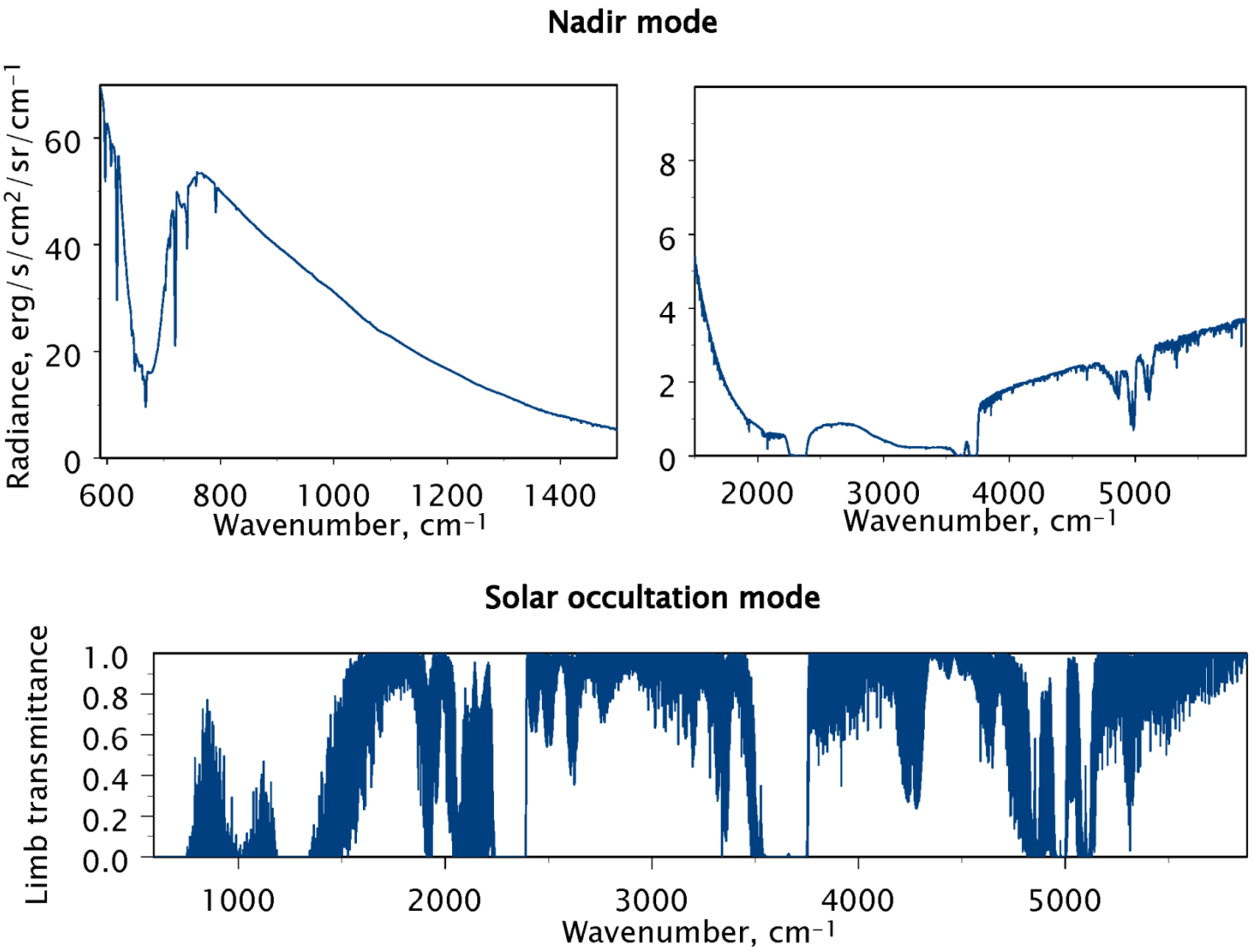
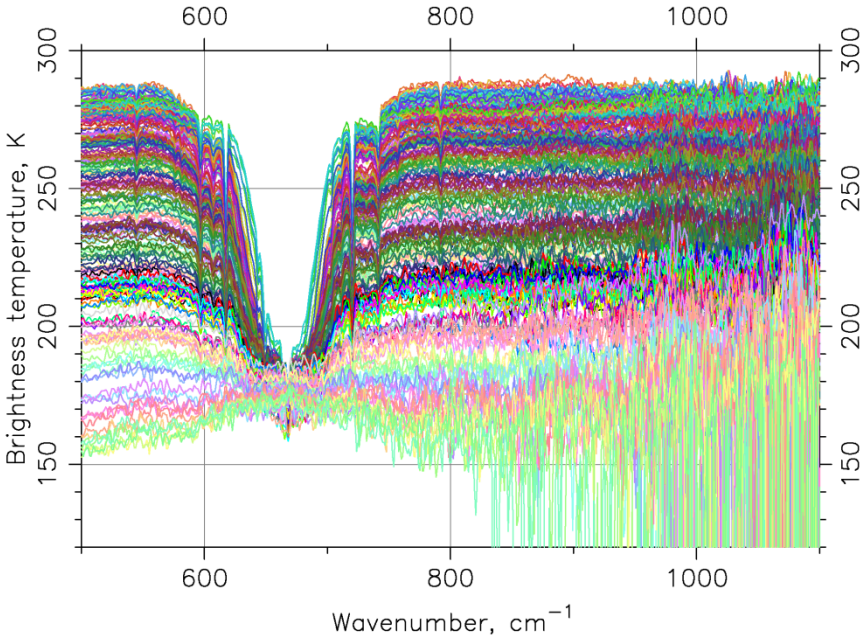
TIRVIM Science Goals

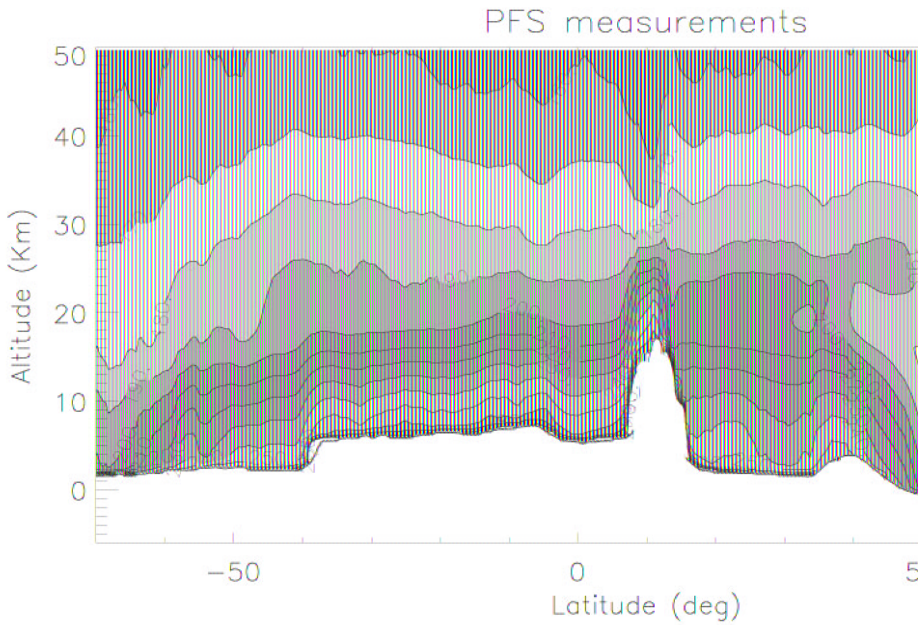
- Search/monitoring of minor constituents
- Monitoring of atmospheric dust and ice clouds
- Monitoring of the thermal state from the surface to 50-55 km with resolution of a few km
- Monitoring of surface temperature

TIRVIM simulated spectra



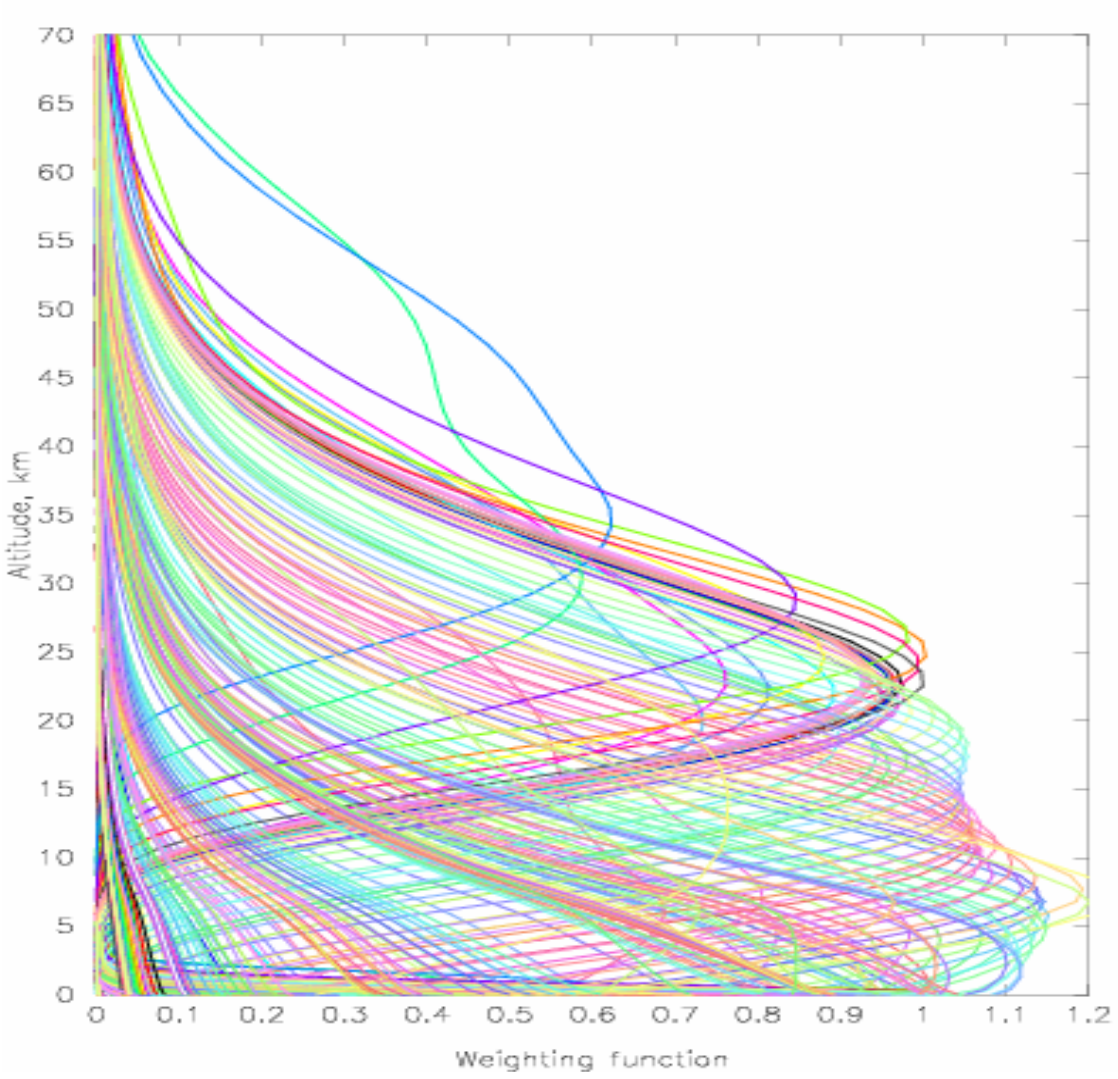
Thermal structure



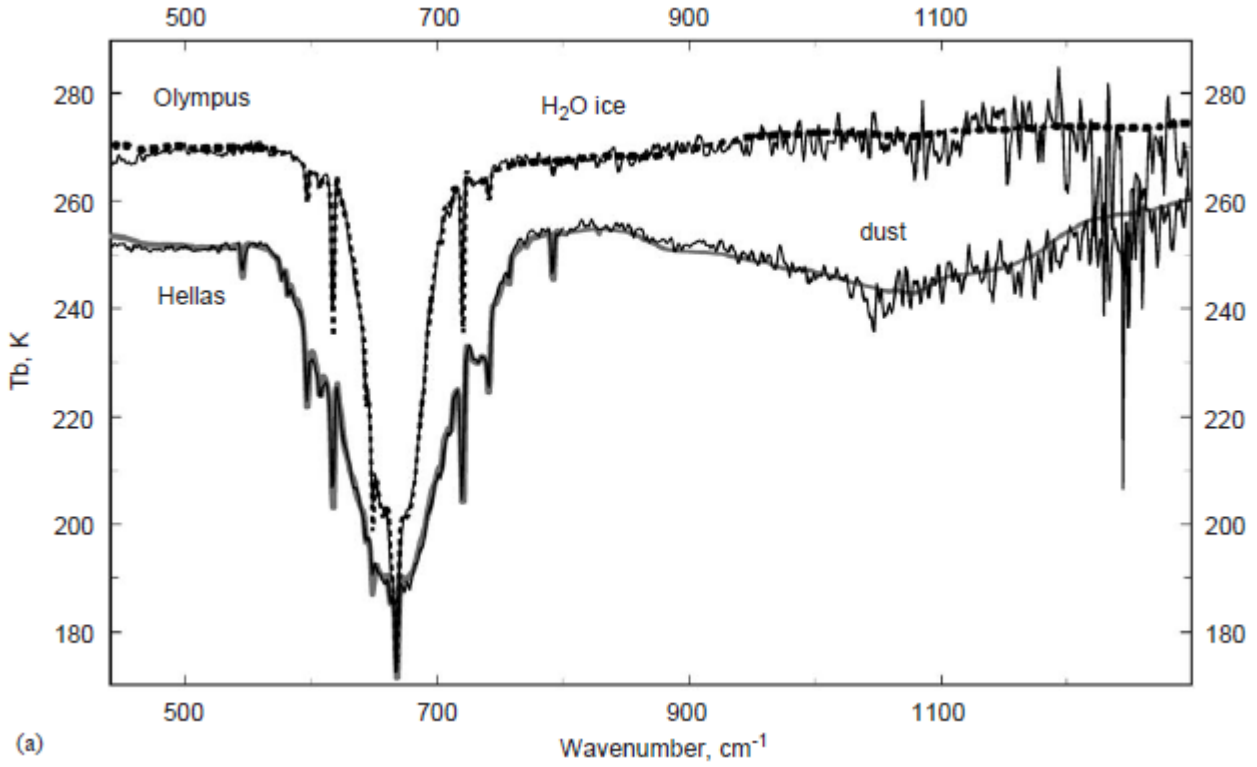


PFS / Mars Express spectra and retrieved temperature field, orbit 68 (Grassi et al., 2005)

Weighting functions in 15 µm CO2 band

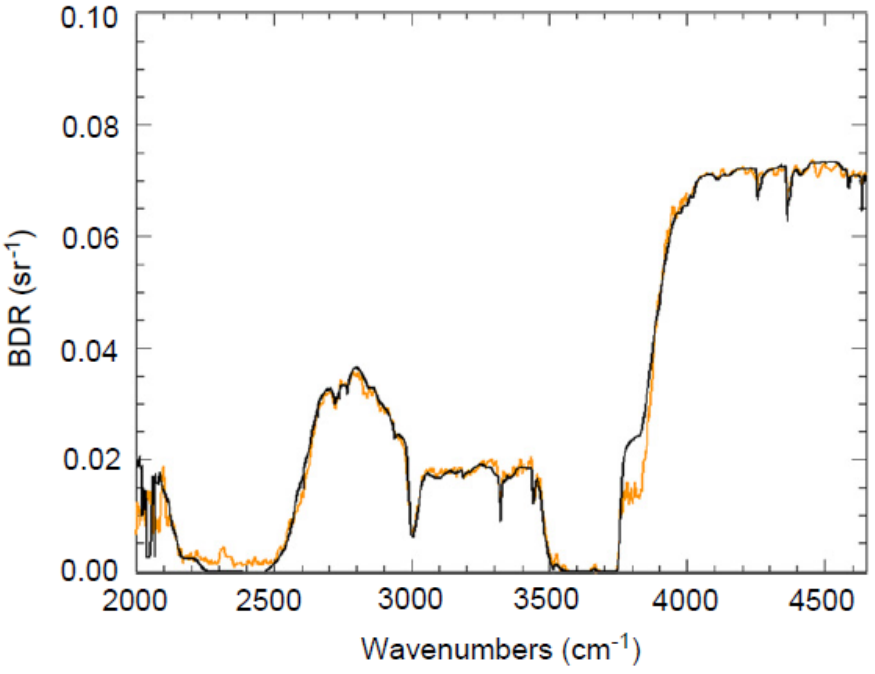


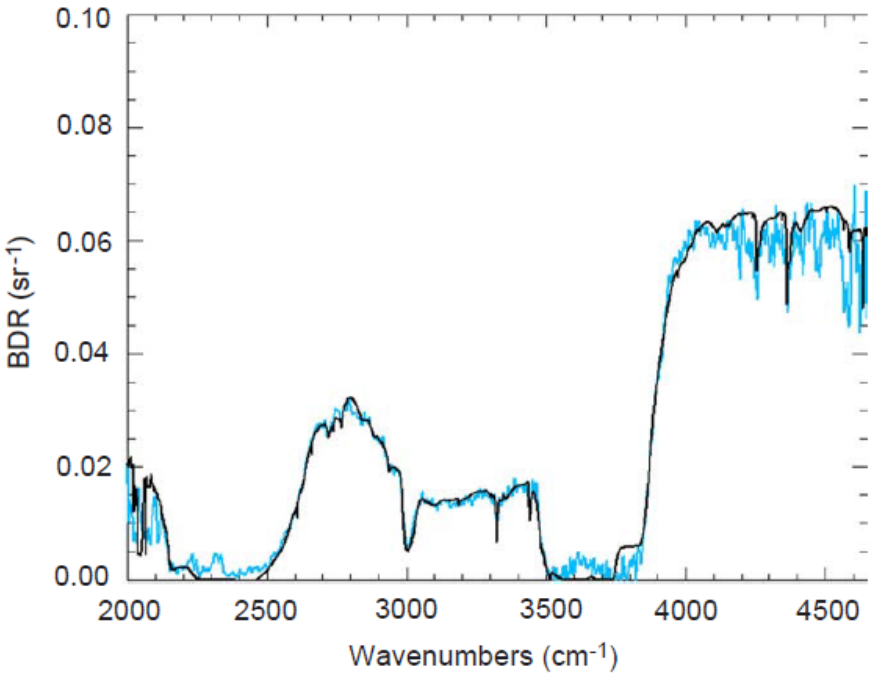
Dust & ice clouds monitoring



Dust and ice bands in PFS / Mars Express spectra over Olympus Mons and Hellas (Zasova et al., 2005)

Surface properties





PFS reflectance spectra of the polar cap fitted with CO2 + H2O ice surface, different grain sizes and dust % (Giuranna, Hansen et al., 2007)

Solar occultation mode

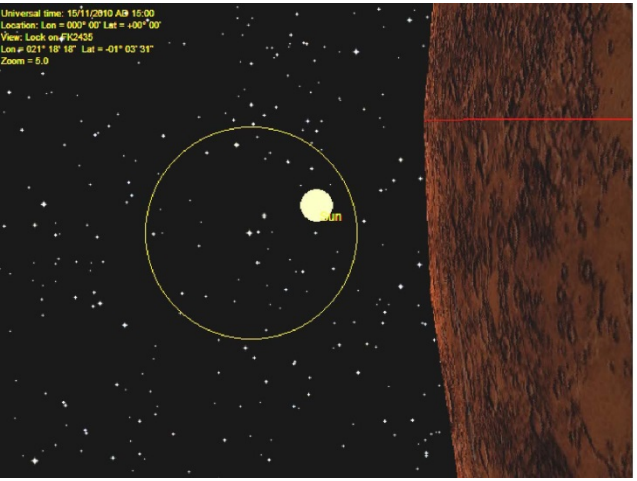
· TIRVIM' FOV is kept pointed to the Sun

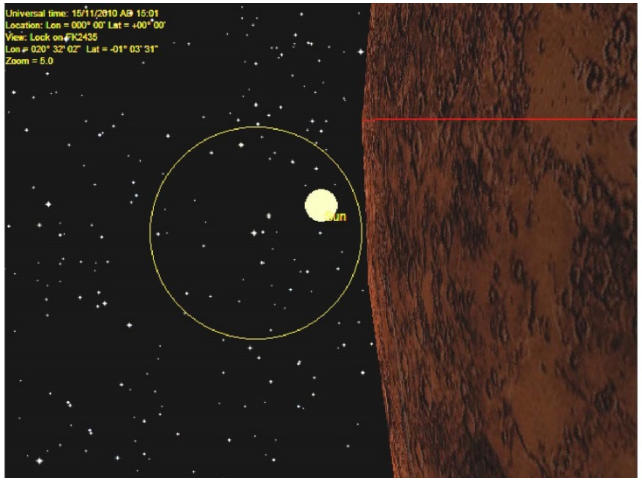
· The Sun approaches the limb, sampling different heights

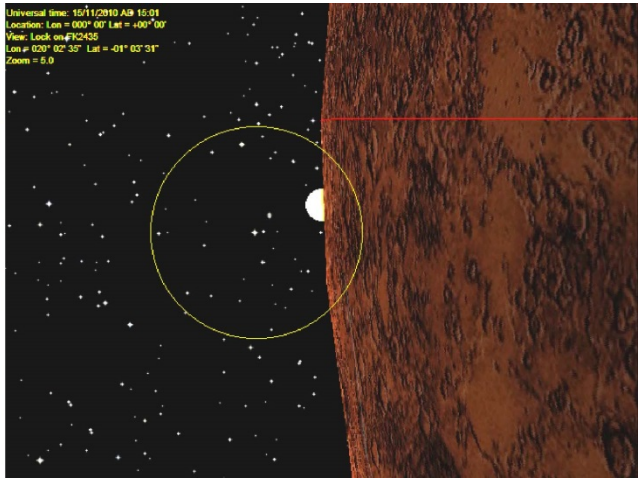
· The Sun disk diameter at limb is ~10km

· About 70 spectra are taken during an occultation (~140 sec)

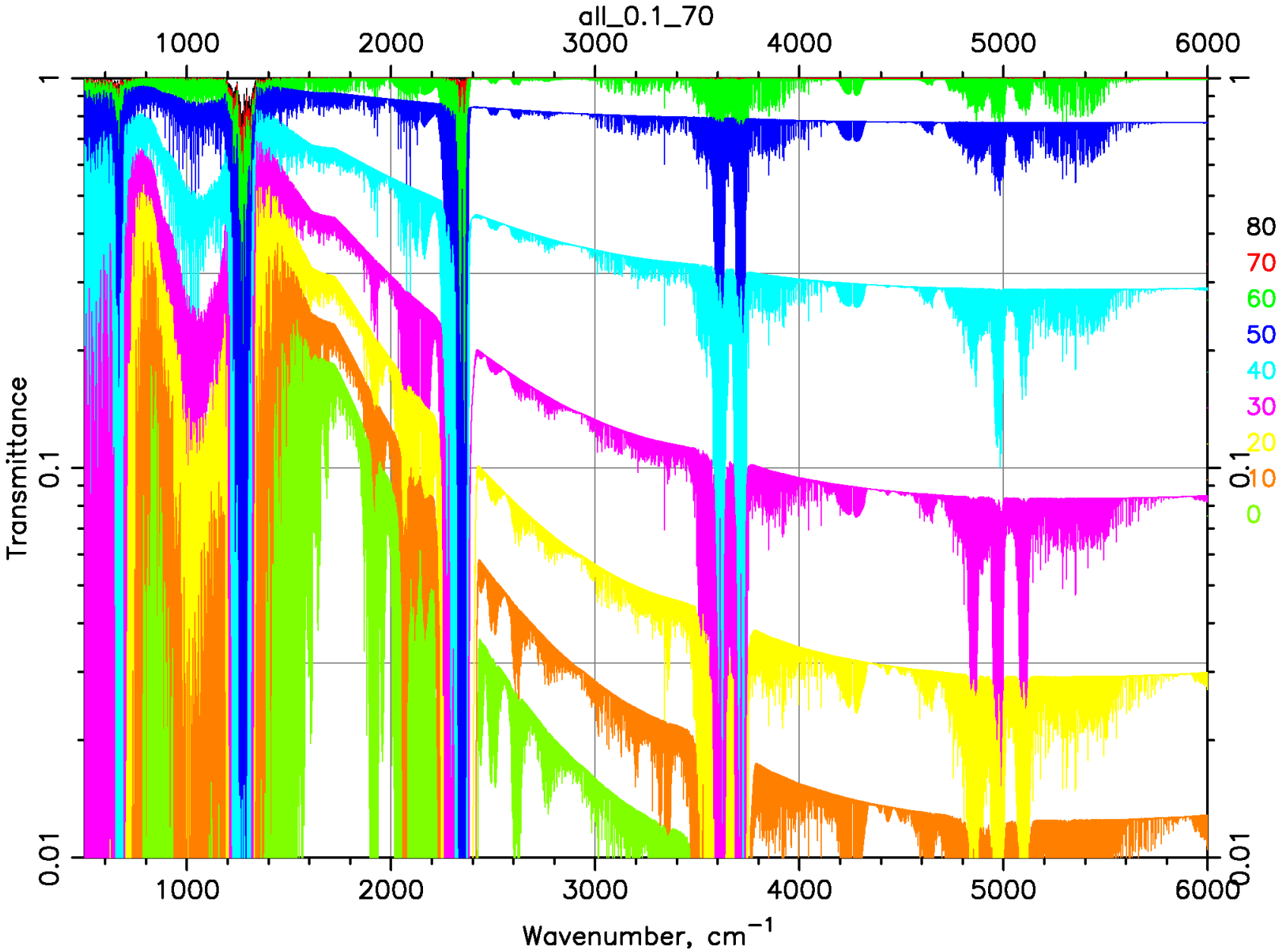
· Self-calibration is provided, as the sequence begins when the Sun is well above the atmosphere (~200km)



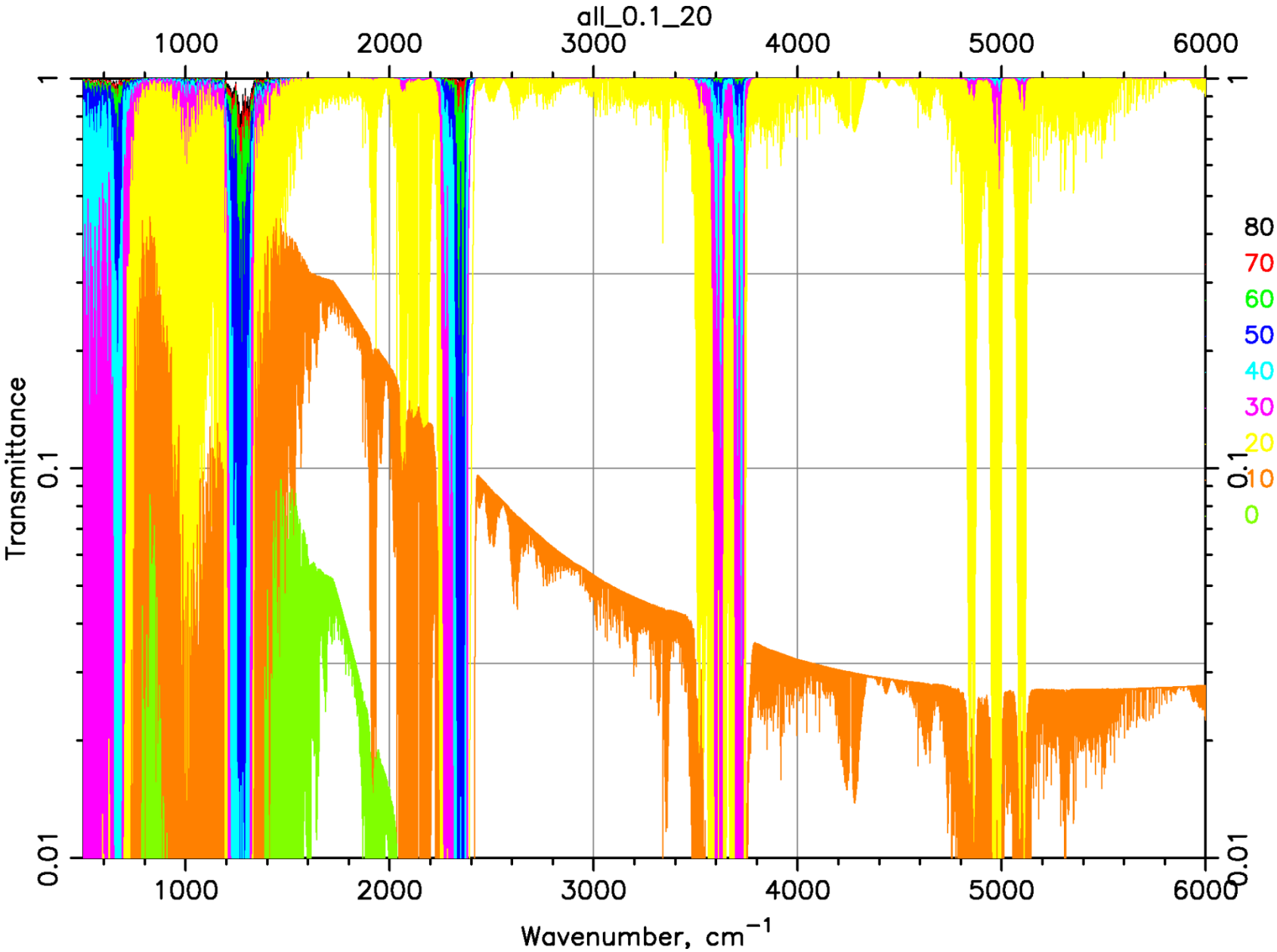




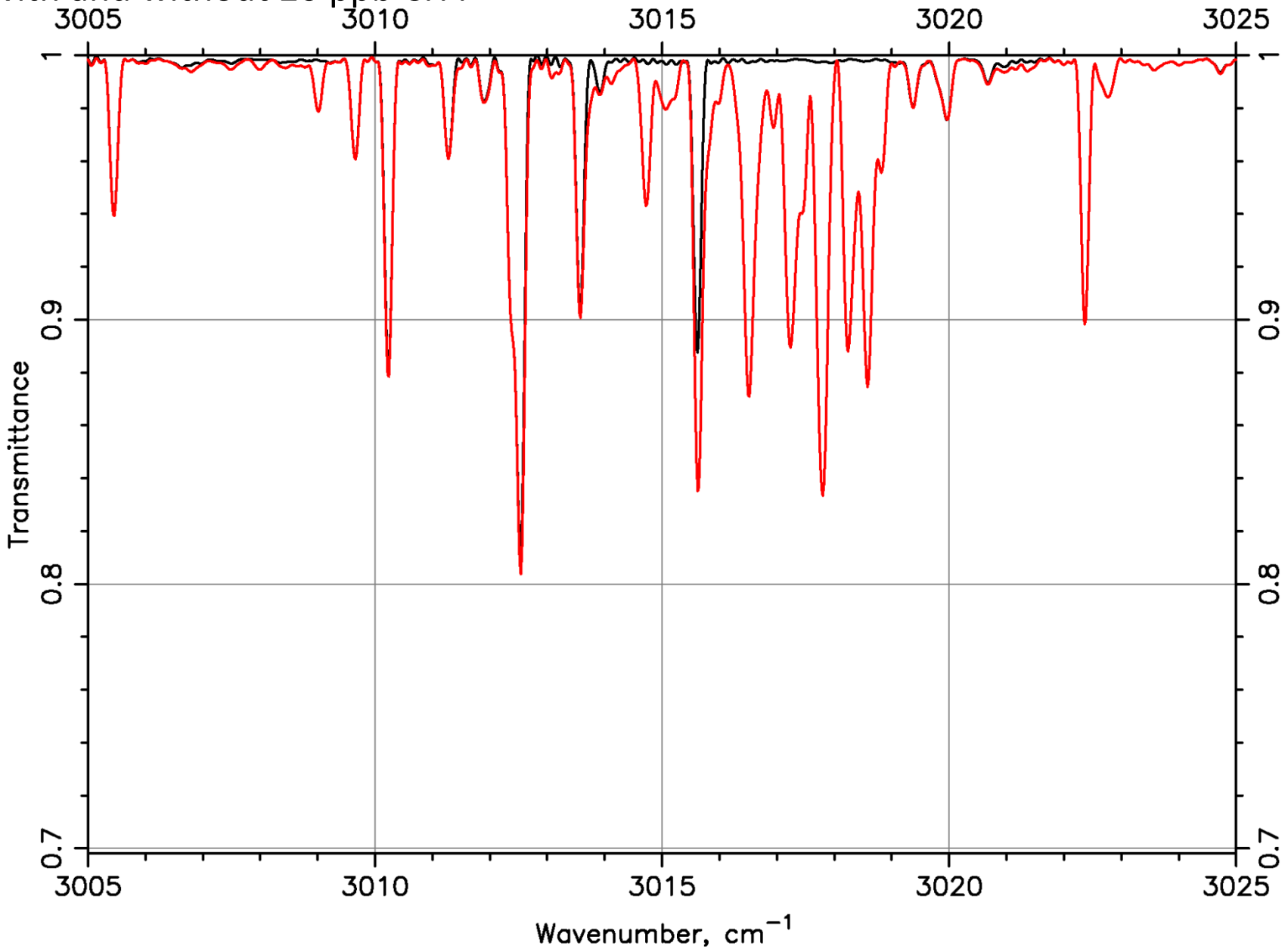
TIRVIM simulated transmittance spectra (dust τ =0.1, h_{top} = 70 km)



TIRVIM simulated transmittance spectra (dust τ =0.1, h_{top} = 20 km)

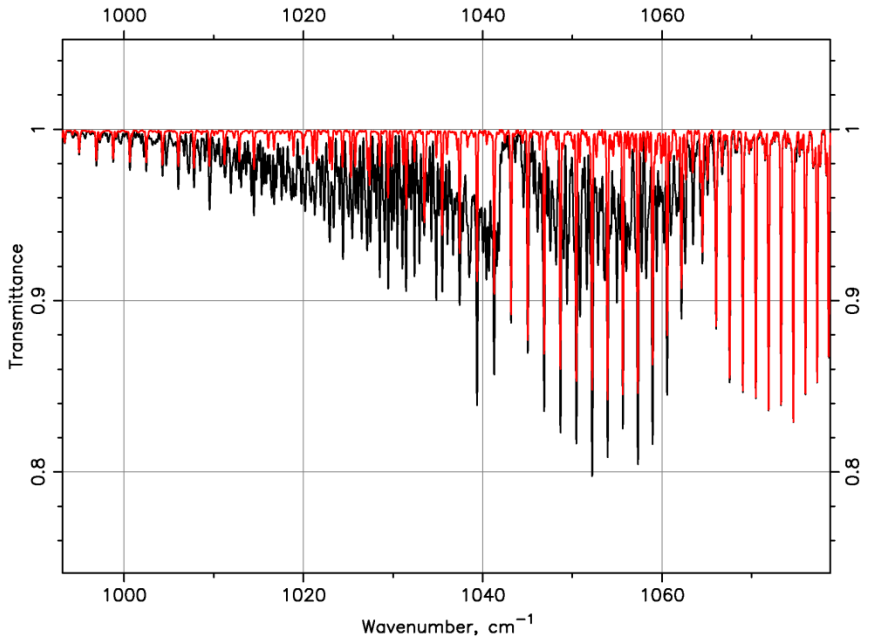


TIRVIM simulated transmittance spectra at 20 km (dust τ =0.1, h_{top} = 20 km), with and without 20 ppb CH4

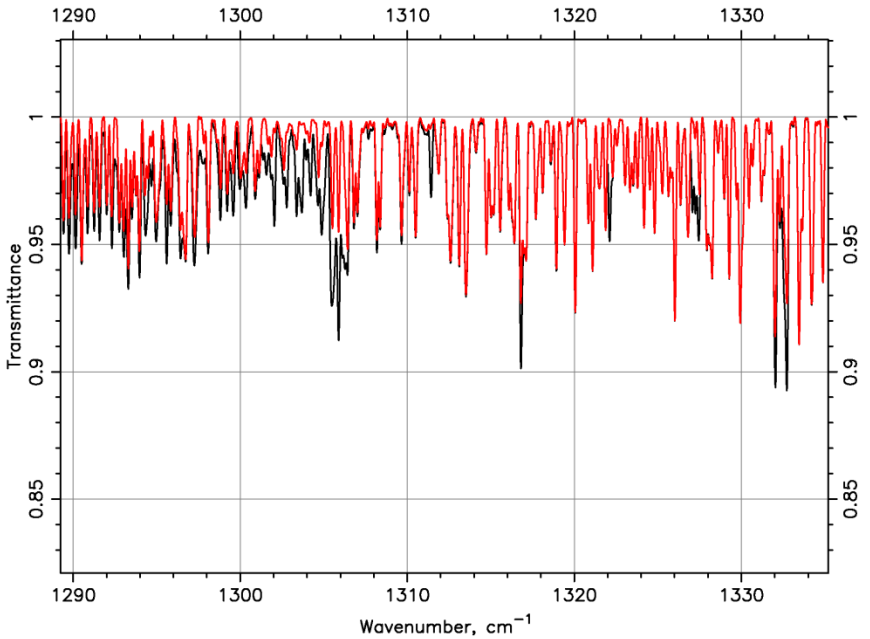


TIRVIM simulated transmittance spectra at 20 km (dust τ =0.1, h_{top} = 20 km), with and without 200 ppb O3 and 18 ppb H2O2

O3



H2O2



Gas	Measurements	Reference	Expected detection limit, ppb (S/N≈1000, Δv=0.15cm-1)	Spectral range, μm
H2O	1-500 ppm			
HDO	0.1-1 ppm			
CO	500-1000 ppm			
O3	0-500 ppb			9.6
O2	0.13%			
H2O2	15 ppb	E08		8
CH4	10 ppb ?			3.3
	Present upper limit, ppb			
HO2	200	V13	50	2.94
C2H2	4	V13	?	
C2H4	4	V13	5	3.36
C2H6	0.2	K11, V13	50	3.35
H2CO	3	K97, V13	100	5.68
CH3OH	7	V13		
NO2	10	M77	1	6.25, 3.43
NO			3	5.28, 5.5
N2O	65	V13	3	4.55, 4.44
NH3	5 / 45	M77 / V13	5	2.3, 3, 5.7
HNO3			0.3	5.85
HCN	2	V13	0.5	3.05
CH3CN				
SO2	0.3	E11, K11	50	4
SO				
OCS	10	M77	1	3.42, 2.44
H2S			50	2.59
HCl	0.3	H10, V13	0.2	3.42
HF			0.05	2.48
PH3	100	M77	2	4.14
CH3Cl	14	V13	5	3.34

References to minor species measurements (upper limits)

V13 - Villanueva et al. (2013). A sensitive search for organics (CH_4, CH_3OH, H_2CO, C_2H_6, C_2H_2, C_2H_4), hydroperoxyl (HO_2), nitrogen compounds (N_2O, NH_3, HCN) and chlorine species (HCl, CH_3Cl) on Mars using ground-based high-resolution infrared spectroscopy. Icarus 233, 11-27.

K11 - Krasnopolsky (2011). Search for methane and upper limits to ethane and SO_2 on Mars. Icarus 217, 144-152.

E11 – Encrenaz (2011). A stringent upper limit to SO_2 in the martian atmosphere. Astron. Astrophys. 530, A37.

E08 – Encrenaz et al. (2008). Simultaneous mapping of H_2O and H_2O_2 on Mars from infrared high-resolution imaging spectroscopy. Icarus 195, 547.

K97 – Krasnopolsky et al. (1997). High-resolution spectroscopy of Mars at 3.7 and 8 μm: A sensitive search for H_2O_2, H_2CO, HCl, and CH_4, and detection of HDO. J. Geophys. Res. 102, E3, 6525-6534.

H10 - Hartogh, P. et al., 2010. Herschel/HIFI observations of Mars: First detection of O_2 at submillimetre wavelengths and upper limits on HCl and H_2O_2. Astron. Astrophys. 521 (L49), 1–5.

M77 - Maguire (1977). Martian isotopic ratios and upper limits for possible minor constituents as derived from Mariner 9 infrared spectrometer data. Icarus 32, 85-97.