Global Wind Measurement from Orbit Using Lidar

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Abstract
Very few measurements have been made of Martian winds yet they create global dust storms, reshape the surface and impact our ability to land precisely.

Laser radars or lidars capable of measuring wind velocity have been developed for a number of Earth applications and one will shortly be operating from Earth orbit providing a global view of Earth's winds. Wind measuring lidars measure a Doppler shifted backscatter signal from the atmospheric molecules and aerosol particles that are entrained in the atmosphere and moving with the wind velocity. Measuring this Doppler shift permits a line of sight wind velocity to be determined and multiple line of sight measurements made at different angles to the wind field permit the Doppler wind vector to be retrieved. Figure (1) shows a cartoon of the signal frequency spectrum returned by a single measurement.

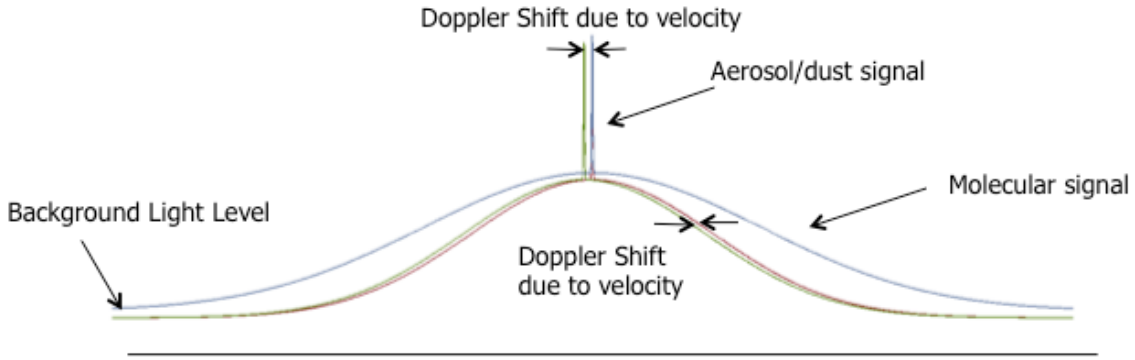

Figure (1) Conceptual lower atmosphere return signal spectrum (red – Mars, green – Mars Doppler shifted, blue – typical Earth spectral signal return for comparison)

The relative signal strengths of the molecular and aerosol/dust signals will be dependent on the local atmospheric conditions. It is easiest to obtain a high velocity accuracy by measuring the aerosol signal Doppler shift however it's dependence on aerosol/dust concentrations means that it is not as ubiquitous as the molecular signal return. Typically a Doppler lidar is designed to measure either the aerosol signal or the molecular signal due to conflicting instrument design requirements for optimizing the measurement of each type of signal.

Using atmospheric dust loading data collected by the Mars Reconnaissance Orbiter indicative of low aerosol/dust loading conditions and atmospheric profiles generated by the MRAMS mesoscale model and the Ames Mars GCM we have analyzed the relative signal strengths as a function of altitude for a variety of atmospheric conditions to assess the relative merits of the two design approaches.

We will present the results of these analyses together with candidate instrument designs for an orbiting lidar capable of measuring Martian global winds.