

# THE SLOWLY VARYING MEAN TRANSPORT IN THE KUROSHIO EXTENSION FROM SEA SURFACE TO SEA FLOOR

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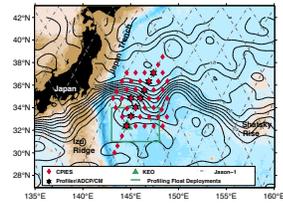
## Overview / Summary

By mapping the total transport streamfunction, the throughflow contribution can be distinguished from the southern and northern recirculations on the sides of the Kuroshio Extension. The transport can be further partitioned into baroclinic and depth-independent deep reference contributions. The slow variation of the mean flow field and its along-stream changes can be quantified relative to pathway crests and troughs.

## 1. Introduction

The transport of the Kuroshio is one key measure of the circulation of the North Pacific, and serves as a metric for numerical models.

How does one quantify the transport in the face of lateral gyres of local recirculation, and spatio-temporal changes?

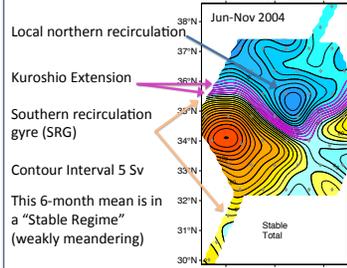


- Acoustic travel times estimate the specific volume anomaly profile and baroclinic transport potential.
- Bottom pressures and currents provide the absolute reference velocities.

## 2. Methods and Circulation features

The Kuroshio Extension System Study (KESS) array of CRIES mapped the baroclinic and the absolute referenced transport through the full water column.

The streamfunction for total transport illustrates the circulation features:



This 6-month mean is in a "Stable Regime" (weakly meandering)

## 3. Distinguishing Throughflow and Recirculation

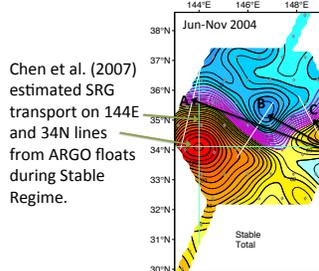
Maps clarify which of the inflowing contours continue east or diverge towards recirculations.

A local northern recirculation is associated with streamfunction contours that encircle the cyclonic low; i.e., ← contours -15 to +10

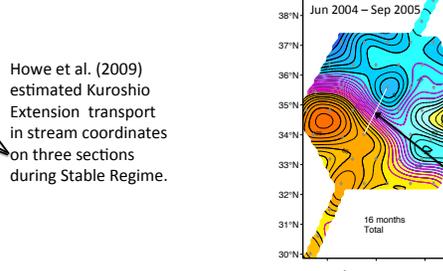
The throughflow is associated with streamfunction contours that can be traced uninterrupted from west to east; i.e., ← magenta contours 15 to 40

The southern recirculation gyre is associated with streamfunction contours that encircle the anticyclonic high; i.e., ← contours 50 to 120.

## 5. Comparison with Contemporaneous Estimates



Chen et al. (2007) estimated SRG transport on 144E and 34N lines from ARGO floats during Stable Regime.



Howe et al. (2009) estimated Kuroshio Extension transport in stream coordinates on three sections during Stable Regime.

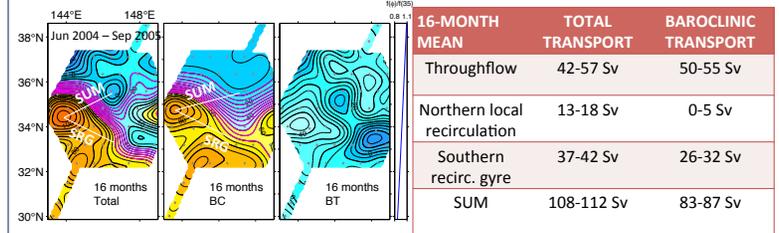
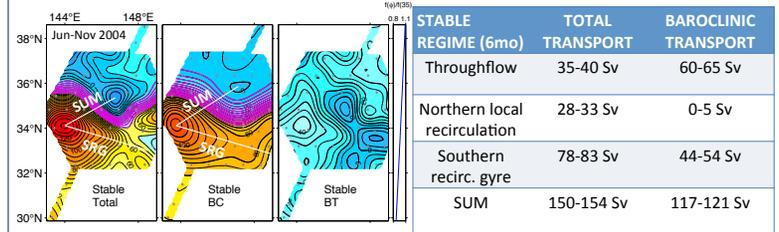
Jayne et al. (2009) estimated 16-month mean total stream coordinates transport from CM moorings on KESS central transect, spanning Stable & Unstable Regimes.

Mapped absolute SRG transport: 78-83 Sv. Chen et al.'s SRG estimate, 101 ± 8 Sv, assumed the 1500 m velocity extended to the bottom. This was an overestimate because the 1500 m velocities have about 50/50 contribution from baroclinic and deep nearly depth-independent currents.

Total transport to zero-crossings: Section: A B C  
 Howe et al: 138 Sv 124 Sv 75 Sv  
 Mapped: 135 Sv 117 Sv 70 Sv  
 The mapped geographic mean estimates underestimate the stream-coordinates mean transports slightly in the Stable Regime.

Total transp: stream-coords geographic  
 Jayne et al: 114 ± 13 Sv 79 Sv  
 Mapped: -- 83 Sv  
 (using same geographic end-points)  
 Independent measurements of the current confirm a ~30% reduction of transport in a geographic mean for a narrow strongly meandering jet bounded by recirculations.

## 4. Mean Transports: Stable 6-months & Combined 16-months



## 6. Conclusions

- Throughflow total transport ~40 Sv compares well with throughflow south of Japan (42-43 Sv) as reported by Ichikawa et al. (2001) and website www.riam.kyushu-u.ac.jp/oed/asuka/alt.
  - total throughflow increased in 16-month mean, but the distinction between throughflow versus recirculation contours may be ambiguous.
- Strong meandering weakens most geographic mean transports 20-30% in 16-month period.
- Throughflow baroclinic transport re 5300 dbar associated with the upper jet carries 60-65 Sv in the Stable Regime.
- Deep flows consist of many small recirculations ~20-40 Sv;
  - mean patterns are remarkably similar in the two intervals, despite the strong temporal variability in the Unstable Regime.
- Northern local recirculation, not evident in the baroclinic transport, is a barotropic feature.
- Southern recirculation total transport (~80 Sv) is ~60% baroclinic;
  - Two cold-core rings passed through the SRG soon after the Stable Regime, reducing its mean baroclinic and total transports each by nearly half.

## References

Chen, S., B. Qiu, and P. Hacker (2007) 'Profiling float measurements of the recirculation gyre south of the Kuroshio Extension in May-Nov 2004' *Jour. Geophys. Res.* **112**, C05023, doi: 10.1029/2006JC004005.  
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## Acknowledgements

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