



Diurnal cycle

Jon's meeting summary

Presented by Steve

Using notes from Ken

Errors or biases

- Google tells us 2x more errors than biases!
- Results **11 - 20** of about **140,000** for [diurnal cycle biases](#)
- Results **1 - 10** of about **231,000** for [diurnal cycle errors](#)

A general statement

- It was widely agreed than:

The diurnal cycle is hard.....

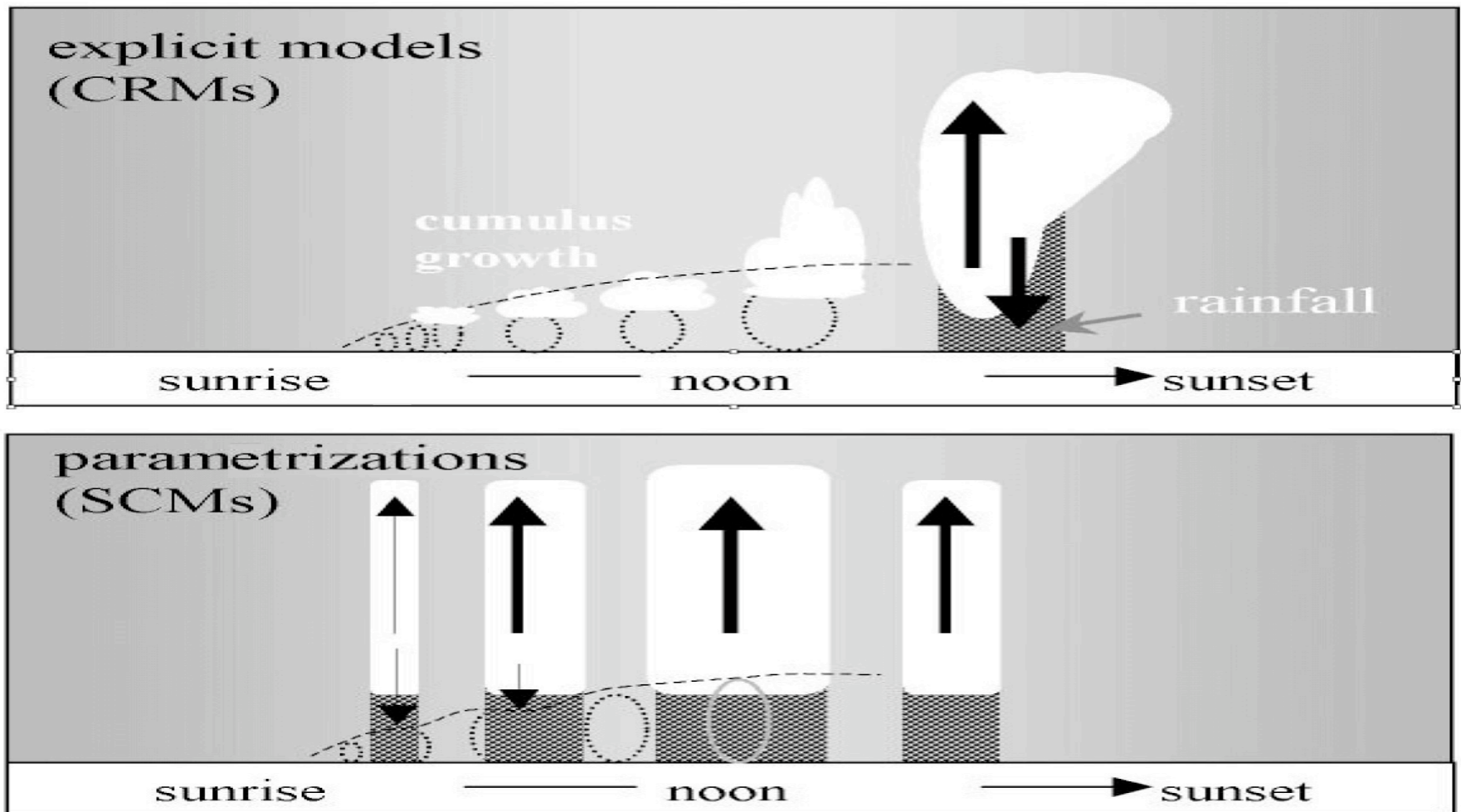
The end

Contents/the questions we discussed

- What are we thinking of when we say “diurnal cycle”?
- How wrong are we now?
- Have the root causes been identified?
- What are the broader implications of these errors?
- Should “we” design/coordinate an experiment?

The groups interest in the diurnal cycle?

- Was very diverse! Its not just this issue:



The groups interest in the diurnal cycle included:

- Daily pattern of rain/convection & clouds over land
- Daily pattern of rain/convection & clouds over sea
- Land/sea interactions and sea breezes
- Propagating mesoscale systems
- Nocturnal jet/stable boundary layer issues
- Surface flux variability
- Roles of land use/orography in relation to diurnal cycle
- Role of BL heterogeneity on diurnal cycle of convection
- Impacts of diurnal cycle on longer time and larger spatial scales
- Role of SST diurnal cycle during suppressed periods of the MJO
- Role of diurnal cycle in Monsoons
- Diurnal cycle of marine stratocumulus
- Role of congestus in diurnal cycle

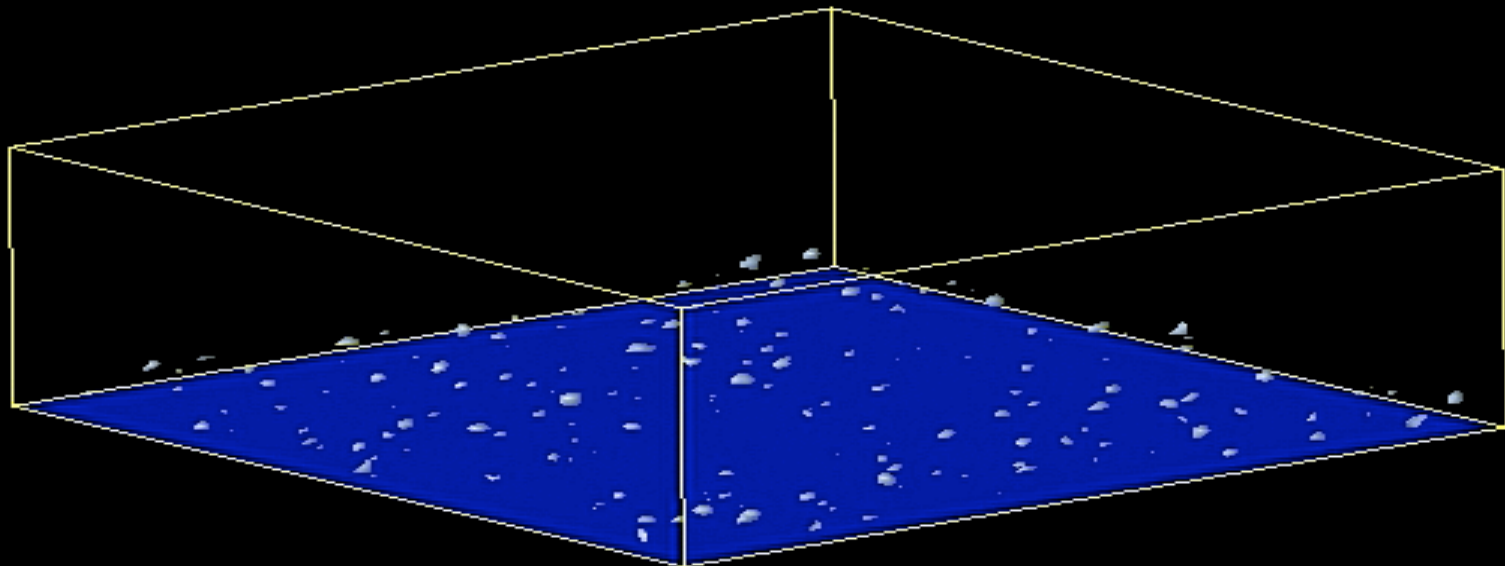
How wrong are we now?

- Generally its not well done in GCMs
 - especially over land
- Has anyone got it right?
 - Models with 4km or less do better but why?
 - They are not resolving the shallow to deep process but do capture sea breezes and tend to do convection on the resolved scale
 - a clever physics package
 - Dave Randall (not MMF) is only person clever enough but no one knows why.....
 - MMF
 - Again 4km is doing better than we might expect...

CRMs can do it with sufficient res

An animation from the Met Office cloud resolving model

3D; 100 m grid length; 25.6 km x 25.6 km x 12 km



Have the root causes been identified?

- We are quite good at getting the sun to rise and set
 - But question 3 hourly updating of aspects of the radiation...
- What needs changing to get this right?
 - It's the **full package of physics** i.e. (Convection scheme, BL (nocturnal/stable), land surface etc... Don't just blame convection or Martin will get cross
 - Coupling between large scale and grid-scale parametrizations

Have the root causes been identified?

- It's a coupled system and we are not representing this coupling
 - Cloud/radiation interaction on cloud scales
 - Land radiation on small scales
- Entrainment is not a fixed value
- Transitions of scales of processes
 - BL > shallow Cu > Deep Cu > Mesoscale propagation

What are the broader implications of these errors?

- How much does it matter if we are wrong?
 - Weather forecasts
 - Radiation balance in climate
 - How can we trust climate models if they can't get this right?
- Carbon budget etc... needs correct diurnal timing
- We need to look at current diurnal cycle in NWP and climate models much more (in a multi-model sense). Encourage 3 hourly monthly means of key variables
- We didn't come up with a full list but discussed was:
 - Omega at 500 mb
 - Radiation at TOA/surface
 - Cloud/precip info ...

Should “we” design/coordinate an experiment? How and are observations needed?

- We believe the starting point to tackle the problem is to better understand the models we have now (as previous slide)
- We did not come up with any GEWEX type plan (a process based study bringing together Land, stable BL and clouds) but noted GEWEX does have this in its roadmap

The long and short of it

- In the shorter term:
 - We recommend that effort is put into analysis of the diurnal cycle climate models. This may help understand how far out we are and estimate implications.
- In the longer term
 - Sensitivity studies where the diurnal cycle is forced to be better may help understand implications of getting it wrong *but interpretation could be difficult*
 - Physics packages needs to better handle these highly coupled situations involving a range of scales