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The Observed Winter Circulation at Insight's Landing Site and its Impact on Understanding the Year-Round Circulation and Aeolian Activity in Elysium Planitia and Gale Crater.

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InSight landed < 550km from the Mars Science Laboratory rover. Both missions carried a suite of meteorological instruments, but MSL's wind sensor was damaged on landing and failed after ∼two Mars years [1]. This made it difficult to characterize the diurnal and seasonal cycles of winds in Gale Crater. Fortunately, InSight's wind sensor is returning good wind data for the landing season (Ls∼300°, northern winter). A complementary presentation provides a detailed look at the observed diurnal cycle of InSight winds and its variability [2].

Here, we use atmospheric models, primarily the MarsWRF multi-scale model, run at ∼km to 5km scale resolution over the MSL/InSight region, to provide predictions based on our current understanding of the underlying physics. We then improve the models by modifying them to better match the circulation at InSight in northern winter, and use these results to better understand the circulation in Gale Crater. Finally, we extend our simulations over a full Mars year to provide insight into the orientation, morphology, and migration of aeolian features in the vicinity of InSight and MSL.

In this region, the large-scale circulation is largely controlled by the seasonal Hadley circulation, with near-surface winds blowing from ∼south to north in northern summer and ∼north to south in winter. Both landing sites also sit on or close to the hemispheric dichotomy boundary, resulting in daytime upslope flows (from ∼north to south) and nighttime downslope flows (from ∼south to north); these tend to enhance the Hadley circulation during the daytime in northern winter and at night in summer.

For InSight's location, most models predict winds from between the ∼north and west virtually all sol in northern winter [e.g. 3], although there is more model-to-model variation in wind speed. In Gale Crater, however, the situation is complicated by the presence of very large topographic gradients. For example, models suggest that in northern winter the ∼north-to-south Hadley circulation winds are enhanced at night by strong downslope winds on the northern rim slopes, resulting in very strong winds at MSL's location [e.g. 4].

Our goal is to develop a model of the seasonal cycle of winds over the entire region which simultaneously matches the InSight and partial MSL wind datasets and the observed aeolian features. Unfortunately, while evidence points toward most aeolian activity near MSL occurring in northern winter at night [5], MSL's wind sensor was unable to measure nighttime winds well [1]. By measuring regional winds over the full diurnal cycle in northern winter, InSight wind data allow us to (i) directly measure the winds approaching Gale Crater from the ∼north, (ii) constrain and improve MarsWRF and other models, and hence (iii) better understand the true nature of the winds and aeolian processes in Gale Crater and over the entire region.

[1] Newman, C. E. et al. (2017) Icarus, 291, 203–231. [2] Viúdez-Moreiras, D. et al. (2019) EGU. [3] Spiga et al. (2018) SSR, 214:109. [4] Pla-Garcia, J. et al. (2016), Icarus, 280, 103-113. [5] Viúdez-Moreiras, D. et al. (2019), Icarus, 319, 909-925.