Kuroshio Variability in the western North Pacific

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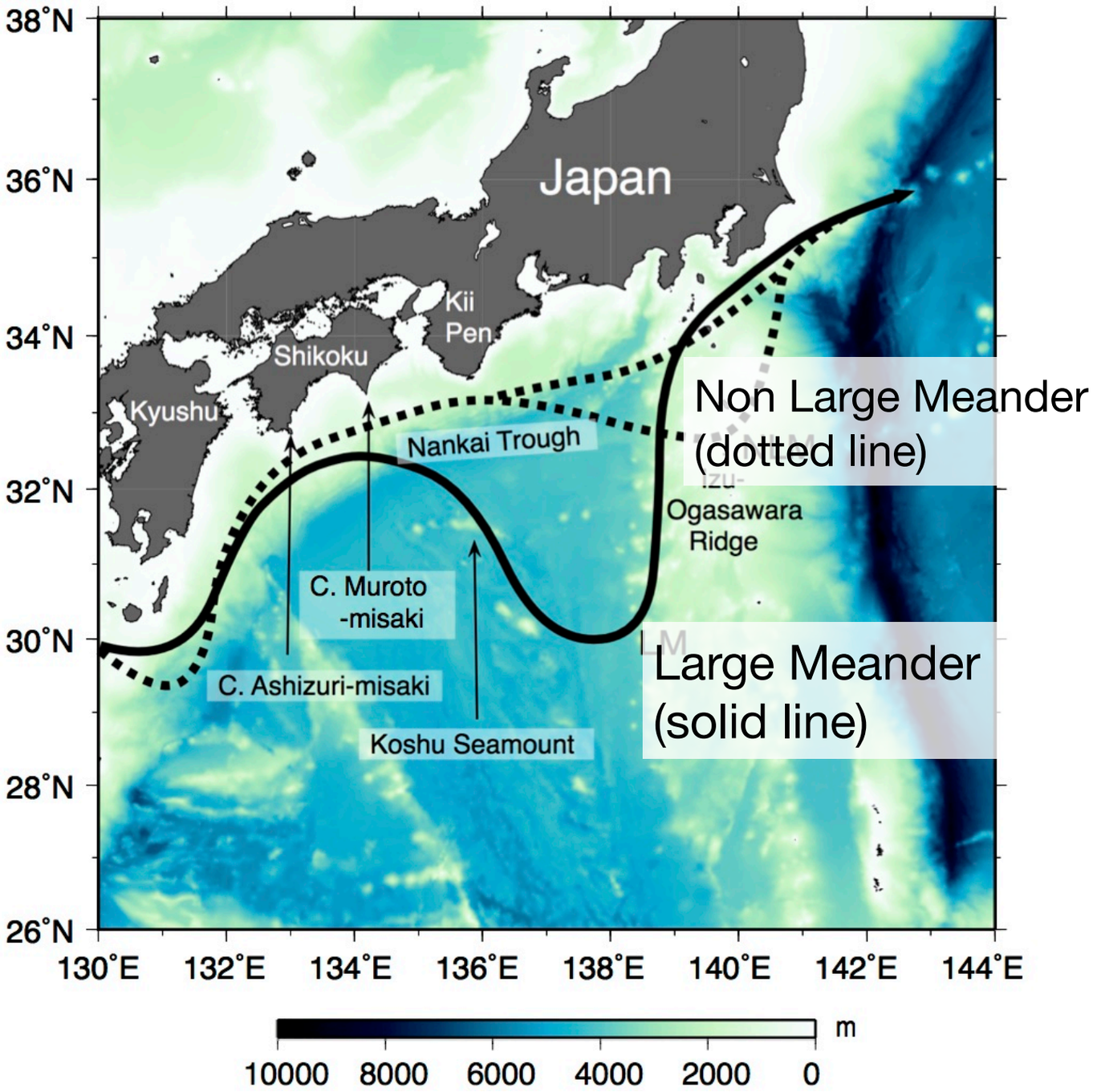
Introduction

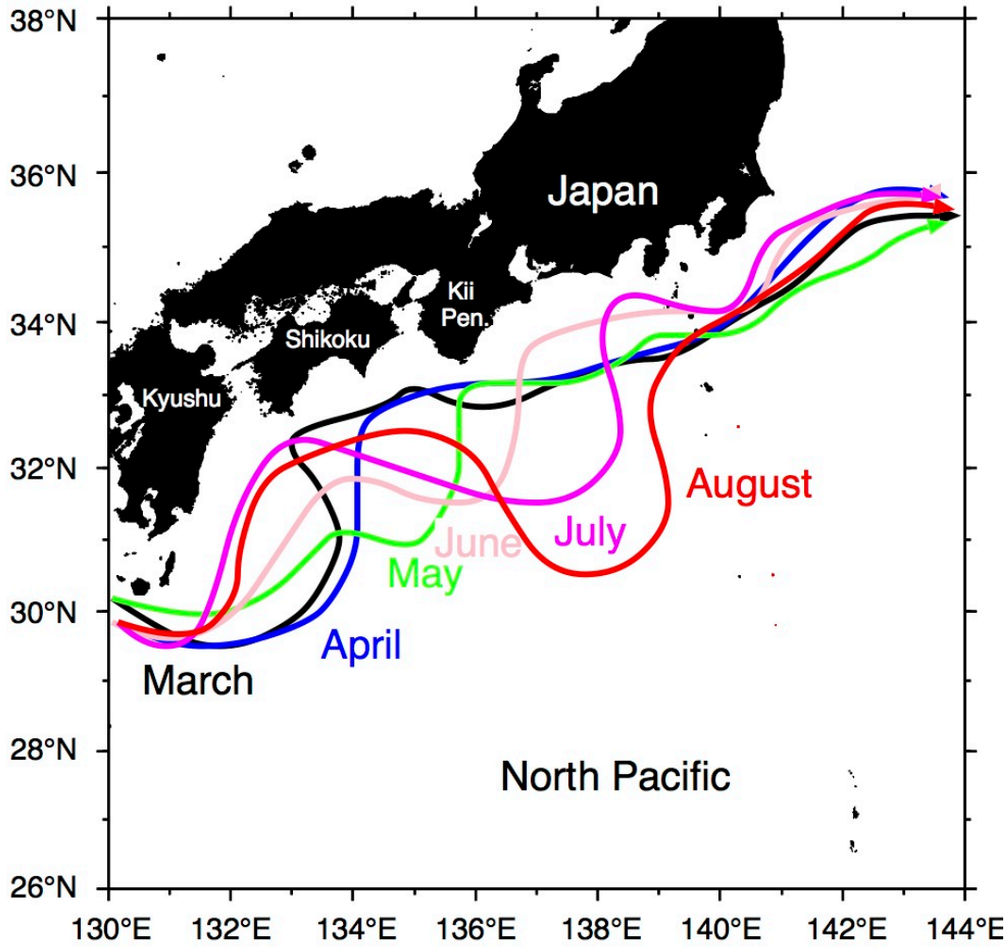
Two stable Kuroshio paths south of Japan



Kawabe (1985, 1995), Nagano et al. (2018)

Propagation of small meander and development to LM

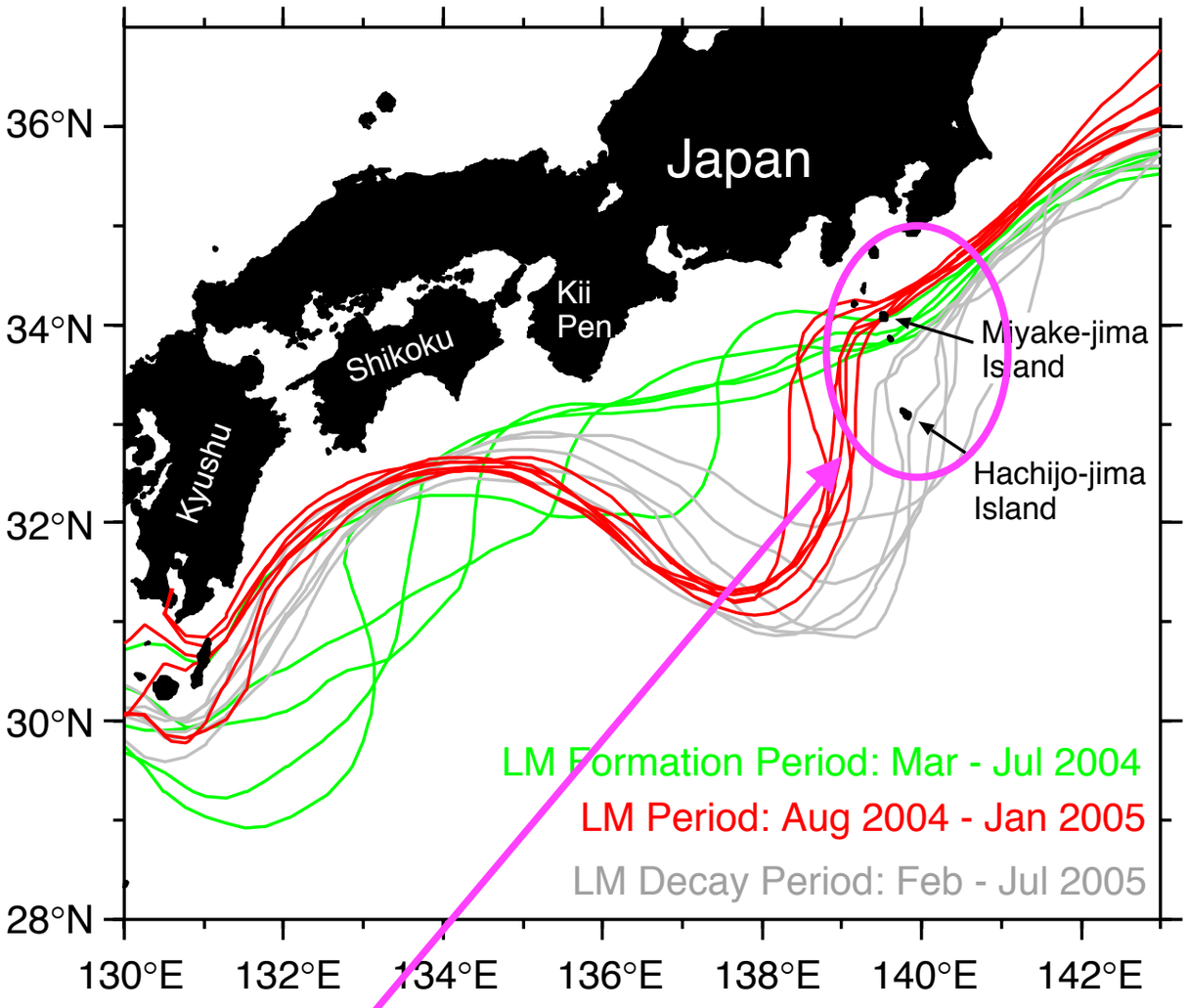
March-August 2004



Nagano et al. (2018)

Further classification of Kuroshio LM paths

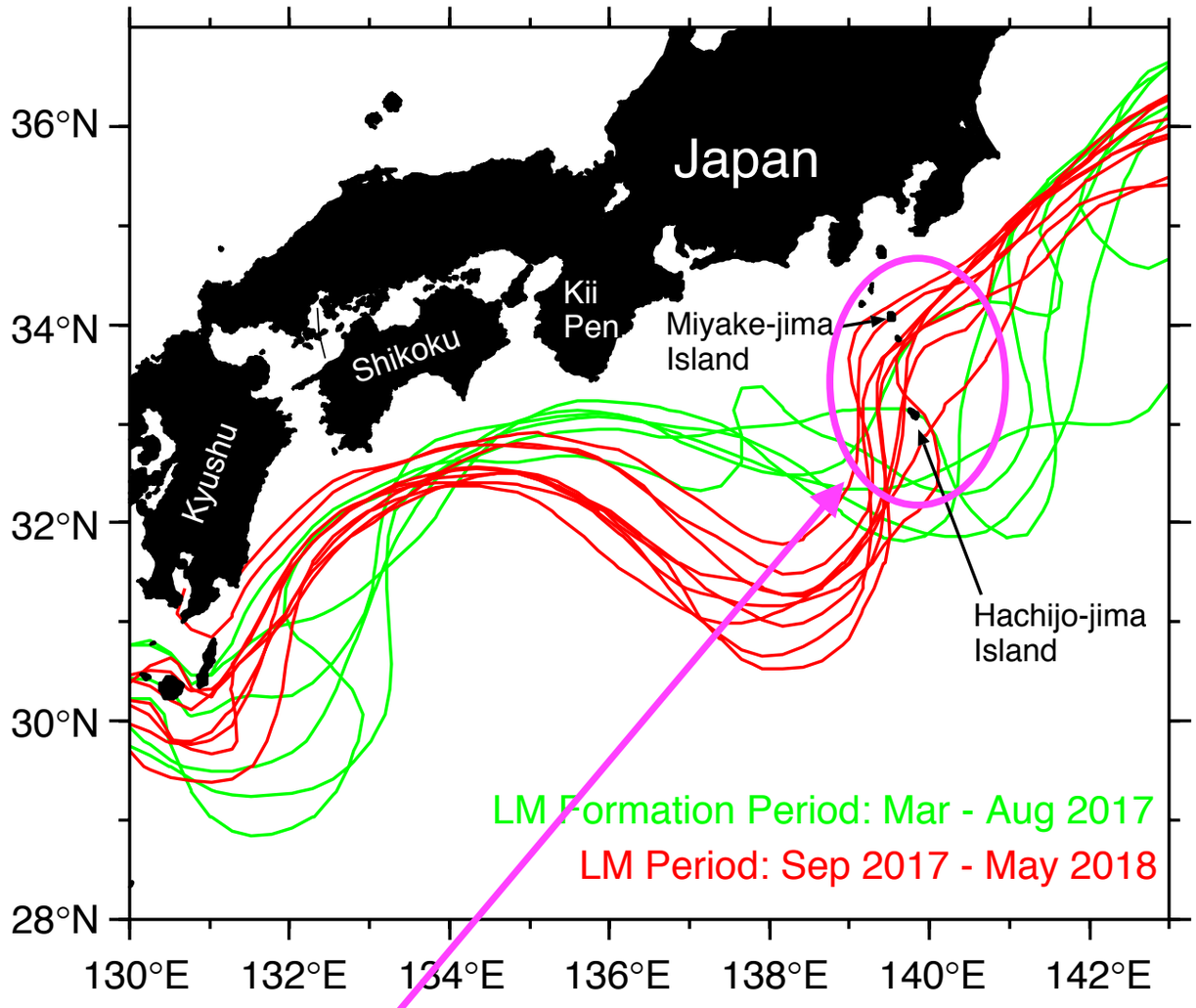
Type 1 (2004–2005 LM)



Stably flows at the channel north of Miyake-jima Island

Stable type LM

Type 2 (2017–present LM)



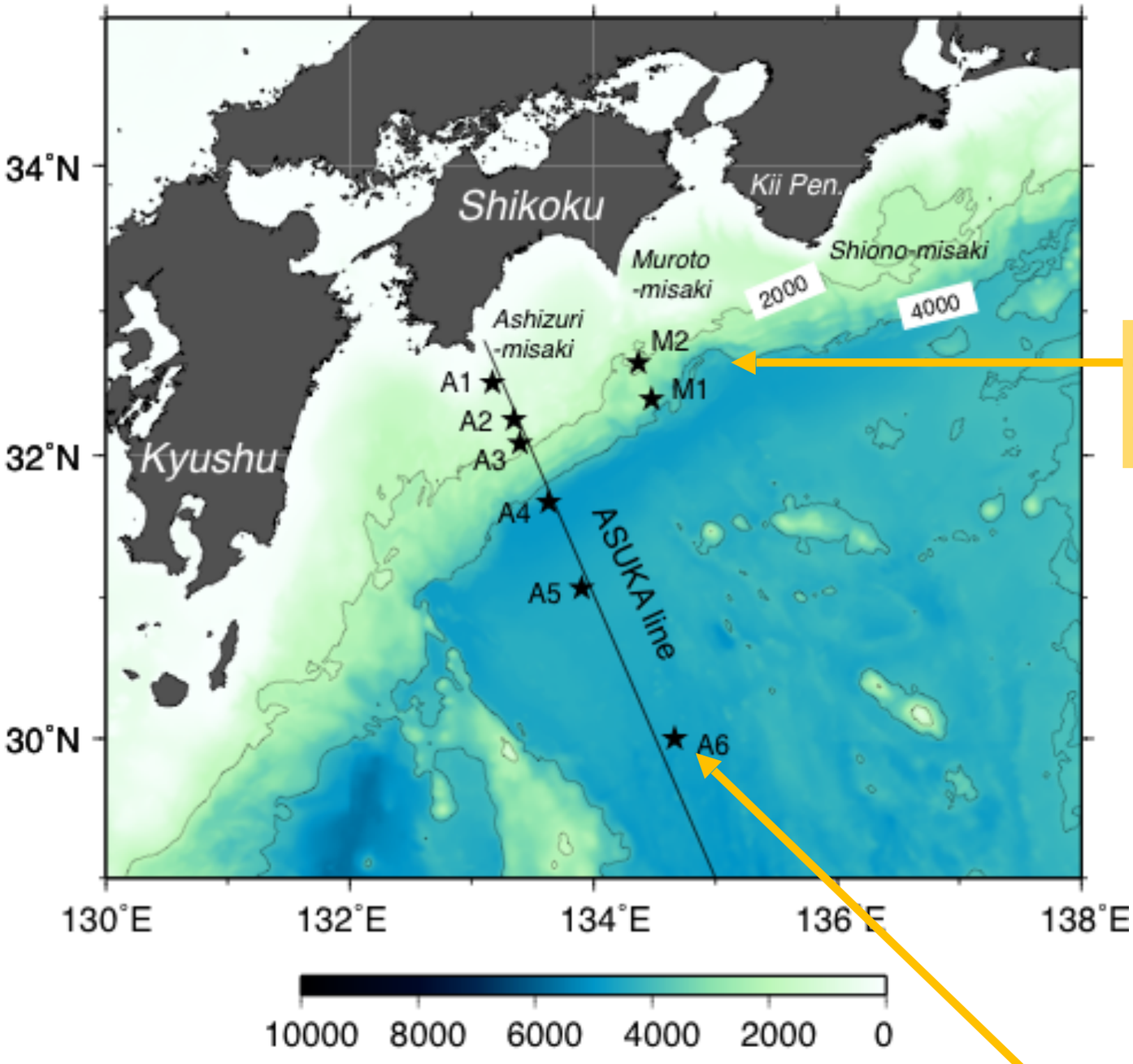
Unstably flows between Miyake-jima and Hachijo-jima Islands and with larger zonal scale. 1981-1984 LM is similar.

Unstable type LM

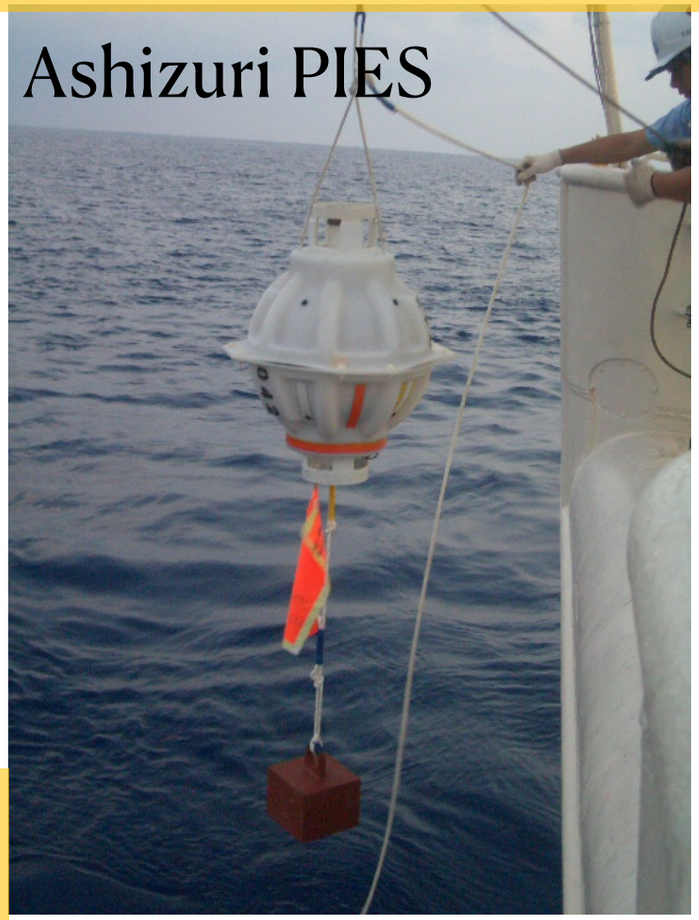
Nagano et al. (2019)

Bottom Pressure Data and Observations off Shikoku

Nagano et al. (2018)



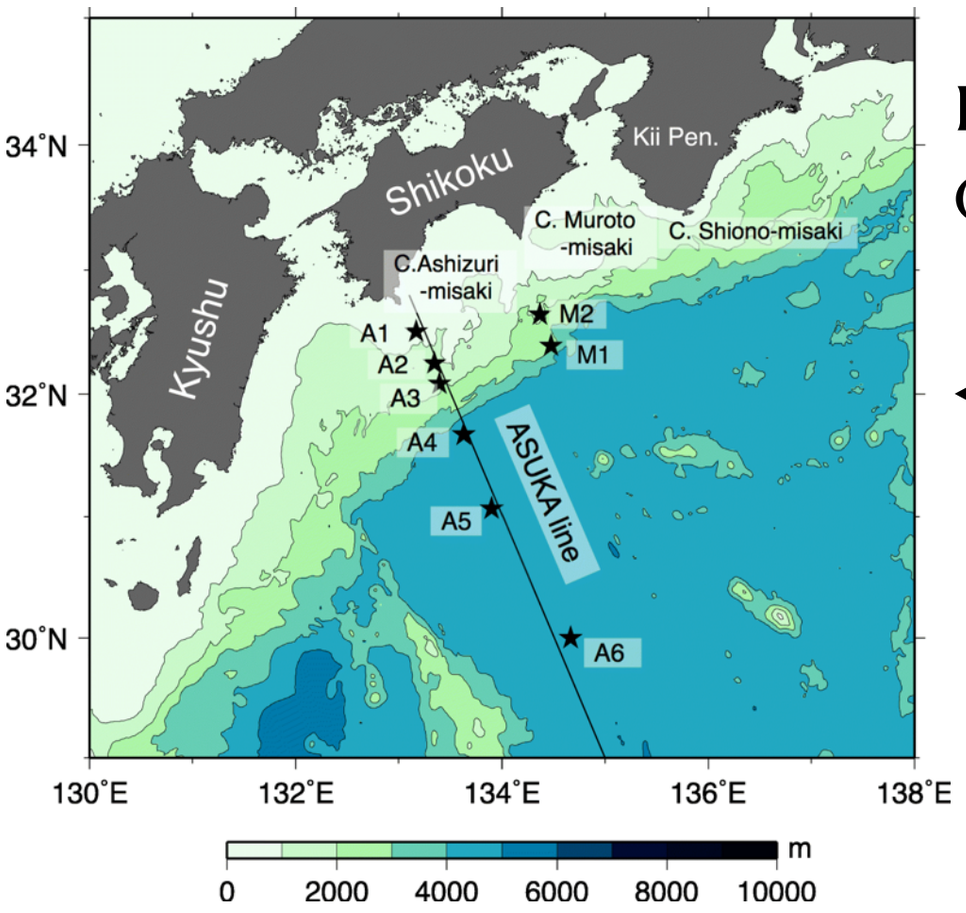
Ocean Bottom Pressure (OBP)
Observation: Jan 2004-Dec 2006



Inverted echo sounder with pressure gauge (PIES) observation: Jul 2004-Oct 2006

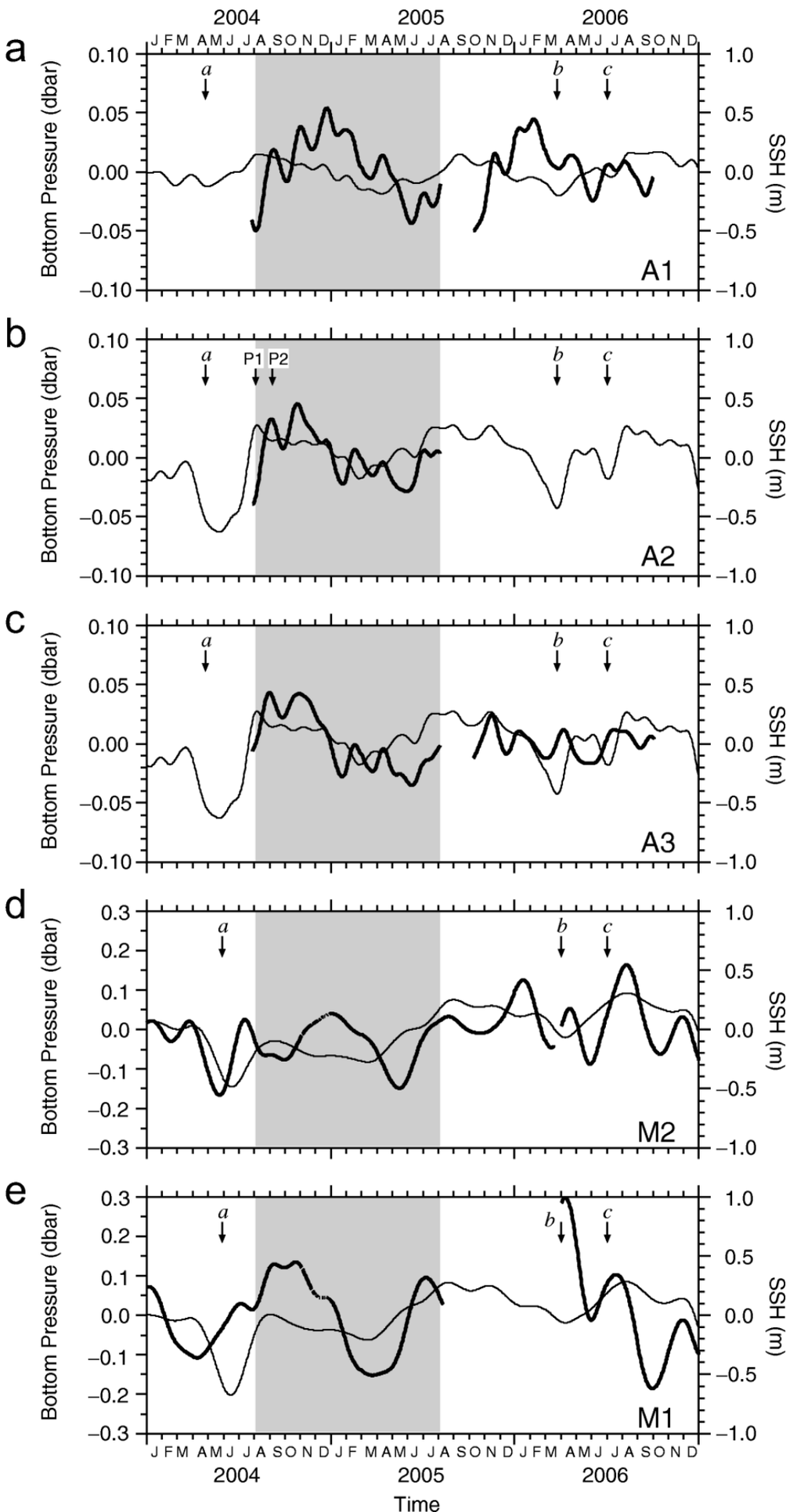
Bottom pressure (BP) change associated with the formation of the 2004—2005 LM path

Nagano et al. (2018)

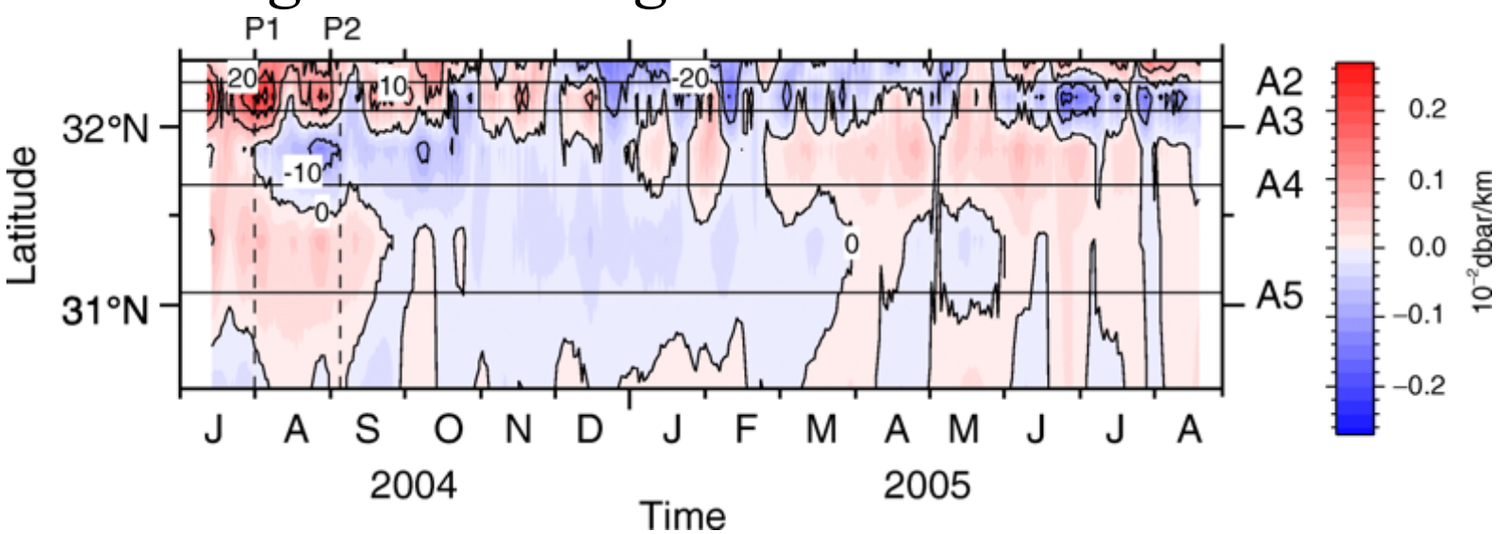


PIES and OBP locations

BP (thick line) and SSH (thin line)



Pressure gradient along the ASUKA line



Change of GEM-based potential temperature associated with BP increase

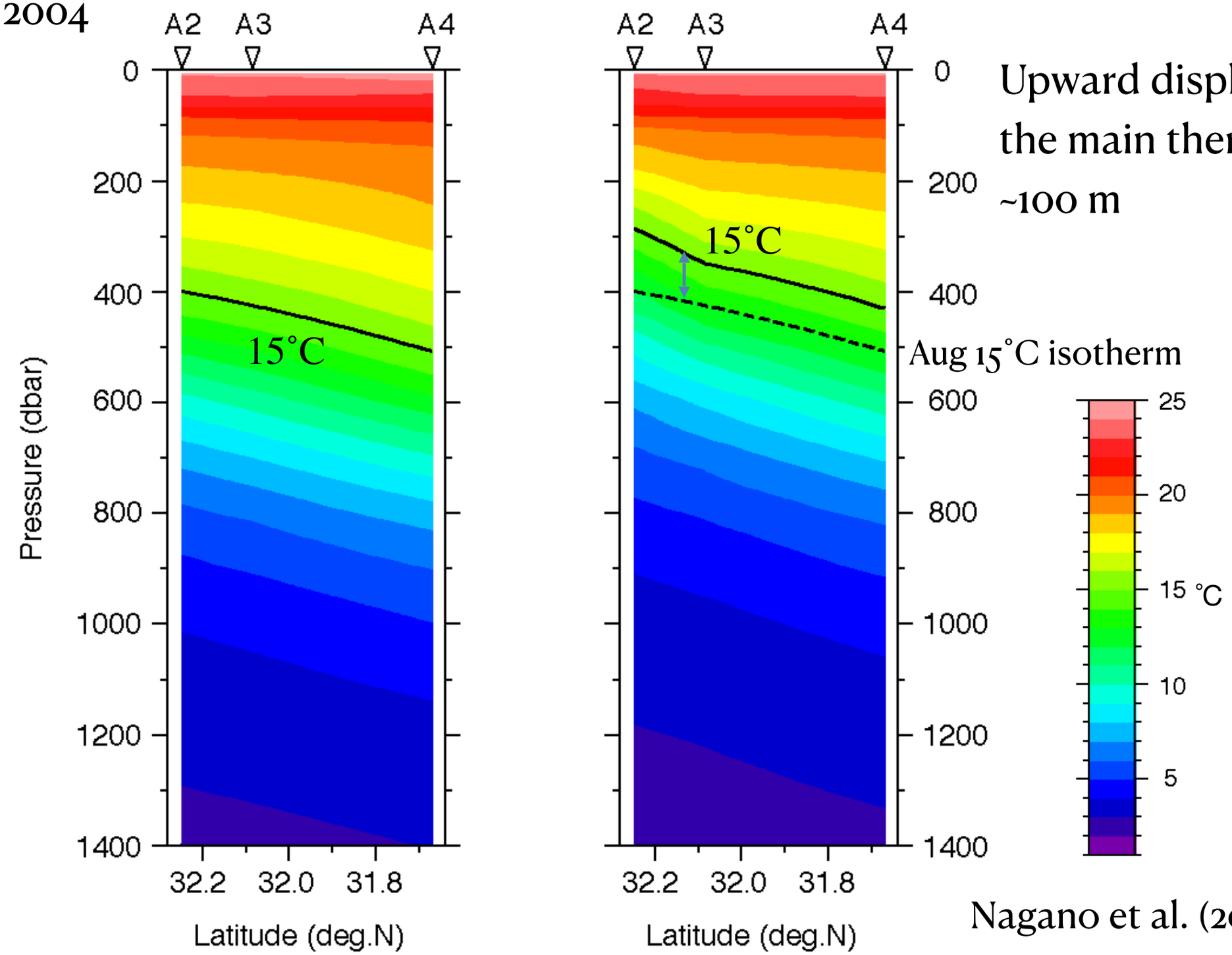
Just after LM formation

SSH is maximal

Aug 1, 2004

BP is maximal

Sep. 5, 2004



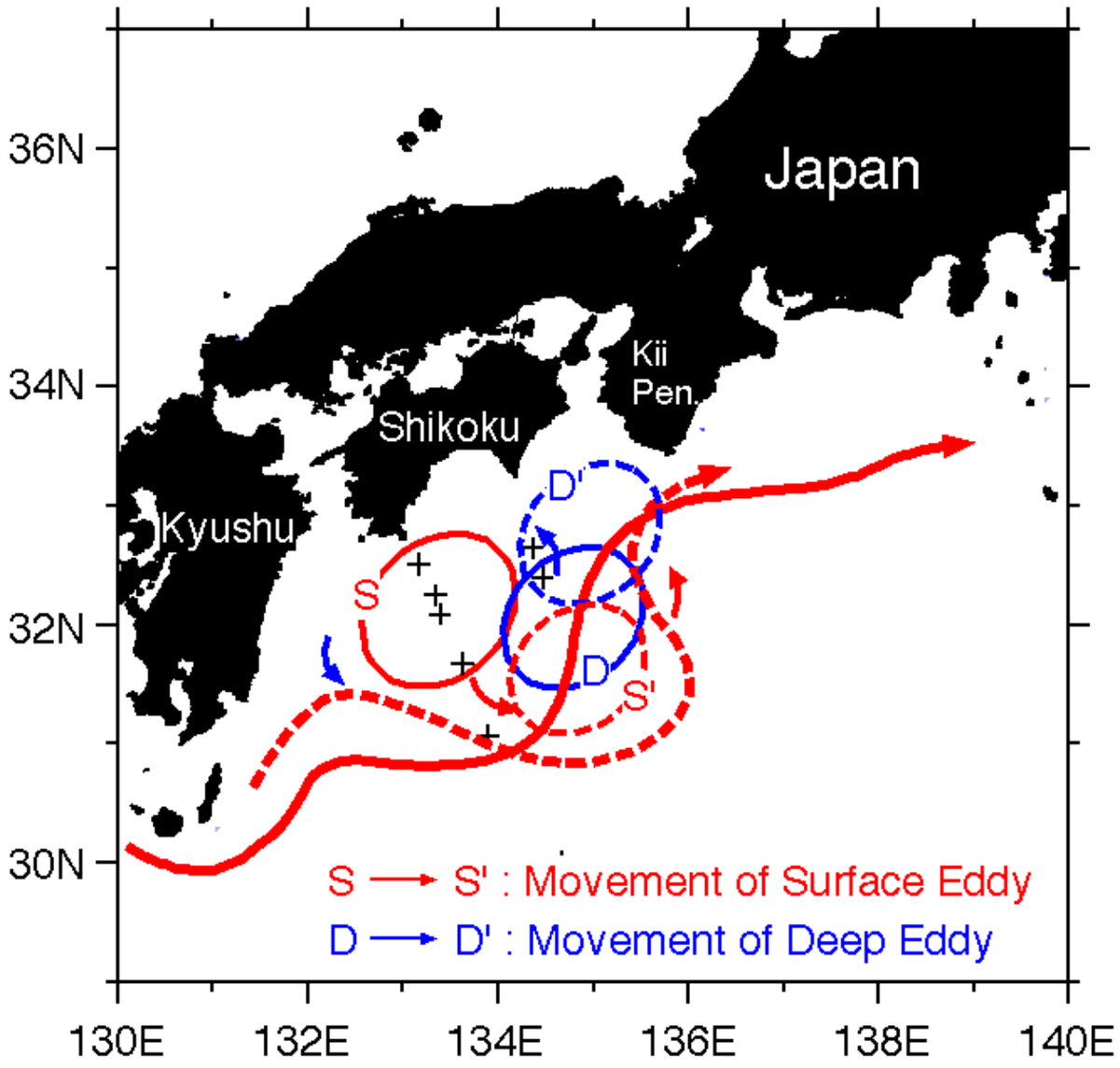
Upward displacement of the main thermocline by ~100 m

Nagano et al. (2018)

Implications from the BP data analysis of the 2004-2005 LM

Development of small meander to LM through baroclinic instability

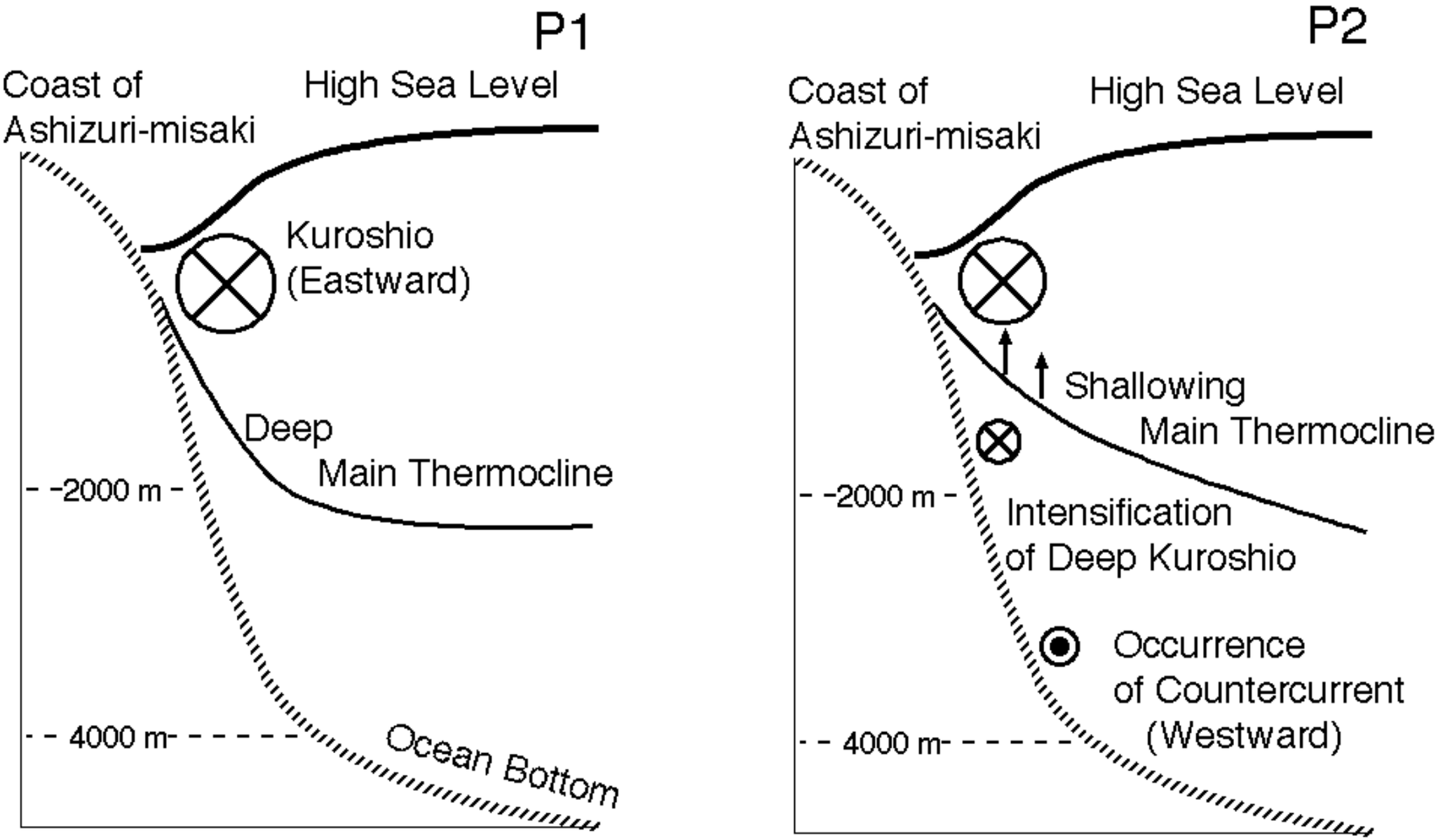
Deep BP depression leads surface eddy by ~2 month



Phase lead was confirmed by observations

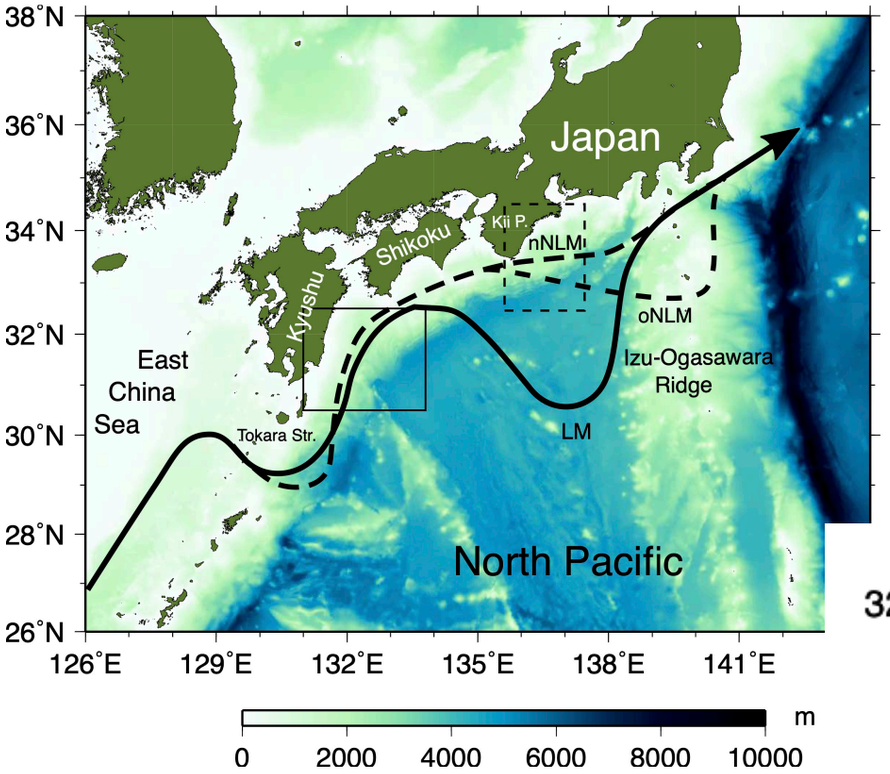
Nagano et al. (2018)

Stable type LM path seems to be steered by bottom slope, because BP and BP gradient is large just after LM formation. This is consistent with the stable LM path.

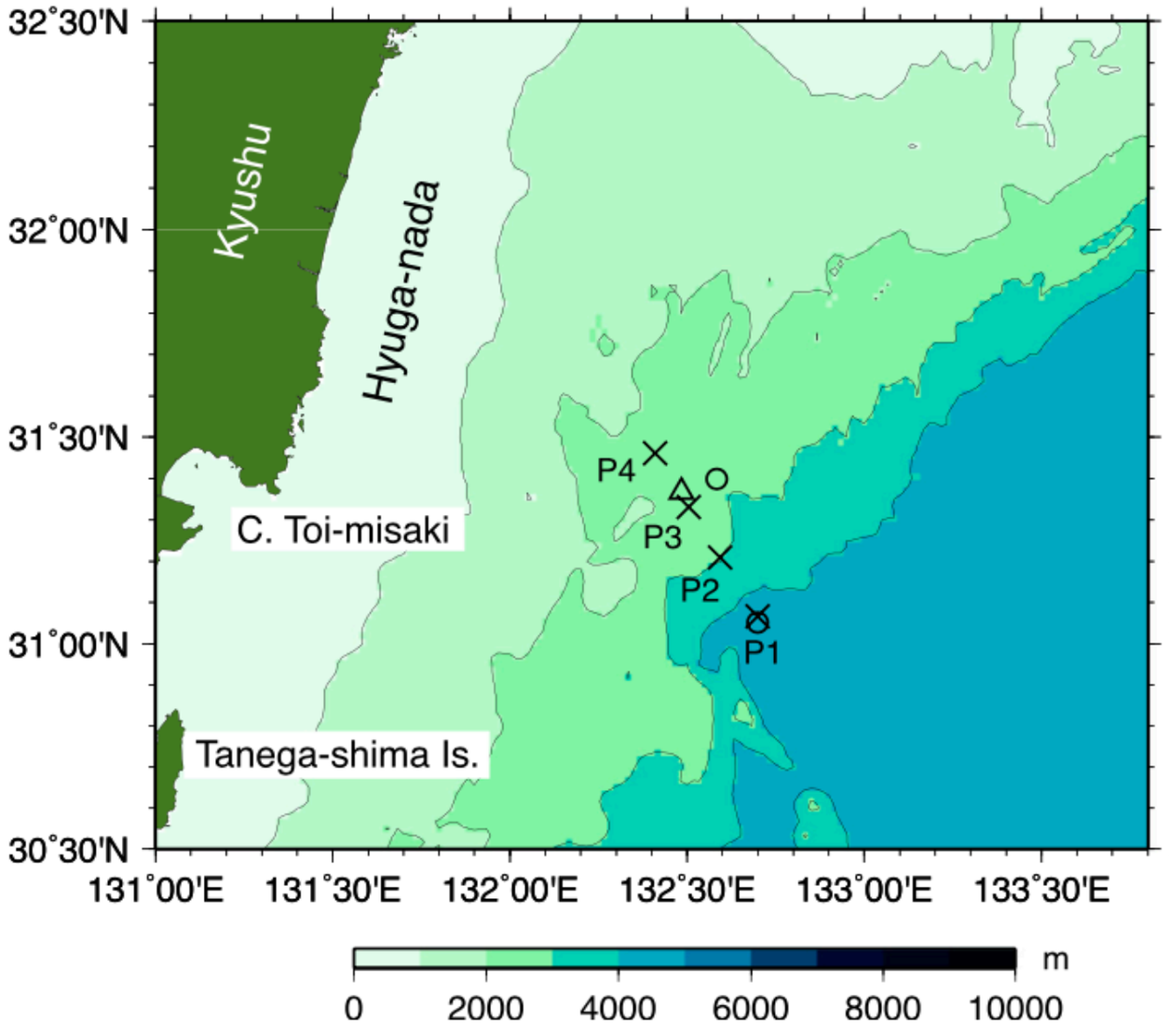


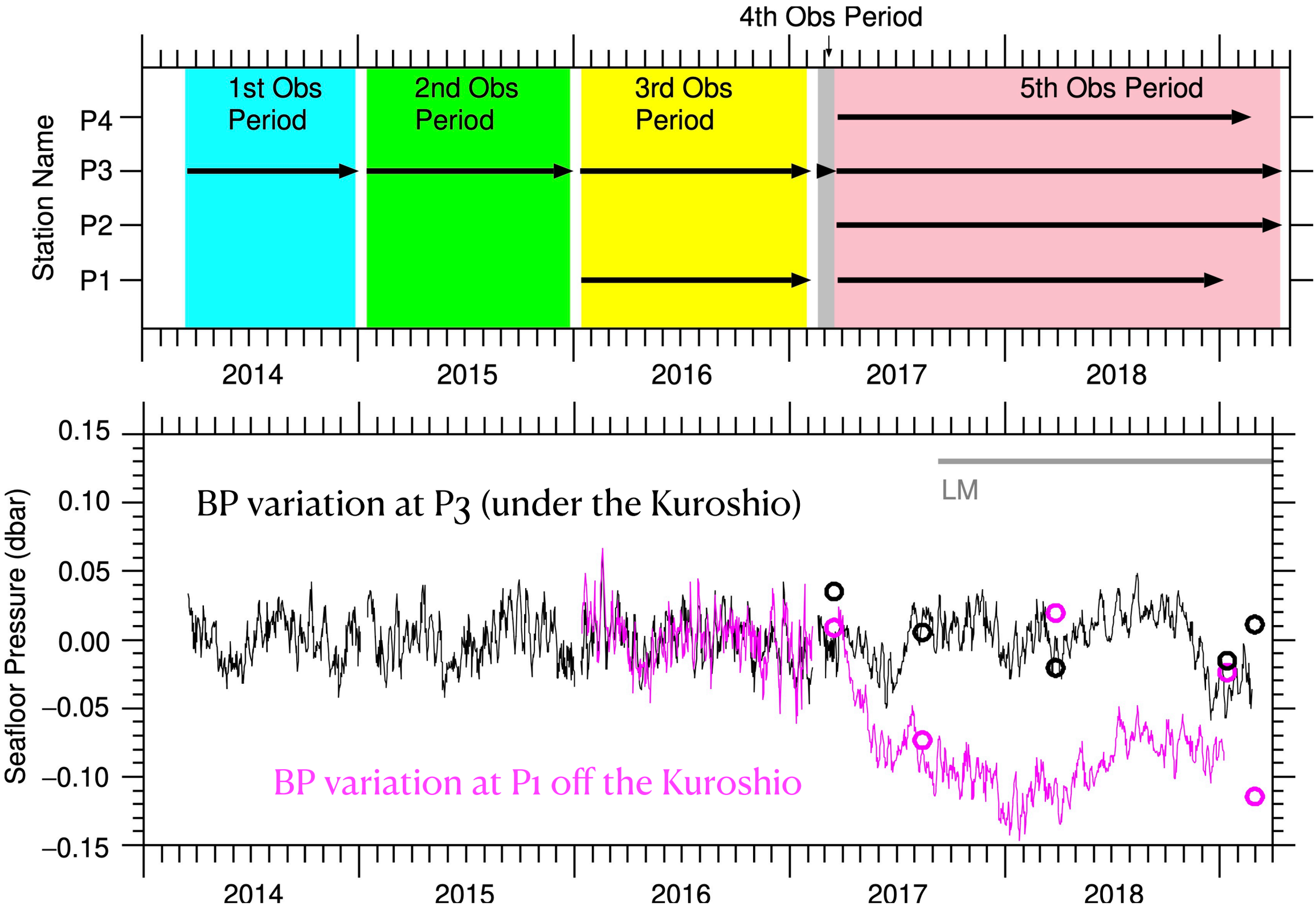
Nagano et al. (2018)

OBP observations off Kyushu during 2014-2019



Nagano et al. (2021)

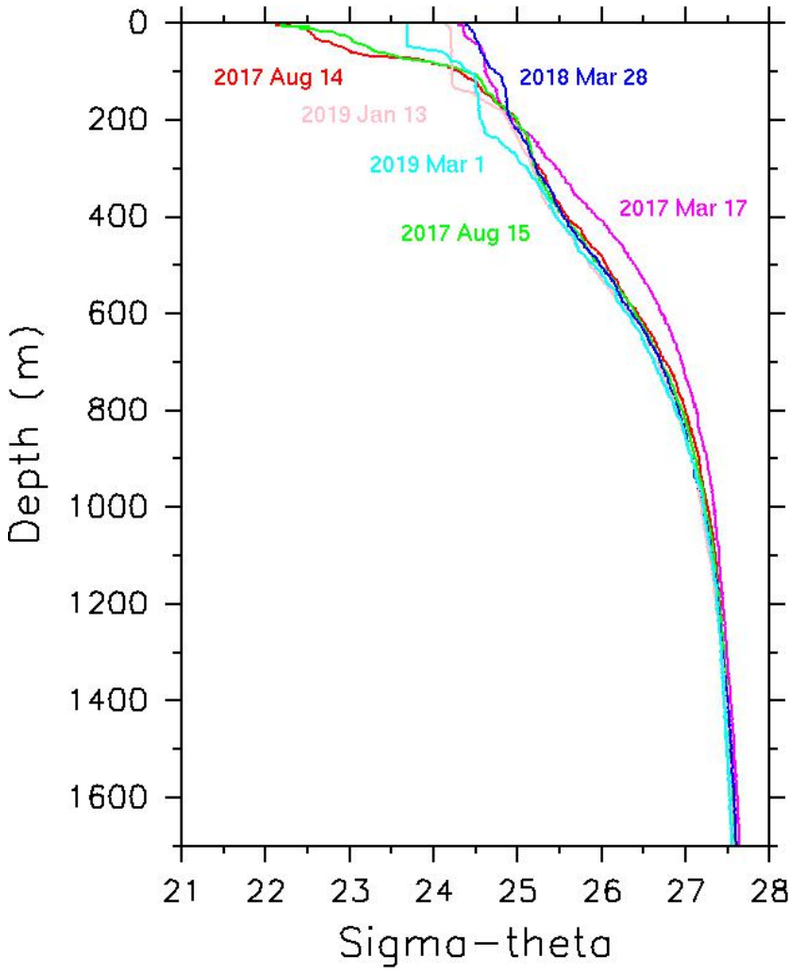




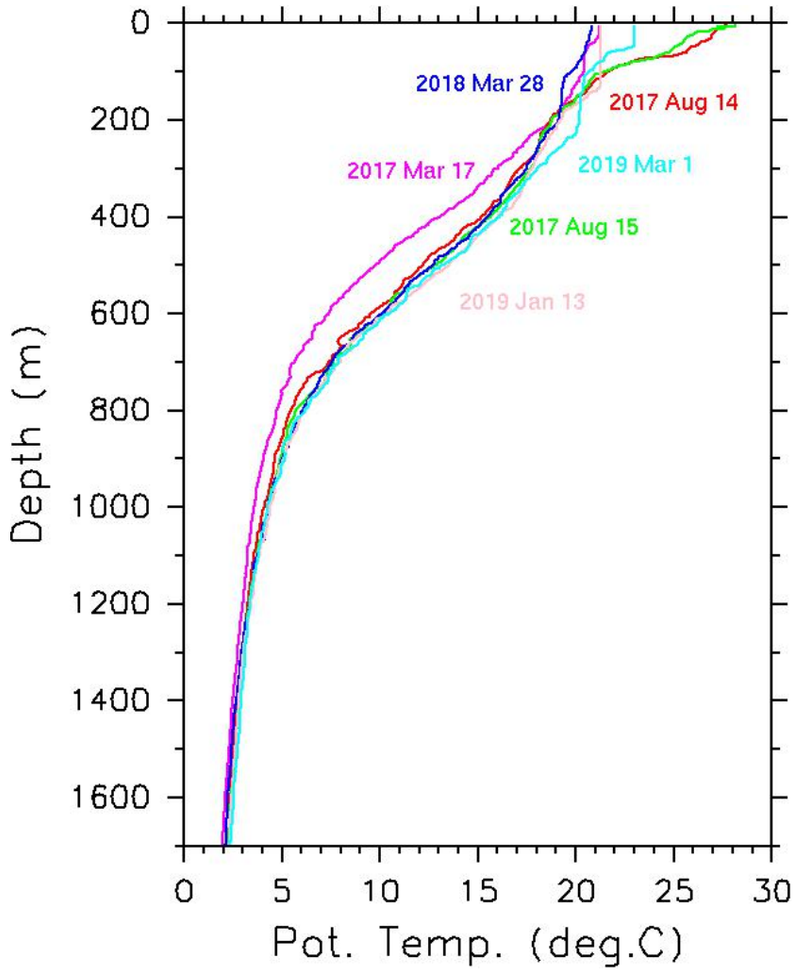
Nagano et al. (2021)

Changes in hydrographic profiles at Station P1 offshore the Kuroshio

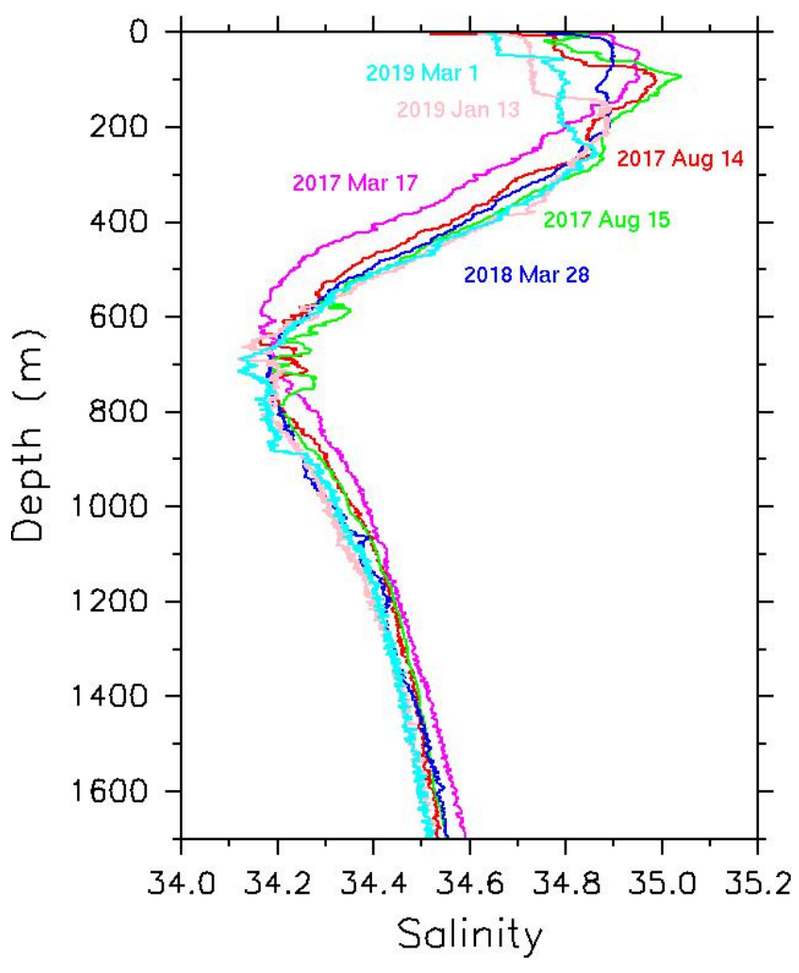
Pot. density σ_θ



Pot. temperature θ



Salinity



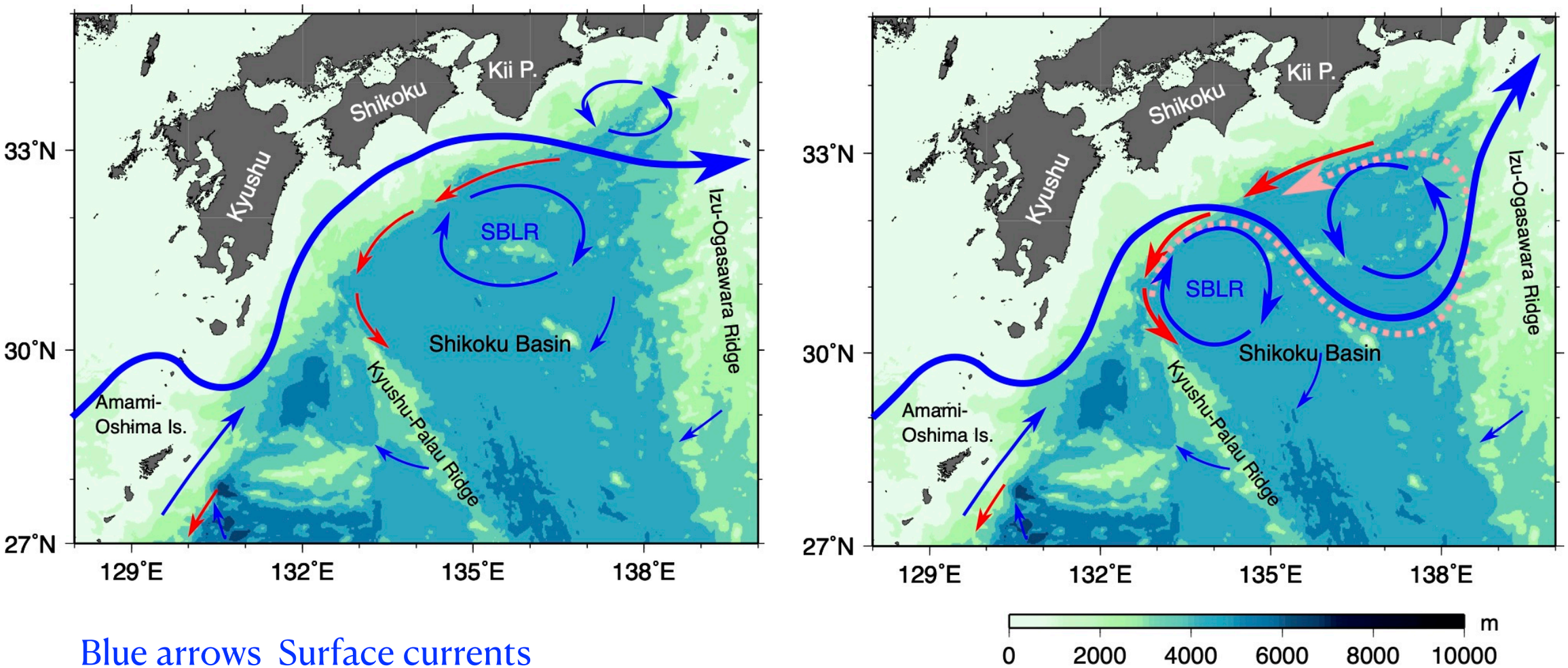
After the formation of the LM, the main pycnocline was displaced upward. As a result, BP was observed to be dropped

Nagano et al. (2021)

The offshore BP drop caused an intensification of the deep current along the northern periphery of the Shikoku Basin

a NLM period

b LM period



Blue arrows Surface currents

Red arrows Deep currents

Nagano et al. (2021)

Summary

Two types of the Kuroshio large meander (LM): stable and unstable types

Stable type LM (2004-2005 LM and other most of LMs) develop through the baroclinic instability of the cyclonic deep eddy. Bottom steering is strong and is responsible for the stable character of the current path

Unstable type LM (1981-1984 and 2017-presentLM) formation process is different from stable type LM. Baroclinic instability seems not to be important to the LM. Bottom slope steering is not effective, so that the path is variable.

Bottom pressure data are useful for oceanographic studies.

The results have been published in the following papers.

Nagano, A., T. Hasegawa, H. Matsumoto, and K. Ariyoshi (2018) Bottom pressure change associated with the 2004-2005 large meander of the Kuroshio south of Japan, *Ocean Dynamics*, doi: 10.1007/s10236-018-1169-1

Nagano, A., Y. Yamashita, T. Hasegawa, K. Ariyoshi, H. Matsumoto, and M. Shinohara (2019) Characteristics of an atypical large-meander path of the Kuroshio current south of Japan formed in September 2017, *Marine Geophysical Research*, doi: 10.1007/s11001-018-9372-5

Nagano, A., Y. Yamashita, K. Ariyoshi, T. Hasegawa, H. Matsumoto, and M. Shinohara (2021) Seafloor Pressure Change Excited at the Northwest Corner of the Shikoku Basin by the Formation of the Kuroshio Large-Meander in September 2017, *Frontiers in Earth Science*, Vol.8, 583481, doi: 10.3389/feart.2020.583481