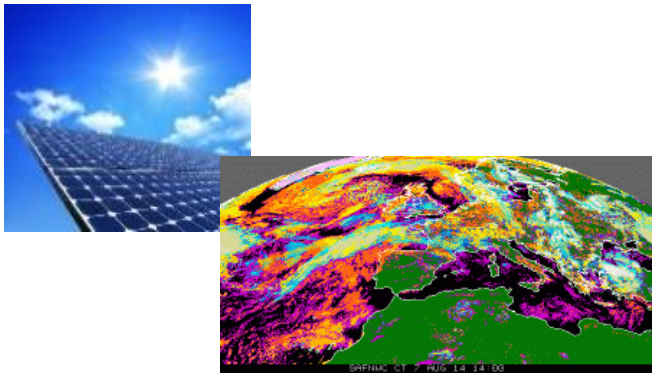
# Recent work

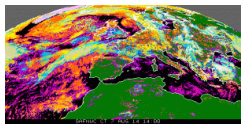


*Annika Schomburg, Christoph Schraff*

# Outline

- Status photovoltaic data assimilation

- Status cloud assimilation



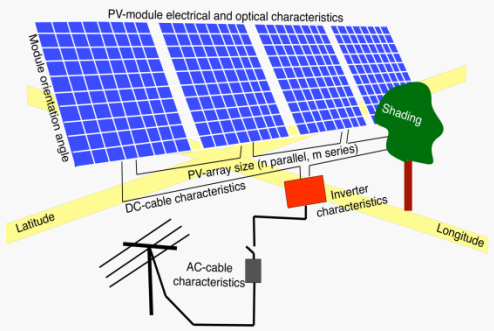
# Photovoltaic power

# Assimilation of photovoltaic power

## Forward operator:

**Model variables:**
- surface irradiance
- 2m temperature
- albedo

**Forward operator for PV module**




Source: Yves-Marie Saint-Drenan, IWES

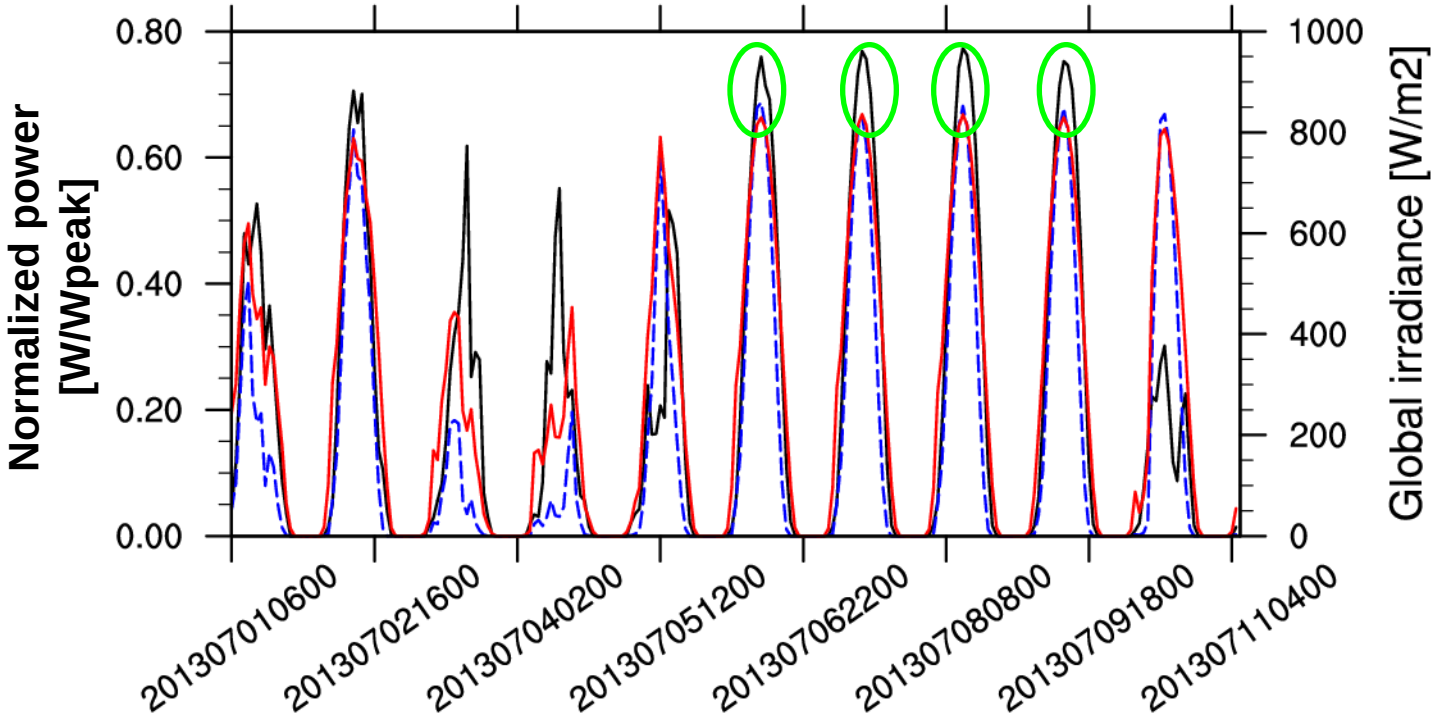
**Synthetic PV power** (clouds main forcing factor)

# Test of operator: Example of simulated and observed photovoltaic power

**Model forecast solar insolation at surface**

**Observed photovoltaic power**

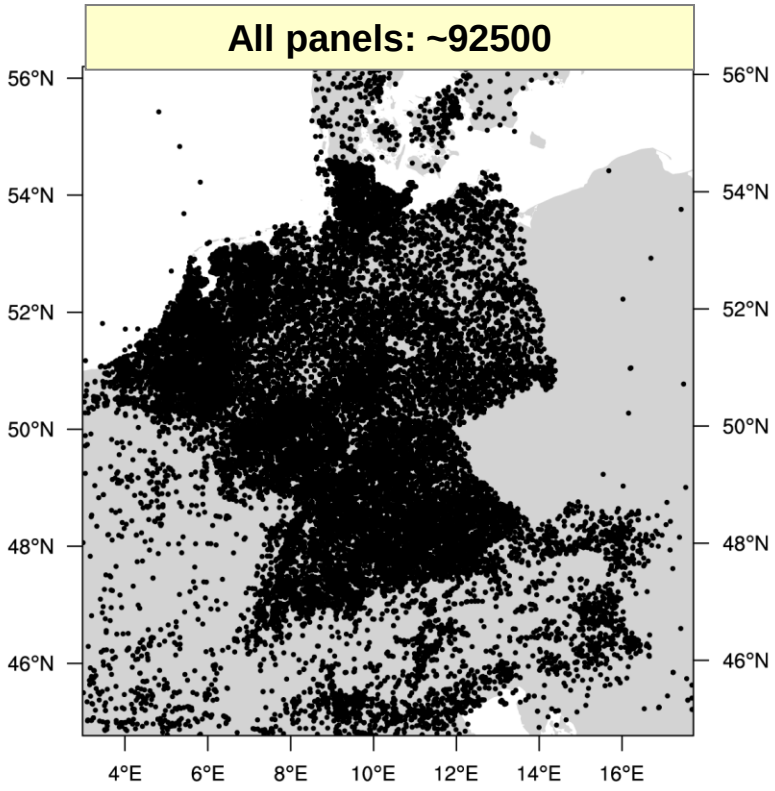
**Simulated photovoltaic power (based on model forecast radiation)**

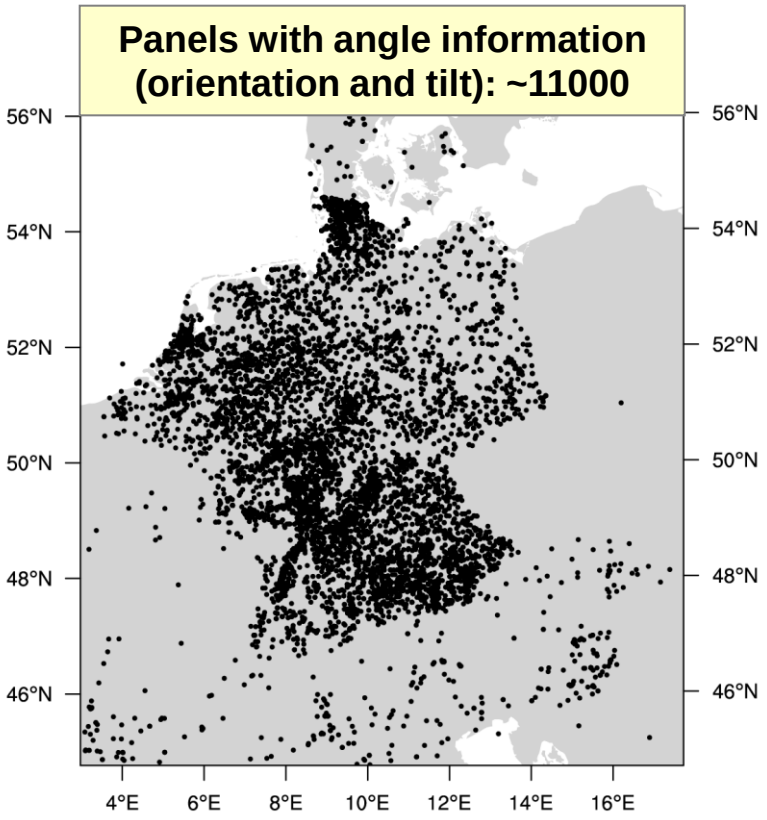


# Data availability: SMA data

1 month of test data (May 2014) over COSMO domain available

- Exact location of panels known
- For some panels orientation and tilt angle information available



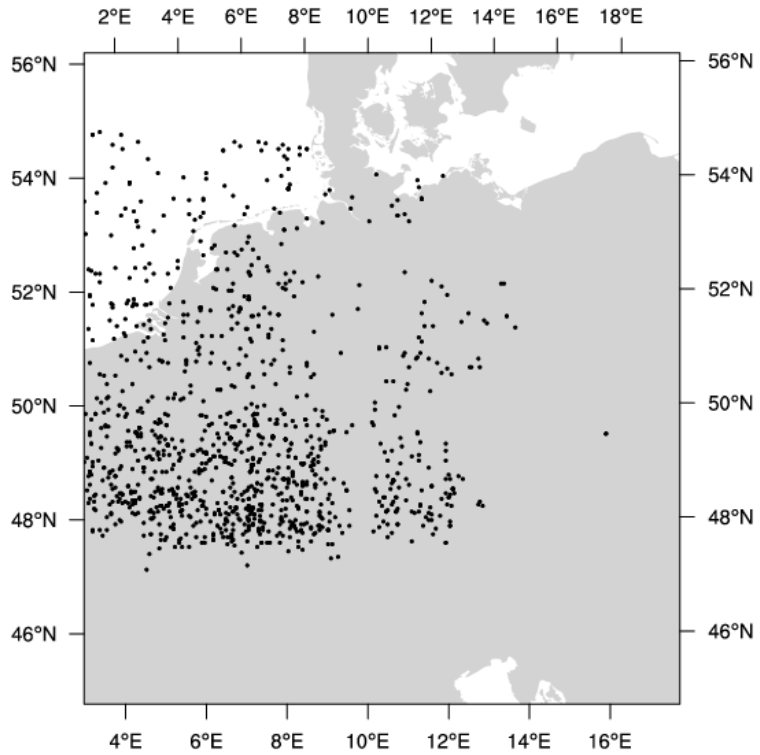



# Next steps

- Currently: Setup a framework for Quality control (*Because our project partner, the IWES Fraunhofer institute, who was supposed to do that work package is not allowed to see the data*)
- Data may be affected by:
  - Failure of single strings
  - Soiling
  - Shading by trees oder buildings
  - Peak power given or other meta-data incorrect
  - No information on temperature coefficients
  - Snow

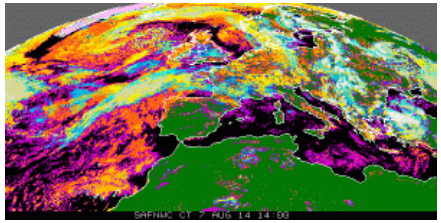
  → Idea: Feed forward operator with satellite surface radiance product, compare with PV power observations

# Data availability: MeteoControl data




- 1 year of test data available
  - July 2012 – June 2013
  - Exact location of panels is not revealed, power mapped and aggregated to COSMO grid points by MeteoControl
  - but mapped incorrectly, wating for a corrected data set

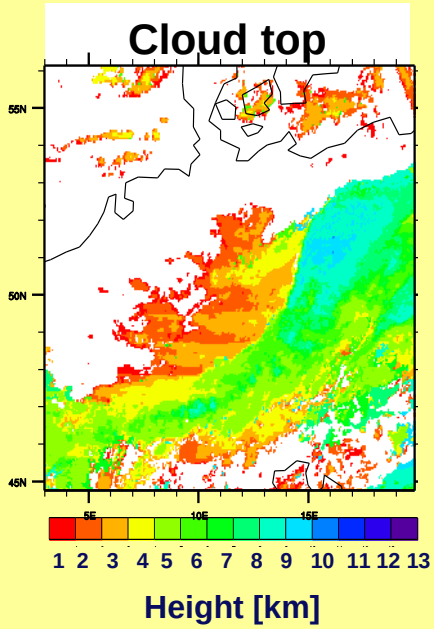
# Satellite cloud products



# Method

- Extract information if a pixel is observed as **cloudy:**

**OBSERVATION:**
**Satellite product: cloud top height**




Assimilated variables:

Cloud top height

100%

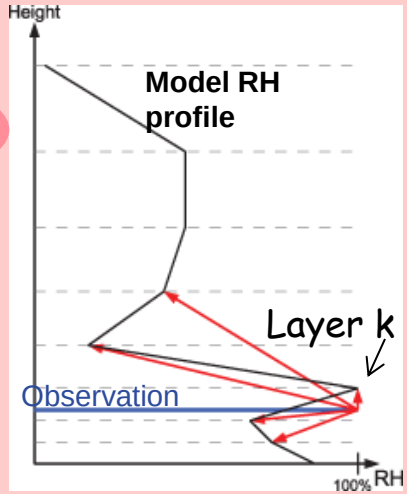
Relative humidity at cloud top height

**MODEL EQUIVALENT**

Determine cloud top model equivalent: top of most humid layer **k** close to observation

height(k)

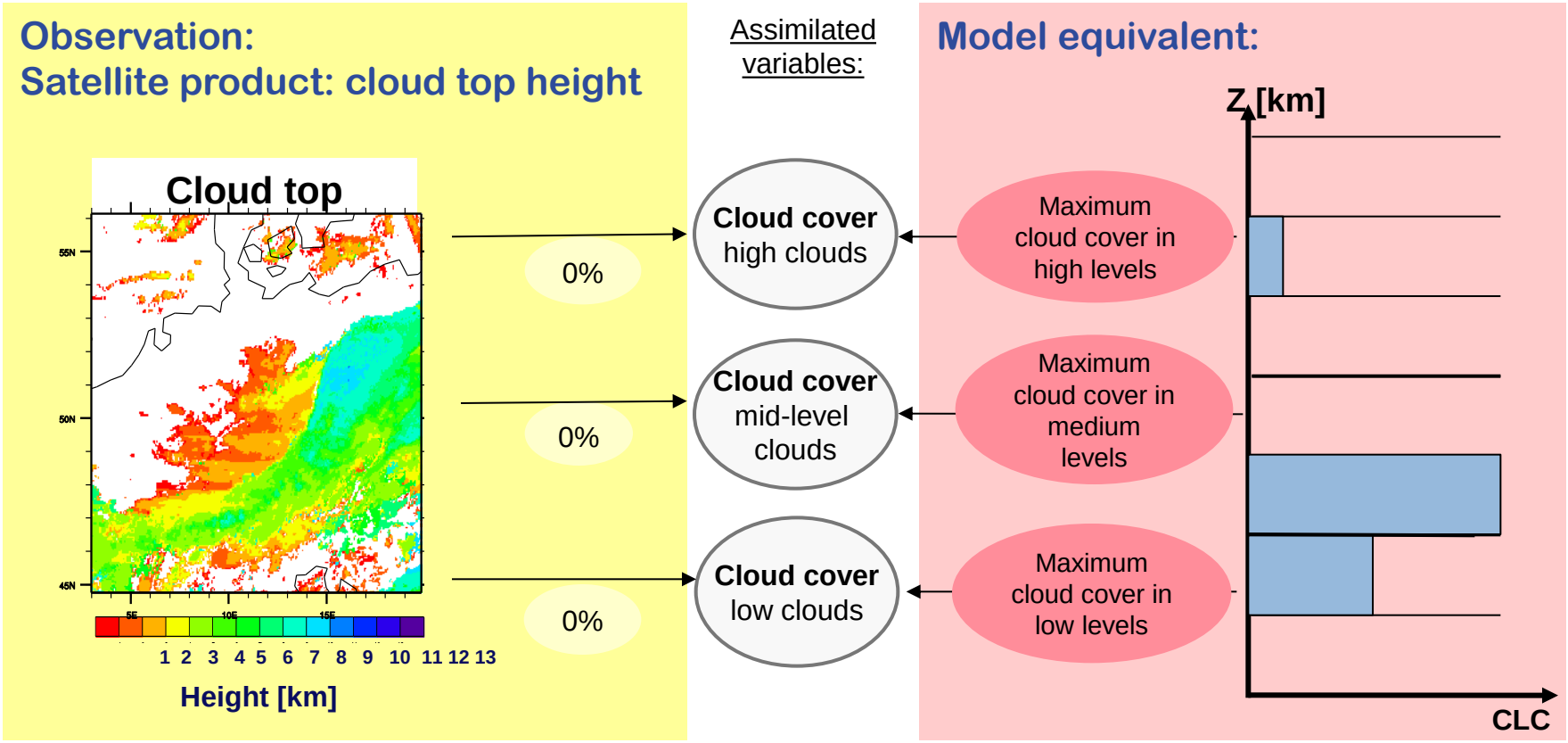
RH(k)




see Schomburg et al., QJRMS, 2014

# Method

- Extract information if a pixel is observed as **cloud-free:**

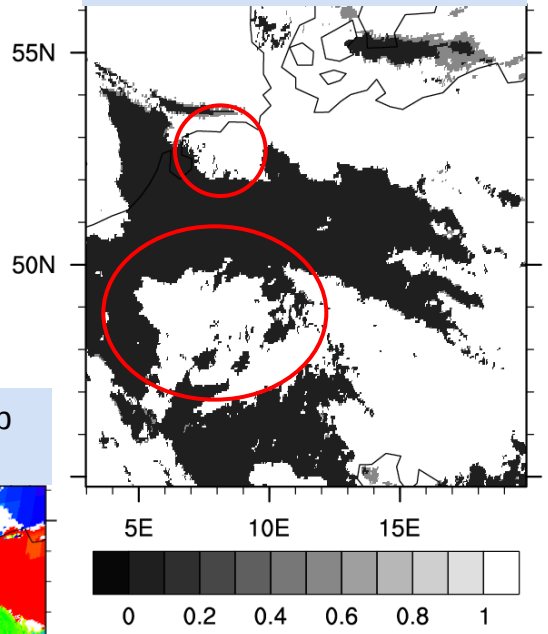



see Schomburg et al., QJRMS, 2014

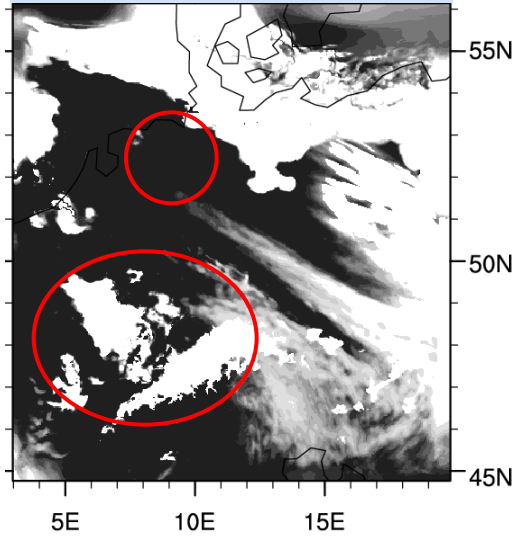
# Comparison of cycled experiments

**Total cloud cover of first guess fields after 20 hours of cycling**

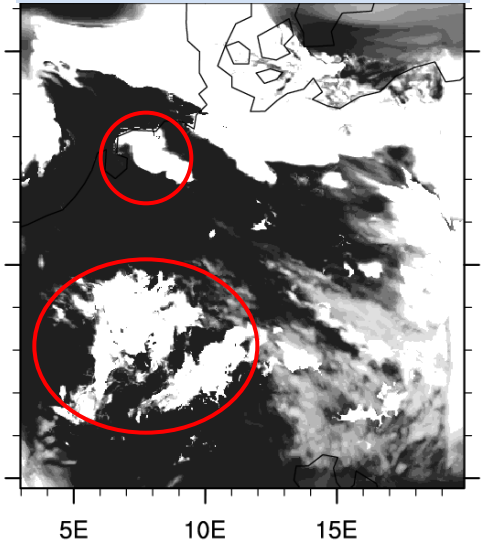
satellite obs



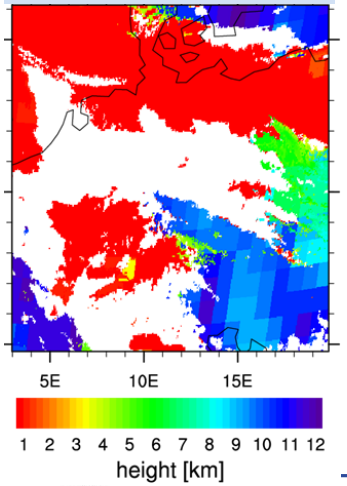

conventional only




conventional + cloud




Satellite cloud top height

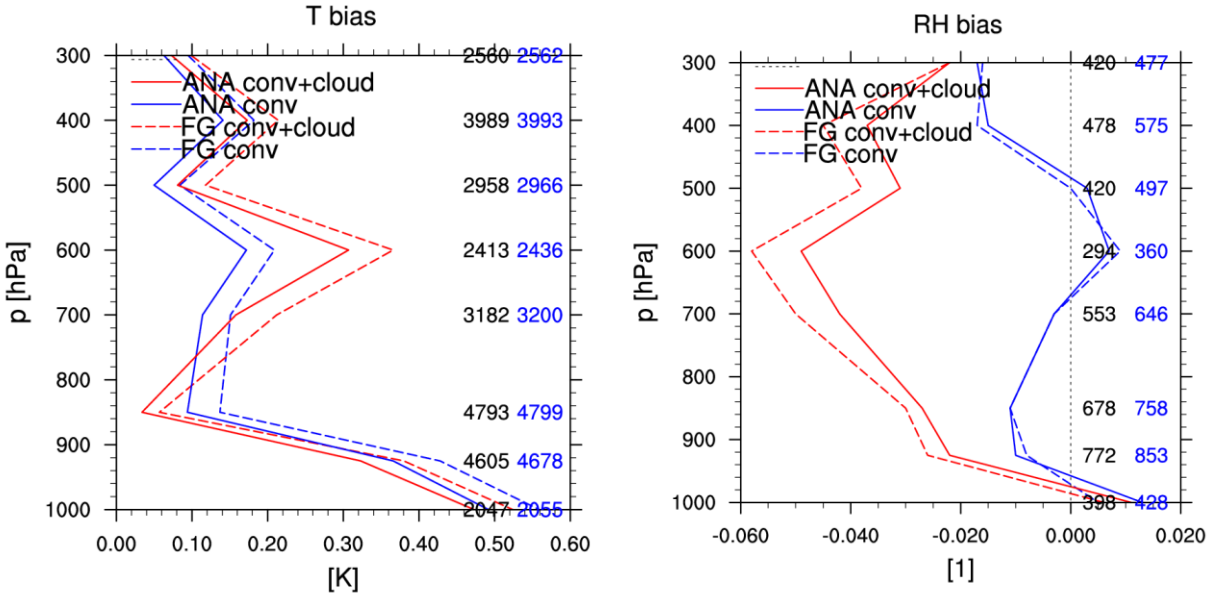



12 Nov 2011
17:00 UTC

Low stratus clouds: Improved cloud cover in analysis-cycle

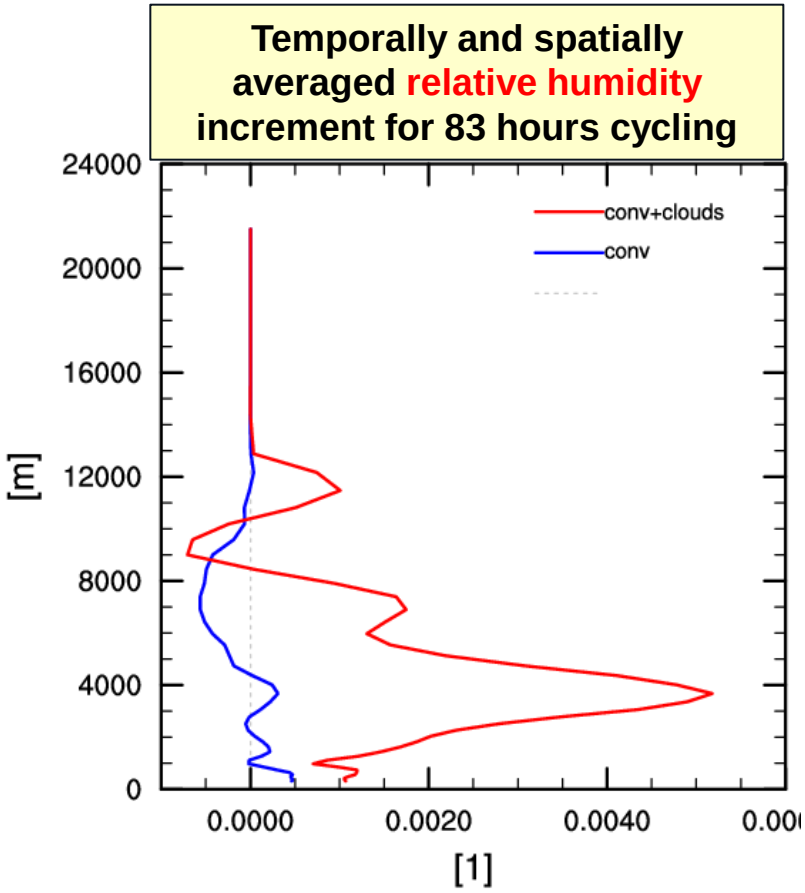
# Upper air verification for 83 hours cycling starting at 12 UTC, 12 Nov 2011: bias

Bias: OBS - FG



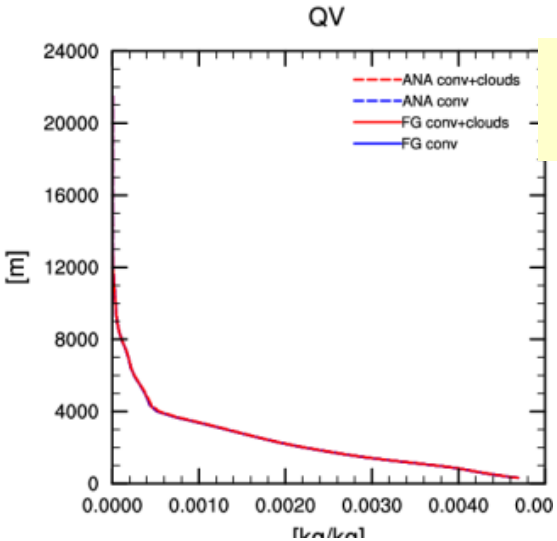

**assimilation of conventional obs only**
**assimilation of conventional + cloud obs**

# Averaged increments (spatially and temporally over 83h)

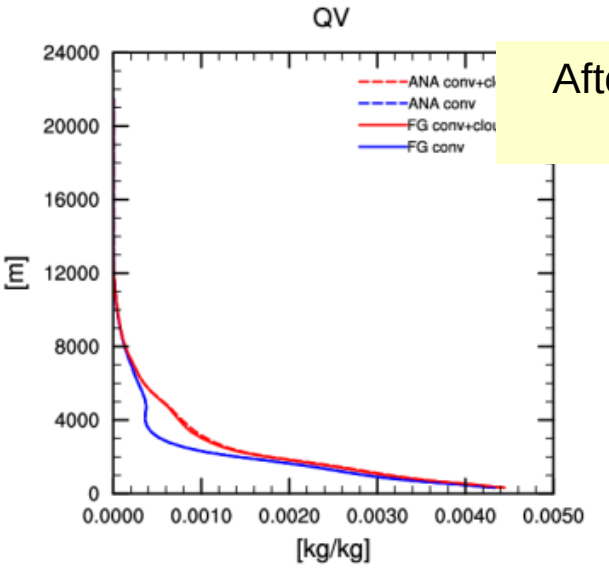



Weird positive moisture increment at 3-4 km height!

# Domain-averaged specific humidity profiles

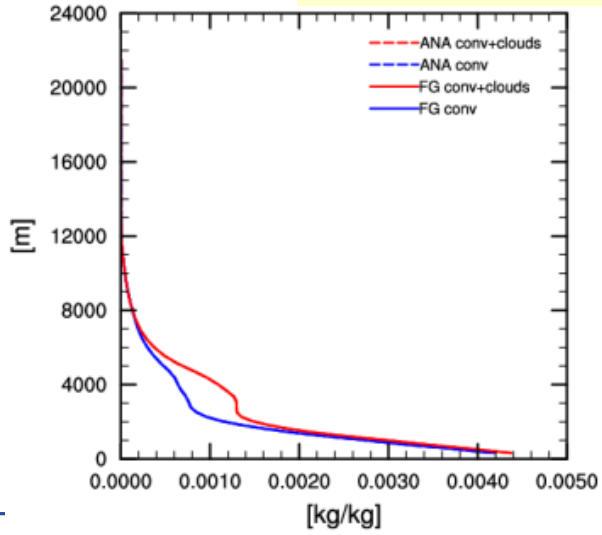



Beginning of cycling




After 24 hours of cycling

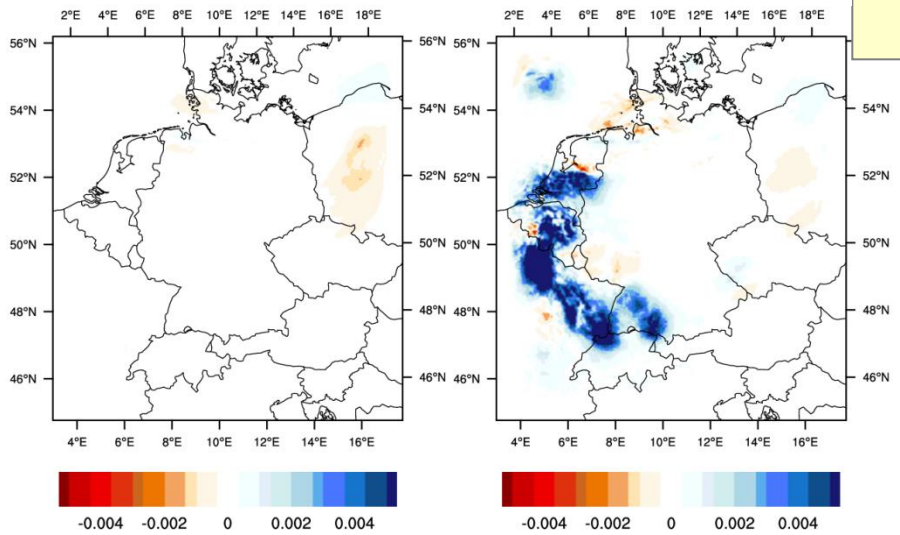
After 48 hours of cycling




**assimilation of conventional obs only**
**assimilation of conventional + cloud obs**

# Moisture increment for 12 UTC, 13 Nov 2011

**Conventional only**

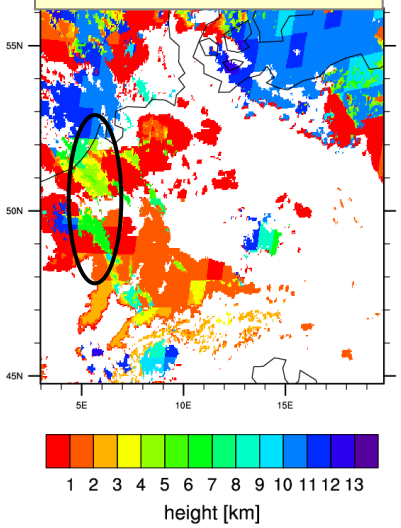



**Conv+cloud**

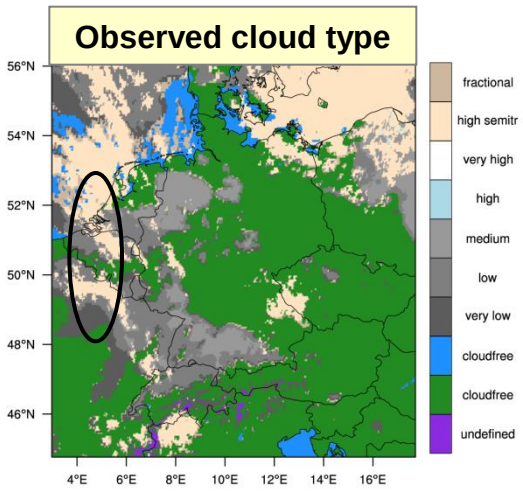



**Mid-level moisture increment**

**Observed cloud top height**




**Observed cloud type**



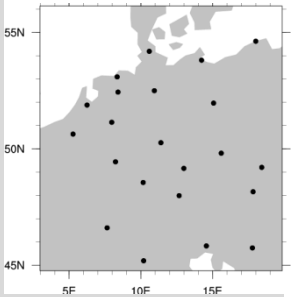

→ **Problems caused** by **incorrect cloud top height** in NWCSAF cloud top height products

# Eliminate suspicious observations

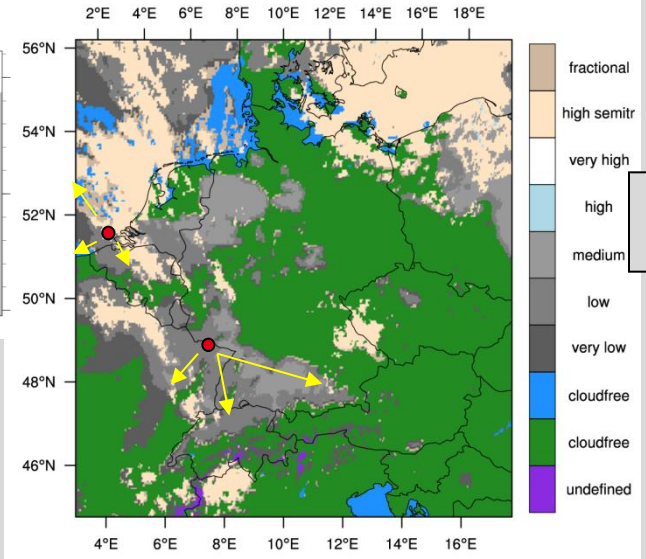
→ *Use flag from cloud analysis to throw away data flagged as "inconsistent"*

**Preprocessing to merge satellite and radiosonde cloud top height information (Cloud analysis)**: Use nearby radiosondes within the same cloud type to correct (or approve) cloud top height from satellite cloud height retrieval

*Radiosondes: coverage*

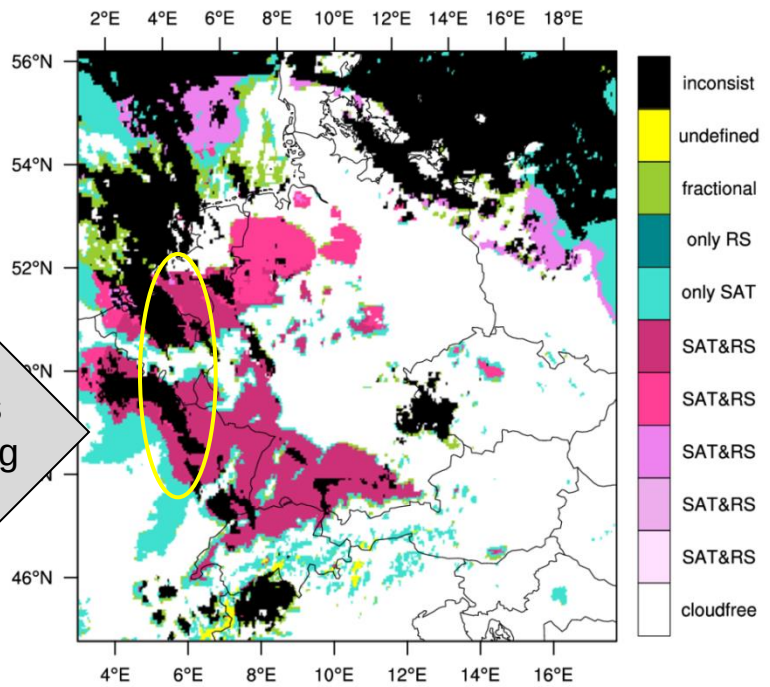



Satellite cloud type

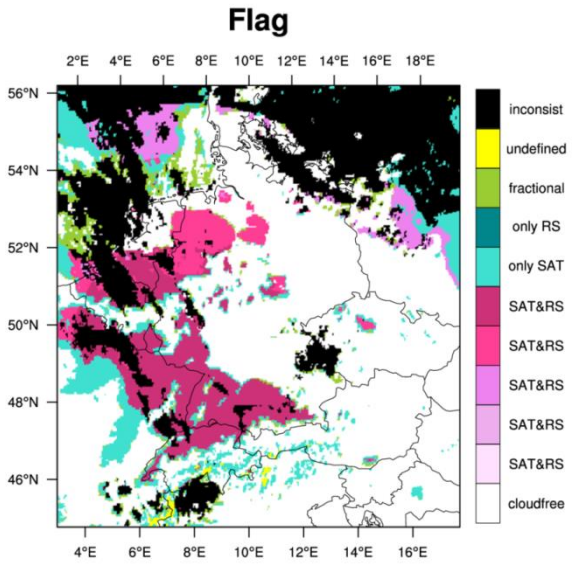


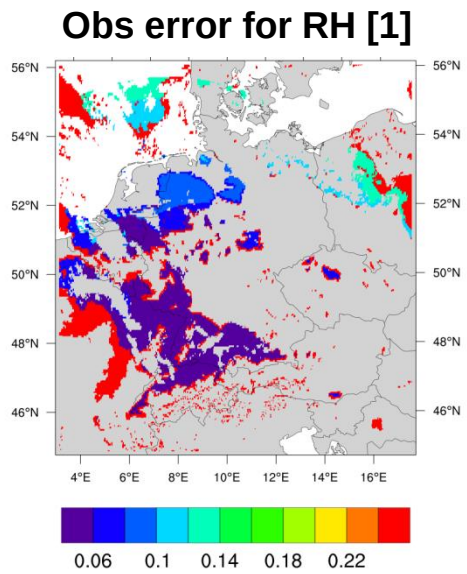

Provides quality flag

Flag



# New experiment

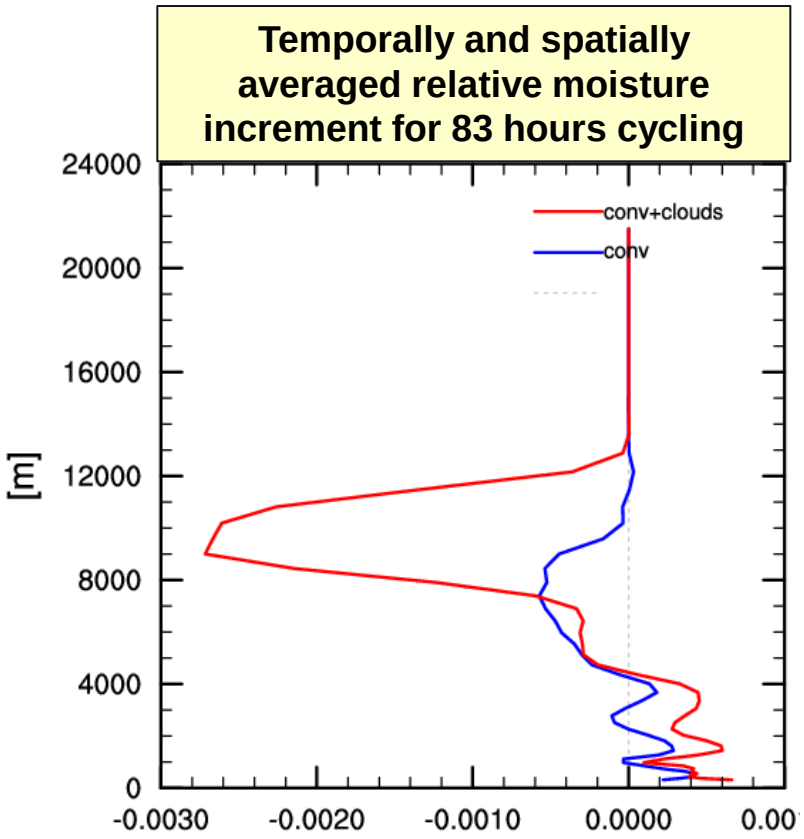



→ **New simulation**

- with more strict data elimination
- and higher observation errors for non-confirmed relative humidity observation at cloud top

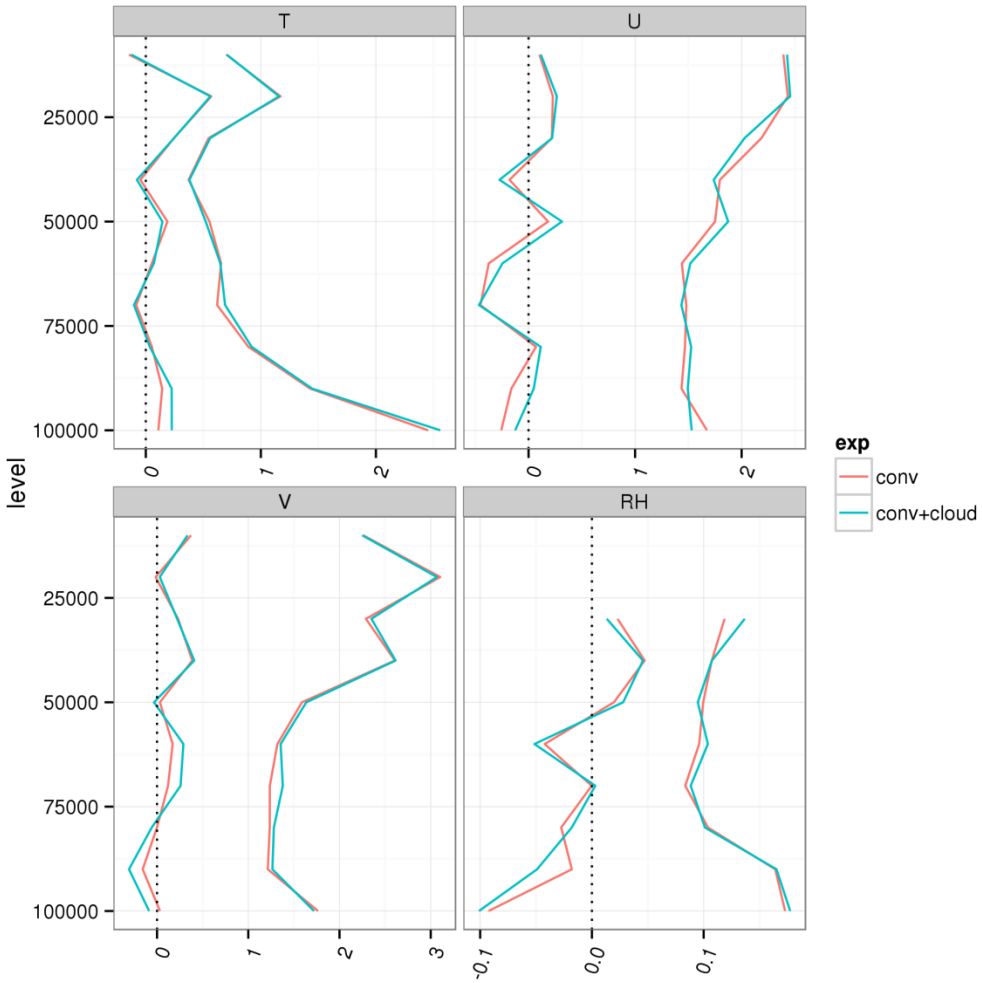
# New cycling results: Averaged increment profile for relative humidity




→ Peak of positive moisture increment at 4km height has vanished

→ Negative peak at 8km probably due to too many high ice clouds in COSMO

# Results of new experiment with rigid quality control: Upper air verification

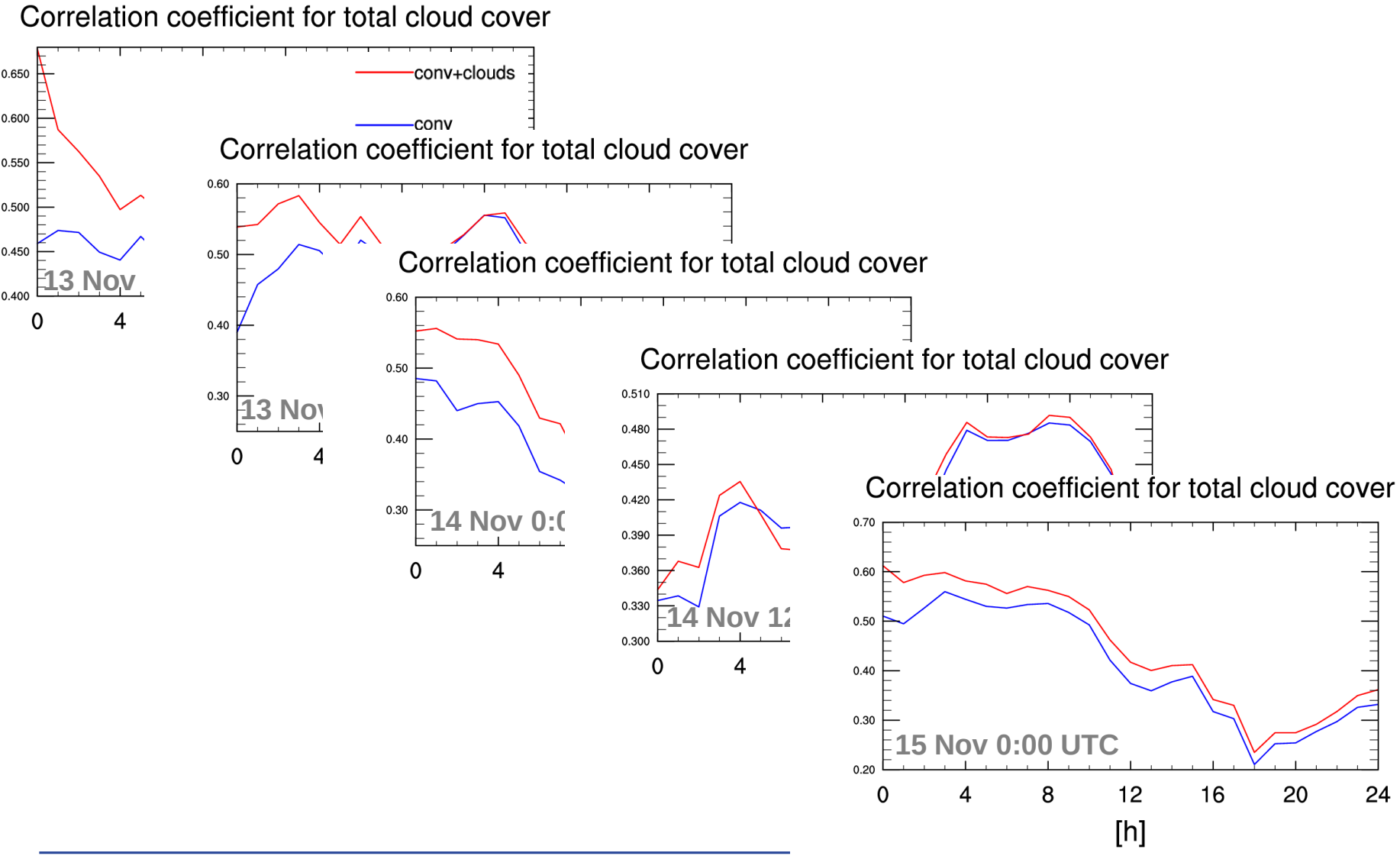



Bias and RMSE for forecast hours 1-6

Scores computed based on several 6h-forecasts from 13-15 November 2011:

→ No detrimental effect of cloud assimilation visible any more

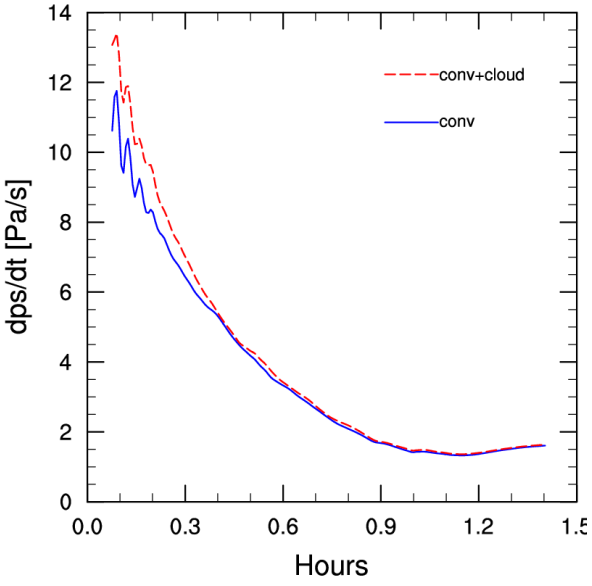
# 24 h forecast results (5 forecast runs initalized each 12 hours)



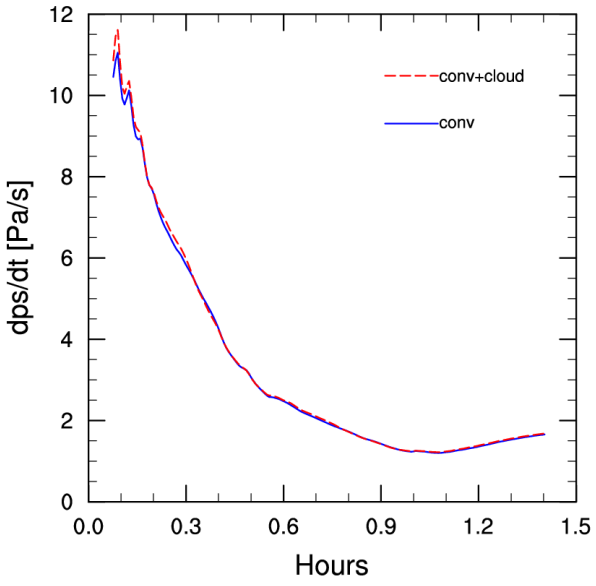
# Noise: $dp_s/dt$

*Question: Do we see problems in noise at beginning of forecast due to high observation density and low localization radii??*

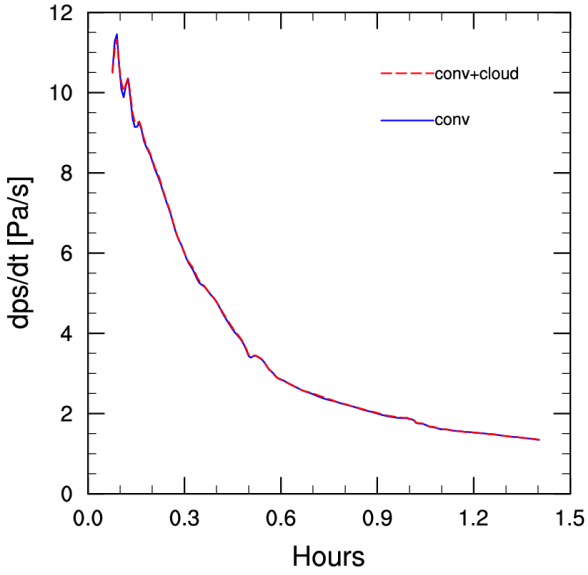
**Initialised at 13 Nov, 0:00 UTC**




**Initialised at 13 Nov, 12:00 UTC**




**Initialised at 14 Nov, 12:00 UTC**



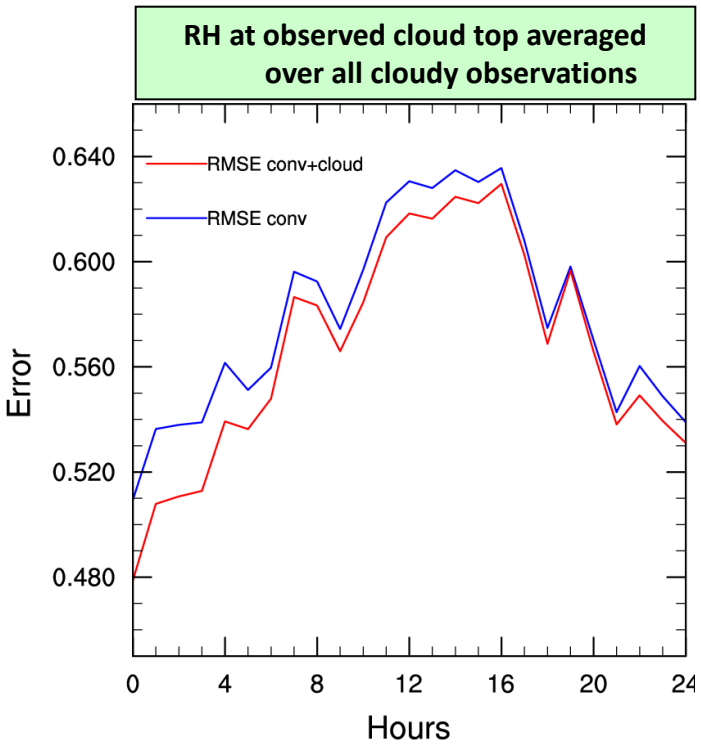

→ Noise at beginning of simulation due to more observations declines to level of control run after less than half an hour

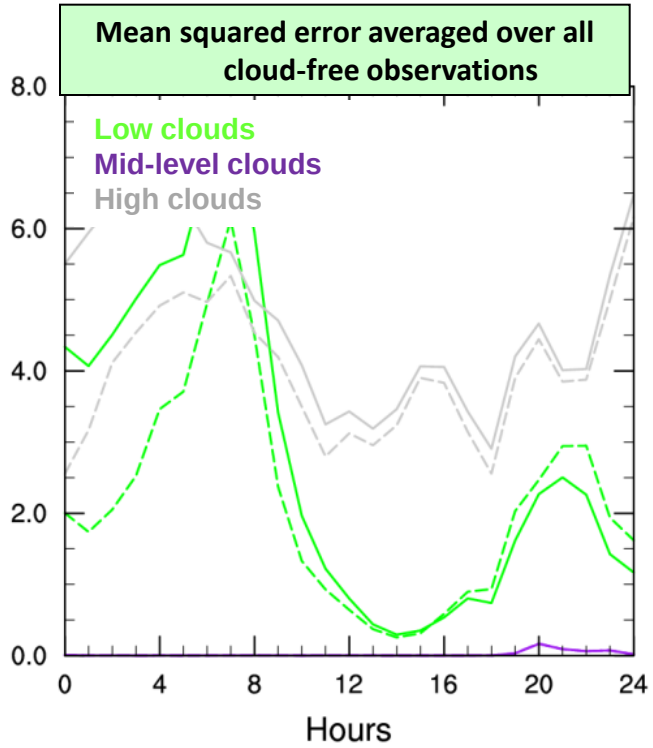
# Conclusion

- For **photovoltaic power assimilation**
  - Finally got some data
  - **Next steps quality control** etc.

- For **cloud product assimilation**:
  - **Previously** found **bad verification scores** for standard upper air verification
  - **Now** with a more strict data elimination:
    - **neutral impact on standard upper air** variables
    - **positive for cloud variables**

# Forecast results for cloud variables for a 24h forecast

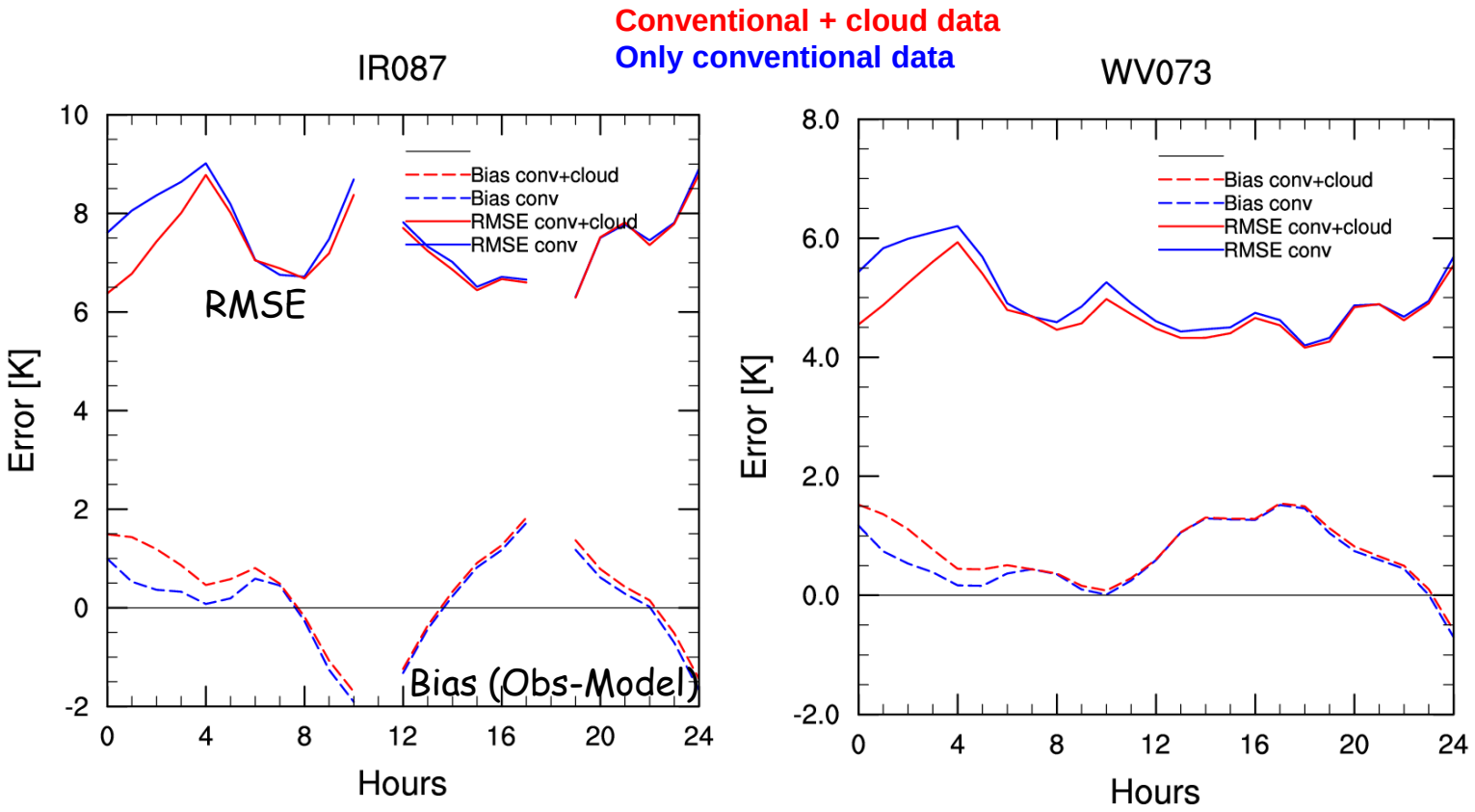



**Conventional + cloud data**
**Only conventional data**

→ Long lasting positive impact in forecast on cloudy and cloud-free pixels

# Forecast results for a 24h forecast: Synthetic radiances




→ Positive impact also visible in independet observations: Synthetic satellite radiances for a window and vater vapour channels