- We all are aware of the **Global Positioning System (GPS)** constellation of satellites that we use for positioning, navigation and time keeping
- Global Navigation Satellite Systems (GNSS) refers to multiple different satellite navigation systems, such as GPS, Galileo, GLONASS, etc ...
- **GNSS Reflectometry** (GNSS-R) utilizes GNSS signals reflected off of the Earth for remote sensing. Properties of the reflected signal contain information about the surface.
- GNSS-R uses GNSS
 Welcome & Overview
 signals to form a radar



How does the CYGNSS mission make innovative use of GNSS signals?



Measure winds in tropical cyclones

Hurricane Dorian overpass on 30 Aug 2019 at 02:45 UTC



- Image surface reflectivity and soil moisture
 - Global monthly mean, Apr 2018



- Map flood inundation after hurricane landfall
 - Aftermath of Hurricane Harvey landfall in SE Texas, Aug 2018



- First dedicated spaceborne GNSS reflectometry mission. Goal is to measure ocean surface wind speed and to measure tropical cyclones
- Launched in December of 2016, CYGNSS is now in extended mission life
- Given the success of the mission NASA funded development of a "Next Generation" GNSS-R receiver
 - Higher resolution
 - Higher accuracy
 - New and better science!

NASA CYGNSS (Cyclone GNSS) is a constellation of 8 microsatellites that receive GPS reflections off of the Earth's surface (PI Ruf – University of Michigan)





In a unique international partnership, Air New Zealand will certify, install and fly the NASA GNSS-R NgRx on a domestic Q300!

- NASA (University of Michigan) customizing the hardware for airborne operations
- MBIE supporting for NZ engineering and science (University of Auckland, Canterbury University) working with NASA colleagues to advance the technology and science *in* advance of the next mission



A Walk Through the Rainbow with PACE 6 days ago

Syncing NASA Laser, ESA Radar for a New Look at Sea Ice 7 days ago

Conditions Ripe for Active Amazon Fire, Atlantic Hurricane Seasons 14 days ago

NASA Ocean Ecosystem Mission Preparing to Make Waves 2 months ago

NASA Snow Campaign Wraps 2020 Survey 2 months ago

NASA's ICESat-2 Measures Arctic Ocean's Sea Ice Thickness, Snow Cover 2 months ago

NASA, New Zealand Partner to Collect Climate Data from Commercial Aircraft



NASA is partnering with the New Zealand Ministry of Business, Innovation and Employment, New Zealand Space Agency, Air New Zea the University of Auckland to install next-generation Global Navigation Satellite System (GNSS) reflectometry receivers on passenger a collect environmental science data over New Zealand.



Agreement between the **National Aeronautics and Space Administration** And the Ministry of Business, Innovation and Employment

Concerning the **Collection and Analysis of Surface Scattering Measurements**

The National Aeronautics and Space Administration (hereinafter referred to as "NASA") and the Ministry of Business, Innovation and Employment (hereinafter referred to as "MBIE" or together with NASA as the "Parties"):



International and Interagency Relations

FOR THE MINISTRY OF BUSINESS. INNOVATION, AND EMPLOYMENT:

Dr. Peter Crabtree Head of New Zealand Space Agency

Air New Zealand joins Nasa for special mission

25 Feb, 2020 10:06am



Spacecraft: Air New Zealand operates 23 Q300 aircraft across its network. Photo / Supplied, Air New Zealand



Air New Zealand joins NASA climate science mission

In a world first, Air New Zealand and NASA are working together to monitor climate change impacts, with the airline to collect unique environmental data during domestic flights.

25 February 2020

NZ Herald

What opportunities does our collaboration with CYGNSS unlock for NZ?

Permanently installing GNSS-R on a regional aircraft is a novel forward thinking concept that has captured international visibility and attention for New Zealand

- Developing science payload operations centre (SPOC) at UofA ^{34.5°5} for GNSS-R communications and science data offloads
 - infrastructure in place to support future and ongoing aerospace missions
- Participation in an ongoing NASA mission/opening new international collaborative research opportunities
- Developing state-of-the-art remote sensing engineering and science expertise in a growing field



Q300 Measurement Count (1yr)







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What opportunities does our collaboration with CYGNSS unlock for NZ?

- Developing retrievals for soil moisture and inundation
 - Canterbury University and University of Auckland
- Overlapping CYGNSS for mission calibration and expanded terrestrial science
- Extending CYGNSS coverage through airborne collection to support future mission
- Data records will support more science than this
 - Dense and long-time records for seasonal and multi-year trends
 - Large diversity of NZ terrain due to large span of latitudes







What are other innovative ways in which (aero)space can drive science, innovation and productivity in New Zealand ?

- New platforms and advancing technology is enabling new science, applications and scales of observations
 - Long-duration high-altitude UAS have potential for large area/long-term monitoring
 - Constellations of small-SATs provide enhanced temporal sampling and/or more advanced techniques
 - Companion satellites can provide significant additional science cost effectively
- Rapid and efficient development of measurement methodologies in support of evidence-based science.
- NZ's environmental diversity, coupled with extensive local knowledge, physical sciences expertise and accessible airspace provides an ideal incubator. This gives us a competitive edge in the international aerospace sector.
- Design mission payloads in partnership with NZ aerospace (piloted and unpiloted aviation, orbital and sub-orbital) addressing NZ and global priorities
- Develop integrated observational solutions for businesses ranging from agritech, horticulture, hydropower, forestry, national security and ecotourism

Earth Observing Payload Innovation Impact Industry Government lwi/Hapu Aerospace Simile Simile **Civil Aviation National Policy Defense/Security Data Analytics Regional & Local Technology Partners** Government Remote End-Users **Research/Education** Sensing Tech Forestry/Agriculture lee! **Energy Management** Water Management **Climate & Environmental Resiliency Planning**