The Martian Dust Cycle: Observations and Modeling
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The dust cycle is critically important for Mars' current climate system. Suspended atmospheric dust affects the radiative balance of the atmosphere, and thus greatly influences the thermal and dynamical state of the atmosphere. Evidence for the presence of dust in the Martian atmosphere can be traced back to yellow clouds telescopically observed as early as the early 19th century. The Mariner 9 orbiter arrived at Mars in November of 1971 to find a planet completely enshrouded in airborne dust. Since that time, the exchange of dust between the planet's surface and atmosphere and the role of airborne dust on Mars' weather and climate has been studied using observations and numerical models. The goal of this talk is to give an overview of the observations and to discuss the successes and challenges associated with modeling the dust cycle.

Dust raising events on Mars range in size from meters to hundreds of kilometers. During some years, regional storms merge to produce hemispheric or planet encircling dust clouds that obscure the surface and raise atmospheric temperatures by tens of kelvin. The interannual variability of planet encircling dust storms is poorly understood. Although the occurrence and season of large regional and global dust storms are highly variable from one year to the next, there are many features of the dust cycle that occur year after year. A low-level dust haze is maintained during northern spring and summer, while elevated levels of atmospheric dust occur during northern autumn and winter. During years without global-scale dust storms, two peaks in total dust loading are generally observed: one peak occurs before northern winter solstice and one peak occurs after northern winter solstice.

Numerical modeling studies attempting to interactively simulate the Martian dust cycle with general circulation models (GCMs) include the lifting, transport, and sedimentation of radiatively active dust. Two dust lifting processes are commonly represented in these models: wind-stress lifting (i.e., saltation) and dust devil lifting. Although the predicted patterns of dust lifting and atmospheric dust loading from these simulations capture some aspects of the observed dust cycle, there are many notable differences between the simulated and observed dust cycles. For example, it is common for models to predict one peak in global dust loading near northern winter solstice due to excessive dust lifting in the Hellas basin at this season. Additionally, it is difficult for models to realistically capture the observed interannual variability in global dust storms. New avenues of dust cycle modeling research include exploring the effects of finite surface dust reservoirs and the effects of coupling the dust and water cycles on the predicted dust cycle.