MARTIAN GLOBAL-SCALE SEASONAL CO_2 CHANGE: COMPARISON OF GEODETIC OBSERVATIONS AND NUMERICAL SIMULATIONS. Ö. Karatekin, V. Dehant, O. de Viron, Royal Observatory of Belgium, 3 Avenue Circulaire, 1180 Brussels Belgium. (o.karatekin@oma.be).

Introduction: The Martian atmosphere exhibits an annual cycle in the CO_2 concentration; as much as 30% of the atmosphere takes part in seasonal exchange of mass between the atmosphere and the seasonal polar caps. The signature of this global-scale annual cycle can be found in the variation of gravitational field. This information can be used to estimate the global-scale seasonal mass and atmospheric pressure variations. With recent Mars Global Surveyor mission, global scale $C0_2$ change in polar caps has been estimated by several authors [1], [2], [3]. Although similar geodetic data are used, the results vary due to the differences in the approximations made. In the present study, these approaches are discussed and the polar mass changes are estimated. The results are compared with the values given by two Martian Global Circulation Models (GCM) as well as observations.

Geodetic observations and Seasonal CO_2 Changes: At seasonal time scales, the distribution of mass at the planet's surface varies because of atmospheric circulation and condensation/sublimation of polar caps. Time variation of zonal coefficients of gravity field can be estimated from Mars Global Surveyor (MGS) mission [3], [4]. In the present study, seasonal variations of the gravity field (expressed in dimensionless zonal harmonics of degrees 2 and 3, namely, $\Delta J_2(t)$ and $\Delta J_3(t)$ calculated from the MGS, pathfinder and Viking Lander data according to [3]), are employed.

Any variation in mass distribution gives rise to a change in the gravity field. From geodetic measurements, the variation of gravity field coefficients can be estimated. Changes in zonal harmonics are directly linked to the variations in surface mass density distribution ($\Delta\sigma$) [5] by:

$$\Delta J_\ell(t) = -\frac{R^2}{M}\int \Delta\sigma(\Omega, t)\, P_\ell(\mu)\, d\Omega$$

In the equation above, R ands M correspond to the mean radius and mass of the planet, P is the Legendre's polynomial of degree ℓ, μ is the sine of latitude, and Ω is the solid angle representing the colatitude and the latitude.

On the other hand, the mass change on each polar cap can be obtained form $\Delta\sigma$, by using the geometry of polar cap and its mass distribution.

Results: Seasonal polar mass changes and surface pressure variations are estimated. The outputs of GCM of Laboratoire de Météorologie Dynamique (LMD) [6] and NASA Ames [7] are used as a comparison with the present results.

Polar Cap Mass Change Estimation: In figures 1 and 2, estimated seasonal CO_2 mass changes are plotted together with the outputs of GCMs. These preliminary results show fairly good agreement in general, despite the high uncertainties in geodetic measurements and the assumptions made on the geometry of polar caps [1]. The most important discrepancy occurs on the North Pole, during the summer season (90°<Ls<180°). Moreover, the CO_2 on the North Pole from GCMs starts to accumulate later with respect to the results derived from geodetic observations.

Surface Pressure Estimations: From the estimated total mass change in polar caps, global scale atmospheric pressure variation can be calculated. In figure 3, estimated mean surface pressure variation by the present method is compared with the GCM results of LMD. In agreement with the previous results, the comparison is fairly good, except for the northern summer season.

Conclusions: Seasonal mass change between the polar caps can be estimated by geodetic measurements. The preliminary results are in fairly good agreement. According to these results, the most important discrepancy occurs on the northern summer season. These discrepancies will be discussed in the paper.

References: [1] Karatekin O., Duron J., Rosenblatt P., Dehant, V. (2003), *EGS* Abstract#06709. [2] Smith D. and Zuber M. (2003) *EGS* Abstract#07285. [3] Yoder C. F., Konopliv A. S., Yuan D. N., Standish E. M., Folkner W. M., (2003) *Science,* 300, 299-303. [4] Smith D., Zuber M., Neumann A., (2001) *Science*, 294, 2141-2146. [5] Chao B. F. and Rubincam D. P. (1990) *JGR*, 95, B9,14755-14760. [6] Forget F. Hourdin F., Fournier R., Hourdin C., Talagrand O., Collins M., Lewis S., Read P., Huot J.-P. (1999) *JGR*, 104, E10, 24155-24176. [7] Smith D., Zuber M., Haberle R. M., Rowlands D., Murphy J. (1999). JGR, 104, E1, pp. 1885-1896.

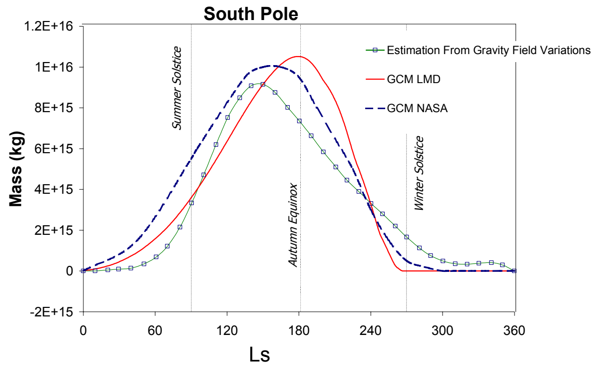

Figure 1. Seasonal mass change in south polar cap.

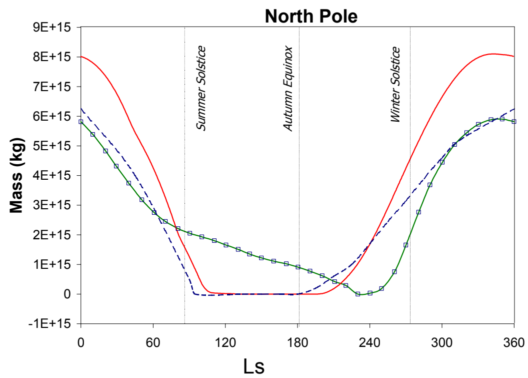

Figure 2. Seasonal mass change in north polar cap (Legend is given in Figure 1).

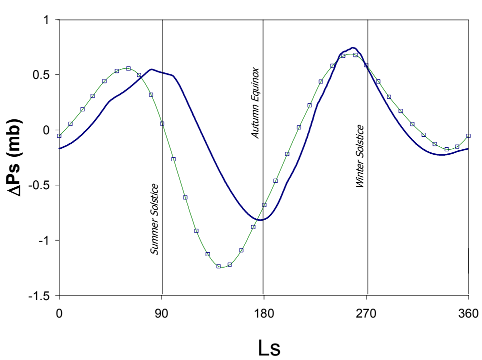

Figure 3. Mean surface pressure variation (Legend is given in Figure 1).

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