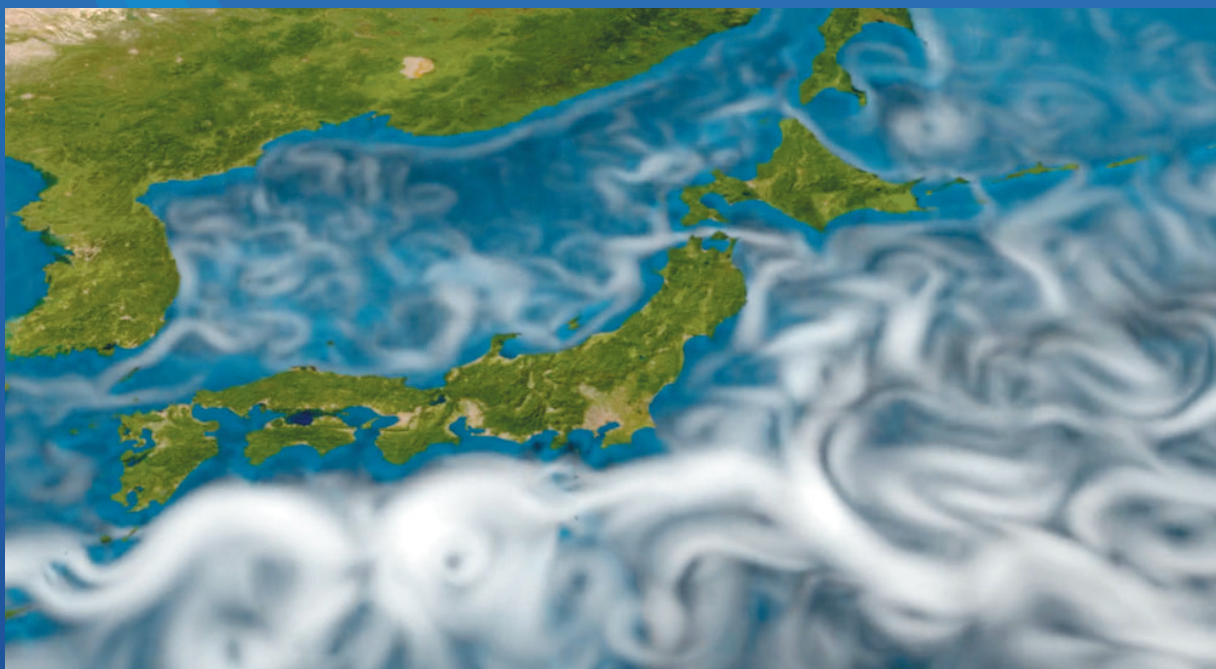


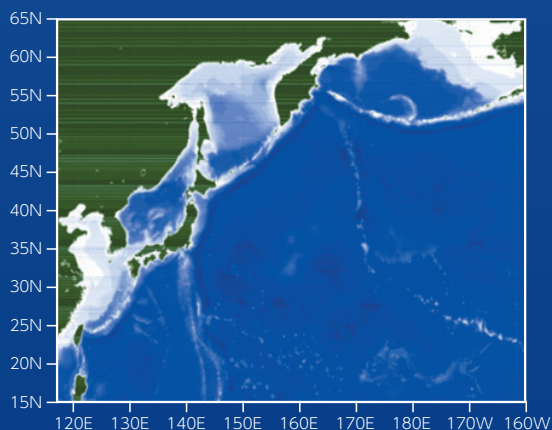


Four-dimensional variational Ocean ReAnalysis for the western North Pacific

FORA-WNP30



Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and Meteorological Research Institute, Japan Meteorological Agency (JMA/MRI) produced the Four-dimensional variational Ocean ReAnalysis for the Western North Pacific over 30 years (FORA-WNP30). It is the first-ever dataset covering the western North Pacific over three decades at eddy-resolving resolution. This dataset has 0.1 degree (about 10 km) spatial resolution and provides accurate estimation of ocean environmental changes around the Japanese Archipelago including a variety of meso-scale (several tens to several hundreds of km) phenomena, such as eddies, meanders, oceanic fronts, etc. FORA-WNP30 is a valuable dataset for a variety of oceanographic research topics and potentially for related fields such as climate study, meteorology, and fisheries.

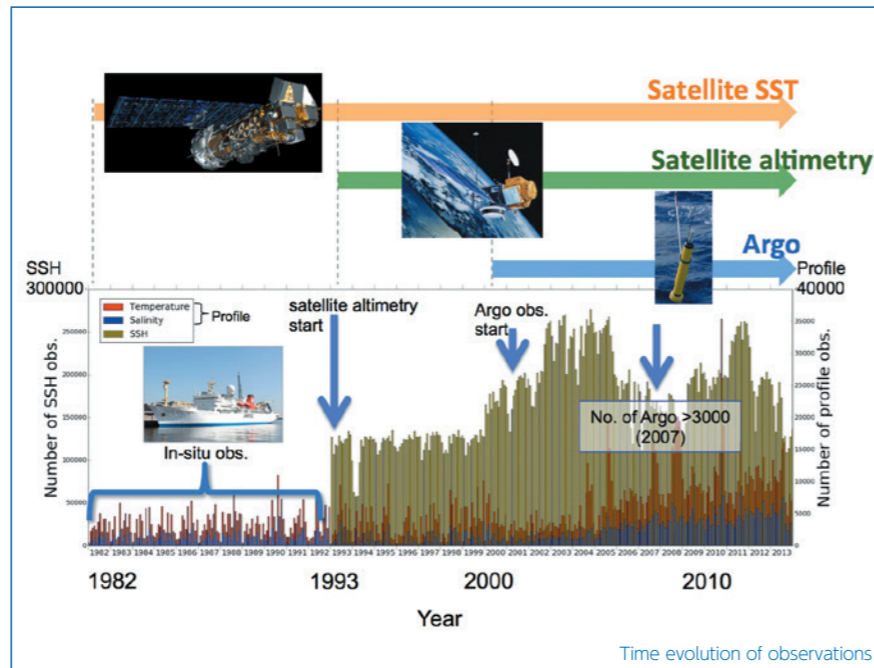


- [dataset name]** FORA-WNP30
- [analysis domain]** 15° – 65° N, 117° E – 160° W
- [spatial resolution]** 0.1° latitude × 0.1° longitude
(1/6° east of 160° E and north of 50° N)
vertical 54 layers (0-6300m depth)
- [analysis period]** 1 Jan. 1982 – 31 Dec. 2014
- [variables]** daily mean values of sea surface height,
potential temperature, salinity,
current velocity (N-S and E-W components),
sea ice concentration
- [data format]** NetCDF

Analysis domain of FORA-WNP30

Ocean data assimilation system and ocean observations

FORA-WNP30 is produced by a state-of-the-art 4-dimensional variational ocean data assimilation system, MOVE-4DVAR, developed in JMA/MRI (Usui et al., 2015). The ocean general circulation model used in MOVE-4DVAR is based on MRI.COM, the ocean model framework developed in JMA/MRI (Tsuji no et al., 2010). All the reanalysis calculation was carried out on the Earth Simulator with the support of JAMSTEC. It is the first-ever dataset covering the western North Pacific over three decades at eddy-resolving (about 10 km) resolution. Therefore, the major ocean current such as the Kuroshio and Oyashio, and the associated meso-scale phenomena such as eddies, fronts, and meanders, are finely reproduced. In particular, **FORA-WNP30** successfully reproduces anomalous events such as the Kuroshio large meander and anomalous intrusion of the Oyashio in 1980s, when there is no satellite altimeter data.

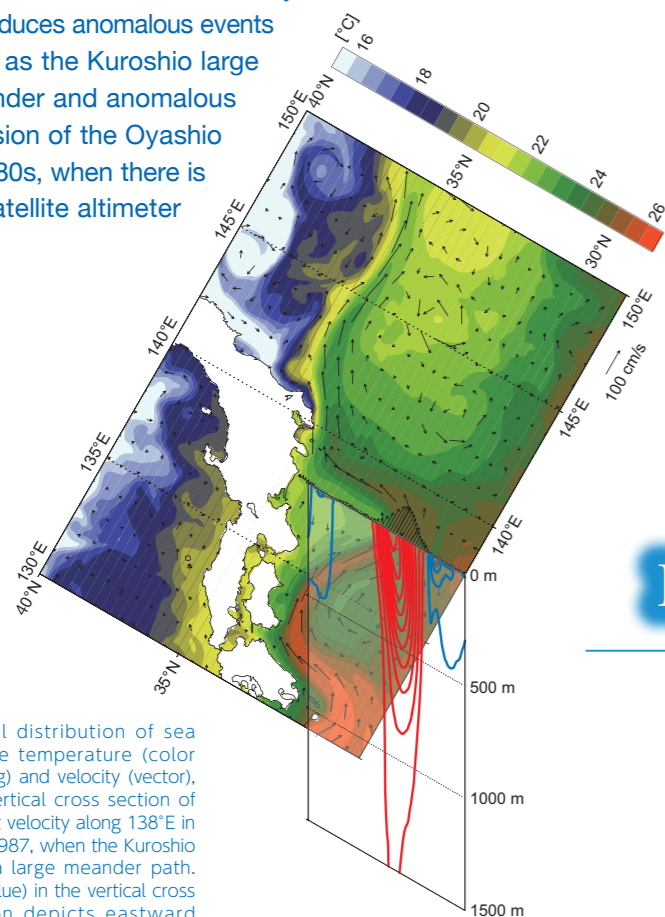


In-situ temperature and salinity profiles above 1500m-depth, gridded sea surface temperature (SST) and satellite altimeter-derived sea surface height (SSH) are assimilated in **FORA-WNP30**. The temperature and salinity profiles are collected from the World Ocean Database 2013 (WOD13) and the Global Temperature Salinity Profile Program (GTSP). The gridded SST is Merged satellite and in situ Global Daily Sea Surface Temperature (MGDSST) compiled in Japan Meteorological Agency (Kurihara et al., 2006). The altimeter-derived SSH observations are AVISO along-track multitemission products for TOPEX/Poseidon, Jason-1/2, ERS-1/2, Envisat, GFO and Cryosat-2. The SSH data is available since 1993, and the number of assimilated observations is closely linked to the number of satellite data. The number of temperature and salinity data is almost constant before 2003 but doubled in 2008 compared to that in 2003, indicating the large contribution of Argo floats.

Kuroshio large meander

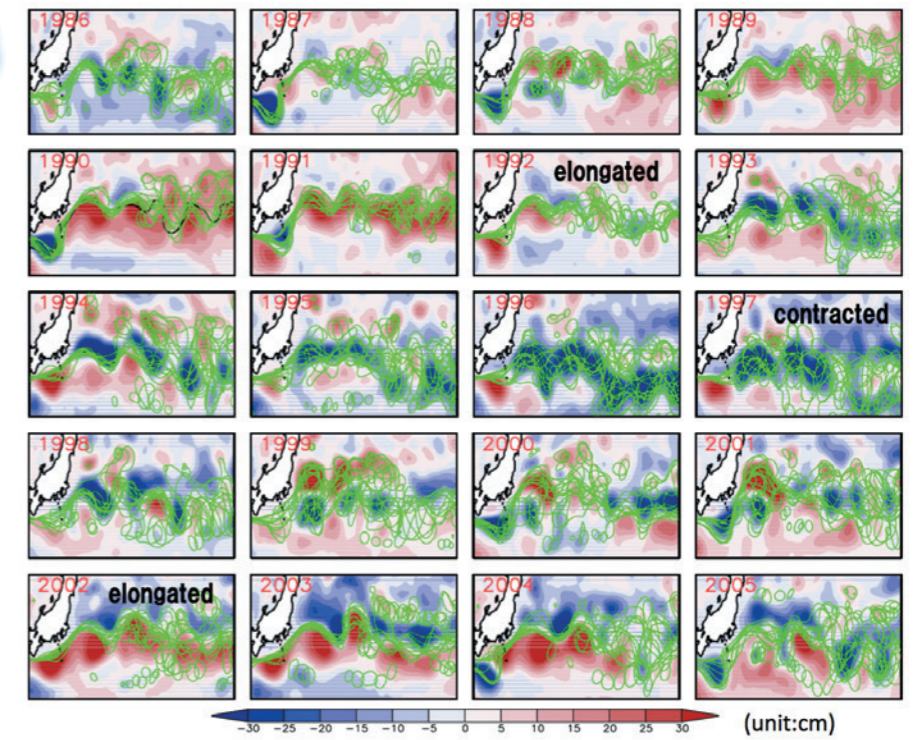
Figure shows sea surface temperature and velocity fields south of Honshu Island and the Kuroshio Extension region in June 1987, when the Kuroshio took a large meander path. The 3-dimensional structure of the Kuroshio front are finely captured. In particular, **FORA-WNP30** reproduces the large meander events observed several times in 1980s, which is an advantage of the dataset.

Spatial distribution of sea surface temperature (color shading) and velocity (vector), and vertical cross section of current velocity along 138°E in June 1987, when the Kuroshio took a large meander path. Red (blue) in the vertical cross section depicts eastward (westward), respectively, and contour interval is 10cm/s.



Interannual variation in the Kuroshio Extension

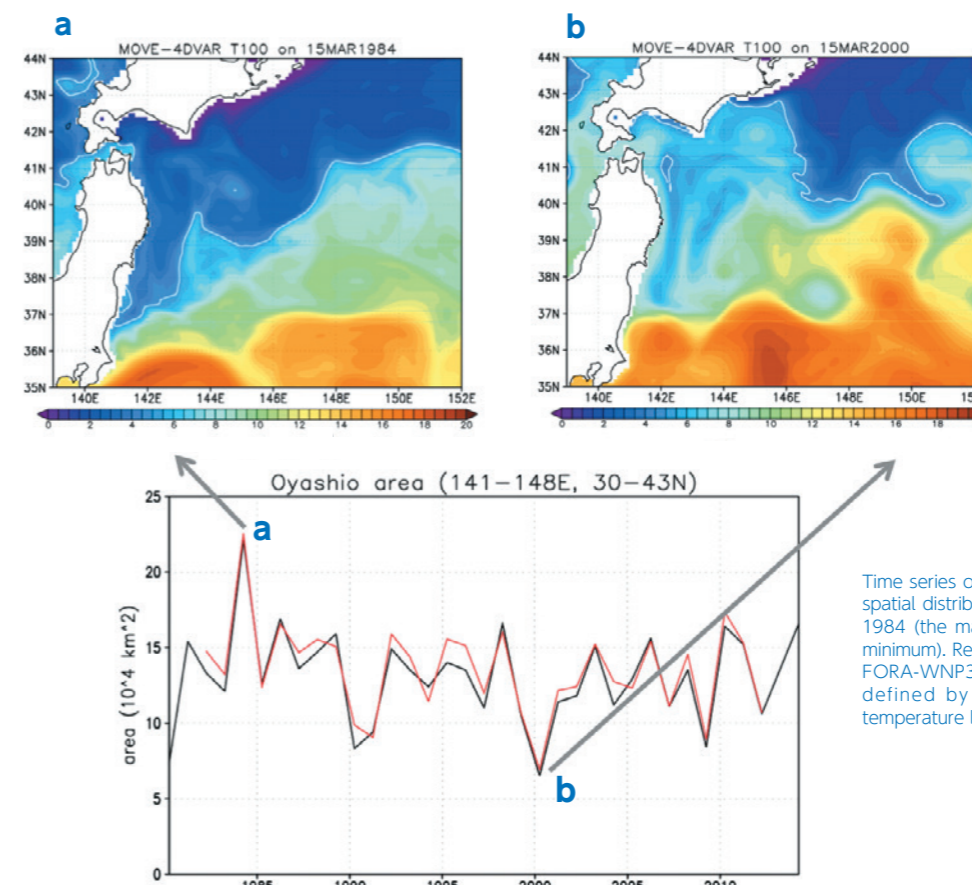
The Kuroshio Extension has two distinct modes: an *elongated mode* in which the northward shift of a strong eastward jet is accompanied by a strong southern recirculation gyre, and a *contracted mode* in which the southward shift of a weak jet is accompanied by a weak recirculation gyre (Qiu, 2002). **FORA-WNP30** has reproduced the gradual change from the elongated mode of the Kuroshio Extension in 1992 to the contracted mode. This modal transition reversed after 1997 and the Kuroshio Extension returned to the elongated mode in 2002.



Monthly mean paths (green lines) of the Kuroshio Extension and sea surface height anomalies (red and blue) during 1986-2005

Southward intrusion of the Oyashio Current

Interannual variation in the Oyashio area in spring represented by **FORA-WNP30** shows a good agreement with that from the analysis of Japan Meteorological Agency (JMA). **FORA-WNP30** illustrates that the Oyashio water intrudes southward along the east coast of Honshu Island and the southern tip of the Oyashio water extends to around 36°N in March 1984. In contrast, the Oyashio area is hardly found in Kuroshio-Oyashio transition region in March 2000.



Time series of the Oyashio area in spring (March-May), and spatial distribution of temperature at 100m-depth in March 1984 (the maximum of the Oyashio area) and 2000 (the minimum). Red and black lines denote area calculated from FORA-WNP30 and JMA analysis. The Oyashio area is defined by the area of cold water at 100m with temperature less than 5°C within 141°-148°E and 30°-43°N.



Access and use of FORA-WNP30

FORA-WNP30 is now available as a basic ocean reanalysis dataset for widespread fields of climate/ocean research activities. Please refer and accept the terms and conditions of use for FORA-WNP30 described in the following web-site. If you use this dataset for non-scientific or non-educational purposes, please inform us (fora_req@jamstec.go.jp) in advance and follow our instructions.



FORA web-site

<http://synthesis.jamstec.go.jp/FORA/e/>

If you have any questions about FORA dataset,
please contact JAMSTEC/CEIST at the e-mail address
fora_req@jamstec.go.jp with your name and affiliation.



Earth Simulator

FORA (4(Four)-dimensional variational Ocean ReAnalysis) – WNP30



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