Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Evaluation of the two-moment-microphysical scheme using observations from radar and SEVIRI

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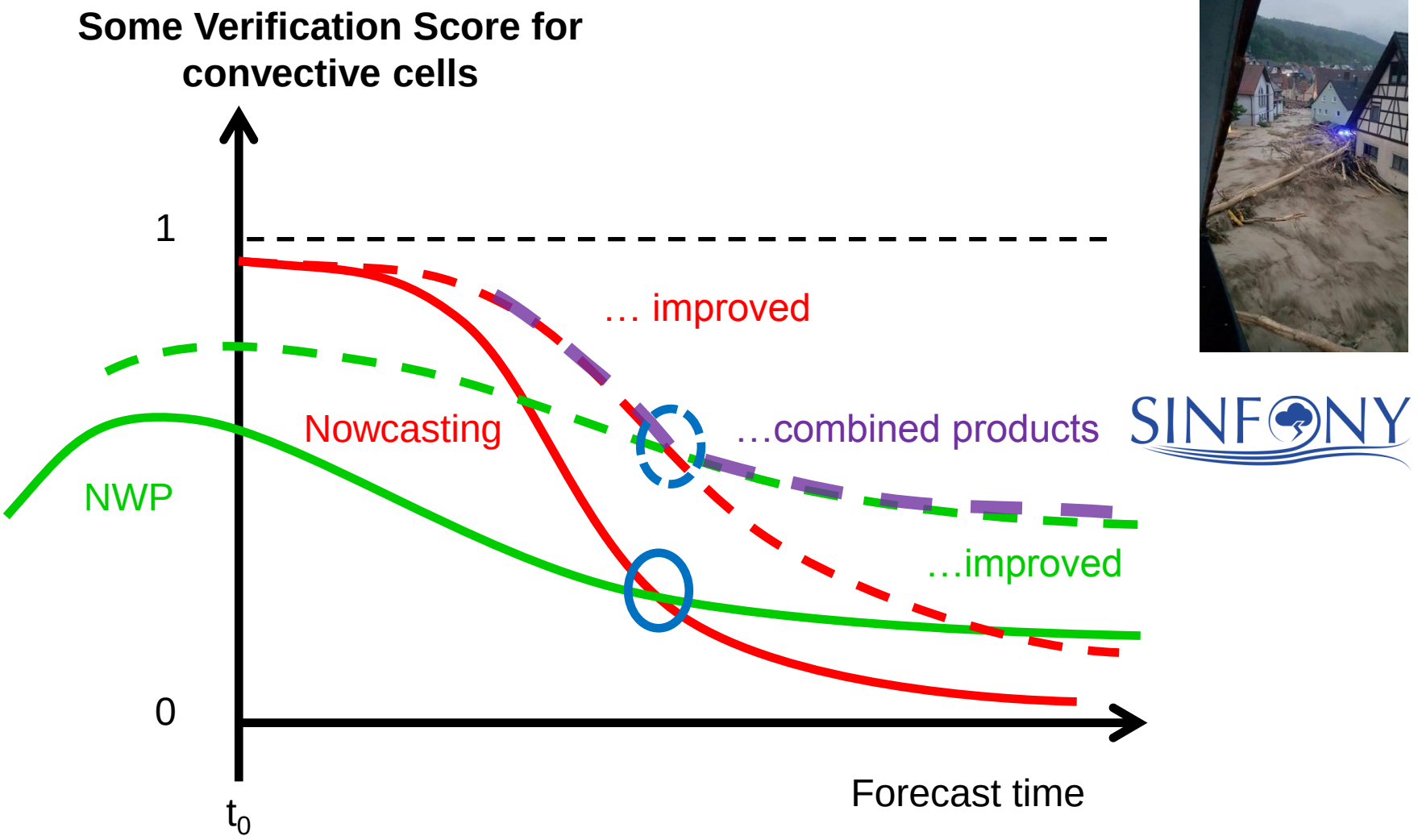
SINFONY

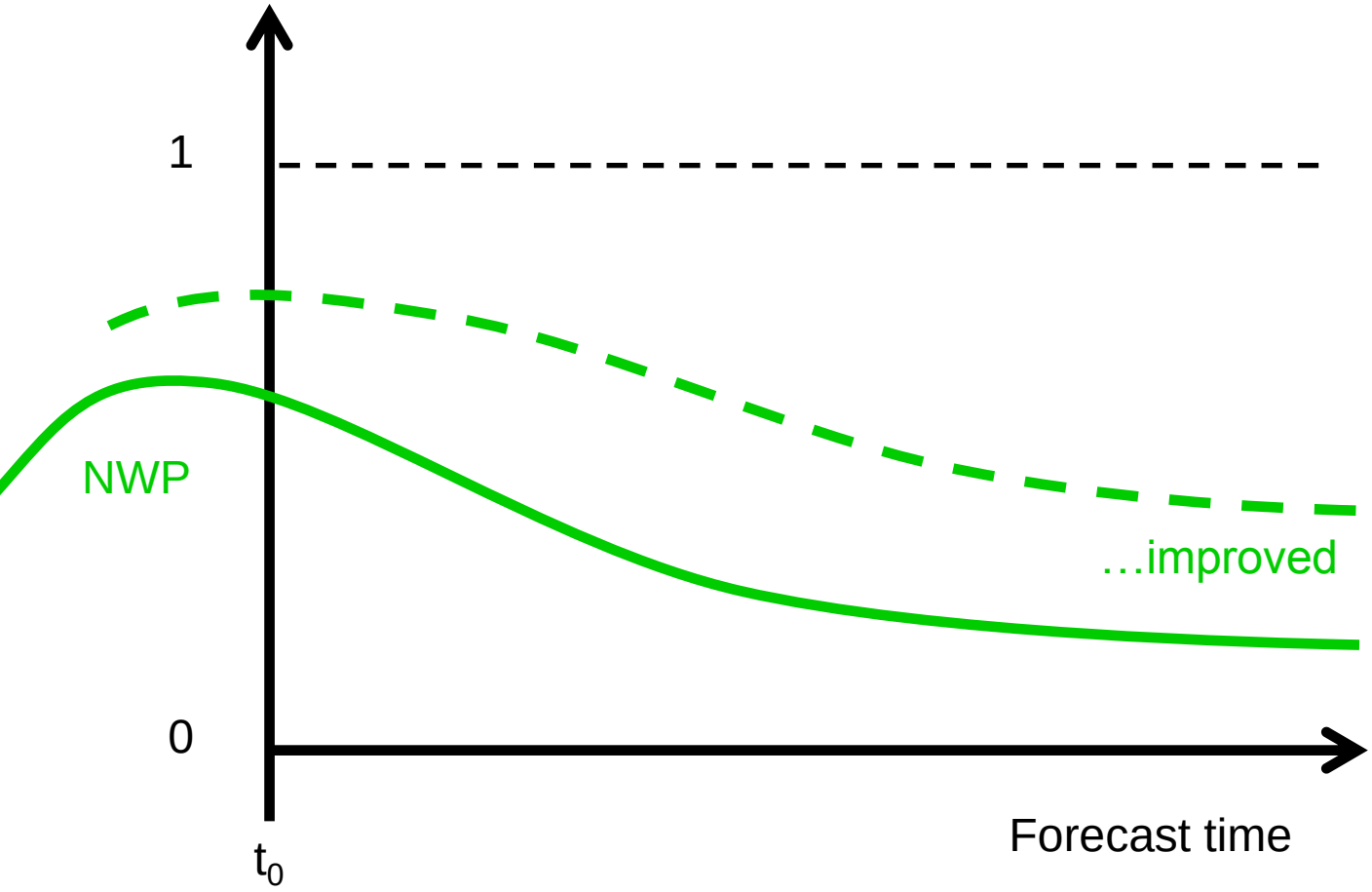
SINFONY Idea



SINFONY

SINFONY Idea

Some Verification Score for convective cells



Improved Assimilation and **Physics** at the convective scale for a better match with Nowcasting.

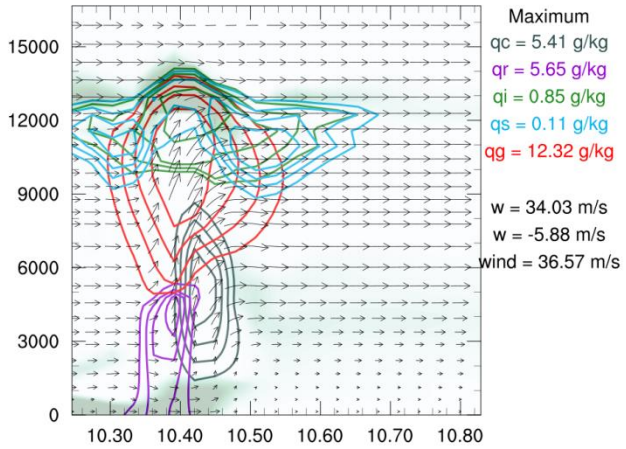
Two-moment microphysics

➔ **Research question:** does the two-moments microphysical scheme provides a better representation of clouds and convection?

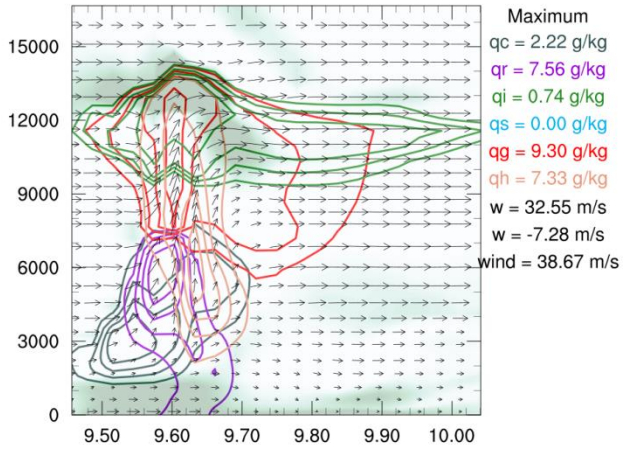
➔ We test the 2-moment-scheme of Seifert and Beheng (2006) with additional hail class by Blahak (2008) and Noppel et al. (2010)

- Additional prognostic number concentrations, more realistic particle sizes
- Additional hail class allowing for large hail particles
- But computationally more expensive, and not yet tuned!

COSMO 1MOM



COSMO 2MOM



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- We test the 2-moment-scheme of Seifert and Beheng (2006) with additional hail class by Blahak (2008) and Noppel et al. (2010)
  - Additional prognostic number concentrations, more realistic particle sizes
  - Additional hail class allowing for large hail particles
  - But computationally more expensive, and not yet tuned!

- We investigate month-long simulations with convective-resolving resolution (~2km) in Germanny during the highly convective period of summer 2016.
  - COSMO
  - ICON-LAM
  - COSMO-2mom (identical as COSMO, but with 2-Mom.-Microphysics)
  - ICON-LAM-2mom (identical as ICON-LAM, but with 2-Mom.-Microphysics)

Outline

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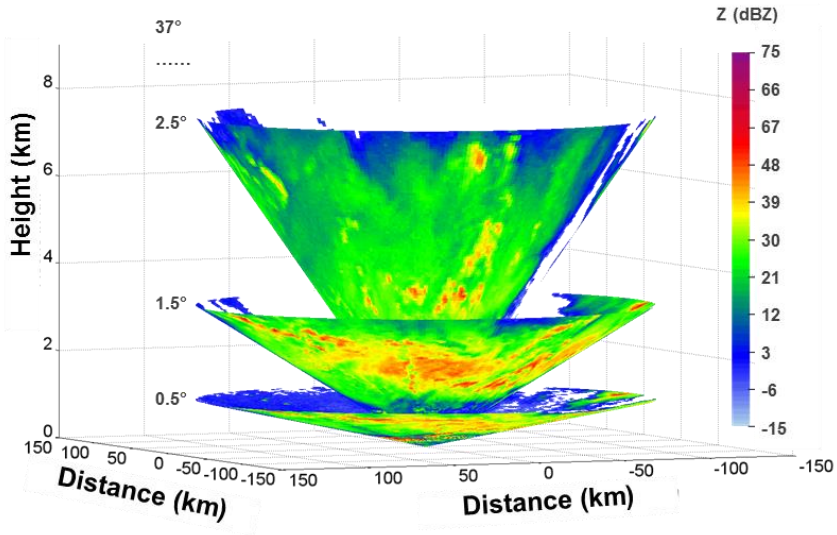
I. **Comparison form the nowcasting cell-detection algorithm**

II. Comparison from radar statistics

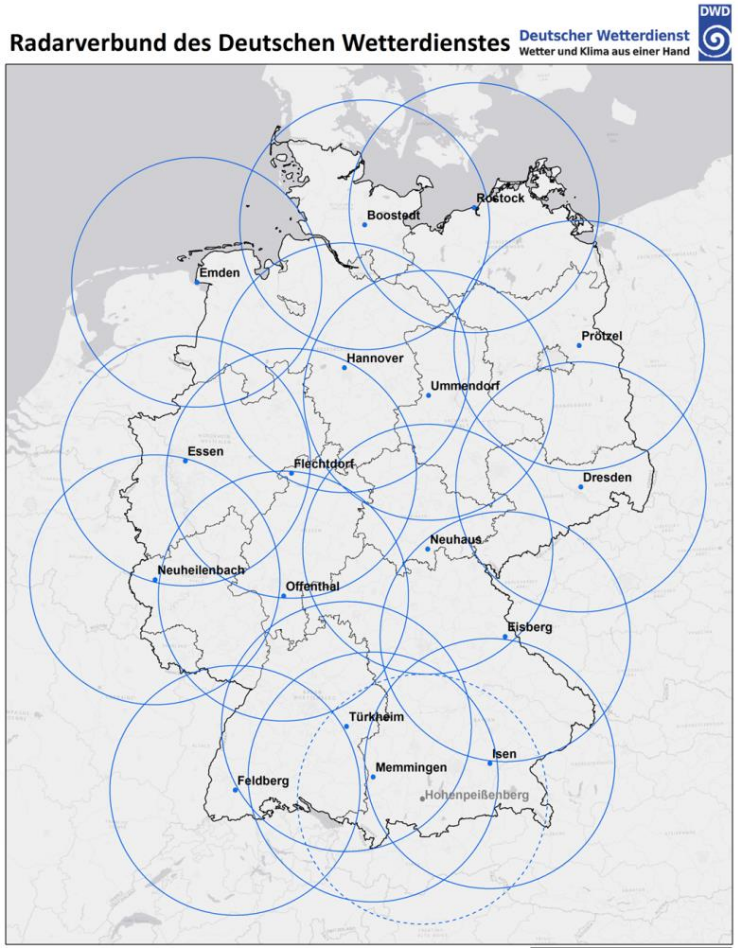
III. Comparison from satellite statistics

Radar in model/observations

➔ Every five minutes the 17 operational radars from the DWD provide volume scans (ten elevation angles). The radar forward operator EMVORADO (Zeng and Blahak 2016) mimics the radars scanning strategy from the DWD radars applied on the model fields thus providing equivalent data.



Simulated Radar Scans



DWD Radar Network

Radar composites in models and obs.

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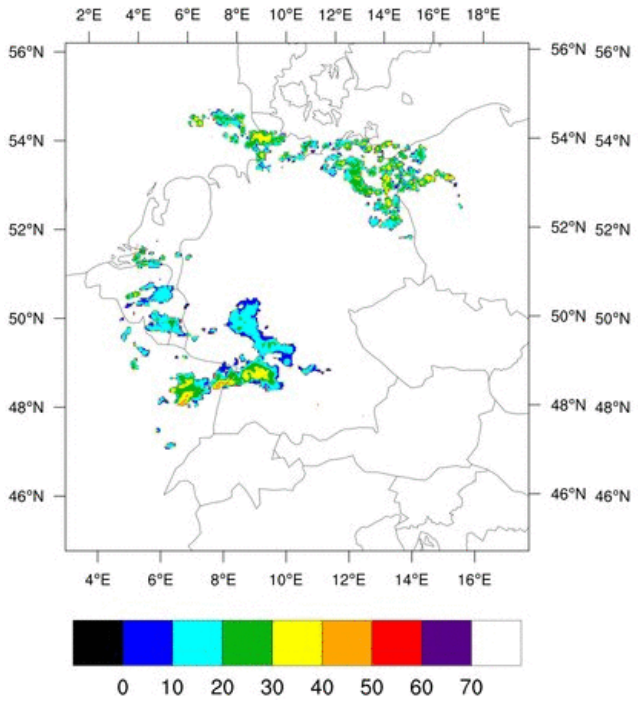
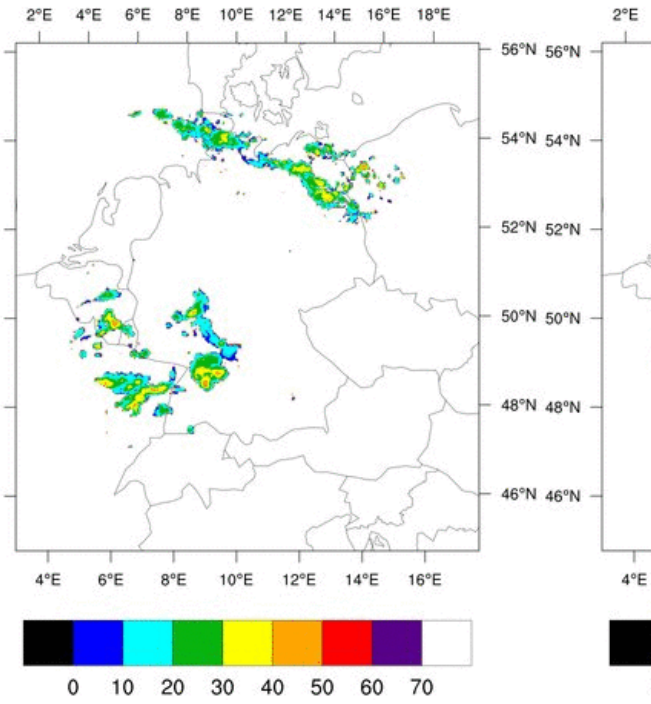
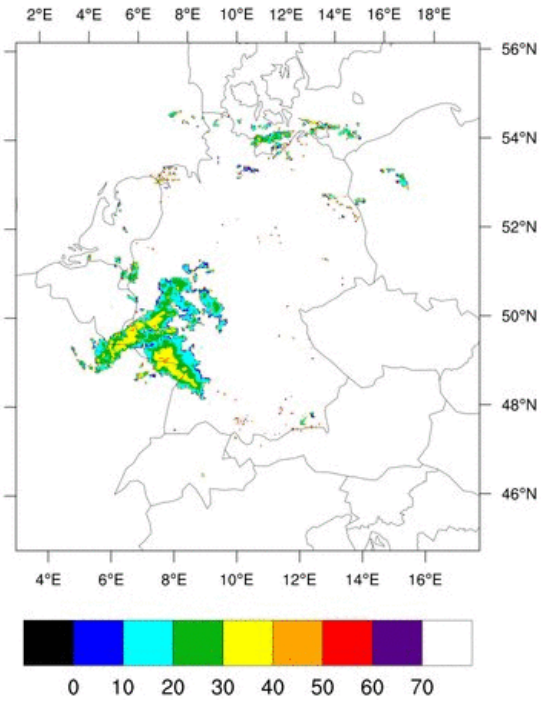
COSMO 1MOM



COSMO 2MOM



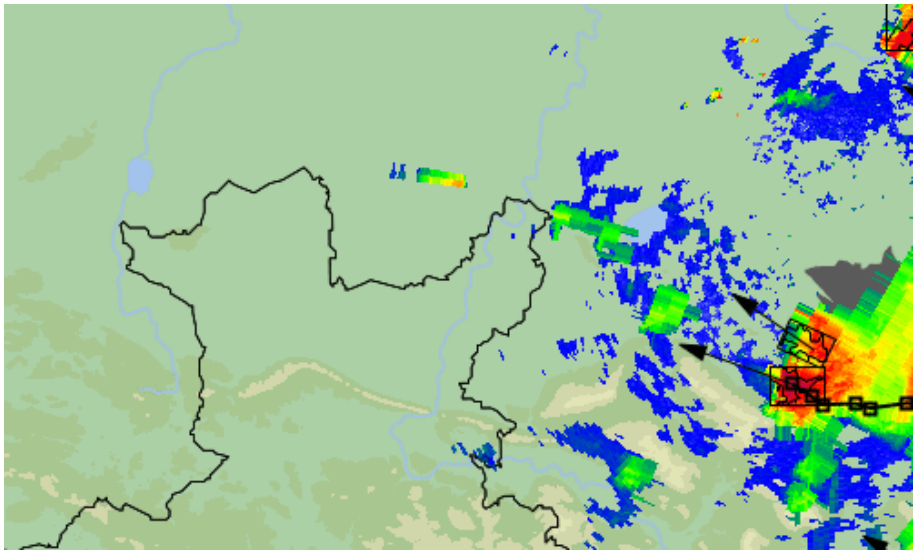
OBSERVATION



Cell detection with Nowcasting

- KONRAD3D is a system for detection, tracking and forecast of convective cells (thunderstorms) based on weather radar measurements for Nowcasting.

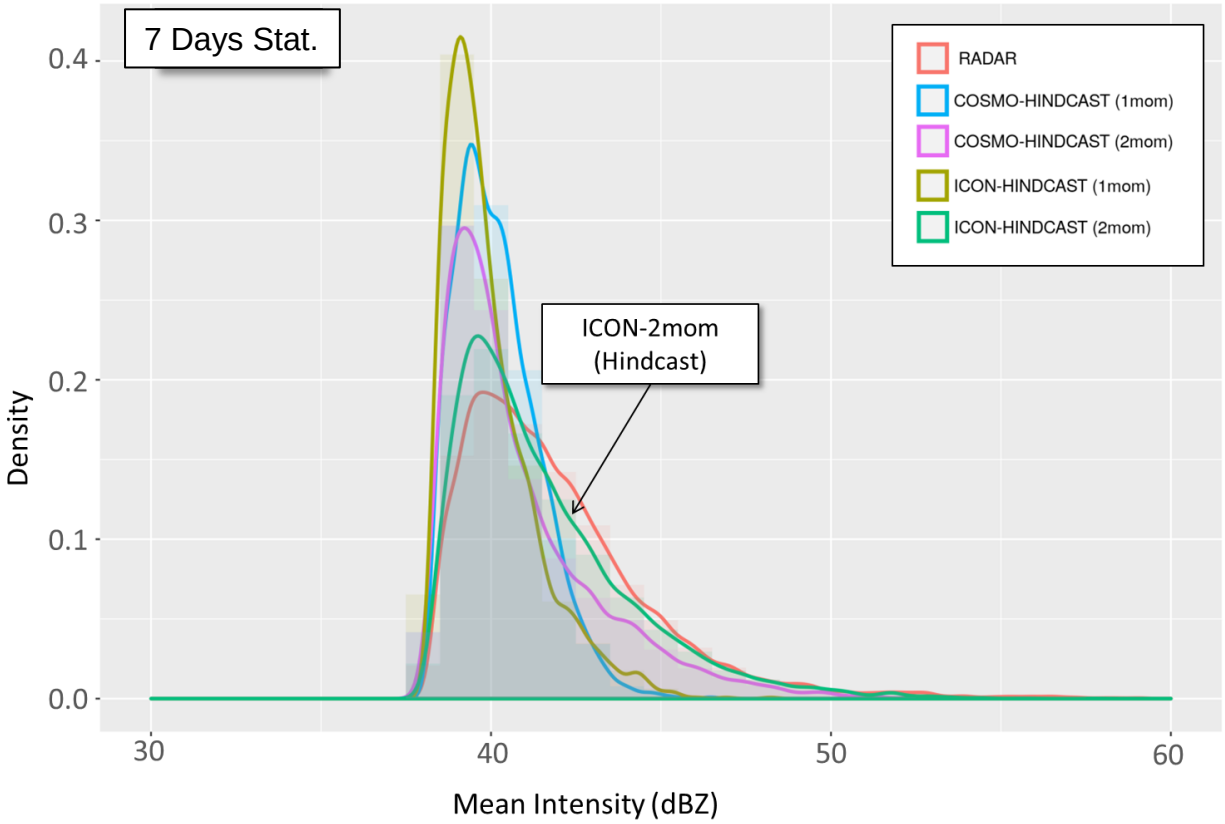
- KONRAD3D exploits radar data from different heights (three-dimensional approach) and uses an adaptive threshold for the detection of convective cores.



KONRAD3D

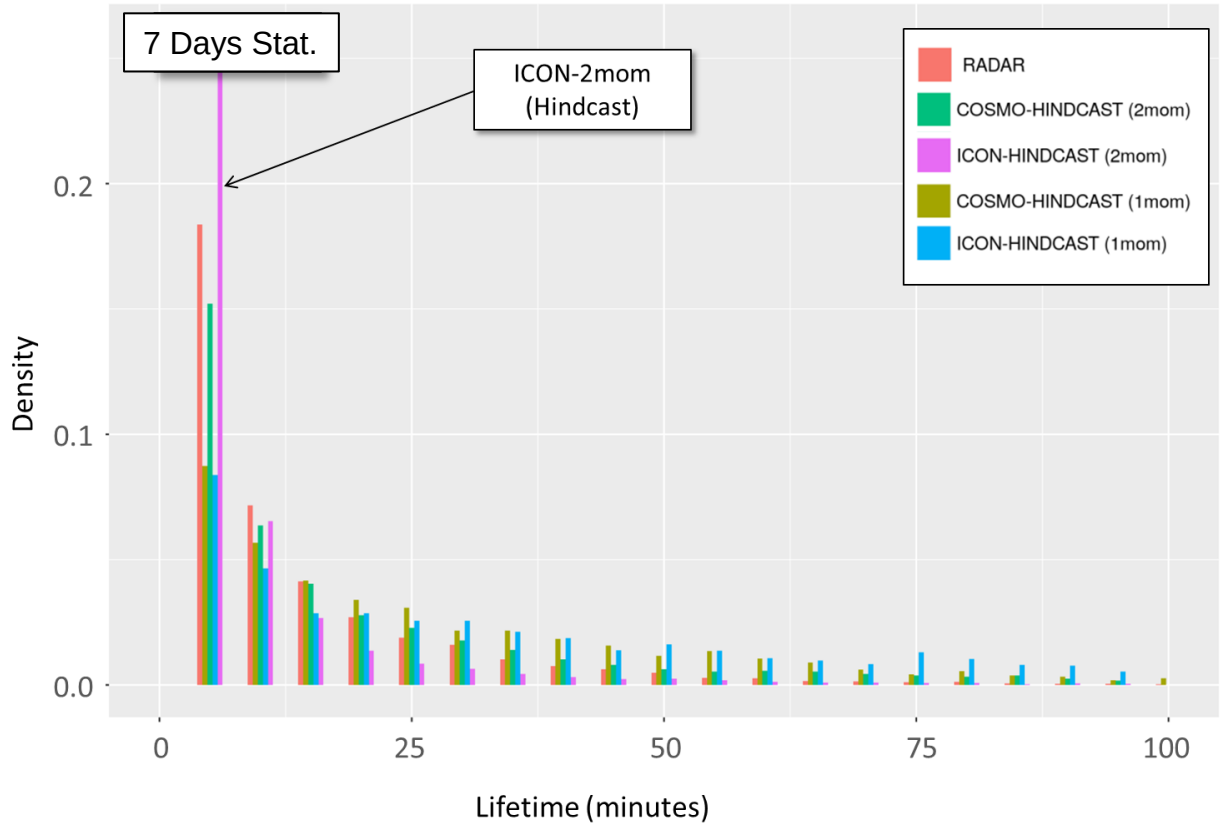
Cell-intensity histogram

- High-intensity cells can only be modeled by the two-moment scheme.
- ICON 2-mom histogram is the closest to the observations.



Cell-lifetime histogram

➔ Most cells are short lived in the observations and in the simulations with the two-moment scheme. Cells with the one-moment scheme live longer.



Outline

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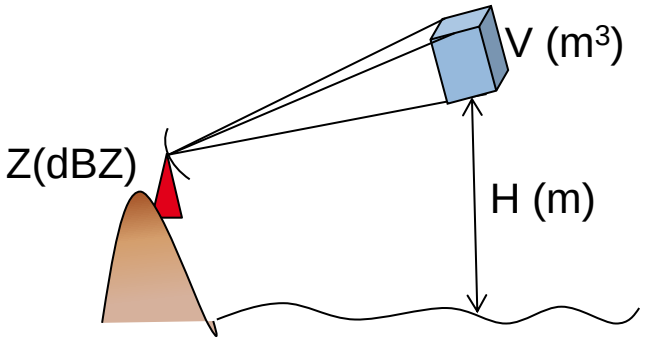
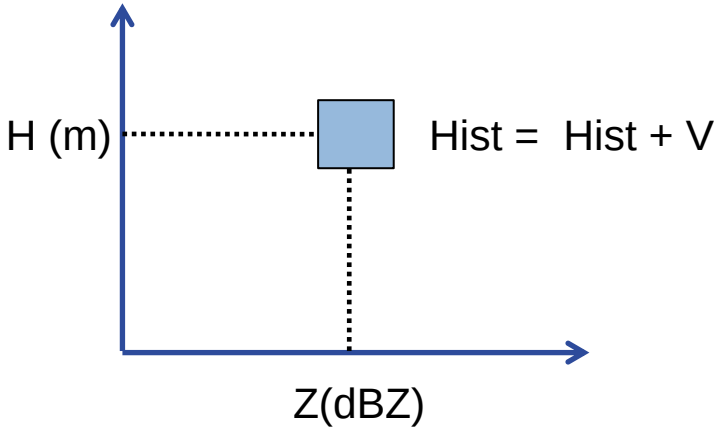
2D-Height-Reflectivity Histogram

- Giving the localized aspect of convection and with no assimilation, standard scores like the FSS do not provide reliable information. We aim for a *model climatology* comparison.

- We compare the 2D-Height-Reflectivity Histogram. This is possible because EMVORADO follows the same strategy as the DWD radars.



Observation / Model

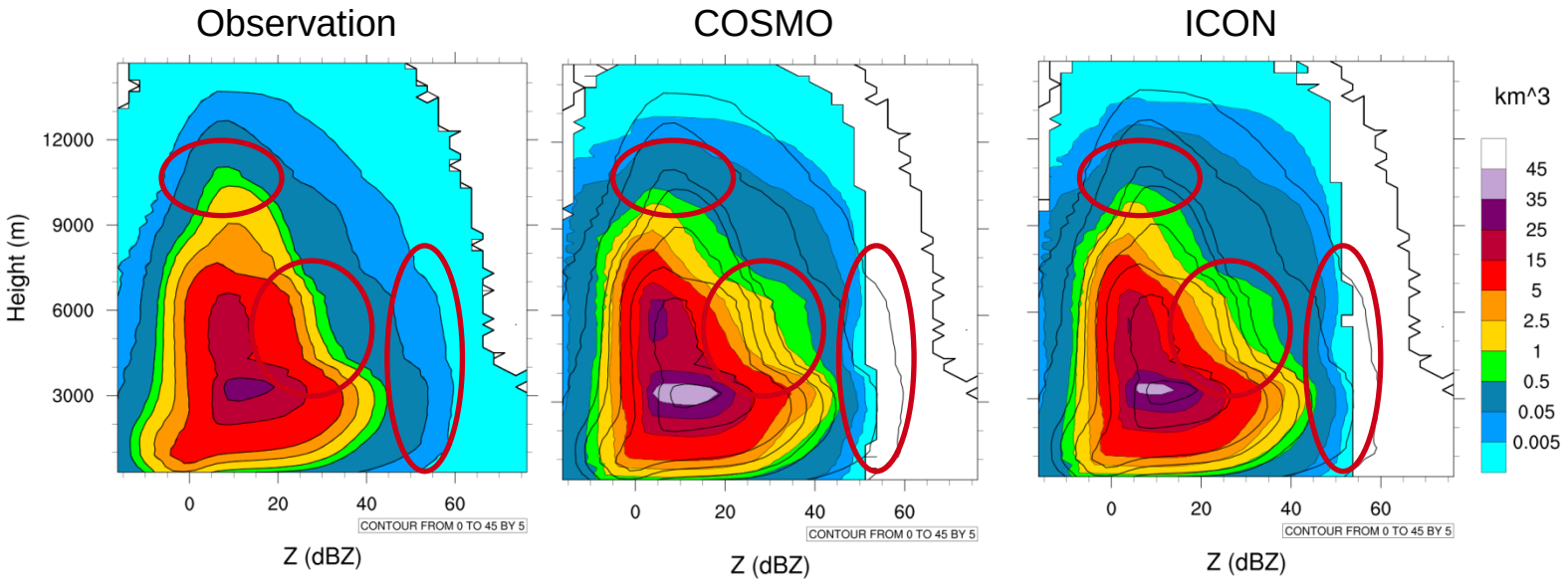


Histogram

COSMO and ICON Histograms

- The COSMO-histogram has a similar structure as in the observations. Three relevant differences are: (a) COSMO-histograms rarely reach 10 km; (b) the quadrant (10-40 dBZ ,3-6 km) show large departures, maybe, stratus clouds?, (c) COSMO never reaches reflectivites over 50 dBZ.

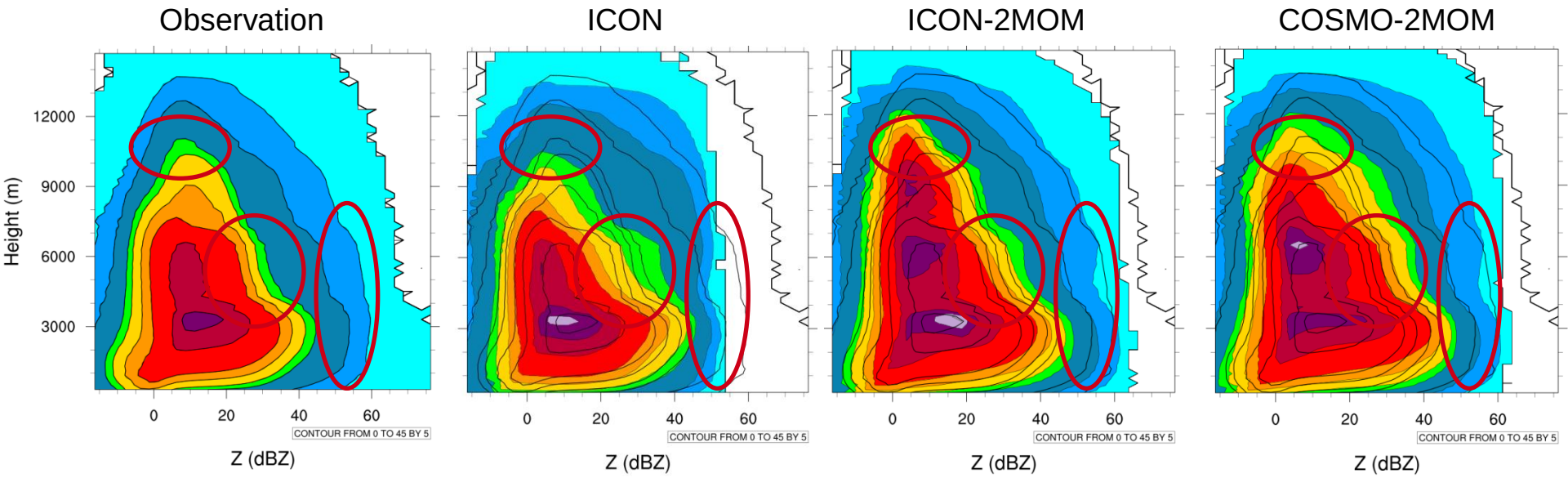
- ICON and COSMO-histograms are very similar.



Two-Moments-Histograms

- The 2 Moment –scheme improves the histograms in all regions, but it shows too often low reflectivities (0-10 dBZ) at 6000 m. Particularly very high reflectivities are better matched by the 2-moment scheme.

- ICON is similar. There are larger differences by changing the microphysical scheme as by changing the dynamical core.



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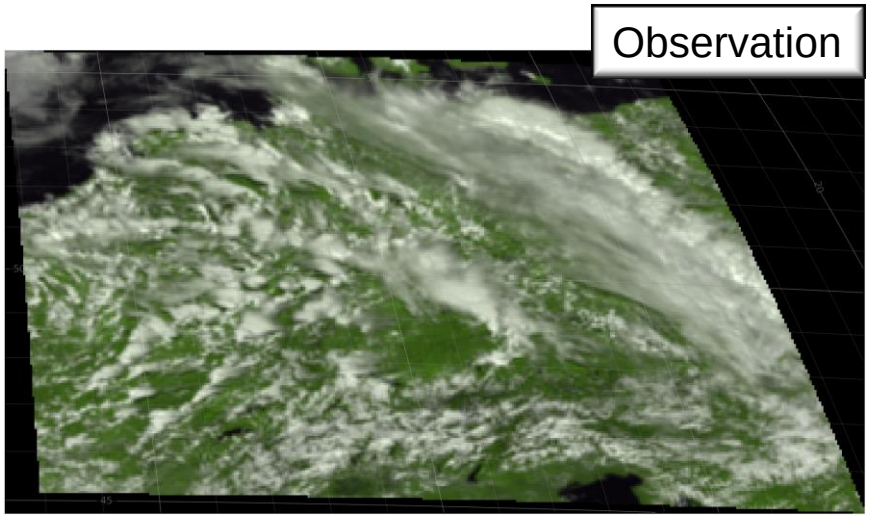
- However, it produces too many middle clouds (above 4000 m) with 0-20 dBZ

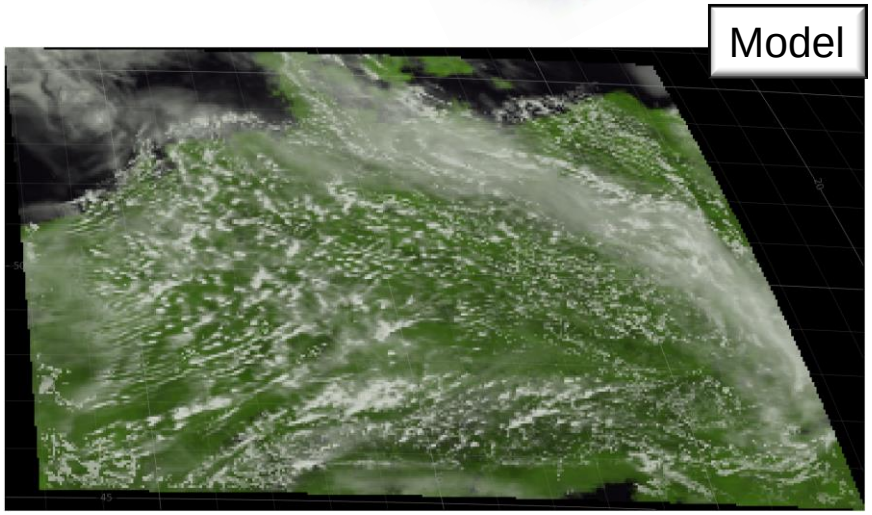
III. Comparison from satellite statistics

SMG-SEVIRI Visible Channels

- Forward-operator: **MFASIS** (Method for FAst Satellite Image Simulation) is a fast look-up table based RT-method (Scheck et al., 2016).

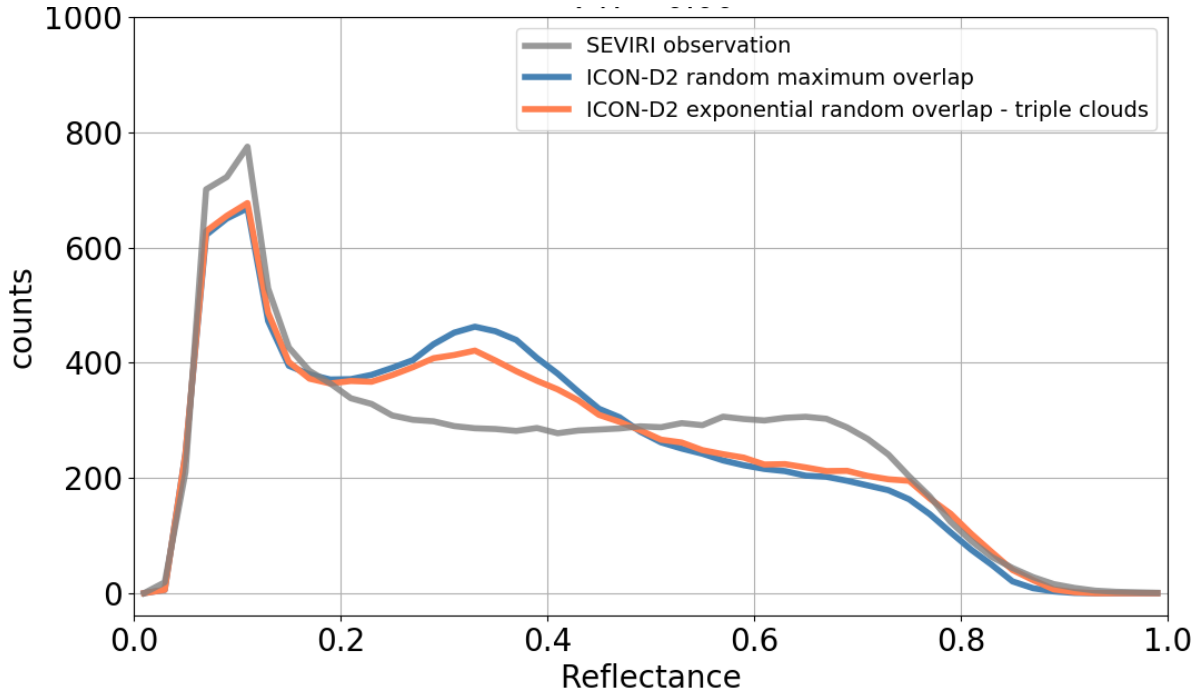
- We investigate two channels in the visible spectrum (only ICON-2mom).





SMG-SEVIRI Visible Histograms

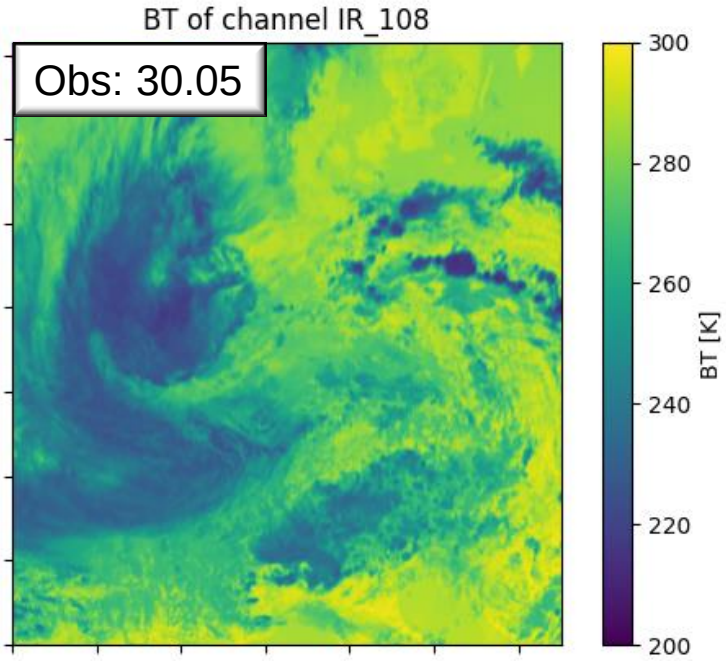
- Histogram of one month, only reflectances at 12.00 .
- There is still some uncertainty in the forward operator, due to uncertainties in cloud overlap, the variability of hydrometeors and effective radius. Here we show different variations.
- The Visible signal is related to cloud fraction and cloud thickness: it seems that the model produces too many thin clouds, but it lacks thicker ones.

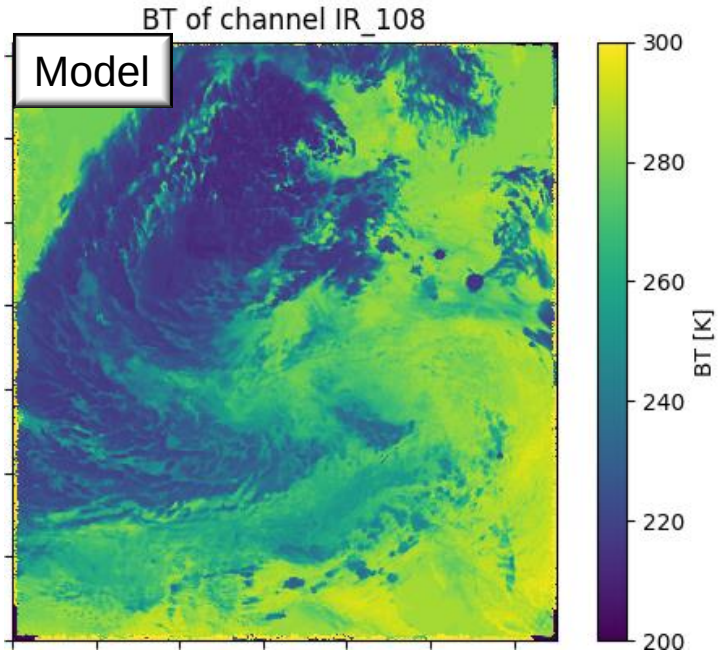


SMG-SEVIRI IR Channels

- Forward-operator: **RTOV v10** (Radiative Transfer for TOVS) is a very fast radiative transfer model for passive visible, infrared and microwave downward-viewing satellite radiometers, spectrometers and interferometers (Saunders, R. et al. 2018).

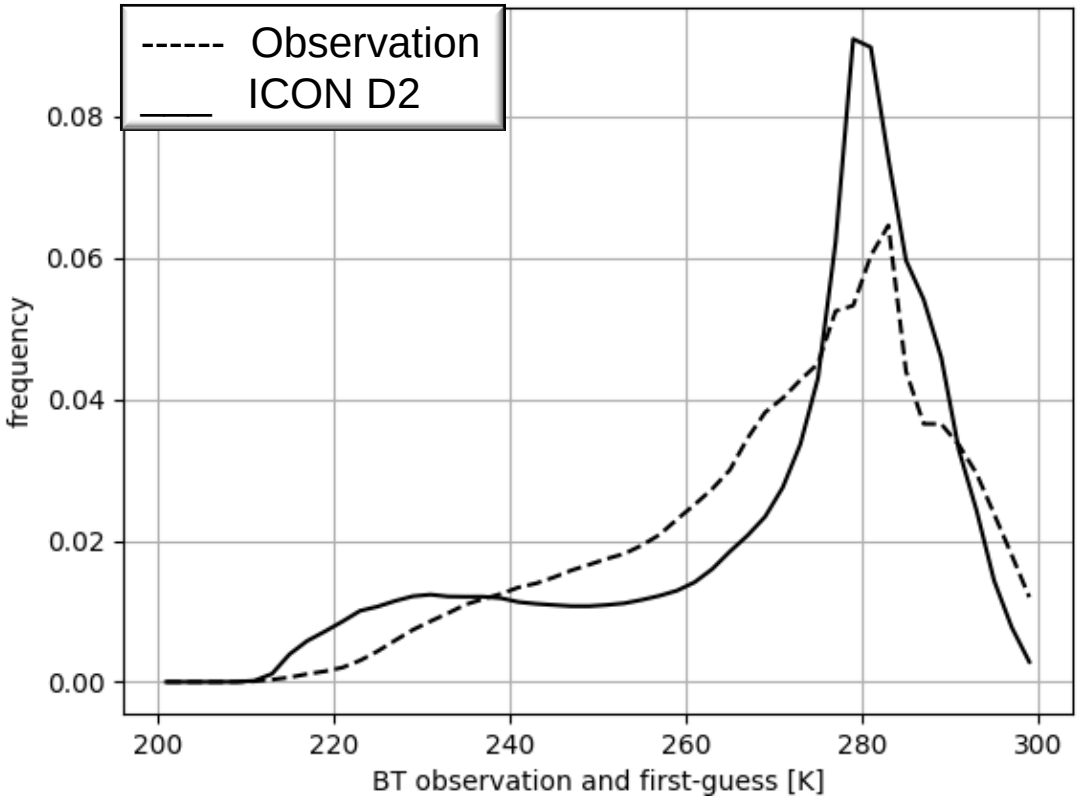
- We investigate four channels in the infrared spectrum.





SMG-SEVIRI Visible Histograms

- One month only reflectances at 12.00 .
- The Brightness Temperature is related to Cloud Height: results suggest that the model produces too many low and high clouds, but lacks middle clouds.



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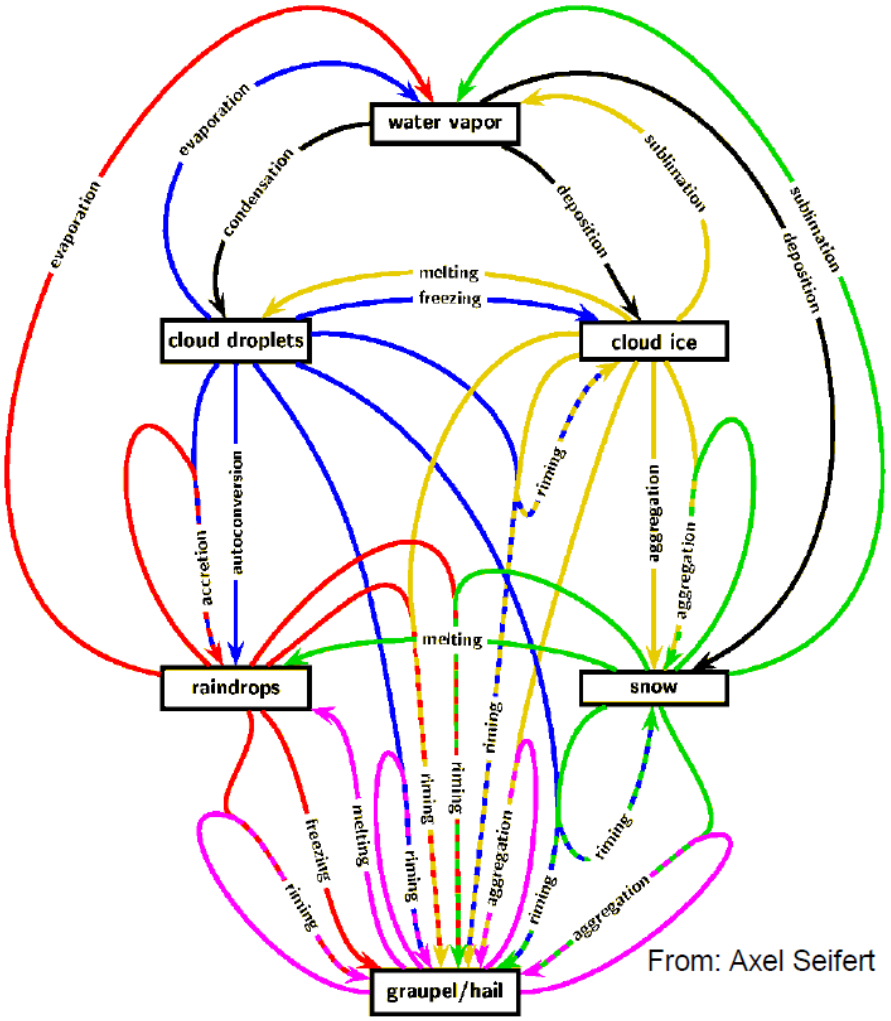
III. Comparison from satellite statistics

- The two-moment simulations seems to miss middle clouds. The missing clouds are likely thick and therefore related to the micropysics.

How to use the results?

- Radar shows too few middle clouds, satellite show too many. Is this contradictory?

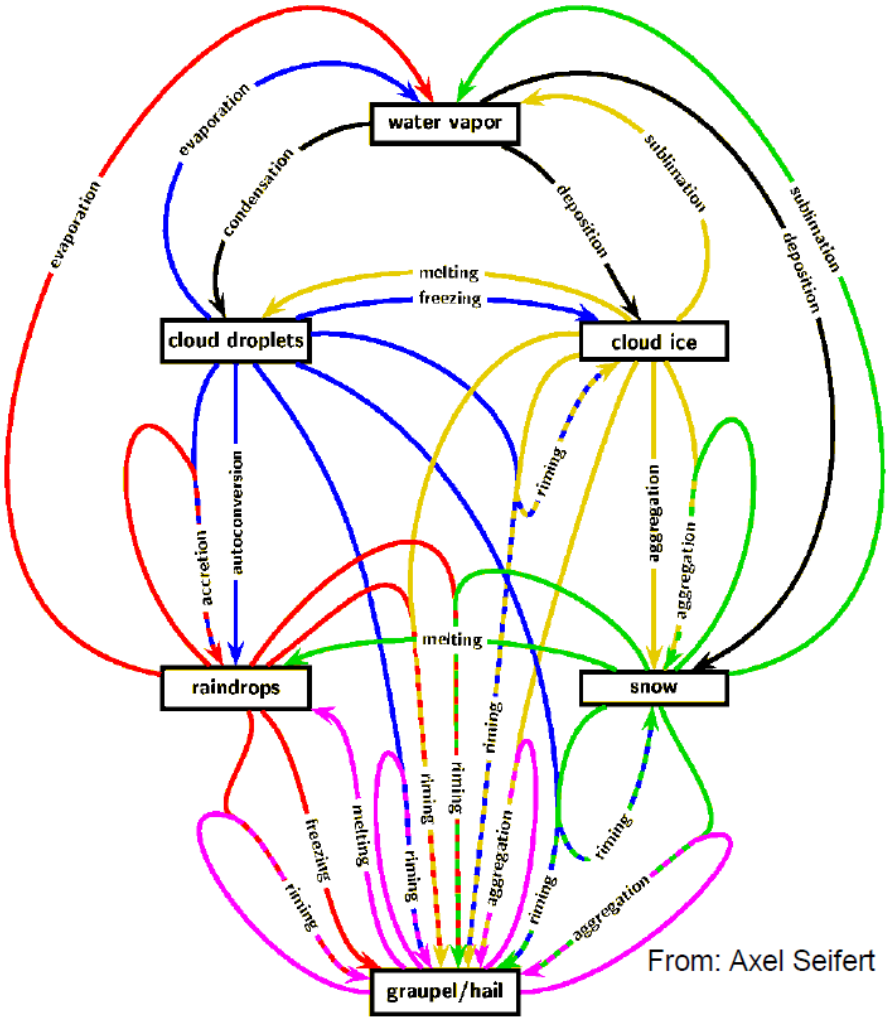
- This is work is progress, but let us suppose that we confirm the results. Lets have an example on how to use the results to improve our two-moments microphysical scheme.



From: Axel Seifert

How to use the results?

- First we saw that the model might have a problem with middle-high clouds, which are usually cold.



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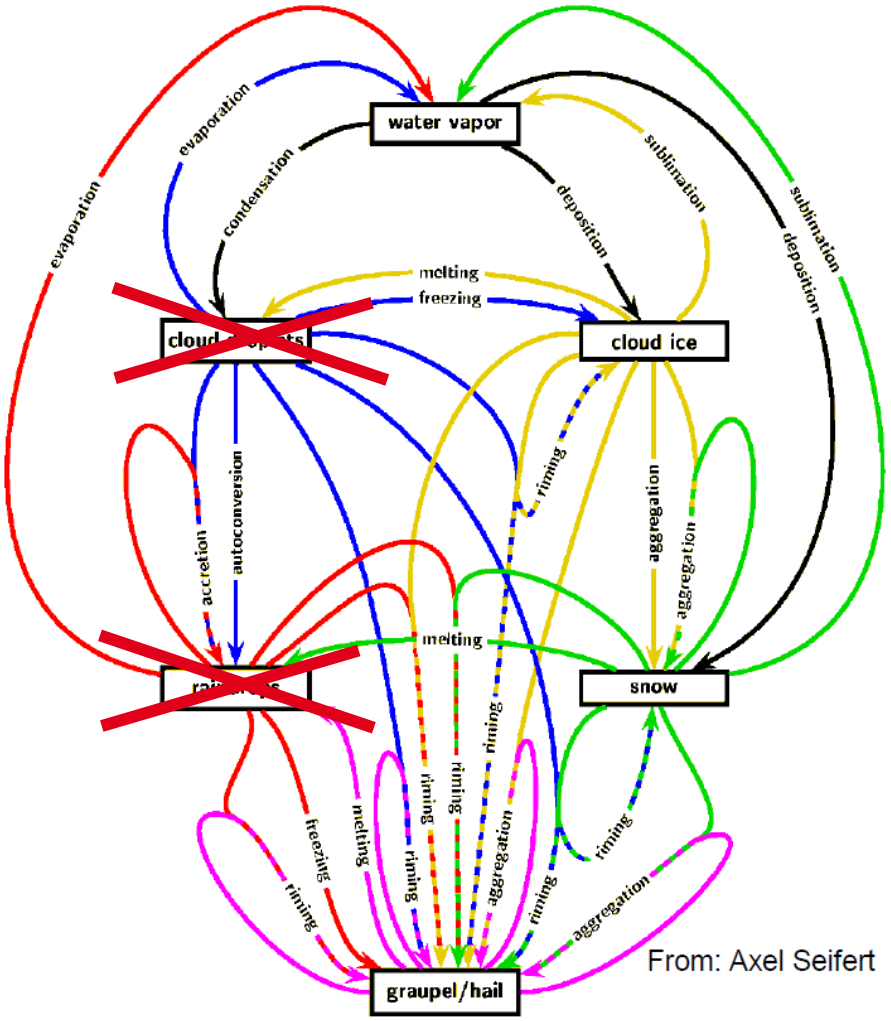

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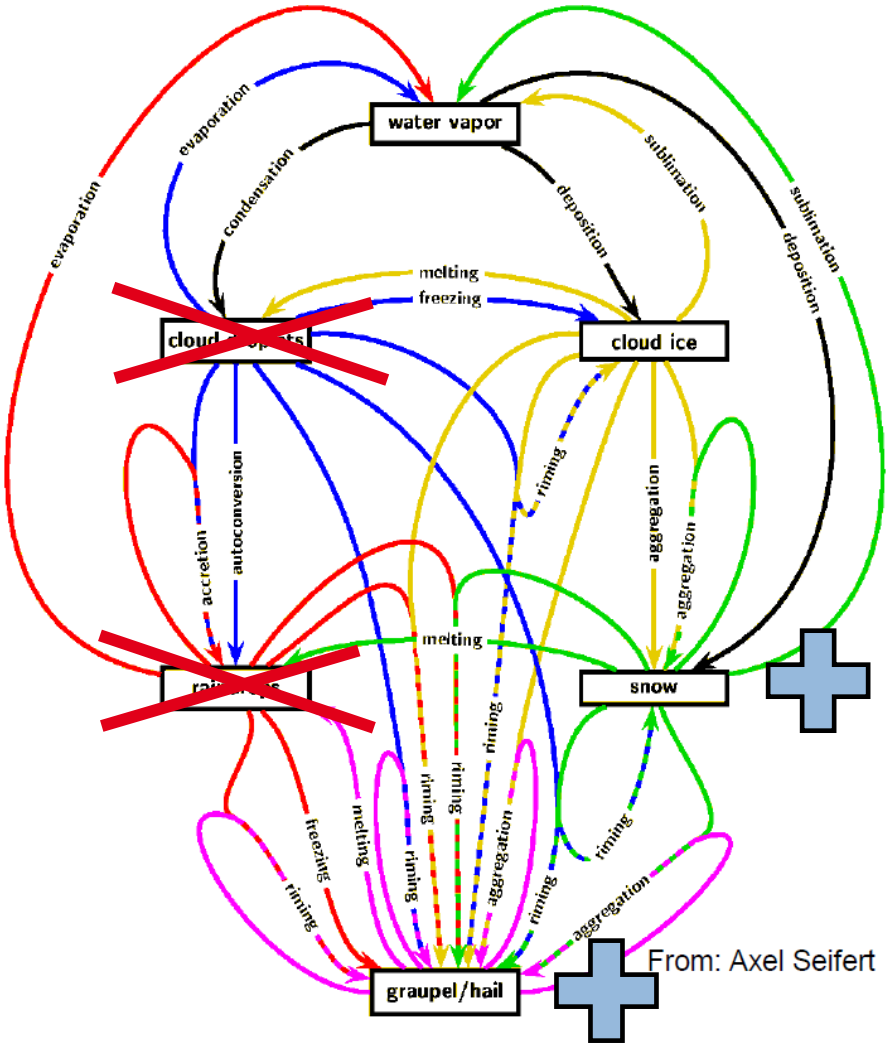
- Radar measurements indicate that these clouds are too thick, but this signal is dominated by large hydrometeors.



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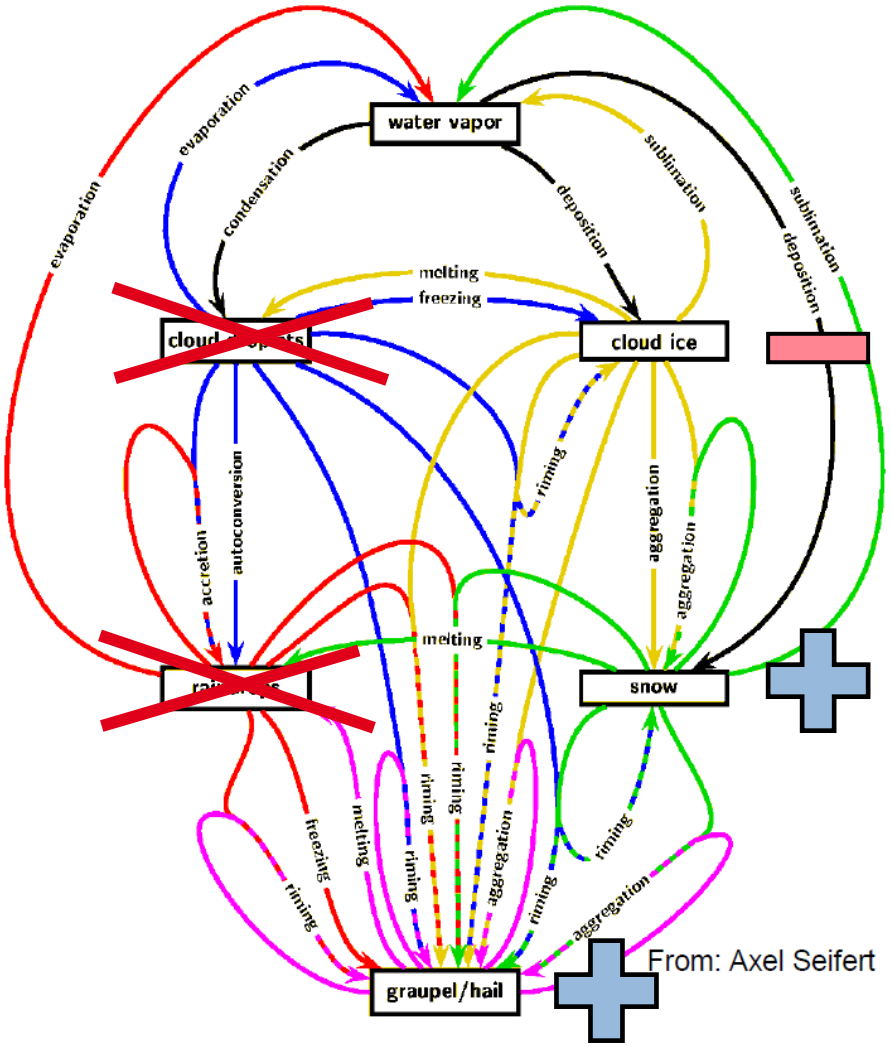

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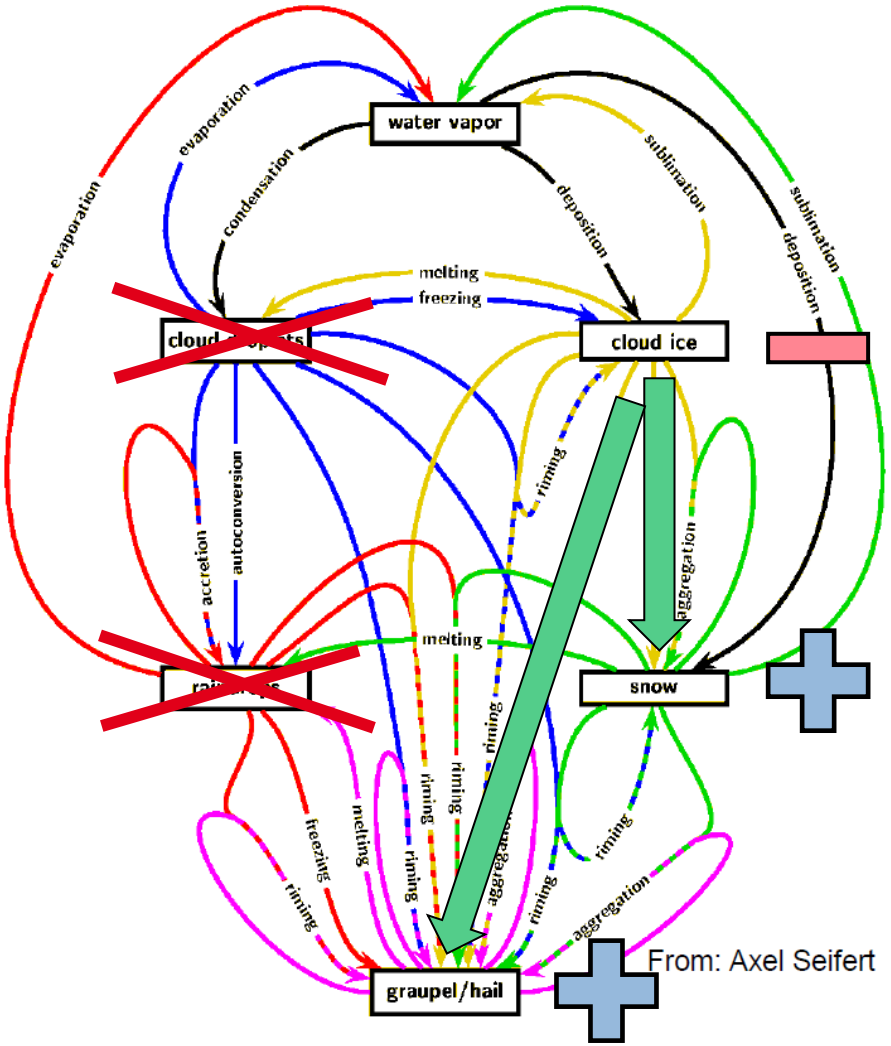
- Radar measurements indicate that these clouds are too thick, but this signal is dominated by large hydrometeors.
- Satellite radiances suggest that these clouds are too thin, but this signal is dominated by the small hydrometeors.
- A plausible hipotheiss is then that the conversion rates from ice to snow and graupel are too fast.



Conclusions

- The SINFONY project in the DWD aims for a seamless transition from nowcasting to forecasting: this would be better if we could improve the model physics for convection.

- The radar reflectivity histograms with the two-moment scheme of Seifert and Beheng reach height and intensities comparable to observations. This is reflected on object-oriented properties: cells with the S-F scheme are intense and short-lived, similar as in the observations. However the histogram become worst for the low reflectivities.

- The combination of radar and satellite is key to further development. Current measurements suggest that the problem with the low reflectivities in the two-moment scheme might be related to a too fast transition between ice and snow/graupel.

Thank you very much!