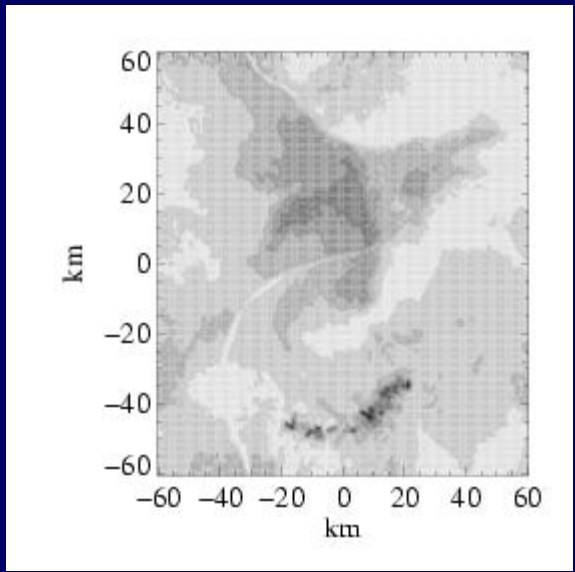
The effect of fluctuations on the timing of the diurnal cycle of deep convection over land.

Alison Stirling
Jon Petch

Moisture and temperature in the boundary layer at dawn.

Q



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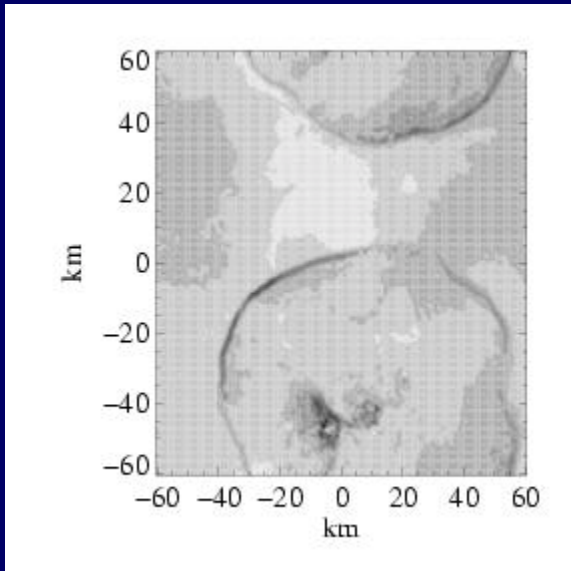

Simulated initial conditions at dawn.

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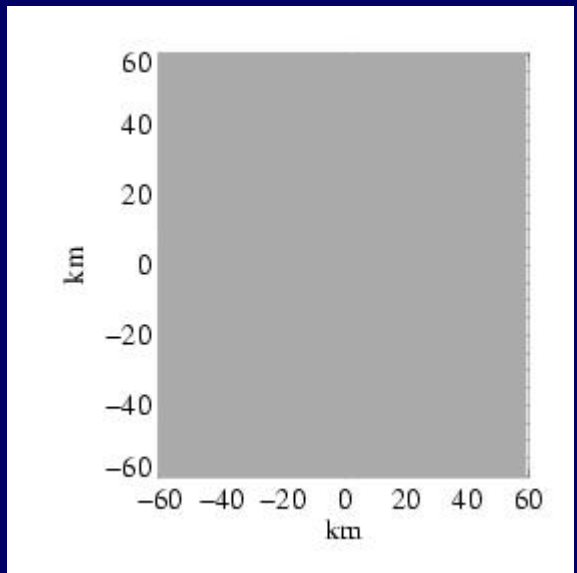
Q



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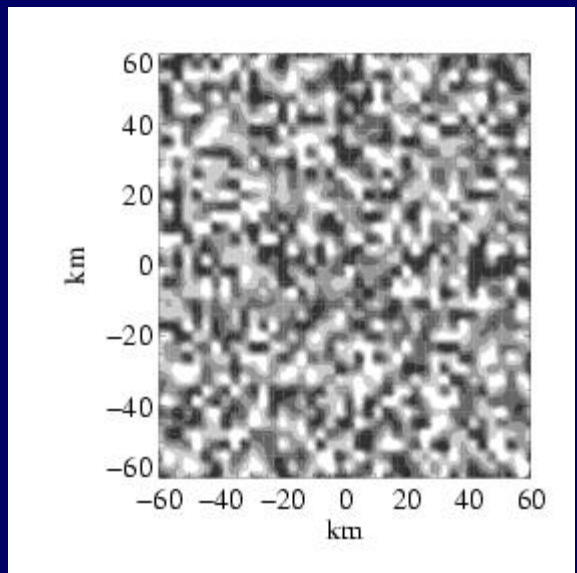
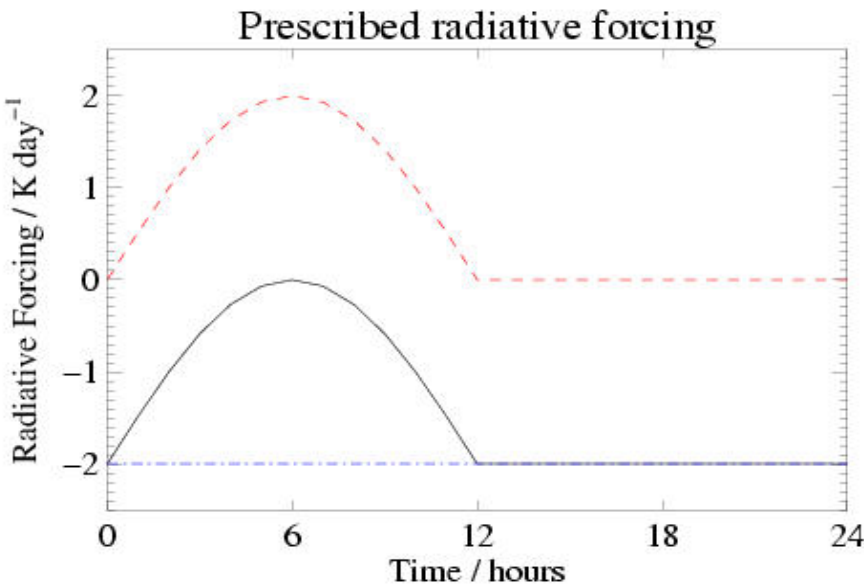


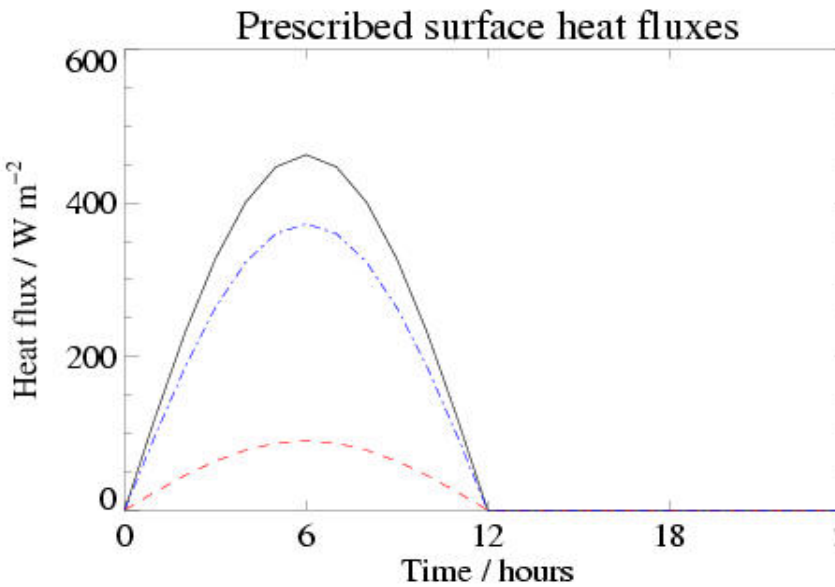
Questions

- Does the initial variability in moisture and temperature affect the development of convection?
- Are there separate issues involving balance in the spin-up phase?

Met Office CRM

- 2-D simulations
- 400 km X 20 km
- 400 m resolution in horizontal, 80 levels in vertical
- Idealised forcing - prescribed surface fluxes,
  balance the radiative forcing over 24 hours





Generating variability to use as initial conditions

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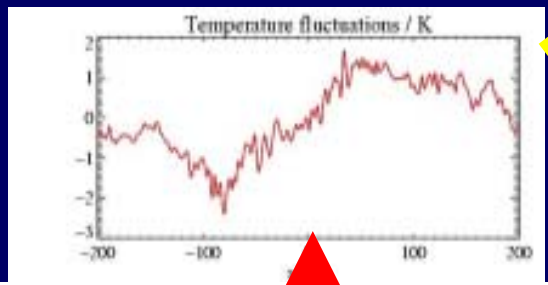
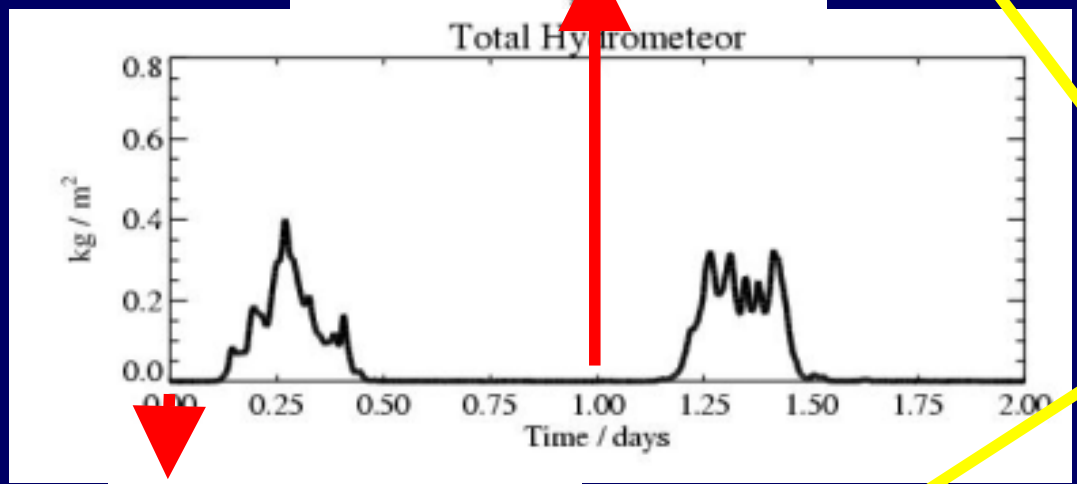
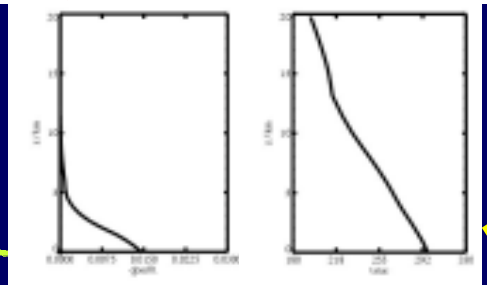
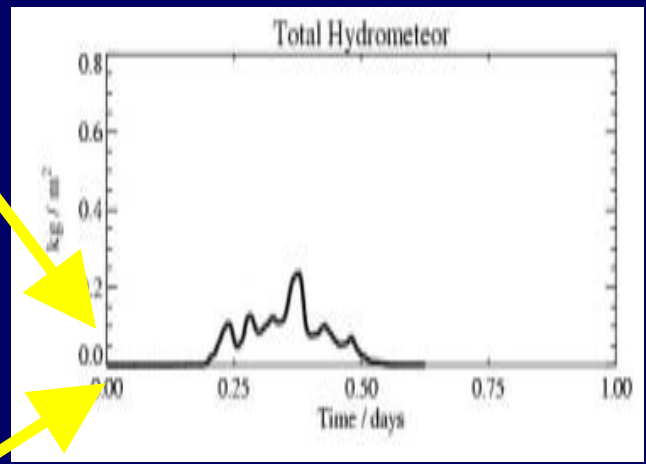


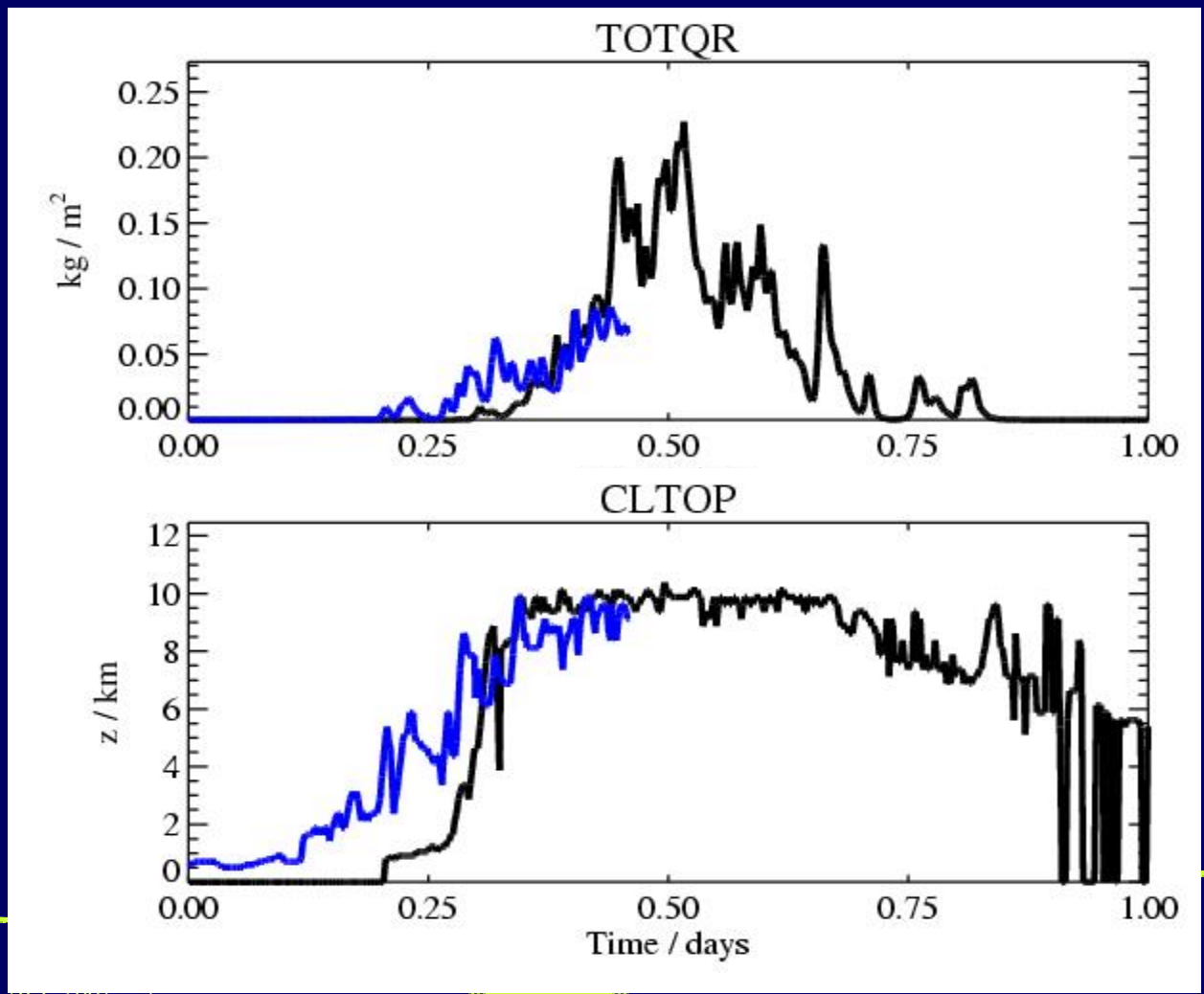


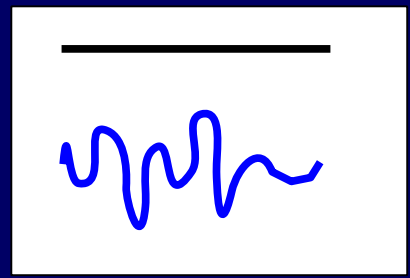




Comparison of timing between

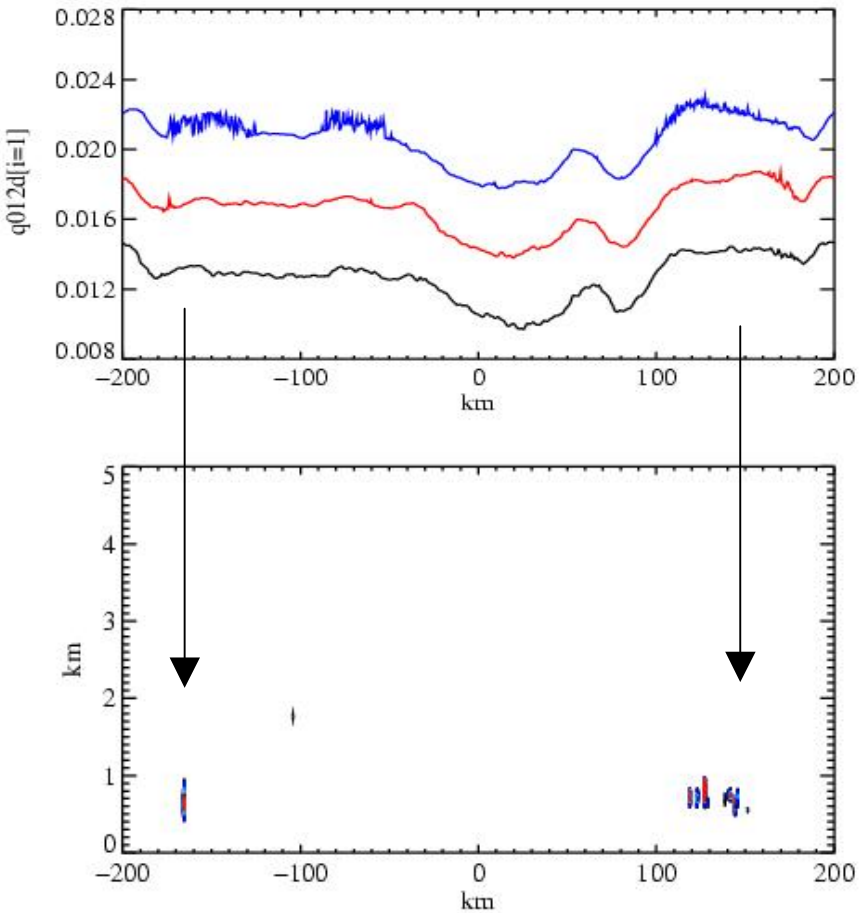
- different initial conditions

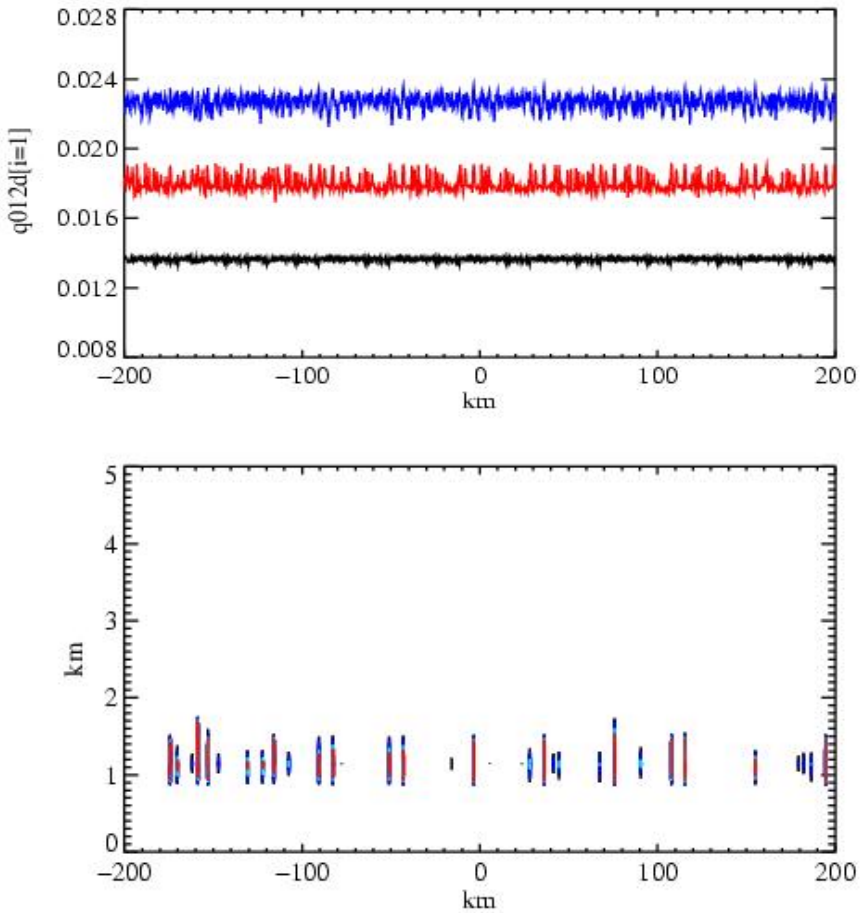




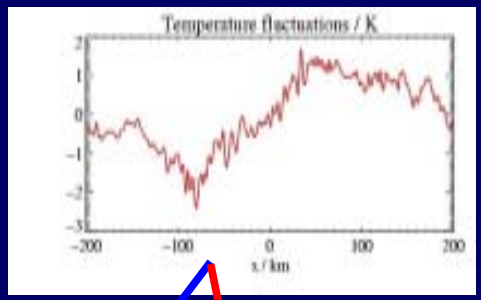
Realistic fluctuations can bring forward the onset of convection (in this case by 2 hours)

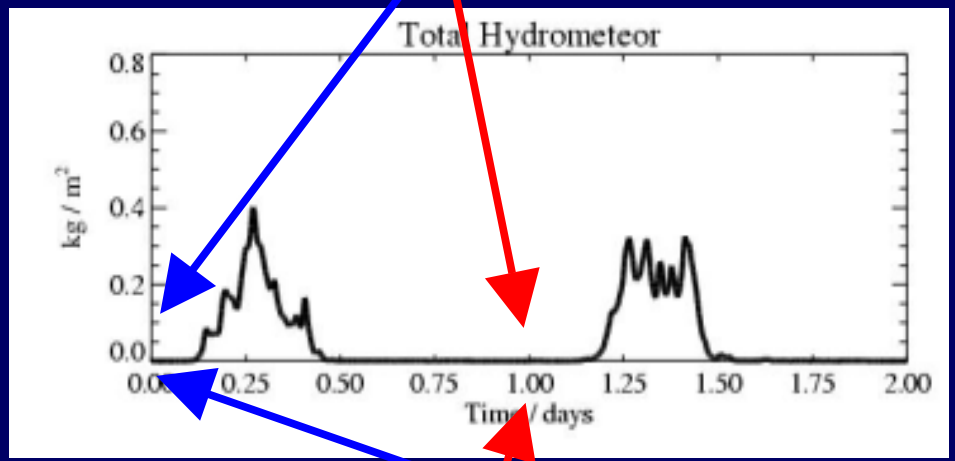
Evolution of fluctuations

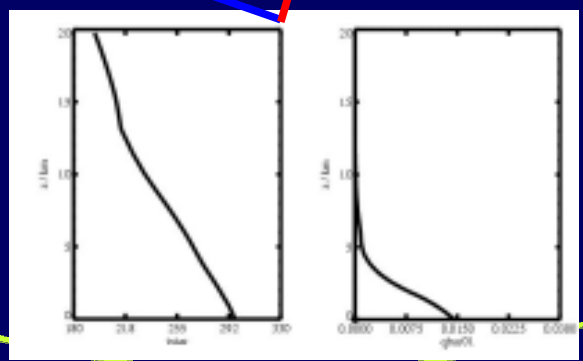




Exploring the effect of spin-up on the timing of convection

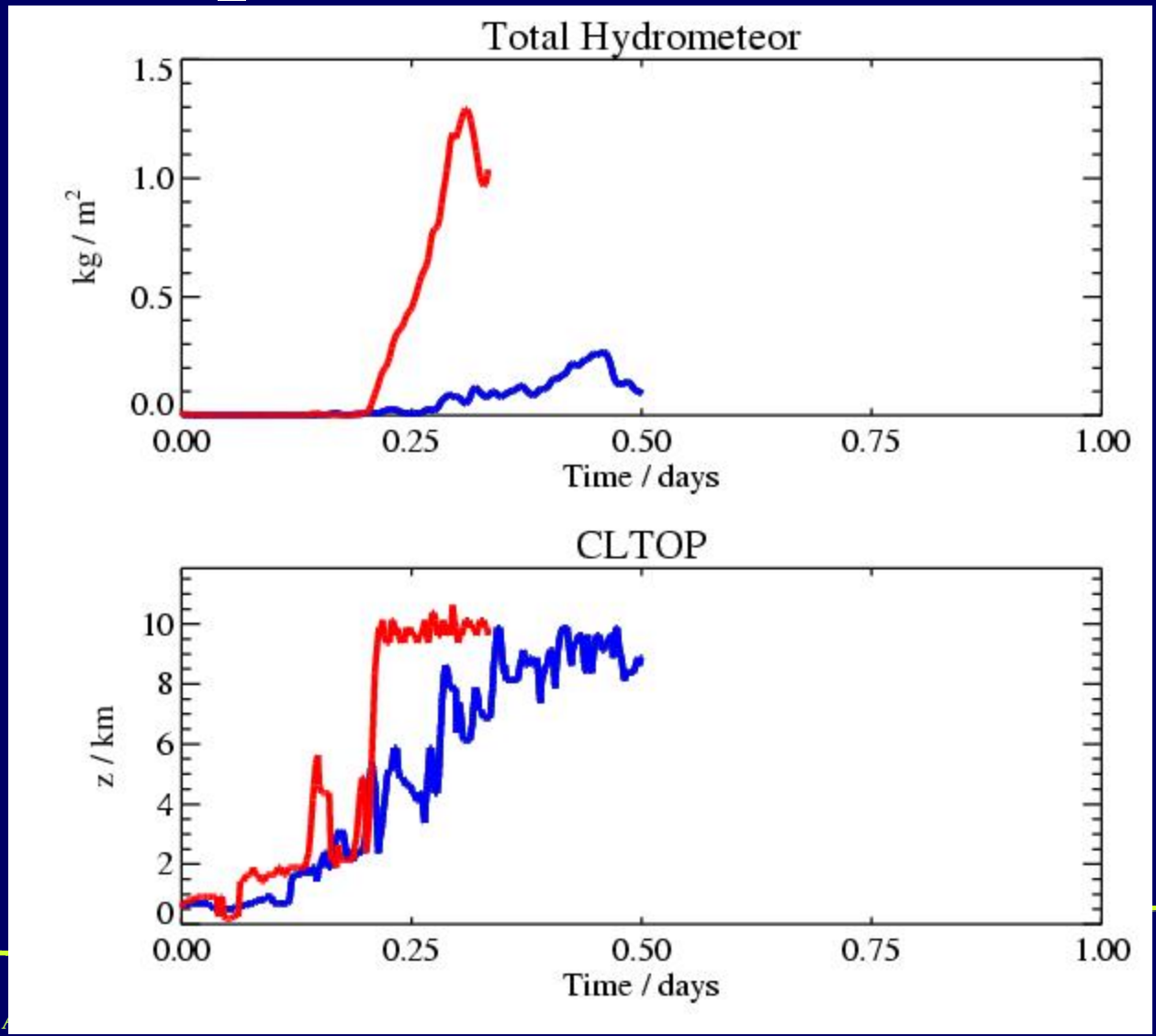






Identical temperature and moisture variability: one simulation started from rest, one simulation continued into a second day.

Spin up vs spun up



From rest (spin-up)

From a mature simulation (spun-up)

The differences suggest that the velocity field may affect development.

Implications

- The absence of realistic fluctuations during spin-up affects the timing (in this case by about 2 hours)
- Fluctuations in the velocity field may also be important (difference in development between starting a simulation from rest and carrying on into day 2)
- Need to include realistic fluctuations to get realistic timing
- We next consider what aspects of the variability are important

Identifying the important characteristics of the variability

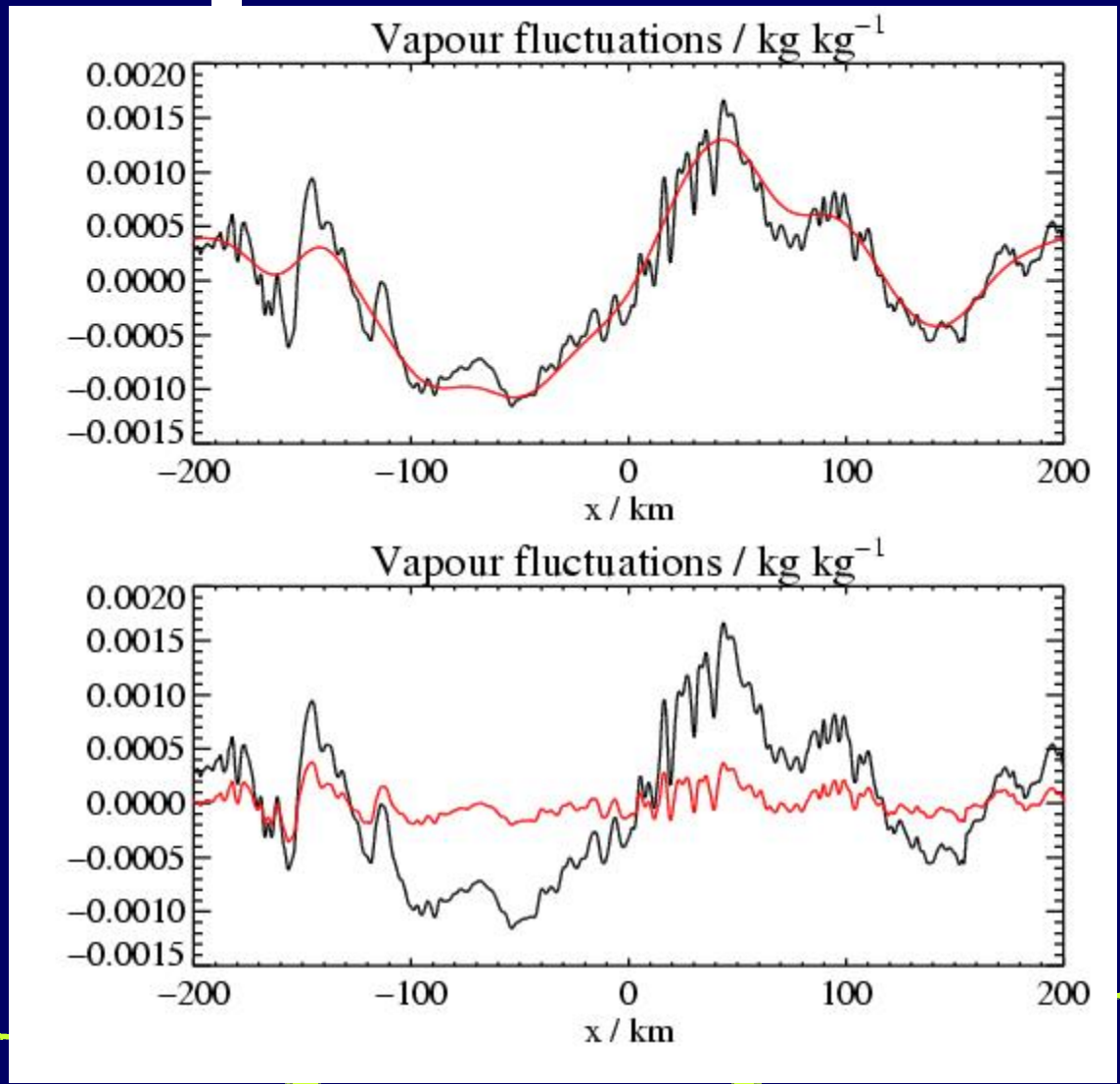
- **Scale**

Do fluctuations of size 1 km matter, or is it just the larger scale variability that affects the development

- **Location**

Is it only fluctuations in the boundary layer that matter?

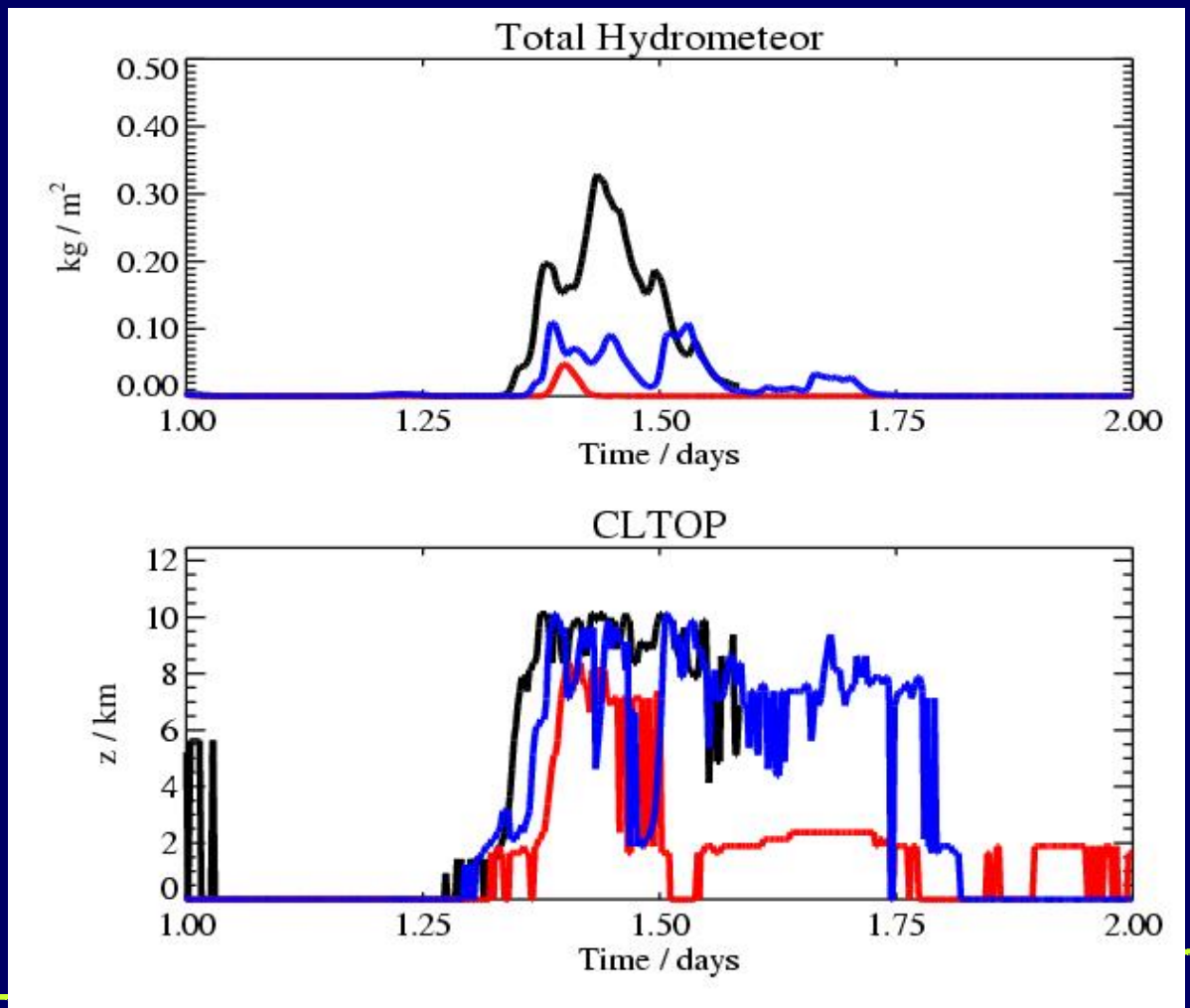
Scale of Fluctuations

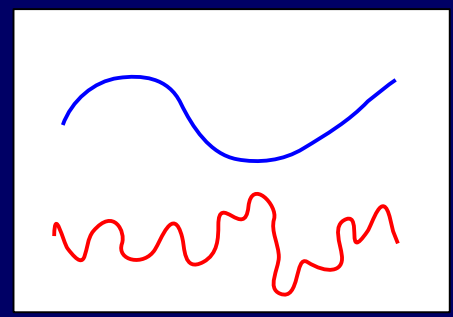


Fluctuations smoothed on scales less than 100 km

Large scale fluctuations removed, only small scale remain.

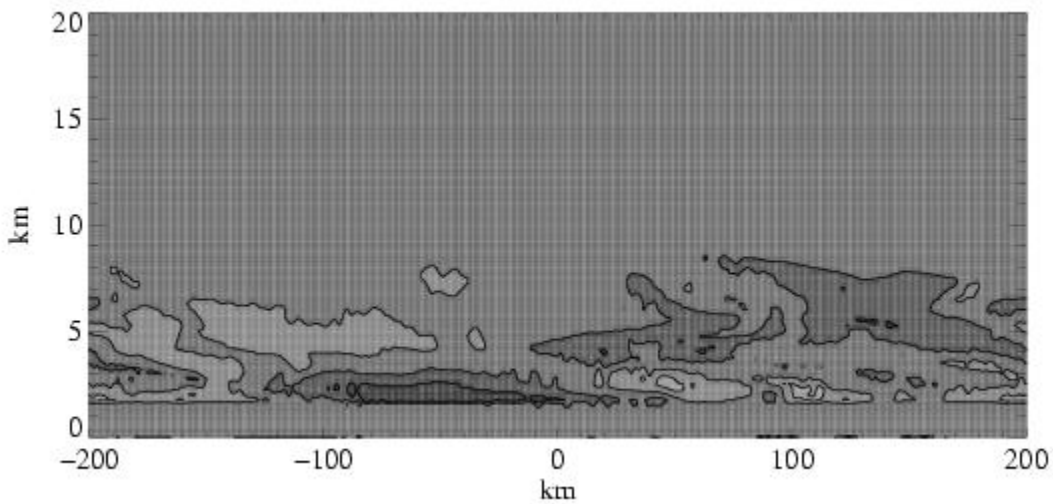
Flucuations on different scales

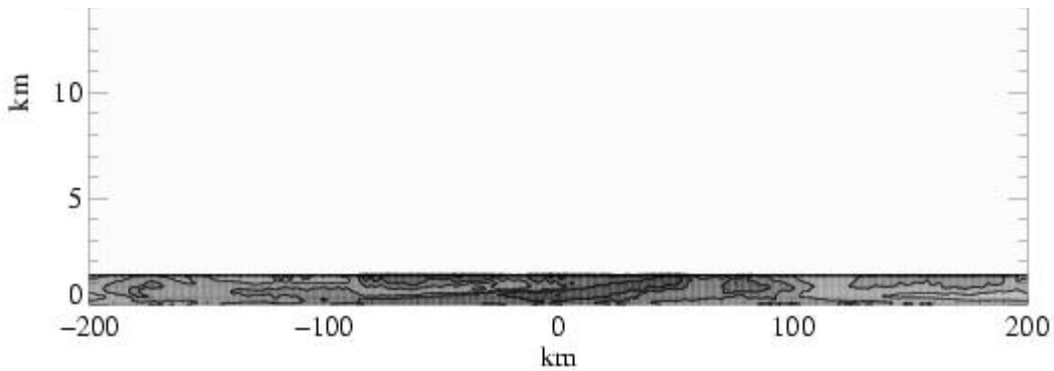




The larger scale fluctuations appear to be more important for convective development

Location of fluctuations

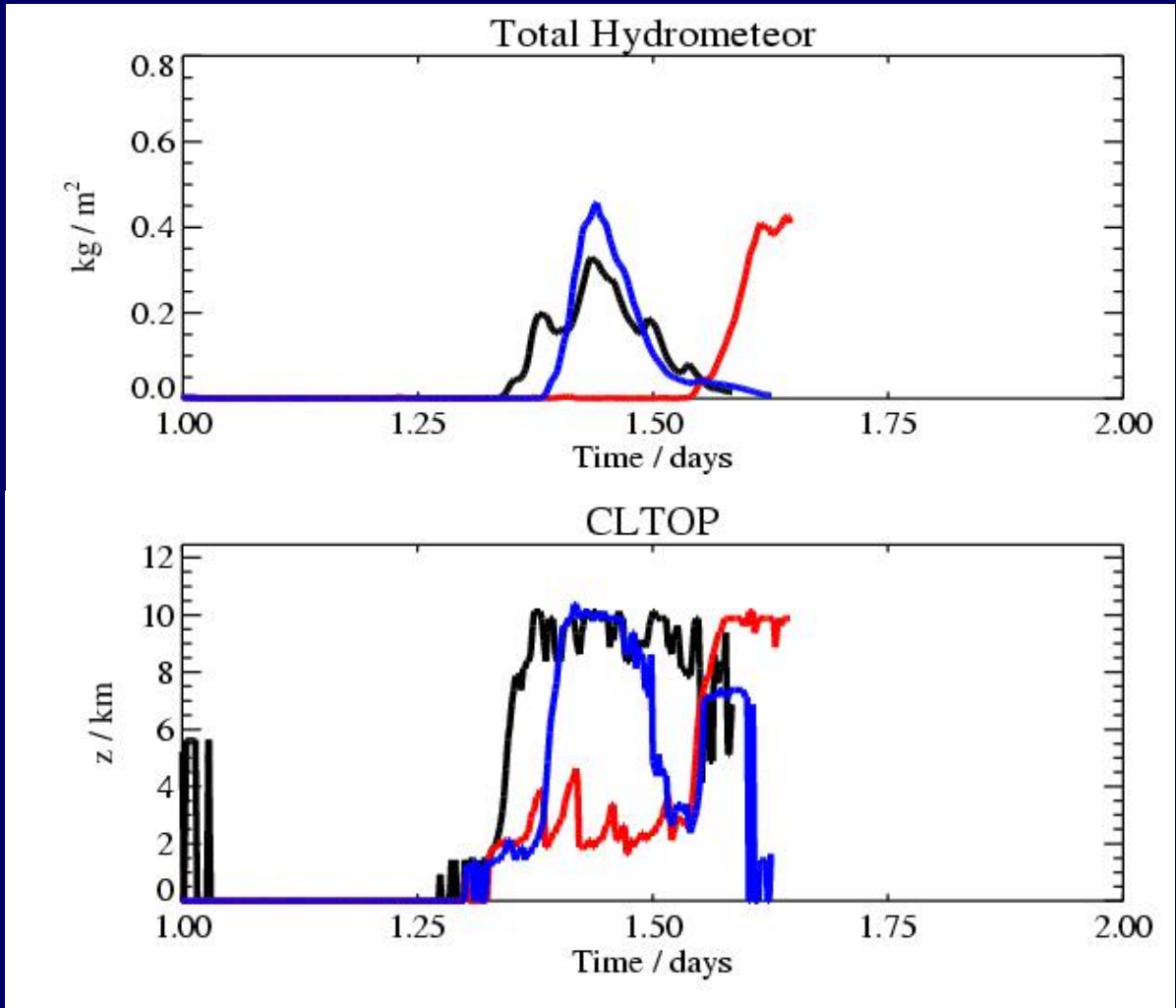


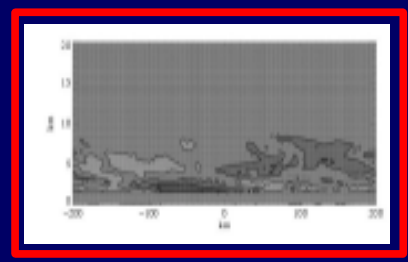


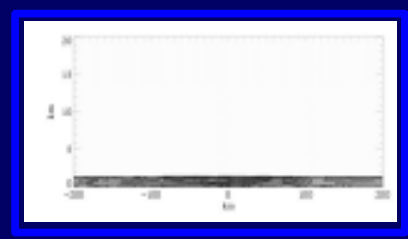
No q or T fluctuations in the boundary layer

T and q fluctuations only in the boundary layer

Location of fluctuations contd.







Boundary layer fluctuations are critical. Above the boundary layer , fluctuations have a small effect.

Conclusions

- Realistic variability in moisture and temperature fluctuations in the boundary layer are required.
- The variability is important on scales greater than 100 km.
- The initial velocity field appears to influence the development to some extent.
- These fluctuations are likely to be important in regions of high convective inhibition.
- Observations?