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The MARs Boundary Layer LIDAR (MARBLL) observation strategies and corresponding performance predictions.

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The MARBLL instrument is the first Martian LIDAR concept providing simultaneous wind speed and aerosol density measurements. Its design, validated with a prototype, relies on a Mach-Zehnder interferometer as well as on the laser inherited from the ChemCam instrument. Whereas the aerosol density profile is classically determined by measuring the amount of backscattered light along the line of sight (LOS), the wind speed measurement uses the Doppler shift created by the velocity of the particles along this LOS. Its performances for a Martian configuration have been simulated. Because, the lidar is only able to measure the wind-speed projected along the line of sight, various observation strategies have been tested.

Whereas the vertical sounding allows the direct determination of altitude profiles of aerosols and vertical wind-speed, the measurement of the horizontal wind vector requires specific techniques. The "conical scan" that has been tested consists in sounding the envelope of a cone with the laser, shooting at a given elevation (typically 45) for a selected range of azimuths. The vertical and horizontal wind speed at every altitude can then be deconvolved by fitting a sinusoid on the azimuthal data. The same method can be used at low elevations, for a high vertical resolution measurement near the surface.

Eventually, the instrument performances have been predicted using two models. On the one hand, an end-to-end instrument model, describing the whole optical line, interferometer and electronics noises and performances, enabling us the obtain the signal-to-noise ratio (SNR) for each shot as well as the one-sigma error expected for the LOS wind-speed measurement at a given altitude. On the other hand, the Large-Eddy Simulation (LES) model developed at Laboratoire de Météorologie Dynamique, is used to set up the actual measured LOS wind-speed resulting from the combination of the project wind vector components along the lidar LOS. The error on the aerosol density measurement is easily obtained thanks to the SNR whereas the one-sigma error on horizontal and/or vertical wind speed for a given measurement strategy is then determined by propagating the LOS one-sigma error through the employed method (directly for the vertical shot, and through least square fits for the conical scan). A Monte-Carlo method is then used with time, space and observation parameters (the simulated measurement is done at various start times, positions in the simulation box and starting azimuths) in order to finally compute the one-sigma error for one measurement strategy, with a particular set of parameters, therefore allowing us to choose the optimal ones for the instrument design.