Transport of marine debris in North Pacific: the case of Hawaii

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Introduction
Studies of marine debris transport over large distances are very limited. Long-term position tracking is required to collect the necessary data. In general the transport of marine debris is determined by the surface ocean currents and winds. The effect of wind on marine debris motion is called windage; high windage debris is affected by the wind more than low windage type. The 2011 tsunami in Japan was a very tragic event that generated a large amount of unusual debris. Data of tsunami debris were used as an experiment of the nature and many pieces could be directly traced back to origin (e.g. registration numbers on boats). SCUD (Surface Currents from Diagnostic model) model was employed to simulate the drift of tsunami debris from the coast of Japan across the North Pacific to Hawaii.

Japanese Tsunami 2011
We applied SCUD model to simulate the drift of Japanese Tsunami Debris (JTMD) across the North Pacific Ocean. Virtual tracer was placed along the East coast of Japan and its magnitude was weighted by the reported number of damaged houses. Then the tracer was advected by model currents and winds. As the effect of wind it was considered in the 0-5% range (0-5% windage).

The source function along the East Japanese Coast

Formulation of the diagnostic model

SCUD model uses the diagnostic model SCUD

\[ \text{SCUD model} \]

Where: \( U, V \) - modelled ocean current components
\( h \) - sea level anomaly
\( w_x, w_y, w_z \) and \( v \) component of surface wind (QSCAT)
\( v_{x}, v_{y}, v_{z} \) - similarly corresponding V component coefficients

Model solution

Special Cases

With known times and locations of origin and destination of a particular marine debris, the model can calculate probabilistic trajectory. Combination of forward (from the origin) and backward (from the destination) model tracer solutions results in a probabilistic pathway. The model can calculate probabilistic trajectory. Combination of forward (from the origin) and backward (from the destination) model tracer solutions results in a probabilistic pathway.

The Story: Changing composition in time

Timeline of JTMD in Hawaii

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