SEASONAL CO_2 OBSERVATIONS ON NORTH AND SOUTH OF MARS AS SEEN BY HEND (MARS ODYSSEY) AND MOLA (MGS). M. L. Litvak[1], I. G. Mitrofanov[1], D.E. Smith[2], M.T. Zuber[3,2], W. Boynton[4], R. S. Saunders[5], D Drake[6] 1 – Space Research Institute, RAS, Moscow, 117997, Russia, max@cgrsmx.iki.rssi.ru; 2-Laboratory for Terrestrial Physics NASA/Goddard Space Flight Center, MD,20771, USA; 3- Massachusetts Institute of Technology, Cambridge, MA, 02139-4307, USA; 4 - University of Arizona, Tucson, AZ 85721, USA, 5 - Jet Propulsion Laboratory, Pasadena, CA 91109, USA.; 6-Lansce 3, Los Alamos Nat'l Lab. Los Alamos, NM and TechSource Inc, Santa Fe, NM 87594,USA.

Introduction. The first year of neutron mapping measurements from the Mars Odyssey spacecraft are presented based on observations from the High Energy Neutron Detector (HEND) [1]. The HEND instrument is a part of GRS suite [2, 3] responsible for registration of epithermal and fast neutrons originating in the Mars subsurface layer [1, 4]. The gamma–ray and neutron spectrometers measure the scattering of fast neutrons from the Martian surface, which is caused by bombardment of primary cosmic rays and is strongly sensitive to the presence of hydrogen atoms [5, 6]. Even several percent subsurface hydrogen significantly depresses the flux of epithermal and fast neutrons. The recent Mars Odyssey observations detected a considerable amount of hydrogen, almost certainly corresponding to water ice, in the shallow near surface of the southern and northern hemispheres of Mars [1-4].

Observations of surface composition based on neutron measurements are most effective only within 1-2 m of the surface [7-9]. Thus, the seasonal CO_2 coverage, which may achieve up to 1.5 m thickness in the polar regions [10], hides the subsurface layer from the observer. Mars Odyssey observations from the first mapping year tracked seasonal changes from late winter in the northern hemisphere (NH) to NH summer. We have analyzed the data to search for variations in the epithermal neutron flux caused by the sublimation of CO_2 snow in NH and the accumulation of CO_2 coverage in southern hemisphere (SH).

Data Analysis. To attempt to detect seasonal effects in the neutron data, we divide the northern and southern hemisphere regions into several latitude belts. We averaged the neutron flux within given latitude belt and studied the dependence of averaged neutron flux versus solar longitude (L_s). The normalization was used on the maximum flux of neutrons, which is observed in the equatorial region of Mars near Solis Planum. This region may be interpreted as the driest surface on Mars. One may assume that long-term variations of the neutron flux in this region are mainly produced by a variation of primary cosmic rays or intensive solar activity. That is why selected normalization helps to extract seasonal variation of neutrons from the collective neutron flux changes during the period of observations. The resulting curves for longitude belts for NH and SH are presented in Figure 1.

The first direct measurements of seasonal variations in CO_2 snow depth were obtained by the MOLA instrument [11, 12] on the Mars Global Surveyor (MGS) spacecraft for the previous Martian year [10]. To study the behavior of seasonal CO_2 coverage, we combined HEND and MOLA observations within the same latitude belts for the same Martian seasons. The result shows an excellent correlation between the epithermal neutron flux observed by HEND and the snow depth measured by MOLA for different latitude belts. The most evident correspondence for high latitudes of NH is shown in Fig 3.

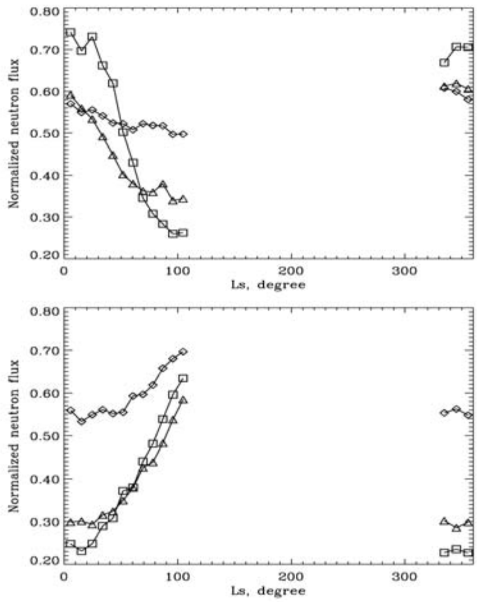

Fig. 1. Seasonal variation of average neutron fluxes for longitude belts in the NH (top) and SH (bottom).

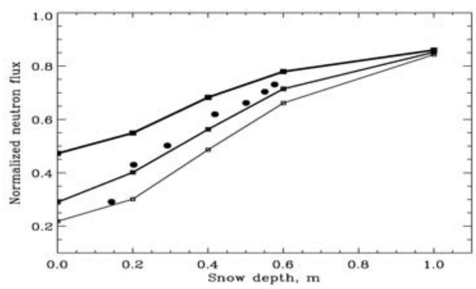

Fig. 2. Correspondence between neutron flux (observed by HEND) and CO_2 snow depth (measured by MOLA) for NH near-polar longitude belt at same Martian seasons. The solid curves correspond to subsurface models with 35% of H_2O in the basal layer placed below a dry layer and covered by CO_2 snow. Thick, medium and thin solid curves correspond to dry layer thicknesses with 40 g/cm^2 , 20 g/cm^2 and 10 g/cm^2.

Conclusions. The strong correlation between variations in neutron flux from HEND and seasonal CO_2 variations is found in different latitude belts. The interpolation of the relationship between HEND and MOLA data provides the ability to measure CO_2 snow depth from several cm, where HEND has significant efficiency, up to 1-2 meters, at which MOLA measurements are most accurate.

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