New methods for the evaluation of atmospheric models with satellite remote sensing observations

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Approach

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Introduction

We present new methodologies for the comparison of satellite remote sensing observations and output of atmospheric models. We utilised observations of MODIS and SEVIRI to evaluate the LMK model. The comparison relies on observations and output from July and August 2004 and on two case studies: a stratiform cloud and a shallow convection case. First results of the long-term evaluation show systematic overestimations of brightness temperature (BT) and underestimations of cloud top pressure. Further analysis relies on the diurnal cycle and regional dependencies of bias and RMSE. Finally, we apply a tracking algorithm to MSG and LMK data which allows the analysis of differences in life time, origin, and path of convective cells.

Approach

- Interpolate and determine total cloud cover (b), τ, BT and patchiness:
  \[ p_{1,2} = \frac{(N_{\text{cld}} \pm N_{\text{free}})}{n} \]

- Aggregate cloud optical thickness:
  \[ \tau_{\text{agg}} = -\mu b \left[ \frac{1}{n} \sum_{i} \exp \left( -\frac{\tau_i}{\mu} \right) \right] \]

For aggregation use \( \tau_{\text{agg}} \) in clear sky cases and for domain averages use \( \tau_{\text{agg}} \).

Observations

LMK from DWD: output every hour, \( \Delta x=2.8 \) km, MODIS: overpass Europe 1-2 times a day, \( \Delta x=0.25-3 \) km; SEVIRI: full disk every 15 min., \( \Delta x=5 \) km for Europe.

Long-term analysis

- Agreement in b, diurnal cycle in RMSE.
- Underestimation of cloud top pressure.
- Overestimation of BT (large bias, high correlation (0.86)), diurnal cycle in RMSE.
- Latter possibly due to erroneous implementation of viewing geometry. This would also explain the increasing bias with decreasing BT and cloud top pressure.

Tracking

- Tracking of convective cells and comparison of origin, path, diurnal cycle, and PDFs of area, path length and lifetime as well as merging and splitting of cells (not shown) contains large potential for evaluation purposes.

Conclusions and outlook

New algorithms for the evaluation of atmospheric models have been presented utilizing LMK, SEVIRI and MODIS observations. The patchiness parameters are able to identify differences between LMK and satellites. The aggregation of cloud optical thickness is widely applicable, and cloud optical thickness turned out to be a valuable parameter for evaluation purposes. LMK tends to overestimate the frequency of large cloud optical thicknesses and shows no significant structural differences in cloud optical thickness fields, probably due to an overestimation of updrafts (see also Van Lipzig et al. 2006 and Schröder et al. 2006). For July 2004 we found reasonable agreement in cloud cover and underestimations in cloud top pressure. RMSE of cloud cover has a distinct diurnal cycle. For August 2004 BT 10.8

References:


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