Modeling Snow Distribution with ALPINE3D and Parameterization of Wind Driven Processes for Use in Other Applications

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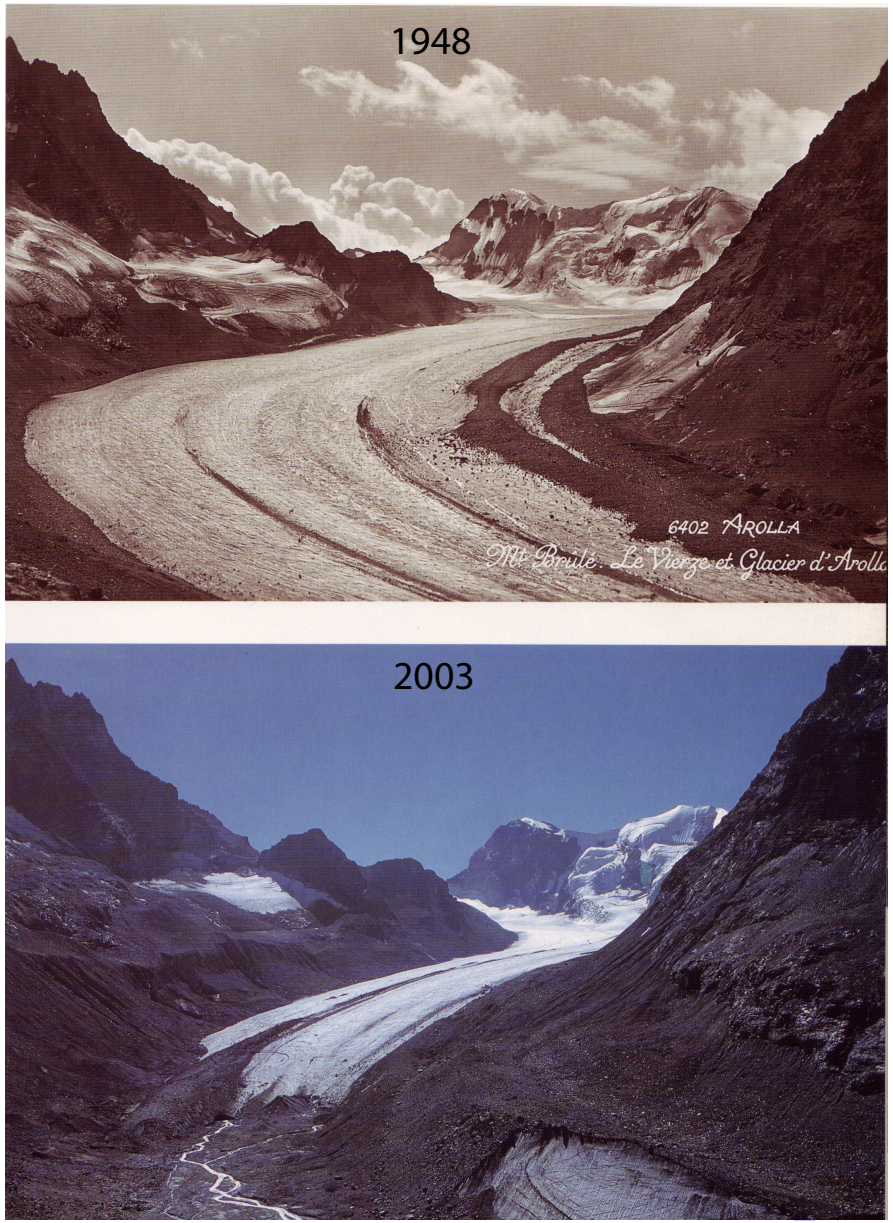
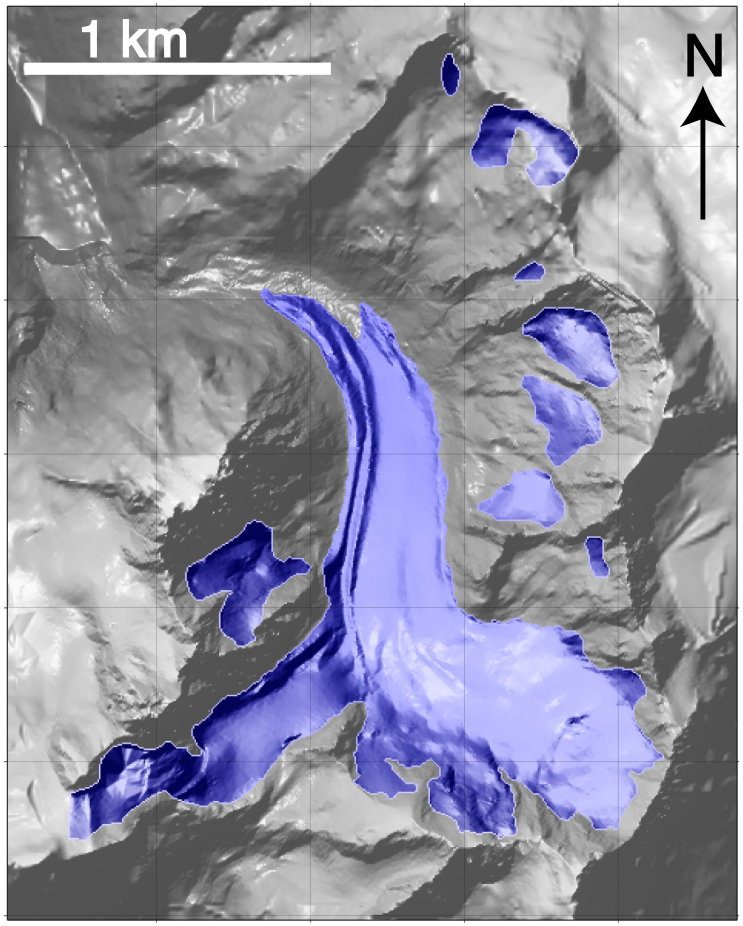
Outline: Snow Accumulation in Complex Terrain?

* Local wind fields.
* Wind driven accumulation processes using APLINE3D.
* Validation with snow depth estimation using helicopter borne LIDAR.

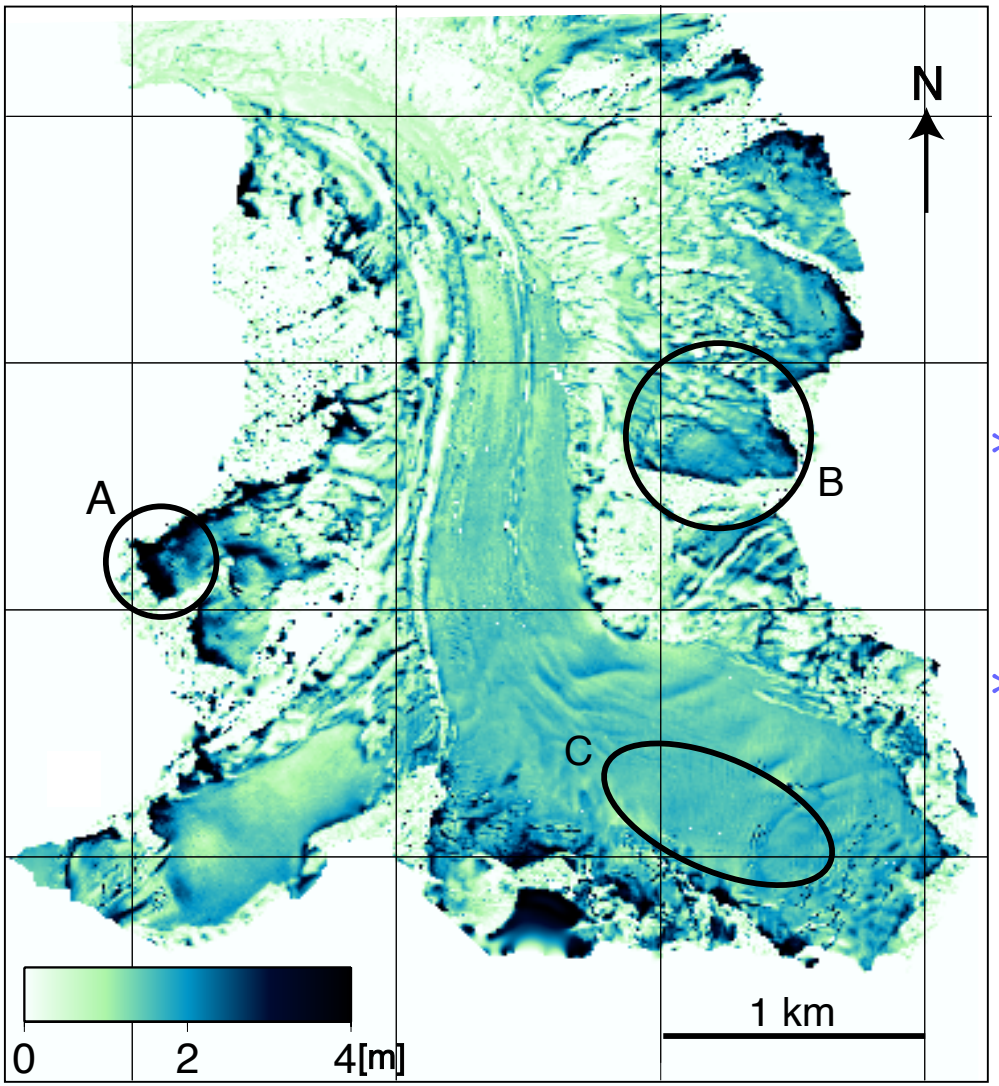

1948
6402 AROLLA
Mt Brulé - Le Vierge et Glacier d'Arolla
2003

The Study Site: Haut Glacier d'Arolla



* Catchment area: 13 km^2.
* Glaciated area (blue): 5.3 km^2.
* Main glacier: 4.4 km^2
  'small glaciers': 0.9 km^2.
* Elevation Range: 2500–3800 m.a.s.l.

Snow Depth Measurements with LIDAR



* Snow depth distribution from LIDAR measurements: October 2006, May 2007.
* Height accuracy: 10–15 cm.

Local Wind Fields in Complex Topography

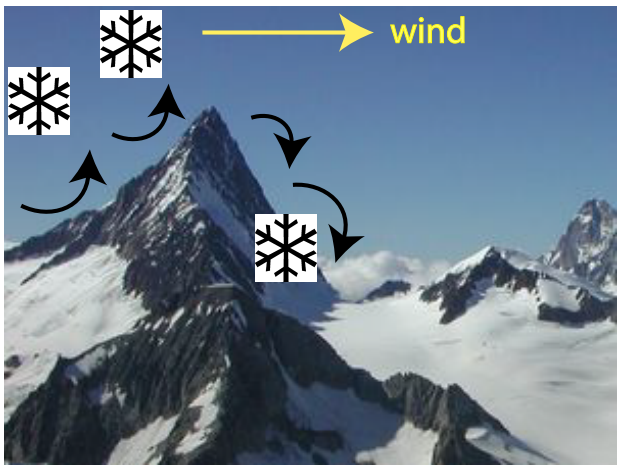
- Mesoscale atmospheric model ARPS (Advanced Regional Prediction System).
- Horizontal resolution 30 m.
- Topographic smoothing in order to obtain slopes $< 50°$.
- Modeling main wind directions 

with different wind speeds.

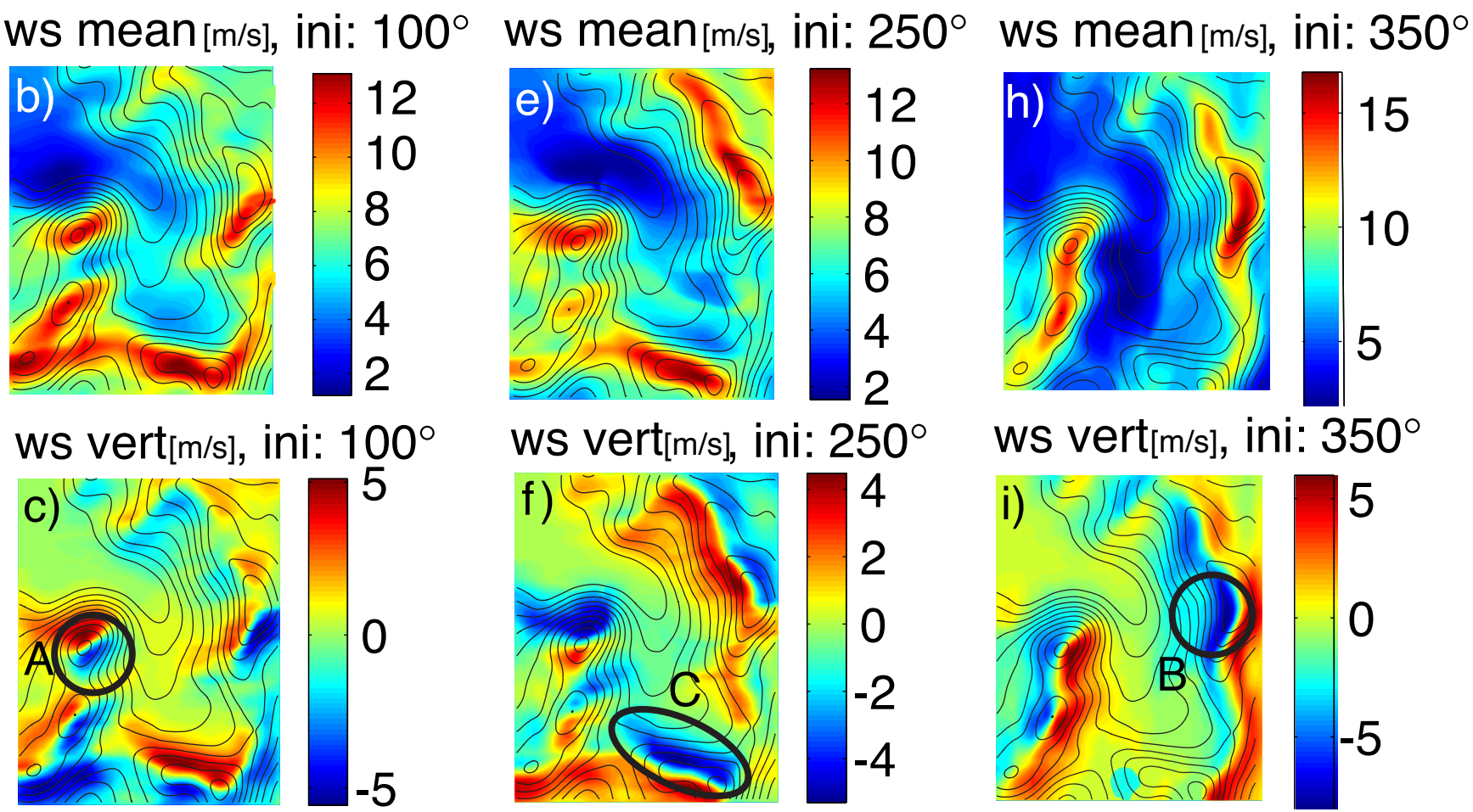
Modeling of Wind Driven Snow Distribution

Snow distribution modeling using ALPINE3D for typical wind fields:

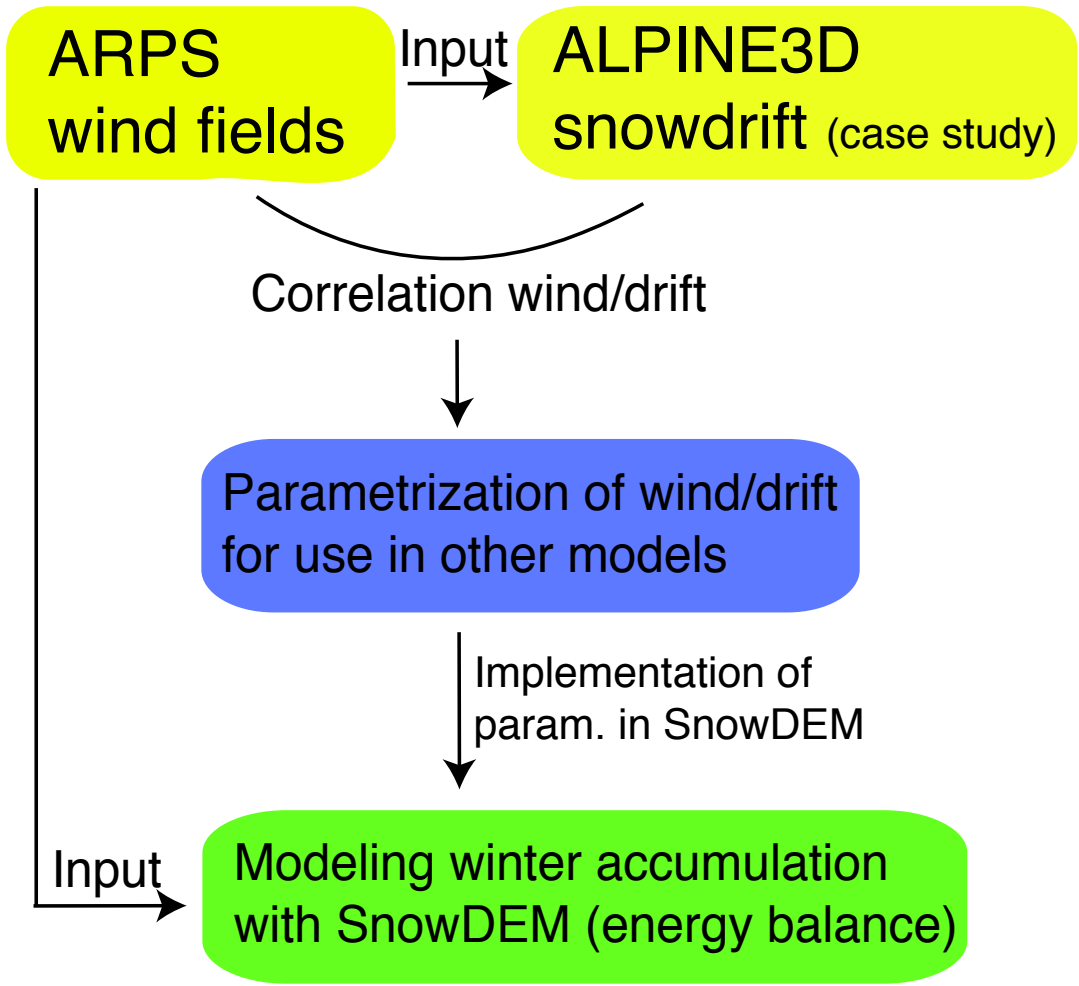
* Snow drift,
  $\Rightarrow$ snow surface properties are important (SNOWPACK).
* Preferential depositon of precipitation [Lehning et al. 2008],
  $\Rightarrow$ settling velocity $\downarrow$ in the luff, $\uparrow$ in the lee side of a ridge.
  $\Rightarrow$ preferential deposition of precip. in lee side of a ridge.



Local Wind Fields



Modeling Framework

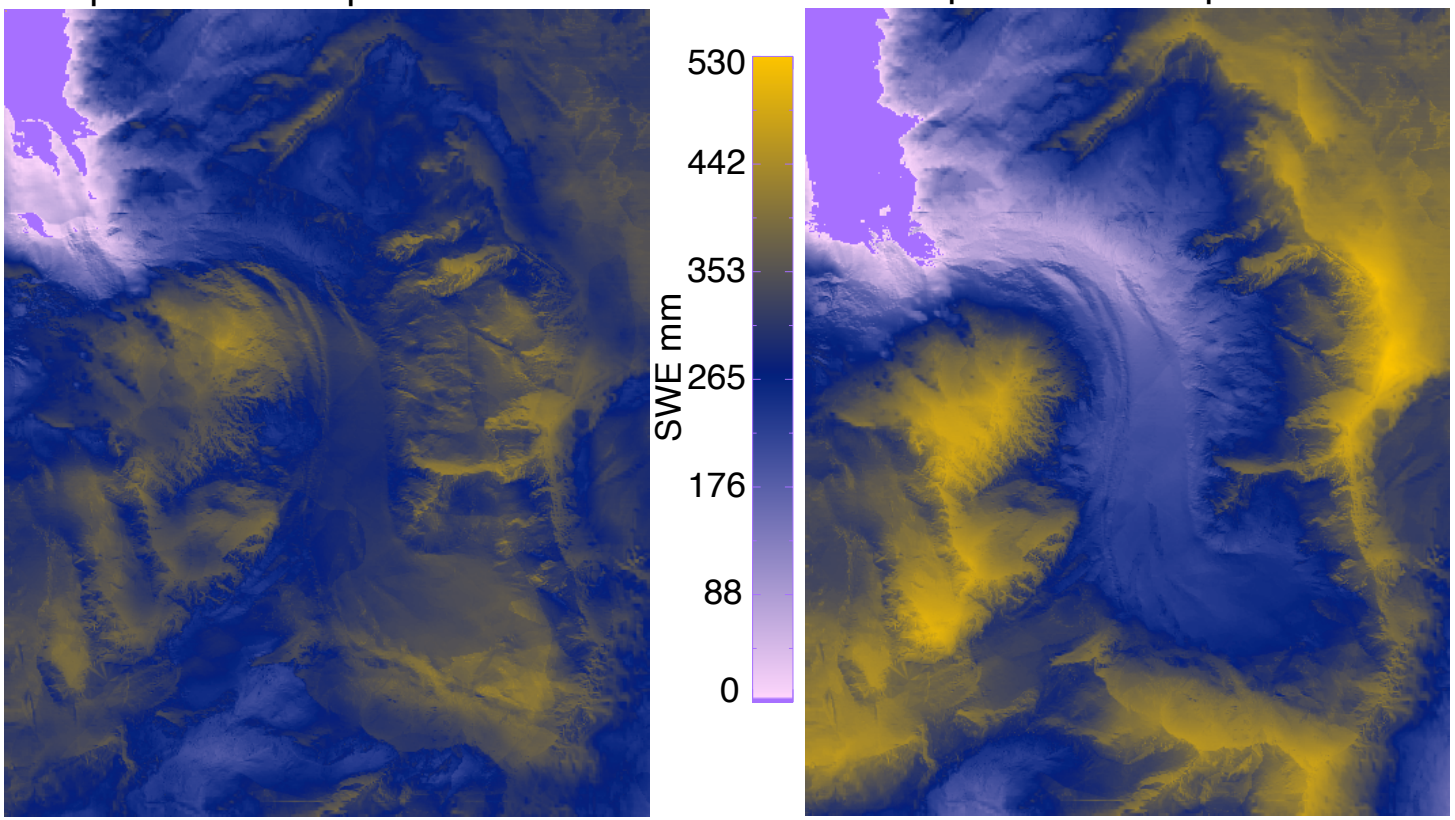


Including Preferential Deposition in SnowDEM

Modeled snow distribution: May 1st, 2007

with preferential deposition

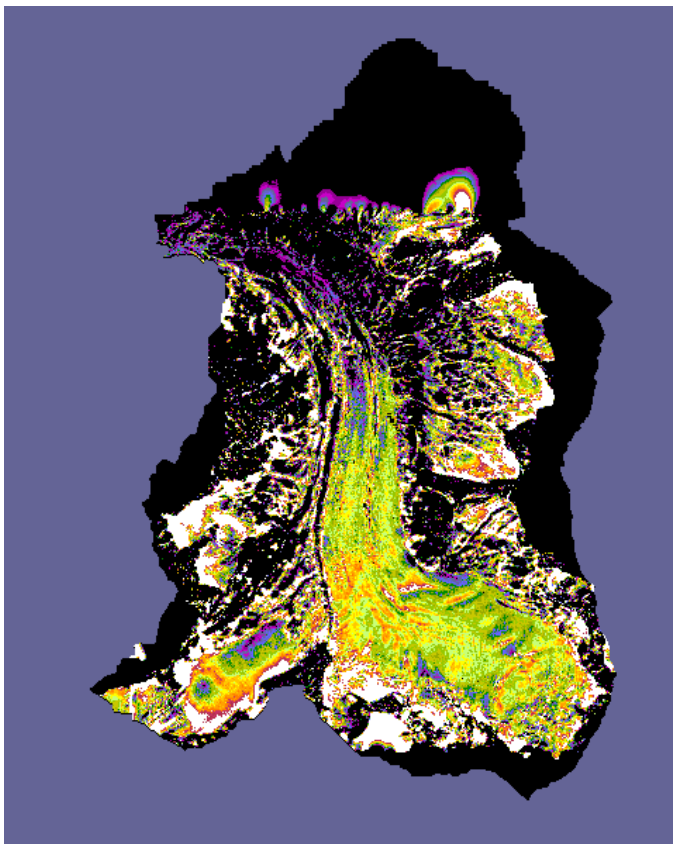
without preferential deposition

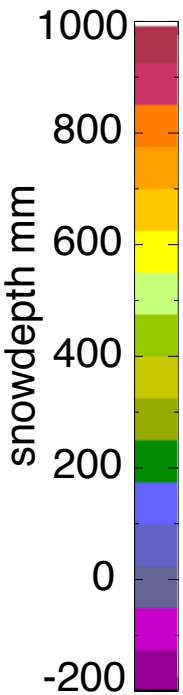


Validation: LIDAR Snowdepth – Modeled Snowdepth

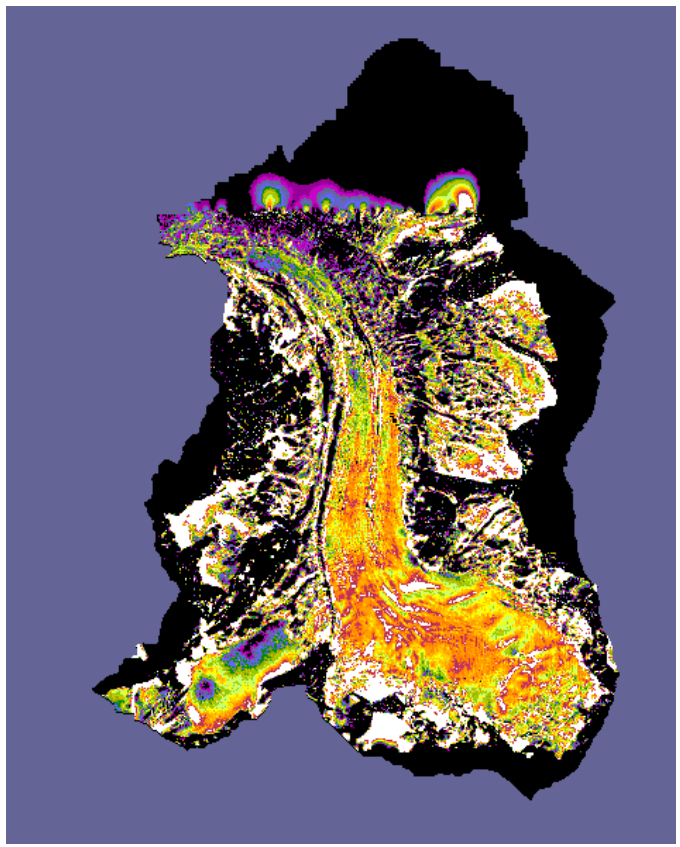
snowdepth (LIDAR) - modeled snowdepth

with preferential deposition





without preferential deposition



- Preferential deposition of precipitation accounts for a large amount of snow distribution.
- Areas of enhanced accumulation correspond to glaciated areas.
- Areas of enhanced accumulation correspond to areas of low mean wind speed and negative vertical wind velocity,

$\Rightarrow$ Local wind fields are a key factor for glacier mass balance and water availability in the future.

Acknowledgements

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