Active Surface Processes on Mars

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Summary:

The ESA ExoMars Trace Gas Orbiter (TGO) and NASA InSight missions are both focused on detecting and monitoring active surface processes on Mars. Although these missions have different overall goals, they both demonstrate that understanding the present is key to understanding the past. This study will use sub-pixel image correlation to identify and quantify a range of active surface processes on Mars that not only complement the above missions, but also help inform future missions and studies of habitability on Mars. The student will participate in the ExoMars TGO mission through two supervisors recently being appointed Guest Investigators.

Description:

For the first time we now have the data and methods sufficient to identify and monitor active surface processes on Mars. Since the arrival of Mars Reconnaissance Orbiter (MRO) in 2005, near global coverage of unprecedented resolution has been achieved. With the advent of sub-metre resolution at Mars, even small-scale surface changes can be identified and large areas examined using methods that were previously only possible in studies of active surface processes on Earth.

Using a method of automatic and precise orthorectification, co-registration, and sub-pixel correlation of orbital images, the software package “Co-registration of Optically Sensed Images and Correlation" (COSI-Corr) can detect surface displacements of between ~1/20 to 1/50 of a pixel [*Leprince et al., 2007*] and has been validated for use with different feature types, including terrestrial glaciers [*Herman et al., 2011*] and earthquakes [*Hollingsworth et al., 2012*], as well as dune and ripple migration on Earth [*Vermeesch and Leprince, 2012*]. One recent study demonstrated the first application of the COSI-Corr method to quantify ripple migration rates on Mars [*Bridges et al., 2012*].

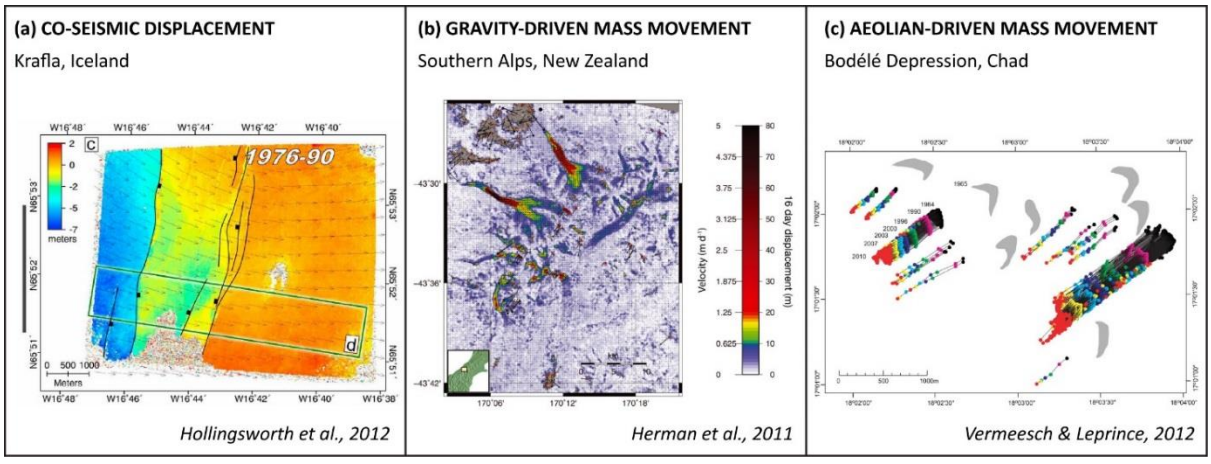

Figure 1. *Examples of the successful application of sub-pixel correlation and change detection with COSI-Corr to quantify active surface processes on Earth identical to those for study in this proposal. (a) Epipolar displacement field for the central section of the Krafla fissure swarm with a 14 year time gap [Hollingsworth et al., 2012]. (b) Velocity of mountain glaciers in the Southern Alps, New Zealand, over a 16 day period [Herman et al., 2011]. (c) Individually tracked image pixels of sand dunes in the central Bodélé Depression, Chad, over a 26 year time period [Vermeesch and Leprince, 2012].*

This project will apply this method to features on Mars from a range of different image sensors, including MOC, HRSC, CTX and HiRISE. The distribution and activity of these processes will each provide different insights into the atmospheric and climatic processes in the present-day, and ultimately throughout Mars' history.

The objectives of this project are to understand the martian atmosphere and climate through active surface processes, specifically: (1) use active dune and ripple migration to quantify wind velocities and sand fluxes in order to determine their seasonal dependence and geographic distribution; (2) use active dust devil activity to determine their velocity, seasonal dependence, diurnal activity and geographic distribution in order to estimate their dust-lifting capacity; and (3) study glacial features to identify active ice-related processes at high- and mid-latitudes in order to understand the processes operating and their climate-driven control.

Research Environment:

The student will be based in the Department of Earth and Planetary Sciences at Birkbeck, University of London, and part of the Centre for Planetary Sciences at UCL/Birkbeck (CPS). The CPS is a cross-disciplinary research group made up from four different departments and over 50 members of academic and research staff. The CPS offers a strong, vibrant and supportive group focusing on cross-disciplinary research themes, and is actively involved in current and future missions. The student will be located in the UCL Regional Planetary Image Facility (RPIF), the only NASA facility of its kind in the UK, which provides remote sensing techniques essential to the project.

References:

Bridges, N.T et al. (2012), Earth-like sand fluxes on Mars, *Nature*, 485, 339-342.

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Hollingsworth, J., et al. (2012), Deformation during the 1975–1984 Krafla rifting crisis, NE Iceland, measured from historical optical imagery, *J. Geophys. Res.*, 117, B11407.

Leprince, S., et al. (2007), Automatic and Precise Orthorectification, Coregistration, and Subpixel Correlation of Satellite Images, Application to Ground Deformation Measurements. *Geosci. Remote Sens. IEEE Transactions*, 45, 1529-1558.

Vermeesch, P., S. Leprince (2012), A 45-year time series of dune mobility indicating constant windiness over the central Sahara, *Geophys Res. Lett.*, 39, L14401.