SYMMETRIC ACCUMULATION OF THE SEASONNAL SOUTH POLAR CAP OF MARS. F. Schmidt[1,2], and S. Douté[1], B. Schmitt[1], M. Vincendon[3], Y. Langevin[3], J.-P. Bibring[3] and the OMEGA Team, [1]Laboratoire de Planétologie de Grenoble, Université de Grenoble, CNRS, INSU, BP 53, 38041 Grenoble Cedex 9, France, (fschmidt@obs.ujf-grenoble.fr), [2]At present time at ESA-ESAC, Villafranca, Spain, [3]Institut d'Astrophysique Spatiale, Université Paris XI, Bâtiment 121, 91405 Orsay cedex, France.

Introduction: About half of the Martian atmosphere, which is mainly composed of CO_2, is trapped during the winter at the surface near the pole in the form of CO_2 frost. During the spring, the CO_2 is heated up and sublimates. This major martian climatic cycle has been revealed be the pioneer work of Leighton and Murray [1]. Contrary to the North polar cap, the South polar region is asymmetric around the geographic pole as observed in the visible range [2], thermal infrared range or by OMEGA in the near infrared range [3,4]. One particular region, called the cryptic region [5] sublimates faster than the surrounding, herein called anti-cryptic region.

This recession asymmetry can be due to an asymmetry in accumulation, or in the sublimation flux. The CO_2 net accumulation has been estimated using various methods at large scale using the gamma ray spectrometry by GRS [6] and the neutron spectrometry by HEND [7]. Other studies using MOLA data shows no clear evidence of symmetric accumulation [8]. There is a lake of observational evidences about the SSPC accumulation at the scale of the cryptic region. In addition, both observations by TES [9], by PFS [10] and GCM calculations [9] show that there is an asymmetry in snowfall, most probably due to topographic forcing.

During the recession phase, the sublimation flux is mainly controlled by albedo of the ice layer [3]. Albedo of the cryptic region is lower than the one on the anti-cryptic region [5] leading to a relative faster sublimation in the cryptic region. We will discuss here if this albedo difference is at the origin of the recession asymmetry or if the accumulation is asymmetric too.

Method: We propose to compare the CO_2 accumulated mass measured by GRS/HEND during the polar night, to the sublimated CO_2 mass estimated by our model, using parameters (such as albedo and crocus line) provided by OMEGA. This comparison is done for two sectors: the so-called cryptic sectors (60°E-260°E) and anti-cryptic sector (100°W-60°E).

OMEGA Observations. The SSPC has been observed by OMEGA between 2004-2006. See [3] for more details about the dataset, the detection method and first results. We use both NIR channels C and L (1-5 microns). We use here the Wavanglet method: an automatic spectral identification algorithm based on a wavelet transform [11]. For this study, we use 4 spectral endmembers: 3 endmembers used in the latter reference (synthetic CO_2 ice, synthetic H_2O ice and observed dust) and one observed OMEGA spectrum of water ice clouds. The algorithm produces a detection mask for each endmember and for each observation included in the dataset of interest. We will focus here on CO_2 ice only. Data are analyzed per 0.3° and 10° bins respectively by in latitude and in longitude. Along one latitude profile corresponding to a given central longitude, we extract the crocus line evolution from those detection masks.

Calculating the instantaneous or integrated CO_2 ice mass budget requires the monitoring of its bolometric albedo, under the aerosols layer. We propose to estimate bolometric albedo in a two steps process: (i) estimation of the reflectance at 1.07 microns in the continuum using Vincendon's approach to remove the contribution of aerosols [12]. At these wavelength, aerosols significantly modify the apparent surface albedo, notably bright icy surfaces appear darker. This method uses the light coming only from the aerosols diffusion in the spectral region where the ice is perfectly dark (ii) estimation of the spectrally integrated albedo using empirical law. We calculate the bolometric albedo using OMEGA visible and near IR channels and estimate relationship between reflectance and bolometric albedo. This parameter increase with time for both cryptic and anti-cryptic sector, see figures 1 and 2. To avoid effects of the lake of data, we use an empirical function of this increase for both sectors.

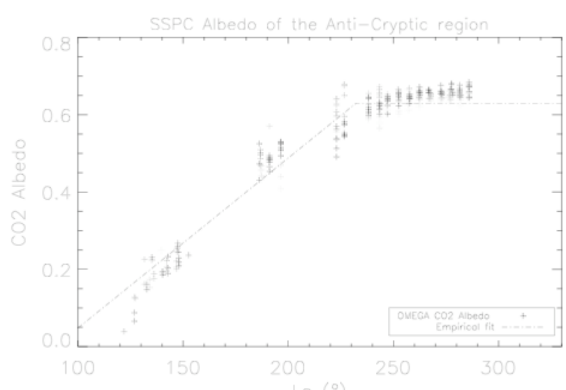

Fig 1: Albedo increase versus time in the cryptic sector (60°E-260°E).

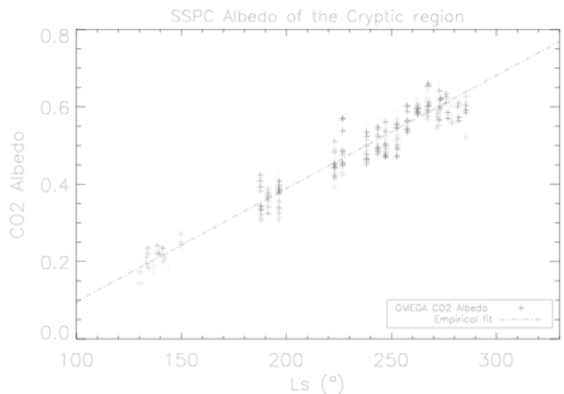

Fig 2: Albedo increase versus time in the anti-cryptic sector (100°W-60°E).

Modeling of the sublimation flux. The CO_2 mass balance is related to the radiative balance at the surface [13]. We use here a model based on the parameterization of the "instantaneous" insolation [3] and compute the daily averaged sublimation mass. The date of the beginning of the sublimation is a free parameter; the OMEGA crocus line fixes the date of the end of the sublimation. We suppose that the effect of slope is negligible [3]. Atmospheric parameterization is the same than previously used [14]. We use both empirical laws of bolometric albedo versus time, as described previously.

Results and conclusion: Figure 3 shows the total sublimated mass expected using our model and the OMEGA dataset (CO2 ice albedo and crocus lines). Regarding this study for both sectors, the main conclusion is that the SSPC accumulation is symmetric. At 85°S, the total sublimated mass expected is higher for the anti-cryptic region, where the snow events are more likely. In comparison, the CO2 mass measured by GRS/HEND are plotted in the same graph. The expected masses are always within the errors bars of the GRS measurements, for both cryptic and anti-cryptic regions. The second main conclusion is about the good agreement between (i) the total mass measured by GRS/HEND during the polar night and (ii) the model using the OMEGA dataset. This study validates the use of an energy balance approach to estimate the sublimation mass. This means that all energy that is absorbed at the surface is converted to CO2 sublimation latent heat. For the cryptic region, two main scenarii are proposed to explain the unusually low albedo: a transparent slab of CO_2 ice [15] or an ice layer covered by a thin layer of dust [16]. Whatever the right scenario, dust, that mainly absorbed the energy, must be in thermal contact with CO2 ice, as previously showed by TES [5].

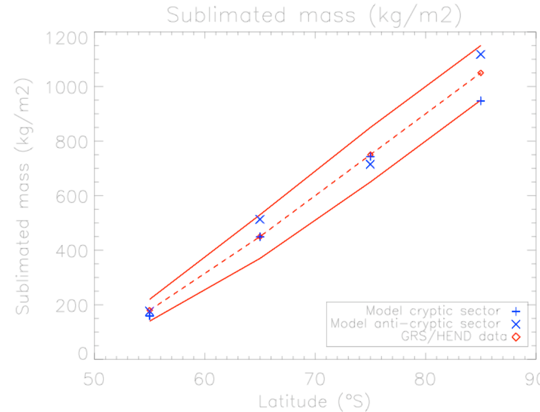

Fig 3: Sublimated mass estimated from the model using OMEGA albedo and crocus lines for both cryptic and anti-cryptic sectors, compared to the GRS/HEND measurements [6,7]. Lines represent the errors bars of this measurement.

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