National Aeronautics and Space Administration
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CYGNSS Observations of Extratropical Cyclones

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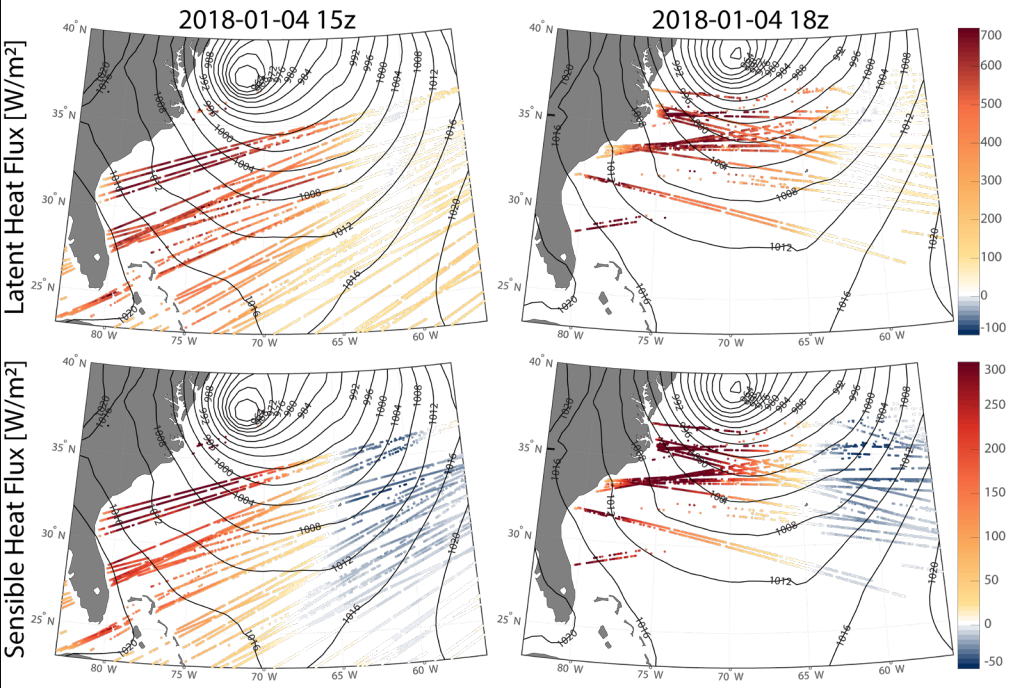

Latent (LHF) and sensible heat flux (SHF) observations from CYGNSS of a rapidly developing extratropical cyclone in the Western Atlantic Ocean.

Science Question: Could observations from the Cyclone Global Navigation Satellite System (CYGNSS), while being in a tropical orbit, provide valuable observations of the surface processes occurring within low-latitude extratropical cyclones (ETCs)?

Data & Results: We used CYGNSS's Level-2 (L2) surface wind speed & ocean heat flux observations to better understand surface processes occurring within and around low-latitude ETCs. While CYGNSS is a tropical mission, it can observe strong wind speed and fluxes as ETCs develop, especially along western boundary currents (i.e. Kuroshio/Gulf Stream). Observations of specific case studies and composite analysis since launch inform us of the distribution of fluxes and wind speeds across ETCs and how they vary between different basins.

Significance: ETCs play a large role in Earth's weather and climate. While their synoptic-scale dynamics are well understood, there's a lack of observations of surface processes for those developing over the ocean. CYGNSS's all-weather observations and rapid revisit allow for better observations of these surface processes, giving us a better understanding of their possible impact throughout the life-cycle of an ETC.

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Data Sources:
- Cyclone Global Navigation Satellite System (CYGNSS)
  - Level 2 (L2) Climate Data Record (CDR) Wind Speed Observations, Version 1.0
    - PO.DAAC Link: https://podaac.jpl.nasa.gov/dataset/CYGNSS_L2_CDR_V1.0
  - L2 CDR Ocean Surface Heat Flux Product, Version 1.0
    - PO.DAAC Link: https://podaac.jpl.nasa.gov/dataset/CYGNSS_L2_SURFACE_FLUX_CDR_V1.0
- NASA GISS Extratropical Cyclone Database: https://data.giss.nasa.gov/storms/obs-etc/

Technical Description of Figure:
CYGNSS observations of (top) Latent Heat Flux [W/m^2] and (bottom) Sensible Heat Flux [W/m^2] for an ETC in the Western Atlantic Ocean in January 2018. Mean sea-level pressure [hPa, solid contours every 4 hPa] indicate location of ETC at1500 UTC 04 Jan. (left), and 1800 UTC 04 Jan. (right). CYGNSS observations span $\pm$1.5 hours from the time listed.

Scientific significance, societal relevance, and relationships to future missions:
While we've had a good understanding of the synoptic-scale Extratropical Cyclone (ETC) dynamics for over a century, unresolved questions remain regarding how surface processes, especially over the ocean, play a role in their development. These processes can be difficult to observe due to a lack of in-situ observations and remote sensing instruments that cannot consistently observe surface processes due to attenuation and/or their orbital tracks. CYGNSS is a satellite mission designed to observe surface wind speeds in all-weather conditions using reflected GPS signals off the ocean surface. As a constellation of eight small satellites, CYGNSS provides rapid revisit and daily coverage over the tropical and subtropical oceans.

While CYGNSS is a tropical mission, its field of view allows consistent observations up to the 38th parallel in both hemispheres. This region often features rapid cyclogenesis with western boundary currents (like the Gulf Stream/Kuroshio) featuring large surface heat fluxes. This paper utilizes surface wind speed and surface heat flux observations from CYGNSS to better understand the surface dynamics during ETC genesis and evolution. It motivates the need for more remote sensing instruments to observe the surface processes occurring within marine-based ETCs.