

Northeast Greenland drainage basins derived from the TanDEM-X global DEM and Sentinel-1 ice velocities

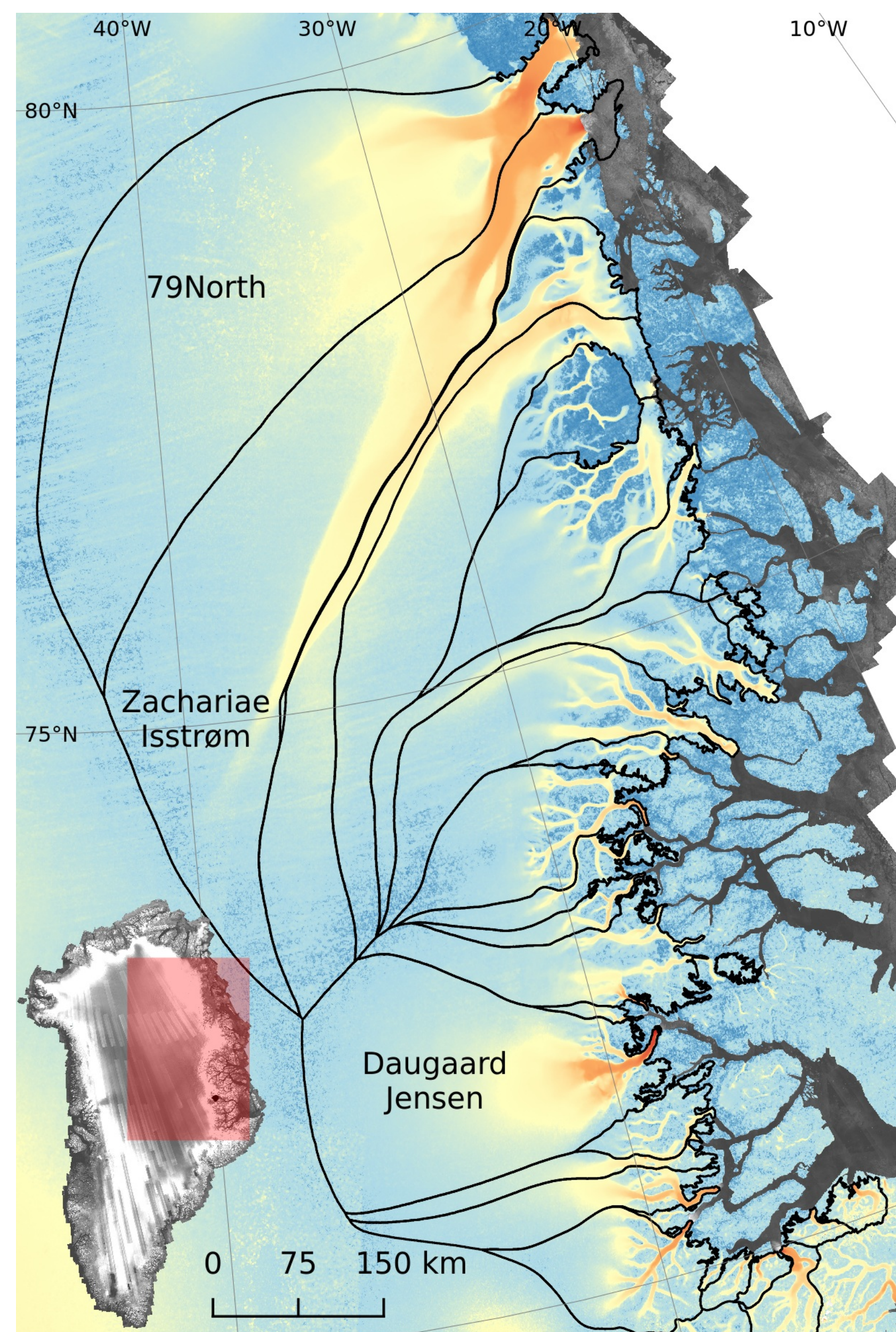
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1. Drainage basin delineation



- The **drainage divides** of ice sheets separate the overall glaciated area into multiple sectors
- For the delineation of individual glacier catchments, a classical **flood-filling watershed algorithm** was adapted to use both elevation (TanDEM-X global DEM) and ice velocity data (Sentinel-1 velocity from Greenland CCI project)
- In regions of fast flow (e.g. $> 20 \text{ m a}^{-1}$) the velocity flowlines are followed and in slower regions the steepest surface slope indicates the drainage direction
- Watershed approaches using only a DEM result in erroneous basin boundaries if catchments for current ice sheet conditions are desired
- Other datasets for drainage sectors are available but aggregate multiple outlet glaciers in one basin [1] or lack detailed methodological description for combining slope information and ice velocities [2]
- We delineated catchments for the Northeast Greenland Ice Sheet for 31 individual outlet glaciers

Drainage basins statistics

Glacier basin	Area [km ²]	Area fraction of Greenland [%]	Sea level rise potential [m]
Nioghalvfjordsfjorden (79North)	107,791	6.28	0.58
Zachariae Isstrøm	84,398	4.92	0.51
Dagaard-Jensen	48,369	2.82	0.28

Krieger, et al., "Drainage basin delineation for outlet glaciers of Northeast Greenland based on Sentinel-1 ice velocities and TanDEM-X elevations", Submitted.
Ice velocity: Nagler, et al. "The Sentinel-1 mission: New opportunities for ice sheet observations." Remote Sensing 7.7 (2015): 9371-9389.

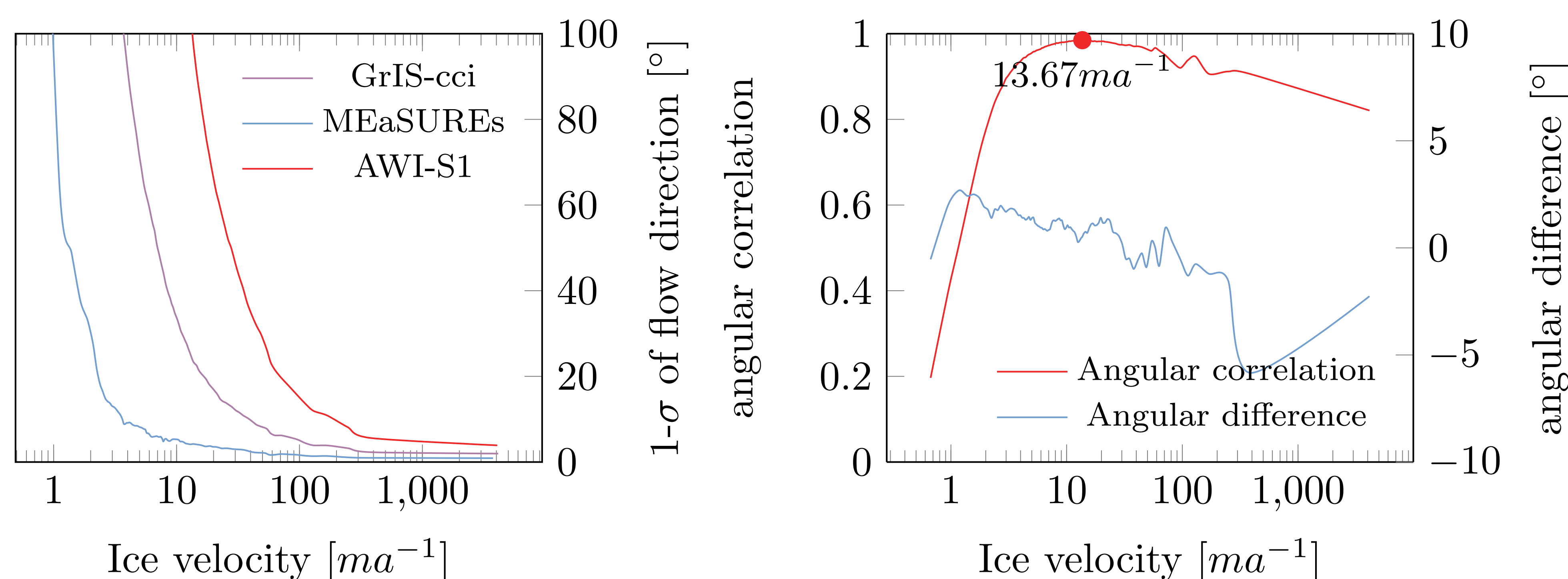
[1] Zwally, et al., "Antarctic and Greenland drainage systems, GSFC cryospheric sciences laboratory." (2012).

[2] Mouginot, et al. "Fast retreat of Zachariae Isstrøm, northeast Greenland." Science 350.6266 (2015): 1357-1361.

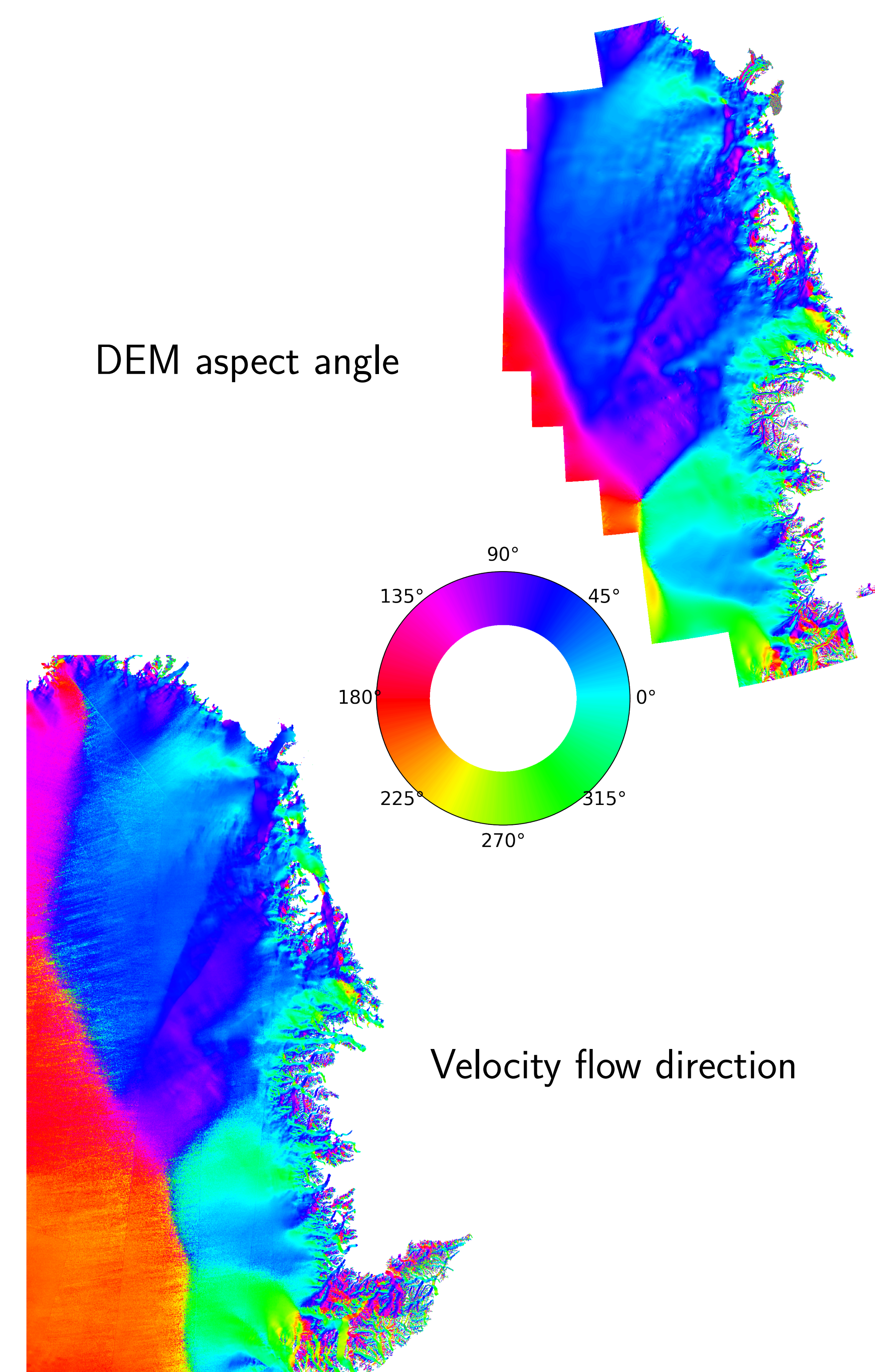
2. Ice flow directions

- DEM aspect angles were calculated for the TanDEM-X global DEM smoothed by a kernel with width of 20-times the local ice thickness
- Correlations between the DEM aspect angles and the velocity flow direction are close to 1 over a wide range of velocity magnitudes
- For decreasing absolute ice velocities the uncertainty of estimated flow directions are increasing and DEM aspect angles provide a more accurate direction of ice flow
- Measured ice flow direction can divert from the DEM aspect angle for fast ice velocities where the downhill flow is obstructed by large bedrock features or through interaction with other ice masses at glacier junctions
- At a velocity of 13.67 m a^{-1} the maximum correlation is reached for the GrIS-cci velocities and TanDEM-X global DEM aspect angles. This velocity threshold is utilised during the modified watershed processing

Uncertainty of ice velocity directions



DEM aspect angle



Velocity flow direction

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Proposal: DEM_GLAC0671

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