Prediction of dust optical depth from Mars images observed by the Mars Orbiter Camera onboard the Mars Global Surveyor

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Dust optical depth data is crucially important to understand processes of dust haze transport in the Mars atmosphere. Generally speaking, suspended dust is concentrated in the lowest levels of the atmosphere and therefore has smaller horizontal scales, O(1km)-O(100km). Although images of the Mars surface in the visible wavelengths that have a high enough horizontal resolution are available, dust optical depth data in the visible wavelengths are not available. Although dust optical depth data in the infrared wavelengths observed by infrared spectrometers is also available, the FOV of the spectrometers is too narrow to provide two dimensional dust distributions. In this study, we propose a method based on Convolutional Neural Network for predicting a dust optical depth value in the infrared wavelengths from a visible image including the infrared observation point, focusing on the Arcadia Planitia (180°E - 40°N). The method treats a dust optical depth value observed by the Thermal Emission Spectrometer onboard Mars Global Surveyor (MGS/TES) as a dependent variable, and a 128×128 piexels image centered at the observation point of the dust optical depth taken by Mars Orbiter Camera onboad MOC (MGS/MOC) as a independent variable. In other words, it is multi-dimensional non-linear regression predicting infrared dust optical depth from a visible image subset of a area where infrared dust optical depth data is not available. Dust optical depth data is extremely inhomogeneous because the number of dust storm pixels showing large dust optical depth values is much smaller than that of the surface pixels showing smaller dust optical depth. Therefore, the reliability of the proposed method is low in the case of predicting dust optical depth of dust storms. On the other hand, if we try to predict horizontal distributions of dust haze showing relatively low dust optical depth, the proposed method provides 90% confidential intervals of about ±0.15.

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