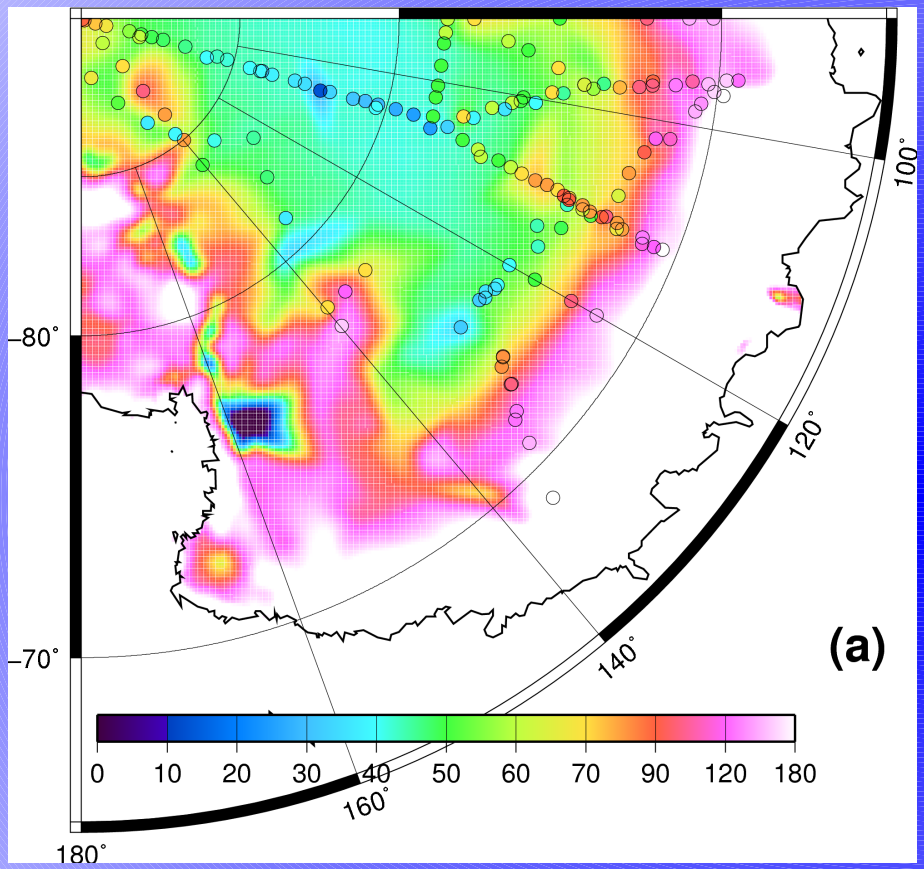
LGGE ITASE-related activities, recent and future

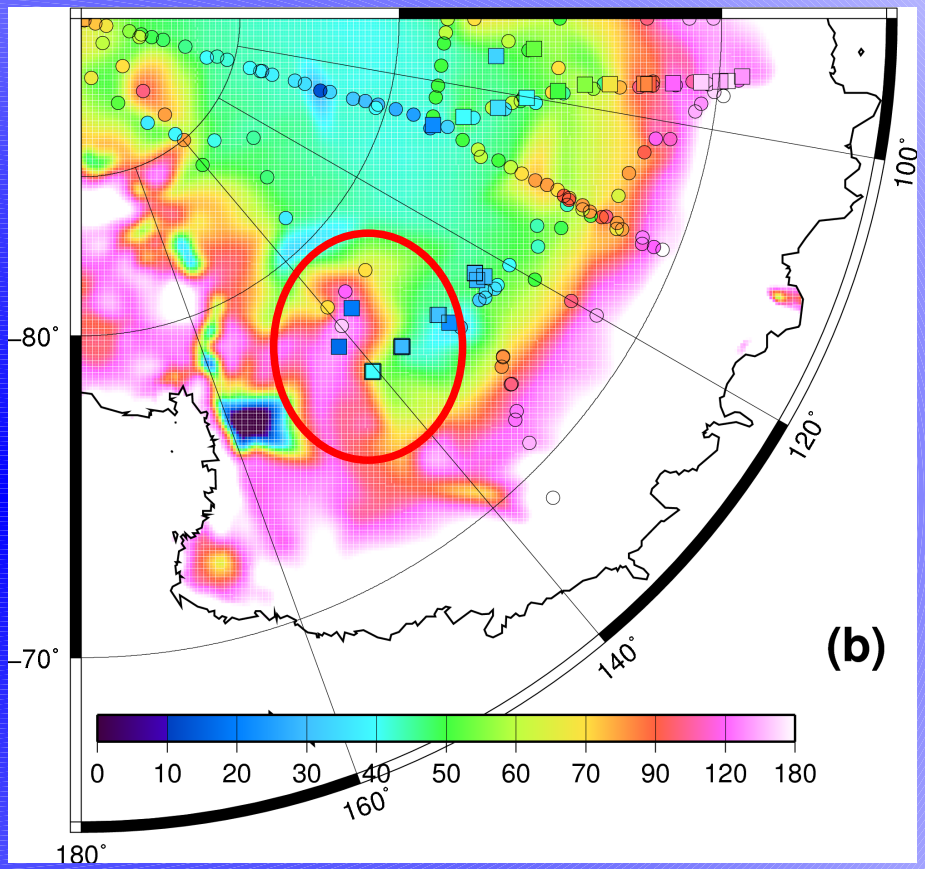
Laboratoire de Glaciologie et Géophysique de l'Environnement
CNRS / UJF / OSUG
Saint Martin d'Hères France
genthon@lgge.obs.ujf-grenoble.fr

Climate model validation / calibration:

Should we trust earlier reports of Antarctic surface mass balance?

More recent reports of SMB significantly differ





Ante ~2000 (Vaughan / Arthern)

Post ~2000 (incl. IT/FR ITASE reports)

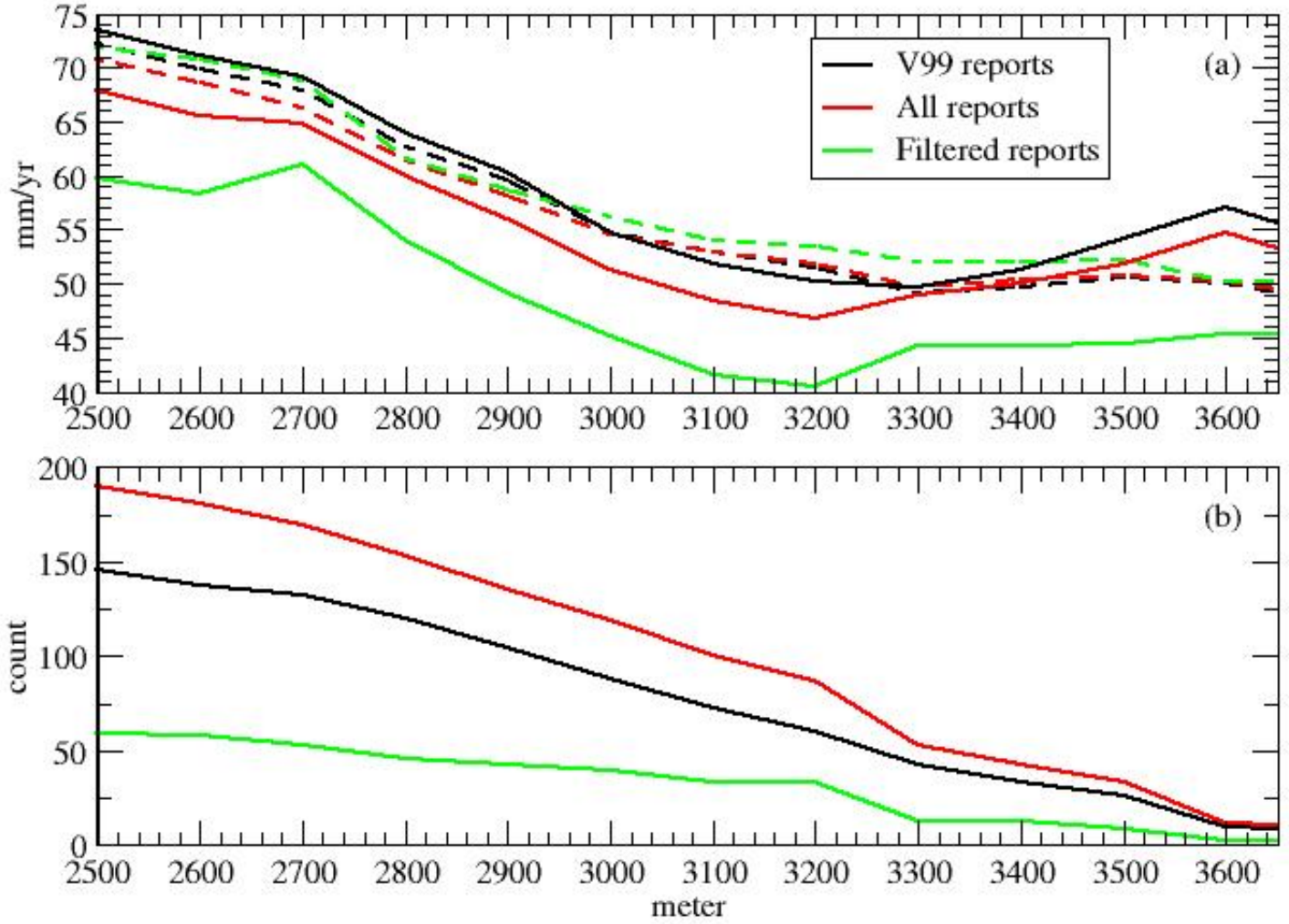
Data quality control

SMB MEASUREMENT METHODS	APPLICABILITY CONDITIONS	RELIABILITY		
		ANNUAL	MULTI-ANNUAL	DECADAL
Anthropogenic radionuclides	Dry snow facies – little mixing – Absolute calibration and dating tool with reference horizon levels	/	**A**	**A**
Stake measurements	Everywhere – Annual and multiyear averaged SMB variability studies	**C**	**A**	**A**
Natural ^{210}Pb	Dry snow facies – little mixing – Less accurate than anthropogenic radionuclides	/	/	**B**
Stable isotope content and Chemical markers	Dry snow facies – Annual and multiyear averaged SMB variability studies - Difficulty for clear observations in areas with very low SMB values (Central Antarctic plateau) - Subjectivity in annual layers counting	/	**B**	**B**
Snow stratigraphy	Dry snow facies – "Low" reliability and accuracy	**C**	**C**	**C**
Precipitation gauges	Not reliable - Not accurate	**C**	**C**	**C**

Reliability and applicability conditions of SMB field measurement methods. A = reliable; B = conditionally reliable; C = unreliable; / = not applicable. See Magand and others (2007) for details.

Magand O., C. Genthon, M. Fily, G. Krinner, G. Picard, M. Frezzotti, and A. A. Ekaykin, 2007. An up-to-date quality-controlled surface mass balance data set for the 90°–180°E Antarctica sector and 1950–2005 period, J. Geophys. Res. 112, D12106, doi:10.1029/2006JD007691.

Genthon, C., O. Magand, G. Krinner, and M. Fily, 2008a. Do climate models underestimate snow accumulation on the Antarctic plateau? A re-evalutation of / from in-situ observations, Annals of Glaciology, in press.


V99 reports
All reports
Filtered reports
(a)
mm/yr
75
70
65
60
55
50
45
40
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
(b)
count
200
150
100
50
0
meter
(Surface elevation >)

However heart-breaking, it is recommended that those (many) older reports obtained with unreliable or unreported techniques are discarded.

Atmospheric chemistry model and ice cores

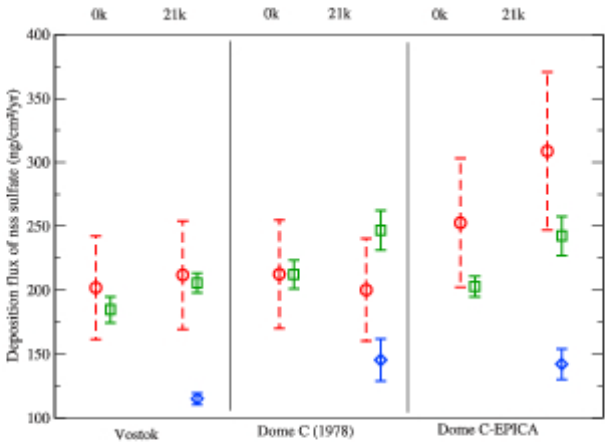


Figure 1. Observed (red circles) and simulated (green squares and blue diamonds) deposition fluxes of nss SO_4 at Vostok, Dome C (1978) and EPICA-Dome C for present day (0 k) and LGM (21 k). Measurements uncertainties (red bars, taking into account uncertainties on both concentration and snow accumulation) and interannual variabilities of the model (green and blue bars) are represented. Simulations 21 k-CLIMAP (blue diamonds) and 21 k-testCG (green squares) allow to compare the LGM *CLIMAP Project Members* [1981] sea-ice lid effect with a test of reduced summer lid, as suggested by *Crosta et al.* [1998] and *Gersonde et al.* [2005].

have been widely quoted in the past as evidence of increased

are prescribed [*Kettle et al.*, 1999] and ocean to atmosphere fluxes are calculated using the parameterization of *Liss and Merlivat* [1986]. Furthermore, the calculated fluxes are weighted by the fraction of the ocean free of sea-ice, to take into account the lid-effect of sea-ice. DMS is oxidized through various chemical pathways and finally converted into end cycle species, MSA and nss SO_4 aerosols. All species are transported and undergo dry and wet deposition. Prescribed fields from a 3D atmospheric chemistry model (IMAGES [*Müller and Brasseur*, 1995]) are used for photodissociation rates of hydrogen peroxide (H_2O_2) and oxidant concentrations (hydroxyl OH, hydroperoxyl HO_2, nitrate NO_3 radicals and ozone O_3). A comprehensive evaluation and validation of the model for present-day climate in the mid- and high-southern latitudes was carried out by *Cosme et al.* [2002]. The updated version used here yields results very similar to those reported by *Cosme et al.* [2002].

[7] To simulate the ice age atmospheric circulation, we use modified boundary conditions as recommended by the Paleoclimate Modeling Intercomparison Project (PMIP) [*Joussaume and Taylor*, 1995]. Modified parameters are: the glacial topography [*Peltier*, 1994], sea surface temperatures and sea-ice coverage [*CLIMAP Project Members*, 1981], albedo and roughness derived from Crowley's vegetation [*Crowley*, 1995], ice core CO_2 concentration, and astronomical parameters. The Antarctic LGM climate is reasonably well simulated to the extent of validation data availability (e.g. reduced temperature and precipitation). It is also consistent with LGM simulations by other models (see *Krinner and Genthon* [1998] for a previous version of the LMDZ model and also see *Pollard and PMIP Participating*

Climate / chemistry modelling for ice core data: S sensitivity to sea-ice extent

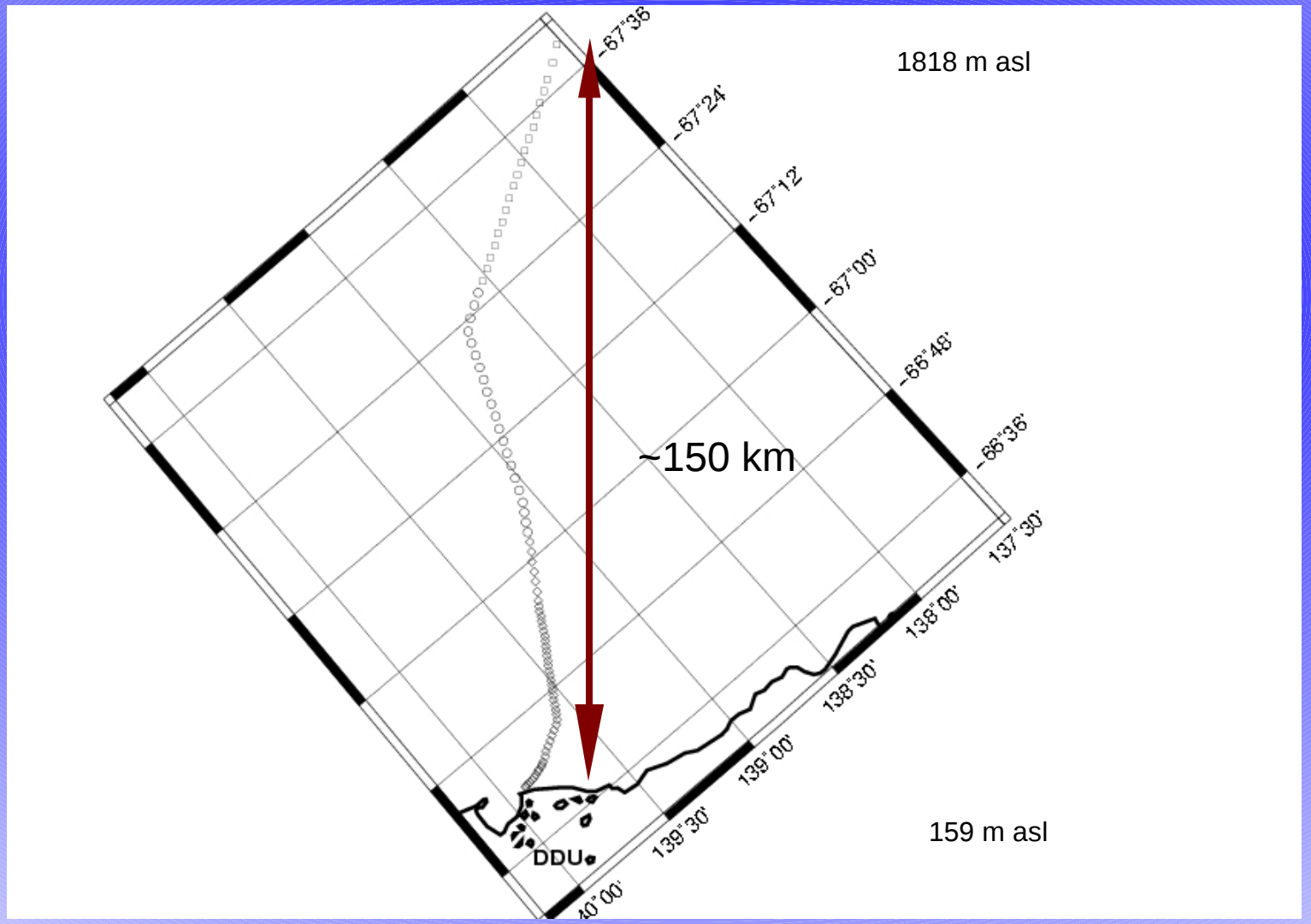
Reconstructing interannual sea-ice extent from shallow annually dated cores?

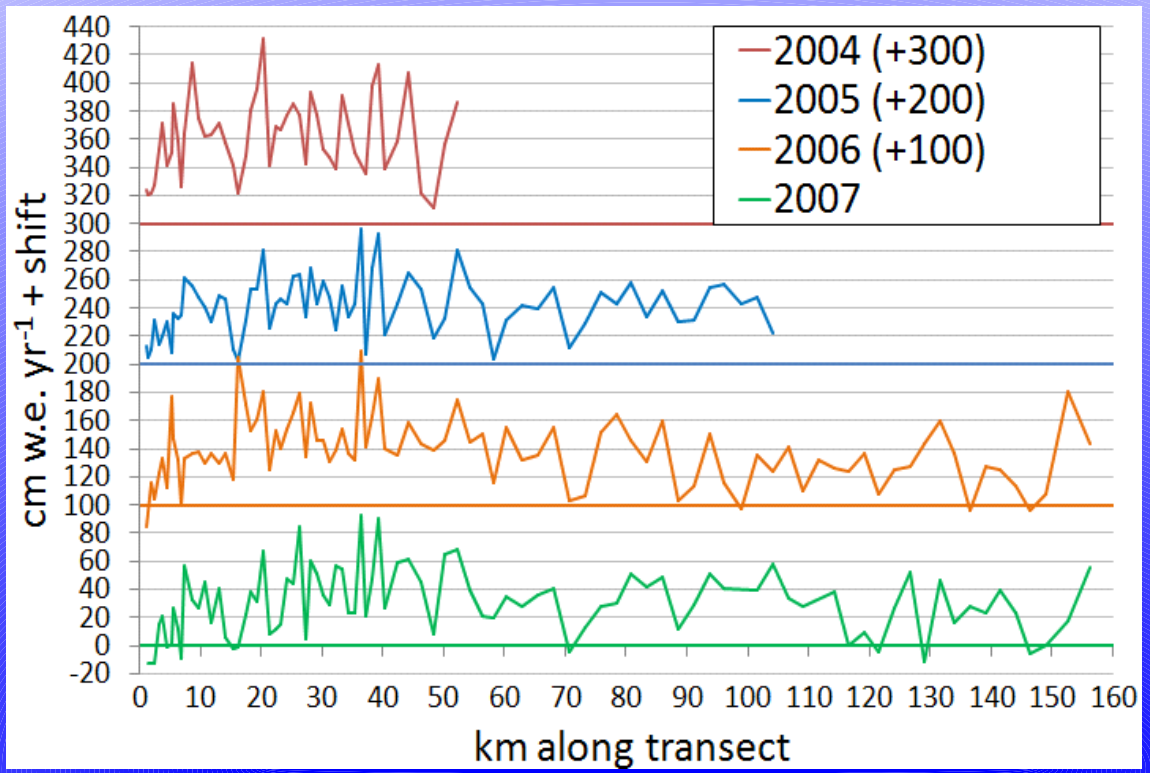
GLACIOCLIM, A long-term observatory program

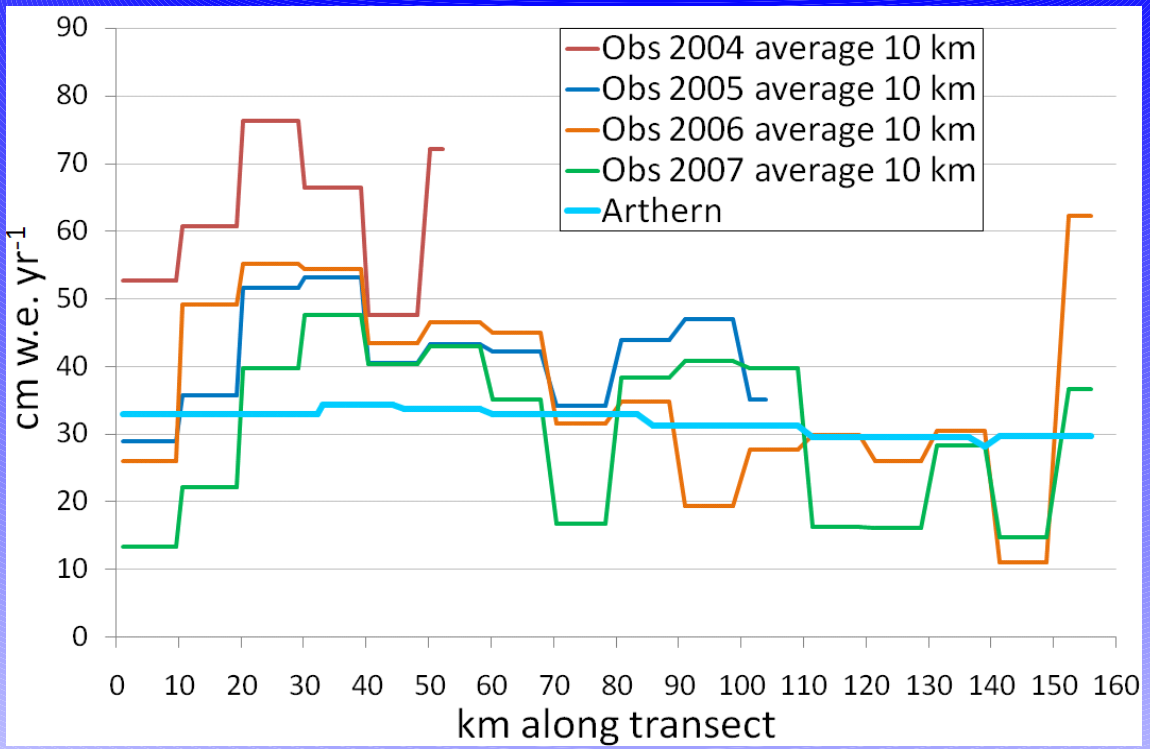
Coast-to-plateau transition region is the most sensitive to climate warming in terms of SMB / contribution to sea-level

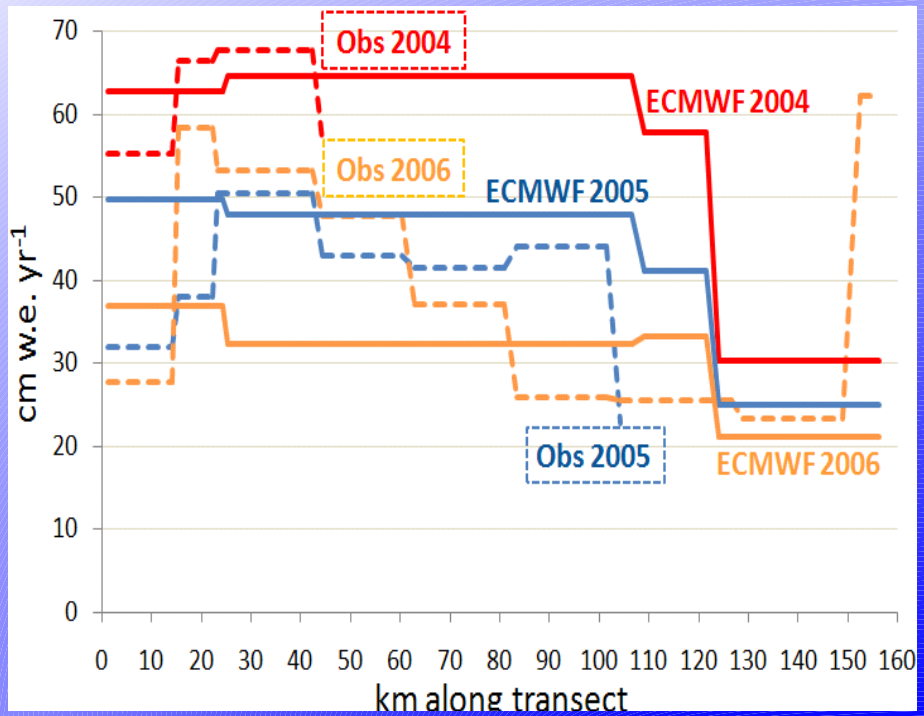
=>

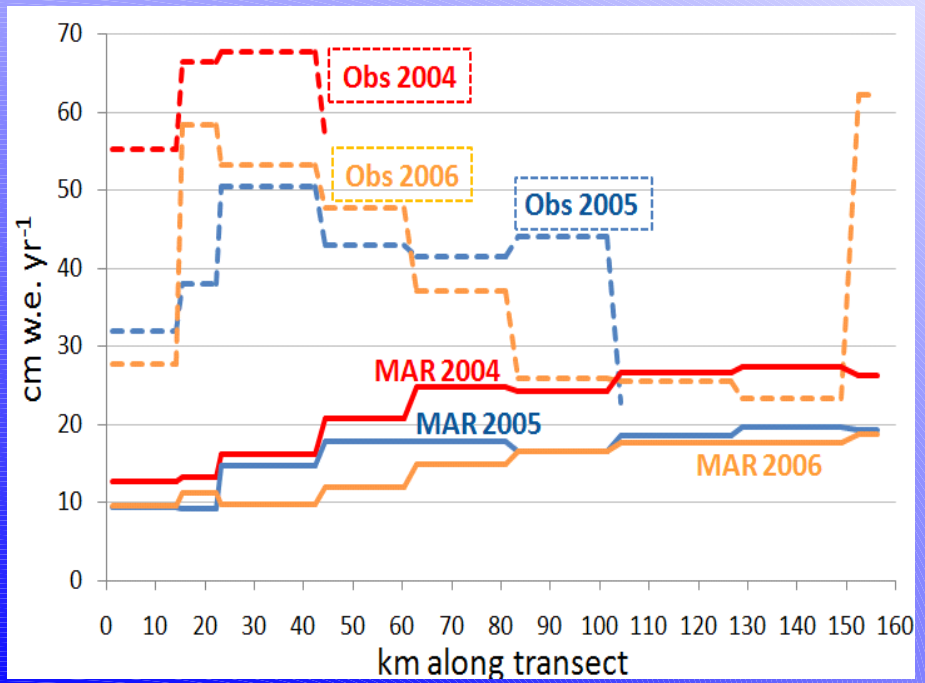
the GLACIOCLIM-SAMBA transect

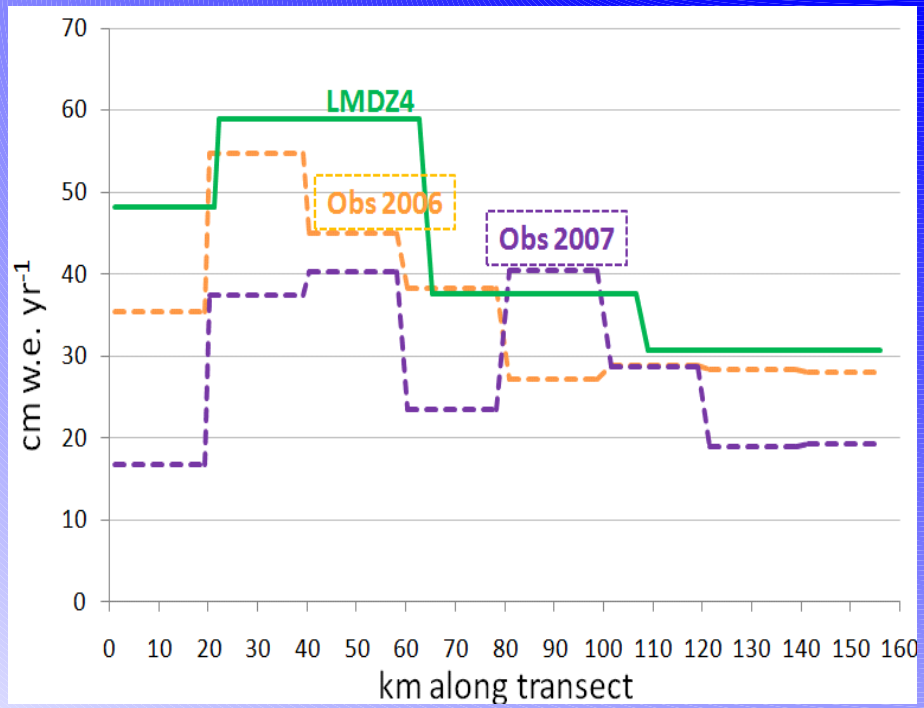



2004 (+300)
2005 (+200)
2006 (+100)
2007
cm w.e. yr-1 + shift
km along transect


Obs 2004 average 10 km
Obs 2005 average 10 km
Obs 2006 average 10 km
Obs 2007 average 10 km
Arthern
cm w.e. yr-1
km along transect



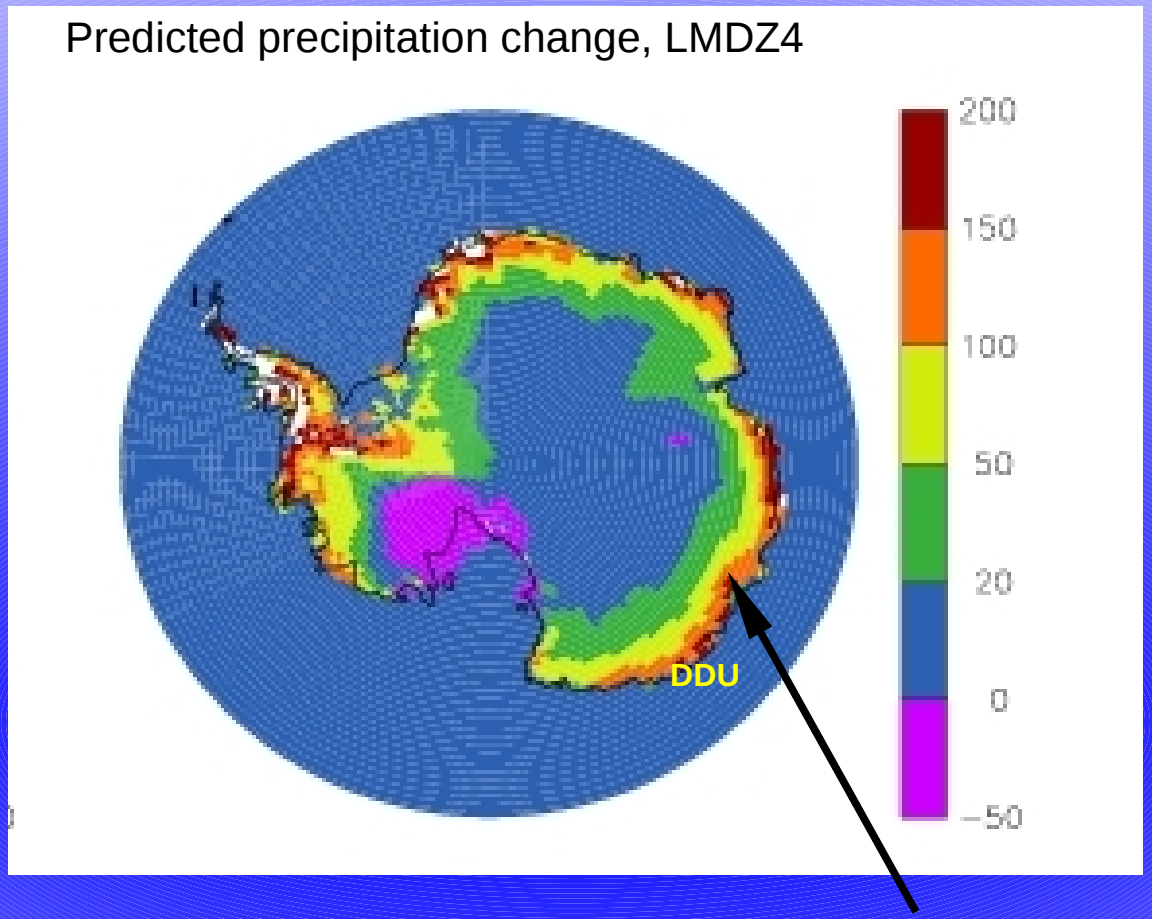




Do models succeed to reproduce accumulation along transect?

- Not quite...

- Do we care?

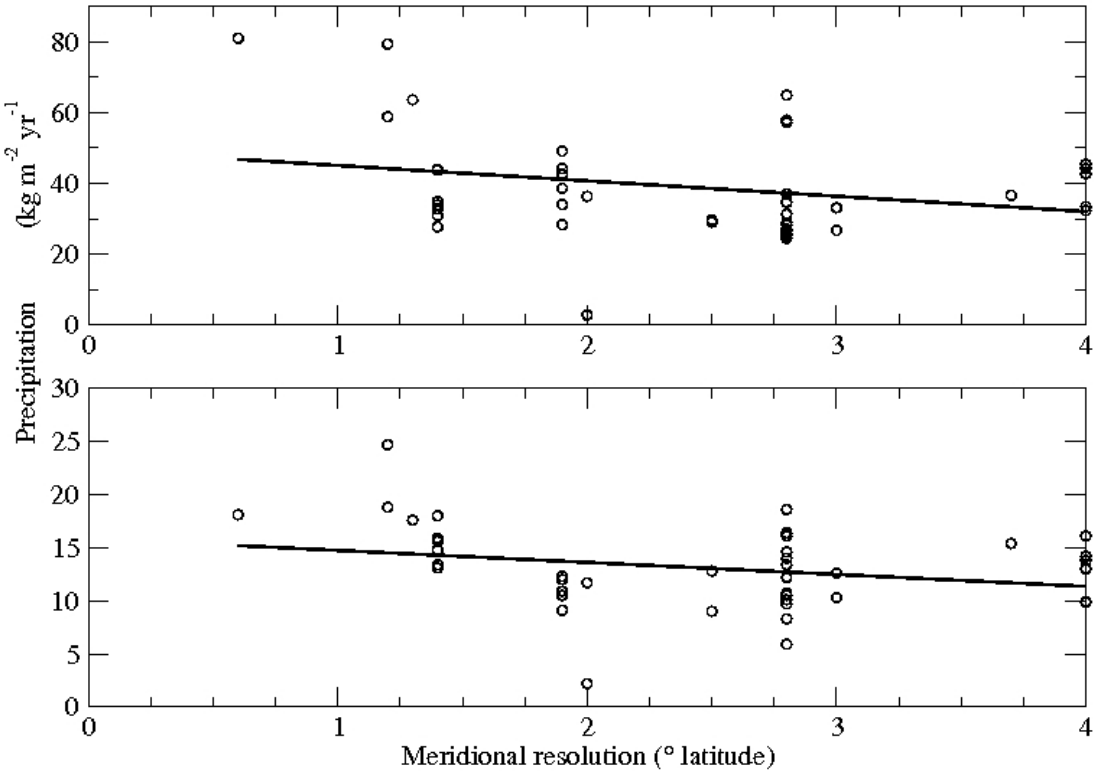


- 50% of current Antarctic accumulation, much more of predicted precipitation change

- Complex processes: Orographic precipitation, evaporation, blowing snow

- Only ~20% of all Antarctic SMB reports in the current / projected high accumulation region

- Very few long term / annually resolved reconstruction / monitoring



Coast – plateau (<2200 m)

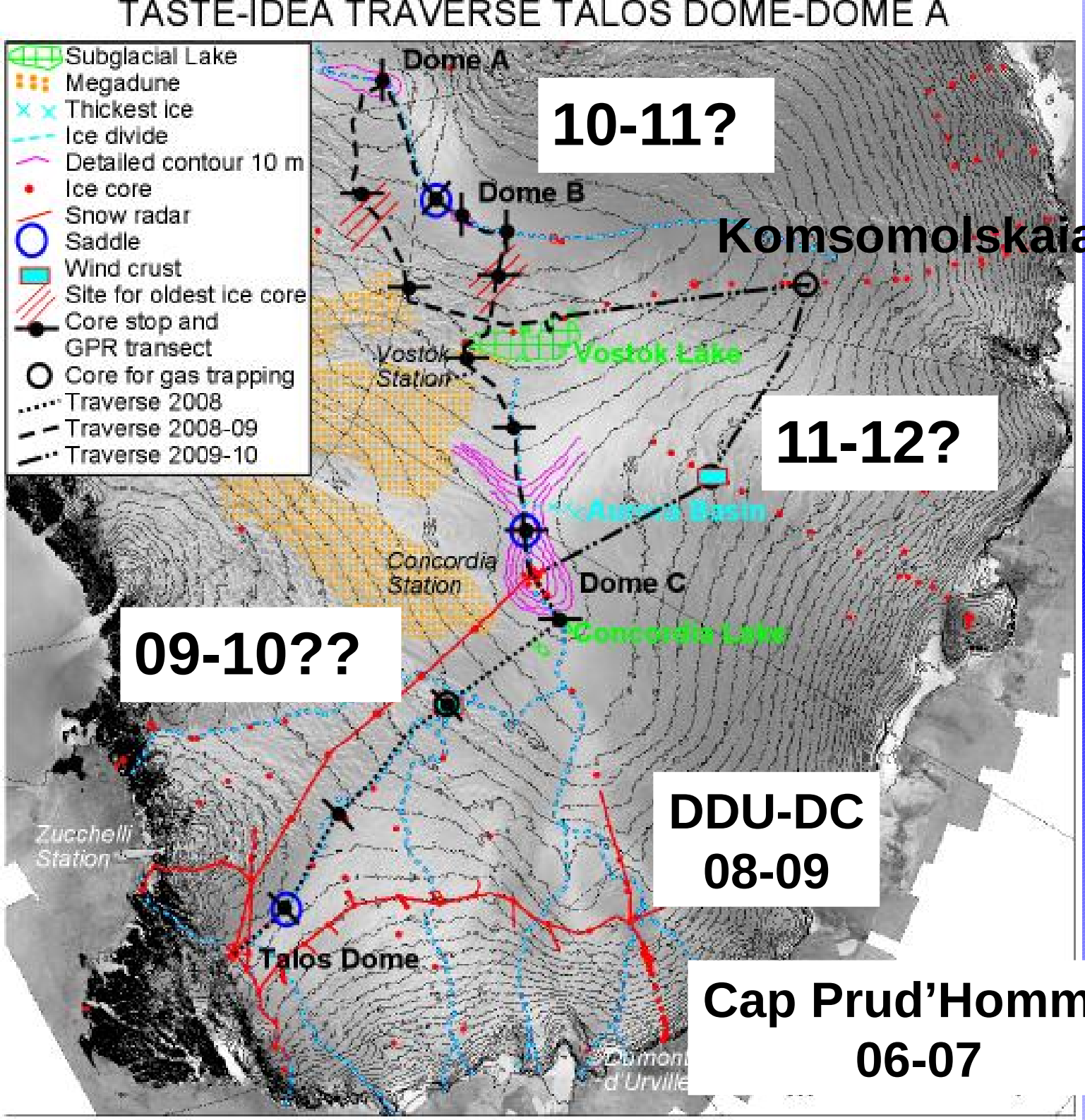
Plateau (>2200 m)

XXIst century Antarctic precipitation change in IPCC / CMIP3 models

Coast – plateau transition zone is most sensitive

Prospects:

IPY TASTE-IDEA (mostly plateau..)



Italy **(M. Frezzotti)**

Russia **(V. Lipenkov)**

France **(M. Fily)**

Dumont d'Urville – Dome C traverse
2008-2009
Logistic traverse

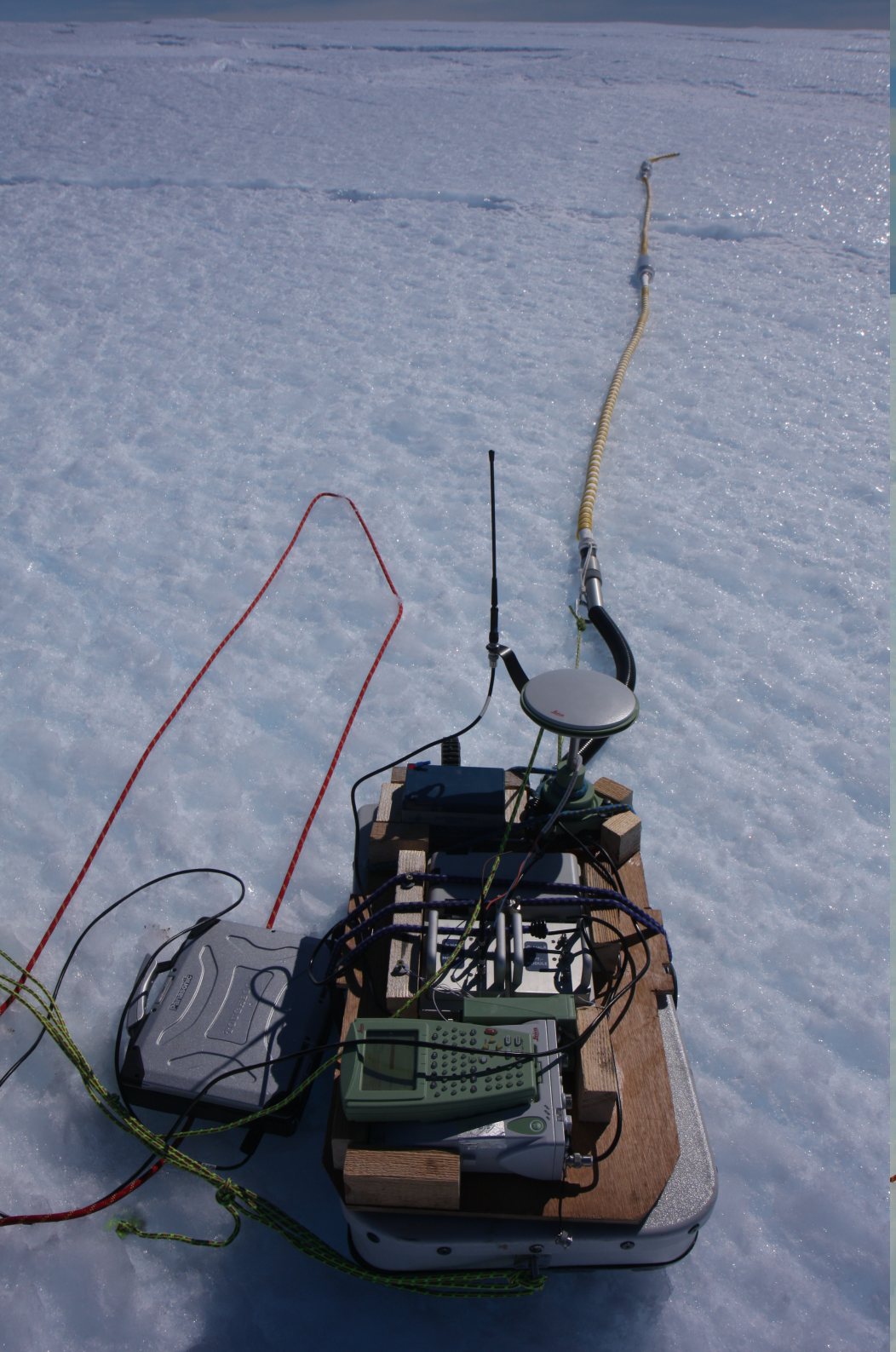
1 – Snow radar with shallow cores for dating (radioactivity)
+ GPS (precise topography)

2 – Snow pits for 10Be (solar activity) with associated chemistr

3 – Radar corner reflectors for interferometry (Concordia lake)

Collaboration with:
Glacioclim: Surface Mass Balance network (stake, meteo station)
DACOTA: ice stream study, Astrolabe galciers
(in situ + airborne radars)

Raid Dumont d’Urville - Dôme C



Prospects:

GLACIOCLIM is a long term – annual survey program

+ ITASE-like reconstruction

US-ITASE in West Antarctica

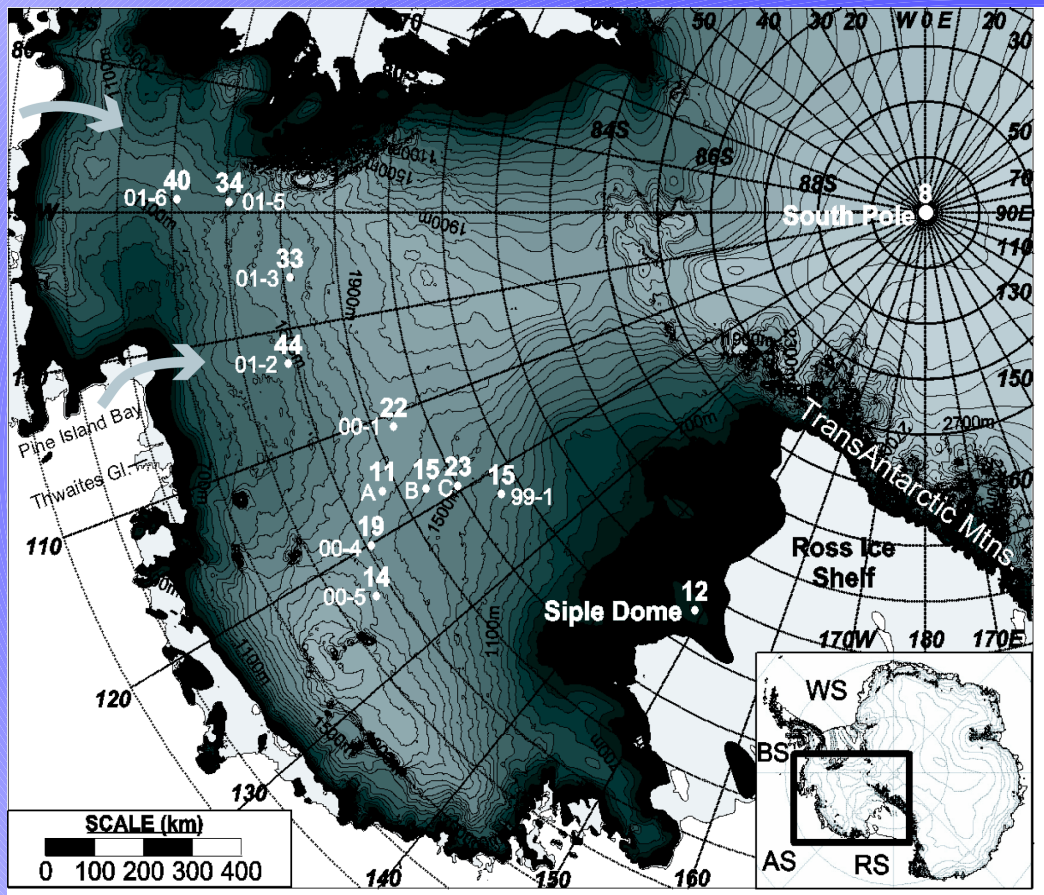


Figure 2: Ice core locations and mean accumulation rates (1922-1990). Core site locations: 01-06, 01-5,01-3 and 01-2 in the Pine Island-Thwaites drainage system; 00-1, RIDS A,00-4 and 00-5 near the ice divide, and RIDS B, RIDS C, 99-1 and Siple Dome in the Ross drainage system. The arrows indicate dominant moisture pathways. WS=Weddell Sea,BS=Bellingshausen Sea, AS=Amundsen Sea, and RS=Ross Sea. A digital elevation model was used to produce the shaded relief map (Liu et al., 2001).

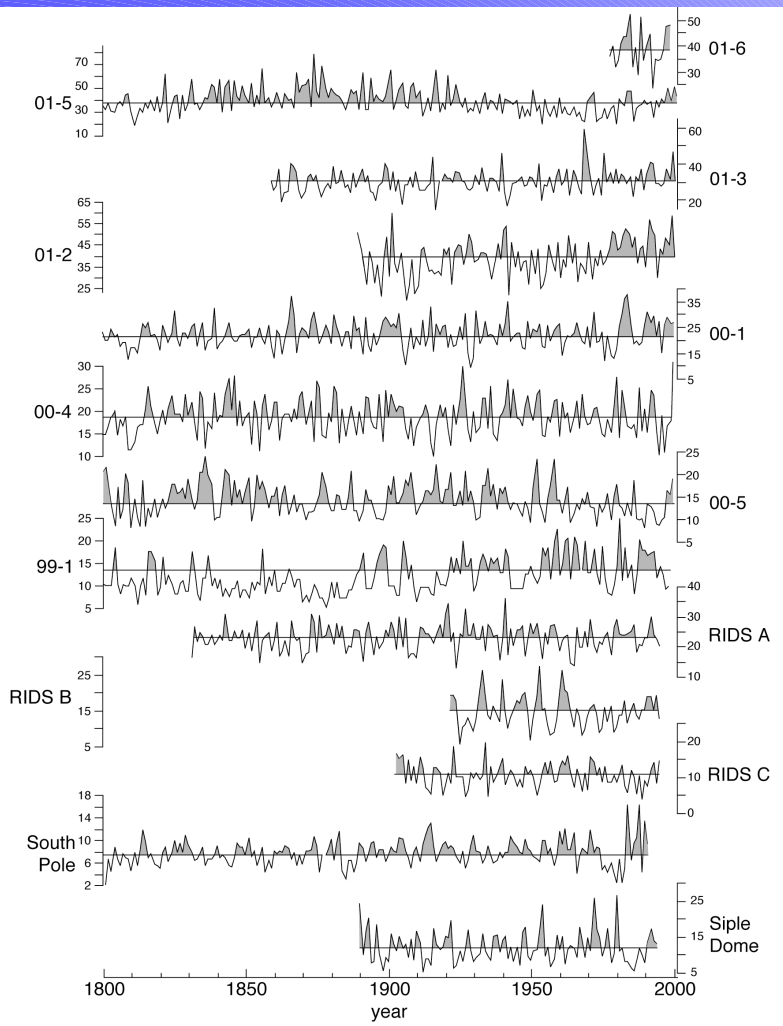
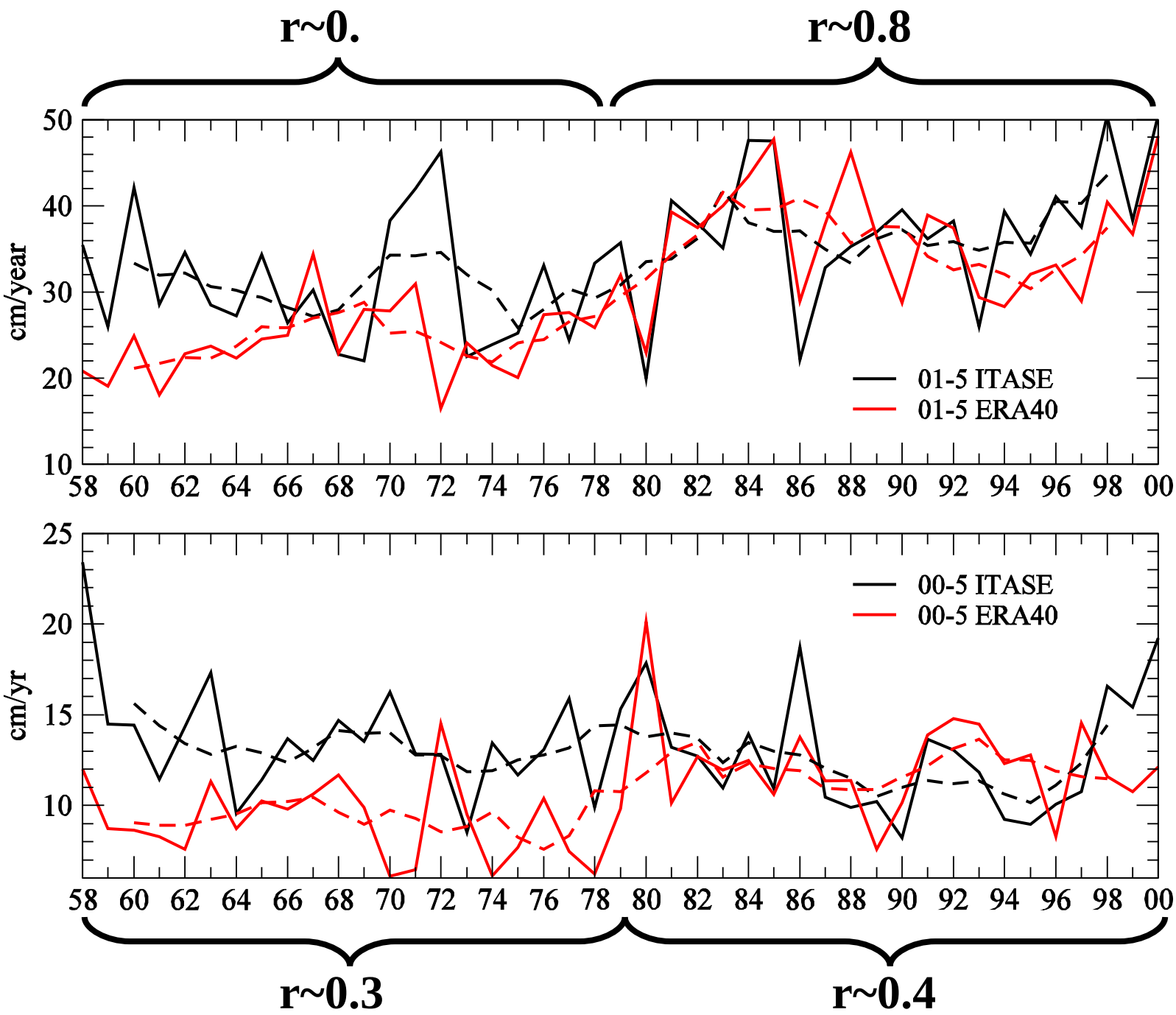


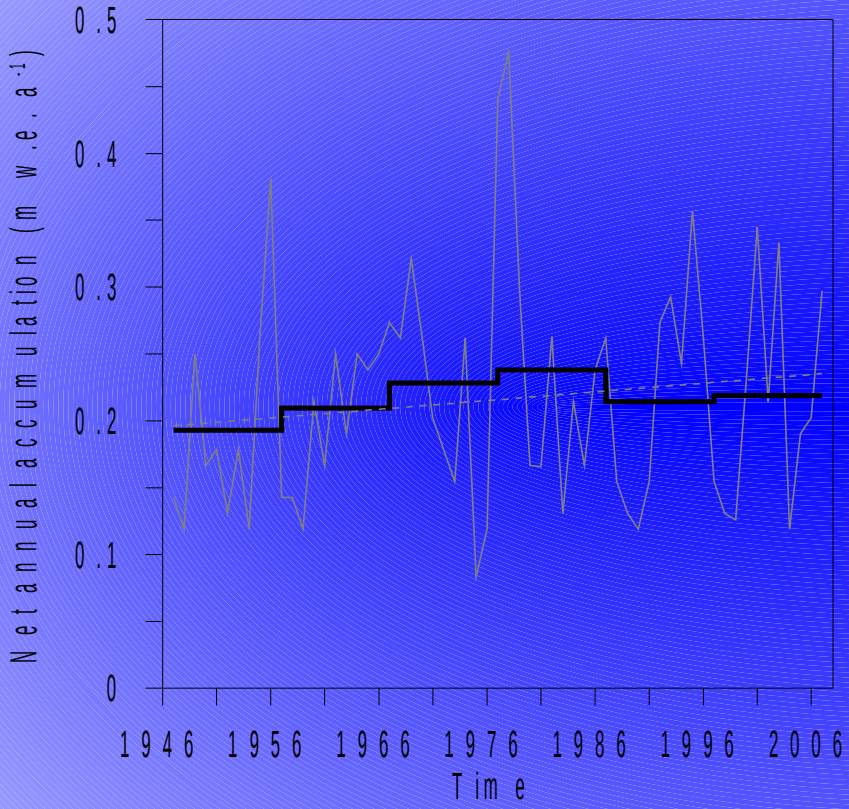
Figure 1: The thirteen annual accumulation rate records in w.e. (cm a^{-1}) from 1800-2001. The line through each record denotes the mean for the full record, and the shading indicates accumulation above the mean.

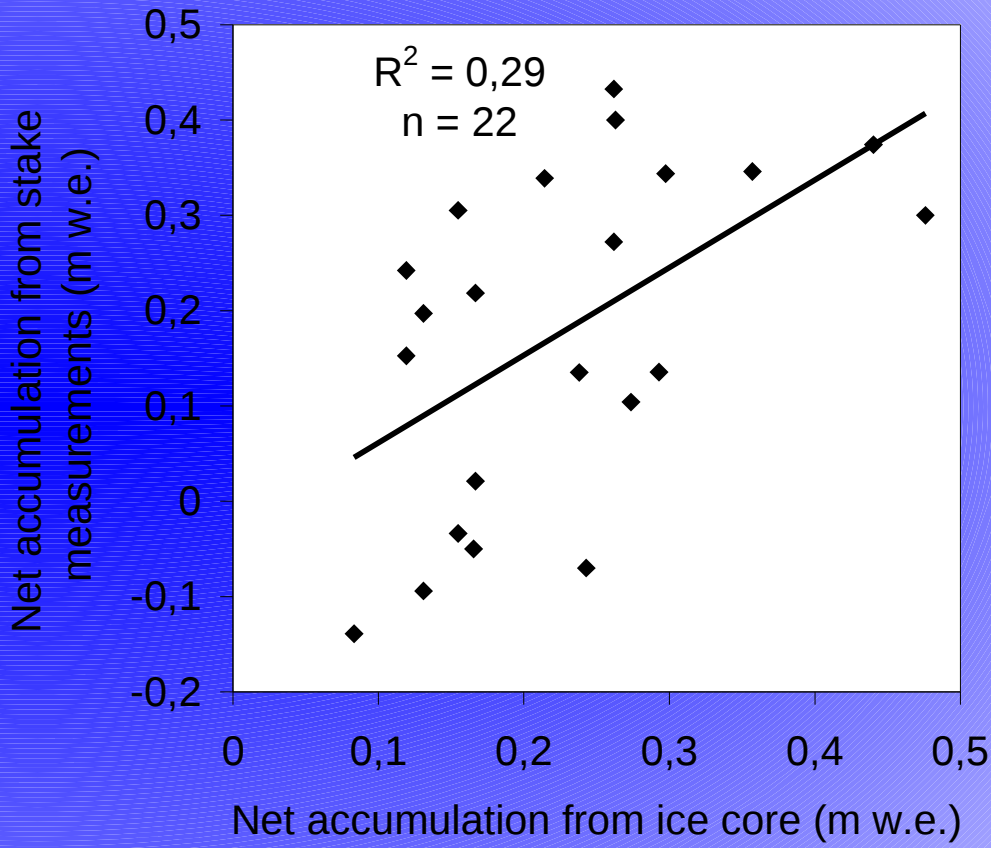
Annual resolution (chemical tracers) => inter-annual variability

Two US-ITASE ice-cores versus ERA40: crucial information for ERA40 validation



Accumulation from short ice core in Adélie Land coastal area





Significance level of the observed trend?

⇒ Drilling at several sites in 2008-09

⇒ Isochrone assessment with GPR measurements

Who:

ITASE: O. Magand, M. Fily (LGGE), with M. Frezzotti (ENEA), V. Masson (LSCE) ...

GLACIOCLIM: C. Genthon, V. Favier

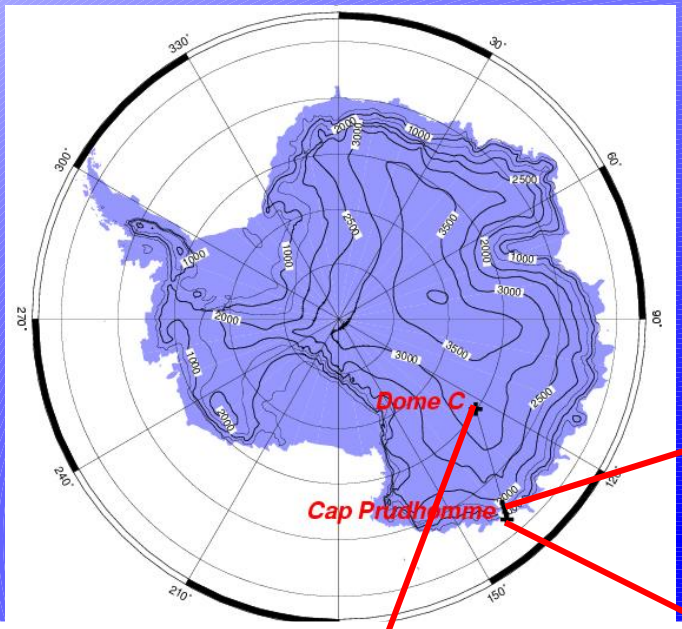
With support IPEV, PNRA, INSU

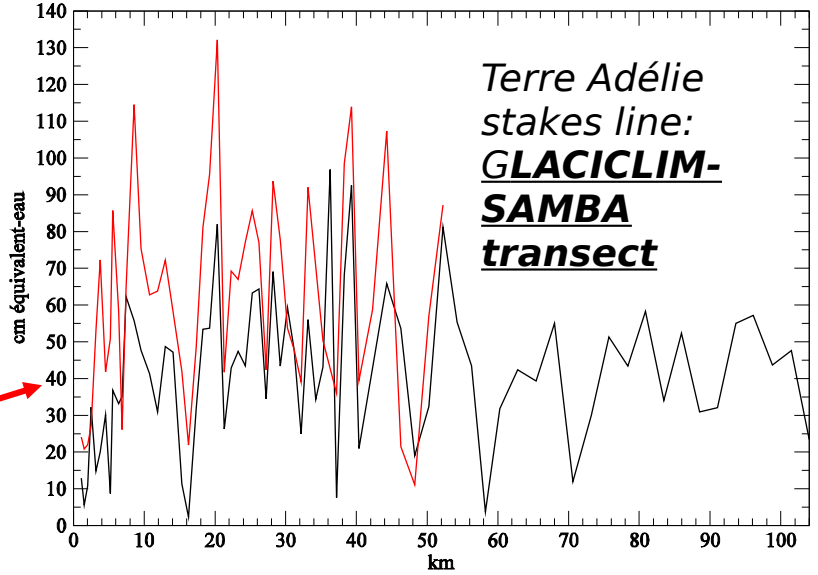
Lab / models: G. Krinner, C. Genthon, H. Gallée, C. Agosta

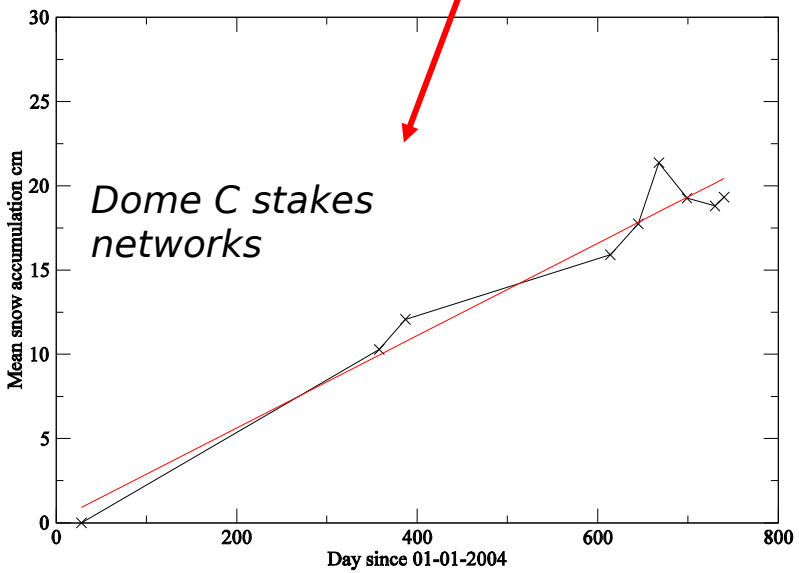
And many more hands on the field...

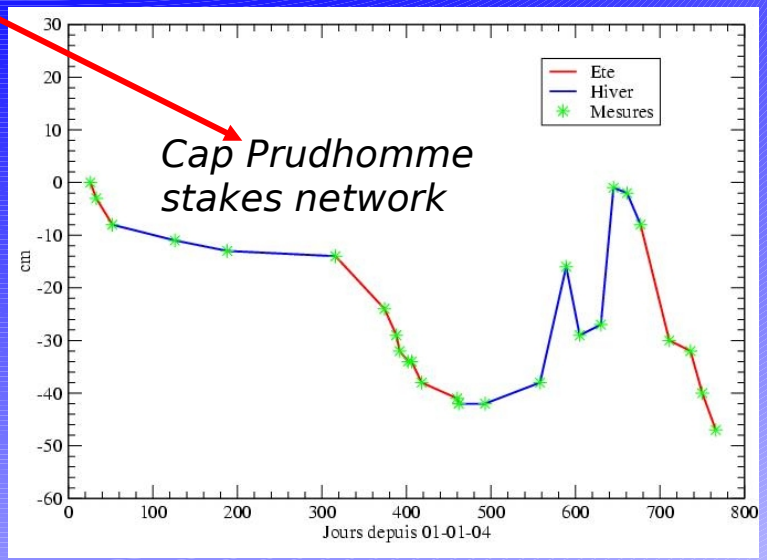
The GLACIOCLIM-SAMBA Observatory

http://www-lgge.obs.ujf-grenoble.fr/~christo/glacioclim/samba/









GLACIOCLIM-SAMBA: SurfAce Mass Blance of Antarctica

- Adélie Land / Dome C

- Coast, coast-to-plateau transition, plateau

- Annual campaign / survey (or more frequent close to Dumont d'Uville)

- Long term program (> 10 years, hopefully more), start 2004.

- Data distribution: *http://www-lgge.obs.ujf-grenoble.fr/~christo/glacioclim/samba/*

>500 km on ice each year ... on logistics of opportunity (IPEV)

2003-04

2004-05

2006-07