Charter for
IOVWST Climate Working Group
April 14, 2014

1. Introduction

The Ocean Vector Wind (OVW) Climate Working Group (CWG) is a subgroup of the International OVW Science Team (IOVWST). The group was initiated at the 2013 IOVWST Meeting in Hawaii with the primary objective of advancing the application of OVWs to climate research.

2. Motivation for Working Group Formation

There are now 23 years of scatterometer observations starting with ERS-1 in 1991. As compared to wind-speed-only retrievals, the scatterometer observations are unique in that they also provide directional information from which one can obtain the zonal and meridional wind stress field as well as the field's curl and divergence. Combining the scatterometer observations into a consistent, multi-decadal OVW climate data record (CDR) will be an important contribution to understanding the Earth's changing climate.

3. Scope

The scope of the CWG Charter is intentionally broad to cover the many issues related to generating OVW-CDRs. The CWG will prioritize these CDR issues according to importance and likelihood of progress, as outlined below in Task 2. A more limited, workable scope will then be defined, depending on the commitments of the CWG members.

4. Essential Climate Variables: Sea-Surface Stress and Ocean Vector Wind

Scatterometers measure surface roughness, not wind speed directly, and it is generally assumed that surface roughness is more closely correlated with the wind stress $\boldsymbol{\tau}$ on the sea-surface rather than with a wind speed measured at some elevation above the ocean surface (typically 10 m). For this reason, scatterometer wind retrievals are usually defined as the 10-m equivalent neutral wind, called $\mathbf{U}_{10EN}$, rather than the actual wind at 10 m. By this definition, the relationship between $\mathbf{U}_{10EN}$ and $\boldsymbol{\tau}$ is

$$\boldsymbol{\tau} = \rho C_{D10} \left|\mathbf{U}_{10EN}\right| \mathbf{U}_{10EN}$$

where ρ is air density and C_{D10} is the neutral stability drag coefficient at a height of 10 m and is a function of $\mathbf{U}_{10EN}$. Many ocean applications require $\boldsymbol{\tau}$, while the starting point for meteorological applications is often $\mathbf{U}_{10EN}$. There is an IOVWST Stress Working Group focused on the relationship of $\boldsymbol{\tau}$ and $\mathbf{U}_{10EN}$ (i.e. the drag coefficient). Herein, CDRs for both quantities are considered with the realization that the calibration and validation methods for the $\boldsymbol{\tau}$ and $\mathbf{U}_{10EN}$ CDRs are quite different.

Given either $\boldsymbol{\tau}$ or $\mathbf{U}_{10EN}$, the 4 principal variables are (with $\mathbf{X}$ denoting either $\boldsymbol{\tau}$ or $\mathbf{U}_{10EN}$)

1. Meridional component $\mathbf{X}_V$
2. Zonal component $\mathbf{X}_U$
3. Curl $\nabla \times \mathbf{X}$
4. Divergence $\nabla \cdot \mathbf{X}$

When averaging to monthly timescales and longer (a typical first step in CDR generation), a fifth variable comes into play: the average of the instantaneous wind speed or stress $\overline{X}$, given by the average $\left\langle \mathbf{X}_U{}^2 + \mathbf{X}_V{}^2 \right\rangle$. $\overline{X}$ plays an important role in air-sea fluxes and momentum exchange. The terminology "OVW" used herein refers to this set of 5 variables that is related to either $\boldsymbol{\tau}$ or $\mathbf{U}_{10EN}$.

5. Multiple CDRs

The CWG recognizes the scientific value of having multiple, credible OVW-CDRs. The primary intention of the Group is to freely exchange information and ideas that will help the various data providers to improve their respective OVW datasets rather than driving the Group towards a single consensus OVW-CDR. Multiple CDRs provide one of the best ways to assess the accuracy and limitations of OVW for climate research. However, a single consensus OVW-CDR (with uncertainty information) is certainly not precluded if it emerges from the work of the CWG.

6. Sensors

The OVW sensors to be considered are the following:

- Ku-band Scatterometers: NSCAT, QuikSCAT, OSCAT, RapidScat, CNSA HY-2A
- C-band Scatterometers: ERS-1, ERS-2, ASCAT-1, ASCAT-2
- L-band Scatterometers: Aquarius and SMAP
- Polarimetric Radiometer: WindSat

7. Normalized Radar Cross Sections σ_o

The radar backscatter measurement of the normalized radar cross section σ_o is the foundation for all subsequent OVW processing. As such, it is the fundamental CDR for scatterometers. Likewise brightness temperature T_B is the fundamental CDR for passive microwave radiometers like WindSat. Issues related to σ_o and T_B generation/calibration will be primarily handled by the various agencies responsible for the particular OVW mission. However, the CWG will need to be kept informed so that it can assess the impact of σ_o and T_B calibration on the OVW-CDRs, as is discussed in Task 3.

8. Level-3A OVW-CDRs

The basic OVW-CDR consists of an orbit-by-orbit archive of swath-registered OVW variables, generally referred to as the Level-2 dataset. To reduce data volume and facilitate analyses, the Level-2 swath OVW variables are typically monthly averaged onto a latitude-longitude earth grid, thereby producing a basic Level-3 product. The basic Level-3 CDR is called L3A and is defined as a CDR for which the OVW variables come from a single sensor, with no ancillary wind information required (i.e. no background field, no in situ observations, etc.) other than those required for Level-2 processing ambiguity removal. Also, the gridding and averaging methods for generating L3A need to be straightforward.

9. Level-3B OVW-CDRs

Level-3B OVW-CDRs are similar to L3A CDRs except that they consist of OVW variables from two or more satellite sensors that have been inter-calibrated. Dealing with multiple sensors requires the consideration of several factors:

- Differences in the σ_o and T_B calibration by the various data providers
- Radar frequency differences among the sensors, particularly with respect of the geophysical model functions and rain contamination
- Temporal and spatial sampling differences among the satellite sensors, particularly those having to do with the natural diurnal cycle

10. Level-4 OVW-CDRs

Level-4 CDRs are complex assimilation products consisting of merged satellite OVW retrievals, numerical models, and in situ observations. The objective of L4 CDRs is to provide a spatially and temporally complete product benefiting from multiple types of observations. Comparing various L4 CDRs can be challenging given the significant differences in the construction methods and usage of ancillary data.

11. Tasks

The Task List for the CWG is as follows:

1. Review this Task List and determine the degree to which it follows the more generic GCOS Guidelines for CDR generation given in https://www.wmo.int/pages/prog/gcos/Publications/gcos-143.pdf. Make modifications if necessary.
2. Prioritize tasks according to importance and the likelihood of making progress. Define a more limited workable scope that is commensurate with the commitments of the CWG members. Establish Subgroups responsible for performing tasks.
3. Review the status of σ_o generation and calibration as provided by the various agencies. Of particular concern is (a) the possibility of long-term instrumentation drift, (b) data processing inconsistencies over time, and (c) quality control procedures (i.e., data exclusion). Assess the impact of σ_o generation and calibration on OVW retrievals. (For example, something as simple as differences in the data exclusion procedures used by different data providers can be misinterpreted as climate change.)
4. Review the status and availability of existing OVW-CDRs (L3A, L3B, and L4) and the variables contained in the various CDRs (**τ, U**$_{10EN}$, curl, divergence). Select the CDR variables to compare and evaluate.
5. Develop a plan for inter-comparing and evaluating the selected CDR variables. Adopt standardized performance metrics, common data formats, and other procedures that will facilitate objective comparisons and evaluations.
6. Obtain full documentation on CDR generation from the data providers, including geophysical model functions, description of OVW retrieval algorithms, and methods for merging OVW retrievals obtained from sensors on different spacecraft.
7. Perform the inter-comparisons and evaluations of the various OVW-CDRs. Explain and, if possible, resolve differences among the OVW-CDRs.
8. Compare the scatterometer U_{10EN} variable to the existing 27-year CDR of passive microwave wind speeds and the 22-year altimeter wind speed record. Include CYGNSS wind speeds when they become available. Attempt to explain and reconcile any significant differences that are found.
9. Compare long-term trends seen in the OVW-CDRs with trends derived from buoys and other in situ measurements.
10. Identify CDR issues specific to the generation of curl and divergence. These spatial derivatives require consistency in **τ** and **U**$_{10EN}$ in both the along-track and cross-track directions. Areas of missing data (such as those due to rain contamination, swath edges, or nadir gaps) pose special problems when generating curl and divergence CDRs.
11. Assess the impact of diurnal and semidiurnal variability on merging together satellites operating at different local times.
12. Determine the impact of rain on the fidelity of the OVW-CDRs. Assess the degree of inter-CDR inconsistencies that result from the rain exclusion being different for L-, C-, and Ku-band.
13. Provide an accuracy/limitation assessment of OVW-CDRs for climate studies. Issues to be addressed include the degradation in accuracy to due rain, extreme wind events (very low and very high), and spatial/temporal sampling issues related to producing gridded L3 and L4 products. This assessment will, in a large part, be based on the results coming from the above Tasks (i.e, the degree of consistency among the various OVW-CDRs, comparisons with radiometer/altimeter wind speeds, comparisons with buoys, the impact of rain, and such).

14. Establish the means for the CWG to interface with the broader climate research and modeling community outside of IOVWST. This includes the creation of a CWG website and the collaboration and coordination with other international CDR organizations like GCOS and SCOPE-CM.

12. Organization and Meetings

The CWG will be organized into several smaller Subgroups, each with a lead scientist. For the most part, individual Subgroups will be formed to address the various Tasks listed above. The number and types of Subgroups will depend on the commitments of the CWG members. Each Subgroup will determine its mode of operation and the type and frequency of meetings required to achieve its objectives. The Subgroups are encouraged to use their existing websites to report results and link to the CWG website. The Subgroups will convene once a year as part of the IOWVST meeting to discuss and integrate results. A review article discussing the activities of the various Subgroups will be published.

13. Overall Goal

The overall goal of the Climate Working Group is to advance our understanding of the many issues related to constructing OVW-CDRs. This knowledge will, in turn, lead to improved CDRs that better serve the needs of the climate research community. It will also lead to better understanding of the accuracies and limitations of the OVW-CDRs.