

Basal roughness, sedimentary distribution and flow configuration in West Antarctica

**Implications for Thwaites Glacier, based on knowledge gained from
the Siple Coast**

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JACKSON

SCHOOL OF GEOSCIENCES

Motivation

- + Sources and sinks for WAIS subglacial tills

Methodology

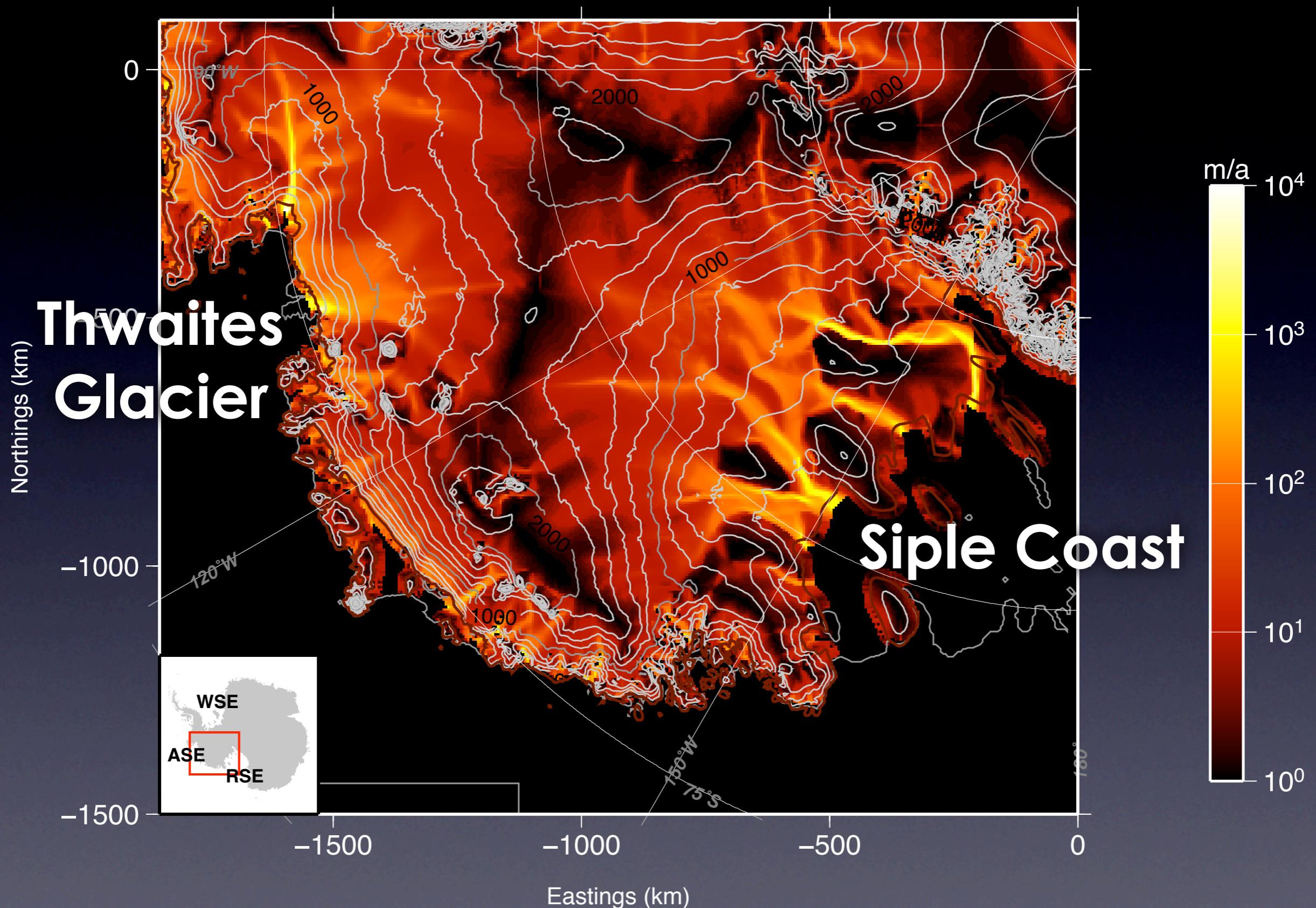
- + Isostatic anomalies from gravity
- + Along-track RMS slope analysis of RES profiles

Results

- + The Siple Coast ice streams show evidence of till deposition;
- + WAIS interior and Thwaites Glacier show restricted smooth, lubricated regions
- + Little evidence for downstream transport of till at Thwaites Glacier

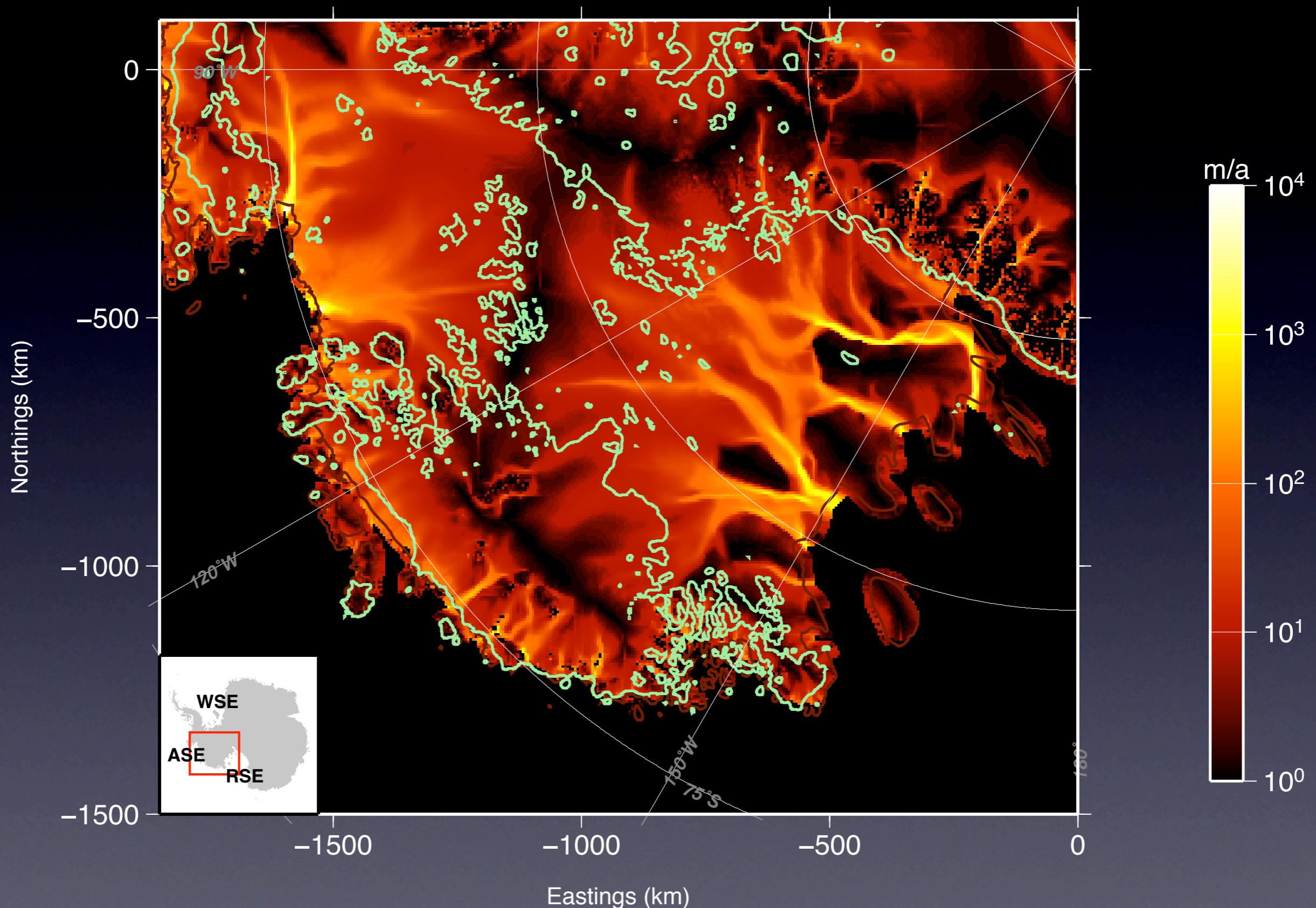
Motivation:

Balance Velocities [Le Brocq et al., 2005]



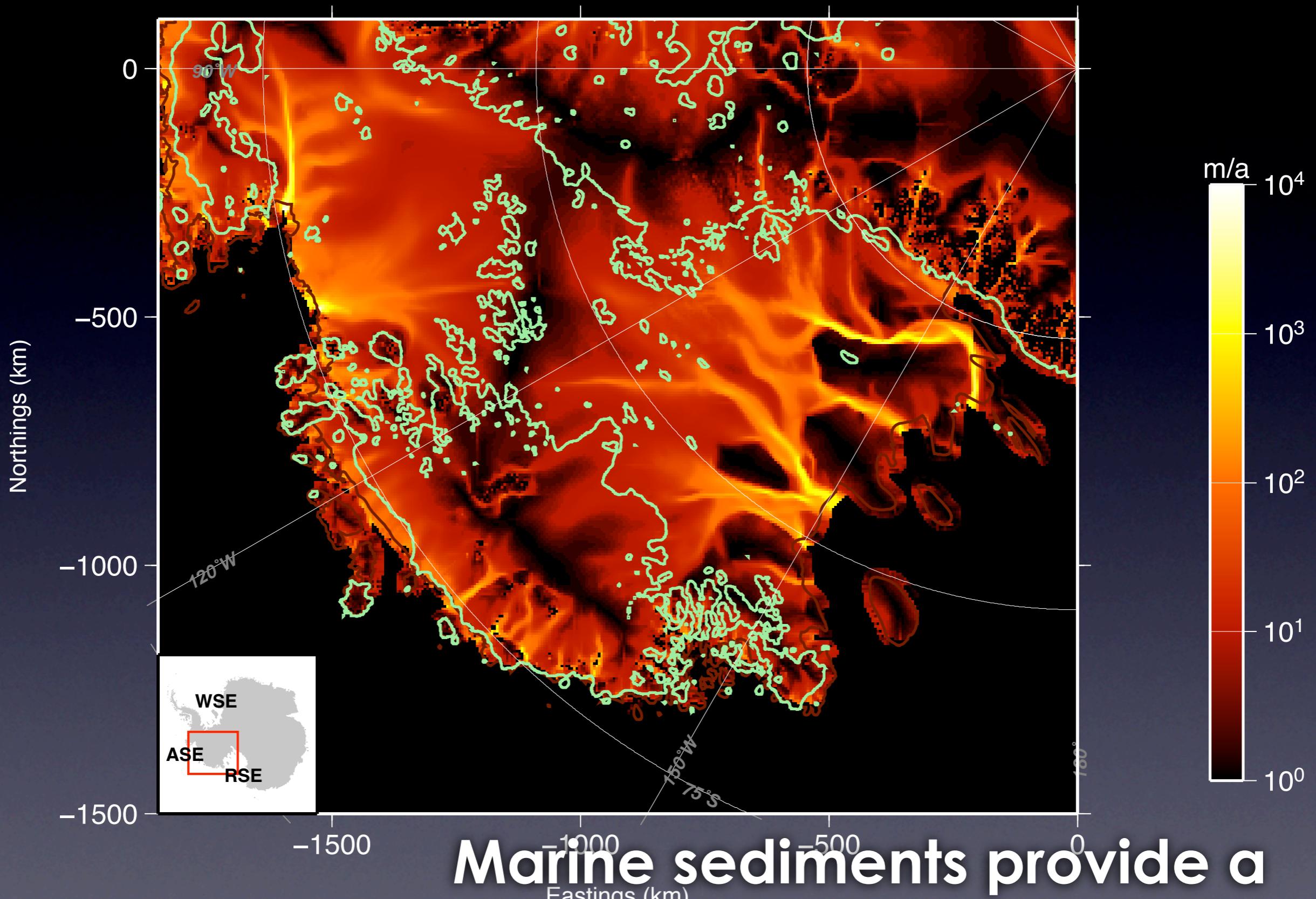
Motivation:

Alry isostatic deglaciated coastline [Holt et al., 2006]



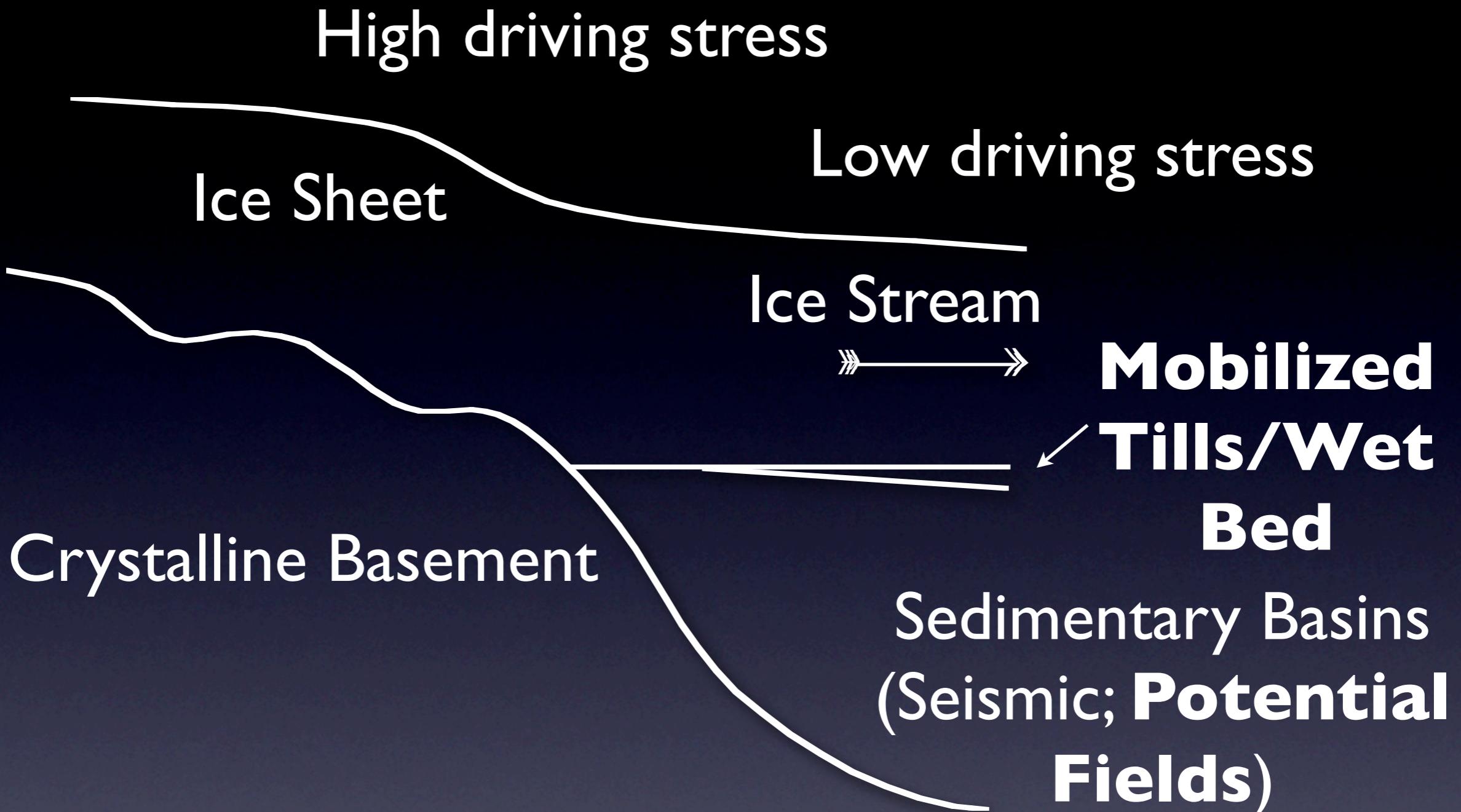
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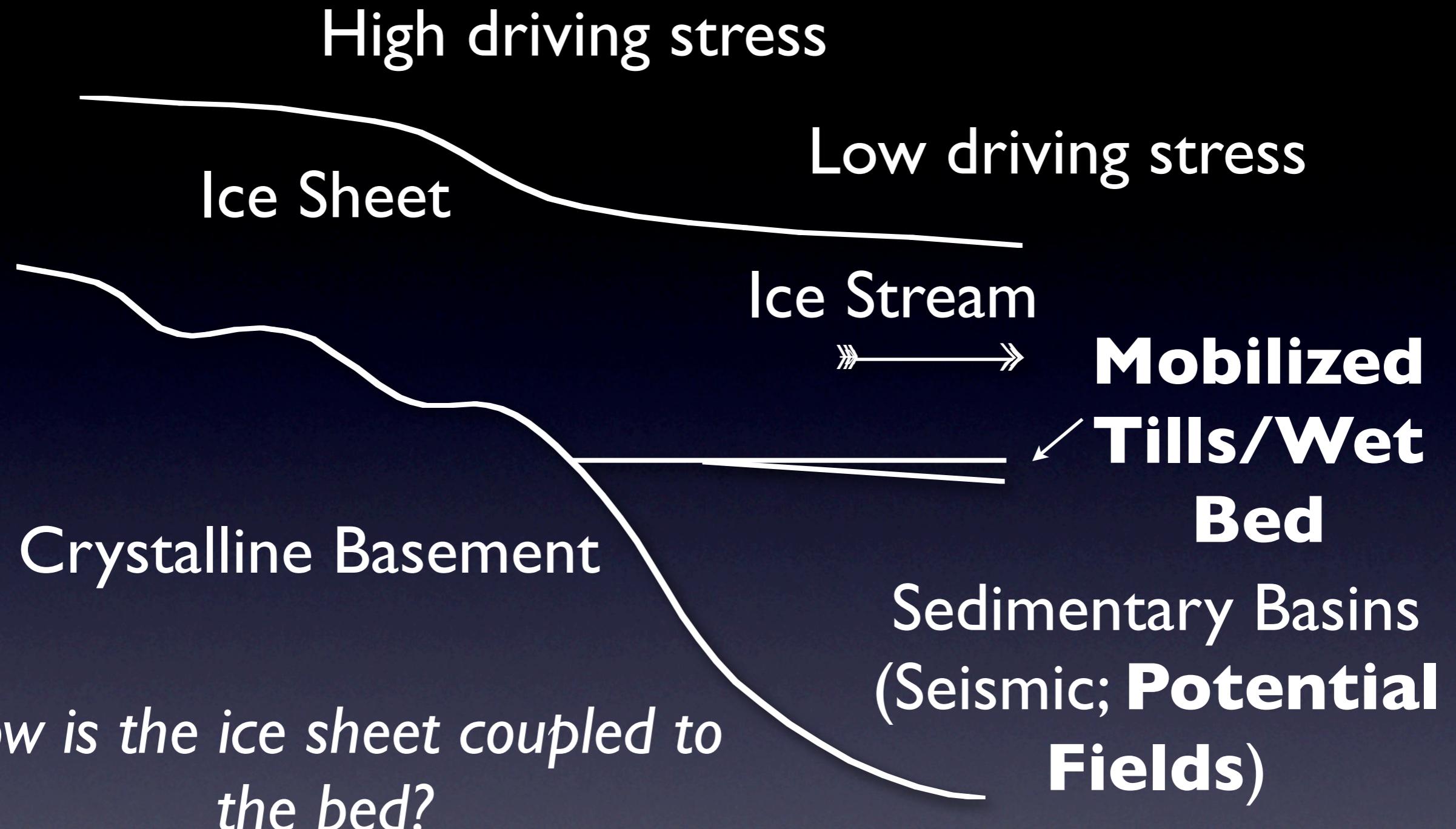


Marine sediments provide a
geologic control on ice streaming?

Motivation:



Motivation:



Motivation:

High driving stress

Ice Sheet

Low driving stress

Ice Stream



**Mobilized
Tills/Wet
Bed**

Crystalline Basement

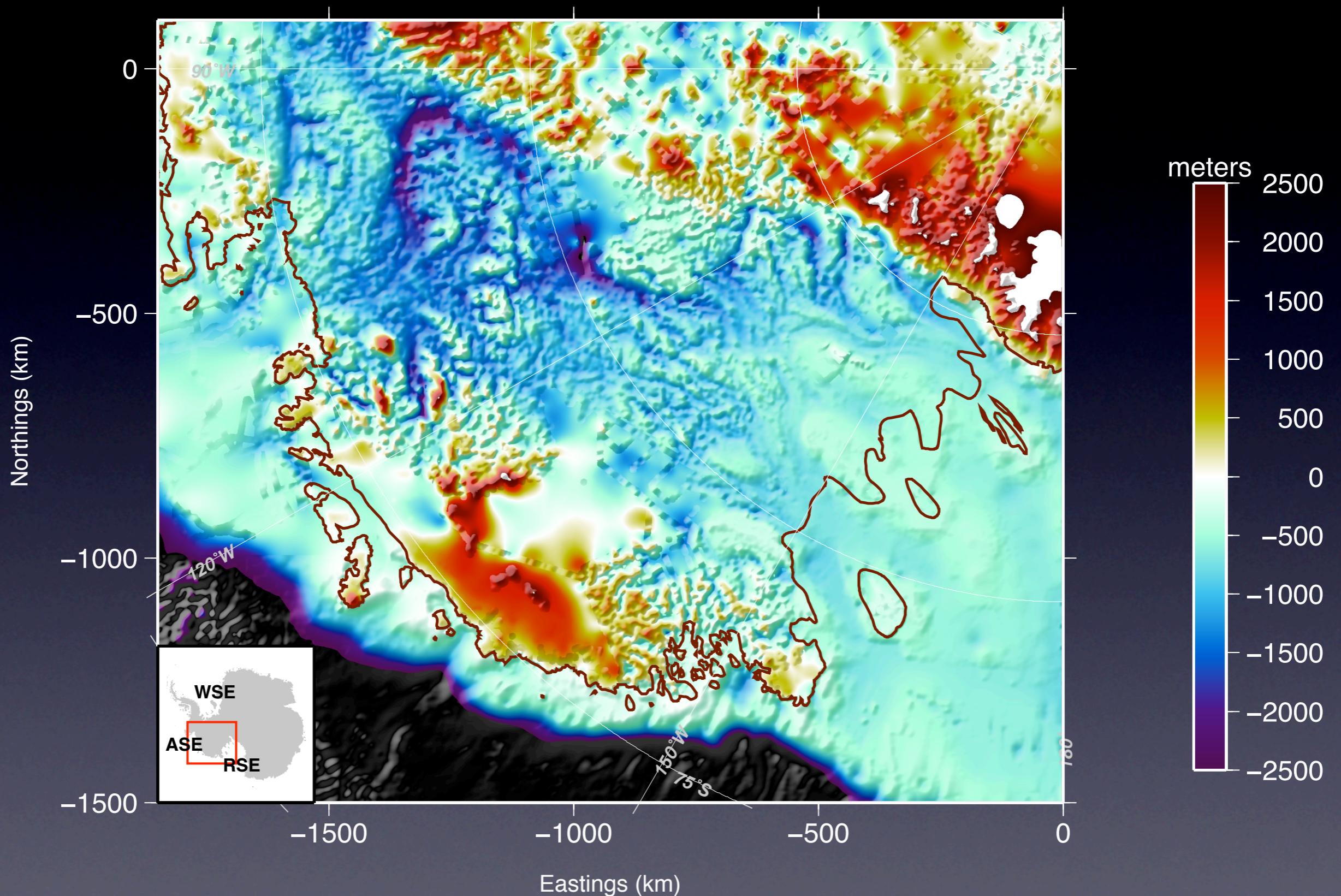
Sedimentary Basins
(Seismic; **Potential
Fields**)

*How is the ice sheet coupled to
the bed?*

*How are subglacial processes
reflected in subglacial morphology?*

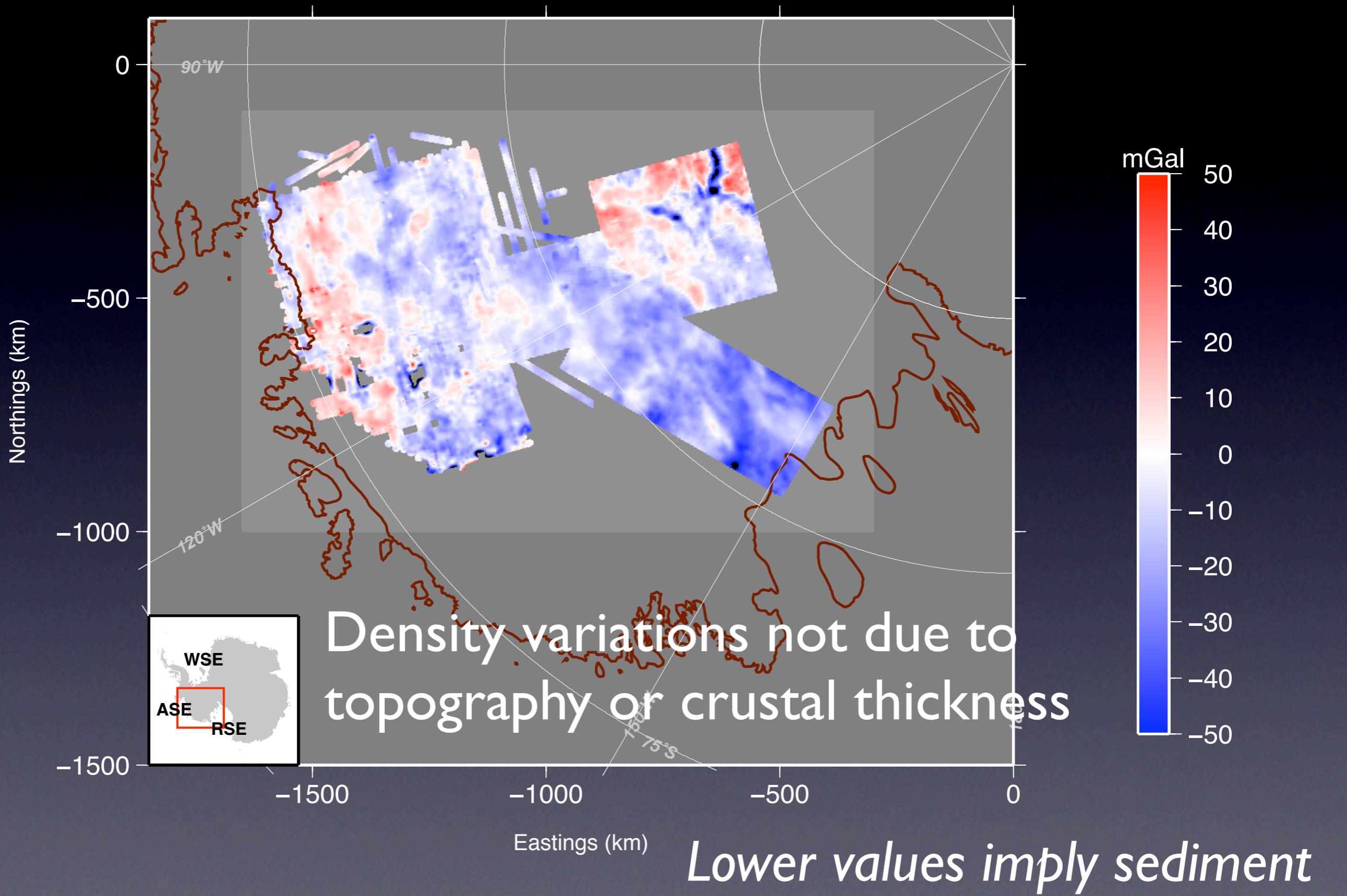
Methodology:

Bedrock elevations [Holt et al., 2006]



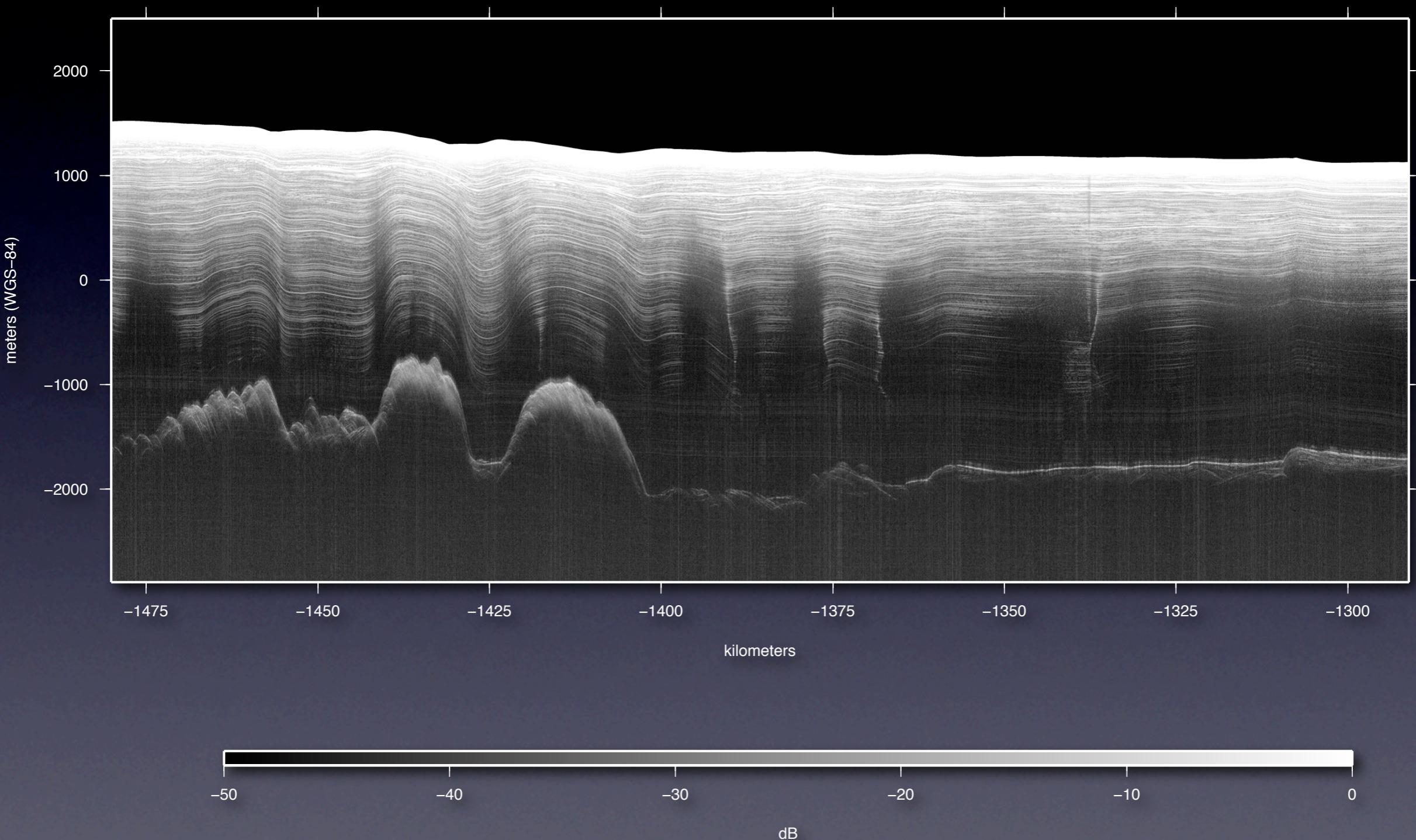
Methodology:

Isostatic anomaly [Diehl et al., ISASE X 2007]

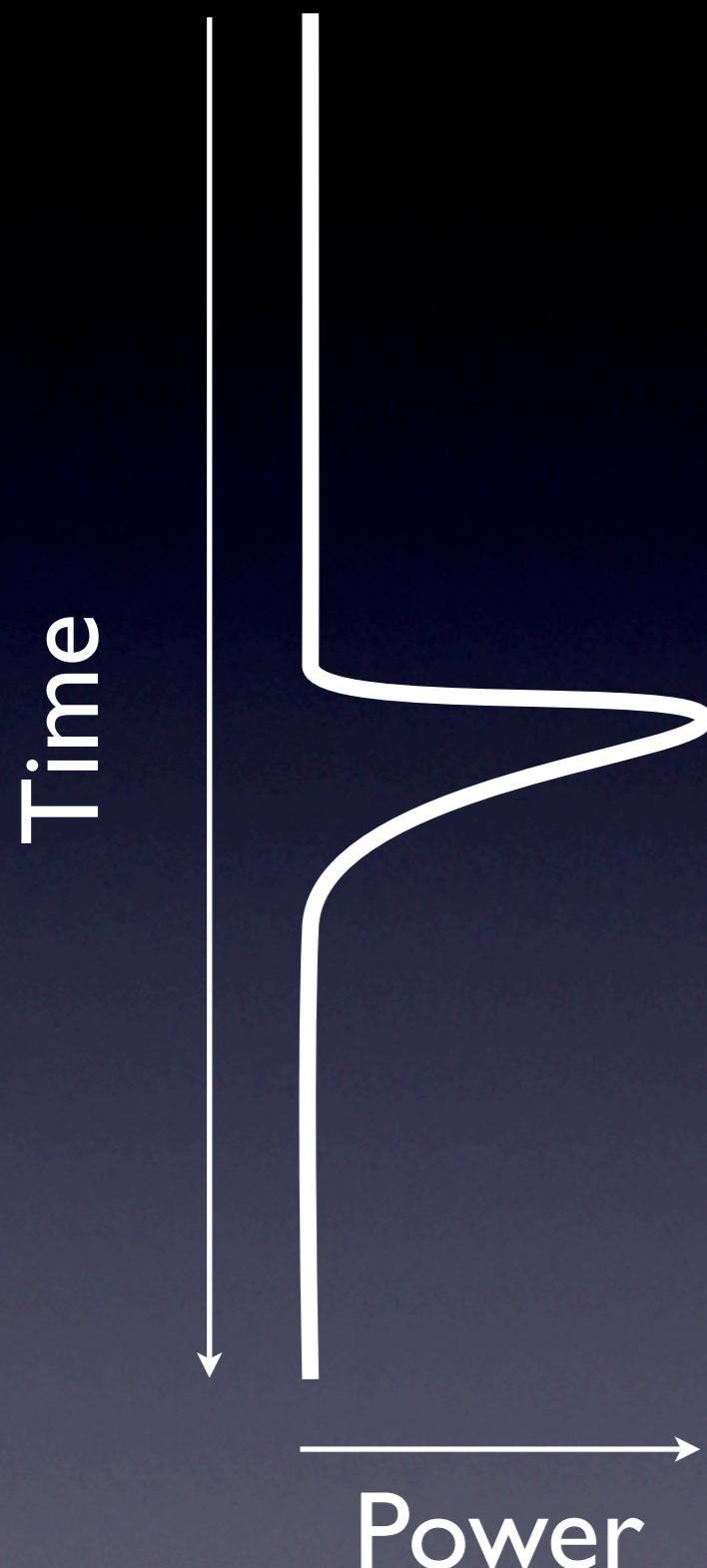


Methodology:

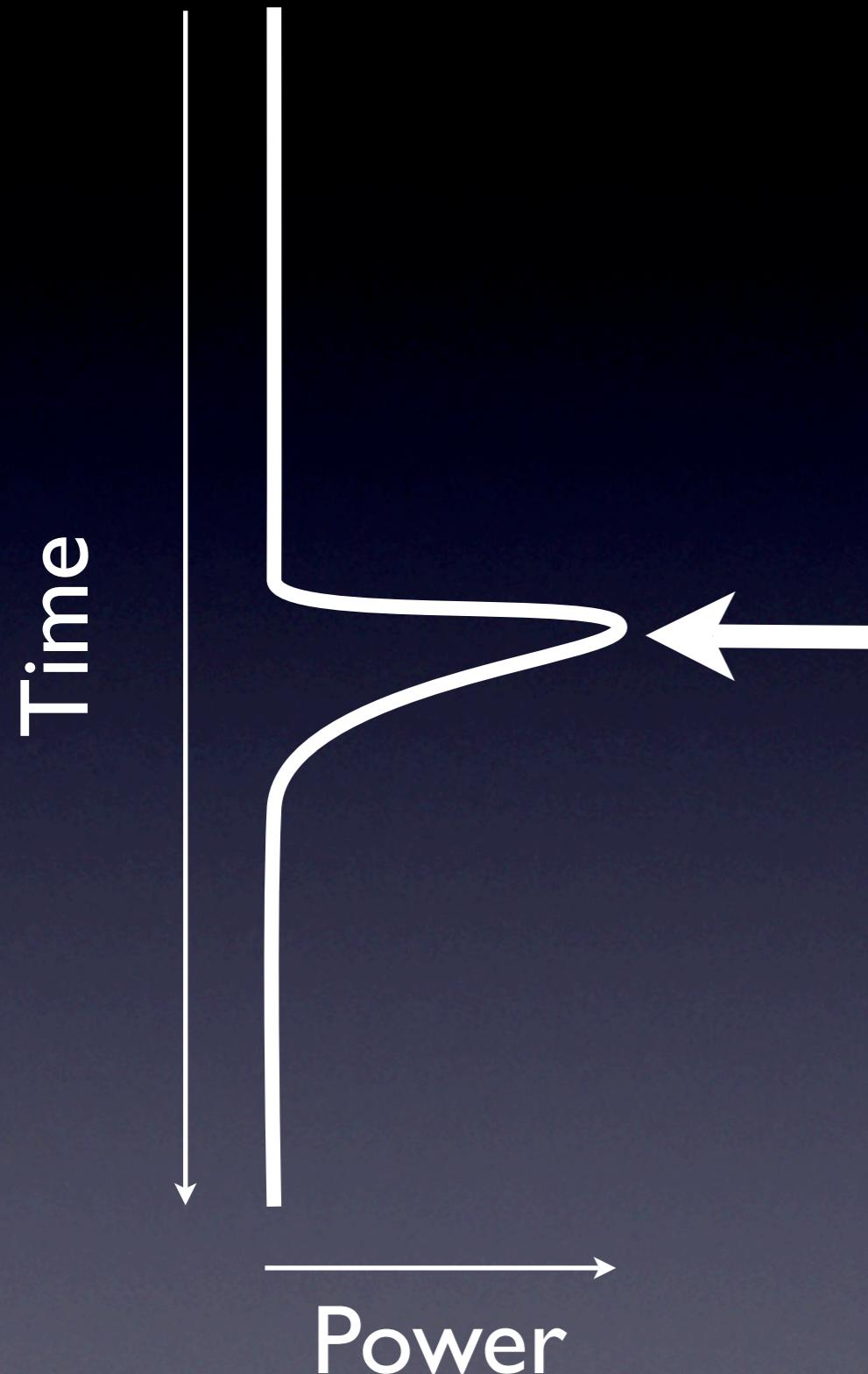
THW/SJB2/DRP10b



Methodology:

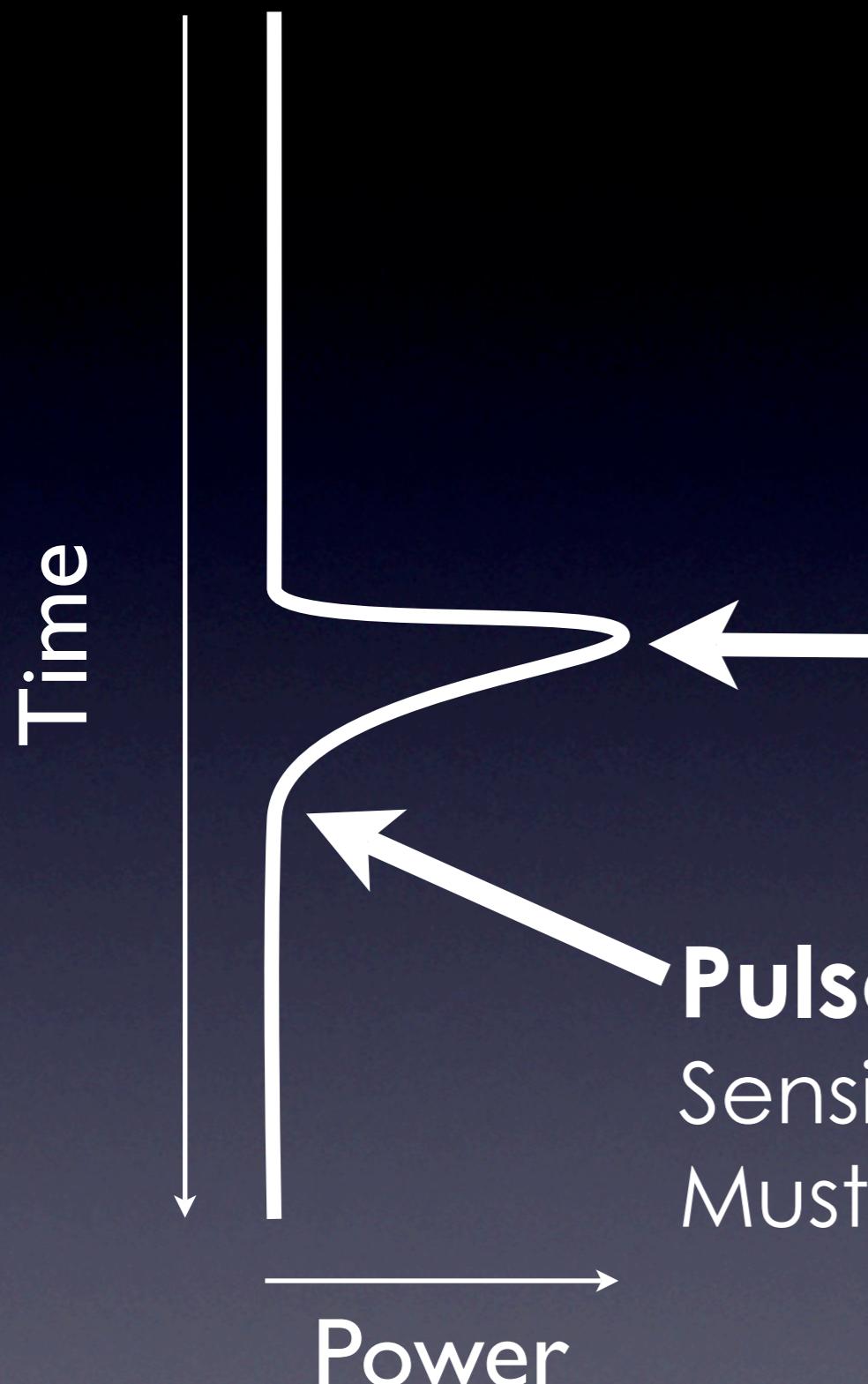


Methodology:



Peak Echo Power:
Sensitive to 'wetness'/scattering
Must account for ice attenuation

Methodology:



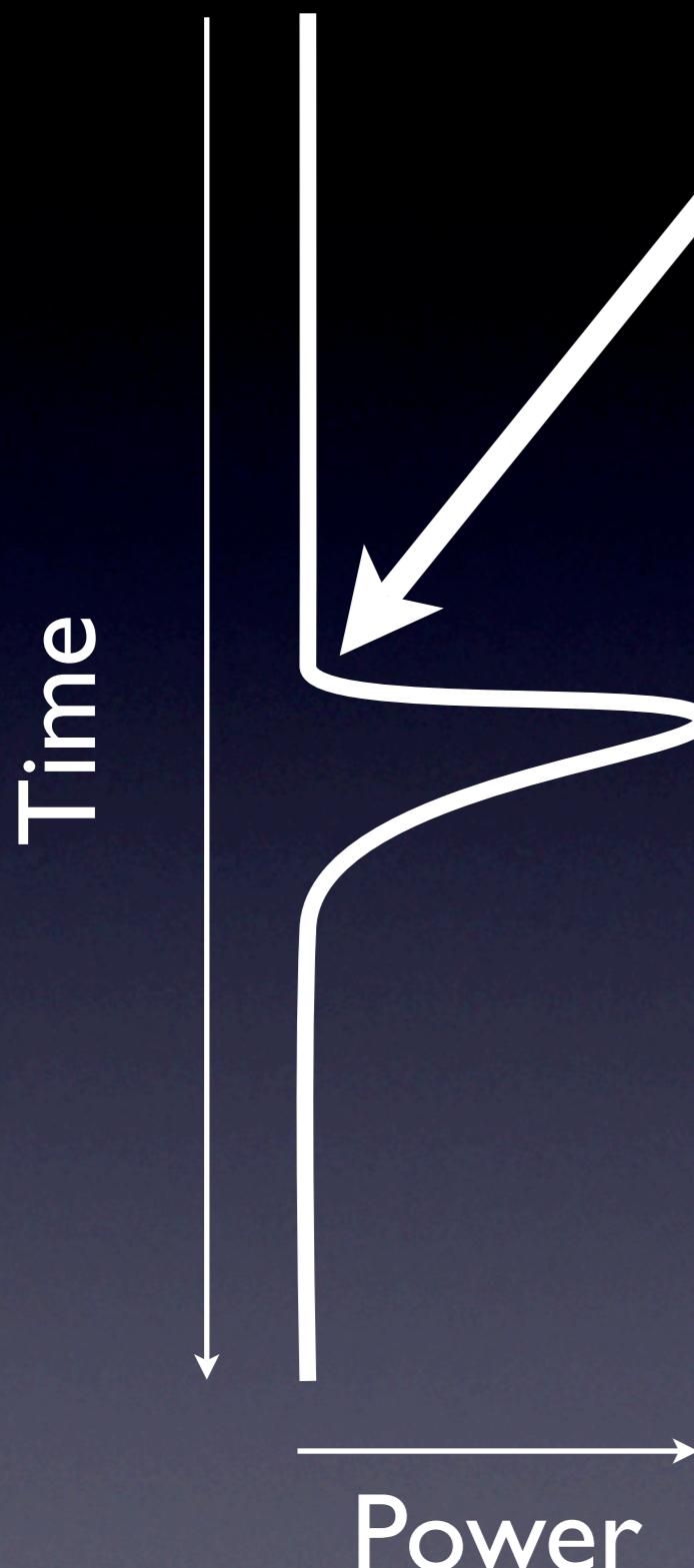
Peak Echo Power:

Sensitive to 'wetness'/scattering
Must account for ice attenuation

Pulse width:

Sensitive to small-scale slope distribution
Must account for ice attenuation

Methodology:



Along track variability:

Sensitive to regional roughness

Range ambiguities are important

Peak Echo Power:

Sensitive to 'wetness'/scattering

Must account for ice attenuation

Pulse width:

Sensitive to small-scale slope distribution

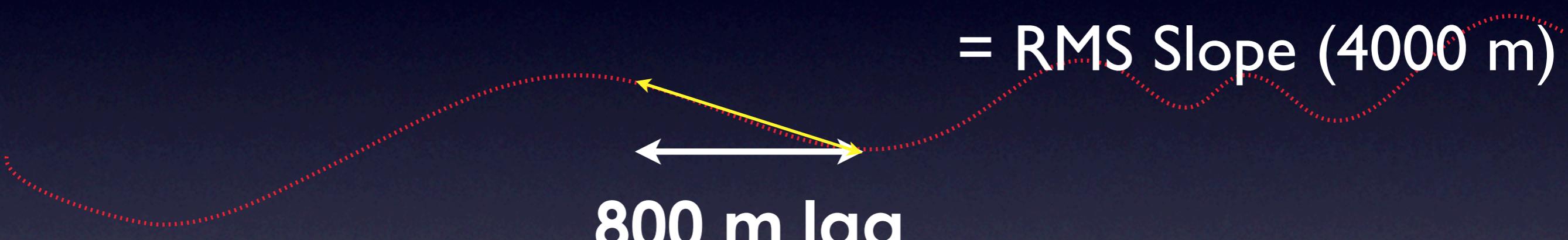
Must account for ice attenuation

Methodology:

$$\sqrt{-\frac{\sum(\text{Angle})^2}{(n)}} = \text{RMS Slope (800 m)}$$

$$= \text{RMS Slope (2000 m)}$$

$$= \text{RMS Slope (4000 m)}$$



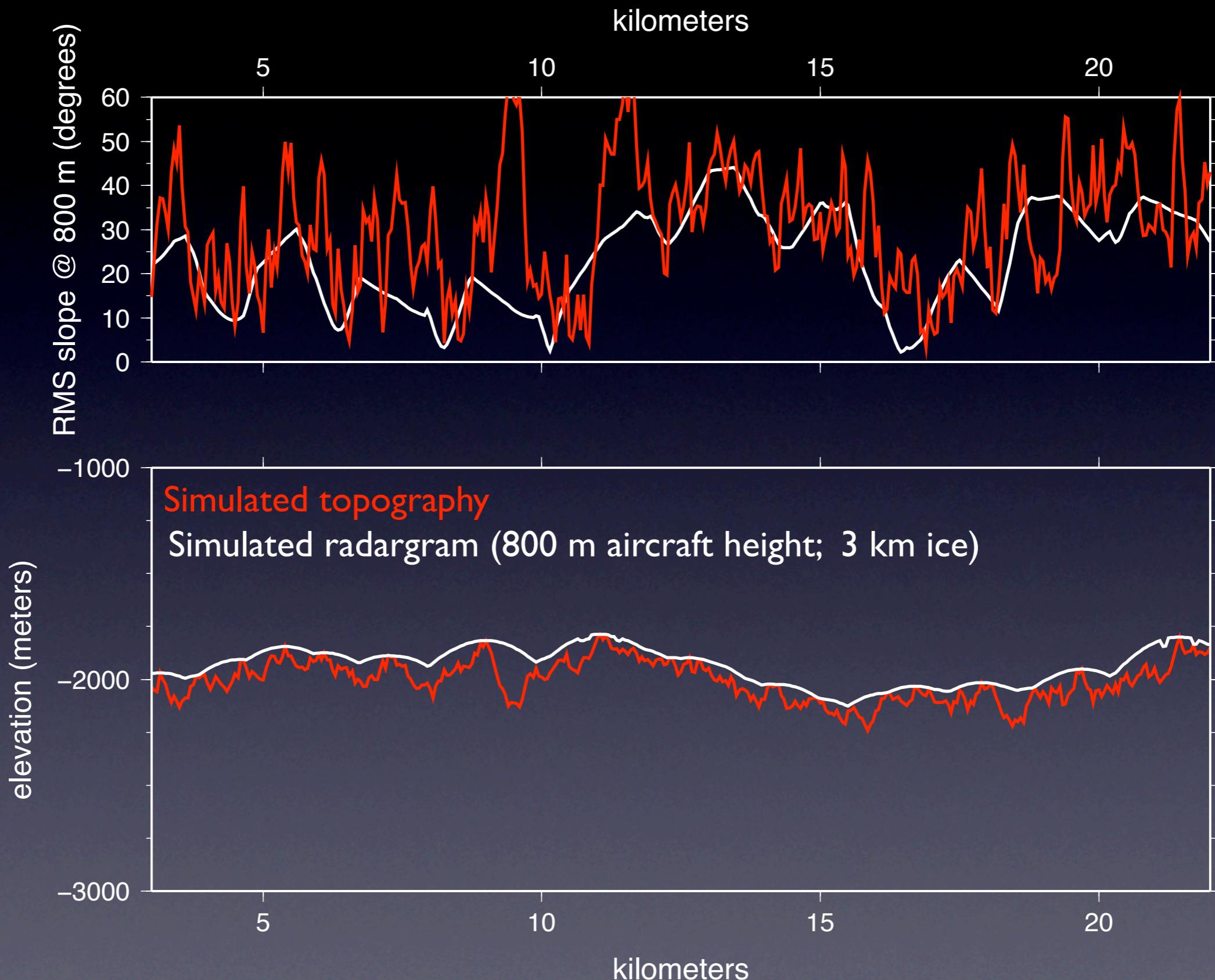
800 m lag

20 meter Bed Picks

(Interpolated from 4 Hz radar traces)

UNMIGRATED!!!

Methodology:



Methodology:

Radar Datasets

'87-'89 GSRIES (University of Wisconsin)

+ 50 MHz Coherent Narrowband; no GPS (5-10 km grid)

'91-96 CASERTZ (UTIG)

+ 60 MHz Incoherent Narrowband; (5 km grid)

'97-99 SOAR (UTIG)

+ 60 MHz Incoherent Narrowband (Improved dynamic range; 5-10 km grid)

2000 ATRS (UTIG)

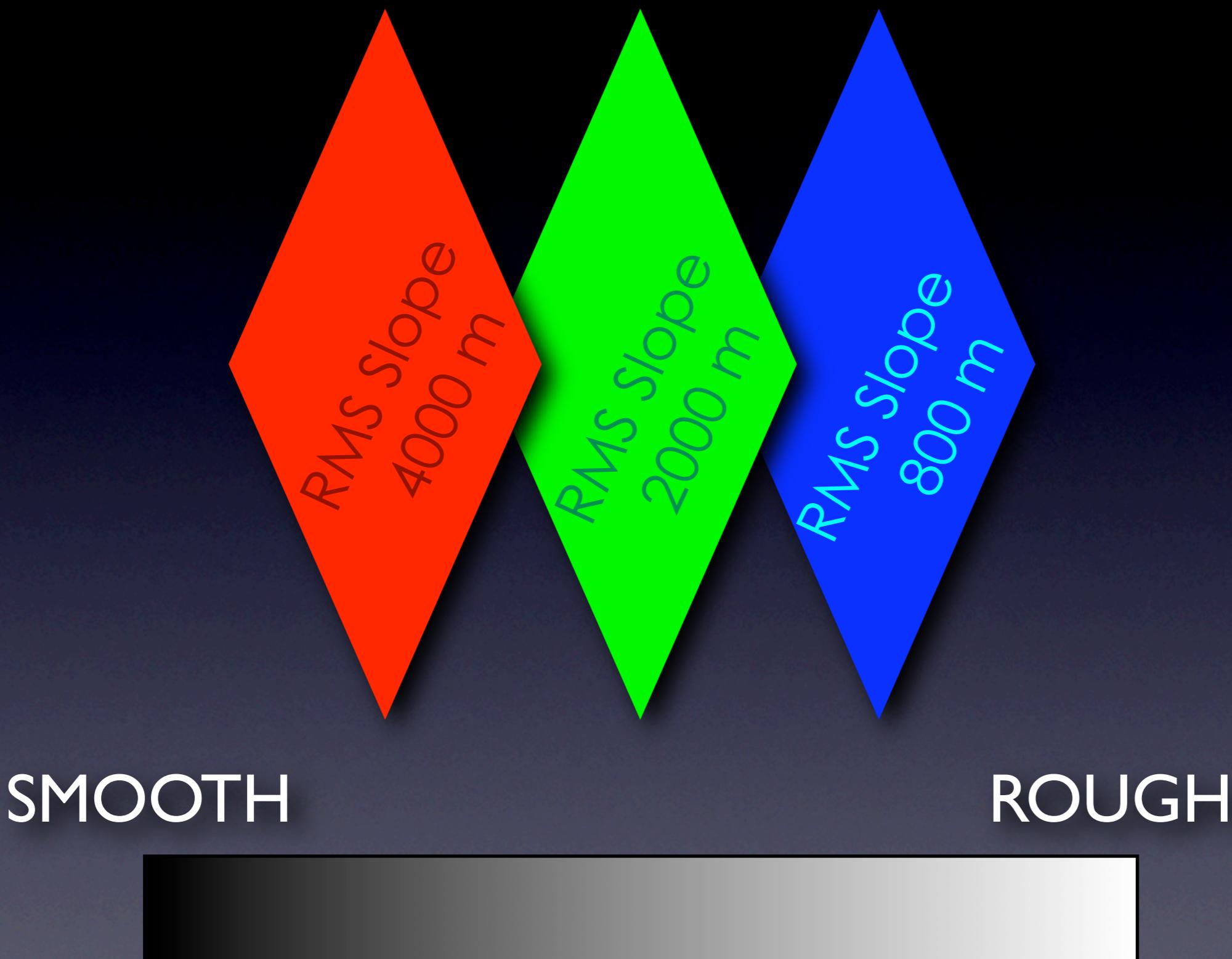
+ 60 MHz Coherent Broadband (Test Season)

'04-'05 AGASEA/BBAS (UTIG+BAS)*

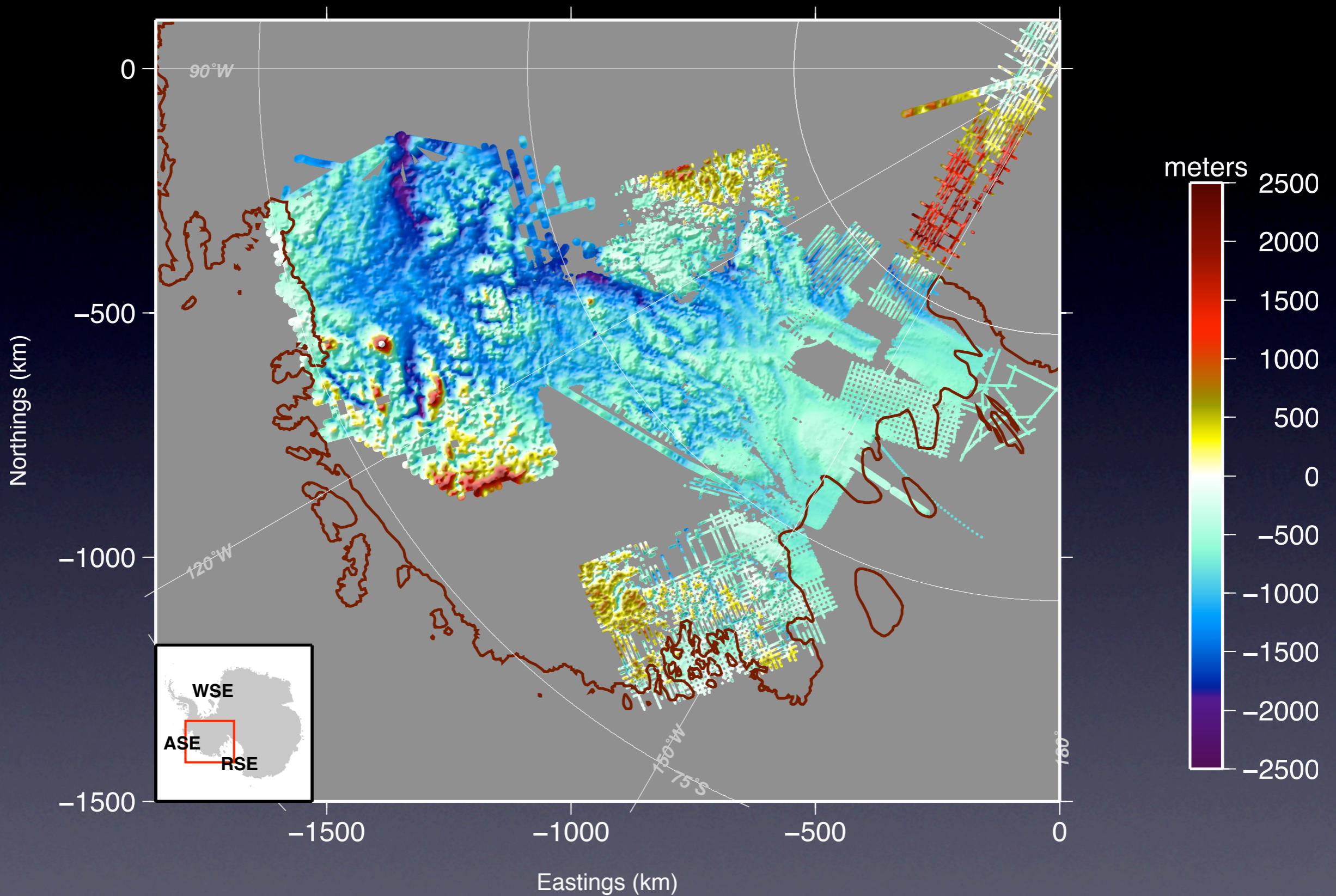
+ 60 MHz (+150 MHz) Coherent Broadband (15 km grid)

*Thwaites Glacier only

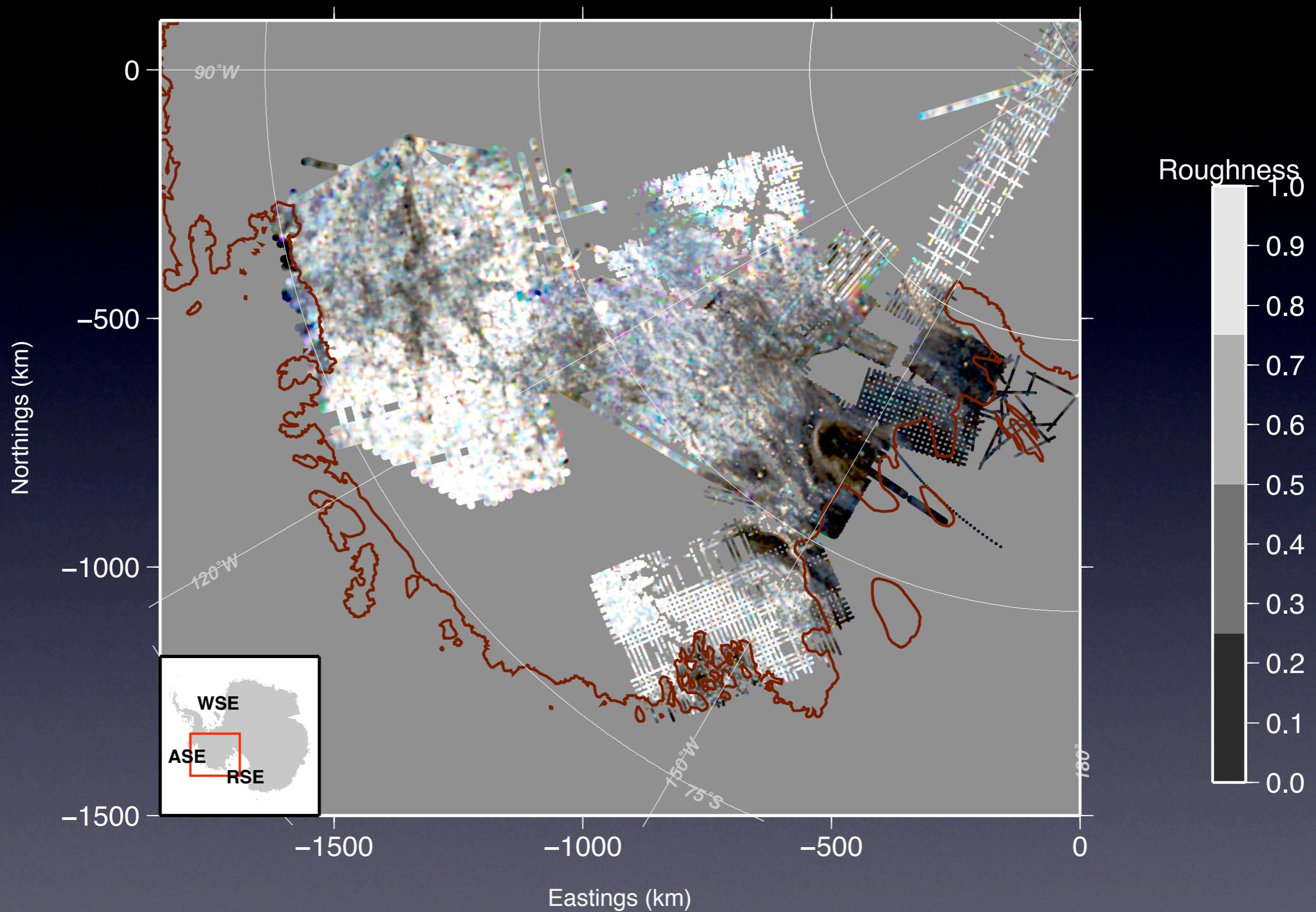
Methodology:



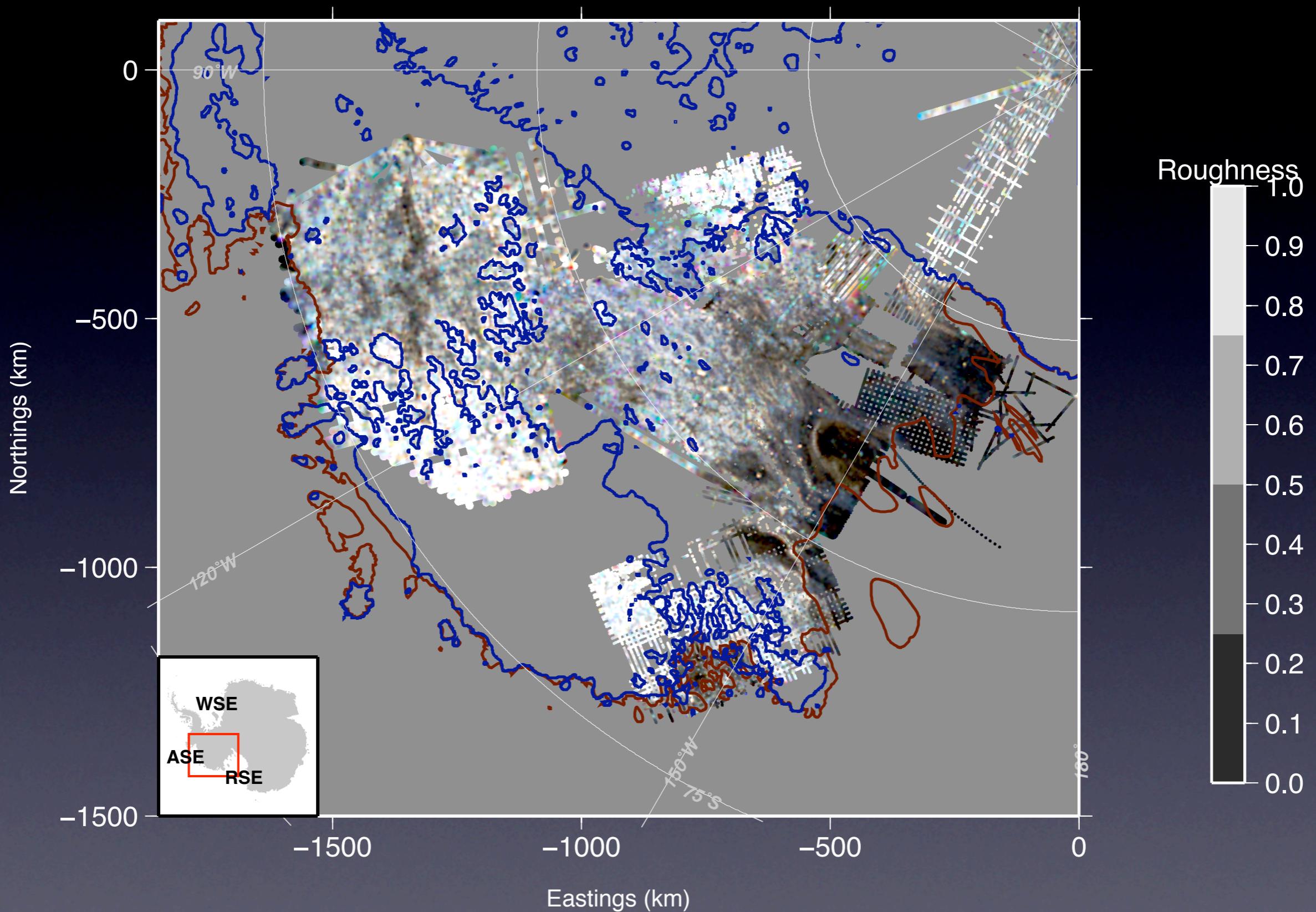
Results:



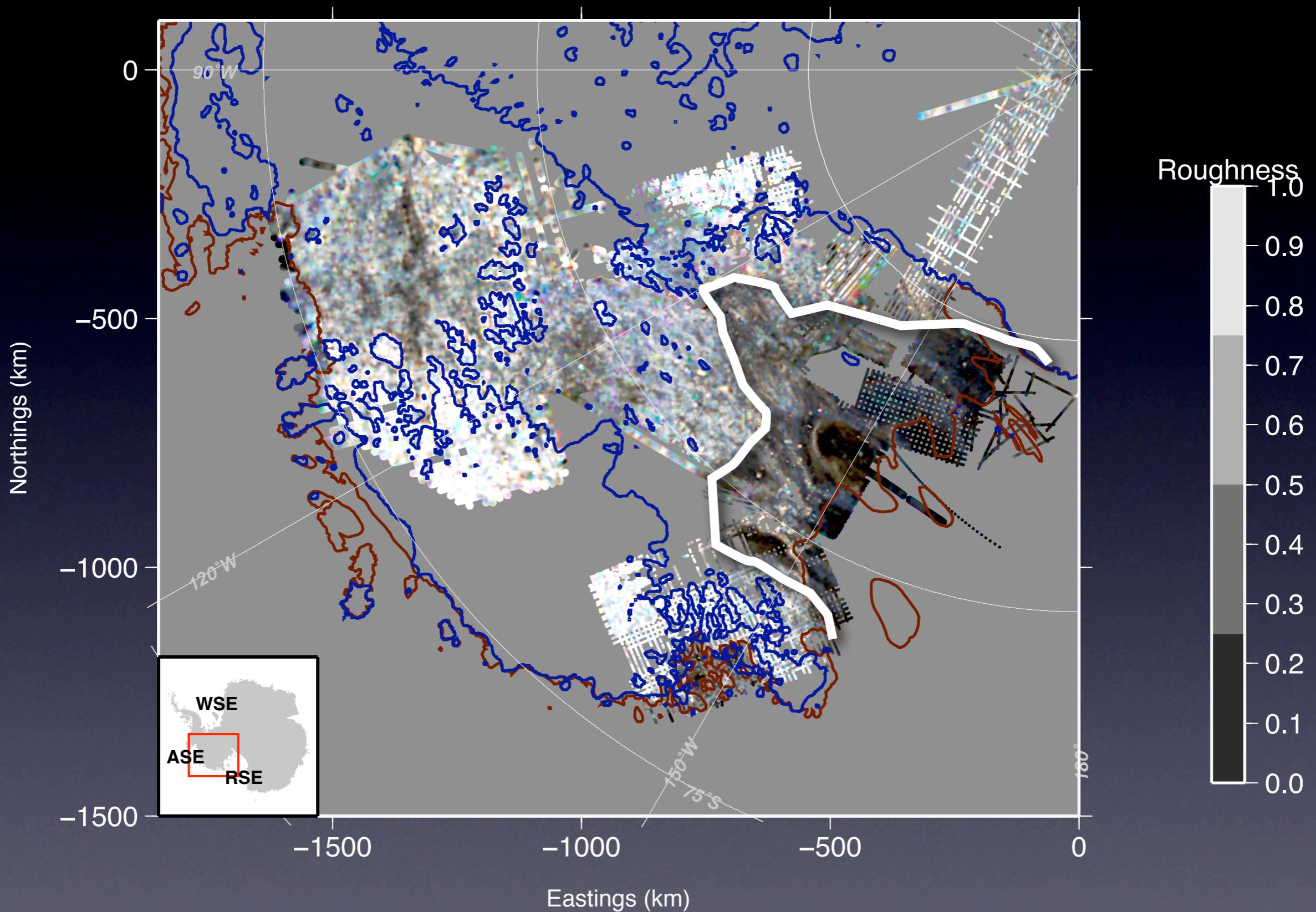
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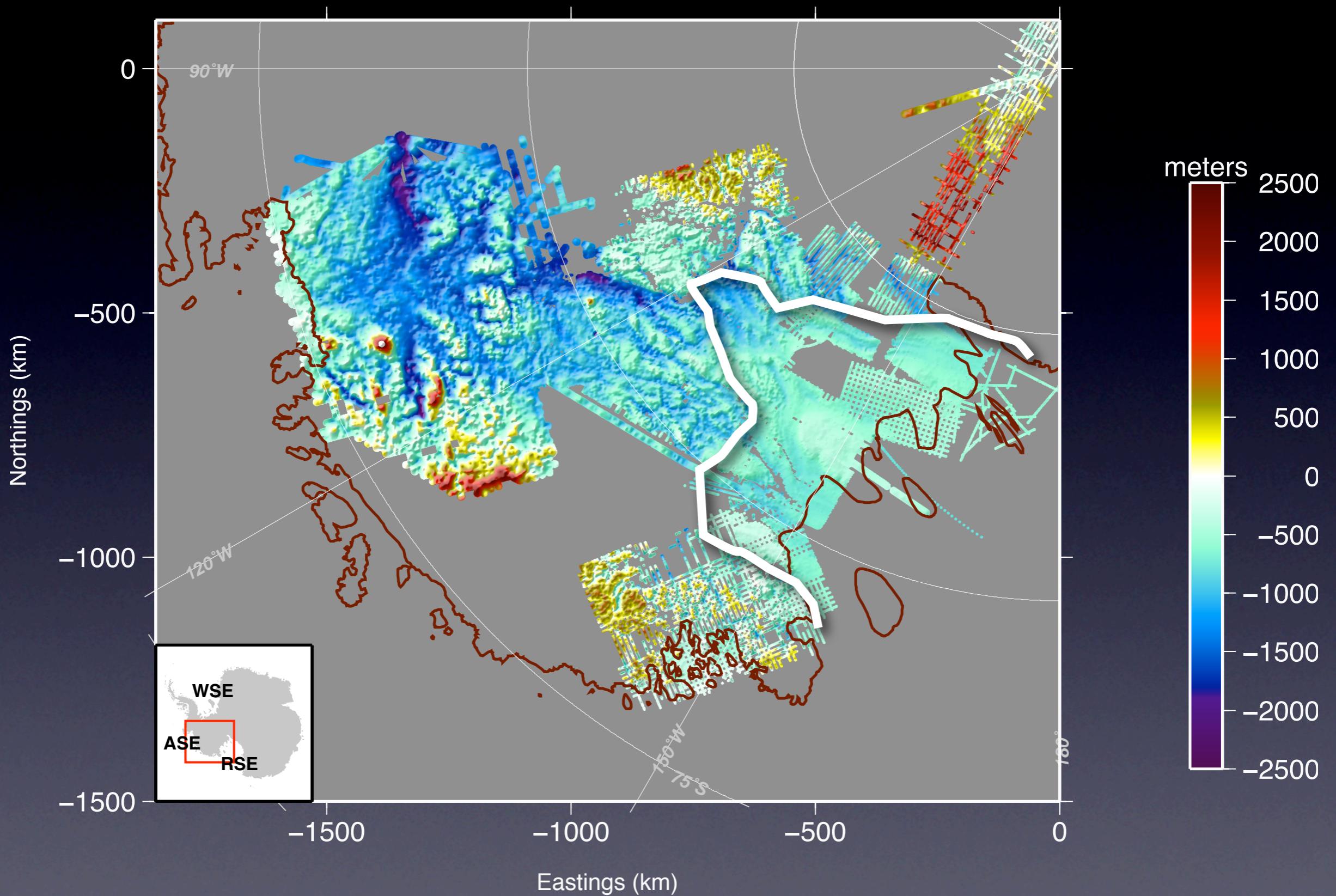
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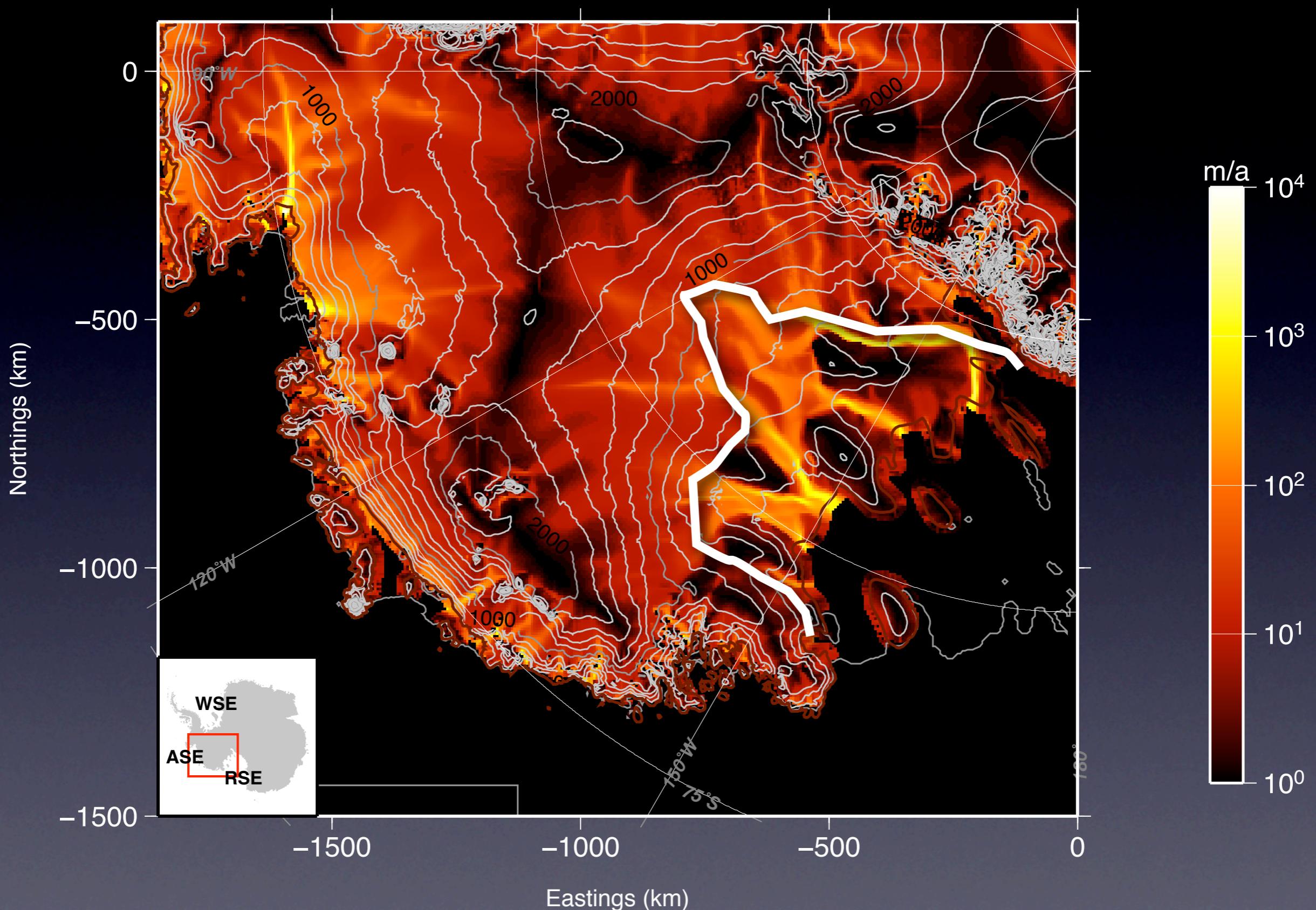


Results:



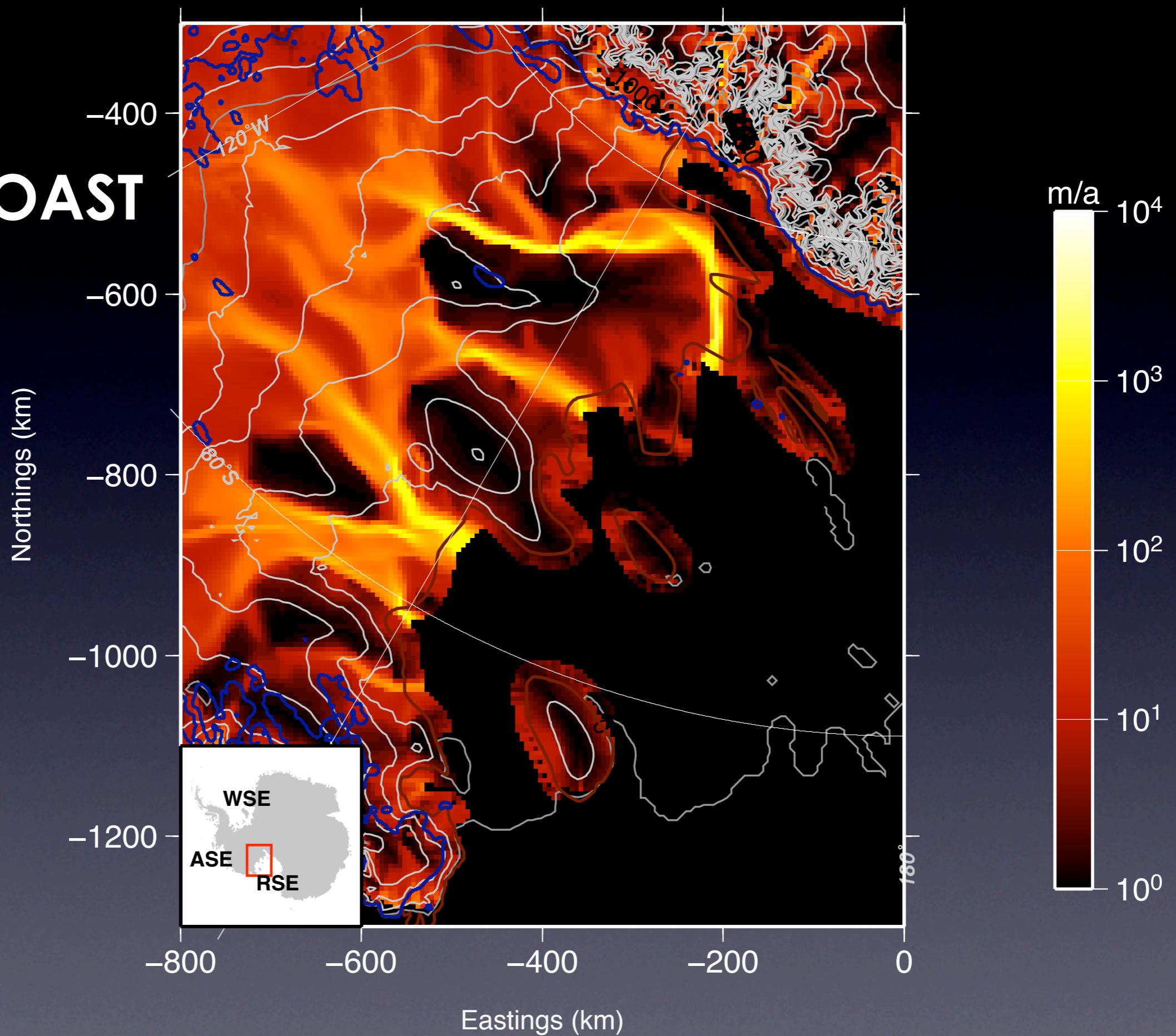
Results:

Balance Velocities [Le Brocq et al., 2005]



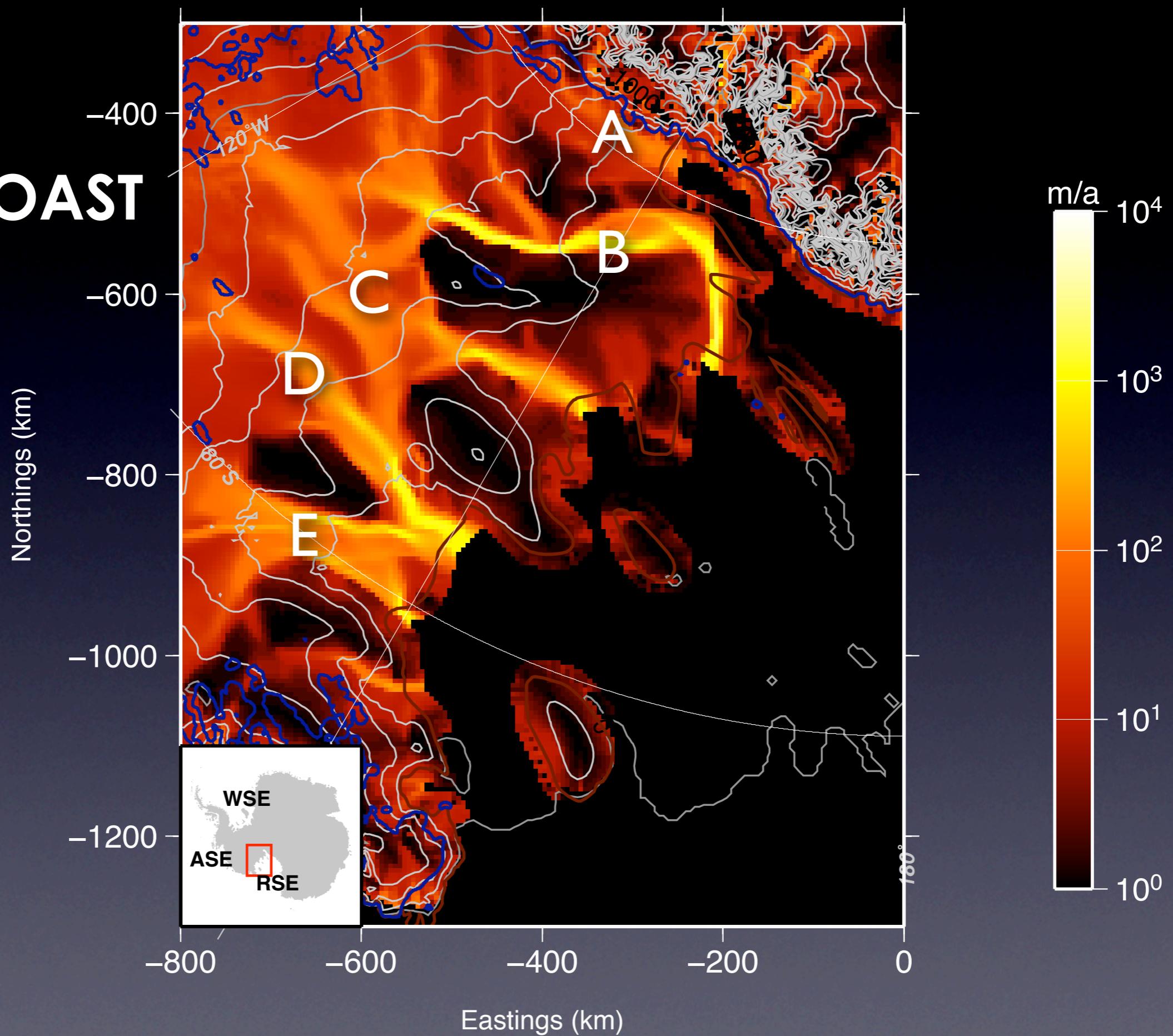
Results:

SIPLE COAST



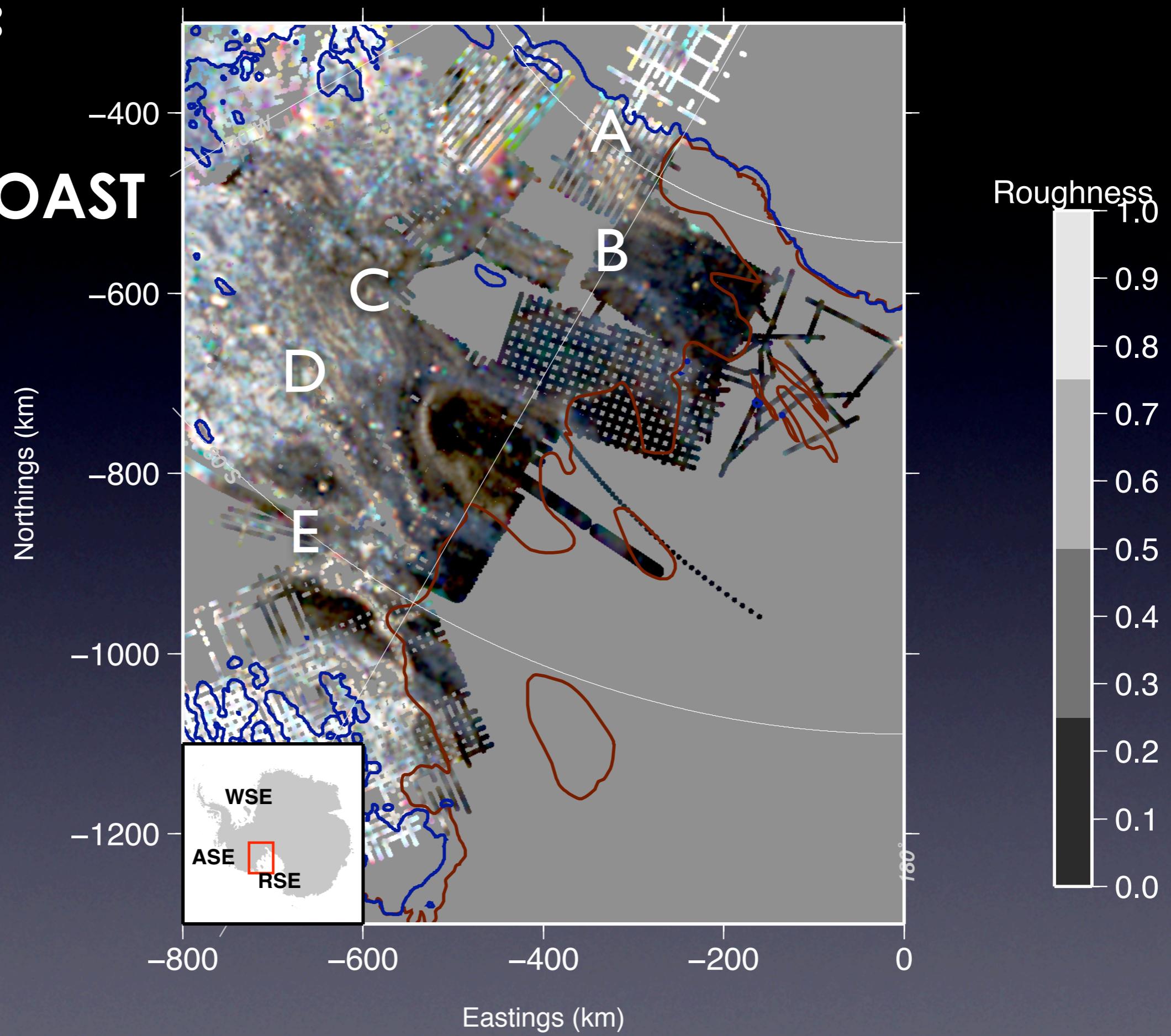
Results:

SIPLE COAST



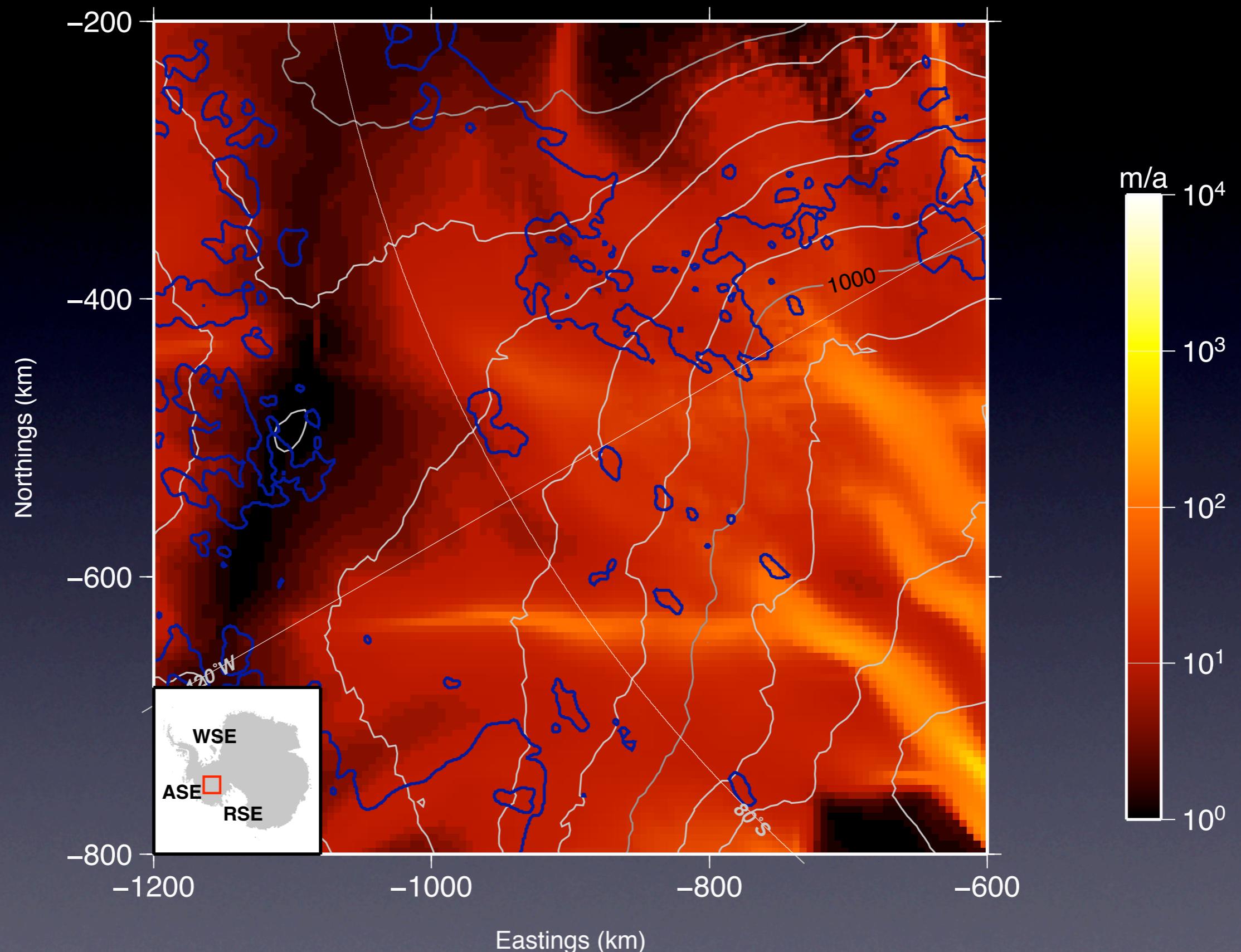
Results:

SIPLE COAST



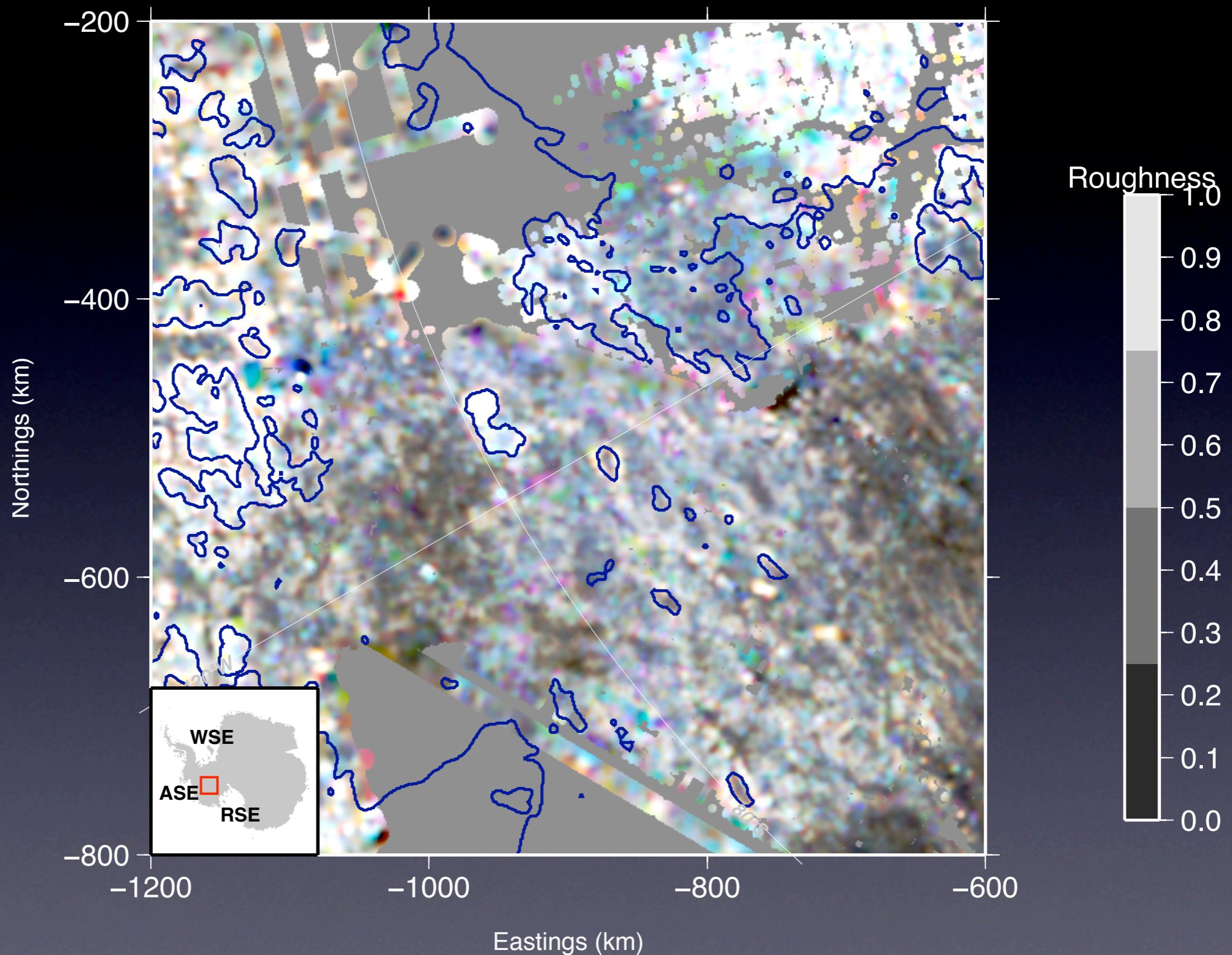
Results:

WAIS DIVIDE



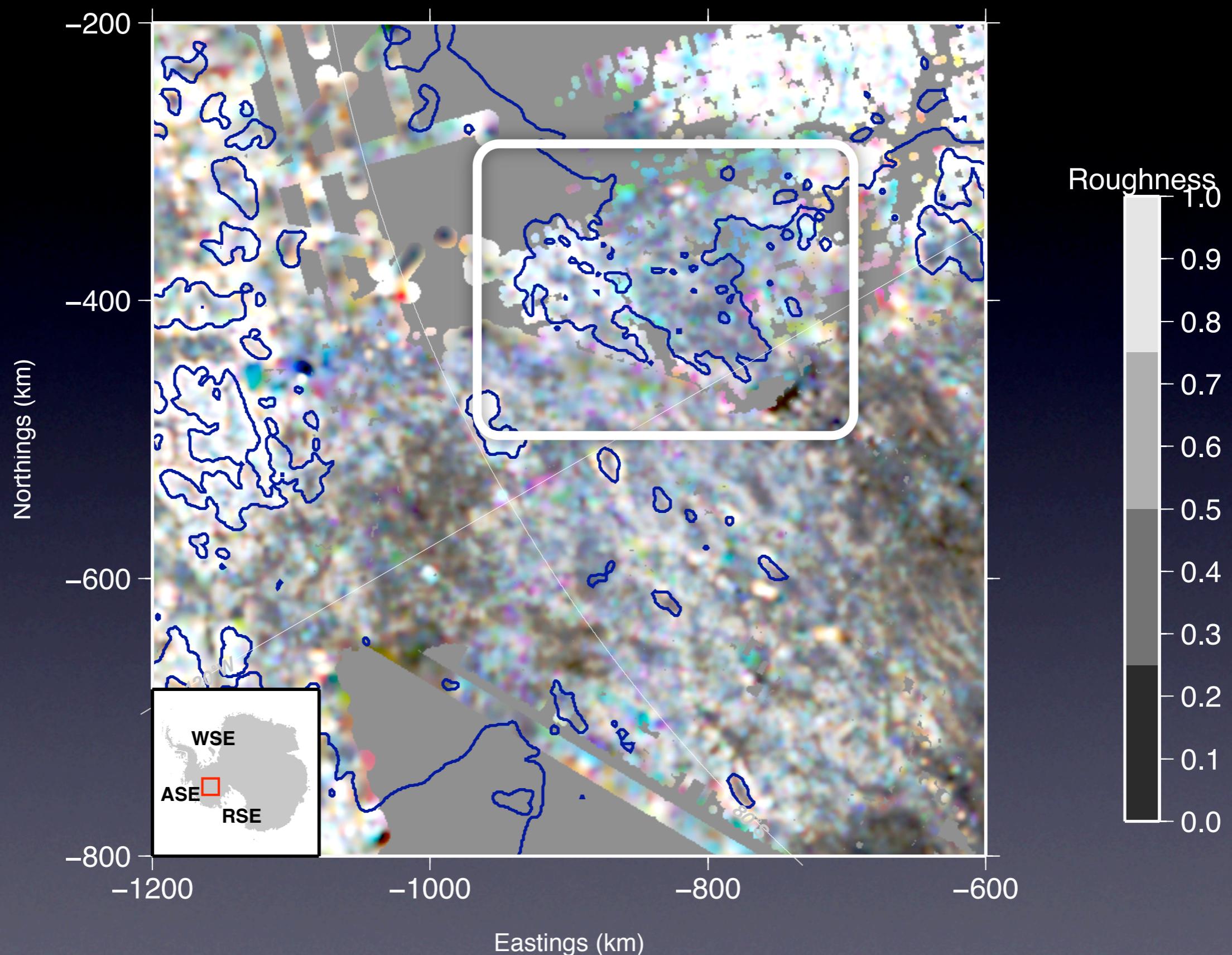
Results:

WAIS DIVIDE



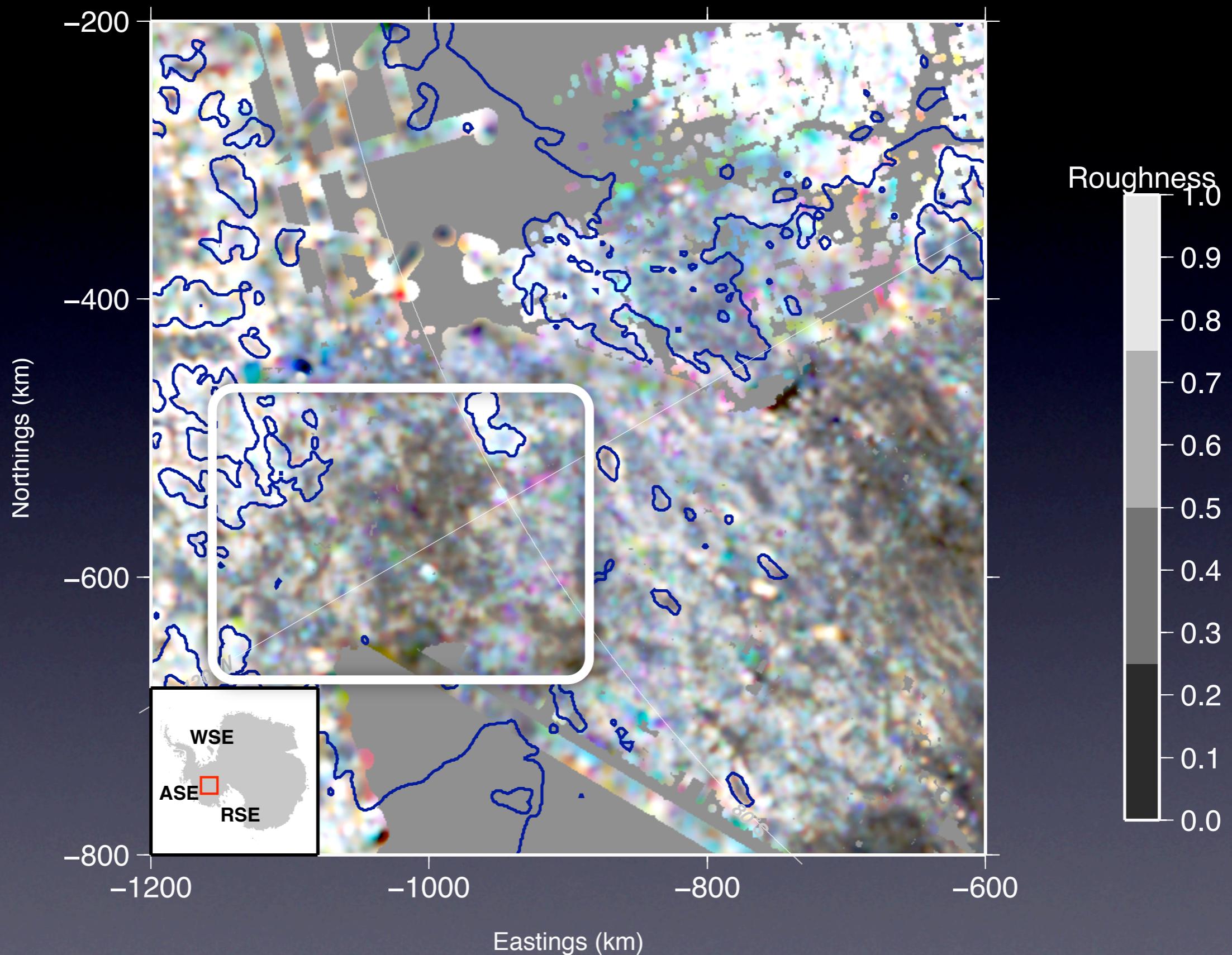
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WAIS DIVIDE



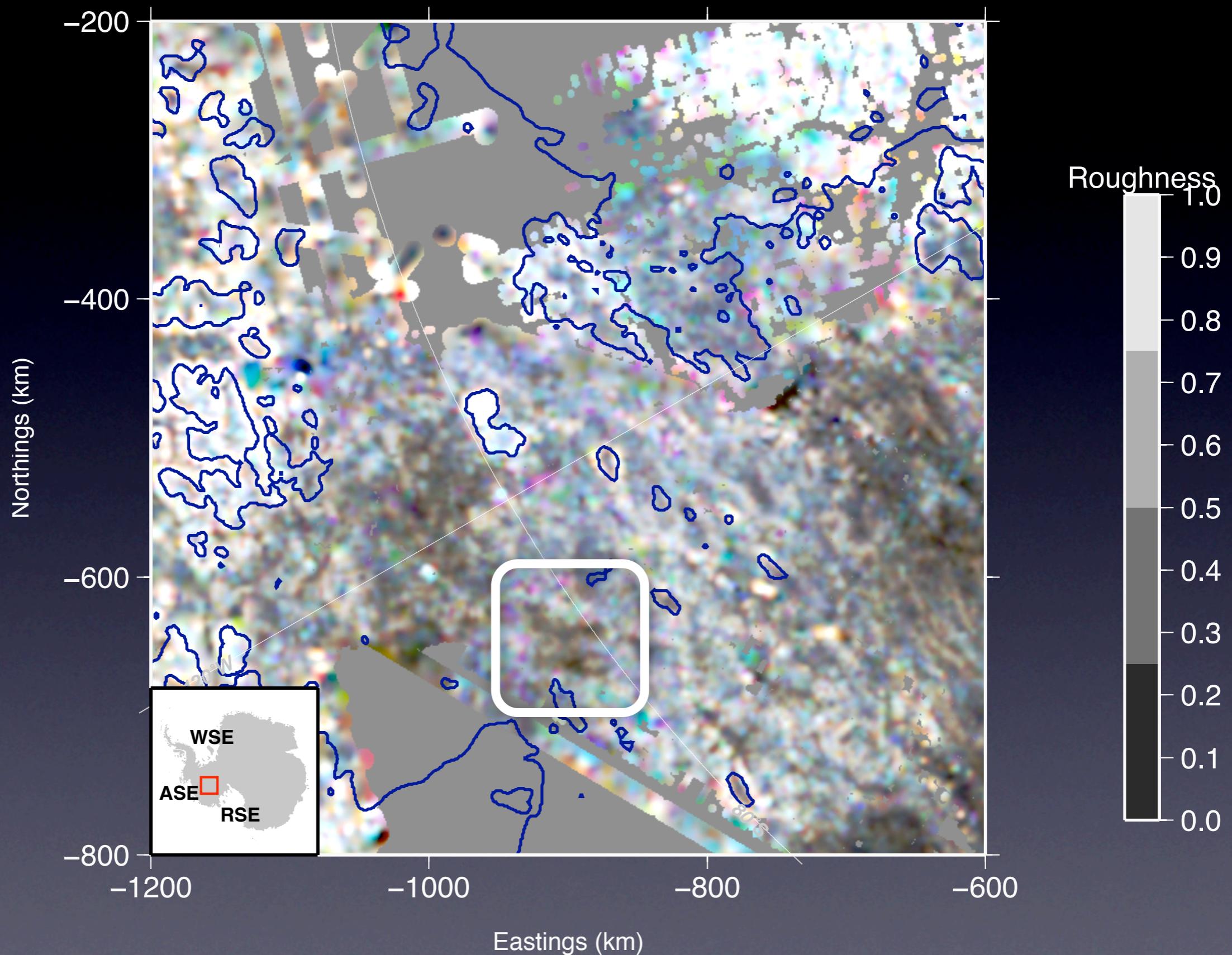
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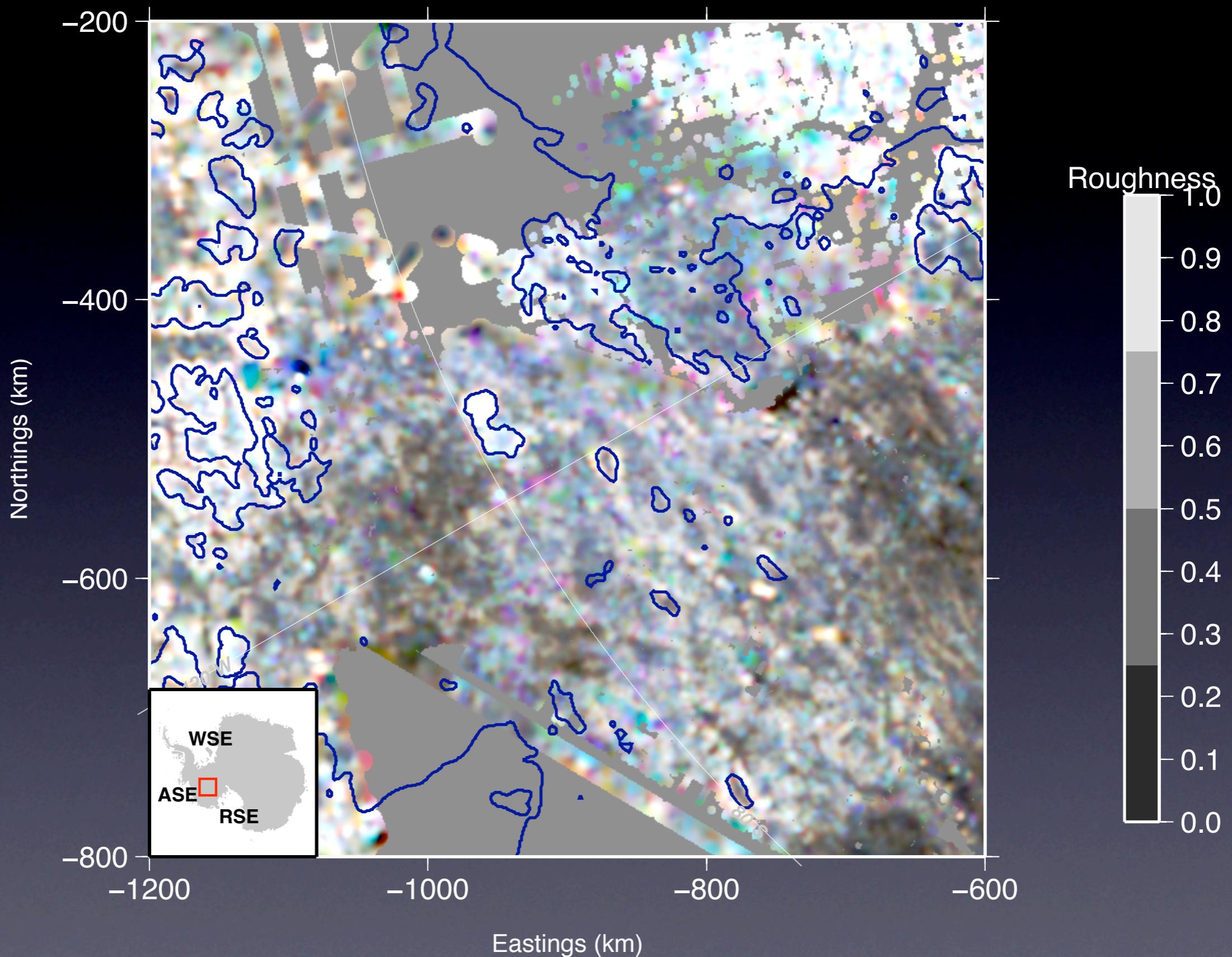
Results:

WAIS DIVIDE



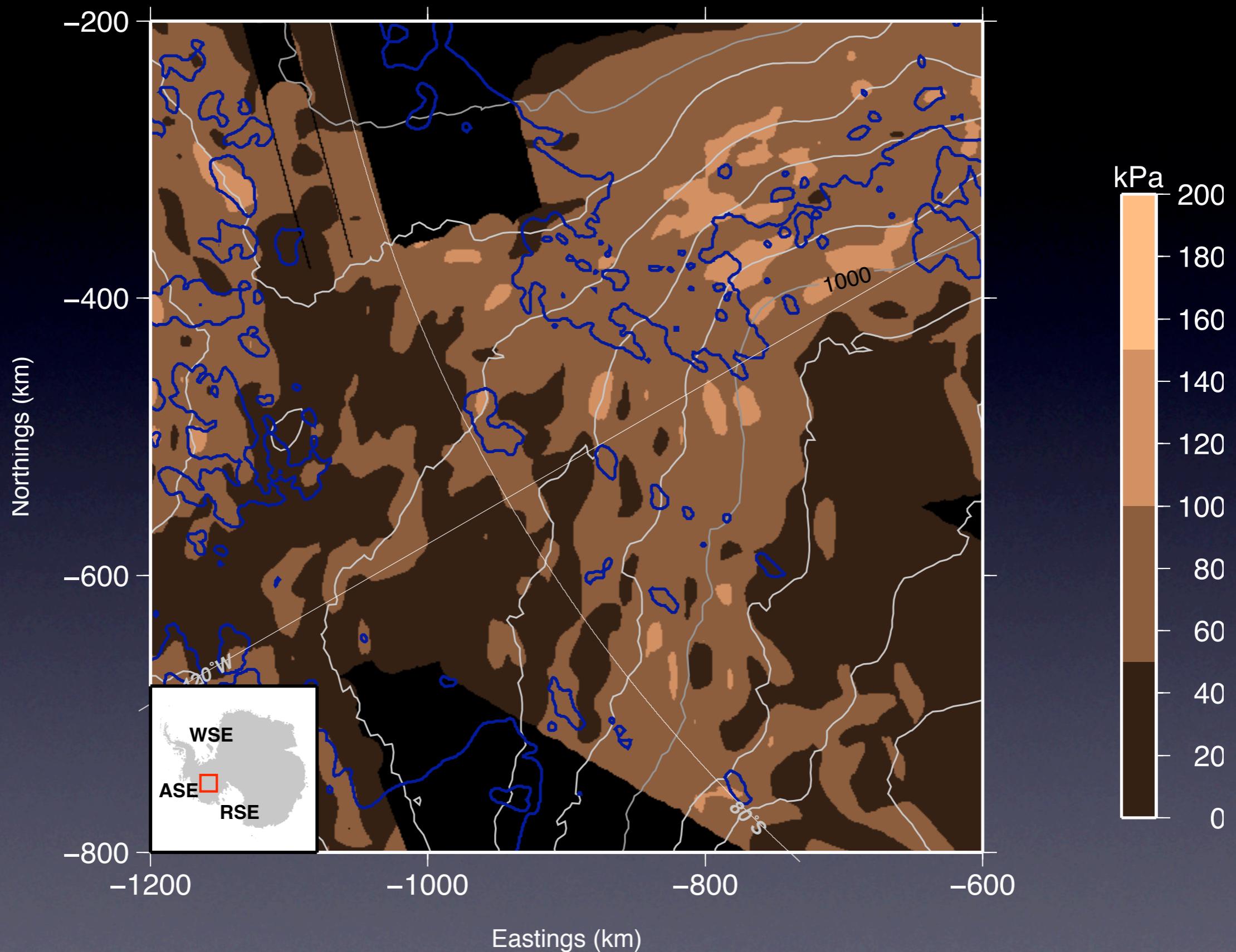
Results:

WAIS DIVIDE



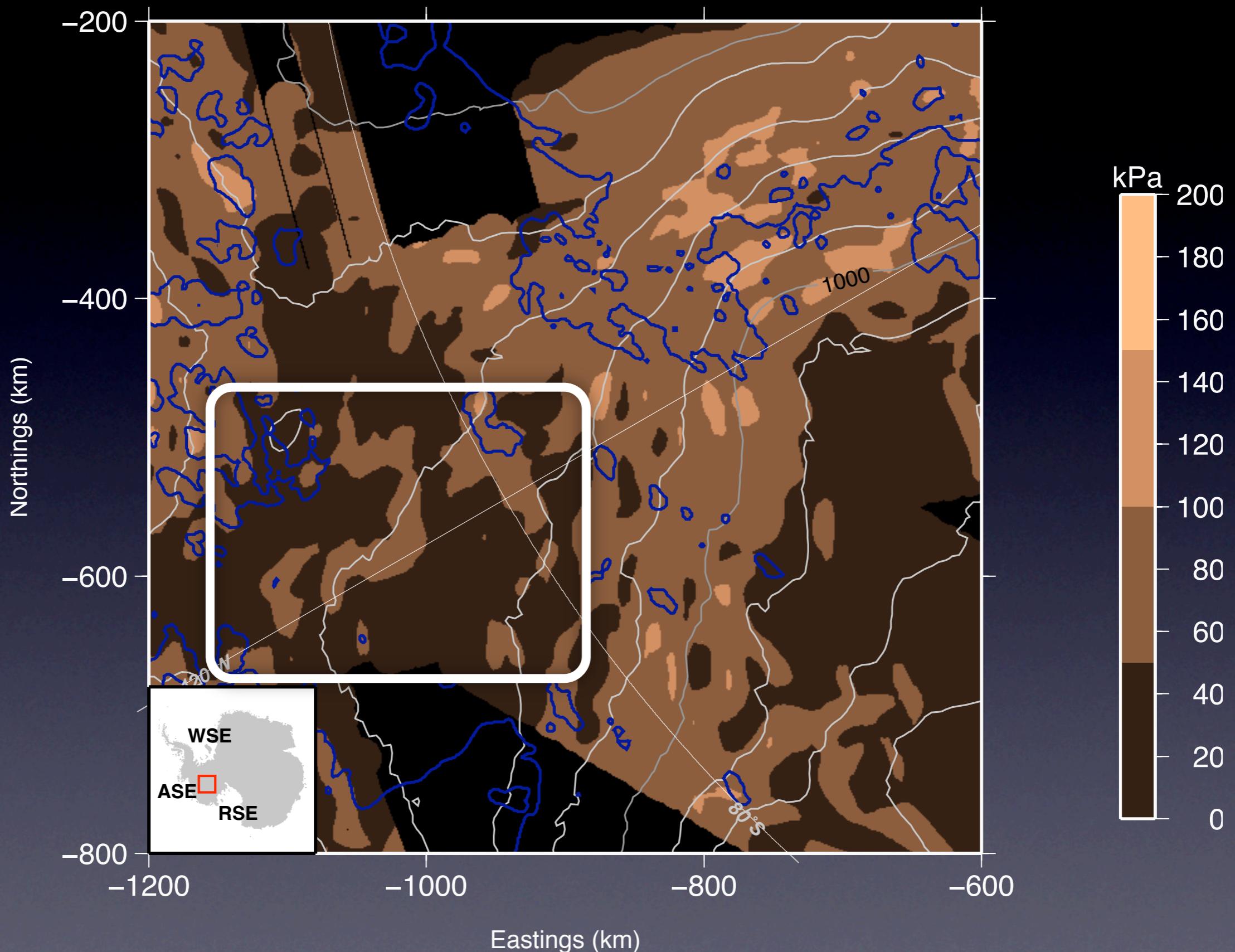
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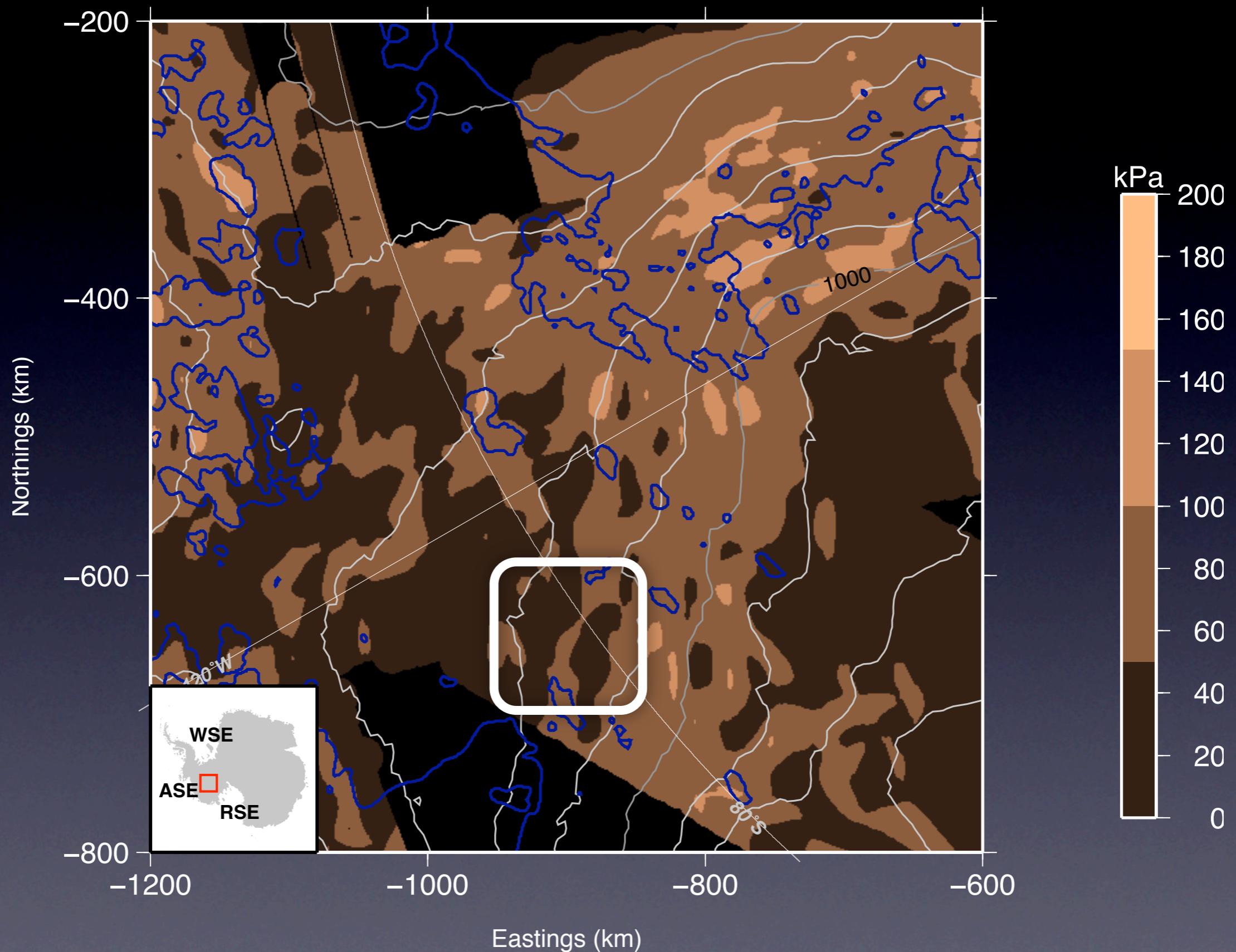
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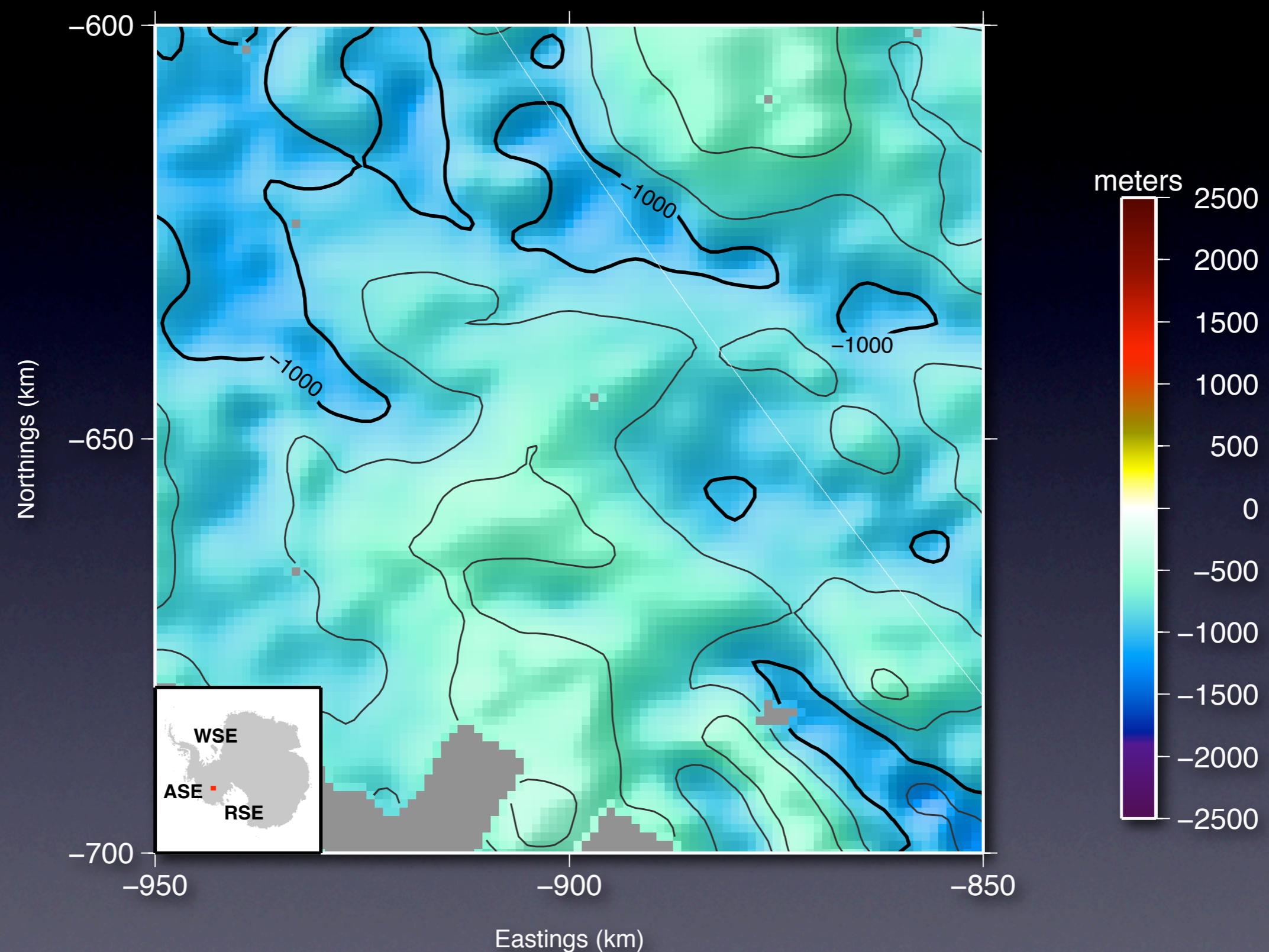
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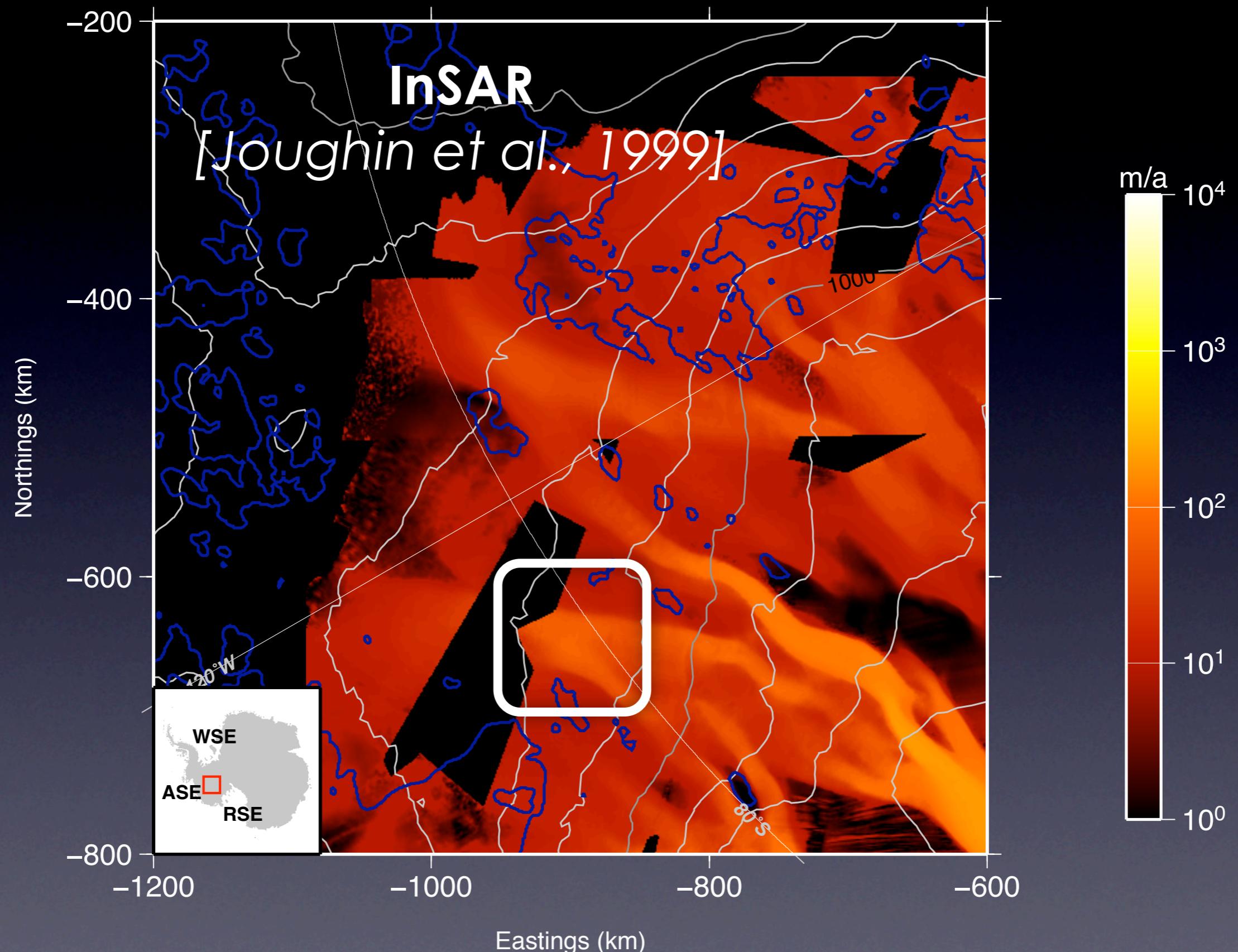
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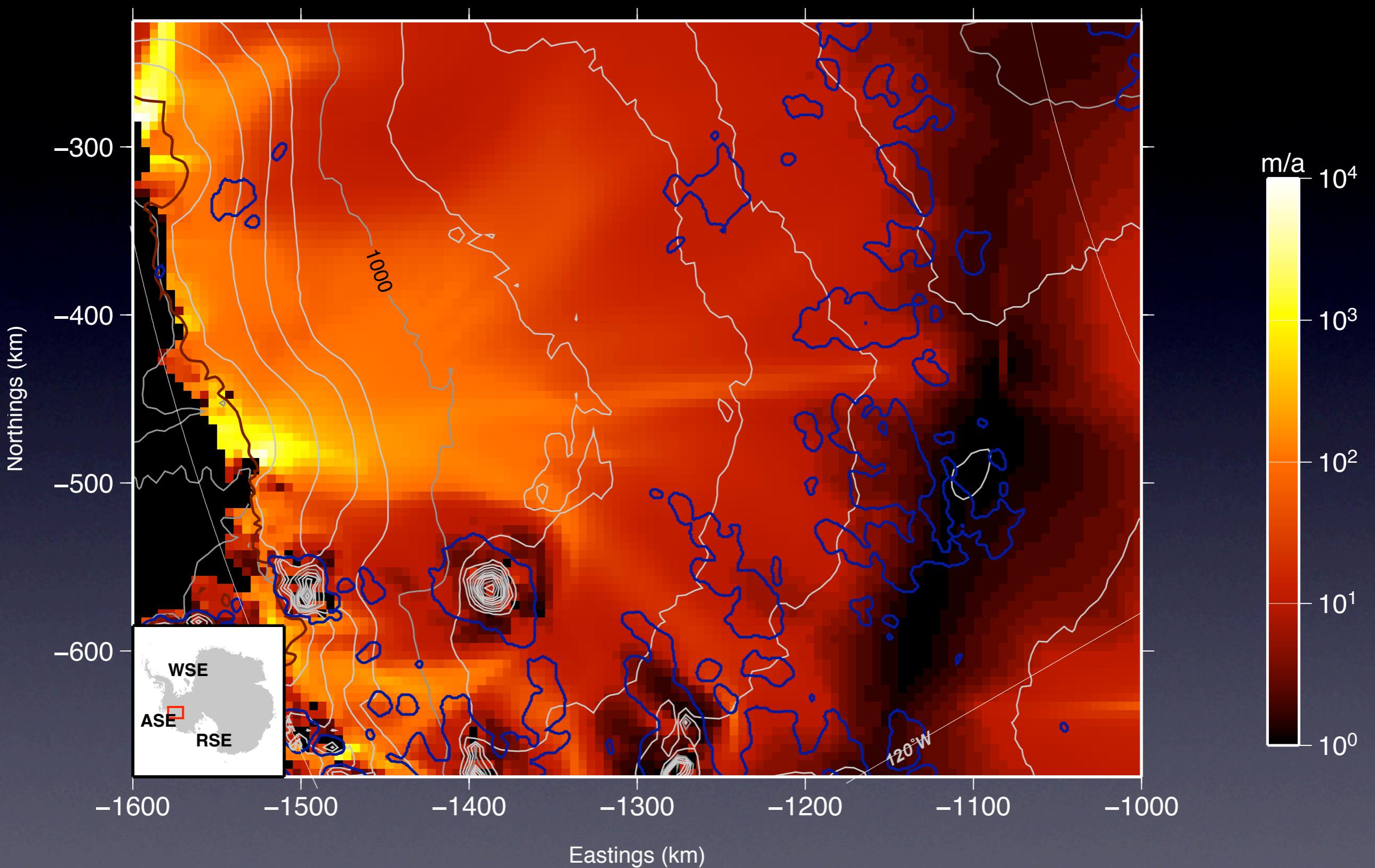
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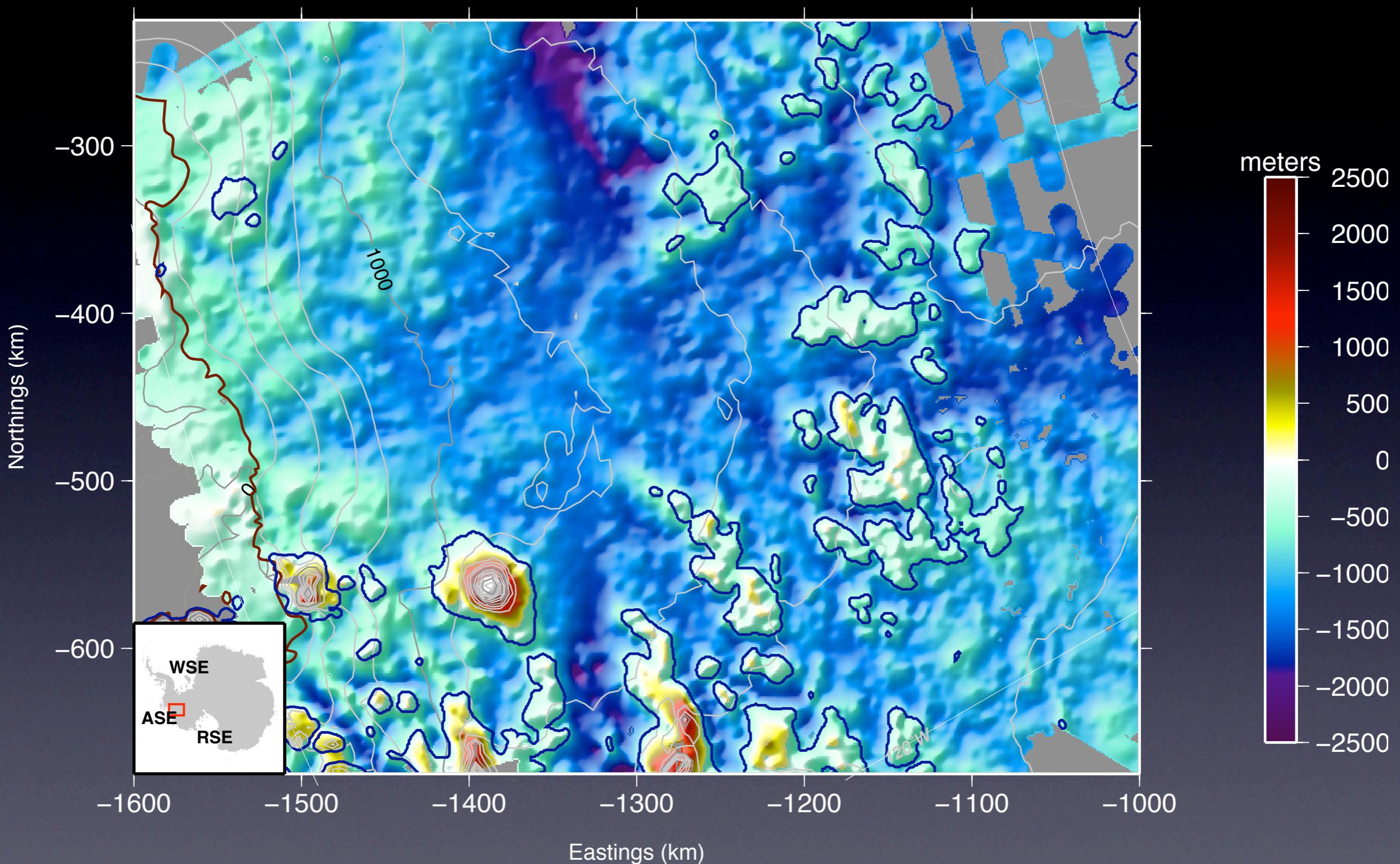
Results:

THWAITES GLACIER



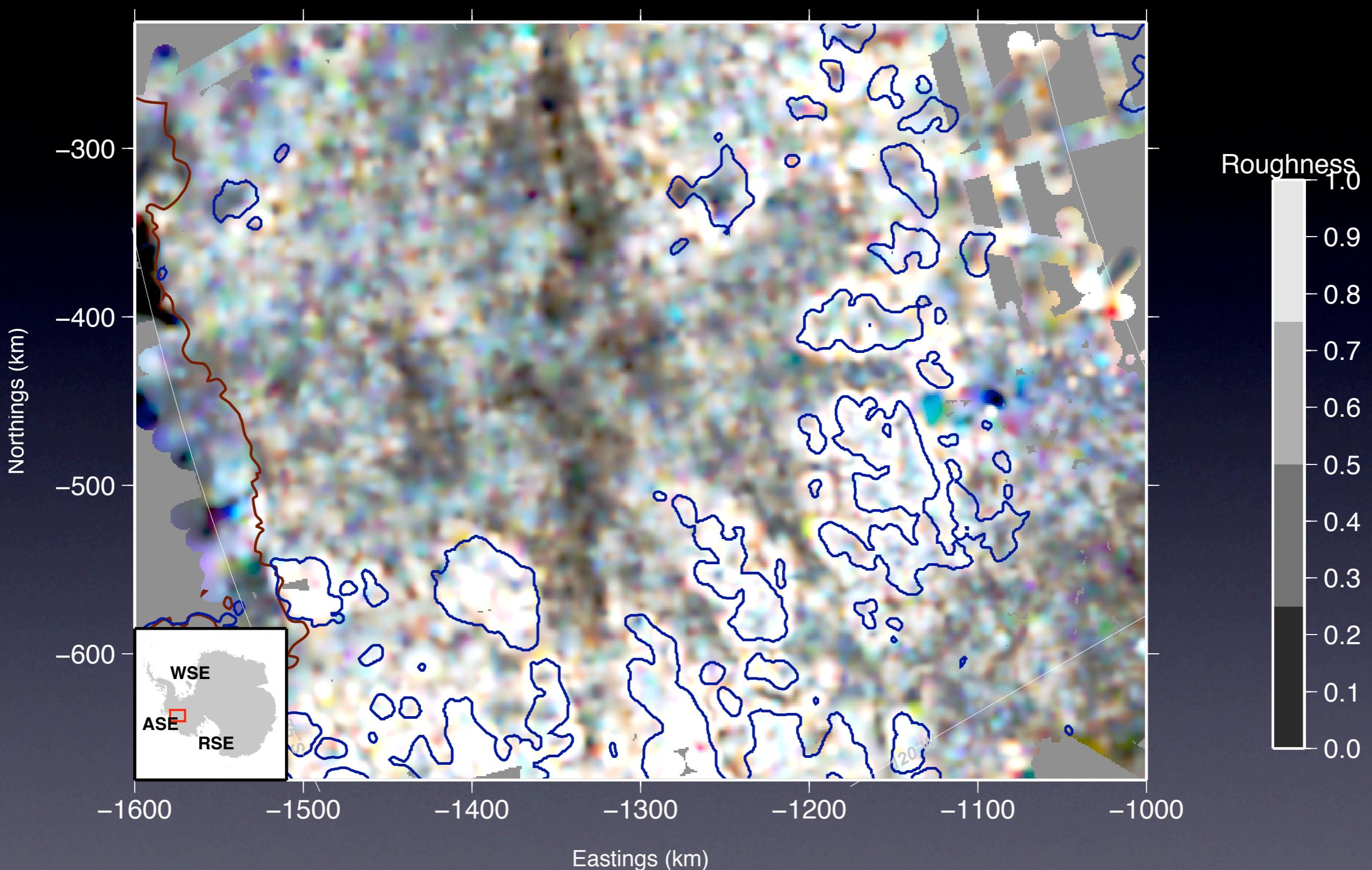
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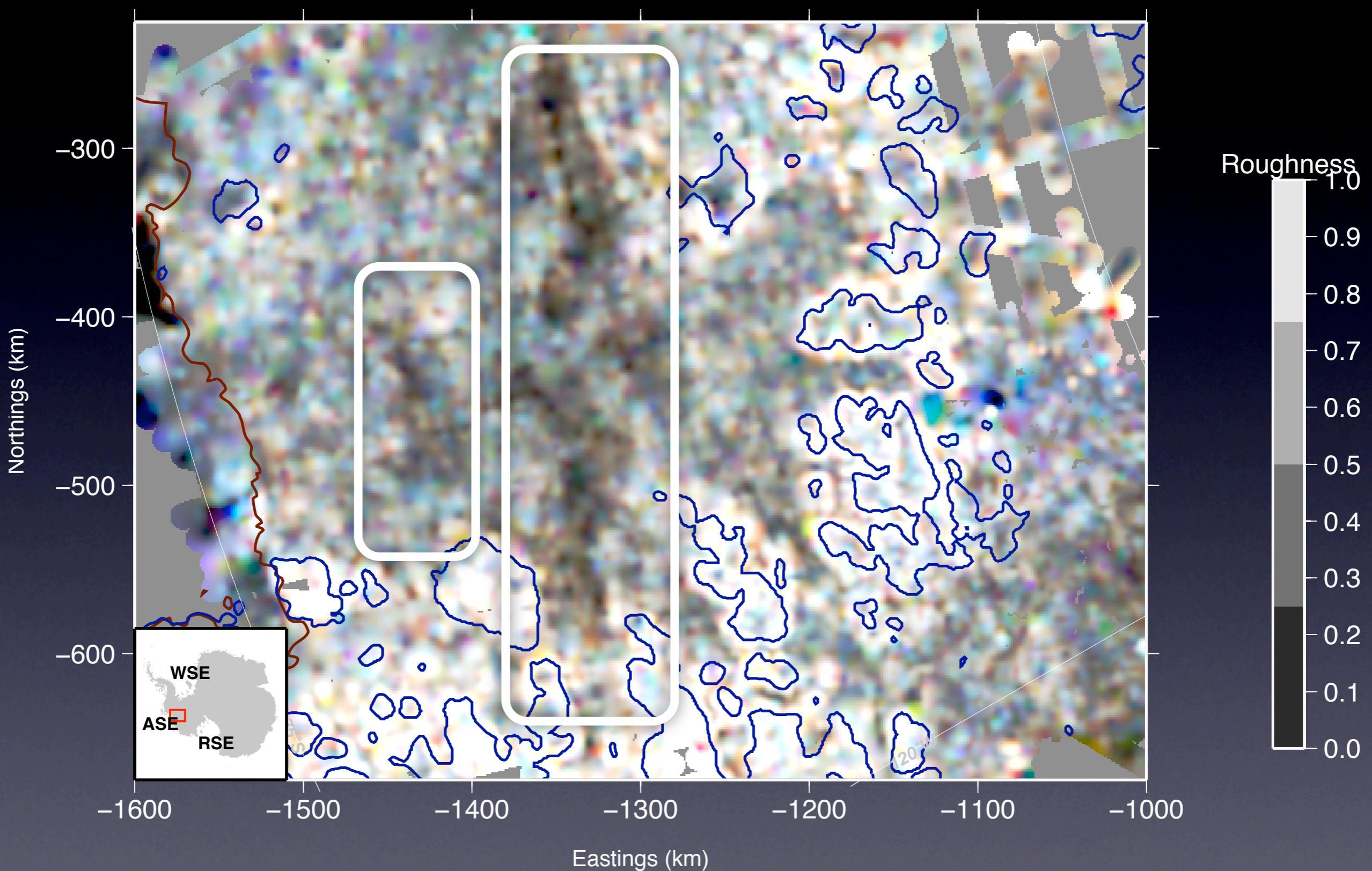
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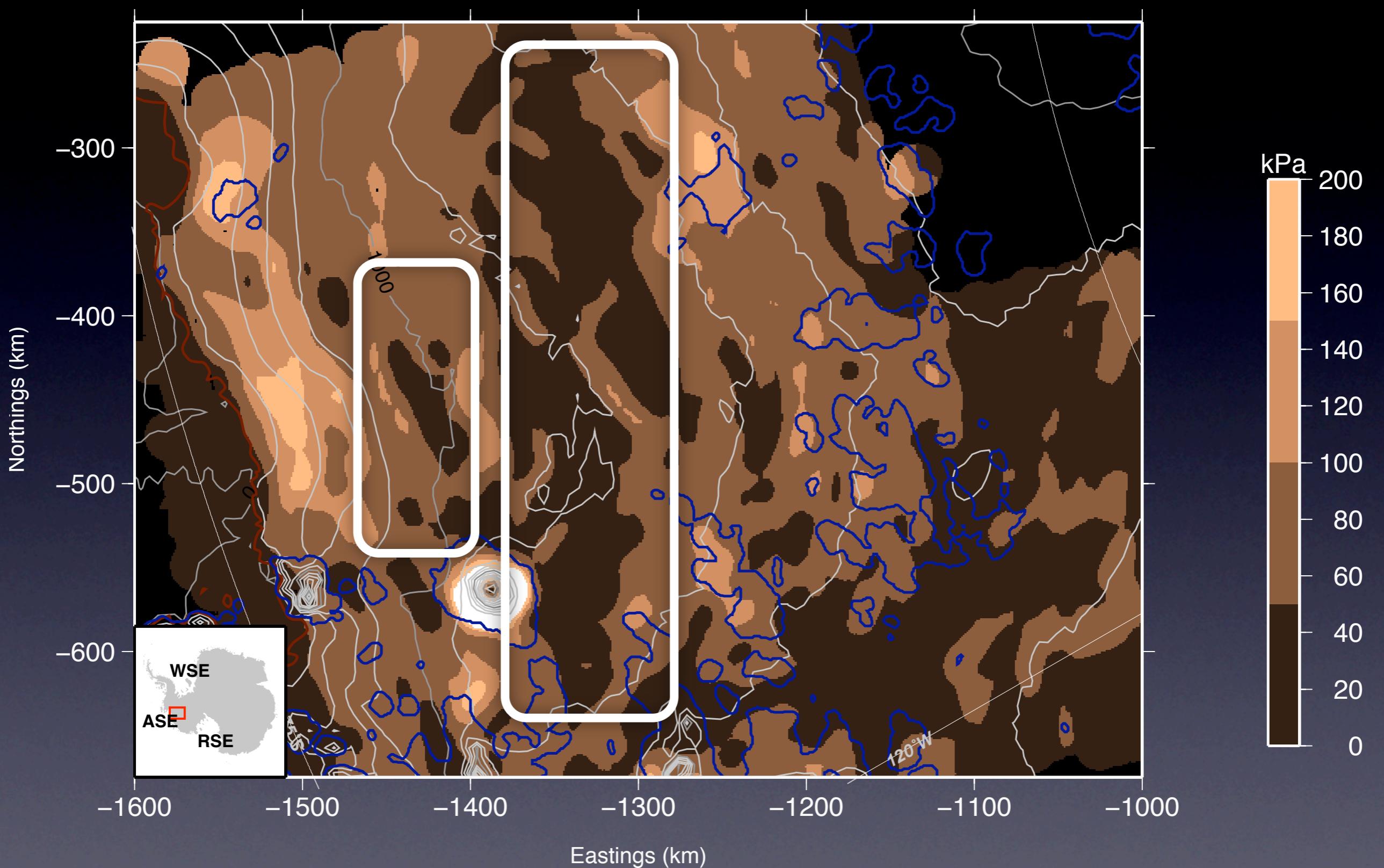
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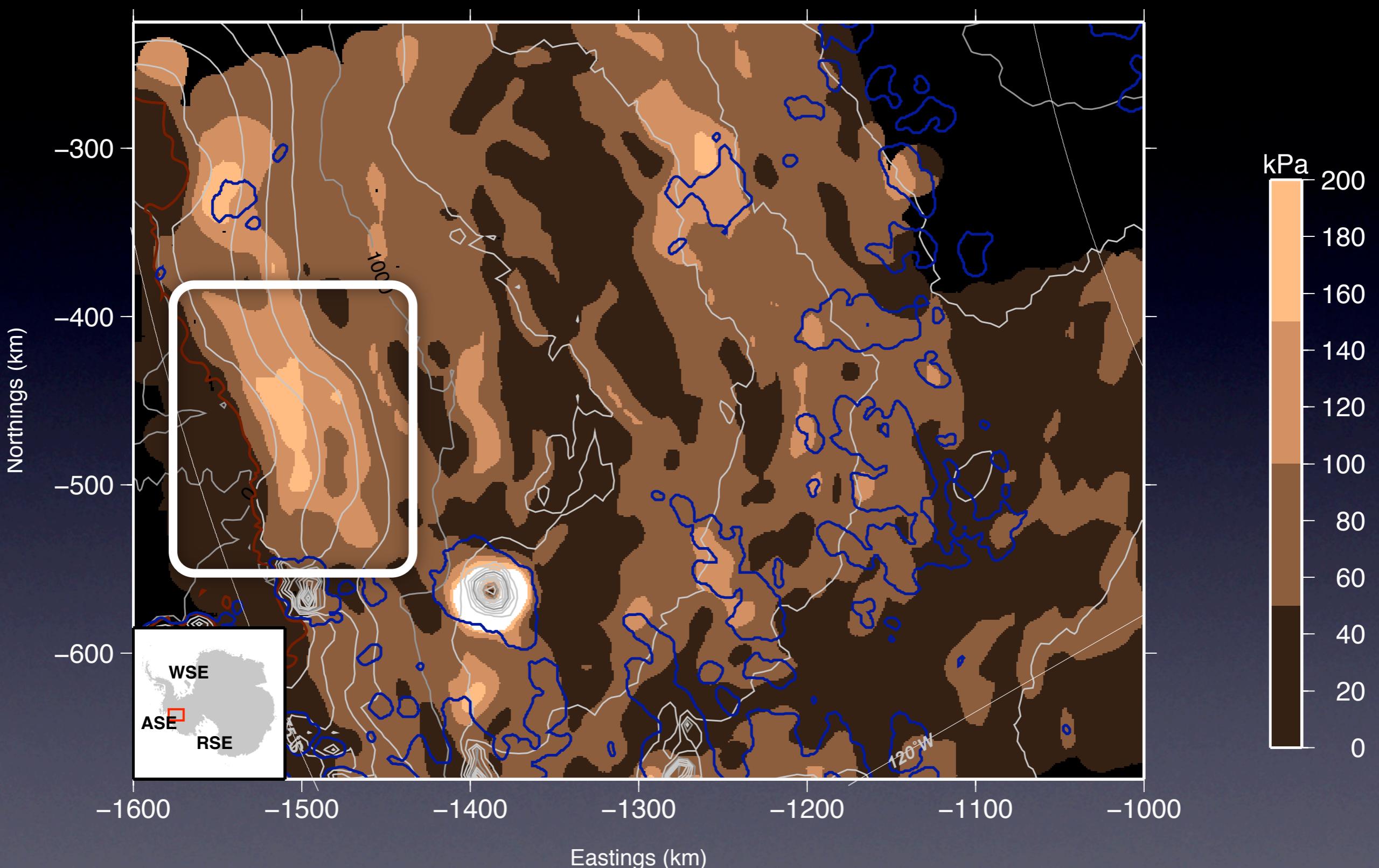
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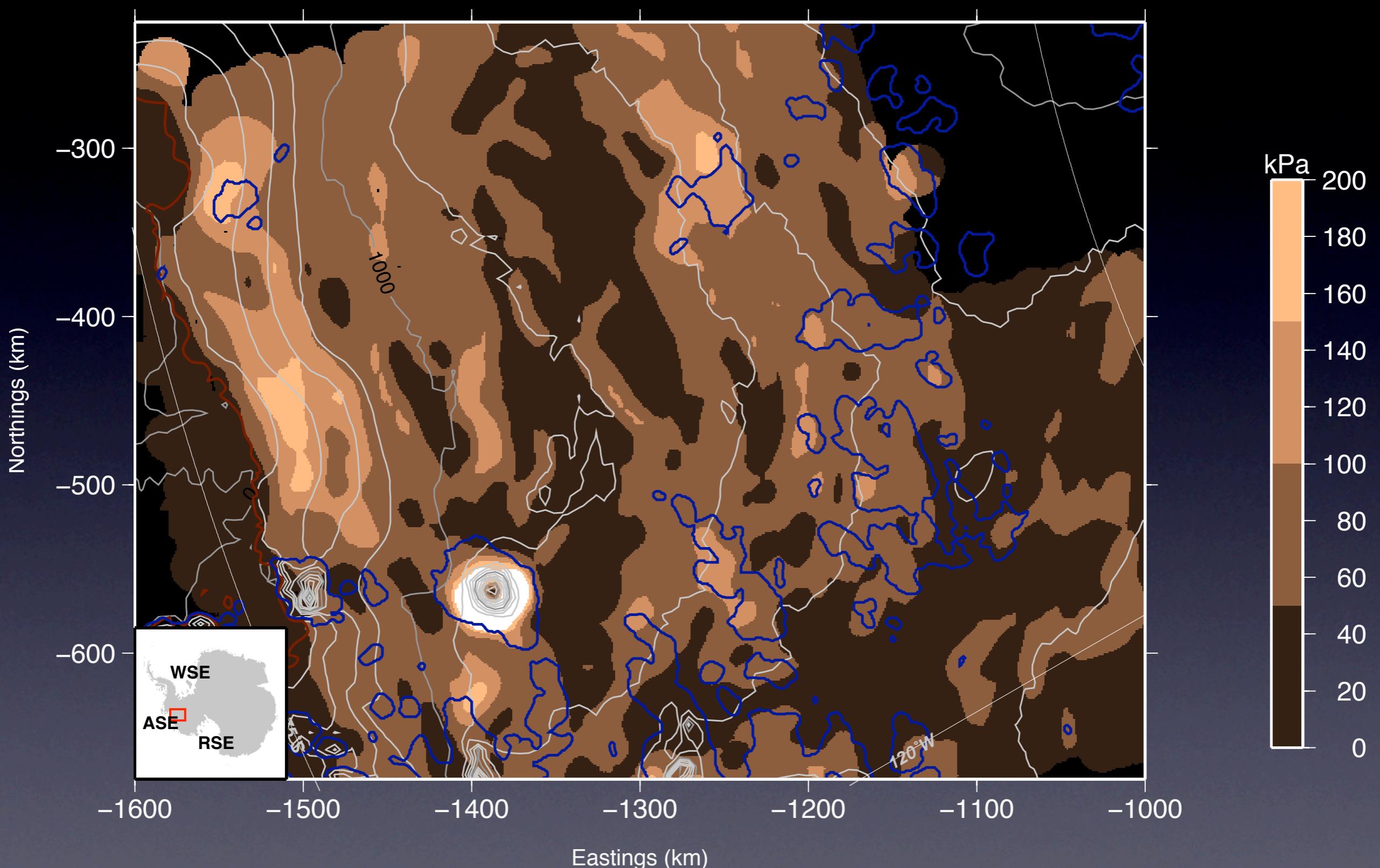
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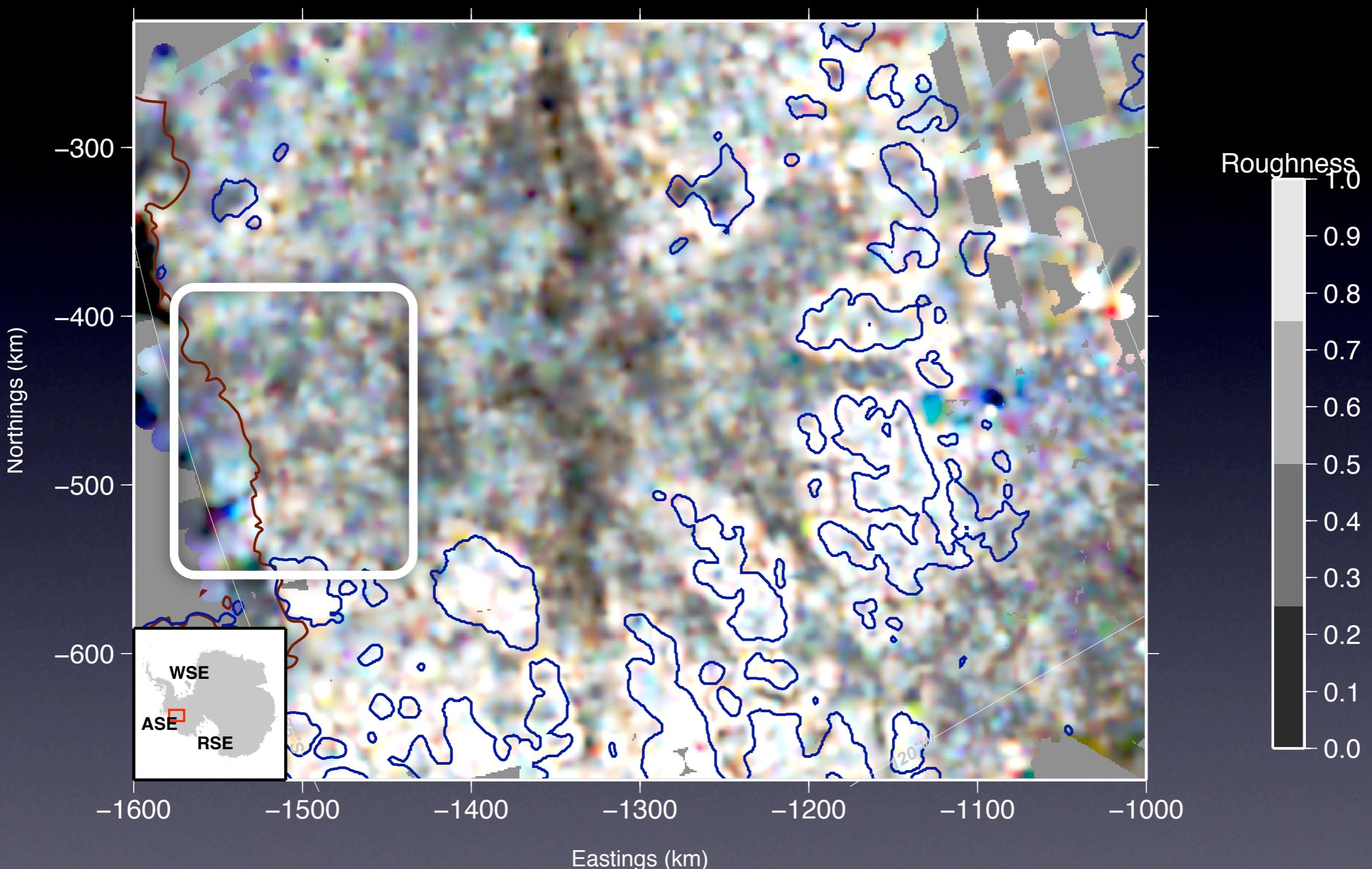
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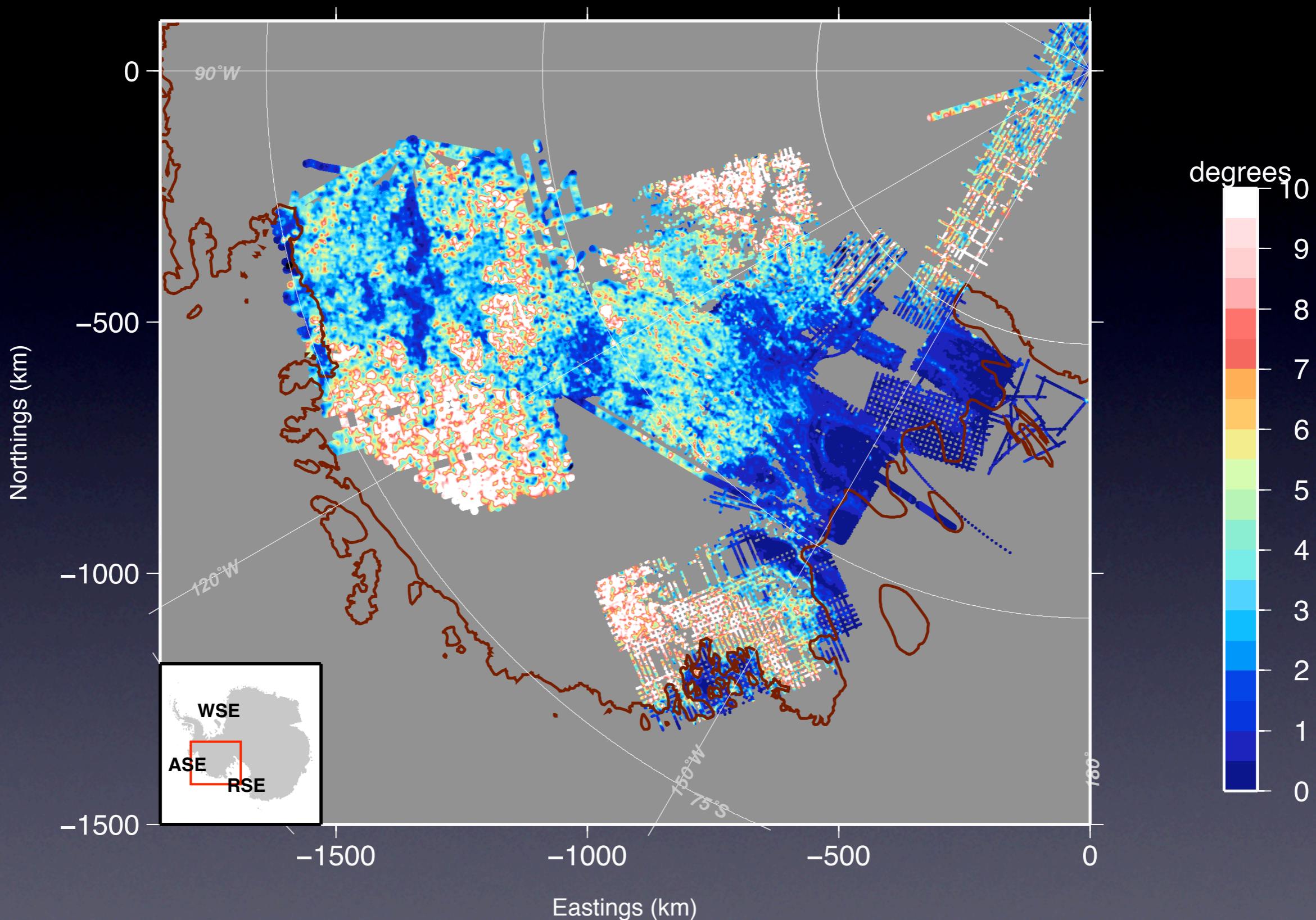
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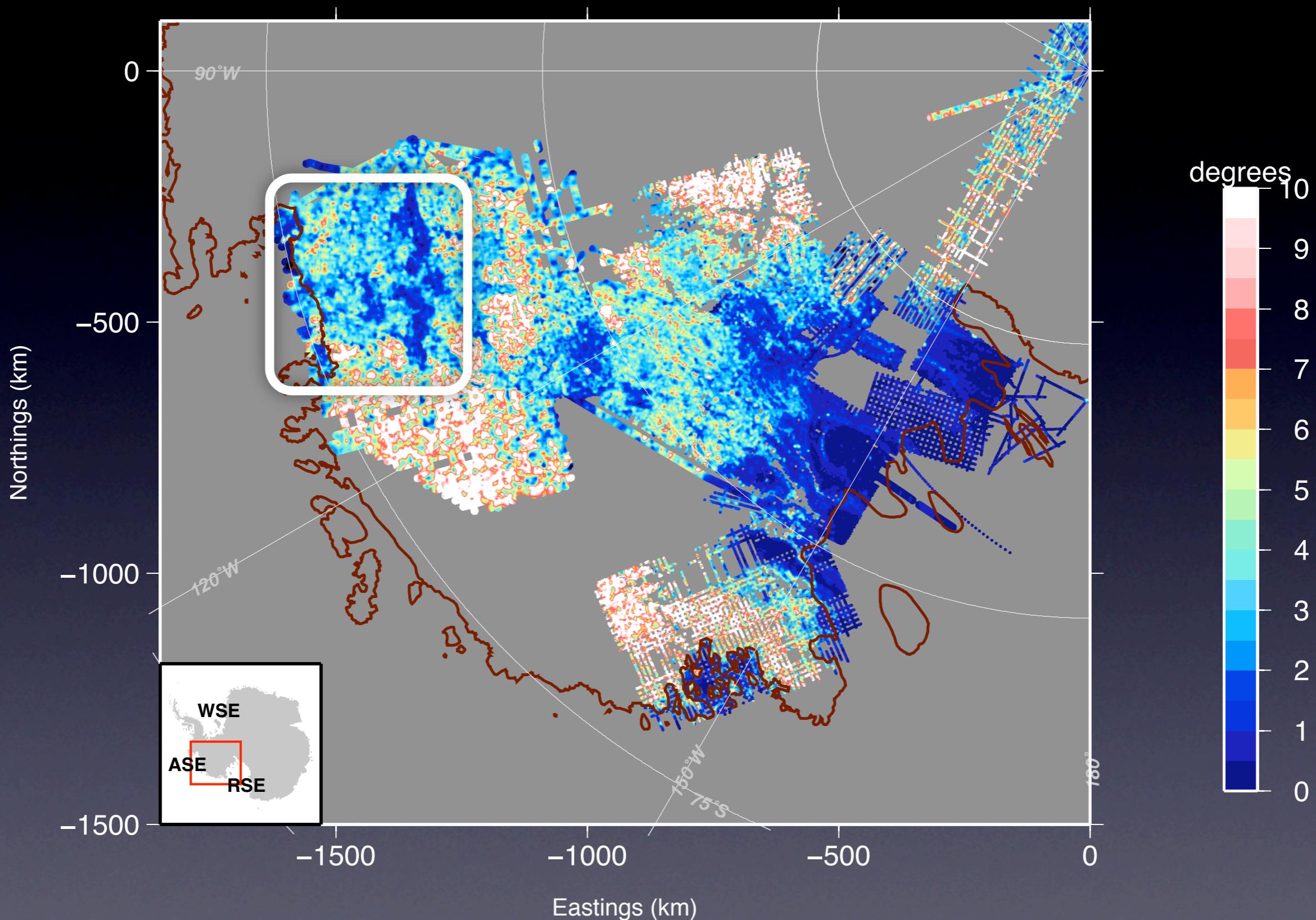
Results:

800 meter RMS slope only



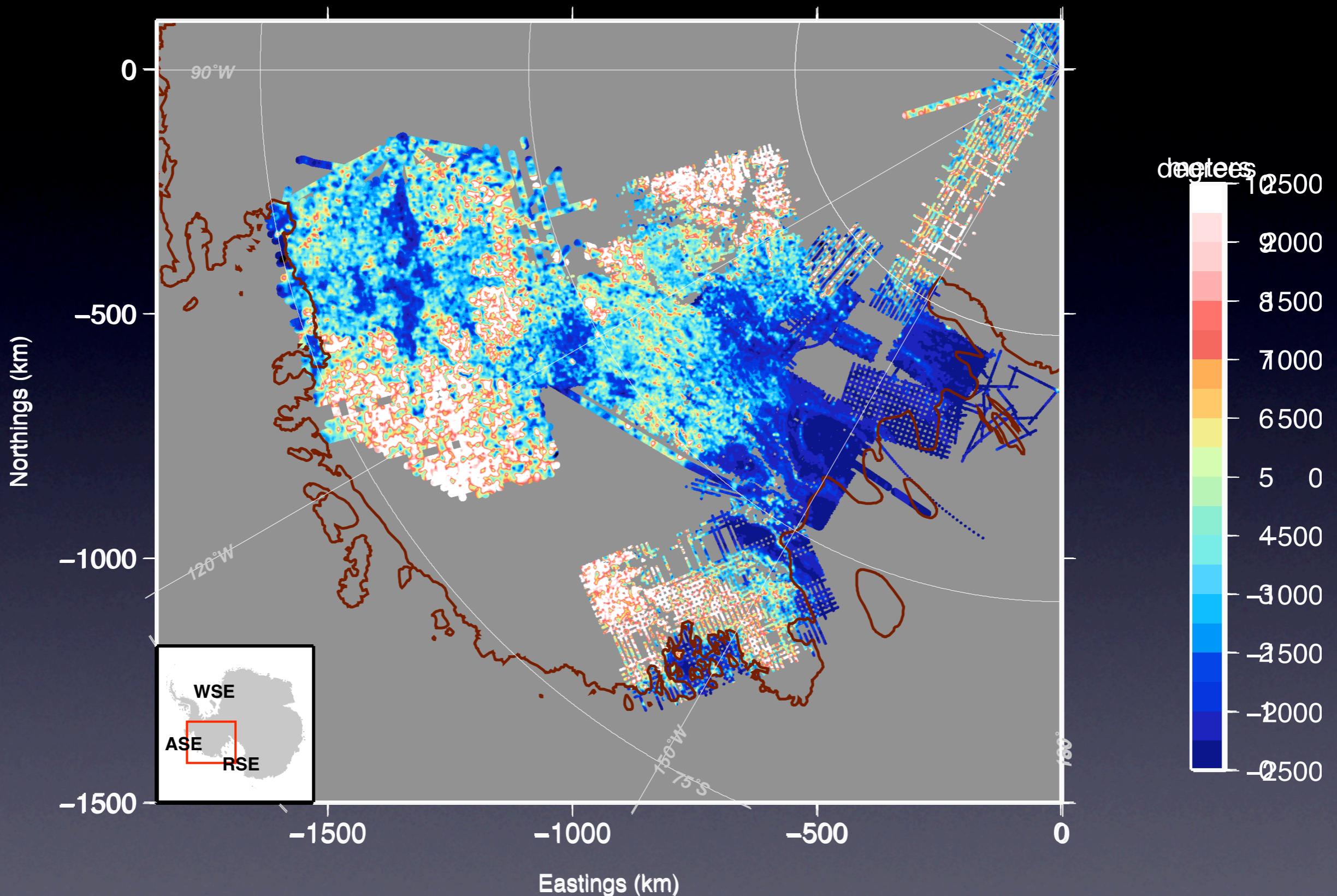
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800 meter RMS slope only



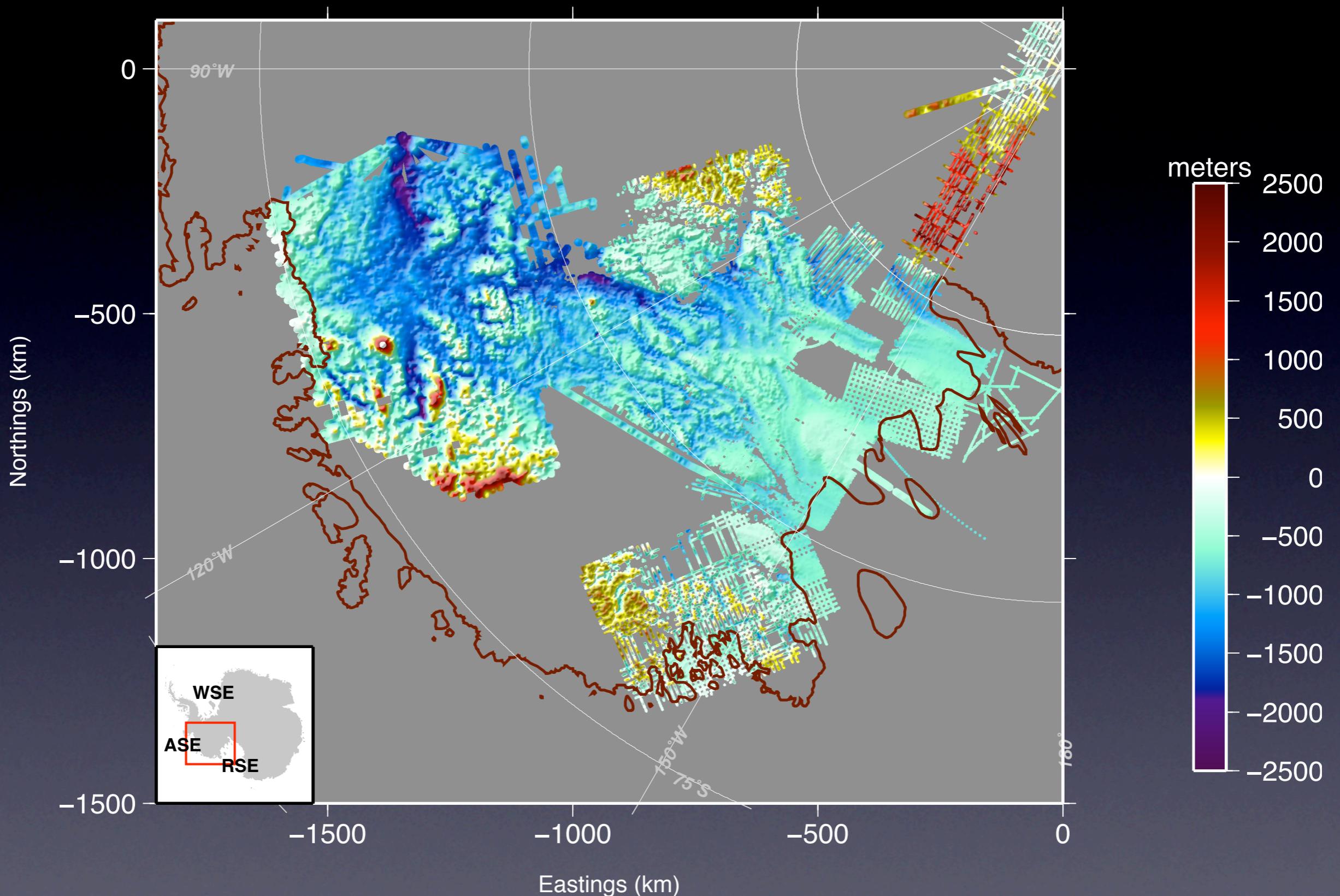
Results:

800 meter RMS slope only



Results:

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Results:

- +the basal interface of the WAIS is heterogeneous
- +these results are broadly consistent with marine sediments being the source of lubricating tills
- +The Siple Coast is characterized by downstream smoothing, consistent with pervasive downstream transport of till; and mobile ice stream trunks (i.e. Siegert *et al.*, [2003].)
- +The WAIS interior has extensive, sharply defined smooth regions with low driving stresses
- +Downstream transport of till does not shape the base of Thwaites Glacier; consistent with offshore results (i.e. Lowe and Anderson, [2003])

Results:

Thanks to the:

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