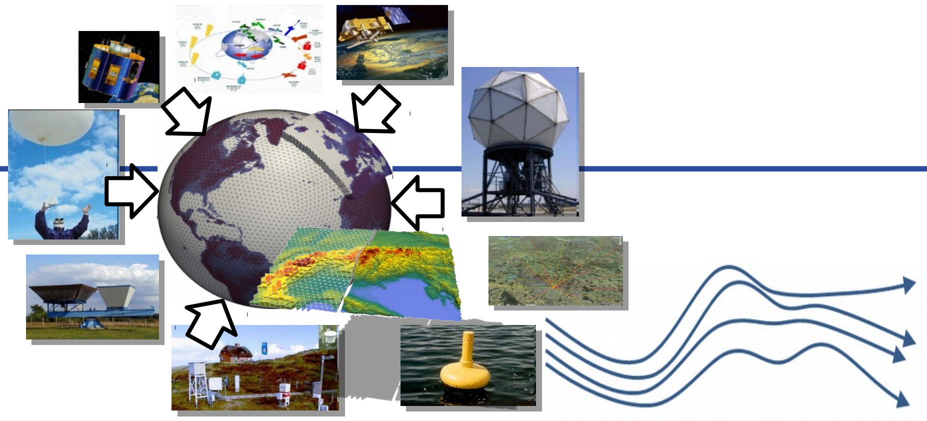


Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Assimilation of visible channels in a convective-scale data assimilation framework

Roland Potthast
L. Bach, **L. Scheck**, C. Stumpf,
C. Schraff, M. Weissmann, U. Blahak, C. Köpken-Watts

Deutscher Wetterdienst

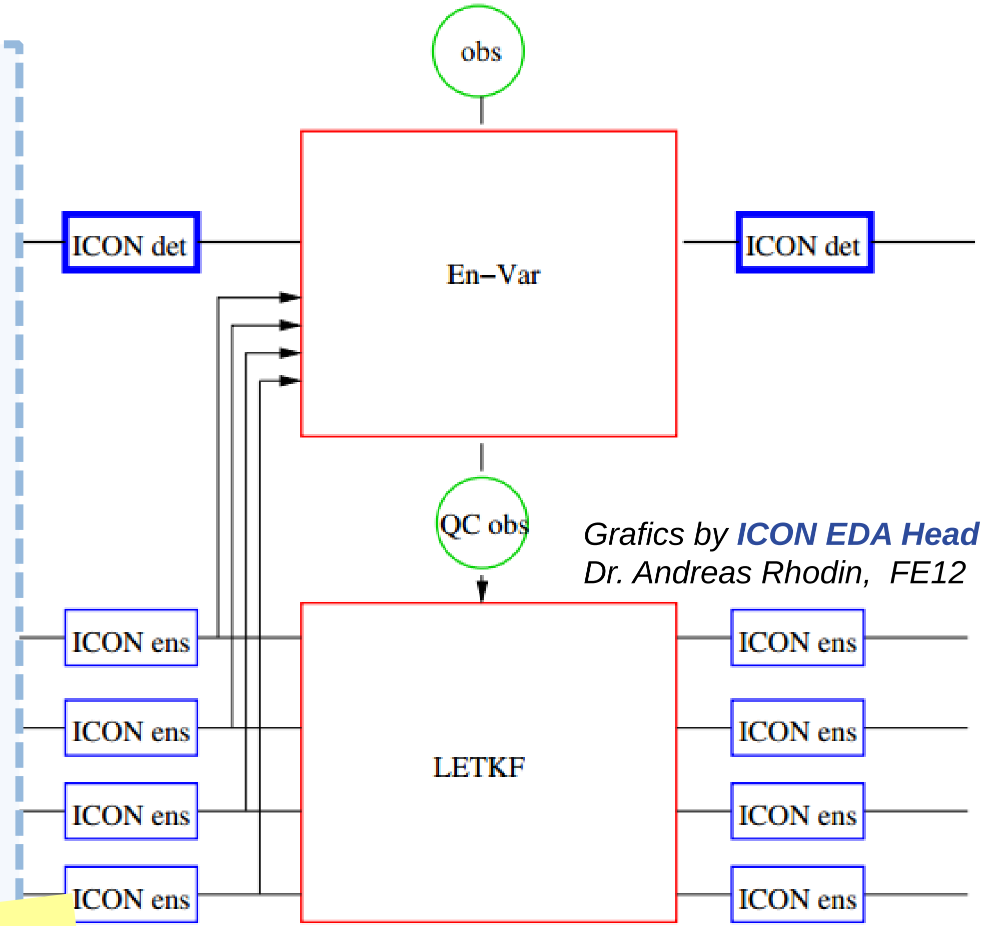
Ensemble Data Assimilation EnVar

Operational since January 2016

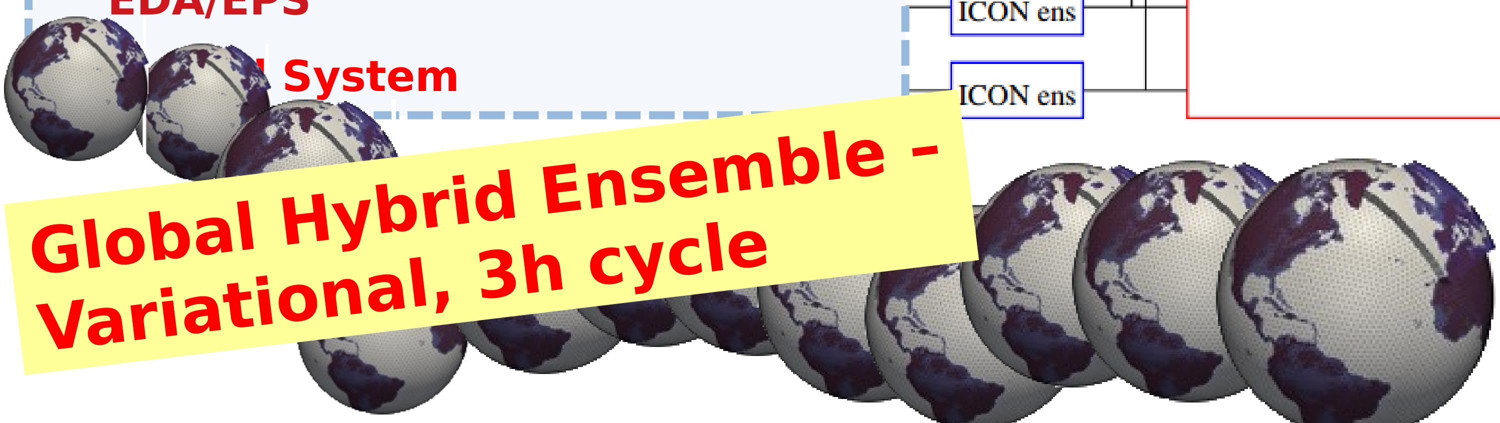
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

We are running **ICON EDA** in our Routine since *Jan 2016*

- 40 Members each with 40km global resolution and 20km NEST over Europe
- 1 deterministic 13km/6.5km
- **EPS forecasts** 40 Members 7 Days + 1 Deterministic
- **Output for convective-scale EDA/EPS**
- **l System**

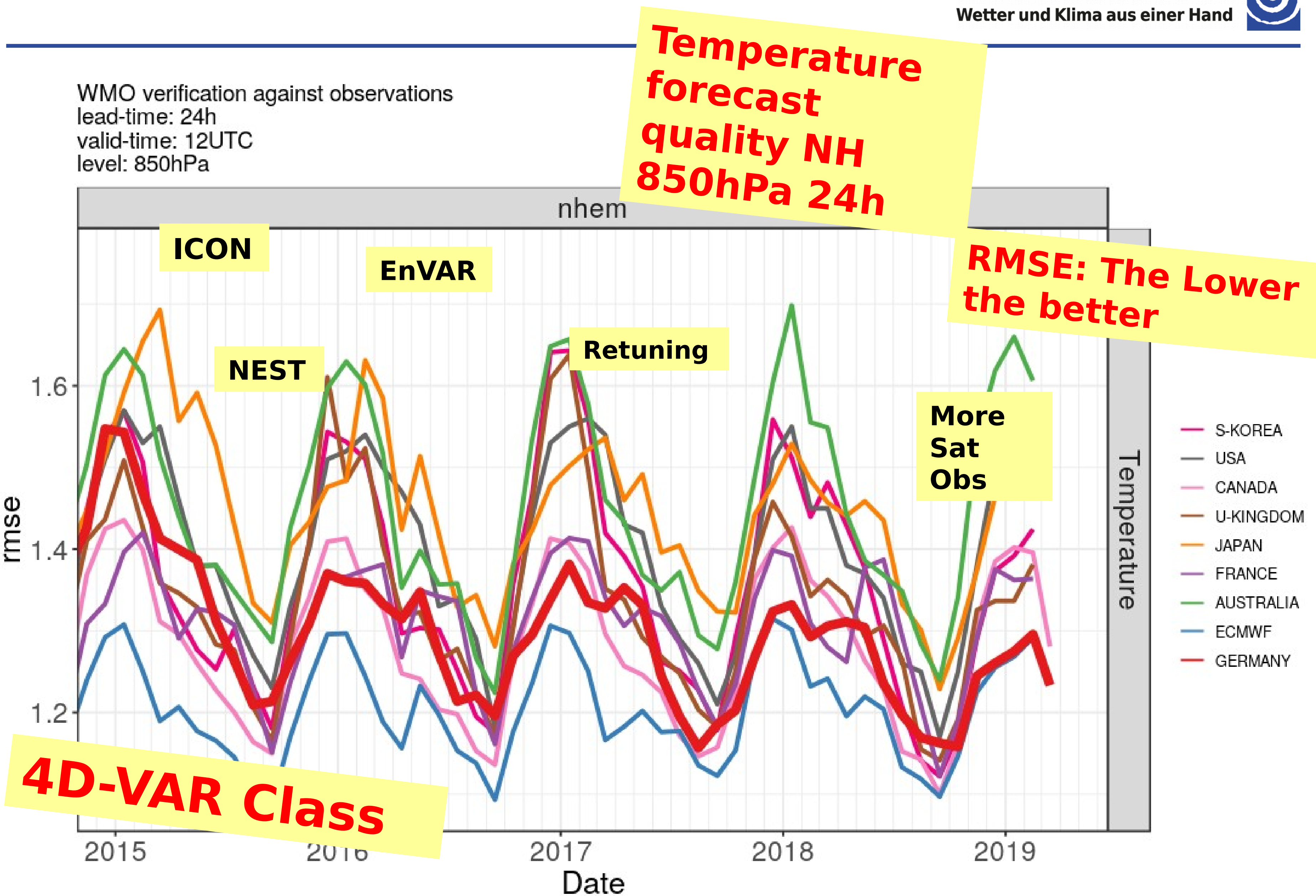


*Grafics by **ICON EDA Head** Dr. Andreas Rhodin, FE12*



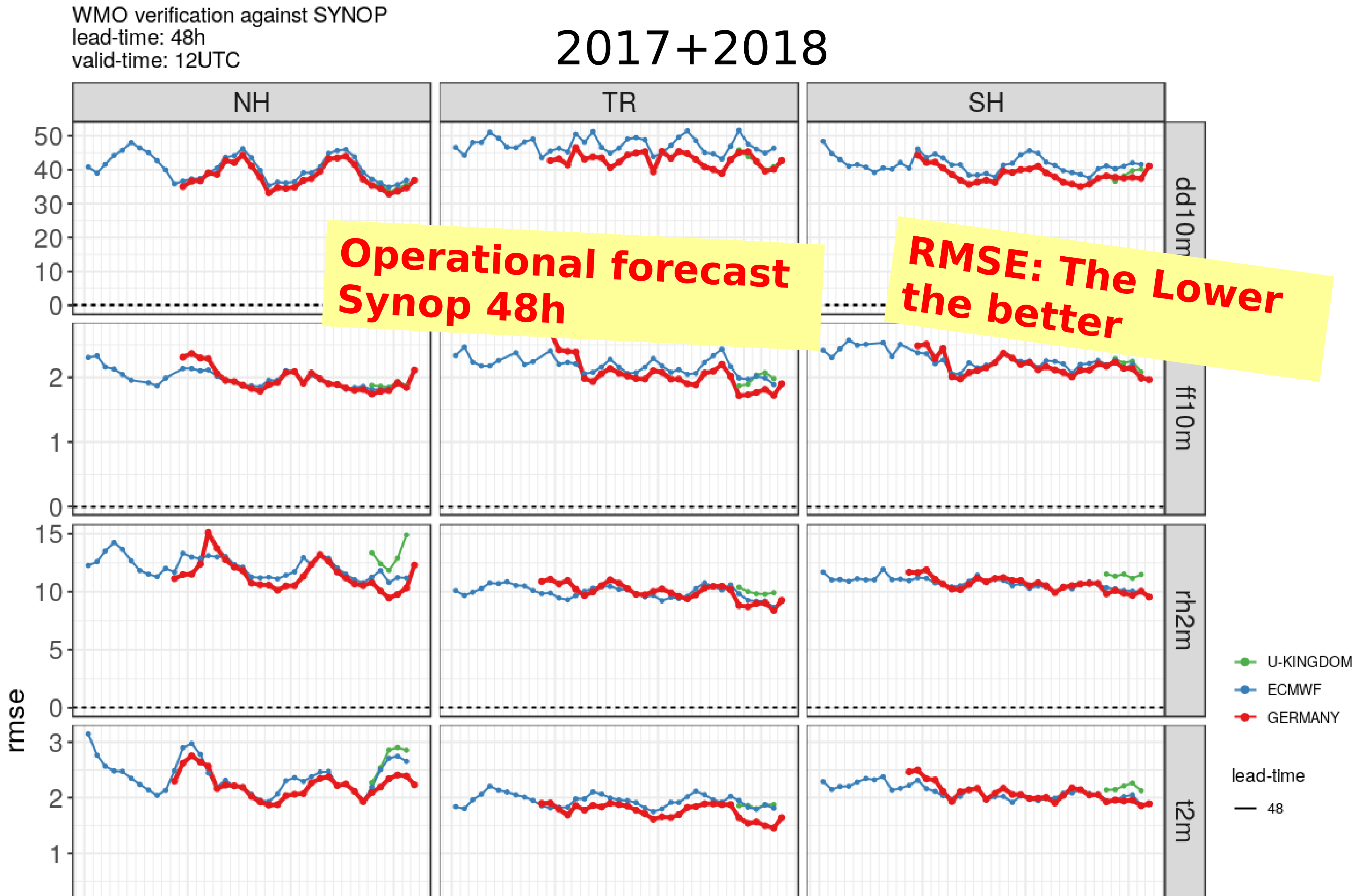
Global Hybrid Ensemble – Variational, 3h cycle

Hybrid Methods: EnVAR Scores



Hybrid Methods: EnVAR Scores

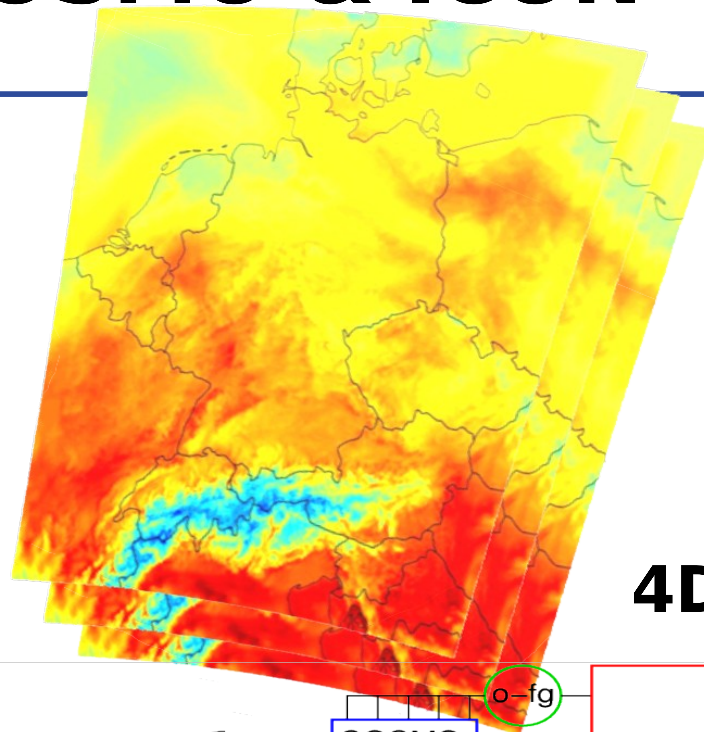
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



KENDA for COSMO & ICON

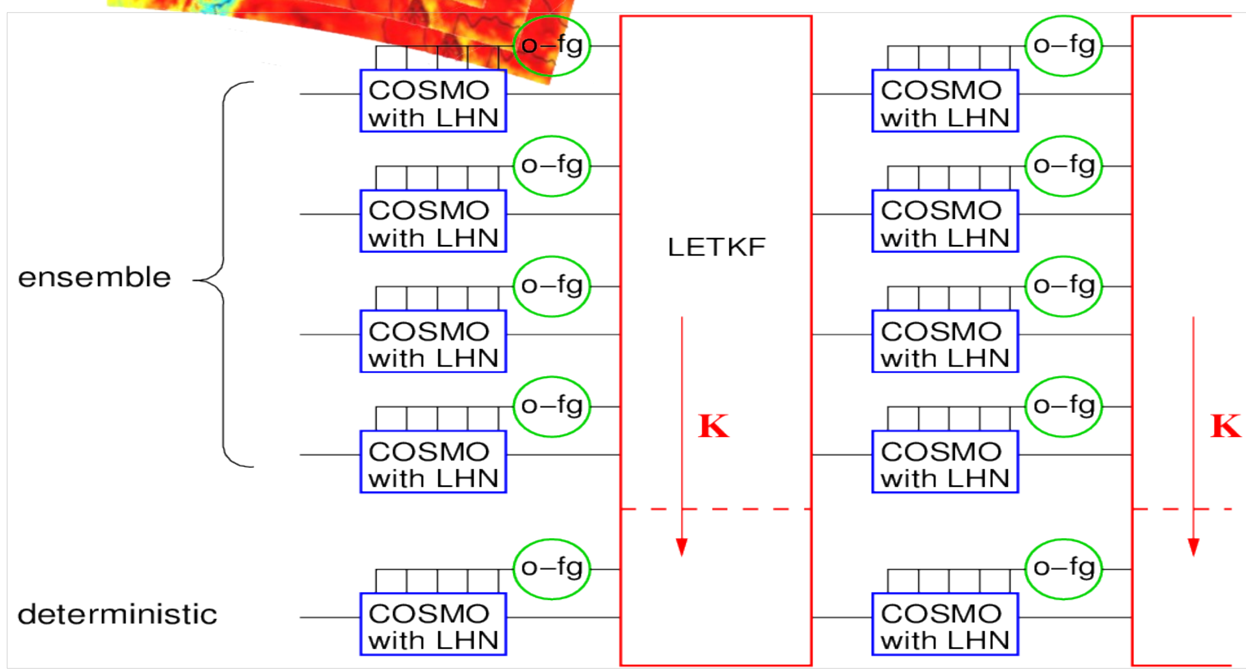
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

4D-LETKF for Convection Permitting Model



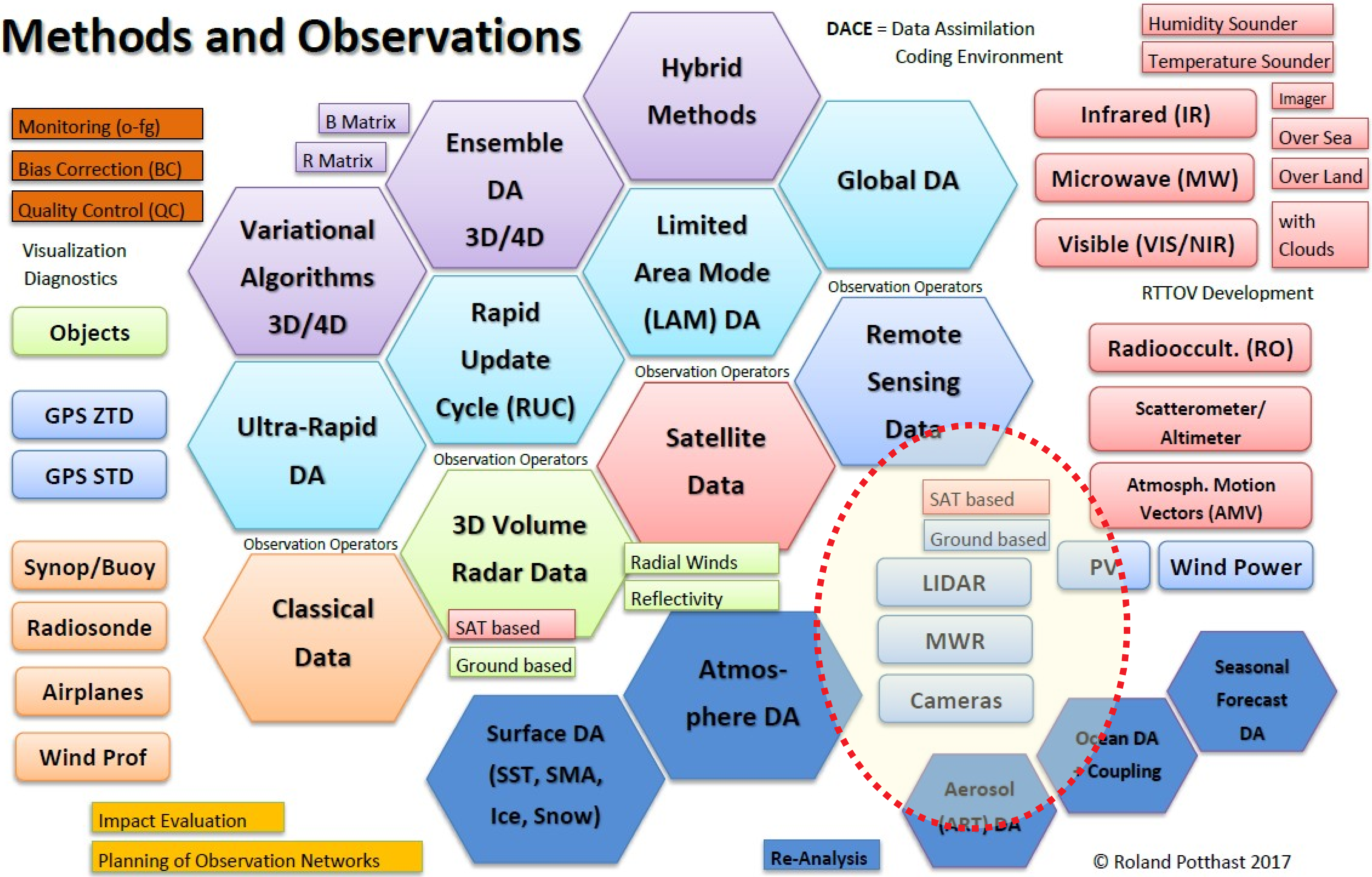
COSMO-DE & ICON LAM
Resolution 2.2km
Central Europe

4D-LETKF



The World of Data Assimilation (DA)

Methods and Observations



Why talk about data assimilation of solar channels in the context of boundary layer meteorology?

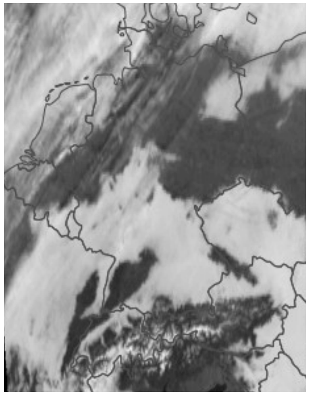
In contrast to WV channels: *visibility of low clouds*

Low clouds are connected to boundary layer processes

- ➔ Convective initiation: temporal extension of the warning horizon
- ➔ More accurate representation of low stratus

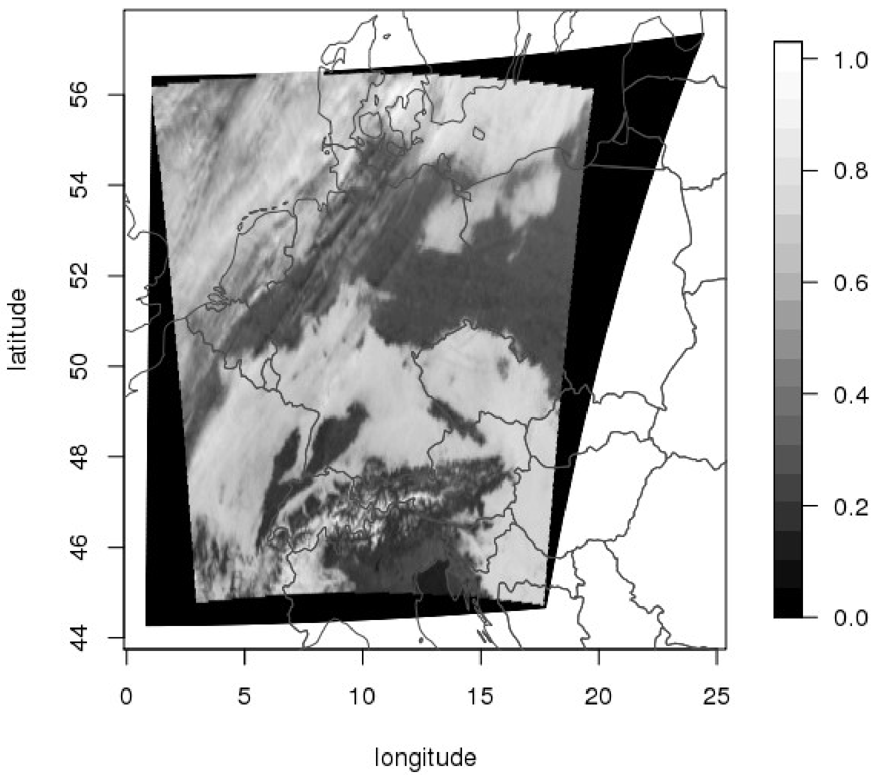
Feedback on boundary layer variables

- ➔ Cloud-boundary layer coupling
- ➔ Improvement of screen-level variables through better radiation

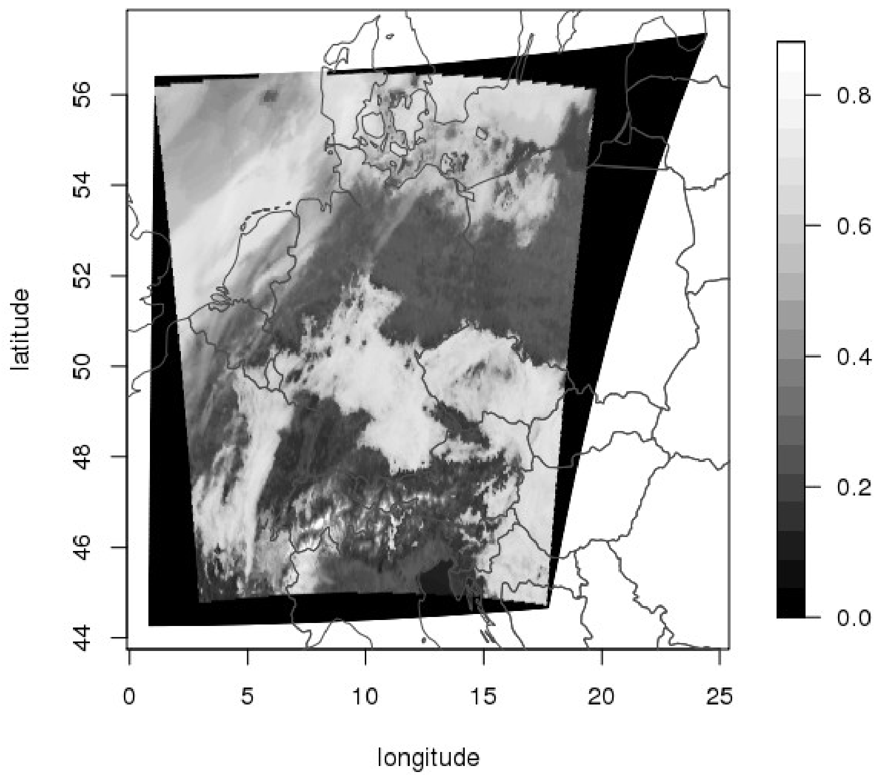


Example: Observations & model equivalents

Observations

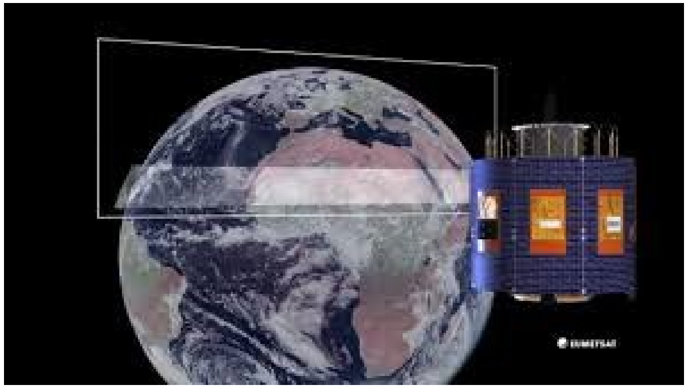


Model equivalents



Observations

- Cloud-sensitive imager channels in the visible spectral range (0.6 µm)
- Reflectance: percentage of in-falling solar radiation reflected by earth‘s surface & clouds
- SEVIRI instrument on MSG (0°/0°)
- Temporal resolution 15 minutes
- 5km x 3km satellite pixels (over German COSMO domain)



Model equivalents

Observation operator

- ➔ **Fast** 1D-RT radiative transfer method MFASIS (Scheck, 2016)
- ➔ Makes **operational assimilation** of visible channels conceivable
- ➔ Implemented to **RTTOV** (A.Fernandez & O.Stiller; NWP-SAF)

Model variables

Temperature
Pressure
Specific humidity
Cloud water
Cloud ice
Snow
Cloud cover
Scattering angle

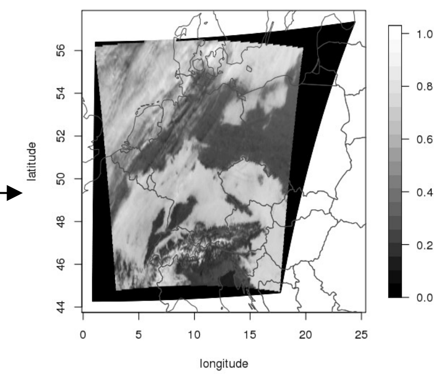
Compute

dimensions

Look Up Table

Integrated optical depth
Effective particle radius
Albedo
Sun zenith angle
Satellite zenith angle
Scattering angle

Simulated satellite image

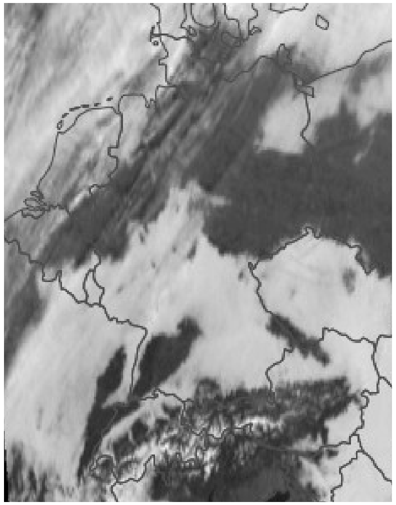


Why assimilate visible channels?

- Information on cloud cover
- Added value to WV channels: visibility of low clouds
- No mixed temperature-humidity signal: only cloud-sensitive

- < 5% upper-air observations in convective-scale DA are moisture-sensitive
- Up to 50.000 additional obs/day

- Primary goal is improvement of cloud cover
- Through correlations, dynamics and physics improvement of moisture fields, precipitation, radiation, screen-level variables

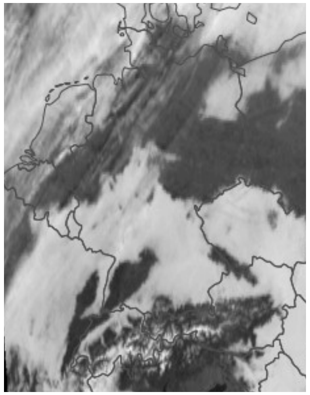


Why are solar channels interesting in the context of boundary layer meteorology?

- In contrast to WV channels: **visibility of low clouds**

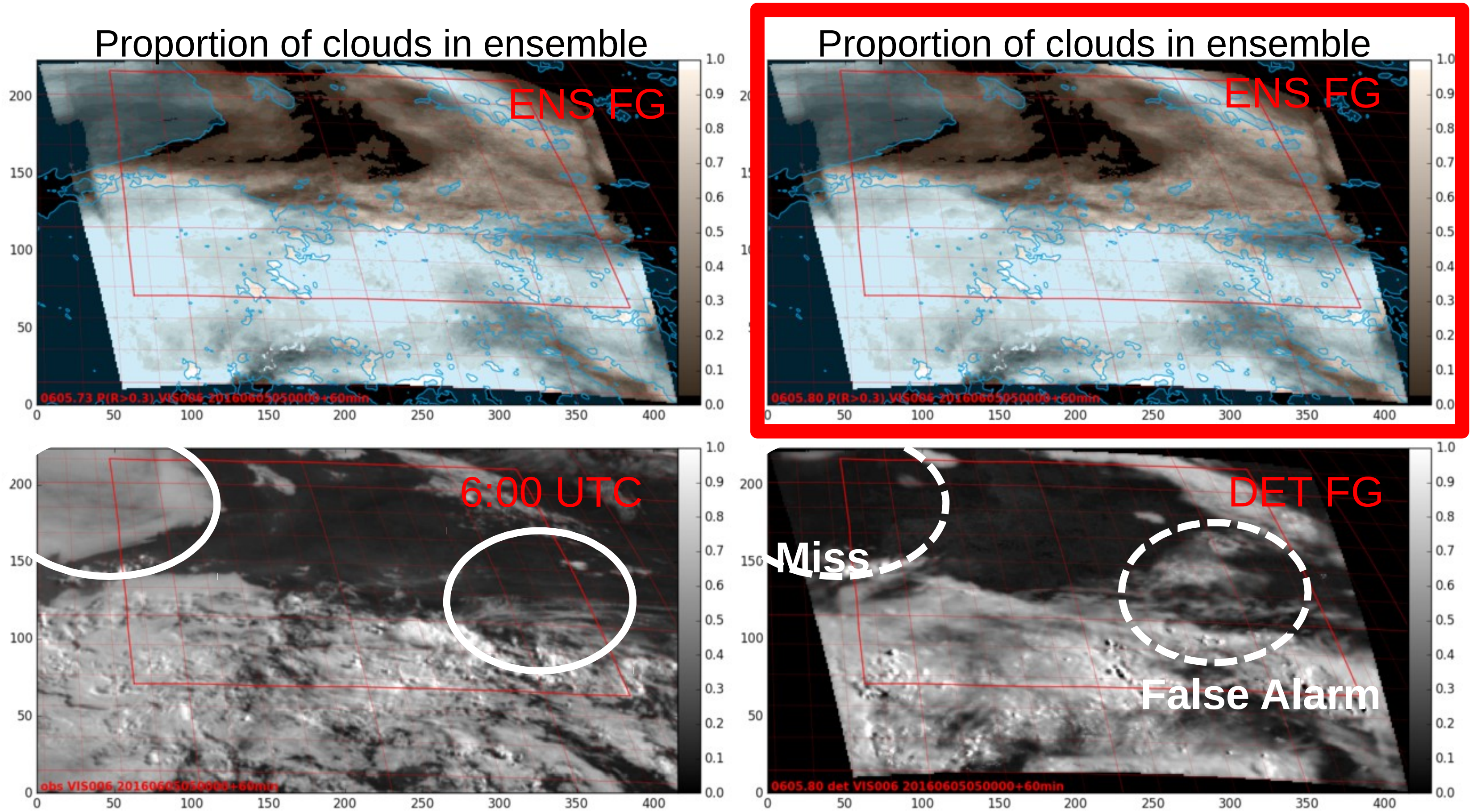
- Convective initiation: temporal extension of the warning horizon
- Low stratus

- **Cloud-boundary layer coupling**
- Improvement of screen-level variables through better radiation



Case study: First Guess 06 UTC

Before assimilating SEVIRI



Observation

Deterministic run

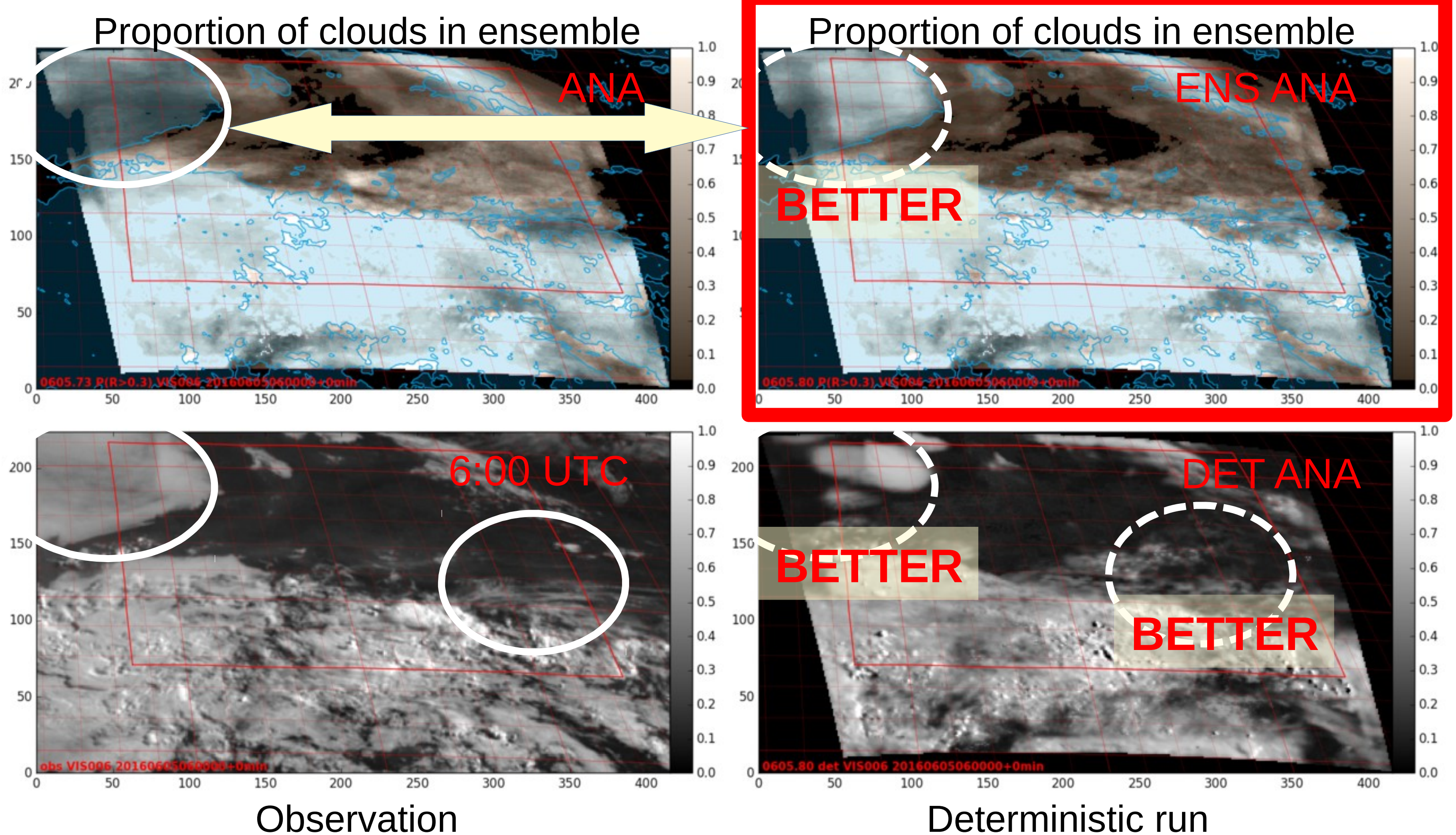
Can we correct for the miss and false alarm in the deterministic run?

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

©L.Scheck

Case study: Analysis 06 UTC

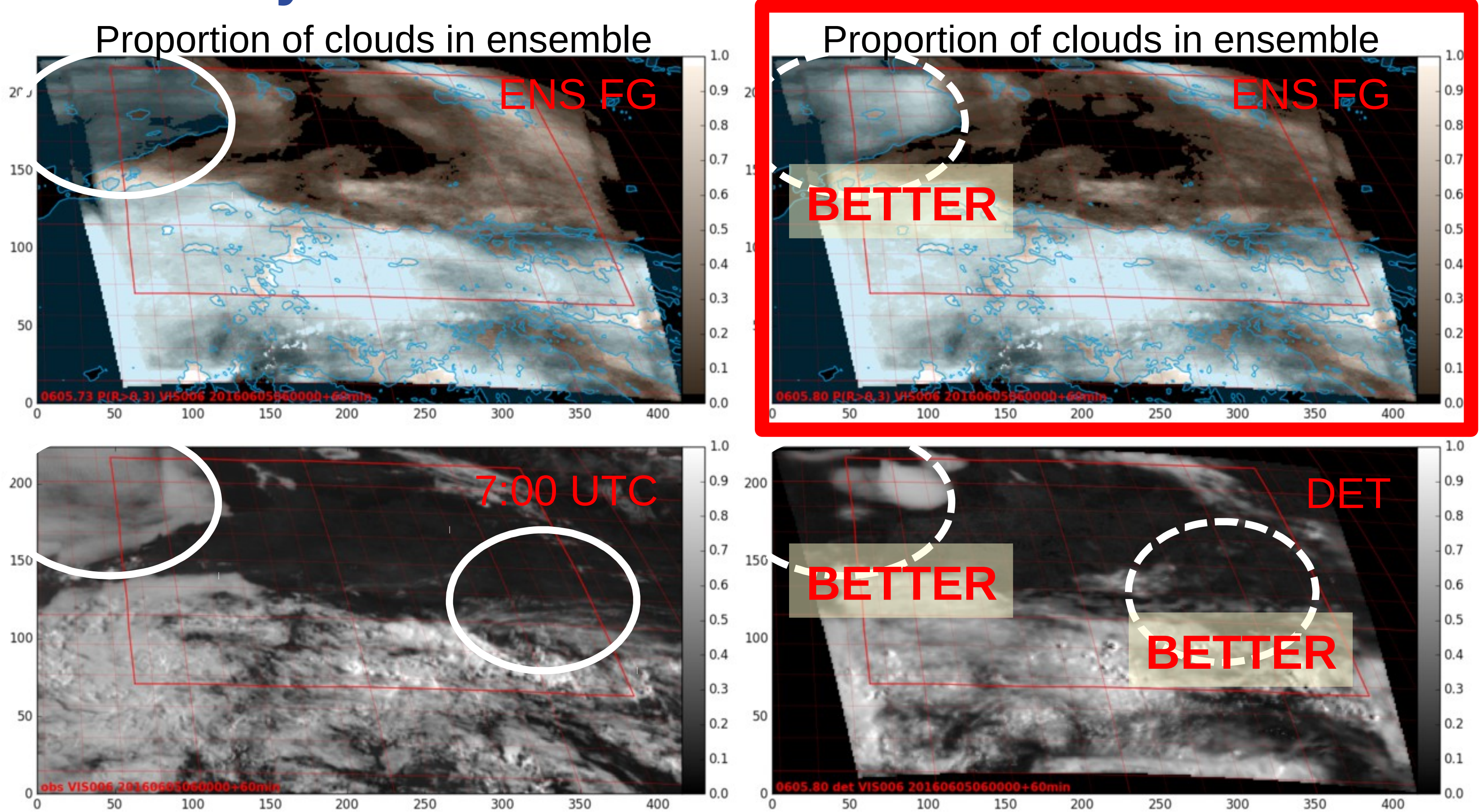
With SEVIRI



Miss is generated in both det. Run & ensemble using SEVIRI-VIS; false alarm is eliminated

Case study: First Guess 07 UTC

With SEVIRI



Observation

Deterministic run

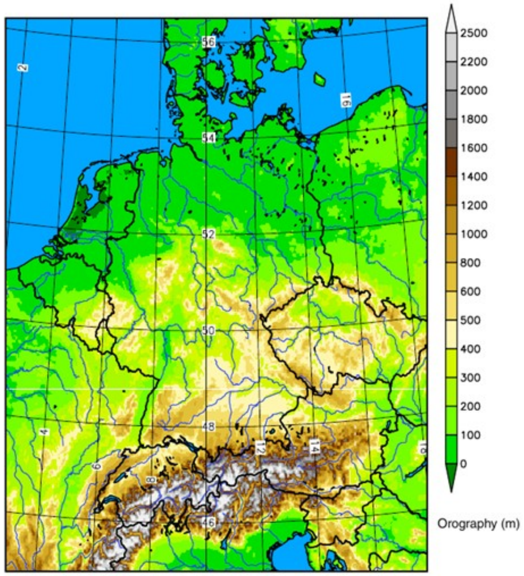
Die Korrektur bleibt in der Vorhersage bestehen

(I) Assimilation experiments

Assimilation experiments: Configuration

- Convective period (May / June 2016)
- COSMO-DE (Δx=2.8 km)
- KENDA routine set-up including LHN

- Superobbing 5 x 7 Pixel
- Assimilation 1/hour at analysis time
- Observation error
- Localisation (hloc=35km, vloc=10)



- Conventional obs + Mode-S (reference)
- Conventional obs + Mode-S + SEVIRI-VIS (experiment)

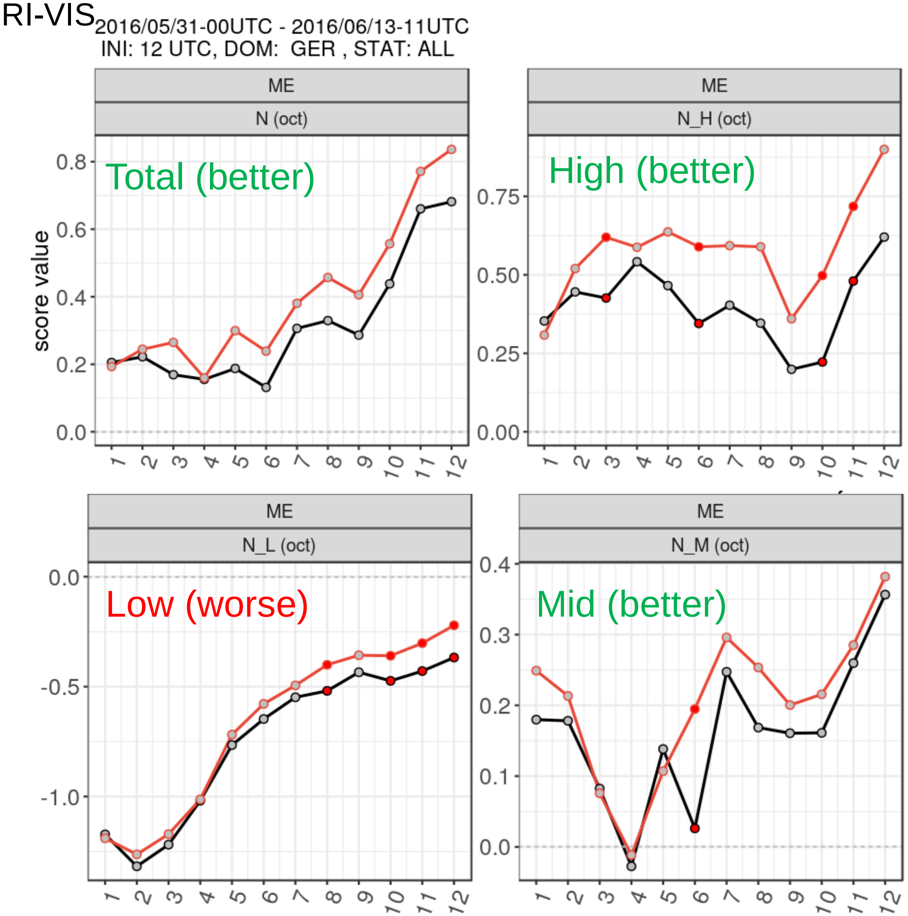
12-hour forecasts
06,12,18,00
31.05.2016 to 13.06.2016

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

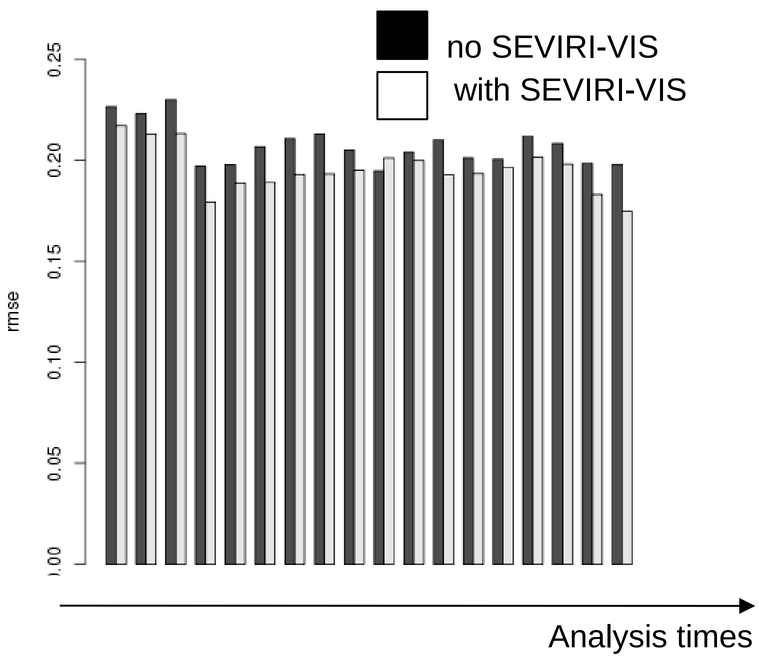
Cloud cover

Mit SEVIRI-VIS
Ohne SEVIRI-VIS

Cloud cover BIAS (FC, SYNOP)



Reflectance RMSE (FG, SEVIRI)

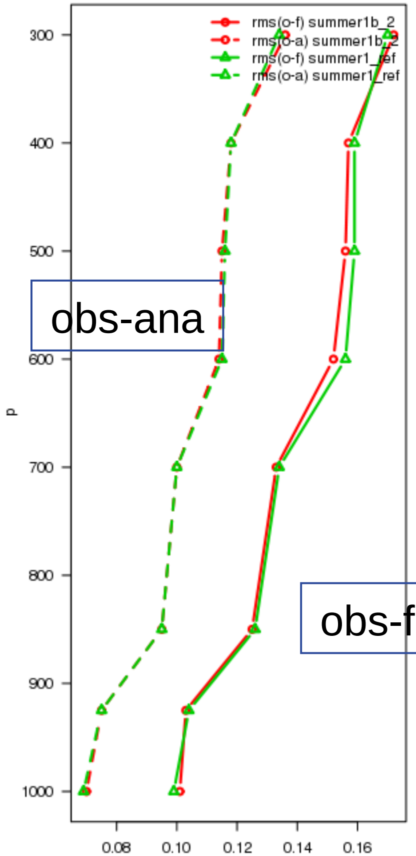


Reflectance verified against SEVIRI-Vis and cloud cover verified agains SYNOP

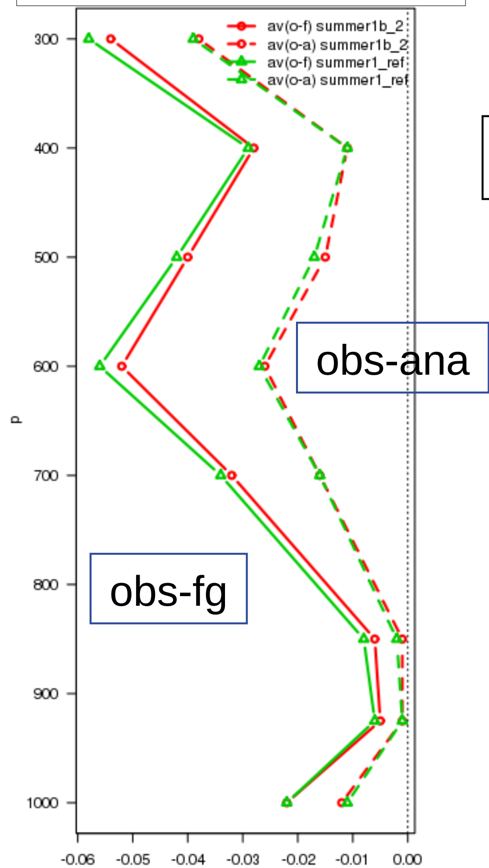
Moisture fields

With SEVIRI-VIS
Referenz

RH RMSE (FG, TEMP)

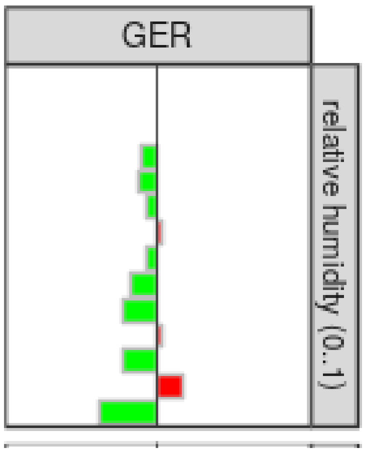


RH BIAS (FG, TEMP)



Better with SEVIRI-VIS

RH RMSE (FC , TEMP)



Relative humidity verified against radiosondes

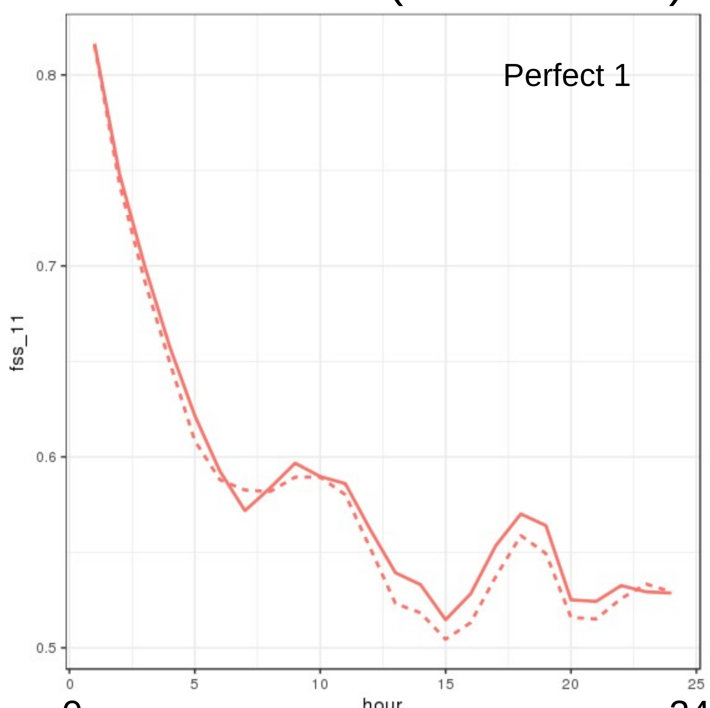
12-hour forecasts
06,12,18,00
31.05.2016 to 13.06.2016

Convective precipitation

Precipitation rate FSS (FC, Radar)

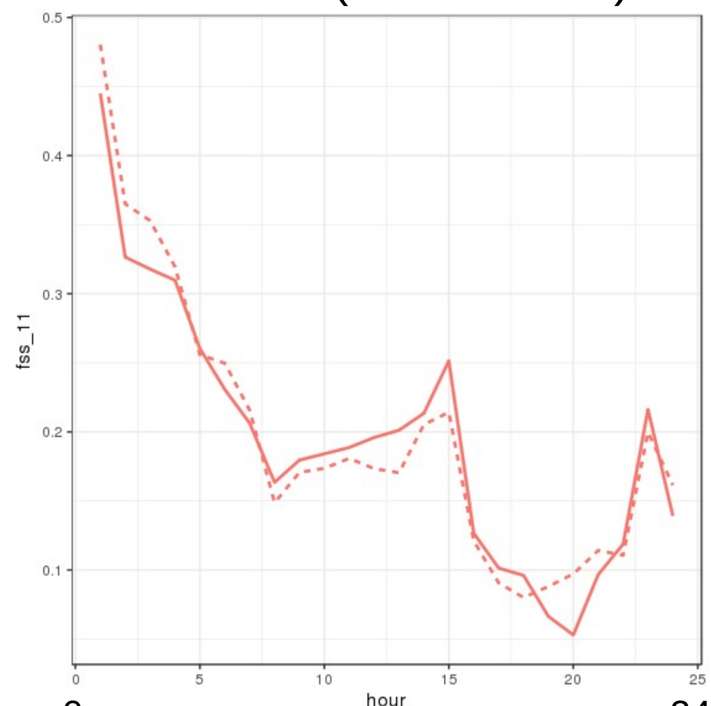
With SEVIRI-VIS
Without SEVIRI-VIS

0.1mm/h (Skala 11 GP)



0 24
Lead Time

5mm/h (Skala 11 GP)

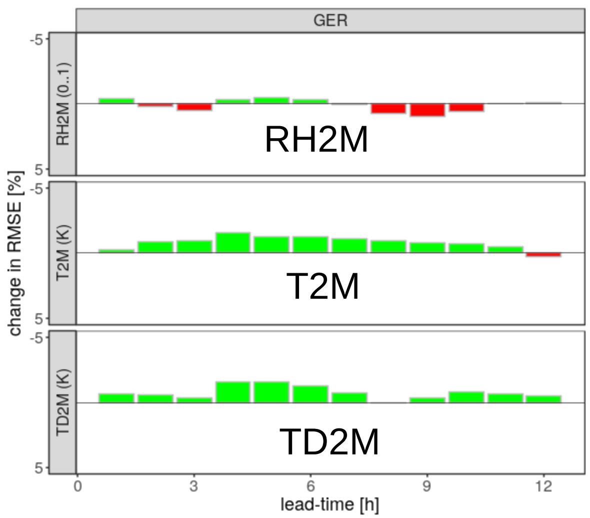


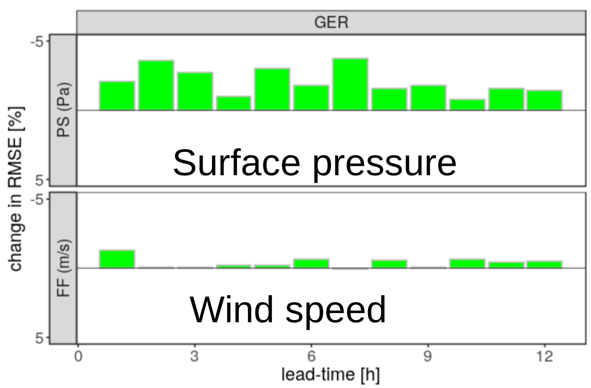
0 24
Lead Time

Verified against derived radar rain rates

Screen-level variables

Better with SEVIRI-VIS



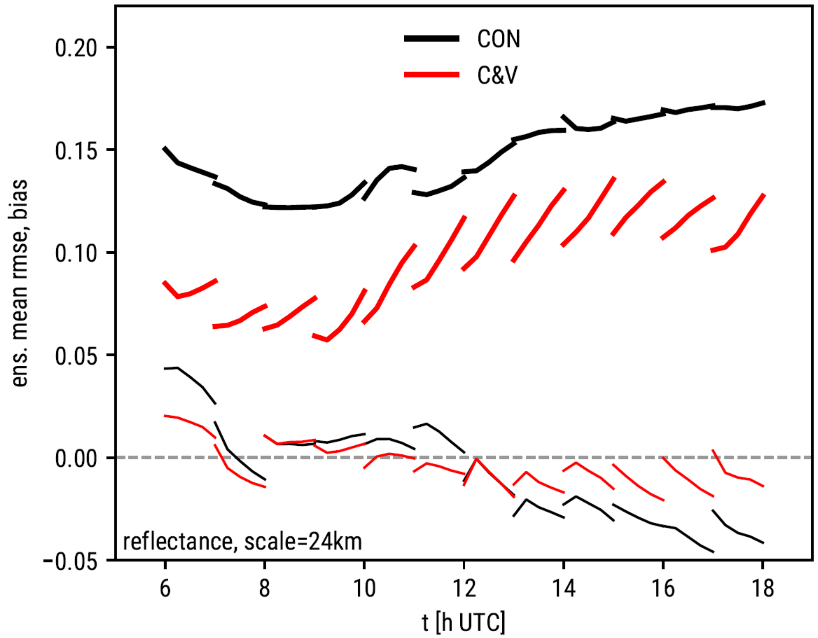


Screen-level variables verified against SEVIRI-VIS

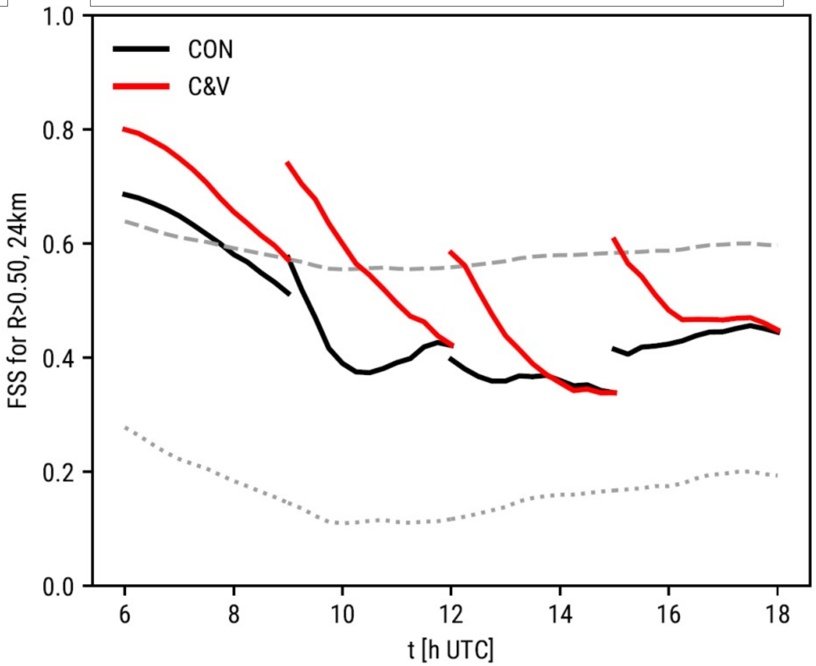
Scale: 24 km

Error growth during forecast

Reflectance (RMSE, BIAS; SEVIRI)



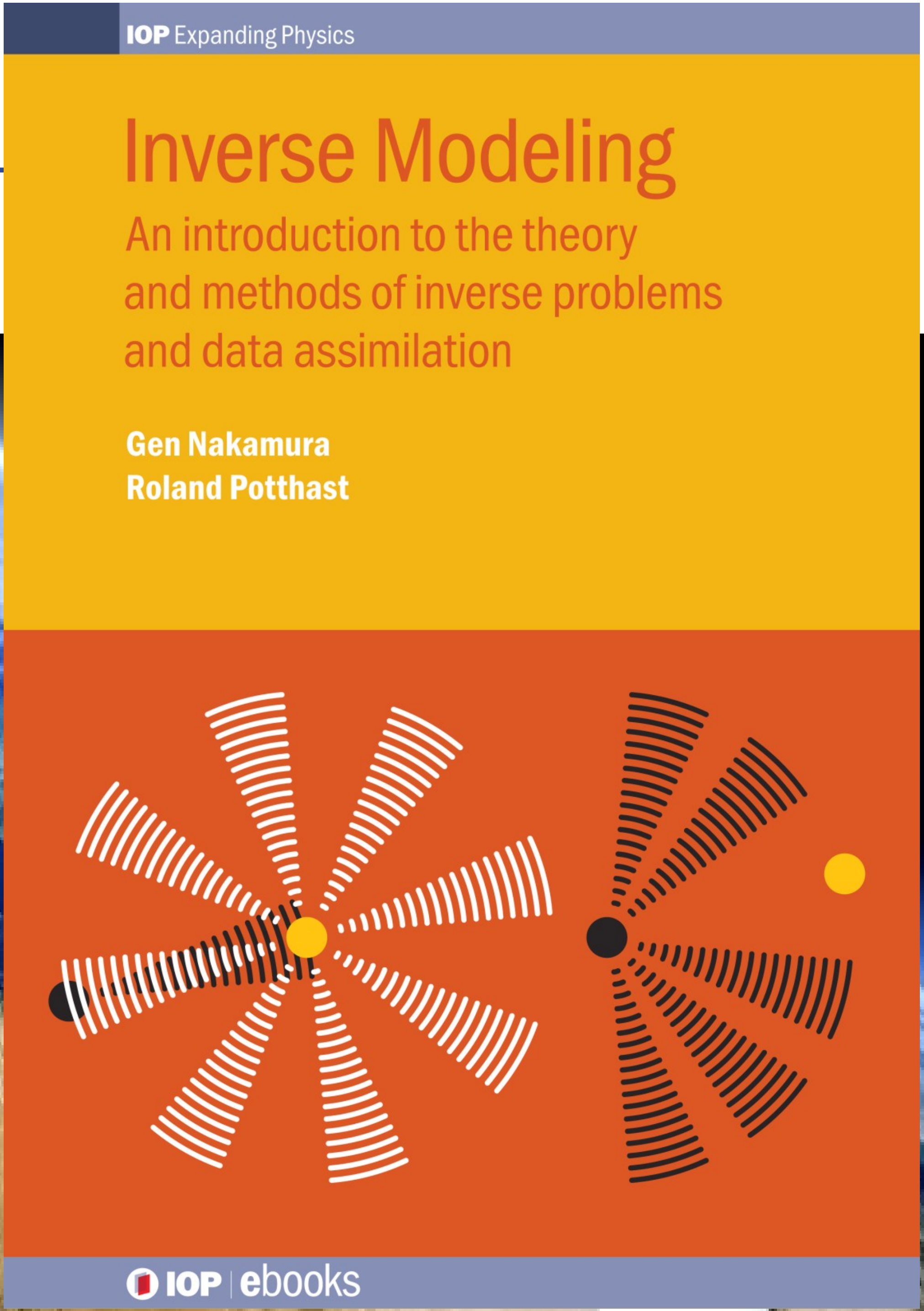
Precipitation rate (FSS; Radar)



With SEVIRI-VIS
Without SEVIRI-VIS

Verified against derived SEVIRI reflectance and radar rain rates

Many Thanks!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