INVESTIGATING MARS' SOUTH RESIDUAL CO_2 CAP WITH A GLOBAL CLIMATE MODEL. M. A. Kahre (melinda.a.kahre@nasa.gov)[1], J. Dequaire[2], J. L. Hollingsworth[1], and R. M. Haberle[1], [1]NASA Ames Research Center, Moffett Field, CA, U. S. A., [2]University of Oxford, Oxford, U. K.

Introduction: The CO_2 cycle is one of the three controlling climate cycles on Mars. One aspect of the CO_2 cycle that is not yet fully understood is the existence of a residual CO_2 ice cap that is offset from the south pole. Previous investigations suggest that the atmosphere may control the placement of the south residual cap (e.g., Colaprete et al., 2005 [1]). These investigations show that topographically forced stationary eddies in the south during southern hemisphere winter produce colder atmospheric temperatures and increased CO_2 snowfall over the hemisphere where the residual cap resides. Since precipitated CO_2 ice produces higher surface albedos than directly deposited CO_2 ice, it is plausible that CO_2 snowfall resulting from the zonally asymmetric atmospheric circulation produces surface ice albedos high enough to maintain a residual cap only in one hemisphere. The goal of the current work is to further evaluate Colaprete et al.'s hypothesis by investigating model-predicted seasonally varying snowfall patterns in the southern polar region and the atmospheric circulation components that control them.

Methods: We use a version of the NASA Ames Mars Global Climate Model (GCM) that includes a sophisticated CO_2 cloud microphysical scheme. Processes of cloud nucleation, growth, sedimentation, and radiative effects are accounted for. Our approach is to modify the microphysical routines that have previously been developed and tested for water ice clouds to make them appropriate for the prediction of CO_2 ice clouds [2,3,4,5,6].

Results: Our simulated results are consistent with the Colaprete et al. investigation. Figures 1 and 2 show the GCM-predicted annual mean column CO_2 cloud visible opacities and CO_2 snowfall rates over the south pole. A zonal asymmetry in the annual mean cloud pattern is present, with increased cloudiness in the western hemisphere (in the Argyre corridor). The snowfall pattern is also asymmetric and consistent with the cloud pattern.

The CO_2 cloud and snowfall patterns in the south polar region are controlled by the topographically forced atmospheric circulation. Figure 3 shows the stationary eddy thermal pattern in the southern hemisphere during winter. The cold (warm) stationary thermal anomalies are hydrostatically consistent with intense cyclonic (anticyclonic) geopotential height anomales (not shown). The stationary wave pattern is dominated by the s=1 mode. The cold thermal anomaly in the western hemisphere produced by the stationary circulation is generally consistent with the enhanced cloudiness in the Argyre longitudinal corridor. It is notable, however, that the peak of the cold anomaly resides to the west of the longitudinal corridor of enhanced cloudiness.

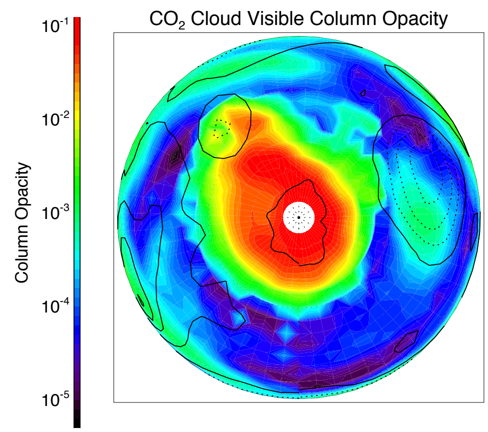

Figure 1: Annual mean column-integrated CO_2 cloud visible opacities over the south pole.

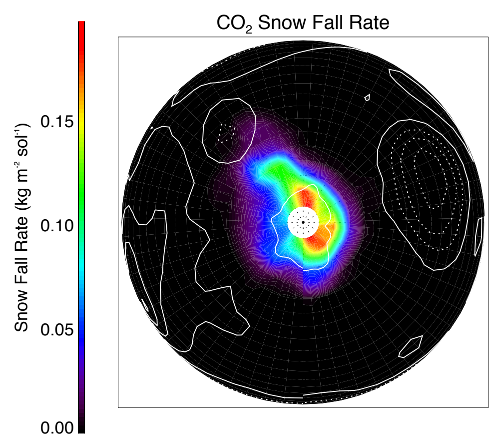

Figure 2: Annual mean CO_2 snow fall rates over the south pole.

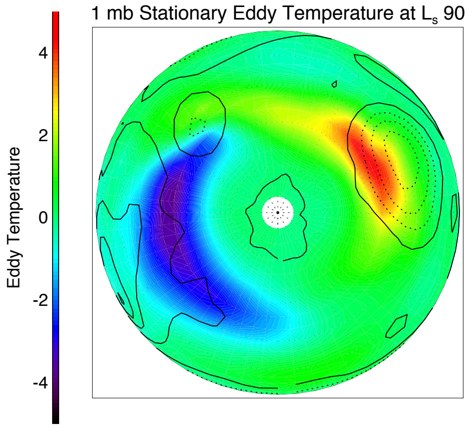

Figure 3: Stationary eddy temperatures at the 1-mb pressure level over the south pole at L_s 90°.

Summary and Future Work: Our simulated results thus far agree well with the Colaprete et al. study—the zonally asymmetric nature of the atmospheric circulation produces enhanced snowfall over the residual cap hemisphere throughout much of the winter season. However, the predicted snowfall patterns vary significantly with season throughout the cap growth and recession phases. We will present a detailed analysis of the seasonal evolution of the predicted atmospheric circulation and snowfall patterns to more fully evaluate the hypothesis that the atmosphere controls the placement of the south residual cap.

References: [1] Colaprete, A. et al. (2005) *Nature, 435,* 184–188. [2] Montmessin, F. et al. (2002) *JGR, 107*. [3] Montmessin, F. et al. (2004) *JGR, 109*. [4] Maattanen, A. et al. (2005) *JGR, 110*. [5] Colaprete, A. et al. (2008) *P&SS, 56,* 150–180. [6] Listowski, C. et al. (2013) *JGR, 118*.