Constraining Latent and Sensible Heat Fluxes during Drifting and Blowing Snow Events in Antarctica using in–situ Measurements and Large–Eddy Simulations

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[2]WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland

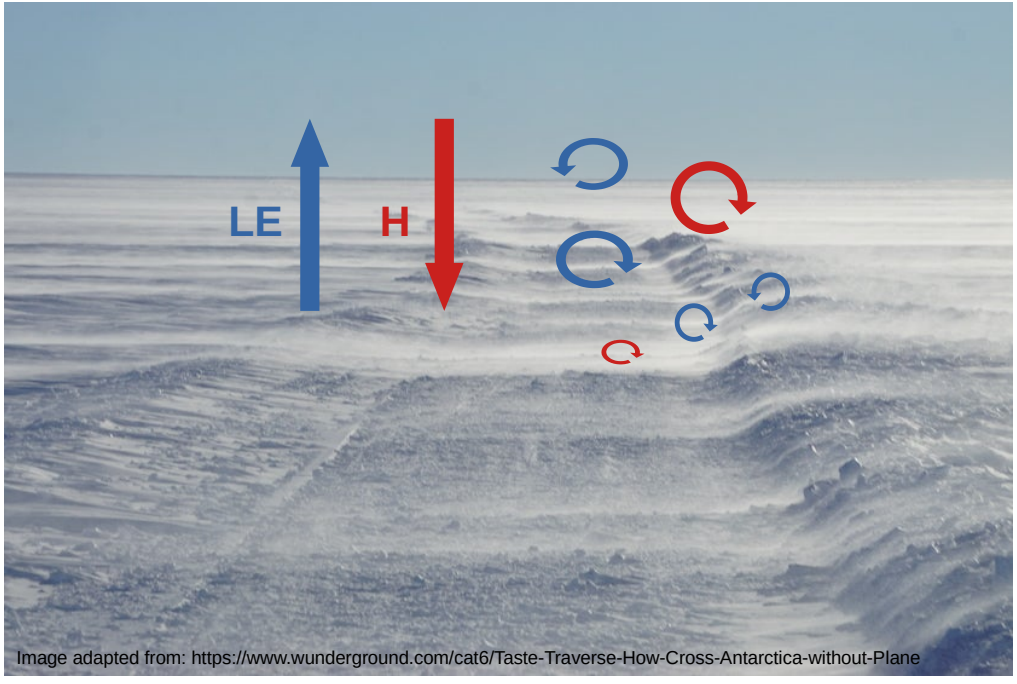
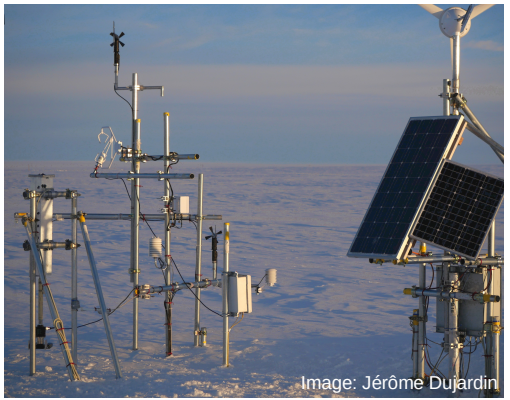


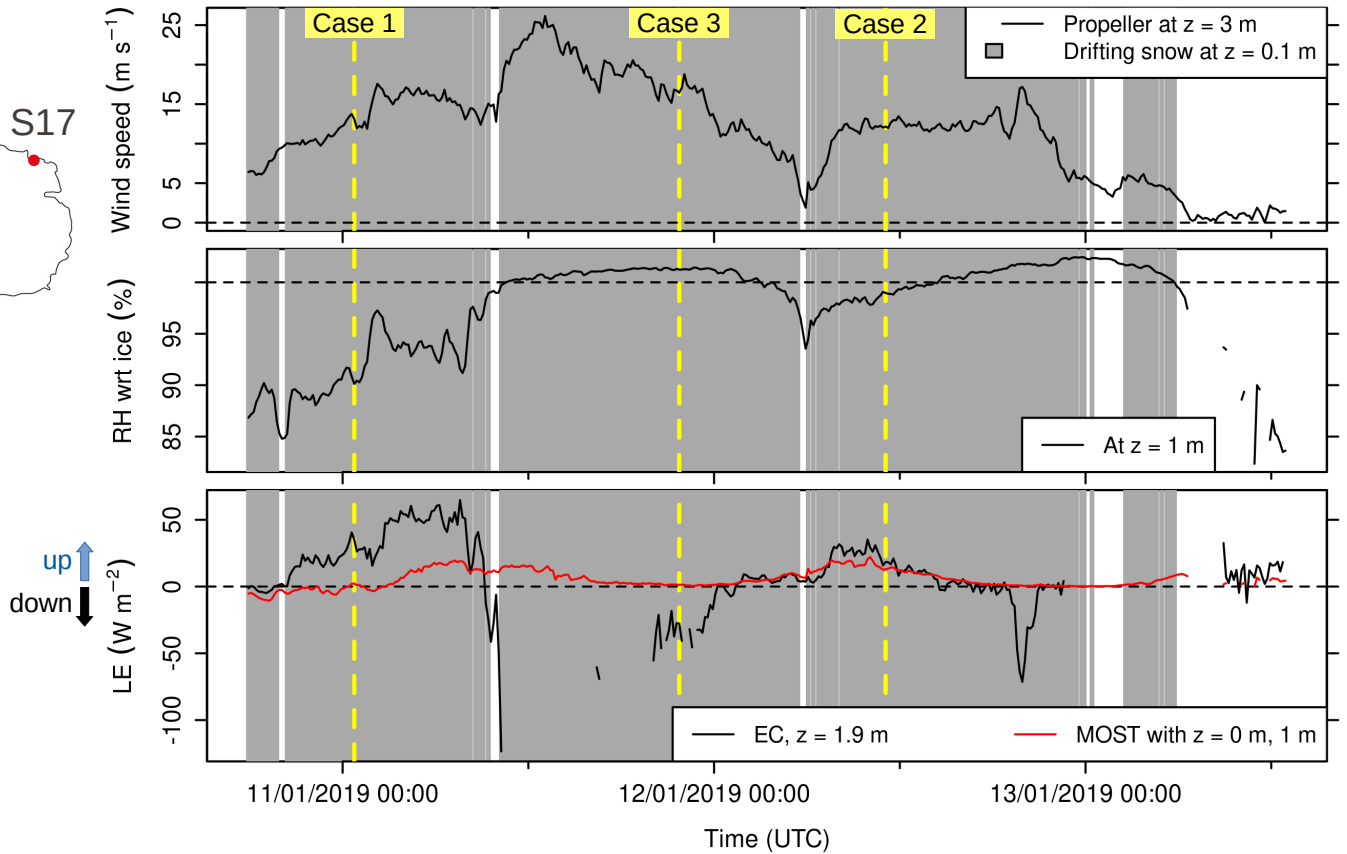
Image adapted from: https://www.wunderground.com/cat6/Taste-Traverse-How-Cross-Antarctica-without-Plane

Measurements at S17, Antarctica



- MOST bulk approach can strongly underestimate LE and H
- More on measurement uncertainties:

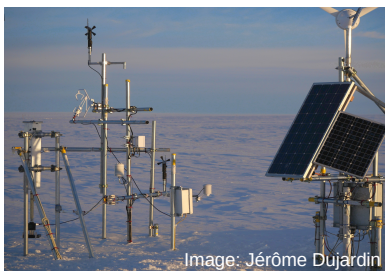
  Sigmund et al., BLM, 2021,
  doi: 10.1007/s10546-021-00653-x



Research Question

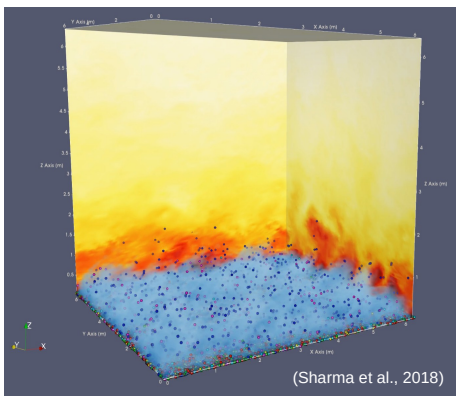
- How to validate and improve parametrizations of LE and H in conditions of drifting and blowing snow?

Measurements



Boundary conditions

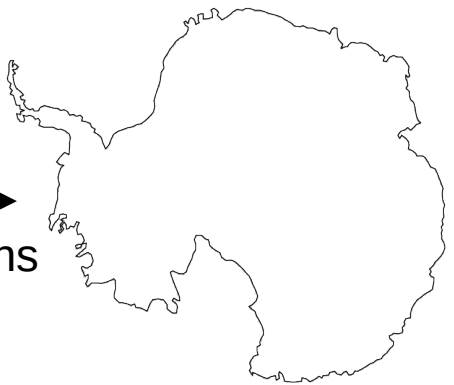
LES with Lagrangian snow particles



Domain: 38 x 19 x 18 m^3

Improved Parametrizations

Large-scale model

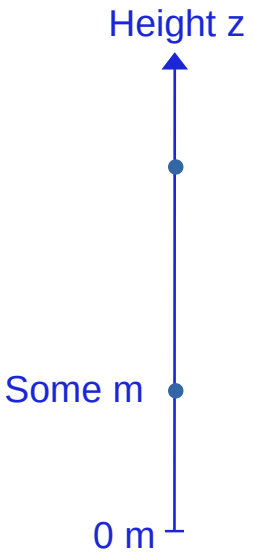


e.g., CRYOWRF
(Sharma et al., GMD, 2023)

Parametrizing LE and H with drifting snow

Existing approach:

1. Concentration and size distribution of particles
2. Transfer of moisture and heat between particle and air



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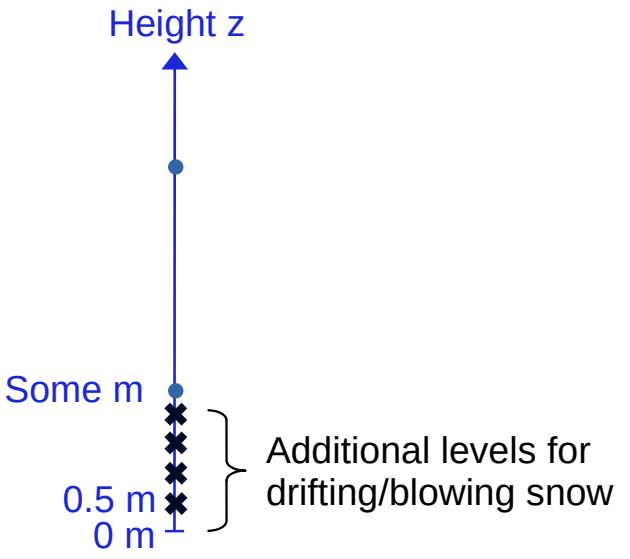
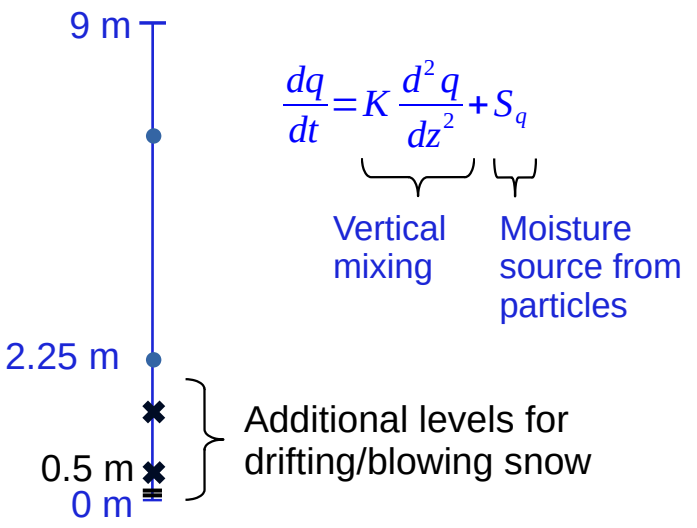


Parametrizing LE and H with drifting snow

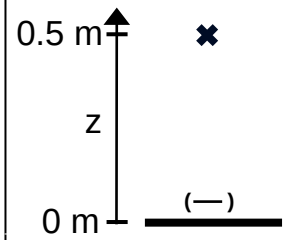
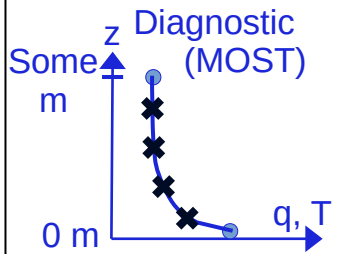
1D model:

1. Concentration and size distribution of particles

2. Transfer of moisture and heat between particle and air



Parametrizing LE and H with drifting snow

	Existing	Improvement
Discretization		
T and q near surface		
Snow particle temperature (T_p)	Thorpe-Mason (1966): $\frac{dT_p}{dt}=0$	

1D model:

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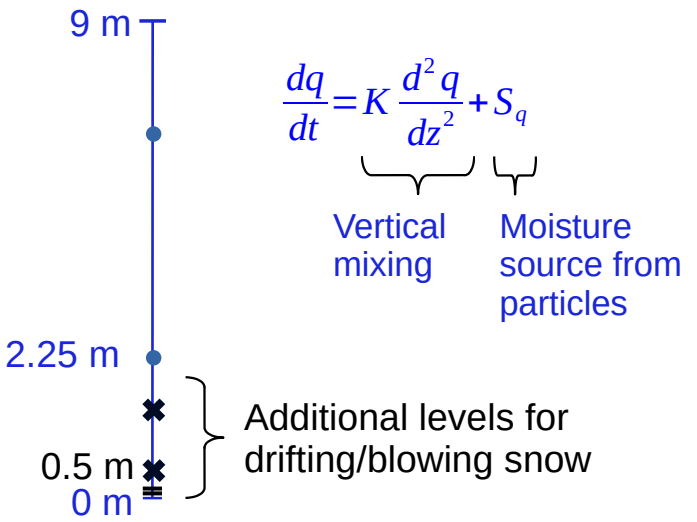

Parametrizing LE and H with drifting snow

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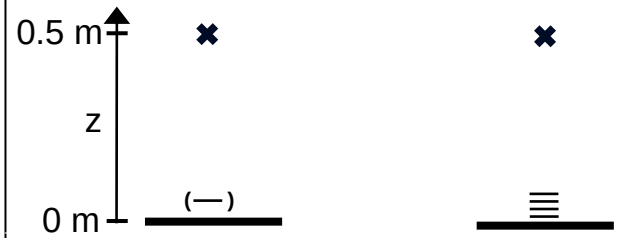
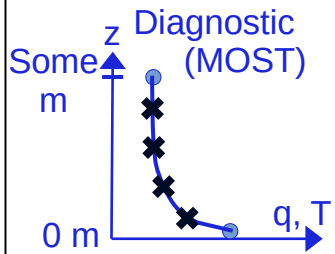
Discretization		
T and q near surface		
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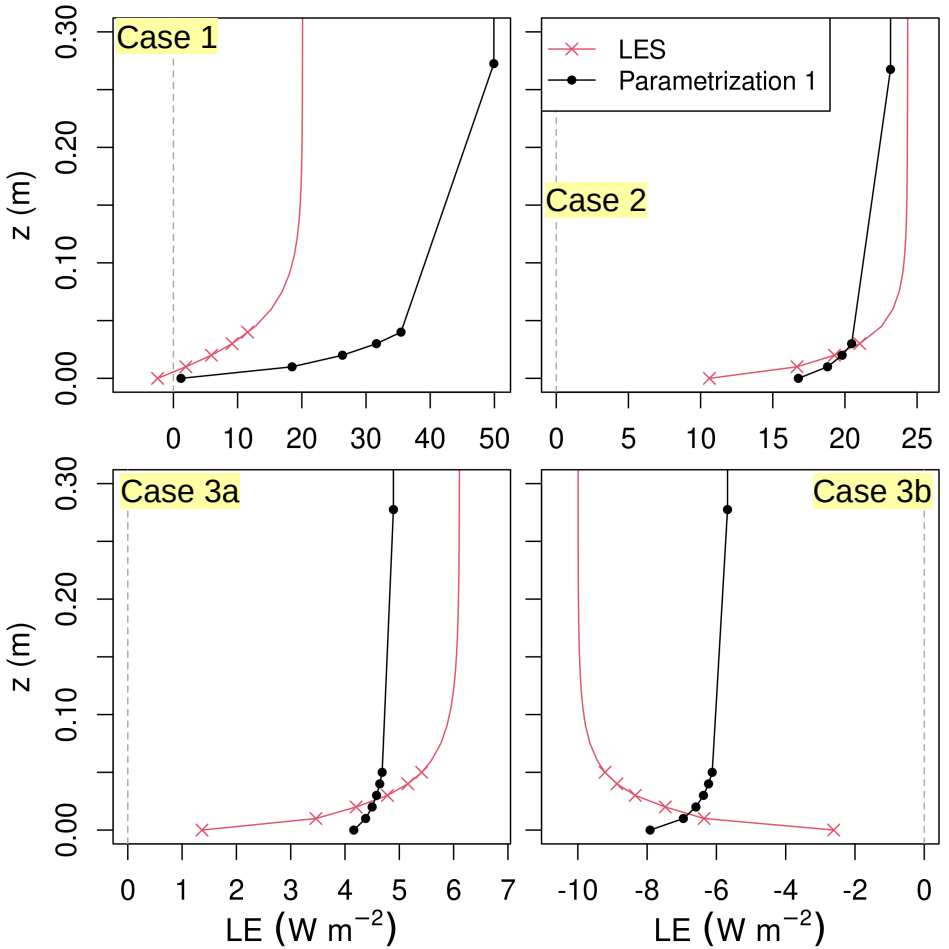

Parametrizing LE and H with drifting snow

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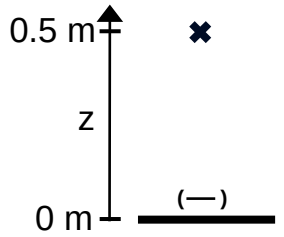
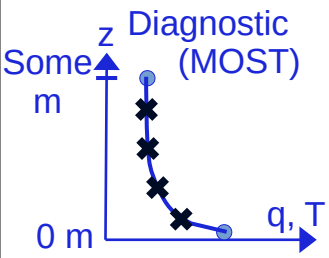
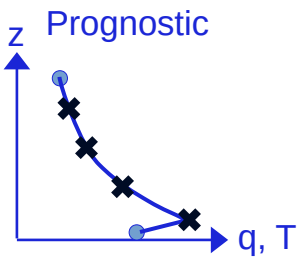
Discretization		
T and q near surface		
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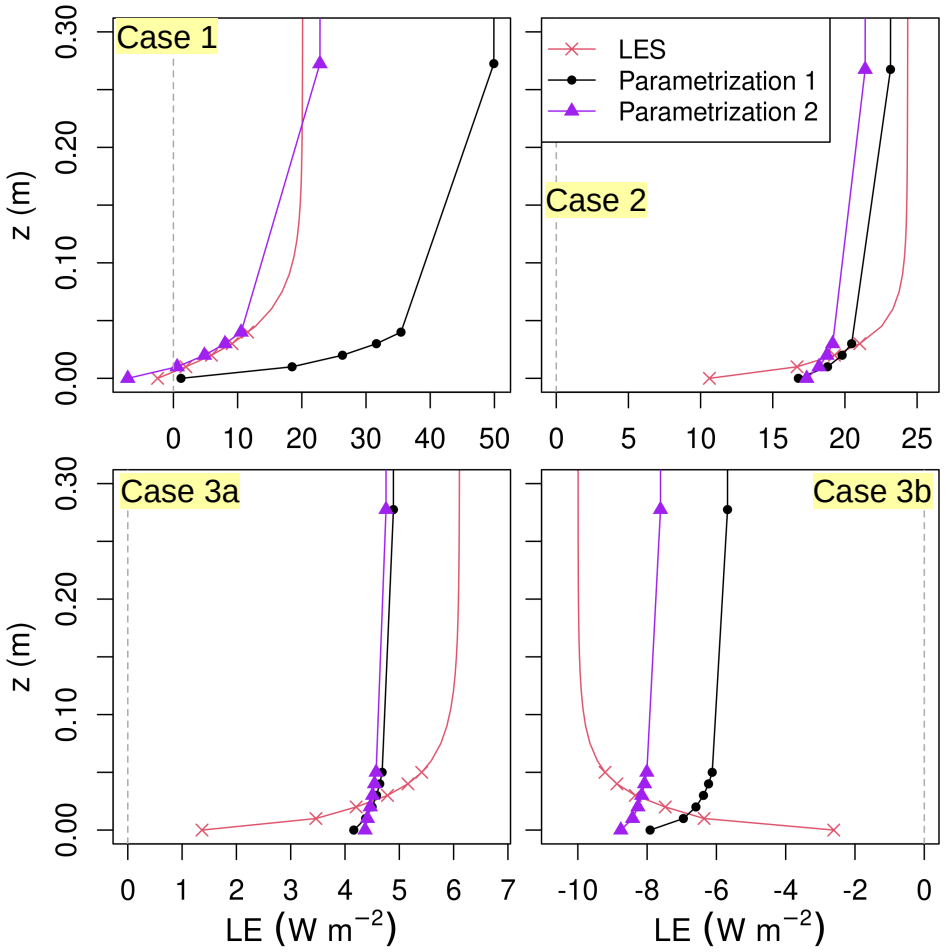

Parametrizing LE and H with drifting snow

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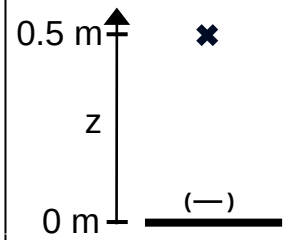
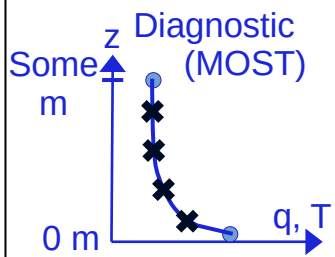
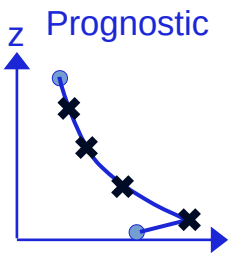
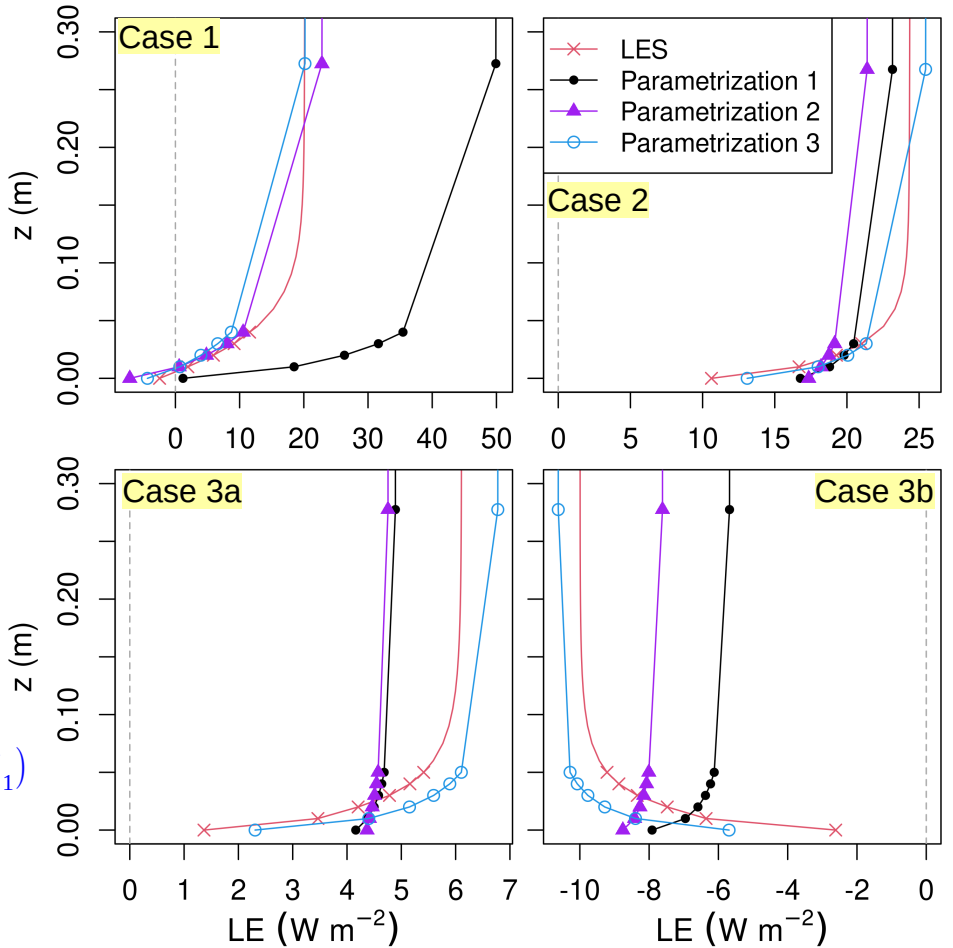
Discretization		
T and q near surface		
Snow particle temperature (T_p)	Thorpe-Mason (1966): $\frac{dT_p}{dt}=0$	$\frac{dT_p}{dt}=f\left(T_1-T_0, d_p, z, u_*, RH_1\right)$ in lowest 0.3 m



Parametrizing LE and H with drifting snow

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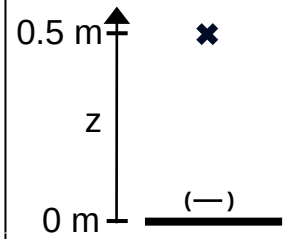
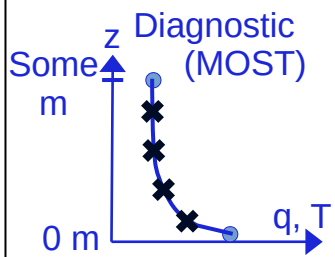
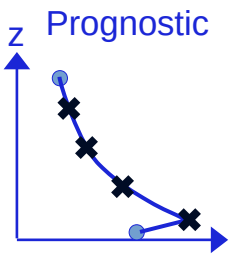
Discretization		
T and q near surface		
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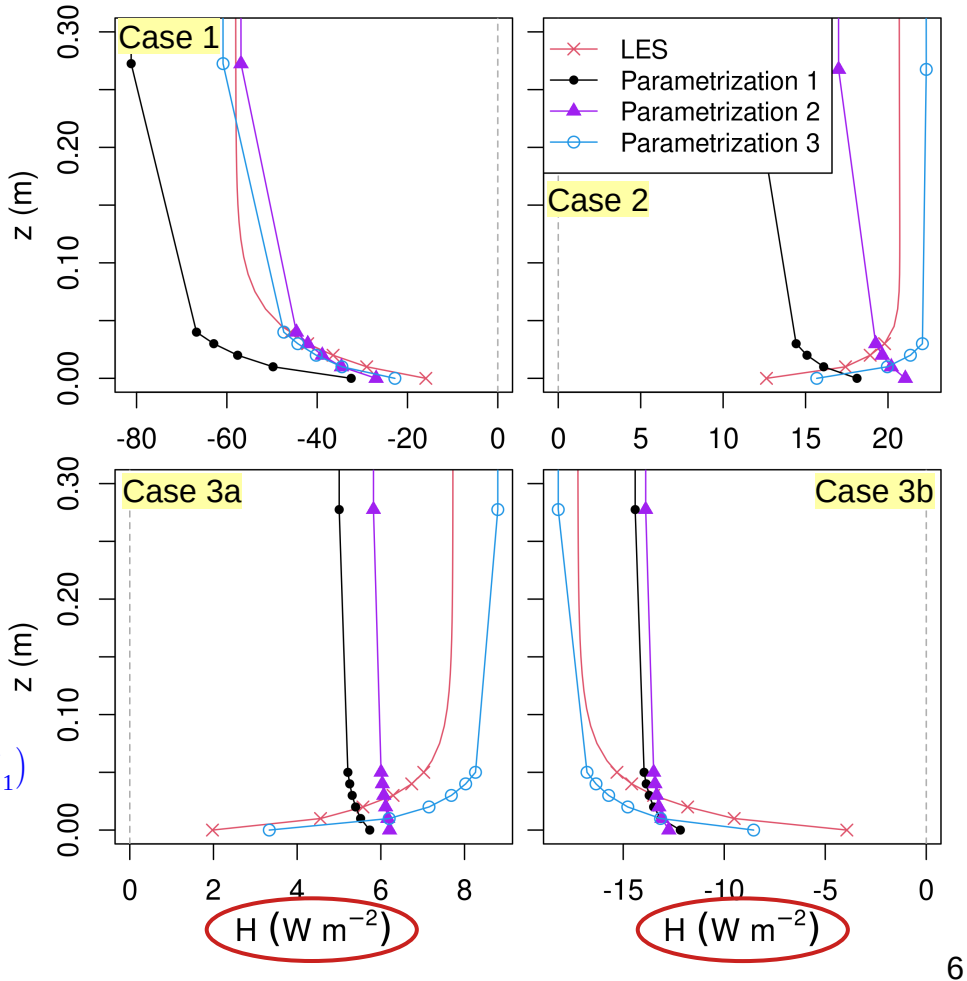
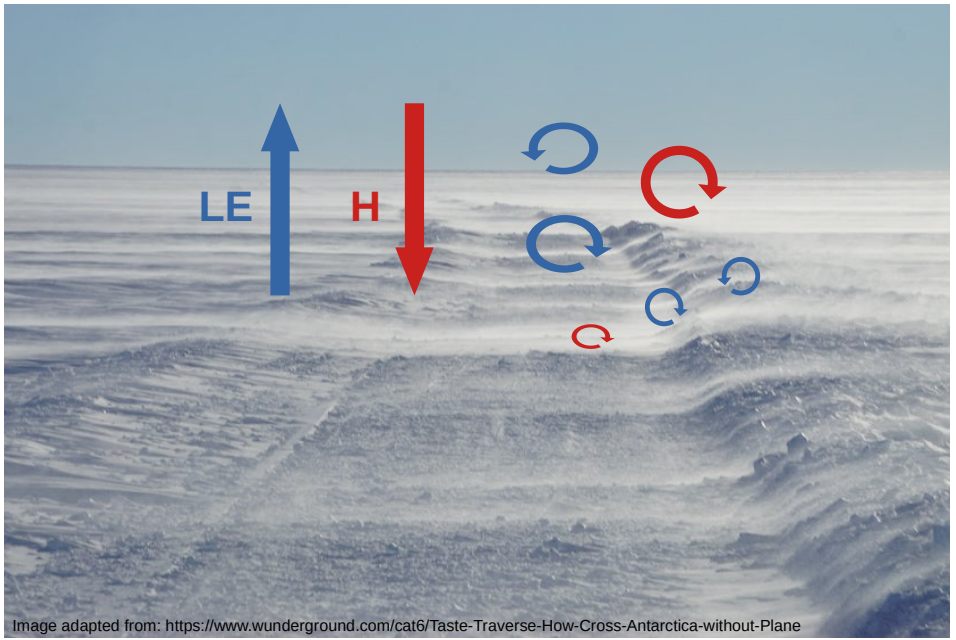


Conclusions and outlook

- Successful step towards reliable parametrizations of drifting snow effects
- Implementation in the large-scale model CRYOWRF is planned
- Parametrization of particle concentration remains to be validated



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References:

Sharma, V., Comola, F., and Lehning, M., *On the suitability of the Thorpe-Mason model for Calculating Sublimation of Saltating Snow*, The Cryosphere, 12, 3499–3509, 2018.

Sharma, V., Gerber, F., and Lehning, M., *Introducing CRYOWRF v1.0: Multiscale atmospheric flow simulations with advanced snow cover modelling,* Geoscientific Model Development, 2023, in press.

Sigmund, A., Dujardin, J., Comola, F., Sharma, V., Huwald, H., Melo, D.B., Hirasawa, N., Nishimura, K., Lehning, M., *Evidence of Strong Flux Underestimation by Bulk Parametrizations During Drifting and Blowing Snow,* Boundary-Layer Meteorol, 2021.

Thorpe, A.D. and Mason, B.J., *The evaporation of ice spheres and ice crystals,* British Journal of Applied Physics 17, 541–548, 1966.