Validating GME IWCs with CloudSat satellite observations

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GME

1. GME
2. CloudSat
3. Approaches
4. Sampling & sensitivity issues
4. Case 1
5. Summary case studies
6. Outlook

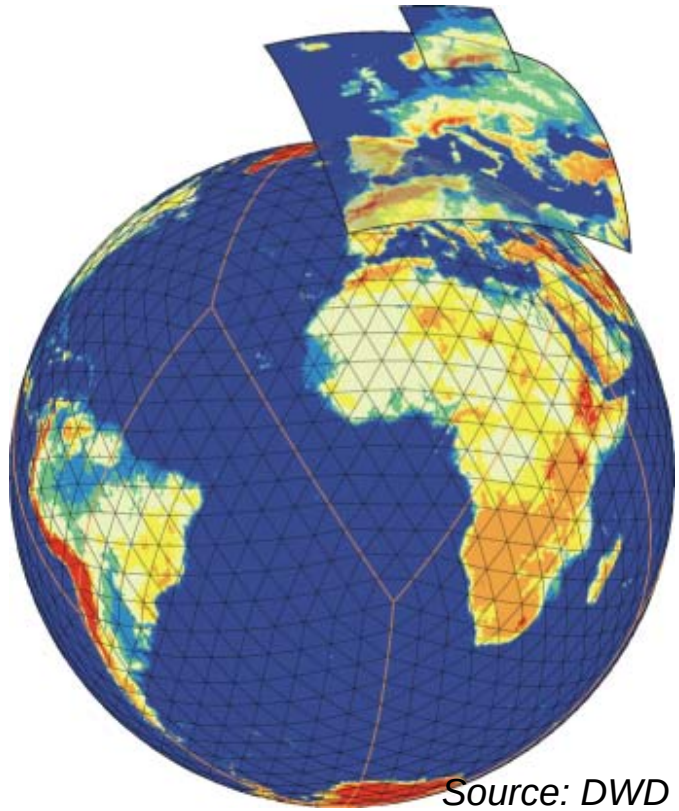
- global, hydrostatic forecast model
- vertical resolution: 40 hybrid level, up to 10 hPa
- horizontal resolution: ~40 km
- daily operational forecasts with hourly resolution
- 4 hydrometeor classes: QC, QI, QR, QS

GMErouti

- QC, QI prognostic
- QR, QS diagnostic

GMEexp

- all hydrometeor classes prognostic
- improved microphysical parameterizations: e.g., new size parameterization for snow, etc.



Source: DWD

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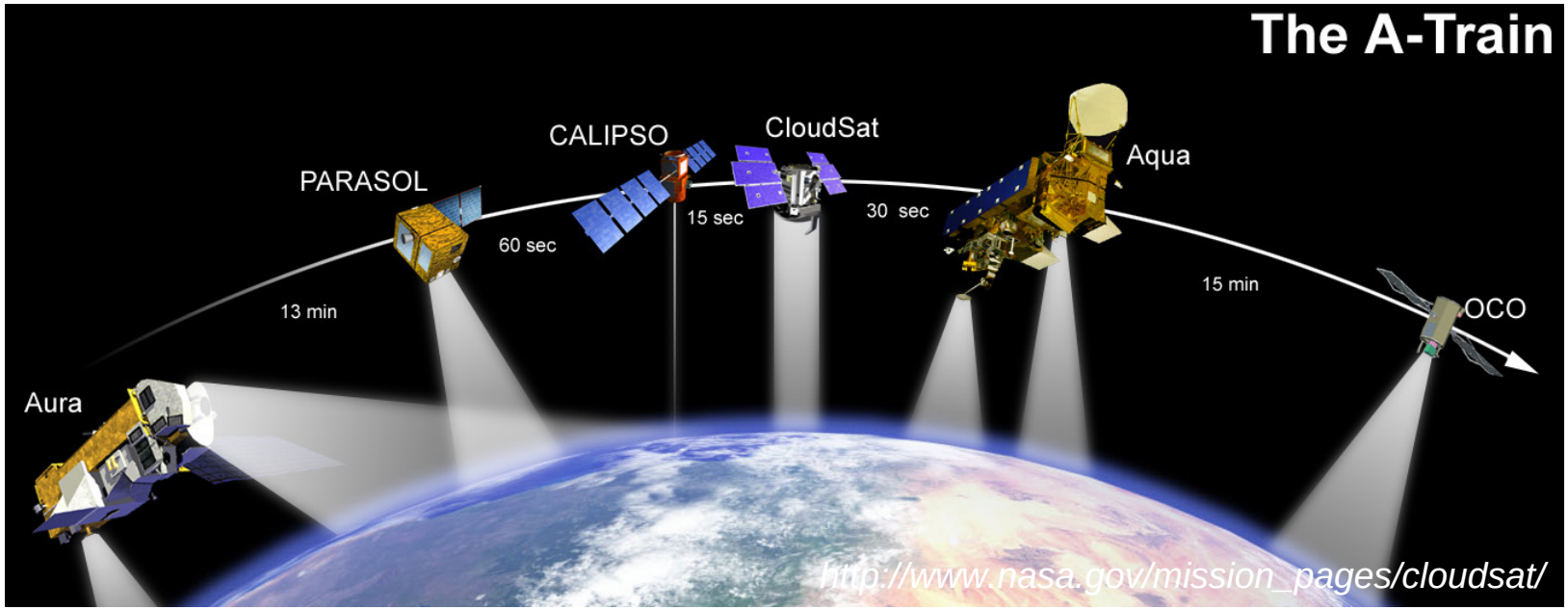
CloudSat CPR (Cloud Profiling Radar)



- operational since June 2006
- polar orbiting in ~705 km height (~1.5 h for 1 orbit)
- 94 GHz
- detection limit: -28 dBZ to 29 dBZ
- vertical resolution: 500 m, up to 30 km height
- horizontal resolution: 1.1 km
- footprint: 1.7 km along-track, 1.3 km across-track

Two possible approaches

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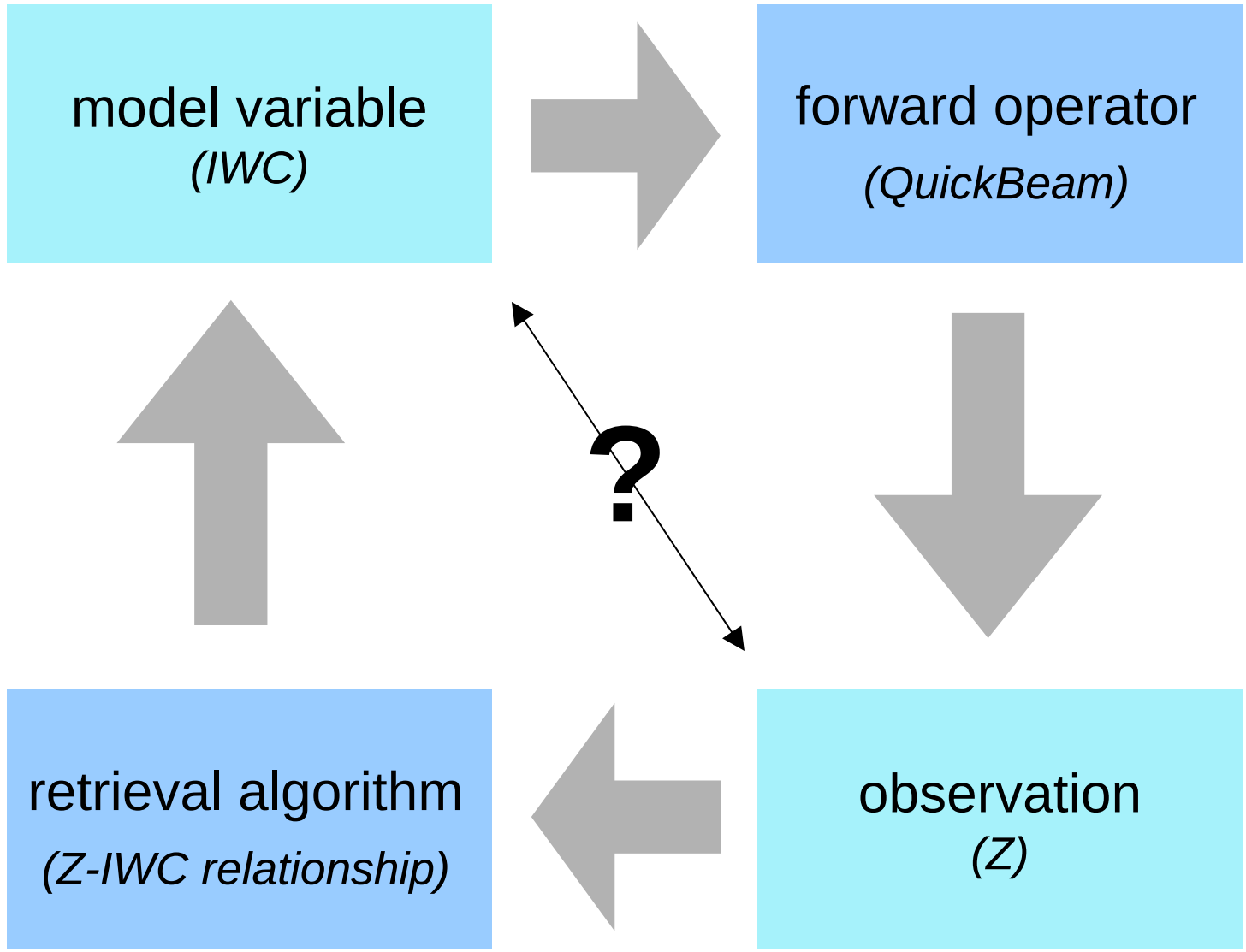

Sampling & sensitivity issues

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resolution

- horizontal: GME interpolated to CloudSat track (nearest neighbour)
- vertical: GME and CloudSat interpolated to equidistant levels
- no temporal interpolation of the GME data:
  use x-h prediction of the 00 UTC run of the same day

sensitivity

- CloudSat detection limit: - 28 dBZ $\rightarrow$ 0.001 g m^{-3}

Cold front 10 August 2008

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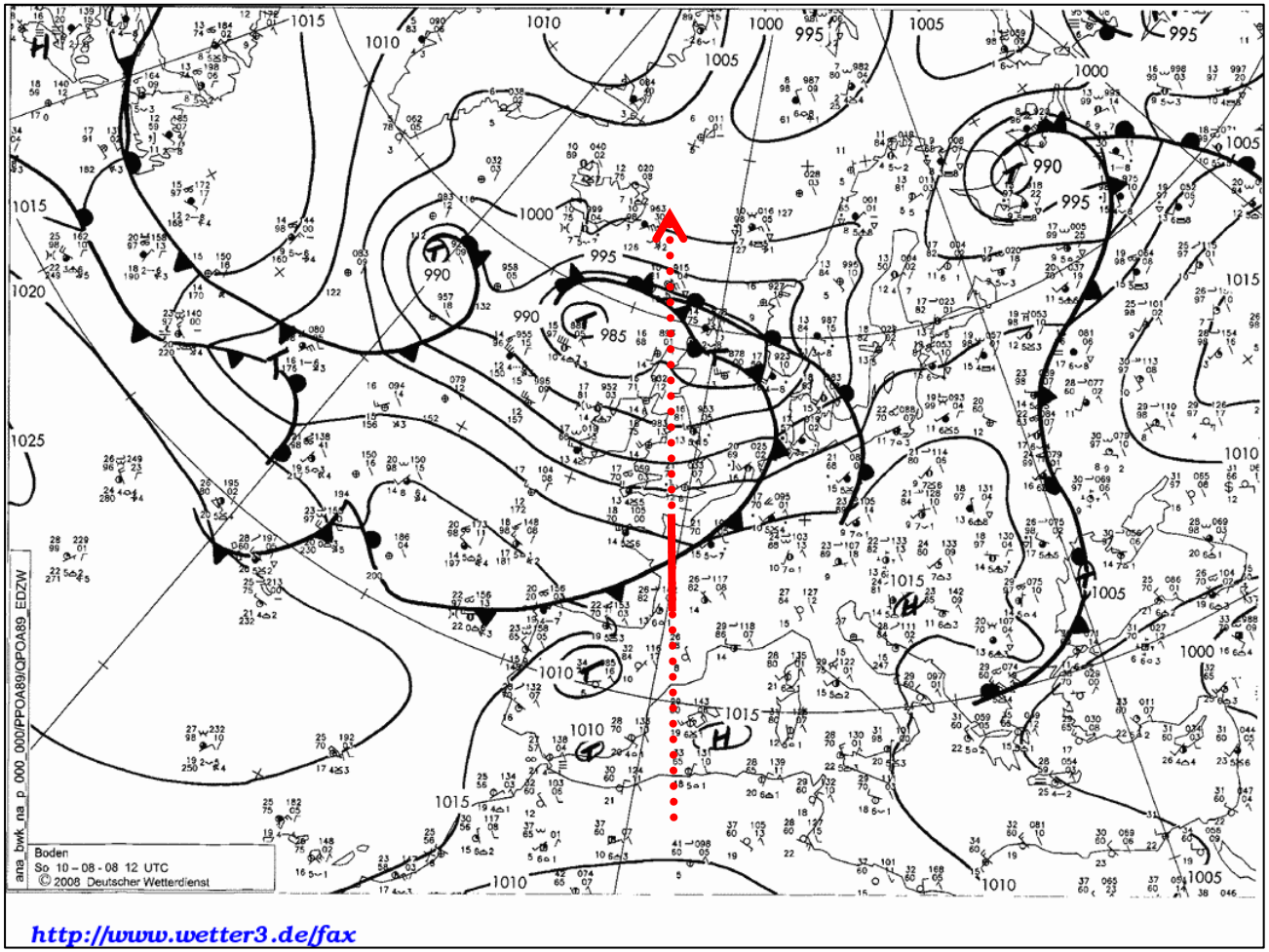
DWD surface analyses 20080810 12 UTC



Radar reflectivity factor Z

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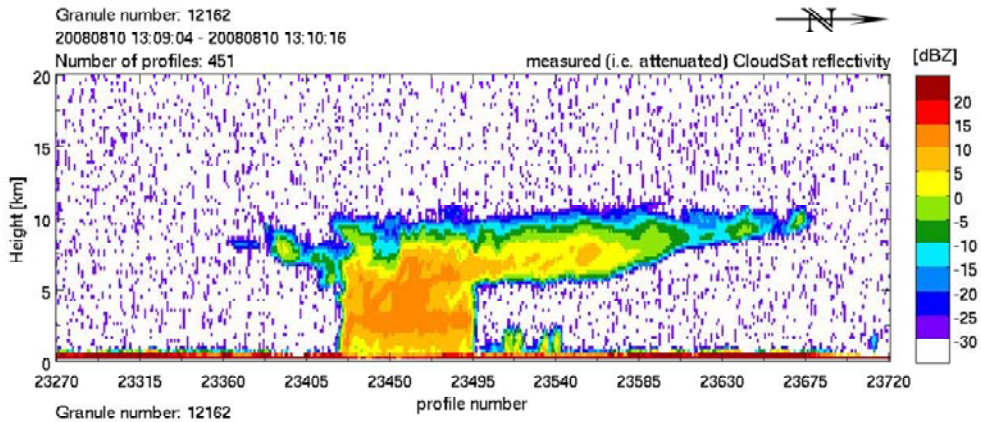
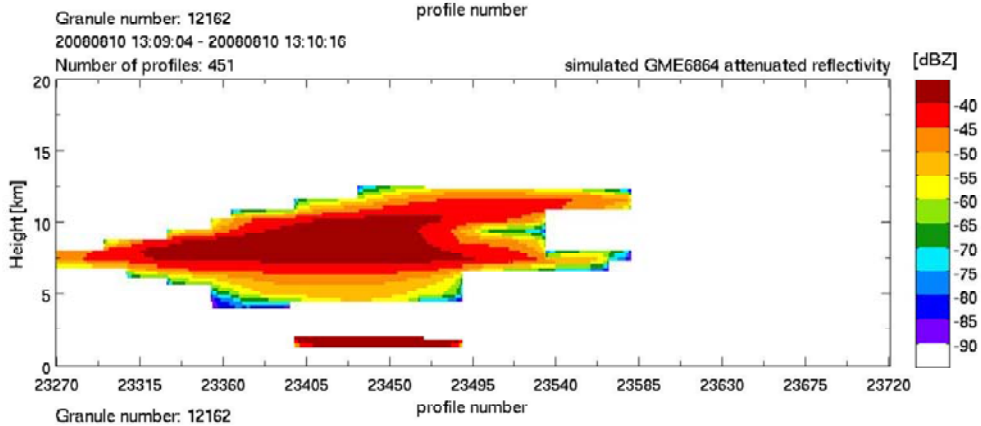
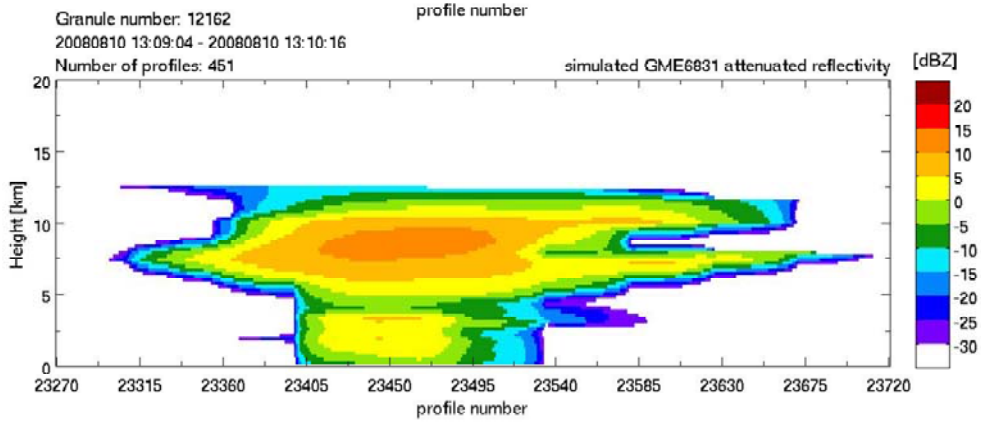
CloudSat



GMErouti



GMEexp



Scale!

Z_{GME} versus $Z_{CloudSat}$

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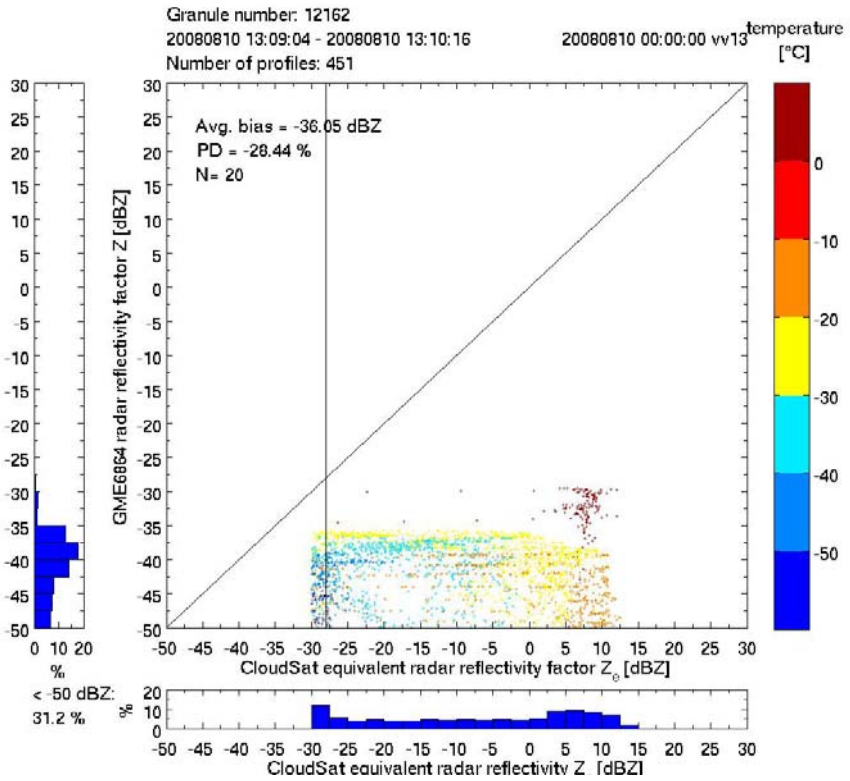
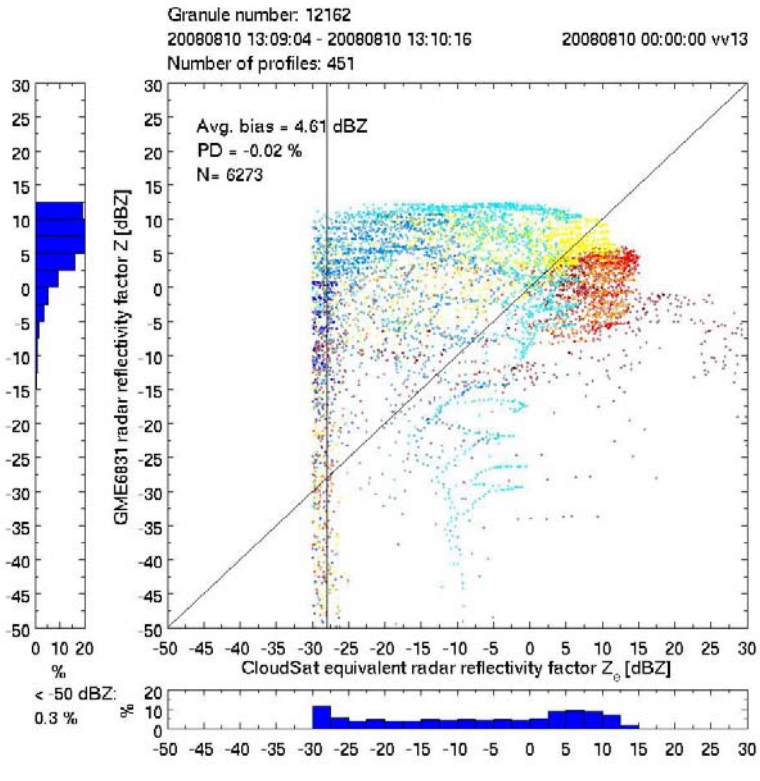
GMErouti



GMEexp



IWC = ice & snow

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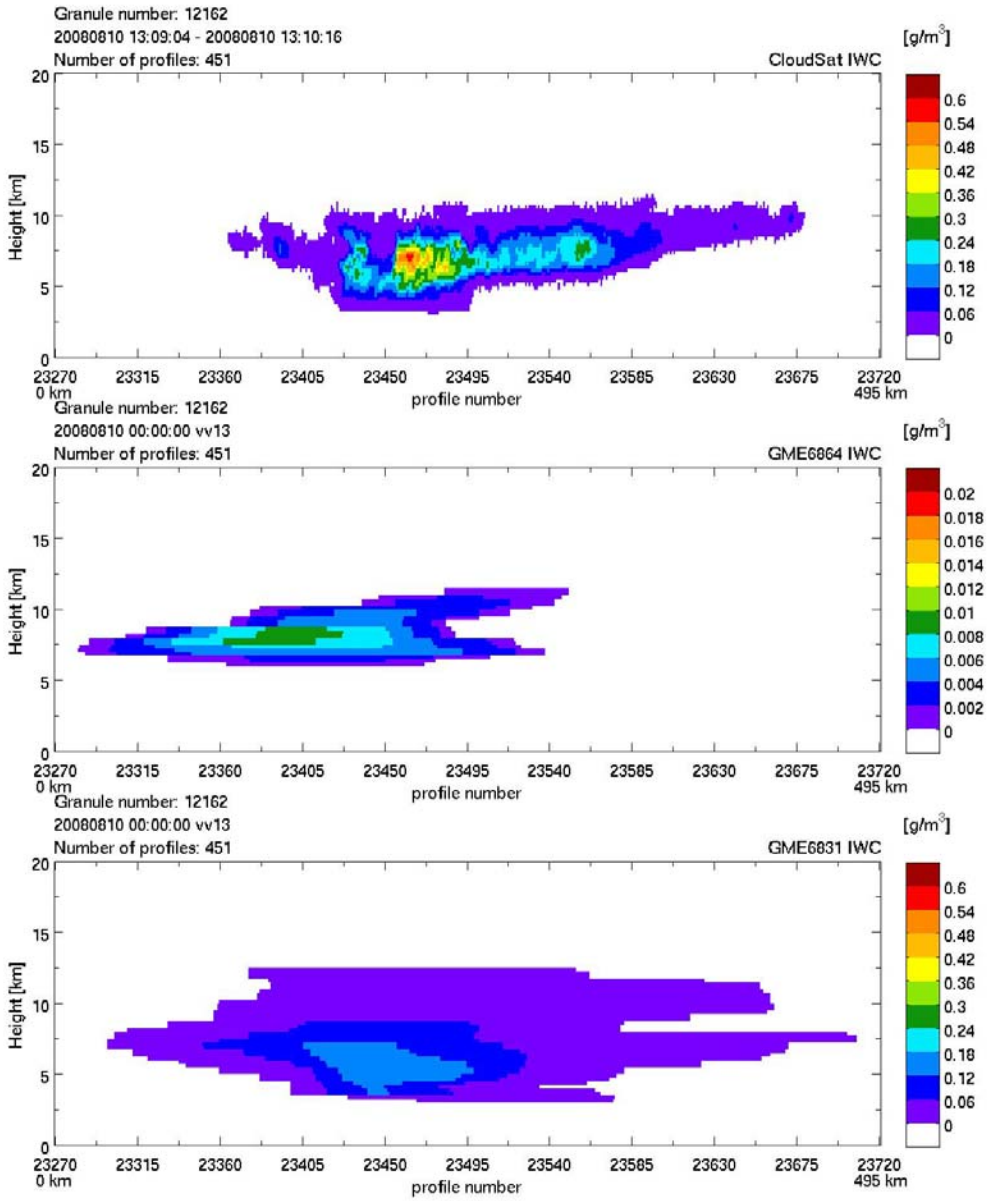
CloudSat

GMErouti

GMEexp



Scale!

IWP

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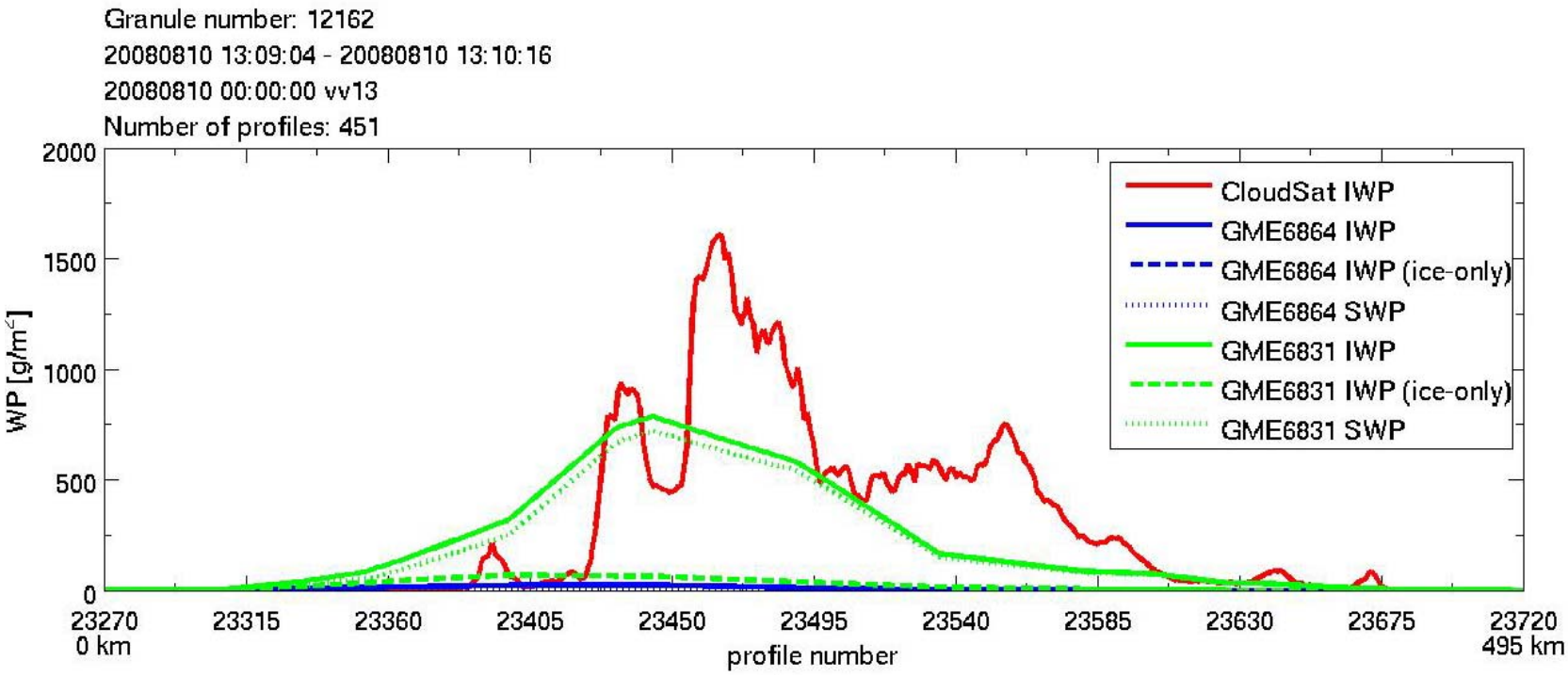

Overview cases

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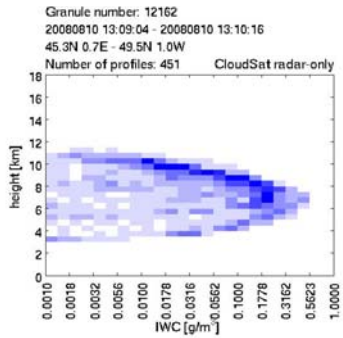
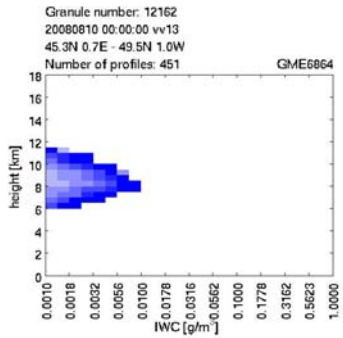
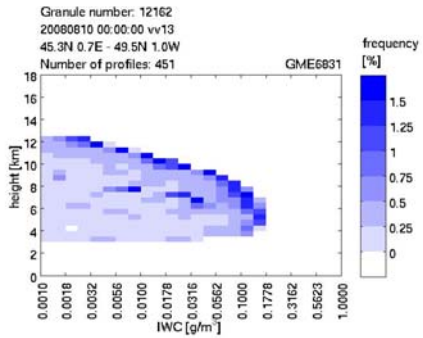
CloudSat | **GMErouti** | **GMEexp**

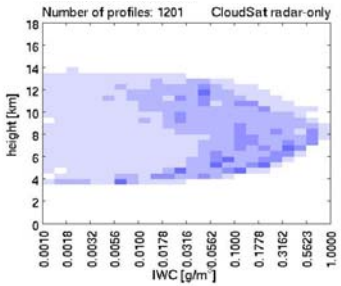
case 1
cold front

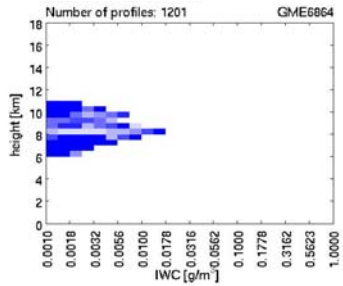


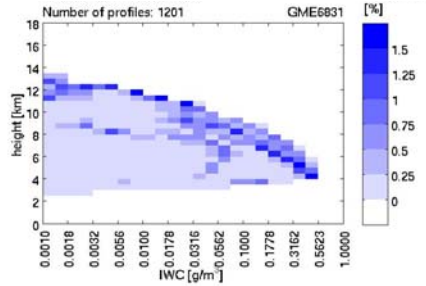




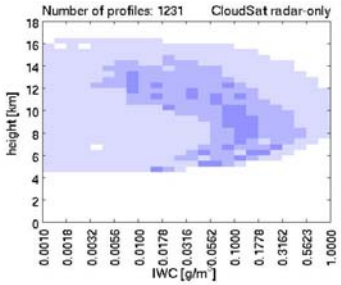
case 2
warm front

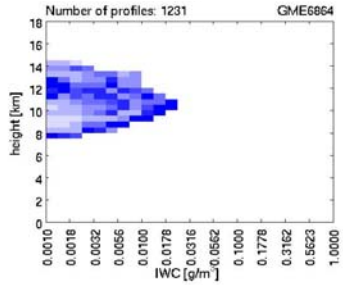


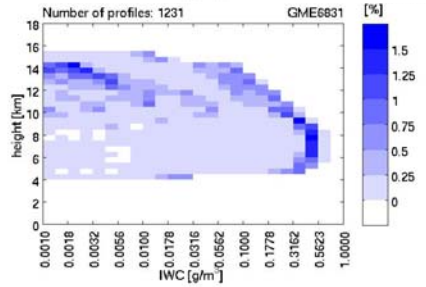




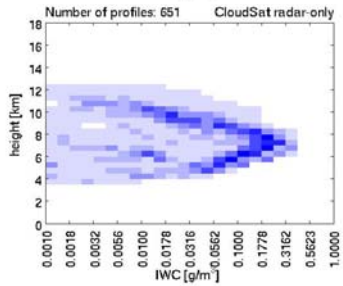
case 3
warm pool

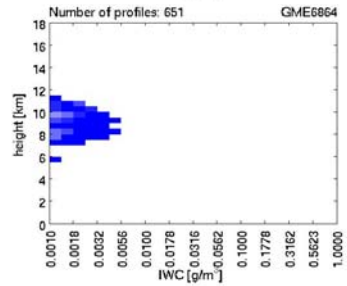


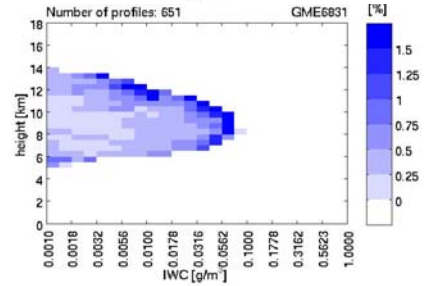




case 4
Ice cloud







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case	database	cloud top [km]	mean IWC [10^{-1} g m^{-3}]	max IWC [10^{-1} g m^{-3}]	rain	snow
1 cold front	CloudSat CPR	11.0	0.853	5.900	-	-
	GMErouti	12.5	0.038	0.094	no	no
	GMEexp	12.5	0.382	1.707	yes	yes
2 warm front	CloudSat CPR	13.0	1.102	8.300	-	-
	GMErouti	13.0	0.031	0.158	no	no
	GMEexp	13.0	0.852	5.562	yes	yes
3 warm pool	CloudSat CPR	16.0	0.977	10.030	-	-
	GMErouti	16.5	0.060	0.224	no	no
	GMEexp	16.0	1.256	6.032	yes	yes
4 ice cloud	CloudSat CPR	12.0	0.681	4.160	-	-
	GMErouti	14.5	0.026	0.050	no	no
	GMEexp	12.5	0.196	0.756	no	yes

Summary & Outlook

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What's good about the new GME version?

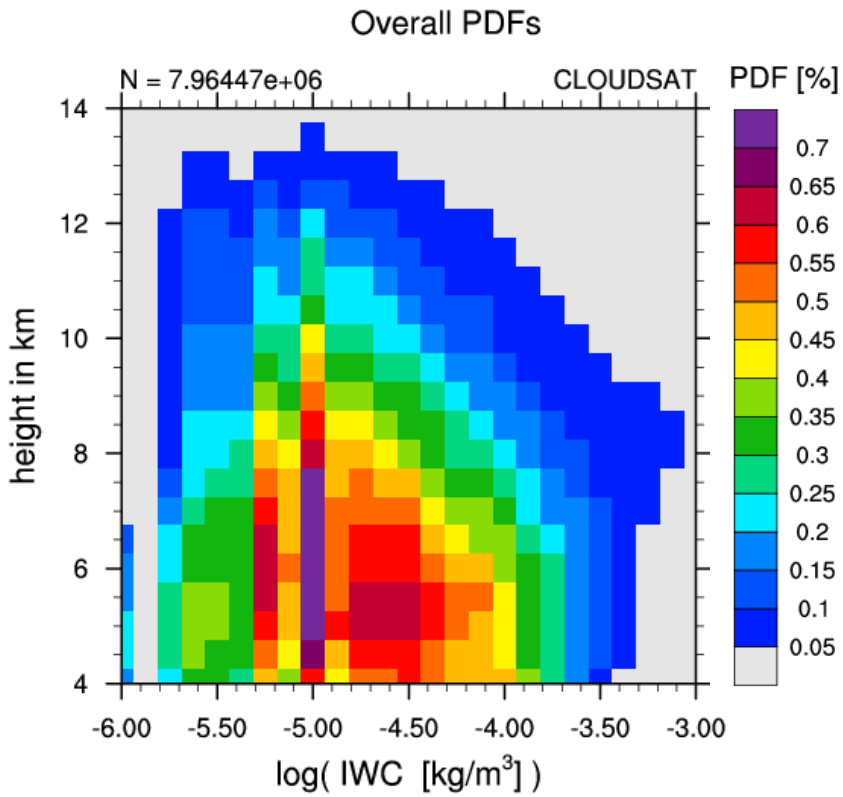
- magnitude of the IWC values fits better to CloudSat
- position and extension of the clouds is recognized better

What needs further improvement?

- frequency distribution of the simulated reflectivities is very narrow and lopsided
- cloud top often too high
- IWCs still too small

To do:

- 11-d statistics!
- search for CloudSat error?



Thank you for your attention!