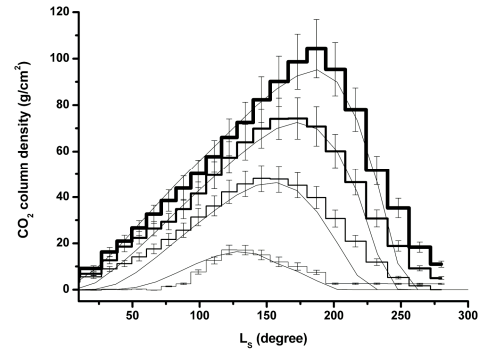
Southern pole of Mars: Estimations of column density, mass and volume density of CO_2 deposit from Mars Odyssey and MGS data.
M.L. Litvak[1], I.G. Mitrofanov[1], A.S. Kozyrev[1], A.B. Sanin[1], V. Tretyakov[1], W.V. Boynton[2], Kelly N.J[2], R. S. Saunders[3], [1]Space Research Institute, RAS, Moscow, 117997, Russia, max@cgrsmx.iki.rssi.ru, [2]University of Arizona, Tucson, AZ 85721, USA, [3] NASA Headquarters, Washington, DC 20514, USA.

Introduction. Four years of mapping of the martian surface from Mars Odyssey give us a lot of observational data to trace not only the growth and sublimation of martian seasonal caps within one martian year but also to distinguish the difference between martian seasons from one year to another. In this work we have used data gathered by High Energy Neutron Detector (HEND) for southern hemisphere of Mars 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), Mars Orbiter Laser Altimeter (MOLA) and General Circulation Model (GCM) [1-3].

Analysis of long term variations of neutron spectroscopy data is proved as a very effective way for observation of seasonal deposit's evolution [4,5]. It was discovered that ground CO_2 frost effectively hides upper water rich surface layers (located poleward 60S/60N latitudes) from the orbit neutron and gamma spectroscopy (GRS, HEND and NS observations). This effect was suggested as a base for estimation of column density of CO_2 deposit at different latitudes [4,5,2] on North and South of Mars and reconstruction of multidimensional model of CO_2 deposit showing how snow depth varies as function of latitude, longitude and time.

Data Analysis. The seasonal curves of neutron flux at epithermal and fast energy ranges were used to deconvolve evolution of snow depth (column density measured as g/cm^2) at different southern latitudes for previous and current martian years. All curves are extracted from 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).

The implementation of numerical model of HEND observations and special minimization procedure for getting model parameters allowed finding best fit correspondence between model predictions and observations which lead to estimation such values as deposit column density and mass [see also 5].



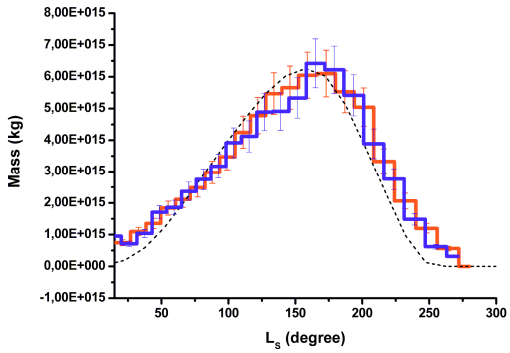


Fig.1(UP). Seasonal curves of CO_2 deposit column density (HEND data) for different southern latitudes (80S-90S, 70S-80S, 60S-70S, 50S-60S) are compared with GCM's predictions.
Fig.2(DOWN). Mass estimations of southern seasonal cap (HEND data) for the Mars Odyssey first year (blue curve), Mars Odyssey's second year (red curve) and GCM's predictions(dashed curve) are presented for the southern hemisphere.

HEND Results. The results of data deconvolution analysis are presented in figure 1: here we have shown four seasonal curves (latitude belts 80S-90S, 70S-80S, 60S-70S, 50S-60S) of CO_2 column density as a function of seasons (you say season/al twice in this sentence); and figure 2: here we have shown mass estimates for the southern seasonal cap (60S-90S) made for two successive martian years. It was found that the maximum CO_2 deposit thickness varies from 16-18 g/cm^2 at boundary latitudes and up to 100-110 g/cm^2 at near polar latitudes. These maxima were observed in different time windows: ~L_S=130^o for the 50S-60S latitude belt and ~L_S=185^o for the 80S-90S latitude

belt. The comparison between different martian years shows that possible differences can be observed only during the middle of the southern winter and can be explained as snow depth variations of 3-5%.

Comparison with GCM, MOLA & GRS. On figures 1-2 we have also presented comparison between HEND estimations and GCM predictions which show good coincidence in estimation of maximal column density and mass of CO_2 deposit, but reveals some discrepancy in time behavior of southern seasonal cap especially in period of sublimation of CO_2 deposit.

Parameterizations (column density & mass) of Southern seasonal cap made by GRS have also been compared with HEND values. It was found that GRS values are smaller than HEND but it is still within error bars.

Another type of comparison which could be done is a comparison with MOLA/MGS estimations of snow depths (measured in cm) and total masses of seasonal caps. Direct comparison between neutron spectroscopy data (g/cm^2) and altimetry data (cm) leads to the estimation of the volume density of CO_2 deposit. In this study it was found that average volume density of southern CO_2 deposit lies below $1 g/cm^3$.

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References:

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