Geophysical Research Abstracts
Vol. 20, EGU2018-9292-2, 2018
EGU General Assembly 2018

A regional satellite constellation optimization for GNSS remote sensing of soil moisture

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Surface soil moisture measurements are essential to study water cycles, land surface hydrology and even climate. Global Navigation Satellite System (GNSS) reflected L-band signals can be used to measure soil moisture as a low cost GNSS reflectometry system. The potential of GNSS remote sensing in studying the soil moisture in space borne missions have been experimented in missions such as SMAP and UK-DMC. However, the number of specular points and spatial sampling provided by these missions are not optimal especially in regional scales. Optimization of a satellite constellation improving the number of samplings to retrieve the soil moisture is a key problem. Therefore, the parameters of the 2-D lattice and 3-D lattice flower constellations have been optimized by applying the Genetic algorithm to increase the number of specular points and improve the specular points' distribution, as well. To determine the specular points' positions and distributions, GPS satellites and the designing LEO satellite positions are required in a time duration. Consequently, GPS and LEO satellites initial positions are propagated with Adams numerical integration method. Then, specular points' positions are obtained by Gleason's method using satellites positions. The application of both circular and elliptical orbits are surveyed in this study. Finally, the optimized constellation parameters demonstrate a better geometric conditions in remotely sensing the soil moisture due to the higher number and denser distribution of specular points in the study area of this research.