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GeoComplexity and scale: surface processes and remote sensing of geosystems. GeoComplexity and scale: surface processes and remote sensing of geosystems

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Understanding the role of scaling in different planetary surface processes within our Solar System is one of the fundamental goals of planetary and solid earth scientific research. There has been a revolution in planetary surface observations over the past decade for the Earth, Mars and the Moon, especially in 3D imaging of surface shape (from the planetary scale down to resolutions of 75cm). I will examine three areas that I have been active in over the last 25 years giving examples of newly processed global datasets ripe for scaling analysis: topography, BRDF/albedo and imaging.

For understanding scaling in terrestrial land surface topography we now have global 30m digital elevation models (DEMs) from different types of sensors (InSAR and stereo-optical) along with laser altimeter data to provide global reference models (to better than 1m in cross-over areas) and airborne laser altimeter data over small areas at resolutions better than 1m and height accuracies better than 10-15cm. We also have an increasing number of sub-surface observations from long wavelength SAR in arid regions, which will allow us to look at the true surface rather than the one buried by sand. We also still have a major limitation of these DEMs in that they represent an unknown observable surface with C-band InSAR DEMs representing being somewhere near the top of the canopy and X-band InSAR and stereo near the top of the canopy but only P-band representing the true understorey surface.

I will present some of the recent highlights of topography on Mars including 3D modelling of surface shape from the ESA Mars Express HRSC (High Resolution Stereo Camera), see [1], [2] at 30-100m grid-spacing; and then co-registered to HRSC using a resolution cascade of 20m DTMs from NASA MRO stereo-CTX and 0.75m digital terrain models (as there is no land cover on Mars) DTMs from MRO stereo-HiRISE [3]. Comparable DTMs now exist for the Moon from 100m up to 1m.

I will show examples of these DEM/DTM datasets along with some simple analyses of their scaling properties.

Global 1km, 8-daily terrestrial land surface BRDF/albedo maps exist for US sensors from MODIS and by orbit from MISR. More recently, the ESA GlobAlbedo project [4] has produced land surface datasets on the same spatio-temporal sampling using optimal estimation with full uncertainty matrices associated with each and every 1km pixel. By exploiting these uncertainty estimates I show how upscaling can be performed as well as analysing their scaling properties.

Recently, a very novel technique for the super-resolution restoration (SRR) of stacks of images has been developed at UCL [5]. First examples shown will be of the entire MER-A Spirit rover traverse taking a stack of 25cm HiRISE to generate a corridor of SRR images along the rover traverse of 5cm imagery of unresolved features such as rocks, created as a consequence of meteoritic bombardment, ridge and valley features. This SRR technique will allow us for $\approx$400 areas on Mars (where 5 or more HiRISE images have been captured) and similar numbers on the Moon to resolve sub-pixel features. Examples will be shown of how these SRR images can be employed to assist with the better understanding of surface geomorphology.

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