Development of a new seamless prediction system for very short range convective-scale forecasting at DWD

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Ulrich Blahak, Roland Potthast, Kathrin Wapler, Axel Seifert, Alberto De Lozar, Elisabeth Bauernschubert, Christian Welzbacher, Robert Osinsky, Martin Rempel, Michael Hoff, Markus Junk, Lilo Bach

German Meteorological Service, Offenbach, Germany

Motivation and project overview

New internal project at DWD to develop a seamless ensemble prediction system for convective-scale forecasting from observation time up to +6 h / +12 h forecasts.

Focus: severe summertime convective events (heavy precipitation, hail, wind gusts, etc.)

Up to now, the first 1-2 h covered by purely observation-based nowcasting, whereas convection-allowing ensemble NWP (COSMO-DE-EPS) only reaches/outperforms quality of nowcasting at later times. New NWP forecasts only every 3 h and after some technical time delay.
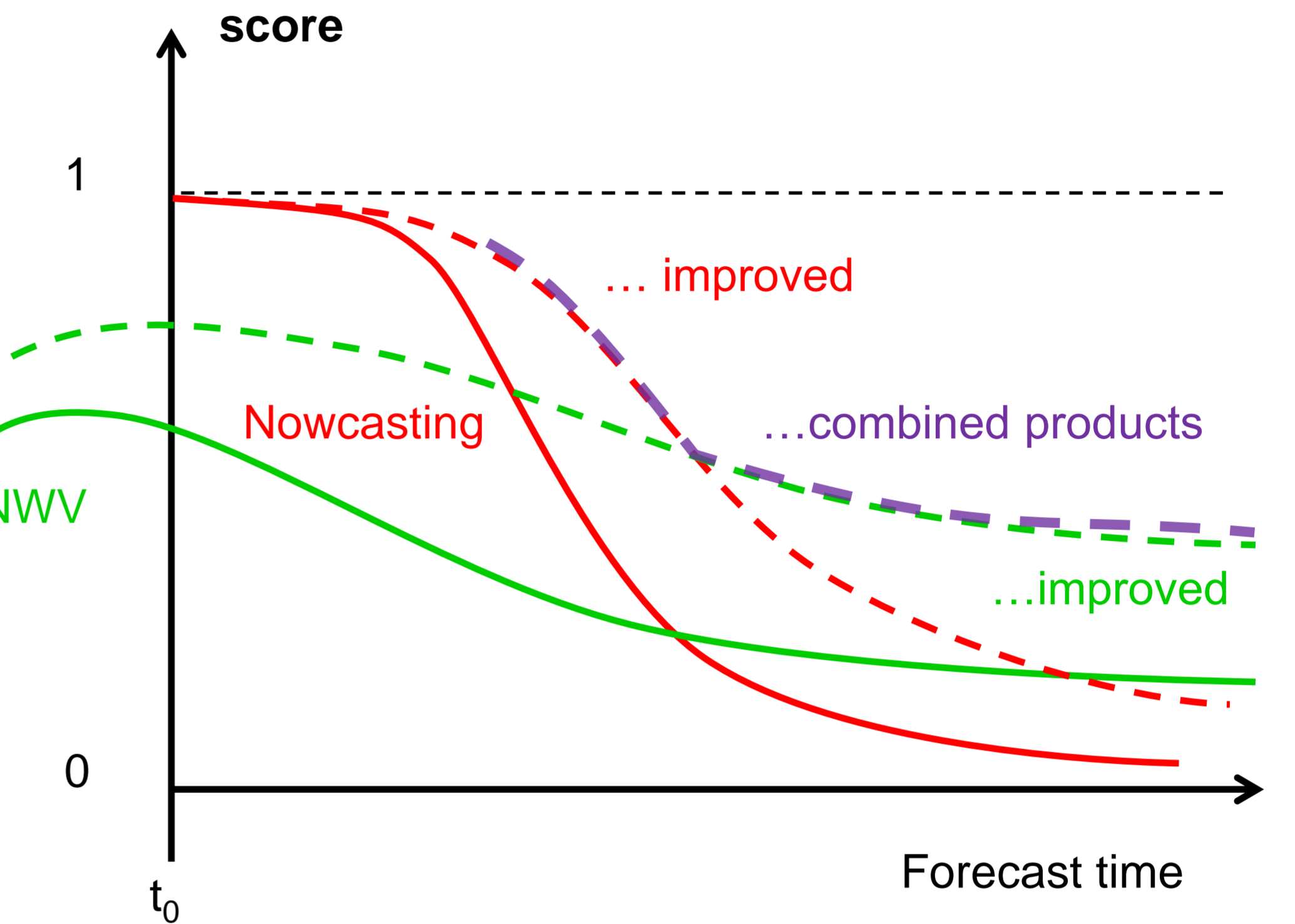
Moreover, nowcasting and ensemble NWP treated as two separate and independent methods, few common products available for the forecasters.

Goal: narrow down these gaps, on the one hand by enhancements to both nowcasting and NWP separately and on the other hand by mutual information exchange and combination. Use of high-resolution observational data (3D radar, satellite, GPS-derived moisture, lightning, etc.).
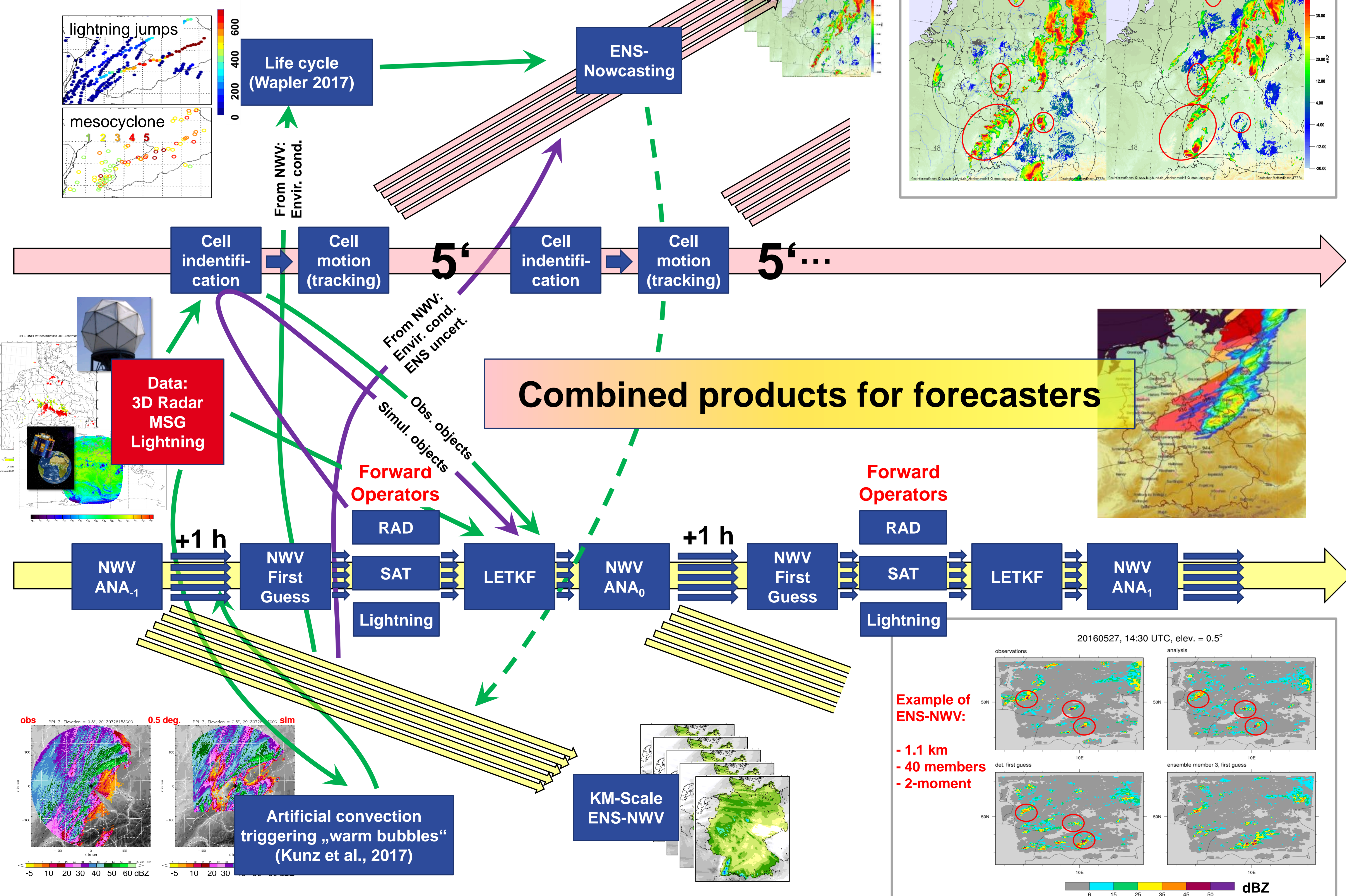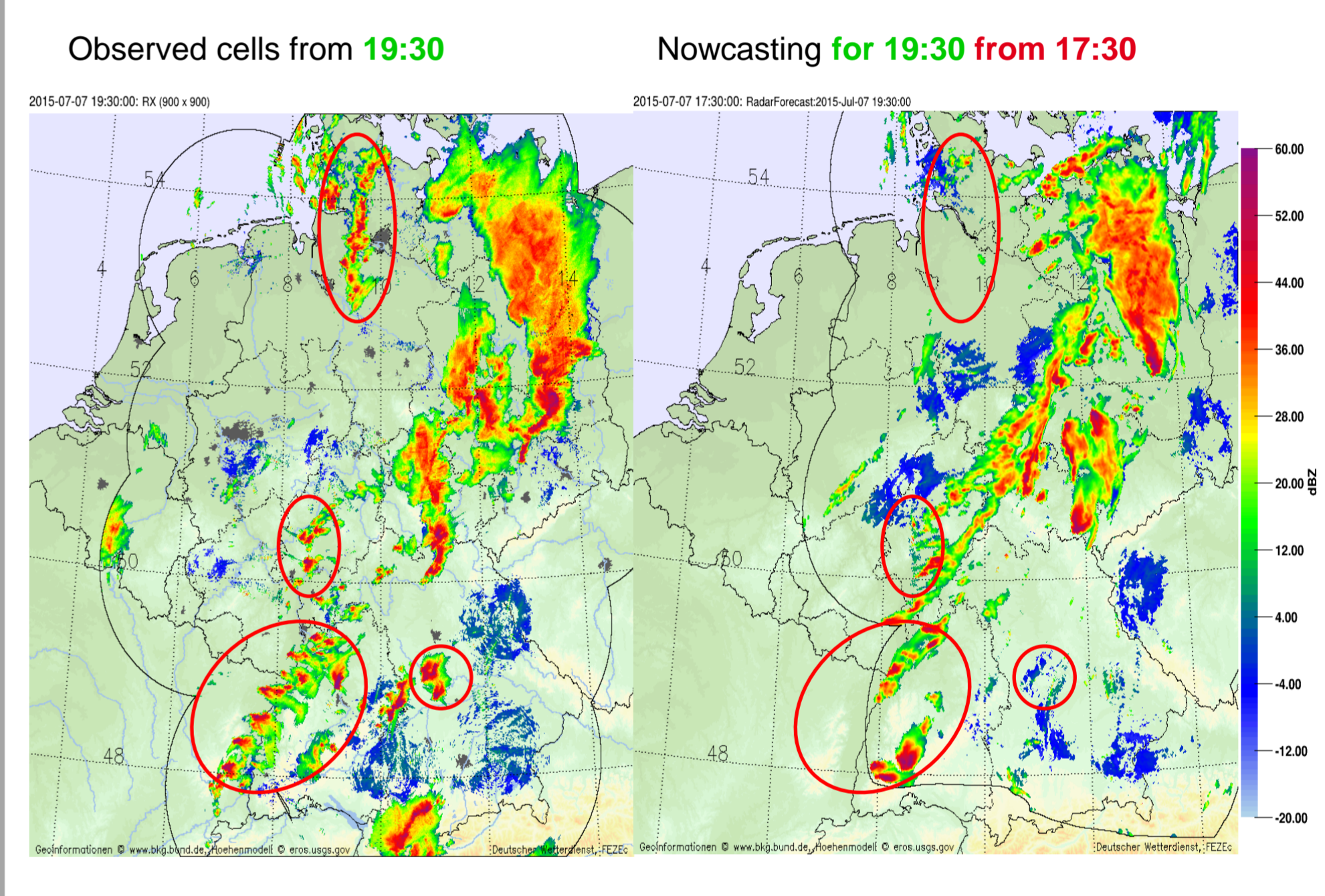
We consider in particular:

- Nowcasting ensembles, ensembles of "objects", also informed by uncertainties from NWP
- Life cycle in nowcasting (Wapler, 2017), informed by radar, lightning and satellite data, and by ensemble NWP
- Rapid Update Cycle (RUC) ensemble NWP (1-km-scale, LETKF, hourly update, ~40 members, advanced physics (2-moment microphysics including hail, 3D turbulence)
- LETKF assimilation (Schraff et al., 2016) in ensemble NWP in observation space of
  - 3D radar data (Bick et al., 2016; Zeng et al., 2016)) - native observations & nowcast "objects"
  - MeteoSat SEVIRI IR / VIS (Scheck et al., 2016)
  - Lightning flash density using the Lightning Potential Index as a forward operator
  - Assimilate severe conv. cells into ENS-NWP at correct location as early as possible
- New products combining nowcasting and NWP for our forecasters

Some forecast quality score

... improved
Nowcasting
...combined products
NWV
...improved
Forecast time

Typical example of problems with nowcasting for longer lead times:

Observed cells from 19:30   Nowcasting for 19:30 from 17:30

lightning jumps

mesocyclone

Life cycle (Wapler 2017)

ENS-Nowcasting

From NWV: Envir. cond.

Cell indentification → Cell motion (tracking)   5'   Cell indentification → Cell motion (tracking)   5'...

Data: 3D Radar MSG Lightning

From NWV: Envir. cond. ENS uncert.

Obs. objects

Simul. objects

Forward Operators
RAD
SAT
Lightning

Combined products for forecasters

Forward Operators
RAD
SAT
Lightning

+1 h   NWV ANA$_{-1}$ → NWV First Guess → LETKF → NWV ANA$_0$ +1 h   NWV First Guess → LETKF → NWV ANA$_1$

obs   0.5 deg.   sim

Artificial convection triggering „warm bubbles" (Kunz et al., 2017)

KM-Scale ENS-NWV

Example of ENS-NWV:
- 1.1 km
- 40 members
- 2-moment

20160527, 14:30 UTC, elev. = 0.5°
observations   analysis
det. first guess   ensemble member 3, first guess

dBZ

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