

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

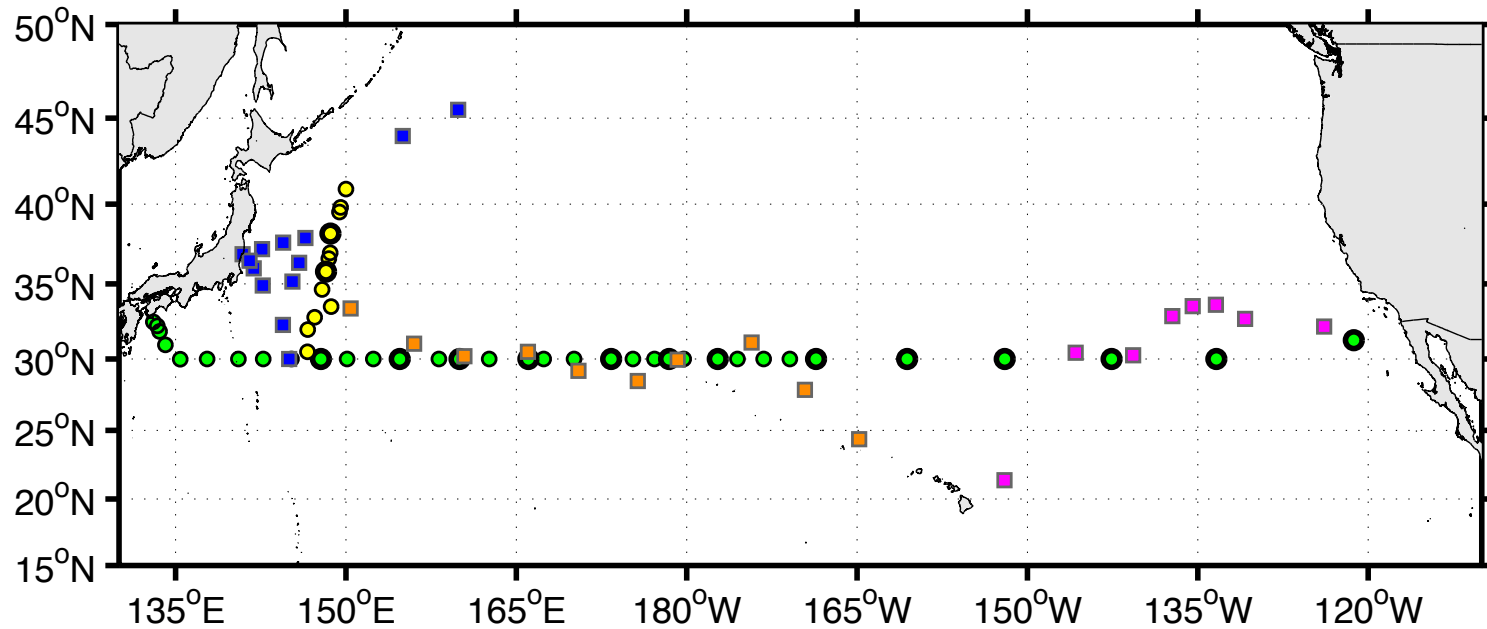
S. Yoshida, S. Jayne, A. Macdonald, K. Buesseeler and I. Rypina

Woods Hole Oceanographic Institution

EGU Vienna

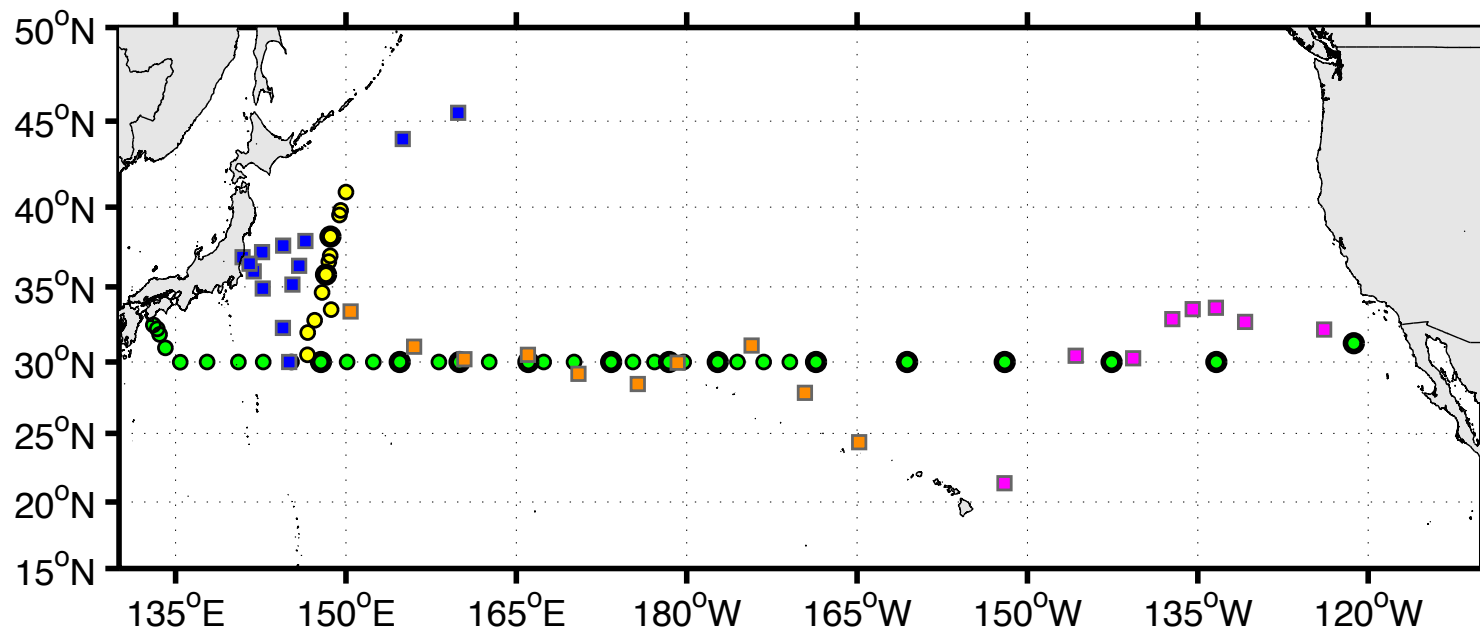


WHOI 2012-2013 samples from North Pacific



	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

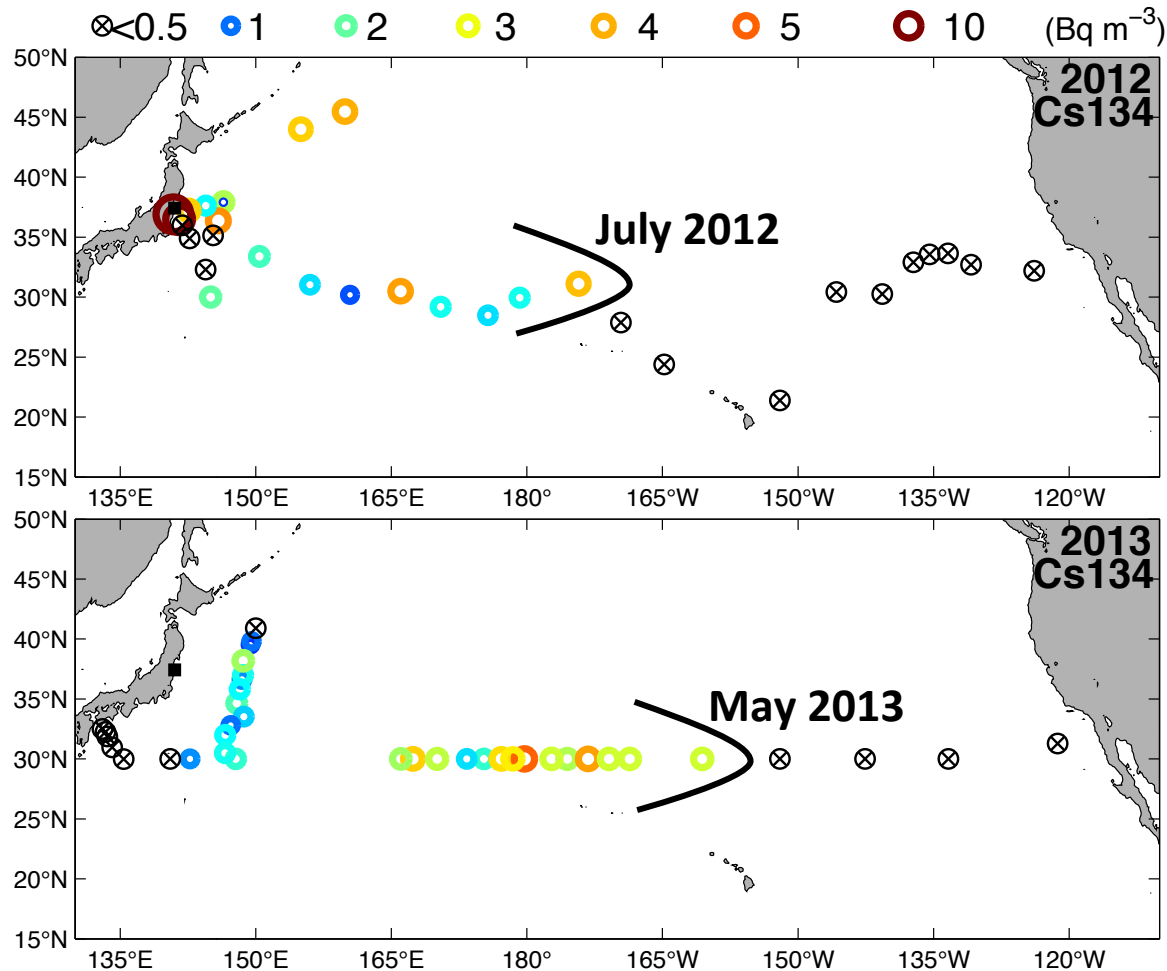


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Cesium isotopes

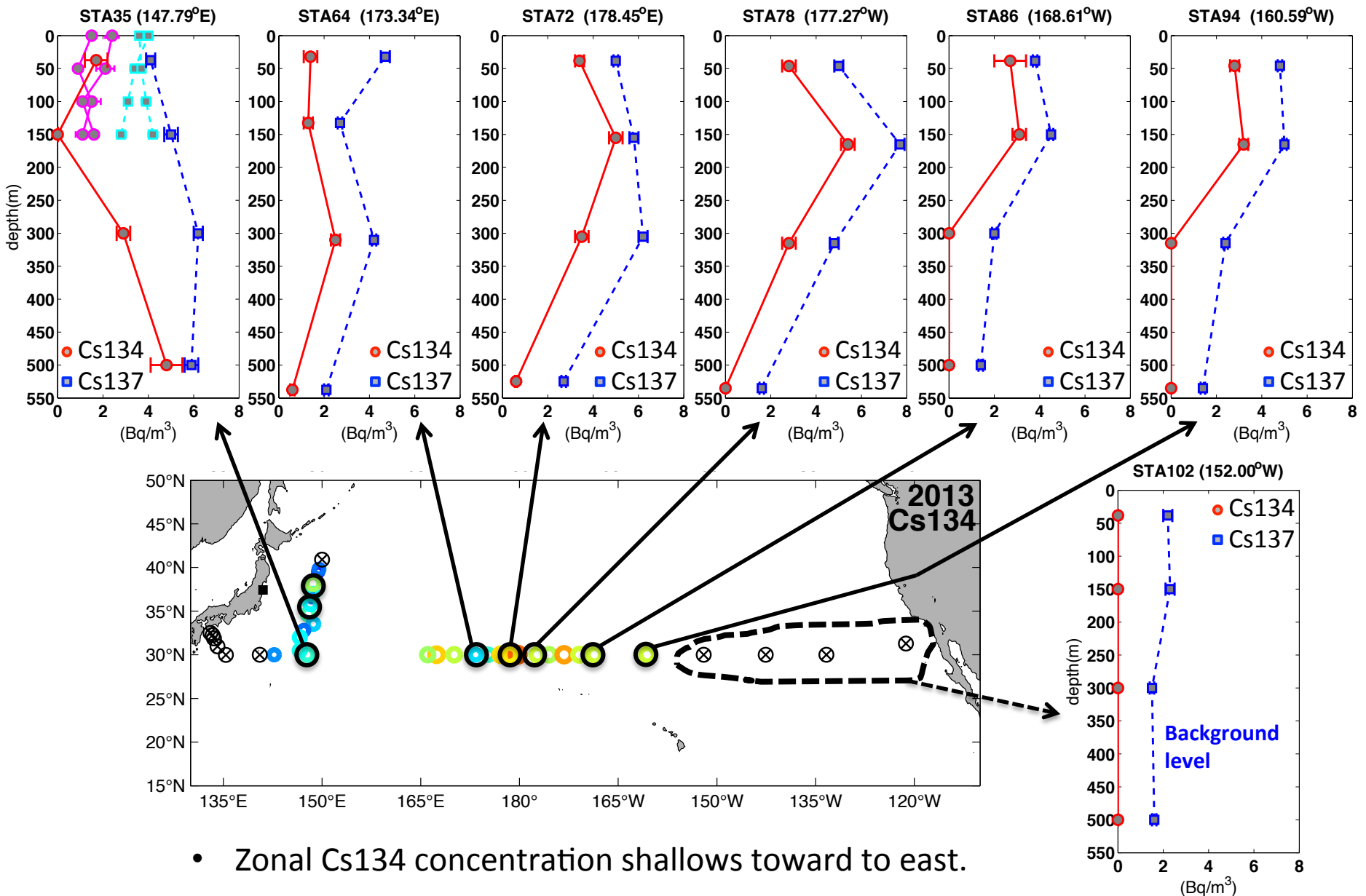
Cs134 (2.06yr half-year) **Fukushima origin**
Cs137 (30.07yr half-year)

Surface Cs134 concentration



- 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.

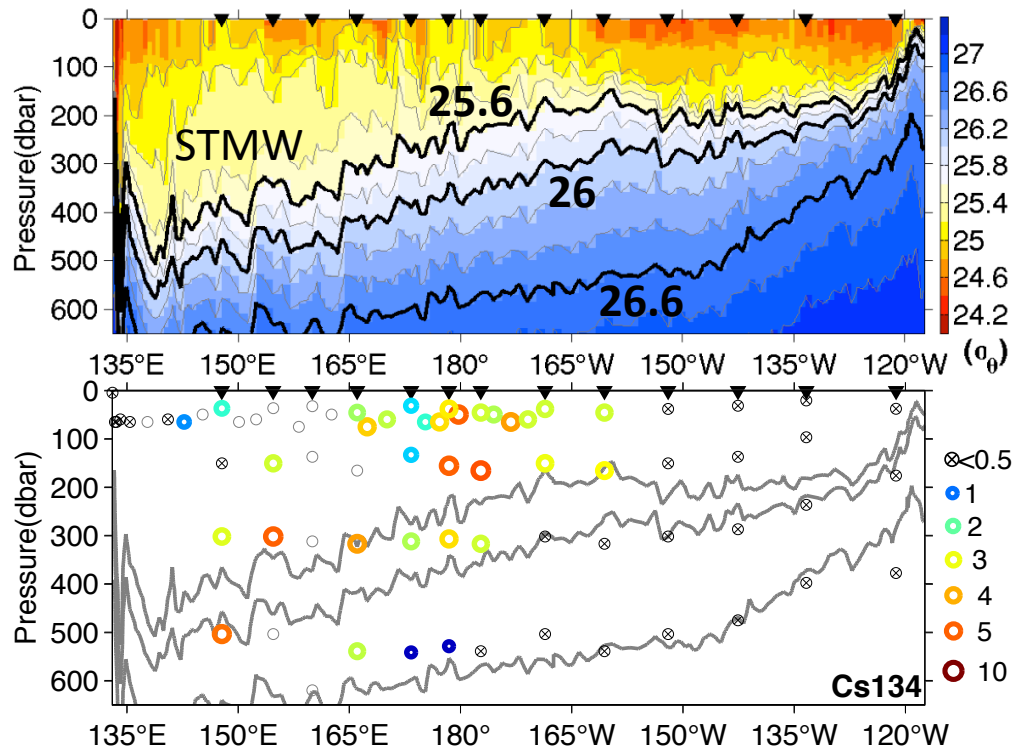
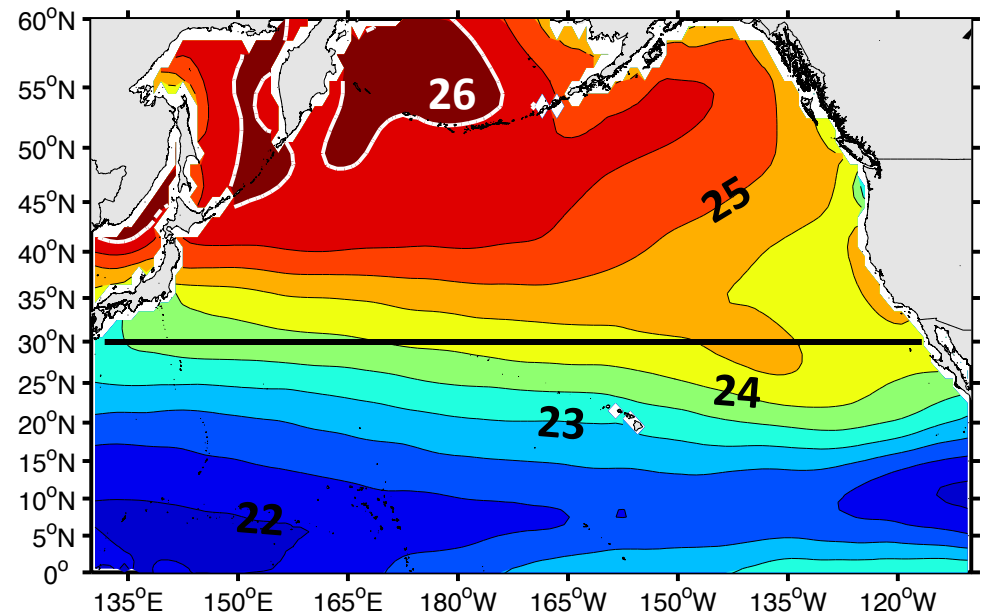
Vertical penetration



- Zonal Cs134 concentration shallows toward to east.

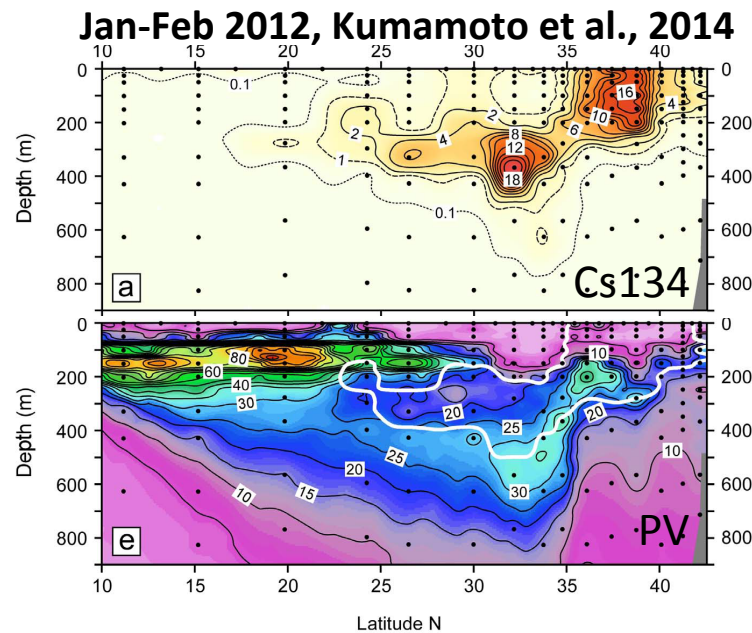
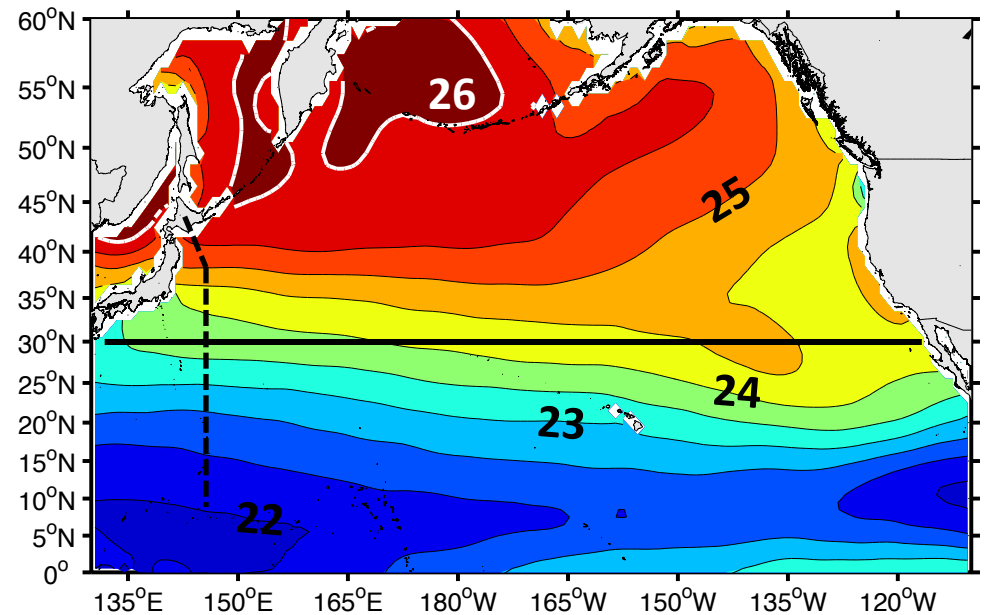
P02 transect

- 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.

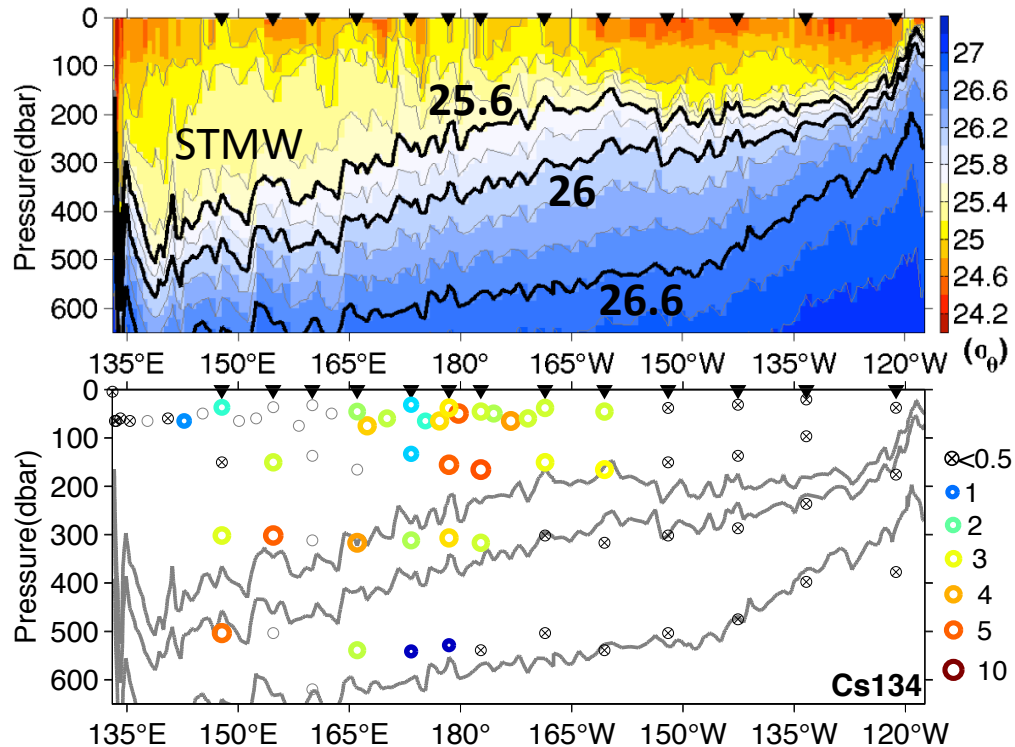


P02 transect

- 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.



- Deep penetration driven by mode water formation process?

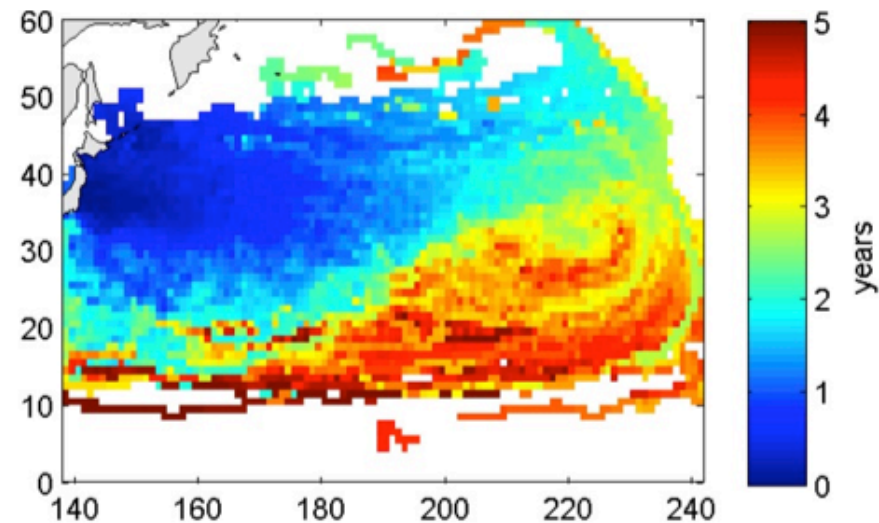
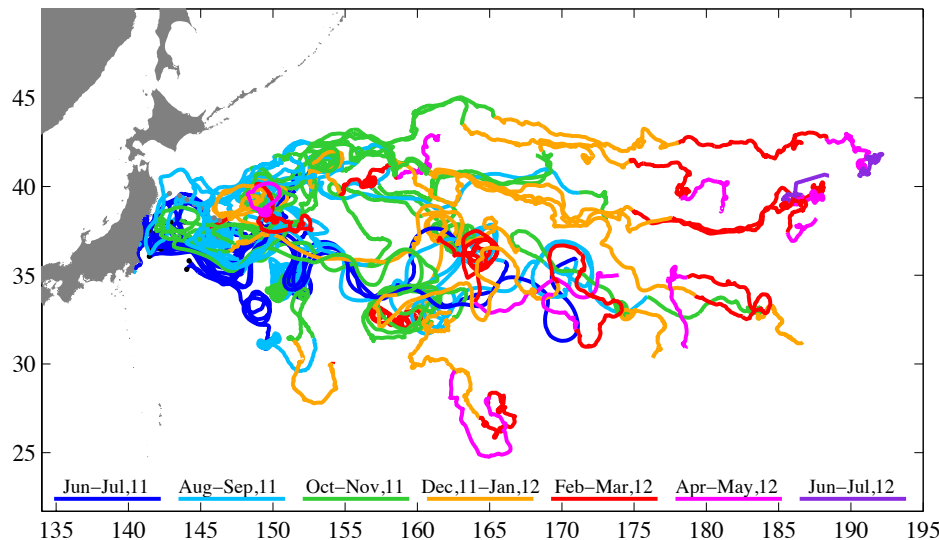


Probability using surface drifter tracks

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

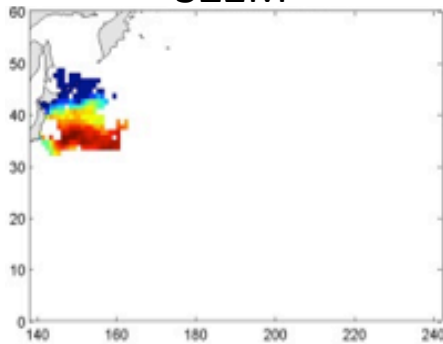
$$\text{Probability } P_{i,j} = \frac{N_{i,j}}{N} \quad \text{Travel time } \bar{T} = \frac{\sum T_{i,j}}{N_{i,j}}$$



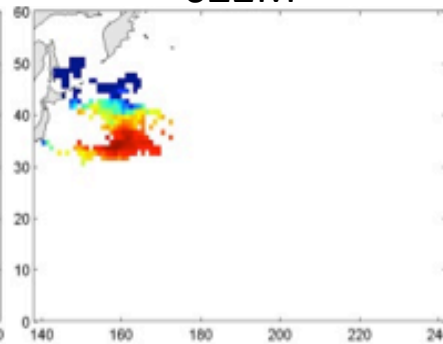
Rypina et al., 2014

Progression of tracer

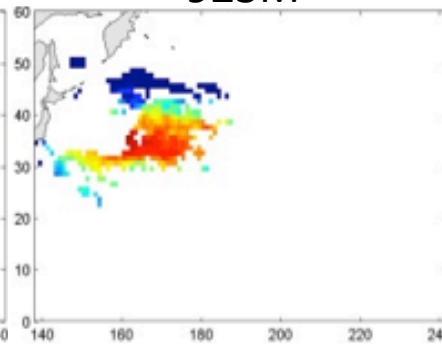
$3 \pm 2M$



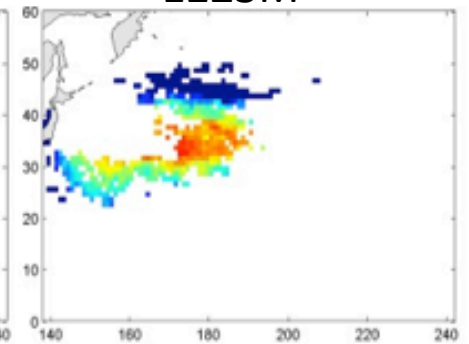
$6 \pm 2M$



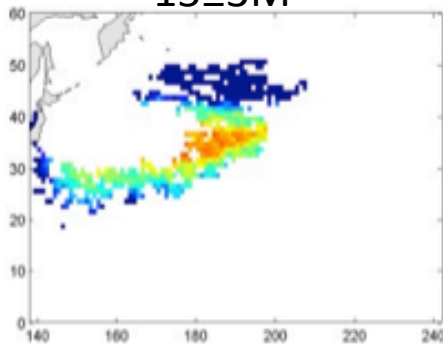
$9 \pm 3M$



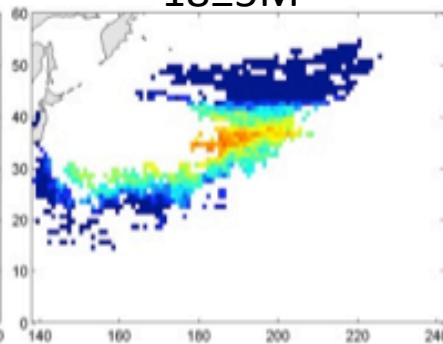
$12 \pm 3M$



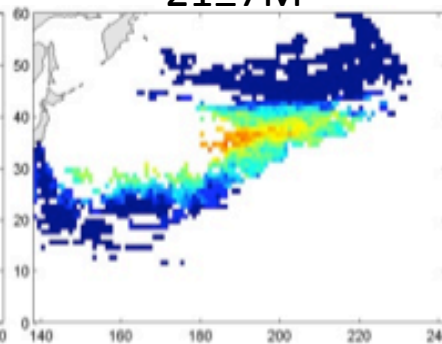
$15 \pm 3M$



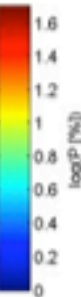
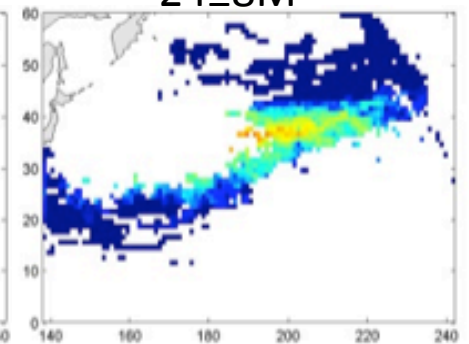
$18 \pm 5M$



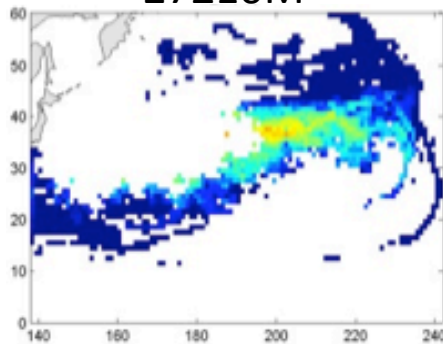
$21 \pm 7M$



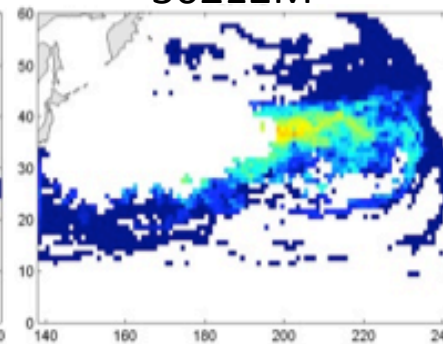
$24 \pm 8M$



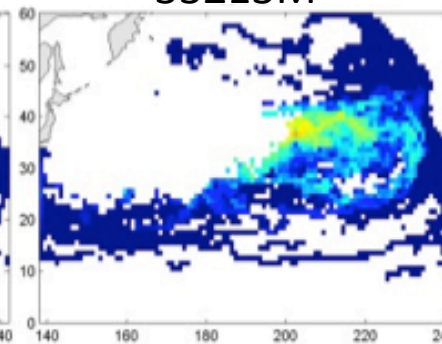
$27 \pm 10M$



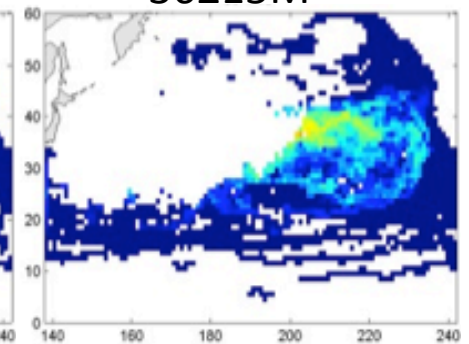
$30 \pm 12M$



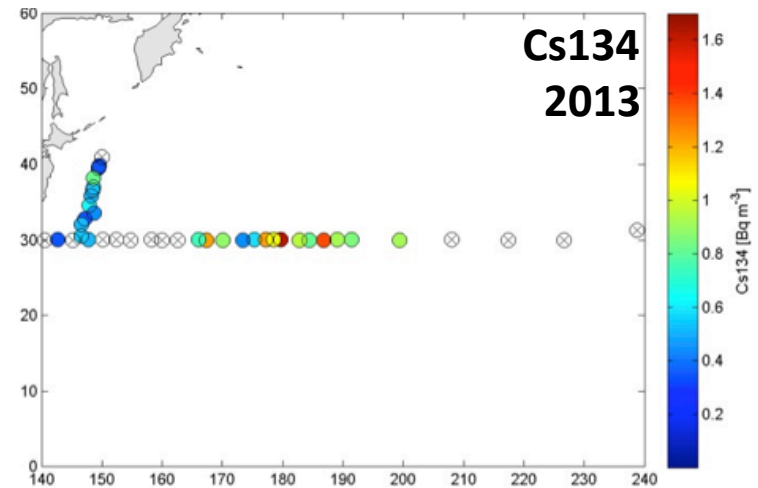
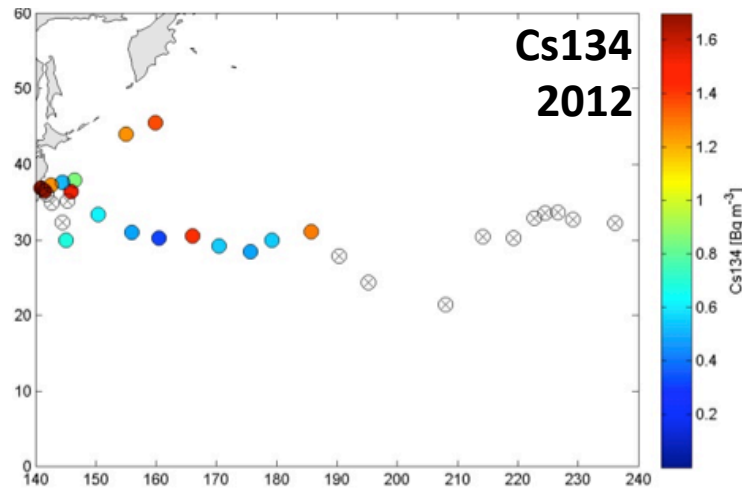
$33 \pm 13M$



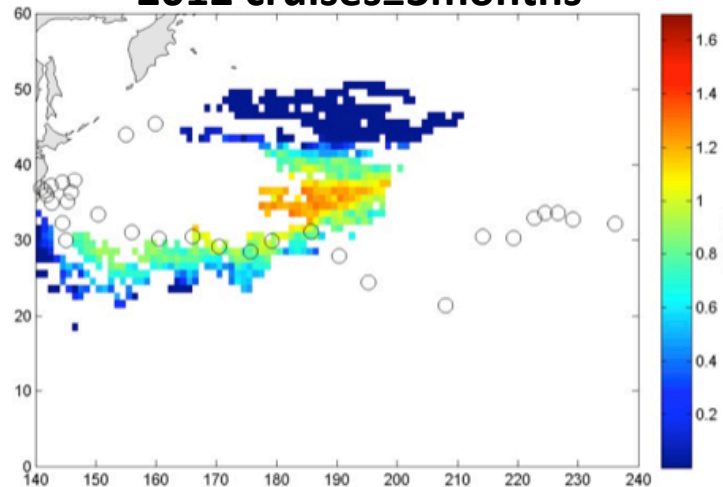
$36 \pm 15M$



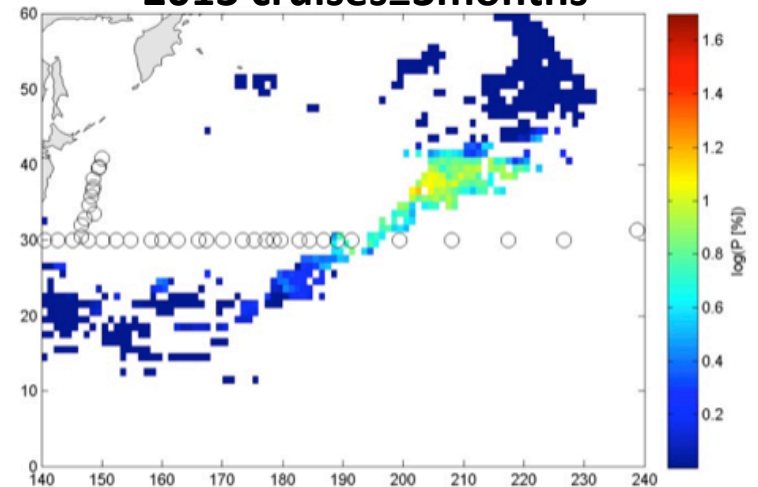
Comparison with observations



**Probability
2012 cruises ±3 months**



**Probability
2013 cruises ±3 months**



- 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, $26\sigma_\theta$) 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.