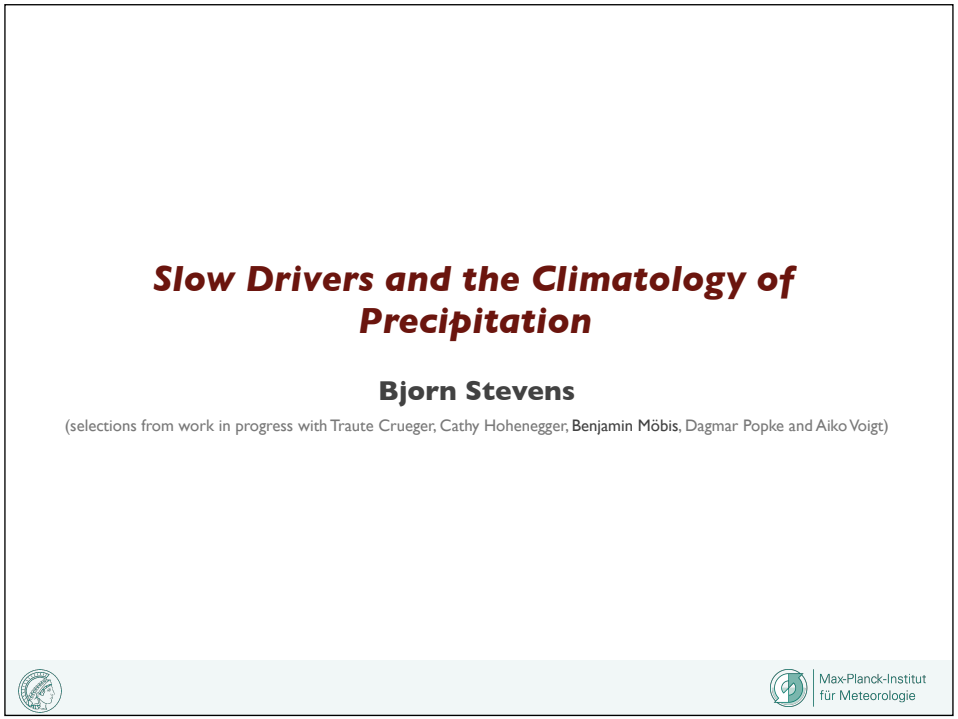
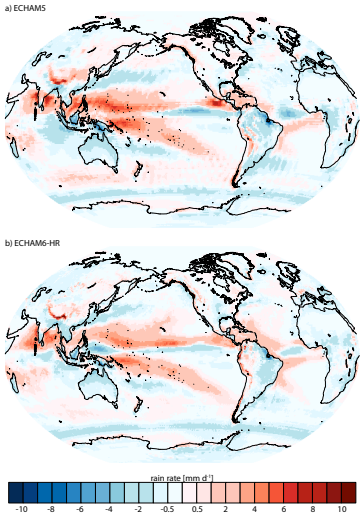


This is a different talk than originally advertised. In preparing for the meeting I decided that I would get more out of your reactions to ongoing work to understand deep convection, even if much is preliminary, then I would if I gave you the rather more polished talk that I had originally planned. The latter is anyway in press and you can read it if you are interested.

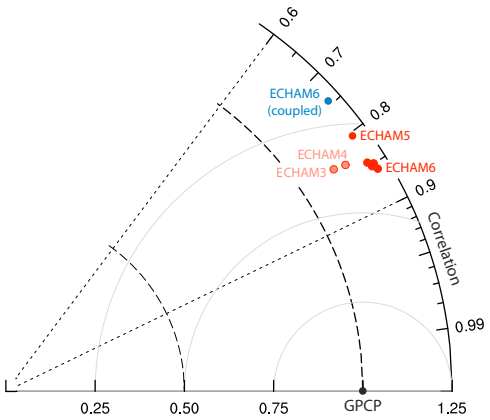
Characteristics of the ECHAM Precipitation Climatology



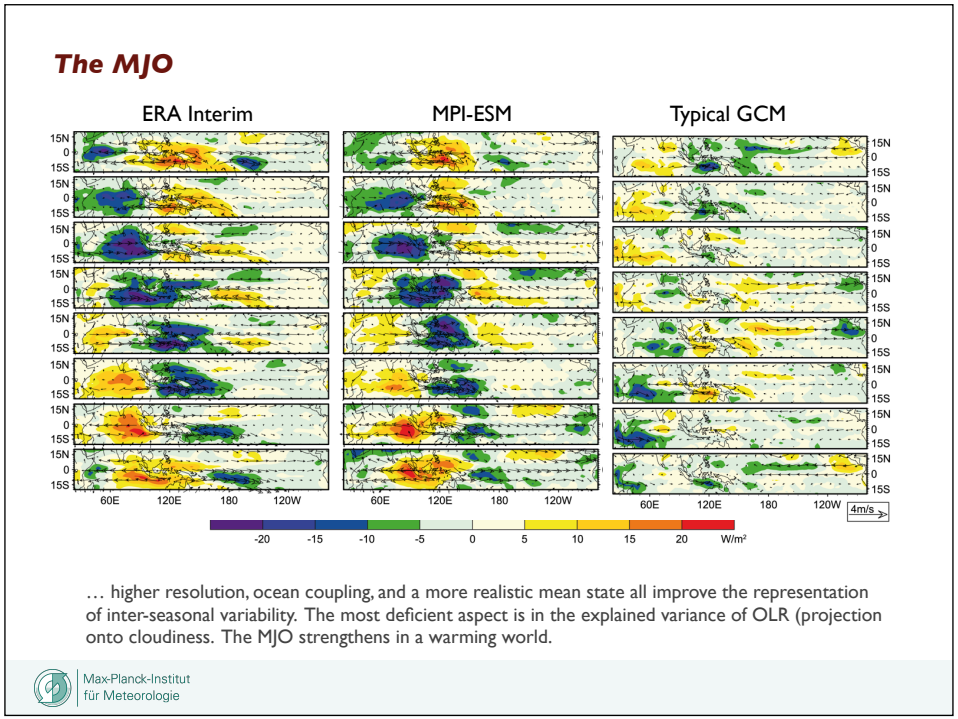
- General northward displacement of precipitation features, modulo the Atlantic
- Possibly too much warm-pool precipitation
- Too little precipitation over tropical land
- Poor representation of the diurnal cycle
- Generally good representation of tropical variability

...these features (mostly) get worse with coupling, and are long standing.

Taylor Diagrams



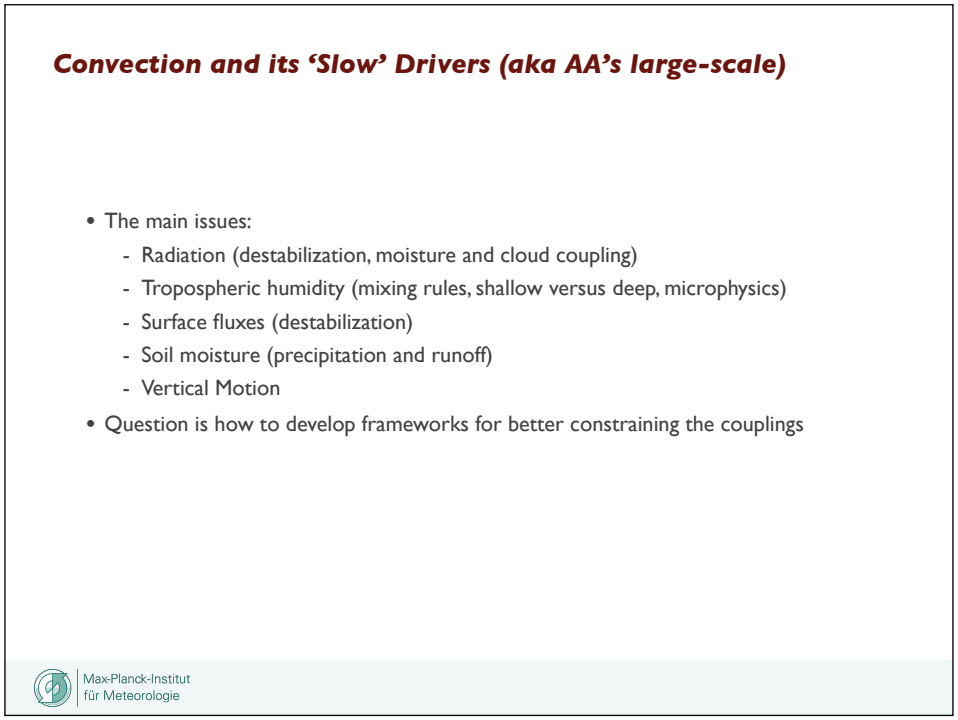
... in the coupled model biases are amplified.



The MJO gets better the more realistic the model becomes …. here we show the 850 hPa wind and the OLR regressed on the MJO index derived from the first two principle components of the multivariate EOF of band-passed (20-100 day) filtered anomalies of u200, u850 and OLR.

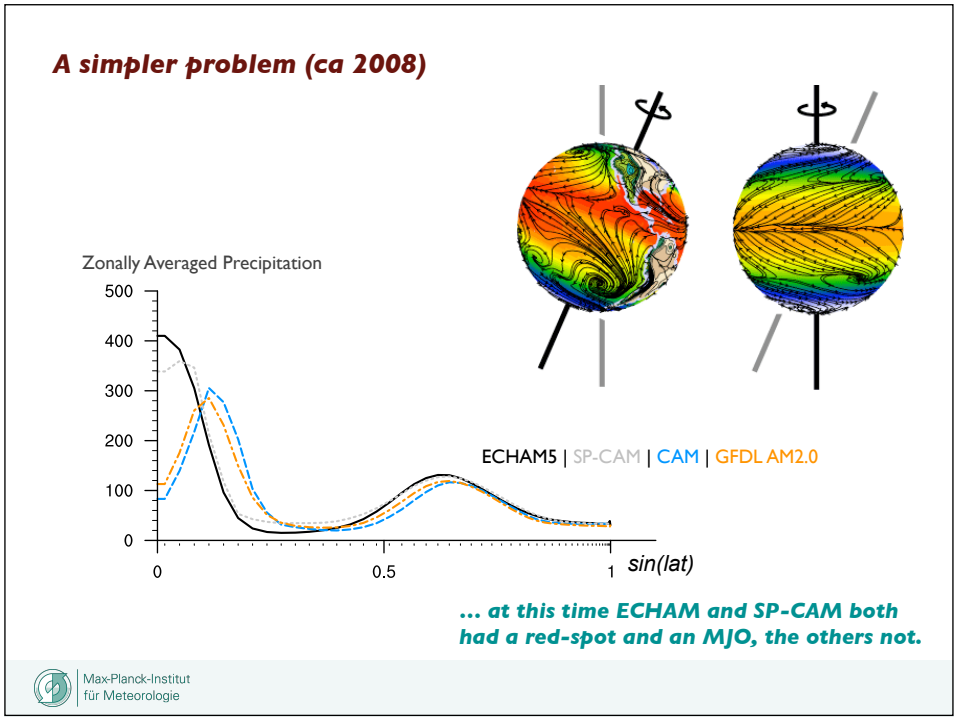
the MJO in ECHAM has always been good, but it has not really been understood as to why.

Of course it is not perfect, the main weakness we have identified is in the projection of the MJO onto the OLR, which raises a question that Sandrine has done a lot of work on, namely the coupling of convection to radiation. This is what I was thinking about when I was talking about slow drivers.



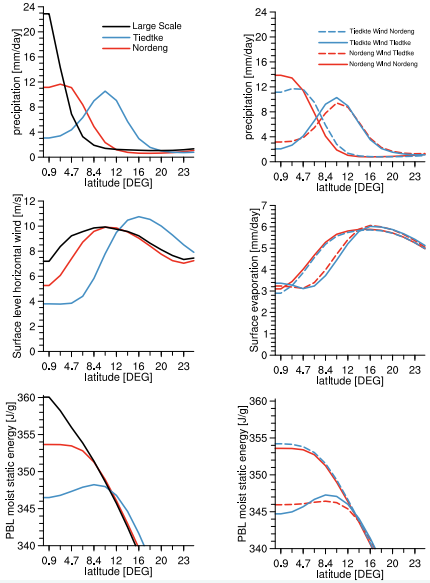
The cumulus parameterization problem, as I see it, is to get the coupling right between convective processes and their slow precursors… some of which I list here. To get a realistic MJO in our model (or in any model for that matter, as some of you have shown) … really only requires one not to neglect the second point. Although as indicated in the last slide, the main limitation in our model is likely the first point.

To understand the interplay between convection and its slow precursors I find it useful to give complex models simple problems … one is motivated by the next slide and will be discussed in more detail.



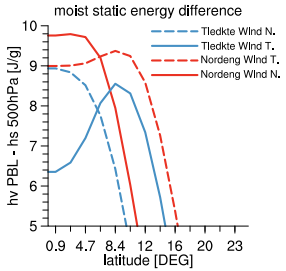
This is an example of the zonally averaged precipitation from a number of models, which I put together a few years ago. The point that struck me in doing so was that those models which produced an equatorial ITCZ tended to have a good representation of intraseasonal variability

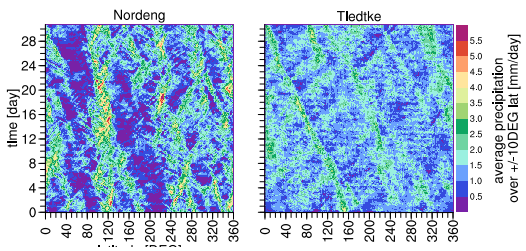
Convection on Planet Möbis

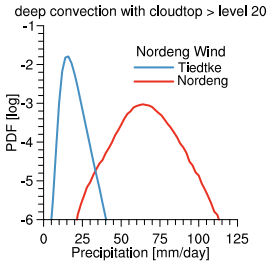


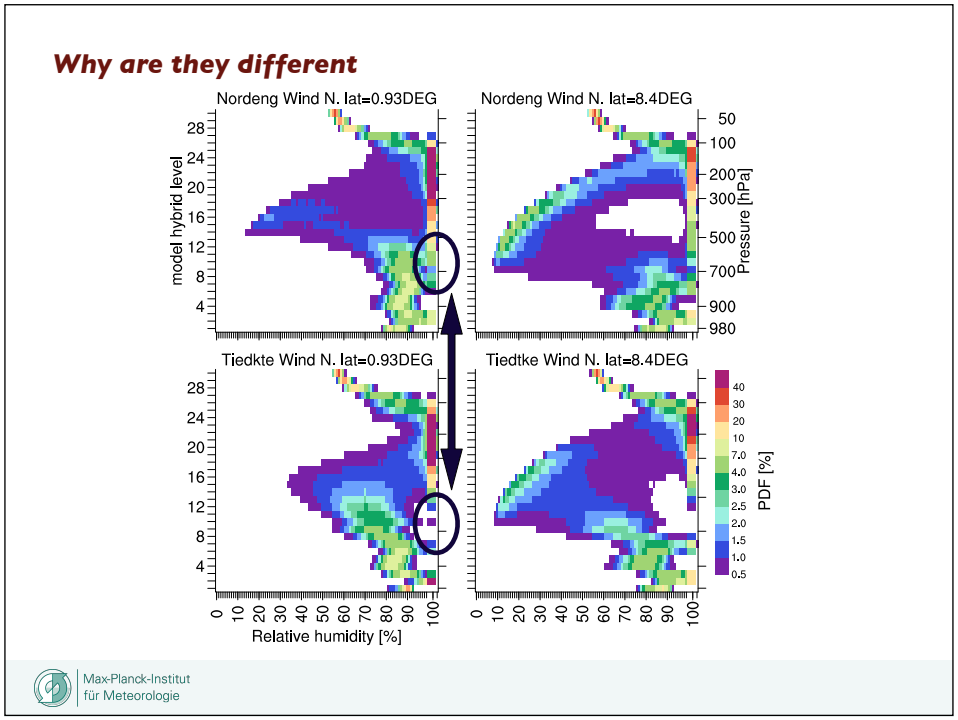
- ITCZ placement couples strongly with dynamics
- Decoupling from the dynamics is as simple as fixing the wind field seen by the evaporation
- This provides a framework for understanding the convective dynamics

How are they different?





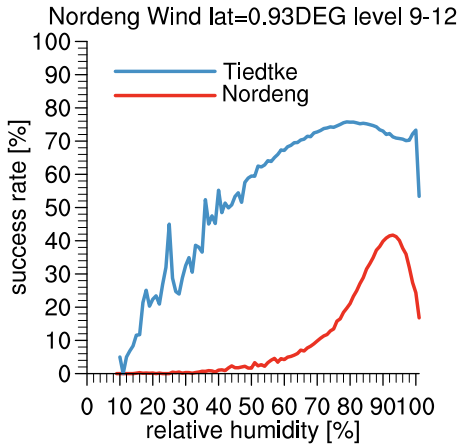




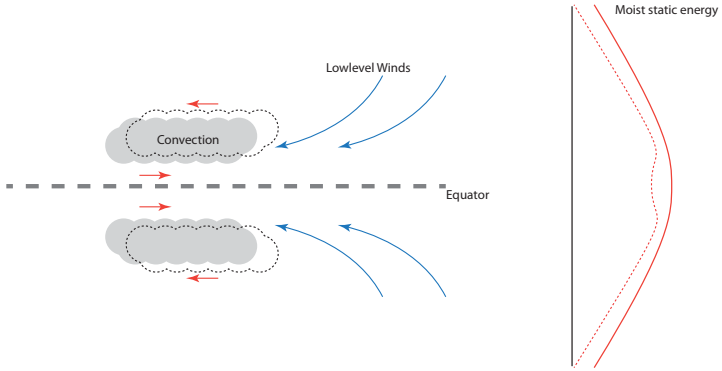
Distinct deep and shallow convective structure, separating at about 700 hPa; likely reflecting assumptions made in the convective parameterization. Nordeng supports a non-convecting mode at the equator, which is surprising because it wants to convect there more than Tiedtke. Tiedtke appears to convect through a drier lower (500-800 hPa) troposphere.

This mode also more pronounced on the flanks. The key question is how humidity projects onto this humidity structure.

Tiedtke decouples from the large-scale moisture field



Our conceptual framework

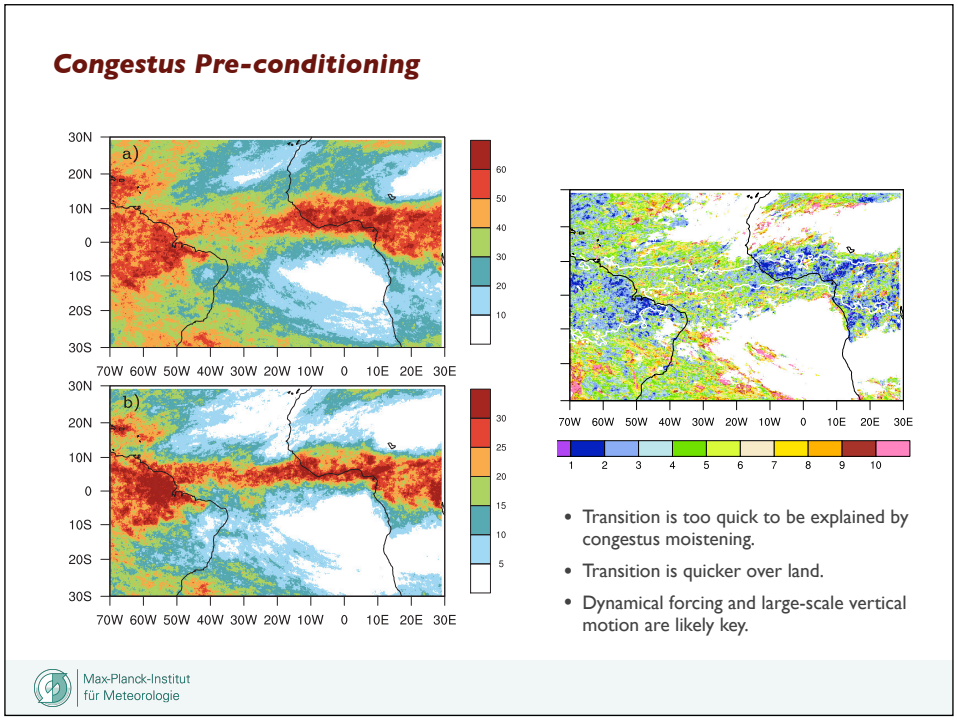


*Nordeng is more **strongly coupled to tropospheric humidity**. Leads to more organized, but patchy convection, that is **less strongly coupled to surface winds**, and hence surface wind feedbacks. Thus the **surface wind feedback pictured above plays a less decisive role.***

Remarks

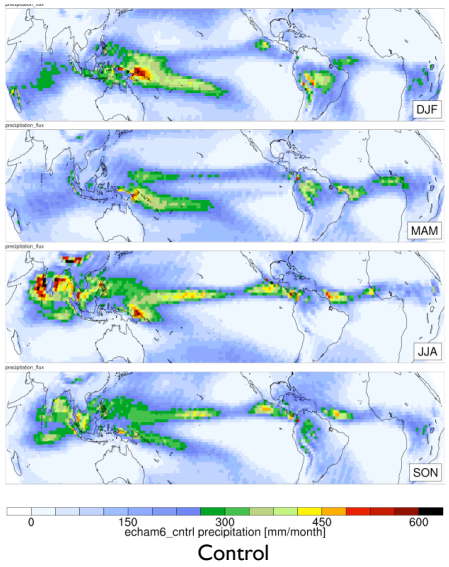
- Persistent precipitation biases over two decades of earth-system modeling at the MPI-M
  a. convection biases of the new model (more or less the same as always)
  b. MJO (a feature of the convection scheme)
- A good simulation of the MJO and tropical variability in general
  - the key feature is in how our model couples convection to large-scale moisture
  - the convective firing using Nordeng's modification to the Tiedtke model couples convection much more strongly to free tropospheric humidity, and favors rarer, more organized, and more intense convection

Related points:
- congestus pre-conditioning;
- radiative pre-conditioning;
- role of the diurnal cycle.



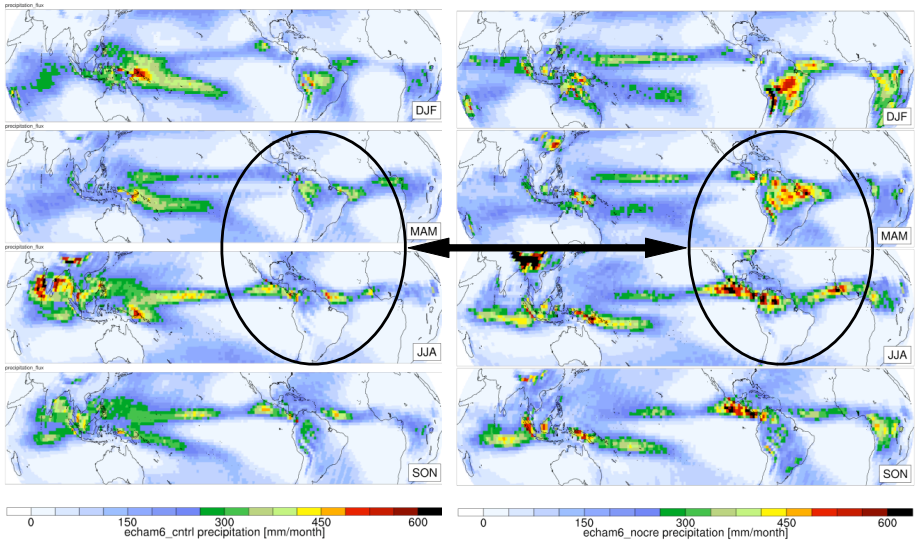
Work with Hohenegger, inspired by work done by Dave Raymond some years ago. Congestus have tops between 240 and 273 K; Deep clouds have colder tops.

Radiative Pre-conditioning



Control

Cloud Radiative Effects (underline the land-sea bias)



Control

No CRE

The climate of a truely equable planet

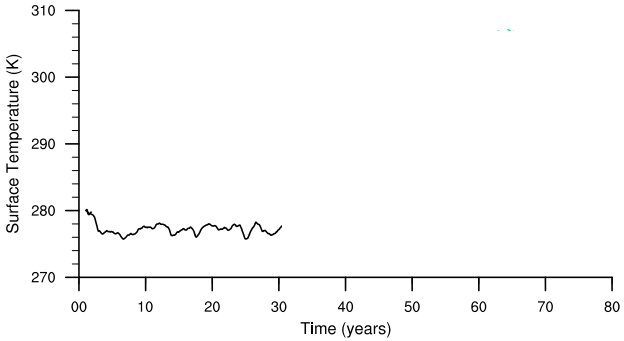


Figure 2.3: Temporal evolution of SSTs in control and 4xCO_2 experiments with and without a diurnal cycle. solid: Nordeng-Scheme, dashed: Tiedtke-Scheme.

The climate of a truely equable planet

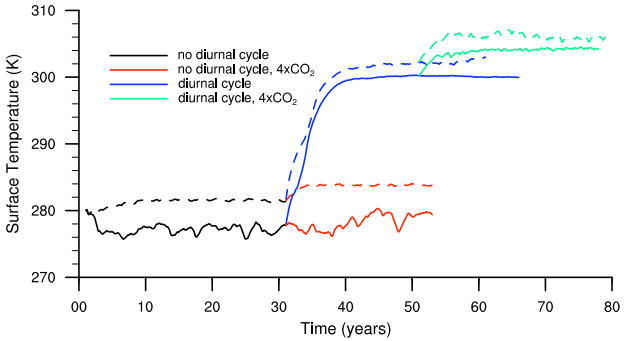


Figure 2.3: Temporal evolution of SSTs in control and 4xCO_2 experiments with and without a diurnal cycle. solid: Nordeng-Scheme, dashed: Tiedtke-Scheme.

Final Remarks

- Convection and convection related biases are large and long standing.
- Quite likely there is no magic bullet for improving convection in large-scale models.
- An adequate coupling to free tropospheric moisture is surely a necessary condition … this likely strengthens the coupling to large-scale convergence, reminding us of the CISK wars.
- The inadequate coupling of convection to radiation, through clouds, maybe be at the heart of more problems.
- Some surprising results, and sensitivities, from radiative convective equilibrium with a full physics model.

and as a meta point … model hierarchies of the second type have a lot to offer.