Status of KENDA
WG1 activities

Deutscher Wetterdienst

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- WG1 overview
- KENDA overview

WG1 Overview

- KENDA
- CNMCA: LETKF for COSMO-ME (7 km)
- RHM:– new hierarchical Bayes approach to ensemble-variational DA
  - new method to account for obs error correlations
  - assimilation of T2m obs: correction of T in low troposphere + soil
- ARPA-Piemonte (Giorcelli): FASDAS (Flux Adjusting Surface DA System)
  - for assimilation of T2m obs: corrects T in atmosphere + soil (long memory)
  - Exp. Jan – May: shown to improve T2m bias + precip in forecasts
- DWD: Latent Heat Nudging in (7-km) COSMO-EU, operational
  (OPERA precip rate data used outside COSMO-DE domain)

Latent Heat Nudging for COSMO-EU (7km): **direct impact**

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verification against
Radar precipitation

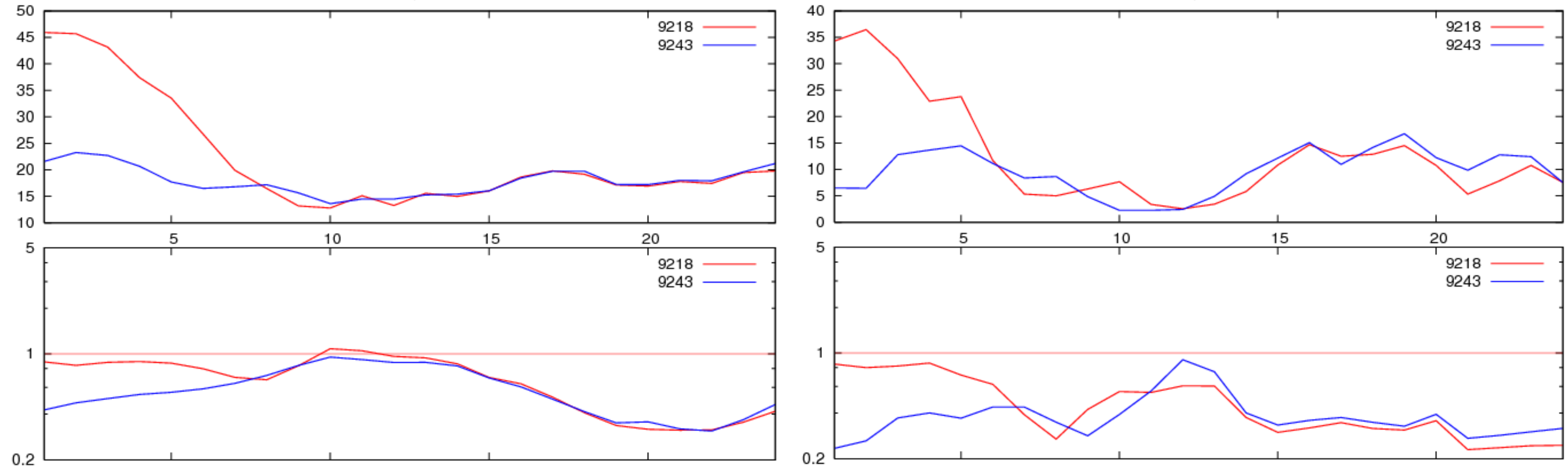
August 2012

COSMO-EU with LHN
COSMO-EU no LHN

threshold **0.1 mm/h** **2.0 mm/h**

ETS

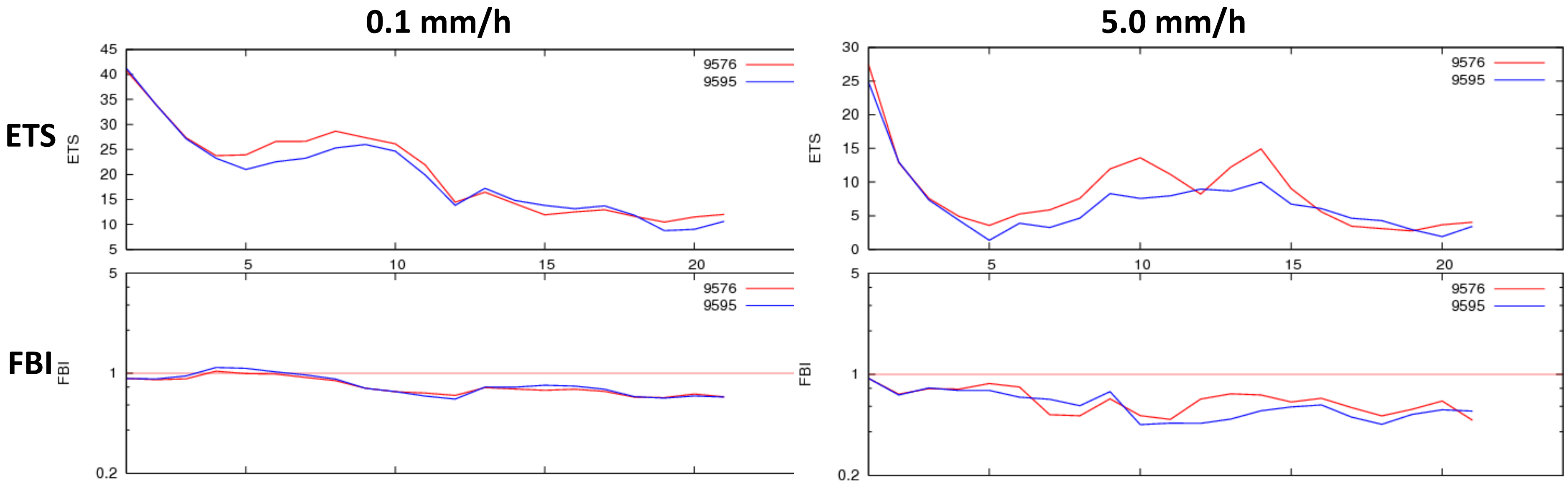
FBI



- ✓ slightly (!) positive impact for T2m, Td2m
- ✓ neutral impact on other COSMO-EU verification

June/July 2013

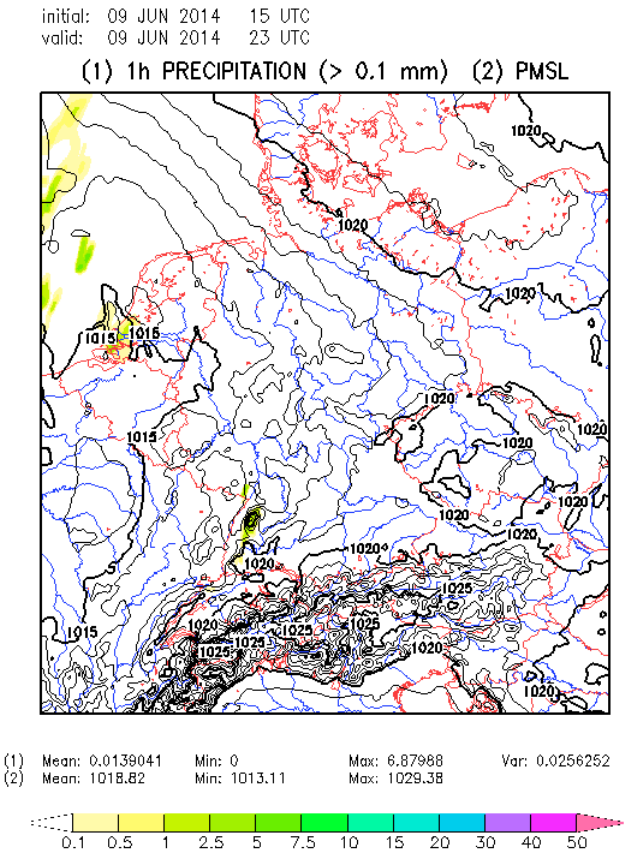
COSMO-DE with LHN, lateral BC: COSMO-EU with LHN
COSMO-DE with LHN, lateral BC: COSMO-EU no LHN

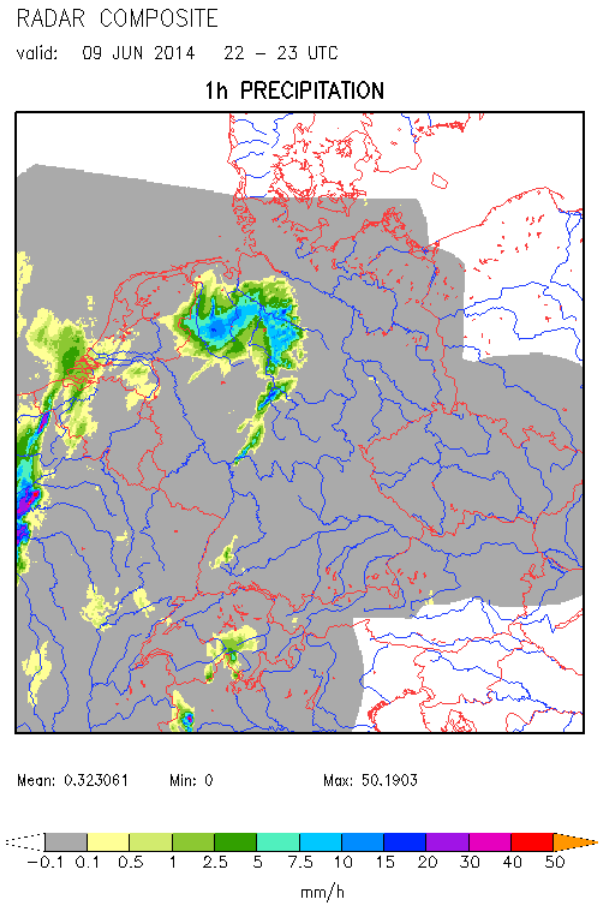


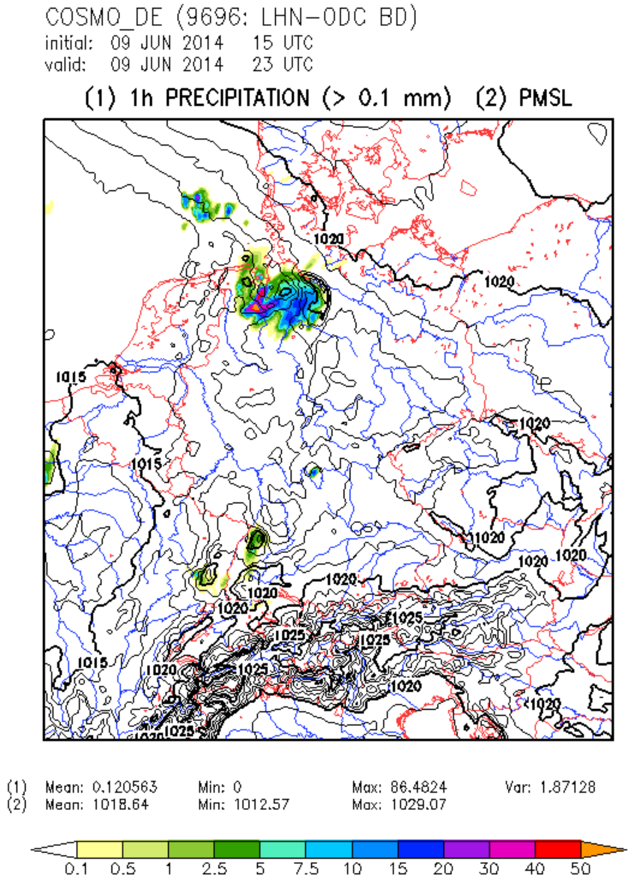
- ✓ small, but long-lasting positive impact on precip
- → introduced operationally last week

8-h forecast of COSMO-DE with LHN (for 09.06.2014, 23 UTC)

lateral BC without LHN	radar obs (precip)	lateral BC with LHN







KENDA, main task: testing, tuning, refinement

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DWD

- **ARPA-SIM**: OSSE, with RH → RH/2 in certain numbers of ens. Members

- **MeteoSwiss**: 1-hrly LETKF cycle over 1 month, lateral BC: ECMWF EPS/ IFS
  → reasonable results (slightly worse than nudging), problems with Td2m

  new test (IFS EPS forecast perturbations centred at IFS det.) :
  → problems with RH: (too) many RH obs rejected

- **DWD**: BACY 'stand-alone' (BAsic CYcling) scripting environment

  → 1.5 days of 1-hrly LETKF cycle (N_{ens}=40) computed in 1 day → YIPPEE !!)

  first goal: replace nudging with deterministic LETKF analysis
  → focus on quality of deterministic analysis/forecast

KENDA, new series of experiments: **summary**

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DWD

- ✓ lateral BC spread (+ quality) important
- ✓ soil moisture perturbations beneficial near surface
- ✓ no very obvious problems with combining LETKF & LHN
- ✓ deterministic forecasts: LETKF comparable / better than nudging (YIPPEE !)

  negative: surface pressure → reducing ps obs errors helps a bit

  (need more spread of ps in lateral BC)

  needs attention: precip (exp. 0-UTC runs) ; high cloud

BUT, results are preliminary !!

- only 6 days → need longer periods, different weather situations
- quality control of RH too restrictive in LETKF (assim. + verif.)
- need to re-do some experiments (e.g. no-RTPP, impact of LHN with C-DE soil…)

KENDA: other tasks

- SPPT (stochastic physics) : adapted for use in cycled DA, in COSMO V5_1
- Pattern Generator (3D, 2D) : incorporated into COSMO, almost finished (RHM)

KENDA: verification tasks

- MEC (model equivalent calculator), for production of 'full' NetCDF feedback files (input for verification: NEFFprove, VERSUS)
  - preliminary (still slightly buggy) version developed
  - planned end of Oct.: working basic version
    - ✓ conv. upper-air obs / surface obs used in DA (ps, T2m, RH2m, uv10m)
    - ✓ temporal interpolation of model values to exact obs times (in obs space)
  - thereafter: add additional variables which are not actively assimilated (cloud, precipitation, gusts, MSLP, Td2m, radiation, etc.)

- NEFFprove ensemble-related verification tool, using feedback files (Amalia Iriza):
  - ready for experimental use
  - further testing / more diagnostic output + docu / revisions dep. on users needs

- **Radar** : **3-D radial velocity V_r** & **reflectivity Z** (Zeng, Bick)
  - thinning, superobbing strategies implemented, monitoring set up
  - first DA cycles run (see slides)

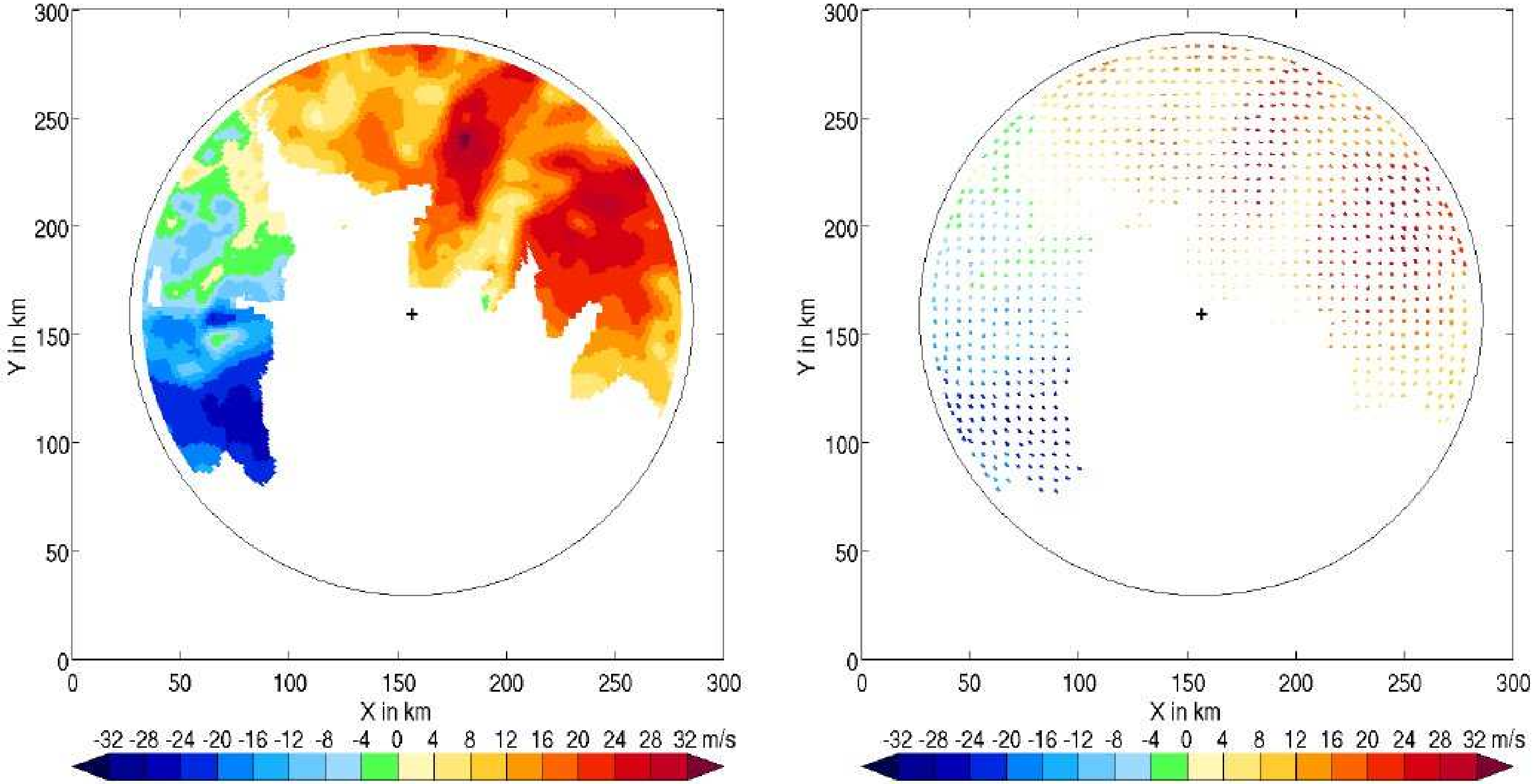
- **GPS slant path delay**: pure obs operator implemented
  (Bender) to do: testing, writing feedback files …

- SEVIRI **cloud top height** : tuning experiments on thinning, localisation... (see slides)
  (Schomburg)

- **SEVIRI cloudy radiances**: first cycled DA exp.,
  (Perianez) using different (cloud-type dep.) bias corr., vertical localisation
  → positive impact on simulated radiances in first guess

- novel ground-based remote sensing (Haefele, MCH)
  Raman lidar (T + qv profile), **microwave radiometer** (T + qv prof., IWV, ql, BT):
  - report written on new profiler obs with potential use in COSMO
  - working on O-B statistics for radiometer and LIDAR obs at Payerne

superobbing by averaging / median of sample

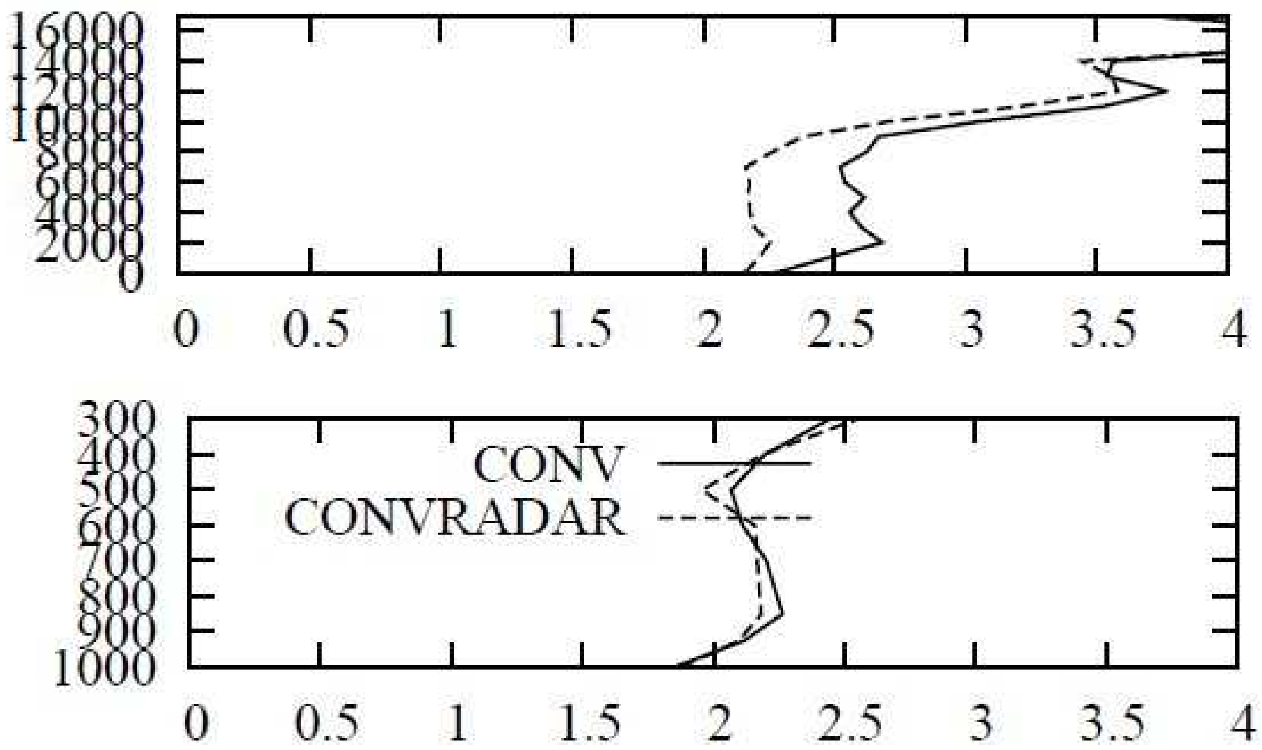


(a) original data (b) superobservation data

PPI at elevation 2.5° **grid length of Cartesian grid: 5.6 km**

1-hrly LETKF cycling over 5 days (1 – 6 June 2011)

RMSE of first guess (1-hr forecast)



against Radar radial velocity

against radiosonde + aircraft wind speed

assimilation of **radar reflectivity** :
case study

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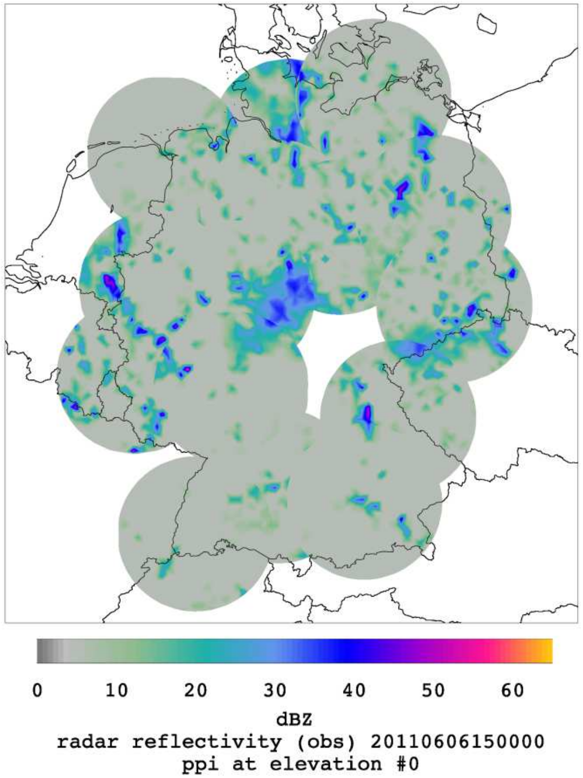
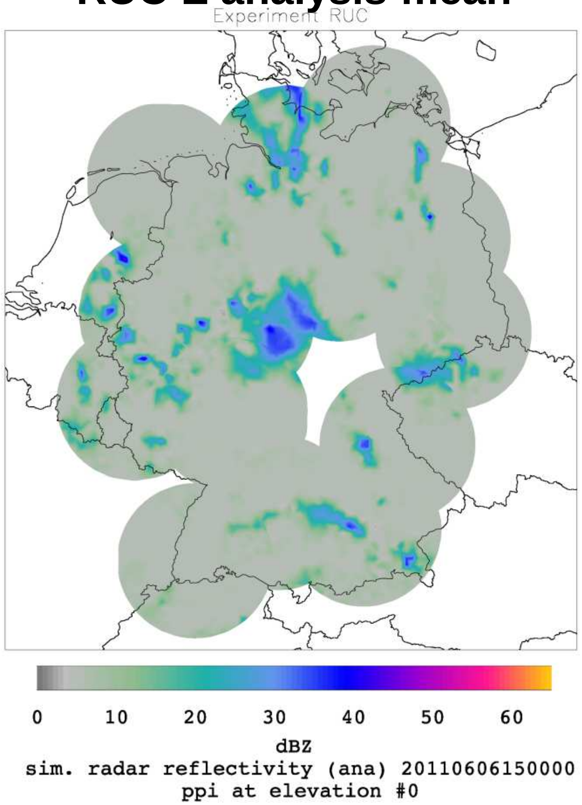
DWD

- RUC-Z: 15-min cycling over 3 hrs (12–15 UTC, 6 June 2011), 6-h fcst. (15–21 UTC)
  obs: reflectivity & no-reflectivity (constrain all values ≤ 5 dBZ to 5 dBZ) only
- CNTL: 1-hr cycling, using radiosonde, aircraft, synop

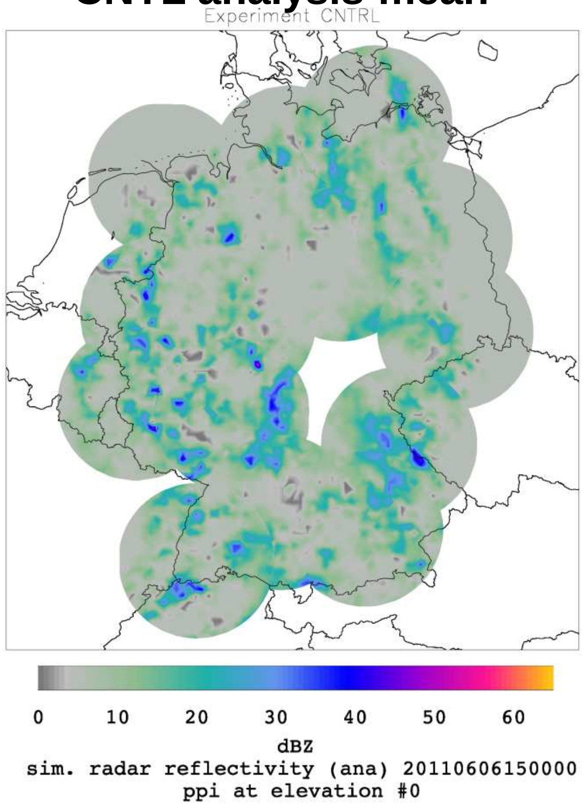
radar obs (15 UTC)



RUC-Z analysis mean



CNTL analysis mean



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assimilation of **radar reflectivity** : case study

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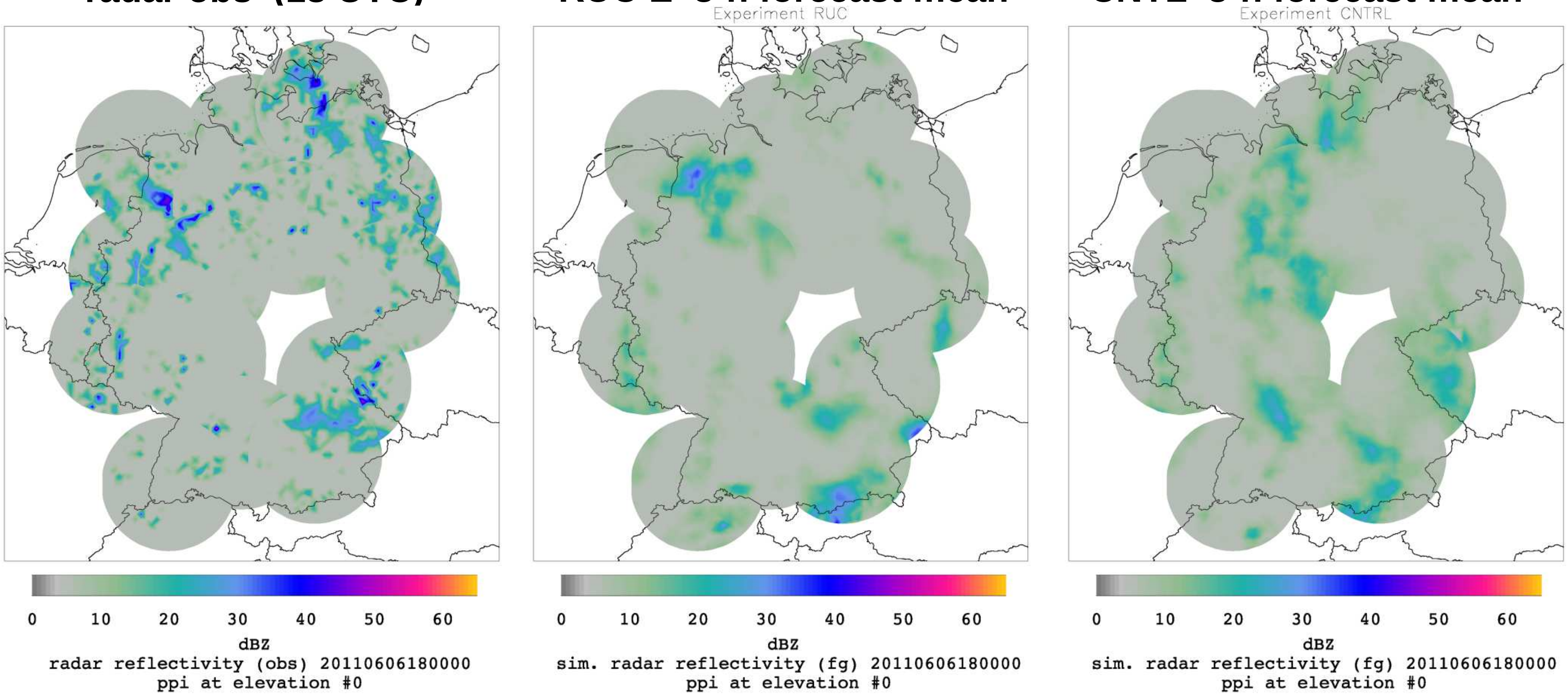
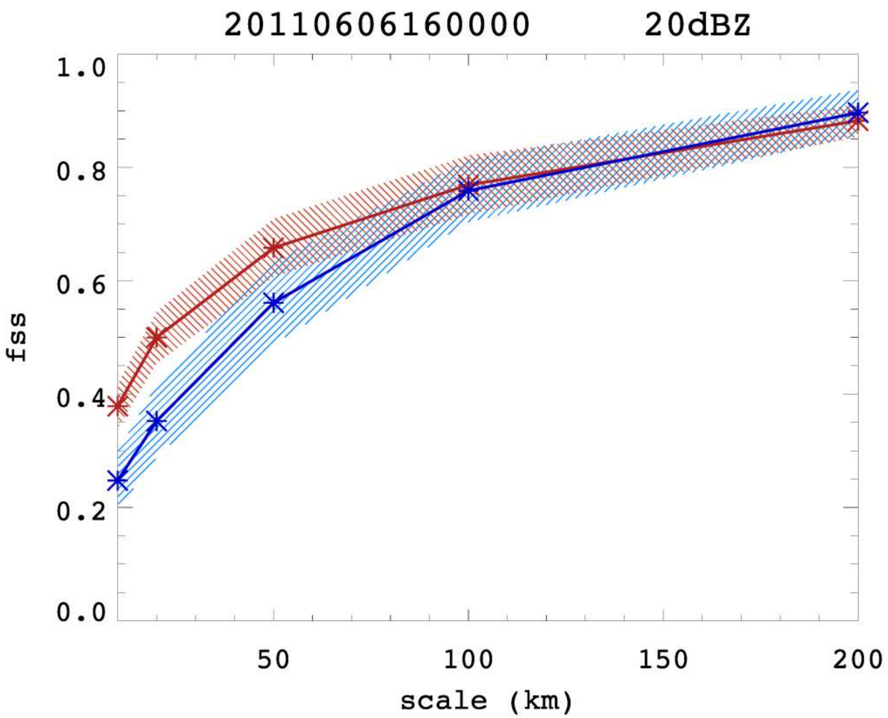
→ positive impact for reflectivity assimilation decreases quickly in the forecast

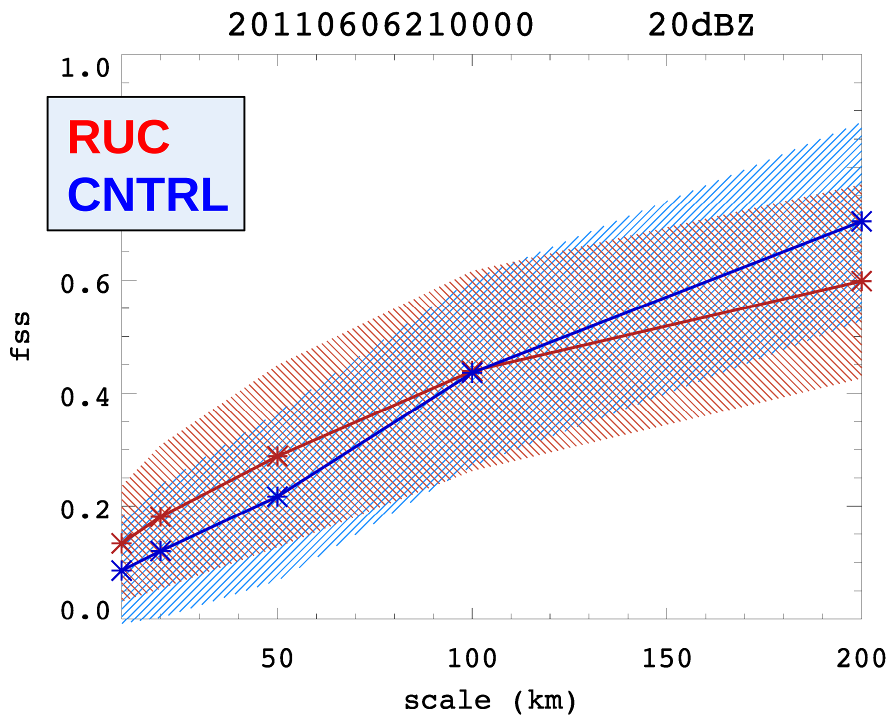
radar obs (18 UTC) **RUC-Z 3-h forecast mean** **CNTL 3-h forecast mean**



FSS (as function of scale)

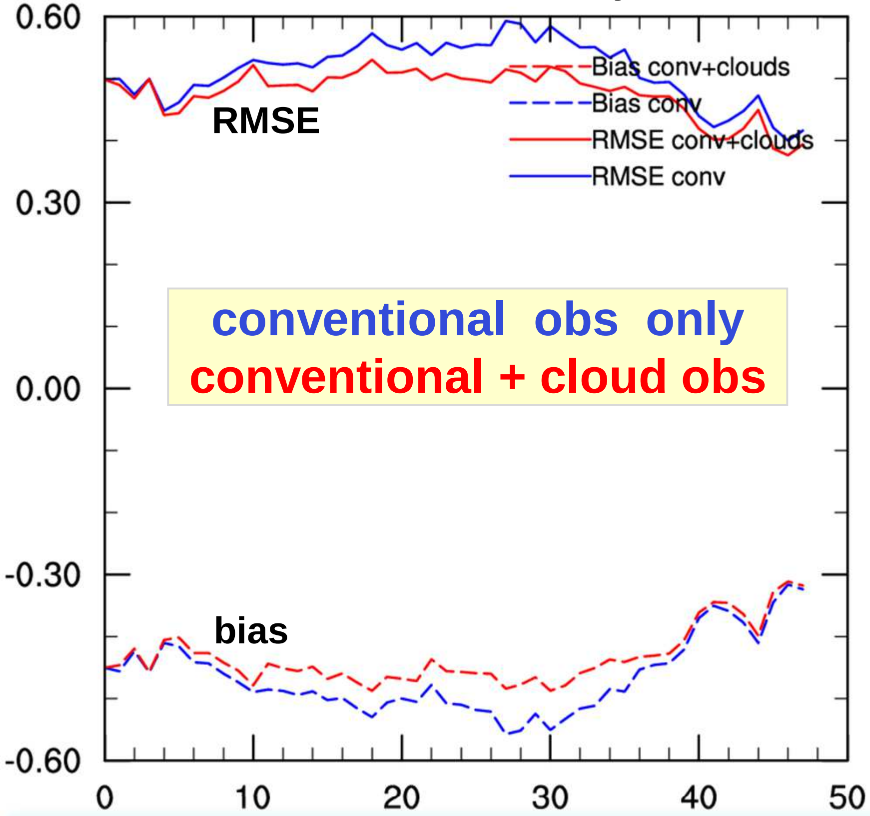
1-h forecast **6-h forecast**



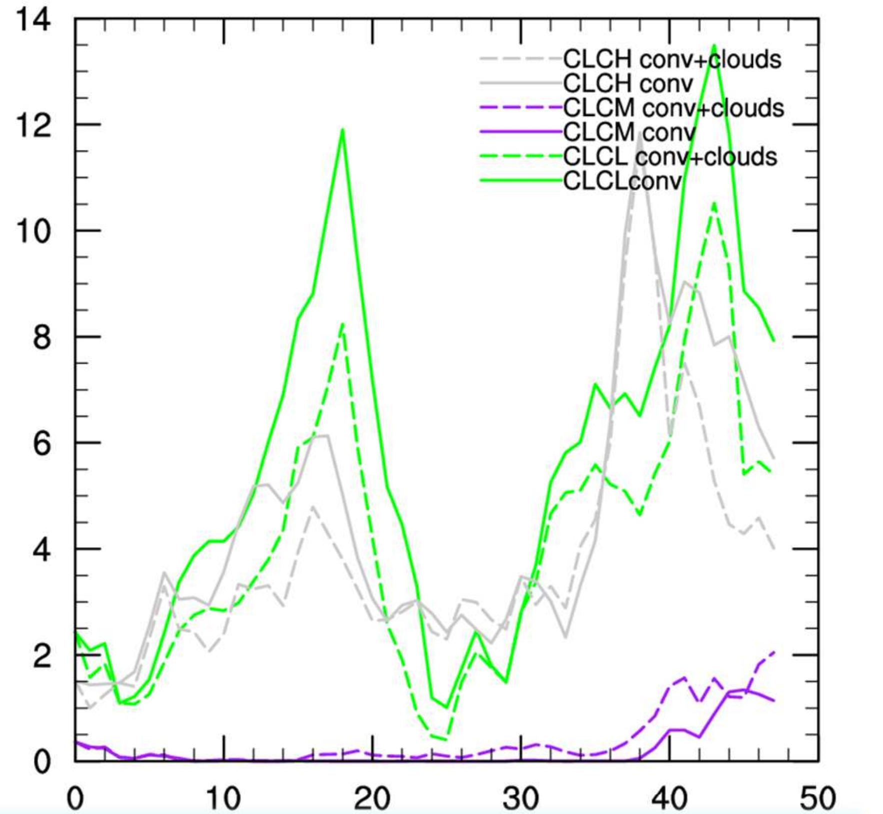


time series of first guess (1-h forecast) errors for 50 hours of LETKF cycling
(starting 12 Nov. 2011, 12 UTC)

RH at observed CTH, for **cloudy** obs locations



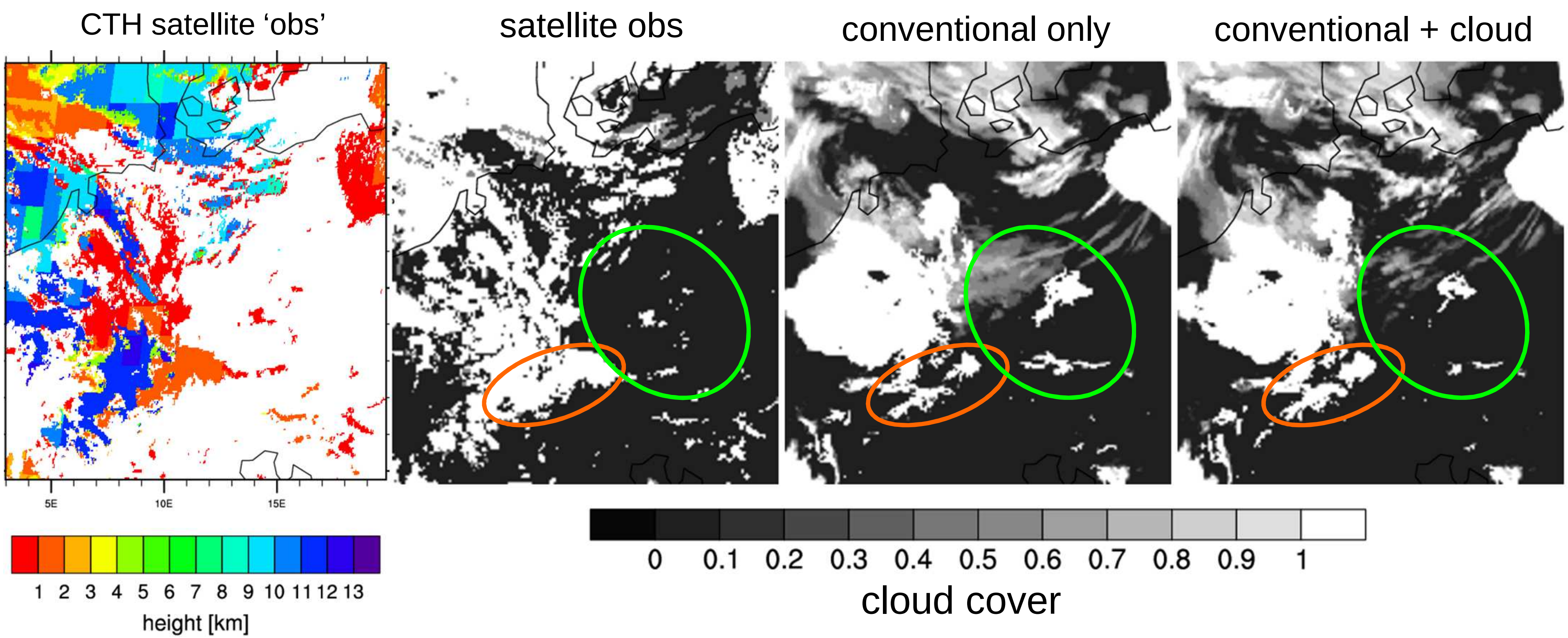
MSE of cloud fraction, for **cloud-free** obs locations



→ reduced errors for cloudy and cloud-free areas (except for false-alarm CLCM)

6-h forecast of total cloud cover after 12 h of LETKF cycling

(valid for 13 Nov. 2011, 6 UTC)



→ positive impact on cloud cover, persists into forecasts

use of (SEVIRI-based) cloud top height (CTH): upper-air verification for 82 hours DA cycling

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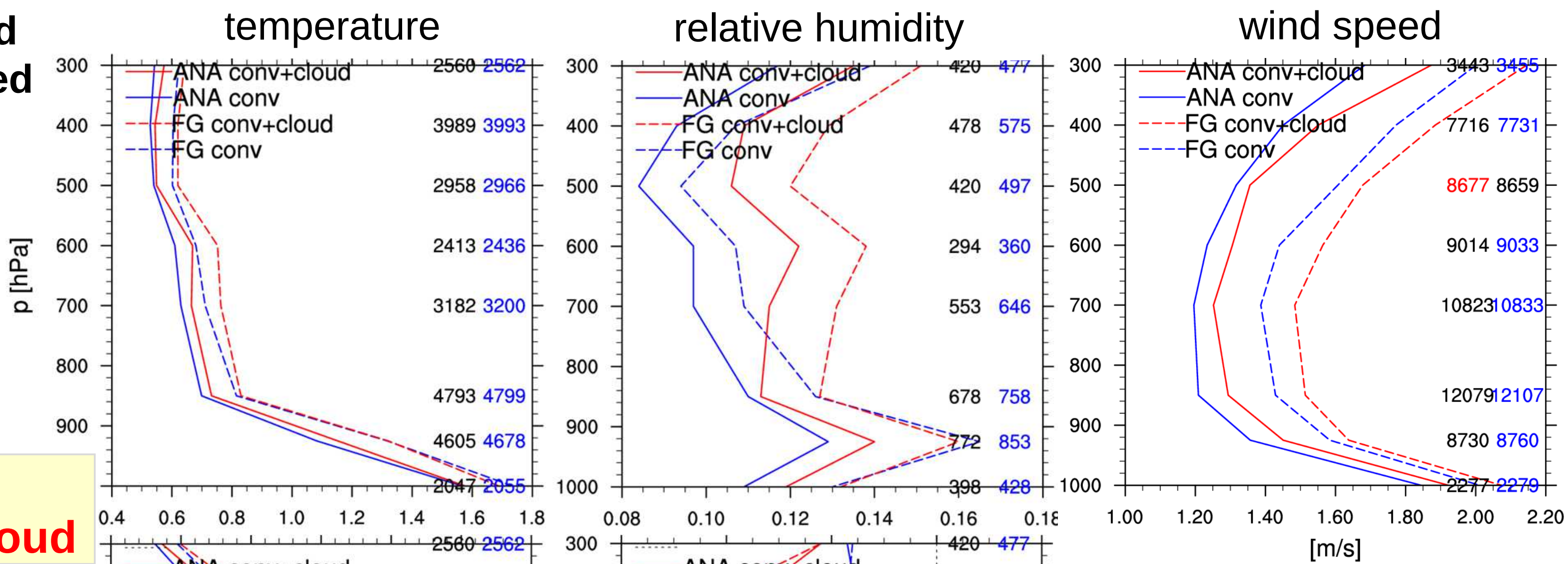
DWD

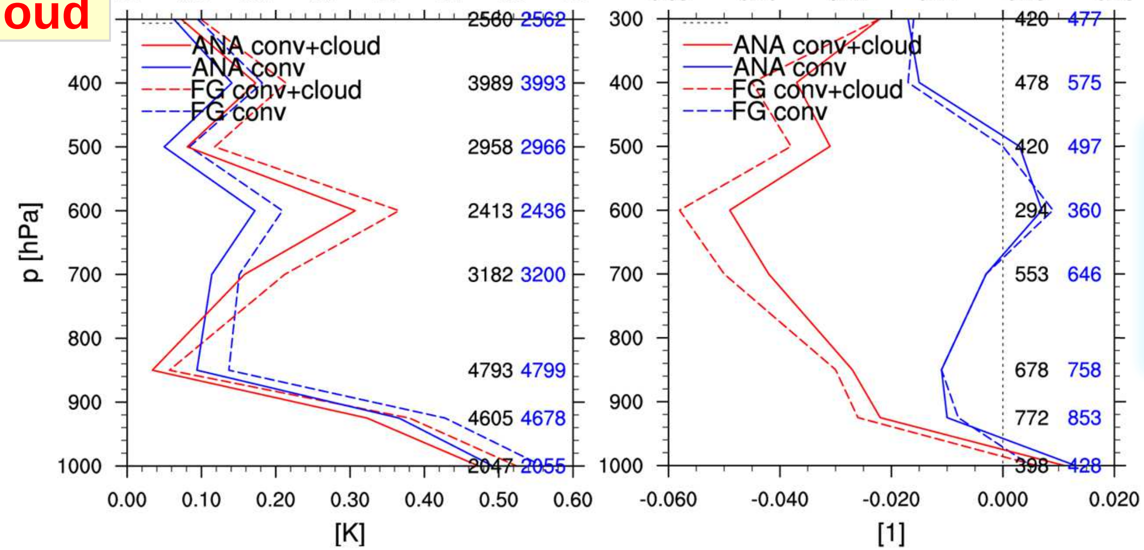
ana: solid
FG: dotted

RMSE



conv
conv + cloud

bias



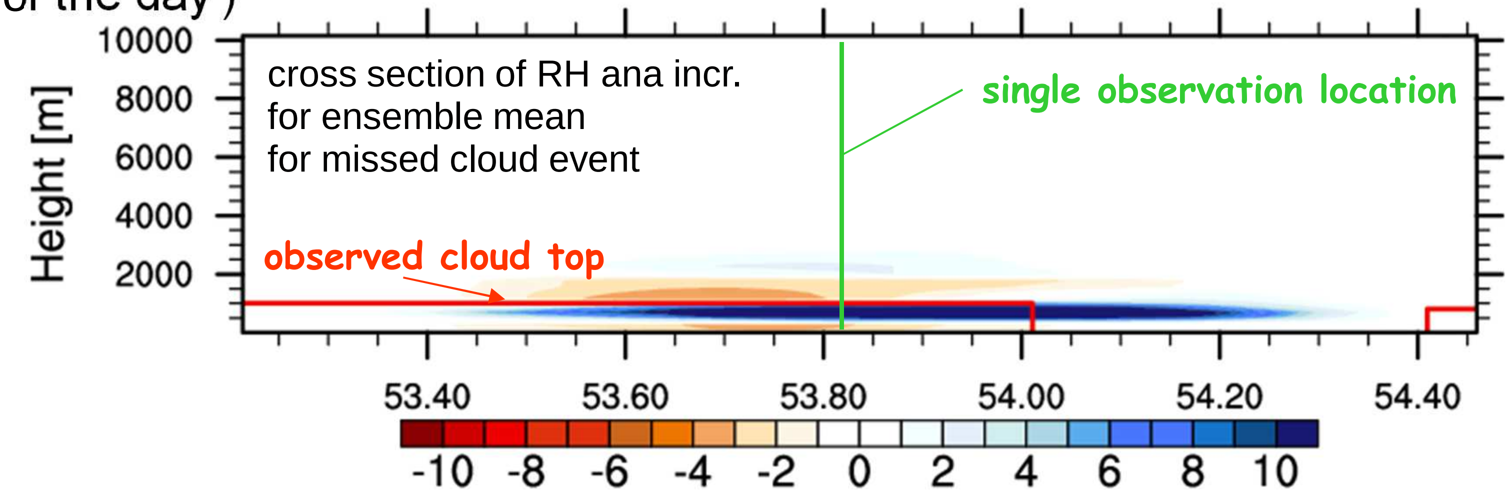
→ wet bias (except low levels)

→ increased RMSE

– at observed CTH, assume observed RH = 100 % over water / ice
COSMO model: in ice cloud, usually RH < 100 % over ice

→ adjust bogus RH-obs value ?

– f.g. ens. perturbations of LETKF do not capture real (observed) cloud structures (i.e. 'errors of the day')



→ adjust localisation (make it cloud dependent) ?

→ work needed to find out reasons + remedies

→ more extended tests, other meteorological situations, etc.

KENDA plan

SMC meeting Feb 2014: **extend PP KENDA** (by ~ 1 y, Sep. 2015)
reason: clear project **aim: operationability**

- Background: KENDA pre-operational at MeteoSwiss in summer/autumn 2015
  KENDA pre-operational at DWD in Oct. 2015 (for det. forecasts)
- Quality: match quality of current operational nudging + LHN
  - LBC with realistic spread, e.g. add ECMWF EPS forecasts with larger forecast lead time to IFS det. (MCH); optimize ICON-LETKF (DWD)
  - additive covariance inflation: SPPT, (perturbed physics ? Self-evolved pert.? Incremental perturbations with prescribed spatio-temporal correlations ?)
  - recommended setup: update frequency, (ensemble size), specified obs errors, adaptive methods (inflation, localisation,..), multi-scale analysis with variable localisation, (possibly noise control by incremental analysis update),
- Complete DA cycle: soil: add SST and snow depth analysis
- Technical: Grib-2 ; robustness: creation of new ens members if few have crashed