A Stable Satellite Wind Climate Data Record for Climate Variability Studies

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1. INTRODUCTION

- Multiple scatterometers and radiometers processed at Remote Sensing Systems (RSS) were used to develop a Climate Data Record (CDR) of Ocean Vector Winds (OVW, 1999-present) and Ocean Wind Speed (OWS, 1988-present).
- The main objective of the RSS wind CDR is to provide wind timeseries consistent with the climate data records of other air-sea essential climate variable (AS-ECV) derived from RSS radiometers: Atmospheric water vapor, precipitation, sea surface temperature, and cloud liquid water. This set of AS-ECV facilitates studies of climate variability, and investigations on the relationship between changes in the atmospheric circulation and the water cycle, at local and global scales.

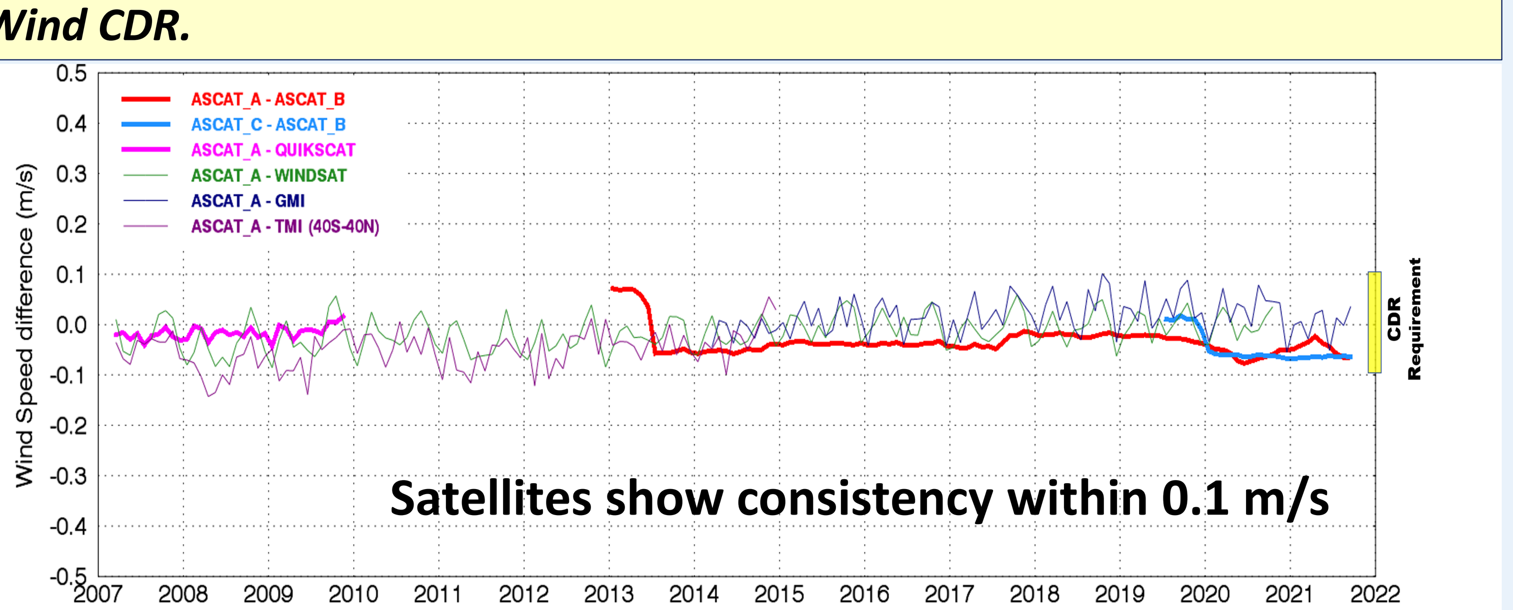
Table 1: Past, present, and future scatterometers and radiometers used to create the RSS wind CDR.

Scatterometers	Sensors	Mission life	Ascending Node Time	Rain impact	High wind capability
Ku-band	QuikSCAT	1999-2009	6 am	Significant	Limited
C-band VV-pol	ASCAT-A, -B, -C	2007-present	9:30 pm	At low winds	Limited
C-band cross-pol	**SCA**	**2025-2047**	**9:30 pm**	**TBD**	**Yes**
Radiometers					
(Wind Vector)	WindSat COWVR WSF-MWI	2003-2020 2021-present Launch: 2024	6 pm Precessing 6 pm	All-weather TBD TBD	Yes (TC-winds) Limited TBD
(Wind Speed only)	SSMI, SSMIS TMI and GMI AMSR-E/AMSR2 SMAP AMSR3	1988-present 1998-present 2002-present 2015-present Launch: 2024	4 to 10 pm Precessing 1:30 pm 6 am 1:30 pm	Yes, flagged Yes, flagged All-weather All-weather All-weather	Limited Limited Yes (TC-winds) Yes Yes (TC-winds)

2. Cross-Calibration and Stability of RSS CDR

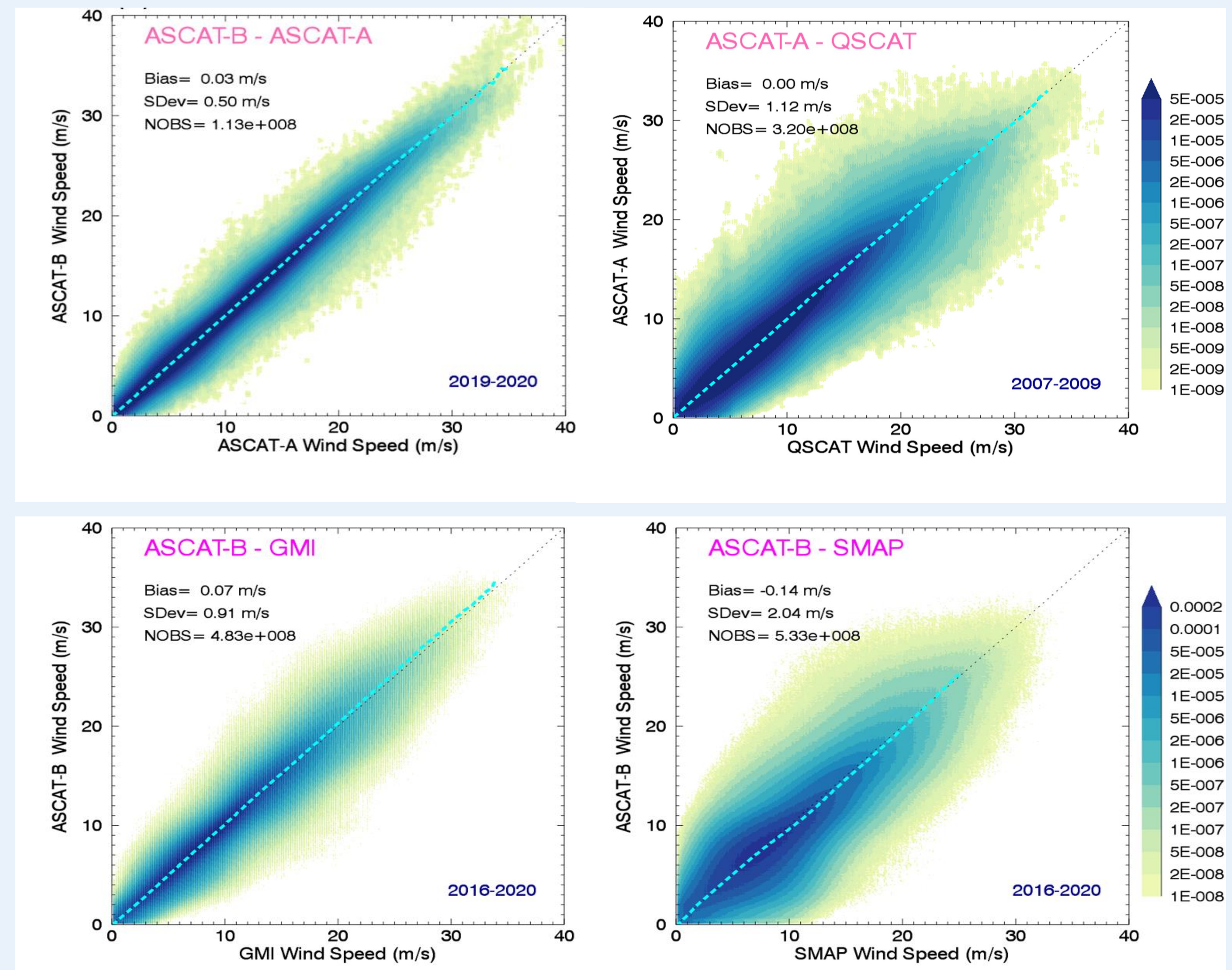
- The cross-calibration is achieved by using a common Radiative Transfer Model for all radiometers, and calibrating the scatterometer model functions (GMFs) to radiometers winds.
- Non-sun-synchronous radiometers (TMI/GMI) are used for transferring calibration to different times of day [e.g.: QSCAT (6 am/pm) → ASCAT(9:30 am/pm)]
- In-situ winds are then used for validation (see section 4.)

Figure 1: Differences between collocated scatterometer and radiometer measurements between 55 N/S on a monthly timescale for satellites used in the RSS Wind CDR.



3. Verification of Cross-Calibration for Scatterometers/Radiometers (0-35 m/s)

Figure 2: Matchups between collocated ASCAT-A and ASCAT-B and with other satellites in the RSS wind CDR: QuikSCAT, GMI, and SMAP.



4. Validation with In-situ Winds

- An independent validation of each sensor is performed using traditional in-situ wind observations from global moored buoys (0-15 m/s) as well as novel observations from Saildrones, which provide accurate observations even at hurricane-force wind speeds.

Figure 3: ASCAT-B colocated to buoys within 30-min, 25 km

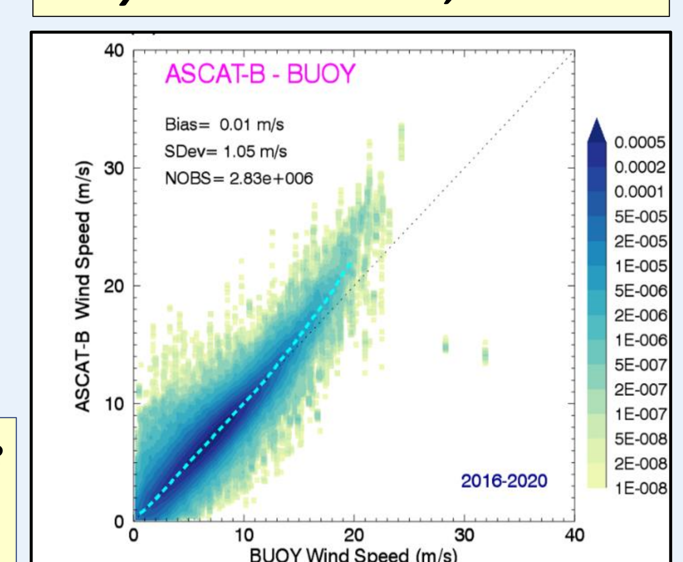
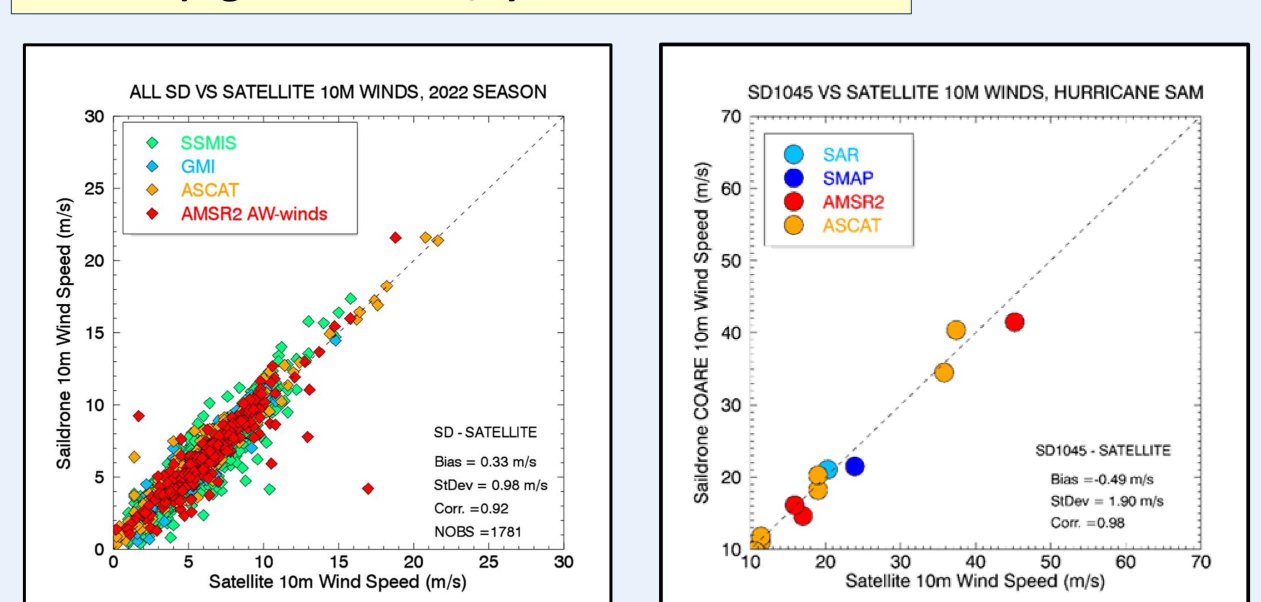


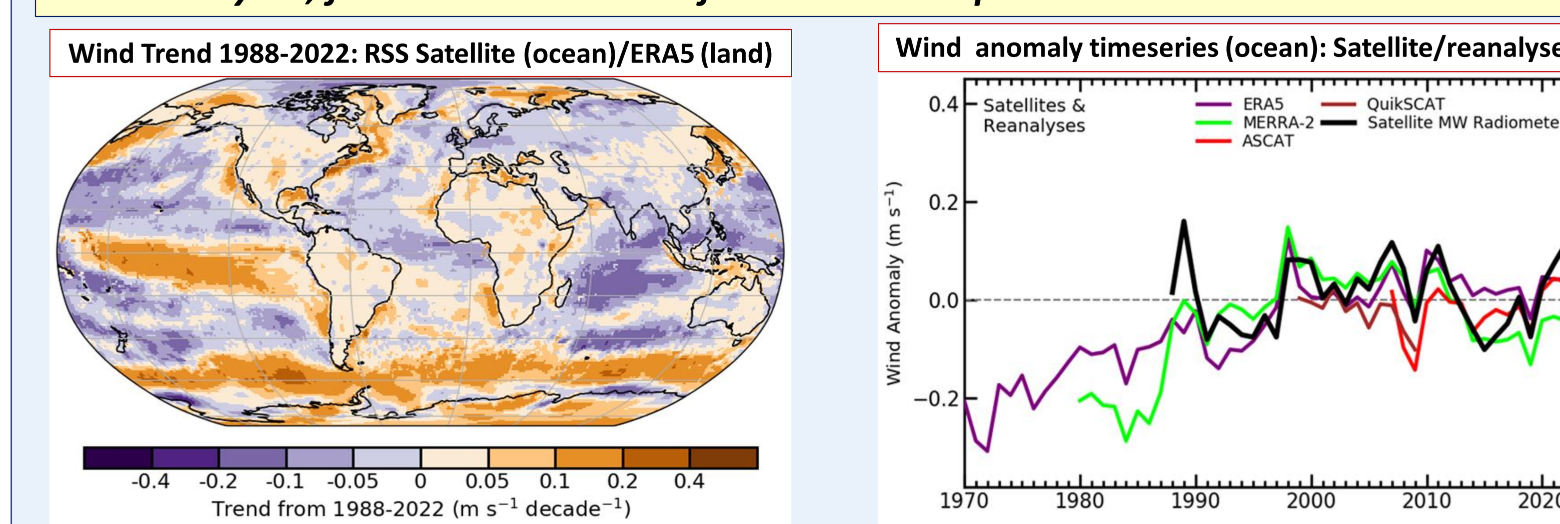
Figure 4: Matchups between satellites in the RSS wind CDR and Saildrone measurements made in the Atlantic in Fall 2022 at low-to moderate winds (left) and in Hurricane Sam in 2021 (right, 10-45 m/s).



5. RSS Wind CDR and Climate Variability Studies

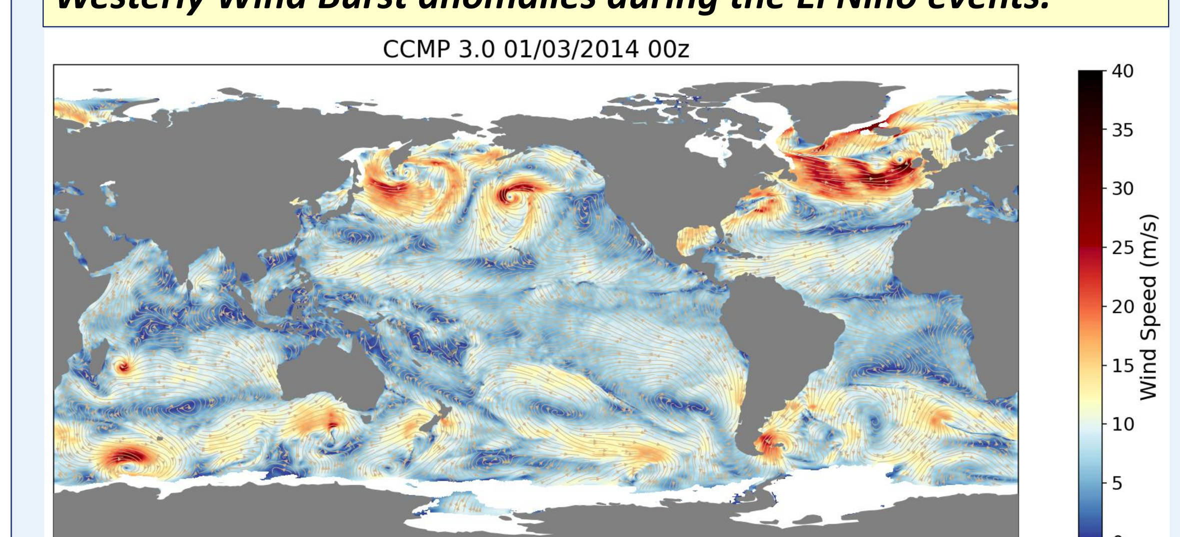
- The RSS wind CDR is optimally suited for studying the interannual and decadal variability of winds at regional and global scales.
- Additionally, the consistency between this wind CDRs and other AS-ECVs (e.g., SST, water vapor, etc...) processed at RSS allows study of changes in climate variability in a wider context (e.g., changes in atmospheric circulation or changes in the hydrological cycle).
- These datasets are routinely used for anomaly and trend analyses in the annual AMS State of the Climate report.

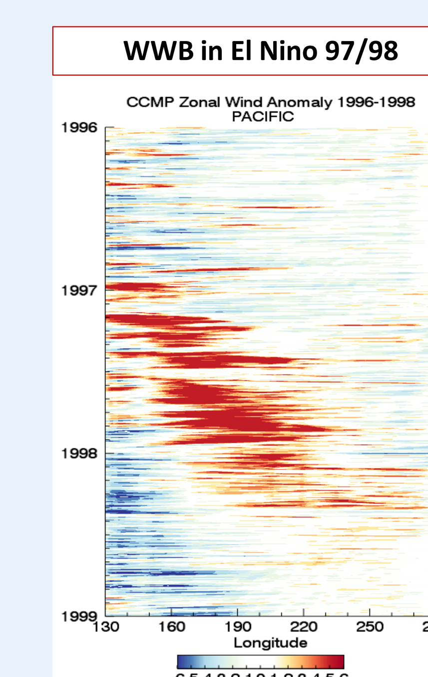
Figure 5: Wind trend map (left, 1988-2022) and wind anomaly timeseries (right) for satellite and reanalyses; from the AMS State of the Climate Report 2022



- Data from the OVW and OWS CDRs are also the building blocks of other datasets used for climate variability analyses, such as CCMP
- CCMP was used here to study tropical wind variability, with special focus on Westerly Wind Bursts events preceding El Nino.

Figure 6: (Bottom) Sample 6 hourly gridded map of the CCMP Wind Vector product (1988-present), using the RSS wind CDR. (Right): An example of how CCMP can be used to examine Westerly Wind Burst anomalies during the El Nino events.





6. Summary and References

- All RSS wind satellite data and CCMP are available at **www.remss.com**
- RSS focuses on production of **climate-quality satellite winds**
- **Consistent methodology across sensors**: radiometers/scatterometers
- Cross-calibrated and highly accurate data
- **Validated versus buoys and Saildrones**, at all wind regimes
- **Stability of the timeseries** is continuously monitored
- Future additions: AMSR3, MWI, **SCA on MetOp-SG**

CDR: Ricciardulli and Manaster (2021)
Saildrone Validation: Ricciardulli et al, (2022)
State of The Climate, "Global Climate": Dunn et al, BAMS, 2023
CCMP: Mears et al, (2019); Mears et al, (2022)