# Sand dune migration and sand flux on Mars measured from HiRISE


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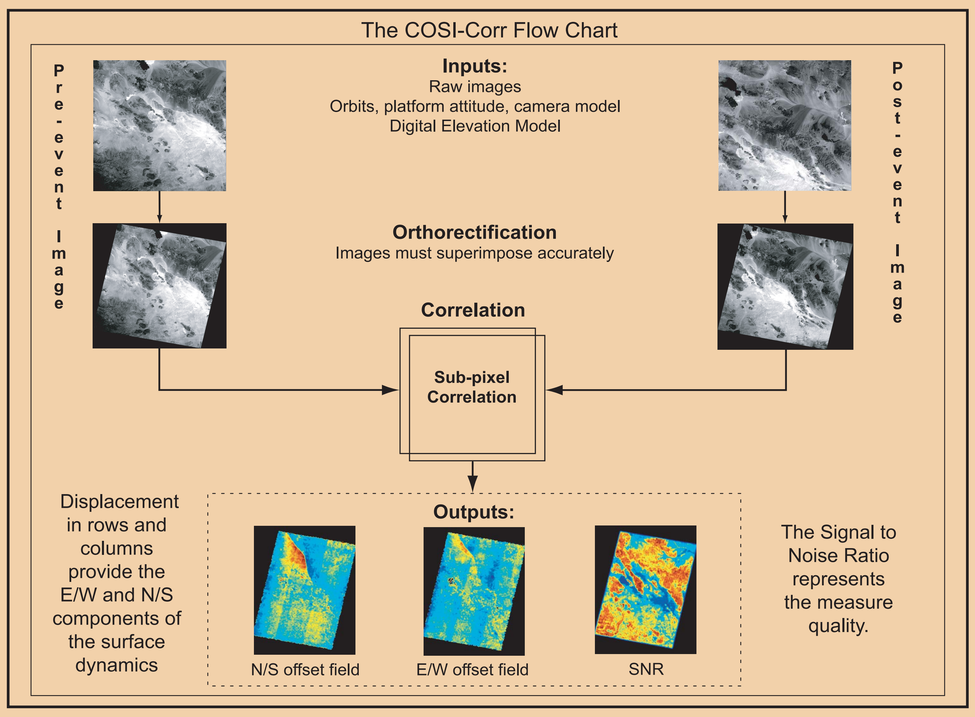
ABSTRACT: Strong and sustained winds on Mars have been considered rare based on surface meteorology measurements and global circulation models such that the presence of abundant dunes and evidence of wind erosion have been a long standing mystery. Recent studies, have demonstrated sand activity but could not determine whether entire dunes are moving, thereby implying large sand fluxes, or whether more localized and surficial changes have occurred. Here, we measure the migration rate of sand ripples on Nili Patera martian dunes and show that the dunes are near steady state, with their entire volumes composed of mobile sand. The dunes have unexpectedly high sand fluxes similar those in Victoria Valley, Antarctica, implying that rates of landscape modification on Mars can be similar to that on Earth.


Co-Registration of Optically Sensed Images and Correlation (COSI-Corr), allows for precise orthorectification, coregistration, and correlation of optical images. The software package is available at: http://www.tectonics.caltech.edu/slip_history/spot_coseis.



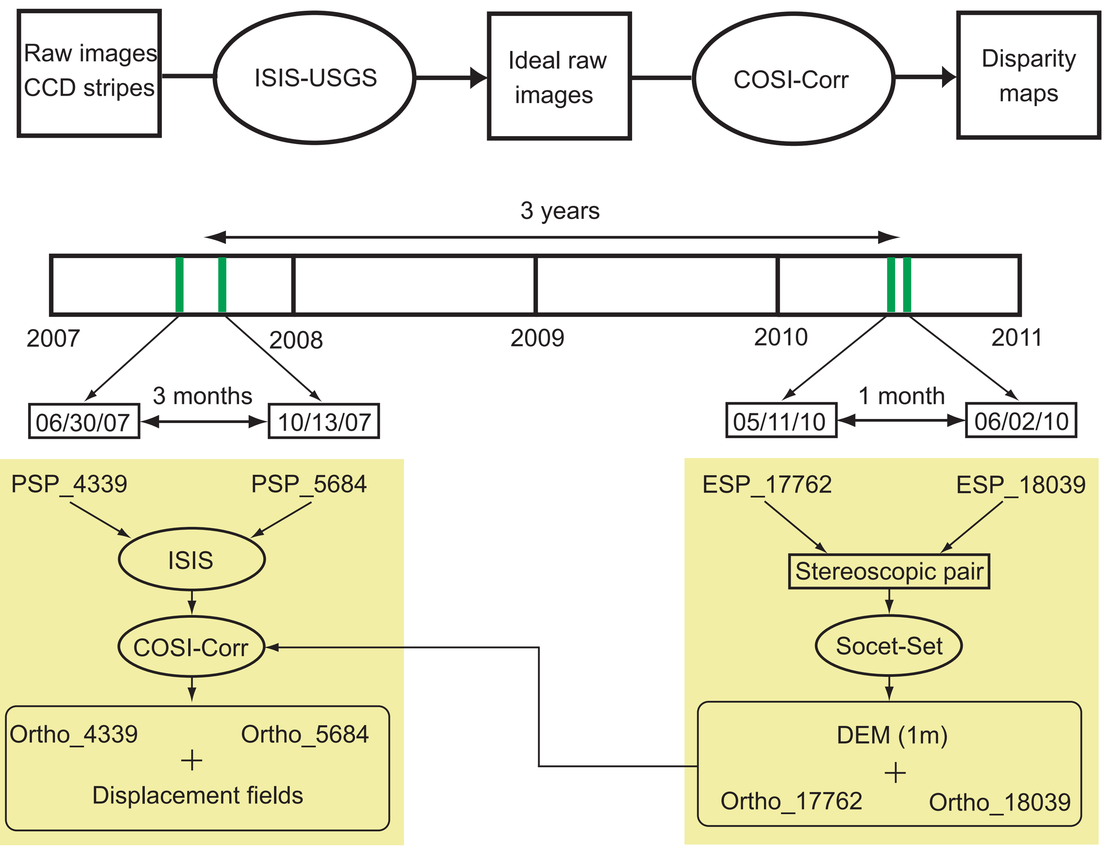







Figure 1: HiRISE image 4339 showing the Nili Patera dune field study area where images 4339 and 5684 overlap. Upper inset shows the location of this area (red box) with respect to the entire dune field. Lower inset is a close-up of one of the dunes, showing the rippled surface.

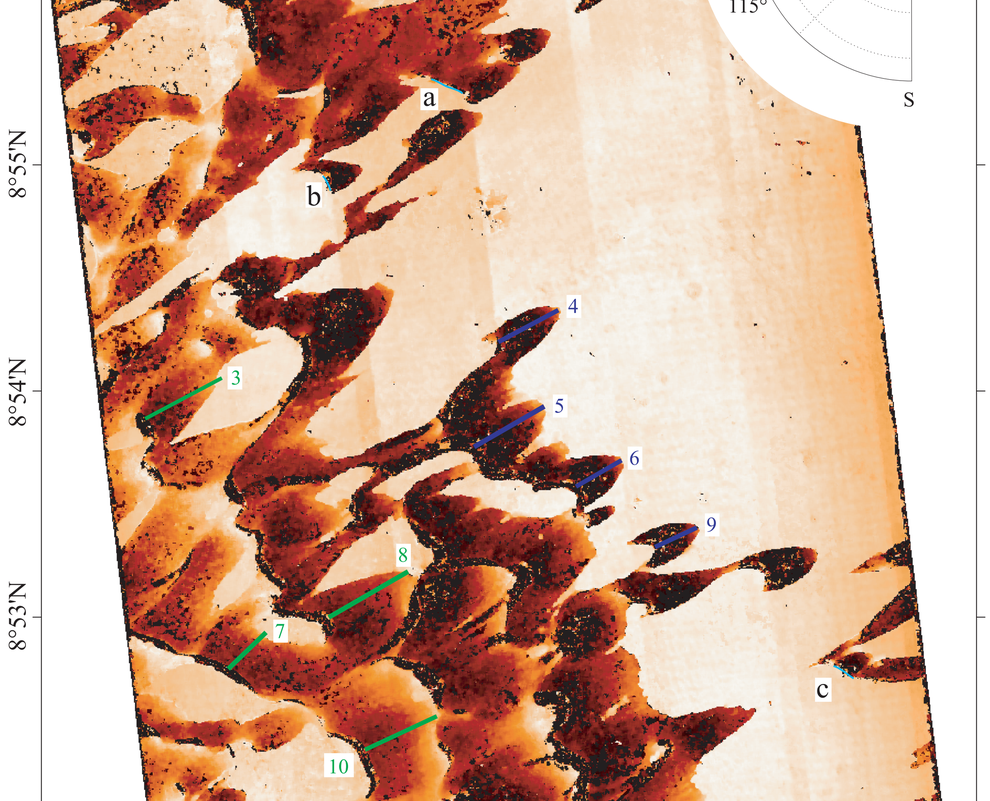



Figure 2: Ripple displacements in the Nili Patera dune field derived from correlating HiRISE images 4339 and 5684. Green and dark blue numbered lines show where profiles of ripple displacement were retrieved. Light blue lines with letters show where dune lee front displacements were measured between images 4339 and 17762. Inset shows a rose diagram of the ripple migration azimuth distribution.

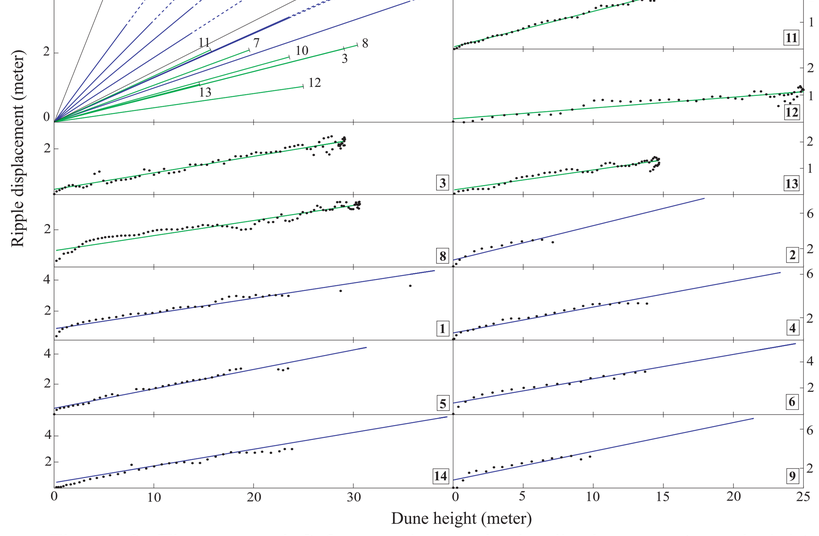



Figure 3: The upper left frame shows ripple displacement vs. height for profiles on upwind (blue) and downwind (green) dunes ("upwind" refers to dunes in the northeast part of the field that are unsheltered from prevailing northeasterly winds, whereas "downwind" dunes are in the southwest part of the field and are partially sheltered by the dunes to the northeast). Solid lines are fits to the points. Dashed lines are extrapolations out to the dune crest for cases where displacements could not be correlated above a certain amount of displacement. Black lines are isopleths of dune migration rates, with labels in units of meters per Earth year. The location of the profiles is shown in Fig. 2. The individual profiles and measured ripple displacements are shown in the other frames.

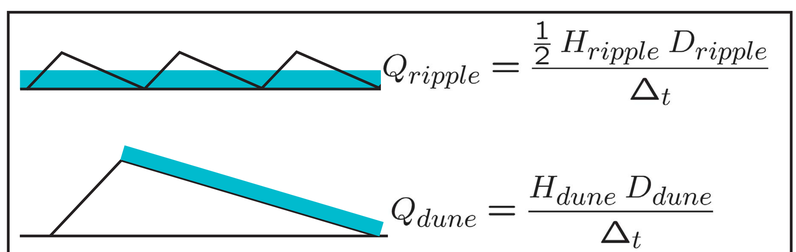



Figure 4

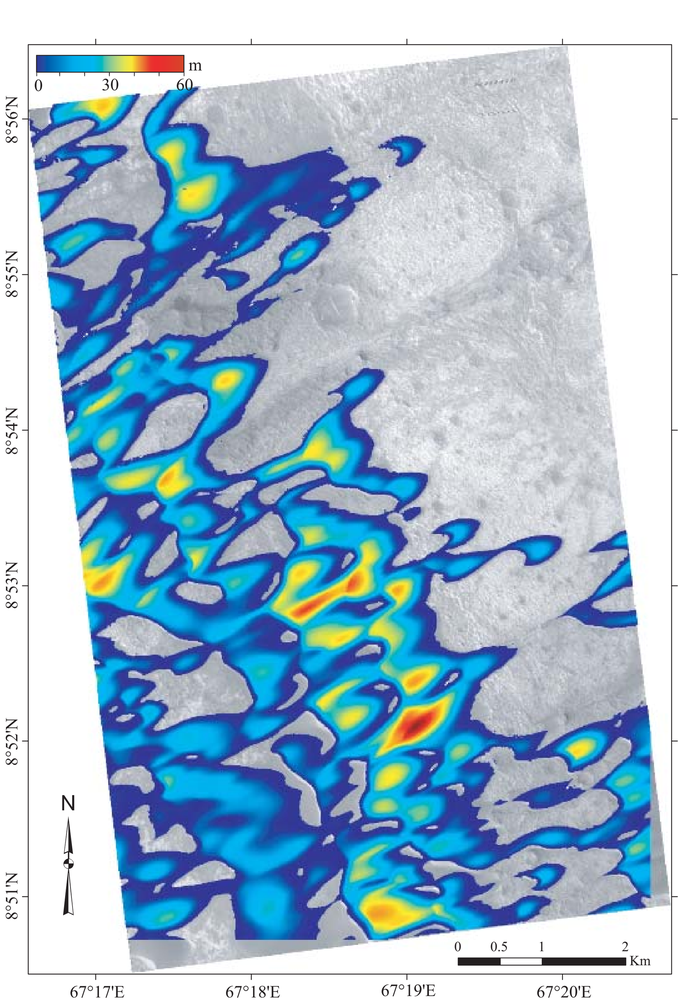



Figure 6: Dune elevation relative to bedrock base. Elevation and height maps are based on stereo images 17762 and 18039.

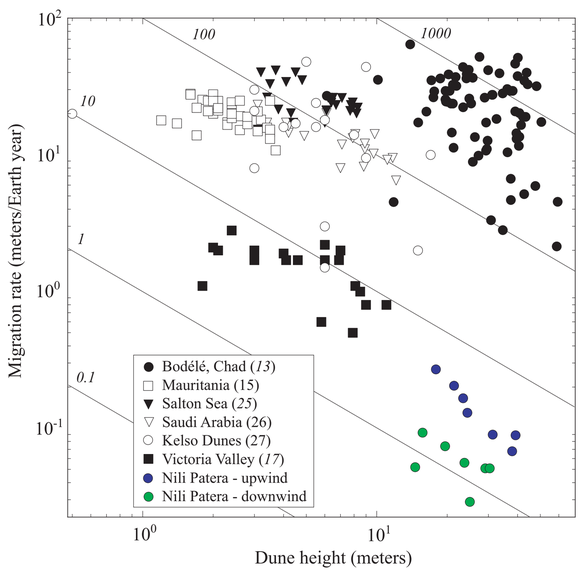



Figure 7: Dune migration rates are plotted as a function of dune height for a number of sites on Earth and the 14 dunes selected in Fig. 2. Diagonal lines are isopleths of sand flux, with values in units of m3/m-/earth year.

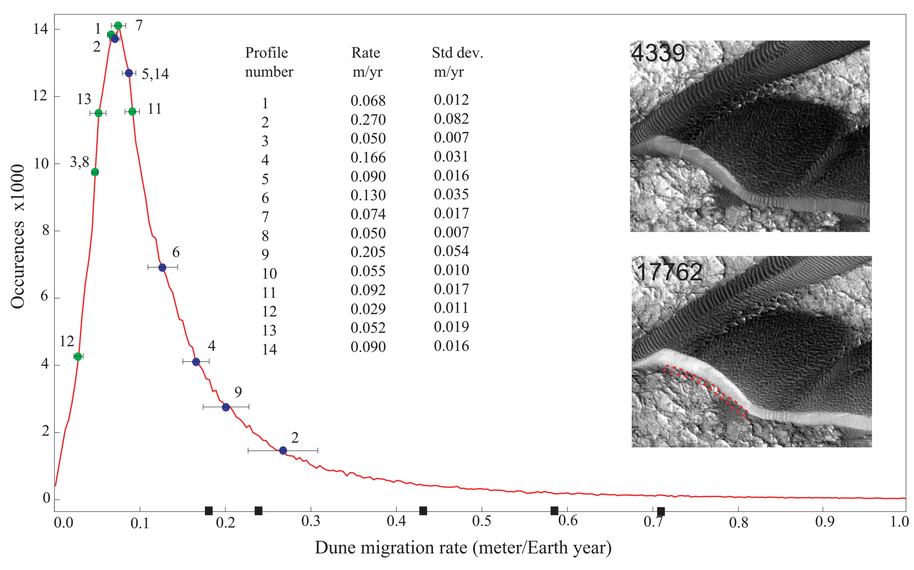



Figure 5: Histogram of dune migration rates, obtained from equations Fig. 4, for all pixels above 0.5 m elevation over the (4339-5684) 105 day time interval. Blue and green circles are rates for individual upwind and downwind dunes, based on profiles displayed in Fig. 2. Horizontal bars are standard deviations from the profile fits. Black boxes are rates derived from lee front advance over the (4339-17762) 941 day interval (inset). The location of these lee fronts is shown in Fig. 2.