Global Mapping of Northern Martian Seasonal Cap with HEND Instrument during 2002-2007 Years.

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Introduction: In this work we have used data gathered by High Energy Neutron Detector (HEND) during five years of observations onboard Mars Odyssey. We have focused our efforts on observation of northern seasonal cap to make estimation of CO_2 deposit column density and mass for different latitude belts as a function of time. We also have tried to make comparison with other observational data and estimations provided by Gamma Ray Spectrometer (GRS), orbital tracking data, Mars Orbiter Laser Altimeter (MOLA) and General Circulation Model (GCM) [1-4].

Analysis of seasonal variations of neutron albedo is found as one of direct ways for observation of seasonal redistribution of atmospheric mass between Martian poles[5,6]. The CO_2 frost (with thickness more than several centimeters) changes the structure of subsurface and distribution of water ice in upper layers of regolith causing significant changes of neutron flux. This effect was suggested as a base for estimation of column density of CO_2 deposit and reconstruction of multidimensional model of CO_2 deposit showing how snow depth varies as a function of latitude, longitude and time.

Data Analysis: The seasonal variations of neutron flux above Martian poles can be used to extract snow depth (column density measured as g/cm^2) at different latitudes for different seasons. All processed data are based on derived HEND data DHD (background subtracted data with reduced solar events presented at the PDS). It was normalized to the data observed at Solis Planum to avoid variations of neutron flux caused by long term changes of Galactic Gamma Rays flux and systematic effects (gain and temperature drifts in HEND detectors).

In this study we have used numerical modeling of HEND data with MCNPX code [7] to find best fit correspondence between model predictions and observations which lead to estimation of column density and mass of seasonal CO_2 frost. [6].

Results: The evolution of snow depth at different latitudes and total mass of northern seasonal cap trough the Martian year is shown on figure 1 and 2. The maximal thickness of CO_2 frost and mass of northern seasonal cap are observed at the end of northern winter and estimated as ~ 70 g/cm^2 and 3.5 x 10^{15} kg correspondingly. The comparison with MOLA data revealed that volume density of CO_2 deposit may vary from 500 kg/m^3 up to 900 kg/m^3 at different locations within seasonal cap.

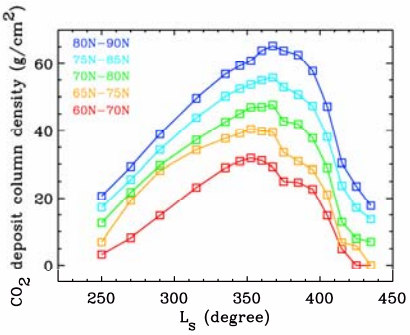

Fig.1. Seasonal curves of CO_2 deposit column density (HEND data) for different southern latitudes (80N-90N, 75N-85N, 70N-80N,65N-75N, 60N-70N).

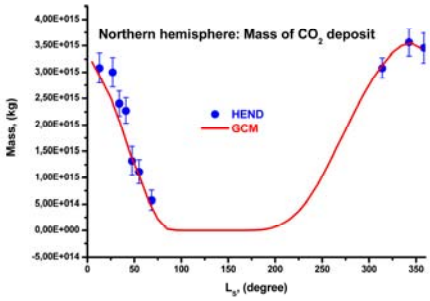

Fig.2. Mass estimations of northern seasonal cap from HEND data and GCM's predictions.

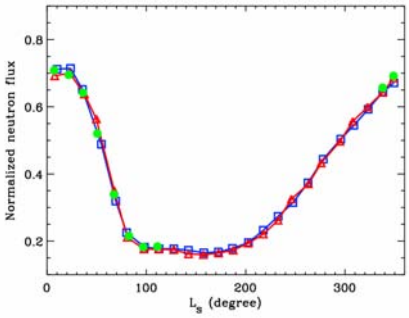

Fig.3. Three Martian years (shown by different color) of observations of Northern seasonal cap (neutron flux above 80N-90N latitude zone).

In this study we have also performed comparison with GRS results, GCM predictions and gravity models in order to validate mass estimations. It was found that differences among these methods and observations may be covered within less than three standard deviations.

The duration of HEND observations (more than 5 years) is long enough to search for interannual variations of CO_2 cycle. On figure 3 we have presented comparison between different seasonal curves measured for three successive Martian years. It seen that difference from year to year is not so significant and can be covered within 5-10%.

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