Remote Sensing of the Terrestrial Water Cycle with the Cyclone Global Navigation Satellite System (CYGNSS)

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Abstract

The CYGNSS constellation of eight satellites was successfully launched in December 2016 into a low inclination (tropical) Earth orbit. Each satellite carries a four-channel bistatic radar receiver which measures signals transmitted by Global Positioning System (GPS) satellites and scattered back into space by the Earth surface. Over the ocean, surface roughness, near-surface wind speed and air-sea latent heat flux are estimated from the surface scattering cross section. Over the land, estimates of near-surface soil moisture and imaging of inland water bodies and flood inundation are derived from the surface reflectivity. The measurements are able to penetrate through all levels of precipitation and through most vegetation canopies due to the long radio wavelength at which GPS operates. The number of satellites in the constellation and their continuous data-taking operation produces high spatial sampling density and low temporal revisit times. Over ocean, this makes possible the reliable detection of tropical cyclone intensification and the resolution of diurnal cycles in tropical winds. Over land, diurnal soil moisture variability is resolved and rapidly changing flood inundation events are mapped. Engineering commissioning of the constellation was completed in March 2017 and the mission is currently in its science operations phase. Science data products are regularly produced over ocean for wind speed, surface roughness, and sensible and latent heat fluxes and over land for near surface volumetric soil moisture. Data products currently in development over ocean include tropical cyclone intensity (peak sustained winds) size (radius of maximum winds), extent (34, 50 and 64 knot wind radii), storm center location, and integrated kinetic energy. Over land, data products in development include refined versions of volumetric soil moisture content, flood inundation extent, time-varying inland water body maps, and riverine streamflow rate. An overview and the current status of the CYGNSS mission will be presented, together with updates on terrestrial science data products in development that are related to the terrestrial water cycle.

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H107. Remote Sensing, Modeling and Data Assimilation of the Terrestrial Water Cycle

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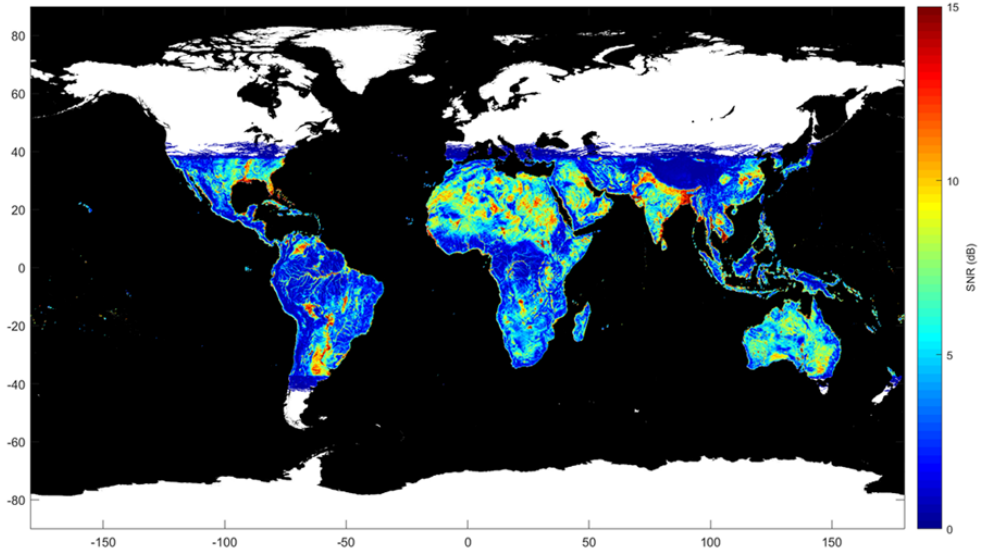
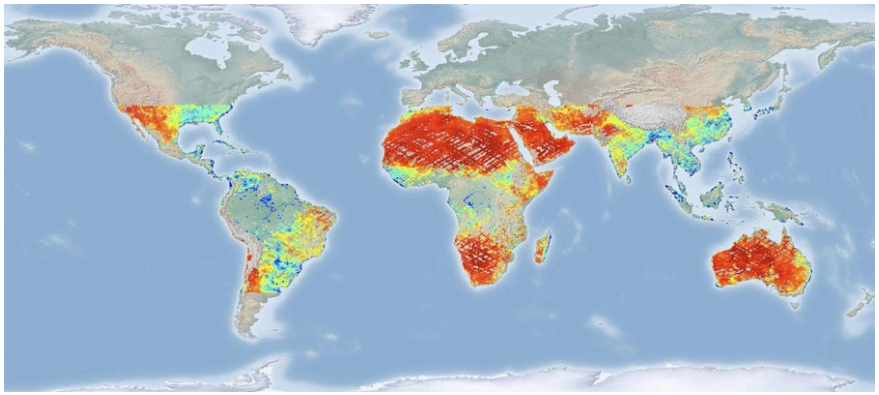
- CYGNSS consists of 8 microsatellites carrying radar receivers measuring GPS signals scattered from by surface
  - Retrieve ocean surface wind speed from roughening, similar to traditional radar scatterometry
  - Measure soil moisture from dielectric constant, similar to traditional microwave radiometry
  - Map inland water body extent from coherent reflections by calm water

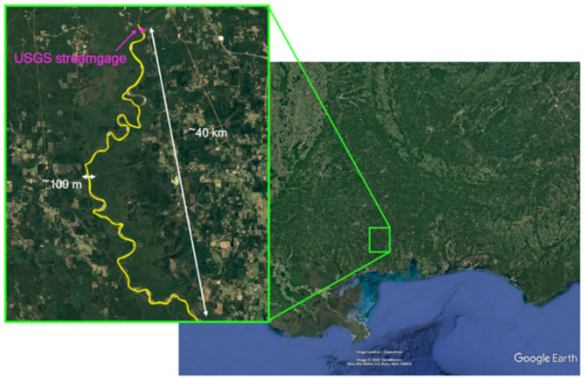


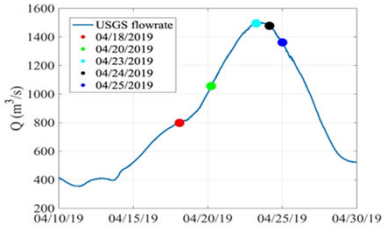
Terrestrial Measurement Capabilities

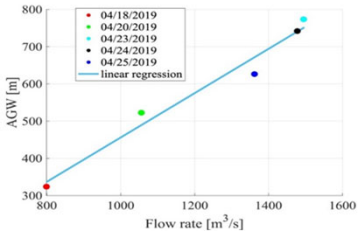
Soil Moisture



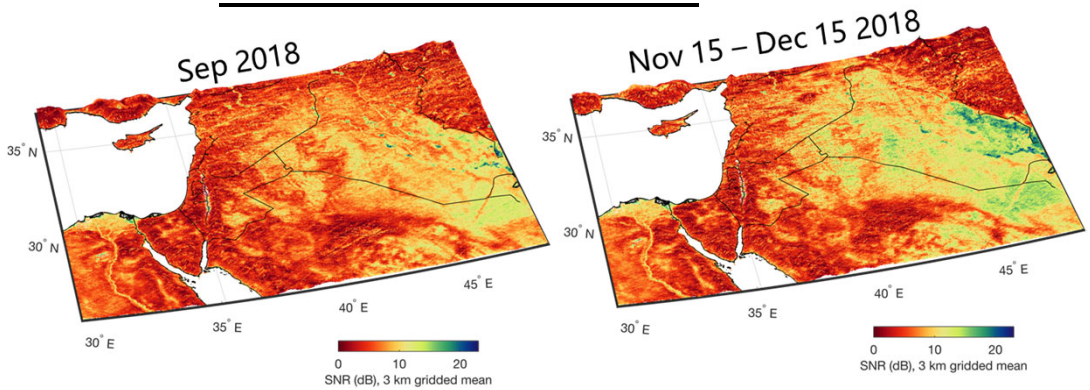
River Flow Rate







Flood Inundation



Summary

- CYGNSS was launched on 15 Dec 2016
- All eight spacecraft and GNSS-R science payloads are performing nominally with global coverage between 38S and 38N latitude and typically 2-3 regional revisits per day
- Measurements over land enable:
  - Soil moisture measurements
  - Inland water extend (e.g. flood inundation)
  - River flow rate (via river width)
- For more information: Chris Ruf <cruf@umich.edu>