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Particularities of the inter-years and seasonal variations of the water equivalent content within the surficial soil layer on Mars revealed based on the data analysis of the HEND instrument observations.

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1. Introduction

How much of the water amount is involving in both the seasonal polar caps and the seasonal permafrost formation on Mars represents one of the main scientific tasks for understanding of the modern water cycle on the planet. The existing HEND's observations, accumulated during the last five Martian years, are unique data, which may to help us to understand better the particularities of a inter-years and a seasonal water cycle in the system "atmosphere-permafrost-polar caps. In the work we report the study results of the inter-years and seasonal variations of the water equivalent content within the surficial soil layer derived from the multiyear's observations of the HEND instrument on the board of the OA Mars Odyssey.

2. The HEND's observations

Steps of the HEND data analysis: In our study we focused on the variations of the fast neutrons flux (FN2) with effective depth of their generation ~20 cm that is equal to the seasonal thermal skin layer of the Martian soil. The measured fast neutrons flux (with energy 2.5-10 Mev) has been normalized to the flux from the Solis Plunum area (most dry place with water content 2 mass. %). Converting of the normalized fast neutrons flux into the water equivalent content (in mass %) was performed using the MCNPX Monte Carlo code [1]. In numerical simulations we used homogeneous model with only one unknown parameter (water content), taking into account a soil composition of major soil forming elements (derived from Mars Pathfinder and MER data) and an atmosphere thickness as a function of place and the Martian season (taken from Ames General Circulation Model). Measured normalized flux has been compared with model predictions calculated as a function of water content (see details in [2]. Best correspondence between data and simulations gave us best estimation of water content (as the hydrogen water equivalent) within the surficial soil layer in 15-20 cm.

2.1. Results

The multiyear's water equivalent content distributions as function of the latitude (for the winter and the summer seasons) are illustrated on the Fig.1 in the form of the scatter plots. Comparison between the winter and the summer spatial distribution of the derived water equivalent content shows noticeable differences. The differences are seen especially well on the middle and high latitude. As one can see from the Fig.1, the observing

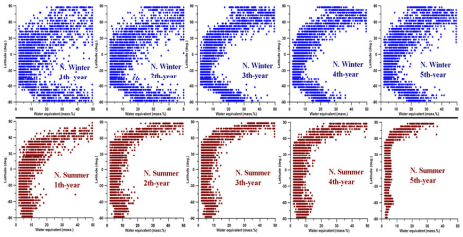

Figure 1: Scattering plots of the water equivalent content versus the latitude during the N-winter (upper row) and N-summer (low row) seasons for the five Martian years of the HEND's observations.

seasonal spatial distribution of the water equivalent content characterized by distinct asymmetry between both hemisphere of Mars. Reforming of the multiyear's HEND observations of the fast neutron fluxes in the water equivalent content values (in mass. %) has been converted separately for the summer season (Ls=150°-170°), two winter's sections (Ls=300°-320°, Ls=340°-360°) and several spring's sections (Ls=0°-20°, Ls=20°-40°, Ls=40°-60°) in the Northern hemisphere of the planet. Zonally averaged meridional profiles of the water equivalent content for the seasons are shown on the

Fig.2. As it well seen from the plots, the

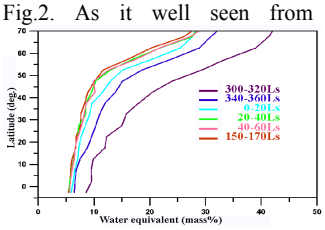

Figure 2: Zonally averaged meridional profiles of the water equivalent content in the surficial soil layer for the different seasons in the Northern hemisphere of Mars.

values of the water equivalent content decrease gradually from the winter to the spring's end and approach finally it's the summer-time values. Mapping results of the summer and the winter water equivalent content distribution (Fig.3) separately for each of three years of the HEND observations demonstrate a sufficiently similar trend. However, analysis of the zonally averaged meridional profiles of the water equivalent content in the different

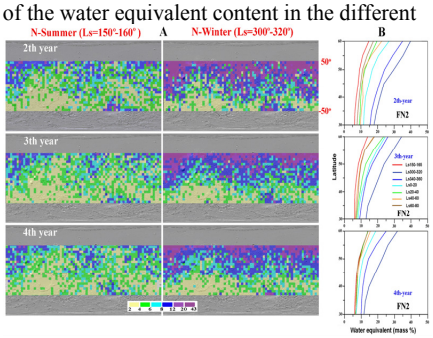

Figure 3: The maps of the HEND water equivalent content in the surficial soil layer for the summer and the winter seasons in each of three years of the HEND observations (A) and derived from the maps zonally averaged meridional profiles (B) of the water equivalent content for different seasons in the Northern hemisphere of Mars.

seasons for each year of the HEND's observations (Fig.3b) shows distinct difference between the winter- and summer-time water equivalent amounts on the latitudes 30º-40ºN. The difference approaches the values from 6-7 mass% in 4th year to 7-10 mass% in the 3rd year and to 12-15 mass% in 2nd year. At that, the intensity of the water equivalent content decrease during the period from the Ls=360º to Ls=60º is also varies differently from one to other years of the observations. Comparison between the summer-time and the winter-time meridional profiles of the water equivalent content for each year of the HEND's observations are presented on the Fig.4. It is notably that the summer-time profiles of the water equivalent content for each of three years are very similar, while the winter-time profiles show very noticeable differences. As one can see, the water equivalent content difference between the winter-time profiles varies from 5 to 12 mass. %. At that, the difference of the water equivalent content between the winter and the summer has been changed from one to other year of the observations (Fig.4c). The most changes of the water equivalent content related with 2-th year. It approached 12-15

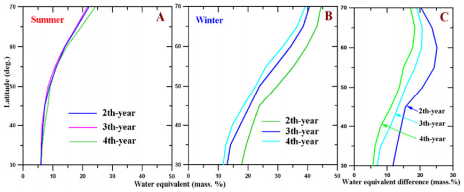

Figure 4: Zonally averaged meridional profiles of the water equivalent content in the Martian surficial soil derived from different years of the HEND's observations in the summer (A) and the winter (B) seasons. C – Difference values between the winter and the summer water equivalent content.

and 20-25 mass. % in the latitude ranges 30º-40ºN and 50º-60ºN respectively.

3. Summary

The distinctive inter-years and the seasonal variations of the water equivalent content in the surficial layer of the Martian soil (up to ~20 cm) has been found based on conducted analysis of the multiyear's observations fulfilled by the HEND neutrons detector . More results will show during the presentation.

Acknowledgements

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References

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[2] Mitrofanov et al., (2004), *Sol. Sys. Res., 38, 4, 253-257.*