# FROM SPICAM IR TO ACS NIR, DAYSIDE NADIR OBSERVATIONS IN THE NEAR INFRARED

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**Introduction:** The SPICAM instrument onboard the Mars Express orbiter, operating from January 2004 until present, consists of two spectrometers: UV and near-IR (1000–1700 nm). The spectral range of SPICAM IR allows simultaneous retrievals of the column-integrated abundance of water vapor abundance in the 1.38 μm band and the 1.27 μm O2(a1 Δg) emission rate from the nadir observations [1]. No evidence of instrument degradation or properties drift is noted till now. From mid 2018 ACS NIR instrument onboard ExoMars 2016 mission will extend this remarkable multi-annual nadir monitoring survey adding new possibilities [2].

The infrared channel of SPICAM has provided a nearly continuous survey of the column-integrated abundance of water vapor since 2004 using the water vapor 1.38μm absorption band. This dataset spanning Martian Years 27-34 enables the investigation of both the seasonal and the inter-annual variations of atmospheric water.

At the same time an indirect measurement of the ozone column may be accomplished via the O2(a1g) dayglow detected with the IR channel. As the O2(a1 Δg) dayglow originates from ozone photolysis, it reflects the distribution of ozone that is one of the most chemically reactive species of the Martian atmosphere. The excited $O_2$ molecule can subsequently emit a photon at 1.27μm or be quenched by $CO_2$. The latter process dominates at altitudes below 20 km and therefore dayglow only reflects the ozone abundance above 20 km.

The comparison with simultaneous water vapor observations has showed that the revealed O2(a1 Δg) dayglow variations truly depend on the water vapor variations, and their anti-correlation prediction is clearly confirmed [3]. Seasonal patterns of $H_2O$ and $O_2(a1\Delta g)$ dayglow are rather stable from year to year with minor interannual variations.

Dedicated radiative transfer calculations indicate that water vapor retrieval based on the optically thin 1.38μm absorption band in nadir is mostly sensitive to the water present in the first kilometers of the atmosphere above the surface. By that the Emission Phase Function (EPF) observations of water vapor band allow accessing poorly known H2O vertical distribution at lower altitudes for different seasons and locations. This is not yet applicable for the ExoMars mission pointing strategy, but can be used to reanalyze existing SPICAM dataset and plan future Mars Express observations. Preliminary results will be presented.

The upcoming ACS NIR experiment follows the lineage of the SPICAM-IR instrument to characterize the Martian climatic processes and aeronomy phenomena [2]. ACS NIR with its ten-fold better spectral resolution will significantly enhance the fidelity of atmospheric measurements.

The unique characteristics of the TGO orbit will allow a detailed sampling of the diurnal cycle of the main climatic properties of the Martian atmosphere. As designed, the TGO orbit during the Science Phase will produce a complete daily cycle every two months, yielding a representative atmospheric state every hour of the day.

Another advantage of TGO orbit is the high freqiuency of occultation events, up to 24 per day. Measured vertical profiles of H2O in solar occultation mode down to the altitudes of 10 km will be used to specify water distribution during nadir data processing. Furthermore, unlike SPICAM data treatment, where climatology and aerosol load were derived from outer sources and models, the ACS NIR data processing will be supported by dust, ice and temperature profiles measurements in parallel by TIRVIM channel. By this ACS science products will be very self consistent.

No other spacecraft in the past was able to perform this kind of survey and TGO will open a new era of investigations, constraining Martian climate variability from diurnal through seasonal up to interannual timescales.

**References:**

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