Derivation of Martian Meteorological Parameters Using Ground-based Telescopes

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Despite the increasing number of spacecraft sent to Mars in recent times, many properties of the Martian atmosphere remain relatively unconstrained. Indeed, the Martian surface pressure has only been continuously monitored for any length of time at a total of three surface locations. A more complete set of meteorological data is important both for the characterisation of the atmosphere and as input for general circulation models (GCMs) used in the prediction of atmospheric parameters for future Mars missions.
Near-infrared spectroscopy provides a method of obtaining much information about the atmospheric state of a planet. In the 1-2.5 μm region spectral lines of CO_2, H_2O, CO, O_2, O_3 and many others are present to varying degrees. These spectral lines give information not only about the composition of the atmosphere but also about its temperature and pressure via spectral band shapes. Many aerosols, such as Martian dust, also strongly influence the radiative output of Mars in this region.
The use of high-resolution (R~30000) ground-based spectroscopy (with NASA IRTF/CSHELL) has allowed us to develop a method to retrieve Martian atmospheric parameters, such as surface temperature and pressure, across the entire Martian disk by way of forward-modelling. Our input spectra are observations taken close to the 2005 Martian opposition (Oct 25-27, 2005) at a number of different wavelengths: 1.597 μm, 1.603 μm, 1.607 μm, 2.073 μm and 2.332 μm. `Initial guess' values are taken from the Mars Climate Database (MCD) and iteration proceeds using a Levenberg-Marquardt update rule. Radiative transfer modelling is performed by the SMART package of tools. Resulting spectra typically match our observed spectra very closely.