

Remote sensing of Greenland tidewater glaciers

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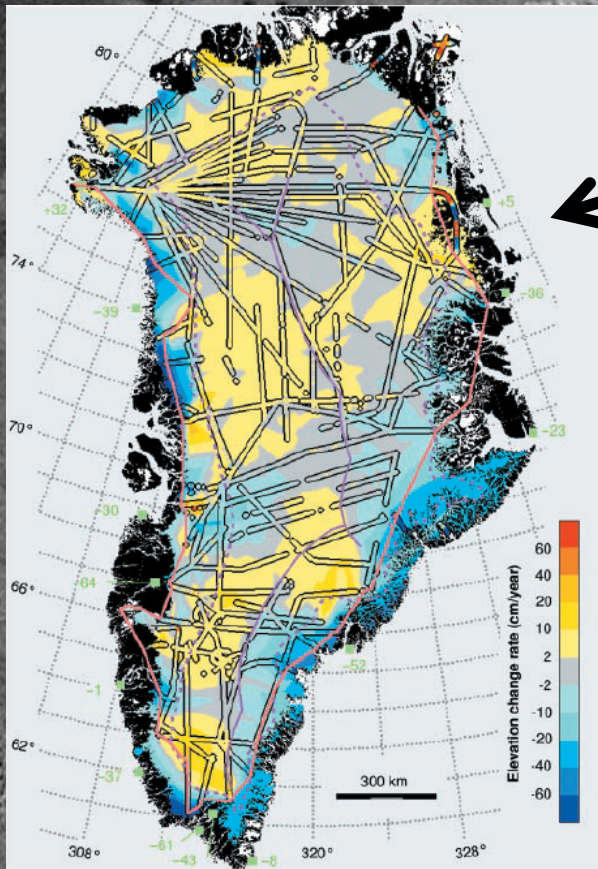


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Consortium Newid Hinswbd Cymru
Climate Change Consortium of Wales



Ice loss from Greenland since early 1990s

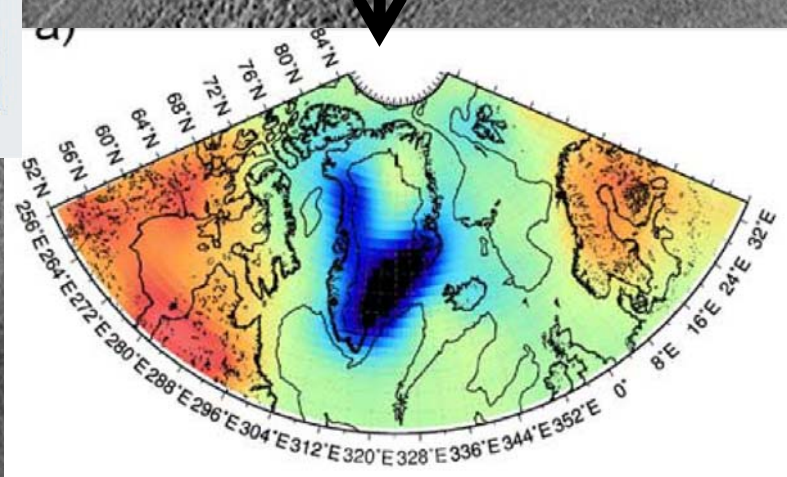


Krabill et al., *Science*, (2000)

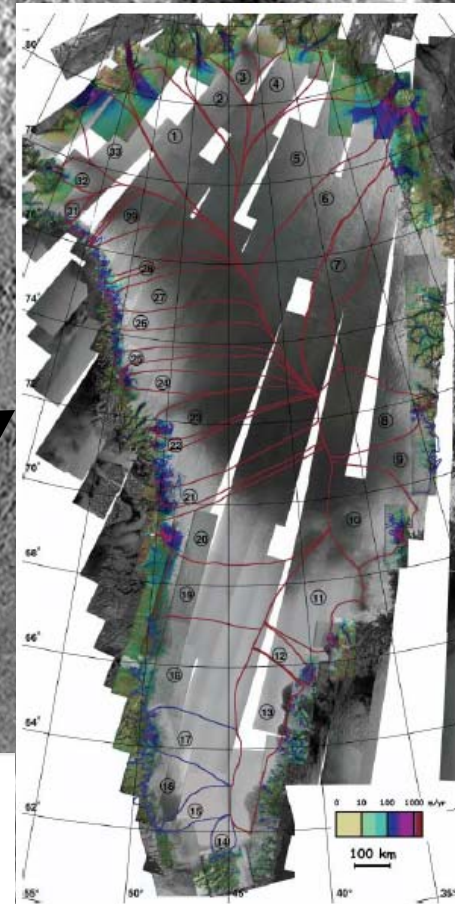


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- Surface elevation
 - Peripheral thinning
 - Concentrated in marine-terminating glaciers (Sole et al., *The Cryosphere*, (2011))
- Increases in flux discharge
- Regional mass losses

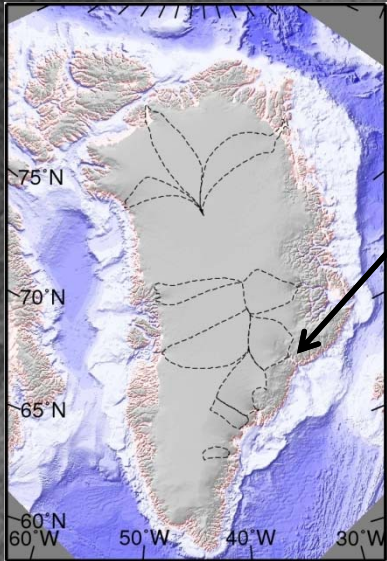


Wouters et al., *GRL*, (2008)

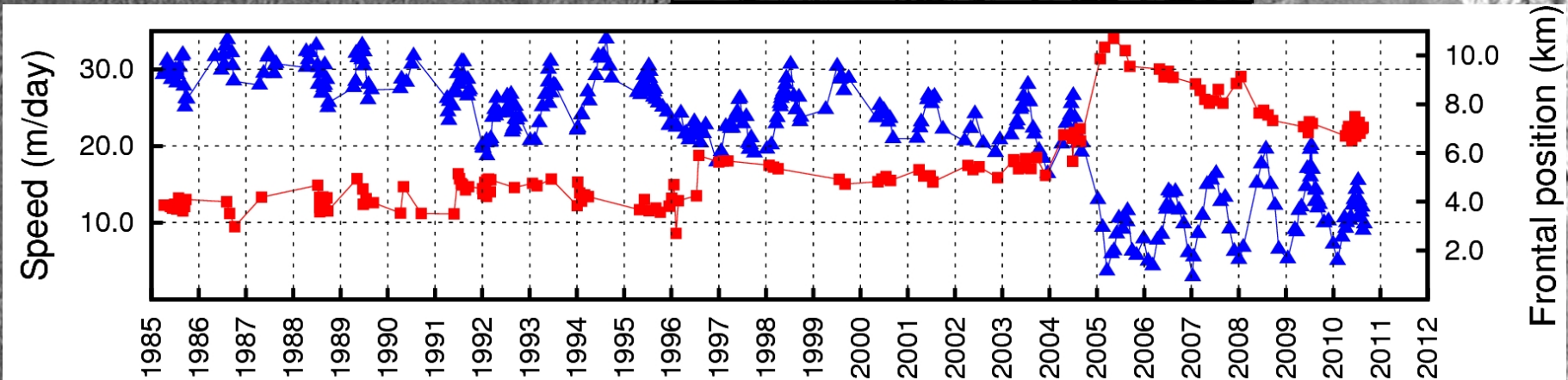
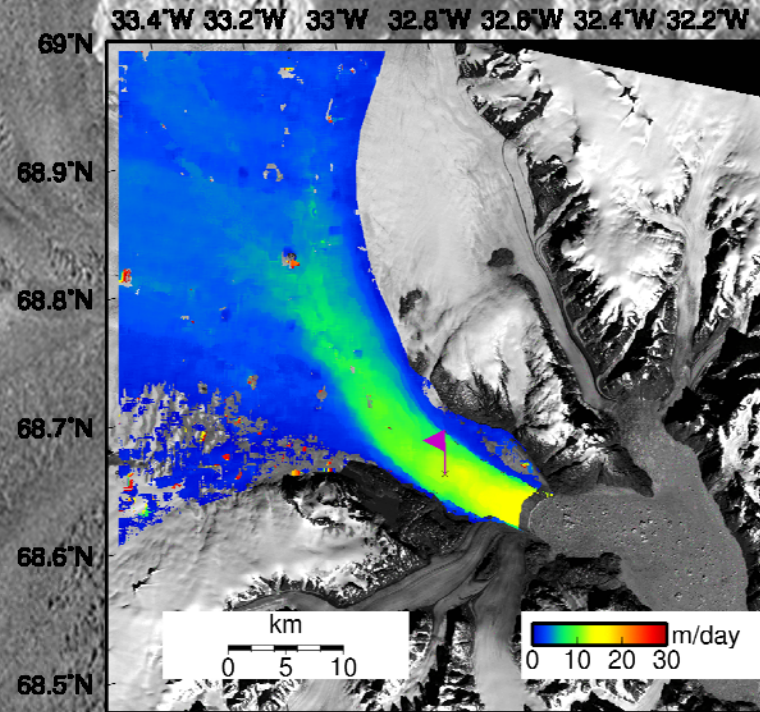


Rignot and Kanagaratnam, *Science*, (2006)

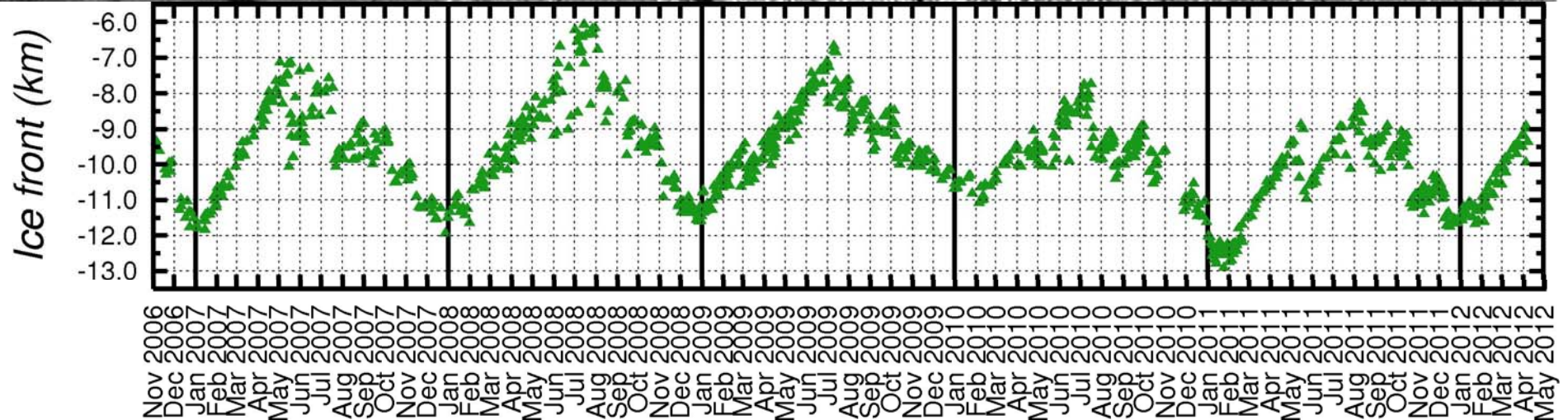
Kangerdlugssuaq



Data points from
1992 onwards from
Adrian Luckman



Kangerdlugssuaq frontal position



Data from
Adrian Luckman

Seasonal drivers ?

Surface meltwater

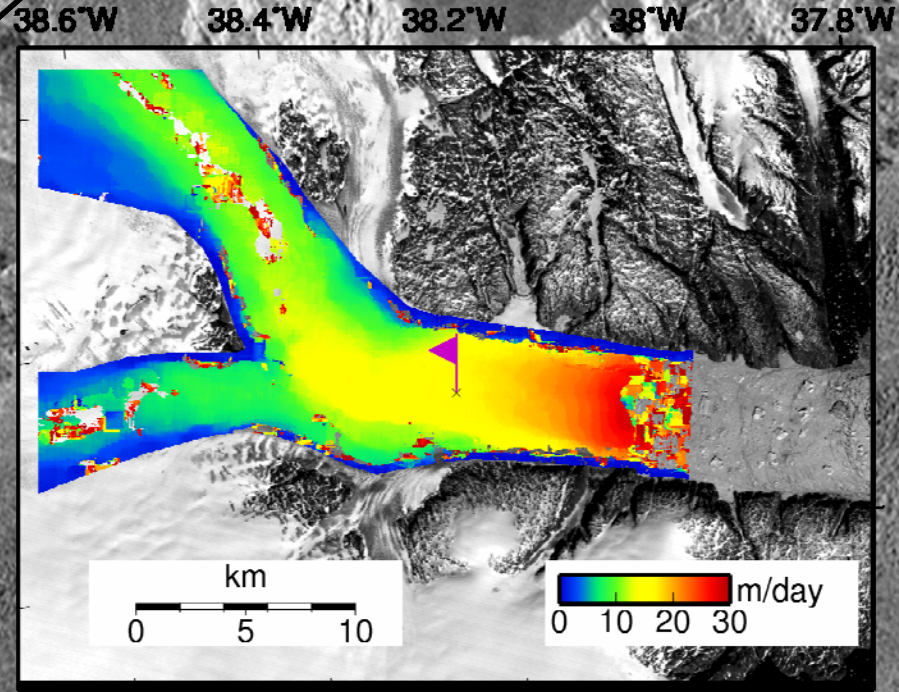
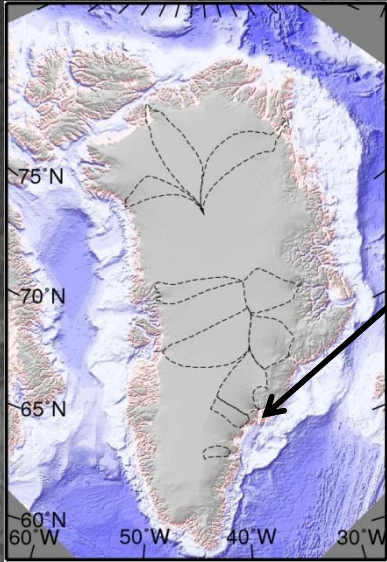
- Crevasse hydrofracture
- Basal lubrication
- Fjord circulation (basal melting)

Fjord conditions (sikussak)

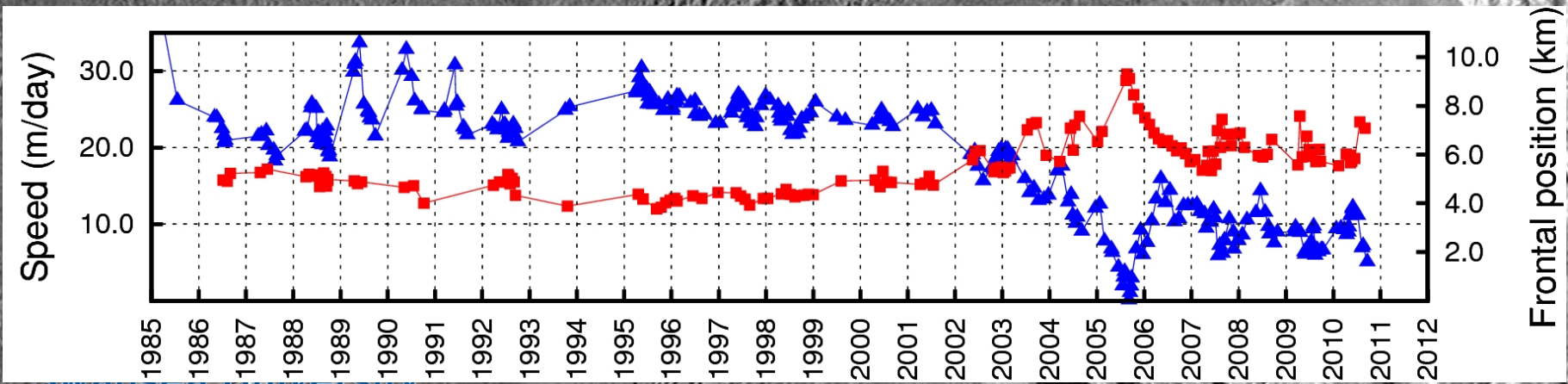


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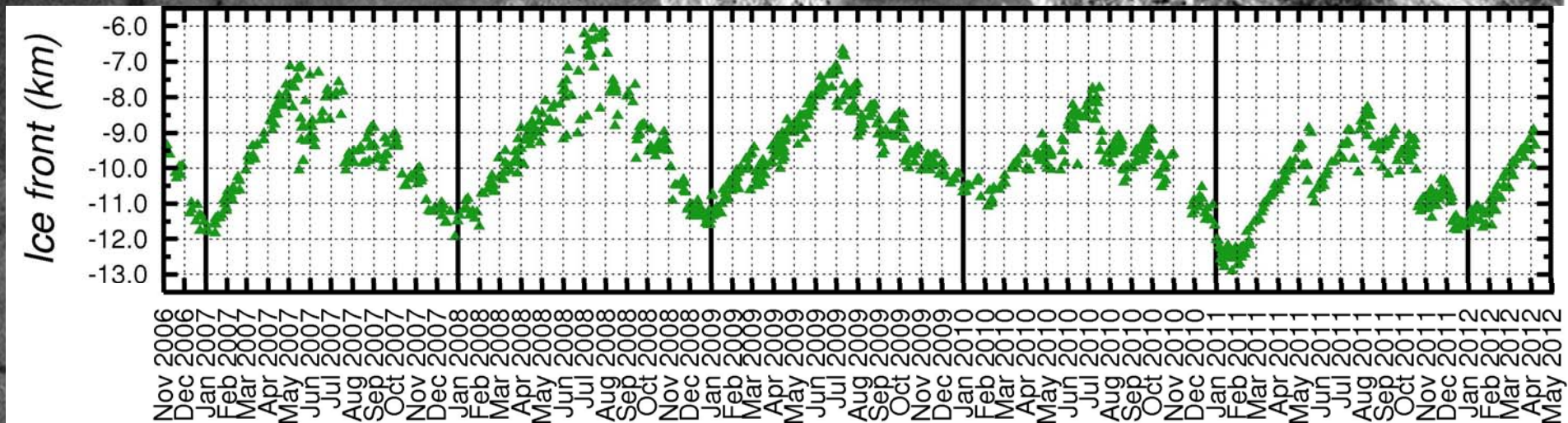
Helheim



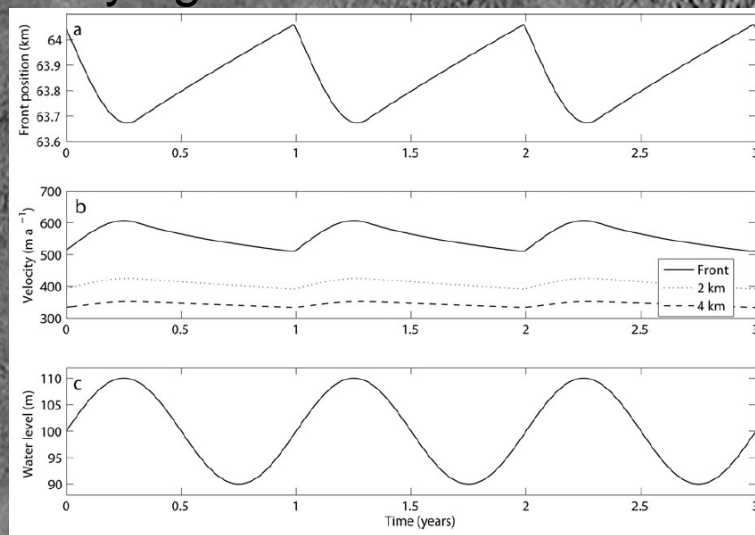
Data points from 1992 onwards from Adrian Luckman



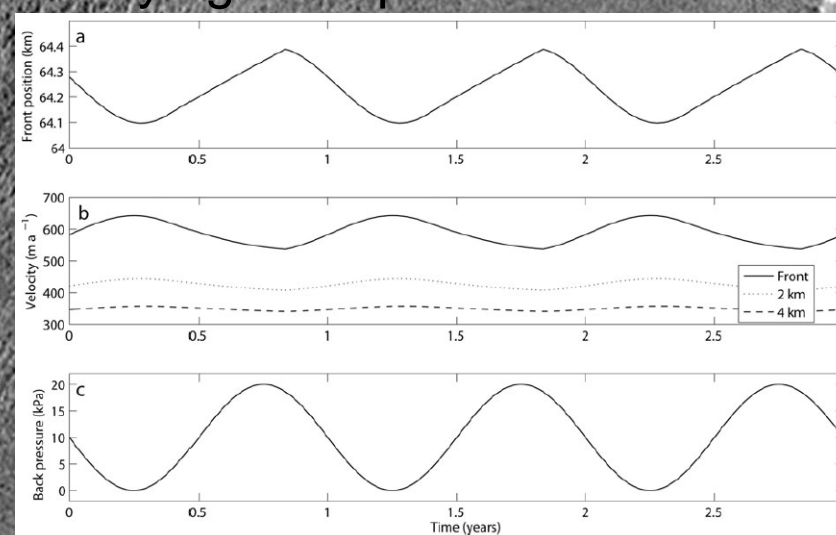
Kangerdlugssuaq frontal position



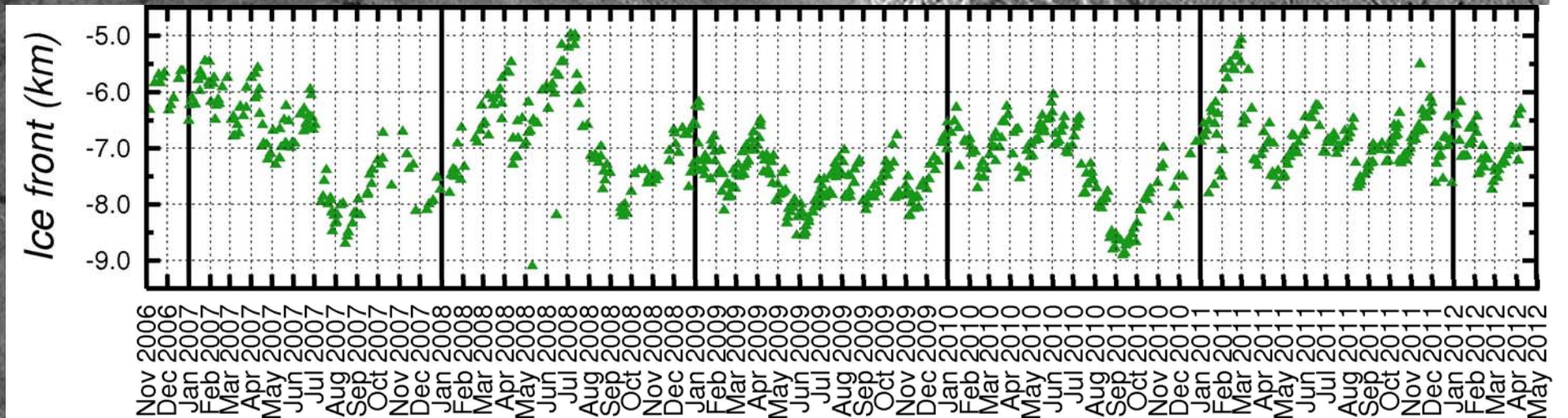
Varying crevasse water levels



Varying back pressure



Helheim frontal position

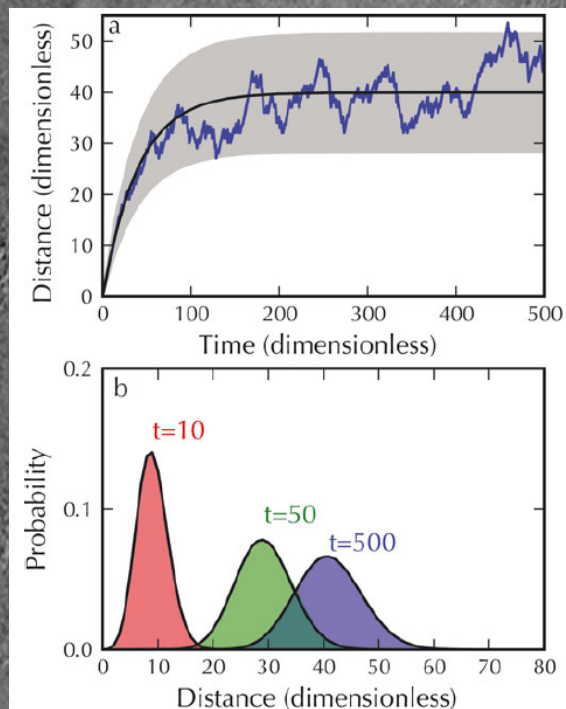
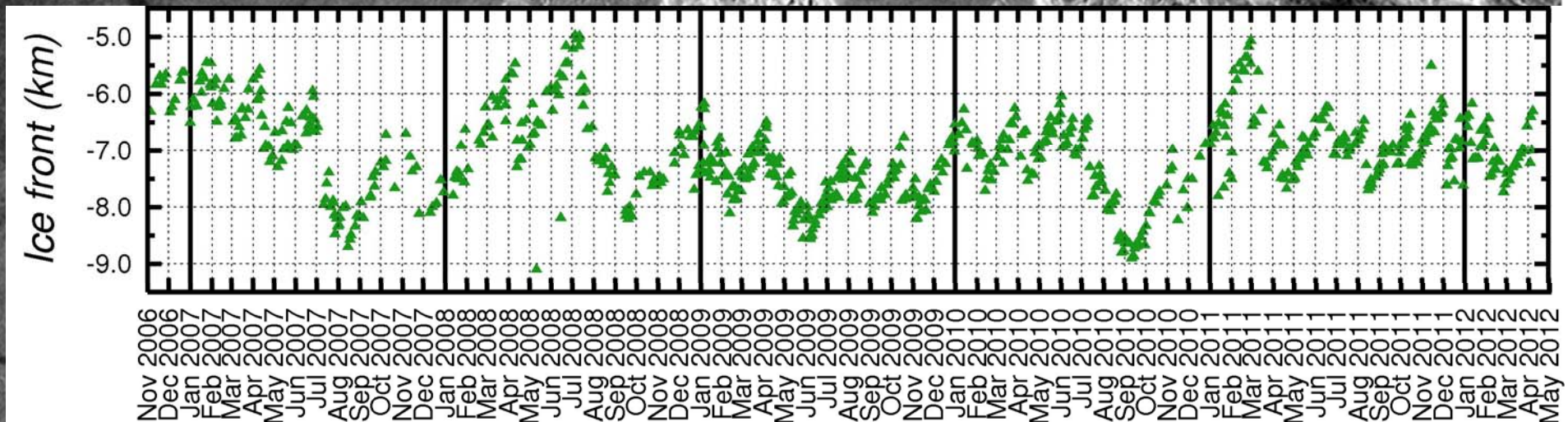


Data from
Adrian Luckman



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Helheim frontal position



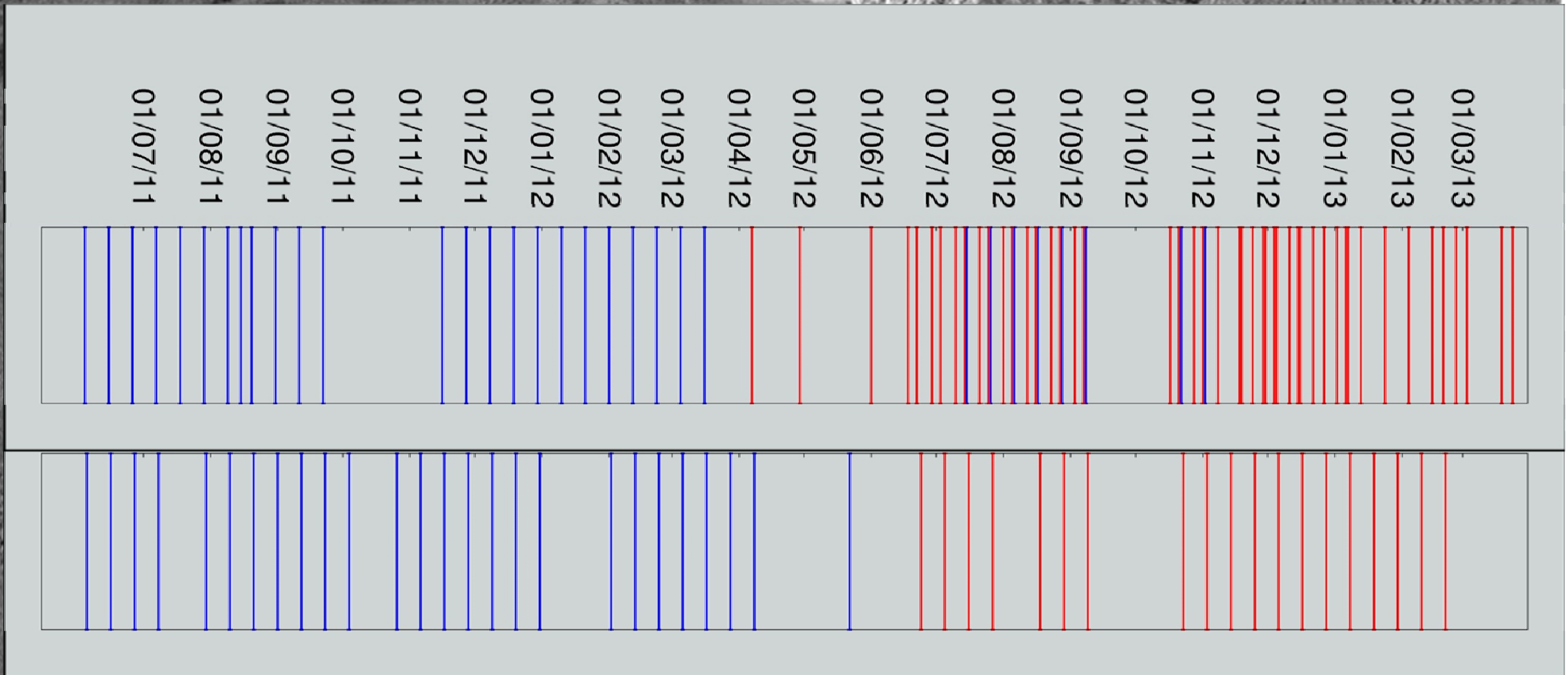
Bassis et al., (2010) a stochastic model of calving front evolution for a grounded glacier.

From a probability distribution of terminus position as a function of time can get expected values of terminus position (and calving rate and terminus velocity).

For a grounded tidewater glacier:
 PDF based on a constant terminus velocity and a 'calving' transition rate that is vanishingly small beyond a distance H from terminus

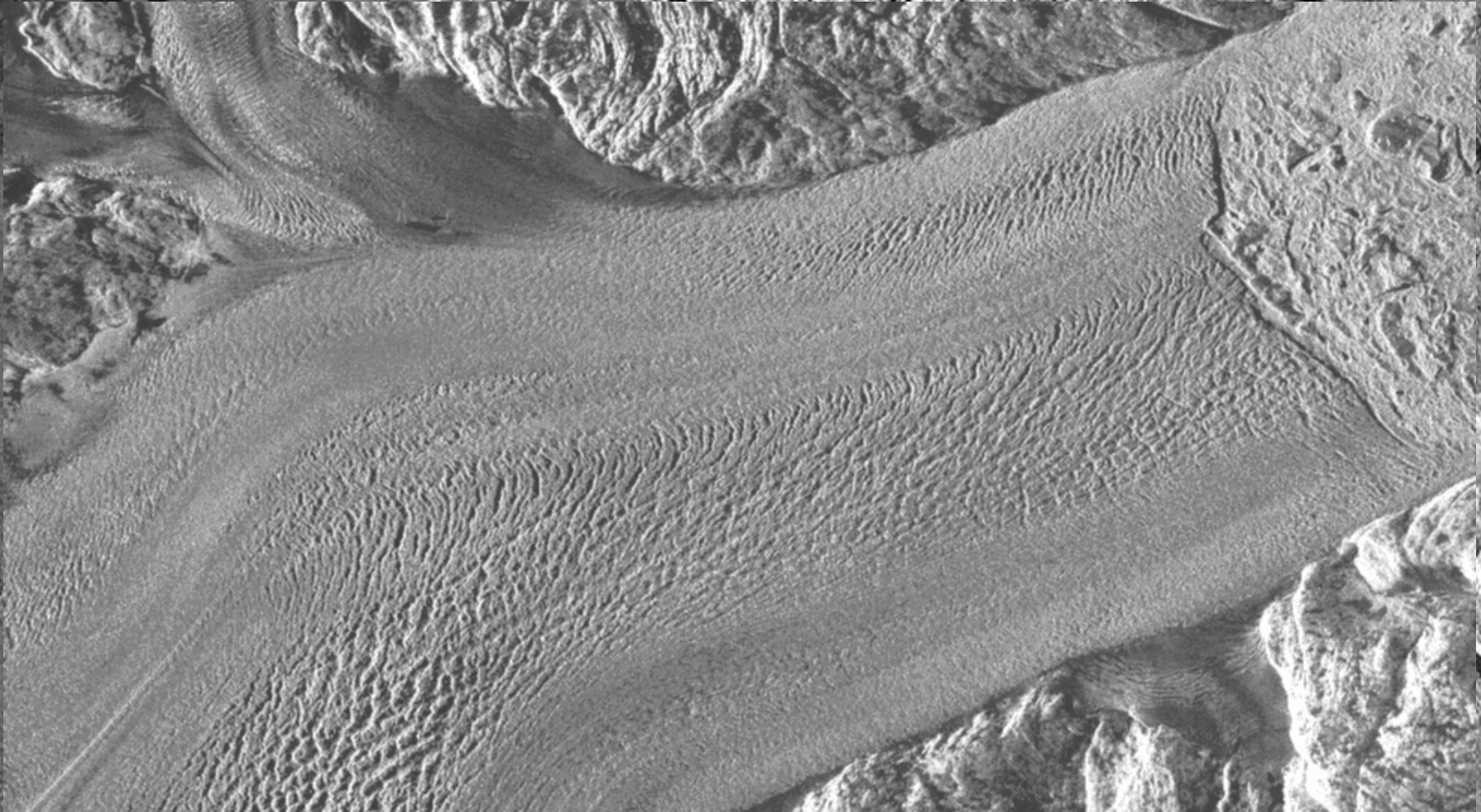
11-day image sequences

Helheim 1x1 multilooking, Incidence = 37°

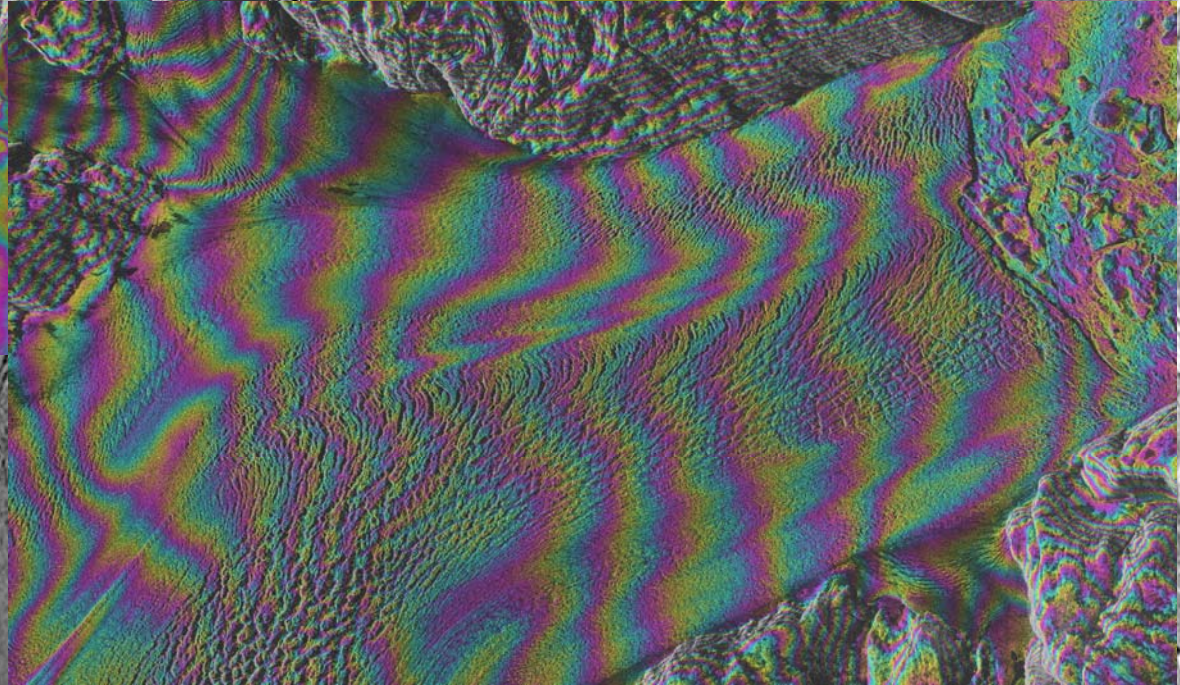
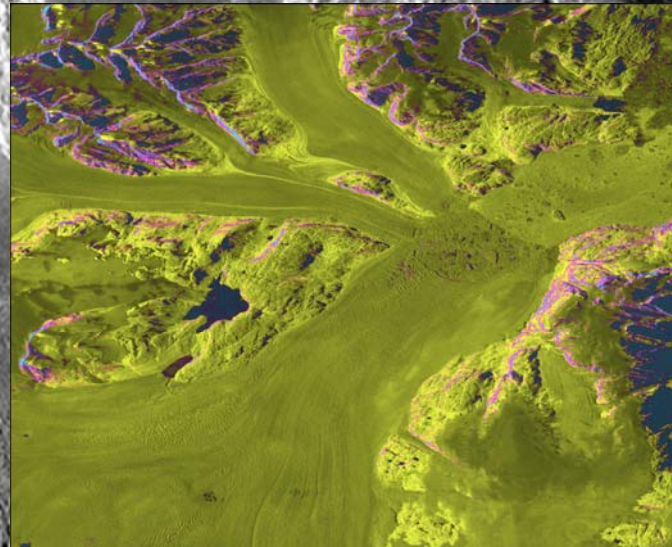
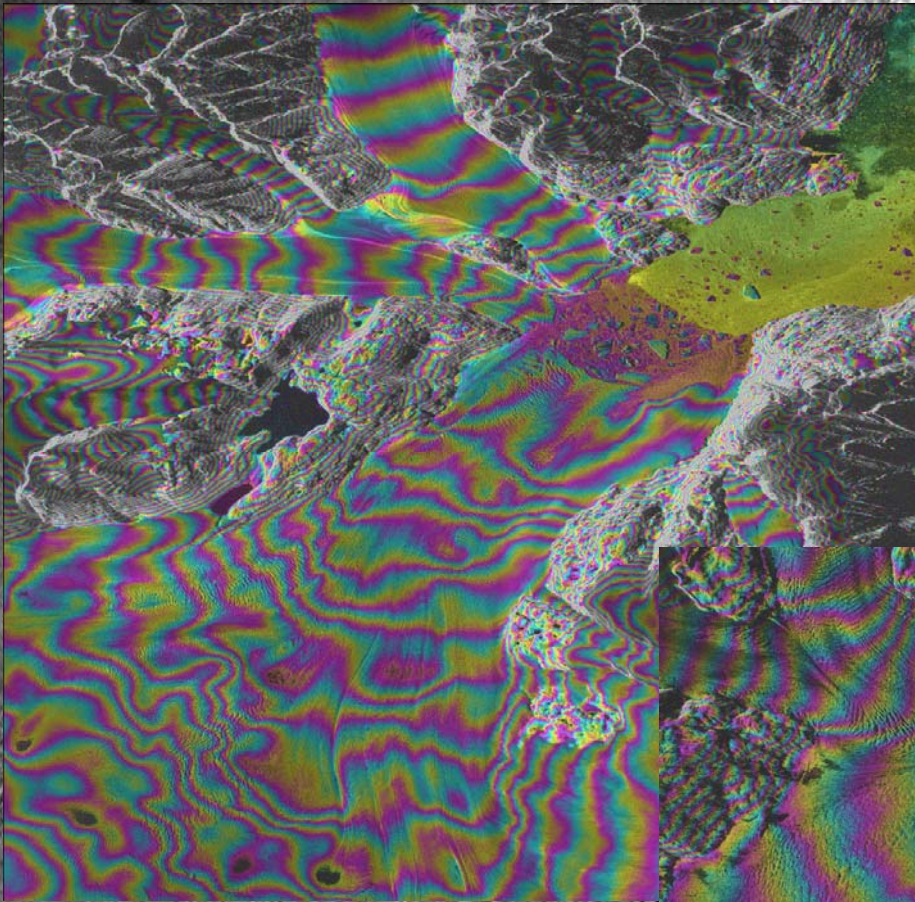


Kangerdlugssuaq 4x4 multilooking, Incidence = 44°

Intensity images

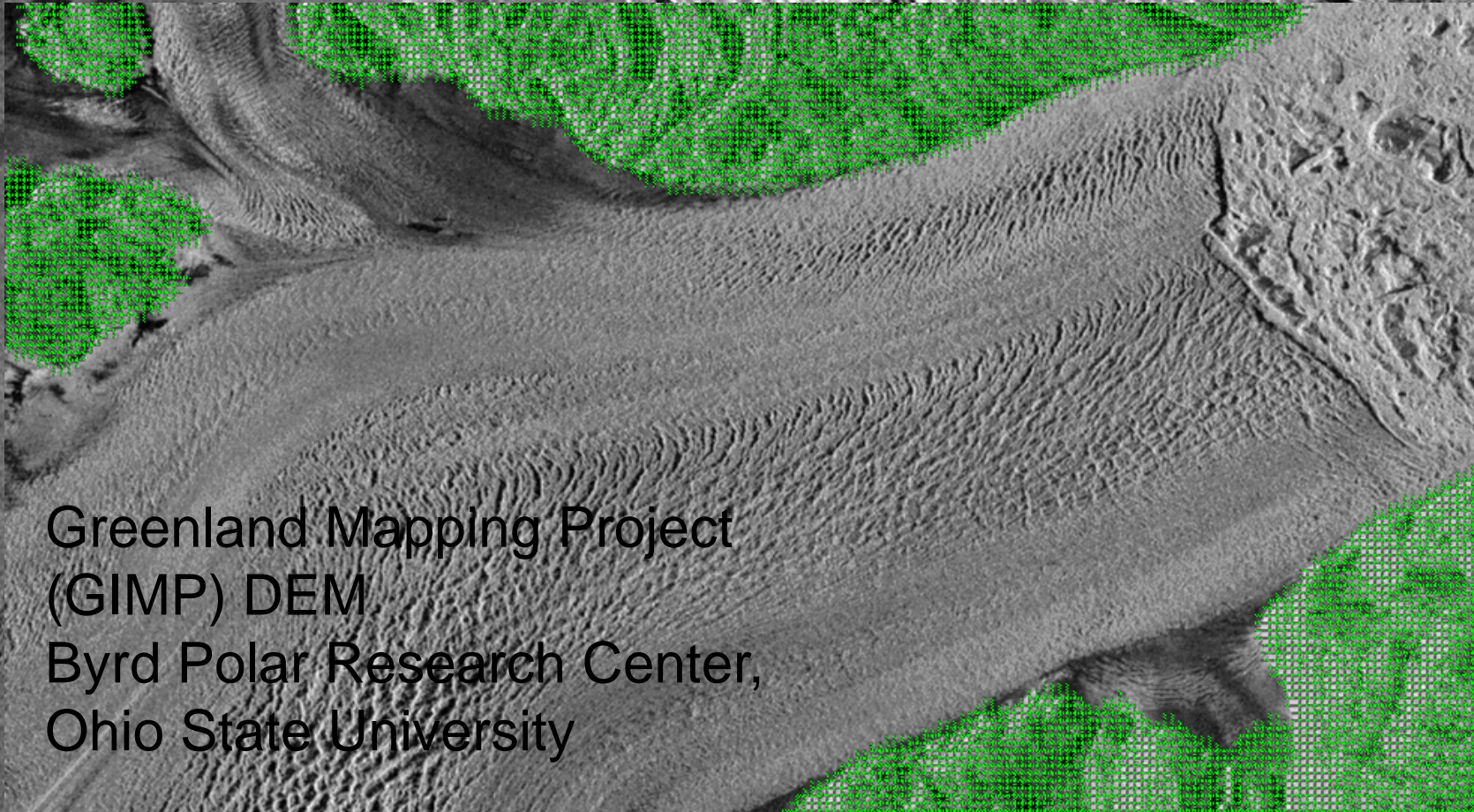


Flattened interferograms



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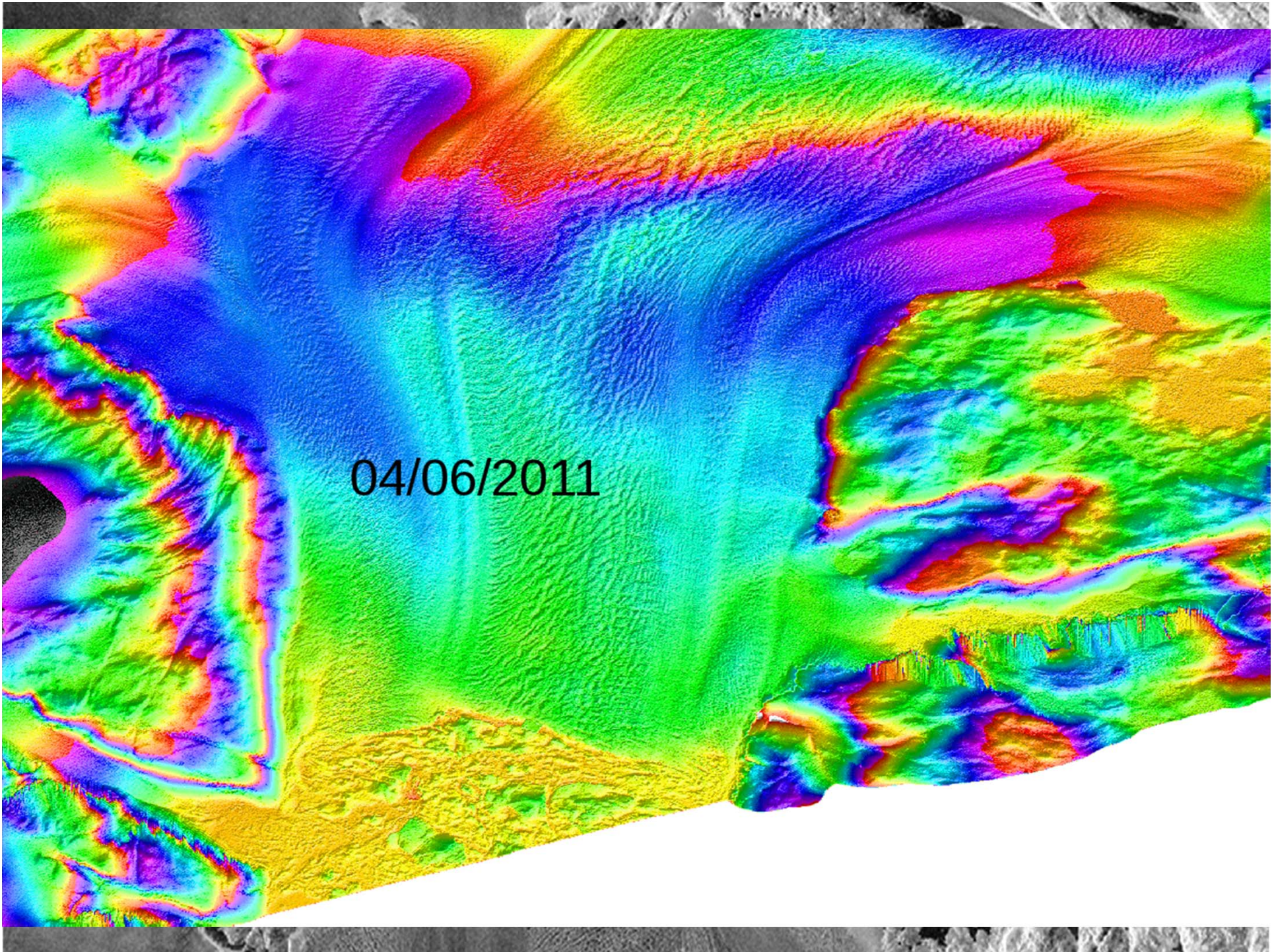
Ground control points



Greenland Mapping Project
(GIMP) DEM
Byrd Polar Research Center,
Ohio State University

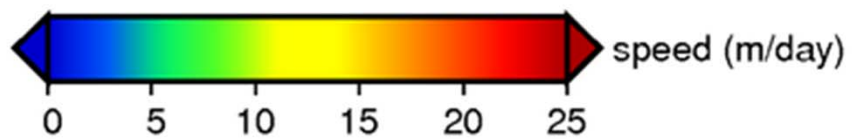
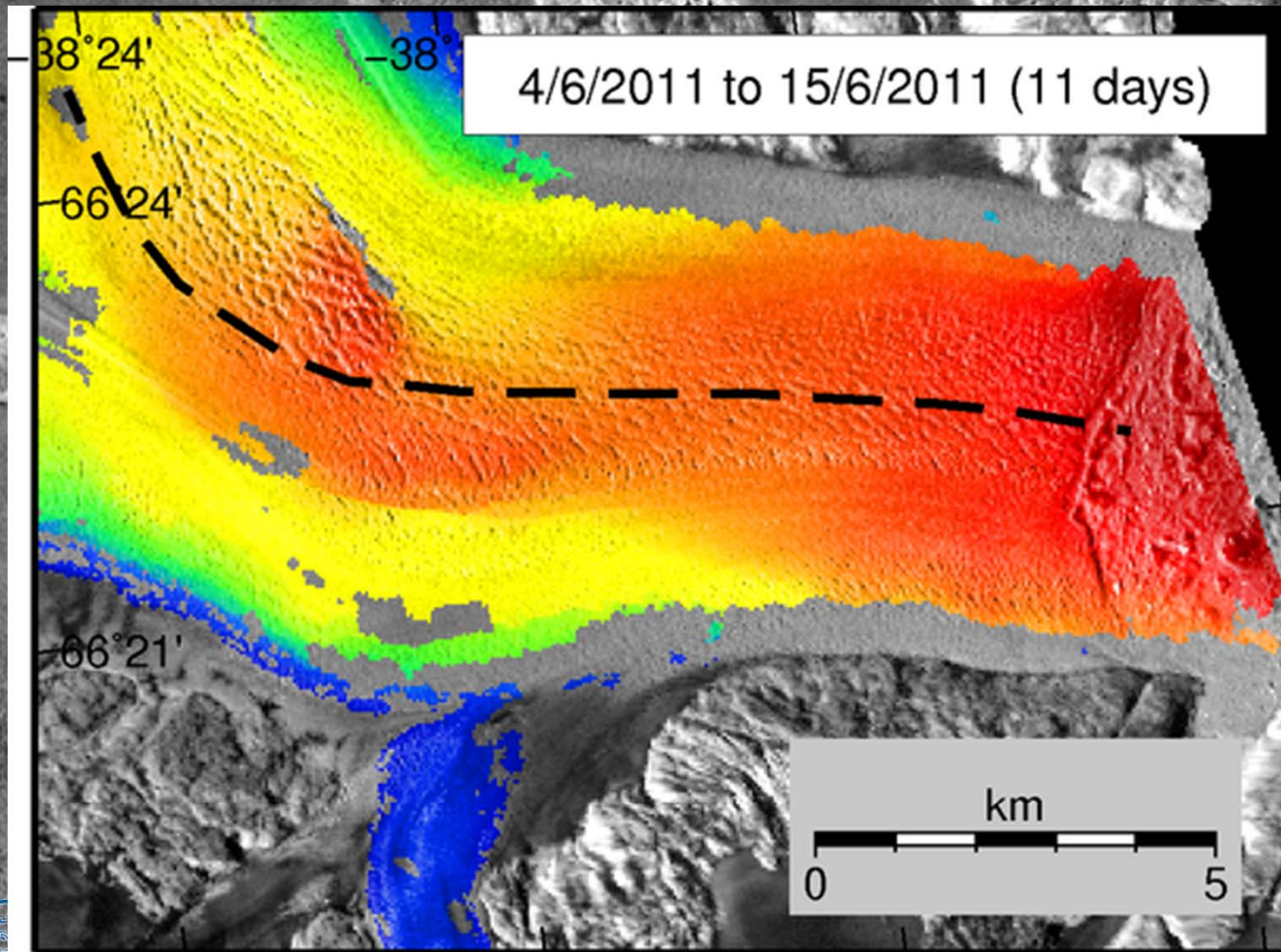


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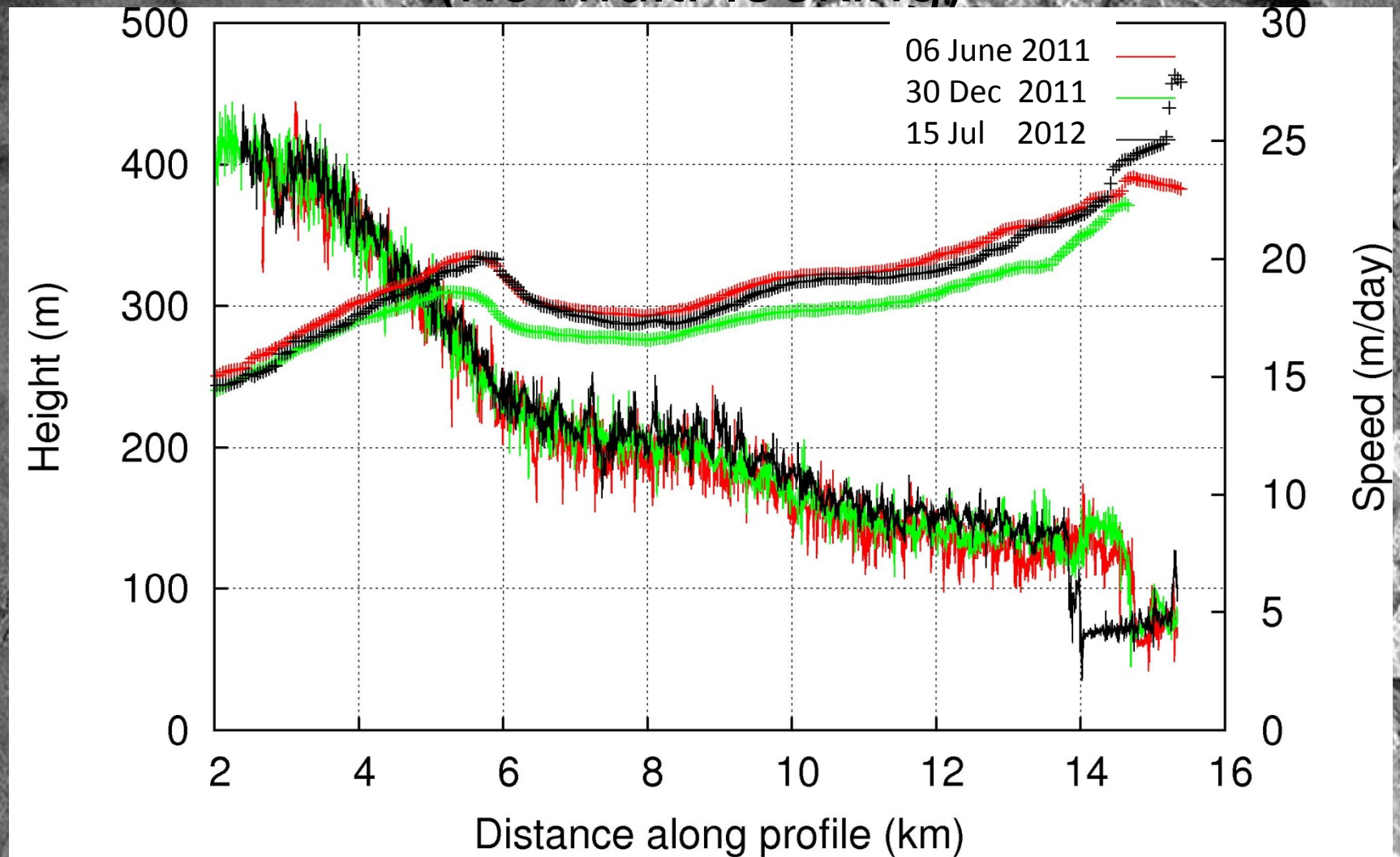


04/06/2011

Feature-tracked surface speeds

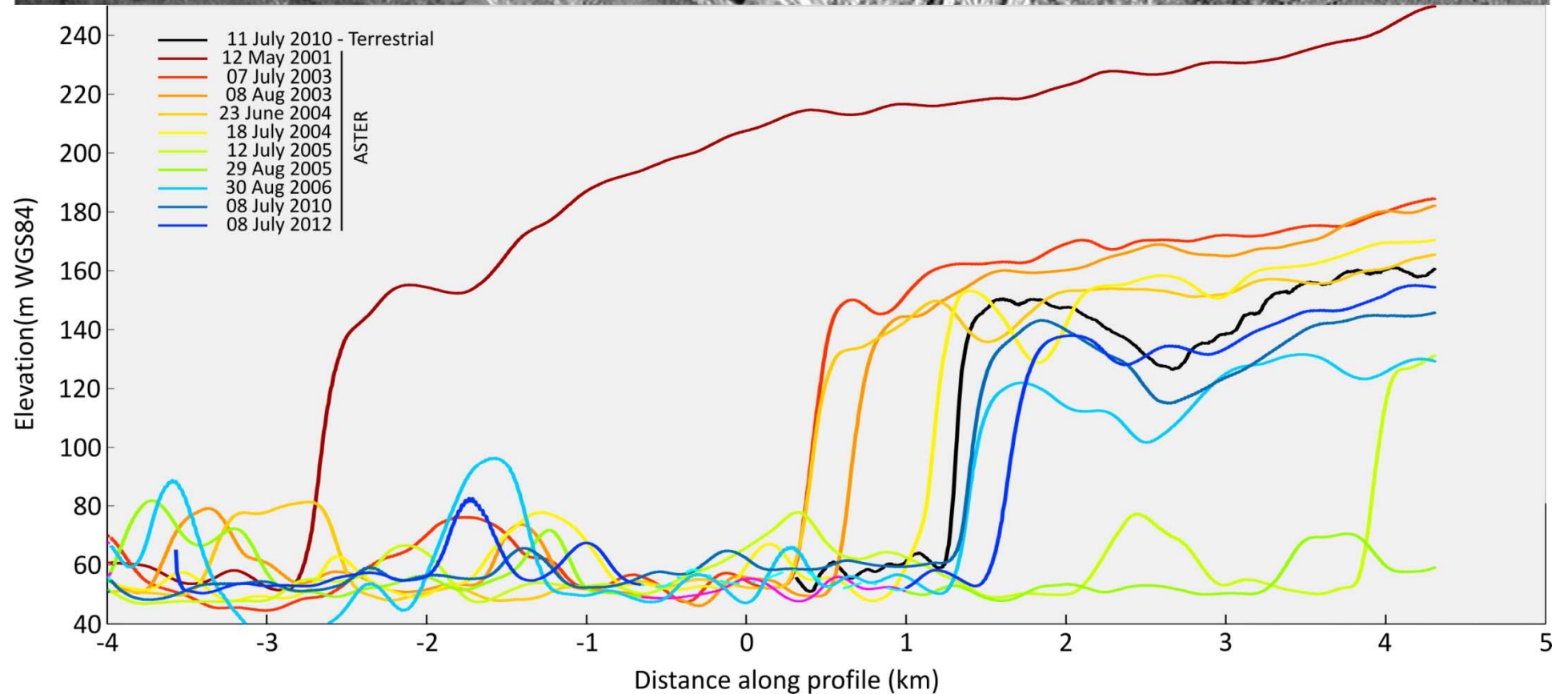


Helheim down-slope profiles (no multi-looking)



Surface elevations from ASTER

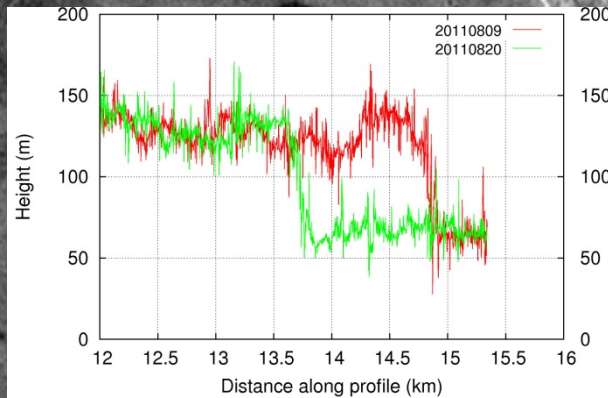
Figure produced by Tim James



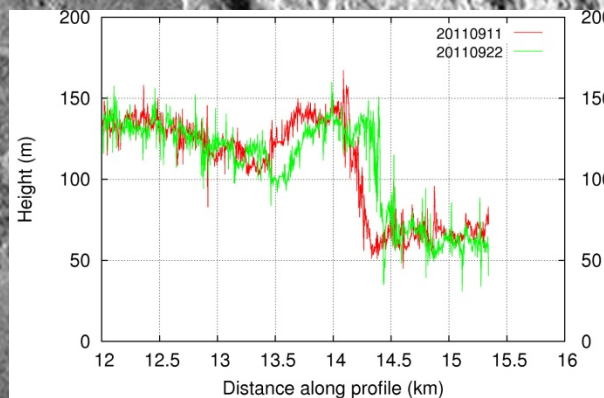
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Down-slope profiles

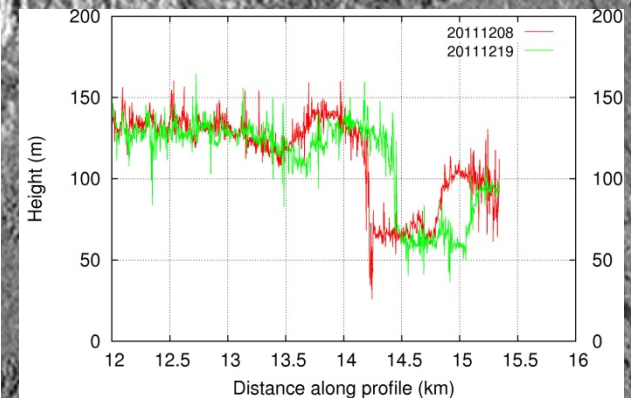
August 2011



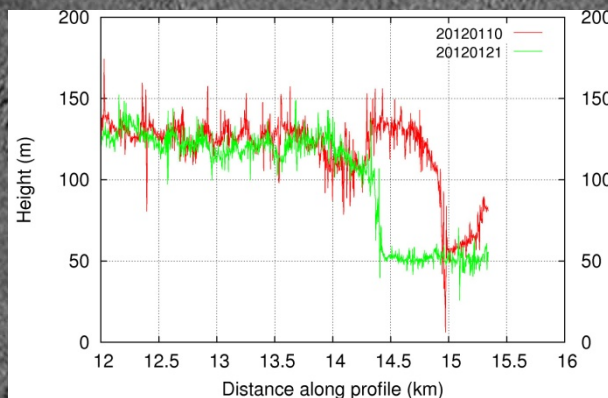
September 2011



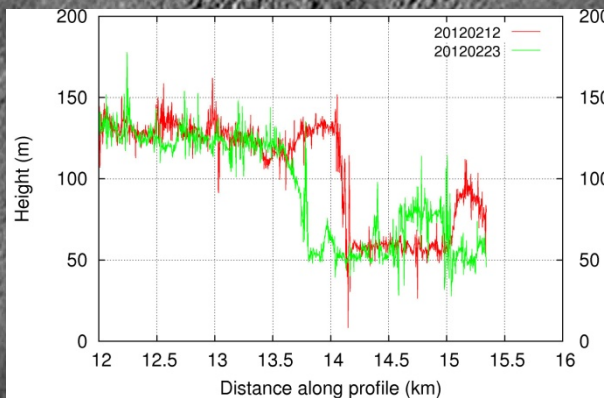
December 2011



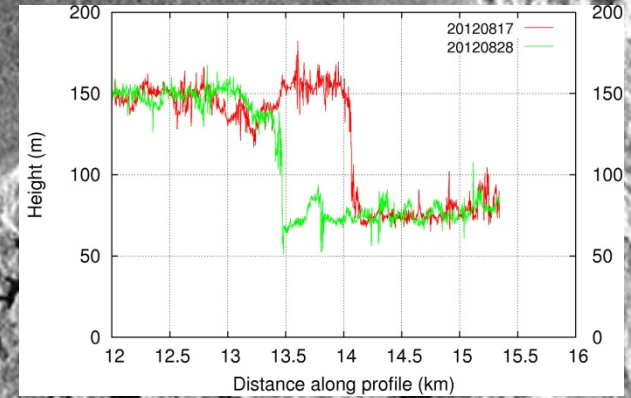
January 2012



February 2012

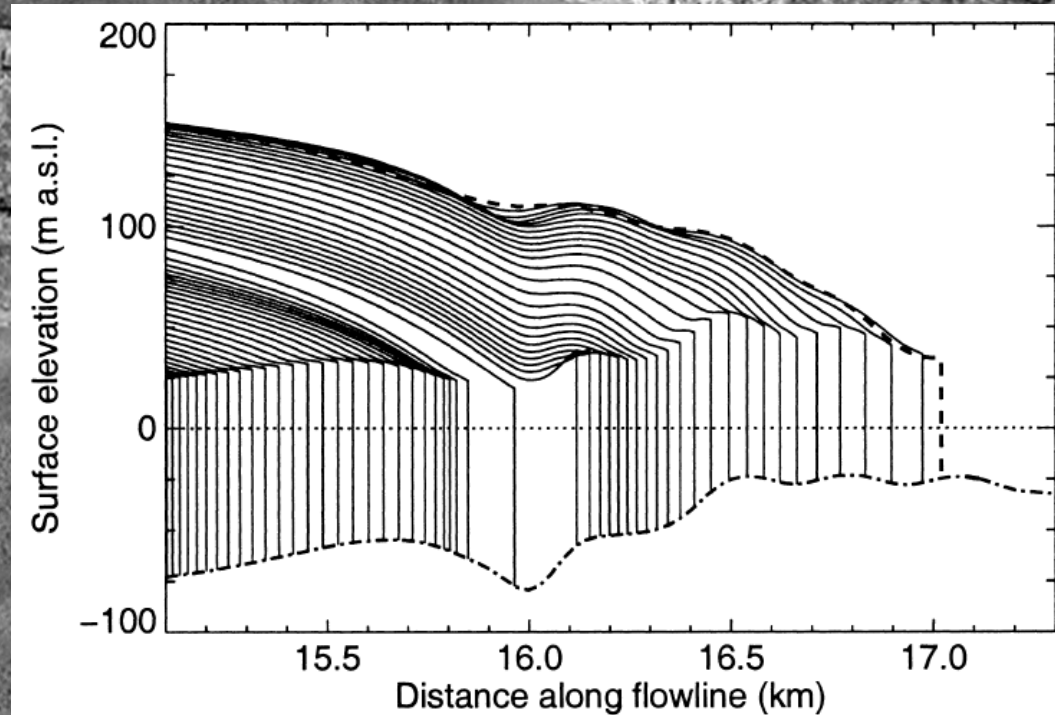


August 2012



The retreat of a tidewater glacier: observations and model calculations on Hansbreen, Spitsbergen

ANDREAS VIELL,^{1,2*} JACEK JANIA,³ LEZEK KOLONDRÁ³

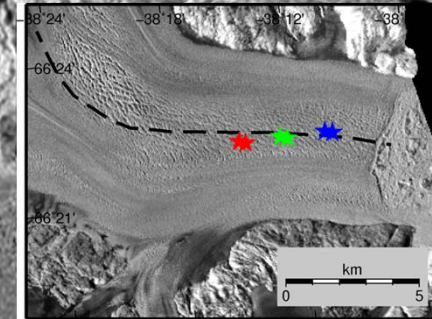


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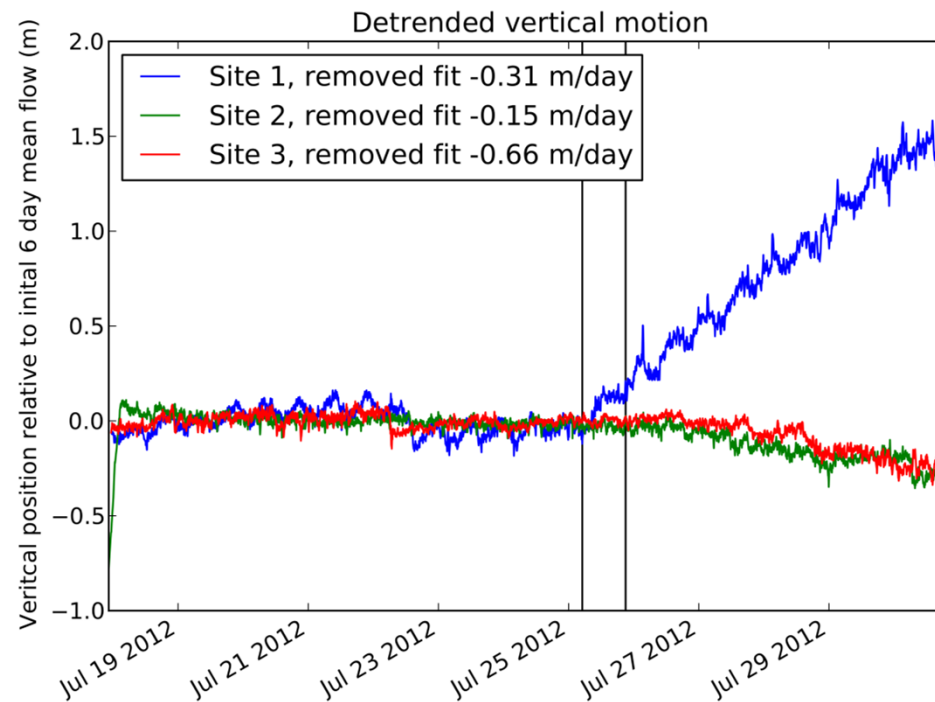
Rapid retreat was determined by the bed topography and long-term thinning, rather than any short-term climate trigger.

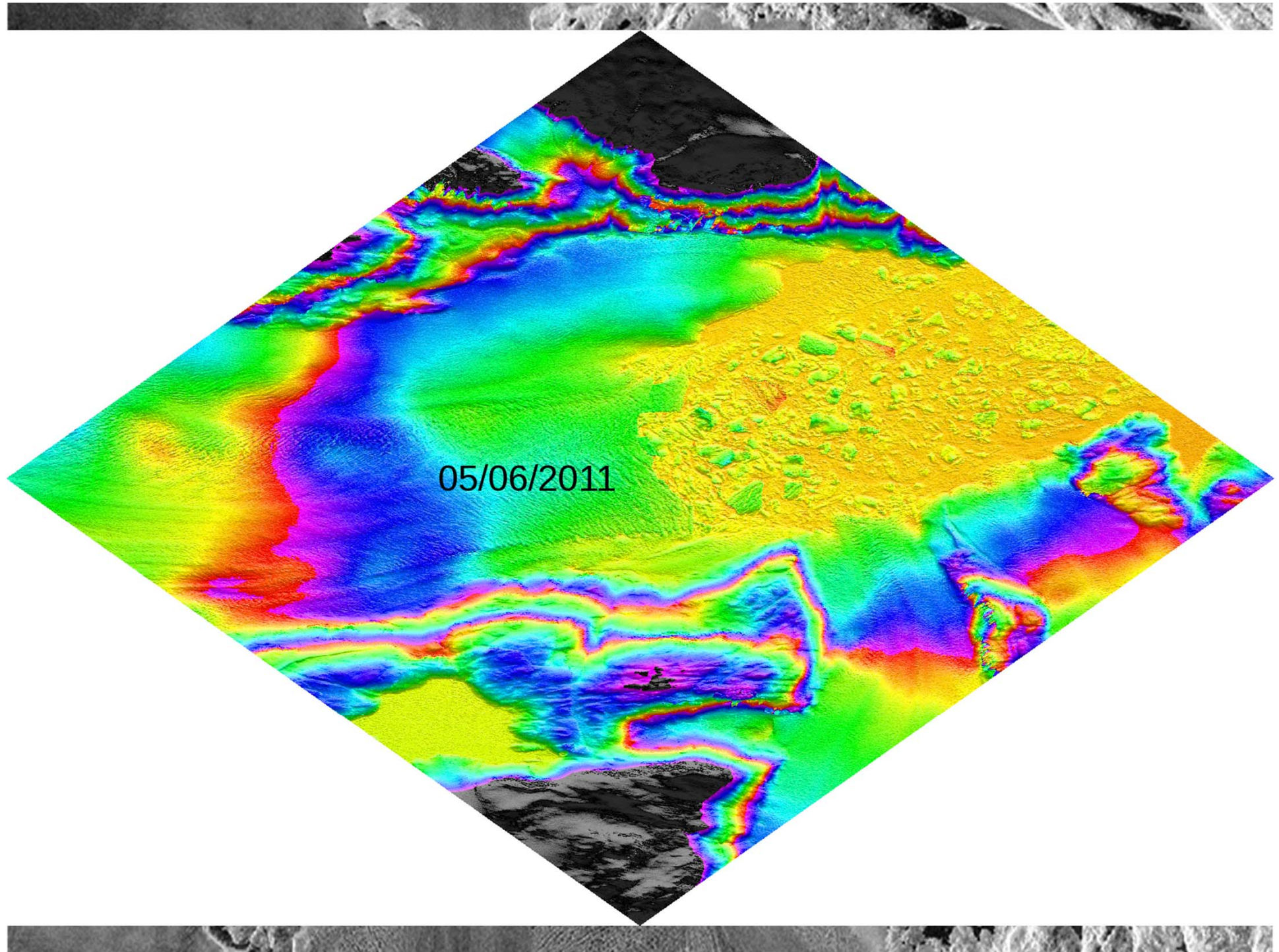
Networks of Sensors in extreme environments: High-resolution glacier dynamic monitoring

NERC funded project with Tavi Murray, Ian Rutt, Tim James and Nick Selmes from Swansea (plus Sheffield and Newcastle Universities)

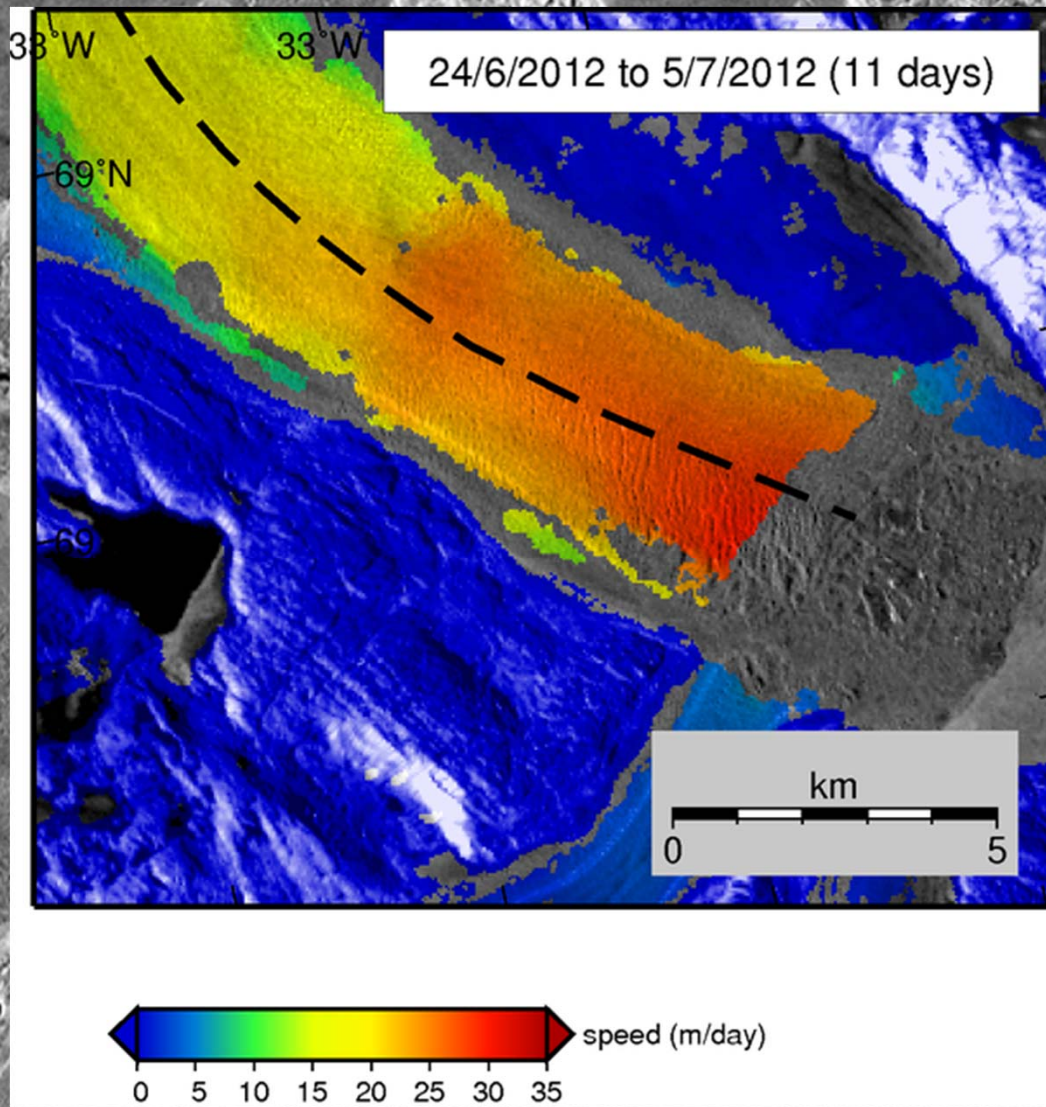


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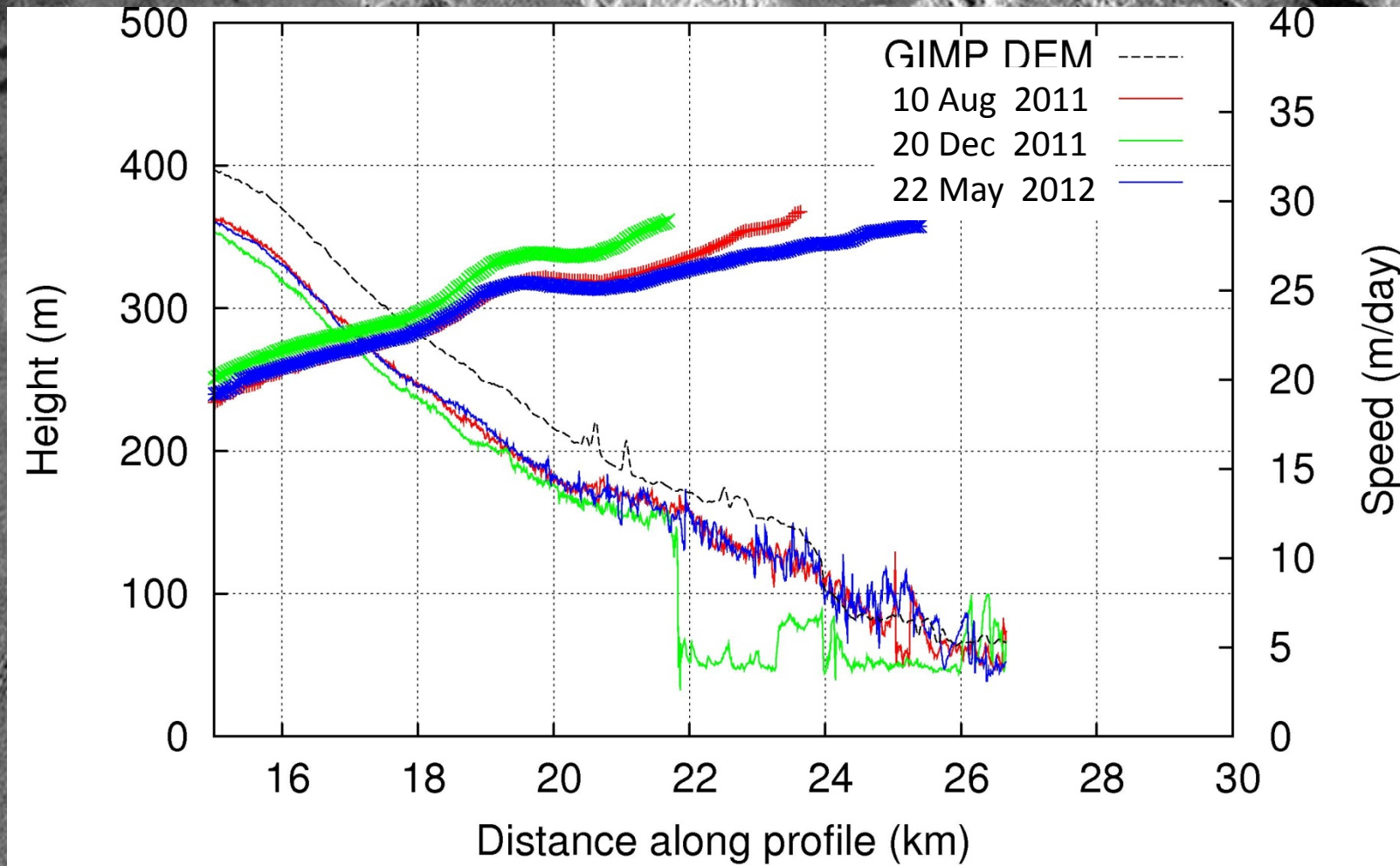


Feature-tracked surface speeds



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Downslope profiles



Next steps...

Catch up with the data !

Generate 11-day time series of surface velocities and elevations

Investigate X-band penetration characteristics using airborne lidar and in-situ GPS.



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