

Surface Roughness as Indicator of
Geophysical Change in Greenland Glaciers
and Ice Streams —
Conclusions from ICESat and IceBridge
Data Analysis
(- and Model Implications?)

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and

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Satellite Altimetry

- Geophysical measurement of surface elevation from satellite, using active microwave radar technology or laser technology
- Satellites with radar altimeters
 - (1) SEASAT (1978)
 - (2) GEOSAT (1985–1989)
 - (3) ERS-1 (1991-1996)
 - (4) ERS-2 (since 1995)
 - (5) TOPEX/POSEIDON
 - (6) JASON-1/2
 - (7) ENVISAT (since 2002)
- Satellite with laser altimeters
 - ICESat: GLAS (since 2003)





Herzfeld



Professor Dr. UTE CHRISTINA HERZFELD received her M.Sc. and Ph.D. at the University of Cologne, Germany. She was awarded the Humboldt Prize of the International Association for Antarctic Geology for outstanding contributions in the field of glacial geomorphology.

Since 2002, the Herzfeld has been head of the Geomorphology Division of the University of Cologne, Germany. The author is a geomorphologist and glaciologist with extensive field experience on field expeditions to Antarctica, Greenland and Alaska. She was awarded the Humboldt Prize of the International Association for Antarctic Geology for outstanding contributions in the field of glacial geomorphology.







Atlas of Antarctica


Ute Christina Herzfeld

Atlas of Antarctica





Topographic Maps from Geostatistical Analysis of Satellite Radar Altimeter Data



with CD-ROM


Herzfeld • Atlas of Antarctica

Although it is generally understood that the Antarctic ice sheet plays a critical role in the changing global system, to date there is a general lack of readily available information on the subject. The Atlas of Antarctica is the first atlas on this subject destined to be published in 20 years. It contains a 1:45 accurate topographic and elevation map derived from satellite altimetry (ICESAT and ERS-1 radar altimetry data), which is the best of its kind available today. Each map is accompanied by a description of geographic and glaciological features.

The atlas features chapters familiar to the reader with the world of the Antarctic ice sheet and its role in the global system, as well as chapters on satellite remote sensing and geostatistical methods at local, regional and global scales. Applications include detailed regional and global glacier inventories of the inland ice, some of which are currently changing rapidly. Combinations with SSB data facilitate the study of surface structures and flow features.

Despite its size of 200 pages, the Atlas of Antarctica is not only intended for use by researchers and students in glaciology, geophysics, remote sensing, cartography and Antarctic research, but also an informative and enjoyable text for any reader interested in the seventh continent. The Atlas is accompanied by a CD-ROM containing all the atlas maps and elevation models – enabling the reader to discover a wealth of fascinating details in Antarctica.

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EXTRA INFORMATION

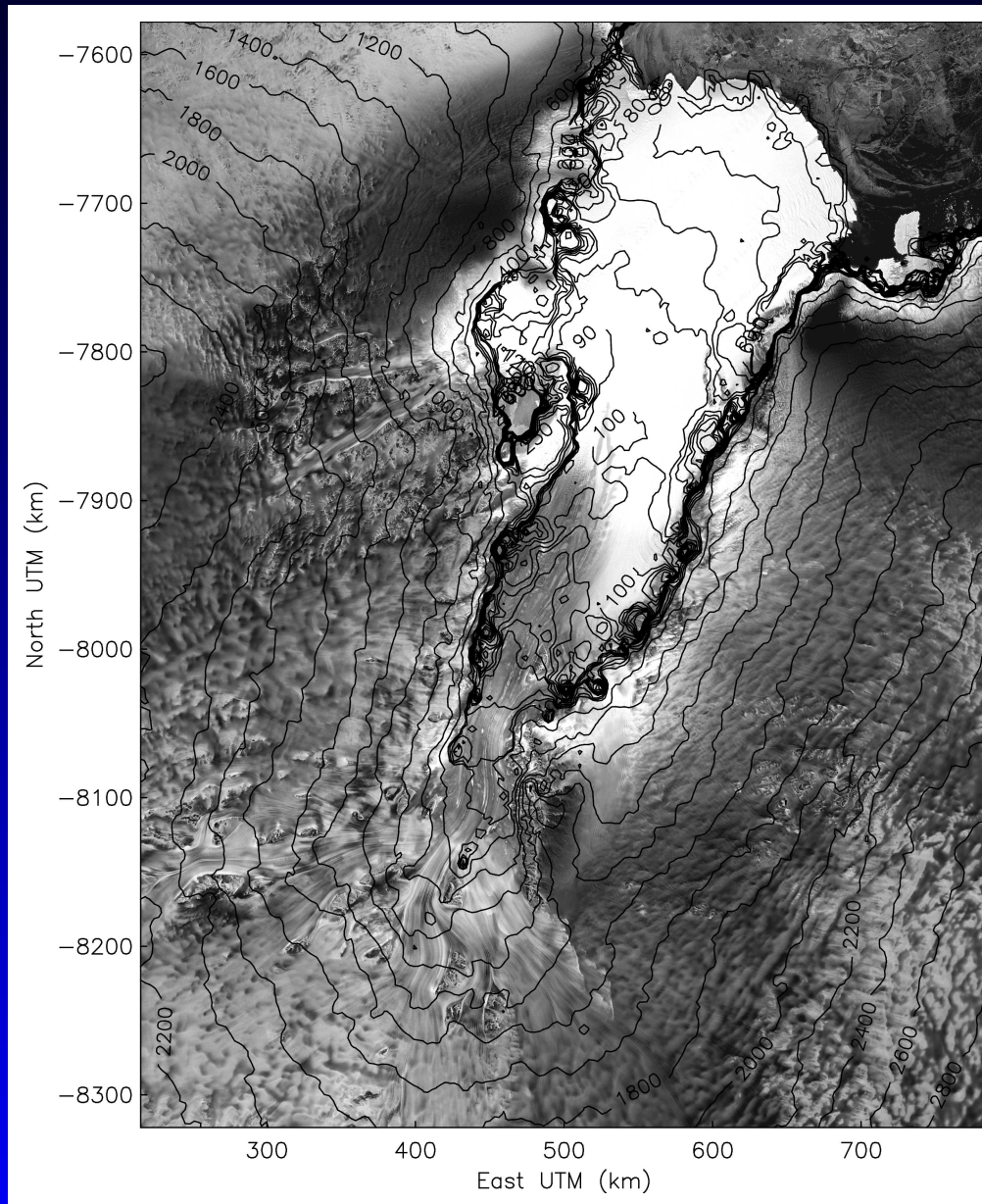
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with CD-ROM

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Topography and Flowlines of Lambert Glacier/Amery Ice Shelf System



Elevation:

1997 ERS-2 data
(1 Aug–31 Oct 1997),
geostatistical analysis
(Herzfeld et al.)

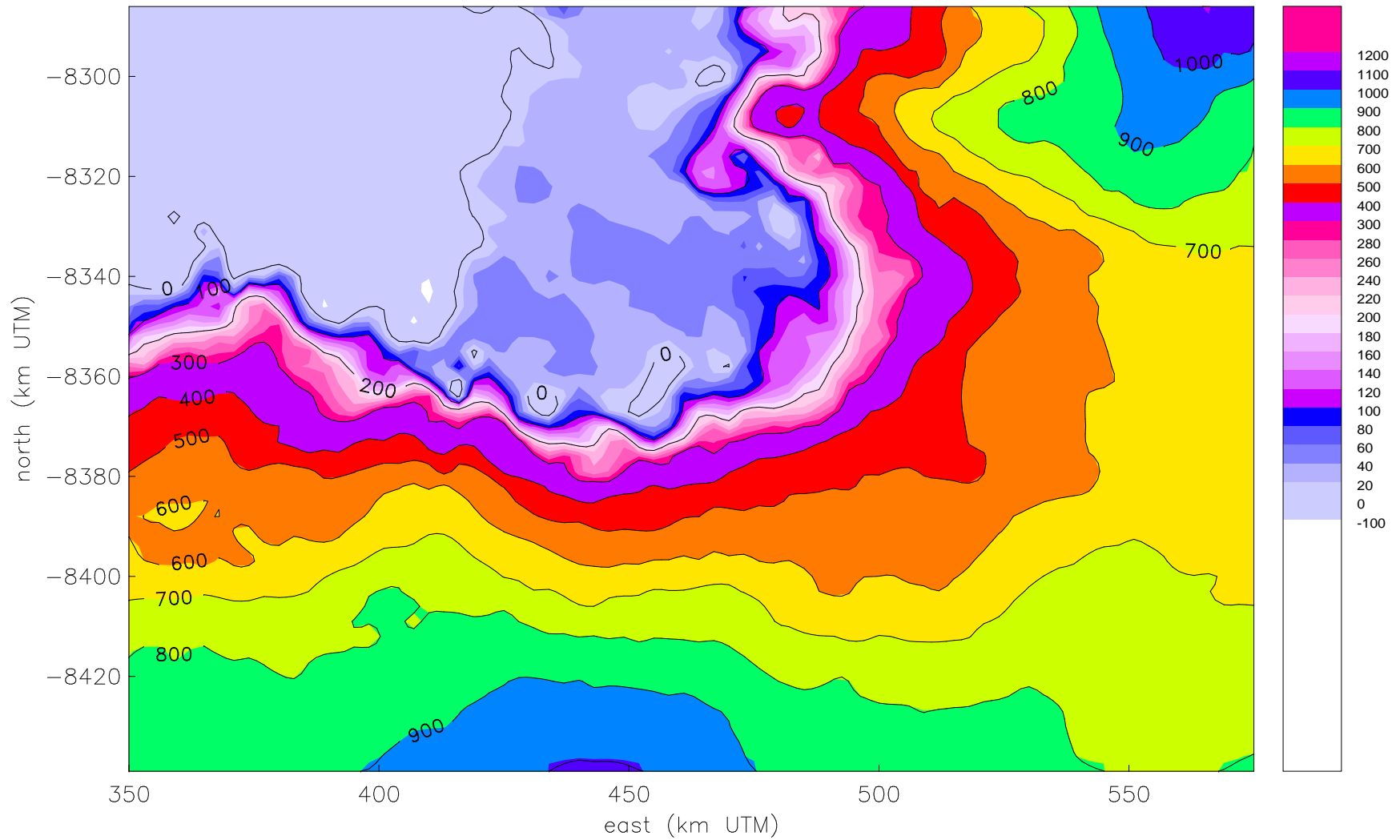
Surface Structure:

1997 RADARSAT
data (RADARMAP
1st Antarctic mission,
2 Sept- 20 Oct 1997;
Mosaic Jezek et al.,
125m pixels)

Data integration and
geo-referencing:

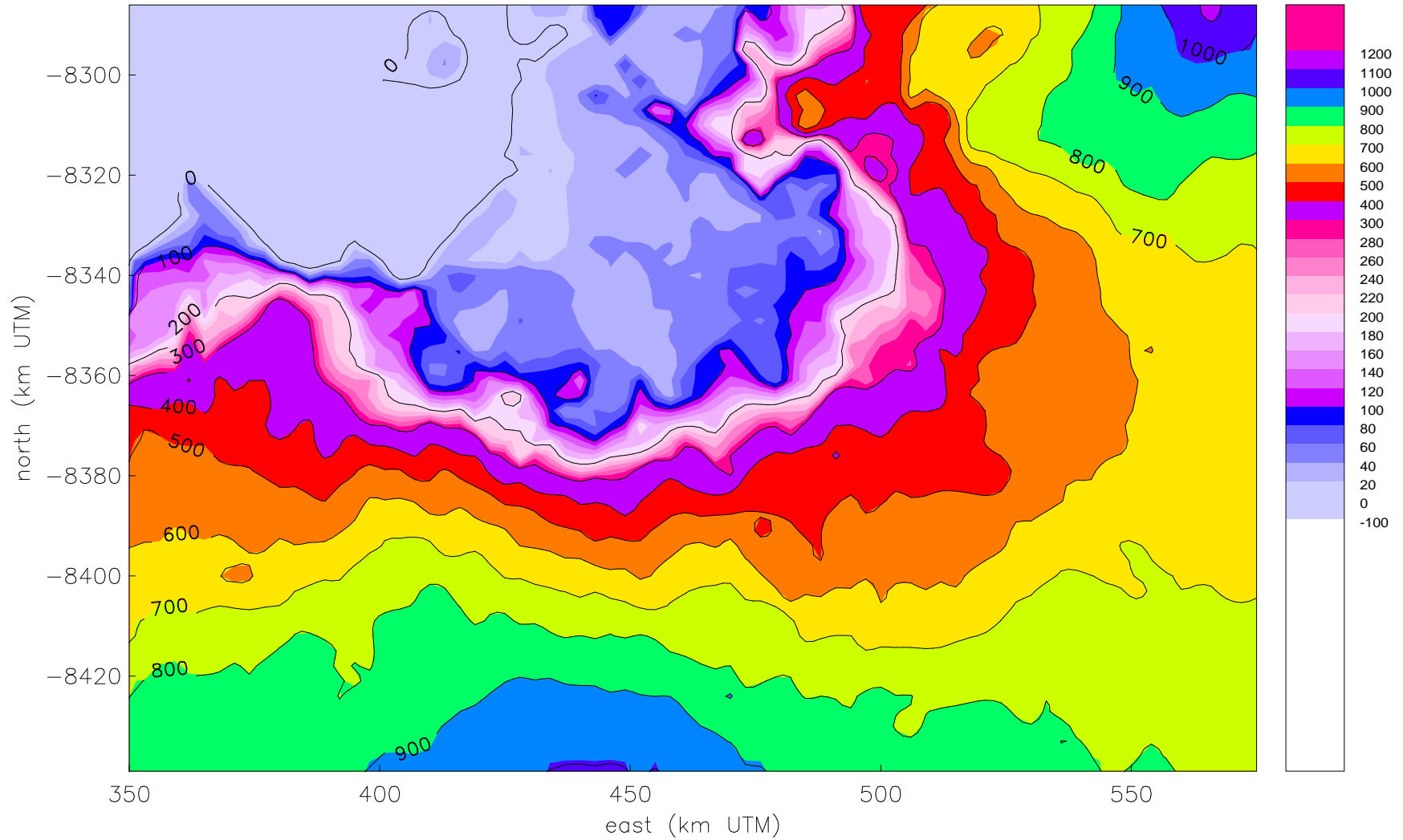
Stosius and Herzfeld

Pine Island Glacier – ERS-1 Data, 1995



1:2000000, m261e243-279n71-77.e.smallpine2.v2.col8

Pine Island Glacier – GLAS Data



GLA06 Data, (Laser 2A, gain-crit, rel18), Oct/Nov 2003, vario(350,3450,6000m), search-rg 30km, 1:2000000, gla06.1.gain.smallpine2.v2.col8

higher-resolution properties and processes
— same tendency in modeling

What is spatial surface roughness?

- a derivative of (micro)topography
- characterization of spatial behavior

Niwot Ridge Snow Surface: Winter ————— Summer





Bering Glacier, 1994, mature surge stage, Khittrov Hills in background

Jakobshavn Isbræ Drainage Basin – Spring Ice Surface

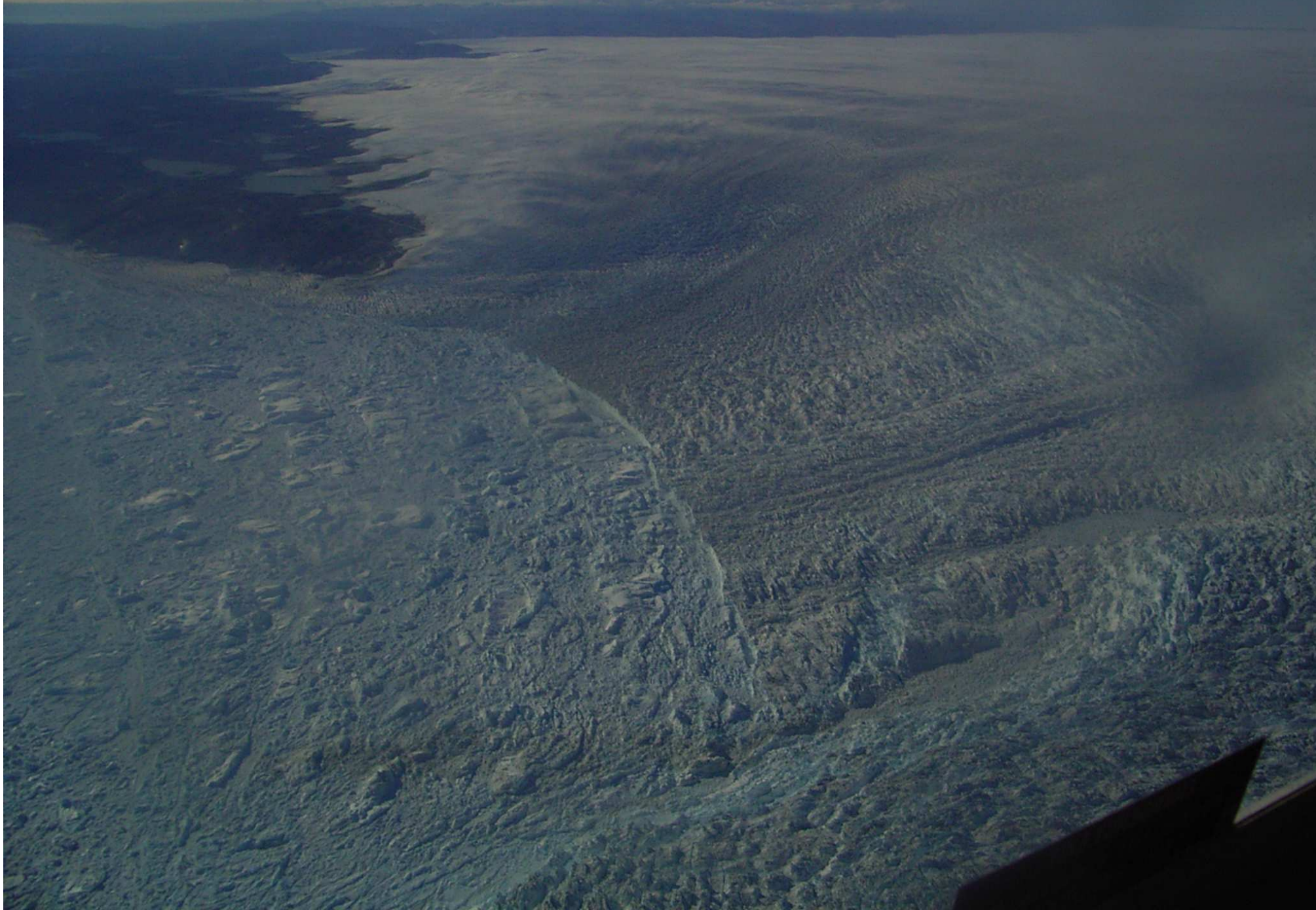


Jakobshavn Isbræ Drainage Basin – Summer Ice Surface





Jakobshavns Isbræ: August 1996



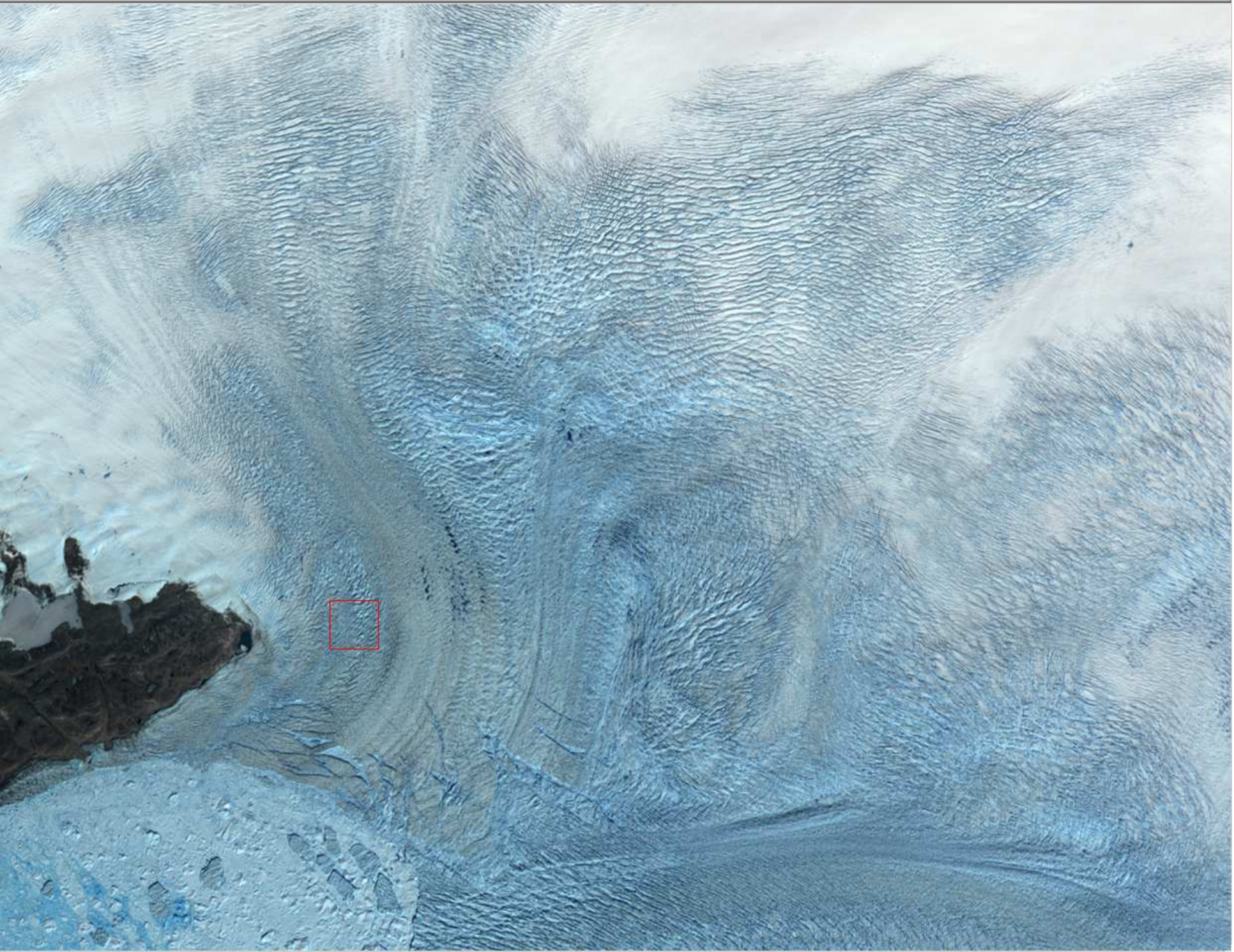
Calving Front of Jakobshavns Isbræ on 16 July 2005

How do we measure surface roughness? — The GRS !



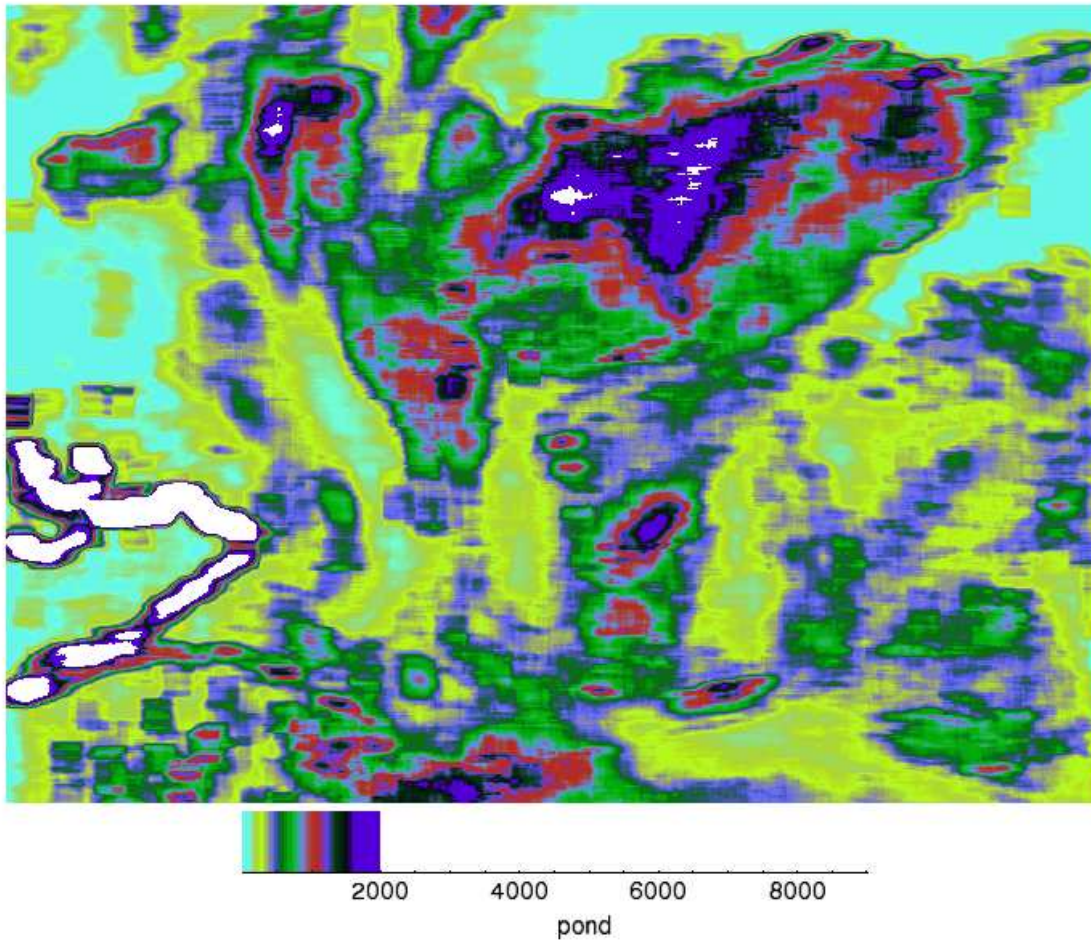


Mapping Deformation Properties using Geostatistical Classification based on ASTER DATA

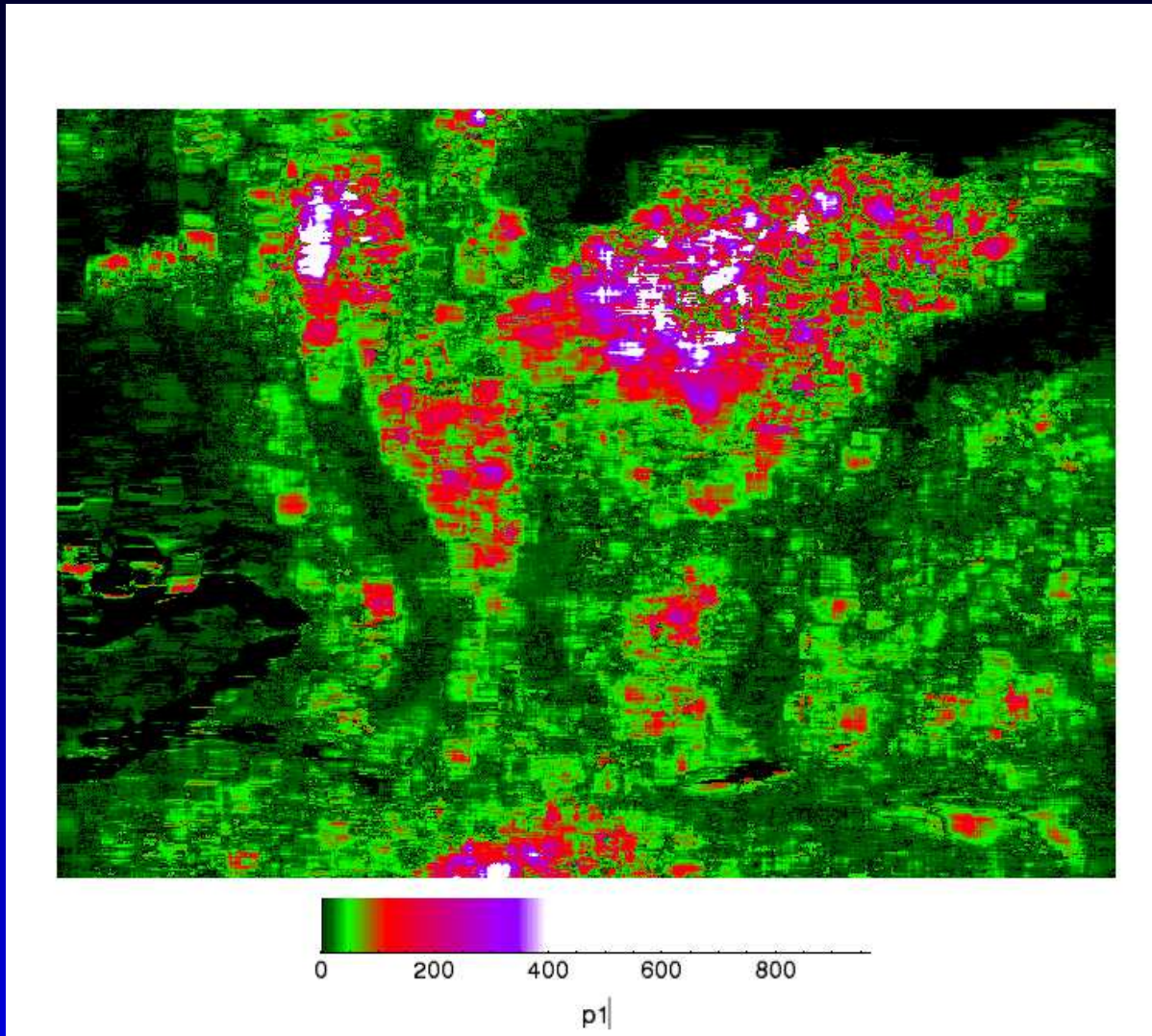


Jakobshavn Isbræ: North Icestream — ASTER Data, May 2003

ASTER Data Classification: Parameter *pond*



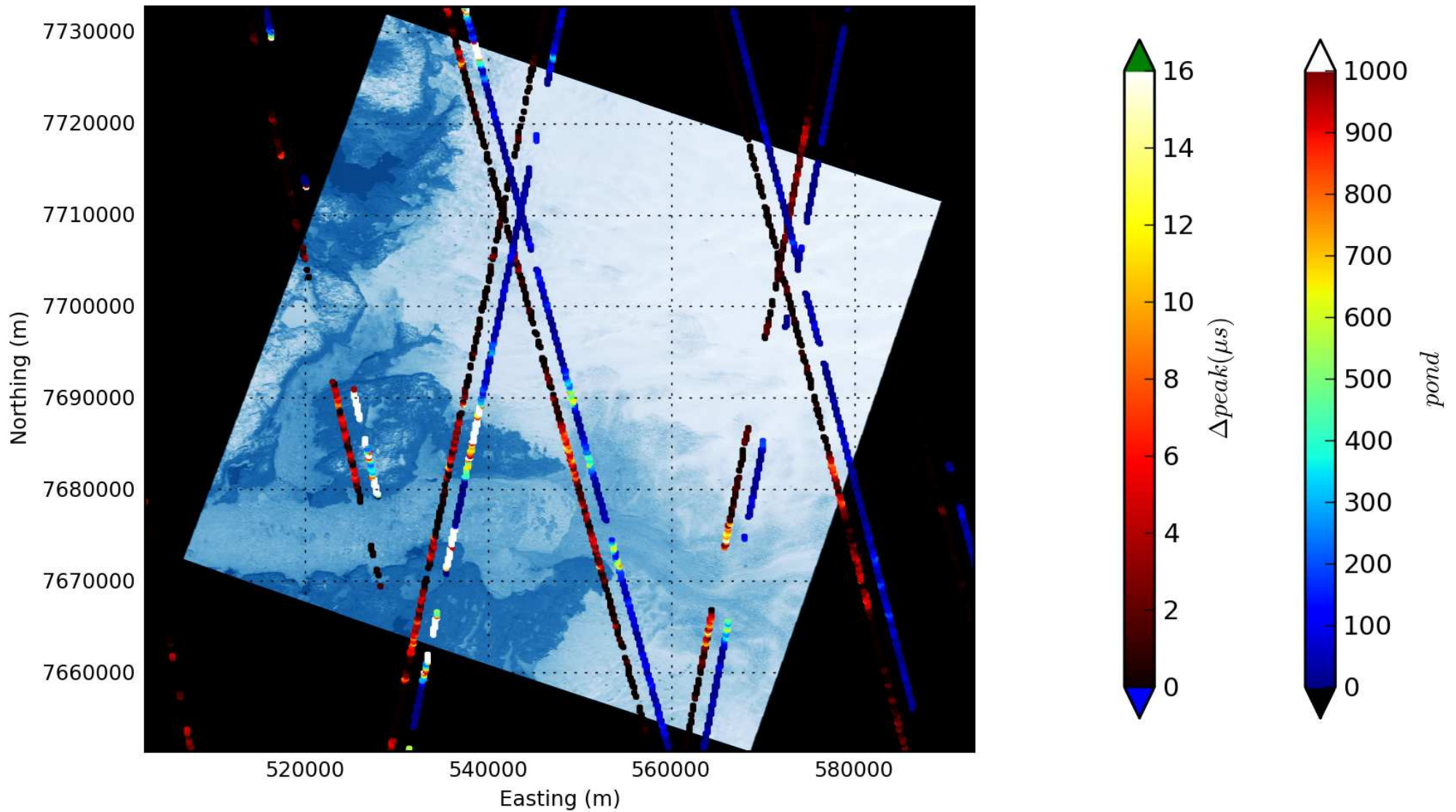
ASTER Data Classification: Parameter p_1



window 20, offset 1, direction N-S

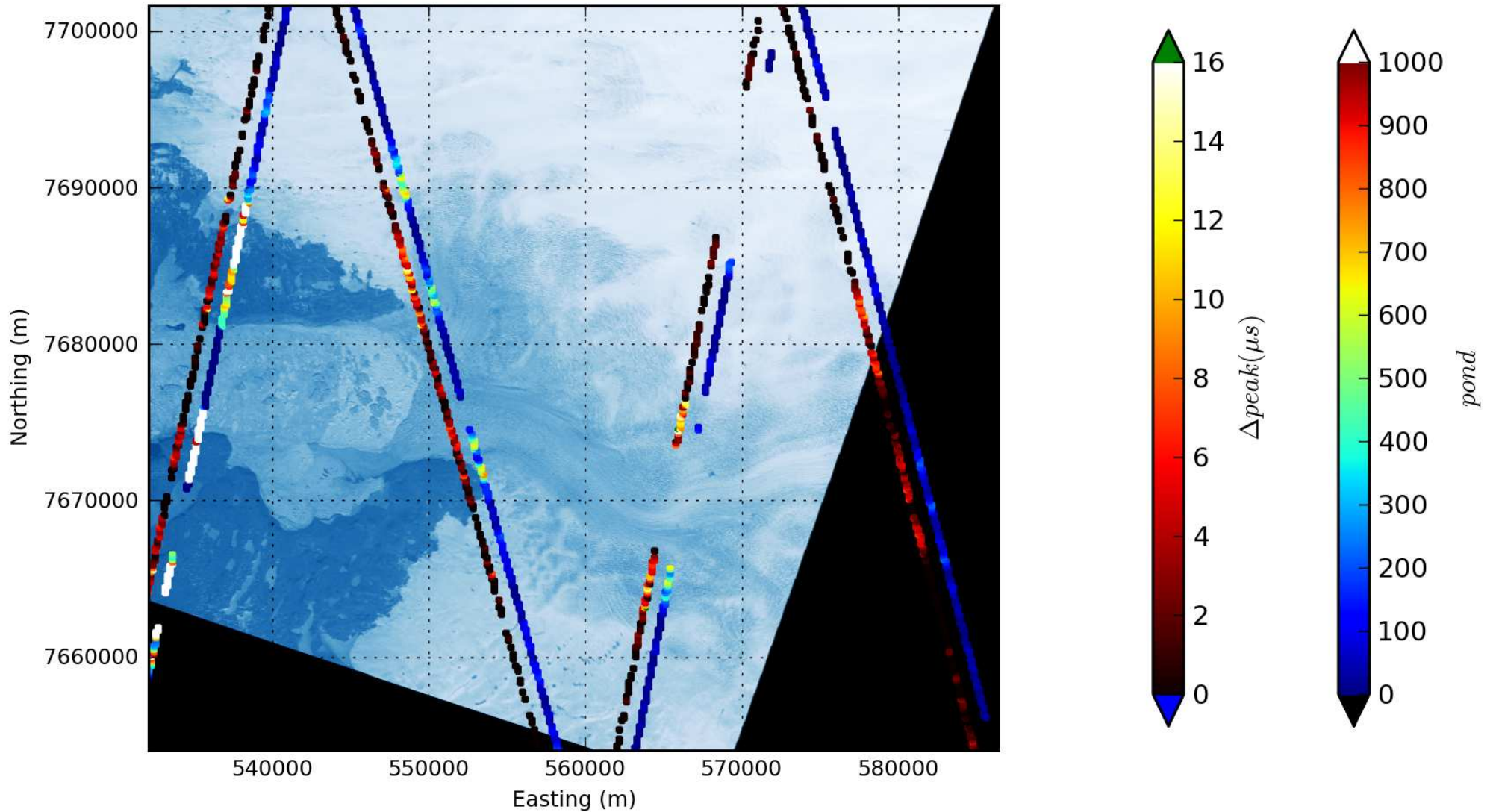
Dynamic Provinces in Jakobshavns Isbræ
from ICESat (GLAS, 2003-2009)
and IceBridge (ATM, 2009) Data

Jakobshavn Isbrae - Roughness measures



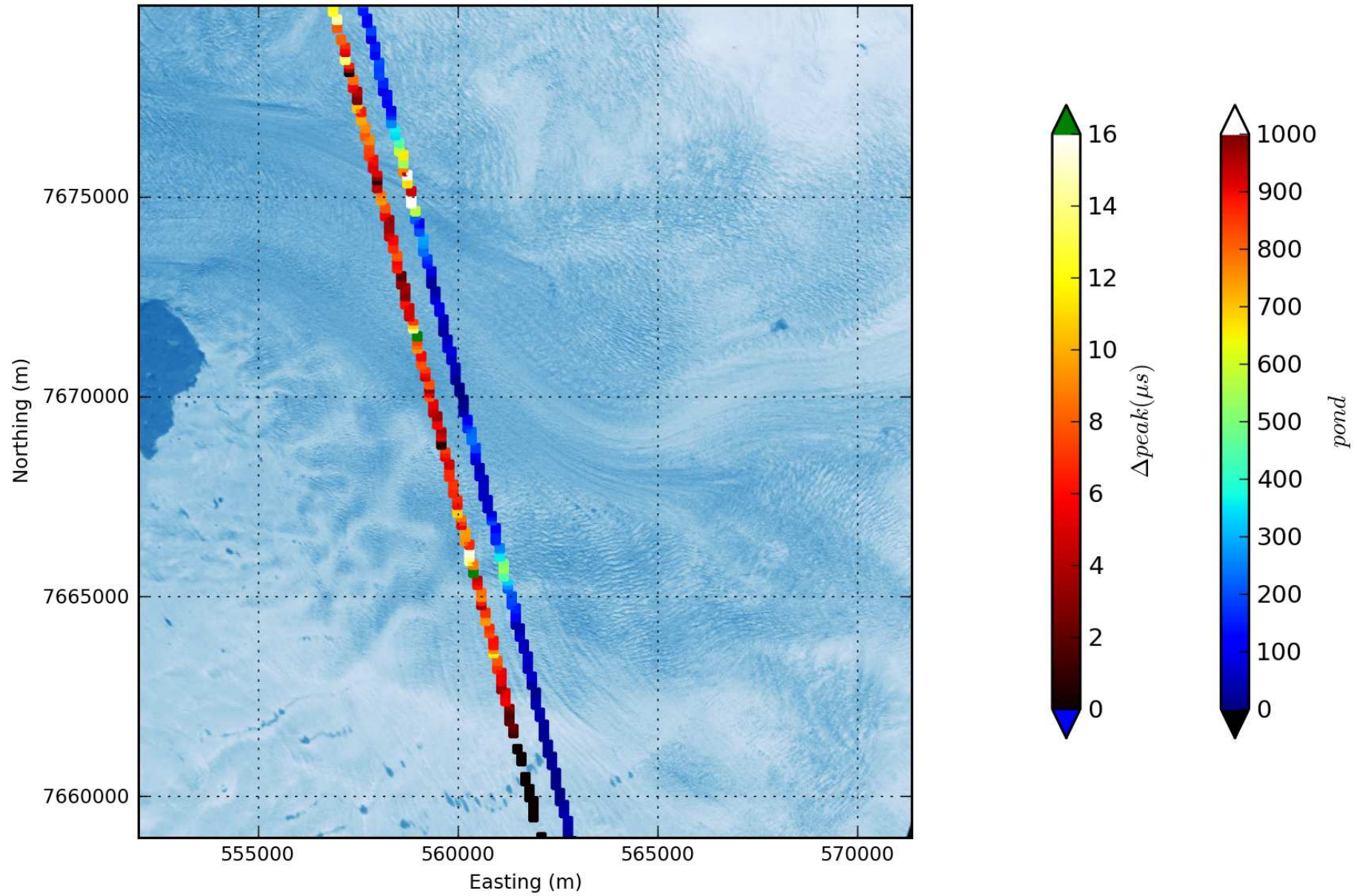
GLAS L3C 05/2005 left to right: $\Delta peak(\mu s)$, *pond*
ASTER 3B 05-2003 Background

Jakobshavn Isbrae - Roughness measures



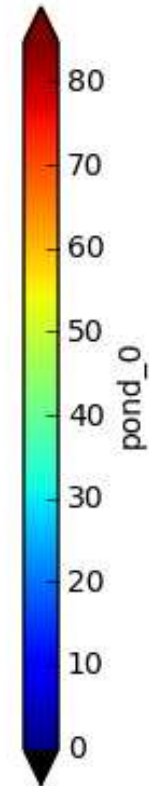
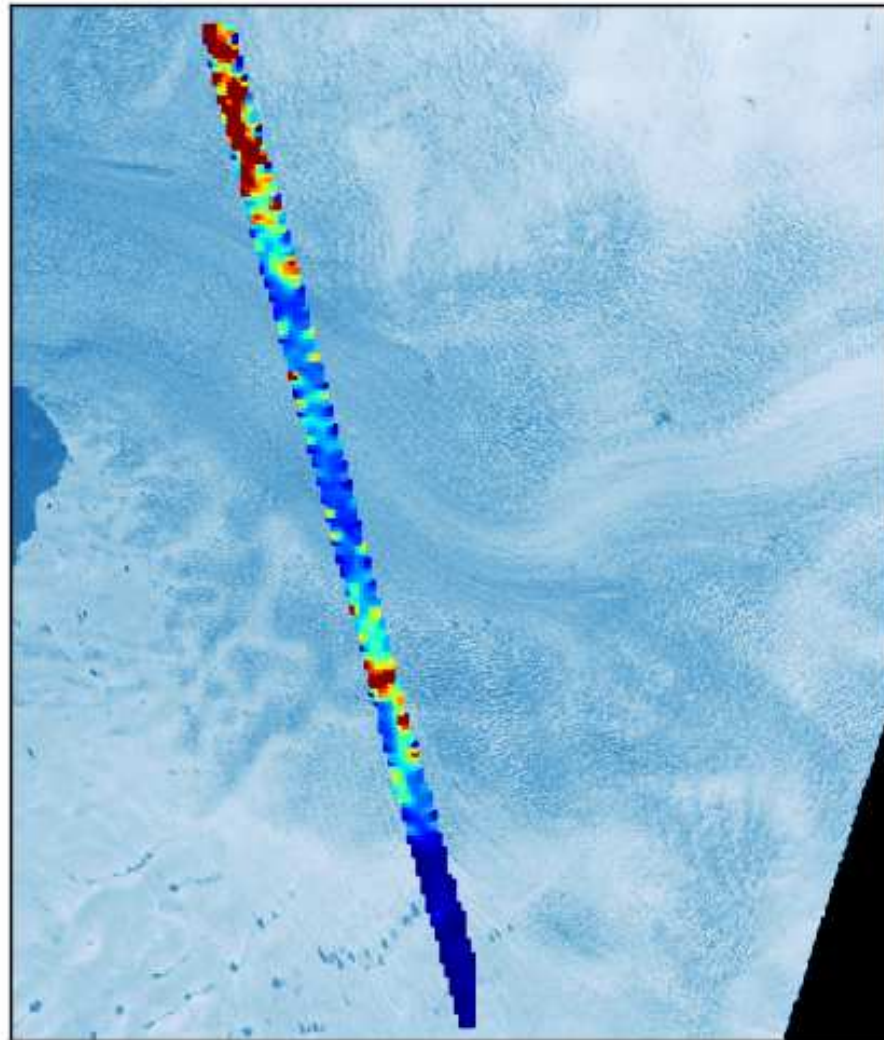
GLAS L3C 05/2005 left to right: $\Delta peak(\mu s)$, *pond*
ASTER 3B 05-2003 Background

Jakobshavn Isbrae - Roughness measures



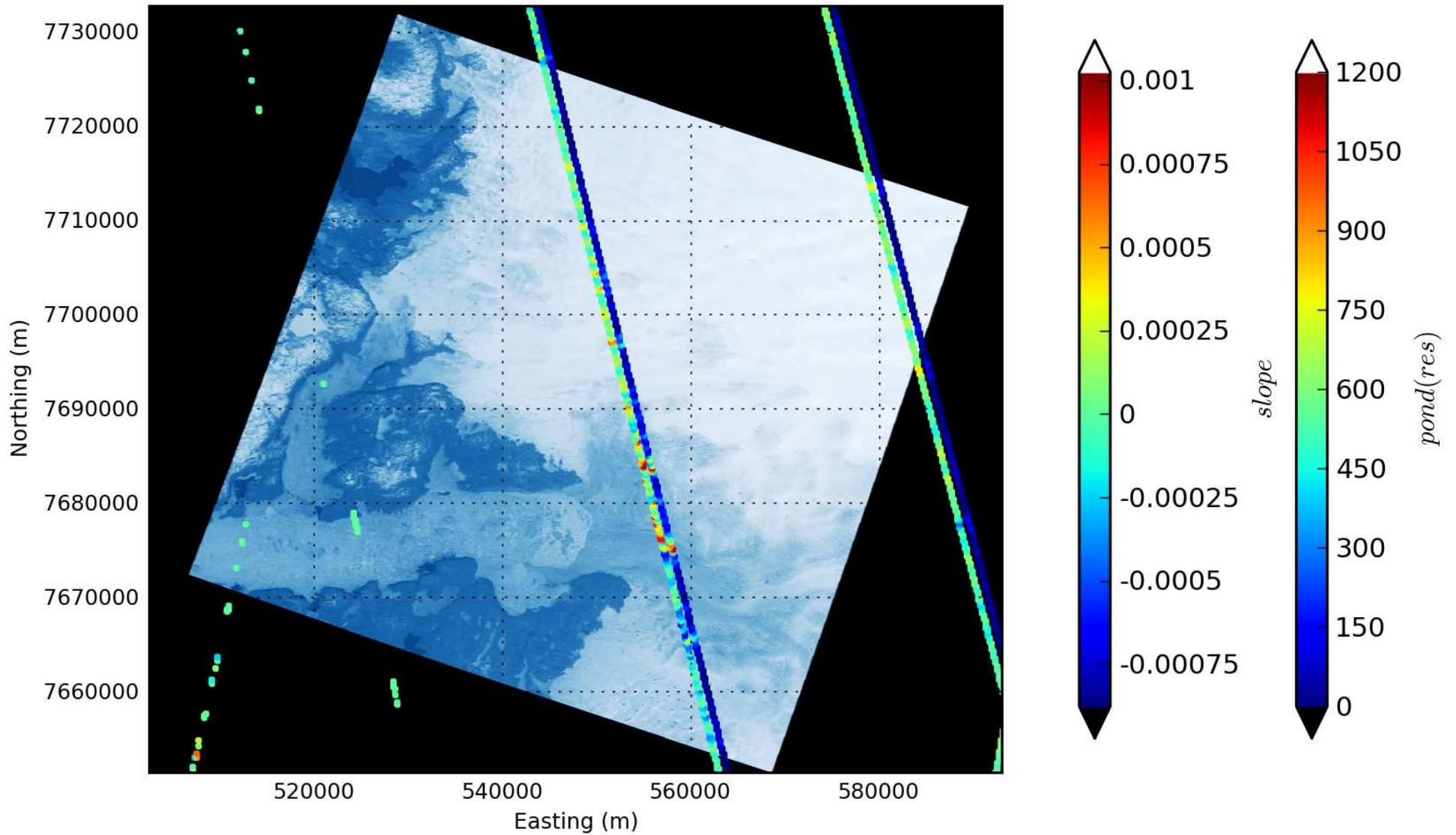
GLAS I 31 11/2007 left to right: $\Delta_{peak}(\mu s)$ *pond*

Jakobsnavn Isbrae - roughness measures



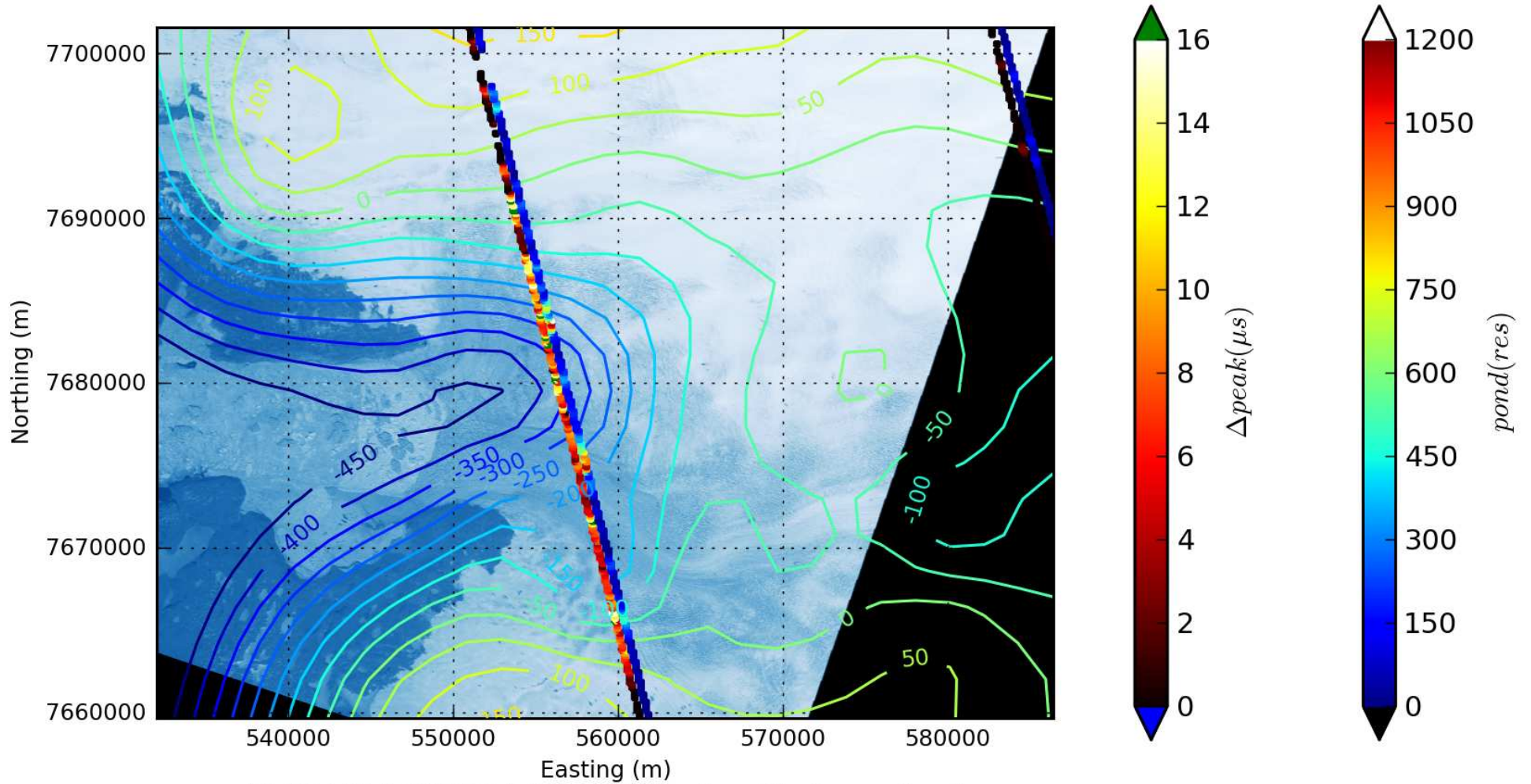
ATM full pond_0 parameter
ASTER 3B 05-2003 Background

Jakobshavn Isbrae - Roughness measures



/data/wallinb/jak/plots/v5/jak_GLASL3I_slopepondres_zoom1_v4.png 2010-1-21

Jakobshavn Isbrae - Roughness measures



GLAS L3I 11/2007 left to right: $\Delta peak(\mu s)$, $pond(res)$
ASTER 3B 05-2003 Background
with CRESIS Bed contours

Possible implications of spatial surface roughness analyses for climate modeling

- (1.) Indicator variable for harder-to-observe spatial properties
- (2.) Ice dynamics
- (3.) Effects on energy fluxes ice-atmosphere
- (n.)[your idea here]

Snow- and ice-surface-roughness — Climate — Ablation feedback

- (1) Derivation of mathematical relationship bt surface roughness and geostatistical characterization
- (2) Calculation of surface roughness length from GRS measurements
- (3) Utilization of micrometeorological observations (PARCA Network Greenland; Mountain Research Station, Niwot Ridge (NSF CU LTER))
- (4) Calculation of energy available for melting (with J. Box, M.Kuhn)

Result: Melt energy varies by a factor of 2.6 dependent on surface roughness !!

HERZFELD, U.C., J.E. BOX, K. STEFFEN, H. MAYER, N. CAINE, and M.V. LOSLEBEN, A case study on the influence of snow and ice surface roughness on melt energy, Zeitschrift Gletscherkunde Glazialgeol., v. 39 (2003/2004, printed 2006), p. 1-42