Seven years of observations of Martian Seasonal Caps onboard Mars Odyssey by HEND instrument.

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Introduction: Analysis presented in this study is based on neutron spectroscopy data gathered with HEND/GRS instrument onboard Mars Odyssey. Starting from 2002 this mission passed through primary and several extended phases getting more and more science data including results of global mapping of Martian neutron albedo. It is very efficient technique for exploration of water ice distribution [1-6] as well as for observation of martian seasonal caps [7-9]. Hydrogen in the upper (1-2 m) layer of subsurface in polar areas is very efficient moderator of fast and epithermal neutrons which are produced by Galactic Cosmic Rays. It leads that neutron albedo (above thermal neutron energy range) is very low in high latitude areas of Mars [1-6]. But it is true only for summer period of time when CO_2 is not condensed on the ground from atmosphere. Presence of seasonal dry CO_2 frost with thickness more than several centimeters up to 1 m changes the structure of subsurface and distribution of water ice in upper layers of regolith causing significant variations of neutron flux. These variations may be used for observations of growing and sublimation of Martian snow caps.

Data Analysis: At near polar latitudes difference in neutron flux value between summer and winter seasons may achieve as high as 3-5 times and ~20% at the border of snow cap. It means that counting statistic in neutron detectors may be used to map contours of snow caps at different seasons to be valid to discover areas with presence of > 5 g/cm^2 of CO_2 frost.

But to convert counts in neutron detectors to real physical values such as column depth (g/cm^2), mass, density it is necessary to use more complicated approach based on numerical modeling of nuclear processes happened when neutrons are produced, scattered and captured in martian regolith, atmosphere and spacecraft body. Comparison between modeled counting rate (numerically simulated for the given model of regolith + CO_2 frost) and observed counting rate (in HEND detectors) is the main factor to extract best fit parameters of model: water ice distribution and column density of CO_2 frost (see example on figure 1-2).

Now Mars Odyssey operates at Martian orbit more than 7 years which corresponds to 4 Martian years. It has been used to search for inter annual variations of seasonal cycles trying to compare dimensions and thickness of snow caps for different Martian years.

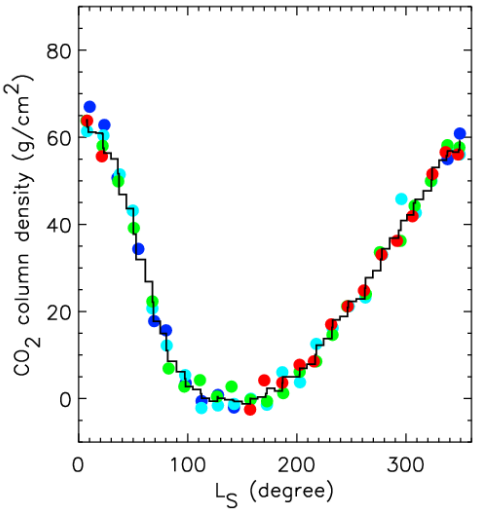

Fig. 1. The seasonal profile (deconvolved from HEND data) of snow depth at north polar latitudes. Color circles correspond to different Martian years; black curve is average seasonal profile for fourth Martian years.

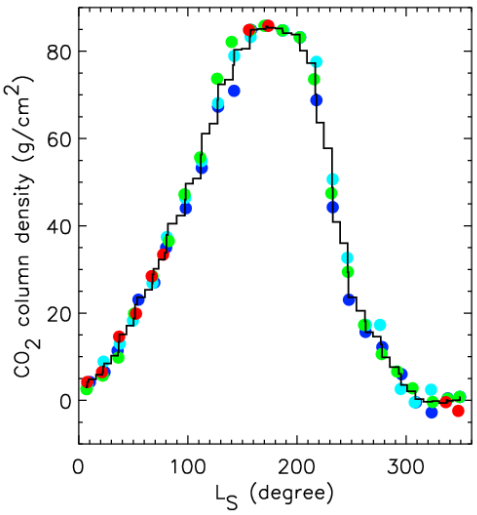

Fig. 2. The seasonal profile (deconvolved from HEND data) of snow depth at south polar latitudes. Color circles correspond to different Martian years; black curve is average seasonal profile for fourth Martian years.

Results: Concluding results of our investigations we may list them in the following order:

1) Using of neutron counting statistic to follow up contours of Martian snow caps for different seasons.

2) Comparison with the visual and infrared observations.

3) Modeling of snow caps with estimations of column density and mass of snow deposit.

4) Comparison with other nuclear instruments such as NS, GRS and climate models.

5) Calculation of volume density through comparison with MOLA.

6) Search of inter annual variations in growing/sublimation of snow caps and thickness of snow deposit.

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