

# Modelación Aplicada del Océano

## Curso Básico CROCO

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21 Enero 2021

# Anuncios

- Hoy: **Partículas**

## Contenido

- Aspectos generales entre cálculo Lagrangiano online y offline
- Algunos modelos Lagrangianos
- Activación del modelo lagrangiano CROCO

## Aspectos Generales

- Existen varias formas de representar la deriva de partículas en CROCO.
- Las podemos dividir en dos secciones:
  - ▶ **Online:** Cuando la trayectoria y/o propiedades de las partículas son calculadas en simultáneo con el modelo.
  - ▶ **Offline:** Cuando el cálculo es *a posteriori*.
- En ambos casos, es una interacción *one way*. La física impacta las partículas, mas no viceversa.
- Si la física está mal, las trayectorias de las partículas no saldrán bien.

## Aspectos Generales

- Estos enfoques tienen ventajas y desventajas
- **Online:**
  - ▶ **Ventaja:** Mayor precisión en la trayectoria; esta es calculada en cada paso de tiempo del modelo (cada pocos minutos).
  - ▶ **Desventaja:** Modificar un experimento significa recalcular todo.
  - ▶ **Desventaja:** Número limitado de opciones dentro del código.
- **Offline:**
  - ▶ **Ventaja:** Repetir o modificar un experimento es rápido.
  - ▶ **Ventaja:** Podemos usar varios códigos.
  - ▶ **Ventaja:** Permite trayectorias en reversa.
  - ▶ **Desventaja:** Hay que grabar los modelos con alta resolución temporal.



### Office of Response and Restoration

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### GNOME

[GNOME Overview](#) | [Download/Install](#) | [Manual/Tour](#) | [Location Files](#) | [Toolkit](#) | [FAQs](#) | [News](#)

GNOME (General NOAA Operational Modeling Environment) is the modeling tool the Office of Response and Restoration's (OR&R) Emergency Response Division uses to predict the possible route, or trajectory, a pollutant might follow in or on a body of water, such as in an oil spill.

[Download the latest version of GNOME.](#)

GNOME supports different user experience levels through user modes. To quickly set up spill scenarios customized for each incident, OR&R modelers use GNOME in Diagnostic Mode, which enables them to incorporate a number of outside atmospheric and oceanic circulation models. However, anyone can use GNOME in Standard Mode and with the help of regionally specific location files, set up their spill scenarios to:

- Predict how wind, currents, and other processes might move and spread oil spilled on the water.
- Learn how these predictions of where and how oil might move are affected by uncertainty in observations and forecasts for ocean currents and wind.
- See how spilled oil is expected to change chemically and physically, known as weathering, during the time that it remains on the water surface.



*GNOME model output depicting relative distribution of oil.*

#### On Our Radar

Response Tools for Spills



Preparing for Hurricane Season



How Does NOAA Model Oil Spills?



<https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/gnome.html>

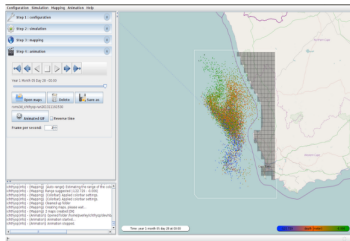


## A Lagrangian tool for simulating ichthyoplankton dynamics

### About Ichthyop

Ichthyop is a free Java tool designed to study the effects of physical and biological factors on ichthyoplankton dynamics.

It incorporates the most important processes involved in fish early life: spawning, movement, growth, mortality and recruitment. The tool uses as input time series of velocity, temperature and salinity fields archived from ROMS, MARS, NEMO or SYMPHONIE oceanic models (either files or OpenDAP).



Select Language | v

### Downloads

Download Ichthyop. It is free and open source.

[Download now](#)

### Latest News

- A new website for Ichthyop  
Ichthyop has now its own dedicated website: <http://www.ichthyop.org> and its own contact email address...

[Read More](#)

### Latest Forum Threads

- Vertical Migration
- Equations
- the simulation is not done
- Time value problems
- Simulating HYCOM

# Partículas

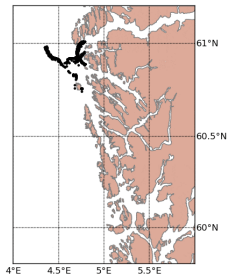
## OPENDRIFT



OpenDrift is a software for modeling the trajectories and fate of objects or substances drifting in the ocean, or even in the atmosphere.

OpenDrift is open source, and is programmed in Python. As the software is very generic, it is rather a "framework" than a "trajectory model" in the traditional sense. Trajectory models for specific purposes (e.g. oil drift, search and rescue, larvae drift etc) may reuse all common functionality from the core model, and need only implement a Python Class describing the purpose-specific processes (physics/biology etc). See [Requirements](#) and [Data model](#) for more detailed information.

A [journal paper about OpenDrift](#) is published in Geoscientific Model Development.



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Clone this wiki locally

<https://github.com/OpenDrift>

<https://github.com/OpenDrift/opendrift/wiki>



# Partículas

## CROCO - FLOATS

- **GNOME:**

- ▶ Amigable, Windows, orientado a derrames de petróleo, deriva de objetos. Incluye efecto del viento (*windage*), evaporación de petróleo, incerteza en las trayectorias.

- **ICHTHYOP:**

- ▶ Java (Linux/Windows). Foco inicial en larvas. Adaptado a ROMS/CROCO.

- **OpenDRIFT:**

- ▶ Python. Módulos de cálculo específicos para cada tema: petróleo (similar a GNOME), larvas.

- Online

```
define FLOATS
                                /*  Lagrangian floats model  */
# ifdef FLOATS
#  undef  FLOATS_GLOBAL_ATTRIBUTES
#  undef  IBM                      <--- (?)
#  undef  RANDOM_WALK
#  ifdef  RANDOM_WALK
#   define DIEL_MIGRATION
#   define RANDOM_VERTICAL
#   define RANDOM_HORIZONTAL
#  endif
# endif
```

# Partículas

## CROCO - FLOATS

- Código relevantes

```
def_floats.F  
floats.h  
random_walk.F  
step_floats.F  
wrt_floats.F
```

- La versión offline de FLOATS se llama **ROFF**, y fue desarrollado por Xavier Capet (UCLA → CNRS).

# Partículas

## CROCO -FLOATS

- Archivo extra - floats.in

```
1  Ftitle (a80)
```

```
ROMS 1.0 - Initial Drifters Locations - SMB exp.
```

```
2  Ft0,Fx0,Fy0,Fz0, Fgrd,Fcoor,Ftype,Fcount,Fdt,Fdx,Fdy,Fdz
```

```
0.0 -17.666 20.636 -10.0 0 1 0 1 0.00 0.000 0.000 0.0
```

```
0.0 -17.583 20.480 -10.0 0 1 0 1 0.00 0.000 0.000 0.0
```

```
99 END of float input data
```

Este archivo debe estar en el directorio donde corre el modelo.

# Partículas

## CROCO - FLOATS

- Archivo relevantes - croco.in

```
floats: LDEFFLT, NFLT, NRPFFLT / inpname, hisname
```

```
      T      6      0
```

```
floats.in
```

```
floats.nc
```

```
float_fields: Grdvar Temp Salt Rho Vel
```

```
      T      T      T      T      T
```

### IBM

- Podemos convertir nuestras partículas en un IBM (*Individual Based Model*) dándole propiedades a las partículas como:
  - ▶ Tamaño
  - ▶ Madurez (estado larval)
  - ▶ Densidad
  - ▶ Activa/Desactiva (Viva/Muerta)
  - ▶ Fase (pelágica, bentónica)
- Podemos hacer variar estas propiedades en función de
  - ▶ Tiempo
  - ▶ Temperatura (°C acumulados)
  - ▶ Salinidad (rango mínimo tolerable)
- Se pueden configurar opciones para especies distintas.

### IBM

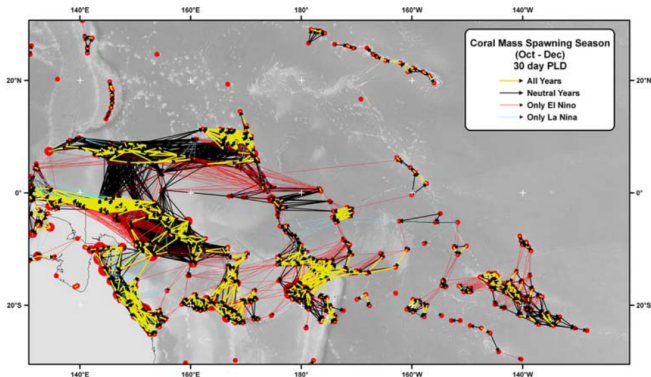
- Nuestro resultado es un archivo (NetCDF) con
  - ▶ Latitud
  - ▶ Longitud
  - ▶ Tiempo
  - ▶ Temperatura/Salinidad/Tamaño/...
  - ▶ Status (Activa/Desactiva/Missing/En Tierra)

para cada partícula.

- Con esta información podemos analizar.
  - ▶ Origen/Destino
  - ▶ Distancia recorrida (Final/Trayectoria)
  - ▶ Matriz de Conectividad (fuentes/sumideros)
  - ▶ **Teoría de Grafos** (vertices y enlaces)
  - ▶ Identificar procesos físicos (filamentos, remolinos)

# Experimentos de Dispersión

## Teoría de grafos



**Fig. 5** Difference in connectivity between years for a 30-day **PLD** during the coral mass spawning season of October through December (Table 3, a-c). Dispersal connections

common to all years are highlighted in **yellow**. Unique connections occurring in only 1 year are plotted for the El Niño (1997), La Niña (1999), and neutral year (2001)

**Figura:** Tomado de Treml et al., 2008



# Resultados de Dispersión

## Matriz de Conectividad

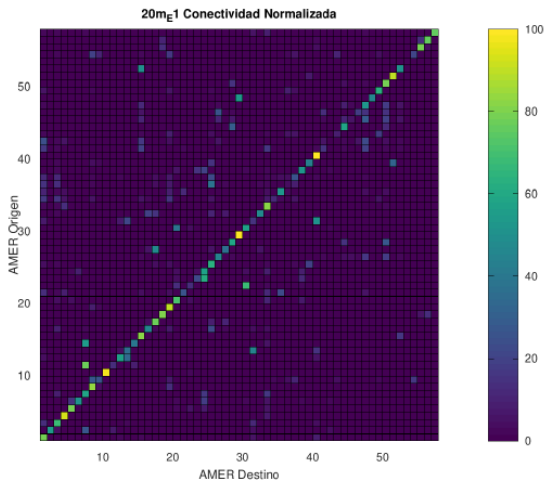
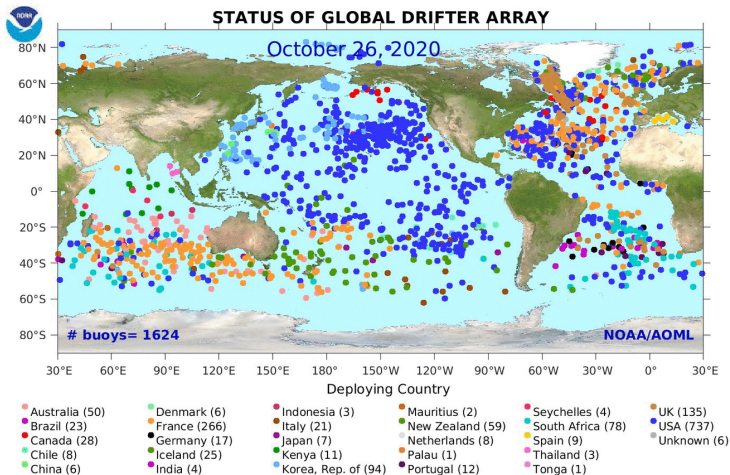


Figura: Matriz de Conectividad entre regiones

- Global Drifter Project  
<http://www.aoml.noaa.gov/phod/gdp/index.php>
- ARGO repository at NODC  
<http://www.argo.ucsd.edu/>
- ¿Métricas?

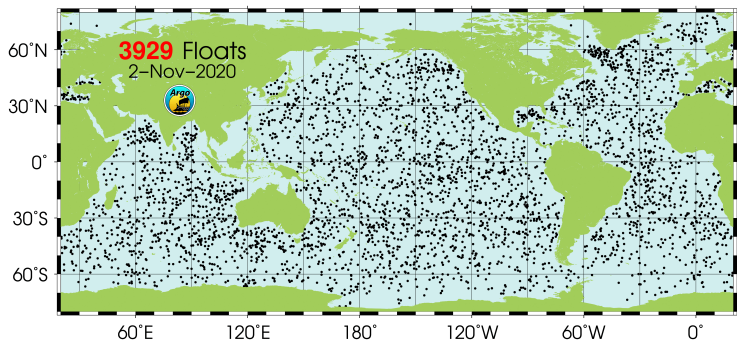
# Partículas

## Drifters



# Partículas

ARGO



# Experimentos de Dispersión

Análisis de la intrusión de la corriente de Kuroshio en el NE de Taiwan usando el método Lagrangiano

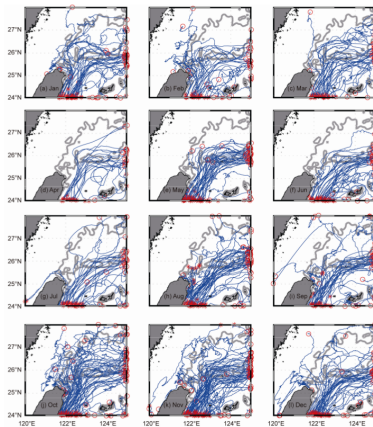


Figure 2 Trajectories of the drifters assembled in each month. Red stars in the figures stand for the starting positions of the trajectories in the region. Red circles stand for their ending positions, where the drifters leave the region or go into the next month.

Figura: Tomado de Liu et al., 2015

## Referencias

- ROFF
- GNOME

Beegle-Krause, J., 2001, March. General NOAA oil modeling environment (GNOME): a new spill trajectory model. In International Oil Spill Conference (Vol. 2001, No. 2, pp. 865-871). American Petroleum Institute.

- ICTHYOP

Lett, C., Verley, P., Mullon, C., Parada, C., Brochier, T., Penven, P. and Blanke, B., 2008. A Lagrangian tool for modelling ichthyoplankton dynamics. *Environmental Modelling & Software*, 23(9), pp.1210-1214.

Treml, E.A., Halpin, P.N., Urban, D.L. et al. Modeling population connectivity by ocean currents, a graph-theoretic approach for marine conservation. *Landscape Ecol* 23, 19-36 (2008).

## Referencias

- OpenDRIFT

Dagestad, K.-F., Röhrs, J., Breivik, Ø., and Ådlandsvik, B.: OpenDrift v1.0: a generic framework for trajectory modelling, *Geosci. Model Dev.*, 11, 1405–1420, 2018.

- ARIANE, LTRANS, LarvalMap, PartTrack, WebDrogue, Two-Way PTM, OILTRANS, etc...

Liu, X., Chen, D., Dong, C. et al. Variation of the Kuroshio intrusion pathways northeast of Taiwan using the Lagrangian method. *Sci. China Earth Sci.* 59, 268–280 (2016).