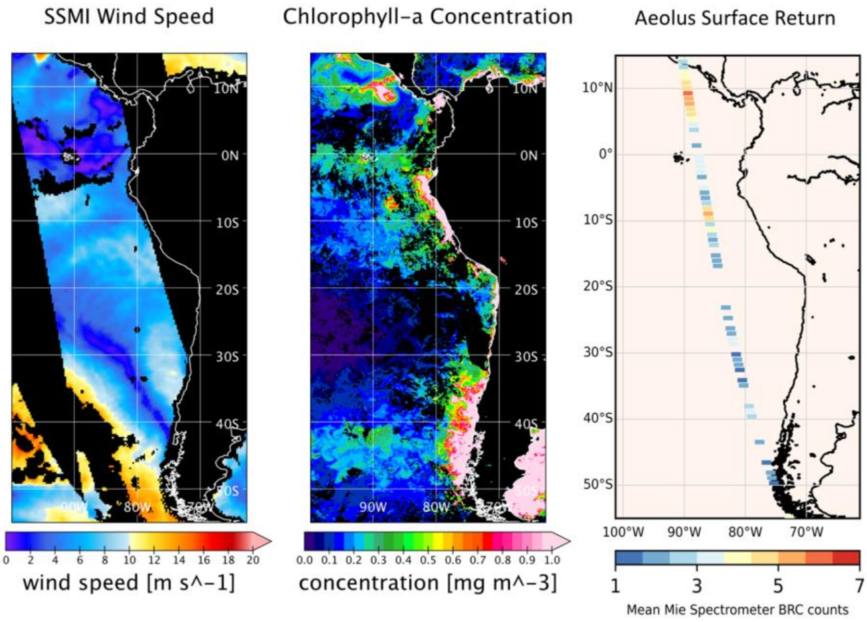
AO 9544 Aeolus + Innovation

SEA-FLECT:
Winds from Aeolus LIDAR
SEA Surface ReFLECTance

Delivery D3

Dataset Description Document



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1 COLLOCATION

1.1 Document objectives and organization

1.1.1 Study objective

The main objective of SEA-FLECT is to define, calibrate and validate an ocean surface wind speed retrieval method from ALADIN lidar surface returns. These retrievals are then used to develop a demonstrational Aeolus surface wind product.
It is expected that a successful wind speed retrieval may be hampered or even impossible under specific observation conditions. An accurate characterization of the conditions allowing for a successful application of the proposed retrieval method therefore constitutes another major outcome of the project.

1.1.2 Document objective

The development of a surface wind retrieval algorithm requires assessment of environmental conditions at the time and coordinate when an Aeolus/ALADIN surface return is measured.
The ALADIN surface return is determined by wind conditions (wind speed, white-capping), sub-surface ocean colour, and near surface atmospheric conditions (sea salt).
Measurements of these supporting data can be obtained using (other) earth observation (EO) data. In particular, it would be beneficial if the EO measurements would be available for the same time and place as the ALADIN surface measurements. Objective of this document is to provide a description of the individual datasets in the ocean surface wind validation data pool including their metadata.

Commented [AS1]: Explaining the collocation criteria in detail should not be the focus here, but rather part of Delivery 2 (D2). The main purpose of this document (D3) is to describe the datasets used, including details of e.g. their geographical and time coverage, sampling, product accuracy, etc. and how they will be used for the data validation. For the explanation on how they will be used, the collocation criteria should be provided. The auxiliary data files in the data pool should be described such that the reader can understand how it is used and the interfacing with the Aeolus data processors or how they are used for the product validation. Many thanks for updating this document / final report chapter accordingly.

1.1.3 Document organization

This document provides a description of the SeaFlect (auxiliary) data files used either as input to the Aeolus data retrieval algorithm or for its validation. The following data will be used in SeaFlect:

EO data source	geophysical parameter	section
Aeolus / ALADIN including AUX-MET data from ECMWF	Surface reflectance Sea surface wind	2
Sentinel 3A / OLCI Aqua / MODIS Terra / MODIS Suomi-NPP / VIIRSSN	Chlorophyll concentration	**Error! Reference source not found.**
HY-2B	Sea surface wind	4.1

2 SEA SURFACE RETURN SIGNALS

Sea surface return signals are measured by the Aeolus ALADIN instrument. For the SeaFlect project Level 1b data have been downloaded from aeolus-ds.eo.esa.int. Data were retrieved from the directory: /ADDF/L1B_preliminary_products/ALD_U_N_1B/1BXX. XX is the processing version. Processing version changes in time and is different for different periods.
For analysis purposes collocated weather parameters provided by ECMWF have been added to the Aeolus data and are located in the directory /ADDF/Meteorological/YYYY-MM/DD, where YYYY is the year, MM the month and DD the day index.

3 OCEAN COLOR

The sea surface return signal from the ALADIN instrument contains a contribution from the sub-surface, which is due to scattering of the laser beam by substances in the water and the sea water itself. Initial focus of the project is on oligotrophic waters, where the dominating contribution, aside the one from pure sea water, is due to chlorophyll.
For collocation of the Aeolus data and satellite enabled chlorophyll data, 2 options are available: use of chlorophyll data derived from the individual satellite observations or use of daily aggregated maps. The latter option has been selected. Use of the Level-4 data is justified for the following reasons:

- Chlorophyll concentrations are not as volatile as windspeed,
- Ocean color instruments are typically passive instruments and therefore satellite overpasses will be during daytime, whereas Aeolus/ALADIN is moving in an dusk/dawn orbit. This results in overpass times differing several hours.

Daily aggregated Level-4 chlorophyll data distributed by the Copernicus Marine Service CMEMS (https://marine.copernicus.eu/services) have been used. Data are distributed as either near real time (after 2020-07-1) or reprocessed products.

nrt product	
service url	https://nrt.cmems-du.eu
service_id	OCEANCOLOUR_GLO_CHL_NRT_OBSERVATIONS_009_033
product_id	dataset-oc-glo-bio-multi-l4-chl_interpolated_4km_daily-rt
reprocessed product	
service url	https://my.cmems-du.eu
service_id	OCEANCOLOUR_GLO_CHL_REP_OBSERVATIONS_009_082
product_id	dataset-oc-glo-bio-multi-l4-chl_interpolated_4km_daily-rep

The level-4 chlorophyll data are available at a resolution of 4 km for the whole period of the Aeolus mission and are updated daily. The latter makes this data source suitable for use by an operational service retrieving sea surface wind speed from Aeolus/ALADIN surface return signals. Algorithms are available to estimate the subsurface signal at the 355 nm used by the ALADIN laser [ref Adam] from the chlorophyll concentration.

4 SEA SURFACE WIND

Sea surface wind is measured by scatterometers carried, among others, by the European MetOp satellites and the Chinese HY-2x satellites.

4.1 Scatterometer data

4.1.1 Minimum collocation distance

For developing a sea surface wind speed algorithm, it would be ideal if ALADIN and scatterometer data could be found meeting the following criteria:

- Maximum spatial distance: 50 km,
- Maximum time difference: 10 minutes.

Criteria are based on spatial and temporal scale of wind variability[1]. The spatial criterium is the most important. If the time criterium is relaxed, a more statistical analysis is still feasible.

Commented [AGS2]: Remove this section and rather describe the datasets that are used, including the mission, instrument, parameter geographical and time coverage, the product and it's data quality information (product errors, quality flags, etc)

Commented [AGS3]: Please reference where this requirement comes from (e.g. a discussion in D2?). Is it needed in all geographical regions and at all times of the day? Perhaps relaxing this would be a possibility in regions with very stable weather conditions (e.g. persistent high pressure regions). This discussion should also be done in D-2 rather than in D3. In this document, describe the selected datasets only as mentioned above

Several scatterometers provided sea surface wind data during the Aeolus mission. However, for most missions the spatial distance criterium cannot be met. This is demonstrated below in Figure 1 MetOp/ASCAT scatterometer. Figure 1**Error! Reference source not found.** shows 3 orbits for both Aeolus and ASCAT-B. Orbits do overlap, but only in the polar regions which are not relevant for this study. Here the north pole is shown, but the same holds for the south pole.

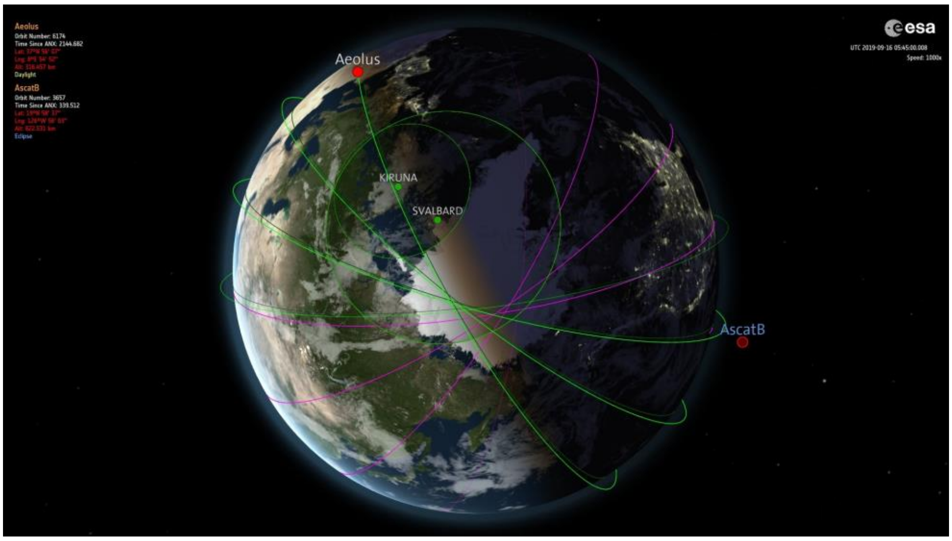

Figure 1: Example orbits of MetOp-B / ASCAT and Aeolus / ALADIN, visualized using the ESA developed SAMIE tool.

[1] Rational for collocation criterium is explained in D2

Observations meeting the strict collocation criteria can be found only at rather high and rather low latitudes. Exception might be the Chinese HY-2B instrument, its orbit shows a smaller inclination angle and the orbit is drifting. It should be noted that HY-2B uses a fan-beam imaging mechanism, which is quite different from the ASCAT mechanism.

As an example, Figure **2** shows wind speed retrievals by the HY scatterometer for an orbit recorded 18 April 2021.

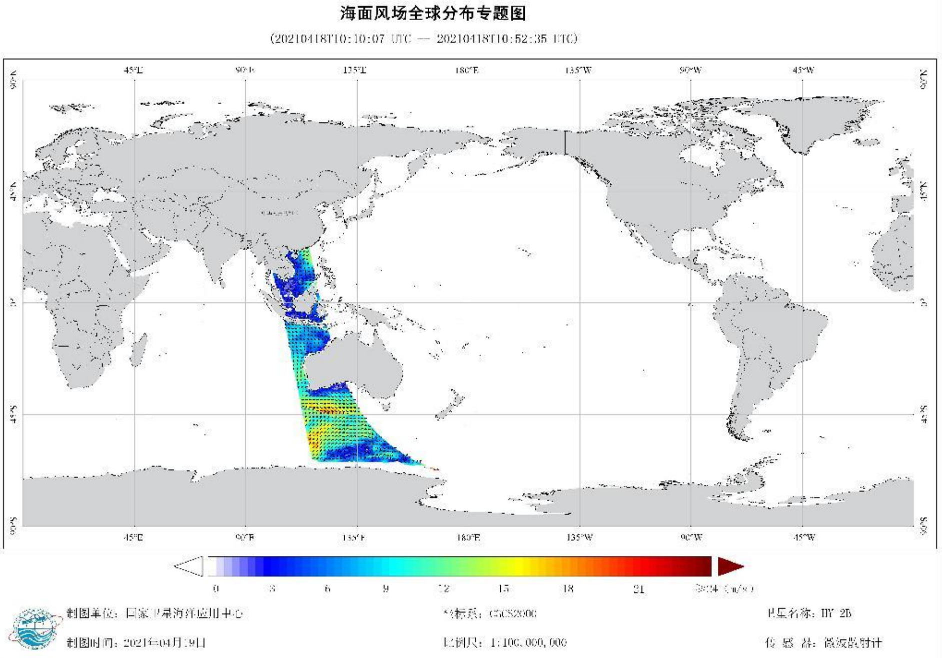

Figure 2. HY-2 sea surface wind speed retrievals orbit 18 April 2021.

A sample of data has been retrieved from the Chinese Ocean Satellite Data Service Center and collocation with Aeolus data is being investigated.

5 COLLOCATION DATABASE

For algorithm development and validation, a data pool has been set-up. The data pool consists of netCDF files. Data from different sources are located in separate groups. The following groups are implemented:

- L1B Aeolus L1B data
- MET Aeolus AUX-MET meteorological data
- OC Ocean color data
- HY2B HY-2B wind data

Group	**Parameter short name**	**Parameter long name**	**Dimensions**	**Units**
L1Bmie	time	(start of observation) time	time	seconds since 2019-01-01, UTC
	bin			
	ctime	observation centroid time (AOCS)	time	Seconds since 2019-01-01, UTC
	altdem		time	sea surface height above geoid
	avg_uv_energy		time	
	uv_energy_std_dev		time	
	lon	longitude mie data	time, bin	degrees east, WGS 84
	lat	latitude mie data	time, bin	degrees north, WGS 84
	alt	satellite altitude	time, bin	m
	azi	azimuth viewing angle	time, bin	degrees
	elev	sun elevation angle	time, bin	degrees
	sun	sun azimuth angle	time, bin	degrees
	range	index range bin	time, bin	-
	err	Mie error quantifier	time, bin	
	sgnlstdv	useful signal standard deviation	time, bin	-
	scat	Mie scattering ratio	time, bin	-
	r_scat	Rayleigh scattering ratio	time, bin	-
	snr	Mie signal to noise ratio	time, bin	-
	r_snr	Refined Mie signal to noise ratio	time, bin	-
	flag	Data quality flags	time, bin	(bit values)
	sgnl	useful signal strength	time, bin	-
L1Bray	time	(start of observation) time	time	seconds since 2019-01-01, UTC
	bin			
	ctime	observation centroid time (AOCS)	time	Seconds since 2019-01-01, UTC
	altdem		time	sea surface height above geoid
	avg_uv_energy		time	
	uv_energy_std_dev		time	
	lon	longitude mie data	time, bin	degrees east, WGS 84

	lat	latitude mie data	time, bin	degrees north, WGS 84
	alt	satellite altitude	time, bin	m
	azi	azimuth viewing angle	time, bin	degrees
	elev	sun elevation angle	time, bin	degrees
	sun	sun azimuth angle	time, bin	degrees
	range	index range bin	time, bin	-
	err	Mie error quantifier	time, bin	
	err_a		time, bin	
	err_b		time, bin	
	sgnlstdv_a	useful signal standard deviation	time, bin	-
	sgnlstdv_b	useful signal standard deviation	time, bin	-
	snr_a	signal to noise ratio ??	time, bin	-
	snr_b	signal to noise ratio ??	time, bin	-
	flag	Data quality flags	time, bin	(bit values)
	sgnl_a	useful signal strength	time, bin	-
	sgnl_b	useful signal strength	time, bin	-
L2A	dt		time	
	time		time	
	Kmie		time	
	Kray		time	
	firstmatchingbin		time	
	bin_1_clear		time	
MET	dx	Collocation distance	time	m
	dt	Collocation time difference	time	seconds
	time	Time	time	seconds since 2019-01-01, UTC
	lat	Latitude	time	degrees north
	lon	longitude	time	degrees east
	zg	Geopotential height	time	cm
	us	u-component sea surface wind speed	time	cm/s
	vs	v-component sea surface wind speed	time	cm/s
	ps	Surface pressure	time	Pa
	zs	Surface Height	time	m
	flag	quality flags	time	(bit values)
OC	chl	chlorophyl-a concentration	time	mg/m3
HY2B	*time*	*time*	*time*	*seconds since 2019-01-01, UTC*
	lat	*latitude*	*time*	*degrees north*
	lon	*longitude*	*time*	*degrees east*
	us	*u-component sea surface wind speed*	*time*	*m/s*

Commented [GH4]: chlorophyll error is available and might be added.

	vs	*v-component sea surface wind speed*	*time*	*m/s*

Based on the above data pool, the wind product has been created and stored in a similar netCDF data file.

Group	Parameter short name	Parameter long name	Dimensions	Units
	time	(start of observation) time	time	seconds since 2019-01-01, UTC
	altdem		time	
	chl		time	
	us		time	
	vs		time	
	Vmet		time	
	qflag		time	
	use		time	
	lat		time	
	lon		time	
	alt0		time	
	alt1		time	
	alt2		time	
	sgnl0		time	
	sgnl1		time	
	sgnl2		time	
	range0		time	
	range1		time	
	range2		time	
	dz0		time	
	dz1		time	
	sgnlx0		time	
	sgnlx		time	
	success_mod		time	
	success_met		time	
	W_mod		time	
	W_met		time	
	term_wc_mod		time	
	term_wc_met		time	
	term_u_mod		time	
	term_u_met		time	
	term_s_mod		time	
	term_s_met		time	
	Rtot_mod		time	
	Rtot_met		time	
	Rwc_mod		time	
	Rwc_met		time	

	Ru_mod		time	
	Ru_met		time	
	Rs_mod		time	
	Rs_met		time	
	frac_wc_mod		time	
	frac_wc_met		time	
	frac_s_mod		time	
	frac_s_met		time	
	frac_u_mod		time	
	Vmod		time	

The aeolus data haven been collocated for specific areas of the globe. Areas are summarized in the table below.

Area id	Latitude range		Longitude range		Description
A	-29.0	-24.0	-115.0	-101.0	Atlantic off Portugal
B	-22.5	-12.5	-32.0	-25.0	Brasilian Atlantic gyre
G	-90.-	90.0	-180.0	180.0	Global
H	10.0	18.0	-170.0	-150.0	Hawaii Islands zone
E	-30.0	-20.0	-125.0	-100.0	Easter Island zone
I	-30.0	-21.0	70.0	90.0	South Indian gyre
M	10.0	20.0	150.0	165.0	Mariana Islands zone
P	34.0	40.0	-25.0	-15.0	Argo float (E) 00Ef
S	22.0	27.0	-70.0	-45.0	South-Sargasso Sea
W	-55.0	-40.0	30.0	140.0	White capping area 0
X	-55.0	-40.0	40.0	70.0	White capping area 1
Y	-55.0	-40.0	70.0	100.0	White capping area 2
Z	-55.0	-40.0	100.0	130.0	White capping area 3
D	-76.0	-74.0	120.0	130.0	Dome-C
L	28.05	29.05	22.0	23.05	Lybya-4
R	-5.0	2.5	-70.0	-60.0	Rain Forest
V	-30.0	-28.0	125.0	135.0	Great Victoria Desert (AUS)

The areas can be grouped together as follows:

- EMBSIHPA: oligotrophic areas derived from Morel et all.
- WXYZ: Southern ocean
- DLRV: Calibration sites