SUMMER OBSERVATIONS OF THE MARTIAN NORTH POLAR RESIDUAL CAP BY THE HIGH RESOLUTION STEREO CAMERA (HRSC) IN 2004/2005 AND 2006. D. Reiss[1], H. Hoffmann[2], F. Scholten[2], H. Hiesinger[1], K.-D. Matz[2], G. Neukum[3], [1]Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (dennis.reiss@uni-muenster.de), [2]Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Rutherfordstr. 2, 12489 Berlin, Germany, [3]Institute of Geosciences, Planetology and Remote Sensing, Freie Universität Berlin, Malteserstrasse 74-100, 12249 Berlin, Germany.

Introduction: Monitoring the polar caps is important for understanding the current climate on Mars. The northern residual cap (NRC) is an important source of atmospheric water vapour and it is unclear if there is a net sublimation or deposition of water vapour under present climatic conditions. The recession of the seasonal polar cap in spring uncovers the bright NRC, which is composed of H_2O ice [1]. First observations suggested interannual changes of the NRC in extent [2, 3]. Bass et al [4] showed that these observed changes are most likely due to seasonal variations. Detailed examination of the interior cap showed that the albedo varies spatially but is generally repeatable interannually [5]. Hyperspectral data from OMEGA acquired between L_S ~93° and ~127° in 2004/2005 revealed that the albedo decrease on the polar cap is due to the sublimation of fine-grained frost which exposes older large-grained ice. In outlying regions, dominated by large-grained ice, the albedo increases with time [6]. We tracked the seasonal and possible interannual albedo changes of the NRC using the Lambert albedo derived from High Resolution Stereo Camera (HRSC) image data [7] of the summer seasons 2004/2005 (L_S ~120°-~160°) and 2006 (L_S ~90°-~150).

Dataset and Method: For our analysis we used 44 (22 in each summer) HRSC images north of 75°N (Figure 1). Although the temporal and spatial coverage is not complete, there are several areas of yearly and multi-year repeated coverage with high resolution. Lambert albedos were derived for the panchromatic nadir channel (675 ± 90 nm), the blue channel (440 ± 45 nm), the green channel (530 ± 45 nm), the red channel (750 ± 20 nm), and the near-infrared channel (970 ± 45 nm). After radiometric correction, HRSC image data are given in units of I/F corresponding to the ‘‘radiance factor’’ [8], i.e. the ratio of the surface reflectance as measured and the reflectance of a perfectly diffuse surface illuminated at 0° incidence [7]. To derive the Lambert albedo, incidence angles were determined for each pixel separately to account for the large variance of illumination within and between the image scenes. The emission angles of the red and infrared channel are -15.9° and +15.9, respectively and the large viewing angle offsets are likely to have an influence on the measurements due to different scattering contributions of the atmosphere and surface. Simultaneous observations at identical atmospheric conditions with the OMEGA imaging spectrometer on Mars Express [9] revealed largest discrepancies with the HRSC red and infrared channel whereas the blue and green channel with emission angles of -3.3° and +3.3°, respectively, generally agree well with the OMEGA observations [7, 10]. Therefore, our analysis is mainly based on the green channel (less influenced by atmospheric conditions than the blue channel) and, if not available, on the nadir channel. To constrain the evolution of the residual cap, we made Lambert albedo mosaics of images which were acquired within a time span of ~5° to ~10° L_S and compared their percent albedo changes. For interannual changes, we compared single images which were acquired within ~5° L_S of each other in different years.

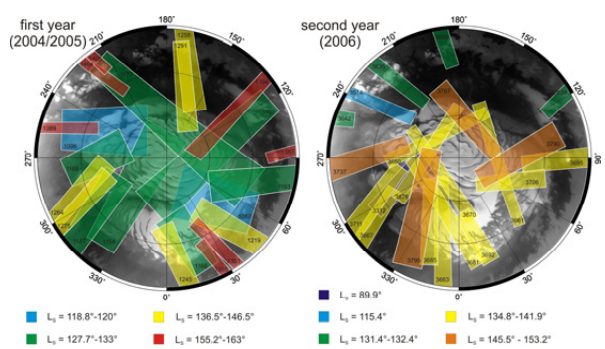

Figure 1. Spatial and temporal coverage of HRSC imagery in the northern summer (LS 90°-180°) of the North Polar region in the first (2004/2005) and second (2006) year. Polar stereographic projection from 75°N with latitude grids each 5° and longitudes in east. Orbit numbers are given on top of the footprints (Background: Mosaic of Mars Orbiter Camera – Wide Angle (MOC-WA) images E2300125 and E2300689).

Results:

Seasonal evolution, First year (2004/2005): The albedo of the NRC from L_S ~120° to ~130°is relatively stable. Changes in brightness are in the range of <5 %

(Figure 3, 1). Around L_S ~135° the albedo starts to decrease (Figure 2, top and Figure 3, 2).

Seasonal evolution, Second year (2006): There is a a strong albedo increase from L_S 90° to 137° (Figure 3, 3). The albedo starts to decrease after L_S ~142° (Figure 2, bottom).

Interannual comparision: Based on the available HRSC data for the two years all regions show higher albedo values in the second year at around the same time of the summer season (Figure 4, 1-4).

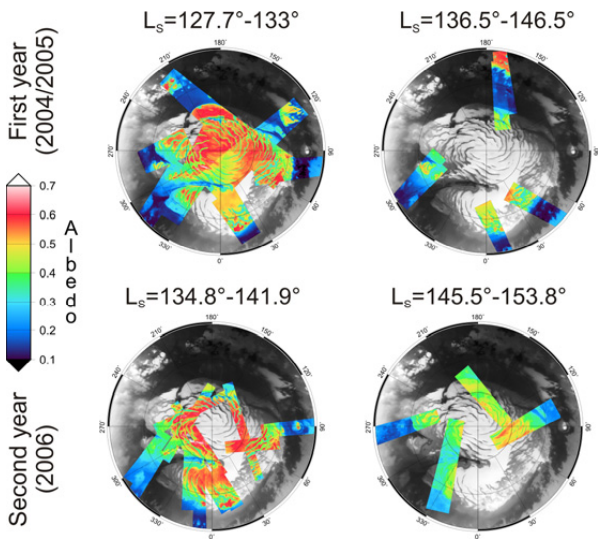

Figure 2. Selected seasonal Lambert albedo changes (in percent) between HRSC-mosaics within 2004/2005 (top) and 2006 (bottom). Lambert albedo data were derived from the HRSC nadir channels (675 ± 90 nm).

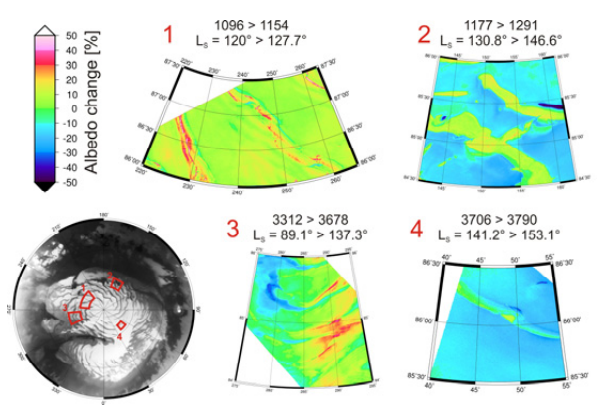

Figure 3. Seasonal changes in Lambert albedo (in percent) in selected regions of the NRC in 2004/2005 (top) and 2006 (bottom). Lambert albedo data were derived from the HRSC green channels (530 ± 45 nm).

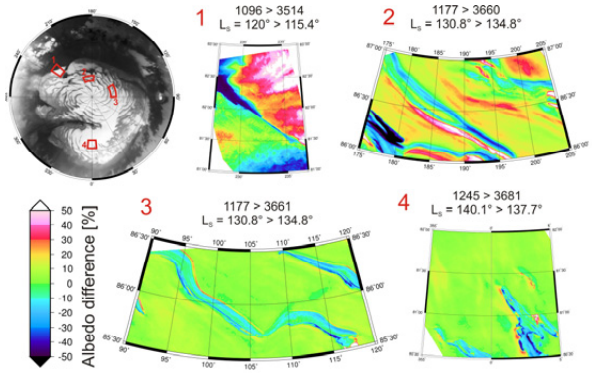

Figure 4. Interannual differences in Lambert albedo (in percent) in selected regions of the NRC between HRSC-orbits from the first year (2004/2005) to the second year (2006). The compared HRSC-orbits were acquired at around the same local time. Lambert albedo data were derived from the HRSC green channels (530 ± 45 nm).

Discussion: The relatively stable cap albedo in the first year from L_S ~120° to ~130° is in agreement with the results of Region B (42.5°E, 85.1°N) in [6]. Both OMEGA measurements at L_S 117.4° and 127.6° indicate large-grained ice. Our measured albedo decrease of the cap between L_S ~135° and L_S ~160° is similar to the measurements of Benson and James [2005] near the geographic north pole in 1999, 2001 and 2003. They observed a strong drop in albedo starting at L_S 134°.In the second year we observed that the seasonal evolution is similar to the first year with a strong albedo increase in early summer and an albedo decrease around mid-summer. However, in the second year the albedo decrease starts not before L_S ~142° (Figure 2, bottom) in contrast to the first year (around L_S ~135°, Figure 2, top). This result is consistent with the interannual comparisions of brighter albedos at around the same time of the year (Figure 4).

Conclusions: The seasonal summer evolution of the NRC is similar in both years. However, HRSC results indicate a time-delay of L_S ~7° at mid-summer (based on Figure 2) in the seasonal evolution of the NRC in 2006 compared to 2004/2005. The interannual albedo differences are most likely caused by this delay.

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