

RAPID DELIQUESCENT AND EFFLORESCENCE OF SALTS ON THE GARWOOD ICE CLIFF, ANTARCTICA: INSIGHTS INTO ATMOSPHERICALLY-CONTROLLED ALBEDO CHANGE AND GROUNDWATER FORMATION AND IMPLICATIONS FOR MARTIAN RSL. J. S. Levy¹, A. N. Deutsch², J. W. Head³, J. L. Dickson⁴, and, ¹Colgate University Dept. of Geology (jlevy@colgate.edu), ²NASA Ames Research Center (adeutsch@usra.edu), ³Brown University, ⁴Caltech

Introduction: Changes in albedo on seasonal to diurnal timescales are observed in many dynamical planetary landforms, notably including recurring slope lineae (RSL) on Mars [1]. A range of hypotheses have been proposed to account for these cyclic albedo changes including seasonal groundwater flow [1-3], dry avalanching [4], and salt deliquescence/expansion [5-6]. Here, we report on rapid (~5 seconds) albedo changes resulting from deliquescence of surficial soil salts in Garwood Valley, McMurdo Dry Valleys, Antarctica. These albedo changes occur much more quickly than lab-measured deliquescence reactions (~hours) [7]. The albedo changes are cyclic (days to hours), but also show seasonal trends. We describe how time-lapse imaging and surface meteorological (met) measurements can be used to constrain phase changes of the surficial soil salts, and we consider how these observations would be different for sensors that could only image the site in the late afternoon (e.g., HiRISE) [8].

Results: We analyze time-lapse images of the Garwood Ice Cliff for changes in surface albedo for 3 local summer field seasons between 2014 and 2016. Image acquisition times are correlated to met station relative humidity (RH) data, after correcting it to boundary condition soil RH, allowing diurnal cycles to be resolved clearly (Fig. 1). Salt patch deliquescence (D) and efflorescence (E) show a clear hysteresis: the salt patch darkens (D or both D&E) on the rising phase of RH, stays wetted through the peak, and then turns bright (E) on the drying phase, typically several RH % further down the peak. The surface stays dry through

minimum daily RH and then darkens again during the rising RH period. It is notable that wetted surfaces are completely absent by afternoon, but that they persist extensively through night. Deliquesced (wet) conditions dominate above soil RH = 60%, providing constraints on salt type and/or salt mixtures present at the site.

This work highlights the importance of high temporal-cadence observations in interpreting dynamic planetary landforms like RSL. Orbital observations of this site locked in an afternoon orbit would not detect albedo change driven by brine formation.

References: [1] McEwen, A.S., et al. (2011) *Sci.* 333, 740–743. [2] Huber, C., et al. (2020) *Icarus* 335, 113385. [3] Stillman, D.E., et al. (2014) *Icarus* 233, 328–341. [4] Dundas, C.M. et al. (2017) *Nat. Geo.* 10, 903–907. [5] Wang, A., et al. (2019) *Icarus* 333, 464–480. [6] Bishop, J.L., et al. (2021) *Sci. Adv.* 7, eabe4459 [7] Gough, R. et al. (2017) *EPSL* 476, 189–198. [8] McEwen, A.S. et al. (2010) *Icarus* 205, 2–37.

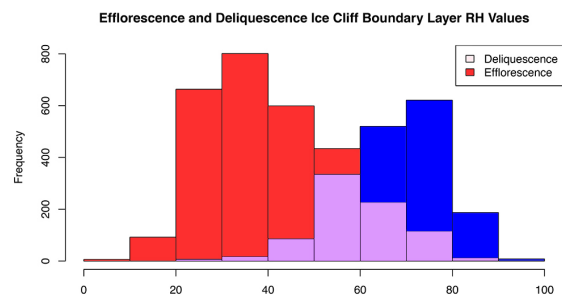


Fig. 2. Frequency of deliquescence (wet) and efflorescence (dry) events in RH space.

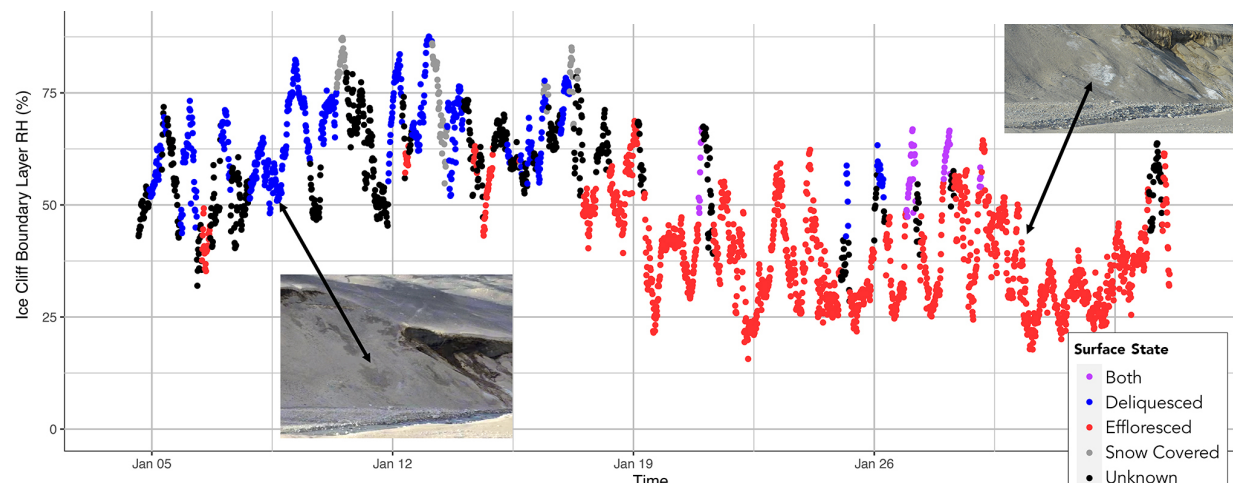


Fig. 1. Boundary layer relative humidity during January 2015. Color shows salt patch surface state. Note diurnal and seasonal trends.