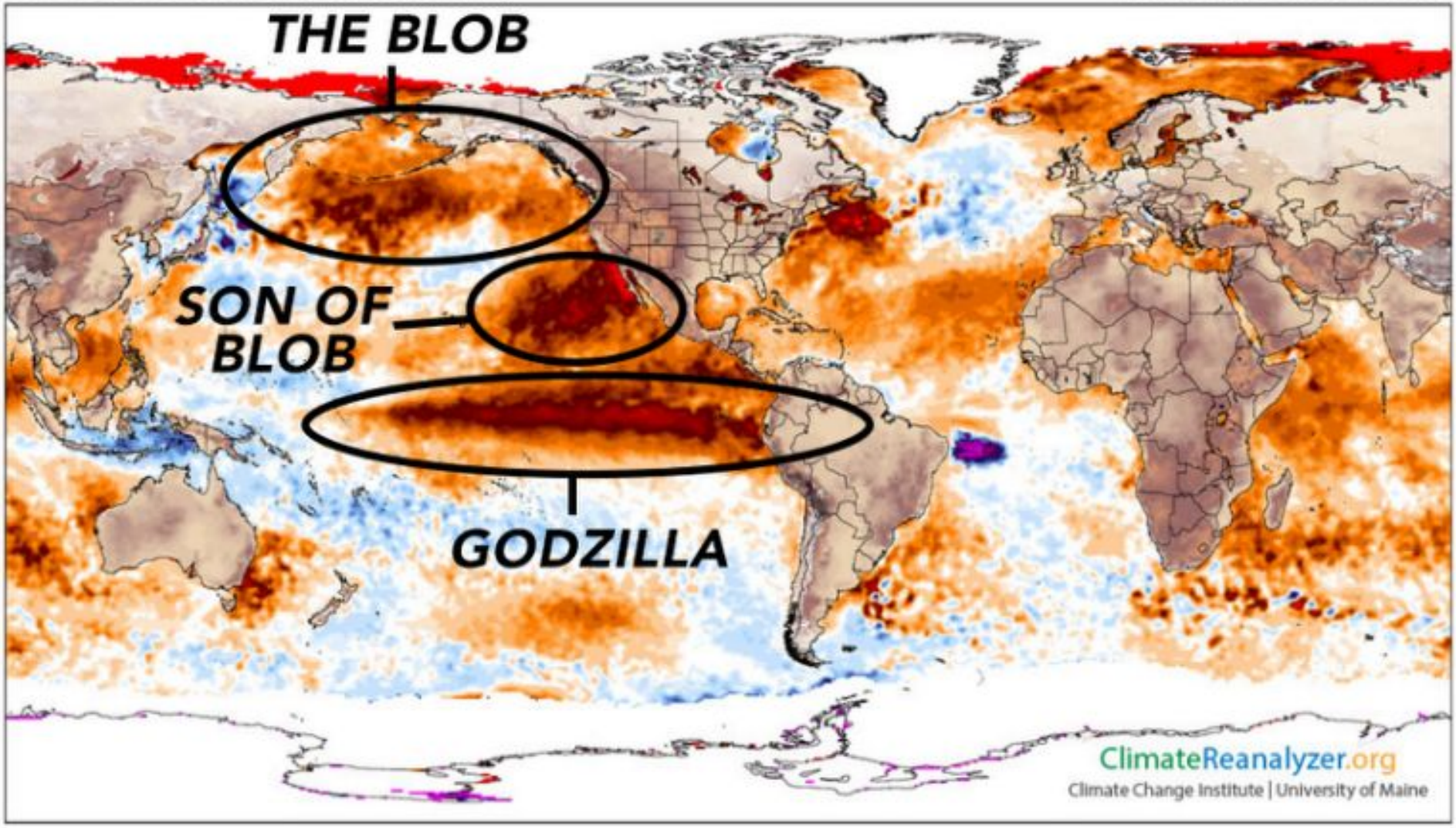
The North Pacific Atmosphere-Ocean System in Recent Years from the Media/Public Perspective

CFSV2 | Sea Surface Temperature Anomaly

Wednesday, October 14, 2015



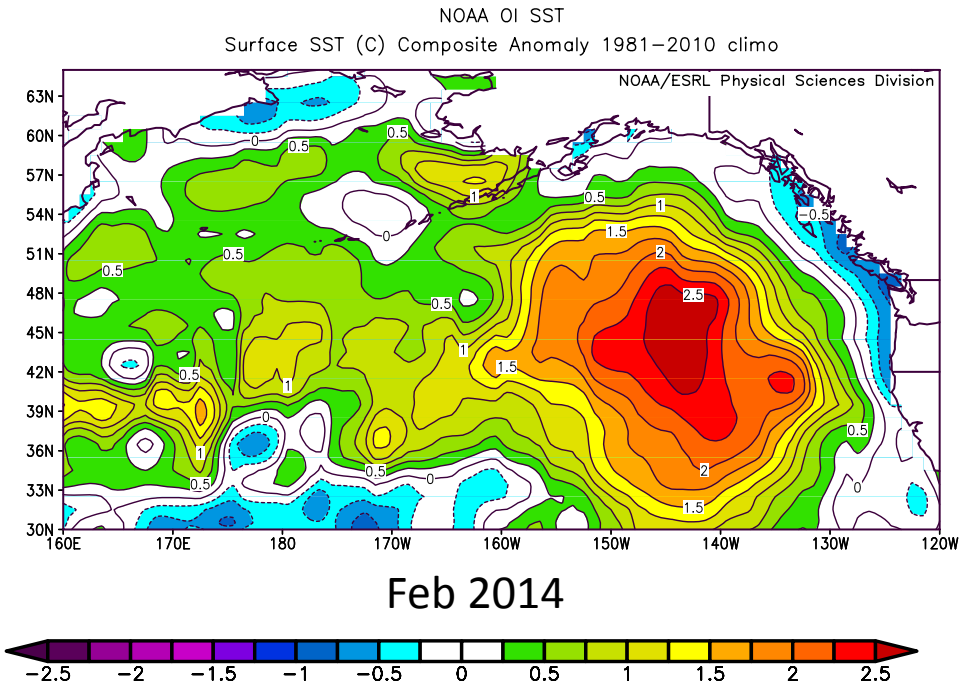
-7.2 -5.4 -3.6 -1.8 0 1.8 3.6 5.4 7.2

-4 -3 -2 -1 0 1 2 3 4

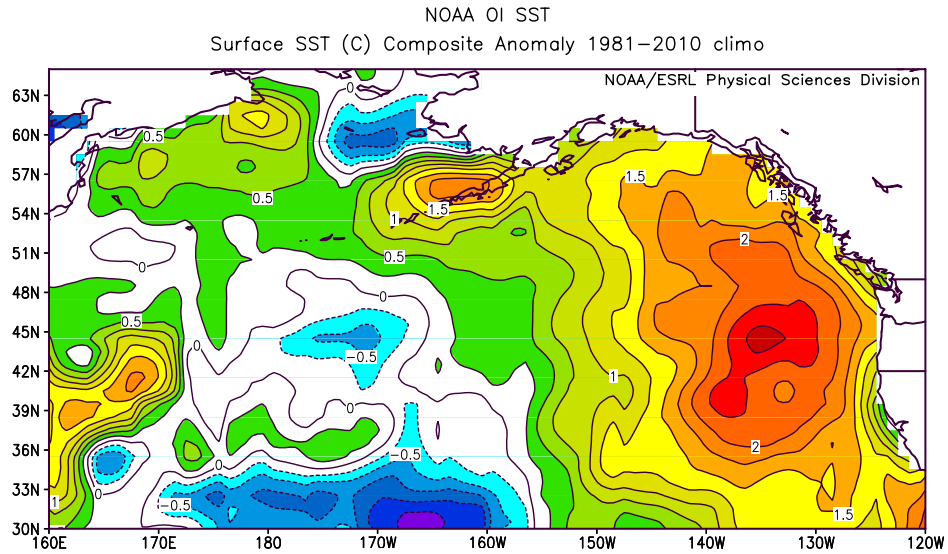
Temperature Anomaly (°F/°C)

CFSR 1979-2000 Baseline

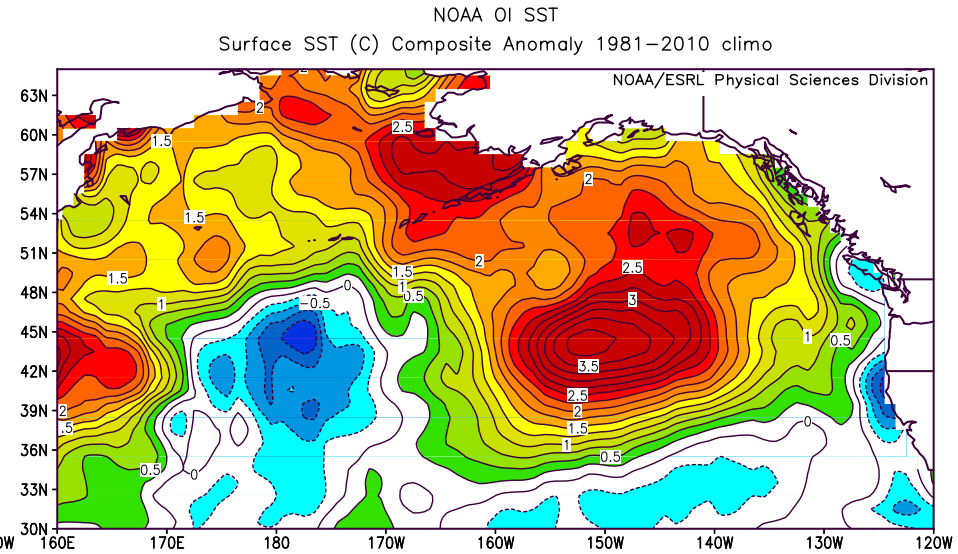
Sea Surface Temperature (SST) Anomalies in the NE Pacific



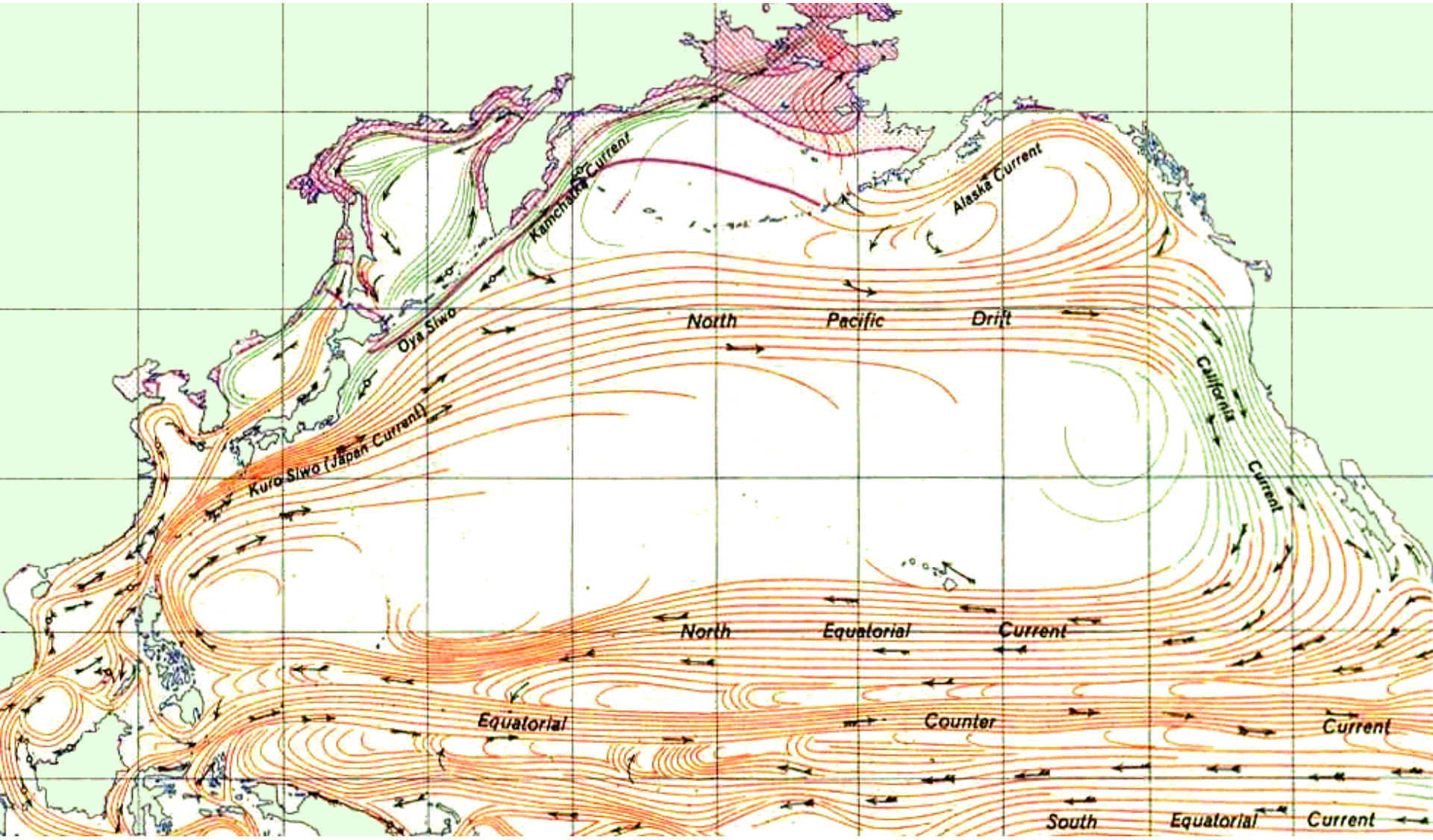
Feb 2014



Apr 2015



Sep 2016


Kamchatka Current
Oya Siwo
Kuro Siwo (Japan Current)
Alaska Current
North Pacific Drift
California Current
North Equatorial Current
Equatorial Counter Current
South Equatorial Current

The large-scale oceanic response to time-varying atmospheric forcing is complex, typically involving depth-dependent (baroclinic) and depth-independent (barotropic) motions.

Open question: Have changes in the upper ocean flow been important to the evolution of recent temperature anomalies?

The Response of the NE Pacific Ocean Circulation to Recent Atmospheric Forcing

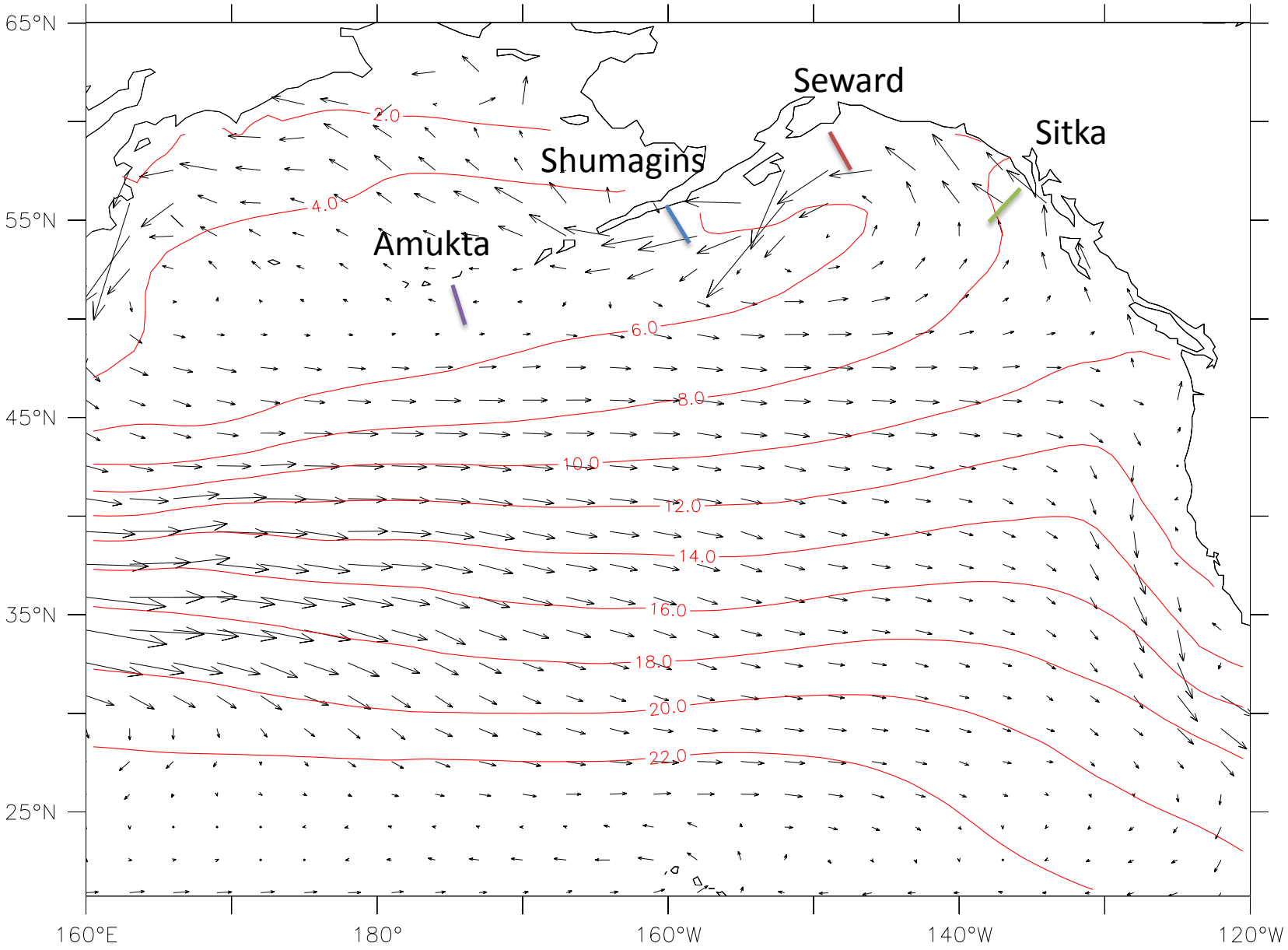
Nick Bond – University of Washington/JISAO
Phyllis Stabeno – NOAA/PMEL

- Atmospheric Forcing
- Upper Ocean Currents
- Ocean Profiles in the Coastal Gulf of Alaska

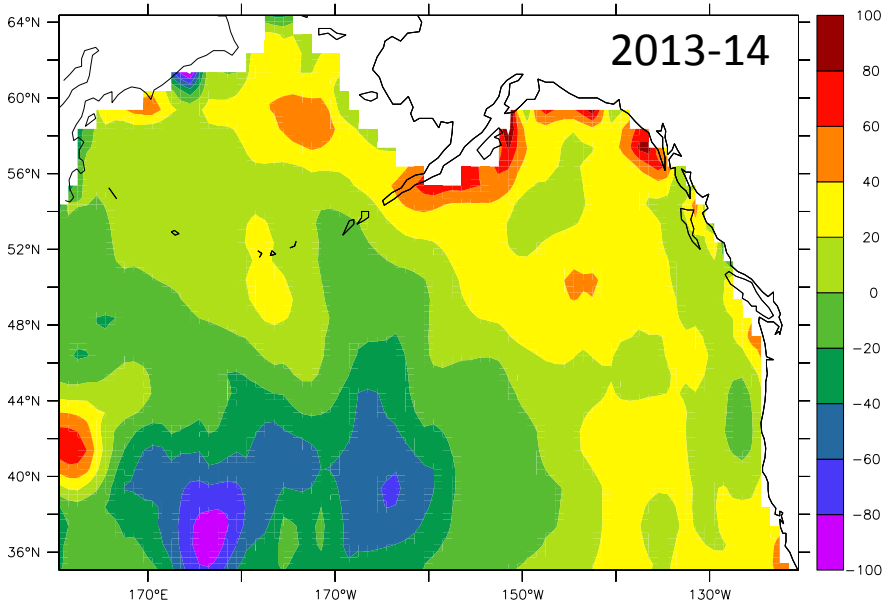
Primary Data Source – NOAA/NCEP Global Ocean Data Assimilation System (GODAS)

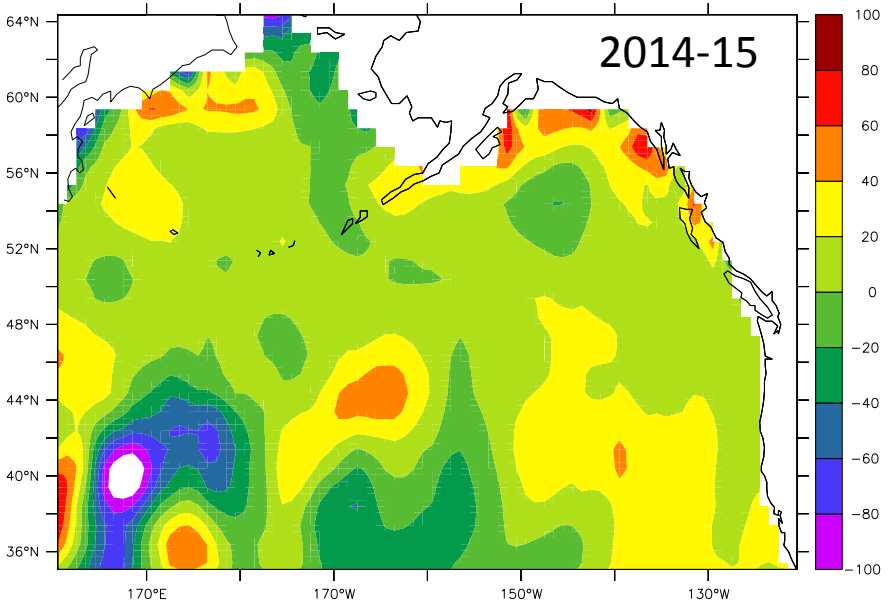
- Based on MOM.v.3 numerical ocean model with continuous assimilation of data from Argo, satellite (SST and SSH), etc.
- Atmospheric forcing from the NCEP II Reanalysis
- Suitable for diagnosis of broad-scale aspects of the physical oceanography (1980-2016)

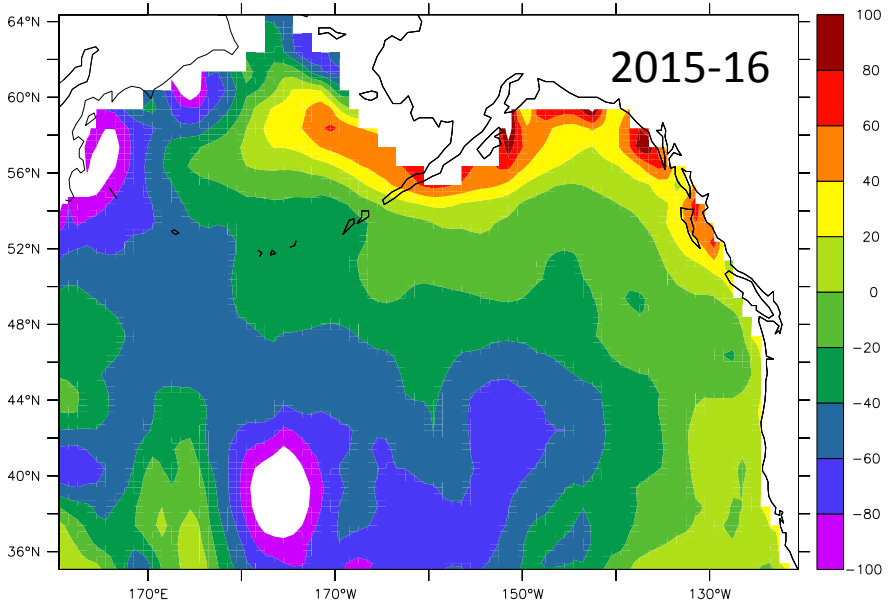
Annual Mean Currents and Temperatures (0-100 m)



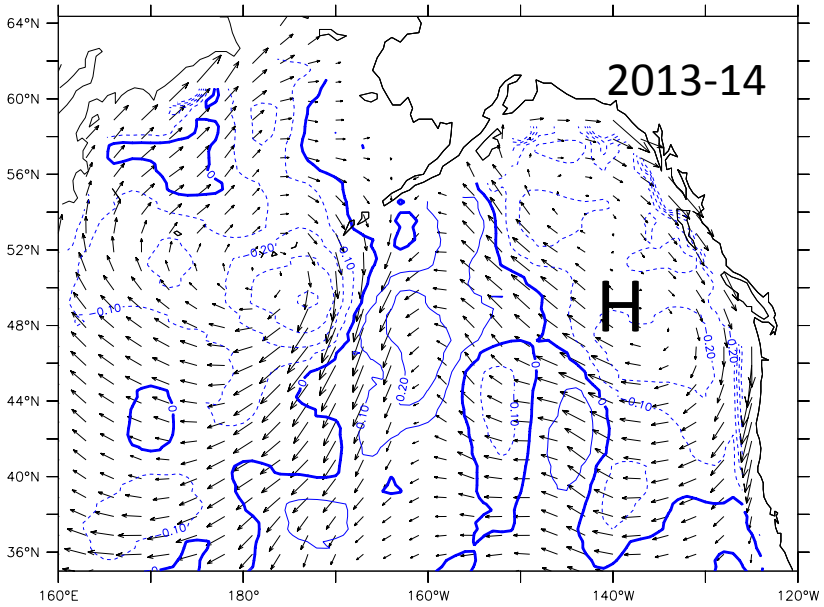
Mean Winter Net Surface Heat Flux Anomalies (W/m2)

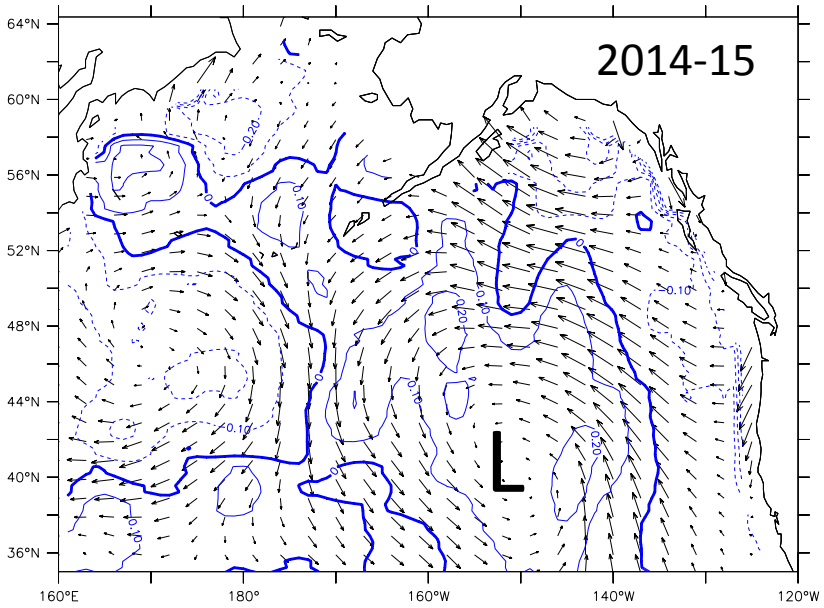


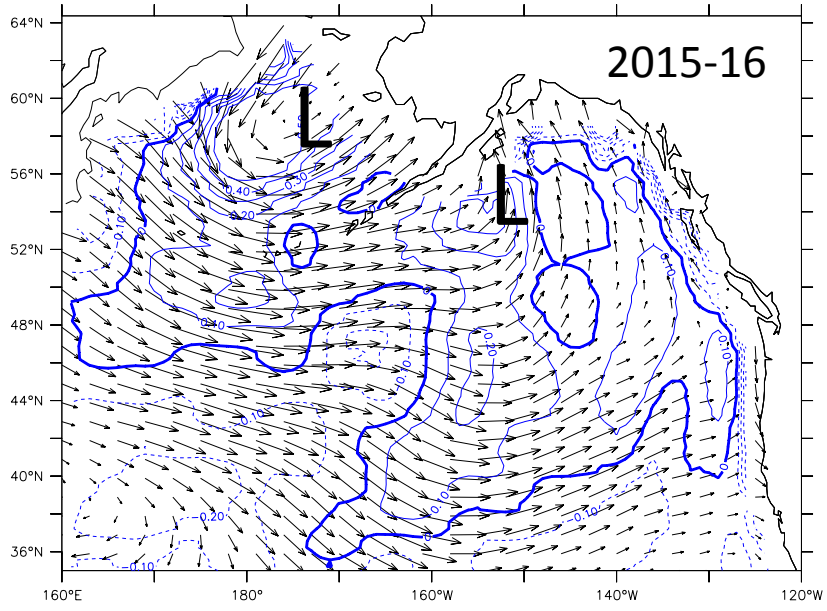




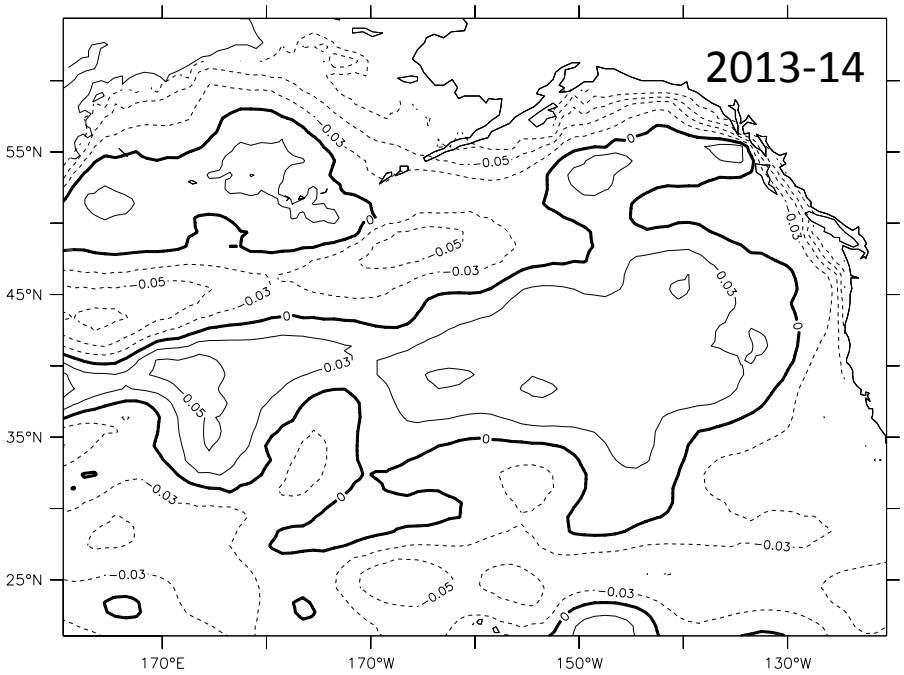
Mean Winter Wind Stress and Wind Stress Curl Anomalies

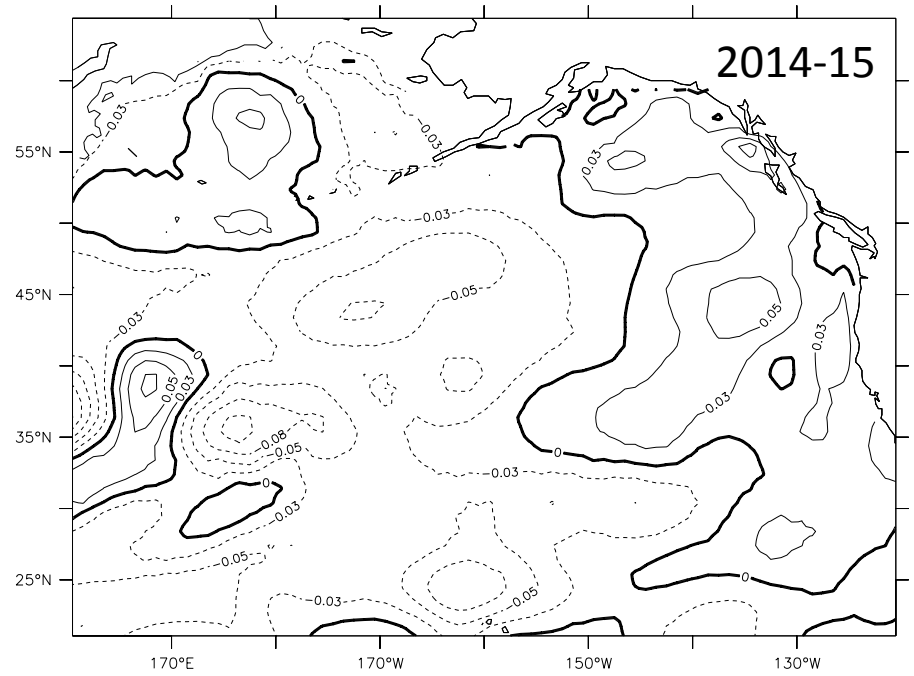


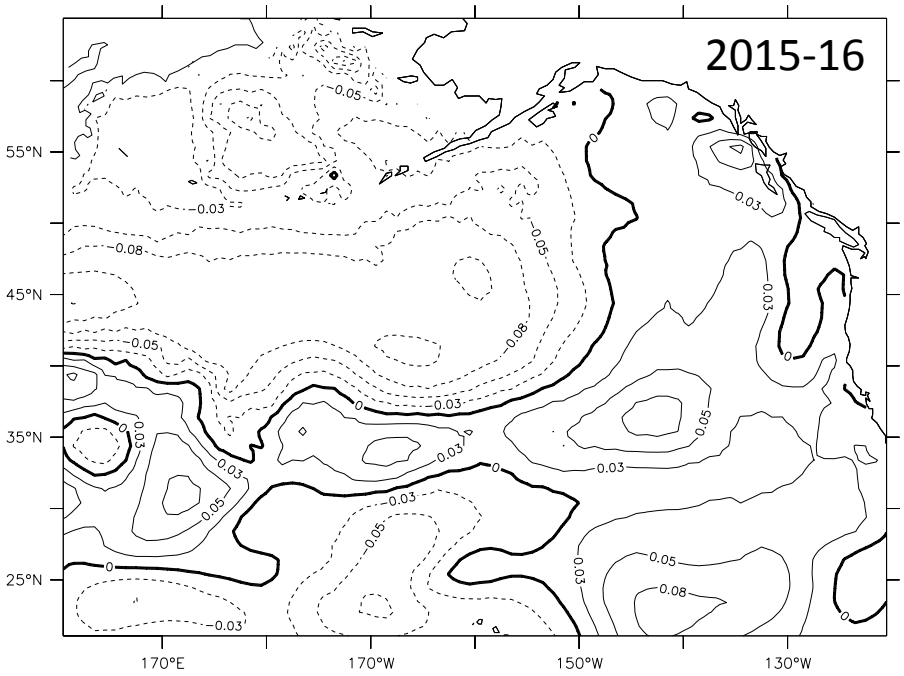




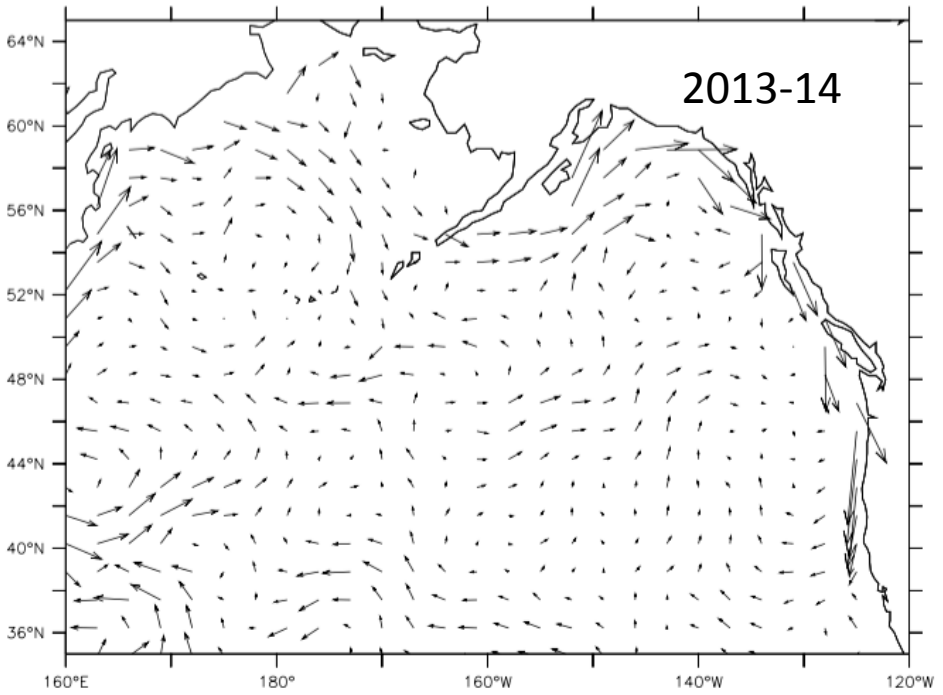
Winter Average Sea Surface Height Anomalies (m)

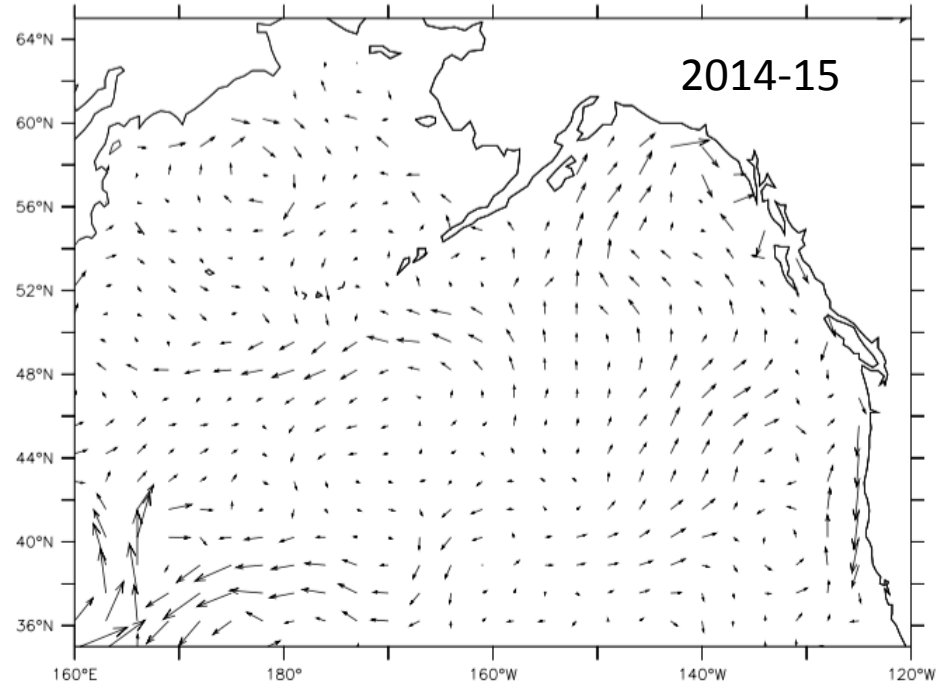


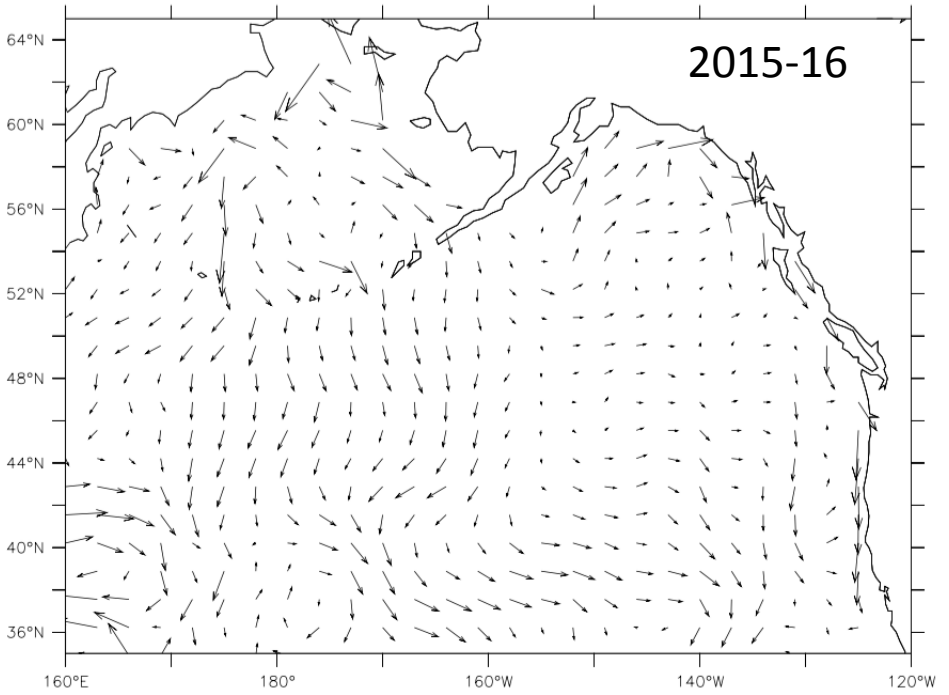




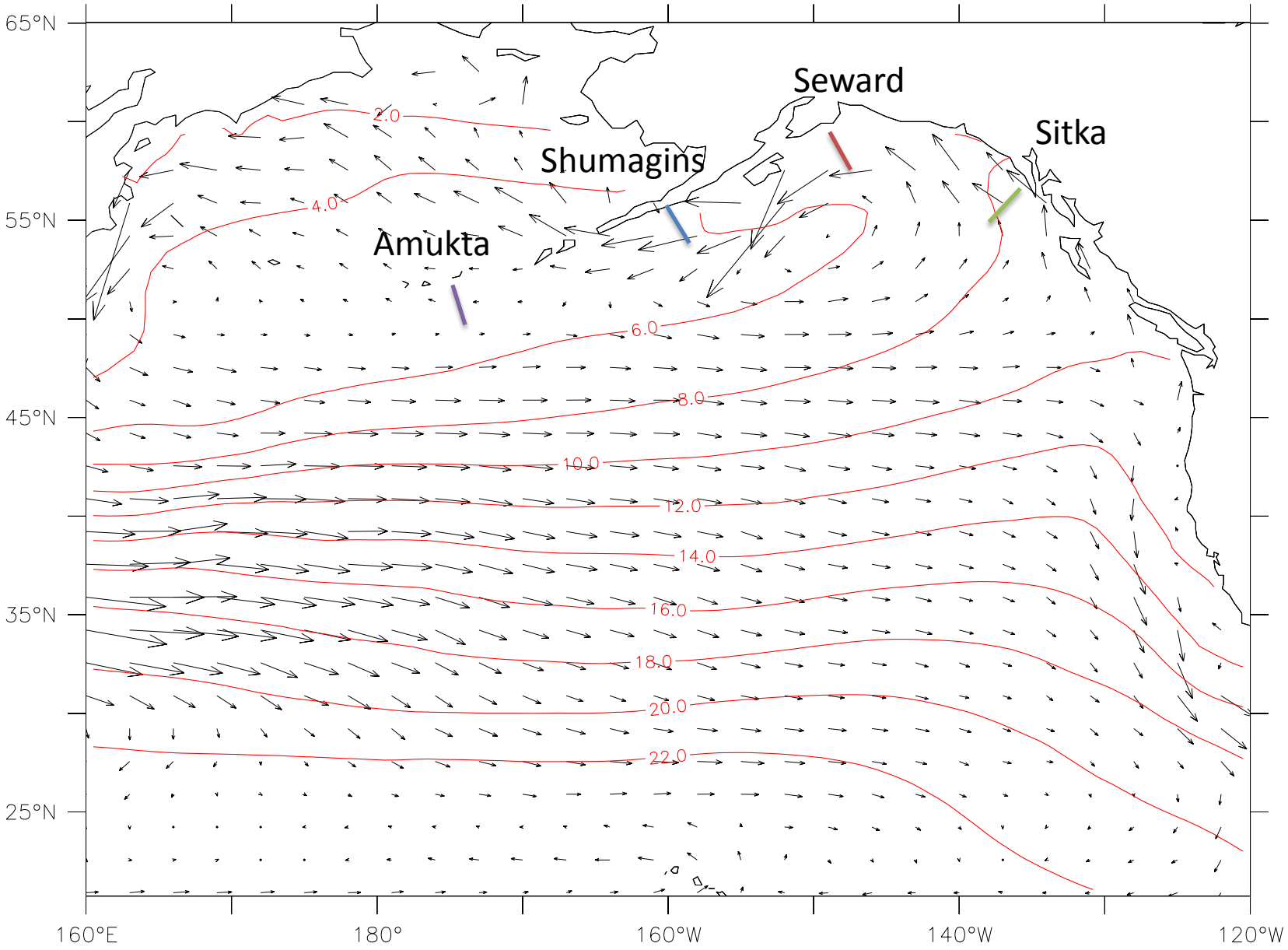
Mean Winter Current Anomalies (0-100 m)

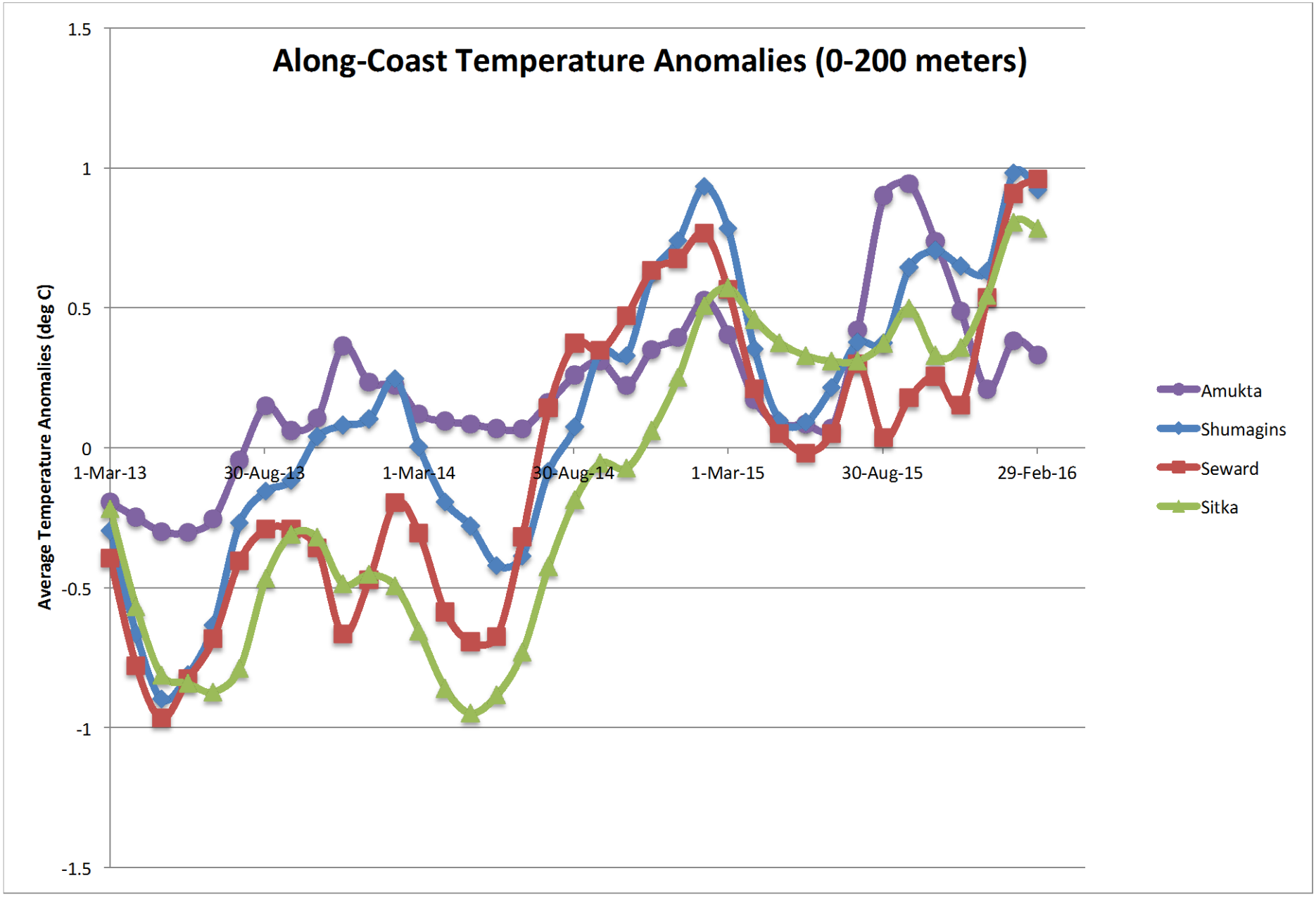


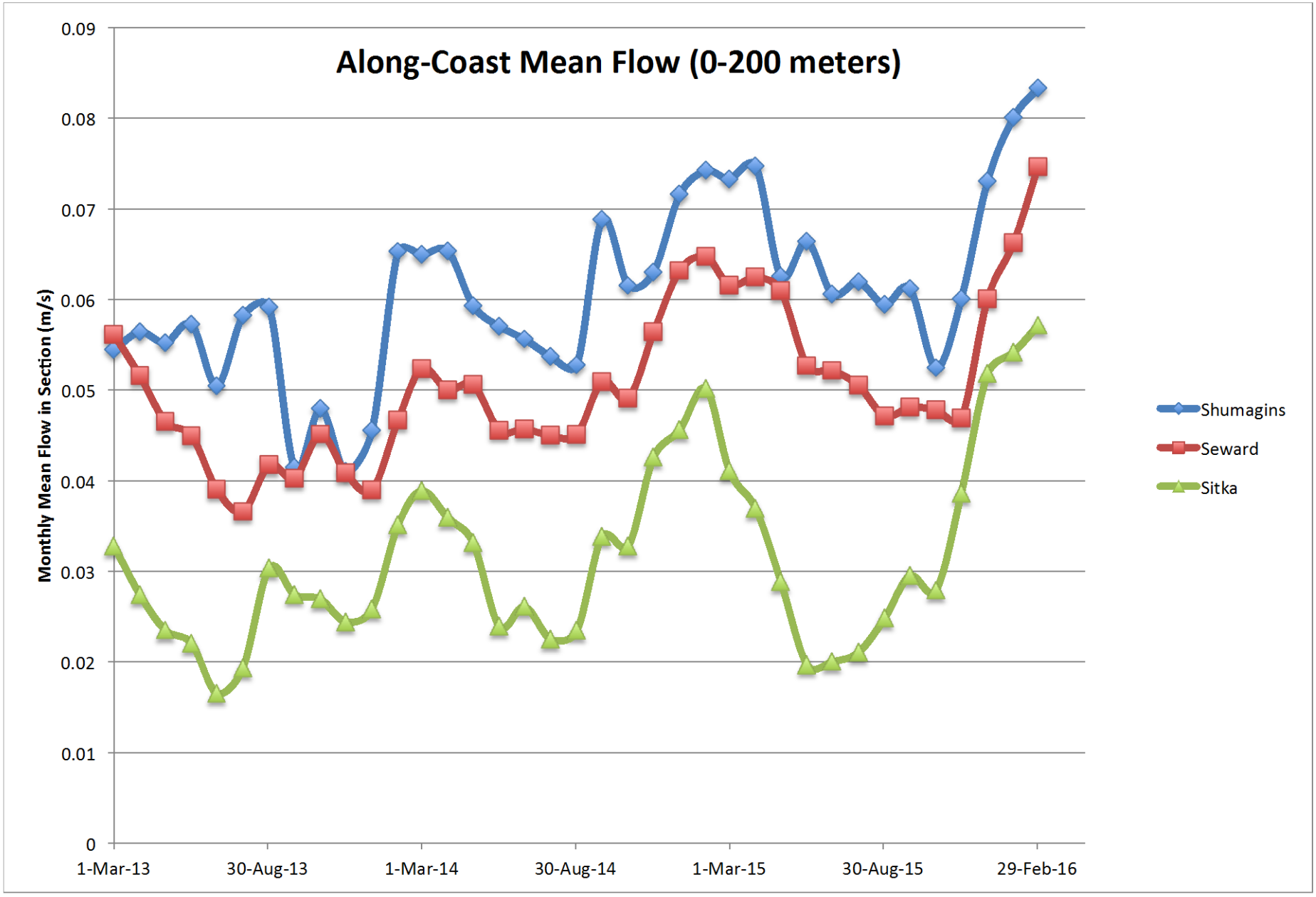


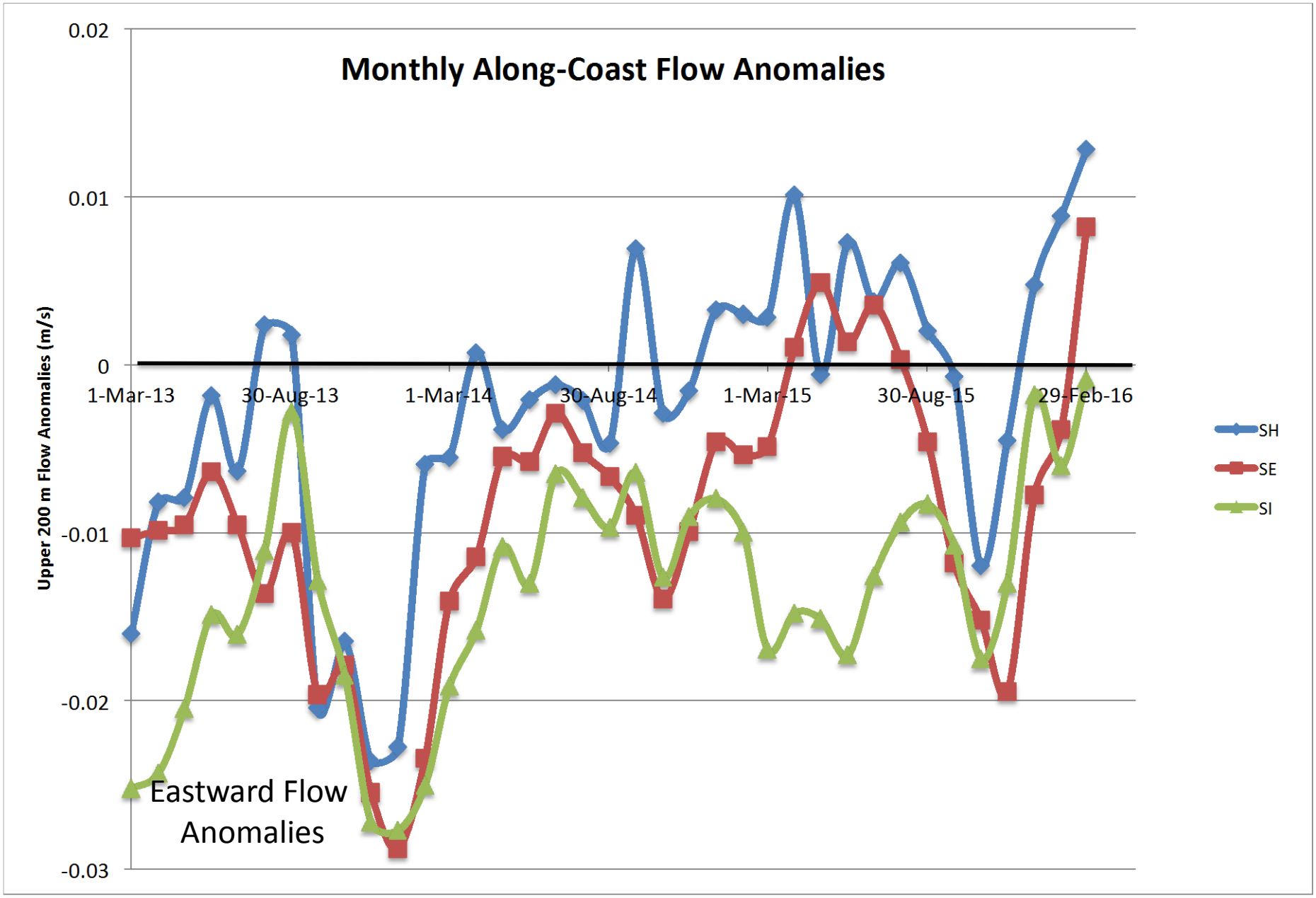


Annual Mean Currents and Temperatures (0-100 m)




Along-Coast Temperature Anomalies (0-200 meters)
Average Temperature Anomalies (deg C)
1.5
1
0.5
0
-0.5
-1
-1.5
1-Mar-13
30-Aug-13
1-Mar-14
30-Aug-14
1-Mar-15
30-Aug-15
29-Feb-16
Amukta
Shumagins
Seward
Sitka


Along-Coast Mean Flow (0-200 meters)
Monthly Mean Flow in Section (m/s)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1-Mar-13
30-Aug-13
1-Mar-14
30-Aug-14
1-Mar-15
30-Aug-15
29-Feb-16
Shumagins
Seward
Sitka


Monthly Along-Coast Flow Anomalies
Upper 200 m Flow Anomalies (m/s)
0.02
0.01
0
-0.01
-0.02
-0.03
1-Mar-13
30-Aug-13
1-Mar-14
30-Aug-14
1-Mar-15
30-Aug-15
29-Feb-16
SH
SE
SI
Eastward Flow Anomalies

Simple Heat Budget

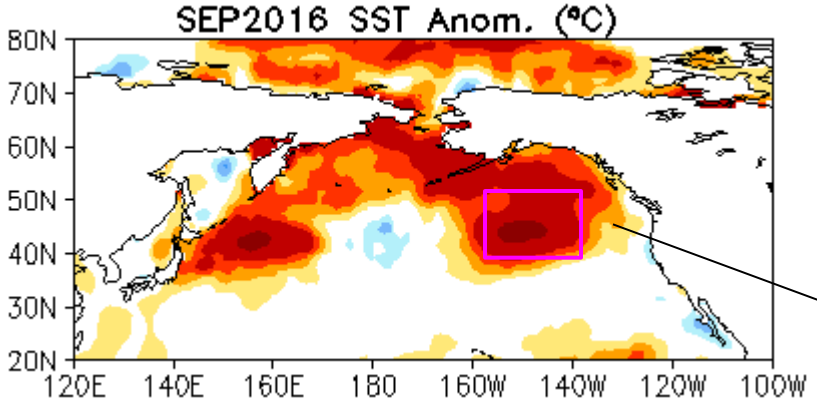
Near the shelf in the coastal Gulf of Alaska, about 1.5 C of anomalous warming occurred between late spring of 2014 and early winter 2015 in the top 200 m of the water column ⇒ ~ 1.2×10^9 Joules/m^2.

The average net surface heat fluxes were ~ 20 W/m^2 greater than normal during the period. This amount of heating over 6 months can account for almost all of the overall increase in temperature.

The contribution of anomalous along-coast advection to the heating appears to be relatively small.

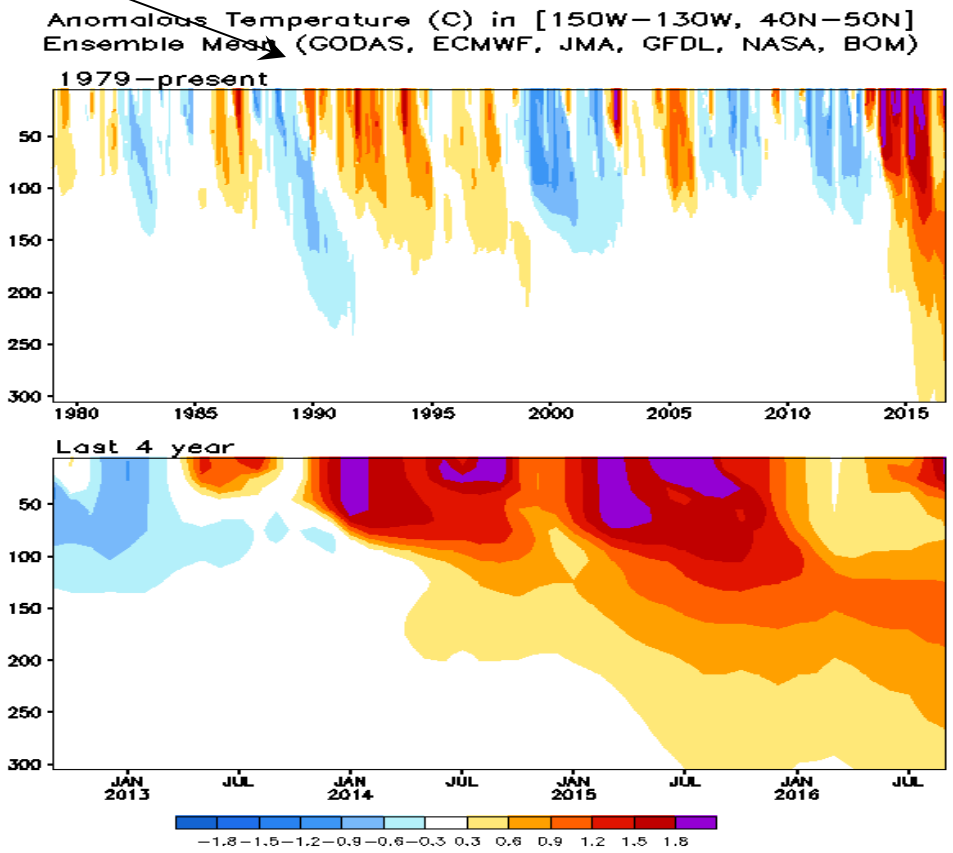
More complete treatment would include consideration of vertical and cross-shelf advection.

From Monthly Ocean Briefing by NOAA/NCEP on 11 Oct 2016

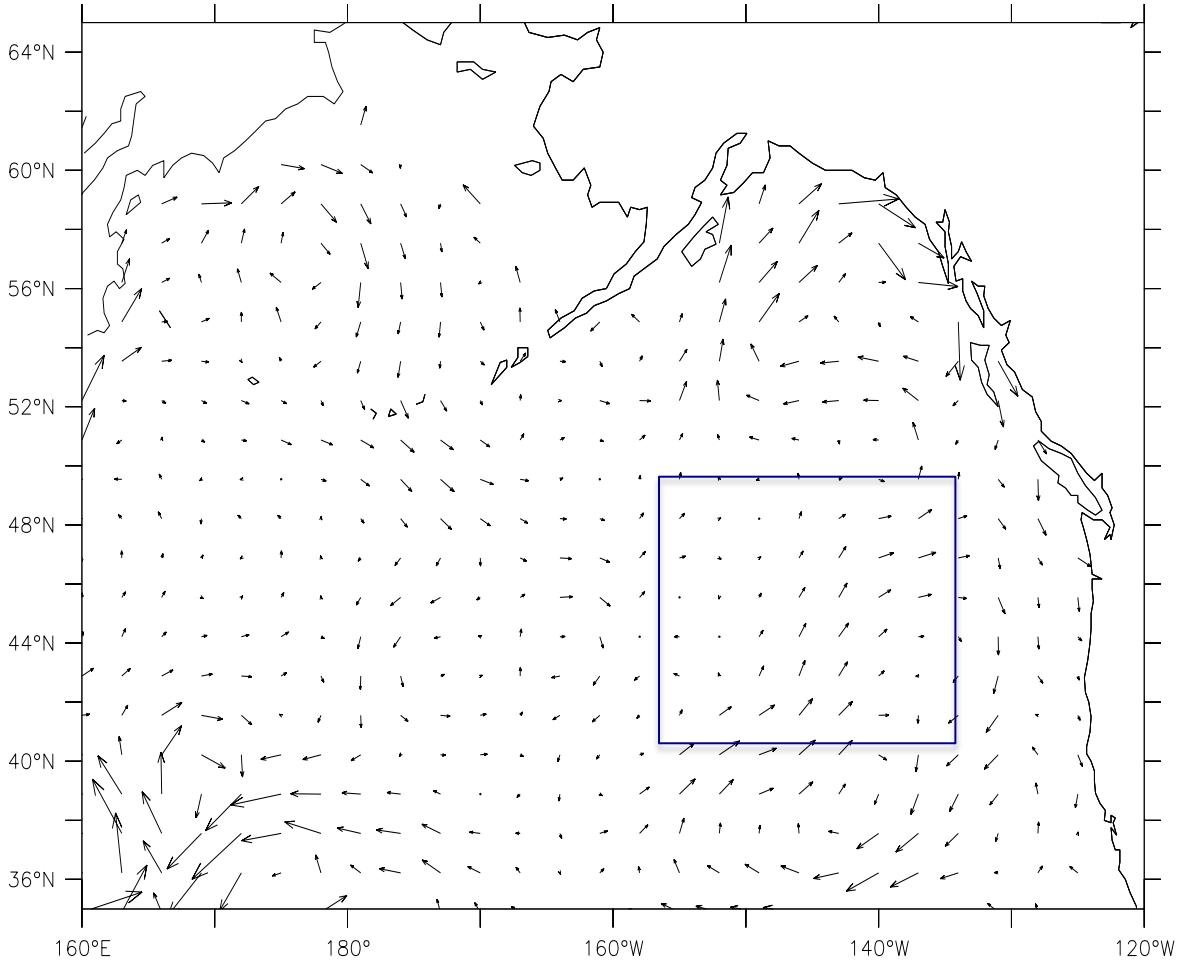


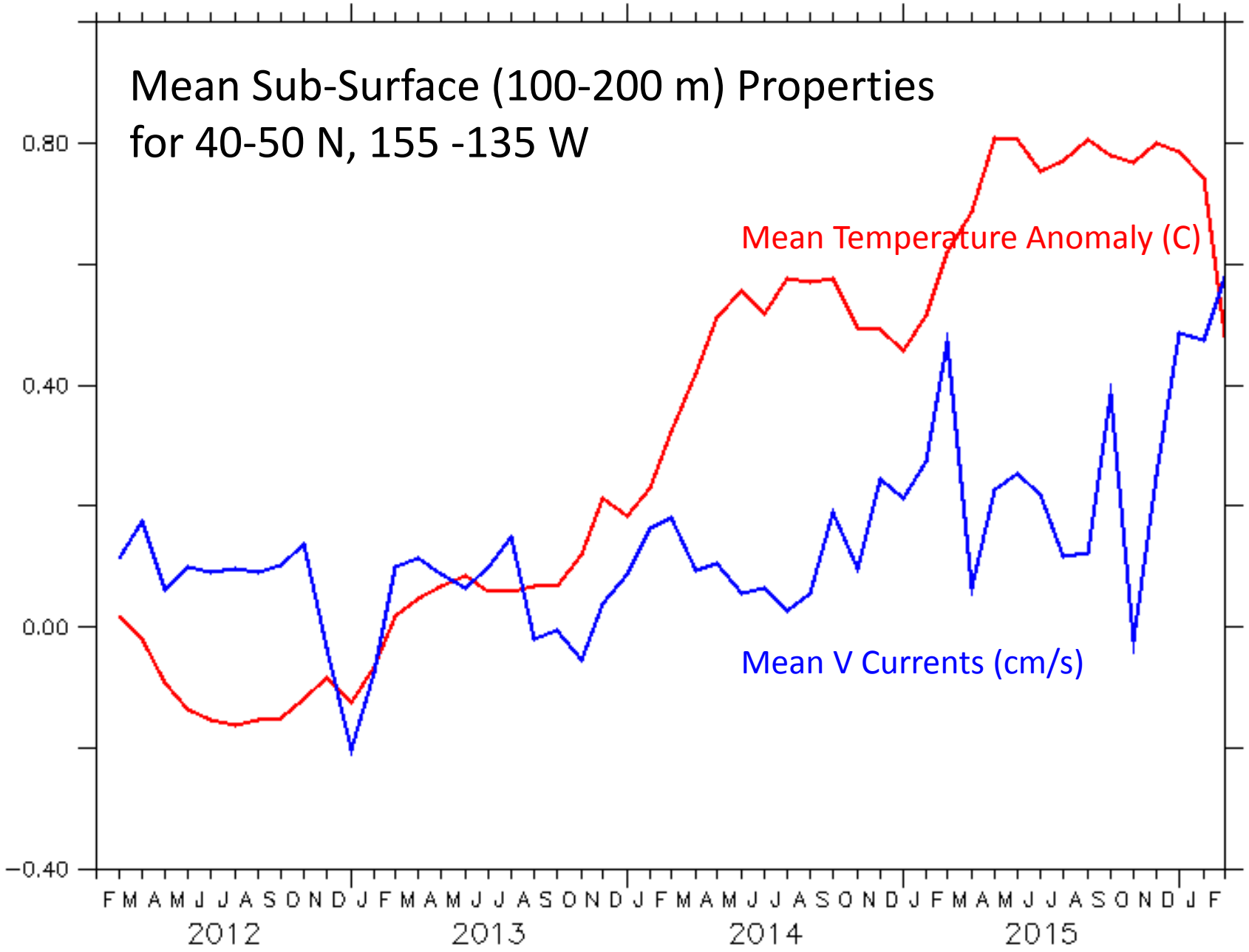
Recent Conditions in North Pacific Ocean

- **Between winters of 2013/14 and 2015/16, northeast Pacific experienced the strongest SST warming ever recorded (Bond et al. 2015)**
- **Warming has gradually extended to 300m since the late 2013.**
- **Near surface warming has re-emerged and intensified since Jun 2016.**



Mean Anomalous Currents in 100-200 meter layer (June 2014 – Nov 2015)




Mean Sub-Surface (100-200 m) Properties
for 40-50 N, 155 -135 W
Mean Temperature Anomaly (C)
Mean V Currents (cm/s)
0.80
0.40
0.00
−0.40
F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F
2012
2013
2014
2015

Final Remarks

- The GODAS ocean reanalysis has been used to examine upper-ocean temperatures and currents during the recent NE Pacific marine heat wave

- Anomalous net heat fluxes at the air-sea interface can account for the heating occurring in the coastal Gulf of Alaska

- Downward and poleward flow anomalies at depth may be important to the warm temperatures below the mixed layer in the basin

- Considerable month to month variability occurs in the upper ocean currents of the coastal Gulf of Alaska