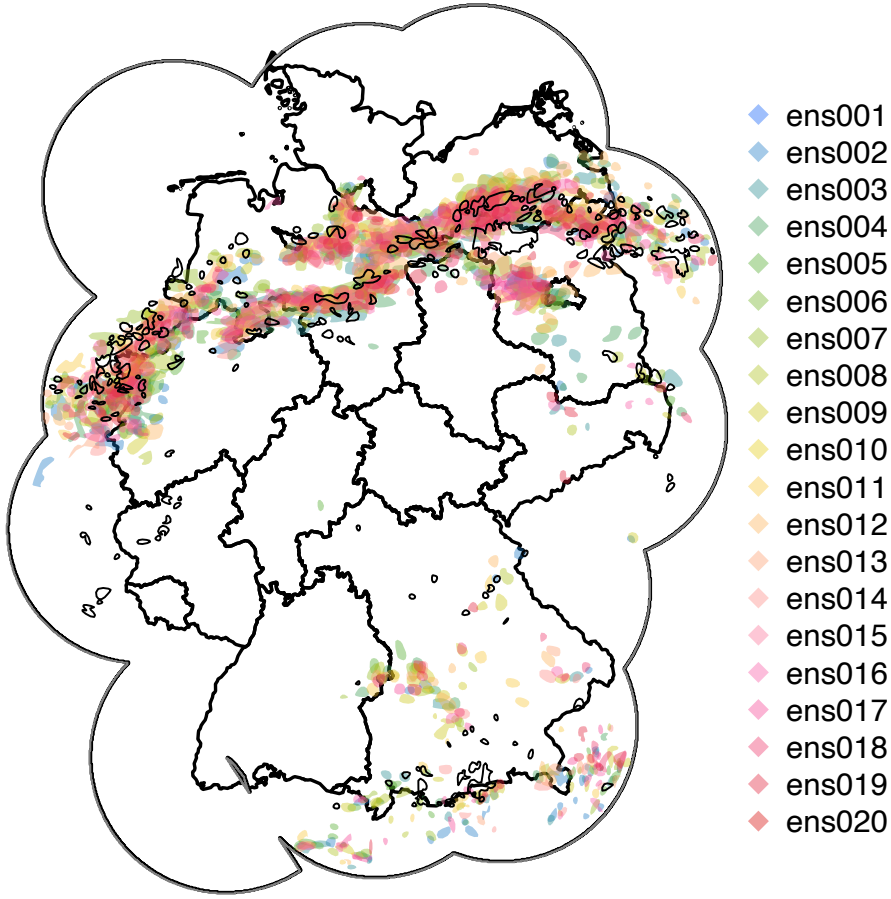
SINFONY project

- Seamless INtegrated FOrecastiNg sYstem
- Here: „seamless“ = „from minutes to hours“
- Aim: Development of a coupled probabilistic system consisting of precipitation nowcasting and short-range numerical weather prediction (+12 h) on the convective scale

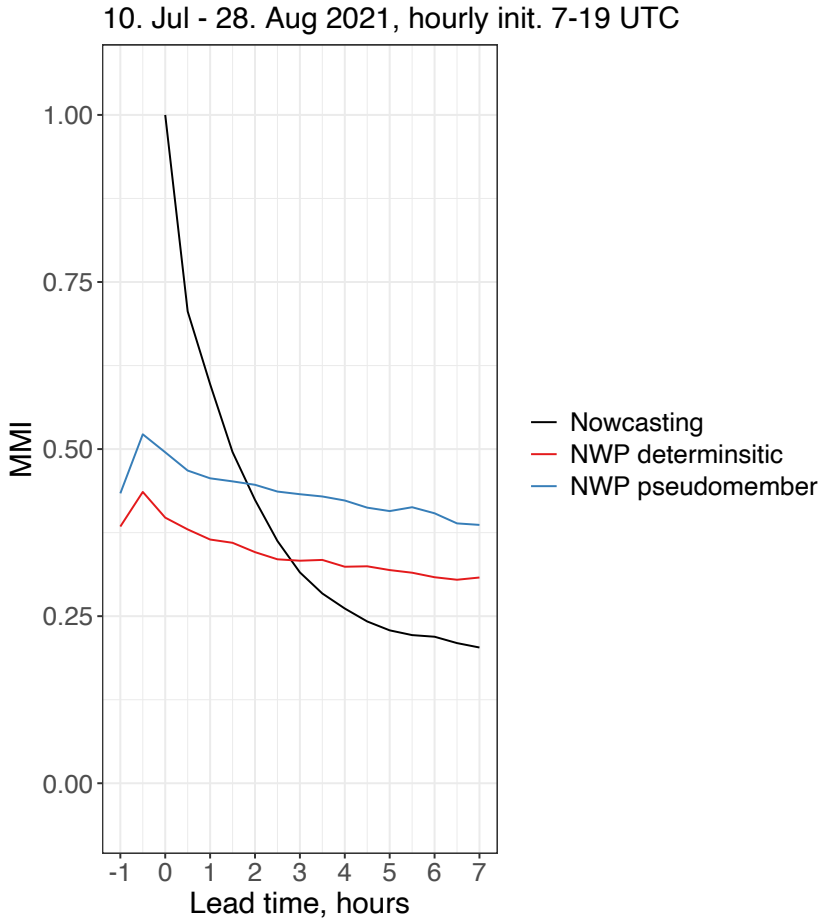
- SINFONY-RUC (Rapid Update Cycle)
  - Hourly initialization of ICON-D2-EPS (20+1 members) + 8 hours lead time
  - 2-moment microphysics
  - Running since June 2021
- Object-based verification of features from KONRAD3D cell detection tool of observed radar reflectivities and from model equivalents (EMVORADO forward operator)
  - Reflectivity objects as polygons with several properties, e.g., position, size, intensity, …



Object-based verification

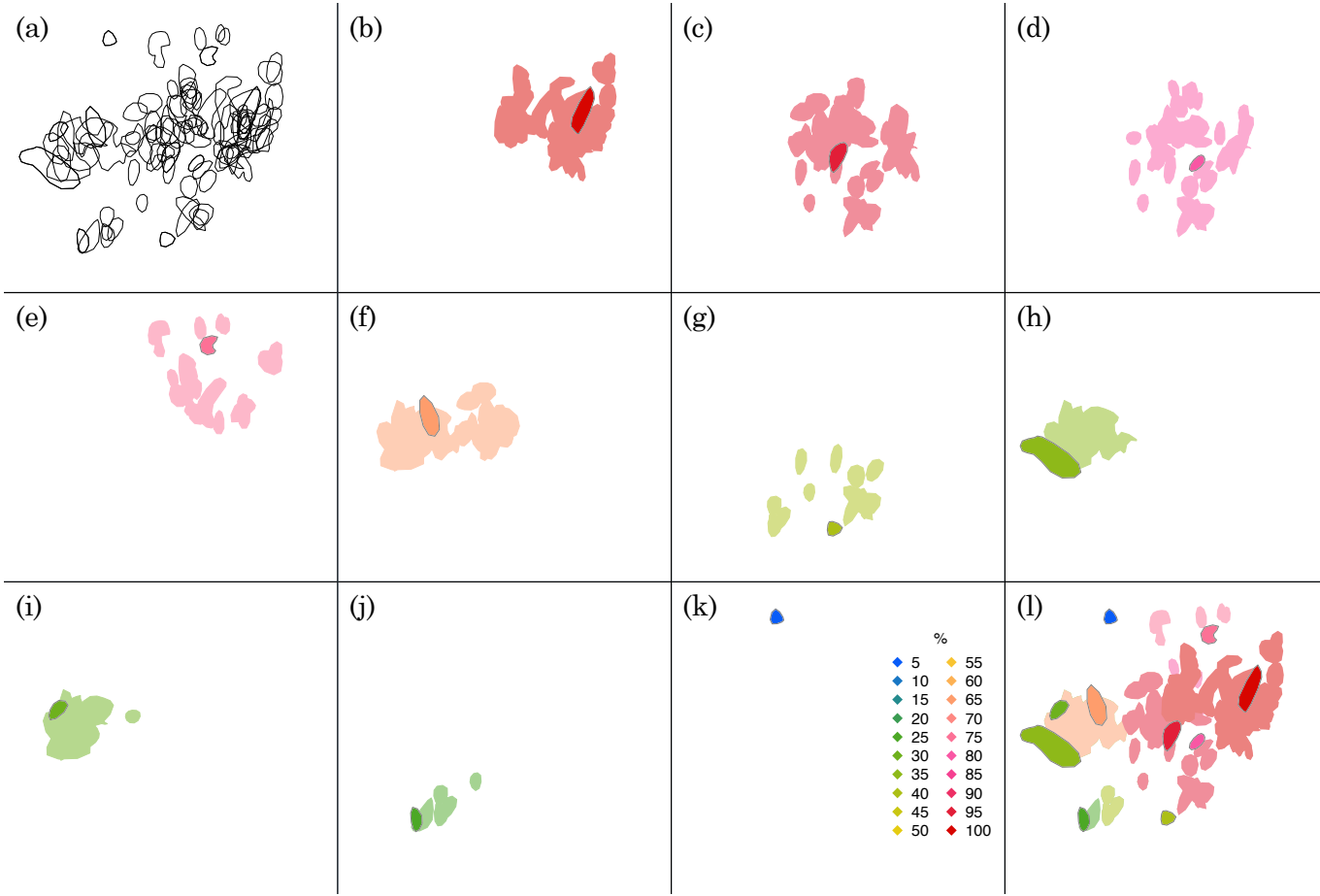
- Score: MMI („Median of Maximum Interest“, Davis et al., WAF, 2009)
  - Systematic comparison of various properties (e.g. distance and area measures) of all observed and all predicted objects
  - Range [0; 1], 1 = perfect forecast

- Nowcasting starts from observations with a perfect MMI (=1) and is superior to NWP on the very short range
- NWP deterministic
  - Better than nowcasting after about three hours
- NWP pseudomember
  - Better than nowcasting after about two hours
  - Yields 20–25% higher MMI than deterministic



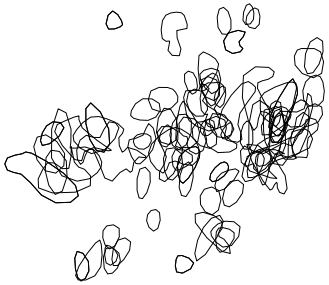
Pseudomember (Johnson et al., WAF, 2020)

1. Make a list of all objects in the forecast ensemble, together with the objects' probabilities, calculated from the percentage of ensemble members with a matching object (i.e. similar position and size)
2. Sort all of the objects by probability, breaking ties according to the average total interest with all the objects from other ensemble members that it matched to.
3. Add the highest probability object to the object list of the pseudomember.
4. Remove from consideration the added object, as well as all matching objects in other members that contributed to the probability of the added object, leaving a new, smaller list of objects.
5. Repeat from step 2 until no objects remain in the list of ensemble forecast objects.



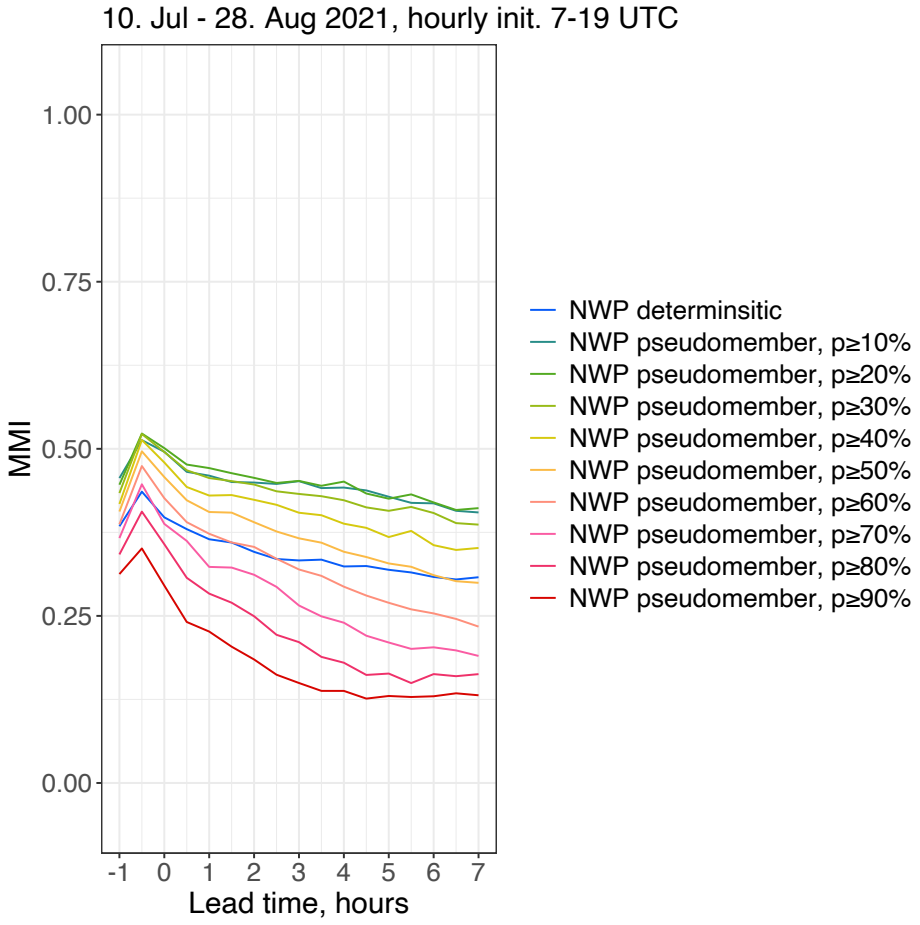
Pseudomember

- Selection of the locally most representative objects from the ensemble
- Each pseudomember object has a probability of occurrence, i.e., the percentage of ensemble members with similar objects
- Use unified area of „matching“ objects from other members to define uncertainty regions

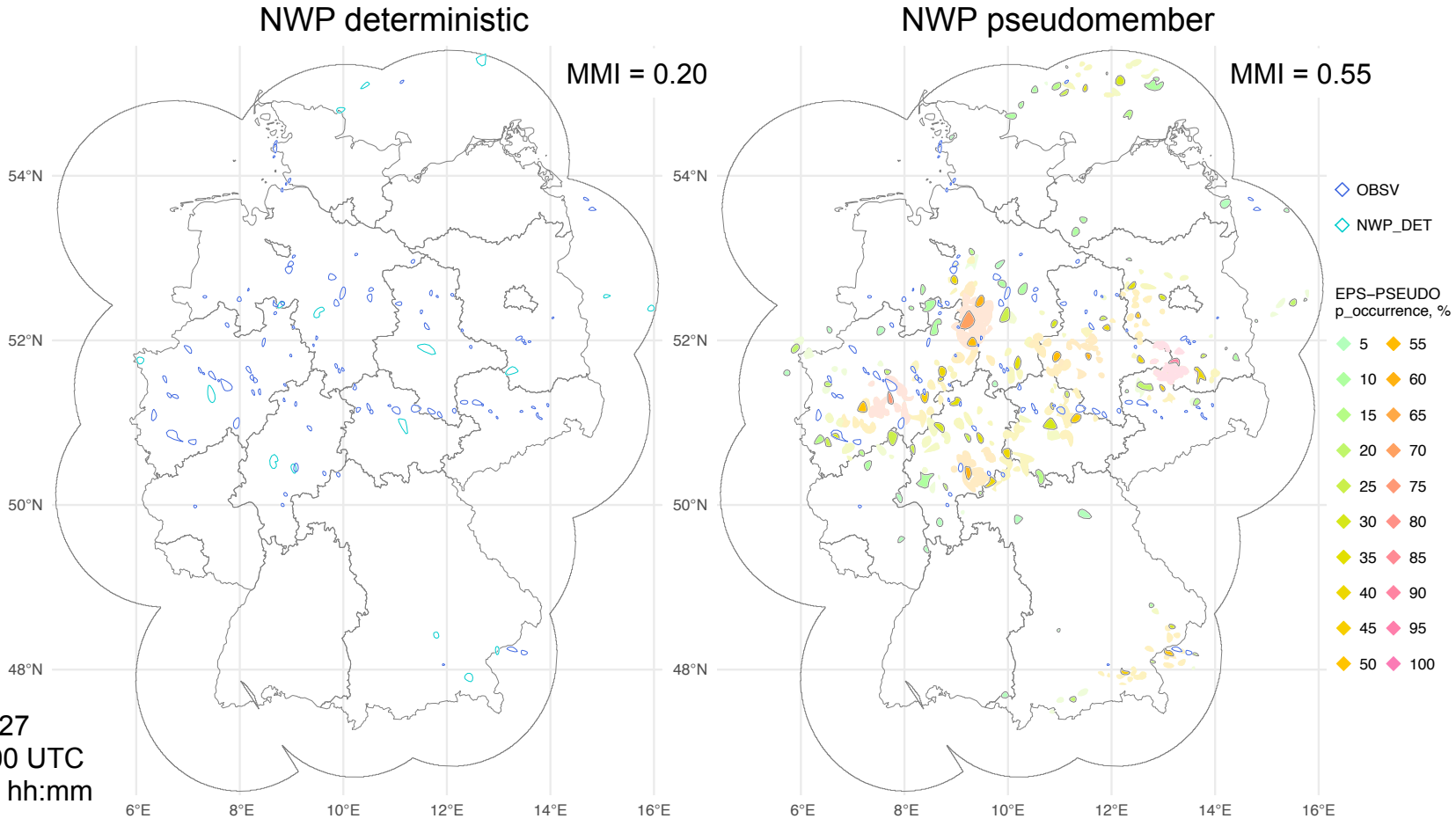


Probability of occurrence

- Perfect forecast would yield highest scores when considering pseudomember objects with a probability of occurrence p ≥ 50%
- Here: Best MMI scores when considering objects with p ≥ 10%, 20% or 30%
- Not visible from this plot, but
  - Restricting to higher p-values leads to too small number of objects
  - On the other hand, small p-values cause „overforecasting“ with many „hits“ but also more „false alarms“. MMI obscures this.
  - More details revealed by MMIO and MMIF which take into account hits and false alarms - but not in this talk!
- p ≥ 30% is the best selection of objects when considering MMI, MMIO and MMIF (not shown)



Example: pseudomember objects with p ≥ 5%



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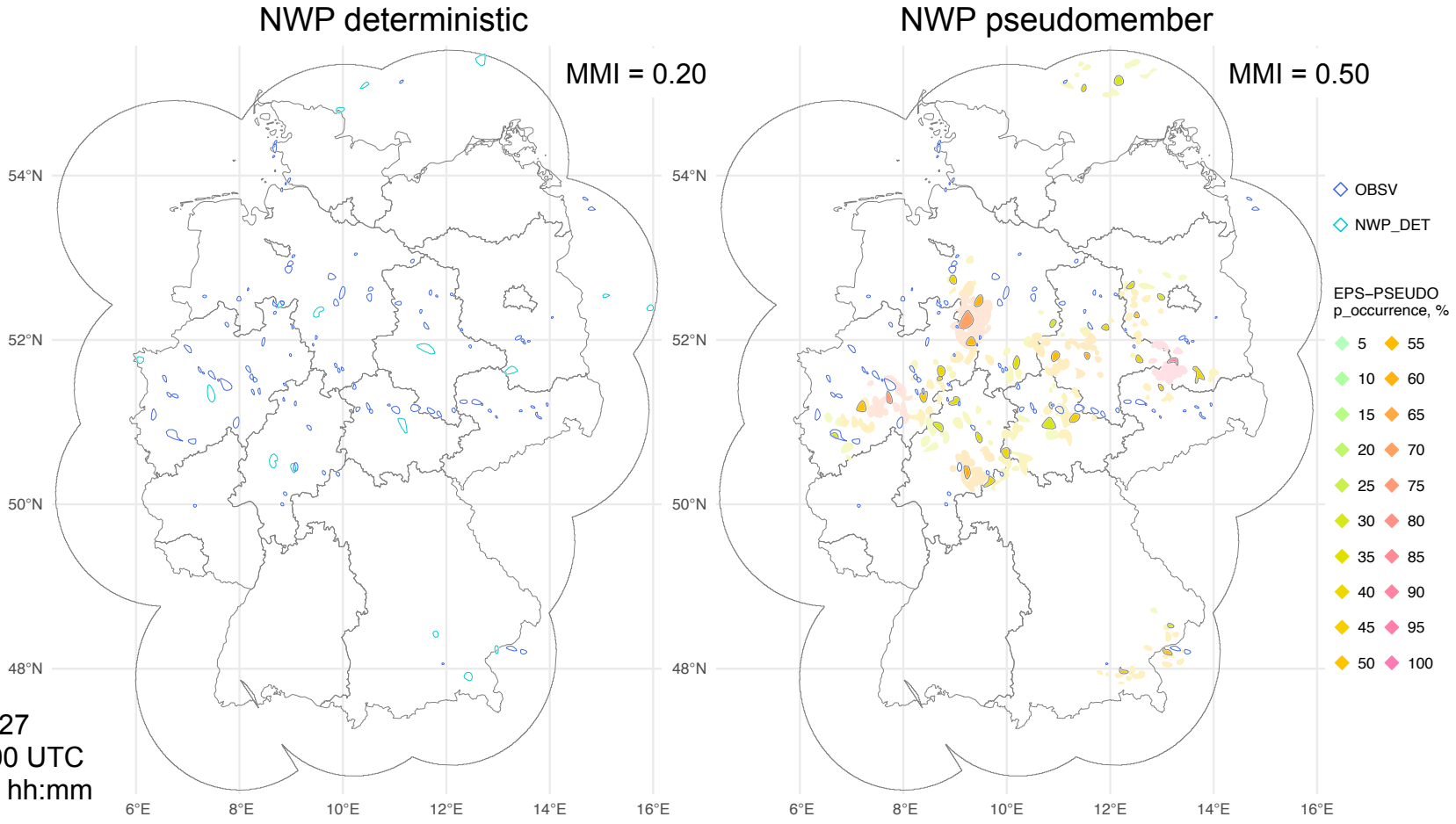
Example: pseudomember objects with p ≥ 30%



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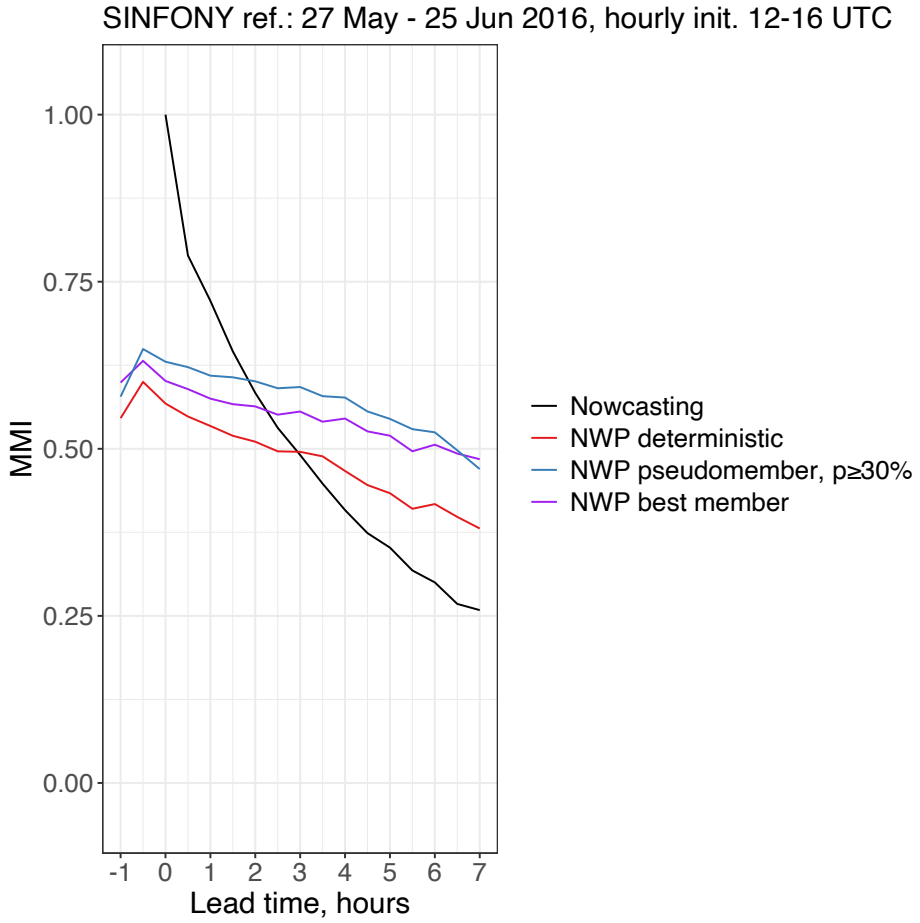
Local beats global

- Pseudomember: a-priori selection of locally most representative objects only based on ensemble forecasts
- „Best member“: a-posteriori selection; use observations to evaluate which member is globally the best at each time step
- Pseudomember has higher MMI than the best member selection!



Conclusions

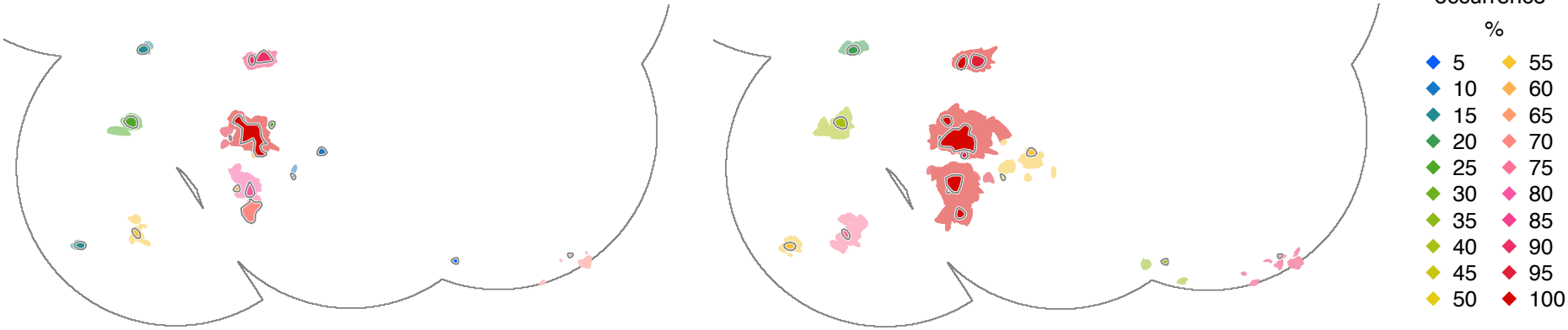
- SINFONY-RapidUpdateCycle running since June 2021
  - Hourly initialization of ICON-D2-EPS (20+1 members), + 8 hours lead time
- Object-based verification evaluates SINFONY-RUC simulations employing the MMI
- Pseudomember persistently yields highest MMI
- Pseudomember
  - A-priori selection of locally most representative objects based on ensemble forecasts
  - Contains information about probability of occurrence and uncertainty regions of objects

Future work

- Define measures like reliability and spread for objects using the uncertainty regions
- Account for temporal uncertainty, i.e., consider ± a few time steps for the pseudomember selection

Without temporal uncertainty

Considering ± 5, 10 minutes



- Considering temporal uncertainty yields similar pseudomember objects but with higher probability of occurrence and larger uncertainty regions