EUMETSAT
EUMETSAT METEOROLOGICAL SATELLITE CONFERENCE 2021
VIRTUAL
20 – 24 SEPTEMBER 2021

NWP, Ocean and Futher Application Benefits of the Virtual Scatterometer Constellation (No 224)

23.09.2021 12:15 - 12:25 Live oral presentations
S04-A - 2D/3D Wind assimilation/diagnostics (Dppler Wind Lidar, mainly, plus diagnostics and surface winds)

Ad Stoffelen[1], Anton Verhoef[1], Jeroen Verspeek[1], Jur Vogelzang[1], Zhen Li[1], Marcos Portabella[2], Ana Trindade[2], Zhixiong Wang[3], Giovanna De Chiara[4], Christophe Payan[5], Anne-Lise Dhomps[5], Alexander Cress[6], James Cotton[7], Luca Brocca[8], David Long[9], Isabel Monteiro[10]

[1] KNMI Royal Netherlands Meteorological Institute
[2] ICM/CSIC Institut de Ciències del Mar
[3] Nanjing University of Information Science and Technology (NUIST)
[4] ECMWF
[5] Météo-France
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[9] Brigham Young University (BYU)
[10] IPMA - Portuguese Institute for Sea and Atmosphere

The prime ocean vector winds user requirement is enhanced temporal coverage for the tracking of mesoscale transient features and resolving coastal air-sea breezes and their diurnal cycle. Hence, collaboration and cooperation between Europe, India and China is ongoing to elaborate our OSI SAF plans to develop high-quality services and applications, while the global virtual constellation of wind scatterometers is being extended, in order to benefit world-wide users. Besides the comprehensive and versatile quality monitoring by the wind data providers, extended quality monitoring has been performed by the Numerical Weather Prediction (NWP) centres, before relying on data assimilation techniques to improve the initial model state of the forecast model by using the actual constellation scatterometer winds. For example, first Observing System Experiments (OSE) at several European NWP centres show neutral to positive forecast impact by assimilating HY-2B winds processed by KNMI. These new winds, measured at 6:00 and 18:00 Local Solar Time (LST) are furthermore much welcomed by the marine nowcasting professionals to complement the current virtual constellation of wind scatterometer data at 8:45/20:45 and 9:30/21:30 LST from ScatSat and ASCAT-A/B/C, respectively. Later in 2021, more scatterometer systems measuring at different local times will be added (OceanSat-3 from ISRO at 12:00/0:00 LST, CMA WindRad at 6:00/18:00 LST and HY-2C at varying LST). Ground station extension is much welcomed for the European marine nowcasting and NWP applications. Access to more timely constellation winds is the single achievable requirement by our users that would bring most benefit.

Concerning ocean model forcing, the HY2 data has been used to verify a new blended scatterometer and NWP wind product that exploits the virtual wind scatterometer constellation in more detail by

extracting and isolating the global wind structures associated with the air-sea interface, but that are not resolved in (ocean-coupled) global NWP. The resulting improved ocean forcing and NWP bias product may be extended, inter alia, to include the information brought by the HY2 scatterometers. In particular, the sun-asynchronous HY-2C wind data would be invaluable to further develop this product. The extracted structures are stable in time and may be used to allow Best Linear Unbiased Estimation in NWP data assimilation. The bias correction structures reduce the so-called o-b variance by 20%, which is enormous and should in principle much enhance the benefits of scatterometer wind data assimilation in NWP. This remains to be tested, however.

Preliminary work on using the HY-2B scatterometer backscatter data for soil moisture and accumulated rain observation over land has commenced, indicating the potential of such development. A virtual constellation is further very useful for the assessment of accumulated rain as more observations per day will become available at each ground pixel. It goes without saying that an accumulated rain product, based on land backscatter measurements is highly complementary to rain products based on microwave rain cloud measurements, as the latter cannot track the fast moist convection processes and its associated rain, while the accumulated rain acts more like a rain gauge, where all rain is collected in the measured soil wetness.

In summary, the virtual constellation of wind scatterometers has already contributed to relevant processing, monitoring and application developments over sea, land and ice, where further NWP and more general application benefits are expected with the further ongoing extension of the constellation and its applications.

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A land-corrected ASCAT coastal wind product (No 123)

23.09.2021 11:40 - 11:45 Live oral presentations
S06-A - Wind - Part 1

Jur Vogelzang[1], Ad Stoffelen[1]

[1] KNMI Royal Netherlands Meteorological Institute

Accurate wind information in coastal regions is important for a large number of activities. Scatterometers give accurate wind information over the open sea, but in the coastal region the interpretation of the radar backscatter, ?^0, is hindered by land contamination. An obvious strategy to retrieve scatterometer winds closer to the coast is to correct for land contamination. Such an approach has been developed for QuikSCAT using the expected land contribution from a large database of ?^0 values. In this paper we present an alternative method for ASCAT, based on the land fraction in the full resolution ?^0 product that is being developed by EUMETSAT. This land fraction is calculated for each footprint from the Spatial Response Function (SRF) and a high resolution land-sea map. For each coastal wind vector cell (WVC) a simple linear regression is made between the land fraction and ?^0 value of all antenna footprints contributing to that WVC. The regression parameters are used to correct each individual ?^0 value. The corrected ?^0 values are aggregated into one ?^0 per beam and passed over to the inversion algorithm. So far, results have been inspected visually, and good results are obtained using Gaussian weights in the aggregation. Quantitative validation is hard, as there are not many buoy measurements close to the coast. Moreover, coastal winds may have large spatial variability, so representativeness is a problem here. NWP winds are known to be unreliable in the coastal zone. Alternative validation will be investigated, like investigating the wind and available residuals and QC parameters as a function of distance from the coast.

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Quadruple and quintuple collocation analysis of buoy, scatterometer, and NWP winds (No 122)

23.09.2021 11:35 - 11:40 Live oral presentations
S06-A - Wind - Part 1

Jur Vogelzang[1], Ad Stoffelen[1]

[1] KNMI Royal Netherlands Meteorological Institute

Triple collocation analysis is an established method to determine the linear intercalibration and error variances of a physical quantity measured simultaneously in space and time by three observing systems. The method can be readily extended to four or more systems, and cast in an elegant form with the covariance equations. Representativeness errors can be included in a natural manner in the formalism. The off-diagonal covariance equations are used to calculate the calibration scalings and the common variance, while the diagonal terms yield the error variances. In case of quadruple collocation, there are 6 off-diagonal equations and 4 unknowns, so there are 15 possible combinations of equations. Of these combinations, 12 have a solution, while 3 are unsolvable. In addition, the two unused equations can be solved for an error variance. It is shown that the additional error variances give no clue on the representativeness errors involved; these have to be found using other complementary methods. Quadruple collocation analysis is performed on bASE, bBSE, and bABE collocations of ocean surface wind vectors, where “b” stand for buoys, “A” for ASCAT-A, “B” for ASCAT-B, “S” for ScatSat, and “E” for the ECMWF forecast, using all data in the period October 2016 to July 2017. It is found that representativeness errors from differences in spatial variances minimize the spread in the twelve solutions when the spatial variances are evaluated at about 200 km for u and about 100 km for v, in agreement with earlier results and the expected improvement in the true resolution of the ECMWF model. The spread in the solutions is an indication for the reliability of the underlying error model. From the results it is concluded that the scatterometer error standard deviations from triple collocation analyses are consistent within 0.05 m/s, probably limited by the physical reliability of the error model applied. By introducing an efficient numerical solution scheme, the method can readily be extended to quintuple collocations. Here there are 10 off-diagonal equations, 5 unknowns, and 252 possible combinations. Quintuple collocation analyses on a bABSE collocated dataset confirms the results from quadruple collocation analyses. Quadruple and quintuple collocation analysis does not give much information on the error covariances involved, but is most useful to check the consistency of the error model used.

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Towards QuikSCAT coastal winds at OSI-SAF (No 158)

23.09.2021 11:45 - 11:50 Live oral presentations
S06-A - Wind - Part 1

Giuseppe Grieco[1], Marcos Portabella[1], Ad Stoffelen[2], Jur Vogelzang[2], Anton Verhoef[2]

[1] Barcelona Expert Center (BEC) Institut de Ciencies del Mar (ICM-CSIC)
[2] KNMI Royal Netherlands Meteorological Institute

Accurate high-resolution QuikSCAT-derived winds with dense coastal sampling are strategic for both scientific and civil applications.
This study presents the implementation of the QuikSCAT spatial response function (SRF) analytical model and its parameterized version by means of a pre-computed look-up-table (LUT), provided by the Brigham Young University (BYU). Their validation and their differences are discussed in detail. In addition, the implementation of the land contribution ratio (LCR) computation and its visual validation are discussed. The slice ?0 noise is also carefully characterized and the measured Kp is compared to that provided in the QuikSCAT level 1b full resolution files (L1B). Different levels of ?0 are considered for the computation of the Kp, ranging from low to moderate and high wind speed regimes.
The preliminary results show that the analytical and the LUT-derived SRFs are consistent with each other, even if some non-negligible differences are apparent. In particular, the LUT-derived SRFs have less spatial detail with respect to the analytical ones. Furthermore, analytical SRFs are generally not symmetric with respect to the slice centroid, while the LUT-derived ones are. The validation procedure of the LCR shows that the obtained values are consistent with the coastline. However, the differences between the analytical and the LUT-derived SRFs induce differences in the LCR values of up to a few percent. These differences are expected to impact the coastal wind field retrievals, but the investigation of this aspect is left for future studies.
Both measured and L1B Kps decrease with increasing ?0 levels, and horizontally (HH) polarized acquisitions are noisier than those vertically (VV) polarized.
The measured Kps show that the farther from the egg centroid, the noisier the slice ?0 , showing a rather symmetric parabolic trend. In contrast, the Kps provided in the QuikSCAT files do not show the same trend, i.e., the Kp is rather constant for slice indices higher than 2.
The comparison among the eight available slices shows some inter-calibration issues, especially for HH acquisitions. The more distant the slices from each other, the higher the bias, which can reach 0.8 dB for HH acquisitions. This analysis also shows a non-negligible trend of the bias with respect to the antenna azimuth angle. Once more, the bias is more pronounced for HH acquisitions.
Finally, the Kps computed over ocean are lower than those computed over land and sea-ice, where the Kp estimated value is more in particular correlated to the sea-ice fraction.

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Developments of the operational sea ice concentration algorithm at DMI (No 94)

24.09.2021 12:20 - 12:25 Live oral presentations
S06-C - Temperature and sea ice

Fabrizio Baordo[1], Rasmus Tonboe[1], Luis Vargas[1]

[1] Danish Meteorological Institute

As part of the Continuous Development and Operational Phase (CDOP) of the EUMETSAT OSI-SAF project, work is ongoing to implement technical and scientific upgrades to the near real time sea ice concentration (SIC) retrieval algorithm. The ambition is to 1) reduce SIC uncertainties in general and in particular during summer, 2) increase spatial resolution and
timeliness, 3) improve the spatial resolution, 4) and to unify the processing of the sea ice climate data records and the operational processing. Several studies have been conducted focusing on SIC product improvements and its implementation will also lead to a more flexible framework which will allow to easily deal with different and future satellite instruments. On the
short term, technical changes are mainly required to handle the generation and dissemination of Level 2 (L2) products which, at the current state, are derived from the observations collected by the SSMIS and AMSR2 microwave radiometers on board of polar orbiting satellites. The goal
is to process the Level 1 satellite swaths as soon as they are available at DMI and provide the users with the L2 data on a reduced temporal resolution (possibly every 2-3 hours) compare to the 24 hours of the Level 3 product. Scientifically, the current operational algorithm implements radiative transfer calculations for correcting the atmosphere influence on the observed brightness temperatures which are successively used in the calculations of the ocean and ice dynamical tie-points. We are currently investigating the possibility of reviewing the atmospheric correction scheme by utilizing the Radiative Transfer for TOVS (RTTOV) part of the
NWP-SAF community. On the long term, the importance of adopting RTTOV is not only motivated by a scientific interest, but it will also satisfy the requirement of minimizing the effort of introducing new satellite instruments such as the EPS-SG Microwave Imager. Results of the ongoing developments will be presented at the conference.

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New Southern Hemisphere Ice Type Classification (No 144)

24.09.2021 12:25 - 12:30 Live oral presentations
S06-C - Temperature and sea ice

Emily Down[1], Signe Aaboe[1]

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EUMETSAT Ocean and Sea Ice SAF, in work done at MET Norway, has recently added a near real-time Sea Ice Type product for the Southern Hemisphere based on passive microwave satellite observations. Monitoring of ice type in the Southern Hemisphere is new, and will in the future provide an extra time series to be used in climate studies, alongside sea ice concentration and extent. To classify the ice types from satellite data in the Antarctic is more challenging than in the Arctic due to greater variation in the ocean conditions, greater movement of the ice, and generally younger ice with less differentiation between the older and younger ice. We use the GR37-19V brightness temperature gradient from AMSR2 to create monthly probability distributions for first-year ice and multi-year ice (which has survived at least one summer melt period) for one year and use a blend of these distribution functions to calculate the ice type. We then correct for a type of first-year ice, likely pancake ice, which erroneously appears in this model as multi-year ice. For the correction we use a model in which the ice is backtracked to the previous ice extent minimum using the ice drift, to remove ice that was modelled as multi-year ice but which did not exist following the previous summer melt period. In this presentation the new product will be showcased, including limitations and potential for future development.

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Satellite Application Facility on Ocean and Sea Ice (OSI SAF): Focus Future (No 425)

24.09.2021 15:25 - 15:35 Live oral presentations
S06-D - Bio-geophysical and multi-mission products

Cécile Hernandez[1], Hervé Roquet[1]

[1] Météo-France

The EUMETSAT Satellite Application Facility on Ocean and Sea Ice develops, processes and distributes, in near real-time, products related to key parameters of the ocean-atmosphere interface. The OSI SAF also offers climatological data records. The OSI SAF team focuses on sea surface winds, Sea and Sea Ice Surface Temperature (SST/IST), radiative fluxes: Downward Longwave Irradiance (DLI) and Surface Solar Irradiance (SSI), sea ice concentration, edge, type, emissivity, drift.
The applications of OSI SAF products are numerous, the most general ones are the assimilation into models, the validation of models, oceanography, research and environmental monitoring.
We will illustrate some of the OSI SAF committed products based on the new generation of EUMETSAT satellites: MTG SST, Metop-SG wind and sea-ice products. These products will ensure continuity with current operational products.

We will also describe OSI SAF plans to exploit the new capabilities offered by the MTG and Metop-SG satellites:
- full exploitation of the cross polarisation measurements of the SCA scatterometer in the ocean wind vectors retrieval;
- new regional sea surface temperature product at high space and time resolution, relying on the high resolution (1 km) infrared channels of the FCI instrument;
- prepararation for ocean colour related products, exploiting FCI visible and near infrared channels;
- new sea-ice age product.

In the next years, existing sea-ice, wind and MSG SST Climate Data records will be improved and extended. Two new CDRs will be added to the OSI SAF portfolio: an iceberg CDR, based on available radar altimeter wave form data; and a sea-ice surface temperature Climate Data Record based on the Climate SAF AVHRR Fundamental Climate Data Record;

To strengthen efforts towards users in term of support, training and outreach, the OSI SAF will inter alia propose a higher visibility on the rapid changes in Arctic and Antarctic sea-ice cover by providing tailored sea-ice index products (climate indicators) and improve their online visualization;
The OSI SAF team will also work towards an observation operator for sea ice together with the NWP SAF in a federated activity using RTTOV.

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Panel discussion (No 471)

24.09.2021 13:30 - 14:30 Live oral presentations
SPECIAL EVENT - The EUMETSAT SAF Network: Preparing for the future

Cécile Hernandez[1]

[1] Météo-France

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HY-2B and HY-2C winds and services from the OSI SAF (No 84)

Posters
E-Poster session

Anton Verhoef[1], Ad Stoffelen[1], Rianne Giesen[1], Juhong Zou[2], Zhixiong Wang[3], Simon Elliott[4], David Long[5]

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[2] NSOAS National Satellite Ocean Application Service
[3] NUIST Nanjing University of Information Science & Technology
[4] EUMETSAT
[5] Brigham Young University Center for Remote Sensing

The Haiyang 2B (HY-2B) satellite was launched on 25 October 2018 and the Haiyang 2C (HY-2C) was launched on 21 September 2020. Both satellites are operated by the Chinese National Satellite Ocean Application Service (NSOAS) and carry a Ku-band pencil-beam scatterometer similar in concept as the US QuikSCAT and the Indian OSCAT scatterometers. HY-2B is in a sun-synchronous orbit with a local time of descending node at 6:00, whereas HY-2C is in a drifting orbit with 66° inclination. HY-2C provides wind measurements between ~73° N and ~73° S which includes almost all global oceans.
Within the context of the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF), KNMI produces level 2 wind data from various scatterometer instruments in near-real time. HY-2B and HY-2C winds are now being produced for evaluation by a limited group of European users. A wider distribution is strived for, depending on agreements between EUMETSAT and NSOAS. Wind products are created with 25 km and 50 km swath grid spacing. The processing algorithms for the wind processing are to a great extent based on the algorithms as developed in the OSI SAF and Numerical Weather Prediction (NWP) SAF for earlier Ku-band scatterometers, and have been improved in close cooperation with colleagues from China. Moreover, EUMETSAT currently facilitates 5-7 daily orbit dumps to a Finnish ground station to improve timeliness. Furthermore, HY-2B winds are added as near-real time L3 products to the EU Copernicus Marine Environment Monitoring Service (CMEMS, https://marine.copernicus.eu/about-us/about-producers/wind-tac/).
The local time of Equator crossing of the polar orbit is 6:00 for HY-2B. Due to this the mission helps to close the gaps in the temporal coverage of the current operational missions of ASCAT on the Metop satellites (9:30) and OSCAT on ScatSat-1 (8:45). Due to its drifting orbit HY-2C provides a good monitoring of the diurnal cycle and regular collocations with all other scatterometers in operation which helps in instrument intercalibrations. Both products are visualised in the Multi-Platform product viewer on the OSI SAF wind web-site (https://scatterometer.knmi.nl/tile_prod/). This viewer allows the user to zoom in on a region of interest and conveniently display the wind fields from different satellites over time. Hence, the development of meteorologically interesting features can be easily followed by comparing different products.
The use of generic algorithms for Ku-band scatterometer wind processing has allowed us to develop good quality wind products in a relatively short time. The comparisons with NWP model winds and buoy

winds show that the HY-2B and HY-2C winds are of comparable quality to the OSI SAF wind products from e.g. ScatSat-1 and SeaWinds.
We will show some validation results for the wind products, show how they are displayed in the Multi-Platform viewer and we will give an update on the availability of the products to the user community.

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Towards triple collocation analysis of 4D wind observations (No 133)

23.09.2021 12:05 - 12:15 Live oral presentations
S04-A - 2D/3D Wind assimilation/diagnostics (Dppler Wind Lidar, mainly, plus diagnostics and surface winds)

Federico Cossu[1], Marcos Portabella[1], Wenming Lin[2], Ad Stoffelen[3], Gert-Jan Marseille[3], Jur Vogelzang[3], Isabel Monteiro[4]

[1] Institute of Marine Sciences (ICM-CSIC)
[2] Nanjing University of Information Science & Technology
[3] KNMI Royal Netherlands Meteorological Institute
[4] IPMA - Portuguese Institute for Sea and Atmosphere

The resolution of regional numerical weather prediction (NWP) models has continuously been increased over the past decades, in part, thanks to the improved computational capabilities. At such small scales, the fast weather evolution is driven by wind rather than by temperature and pressure. Over the ocean, where global NWP models are not able to resolve wind scales below 150 km, regional models provide wind dynamics and variance equivalent to 25 km or lower. However, although this variance is realistic, it often results in spurious circulation (e.g., moist convection systems), thus misleading weather forecasts and interpretation. An accurate and consistent initialization of the evolution of the 3-dimensional (3-D) wind structure is therefore essential in regional weather analysis. The research will focus on a comprehensive characterization of the spatial scales and measurement errors for the different operational space-borne wind products currently used and/or planned to be used in regional models. In addition, a thorough investigation and improvement of the 4-D (including time) consistency between different horizontal and/or vertical satellite wind products will be carried out. Such products include the Ocean and Sea Ice Satellite Application Facility (OSI SAF) scatterometer-derived sea-surface wind fields, the Nowcasting and Very Short-Range Forecasting (NWC) SAF Atmospheric Motion Vectors (AMVs), Aeolus and/or Infrared Atmospheric Sounding Interferometer (IASI) wind profiles. Densely sampled aircraft wind profiles (Mode-S) will be used to verify and characterize the satellite products. To this end, the experience of the NWC, OSI, and NWP SAFs will be exploited. Moreover, data assimilation experiments of the consistent datasets into the HARMONIE-AROME regional model will be carried out in two different regions, i.e., the Netherlands and the Iberian Peninsula regional configurations.
Regarding the characterization of the spatial scales and measurement errors, the widely used triple collocation analysis in scatterometry is further analyzed and adapted for the purpose of this project. Scatterometer winds are collocated with buoy observations and ECMWF model output during a period of 14 months on a global scale over the oceans. Different techniques to estimate the representativeness errors of the collocated data sets are inter-compared and their inconsistencies analyzed. The triple collocation method is then exploited to characterize the errors of the different sources at different scales. The analysis is performed for different oceanic regions and seasons.
Finally, an algorithm for collocating 4D wind observations from Aeolus, Mode-S data, and ECMWF

model output over a region of Western Europe is currently being developed. Moreover, experimental 4D wind data from IASI are analyzed to evaluate its possible use as an additional source of wind observations for regional data assimilation.