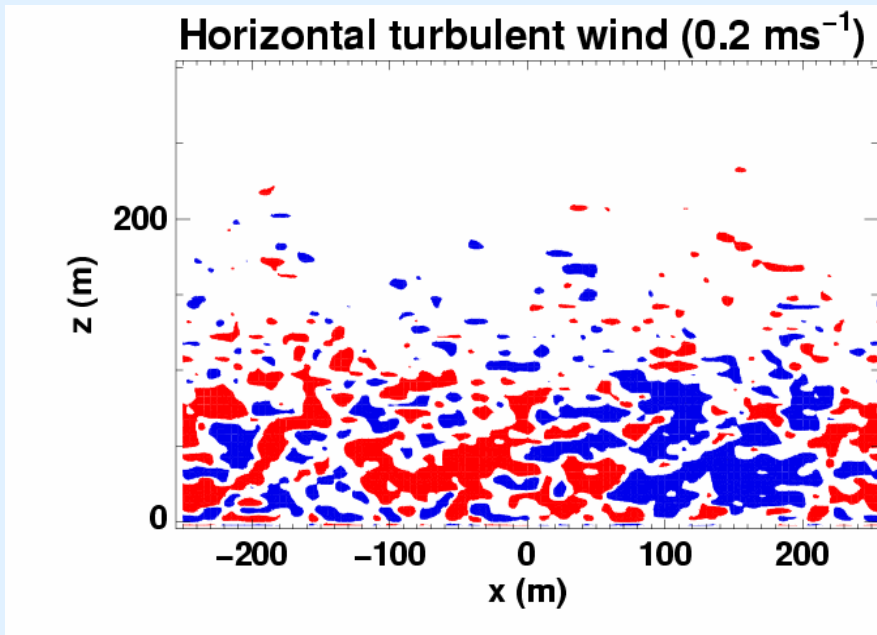


Large-eddy simulation of stable polar boundary layers



Bob Beare and Kieran Walesby
University of Exeter, UK.

Thanks also to Phil Anderson (formerly BAS)

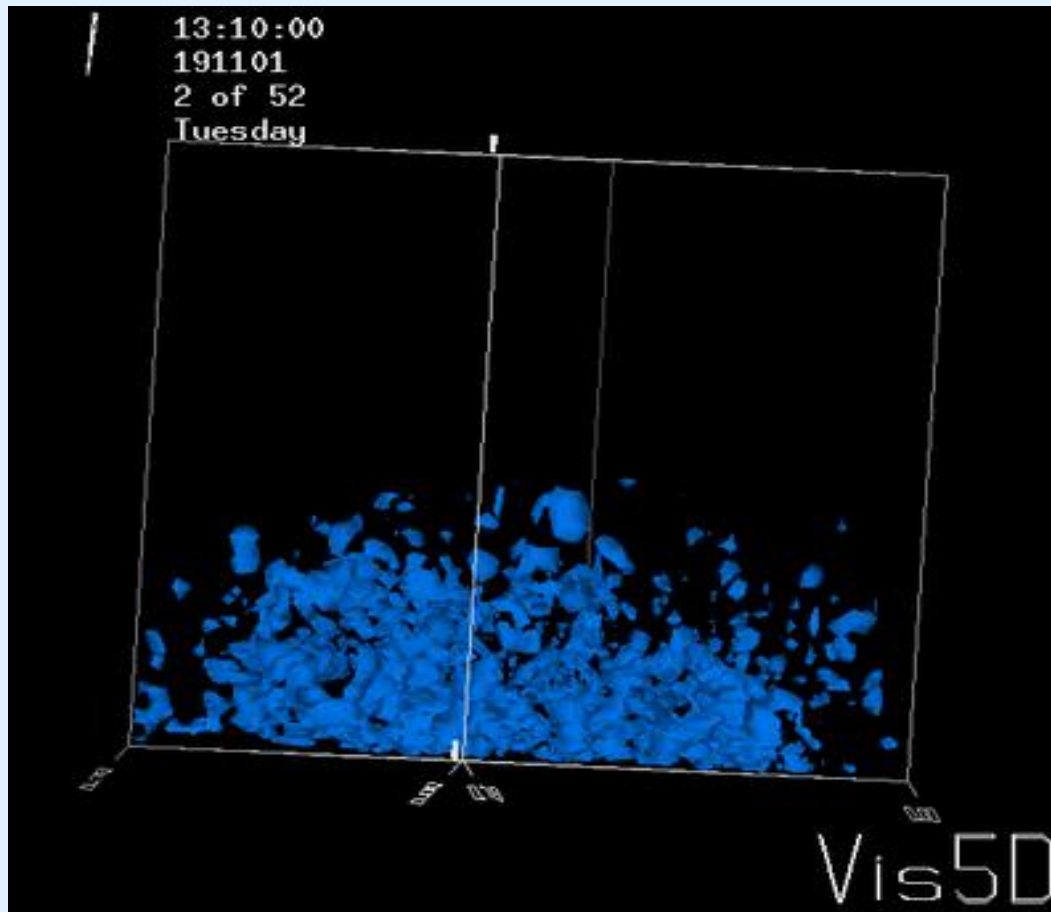
Stable polar boundary layer parametrization in GCMs.

- Stable means stratified boundary layers (potential temperature increasing with height).
- Forecasting surface temperatures.
- Antarctic winter climate, King et al. (2001) QJRMS.
- Polar amplification signal in stable boundary layer.
- Spin down of polar lows.

Large-eddy simulation

Navier-Stokes decomposed into resolved and sub-grid components. Met Office LES model.

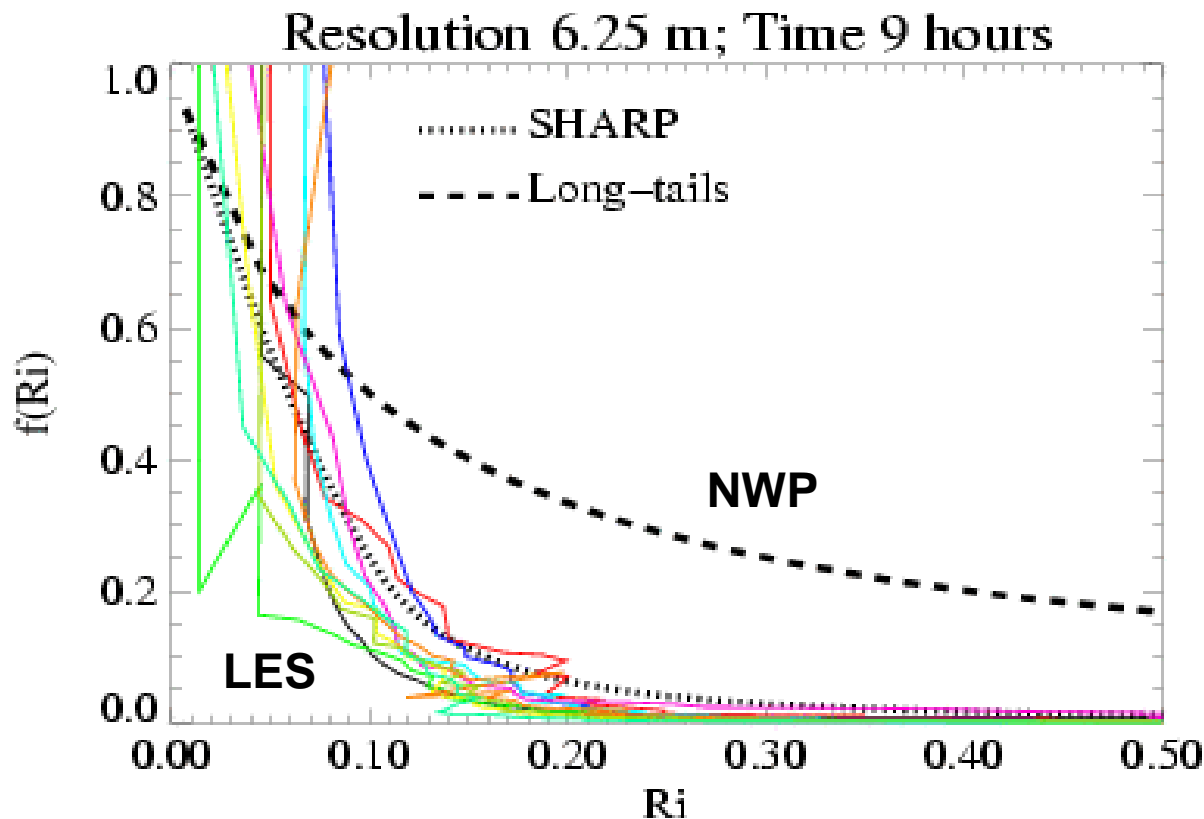
Explicitly resolve boundary-layer turbulence



Vertical
Velocity
Iso-surfaces

Parametrization validation using LES

$$\overline{w'c'} = -K_c \frac{\partial c}{\partial z}, \quad K_c = l_m^2 S f(Ri).$$



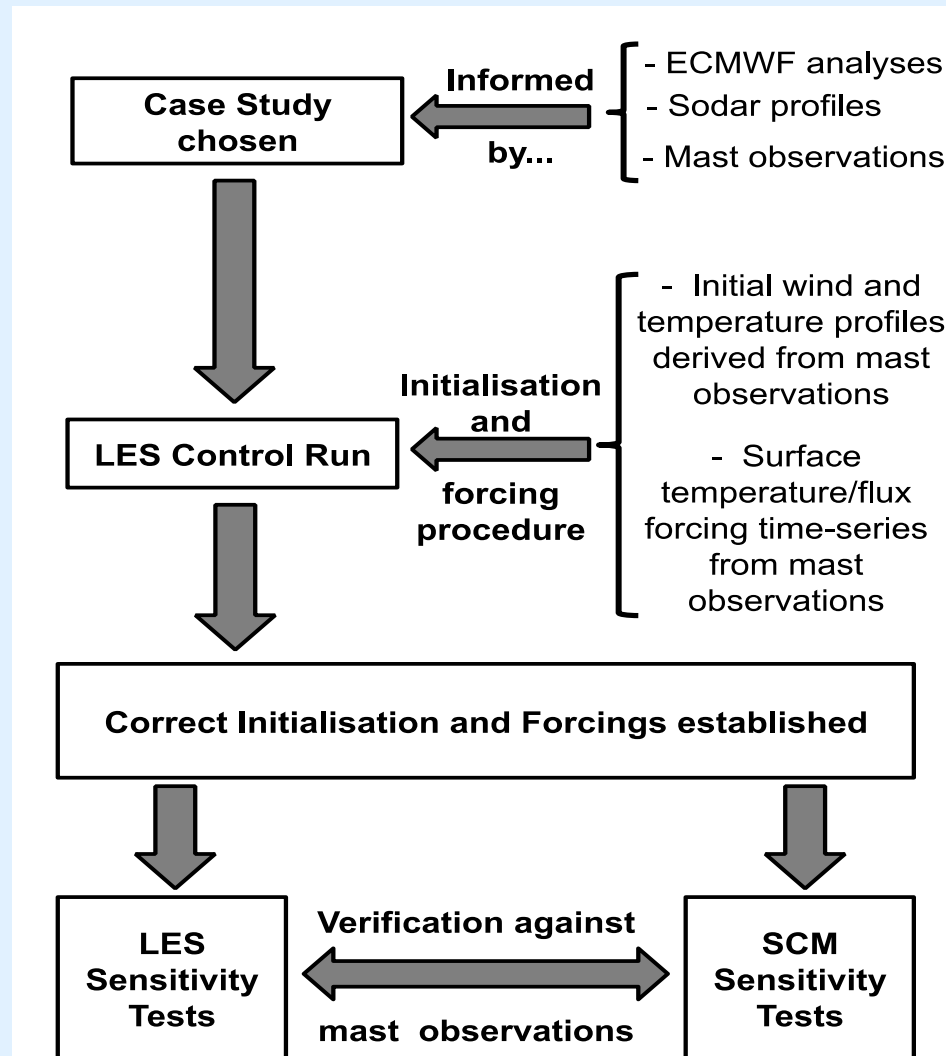
GABLS-1

Idealised arctic BL

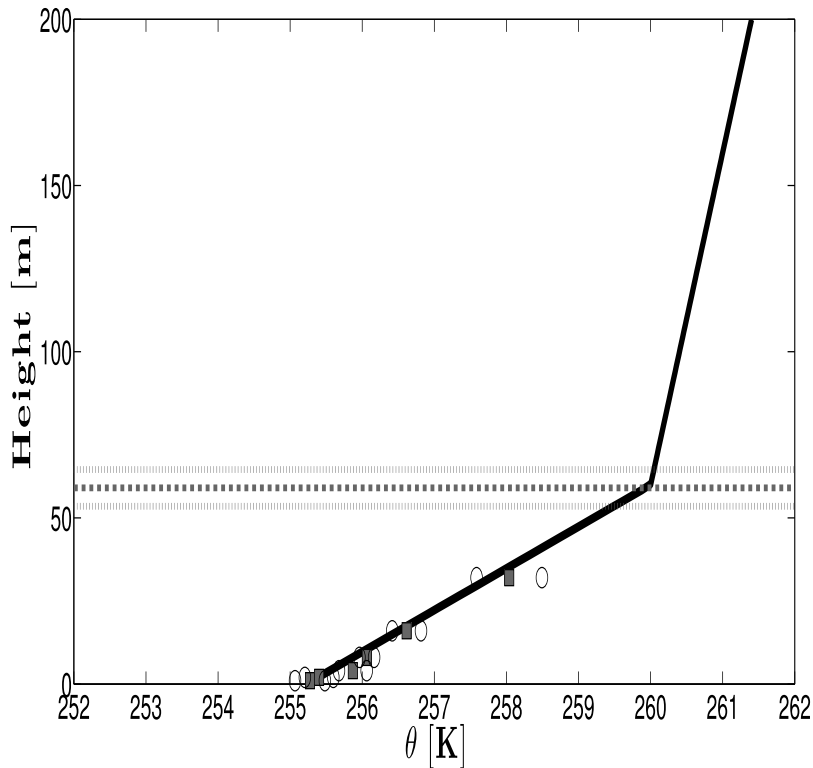
Based on SHEBA
 data.

Beare et al. 2006.

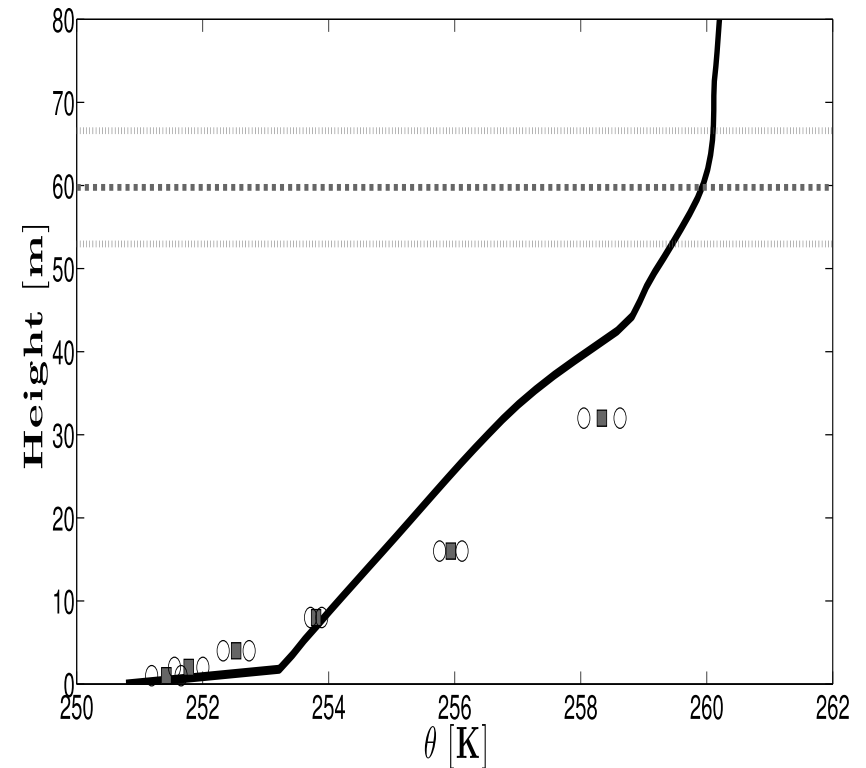
Modelling Antarctic boundary layers



Antarctic spring case (Oct 2003)

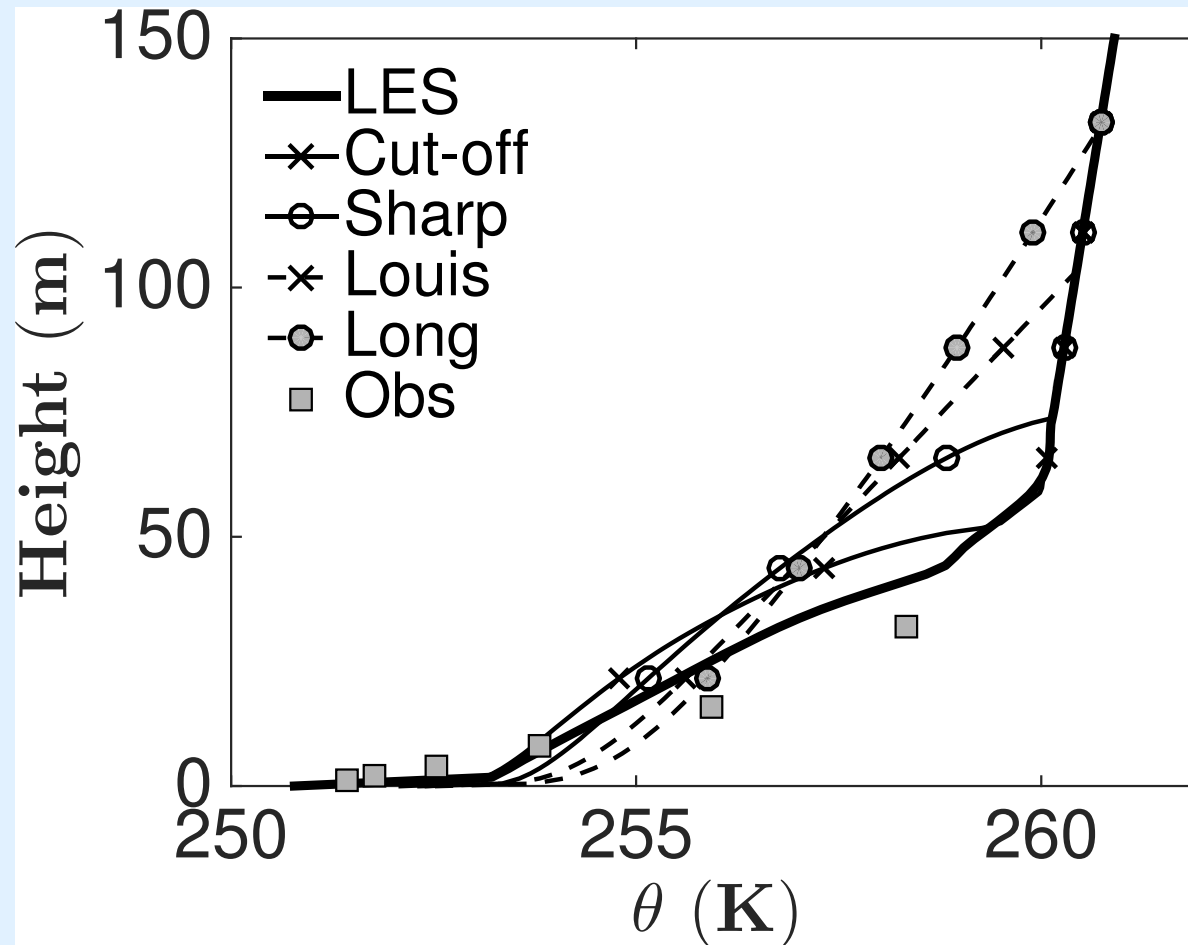


Initial potential temperature

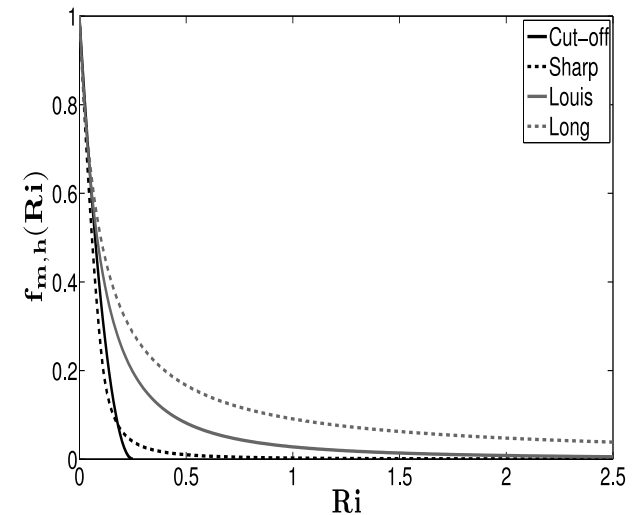


Final potential temperature
(4 h integration)

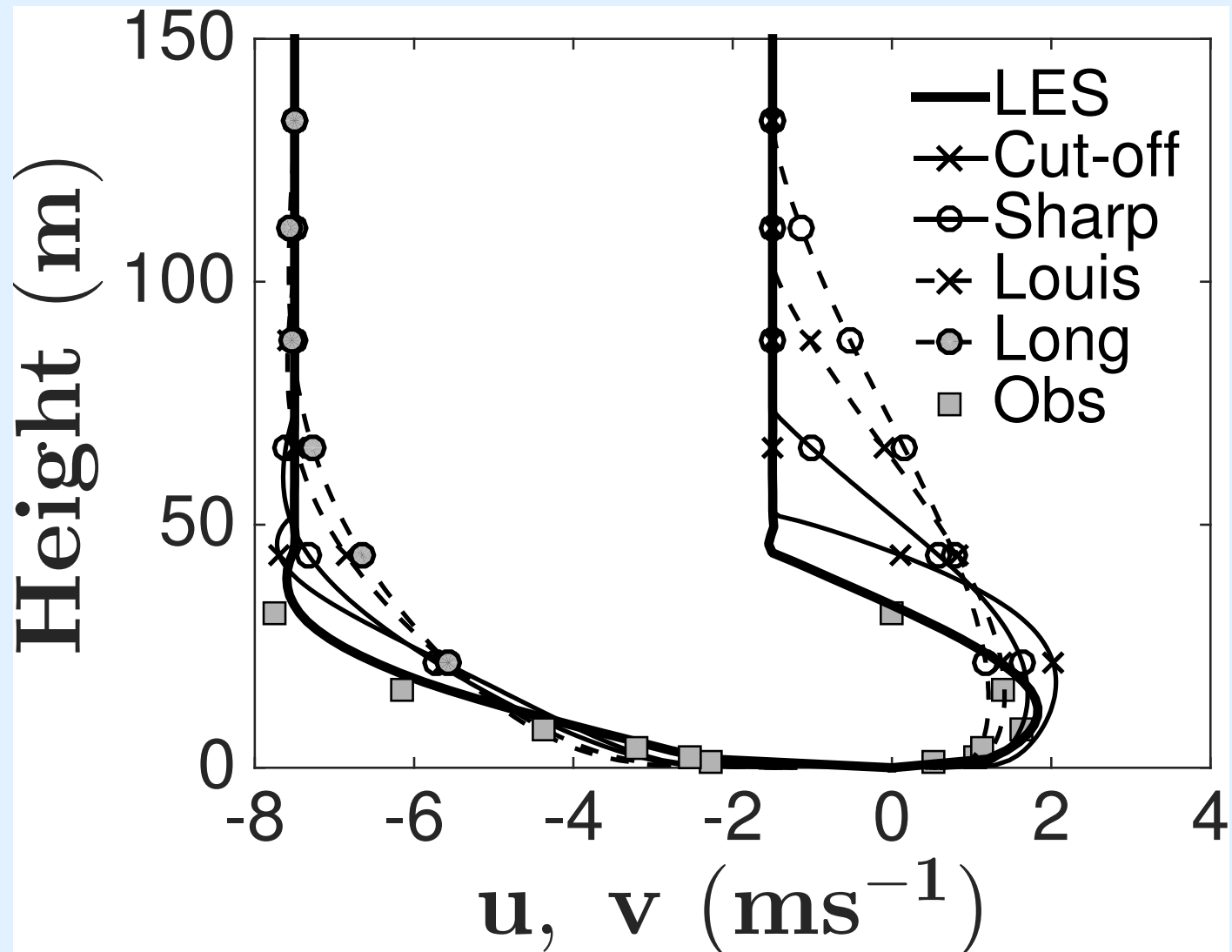
Parametrization, LES and Obs compared



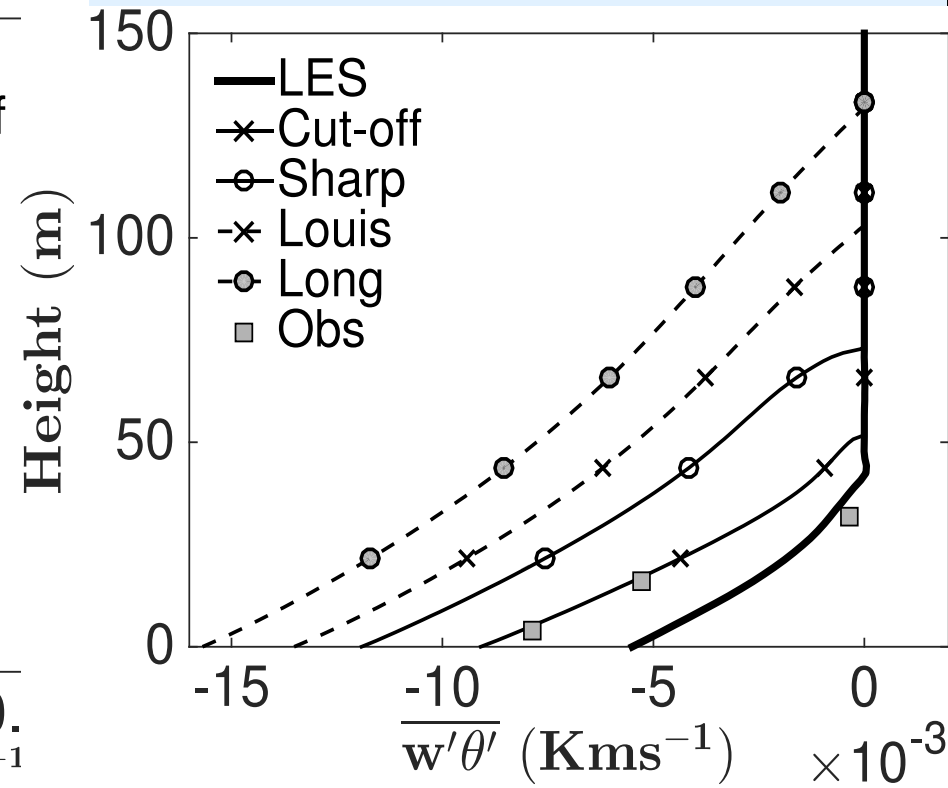
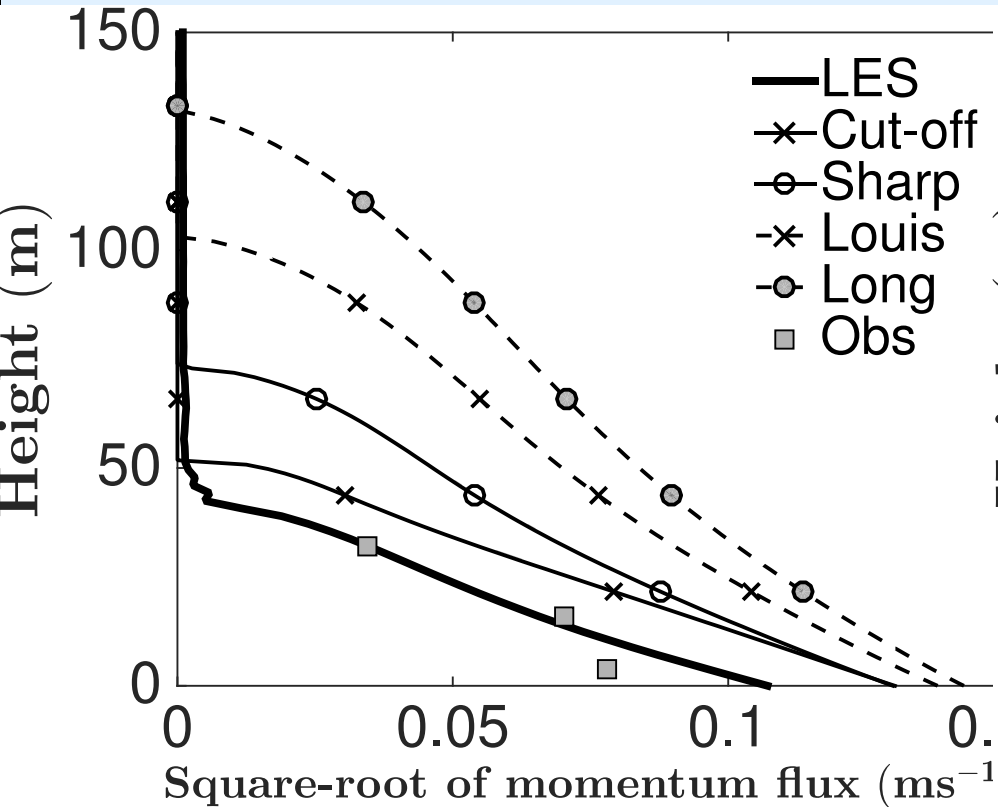
Progressively sharper tails with Ri.



Parametrization and LES winds



Vertical fluxes



Summary

- LES of observed Antarctic boundary layers support sharper-tailed stability functions
- Extensions: surface exchange, gravity waves.
- Walesby and Beare 2015 QJRMS, under review.