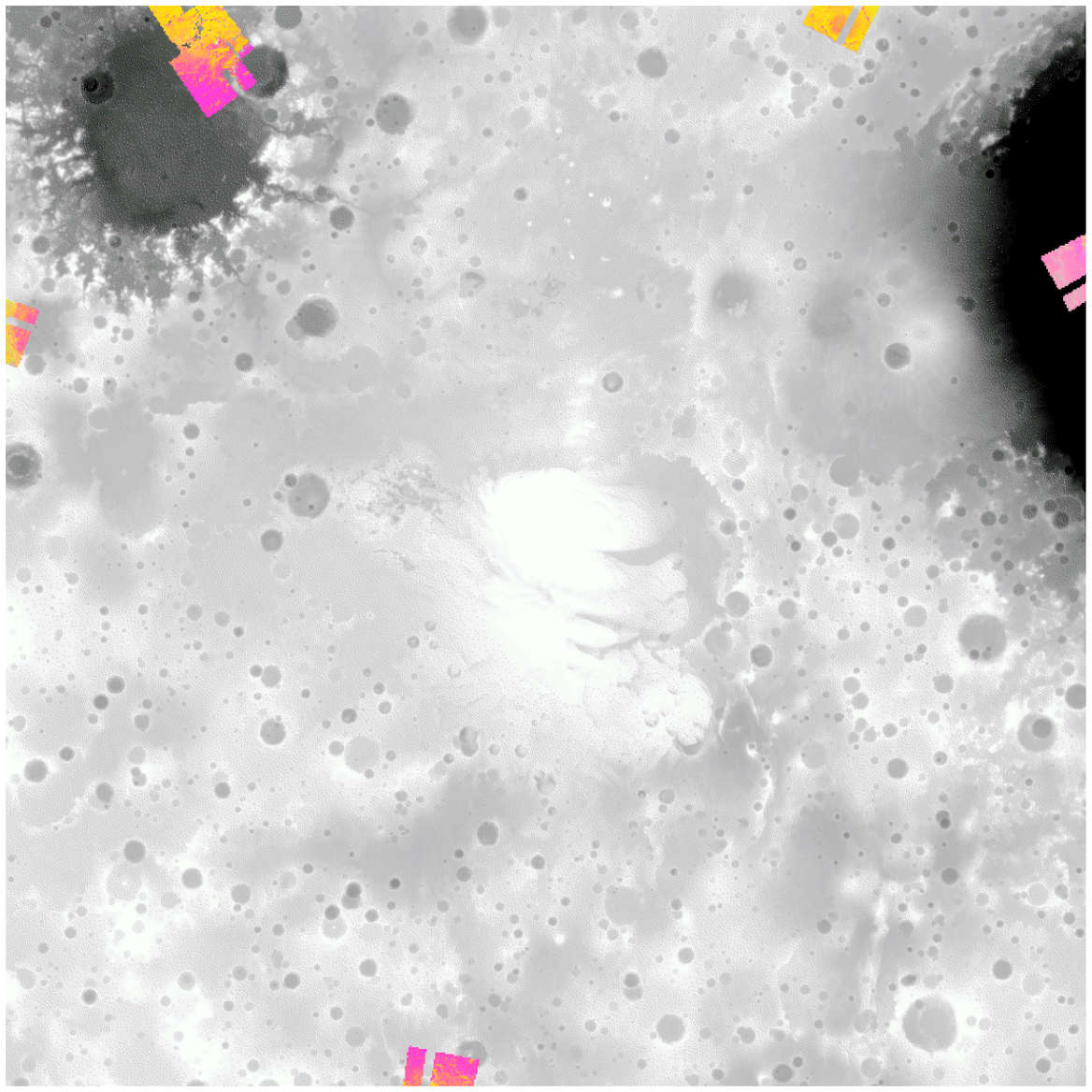
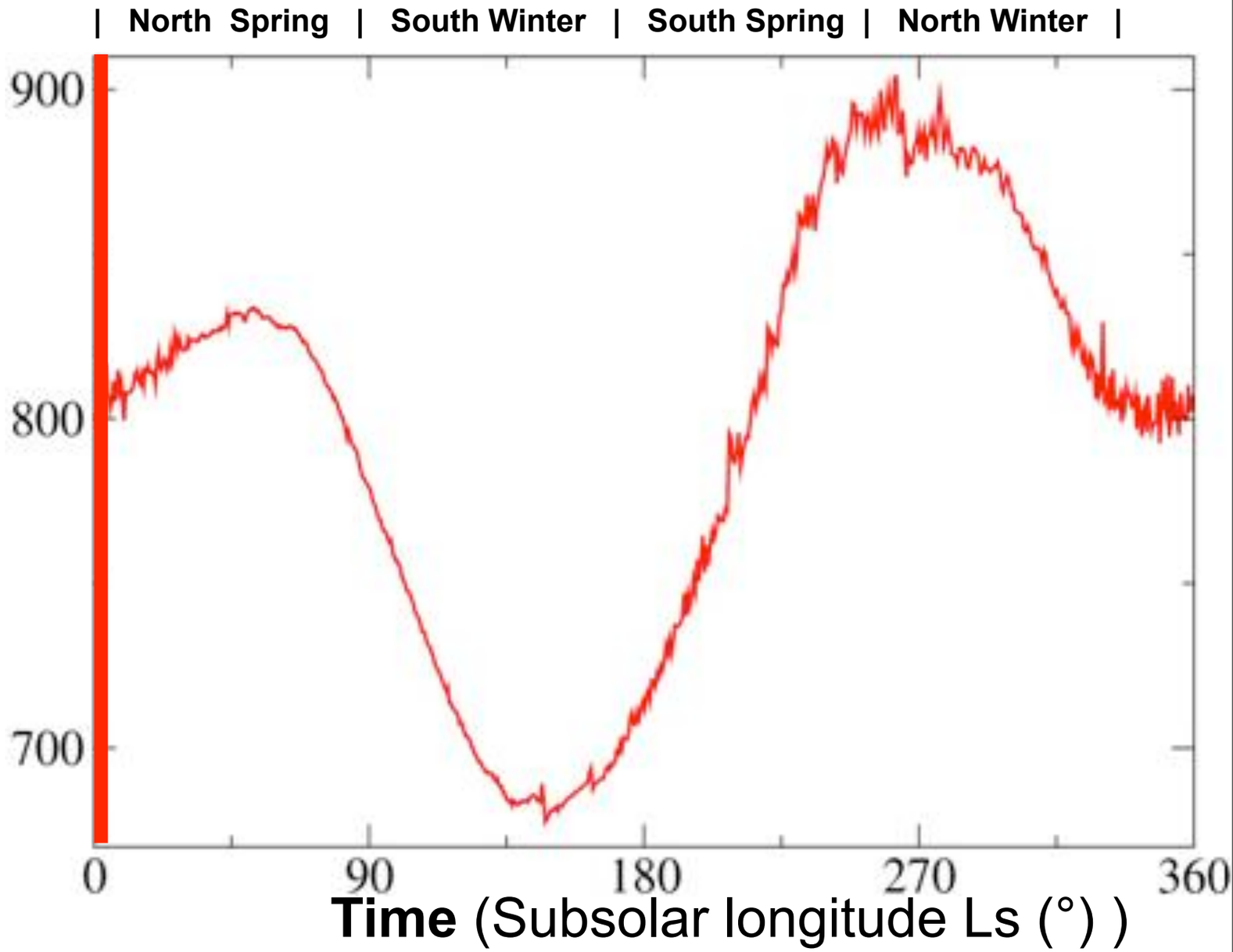


Mapping the CO_2 sublimation of the southern hemisphere of Mars

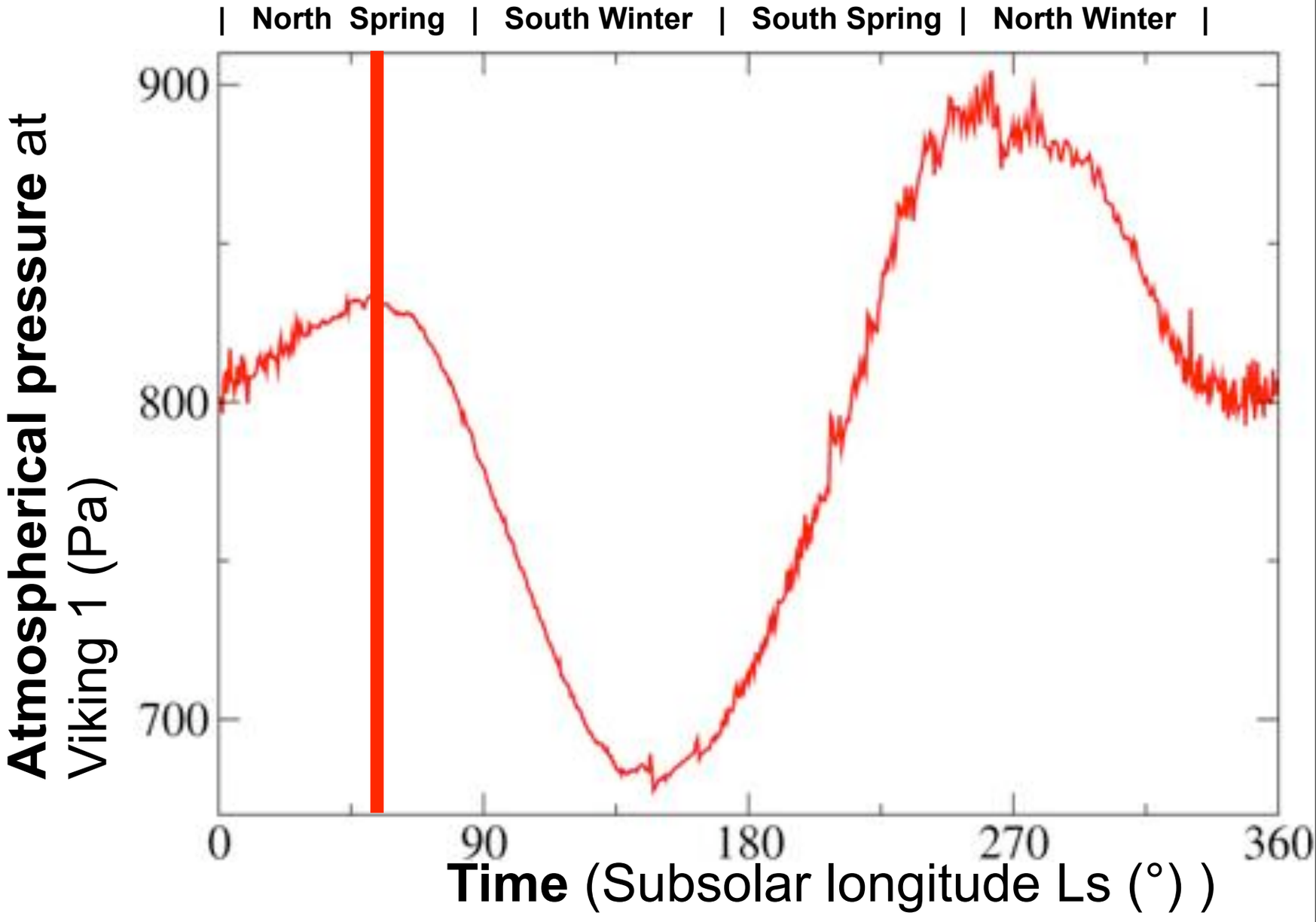
Frédéric Schmidt (ESAC), Patrick Martin (ESAC)

ESA Inter-Departmental Science Workshop, ESTEC
Thursday 28th August 2008

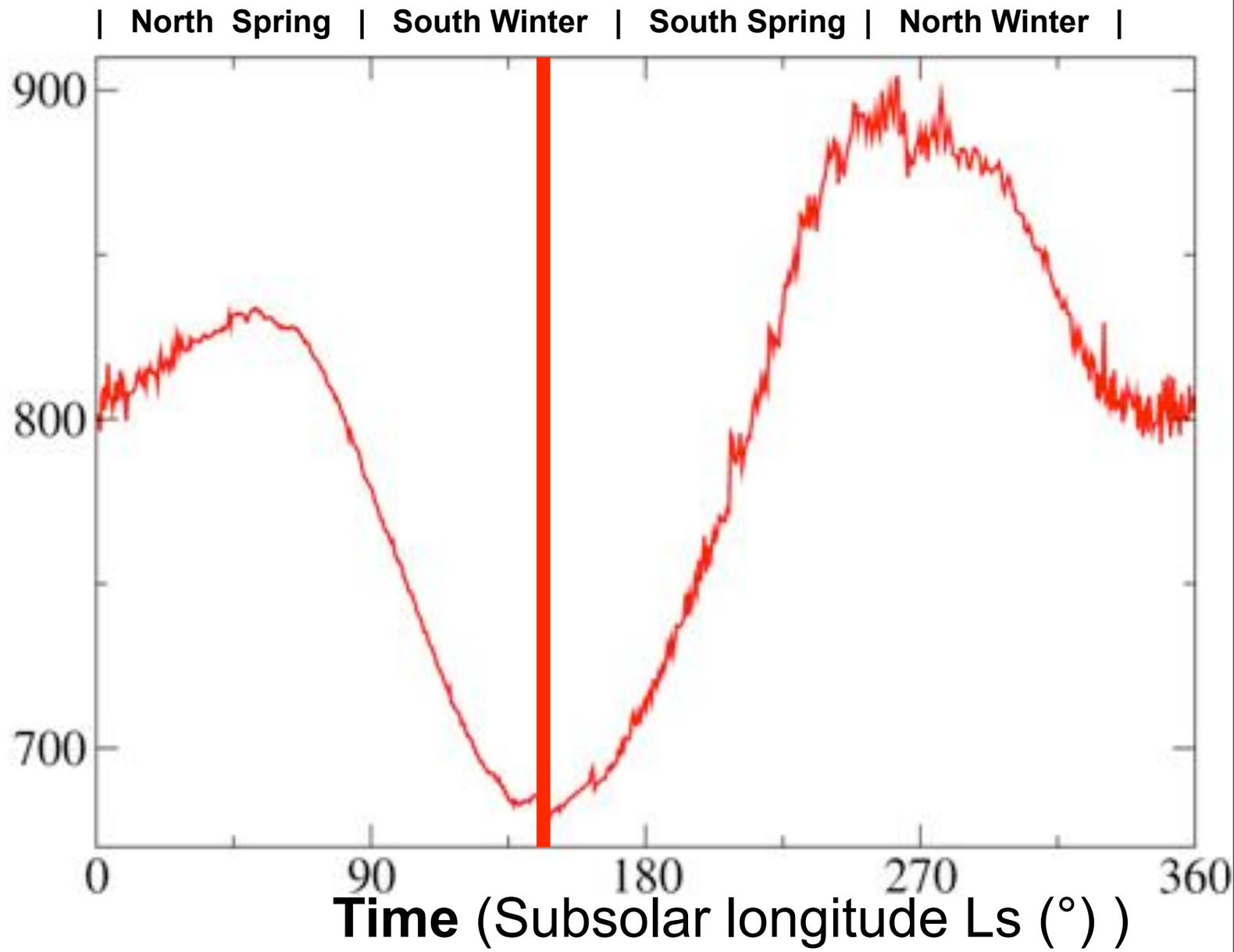
Martian Seasonal cycle



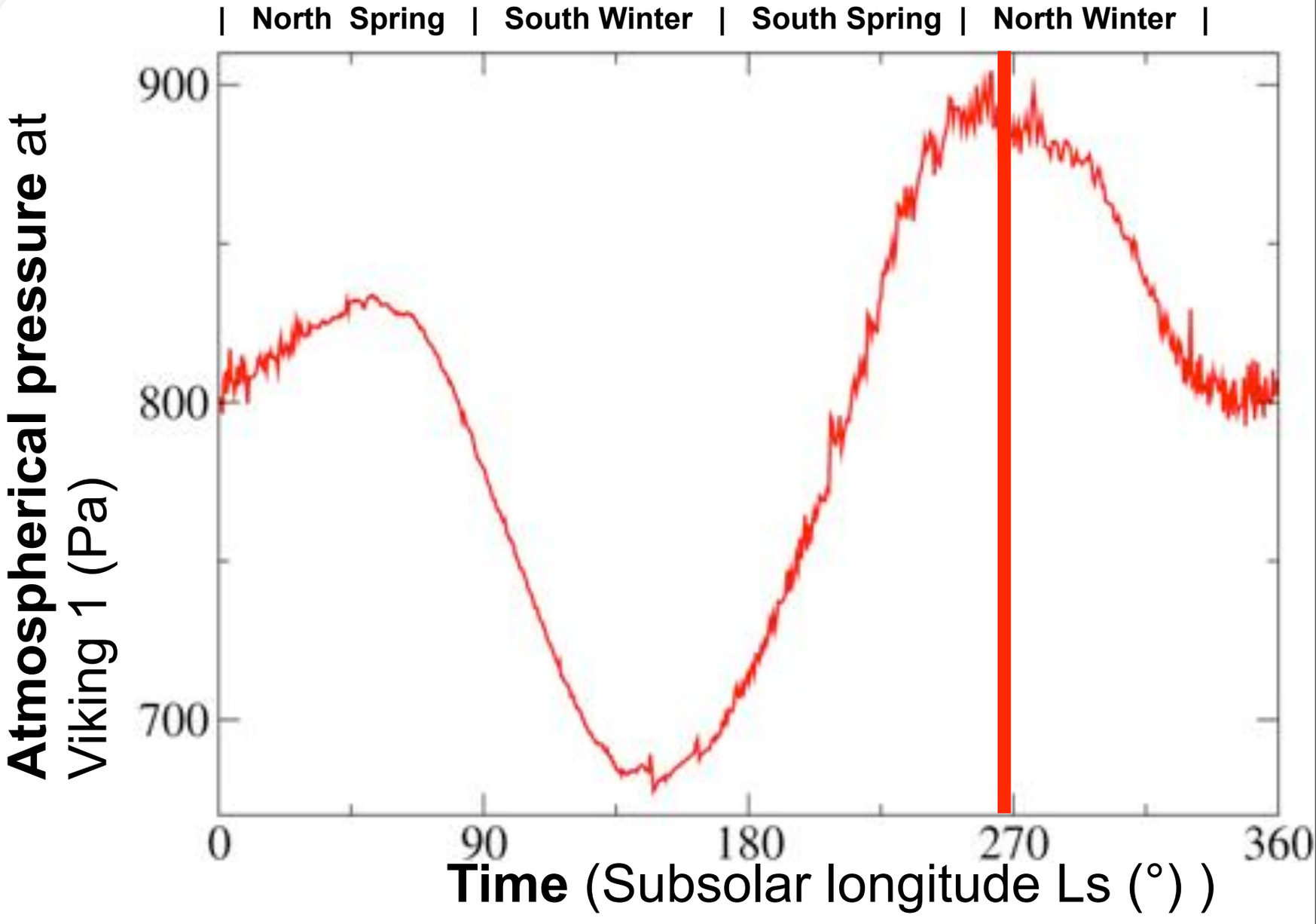
Martian Seasonal cycle



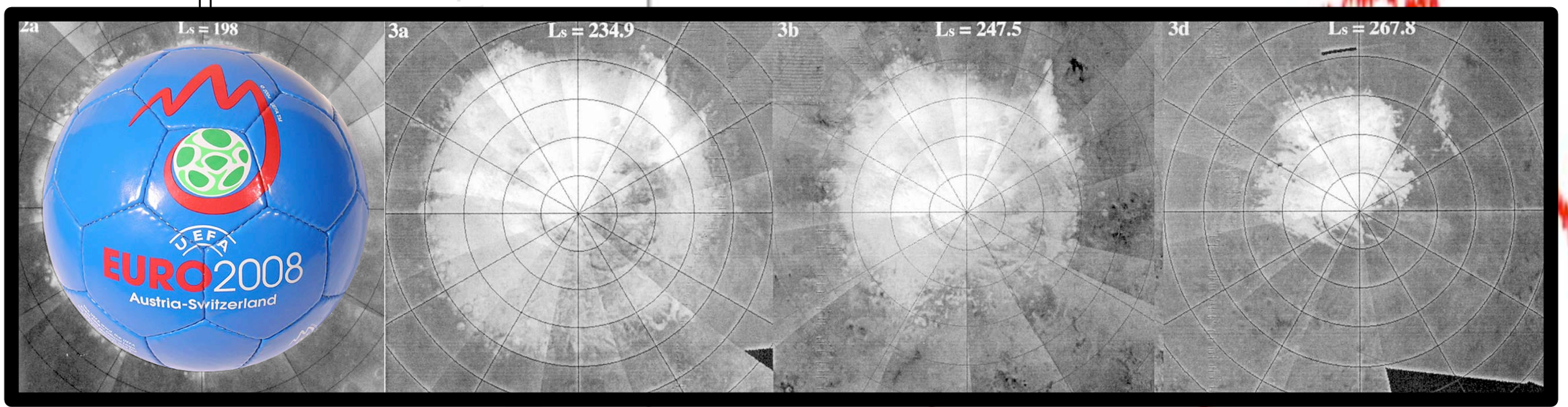
Martian Seasonal cycle



Martian Seasonal cycle



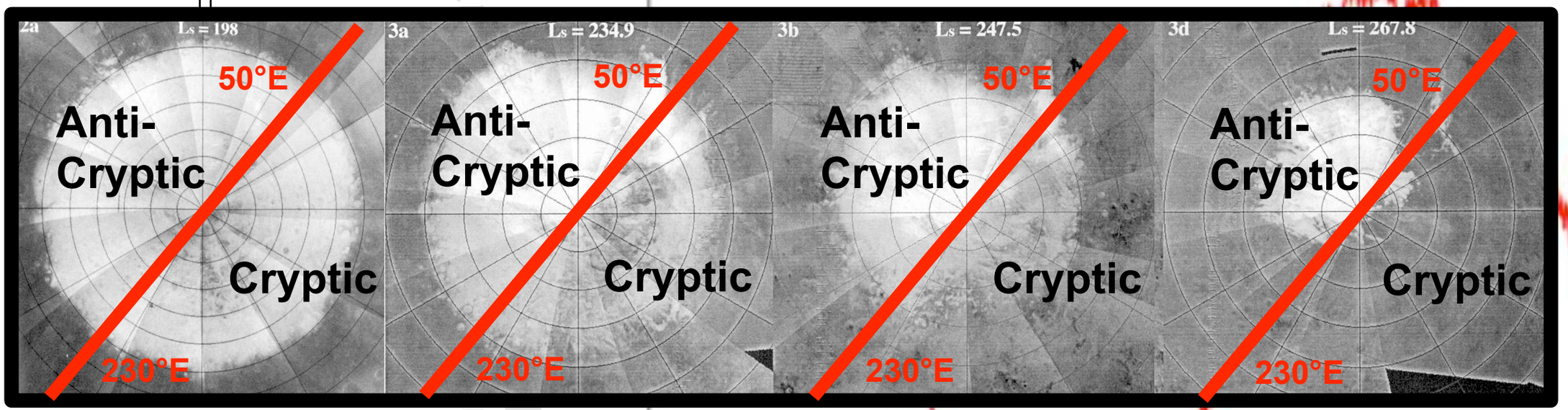
Martian Seasonal cycle



CO_2 condensation/sublimation

South polar region by Viking

Martian Seasonal cycle

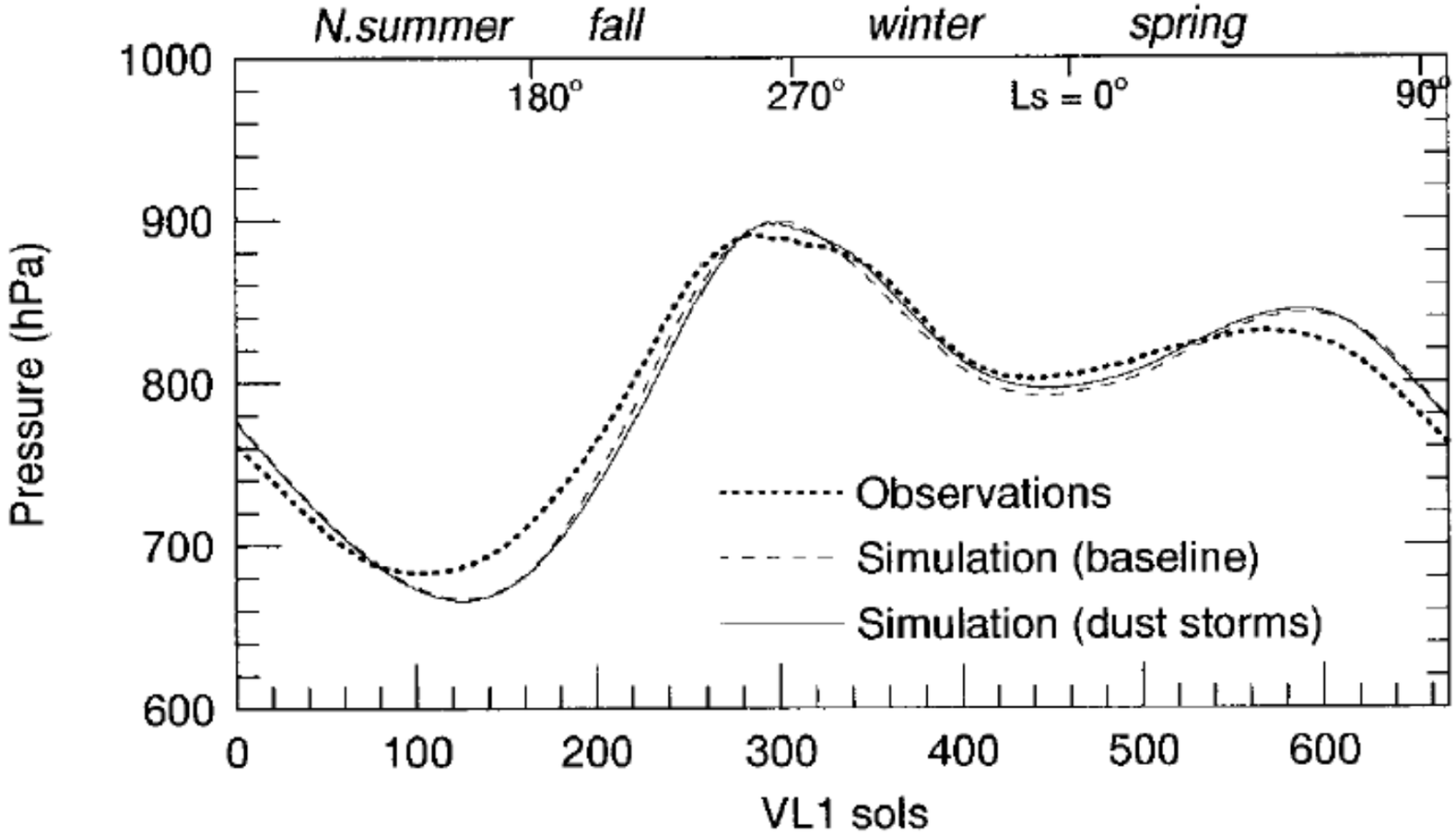


Cryptic region :

- darker
- recession faster

Present time climate at global scale

- GCM
  - Condensation
  - Sublimation
  - Snow



Forget, F et al., *Icarus,* **1998**, *131*, 302-316

- CO_2 ice albedo = constant

To regional scale…

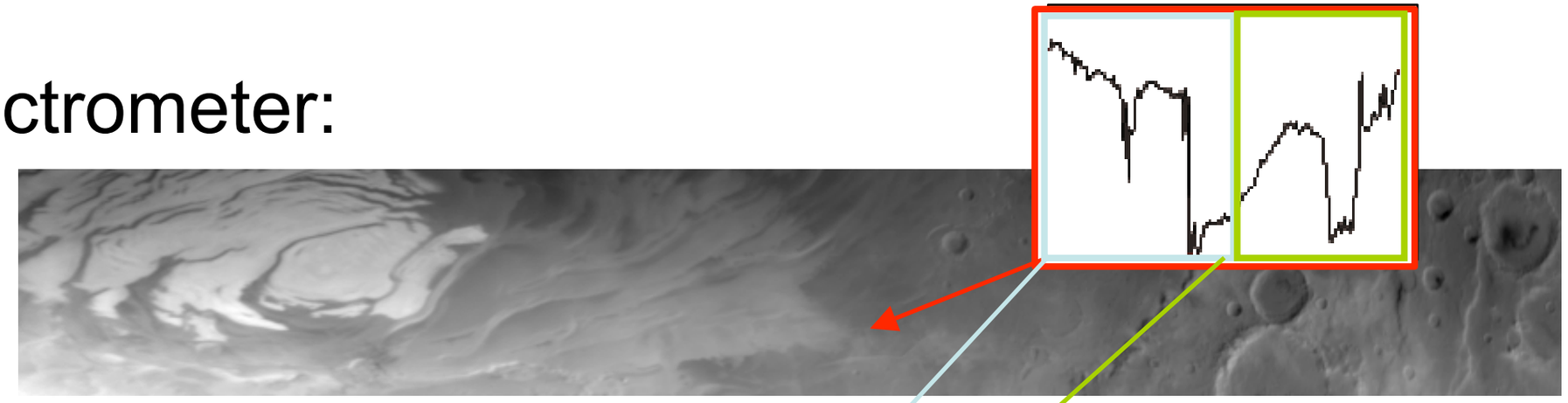
- Interests :
  - –High spatial resolution observations
  - –High resolution GCM

- Implications :
  - –Seasonal CO_2 cycle
  - –Minor species (Ar, water, dust)
  - –Past climate

Effect of the cryptic region ?

OMEGA onboard Mars Express

Imaging spectrometer:



Near infra-red:

- C Detector between 1 et 2.6 microns)
- L detector between 2.6 et 5 microns)

Spatial sampling : ~ 1 km

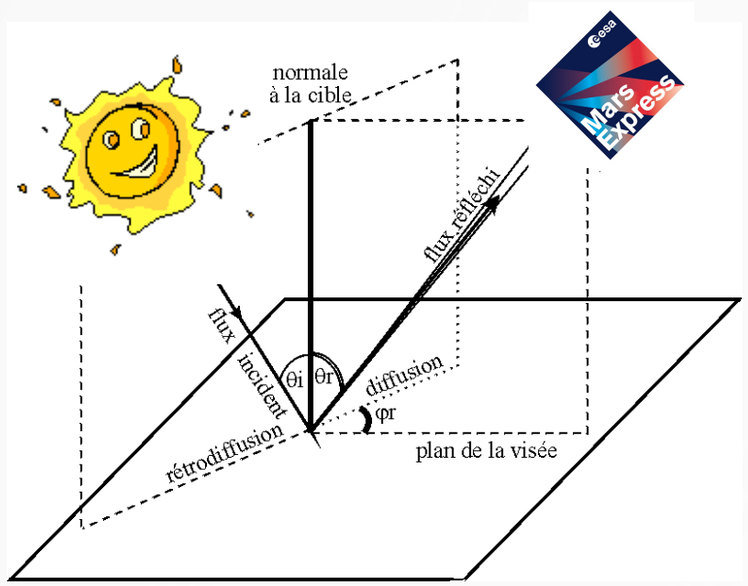
Spectral sampling : 0.01 microns

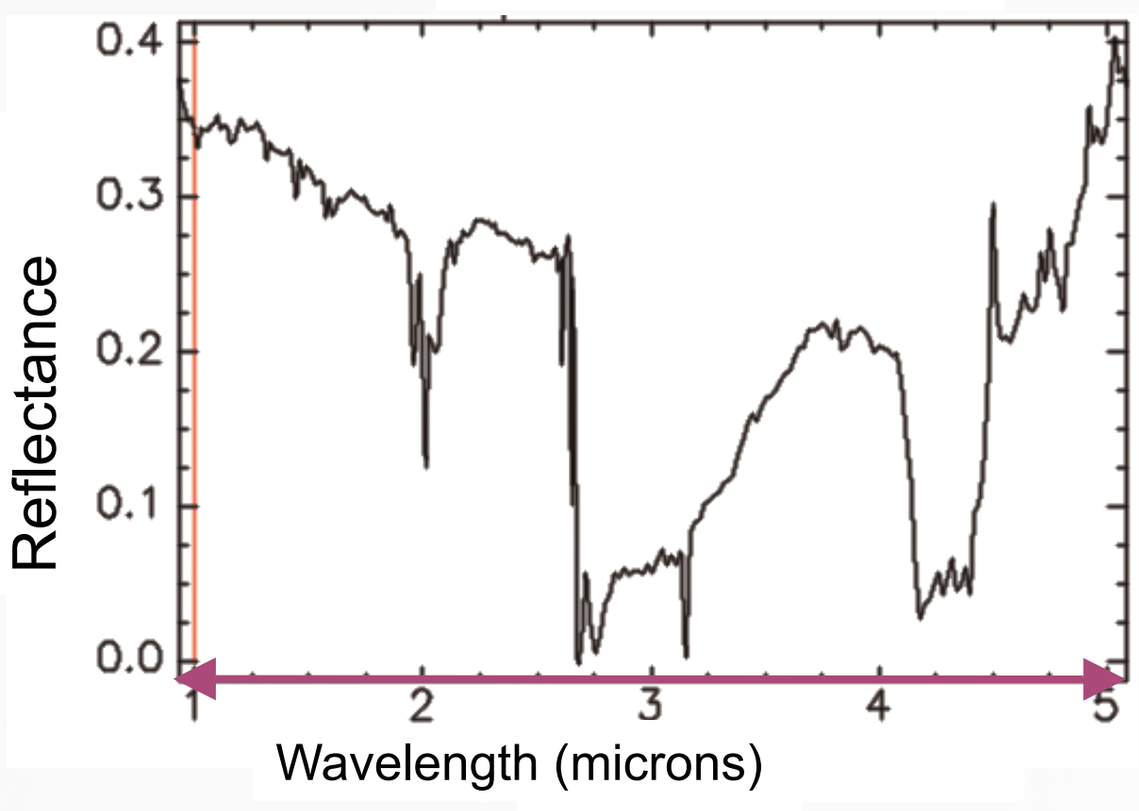
DATASET : 1000 Cubes of
256 spectels, 256 lines * 2000 columns = 500 000 pixels.

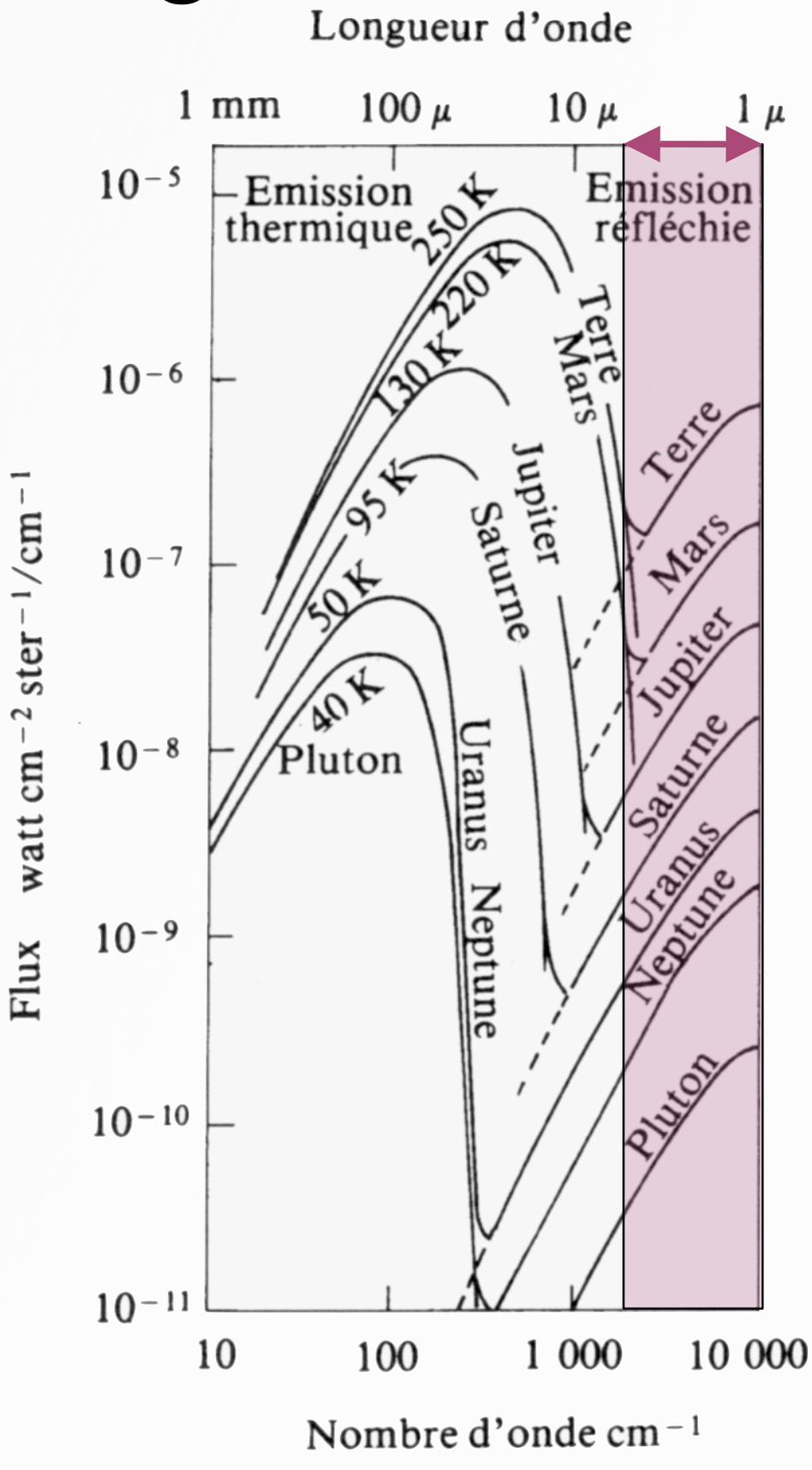
Formation of the OMEGA signal

Contribution :

- atmosphere
- surface

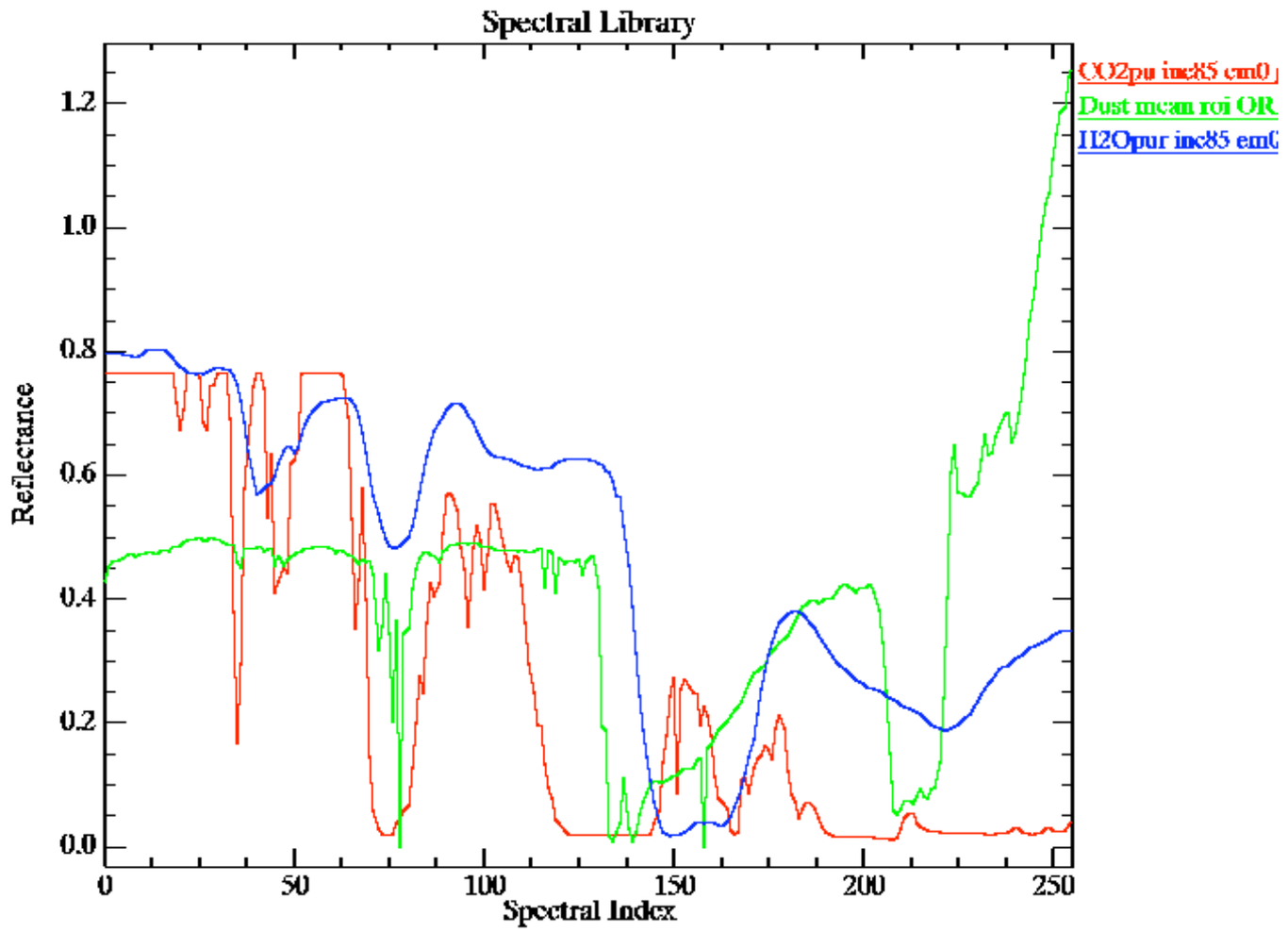






Wavanglet

- Spectral pattern recognition :
  - supervised
  - automatic
  - fast
  - independent of observation geometry

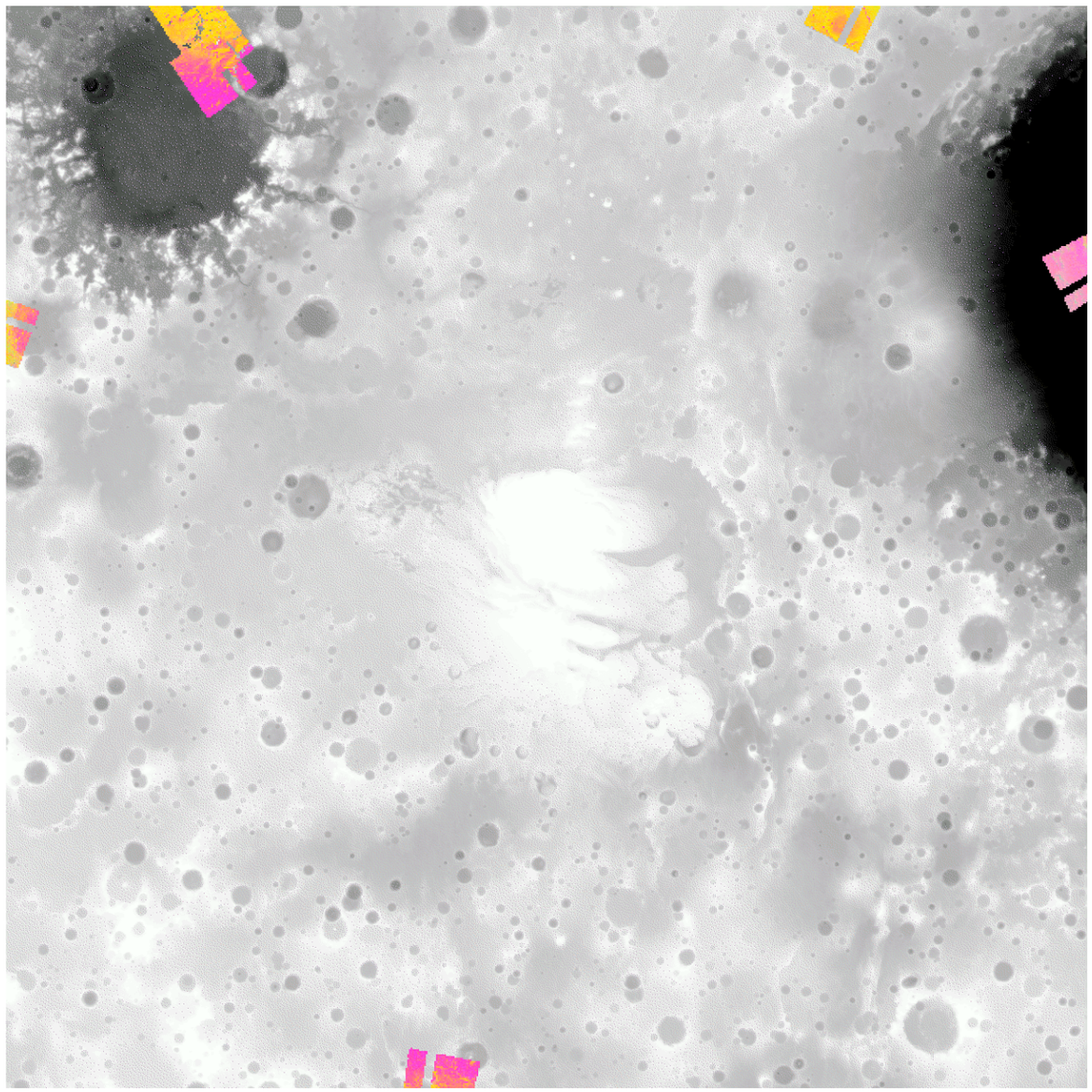


Schmidt, F.; Doute, S. & Schmitt, B., Wavanglet : an efficient supervised classifier for hyperspectral images, *IEEE Transactions on Geoscience and Remote Sensing,* 2007

Mass treatment

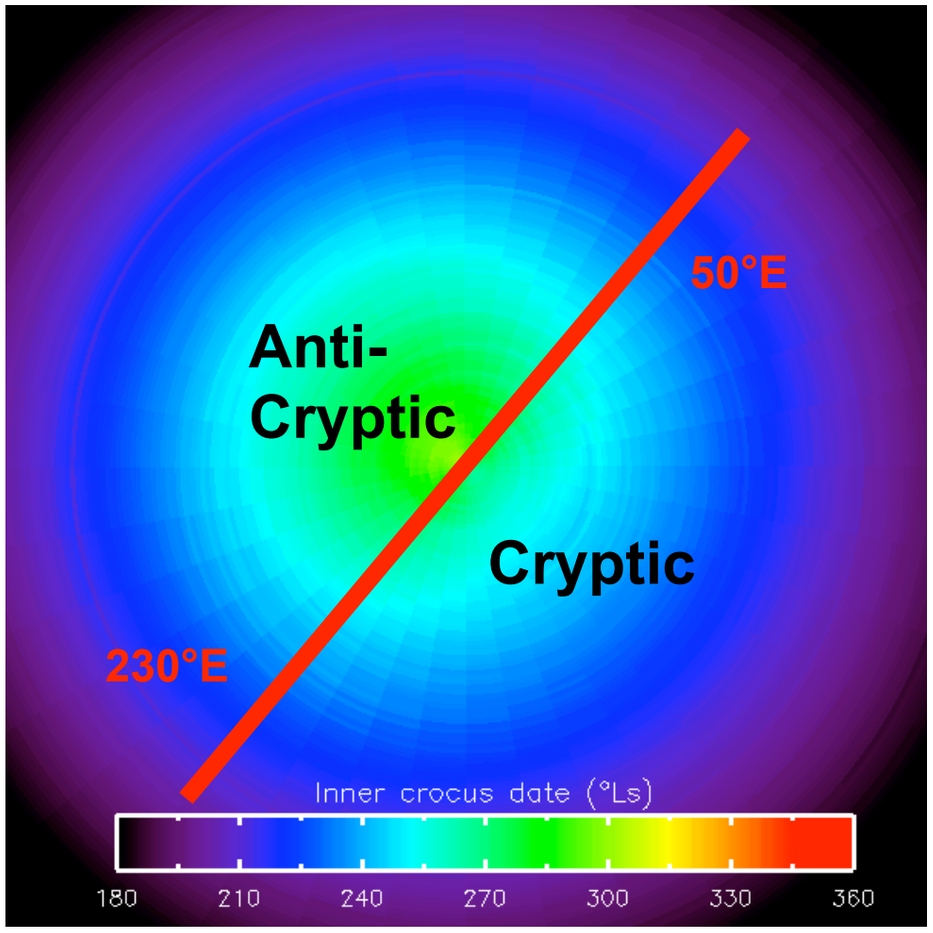
- Detection of water and CO_2 ice :
  - –on the complete OMEGA dataset
  - –Map projection

⇒Seasonal South Polar Cap recession in 2005

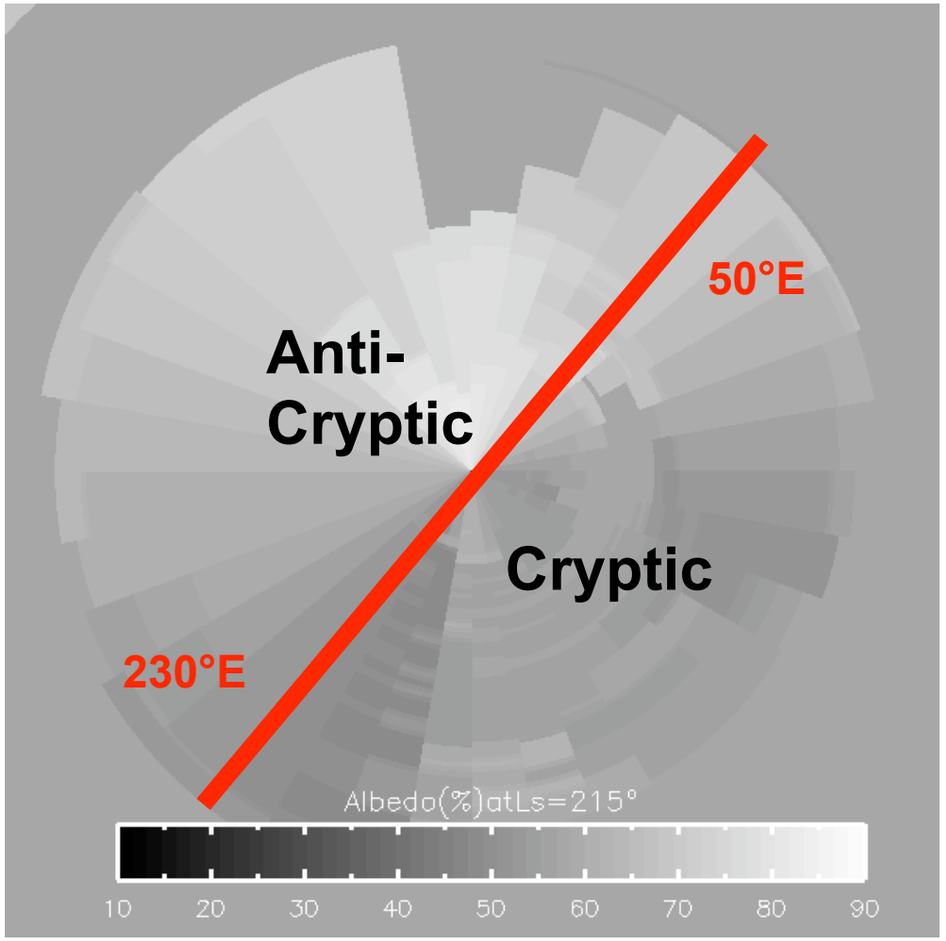


Extraction of crocus dates and albedo

- map of interpolated crocus dates and albedo



crocus date : date of end of sublimation



albedo : interpolation in time and space

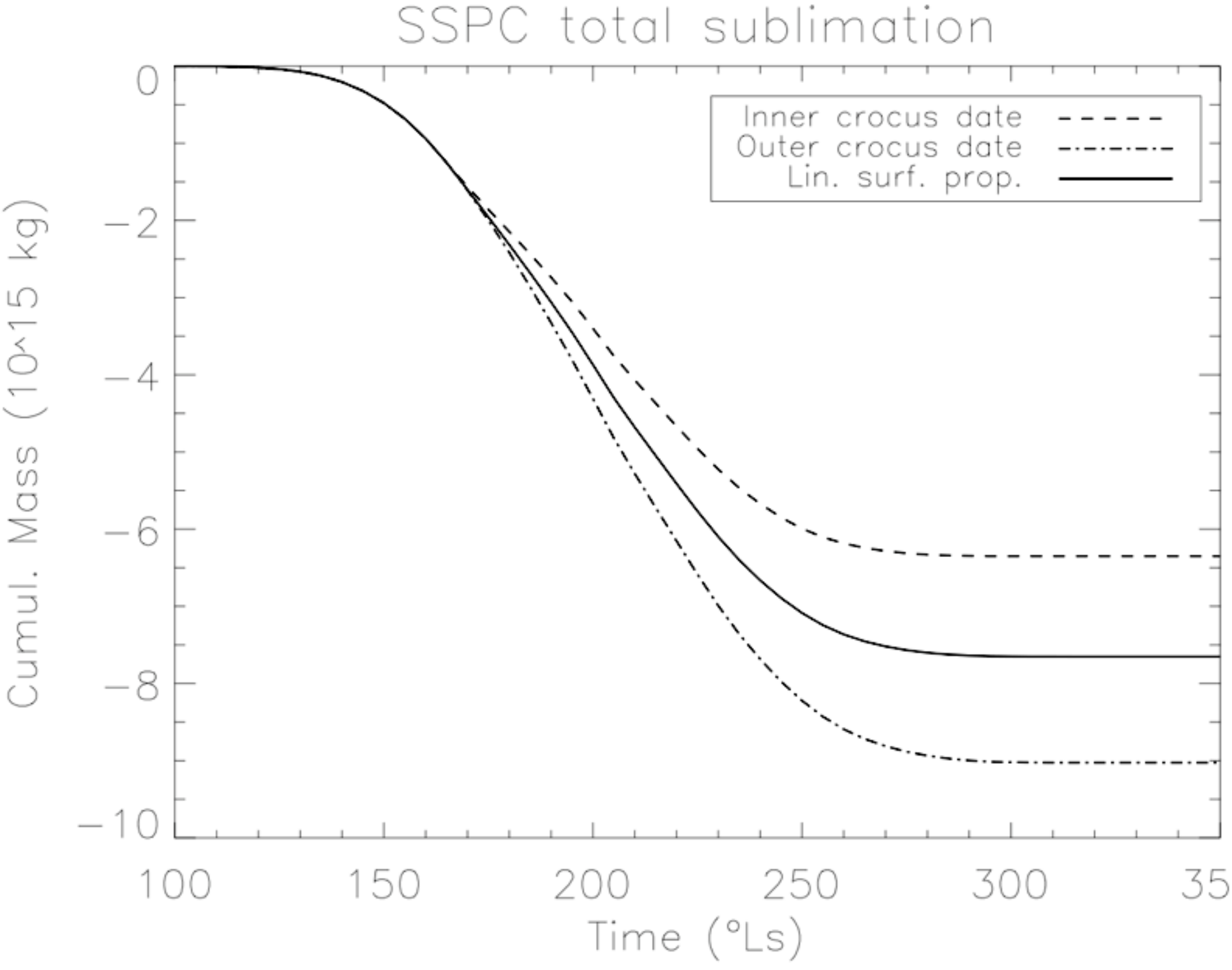
CO_2 ice sublimation model

- CO_2 release model : D-frost
  - CO_2 ice in equilibrium with the gas (atmosphere)
  - radiative balance at the surface
  - slope and shadow

$$\frac{\partial M_{CO_2}}{\partial t} = (F^{out}_{therm} - W^{in}_{sun} - W^{in}_{scat} - W^{in}_{IR} - W^{in}_{floor} - F^{in}_{cond}) \frac{1}{L_{CO_2}}$$

Schmidt, F. et al., *Icarus*, 2008, (under review)

Total sublimation



Total : 7.7 10^{15} kg

Compatible with :

- GRS

N. J. Kelly, et al., (2006) JGR E , 111, 3

- HEND

M. L. Litvak, et al., (2007) JGR E, 112, 3

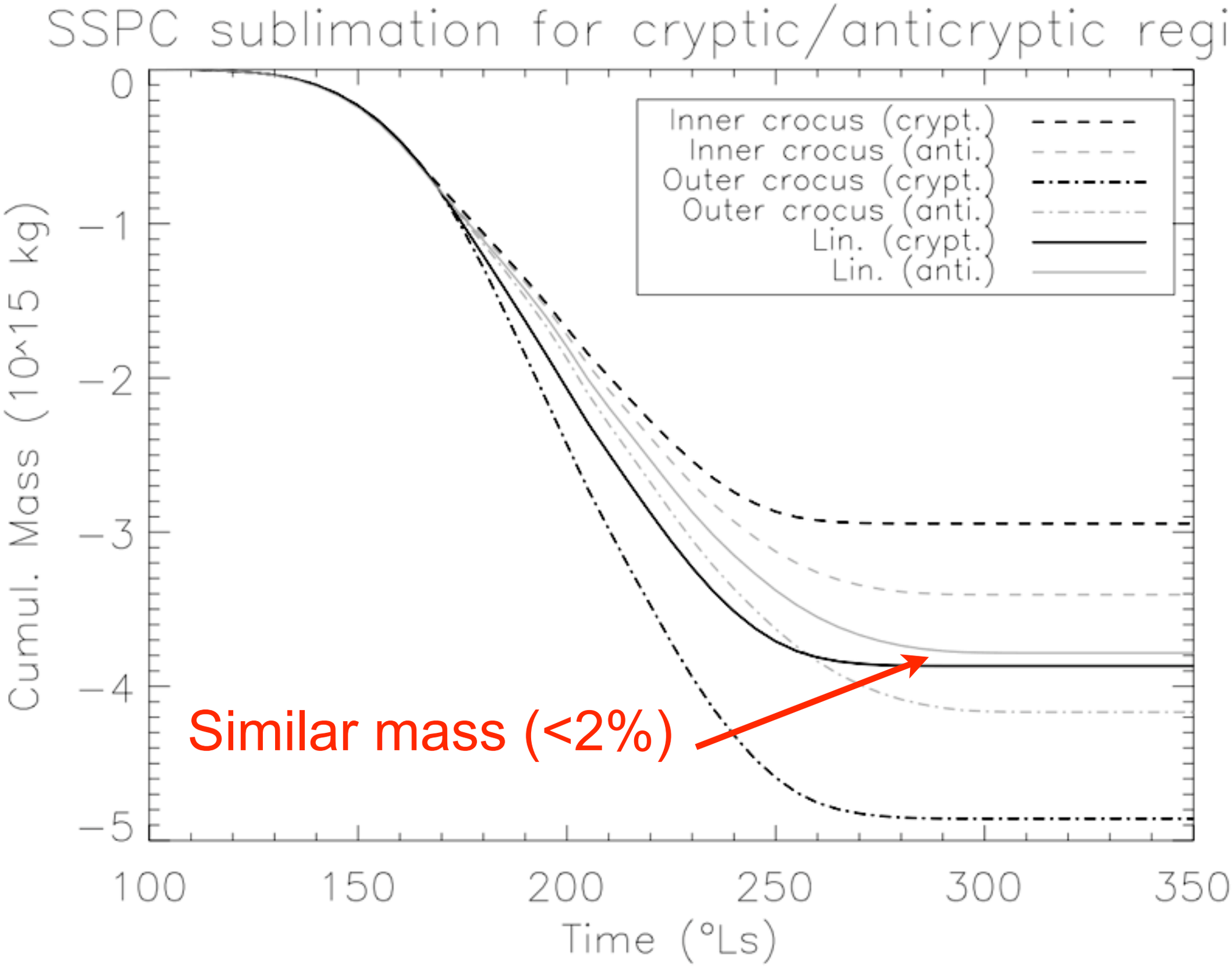
- gravity

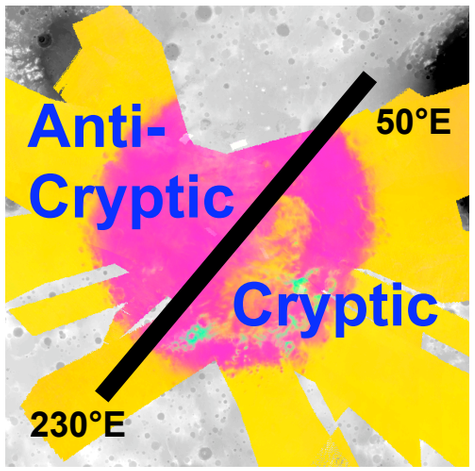
Karatekin, T. et al. (2006), JGR E, 111, 6003

- GCMs

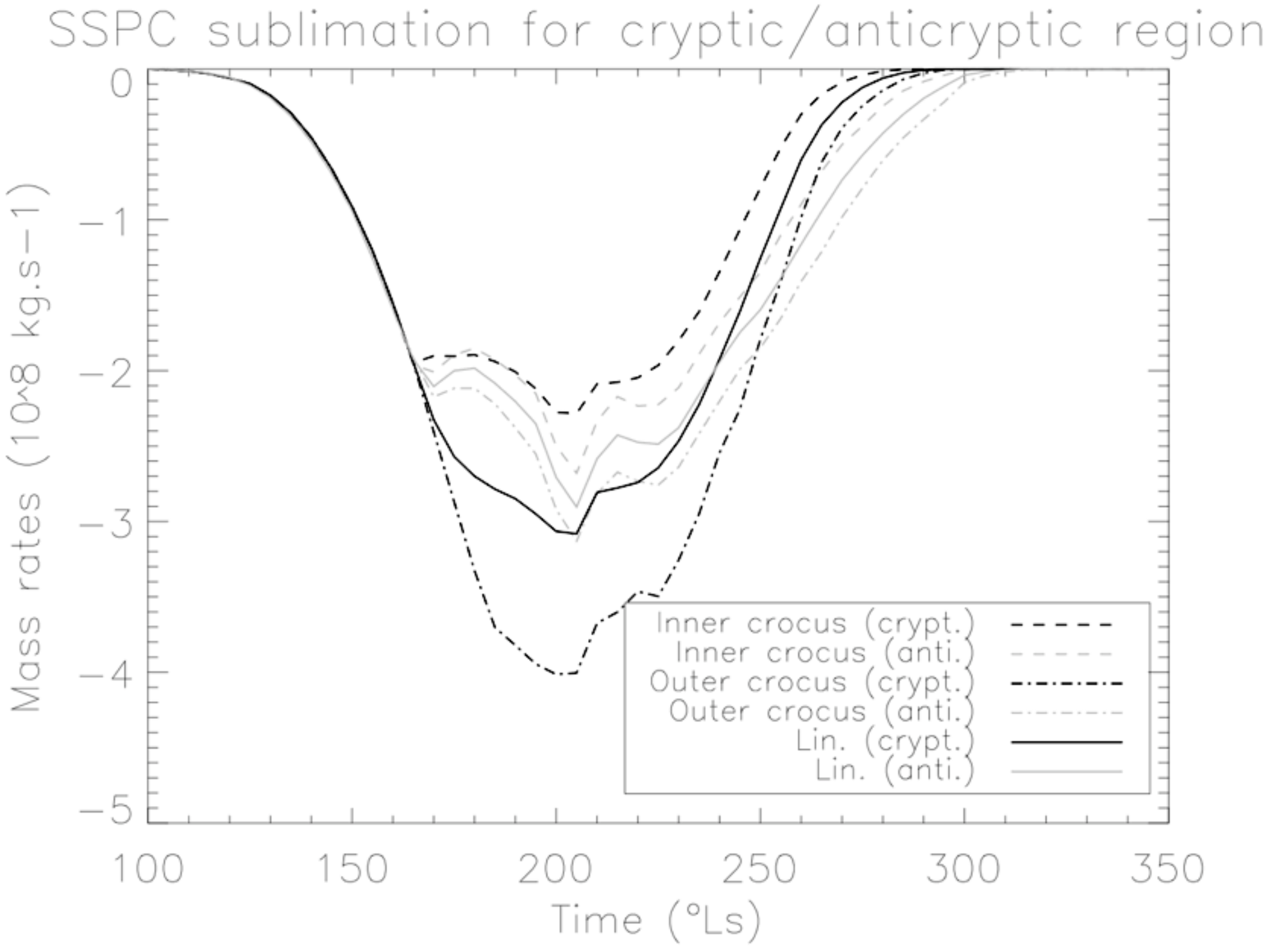
F. Hourdin, et al, (1995) JGR E, 100

Regional sublimation

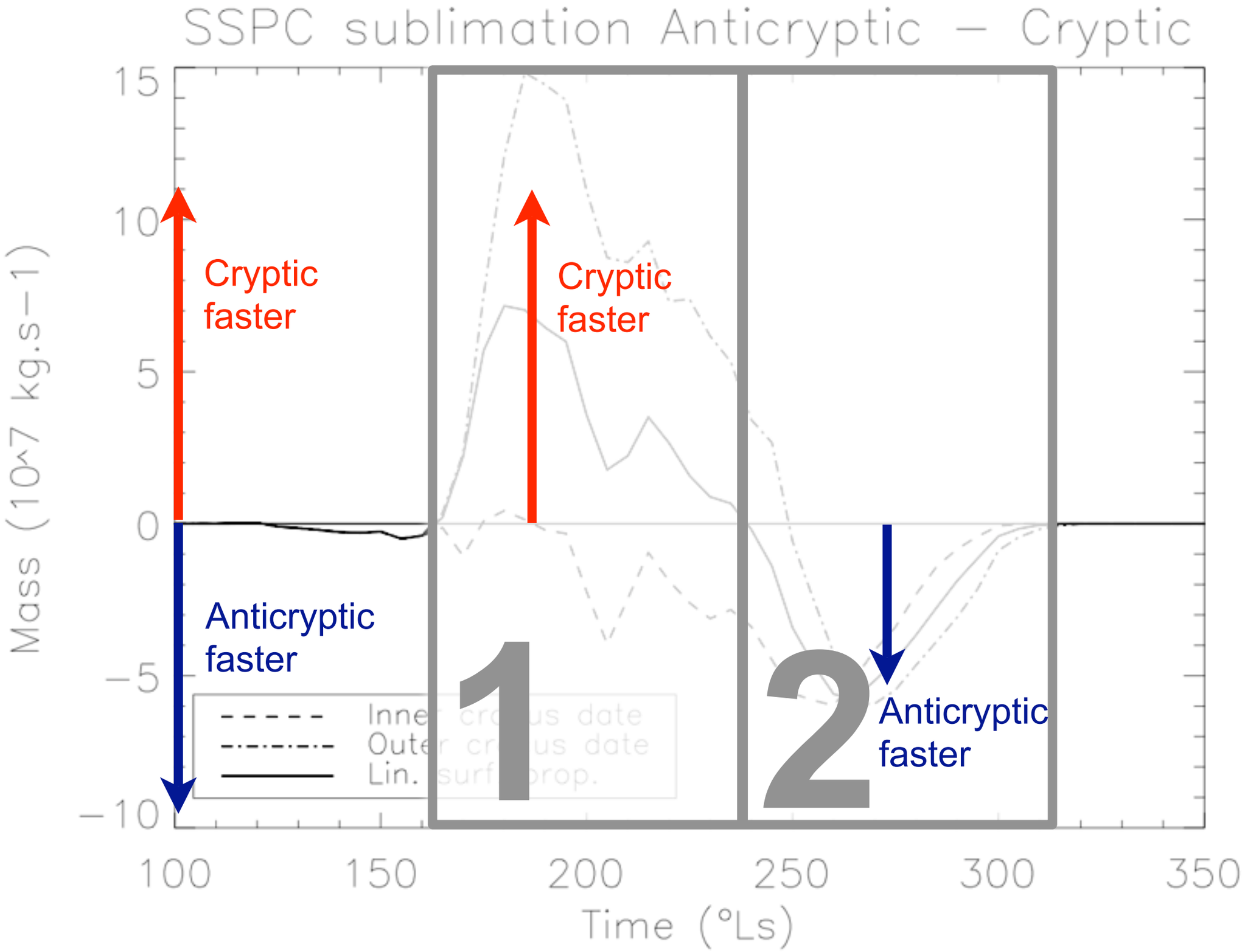




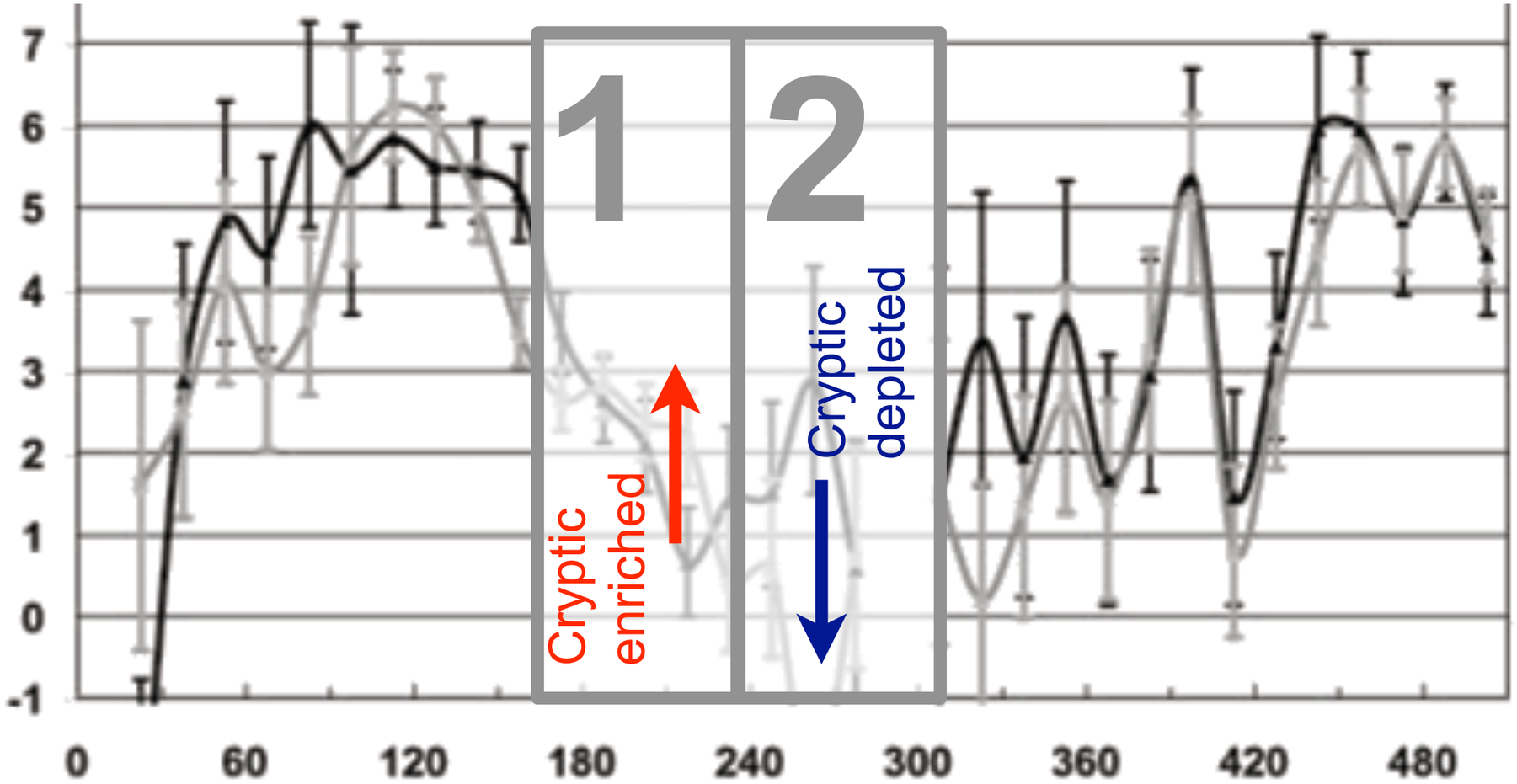
Sublimation rate



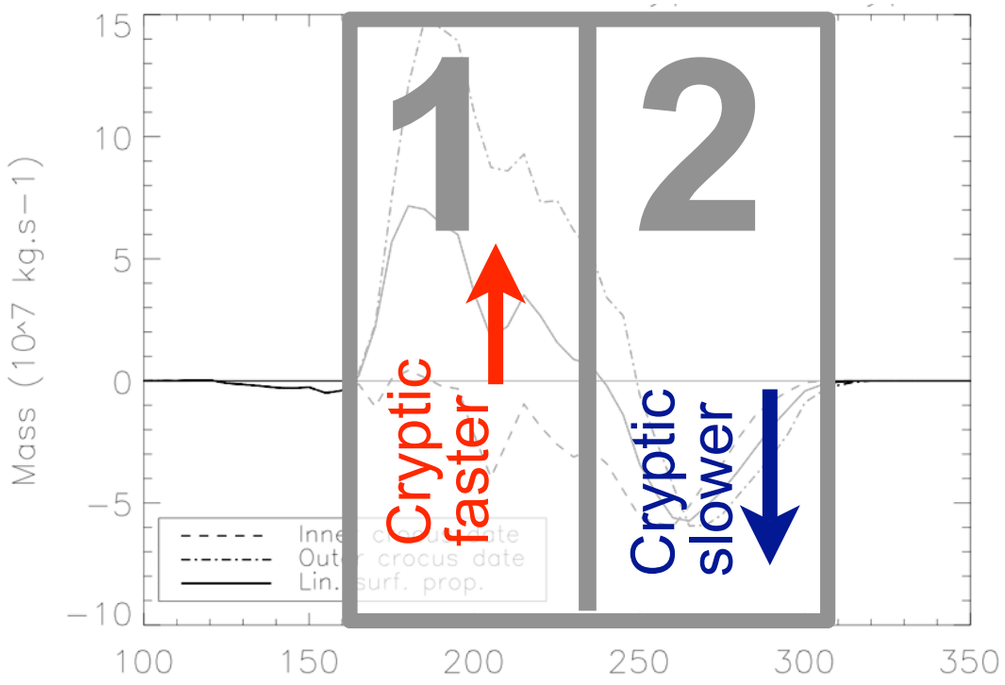
Sublimation rate difference



Argon a non condensable gas



Sprague, A. et al., JGR, 2007



1 Faster sublimation but enriched in Ar

2 Slower sublimation but depleted in Ar

?

Conclusion

- Pump up of the southern atmosphere :
  - symmetric in time average
  - two steps in time
    - faster in cryptic then in anticryptic

- Argon measurements not consistent
  - dynamical effect ?

- Implications
  - zonal wind ?
  - stability of the permanent cap ?

Others activities at ESAC

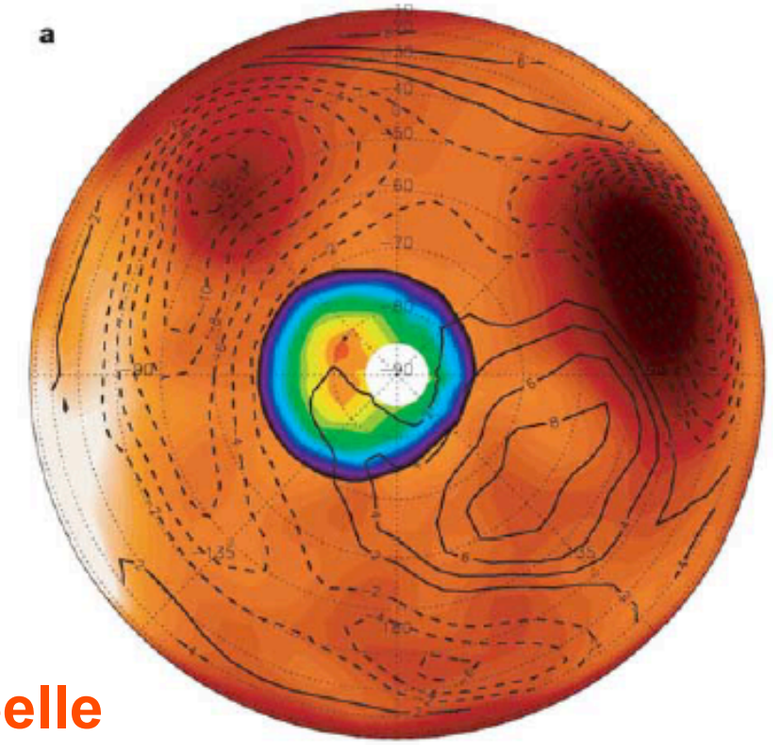
- Hyperspectral data analysis : ICA, bayesian analysis
- Polar geology : volcanism, habitability
- Spectroscopic analysis : ice and mineralogy


UEFA
EURO2008
Austria-Switzerland

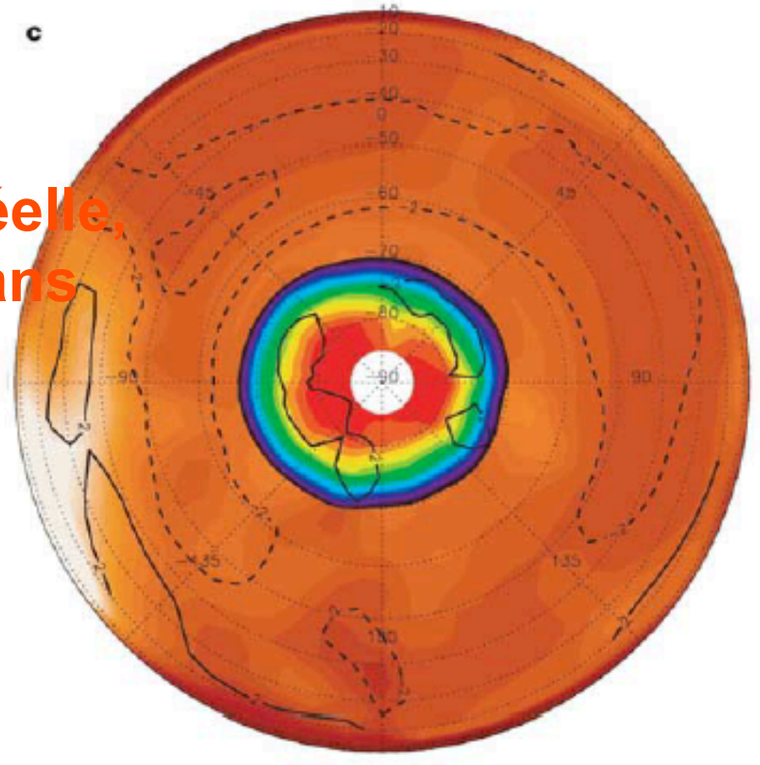
Mode de dépôt

- Condensation directe Vs précipitation de neige
  - Asymétrie de précipitation due à la topographie
  - ⇒petits grains
  - ⇒Albédo plus fort

Colaprete, Nature, 2005



Topographie réelle



Topographie réelle, sans Hellas, sans Argyre

Métamorphisme

- Augmente la taille des grains

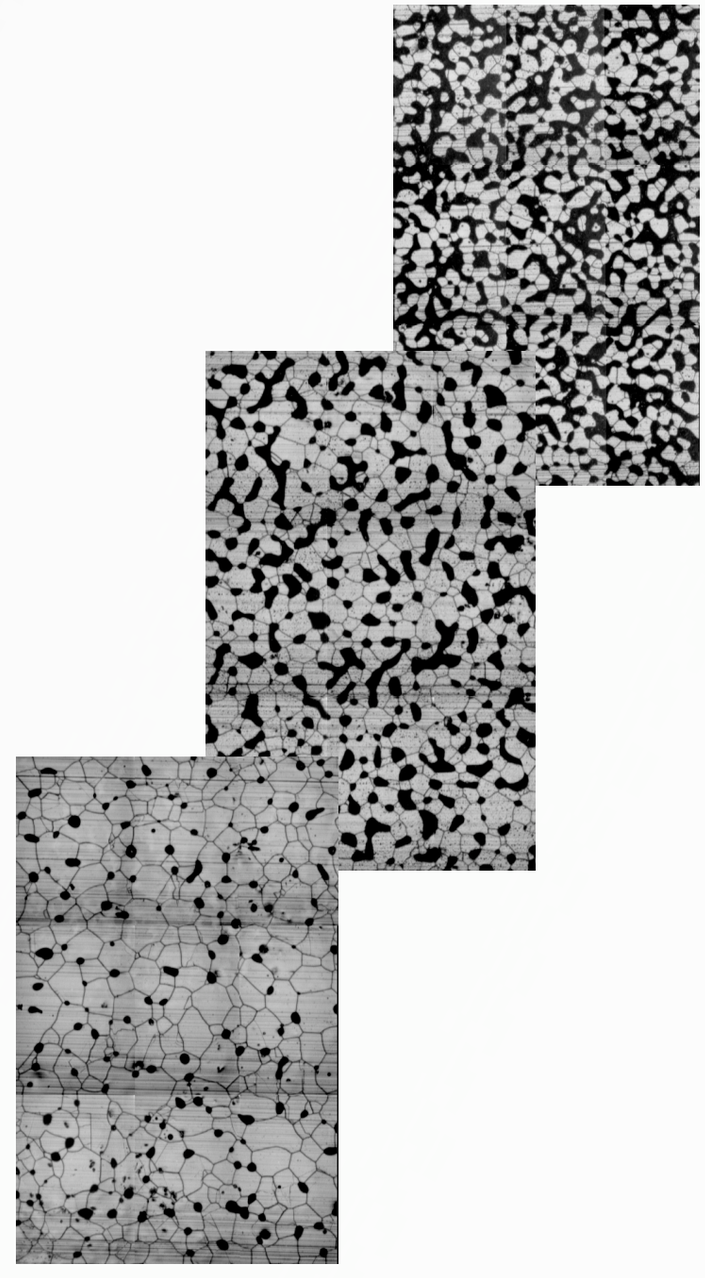
- Boucle de rétroaction positive
  - –Albédo plus faible

  ⇒Absorption solaire plus grande

  ⇒Métamorphisme plus fort

  ⇒ Taille de grain plus grande

  ⇒ Albédo plus faible



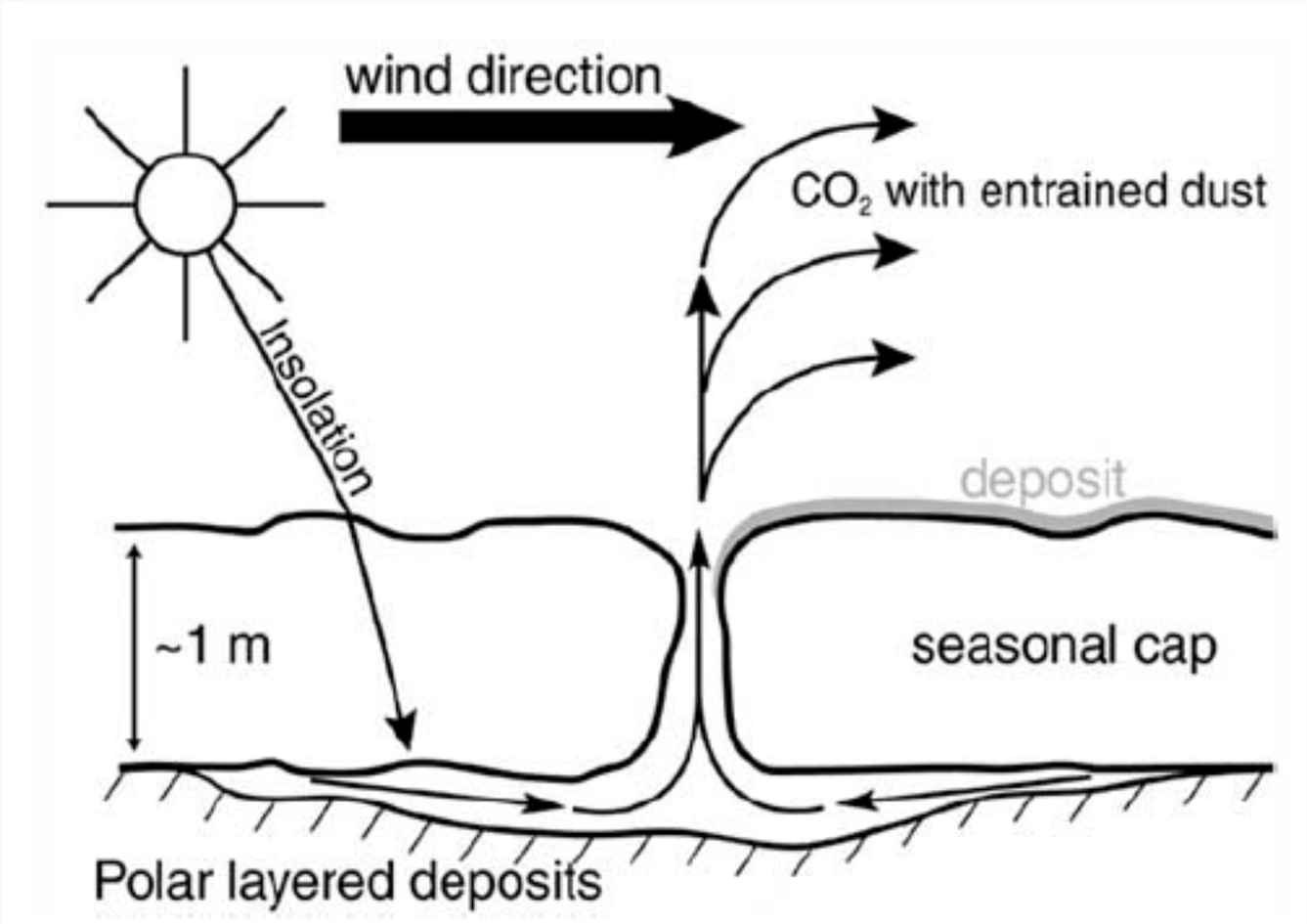
Credit : LGGE

Précipitation de poussière

- Différentes sources :
  - –Atmosphère
  - –Geysers

Piqueux, JGR, 2002

Kieffer, Nature, 2006



Mécanisme de nettoyage

- Différents mécanismes :
  - –Par enfoncement des poussières
  - –Par extraction

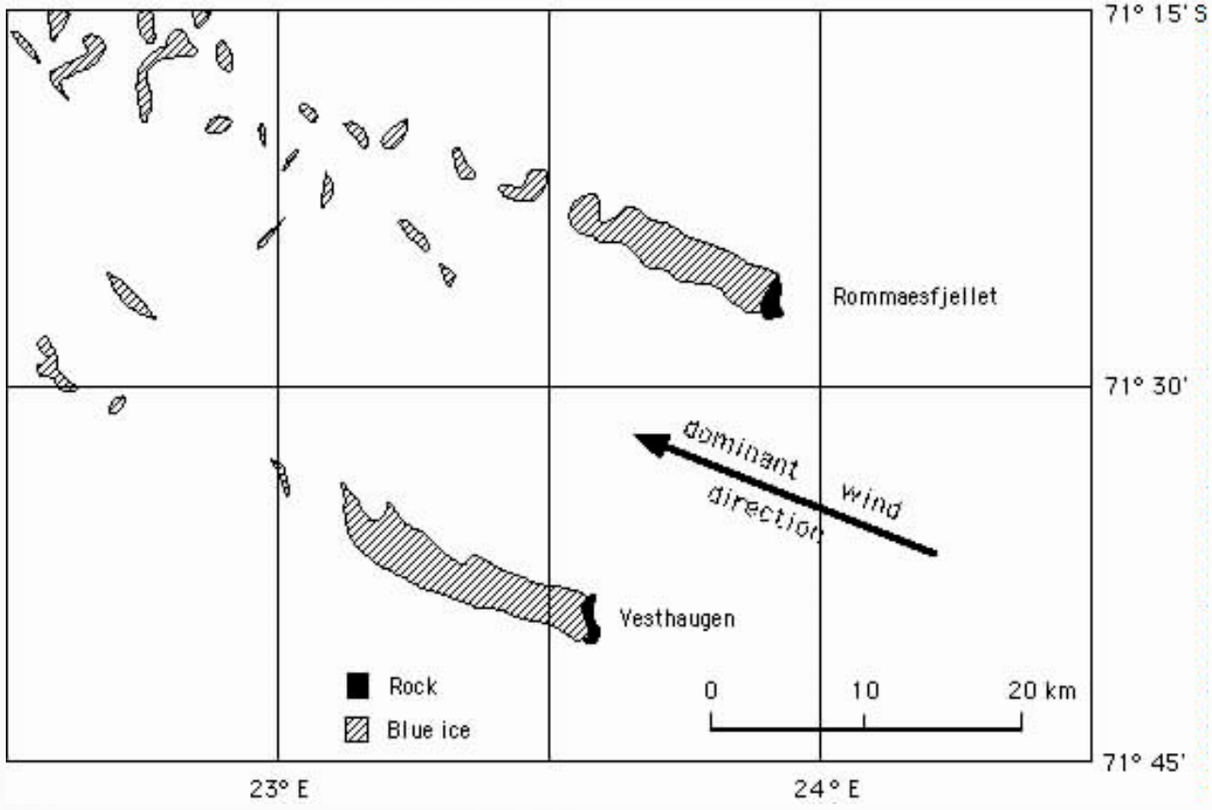
Kieffer, JGR 2000

Portyankina, Mars Polar Conf., 2003

- Boucle de rétroaction négative
  - –Albédo plus faible
  - ⇒Absorption solaire plus grande
  - ⇒Nettoyage plus efficace
  - ⇒Albédo plus fort

Ablation mécanique

- Analogie terrestre
  - Topographie créée de la turbulence
  - Blue Ice Aera

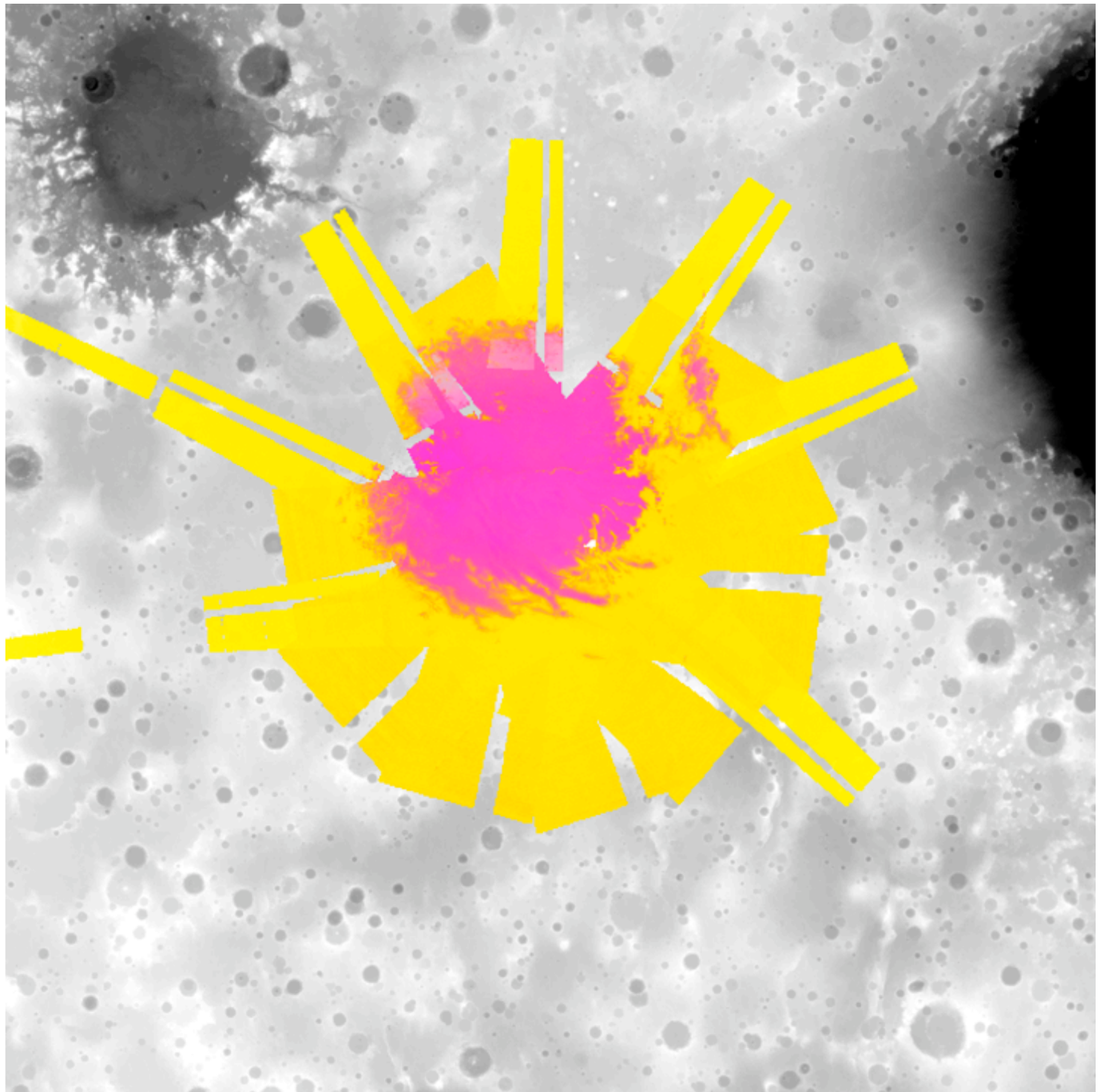


Bintanja, Rev. Geophysics, 1999

- Mars :
  - Peu probable (faible densité atmosphérique)
  - Observation

Montagnes de Mitchell

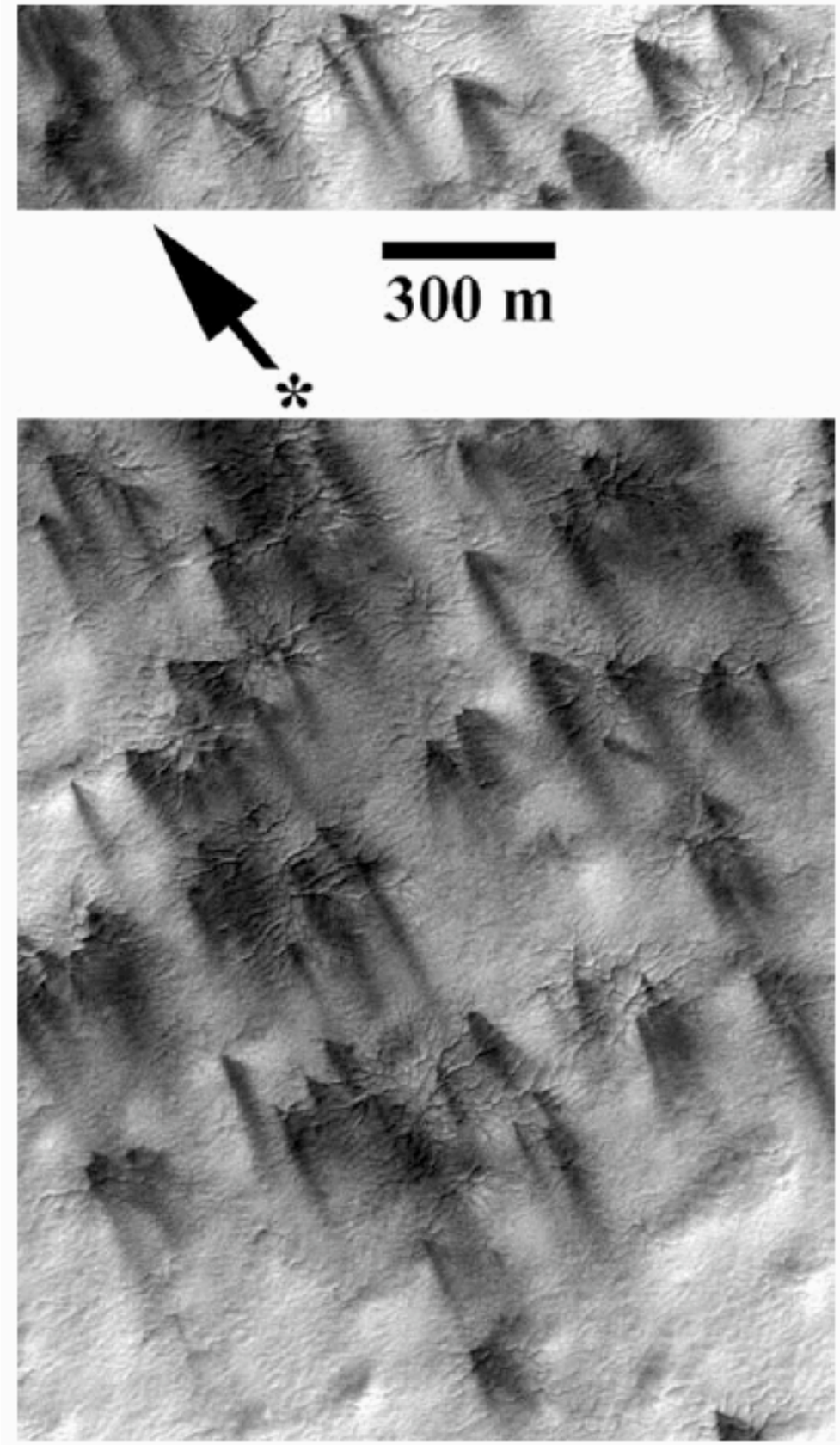
- Mosaique :
  - Ls=264-266°



29

Spiders

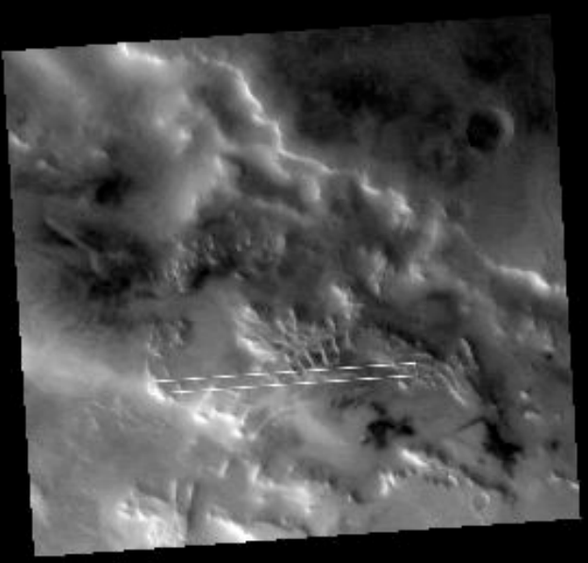
- Observation MOC
  - –Ls=208



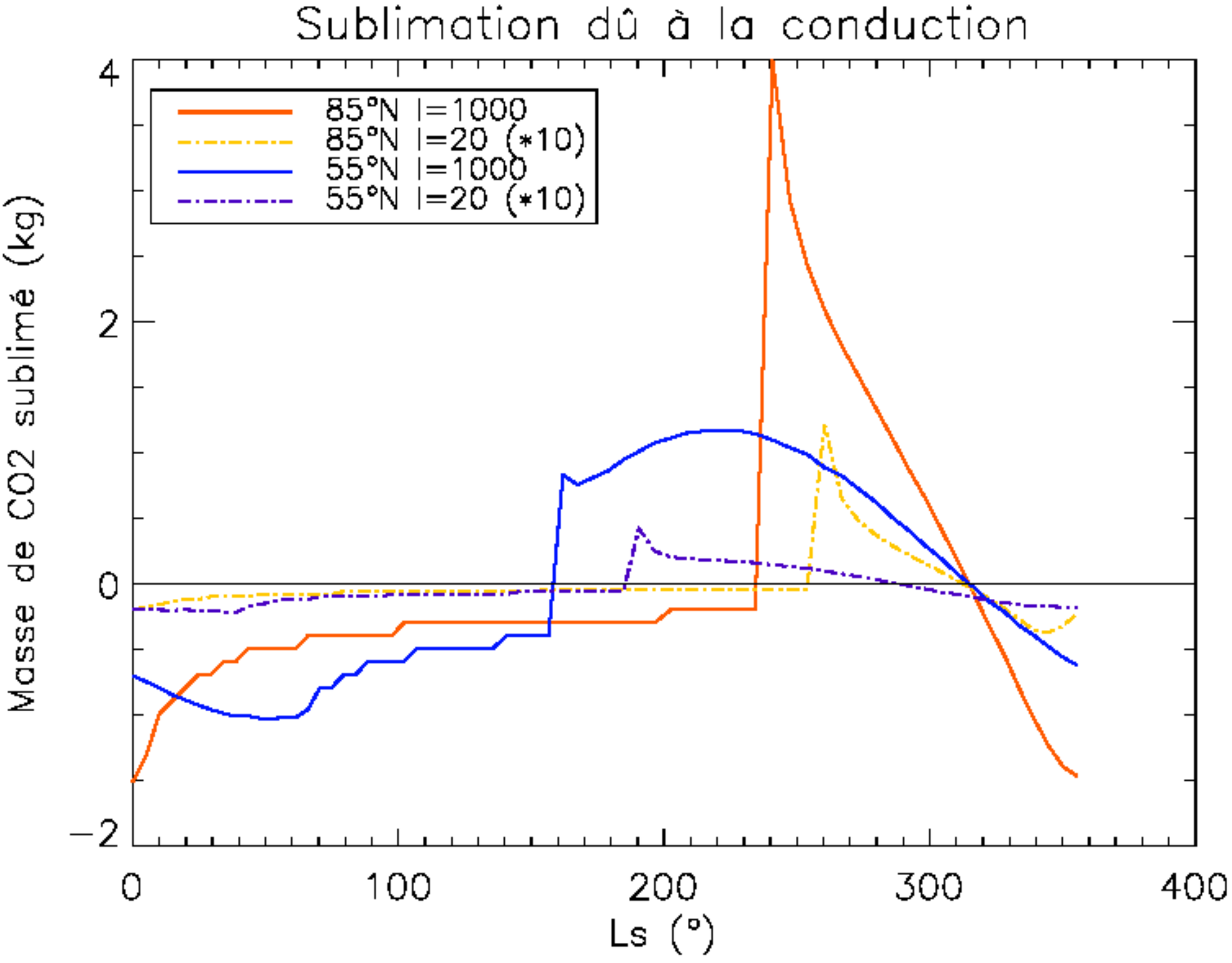
Spiders ?

- Inca city (81.5°S / 64.98° W) MOC

Ganna Portyankina, personal communication



Credits : JPL/NASA/Malin Space Science Systems


Sublimation dû à la conduction
85°N I=1000
85°N I=20 (*10)
55°N I=1000
55°N I=20 (*10)
Masse de CO2 sublimé (kg)
4
2
0
−2
0
100
200
300
400
Ls (°)