DORIS absolute velocities on Sorsdal and Lambert glaciers in Antarctica

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Summary

Introduction

Context

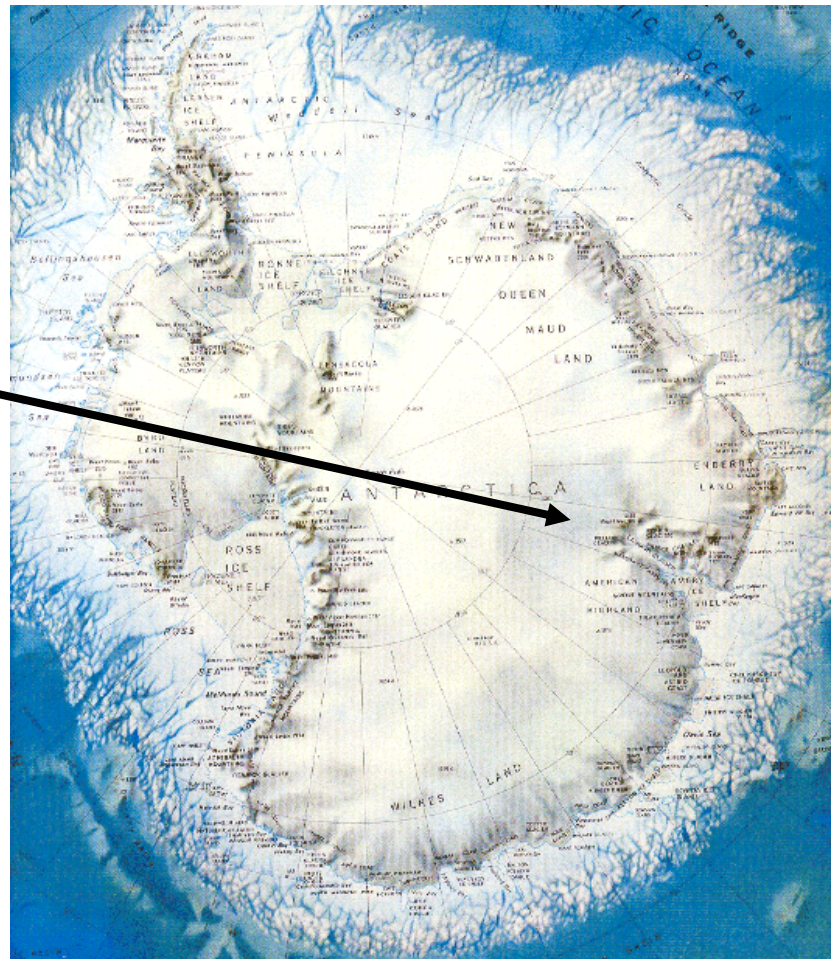
IDS Pilot Experiment campaigns
- sites & installation
- data acquisition (lessons learnt)
- processing
- velocity results
- comparisons

Conclusions

Introduction

90% of the Antarctic ice sheet is discharged in glaciers & ice stream

In East Antarctica, the Lambert-Amery glacier-ice shelf drainage system is the largest



Context

Ice discharge in Antarctica and Greenland influences the global sea level and climate changes

Ice accumulation rate **MASS BALANCE ?** **Ice thickness changes**

Tools for surface velocities :

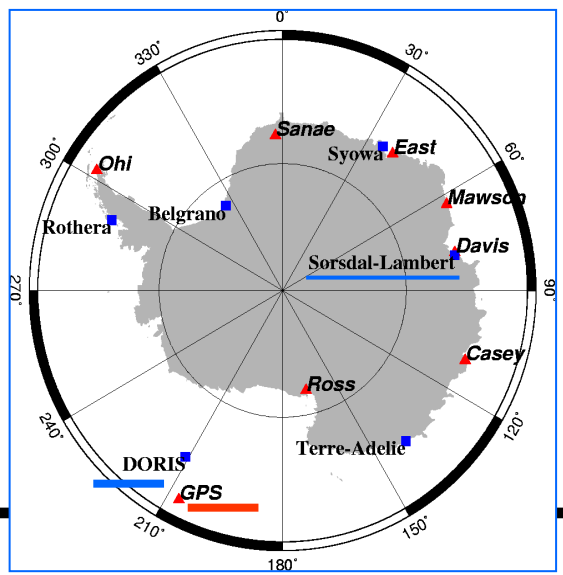
Altimetry : radar (ERS, Envisat,…), laser (Icesat) > mapping
Geodetic : GPS, DORIS
…

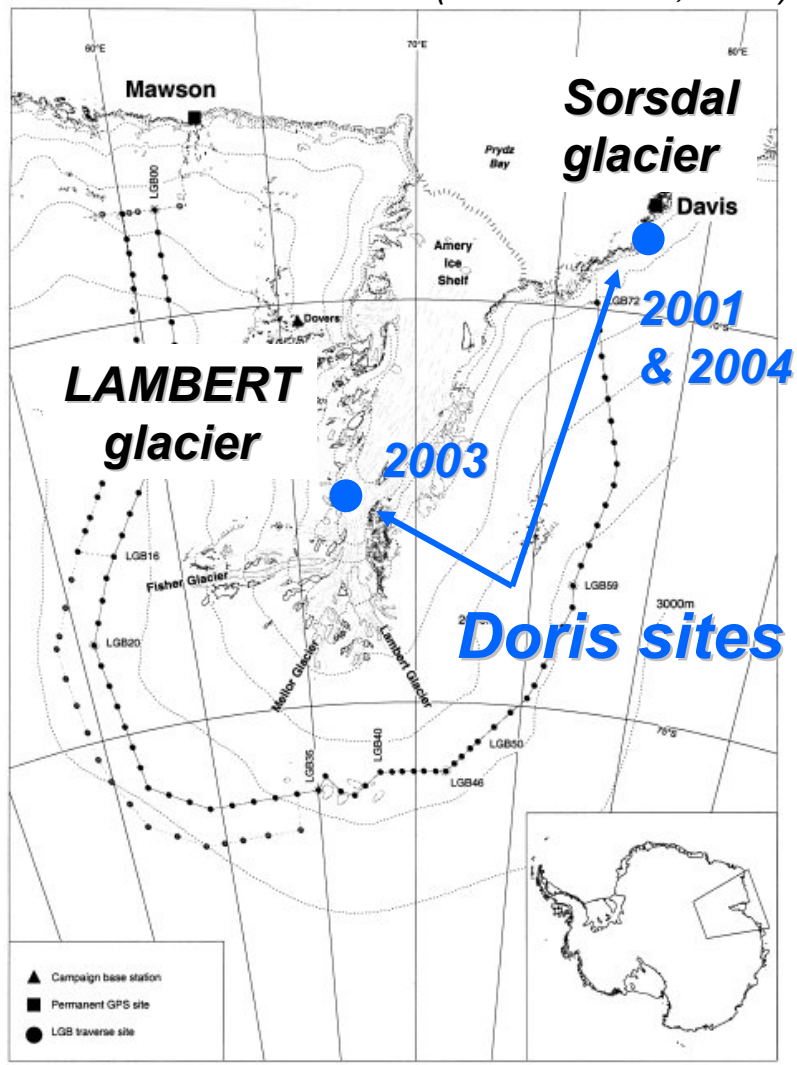
A very difficult task: complex drainage structures, strong local variability (velocity, precipitations…)

IDS Pilot Experiment campaigns

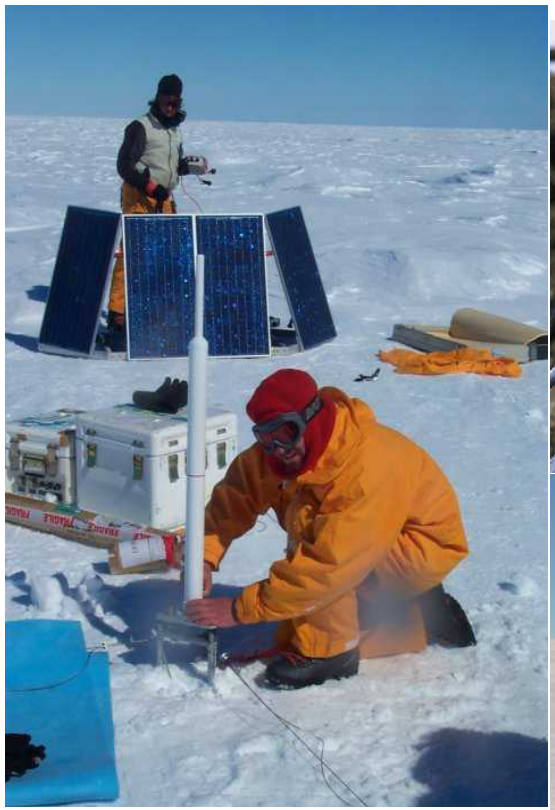
(From Manson, 2000)

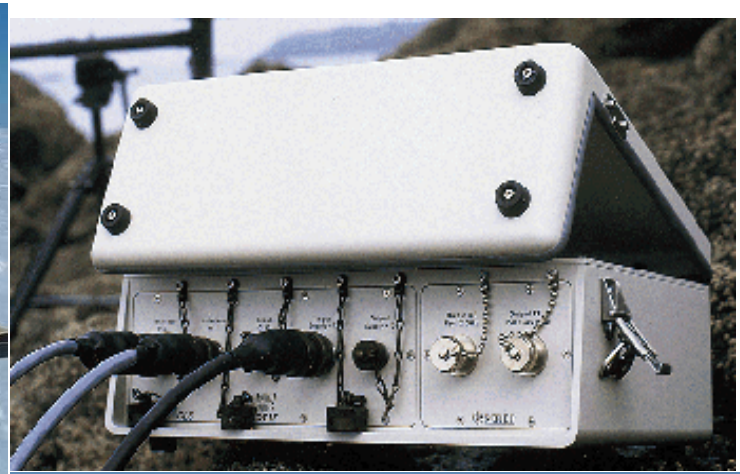
GEOSCIENCE AUSTRALIA proposition for several weeks DORIS permanent monitoring stations





DORIS campaigns: sites & installation





Beacon program :
Satellite selection (SPOTs)
Approx. position (few km)
Sequences of transmission
IAT clock synchronisation
Initial training by SIMB/IGN
> Self operating

Power supply :
75 ah needed
2x60 W solar panel
Voltage regulator

SSALTO/CNES Control Center :
401.25 MHz & 2036.25 MHz signals received at Toulouse, within a few hours
Signal char. and Doppler obs. systematically checked
Contact at Davis base in case of anomaly

< Daily control

Data acquisition & lessons learnt

Campaign	Period	# days (obser.)	DORIS dataset Sat pass./obs. #	Comments
Sorsdall 2001	12-Nov-2001 13-Jan-2002	23	Spot2 5/13 Spot4 26/685 Topex 3/61	Power supply deficiency, too many satellites tracked
Lambert 2002	9-Dec-2002 23-Jan-2002	11	Spot4 93/2928 Spot5 74/3621	Nominal operations after full beacon initialisation (self-training)
Sorsdall 2003	29-Nov-03-08-Dec-03 02-Jan-04-23-Jan-04	9 21	Spot4 24/653 Spot5 29/1191 Spot4 122/2101 Spot5 147/5130	Interruption due to a big storm and Katabatic wind

Save power :
2 sat. enough

encouraging

Meteo risk

Velocities processing

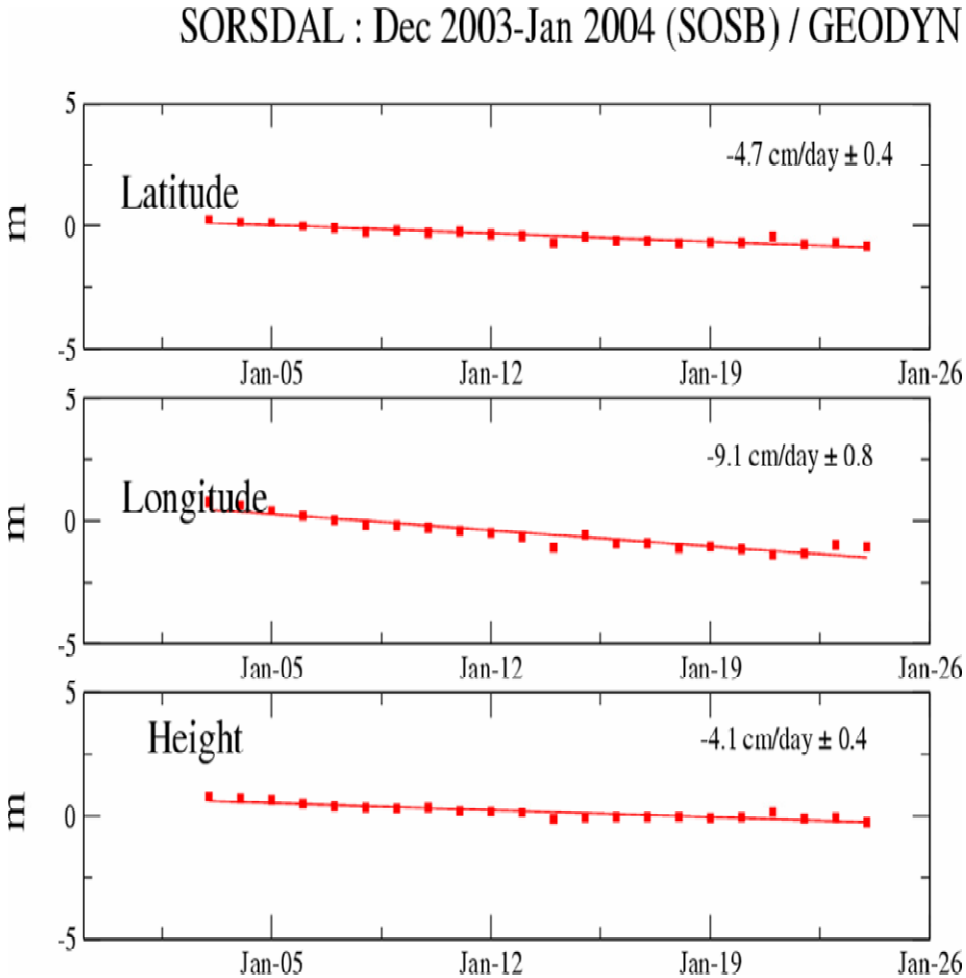
by Geoscience Australia IDS Analysis Center (R. Govind)

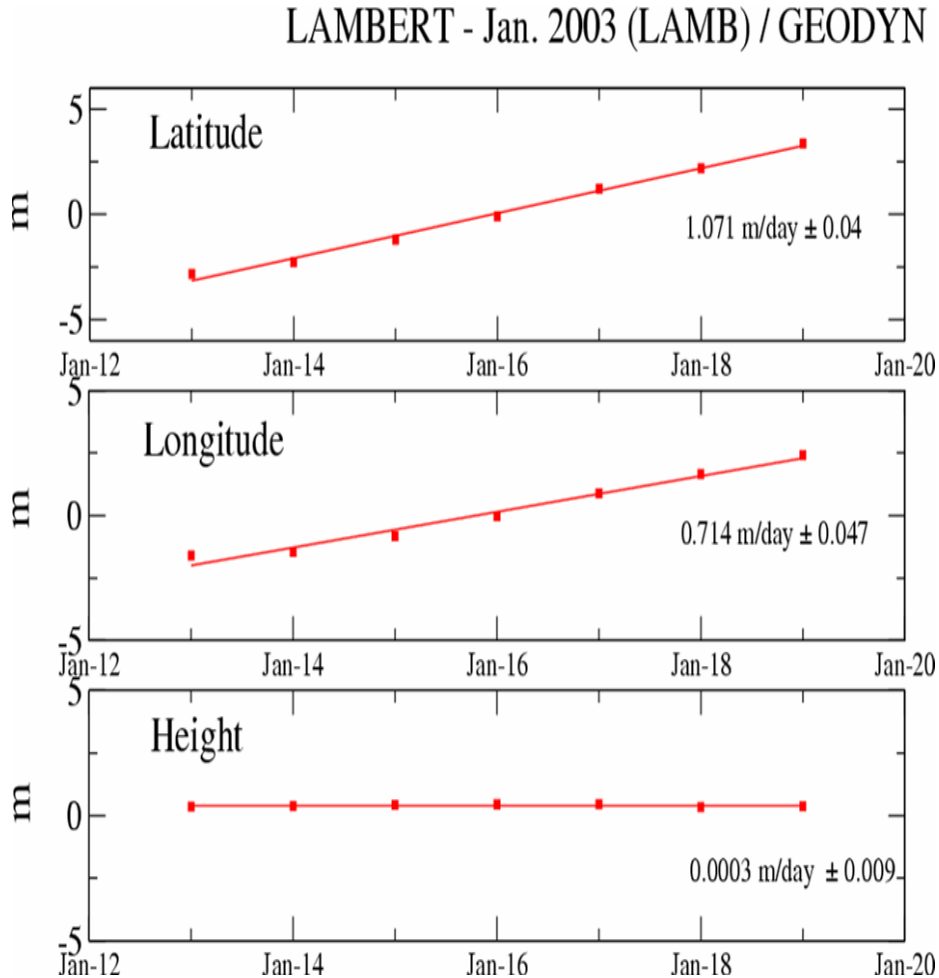
GEODYN software (NASA/GSFC, F. Lemoine)

- **Modelling**
  - GGM01S gravity field
  - Time varying gravity applied for zonals up to degree 5, C(2,1) and S(2,1)
  - Ocean Tides – GOT99
  - Ocean Loading – from GOT99
  - ITRF2000 apriori coordinates and velocity
- **Partials Generated for Each Satellite as follows:**
  - **Global Set:**
    - GM, Semi-Major Axis, flattening
    - Gravity coefficients to degree and order 10
    - X-Pole, Y-Pole and A1-UT1
    - Tracking Station Coordinates
  - **Arc Set:**
    - State Vector
    - 8-hourly drag coefficient
    - General Acceleration (4)
      - Once/rev sine and cosine – along and cross track
    - Measurement biases (Doppler) pass-by-pass
    - Tropospheric Scale Bias – pass-by-pass

- **Estimated Parameters at the Combination stage (all possible satellites):**
  - Tracking Station Coordinates
  - X-Pole, Y-Pole and A1-ut1
  - Gravity Field Coefficients to degree and order 2
  - GM
  - Satellite state vector, General Acceleration, Drag

Results





Sorsdal (2003) > 10 cm/day

Lambert > 130 cm/day

DORIS results & GPS comparison

DORIS results

Site	Velocity (cm/day)	Azimuth
Sorsdal (Dec 2001-Jan 2002) *	31.0	246.4
Sorsdal (Dec 2003-Jan 2004)	11.0	242.7
Lambert (Jan 2003)	128.7	56.3

* *under refinement*

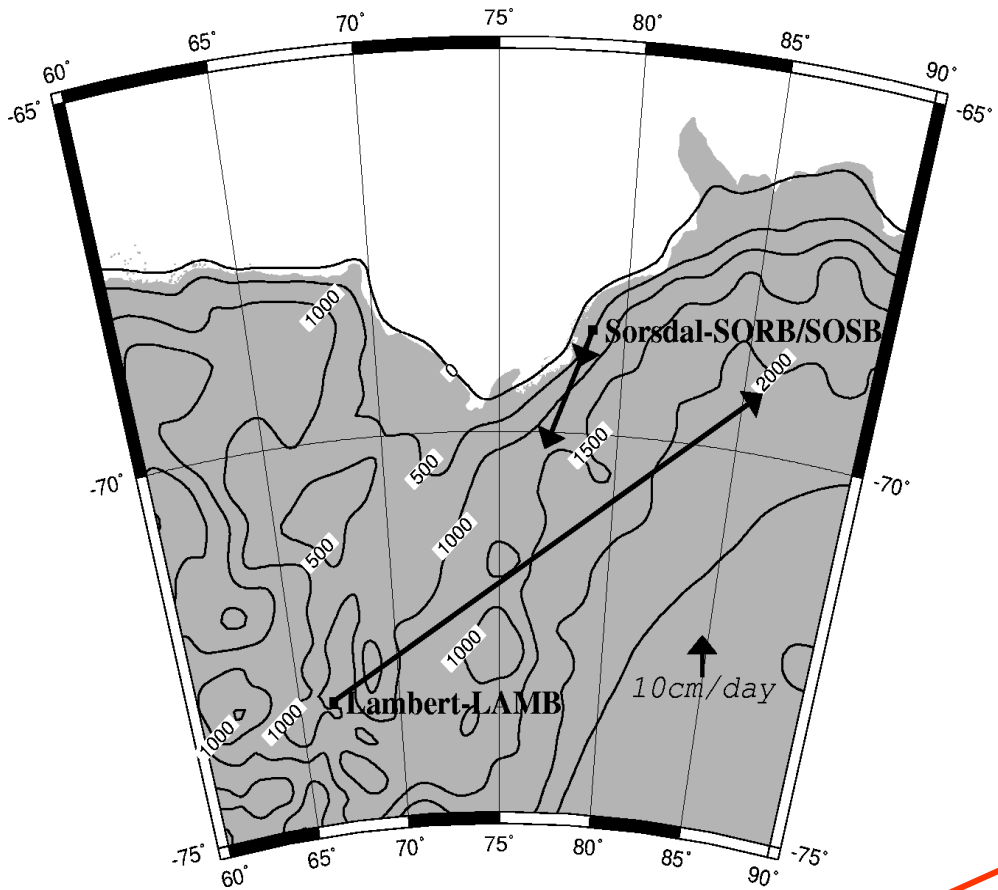
Sorsdal (Dec 2001-Jan2002)

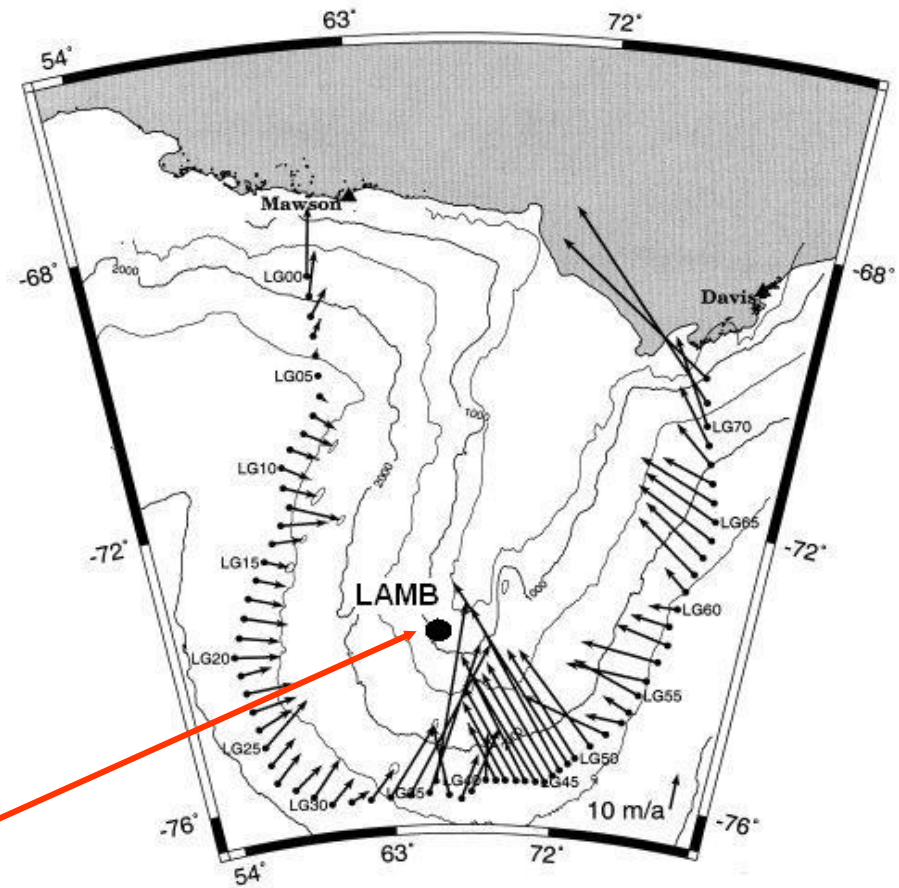
	DORIS	GPS
Days between obs.	31	65
Velocity (m/day)	0.31	0.31
Azimuth (°)	246.37	244.43

(Patrick, Univ. Melbourne, 2003)

Comparisons

(from Manson, 2000)

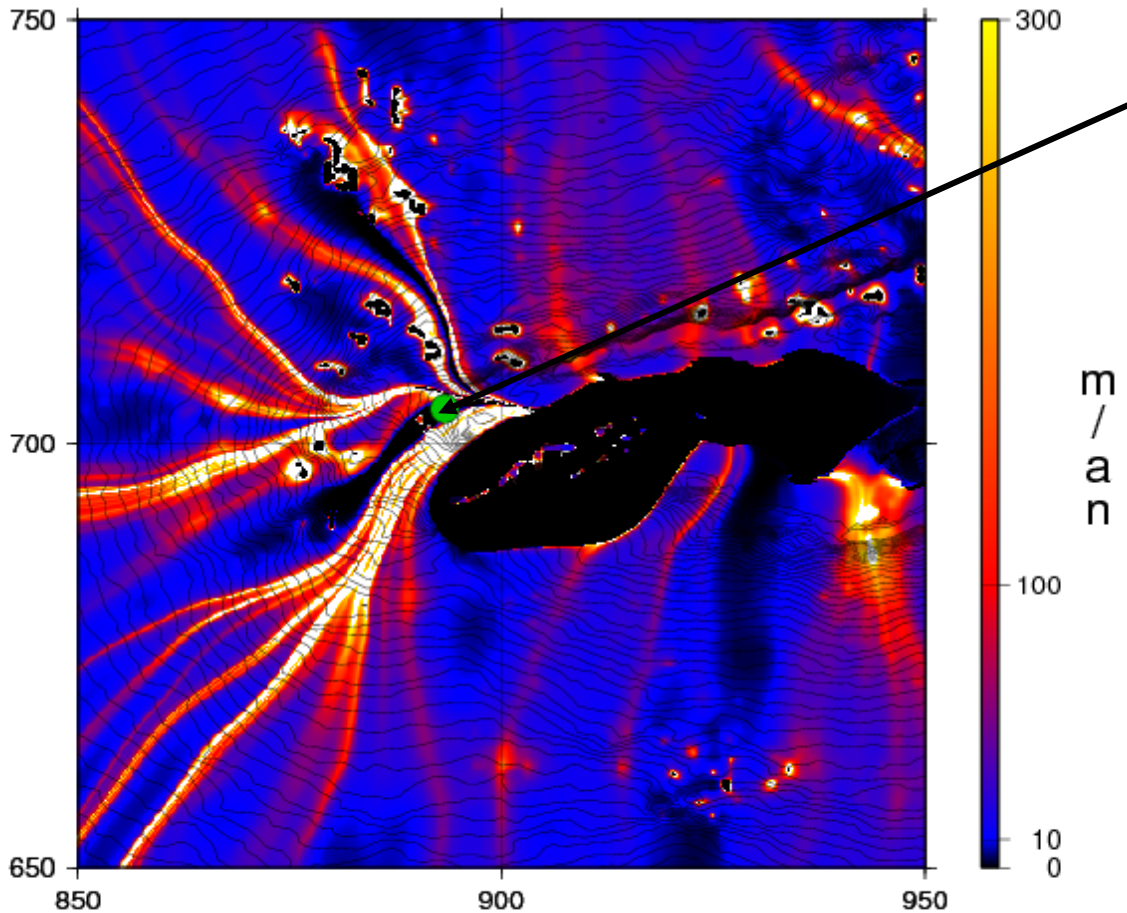




DORIS velocities

GPS velocities (1995-1998)

DORIS/ERS



green dot is Lambert glacier DORIS point

DORIS velocity : > 450 m/yr

ERS-1. (From . Testut, 2003)
5 km digital elevation model > high velocity zones

Conclusions

DORIS monitoring of surface displacement

- **> self operation of the beacon**
- **> routine data control at Toulouse, France**
- **> installation precaution (beacon program, power supply)**
- **> 2 or 3 polar satellites for high resolution**

SORSDAL-LAMBERT glaciers dynamics

- **> DORIS velocities from 10 to 130 cm/day**
- **> very strong local variation of ice-flow rates (2 to 60 m/day over 2 km at Sorsdal, from Patrick, 2003)**

Proposition for a DORIS experiment at International Polar Year?

- **> Greenland (retreat of coastal glaciers)**
- **> …**