Chang'E-2 Microwave Radiometer Data in the Lunar Polar Region. F. Yang[1] and Y. Xu[1], K. L. Chan[1] , X. P. Zhang[1] , G. P. Hu[1] [1]State Key Laboratory of Lunar and Planetary Sciences, Macau University of Science and Technology, Macau (yixu@must.edu.mo)

Introduction: Lunar orbiters Chang'E-1 (CE-1) and Chang'E-2 (CE-2) were launched in 2007 and 2010, respectively. Both carried Microwave radiometer (MRM), which conducted passive microwave remote sensing measurements to obtain the TB of the lunar surface at 3, 7.8, 19.35, and 37GHz [1]. The first microwave map of the complete Moon was made by the CE-1 MRM data[2]. In polar region, CE-1 TB map shows some cold patches, where local temperature minima are independent of day and night due to absence of direct illumination in PSRs [3]. The CE-2 MRM data have been used to investigate the properties of lunar surface such as regolith thickness, dielectric constant, and titanium abundance within a depth of several meters in middle and low latitudes. The purpose of this work is to take a close look at MRM data in the polar regions of the Moon and analyze the characteristics of the brightness temperature (TB) in permanently shadowed regions (PSRs), especially where evidence of water ice has been found.

Data: CE-2 observation covered the entire Moon by seven times and the local time coverage of the CE-2 data was over a complete lunation. The total effective time of MRM data is 279818 min for 2401 tracks. The spatial resolutions of CE-2 MRM are 25 km and 17.5 km for 3 GHz and three remaining channels, respectively. The absolute temperature accuracy is less than 0.5 K over the temperature range 100–350 K. Themicrowave TB range is set as 30K-400K TB and points outside this range are considered as anomalous and excluded from this study.

Results:

TB in Low Latitude and High Latitude. We extract the TB data of channel 1 (3 GHz) and channel 4 (37 GHz) in the latitude zones 20∘ N/S and 85∘ N/S to analyze the changes of TB data during the whole observation mission.The width of the zones was ± 0.1∘ in latitude.The observation date varies from Oct. 15, 2010, to May 20, 2011. We analyze the TB in the daytime (6:00-18:00) and nighttime (0:00-6:00; 18:00-24:00) in the latitude zones 20∘ N/S.

we could observe in Fig.1(a)(b), in low latitude, the changes of TB of channel 4 and channel 1 that are dominated by diurnal variation with lunar local time, although the diurnal variation of channel 1 is smaller than that of channel 4. Because channel 1 signal originates in deeper subsurface layer than channel 4, it is less sensitive to the sunlight and more stable during the lunation period. The effects of topography and physical properties of regolith also cause the vibrations of TB at the same local time, but they are masked by the effects of solar incidence. To extract the physical characteristics of lunar regolith or topography effects, the diurnal variation should be removed, e.g.,with spherical harmonics fitting as proposed in [3].

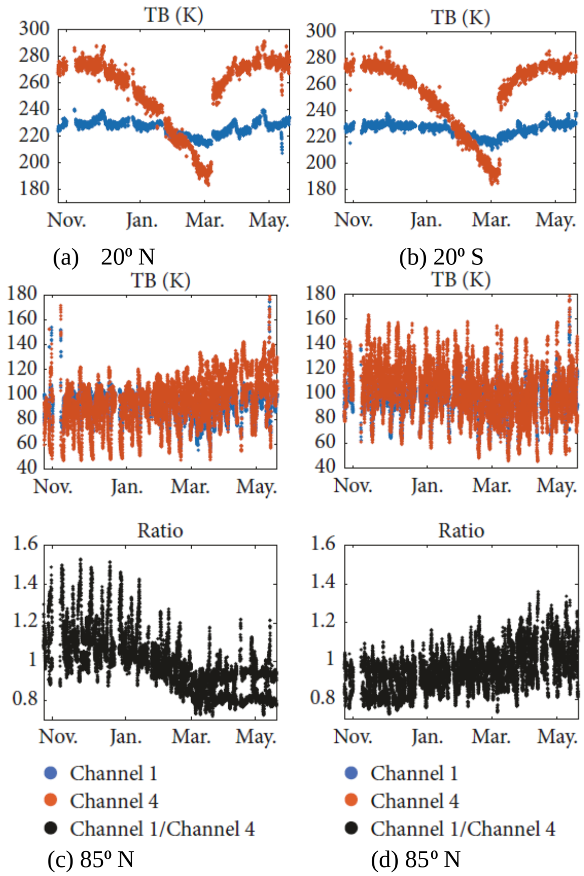

Figure 1 The data shown in (a)–(d) is selected in the latitude zones 20º N/S and 85º N/S, respectively.

The upper part in Figures 1(c)(d) shows the TB variations at latitudes 85º N and 85º S, and the under part shows the TB Ration (TBR) variations between channel 1 and channel 4. Compared to low latitude area, the daytime and nighttime TB data in 85º N/S are less distinguished. In addition, TB and TBR variations in 85º N and 85º S show opposite trends, especially the TBR. The TB increases slowly with the date in the north and decreases slowly in the south as shown in Figures 1(c) and (d). The reason for the difference can be explained by the seasonal variations. The relative change ofmonthly maximum lunar solar flux is larger at high latitude comparing with that in low latitude. This leads to the significant seasonal variations in high latitude and diurnal variation is more recognizable in low latitude. The seasonal variations of TB in high latitude are recognizable because the seasonal changes of solar flux become comparable to the day and night variations in high latitude, while diurnal variation of solar flux dominates in low latitude regions.

TB in PSR with Plausible Ice Evidence. Even TB values are lower than 100 K in all the observation regions, and TBR of those with plausible water ice could reach some high value such as 1.35, while the TBR varies from about 0.95 to 1.1 in Idel son L Crater, a PSR crater without the plausible ice evidence. The TBR reflects the TB differences between channel 1 and channel 4. Microwave signals in channel 1 and channel 4 originate from several meters and several centimeters depth of the lunar regolith, respectively.We could observe that high TBR resulted by relatively stable channel 1 TB and low channel 4 TB, which is easily affected by direct or indirect solar illumination and decreases with largely reduced solar flux in PSRs.

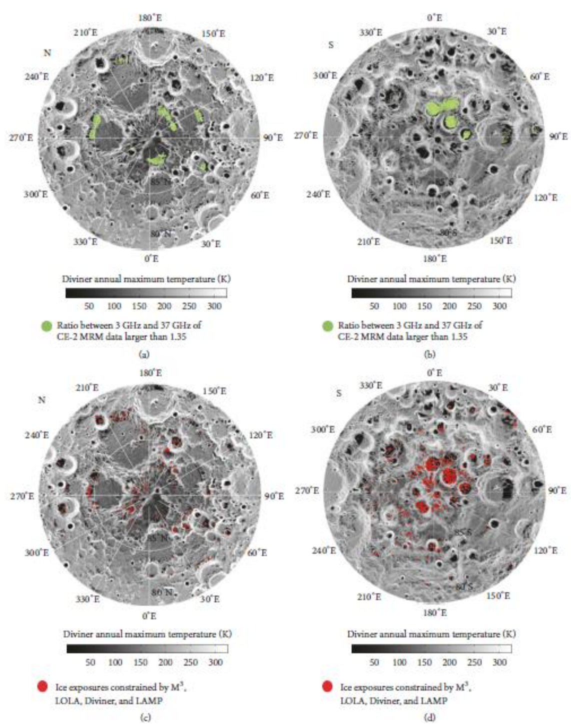

Figure 2 Distribution of the ratio scattering points where it is no less than 1.35 overlain on the Diviner annual maximum temperature for the northern (a) and southern (b) polar regions; ((c) and (d)) Distribution of the water-ice-bearing pixels constrained by M^3, LOLA, and Diviner overlain on the Diviner annual maximum temperature for the northern (c) and southern (d) polar regions[4].

Based on statistic results, high maximum TBR (⩾1.35) always appears in the places where TB of channel 4 is lower than 100 K, which also indicates low physical temperature. However, only 1.37% locations with low TB of channel 4 (< 100 K) can reach high maximum TBR.

Figure 2 shows high MRM ratio value distribution maps, comparing with result using M^3 data[4]. The result using CE-2 MRM data has a good consistence with other instruments data to some extent.

To obtain the quantity value of the correlation between the water ice distribution retrieved from M^3 data and distribution of TBR where it is no less than 1.35 in polar regions (80º N/S-90º N/S), we calculate the proportion of the summation over area with the M^3 data in the regions of interest for south pole and north pole, respectively.

The CE-2 (TBR⩾1.35) and M^3 data in the study area are collected in 15×15 km^2 bins. The boundaries of the disks in Figures 2 are within the 80º latitude circle. The conditional correlation is defined as $C = NM3 \cap CE{-}2/NCE{-}2$, $NCE{-}2$ which denotes the summation of the bins where TBR is no less than 1.35, and $NM3 \cap CE{-}2$ denotes the summation of the bins where TBR is no less than 1.35; M3 data with water ice proof exists. The results are 0.74 and 0.56 in south and north poles, respectively. Amundsen crater is considered as place with water ice since evidence was provided by LP neutron spectrometer[5] and LAMP[6], but M3 data indicates that no water ice exists here. If we consider the Amundsen crater as the case with water ice, the results are 0.89 and 0.56 in south pole and north pole, respectively.

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