THE MARS CLIMATE SOUNDER—SIX MARTIAN YEARS OF GLOBAL ATMOSPHERIC OBSERVATIONS READY FOR ASSIMILATION

D. M. Kass[1], J. T. Schofield[1], D. J. McCleese[2], A. Kleinböhl[1]
[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [2]Synoptic Science, Altadena, CA, (david.m.kass@jpl.nasa.gov)

The Mars Climate Sounder (MCS) began continuous observations of the surface and atmosphere of Mars on 24th September 2006 and has been operating successfully ever since, completing six Mars years of daily, global coverage on 6th January 2018.

MCS is a passive 9-channel radiometer on the Mars Reconnaissance Orbiter (MRO) that is optimized for atmospheric observations [1]. It uses limb staring to obtain atmospheric profiles from the surface to ~80 km. The instrument consists of two telescopes that are slewed in azimuth and elevation to view the martian atmosphere in limb, nadir, and on-planet geometries (Figure 1). Each channel consists of 21 detectors, which observe the atmosphere simultaneously. Their angular separation provides an altitude resolution of ~5 km (half a scale height) at the Mars limb.

Figure 1: Mars Climate Sounder Flight Instrument

MCS has 8 mid- and far-infrared (IR) channels and one visible/near-IR channel, ranging from 0.3 to 45 μm. Three channels cover frequencies around the 15 μm CO_2 absorption band (A1, A2 and A3) and are used for pressure and temperature sounding. A channel centered around 22 μm (A5) gives information about dust opacity while a channel centered at 12 μm (A4) covers an absorption feature of water ice. In the far-IR, three channels (B1, B2, and B3) are designed to give information about surface temperature, water vapor abundance and dust and condensate opacities.

MRO is in a sun-synchronous polar orbit [2] and provides global observations at 3 AM and 3 PM. In addition, MCS uses azimuth scanning to observe at four additional local times: 1:30 AM, 4:30 AM, 1:30 PM and 4:30 PM [3]. The polar MRO orbit covers all longitudes in 13 orbits (each separated by ~27°) over 24 hours 20 minutes. Each day, the ground track "walks" ~5° to the east.

The MCS retrieval algorithm [4, 5, 6] produces vertical profiles of temperature, dust and water ice extinction versus pressure (Figure 2). It also produces surface brightness temperatures. The retrievals are based on a modified Chahine method [7]. This is an iterative technique that simultaneously solves for all fields by minimizing the radiance residuals. The algorithm uses both limb observations and (where available) nearby on-planet or nadir observations. The on-planet observations are used for the surface temperature retrieval and to retrieve the temperature in the lower atmosphere when the limb is too opaque due to aerosols.

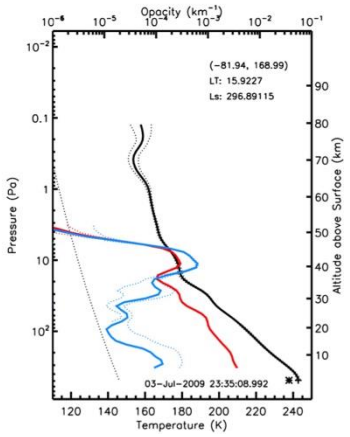

Figure 2: MCS retrieved profile of temperature (black), dust (red), water ice (blue) and surface temperature (*).

Aerosol radiative transfer is performed using both absorption and single scattering. The dust and water ice properties are determined with Mie calculations using a gamma distribution with an r_{eff} = 1.06 μm for dust and an r_{eff} = 1.4 μm for water ice.

All MCS profiles are publicly archived on PDS (http://atmos.nmsu.edu/data_and_services/atmospheres_data/MARS/aerosols.html).

Acknowledgments: Work at the Jet Propulsion Laboratory, California Institute of Technology, is performed under contract with NASA. © 2018, California Institute of Technology. Government sponsorship acknowledged.

References: [1] McCleese, *et al.* (2007) *JGR, 112*, E002790. [2] Zurek and Smrekar (2007) *JGR, 112*, E05S01. [3] Kleinböhl *et al.* (2013) *GRL, 40* 1952-1959. [4] Kleinböhl *et al.* (2009) *JGR 114*, E10006. [5] Kleinböhl *et al.* (2011) *JQRST 112*, 1568-1580. [6] Kleinboehl *et al.* (2017) JQSRT, 187, 511-522. [7] Chahine (1972) *J. Atmos. Sci., 27*, 960-967.