



“Multitemporal mass balance changes of the Northern Patagonian Icefield (NPI) from 1975 to 2016”

I. Dussaillant^{1,2}, E. Berthier¹, F. Brun², V. Favier², A. Dehecq³, J. Belart⁴

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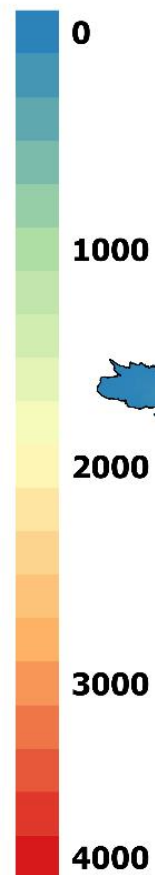
North Patagonian Icefield (NPI)



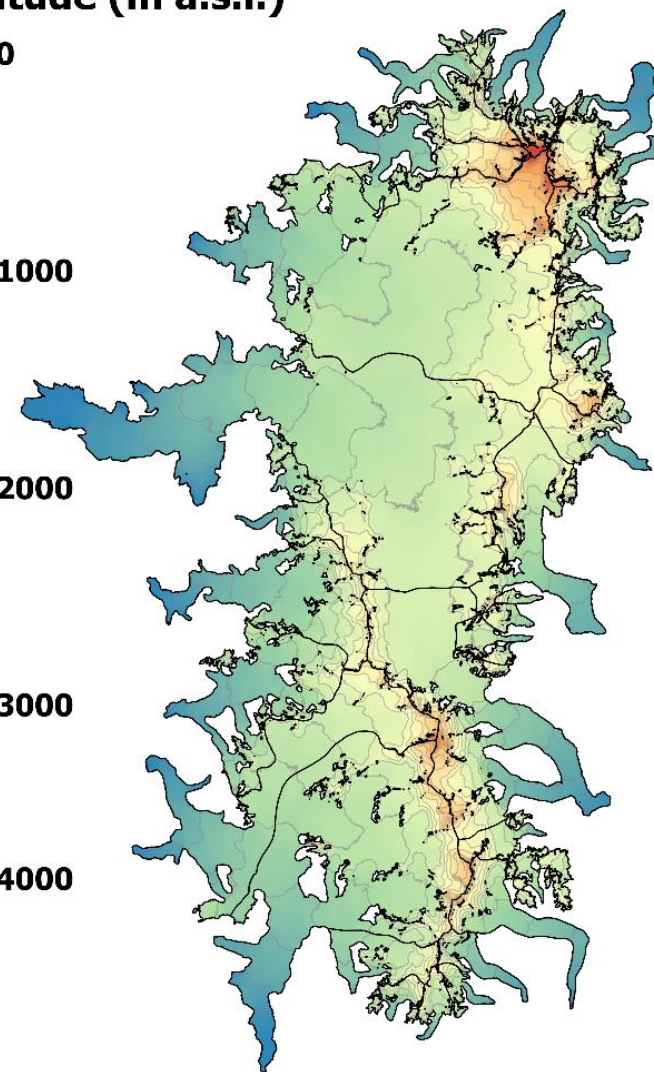
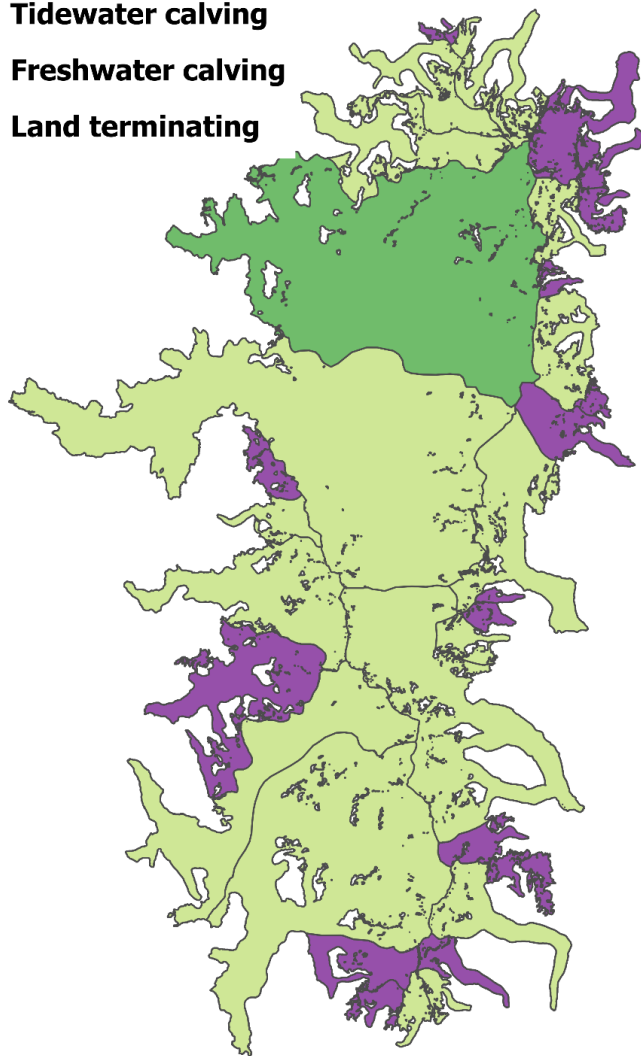
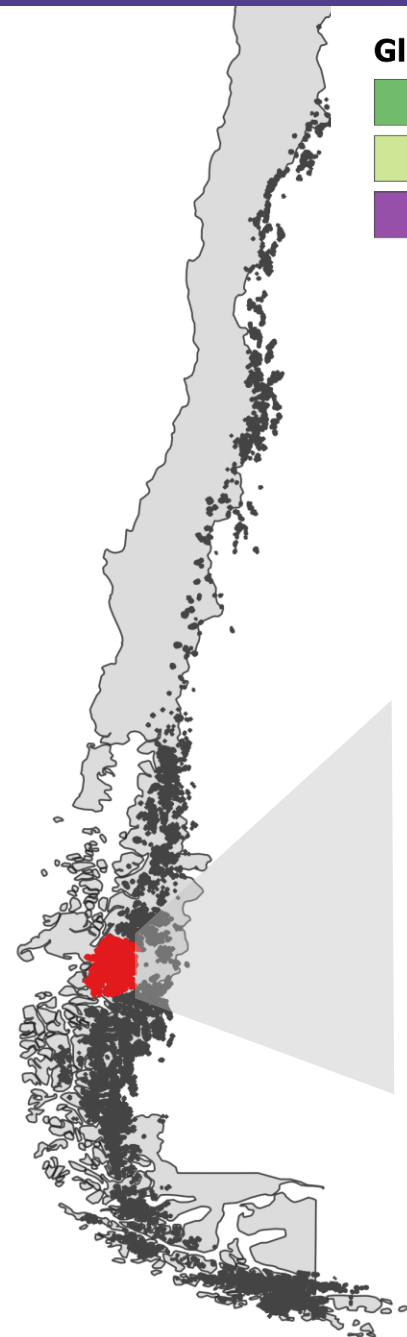
Glacier type

- Tidewater calving
- Freshwater calving
- Land terminating

Altitude (m a.s.l.)



0 10 20 30 km



Multiple archive of elevation data for the NPI



1975

Militar Geographic Institute (IGM)
Topography, 25 m contour lines

2000

SRTM
DEM

2005

SPOT5

2012

DEMs

2016

SPOT6-7

Objective

Observe sub-period mass balance variations in the NPI to
build a strong basis for a posterior climatological analysis

Past period glacier changes (1975-2000)

Compare SRTM with IGM Chilean topography derived (manually) from aerial photographs acquired in 1975

- **Not novel approach...** published in *Rignot et al. 2003*
- This repetition aims at **checking the quality of IGM topography**

Present period glacier changes (2000-2016)

Compare SRTM, SPOT5-HRS DEMs for 2005 and 2012, SPOT6-7 DEMs for year 2016

- **Novel approach for NPI using photogrametric DEMs**

Past period glacier elevation change (1975 – 2000)

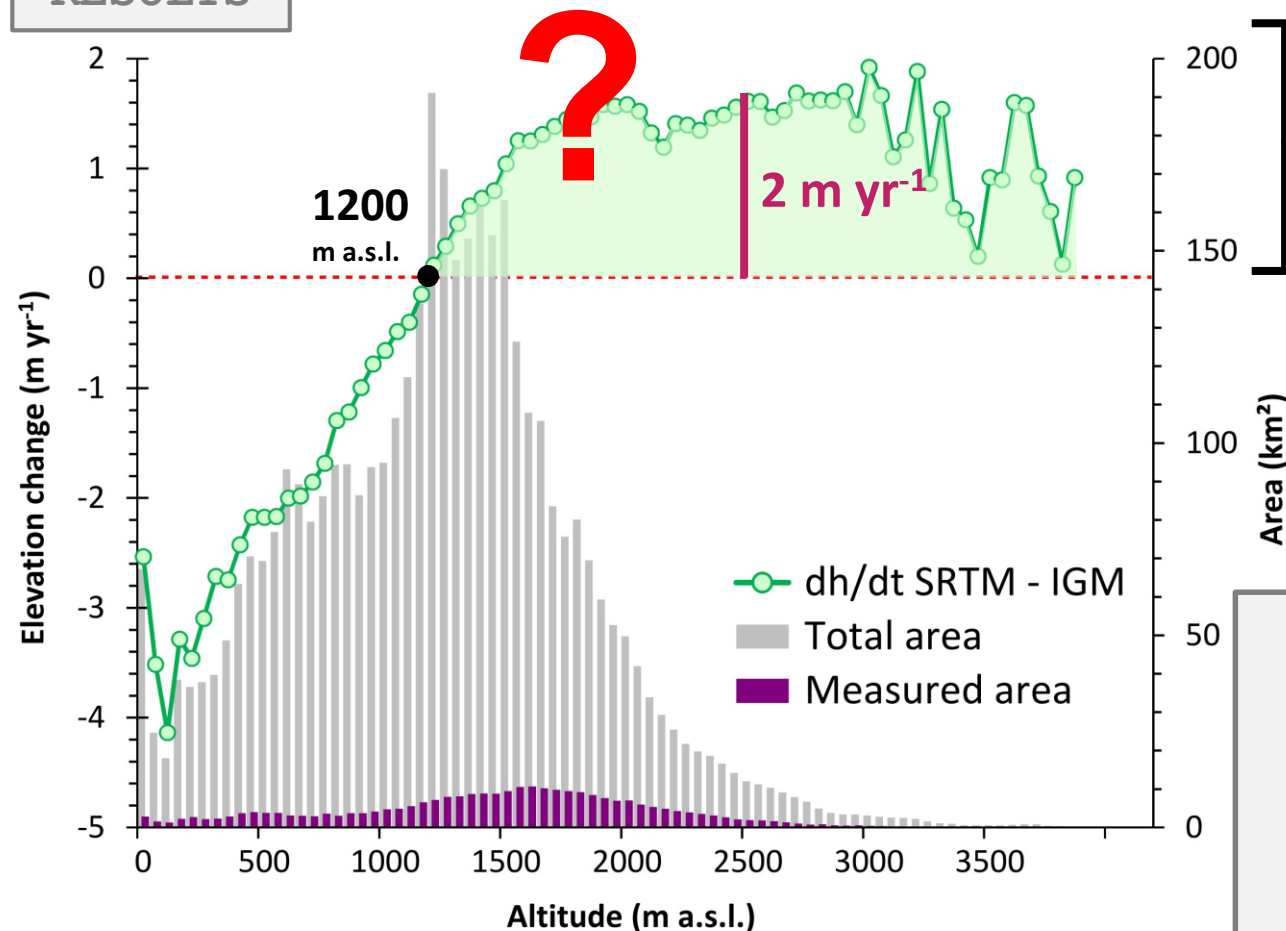


1975
IGM Topography

2000
SRTM DEM

→ Same datasets as used in
Rignot et al. 2003

RESULTS



Unexpected

thickening rates

above 1200 m a.s.l.

> 1 m yr⁻¹

Is this right?

TEST Analysis

→ Look at high altitude

Nunatak extent changes

from 1975 to 2000

Past period glacier elevation change (1975 – 2000)



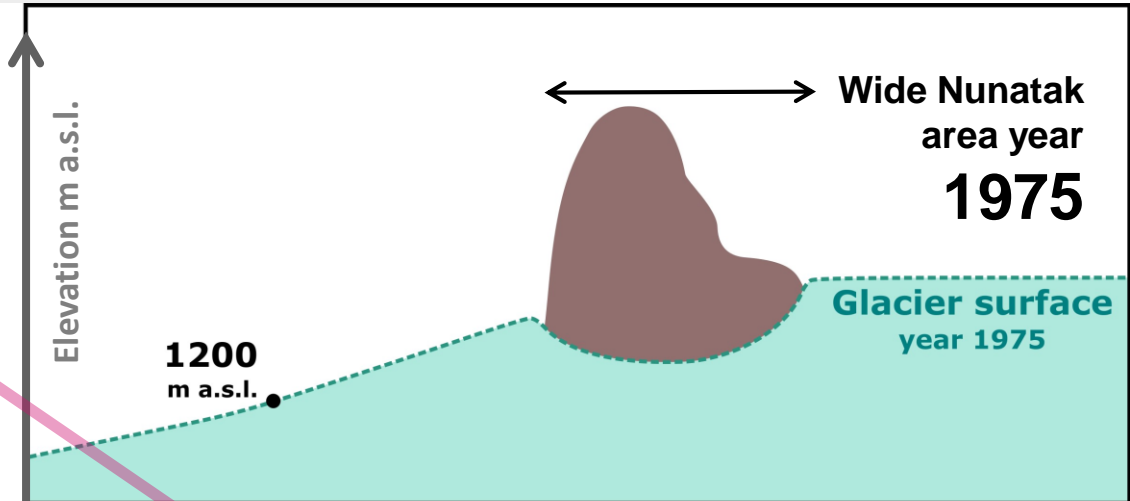
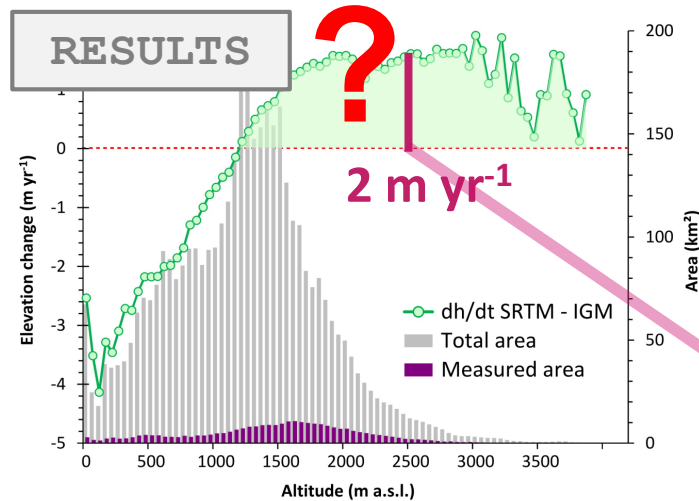
1975

2000

IGM Topography

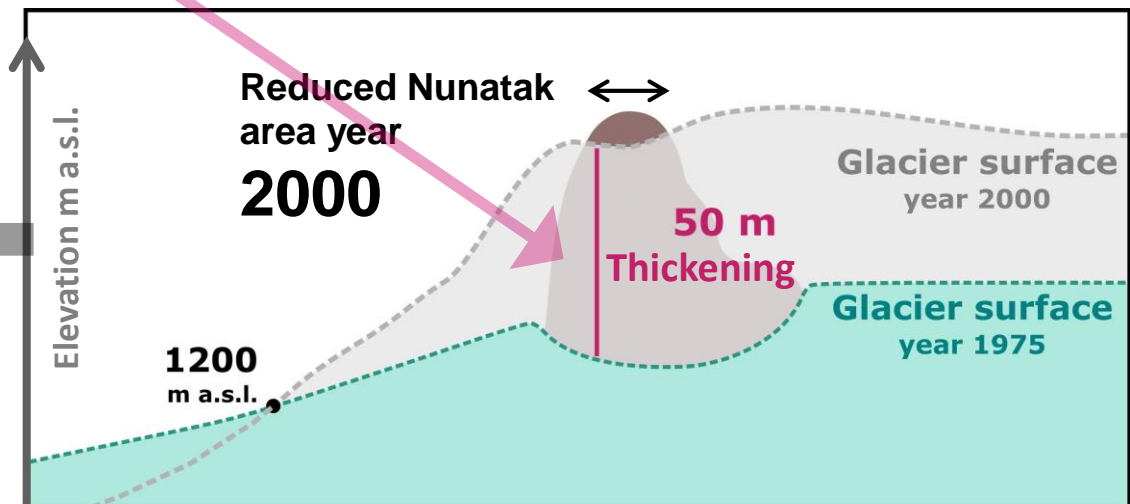
Vertical cross section of a Nunatak in the NPI

RESULTS



To observe if this is the case we propose an

image analysis



Past period glacier elevation change (1975 – 2000)



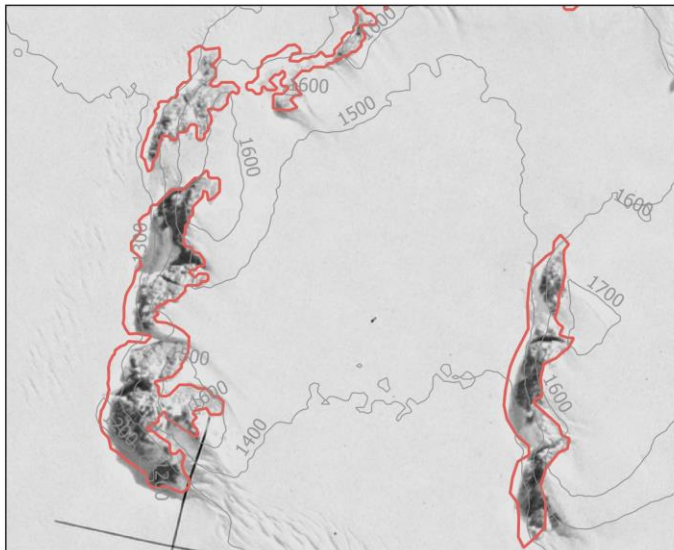
1975
IGM Topography

2000
SRTM DEM

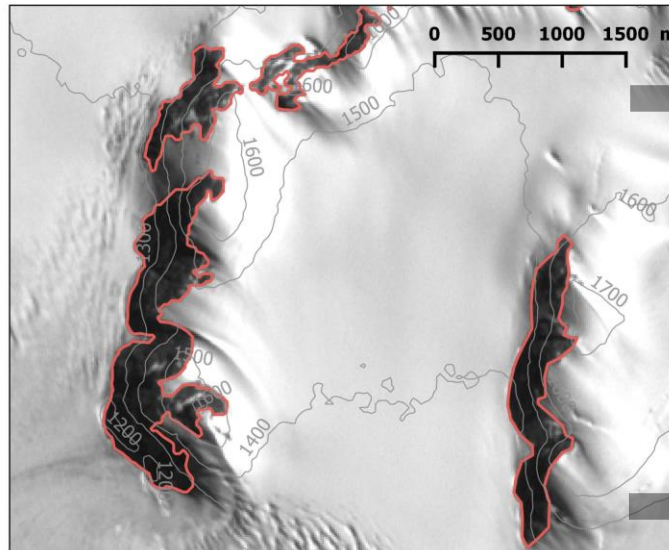


Image analysis of
NPI Nunatak extent

KH9-Hexagon, 6 april 1979



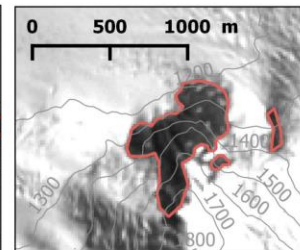
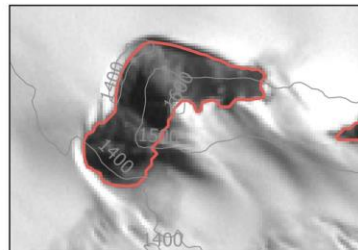
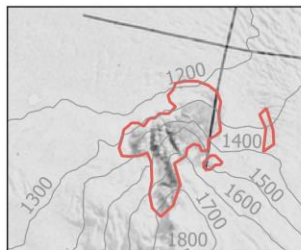
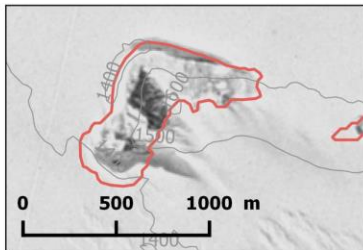
Landsat ETM-7, 8 mars 2000



**NO reduction of
Nunatak extent**
NO thickening at
high altitude from
1979 to 2000

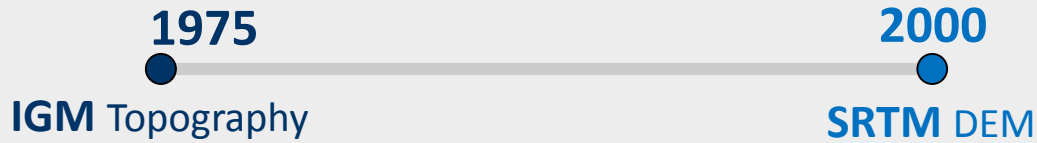
Rather...

**INCREASE of
Nunatak extent**
Reveals thinning
above 1200
m a.s.l.



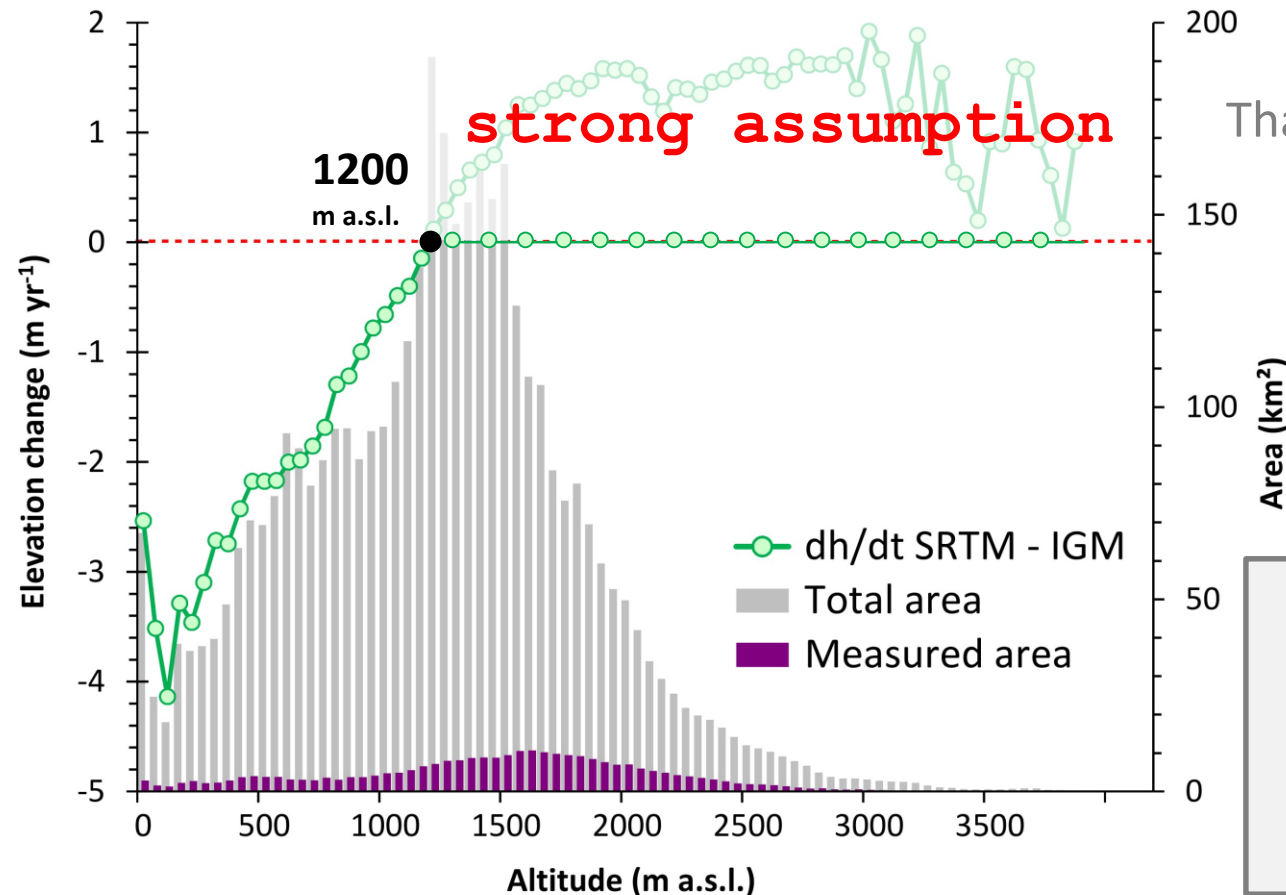
CAUTION! Artefacts in IGM maps showing high altitude thickening

Past period glacier elevation change (1975 – 2000)



**Artefacts in IGM maps
showing high altitude thickening**

RESULTS



One option is to assume
That all elevation change rates
above 1200 m a.s.l.

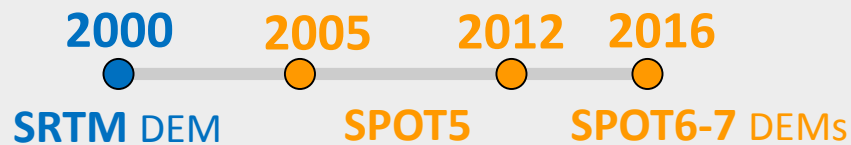
$$= 0 \text{ m yr}^{-1}$$

As done by
Rignot et al. (2003)

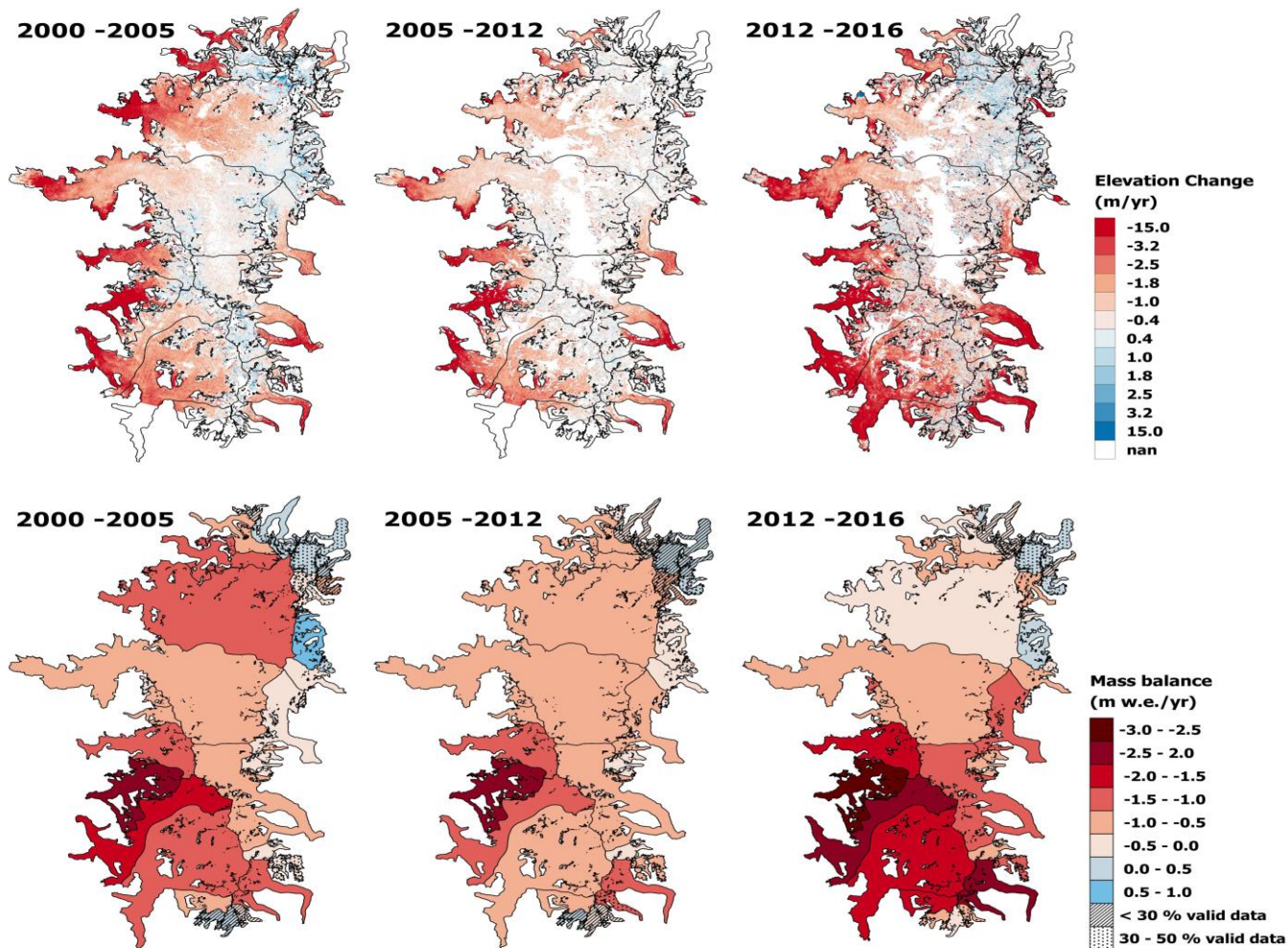
CAUTION!

Is there an elevation bias
affecting lower altitudes
as well?

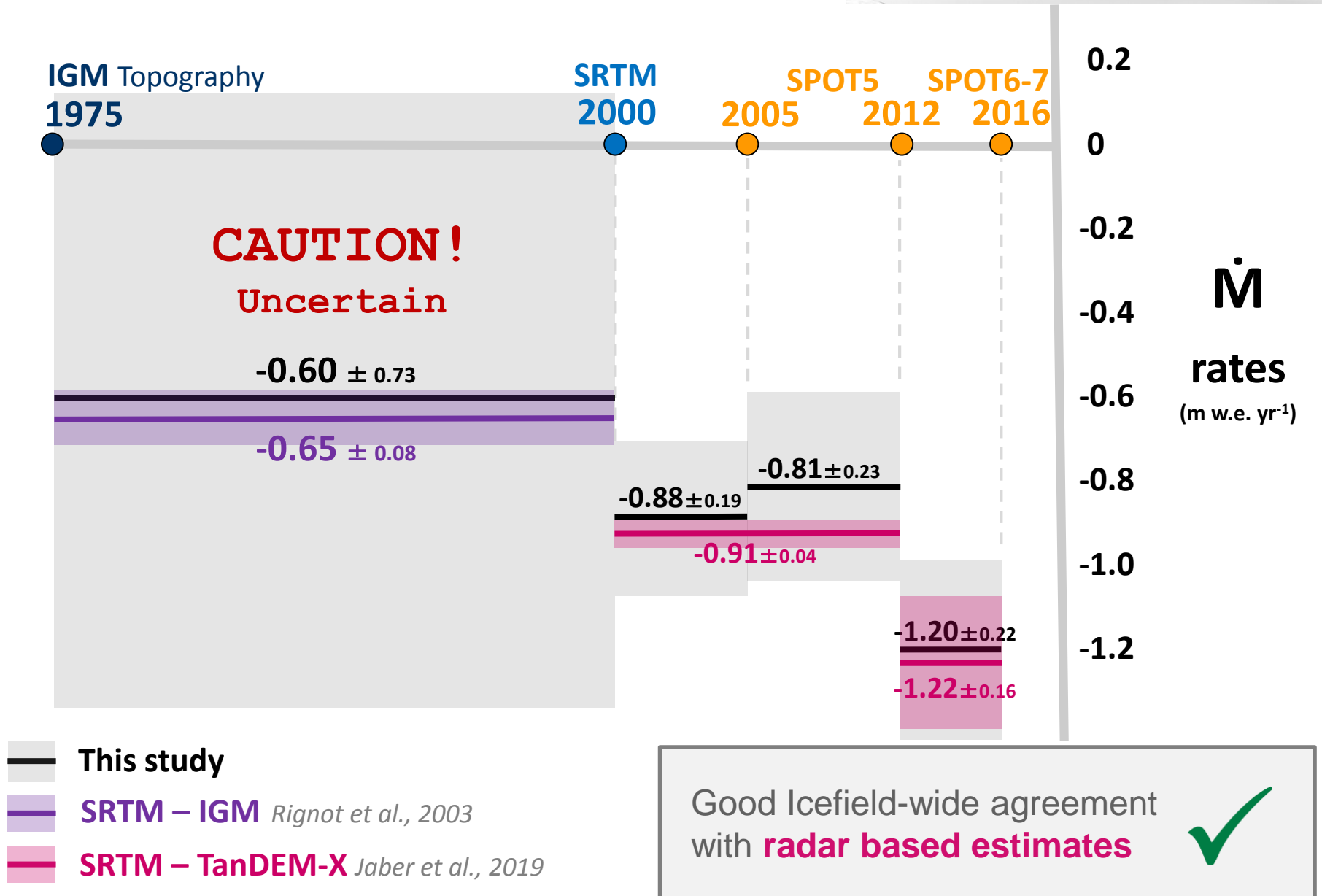
Recent period glacier elevation change (2000 – 2016)



RESULTS



All sub-periods results (1975 – 2016)



Conclusions

1975

IGM

Topography

2000

SRTM

DEM

2005

SPOT5

2012

DEMs

2016

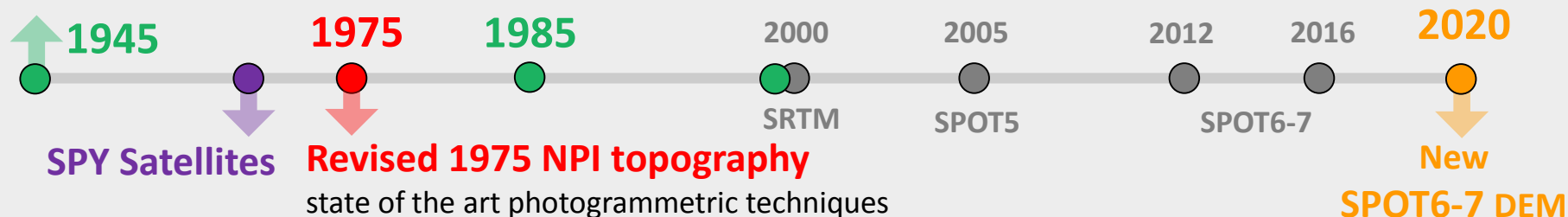
SPOT6-7

Preliminary results suggest **acceleration of Icefield-wide mass loss** from 1975 to 2016

- We suggest moderate mass loss rates before 2000 ($-0.6 \text{ m w.e. yr}^{-1}$)
CAUTION! thickening rates not supported by image analysis over SRTM-IGM elevation change grids
- We show **stable strong mass loss during 2000-2012** (-0.8 - $-0.9 \text{ m w.e. yr}^{-1}$)
- We show **significant acceleration of mass loss during 2012-2016** ($-1.2 \text{ m w.e. yr}^{-1}$) supported by independent estimates with radar DEMs

Perspective

Historical stereoscopic image survey



MOTIVATION

Improved-longer mass balance observations under different climate conditions to infer more accurately the **role of precipitation and temperature in NPI glacier changes**

How it looks... in search for advice...

- High potential of **SPY satellites** and a new **SPOT 6-7 DEM (2020/21)**
- **No easy access** to 1975 airborne images: **TOP SECRET!**
- Three other surveys of **historical stereoscopic images** on NPI
 - NOT FREE:** need for funds to buy images from IGM and Chilean Air Force (SAF)
 - Need to re-scan:** Insufficient quality of image scan



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Thank you!

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