Five years monitoring activity on radioactive cesium in seawater after the Fukushima Dai-ichi Nuclear Power Plant Accident

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Introduction

After the Fukushima Dai-ichi nuclear power plant accident, many studies had been reported the oceanic dispersion patterns of radioactive Cs derived from this accident.

Here, we summarize the dispersion pattern of Fukushima-derived radiocesium in the North Pacific and temporal change in the concentration of ^{137}Cs in seawater near the Fukushima site, based on the observational data obtained during five years.

Main topics are as follows;

- eastward dispersion in surface seawater
- southward intrusion with mode waters
- temporal changes in ^{137}Cs in coastal seawater

References updated from last WS @Qingdao (PICES2015)

Kaeriyama, H. et al. (2016): Sci. Rep., 6, 22010

Kaeriyama, H. (in press): Fish. Oceanogr., Tsunami special issue published in Jan 2017

Kakehi, S. et al. (2016): J. Environ. Radioact., 153, 1–9

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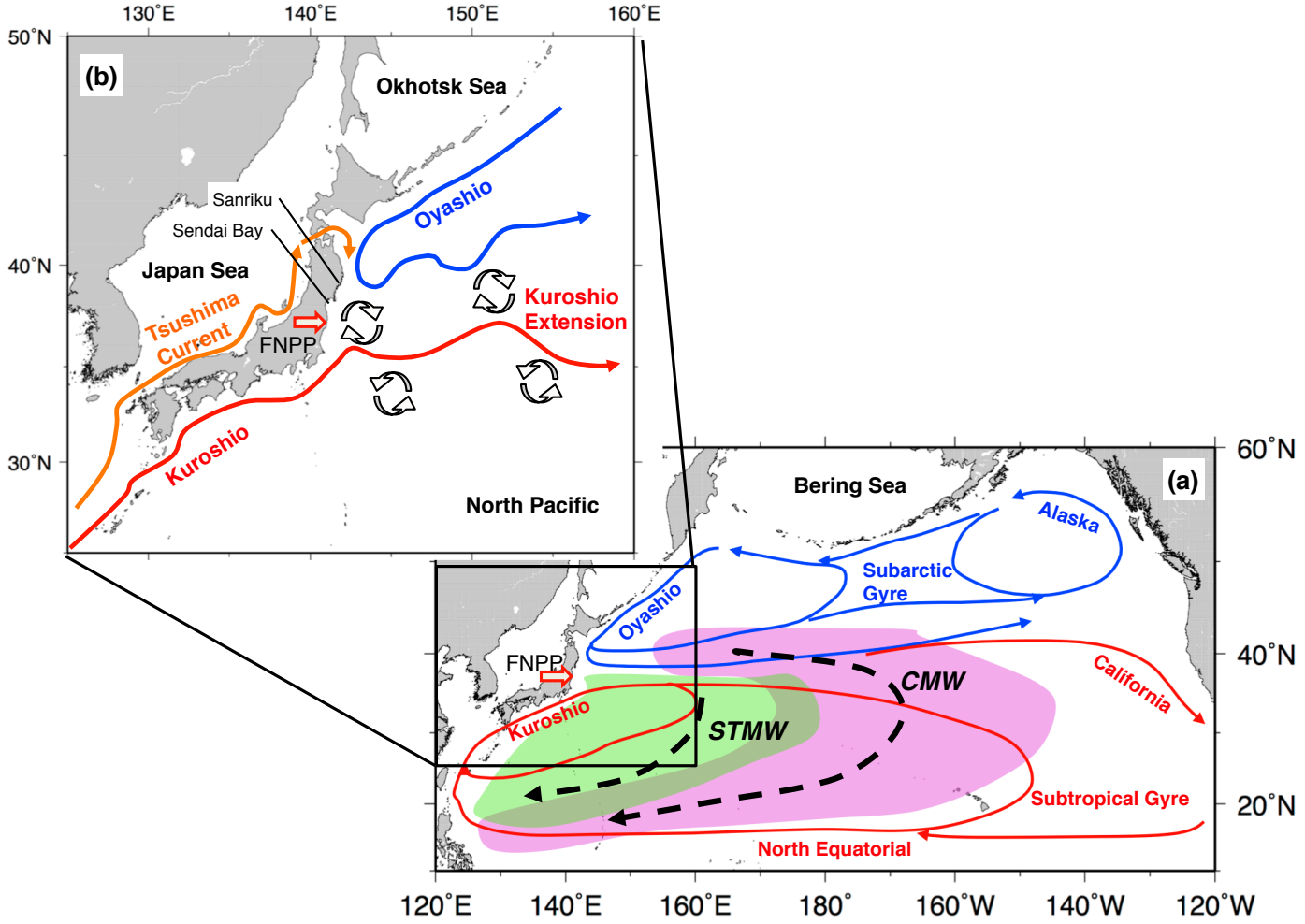
Oceanic background

major sea surface and subsurface seawater movements associated with FNPP studies



Kaeriyama (in press)

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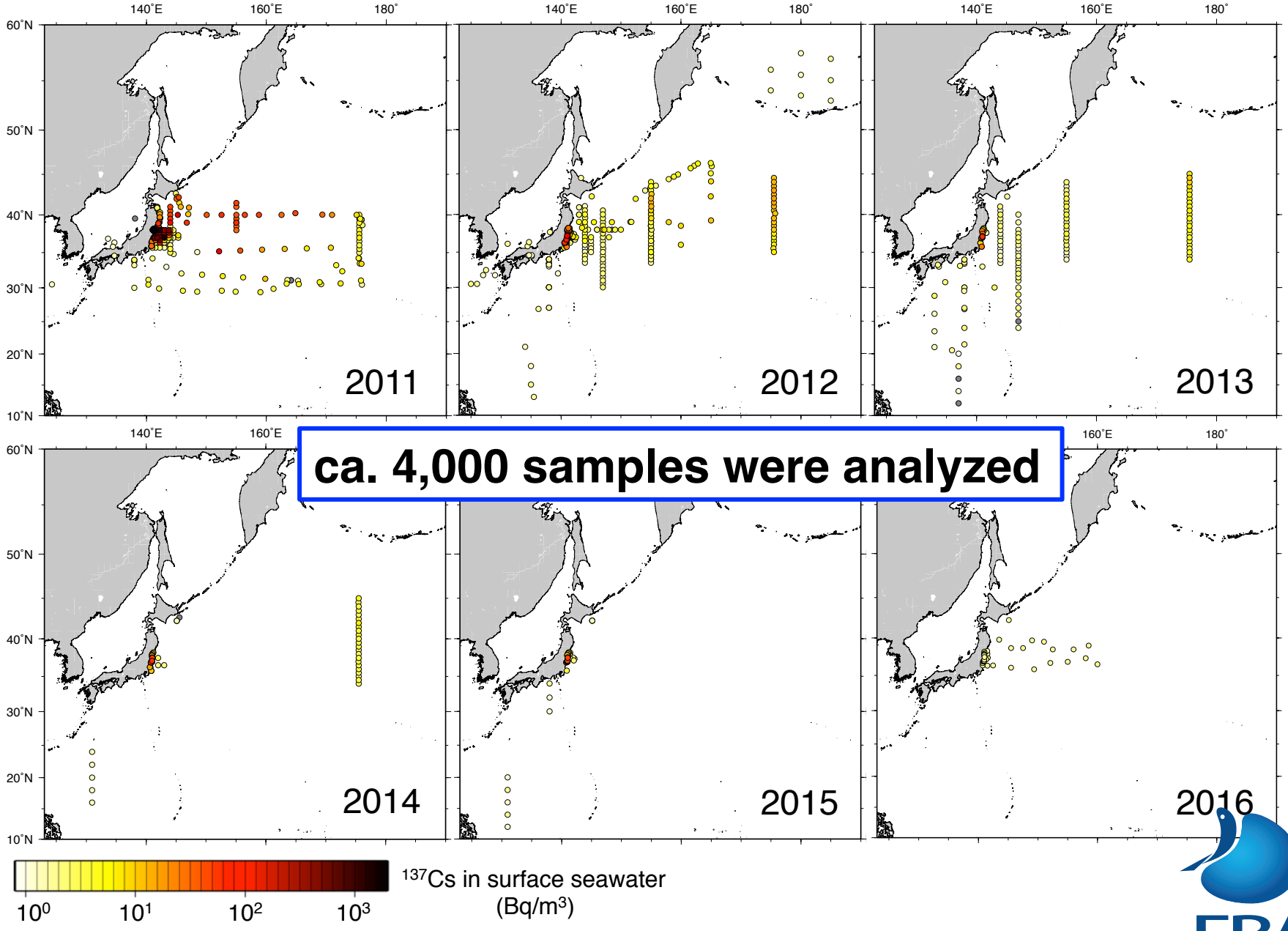
Monitoring activity on seawater by FRA



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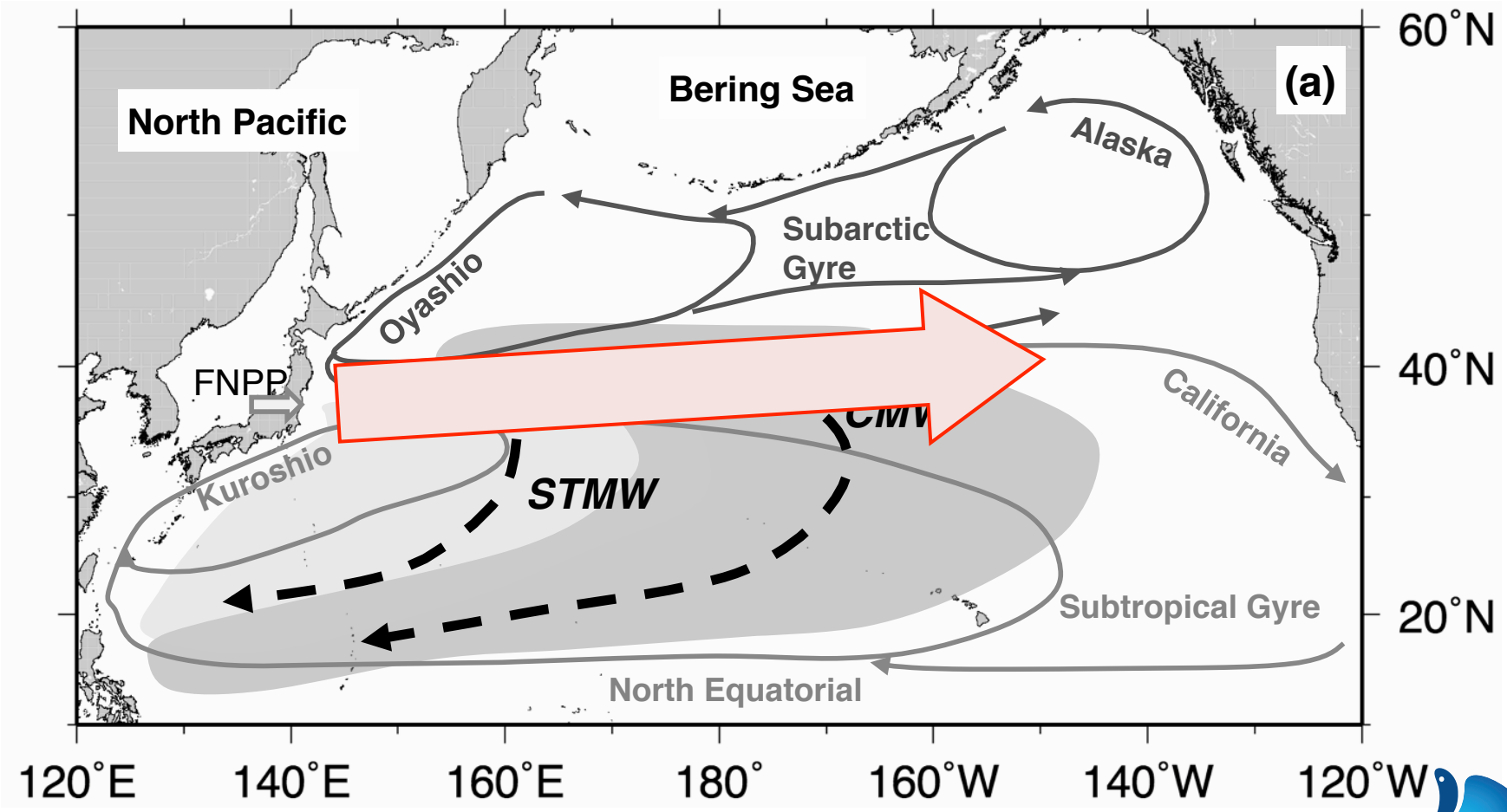
Eastward dispersion in surface seawater



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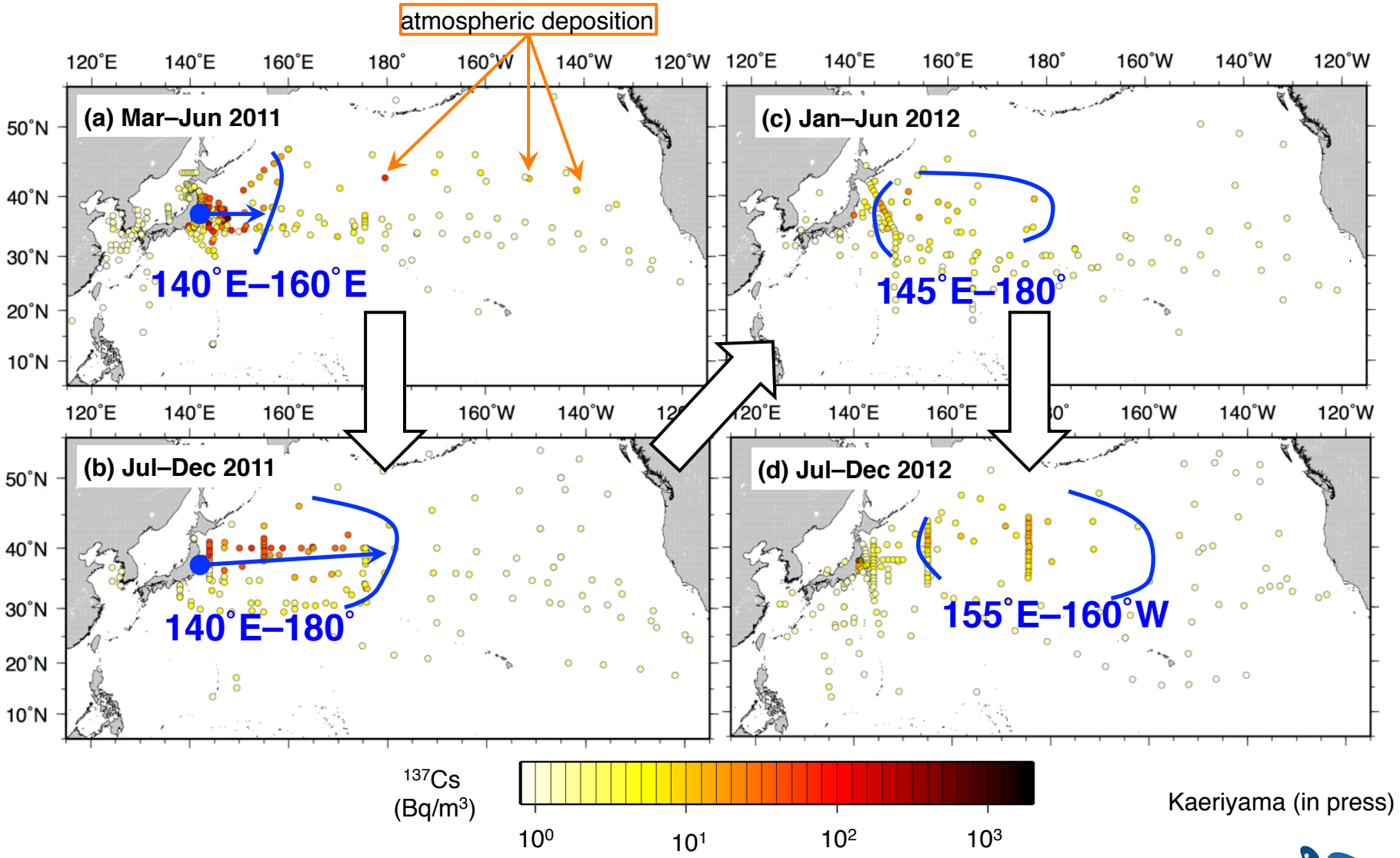
Eastward dispersion in surface seawater



Kaeriyama (in press)

Data were cited from Aoyama *et al.* (2013a); Aoyama *et al.* (2013b); Aoyama *et al.* (2015b); Buesseler *et al.* (2012); Charette *et al.* (2013); Inoue *et al.* (2012a); Inoue *et al.* (2012b); Inoue *et al.* (2012c); Kaeriyama *et al.* (2013); Kaeriyama *et al.* (2014); Kaeriyama *et al.* (2015); Kaeriyama (2015); Kaeriyama (this study); Kamenik *et al.* (2013); Kim *et al.* (2012); Kumamoto *et al.* (2013); Kumamoto *et al.* (2014); Kumamoto *et al.* (2015a); Kumamoto *et al.* (2015b); Ramzaev *et al.* (2014); Smith *et al.* (2014).

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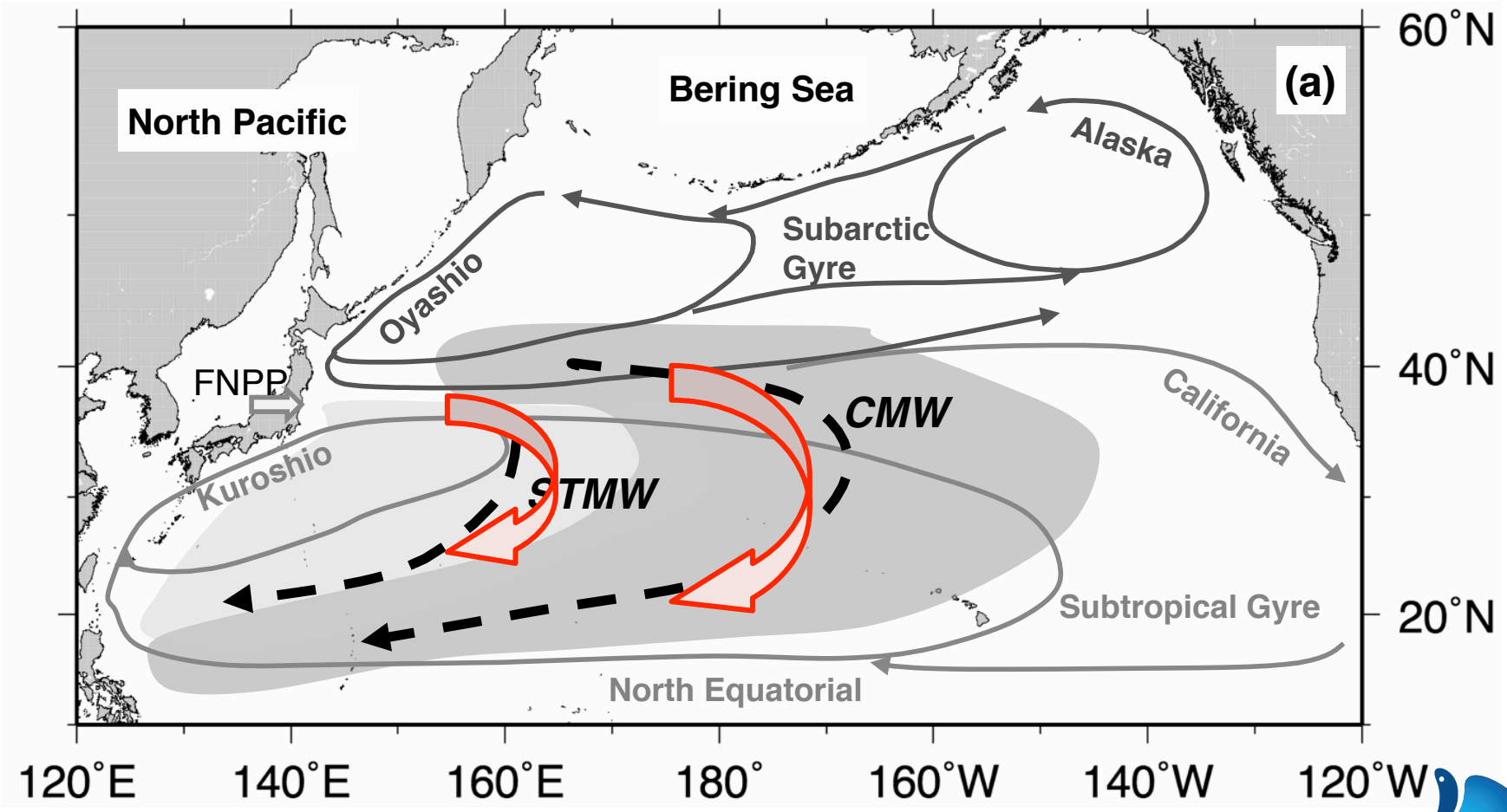
Southward intrusion with mode water



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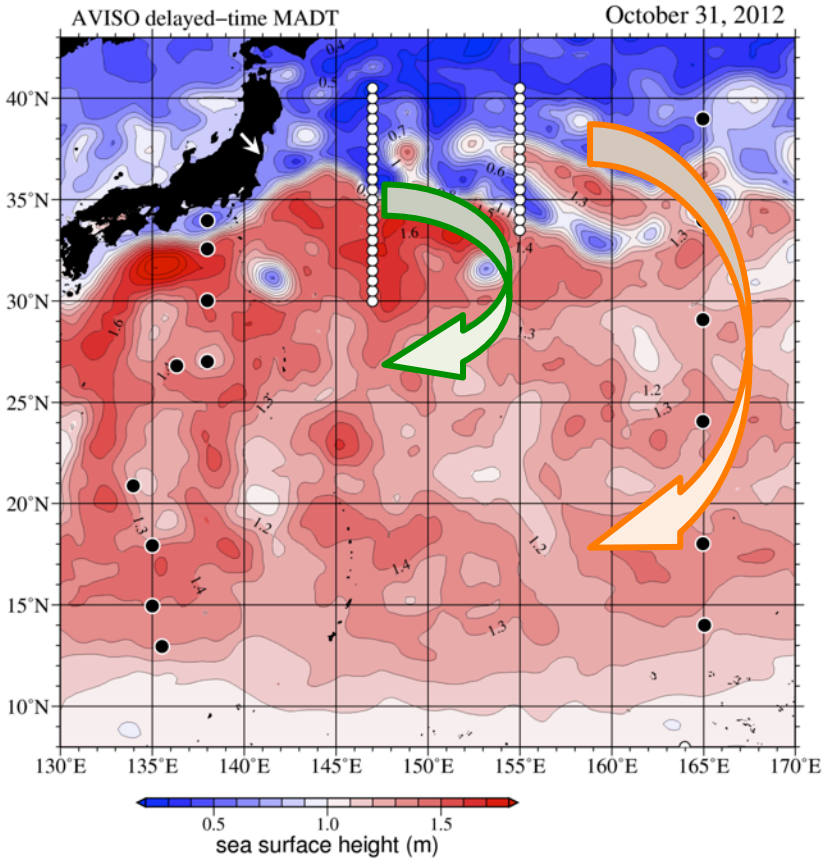
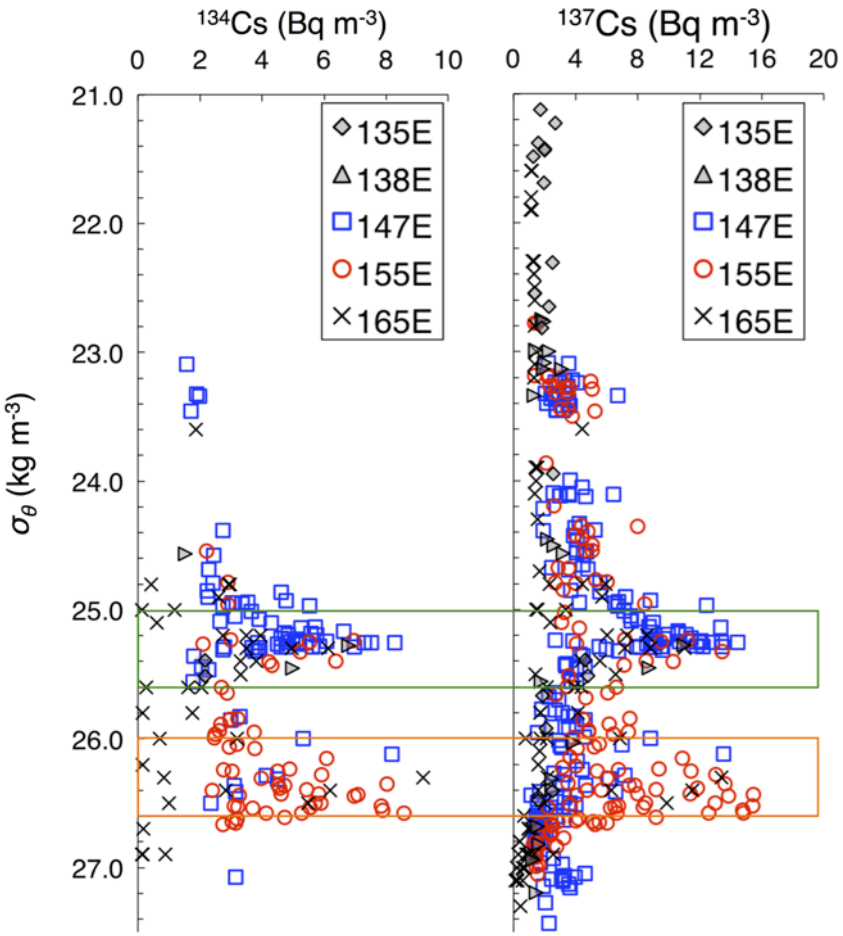
Southward intrusion with mode water





Subtropical mode water: 25.0–25.6 σ_θ

Central mode water: 26.0–26.6 σ_θ

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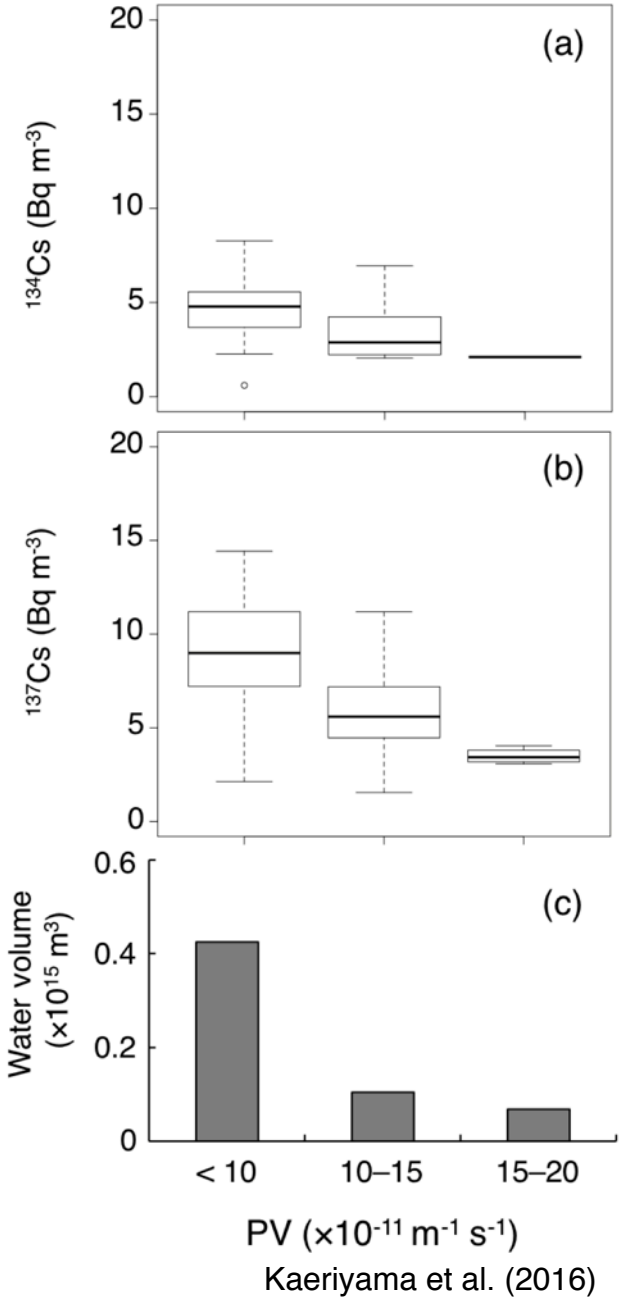
Southward intrusion with mode water



Kaeriyama et al. (2016)

Source term estimation of Fukushima-derived radiocesium (^{134}Cs or ^{137}Cs)

Source	Direct release	Atmospheric deposition on ocean surface	Reference
Fukushima accident	2.8 - 4.2	12 - 15	Aoyama et al (submitted)
	12 - 42		Bailly du Bois et al. (2012)
	11 - 16		Charette et al (2013)
	2.3		Dietze and Kriest (2012)
	2.9 - 4.3		Tsumune et al (2013)
	4	5	Kawamura et al (2011)
	4.1 -4.5	5.7 - 5.9	Estounel et al. (2012)
	3.5	7.6	Kobayashi et al. (2012)
Global fallout		76	Buesseler (2014)*
Close-in fallout		28	Buesseler (2014)*

*based on Aarkrog (2003)

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Total amount of Fukshima-derived ^{137}Cs: 15–20 PBq
^{137}Cs in STMW in Oct–Nov 2012: 4.2 PBq

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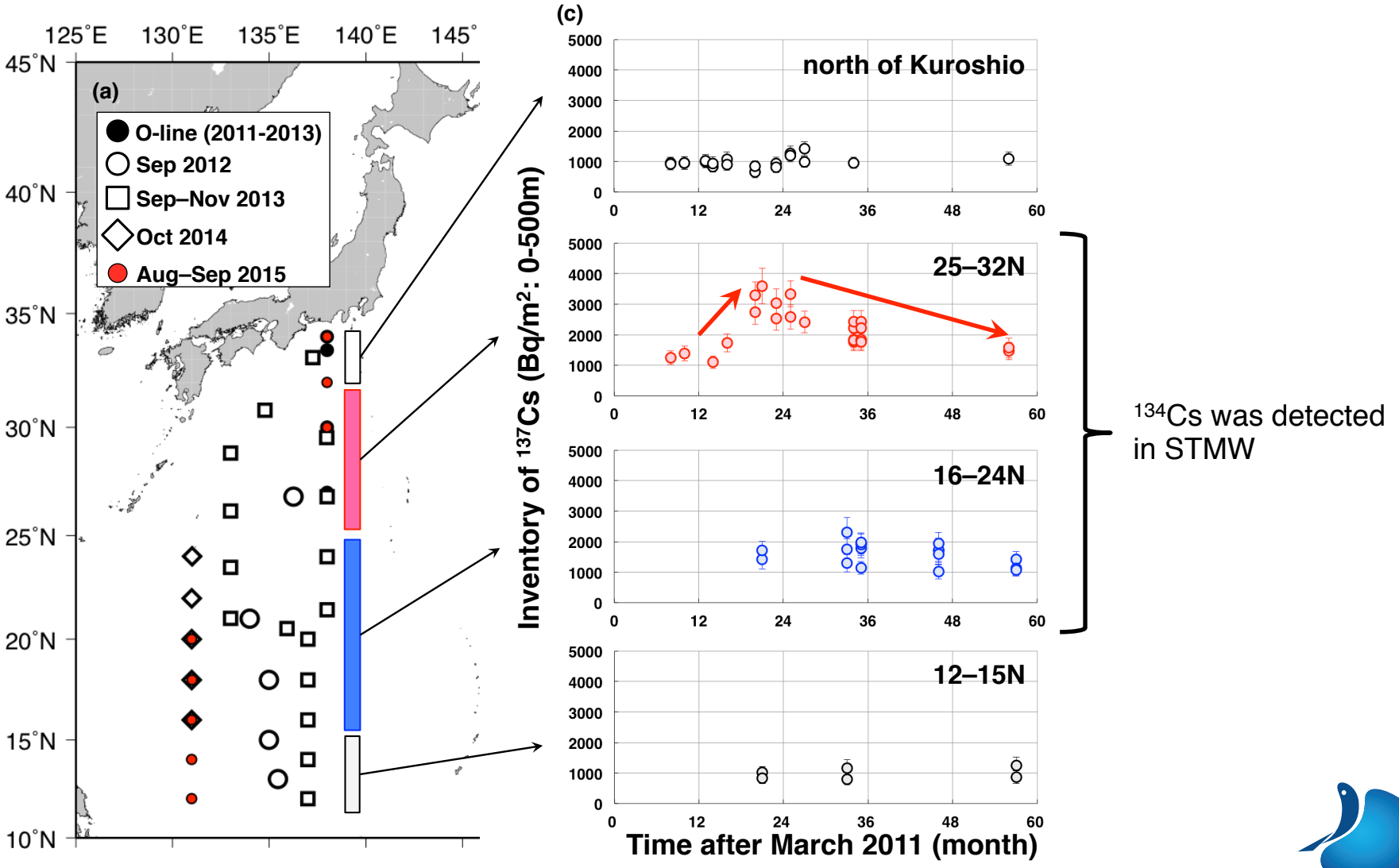
Southward intrusion with mode water

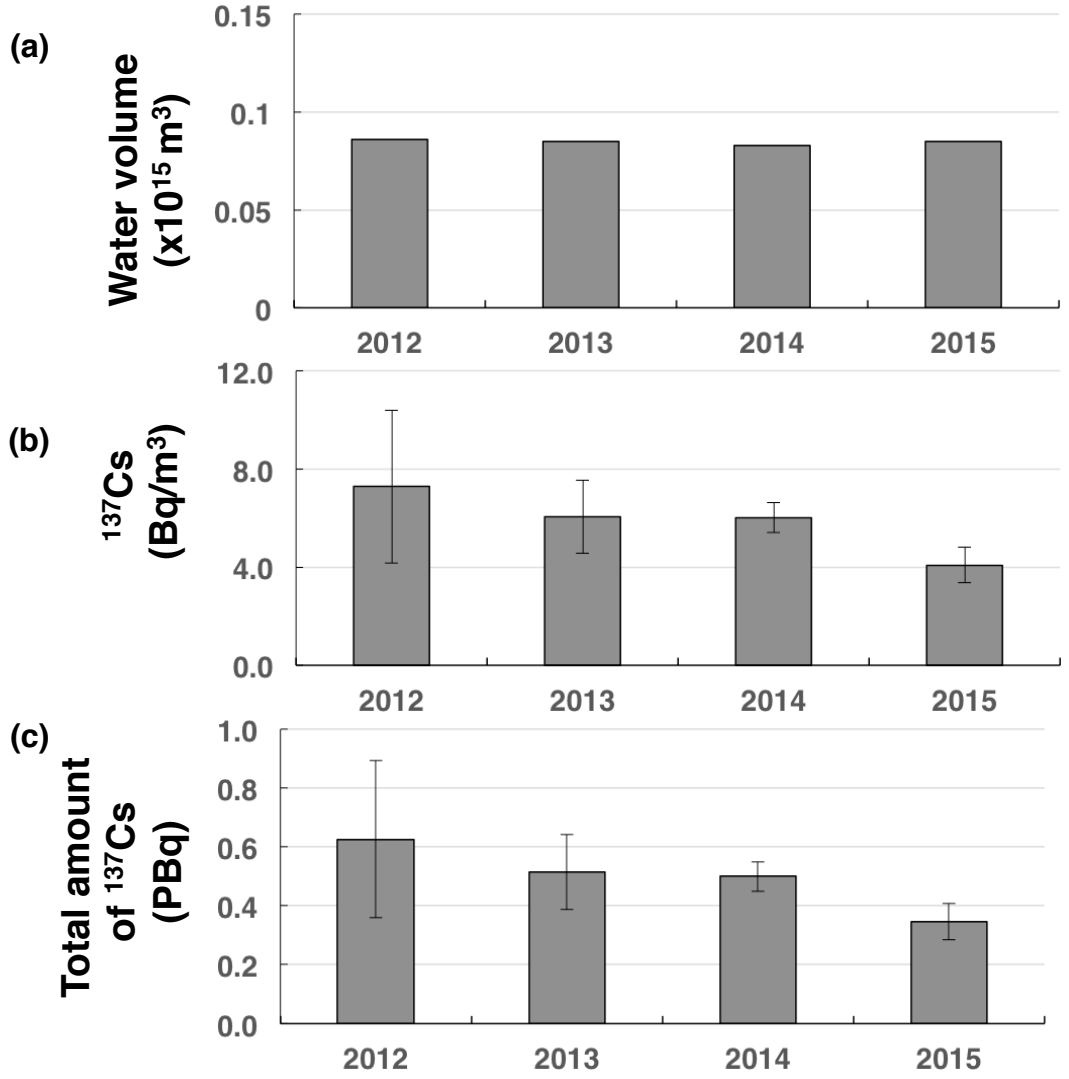
year to year variation of ^{137}Cs in STMW



Kaeriyama et al., Goldschmidt2016Yokohama

Southward intrusion with mode water

^{137}Cs in STMW in the area south of Japan islands had been decreased from 0.63 PBq in 2012 to 0.35 PBq in 2015



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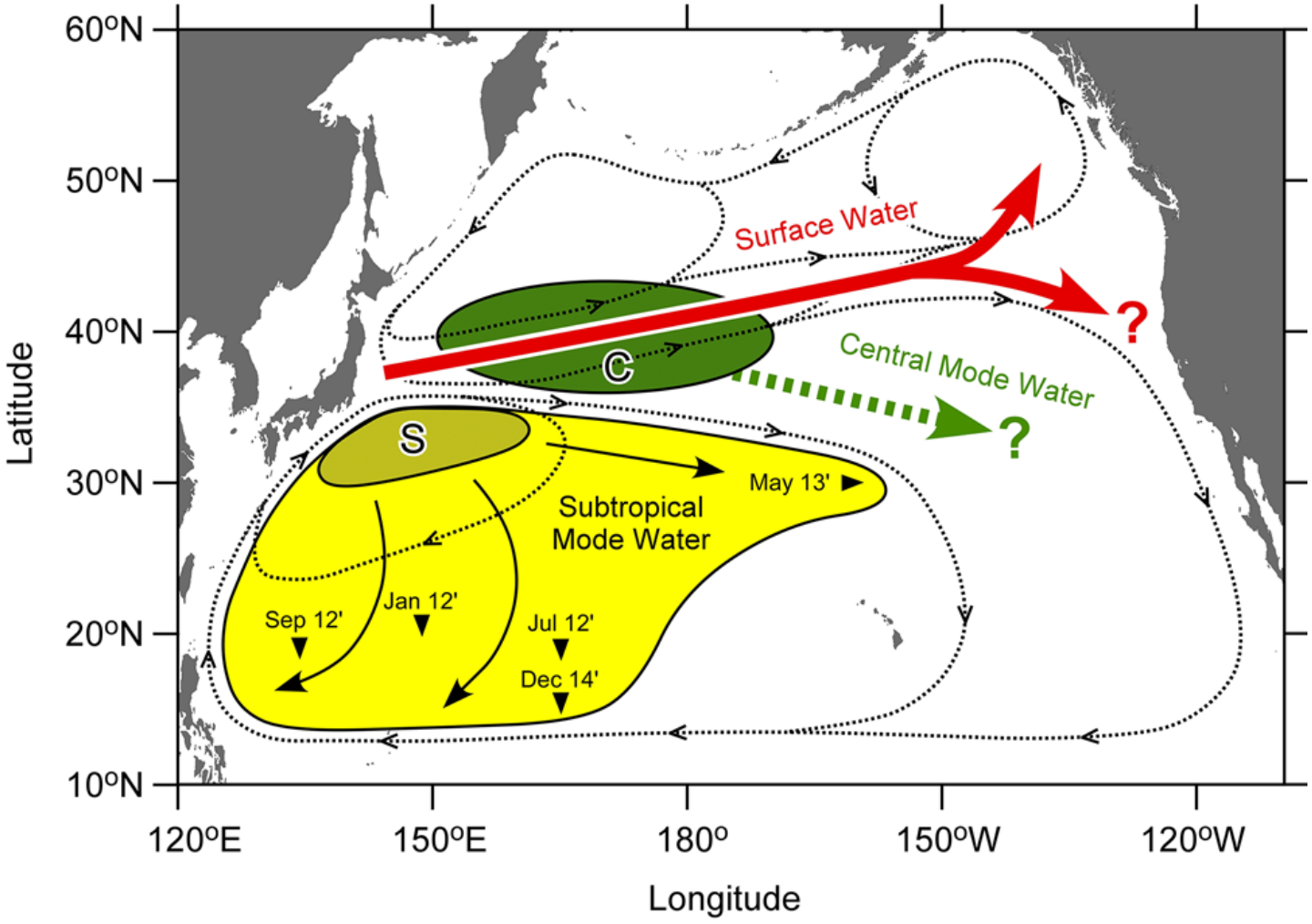
Southward intrusion with mode water

The updated schematic view of FNPP-derived radio active cesium in mode waters

Kumamoto et al. (2016): J. Radioanal. Nucl. Chem.



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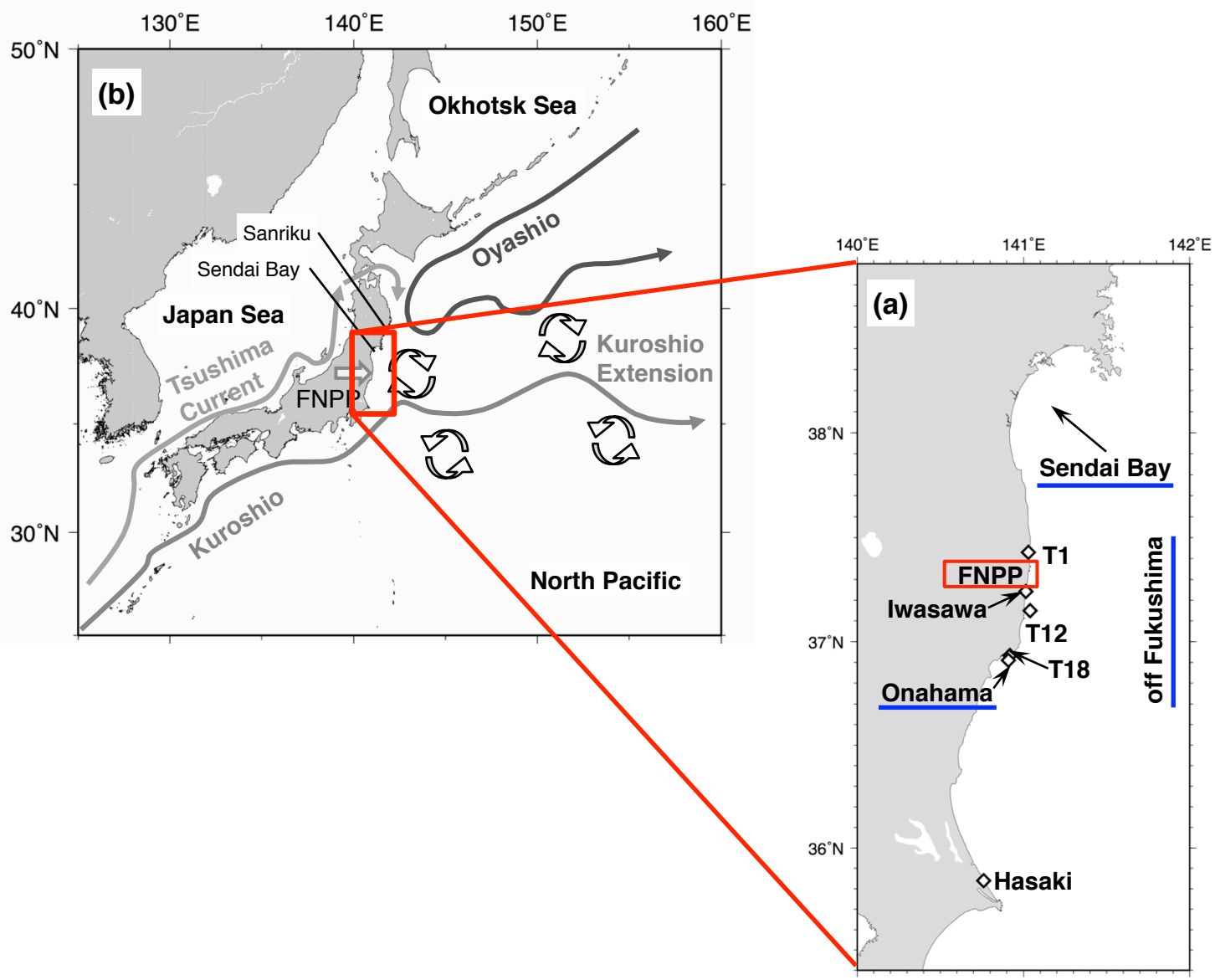
coastal area off the FNPP



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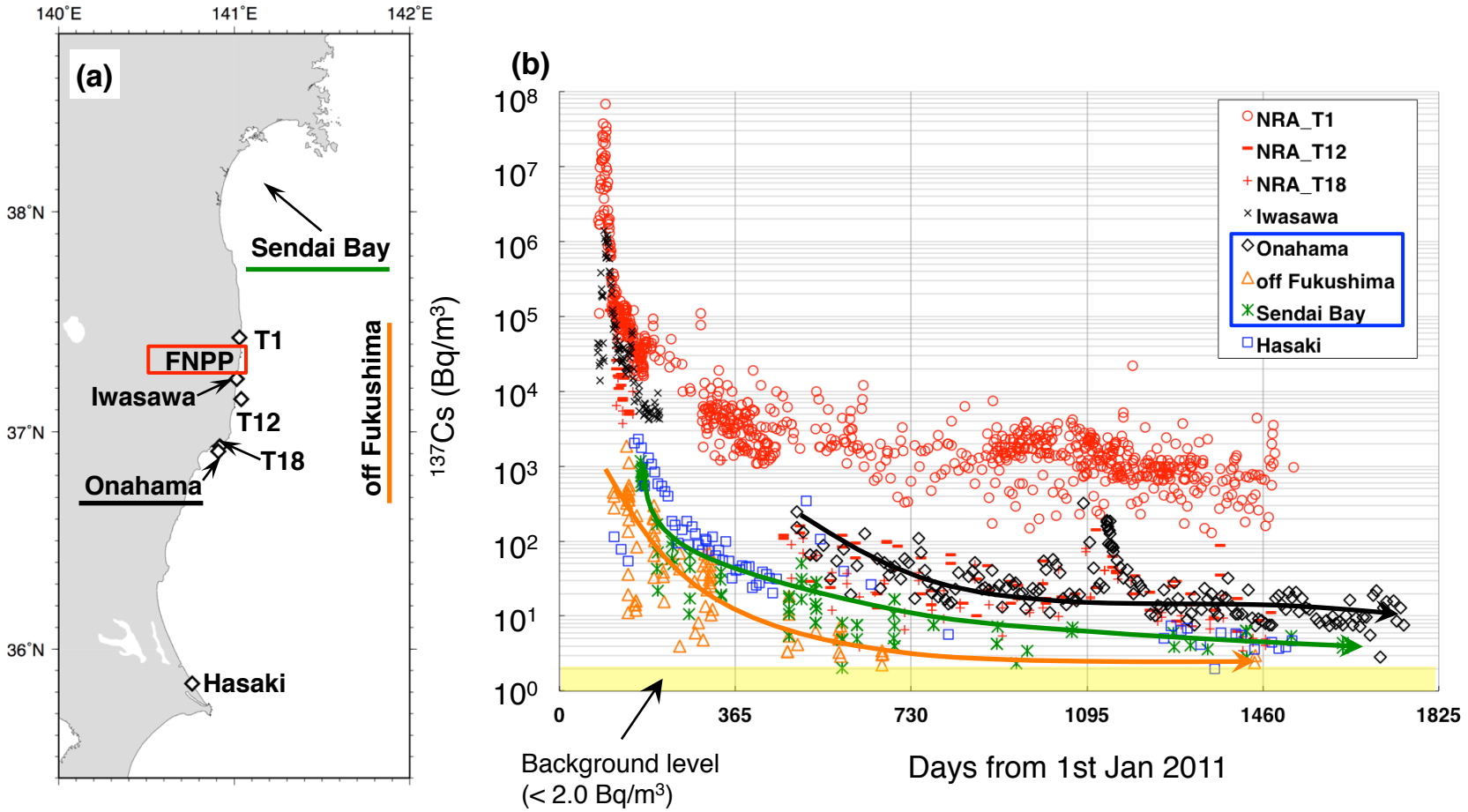
coastal area off the FNPP



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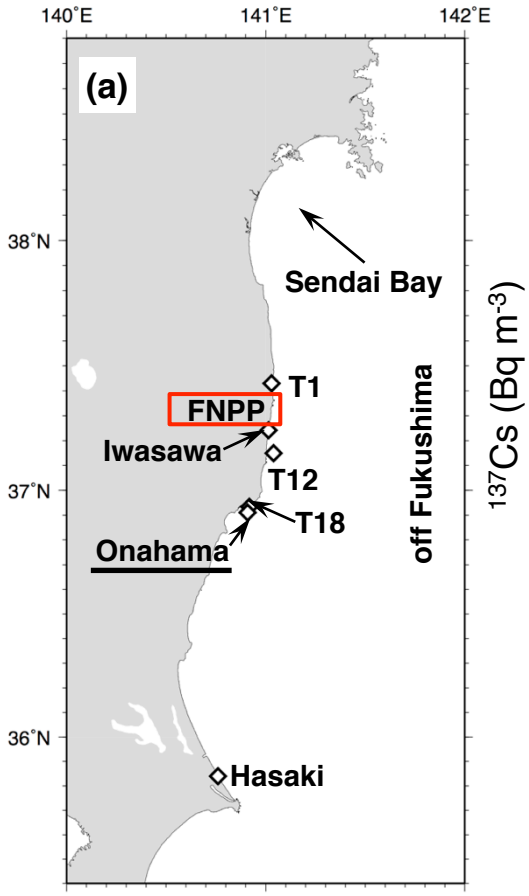
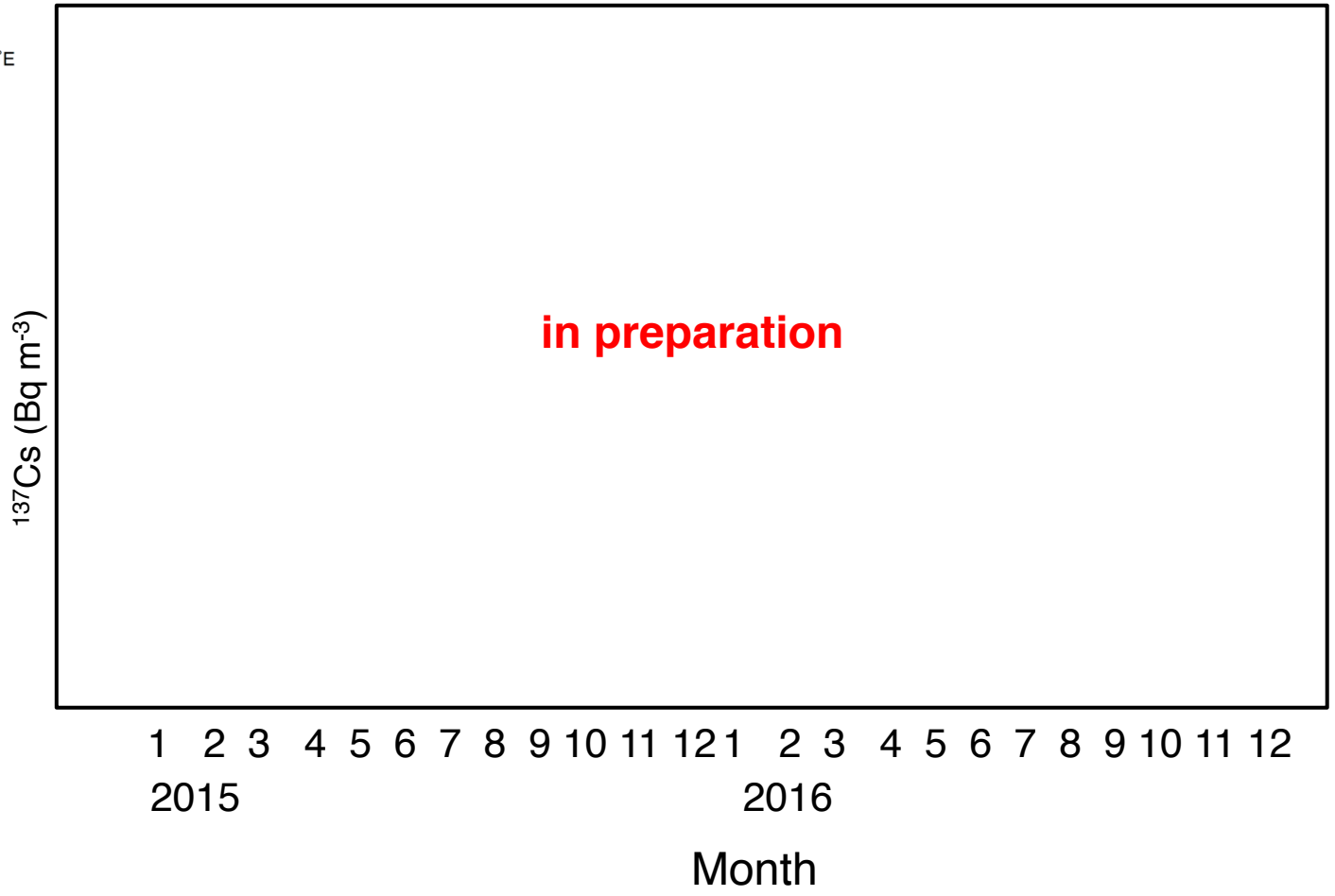
Onahama station (south of FNPP)





Kaeriyama (unpublished)

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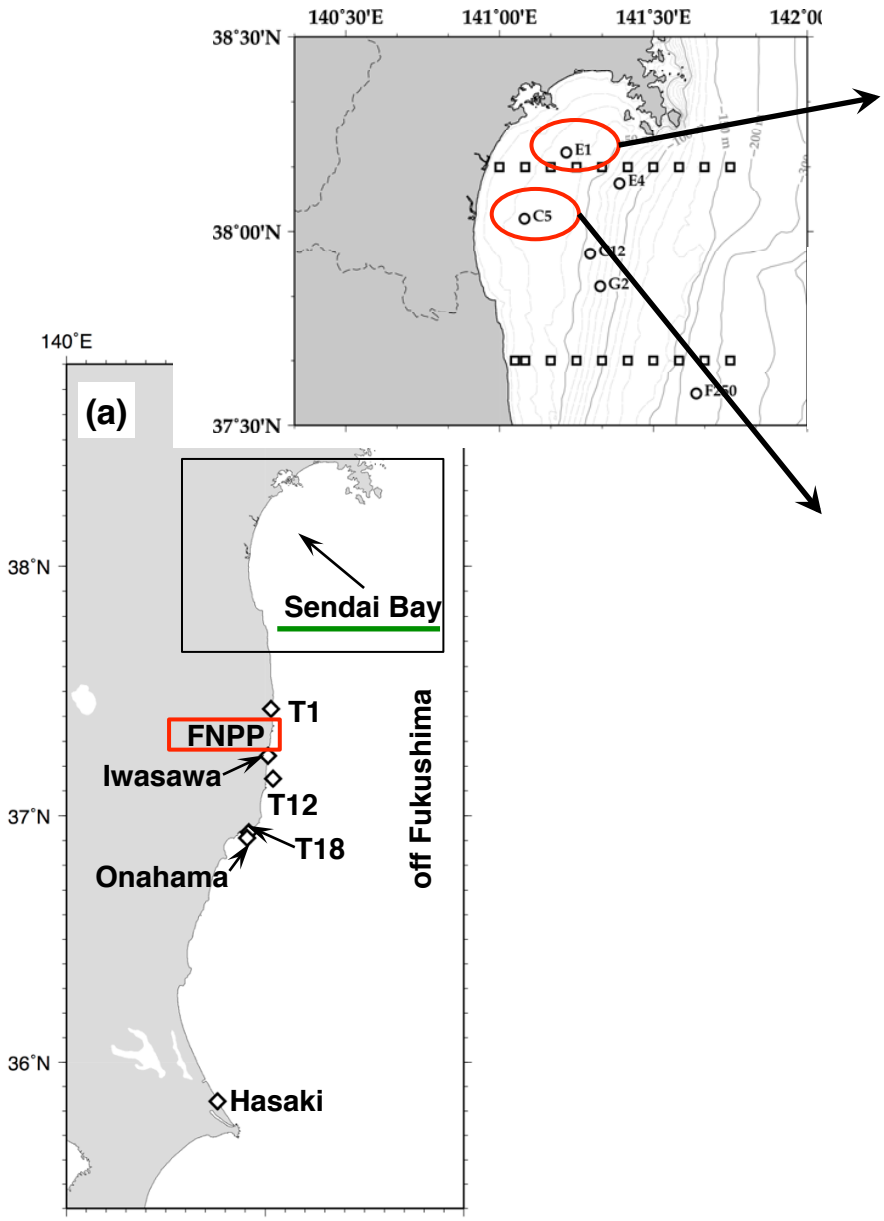
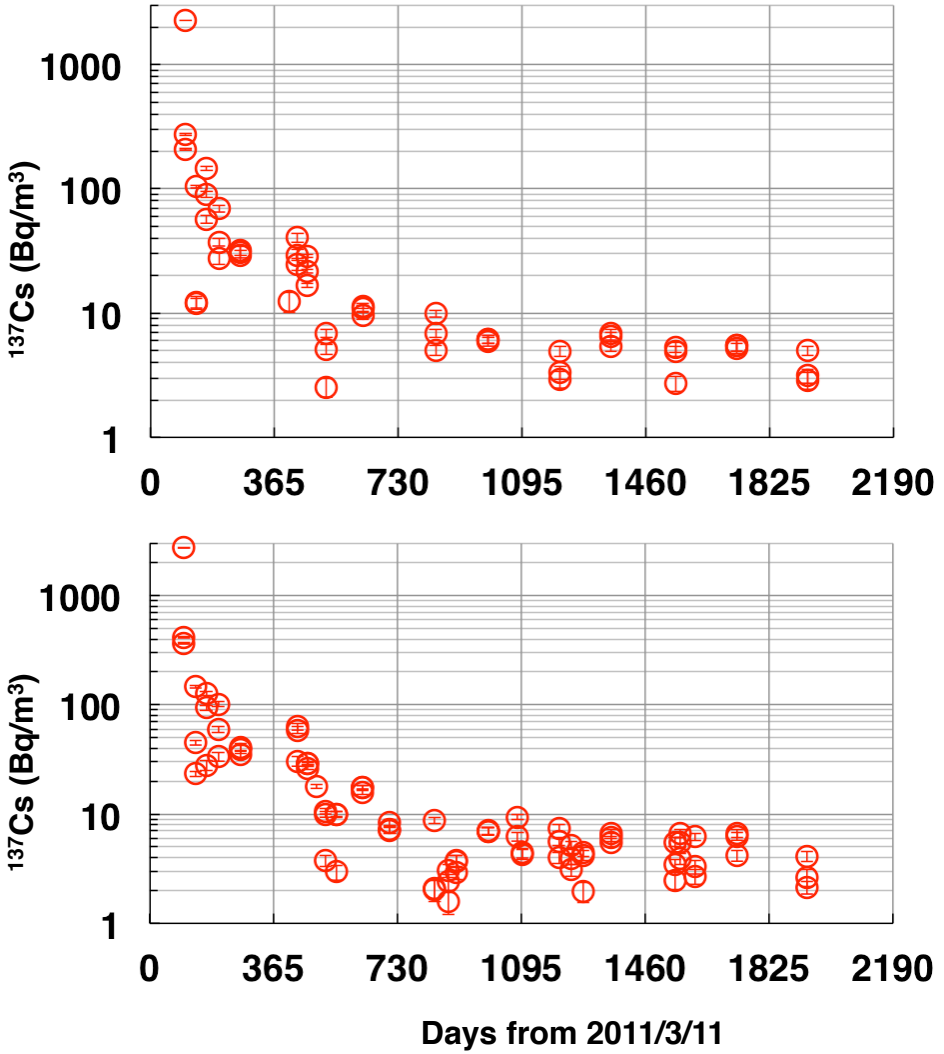
Sendai Bay (north of FNPP)





updated from Kaeriyama et al. (2015)

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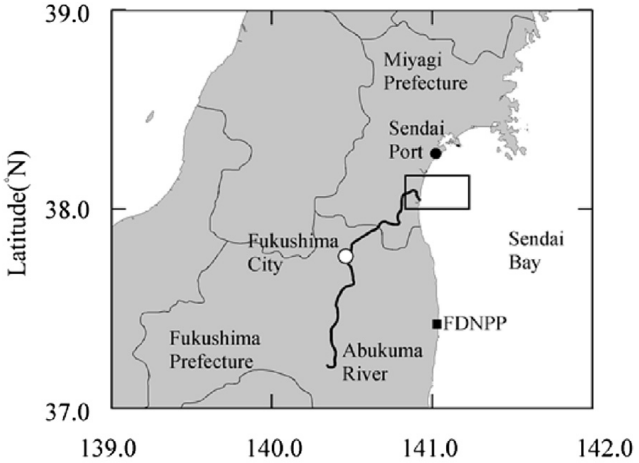
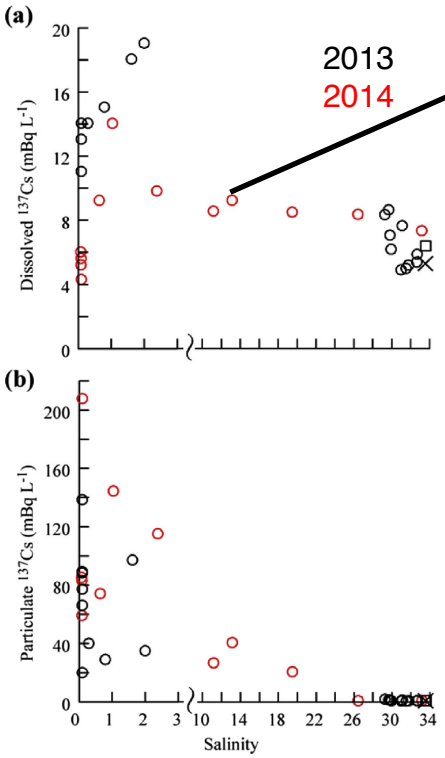
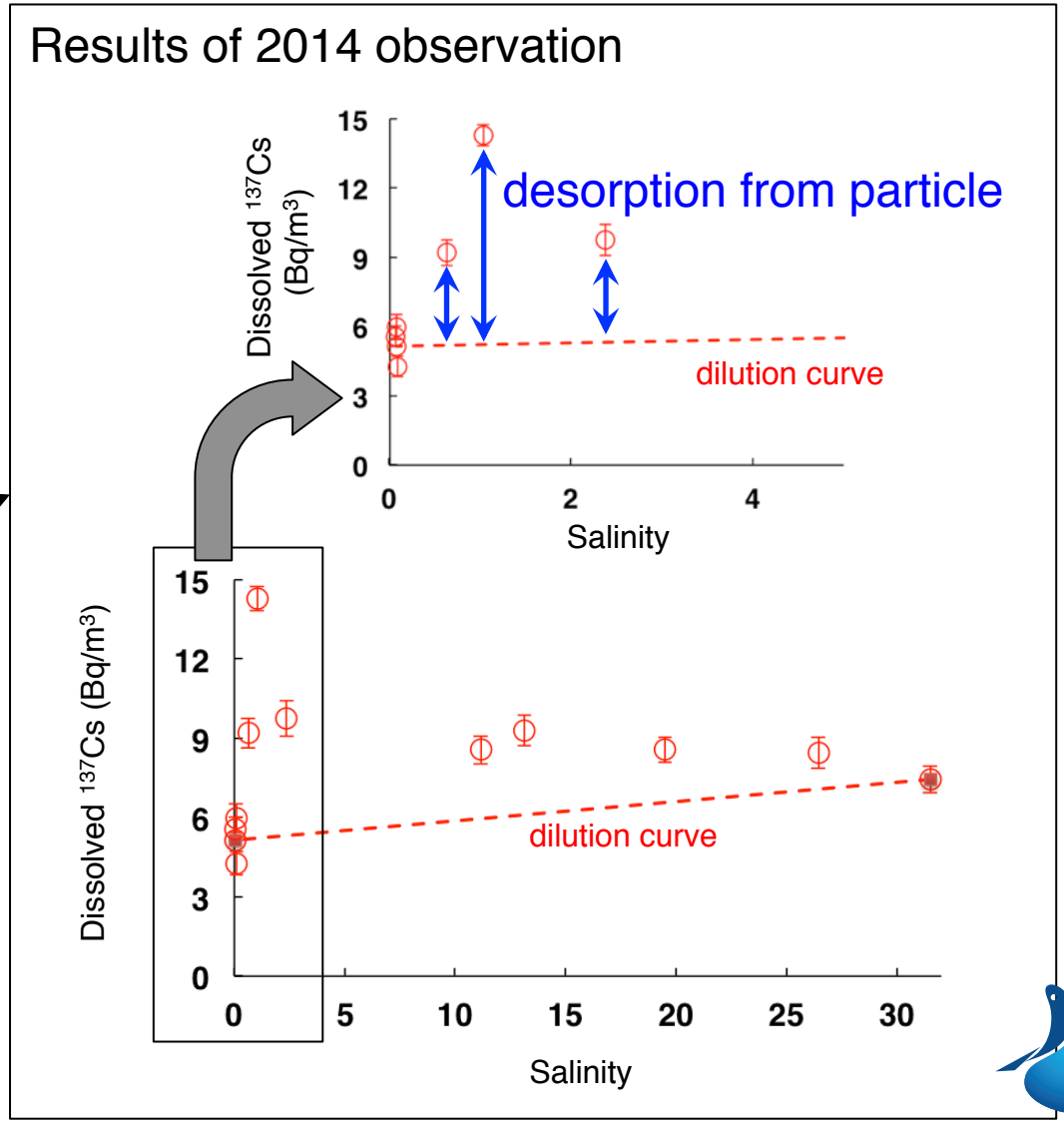
Future perspective (river input)

Possible continuous source of radioactive Cs from land through river







Kakehi et al. (2016)

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Conclusion

Oceanic dispersion of Fukushima-derived radiocesium had been well documented during five years from the accident

key features

1. eastward dispersion in surface water north area of Kuroshio Extension
2. subsurface intrusion with mode waters

Future perspective: the destination of Fukushima-derived radiocesium in mode waters

Coastal area off Fukushima

The concentration of ^{137}Cs are still higher than those before accident has been declining, but continuous monitoring should be done

Future perspective: Small but continuous input of Fukushima-derived radiocesium through river should be continuously studied, such as how many, dissolved and/or particulate, bioavailable particulate, and so on.

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Thank you for your attention

References

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Kaeriyama, H. (in press) Oceanic dispersion of Fukushima-derived radioactive cesium: a review. *Fish. Oceanogr.*

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