Clouds and the global circulation: a model developers experience

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- Reflections on this topic after 30 years of global model development work
- Systematic errors** and the representation of convection!
- Some possible discussion points

Modelling the mean tropical circulation is primarily a boundary value problem hence:

- Late ’80s – Representing shallow convection in Trades provided ventilation-> huge improvement in moisture supply for deep convective regions

- Early ‘90s – Low wind speed fluxes eg in ‘warm pool’ -> more moisture supply-> Major impact on Walker circulation

- Early ’00s – Improving cloud/radiation interaction (with McICA) -> improved tropical land .v. sea precipitation distribution

Each of the above alleviated a major systematic error

(As did orographic GWD for the NH extratropics, ’80s)

The RSPCCS!!

Convection schemes (particularly the deep part) are far too often the scapegoat for other model failings or weaknesses!

Much of the time convection is a ‘slave’ to its environment and just one part of a ‘unified physics scheme’ **

Likewise problems where there are large systematic precipitation errors such as the double ITCZ, monsoons etc repeatedly get the reaction ‘It must be the fault of the (precipitating) convection scheme’

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All three of the examples on the previous slide are cases where the deep convection scheme was the prime suspect!!

Of course convection is fundamentally important in tropical systems and tropical variability such as the MJO, TCs, diurnal cycle…….
Major improvements have been made to convection schemes in recent years such as sensitivity to environmental moisture, coupling to PBL evolution etc

Three more specific modelling issues for possible discussion?

1) Most (all?) models under-represent middle level clouds especially in the Tropics. Not entirely surprising as the processes involved are not very well understood
But does this deficiency confuse the relative importance of low/high cloud feedbacks or at least raise some doubts?

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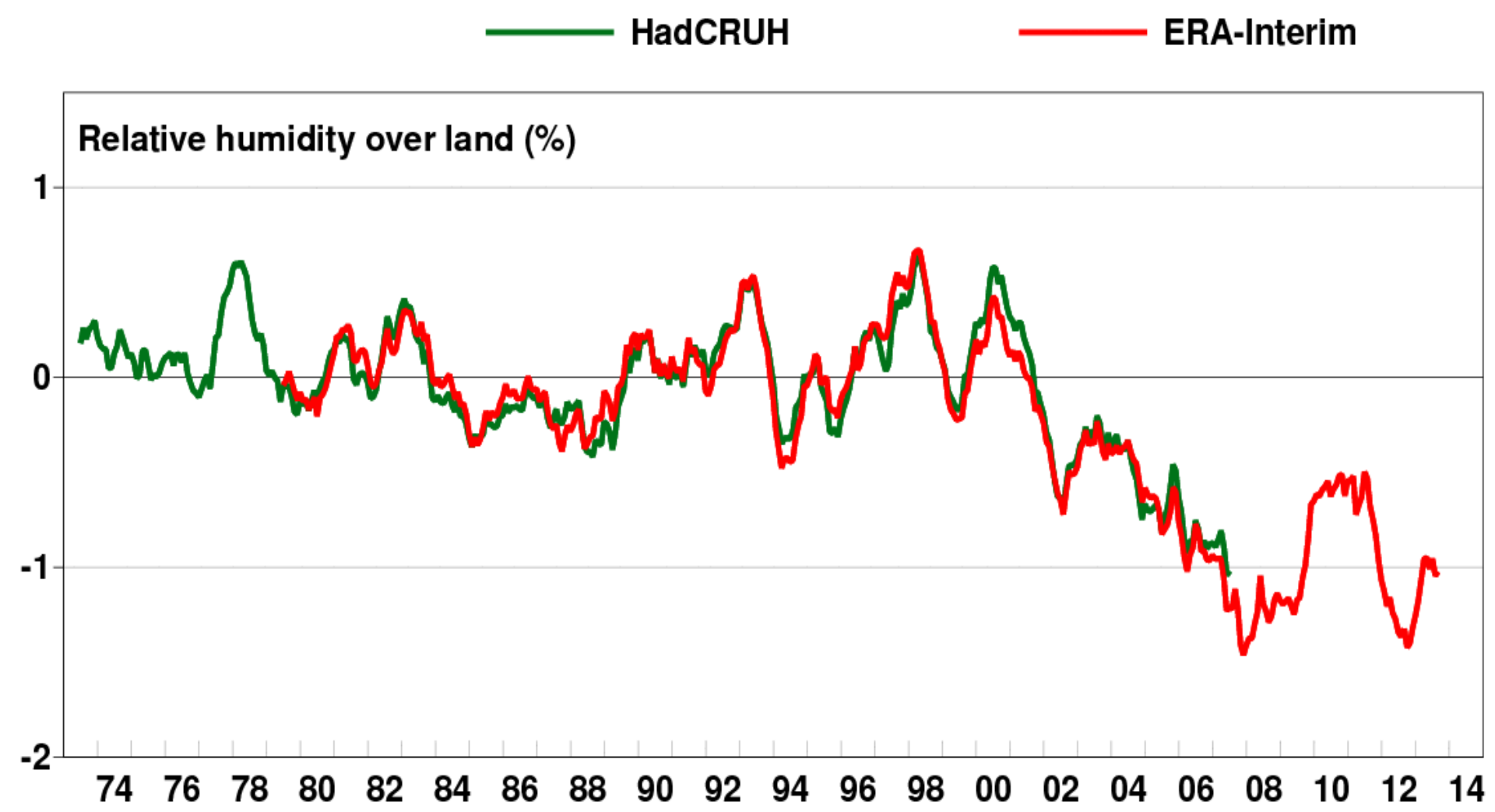
But does this deficiency confuse the relative importance of low/high cloud feedbacks or at least raise some doubts?

2) The facile argument that a warmer atmosphere implies more moisture availability and hence lead to more extremes etc is rather dubious. It assumes that relative humidity changes little and is based on models whose moist physics schemes employ a variety of humidity-related thresholds (which are also tuned).

NB Recent reanalysis results (supported by observations) show RH falling over land)

(see also article in BAMS 2013: Blunden and Arndt)



Courtesy of Adrian Simmons

A Key Question

What do we do about persistent systematic errors in our models?

Suggestion

With the quality of the latest reanalyses perhaps we can be smart and use relaxation techniques somehow to assess the impact of existing systematic errors on the models abilities to answer some of our Challenges?

Model development really matters!!

Plenty of users but not enough developers

Contrast with e.g. Apple, BMW, Mercedes etc who invest massively in model development!!

I hope that this workshop includes outcomes that offer some direct input to help developers advance what is one of our principal tools of climate science