MARS CLIMATE DIAGRAM DATABASE. H. Hargitai[1], Sz. Bérczi[1], Sz. Nagy[2], A. Gucsik[3], Á. Kereszturi[4] [1]Eötvös Loránd University, Institute of Physics, Dept. G. Physics, Cosmic Materials Space Res. Group, H-1117 Budapest, Pázmány Péter sétány 1/a. Hungary (hargitai@ludens.elte.hu), [2]Eötvös Loránd University, Dept. Petrology and Geochemistry, H-1117 Budapest, Pázmány P. s. 1/c. Hungary, [3]University of West Hungary, Bajcsy-Zs. u. 4., Sopron, H-9400, Hungary, [4]Collegium Budapest, Institute for Advanced Study, H-1014 Budapest, Szentháromság tér 2. Hungary

Introduction: An online Mars Climate Diagram Database [8] has been produced for better visualization of the climatic data of Mars, especially for use in education. The diagrams are modified versions of the Walter-Lieth Climate Diagram standard originally developed in 1967 [1] .

The terrestrial diagrams: The two main parameters of the Walter-Lieth Climate Diagrams are temperature and precipitation. A third important parameter is the indication of frost periods. Its data section contains the name of the meteorological station, its height above sea level, the annual average of temperature and annual precipitation, Mean daily min. temperature of the coldest month, Mean daily max. temperature of the warmest month, absolute minimum and maximum temperature. The diagram was developed for use in agriculture, bio- and geosciences. It is a tool for visualizing the general characteristics of terrestrial climate zones.

The Walter-Lieth Climate Diagrams applied for Mars help visualizing meteorological / climatic phenomena and orbital parameters through local meteorological conditions. It can be used in school atlases, planetary science textbooks, geography classes etc.

Sources for the Mars diagrams: The Mars Global Surveyor Thermal Emission Spectrometer datasets [2][3] provide a multi-(Martian)-year almost global dataset of local meteorological conditions. Although the data is not measured directly, as in the case of the Viking landers, but through hyperspectral data, it provides a reliable and more rich dataset for such purpose (with some limits). TES spectra (and its derived temperature values) are available for twice every sol at a particular location: near the daily maximum (14h) and near the daily minimum (02 h) temperatures, providing enough data for a climate diagram.

Viking Lander datasets has been used as a surface reference for the TES data. Data from literature [4] was also used (frost). TES data was extracted using the vanilla software.

The Mars Climate diagrams: The Walter-Lieth Climate Diagram was modified to fit the special characteristics of the Martian conditions (Fig. 1).

Common data displayed

- Sources (instrument)
- Time data is taken (hour)
- Period data is taken (Earth Date)
- *Geographic location*
  - Latitude line (x±0.5°; measured through 0-360° longitude)
  - Specific location (Name, Coordinates [W longitude], Height)
- *Actual data (measured data points)*
  - Temperature values at 14h (max)
  - Temperature values at 02h (min)

(instead of average daily temperature curve)

Supplementary data (in separate diagrams)

- Period of Frost cover (from [4])
- Solar Distance
- Local Pressure
- Atmospheric opacity (for dust)

Year-by-year variation of meteorological factors is much less than on Earth and is mainly caused by dust activity. Since during the selected Mars year a major dust storm modified “normal” data (Dec 1999 – Nov 2001), for comparison, data from the previous Mars year was also used.

Further uses of the diagrams: The various data-type diagrams are suggested to be used simultaneously. The diagrams can be used for different purposes in different combinations. In our database various types of data are displayed in separated diagrams. In actual use for educational purposes, the following tasks can be given to students; computing, plotting the values and comparing them to their terrestrial counterparts (measured locally or taken from literature, like [9]).

Special Lines:

- Line showing the freezing point of water
- Line showing the freezing point of CO_2
- Line of Mars Tropics and special Circles

Computed data:

- Annual average of temperature
- Absolute min/max temperature (value/date)
- Annual temperature range
- Max./Min diurnal temperature range (value, date)
- Max/min pressure (value/date/season)
- Duration of the frost cover (sols) (number of sols when temperature is below/at the freezing point of CO_2)
- Number of sols when temperature can be 0–2 °C
- Number of sols when temperature can be >2°C

- Approx. duration in a sol when temperature is 0–2 °C
- Number of sols when dust activity is high (with dates of a specific year)
- Number of possible freeze-thaw (H_2O) / frost-sublimation (CO_2) cycles per year
- Characteristic dust storm months

Some phenomena observable in the diagrams

- Effects of dust storm (crosscheck dust diagrams and day/night temperature): max. temp decreases, min. temp increases.
- Diurnal temperature change in winter/summer: difference is greater in summer
- Effect of solar distance in low latitudes (Equator temperature curve) and high latitudes (length of summer)
- Pressure diagrams: effect of height and temperature (CO_2 sublimation) (etc.)
- Change from Viking (1977) to TES (2001) (Higher max. temperatures)

Geographic use: Using the diagrams, lines of special climatic boundaries are created (for example, line of occurrence 0°C). From these, climatic zones can be defined. These are then correlated (linked) to the observed geomorphologic features and then predictions can be make to occurrences of geomorphologic features (like relaxed craters, polygonal patterned ground etc) or phenomena. Thus, climatic explanation of geomorphologic phenomena can be made.

The "12×56/270" calendar description. Since these data are useful especially for future in situ *human* exploration, and several meteorological phenomena are local time/sol dependent in many respect, I used a calendar that is more practical in the everyday sense of time: the Mars year in the diagrams is split to 668/669 sols (instead of continuous Ls values) and 12 equal-interval (56 sol) months (Month 12 is 52/53 sols long). Although several mission-based and other Mars calendars exists [5, 6, 7], for handling such climatic data, an equal-length larger unit ("month") and sol-based calendar fits the best. This calendar is described in more detail in the online database. [8] The start/end dates of the Mars year used for creating the diagrams:

Ls	*Orbit*	*Spacecraft Clock*	*Description*
269.5	3558	~630529096	* START
270	11961	~689871962	** END

*1st sol of the Year (1999/12/25) **1st sol of the next Year (2001/11/12)

References: [1] Walter, H. and Lieth H. (1967) Klimadiagramm Weltatlas. VEB Gustaf Fischer Verlag, Jena. [2] P. R. Christensen et al. (1998) Results from the Mars Global Surveyor Thermal Emission Spectromete Science 13 March 1998: Vol. 279. no. 5357, pp. 1692 – 1698 [3] MGS Thermal Emission Spectrometer Data Archive http://testest.mars.asu.edu/data_archive.html [4] Stephen R. Lewi et al (1999). A climate database for Mars., Journal of Geophysical Research – Planets, vol. 104, no. E10, pages 24,177–24,194 [5] Clancy et al. (2000), Journal of Geophys. Res 105, p 9553 [6] http://www-mars.lmd.jussieu.fr/mars/time/martian_time.html
[7] http://cmex.ihmc.us/cmex/data/MarsCalendar/index.html
[8] http://planetologia.elte.hu/mcdd/
[9] http://www.globalbioclimatics.org/plot/diagram.htm

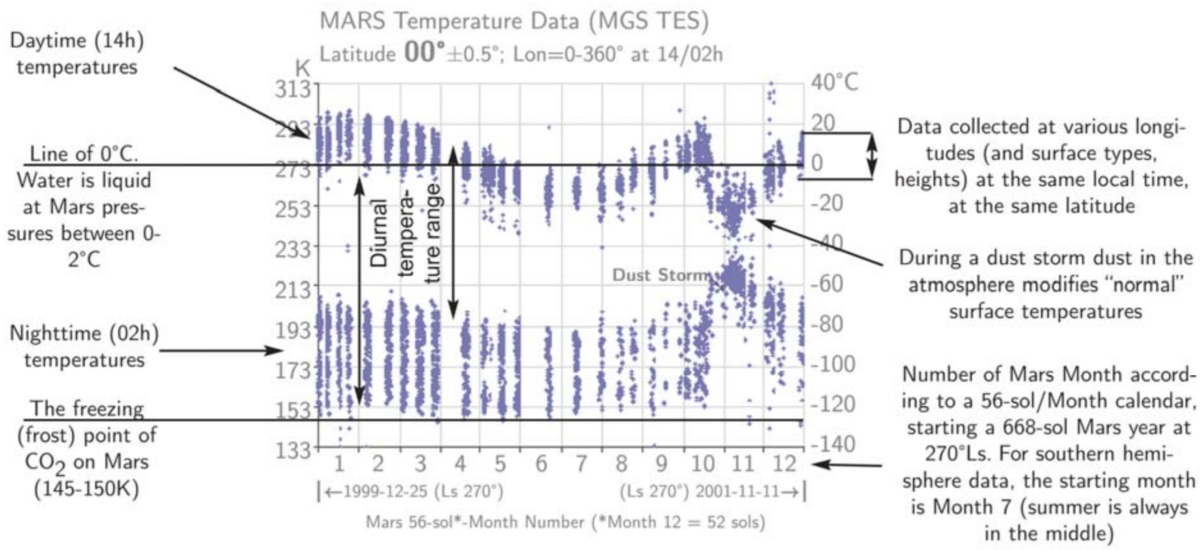

Fig 1. Sample diagram with explanation from the Mars Climate Diagram Database