Pfs results at Mars

By
V.Formisano and the PFS Team

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Publications

- Formisano et al : Detection of methane… Science Dec. 3 , 2004 .
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  - Giuranna et al: Calibration SW channel
  - Fiorenza & Formisano : a solar spectrum for PFS
  - Grassi et al : Temperature profile retrieval methode.
  - Grassi et al : Temperature profile over Olimpus
  - Formisano et al : Comparison of PFS spectrum with ISO SWS
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  - Hansen et al : South pole ice composition.
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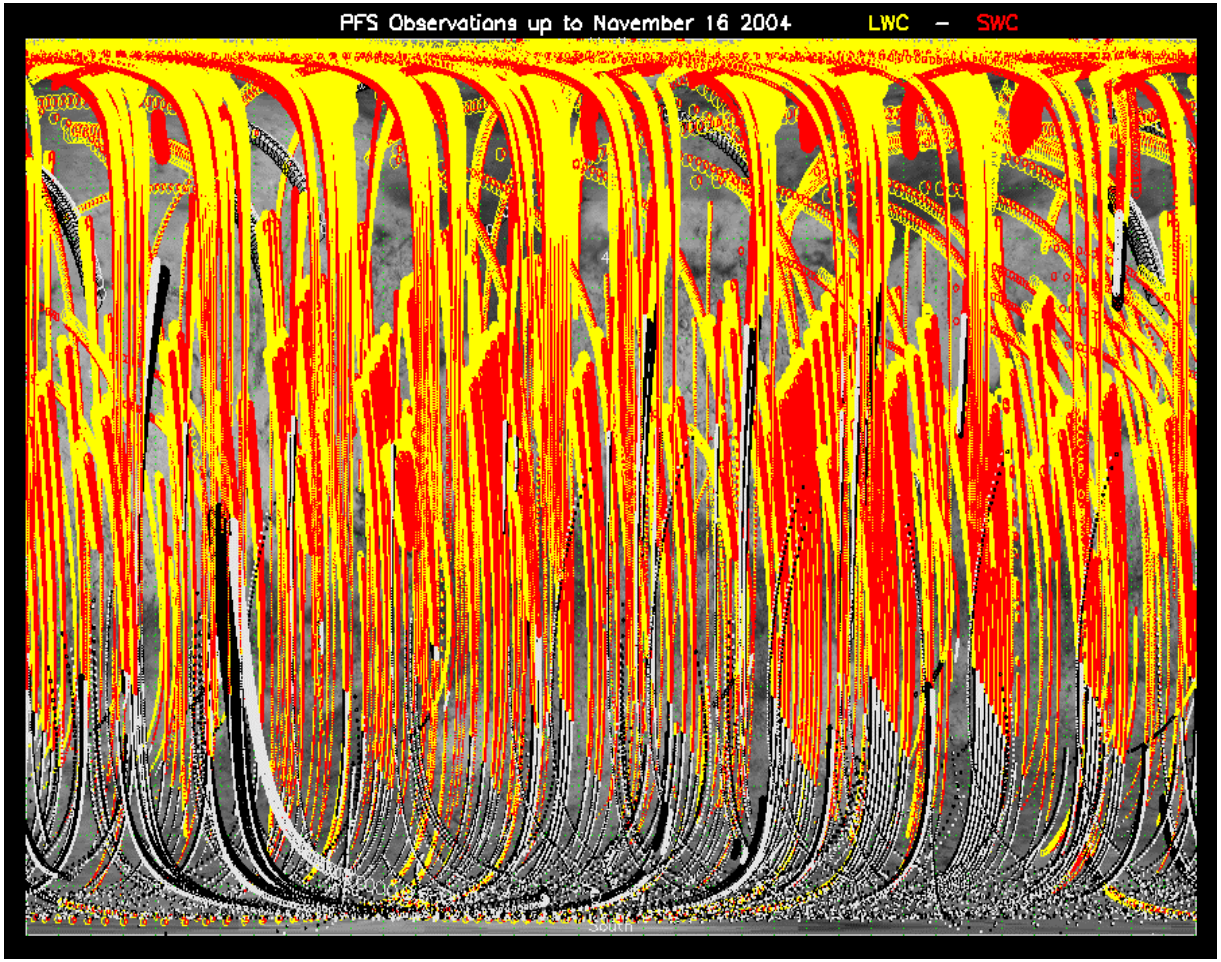
0- Generalities 1/3

- **PFS AT MARS WAS SWITCHED ON FOR THE FIRST TIME ON JANUARY 10 , 2004.**
- **SINCE THEN WE HAVE BEEN OPERATING 560 ORBITS OUT OF 1276 .**
- **WE HAVE ACQUIRED 140 000 SPECTRA BOTH ON THE DAYSIDE AND NIGHTSIDE , AT THE EQUATOR AS WELL OVER BOTH POLES.**
- **THE COVERAGE ACHIEVED IS SHOWN IN THE FIGURES : LAT-LONG COVERAGE (COLOR) AND LAT – LOCAL TIME COVERAGE (BLACK) :**

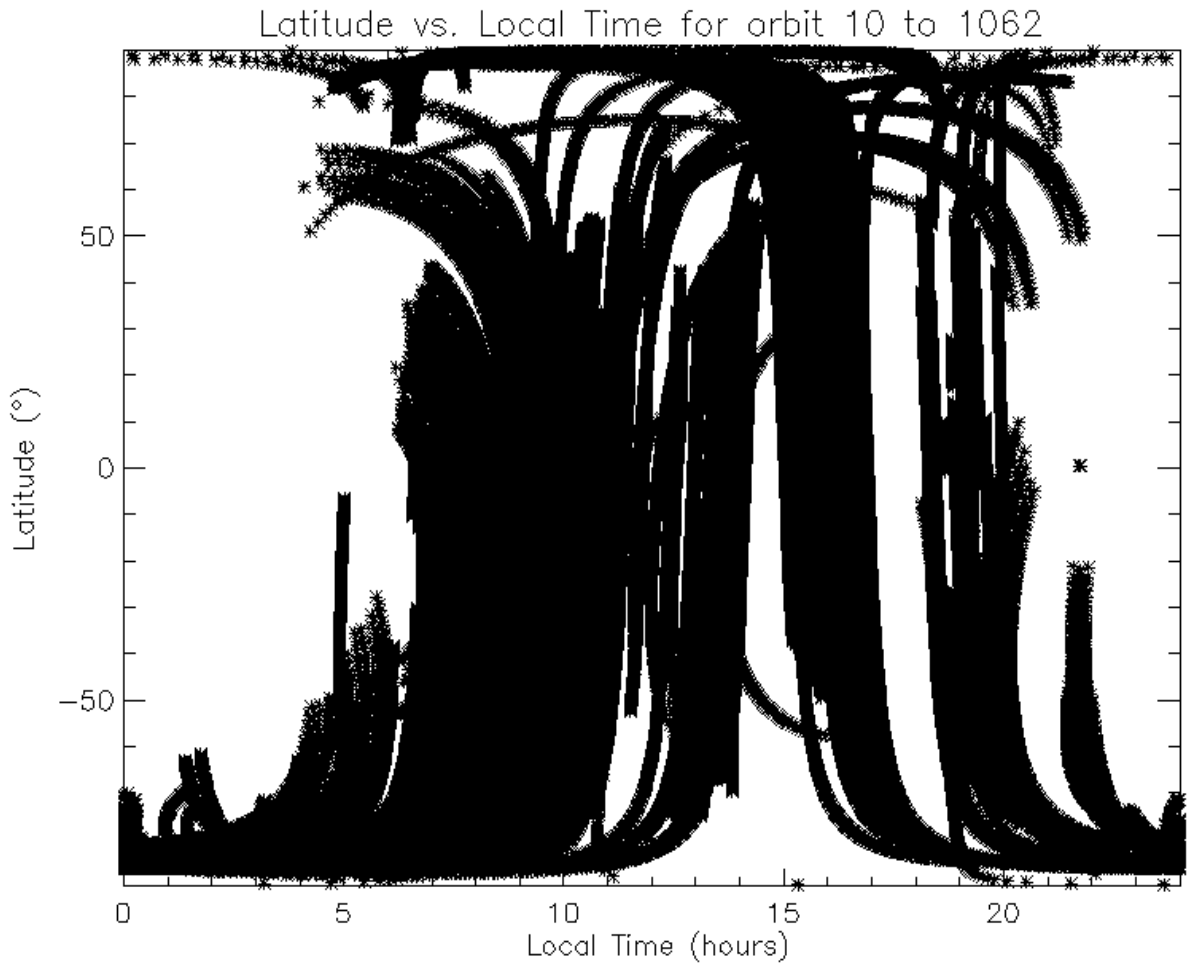
0- Generalities



Lat. – long.

Coverage of the planet Mars achieved with PFS in Jan. 2005 . In color dayside measurements , in black night side measurements.

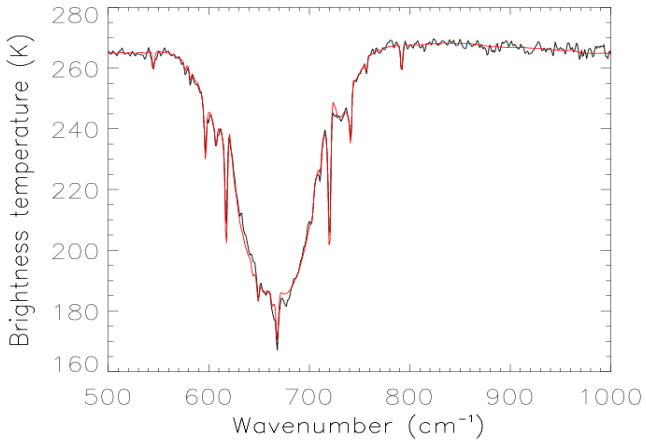
0- Generalities 3/3

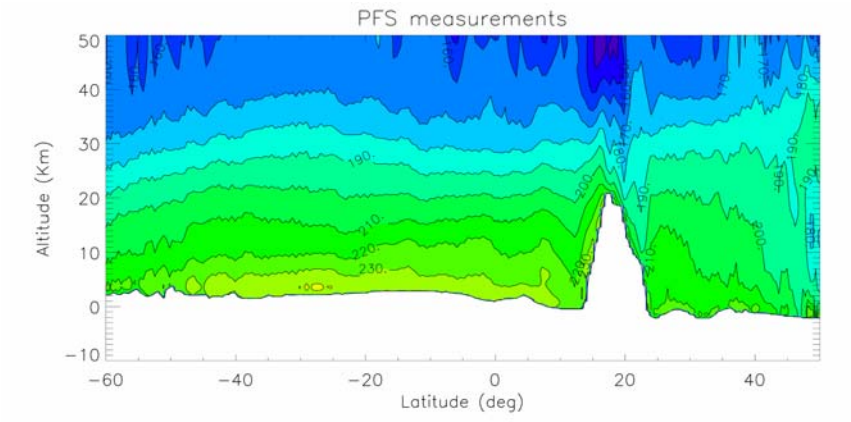


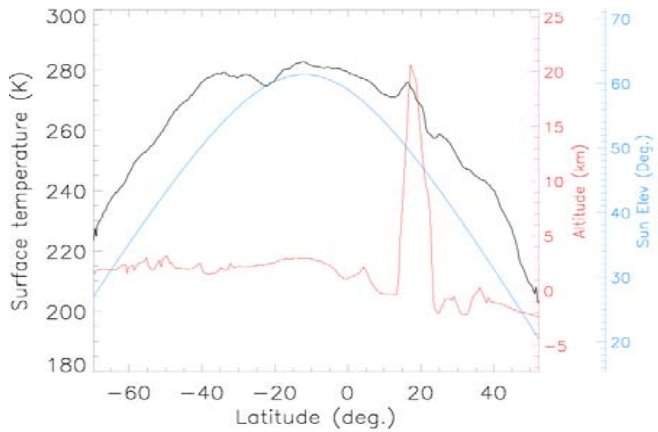
Lat – local time coverage of the PFS data until January 2005.

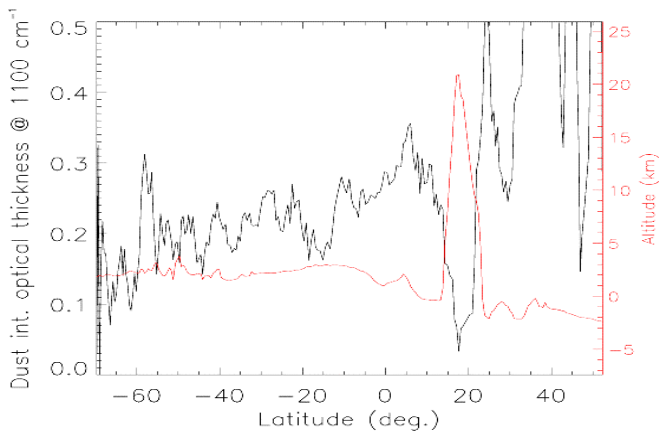
note the absence of observations in the nightside close to the equator . Note that Ls has been changing from 330 to 140 deg.

1.1 – Temperature fields over Olimpus







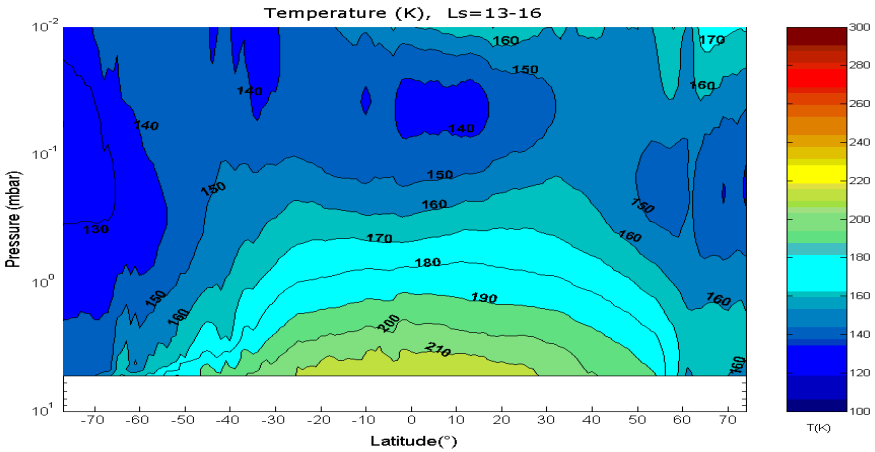


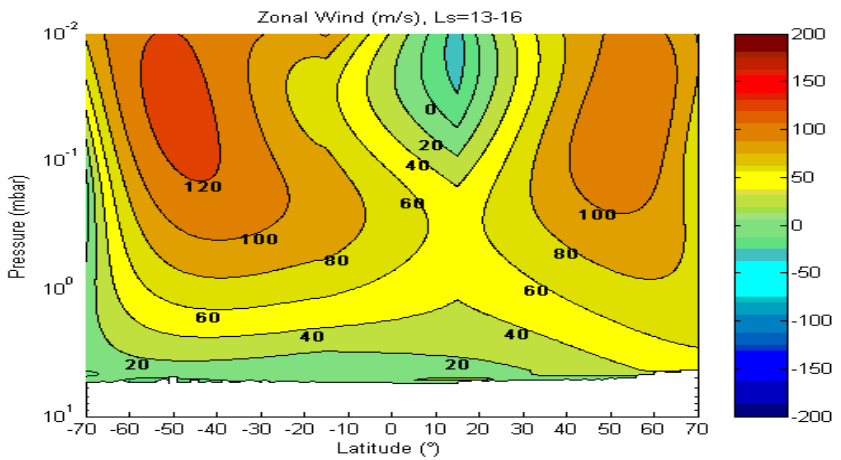
1.1 – Temperature fields over Olimpus 2/3

- The 15 microns band measured is inverted to produce the vertical temperature profile with which a syntetic spectrum is computed : the quality of the fit demonstrate the quality of the temperature profile.
- The measured spectrum also provides the soil temperature , which is , here , compared with the sun elevation and with altimetry. Note the increase of temperature over Olimpus , a better solar illumination. A temp anomaly is seen at -25 deg S.
- The temperature field usually follows the altimetry closely . Over Olimpus , however, it shows an anomalous adiabatic cooling due probably to local mesoscale up ward circulation .
- Dust opacity seems to be increasing toward northern plains in this orbit , but over Olimpus decreases drammatically due to altimetry .

1.1 – Temperature fields 3/3

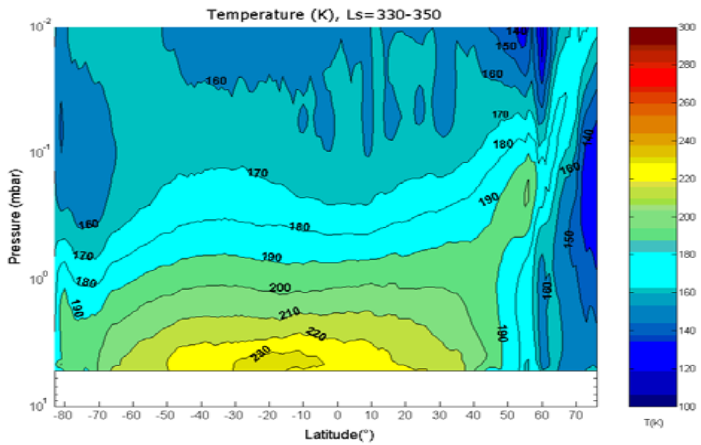
Mean meridional cross section of (top) retrieved temperature and (b) gradient thermal winds for the period Ls=13-16. Eastward thermal winds are positive.

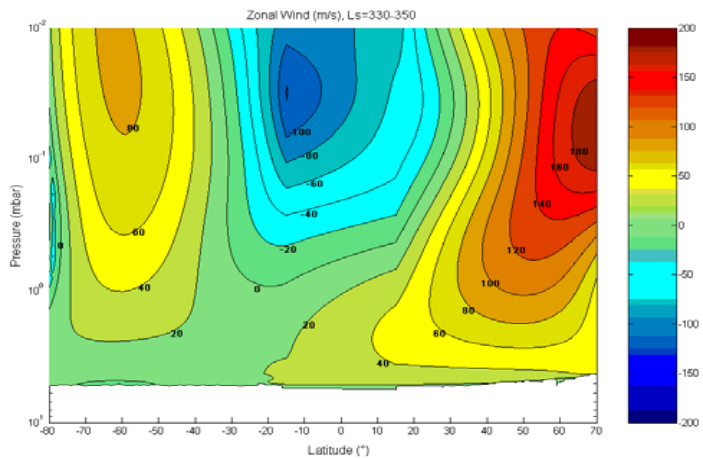




Mean meridional cross section of (top) retrieved temperature and (b) gradient thermal winds for the period Ls=330-350.

Eastward thermal winds are positive.

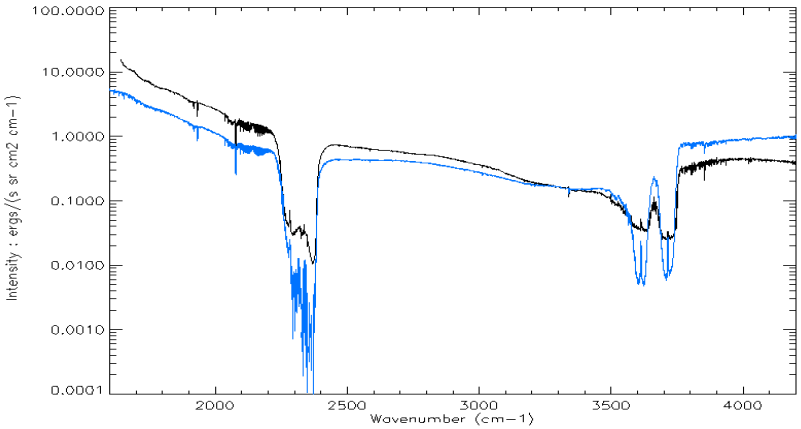


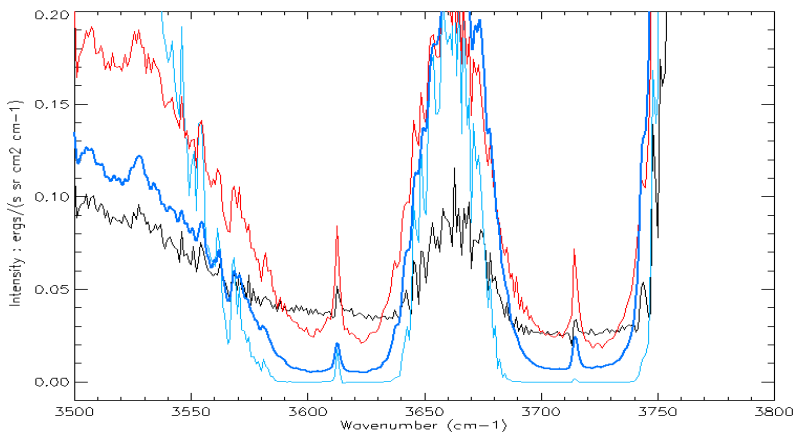


1.2 – Comparison with ISO SWS

Top: global PFS (black) and ISO SWS (blue) spectrum

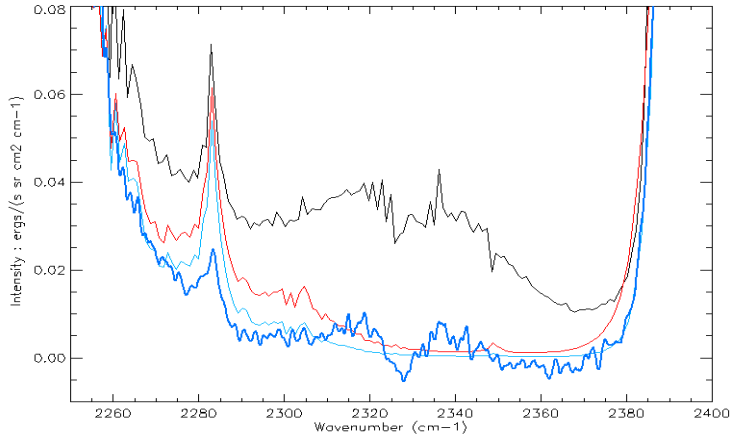
Bottom: ISO, PFS , and synthetic spectra in 2.7 μm band

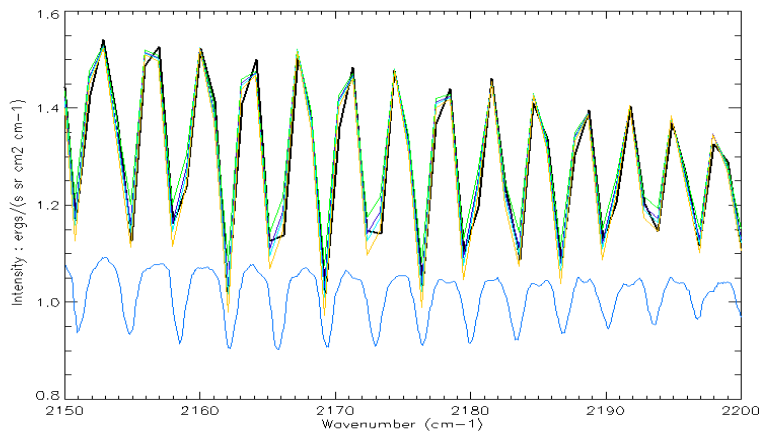




Top:PFS,ISO,and synthetic spectra in the 4.3 μm band

Bottom : ISO and PFS CO lines : 700 and 1000 ppm respectively





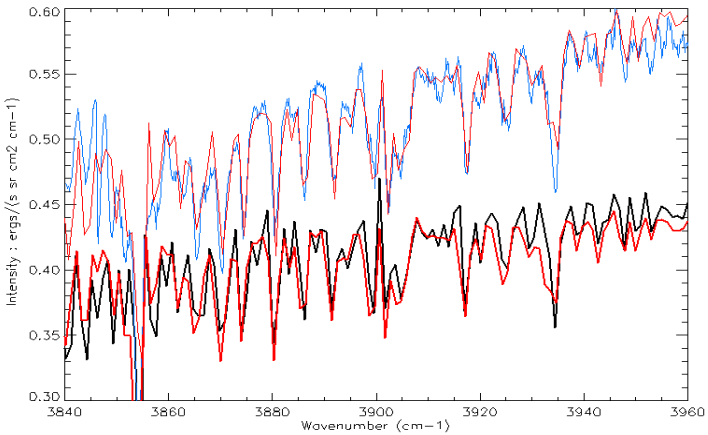
1.2 – Comparison with ISO SWS

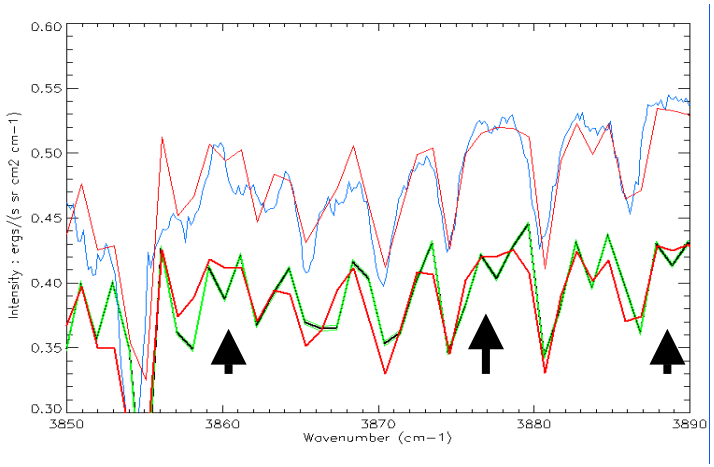
Top: PFS (black), ISO (blue) water lines .Fit with 400 ppmv

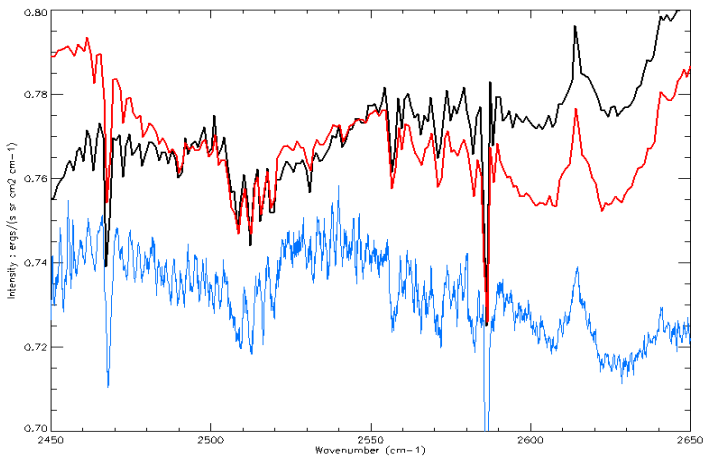
Bottom: PFS,ISO and synthetic isotopic CO_2 bands

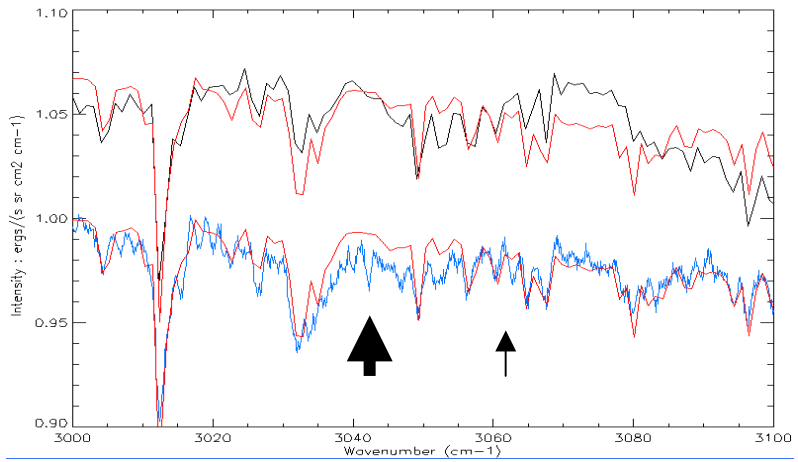
Top: blow up of water lines: 3 new lines are seen (HF, H2S ?)

Bottom : unidentified extra lines in ISO in the methane region

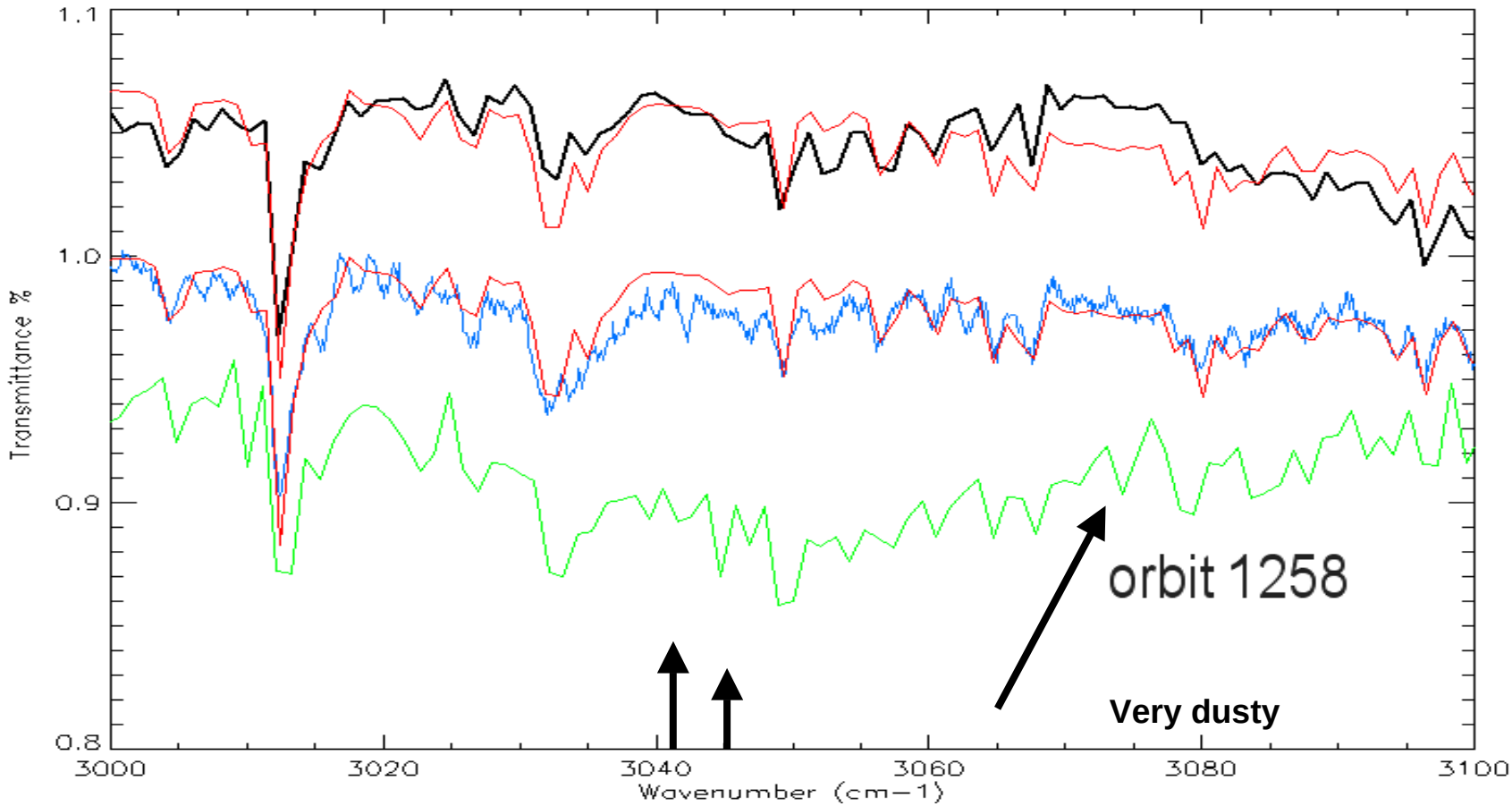








1.2 – Comparison with ISO SWS new lines

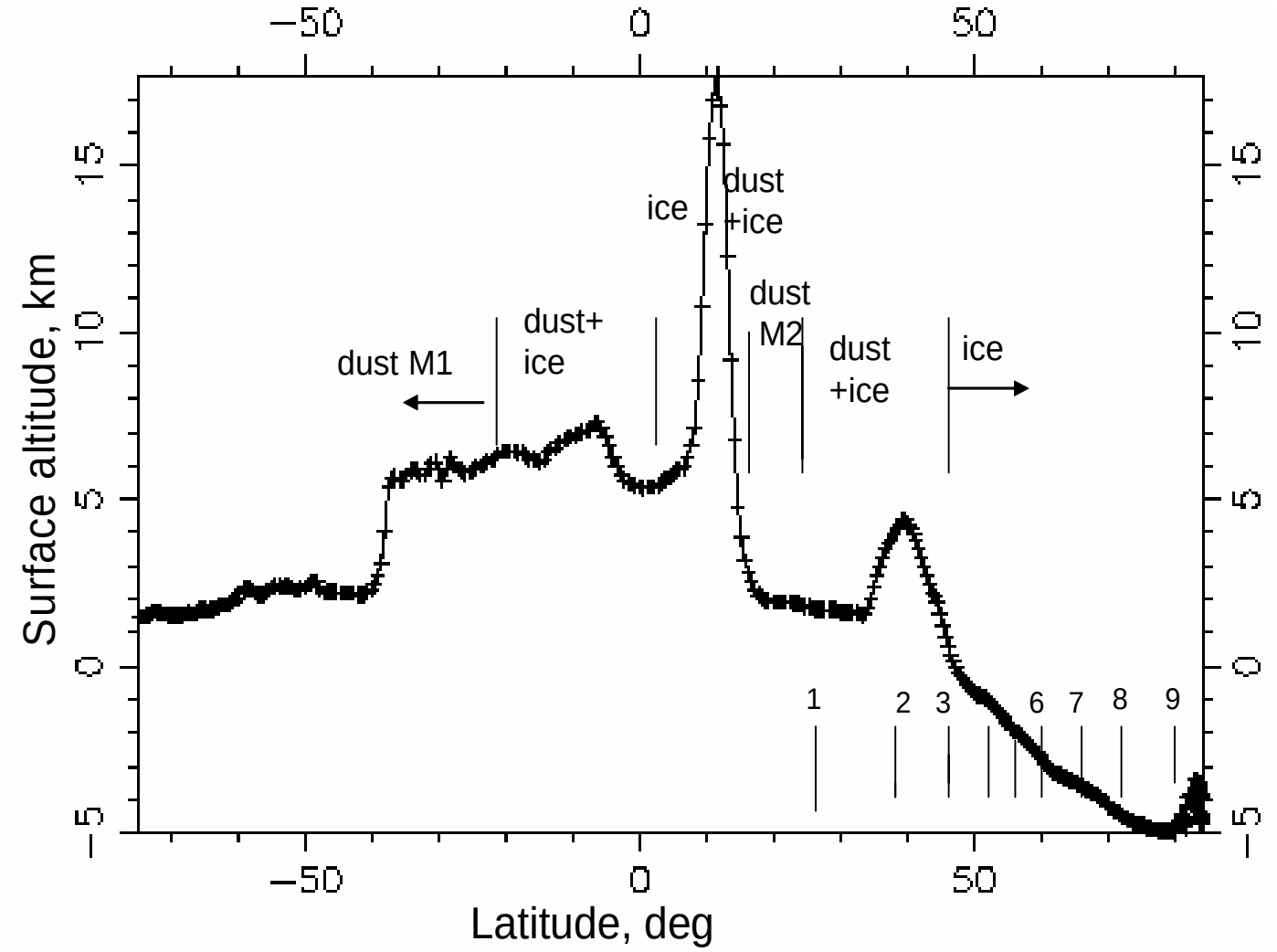


New lines in this spectral region appear to come and go : orbit 1258 , a dusty period. Methane has a line at 3056 , 3044,

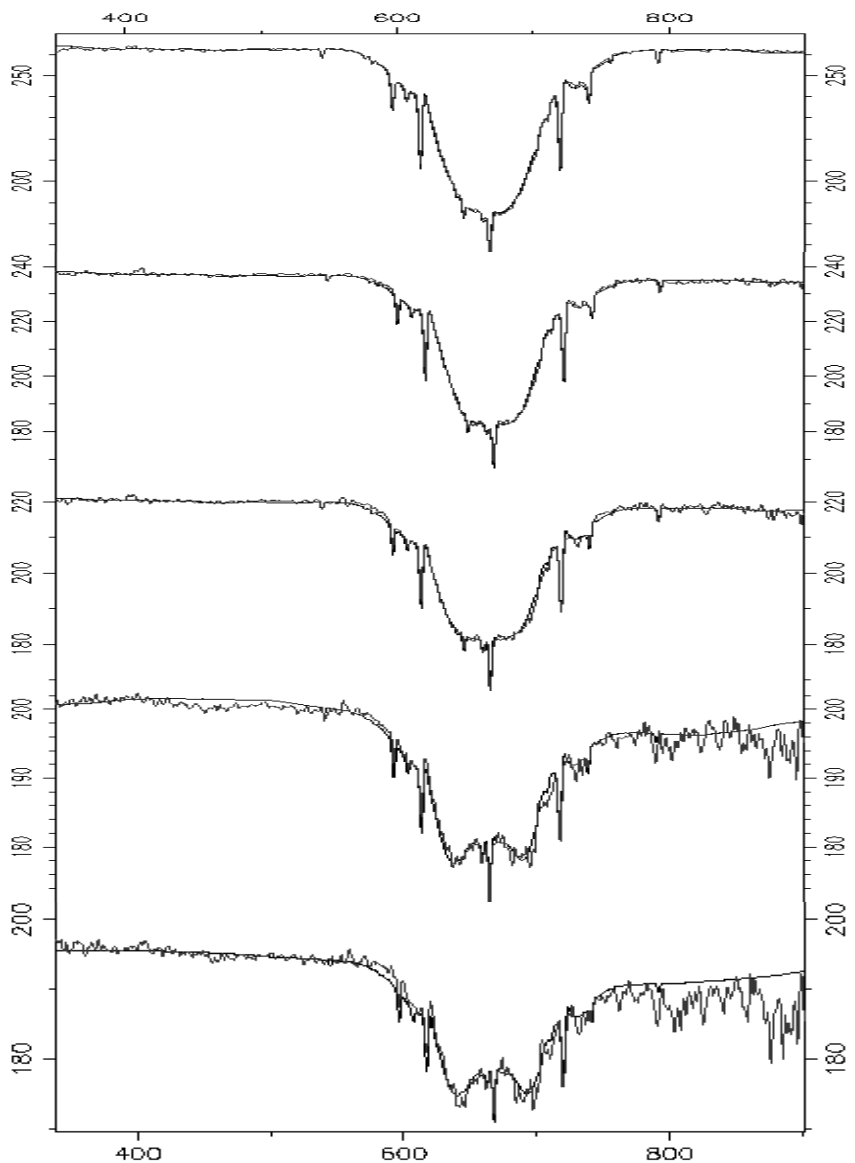
1.2 – Comparison with ISO SWS

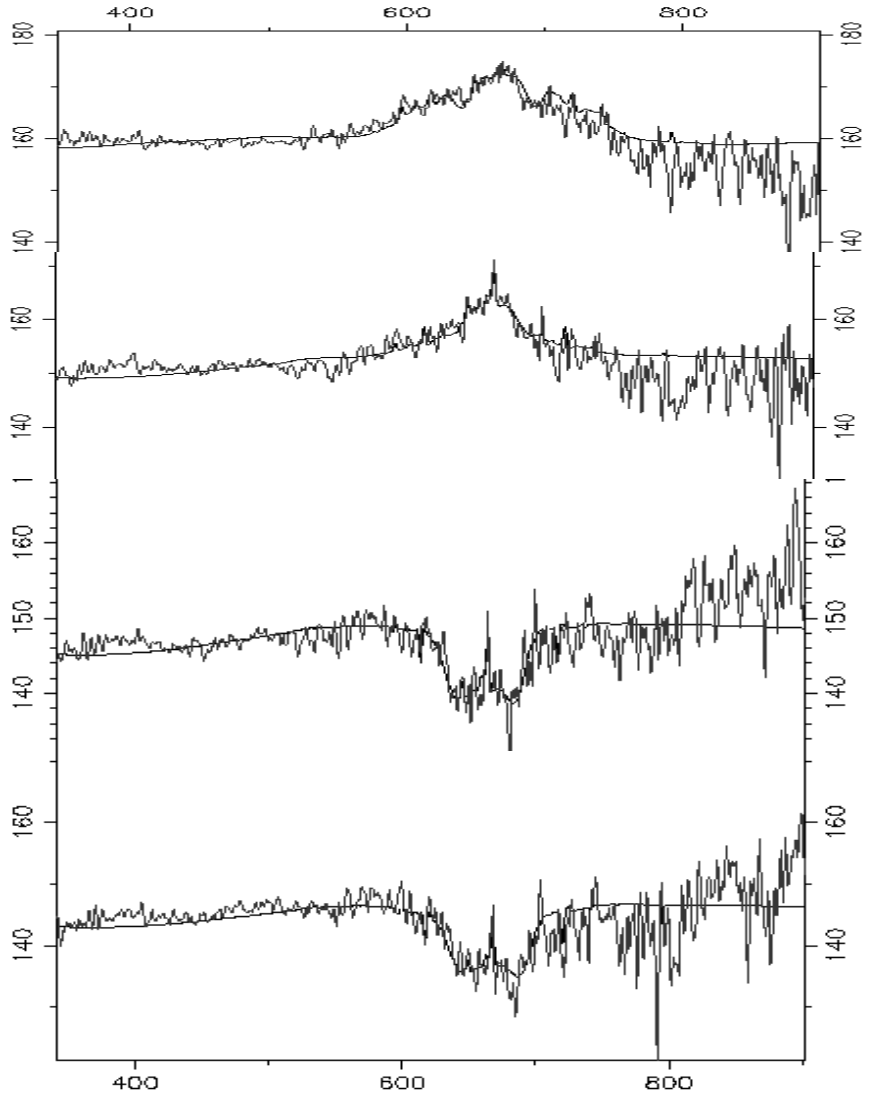
- The comparison with ISO SWS Martian spectrum allows to establish a good confidence with PFS measurements down to small details . (Do not forget : PFS is average over 1680 spectra).
- The spectral range covered was 1750 through 4200 cm^{-1}: PFS works well there.
- Instrumental effect was identified (overshooting of strong solar lines).

1.3 – Polar vortex orbit 68

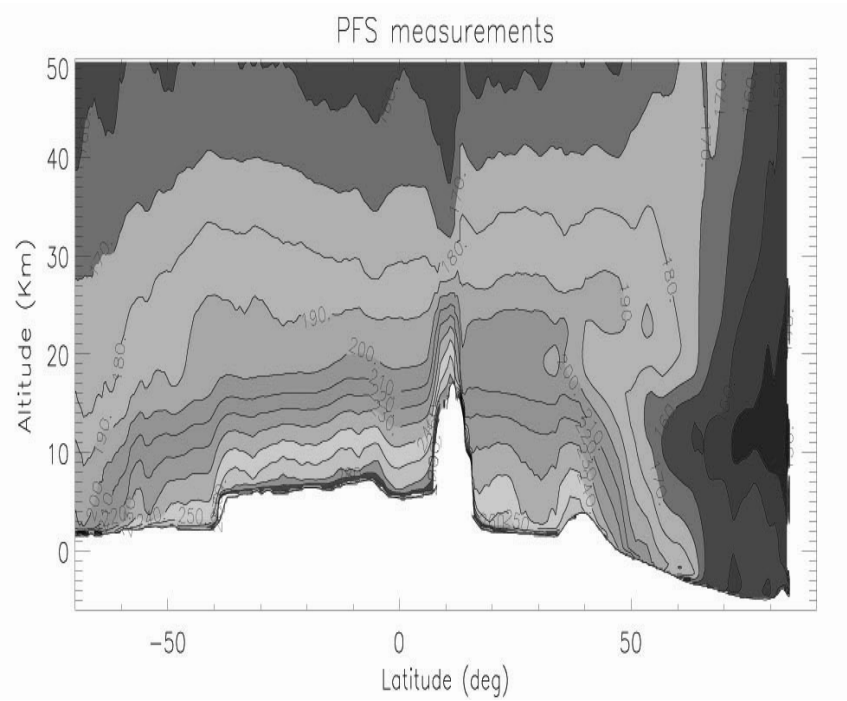


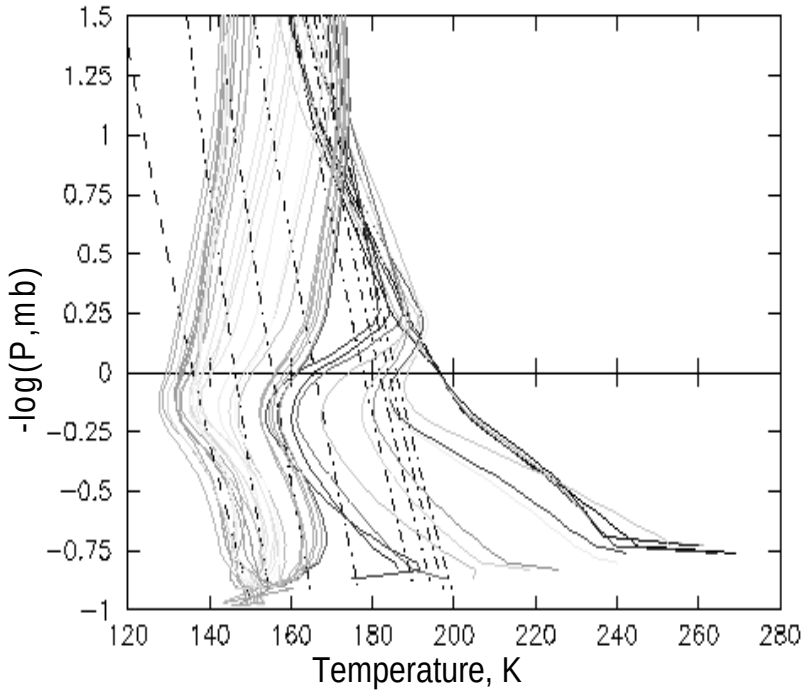
1.3 – Polar vortex





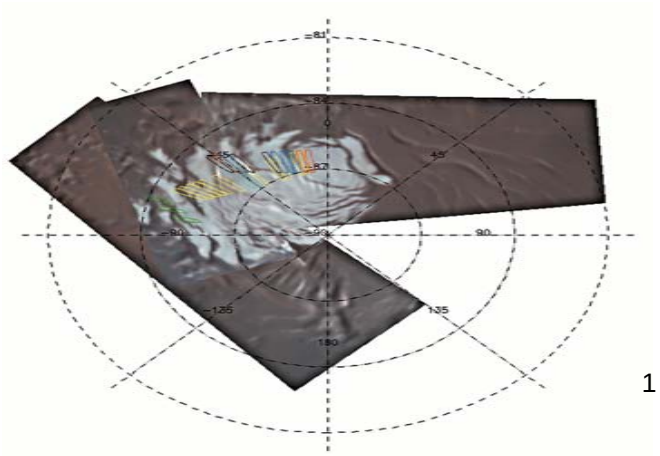
1.3 – Polar vortex



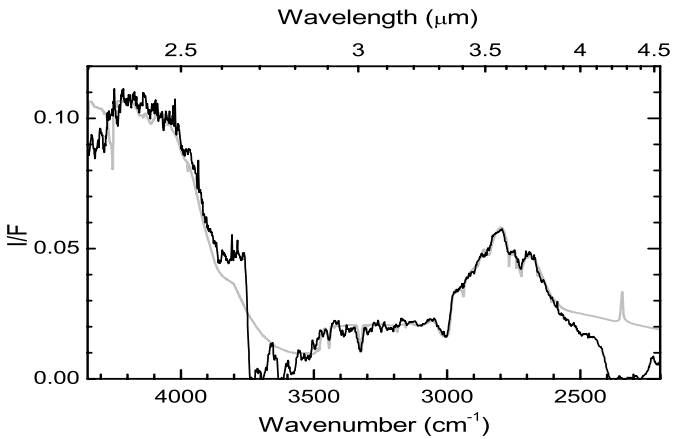


In the descending branch of the Hudley cell thermal inversion is observed toghether with the condensation of water vapor to form water ice clouds (feature at 800 cm-1). More details in the paper poster by Zasova et al.

1.4- Polar ice composition



1



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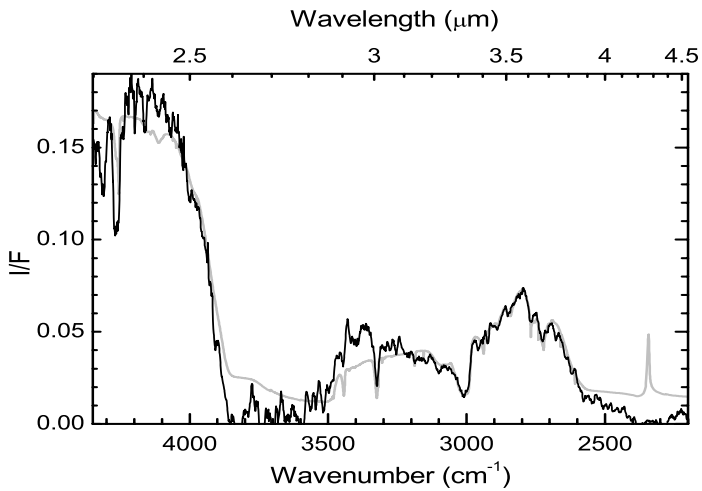

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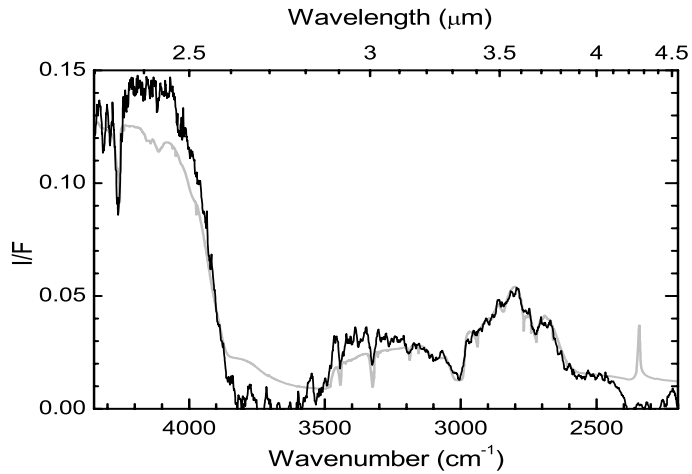

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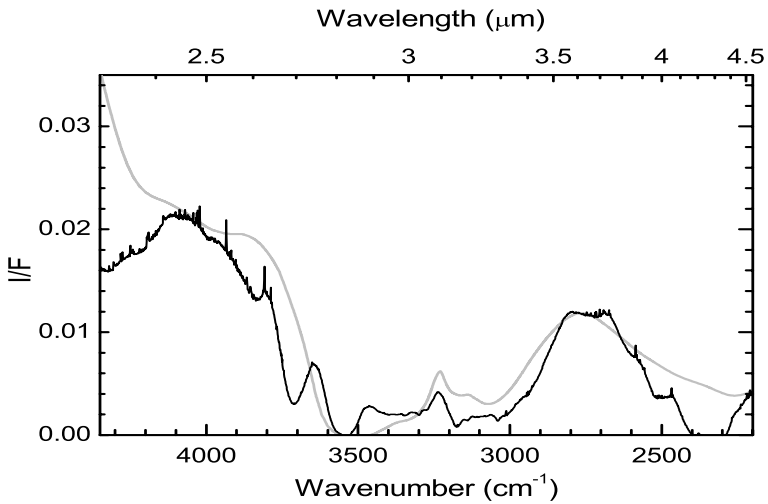
1.4- Polar ice composition



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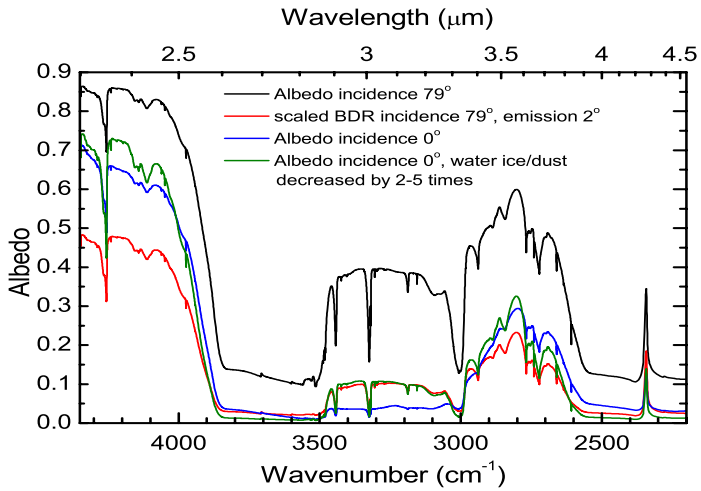
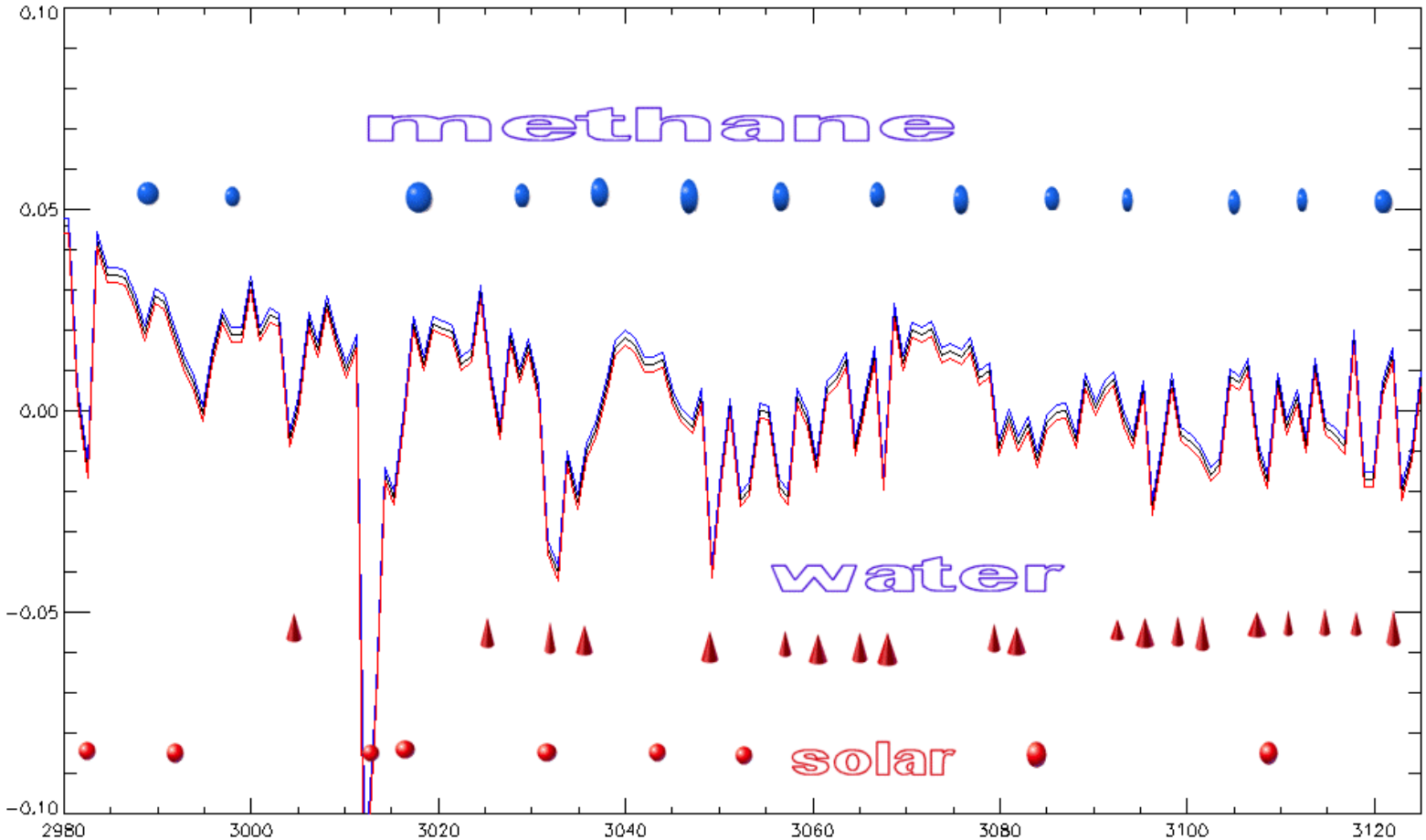


6

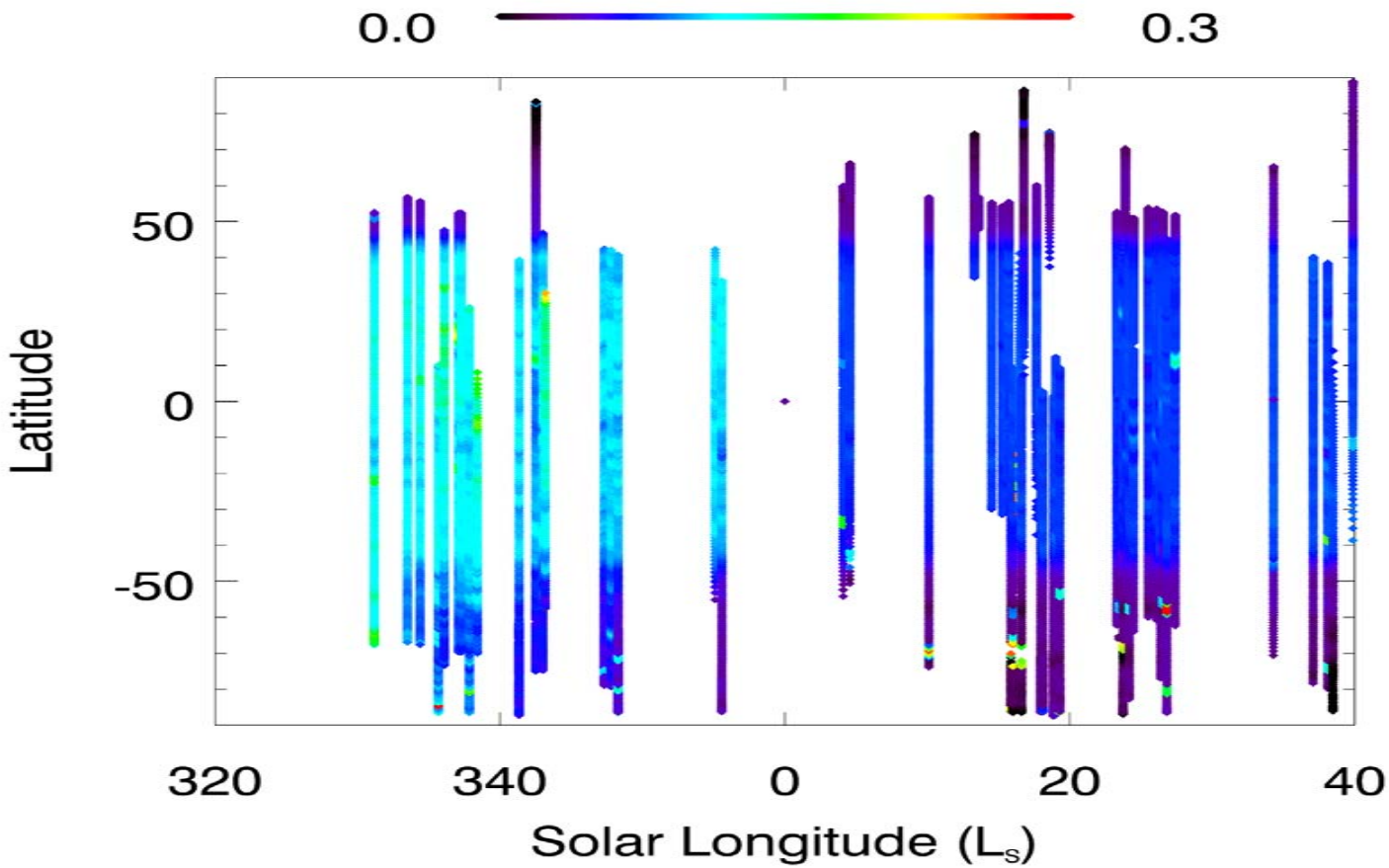
- 1- Mosaic of Mars Express OMEGA images, with the PFS SW footprints for the data used .
- 2-The large average for Orbit 30 (black line) is shown along with a scaled albedo model fit (gray line).
- 3-The bright average for Orbit 30 (black line) is shown along with a scaled albedo model fit (gray line).
- 4-The third (brightest) average for Orbit 41 (black line) is shown along with a scaled albedo model fit (gray line).
- 5-Water ice spectrum at the edge of the residual polar cap. This average is from the areas indicated by the three green outlines in Figure 1. The scaled BDR model is shown in gray. It is a linear combination of large and small grained ice. The mixture consists of about 50% 3-μm and 50% 50-μm snow.
- 6-This figure shows the effect of lighting geometry on models with the same properties. The black, red, and blue models all have the same grain size and dust and water ice content, but the blue model is for albedo at incidence angle 0° while the black spectrum is albedo at incidence angle 79°.

1.5 – Minor species : methane



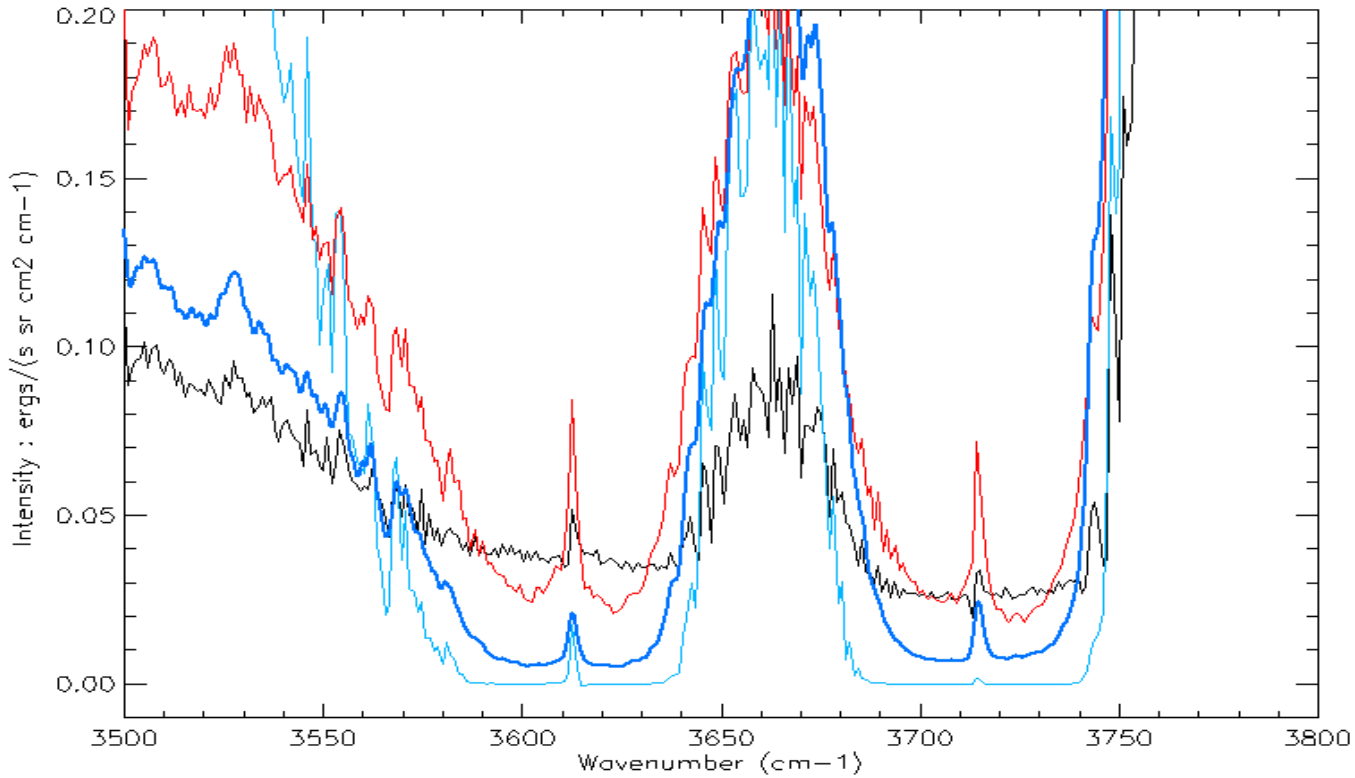
Methane will be discussed in the other presentation on the search for life on Mars.

2 – New results: 2.1- Dust opacity



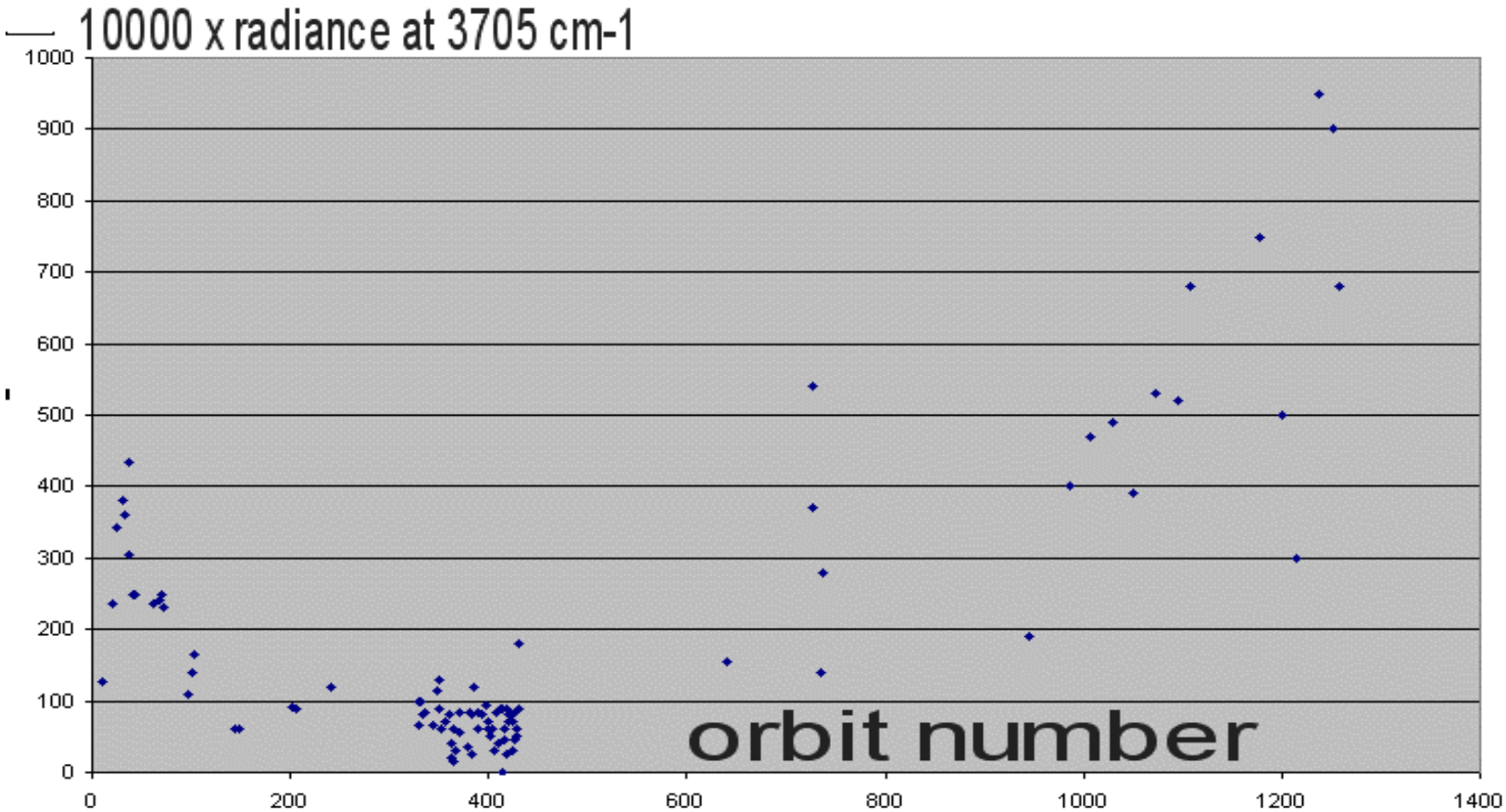
Dust opacity from the 10 microns band : Decrease with time.

2 – New results: 2.1- Dust opacity



The radiance at 3705 is a measure of the dust opacity in the atmosphere (Titov et al.)

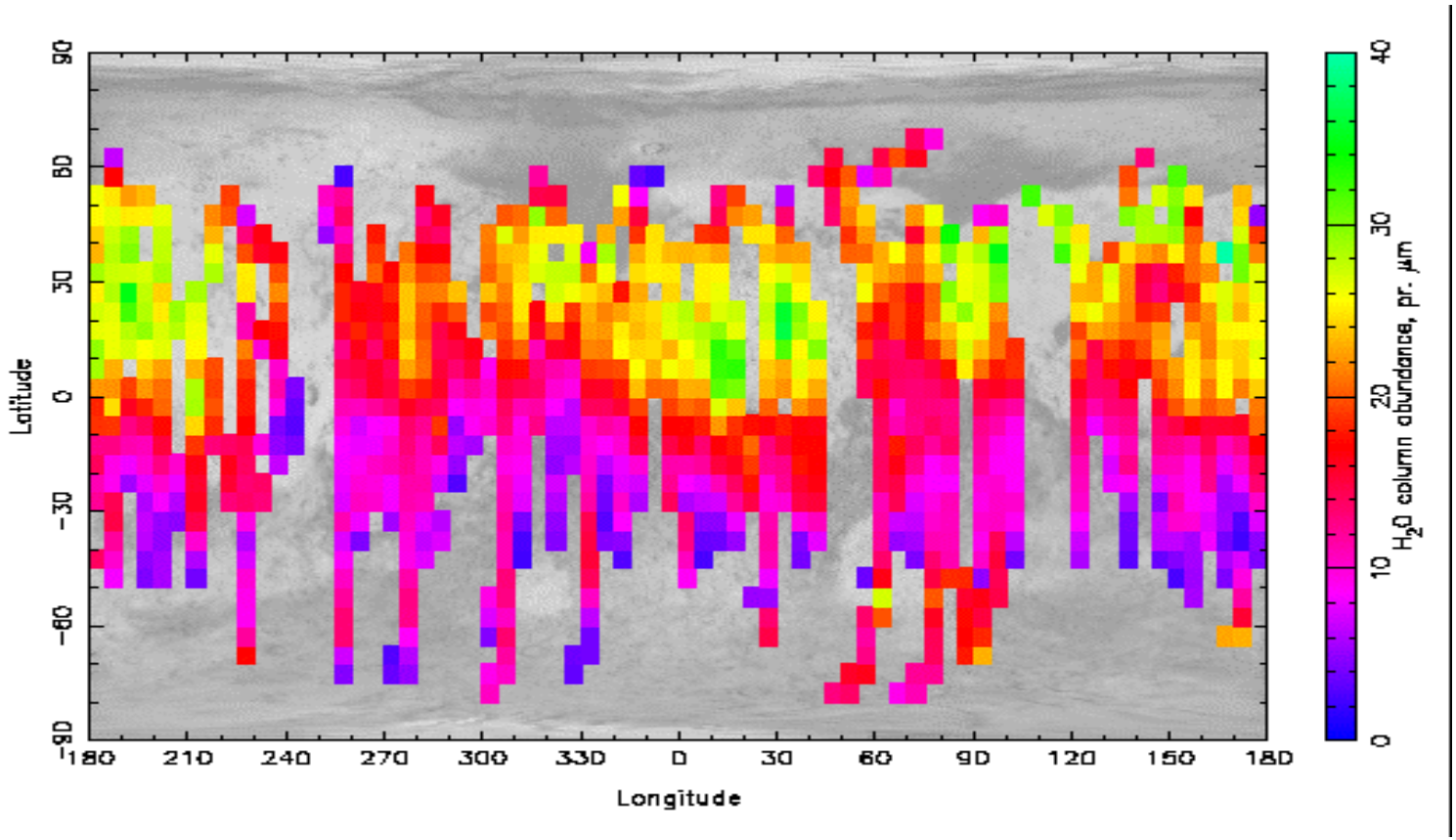
2 – New results: 2.1- Dust opacity



Measured radiance at 3705 (x10000) ergs/(cm2 s sr cm-1) , orbit averages , versus time.

See report by G.Rinaldi. (Not all the orbits are shown). These measurements allow to study the phase function of the dust aerosols.

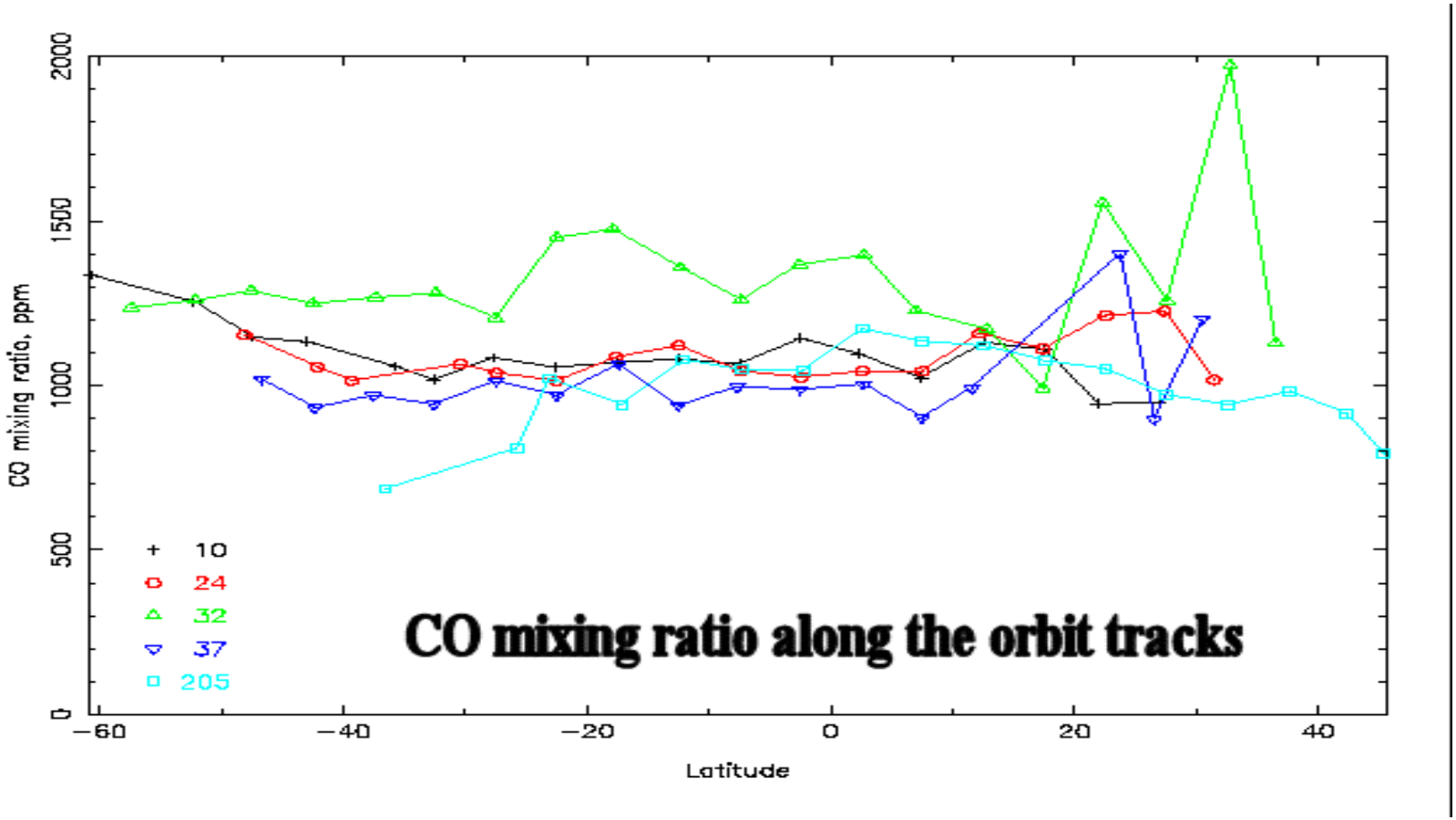
2.2 – Water mapping



Integrated column of water vapor in Martian atmosphere : Map of precipitable microns of H2O.

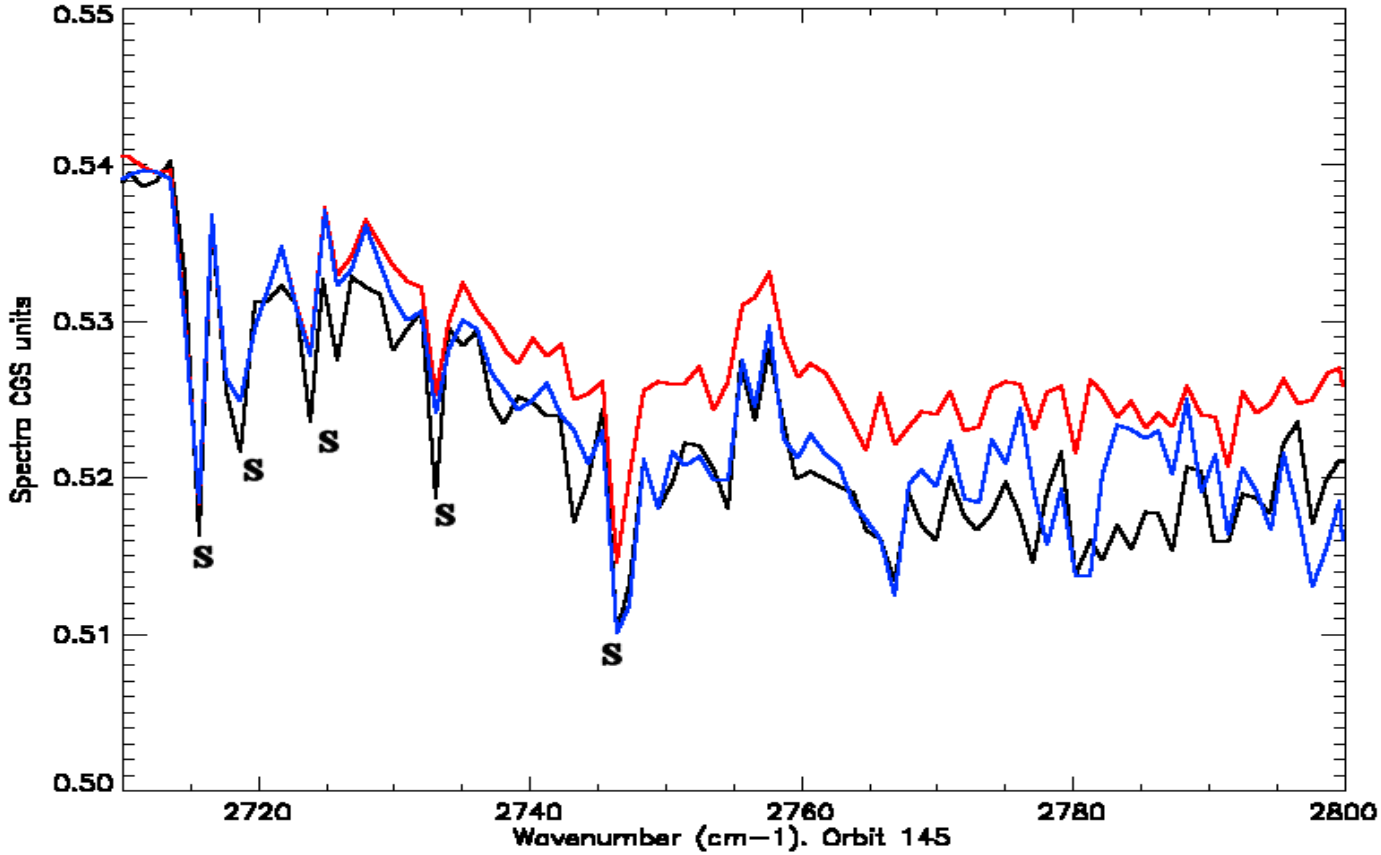
See the report by Ignatiev et al. And by Lellouch et al.

2.3 – CO mapping



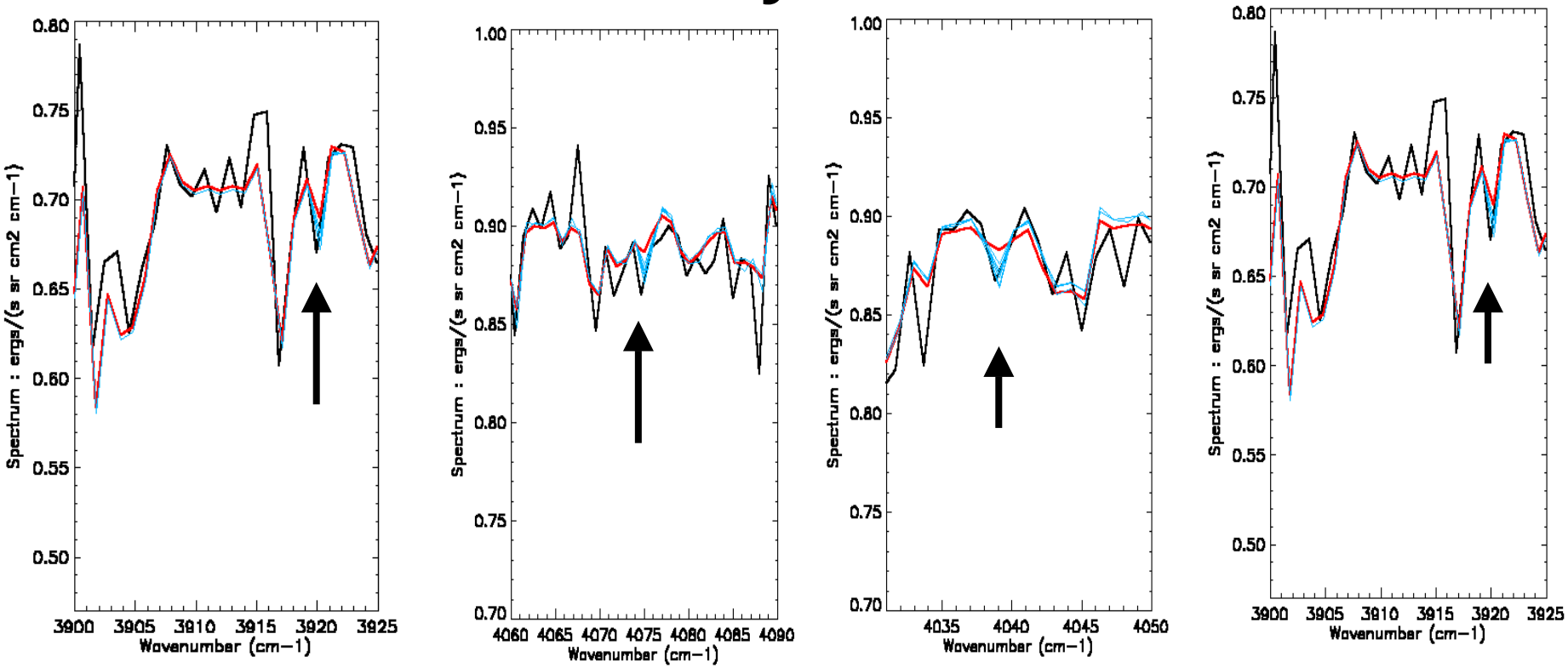
CO seems to range between 900 and 1500 ppm , with the tendency to increase toward the North pole. See the report by Billebaud et al.

2.4 – Minor species : Formaldehyde, HF, HBr



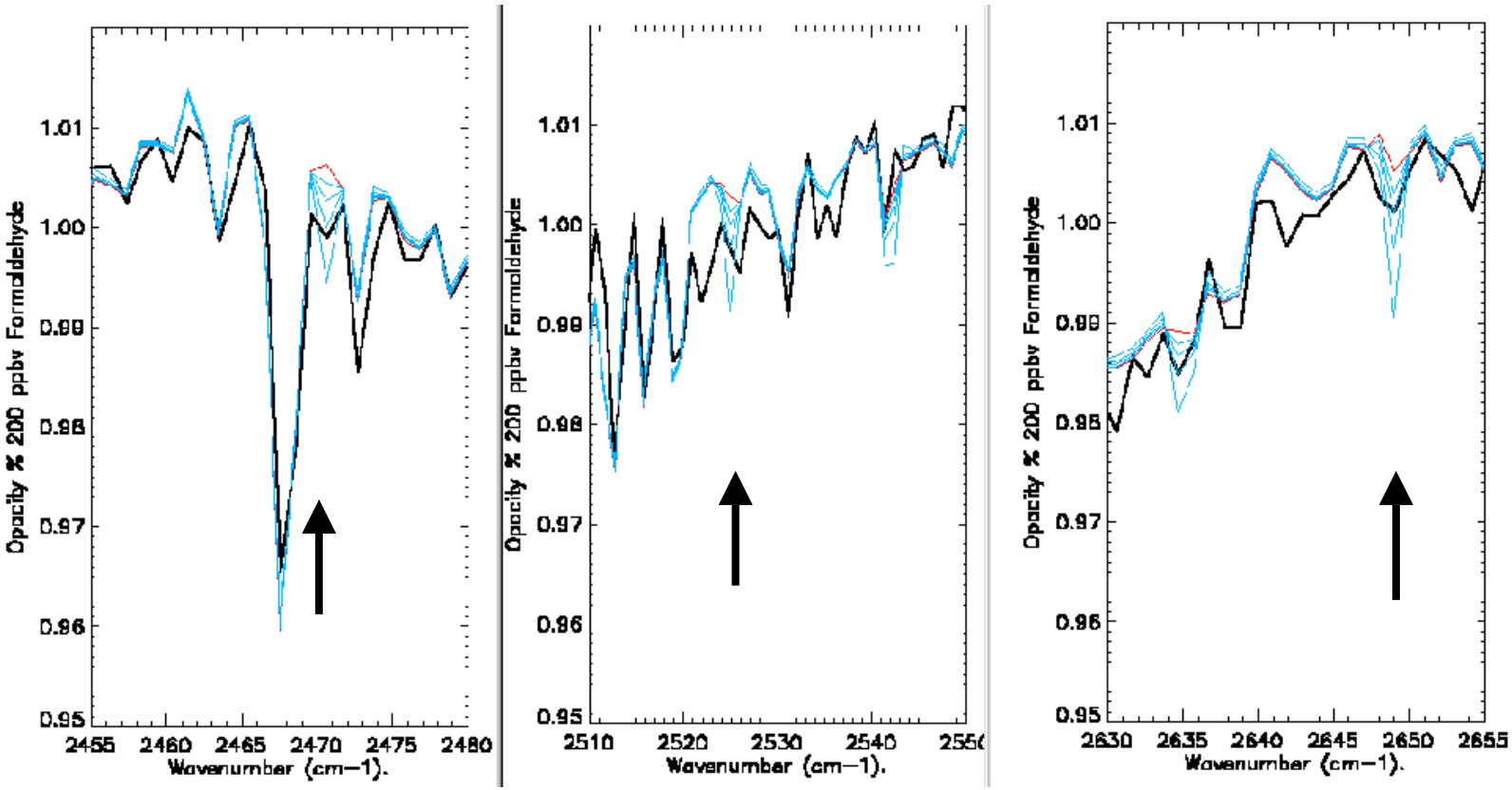
Orbit 145 : CH2O for 200 ppbv is observed . See presentation on Life on Mars.

2.4 – Minor species : Formaldehyde, HF, HBr



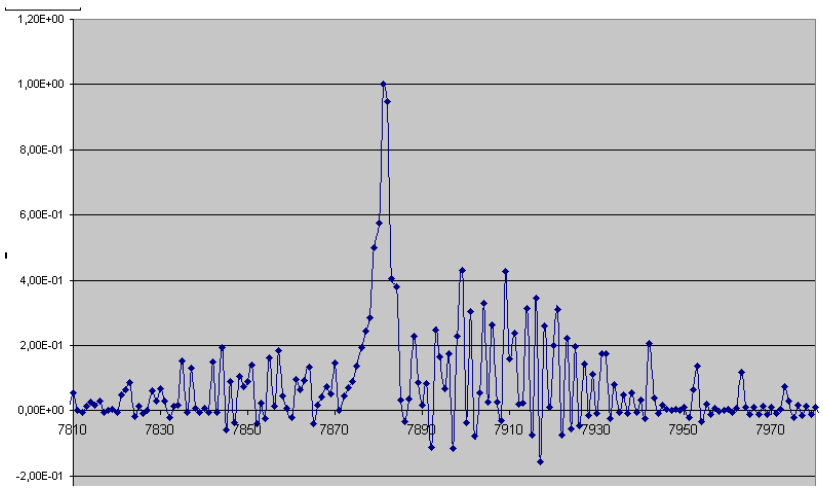
- **FOUR HF LINES IDENTIFIED IN THE PFS AVERAGE SPECTRUM : BLACK MEASURED .RED SYNTHETIC NO HF AND BLUE 200 PPB OF HF.**
- **OTHER LINES TO BE IDENTIFIED ARE AT 4048 AND 4088 CM-1.**

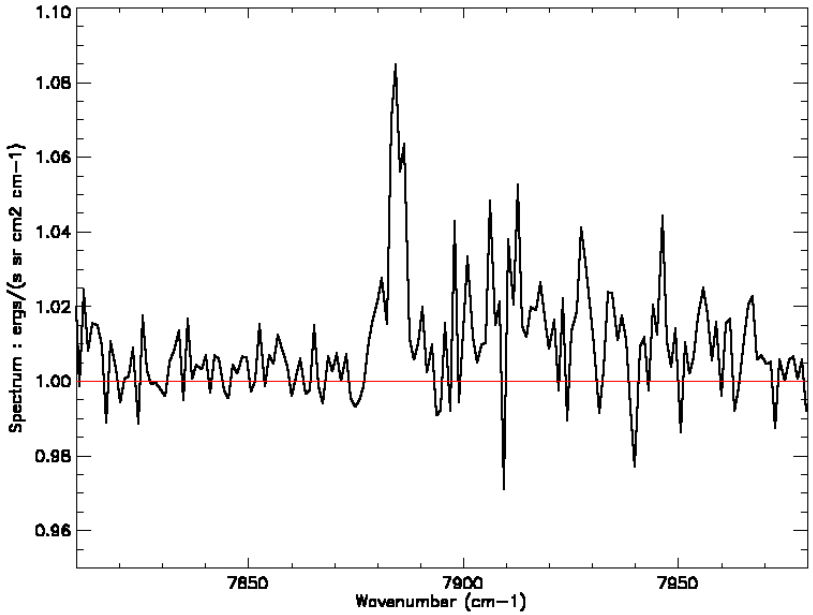
2.4 – Minor species : Formaldehyde, HF, HBr



- **HBr mixing ratio = 150 ppbv**

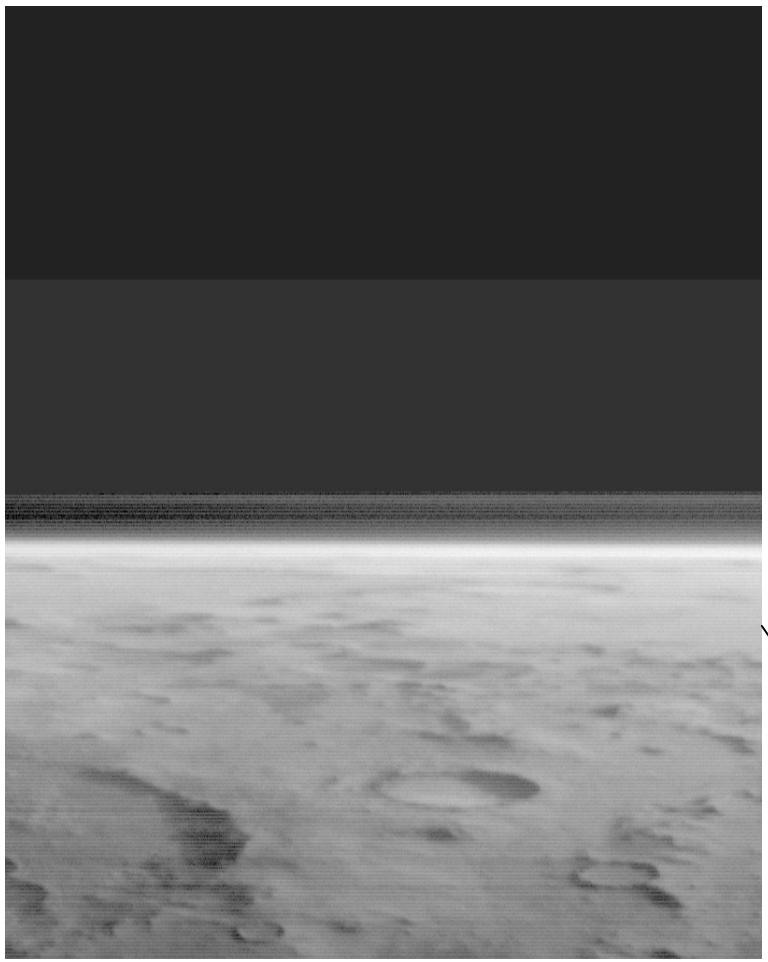
2.5 – Oxygen emission spectrum

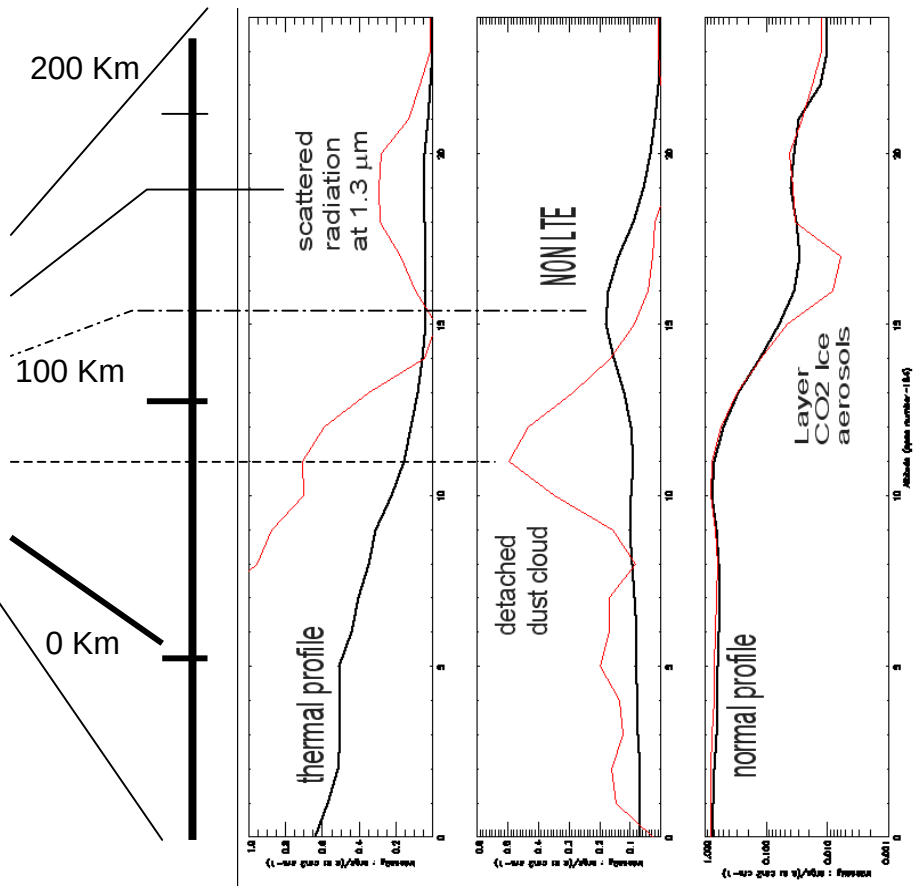




Ozone dissociated by the solar UV releases excited O2 molecules that eventually emit radiation. PFS spectrum has observed this radiation . A full spectrum (34 identified lines) is observed and presented in the POSTER by V. Formisano et al.

2.6 – Limb observations : Structure of the atmosphere

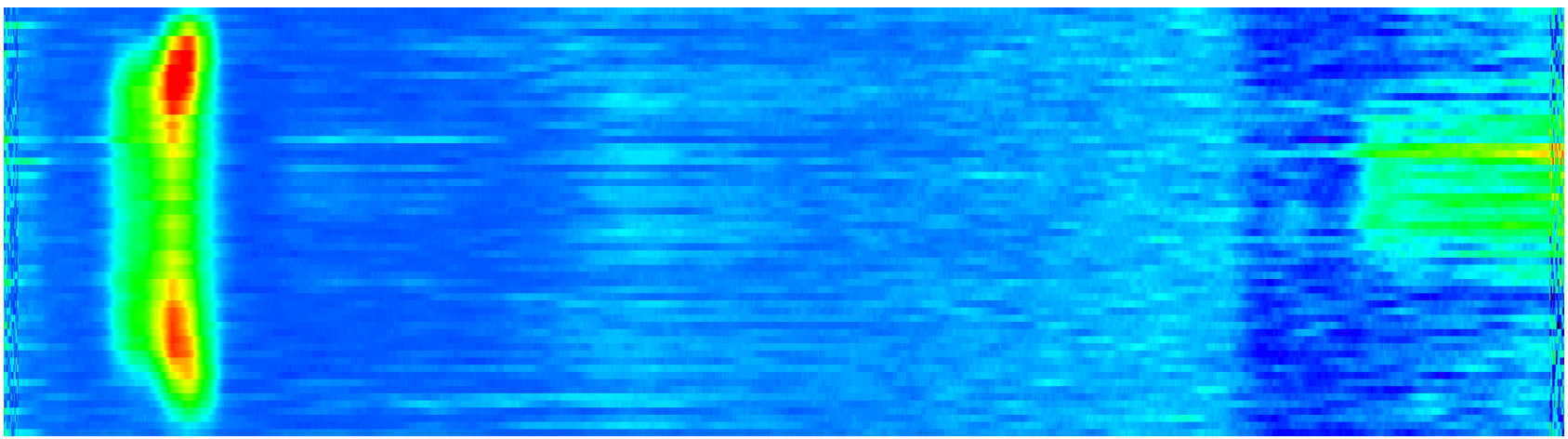




2.6 – Limb observations

- **In orbit 1234 the spacecraft looked tangentially at the horizon , never allowing the FOV to look at altitudes lower than 80 Km . Each layer of the atmosphere was therefore observed twice , except the one at lower altitude (80 Km). I present here the PFS observations.**
- **This is a spectrogram from 2000 to 3800 cm-1.**

- **NON LTE EMISSION** **2.7 μm CO2 BAND**



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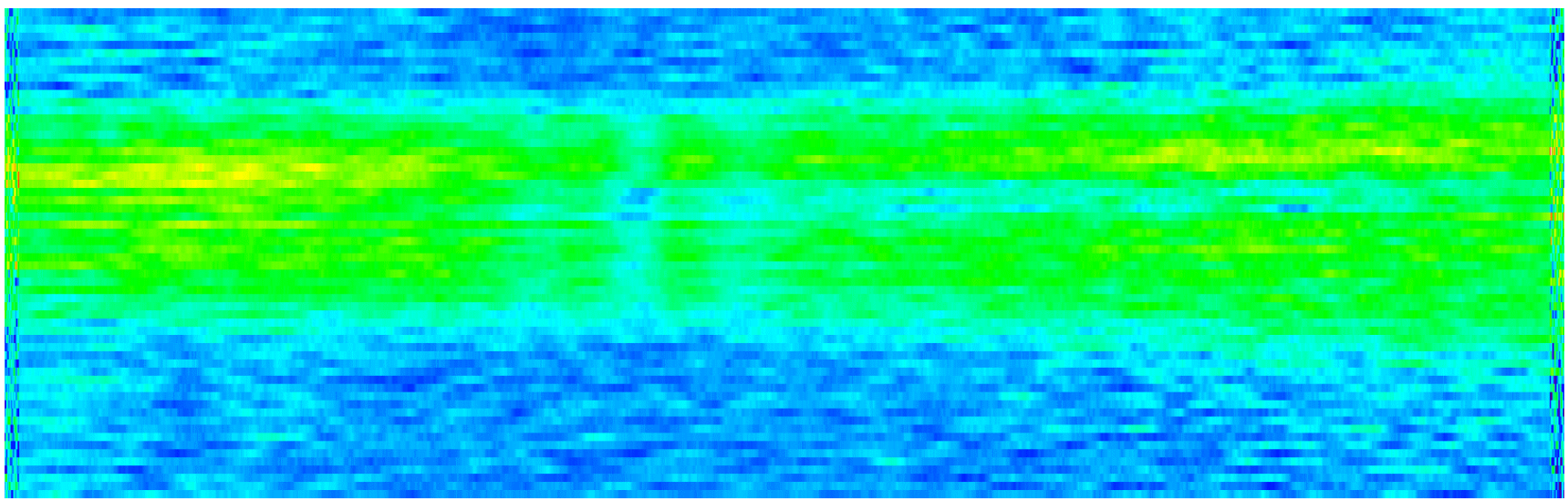
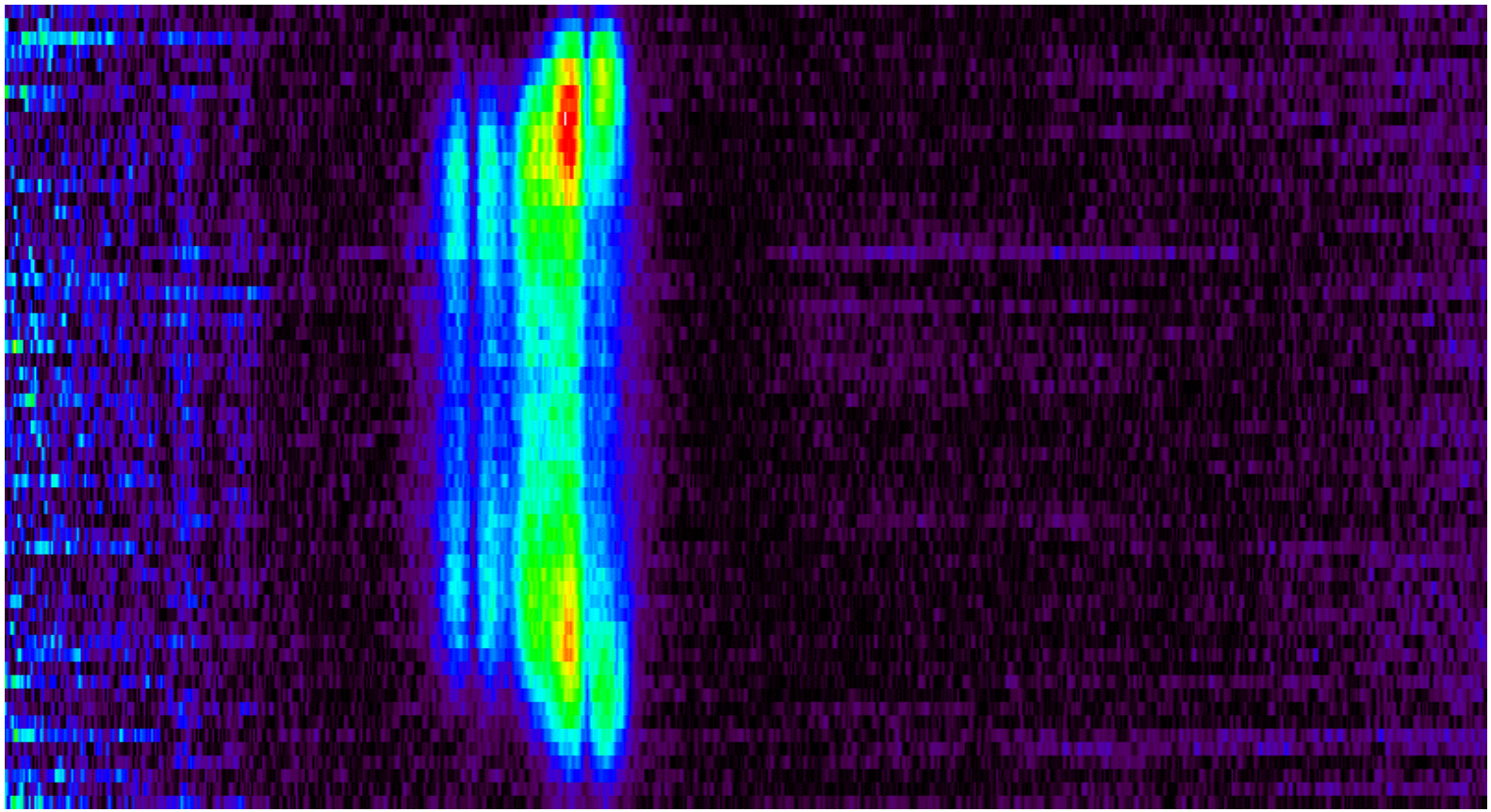
- **In orbit 1234 the spacecraft looked tangentially at the horizon , never allowing the FOV to look at altitudes lower than 80 Km . Each layer of the atmosphere was therefore observed twice , except the one at lower altitude (80 Km). I present here the PFS observations.**
- **This is a spectrogram from 4000 to 5800 cm-1.**

- **SCATTERED RADIATION 2.0 μm CO2 BAND**

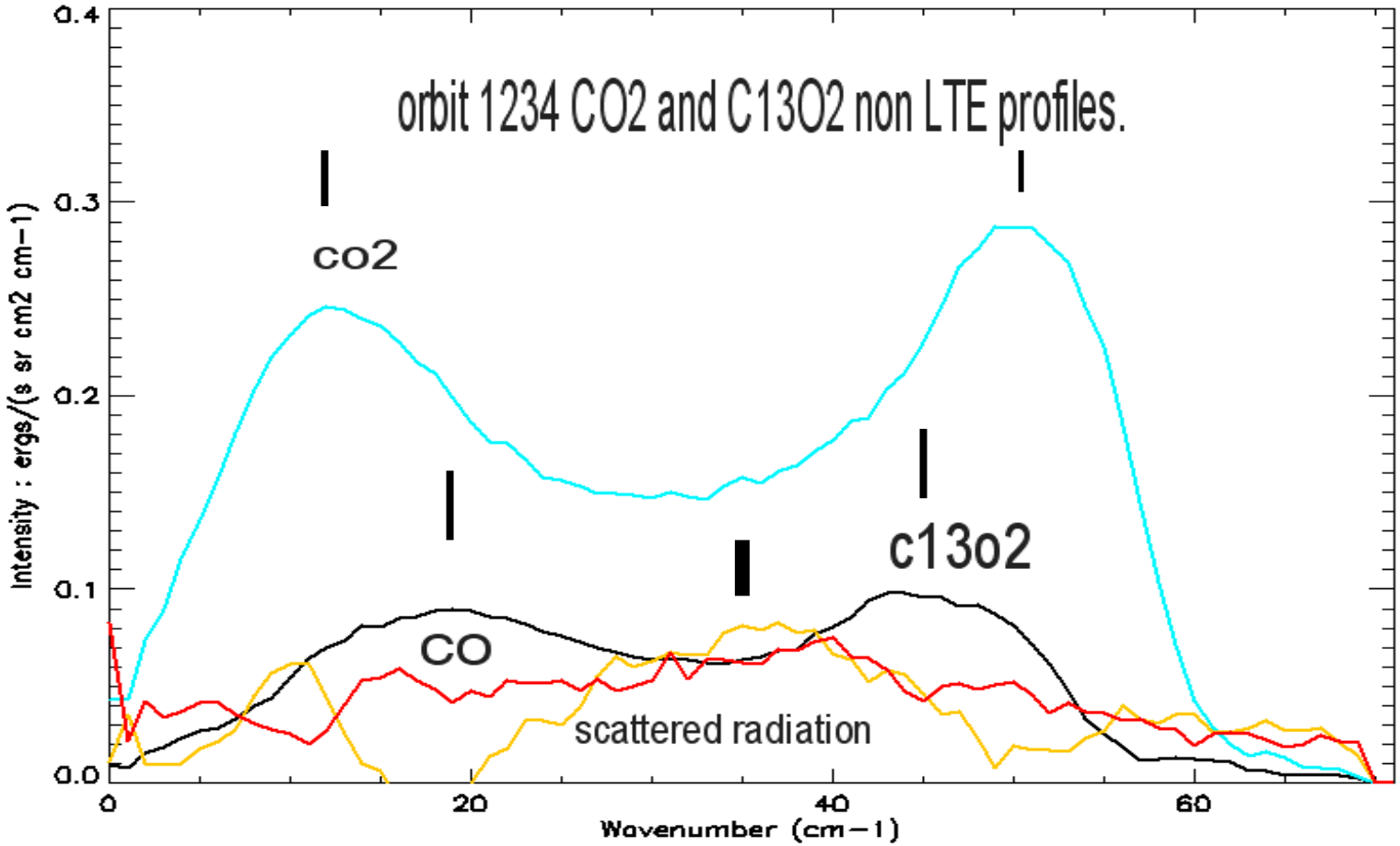


2.6 – Limb observations

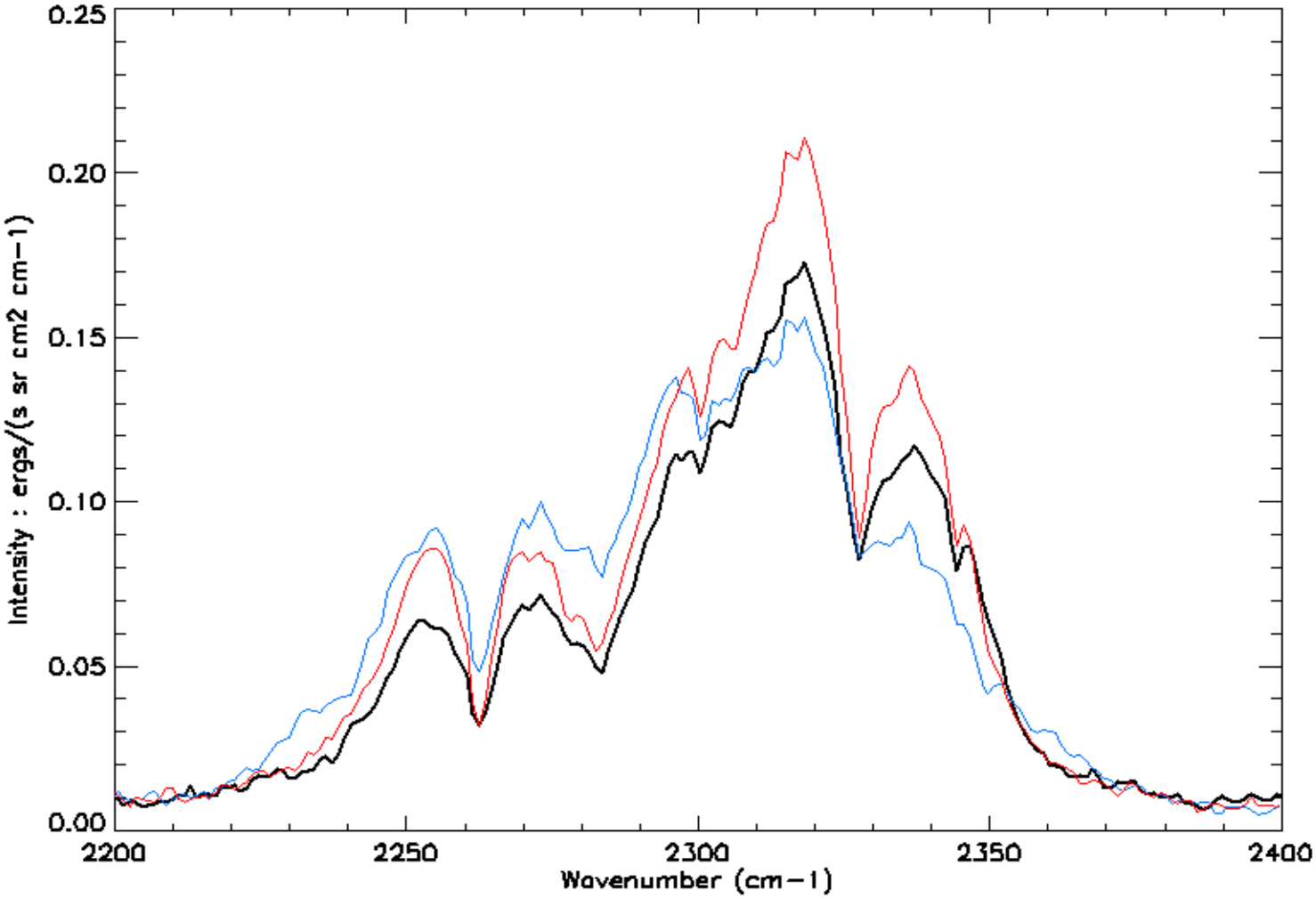


A blow up of the spectrogram in the NON LTE emission region : CO , CO2 , and C13O2 are seen emitting.

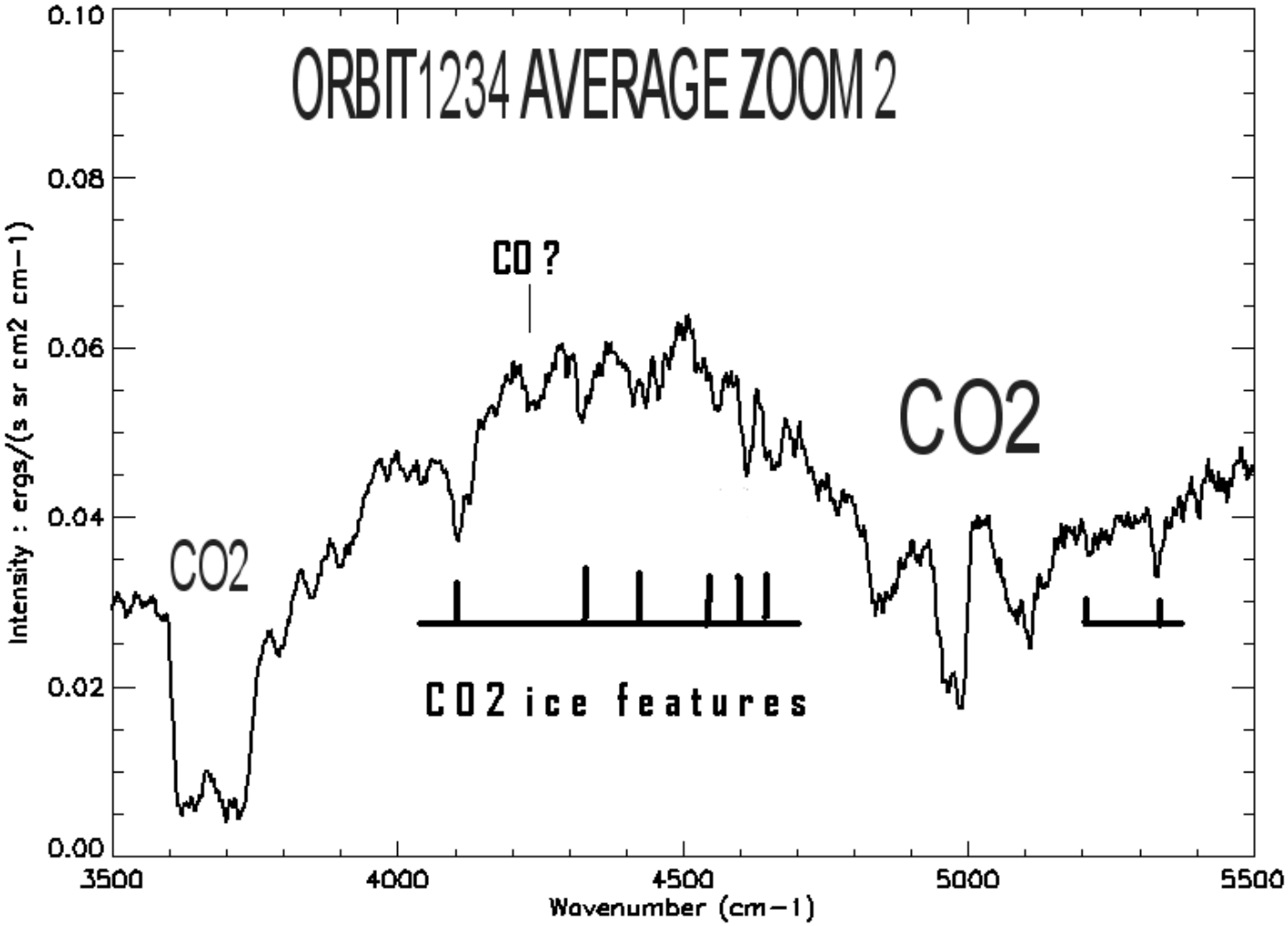
2.6 – Limb observations



2.6 – Limb observations



2.6 – Limb observations



2.6 – Limb observations

- **NON LTE EMISSION OF RADIATION FROM CO_2, AND CO IS SEEN**
- **NON LTE EMISSION OCCURS FROM 80 TO 180 Km**
- **NON LTE EMISSION OCCURS ALSO FOR ISOTOPIC BANDS OF CO_2**
- **NON LTE EMISSION OF CO OCCURS ALSO FOR THE 4280 cm^{-1}**
- **SCATTERED RADIATION IS OBSERVED TOGHETHER WITH NON LTE EMISSION BETWEEN 100 AND 150 Km ALTITUDE.**
- **DETACHED CLOUD LAYERS ARE OBSERVED AT 50-60 Km**
- **VERY SMALL AEROSOLS POPULATION MUST EXIST AT 150 Km OF ALTITUDE WHICH ARE CO_2 ICE PARTICLES.**