Mars' South Polar Halos and Triton's Aureoles: Sublimation-Driven Models of Formation P. Becerra and S. Byrne, Lunar and Planetary Laboratory, University of Arizona. becerra@lpl.arizona.edu

We introduce two similar models for the formation of small scale (50 m) CO_2 frost halos on the South Polar Residual Cap (SPRC) of Mars, and for large (20 km) bright Aureoles around Triton's Zoned Maculae on the southern hemisphere (fig. 1).

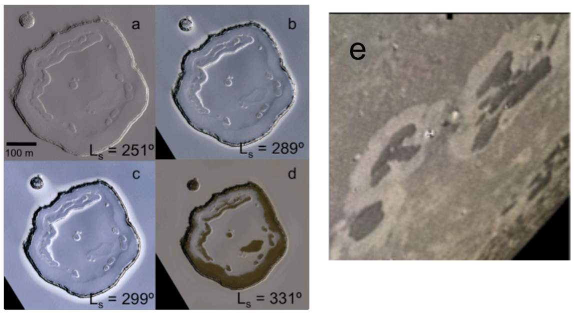

Fig. 1. a,b,c,d) halos on the martian SPRC. e) aureoles on zoned maculae on Triton.

Both Mars and Triton have a so-called "Vapor Pressure" atmosphere, in which the main constituent of the atmosphere exists both as a vapor in the atmosphere and a condensate (i.e. "ice") on the surface [1]. Our models for the features mentioned above track the distribution of surface ice (CO_2 on Mars and N_2 on Triton) throughout the year, by calculating the sublimation/condensation rate of frost in an energy balance equation [2]:

$$L\frac{dm}{dt} = S_0 \cos(i)(1 - A) - \varepsilon\sigma T^4$$

The first term on the right side represents insolation; the second term represents the energy radiated by the surface (L=Latent heat of sublimation of CO_2, S_0=solar constant, A=geometric albedo, i=incidence angle, e=emissivity, s=Stefan Boltzmann constant, T=surface temperature). The models solve this equation for the sublimation rate on three adjacent surfaces on their respective planets (and with the corresponding scales: ~1m^2 on Mars and 100m^2 on Triton). A schematic of the models is shown in figure 2.

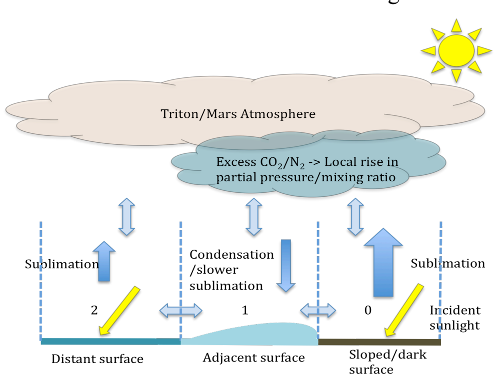

Fig. 2. Schematic of our 1-D thermal model with multi-surface diffusion. The model surfaces/cells are labeled as follows: 0 – slope(Mars)/dark(Triton), 1 – adjacent, 2 – distant.

On Mars, we know from HiRISE and CTX data that these halos show up near the walls of scarps and pits on the SPRC, and that they are seasonal features, appearing only between Ls 280-310. Our theory is that there is condensation, or slower sublimation of CO_2 ice occurring in areas close to the walls of the scarps (cell 1 in fig. 2). This effect is caused by a rise in the partial pressure of CO_2 gas in the local atmosphere, due to a faster sublimation rate from the sloped walls (cell 0) that receive sunlight at lower incidence angles (eq. 1). The enhancement is diminished far from the walls (cell 2), by the diffusion and dilution of the excess CO_2 into the surrounding atmosphere.

On Triton, zoned maculae and their bright aureoles were observed by Voyager 2. They are believed to be made up of volatile materials [3]. There are two geologic units that make up the maculae: Guttae (cell 0 in fig. 2), which are dark (a ~ 0.7) patches at the center of the maculae, and aureoles (cell 1), which are bright (a ~ 0.9) annular features surrounding the guttae. The material that surrounds and coexists with the maculae is called Bright Smooth Terrain (cell 2, a ~ 0.85). The basic premise of the Triton model is that a surface with a lower albedo will have a higher N_2 sublimation rate than a brighter surface when sunlight is striking both surfaces equally (eq 1). Thus, there will be a local rise in the partial pressure of N_2 in the area immediately above the dark patch. This local disturbance will diffuse radially outward, and increase the partial pressure in the areas immediately surrounding the dark patch. As a result, the condensation temperature will be higher in these surrounding areas, allowing for either re-condensation of frost on these surfaces, or a slower sublimation rate.

In both cases, a thicker layer of frost exposing younger ice should be present on surfaces adjacent to the "source" surface (cell 0), where a higher sublimation rate occurs. We present preliminary model results that show that a difference in frost accumulation can in fact be the result of a slope on Mars and of a preexisting darker surface on Triton (fig. 3). This may mean that older ice is being exposed on surfaces that are distant from cell 0. Since older ice is coarser-grained and therefore darker than fresh frost, an albedo difference should emerge between surfaces adjacent to the source and ones distant from it.

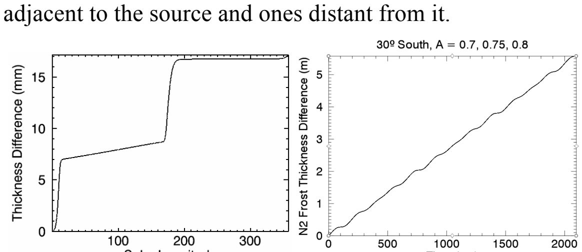

Fig. 3. Preliminary results. Frost accumulation difference between surfaces 1 and 2. Left: Mars. Right: Triton

Our future work will consist of constructing a reflectance model that can be coupled to our thermal model, in order to know just how much frost accumulation difference is required to produce the observed albedo differences.

References: [1] Yelle, et. al. in Cruikshank (1995), *University of Arizona Press*. [2] Hansen and Paige, (1992) *Icarus* 99, 273-288. [3] Croft, et al. in Cruikshank (1995) *University of Arizona Press.*