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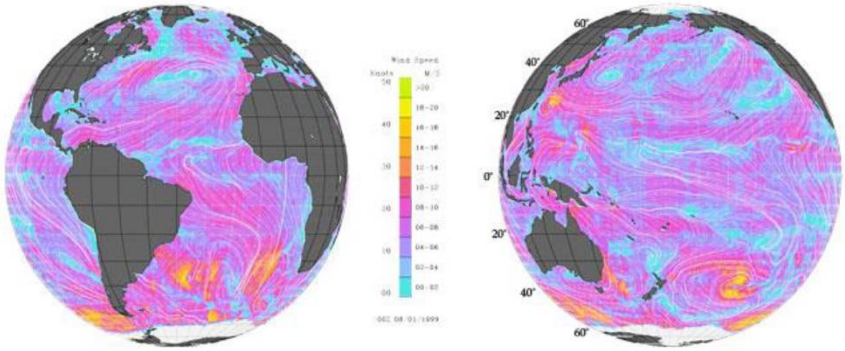
Evaluating and Extending the Ocean Wind Climate Data Record

Prepared for:
Earth Science Division
NASA Headquarters

Prepared by:
Ocean Vector Wind Science Team (OVWST)
Climate Working Group



Telecon Briefing
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Acknowledgments

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Executive Summary

- Satellite sensors have been systematically measuring ocean winds for 30 years
  An vital legacy in studying and monitoring climate variability of the planet's ocean-atmosphere coupling
- The 30-year archive of wind datasets needs to be maintained and periodically updated
  Without version updates and advocacy the older datasets lose consistency with newer datasets
- Possible end of the 30-year wind speed record from satellite radiometers is of concern
  No commitments for follow-on sensors to WindSat, AMSR-2, GMI, or SSM/IS
- The need for absolute wind calibration via ocean buoys will continue into the future
- Plans for evaluating current wind datasets are given, including an OVWST Intercomparison Project
- Methods to be used for extending the OW-CDR into the future (to ScatSat and beyond)
  1. Direct Ku-band σ_o intercalibration (QuikScat/RapidScat ➔ ScatSat) Requires extension of QuikScat Mission
  2. Multi-sensor wind speed intercalibration (ASCAT-A&B/WindSat/AMSR2/GMI ➔ ScatSat)
  3. Stable rain forest targets
- RapidScat has unique diurnal capabilities. Every effort should be made to compensate for its gain anomaly.
- Research should focus on improving the assimilation of satellite winds into numerical models designed to preserve the satellite wind information

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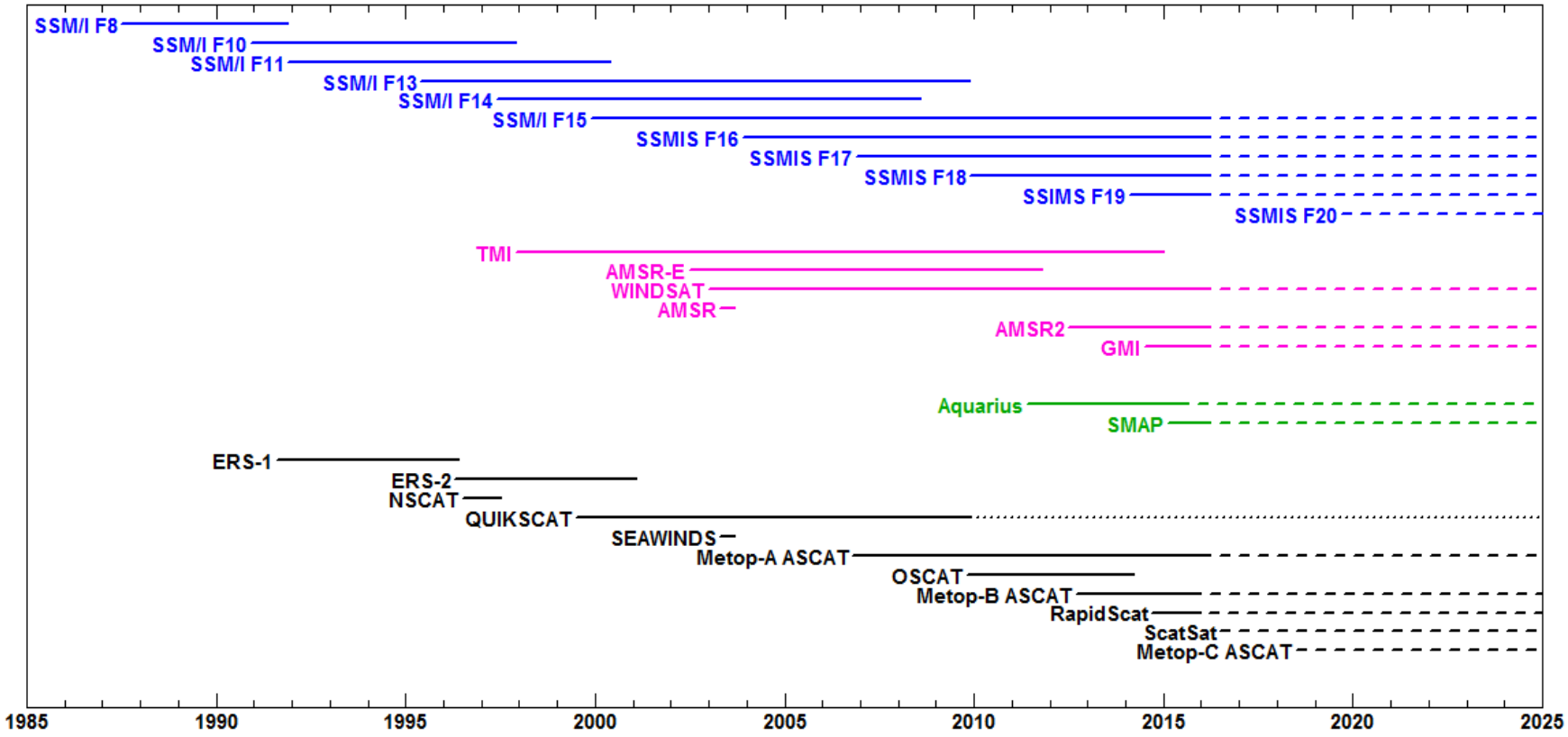
30-Years of Satellite Winds



28 Satellite Wind Sensors:

- 18 passive microwave radiometers
- 10 active microwave scatterometers

(Altimeters not included)

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Current and Future Scatterometer Vector Wind Datasets

Instrument	Document Reference	Time Period	Production Institutions
ERS-1 AMI-SCAT	ERS-1	Jul 1991 – Apr 1996	ESA
ERS-2 AMI-SCAT	ERS-2	Apr 1995 – Jun 2003	ESA
ADEOS-I NSCAT	NSCAT	Sep 1996 – Jun 1997	JPL, RSS
ADEOS-II SeaWinds	SeaWinds	Dec 2002 – Oct 2003	JPL, RSS
QuikScat SeaWinds	QuikScat	Jun 1999 – Nov 2009	JPL, RSS, KNMI
Metop-A ASCAT	ASCAT-A	Oct 2006 – present	KNMI, RSS
Metop-B ASCAT	ASCAT-B	Sep 2012 - present	KNMI
Metop-C ASCAT	ASCAT-C	2018 (planned)	
ISS RapidScat	RapidScat	Oct 2014 - present	JPL
Oceansat-2 OSCAT	Oceansat-2	Sep 2009 – Feb 2014	ISRO, KNMI
ScatSat-1 OSCAT	ScatSat	Jun 2016 (planned)	

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Radiometer Wind Speed Datasets

Instrument	Document Reference	Time Period	Production Institutions
F08 SSM/I	F08	Jul 1987 – Dec 1991	RSS
F10 SSM/I	F10	Dec 1990 – Nov 1997	RSS
F11 SSM/I	F11	Dec 1991 – May 2000	RSS
F13 SSM/I	F13	May 1995 – Nov 2009	RSS
F14 SSM/I	F14	May 1997 – Aug 2008	RSS
F15 SSM/I	F15	Dec 1999 – present	RSS
F16 SSMIS	F16	Oct 2003 – present	RSS
F17 SSMIS	F17	Dec 2006 – present	RSS
F18 SSMIS	F18	Oct 2009 – present	
F19 SSMIS	F19	Apr 2014 – present	
TRMM TMI	TMI	Nov 1997 – Apr 2015	RSS
ADEOS-II AMSR	AMSR	Dec 2002 – Oct 2003	RSS, JAXA
AQUA AMSR-E	AMSRE	May 2002 – Oct 2011	RSS, JAXA
GCOM-W1 AMSR2	AMSR2	May 2012 – present	RSS, JAXA
Coriolis WindSat	WindSat	Jan 2003 – present	RSS, NRL
GPM GMI	GMI	Feb 2014 – present	RSS
Aquarius	Aquarius	Jun 2011 – Jun 2015	RSS, JPL
SMAP	SMAP	Jan 2015 - present	RSS, JPL

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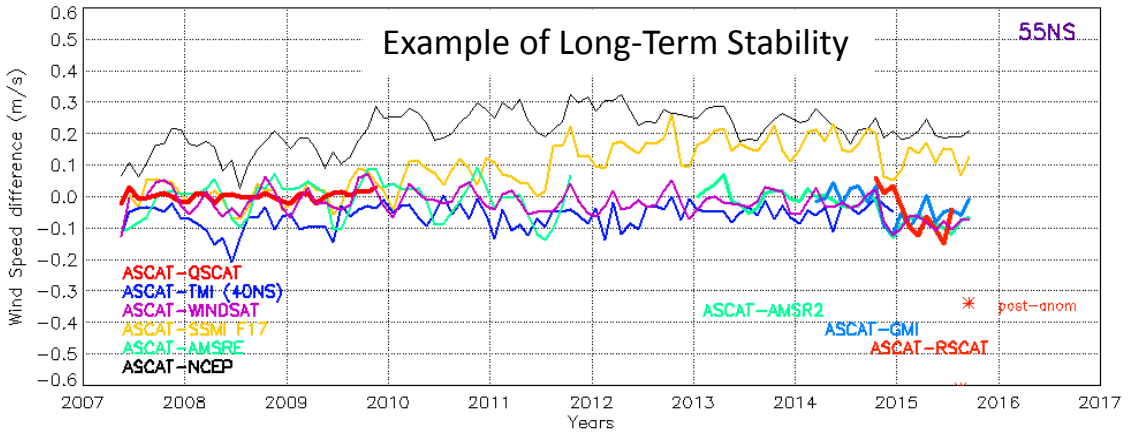
Wind Speed Accuracy Requirements

From WMO Global Climate Observing System (GCOS)

- Wind Speed Accuracy
  - 0.5 m/s for low to moderate winds
  - 10% for winds exceeding 20 m/s
- Sampling Requirements
  - 10 km
  - 3 hours
- Stability requirement is 0.1 m/s/decade
- *Relative stability of 0.03 m/s/decade observed among WindSat, QuikScat, and TMI over 10 years* [1]



[1] Wentz, F.J., 2015: A 17-year climate record of environmental parameters derived from the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager. *Journal of Climate, 28*, 6882-6902

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Evaluating the OW-CDRs

1. **Comparisons of OW retrievals with buoy winds**
   Plus: Provides absolute calibration for wind speed up to 15-20 m/s.
   Minus: Buoy data spatially very sparse; surface currents not available.
2. **Comparisons of OW retrievals with winds from numerical model (such as ECMWF and NCEP)**
   Plus: Global comparisons.
   Minus: Systematic errors exist in the numerical analyses and can be large.
3. **Comparisons of OW retrievals from sensors on two different platforms**
   Plus: Direct measurements of the same wind field; validation dataset not required.
   Minus: Comparisons limited by the required tight spatial/temporal collocation.
4. **Comparisons of OVW retrievals produced by different data providers**
   Plus: Reveals algorithmic uncertainties; validation data not required; no collocation issue.
   Minus: Does not reveal common system errors.

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Assimilation of Satellite Winds into Numerical Models

- Much satellite wind information is lost in Operational Weather Forecast Models (NCEP, ECMWF)

- Spatial and temporal sample of satellite winds poses problems
  - Different local times over an orbit
  - Large spatial holes

- Natural diurnal variability compounds the problem
  - 6 am OW-CDR is different from a 9 am OW-CDR or a 6 pm OW-CDR
  - Global and spatial long-term (decades) trends may be different at different local times

- Seek a middle ground between the 'raw' satellite retrievals and the forecast models
  - CCMP (Cross-Calibrated, Multiple Platform)
  - ERA* (ECMWF Reanalysis)

- Current CCMP widely used in spite of its shortcoming. It could be made better.
  - Long-term trend distortion needs to be fixed
  - Chelton and Bourassa have ideas for improving
  - Leverage off of ERA* work

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OVWST Inter-Comparison Project

Focus on producing a OVW-CDR from Multiple Sensors

Transition from QuikScat (1999-2009 normal spinning mode) to ASCAT-A forms Backbone of OVW-CDR

- Essential that this transition be handled properly
- Sensors have different local observations times; how to handle this?
- TMI can be used to connect sensors between 40S and 40N, but just wind speed
- Information coming from RapidScat, ASCAT, and GMI will help

RapidScat versus ASCAT provides Ku-band and C-band Observations at Same Time

- RapidScat's gain anomalies must be considered

Compare Different Methods for Inter-Calibrating Sensors

- Independent assessments by members of Climate Working Group