THE GNSS-R CYGNSS MISSION: AN UPDATE

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ABSTRACT

The CYGNSS constellation was successfully launched on 15 Dec 2016 and has been operating continuously in science data-taking mode since March 2017. Updates will be presented on the mission status, calibration and validation activities for its science data products, and recent scientific applications of the measurements. Those applications include the use of ocean wind measurements to estimate air-sea latent heat flux, the assimilation of wind measurements made near tropical cyclones into hurricane numerical prediction models, the retrieval of soil moisture from the scattering measurements made over land, and the imaging of inland flooding using over-land measurements.

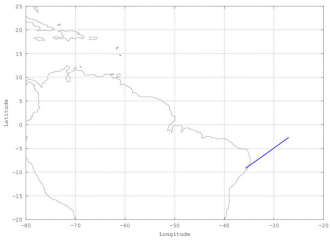
Index Terms— CYGNSS, GNSS-R, small satellites.

1. INTRODUCTION

NASA's Cyclone Global Navigation Satellite System (CYGNSS) mission consists of eight spacecraft in circular low Earth orbit at 35° inclination and ~520 km altitude. The spacecraft carry GNSS-R radar receivers tuned to measure GPS L1 C/A signals scattered from the Earth surface [1].

The CYGNSS constellation was launched on 15 Dec 2016 at 08:37 EST. After an initial several days spent establishing communication and stabilizing power, the engineering commissioning of the eight satellite buses was conducted over the first ~month on orbit. This was followed by functional testing of the GNSS-R receivers in Jan-Mar 2017. The "first light" measurement of Delay Doppler Maps (DDMs) occurred on 4 Jan 2017. Reflectometry mode for the GPS receiver on FM03 was activated while it was crossing over the eastern coastline of Brazil. The sub-satellite track is shown in Fig. 1a.

CYGNSS measures four simultaneous DDMs at locations spaced out around its sub-satellite point depending on where the specular reflections points are located. The first four DDM measurements are shown in Fig. 1b. The two DDMs in the middle (labeled CH2 and CH3) originated over the ocean. The DDM labeled CH1 (on the left) shows a much noisier and fainter ocean reflection and corresponds to a measurement made through a lower gain portion of the downward looking science antenna. The CH4 measurement on the right is a "hot spot" DDM reflection from land near the Brazilian coast.


(a)

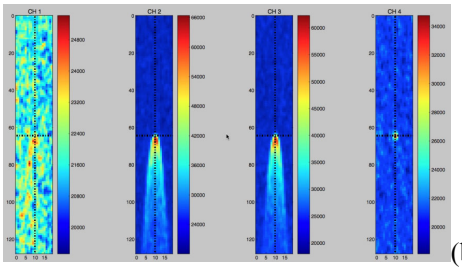

(b)

Figure 1. (a) Sub-satellite track for first DDM measurement. (b) First light DDMS.

2. SCIENCE OPERATIONS PHASE

Continuous science measurements began in March 2017 and have continued uninterrupted since that time. Level 1 (bistatic scattering cross section), Level 2 (ocean surface mean square slope and 10m referenced wind speed) and Level 3 (gridded versions of L2) science data products have been produced from March 2017 to the present and are available to the public at <https://podaac.jpl.nasa.gov/CYGNSS>.

Early science activities were primarily focused on characterization of the EIRP of the GPS transmitted signal, on calibration of the L1 data products [2] and on development of the wind speed retrieval algorithm and validation of its data products [3]. More recently, science activities have focused on the assimilation of wind speed measurements into numerical prediction models, and on the use of land DDMs for soil moisture and flooding applications [4-5].

An example of both the ocean wind and land flooding measurement capabilities of CYGNSS is shown in Figs. 2-3. In Fig. 2, CYGNSS wind speed measurements are made just prior to landfall by Hurricane Harvey on 26 Aug 2017.

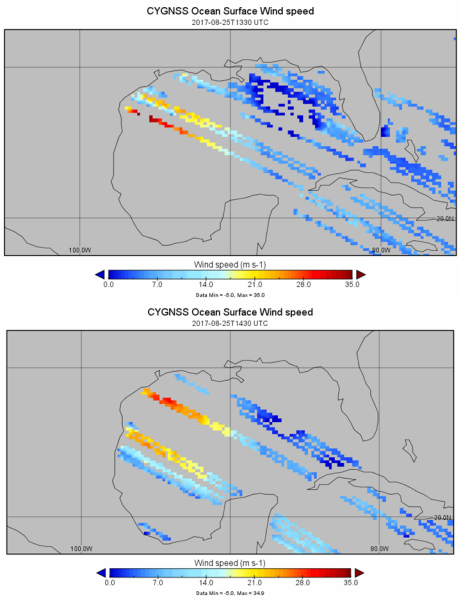


Figure 2. CYGNSS L3 wind speed (v1.1). at 1300-1400 (top) and 1400-1500 UTC (bot) 25 Aug 2017, prior to landfall at ~03:00 UTC on 26 Aug 2017.

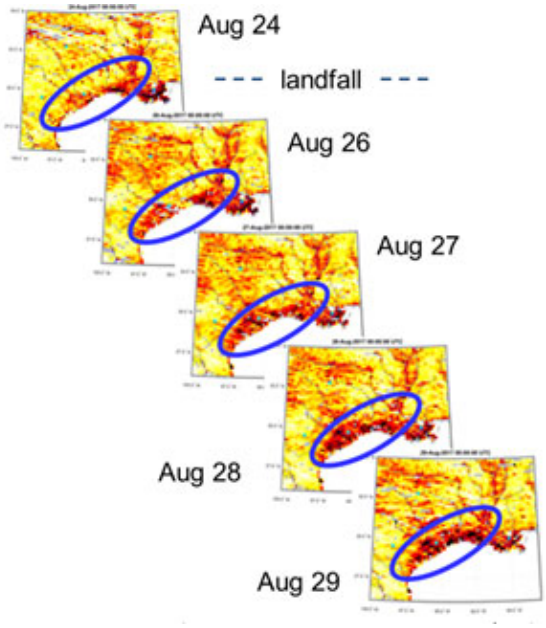


Figure 3. Time lapse CYGNSS SNR images of southeast Texas before and after Hurricane Harvey landfall, with flood inundation indicated by large increases in SNR.

In Fig 3, the daily changes in flooding that occurred in the days after landfall are imaged by the CYGNSS SNR over land in Southeast Texas.

3. CONCLUSIONS

CYGNSS has been successfully operating in science mode since Mar 2017. A mission update and summary of recent science results will be presented.

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