# High-resolution simulations of the observed Antarctic boundary layer

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[5]Met Office

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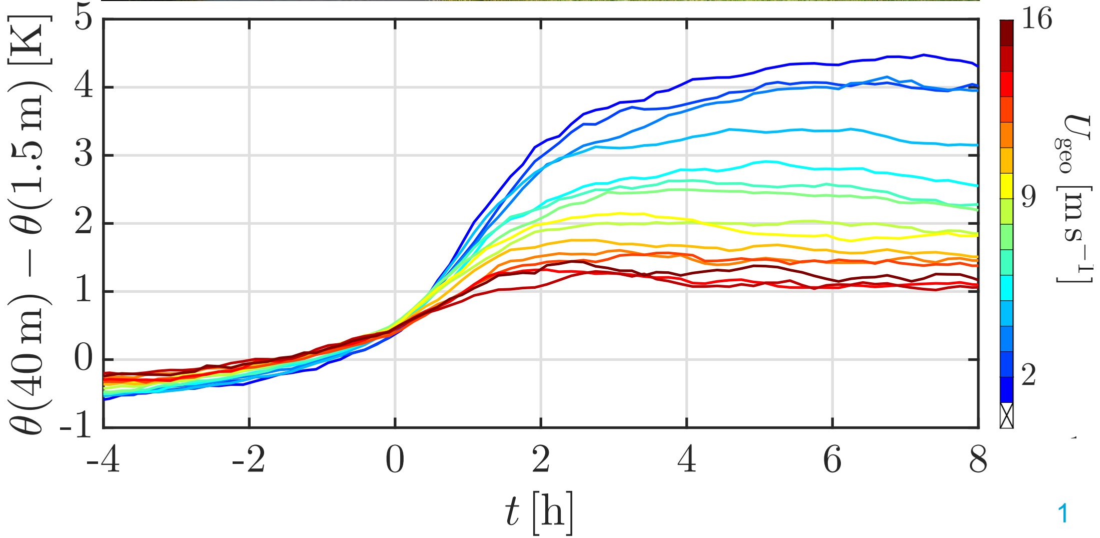
# Mid-latitude SBLs (e.g. Cabauw)

- heterogeneous
- ‘weak’ inversions
- diurnal cycle


***See:***
Van der Linden et al., 2017: *J. Appl. Meteor. Clim.*, **56**, 3035–3046

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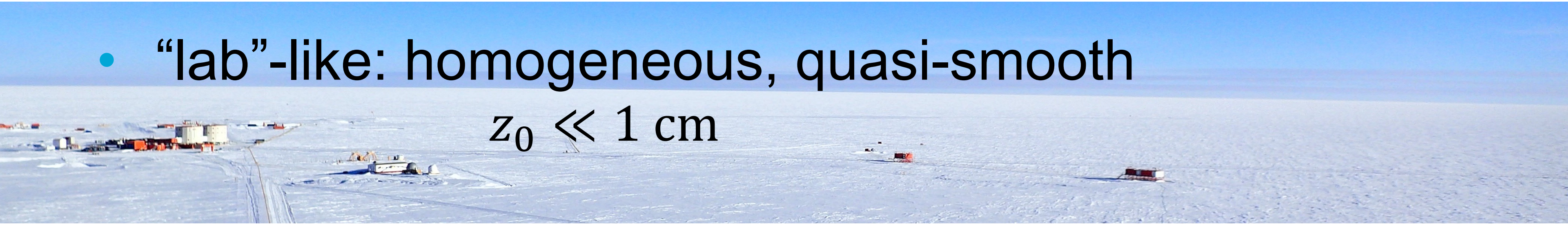
# (Numerical) Antarctic expedition

- Dome C, Antarctica
  - Recent work of Etienne, Christophe and you!

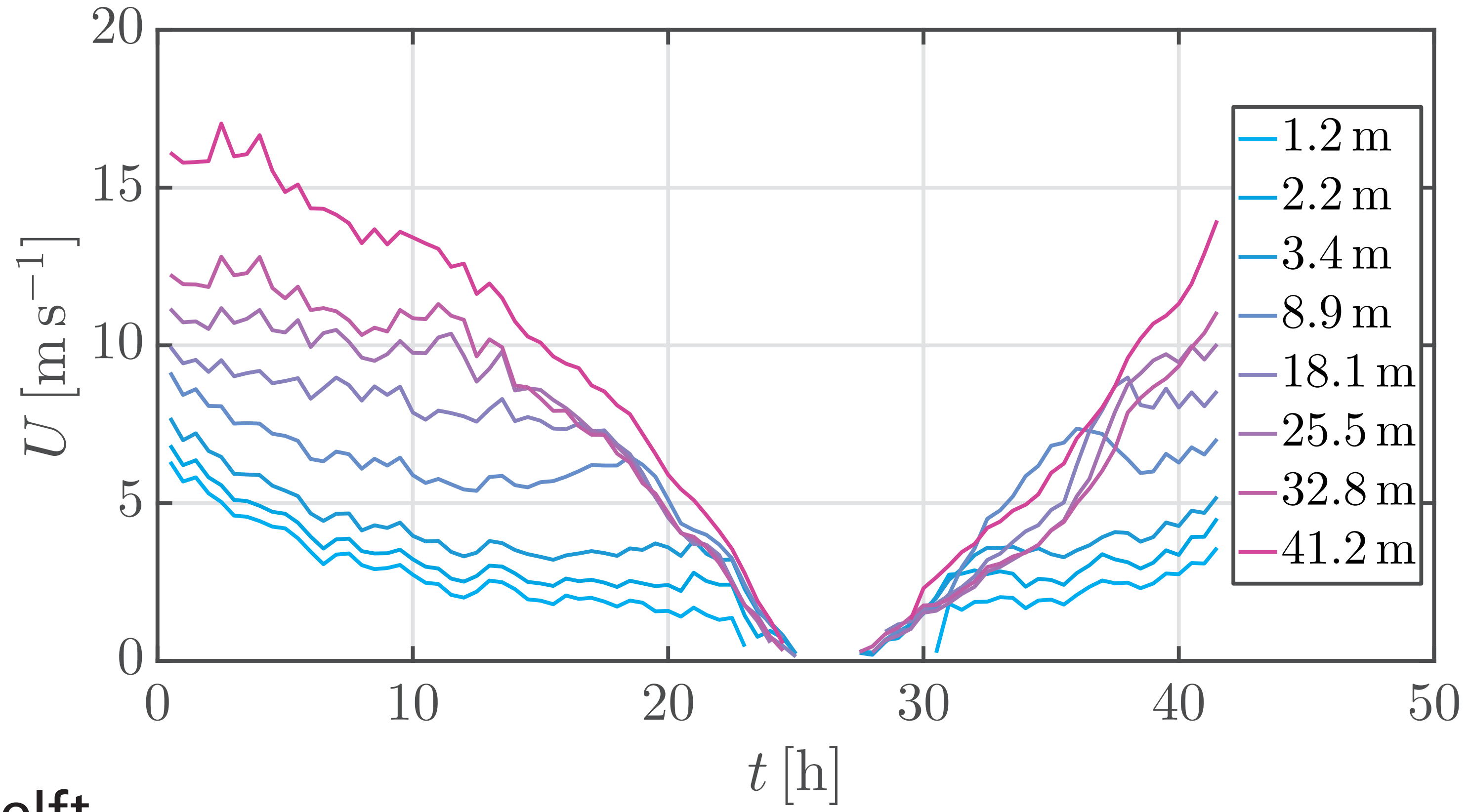


- "lab"-like: homogeneous, quasi-smooth

$$z_0 \ll 1 \text{ cm}$$

- Select on wintertime
  - no diurnal cycle (CBL)
  - *but*, we do have mechanical cycles (!)

# Vanishing pressure forcing

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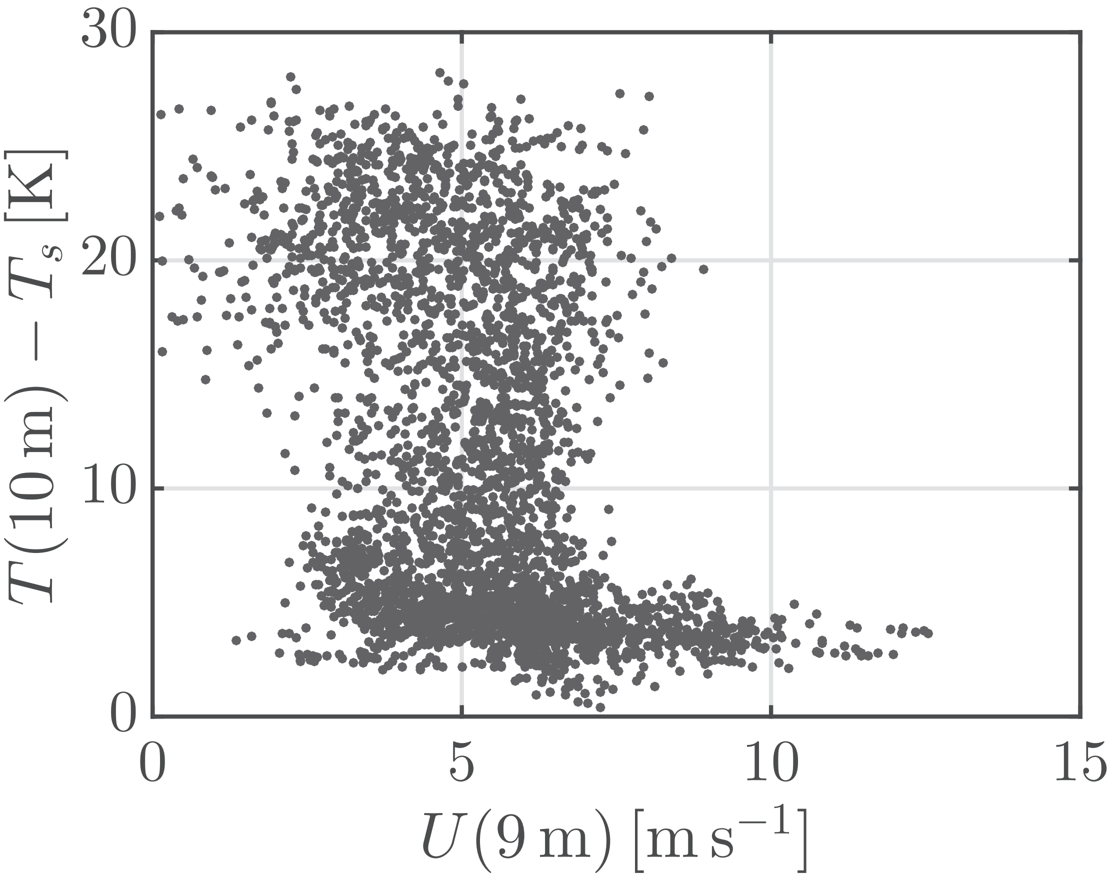
# Antarctic winter cycle

Approximately 70 times in 6 winter periods.




***See also:***

Vignon et al., 2017: *Quart. J. Roy. Meteor. Soc.*, **143**, 1241–1253

Van de Wiel et al., 2017: *J. Atmos. Sc.*, **74**, 1057–1073

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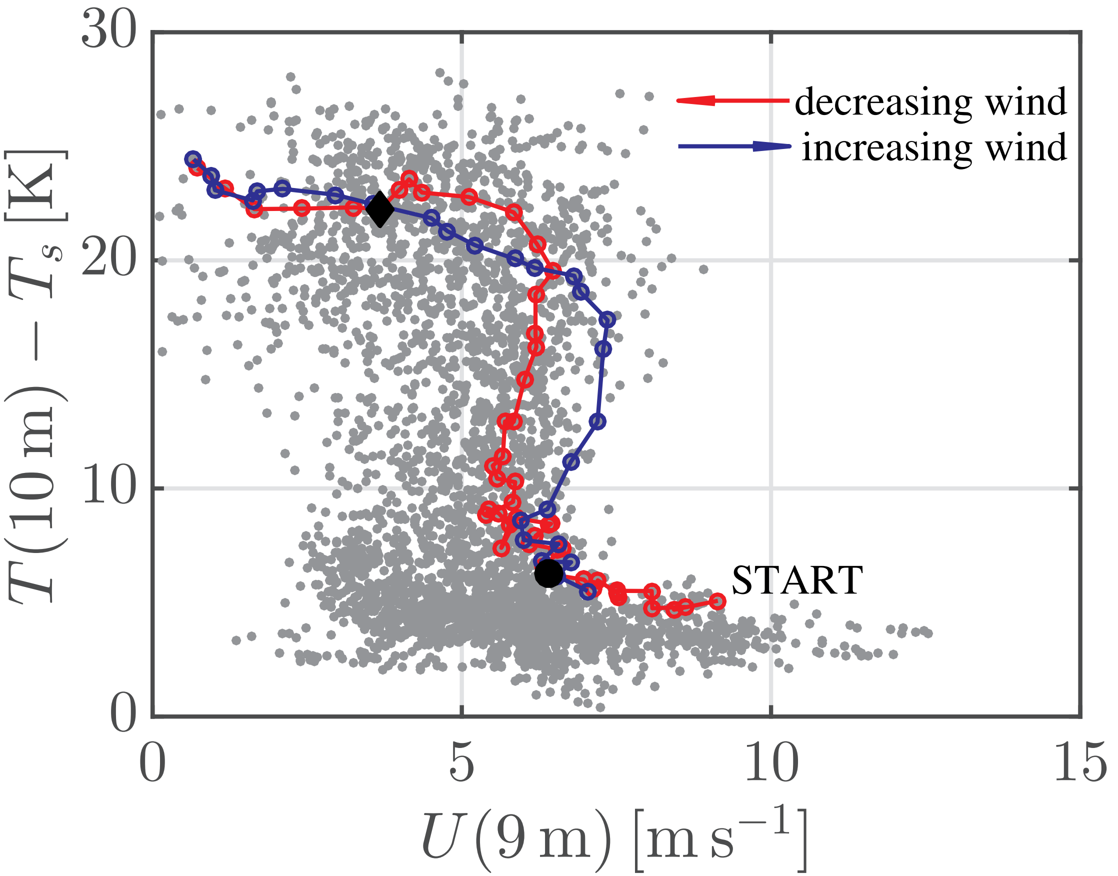


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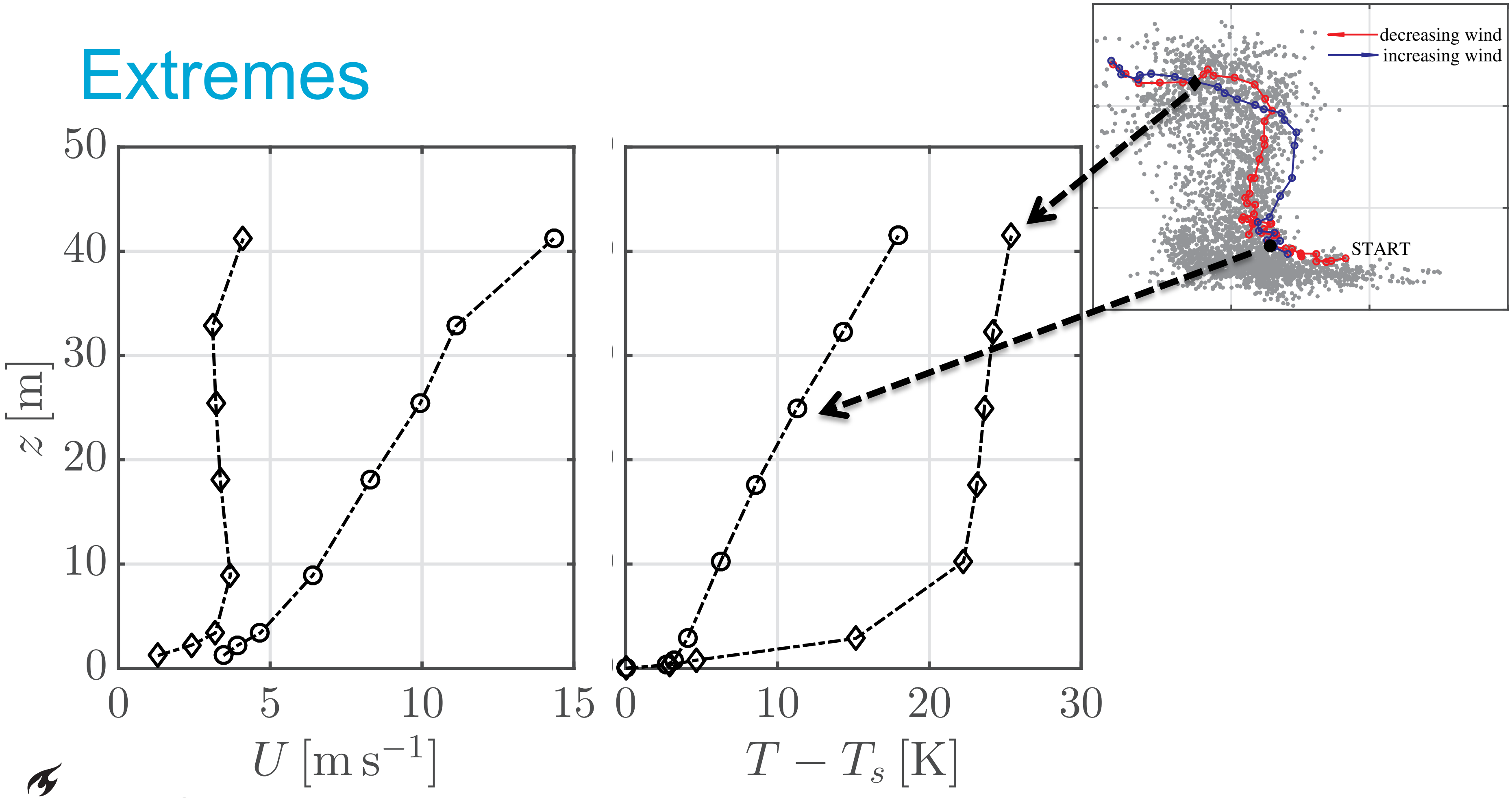
# Extremes


decreasing wind
increasing wind
START
50
40
30
20
10
0
$z$ [m]
0
5
10
15
$U$ [m s$^{-1}$]
0
10
20
30
$T - T_s$ [K]

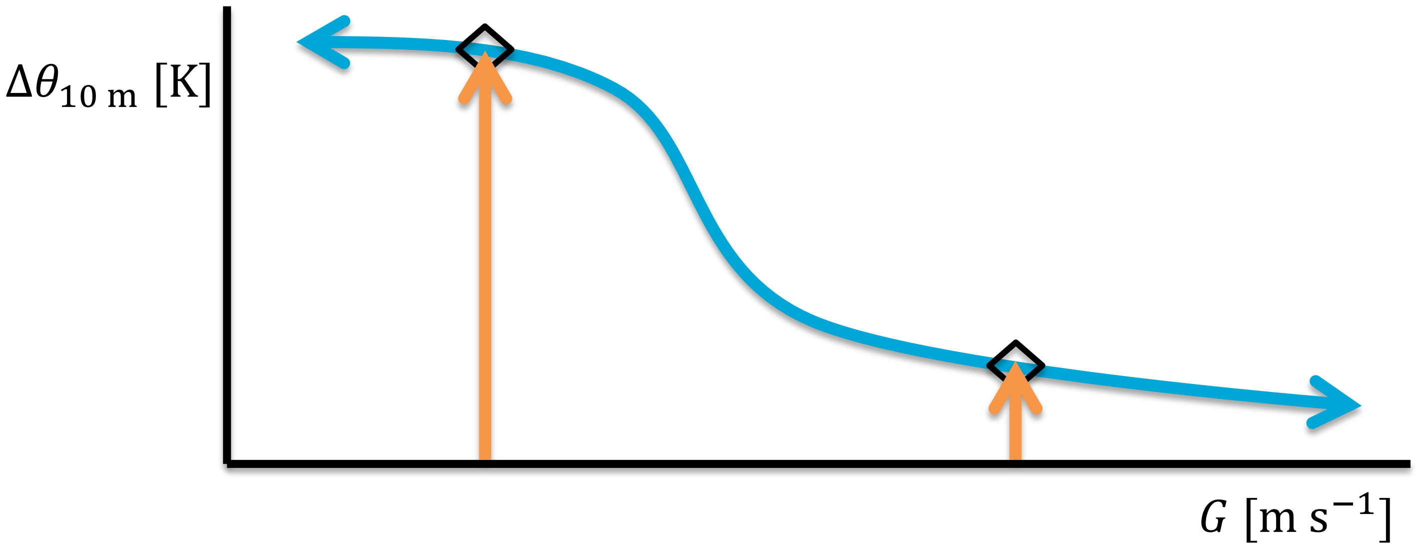
# Ongoing research

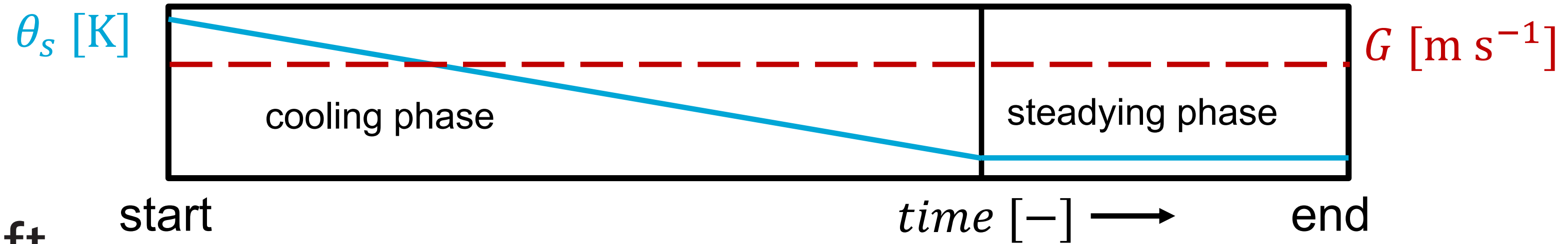
- How does the quasi-equilibrium depend on external parameters?
  - geostrophic wind, subsidence, radiative transfer

- What causes the (apparent) difference in trajectory? Hysteresis effects?

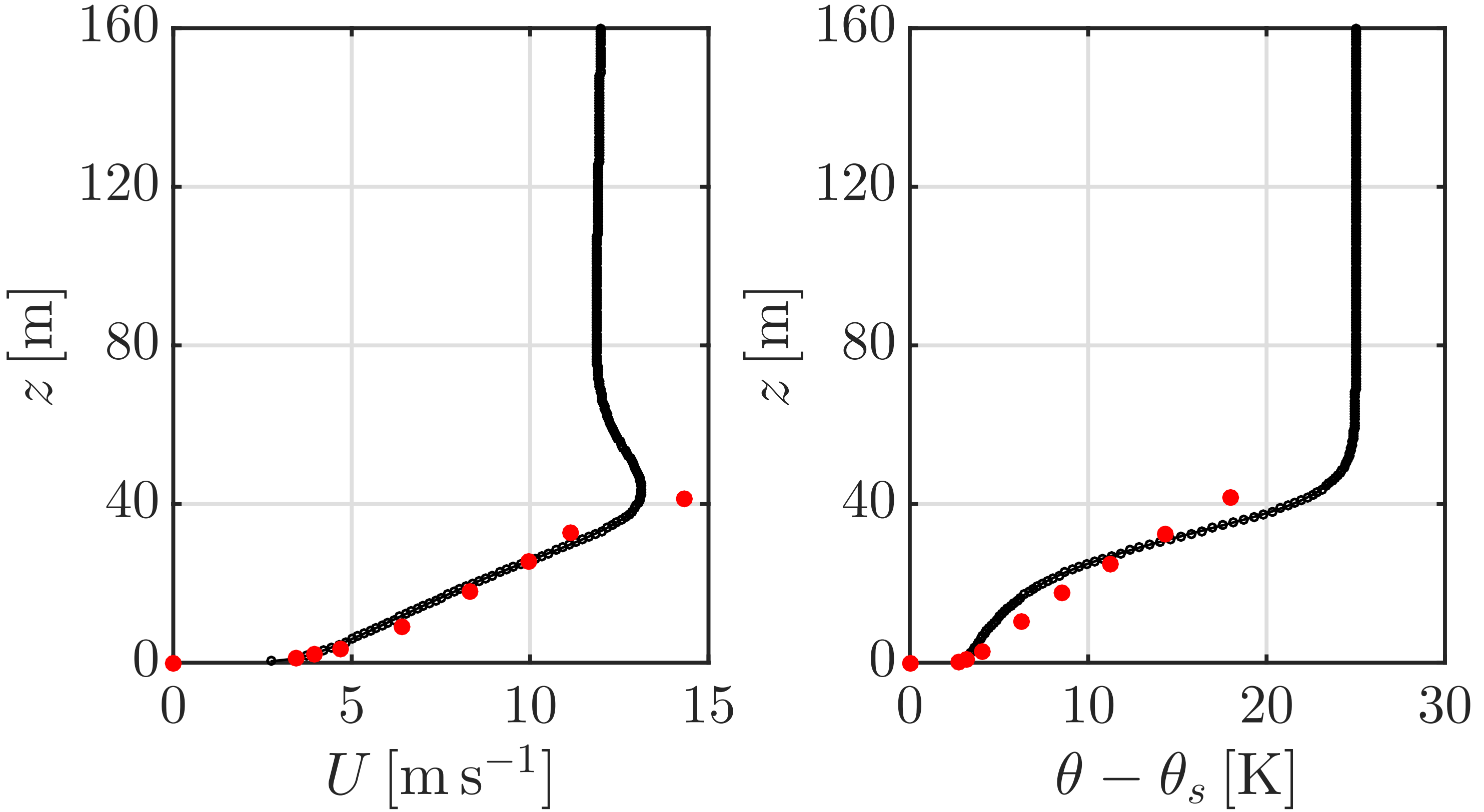
... also, can we model these extremes?

# Simulation philosophy



# Weakly stable – high geostrophic wind




$\boldsymbol{G = 12\ \mathrm{ms}^{-1}, \Delta = 70\ \mathrm{cm}, CR = 1\ \mathrm{Kh}^{-1}}$

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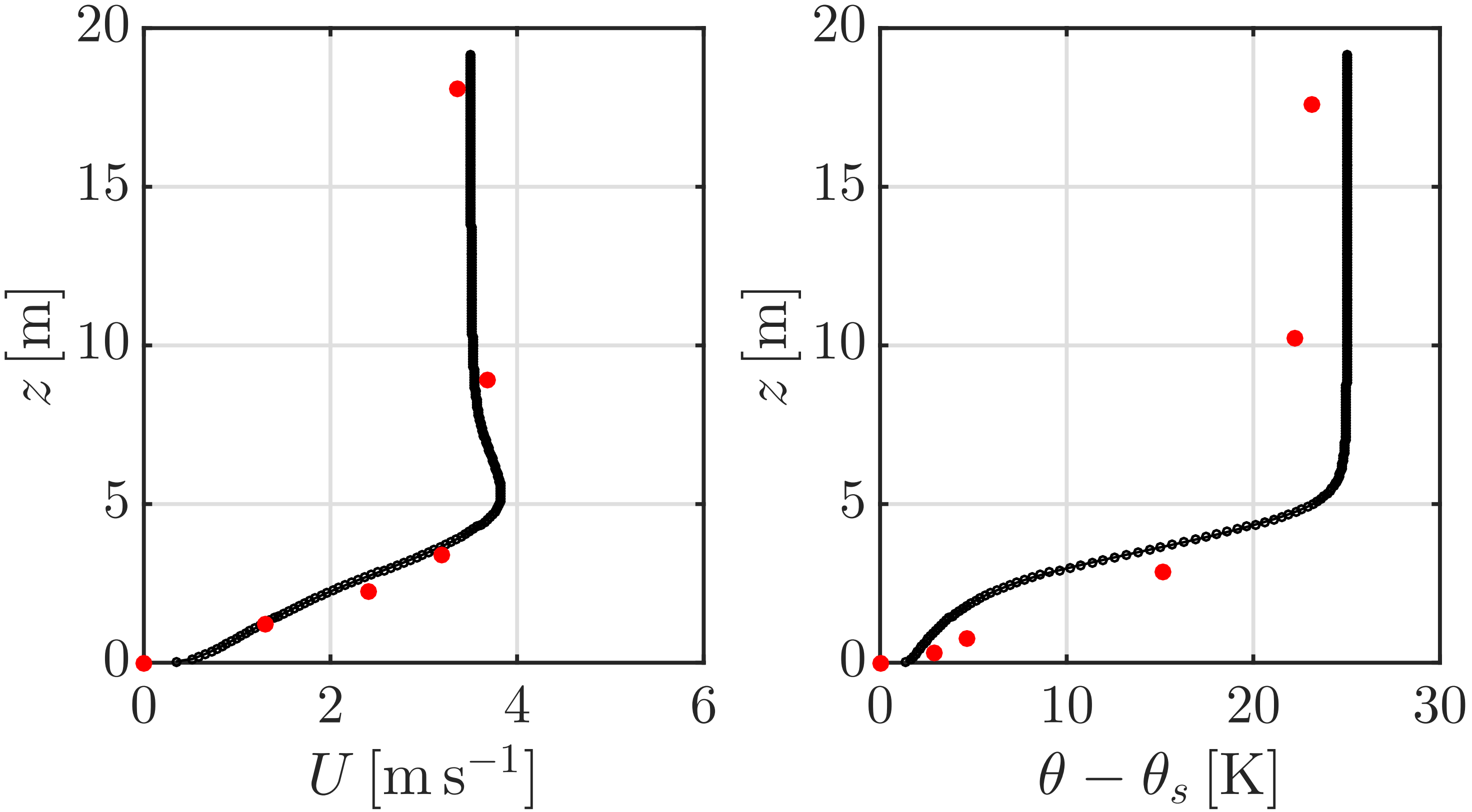
# Very stable – low geostrophic wind




$$G = 3.5\ \mathrm{ms^{-1}}, \Delta = 8\ \mathrm{cm}, CR = 4\ \mathrm{Kh^{-1}}$$

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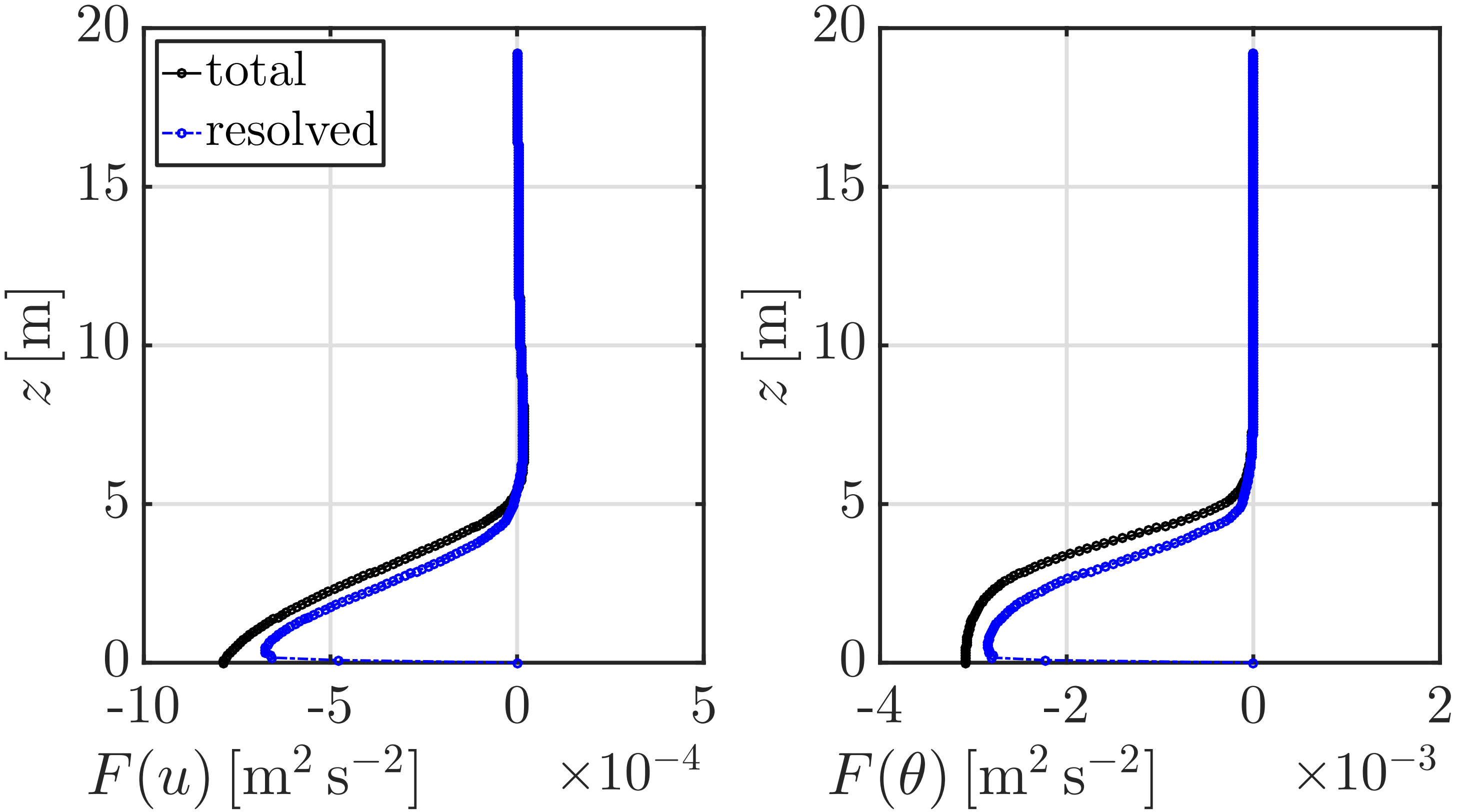
# The turbulent layer




$$G = 3.5\ \mathrm{ms}^{-1}, \Delta = 8\ \mathrm{cm}, CR = 4\ \mathrm{Kh}^{-1}$$

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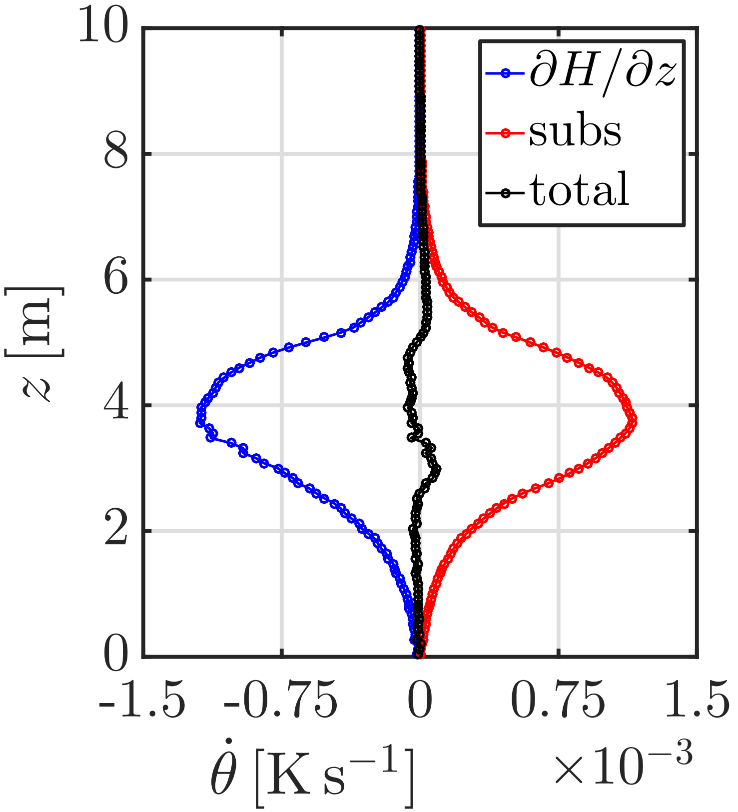
# Thermal budget

- $H_{tot}$ adapts to subsidence
- enables 'quasi'-steady state
- radiation expected to be $10^{-4}\ \mathrm{K\,s^{-1}}$




$G = 3.5\ \mathrm{m s^{-1}}, \Delta = 8\ \mathrm{cm}, CR = 4\ \mathrm{K h^{-1}}$

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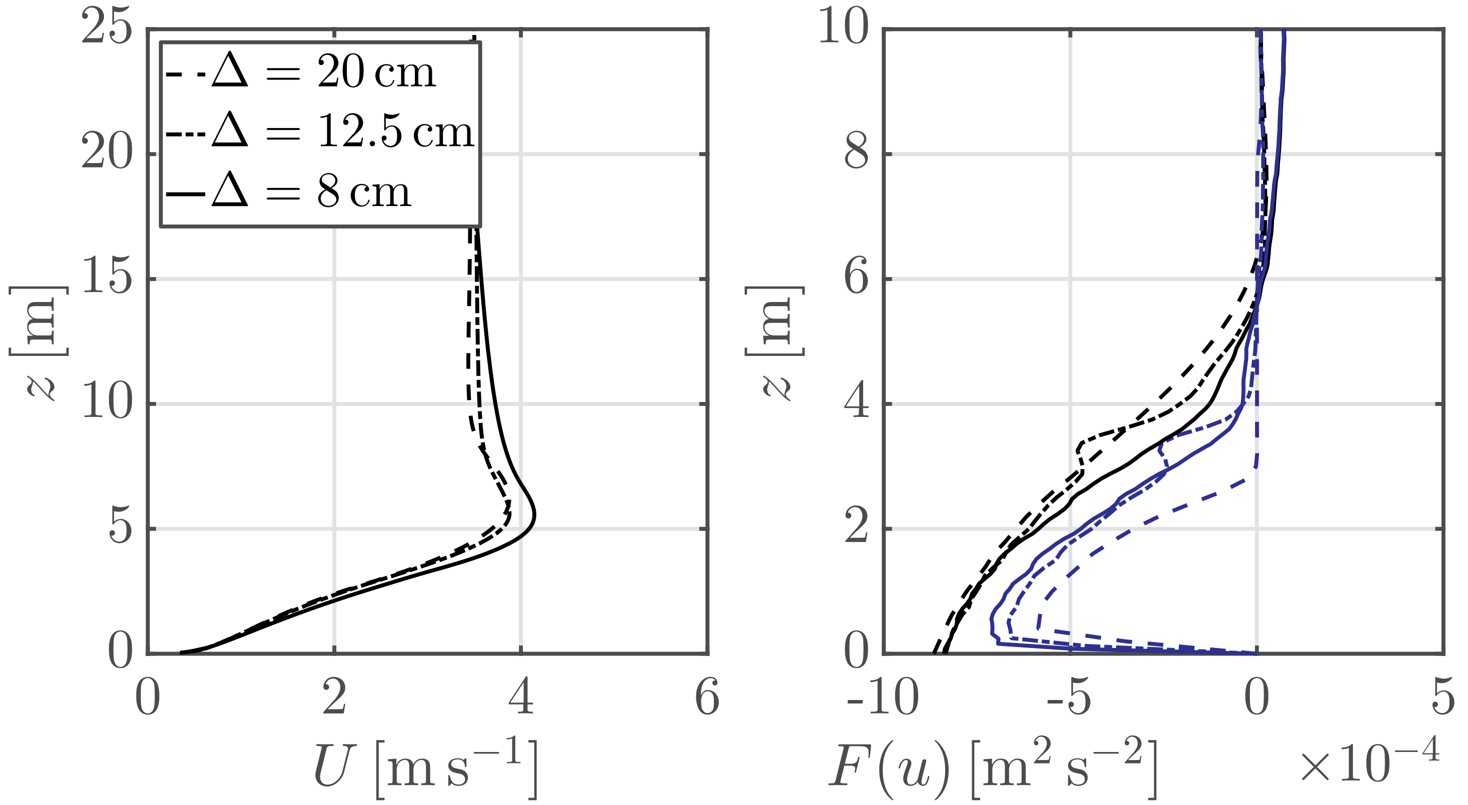
# Resolution dependence




$G = 3.5$ ms$^{-1}$

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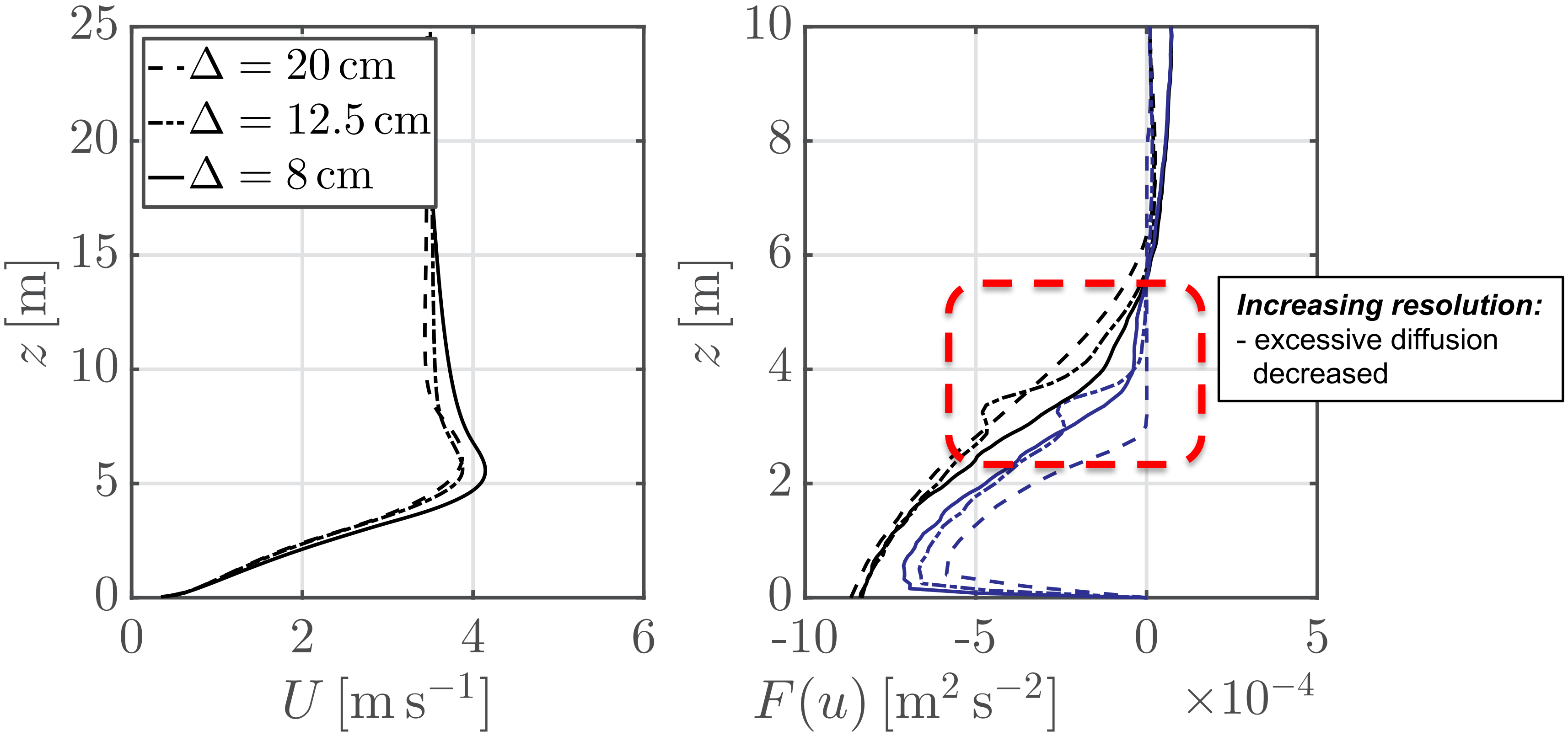
# Resolution dependence




$G = 3.5\ \mathrm{m\,s^{-1}}$

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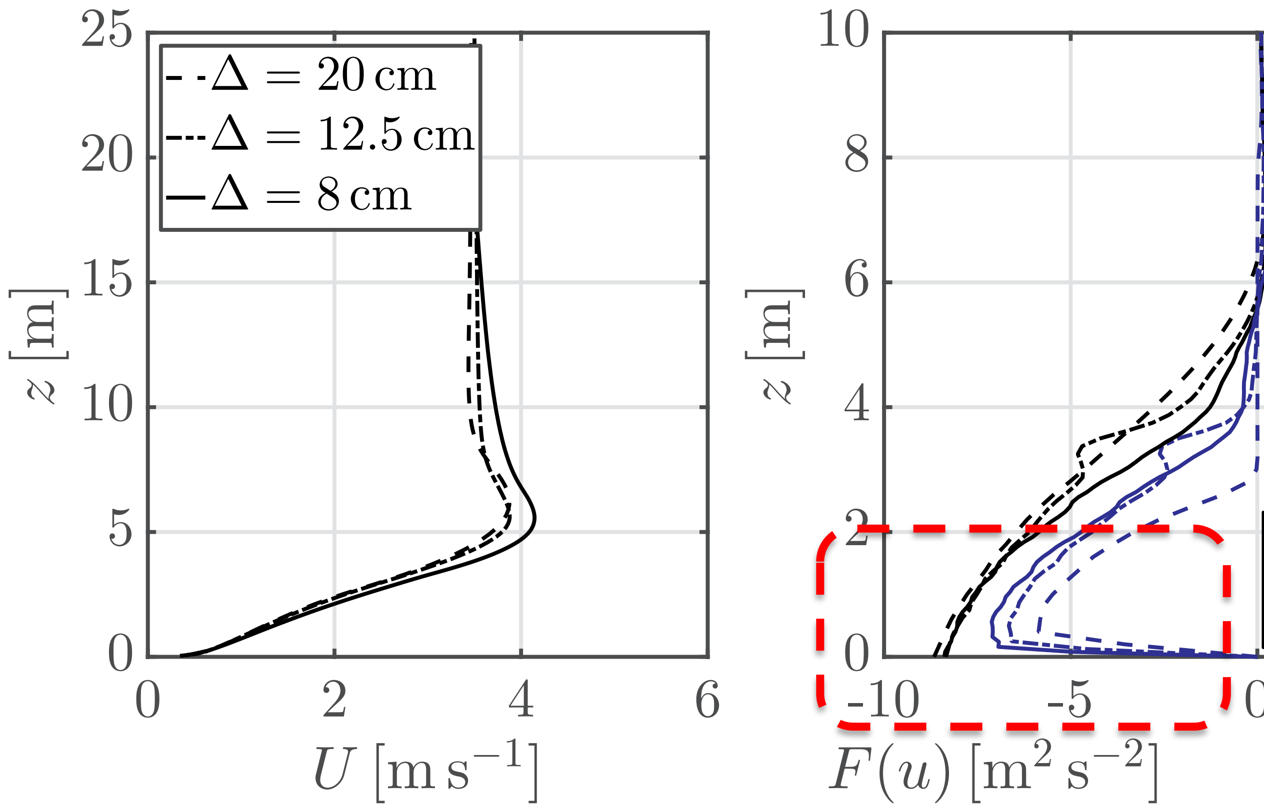
# Resolution dependence




***Increasing resolution:***
- more is resolved
- no effect on total flux

$G = 3.5$ m s$^{-1}$

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# Conclusions and outlook

- New views of SBL in Antarctic winter
  - transitions to extreme inversions

- Very stable LES based on observations:
  - accurate wind profiles
  - temperature still challenging: radiation needed?
  - shallow, continuous turbulent layer ($\sim 5\ \mathrm{m}$) possible!

# Contact

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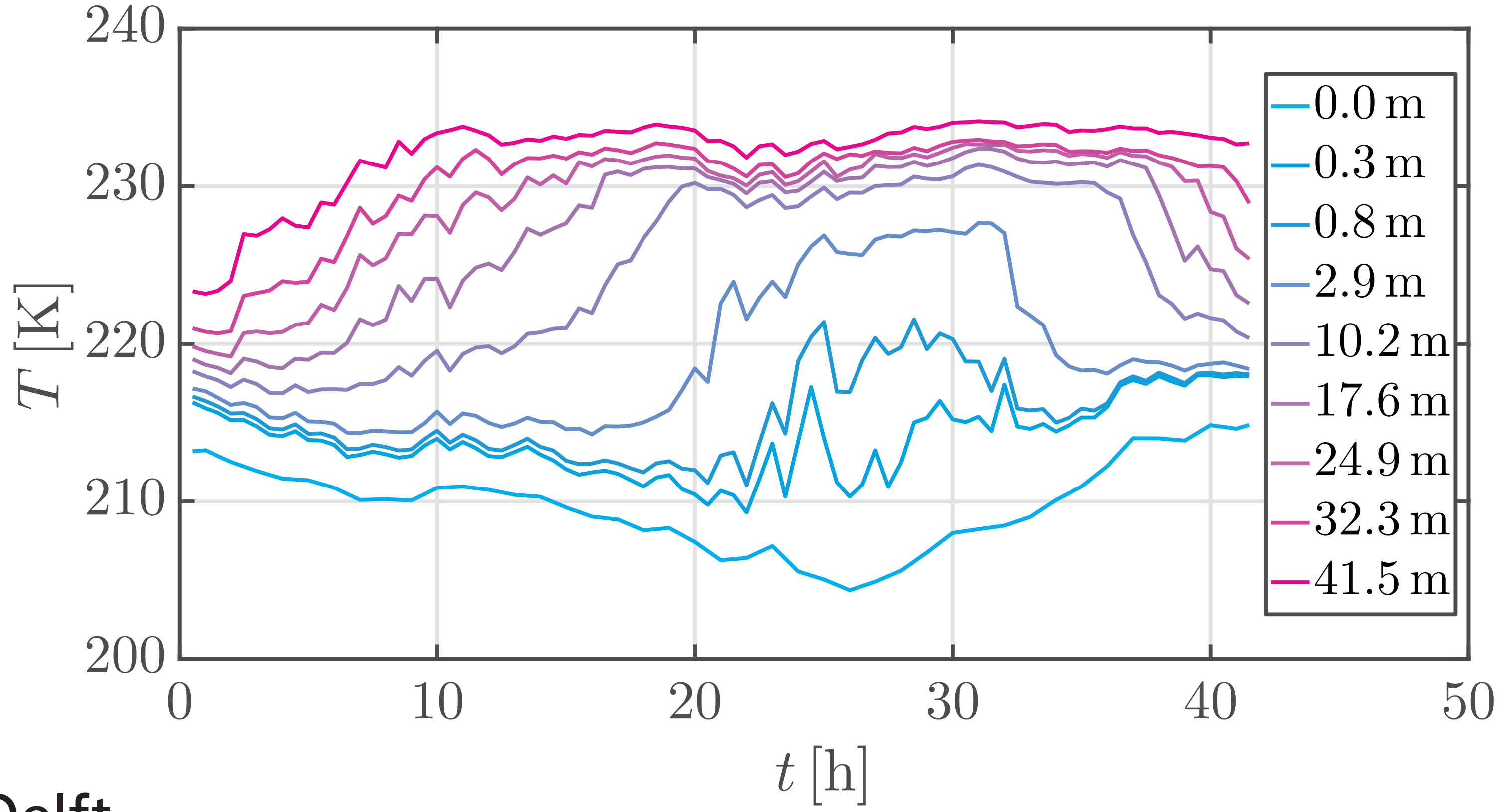
# Backup slide (I)

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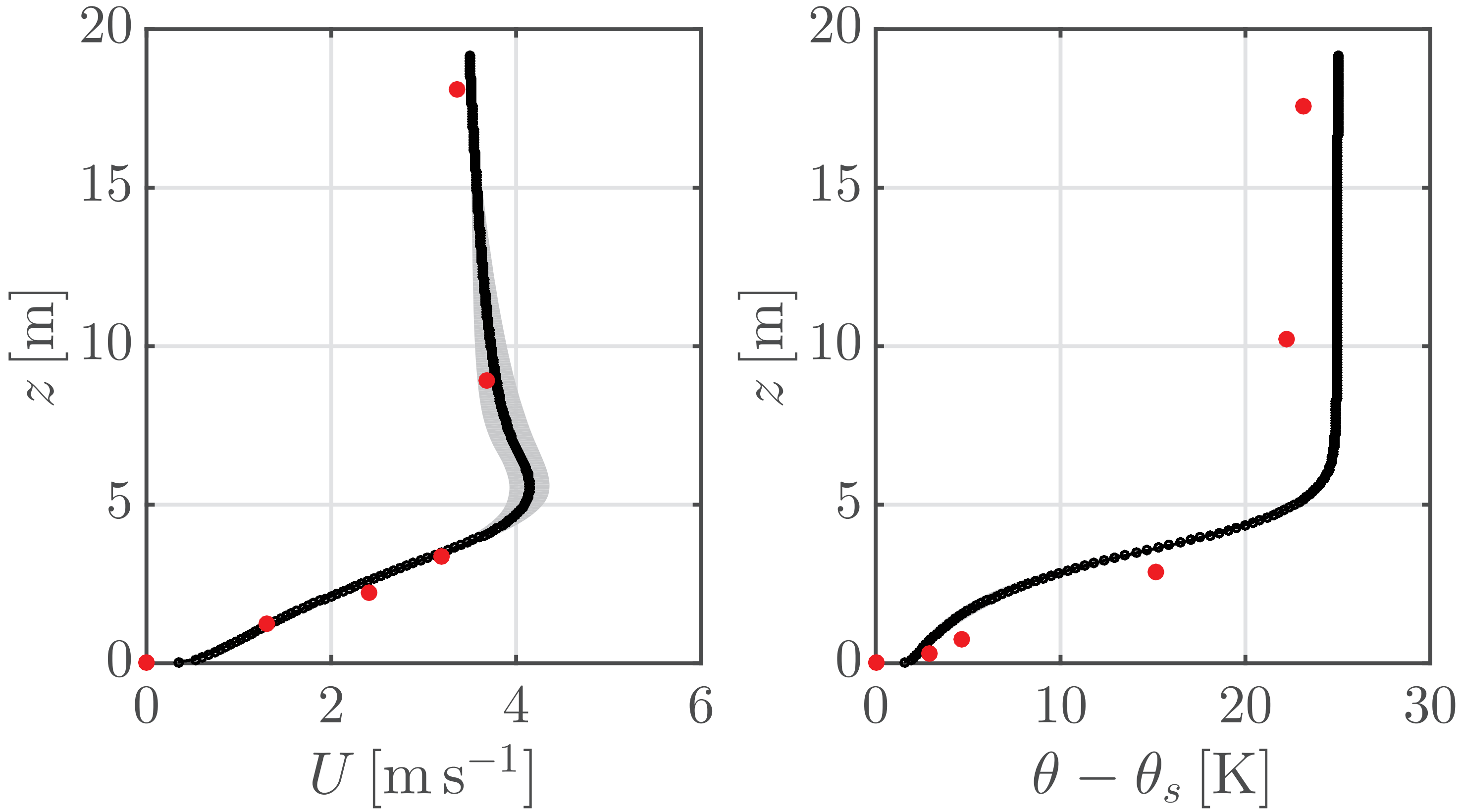
# Very stable – 12 hours earlier




$G = 3.5\ \mathrm{ms}^{-1}, \Delta = 8\ \mathrm{cm}, CR = 4\ \mathrm{Kh}^{-1}$

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