1. Kuroshio Extension

The Kuroshio Extension System Study (KESS) spanned a transition between relatively stable and unstable meandering states. The CPIES array mapped the upper and deep streamfunctions daily with mesoscale resolution for a 16-month period.

Large scale meanders of the Kuroshio Extension are quasi-stationary. However, smaller scale meanders, or frontal waves, continually propagate eastward. The downstream propagation of these frontal waves can even be resolved when the path is highly convoluted.

In the following plots, the upper and deep streamfunctions were band-pass filtered in 30-15d, 15-7.5d and 7.5-3.75d period bands to characterize the eastward-propagating frontal meanders.

3. Case Study: Stable Period (upper & deep, four bands)

One of many frontal waves during Jun-Nov 2004. Shown: upper and deep, unfiltered and filtered \( \Psi \).
- 15-7d & 7-3d features propagate eastward along front with highs and lows vertically aligned upper and deep.
- 30-15d strong features north of 35 N are associated with a WCR propagating westward, not frontal waves.

4. Case Study: Unstable Period (upper & deep, four bands)

One of many frontal waves in Jan-Sep 2005. Shown: upper and deep, unfiltered and filtered \( \Psi \).
- 30-15d and 15-7d features propagate downstream, along the front.

5. Dispersion Curve

Phase speed vs wavenumber and wavelength from CEOF analysis of along-path upper \( \Psi \) in boxed regions (Topic 2).
- Speeds equal those in Gulf Stream within statistical confidence.
  - Comparison symbols show estimates from references cited below.
  - Methodologies differ:
    - Propagation is along-path so distance \( ds \) is longer, with larger \( ds/dt \).
    - Propagation is zonal in the other studies.

SUMMARY

- Upper and deep meanders propagate jointly downstream along the path.
- Speed changes of \( (\lambda, \ell, c) \) = \((220\text{km}, 5\text{d}, 44\text{km/d})\) to \((350\text{km}, 20\text{d}, 17\text{km/d})\).
- Substantial vertical velocities in frontal waves, by tendency and advection, \( \sim 100-200 \text{ m}^2 \text{d}^{-1} \) down- and up-welling entering trough and crest.

References


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