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Mars Wind & Wave Mapping (MWWM) project: A global view of Martian atmosphere from Earth telescopes, Space missions and 3D climate models.

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Abstract

The Mars Wind & Wave Mapping project is an ESA-funded research activity with the objective of extending our current knowledge in the dynamics of Martian atmosphere, comparing remote sensing data from Mars Express (MEX) spacecraft, Earth telescopes and simulations of the Mars Global Climate Model (GCM) and mesoscale models. The expected outputs of this project are a map of wind velocities, based on Doppler measurements during the 2018 Global Dust Storm, and a database of atmospheric gravity waves.

1 Introduction

There is currently a considerable effort from the science community to study planetary atmospheres to understand the role of the climate change in planetary evolution. In particular for Mars, the climate history plays a key role to understand the conditions that could have allowed the presence of liquid water in the past and its consequences for comparative planetology and potential past life habitability. Nevertheless, the knowledge of the mechanisms dominating the planetary atmospheres is still limited. An understanding of the dominant factors and key elements controlling the atmospheric general circulation is a prerequisite for our understanding of terrestrial planets' variability and evolution.

2 Objectives

This new project aims to extend our current research activities in the dynamics of Martian atmosphere and compare data from Earth Telescopes and Space Missions with the Mars Global Climate Model (GCM) and mesoscale models. The proposal is mainly based on the existing collaboration with IA Lisbon and their expertise in processing atmosphere dynamics data. The main two outputs of this project will be a map of wind velocities, based on Doppler measurements during the 2018 Global Dust Storm, and a database of atmospheric gravity waves that can be used to foster the science exchange between observations, global climate and mesoscale models.

3 Winds

Measuring winds on Mars is a challenge for remote observations but a global dust storm offers a unique opportunity to use an innovative technique, measuring the Doppler effect of solar Fraunhofer lines back-scattered on the Mars dust cloud. This innovative Doppler technique, never used on Mars before, has been developed by the research group at IA Lisbon and successfully implemented by retrieving winds at Venus cloud top region [7], producing the first ground-based direct mapping of Venus wind velocities. Although the Martian atmosphere is optically thinner, it is possible to adapt the Doppler method and retrieve wind velocities using the solar radiation back-scattered on the dust particles during a Global Dust Storm. The first ground observations using this technique were already performed as a Target of Opportunity proposal with the Very Large Telescope (VLT) UVES instrument in June/July 2018 [1], and coordinated with simultaneous MEX remote sensing measurements. The first efforts to retrieve a Martian wind velocity field have already demonstrated the proof of concept with promising results Figure 1 [8]. In this contribution we will describe the progress in the preparation of the first global map of Martian winds retrieved from Earth, measured at the altitude of the dust layer using the VLT/UVES data obtained during the past global dust storm in 2018.

4 Waves

The second part of this project is a characterisation of the Gravity Waves in the atmosphere of Mars. These waves have already been detected by MEX OMEGA instrument [9], [13], although there is still an important dataset of unexploited atmospheric observations [6] to be analysed. The second task (MWWM-T2) aims to build the first catalogue of atmospheric gravity waves and morphological parameters using Mars Express OMEGA data. Preliminary work has already started to validate the methodology Figure 2 [2] adapting the technique that was already used successfully for Venus [10],[11],[12]. This task will provide the main wave parameters: time, spatial coordinates, packet length/width, orientation and phase speed, to be analysed in correlation with mars topography, illumination conditions, local time and Mars seasonal climate variability.

5 Expected Results

Both winds and waves induce temporal and spatial variations in the atmosphere and the complete interpretation is only possible with the application of 3D climate models and con-

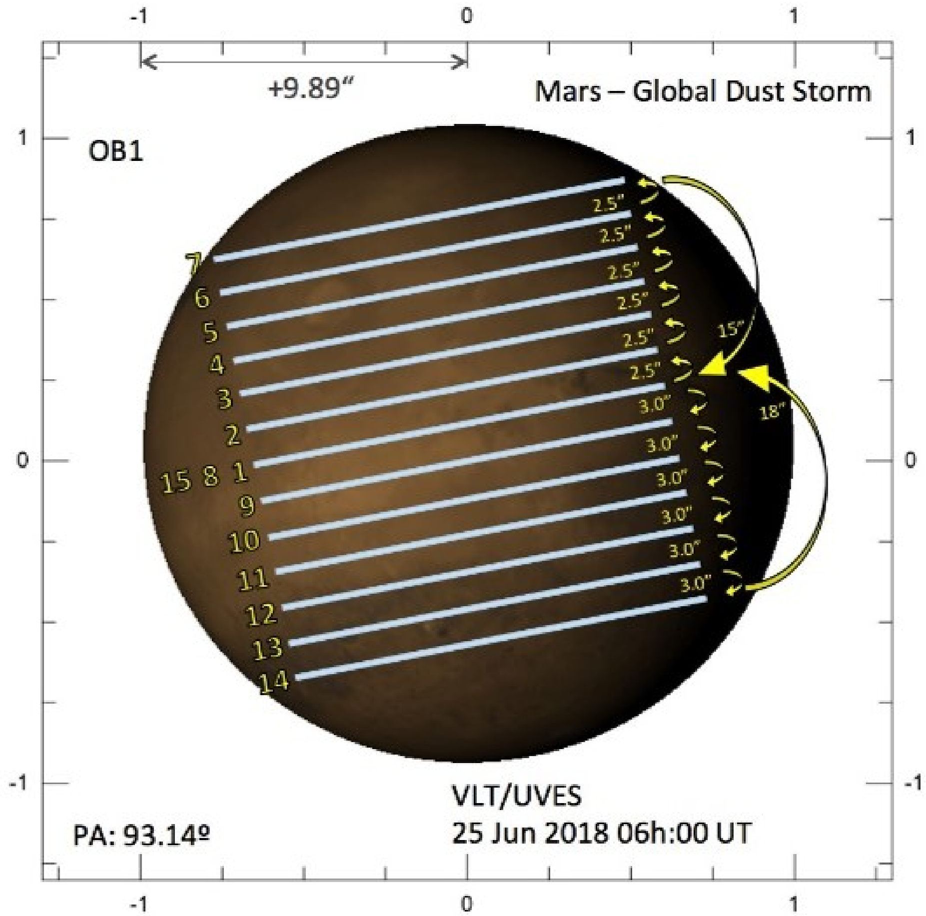

Figure 1: VLT/UVES Observations of Mars Global Dust Storm 2018. [8]

textual information. For this reason this project aims to cover an extensive science exchange with the experts that have analysed the contribution of winds and gravity waves in the Mars climate circulation [13], [4],[5], and strengthen the research collaboration promoting the use of observations performed from Earth and simultaneously from Mars Express and Trace Gas Orbiter [3].

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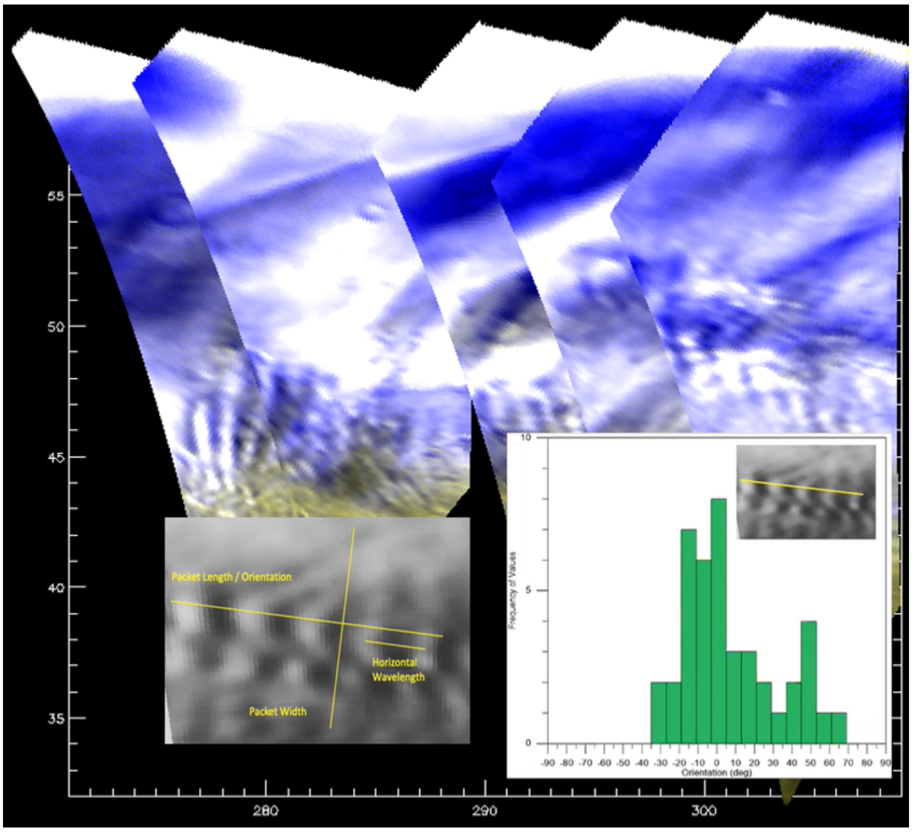

Figure 2: . Preliminary analysis of Gravity Waves [2]

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