Observation-base estimate of the Fukushima radionuclide propagation in the North Pacific

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WHOI 2012-2013 samples from North Pacific

Mirai  June-July 2012  32-45°N, 140-160°E
SEA      October 2012  21-33°N, 152-123°W
SeaDragon June-July 2012  24-33°N, 150-164°W
Emerson  March 2013        30-40°N, 146-150°E
CLIVAR P02 March-May 2013  30°N transect
WHOI 2012-2013 samples from North Pacific

- **Mirai**: June-July 2012, 32-45°N, 140-160°E
- **SEA**: October 2012, 21-33°N, 152-123°W
- **SeaDragon**: June-July 2012, 24-33°N, 150-164°W
- **Emerson**: March 2013, 30-40°N, 146-150°E
- **CLIVAR P02**: March-May 2013, 30°N transect

**Cesium isotopes**
- Cs134 (2.06yr half-year) **Fukushima origin**
- Cs137 (30.07yr half-year)
Detectable Cs134 signals are observed at 174.3°W in 2012 and are extent to 160°W in 2013. No Cs134 is found east of 152°W.
Vertical penetration

• Zonal Cs134 concentration shallows toward to east.
P02 transect

- Center of the subtropical gyre
- Zonal Cs134 concentration deepens in the west and shallows toward to east.
- Cs134 is found deeper than $26\sigma_\theta$ isopycnal surface.
P02 transect

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Deep penetration driven by mode water formation process?
Probability using surface drifter tracks

Global Drifter Program (GDP) dataset
• www.aoml.noaa.gov/phod/dac/index/php
• >6000 drifter tracks in the North Pacific since 1972
• About 60 drifters near Fukushima

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P_{i,j} = \frac{N_{i,j}}{N}
\]

Travel time
\[
\bar{T} = \frac{\sum T_{i,j}}{N_{i,j}}
\]

Rypina et al., 2014
Progression of tracer

3±2M  6±2M  9±3M  12±3M

15±3M  18±5M  21±7M  24±8M

27±10M  30±12M  33±13M  36±15M
Comparison with observations

- Progression of the leading edge of the Cs134 distribution with time away from the Japan coast agrees well with observed Cs134 signals.
Summary

• Detectable Cs134 signals are found at 174.3°W in 2012 and 160.6°W in 2013 at surface and zonal Cs134 distribution deepens in west and shallows toward to east.

• No Cs134 is found east of 152°W in 2013.

• Cs134 is seen in deeper ocean (500m, 26σθ) which is driven by different mechanisms from surface advection.

• Probability tracks in North Pacific shows consistent progression with 2012 and 2013 observations.

• Importance of sampling at eastern N. Pacific to monitor the spread of Cs134 in next 5-10 years.