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How should we represent convective GENESIS?

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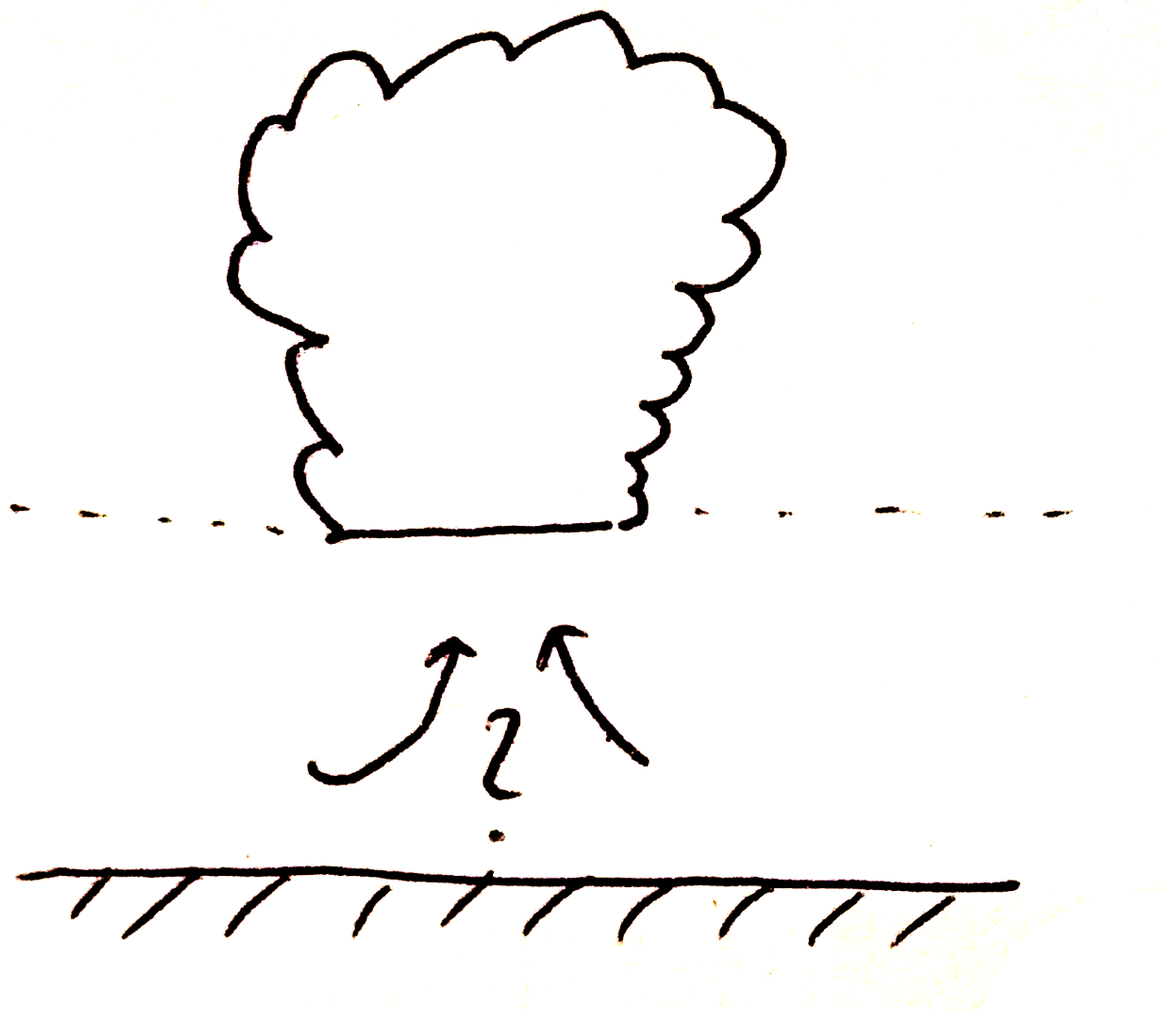
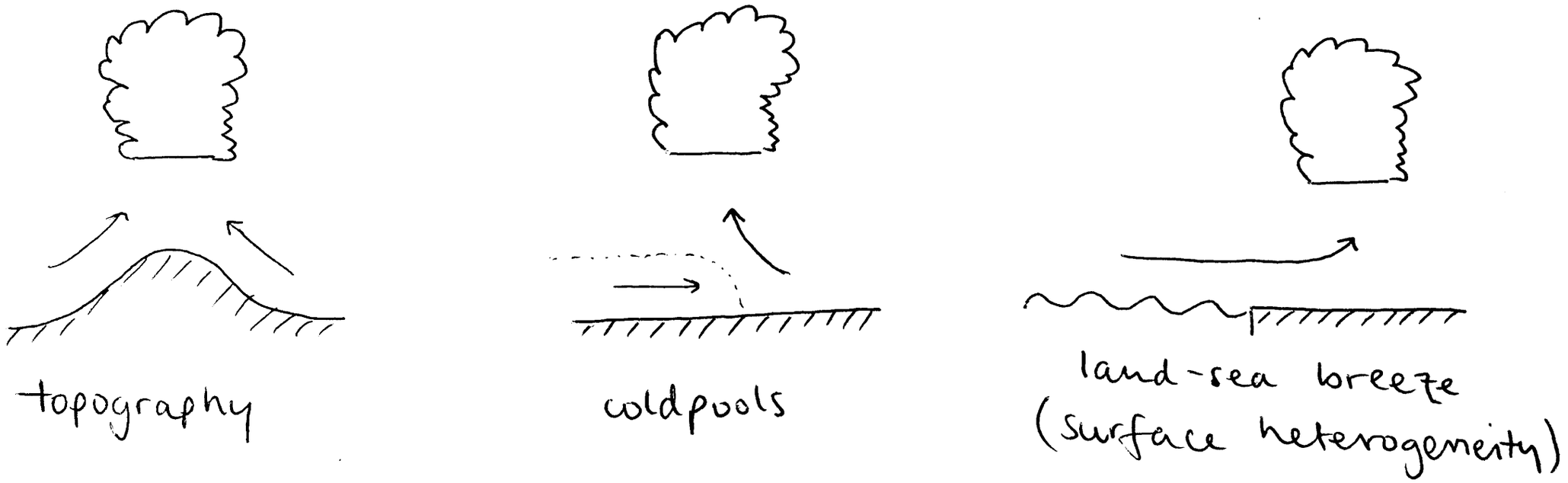
1: University of Leeds, 2: MetOffice

Aim



Aim

- Describe statistics of boundary layer relevant to triggering convection and the sensitivity to presence of different phenomena



- *"What are the length-scales and magnitudes of perturbations which trigger convection?"*

Aim

- Describe statistics of boundary layer relevant to triggering convection and their sensitivity to presence of different phenomena

  - for example: *“What are the length-scales and magnitudes of perturbations which trigger convection?”*

- To formulate a new convection trigger model for the MetOffice Unified Model

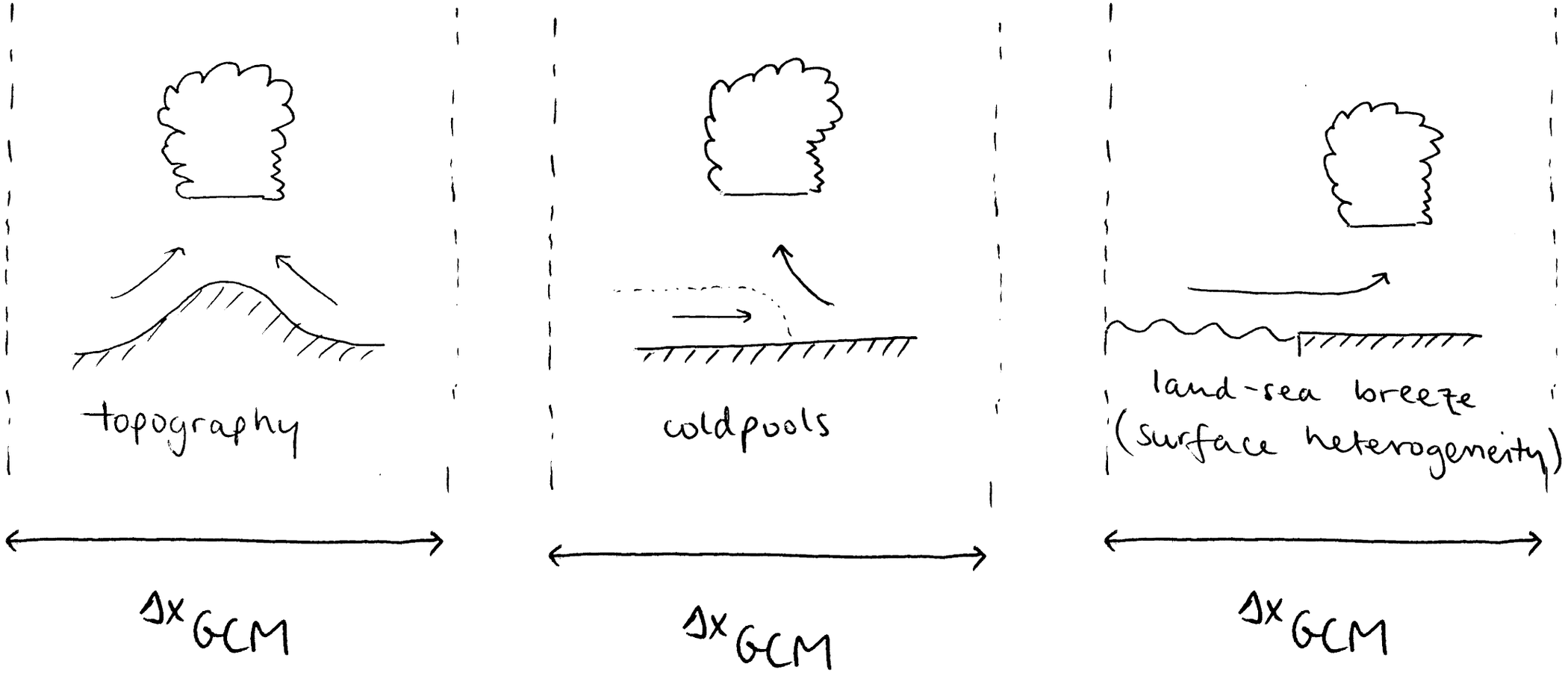
  ➡ Part of 5-year NERC/MetOffice ParaCon project to provide a new convection parameterisation for the MetOffice model

Why?

- GCMs have too coarse resolution to fully represent convection (O(km))

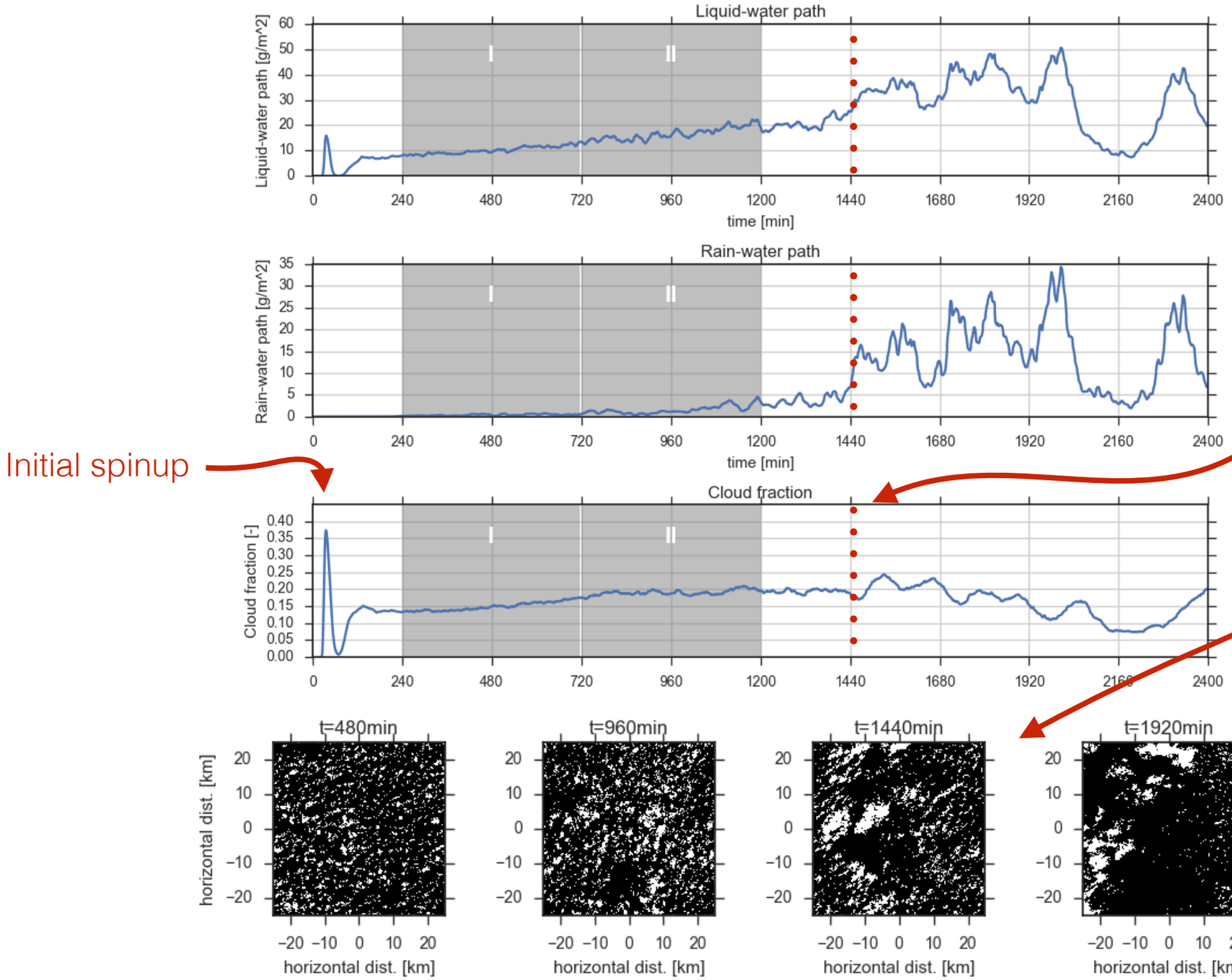
  ➡ Trigger (and evolution) of convection must be parameterised

  ➡ These *sub-grid* features are known to be critical in predicting formation of convection



First case: RICO (*Rain In Cumulus over the Ocean)*

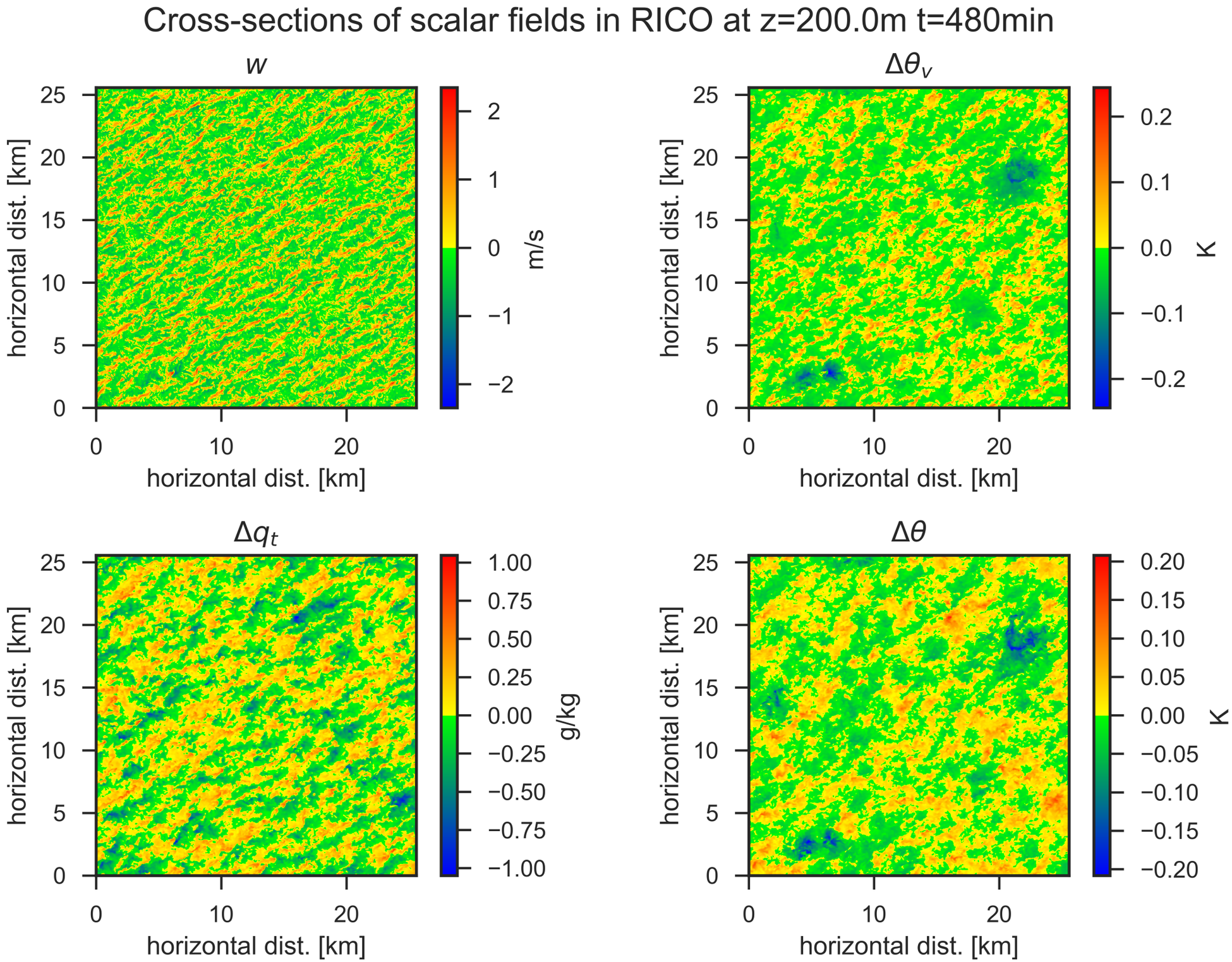
Shallow cumulus over surface with no surface heterogeneity



M. vanZanten et al 2011

simulation carried in UCLALES out by Cathy Hohenegger, MPI, Hamburg

What are the length-scales of variability?



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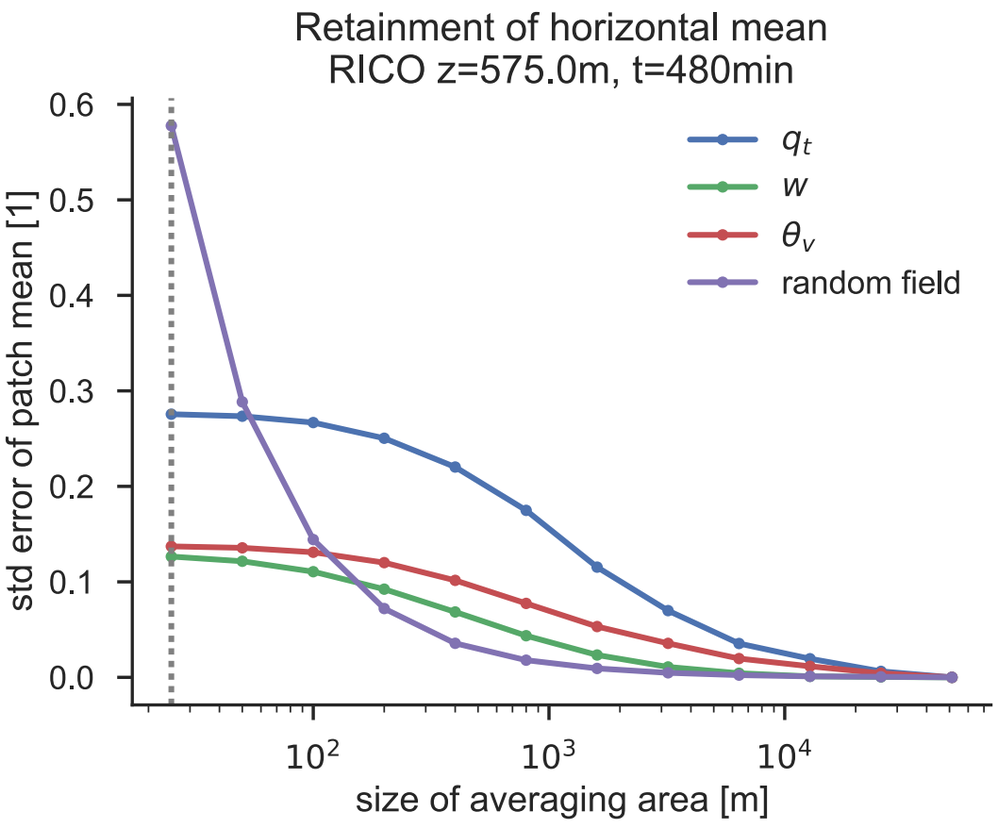
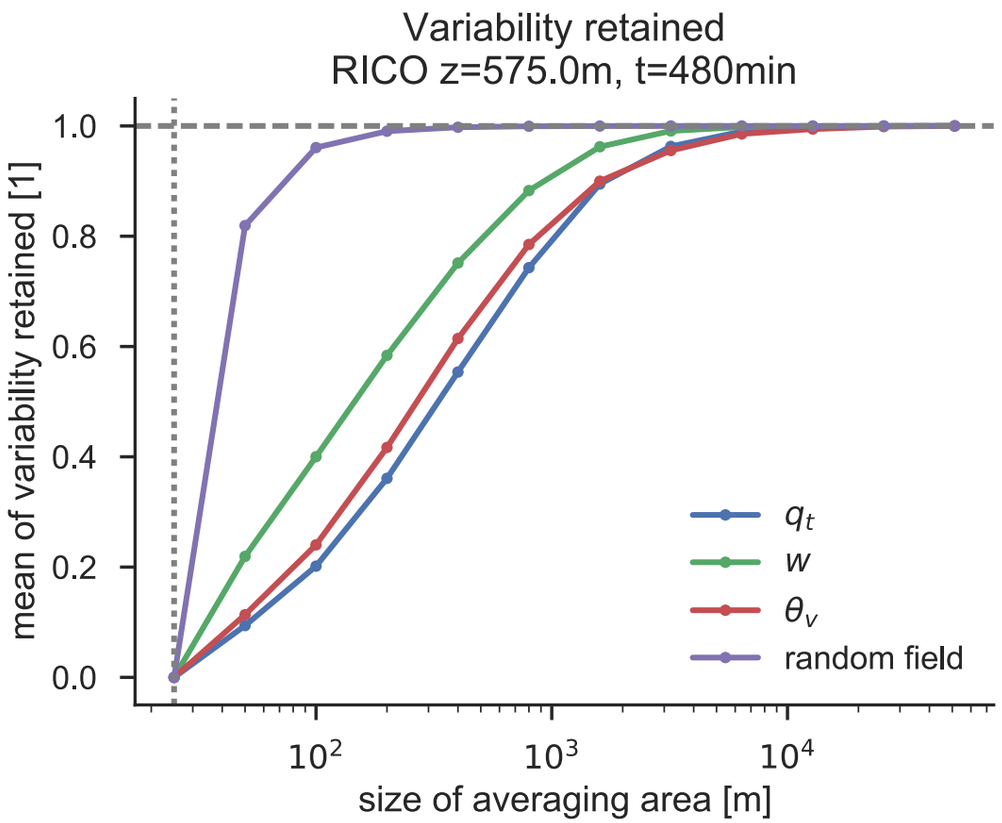


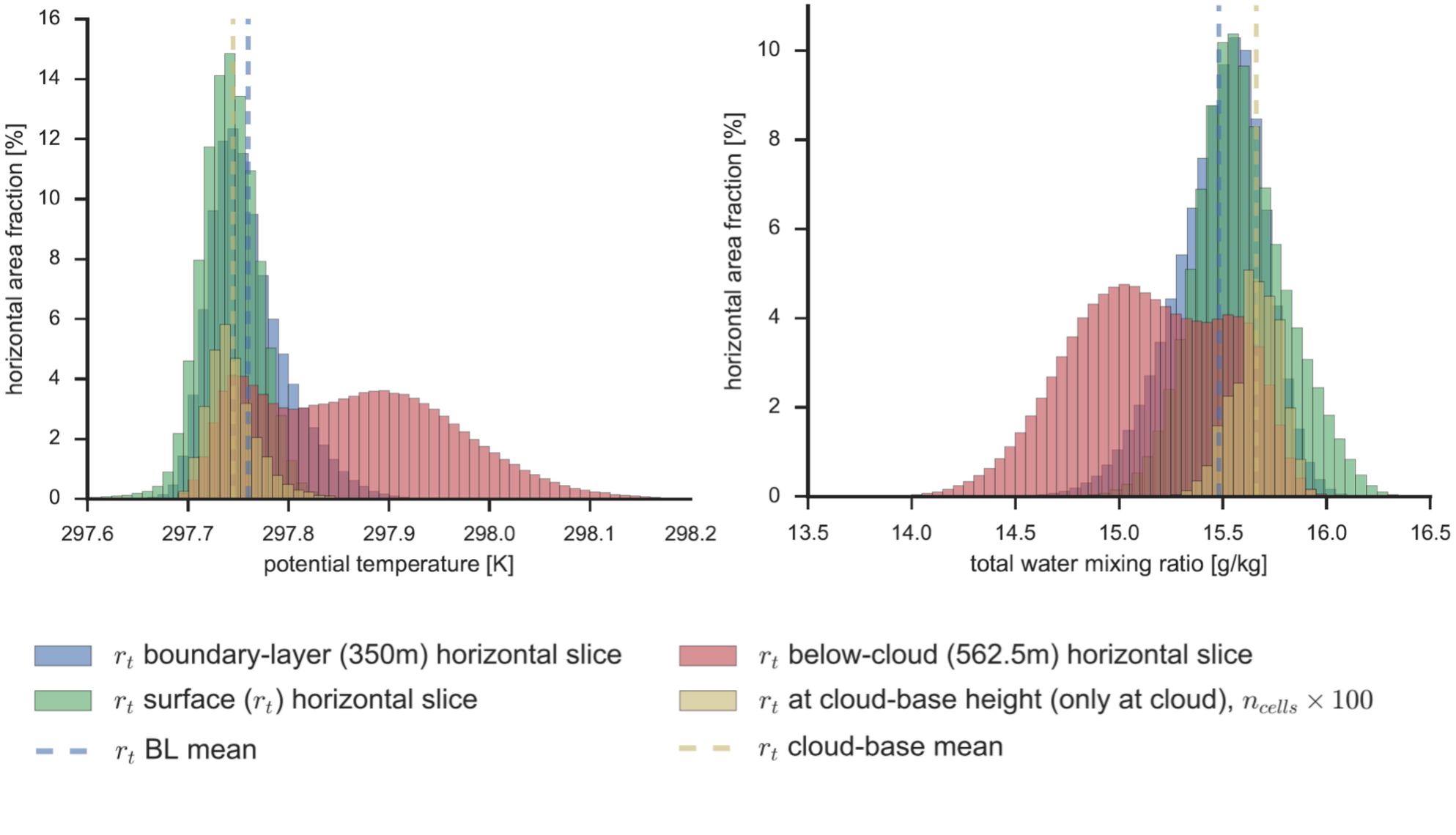


- Split domain into successively smaller patches to evaluate change in statistics

  ➡ scales of variability are different for different scalar fields

  ➡ ~90% of variability retained with L~1000m for θ_v and q_t, ~95% for w

What are the perturbation magnitudes?



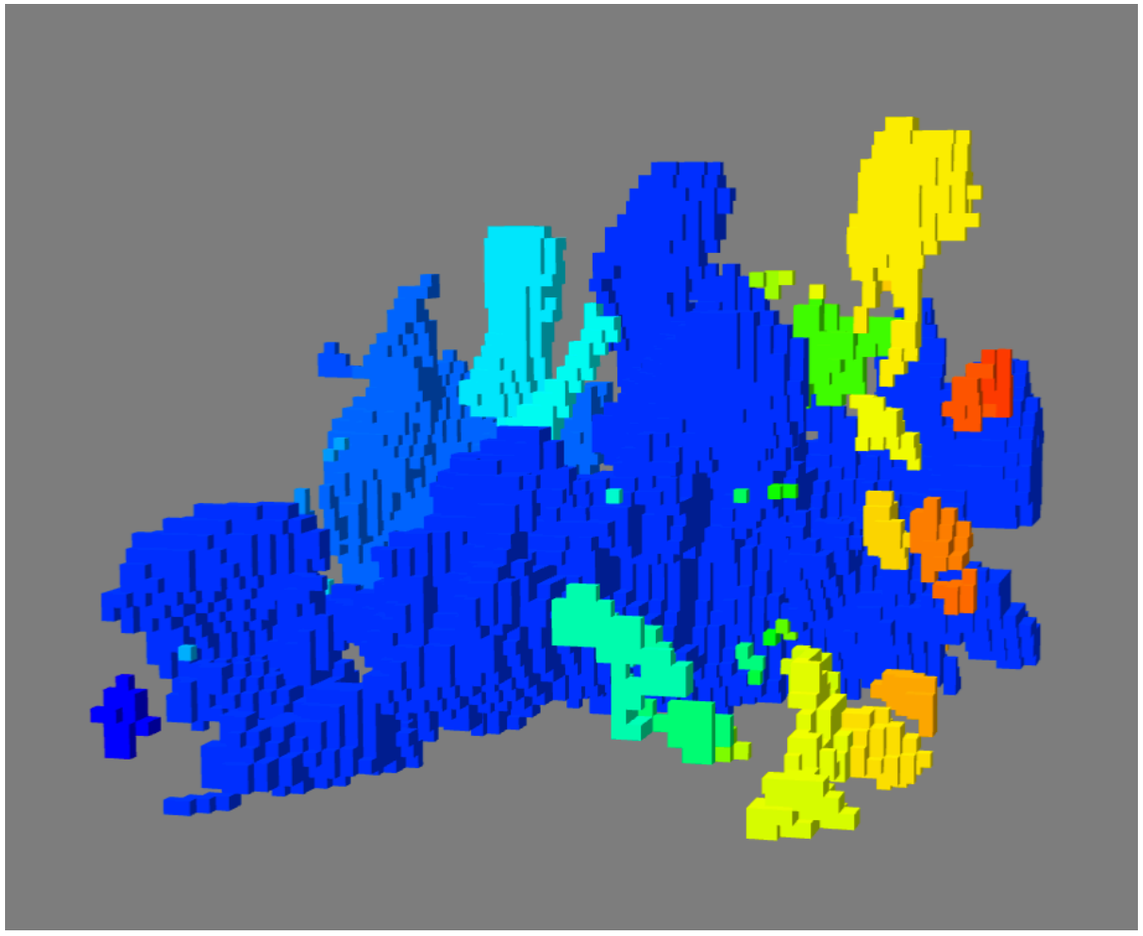
➡ In RICO clouds mostly triggered from perturbations in water vapour, $\Delta q_v \sim 0.2 g/kg$

Can we identify individual triggering objects?

- Identify (and later, track in time) boundary layer structures which cause convection to trigger

  ➡ Developing cloud-tracking code with Steven Boeing

- Use to partition distributions of variability by individual objects (of specific size, volume, etc)

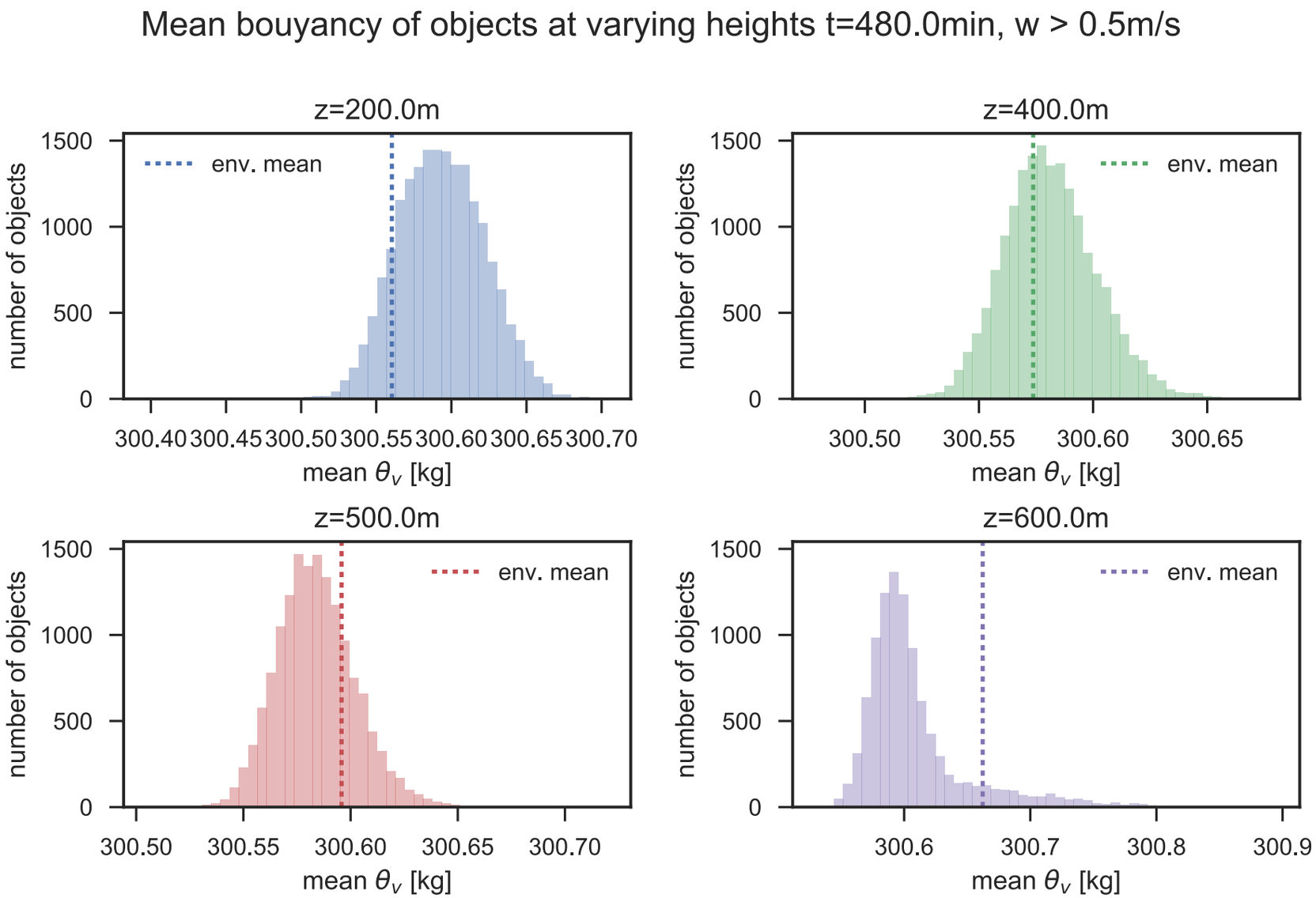


Buoyant elements defined by w > 0.5m/s
in boundary layer of RICO simulation at t=480min

➡ Investigating using object topology as means of classification (Contour-tree analysis by Hamish Carr, Leeds)

How does buoyancy change with height?

Or, what can we do with object identification?

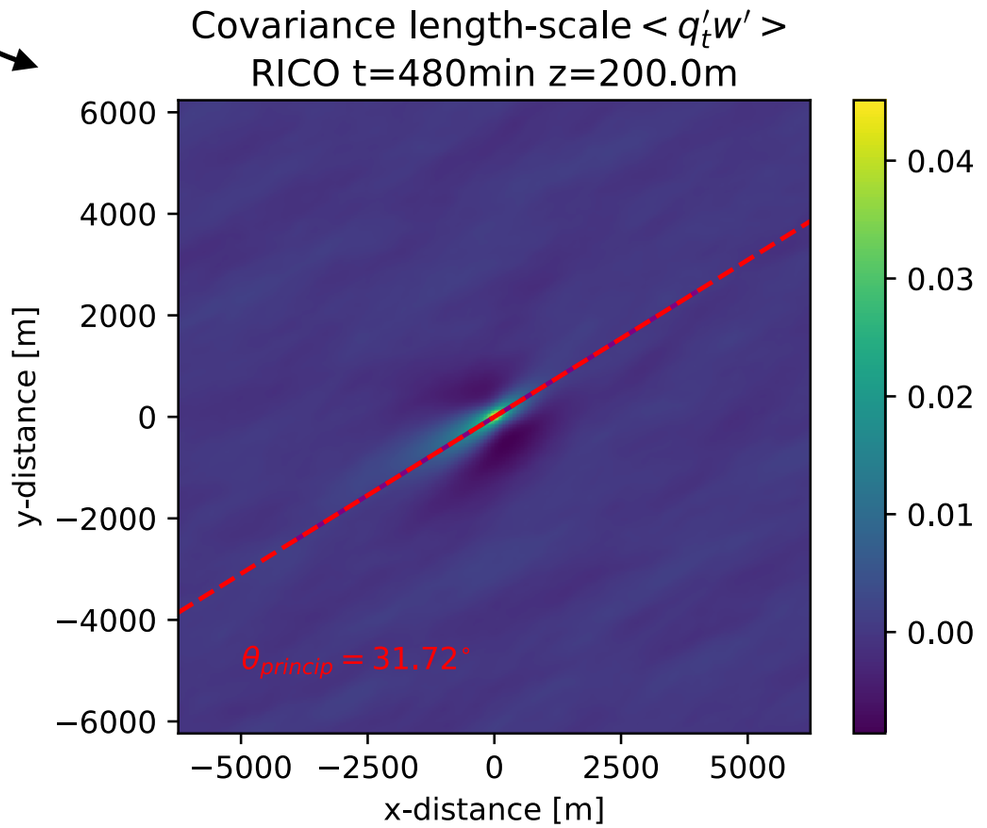


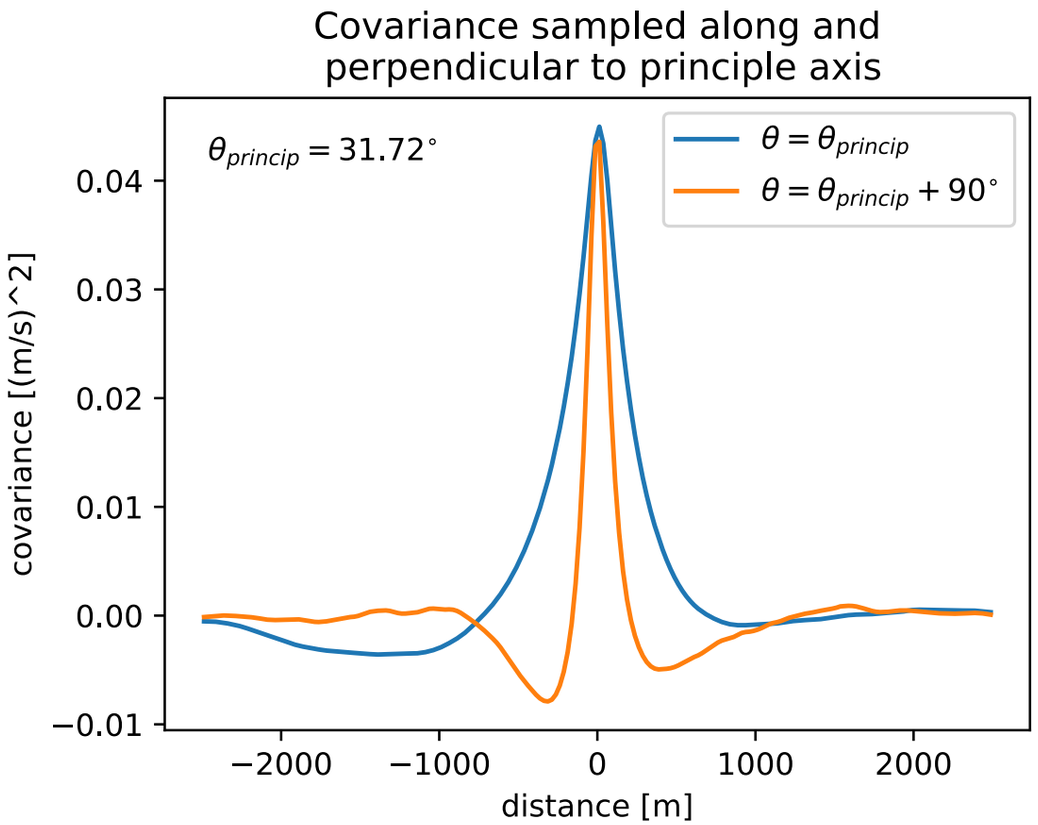
- Change to non-buoyant regime above z~400m, rising elements must have momentum to overcome barrier, analogy to quantum tunneling?

Other methods of analysis

- Cumulant-based analysis to find length-scales of correlation between different scalar fields (with Steven Tobias, Leeds)

  ➡ Currently developing wavelet decomposition, since solution is not periodic and so local correlations may be more relevant





Next steps

- Develop and converge on analysis methods to be used for analysing boundary layer structures
- Set up and run LES simulations (in MONC) which contain phenomena of interest
- Analyse structures and share results with rest of ParaCon
- Develop a model of convective triggering for the future :)

Thank you!

What are the length-scales of variability in the aggregated state?