2014 over-snow traverse to the ice divide between Pine Island Glacier, Rutford and Institute Ice Stream

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CECS

CONTEXT

Project Title

"West Antarctica Ice sheet stability; a glaciological research program on the Ronne Ice Shelf and related ice streams "

Project Director: Andrés Rivera, CECs

Project Reviewed by Eric Rignot, Robert Thomas, Rolf Sinclair, Margit Schwikowski

Project Aims

General:

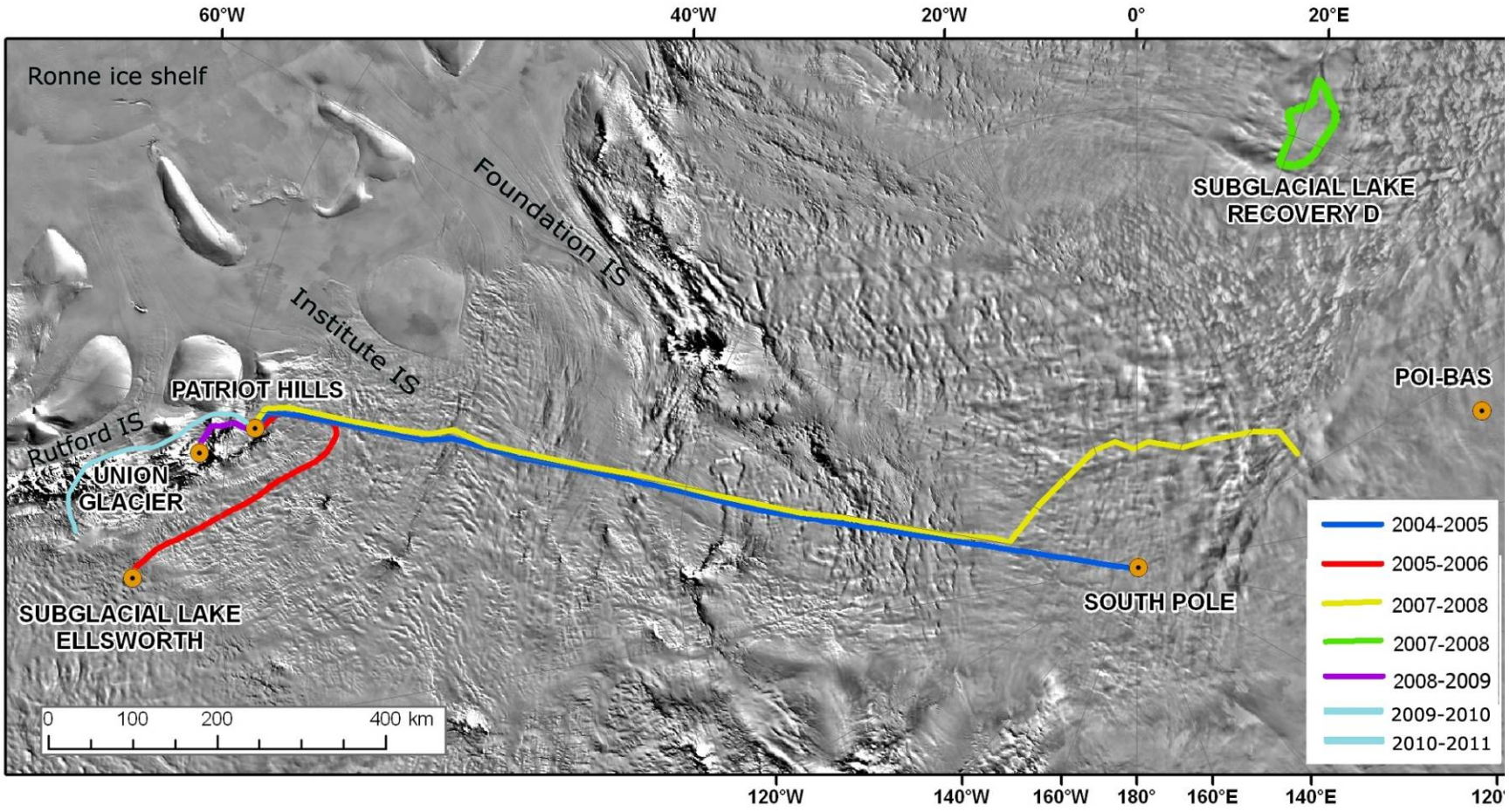
- To study WAIS potential instability in response to oceanographic and climate changes.

Project Aims

Specific:

- Mapping in detail the ice divide between Institute and PIG, and between PIG and Rutford, in order to study possible ice divide migrations and past stability of this part of WAIS.
- Studying shallow snow/firn cores by stable isotope, chemistry analysis and density determination. The resulting data will contribute to ground-trusting accumulation estimations.
- Mapping in detail the surface and subglacial topography of the GZL and upstream areas of the Institute, in order to estimate topographic and geological constrains to possible GL migrations.
- Detailed mapping of the RFS (Ronne-Filchner strait) bathymetry to improve the models of the oceanic circulation underneath the ice shelf, to determine the impact of possible ocean water temperature changes on the GZL of Rutford and Institute ice streams.
- Modelling the surface glacier mass balance based upon automatic weather stations, mass balance measurements (short ice/snow cores) and Re Analysis data.
- Modelling the ice flux of the studied glaciers and their possible changes in different climate and ocean scenarios.

Recent campaigns in Antarctica



The Campaign

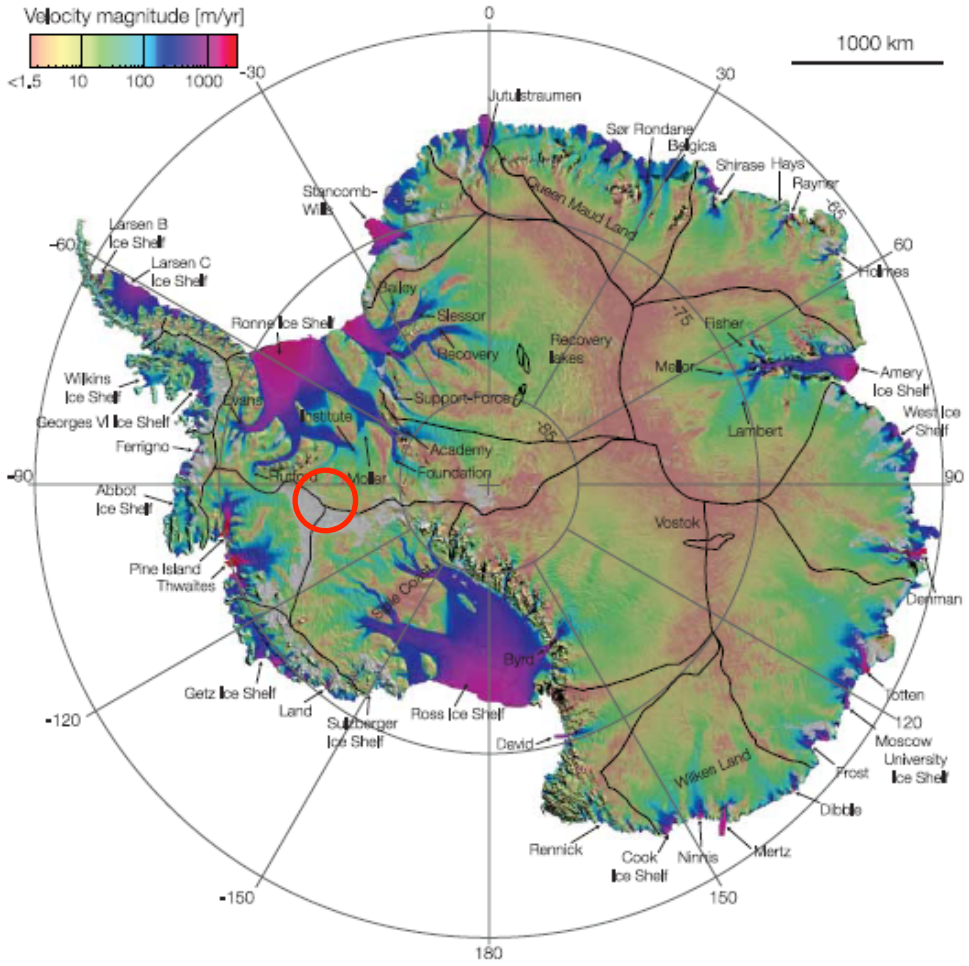
When?: January, 2014

Who?: Andrés Rivera, José Uribe, Rodrigo Zamora & ALE

Where?: From Union Glacier (79º46'S/83º24'W)
to the Ice divide
between PIG, Rutford and Institute Ice stream (1200 km)

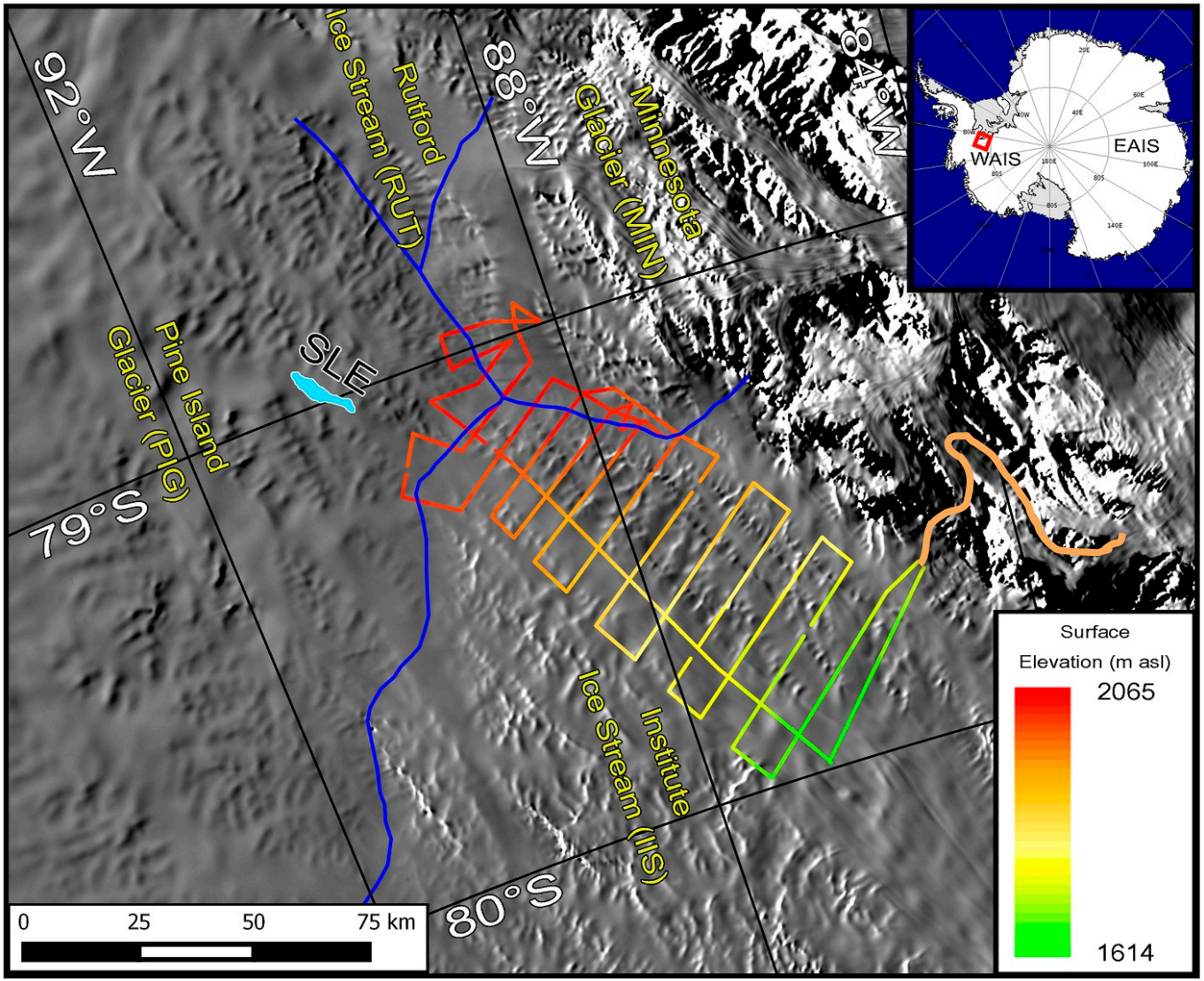
How?: ALE (Antarctic Logistics & Expeditions) facilities

Study Area



Source: Rignot et al, 2011, Science

CECs survey (2014)



Background is a MODIS Mosaic of Antarctic (Scambos et al., 2007)

Blue Ice Landing Zone

Over-Snow Traverse

CECs caboose

Andrés Rivera

Rodrigo Zamora

José Uribe

CECs Antarctic Plateau Mobile Research Station

Methods

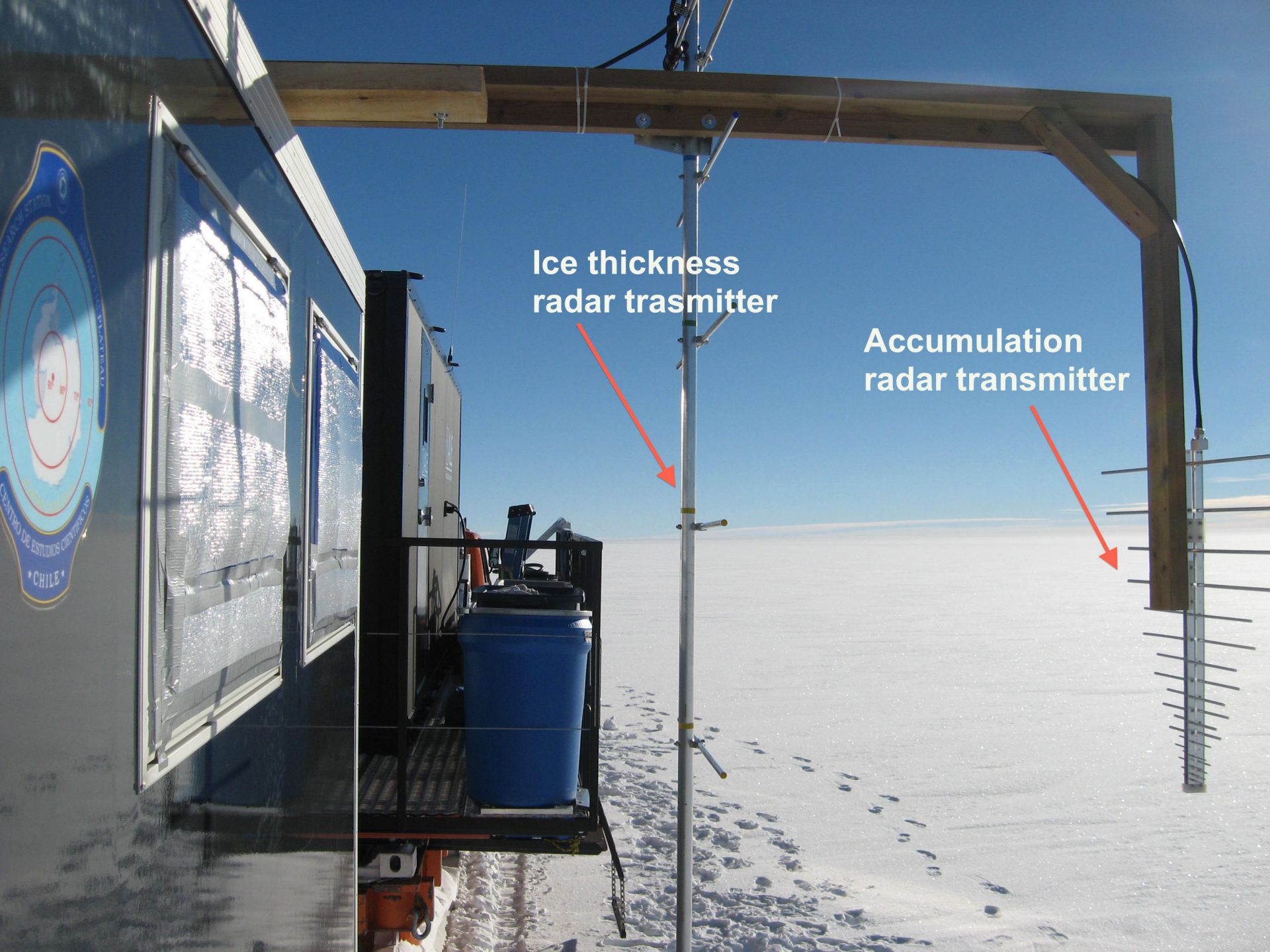
- On-the-ground radar survey (ice thickness and accumulation)
- Dual frequency Lexon GD GPS Receivers
- Installation of stakes
- Ice core extraction
- Automatic Weather Station (on top of the station)

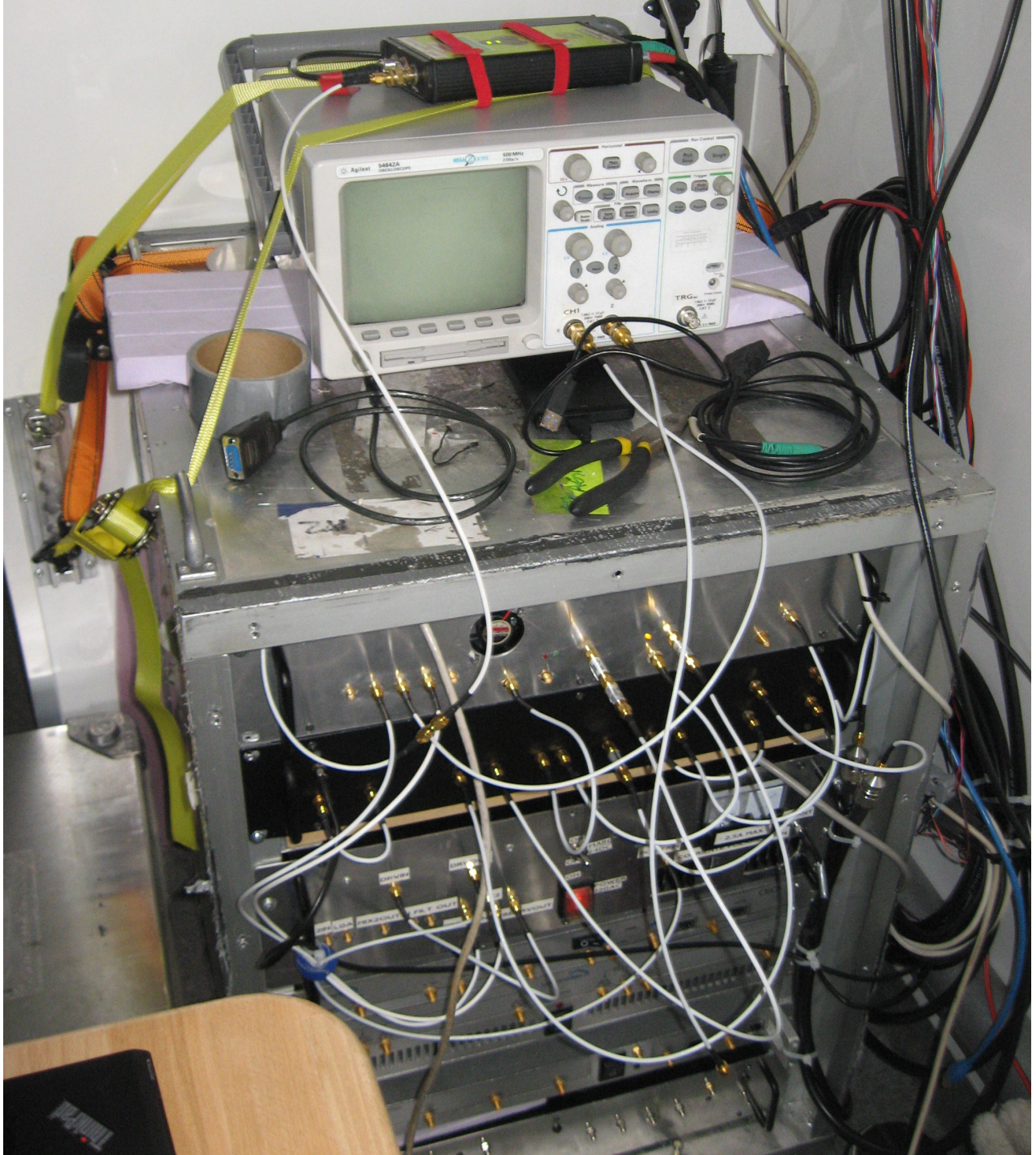
Ice thickness radar

- VHF coherent pulse-compression system (Uribe et al, 2014).
- Output peak power: 200 W
- Central frequency: 155 MHz
- Bandwidth: 20 MHz
- Vertical resolution: 5m
- Pulse repetition frequency (PRF): 10kHz
- Coherent integrations (for better SNR): 256
- Configuration: 2 Yagi antennae. 12dBi of gain
- Receiver: Low gain channel (until 1km depth) and high gain channel (until 4 km depth).

Accumulation radar

- UHF Frequency-modulated continuous wave (FMCW) radar (Uribe et al, 2014).
- Frecuency range: 203-1019 MHz
- Vertical resolution: 12 cm in firn
- Output power: 150 mW
- PRF: 5.5 kHz
- Coherent integrations: 128
- Configuration: broadband log-periodic antennae with gain of 6dBi in each.
- Maximum range: 400 m in ice.


Ice thickness
radar trasmitter
Accumulation
radar transmitter
CHILE


Agilent
54642A
500 MHz
CH1
TRG

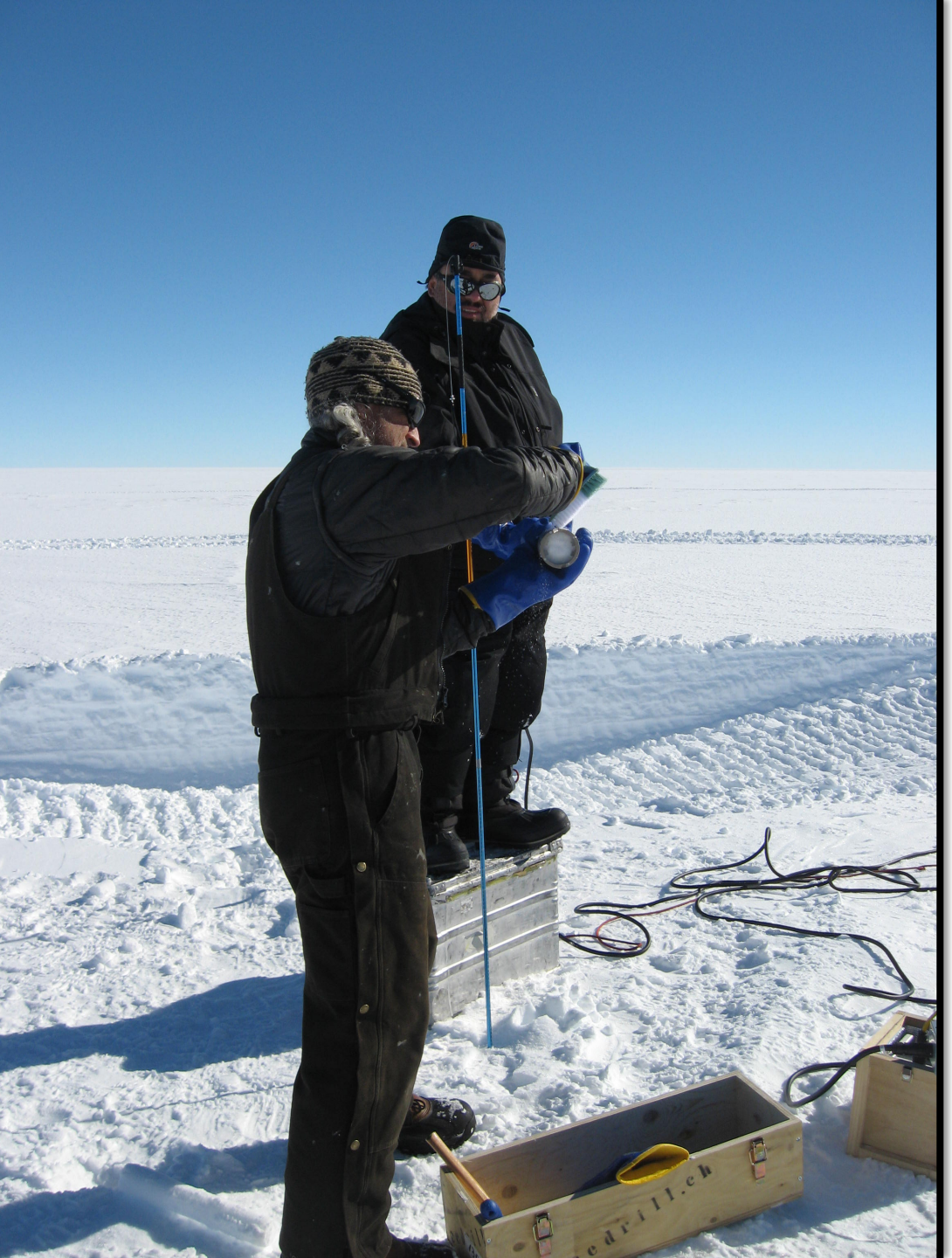
Automatic Weather Station

- Parameters: Temperature, Humidity, Atmospheric Pressure, Solar Radiation (In & Out), wind speed and wind direction.
- Real time satellite transmission.

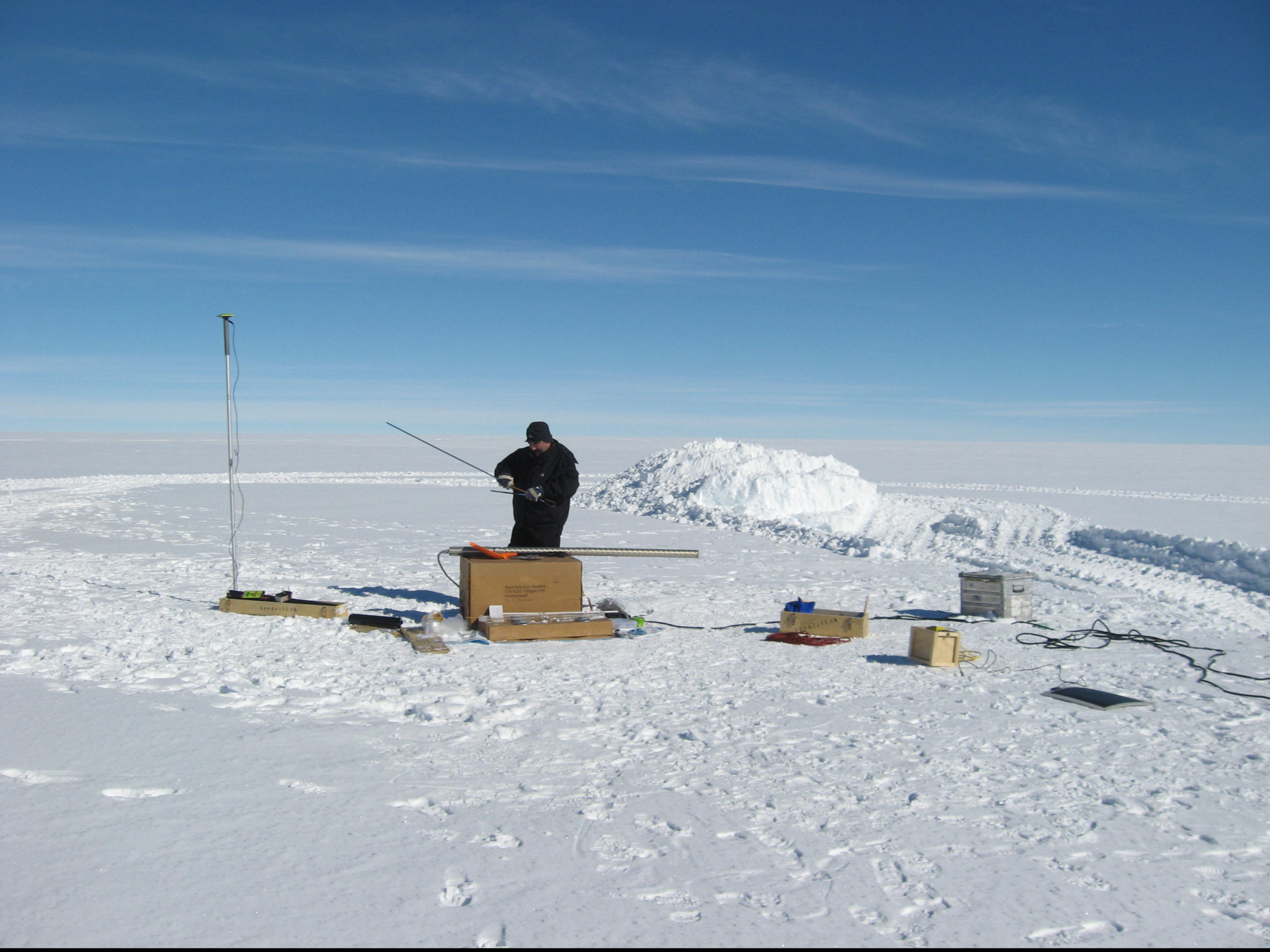

Rodrigo Zamora
José Uribe


GPS and
Weather Station
CECs
CENTRO
DE ESTUDIOS
CIENTÍFICOS
CECs I
MOBILE
RESEARCH
STATION
ANTARCTIC
PLATEAU

Stakes installation and GPS survey

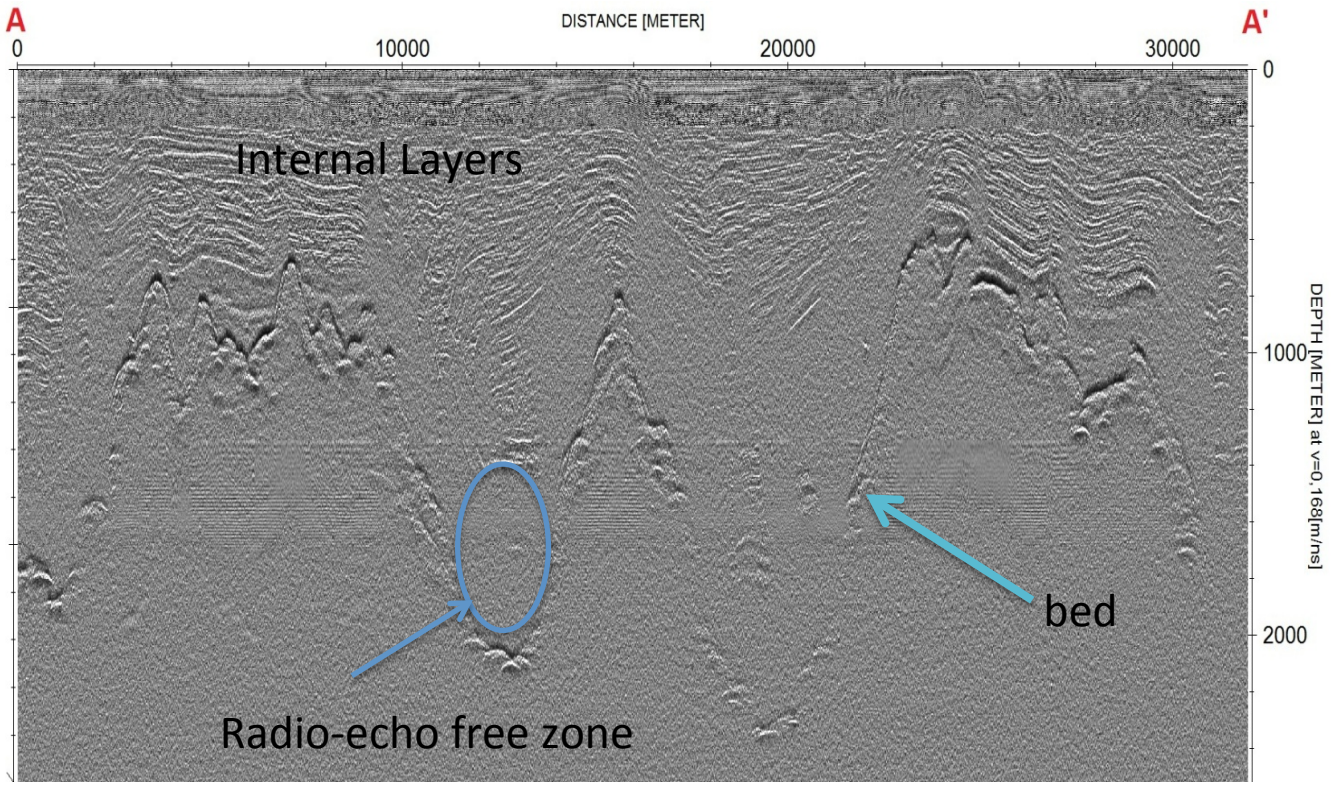


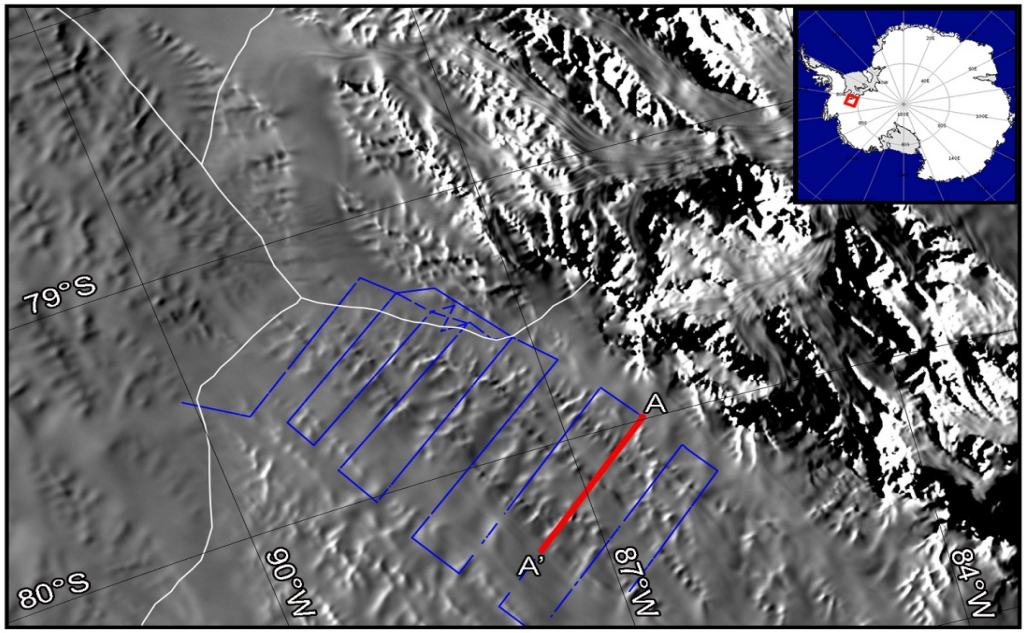
Ice
core
extraction

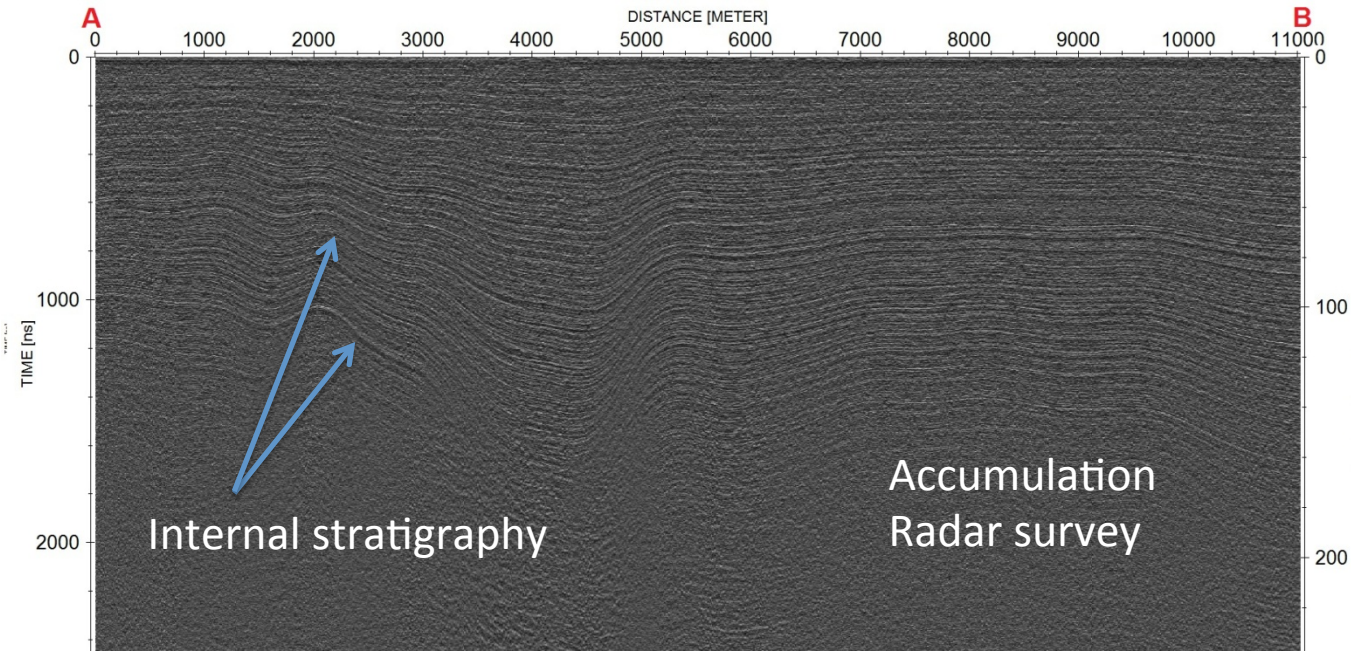


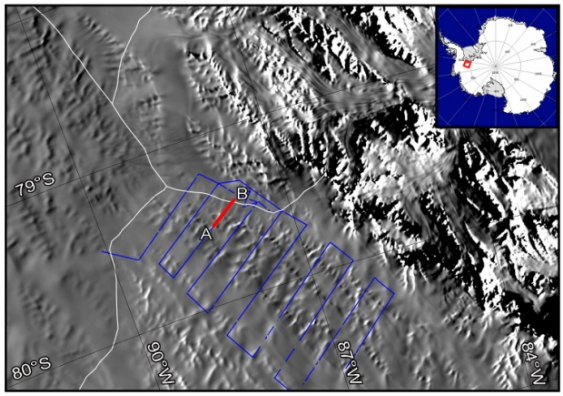
Preliminary Results

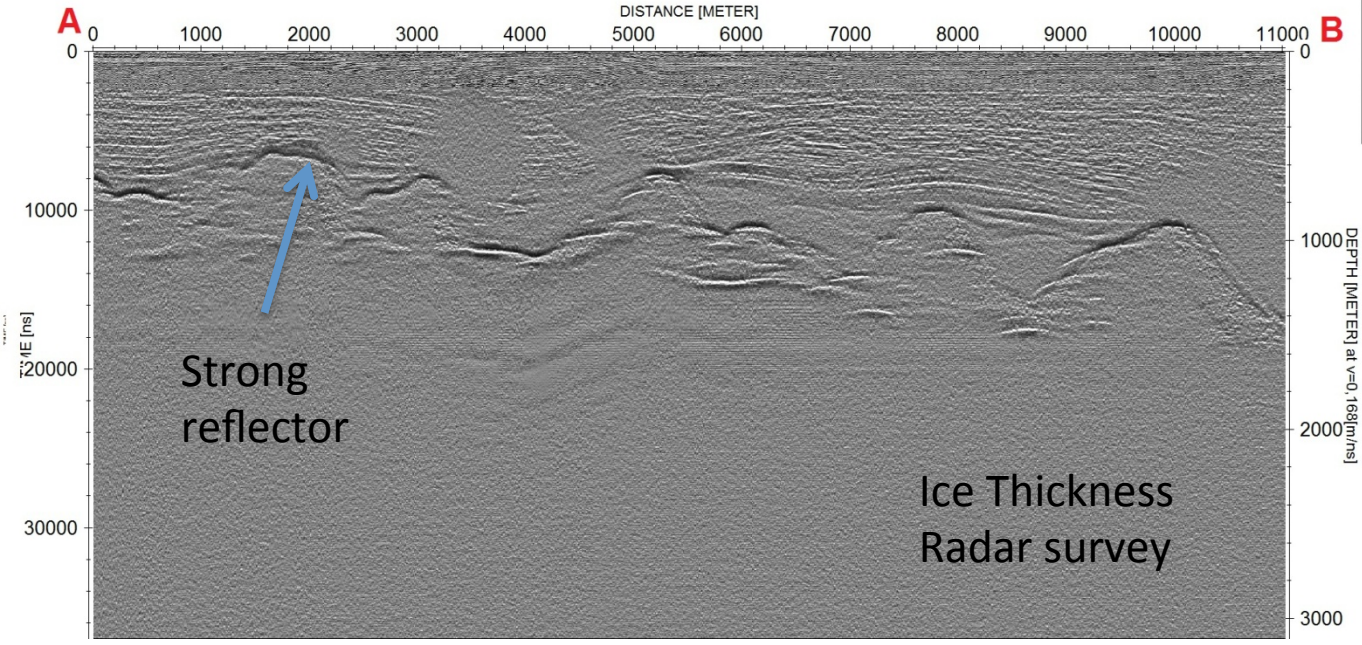
Example Profiles

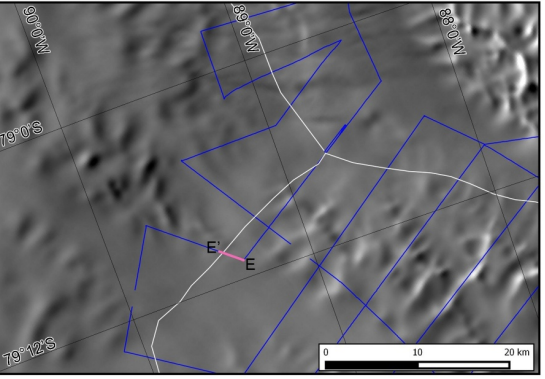

A
DISTANCE [METER]
A'
0
10000
20000
30000
0
1000
2000
DEPTH [METER] at v=0.168[m/ns]
Internal Layers
bed
Radio-echo free zone

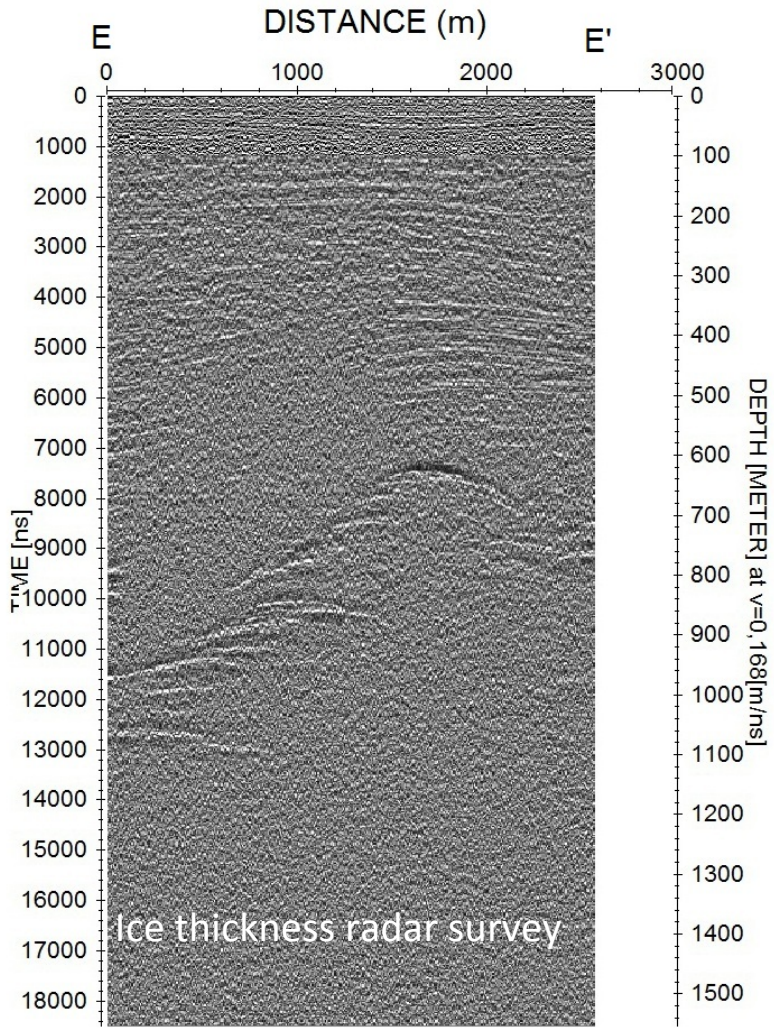

79°S
80°S
90°W
87°W
84°W
A
A'

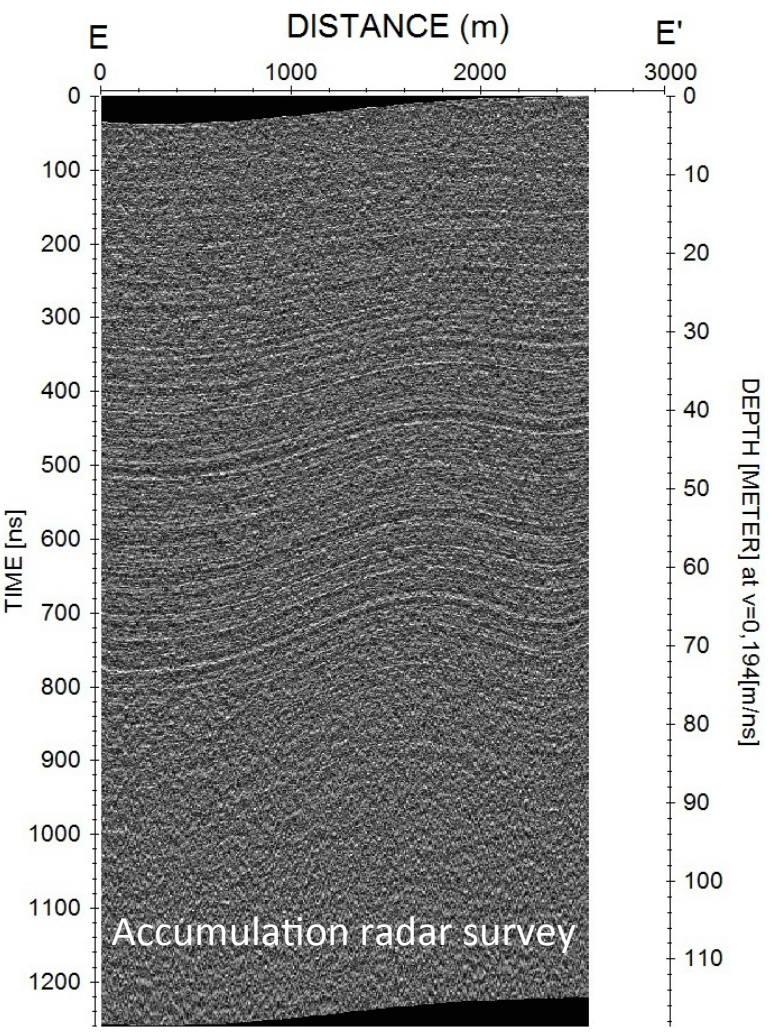

A
B
DISTANCE [METER]
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
TIME [ns]
DEPTH [METER] at v=0.194[m/ns]
100
200
Internal stratigraphy
Accumulation
Radar survey


79°S
80°S
90°N
87°N
84°N
A
B

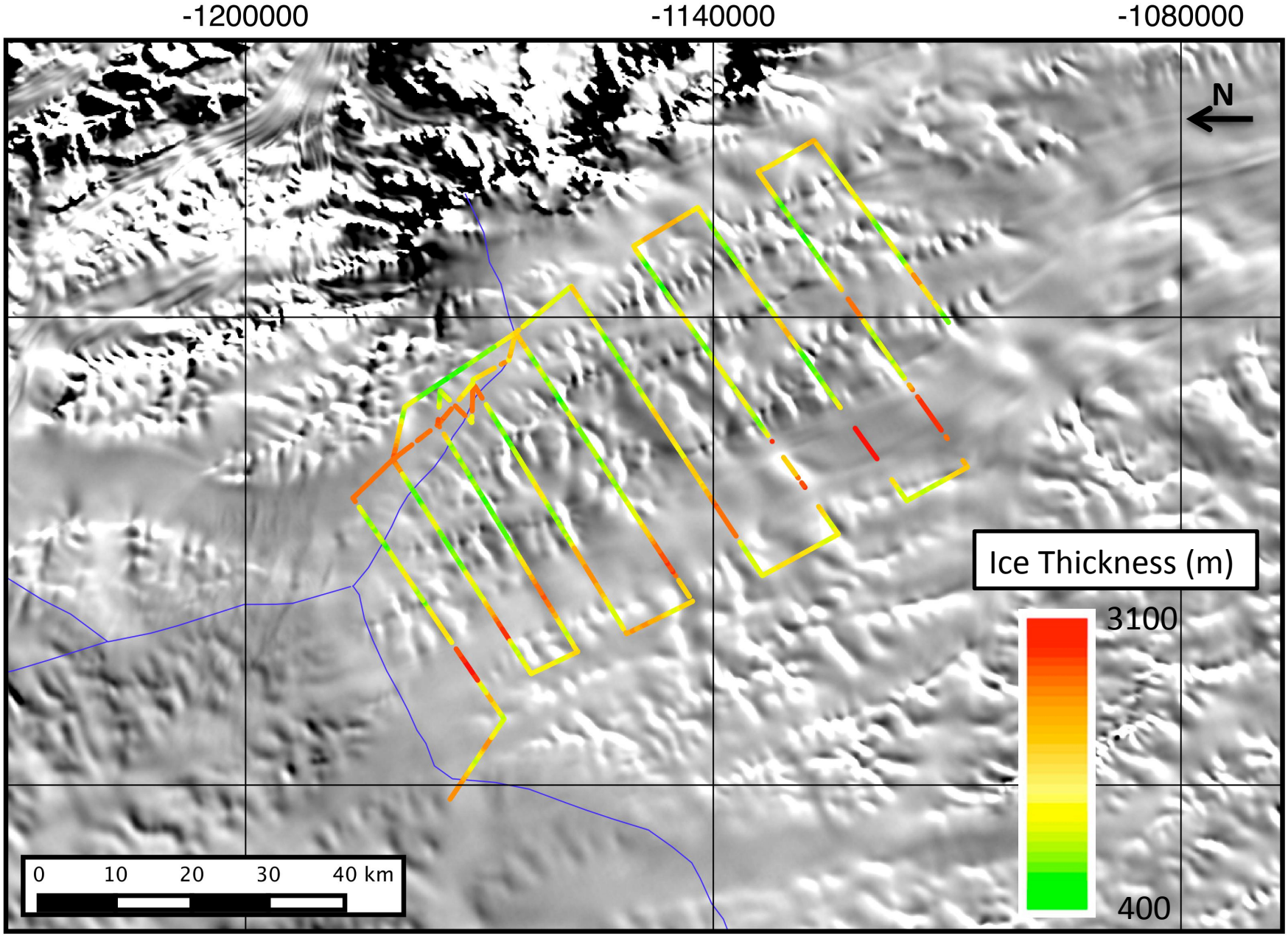

A
B
DISTANCE [METER]
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
10000
20000
30000
1000
2000
3000
DEPTH [METER] at v=0.168[m/ns]
Strong
reflector
Ice Thickness
Radar survey


90°0'W
89°0'W
88°0'W
79°0'S
79°12'S
E'
E
0
10
20 km


E
DISTANCE (m)
E'
0
1000
2000
3000
TIME [ns]
DEPTH [METER] at v=0,168[m/ns]
Ice thickness radar survey

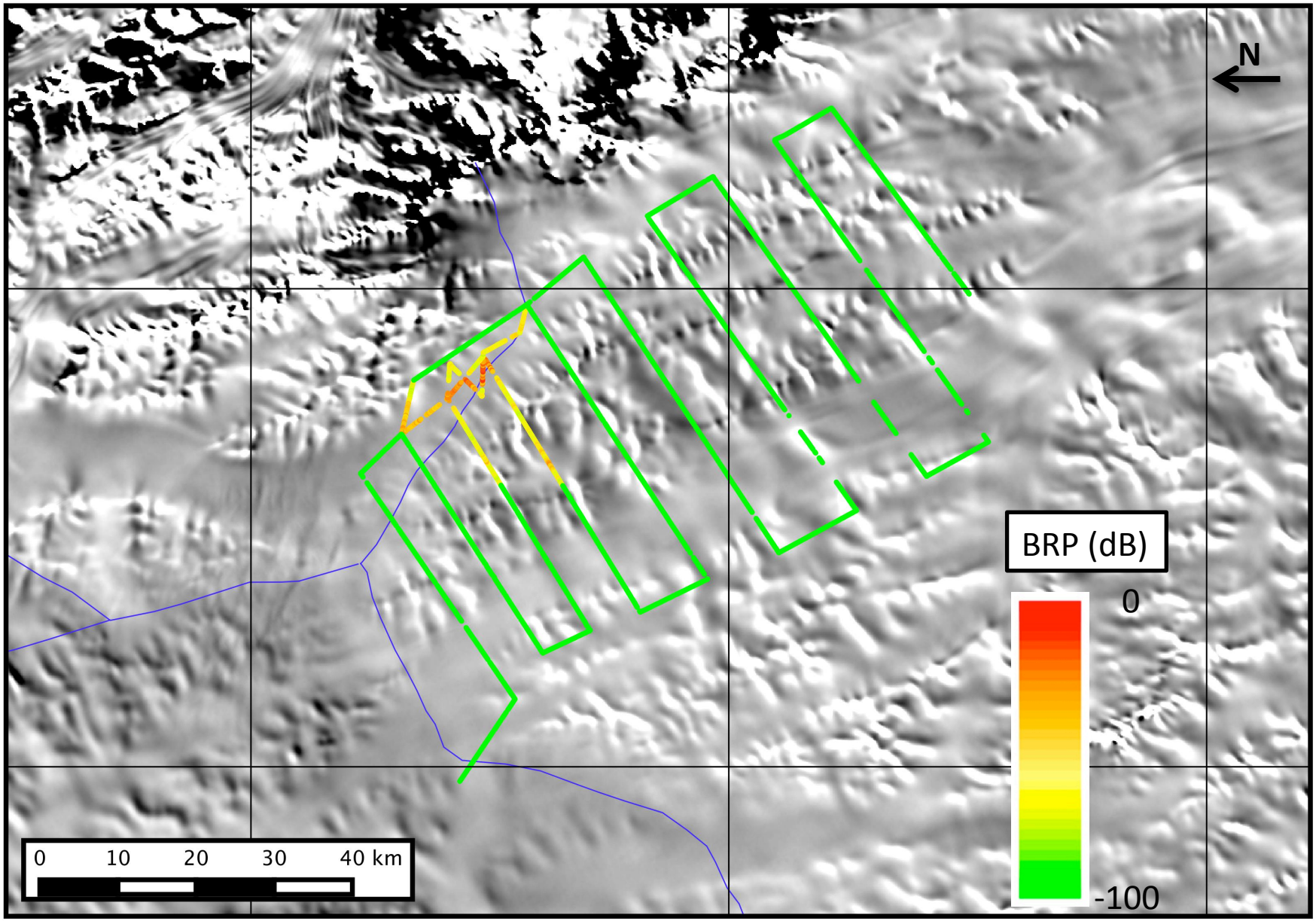

E
DISTANCE (m)
E'
0
1000
2000
3000
TIME [ns]
DEPTH [METER] at v=0,194[m/ns]
Accumulation radar survey

Ice Thickness



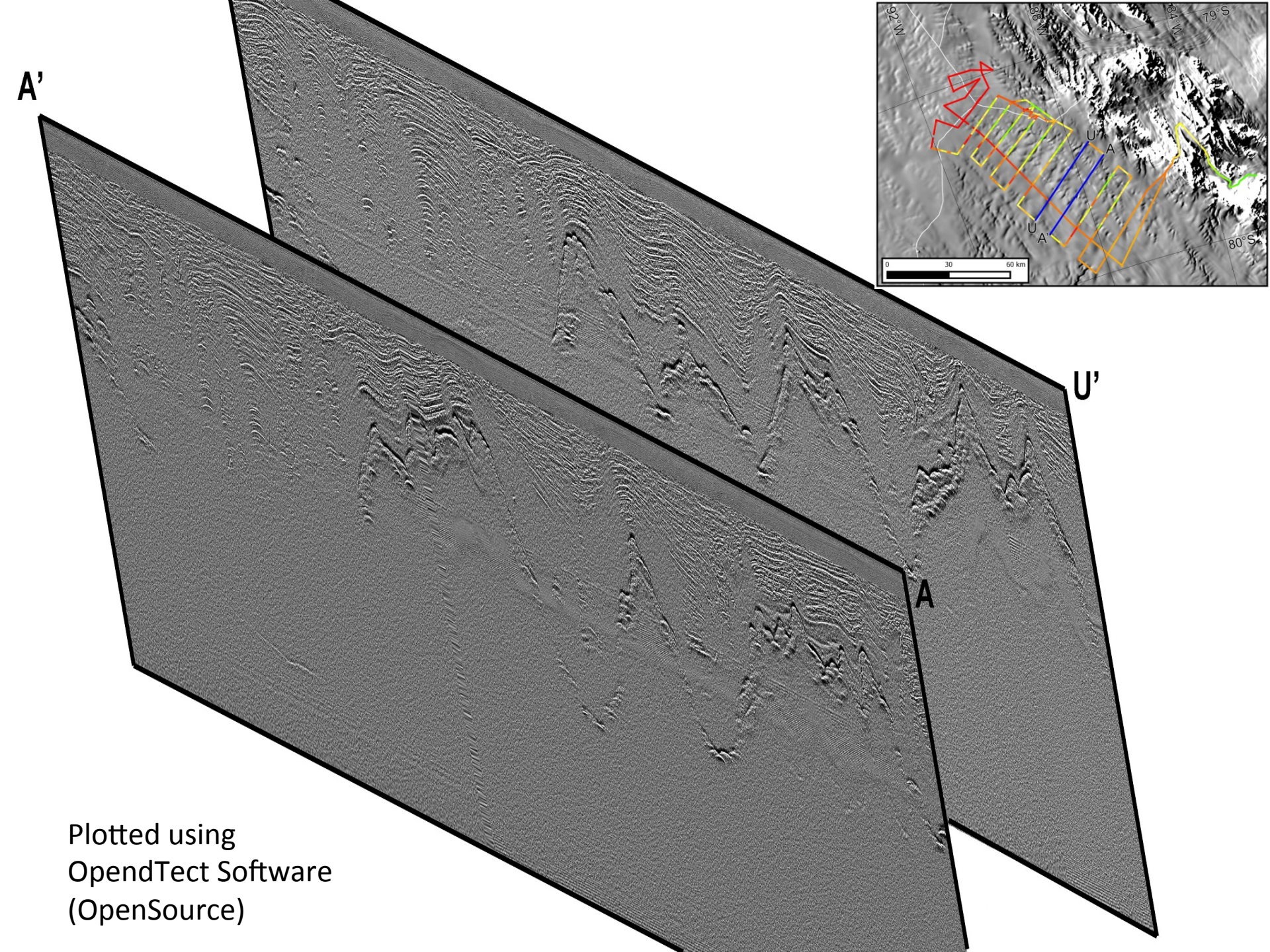
WGS84 / Polar Stereographic. MOA image

Bed Reflection Power



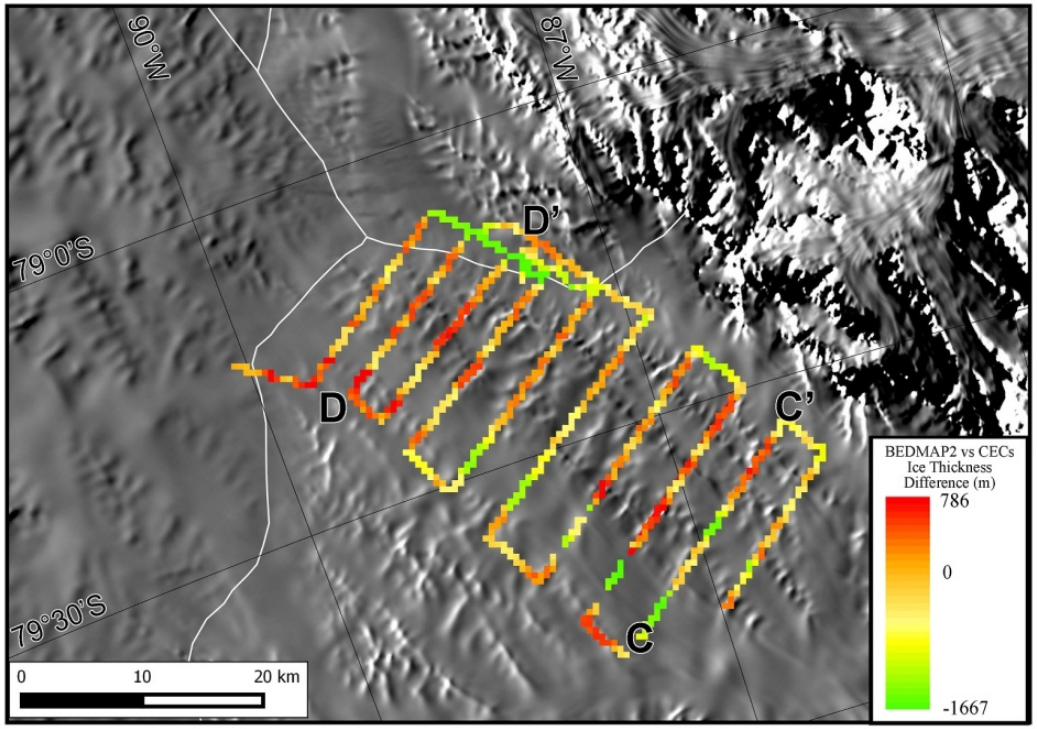
WGS84 / Polar Stereographic

Background is a MODIS Mosaic of Antarctic image

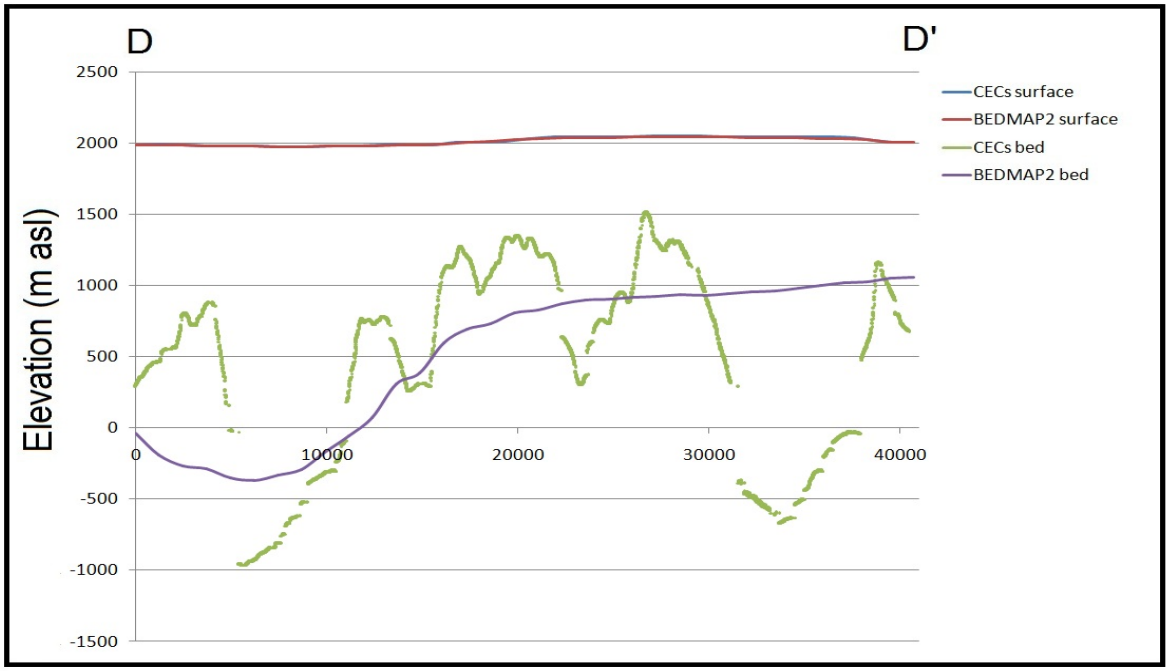


Plotted using
OpendTect Software
(OpenSource)

Comparison between BEDMAP2 and CECs data

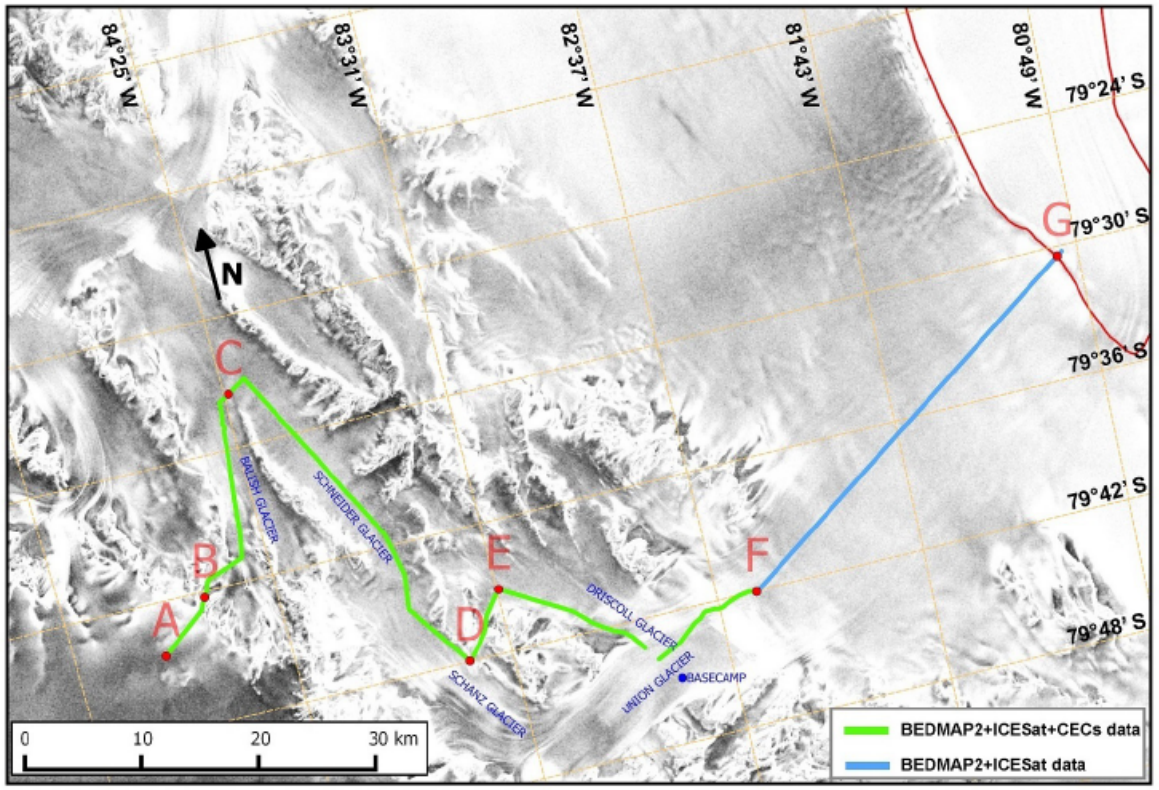


Ice thickness differences
BEDMAP2 vs CECs data (2014)

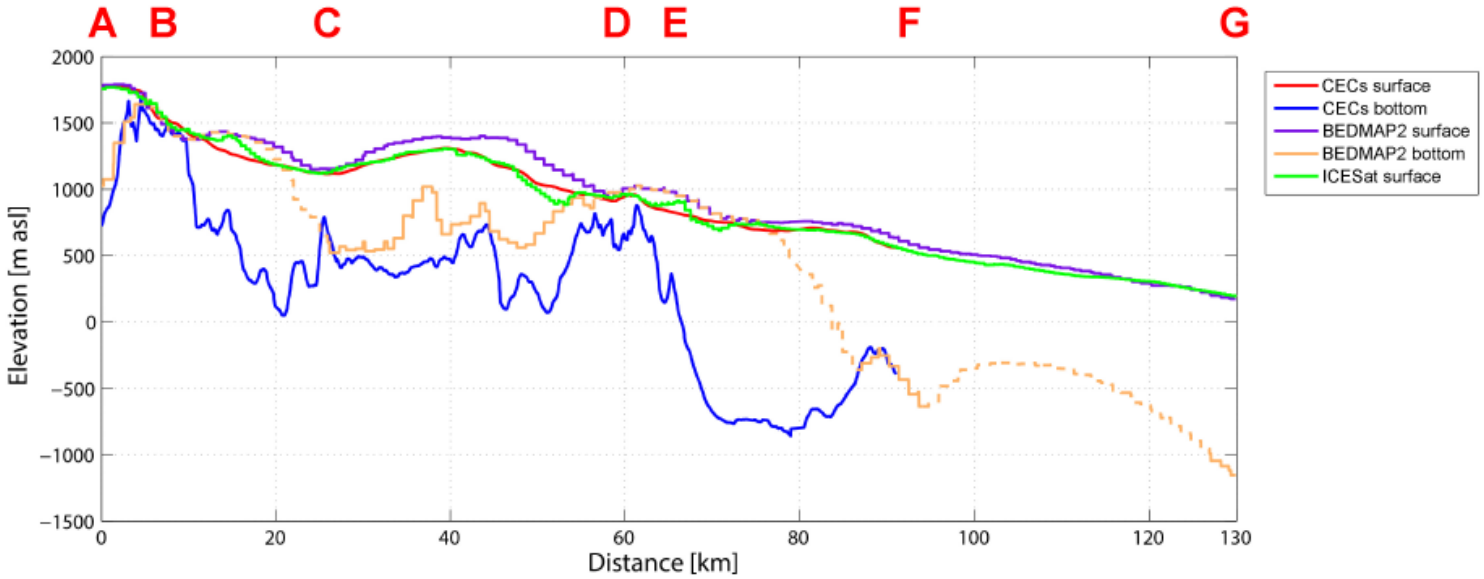


BEDMAP2 vs CECs data (2014)
Surface and Subglacial topography

Differences:
Surface topography: 3.5 ± 7.9 m
Ice thickness: 283 ± 646 m



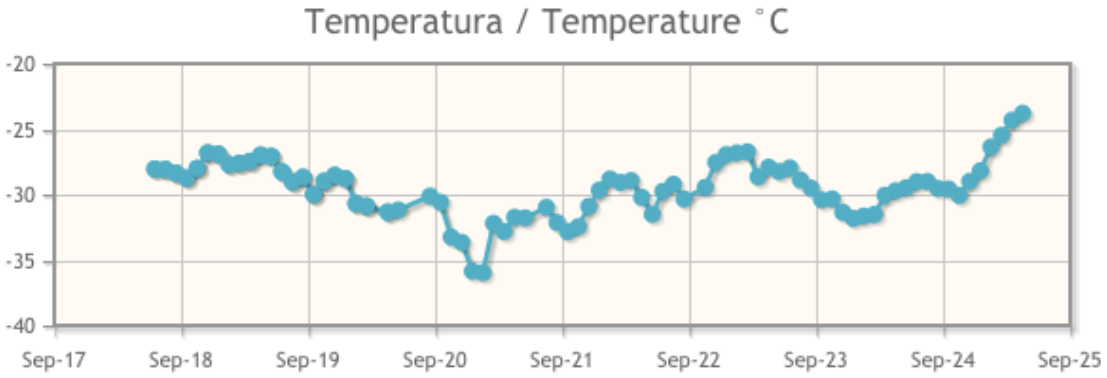
Rivera et al, 2014 "Recent ice dynamics And surface mass balance Of Union Glacier in the WAIS". The Cryosphere

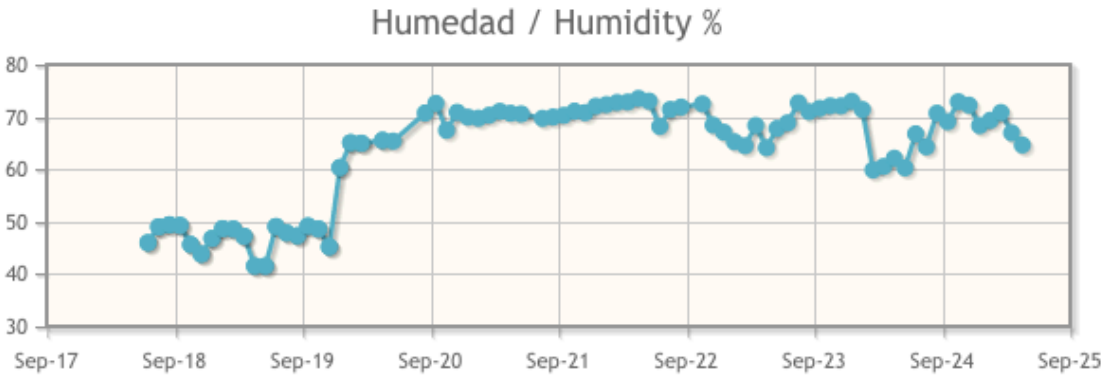


Automatic Weather Station

Estaciones / Stations Datos / Data

••• Gl. Unión Antarctica





T : -23.78 °C
RH : 64.65 %
BP : 903 mb
WS : 4.468 m/s
SLR : 64.73 W/m²
Snow T : -29.27 °C

Fecha / Timestamp GMT +00
2014-09-24 15:00:18
Coordinates
79°45'32.50"S , 82°50'35.70"O
679 m asl

••• On-line

✓ Off-line

http://www.cecs.cl/awsm/antar/

Summary/Conclusions

- We surveyed more than 1200 km of almost unexplored Antarctic plateau including the collection of Radar, GPS, Met data and snow samples
- The maximum ice thickness was ~3.1 km.
- The upper 200 m of snow and firn layers were mapped with a vertical resolution of 0.2 m
- The Ellsworth trough was followed up to the ice divide with PIG
- Other very deep troughs and hanging lateral valleys were also mapped, all of them surrounded by very rough and steep flanks.
- Differences between BEDMAP2 and our GPS/radar survey on compared points, were;
  - Surface topography: 3.5 ± 7.9 m
  - Ice thickness: 283 ± 646 m
- The CECs Team is going back in December to survey in more detail part of the study area.

Thanks

Acknowledgements:
Antarctic Logistic and Expeditions (ALE), Basal fund, CONICYT, CECs. Special thanks to WAIS Workshop organizers.

Contact

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