

# Seasonal-to-decadal geodetic mass balance of Hofsjökull, 2003–2020, based on time-series analysis of DEMs

Joaquín M.C. Belart, Tómas Jóhannesson, Etienne Berthier, Maud Bernat, Romain Hugonnet, Bob McNabb, Þorsteinn Þorsteinsson, Johann Stötter

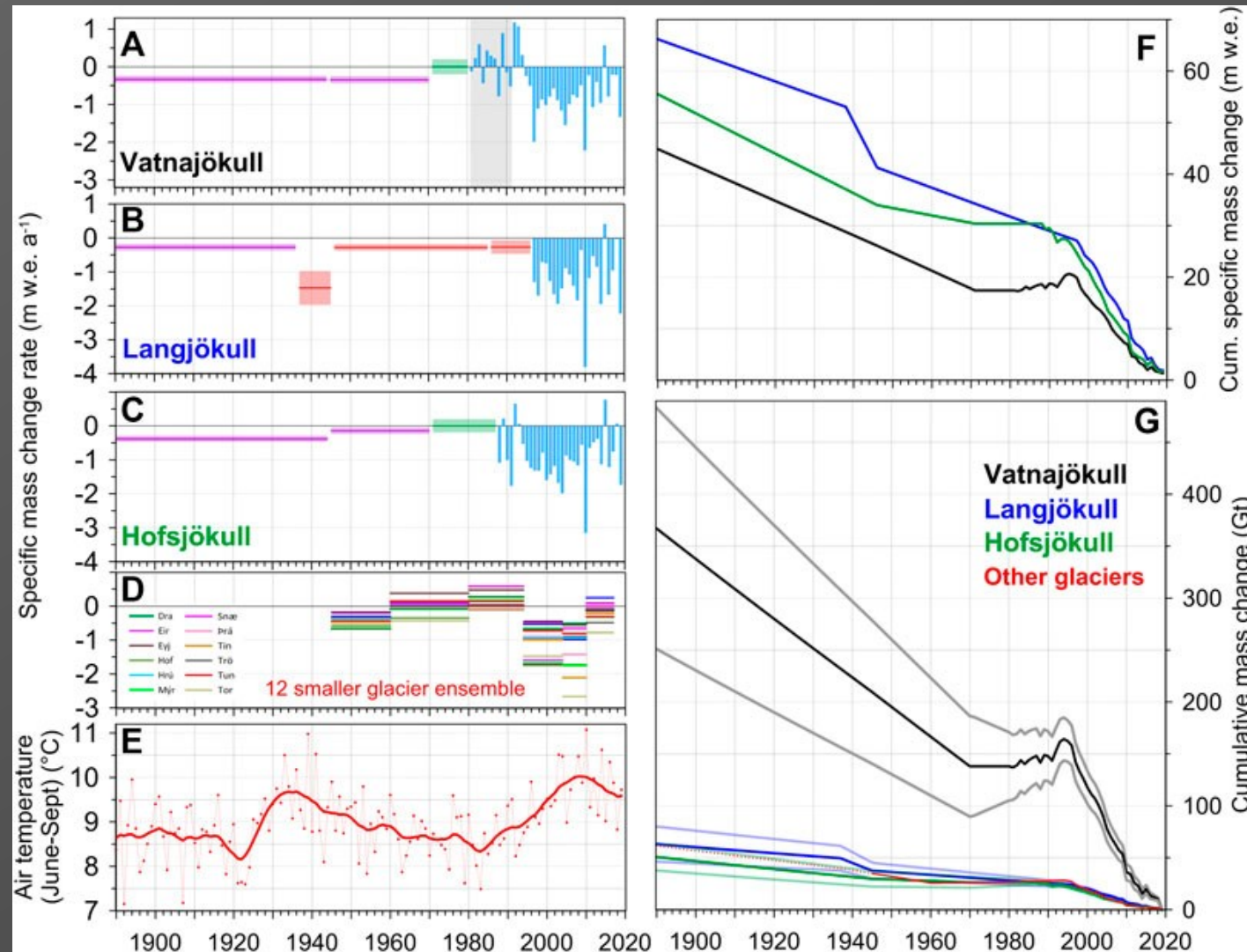
Cryosphere 2022, 25 Aug 2022.  
Safnarhús auditorium, Reykjavík, Iceland



UNIVERSITY OF ICELAND  
INSTITUTE OF EARTH SCIENCES



# Glacier mass balance in Iceland: geodetic observations

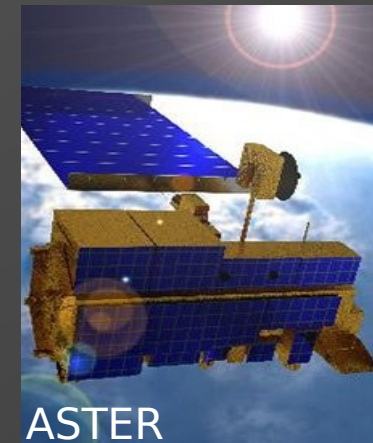


*Aðalgeirsdóttir et al., 2020*



Lidar

*Jóhannesson et al., 2013*



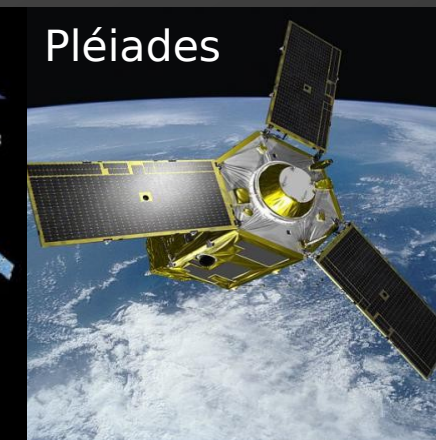
ASTER



SPOT5

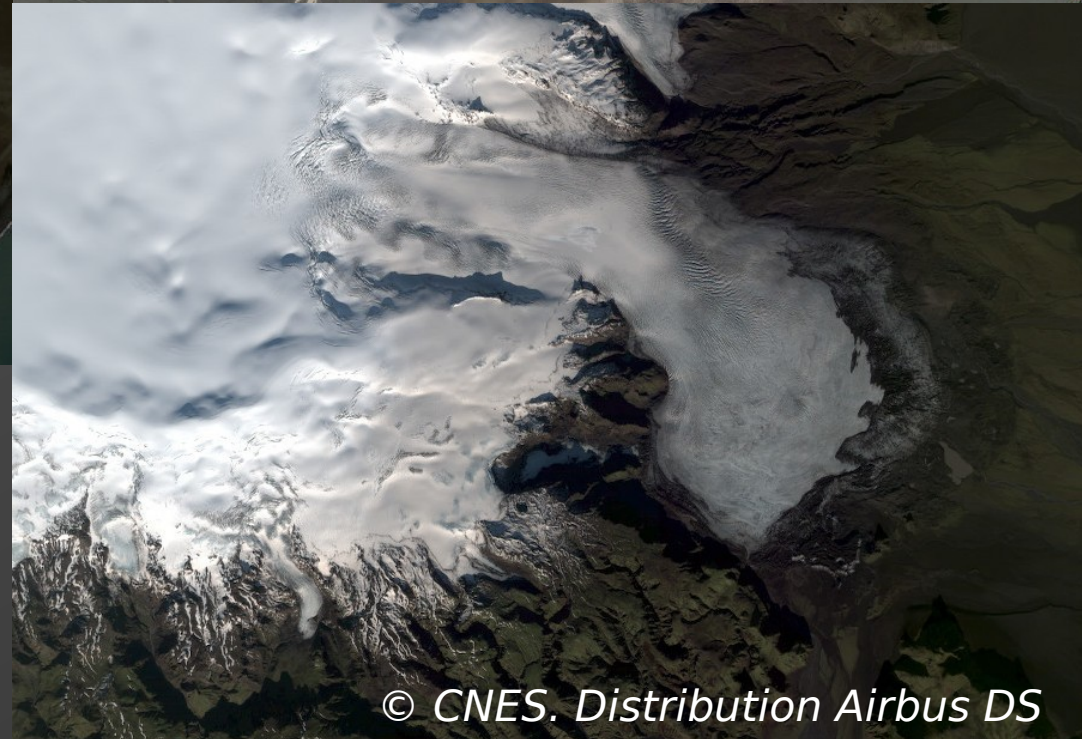
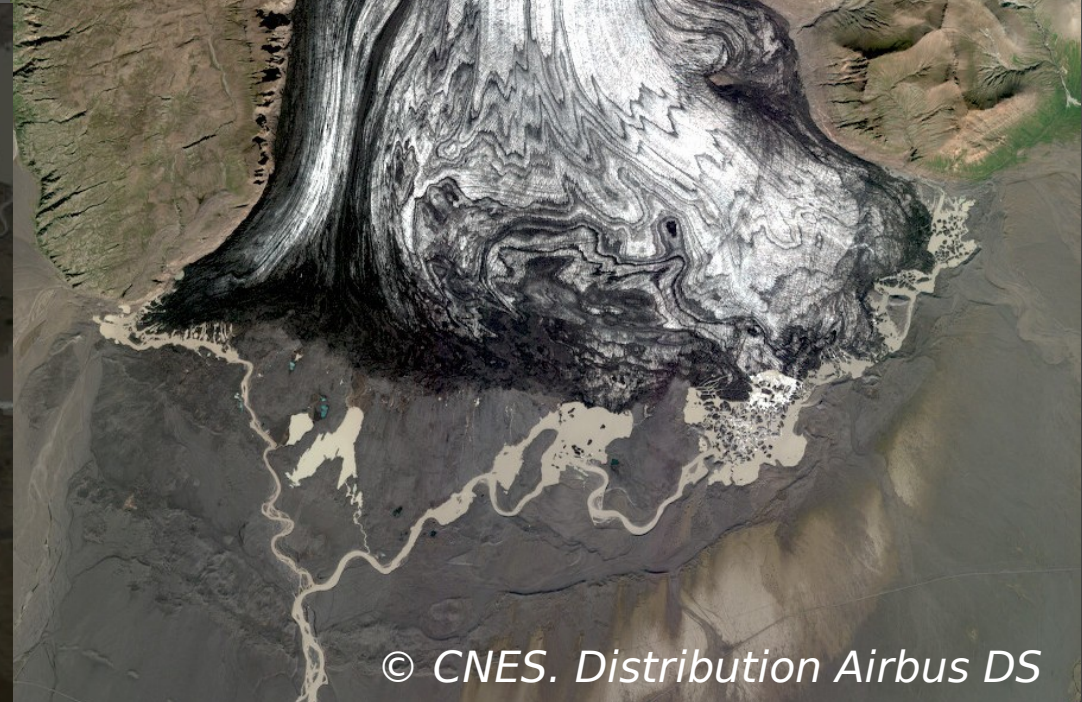
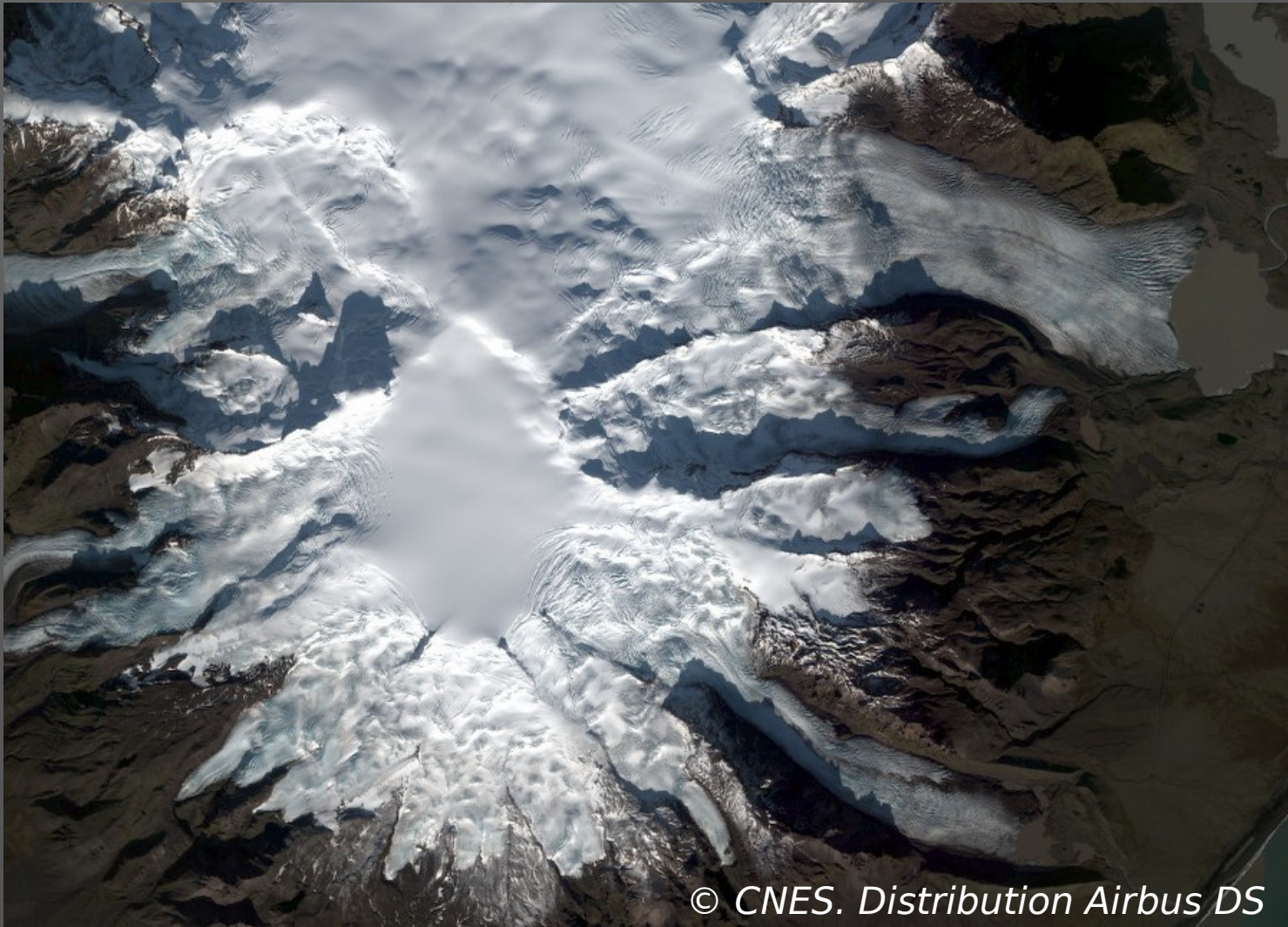


WV01-03 & GE01



Pléiades

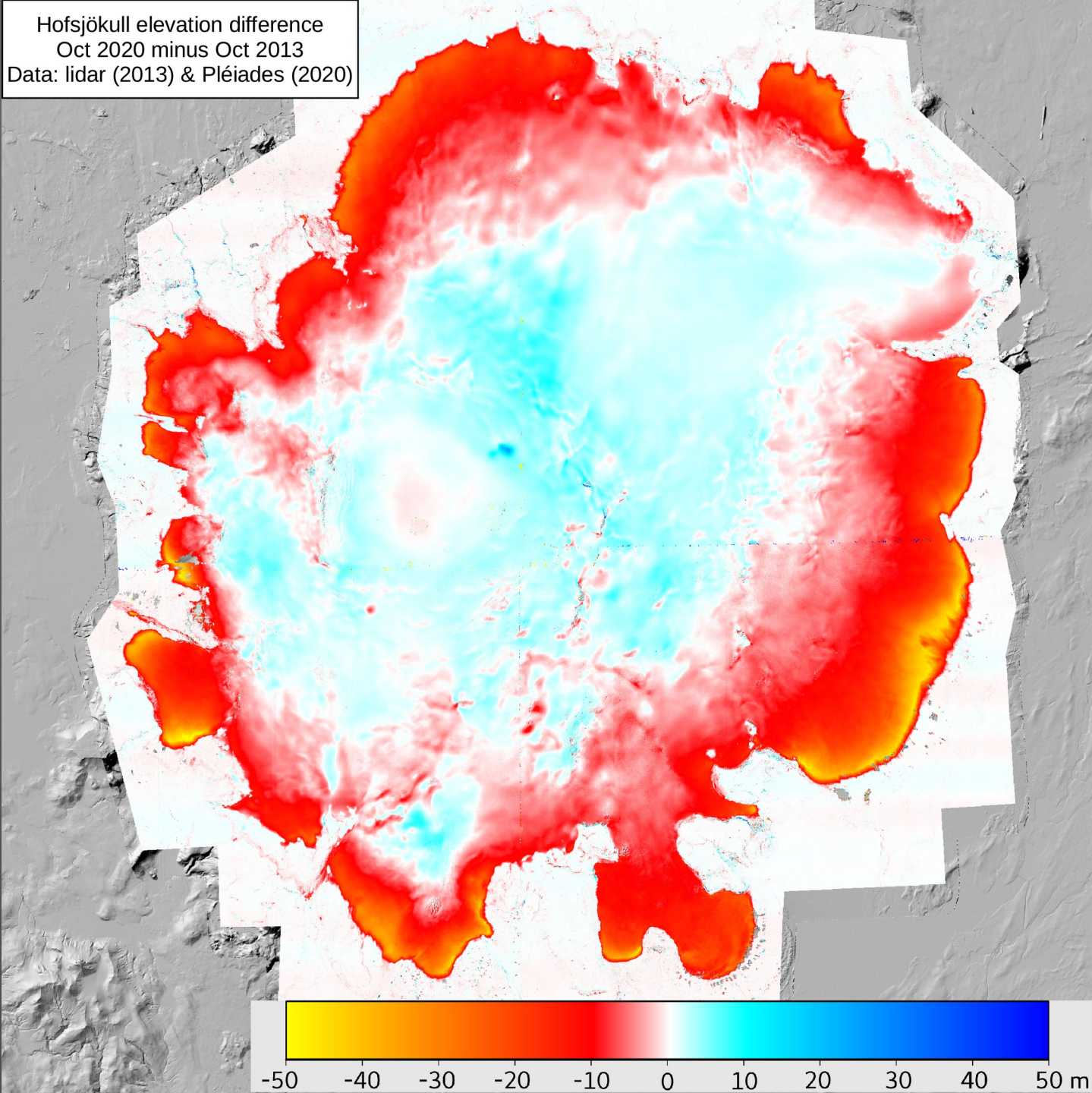
*Porter et al., 2018*



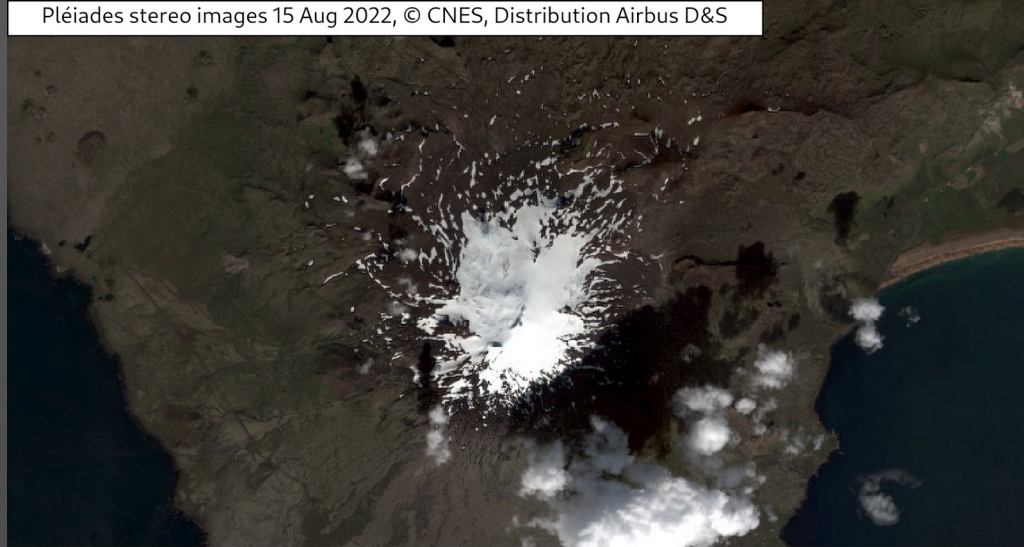
Glacier mapping from Pléiades stereo images:

2020:	~2,000 km <sup>2</sup>
2021:	~15,000 km <sup>2</sup>
2022:	~4,000 km <sup>2</sup>

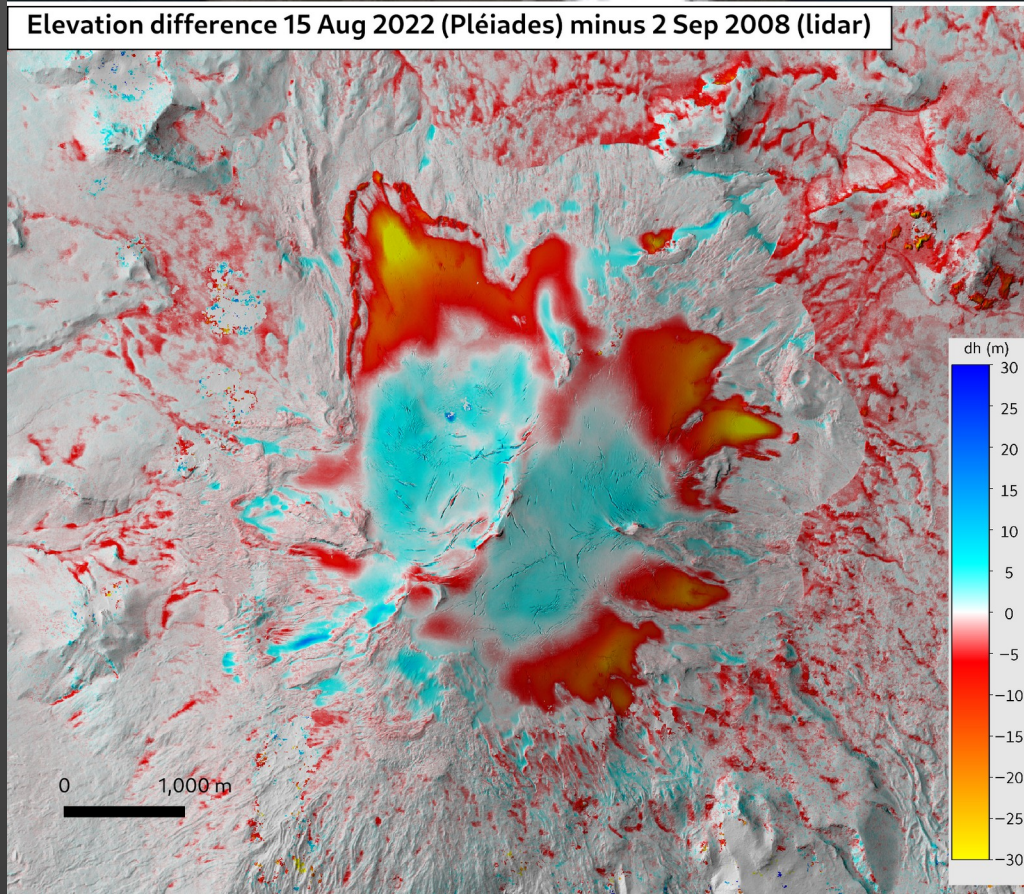
Hofsjökull elevation difference  
Oct 2020 minus Oct 2013  
Data: lidar (2013) & Pléiades (2020)



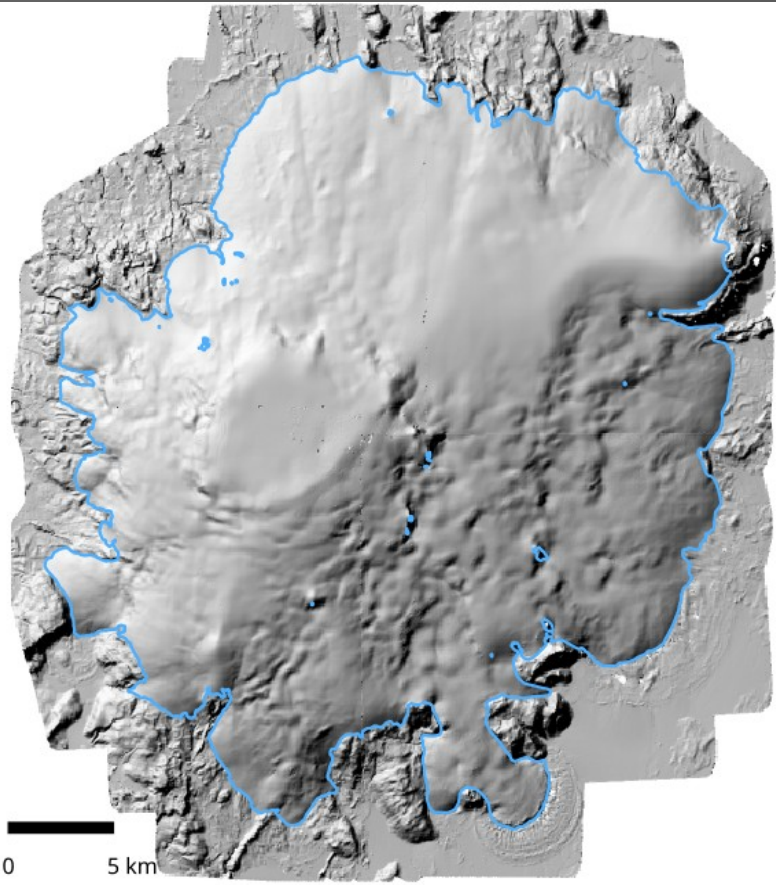
Pléiades stereo images 15 Aug 2022, © CNES, Distribution Airbus D&S



Elevation difference 15 Aug 2022 (Pléiades) minus 2 Sep 2008 (lidar)

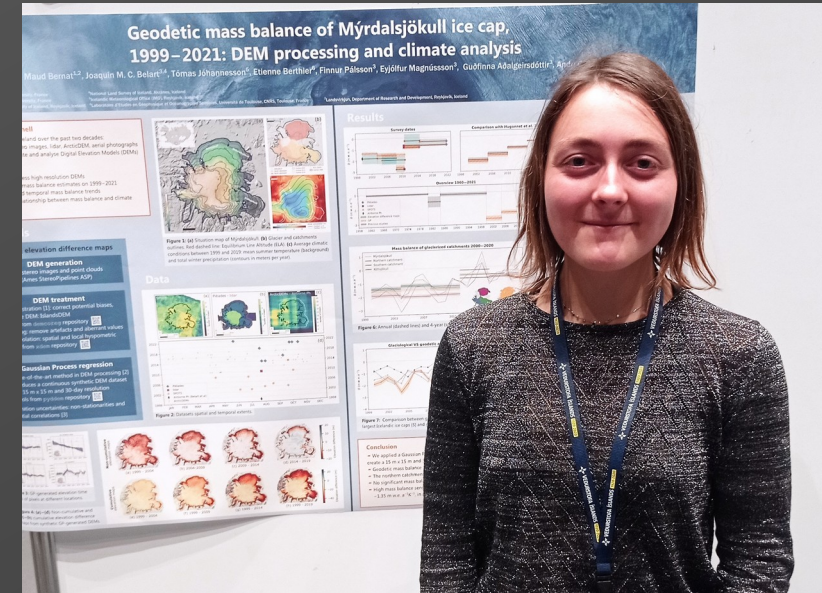


# Case-studies: Hofsjökull (810 km<sup>2</sup>) & Mýrdalsjökull (520 km<sup>2</sup>)



Glaciological mass balance since 1987

Three lidar surveys (2008, 2010, 2013): Calibration and re-positioning of mass balance points

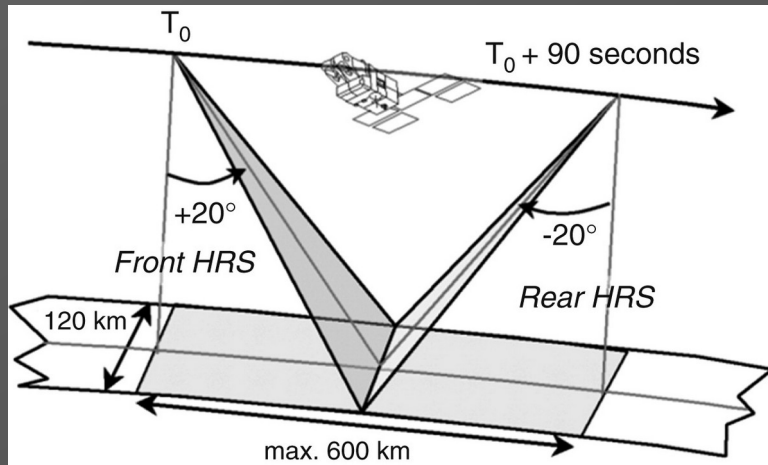


*Maud Bernat, poster session 1*



# SPOT5 processing

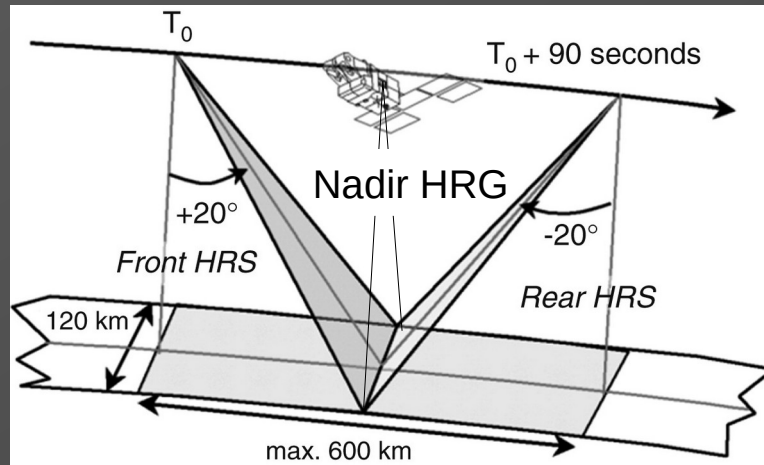
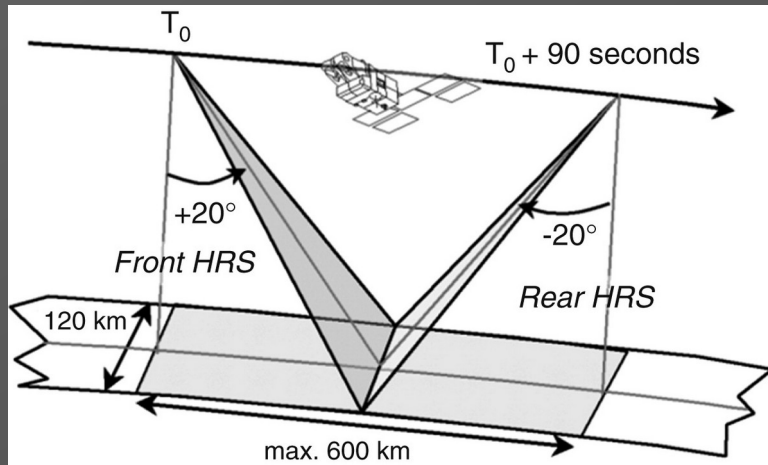
All SPOT1-5 raw imagery is now fully open at:  
<https://regards.cnes.fr/user/swh>



*Korona et al., ISPRS, 2009*

# SPOT5 processing

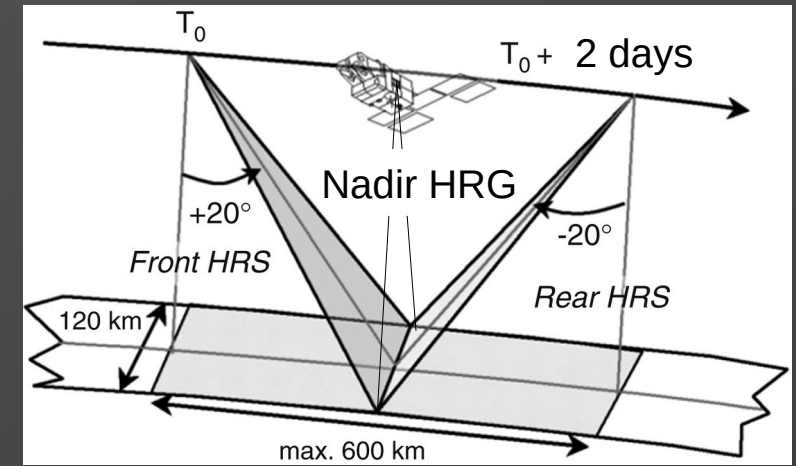
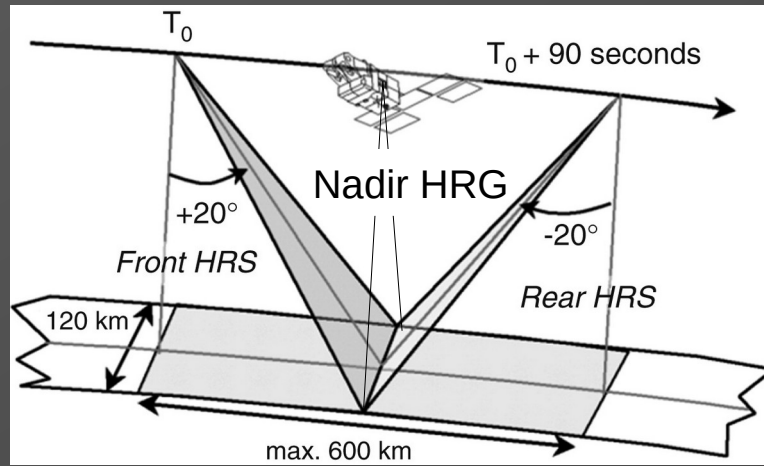
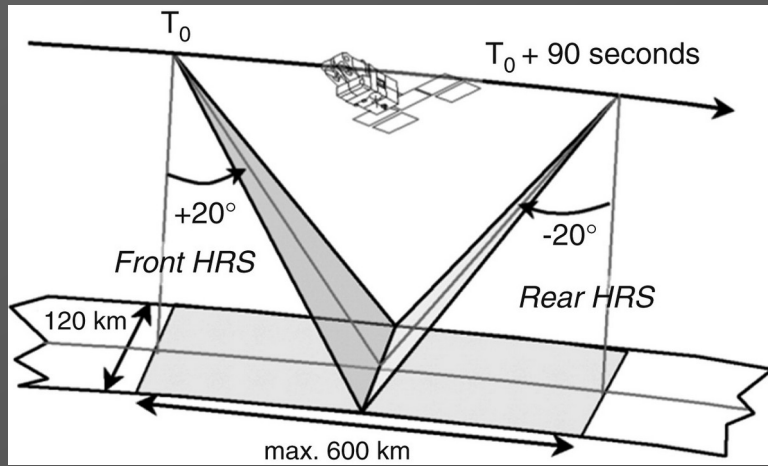
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*Korona et al., ISPRS, 2009*

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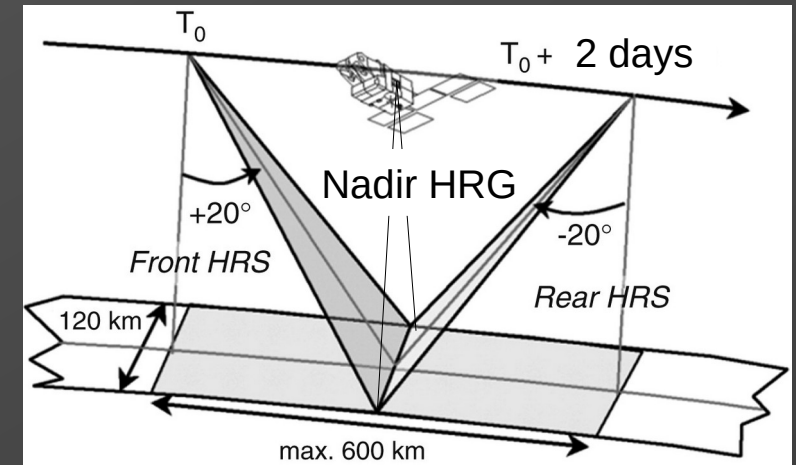
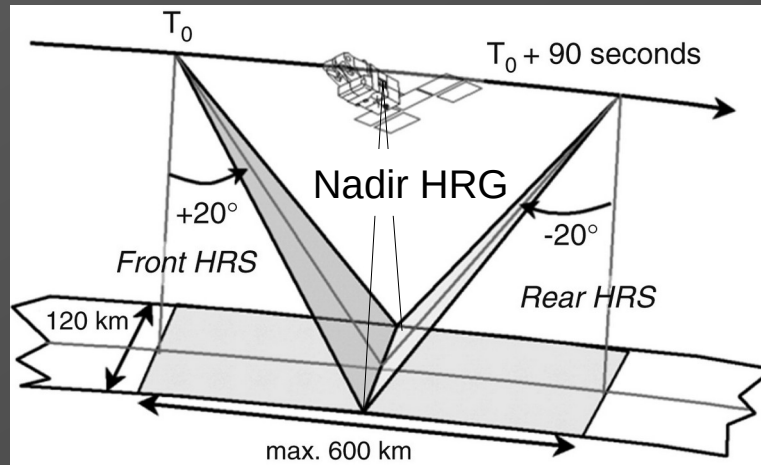
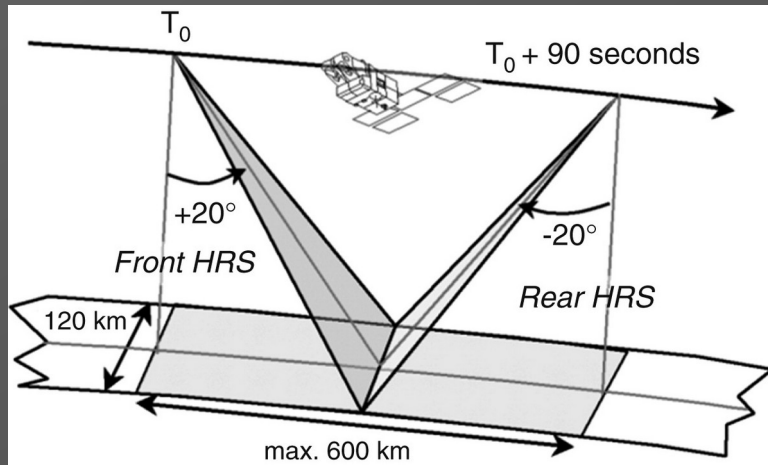


*Korona et al., ISPRS, 2009*



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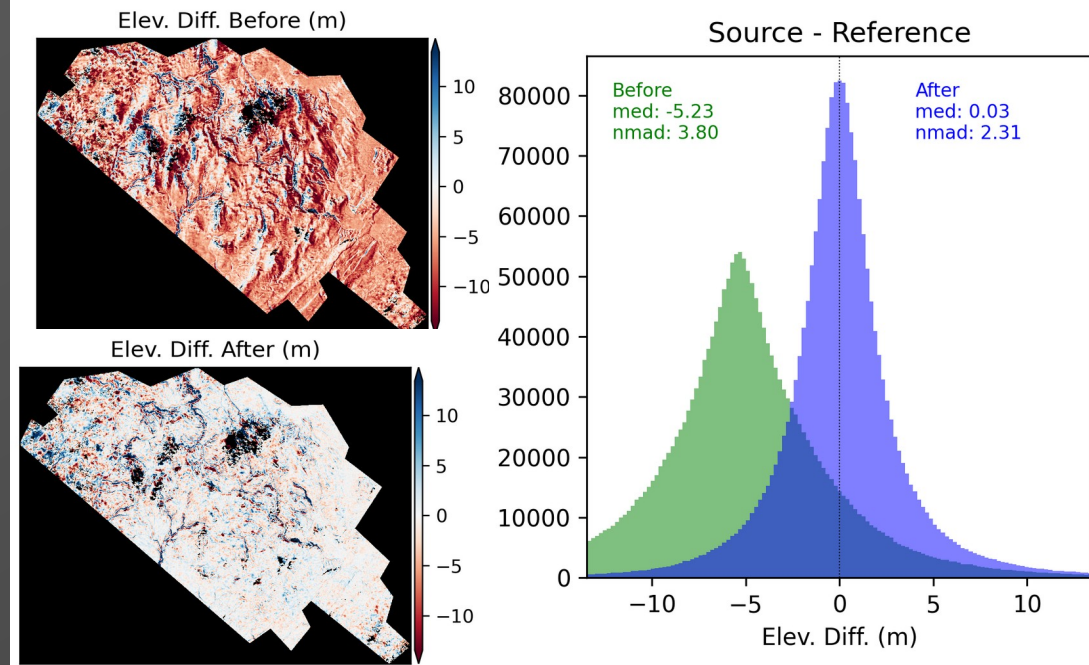
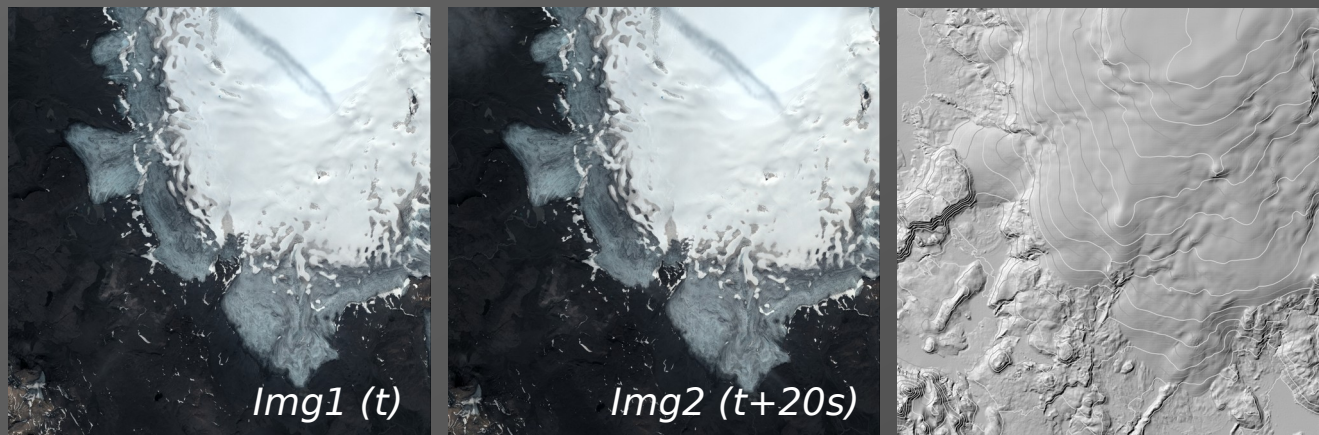


*Korona et al., ISPRS, 2009*

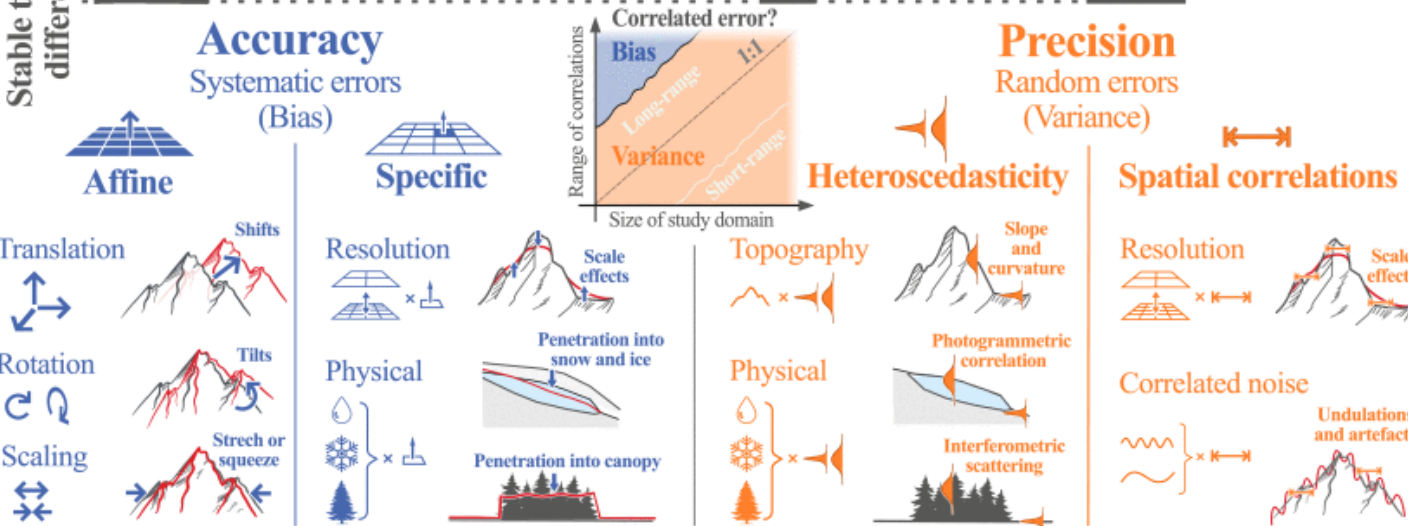
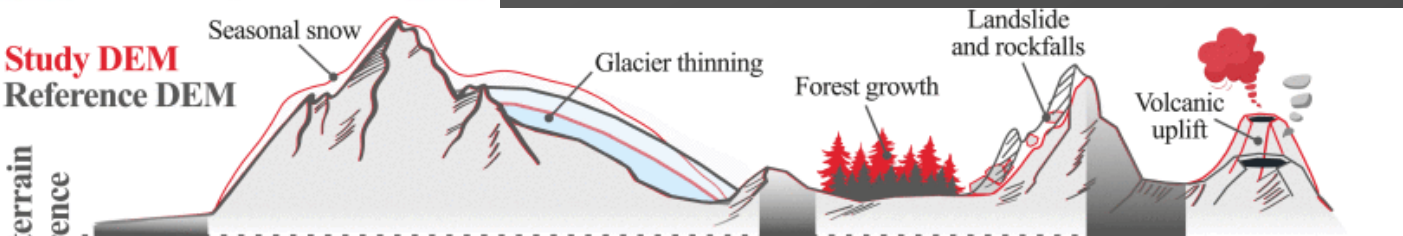
Hofsjökull:

- 197 single images (258 tentative couples)
- 160 DEMs (segments)
- 36 DEMs (single day + 2-day mosaics)

# DEM processing: Ames StereoPipeline



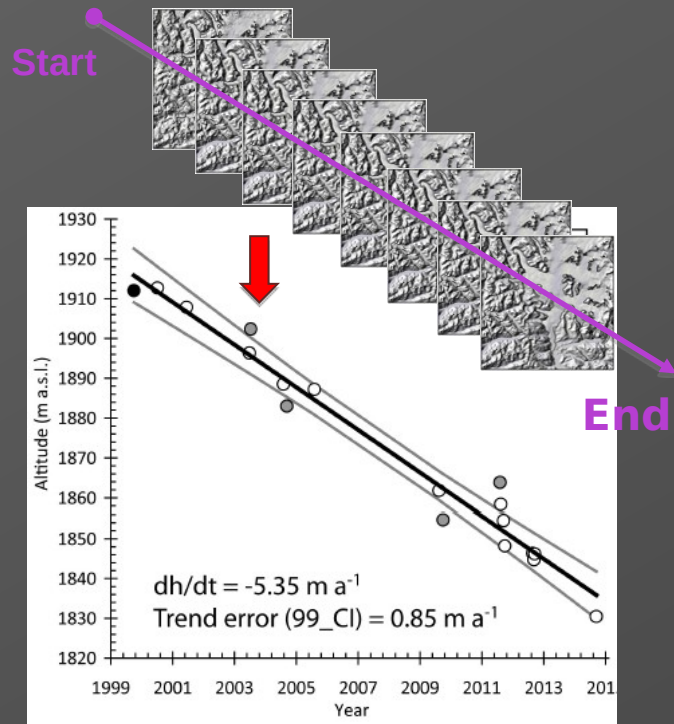
**New Paper Alert**



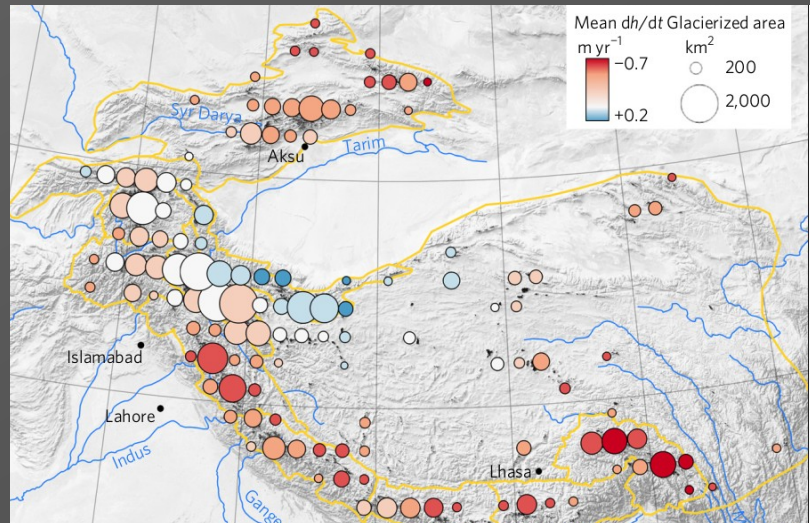
DEM co-registration  
<https://github.com/dshean/demcoreg>  
 (Shean et al., 2016)

Filtering, gap filling, uncertainties:  
 Hugonnet et al., 2022  
<https://github.com/GlacioHack/xdem>

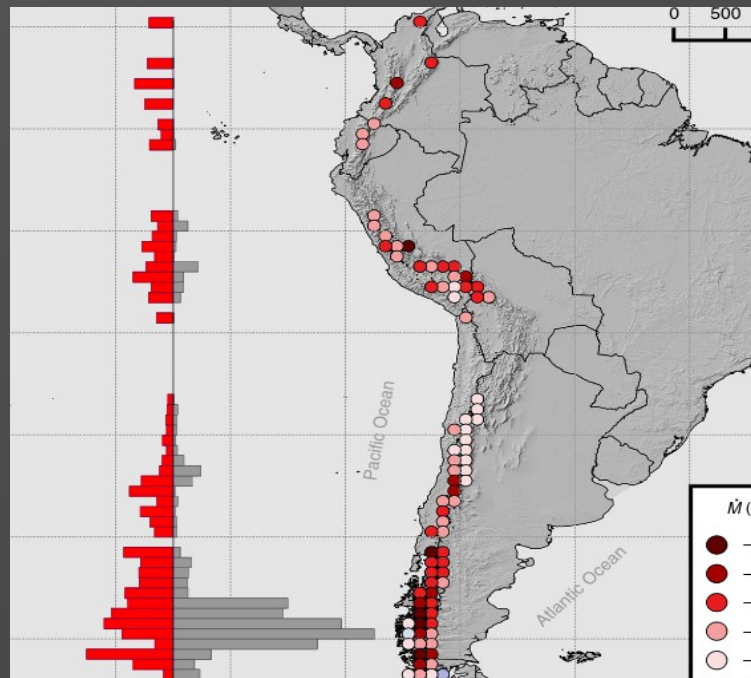
# ASTER DEM stacks



Berthier et al., Frontiers, 2016

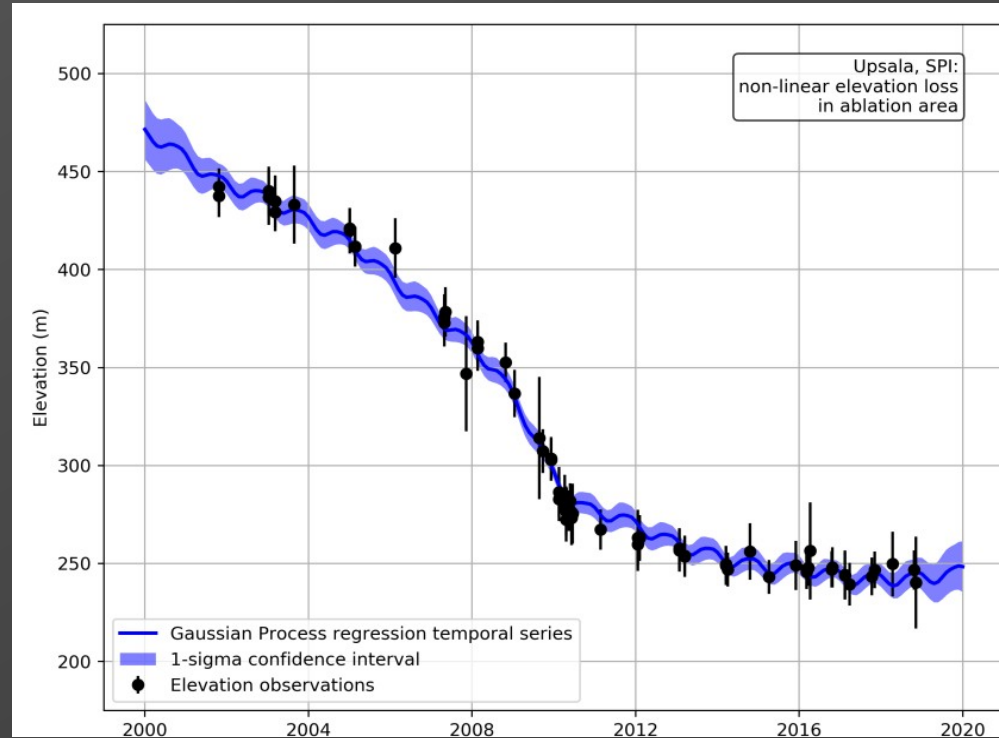


Brun et al., 2017

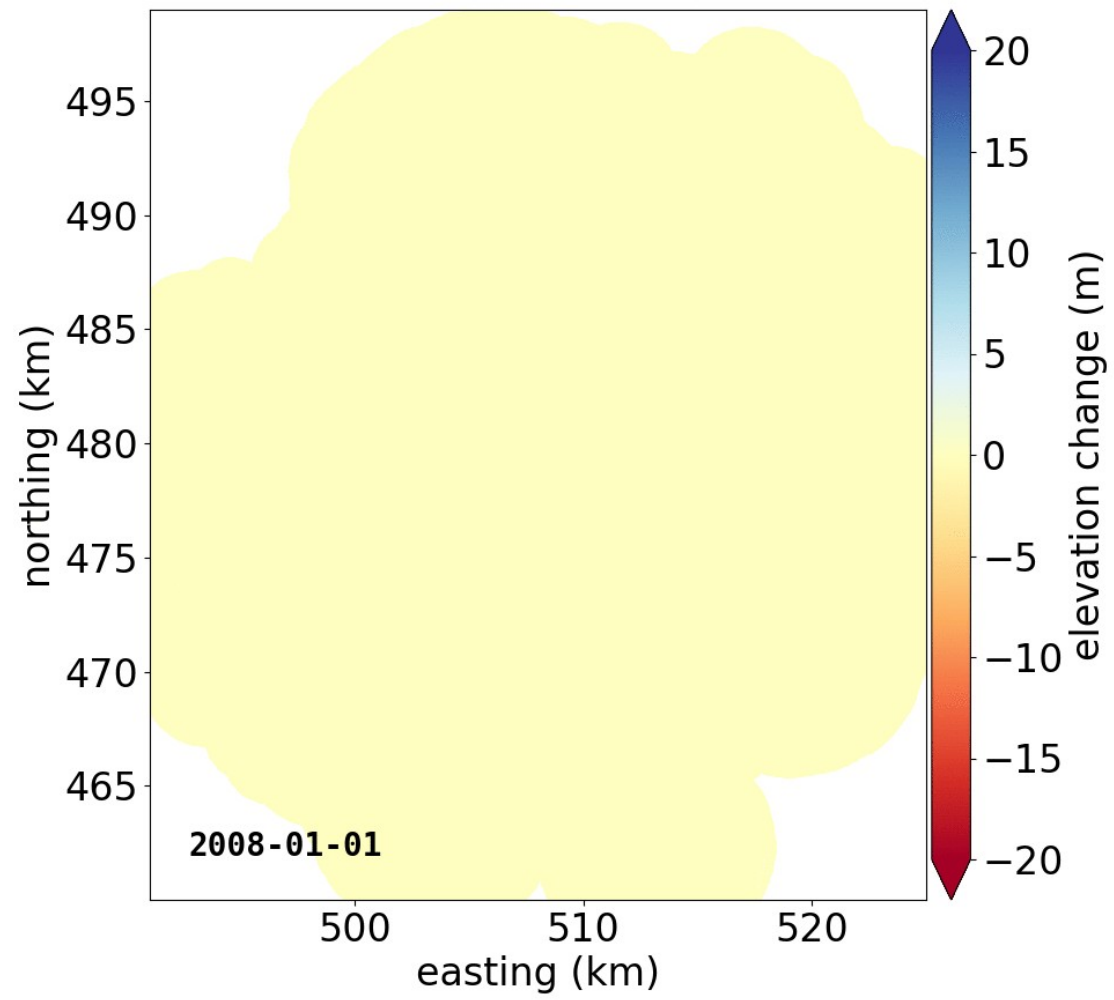


Dussailant et al., 2019

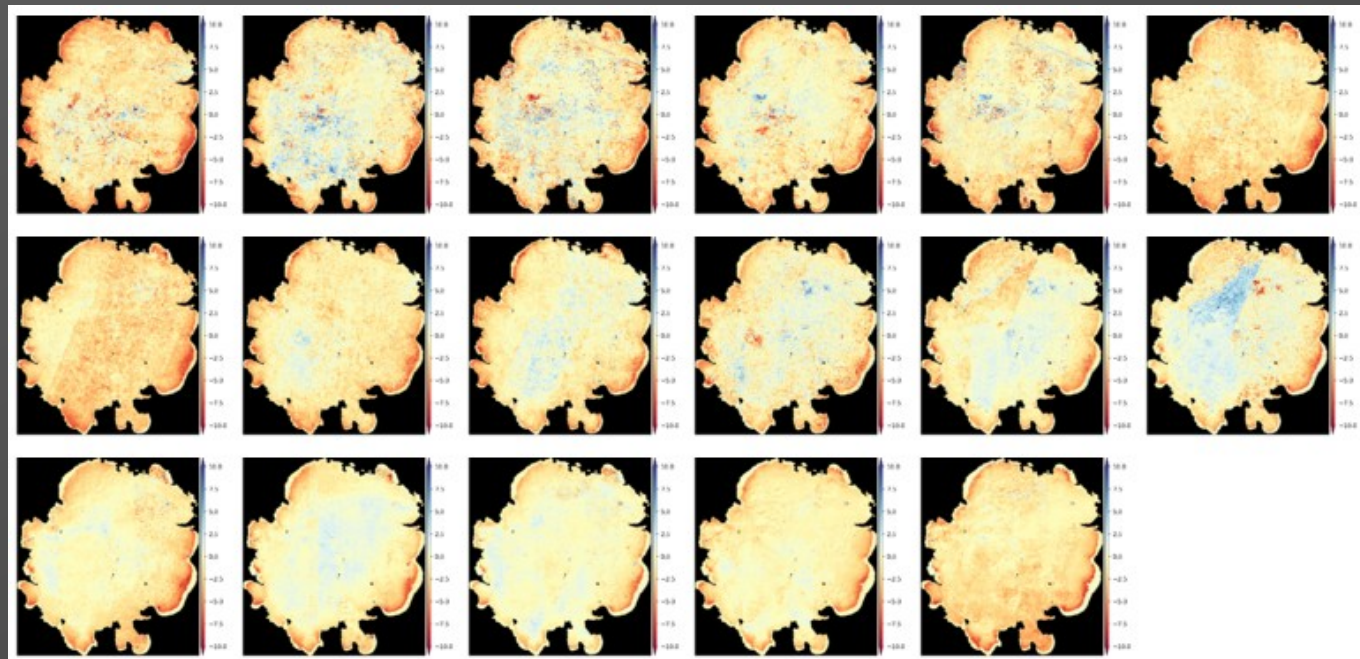
# Gaussian processes



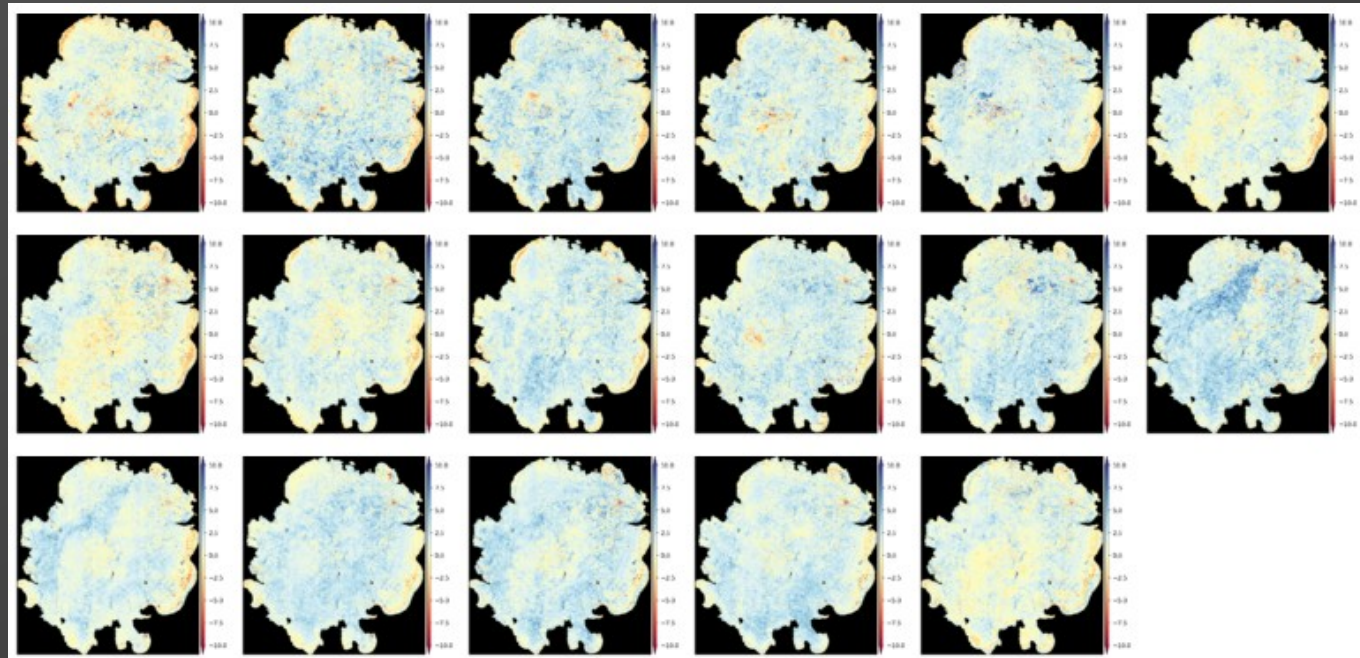
Hugonnet et al., 2021.  
<https://github.com/iamdonovan/>  
<https://github.com/rhugonnet/>



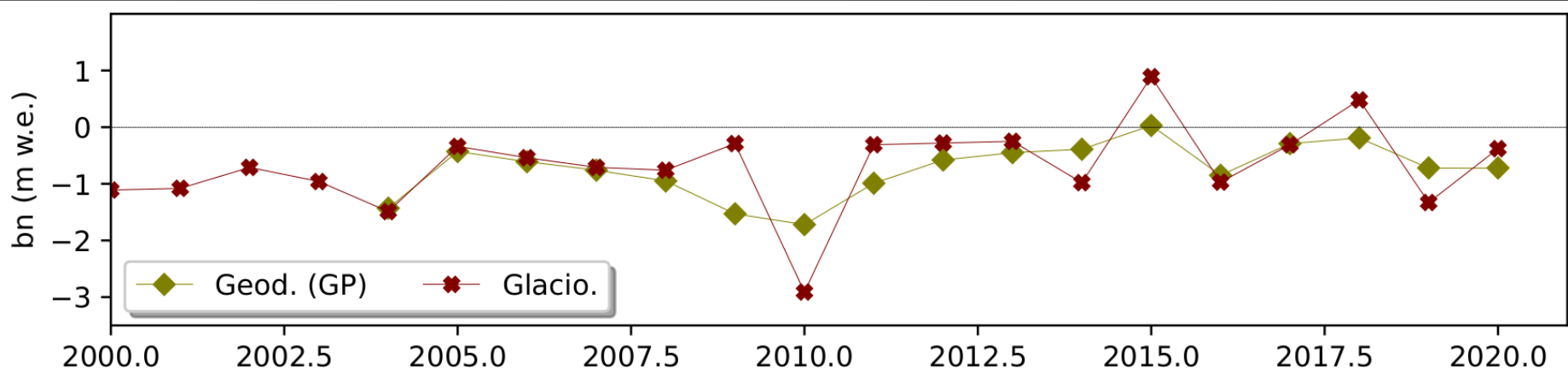
1 Oct - 1 Oct



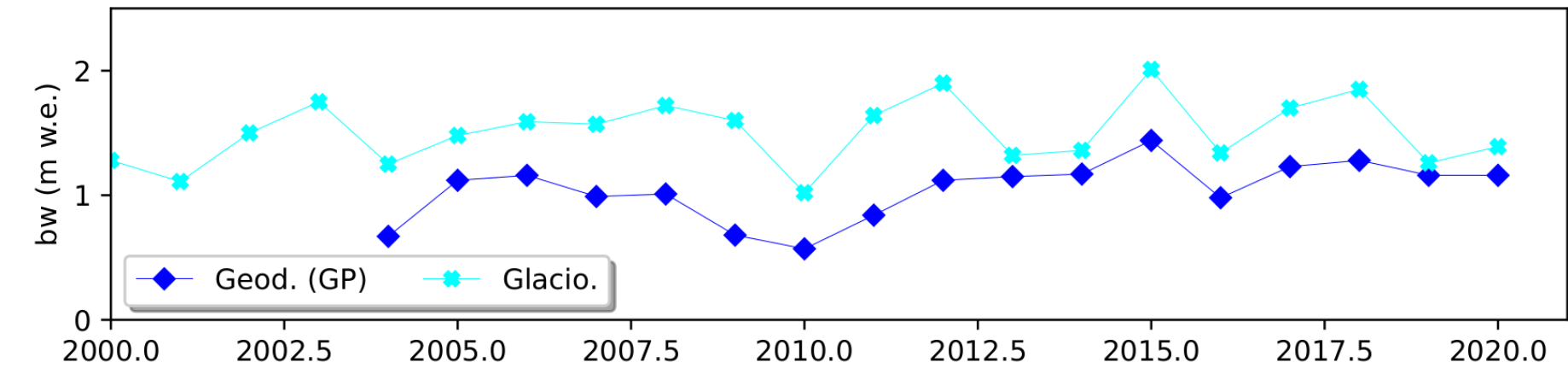
1 Oct - 1 Jun



# Geodetic vs glaciological mass balance



$\Delta V$  to m w.e.:  
 $\rho = 850 \pm 60 \text{ kg m}^{-3}$   
(Huss, TC, 2013)



$\Delta V$  to m w.e.:  
In situ measurements  
( $\rho \approx 500 \text{ kg m}^{-3}$ )

# Perspectives and challenges

Multitemporal, open DEMs available. Particularly abundant in Iceland. High-performance, “off the shelf” methods to process them

Remaining (Non Remote Sensing) challenges:  
Density assumptions/observations. Snow & firn densification

Challenges in satellite stereo in years coming:  
ASTER and Pléiades end of support soon. No open replacement planned.

January 29, 2021

**Upcoming Terra Constellation Exit**

<https://asterweb.jpl.nasa.gov/>

