Ministero dell'Istruzione, dell'Università e della Ricerca (MIUR) Commissione Scientifica Nazionale per l'Antartide (CSNA)

Conferenza nazionale sulla ricerca in Antartide

Roma, Accademia Nazionale dei LIncei – 20-21 ottobre 2015

Antarctic ice sheet and sea level

Barbara Stenni

on behalf of the glaciological community

Dipartimento di Scienze Ambientali, Informatica e Statistica,
Università Ca' Foscari Venezia

PROGRAMMA NAZIONALE DI RICERCHE IN ANTARTIDE
ITALIANTARTIDE

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

VENETIARVM VNIVERSITAS IN DOMO FOSCARI

Università Ca'Foscari Venezia

SLR from 1993 to 2010 (*IPCC, 2013*):

Thermal expansion: 39% (0,8 – 1.4 mm/yr)

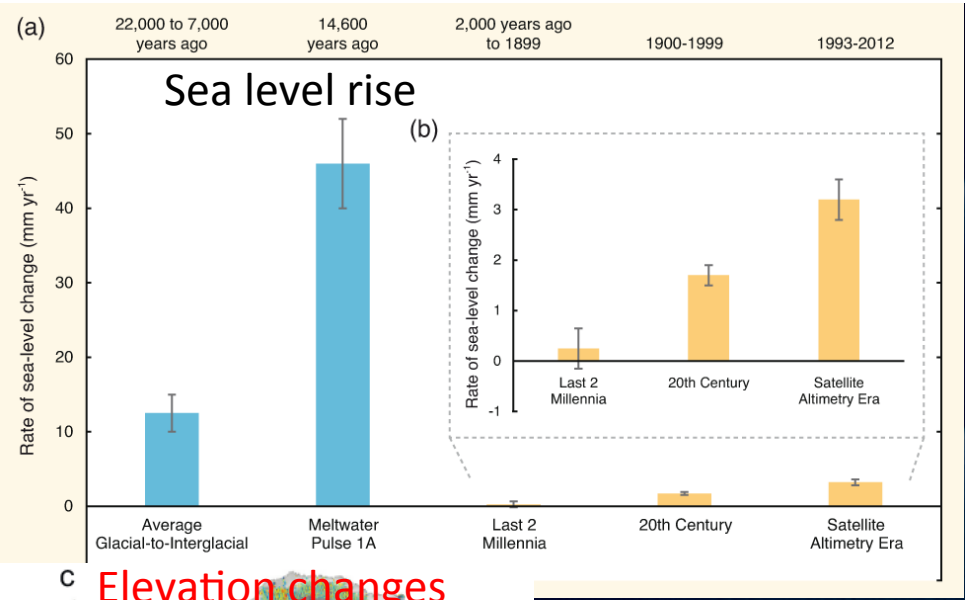
Alpine glacier: 27% (0.3– 1.1mm/yr)

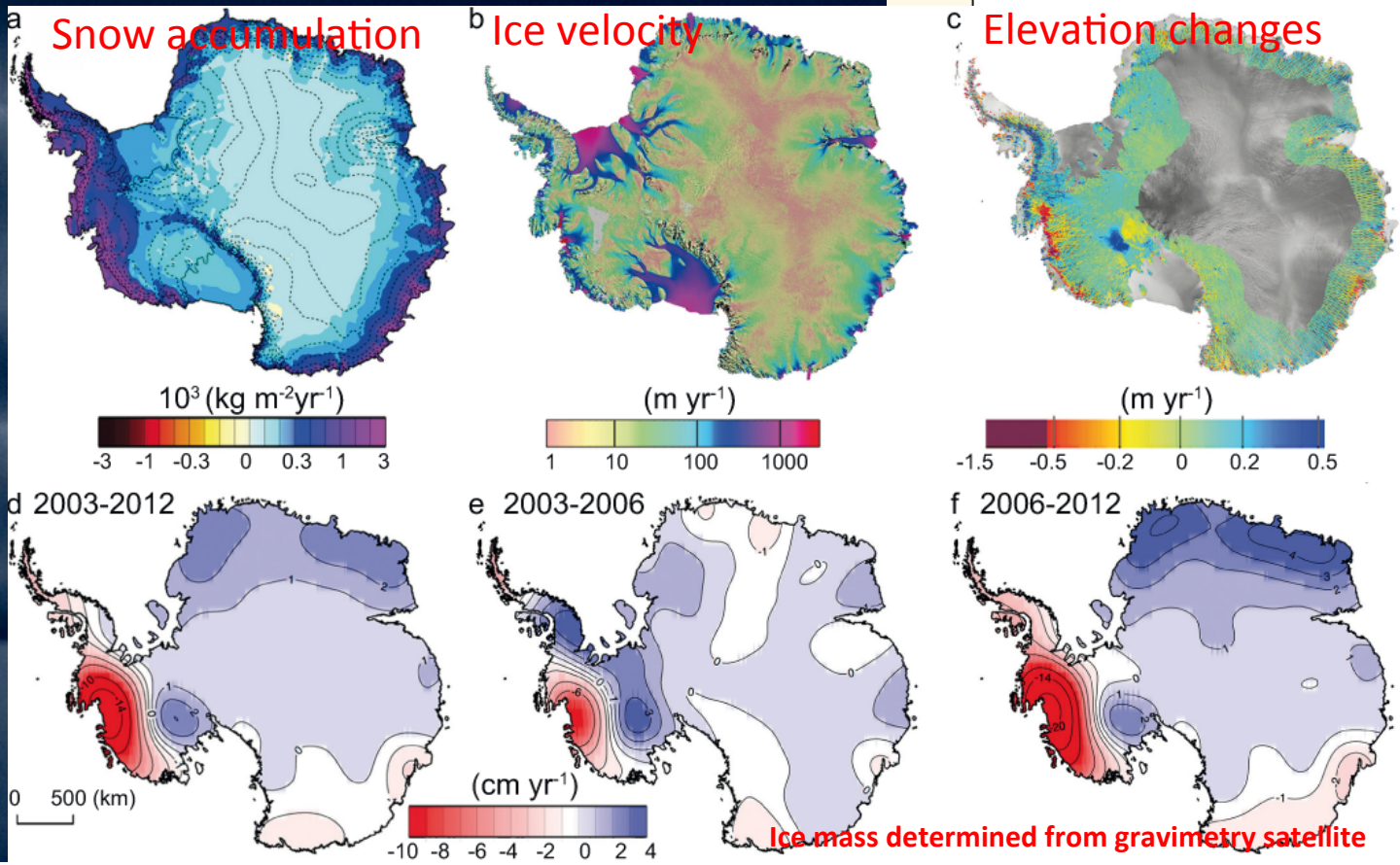
Greenland: 11% (0.25 – 0.4 mm/yr)

Antarctica: 10% (0.15 – 0.4 mm/yr)

Land water storage: 1 3% (0.25 – 0.5 mm/yr)

Total: 2.8 (2.3 – 3.4 mm/yr)



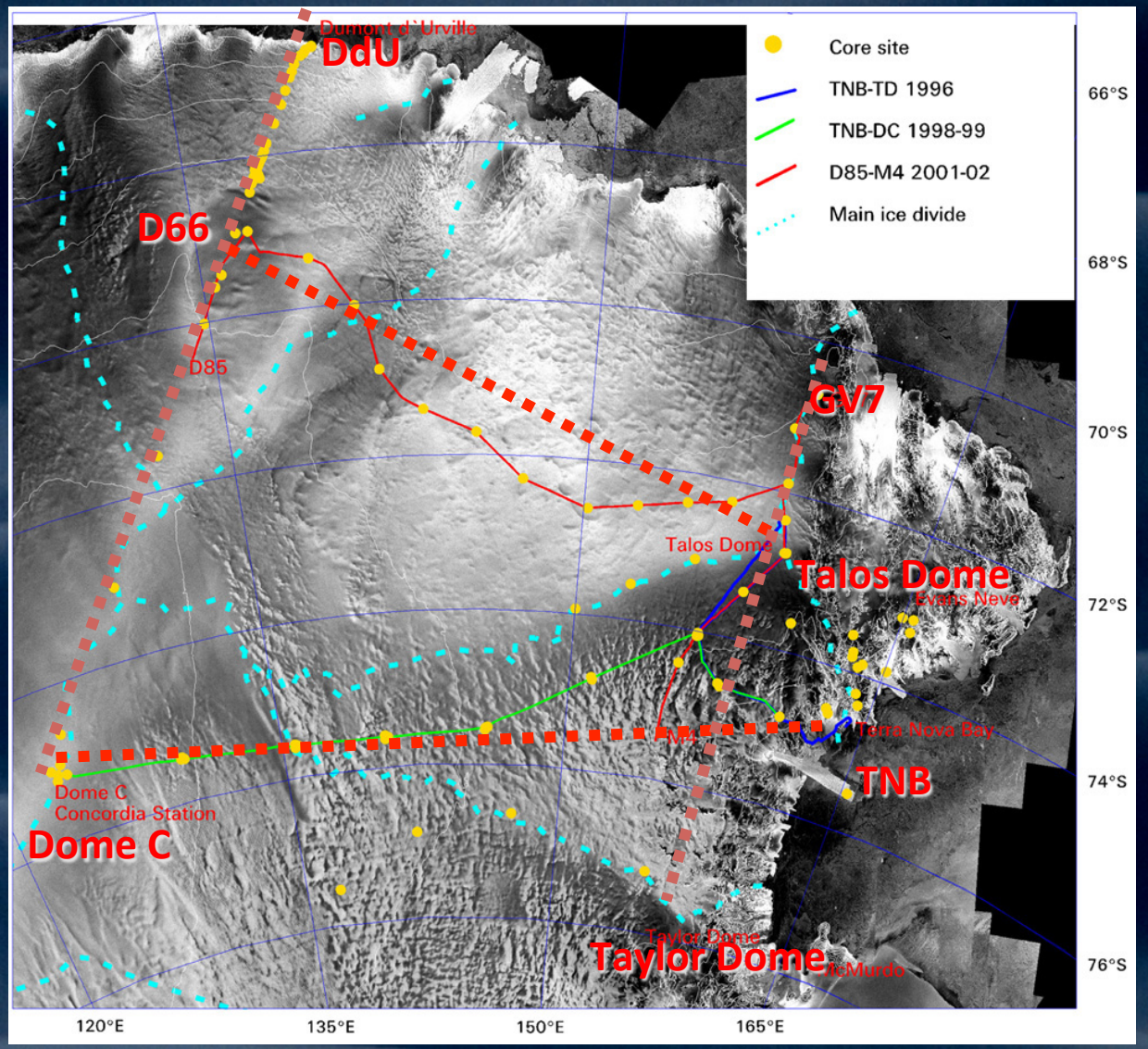


Ice mass determined from gravimetry satellite

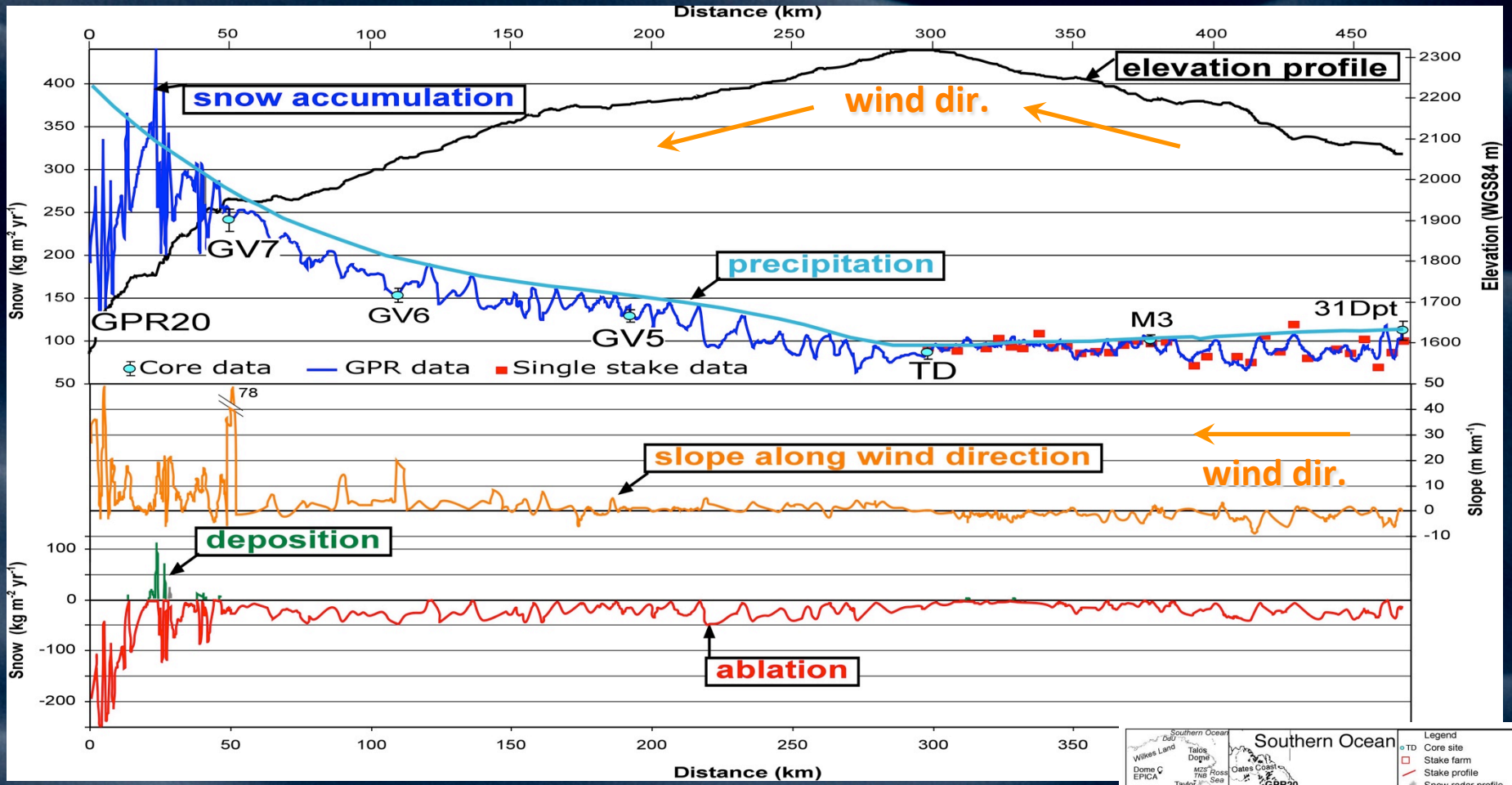
IPCC 2013

As part of ITASE project, PNRA undertook three traverses in Dome C & Talos Dome drainage area (East Antarctica).

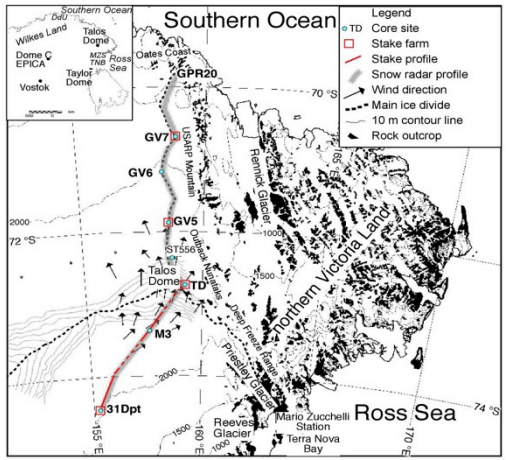
ITASE
INTERNATIONAL TRANS ANTARCTIC SCIENTIFIC EXPEDITION



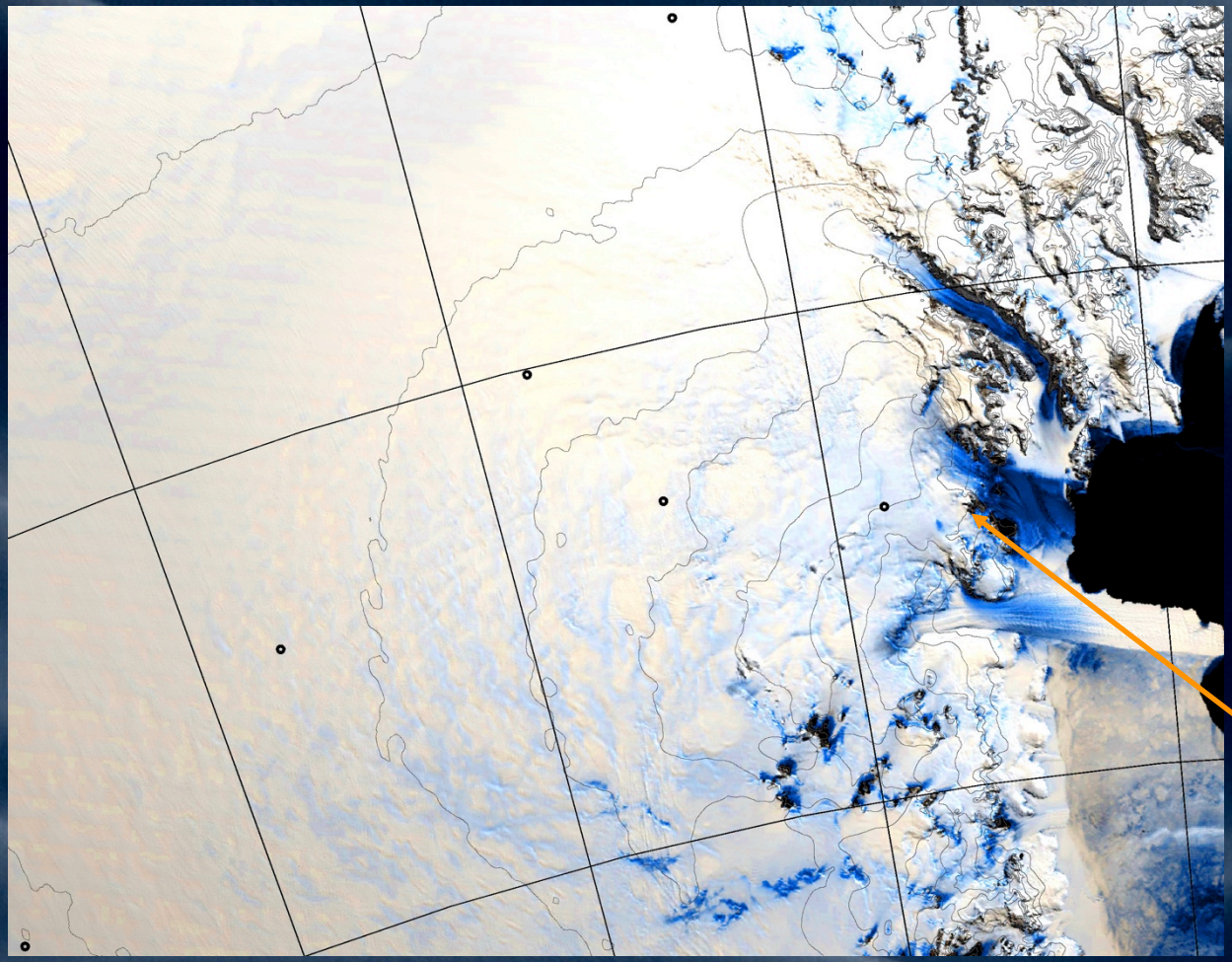
SURFACE MASS BALANCE & KATABATIC WINDS

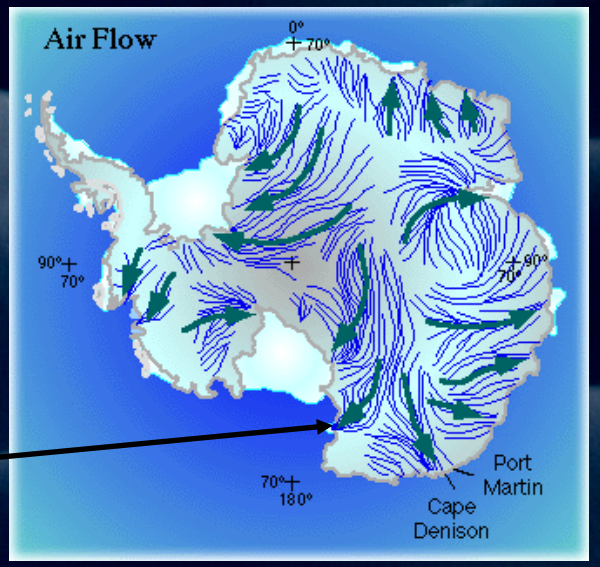


Spatial variations in accumulation are well correlated with surface slope changes along the wind direction and may exceed 200 kg m^{-2} yr^{-1} within one kilometer. Wind-driven sublimation rates are less than 50 kg m^{-2} yr^{-1} in plateau areas and up to 260 kg m^{-2} yr^{-1} in slope areas and account for 20-75% of precipitation. The study shows that mass loss is dominated by sublimation and most of the mass lost is transported away as water vapor . Frezzotti et al, 2004, 2005, 2007



EXTRAORDINARY BLOWING SNOW TRANSPORT IN EAST ANTARCTICA





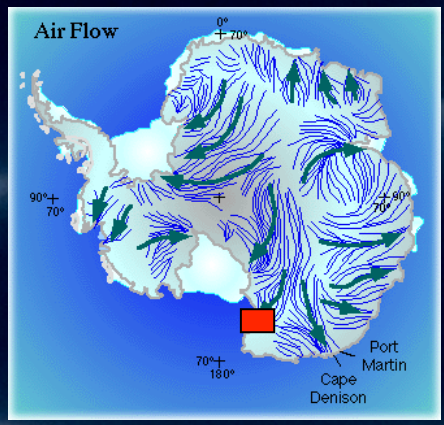
Extensive presence of ablation surface (blue ice and wind crust) suggest that the combine processes of blowing snow sublimation and snow transport remove up to 50% of the precipitation in the coastal and slope convergence area. These phenomena represent a major negative effect on the snow accumulation, and they are not sufficiently taken into account in studies of surface mass balance.

Scarchilli et al. 2010, Scambos et al., 2012

Snow wind transportation was recorded for ~80% of the time, and 20% of time recorded, the flux is > 10^{-2} kg m^{-2} s^{-1} with particle density increasing with height.

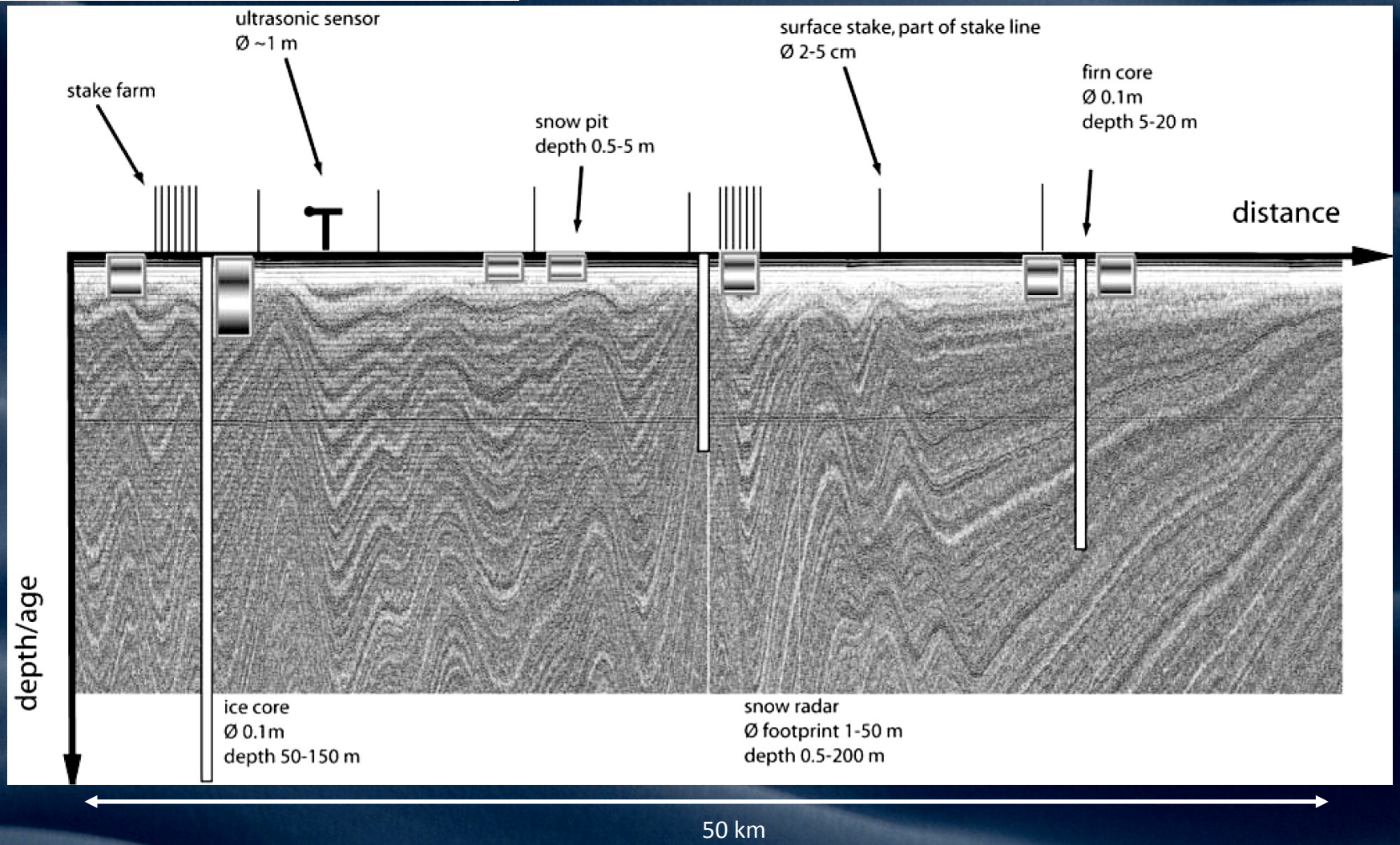
Cumulative snow transportation is ~4 orders of magnitude higher than snow precipitation at the site.

An increase in wind speed and transportation (~30%) was observed in 2007, which is in agreement with a reduction in observed snow accumulation.



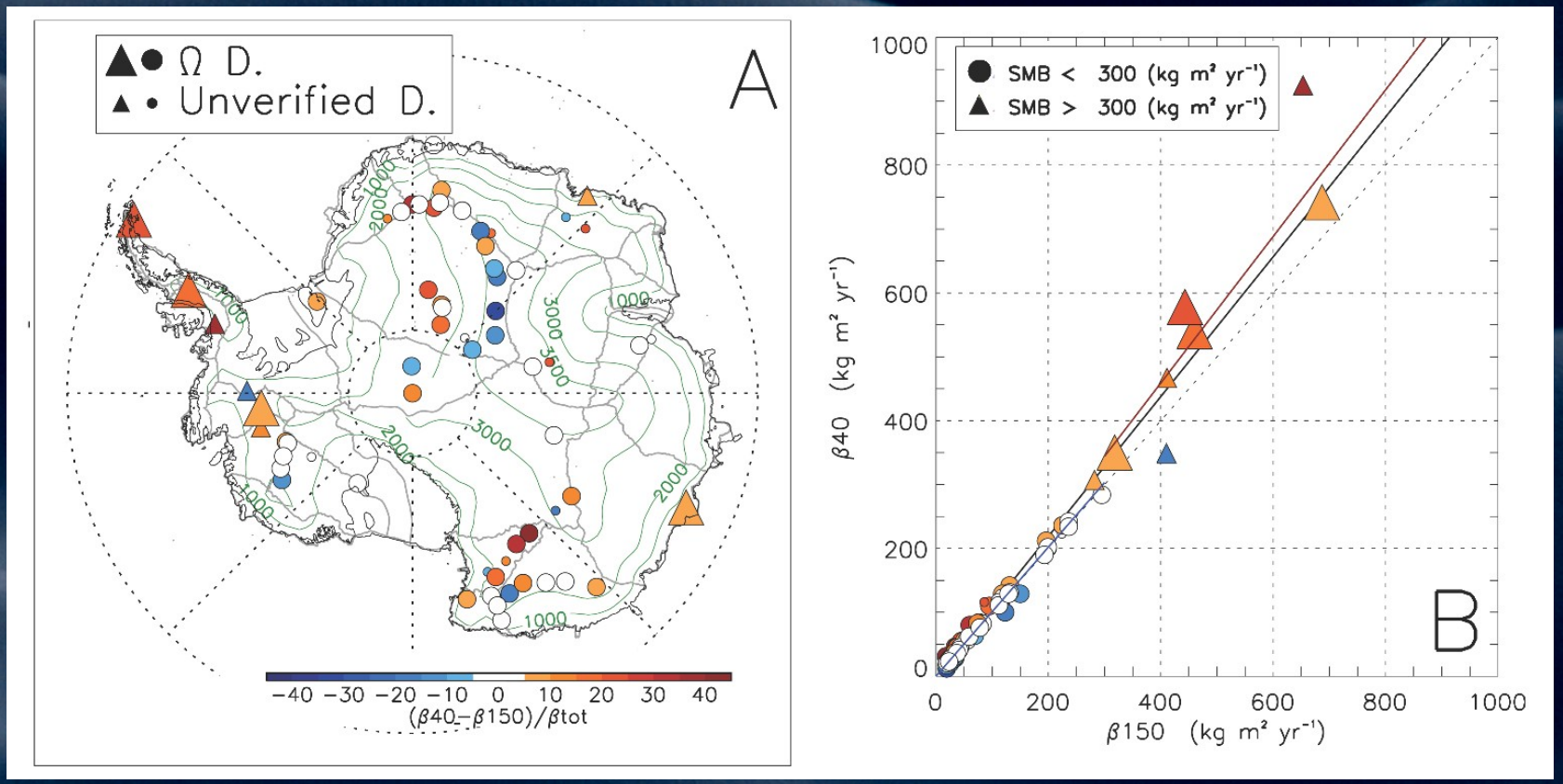
Scarchilli et al. 2010

Ground-based measurements of spatial and temporal variability of snow accumulation in East Antarctica



Spatial and "temporal" spatial interval of SMB observations. Spatial variability of snow accumulation at km scale is 1 order of magnitude higher than temporal variability at 10s-100s years and spatial variability influences the interpretation of past accumulation from ice core analysis.

Frezzotti et al., 2005; 2007; Eisen et al., 2008

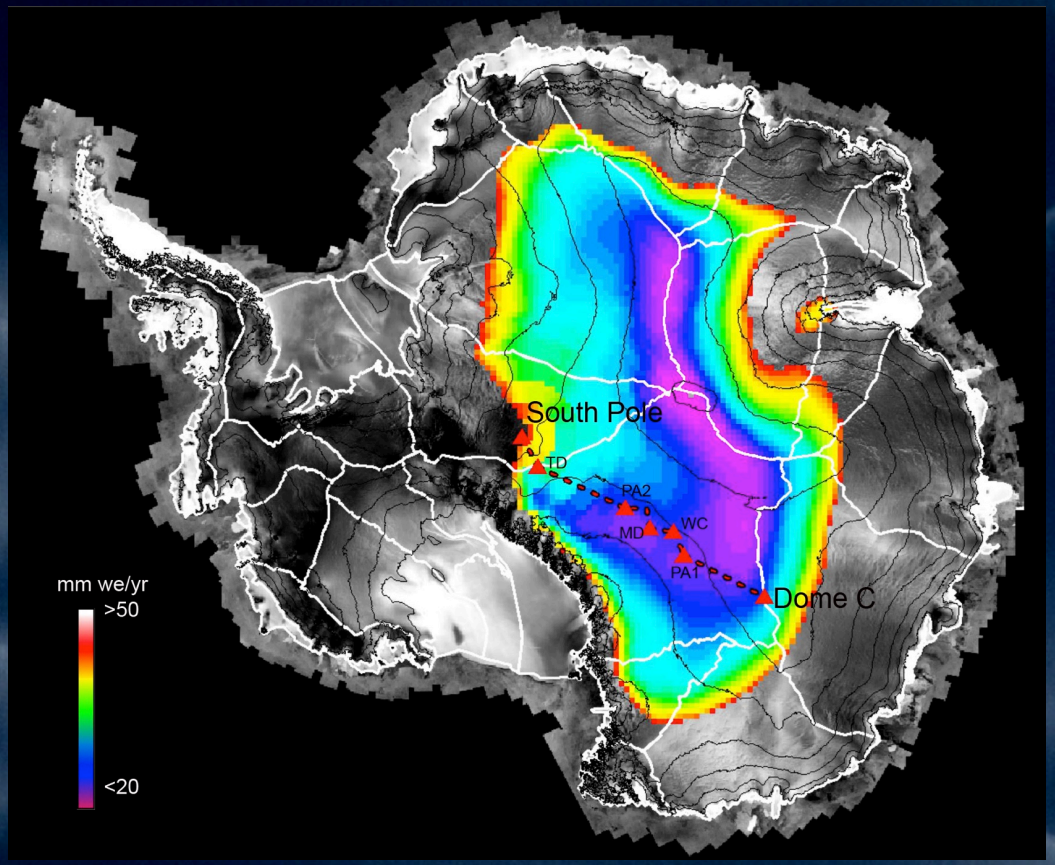


A) Geographical distribution of SMB temporal variability between 1960–present (β40) and Tambora–1960s (β150)
B) Relationships in SMB temporal variability of the last two century 1960s–present (β40) and Tambora–1960s (β150).

SMB changes over most of Antarctica during the last two century are statistically negligible. However, a clear increase in accumulation of more than 10% has occurred in high SMB coastal regions and over the highest part of the East Antarctic ice divide since the 1960s. The decadal records of previous centuries show that the observed increase in accumulation is not anomalous at the continental scale, that high-accumulation periods also occurred during the 1370s and 1610s, and that the current SMB is not significantly different from that over the last 800 years.

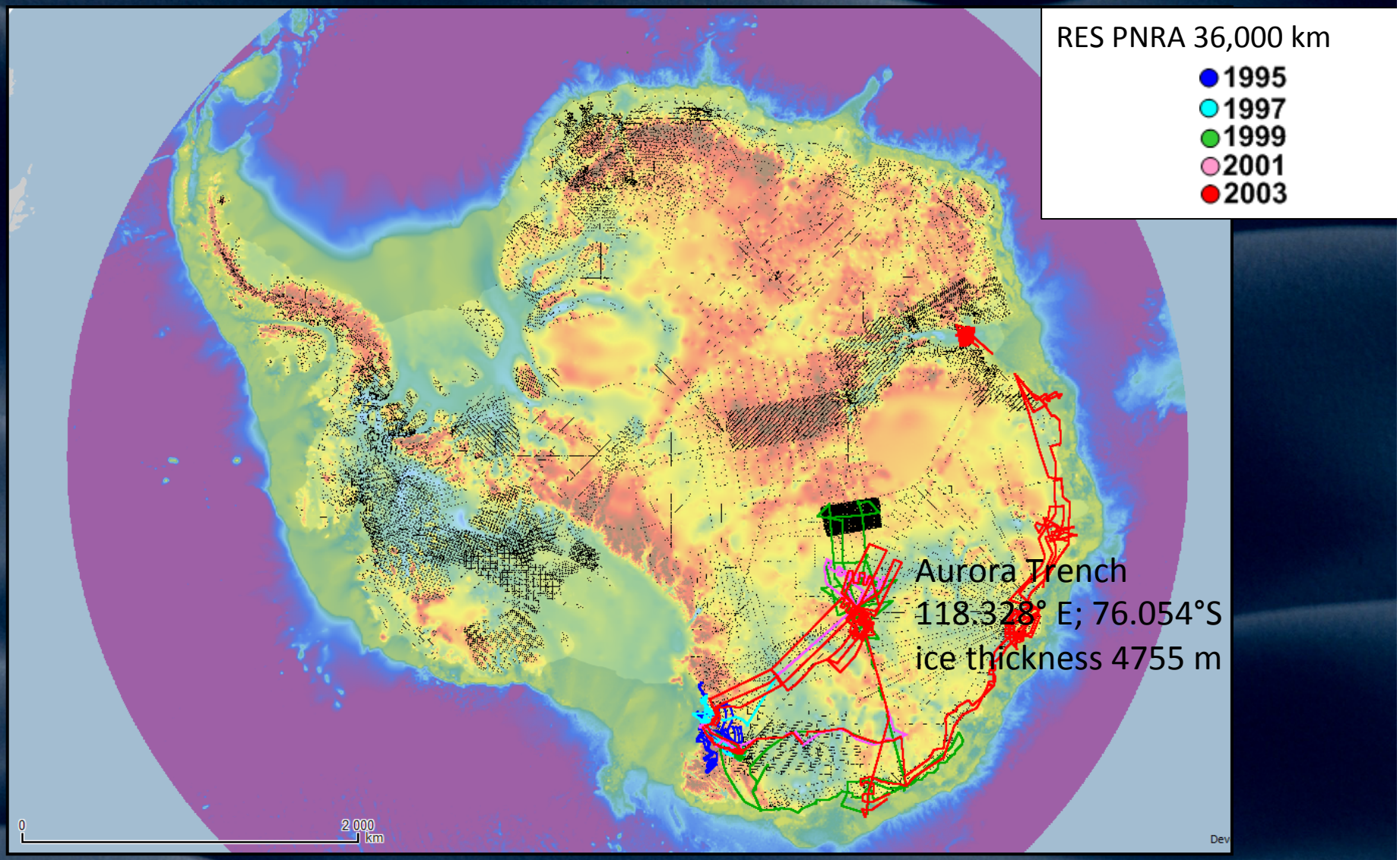
Frezzotti et al., 2013

East Antarctic International Ice Sheet Traverse (EAIIST)



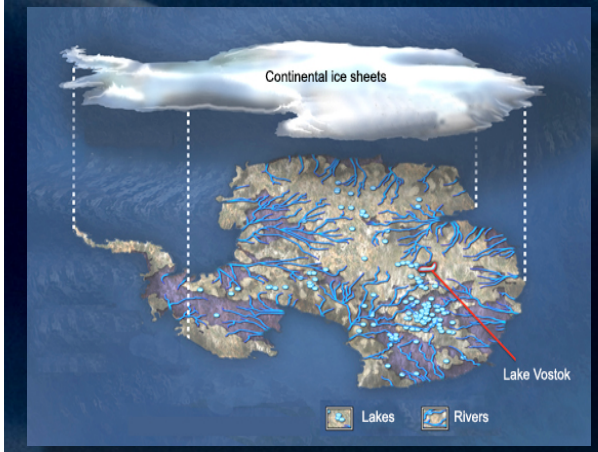
A **consortium** of scientists from three nations, **Italy, France and US** is built around the idea to **explore and study the geophysical** (snow physics, surface mass balance, density, temperature, seismicity, etc.), **geochemical** (impurities, aerosols, air-snow transfer, water isotopes, etc.) and **meteorological dimensions** (AWS, atmospheric dynamic, air mass transport, etc.) of these most inhospitable, remote and unknowns regions of the planet by the means of a scientific traverse.

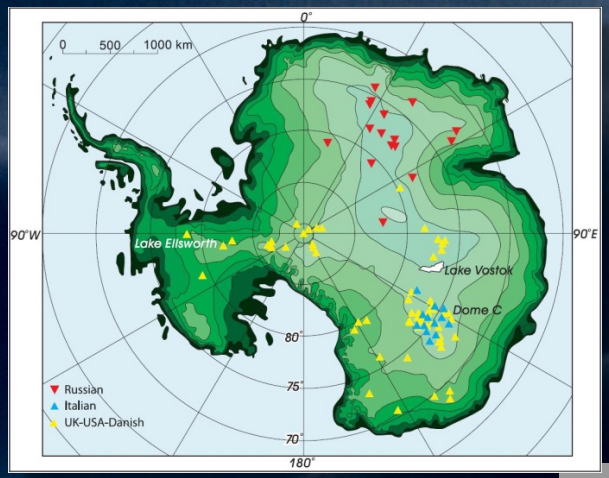
BEDMAP 2 Ice thickness and subglacial topographic model of Antarctica

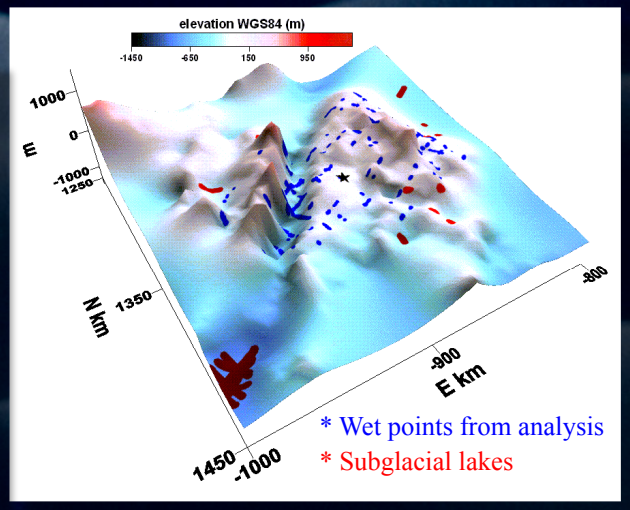


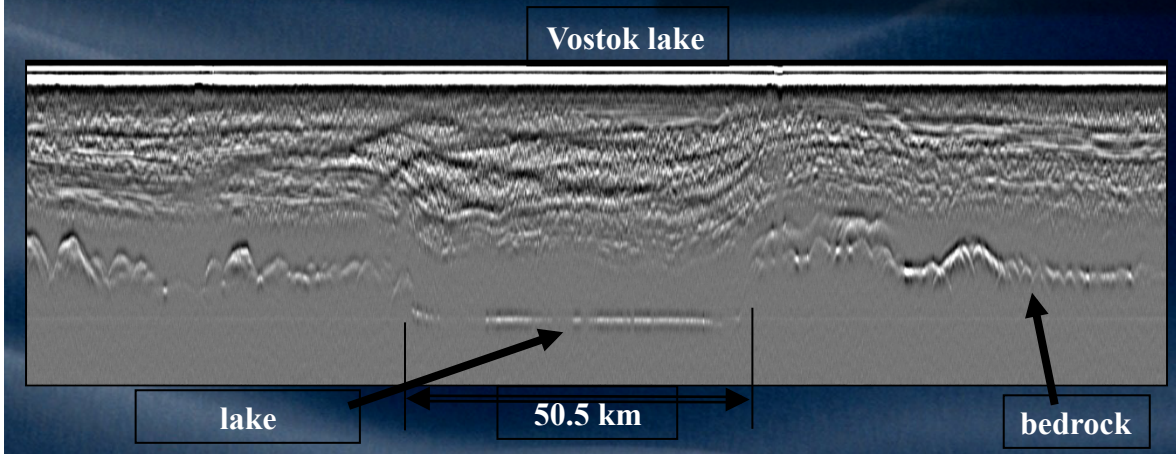
https://www.bas.ac.uk/project/bedmap-2/
Cianfarra et al., 2009; Roberts et al., 2011; Fretwell et al., 2013

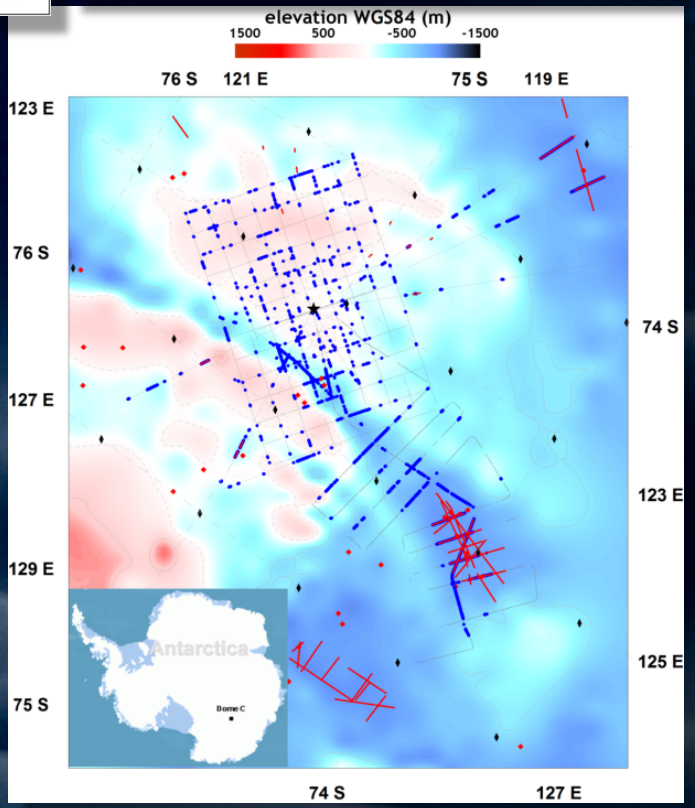
SUBGLACIAL LAKE AND DRY-WET BEDROCK INTERFACE DETECTION BY RADIO ECHO SOUNDING





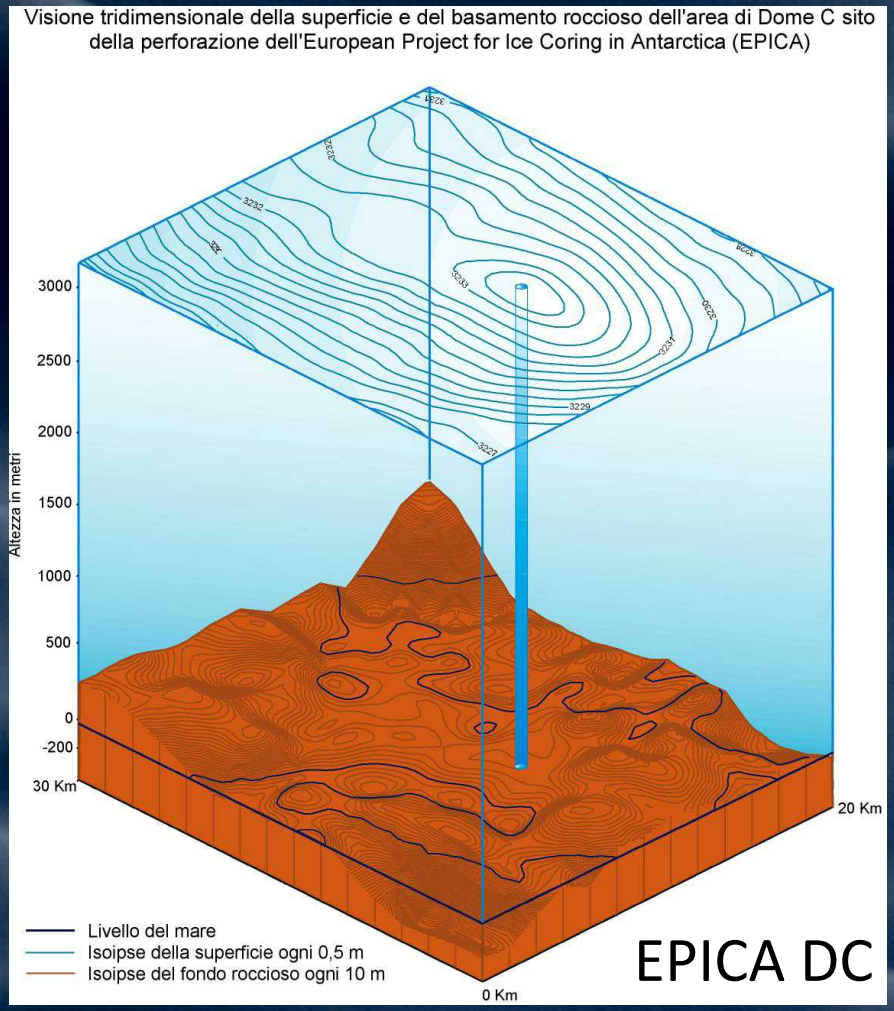


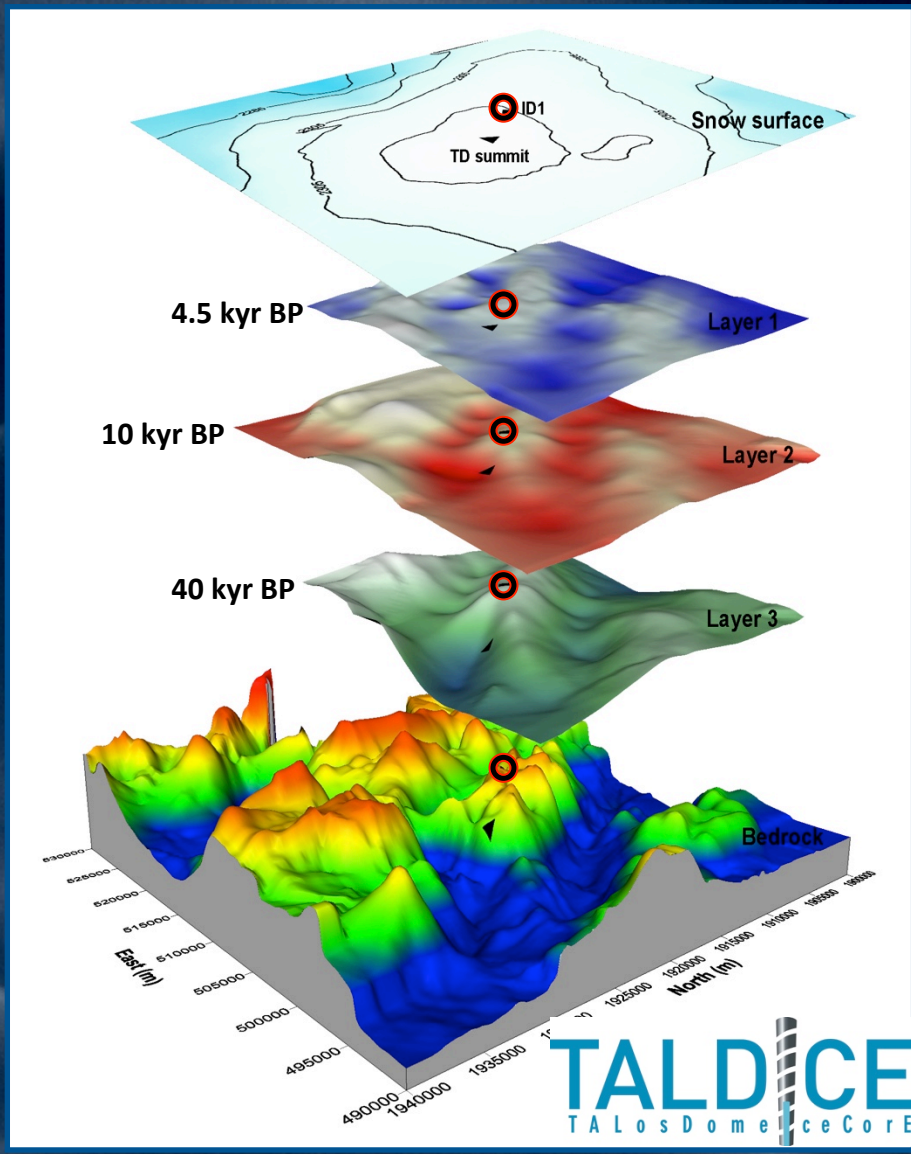




Tabacco et al., 2002, 2003; Cafarella et al., 2006; Urbini et al., 2015; Zirizzotti et al., 2009, 2011, in press.

DETERMINATION OF THE SURFACE AND BED TOPOGRAPHY AT DOME C AND TALOS DOME

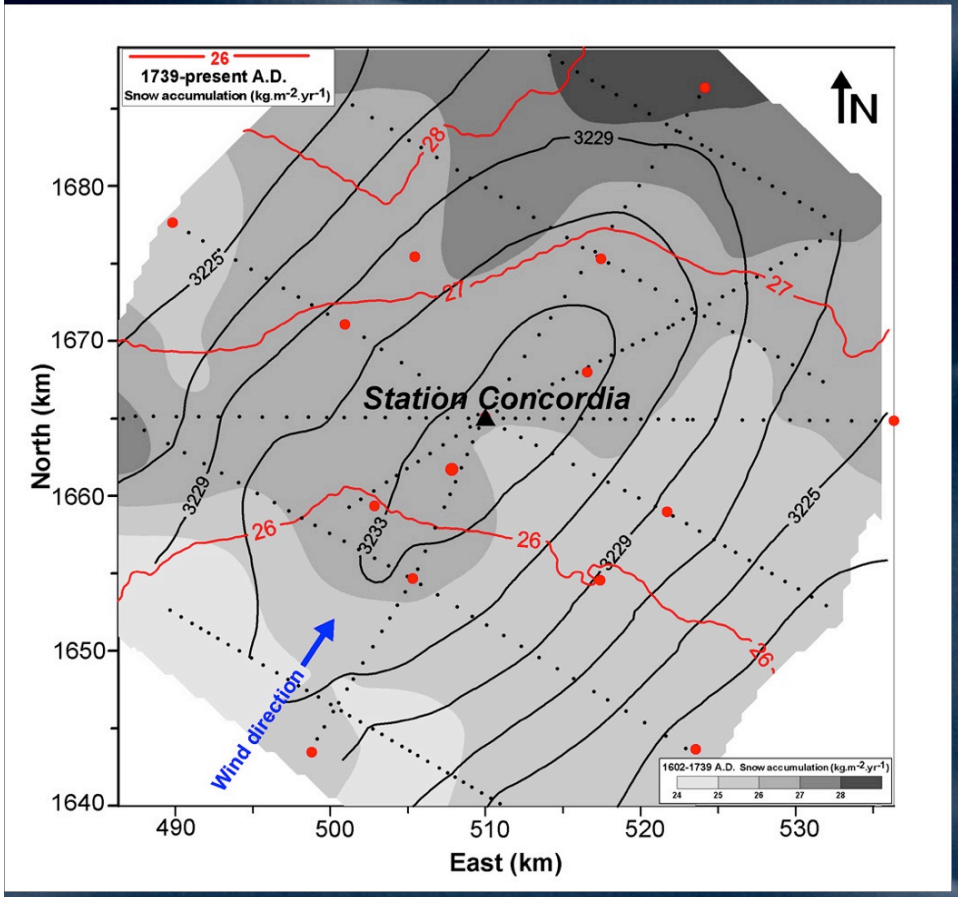




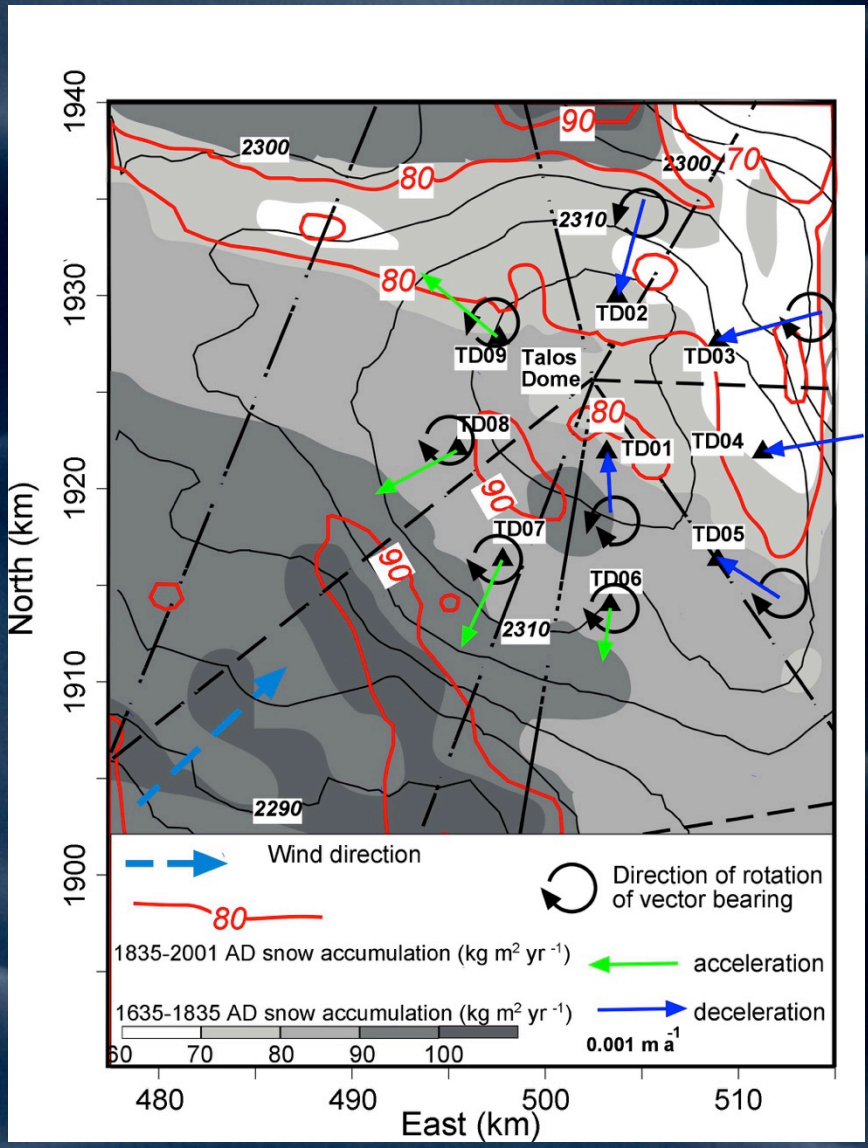
Tabacco et al., 1998; Remy & Tabacco, 2000; Frezzotti et al., 2004; Forieri et al., 2004; Urbini et al., 2006

http://www.taldice.org/

Historical behaviour of Dome C and Talos Dome (East Antarctica) ...

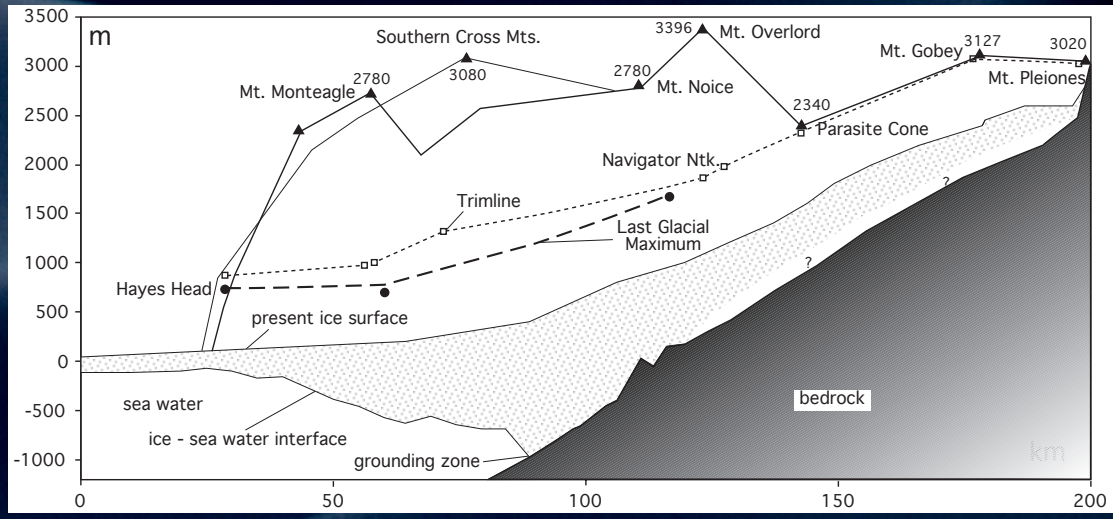


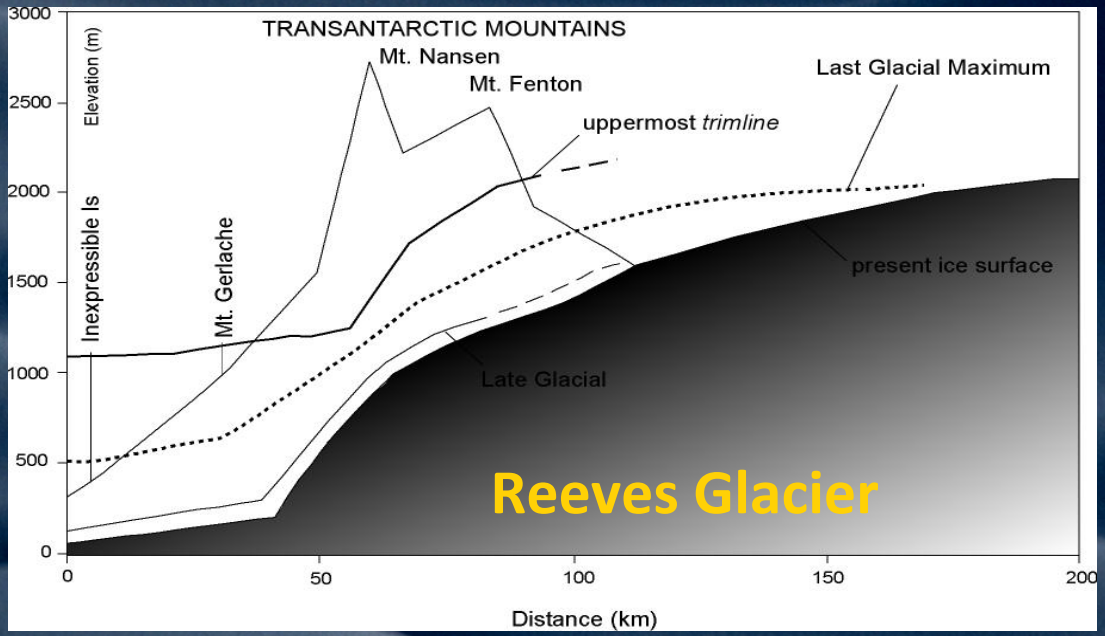
Accumulation behaviour at Dome C



Accumulation and velocity change at Talos Dome

Urbini et al., 2007; Vittuari et al., 2004





LGM - Huge grounded ice shelves and outlet glaciers sealed the coastal areas and thickened up to several hundred meters above the present sea level.

Orombelli et al., 1990; Baroni et. al . 2004

Terra Nova Bay

The RSL curve shows an exponential shape typical of areas that have undergone isostatic rebound.

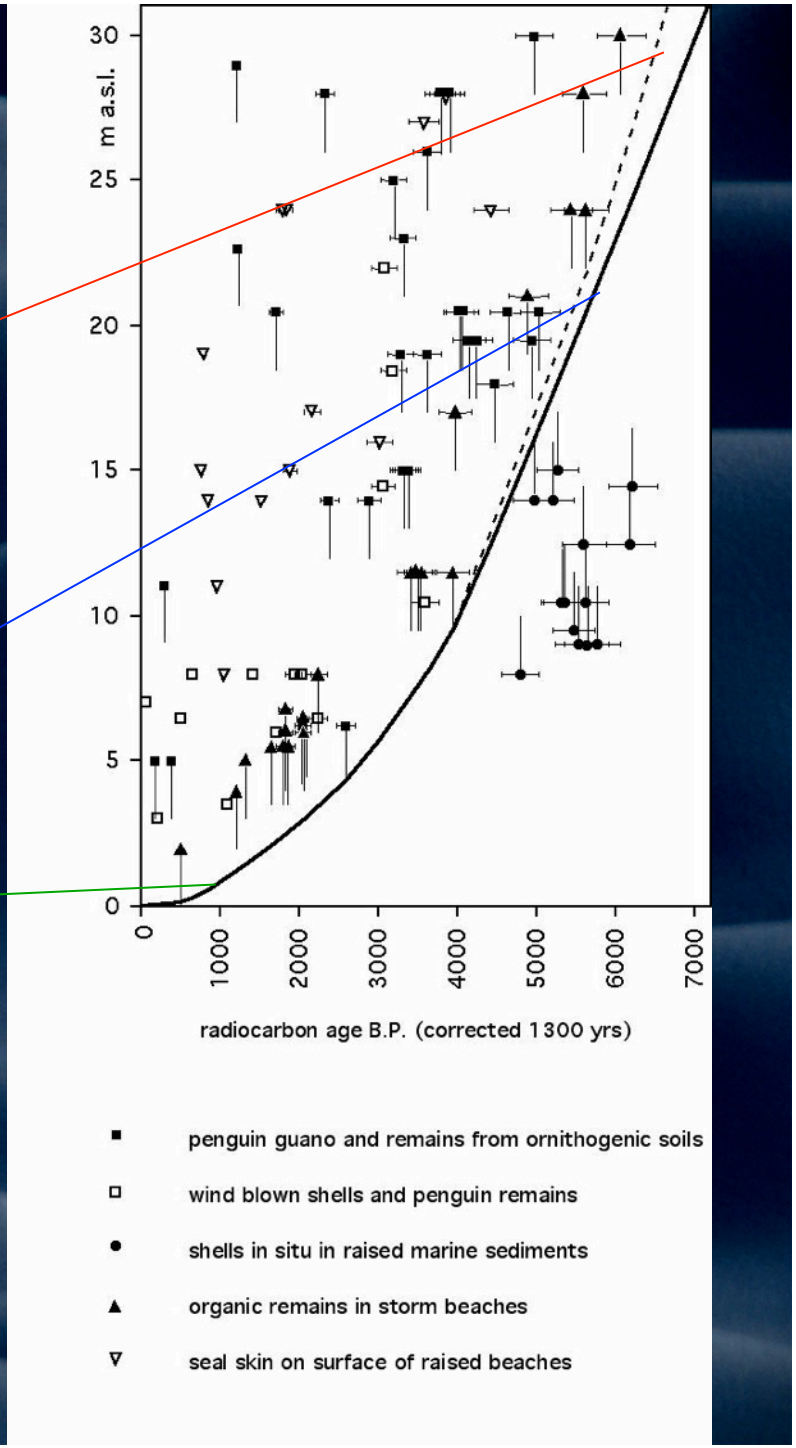
The curve intersects the marine limit between about 6500 and 7000 ^{14}C yr B.P. (ca 8000 yrs Cal BP). We favor the older end of this range, because younger ages are not consistent with dates of *in situ* shells and of penguin rookeries above the marine limit

Initial rates of relative sea-level change were about 8 mm/yr

Over the last 1000 years, this rate has dropped to 0.5 mm/yr.

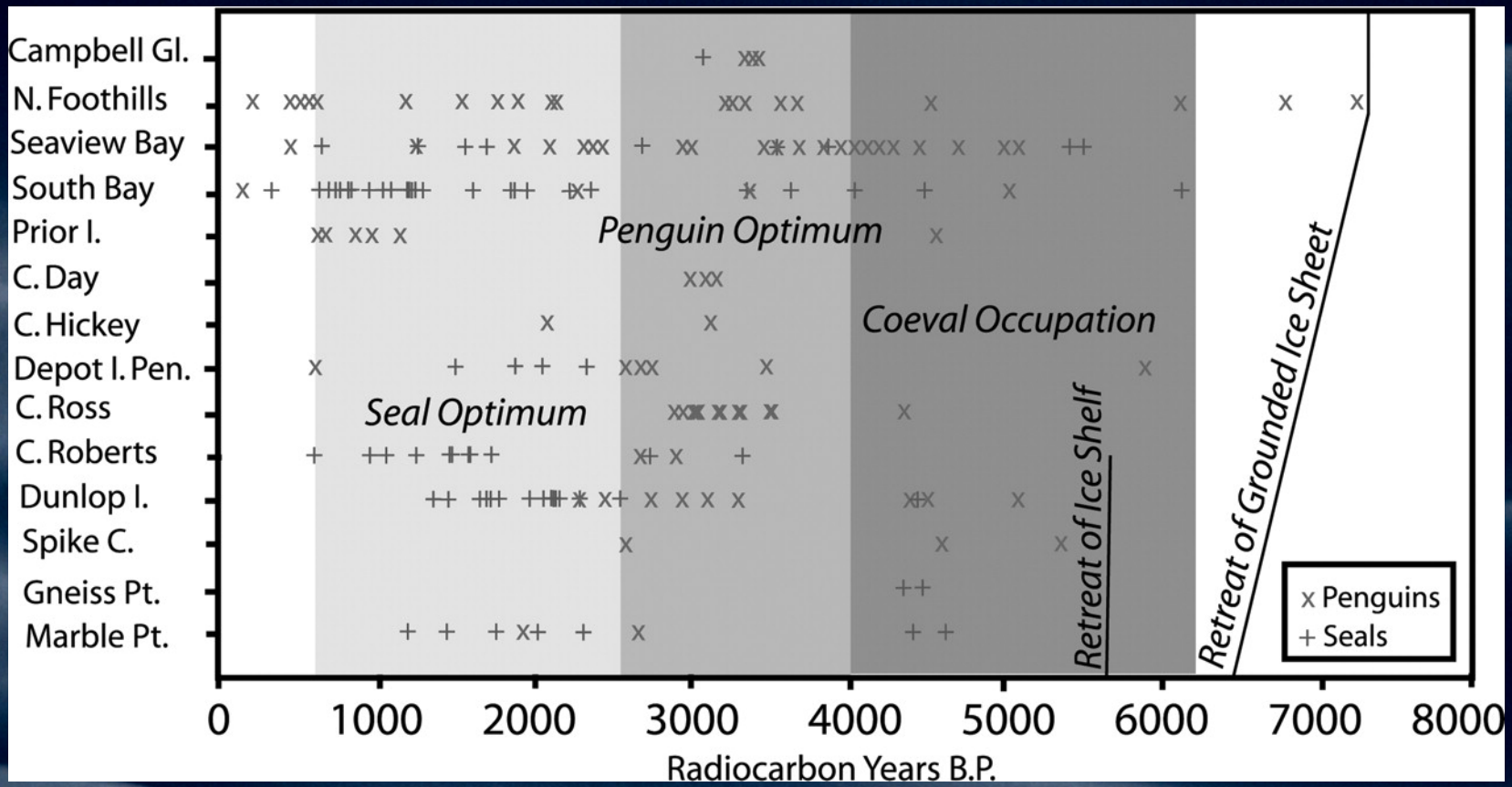
The RSL curve and the age of the marine limit suggest that the final unloading of ice from Terra Nova Bay took place shortly before 7000 ^{14}C yr B.P. (ca 8000 cal BP).

Baroni & Orombelli, 1991, 1994; Baroni and Hall, 2004; Hall et al.,2004



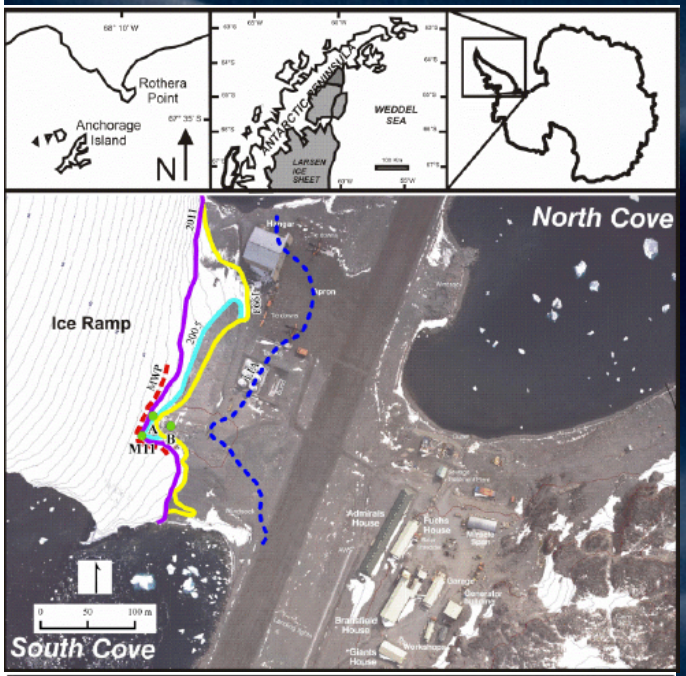
Climate Change Impacts on Cold Climates
Biologic Bellwether of Climatic Changes in Cold Regions

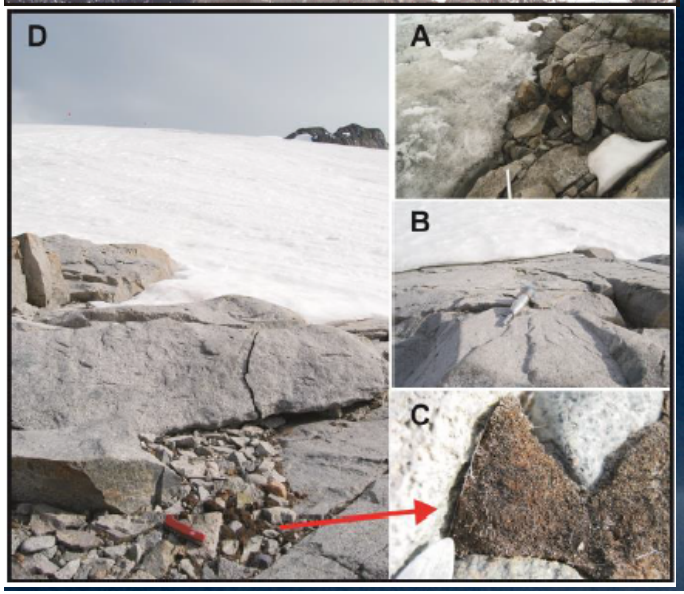
Response of Adélie Penguins and Southern Elephant Seals to Climate and Habitat Changes



Baroni & Orombelli, 1994; Lambert et al., 2002; Hall et. al., 2006; Baroni, 2013 Lorenzini et al., 2010, 2012, 2014; Parks et al., 2015

Glacial fluctuations since the 'Medieval Warm Period' at Rothera Point





Attraverso la datazione di muschi e dei loro suoli affiorati recentemente a causa del ritiro del ghiacciaio, si è potuto datare l'inizio del MWP a 961-800 cal BP e la successiva espansione del ghiacciaio (LIA) tra 671 e 558 cal BP, continuata fino almeno a 490-317 cal BP (Guglielmin et al., 2015).

Site	Material	Measured radiocarbon age	Conv Age BP	cal yr BP age
B	moss	340±40	380±40	490-317
B	organic sediment	1000±40	1040±40	961-800
A	moss	670±40	710±40	671-558
A	organic sediment	800±40	800±40	745-554
M11	moss	540±40	580±30	631-504

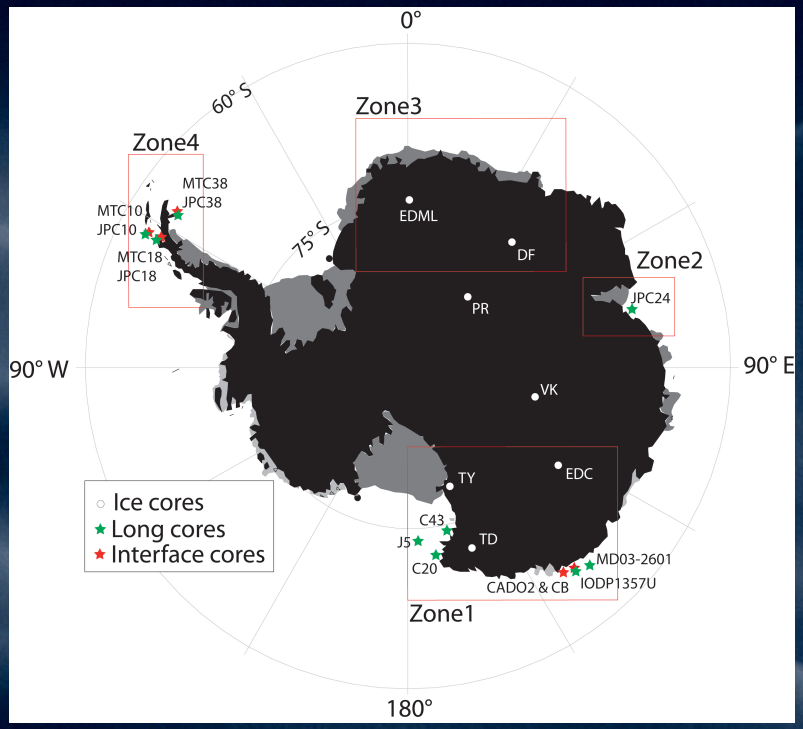
Posizione dei campioni: M11 (a), A (b), B (c e d)

European Science Foundation
SETTING SCIENCE AGENDAS FOR EUROPE

European Partnership in Polar Climate Science
PolarCLIMATE

European Polar Consortium

"HOLOCLIP - Holocene climate variability at high southern latitudes: an integrated perspective"

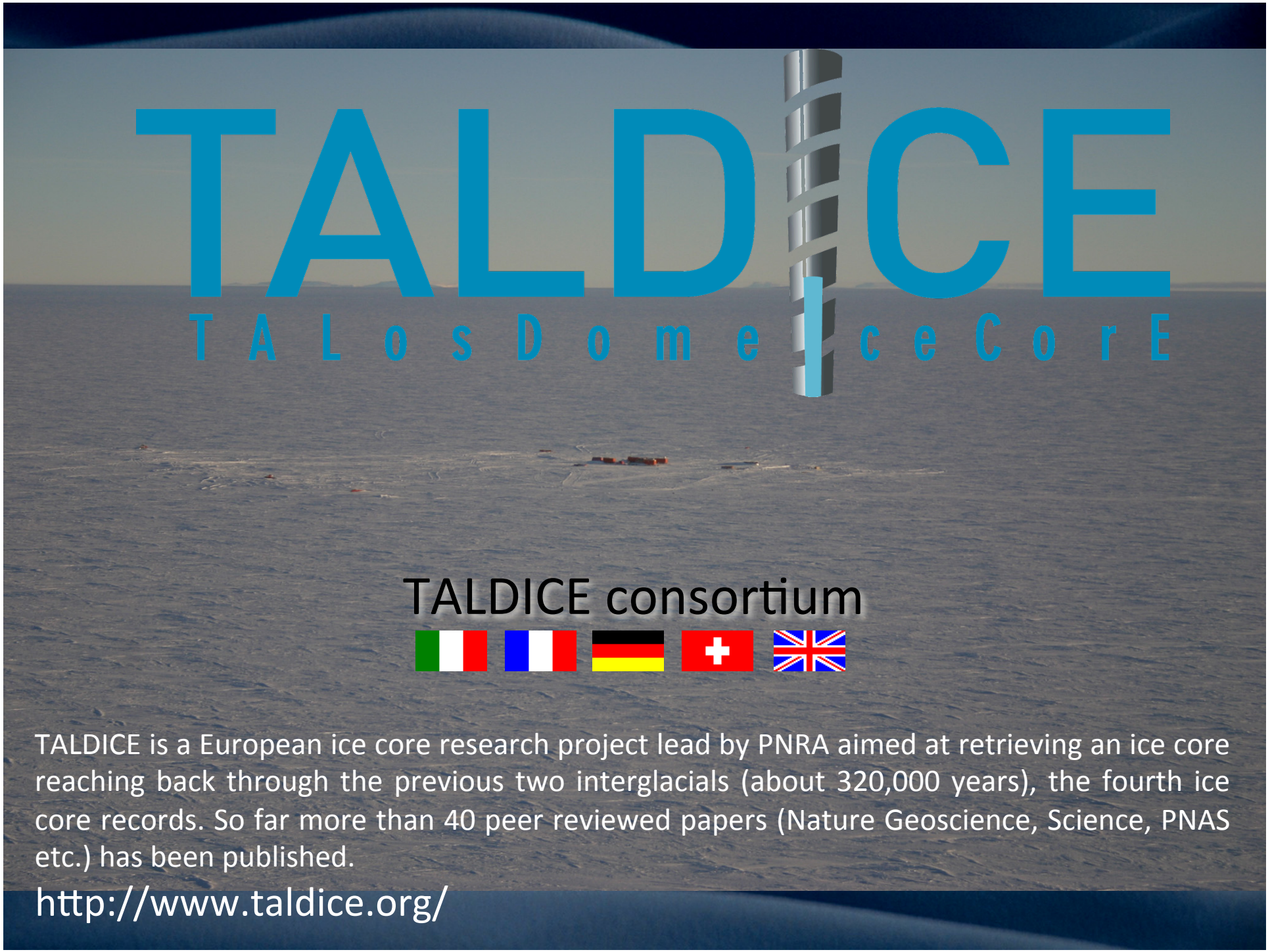


Considered areas

(1) Western Ross Sea, Oates-George V-Adelie Lands including Dome C ice drainage basin, (2) Prydz Bay, (3) Dronning Maud Land and (4) Antarctic Peninsula-Scotia Sea.

Synthesis integrating SH ice and marine data with climate models

So far 26 peer reviewed papers has been published, please visit: www.holoclip.org

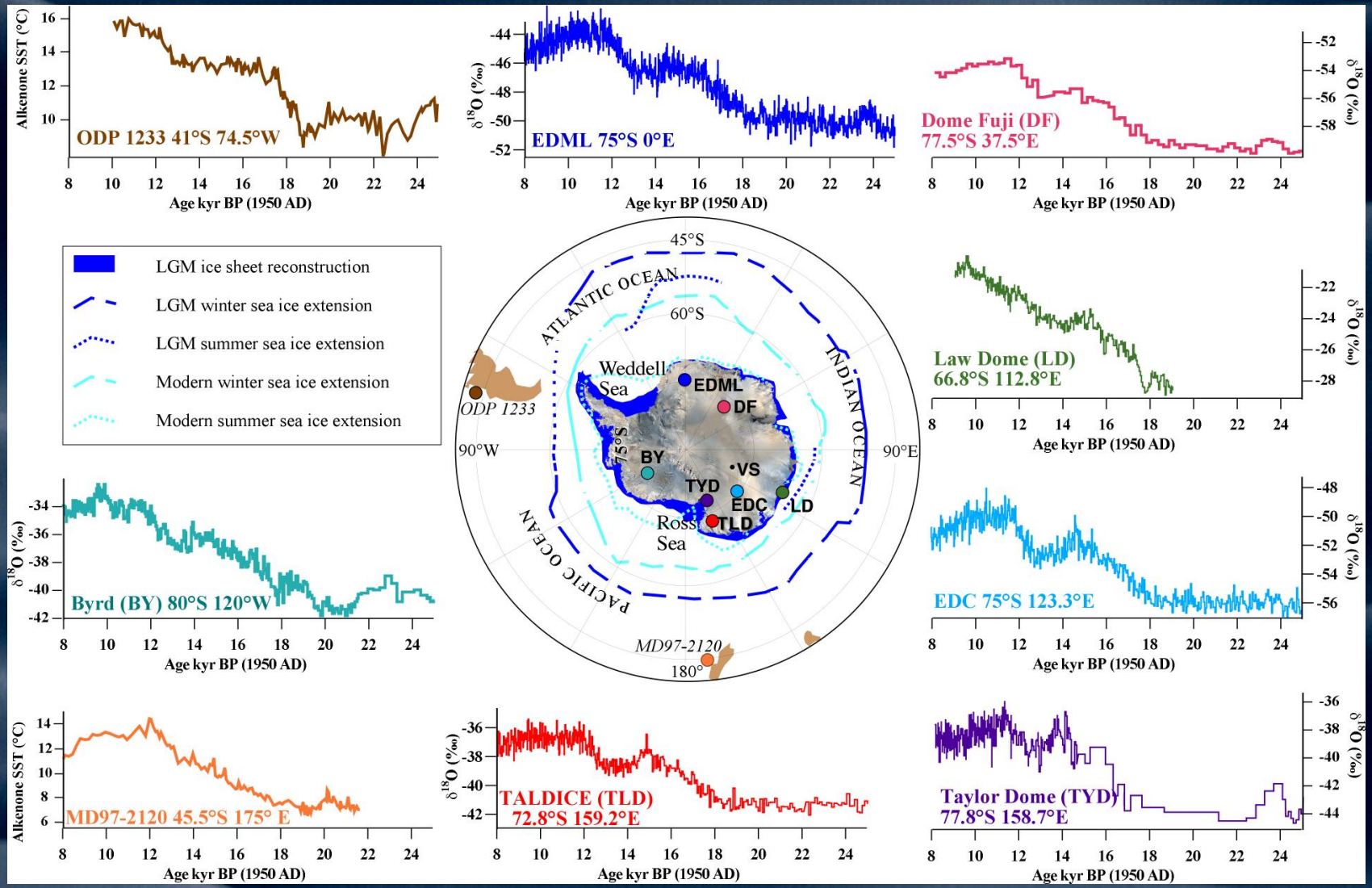


TALDICE consortium

TALDICE is a European ice core research project lead by PNRA aimed at retrieving an ice core reaching back through the previous two interglacials (about 320,000 years), the fourth ice core records. So far more than 40 peer reviewed papers (Nature Geoscience, Science, PNAS etc.) has been published.

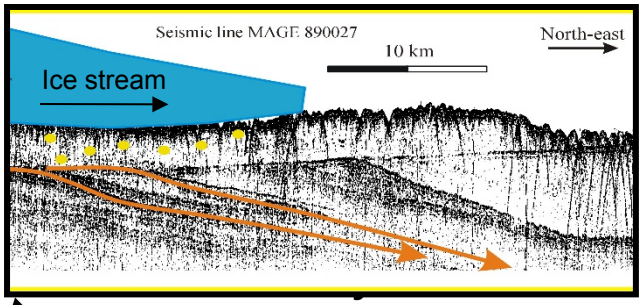
http://www.taldice.org/

Millennial scale climate variability around Antarctica

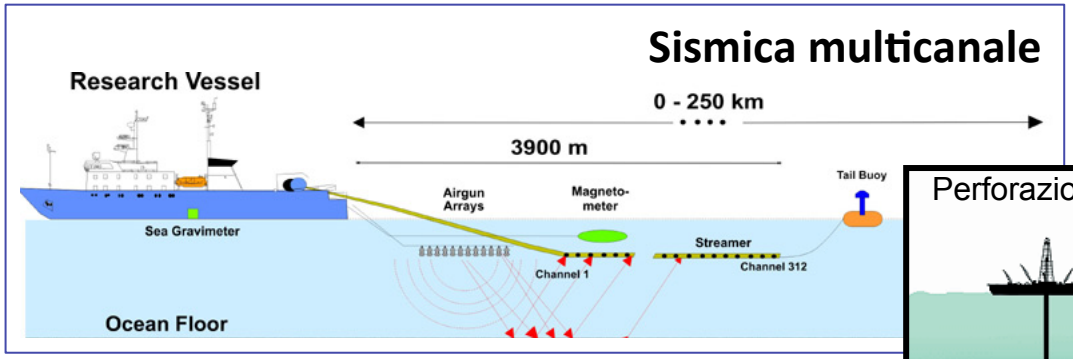


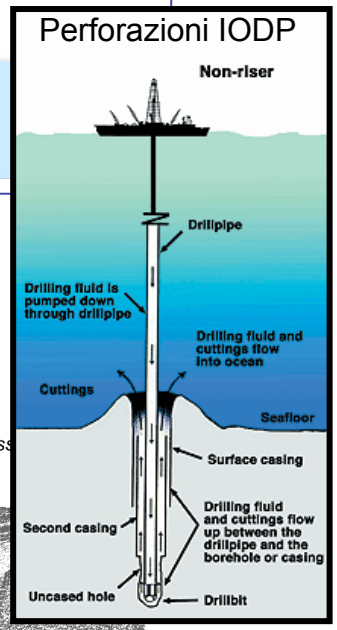
Distinct regional features in terms of warming rates between the Indo-Pacific and Atlantic sectors of Antarctica

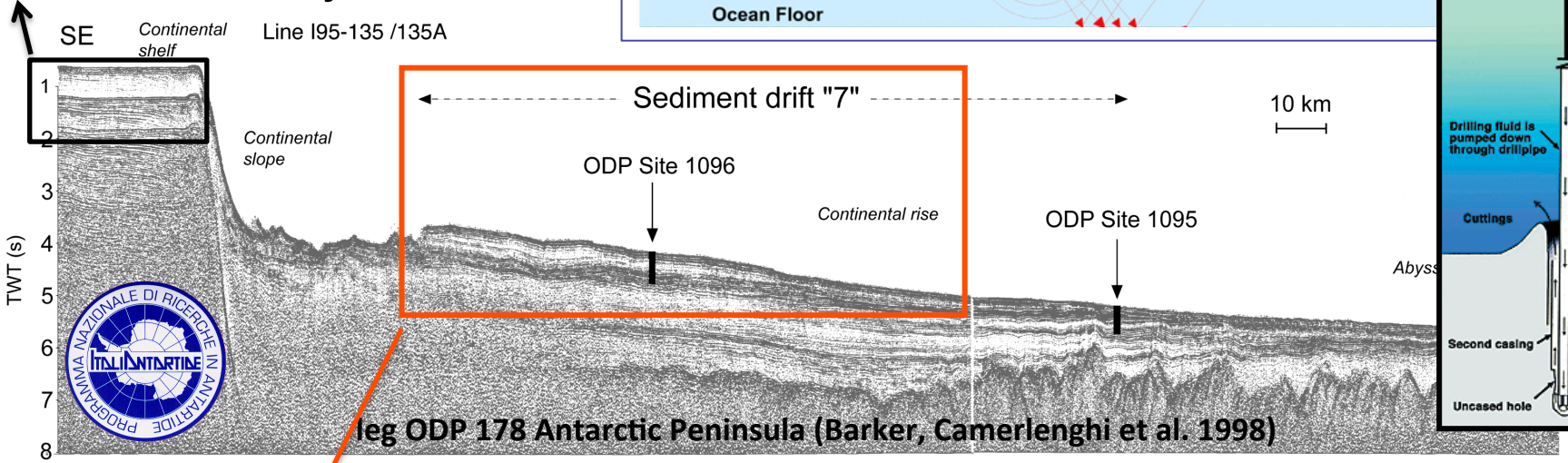
Stenni et al., 2011



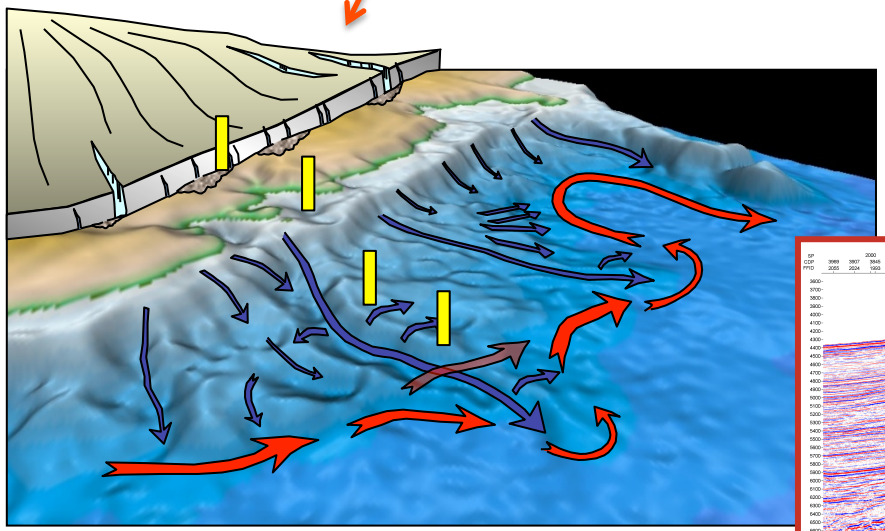
Sismica multicanale



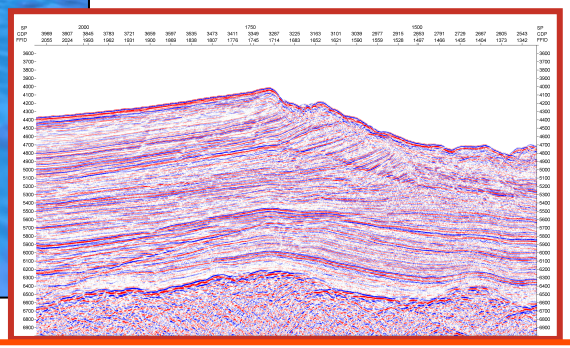




leg ODP 178 Antarctic Peninsula (Barker, Camerlenghi et al. 1998)



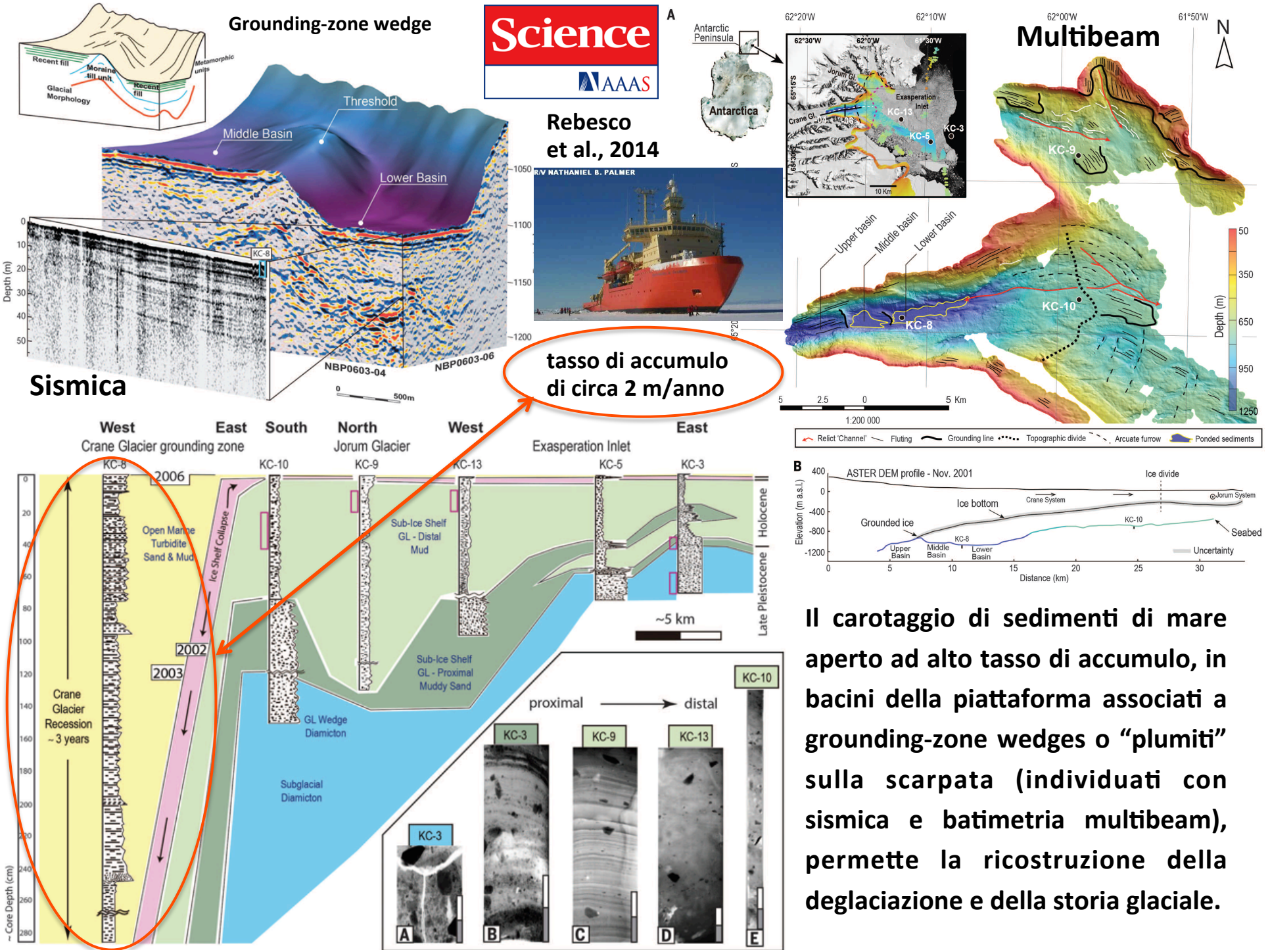
96% recovery on the continental rise



Sulla piattaforma il segnale del ghiaccio è diretto ma discontinuo.

Sui sediment drifts del rialzo è indiretto ma continuo.

La sismica permette di correlare e individuare i siti migliori per carotaggi e perforazioni.



Il carotaggio di sedimenti di mare aperto ad alto tasso di accumulo, in bacini della piattaforma associati a grounding-zone wedges o "plumiti" sulla scarpata (individuati con sismica e batimetria multibeam), permette la ricostruzione della deglaciazione e della storia glaciale.


Thanks for your attention !!!!