The tropical marine boundary layer under a deep convection system: a large-eddy simulation

- **What are the characteristics of the PBL in giga-LES?**
- **How to represent the PBL in a CRM with a grid size of few kilometers?**

in preparation for JAMES

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Observed PBL over tropical oceans

(BOMEX; GATE; TOGA-COARE…)

Zipser; Garstang; Betts; Fitzjarrald; LeMone;

Williams et al, …

"…*cool, dry* air fills the rain areas…at low level…"

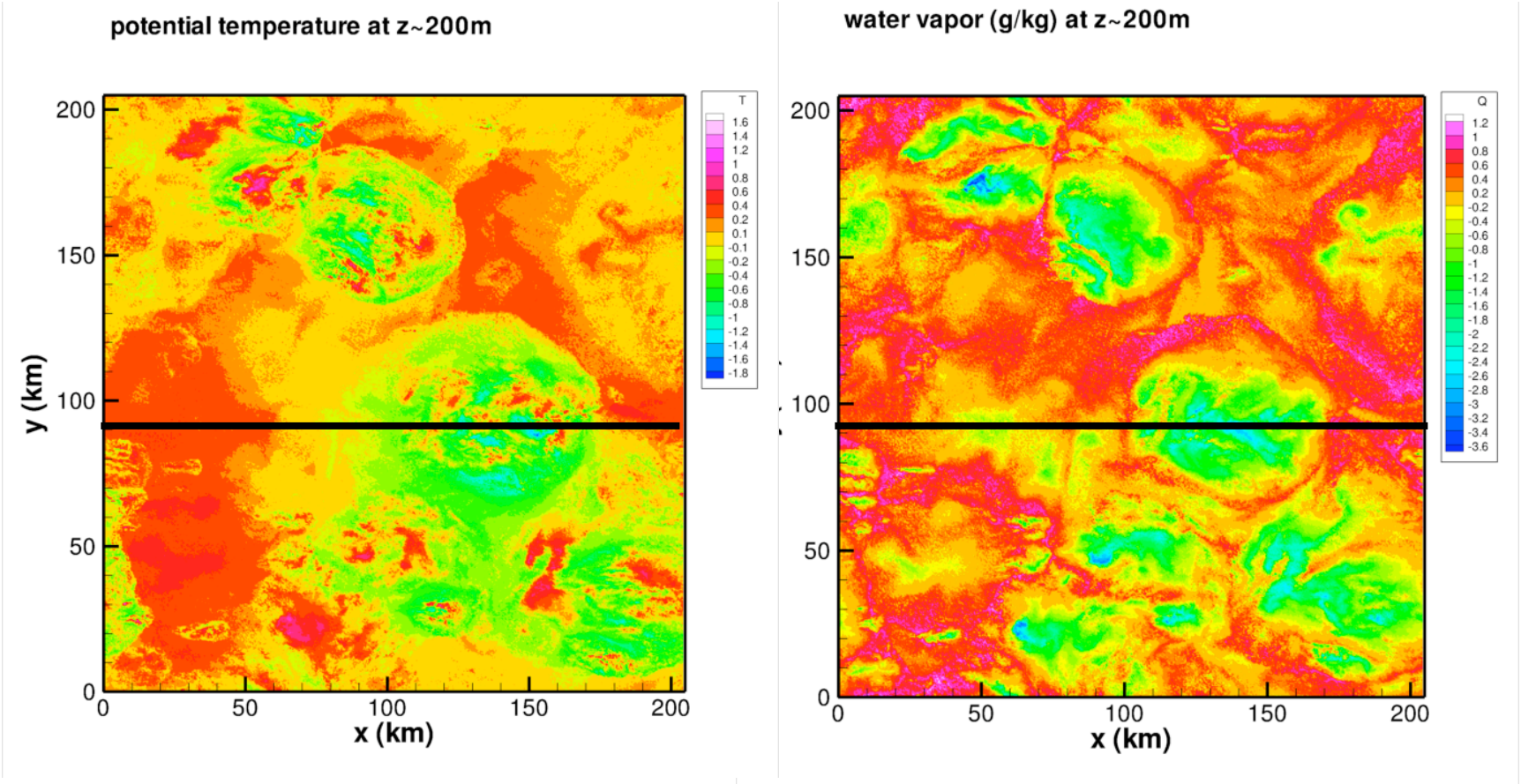
"…thermodynamic structure…subcloud layer changes from unstable to *stable*…"

"…latent and sensible heat fluxes may increase *by an order of magnitude at the sea interface* in the presence of …downdrafts"

"…*the modified BL is about 200 m deep*, and the environmental boundary layer is 500 m deep"

Temperature and moisture at z ~ 200m

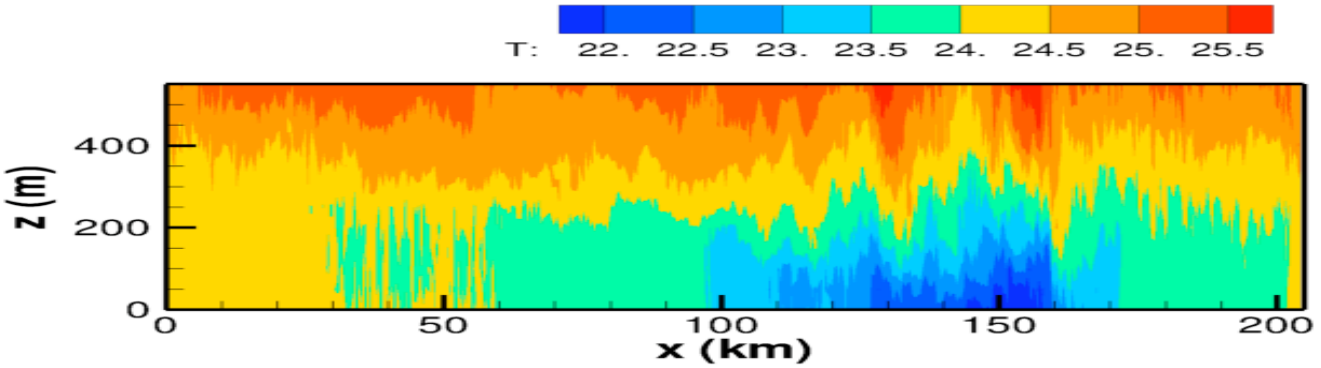
Horizontal plane view



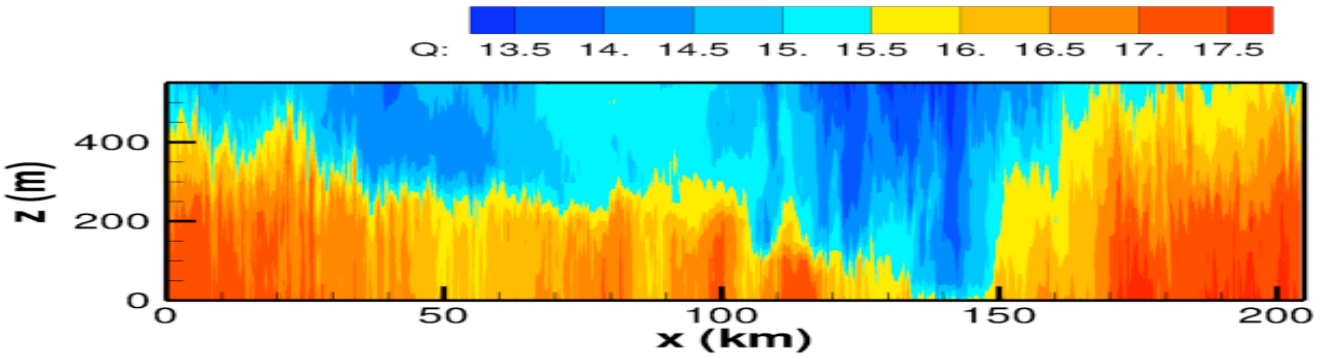
⇒ colder and drier PBL inside cold pools (wakes)

Vertical cross-section of theta (degree C)

vertical plane view

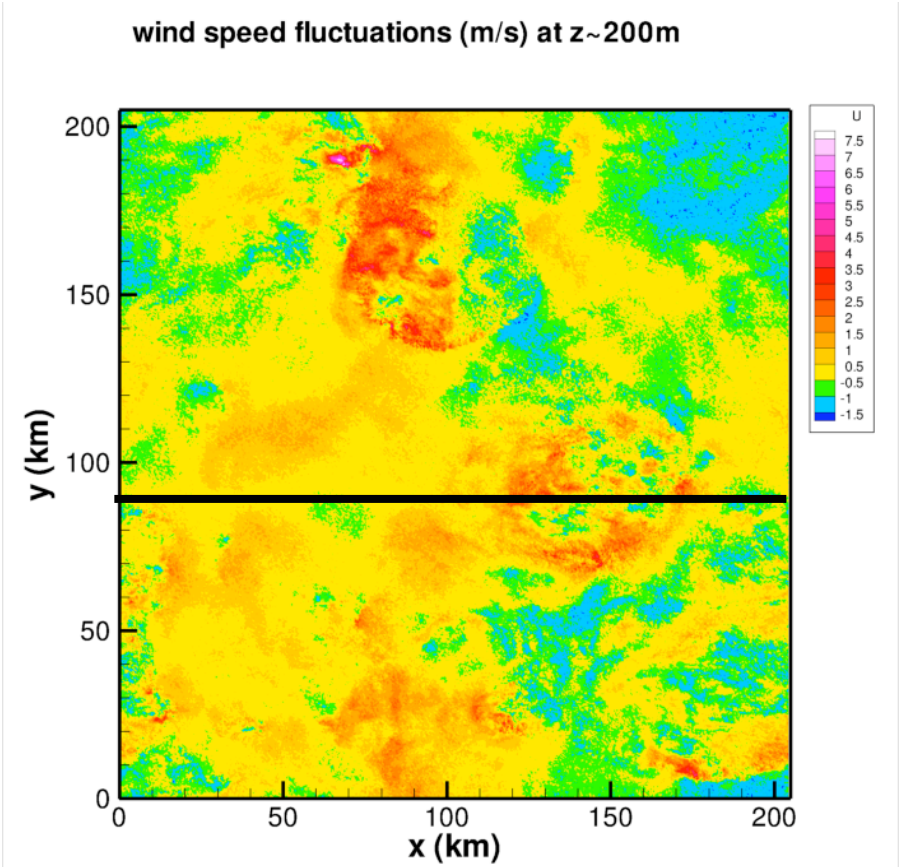


Vertical cross-section of water vapor (g/kg)

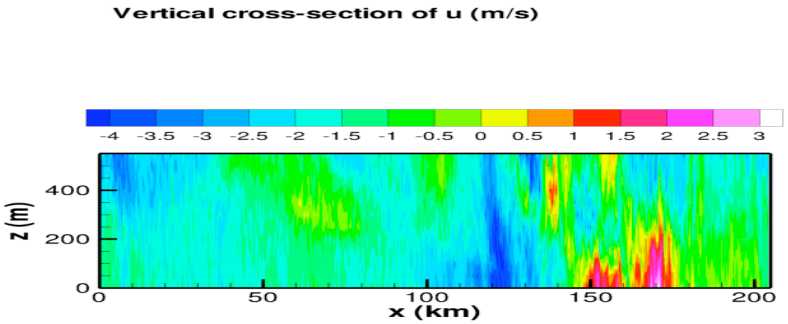


Wind field

horizontal plane

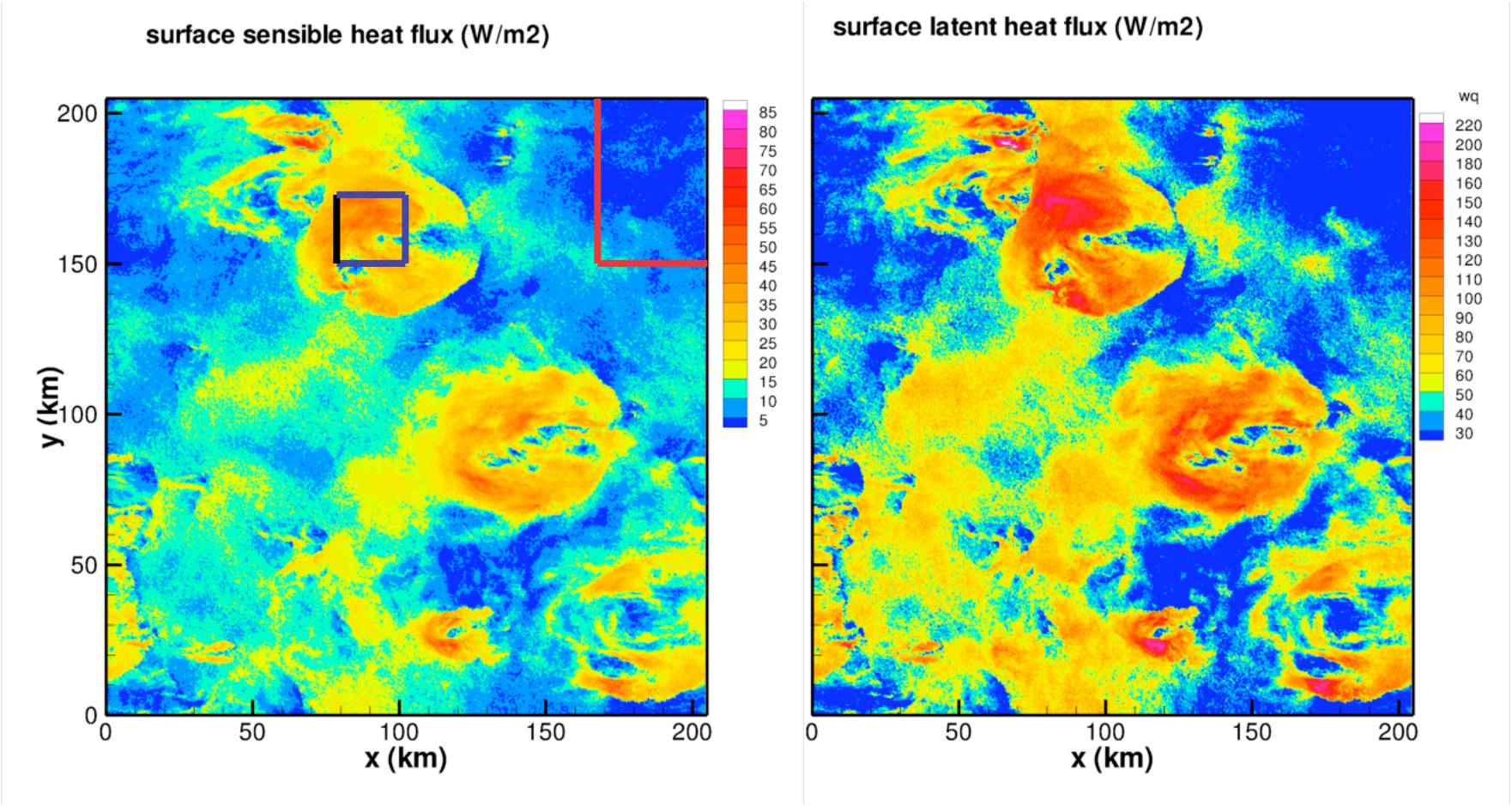


vertical plane



⇒ cold pool spreading out

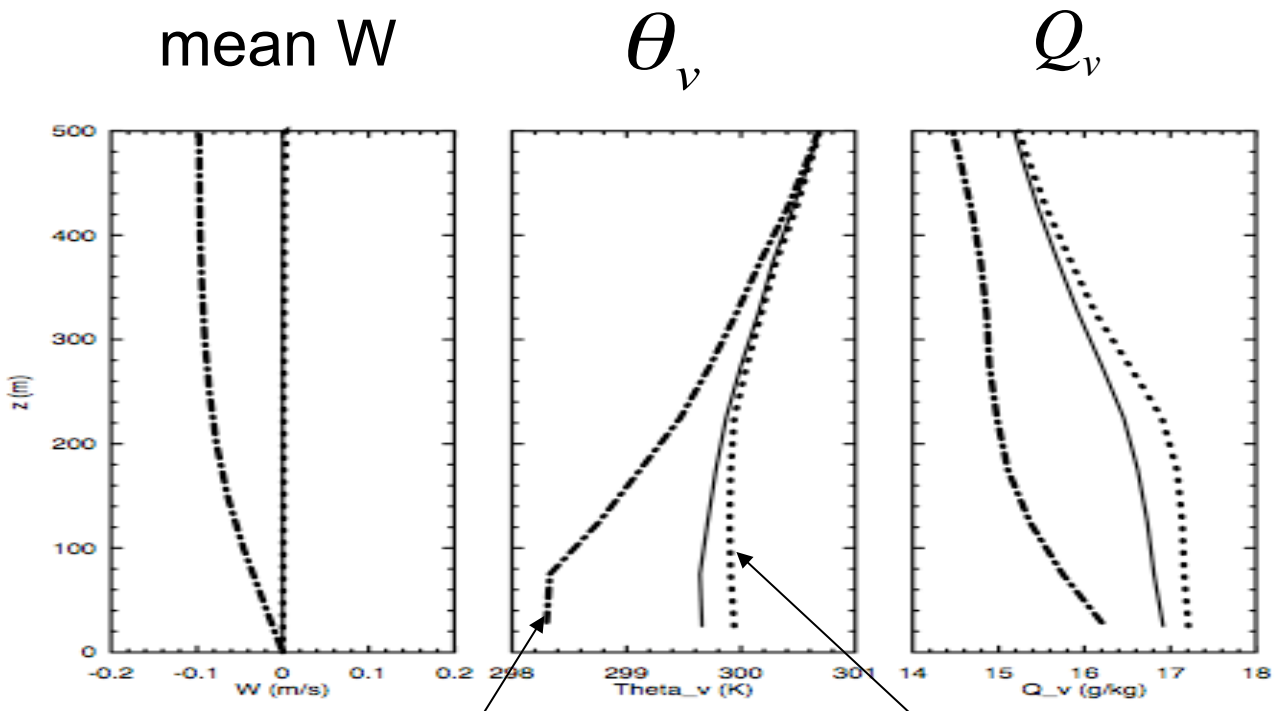
Surface fluxes



⇒ much larger surface fluxes inside cold pools

Sampling inside and outside cold-pool areas ⇒

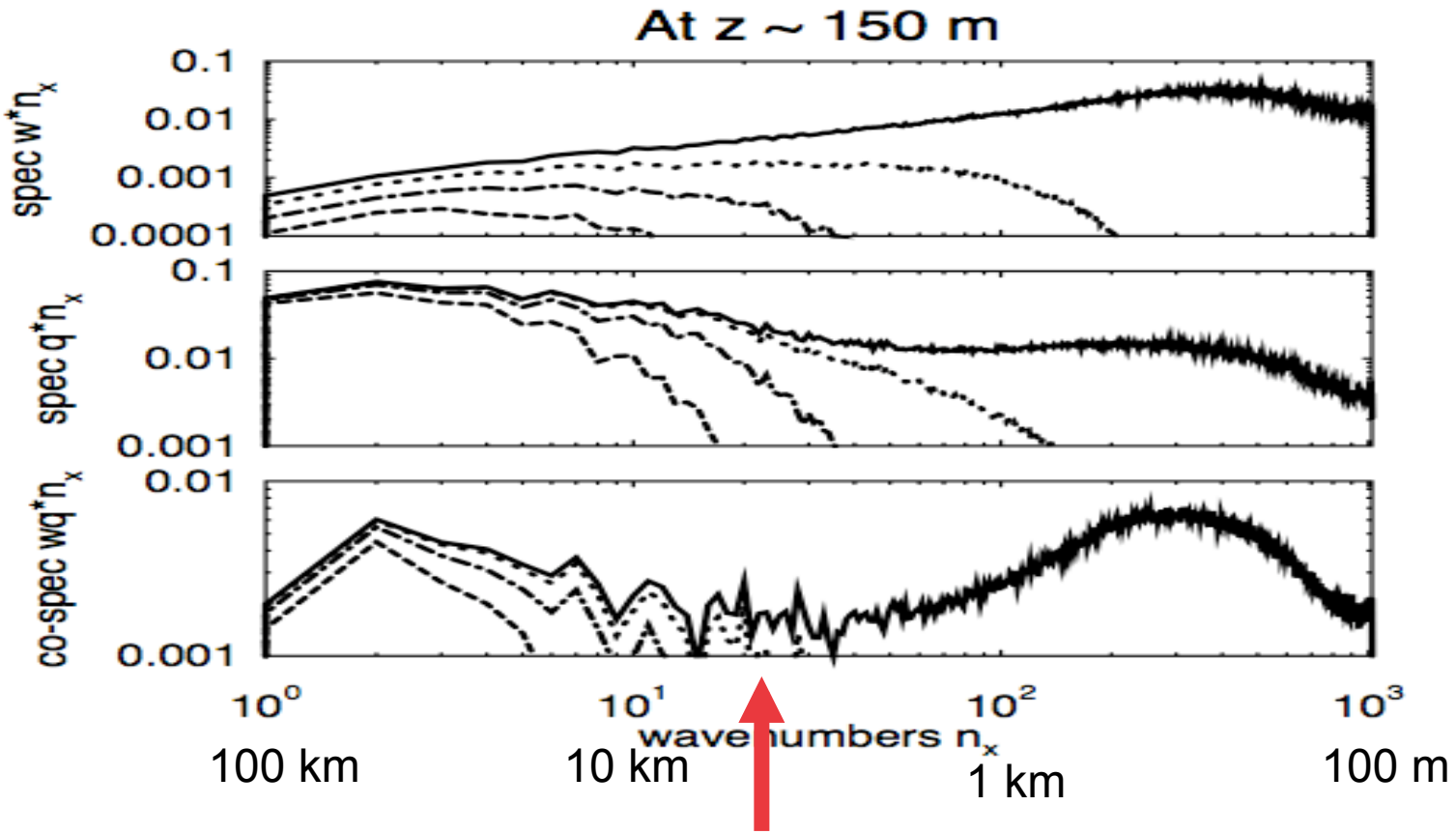
PBL inside and outside cold pools



Inside: the PBL much shallower; very stable above

outside

SPECTRAL ANALYSIS:
spectra and co-spectrum of w and qv

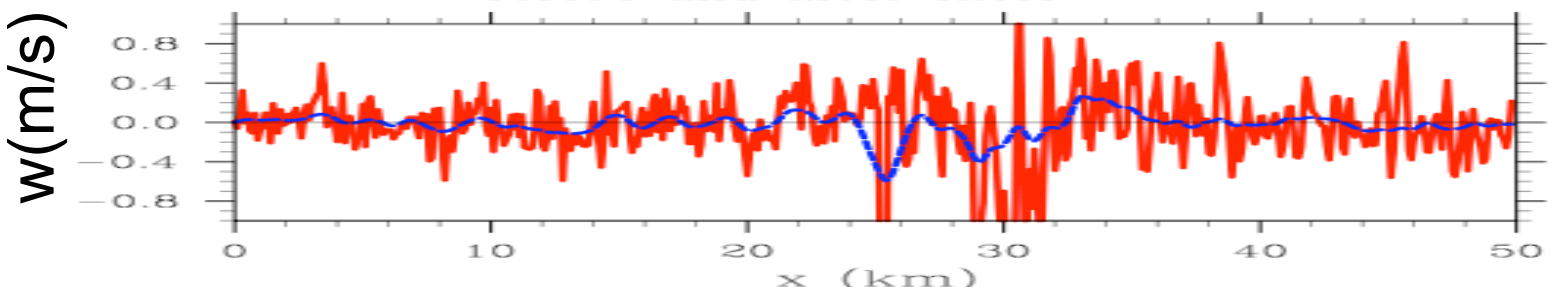


Spectral gap to separate q-flux?

SCALE SEPARATION:

Split the LES flow into RS (i.e.,CRM scales) and SFS

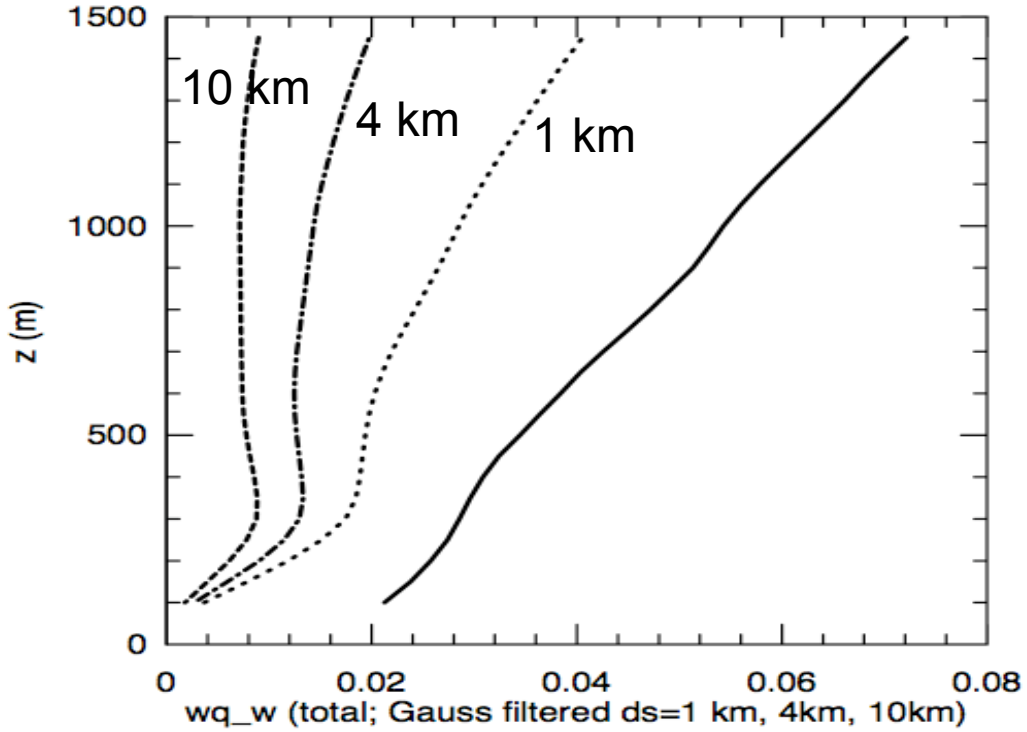
Before (red) and after filter (blue)



x (km)

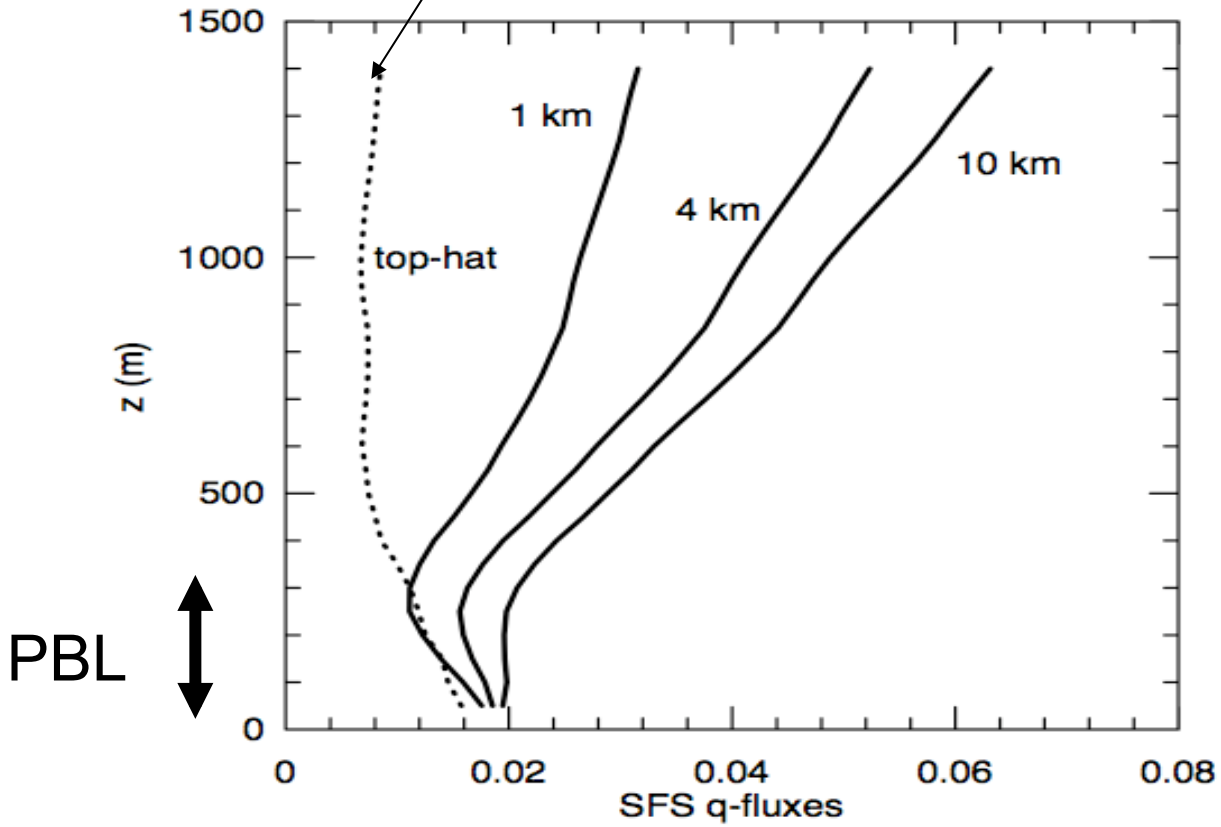
SFS scales: red - blue

Vertical profiles of q-flux with different filter widths



SFS flux: difference from the solid curve ⇒

SFS q-fluxes compared to mass-flux representation: $\overline{wq} = \alpha_u \alpha_d (W_u - W_d)(Q_u - Q_d)$



OK for the PBL but not in the shallow cloud layer?