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Mathematical Mathematical State State

Data for validation

AGCMs

- ECMWF provides twice-daily atmospheric analyses. These analyses incorporate surface observations and satellite data into a 4D data assimilation system that uses a NWP model to carry forward information from previous analyses.
- Problem: The analyses contain a mixture of observations and model. This is especially the case for the tropical circulation.
- Satellite data provide near-global coverage of TOA quantities, such as net solar rad., OLR, SCF and LCF. The last two are used to validate cloud parameterizations
- Satellites also provide cloud information (cloud cover, liquid and ice water path, droplet size and number)
- Data from field programs: Smaller spatial and temporal scales than the AGCM resolution, but can be used for statistical relationships.

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- ► Cumulus parameterizations need to account for mesoscale circulation effects → superparameterization or clever parameterizations
- Better shallow convection parameterizations are needed
- Cloud radiative effects should be part of the cloud scheme.
- The present linear sequential approach (Fig. 10.8) needs to be replaced with a more integrated cloud scheme that simultaneously accounts for radiative, dynamical and thermodynamical effects.

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Future improvements

Future improvements Future improvements in physical processes in **AGCMs** ▶ The coupling of the climate system components within the PBL (e.g., plant canopy, source for chemical species, ocean surface) with an AGCM will only be as good will only be as good as the PBL parameterization \rightarrow need to improve the PBL parameterization Lacking for many processes: good observational data and/or robust computational studies. It is hoped that future field programs will lead to improved understanding of the fundamental physics governing these processes. One could/should to use a hierarchy of 3D models to improve the parameterizations: employ micro-, meso-, and large-scale models, in tandem, to improve the physical parameterization of clouds and the PBL.

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