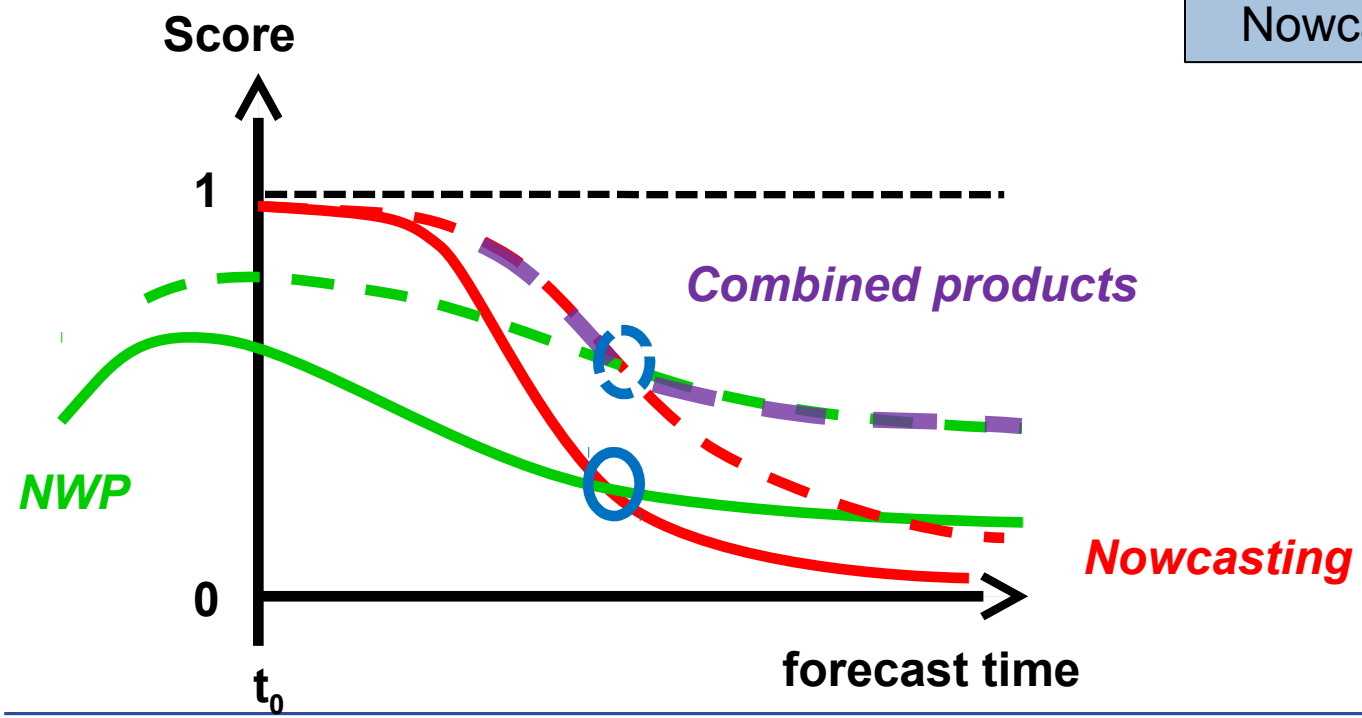
Assimilating SEVIRI-VIS to improve the representation of convective initiation and low stratus

Lilo Bach, C.Schraff, C.Köpken-Watts, U.Blahak, R.Potthast (DWD)
L.Scheck (LMU)

Objective of Sinfony

Enhance forecast skill on the convective scale

Seamless Integration
Nowcasting & NWP

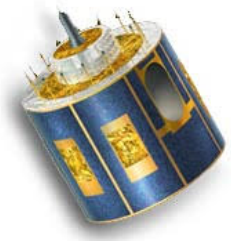


Assimilating observations to improve convection

Preconvective environment

➔ Conventional observations

SINFONY



Convective initiation

➔ SEVIRI-VIS

Active convection

➔ Radar reflectivities and radial winds

➔ Lightning observations

➔ (Radar-) Objects

Assimilating observations to improve convection

Preconvective environment

➔ Conventional observations

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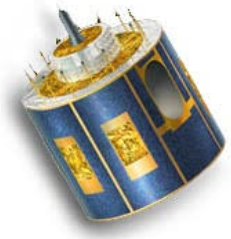


Convective initiation

➔ **SEVIRI-VIS**

Active convection

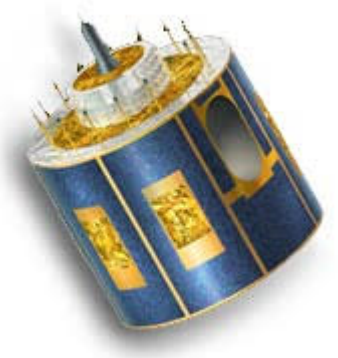
➔ Radar reflectivities and radial winds

➔ Lightning observations

➔ (Radar-) Objects

New observations

- SEVIRI channel in the visible spectral range (0.6 µm)
- Observation operator MFASIS (Scheck et. al, 2016)
- 5km x 3km Pixel (over COSMO-DE domain)

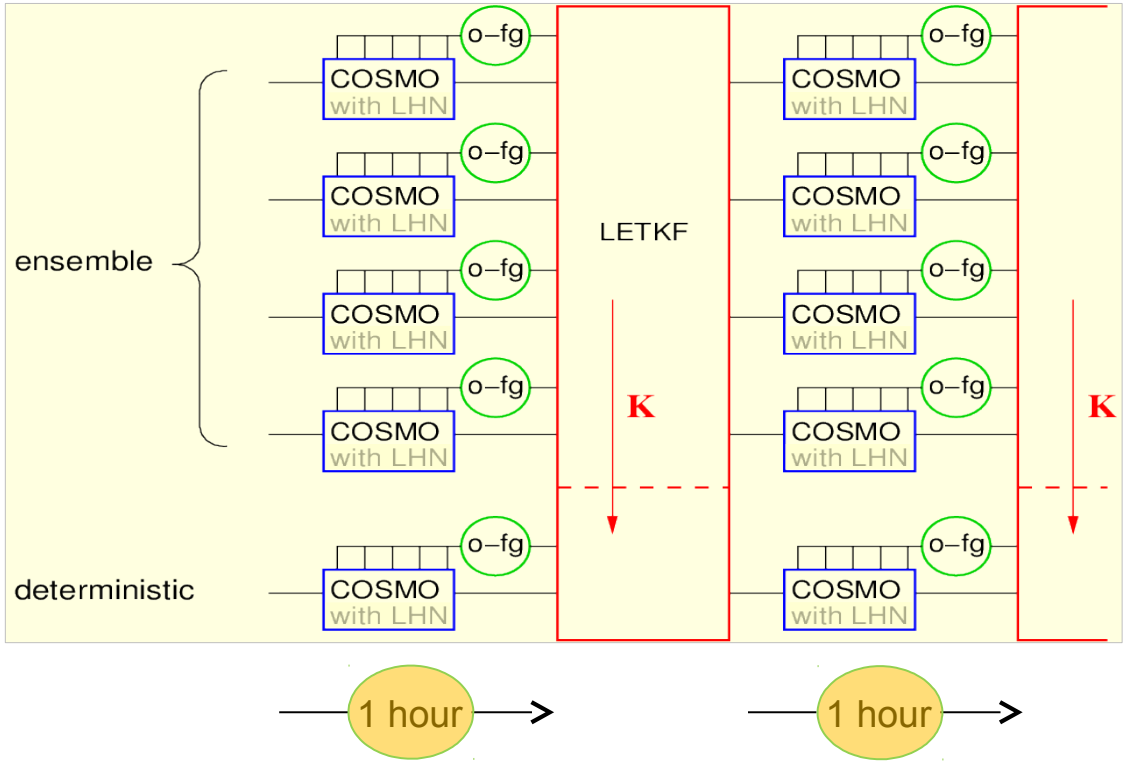


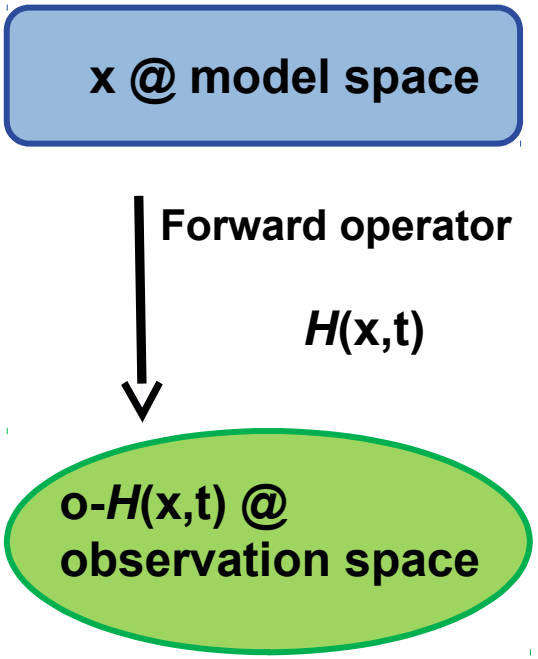
Why assimilate them?

- Information on cloud cover
- Brightness contrast useful to identify low clouds (compared to IR)
- Transparency of thin cirrus

KENDA-LETKF

Schraff et. al, 2016





K: Kalman gain for ensemble mean

Outline

1. Low stratus single observation experiment
2. Experiments in convective period

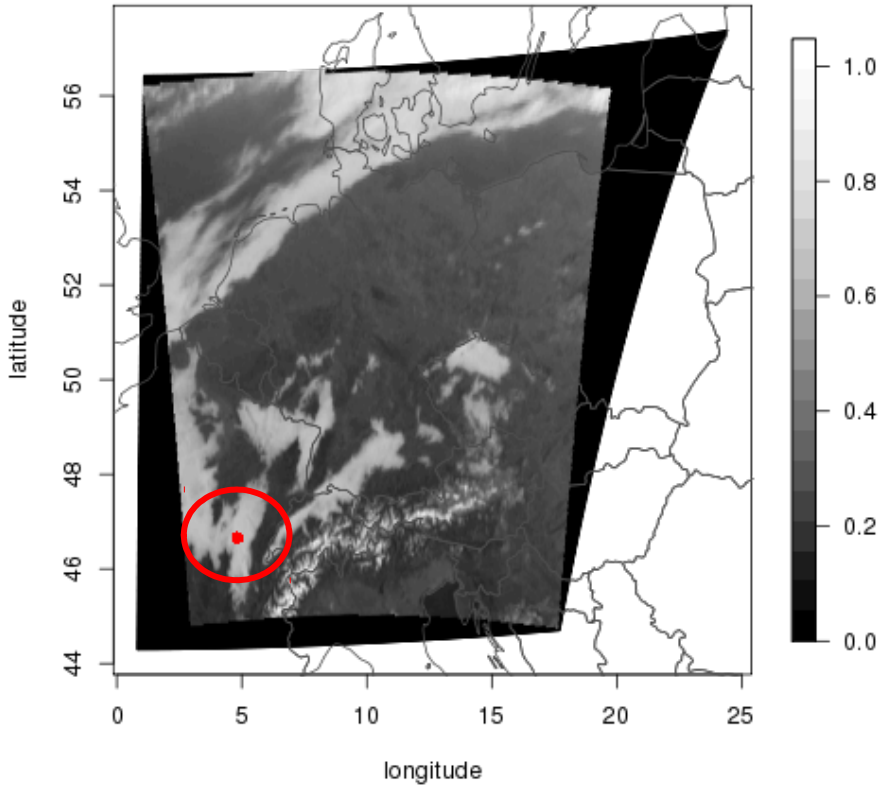
Low stratus

Single Observation Experiment

- December, 30th (2016)
- Low stratus in Southern Germany/ France

Two Experiments

1. Position 950 hPa + narrow vertical localization
2. No vertical localization



Single Observation Experiment

- ➔ December, 30th (2016)
- ➔ Low stratus in Southern Germany/ France

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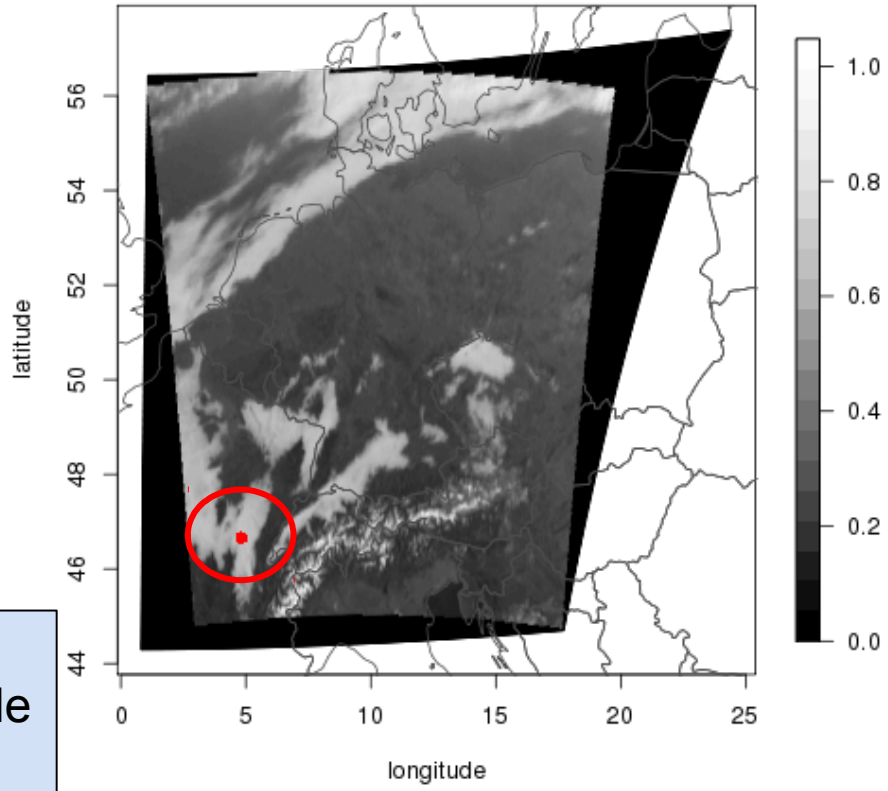
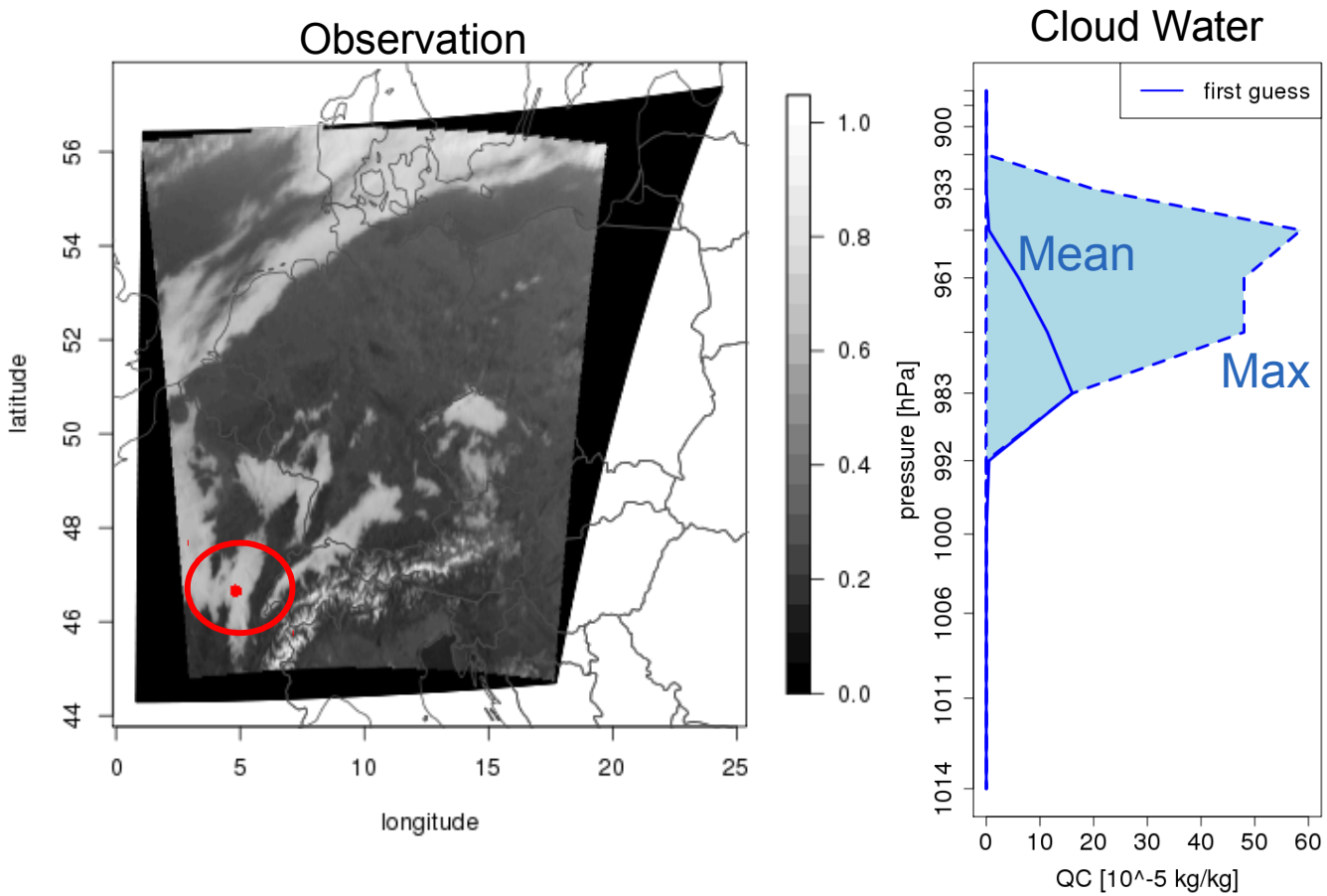


Can we improve the representation of low stratus in the ensemble mean and ensemble members?

How is low stratus represented in the first guess ensemble?



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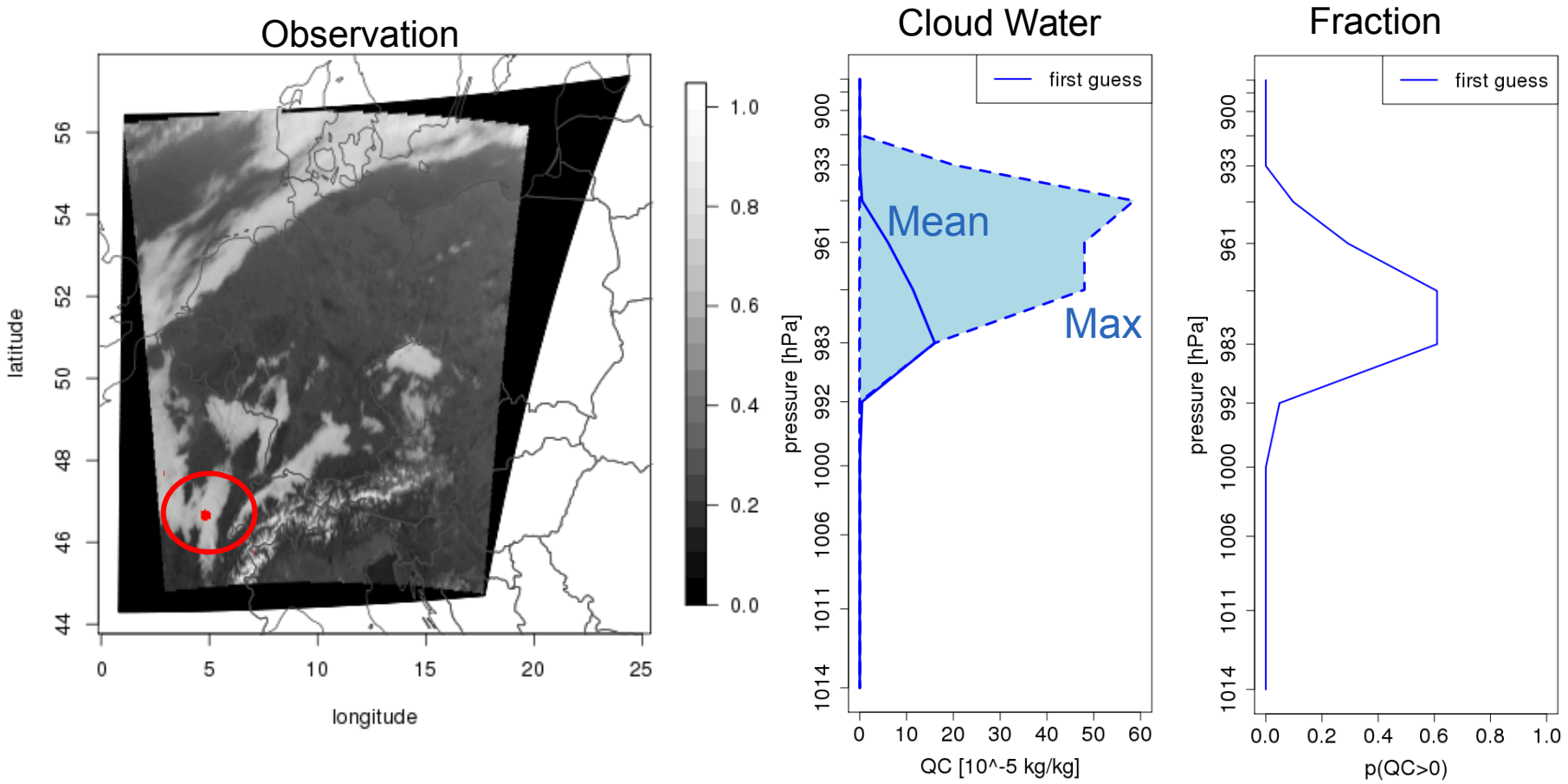
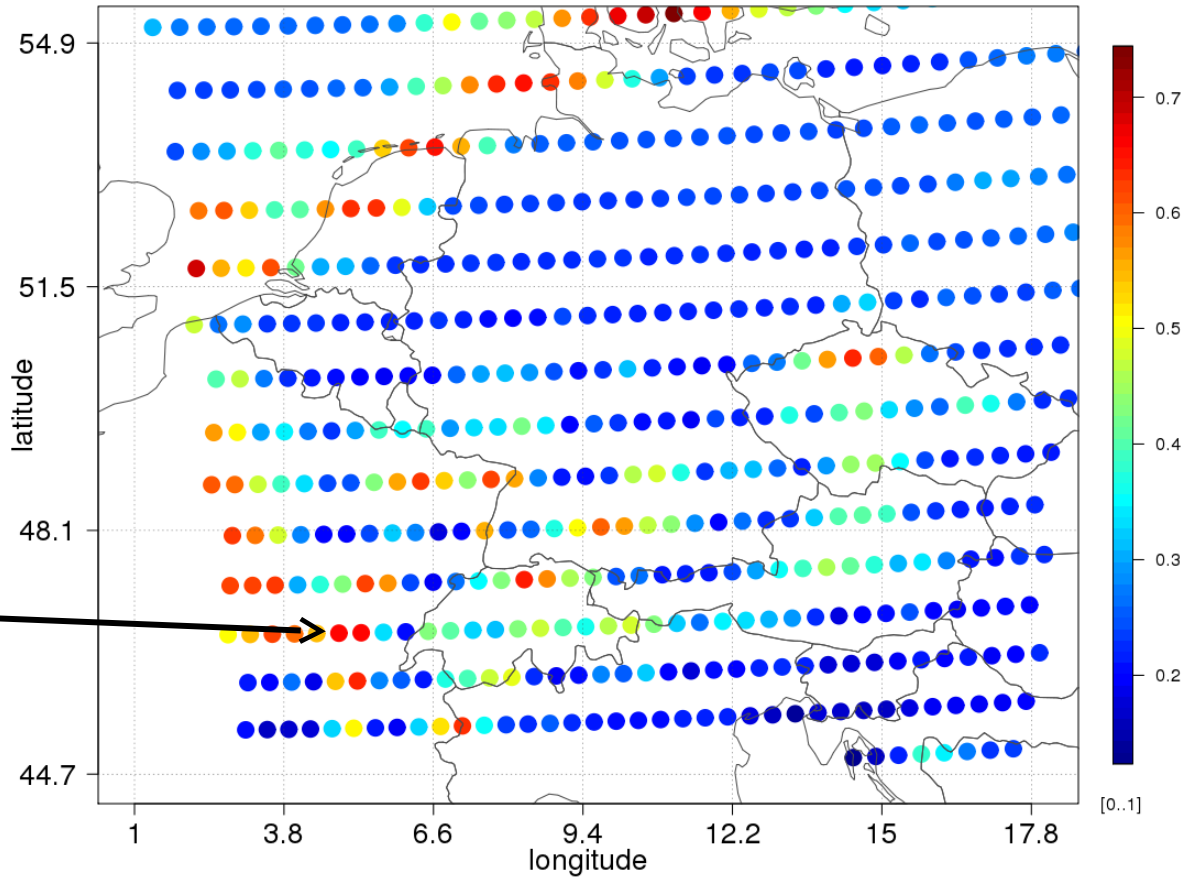


There is room for improvement of the ensemble…

Superobbed reflectance observations



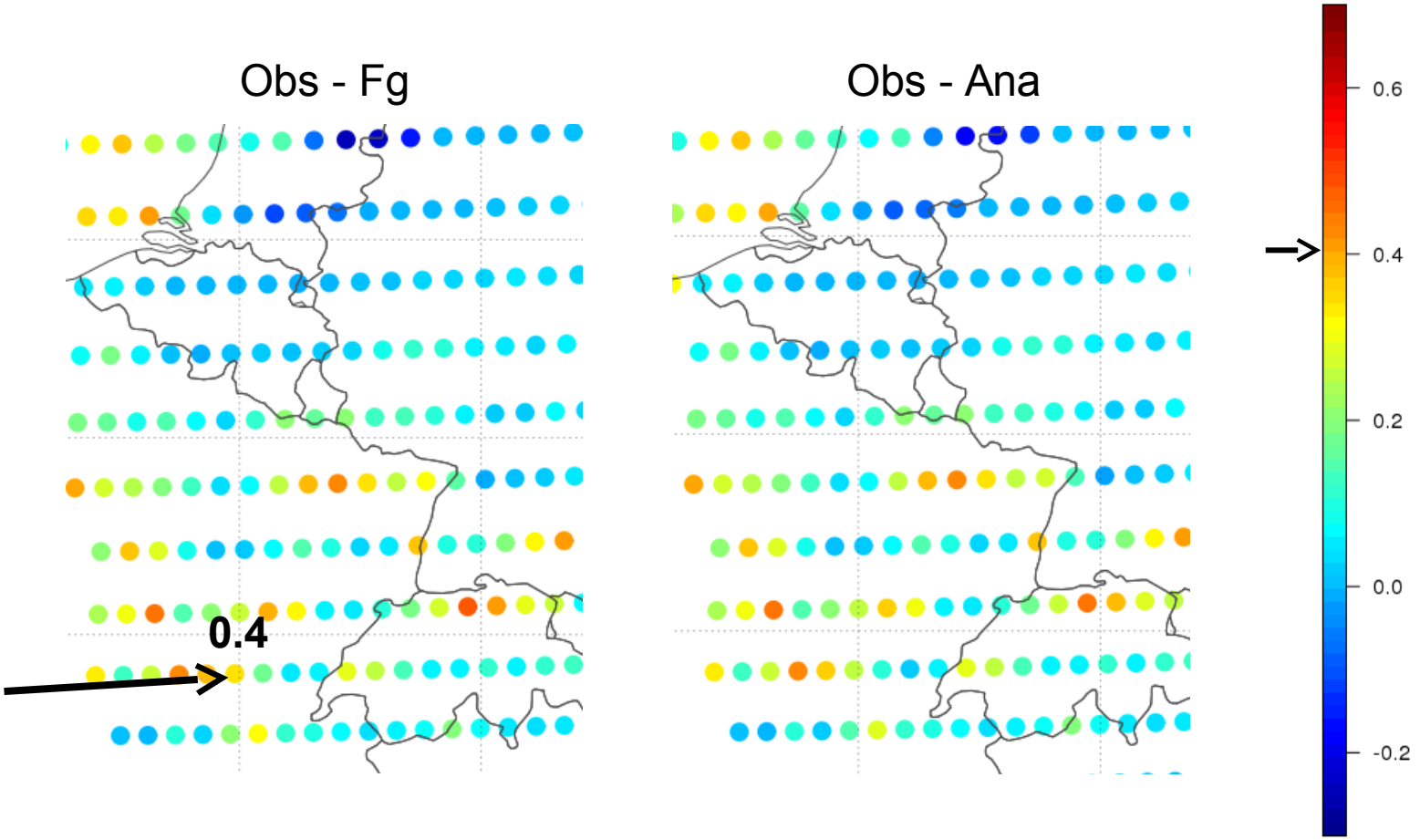
Single Obs

36km x 36km

≈ 500 obs

High reflectance in area of low stratus

Does the filter draw torwards the observations?



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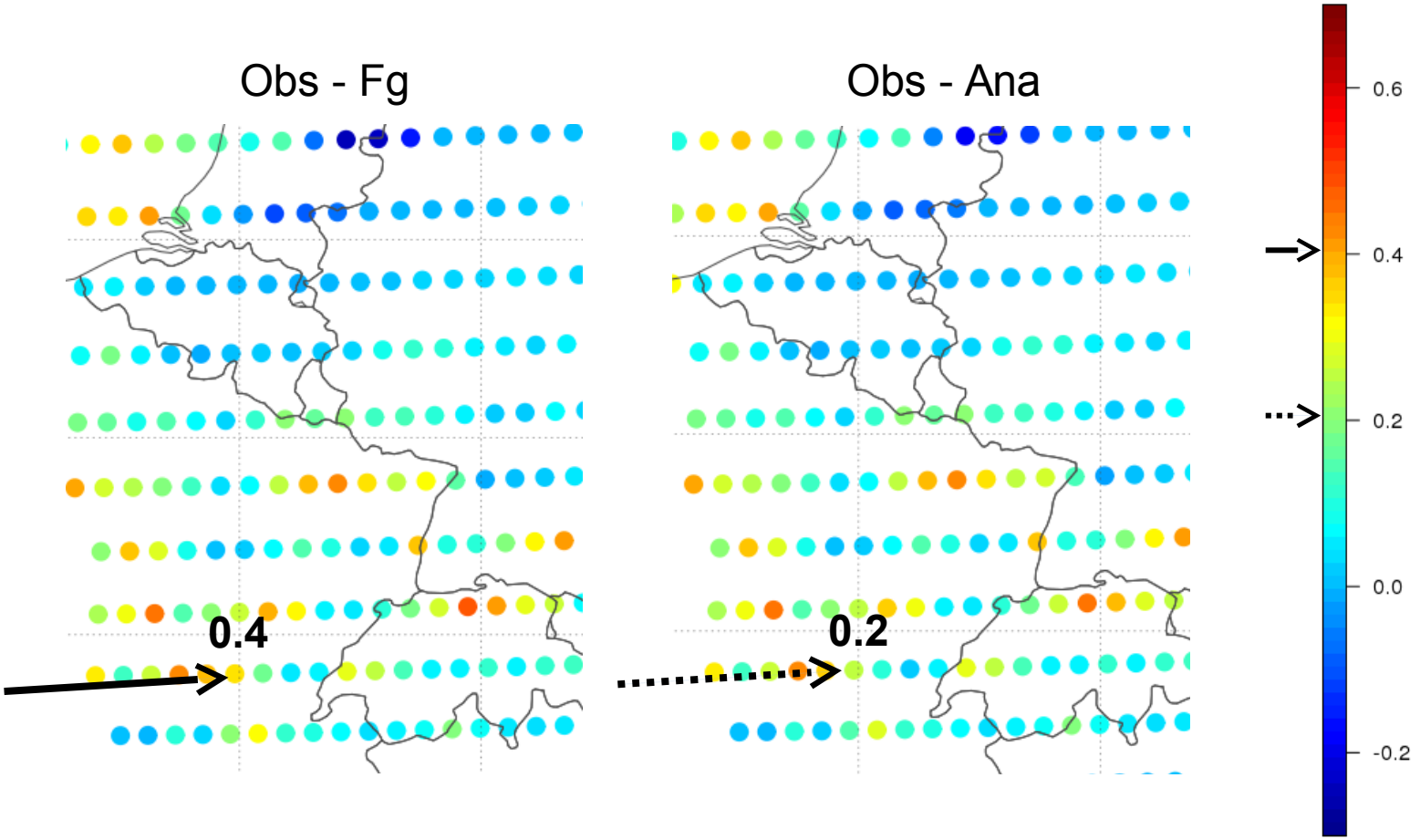
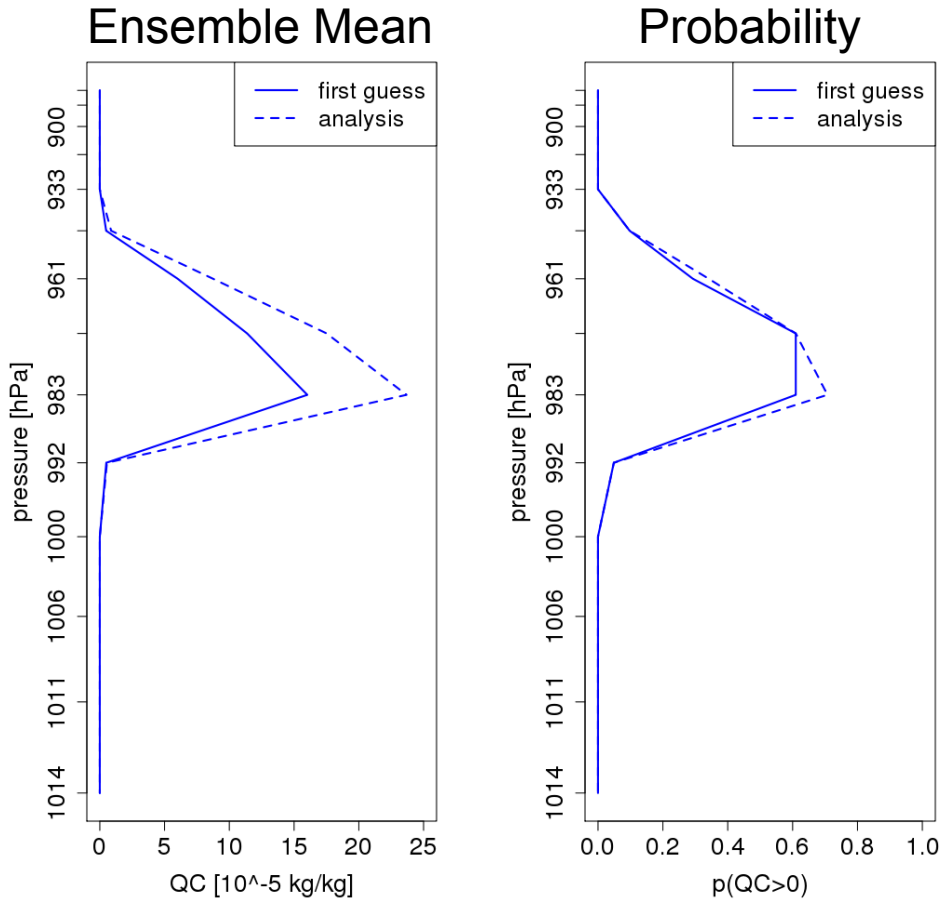
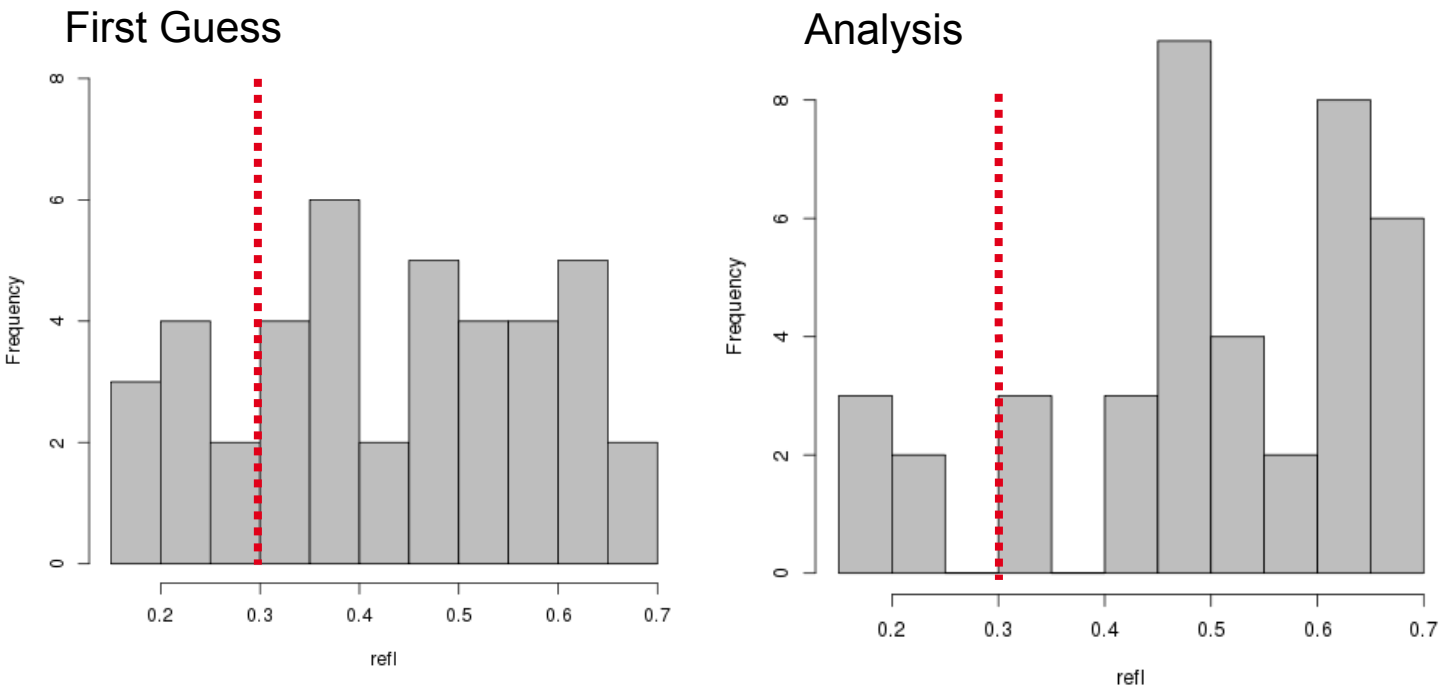


Can we generate cloud water?



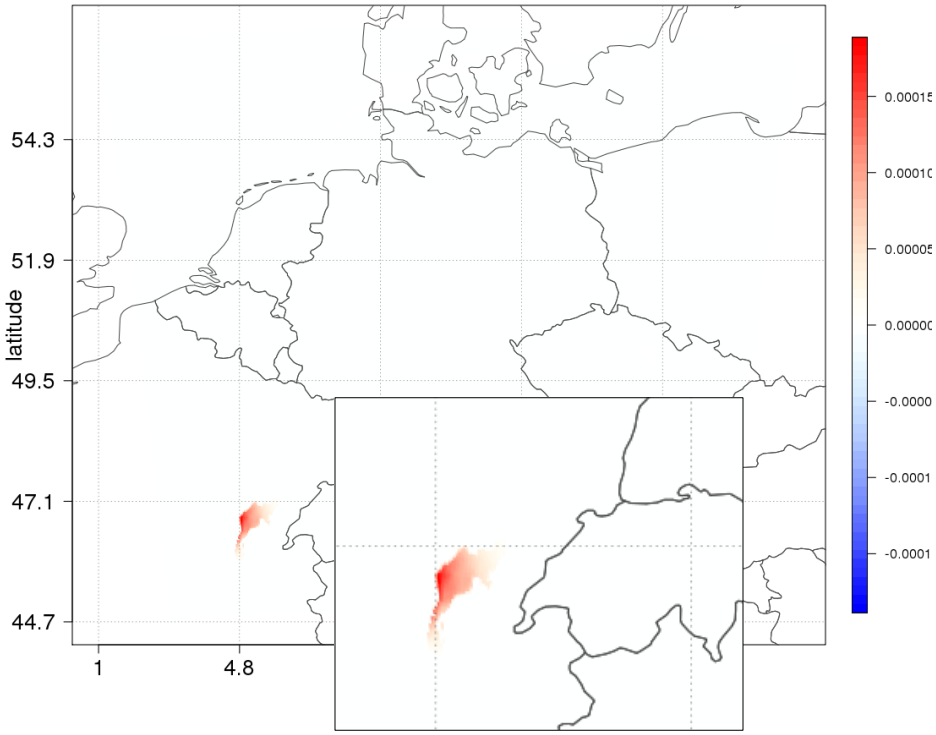
LETKF improves both ensemble mean and ensemble

How does the distribution of reflectance change?

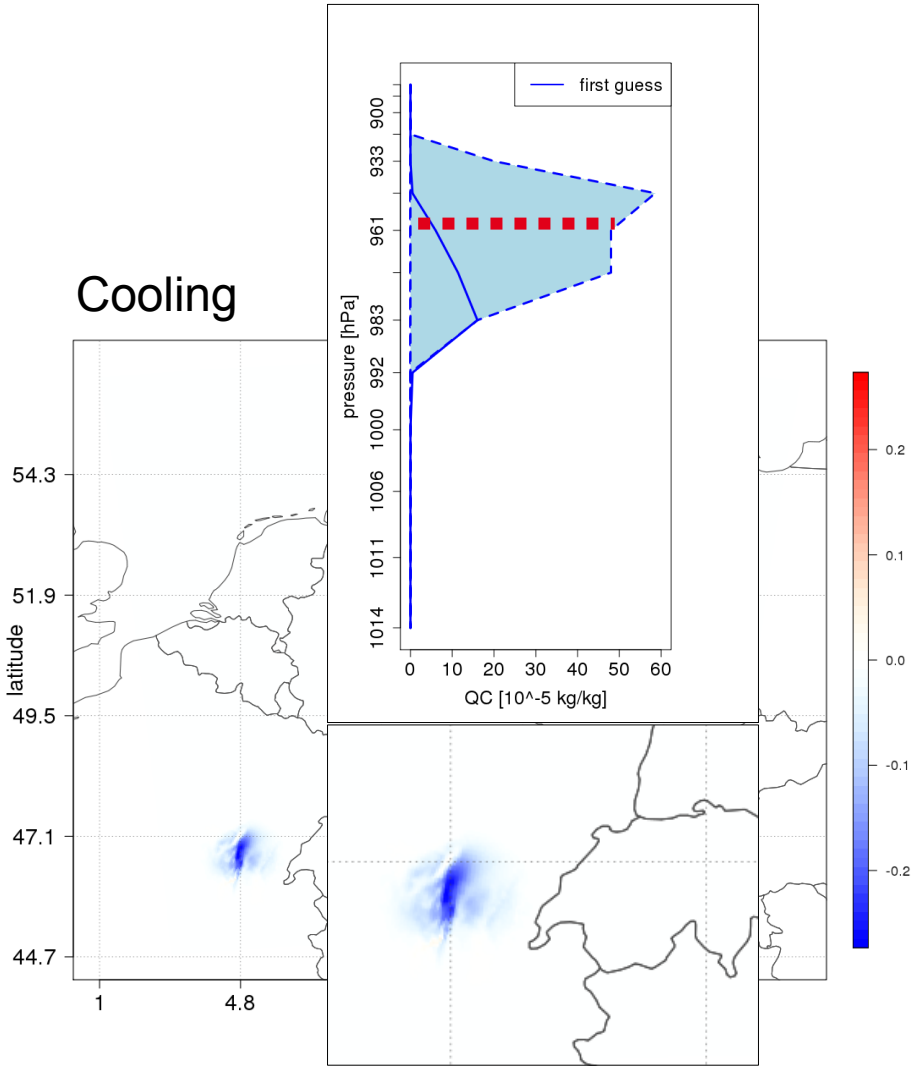


Analysis increments

Generation of cloud water

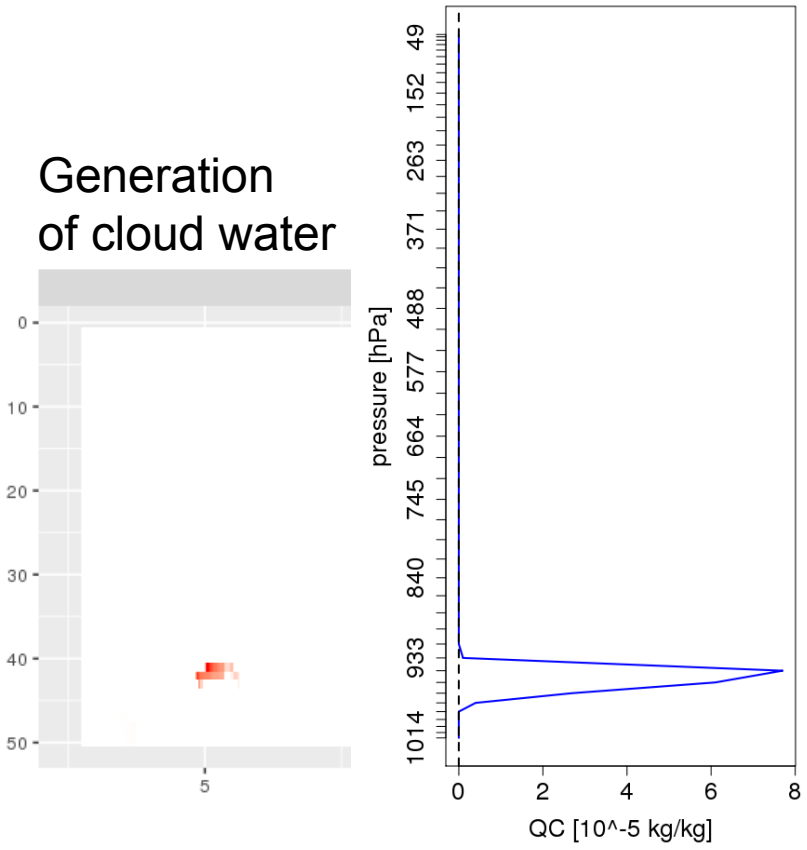


Cooling

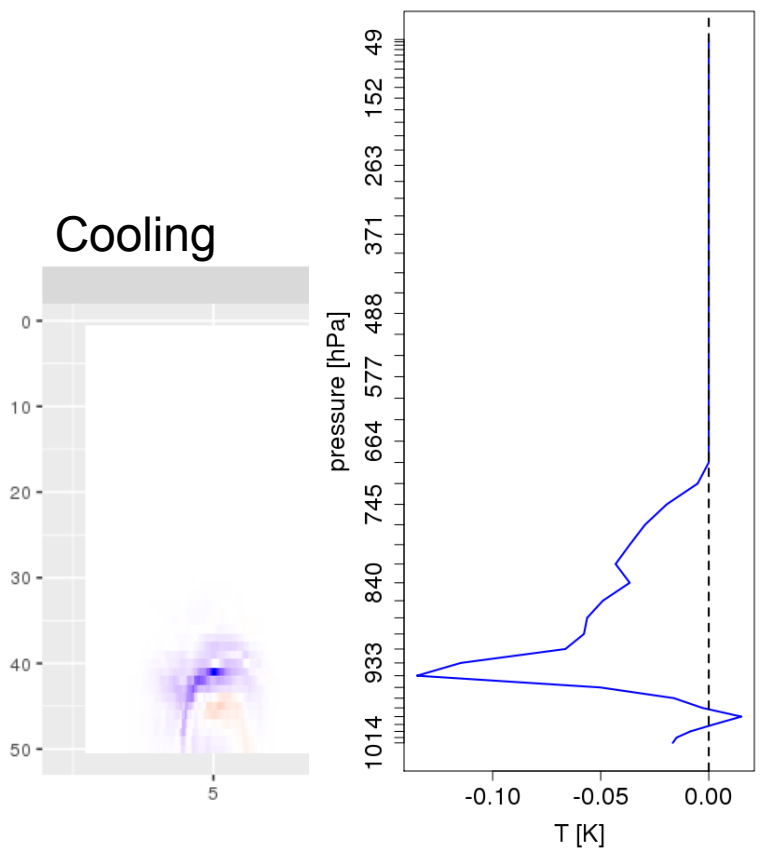


Analysis increments with vertical localization

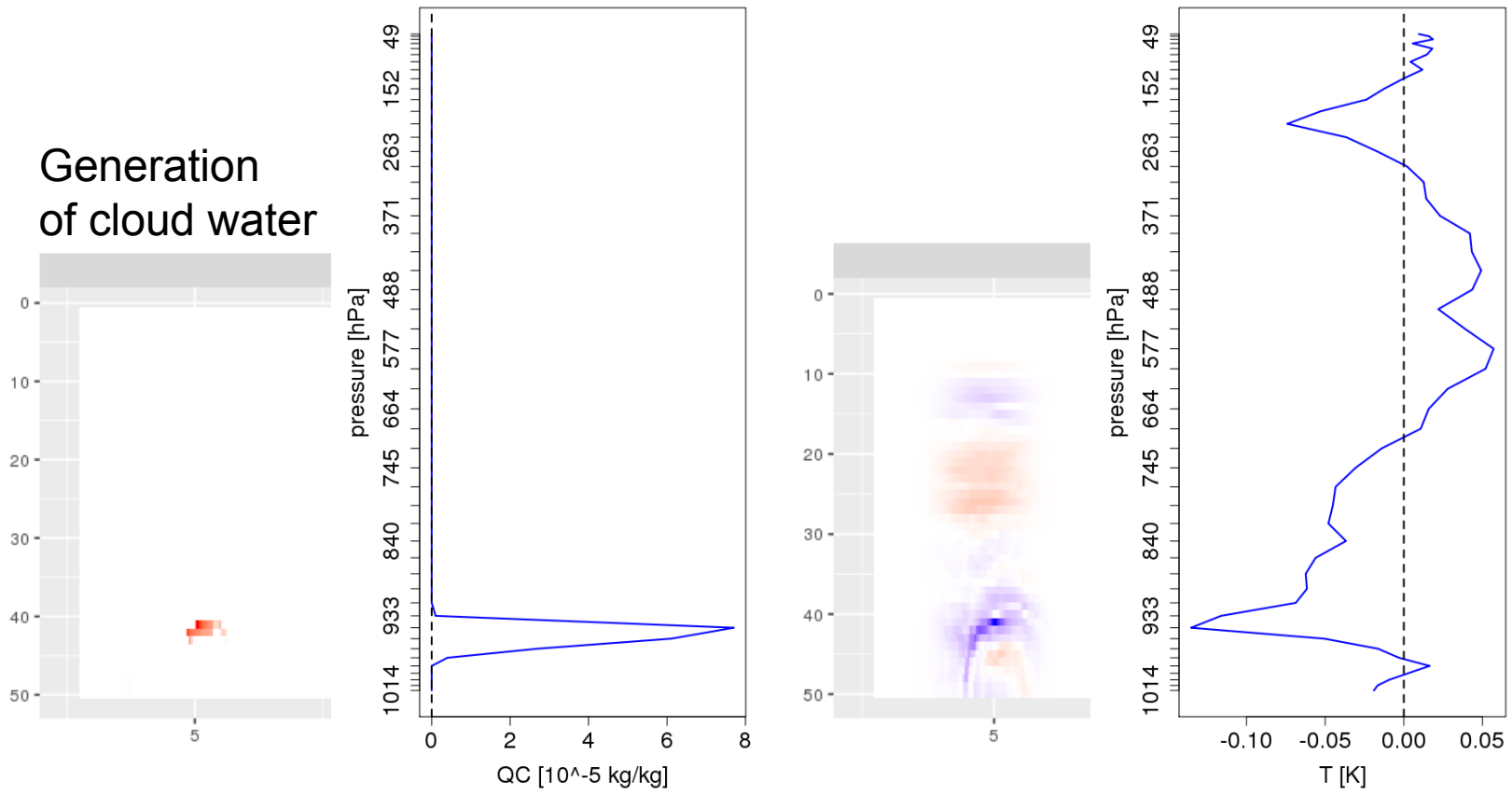
Generation of cloud water



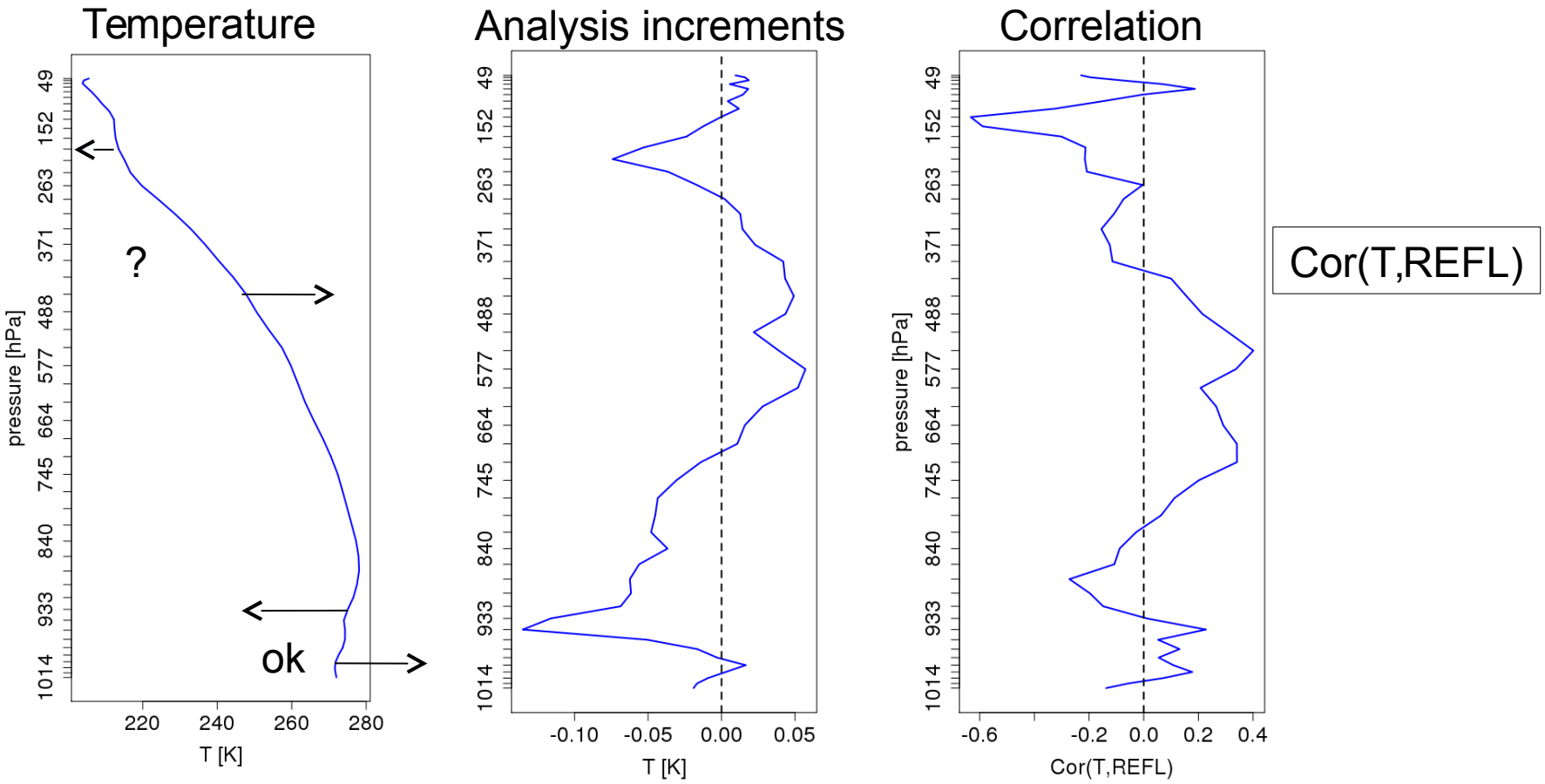
Cooling



Analysis increments without vertical localization



Analysis increments in temperature as would be expected for low stratus vertical profiles?



Vertical positioning and localization

In this case

Cloud Water

Wrong position + vertical localization: no analysis increments

Temperature

No vertical localization: spurious analysis increments due to spurious correlations

Reflectance represents a vertically integrated quantity

Approach

Avoid spurious analysis increments

- Make use of EUMETSAT cloud top height products
  - Optimal Cloud Analysis (OCA)
  - NWCSAF

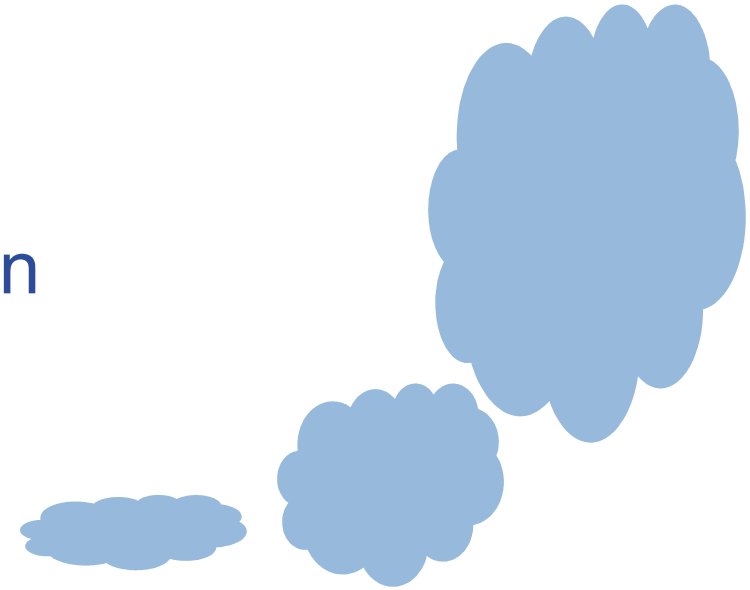
- Position at cloud top height and use asymmetric Gaspari Cohn function?

- Additionally combined assimilation with SEVIRI-IR

SUMMARY low stratus single observation experiment

- LETKF shows reasonable performance
- Improvement of representation of low stratus in ensemble mean and ensemble
- Temperature increments in vertical region of low stratus reasonable (cooling)
- Above questionable but not judgable (no radiosonde)
- Need for vertical localization

Convection



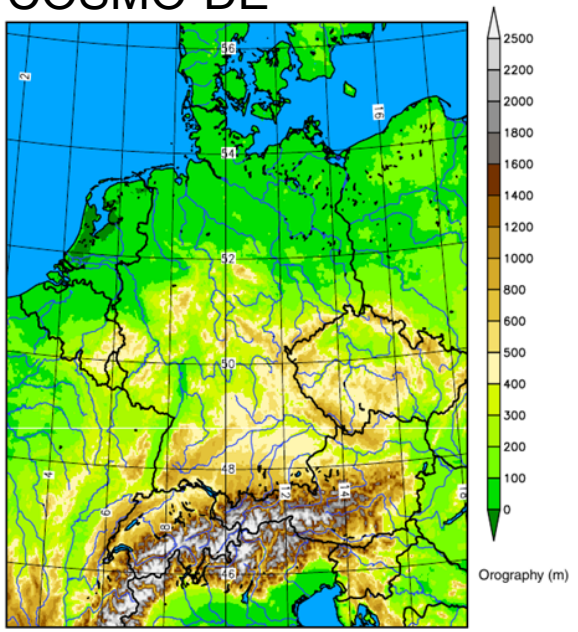
Experiments

- Convective period (May, 28th to June, 6th 2016)
- COSMO-2.8km (convection-permitting)
- Operational set-up

- Superobbing 18km x18km (eff. resolution)
- No vertical localization
- Observation error 0.3
- Assimilation 1/hour (analysis time)

- Conventional obs (incl. MODE-S)
- Conventional obs (incl. MODE-S) + SEVIRI-VIS

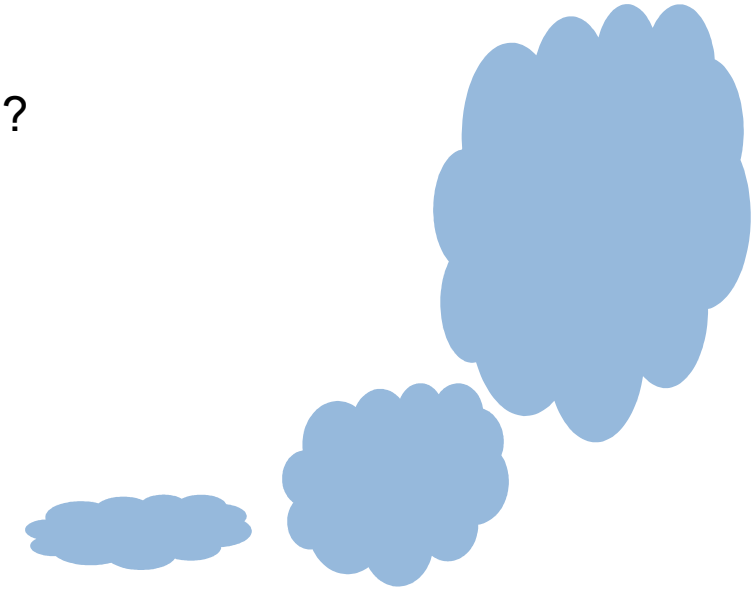
COSMO-DE



Why assimilate SEVIRI-VIS?

1. Can we improve the accuracy of cloud cover?
2. Can we improve the moisture fields?
3. Can we improve convective precipitation?
4. Is the quality of the other variables sustained?

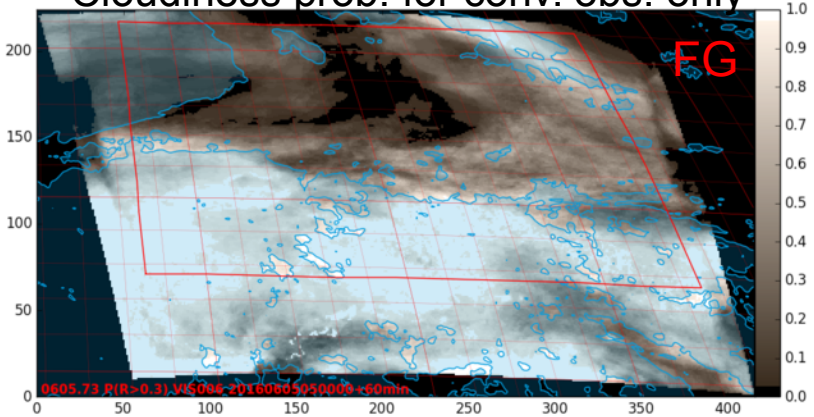
Low stratus



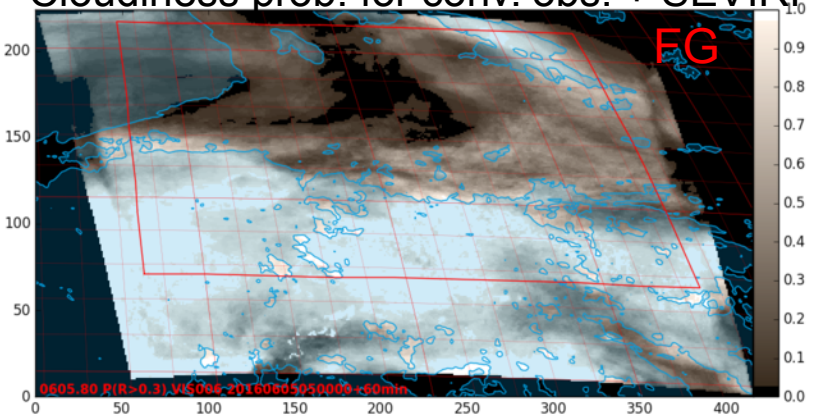
Convective initiation

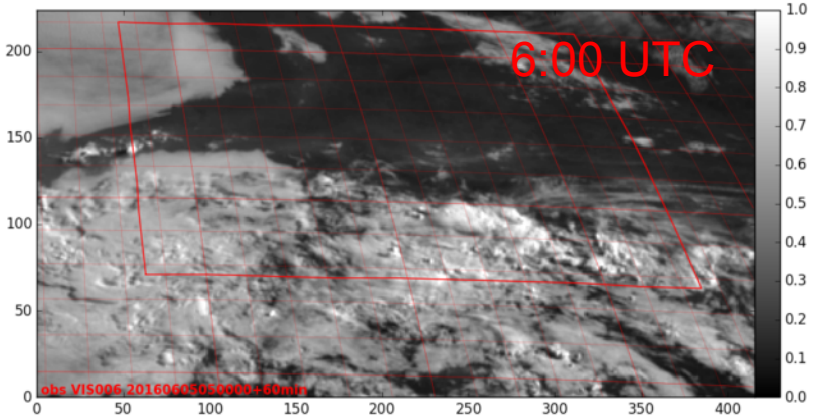
Can we improve cloud cover?

Cloudiness prob. for conv. obs. only

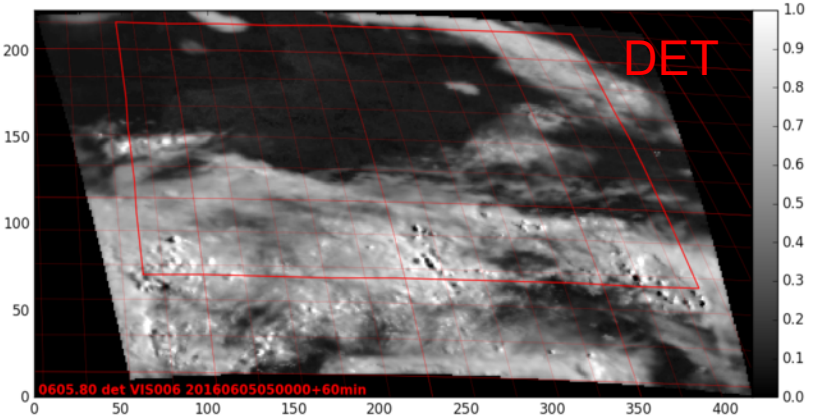


Cloudiness prob. for conv. obs. + SEVIRI





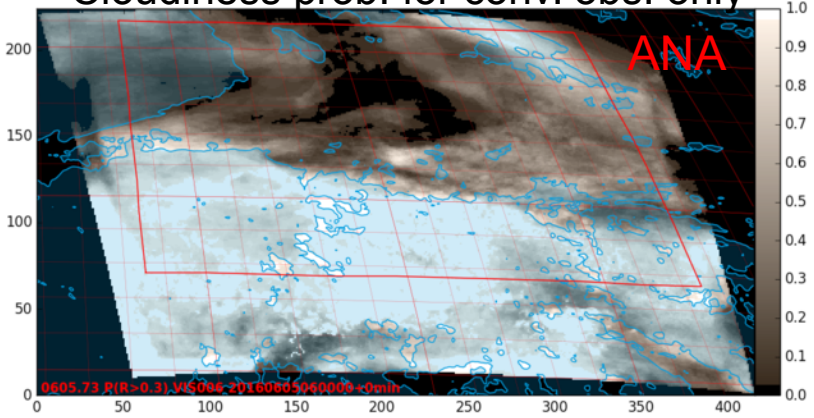
SEVIRI 0.6mu observation



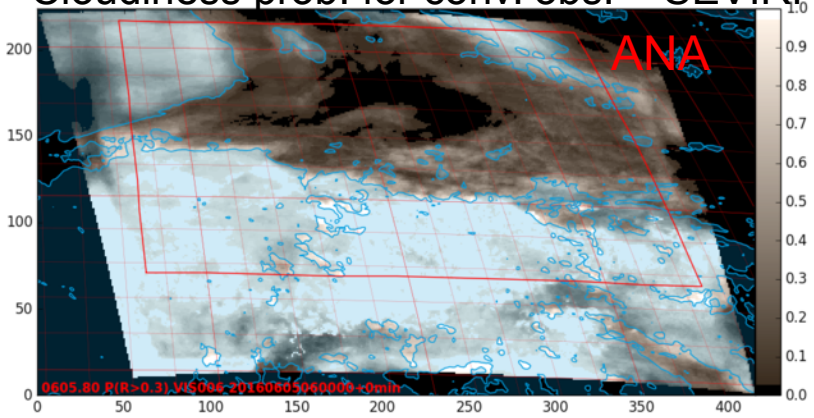
Det. member (conv. obs. + SEVIRI)

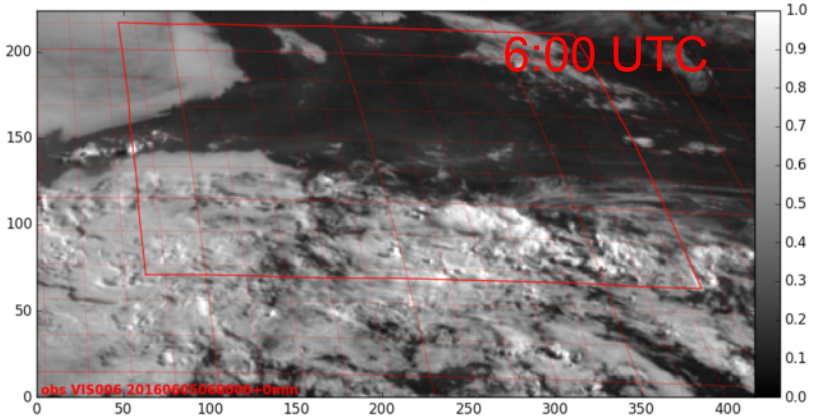
Can we improve cloud cover?

Cloudiness prob. for conv. obs. only

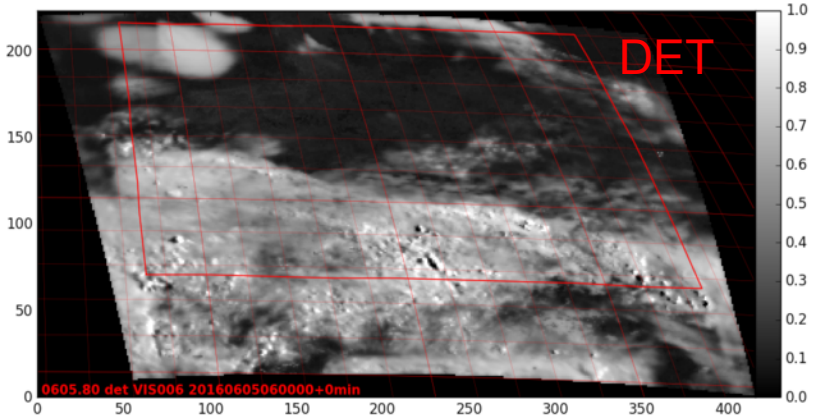


Cloudiness prob. for conv. obs. + SEVIRI





SEVIRI 0.6mu observation



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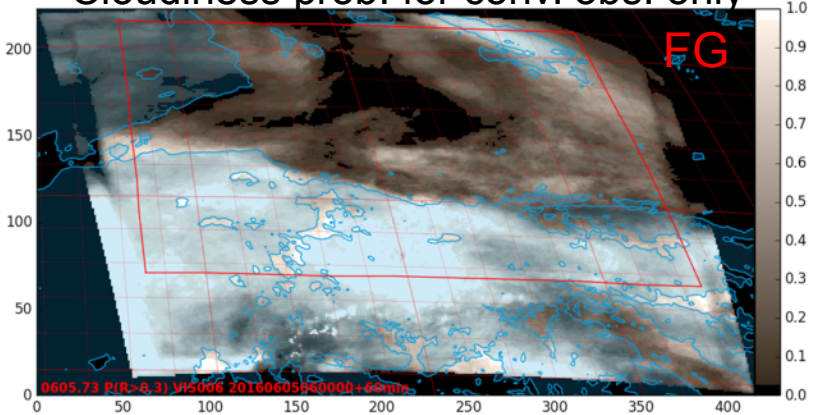

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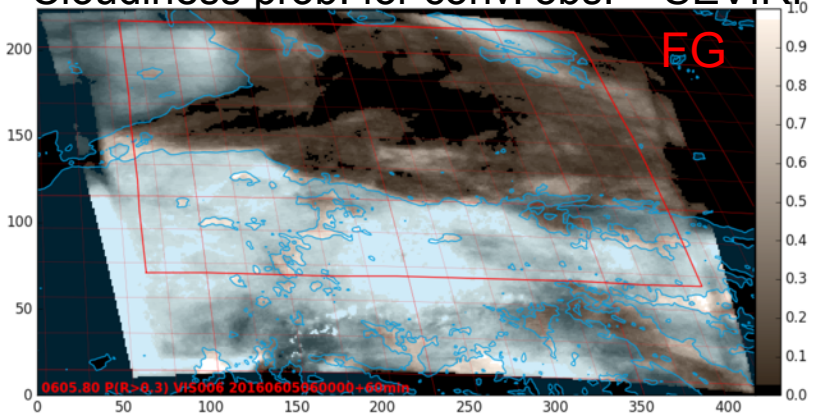
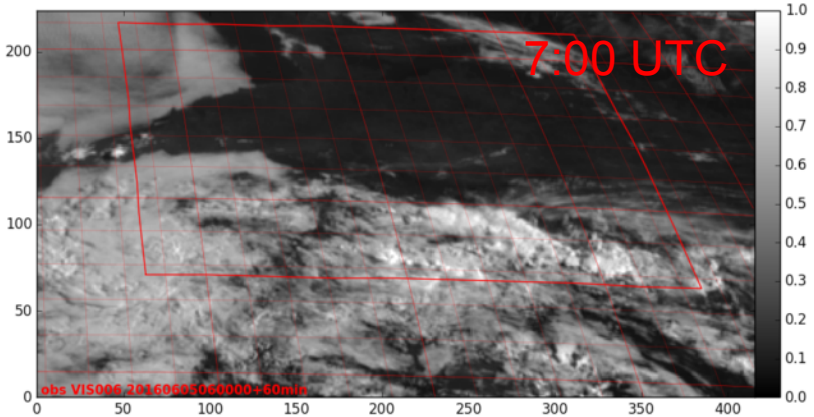
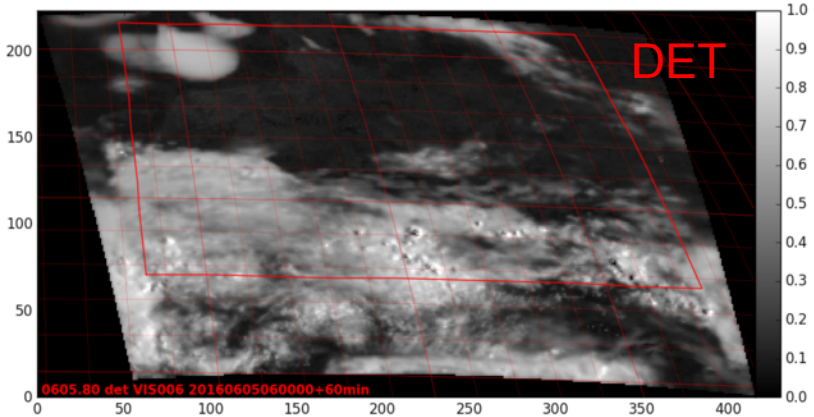




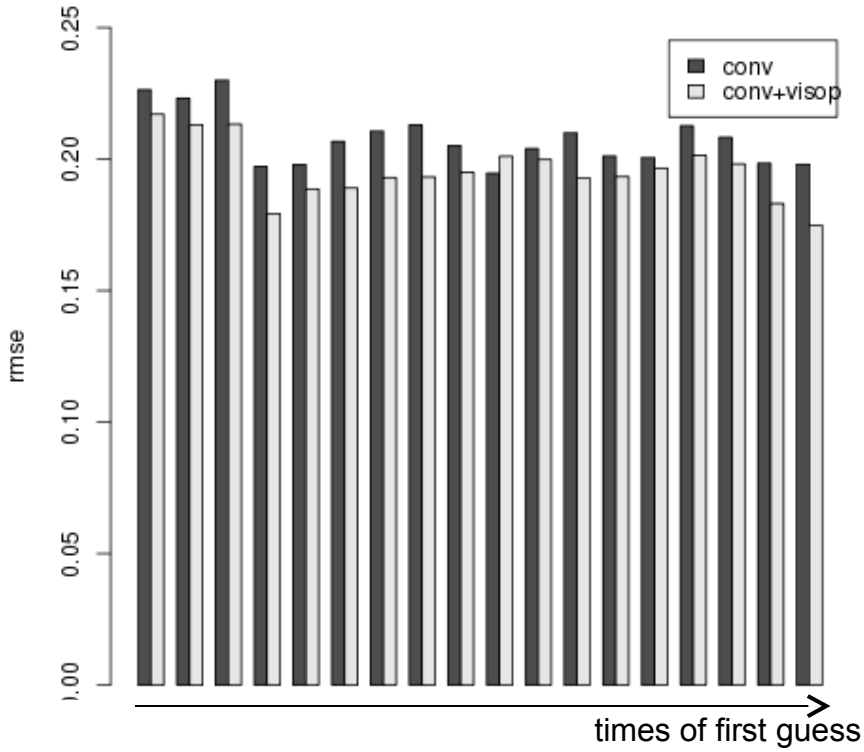
SEVIRI 0.6mu observation



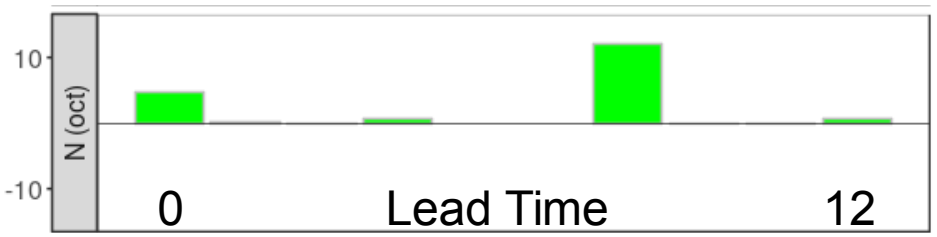
Det. member (conv. obs. + SEVIRI)

Can we improve cloud cover?

First Guess RMSE (reflectance)



Forecast RMSE (cloud cover)



Verified against SYNOP

Averaged over 00,06,12,18 12-hour forecasts

Verified against SEVIRI-VIS

New moisture-sensitive observations

- < 5% of upper-air observations in COSMO-KENDA are moisture-sensitive
- Radiosondes, 9 Lufthansa aircrafts
- Ongoing work on GPS Slant Delay + IR-channels of Seviri + radar reflectivities

<u>SEVIRI-VIS adds, depending on superobbing/thinning</u>

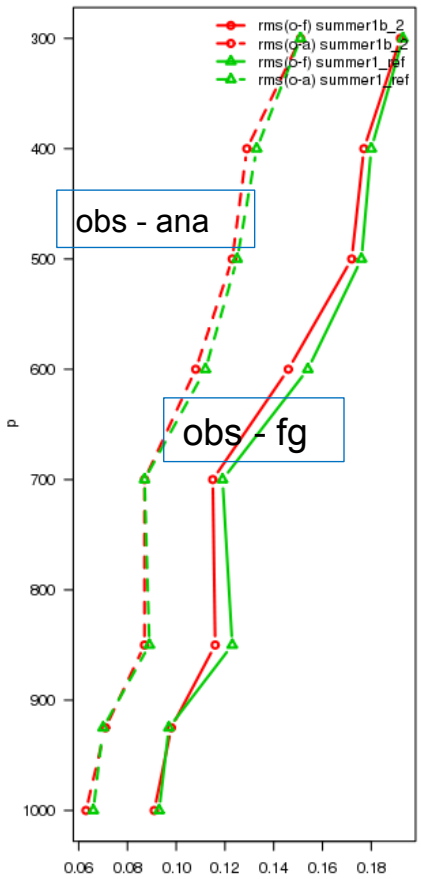
- ≈ 17000 obs/day (summer)
- ≈ 8500 obs/day (winter)

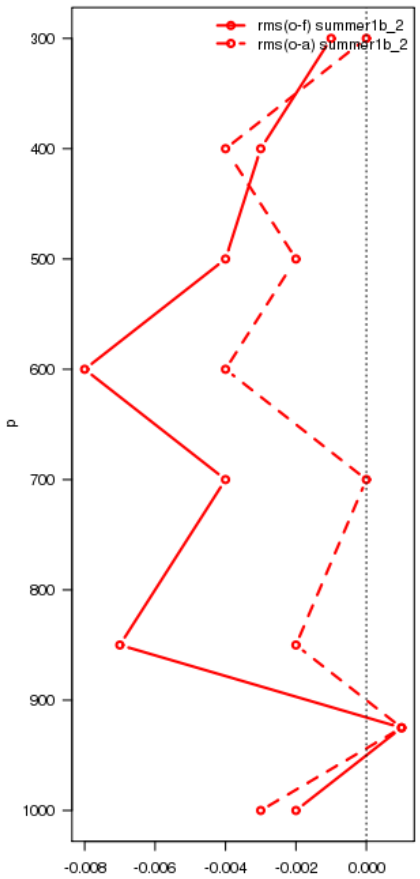
Do we obtain a positive impact on the moisture fields?

Can we improve the moisture fields?

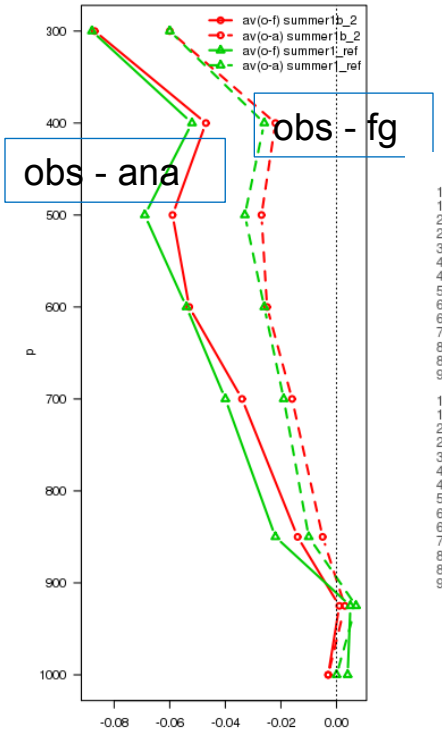
Relative humidity verified against temps and aireps

RMSE



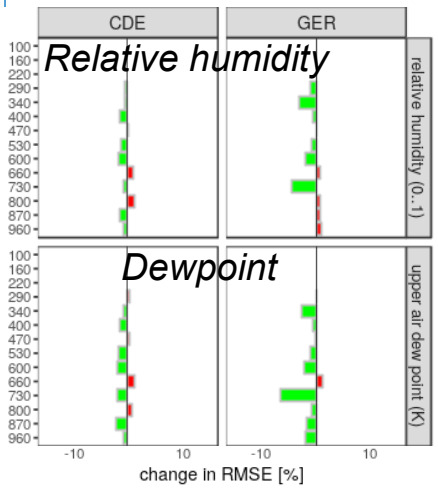


BIAS



exp
ref

RMSE FORECASTS

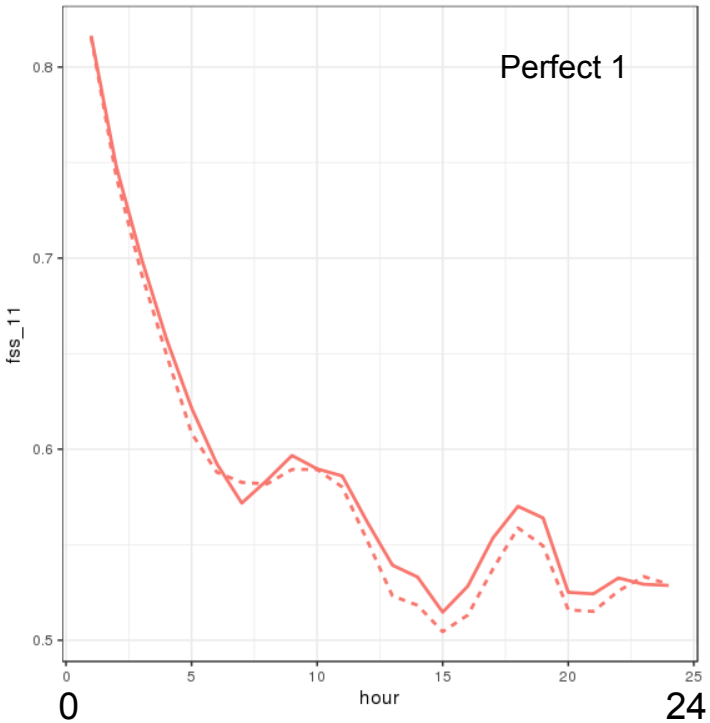


Can we improve convective precipitation?

Verified against derived radar precipitation rates

CONV+VIS
CONV

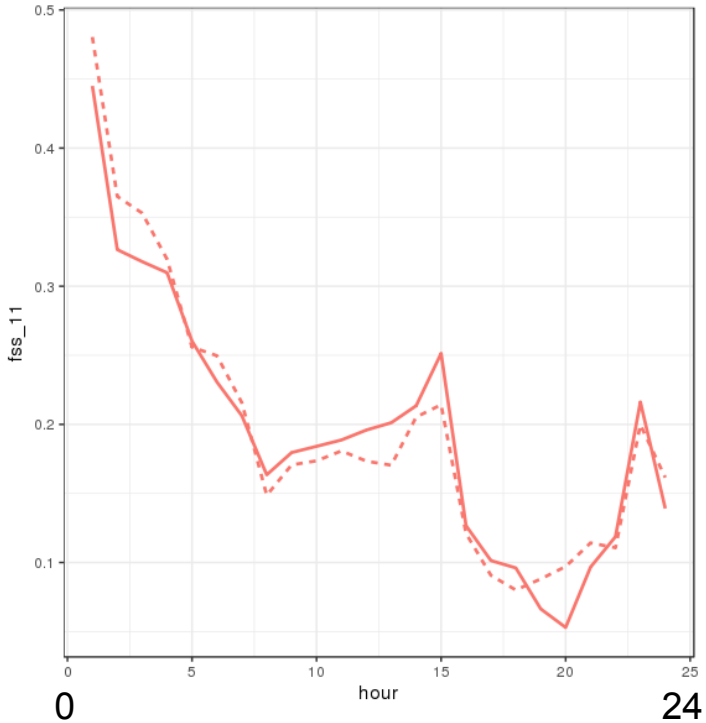
0.1mm/h (Scale 11 GP)



0 24

Lead Time

5mm/h (Scale 11 GP)



0 24

Lead Time

Fraction Skill Score

Frequency Bias unchanged, ETS slightly improved

Is the quality of the other variables sustained?

Verified against radiosondes, aireps and synop

Analysis	First Guess	Forecasts
T	T	T
WIND	WIND	WIND
SURFACE	SURFACE	SURFACE

Better
Neutral
Worse

Surface T2M, TD2M, RH2M, PS, U10M, …

SUMMARY why assimilate SEVIRI-VIS?

1. Can we improve the accuracy of cloud cover?
   ➔ *Yes*

2. Can we improve the moisture fields?
   ➔ *Yes*

3. Can we improve convective precipitation?
   ➔ *Promising at small thresholds, work to be done for higher ones*

4. Retain quality of other variables?
   ➔ *Yes partly, surface degradation due to compensating errors*

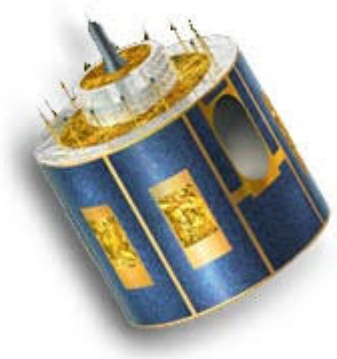
   & lack of vertical localization?

Summary

- First experiments show potential in many directions

Scientific issues

- Impact of vertical positioning and localization using cloud products?
- Do nonlinearities lead to physical inconsistencies such that newly generated clouds evaporate soon after analysis?



What else?

- Switch to RTTOV-MFASIS & ICON-LAM & lots of tuning
- Test combination with SEVIRI-IR allsky
- Goal: improvement of cloud cover and precipitation up to +12 hours

Assimilating SEVIRI-VIS to improve the representation of convective initiation and low stratus

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