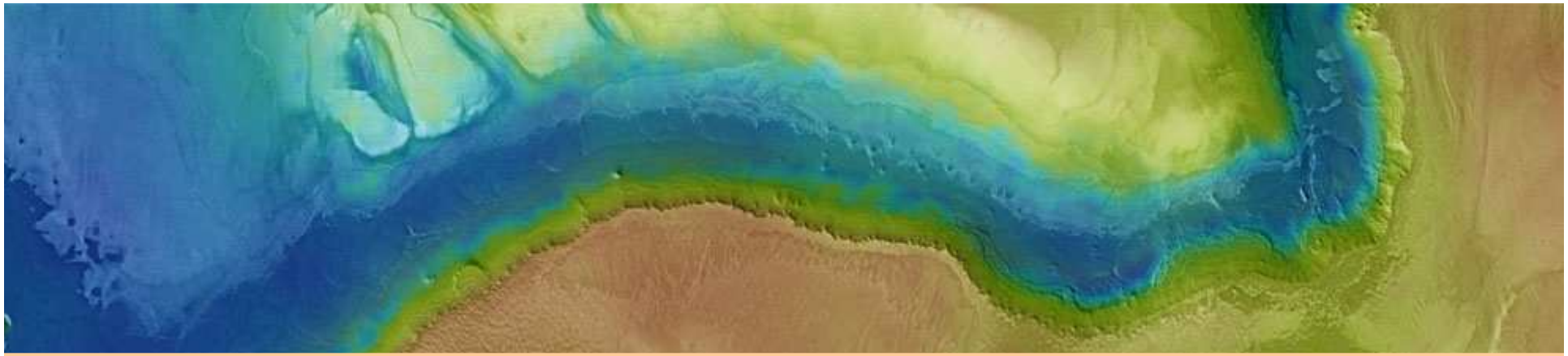


Search for the signs of atmosphere-surface interactions during Martian year from OMEGA/Mars Express data

Evdokimova N. A. [1], Rodin A. V. [1,3], Kuzmin R. O. [1,2], Fedorova A. A. [1]

[1]-IKI, Moscow; [2]- Vernadsky institute, Moscow;
[3] – Moscow Institute of Physics & Technology, Moscow

Photo by ESA

NIR OMEGA spectra (1-2.7 µm, C channel)

- Observations of the North polar cap during MY27 aphelion campain
- Water ice microstructure retrievals
- Tracking its seasonal changes
- Identification of zonal variations associated with atmospheric processes
- search for traces of the atmospheric planetary waves

OMEGA – mapping spectrometer for visible and near-IR spectral ranges

Overview

- **3 detectors:**

0.364-1.070 μm (VNIR) /96 channels

0.926-2.695 μm (C) /128 channels

2.527-5.089 μm (L) /128 channels

- **instantaneous field of view**

IFOV ~ 4.1 arcmin (1.2 mrad)

- **Spectral resolution**

λ/Δλ ~ 70-200

- **highest spatial resolution**

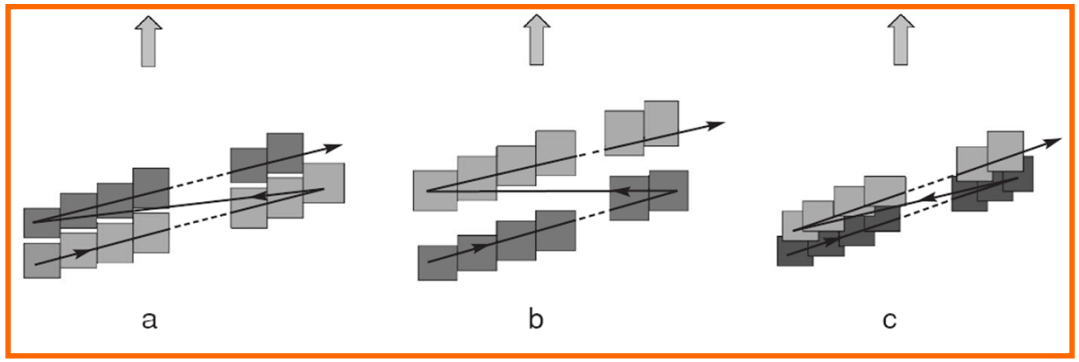
~ 300 meters (periapsis)

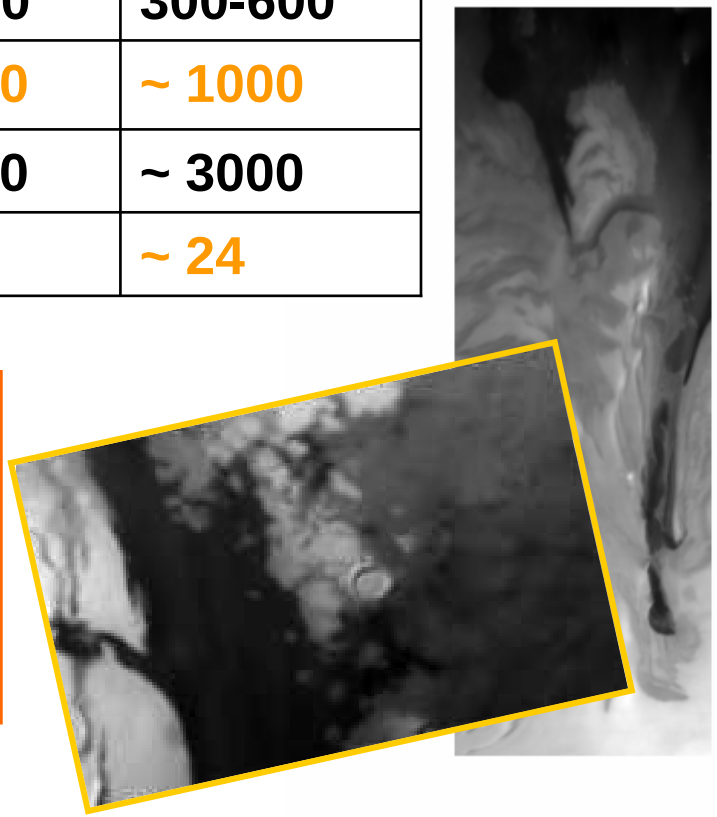
- **Cross-track swaths are**

16, 32, 64 and 128 pixels wide

Typical modes of observations.

Maximum altitude, km	300	1500	4000
“Pixel” size	<360m	<1.8km	<4.8km
Track width, pixel	16	64	128
Track width, km	5-7	60-120	300-600
Track length, pixel	~ 7500	~ 2000	~ 1000
Track lenght, km	~ 3000	~ 3000	~ 3000
Session duration, min	~ 12	~ 12	~ 24

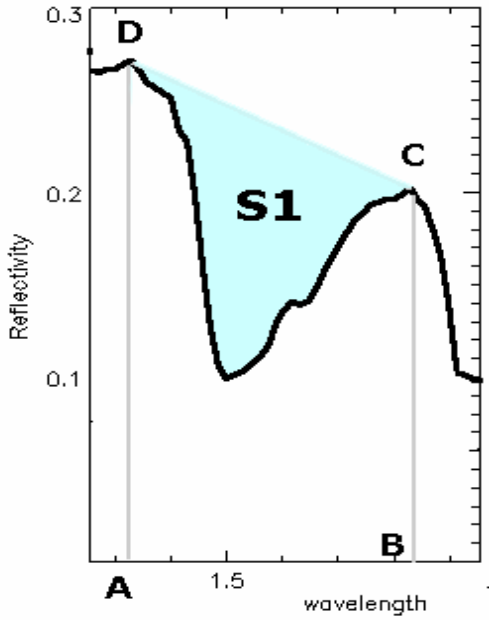




Methodology

- **Mapping spectral features marking ices**
- **Use synthetic indices rather than retrieve abundances:**

  1.2, 1.5, 2.0 μm
- **Work with calibrated radiances rather than relative spectra**
- ***Ad hoc* atmospheric corrections**



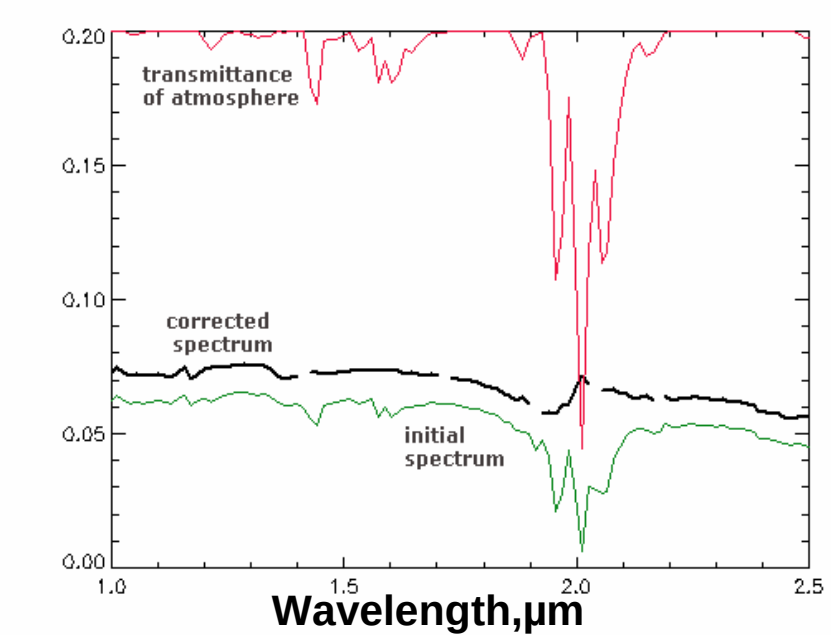
Spectral index:

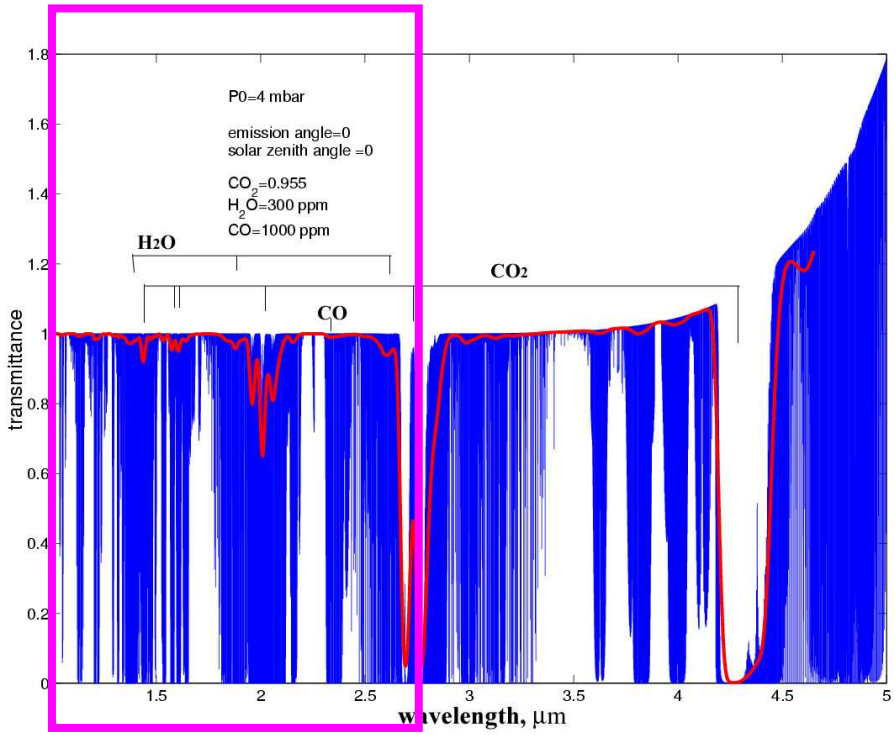
$$Index = \frac{S(ABCD) - S1}{S(ABCD)}$$

Correction on atmospheric absorption

- **MOLA topography**
- **CO_2: *p,T* – from European Mars Climate Database**
- **H_2O column (*L*s, ϕ) - from TES observations**
- **H_2O (ϕ, *l*, *z*) – from GFDL MGCM model**
- **HITRAN(2004)**

OMEGA DETECTOR C





Errors and uncertainities

Due to the instrument

- Dark noise
- Point-spread function error
- Calibration error
- Digitalization error
- Pixel-to-pixel non-linearity
- Degradation of spectral channels

Errors due to models

- Ones due to solar spectrum model
- Due to atmospheric model

Errors and uncertainities

Due to the instrument

- Dark noise ~0.3%
- Point-spread function error -> atm. model error
- Calibration error ~1%
- Digitalization error ~0.3%
- Pixel-to-pixel non-linearity ~0.5%
- Degradation of spectral channels ?

Errors due to models

- Ones due to solar spectrum model ~0.5%
- Due to atmospheric model ~0.2%

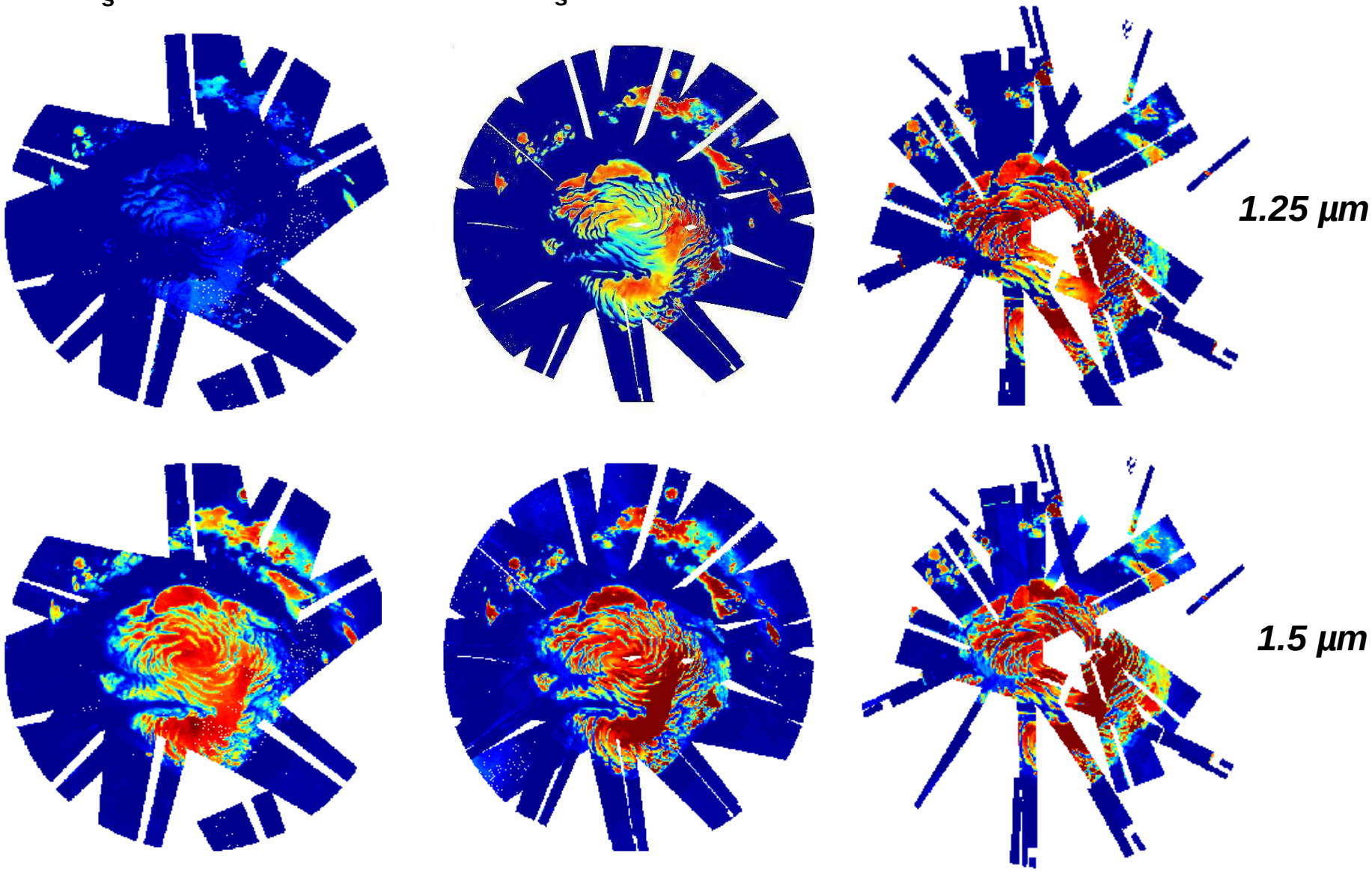
Wide adsorption bands, μm	1.2	1.5	2
Index error, %	2.1	1.45	1.5

Sublimation process of the North polar cap. Aphelion season, MY 27

L_s=93°-97°

L_s=113°-115°

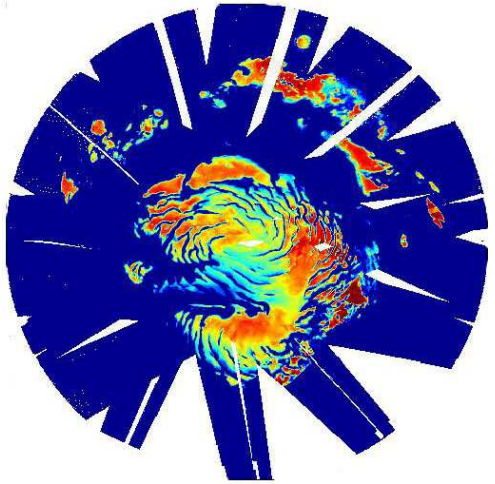
L_s=127°-136°



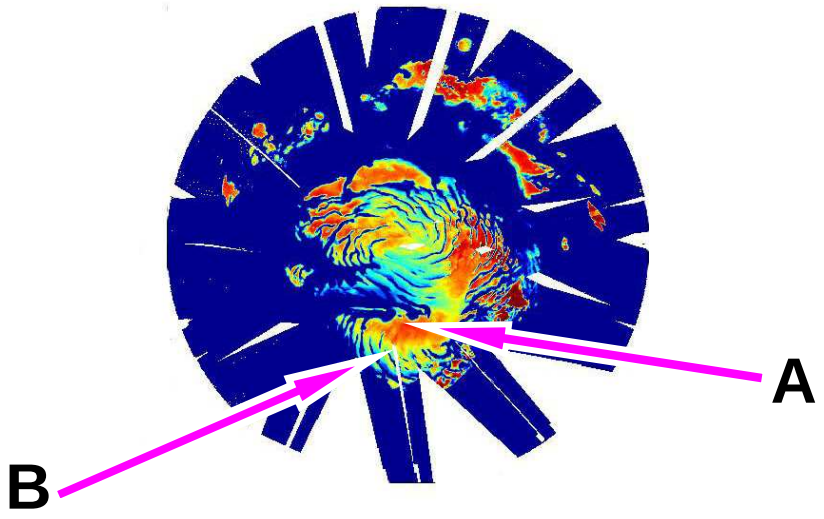
1.25 μm

1.5 μm

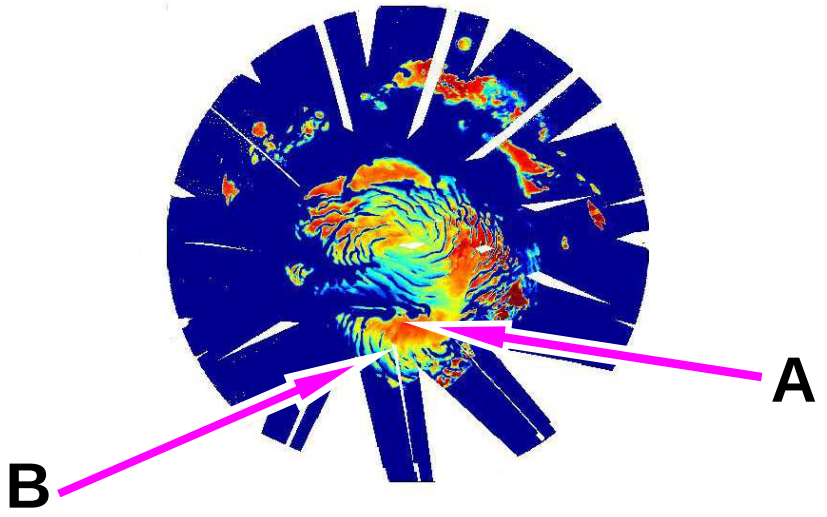
North polar cap,
1.25 μm, Ls ~113º

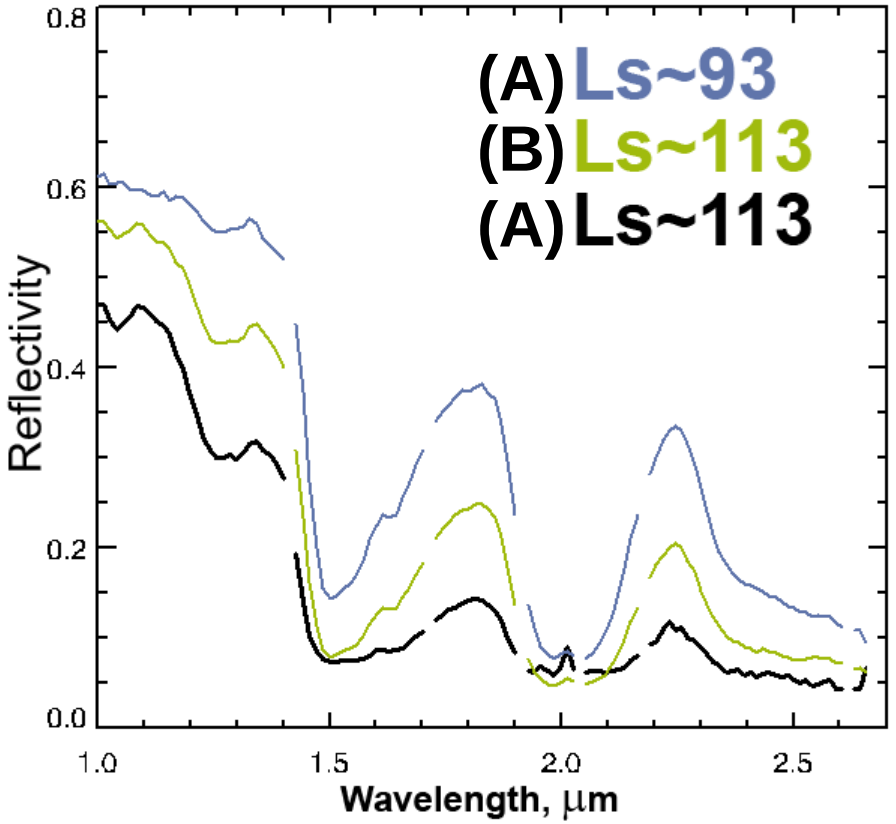


North polar cap,
1.25 μm, Ls ~113º

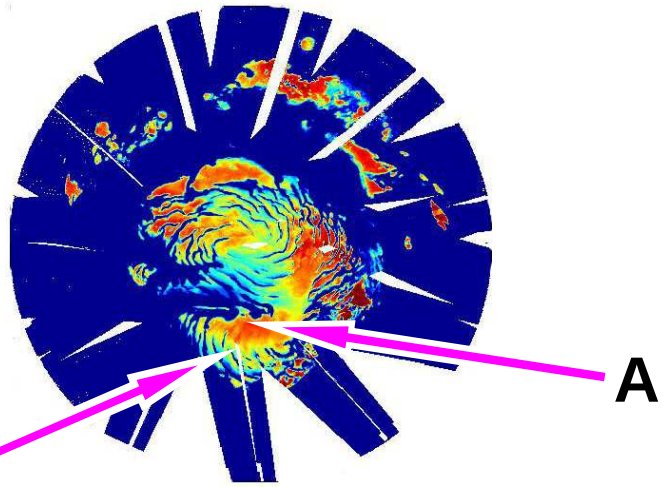


North polar cap,
1.25 μm, Ls ~113º

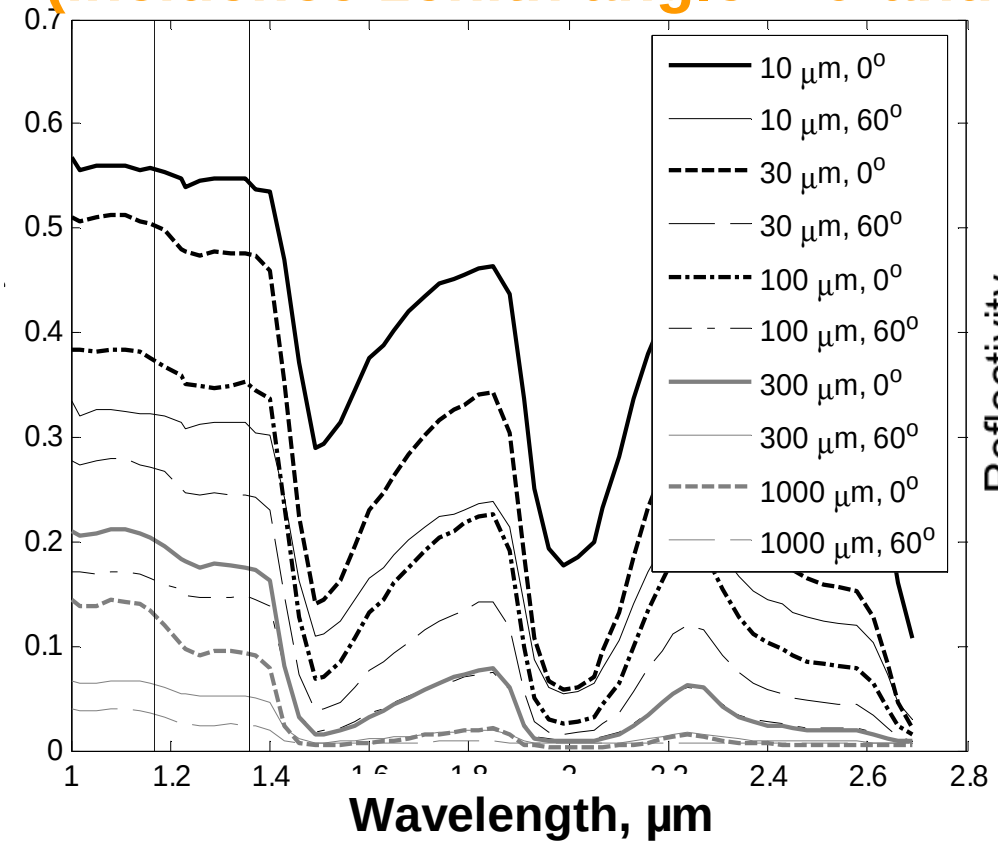


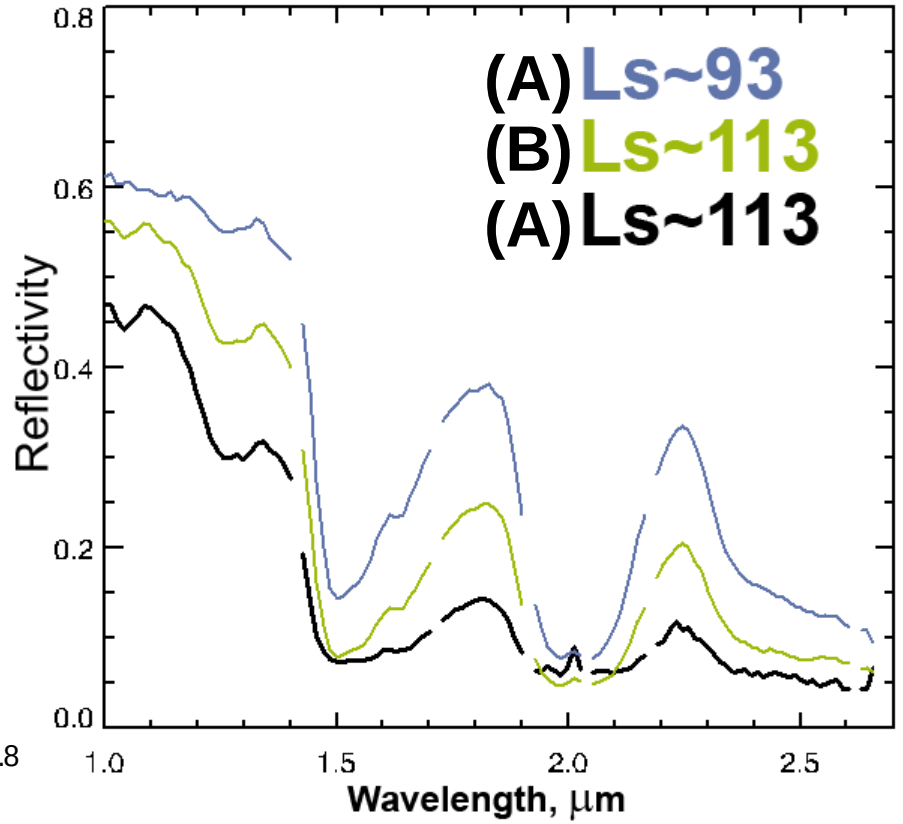


North polar cap,
1.25 μm, Ls ~113º



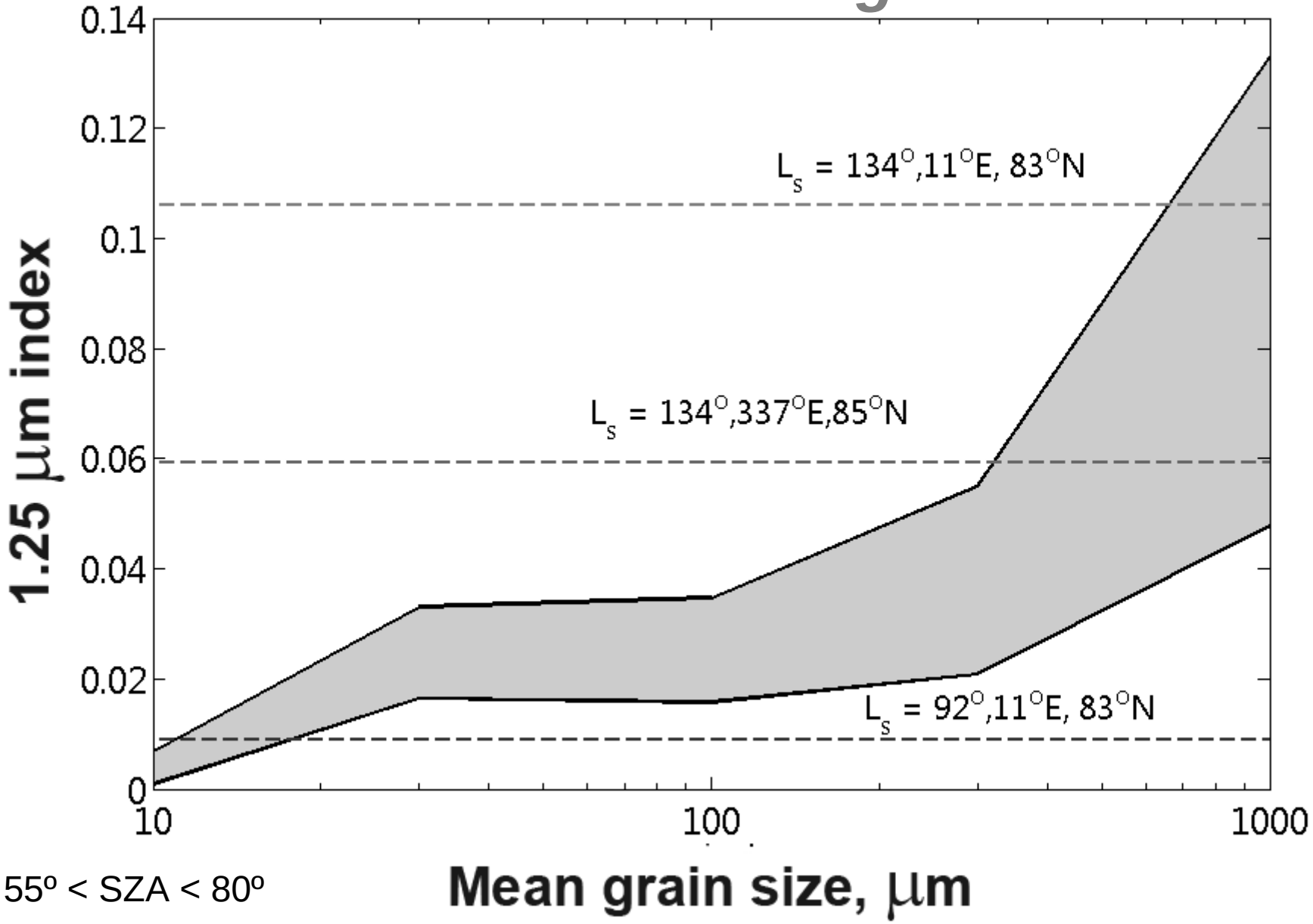
Ray-tracing simulation results:
(incidence zenith angle = 0ºand 60º)





Index 1.25 μm calibration

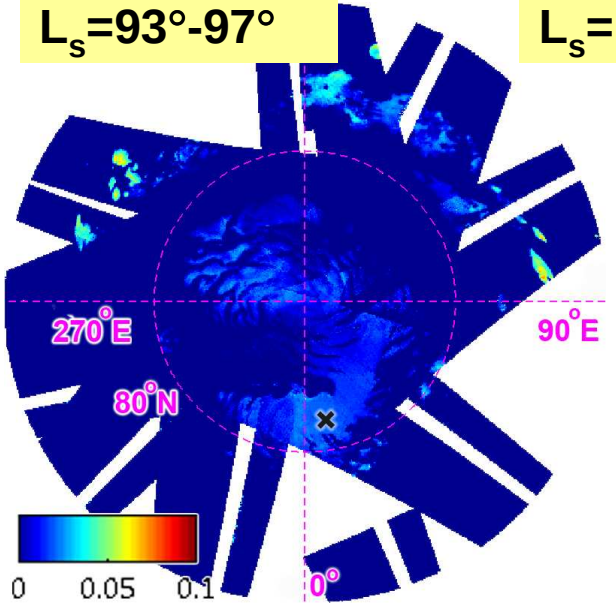
Index value vs. mean grain size



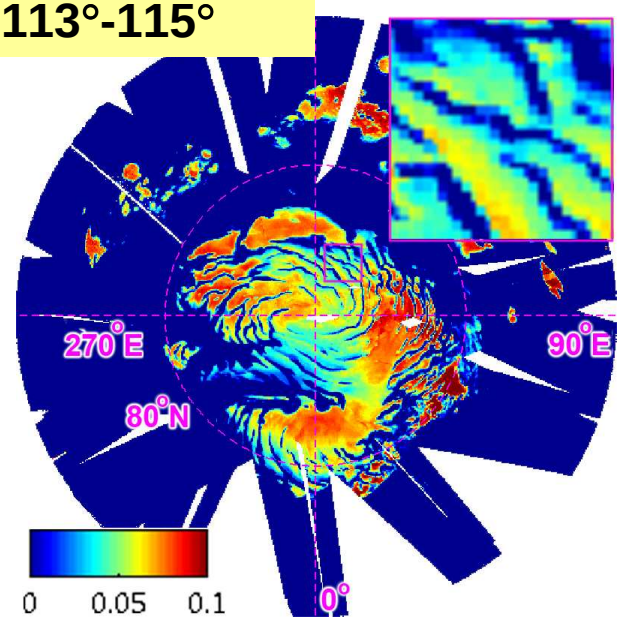
55º < SZA < 80º

Index 1.25 µm mode 3: polar cap sublimation

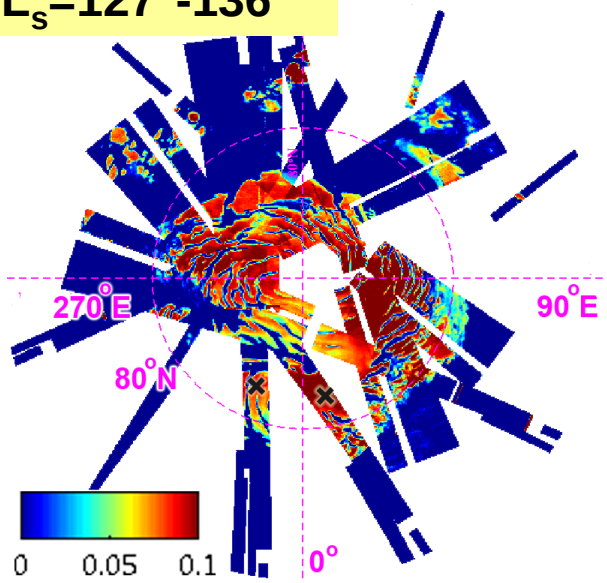
L_s=93°-97°



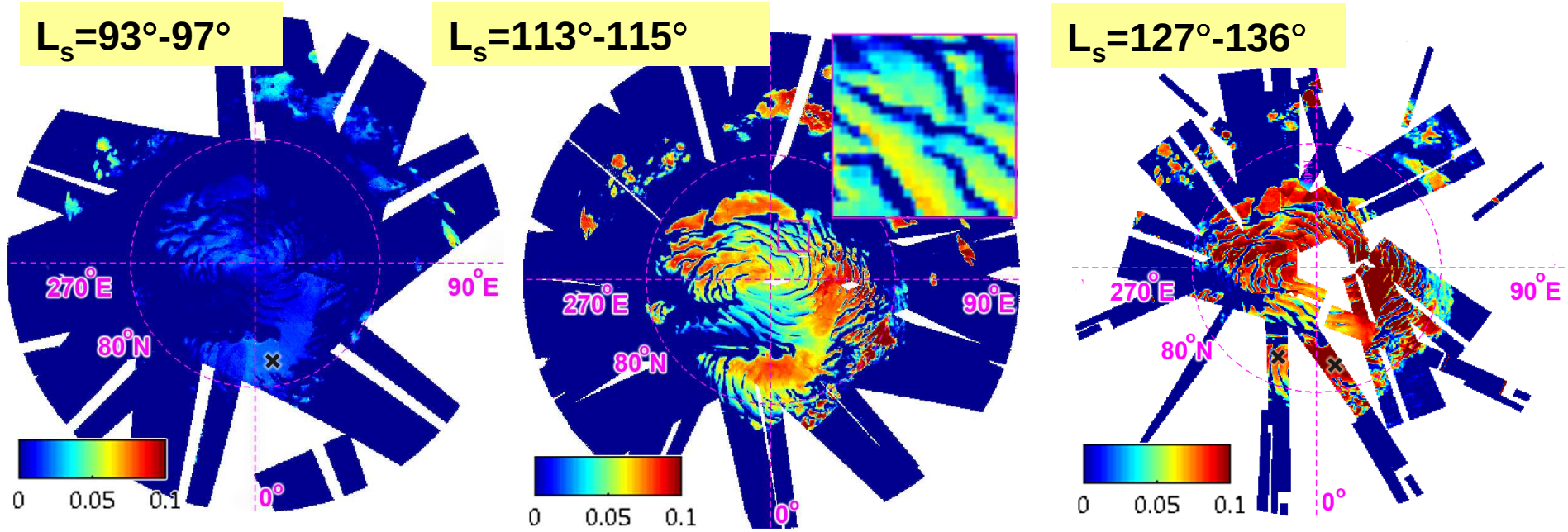
L_s=113°-115°



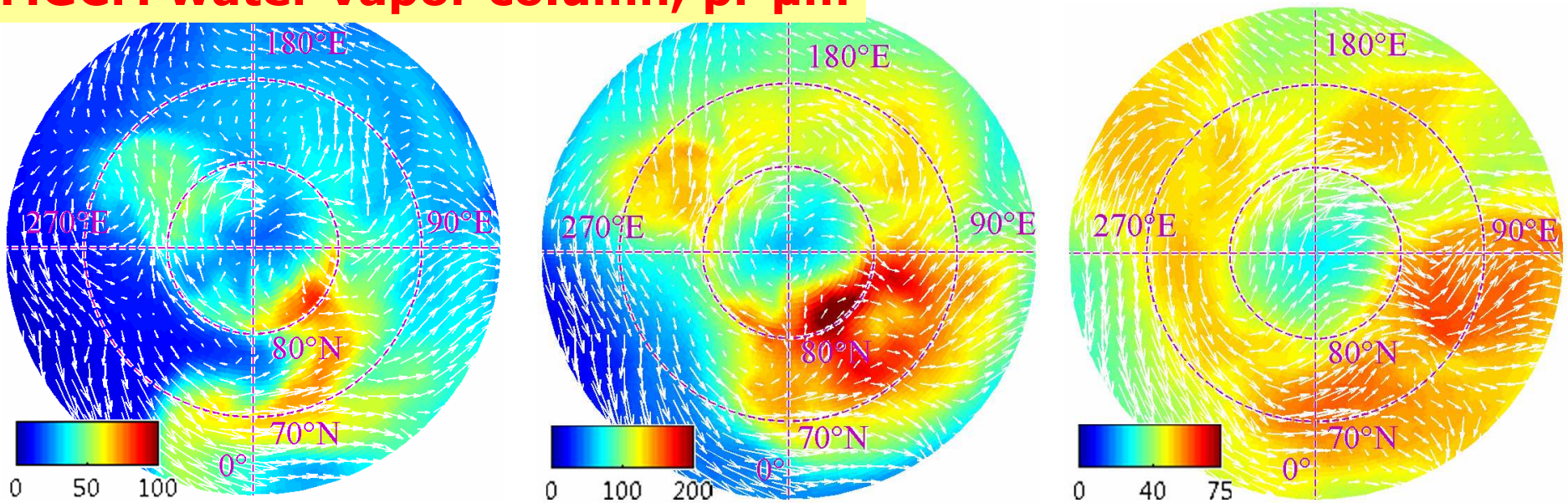
L_s=127°-136°



Index 1.25 µm mode 2 and 3: polar cap sublimation



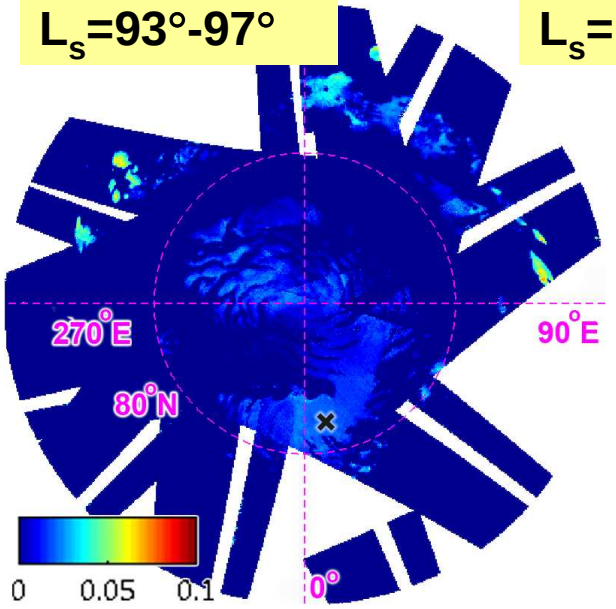
MGCM water vapor column, pr µm



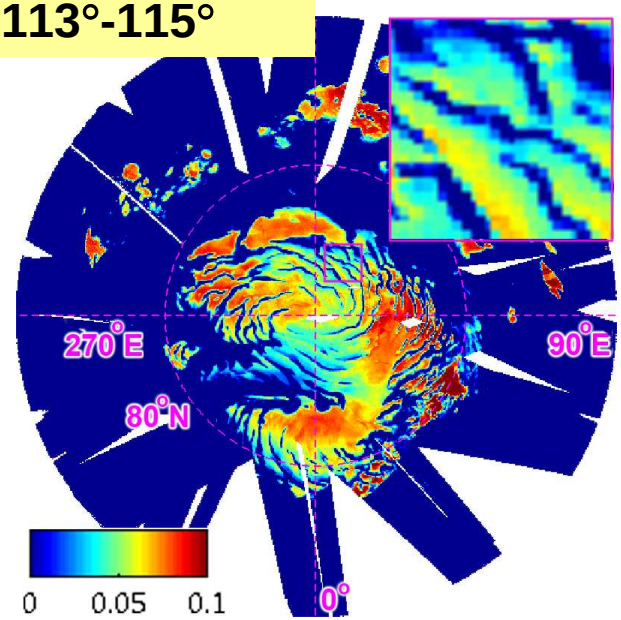
Index 1.25 µm

mode 3: polar cap sublimation

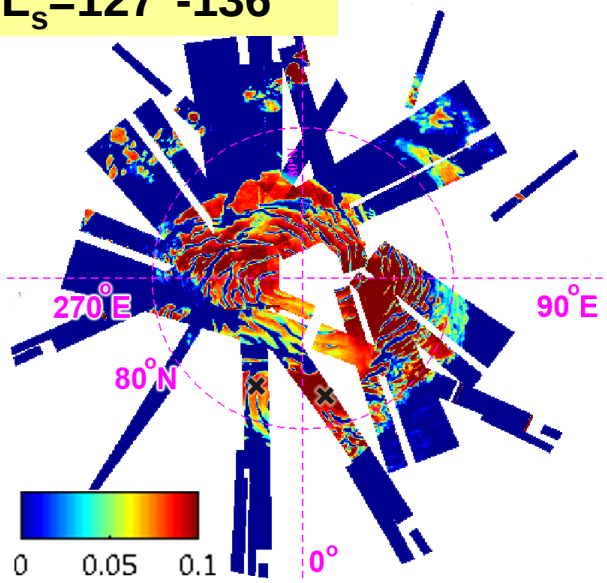
L_s=93°-97°



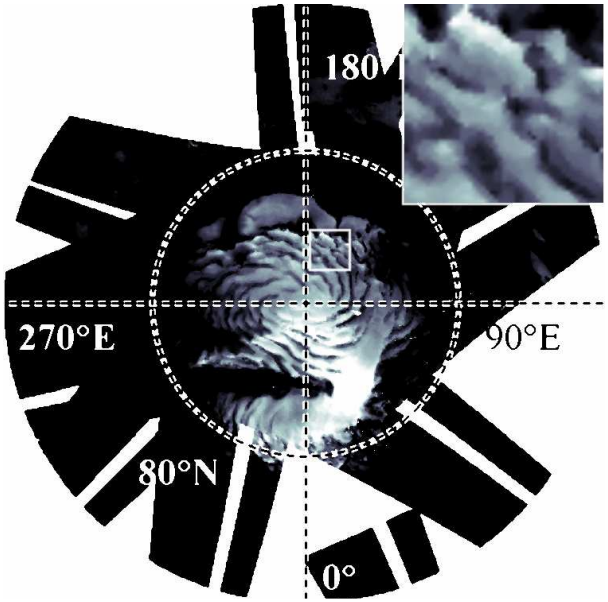
L_s=113°-115°

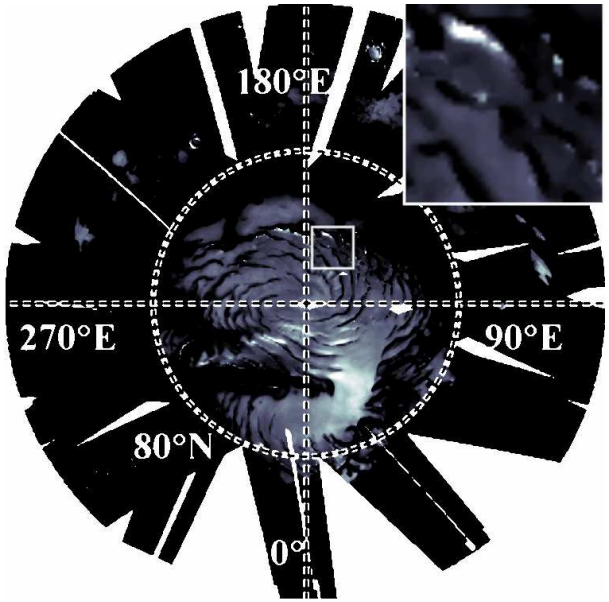


L_s=127°-136°



Reflectivity ~1µm

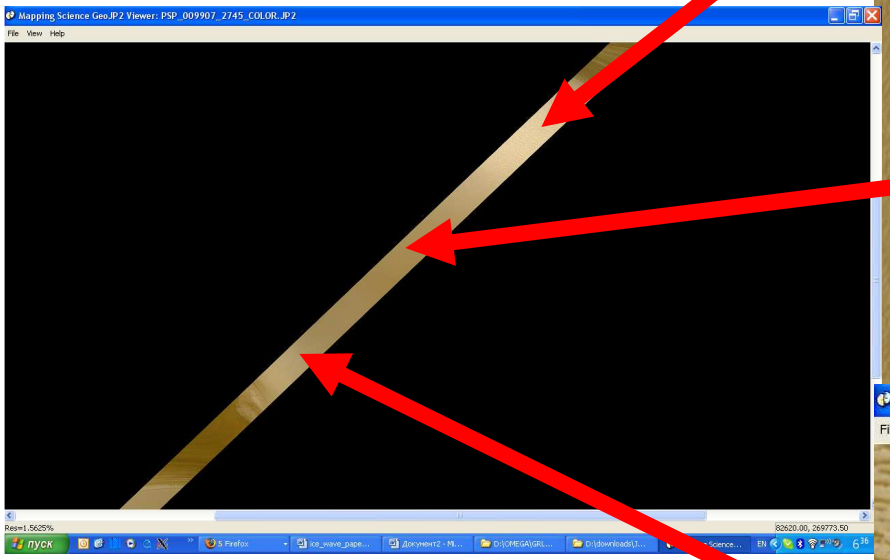




During summer reflectivity is decreasing

-> defrosting

What causes index and albedo variations across terrace?



HiRISE imagery analysis

Conclusions:

- Microphysical structure of frost at the North polar cap reveals the signature of stationary atmospheric waves with the leading wavenumber changing from 2 to 3

- Evolution in time and phase of these patterns coincide with waver vapor distribution predicted by GCM

- Hence, we conclude that North polar cap sublimation is strongly affected by mesoscale wind systems

- At the local scale, there is an evidence of changing wind direction across spiral terraces – probably a contribution of catabatic winds