Surge Type Glacier Identification on Northeast Spitsbergen, Svalbard from Landsat Imagery 1984-2018

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EGU2019-135

UPPSALA UNIVERSITET

Photography encouraged

This presentation participates in OSPP

EGU Outstanding Student Poster & PICO Contest

Introduction

Svalbard archipelago is known as the "surge hot spot" for its high occurrence of glacial surge. This study utilizes all the available **Landsat images (1984-2018)** of 40 major maritime and valley glaciers on NE Spitsbergen, Svalbard to **reconstruct the glacier surface velocity** and identify **historical surge events**.

Procedure

> **Cloud mask**
  MFmask/Fmask (Qiu et al., 2017; Zhu, 2017)
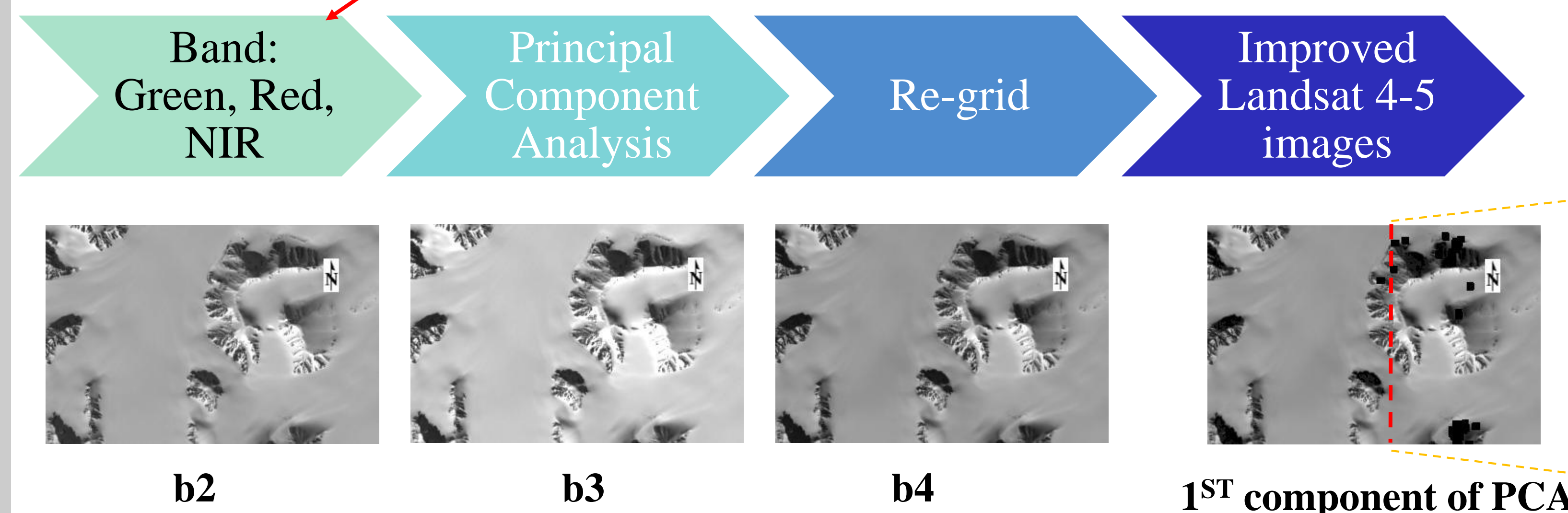
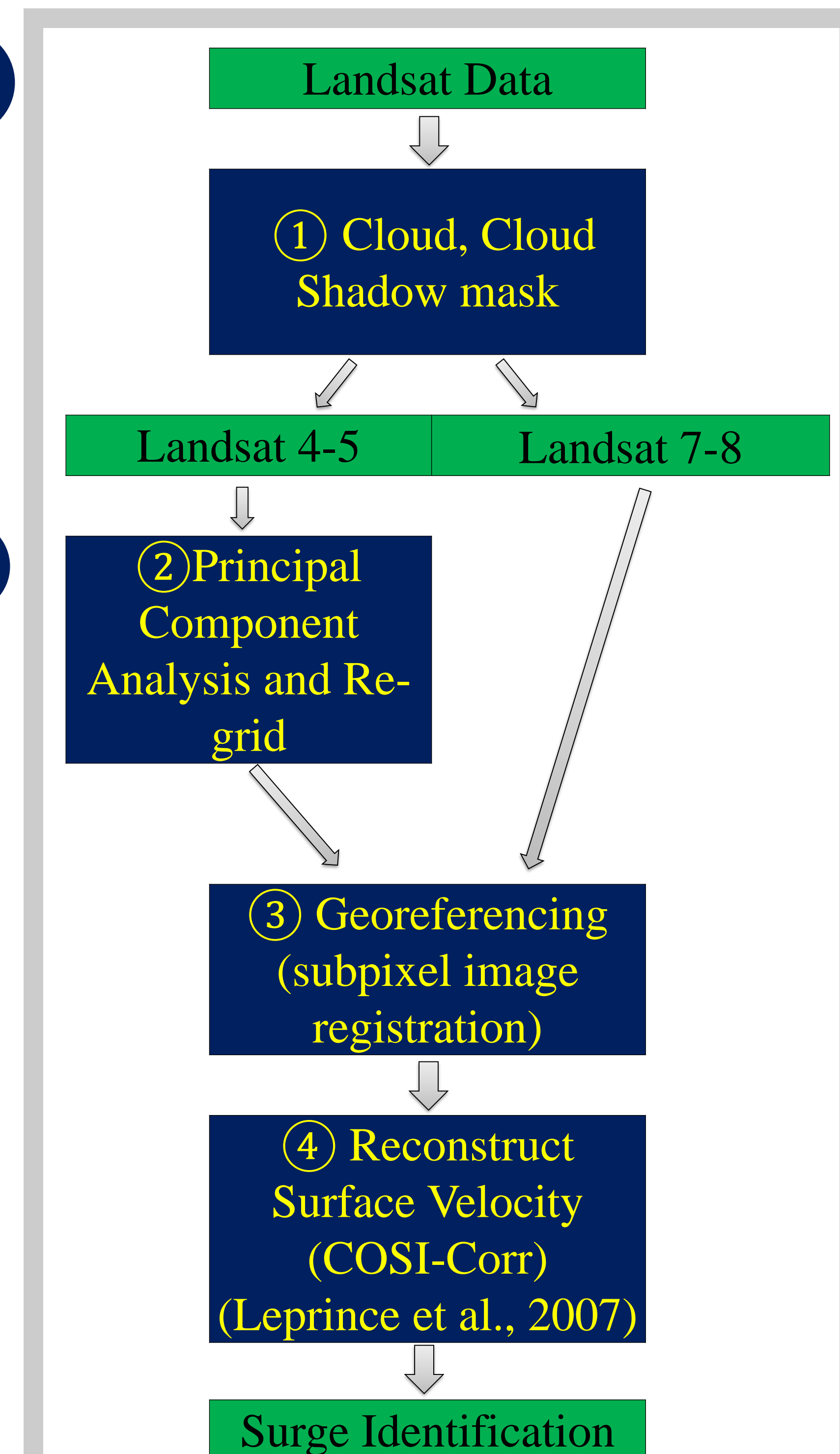**Fig.1 Fmask results: (cloud is marked as white)**
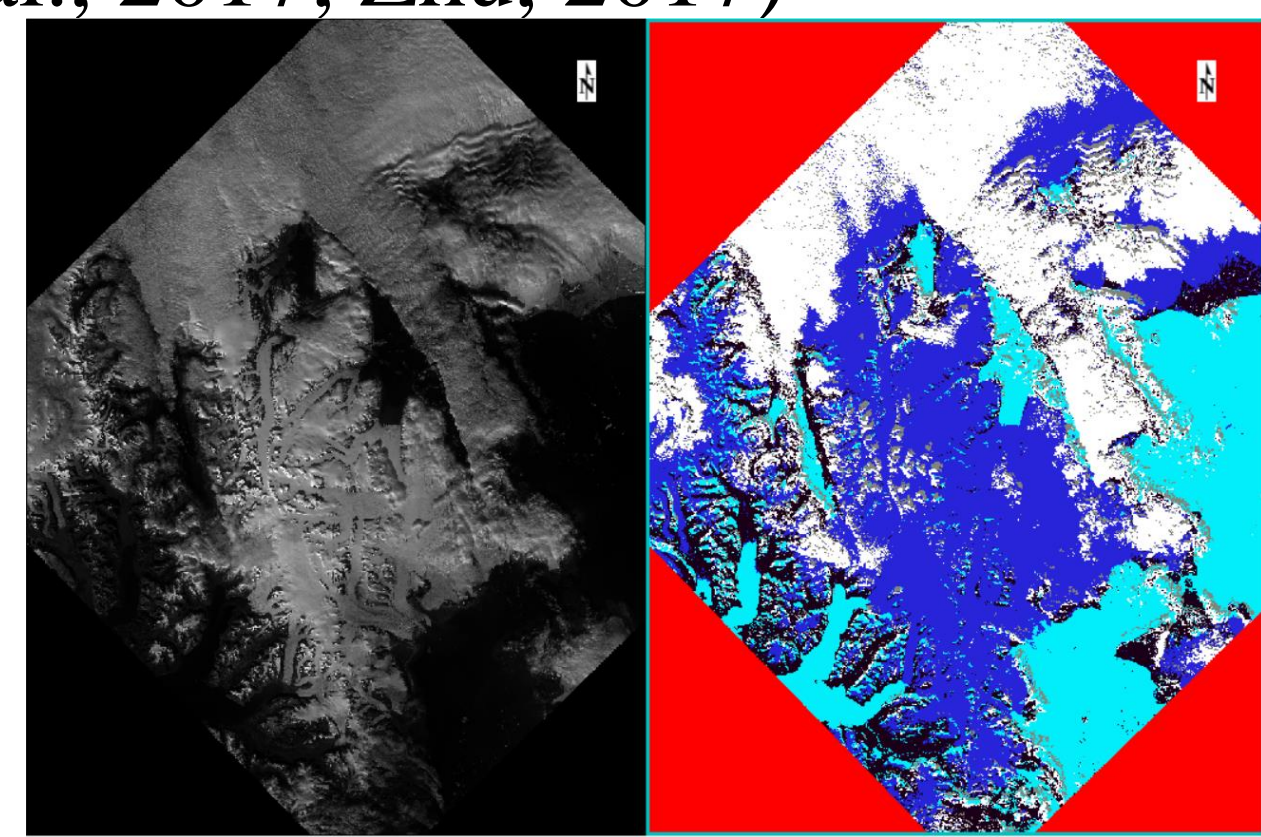
> **Re-grid and PCA**
> (Fahnestock et al., 2016; Scambos et al., 1992)

Table 1. Comparison of Selected Bands of Landsat 4, 5 TM, Landsat 7 ETM+ and Landsat 8 OLI imagery

Landsat 4-5		Landsat 7 Landsat 8	
Bands	**Wavelength (µm)**	**Bands**	**Wavelength (µm)**
Band 2-Green	0.52-0.60		0.52-0.90
Band 3-Red	0.63-0.69	Band 8 - Panchromatic	
Band 4-Near Infrared (NIR)	0.76-0.90		0.503-0.676
Resolution (m)	30	Resolution (m)	15

Band: Green, Red, NIR → Principal Component Analysis → Re-grid → Improved Landsat 4-5 images

b2   b3   b4   1ST component of PCA

Fig. 2 Visible bands and first component of PCA (15 m noise reduced images with enhanced ice topography and improved surface feature)

Landsat Data

① Cloud, Cloud Shadow mask

Landsat 4-5   Landsat 7-8

②Principal Component Analysis and Re-grid

③ Georeferencing (subpixel image registration)

④ Reconstruct Surface Velocity (COSI-Corr) (Leprince et al., 2007)

Surge Identification

③ > **Subpixel Image Registration** (Guizar-Sicairos et al. 2008)
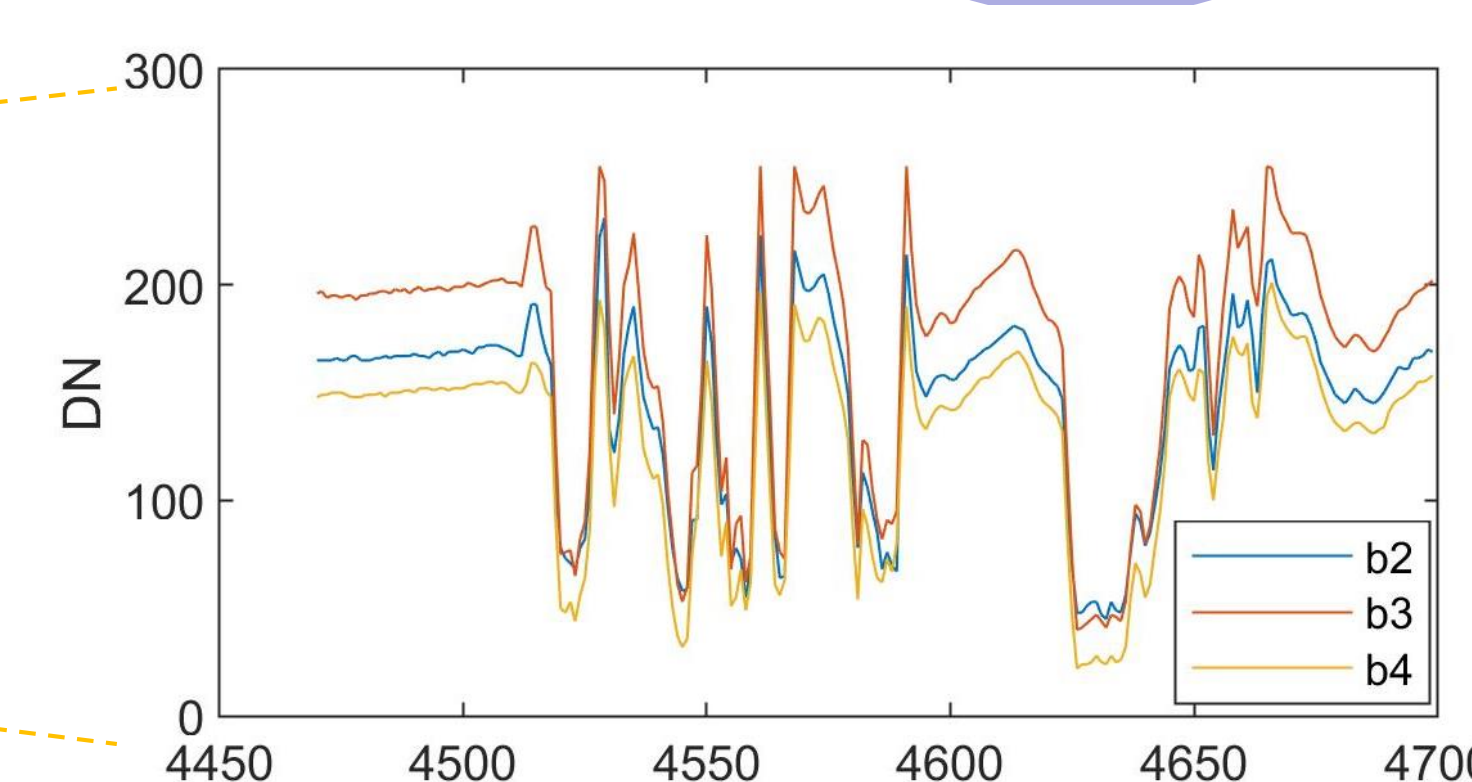
• Winter: Oct - May
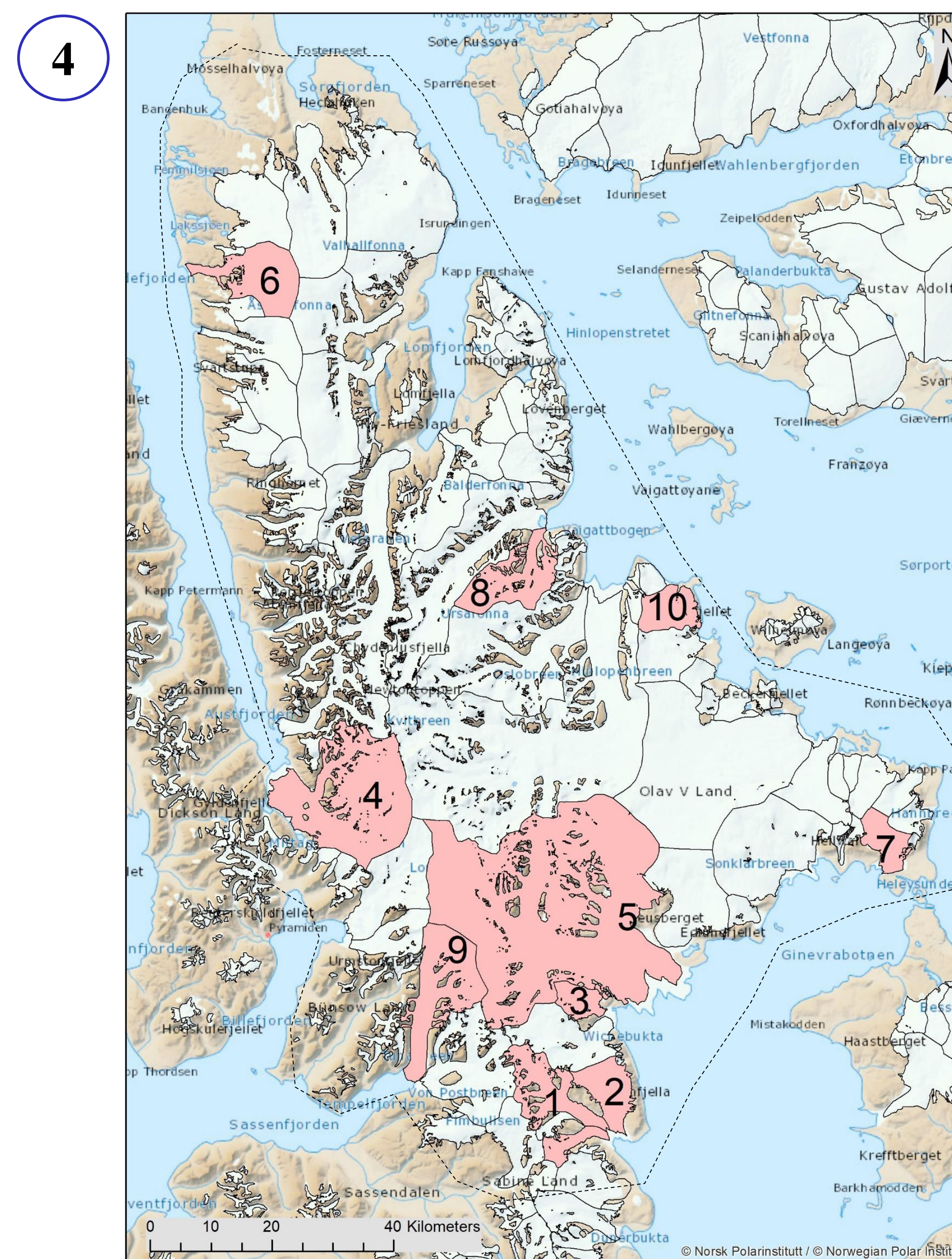• Summer: June - Sept

Low pass filter

Georeferencing

• Low-pass filtered cloud free referencing object

• co-registered images
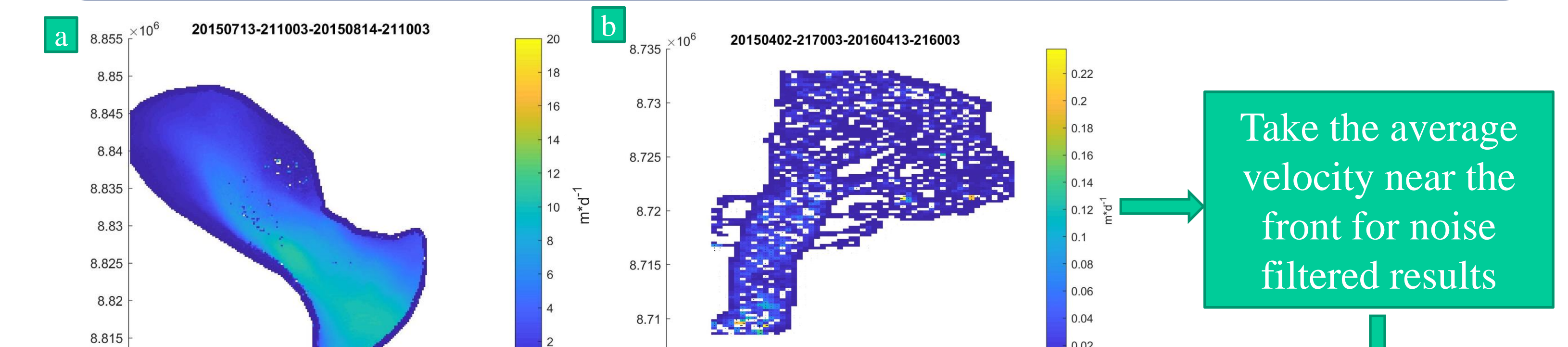• Gaussian filtered image

High pass filter

Fig. 3 Pixel Value of b2, b3, b4 and 1st PCA component along the red dotted line in Fig. 2 (LT05_L1GS_216003_20060621_20161121_01_T2)

**Fig. 4 Study Area and Identified Surge/Active glaciers (Table 2)**

Results

Fig. 5 Velocity Map of Basin 3 (a) and Tunabreen (b)

Take the average velocity near the front for noise filtered results

Table 2 Identified Surge-type glacier and the Active Phase

No.	Glacier	Surge/Accelerate Period	
1	Hayesbreen S	2004-2006	
	Hayesbreen	2004-2006	
2	Heuglinbreen	2004-2005	
3	Johansenbreen	2004-2006	
4	Mittag-Lefflerbreen	2004-2006	
5	Negribreen	2004-2005	2017
6	Nordbreen	2007-2008	
7	Pedasejenskobreen	2015-2016	
8	Polarisbreen	2011	
9	Tunabreen	2003-2005	2016-2017
10	Vaigattbreen	2015	

1) Glacier surface velocity > 1.5 stdv
2) Velocity map
3) Geomorphology evidence: (visual examination of image at identified surge/active period)
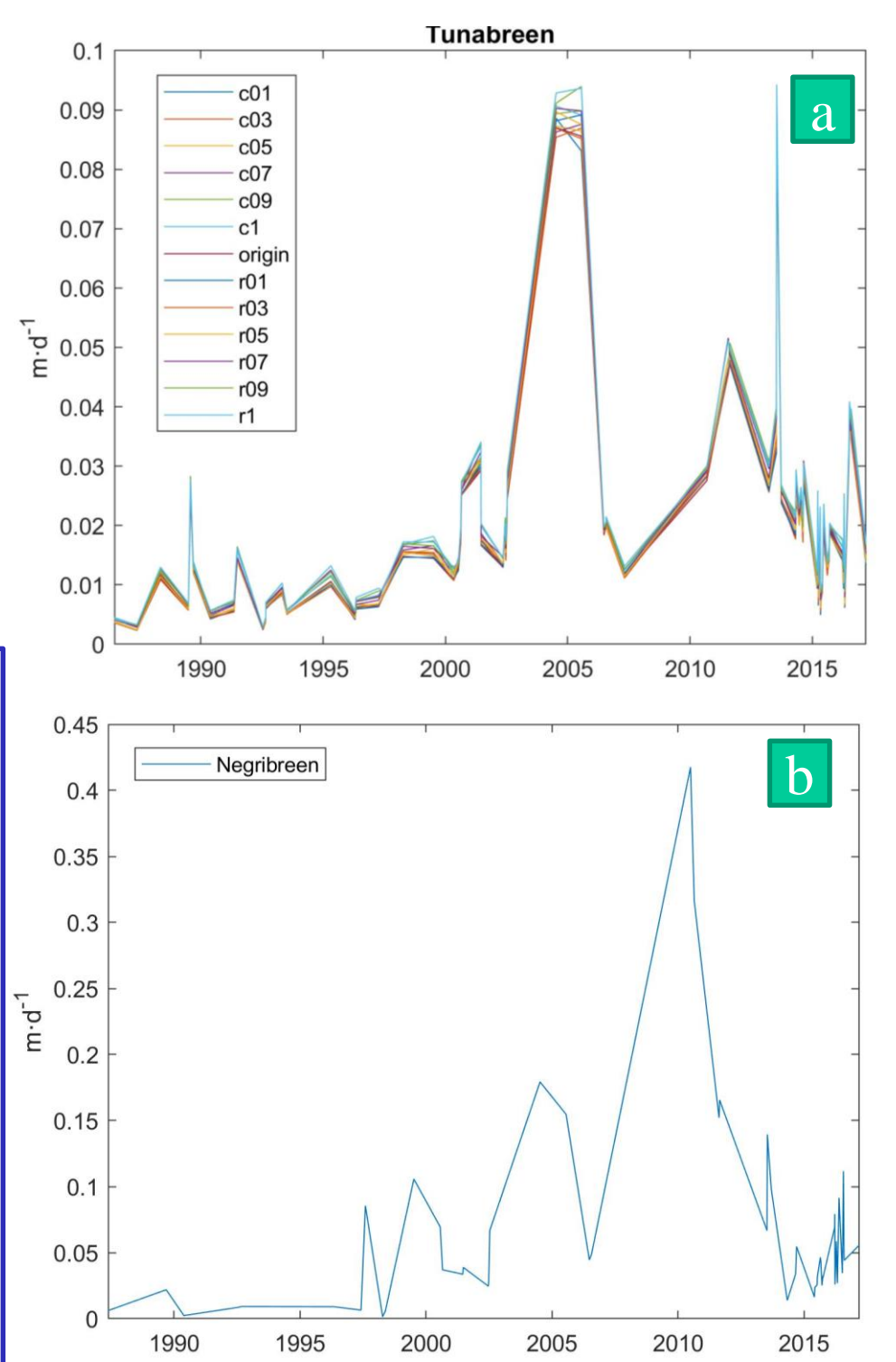
Fig. 5 Average Velocity Near Front (a: Tunabreen; b: Negribreen)

Conclusions

- The method is limited by the spatial resolution of image and the actual displacement of ice flow at given time window.
- The noised feature track results can still provide sufficient information of the relative change of ice flow speed.
- Further research should focus on improving the data resolution and the use of cloud computing platform.

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References

- Fahnestock, M., Scambos, T., Moon, T., Gardner, A., Haran, T., Klinger, M., 2016. Rapid large-area mapping of ice flow using Landsat 8. Remote Sensing of Environment 185, 84–94. https://doi.org/10.1016/j.rse.2015.11.023
- Guizar-Sicairos, M., Thurman, S.T., Fienup, J.R., 2008. Efficient subpixel image registration algorithms. Optics Letters 33, 156. https://doi.org/10.1364/OL.33.000156
- Leprince, S., Barbot, S., Ayoub, F., Avouac, J.-P., 2007. Automatic and Precise Orthorectification, Coregistration, and Subpixel Correlation of Satellite Images, Application to Ground Deformation Measurements. IEEE Transactions on Geoscience and Remote Sensing 45, 1529–1558. https://doi.org/10.1109/TGRS.2006.888937
- Qiu, S., He, B., Zhu, Z., Liao, Z., Quan, X., 2017. Improving Fmask cloud and cloud shadow detection in mountainous area for Landsats 4–8 images. Remote Sensing of Environment 199, 107–119. https://doi.org/10.1016/j.rse.2017.07.002
- Scambos, T.A., Dutkiewicz, M.J., Wilson, J.C., Bindschadler, R.A., 1992. Application of image cross-correlation to the measurement of glacier velocity using satellite image data. Remote Sensing of Environment 42, 177–186. https://doi.org/10.1016/0034-4257(92)90101-O
- Zhu, Z., 2017. Change detection using landsat time series: A review of frequencies, preprocessing, algorithms, and applications. ISPRS Journal of Photogrammetry and Remote Sensing 130, 370–384. https://doi.org/10.1016/j.isprsjprs.2017.06.013

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