Max-Planck-Institut für Meteorologie

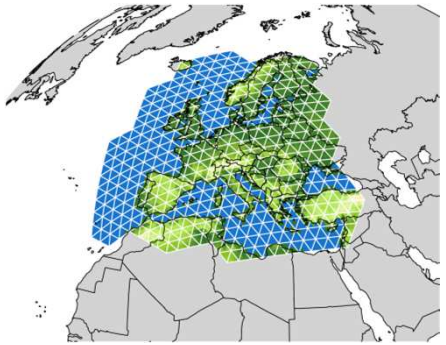
Karlsruhe Institute of Technology

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

ICON

Recent model improvements and current status of the limited-area mode





Günther Zängl, on behalf of the ICON development team

CCIA User Seminar, Offenbach, 07.03.2017

Outline

- Recent model improvements and evolution of global NWP forecast skills
- Limited-area mode: status and first results in comparison with COSMO-DE
- Conclusions and outlook

Recent model improvements

- Ensemble data assimilation (operational since January 2016)
- Various changes in convection scheme and its coupling to the microphysics scheme in order to reduce drizzle bias
- Account for salinity effect on saturation vapor pressure over sea
- New bare soil evaporation scheme (presentation by J.-P. Schulz, CUS 2016) and interception storage for dew/rain and rime (becomes operational next week)

Evolution of forecast quality since 1968: Tendency correlation of sea-level pressure, Northern Atlantic and Europe

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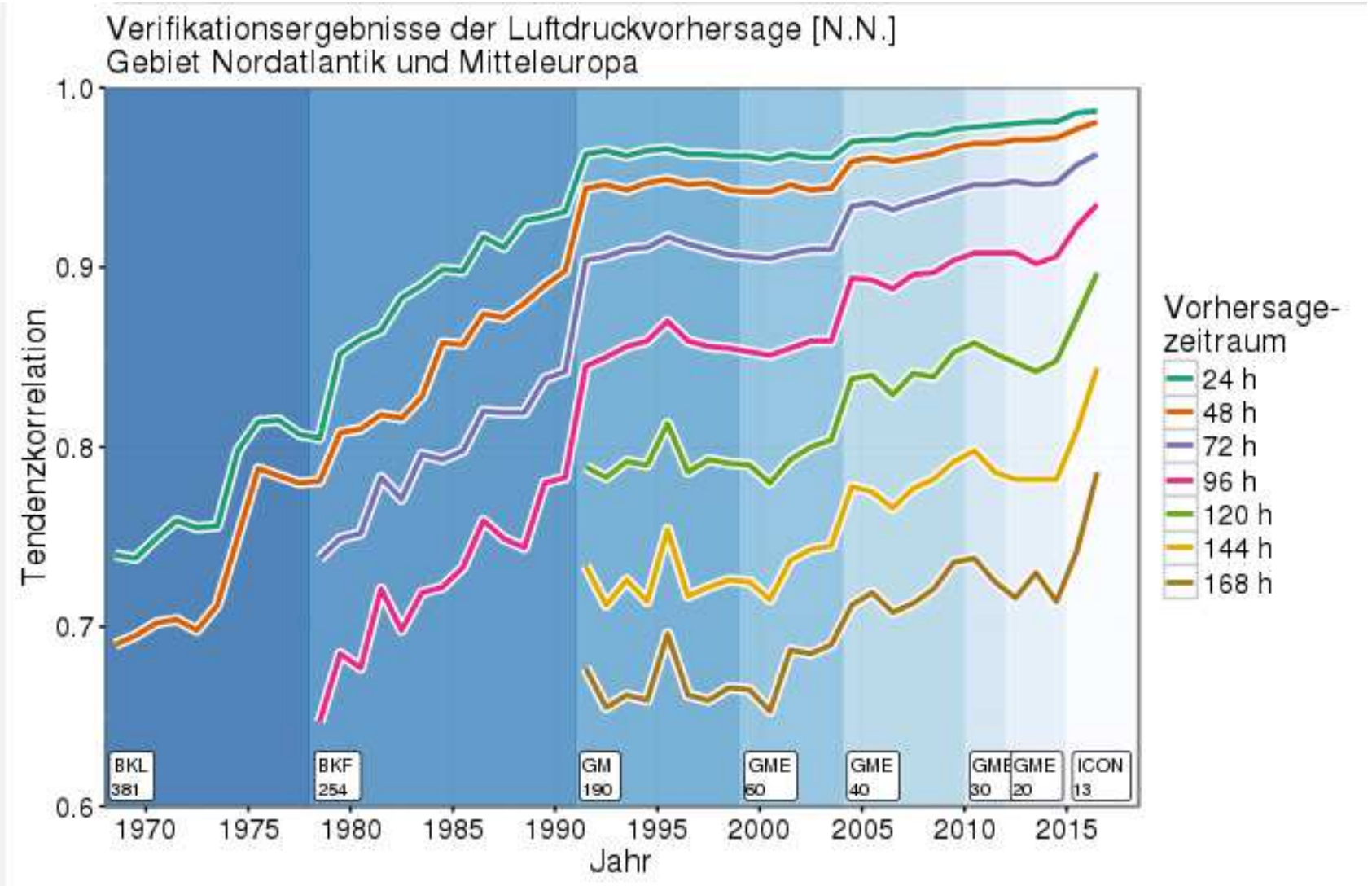

Evolution of forecast quality since 1968: Tendency correlation of 500-hPa geopotential, Northern Atlantic and Europe

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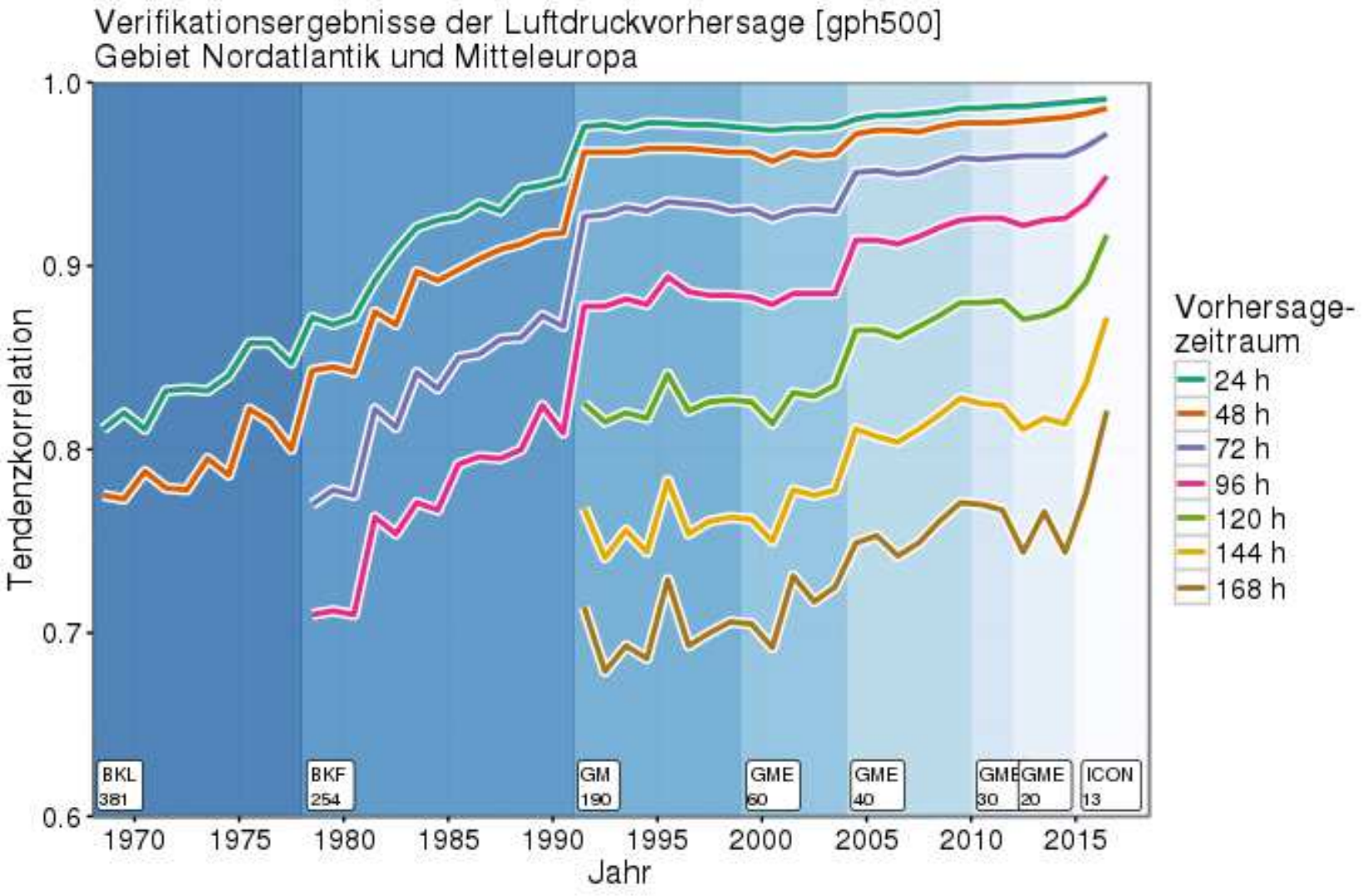
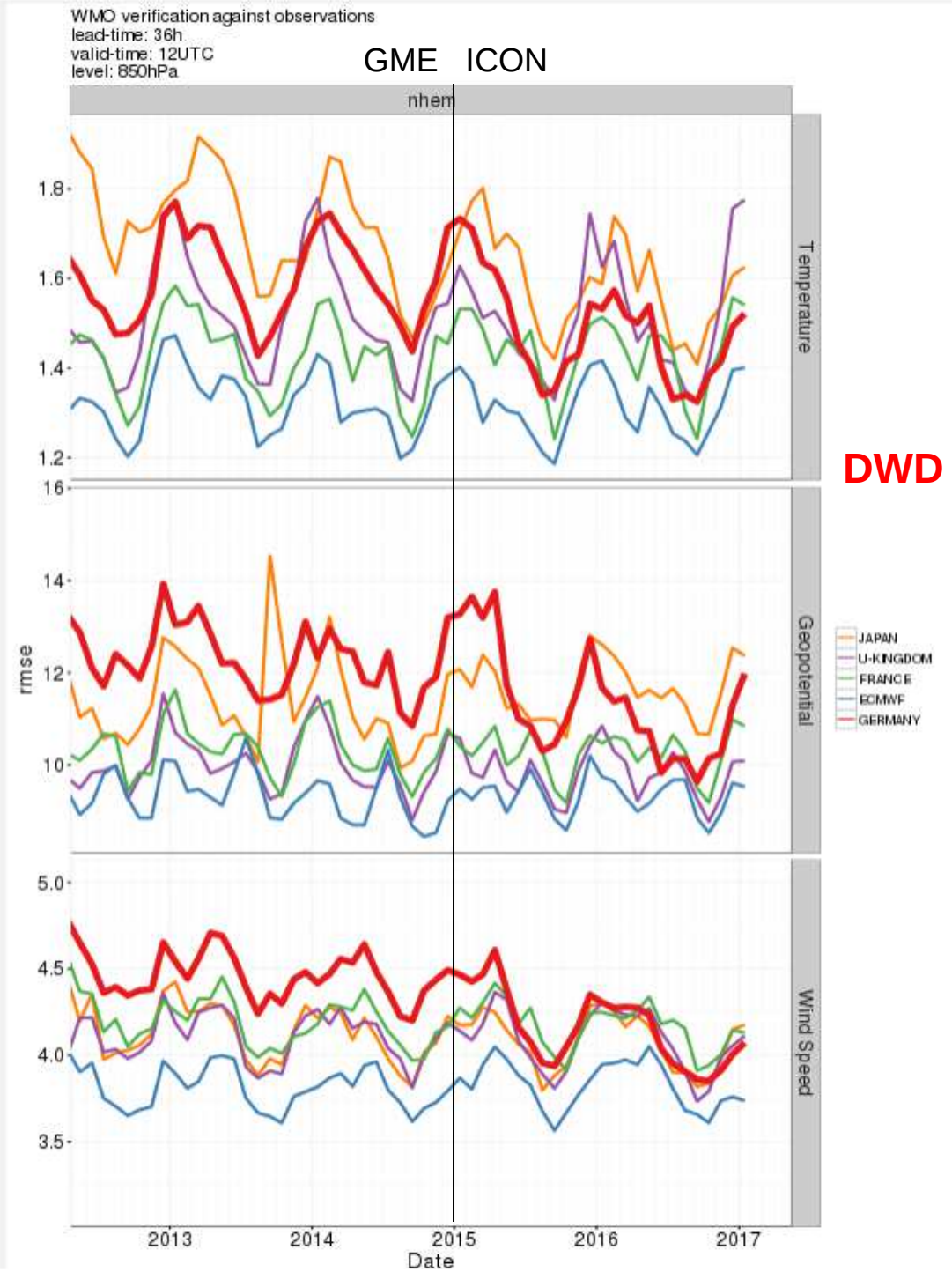


WMO verification against radiosondes

Comparison between DWD and other global NWP centers

RMS errors of temperature, geopotential and wind speed at 850 hPa, lead time 36 h, northern hemisphere

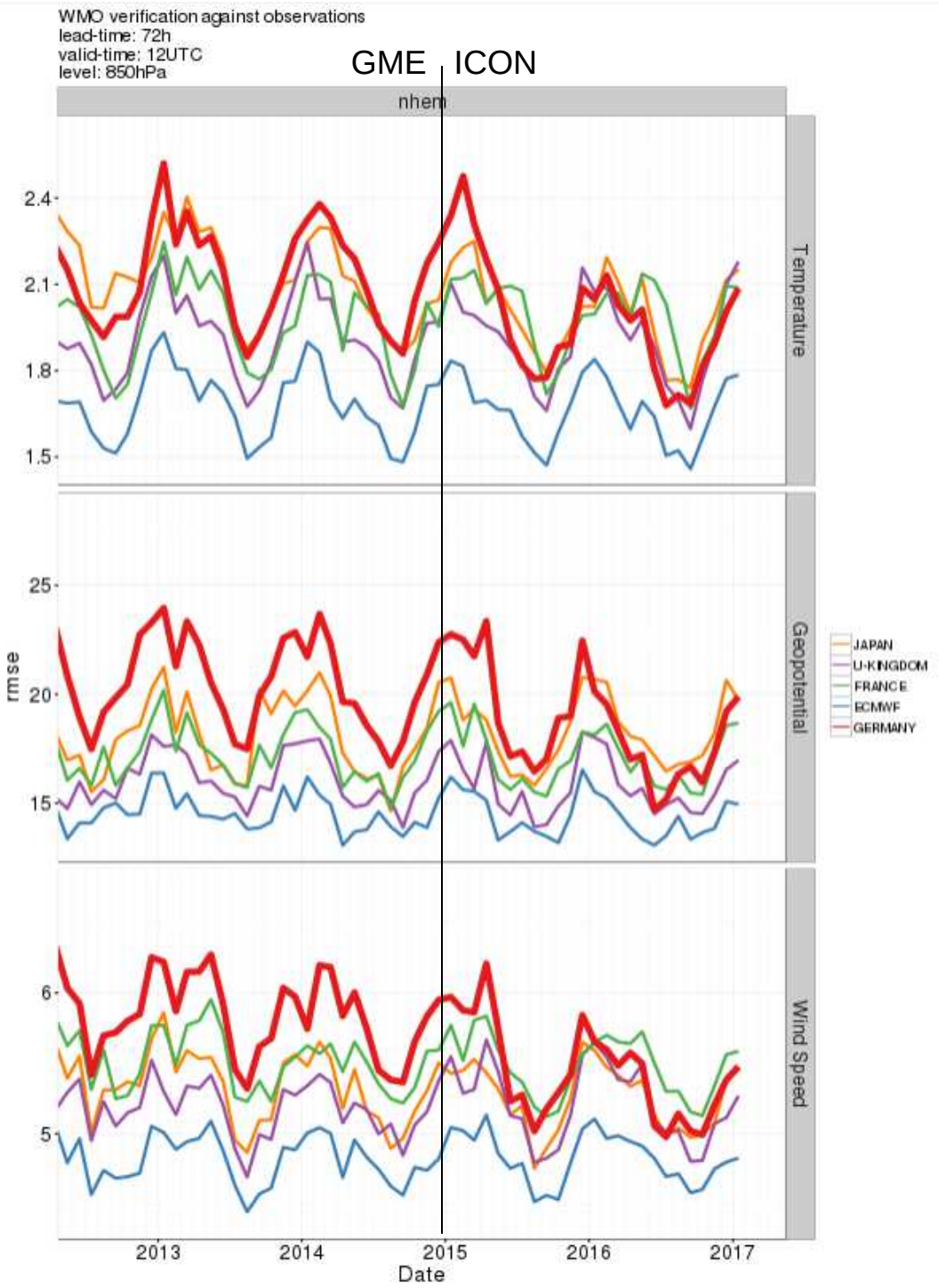


DWD

WMO verification against radiosondes

Comparison between DWD and other global NWP centers

RMS errors of temperature, geopotential and wind speed at 850 hPa, lead time 72 h, northern hemisphere



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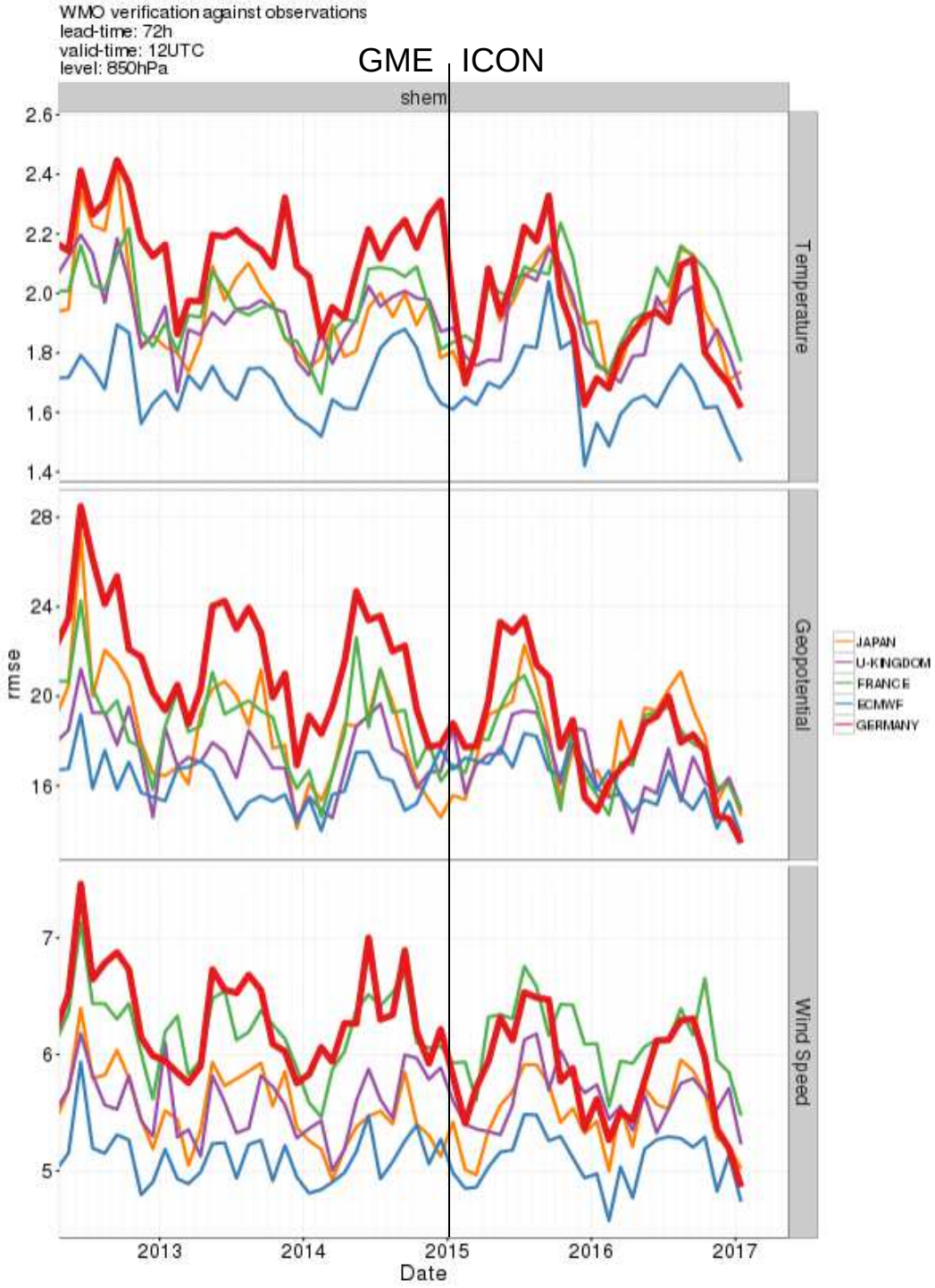

Precipitation verification against SYNOP stations, July 2016, Europe

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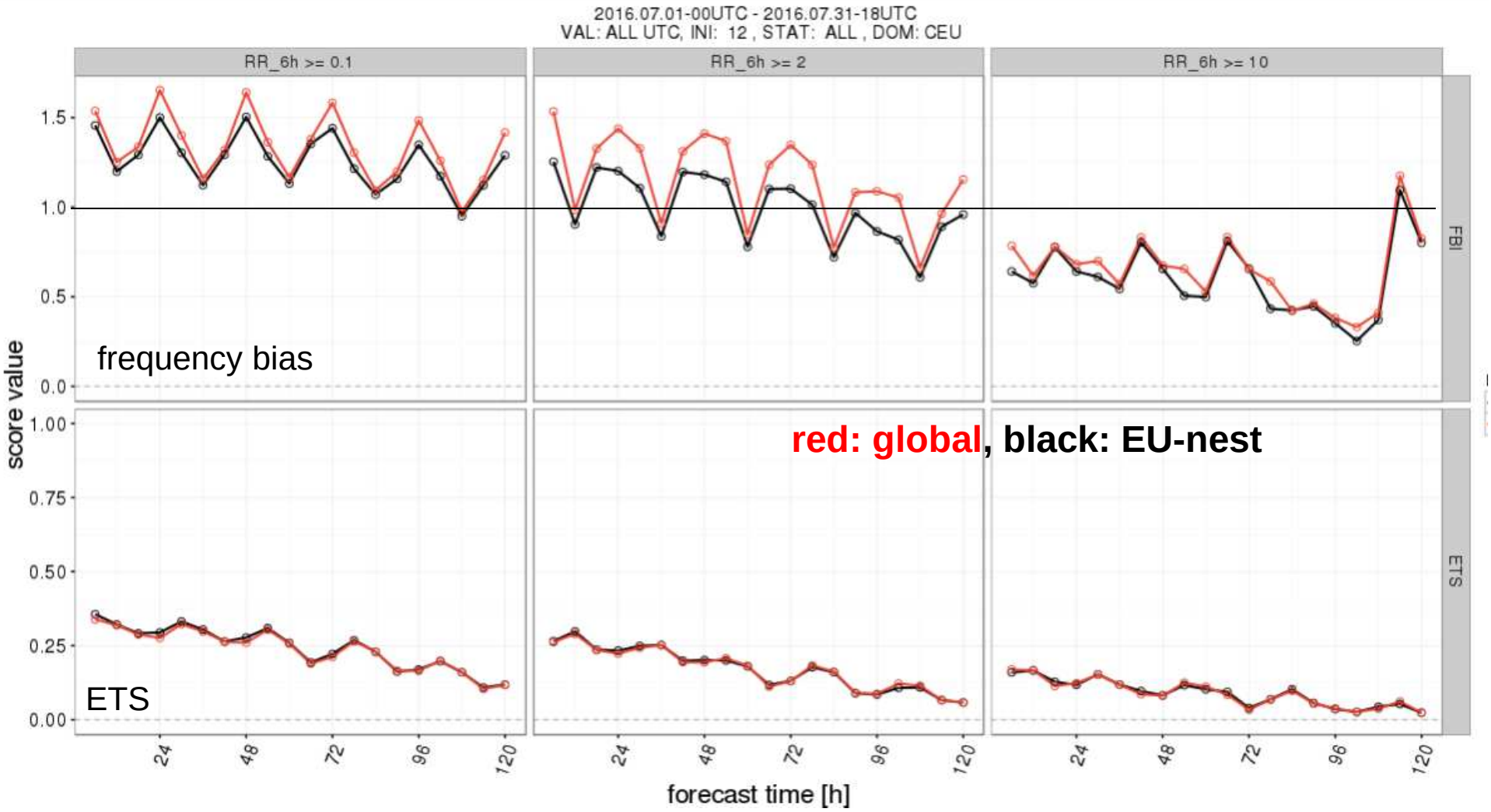

Precipitation verification against SYNOP stations, December 2016, Europe

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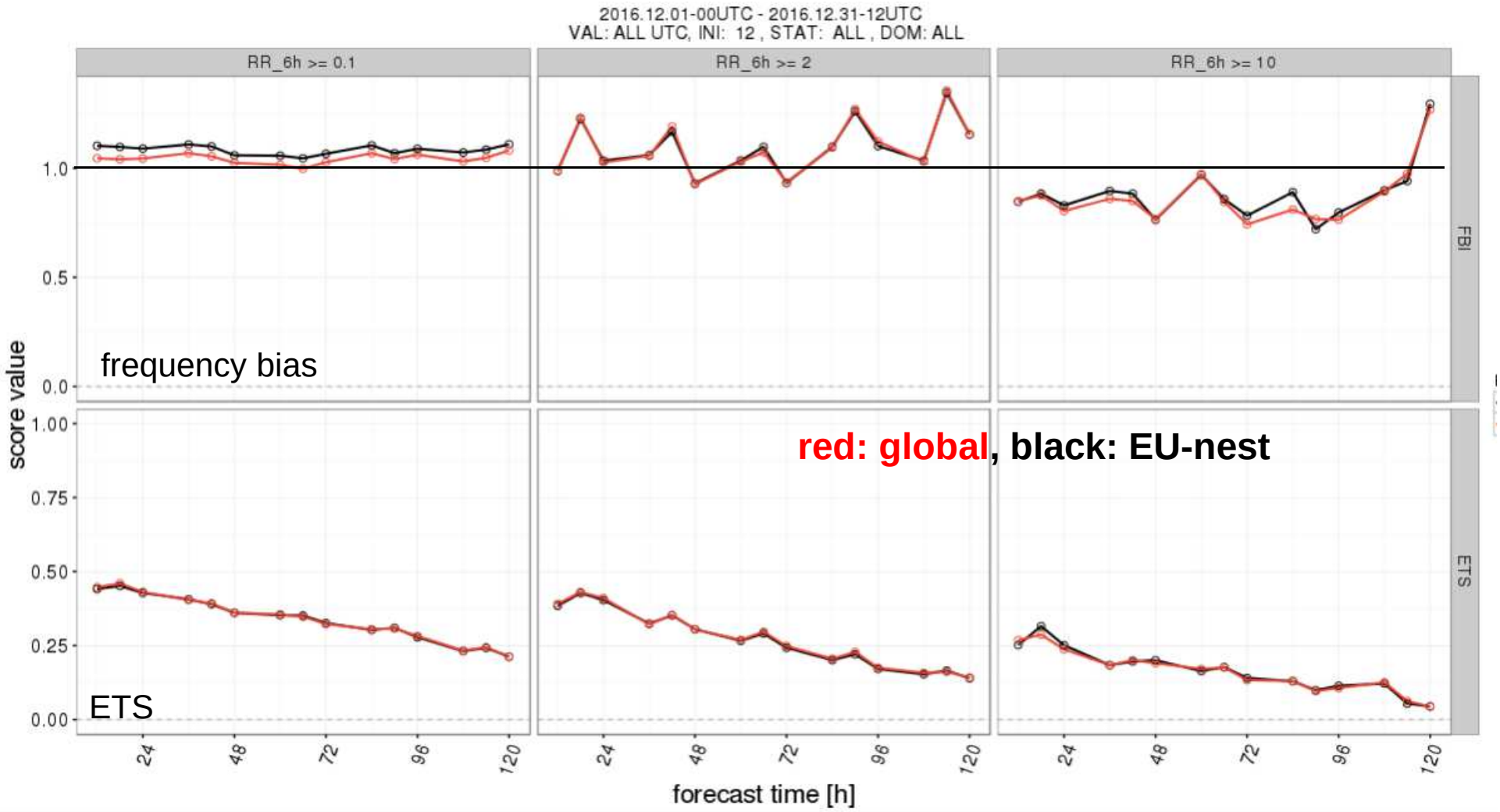
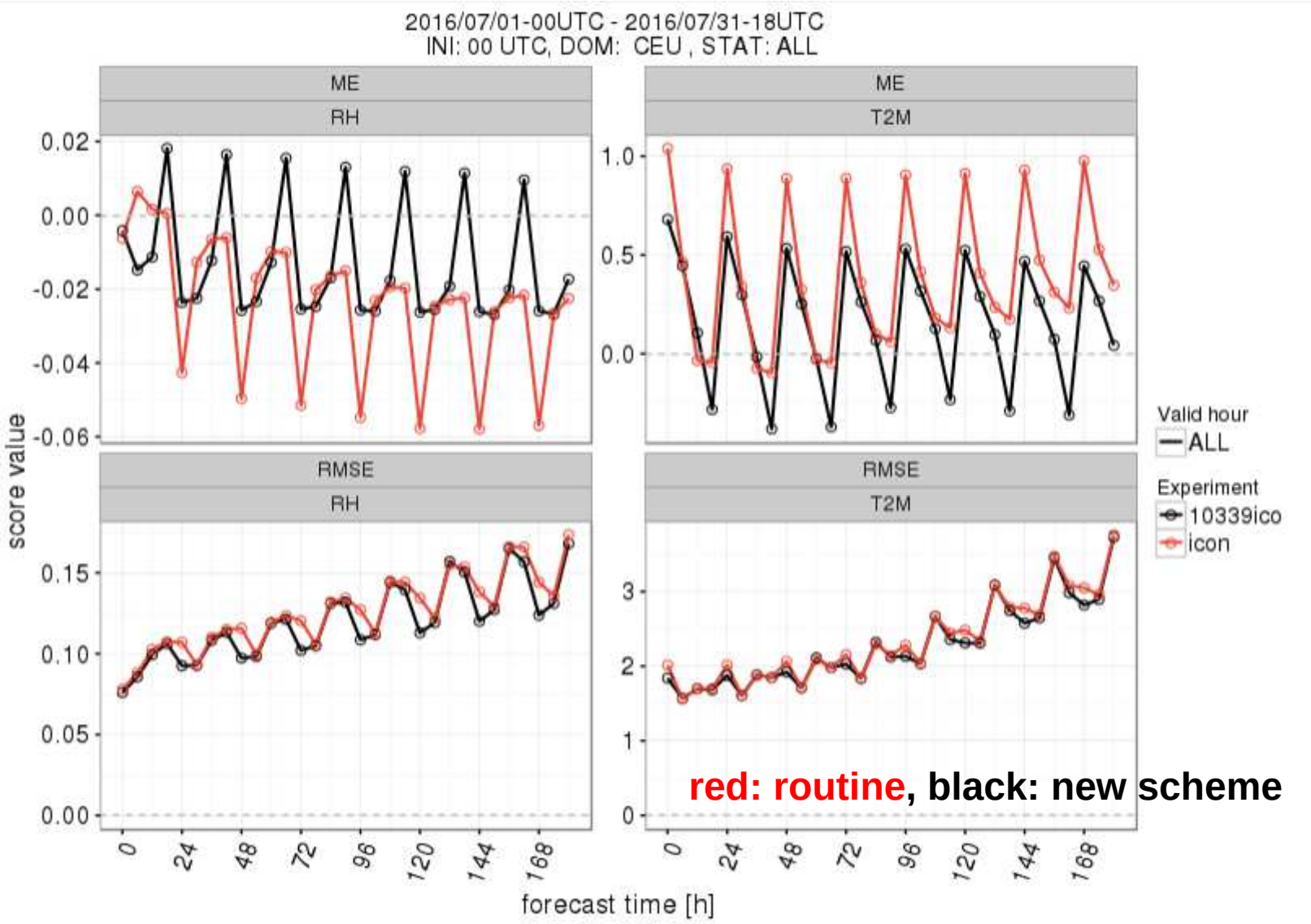


0.1 mm/6h | 2 mm/6h | 10 mm/6h

Impact of new bare soil evaporation scheme: RH and T @ 2m, Europe, July 2016

bias

RMSE



Impact of new bare soil evaporation scheme: RH and T @ 2m, Europe, September 2016

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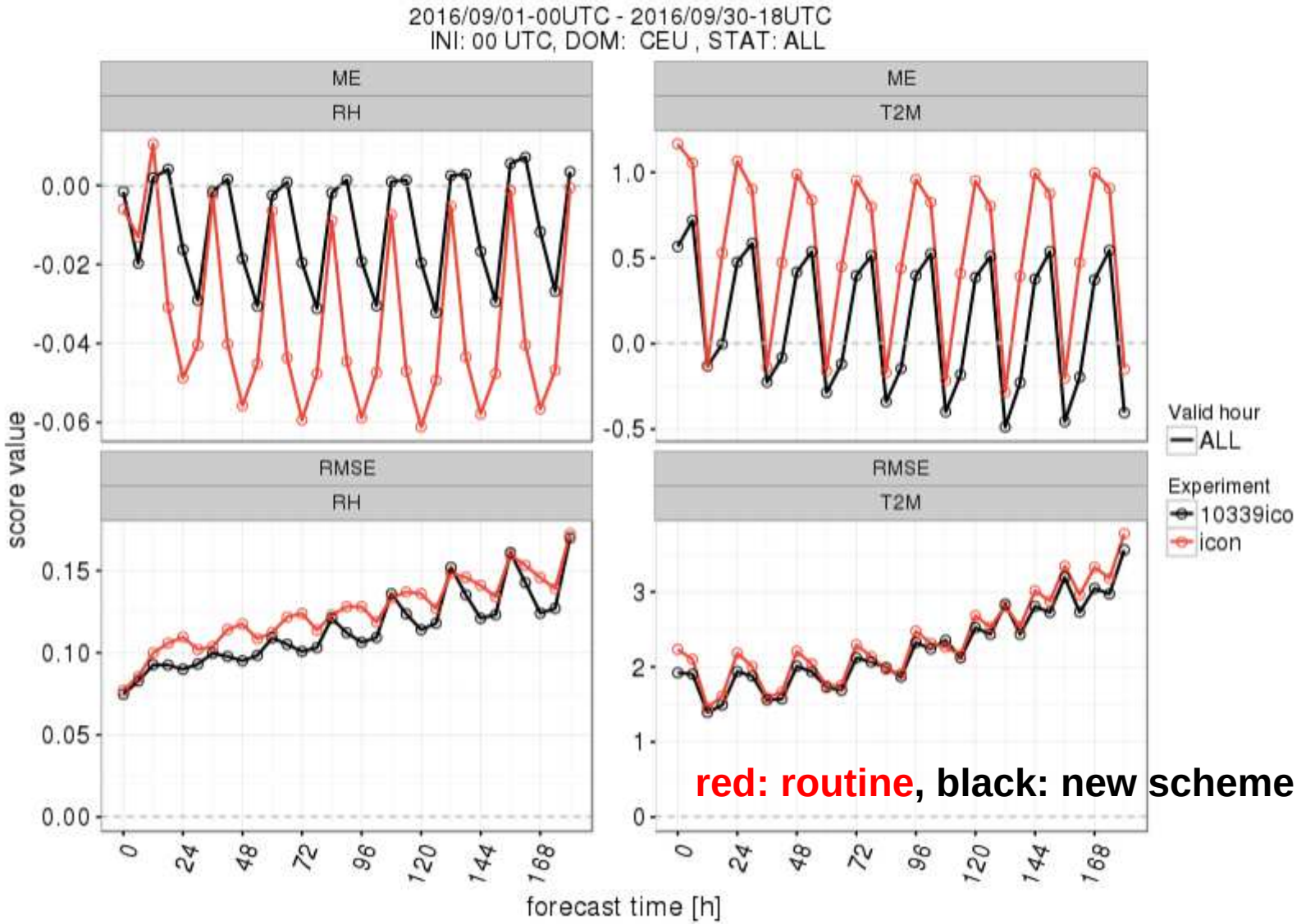

Impact of new bare soil evaporation scheme: RH and T @ 2m, SW-Siberia, September 2016

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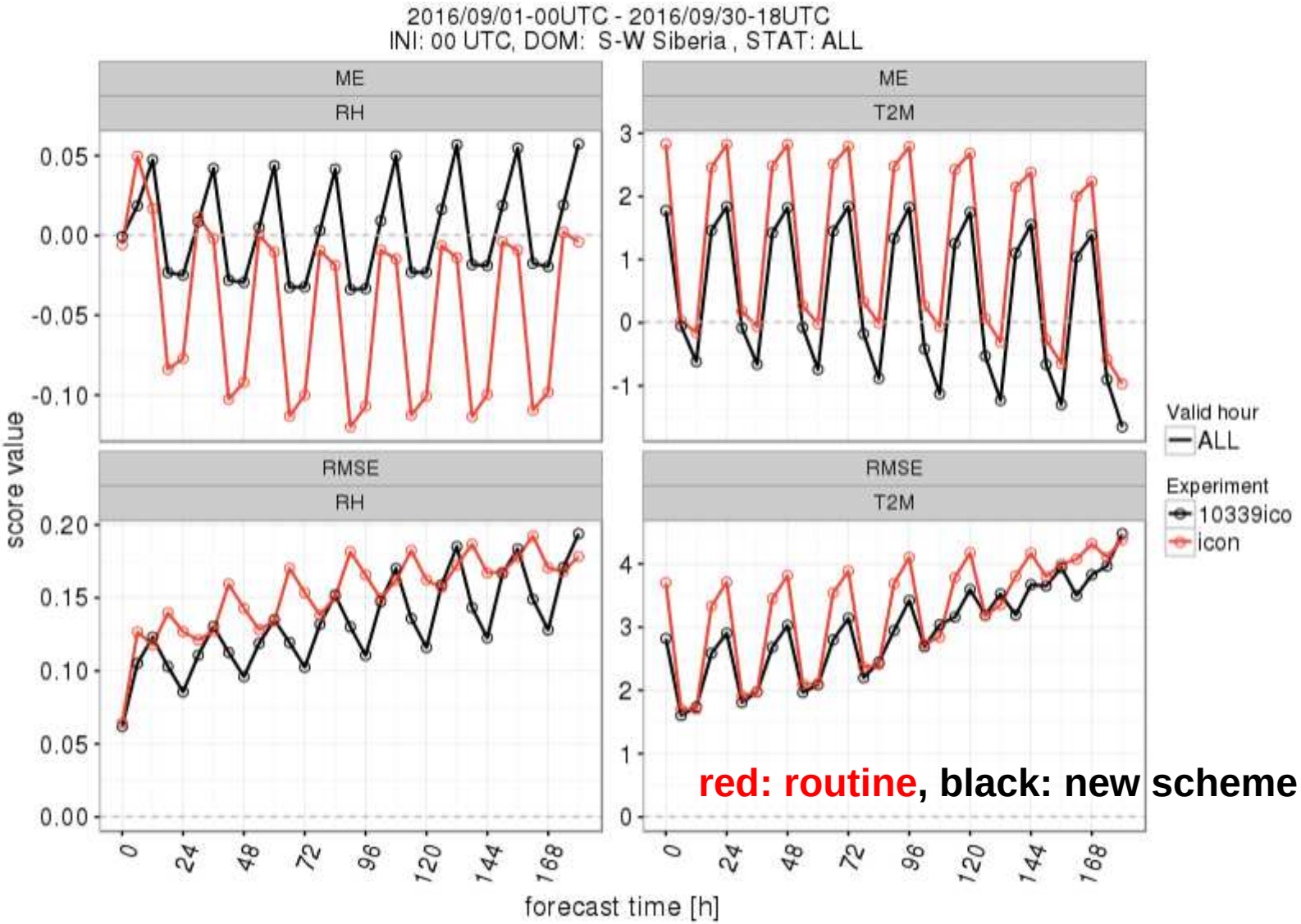

ECMWF is not always better than ICON:
RH and T @ 2m, Central Europe, December 2016

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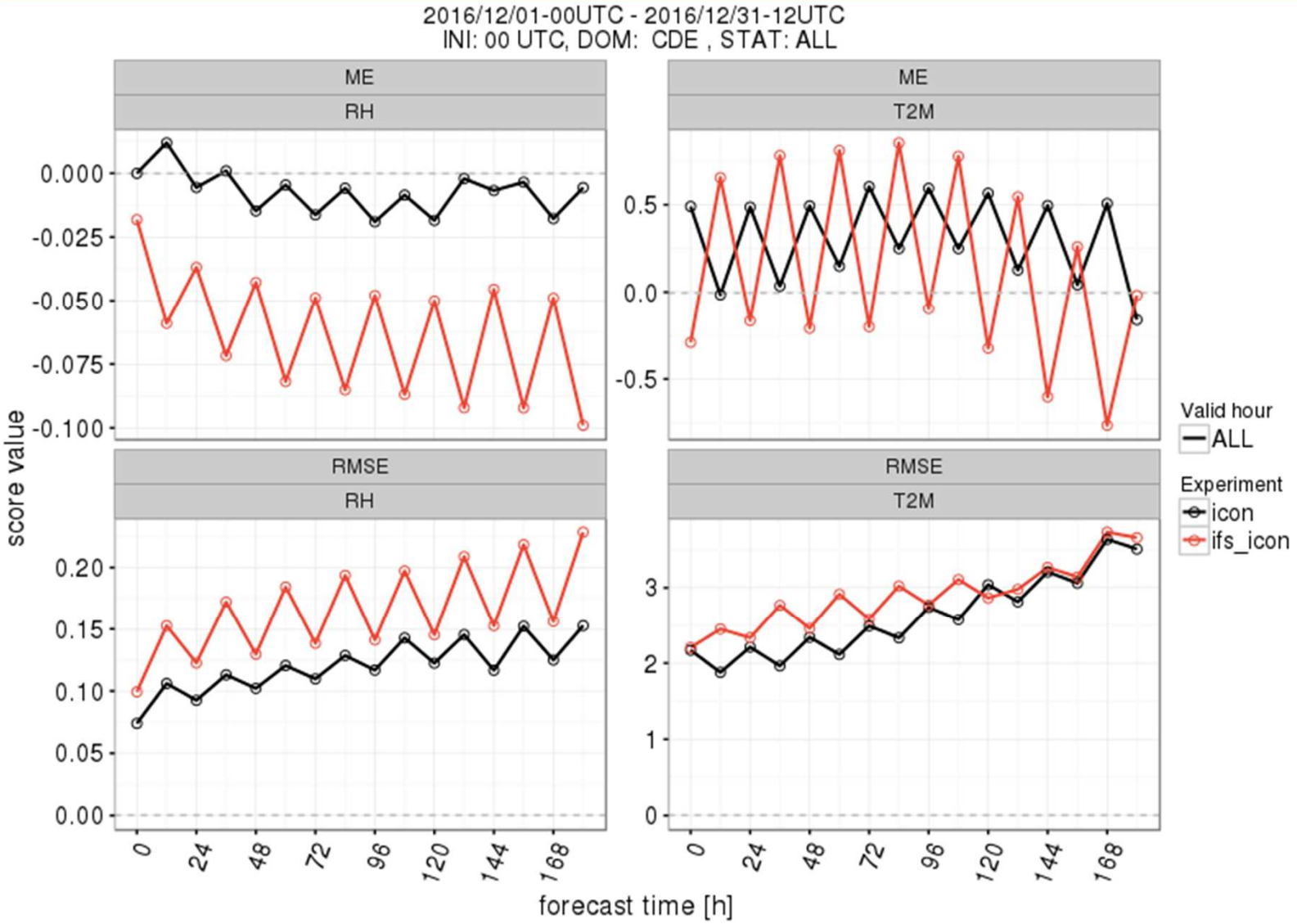

red: IFS (ECMWF), black: ICON

ECMWF is not always better than ICON:
RH and T @ 2m, Central Europe, January 2017

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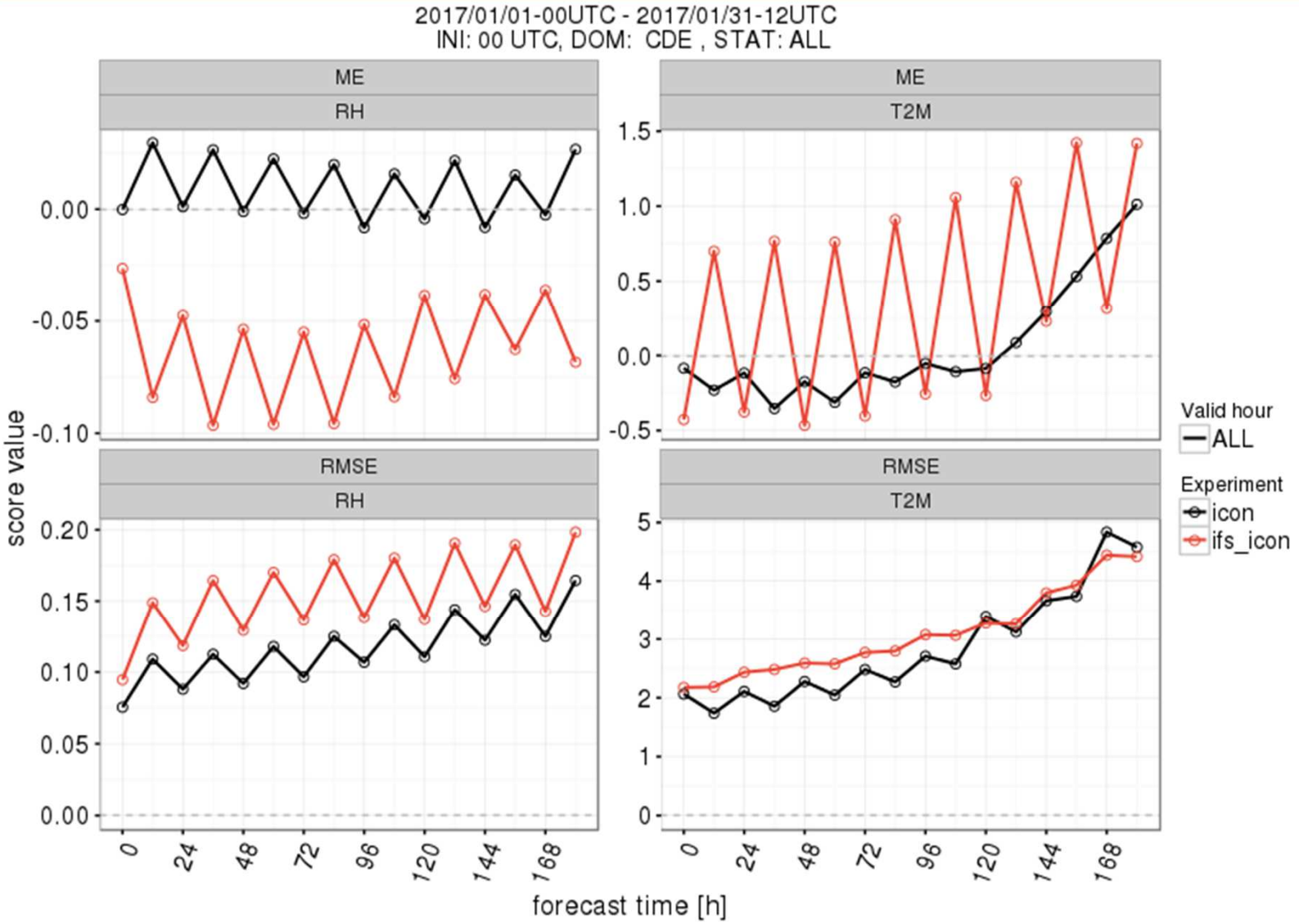

red: IFS (ECMWF), black: ICON

Status of ICON-LAM (limited-area mode)

technical aspects

- Model grid needs to be precomputed with grid generator
- Preprocessing tool ‘remapicon’ executes only horizontal interpolation from source data to ICON grid
- Initial and boundary data from ICON, COSMO and IFS are supported
- Vertical interpolation is done within ICON; thus, changing the setup of the vertical grid does not require rerunning remapicon
- Boundary data can be read asynchronously with prefetching on a dedicated processor

Status of ICON-LAM (limited-area mode)

technical aspects

- Boundary data can be restricted to stripes along the lateral boundaries, covering the interpolation and nudging zones (COSMO model always requires data for full domain)
- Apart from boundary data supply, the limited-area mode is technically nearly identical to one-way nesting, where boundary data are updated at each model time step
- This implies that no physics parameterizations are active in boundary interpolation zone; model output can be masked there
- Nesting (one-way or two-way) can be combined with limited-area mode

Illustration of ‚stripe-grid' used for supply with lateral boundary conditions

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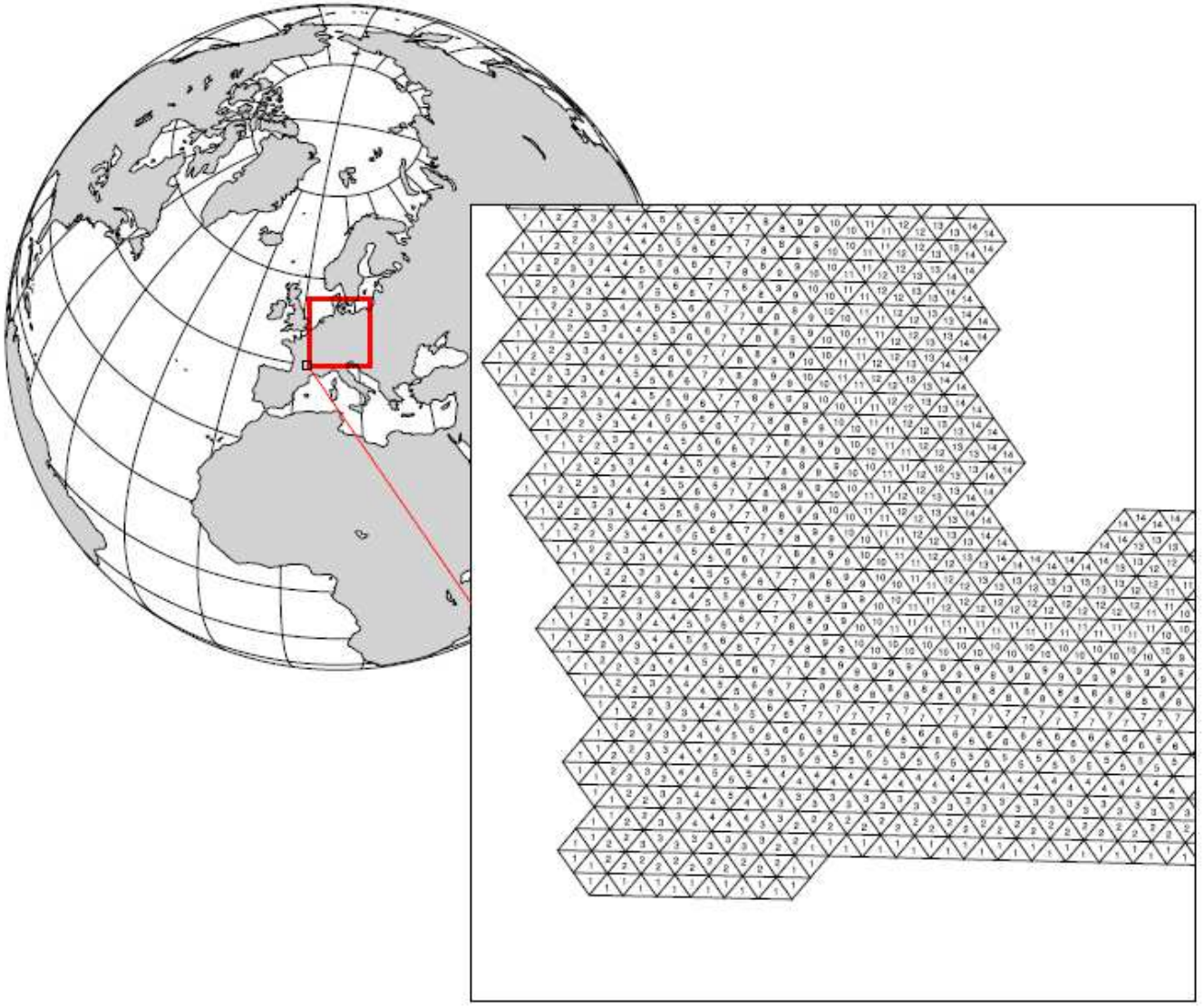


Status of ICON-LAM (limited-area mode)

data assimilation

- Unlike the COSMO-model, no built-in nudging data assimilation is available (3D-Var / EnKF DA is separate code package)
- Instead, the forward operators needed to couple ICON with KENDA will be provided by interfacing ICON with DWD's DACE (Data Assimilation Coding Environment)

Research application: HErZ NARVAL II HD(CP)^2

Convection over the tropical Atlantic ocean, 17 Aug 2016

https://goo.gl/bYfIZT

ICON-LAM (Inital state: ECMWF analysis; LBC: ECMWF forecast)

Domain I: Δ = 2.48 km; Δt = 24 s 10°S to 20°N; 68°W to 15°E

Domain II (two-way nested): Δ = 1.24 km; Δt = 12 s; 4°S to 18°N; 64°W to 12°E

75 model layers with model top at 30 km

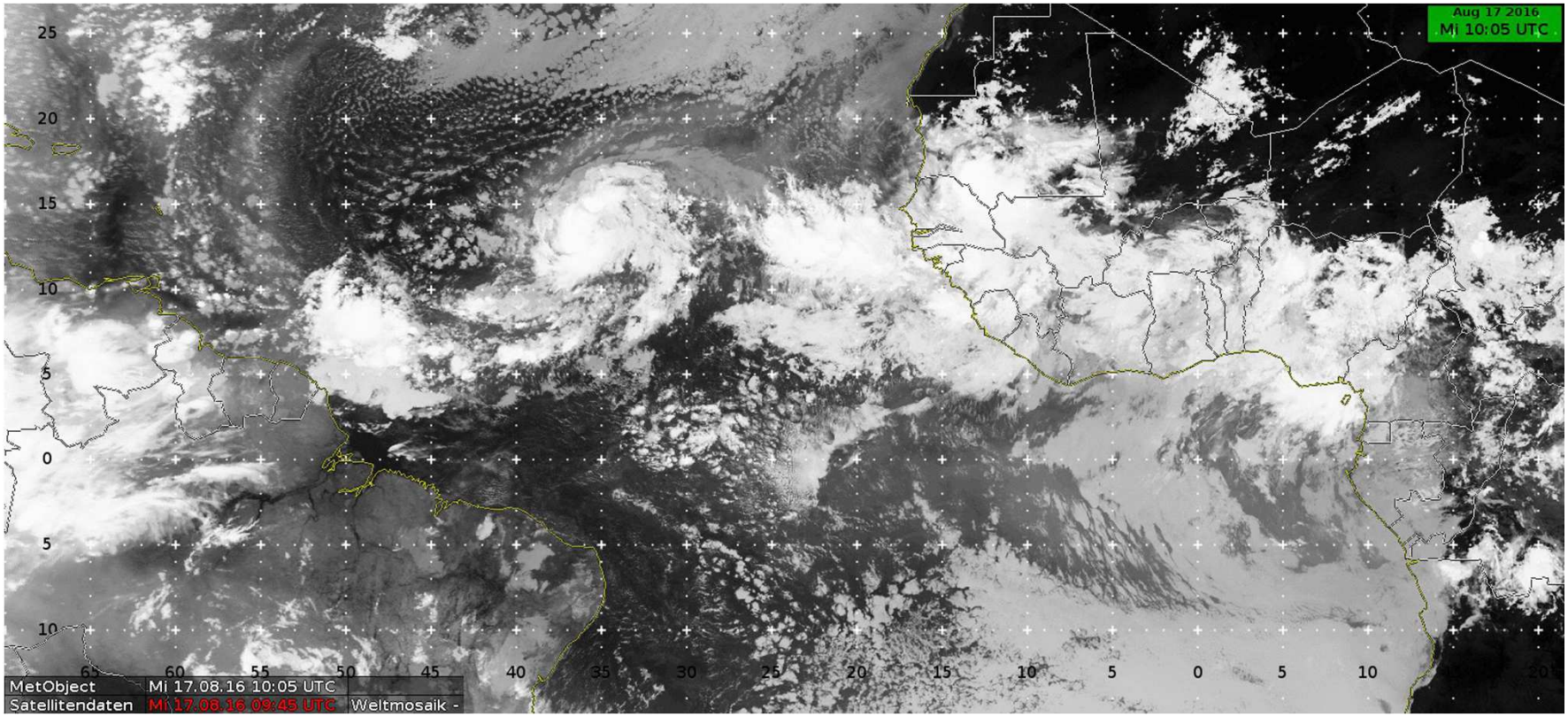
Model runs are performed at ECMWF on a Cray XC40;

Broadwell processors; 1440 MPI-processes, 12 threads; 17280 cores;

36-h forecasts in 5600 sec; 2 TByte output / run.

Daniel Klocke (DWD), Matthias Brueck (MPI-M)

Tropical cyclone FIONA



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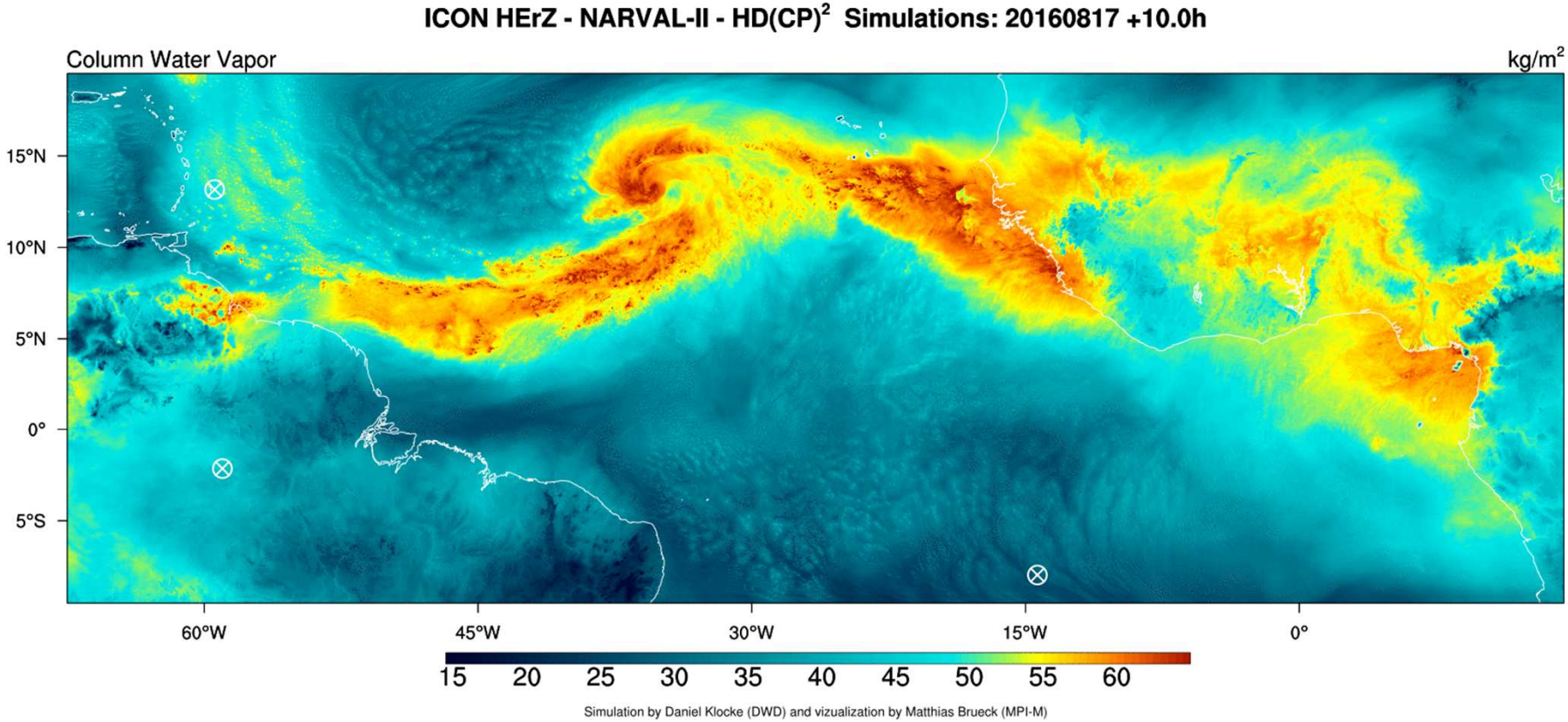

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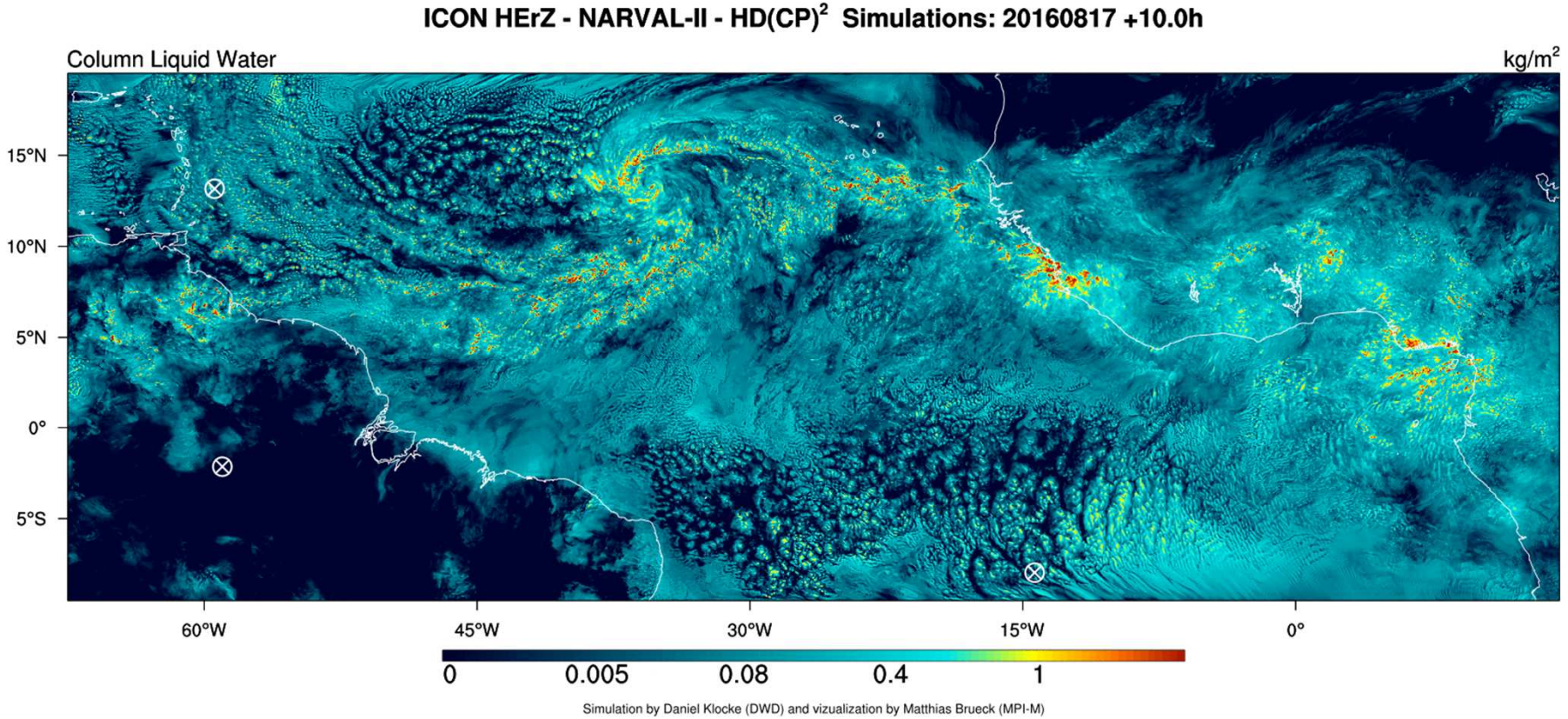

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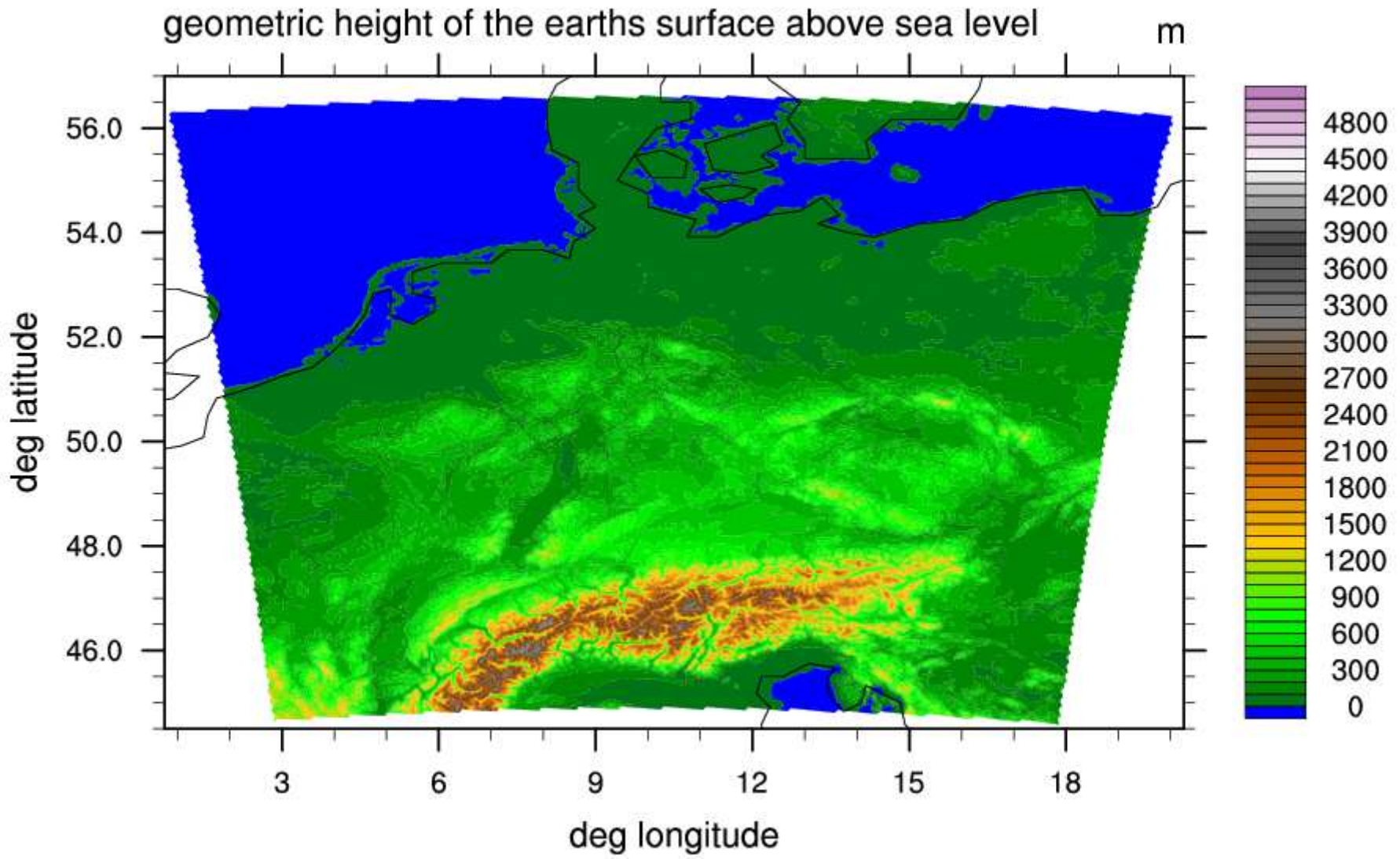
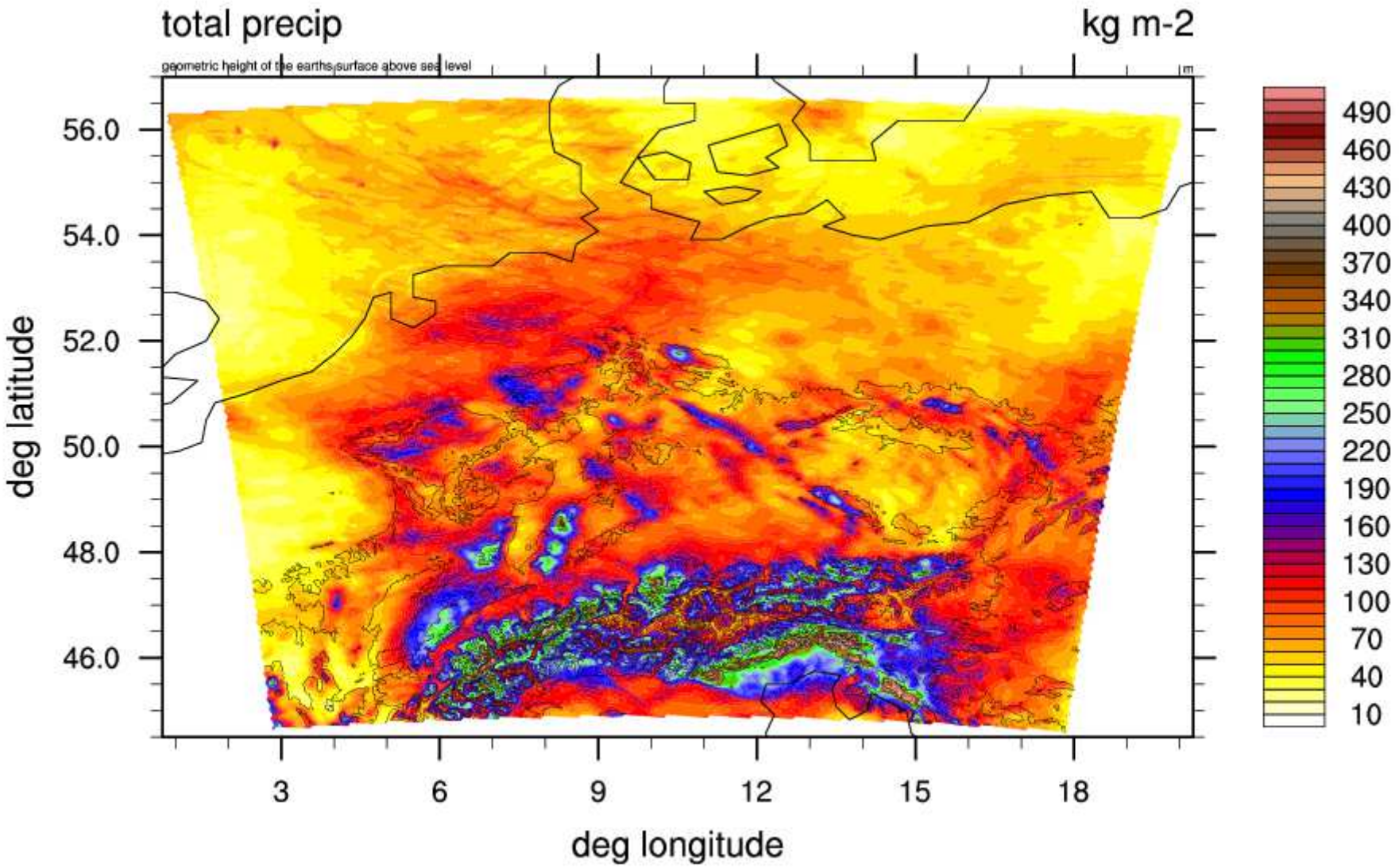
Comparison between ‘ICON-DE’ and COSMO-DE

- Hindcast experiment for February 2016, initialized with interpolated data from ICON-EU and driven with lateral boundary conditions from the ICON-EU assimilation cycle
- Mesh size 2.5 km for ICON, 2.8 km for COSMO-DE, domain configuration nearly identical to that of COSMO-DE
- Computing time about 70% of COSMO-DE despite slightly higher resolution

Model domain and orography



Accumulated precipitation (29 days, mm)



Hindcast experiment COSMO-DE vs. ICON-DE
Surface verification for February 2016

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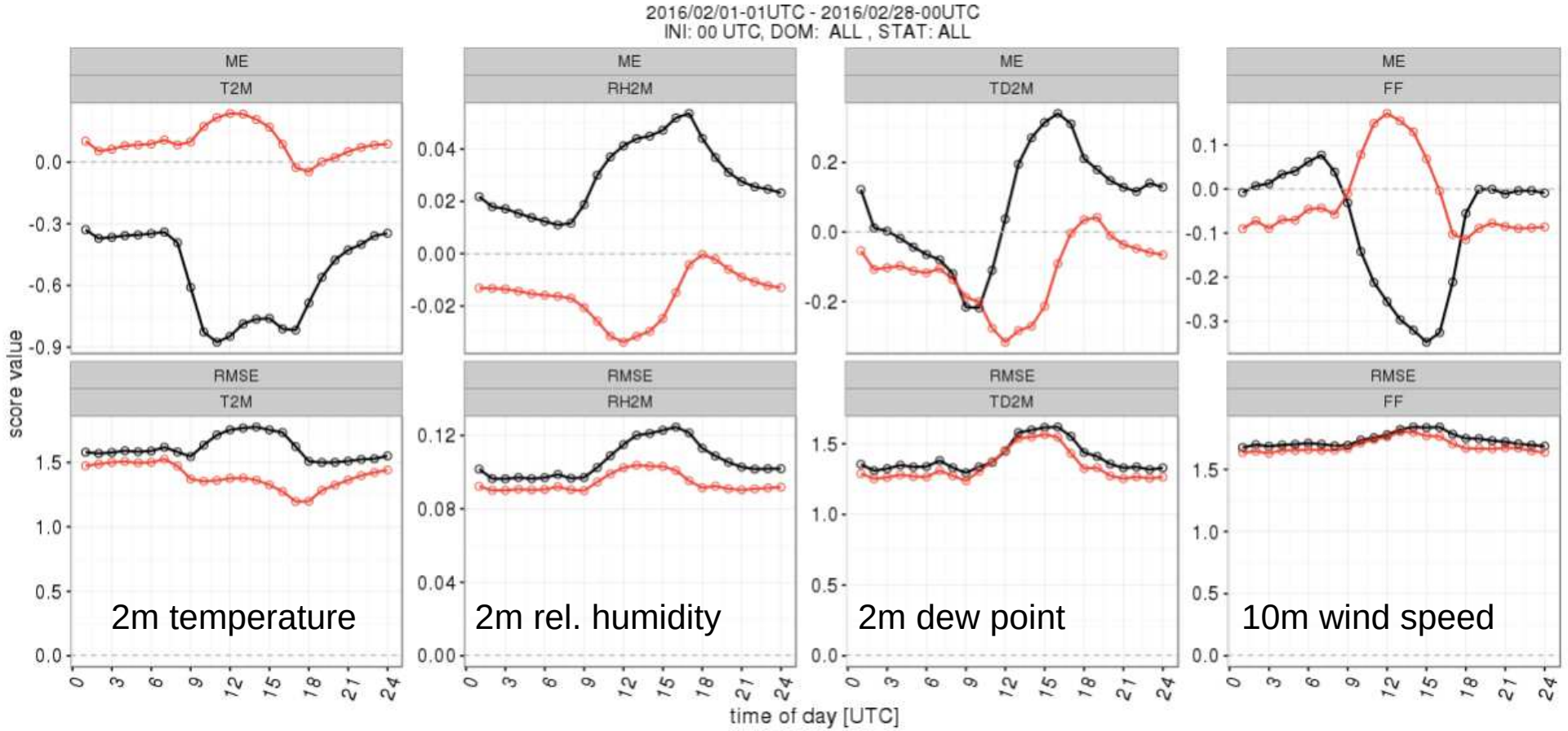

black: COSMO-DE, red: ICON-DE

Conclusions

- ICON achieved a substantial improvement in forecast quality over GME
- ICON-LAM is ready for use without data assimilation (first training course was last week)
- First comparisons with COSMO-DE already indicate significant improvements, particularly for variables for which COSMO-DE is known to have weaknesses