Ocean Surface Current Analysis (OSCAR) Third Degree Resolution User's Handbook

TABLE OF CONTENTS

DATA PRODUCT ABSTRACT

This product contains global near-surface current estimates, derived using quasi-linear and steady flow momentum equations. The horizontal velocity is directly estimated from sea surface height, surface vector wind and sea surface temperature, these data were collected from various satellites and in situ instruments (see processing methods). The model formulation combines geostrophic, Ekman and Stommel shear dynamics, and a complementary term from the surface buoyancy gradient [1].

The ocean surface velocity files are in netCDF format which contain zonal (u) and meridional (v) velocities

INVESTIGATOR'S NAME AND CREDIT

The OSCAR product was developed by Gary Lagerloef, Fabrice Bonjean and Kathleen Dohan from Earth and Space Research (ESR).

If you use OSCAR data in publications, please include the following citation:

> The OSCAR data were obtained from JPL Physical Oceanography DAAC and developed by ESR.

Also, ESR would appreciate receiving a preprint and/or reprint of publications utilizing these data for inclusion in the OSCAR bibliography. These publications should be sent to:

OSCAR Project Office
Earth and Space Research
2101 Fourth Avenue, Suite 1310
Seattle, WA 98121

DATA DESCRIPTION

FILENAMING CONVENTION

The file names have a naming convention of oscar_velNNNN.nc
oscar – name of product
vel – velocity product calculated from altimetry, scatterometer winds, and sst.
NNNN – year of the data or a single day's worth of data with NNNN the number of days since October 5, 1992

FILE FORMAT

The data are in NetCDF files and have a maximum size of 480 MB when zipped.

TEMPORAL COVERAGE AND RESOLUTION

One file consists of an entire year's worth of data, except for the present year. The time resolution within each file is 1/72 year ≈ 5 days, or half a Jason-1 or TOPEX/Poseidon cycle. For the present year, data are added as it comes in.

SPATIAL COVERAGE AND RESOLUTION

The data covers -80° to 80° latitude and 0° to 360° longitude. However the data represents longitude as 20° to 420°, i.e. the entire Earth is represented in the data as 20° to 380°, and the data repeats itself from 380.33° to 420°. Thus 390° is actually 30°. This range for longitude was chosen so that the major ocean basins would not be broken, but continuous.

The resolution is 1/3° in each direction.

DATA PARAMETERS AND FORMAT

Latitude

Definition:	Latitude
Dimension:	481
Unit:	degrees North
Element type:	double

Longitude

Definition:	Longitude
Dimension:	1201
Unit:	degrees East
Element type:	double

Time

Definition:	Time
Dimension:	72
Unit:	days since 1992-10-05 00:00:00
Element type:	integer

Year

Definition:	Time in years
Dimension:	72
Unit:	time in fractional year
Element type:	float

Depth

Definition:	Depth
Dimension:	1
Unit:	meters
Element type:	float

Um

Definition:	Ocean surface Zonal currents maximum mask

Dimension: time, depth, latitude, longitude
Unit: m/s
Element type: double

Vm
Definition: Ocean surface Meridional currents maximum mask
Dimension: time, depth, latitude, longitude
Unit: m/s
Element type: double

U
Definition: Zonal Velocity
Dimension: time, depth, latitude, longitude
Unit: m/s
Element type: double
Missing value: nan

V
Definition: Meridional Velocity
Dimension: time, depth, latitude, longitude
Unit: m/s
Element type: double
Missing value: nan

SAMPLE DATA RECORD

These data are from oscar_vel2008.nc

latitude = 80, 79.6666666666667, 79.3333333333333, 79, 78.6666666666667

longitude = 20, 20.3333333333333, 20.6666666666667, 21, 21.3333333333333

time = 5566, 5571, 5576, 5581, 5586

year = 2008, 2008.014, 2008.027, 2008.041, 2008.055

depth = 15

um = nan, nan, nan, nan, nan

vm = nan, nan, nan, nan, nan

u = nan, nan, nan, nan, nan

v = nan, nan, nan, nan, nan

SAMPLE GLOBAL ATTRIBUTES

These global attributes come from oscar_vel2008.nc.

:VARIABLE = "Ocean Surface Currents" ;
:DATATYPE = "1/72 YEAR Interval" ;
:DATASUBTYPE = "unfiltered" ;
:GEORANGE = "20 to 420 -80 to 80" ;
:PERIOD = "Jan.01,2008 to Dec.26,2008" ;
:year = "2008" ;
:description = "OSCAR Third Degree Sea Surface Velocity" ;
:CREATION_DATE = "18:41 24-Mar-2009" ;
:version = 2009.f ;
:source = "Gary Lagerloef, ESR (lager@esr.org) and Kathleen Dohan, ESR (kdohan@esr.org)" ;
:contact = "Kathleen Dohan (kdohan@esr.org) or John T. Gunn (gunn@esr.org)" ;
:company = "Earth & Space Research, Seattle, WA" ;
:reference = "Bonjean F. and G.S.E. Lagerloef, 2002 ,Diagnostic model and analysis of the surface currents in the tropical Pacific ocean, J. Phys. Oceanogr., 32, 2,938-2,954" ;

AVAILABLE READ SOFTWARE

Read software are available from PO.DAAC's anonymous ftp site for IDL and Matlab at podaac.jpl.nasa.gov/pub/ocean_currents/OSCAR/software.

Unidata also has software available to read NetCDF files with the ncdump command at http://www.unidata.ucar.edu/downloads/netcdf/index.jsp

PROCESSING METHODS

The near-surface velocity is directly derived from sea surface height (ssh), wind stress (τ) and sea surface temperature (sst). It is the sum of the geostrophic, Ekman-Stommel and thermal wind currents, where

$$if\,\overline{U} = -g\nabla\zeta + \frac{h}{2}\nabla\theta + \frac{\tau - AU'(-h)}{h}$$

f – Coriolis parameter
$\overline{U}$ - total velocity
g – gravity acceleration

ζ - sea surface displacement
h – depth
θ - buoyancy force
τ - wind stress
A – eddy viscosity
U' – vertical shear.
The total velocity is the vertical average over a surface layer thickness of 30 m [2].

The data used to calculate the velocity are:
- TOPEX/POSEIDON, Jason-1, Jason-2, ERS1-2, GFO and ENVISAT ssh anomalies, merged into a gridded product (AVISO). An absolute ssh product is obtained by adding to the anomalies a mean dynamic topography which is a combined product recovering 7 years(1993-1999) based on GRACE mission, altimetry and in situ data (hydrologic and drifters data)[2], [3]

- wind velocity from SSM/I [4] October 1992 to July 1999 and QScat [5] August 1999 to present.

- sst from weekly Reynolds Smith O.I.v2 [6].

The altimeter data are initially gridded on a "Mercator" grid (variable, from 1/3°x1/3° at the equator to higher latitude resolution poleward), and horizontal gradients are calculated onto a 1/3°x1/3° grid with a temporal sampling of ≈5 days. Winds and sst are on the same temporal and 1/3°x1/3° grid as described above.

For more detailed information on the processing methods refer to Bonjean and Lagerloef 2002 [1] and http://www.oscar.noaa.gov/methodology.html.

CALIBRATION INFORMATION

Validation information on this product can be found in Johnson et al. 2007 [7]. Note: since the Johnson et al. (2007) article was published, a new OSCAR dataset corresponding to the one described on this web page has been released with significant improvements, notably the implementation of the new AVISO merged altimetry product (2006) into the OSCAR processing. Updated validation results can be found at http://www.esr.org/~bonjean/oscar/global_validation/ .

SOURCES OF ERROR

This section only concerns the source datasets used to estimate surface velocity. High winds and rain can cause anomalous readings in SSM/I and QScat. Errors in the satellite altimetry product can come from residual orbit errors and long wavelength errors. All gridded products are also subject to formal mapping errors.

KNOWN PROBLEMS

These near-surface currents are estimated through a simplified diagnostic model of the surface circulation. Notably, local acceleration and non-linearities are not represented. As shown in [7], the present velocity field is best used for description of large scale and low frequency variations of surface flow (T>=20 days, L>=5° longitude). ESR currently provides the scientific community with an unfiltered velocity field (no post-processing), on a 1/3° X 1/3° grid with a 5 day resolution. Smoothing may have been induced only by the processing of the source data, that is ssh [2], W [4,5] and sst [6]; also some smoothing inherent to the method itself was caused by calculation of spatial gradient (for geostrophic and thermal-wind currents only). When comparing OSCAR to the drifter data, smoothing can also just be implied by the interpolation from the 1/3° X 1/3° per 5-day grid to the drifter locations and times. This sort of indirect smoothing effect is lessened in the 1/3° OSCAR from the 1° OSCAR product. ESR encourages researchers to make comparisons between this velocity field and in-situ observations on meso to short scales. As this surface current estimation is a work in progress, we are interested in any result involving the present velocity field, and we remain available for any help and discussion.

DIFFERENCES BETWEEN 1/3° AND 1° OSCAR

Surface currents are extended closer to the coasts in the 1/3° than 1° OSCAR.

The Maximum Mask velocity (Um, Vm) is the maximum possible extent of the data per day. The data, given in U and V, are confined by the spatial extent of all satellite data on each day. The Maximum Mask velocity uses the geostrophic component for velocity at all points, along with the buoyancy-driven and wind-driven components, where they are available. This is done since sea surface height satellite data extends closer to the coast than wind and temperature at some locations, and the geostrophic component is an order of magnitude larger than the other components outside of the equator. This field is intended for testing purposes only.

The model for equatorial velocities has been changed. The equatorial solution is now used within +/- 5 degrees of the equator. The turbulence parameterization is modified to blend from equatorial empirical values to global empirical values.

The method for calculating gradients has also been changed to suit the higher resolution data, and produces much better comparisons with in situ data.

A filtered velocity is not available in the 1/3° product since the 1° OSCAR filtered velocity is still provided.

Velocities over 3m/s are removed without any further processing.

REFERENCES

1. Bonjean, F., and G. S. E. Lagerloef, 2002. Diagnostic model and analysis of the surface currents in the tropical Pacific Ocean. *J. Phys. Oceanogr.*, vol. 32, pg. 2938-2954. http://www.esr.org/documents/bonjean/bl2002/bl2002.pdf

2. *SALP-MU-P-EA-21065-CLS*, Edition 1.9, June 2008 Ssalto/*Duacs* User Handbook : (M)*SLA* and (M)*ADT* Near-Real Time and Delayed Time Products (http://www.aviso.oceanobs.com/fileadmin/documents/data/tools/hdbk_duacs.pdf)

3. Rio, M. H. and F. Hernandez, 2004. A mean dynamic topography computed over the world ocean from altimetry, in situ measurements, and a geoid model. *J. Geophys. Res.*, 109, C12032, doi:10.1029/2003JC002226.

4. Atlas, R., R. Hoffman, S. Bloom, J. Jusem, and J. Ardizzone, 1996. A multi-year global surface wind velocity dataset using SSM/I wind observations. *Bull. Amer. Meteor. Soc.*, vol. 77, pg. 869-882.

5. Pegion, P. J., M. A. Bourassa, D. M. Legler, and J. J. O'Brien, 2000: Objectively-derived daily "winds" from satellite scatterometer data. Mon. Wea. Rev., 128, 3150-3168. (http://www.coaps.fsu.edu/scatterometry/Qscat/gcv_glob_L2B_1x1.html)

6. Reynolds, R.W., N.A. Rayner, T.M. Smith, D.C. Stokes, and W. Wang. 2002. An Improved In Situ and Satellite SST Analysis for Climate. *J. Clim*. vol. 15, pg. 1609-1625. (http://www.emc.ncep.noaa.gov/research/cmb/sst_analysis/)

7. Johnson, E. S., F. Bonjean, G. S. E. Lagerloef, and J. T. Gunn, 2007. Validation and error analysis of OSCAR sea surface currents. *J. Atm. Ocean. Tech.*, vol. 24, pg. 688-701.

ACRONYMS

AVISO	Archiving, Validation and Interpretation of Satellite Oceanographic data
CHAMP	Challenging Mini-Satellite Payload for Geophysical Research and Application
Dh	Dynamic height
ESR	Earth and Space Research
GDR	Geophysical Data Record
GRACE	Gravity Recovery and Climate Experiment
JPL	Jet Propulsion Laboratory
NetCDF	Network Common Data Form

OSCAR	Ocean Surface Current Analysis
PO.DAAC	Physical Oceanography Distributed Active Archive Center
QScat	QuikSCAT- Quick Scatterometer
SSH	Sea Surface Height
SSM/I	Special Sensor Microwave Imager
SST	Sea Surface Temperature
WOA	World Ocean Atlas

CONTACT INFORMATION

Questions or comments about this data product should be directed via email to the Physical Oceanography DAAC: podaac@podaac.jpl.nasa.gov.

DOCUMENT INFORMATION

Jessica Hausman, PO.DAAC
Fabrice Bonjean, ESR
Kathleen Dohan, ESR
May 2009

ACKNOWLEDMENTS

The research described in this handbook was carried out at Earth Space Research and written at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration.