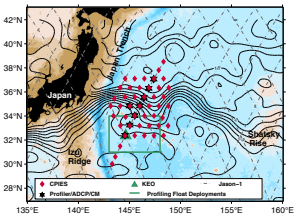
THE UNIVERSITY OF RHODE ISLAND
GRADUATE SCHOOL OF OCEANOGRAPHY

DEEP EDDIES MODULATE FRONTAL MEANDER GROWTH IN THE KUROSHIO EXTENSION

Karen L. Tracey, D. Randolph Watts, and Kathleen A. Donohue
ktracey@gso.uri.edu *www.po.gso.uri.edu/dynamics/KESS* *www.uskess.org*

B1413

1. Upper and deep variability in the Kuroshio Extension



KESS array with RIO05 SSH and bathymetry

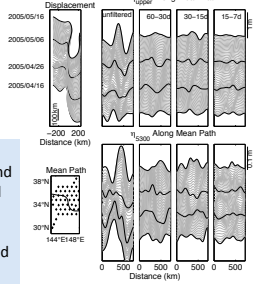
During the Kuroshio Extension System Study (KESS) a two-dimensional array of current-and-pressure- recording inverted echo sounders (CPIES) provided synoptic measurements of the upper and deep fluctuations in the Kuroshio Extension between 143°E and 149°E with mesoscale resolution.

Downstream-propagating meanders, also called frontal waves, with periods 3-60 d were always present between June 2004 and September 2005.

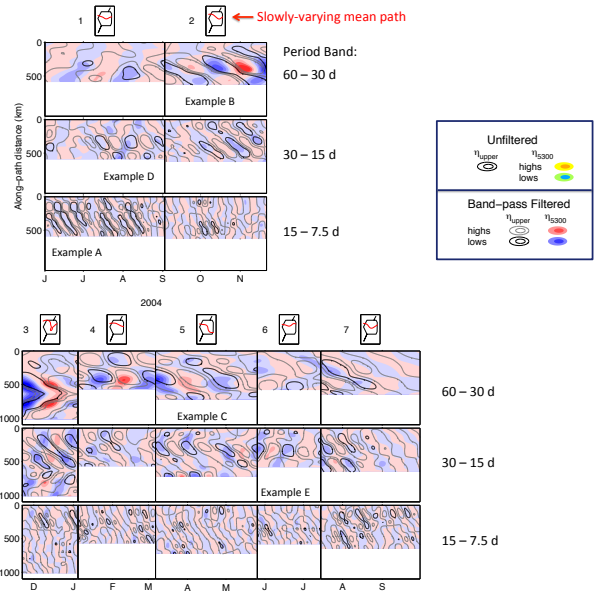
Phase speeds increased smoothly from 10 km d^{-1} for meanders with wavelengths and periods [420 km, 40d] to 35 km d^{-1} for [200 km, 6 d] meanders.

Meandering of Kuroshio Extension is characterized by variability of path displacements as a function of downstream distance or as the variability of surface geopotential height relative to 5300 dbar (η_{upper}) along the temporal mean path.

Anomalies in the deep reference field at 5300 dbar (η_{5300}) were obtained along same mean path as η_{upper}. Both η_{upper} and η_{5300} were band-pass filtered to characterize the eastward-propagating frontal meanders.

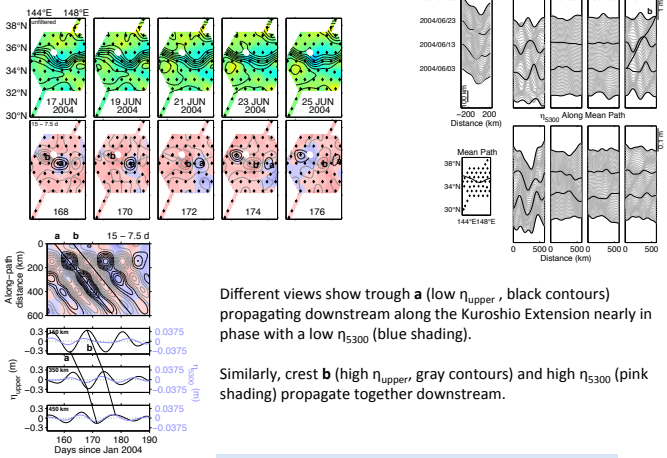


Most meanders did not grow systematically downstream. Instead, meanders alternately grew and decayed as they interacted with remotely-generated deep eddies which propagated into the region from the northeast and east. Interactions have different outcomes depending on the phasing of the upper and deep anomalies.



2. No growth: Upper and deep propagate together with no vertical phase offset

EXAMPLE A



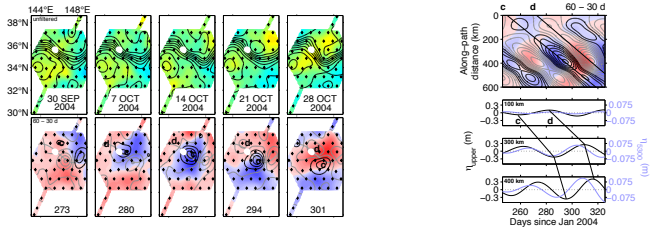
Different views show trough **a** (low η_{upper} , black contours) propagating downstream along the Kuroshio Extension nearly in phase with a low η_{5300} (blue shading).

Similarly, crest **b** (high η_{upper}, gray contours) and high η_{5300} (pink shading) propagate together downstream.

This orientation does not support growth and amplitudes decrease downstream.

3. Growth: Vertical phase offset favorable for baroclinic instability

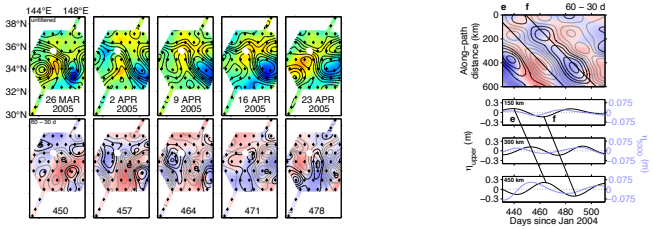
EXAMPLE B



Upper meanders propagating downstream along the jet.
Deep eddies propagating NNE-SSW across the jet.

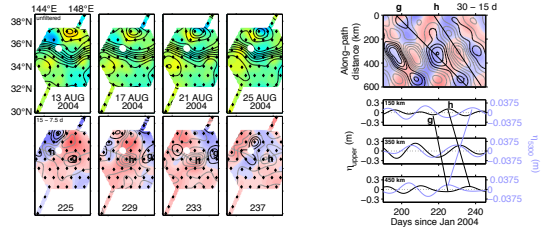
Growth can occur from interaction with pre-existing deep eddies if they encounter each other with the deep eddy offset about ⅛– ¼ wavelength ahead of the upper meander.

EXAMPLE C



4. Growth or decay: Depends on evolving vertical phase offset

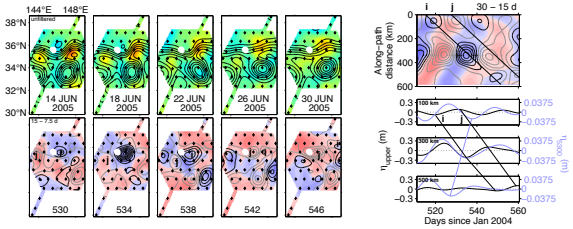
EXAMPLE D



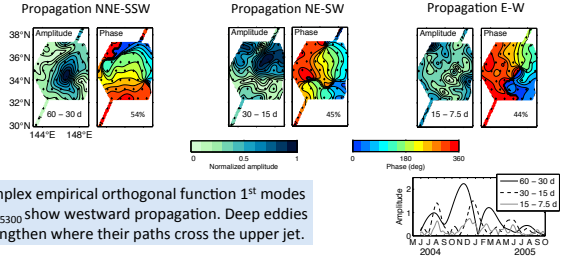
Crest **h** (high η_{upper}, gray contours) and trough **g** (low η_{upper}, black contours) propagate from west to east along the upper jet. Deep η_{5300} anomalies highs (pink) and lows (blue) move in the opposite direction --- from east to west.

As upper highs and lows propagate eastward they encounter pre-existing deep highs and lows translating westward. Interactions have different outcomes depending on the phasing of the η_{upper} and η_{5300} anomalies. If a lower anomaly leads an upper anomaly of the same sign, both features amplify. Otherwise they decay. Their crossing paths generate a cycle of temporary growth and decay.

EXAMPLE E



5. Pre-existing deep eddies translate westward



Complex empirical orthogonal function 1st modes of η_{5300} show westward propagation. Deep eddies strengthen where their paths cross the upper jet.

Bottom pressures from the OFES and HYCOM models also show westward propagation in these period bands (Greene, 2010; Zamorski and Donohue, 2012). High deep variance extends eastward to Shatsky Rise, suggesting the deep eddies originated when the meandering Kuroshio Extension encountered that topography.

Visit poster B1417

Greene, A., 2010: *Deep variability in the Kuroshio Extension*. PhD Thesis. Univ. RI
Tracey, K. L., D. R. Watts, K. A. Donohue, and H. Ichikawa, 2012: Propagation of Kuroshio Extension meanders between 143°E and 149°E. *J. Phys. Oceanogr.*, in press.
Zamorski, S. E., and K. A. Donohue, 2012: Kuorshio Extension meanders: Model data-intercomparison. *Ocean Sciences 2012 poster B1417.*

KESS is funded by National Science Foundation Grants OCE02-21008 and OCE08-51246.