More than one martian year of meteorology observed by the Insight lander

Conference or Workshop Item

MORE THAN ONE MARTIAN YEAR OF METEOROLOGY OBSERVED BY THE INSIGHT LANDER

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Introduction.

InSight has been measuring atmospheric pressure, wind and temperature since December 10, 2018 (around Ls=304° of Martian Year 34), 14 sols after its landing. In particular, more than one Martian year of almost continuous measurements has been obtained in 2018-2020. InSight is located in Elysium Planitia, at 4.50238°N, 135.62345°E in planetocentric coordinates (-2614 m altitude below MOLA areoid). Hence, the geophysical lander is providing the best long-duration meteorological Mars station since Viking. In this work, we review the meteorological phenomena that characterize the pressure and wind measurements at timescales larger than 1000 seconds. A subset of the meteorological observations obtained at the beginning of the mission was previously reporded in [1]. The analysis is helped by comparing the results with prediction from the LMD numerical global climate model (GCM, [2]) as reported before landing by [3].

Pressure.

The absolute pressure measurements is slightly affected by a sensitivity to the temperature of the sensor that has recently been corrected by [4] in order to compare the annual cycle with previous measurements (e.g. Viking Landers)

At timescale larger than one hour, he pressure measurements are characterized by 1) The large seasonal oscillation mostly due to the CO_2 condensation and sublimation cycle; 2) baroclinic waves with periods of typically 2.5 and 7 sols and amplitude up to 4 Pa (Figure 1), and 3) the thermal tides with amplitude up to 40 Pa and period of 1 or a fraction of a sol (diurnal, semi-diurnal, etc…).

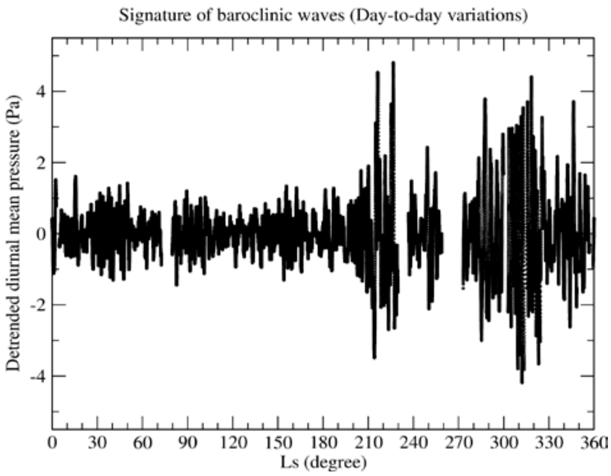

Figure 1. The signature of baroclinic waves as a function of season illustrated by the detrended diurnal mean pressure. As previously reported by [5] using MSL data, Northern hemisphere baroclinic waves can be be significant at the equator.

Winds.

Similarly, the wind direction and velocity can be decomposed into various components. The diurnal mean wind velocity at 1.2 m is remarkably constant around 5 m/s during the first part of the year between Ls=0° and Ls=200° (Figure 2, top). After that date, during northern fall and winter, the wind is stronger and strongly variable from day to day (between 4 and 9 m/s on diurnal average), closely following the baroclinic variations of pressure with maximum wind when the pressure is high. This is expected by the model, but it remains quite spectacular to observe how baroclinic waves can create real weather so close to the equator, with an alternation of quiet and windy sols. Throughout the year, the diurnal-mean wind direction slowly evolves between a northward direction (during most of the northern spring and summer) and west-north-westward direction in fall and winter between Ls=210° and 330° (Figure 2, bottom). This is also predicted by the model and correspond to the expected behavior of trades wind at the Insight landing site (Insight is exposed to "western boundary current" around N. winter solstice). Superimposed on the diurnal mean flow, the wind is subject to large diurnal variations. As expected, the wind velocity is mostly controlled by the evolution of the boundary layer which tends to strongly reduce the wind velocity at night (between 5pm and 9am) when the atmosphere become stratified as the surface cool at night. However this diurnal cycle is not very well predicted by the GCM. Every day, during most of the year the large-scale dominant wind is modulated by a regular diurnal 360° rotation induced by the weak, but non-negligible Northward-Eastward slope that characterizes the Insight landing site at regional scale. During some specific periods, and in particular during the regional dust storms that characterized Mars on Martian year 34 and 35 around Ls=330°, it seems that the planetary-scale thermal tide waves can influence the diurnal cycle in addition to the slope wind. This can be analyzed with the help of GCM simulations in which the region around Insight has been flattened.

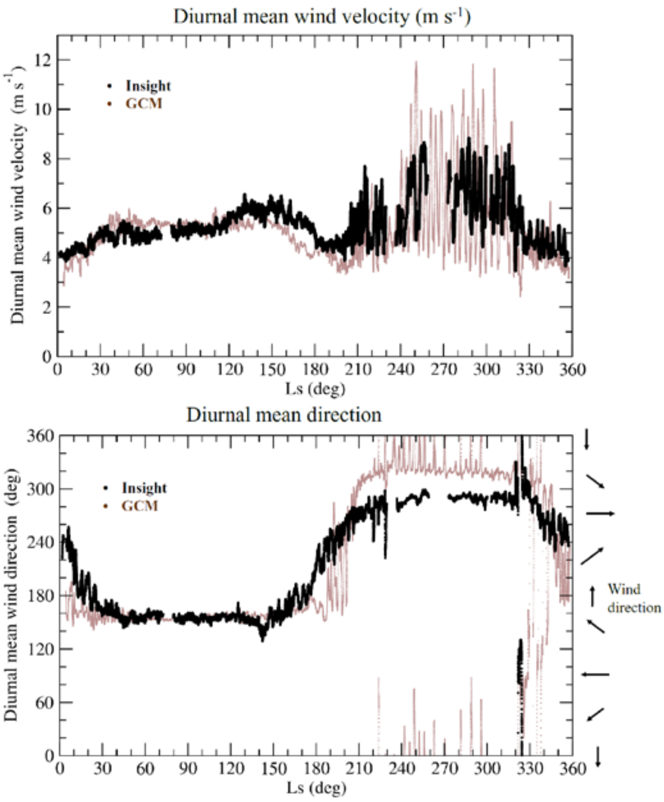

Figure 2: Diurnal mean wind velocity and direction observed by Insight (black), compared to the prediction from the LMD GCM (brown)

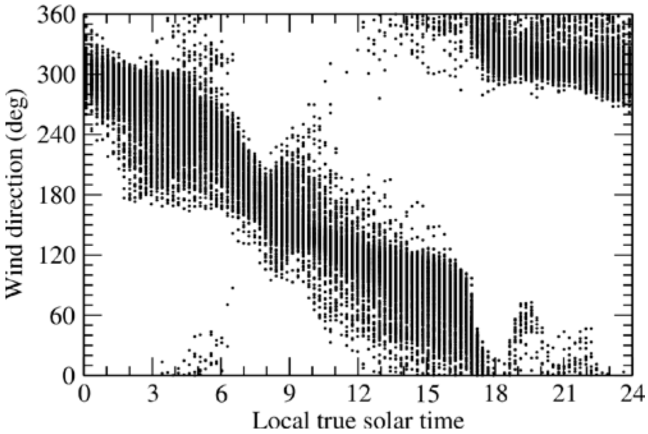

Figure 3 : Direction of the wind diurnal anomaly (1000-s averaged wind vector minus diurnal mean vector) as a function of local time during most of the year (period Ls=325°-0°-200°). The direction characterized by the expected diurnal rotation due to slope winds.

References::

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