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Synergistic studies enhanced through data assimilation: combining multiple retrievals with a Mars Global Circulation Model

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The wealth of observations now available from multiple spacecraft in orbit around Mars and rovers/landers on the surface provides information on several aspects of the atmosphere, although they are restricted in space and time. Most of the observational datasets are largely complementary, so an efficient method to combine them in a physically consistent way will lead to more constrained studies of the evolution of the global martian atmosphere. Data assimilation is one such method, combining multiple retrievals with a Mars Global Circulation Model (GCM) while accounting for errors in both sources of information and producing an optimal representation of the evolving martian surface and atmosphere. Data assimilation is a powerful tool in that multiple parameters each observed independently by different instruments (e.g. water vapour, ozone, carbon monoxide, dust opacity, temperature) are all realistically constrained and physically consistent at the same time, and unobserved parameters can also be influenced by assimilated data (e.g. water vapour assimilation will impact on the water ice distribution). It also allows for study of atmospheric features that change significantly between observations and identifying processes that lead to the observed changes.

Data assimilation studies are prevalent on Earth and are becoming more mainstream for Mars, with several different Mars GCMs now capable of assimilating retrievals using different assimilation schemes. The Open University (OU) ExoMars modelling group Mars GCM has been combined with several retrieval datasets via data assimilation to study features of the ozone, carbon monoxide, water and dust cycles alongside dynamical features such as the polar vortices, surface warming during a global dust storm and planetary waves. OpenMARS (Open access to Mars Assimilated Remote Soundings), a publicly available global reanalysis dataset from 1999-2015, was also created using the OU assimilation system.

This talk will give a brief overview of the benefits and limitations of data assimilation for Mars, and will demonstrate how combining retrievals of different atmospheric parameters with a Mars GCM via data assimilation leads to a better constrained analysis of the martian atmosphere than is possible with retrievals or GCMs alone.