

Analysis of model error using point data

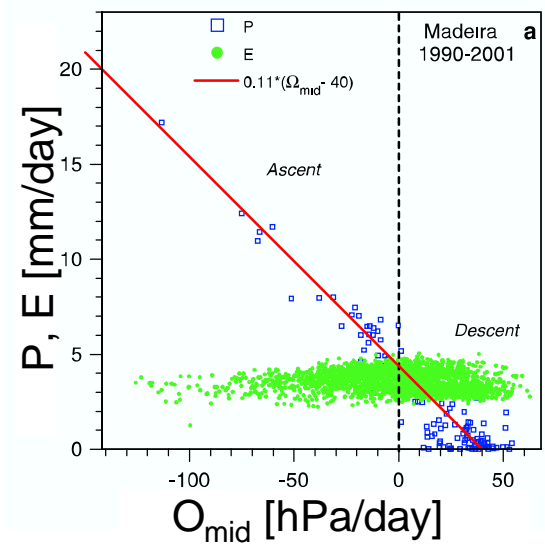
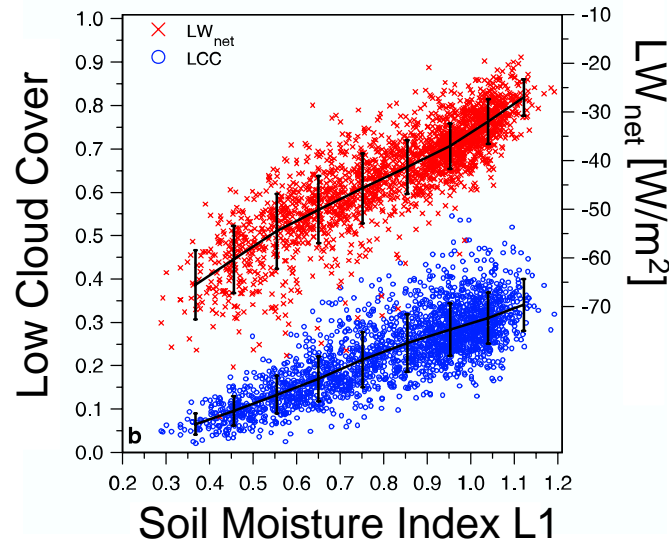
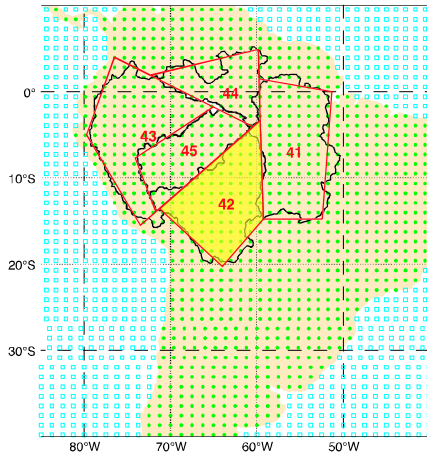
Martin Köhler, ECMWF

- Clouds link water and energy cycles
- Cloud model error can involve complex feedbacks
- International cooperation on model-relevant observations is highly beneficial

Amazon water and energy budget in ERA40

Betts & Viterbo, JGR, 2005

Madeira basin



sfc. energy budget:

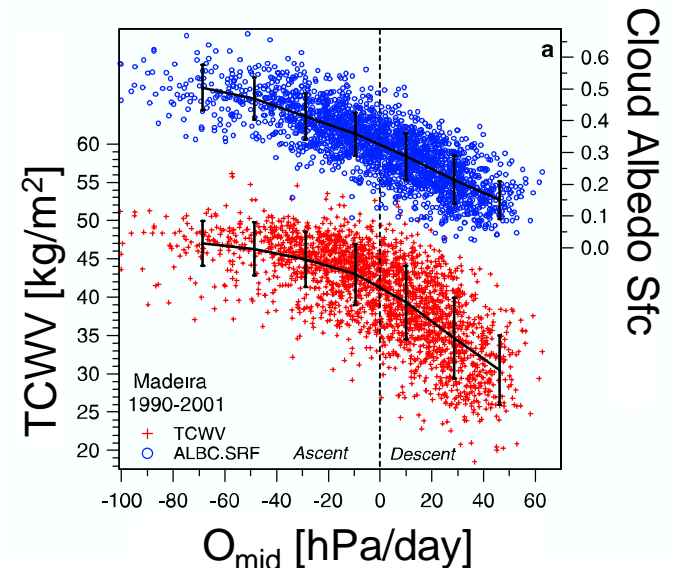
$$LW_{net} + SW_{net} \approx I E + H$$

atmosphere:

$$LCC \quad HCC \quad \leftarrow \quad \Omega_{mid}$$

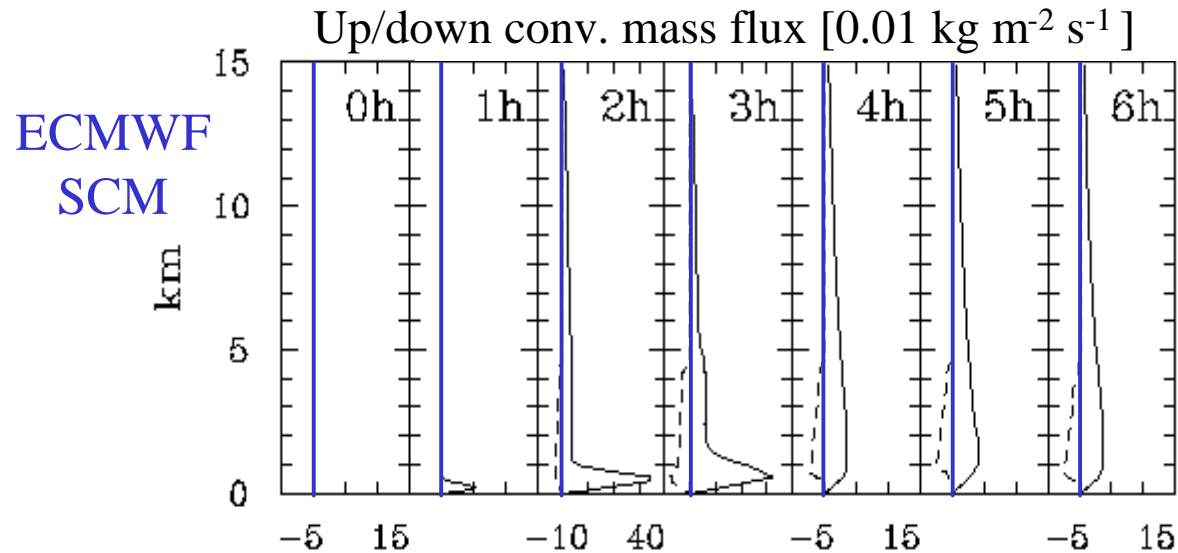
sfc. water budget:

$$\frac{d}{dx} TCSW \approx P - E - Y$$



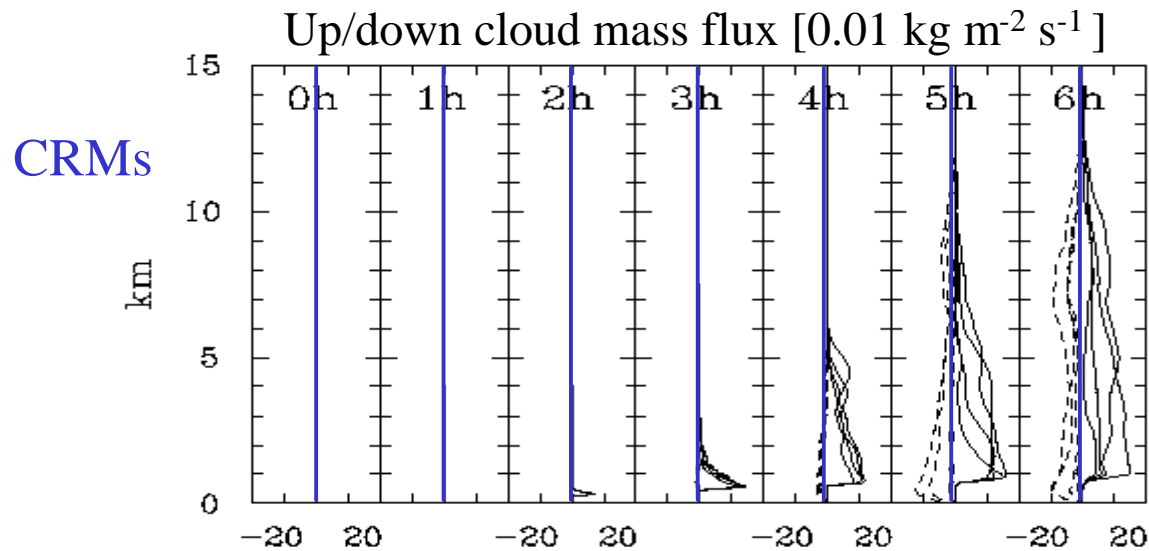
LBA: Diurnal cycle of convection over Amazonia

Grabowski et al., QJ, 2005



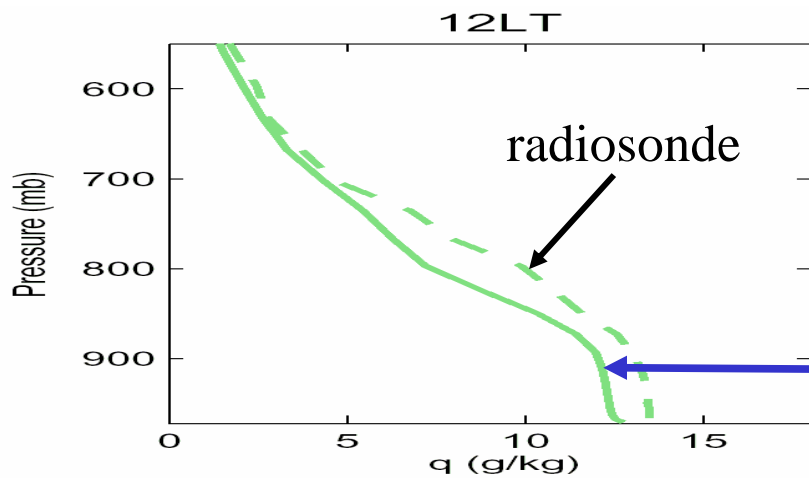
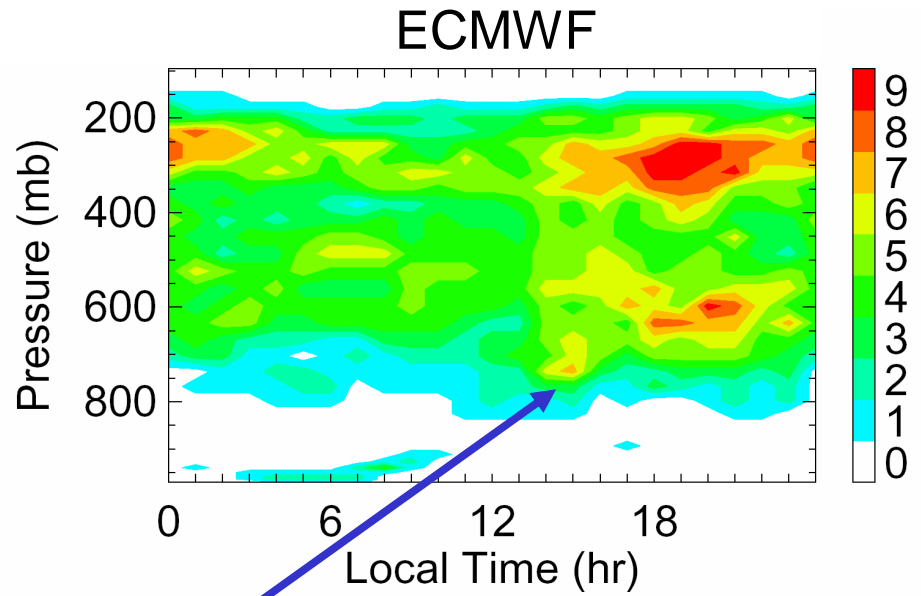
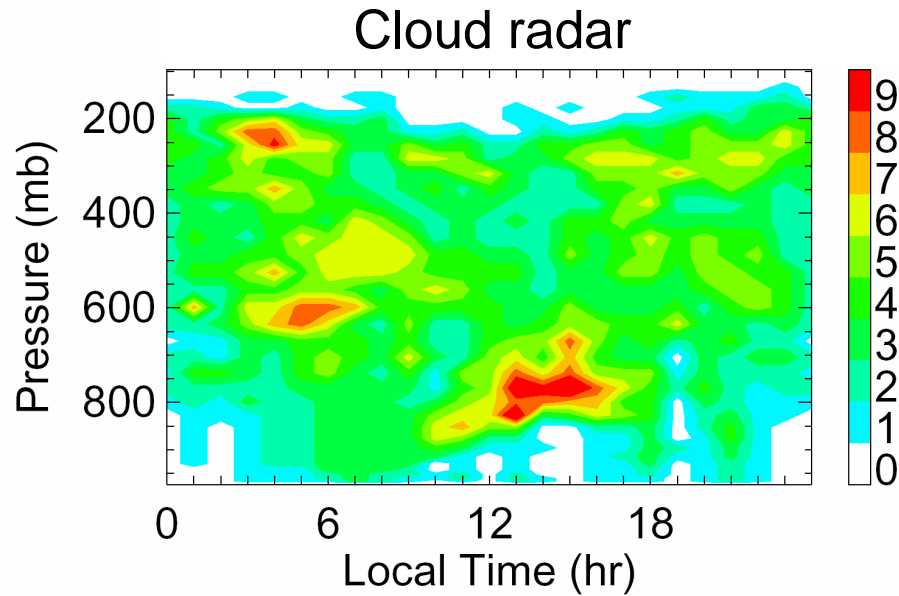
The model reasonably reproduces the diurnal cycle in the mass fluxes but:

- The shallow mass fluxes are too strong
- The cloud (convection) goes too quickly to the deep phase



ARM SGP: number of cloudy hours, July 2003

Sylvain Cheinet et al, 2005

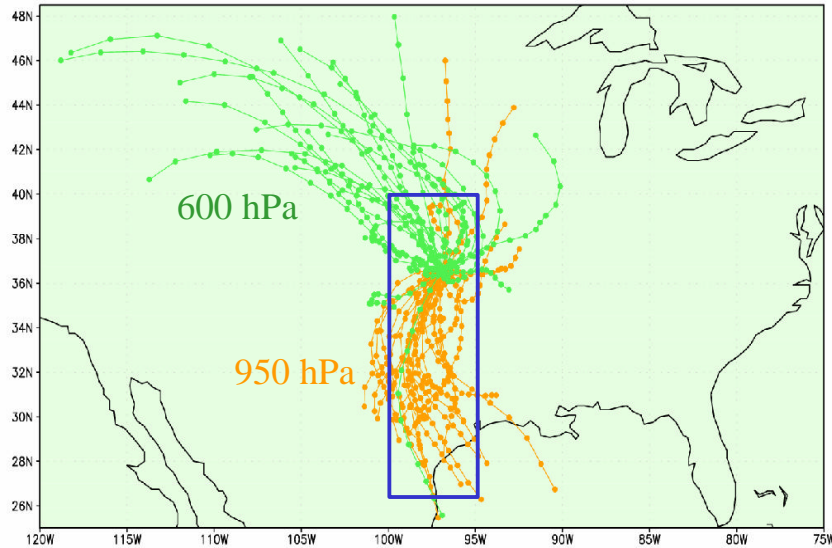


Model lacks afternoon shallow cumulus!

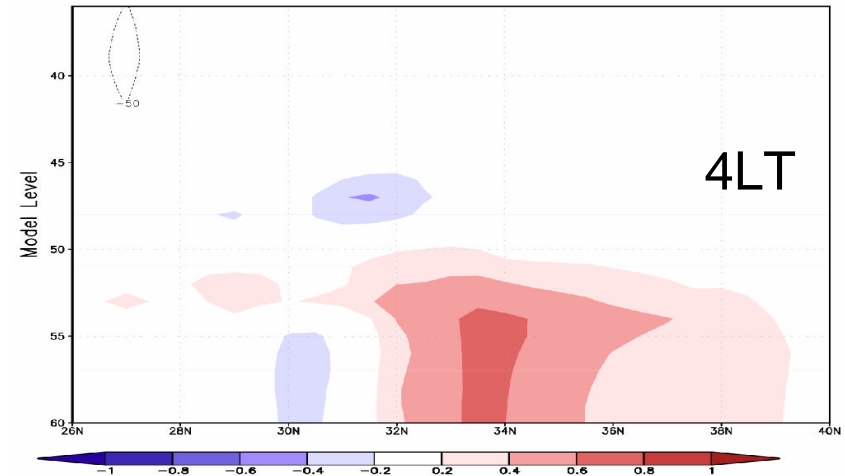
Model too dry!

ARM SGP: daily 36 hr back trajectories, July 2003

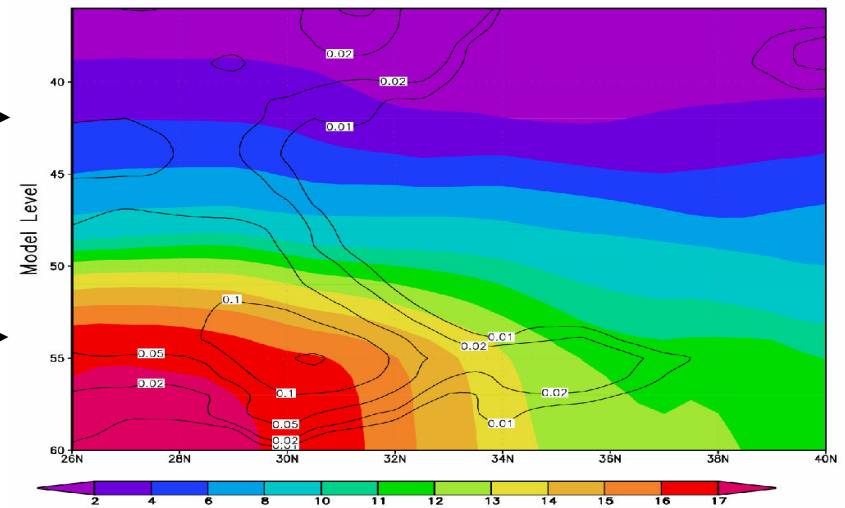
Backward Trajectories



28R1 + half shall. conv. mass flux



28R1



600 hPa →

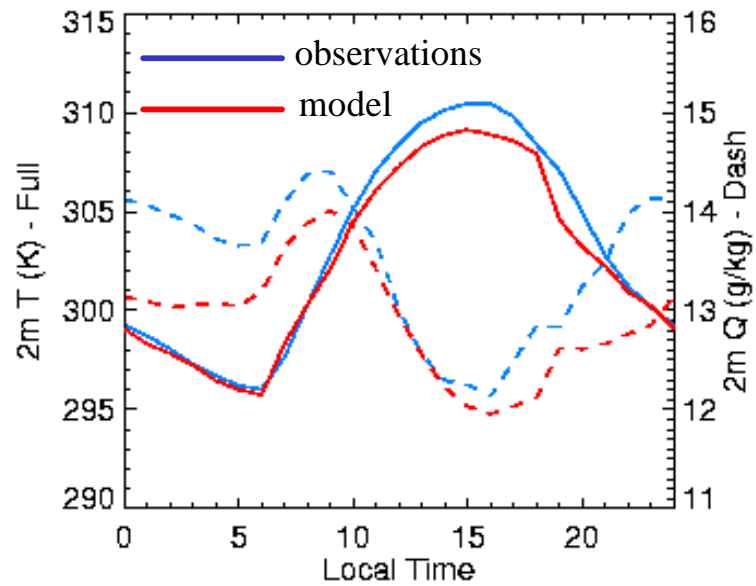
950 hPa →

Cross section of model moisture and cloud cover for fair weather days in July 2003

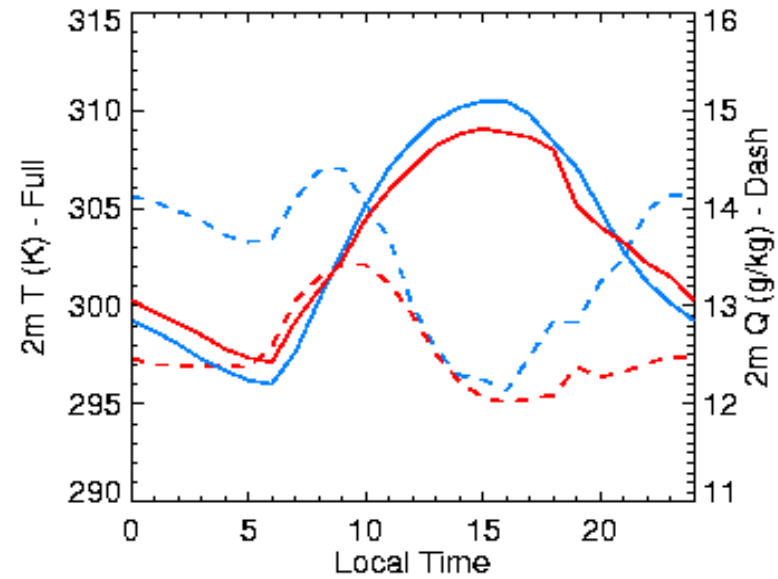
4LT

ARM SGP, moisture sensitivity to stable BL

28R1 + MO stable BL

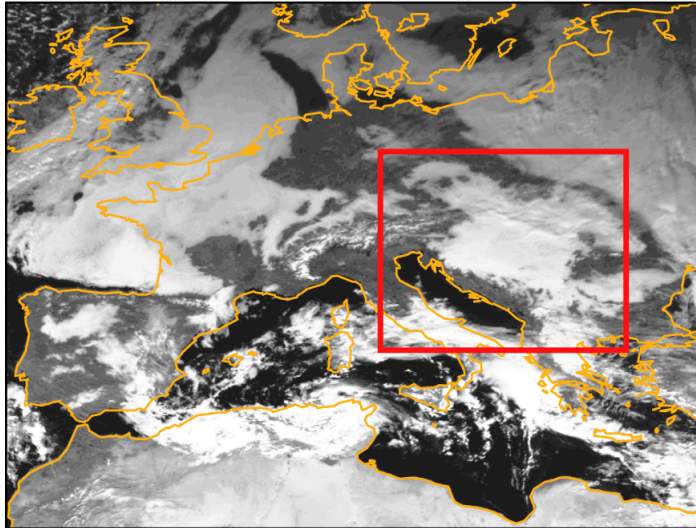


28R1

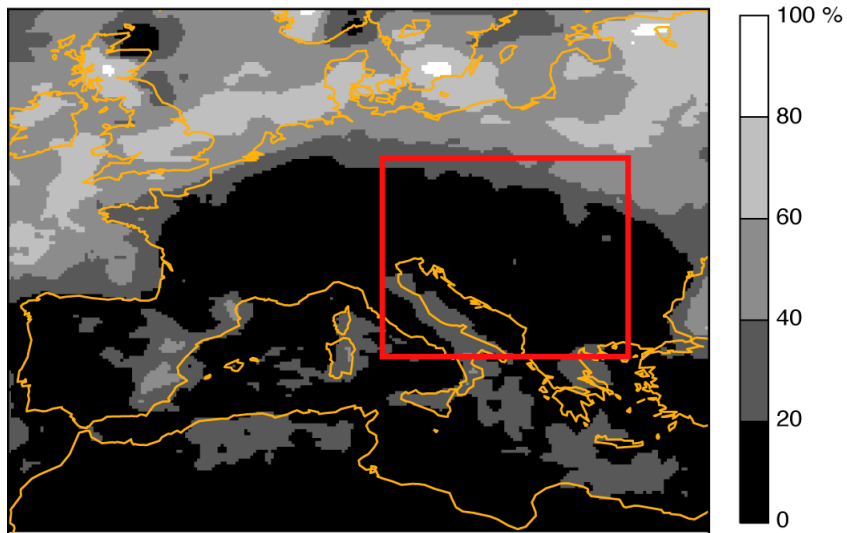


European Winter Stratus: Hungary in December 2004

a METEOSAT visible 10 December 2004



c Low Cloud Cover old model 8–16 December 2004

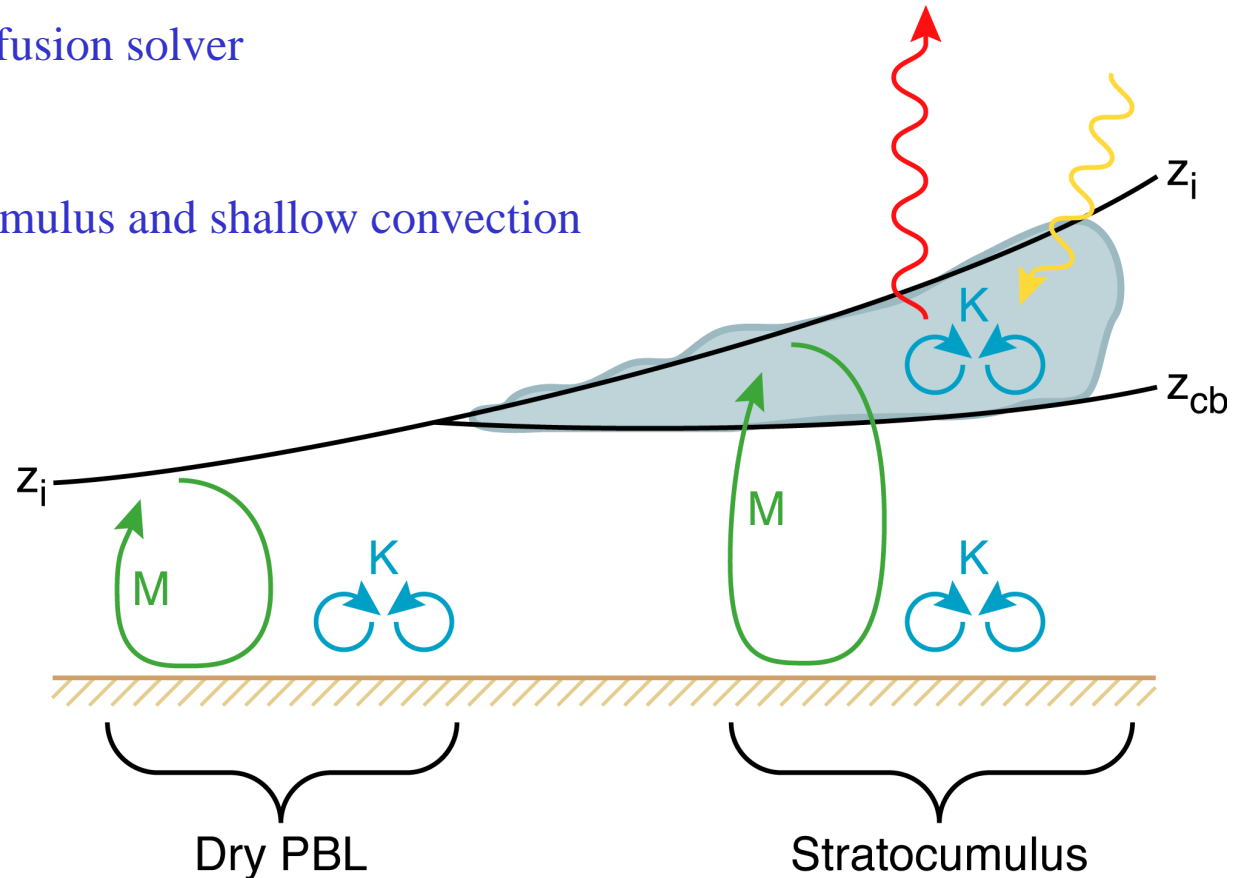


PBL cloud unification – an MK approach

Martin Köhler, ECMWF

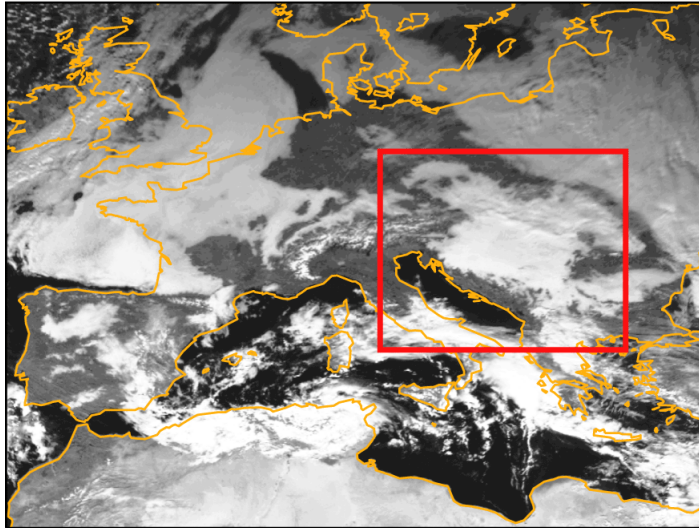
key ingredients:

- moist conserved variables
- combined Mass-flux/K-diffusion solver
- cloud variability
- transition between stratocumulus and shallow convection

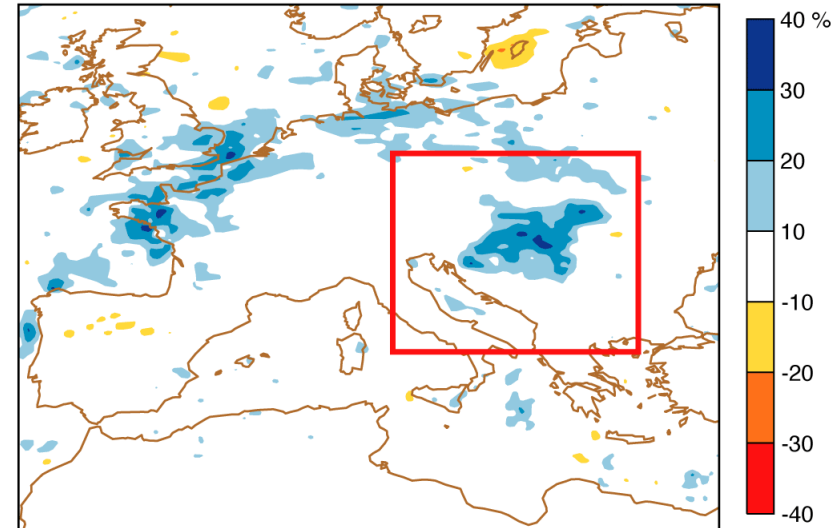


European Winter Stratus: Improvements

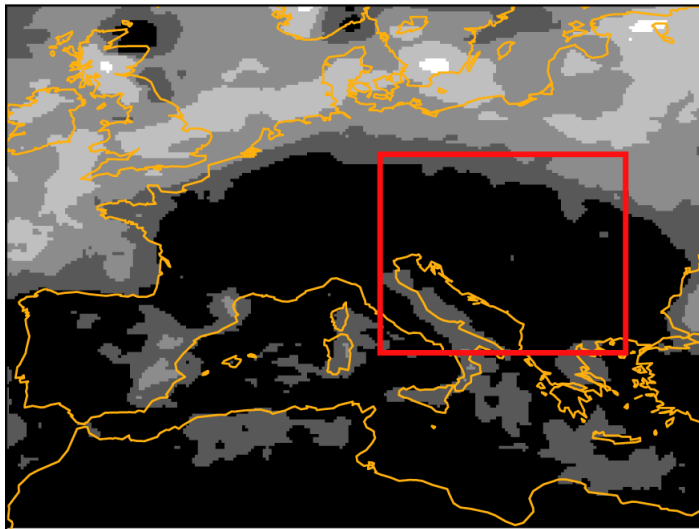
a METEOSAT visible 10 December 2004



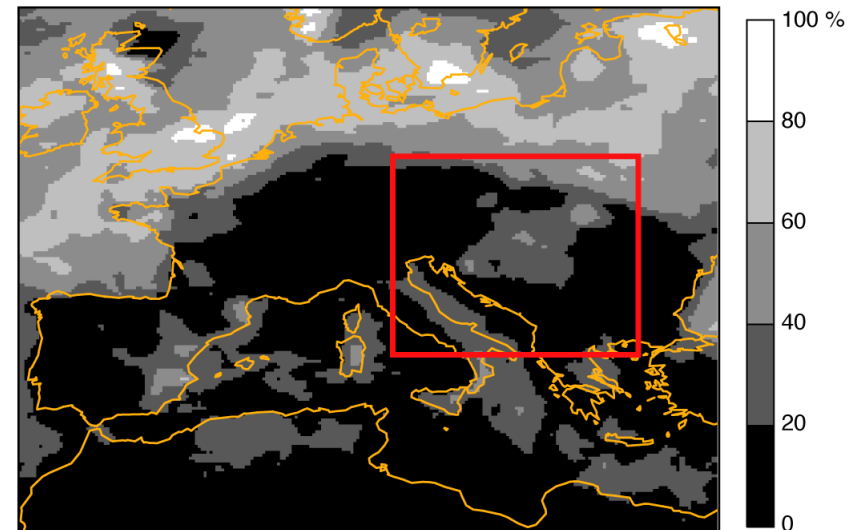
b Low Cloud Cover impact of new PBL 8–16 December 2004



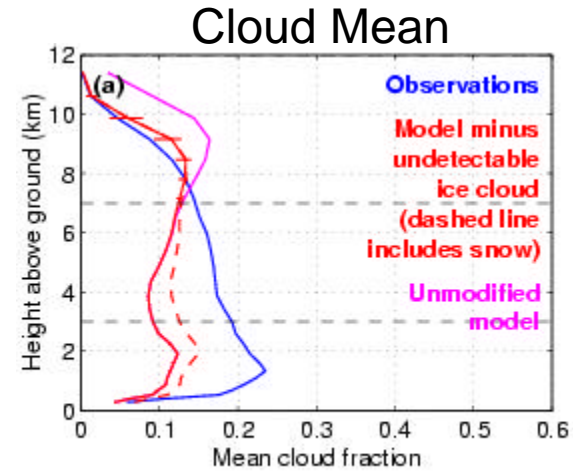
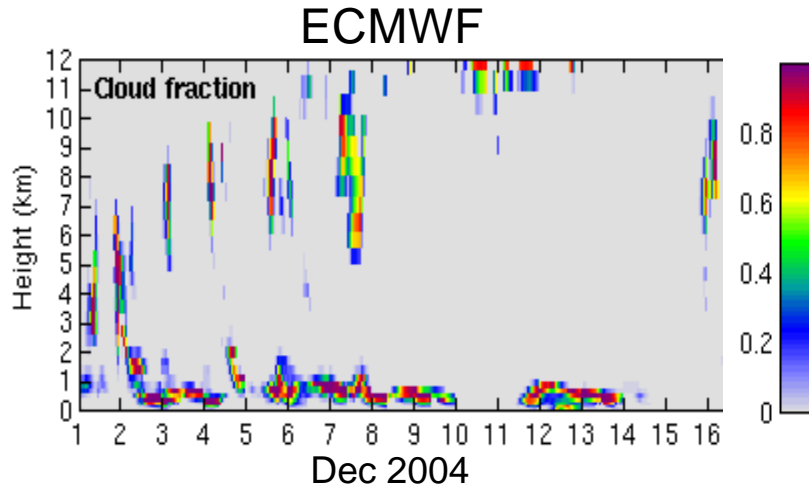
c Low Cloud Cover old model 8–16 December 2004



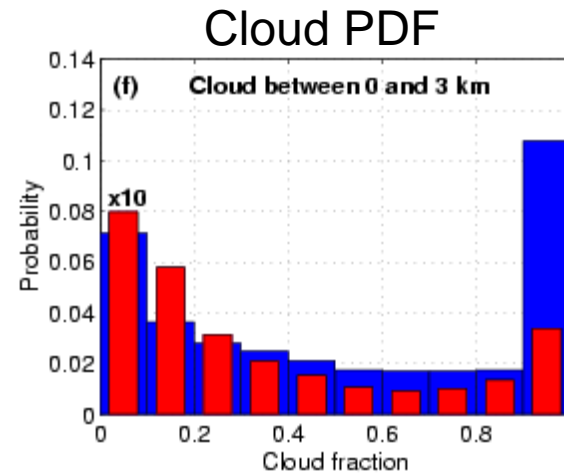
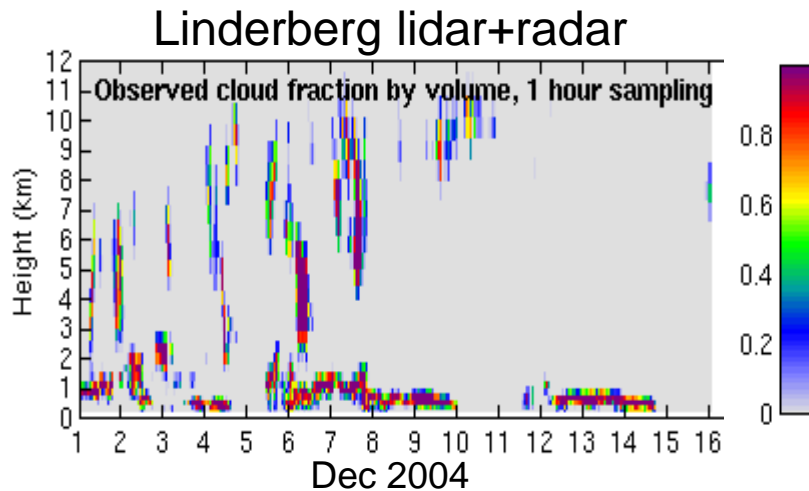
d Low Cloud Cover new PBL 8–16 December 2004



European Winter Stratus: Lindenberg ... CloudNet



Year 2005



Year 2005

model: 12-35h forecasts

Conclusions

- ECMWF has supplied point (MOLTS) and gridded data
- Detailed point data together with gridded data provides powerful tool to disentangle model error
- Cloud observations are not part of MOLTS data
 - ? limit to physical understanding of model error