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

Shunan Feng[1] and Rickard Pettersson[1]
Department of Earth Sciences, Uppsala University, Sweden

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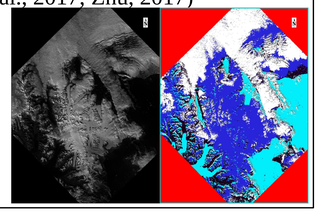
Introduction

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** (1)
MFmask/Fmask (Qiu et al., 2017; Zhu, 2017)

Fig.1 Fmask results: (cloud is marked as white)

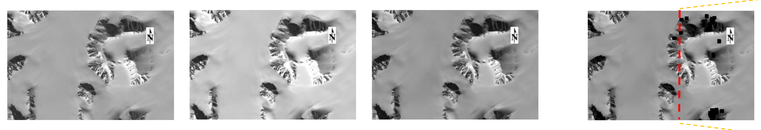


➢ **Re-grid and PCA** (2)
➢(Fahnestock et al., 2016; Scambos et al., 1992)

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

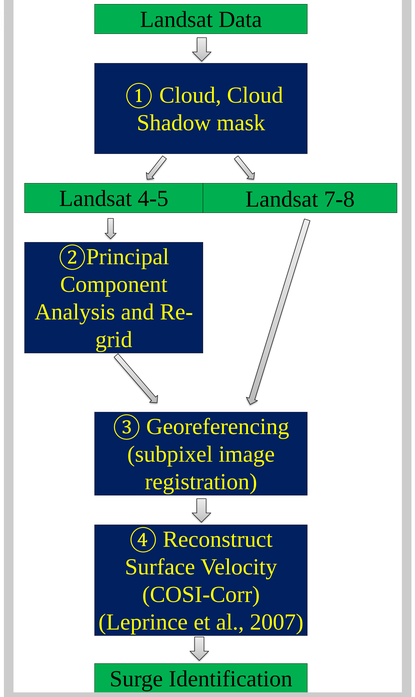
Landsat 4-5		Landsat 7 Landsat 8	
Bands	**Wavelength (μm)**	**Bands**	**Wavelength (μm)**
Band 2-Green	0.52-0.60		
Band 3-Red	0.63-0.69	Band 8 - Panchromatic	0.52-0.90
Band 4-Near Infrared (NIR)	0.76-0.90		0.503-0.676
Resolution (m)	30	Resolution (m)	15

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)



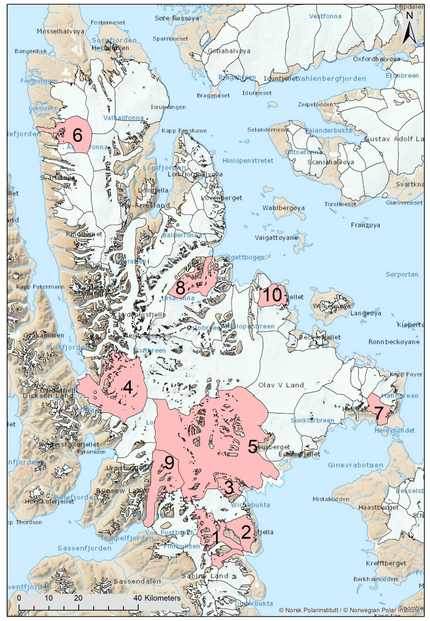


Fig. 4 Study Area and Identified Surge/Active glaciers

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

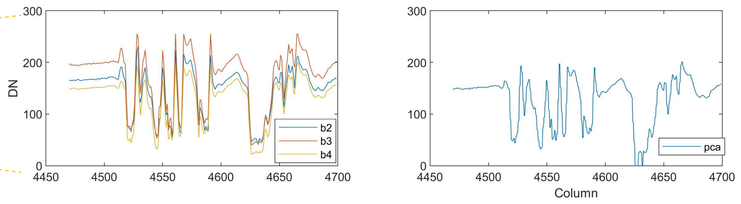
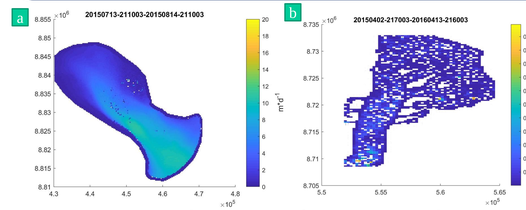


Fig. 3 Pixel Value of b2, b3, b4 and 1st PCA component along the red dotted line in Fig. 2 (LT05_L1GS_216003_20060621_20161121_01_T2)

Results



Take the average velocity near the front for noise filtered results

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

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	

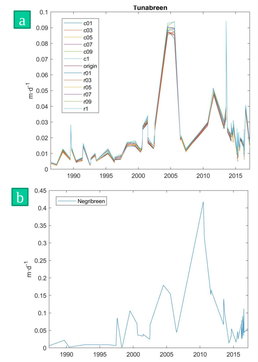


Fig. 5 Average Velocity Near Front (a: Tunabreen; b: Negribreen)

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.

Authors

- Shunan Feng: - MSc student: fsn.1995@gmail.com
- Dr. Rickard Pettersson - Senior Lecturer (supervisor) rickard.pettersson@geo.uu.se

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