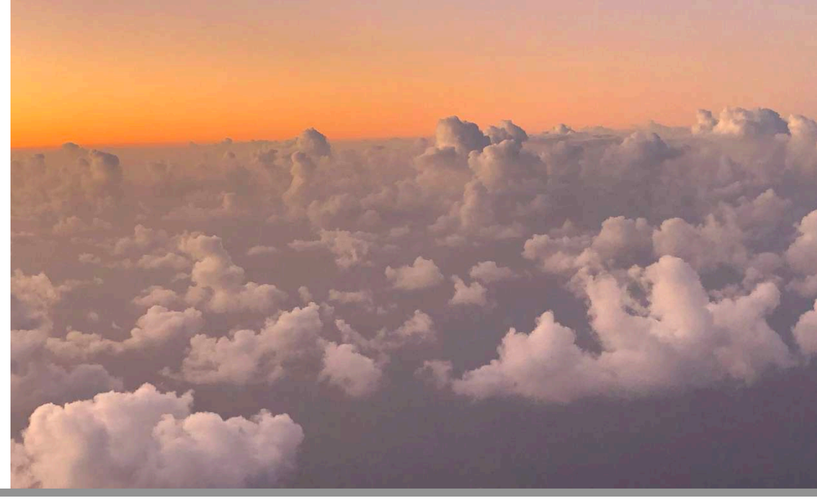


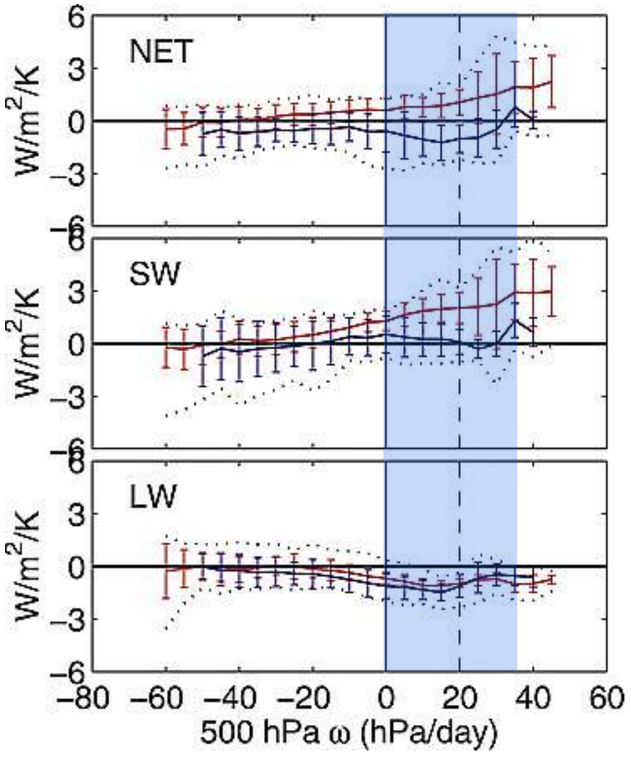
Towards a conceptualization of the trade wind layer structure and its sensitivity to environmental changes in EUREC^{4}A observations and models

Anna Lea Albright, Sandrine Bony, Bjorn Stevens, Raphaela Vogel

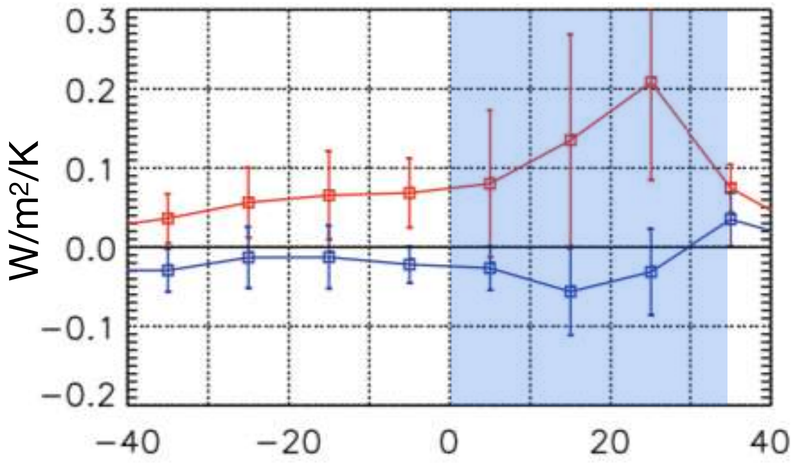
GCMs predict diverging responses of the trade wind planetary boundary layer (PBL) to environmental changes

Large uncertainty in net cloud feedback in trade wind regimes from CMIP3 (Bony and Dufresne, 2005) to CMIP5 (Vial et al, 2013) to CMIP6

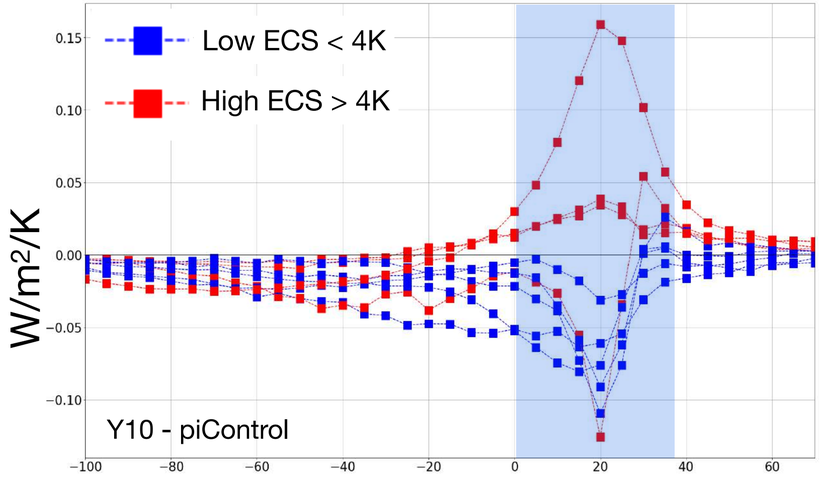
From CMIP3 …



… to CMIP5 …



… to CMIP6.

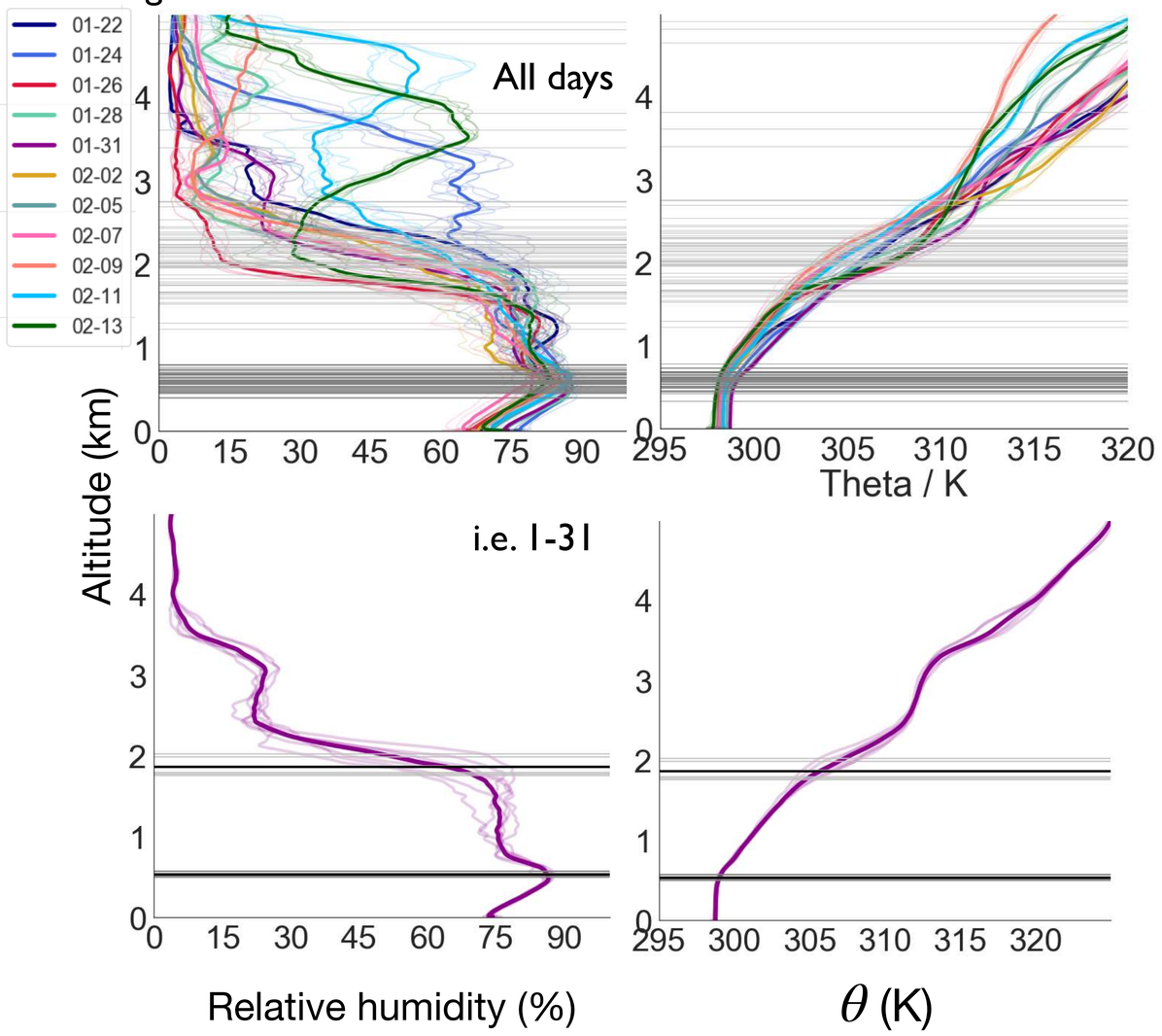


- The uncertainty of the trade wind PBL response to environmental changes and its resulting influence on the spread of climate sensitivity in GCMs motivate our study to examine the structure of the trade wind PBL and its sensitivity to environmental changes in EUREC⁴A observations and models

- Here, we examine three initial questions in EUREC⁴A HALO dropsonde observations:
  1. How to describe the vertical trade wind PBL structure (including mixed layer and inversion base height)?
  2. How variable is mixed layer-mean temperature and humidity?
  3. Can we identify large-scale influences on this mixed layer temperature and humidity variability?

Characterizing the planetary boundary layer vertical structure

HALO flights

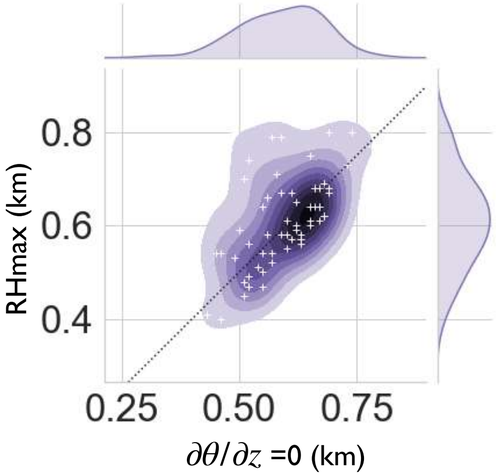


Heights (km) estimated from 65 circles (mean of 12 sondes/circle) from HALO flights

	Mixed layer $\partial\theta/\partial z = 0$ *	**Mixed layer** (RHmax)	**LCL** (Bolton)	**Inversion base** (static stability)
μ (σ)	0.59 (0.08)	0.61 (0.10)	0.75 (0.12)	2.3 (0.75)
range	0.33 - 0.78	0.40 - 0.80	0.52 - 1.1	1.2 - 4.9

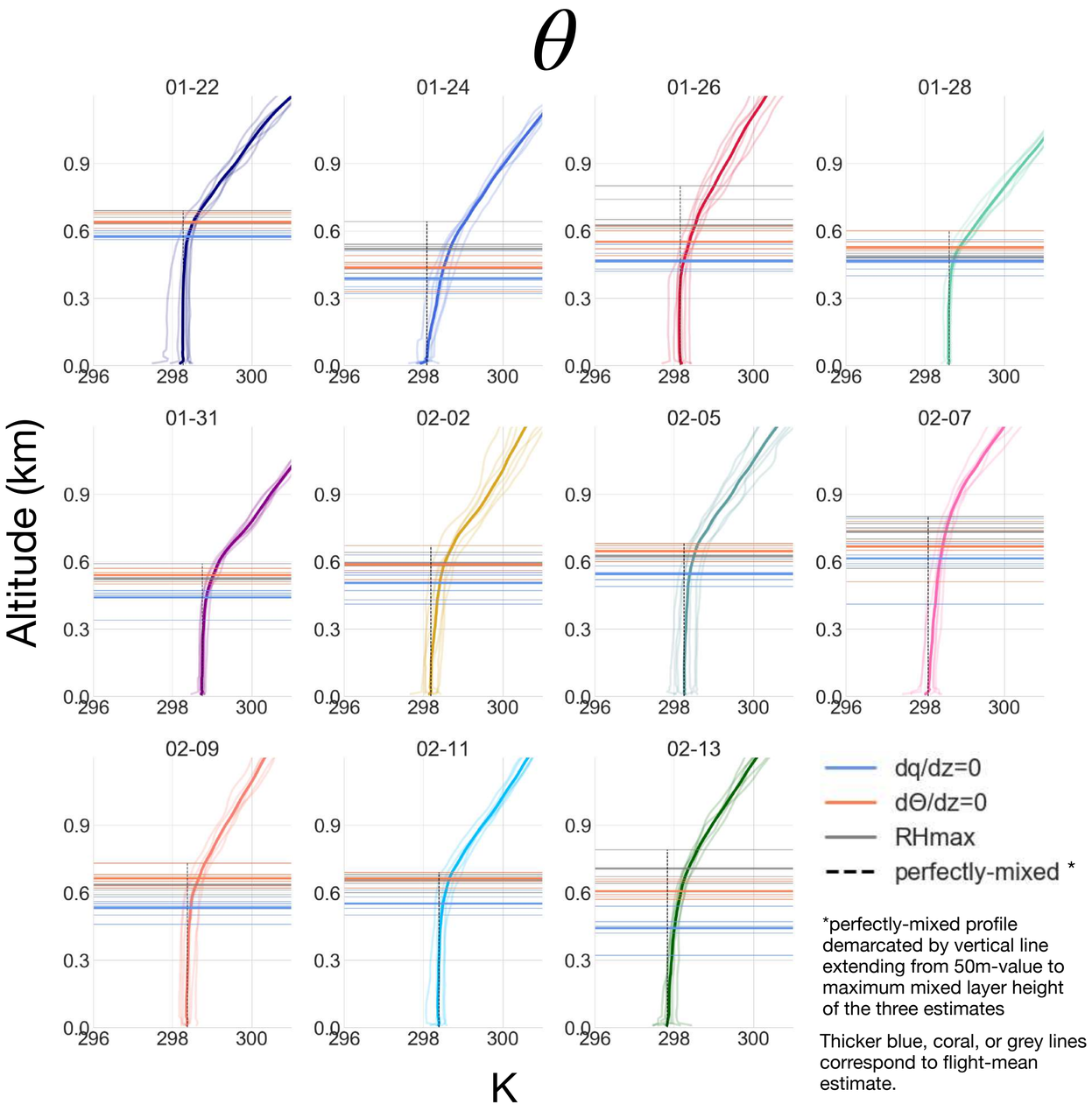
$$* \; | \; \theta - \frac{\int_{50m}^{\eta} \rho\theta\partial z}{\int_{50m}^{\eta} \rho\partial z} \; | < 0.2K$$

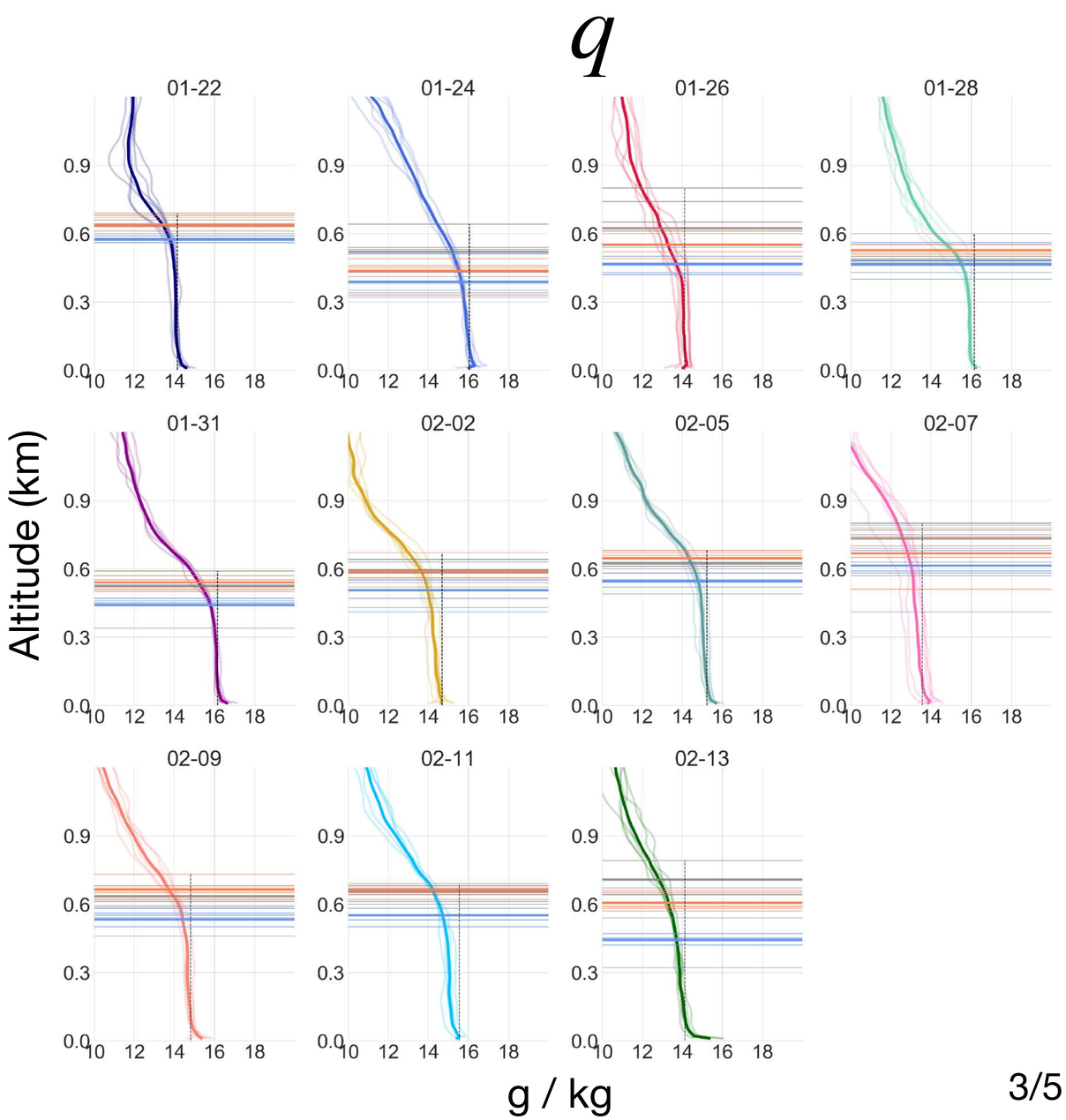
Compare RHmax and $\partial\theta/\partial z$ methods to estimate mixed layer height



Mixed layer height from RHmax or $\partial\theta/\partial z$ denoted by grey lines; inversion base height from where static stability first exceeds 0.1K/hPa given by silver lines. For 1-31, black line corresponds to flight-mean mixed layer or inversion base height.

On most days, mixed layer temperature and humidity profiles largely follow a perfectly-mixed layer

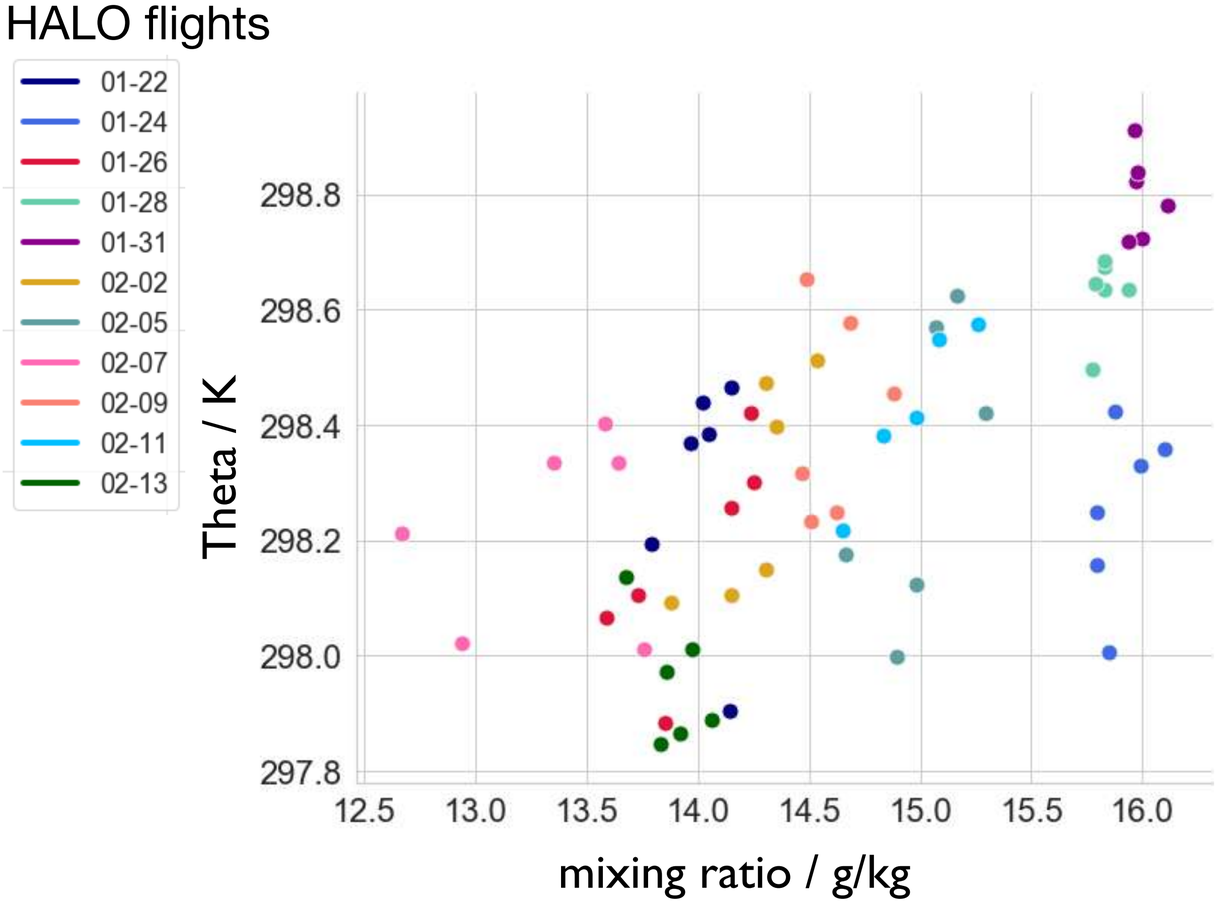




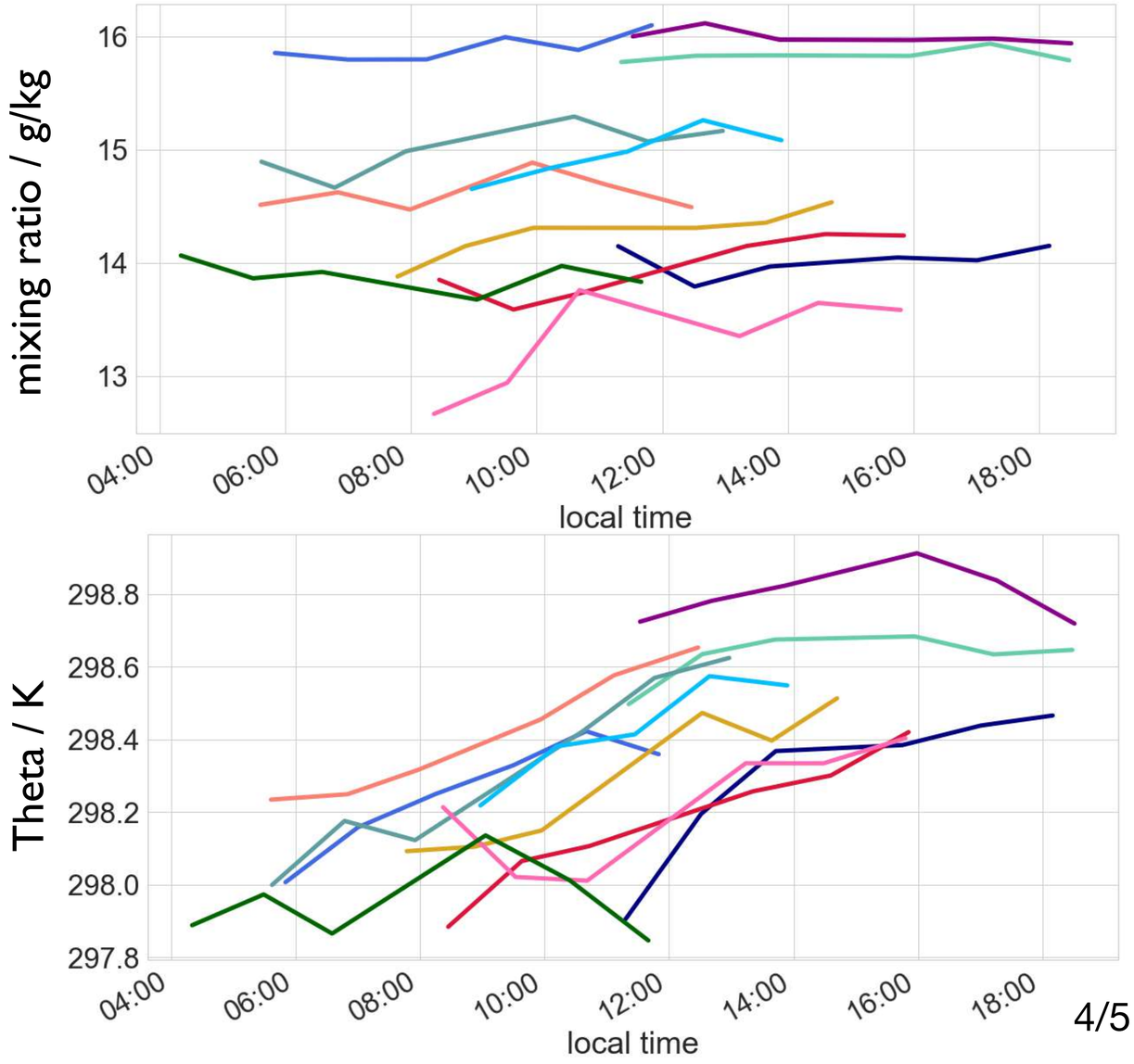
How variable are the mixed layer-mean temperature and humidity?

Variability by flight

(each point is circle-mean from 12 sondes,
colors correspond to flights, see legend for dates)



Diurnal variability



How to identify large-scale influences on mixed layer temperature and humidity variability?

- Develop a statistical framework to investigate the sensitivity of the mixed layer temperature and humidity to a number of large-scale environmental conditions, such as SST, free tropospheric stability or humidity, surface wind speed, surface wind direction, wind shear, 10m temperature, 10m relative humidity
- Verify the ability of a conceptual model of the trade wind PBL to reproduce these sensitivities and compare with output from higher resolution models