Seasonal variation of structure of Martian atmosphere from LWC PFS data

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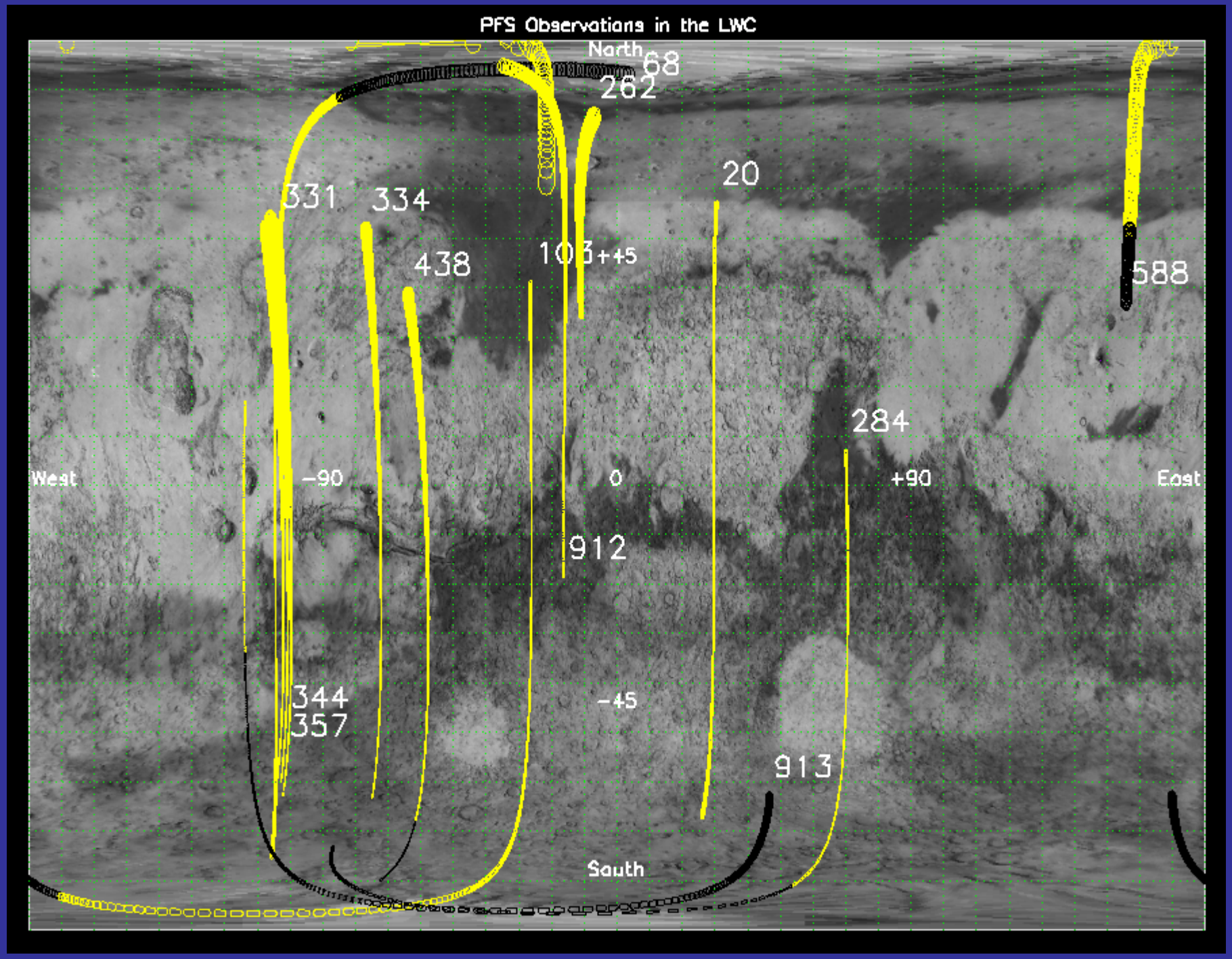
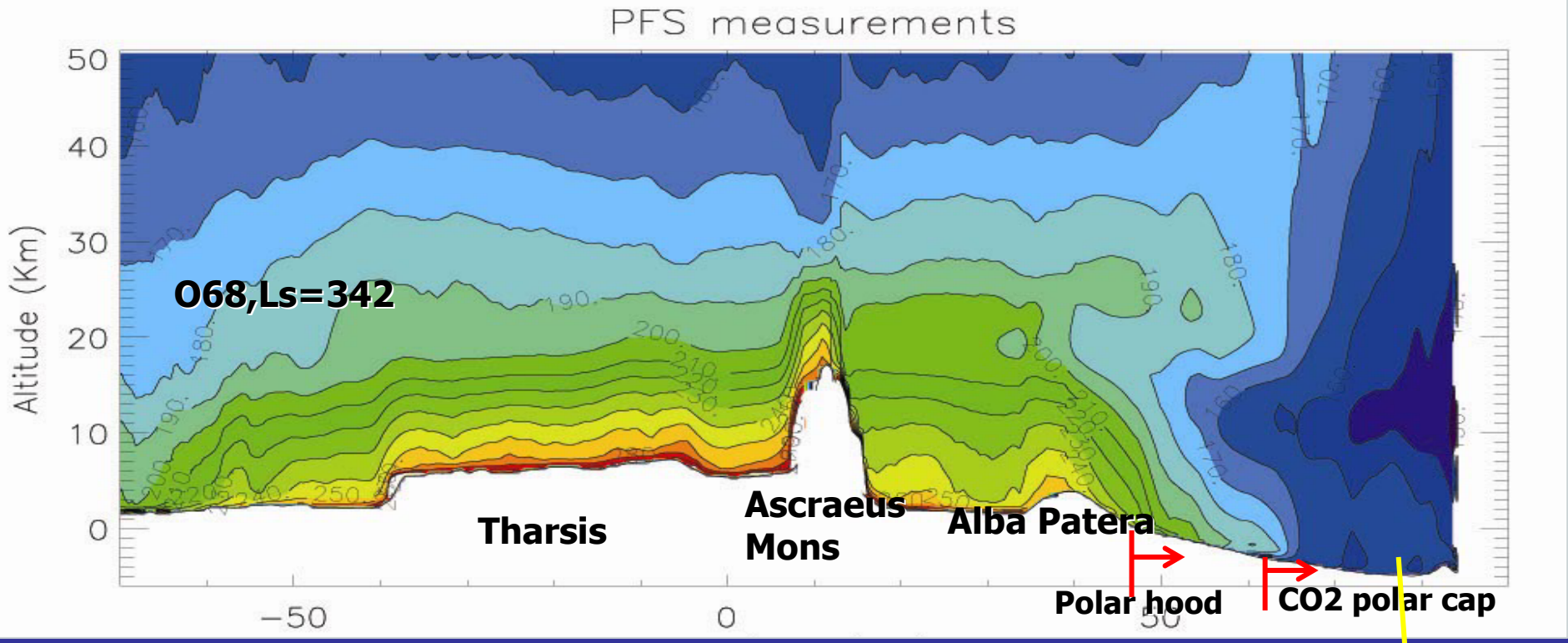
- Longwavelength channel of PFS covers a spectral range 300 – 1500 cm-1 with spectral resolution 1.8 cm-1 and allows to retrieve vertical temperature profiles from the surface up to 50-55 km

- Vertical temperature profiles and aerosol opacity of Martian atmosphere may be retrieved from the same single spectrum on the day side, when the surface temperature is rather high.

- At night side the temperature is low and spectra have to be averaged.

- In the polar regions we also deal with spectra averaged over 2 -10, so effective field of view increases up to 40-200 km respectively.


PFS Observations in the LWC
North
68
262
20
331
334
438
103
+45
588
284
West
−90
0
+90
East
912
344
357
−45
913
South



Temperature field in coordinates latitude-altitude along unique orbit 68 passed through the Northern polar region at night.

Polar hood

Not known before:

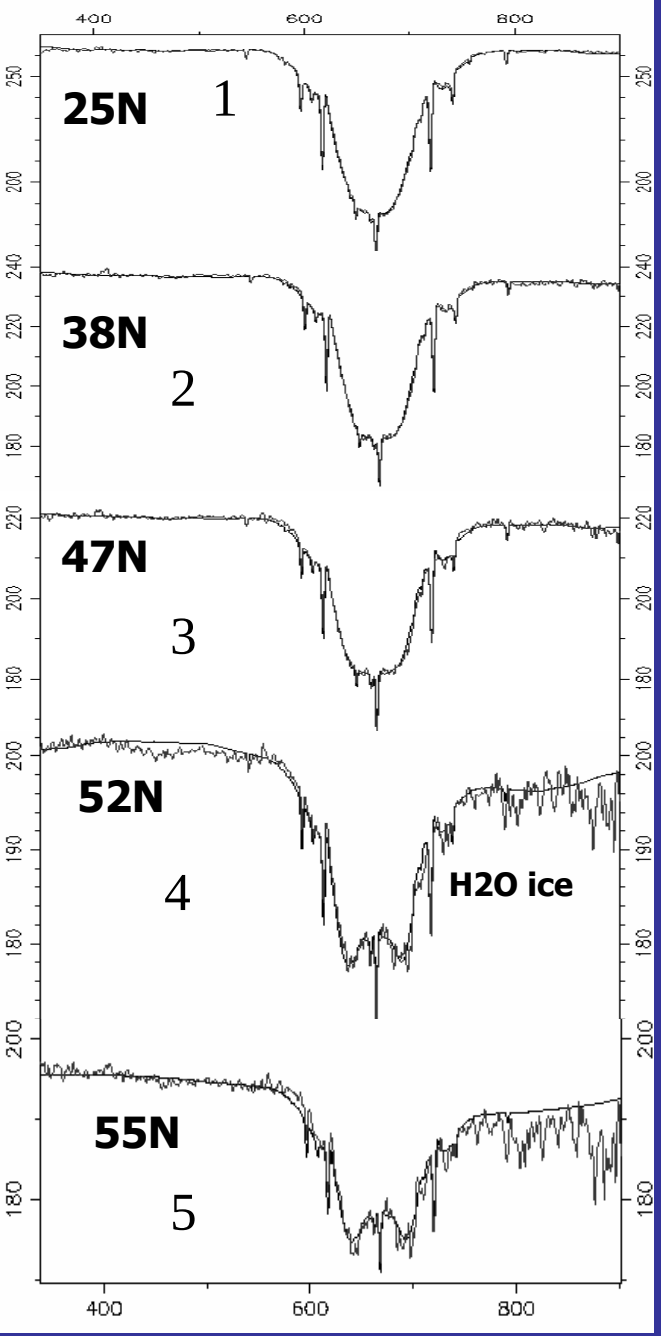
Temperature inversion in the 40-60 ° N interval near 10 km altitude with temperature maximum at 20km altitude is found by PFS LWC measurements.

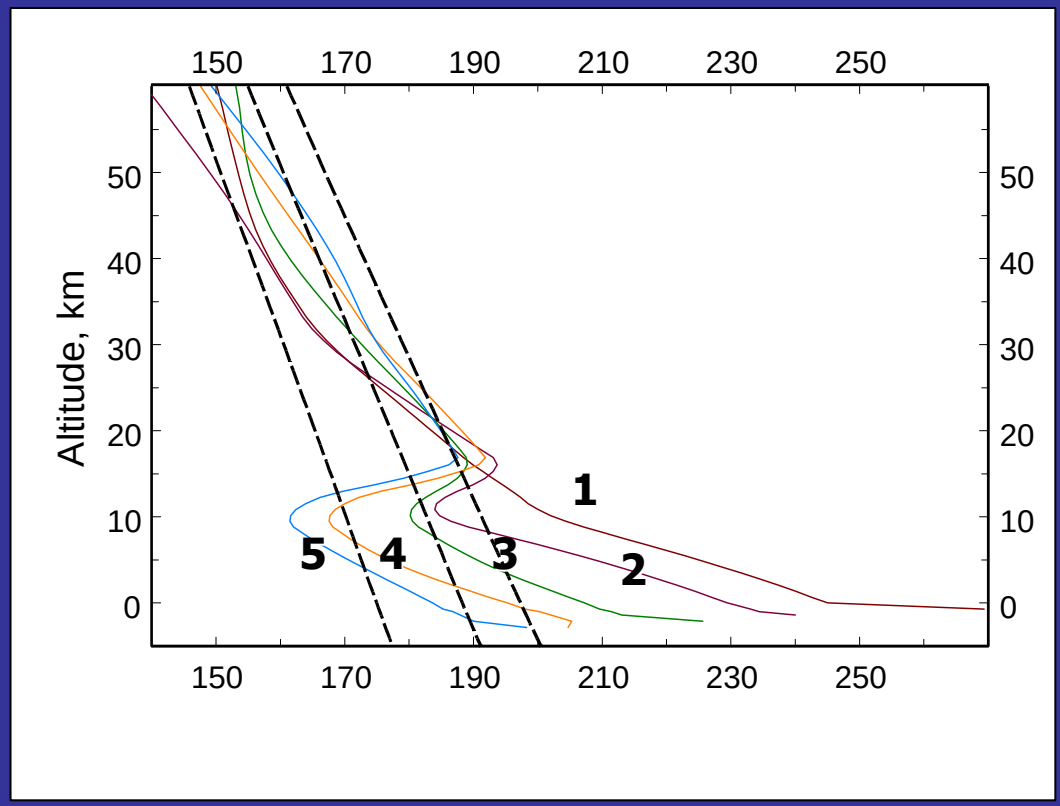
Amplitude of thermal inversion reaches of 20K in the polar hood. It smooths out above the CO2 polar cap, where temperature maximum corresponds to the altitudes not available for the observations with spectral resolution of PFS (polar warming).

-Thermal inversion is a results of dynamics (in descending Hadley branch)?

-The ice clouds in polar hood are responsible for this inversion?

-Influence of topography (Alba Patera)?

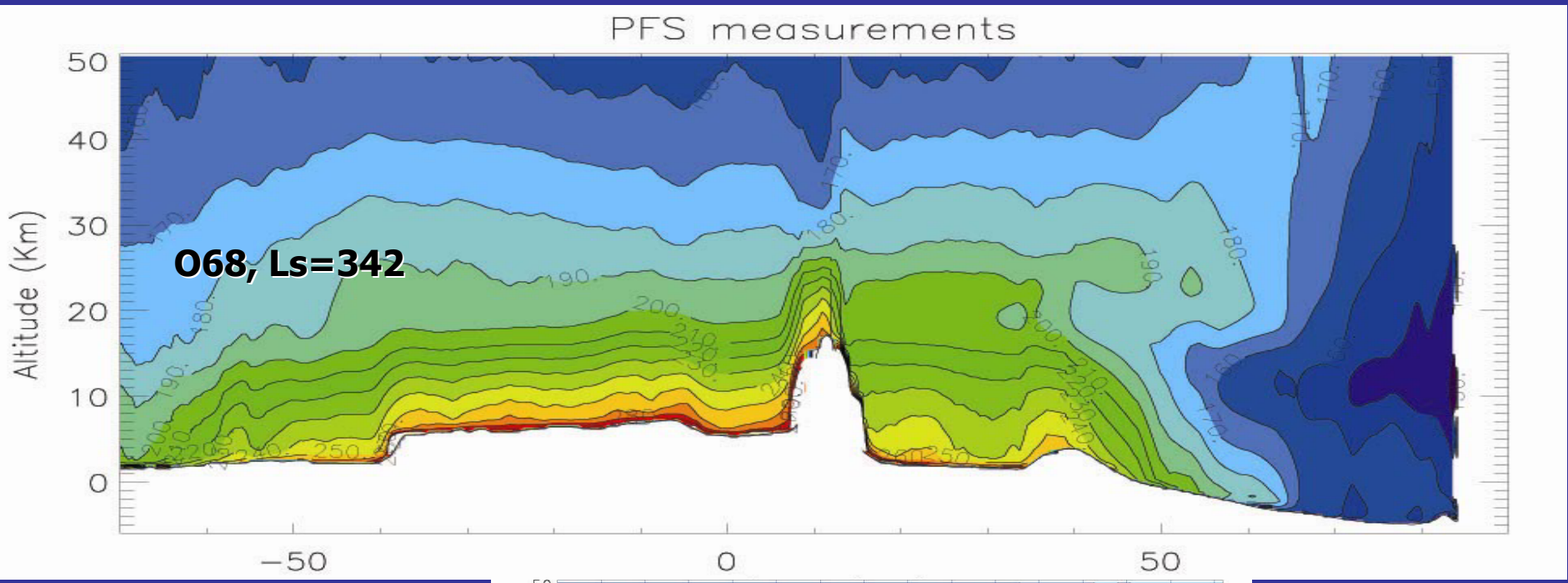




Examples of measured and synthetic spectra and temperature profiles, retrieved from those spectra.

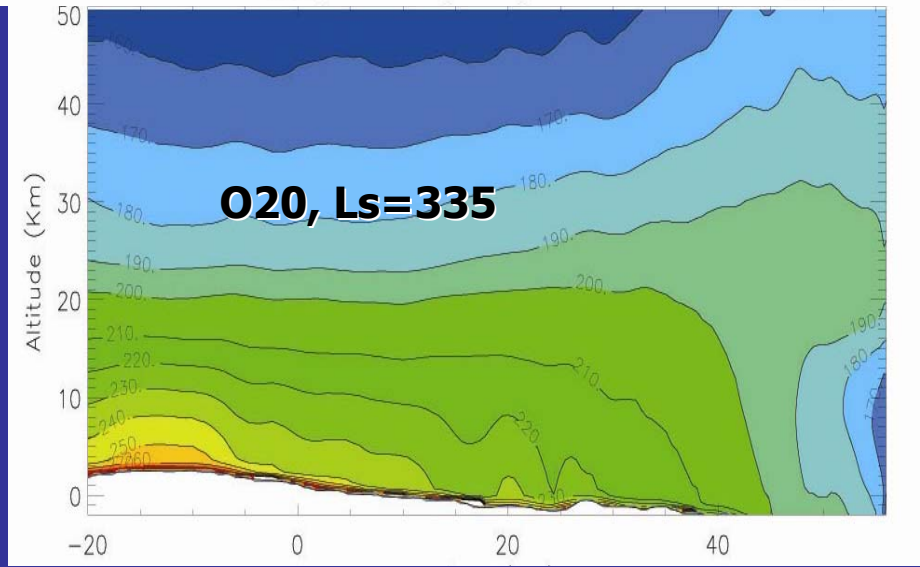
H20 ice band is appeared in the spectrum at 47N. Edge of polar hood is here.

Temperature profiles 2 - 5 have inversion at around 10 km. It's amplitude exceeds 20K (in case 4, 5).

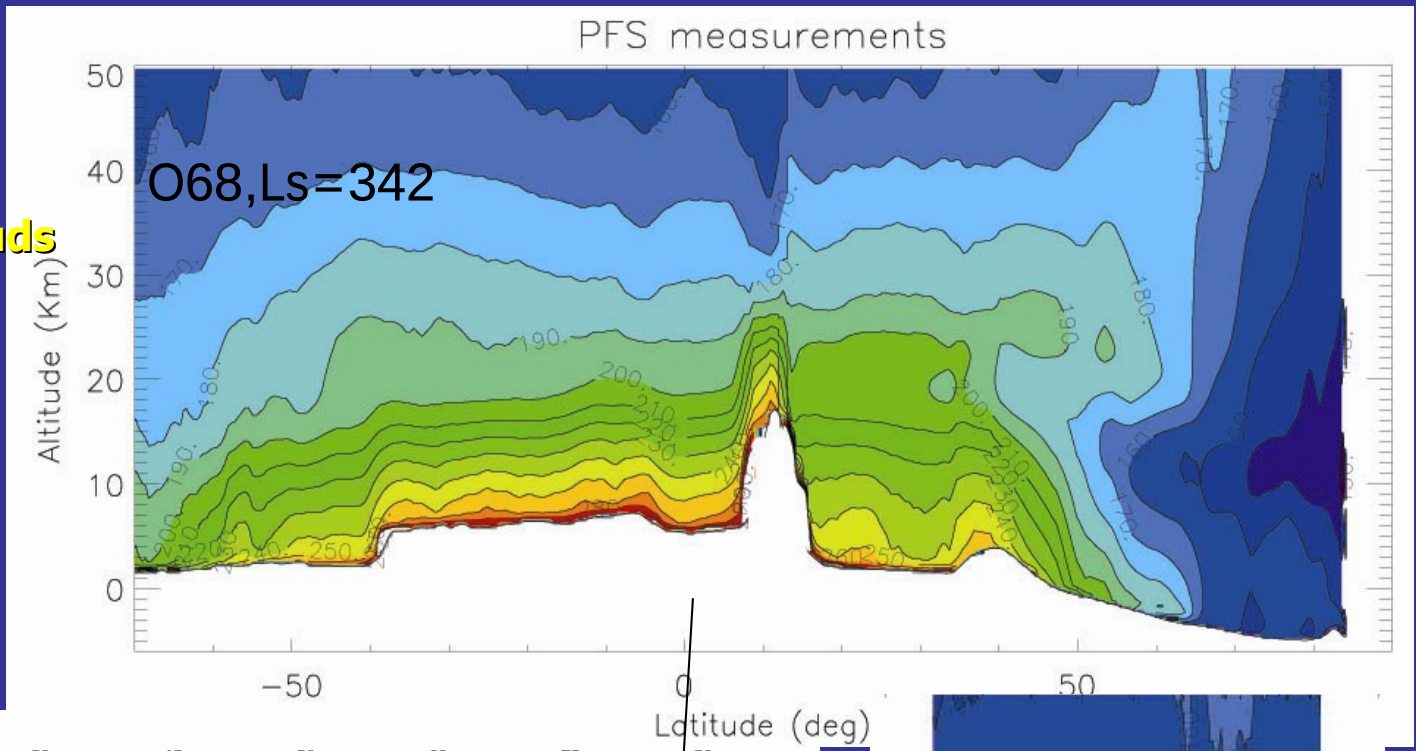


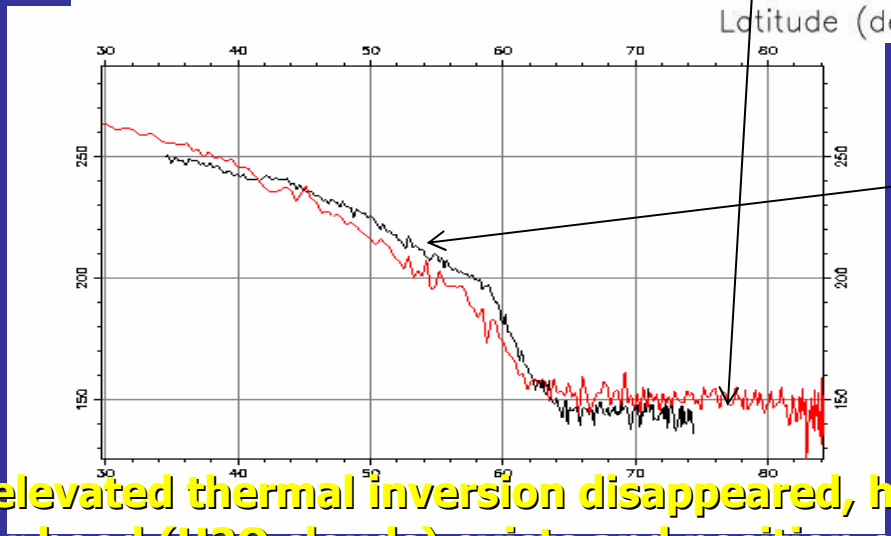
Thermal inversion in the 40-60° N interval is a result of influence of topography (Alba Patera on orbit 68)??

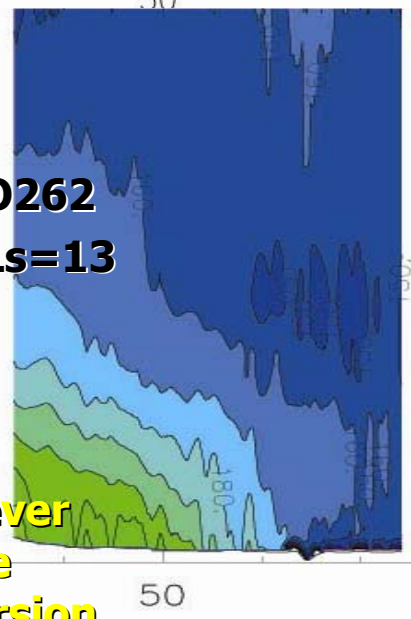
Orbit 20 has flat topography, but temperature inversion is also observed >40° N



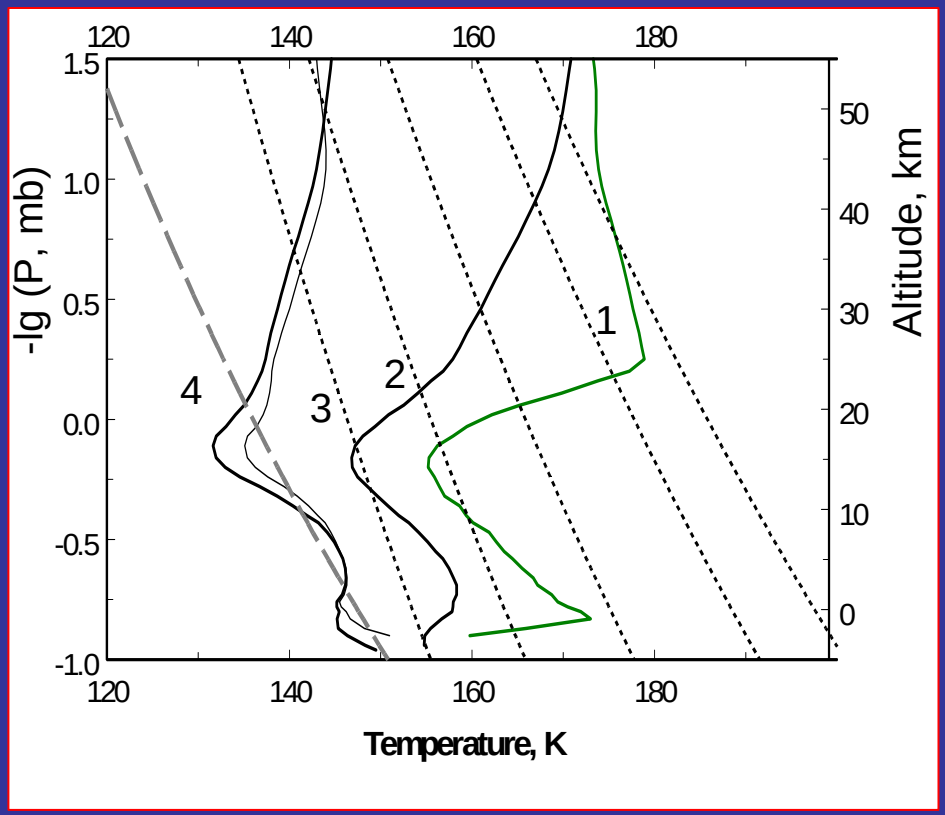
Are the H2O clouds of polar hood responsible for this temperature inversion??

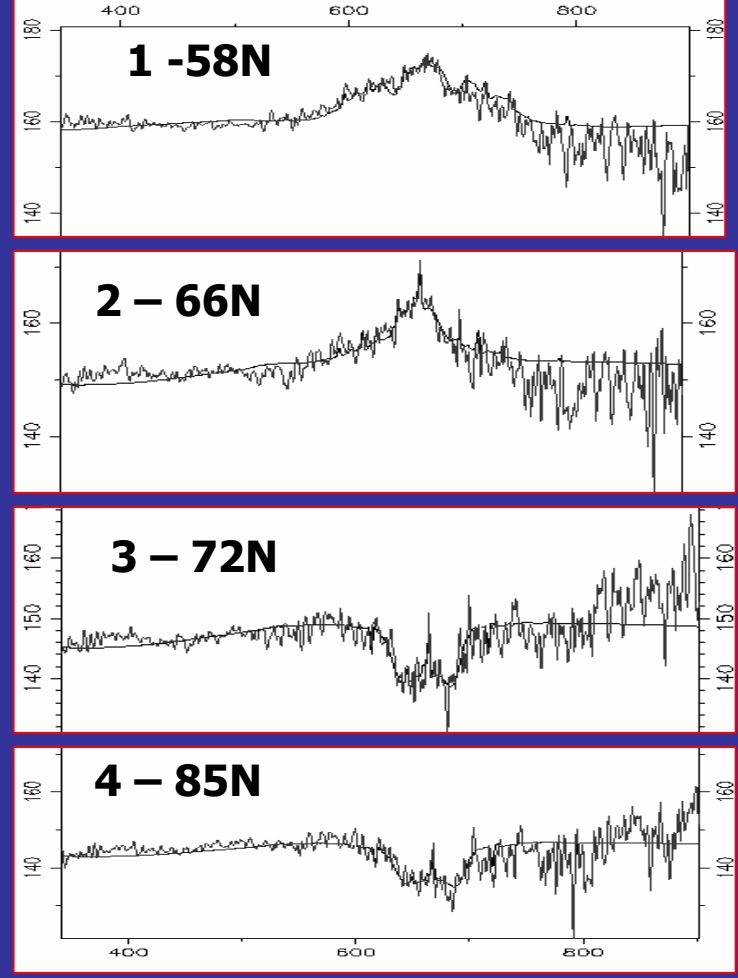






On orbit 262 elevated thermal inversion disappeared, however Northern polar hood (H2O clouds) exists and position of the edge of polar cap is conserved. It means that thermal inversion doesn't depend on these parameters.

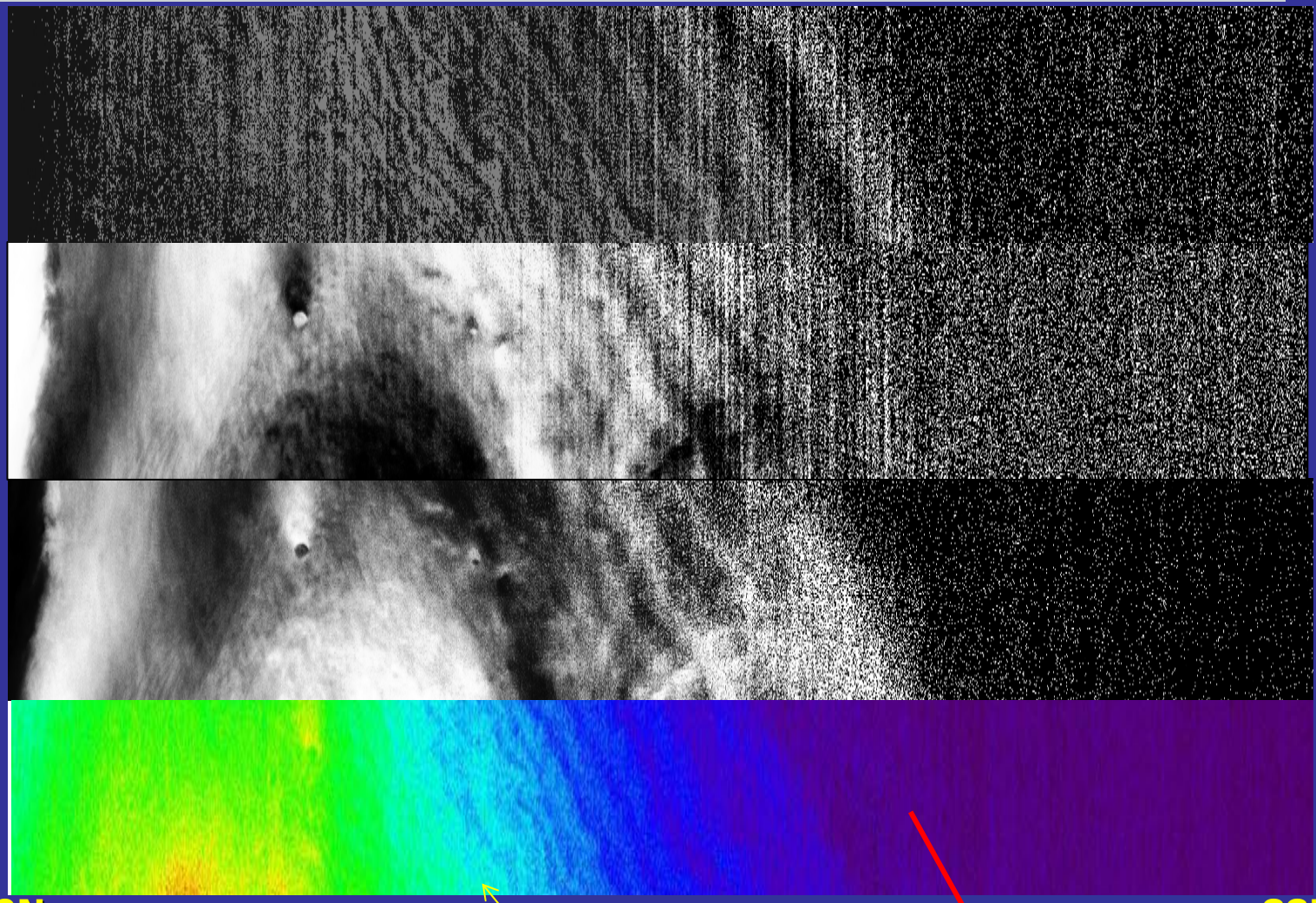


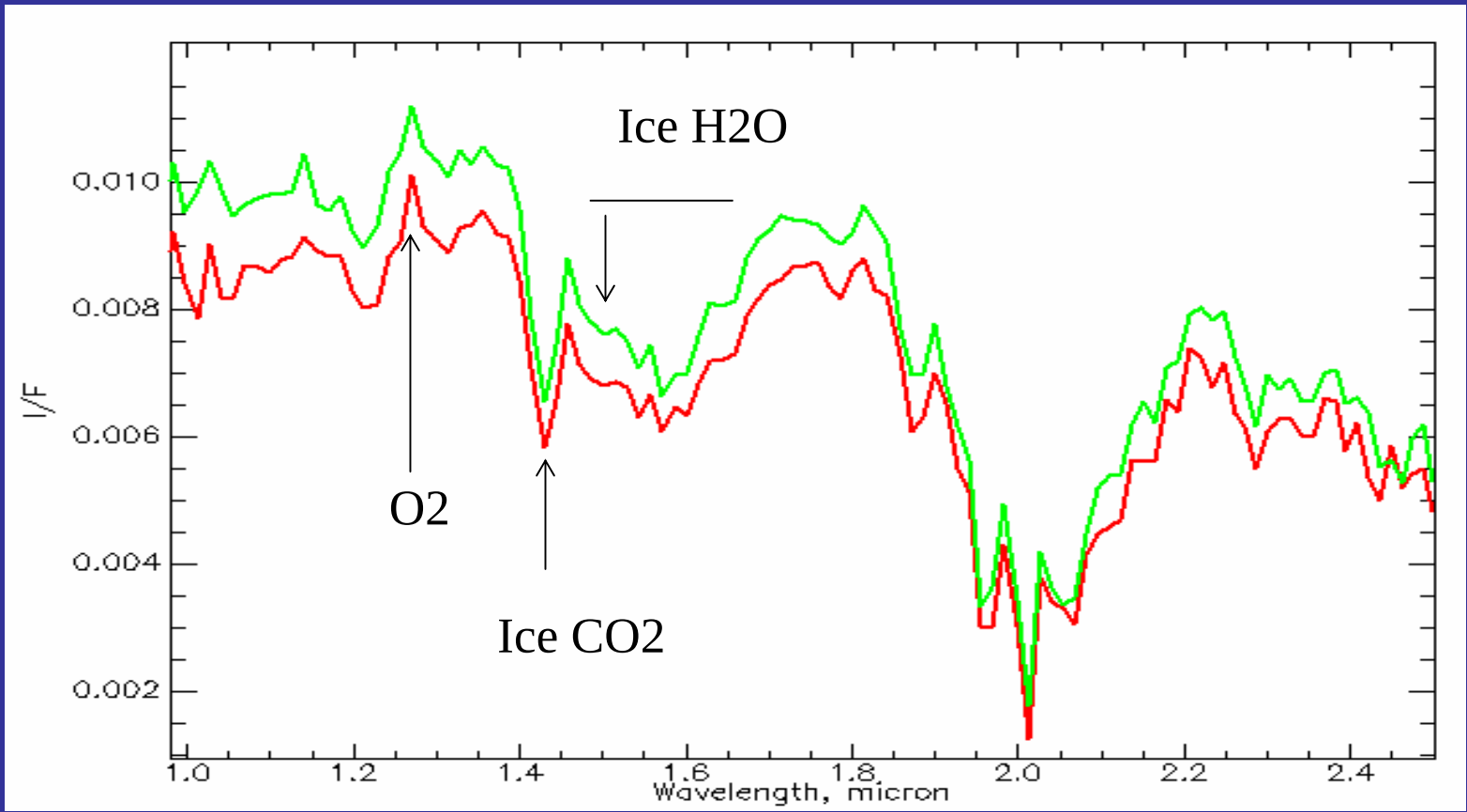


Temperature profiles, obtained from the spectra on orbit 68. Dash-dotted lines mark the temperature of the H2O condensation corresponding to abundance of 0.1, 1, 10, 100, 200, 300 and 400 ppm respectively. Dashed line shows the temperature of the CO2 condensation.

At φ>70ºN (curves 3,4) the CO_2 condensation is observed in the atmosphere below 20 km.

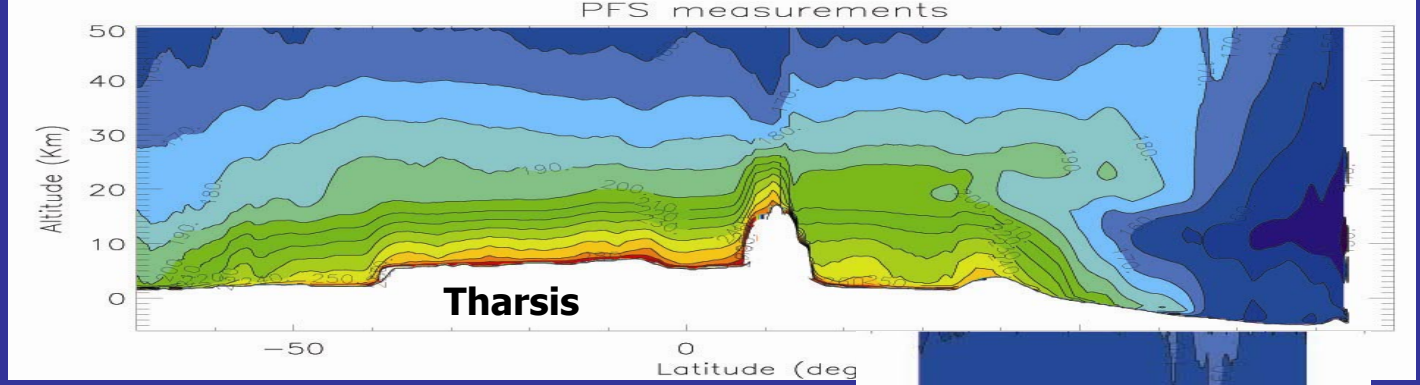
Structure of the Martian atmosphere in the Northern polar region and O2 emission and O3 apparent abundance at late winter. OMEGA and PFS experiments. Zasova L.V., Altieri F, Formisano V., Bibring J-P, Bellucci G., Ignatiev N.I., D. Grassi , Giuranna M. Maturilli A (poster)



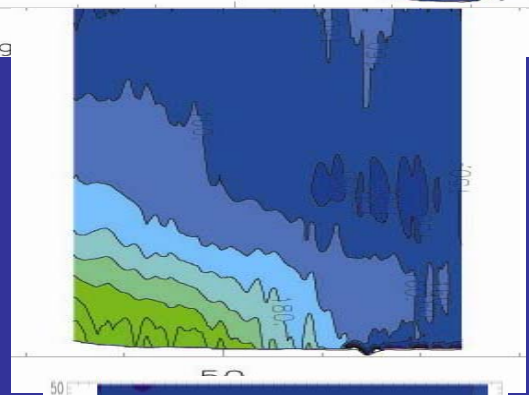


Position of the bands, for which the images in preliminary slide are shown

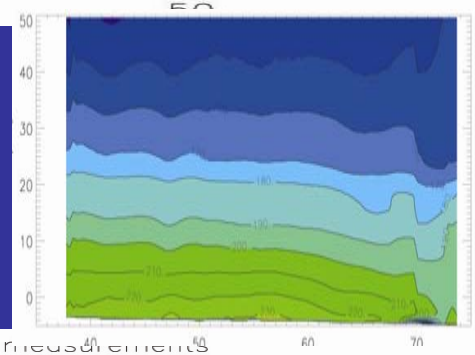
O68, Ls=342



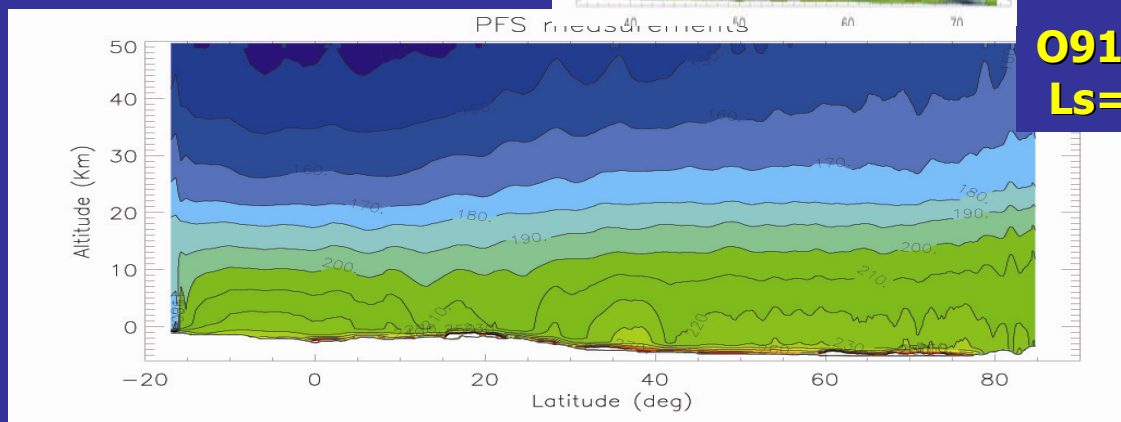
Comparison of temperature fields in N-polar region from spring equinox (northern late winter) to winter solstice (northern summer)



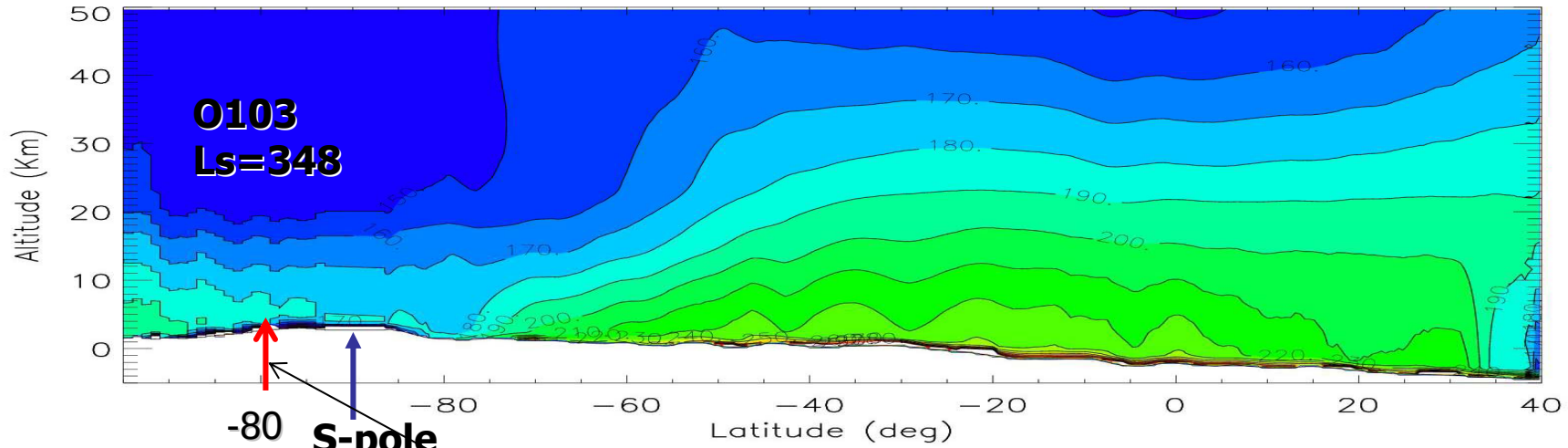
O262
Ls=13



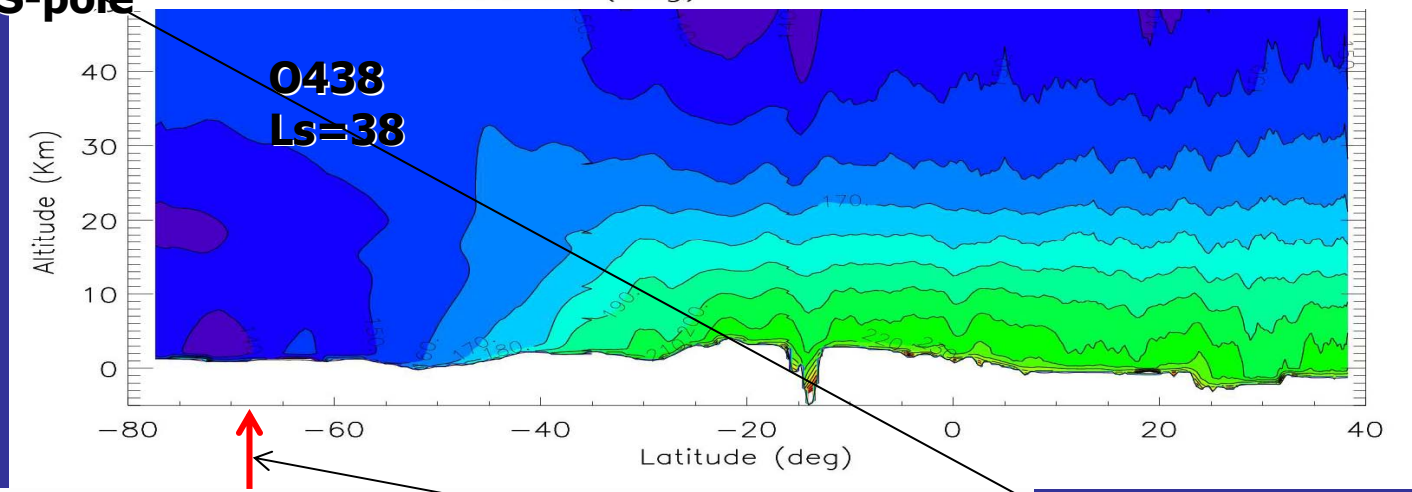
O588
Ls=47

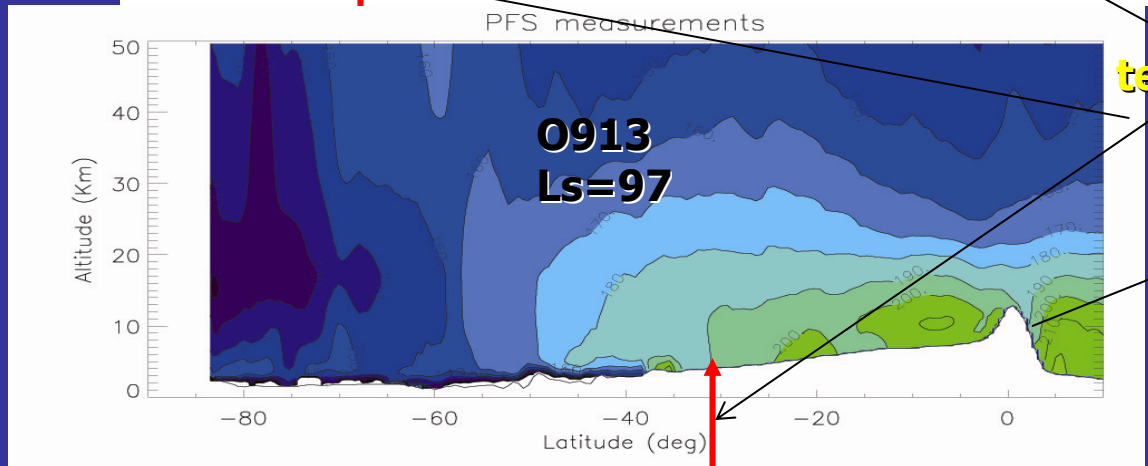


O912,
Ls=96



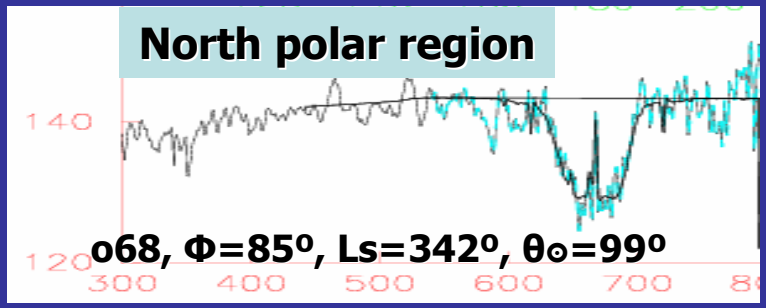
South polar region

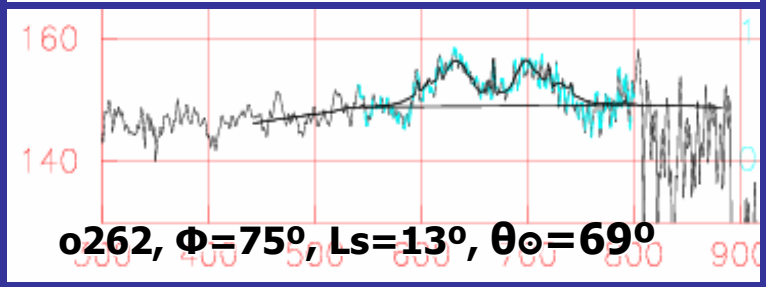


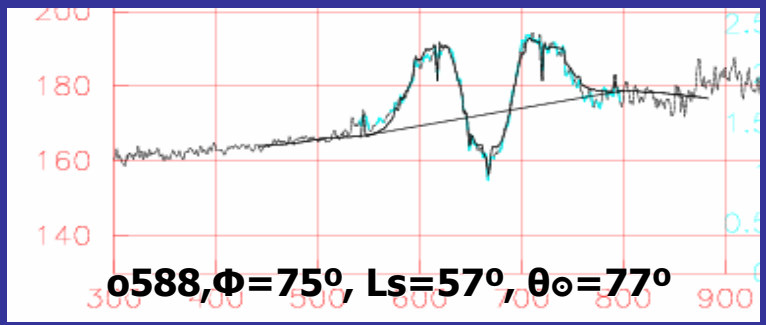


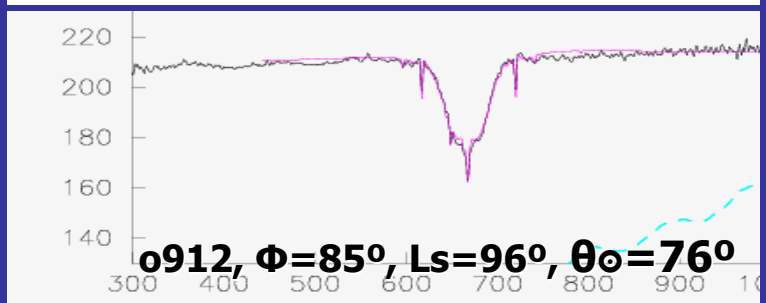
terminator

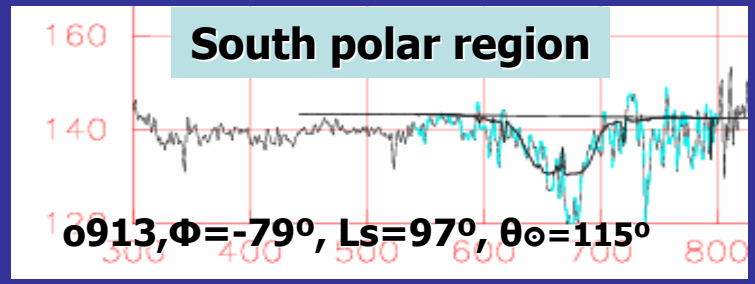
Arsia Mons

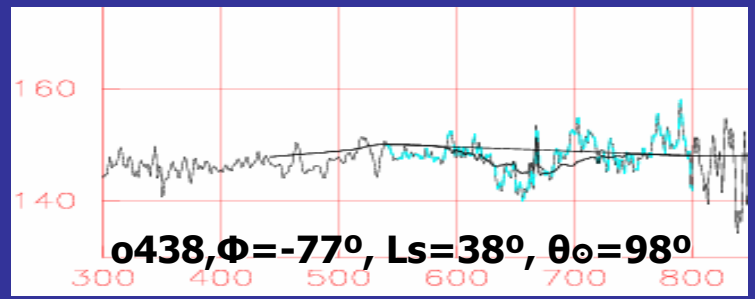


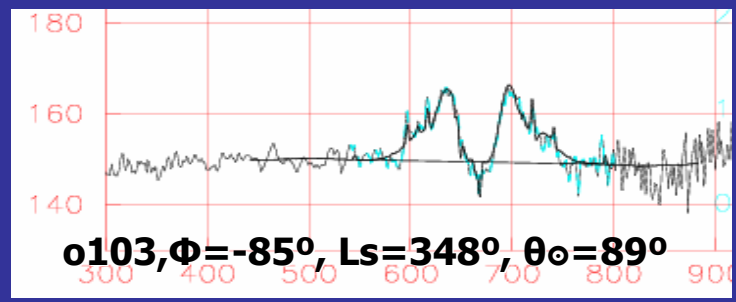


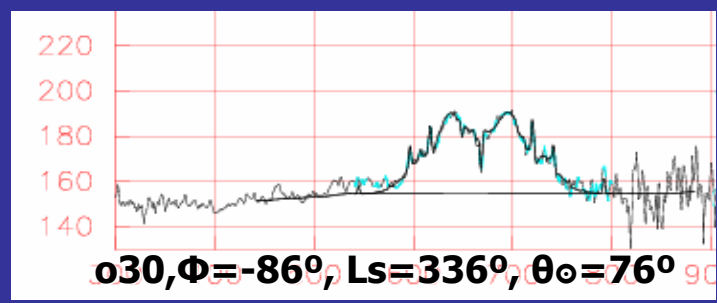












Examples of the spectra, observed at North and South polar regions together with the synthetic ones. Lower two polar spectra are North (summer) and South (late summer). In the case of the North pole the presence of water ice on the surface corresponds to the H2O abundance of 500 – 1000 ppm.

At South pole the surface temperature shows that the CO2 ice on the surface exists.

Conclusion

- Elevated temperature inversion at around 10 km of altitude with temperature maximum around 20 km was found at latitudes > 40 ºN near spring equinox

- This inversion is connected to descending branch of Hadley cell and it disappeared when circulation changes (at Ls=13 – it wasn't observed)

- Surface temperature at 85 N at Ls =97 is of 200 – 220K, which correspond to Psat (H2O) of 500-1000 ppm

- Wave structures are observed in OMEGA images on orbit 68 (O2 emission, CO2 and H2O clouds, apparent abundance of O3) in the latitude range from 70N to 80N (up to terminator). They are observed in the region where the CO2 clouds present in the atmosphere. The temperature profiles, obtained from the PFS LWC data, show that the CO2 condensation in the atmosphere may occur on the day side.