From Atmospheric Evolution to the search of species with astrobiological interest in the Solar System – Case-Studies using PSG

João A. Dias (1,2) (jadias@oal.ul.pt), Pedro Machado (1,2) (machado@oal.ul.pt), José Ribeiro (1,2), Constança Freire (1,2)

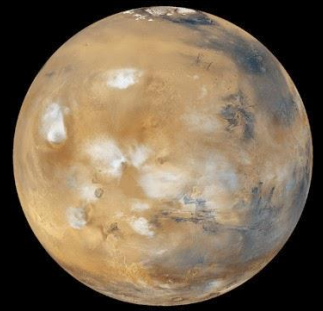
EGU General Assembly

26 May 2022

1 – Institute of Astrophysics and Space Sciences, Lisbon

2- Faculty of Sciences, University of Lisbon

Goals



1. Identify PH_3+SO_2 features on the IR spectra of Venus and constrain abundance

2. Identify CH_4 and H_2O on the IR spectra of Mars and constrain its abundance

3. Identify and determine abundance of CH_4, CH_3D, NH_3, PH_3 on the IR spectra of Jupiter

4. Estimate D/H for Venus, Mars, Jupiter

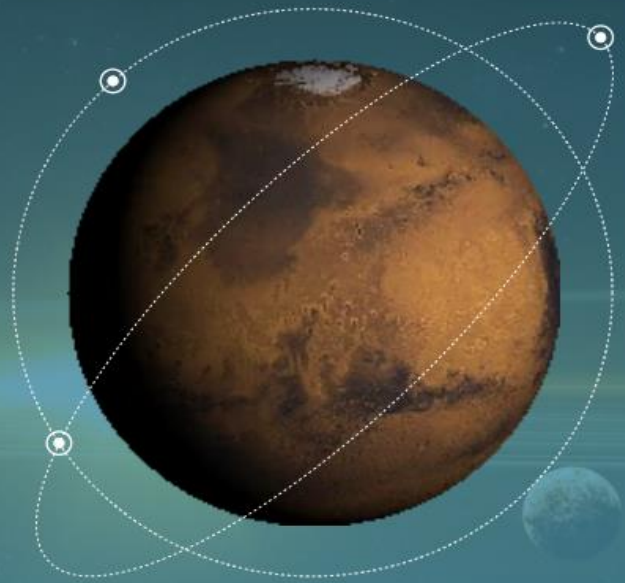
Methods – Planetary Spectrum Generator

Planetary Spectrum Generator

Home Help Databases Modeling Remote operation Retrievals Applications About PSG

Villanueva+2018

psg.gsfc.nasa.gov/atmosphere.php



Mars

Geometry: Mars measured via Nadir from 2.4920 km for date (2021/07/14 13:51 UT)

Atmosphere and surface: Surface pressure: 5.6827 mbar; Molecular weight: 43.64 g/mol; Gases: CO2,N2,O2,CO,H2O,O3,CH4; Surface temperature: 267.56 K; Albedo: 0.200; Emissivity: 0.800; Surface components: Mars;

Instrument parameters: Measurement range 2000-4000 cm with a resolution of 1000 RP. Molecular signatures included; Continuum/background fluxes enabled;

Change Object

Change Composition

Change Instrument

Select template Load template

Results - Sulphur Dioxide on Venus
7.4 μm

Line depth ratio

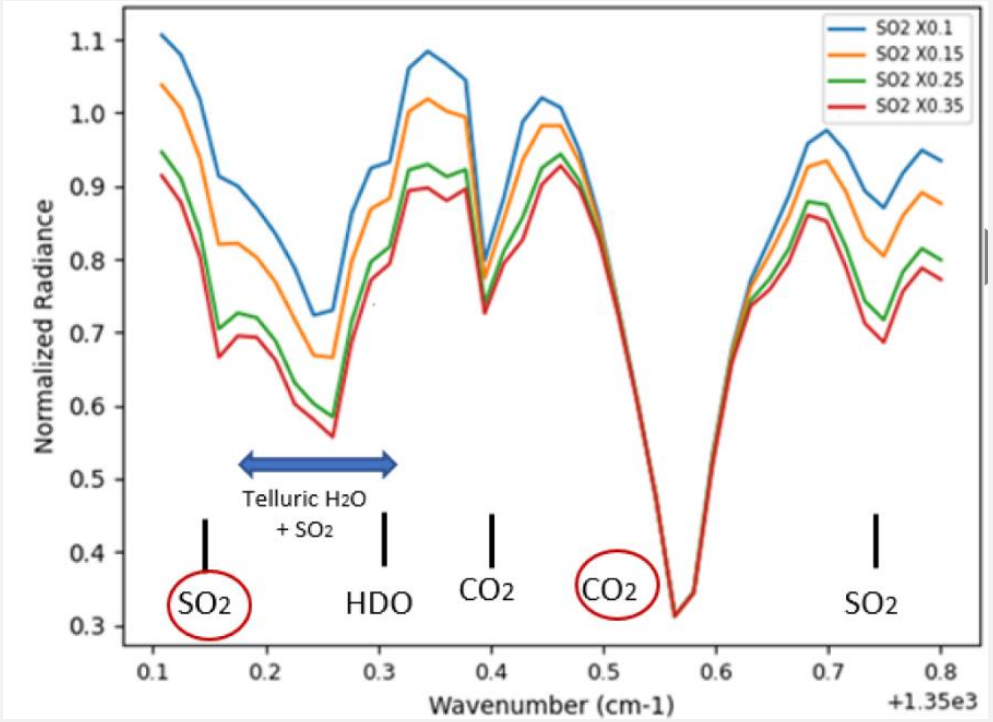


Fig.1. Method of the line depth ratio.
Ldr=d(SO2)/d(CO2). Model input: VIRA (Zasova+2006)

Retrieval

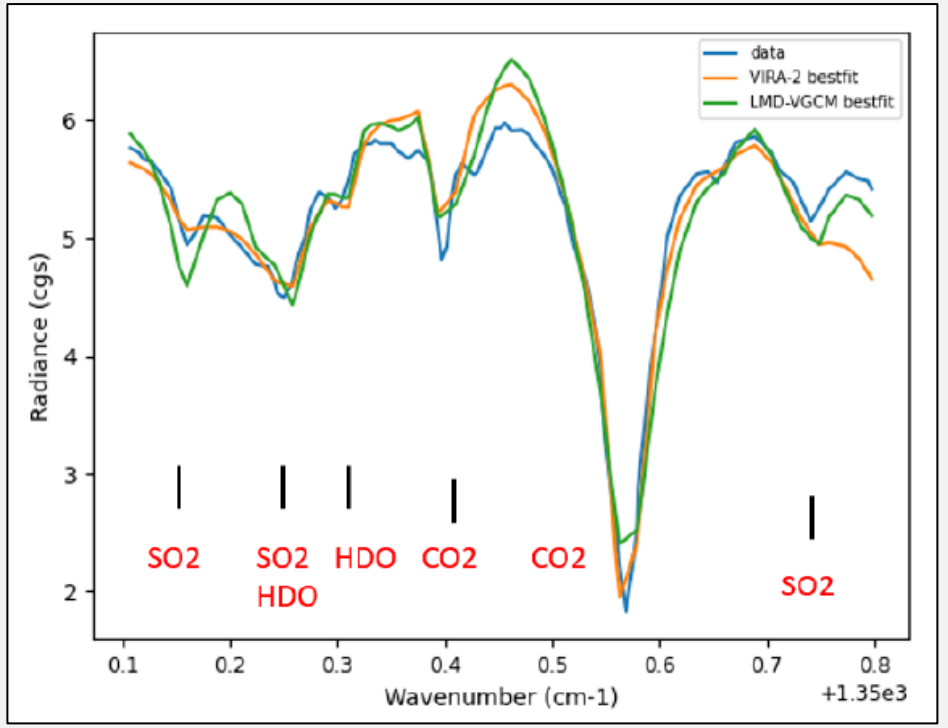


Fig.2. Best-fits obtained for TEXES observations (Encrenaz+2012).

Dias+2022, Atmosphere 13(3), 461

Results - Methane on Mars and Phosphine on Venus 3.3 μm, 10.5 μm

Positive Detection on Mars Express

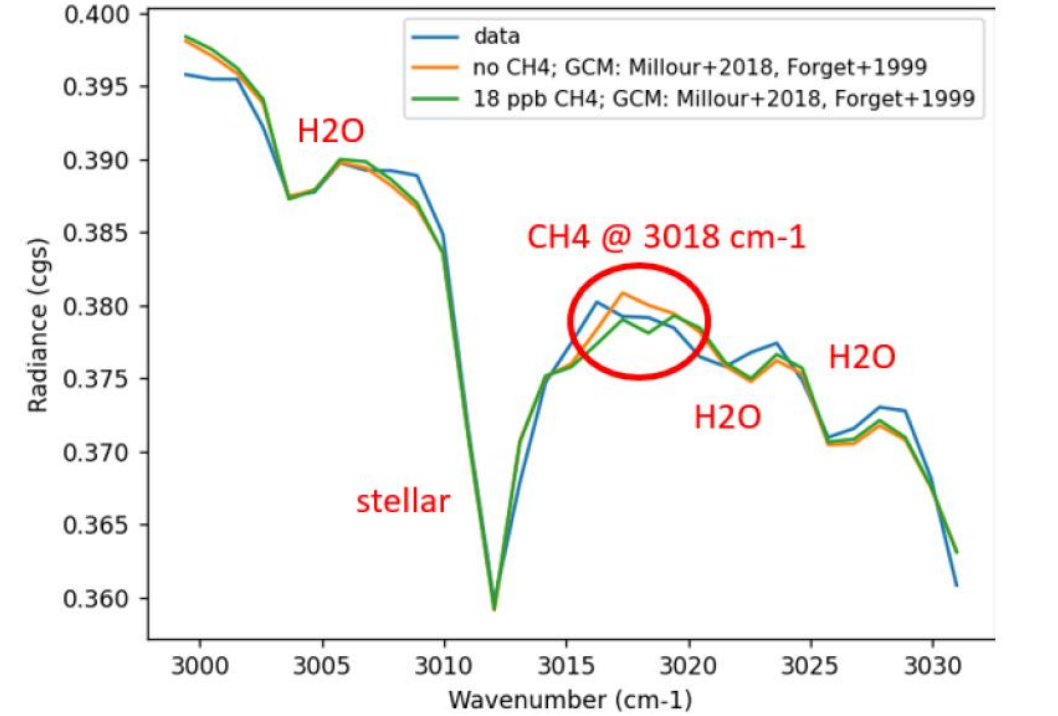


Fig.3- Data (blue) (Giuranna+2019) compared with a model with no CH4 (orange) and other with 18 ppb of CH4 (green)

Non-Detection of Phosphine – IRFT (Mauna Kea)

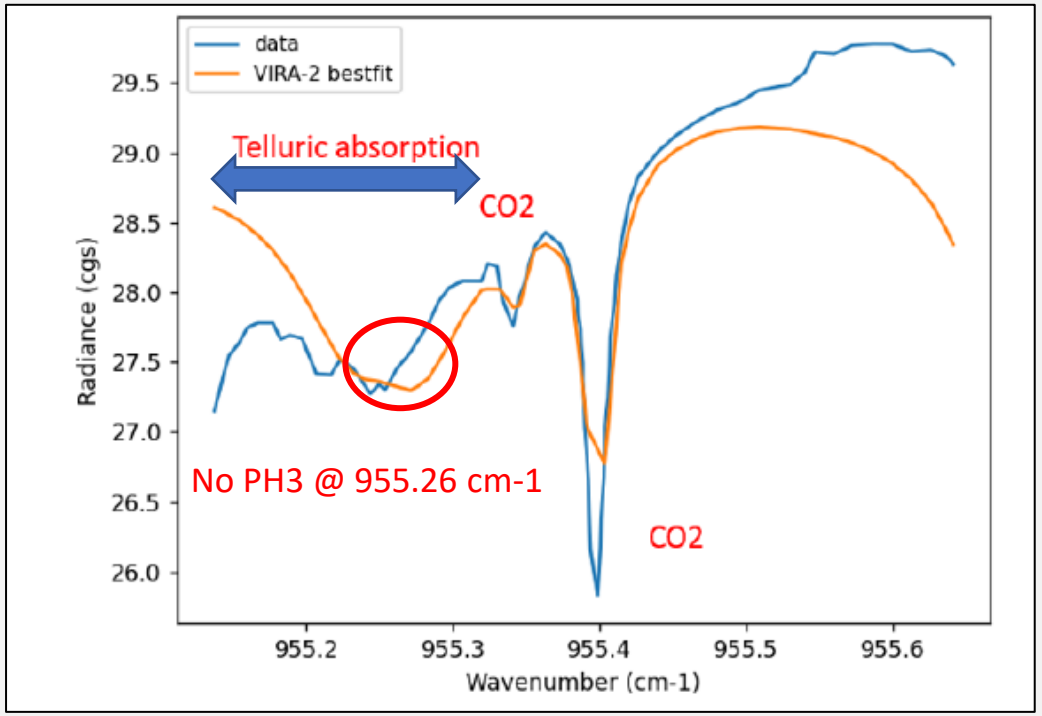


Fig.4. Best-fit model (PSG) as compared with TEXES observations (Encrenaz+2020)

Dias+2022, Atmosphere 13(3), 461

Results - Determining the D/H ratio on Mars 7.2 μm

D/H ~ (5.3-6.5) D/H (Earth)

D/H (Encrenaz+2019) ~ 3.4-4.8 D/H (Earth)

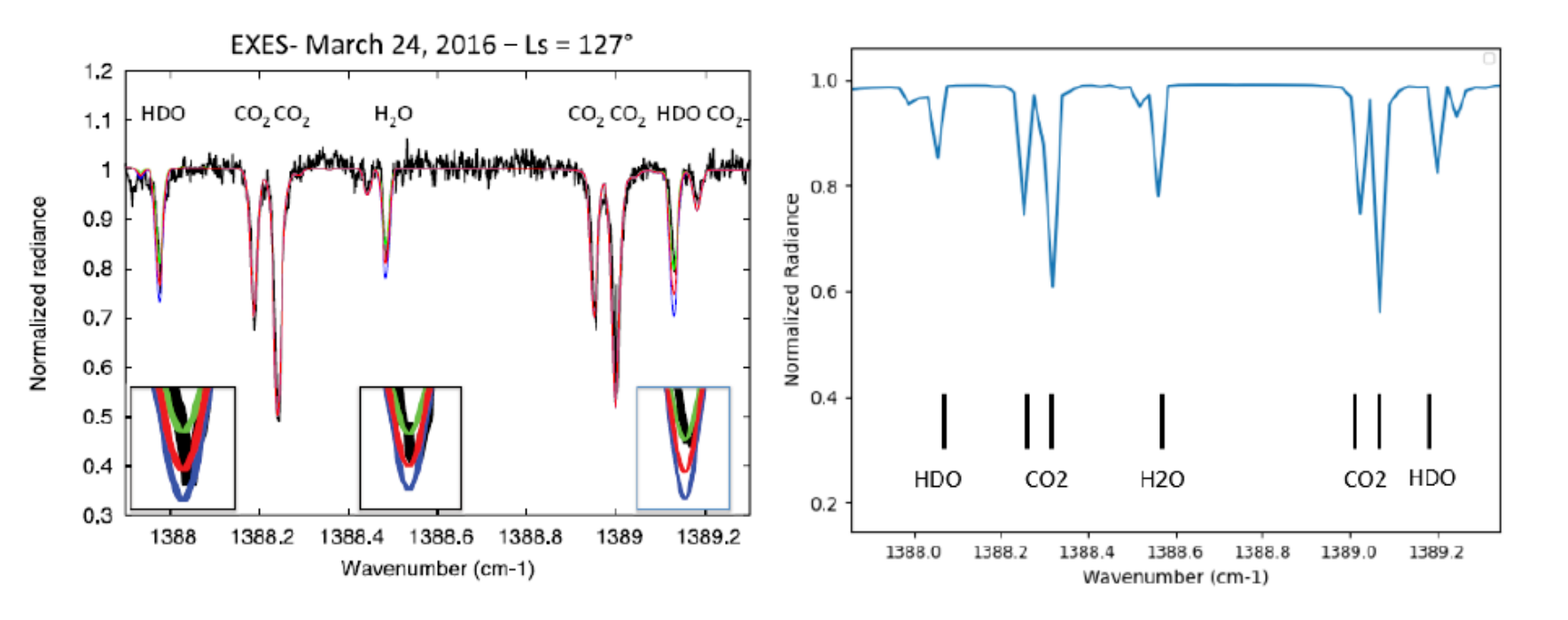


Fig.5. Comparison between EXES data (left) (Encrenaz+2019) and normalized radiance simulation (right), at 1388-1389.2 cm-1.

Dias+2022, Atmosphere 13(3), 461

Conclusions and propects

- Positive detection of SO2 and estimated abundance in agreement with literature (Encrenaz+2012).
- The detection of phosphine on Venus is extremelly difficult due to low abundance and the presence of a telluric water band. Further dedicated observations are needed.
- The historic detection of methane by Mars Express was reproduced using PSG.
- Determination of D/H on Jupiter with PSG (Villanueva+2018) and NEMESIS (Irwin+2008) is ongoing
- Ongoing work in the context of the EnVision and Ariel space missions

From Atmospheric Evolution to the search of species with astrobiological interest in the Solar System – Case-Studies using PSG

João A. Dias (1,2) (jadias@oal.ul.pt), Pedro Machado (1,2) (machado@oal.ul.pt), José Ribeiro (1,2), Constança Freire (1,2)

EGU General Assembly

26 May 2022

1 – Institute of Astrophysics and Space Sciences, Lisbon

2- Faculty of Sciences, University of Lisbon