OceanObs19 Summary of Remote Sensing for Vector Winds and Stress

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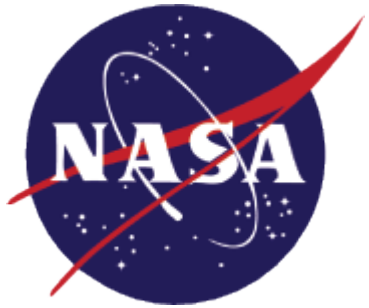


EUMETSAT

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and Water Management

Based on An OceanObs19 Paper

- **Remotely Sensed Winds and Wind Stresses for Marine Forecasting and Ocean Modeling**
- Mark A. Bourassa, Thomas Meissner, Ivana Cerovecki, Paul Chang, Dong Xiaolong, Giovanna De Chiara, Craig Donlon, Dmitry S. Dukhovskoy, Jocelyn Elya, Alexander Fore, Melanie R. Fewings, Ralph C. Foster, Sarah T. Gille, Brian Haus, Svetla Histova-Veleva, Heather M. Holbach, Zorana Jelenak, J. Knaff, Sven A. Kranz, A. Manaster, Matthew Mazloff, Carl Mears, Alexis Mouche, Marcos Portabella, N. Reul, Lucrezia Ricciardulli, Ernesto Rodriguez, C. Sampson, Daniel Solis, Ad Stoffelen, Mike Stukel, Brian Styles, David Weissman, Frank Wentz
- Submitted to Frontiers in Ocean Science
- Thanks to Thomas Meissner for leading the writing on passive instruments (largely non-vector)

Eight Recommended Goals (part 1)

(1) Enhanced temporal coverage through an international virtual constellation to follow the fast, small transient mesoscales;

- Ongoing. Hopefully will further improve.

(2) Improved spatial resolution to better address mesoscale variability, improve coastal sampling, and make visible the areas between rain bands in tropical cyclones;

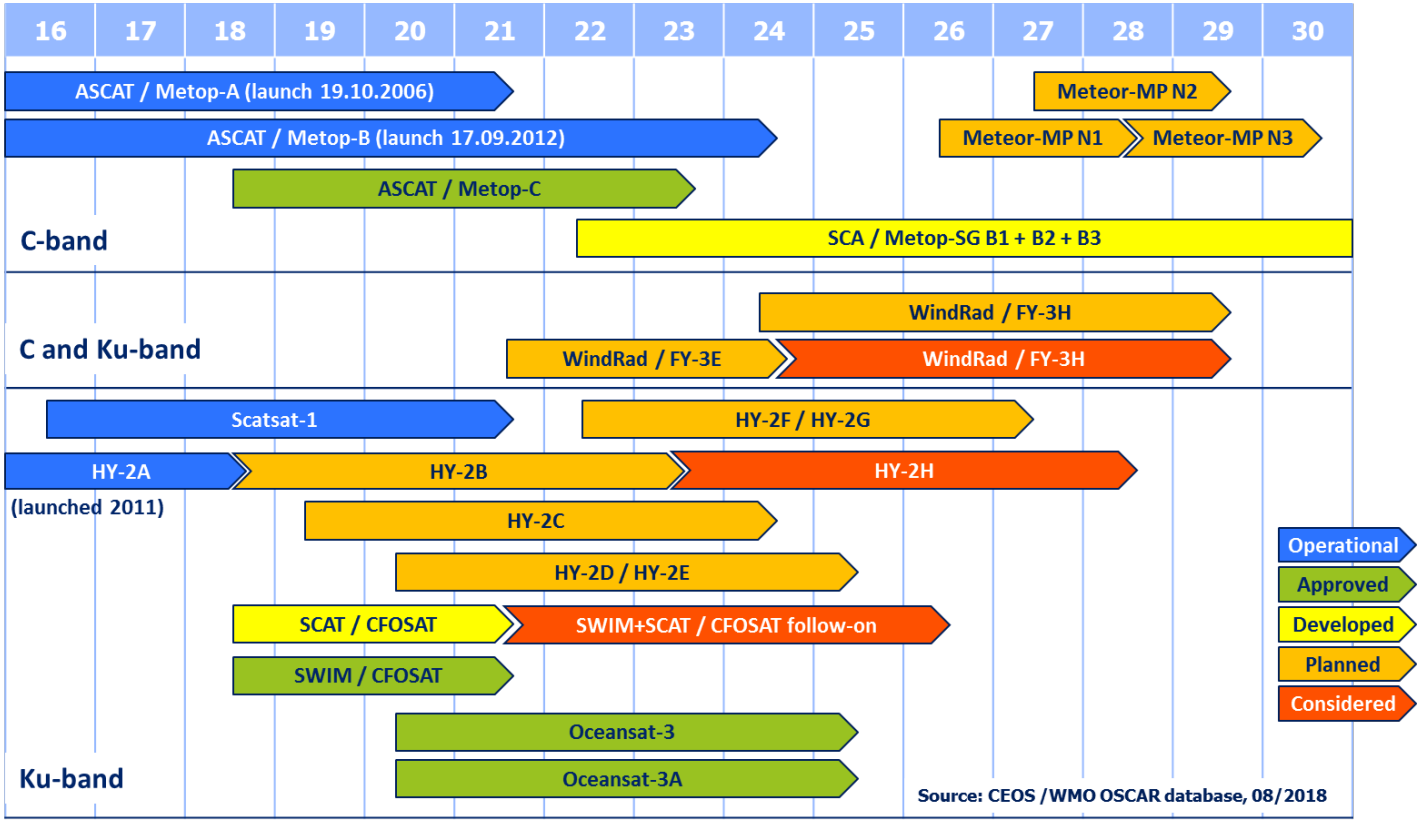
- Several approaches appear viable

(3) Coincident observations of surface vector winds and currents, to better understand the coupling of winds and currents and to improve surface flux parameterizations;

- Doppler

Vector Winds from Scatterometers

- The satellite constellation is growing.
- This will help with temporal coverage if the constellation (or parts of it) is coordinated.



Graphic from draft OceanObs19 White paper

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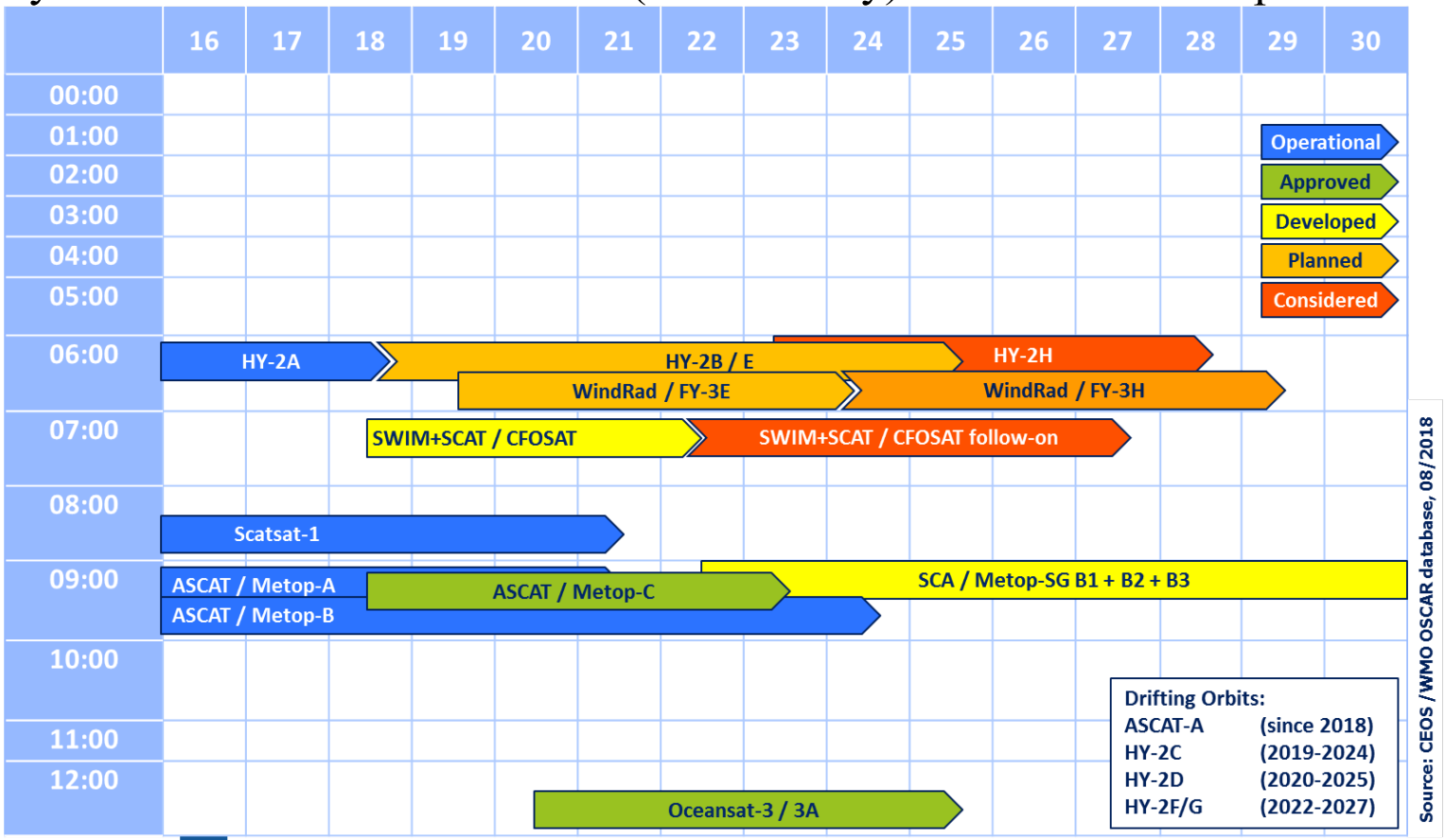
Temporal Sampling

- Temporal coverage is mostly insufficient for the desired temporal sampling.
  - **Except for roughly 8:30 to 10:00 (now) and 6:00 to 7:30 (planned)**.
    - Moving towards desired sampling 25% of the time.
- Only one of these instruments will (theoretically) have the desired spatial resolution.



Graphic from draft OceanObs19 White paper

Eight Recommended Goals (part 2)

(4) Instrument intercalibration (e.g., cone metrics) for all conditions;

(5) Improved calibration for extreme winds (strong and weak);

(6) In situ wind references (including surface currents) to calibrate and intercalibrate satellite winds and surface currents. This goal includes improved understanding of in situ and SFMR calibration at extreme winds to be used in the above calibration;

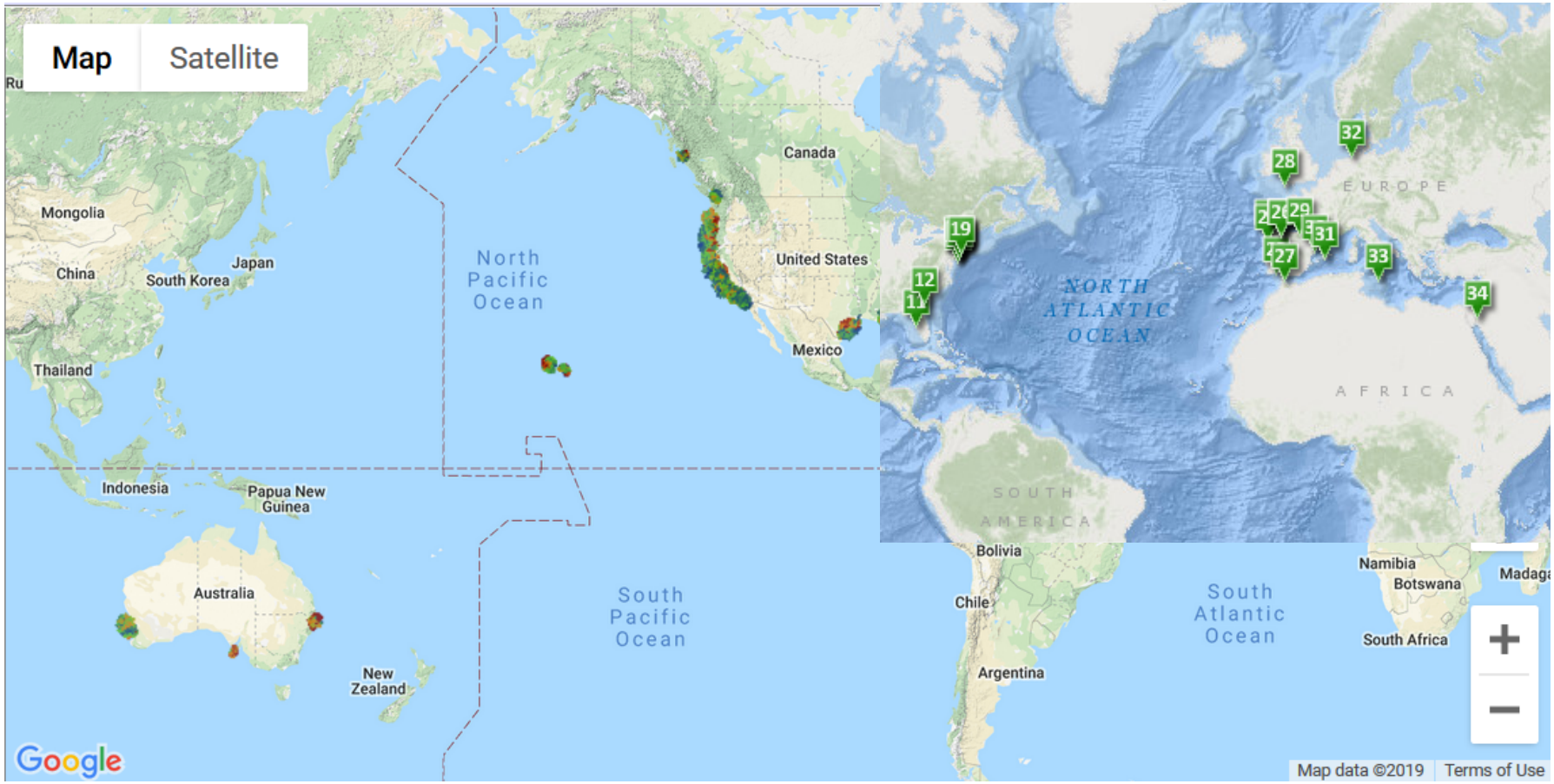
(7) Consider new strategies to observe the TC inner-core and environment with high spatial and temporal resolution from the upper ocean (including pre-and post-storm) to the lower stratosphere. The observations should be used to diagnose physical processes, improve initialization through data assimilation, and evaluate and improve NWP models.

(8) Local bias correction in NWP to follow the BLUE paradigm and improve gridded products;

Plausible Observational Solutions

- Better coordination of the constellation
  - Improve temporal sampling
  - E.g., METOP constellation and Indian and Chinese constellation
- Higher resolution
  - Doppler: under development at ISRO
  - Better antenna: proposed for Metop second generation and to be proposed for Winds and Currents Mission
  - Higher frequency: to be proposed for Winds and Currents Mission
- Several plans an in place (largely awaiting funding) for improving our understanding of in situ observations for extreme winds.
- BLUE paradigm- demonstrate and communicate successes.
- Understanding the momentum profile – still a big challenge

Coastal Radar Coverage

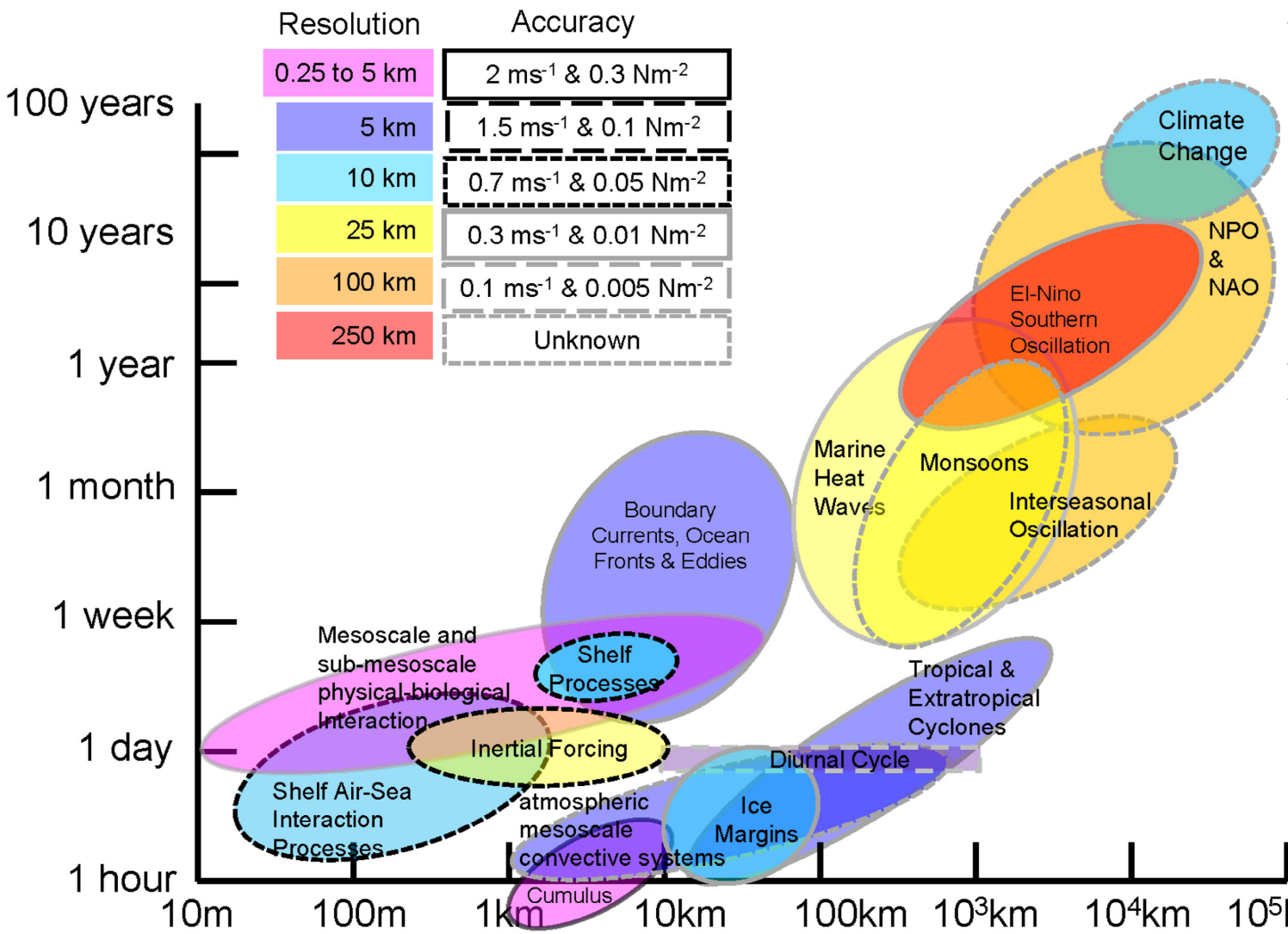


- Coastal radar will be a great help were available for coastal applications
- Coverage is very sparse: we need satellite observations
- http://global-hfradar.org/ & https://doi.org/10.1080/1755876X.2018.1443625

Other Instruments

- Synthetic Aperture Radar (SAR)
  - SAR has spatial resolution better than desired at this time
  - Spatial coverage for winds is poor
- Radiometer winds
  - Some radiometer have the capability to determine direction
    - E.g., WindSat
    - Good for wind speeds down to 3 ms^{-1}
    - However wind directions substantially deteriorate below 8 ms^{-1}
    - Well intercalibated with scatterometers
- Doppler Lidar (Aeolus)
  - Demonstration mission for atmospheric dynamics
  - Large footprint and more limited spatial/temporal sampling
  - Positive impact on NWP prior to completion or cal/val.

Accuracy Requirements



- Mostly dominated by bias, except in the lower left corner
- In the lower left, random errors and (sometimes) the ability to resolve features are limiting to applications

Graphic from draft OceanObs19 White paper

Accuracy Requirements

- The accuracy requirements for surface winds and stress are highly dependent on the phenomena and the spatial/temporal scales of the variability associated with the phenomena.
  - These complications are summarized on the previous slide.
  - There are multiple approaches to meeting these requirements.
- There are trade-offs in resolution and random errors that can be used to optimize different types of technologies for specific applications.
  - Currently, both bias and systematic errors are important at 25 km
  - At finer scales random errors will dominate on shorter timescales.
  - Some of the smaller-scale processes (physical-biological interactions) are influenced more by horizontal shear than by the magnitude of the wind or stress
    - Therefore having very little sensitivity to systematic errors.
- Additional input welcome (particularly if it comes very soon)

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