Proposal for the
Ocean Surface Vector Wind Virtual Constellation

Proposal Team
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Background

An initial proposal for an Ocean Surface Vector Wind Virtual Constellation, to be established under the Committee on Earth Observation Satellites (CEOS), was presented to the 21st meeting of the CEOS Strategic Implementation Team (SIT) in Woods Hole on April 22-24, 2008. As a result of that presentation and the resulting discussion, the SIT recommended that the initial proposal be developed into a more complete proposal. This document is responding to that recommendation and will be presented to the SIT for its consideration at its 22nd meeting in Tokyo September 17-18, 2008. As the reader will surmise, this is a *work in progress*.

Objectives

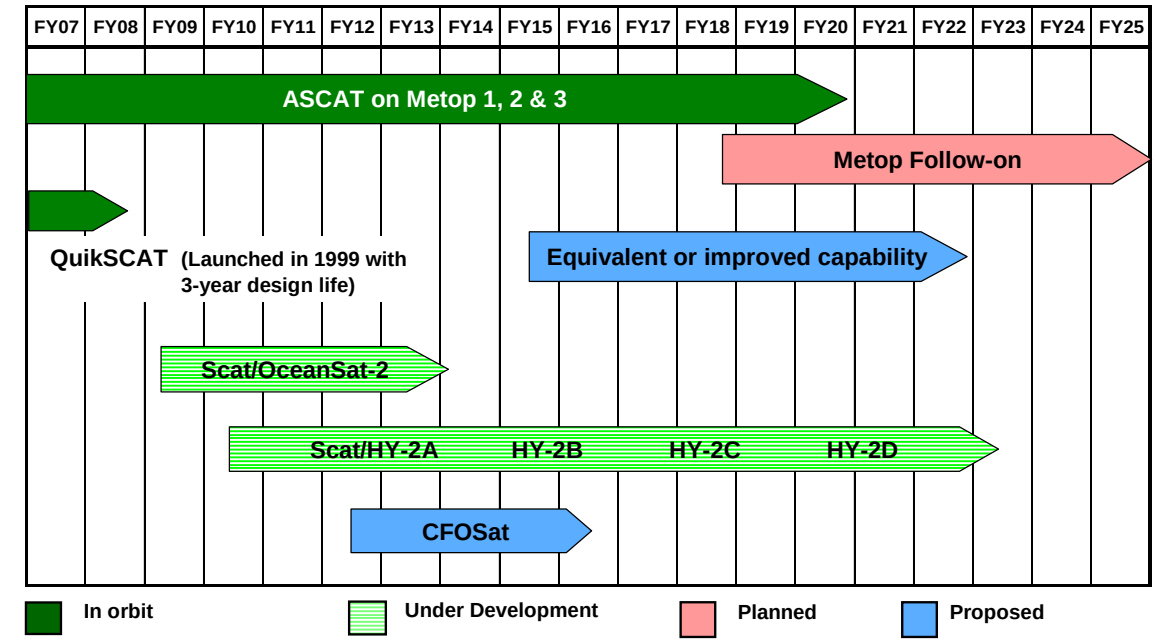
The Ocean Surface Vector Wind (OSVW) Virtual Constellation will utilize satellite scatterometry to collect observations of ocean surface vector winds over the global ice-free oceans. Standard OSVW products will be generated from scatterometers on multiple satellites and made freely available to the international community within sufficient time for inclusion in operational analyses and forecasts, as well as use in retrospective research.

The key space segment capabilities will include the following polar-orbiting OSVW satellite missions in orbit and under development – QuikSCAT, ASCAT on the METOP series, and the scatterometers on OceanSat-2 and the HY-2 series of satellites – as well as planned and proposed future missions such as CFOSAT. (See the figure on the following page.) In addition to the space segment, collaboration as part of this Constellation will include on-orbit calibration, the validation of derived products, the determination of consensus derived products and formats, expediting the delivery of those products to operational forecast centers, collaboration in the operational utilization of those products and assessment of their impact, and shared use in research.

Vision

The OSVW Virtual Constellation will make fundamental operational contributions by enabling significant improvements in marine warnings and forecasts over the global oceans – and hence to the protection of lives and property both on the high seas and along coastal areas. Such warnings and forecasts include those for tropical cyclones and extra-tropical winter storms. This will be accomplished through the use of observations of OSVW from satellite scatterometry in operational analyses and forecasts, especially

OSVW Satellite Missions
Present and Proposed



when used in conjunction with significant wave height from satellite altimetry from the companion Ocean Surface Topography Constellation.

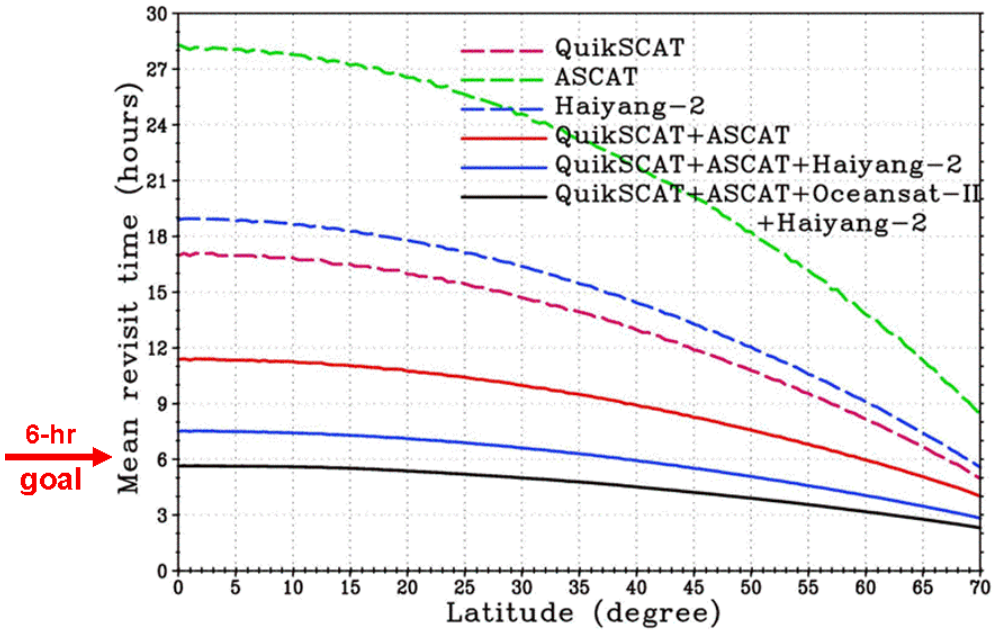
The OSVW Virtual Constellation will also make fundamental research contributions by enabling significant improvements in the performance of ocean models as they evolve toward finer spatial and temporal resolution. These contributions – including a more accurate estimation of surface fluxes of momentum, heat, and gases – will have applications in modeling the ocean circulation and its uptake and transport of heat and carbon dioxide. This will be accomplished through resolution of the diurnal cycle in the wind field, thereby permitting a more realistic parameterization of associated processes occurring at sub-grid scales in the models.

Finally, the OSVW Virtual Constellation will provide critical information needed to characterize how the Earth is changing by establishing a baseline climate-quality data record of the OSVW field.

Statement of Need

While three or more satellite scatterometers are desired, the basic need for two concurrent satellite scatterometers is documented in the following two references. This enables a mean revisit time of 12 hours at the equator, with successively shorter times at higher latitudes as noted in the following diagram.

Sharing Data in a Timely Manner Enables Significant Reductions in Mean Revisit Times



Liu et al., 2007, *Int. J. of Remote Sensing*, in press.

- *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*, October 2004, Action A11: *Ensure continuous operation of AM and PM satellite scatterometers…*
- *WMO Workshop on the Redesign and Optimization of the Space-based Global Observing System*, WMO Headquarters, Geneva, 21-22 June 2007, Recommendation: *Maintain at least two scatterometers to ensure a minimum coverage in all conditions…*

Relation to GEOSS Societal Benefit Areas

OSVW products are required in support of the GEO 2007-2009 Work Plan, *Towards Convergence*, (30 March 2007) under the following two principal societal benefit areas.

- Weather: Improving weather information, forecasting and warning.
  - WE-06-02: Space-based Global Observing System for Weather – Achieve a stable and improved space-based Global Observing System (GOS) including polar components – Satellite scatterometer-derived OSVW are required for operational analyses and forecasts both on the high seas and for coastal areas; as examples, they are used in the early detection, tracking and characterization of tropical cyclones; they are also used as input to surface wave forecasting models.

- Climate: Understanding, assessing, predicting, mitigating, and adapting to climate variability and change.

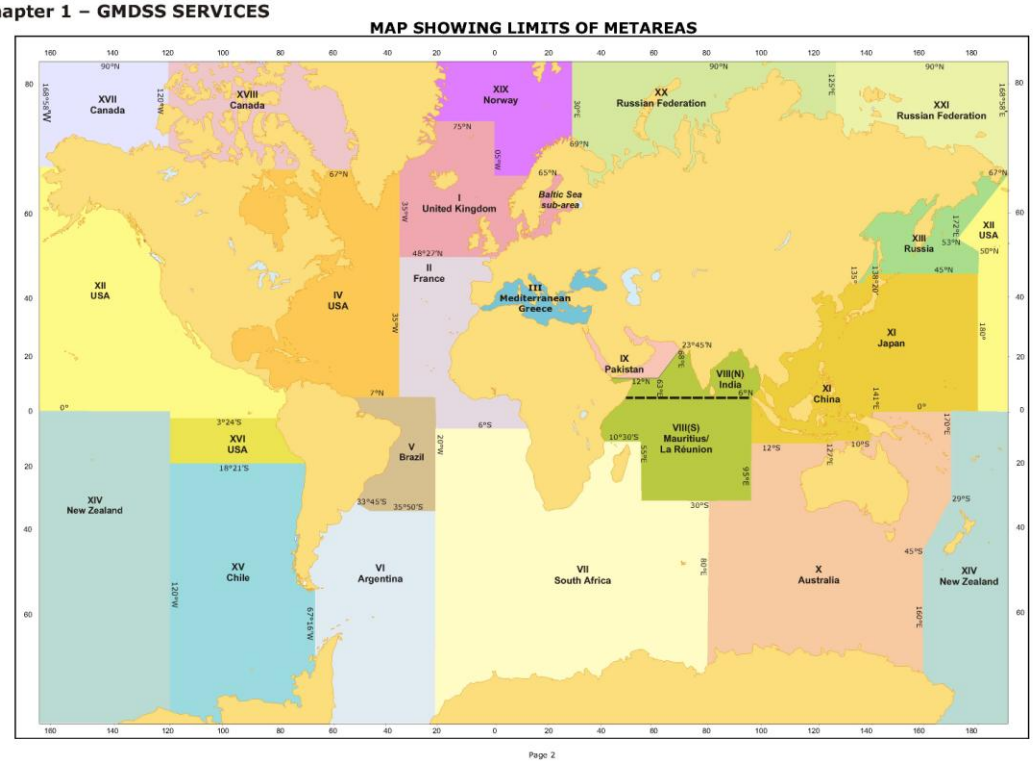
- CL-06-01: Sustained Reprocessing and Reanalysis Efforts – Ensure the development of international mechanisms to coordinate and maintain sustained climate data reprocessing and reanalysis efforts; obtain consistent long-time series of satellite records – Any reanalysis effort for the oceans requires a realistic estimation of surface wind forcing, and satellite scatterometry is the only feasible way to resolve the spatial variability in the OSVW field over the global oceans.
- CL-06-02: Key Climate Data from Satellite Systems – Establish actions securing the provision of key data for climate studies and forecasting from satellite systems – As noted above, satellite scatterometer-derived OSVW are required for operational analyses and forecasts of tropical cyclones and surface waves, both key elements of high-seas and coastal warnings and forecasts.
- CL-06-06: Global Ocean Observation System – Enhance and improve coordination of coastal and marine climate observations in support of a global ocean observation system; observations of the OSVW are required for any operational ocean observing system.

User Community Engagement

Given the requirements noted just above for the OSVW Virtual Constellation, as well as similar requirements for the Ocean Surface Topography (OST) Constellation, these two Constellations will collaborate with an *initial priority* being given to support operational wind and wave forecasting for the high seas worldwide. Each Constellation is capable of delivering one of the two critical observations – OSVW and significant wave heights (SWH) – that are required in preparing such global forecasts. The two Constellations are in the process of establishing a joint collaboration with what is, in effect, a shared user community – the operational Global Maritime Distress and Safety System (GMDSS). GMDSS is the integrated communications system using satellite and terrestrial radiocommunications that ensures, no matter where a ship is in distress, aid can be dispatched; this System also ensures the provision of *maritime safety information* (MSI) – both navigational and meteorological information, including wind and wave conditions – for the global oceans.

For broadcast purposes under the GMDSS, the world's oceans have been divided into a number of Navareas/Metareas – as shown below – for the provision of MSI, and the responsibility for each has been assigned to a particular National Meteorological Service (NMS) or meteorological Issuing Service. The WMO contribution to the GMDSS, coordinated by the joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) with the support of the meteorological Issuing Services, develops specific regulations for the provision of meteorological and oceanographic warnings and forecasts. The joint collaboration will initially focus on establishing contact with the operational forecast center of the NMS corresponding to each of these Metareas.

It will be critical that OSVW and SWH products are delivered within sufficient time to be incorporated into the operational analyses and forecasts for each of these centers.



Through this joint collaboration, the OSVW Virtual Constellation, together with the OST Constellation, can take advantage of the existing GMDSS and its linkages with a very important set of end users, or *customers*, ships on the high seas.

<u>The first step toward establishing operational contacts</u>. As a first step in developing an engagement with this user community, contacts are being sought for each of the GMDSS Metareas in the Southern Hemisphere, where the oceans cover 80% of the surface of the Earth and the typical operational forecast agency is distant from the bigger satellite agencies of the Northern Hemisphere.

The OSVW Virtual Constellation will seek out each contact in order to assess:

- How and under what circumstances existing OSVW and SWH products from QuikSCAT & ASCAT on Metop and Jason & ENVISAT, respectively, are being made accessible today, and
- The extent to which these products are being used in operational high-seas forecasting today,

This process has begun and preliminary results are shown in the following table. As this process progresses, this table will be filled out for the Southern Hemisphere, and then extended to the Northern. These results will serve as a guide to direct, and check on the

efficacy of, activities of the joint Constellation effort. We ultimately are seeking feedback for the space agencies on the operational impact of the timely provision of these wind and wave products – to help justify the continuing provision of these operational services

Southern Hemi-sphere Major GMDSS Metareas	National Meteorological Service Responsible for Operational High-Seas Forecasting in the Metarea	Designated Contact for Metarea (contact not yet responded, or name of initial contact)	Are the following products are being used operationally; if so, how are they being received?							
			Ocean Surface Vector Winds				Significant Wave Height			
			QuikSCAT		ASCAT		Jason		ENIVSAT	
			GTS	FTP	GTS	FTP	GTS	FTP	GTS	FTP
V	*Brazilian Navy, Marine Meteorological Service*	*CDR Antonio Claudio*	*N/A*	---	---	---	---	---	*N/A*	---
VI	*Servicio Meteorológico Nacional, Argentina*	*Paula Etala, Navy*	*N/A*	*some*	*no*	*no*	*yes*	*no*	*N/A*	*no*
VII	*South African Weather Service*	*Mnikeli Ndabambi*	*N/A*	---	---	---	---	---	*N/A*	---
VIII South	*Mauritius Meteorological Services*	*Mohamudally Beebeejaun*	*N/A*	---	---	---	---	---	*N/A*	---
X	*Australian Bureau of Meteorology, National Met & Oceanographic Ctr*	*Graham Warren*	*N/A*	*yes*	*no*	*yes*	*yes*	*no*	*N/A*	*yes*
XIV North	*Fiji Met Service, RSMC Nadi*	*Alipate Waqaicelua*	*N/A*	---	---	---	---	---	*N/A*	---
XIV South	*Met Service of New Zealand, RSMC, Wellington*	*Steve Ready*	*N/A*	*yes*	*no*	*yes*	*no*	*no*	*N/A*	*no*
XV	*Chilean Navy, Hydrographic & Oceanographic Service*	*LCDR Andrés Enríquez*	*N/A*	---	---	---	---	---	*N/A*	---

Present Availability

Significant wave height (SWH)

- Jason – The "OSDR" data stream, BUFR encoded, contains SWG (and non-directional wind speed), but is not useful for sea surface height); the GTS headers are "ISZA01 LFPW" through "ISZL01 LFPW", where the "A-L" indicates geographical regions, and "LFPW" indicates that Météo France did the insertion.
- ENVISAT – Envisat data products, BUFR encoded, include SWH ("RA2_WWP_2P"); products are available for pick-up from ESA FTP sites within 3 hours from acquisition – assuming compliance with ESA data policy.
- Jason-2 – NOAA & EUM will be injecting the Jason-2 OGDR, BUFR encoded, onto the GTS once Jason-2 is declared operational in Nov 2008; the headers for these data are "ISZX01 KNES" for the NOAA CDA passes (Wallops/Fairbanks) and "ISZX01 EUMS" for the EUM passes (Usingen); the "X" indicates global data (not geographically segmented like the Jason OSDR); "KNES" is NOAA/NESDIS & "EUMS" is EUMETSAT.

Ocean Surface Vector winds (OSVW)

- QuikSCAT – a 12.5-km wind product is available from the NOAA/NESDIS web site; while it had been thought that the QuikSCAT product was too large for the limited

bandwidth of the GTS, given the fact that ASCAT products can be accommodated, this situation is being re-assessed.

- ASCAT – a 25-km ASCAT wind product is available from the OSI SAF web site <http://www.knmi.nl/scatterometer/ascat_osi_25_prod/ascat_app.cgi>; these products are also available, BUFR encoded, on the GTS; the UK Met Office does the insertion, and they can be identified by the header "ISXX[01-06]; CCCC = EHDB".

Measures of Success

Because the OSVW and SWH products from the respective Constellations are both required for operational forecasting on the high seas worldwide, these Measures of Success will be applicable to both. A key measure of success ultimately hinges on how well these *Measures* have been integrated into and are being utilized by operationally oriented agencies in their routine provision of products and services to society. Accordingly, these two Constellations each must address the following challenges.

1. Timely data access. A first challenge concerns whether the agency sponsoring a given satellite will agree to making the OSVW and SWH data streams freely available within sufficient time – typically within three hours of collection – so that they can be used for operational purposes.

- Status: Joint discussions concerning timely data access for operational use are underway between the Indian Space Research Organization (ISRO) with its OceanSat-2 satellite, EUMETSAT with its ASCAT on the METOP series, and NOAA with NASA's QuikSCAT. Such discussions, however, have yet to include the sponsor of the HY-2 series of satellites, the Chinese State Oceanic Administration (SOA).

- Action: (a) CEOS to invite the Chinese SOA to participate and engage in these discussions.

2. One-stop shopping. A second challenge concerns the potential for *one-stop shopping* – whether a user, especially those in operational forecast centers distributed around the world, can easily access – preferably from a single source – mutually agreed OSVW and SWH products and formats that originate from multiple sources. *Mutually agreed* in this case means that the data collectors, product generators and distributors, and users can reach consensus.

- Status: Space agencies typically have mission- or sensor-specific web sites where selected data and derived products can be accessed, each in their own formats and under their own terms and conditions. While larger operational forecast centers of the World Weather Watch (WWW) of the World Meteorological Organization (WMO) typically have bi-lateral agreements with their counterpart agencies for the timely exchange of data and derived products, smaller WWW centers – especially those in the Southern Hemisphere – generally do not. At present, an operational forecaster in a smaller center has to know what web sites to visit in order to obtain which derived

product under what conditions and in what particular format – all while doing his or her regular operational job. Instead of that forecaster having to be aware of and go to multiple web sites to access those products, consensus products could be inserted into the existing Global Telecommunications System (GTS) that links operational centers worldwide – assuming adequate bandwidth – so that OSVW and SWH products could be accessed along with other products that are already being delivered on a routine basis to his or her center.

- Action: (a) NOAA and EUMETSAT to explore with relevant WMO programmes and Technical Commissions, primarily and foremost JCOMM and the Commission for Basic Systems (1) the steps needed to utilize the GTS for the worldwide distribution of those consensus OSVW and SWH products – not now available via the GTS – that are compatible with the bandwidth limitations of this system, and (2) whether there are any opportunities to utilize any pilot activities of the forthcoming WMO Information System (WIS) for the same purpose.
- Action: (b) NOAA to explore whether operational QuikSCAT OSVW products can be inserted into the GTS, just as EUMETSAT has arranged for ASCAT; these products are freely available, but via a NOAA FTP site.
- Action: (c) NOAA and EUMETSAT to explore with ESA whether the fast delivery wave product from the ENVISAT altimeter could be inserted directly onto the GTS for operational use by forecast centers worldwide, just as Météo France does for Jason altimeter products.

3. Operational utilization. A third challenge concerns the actual capability of worldwide operational centers to utilize OSVW and SWH products in routine analyses and forecasts for both the high-seas and coastal areas. CEOS, working through the OSVW and OST Constellations, can facilitate the exchange of information concerning *lessons learned* with regard to utilization of OSVW and SWH products, as well as their operational impact, thereby contributing to the development of improved analyses and forecasts. With sufficient demonstrated impact, at some point in the future, one can envision the orbits of scatterometer-carrying satellites being harmonized to provide optimal coverage both in space and time.

- Status: The NASA Ocean Surface Vector Wind (OSVW) Science Team and EUMETSAT ASCAT Science Advisory Group (SAG) each serve as a forum for elements of the research community associated with the particular scatterometer in question; research users can interact, share experiences, and get ideas about what to do next. Similarly, the joint NASA-CNES Ocean Surface Topography Science Team serves as a similar forum for altimetry. Bilateral exchanges between the satellite-providing agencies serve as an additional forum. While operational users in Europe and the U.S. can participate in the meeting of these science groups, as well as attend international conferences like the *Satellite Meteorology & Oceanography Conference* held September 2007 in Amsterdam, this is being done on a more-or-less *ad hoc* basis. However, such participation by operational users in the Southern Hemisphere is more difficult. An OSVW Virtual Constellation, together with the OST Constellations,

could provide a mechanism to bring together operational and research users of OSVW and SWH products in a more structured and effective manner.

- Action: (a) NOAA, EUMETSAT and ISRO to schedule an initial three-way planning meeting to discuss the relative merits of the OSVW Virtual Constellation organizing an operationally oriented scatterometer OSVW user workshop.

4. Improved on-orbit capabilities. A final challenge concerns making improvements to present observational capabilities, as well as post-processing tools for users. CEOS again could provide a forum to identify collaborative opportunities associated with such improved capabilities; and in so doing, help secure the resources required for their implementation.

- Status: NOAA, with the assistance of the NASA, has definition studies underway for an improved satellite capability to observe OSVW in the post-QuikSCAT era. The objective is to develop and implement a capability that would enable resolution of the OSVW field under rainy conditions, especially at high wind speeds, an issue that high-seas forecasters typically face in tropical cyclones and hurricanes, as well as in hurricane-force, extra-tropical winter storms. Similarly, EUMETSAT has definition studies underway concerning what specific capability for observing OSVW should be included in the satellite series that will follow METOP.

- Action: (a) NOAA is pursuing an initiative for a dual Ku- and C-band scatterometer that would combine the best of both QuikSCAT and ASCAT, and be capable of resolving wind from rain – especially under high wind speed conditions.

Proposed Constellation Team – to be drawn from the following, as appropriate

- Co-Chairs
  - EUMETSAT – Hans Bonekamp
  - ISRO – B.S. Gohill
  - NOAA – Stan Wilson
- Members from Space Agencies
  - NASA – Eric Lindstrom
  - ESA – Mark Drinkwater
  - Chinese State Oceanic Administration (SOA) – Lin Mingsen
  - CNES – Bruno Cugny or Juliette Lambin
  - NOAA – Paul Chang
- Members from International Organizations
  - JCOMM
    - Peter Dexter or Jean-Louis Fellous, Co-Presidents
    - Bob Keeley, JCOMM Data Management Coordinator
    - Craig Donlon, JCOMM Services Coordinator
  - WMO
    - Wenjian Zhang, Director of both the Observing and Information Systems Department and Integrated Global Observing System Branch

    - Jean-Michel Rainer, Acting Director of the WMO Information System Branch
    - Miroslav Ondras, Chief, Observing Systems Division, WIGOS Branch, Observing and Information Systems Department
    - Geoffrey Love, Director of the Weather and Disaster Risk Reduction Services Department
    - Edgard Cabrera, Chief of the Marine Meteorology and Ocean Affairs Division, Weather and Disaster Risk Reduction Services Department
- Members from Operational Agencies
    - Météo France – Jean-Michel Lefèvre
    - KNMI – Ad Stoffelen
    - NOAA/National Weather Service/Ocean Prediction Center – Joe Sienkiewicz
    - NOAA/NWS – Fred Branski – operational telecommunications & data management
    - NOAA/U.S. IOOS – Jack Harlan
    - Chinese Meteorological Administration (CMA) – Sun Minghua
    - European Center for Medium-range Weather Forecasts – Peter Janssen, Saleh Abdalla, or Jean Bidlot (also member of the JCOMM Expert Team on Wind Waves and Storm Surges)
    - Indian Meteorological Department – Gounder A. Muthuchami, Regional Meteorological Centre, Chennai
    - UK Met Office – Adrian Hines (also member of the JCOMM Expert Team on Wind Waves and Storm Surges, as well as focal point for GlobWave)

Meetings and Milestones

September 28-29, 2007, Amsterdam – Joint Ocean Surface Vector Wind (OSVW) Science Team and ASCAT Science Advisory Group (SAG) Meeting

- Initial discussions were conducted amongst ESA, EUMETSAT, NASA and NOAA concerning the potential for collaboration within the framework of a CEOS Ocean Surface Vector Wind (OSVW) Constellation.

November 15, 2007, CEOS Plenary, Kona, Hawaii – Side meeting between ISRO, EUMETSAT and NOAA

- Agreement amongst these three agencies to propose an OSVW Virtual Constellation to the CEOS/SIT.

January 22-23, 2008, Bangalore – Joint ISRO/NASA/NOAA meeting

- Bilateral discussions were held with regard to collaboration in an OSVW Virtual Constellation, as well as timely access to Oceansat-2 scatterometer data as a contribution thereto.

March 7, 2008, Bangalore – Joint ISRO/EUMETSAT meeting

- Bilateral discussions, as above, with regard to collaboration in a Constellation and timely access to Oceansat-2 scatterometer data.

June 19-20, 2008, Darmstadt – First meeting of the renewed ASCAT SAG

- Discussions specifically focused on completion of the METOP-A/ASCAT Commissioning Phase, with active participation on the part of NOAA and NASA experts.

July 8, 2008, Boston – Special Session on OSVW at the International Geoscience and Remote Sensing Symposium (IGARSS)

- Side meeting concerning the proposed OSVW Virtual Constellation.

18-19 September 2008, Geneva – Meeting of the Joint Steering Group for the IODE Ocean Data Portal and the WMO Integrated Global Observing Systems (WIGOS) Pilot Project for JCOMM

- The Pilot Project is seeking in particular at developing interoperability between real-time and delayed mode ocean data systems (e.g. ODP) and the WIS. Representation at this particular meeting will help ensure that OSVW (together with significant wave height from the OST Constellation) will be included in the WIGOS framework.

19-21 November 2008, Seattle – NASA Ocean Surface Vector Wind Science Team Meeting

- This meeting offers the opportunity to discuss the proposed OSVW Virtual Constellation with both scientific and operational participants.

Early 2009, ISRO/India – Launch of Oceansat-2 and initiation of its Commissioning Phase

- This represents the first opportunity to expand the OSVW Constellation to include wind products from this Indian satellite.

2-5 December 2008, Guangzhou – Special Session on OSVW at the Pan-Ocean Remote Sensing Conference (PORSEC)

- A PORSEC Workshop on data availability will offer an opportunity to make the case to working-level Chinese scientists for timely access to scatterometry (and altimetry) data from the HY-2 series of satellites in the context of the proposed OSVW (and OST) Virtual Constellation.

8-12 December 2008, Melbourne – JCOMM Management Committee Meeting

- The proposal by the OSVW Virtual Constellation to include OSVW and significant wave height products will be presented to the JCOMM Management Committee for their formal concurrence.

Late 2008/early 2009, Darmstadt – Post-EPS (EUMETSAT Polar System) User Conference

- This will include a discussion of how OSVW requirements will be met on the successor system to METOP-A, B & C.

15-19 June 2009, WAVES 2009 – The 9th International Conference on Mathematical and Numerical Aspects of Waves Propagation, Pau, France

- Opportunity to include interests of the surface wave modeling community in having timely access to global wind and wave products.

June 2010, State Oceanic Administration/China – Launch of HY-2A and initiation of its Commissioning Phase

- This represents the first opportunity to expand the OSVW Virtual Constellation to include wind products from a Chinese satellite.

Appendix – Organizational and Programmatic Linkages

In order to address the above challenges, the OSVW Virtual Constellation must coordinate with and work through the following organizations and programs that concern its domain of interest.

Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). JCOMM, a joint endeavor of the WMO and the Intergovernmental Oceanographic Commission (IOC), manages and coordinates an integrated marine observing, data management and services system that is responsive to the needs of users of marine data and products. It works closely with partners including the International Oceanographic Data and Information Exchange, Global Ocean Observing System, and Global Climate Observing System. It is divided into three Program Areas – Observations, Services, and Data Management – each of which has a number of expert teams or coordination groups to oversee particular activities.

JCOMM Services Programme Area deals with the provision of marine meteorological and oceanographic services around the globe. It regulates, facilitates and supports the delivery of the most visible outputs of the world's marine meteorological and oceanographic organizations. These include warnings of gales, storms, severe tropical weather systems such as tropical cyclones and other hazardous phenomena, information on sea ice conditions and other products disseminated through the Global Maritime Distress and Safety System (GMDSS) in response to requirements established under the International Convention for the Safety of Life at Sea (SOLAS) of 1974. The continuing provision and development of safety-related weather and oceanographic services is a fundamental priority of JCOMM and of its Services Programme Area.

- Peter Dexter – Australian Bureau of Meteorology, one of two Co-Presidents of JCOMM – recently stated: *I think that it is absolutely appropriate that scatterometer and altimeter products should be available on the GTS.* Jean-Michel Lefèvre (Division Marine et Océanographie, Météo-France and member of the JCOMM Expert Team on Wind Waves and Storm Surges) has noted that: *Interest in using satellite data for wave application is growing among Met-Services…because very few in situ data are available in open oceans or seas. Efforts to promote the use of satellite data should continue* [e.g., ESA's GLOBWAVE].

World Meteorological Organization (WMO). The WMO has expressed an interest in the inclusion of products from the OSVW Virtual Constellation, together with significant wave height from the Ocean Surface Topography Constellation, in the GTS for delivery to operational World Weather W centers (WWW). When asked about scatterometer-derived ocean surface vector wind, in addition to altimeter-derived significant wave height from the OST Constellation, being distributed by the GTS,

- Don Hinsman – Former Director of the WMO's Observing and Information Systems Department and Integrated Global Observing System Branch – stated: *The answer is yes. WMO is enthusiastic to carry new and important products.*
- Statement from the 60th Session of the WMO Executive Council, 18-27 June 2008 (EC-LX/B/WP 3.1): *The Council requested that efforts be made by all concerned to ensure that coastal wave and ocean surface meteorological observations be routinely collected and disseminated via the GTS, in order to further improve wave models. It also requested the Secretary-General to promote participation of space agencies in that scheme. The Council recognized that severe coastal inundation events from extreme sea state conditions occurred in many parts of the world…where coastal and ocean surface meteorological observations were still limited or absent, and requested JCOMM and other relevant technical commissions to address this issue as a matter of priority.*

Global Telecommunications System. The GTS is the coordinated global system of telecommunication facilities and arrangements for the rapid collection, exchange and distribution of observations and processed information within the framework of the WWW; observational data and products required at WWW centers are typically exchanged using the GTS; and the OSVW Virtual Constellation has been encouraged by the WMO to make OSVW products available to the GTS, thereby helping facilitating access to those products by all operational users at WWW centers. Given the limited bandwidth of the GTS, the WMO Information System (WIS) is being planned as a successor to the GTS.

The GTS is only directly accessible to operational forecast centers, a factor that rules out its use for reaching other communities such as University groups. The GTS supports a limited range of formats to facilitate ease of access for operational centers; for altimeter-derived significant wave height and scatterometer-derived surface vector winds, the data would be BUFR encoded, a format in general use operationally.

WMO Information System. The WMO Information System (WIS) is being designed to extend the ability of WMO member countries to collect and disseminate data and products in the 21st Century, providing linkages for programs associated with weather, climate, water, and related natural disasters. It is being built upon the GTS of the WMO's WWW using standard elements and at a pace feasible for all member countries. The Integrated Global Data Dissemination Service (IGDDS) project of the WIS is working to ensure the definition and operational implementation of a means for the efficient distribution of space-based observation data and products. The OSVW Virtual Constellation needs to be aware of and coordinate with the development of the WIS and its IGDDS project as they evolve from that inherent in the GTS.

WMO Integrated Global Observing Systems (WIGOS). The WMO Integrated Global Observing Systems (WIGOS) is a concept for a comprehensive, coordinated and sustainable system of observing systems. WIGOS is based on all WMO Programmes' observational requirements. It ensures availability of required data and information and facilitates access through the WMO Information System (WIS) according to identified requirements. Additionally, it helps ensure high data quality standards and benefits from archival and technological innovations. The OSVW Virtual Constellation needs to engage in the WIGOS process through participating in the WIGOS Pilot Project for JCOMM.

Global Maritime Distress and Safety System. The GMDSS is an integrated communications system using satellite and terrestrial radio communications to ensure that, no matter where a ship is in distress, aid can be dispatched. This System also ensures the provision of maritime safety information (MSI) on a global basis at sea. GMDSS was developed by the International Maritime Organization in close co-operation with the International Telecommunication Union, WMO, International Hydrographic Organization, and COSPAS-SARSAT partners. Regulations governing the GMDSS are contained in the SOLAS Convention.

All passenger vessels and all larger cargo ships on international voyages must comply with the GMDSS, and be fitted with applicable satellite and radio communications equipment, according to the sea area (or areas) in which the ship operates, for sending and receiving distress alerts and MSI. Under the GMDSS requirements, all ships are required to be equipped with Inmarsat and/or NAVTEX receivers, to automatically receive MSI, including warnings and forecasts.

For broadcast purposes, the world's oceans were initially divided into 16 Navareas/Metareas for the provision of meteorological information, each the responsibility of a National Meteorological Service (NMS) or meteorological Issuing Service. Recently, five new Navareas/Metareas were created expanding the GMDSS into the Arctic waters. The WMO contribution to the GMDSS, coordinated by the joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) with the support of the meteorological Issuing Services, develops specific regulations for the provision of meteorological and oceanographic warnings and forecasts.