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UAV lidar: from volcanoes to forests

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Improvements in miniaturization and affordability of lidar technology, mainly due to innovation in self-driving cars, means that UAV lidar is now an accessible option for geoscience research. We present applications in which UAV lidar contributes to data collection in ways that would otherwise not be possible in the time frame, budget, and/or with the resolution required.

Volcanoes: Lava flow surface texture can provide information on lava flow dynamics and emplacement. The transition between pahoehoe and a'a flow textures can indicate changes in flow rates and flow thickness, and the morphology of ripples in ropey pahoehoe flows can indicate flow direction. Hell's Half Acre, Idaho, USA, is a basaltic lava flow that was erupted ~5000 y.a. Analysis of UAV lidar data at this lava field shows lava flow surface texture in sufficient resolution to define cm-scale pahoehoe ripples. In addition, larger scale lava features such as channels and inflation/deflation ridges can be mapped which allows us to understand the dynamics of the lava flow emplacement.

Vegetation: UAV Lidar can be useful for analysis of vegetation canopy, both in stripping canopy (lidar last return) and in using it for tree height (lidar first return). By combining UAV lidar with other airborne data, e.g. multispectral imaging, we can identify and map tree species at Ft de Soto Park, in Florida, USA.

Permafrost: Permafrost thermokarst features can develop rapidly and climate change will cause an increase in these rapid thaw events. With UAV lidar we can strip the vegetation to reveal the underlying ground surface which can then be used to assess and model permafrost processes. UAV surveys are quick and relatively inexpensive (as compared to crewed aviation) and data can be collected in response to a thaw event. We present data from Alaska, USA, at known sites of rapid thermokarst thaw.

UAV lidar, both as a stand-alone dataset, and when integrated with other data streams e.g. multispectral and visible imagery, can provide high-resolution data (both spatial and temporal) on a platform that is relatively low-cost and logistically straightforward to deploy.