

KESS and Its Legacies

Report to US CLIVAR

18 July 2012

Meghan Cronin (NOAA PMEL)

- *KESS objectives & field program*
- *Best Practices – <http://uskess.org>*
- *A few highlights from KESS research*
- *Activities since KESS*

KESS Objectives

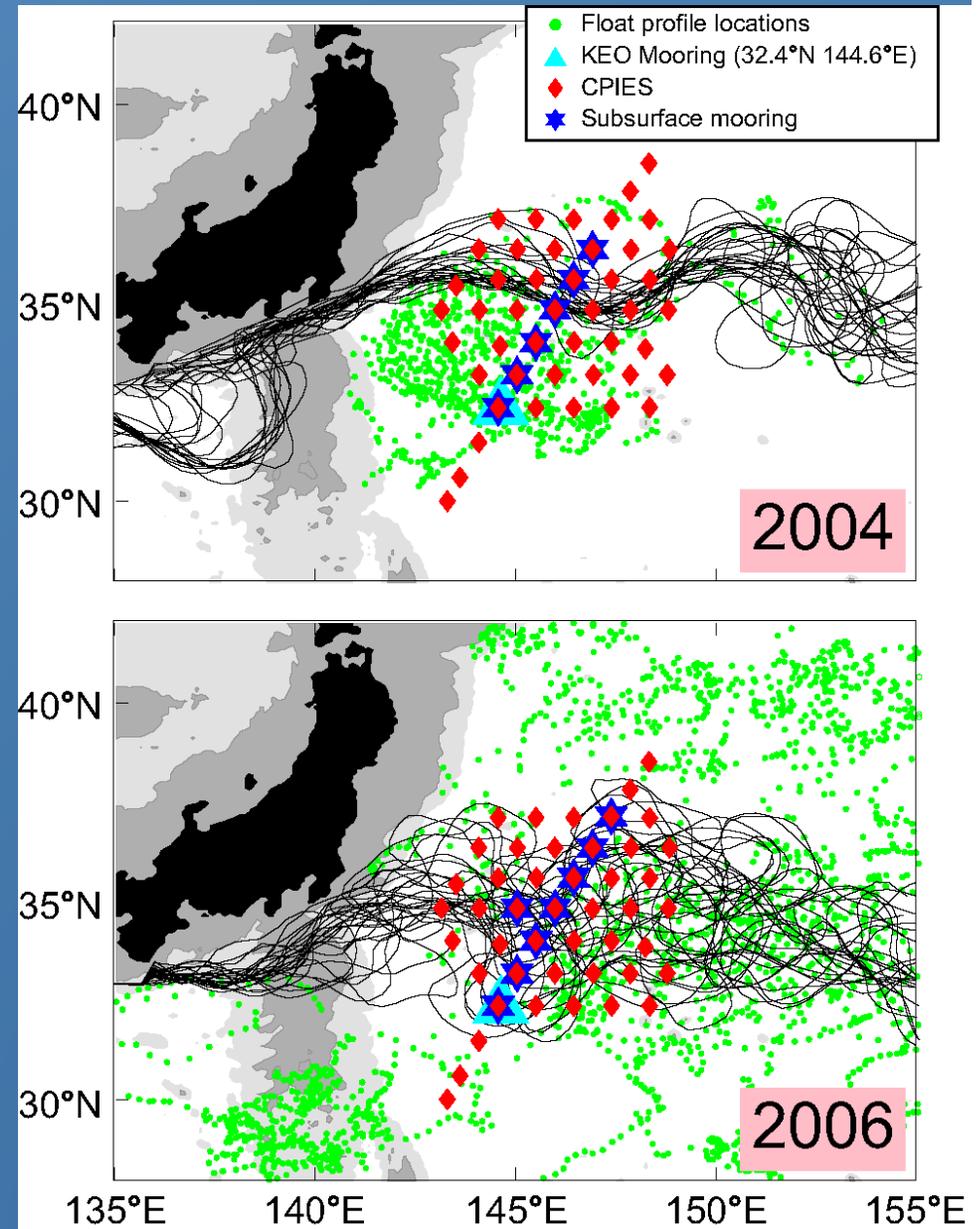
The overall goal of KESS is to identify and quantify the dynamic and thermodynamic processes governing the variability of and the interaction between the Kuroshio Extension and the recirculation gyres:

- To understand processes coupling the baroclinic and barotropic circulation and variability
- To determine and quantify cross-frontal exchange processes in the Kuroshio Extension
- To determine the processes that govern the strength and structure of the recirculation gyres – its position, elongation, stratification, and subtropical mode water formation within the gyres

KESS Observations

May 2004 – June 2006

- subsurface current meter and profiler moorings
- current & pressure recording inverted echo sounders (CPIES)
- profiling Argo floats
- meteorological buoy (KEO)
- atmospheric soundings
- underway ADCP
- hydrography
- satellite altimetry
- $1/10^\circ$ POP model



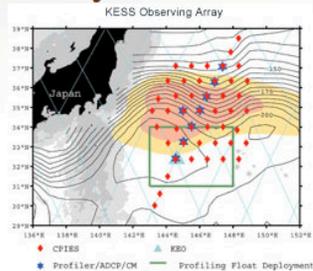


HOME ABOUT KESS COMPONENTS CRUISES DATA

Kuroshio Extension System Study

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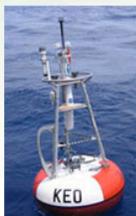
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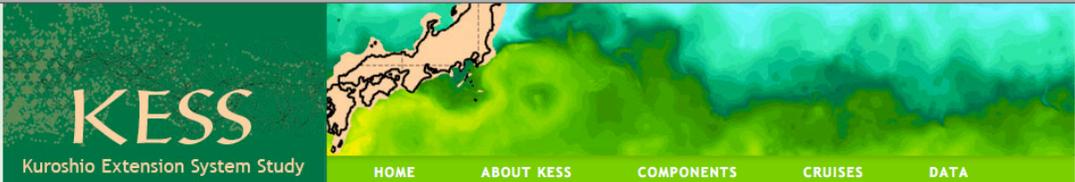
Science Highlights



KEO Surface Buoy
KEO mooring carries a suite of meteorological sensors to measure winds, air temperature, relative humidity, rainfall, and solar and longwave radiation.



SADCP
KESS cruises included data from a hull-mounted Acoustic Doppler Current Profiler (SADCP), which measured the velocity of the upper-ocean currents below the ship.



- DATA PRODUCTS
- PUBLICATIONS
- PRESENTATIONS

Data Products

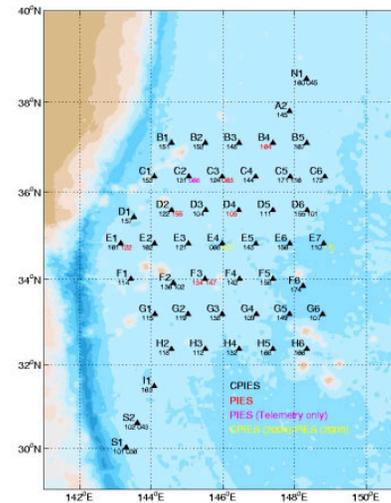
[Argo](#) | [CPIES](#) | [CTD](#) | [Mooring](#) | [KEO Buoy](#) | [Model](#) | [Other](#)

Argo Profiling Floats

University of Hawaii Argo Profiling Floats Data Page

CPIES Data from GSO/URI

Shown below is the KESS CPIES/PIES array superimposed on Smith and Sandwell bathymetry contoured every 1000 m. The CPIES/PIES were moored in water depths ranging from 5300 m on the western side of the array to 6300 m in the east. Data are available for 46 sites (Sites File lists nominal positions and bottom depths). Site designator is given in the upper left hand corner and IES serial number is listed under the triangles. Black is for CPIES sites, red for PIES sites, magenta specifies sites where only telemetry was taken, and yellow designates where instruments were CPIES in 2005, but PIES in 2006. The measurements were made during April 2004 to July 2006 under the sponsorship of the National Science Foundation. The measured quantities include pressure, vertical acoustic round-trip travel time, and currents. All data files in the CPIES archive are provided in ASCII format.



CONTENTS OF HOURLY FILES

There are up to three files for each instrument, where XX is the site designator and YYY is the IES serial number:

- prs/XX_SNYYY.dat -- pressure in decibars
- tau/XX_SNYYY.dat -- vertical acoustic travel time in seconds
- currents/XX_SNYYY.dat -- u,v velocities in cm/sec

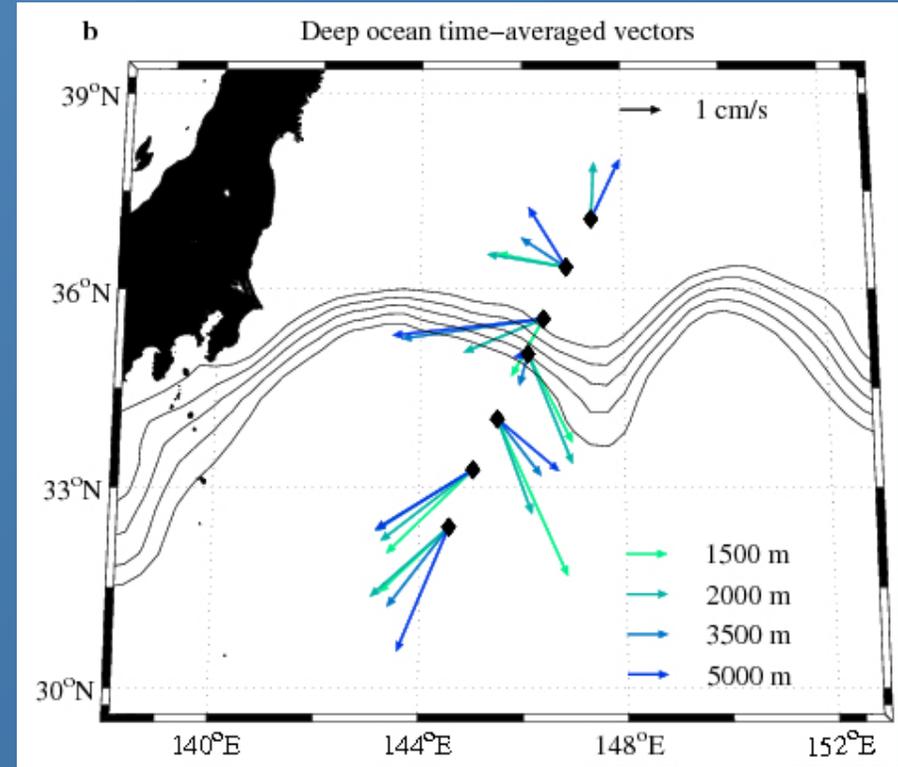
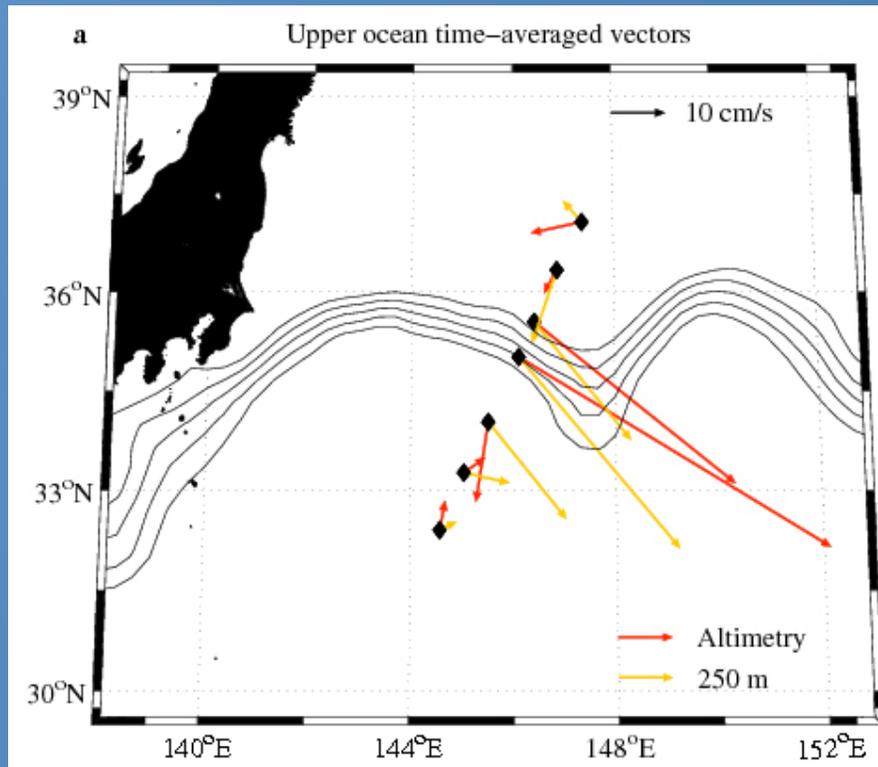
These are the highest quality versions of the data after the least amount of processing. Large data spikes (outliers) and long term drifts have been removed from these records. Details of the processing are provided in the [data report](#). Each file contains year, month, day, hour, minute, second and either pressure, travel time or currents. Missing data values are indicated by NaN.

CONTENTS OF 72 HR LOWPASSED FILES

There are up to three files for each instrument, where XX is the site designator:

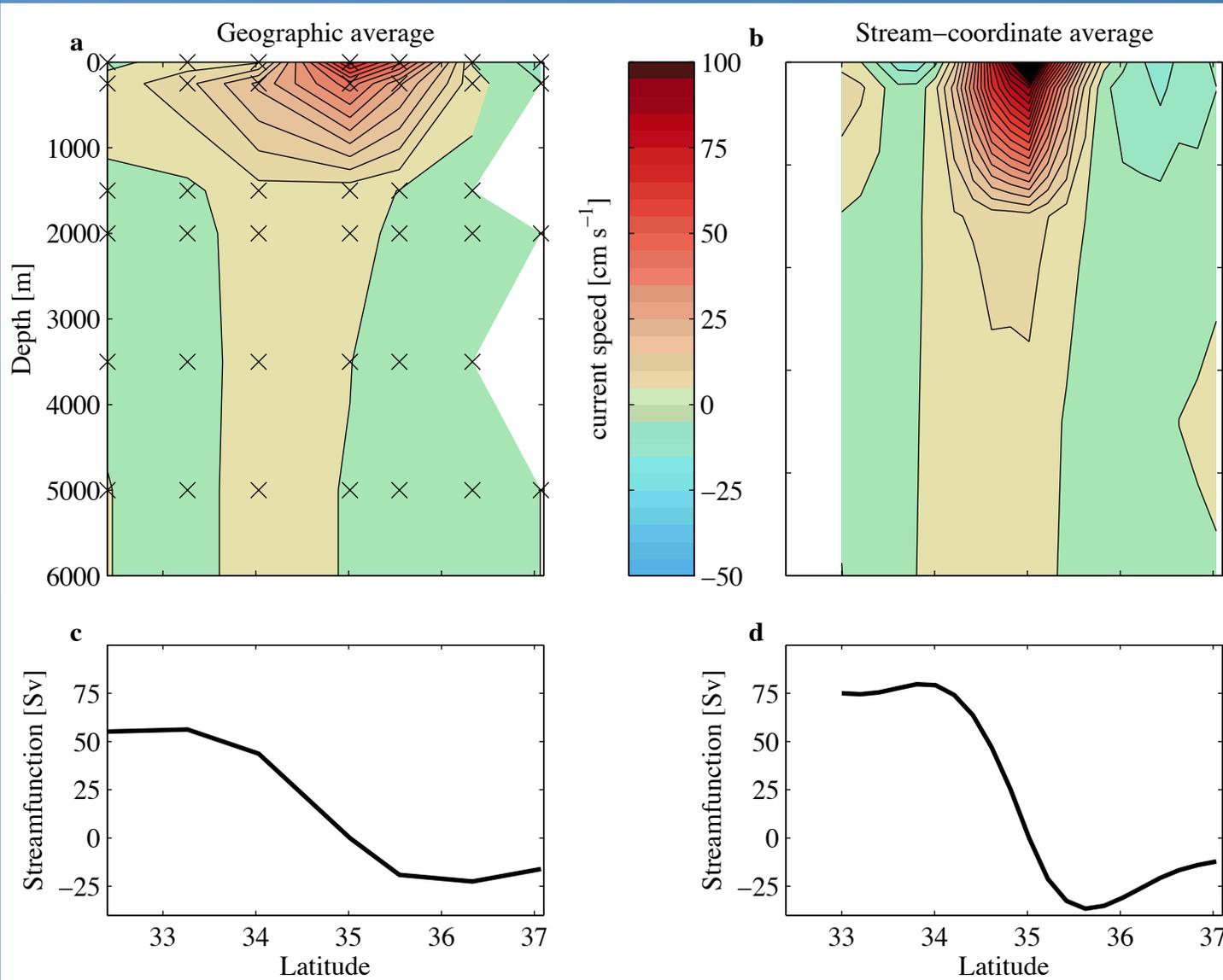
- prs/XX.dat -- leveled, demeaned pressure in decibars
- tau/XX.dat -- vertical acoustic travel time from 0 to 1400 dbar in seconds
- currents/XX.dat -- u,v velocities in cm/sec

KESS Profiler Mooring Observations



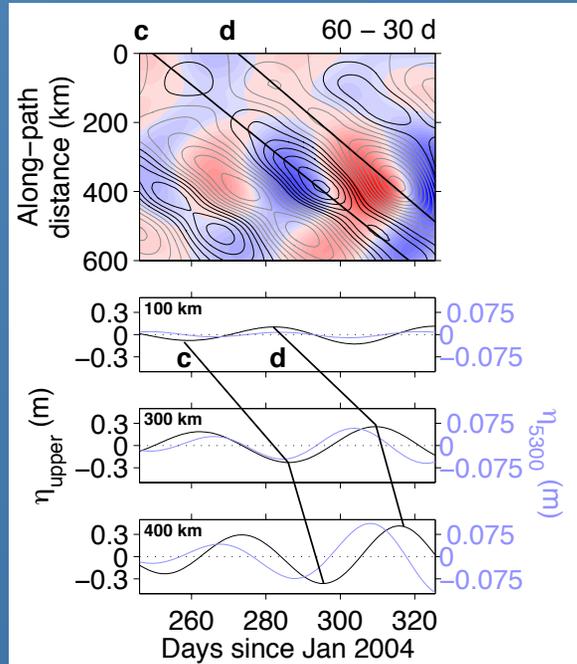
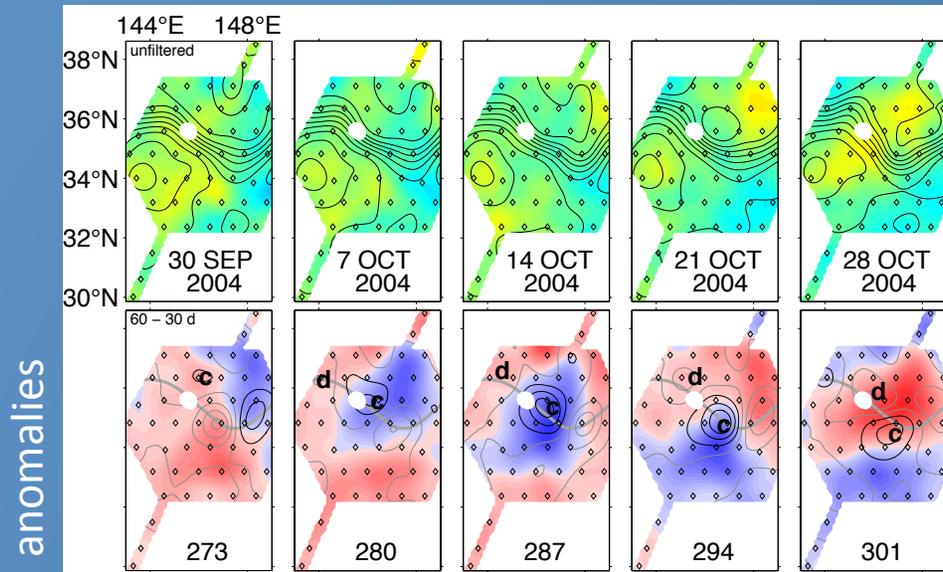
Time-average over KESS period of current meter records, overlaid with average sea surface height contours. (Jayne, et al., Deep-Sea Research I, 2009)

Velocity Section



SSH contour
used as proxy
for the Kuroshio
Extension jet
axis

Example of external eddy triggering growth



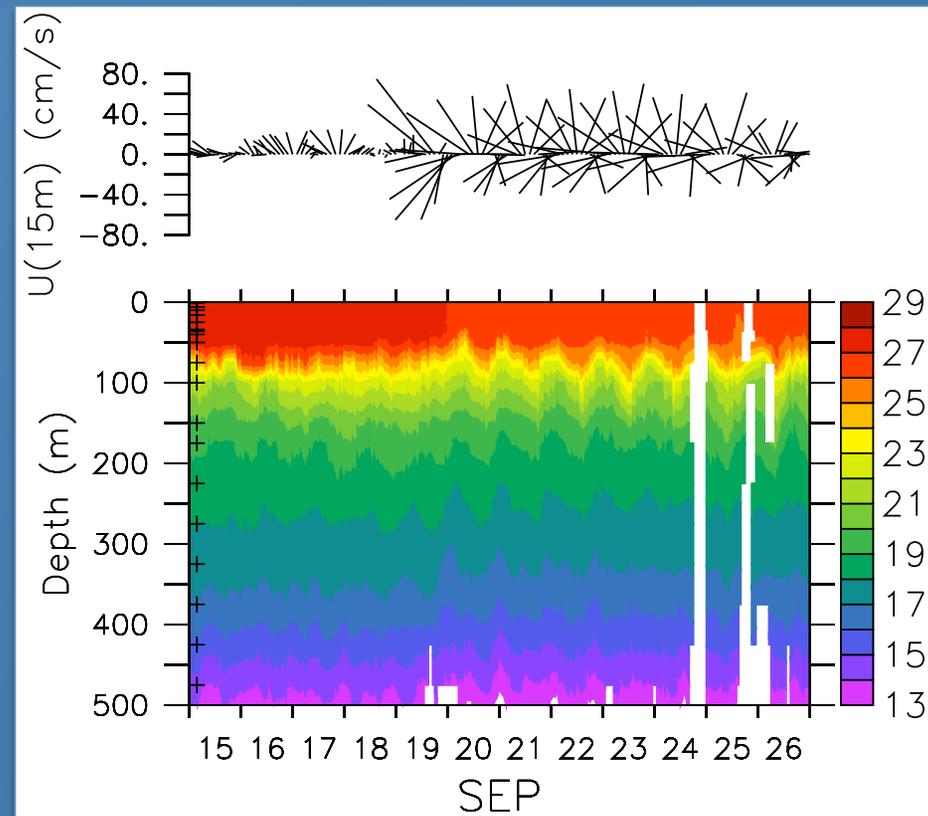
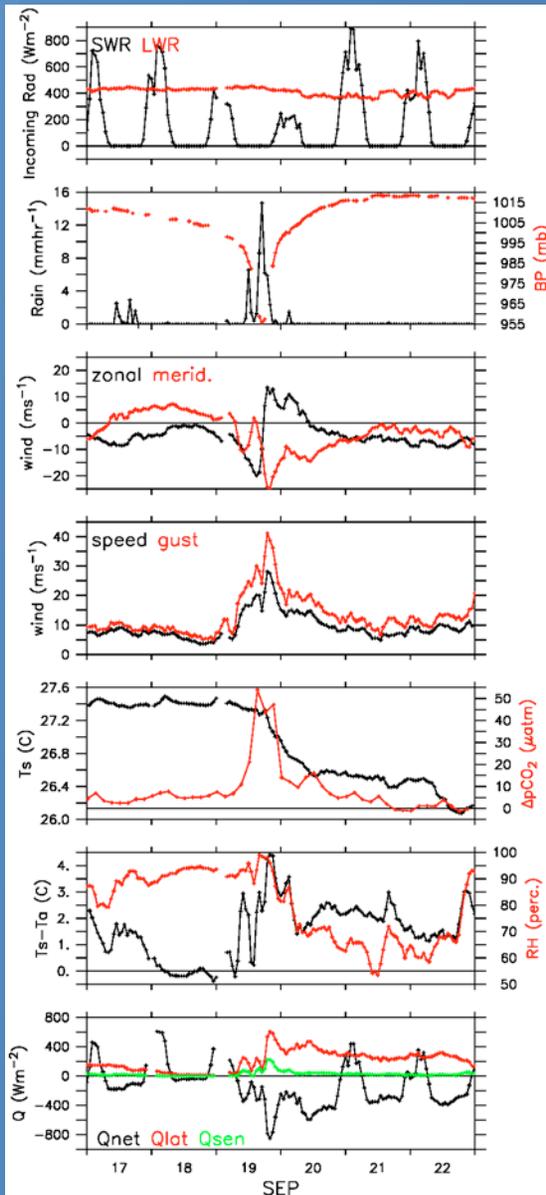
Tracey et al. JPO 2012

Upper meanders (trough **c**, black contours; crest **d**, gray contours) propagate downstream along the jet.

Deep eddies (highs: red; lows: blue) propagate NNE-SSW across the jet.

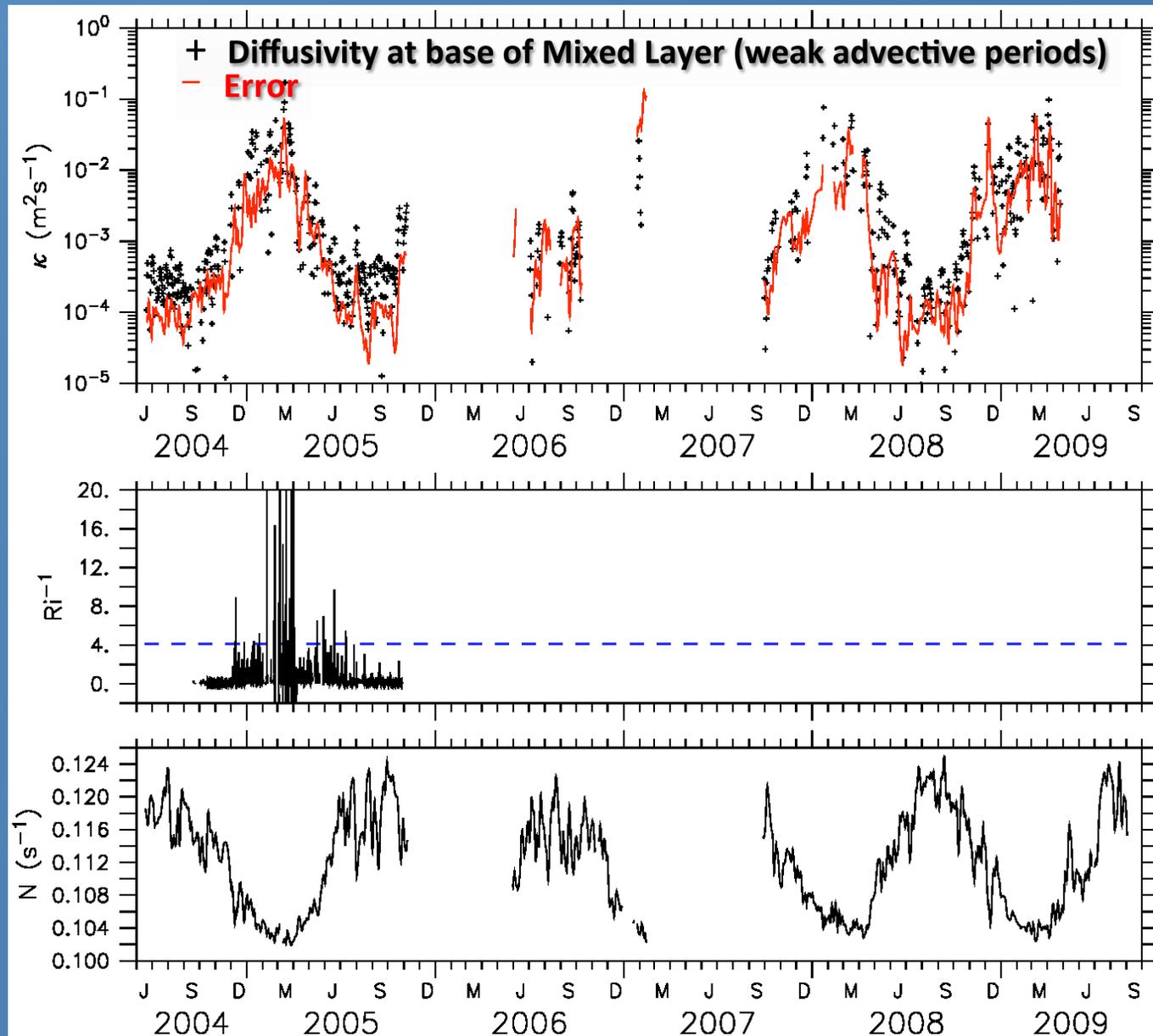
Growth occurs from interaction with pre-existing deep eddies if they encounter each other with the deep offset 1/6-1/4 wavelength ahead of the upper meander.

Bond et al. JGR 2011: Upper-ocean response to typhoon Choi-Wan as measured by the Kuroshio Extension Observatory (KEO) mooring.



Impulsive winds generated NIOs.
Inertial pumping caused heaving for at least a week down to nearly 500m.

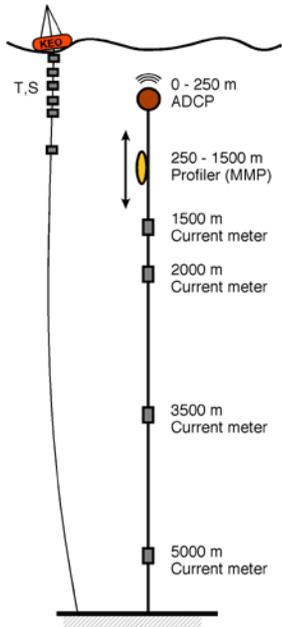
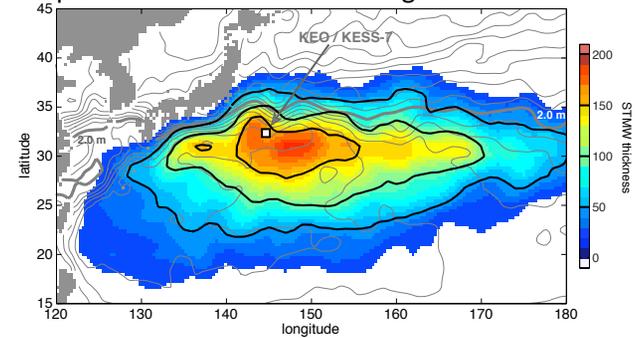
Cronin et al. DSR II In Press: Formation and erosion of the seasonal thermocline in the Kuroshio Extension recirculation gyre.



Subtropical Mode Water

KEO (surface) and KESS-7 (subsurface) moorings

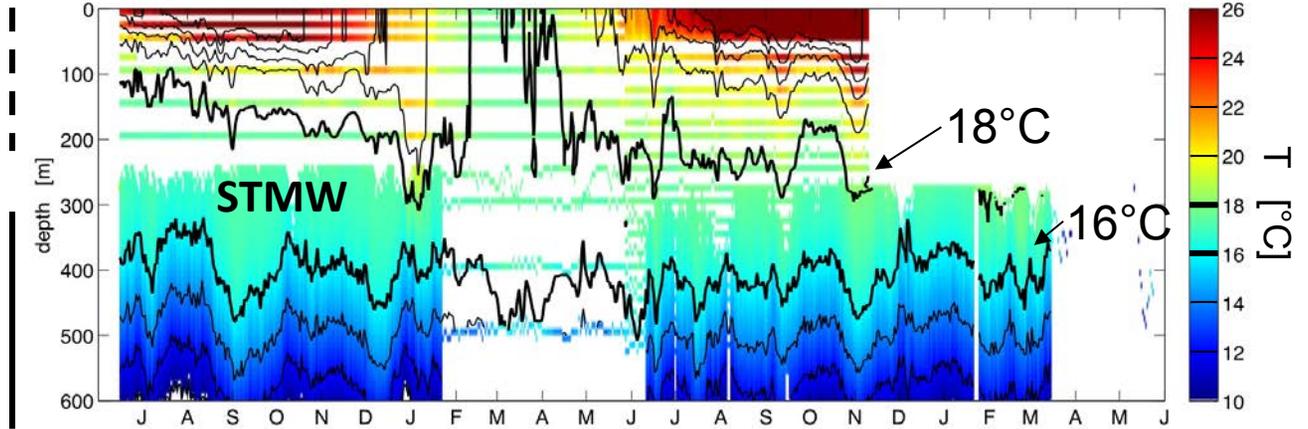
Map of STMW thickness from Argo and KESS floats



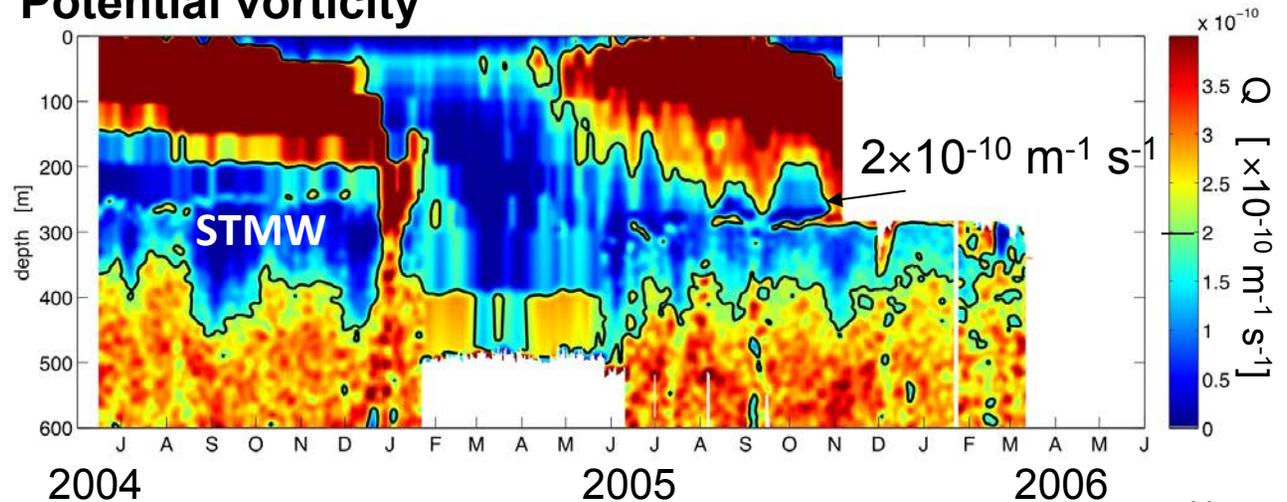
KEO sensors

Moored profiler

Temperature



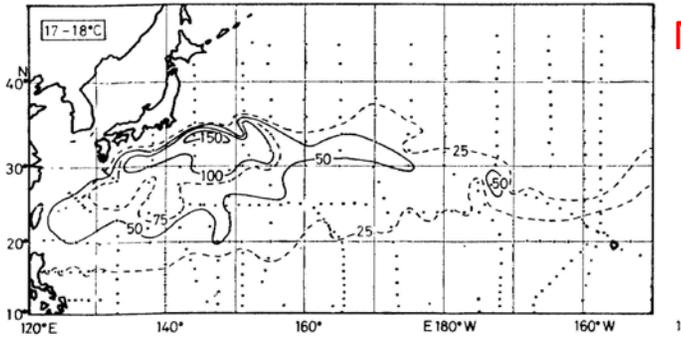
Potential vorticity



STMW:
$$Q = -\frac{f}{\rho} \frac{\partial \sigma_{\theta}}{\partial z}$$

$$< 2 \times 10^{-10}$$

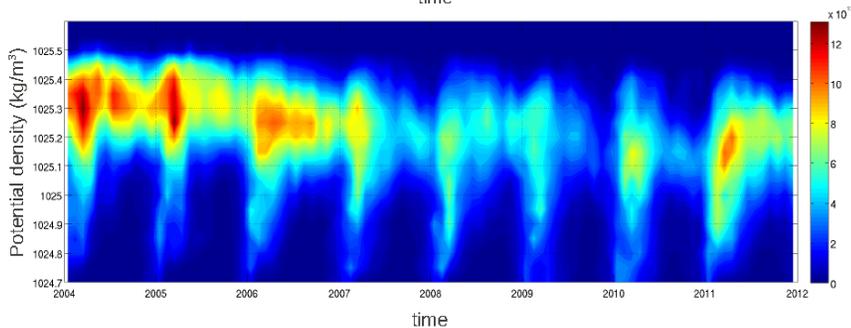
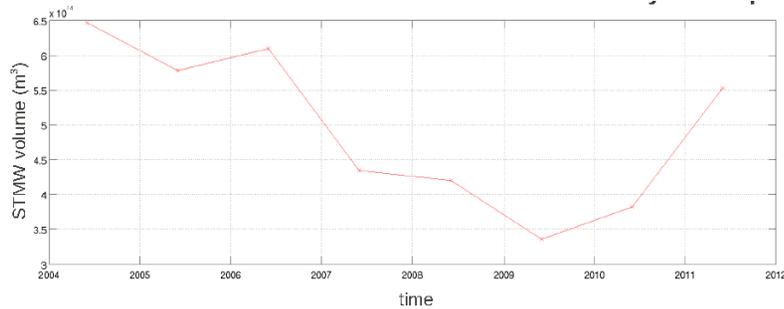
North Pacific Subtropical Mode Water



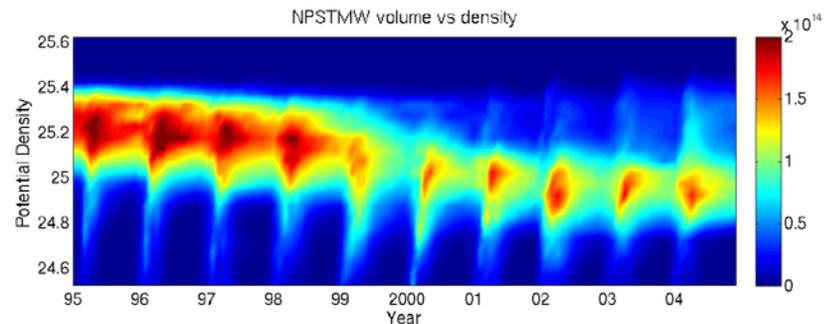
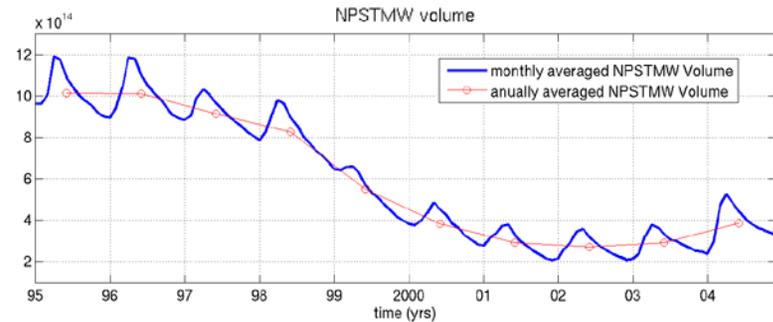
Masuzawa (1969)

Quasi-decadal variability of NPSTMW volume:
 volume min toward the end of each decade,
 at the time of PDO phase shift (from warm to cool)
 (e.g. Davis et al., 2011)

Observations: Argo floats



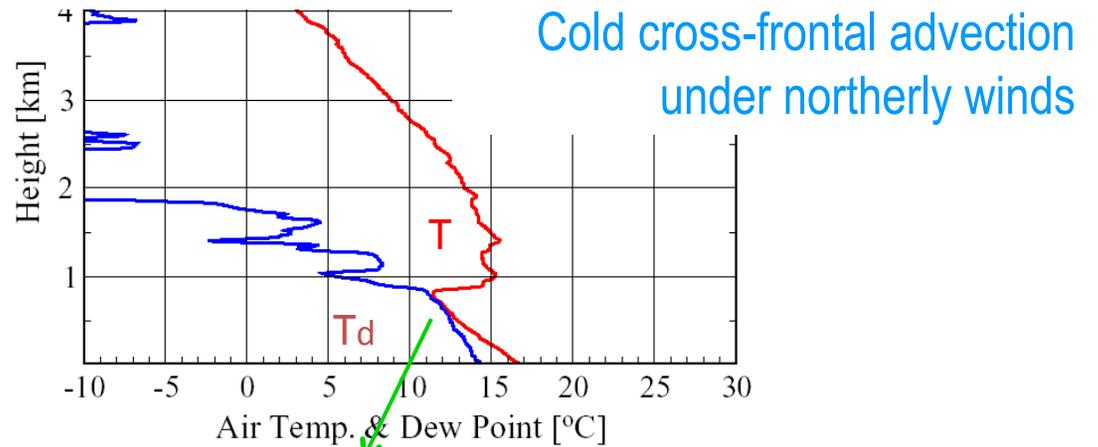
Eddy-resolving (0.1°) POP model results



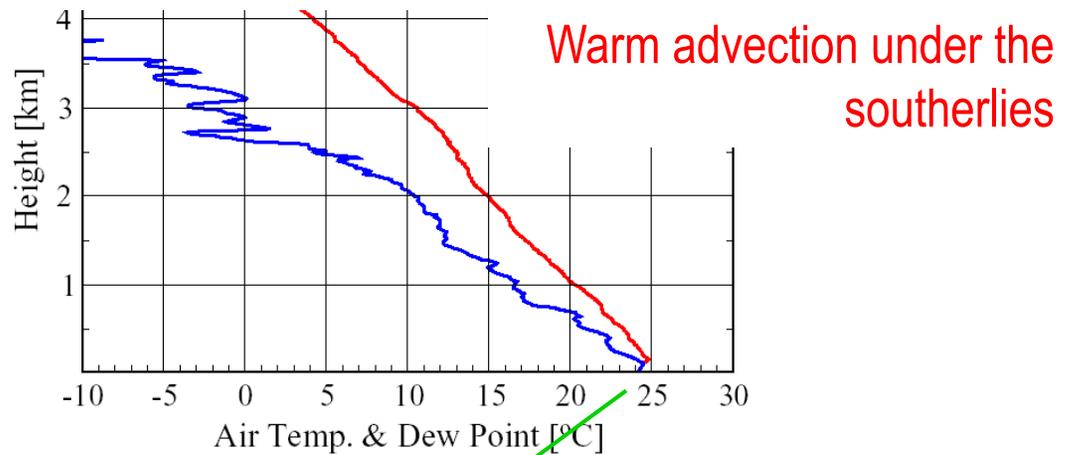
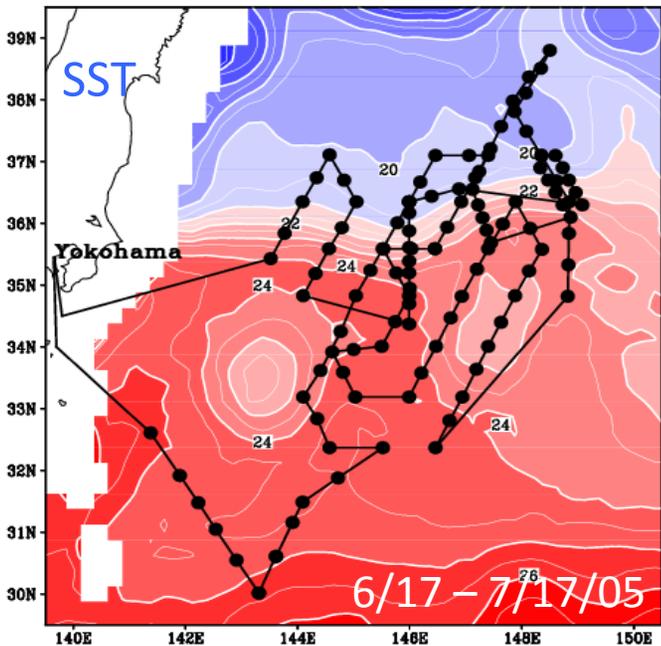
Provided by I. Cerovecki (Scripps)

Atmospheric Sounding Probes Ocean's Effect on Climate

Y. Tanimoto (2009, *J Climate*)



Stratus cloud with an elevated base capped by a primary inversion

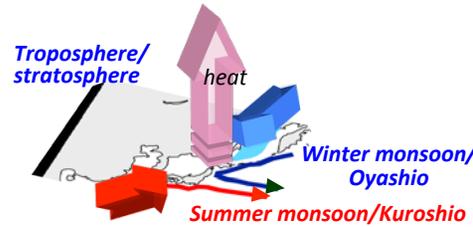


Fog capped by a surface inversion

Provided by S.-P. Xie

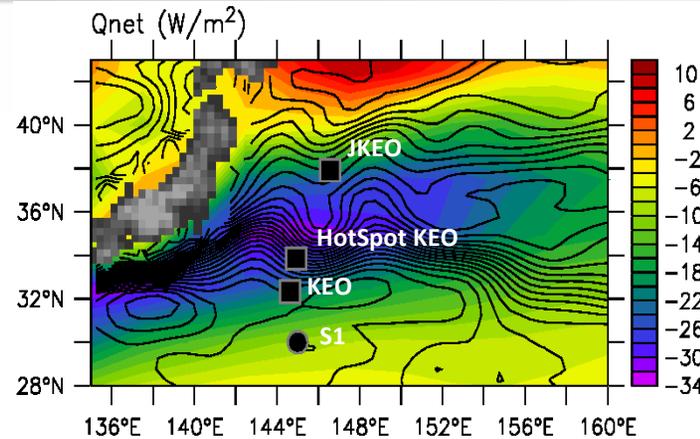
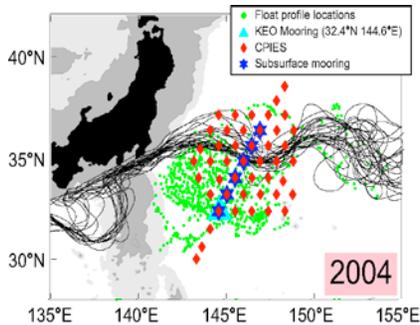


US CLIVAR WBC Working Group



Hot-Spot: A new Japanese Air-Sea Interaction Exp't Lead PI: H. Nakamura

NOAA KEO

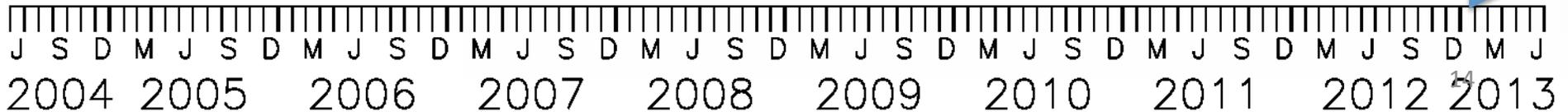


mid-jet Hot-Spot KEO

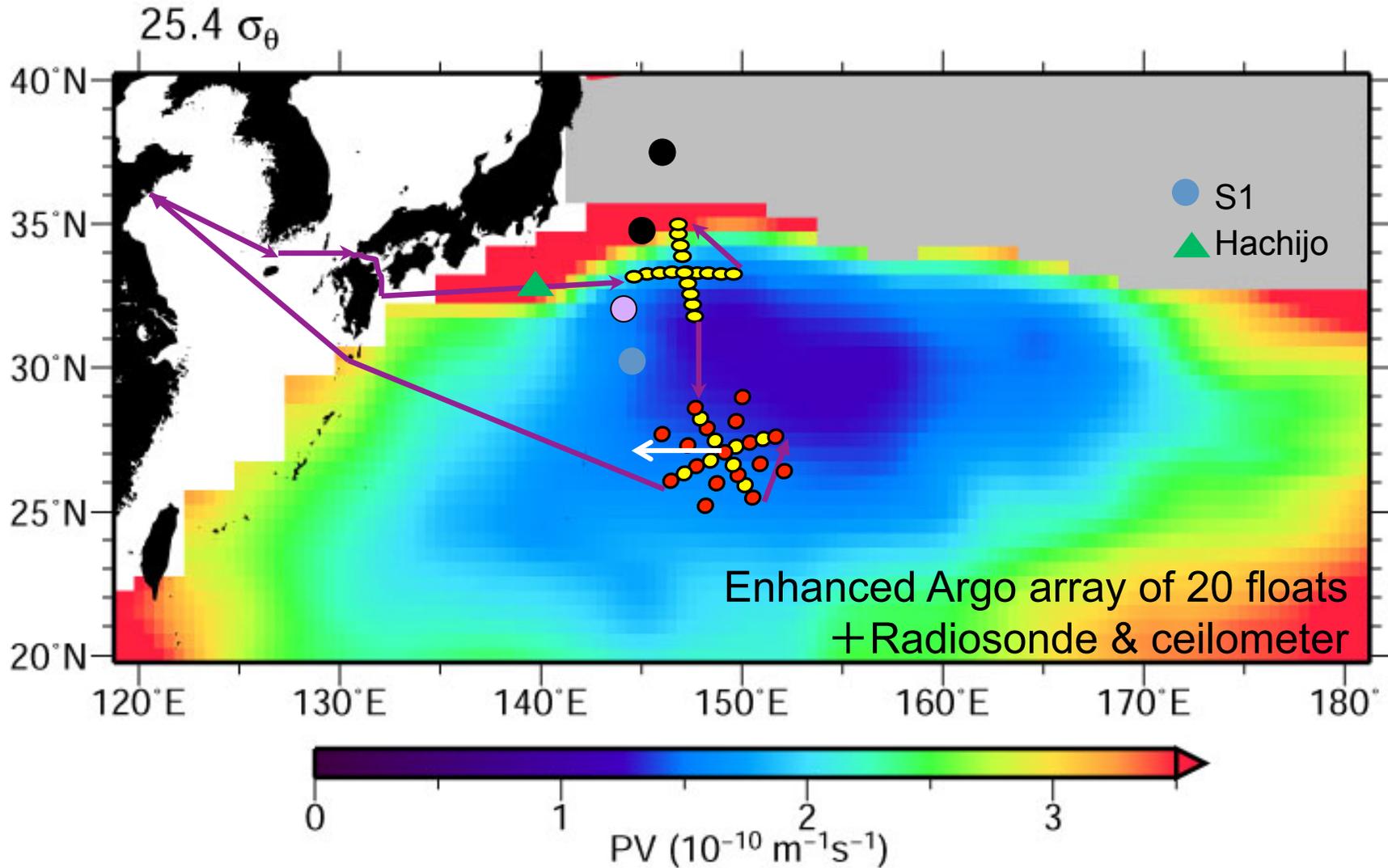
NSF Kuroshio Extension System Study (KESS)

JAMSTEC-KEO

JAMSTEC S1 Biogeochemical mooring

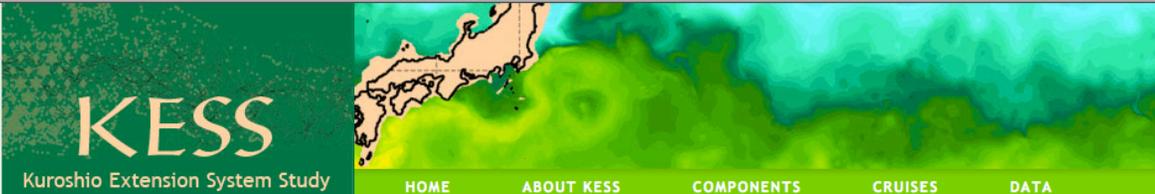


In 2014: Mode water Ventilation Experiment (MoVE)
Lead PI: Shang-Ping Xie (with funding from China)



- Japan buoys
- PMEL buoy

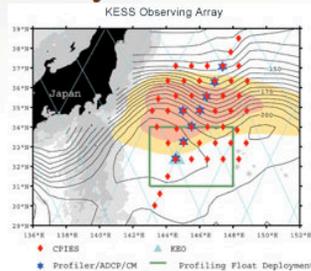
- CTD, atmos sounding
- ARGO float



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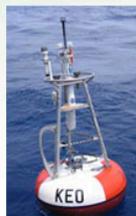
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