National Aeronautics and Space Administration

Calibration of Compact Ocean Wind Vector Radiometer (COWVR)

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Abstract

- The Compact Ocean Wind Vector Radiometer (COWVR) mission was commissioned by the U.S. Air Force to address the expected ocean surface vector wind gap provided by WindSat, which has been recently decommissioned.
- The COWVR payload has been developed by the Jet Propulsion Laboratory (JPL).
- COWVR launched in December 2021 and was installed on the International Space Station. COWVR started collecting data in January 2022.

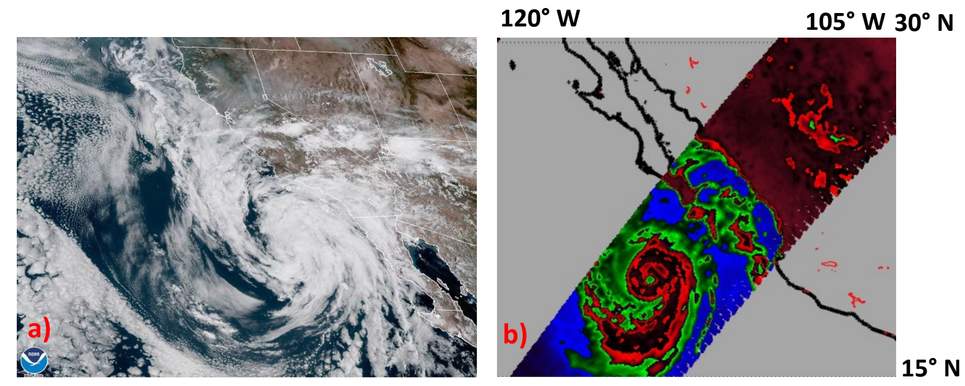

Fig.1a Tropical Storm over California in September 2022 (Courtesy NOAA).
Fig.2b. COWVR shows the storm- Channel 3-34 GHz.

Fig.3. COWVR sensor in the thermal-vacuum chamber.

COWVR Instrument Description

- The COWVR system includes a fully polarimetric radiometer that measures the Ku/Ka-band frequency channels of 18.7, 23.8, and 34.5 GHz by employing a single multi-frequency feed horn.
- No External Calibration, warm or cold loads for radiometer calibration. Internally Calibrated Using PIN Diodes and correlated noise sources.
- A rotating reflector, fixed feed, and ISS installation can cause systematic calibration anomalies in COWVR (discussed below).
- The calibration challenges are briefly discussed here This poster presents calibration results with respect to pointing, polarimetric performance, as well as radiometric performance.

Fig. 2. COWVR is installed on the International Space Station. The reflector and horn are hoisted by two arms which results in blockage for parts of the instrument scan. The two arms each contain star trackers for COWVR.

COWVR Pointing Calibration

- COWVR dealt with some unique geolocation issues early on.
- The geolocation was calculated and validated using three different methods (coastal crossing, stokes shadowing, and centroid calculation).
- One of these methods, shown in figure 3, uses relatively tiny islands and estimates the boundary of the island bases on the measured brightness temperature difference between the island and the ocean, then calculates the centroid of the for ascending and descending orbits.

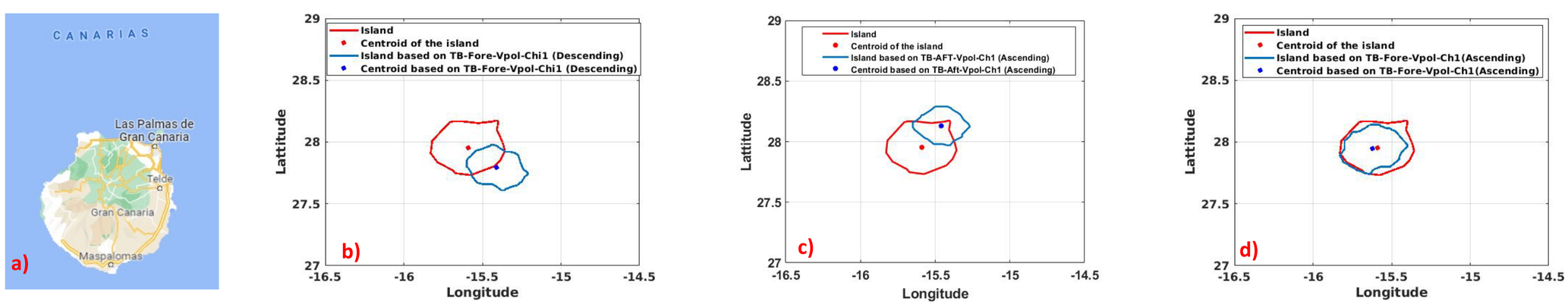

Fig.4. COWVR geolocation correction based on minimization of detected vs. actual islands. Fig.4a shows a small island in the Atlantic, Fig.4b and Fig.4c show a geolocation offset due to a timing error, and Fig.4d shows geolocation accuracy after the timing offset is corrected.

Corrections:

-0.050 deg (look ang)
-0.380 deg (roll)
-0.350 deg (pitch)
-0.090 deg (yaw)
scalar error:
3.03 km → 1.48 km
vector error:
1.35 km → 0.08 km

COWVR Radiometric and Polarimetric Performance

- The project and science team has further calibrated the radiometer, indicating improved polarimetric performance.

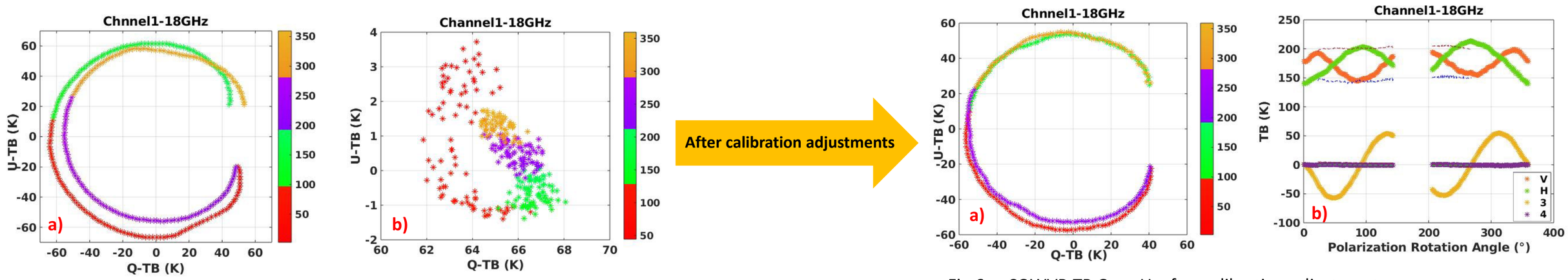

Fig.5a. COWVR TB Q vs. U as a function of the polarization rotation angle. Theoretically, we should see a circle. The deviation from the theoretical is due to differing fore and aft incidence angles. Fig.5b. shows Q leakage into U after polarization correction for two different ISS attitudes. Ideally U = 0 K.

Fig.6a. COWVR TB Q vs. U. after calibration adjustments.
Fig6b. COWVR Tb before (*) and (--) after correcting the polarization rotation angle for all four strokes. The third stokes blue dashed line shows no leakage from Q to U.

Summary

- COWVR is a well-calibrated instrument; with unforeseen calibration challenges and opportunities from installing COWVR on the international space station (ISS). The geolocation correction of the COWVR, which addressed the pointing error, is demonstrated in this poster, along with corrected polarimetric anomalies.

Ongoing Work:

- Inter-calibration of COWVR with GMI Radiometer.

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Poster Number:PRD-EA#009