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Is albedo the key parameter that controls the seasonal south polar cap recession of Mars?

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Introduction: Parts of the Martian atmosphere, which is mainly composed of CO_2, are trapped during the winter at the surface near the pole in the form of CO_2 frost. When the Sun light returns in the spring, the CO_2 is heated up and sublimates. This major martian climatic cycle has been revealed be the pioneer work of Leighton and Murray [1]. Recent GCM modeling of seasonal frost including CO_2 snow, are able to reproduce the Viking Lander 1 pressure measurement assuming a constant albedo value of seasonal caps [2]. Nevertheless, albedos observed by OMEGA [3] and by TES [4] are not constant in space and time. During the sublimation phase, different parameters are involved in temporal evolution of the seasonal cap recession: albedo, thermal emissivity, slopes and surface roughness, or thermal inertia of the ground. We will discuss here to which extent those factors control the Seasonal South Polar Cap (SSPC) recession.

Method: We propose to compare the timing of the SSPC recession observed by the imaging spectrometer OMEGA/MEX using the WAVANGLET method [5] and the net accumulation of the HEND neutron flux instrument [6]. In order to link the timing of the defrost phase to CO_2 mass, we solve a defrost mass balance model [7]. This model solves the energy balance at the surface taking into account several phenomena: the direct sunlight partially absorbed by the atmosphere, the light scattered by the aerosols, the thermal emission of the atmosphere, the thermal emission by the surrounding terrains, the subsurface heat flow, the thermal emission of the ground and the latent heat of sublimation. Local pressure is taken from the Mars Climate Database [2].

Result: At global scale, the SSPC sublimation is longitude-dependent but accumulation measurement seems to be circular/symmetric around the South Pole [6]. This apparent contradiction is resolved by the fact that the albedo increase with time is longitude-dependent too. At local scale of about 300 m (OMEGA pixel size), the SSPC edge can be described by a transition zone mixing frost and already defrosted areas. The typical length of this transition zone is independent of local altitude and surface roughness. On the contrary, albedo distribution, 20 days before the recession, seems to control this transition zone. As a conclusion, albedo is the key that controls SSPC recession. Different processes could be related to albedo such dust contamination, ice metamorphism, deposition type (direct condensation vs snow).

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