Clouds in the Atmosphere of Mars

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Description:

Thin water ice clouds are often seen in the atmosphere of Mars and, unlike Earth, temperatures get cold enough for carbon dioxide ice clouds to form as well. This project will involve the use of the Open University Mars global circulation model to investigate the martian cloud cycle [1]. Dust, water vapour and ice are transported by winds in the martian atmosphere. They interact through absorbing and emitting radiation, affecting atmospheric temperatures and wind patterns in turn [2]. Atmospheric temperatures determine where condensable species freeze into ice, or ice sublimates, and dust may play a further role as a condensation nucleus for ice particles.

In 2018, Mars experienced a global dust storm, when most of the planet was enshrouded in a layer of dust resulting from global-scale dust activity. During such extreme events, the distribution of water vapour and water ice clouds is modified significantly, resulting in the transport of water to much higher altitudes in the atmosphere than is normally possible. This 'uplift' of water is believed to be linked to the overall loss of water from the top of the atmosphere of Mars. Understanding the behaviour of water under a range of dust activity will allow water loss rates to be calculated over time for several Mars years.

The project will involve the simulation of cloud formation in the atmosphere of Mars throughout the annual cycle and the detailed comparison of model predictions with observations made by orbiting spacecraft and with historical data. The global model will then be linked with an upper atmosphere model to estimate long-term water loss rates from the present-day climate of Mars. This is vital to understanding Mars' past and the transition from a warmer, wetter climate.

Modelling work in this project will be closely linked to the latest observations from the NOMAD (Nadir and Occultation for MArs Discovery) instrument [3], aboard ESA ExoMars Trace Gas Orbiter. NOMAD is co-led by our team at the Open University. NOMAD gives uniquely detailed vertical profiles of these constituents and aerosols and the project will include simulation of actual weather events on Mars, extending into the future as the project progresses.

References:

1. Read, P.L. and S.R. Lewis (2004) *The Martian climate revisited: atmosphere and environment of a desert planet.* Springer, New York.

Continued

2. Steele, L.J., S.R. Lewis, and M.R. Patel (2014) 'The Radiative Impact of Water Ice Clouds from a Reanalysis of Mars Climate Sounder Data'. *Geophysical Research Letters* 41, 4471–78. https://doi.org/10.1002/2014GL060235.
3. Vandaele, A.C., et al. (2019) 'Martian Dust Storm Impact on Atmospheric H 2 O and D/H Observed by ExoMars Trace Gas Orbiter'. *Nature* 568, 521–25. https://doi.org/10.1038/s41586-019-1097-3.

Qualifications required: Suitable for graduates with a physics, mathematics or related numerate undergraduate degree.