



ESA–MOST China Dragon 4 Cooperation

→ **ADVANCED TRAINING COURSE IN OCEAN
AND COASTAL REMOTE SENSING**

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**EXPLORATION OF REMOTE SENSING DATA USING SYNTOOL
AND SEASCOPE**

Hosted by



We have more and more satellite data available at very high resolution, it is essential to benefit from all the available data from remote sensors, in-situ and models.

=>Provide a solution to easily open, visualise, compare and blend data collocated in space and time.

Proposed Tools

- Web-based and online: **Syntool**

Web portals in stereo polar or mercator projections, data are projected and tiled. <https://ovl.oceandatalab.com>

- Stand-alone: **SEAScope** interactive viewer

Application implemented in C++, OpenGL, Python. 3D earth, no data projection is needed. Dynamical rendering and interaction with Python are available.

Explore data using Syntool to find illustrations of data synergy.

- Examples of good tracer-current synergy:

Sea Surface Temperature (SST), Chlorophyll-a (Chl) from MODIS and VIIRS are well correlated with GlobCurrent current (Along track Jason-2 above mesoscale eddies):

<https://odl.bzh/Y5qf38AZ>

SAR from Sentinel-1, SST and Chl from VIIRS are in good agreement with altimetry:

<https://odl.bzh/mHBb6Qdu>, <https://odl.bzh/pVtY88ZD>

SAR from Sentinel-1, true RGB from OLCI Sentinel-3 and altimetry from SRAL Sentinel-3 are all clearly showing a mesoscale eddy: <https://odl.bzh/PjgWbs5H>

- No front can be detected in one of the tracer:

No temperature gradient in the SST but signature of the eddy can be seen on the Chl from MODIS: <https://odl.bzh/s5J6GP9Y>

Wind is blowing, no features are visible in the SST but Chl from MODIS is in good agreement with GlobCurrent current: <https://odl.bzh/AZHQK04E>

Explore data using Syntool to find illustrations of issues in currents derived from altimetry due to the lack of resolution.

- SST and Chl from MODIS and VIIRS and GlobCurrent currents are showing some discrepancies: <https://odl.bzh/a0sC8gGL> It highlights the lack of temporal resolution in currents derived from altimetry as there is no altimete track above the missed turn.
- In-situ LASER drifters are in good agreement with SST fronts and reveal errors in GlobCurrent currents: <https://odl.bzh/SoXTEbpL>

- offshore:

 - storm waves

 - swell front

- Archipelago swell sheltering/refraction/diffraction:

 - swell sheltering/refraction/diffraction

- swell current interaction:

 - altimeter

 - sar

- Coast:

 - SAR/optical synergy

 - optical sun glitter sea-mount refraction

 - whitecaps

 - cross seas

 - cape point diffraction

Start SEAScope



- Go to directory C:\Users\szu\seascope_2018_dragon4\seascope or click on SEASCOPE Software icon on the Desktop

- Click on SEAScope to open SEAScope, it may take some time as an index is build during the first opening (it should already have been opened once for testing before)



In SeaScope:

- Look at all the collections using the right panel

Ocean Circulation : drifters, altimetry, globcurrent, cmems

Wind : ECMWF, altimeter

Wave : altimeter, Sentinel-1 SAR

Ocean color : Chla MODIS/VIIRS, OLCI RGB, Sentinel-2 RGB

SST : Level2 IR VIIRS, L3 SEVIRI, Level4 multimission (ODYSSEA)

In SeaScope:

- Look at the calendar and the availability using the bottom panel
- Select a collection, go to a date where the granule is available and play with the settings of the collection using the top left panel (min, max, colorbar, transparency, order of collections ...)
- For Polyline (resp. Polygon), use middle mouse button and Enter (resp. Shift+Enter) to close or end the drawing
- Look for all the functionalities in the manual: seascope.oceandatalab.com (e.g. north always up, collocation enabled , time span, ...).

Start SEAScope and play with notebooks



- Click on SEAScope to open SEAScope if it is not already opened
- Click on JupyterLab to open the Jupyter interface in a browser. A tab in chromium is opened with the address localhost:8888/lab.

To run a Jupyter cell, click on the play button for each cell or type *shift Enter*

- seascope-processor is not used today but may be useful to make transects and save extracted outputs



Derive geostrophic current from ADT

$$E < 10^{-3} R_0 < 10^{-3} \text{ and } w \ll u, v$$

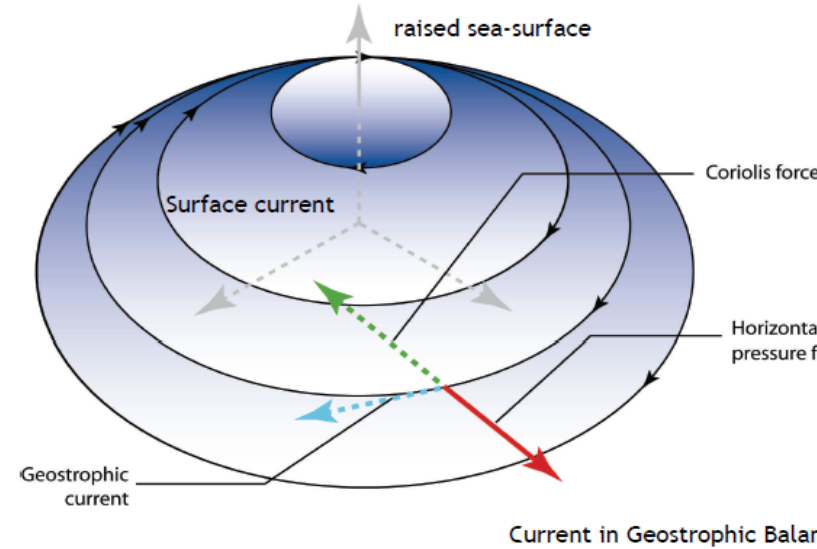
Away from the boundary layers and away from the equator, over large ($> 50\text{-}100$ km) spatial and long ($> 2\text{-}10$ days) temporal scales ocean is to the first order in geostrophic balance.

The largest terms in the equations of motion reduce to the Coriolis force and the pressure gradient.

$$\left. \begin{aligned} 0 &= -\frac{1}{\rho} \frac{\partial p}{\partial x} + fv \\ 0 &= -\frac{1}{\rho} \frac{\partial p}{\partial y} - fu \\ + \text{Hydrostatic equation} \\ 0 &= -\frac{1}{\rho} \frac{\partial p}{\partial z} - g \end{aligned} \right\}$$

$$\mathbf{u}_{\text{geo}} = -\frac{\mathbf{g}}{f} \frac{\partial h}{\partial \mathbf{y}}$$

$$\mathbf{v}_{\text{geo}} = \frac{\mathbf{g}}{f} \frac{\partial h}{\partial \mathbf{x}}$$



The ocean surface velocity field (u, v) can be readily obtained from the gradients of h , the sea level above the geoid h .

In this session, we are going to derive geostrophic current from sea surface height. Data are extracted from SEAScope and results are exported back to SEAScope for easy comparison

Go to the browser where jupyter has opened :

- Open the geostrophy.ipynb notebook and follow the instructions in the notebook:
- Select the Sea Surface Height from the CMEMS ADT collection in SEAScope
- Use *Middle button* to draw a polygon to extract data and *shift enter* to close the polygon, click on the extract button. Extracted granules are shown at the top of the collection panel.

Remember that the geostrophy hypothesis is not valid near the Equator

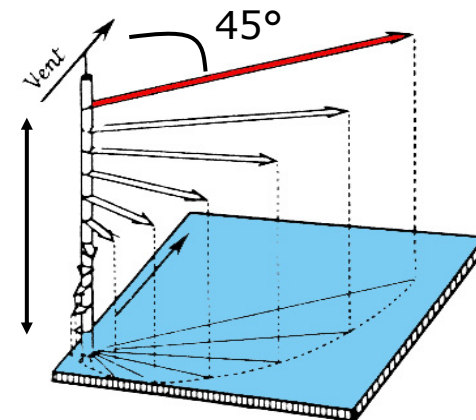
- Run cells in the notebooks to import SSH (play button or *shift enter* to run a cell), compute and export geostrophic velocity into SEAScope
- Go back to SEAScope and compare the computed geostrophic velocity with the one from GlobCurrent geostrophic velocity collection (resolution, smoothness ...)

Wind-driven Ekman

$$u_e = \pm \frac{\pi\sqrt{2}}{\rho(f+w)D_e} e^{\frac{\pi}{D_e}z} * \tau_e * \cos\left(\frac{\pi}{4} + \frac{\pi}{D_e}z\right)$$

$$v_e = \frac{\pi\sqrt{2}}{\rho(f+w)D_e} e^{\frac{\pi}{D_e}z} * \tau_e * \sin\left(\frac{\pi}{4} + \frac{\pi}{D_e}z\right)$$

β
 θ



Model

Rio et al, 2003, 2014

$$\vec{u}_{buoy} - \vec{u}_{alti} = \beta \vec{\tau}_e e^{i\theta}$$

ERA INTERIM Wind stress

τ_e = Effective Wind Stress

D_e = Ekman depth

f = planetary vorticity

w = local vorticity

$$2\omega = \partial_x v_{geost} - \partial_y u_{geost}$$

β and θ are estimated through least square fit by month and 4° boxes. At the surface using the Argo float surface velocity dataset from YoMAHA. At 15m depth using SVP Drifting buoys flagged as DROGUED by the SD-DAC

Derive Ekman currents from wind



In here, we are going to derive Ekman current from the ECMWF wind.

Data are extracted from SEAScope and results are exported back to SEAScope for easy comparison.

Go to the browser where jupyter has opened :

- Open the ekman.ipynb notebook and follow the instructions in the notebook:
- Select the Wind raster from the ECMWF wind raster collection in SEAScope
- Use *Middle button* to draw a polygon to extract data and *shift enter* to close the polygon, click on the extract button. Extracted granules are shown at the top of the collection panel.
- Run cells in the notebooks to import wind, play with theta and beta parameters according to Rio et al, compute and export ekman velocity into SEAScope
- Go back to SEAScope and compare the computed Ekman velocity with the one from GlobCurrent Ekman velocity collection (results may differ depending on your choice of theta and beta parameters)



Compute a Lagrangian trajectory (1/2)



In here, we are going to compute Lagrangian trajectories from one week of currents. Data are extracted from SEAScope and results are exported back to SEAScope for easy comparison.

Go to the browser where jupyter has opened :

- Open the trajectory.ipynb notebook and follow the instructions in the notebook:
- Select any raster velocity collection in SEAScope (GlobCurrent total, geostrophic or your own if you have computed several days of data)
- Use *Middle button* to draw a polygon to extract data and *shift enter* to close the polygon, click on the extract button. Extracted granules are shown at the top of the collection panel.
- Select a week of time span to extract a week of data



- Run cells in the notebooks to import velocities, sort them and enter an initial position where there is a drifter in order to compute Lagrangian trajectories and export trajectories into SEAScope
- Go back to SEAScope and compare your trajectory with the one from AOML drifter collection (do they differ? why? ...)

In here, we are going to derive the swell refraction due to current.

Data are extracted from SEAScope and results are exported back to SEAScope for easy comparison

Go to the browser where jupyter has opened :

- Open the SWELL_refrac.ipynb notebook and follow the instructions in the notebook:
- Select the surface velocity from the GlobCurrent total surface raster collection in SEAScope
- Use *Middle button* to draw a polygon to extract data and *shift enter* to close the polygon, click on the extract button. Extracted granules are shown at the top of the collection panel.
- Run cells in the notebooks to import velocity, compute trajectory of fictive swell rays, play with the number of rays and steps, export wave rays into SEAScope

Go back to SEAScope and compare the wave rays with the current from GlobCurrent

In here, we are going to derive Swell from Sentinel-2 data.
Data are extracted from SEAScope.

Go to the browser where jupyter has opened :

- Open the S2_swell.ipynb notebook and follow the instructions in the notebook:
- Select the Select the Sentinel 2 Red and blue Channels (or the RGB) collection at a resolution high enough to see the waves in SEAScope
- Use *Middle button* to draw a polygon to extract data and *shift enter* to close the polygon, click on the extract button. Extracted granules are shown at the top of the collection panel.
- Run cells in the notebooks to compute Cross spectra and compare the phase to the linear dispersion relation.

Download SEAScope for windows



- You can get SEAScope by copying the directory seascope_2018_dragon4 from the computer
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- Before launching SEAScope.bat (or SEAScope) for the first time, check that there is no config.ini file nor index.fb in the seascope directory. Launch SEAScope, it will build the config.ini using the location of the seascope directory, and build the index.fb using data from the data directory. Opening SEAScope for the first time may take some time as the index is build.
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- A user manual is available at seascope.oceandatalab.com

Let me know if you have any question



Download seascope for Linux



- Copy the seascope_2018_dragon4\seascope\data directory from the computer to get the data
- All the installation procedure is available at seascope.oceandatalab.com/docs/seascope_install_manual_2017-09-08.pdf
- Download SEAScope from seascope.oceandatalab.com and extract it following the installation procedure in the [seascope_install_manual](https://seascope.oceandatalab.com/docs/seascope_install_manual_2017-09-08.pdf) document
- Copy the directory that contains data into the seascope directory
- Launch SEAScope, it will build the config.ini using the location of the seascope directory, and build the index.fb using data from the data directory. Opening SEAScope for the first time may take some time as the index is build.
- If you want to interact with the interface using python: Install the python SEAScope package by following the instruction in the [seascope_install_manual](https://seascope.oceandatalab.com/docs/seascope_install_manual_2017-09-08.pdf) document.
- Installation and User manuals are available at seascope.oceandatalab.com

