

Evidence of a new component in the Martian 3 μm water band under North polar latitudes

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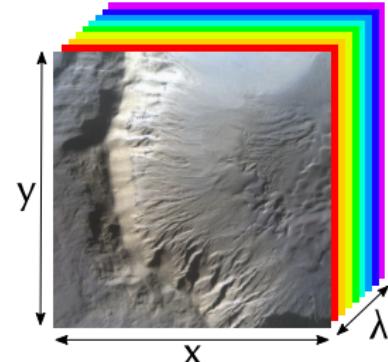
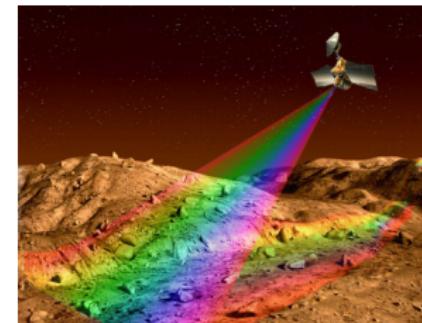
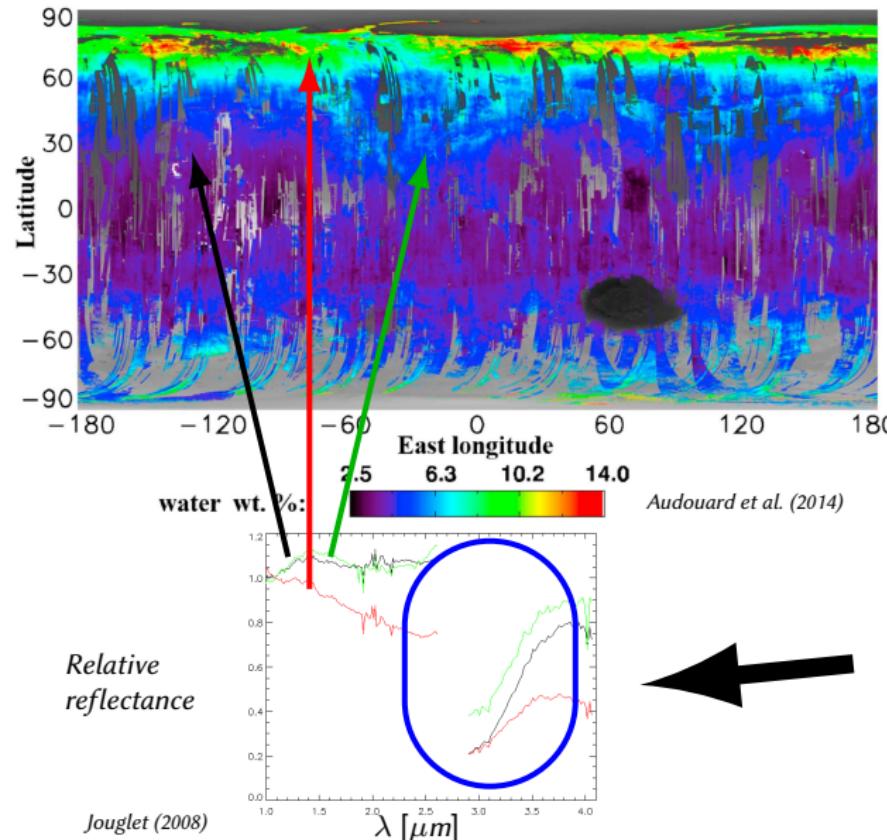
Elbereth Conference - 12th February 2021



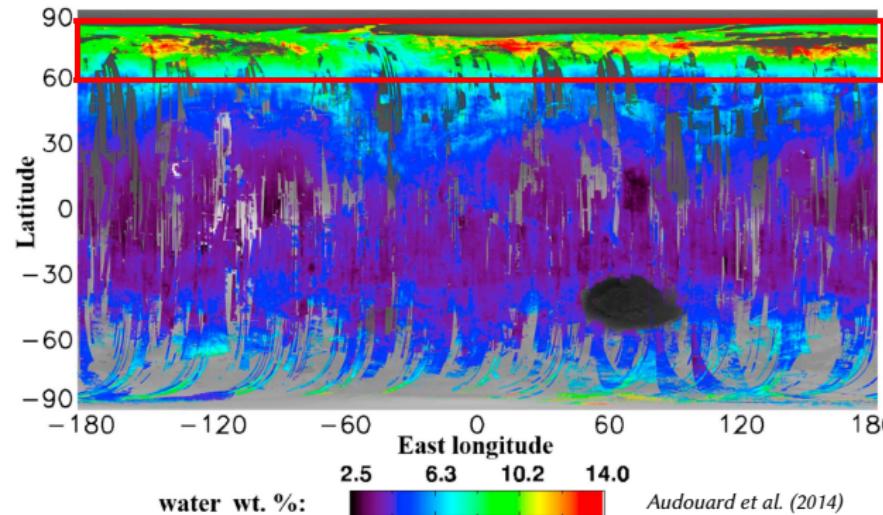
École Doctorale d'Astronomie & Astrophysique
d'Île-de-France



Martian surface aqueous alteration



Martian surface aqueous alteration



Apparent increase
under polar latitudes.



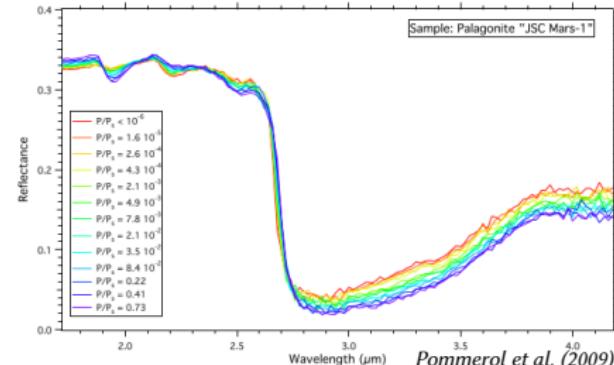
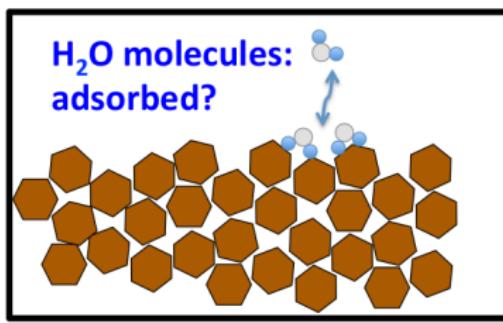
Origin ?

- ▶ surface / atmosphere ?
- ▶ contemporary / old ?

Summary of current main hypotheses

► Adsorbed water?

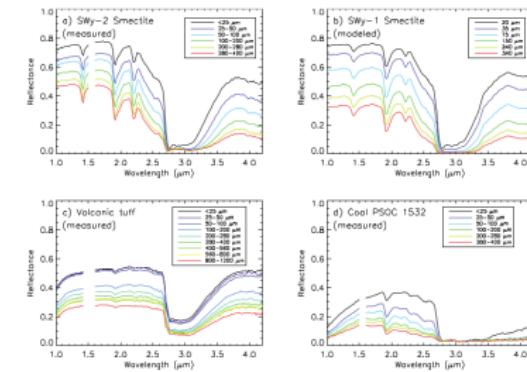
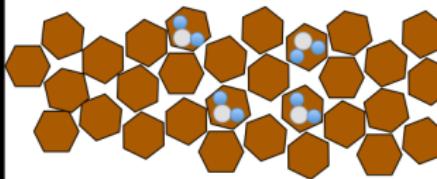
- Surface hydration measurements : 10-11% with OMEGA (*optical surface*) vs 1-2% with Phoenix (*subsurface*)
- Important exchanges with the atmosphere → *Seasonal cycle*
- Expected correlation with the 1.9 μm band



Summary of current main hypotheses

- ▶ Adsorbed water?
- ▶ Chemical alteration?
 - ▶ Observations of hydrated minerals on Mars (sulfates, carbonates...) from both the orbit (OMEGA) and the surface (Phoenix, Curiosity)
 - ▶ Alteration by the ice from the seasonal polar cap?
 - ▶ Presence of other spectral signatures

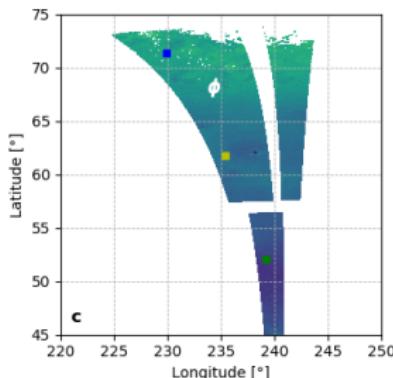
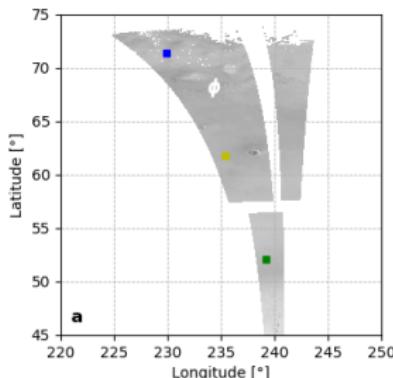
**H₂O molecules:
structural?**



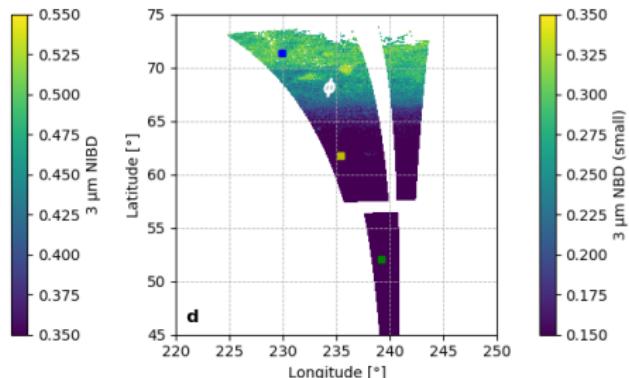
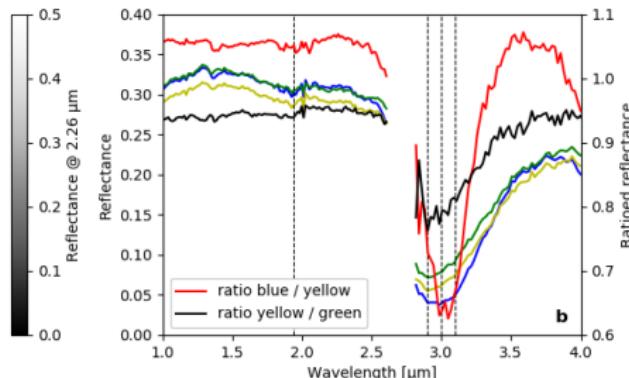
Pommerol and Schmitt (2008)

New signature in the 3 μm band

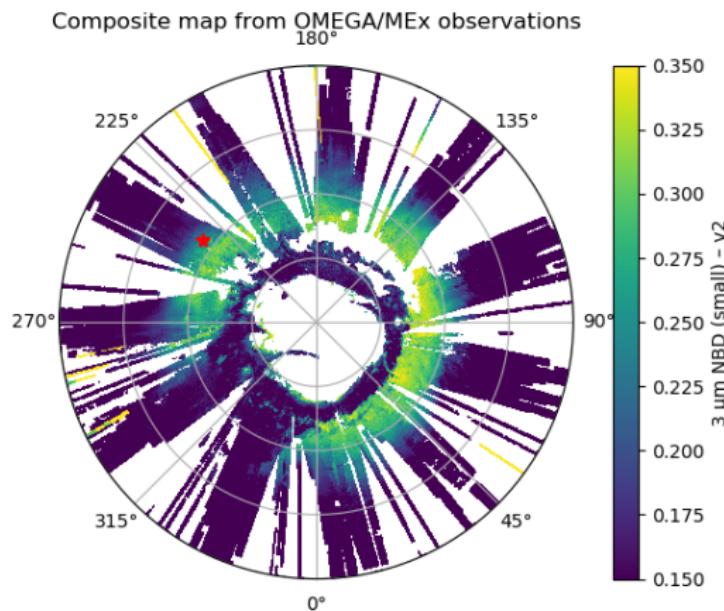
OMEGA/MEx observations ORB0979_3/4
 $L_s = 105^\circ$ | MY 27 | loc't ~ 15h



Average spectra
Dotted lines : 1.94 | 2.9 | 3.0 | 3.1 μm

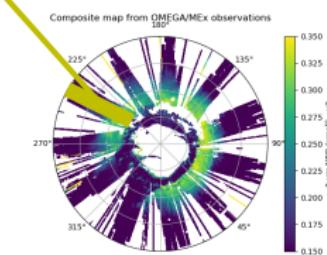
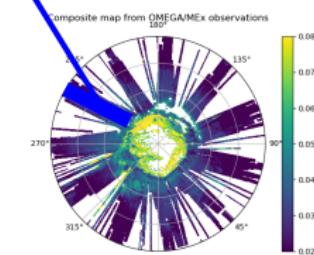
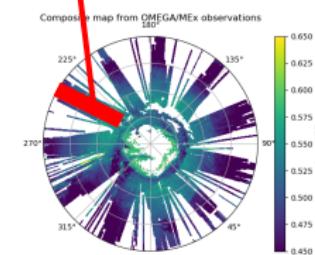
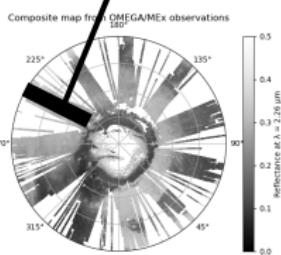
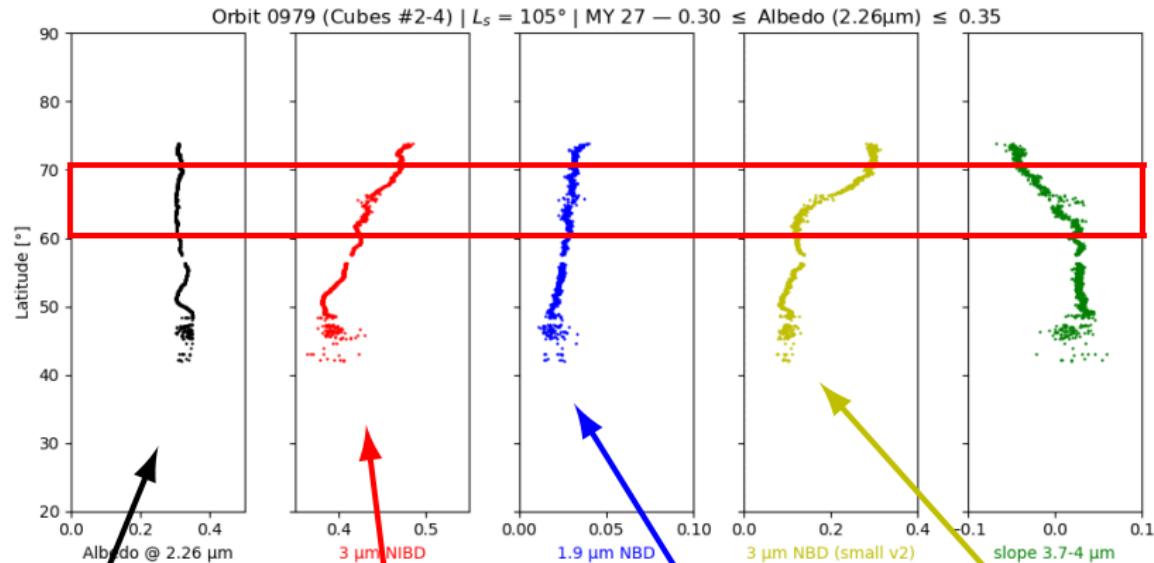


Spatial distribution

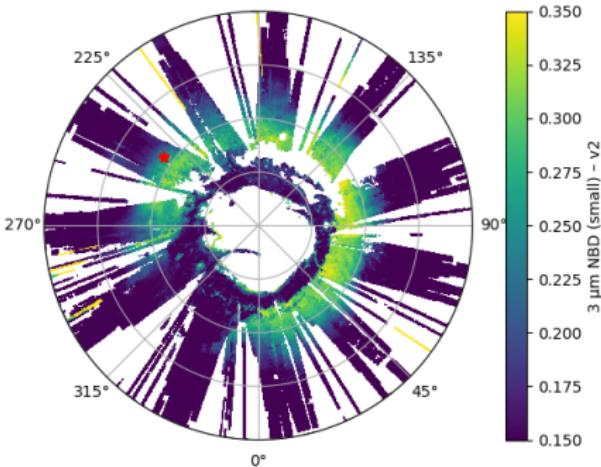


► Presence of an **annular structure**

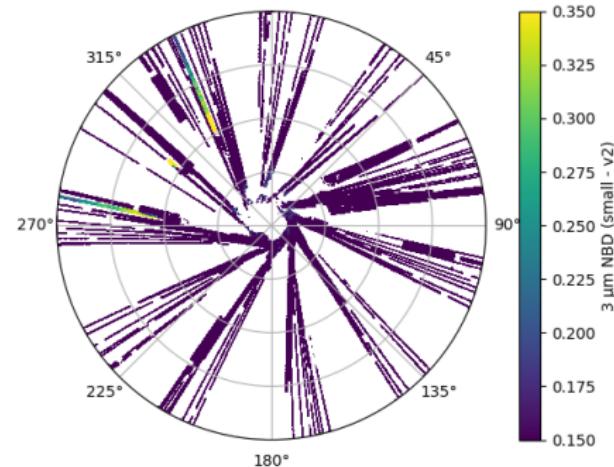
Comparison to other criteria



Position of the 3 μm band - North / South comparison

Composite map from OMEGA/MEx observations
180°

Northern summer
 $(L_s = 100^\circ - 150^\circ, \text{MY } 27)$

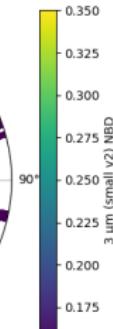
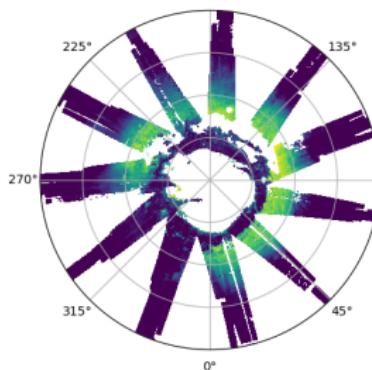
Composite map from OMEGA/MEx observations
0°

Southern summer
 $(L_s = 300^\circ - 350^\circ, \text{MY } 26-27)$

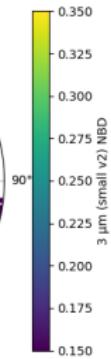
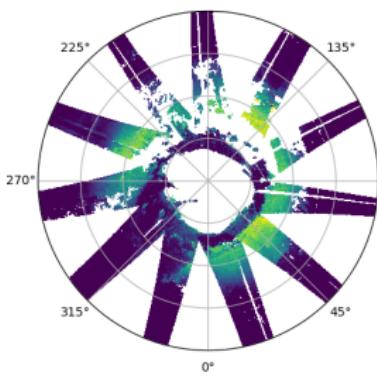
► Specificity of the Northern hemisphere

Temporal stability

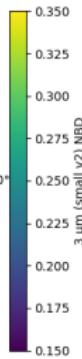
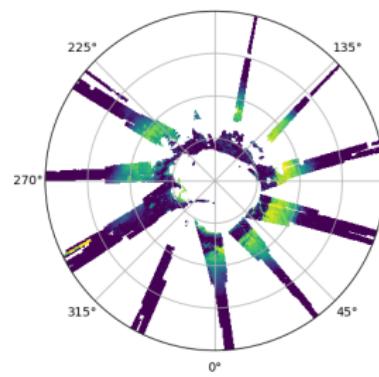
$L_s = 100^\circ - 110^\circ | 180^\circ$ MY 27



$L_s = 90^\circ - 100^\circ | 180^\circ$ MY 27



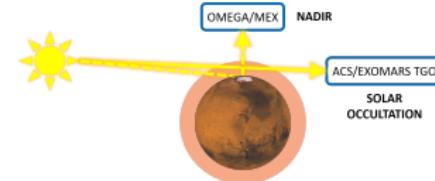
$L_s = 110^\circ - 120^\circ | 180^\circ$ MY 27



Summary

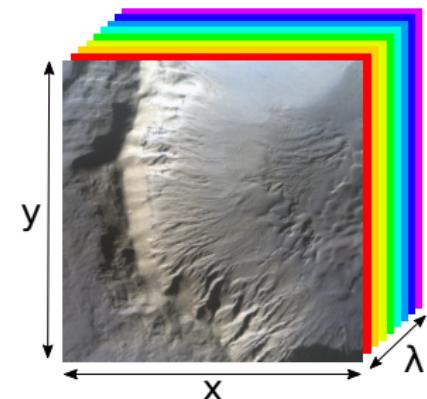
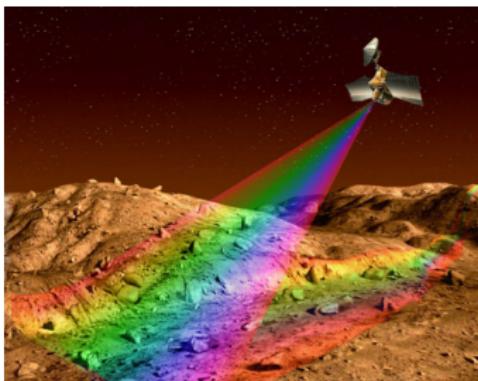


- ▶ Evidence of a specific 3 μm spectral signature in the Northern regions of Mars.
- ▶ Stable across season (L_s) and Martian years.
- ▶ Ongoing investigations to explain this signature.
- ▶ Does not match with adsorbed water.
- ▶ Probably related to the surface composition.



The OMEGA experiment onboard Mars-Express

- ▶ IR mapping spectrometer on an elliptical orbit around Mars
- ▶ 3 channels covering the 0.38 – 5.1 μm spectral range
- ▶ Spatial resolution from 350 m to 5 km
- ▶ **Operating since 2004 → 15 years of available observations**

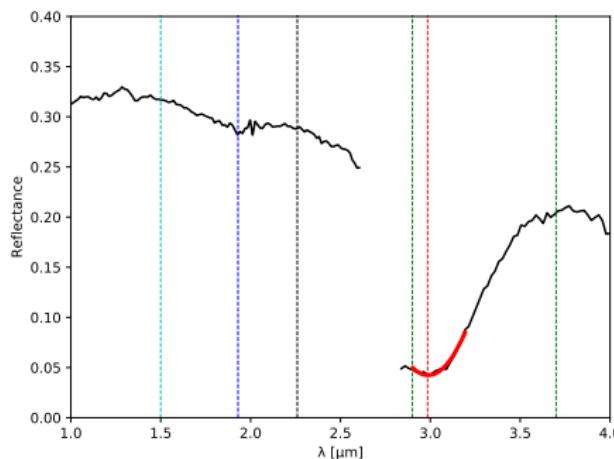
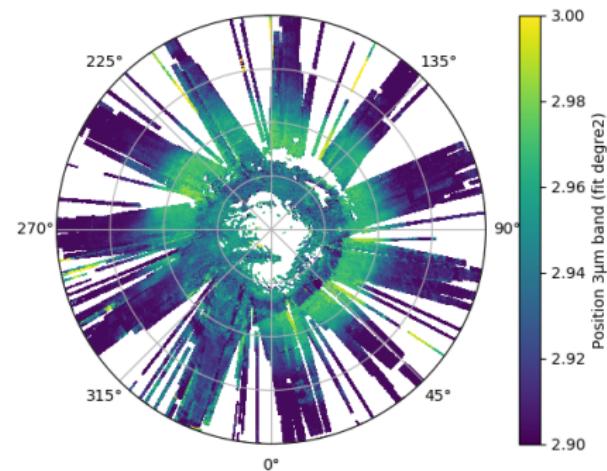


OMEGA-Py

- ▶ Implementation of analysing tools for OMEGA observations in Python based on IDL routines previously developed at the IAS.
- ▶ Python module omegapy :
 - ▶ Reading of OMEGA binary files (PDS-format)
 - ▶ Thermal and atmospheric corrections
 - ▶ Interactive display of the data
- ▶ <https://git.ias.u-psud.fr/astcherb1/omegapy/>



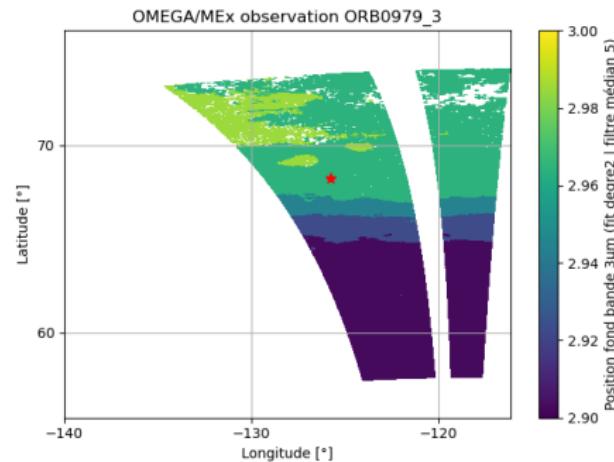
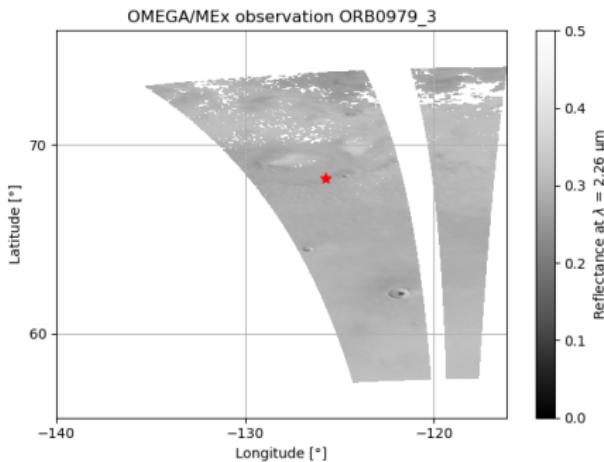
Position of the 3 μm band

Composite map from OMEGA/MEx observations
180°

2nd degree polynomial fit to retrieve the position of the minimum of the 3 μm band.

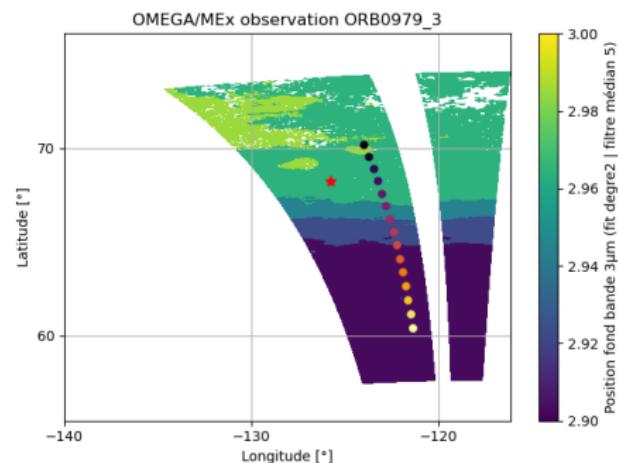
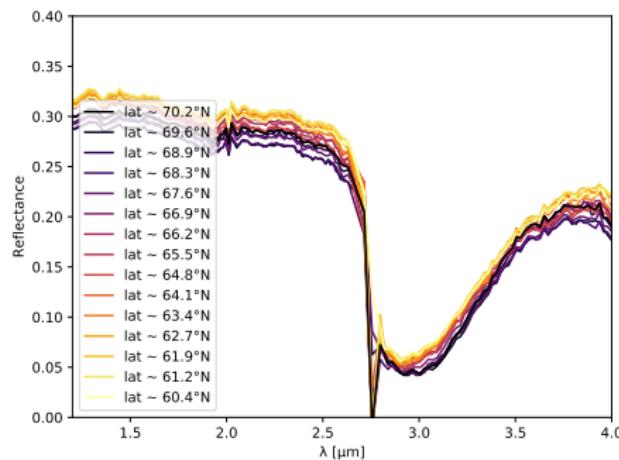
► Presence of an **annular structure**

The "jump" of the 3 μm band - Phœnix region



- ▶ *No strong albedo variations*
- ▶ *Presence of 2 regimes, with a sharp delimitation of a few degree in latitude*
- ▶ *Application of a median smoothing to enhance the step*

The "jump" of the 3 μm band - Phœnix region



The "jump" of the 3 μm band - Phœnix region

