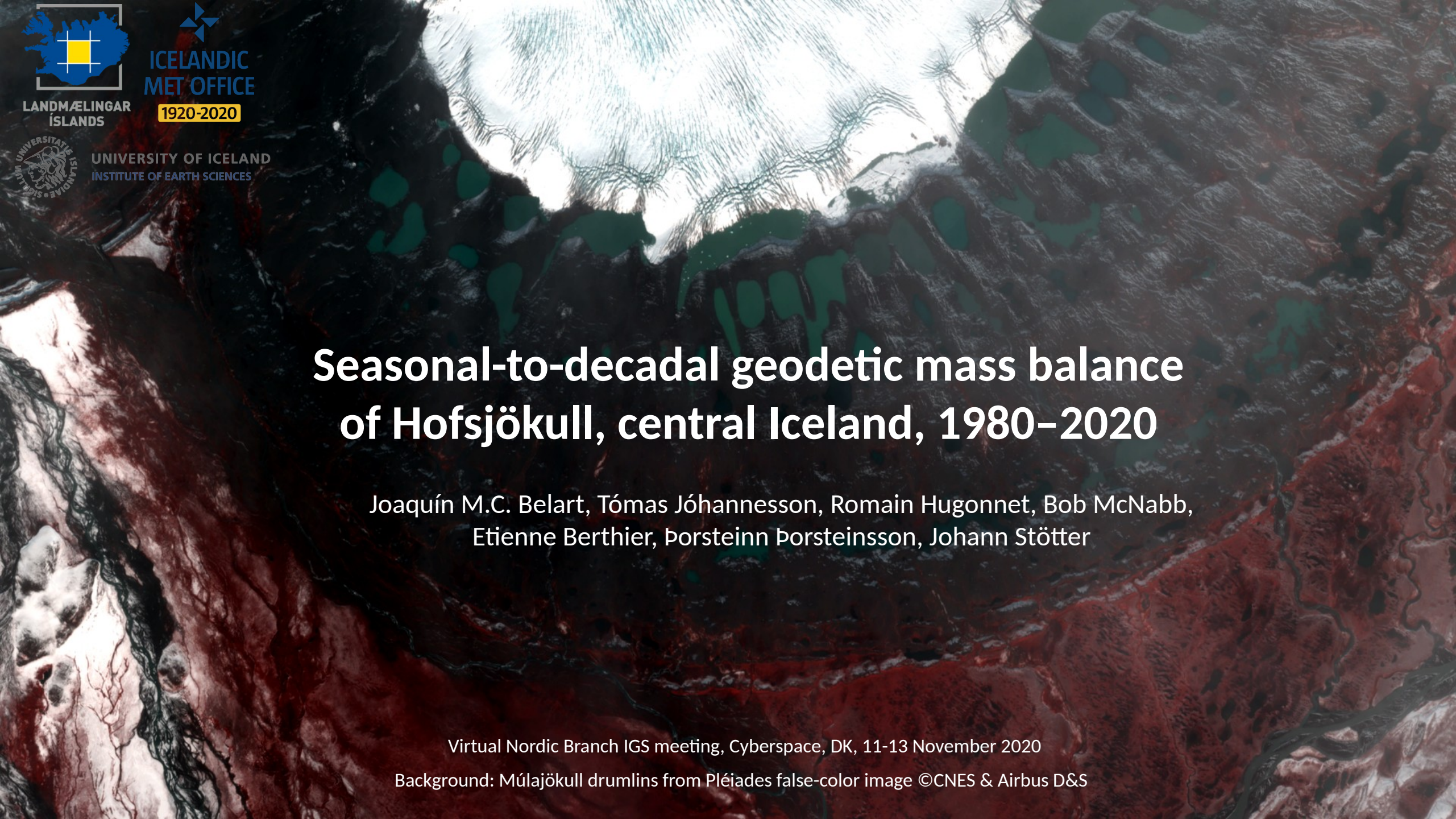


LANDMÆLINGAR ÍSLANDS

ICELANDIC MET OFFICE
1920-2020

UNIVERSITY OF ICELAND
INSTITUTE OF EARTH SCIENCES

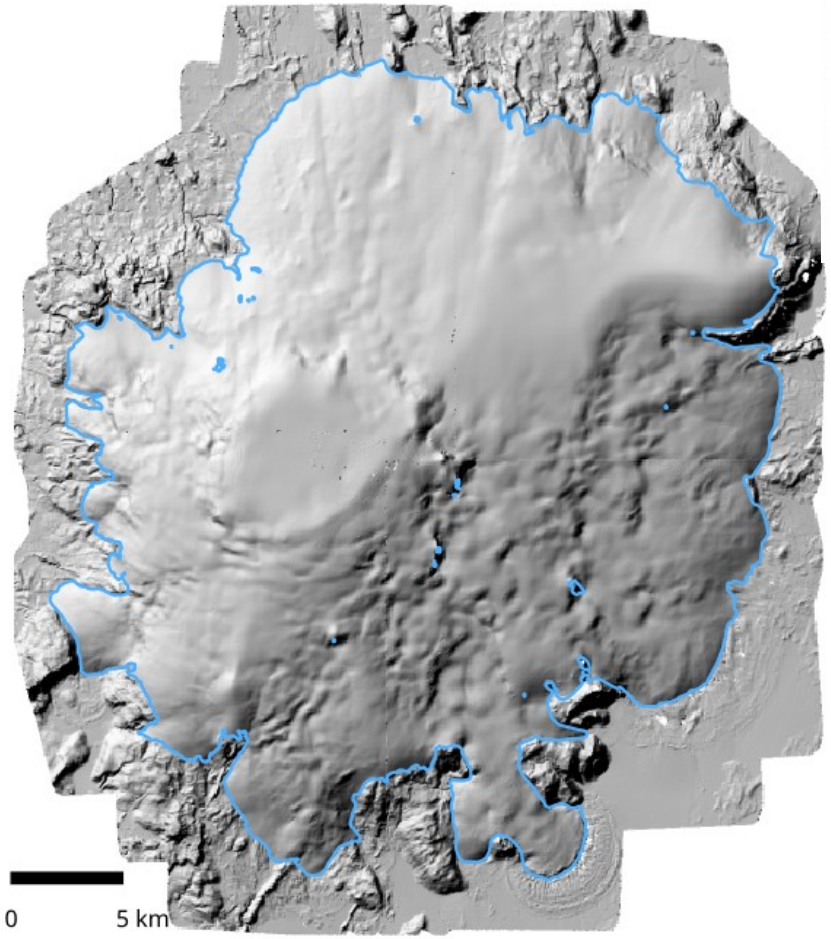
Seasonal-to-decadal geodetic mass balance of Hofsjökull, central Iceland, 1980–2020

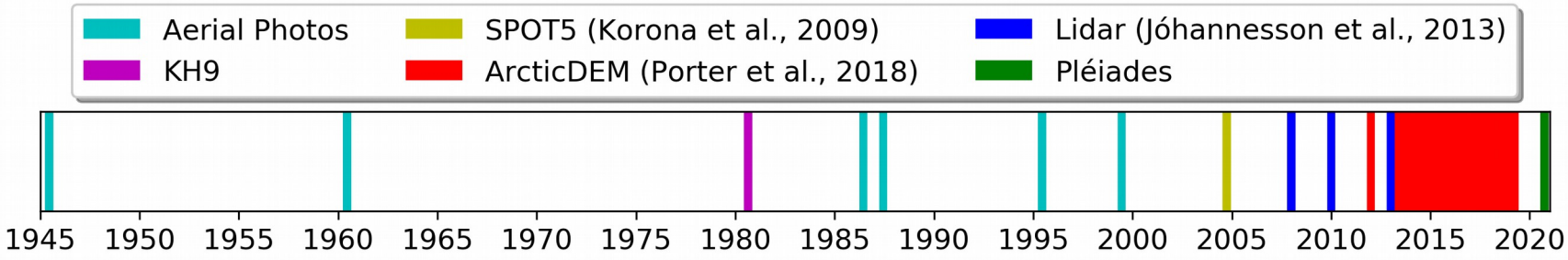
Joaquín M.C. Belart, Tómas Jóhannesson, Romain Hugonnet, Bob McNabb, Etienne Berthier, Þorsteinn Þorsteinsson, Johann Stötter

Virtual Nordic Branch IGS meeting, Cyberspace, DK, 11-13 November 2020

Background: Múlajökull drumlins from Pléiades false-color image ©CNES & Airbus D&S

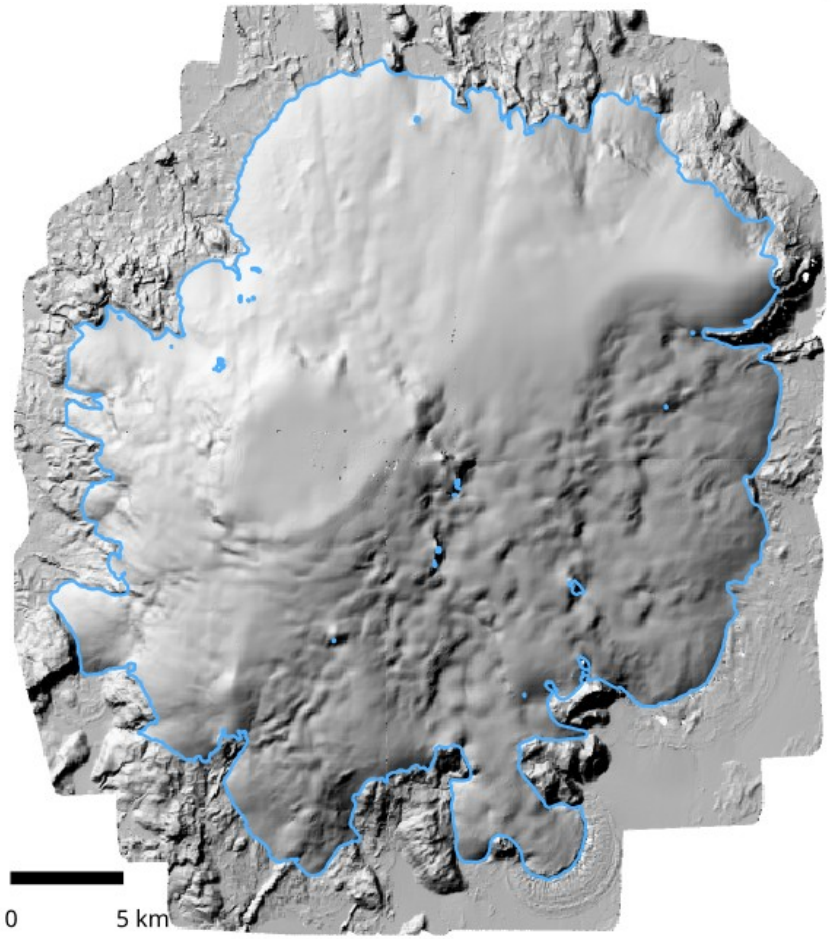
Elevation data on Hofsjökull (810 km^2)



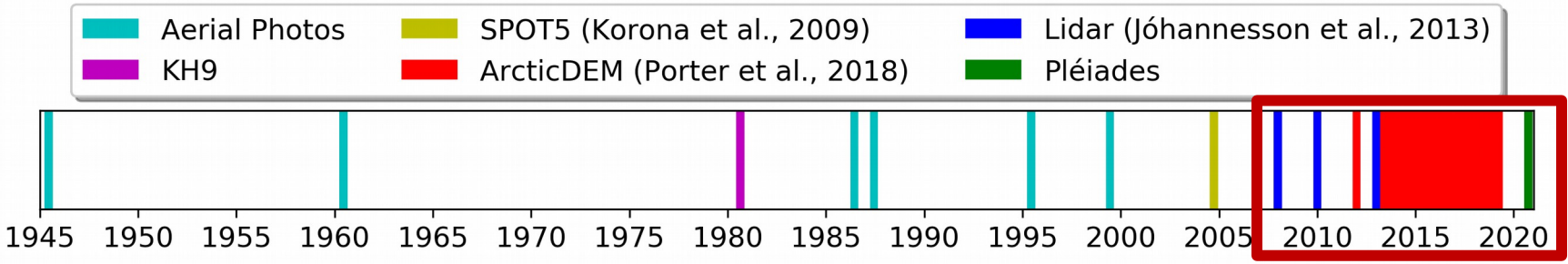


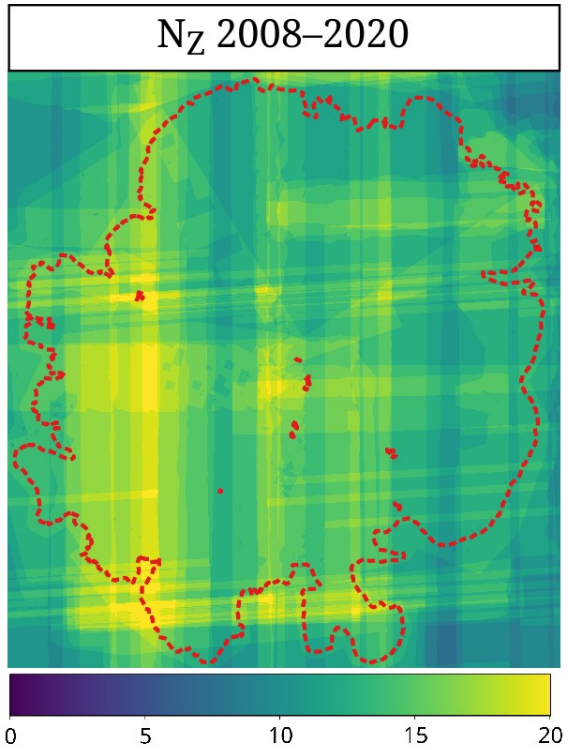
Pléiades DEM, Oct 2020

Elevation data on Hofsjökull (810 km^2)



Pléiades DEM, Oct 2020





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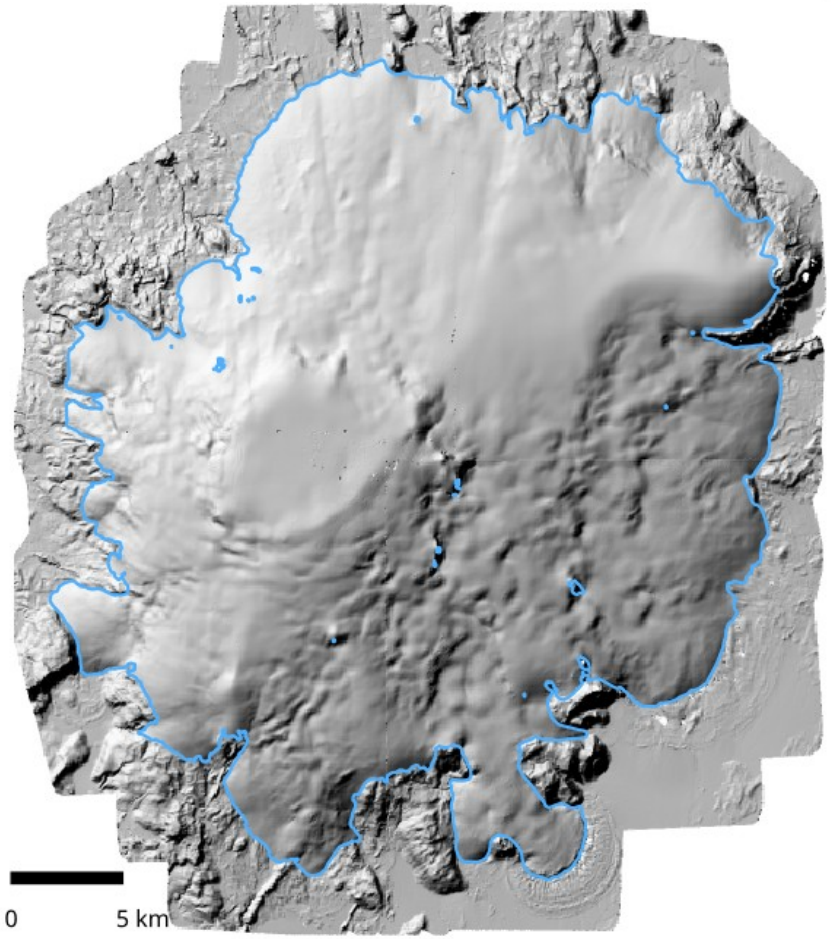
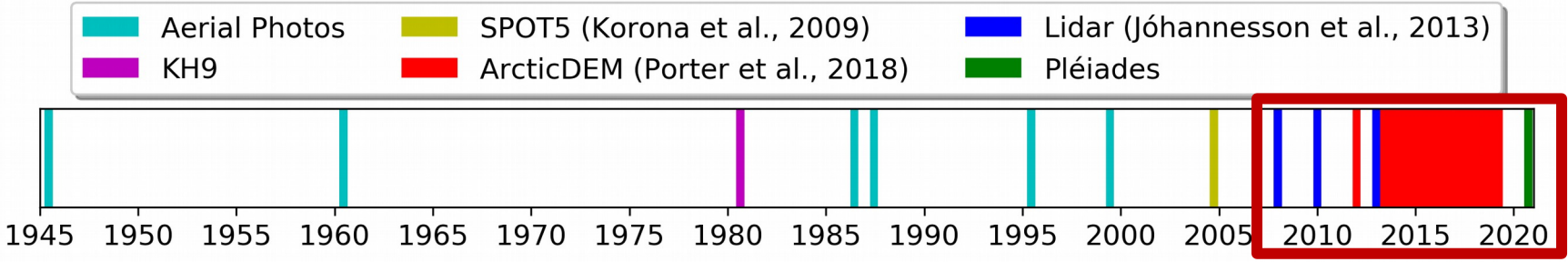
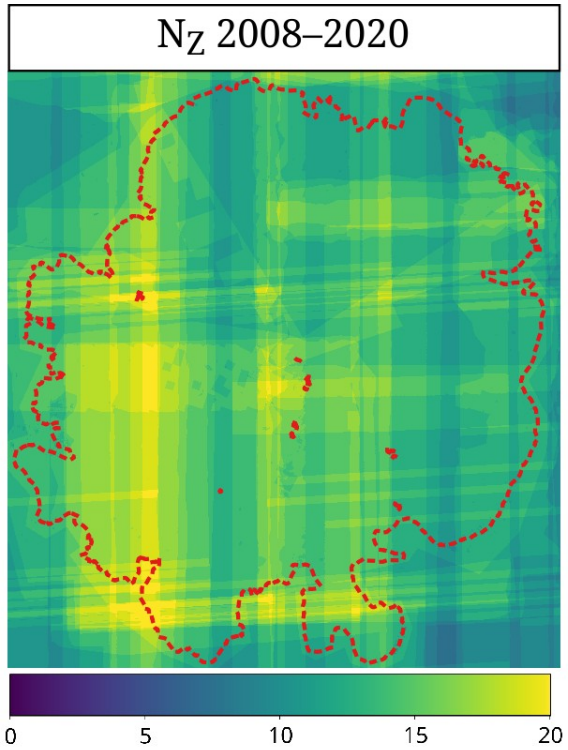


Pléiades DEM, Oct 2020





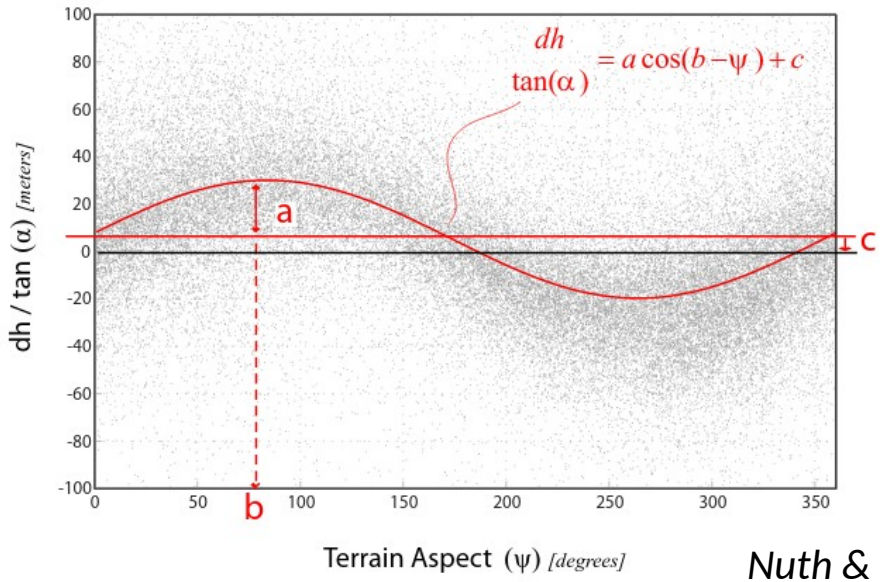
Aims of the study

Efficient handling of multi-temporal DEMs

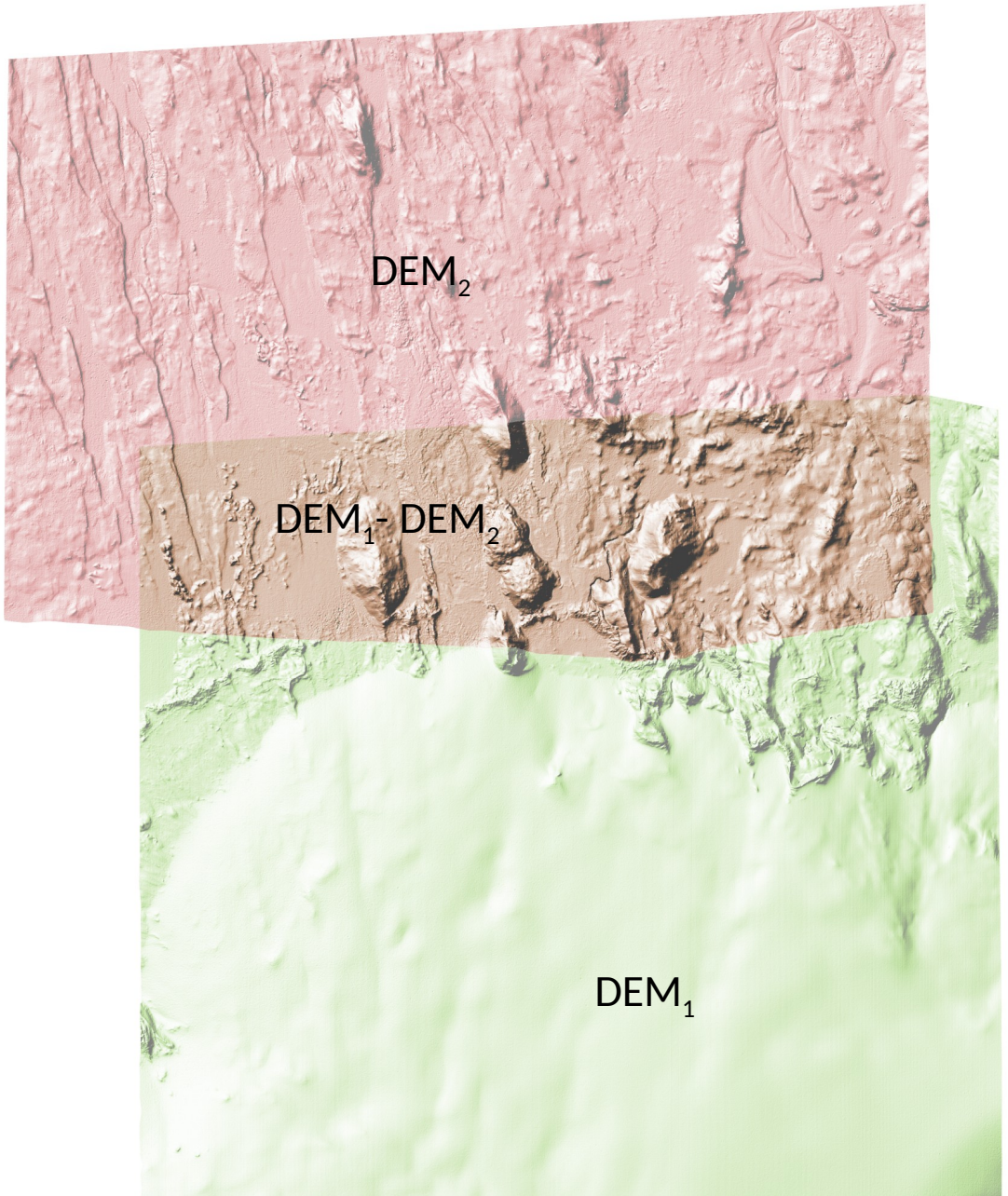
Applications in geodetic mass balance at several time scales

DEM co-registration

- Pairwise shift between two DEMs: $\Delta\xi_{ij}$



Nuth & Kääb, TC, 2011



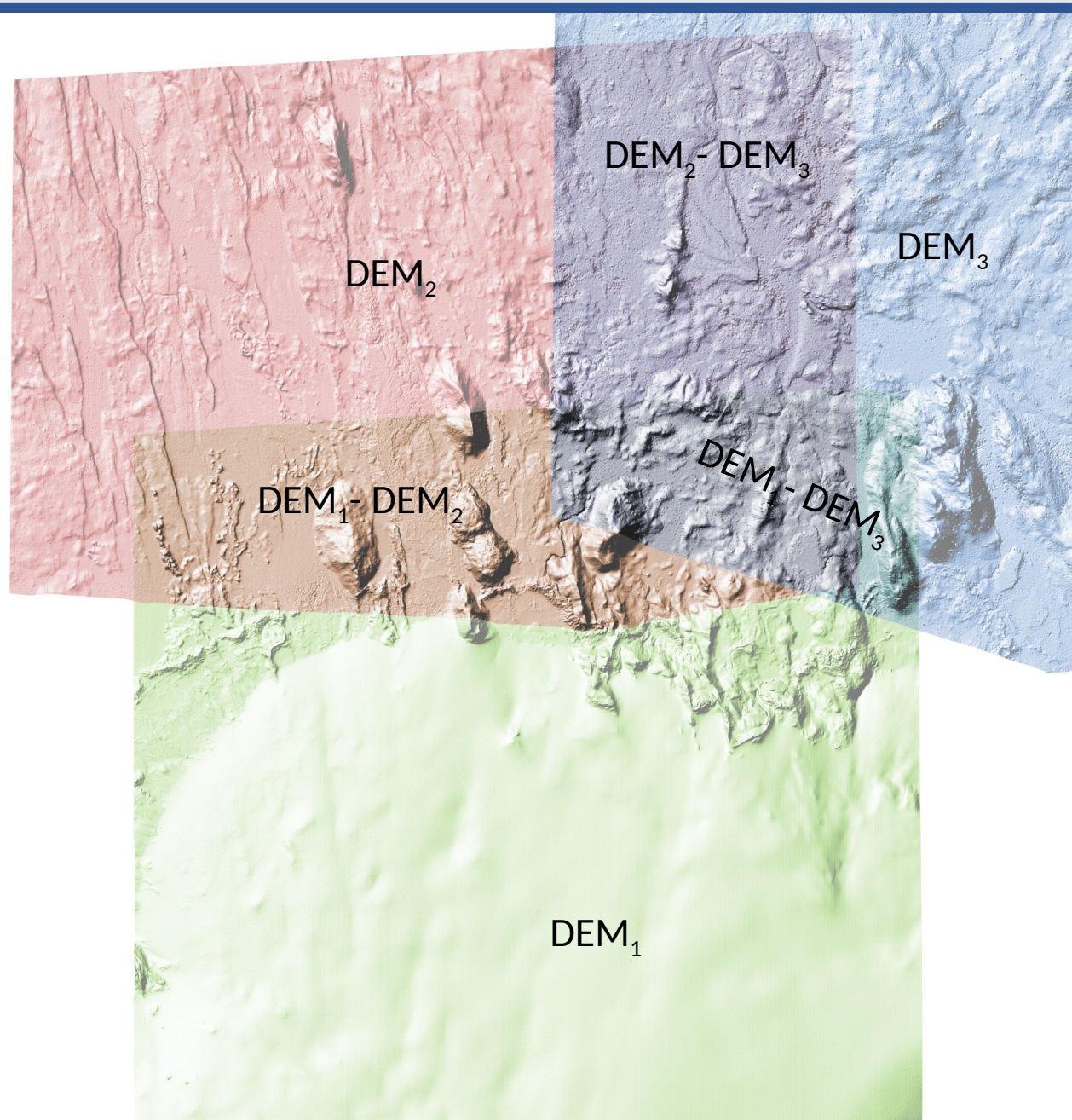
Rscript 'lsqstripoffsets'

- Pairwise shift between two DEMs: $\Delta\xi_{ij}$

$\Delta\xi x_2 - \Delta\xi x_1 = \Delta\xi x_{12}$
$\Delta\xi x_3 - \Delta\xi x_1 = \Delta\xi x_{13}$
(...)

$\Delta\xi y_2 - \Delta\xi y_1 = \Delta\xi y_{12}$
$\Delta\xi y_3 - \Delta\xi y_1 = \Delta\xi y_{13}$
(...)

$\Delta\xi z_2 - \Delta\xi z_1 = \Delta\xi z_{12}$
$\Delta\xi z_3 - \Delta\xi z_1 = \Delta\xi z_{13}$
(...)



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(…)

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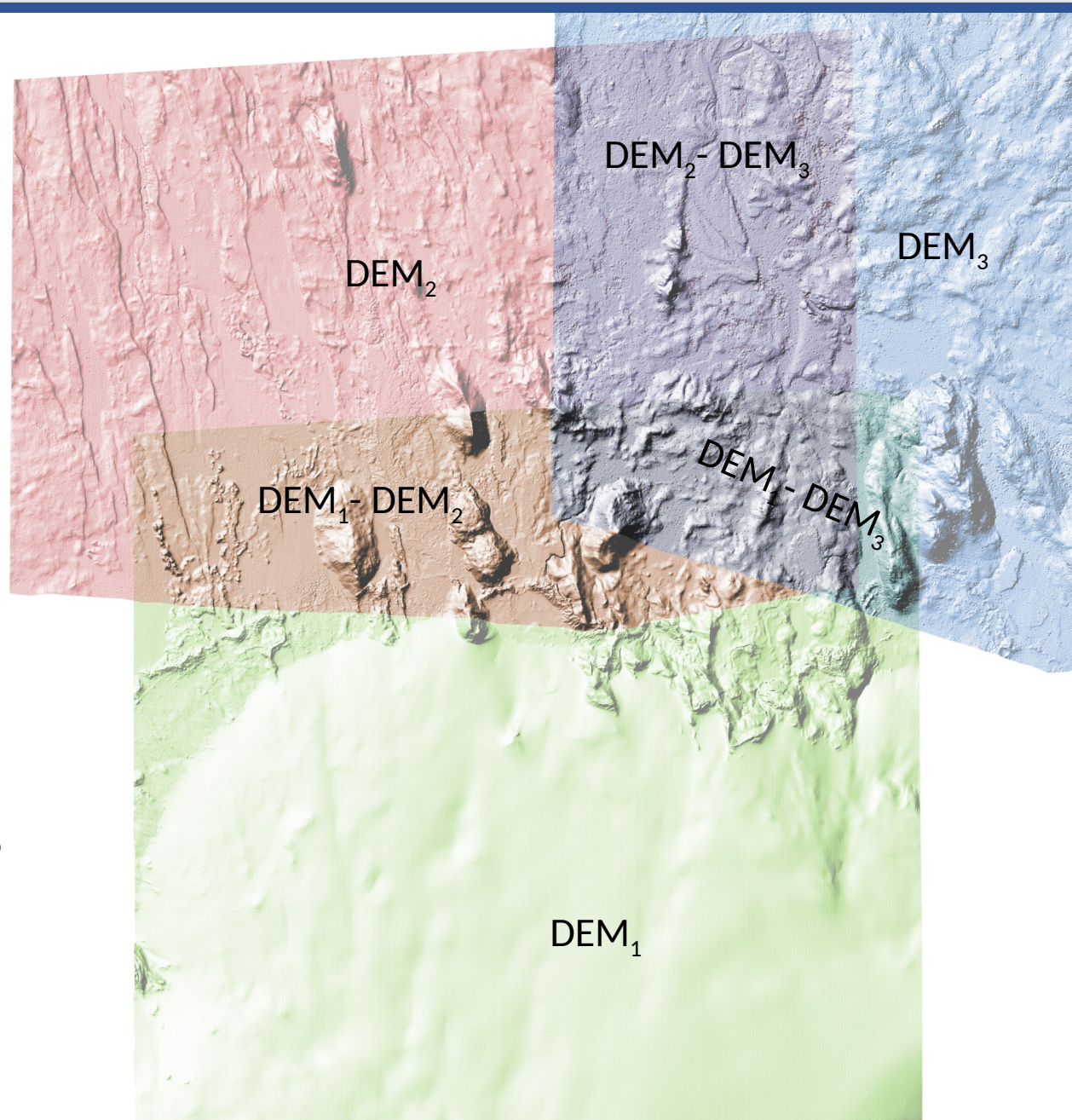
(…)

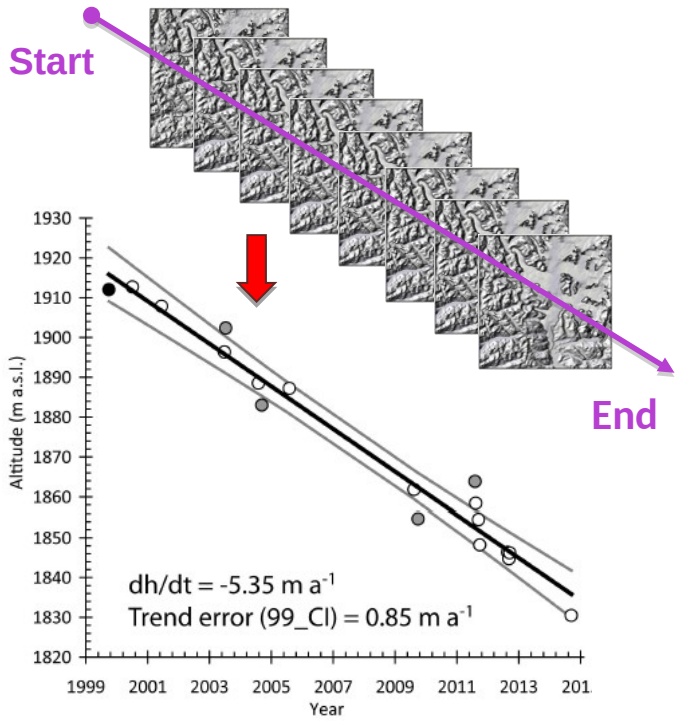
$\Delta\xi z_2 - \Delta\xi z_1 = \Delta\xi z_{12}$
$\Delta\xi z_3 - \Delta\xi z_1 = \Delta\xi z_{13}$
(…)

- 200 ArcticDEMs: 4000 pairwise shifts. Optimal shift ($\Delta\xi_i$) calculated for each individual ArcticDEM strip

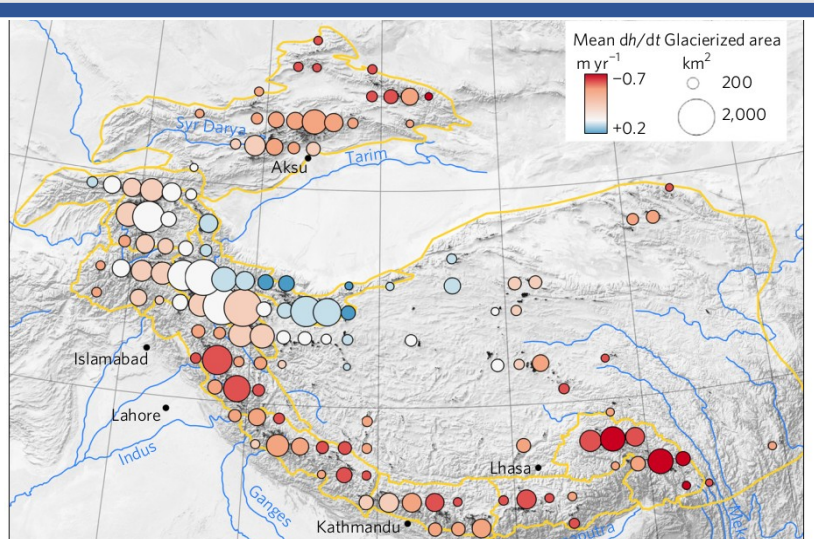
- **Results: Every DEM re-located with sub-meter accuracy (~0.8 m in XY and ~0.3 m in Z)**



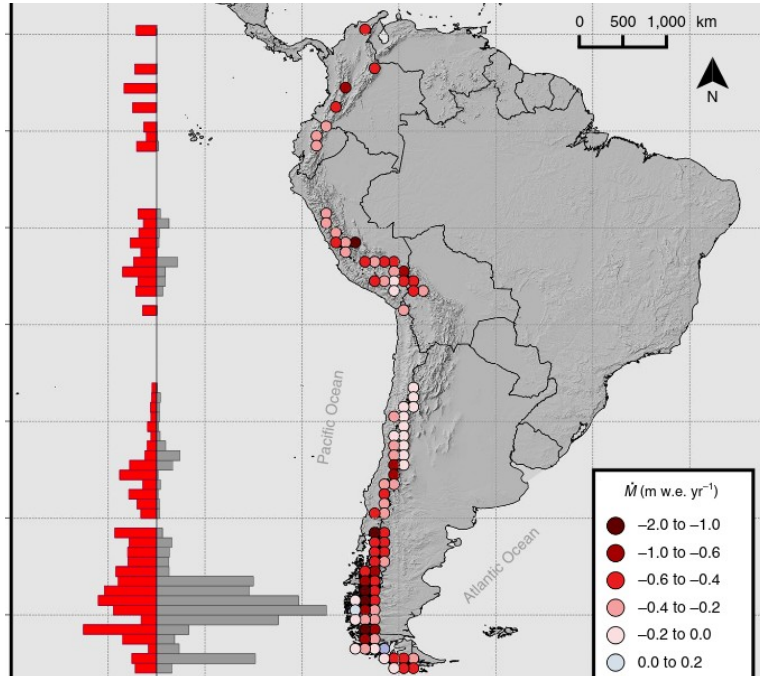
ASTER DEM stacks



Berthier et al., Frontiers, 2016

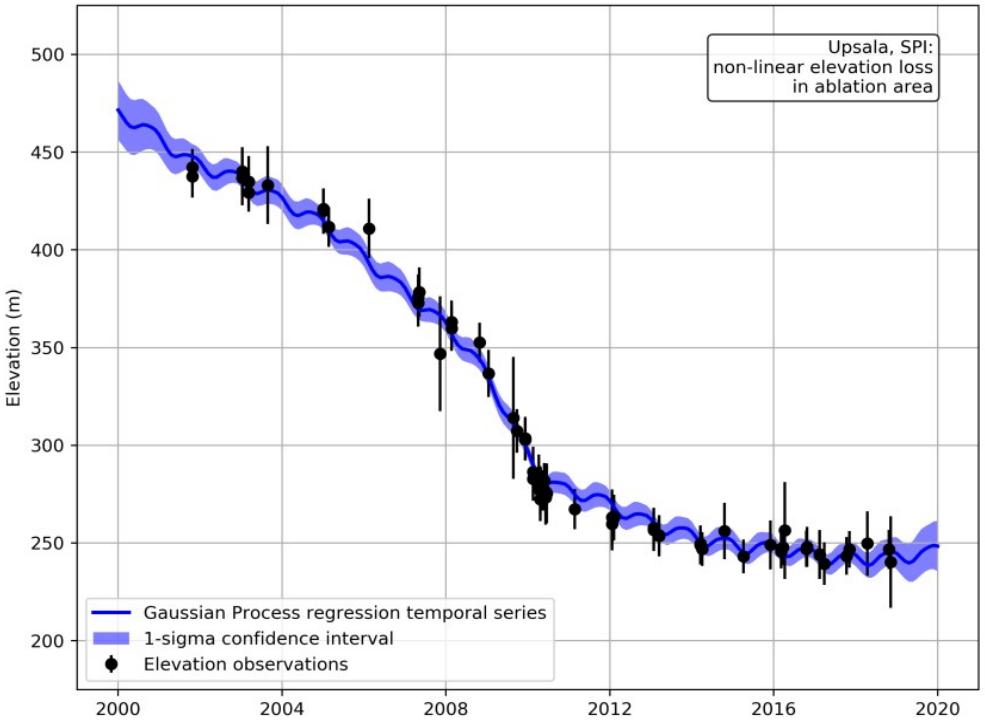


Brun et al., Nat. Geoscience, 2017



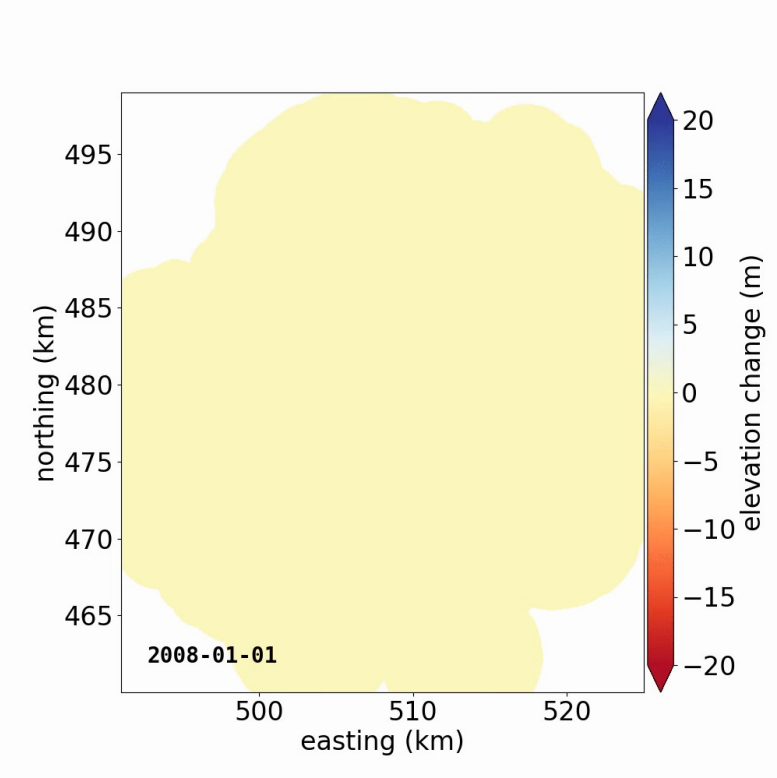
Dussaillant et al., Nat. Geoscience, 2019

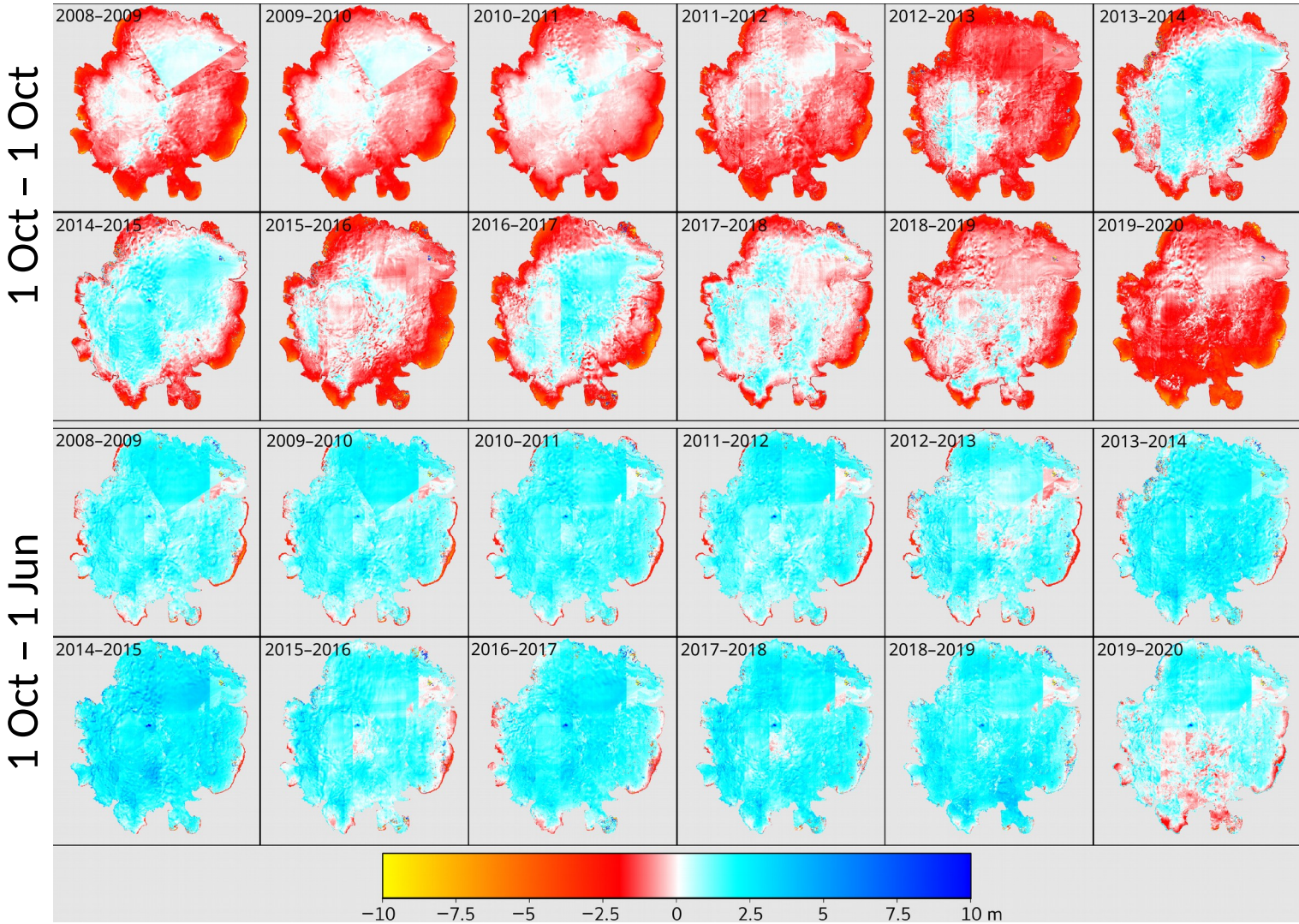
Gaussian processes (GP)



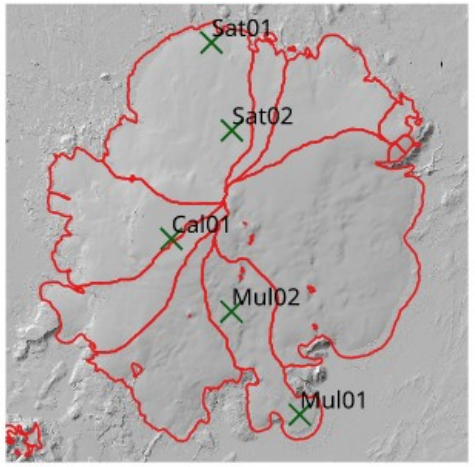
Hugonnet et al., Nature (in revision).
Figure from Hugonnet et al., EGU, 2020
https://github.com/iamdonovan/
https://github.com/rhugonnet/

Hofsjökull: Gaussian processes 2008–2020



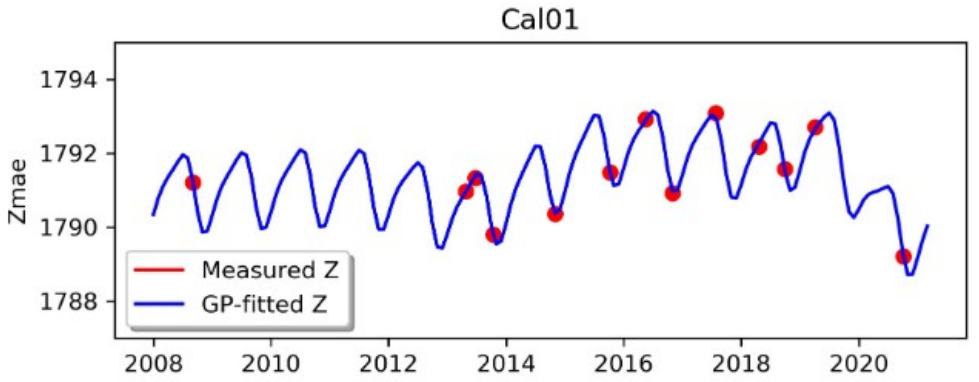


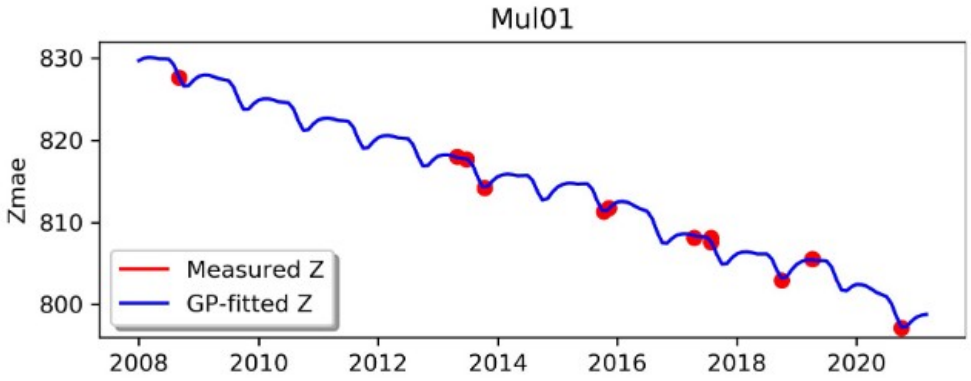
Hofsjökull: Gaussian processes 2008–2020

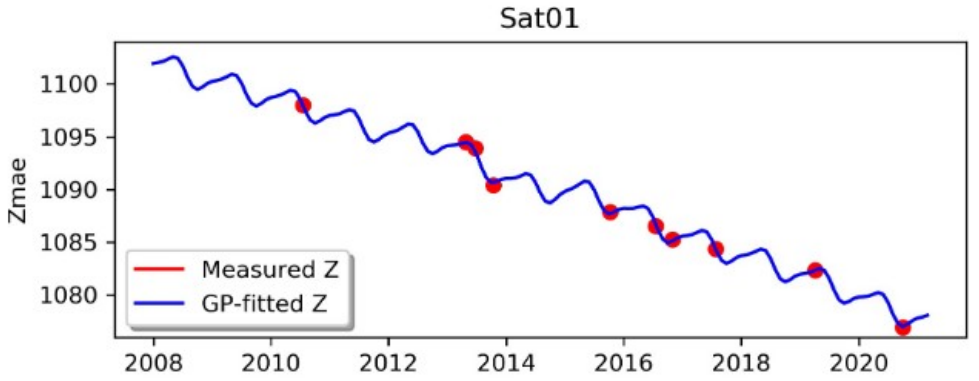


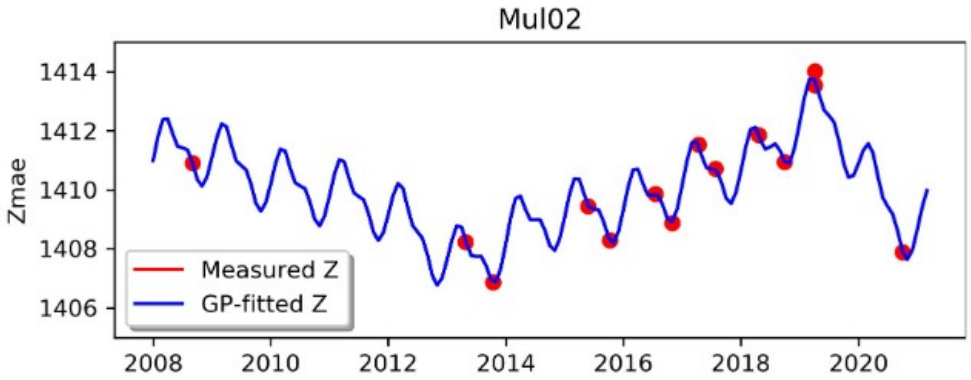
Ablation area:

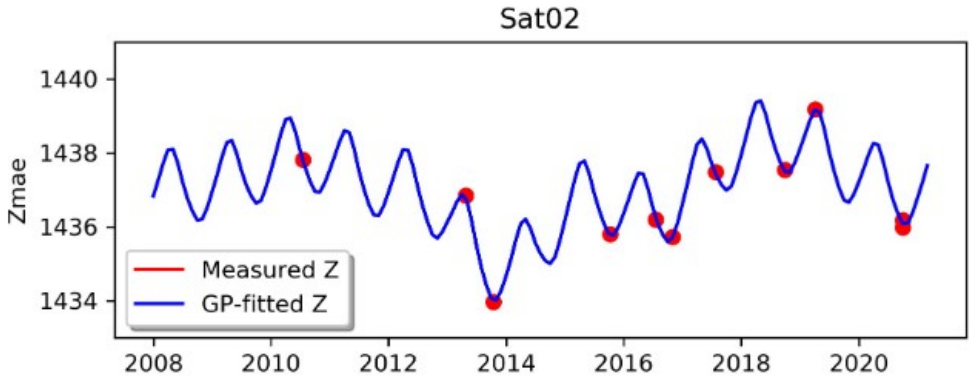
Acc. area:





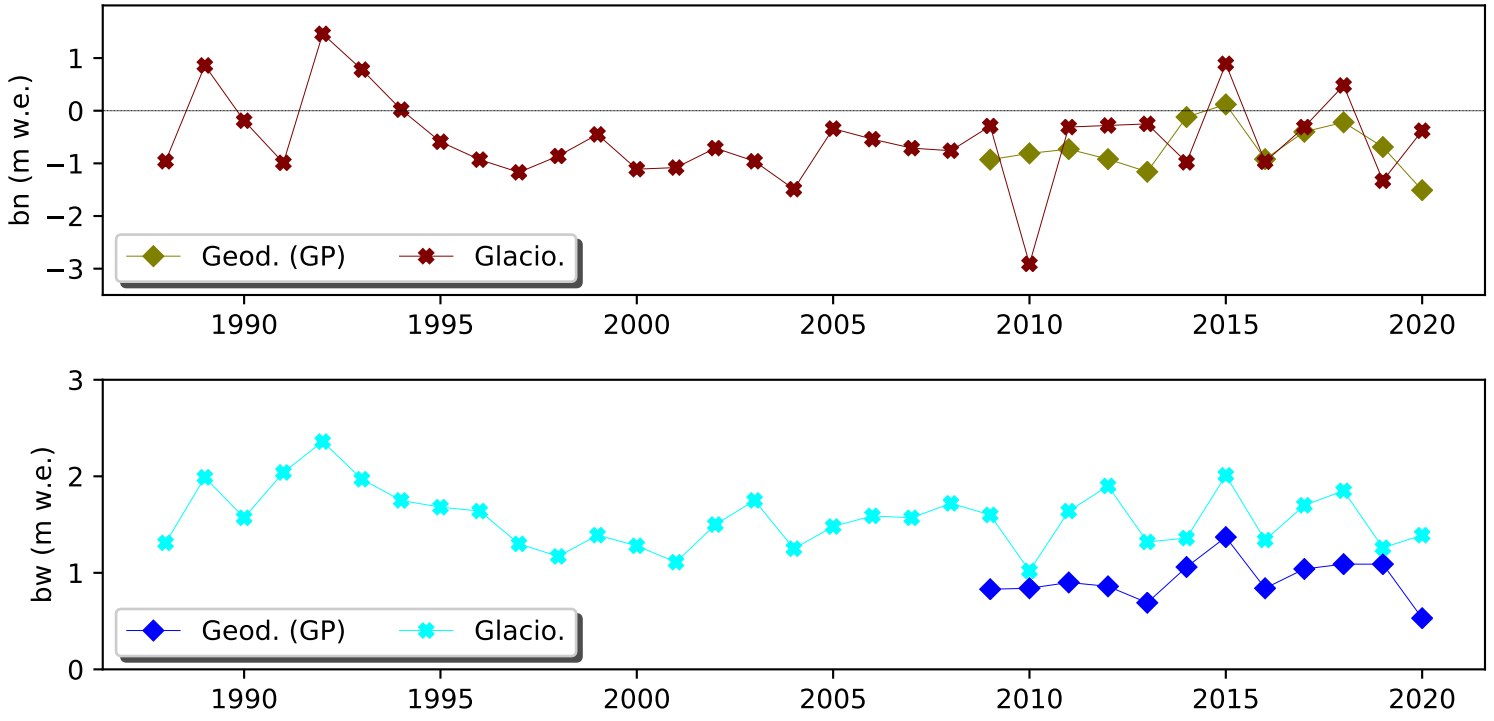






Geodetic vs glaciological mass balance (very preliminary!)

ΔV to m w.e.: ρ = 850 ± 60 kg m^{-3} *(Huss, TC, 2013)*



ΔV to m w.e.: In situ measurements (ρ ≈ 460 kg m^{-3})

Factors affecting comparison:

- Conversion factor
- Dates of surveys
- Firn & snow densification

Take away messages

- Gaussian processes are efficient tools to handle time series of DEMs. Applied to ArcticDEM, lidar, Pléiades… they reveal seasonal and annual variability of mass balance

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

Thank you

Virtual Nordic Branch IGS meeting, Cyberspace, DK, 11-13 November 2020

Background: Múlajökull drumlins from Pléiades false-color image ©CNES & Airbus D&S