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Impact of radiatively active clouds on wind stress based dust lifting during northern hemisphere summer on Mars

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The dust load varies with season in the Martian atmosphere. The dust activity is high during southern spring and summer, while a low background haze of atmospheric dust is maintained throughout northern hemisphere spring and summer. In the absence of regional or global storms, dust devils and local storms maintain the background dust loading during the non- dusty season. Observational surveys of dust devils and general circulation modeling results suggest that it is likely that dust devils are responsible for the presence of atmospheric dust during these seasons. However, a quantitative understanding of the relative contribution of dust devils and local dust storms has not yet been achieved. Here we present preliminary results from an investigation that focuses on the effects of radiatively active water ice clouds on dust lifting processes. The primary tool for this work, the NASA Ames Legacy GCM, is a 3-dimensional model that has been used for investigations of the past and current climate of Mars. The NASA Legacy GCM runs on an Arakawa C-grid with a normalized sigma coordinate vertical grid. A horizontal resolution of 5° in latitude and 6° in longitude is used for the study. Three simulations that included wind stress dust lifting were executed for a period of 5 Martian years: case 1 included no cloud formation, case 2 included radiatively inert cloud formation, and case 3 included radiatively active cloud (RAC) formation. Water ice clouds are known to affect atmospheric temperatures directly by absorption and emission of thermal infrared radiation. They also affect the temperatures indirectly through dynamical feedbacks.
Our results suggest that wind stress lifting may contribute more to maintaining the background dust haze during NH spring and summer than what previous studies have shown. Results show that when radiatively active clouds are included, the clouds in the aphelion cloud belt radiatively heat the atmosphere aloft in the tropics. This heating produces a stronger overturning circulation, which in turn produces an enhanced low-level flow in the Hadley cell return branch. The stronger low-level flow drives higher surface stresses and increased dust lifting in those locations. We examine how realistic these simulated results are by comparing the spatial pattern of predicted wind stress lifting with a catalog of observed local storms. Better agreement is achieved in the radiatively active cloud case. Although wind stress lifting may contribute more to maintaining the background dust haze than previously though, dust devils are also still needed during that time of the year.