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Scene Setting for the ESA HydroGNSS GNSS-Reflectometry Scout Mission

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HydroGNSS is a mission concept selected by ESA as a Scout candidate, and consists of a 40 kg satellite that addresses land hydrological parameters using the technique of GNSS Reflectometry, a form of bistatic L-Band radar using satnav signals as the radar source. The four targeted essential climate variables (ECVs) are of established importance to our understanding of the climate evolution and human interaction, and comprise of soil moisture, inundation / wetlands, freeze /thaw (notably over permafrost) and above ground biomass.

The technique of GNSS Reflectometry shows potential over all geophysical surfaces for low cost measurement of ocean winds, ocean roughness, soil moisture, flood & ice mapping, and other climate and operational parameters. SSTL developed and flew the SGR-ReSI GNSS remote sensing instrument on the 160 kg UK TechDemoSat-1 (TDS-1) in July 2014 and, with sponsorship from ESA, collected data until TDS-1's drag-sail was deployed in May 2019. TDS-1 was a precursor for NASA's CYGNSS mission which uses the SGR-ReSI on its 8-microsatellite constellation for sensing hurricanes. The datasets from TDS-1 have been released via the MERRByS website, and include ocean wind speed measurements and ice extent maps from National Oceanography Centre's C-BRE inversion. At the same time, researchers recognised the benefits of GNSS reflectometry over land, including the unique capability to sense rivers under forest canopies to a high resolution.

HydroGNSS has been proposed for the ESA Scout mission opportunity by a SSTL and a team of partners with a broad range of experience in GNSS technology, GNSS-Reflectometry modelling and applications, and Earth Observation from GNSS-R measurements. The instrument takes significant steps forward from previous GNSS-R experiments by including capability in dual polarisation, dual frequency and coherent reflected signal reception, that are expected to help separate out ECVs and improve measurement resolution. The satellite platform is the 40 kg SSTL-Micro, which has improved attitude determination and a high data link to support the collection of copious

quantities scientific data with a short time delay. HydroGNSS builds upon the growing GNSS-R knowledge gained from UK-DMC, TDS-1, and ORORO / DoT-1, and is anticipated to generate a new research data set in GNSS Earth Observation, specifically targeting land and hydrological applications.

State of the art satellites that target soil moisture such as ESA SMOS and NASA SMAP are highly valued by scientists and operational weather forecasters, but will be expensive to replace. As evidenced by TDS-1 and CYGNSS, HydroGNSS will be able to take GNSS-R measurements using GNSS signals as a radar source, reducing the size of the satellite platform required. The forward scatter L-band nature of the measurement means that they are complementary to other techniques, and HydroGNSS brings further new measurement types compared to TDS-1 and CYGNSS. The small size and low recurring cost of the HydroGNSS satellite design opens the door to a larger constellation that can further improve spatial and temporal global hydrological measurements to an unprecedented resolution, invaluable to the better understanding of our climate.