

Compact Ocean Wind Vector Radiometer: Mission Status and Future Constellations

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The Aerospace Corporation

This work was conducted at the Jet Propulsion Laboratory,
California Institute of Technology under contract with
NASA. Government sponsorship is acknowledged.

and STP-H8 cal/val team

STP-H8 Mission

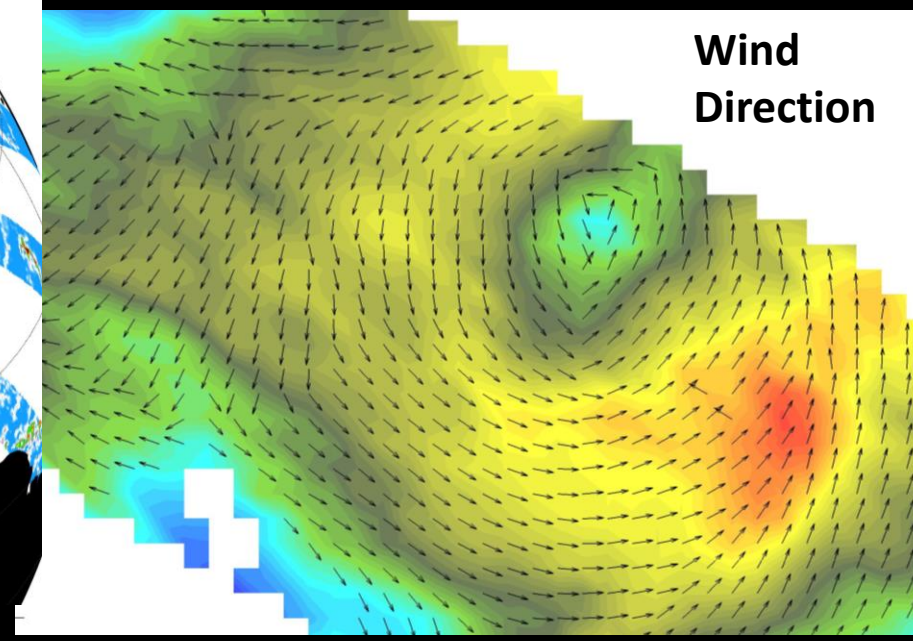
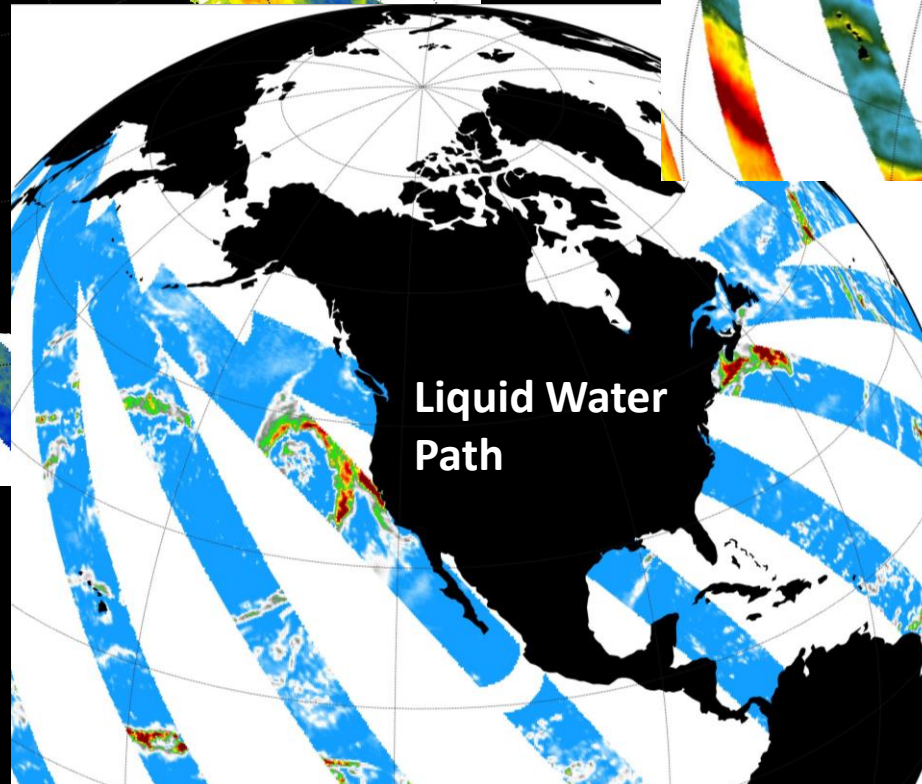
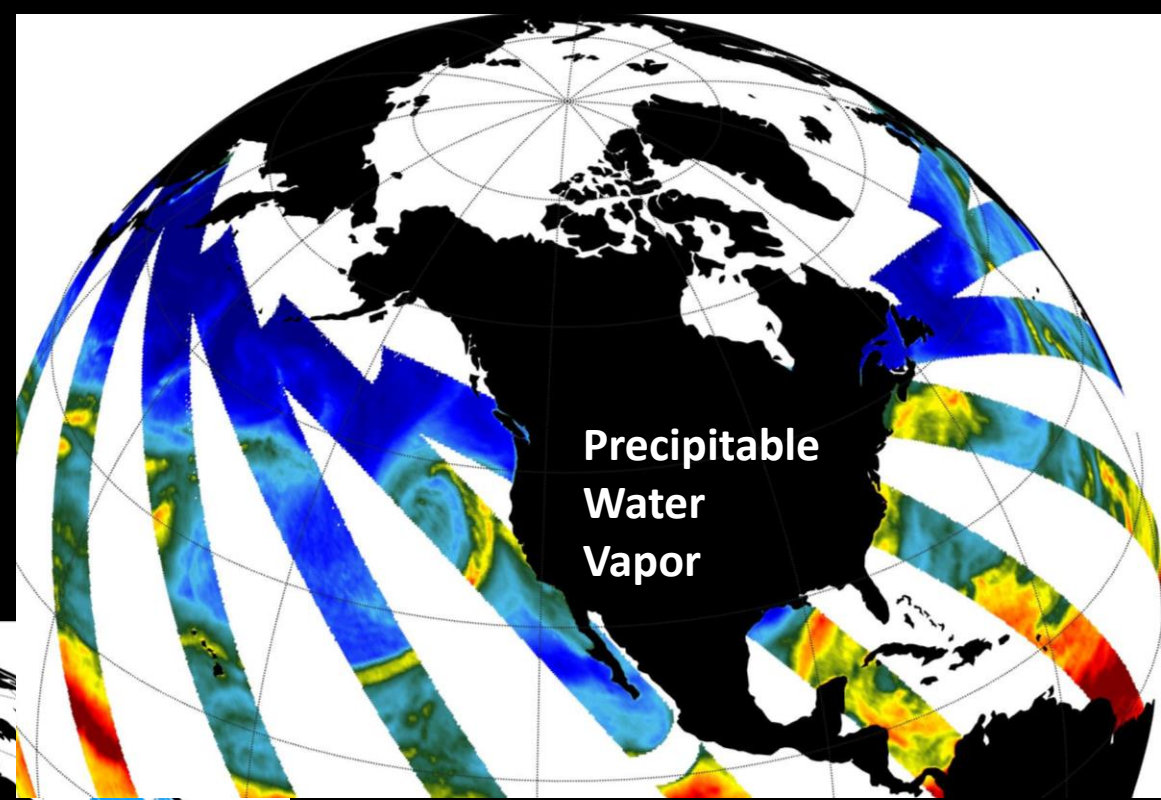
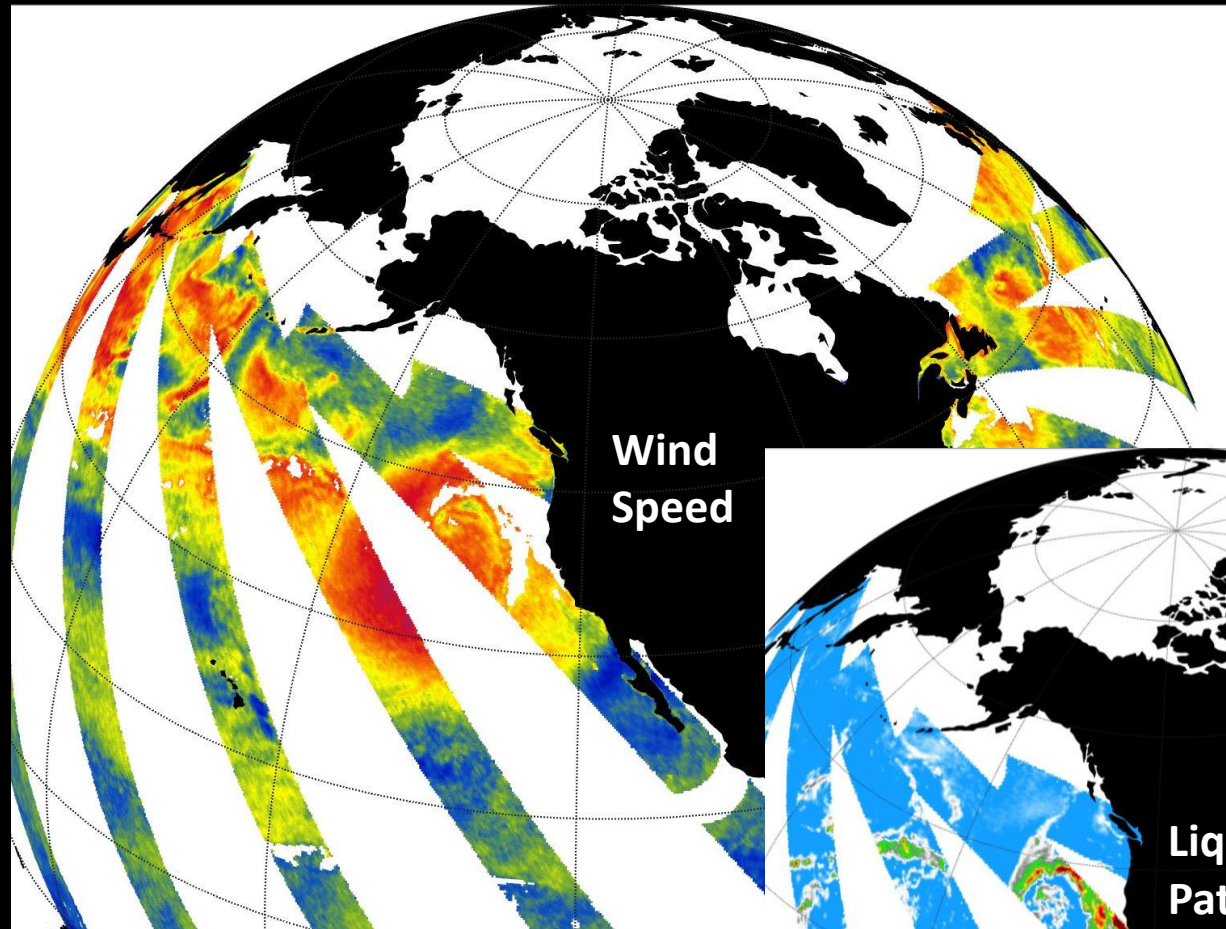


- Space Force mission to demonstrate new low-cost microwave sensor technologies for weather
 - **COWVR: measures ocean surface wind vector, integrated water vapor, cloud liquid water, rain rate**
 - **NASA provided TEMPEST flight spare: measures water vapor profile, convective precipitation**
- Continuous operations since January 7, 2022 (**3.4 years**)
- **Operations secured through August 2025 (extension in discussion with NASA/JAXA/ISS)**
- Science data processing at JPL
- Supports DoD operational weather (JTWC, FNMOC, NRL) with 1-2 hour latency products
- **Data distributed via PO.DAAC (updated daily)**
- NASA funding supports ASAP working group for combined COWVR/TEMPEST studies

WIND VECTOR VALIDATION RESULTS COWVR V10 (PUBLIC RELEASE)

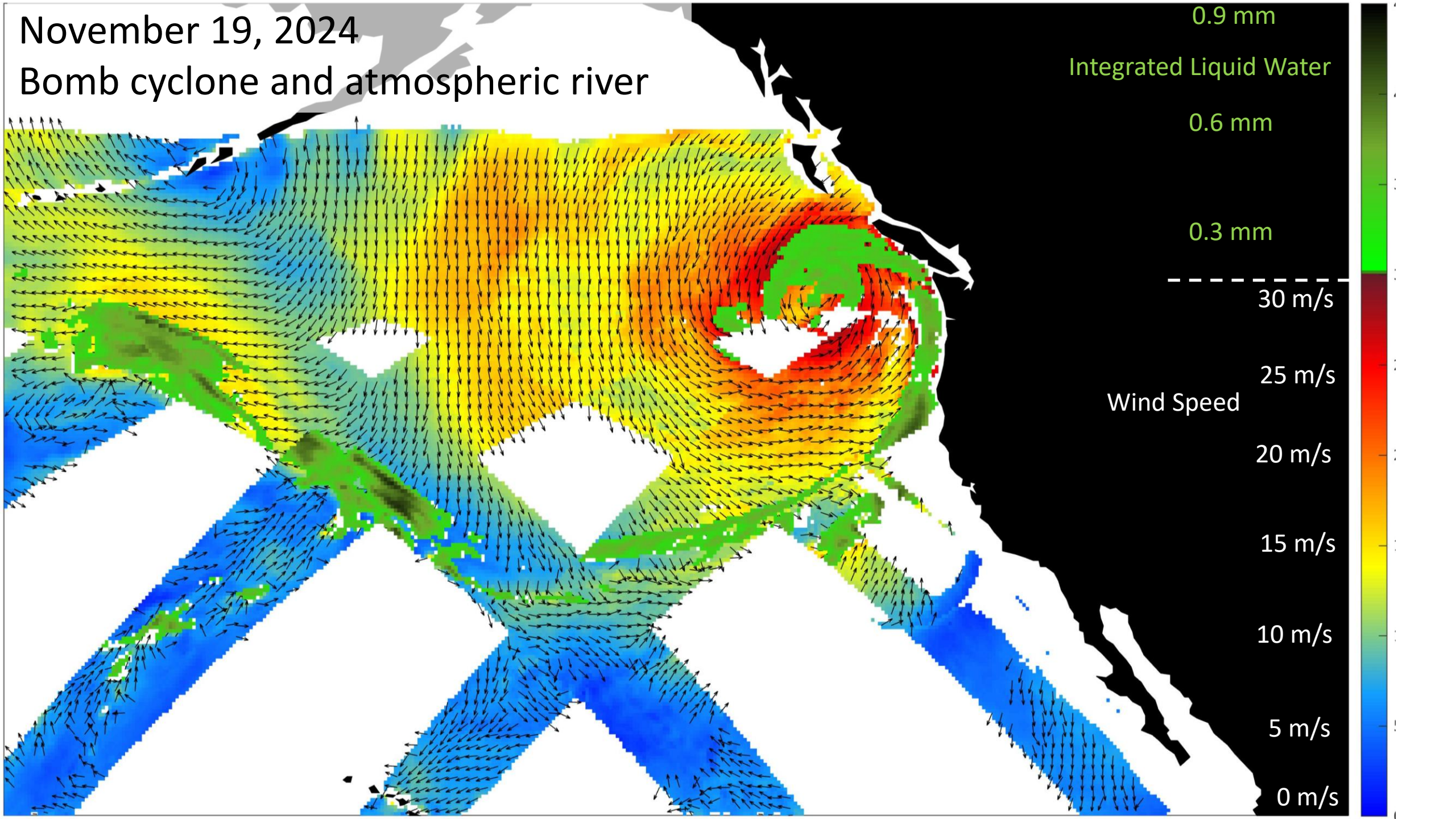


COWVR Products

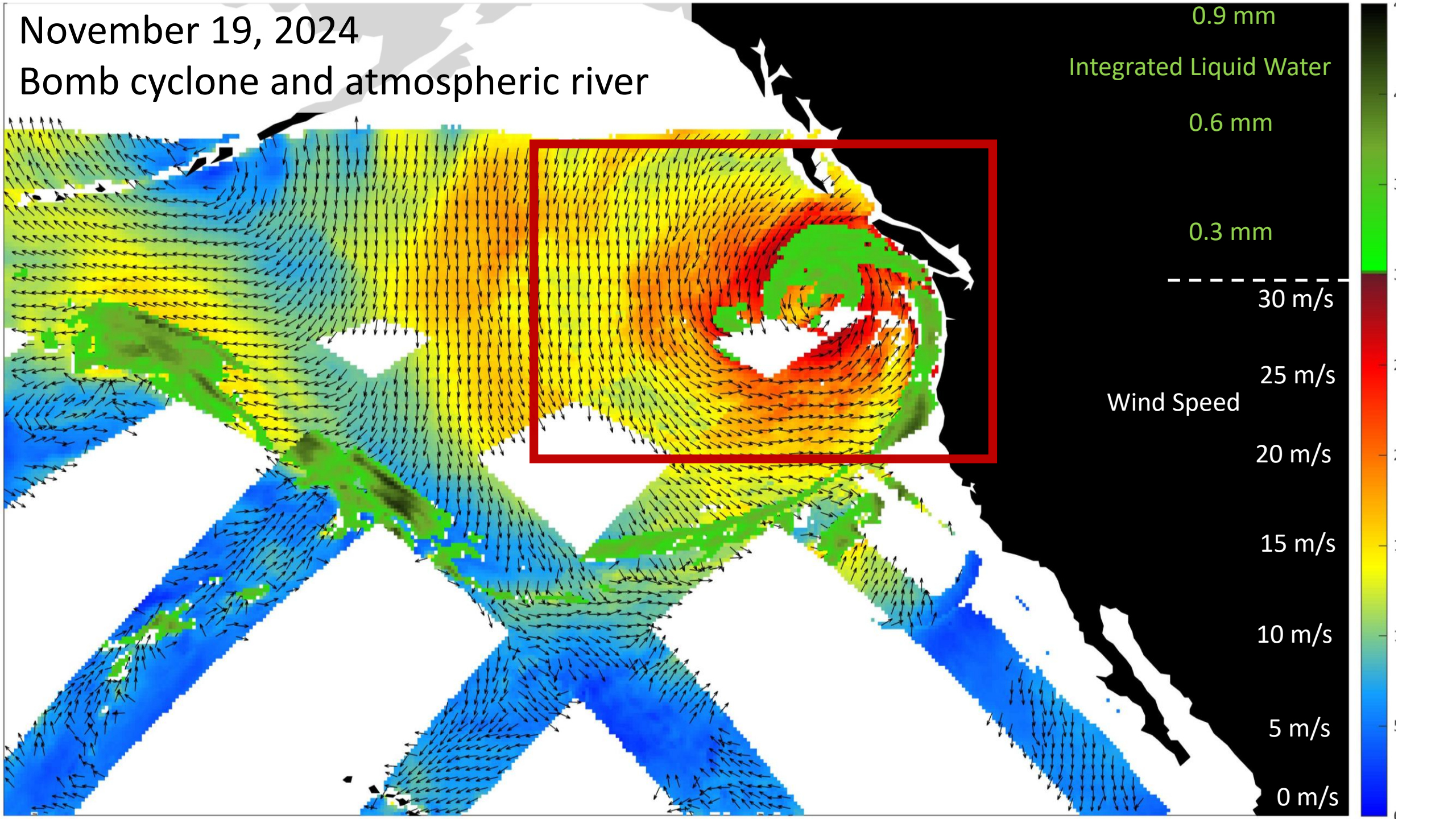


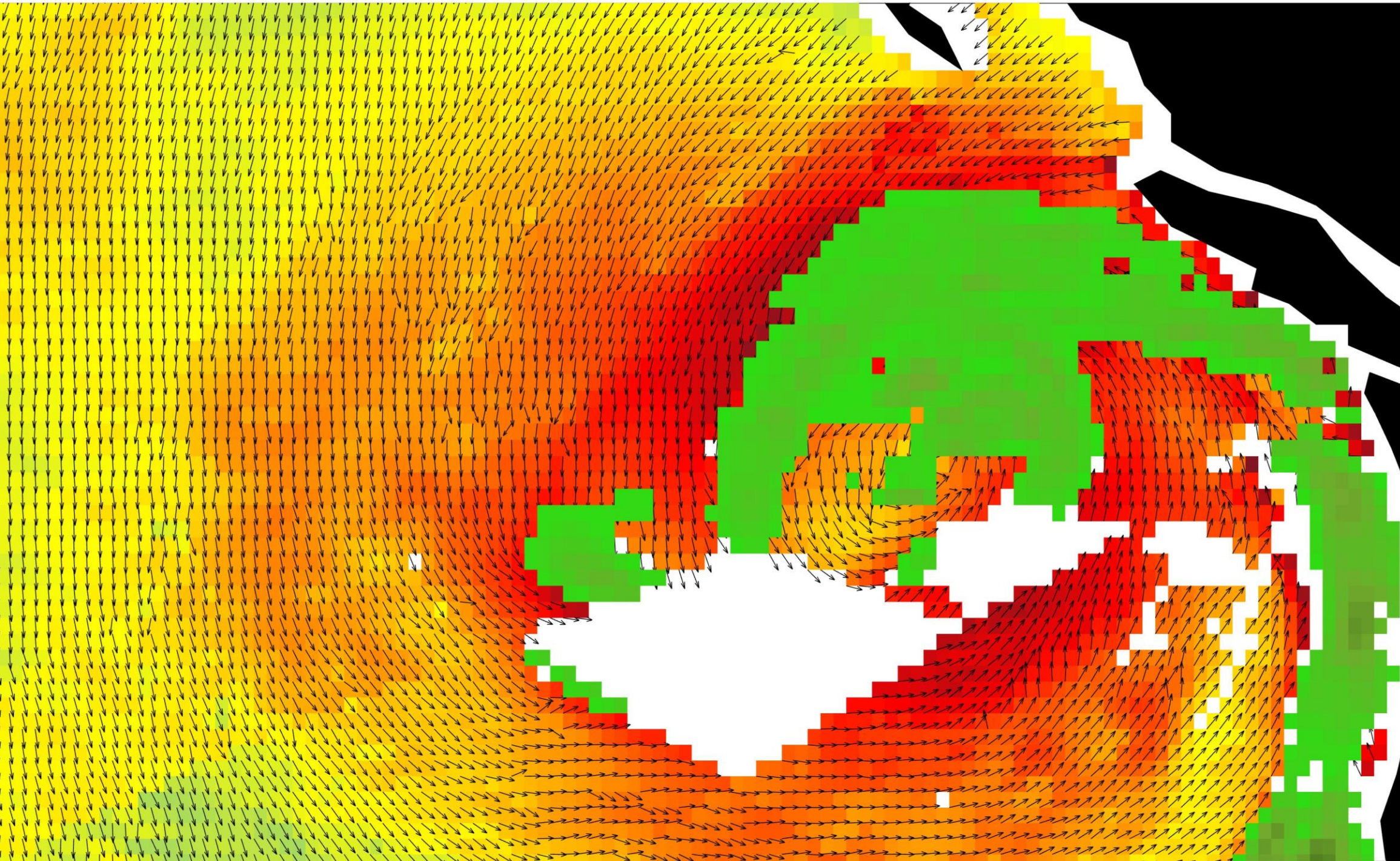
30km spatial resolution
900km swath

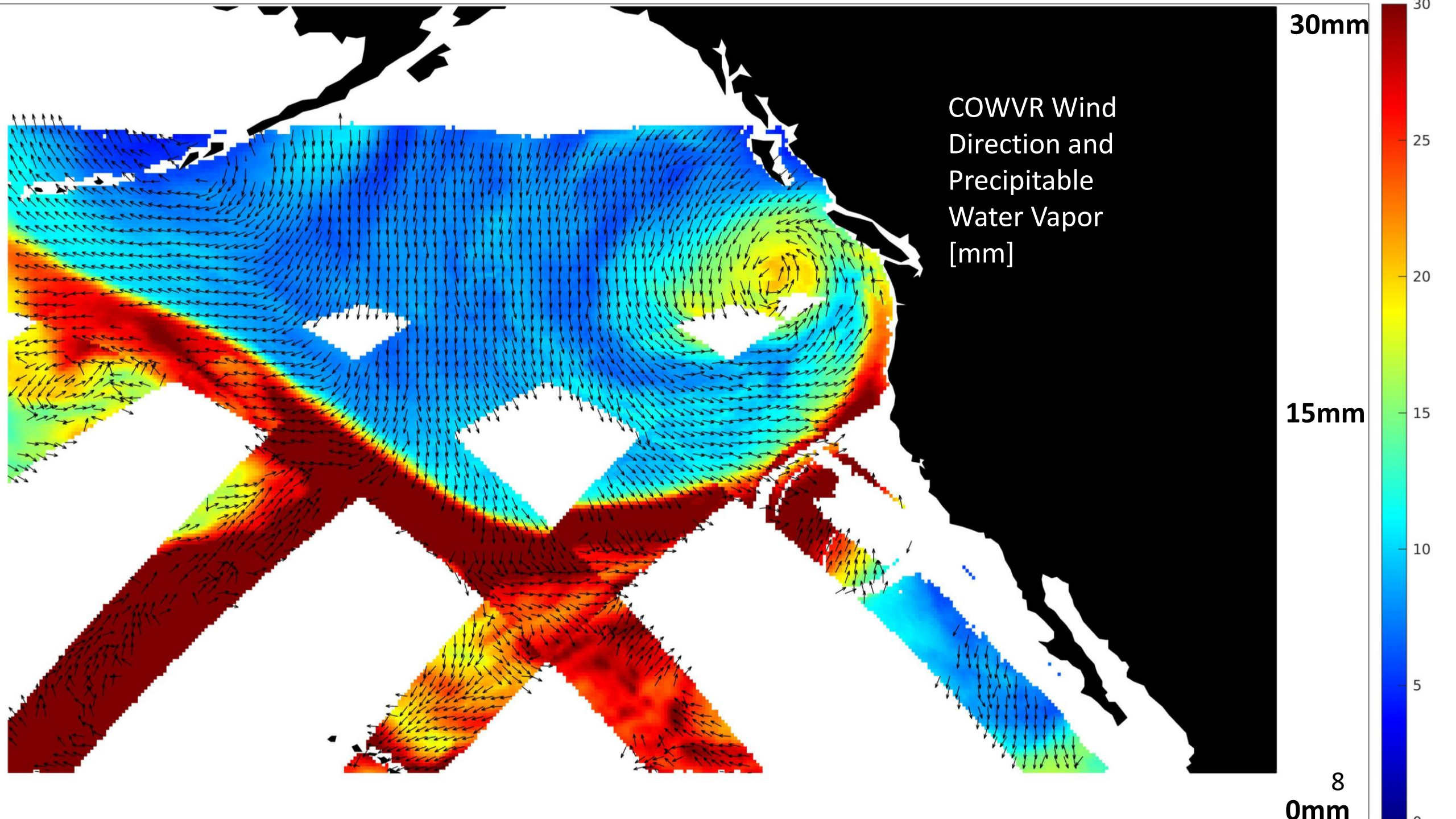
November 19, 2024
Bomb cyclone and atmospheric river



November 19, 2024
Bomb cyclone and atmospheric river

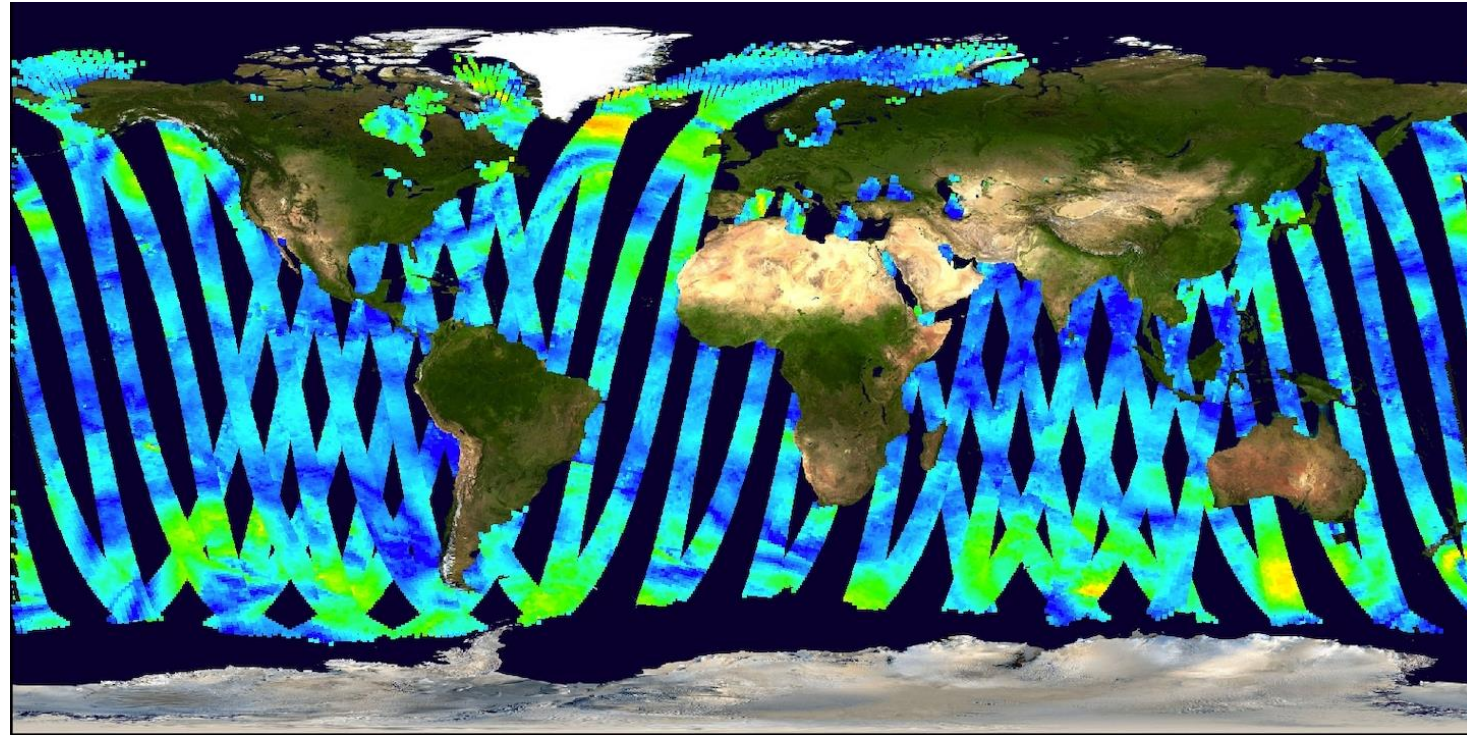






COWVR and MetOp-B/C KNMI ASCAT Intercomparison

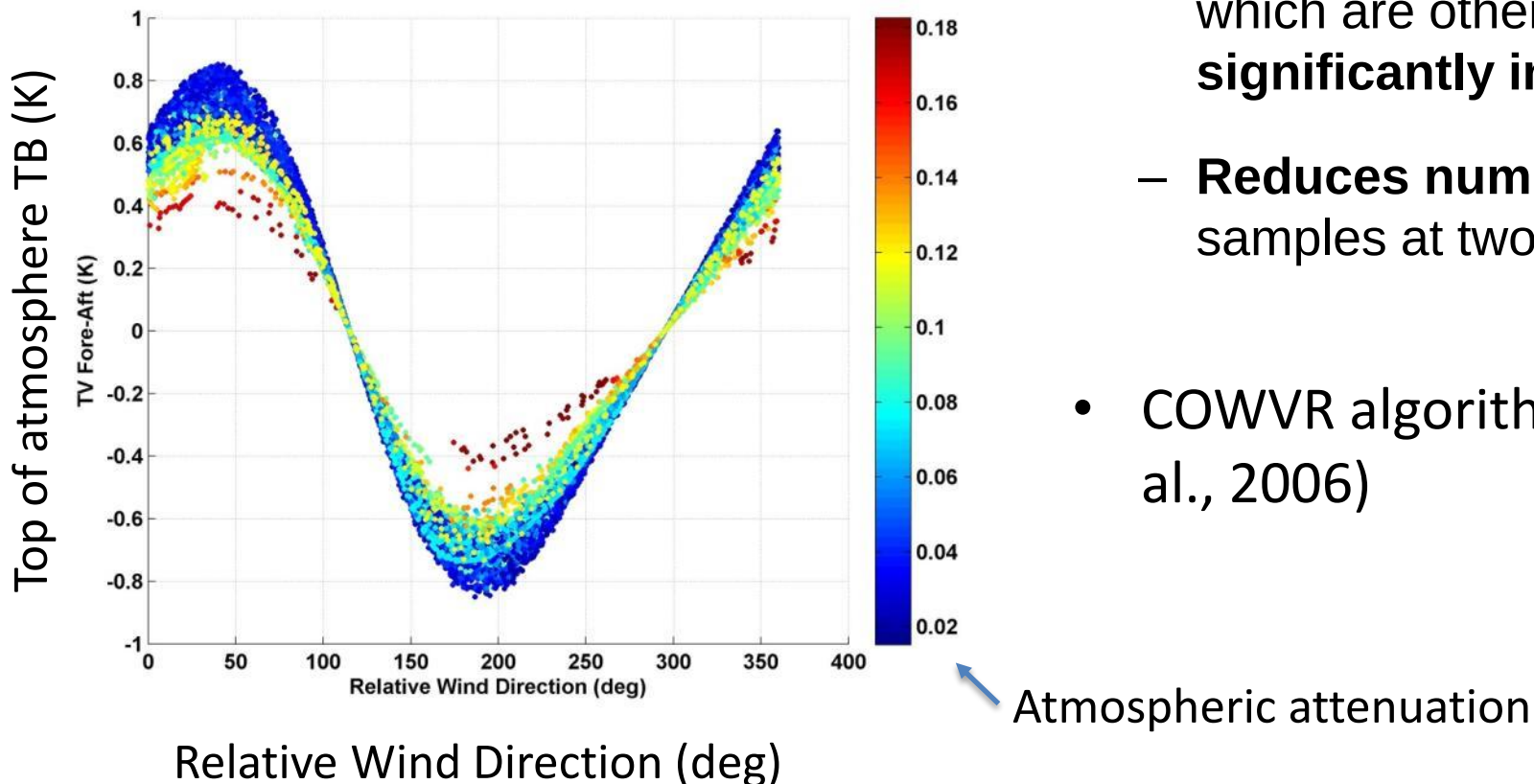
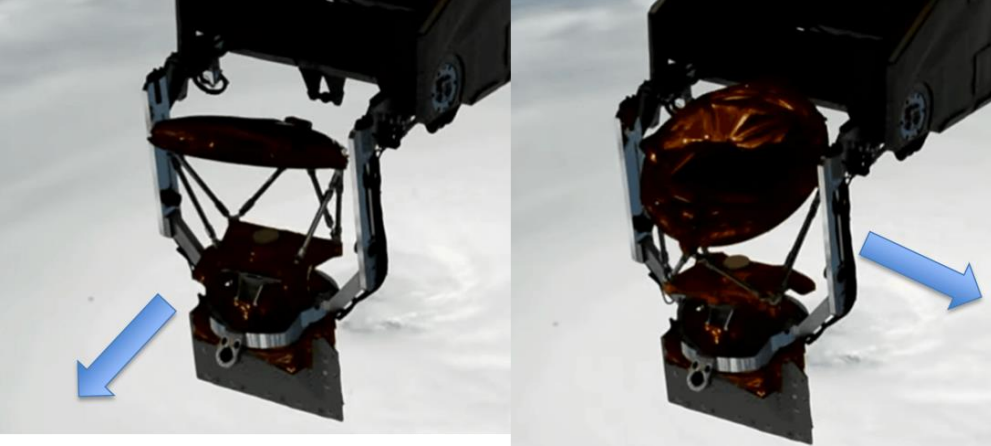
- COWVR matched with co-incident observations from the Advanced Scatterometer (ASCAT) on MetOp-B/C
- Match-ups defined as <25km spatial and ± 30 mins temporal
- Both COWVR and ASCAT product quality flags applied, but no other filtering



EUMETSAT/OSI SAF, KNMI, 2019-11-15, MetOp-C ASCAT Level 2
25.0km Ocean Surface Wind Vectors

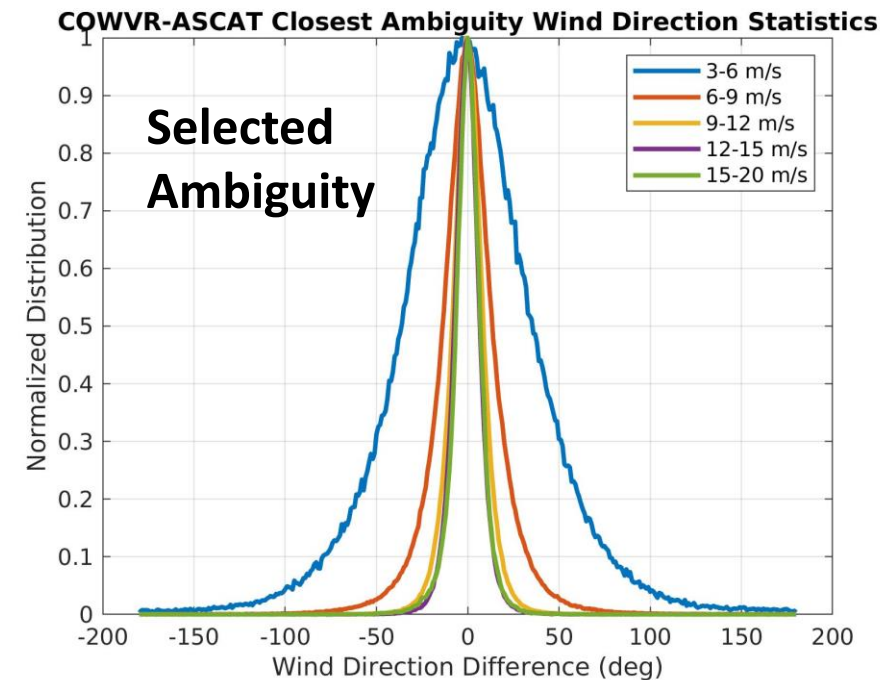
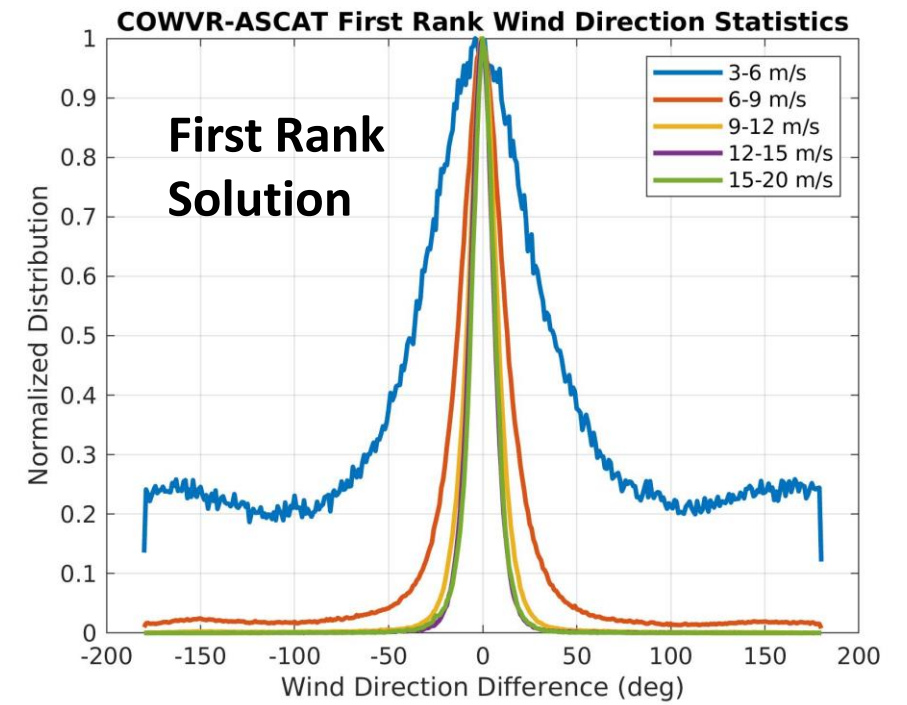
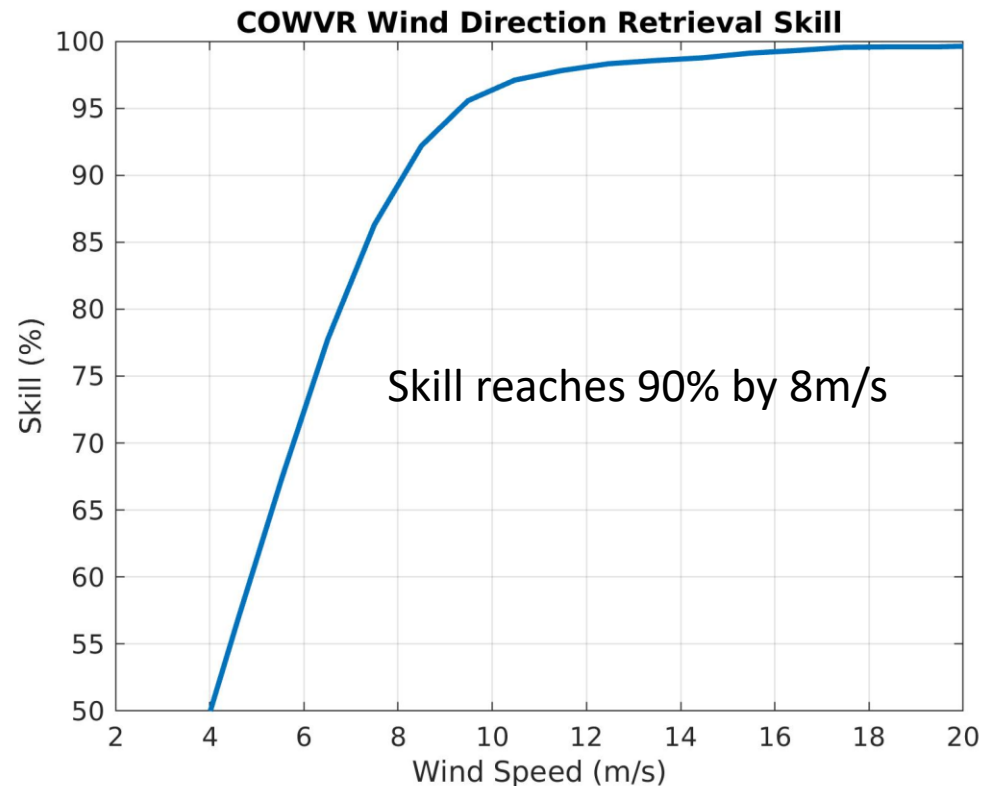
COWVR 2-Look Retrieval Algorithm

- COWVR designed for full 360° un-blocked conical scan
- Using fore and aft looks:
 - Isolates wind direction signal in V/H-pol channels which are otherwise dominated by atmosphere, **significantly improving signal to noise**
 - **Reduces number of ambiguities** by having samples at two relative wind directions
- COWVR algorithm adapted from WindSat (Brown et al., 2006)

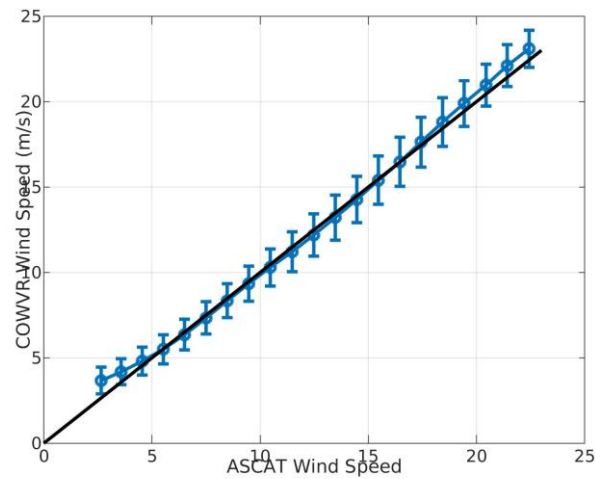


2-look algorithm Skill and Ambiguities (COWVR-ASCAT)

- Very little “nudging” required above 6m/s wind speed
- Algorithm produces 2 solutions on average, typically separated by 180°
- Still some room for improvement at lower winds to reach noise limited simulated performance

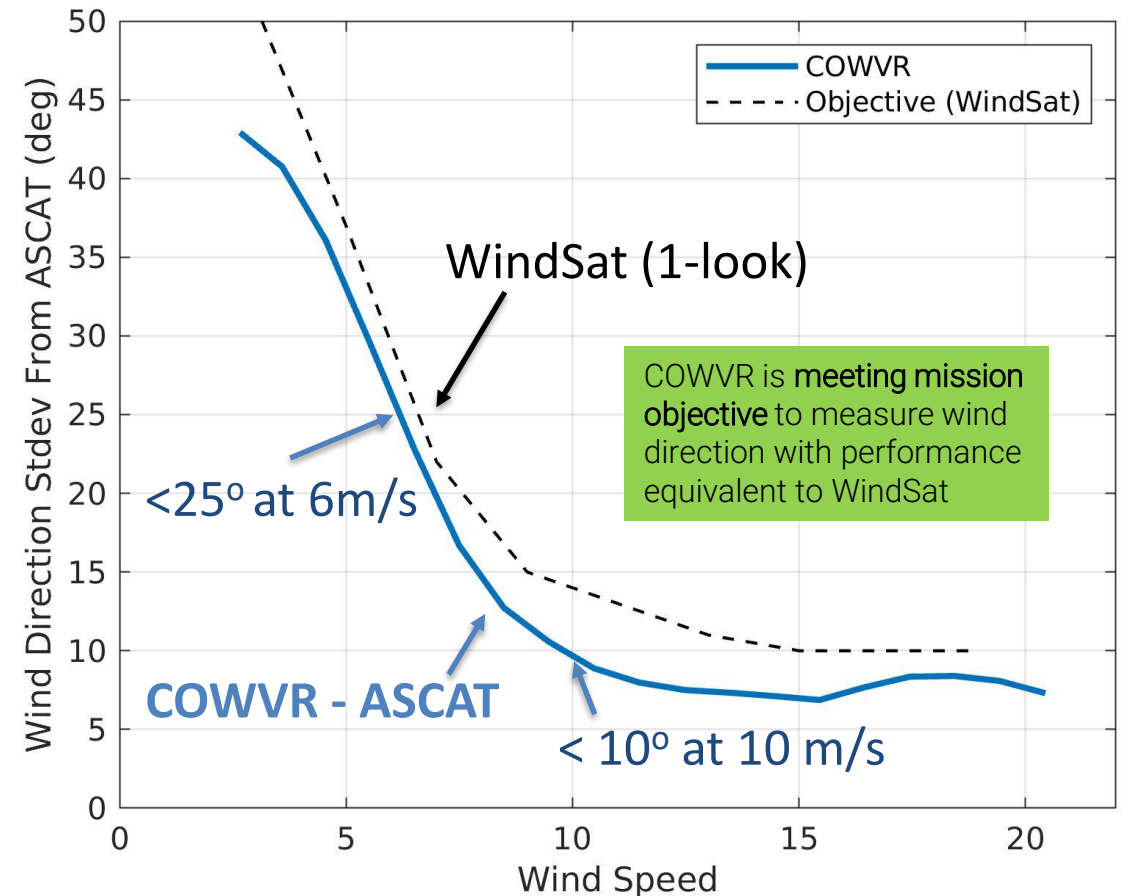
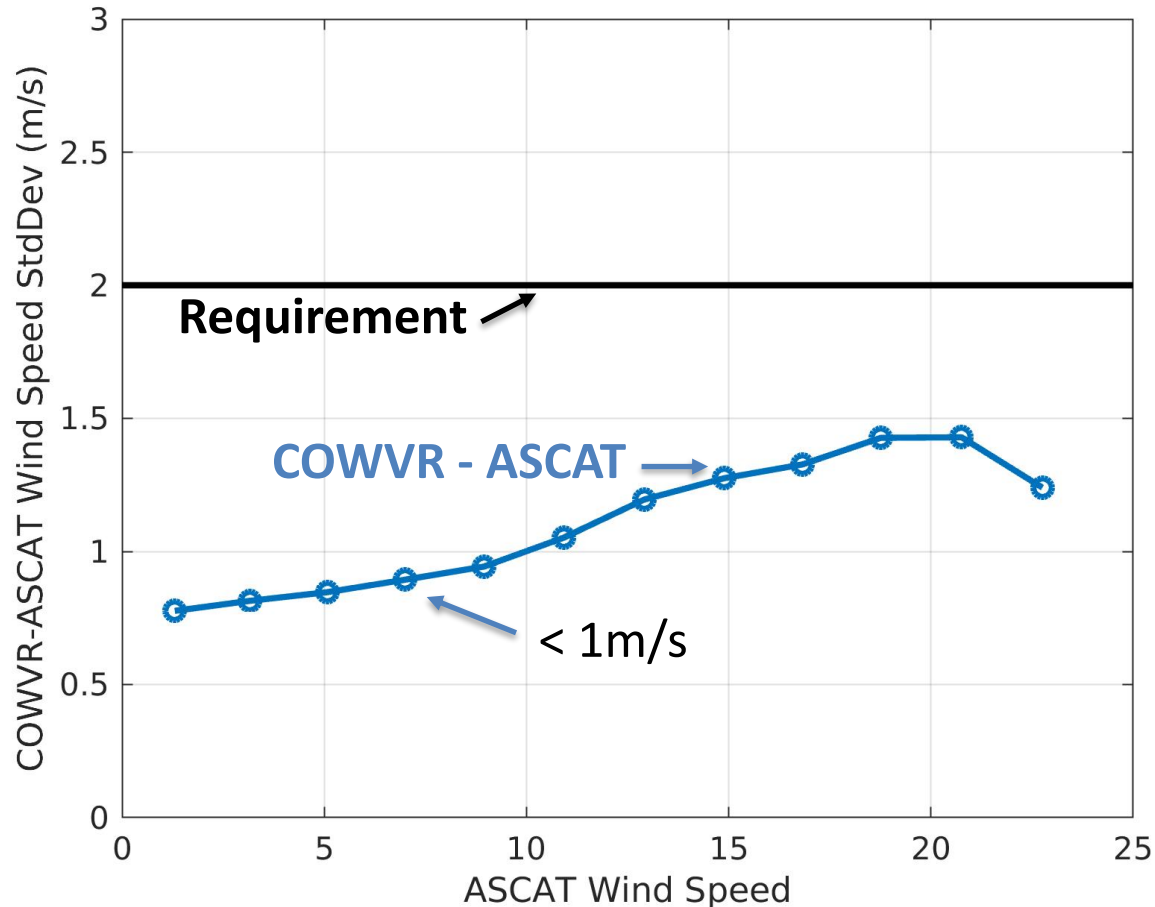


Wind speed
uncertainty less than
1m/s globally,
consistent
performance with
other operational
microwave sensors

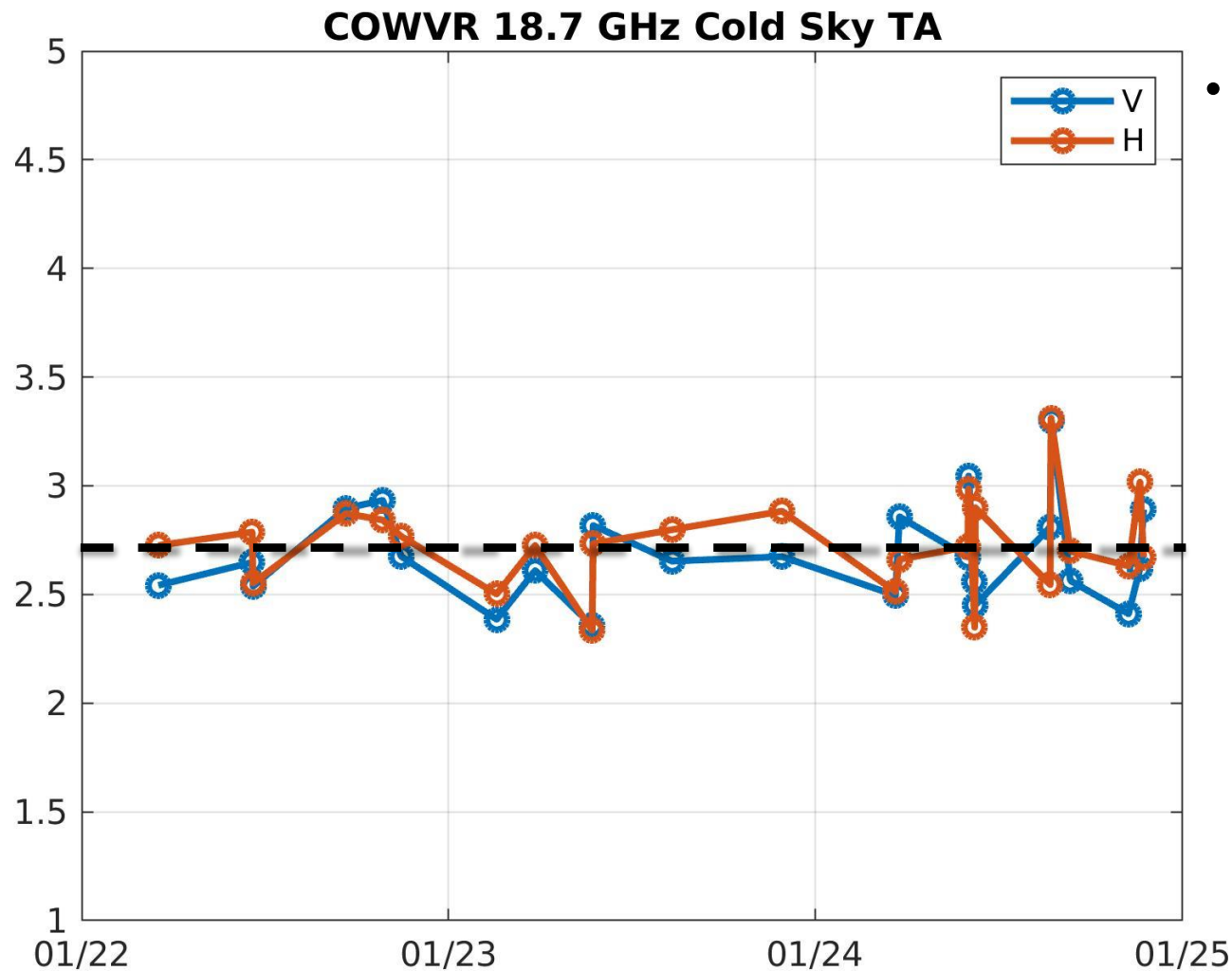


Wind Vector Comparison (COWVR-ASCAT statistics)

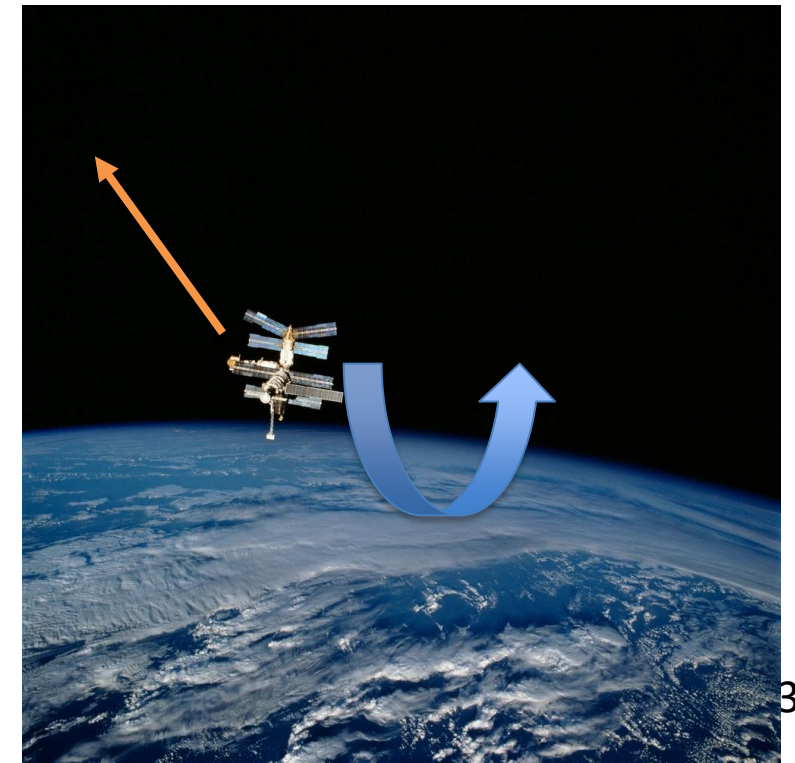
Wind direction uncertainty $< 25^\circ$ globally,
better than WindSat (1-look)



Long-term Calibration and Stability

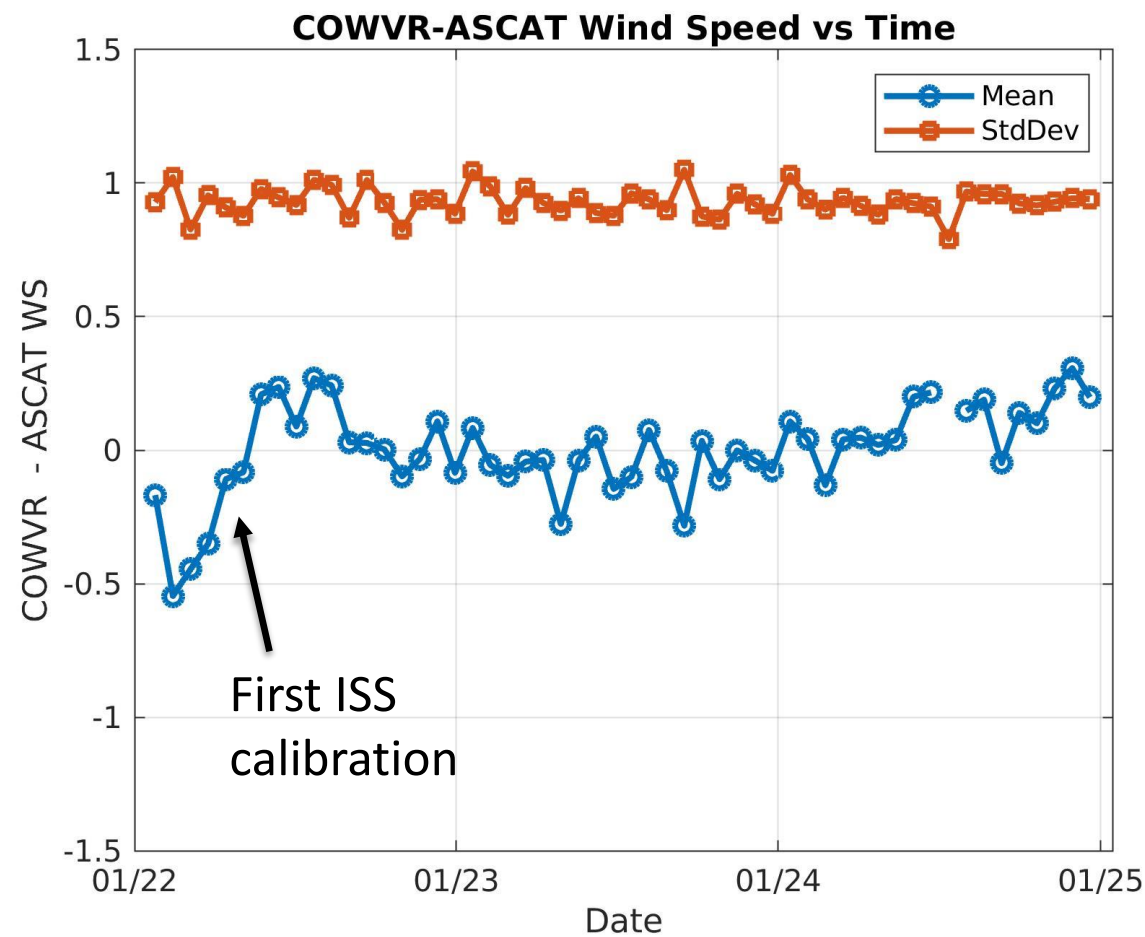


- COWVR is demonstrating electronic calibration sources for an operational conical imager
- Long-term calibration stabilized using periodic views of cold sky during ISS upward pitch maneuvers

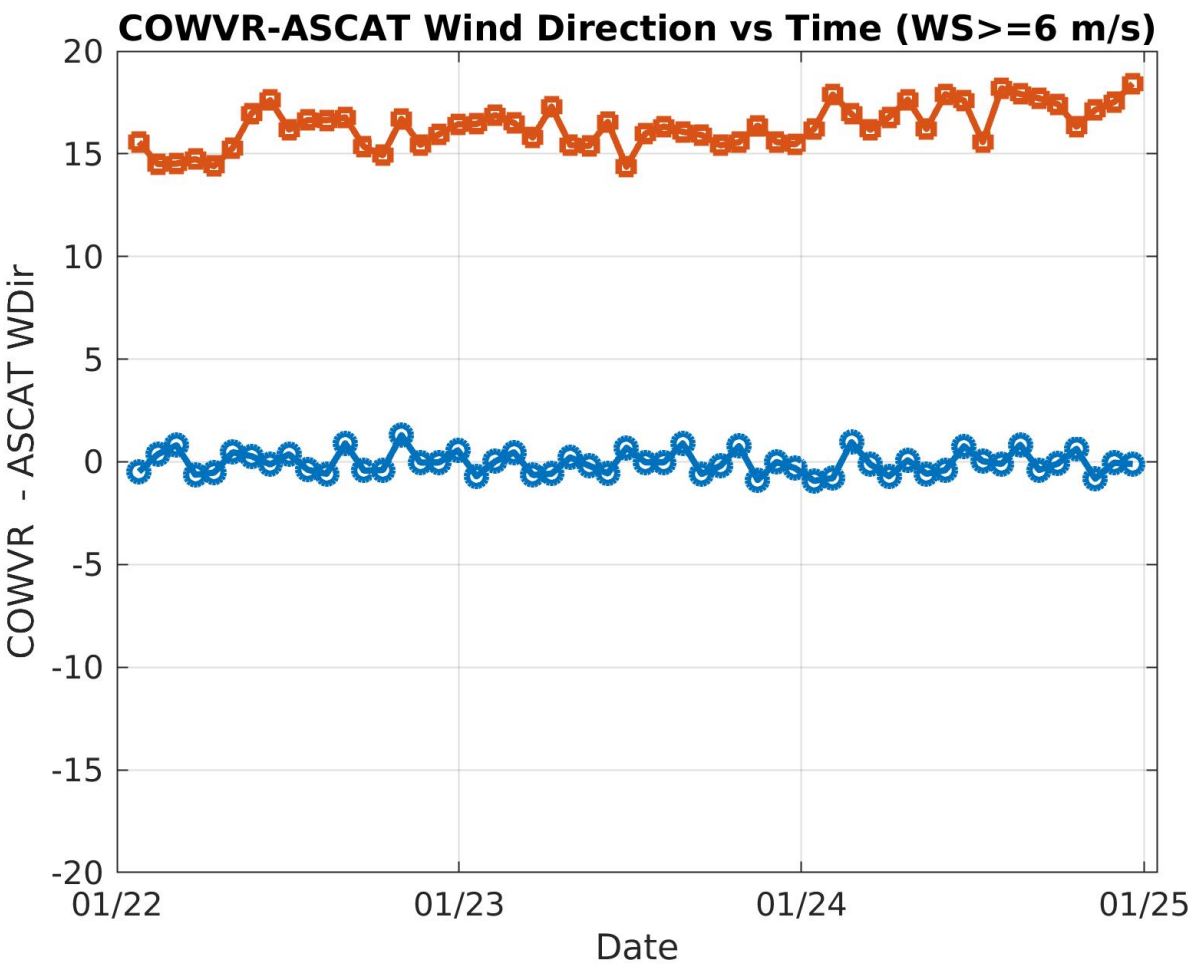


Wind vector validation statistics stable in time relative to ASCAT

Wind Speed (COWVR-ASCAT)



Wind Direction(COWVR-ASCAT)
WS>6m/s & $> \pm 90^\circ$ outliers removed



Data
Access
via
PO.DAAC



Free Text Search

Temporal Search

Enter search text

COWVR

Perform Search

Reset

Start Date

Stop Date

Capabilities Filter

Download

Clear Filter

Filter by Text

Found 3 matching dataset(s)

LIST | TABLE

COWVR STP-H8 Surface Wind Vector and Column-Integrated Atmospheric Water Measurements Version 10.0 (COWVR_STPH8_L2_EDR_V10.0)

- WATER VAPOR INDICATORS
- SURFACE WINDS
- PRECIPITATION PROFILES

- Information
- Coverage
- Data Access
- Documentation
- Citation

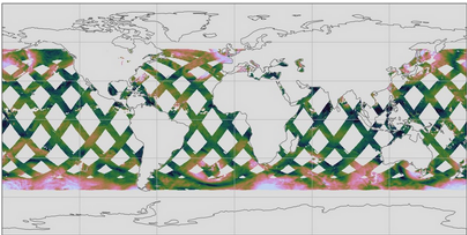
Version: 10.0

Processing Level: 2

Start/Stop Date: 2022-01-08 to Present

Description:

This dataset includes satellite-based observations of geolocated surface wind vectors, precipitable water vapor, and integrated cloud liquid water, as well as the microwave brightness temperatures used to derive them. Theses measurements make up the environmental data record (EDR) from the COWVR (Compact Ocean Wind Vector Radiometer) sensor aboard the international space station (ISS), beginning in January 2022 with forward-streaming to PO.DAAC. Data over the satellite swath are available in HDF5 format with roughly one file per hour (the ISS orbit period is ~90 minutes), and coverage shown in the thumbnail is for a full day. Spatial resolution is roughly 35... [Show More](#)



Status: ACTIVE

Short Name:
COWVR_STPH8_L2_EDR_V10.0

Collection Concept ID:
C3237678855-POCLOUD

Spatial Coverage:
N: 61° **S:** -61°
W: -180° **E:** 180°

Access:

- [Browse Granule Listing](#)
- [Search Granules](#)

Capabilities:

Download



Search for collections or topics



Search Results (9,769 Collections)

COWVR STP-H8 Surface Wind Vector and Column-Integrated Atmospheric Water Measurements Version 10.0

Showing 20 of 24,065 matching granules

Sort

View

Filter Granules

Clear Filters

Granule Search

Granule ID(s) ?

Example: *_20240101_**_20240102_*

Temporal

Start

YYYY-MM-DD HH:mm:ss

End

YYYY-MM-DD HH:mm:ss

☐ Recurring?

Data Access

☐ Find only granules that have browse images☐ Find only granules that are available onlineCOWVR_EDR.000170.20220108
T025845.20220108T040345.V1
001.J.20240103T120647

START 2022-01-08 02:58:45

END 2022-01-08 04:03:45

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001.J.20240103T120648

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START 2022-01-08 09:58:45

END

2022-01-08 11:03:45



Search Time: 0.4s

Add

Download All 24,065

Log In

Public data available with
1 day latencyEach granule (file) is 1
hour

1/7/2022 to present

1000 km

500 mi



MONTH

Aug

Sep

Oct

Nov

Dec

Jan

Feb

Mar

Apr

May

Jun

Jul

Compact Ocean Wind Vector Radiometer (COWVR) Environmental Data Record (EDR) Quick-start Users Guide

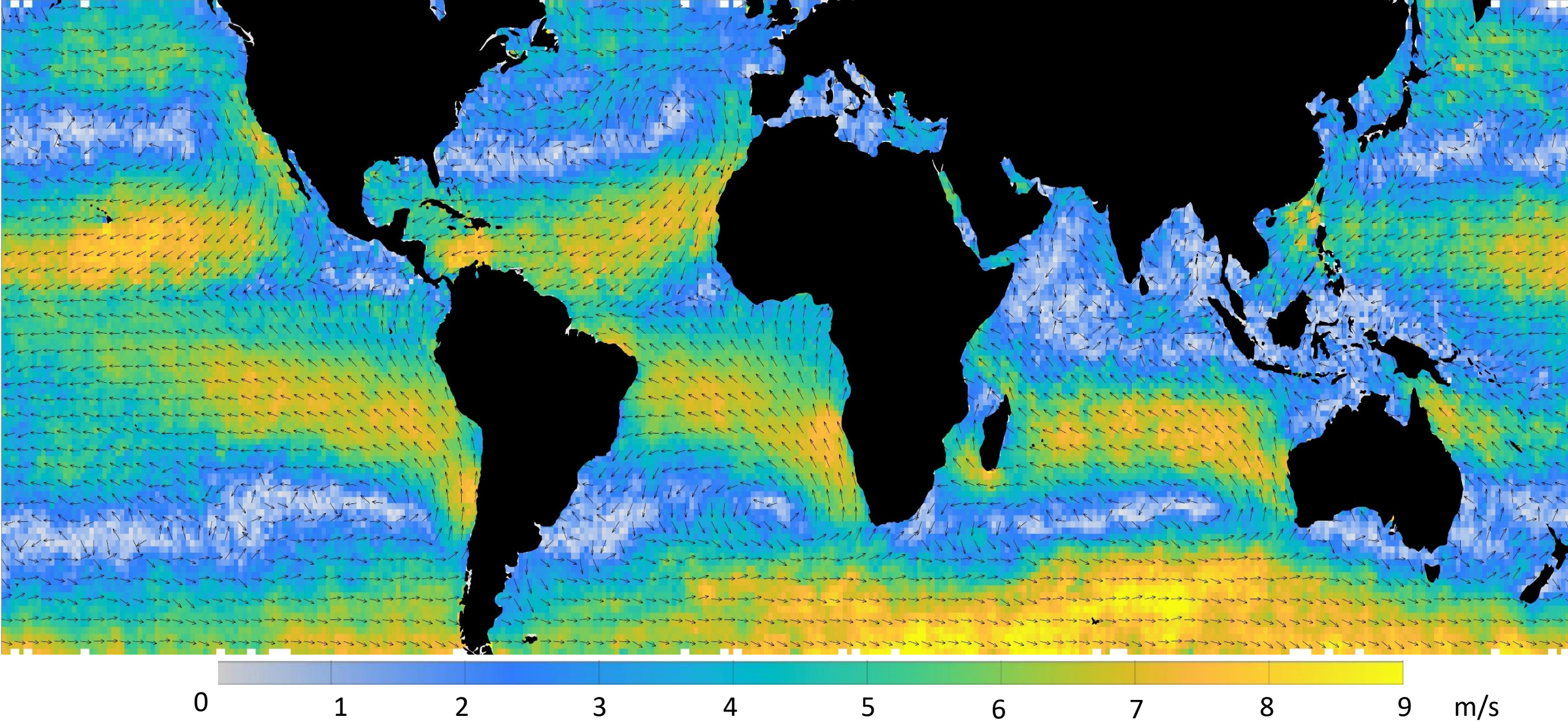
Prepared by: Shannon Brown (shannon.t.brown@jpl.nasa.gov), Mary Morris
Jet Propulsion Laboratory, California Institute of Technology
Date: 9/25/2024
Version 1.0



- Quick start user guide available on PO.DAAC
- Short document to get acquainted with data fields, flagging, ISS considerations, etc.

A long-exposure photograph taken from the International Space Station (ISS) looking down at Earth. The image shows a curved horizon of the planet with a thin layer of white clouds. Below the horizon, numerous light trails from cities and towns are visible, appearing as streaks of white and yellow light. The foreground shows the complex structure of the ISS, including various modules and solar panel arrays, which are slightly out of focus. The overall scene is set against the black background of space.

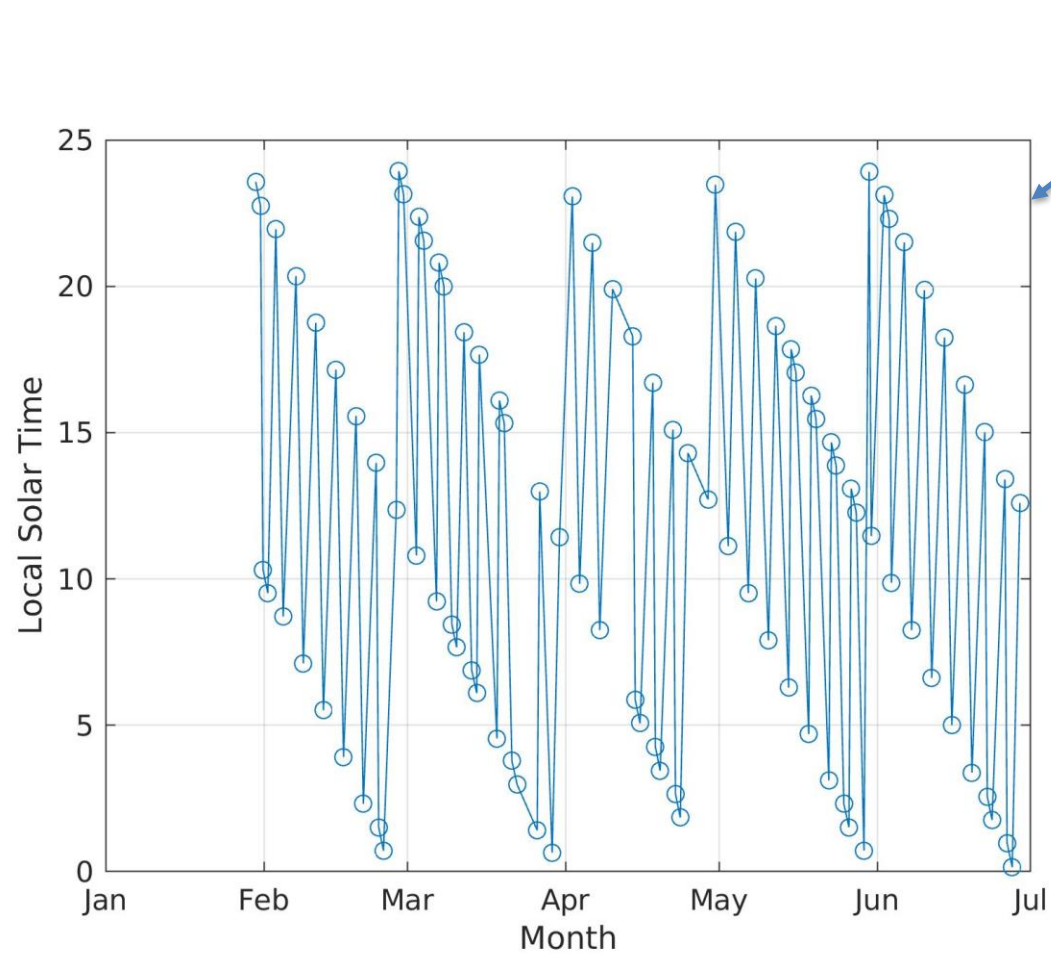
Unique COWVR Sampling from ISS



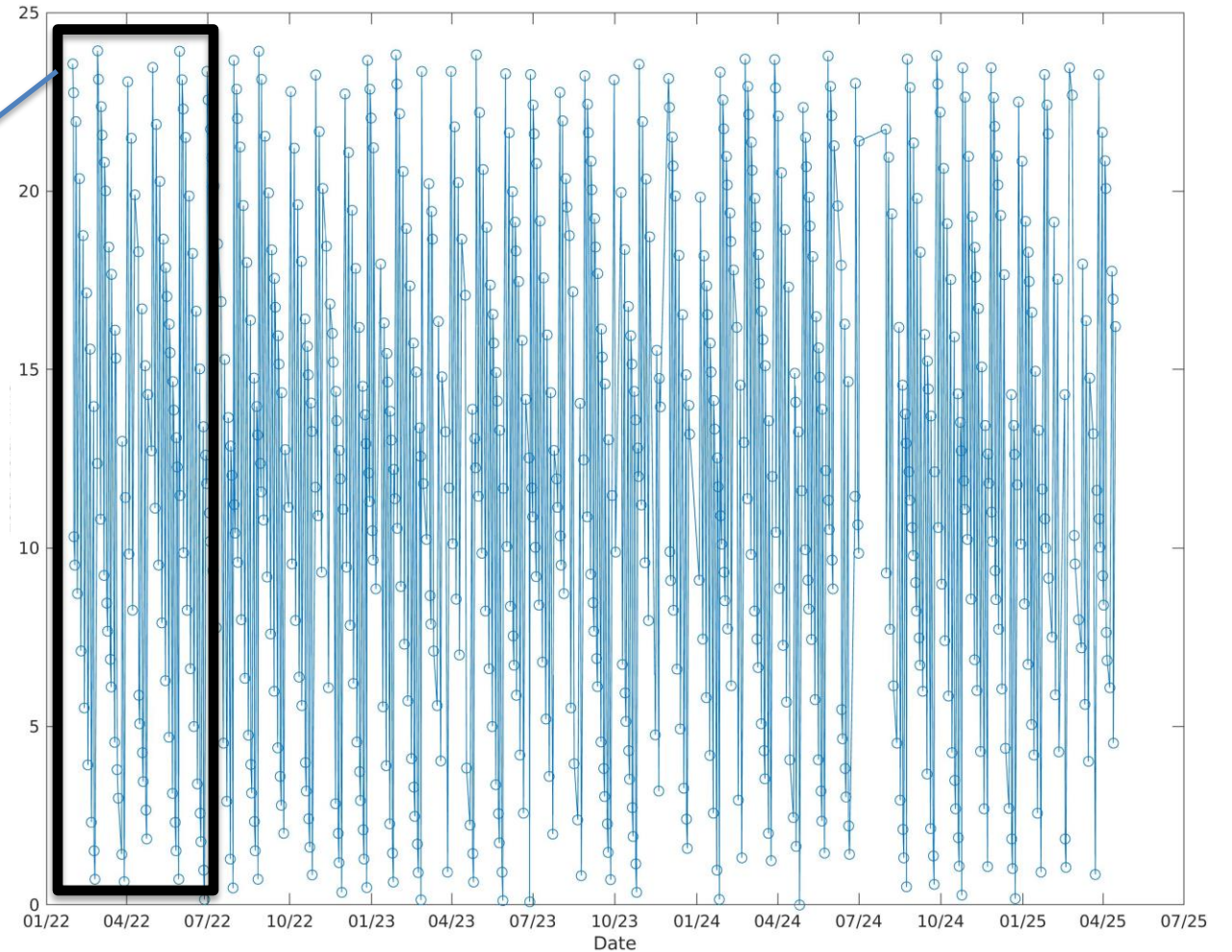
COWVR 3.5-Year Annual Mean Wind Speed and Direction

Diurnal Sampling

Good sampling over diurnal cycle each month



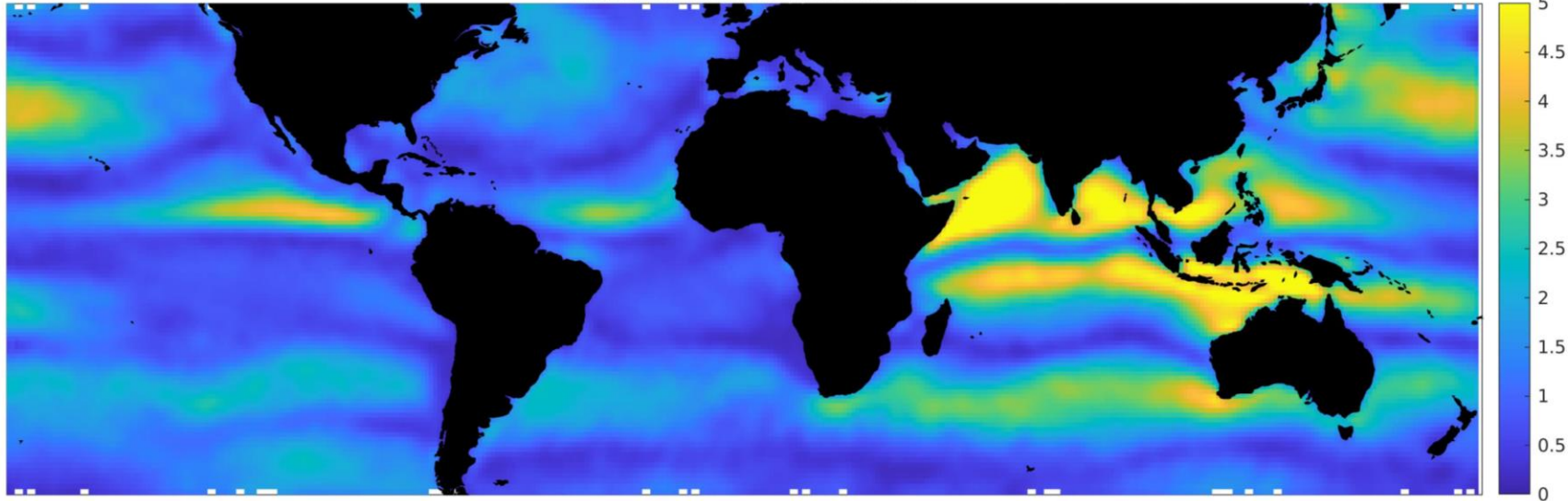
Diurnal Sampling Near Equator



2022 - 2025

Annual Harmonic Amplitude (Zonal)

Zonal: Annual 1st Harmonic



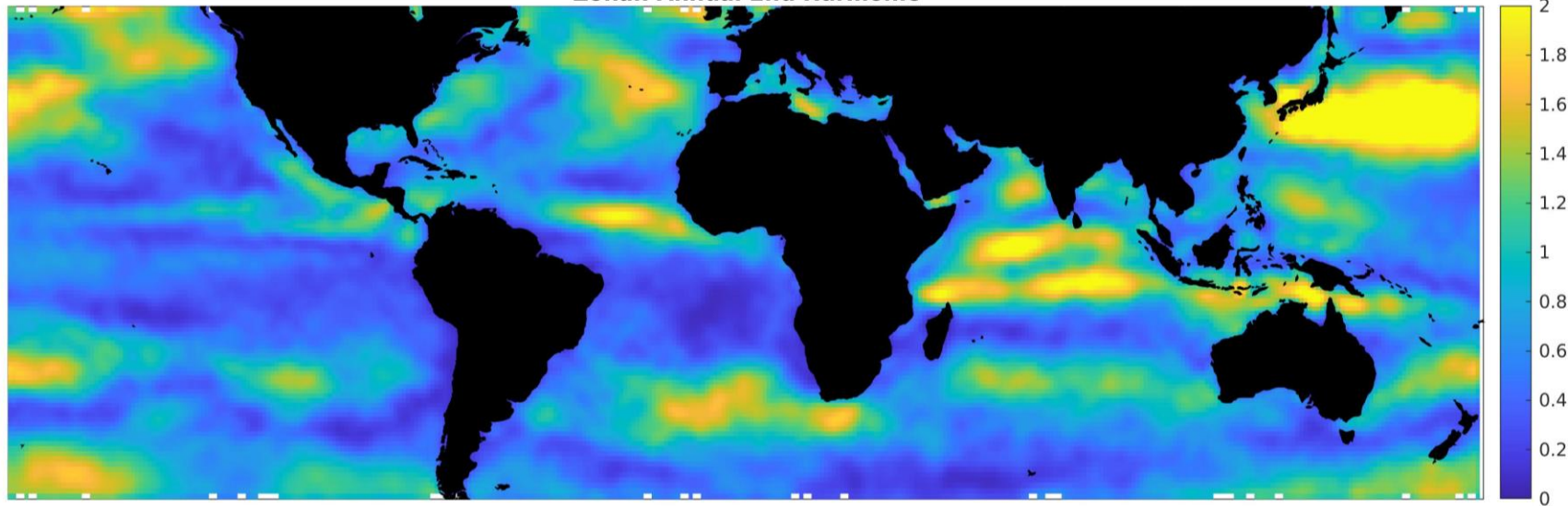
1st Harmonic

W



E

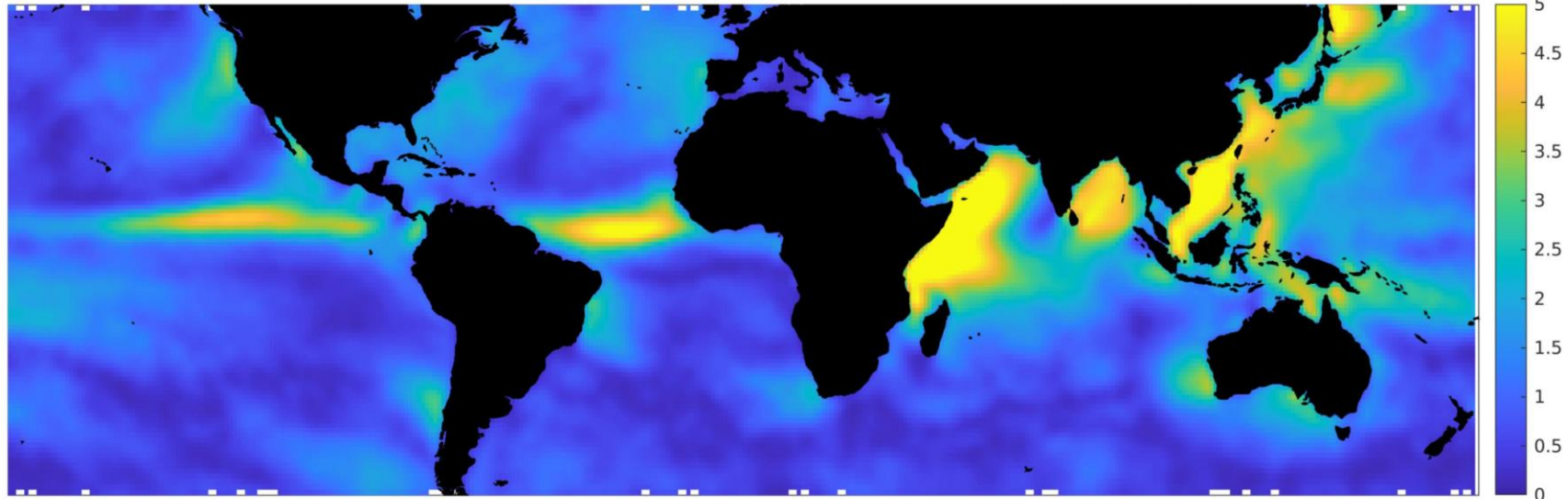
Zonal: Annual 2nd Harmonic



2nd Harmonic

Annual Harmonics Amplitude (Meridional)

Meridional: Annual 1st Harmonic



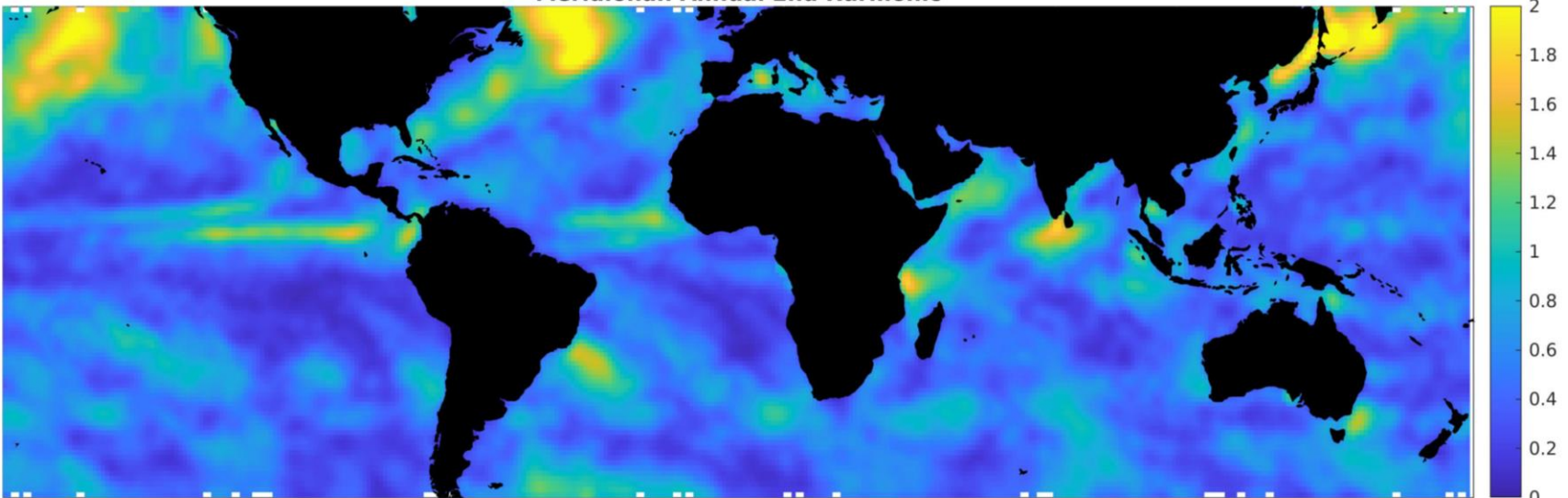
1st Harmonic

N



S

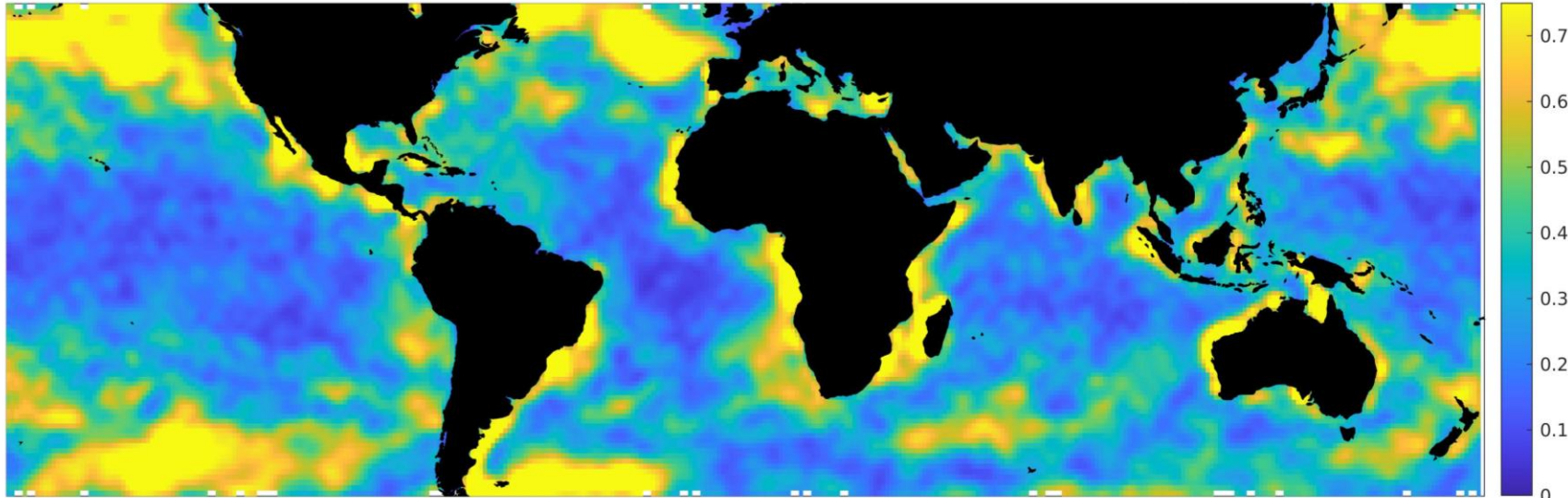
Meridional: Annual 2nd Harmonic



2nd Harmonic

Diurnal Harmonic Amplitude (Zonal)

Zonal: Diurnal 1st Harmonic



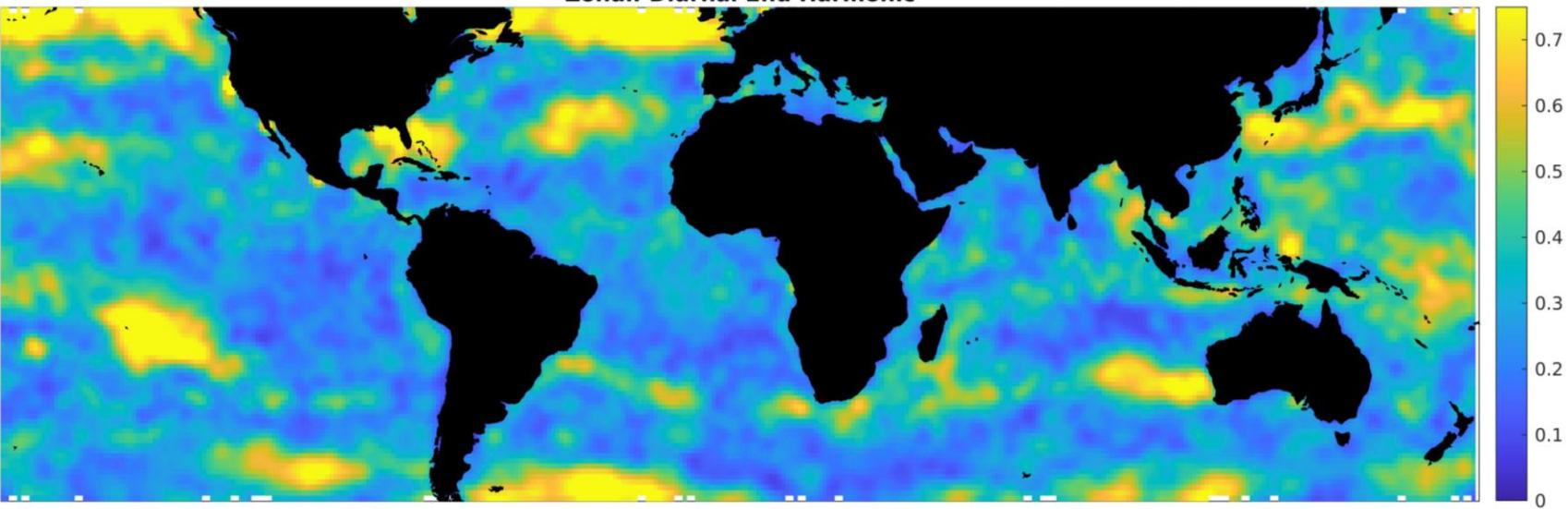
1st Harmonic

W



E

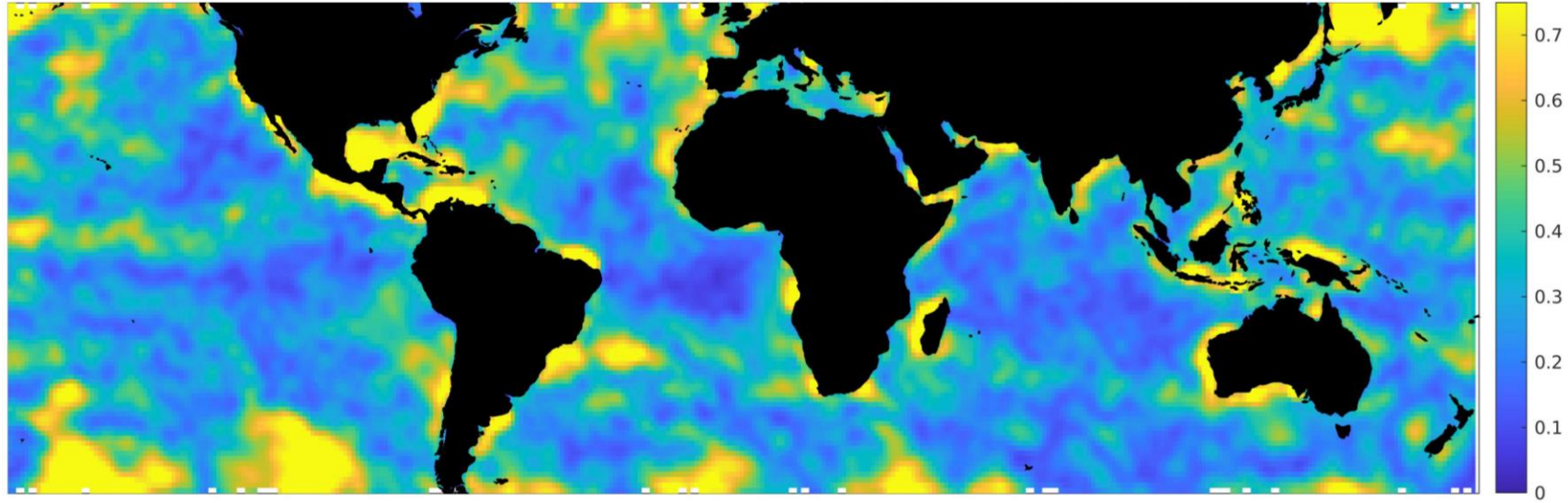
Zonal: Diurnal 2nd Harmonic



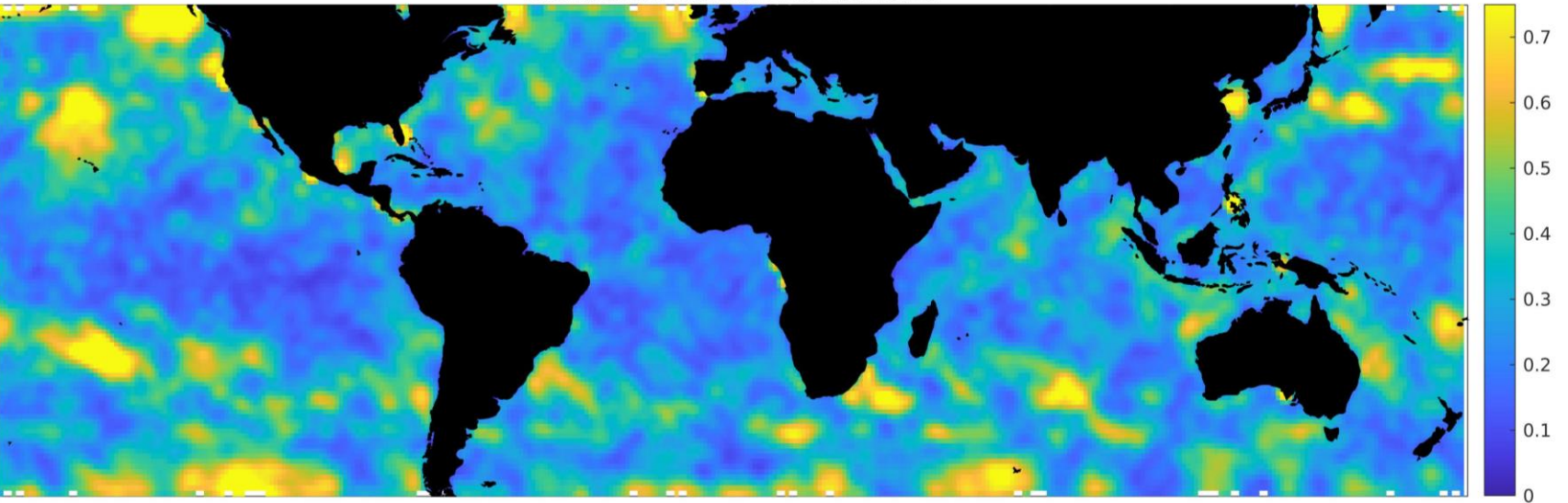
2nd Harmonic

Diurnal Harmonic Amplitude (Meridional)

Meridional: Diurnal 1st Harmonic



Meridional: Diurnal 2nd Harmonic



1st Harmonic

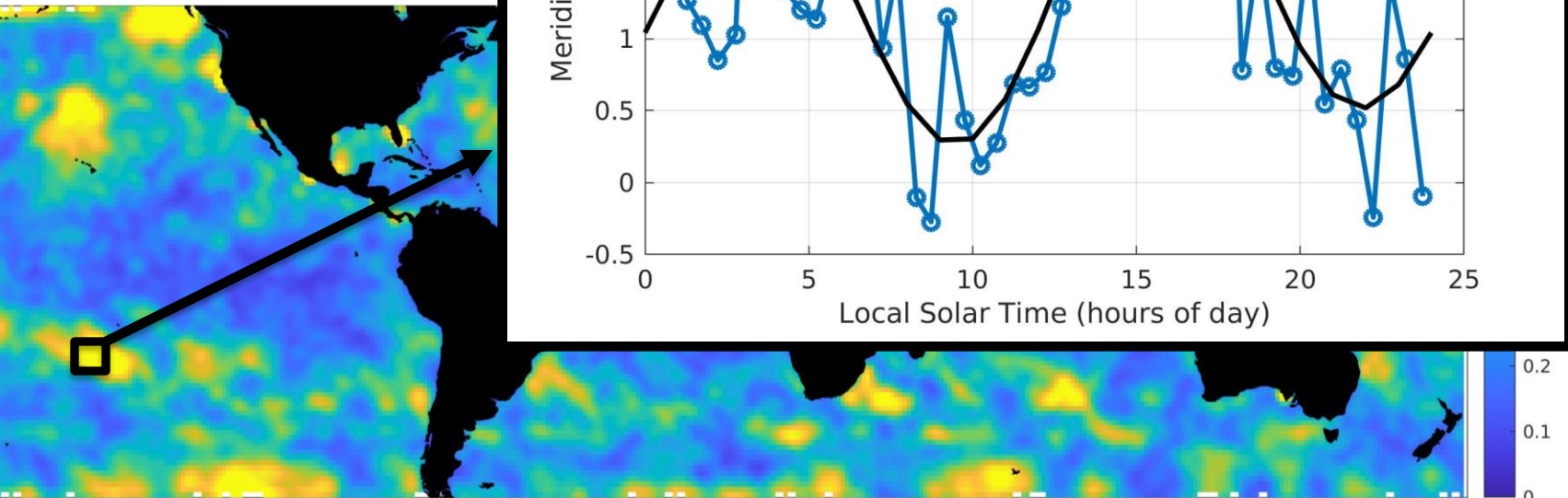
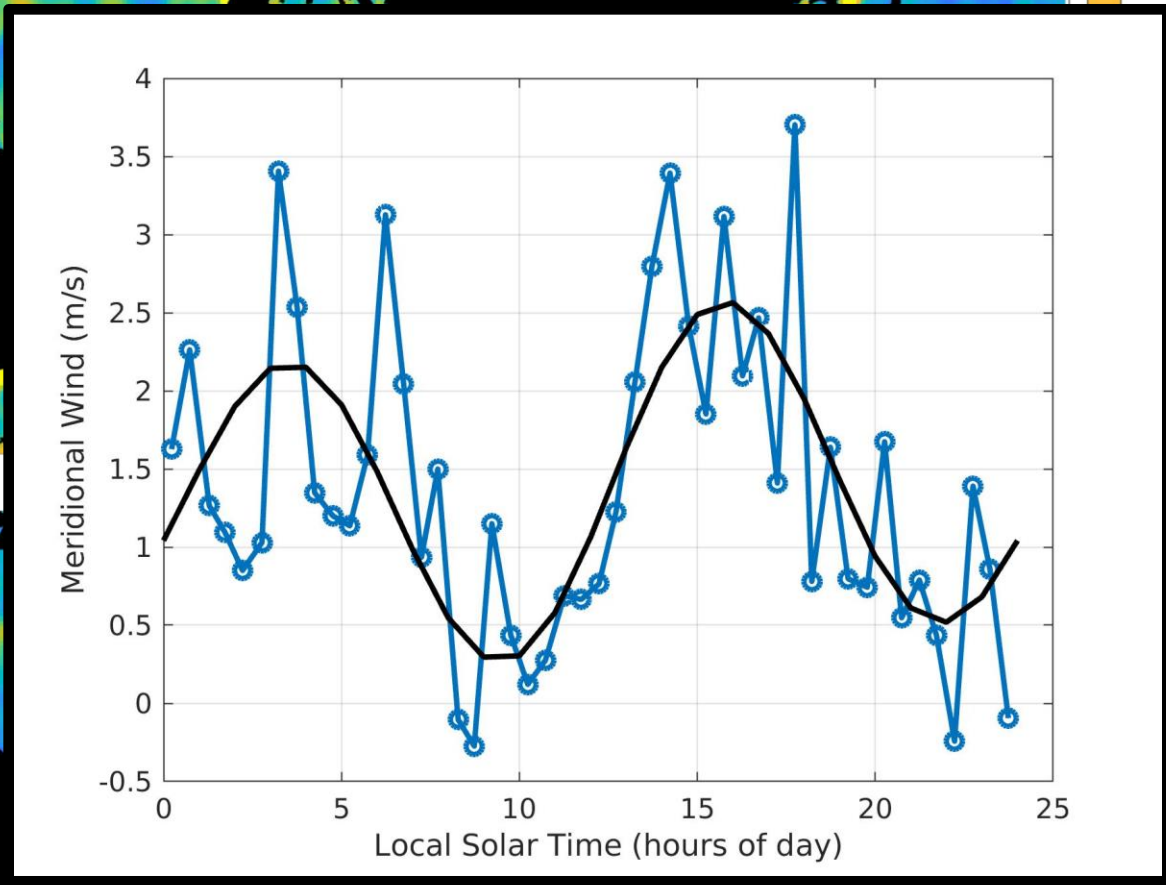
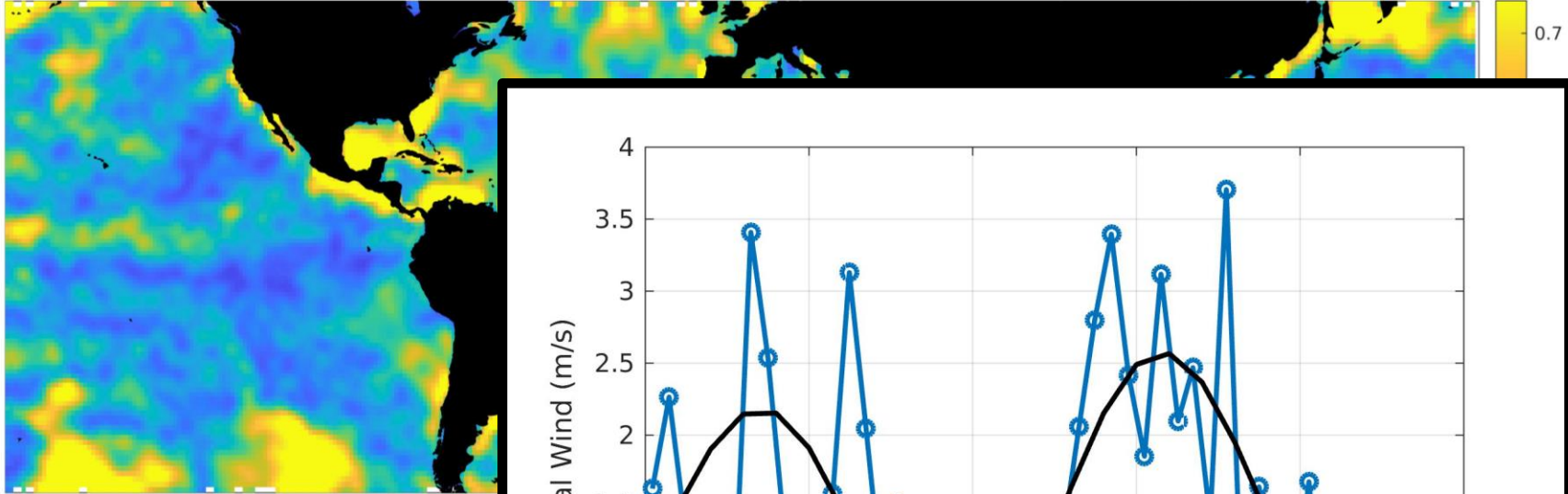
N



S

2nd Harmonic

Meridional: Diurnal 1st Harmonic



Compact Ocean Wind Vector Radiometer (COWVR) technology demonstrated:

Enables a low-cost constellation for rapid revisit
ocean vector wind measurement and microwave
imaging supplementing operational scatterometer
constellation in SSO orbits



Mission Status

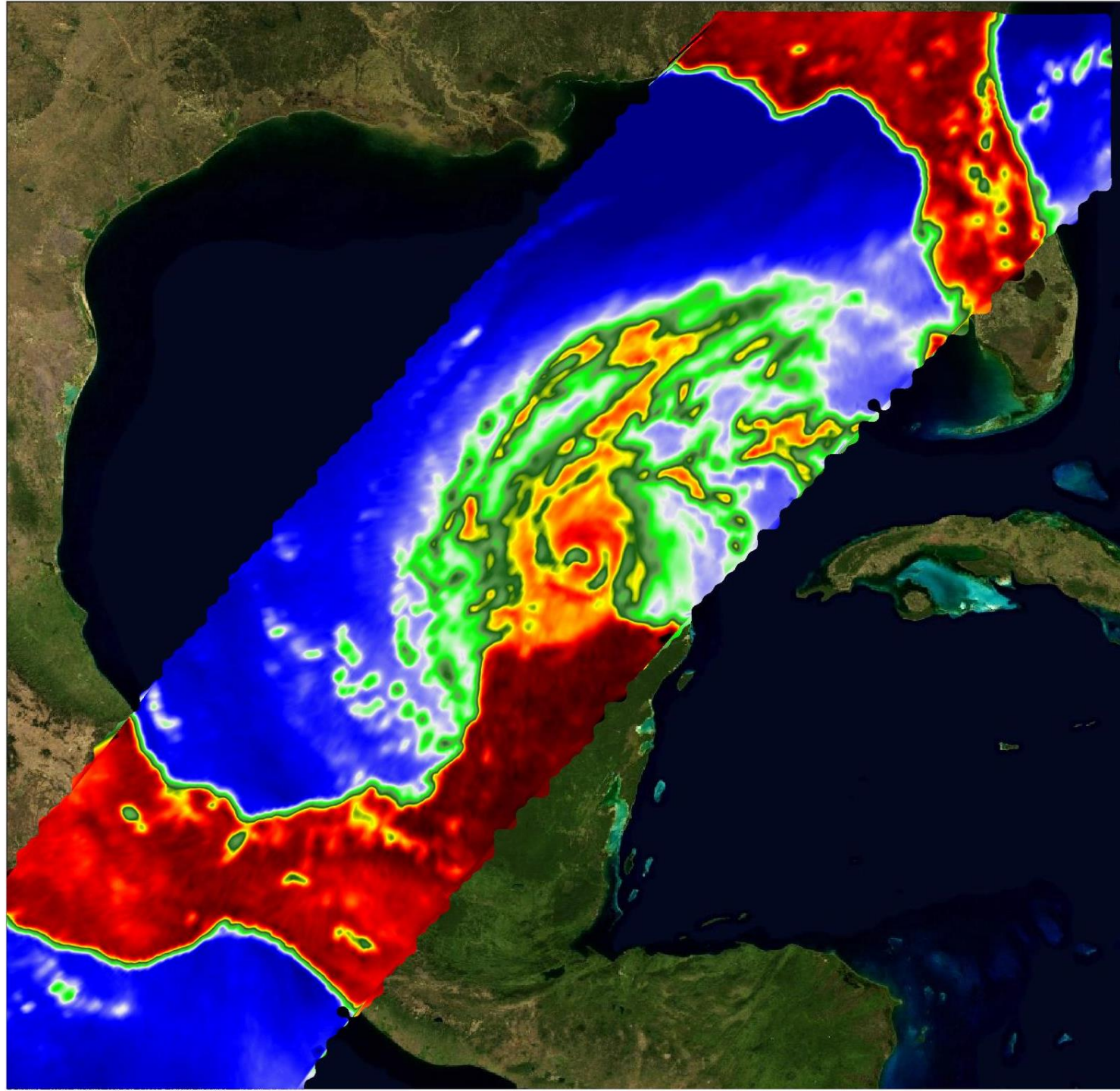
- **COWVR design is validated** for precision microwave imagery and retrievals
- **Paves way for new class of small-satellite conical microwave imagers (NASA AOS, DoD, NOAA)**
- **Uniquely** samples winds combined with atmosphere **over diurnal cycle**
- Providing **low-latency (~2 hour) operational data** since September 2022
- All COWVR and TEMPEST data, including L2 (EDRs), are **available on NASA Earth Data through PO.DAAC** (search COWVR)
- **COWVR will remain operational on ISS through at least August 2025 and may continue into 2026**



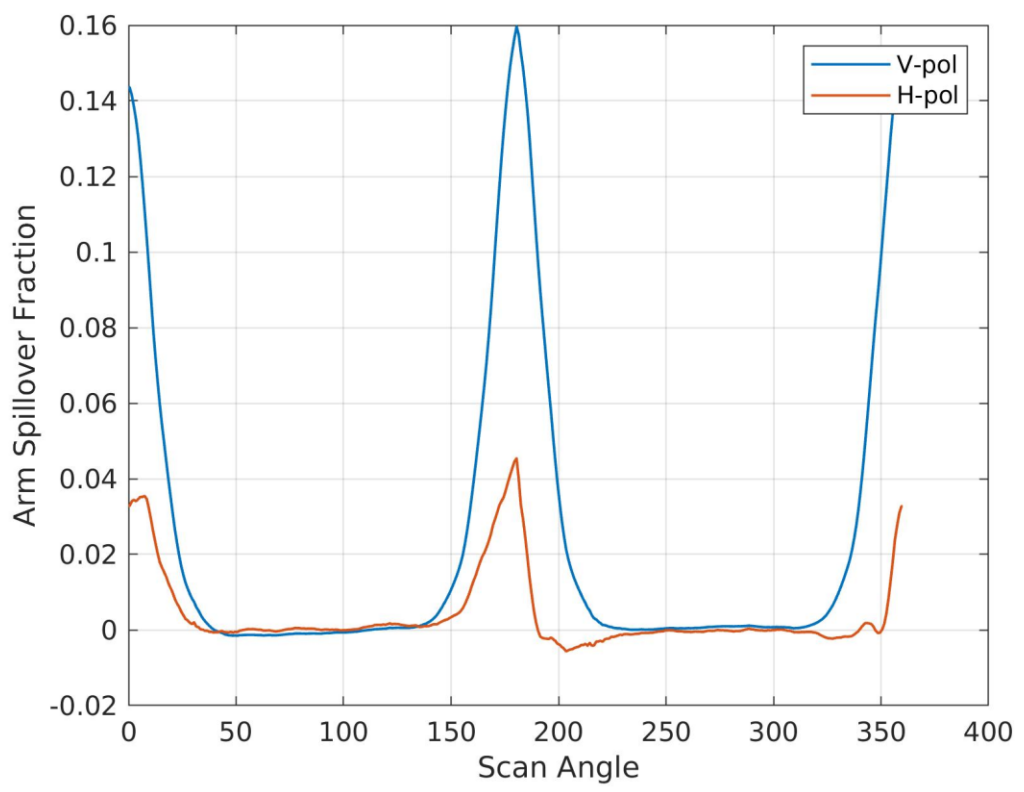
Small Satellite Conical Microwave Imagers Are Ready!

Backup

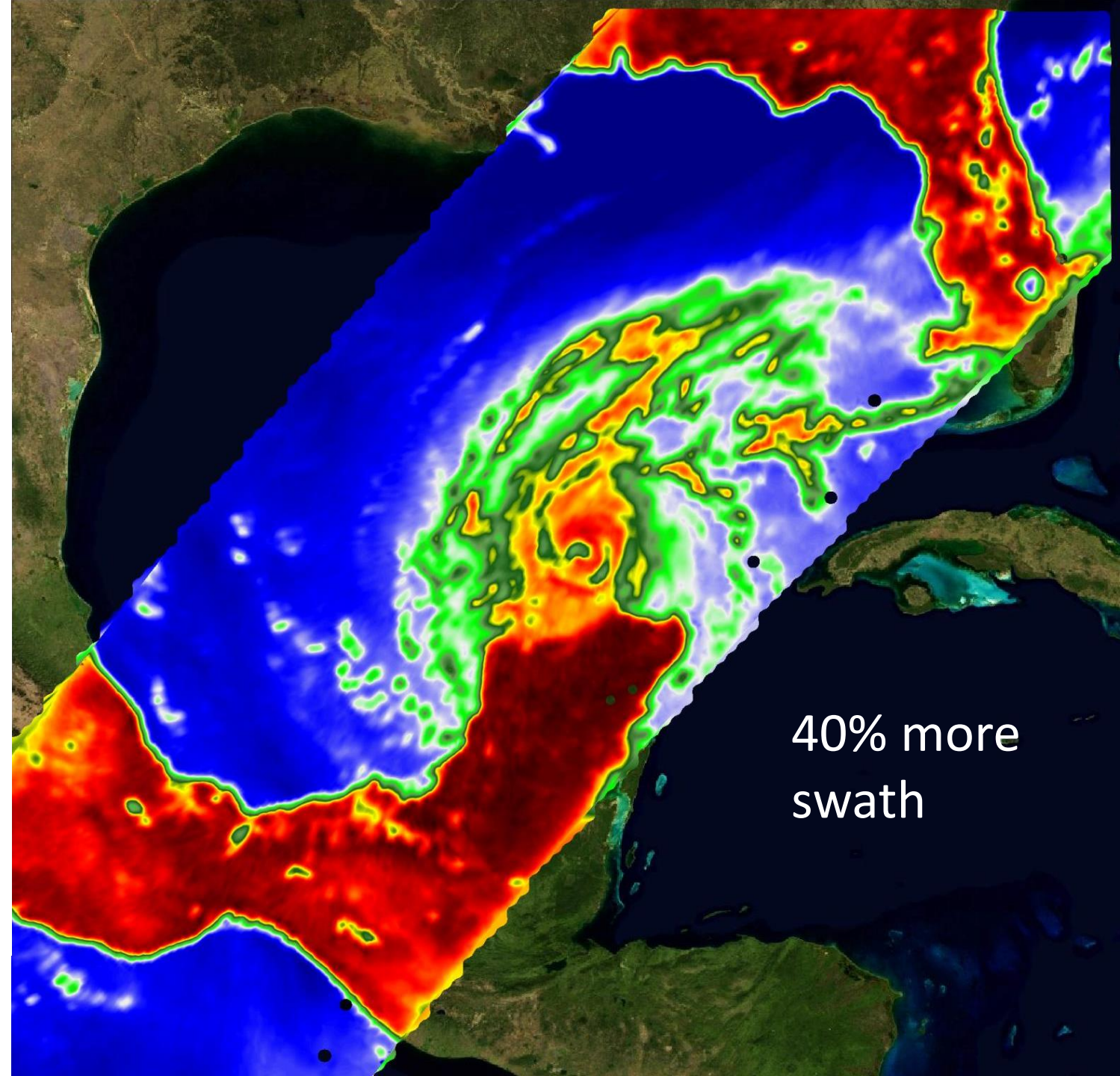
Support arm blockage correction
implemented in ATCF imagery
starting November 2024 adding
extra 40% to swath



Support arm blockage correction
implemented in ATCF imagery
**starting November 2024 adding
extra 40% to swath**

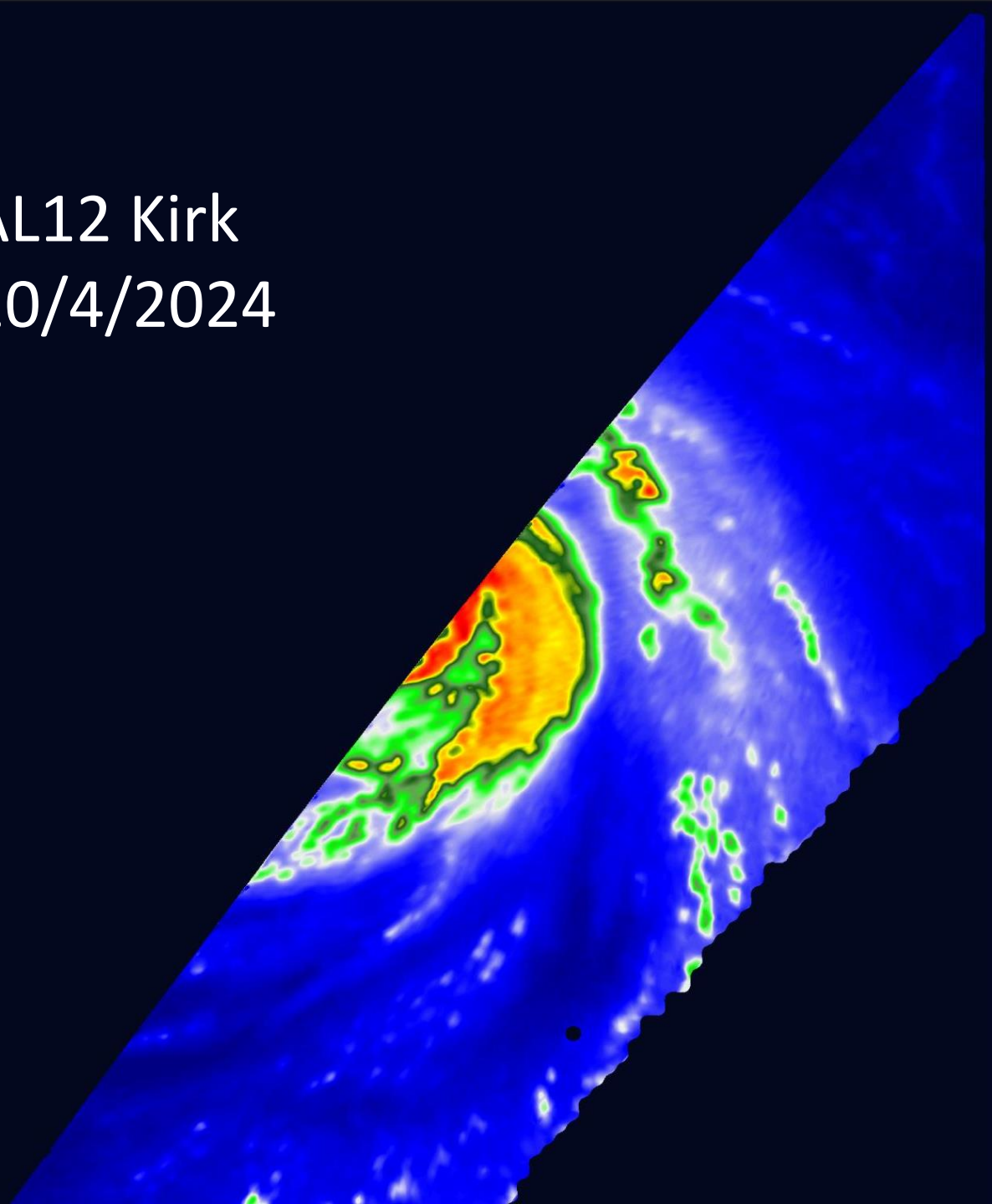


Applied as an angle dependent
spillover correction



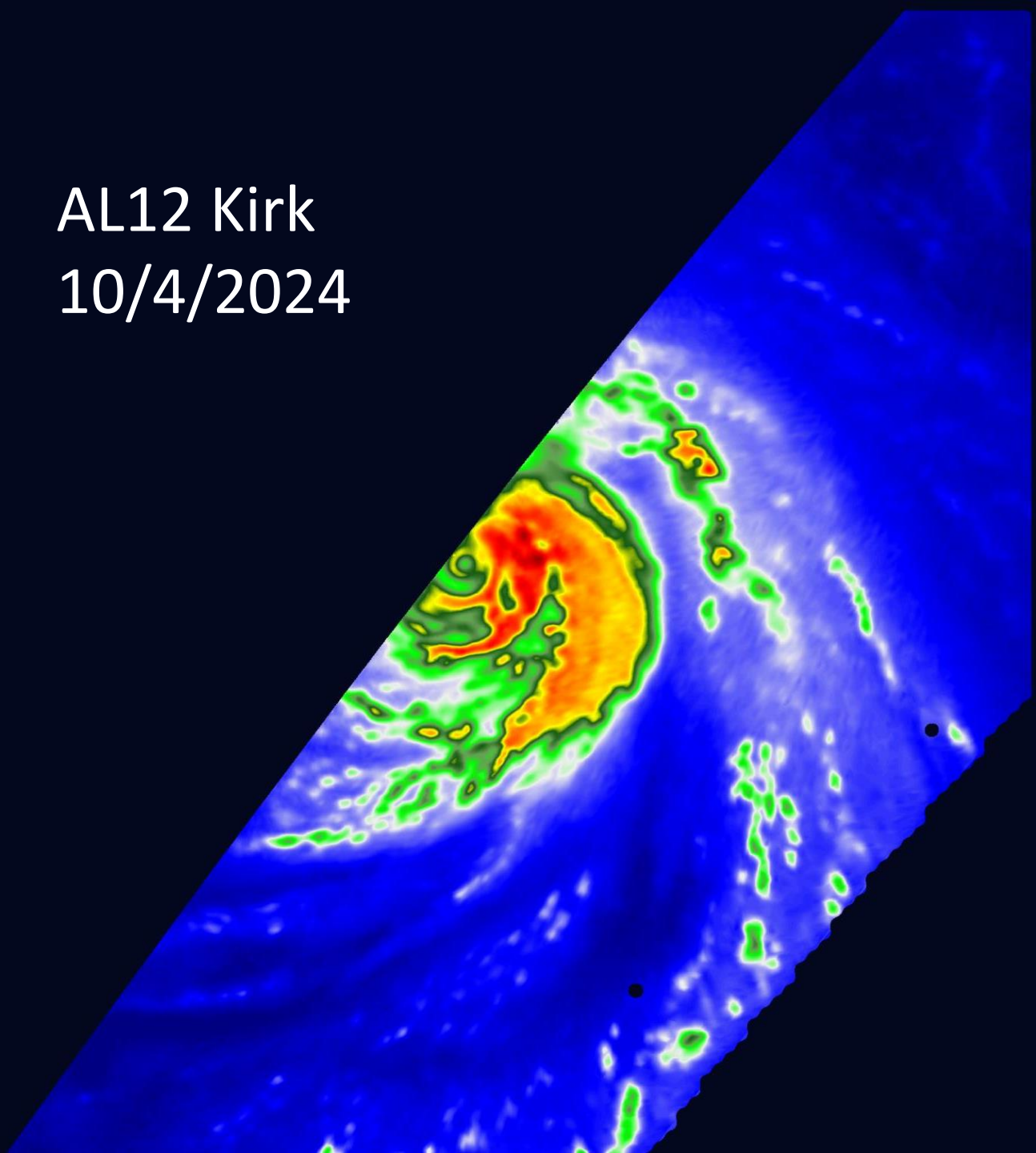


AL12 Kirk
10/4/2024

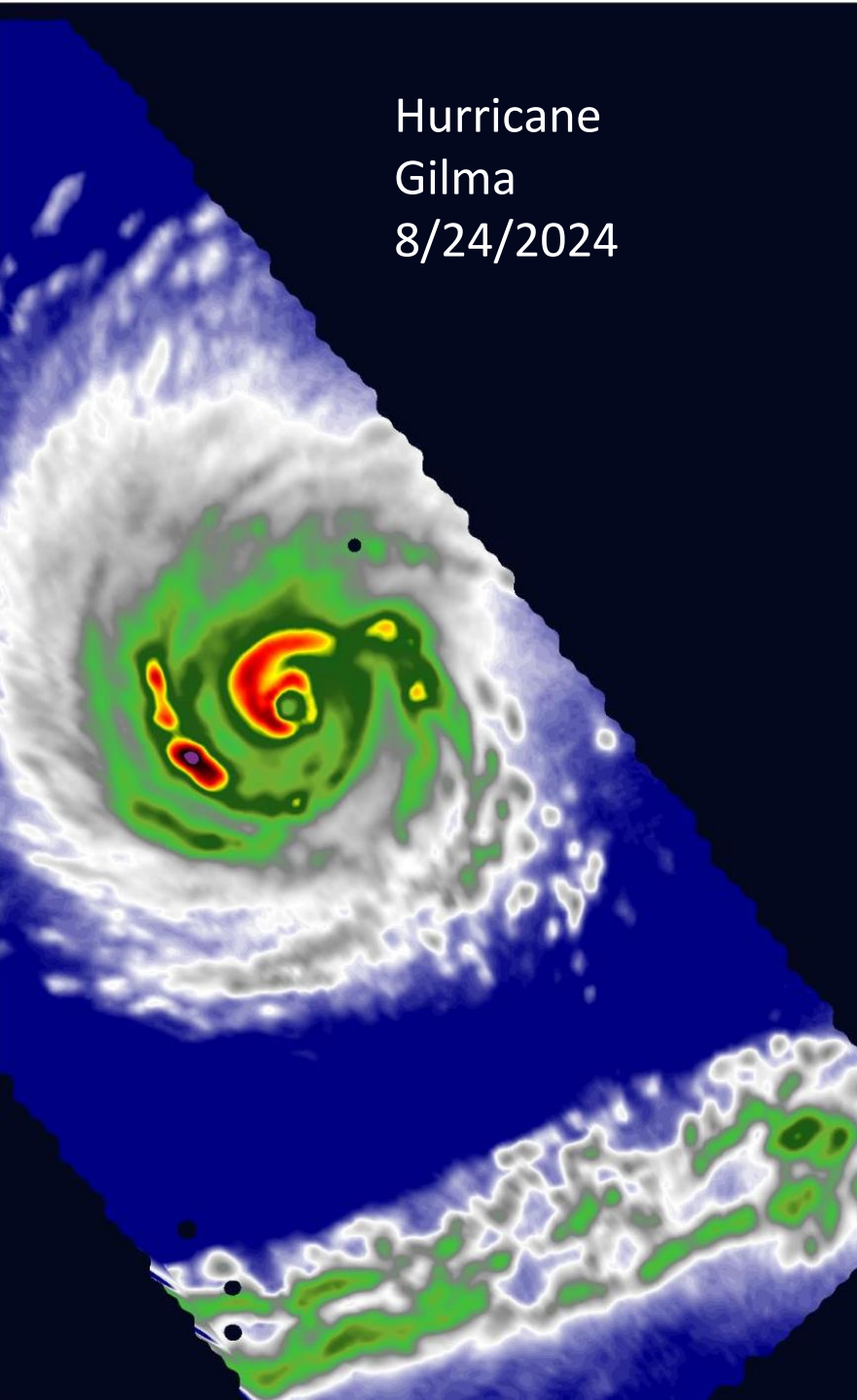




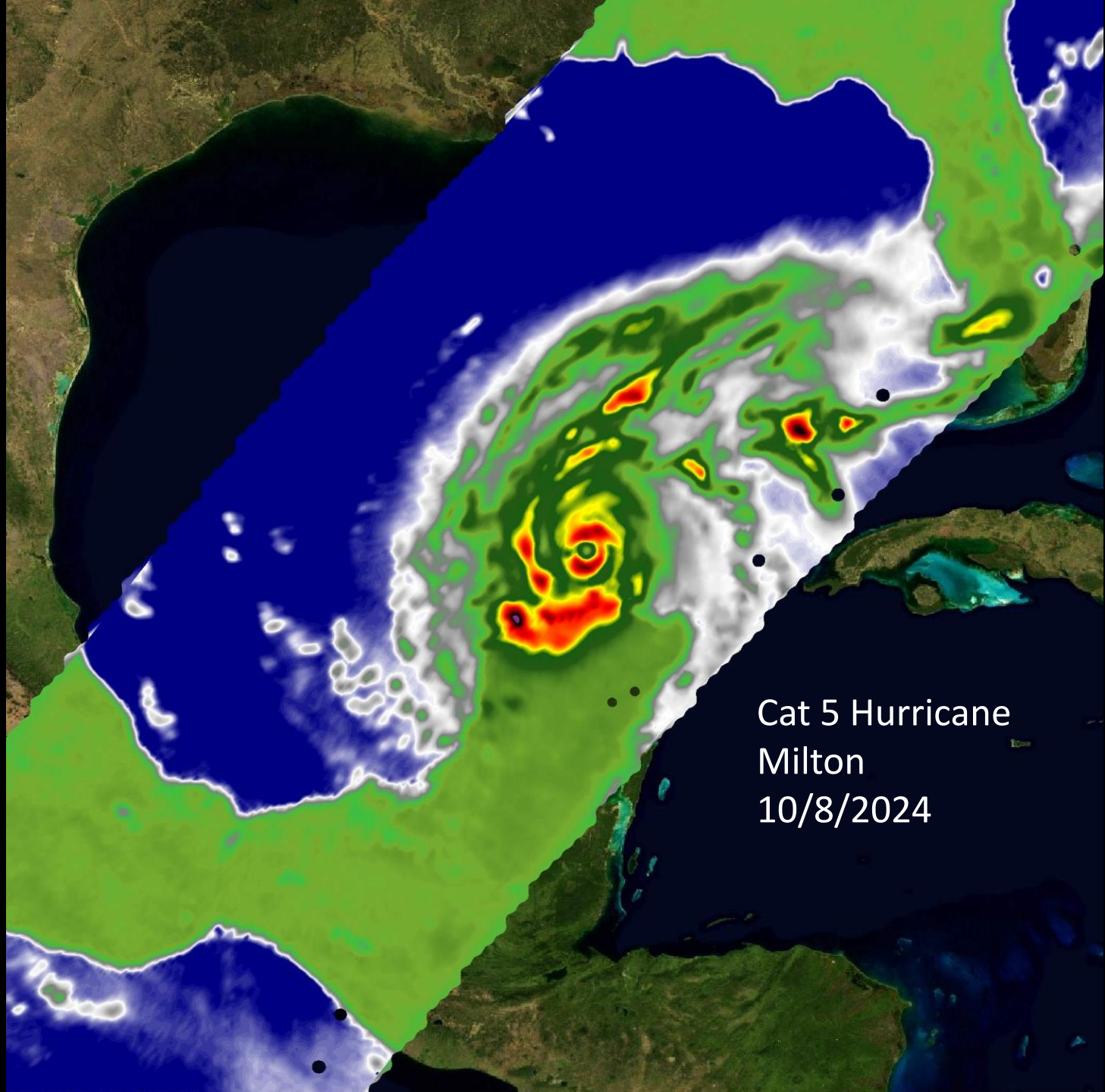
AL12 Kirk
10/4/2024



Hurricane
Gilma
8/24/2024



Cat 5 Hurricane
Milton
10/8/2024



Platform

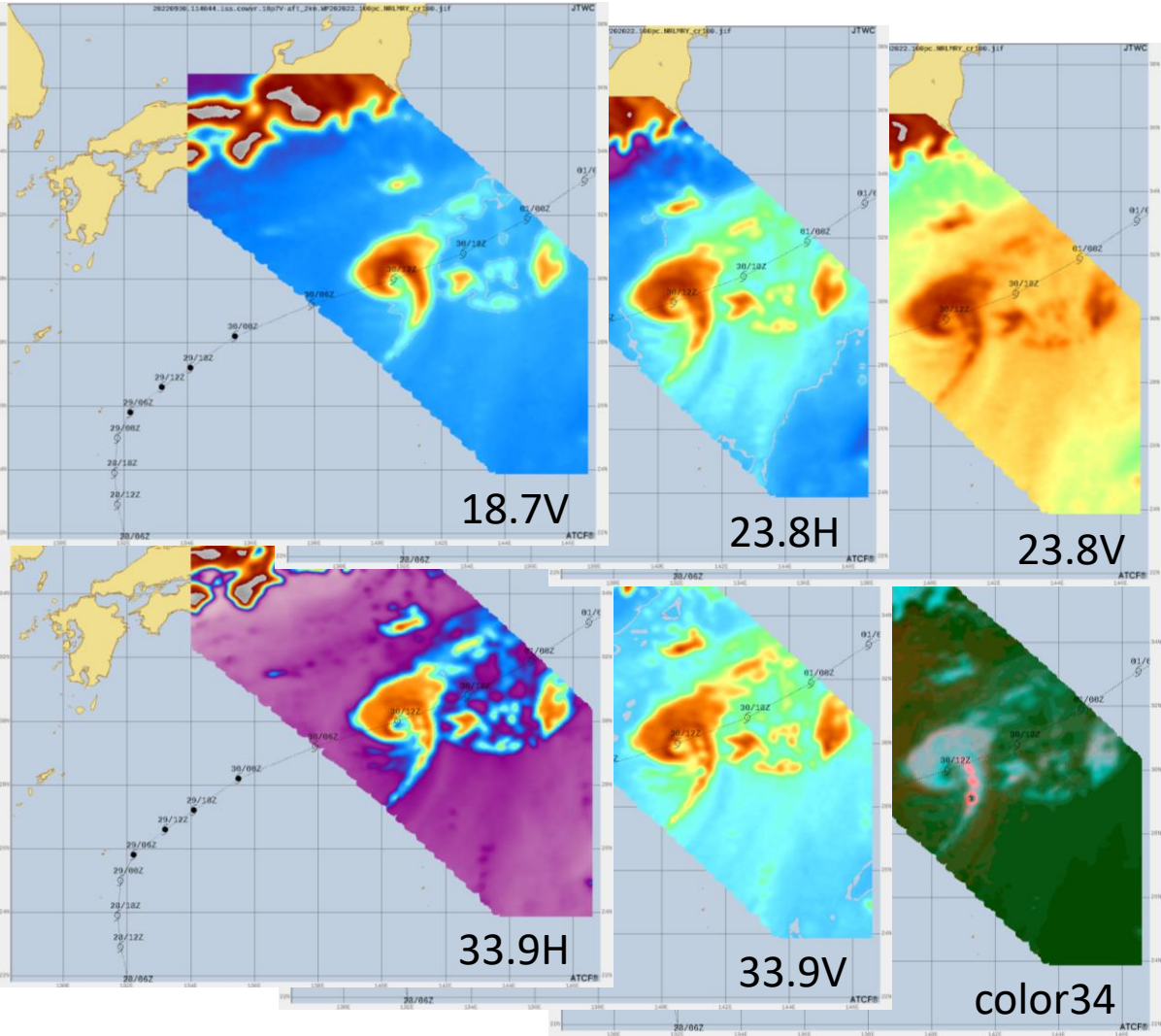


COWVR Imagery Available in Automated Tropical Cyclone Forecasting System (ATCF)

TS 20W (ROKE) - 30 Sep / 114044Z

Latency typically 2 hours

COWVR (aft-look)

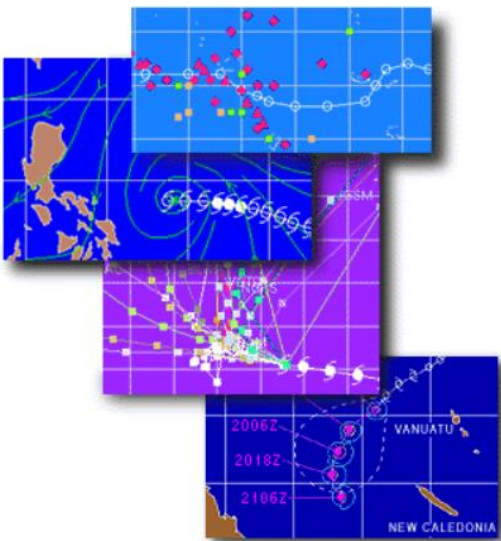


Credit NRL



ATCF®

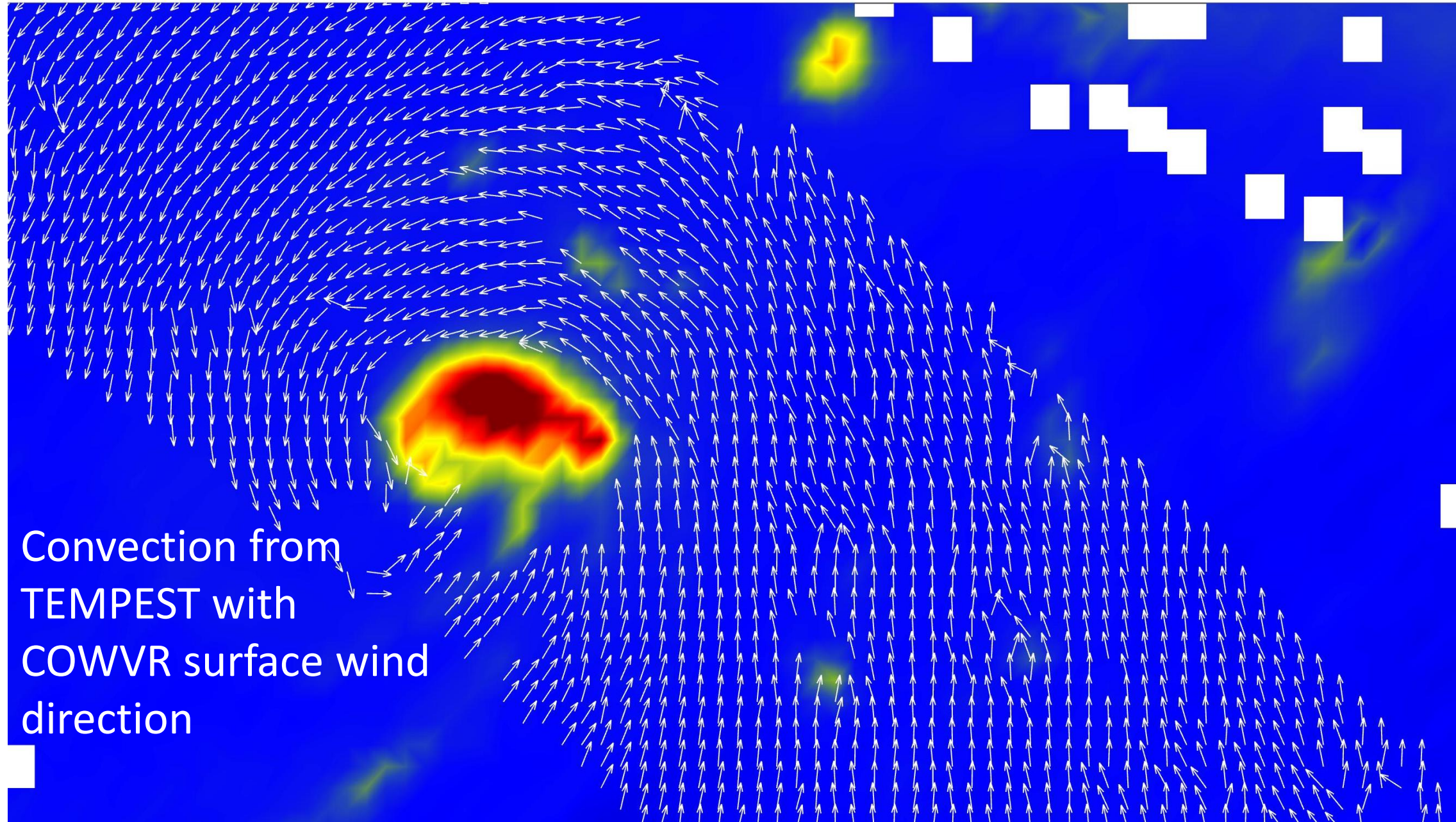
About ATCF ATCF Support TC Imagery



The Automated Tropical Cyclone Forecasting System (ATCF®) developed by NRL Monterey is a computer based application designed to automate and optimize the forecasting process at operational U.S. Department of Defense and National Weather Service tropical cyclone warning centers.

- Operational Users
- The Joint Typhoon Warning Center
 - The Naval Pacific Meteorology and Oceanography Center
 - The Naval Atlantic Meteorology and Oceanography Center
 - The National Hurricane Center
 - The Central Pacific Hurricane Center

COWVR/TEMPEST Synergy (July 20, 2024, Central Atlantic)



JPL Compact Ocean Wind Vector Radiometer

Small-sat Compatible Design

Only reflector rotates

Simple spin mechanism

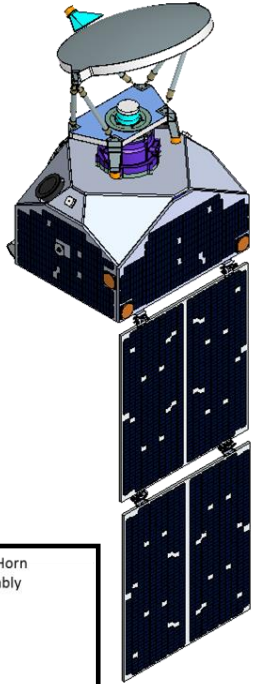
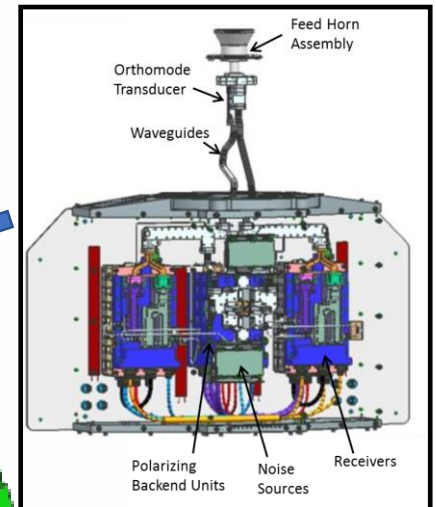
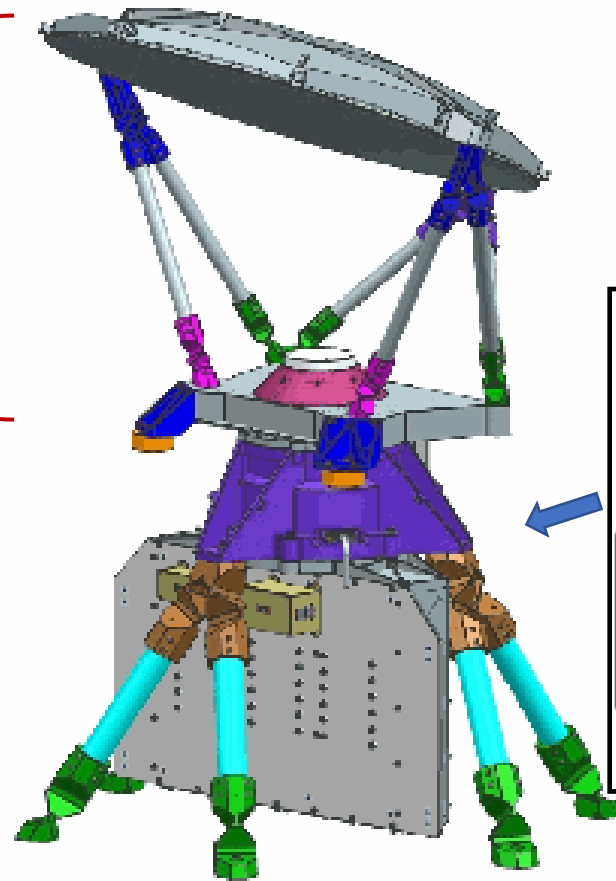
Single broadband feed horn

Fully polarimetric

360° Conical Scan (fore/aft)

10kg rotating

Spinning
portion



Built for 20% of the cost of a traditional microwave imager, with 100% of the data quality