INTERANNUAL ATMOSPHERIC VARIABILITY SIMULATED BY A MARS GCM: IMPACTS ON THE POLAR REGIONS. Alison F.C. Bridger[1], R. M. Haberle[2] and J. L. Hollingsworth[3]: [1]Department of Meteorology, San Jose State University, San Jose CA 95192-0104, USA (bridger@met.sjsu.edu); [2,3]NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035-1000, USA (robert.m.haberle@nasa.gov, jeffh@humbabe.arc.nasa.gov).

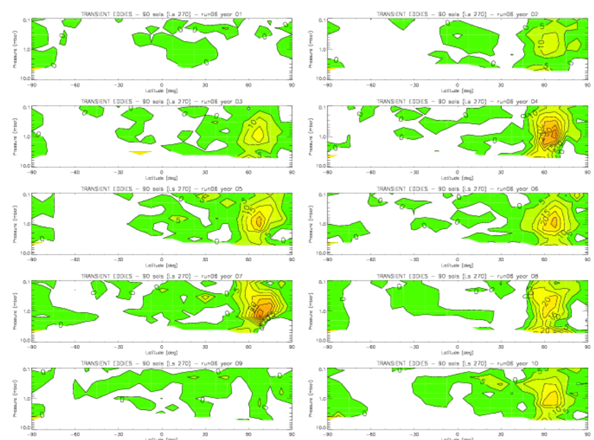
Abstract: It is often assumed that in the absence of year-to-year dust variations, Mars' weather and climate are very repeatable, at least on decadal scales. Recent multi-annual simulations of a Mars GCM reveal however that significant interannual variations may occur with constant dust conditions [1]. In particular, interannual variability (IAV) appears to be associated with the spectrum of atmospheric disturbances that arise due to baroclinic instability. One quantity that shows significant IAV is the poleward heat flux associated with these waves. These variations – and their impacts on the polar heat balance – will be examined here.

Background: The dust loading of the martian atmosphere can vary significantly from location-to-location, from sol-to-sol, and from year-to-year. The surface dust reservoir varies too. However, were the surface and atmospheric dust distributions to remain fixed from one year to the next, it seems likely that the resulting atmospheric circulation at a give season would be repeatable from year-to-year. This follows from the absence of oceans on Mars.

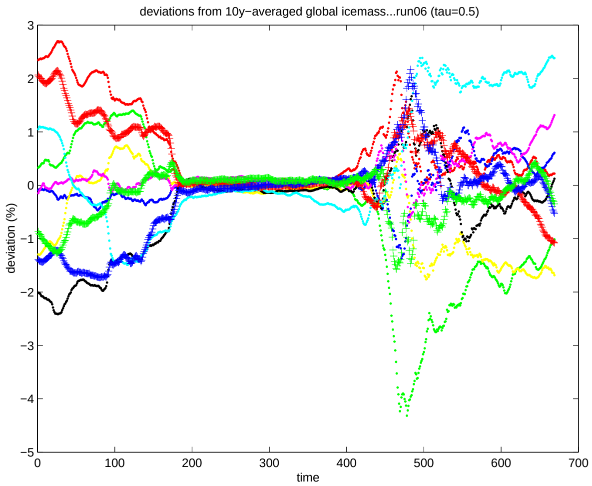
We have recently conducted several multi-annual simulations with the NASA-Ames Mars General Circulation Model (MGCM; [2]). These extend for 10 years beyond a spin-up year (some 40 year simulations have also been performed). Some simulations have fixed dust all year (e.g., with a visible opacity of 0.5), while others have opacities varying through the year (e.g., following Viking observations). In these cases, the dust loading and distribution at a given *Ls* is the same during every year of the simulation. In a new series of simulations, we randomly specify the annual dust variation to fall between a low dust scenario (e.g., 0.3) and a high dust scenario (e.g., Viking)..

Results: In the first set of simulations (opacity fixed at 0.5 for all time), there is significant IAV in a number of parameters. For example, sol-averaged surface pressures at higher latitude sites (e.g., the Viking Lander 2 site) show variations of several tenths of a millibar from the 10-year average during the midwinter season [1]. This is an O(10%) variation from the long-time mean. Likewise, sol-averaged surface temperatures can be as much as 10-20 K above/below the 10-year average at these same sites. Such IAV is typical in the northern winter season at higher northern latitudes; it is far weaker in the corresponding southern winter season.

The region of high IAV is coincident with the location (in space and season) of baroclininc wave activity, suggesting a connection between the baroclinic wave activity and IAV. We have computed the poleward-directed heat flux $\left(\overline{v'T'}\right)$ associated with these eddies (on Earth, this is a substantial fraction of the total poleward atmospheric heat flux). Figure 1 shows the resulting distributions of $\overline{v'T'}$ computed over a 90 sol period centered on Ls 270 for each of the 10 years in the fixed opacity 0.5 simulation (the north pole is to the right on each plot, and the contour interval is 5 Km/s, with larger values shaded). Clearly, there are significant year-to-year variations in heat transport into the winter polar regions; the eddy heat flux in some years is virtually zero (e.g., years 01 and 08), whereas in other years values are O(30-40 Km/s). By comparison, poleward-directed heat fluxes associated with topographically-forced stationary waves have magnitudes O(10 Km/s) and show much less year-to-year variation [1].



In the light of these variations in eddy heat fluxes into to winter polar region, we examine impacts on the polar heat budget. For example, the total accumulated ice mass in the northern polar region, computed as a function of *Ls*, deviates from the 10 year-average by up to ±O(3%) (Figure 2; each color represents a different year, and time is plotted a sol number, where sol 0 is *Ls* 0).



In this talk, we will expand upon the consequences of IAV for the polar region, with attention focussed on those quantities that might be detectable in long-term observations.

References: [1] Bridger,A.F.C., J. L. Hollingsworth, R.M.Haberle and S.R. Rafkin (2003), Granada workshop. [2] Haberle, R.M. *et al* (1999), JGR, 104, p. 8957.