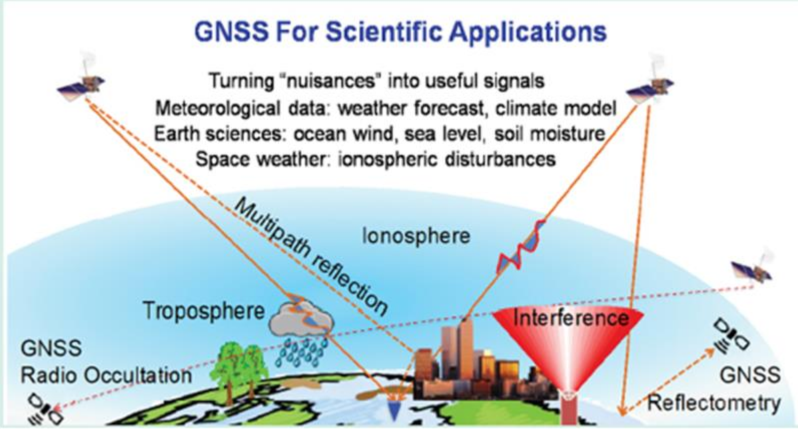
Master of Science Project opportunities

Geoscience and Remote Sensing

GNSS Remote Sensing (several topics)

GNSS signals experience propagation delays due to the water vapor content in the lower atmosphere (up to 20 km, a.k.a. troposphere), and free electrons in the part of the atmosphere ranging from 50 – 1000 km (a.k.a. ionosphere). These delays are a nuisance if interested in precise positioning, but an opportunity if interested in meteorology and ionospheric disturbances that may affect satellite communication and earth observation. Potential topics in this field:



GNSS Water Vapor estimation for weather nowcasting and numerical weather modelling
Water vapor is an important contributor to our weather because of its capability to transport moisture and latent heat in the atmosphere. An increase in water vapor can detect upcoming rainfall before droplets are formed. Current practice is to use the signals from all GNSS satellites to estimate the vertical delay and convert this delay to the integrated water vapor content at the receiver location. Goal of this project would be to estimate slant delays (i.e., in direction of satellite) to improve the spatial sampling.

Early warning of extreme rainfall (with cost-effective GNSS receivers)
This may be particularly interesting for regions with a low density / availability of meteo sensors. A key aspect would be to design an algorithm based on reliable detection and decision criteria to provide timely warnings, which always implies a trade-off between false alarm probability versus probability of missed detection.

GNSS tomography
Satellite tomography refers to the cross-sectional imaging of the atmosphere, where in our case either the water vapor content in the troposphere, or the electron content in the ionosphere is to be inferred from a reconstruction based on the many GNSS signal projections, for which we need a network of GNSS receivers. In both cases, we are looking at a 4D distribution (space and time), which requires solving a challenging inverse problem. An important aspect thereby is the design of the ground network.

GNSS reflectometry with cost-effective GNSS receivers
Reflection of GNSS signals is another nuisance for GNSS precise positioning, which can be exploited for certain remote sensing applications. GNSS reflectometry can for instance be used for sensing snow depths, soil moisture content, or water levels. This project could focus on the use of cost effective GNSS receivers to estimate for instance water levels or soil moisture in the Netherlands.

Antenna calibration tool
For precise kinematic GNSS positioning and meteorological applications, the phase center variations of GNSS antennas is crucial. This is typically achieved by an antenna calibration. High-grade, geodetic GNSS antennas are usually provided with these phase center calibrations. This is not the case for cost-effective antennas. For successful precise solutions, these need to be included in the processing. At TU Delft we have currently an antenna calibration tool available that only allows using GPS signals. Goal of this project is to include additional GNSS constellation(s) to the calibration tool and demonstrate the performance increase.

Information:
Sandra Verhagen (sandra.verhagen@tudelft.nl)
Andreas Krietemeyer (andreas.krietemeyer@knmi.nl)

TU Delft