Calibration, validation and advanced applications of ocean drift models, forced with ocean satellite data, using marine debris reports from natural disasters

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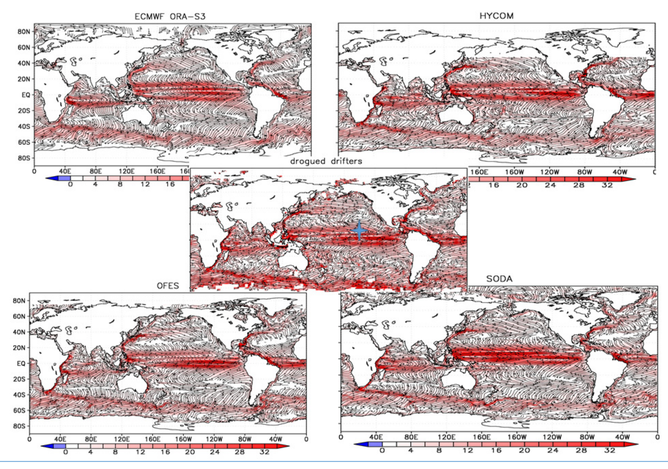
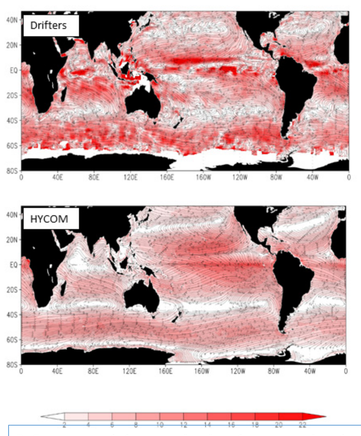
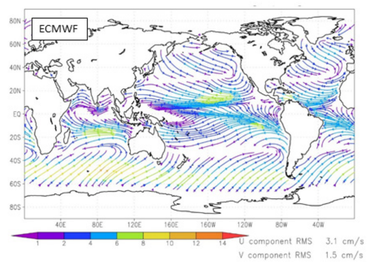
Time-mean currents at 15 meters level in different models



Near-surface currents are difficult for numerical models, theoretical parameterizations and direct or remote measurements.

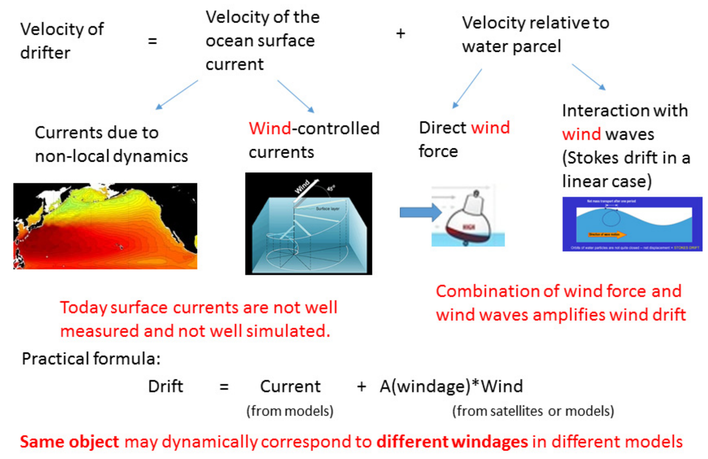
Mean velocity shear between 0 and 15 m depth



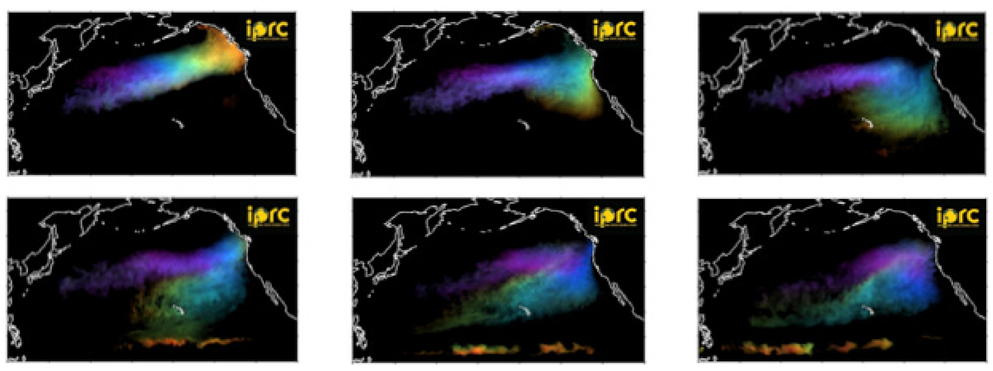


Most problematic is the vertical shear caused by the mixed layer processes. associated with wind forcing and buoyancy flux (Stokes drift, mixing, "momentum injection", Ekman spiral, slipping layers, etc.)

Modeling drift of marine debris

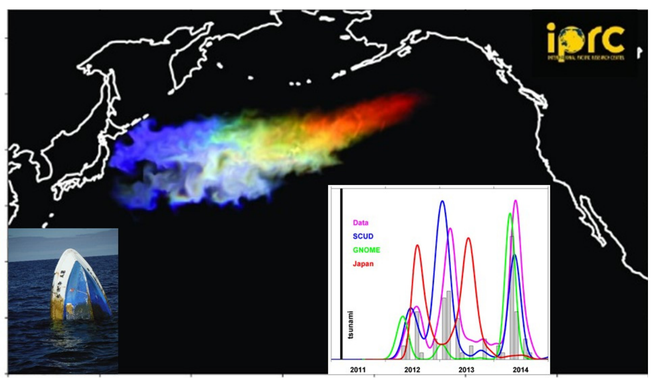


For a broad range of spatiotemporal scales, a surrogate, diagnostic model SCUD (Surface Currents from Diagnostic model) has been built and used Several different applications.

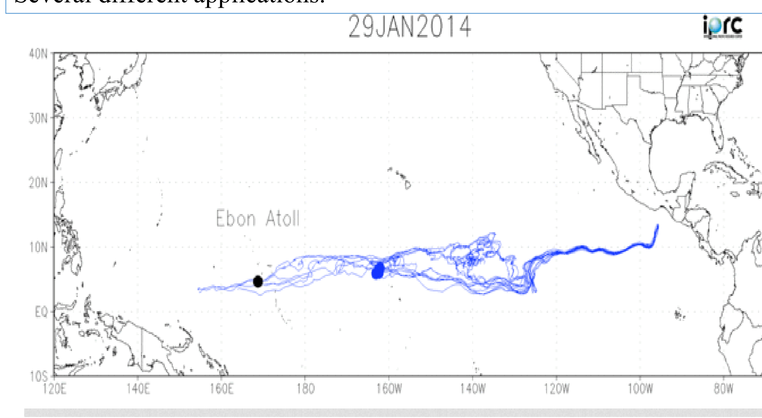


Driftage of Debris from the Tragic Japan Tsunami in 2011

The panels show the debris from the 2011Japan tsunami drifting across the North Pacific one year after the tsunami from March 2012 (top row left) until June 2013 (bottom row right). The colors represent concentration of items of different windages: orange=high windage; purple=low-windage. High-windage debris has reached North America and low-windage debris circulates westward again by September 2012.

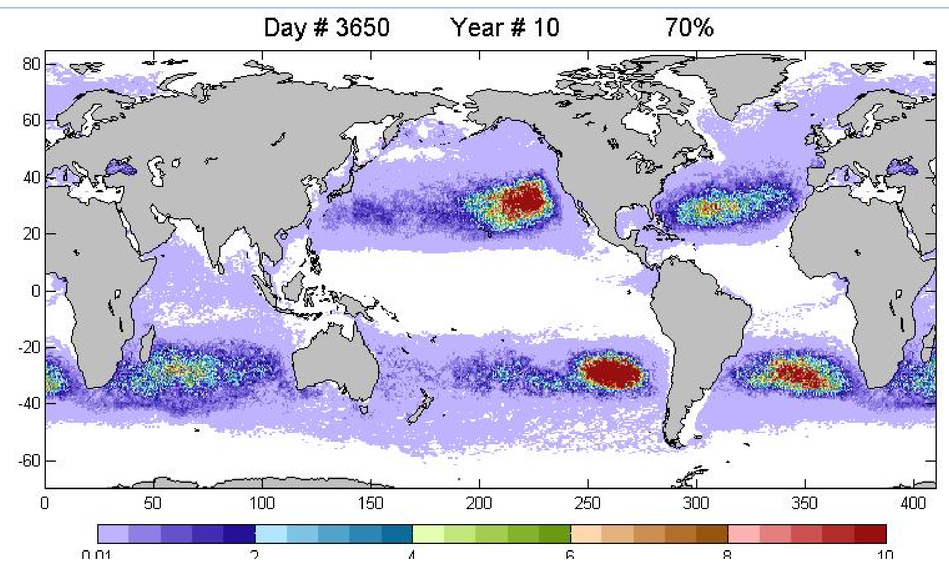


Simulation of marine debris drift from the 2011 tsunami in Japan with the IPRC Drift Model, colors indicating different windages. Inserts: (left) boat sucked out to sea in the tsunami and found north of Hawaii; (right) timelines of "tsunami" boat arrivals on the US/Canada West coast from reports (gray bars and magenta line) and (other colors) drift models.



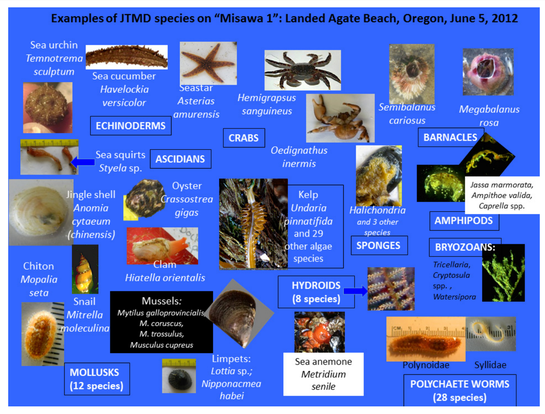
Fisherman's 430-Day Drift across the Pacific Verified

El Salvador fisherman Jose Salvador Alvarenga's story of his improbable 438-day journey across the Pacific after being blown off shore in his malfunctioning motorboat was confirmed with the IPRC Drift Model. The figure shows the paths of 16 tracers in the model from December 20, 2012, until the end of the fisherman's ordeal on Ebon Atoll more than 14 months later.



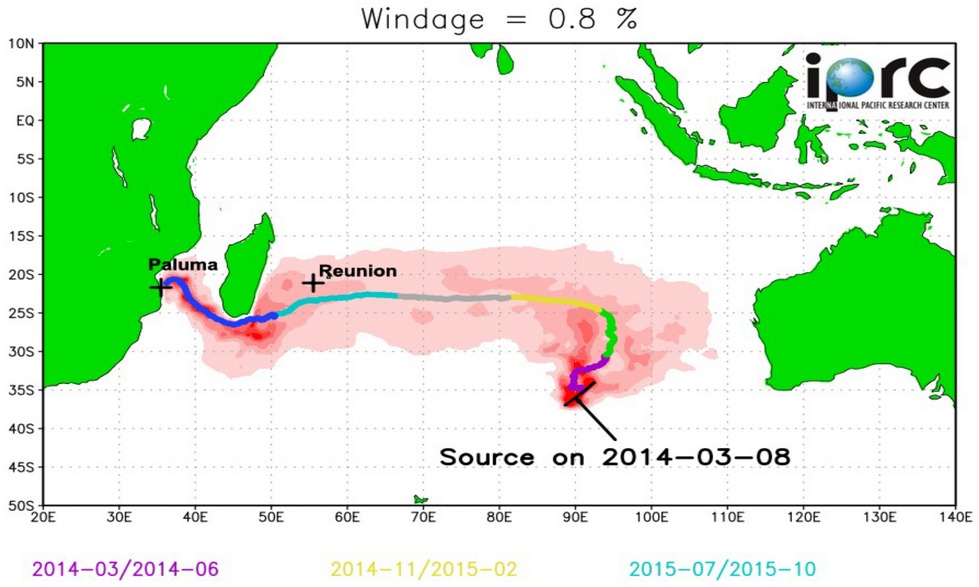
The Five Garbage Patches in the 5 Ocean Gyres

The IPRC Ocean Drift Model helped to identify regions of the World Ocean where marine debris accumulates over long periods of time. The map represents the density of model tracers advected by ocean currents from an initially homogeneous state into the 5 major garbage patches of the global ocean.



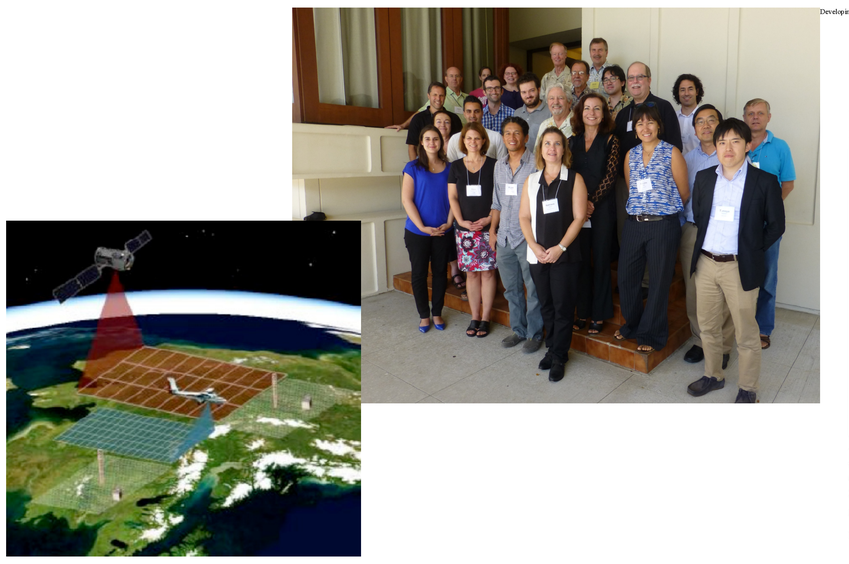
Estimating Transport of Biological Species colonizing man-made debris

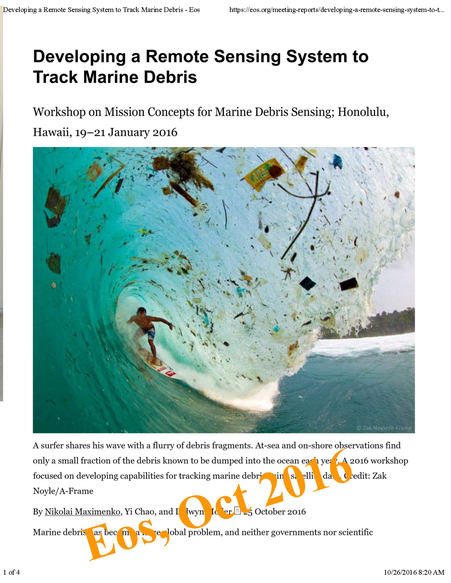
Artificial debris provides a ride across the ocean to coastal species that was not possible on the natural flotsam. More than 300 coastal species from Japan have been reported in North America and Hawaii after the 2011 tsunami. Together with other observations and the exponentially increasing production of plastic, this predicts a possibility of future changes in the eco-regions. Probabilistic models are under development that will help to estimate and monitor risks of invasions.
Figure show the dock that drifted from Misawa (northeast of Honshu, Japan) to Oregon with > 120 species onboard, some of which are also shown.



Estimating the Crash Site of Malaysian Airlines Flight 370

The IPRC Ocean Drift Model has simulated the drift of fragments identified from flight MH370, namely the flaperon found on Reunion, July 2015, the fragment found December 30, 2015, on a beach in southern Mozambique, and the fragment found end of February 2016 on Paluma Sandbank in northern Mozambique.





Marine Debris Observing System

Global monitoring of marine debris is critical for understanding of its dynamics. A workshop on Mission Concept for Marine Debris Sensing, sponsored by the NASA Physical Oceanography, has been held in Honolulu, Hawaii in January 2016. The workshop gathered academics, satellite engineers, citizen scientists, coastal cleanup experts and representatives from national and international agencies and resulted in the Eos report, published in October 2016, and white papers submitted to the 2017-2027 Decadal Survey for Earth Science and Applications from Space, conducted by the National Academies of Sciences, Engineering, and Medicine. Also, collaborative proposals have been submitted in September 2016 to the NASA Interdisciplinary Research in Earth Science.

Please sent your feedback and questions to maximenk@hawaii.edu