The eastern Bering Sea shelf circulation and its role in Pacific-Arctic exchanges

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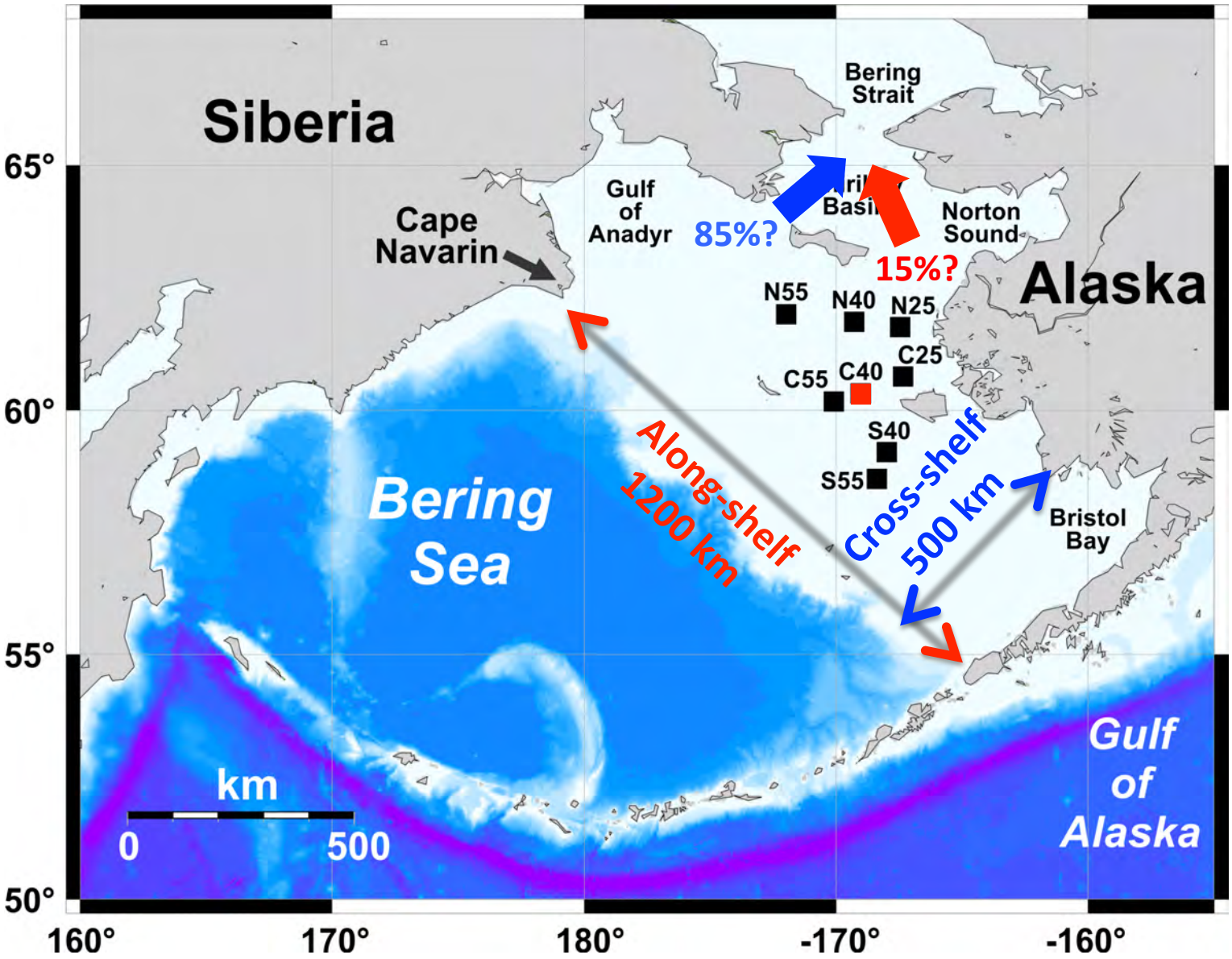
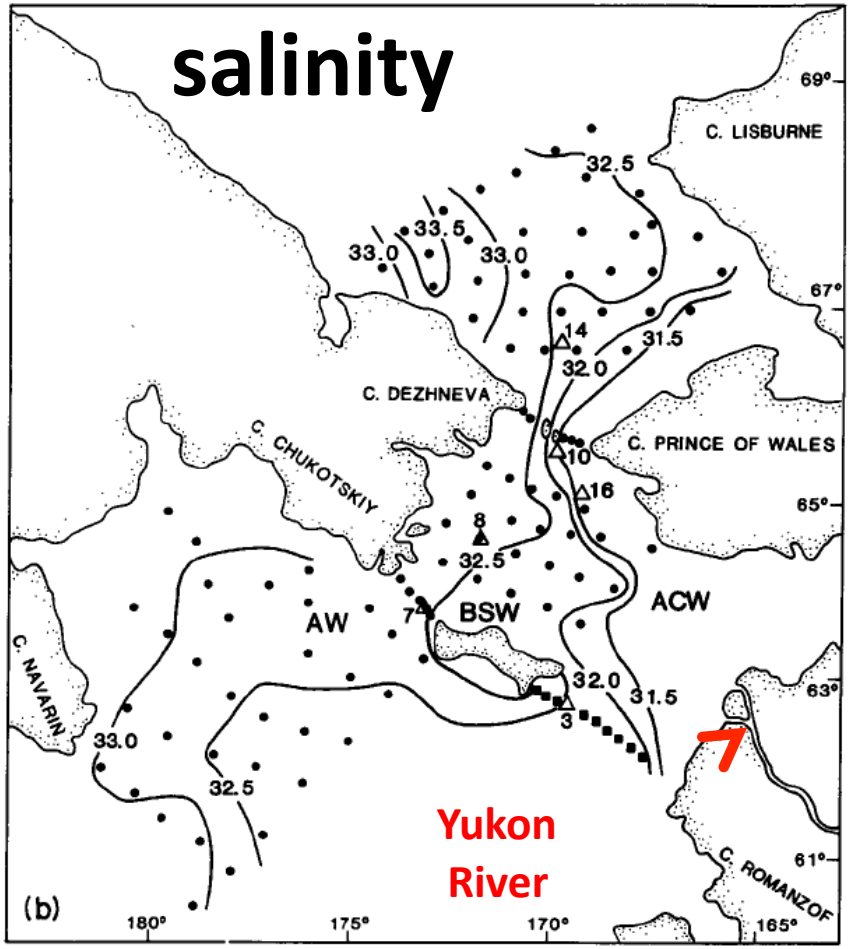
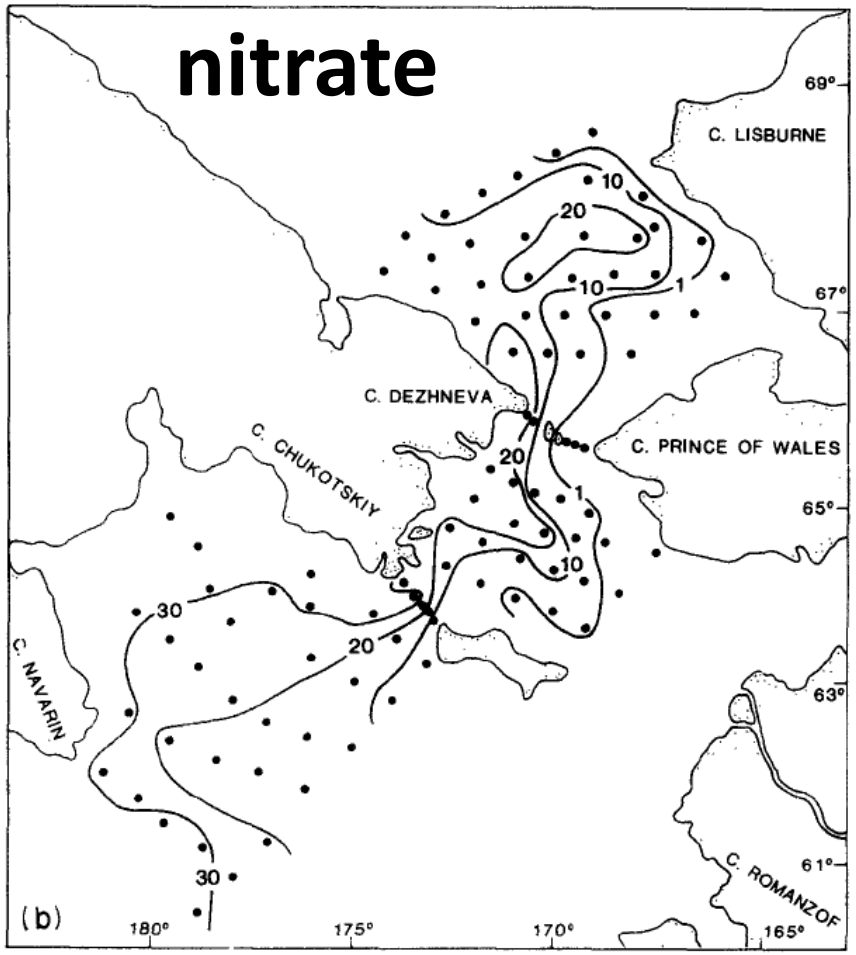
Outline

- **Introduction**
- **Bering shelf circulation: the role of wind direction**
- **Export to the Arctic: where does Bering Strait water really come from?**
  - Current meter mooring data
  - Numerical model results
  - Wind field analysis


Siberia
Alaska
Bering Strait
Gulf of Anadyr
Cape Navarin
85%?
15%?
Norton Sound
N55
N40
N25
C25
C55
C40
S40
S55
Along-shelf 1200 km
Cross-shelf 500 km
Bristol Bay
Bering Sea
Gulf of Alaska
km
0
500
65°
60°
55°
50°
160°
170°
180°
-170°
-160°

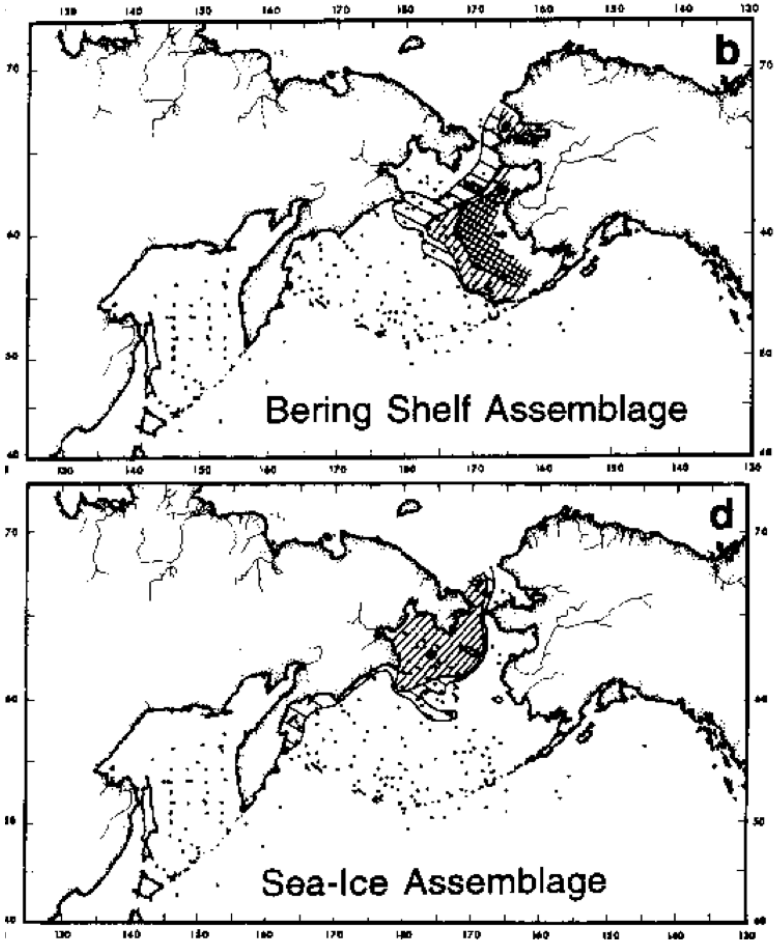
1988 August near-bottom





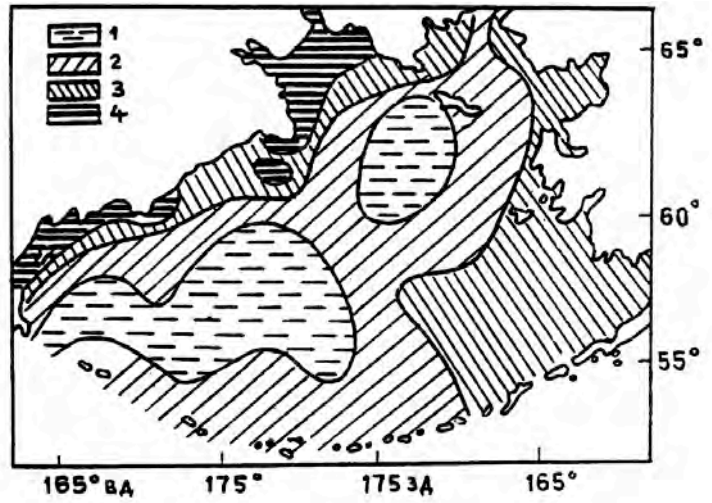
[Walsh et al., 1989]

Diatom Assemblages



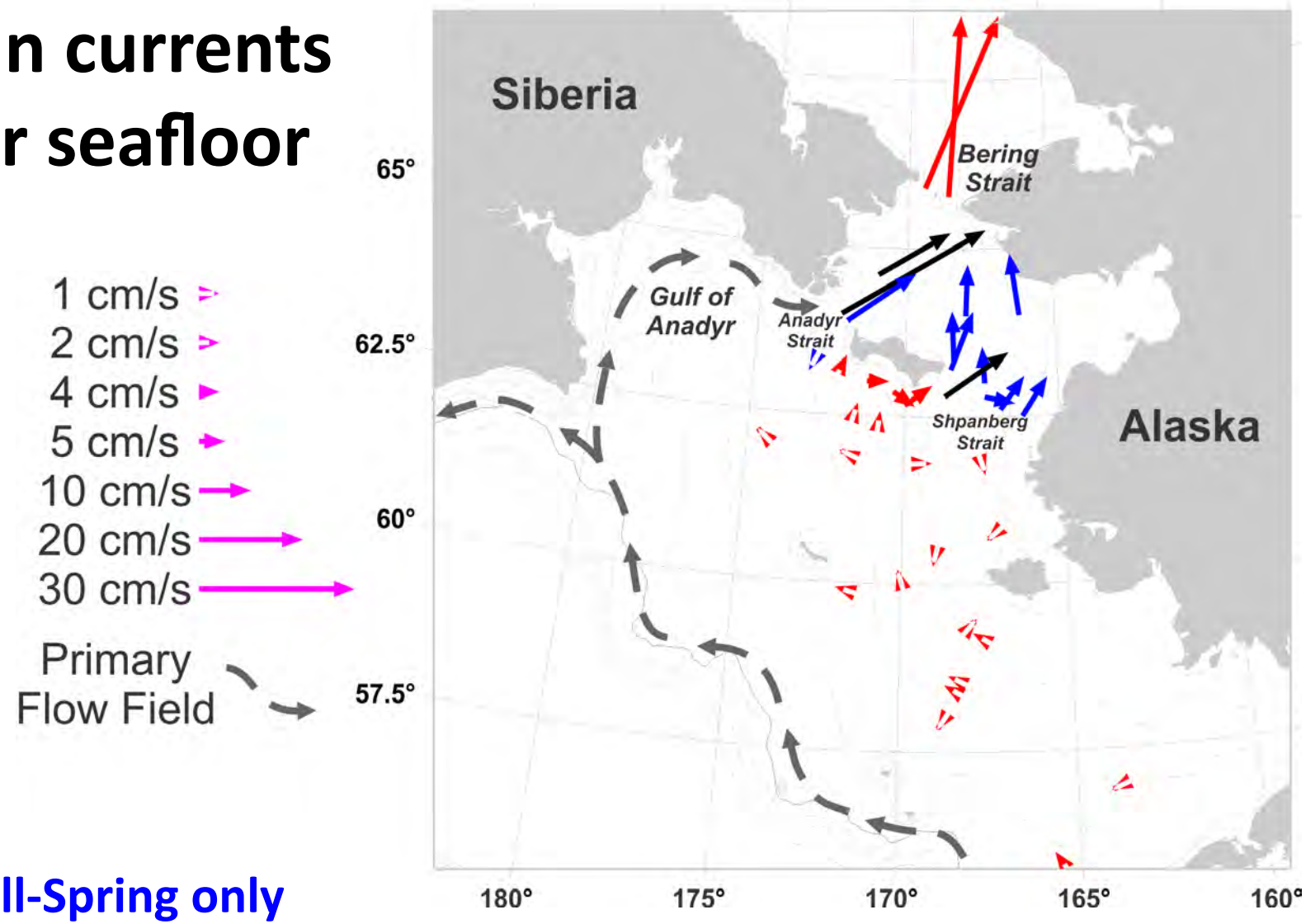
[Takahashi, 1999]

Zooplankton Biomass



[Markina & Khen, 1990]

Mean currents near seafloor

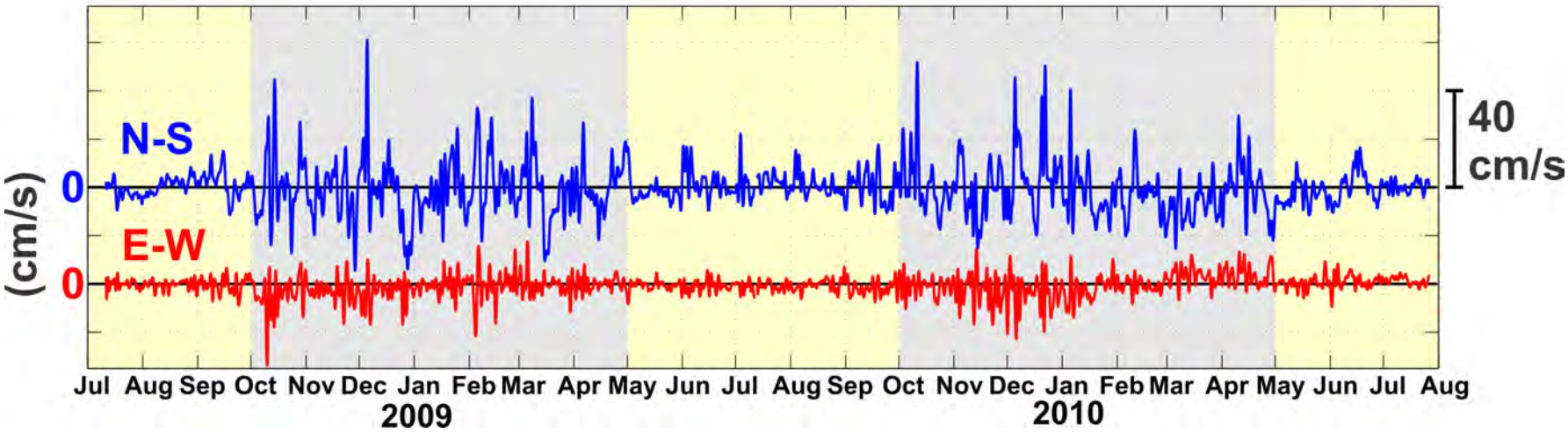


Blue: Fall-Spring only

Black: Summer-Fall only

Red: full year or longer moorings

Subtidal velocity at C40



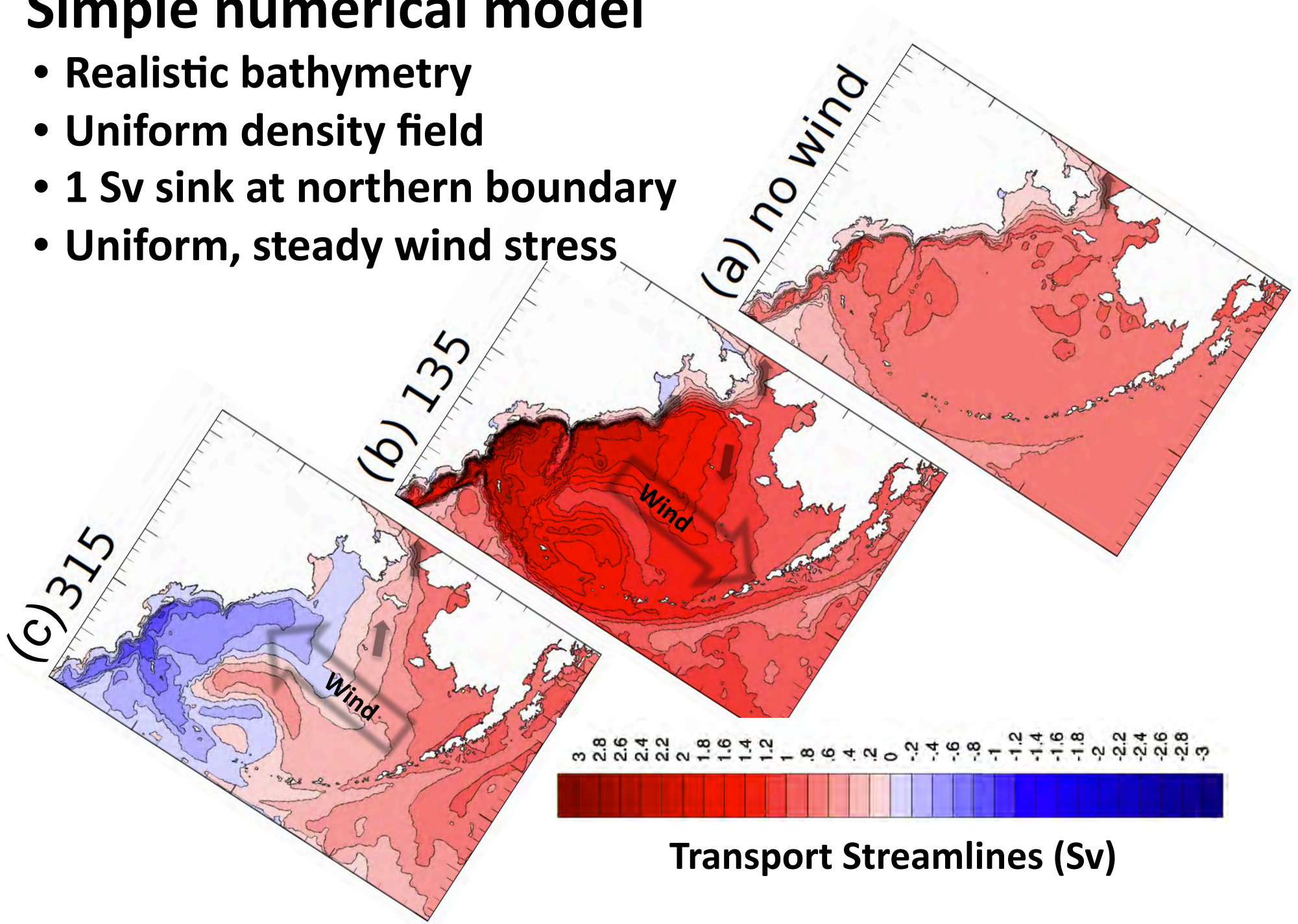
<u>October – April</u>
Weaker stratification
Stronger winds

<u>May – September</u>
Stronger stratification
Weaker winds

- **Large variance but small vector mean**
- **Seasonal differences in variance**
- **Sustained net flow over monthly time scales.**
- **Flow coherent at separations > 400 km for periods > 5 days**
- **Winds & near-surface currents coherent for periods > 4 days**

Simple numerical model

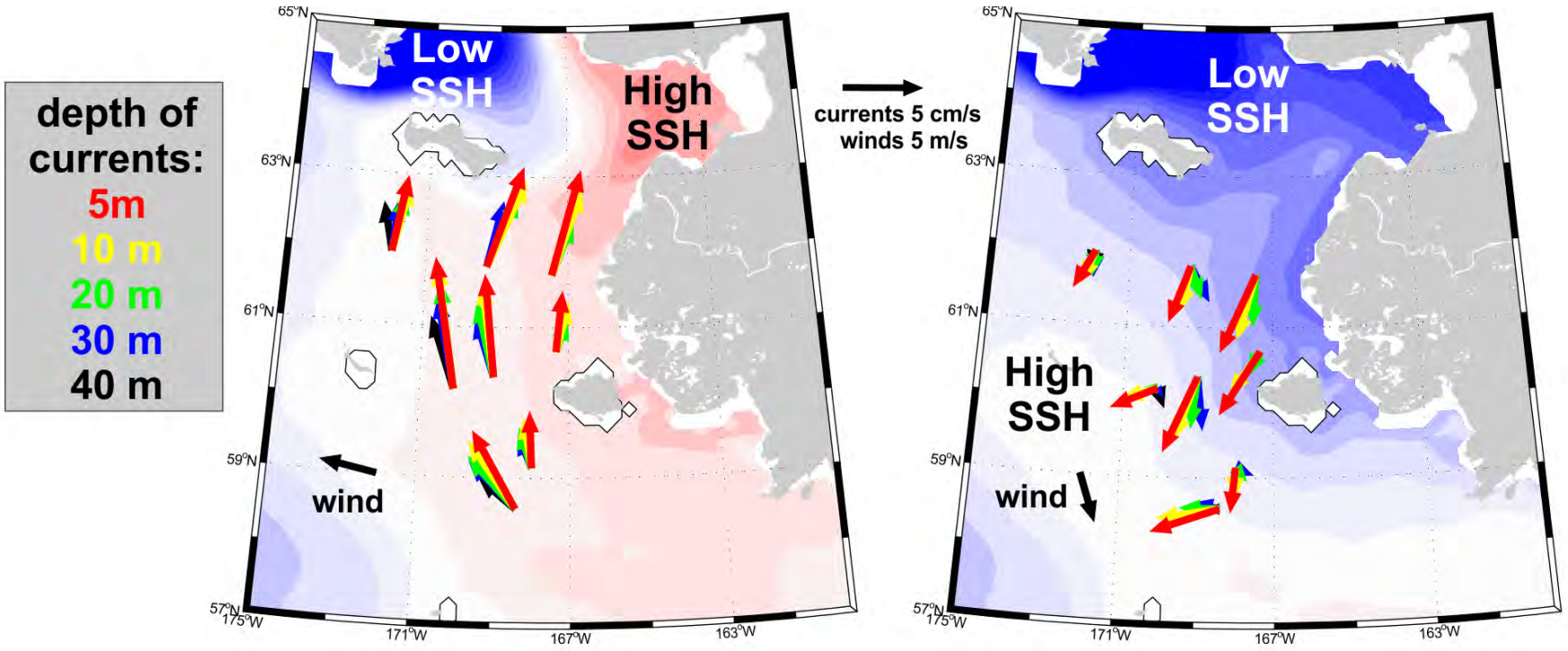
- Realistic bathymetry
- Uniform density field
- 1 Sv sink at northern boundary
- Uniform, steady wind stress



Mooring Array Results

Southeasterly winds

Northwesterly winds

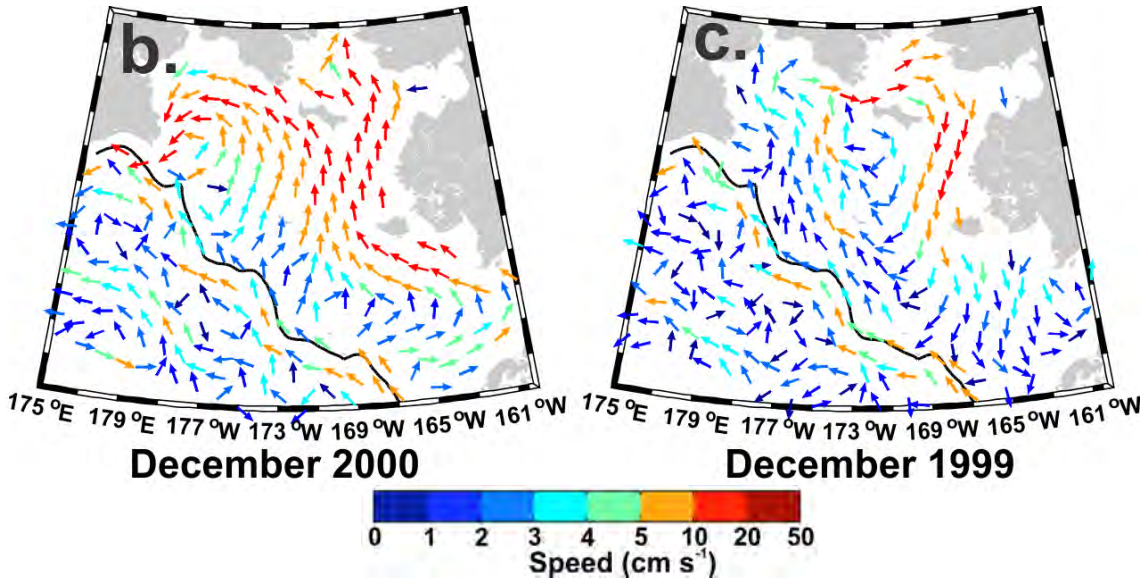


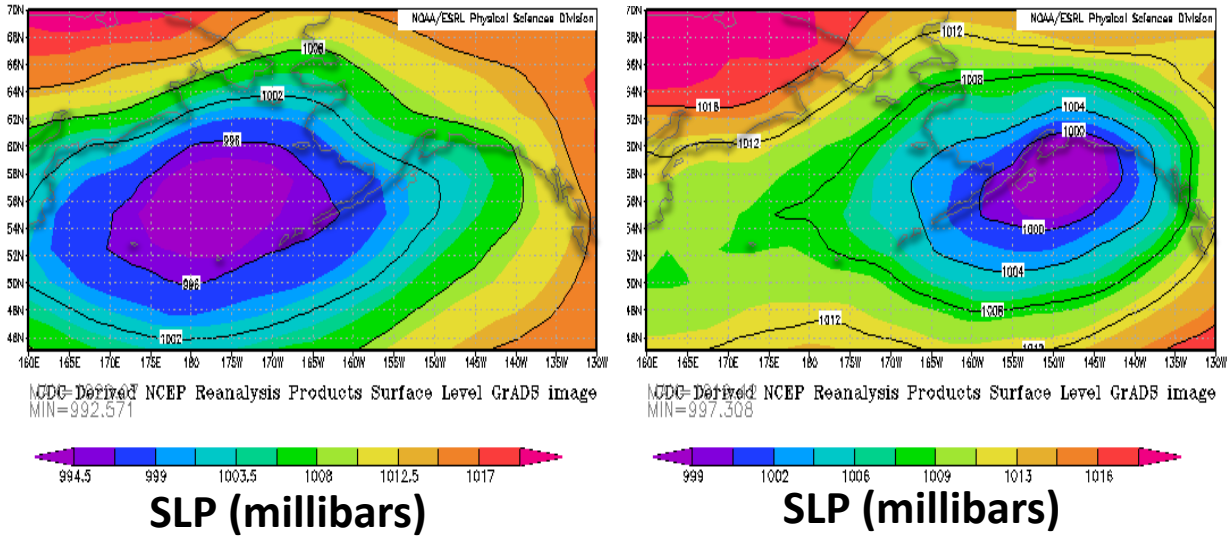
Color contours show hind-cast sea surface heights (SSH)

Example of two extreme months with complex numerical model

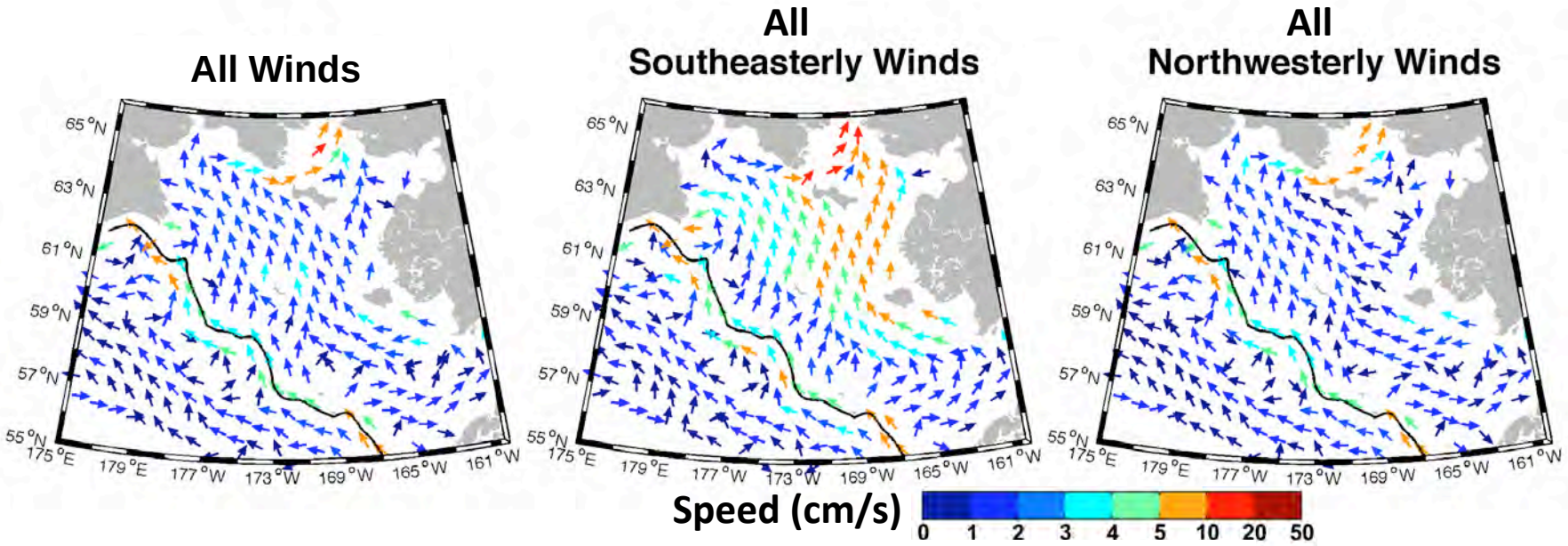
NEP6 3-D model hindcast

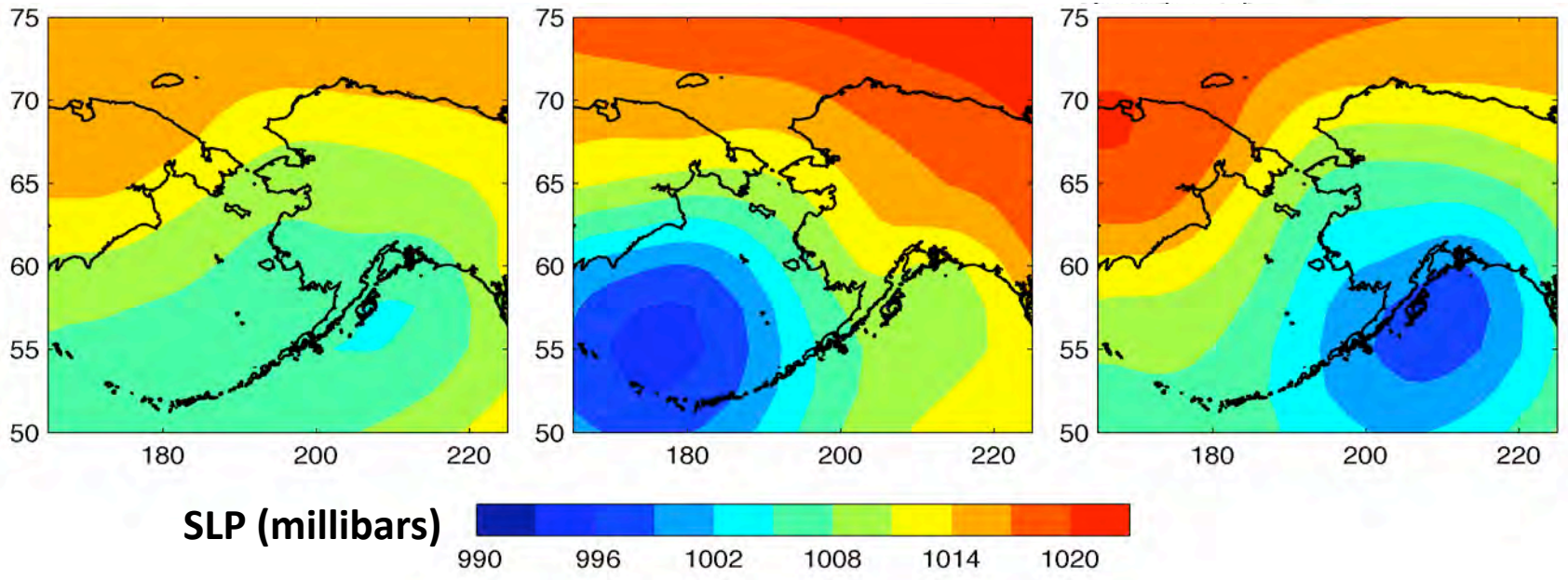
Run with realistic stratification, tides, winds, surface fluxes

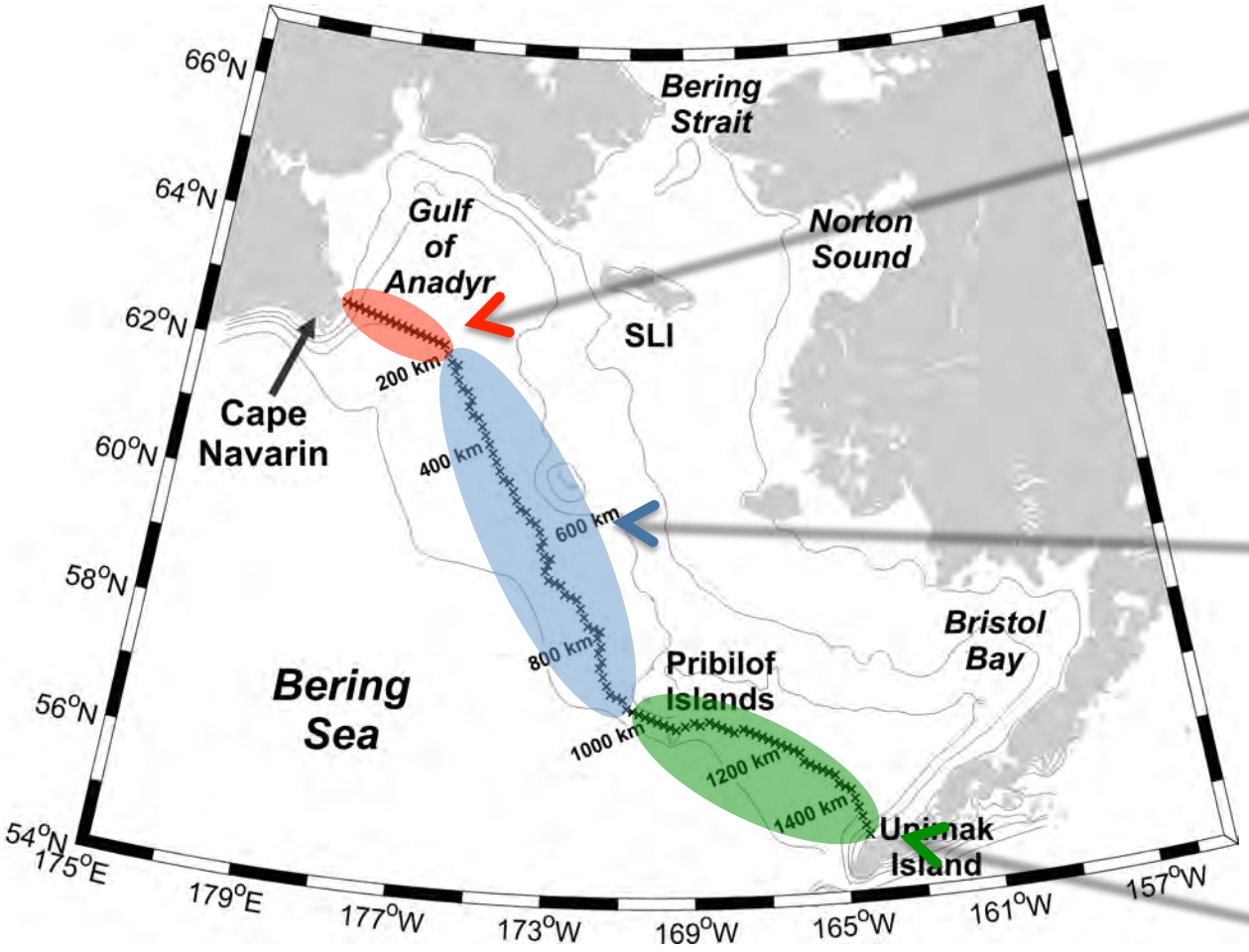




Example of typical winter conditions





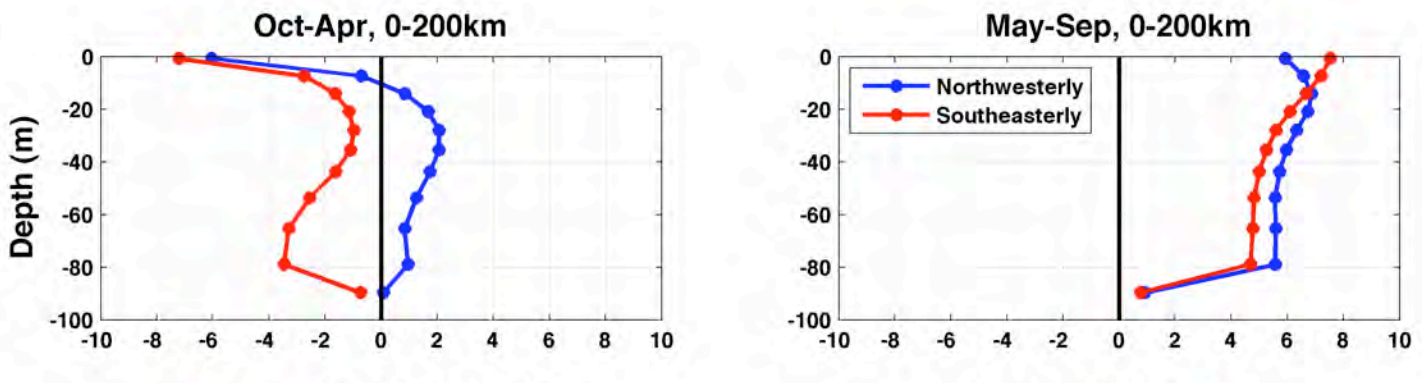


Within 200 km of Cape Navarin

Central Transect

Pribilof Islands to Unimak Island

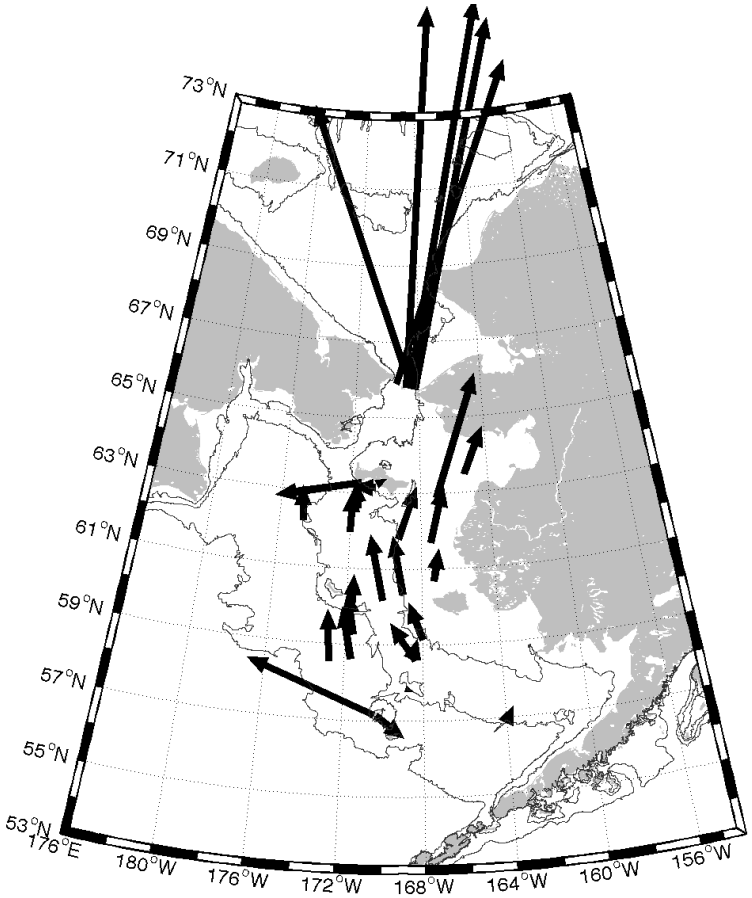
On-shelf flow across the 100-m isobath



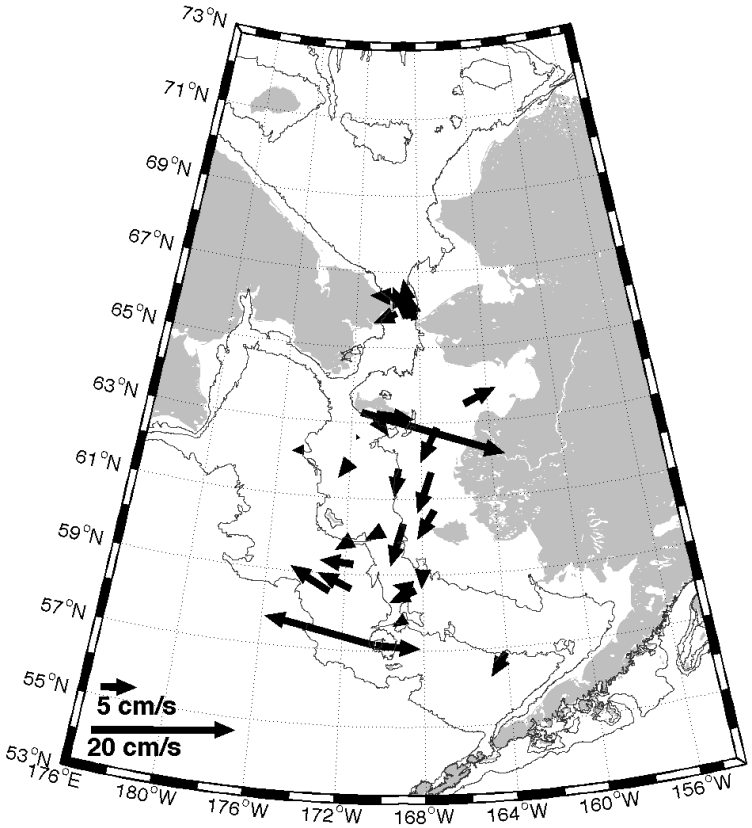
Within 200 km of Cape Navarin

Cross-transect velocity (cm/s)

October-April, 10-20 m instrument depths

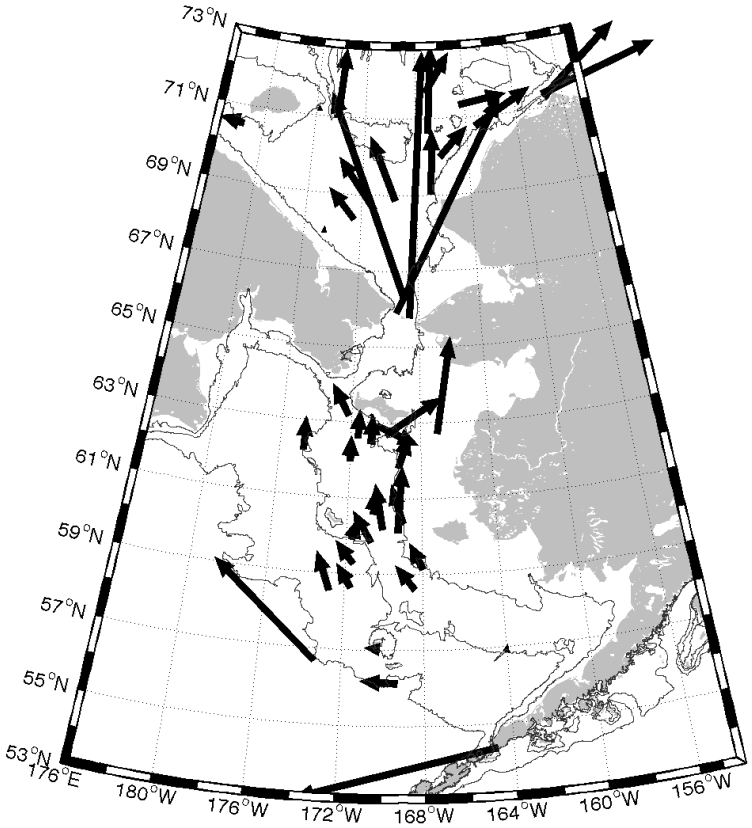


Southeasterly wind @ 60°N, 170°W

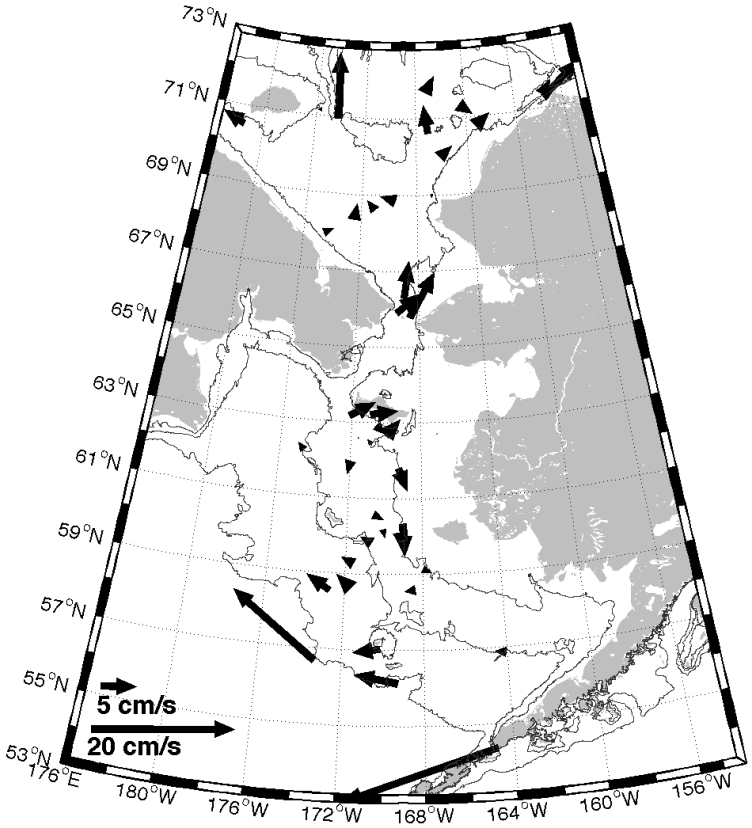


Northwesterly wind @ 60°N, 170°W

October-April, 25-60 m instrument depths

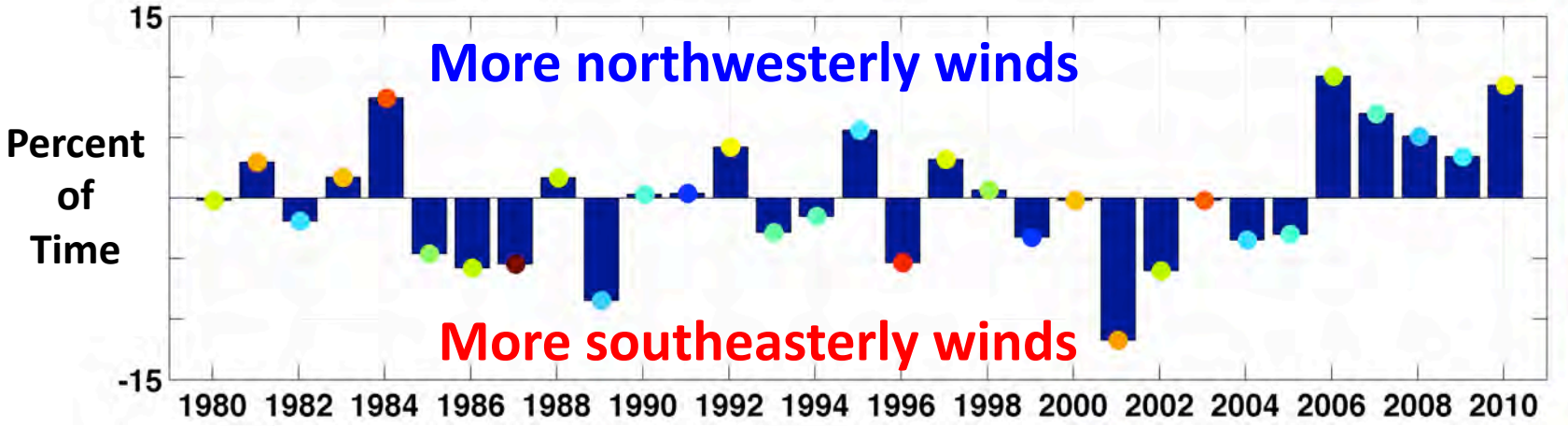


Southeasterly wind @ 60˚N, 170˚W

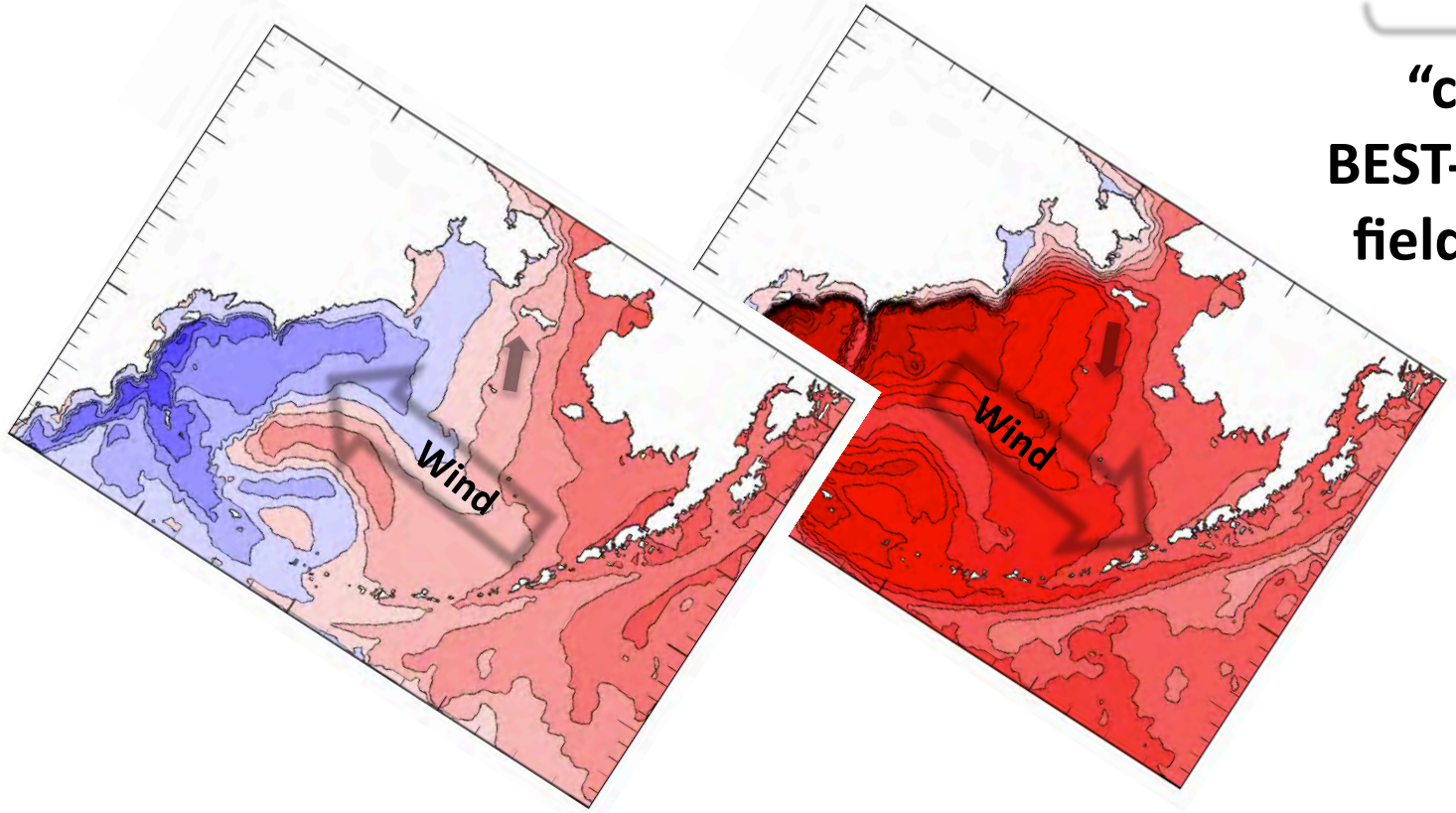


Northwesterly wind @ 60˚N, 170˚W

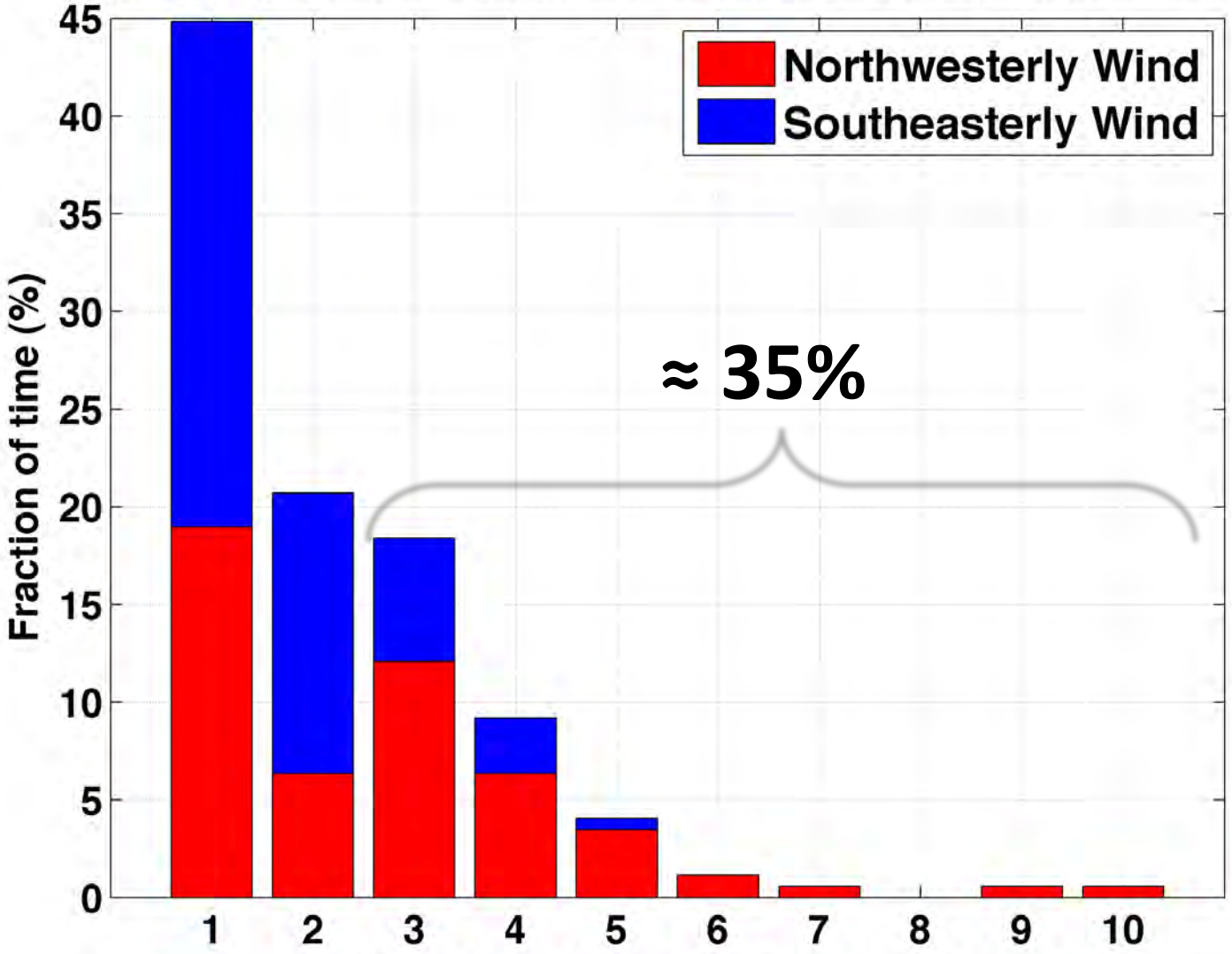
Oct-Apr duration of winds blowing to either side of 225°T



"cold" BEST-BSIERP field years

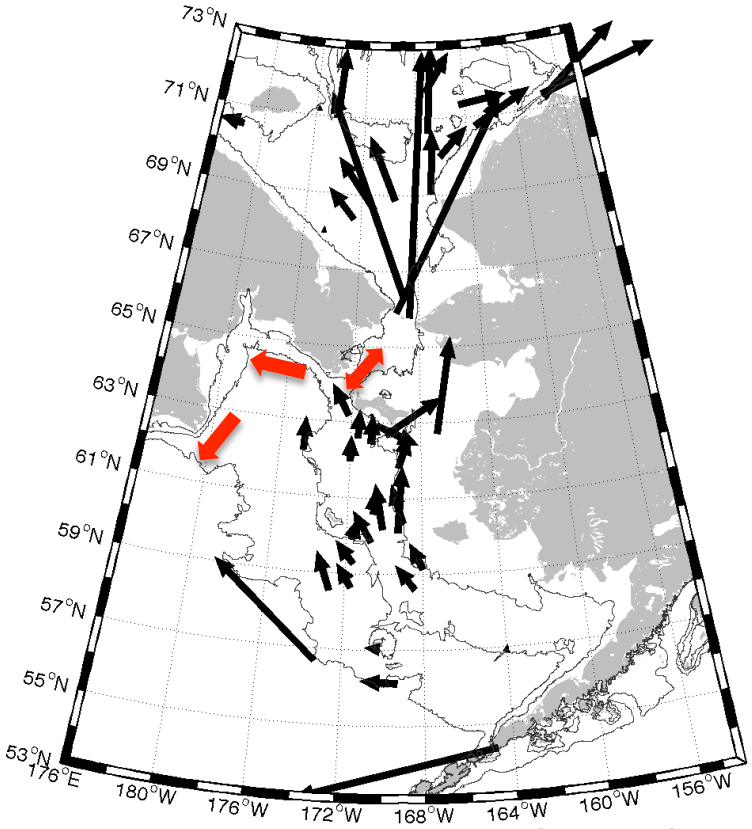


Consecutive months with mean wind stress in each along-shelf direction

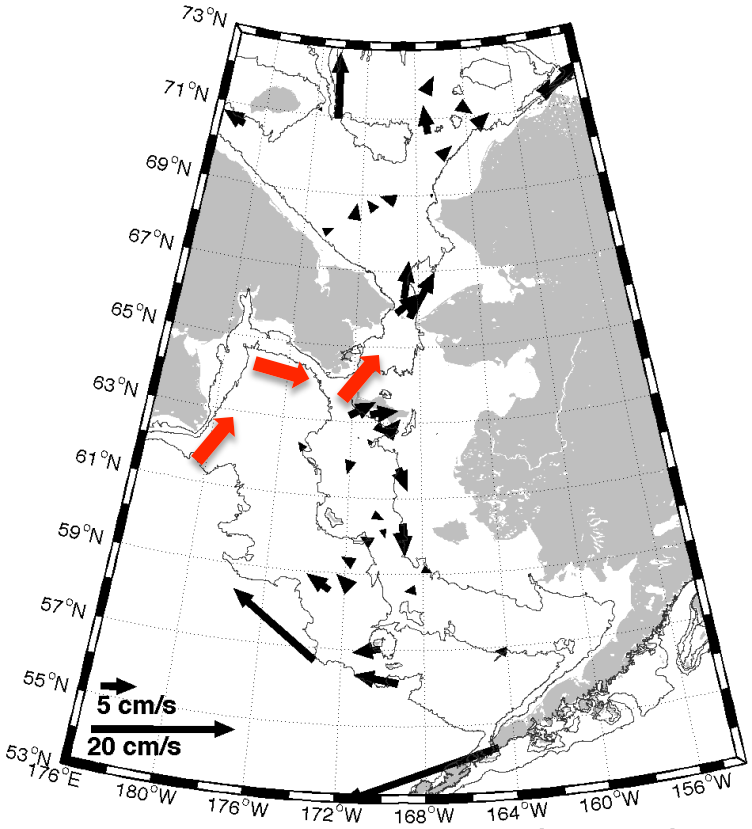


Months in a row before along-shelf stress changes sign

October-April, 25-60 m instrument depths



Southeasterly wind @ 60˚N, 170˚W



Northwesterly wind @ 60˚N, 170˚W

Conclusions

- Bering shelf currents typically have small vector means but exhibit large variance and non-zero means over monthly to seasonal intervals.
- The flow field structure is sensitive to the wind direction, which is set by the relative positions of the Aleutian Low, the Siberian High and the Beaufort High.
- Bering Strait can draw waters from either the eastern shelf or the Gulf of Anadyr. The relative fraction varies in time.
- Prolonged wind direction anomalies result in varying water mass, nutrient, and plankton fluxes across and between these shelves.