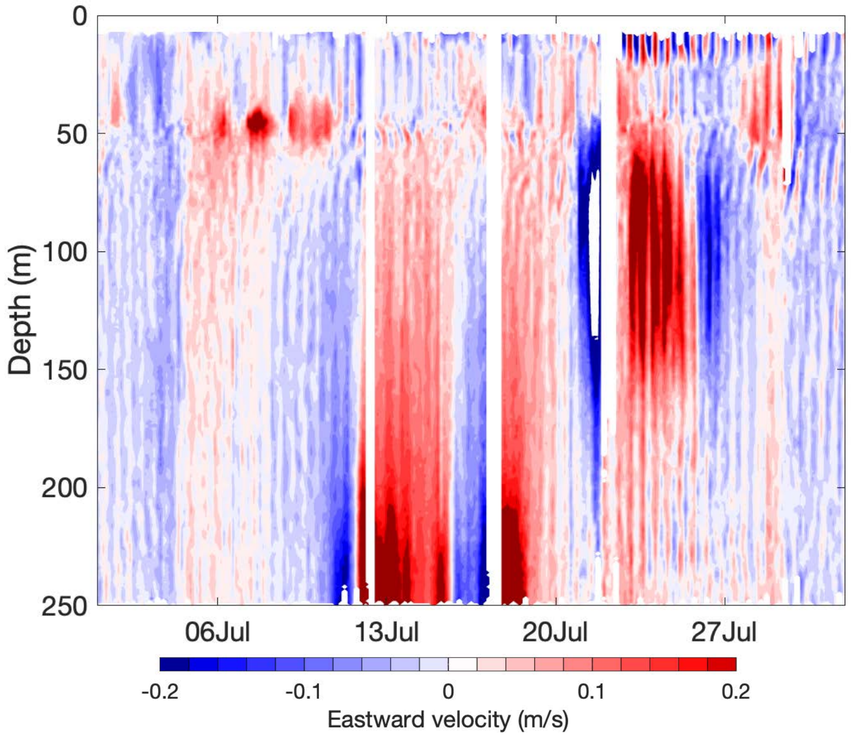
The Partitioning of Kinetic Energy in the Western Arctic Ocean

Sylvia Cole
Woods Hole Oceanographic Institution



Arctic Ocean Circulation Workshop
June 2022

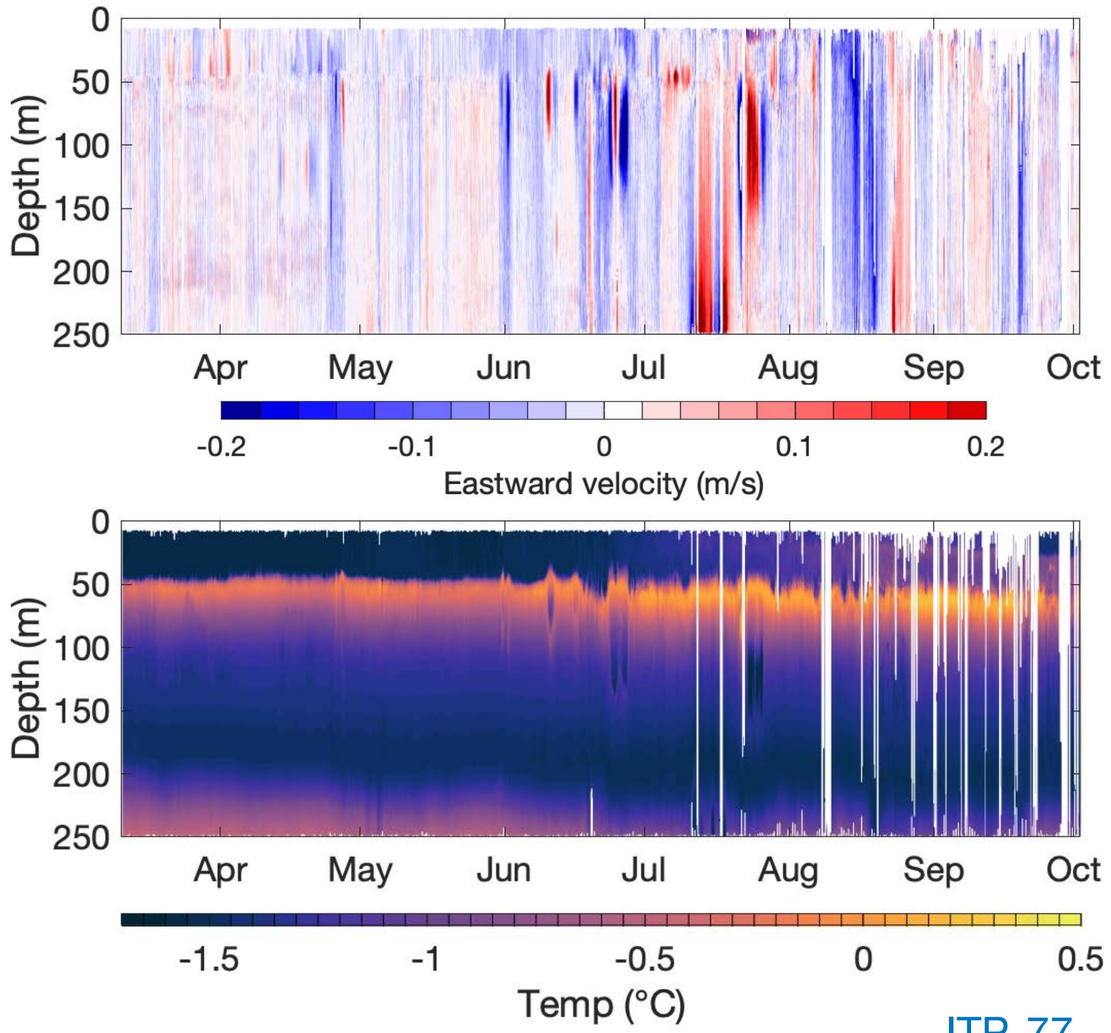
Circulation

Circulation = Mean + Variability

- Mean state
- Eddies
- Near-inertial + smaller-scale motions
  - Depth Structure
  - Seasonality
  - Relationship to ice cover?

GOAL is to quantify and understand:

- Partitioning across scales / processes
- Partitioning with depth and season



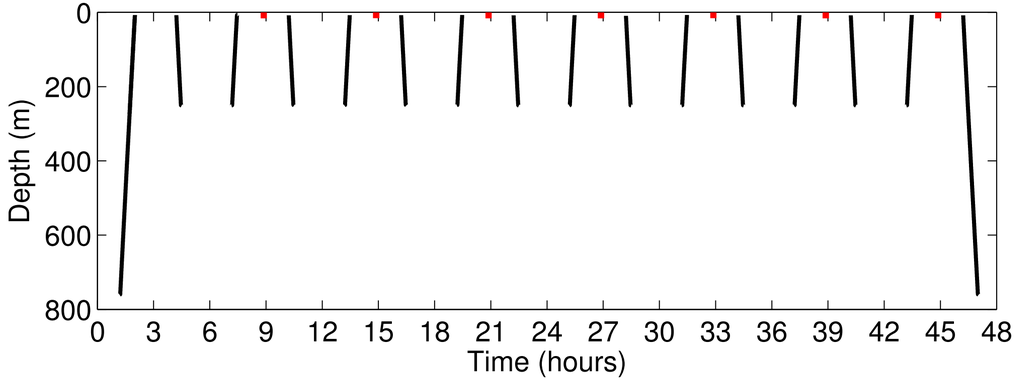
ITP-77

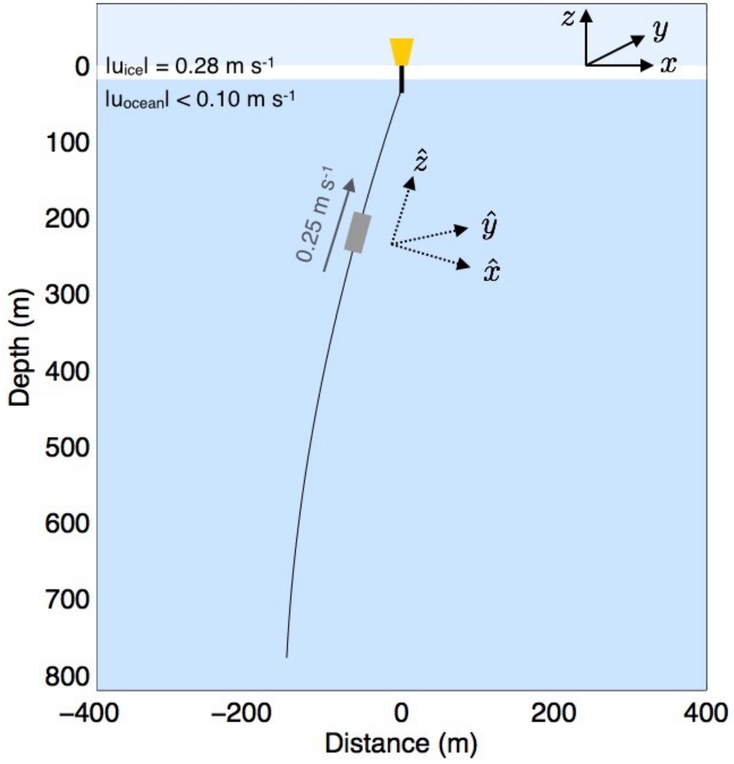
For the Arctic: variability > mean

Ice-Tethered Profiler with Velocity (ITP-V)

Profile ~7-250 m depth every 3 hours
- Observes surface layer and interior
- High temporal and vertical resolution

Moored into and drift with ice cover
- Can estimate horizontal scale

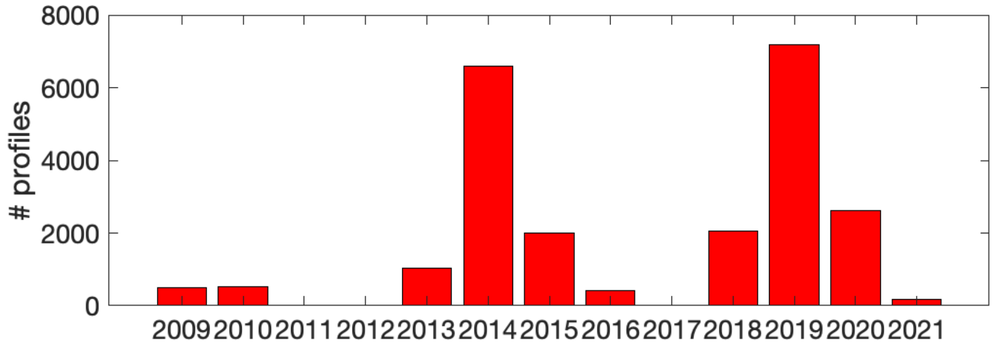




http://www.whoi.edu/itp

ITP-V observations

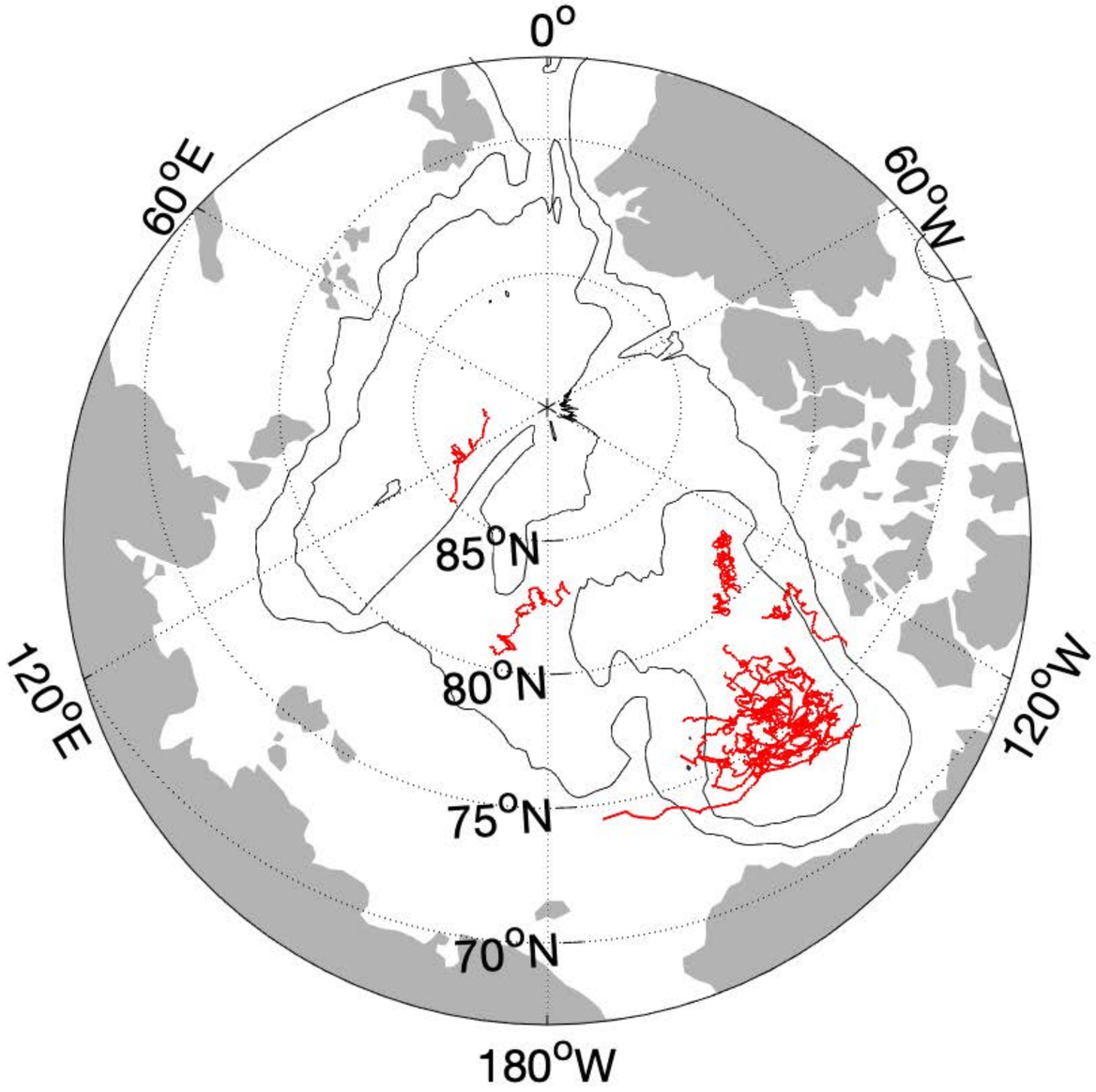
14 ITP-Vs in the Arctic
23,000+ profiles
Primarily central Beaufort Gyre



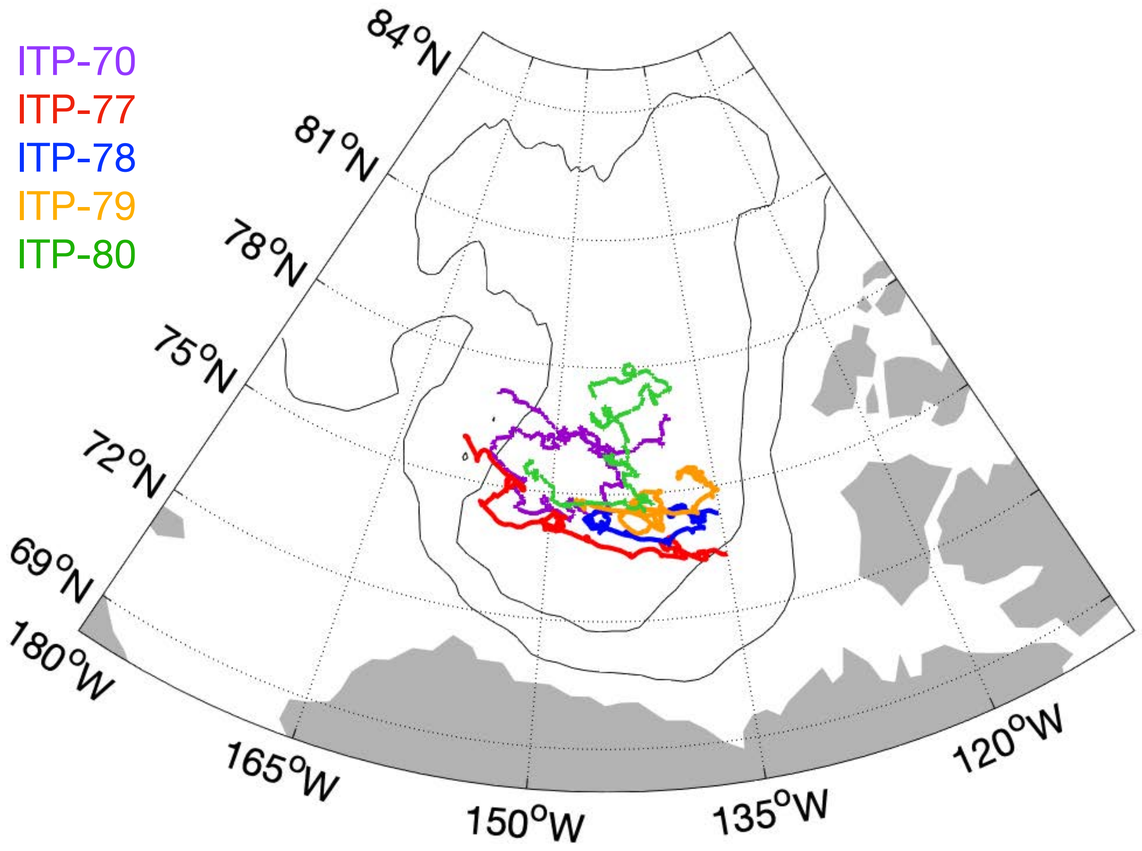
ITP-35

ITP-70, 77, 78, 79, 80, 92

ITP-102, 103, 104, 105, 113, 114, 115

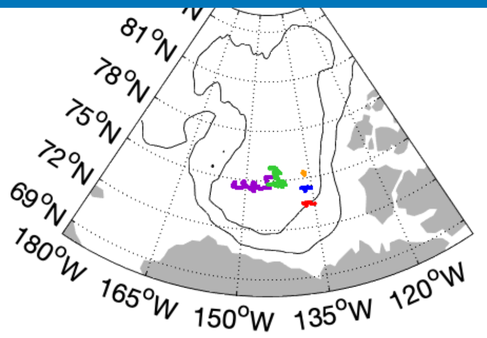


ITP-V observations

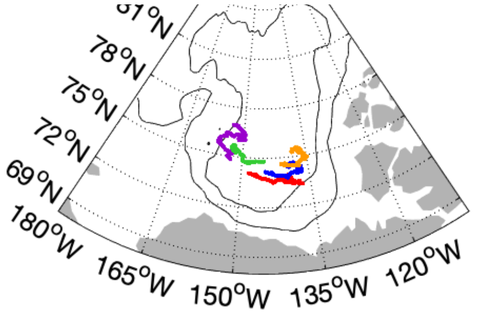


5 ITP-Vs in the central Beaufort Gyre
8,000+ profiles
Aug 2013 to May 2015

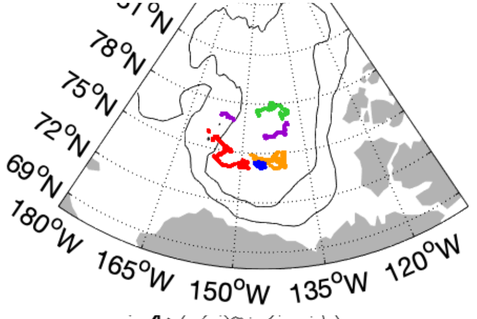
Winter (JFM)
1,844 profiles



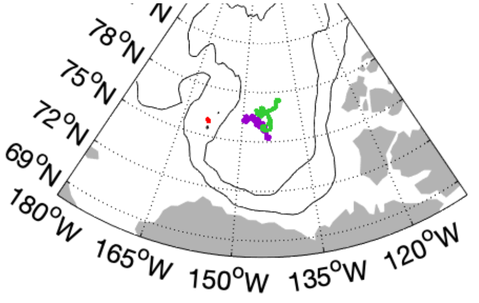
Spring (AMJ)
3,326 profiles



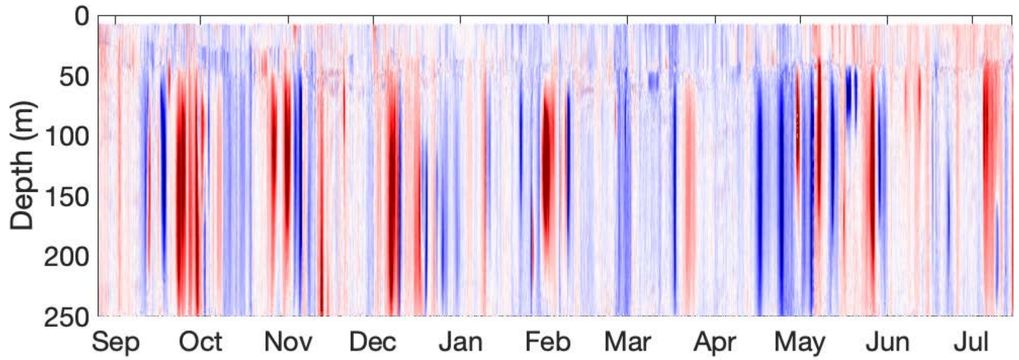
Summer (JAS)
2,093 profiles



Fall (OND)
1,471 profiles

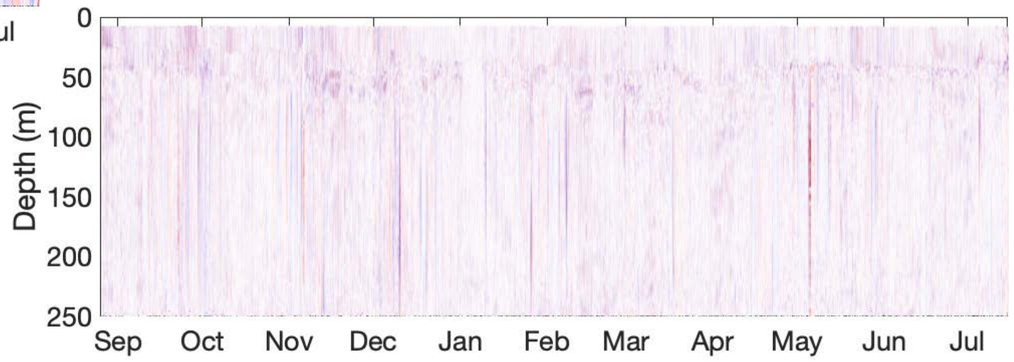


Methods

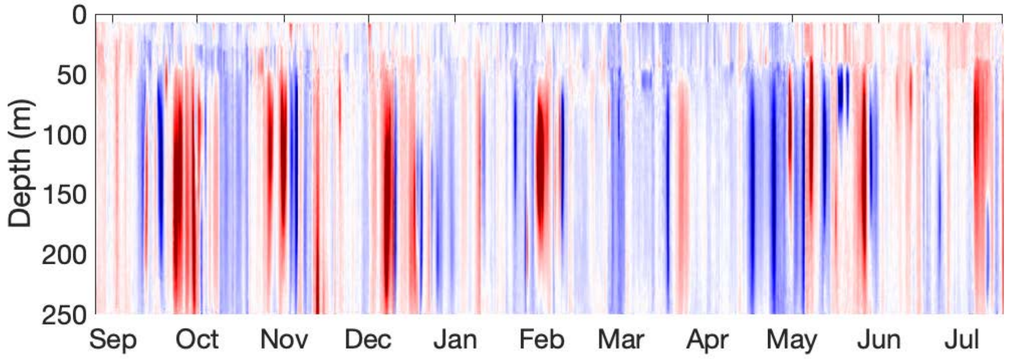


ITP-70

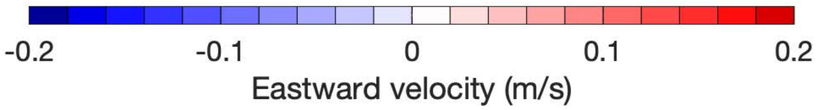
12 hour time filter



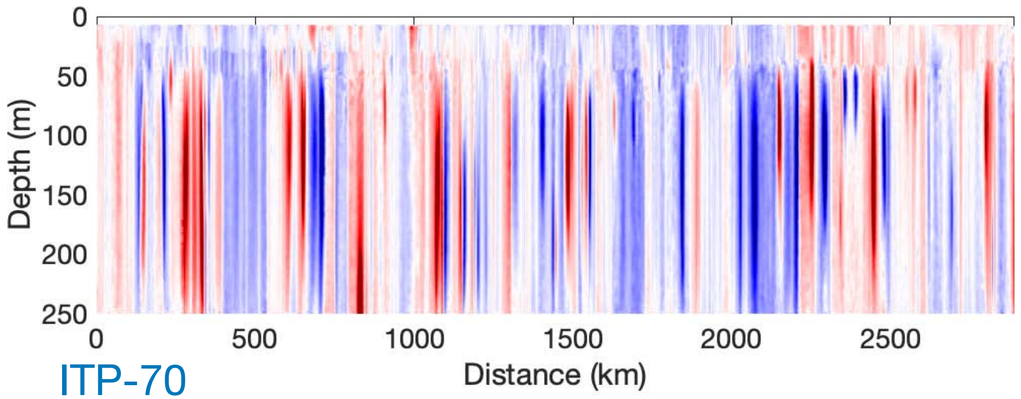
Near-inertial KE



Everything else



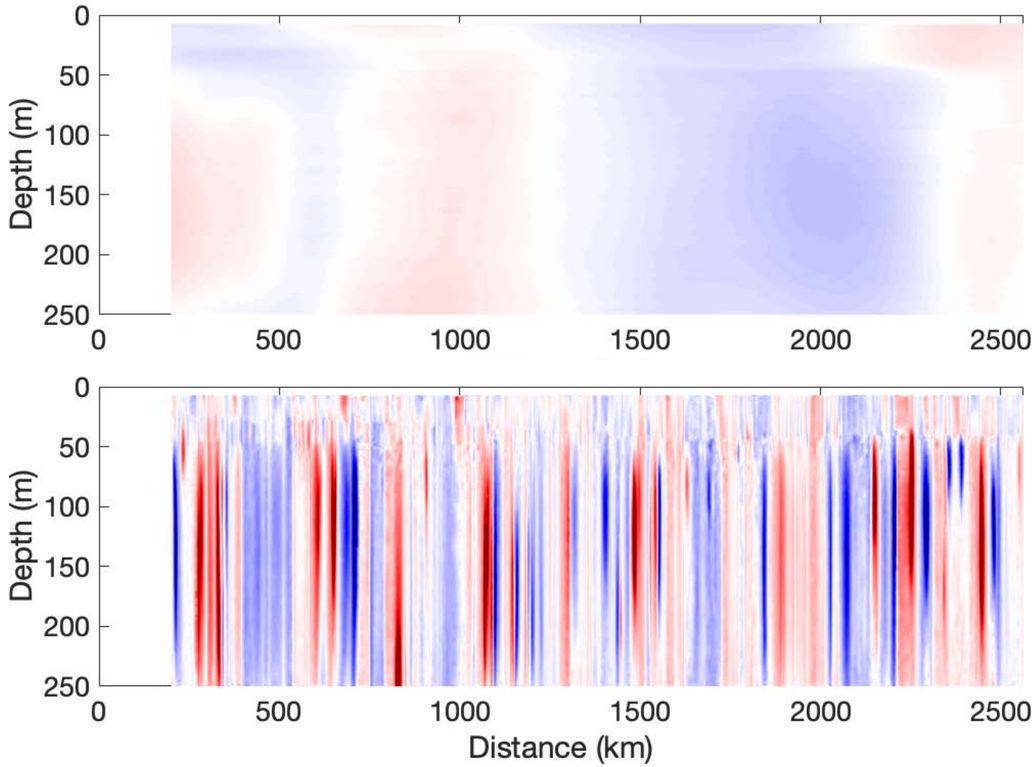
Methods



ITP-70

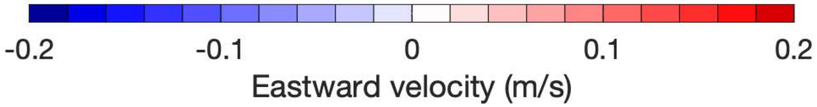
Interpolated to distance

400 km scale spatial filter

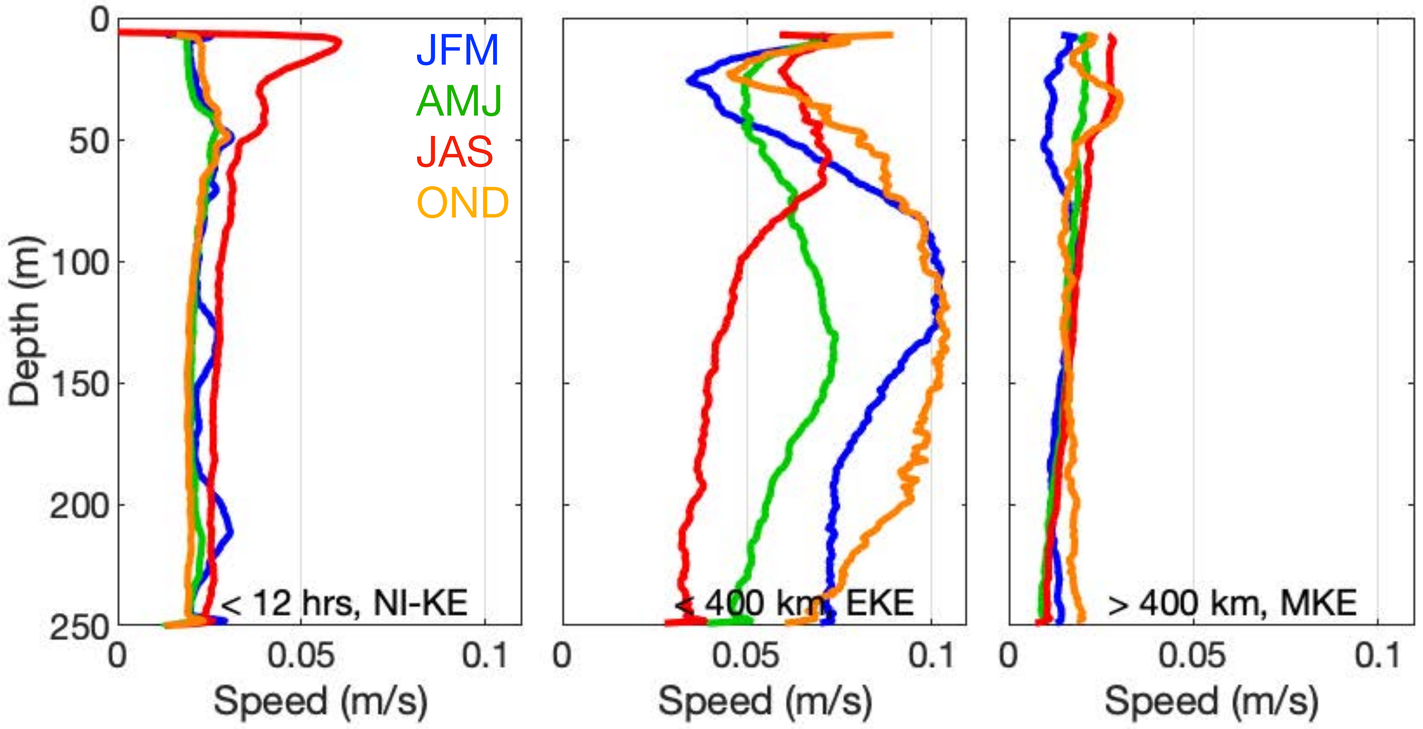


Mean
> 400 km
> ~ 45 days

Eddies
< 400 km
< ~ 0.5-45 days



KE Partitioning



Most energy in the EKE field

Little seasonality below surface layer

Depth structure and seasonality is distinct between processes

Near-Inertial

Seasonal mixed layer

Eddies

Interior maximum
High variabiltiy

Mean

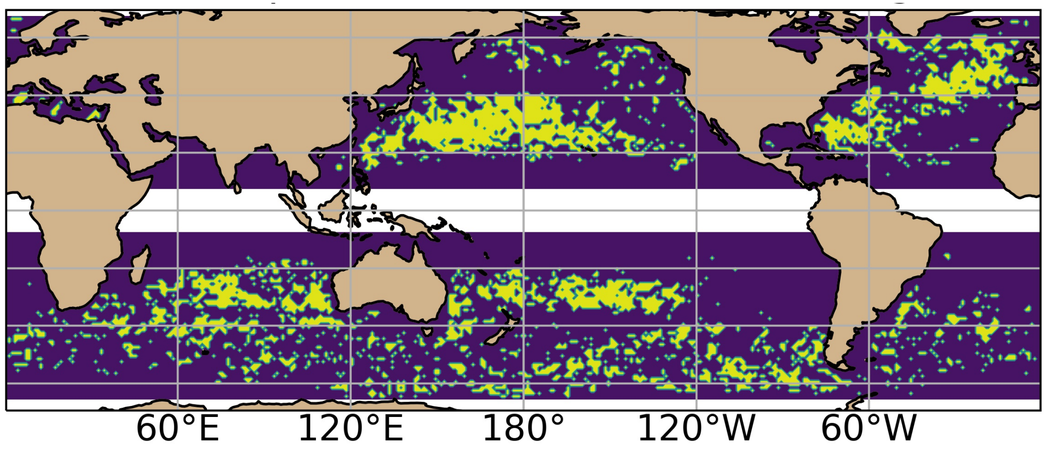
Seasonal mixed layer
Decays with depth

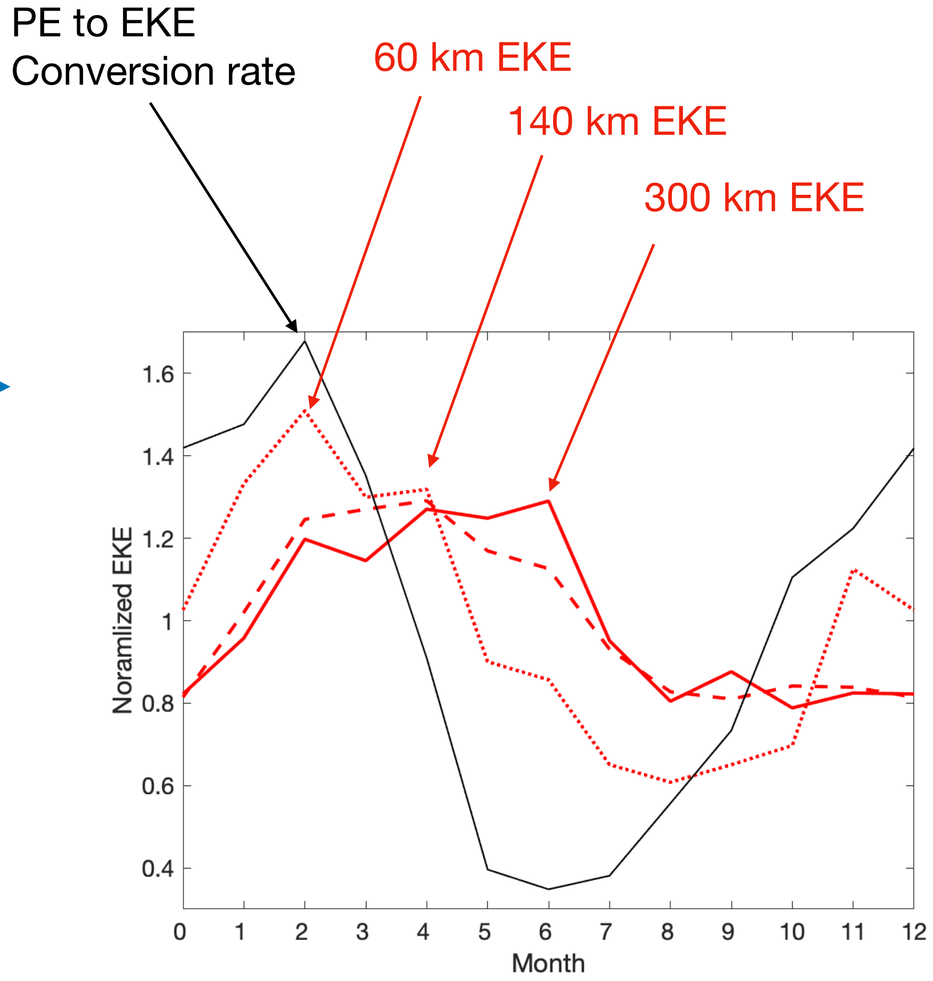
Eddy Kinetic Energy Across Scales

Global EKE analysis: Steinberg et al. 2022 JPO
- Along-track SSH observations
- Partition by scale and season

Learn about the ocean + Directly compare with models →

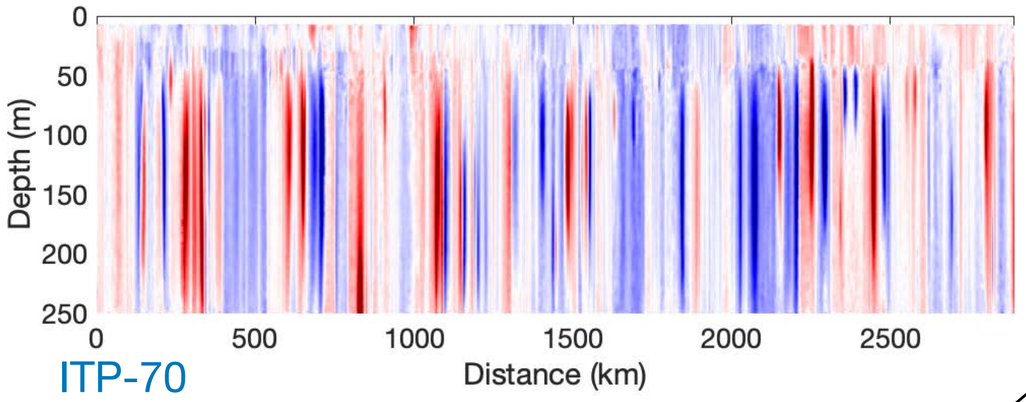
Where inverse cascades are dominant





50°N, 15°W

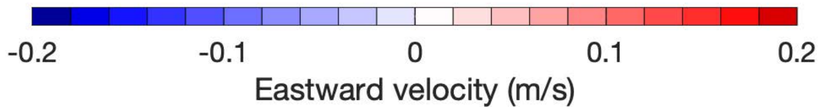
Methods

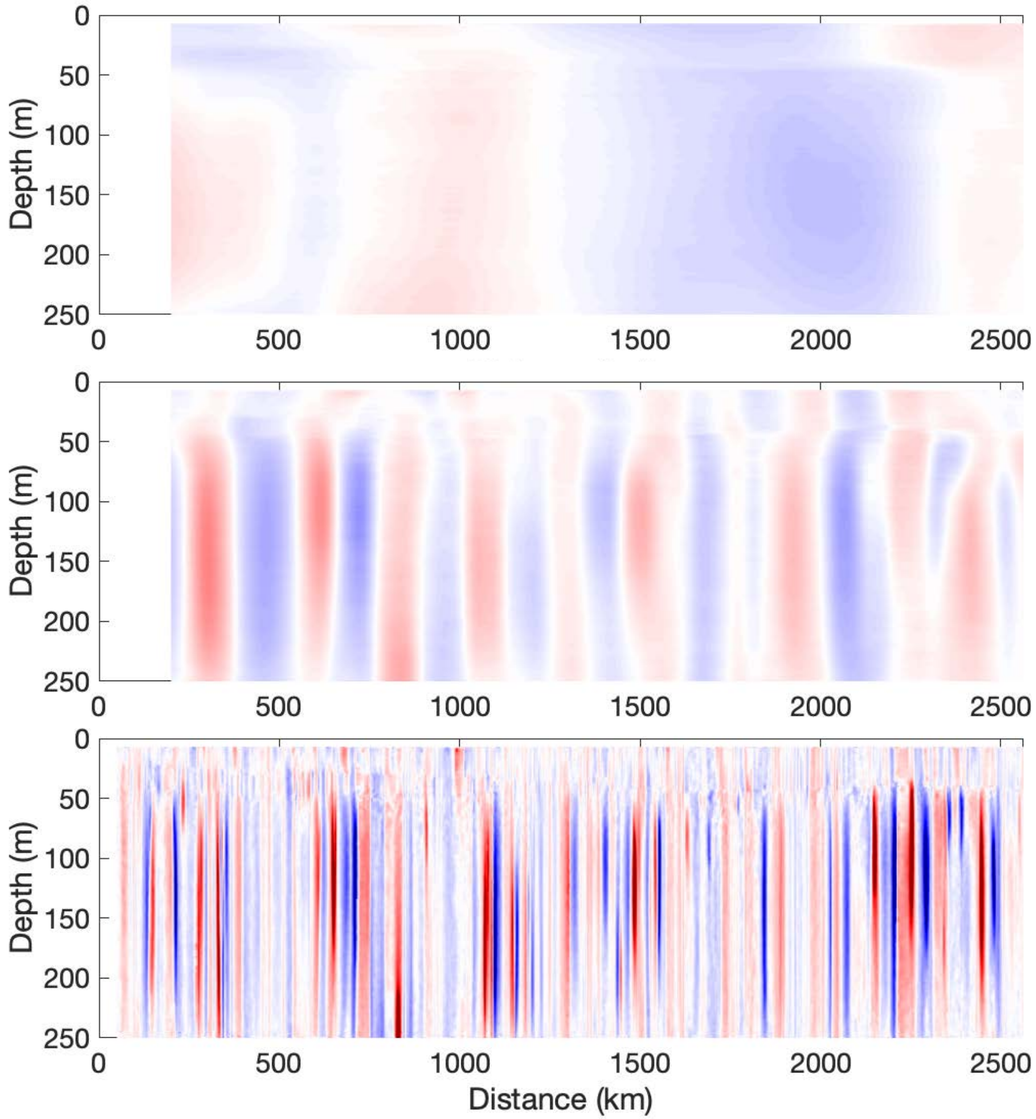


ITP-70

Interpolated to distance

Series of spatial filters
25, 50, 100, 200, 400 km scales



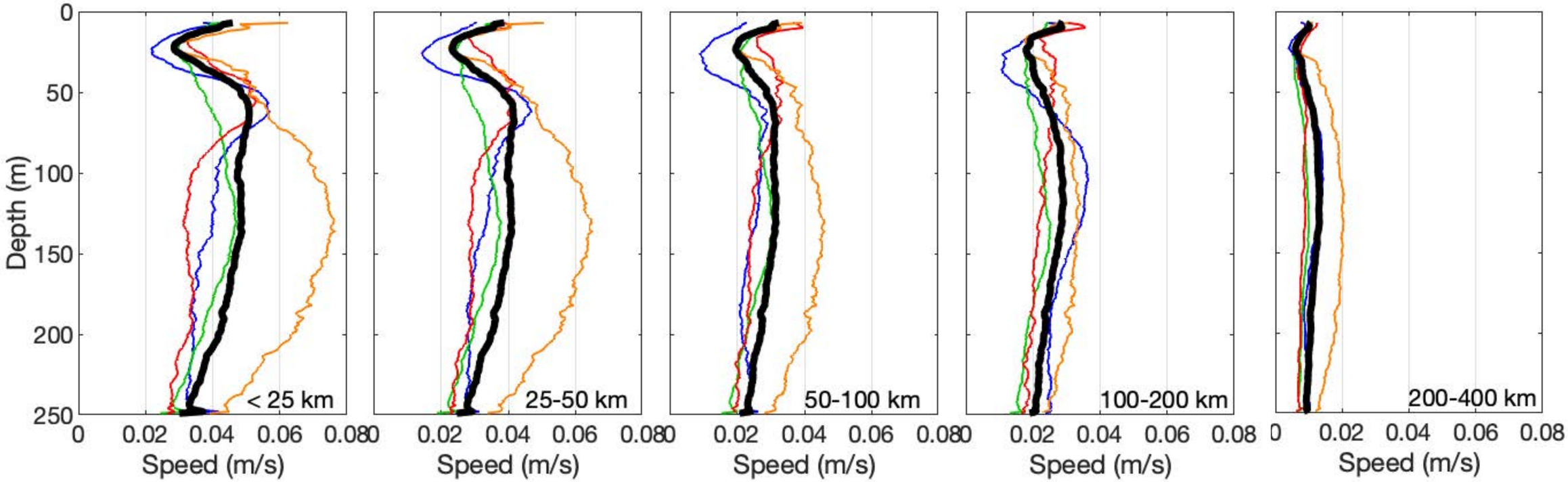


Mean
> 400 km
> ~ 45 days

Large eddies
100-400 km
~10-45 days

Small eddies
<100 km
~0.5-10 days

Eddy Kinetic Energy

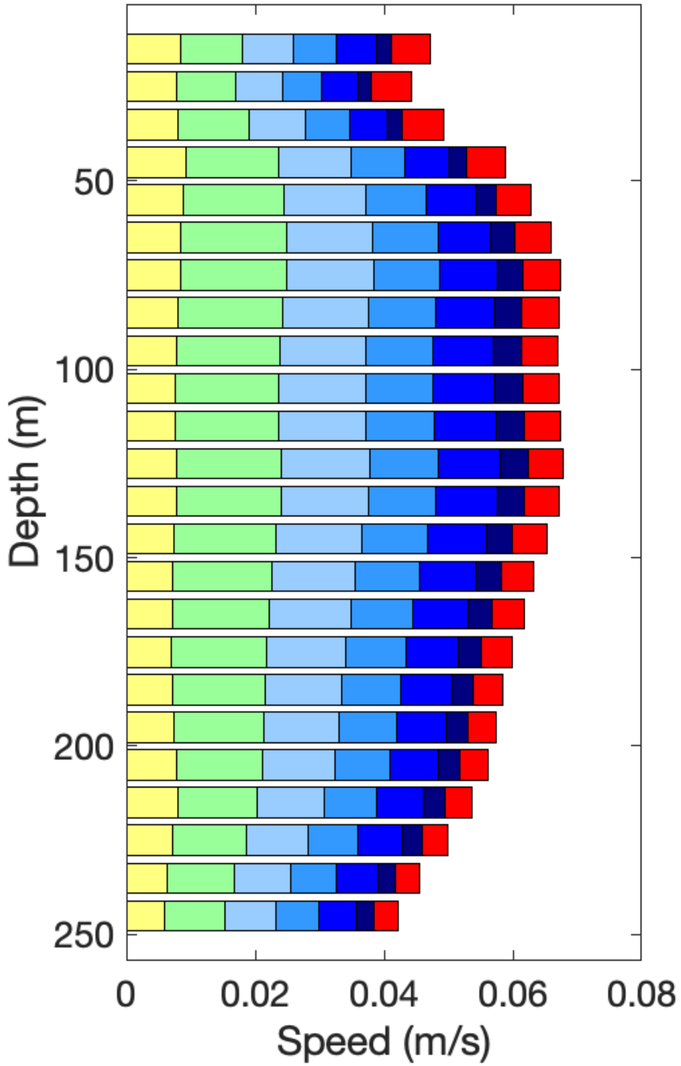


JFM
AMJ
JAS
OND

← Show significant variability, not seasonality

‘Meanders’ are barotropic
Dominant at scales ~100 km

KE partitioning

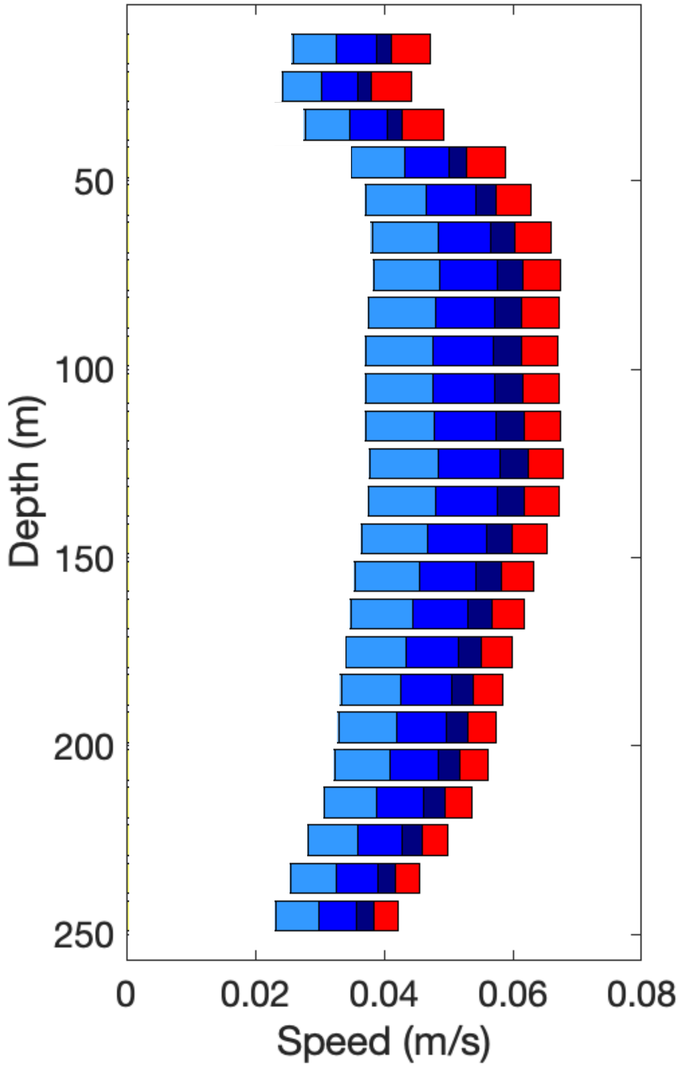


Near-inertial
2-25 km
25-50 km
50-100 km
100-200 km
200-400 km
>400 km

Mean KE:
- 10-15% over 0-30 m
- 8% over 100-150 m

Eddy KE:
- 70% over 0-30 m
- 80% over 100-150 m

KE partitioning



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200-400 km
>400 km

Mean KE:
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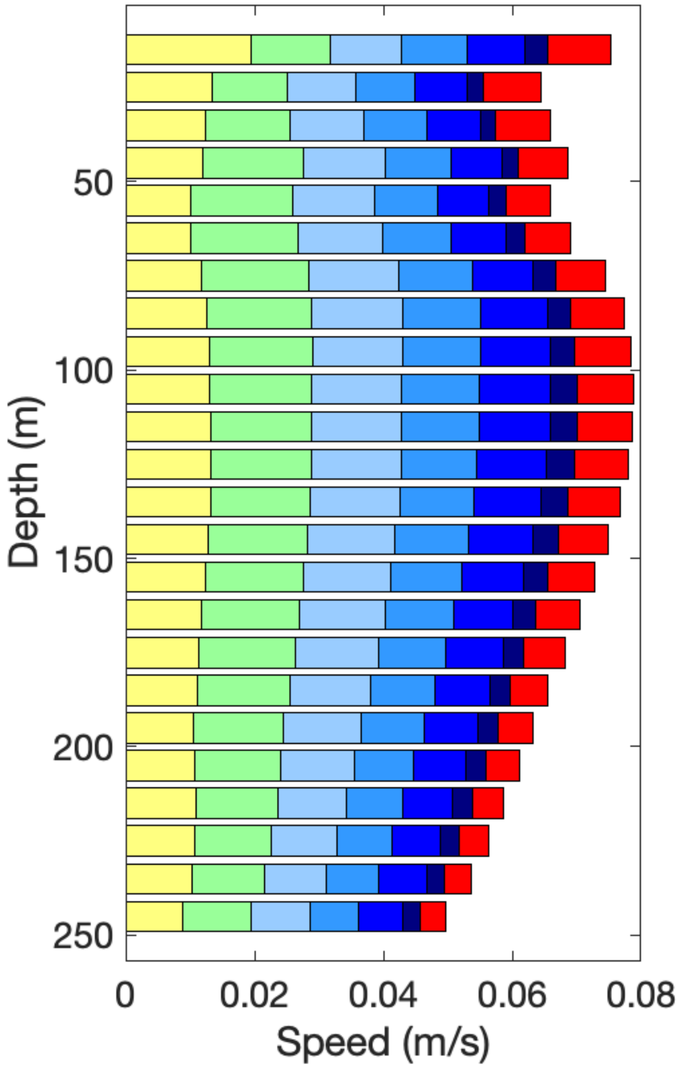
Eddy KE:
- 70% over 0-30 m
- 80% over 100-150 m

A model that resolves all energy > 50 km
Missing more than 50% of the energy at all depths

KE partitioning

JULY - SEPTEMBER



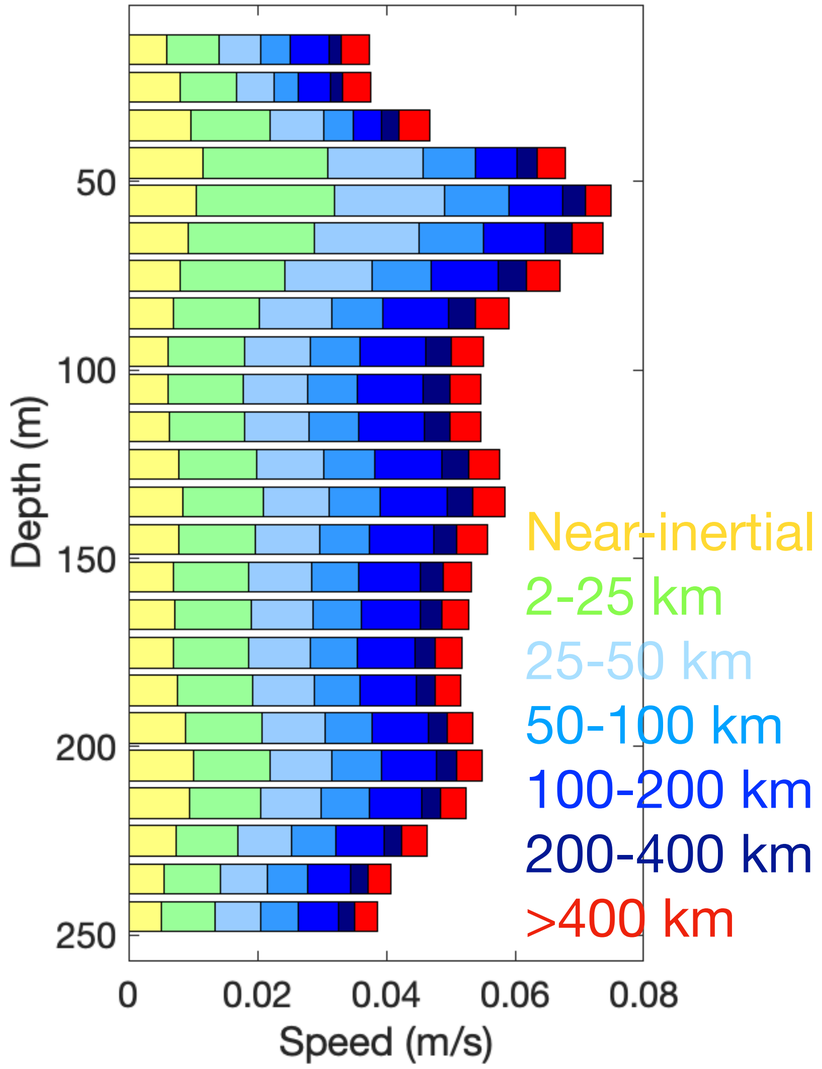
Summer vs. Winter changes are robust in the upper 40 m

All KE components are larger in the summer

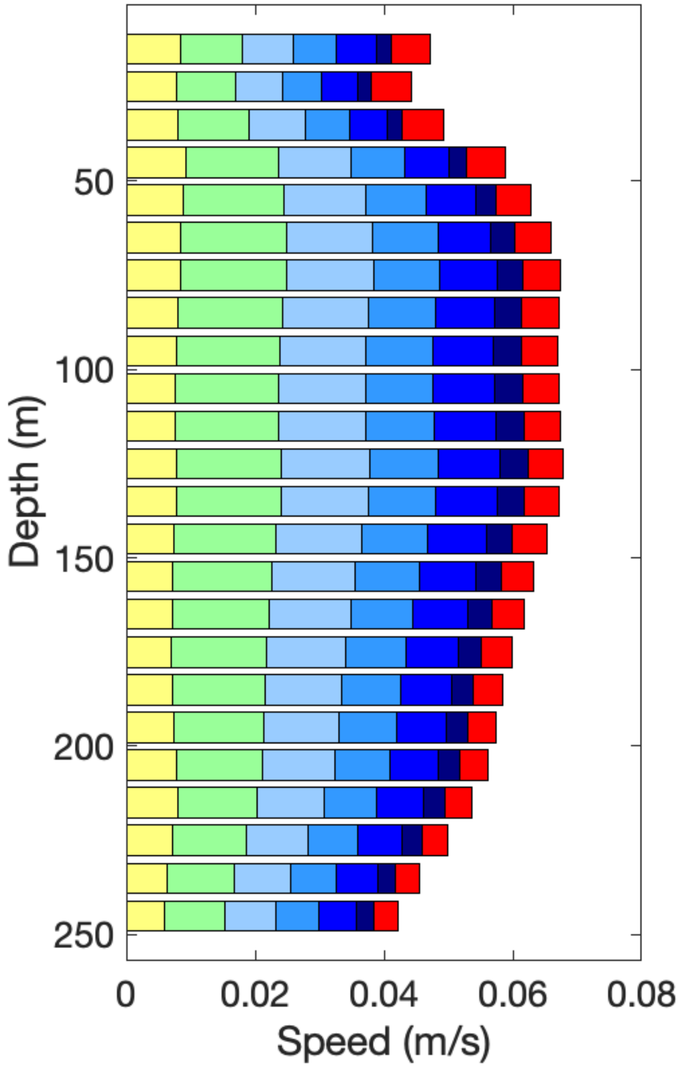
Internal waves

NI motions are elevated in summer at most depths

JANUARY - MARCH



Summary



Work in progress, many details can be cleaned up

Variability >> Mean

Distinct seasonality and depth structure between near-inertial motions, eddies, and the mean circulation

Coming attractions:
Beaufort Gyre vs. edge of Beaufort Gyre
(Eurasian Basin would be desirable)