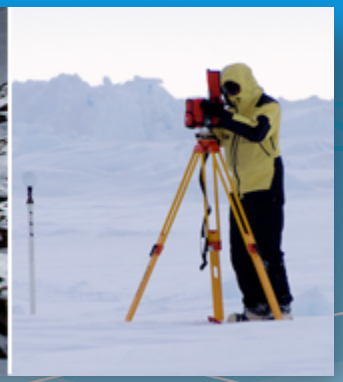

Why we don't know how much it is snowing at the three poles – and how we can learn it

Michi Lehning et al.

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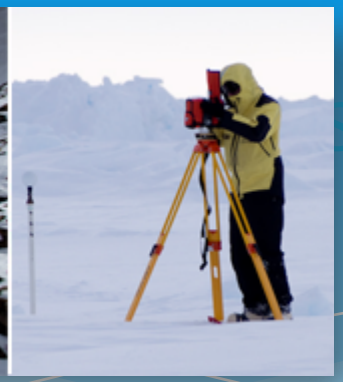

CRYOS
Cryospheric Sciences

SLF

Varun Sharma, Fränzi Gerber, Eric Sauvageat, Francesco Comola, Philip Crivelli, Christian Sommer, Hendrik Huwald, Nander Wever

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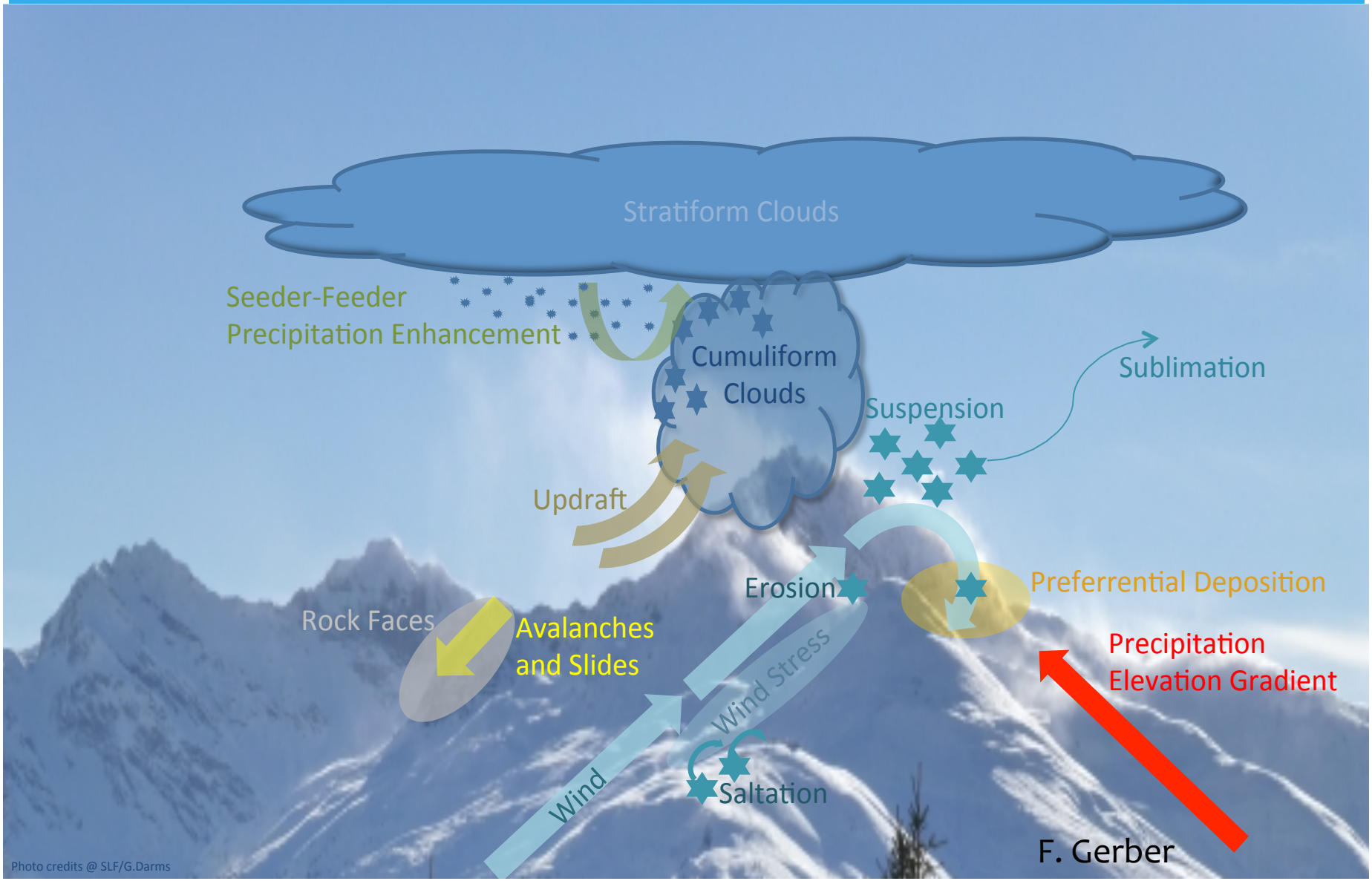
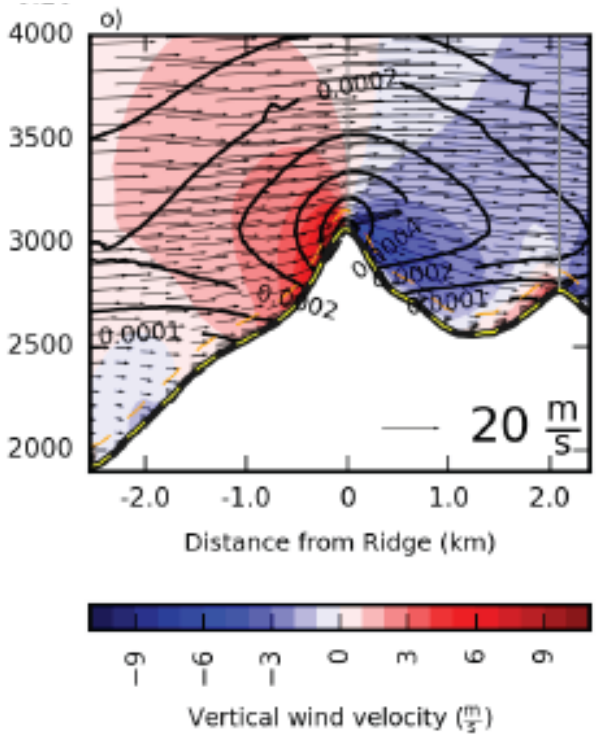
Introduction: From Clouds to Ground

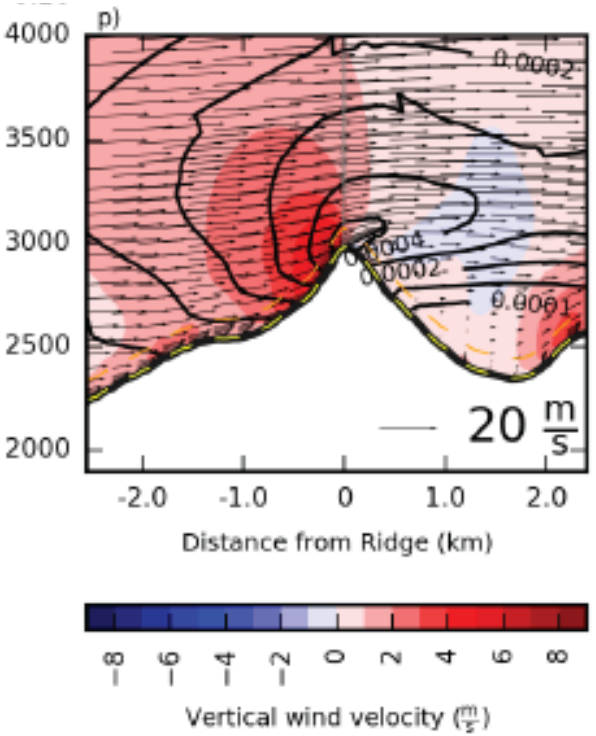


WRF – Simulations of Snow Depositions

Schwarzhorn



Bocktenhorn



Gerber et al., J. Hydrometeorology, 2018

Vertical wind velocity shows strong variations with effects on cloud dynamics and particle movement

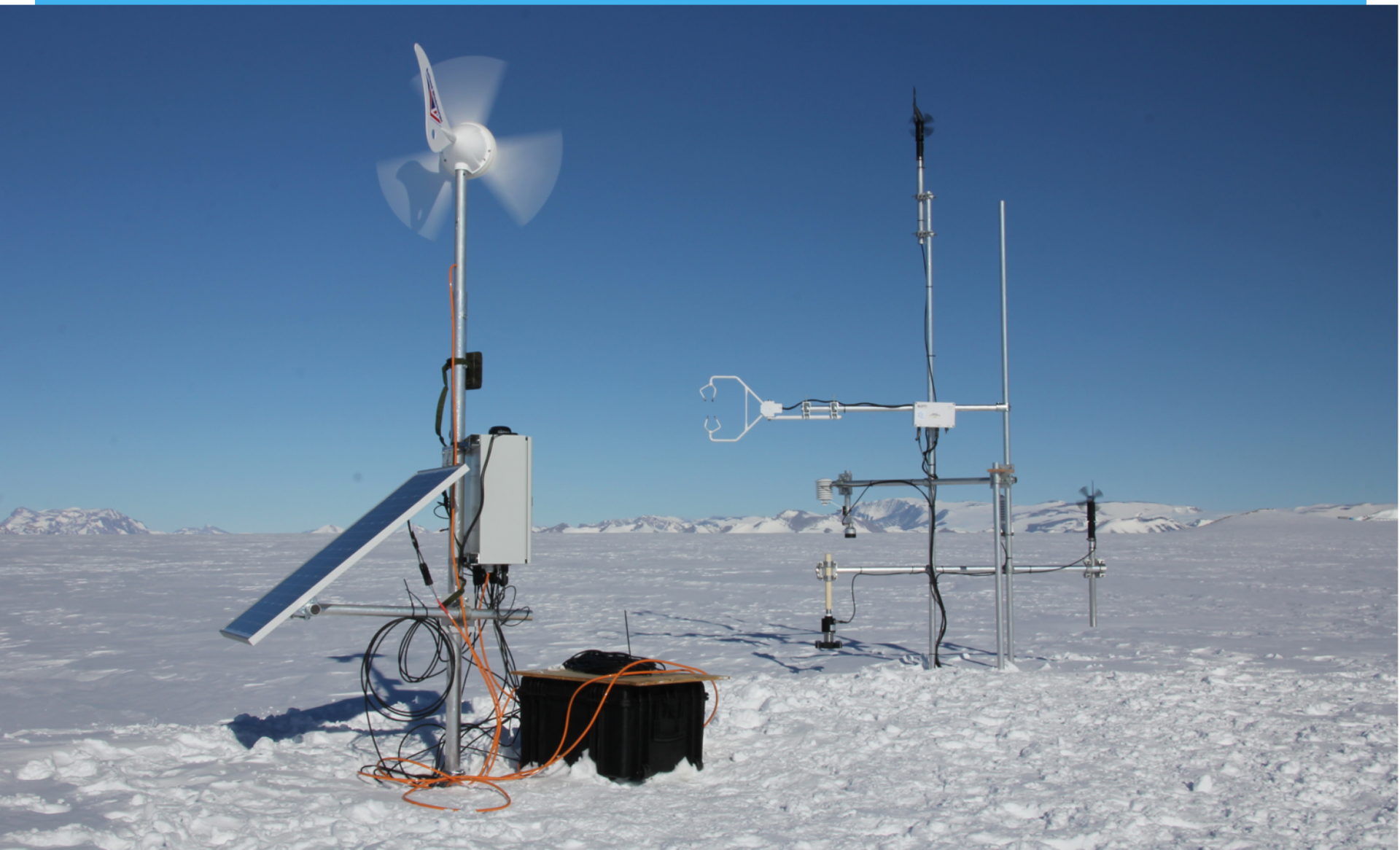
Problem(s) Statement

-> Make a link between measured snow distribution and precipitation

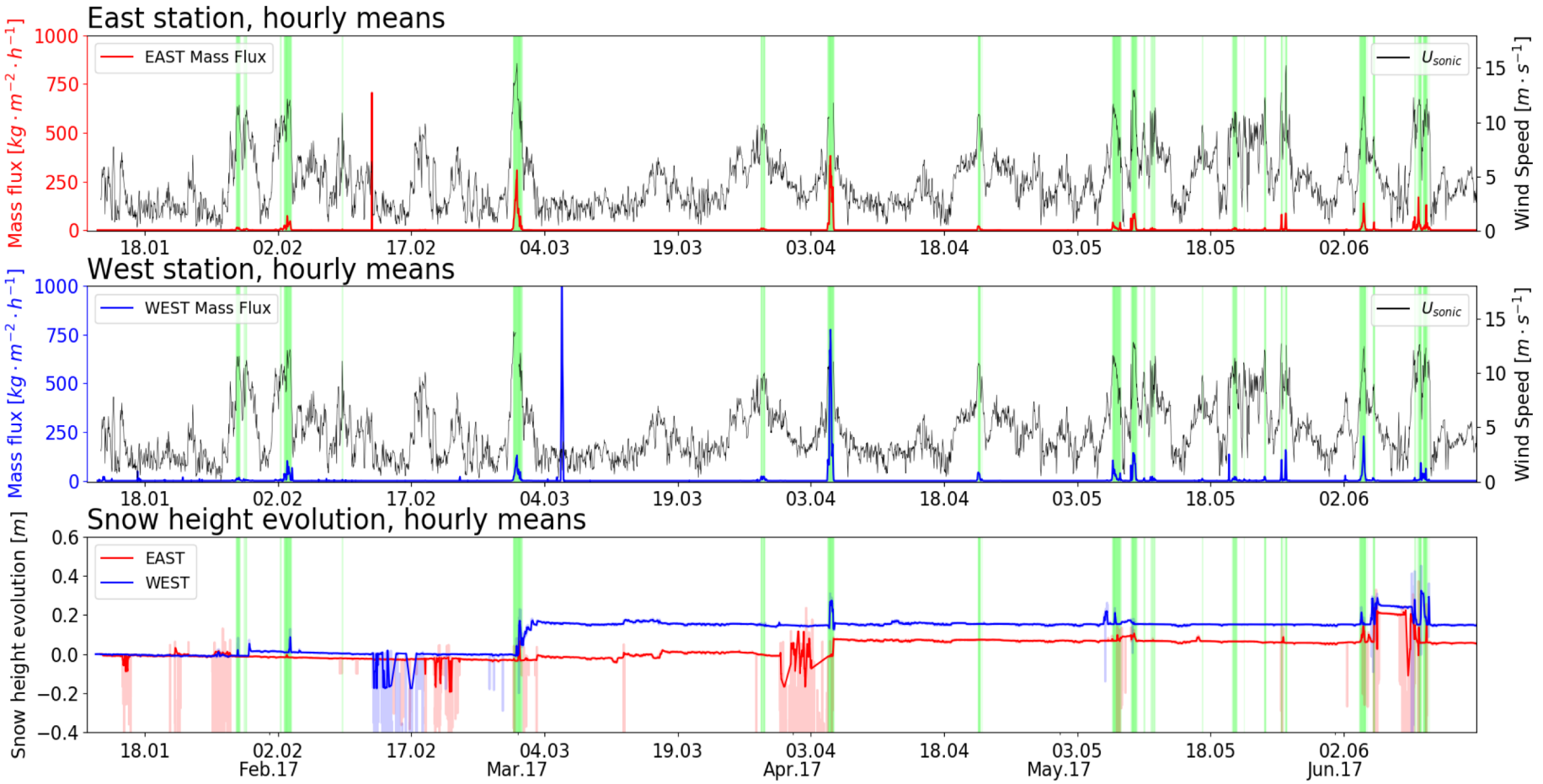
- Drifting and blowing snow is highly non-linear
- Sublimation losses are poorly constrained
- Mass «export» poorly constrained
- Snow deposition not understood

-> Let's look at the physics

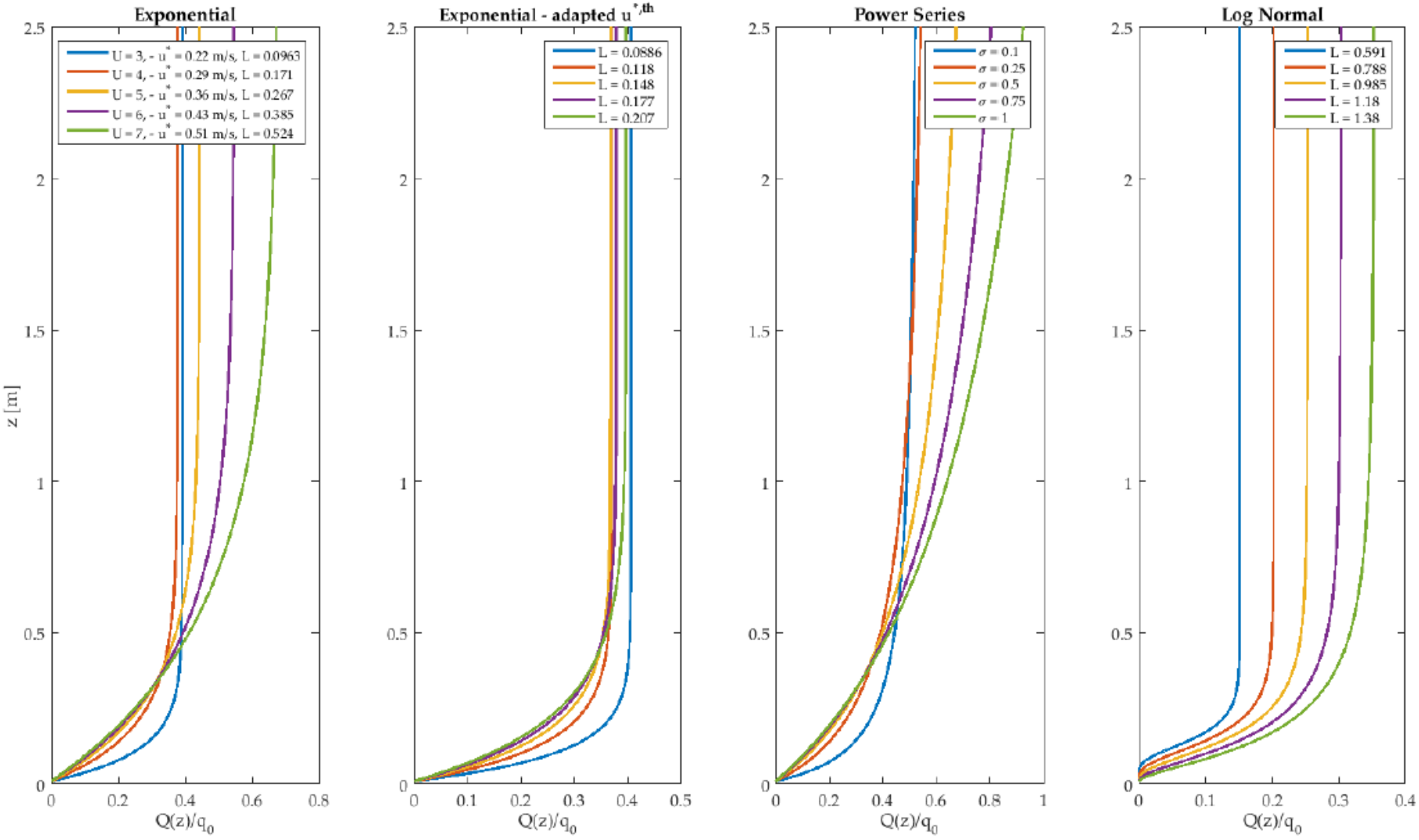
The Stations @ PEA



Mass Flux Measurements



Eric Sauvageat, Hendrik Huwald


Exponential
U = 3, - u* = 0.22 m/s, L = 0.0963
U = 4, - u* = 0.29 m/s, L = 0.171
U = 5, - u* = 0.36 m/s, L = 0.267
U = 6, - u* = 0.43 m/s, L = 0.385
U = 7, - u* = 0.51 m/s, L = 0.524
z [m]
Q(z)/q0
Exponential - adapted u*,th
L = 0.0886
L = 0.118
L = 0.148
L = 0.177
L = 0.207
Q(z)/q0
Power Series
σ = 0.1
σ = 0.25
σ = 0.5
σ = 0.75
σ = 1
Q(z)/q0
Log Normal
L = 0.591
L = 0.788
L = 0.985
L = 1.18
L = 1.38
Q(z)/q0

Full Physics in an LES Model

NUMerical solution

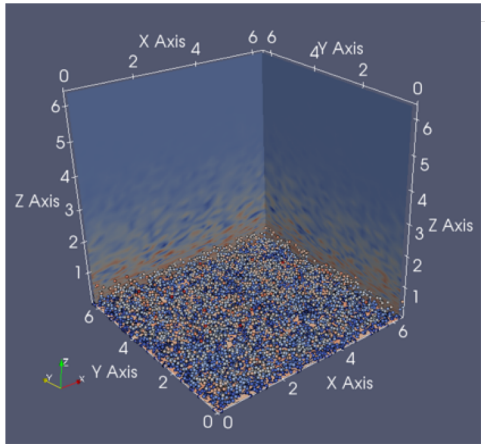
$$\frac{\mathrm{d}m_p}{\mathrm{d}t} = \pi \mathcal{D} d_p \rho_f \left(\widetilde{q} - q_{p,surface}\right) Sh$$

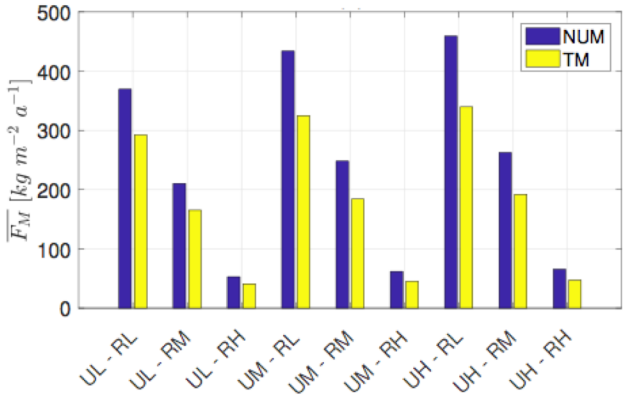
$$c_i\, m_p \frac{\mathrm{d}T_p}{\mathrm{d}t} = L_s \frac{\mathrm{d}m_p}{\mathrm{d}t} + \pi \mathcal{K} d_p \left(\widetilde{\theta} - T_p\right) \mathcal{N}u$$

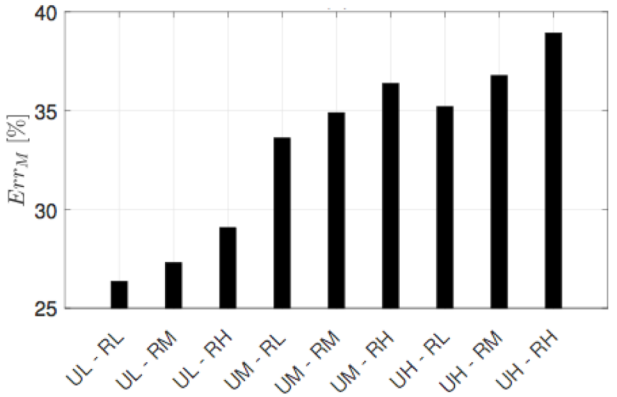
Thorpe and Mason (TM) model

$$\frac{\mathrm{d}m_p}{\mathrm{d}t} = \frac{\pi d_p \left(\sigma_* - 1\right)}{\left(\frac{L_s}{\mathcal{K} T_{a,\infty} \mathcal{N}u}\left(\frac{L_s M}{R T_{a,\infty}} - 1\right) + \frac{1}{\mathcal{D}\rho_s(T_{a,\infty}) Sh}\right)}$$

$$L_s \frac{\mathrm{d}m_p}{\mathrm{d}t} = -\pi \mathcal{K} d_p \left(\widetilde{\theta} - T_p\right) \mathcal{N}u$$







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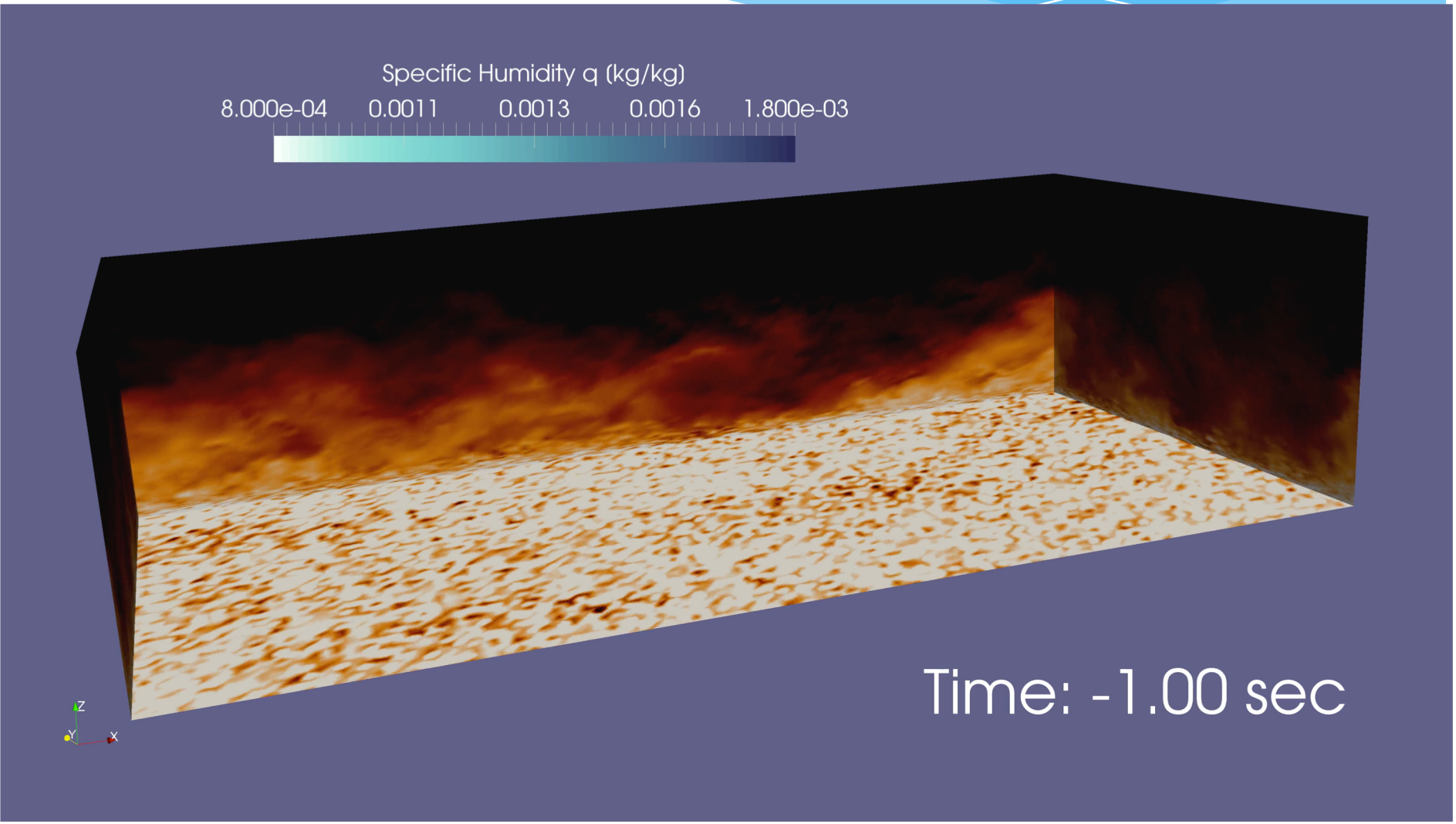
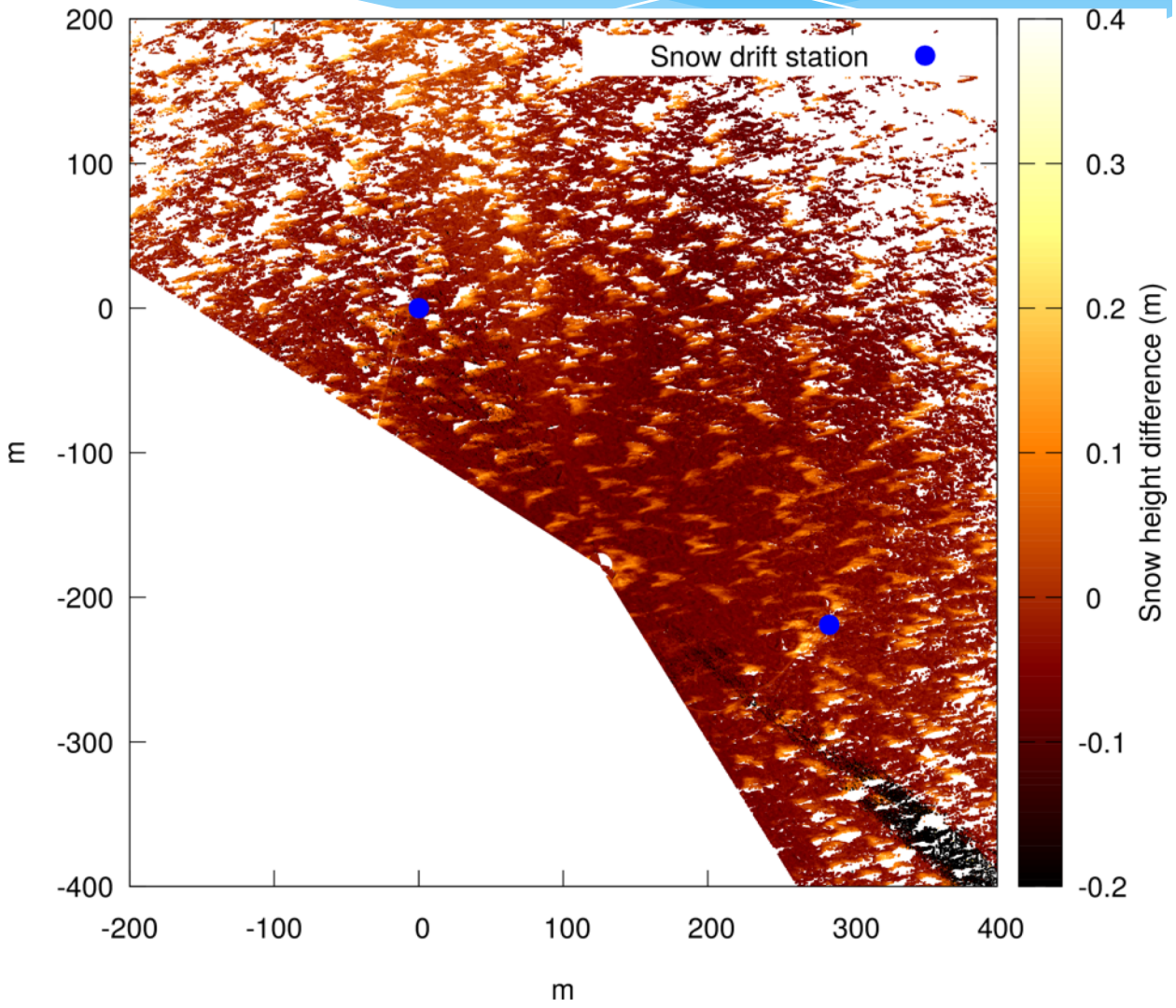
Varun Sharma, Francesco Comola

Non-Equilibrium Sublimation Physics in an LES Model



Snow Deposition in Antarctica (PEA)



It is all Barchan Dunes:

- Snow Immobilization
- Sublimation
- Precipitation
- Surface Mass Balance

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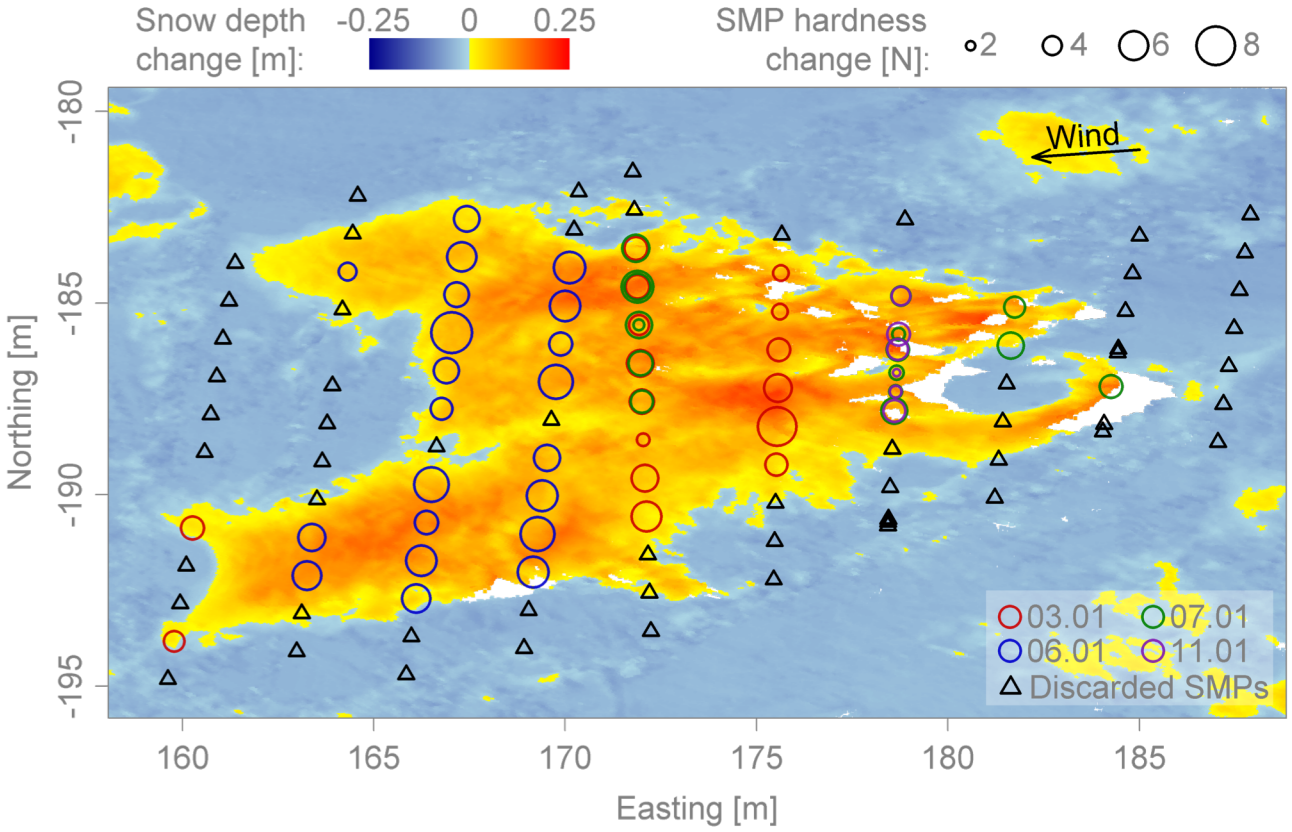
Surface Features and Hardening

Deposition of Snow in Antarctica:

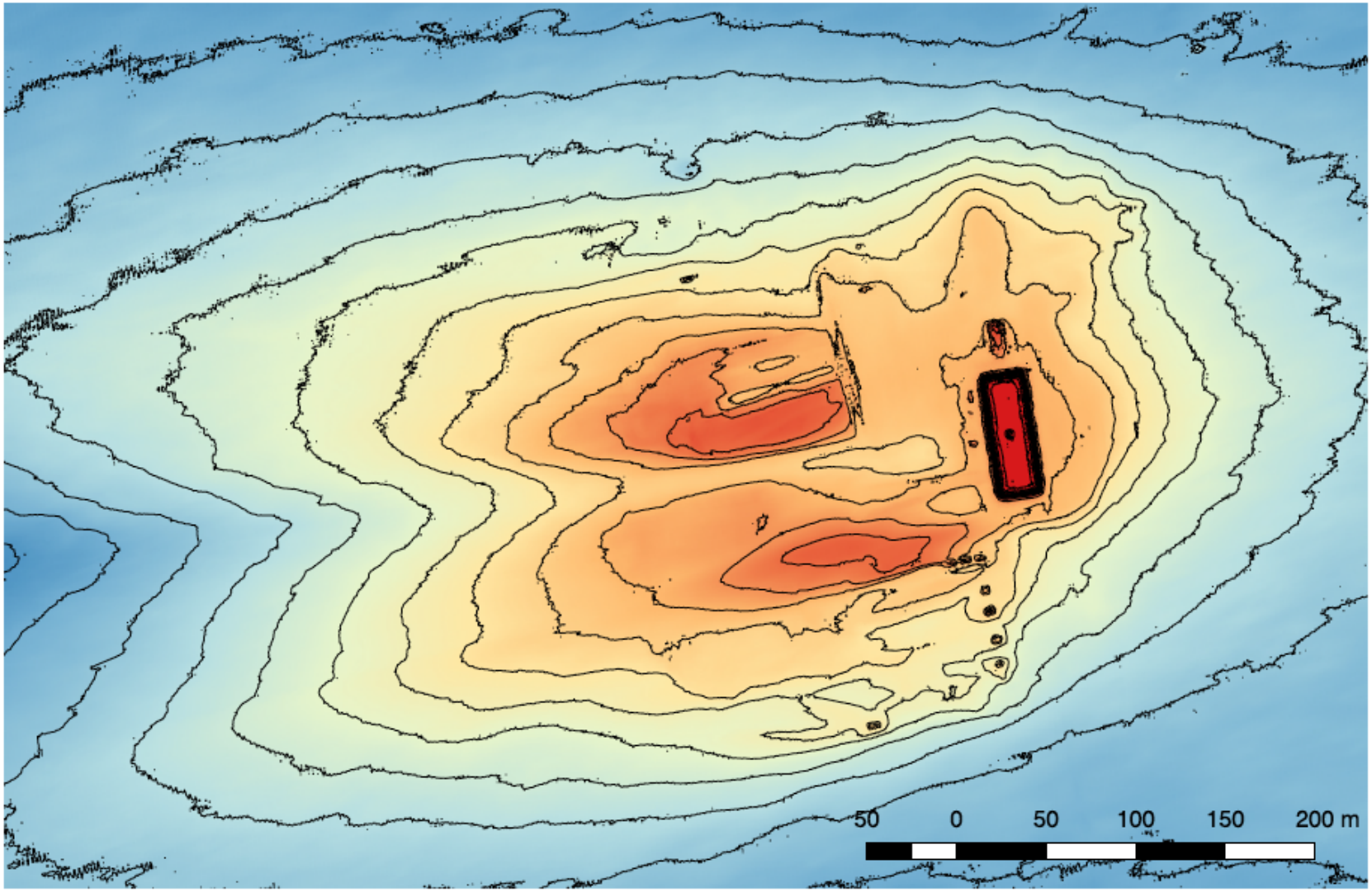
- Initial Deposition is soft
- No hardening without drifting
- Hardening at wind-exposed locations only
- Spatial hardening pattern not fully explained yet



Conclusions - Outlook

* Non – linear processes between “clouds and ground” introduce a large uncertainty in large-scale modelling and prediction
* Progress in disentangling processes is being made and leads to an increase in quantitative understanding
* Upscaling from single (snow) particle dynamics to snow distribution is slowly happening
* **Link to (Model) precipitation is the current challenge**

Snow Deposition Problem @ Neumayer III



OSC Presentations

* From the Clouds to the Ground - Snow Precipitation Patterns in Complex Terrain | **Wednesday** 09:00 | Presenter: Gerber, Franziska
* Local Surface Mass and Energy Balance Processes in East Antarctica | **Friday** 09:00 | Presenter: Huwald, Hendrik
* The Role of Particle Cohesion in the Wind-driven Erosion of Snow | **Friday** 09:00 | Presenter: Comola, Francesco
* Revisiting the Thorpe-Mason model for calculating sublimation of saltationg snow | **Friday** 09:00 | Presenter: Sharma, Varun
* Wind-packing of Snow in Antarctica | **Wednesday** 17:30 | Presenter: Sommer, Christian