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A statistical look at the Viking Lander long–term meteorological data

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Abstract

Due to the recent resurrection of Viking Lander data retrieval project, there now exists much more long–term meteorological data from Mars than has been previously available. As the first step of analyzing the data, we have developed a framework for extensive statistical characterization of the data. The main principle is to divide the Martian year to 12 months of 55-56 sols, and to calculate for each month several statistical variables, such as the mean, the standard deviation, and the mean daily maximum and minimum. In this work we show several full–mission plots of those statistical variables, calculated from both the temperature and the wind data.

1. Introduction

Mars is currently a subject of a wide scientific interest. Hence, there are many current and upcoming missions to the surface and to the orbit of the planet. In addition, there is still much untapped potential to be found in the past missions. Two good examples are the Viking Lander 1 and 2 meteorological missions. For almost 30 years since the death of the last Viking Lander, the scientific community has had access to only a very limited set of the processed temperature and wind data, even though the dataset is by a large margin the longest meteorological one ever measured on Mars.

For the past few years, Finnish Meteorological Institute has been updating and modernizing the original analysis routines to be able to process the whole data in a standard Linux environment. The first stage of the project is now nearing completion, which will be accompanied by the release of the whole mission–long processed meteorological data via the Planetary Data System. The release is tentatively scheduled for the last quarter of the year 2012. In this work we show the first detailed long–term analysis of parts of the preliminary new data.

The newly processed data, including both the temperature and the wind measurements, spans 2245 solar days (sols) for Viking Lander 1 (VL1), with the mean data resolution of 920 samples per sol. A total of 725 sols' worth of data gaps exist, caused by missing or corrupted raw data tapes. The previously published VL1 data sets cover 350 sols of temperature, minus 17 sols of gaps, and 40 sols of wind with no gaps. The data resolution of the previously published data is 25 samples per sol.

The new data for Viking Lander 2 (VL2) spans 1281 sols, with the mean sample resolution of 1419 samples per sol. There are gaps worth a total of 519 sols. The previous VL2 data sets cover 1050 sols of both the temperature and the wind, minus 117 sols of gaps. The data resolution is again 25 samples per sol.

Because of the significantly more data sols compared to the originally published data, the new data allows a significantly deeper long–term VL1 data analysis, as well as a more detailed sub–sol analysis for both landers. In addition to possibly finding new short–time and long–time atmospheric phenomena near the VL sites, with the new data it will be possible to characterise the general diurnal and annual behaviors of the Martian atmosphere more comprehensibly than previously.

2. Martian annual structure

For the ease of discussing long–term data, we have divided the Martian year to 12 months, motivated by the similar tilts of the axes of Mars and the Earth. Each Martian month is therefore 55 or 56 sols long. Therefore, they are not equal in length to the Earth months, but instead should offer a fair analog to the meteorological seasons, as opposed to the easily definable astronomical seasons. By defining the meteorological seasons we get information about the seasonal lag, which then can help us understand the long–term processes better.

3. Methods and results

The main method for studying the long–term behavior is extensive statistical analysis of the Viking Lander data that is being re–processed at Finnish Meteorological Institute.[1, 2] We accomplish this by analyzing various statistics for several meteorological quantities. For Viking lander data, the quantities used are atmospheric temperature, wind velocity, wind direction and pressure. Specifically, for each month we currently calculate the following statistical variables: mean, standard deviation, month max/min, mean daily max/min, median, 10th percentile, 90th percentile, mean time of the daily max/min and the mean time of the daily fastest/slowest change. In addition, we also calculate all of those variables for several *time windows* of each month. For example, what was the mean temperature of the time period 11:00–12:00 LLT and how it changes as a function of the month.

The combination of these variables is able to capture a large part of the information about the long–term behavior of the boundary–layer meteorology. Reducing the full data to a limited number of variables is, we believe, useful in trying to understand what is happening on Mars. However, we feel that calculating several different variables instead of just, for example, the mean and the standard deviation, is helpful. Moreover, the time windows enable us to look at processes that are known to happen at specific times, such as evening, night or morning.

In this work we show several examples of full–mission statistical plots, illustrating the annual cycles of not only the mean, but also other variables as described above. A more comprehensive description of the results is in preparation [2] and hopefully will be published during the year 2012.

4. Summary and Conclusions

The new statistical analysis software allows us to analyze Martian long–term meteorology in ways that have not been possible before. The results have been analyzed only briefly so far, but they seem to reinforce our understanding of how the annual cycle affects the conditions in the boundary layer. More quantitative characterizations will appear in later publications.

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References

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