Surface Drifter Observations

Surface Currents, Sea Surface Temperature, Winds,
Atmospheric Pressure and Surface Salinity

www.aoml.noaa.gov/phod/dac/gdp.html

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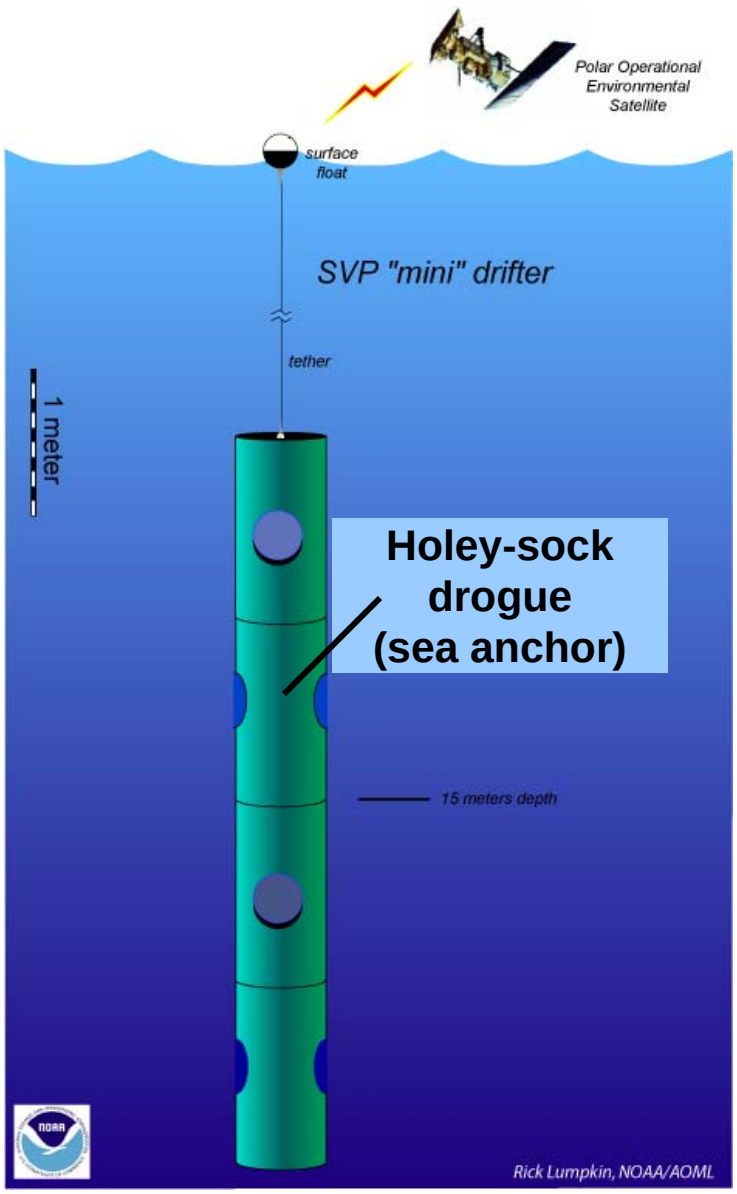
The satellite-tracked drifter



Spherical surface float

Polyurethane impregnated tether

Holey Sock nylon drogue centered at 15-m depth

D-cells batteries inside the float

Sensors:

Drogue: drogue detection by submergence or tether strain sensor

Thermistor: measure SST

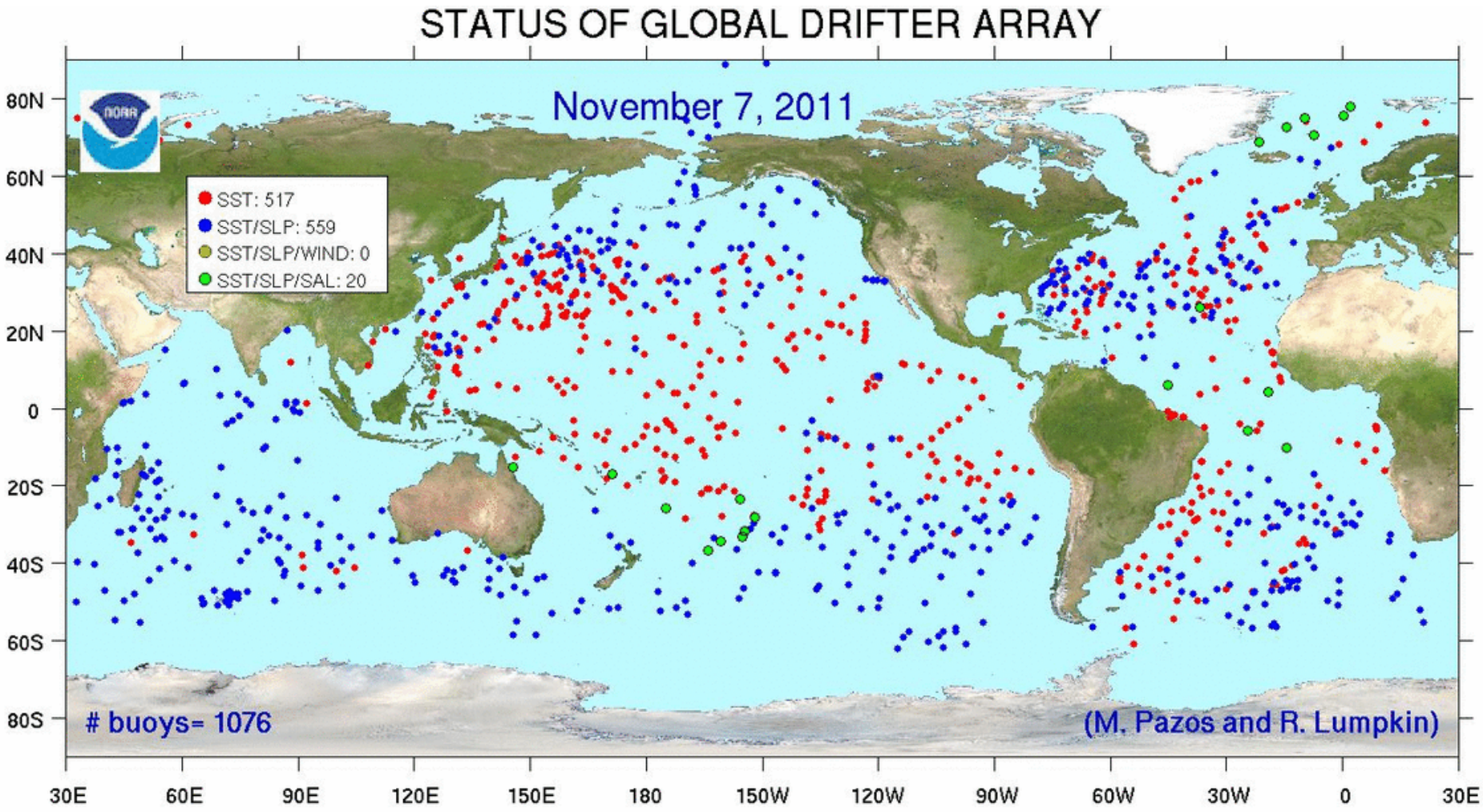
Voltage: Indicates batteries' life

Cost: ~$1800

Other Sensors that can be added:

Barometric pressure, wind, subsurface temperatures, salinity

The Global Drifter Array



Maintained by NOAA's Global Drifter Program with numerous national and international partners

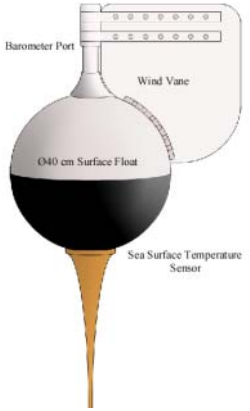
Types of GDP drifters

SVP: “Surface Velocity Program”.
The “basic” drifter: SST and currents.

SVPB: includes barometer on surface float. Data used to improve weather forecasts.

SVPS: includes salinity at base of surface float.

SVPW: includes barometer + wind vane and swivel (direction) + acoustic anemometer (wind speed)

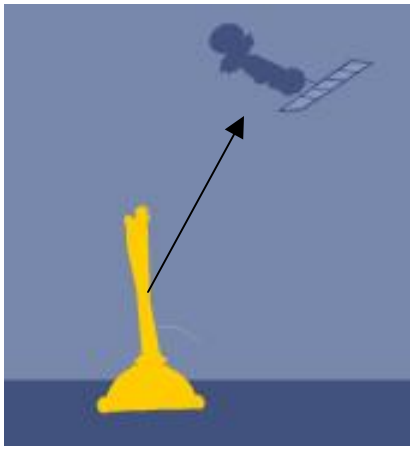


Deploying a drifter

Designed to be easy for one person to deploy from a ship while underway at up to 20 knots.

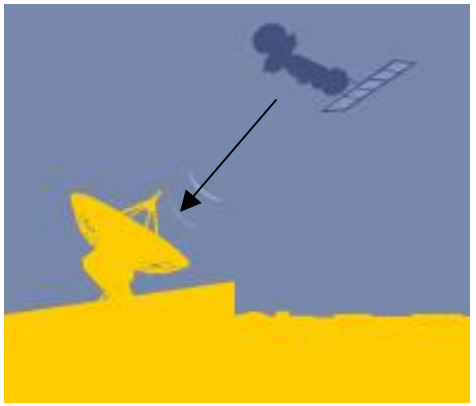
Average lifetime: 450 days.

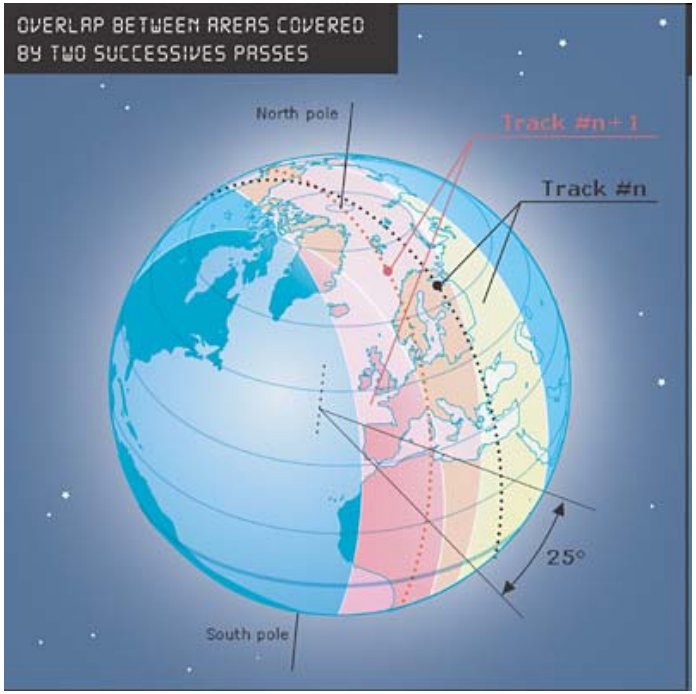
Data transmission: Argos system



Drifters transmit data every 90s, picked up ~once per hour by passing satellite

Polar-orbiting satellites relay data to receiving stations



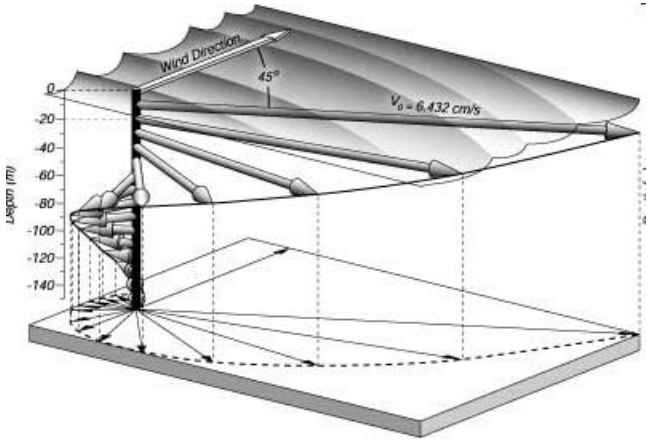


Left: orbit of NOAA polar-orbiting satellite.
Bottom: locations of receiving stations.

Graphics from Argos Users Manual, CLS

Ekman drift

Currents at the ocean surface are caused by many different forces. At very large scales, many currents are associated with a dynamical balance between a pressure force and the Coriolis force. These currents are called "geostrophic". Currents described by a balance of other forces are "ageostrophic". The most common ageostrophic current in the upper ocean is the directly wind-driven Ekman drift.



Several studies have examined how the combination of geostrophic and Ekman drift determines how a drifter moves through the water. For more details, see Niiler and Paduan (1995), Ralph and Niiler (1999), Niiler (2001), Rio and Hernandez (2003) and Rio et al. (2011).

Velocity observations

To lowest order, the velocity of a drifter is a combination of the large-scale geostrophic flow and the Ekman flow at a depth of 15m.

However, drifters do not perfectly follow the water at the drogue depth.

For example, water can sink beneath the surface, while the drifter is forced to stay at the sea surface.

Also, the drifter can "slip" through the water with respect to the motion at the drogue depth.

Slip

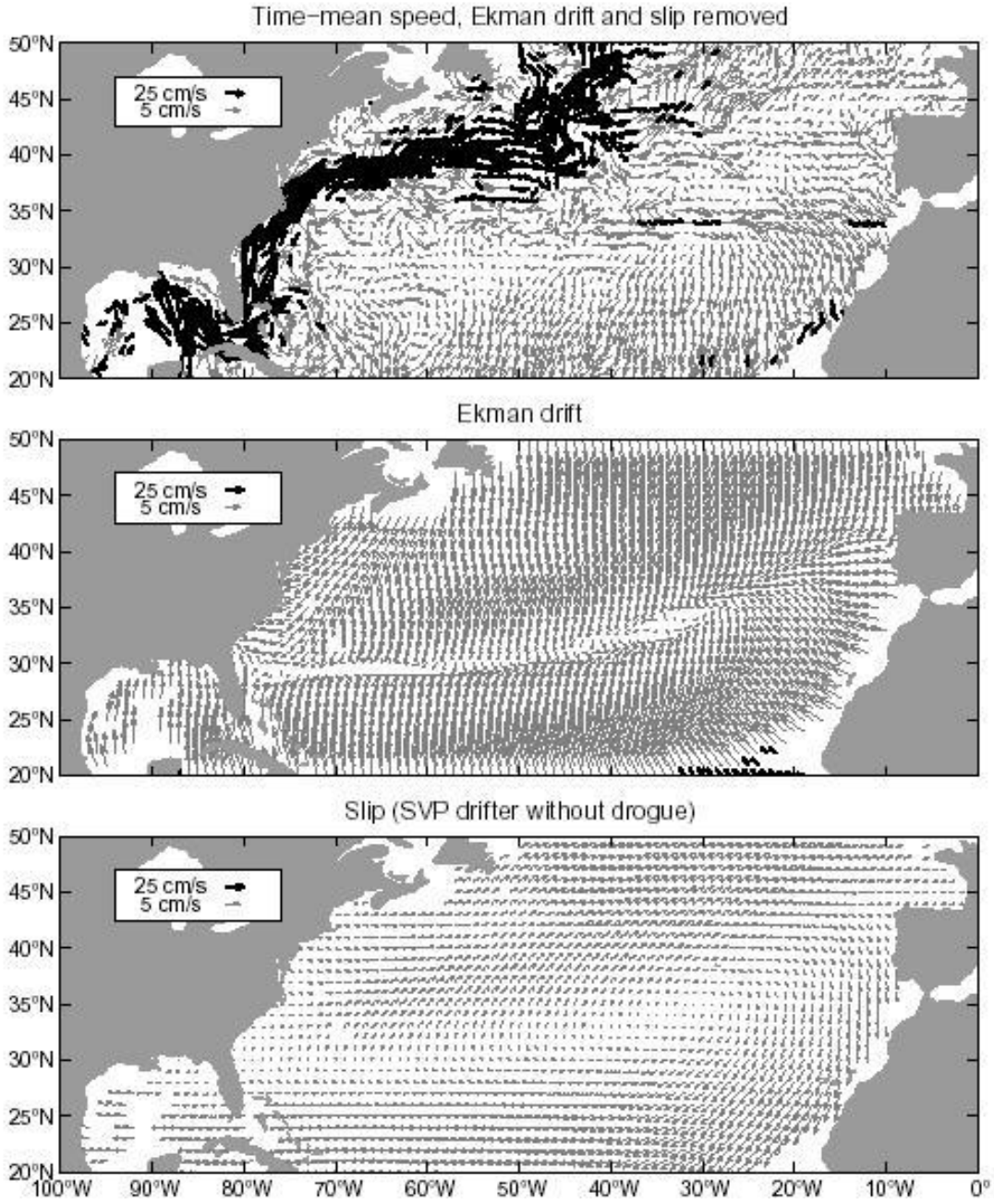
Slip is caused by wind pushing on the surface float, drag on the float and tether, and rectification of surface waves (Niiler et al., 1987; Geyer, 1989).

As long as the drogue remains attached to the drifter, the downwind slip is estimated at 0.7 cm/s in 10 m/s of wind speed (Niiler and Paduan, 1995). If a drifter loses its drogue, it will slip downwind at a speed of 8.6 cm/s in 10 m/s of wind (Pazan and Niiler, 2001).

Very few studies have carefully examined the motion of drifters that have lost their drogues. However, these data may tell us much about how the ocean carries floating marine debris.

Total speed

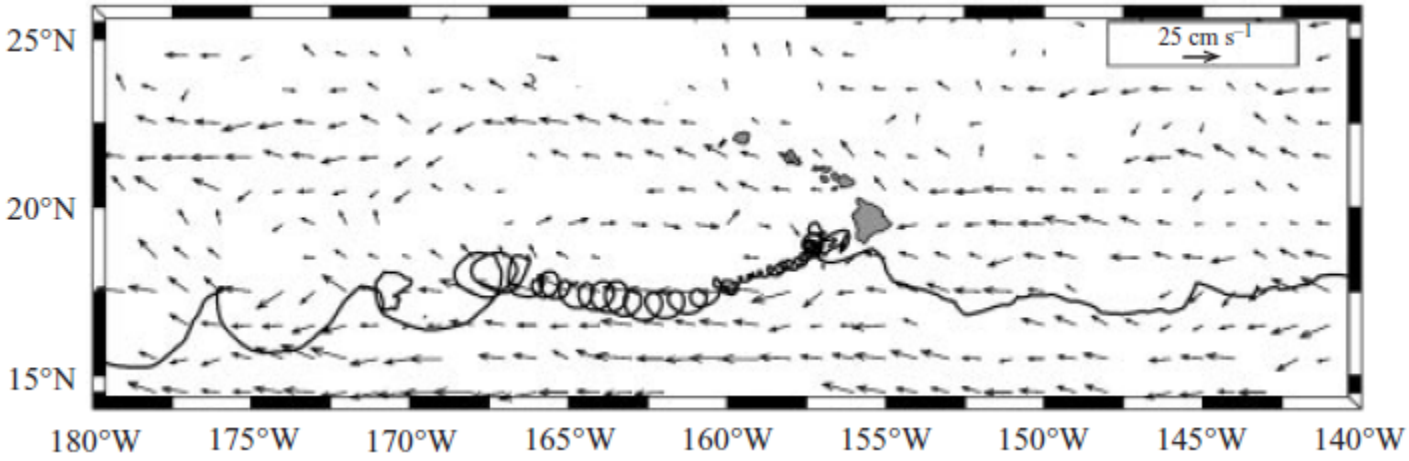
The resulting total speed of a drifter is a combination of the large-scale geostrophic currents at 15 meters depth, plus the upper-ocean wind-driven Ekman flow, plus the slip.

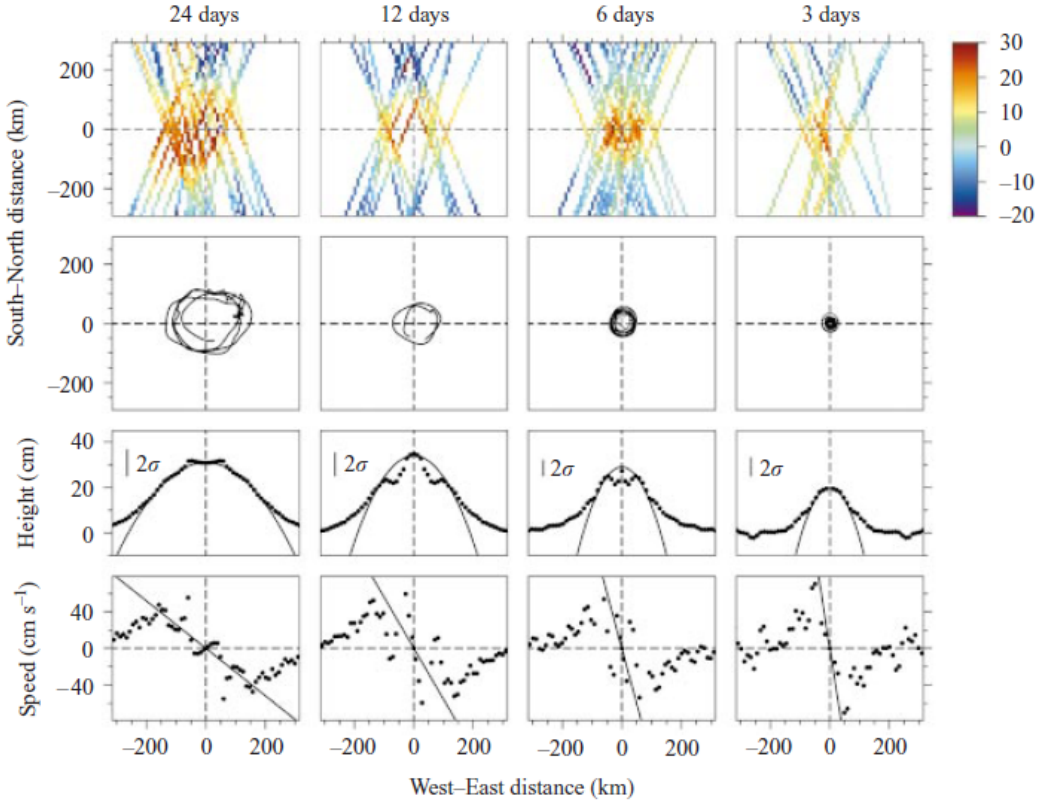


Lumpkin and Pazos (2007)

Research done with drifters

Eddies west of Hawaii

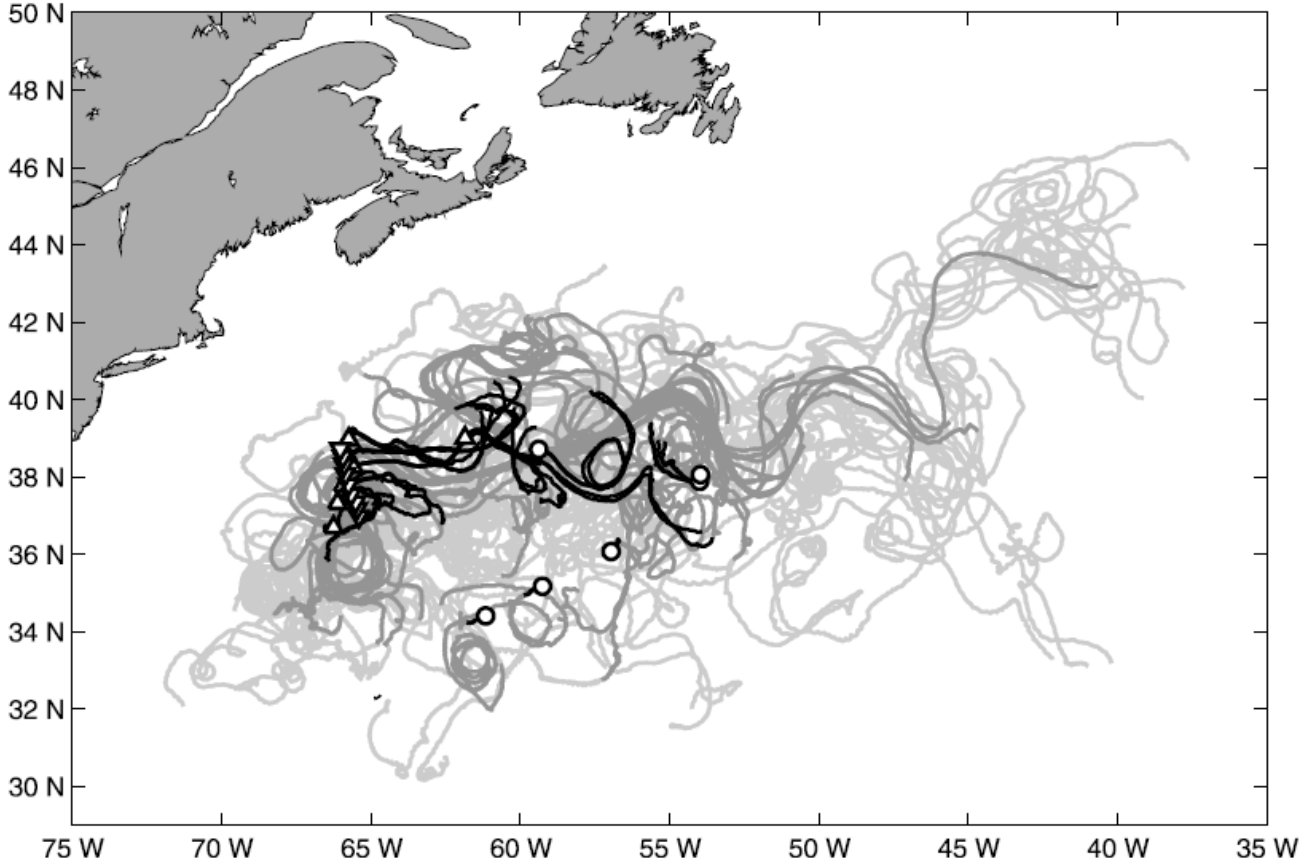




Flament *et al.* (2001)

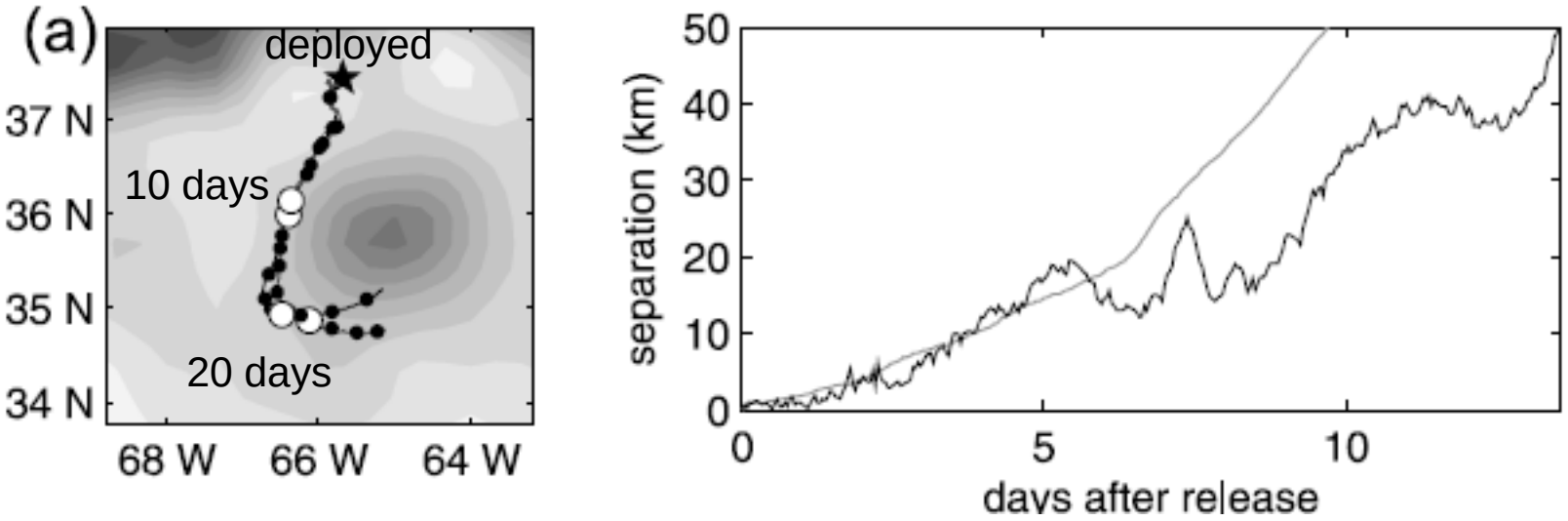
Drifter array in the Gulf Stream region
February—March 2007 cruise, R/V *Knorr*
Goal: measure dispersion (spreading)

60 drifters deployed: 16 trios, 6 pairs.



Black: February. Dark Grey: March. Light Grey: Apr-July

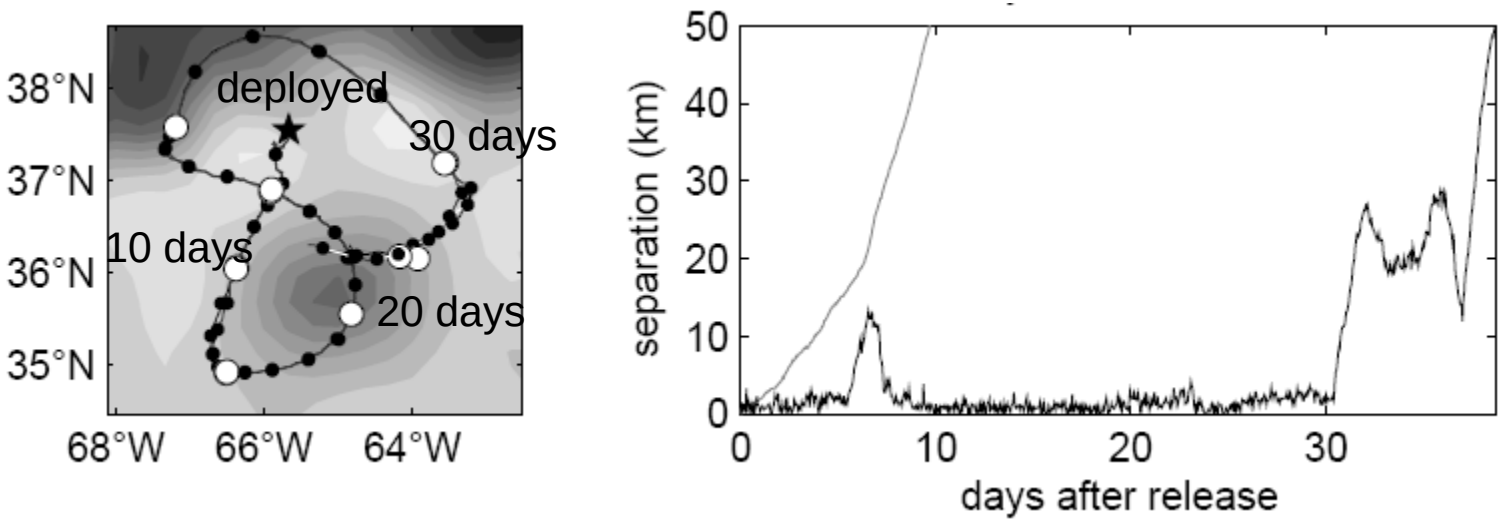
A typical pair



Deployed on 4 March 2007 as part of a trio. Separation at rate close to the mean for all of the drifter pairs.

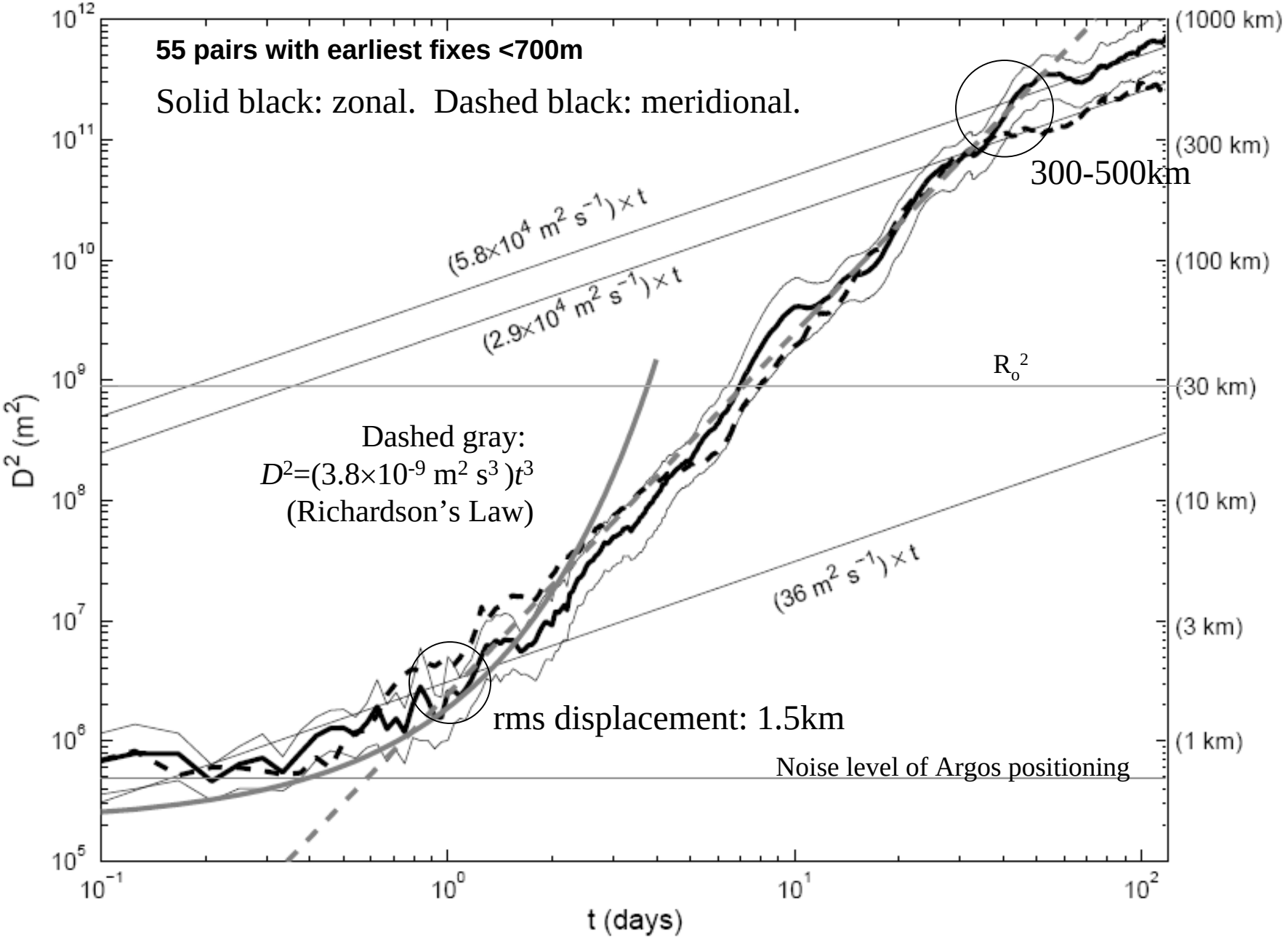
Lumpkin and Elipot (2010)

A very unusual pair



Deployed on 4 March 2007 (a different pair of the same trio as "typical pair"). Separated to 14 km at day 6, but then reconverged and stayed <3km apart for 23 days!

Lumpkin and Elipot (2010)

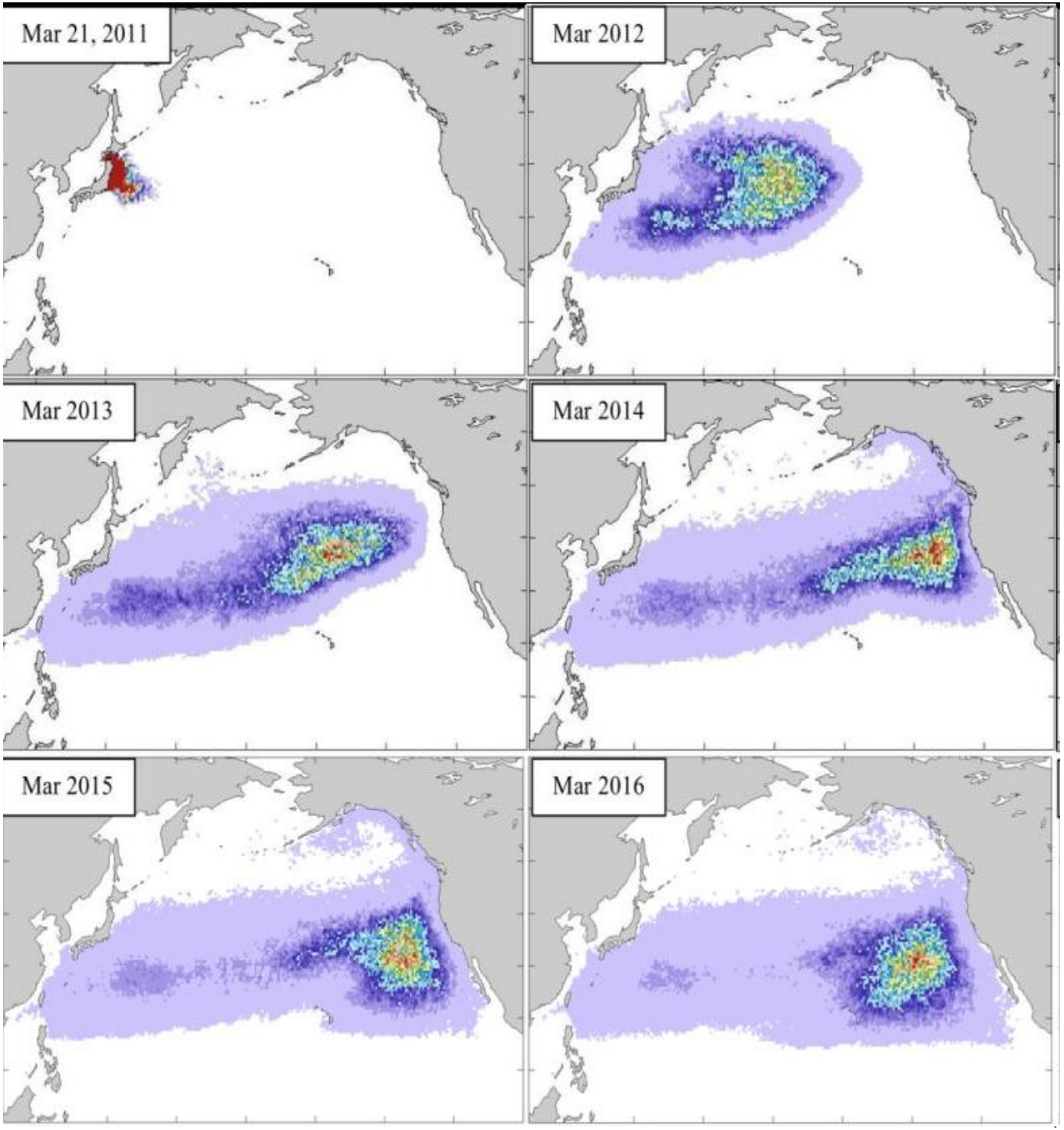


Lumpkin and Elipot (2010)

Using drifter statistics to estimate the fate of floating marine debris

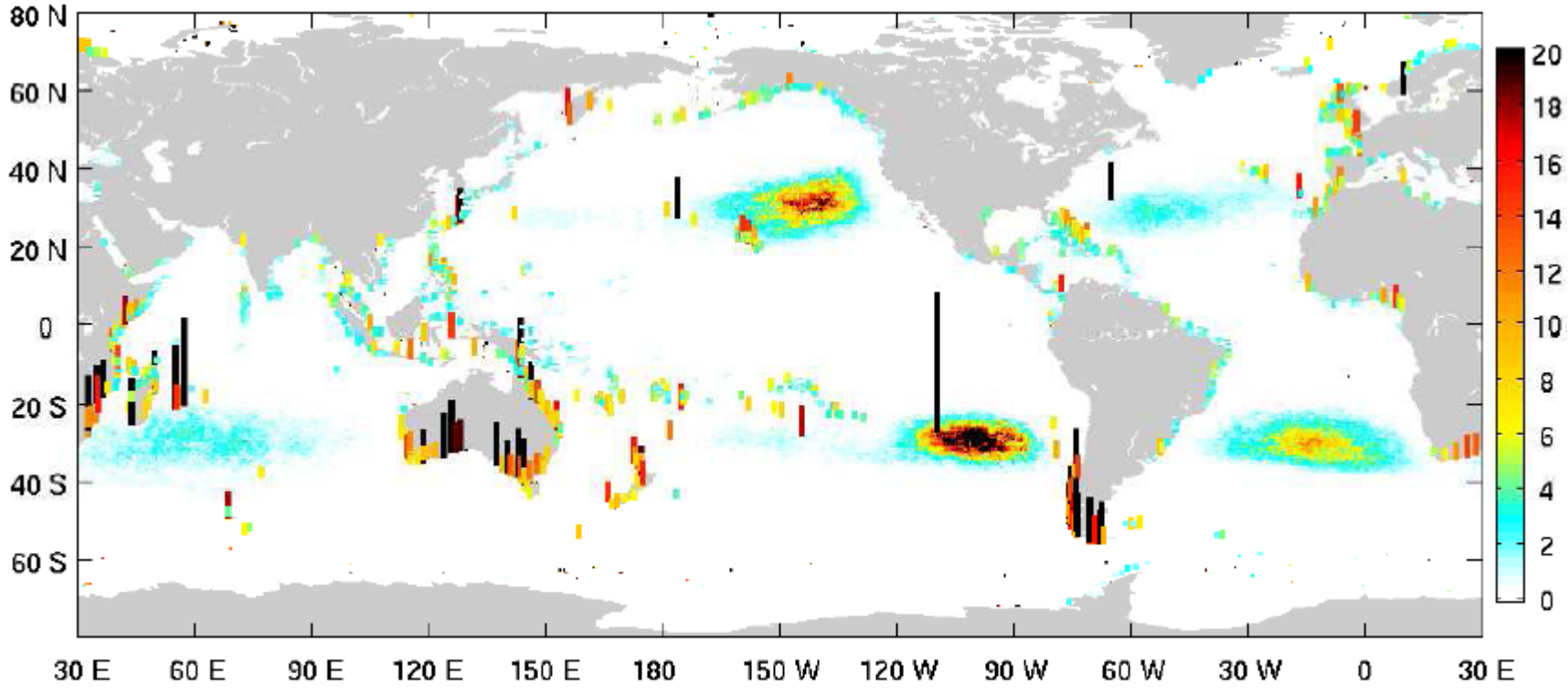
Strategy:

- Divide world's oceans into small boxes.
- For each box, find all the drifters that were ever in the box.
- Calculate where each of those drifters went five days later.
- Assume that those statistics will also describe how marine debris will be carried by ocean currents and winds.
- Use these statistics to simulate the spread of hundreds, thousands or millions of particles.



Simulations by Nikolai Maximenko and Jan Hafner (Univ. Hawaii) using drifter statistics, to simulate fate of debris from 11 March 2011 earthquake and tsunami.

Exposure to marine debris



Distribution of the concentration of floating marine debris in arbitrary units, 10 years after being released homogeneously at a concentration of 1. Vertical bars indicate the concentration of material that has washed ashore, with color corresponding to 10X the value in the color bar.

Lumpkin, Maximenko and Pazos (2011)