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The Mars Dust Cycle: Investigating the effects of radiatively active water ice clouds on surface stresses and dust lifting potential with the NASA Ames Mars General Circulation Model

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The dust cycle is a critically important component of Mars' current climate system. Dust is present in the atmosphere of Mars year-round but the dust loading varies with season in a generally repeatable manner. Dust has a significant influence on the thermal structure of the atmosphere and thus greatly affects atmospheric circulation. The dust cycle is the most difficult of the three climate cycles (CO_2, water, and dust) to model realistically with general circulation models. Until recently, numerical modeling investigations of the dust cycle have typically not included the effects of couplings to the water cycle through cloud formation. In the Martian atmosphere, dust particles likely provide the seed nuclei for heterogeneous nucleation of water ice clouds. As ice coats atmospheric dust grains, the newly formed cloud particles exhibit different physical and radiative characteristics. Thus, the coupling between the dust and water cycles likely affects the distributions of dust, water vapor and water ice, and thus atmospheric heating and cooling and the resulting circulations. We use the NASA Ames Mars GCM to investigate the effects of radiatively active water ice clouds on surface stress and the potential for dust lifting. The model includes a state-of-the-art water ice cloud microphysics package and a radiative transfer scheme that accounts for the radiative effects of CO2 gas, dust, and water ice clouds. We focus on simulations that are radiatively forced by a prescribed dust map, and we compare simulations that do and do not include radiatively active clouds. Preliminary results suggest that the magnitude and spatial patterns of surface stress (and thus dust lifting potential) are substantial influenced by the radiative effects of water ice clouds.