Analysis of H2O transmission spectra in the Martian atmosphere as measured by the ACS-TIRVIM solar occultations
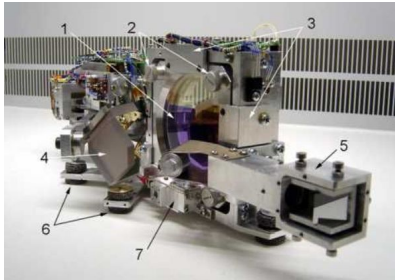
E. Fedorova[1,2], D. Belyaev[1], N. Ignatiev[1], A. Shakun[1], O. Korablev[1], A. Fedorova[1], F. Montmessin[3], A. Trokhimovskiy[1]

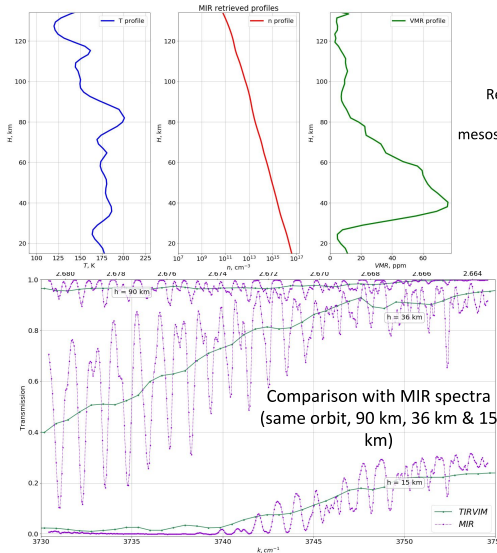[1]Space Research Institute (IKI), Moscow, Russia

[2]MIPT, Dolgoprudny, Russia
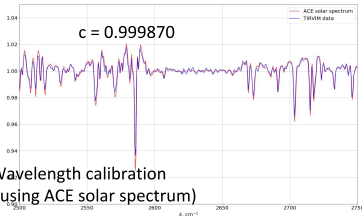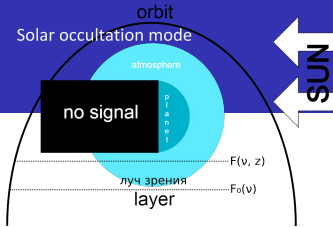
[3]LATMOS/CNRS, Guyancourt, France

November 2020

ACS-TIRVIM

Spectral range	2–17 μm
Spectral resolution	0.1 cm^{-1} (solar occultation)
	0.6 см$^{-1}$ (nadir)

MIR retrieved profiles

Retrieved profiles and spectra from 11MS3-MS-15, Belyaev: Upper mesospheric water on Mars as measured by ACS TGO solar occultations

Comparison with MIR spectra (same orbit, 90 km, 36 km & 15 km)

orbit
Solar occultation mode
atmosphere
no signal
planet
SUN
F(v, z)
луч зрения
F₀(ν)
layer

CO_2 and H_2O absorption cross sections
(2.6-2.8 μm, T = 160 K, p = 0.001 mbar)

c = 0.999870

Wavelength calibration
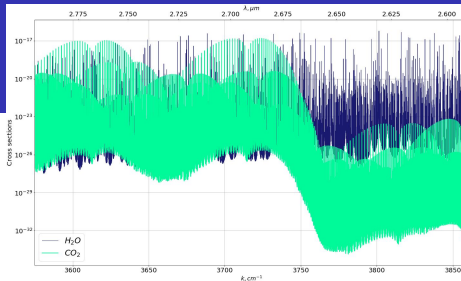(using ACE solar spectrum)

$$k_{new} = c * k_{old}$$

Calculation of the transmission spectra:

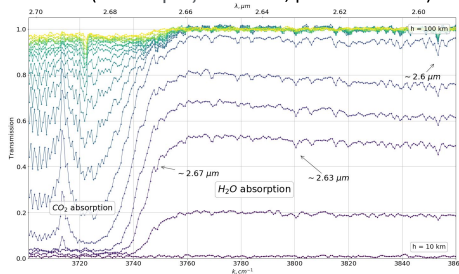$$T(\nu, z) = \exp\left(-2\int_z^\infty \sigma_{CO_2}(T, p)n_{CO_2}(z) + \sigma_{H_2O}(T, p)n_{H_2O}(z)dz\right)$$

TIRVIM instrument function:

$$\frac{1}{\delta}\frac{\sin\left(\pi\frac{k-k_0}{\delta}\right)}{\pi\frac{k-k_0}{\delta}}\left(a + (1-a)\frac{\left(\frac{k-k_0}{\delta}\right)^2}{\left(1-\left(\frac{k-k_0}{\delta}\right)^2\right)}\right)$$

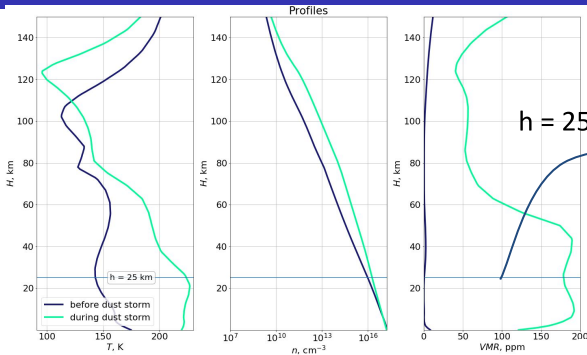where $a = 0.54, \ \delta = 0.6447\,cm^{-1}$

TIRVIM transmission spectra example
(one orbit, 10-100 km)

Profiles

h = 25 km

T(k)
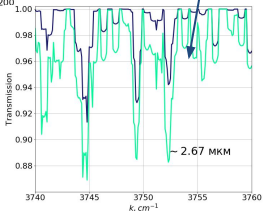
Water vapor transmission spectra
(before & during dust storm)

T [K], n[cm-3], and VMR[ppm] profiles
from GCM (before & during dust storm)

~ 2.67 мкм

~ 2.63 мкм
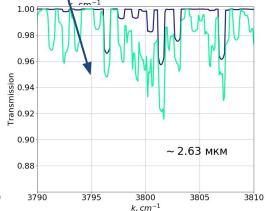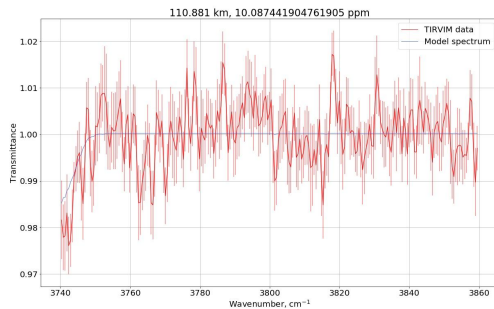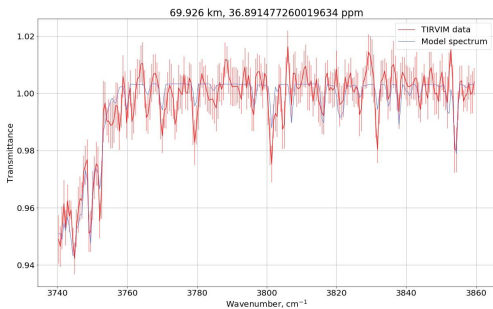
Comparison of model spectra and TIRVIM spectra (2 heights)