Features of the Northeast Pacific Ocean

William Crawford
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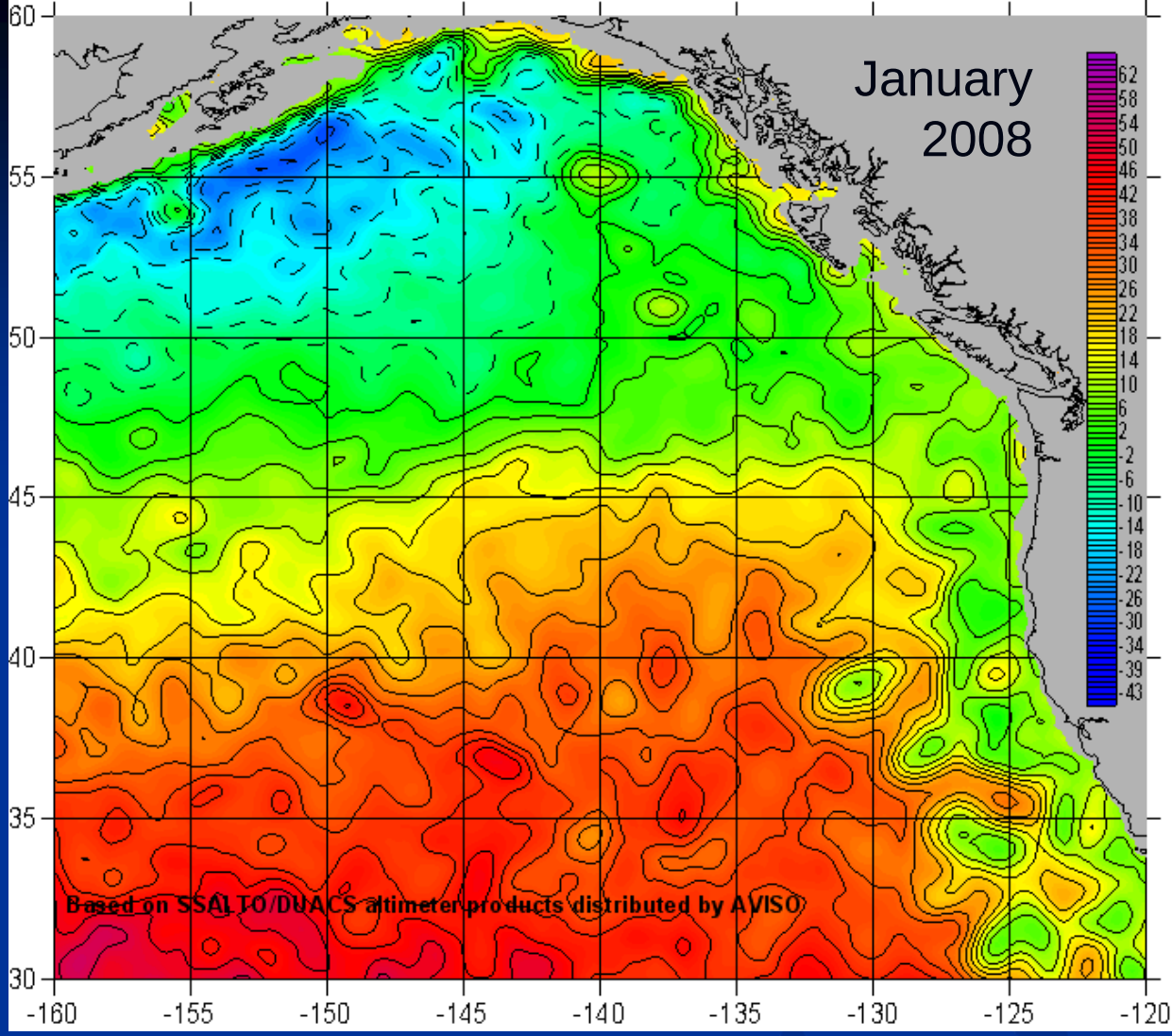
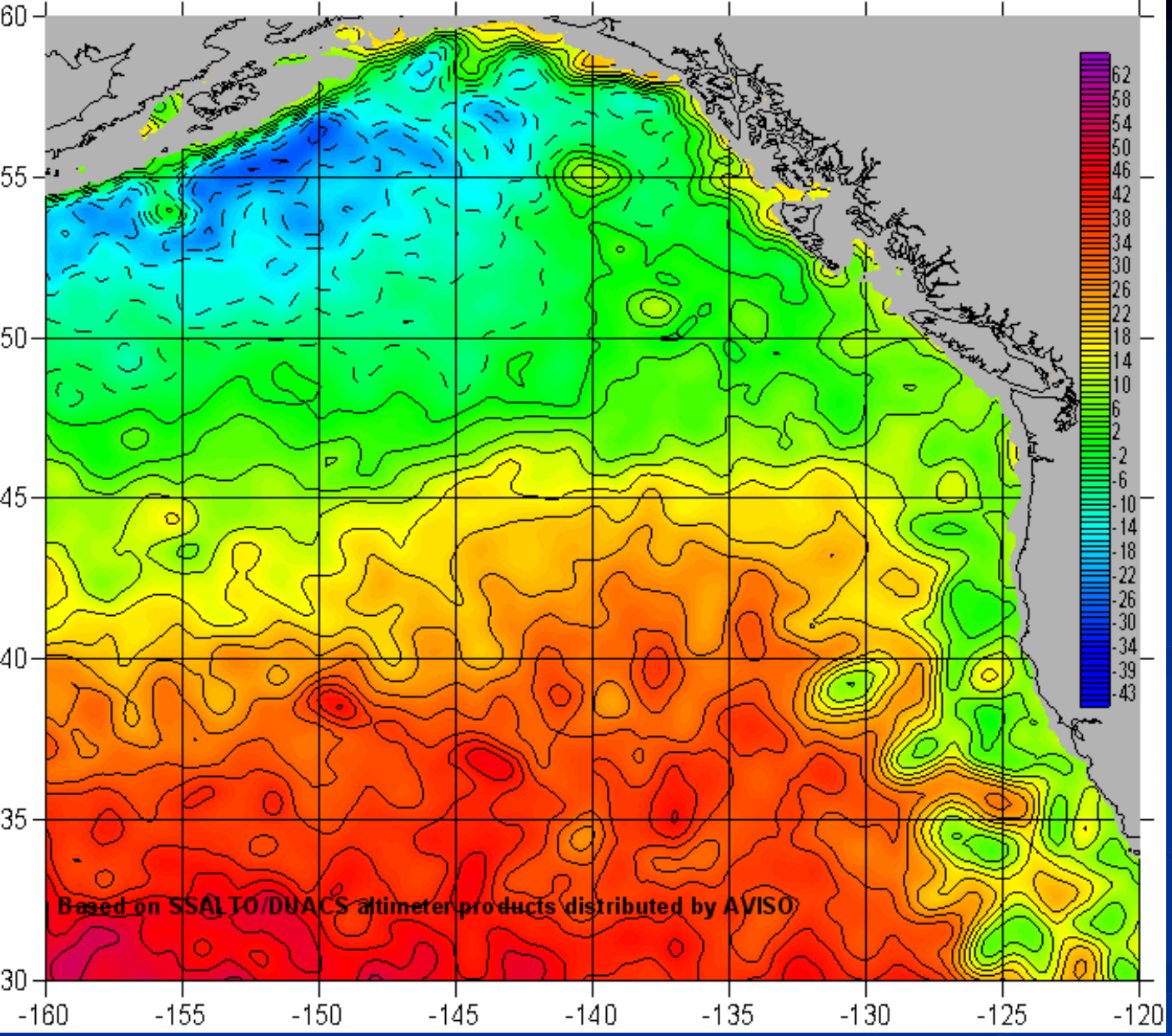


IOS

Fisheries and Oceans Canada

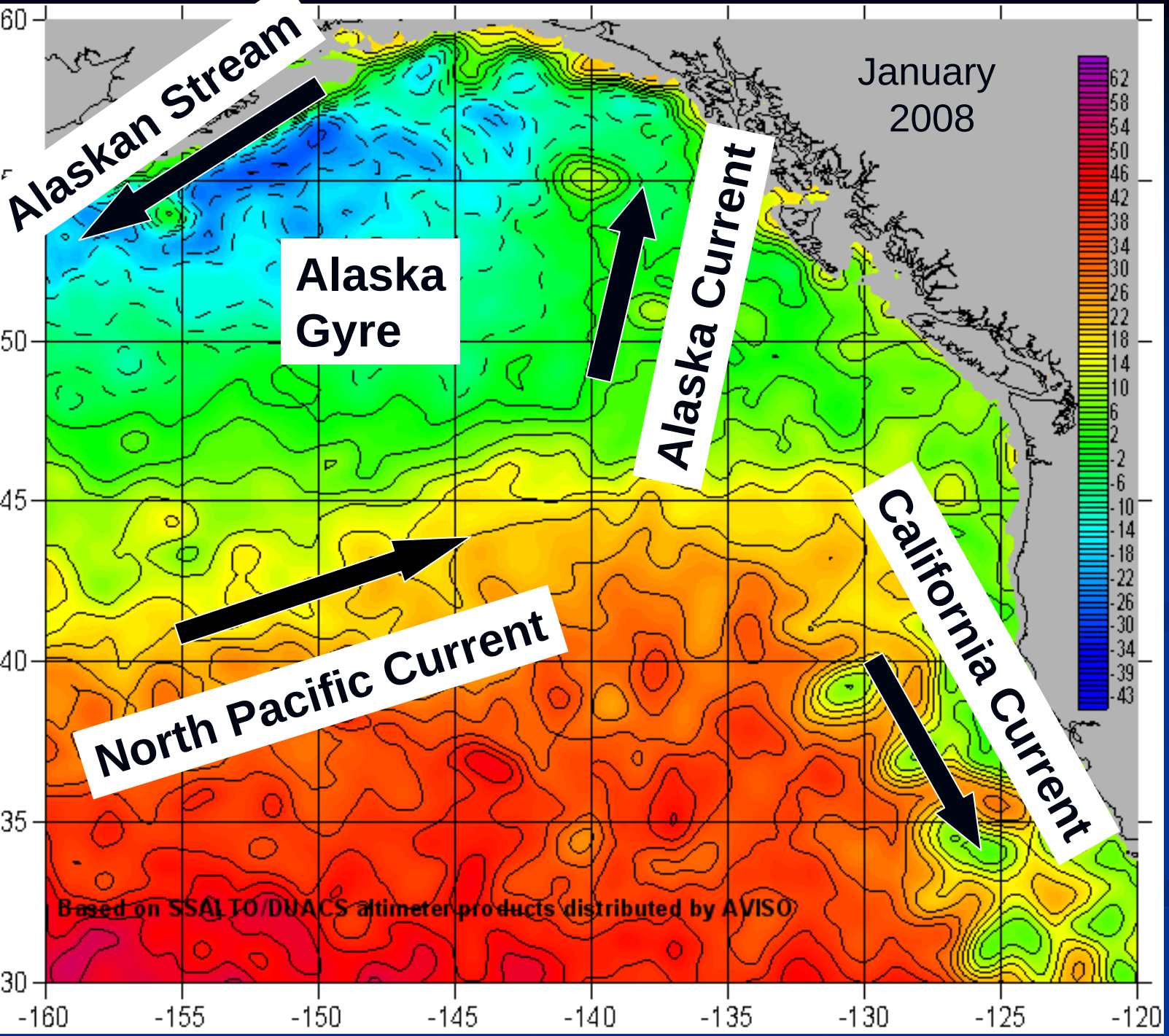
Pêches et Océans Canada



February
January
1998
2008

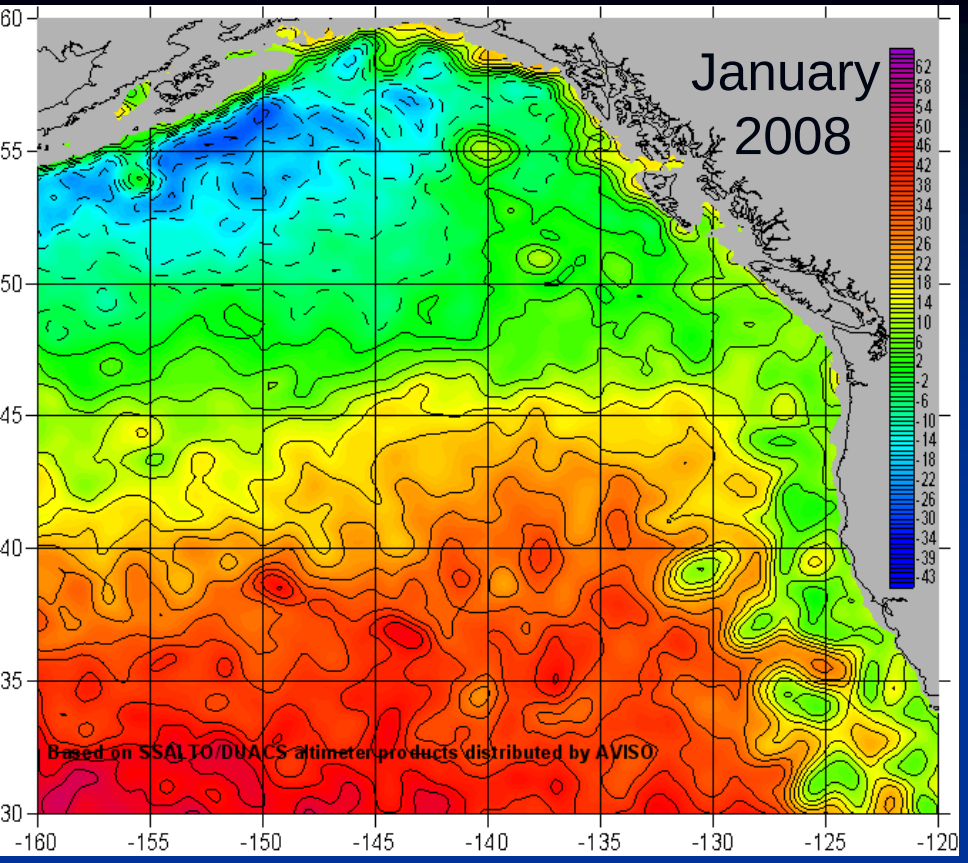
Observations from 1992 to present.

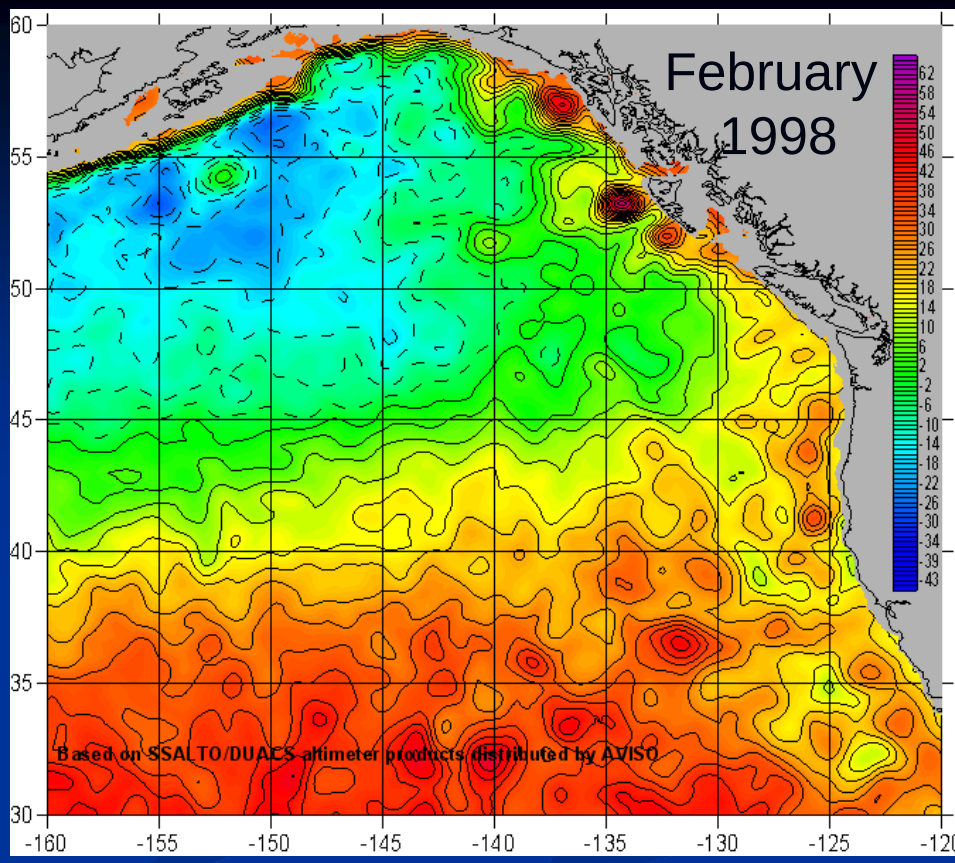
Sea level from AVISO, based on TOPEX/Poseidon, Jason-1, 2, ERS-1, 2, Envisat, GFO. Referenced to Foreman et al. (2008) average sea level.



February 1998

1992 to present



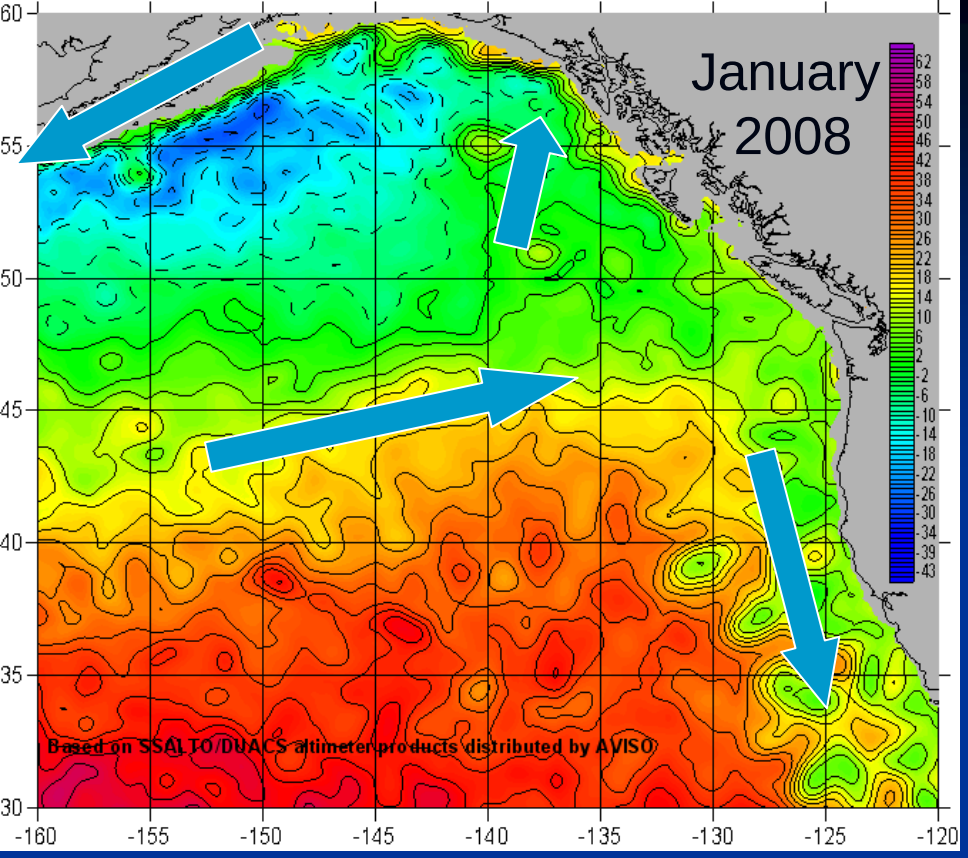


La Niña

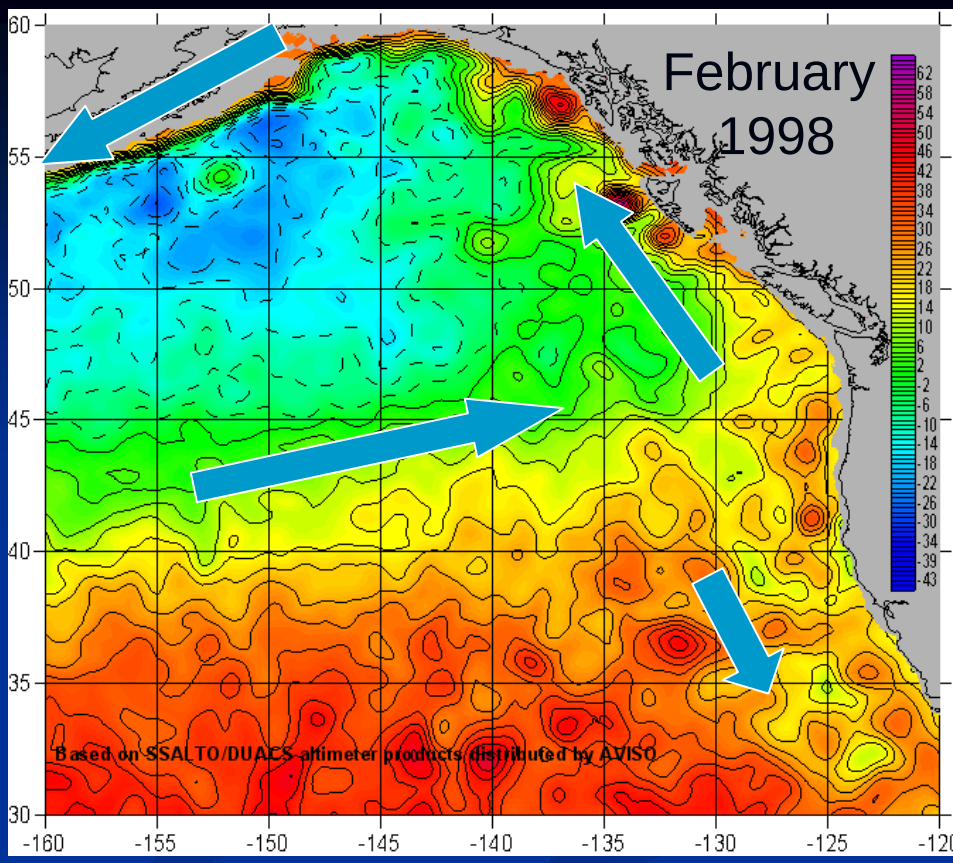
El Niño

Fisheries and Oceans Canada

Pêches et Océans Canada



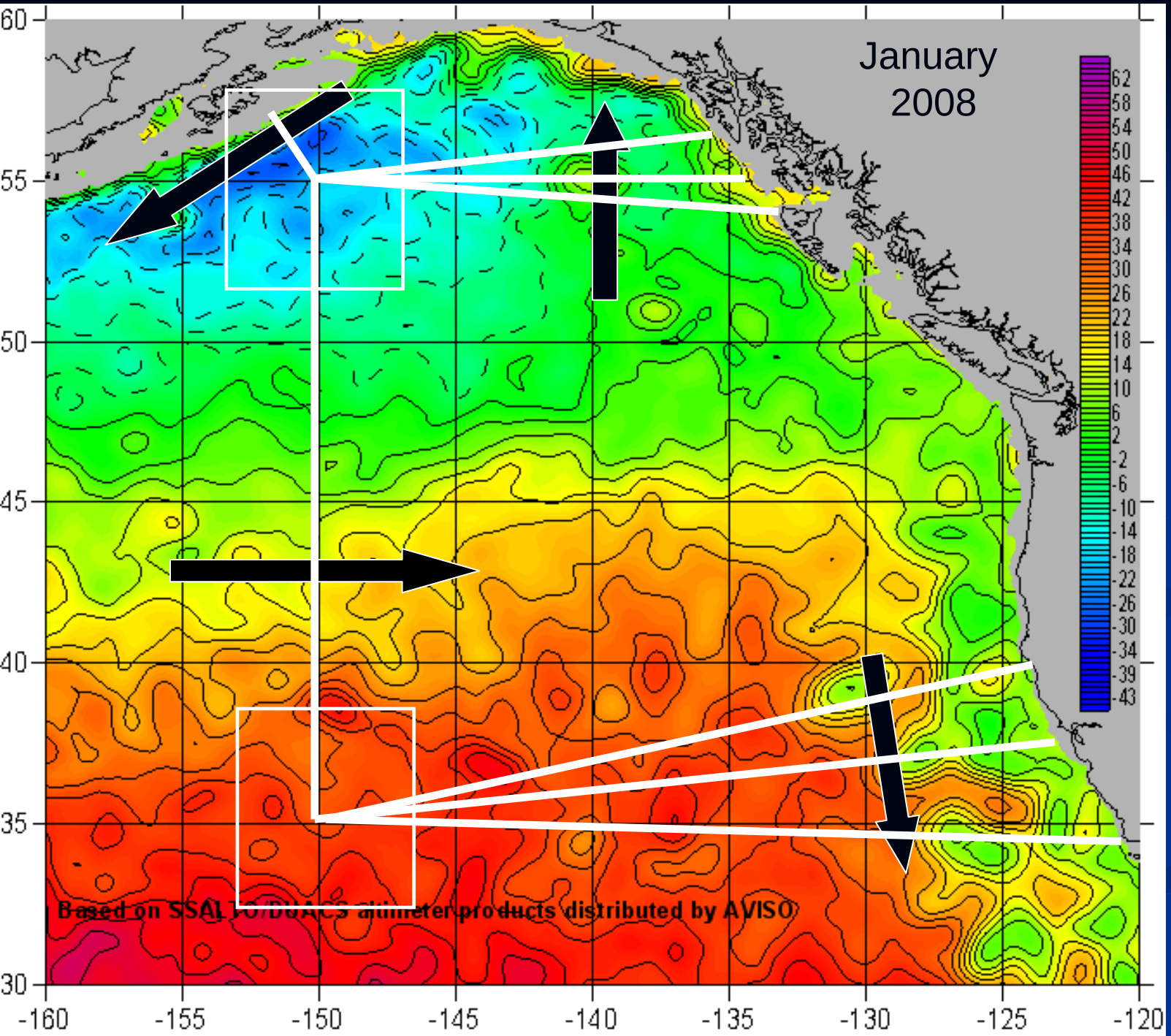
La Niña



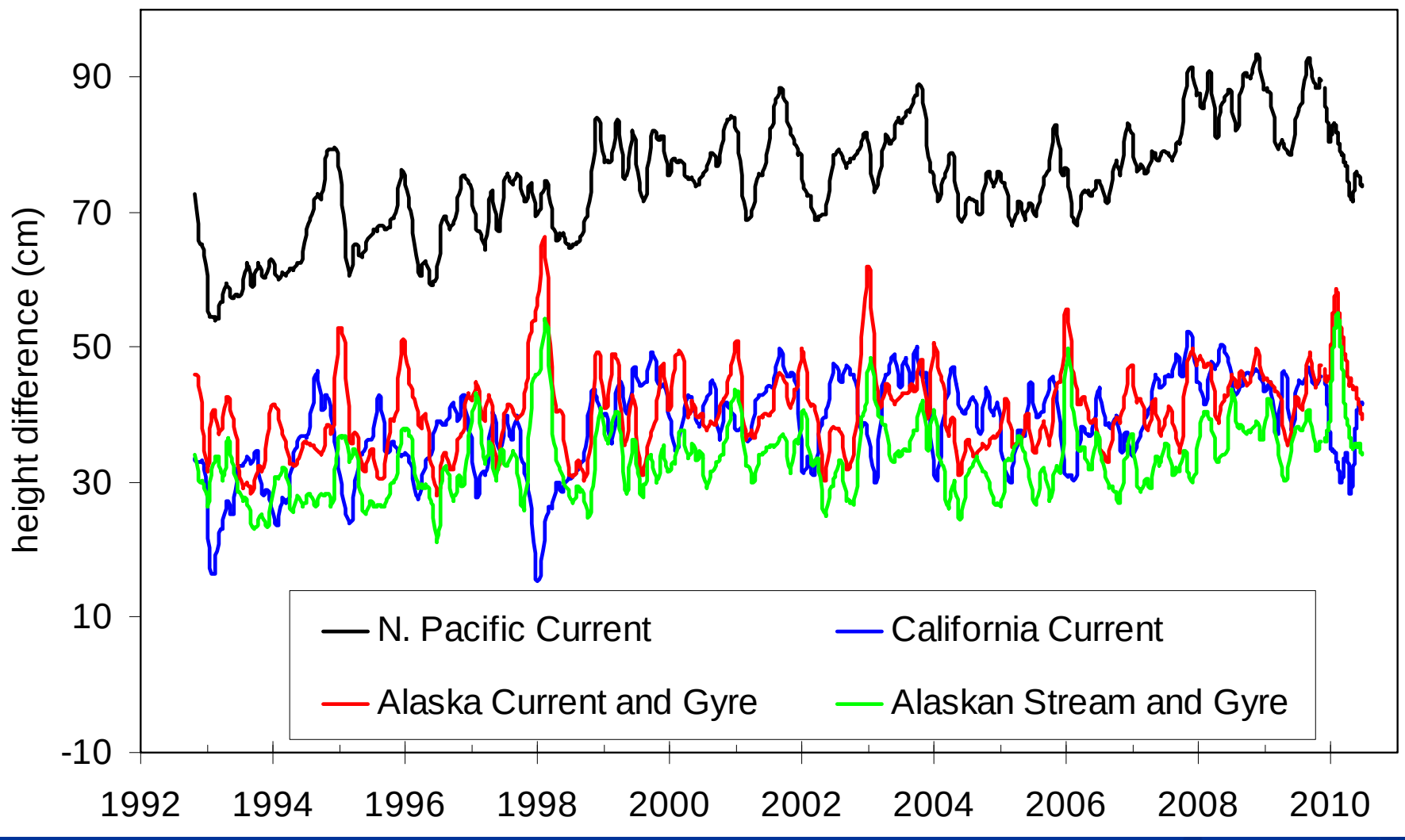
El Niño

Fisheries and Oceans Canada

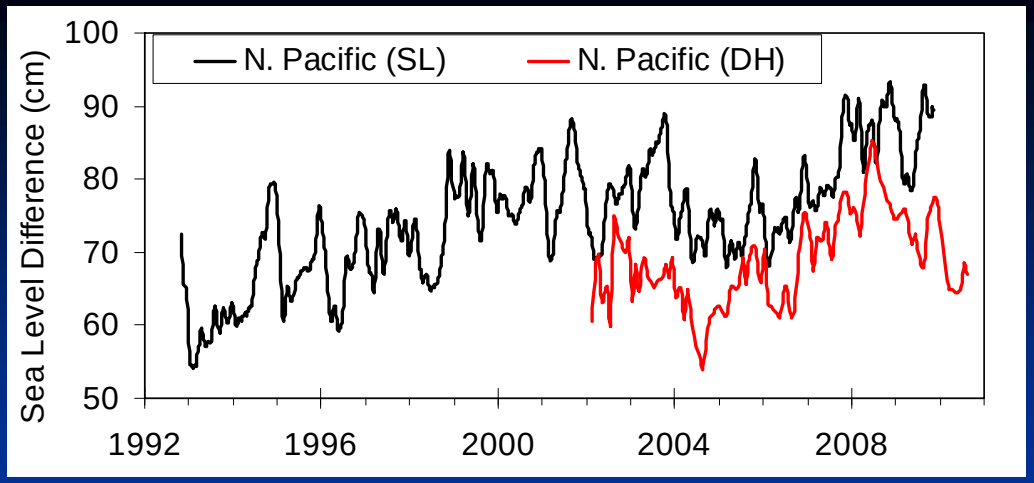
Pêches et Océans Canada

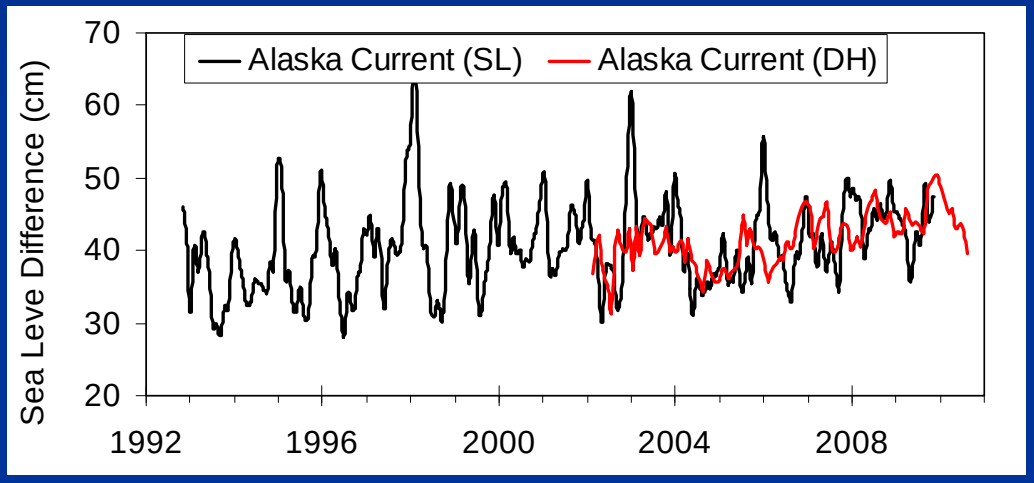


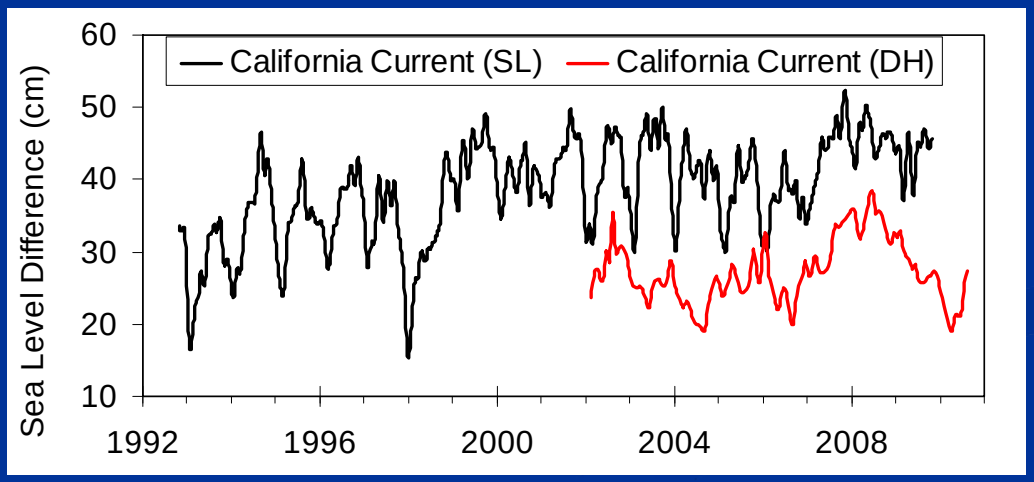
February
1998



Extreme anomalies in coastal currents are not present in North Pacific Current.







Compare with dynamic height differences computed from Argo data monthly since 2002, as prepared by Howard Freeland:

2006, *Atmos.-Ocean* 44:321-330
2004, *Prog. Oceanogr*. 64:31-44

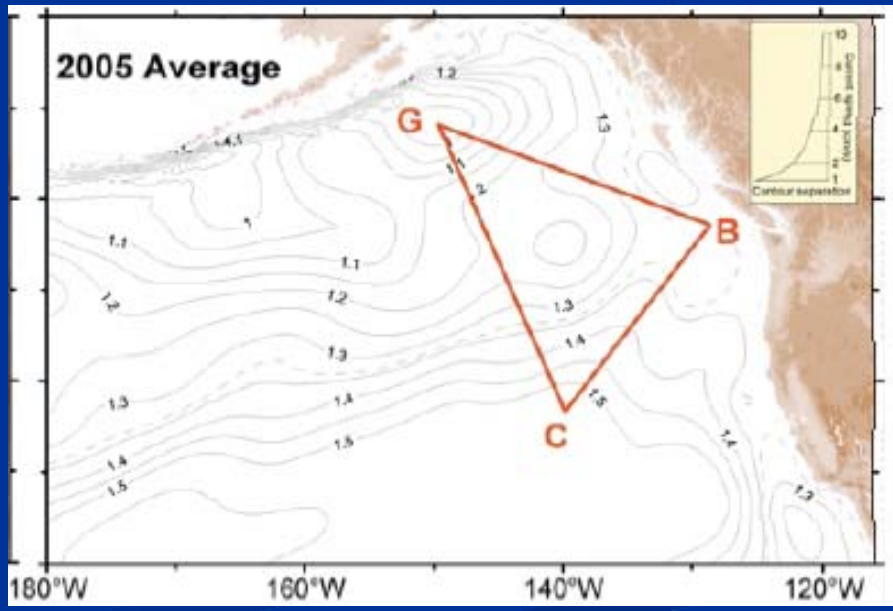
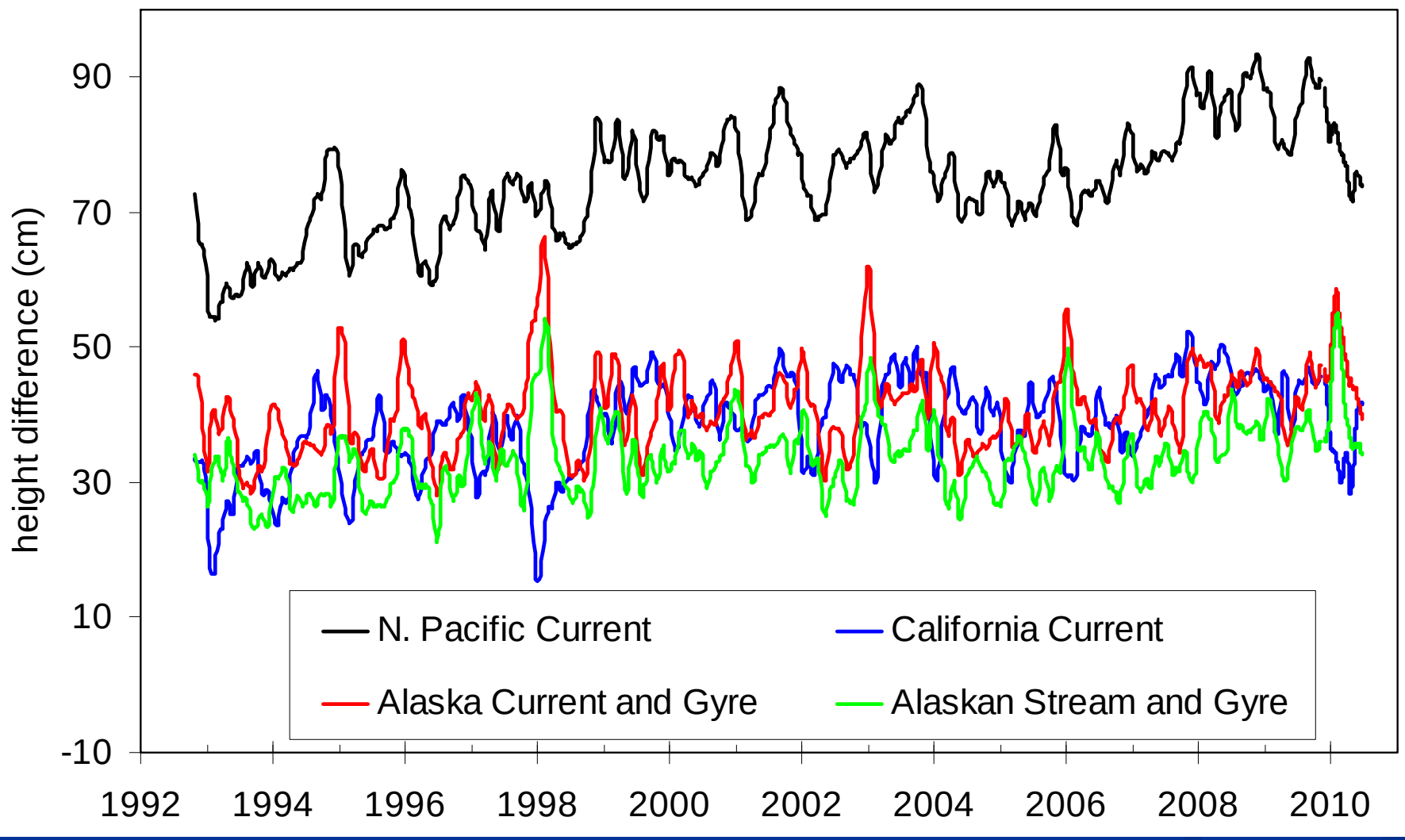


Fig. 3 from Freeland 2006



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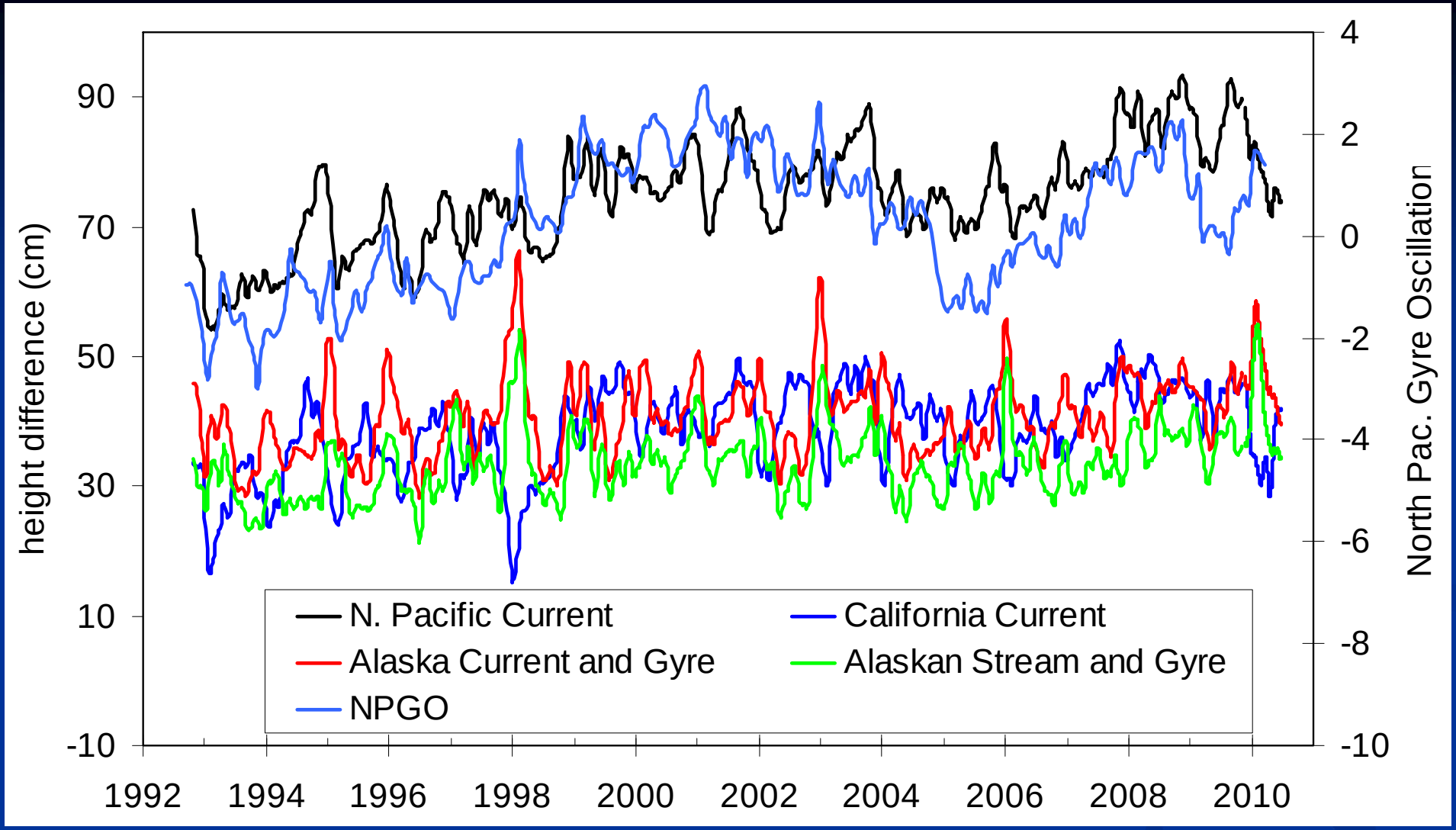
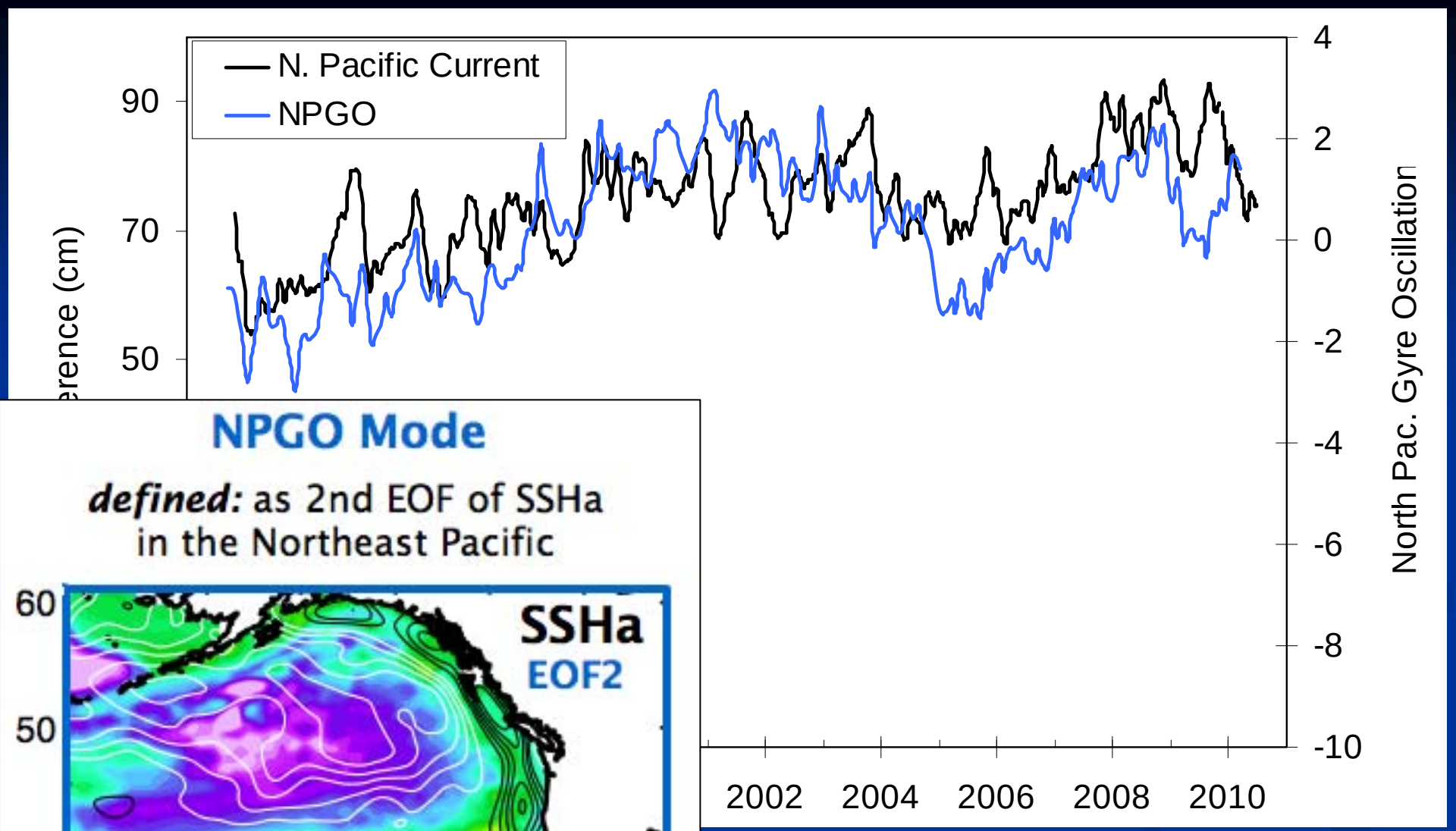


Di Lorenzo et al., 2008: Geophys. Res. Lett., 35, L08607, doi:10.1029/2007GL032838.

Di Lorenzo et al., 2009: Geophys. Res. Lett, 36, L14601, doi:10.1029/2009GL038261.

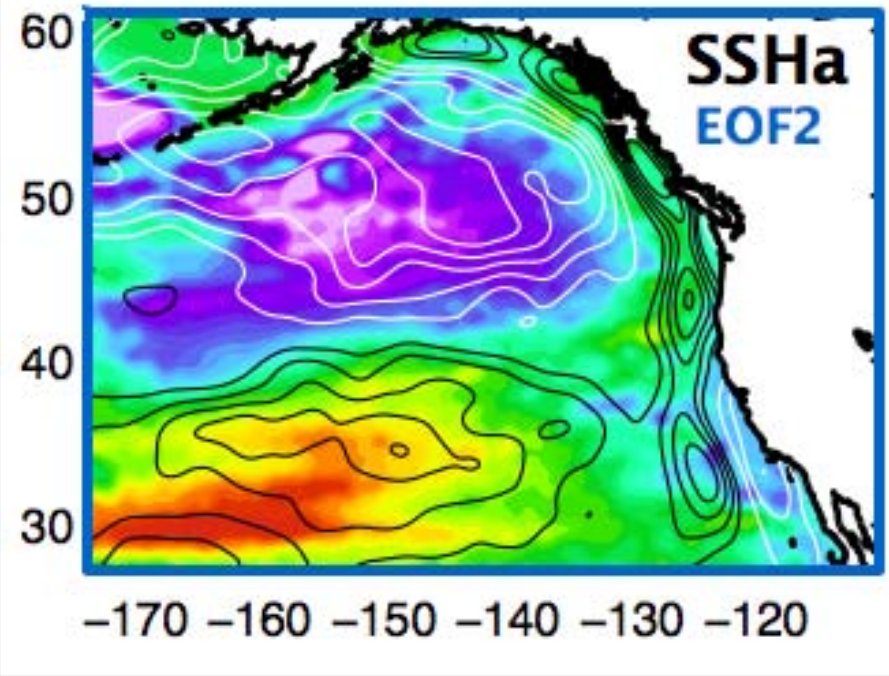
http://www.o3d.org/npgo/

PDO corresponds poorly with variability in these currents.



NPGO Mode

defined: as 2nd EOF of SSHa in the Northeast Pacific



Di Lorenzo E. et al, 2008: Geophys. Res. Lett., 35, L08607, doi:10.1029/2007GL032838

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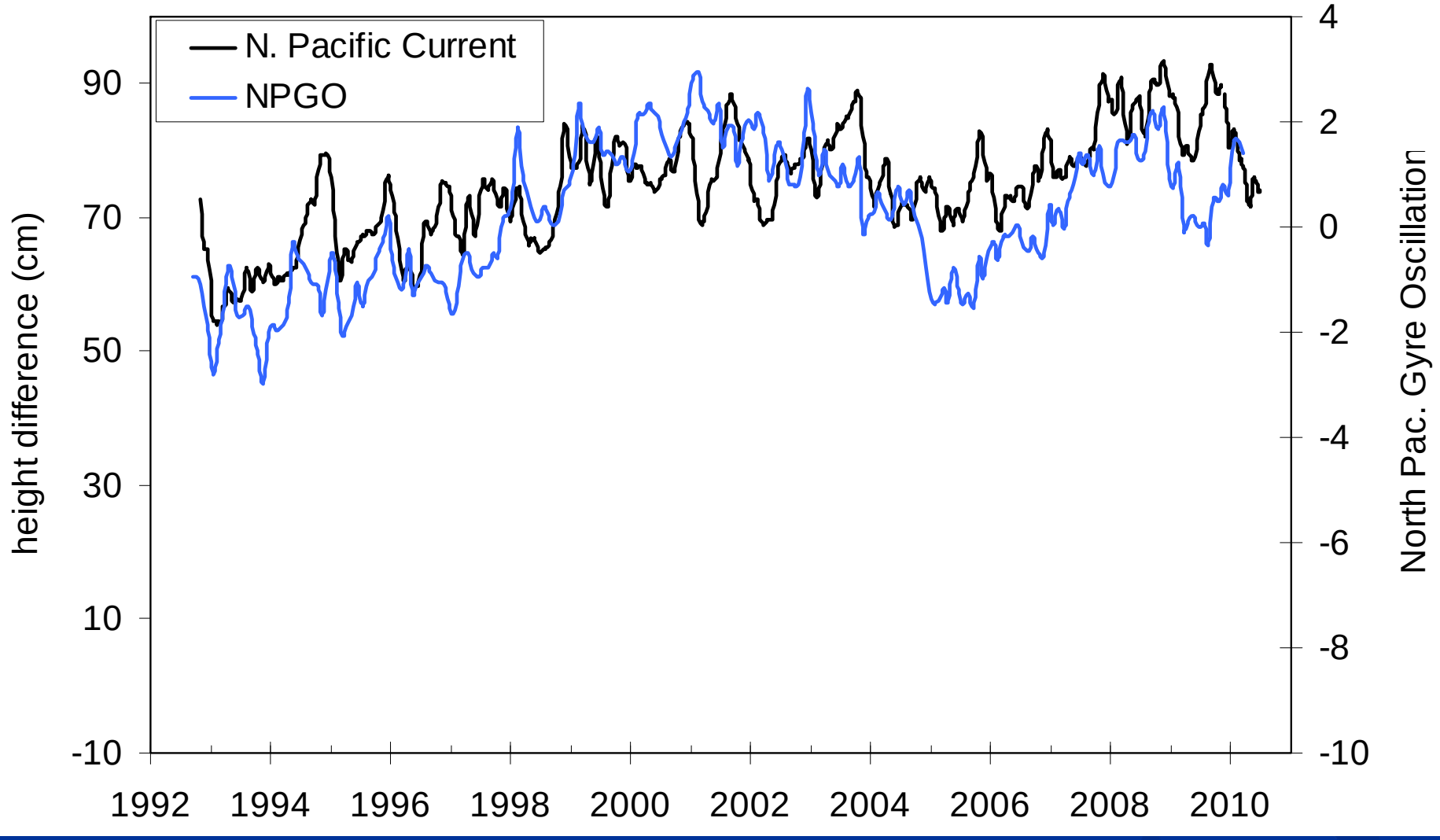

Di Lorenzo E. et al, 2008: Geophys. Res. Lett., 35, L08607, doi:10.1029/2007GL032838

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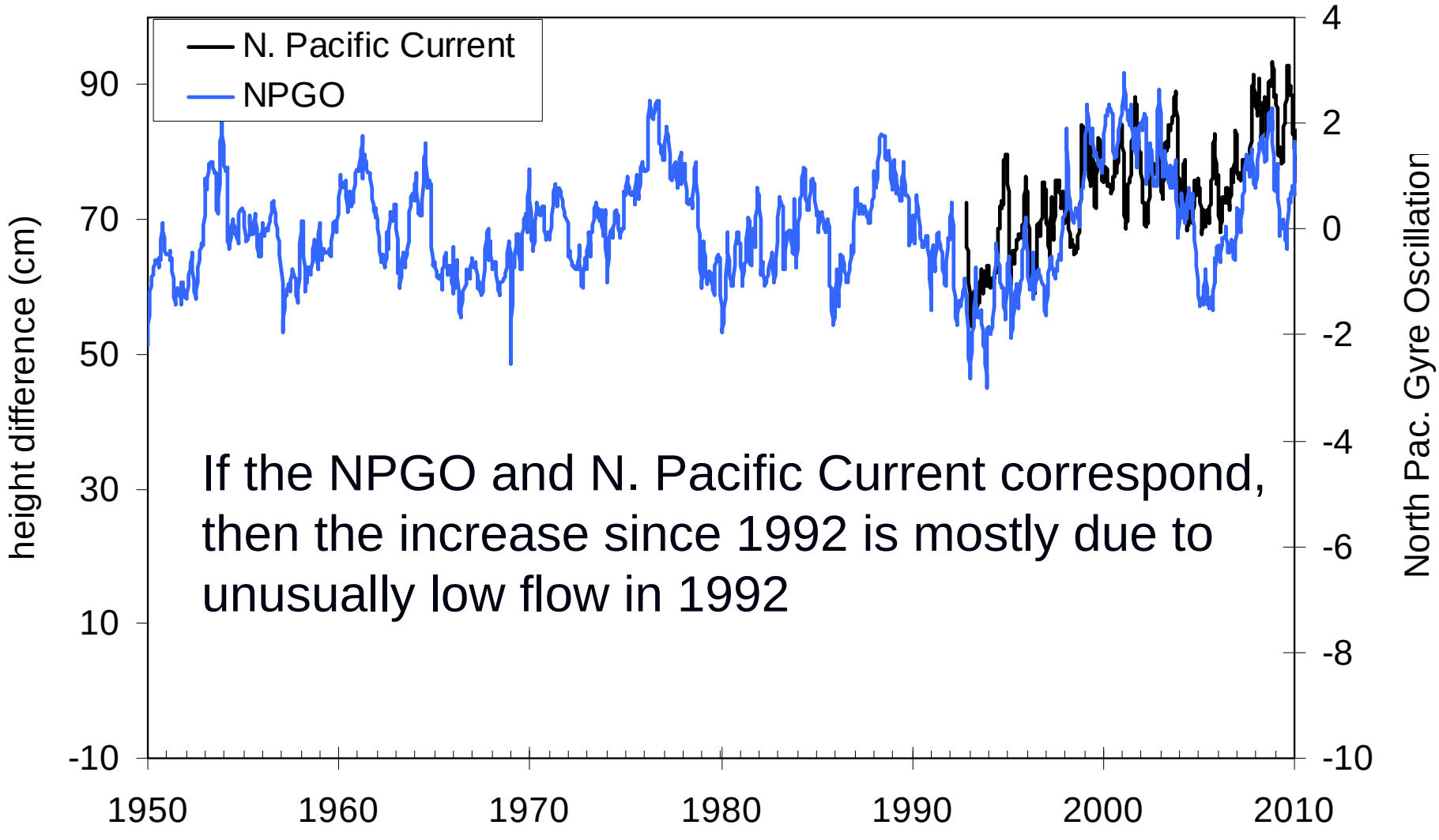

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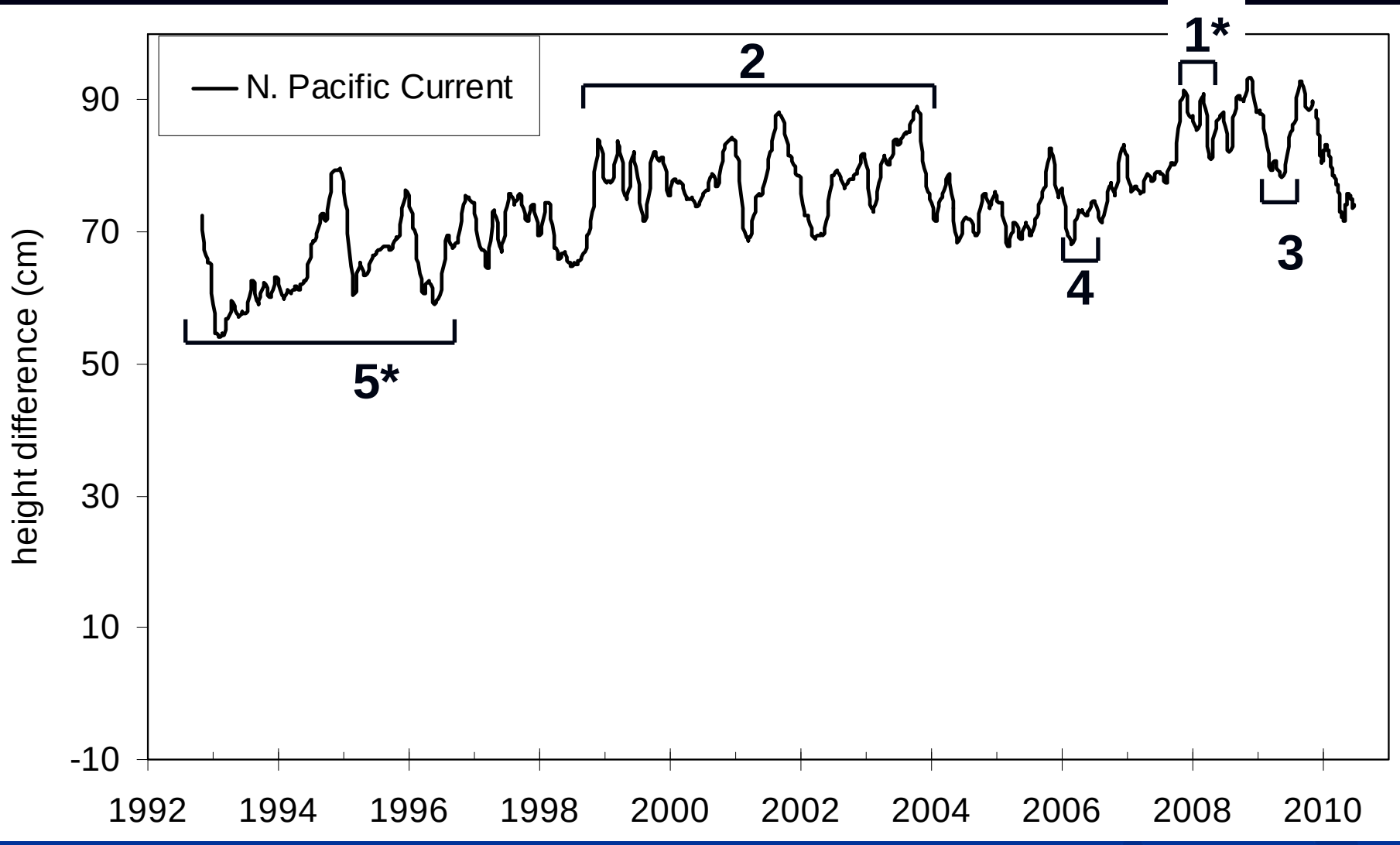
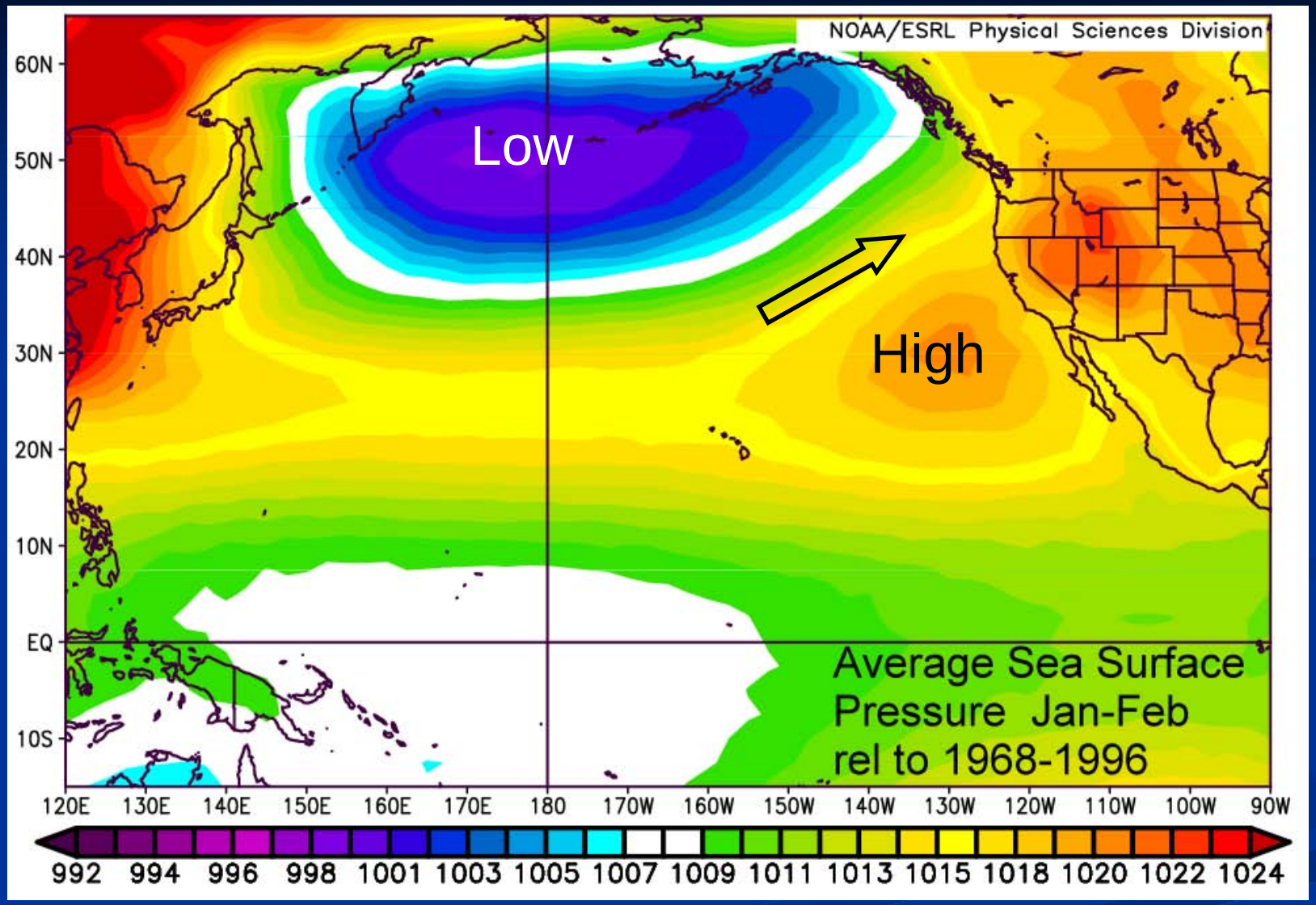
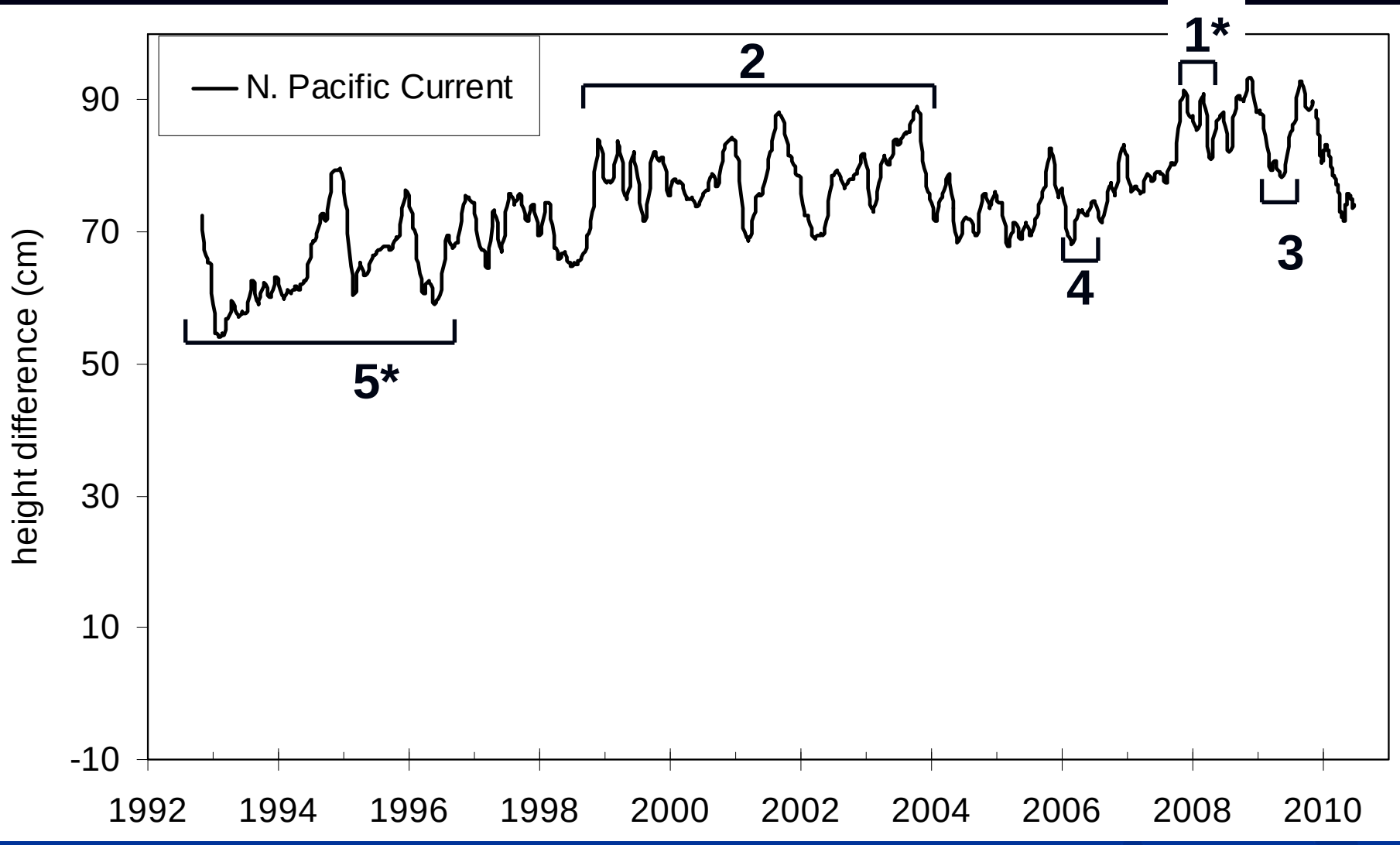


Next: Examine air pressure and wind anomalies at times of strong and weak North Pacific Current.

Average sea level air pressure in Jan-Feb



Air pressure anomaly at sea surface, from NOAA/ESRL Physical Sciences Division



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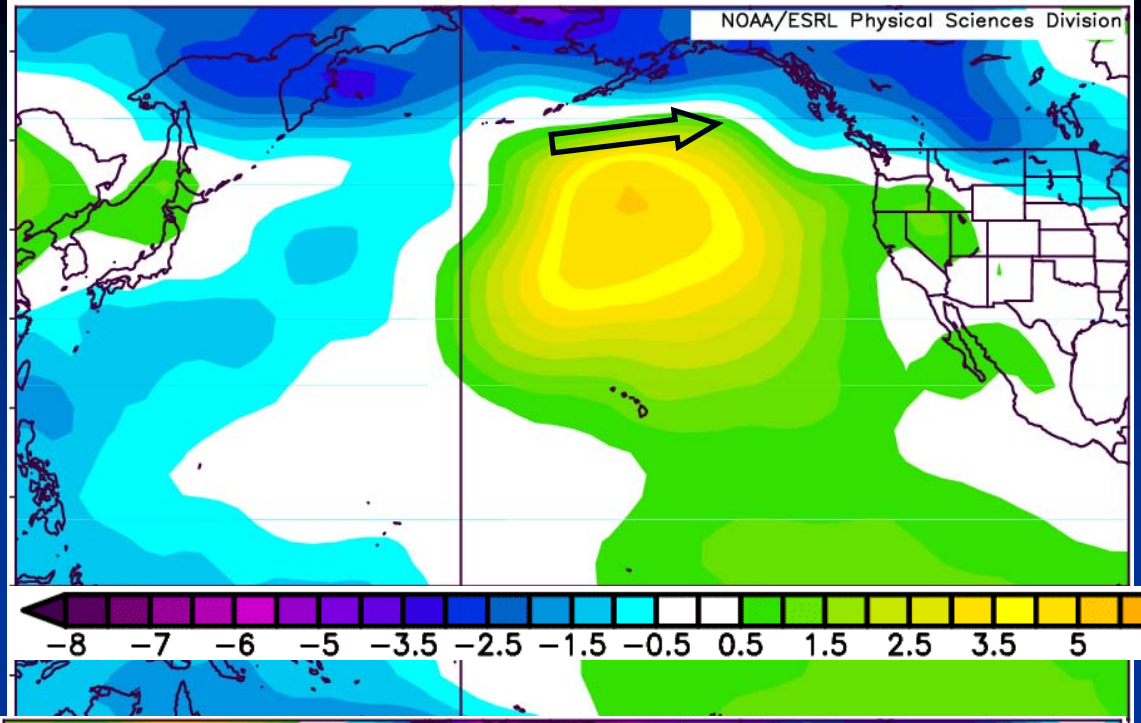
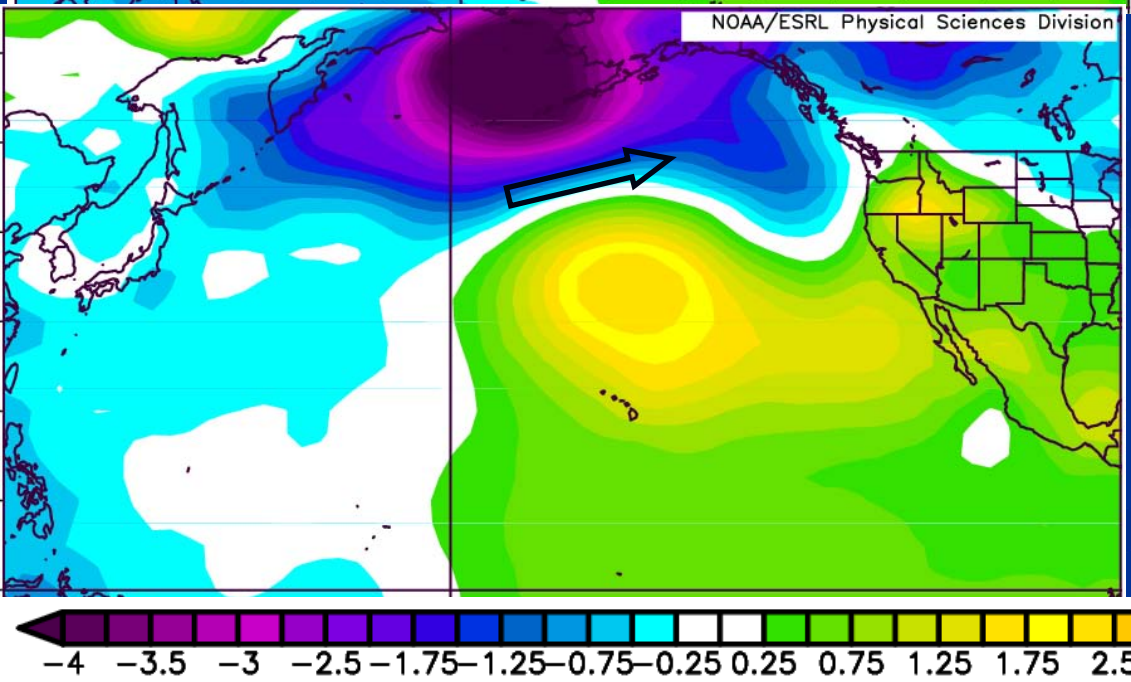
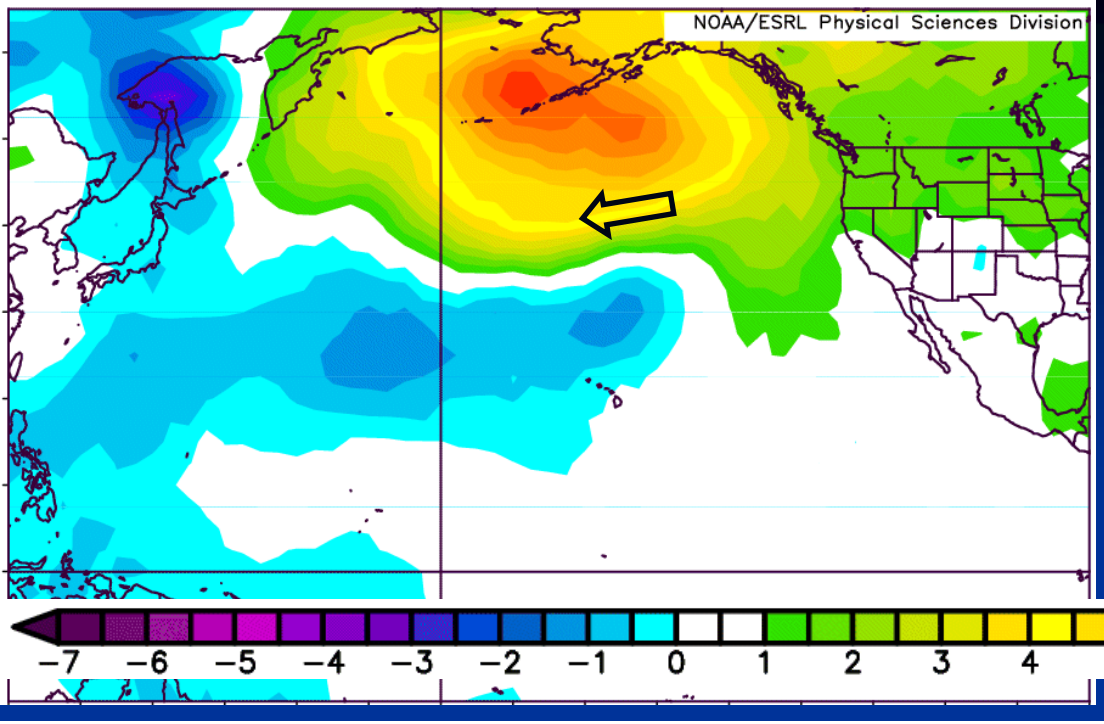


Air pressure **anomaly** at sea surface, from NOAA/ESRL Physical Sciences Division

1* Strongest flow
Oct 2007 – Feb 2008

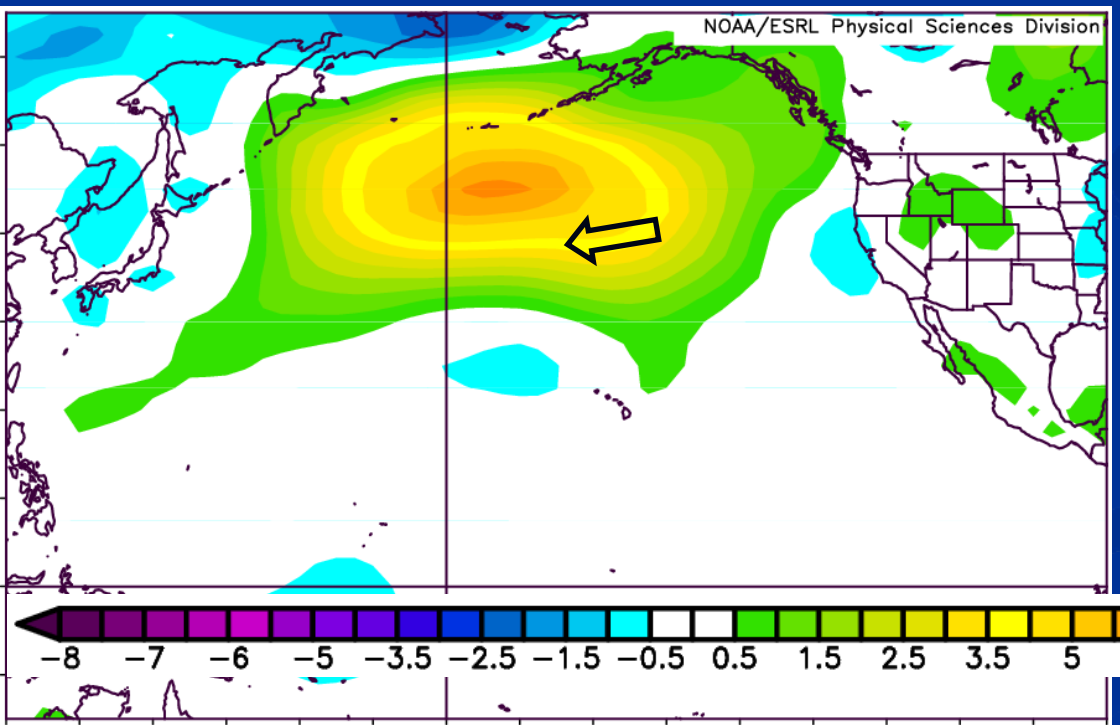


2 Strong flow
Nov 1998 – Feb 2004
Nov-Feb only

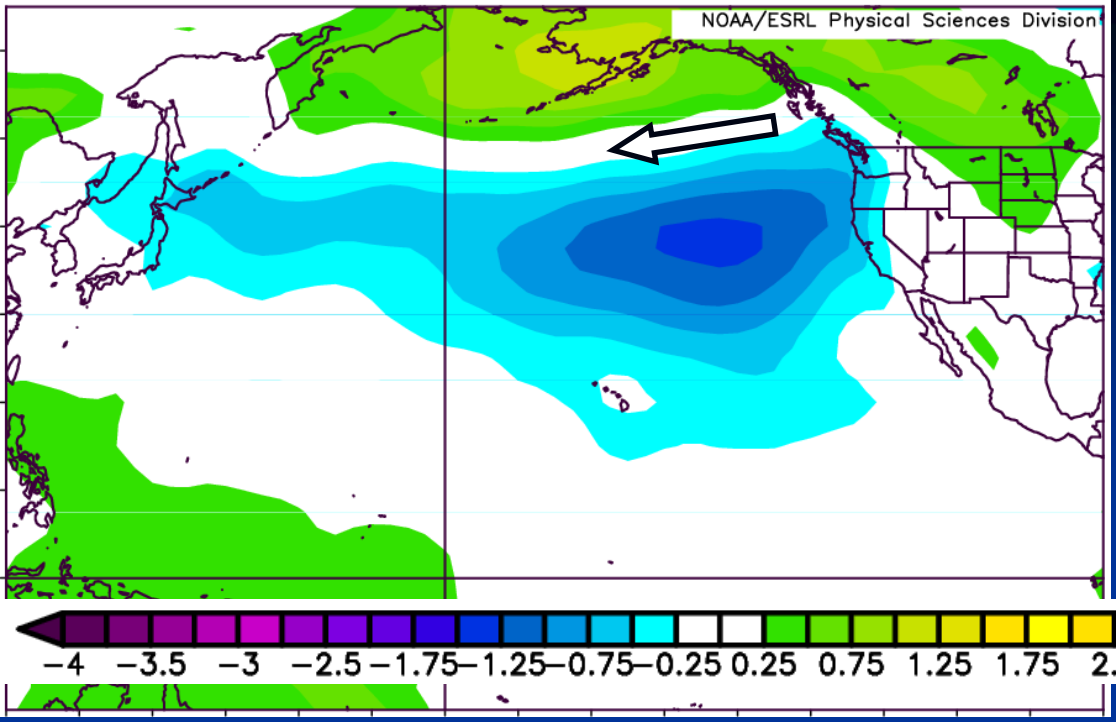


Air pressure anomaly at sea surface, from NOAA/ESRL Physical Sciences Division

3 Weak flow
Mar 2009 – May 2009

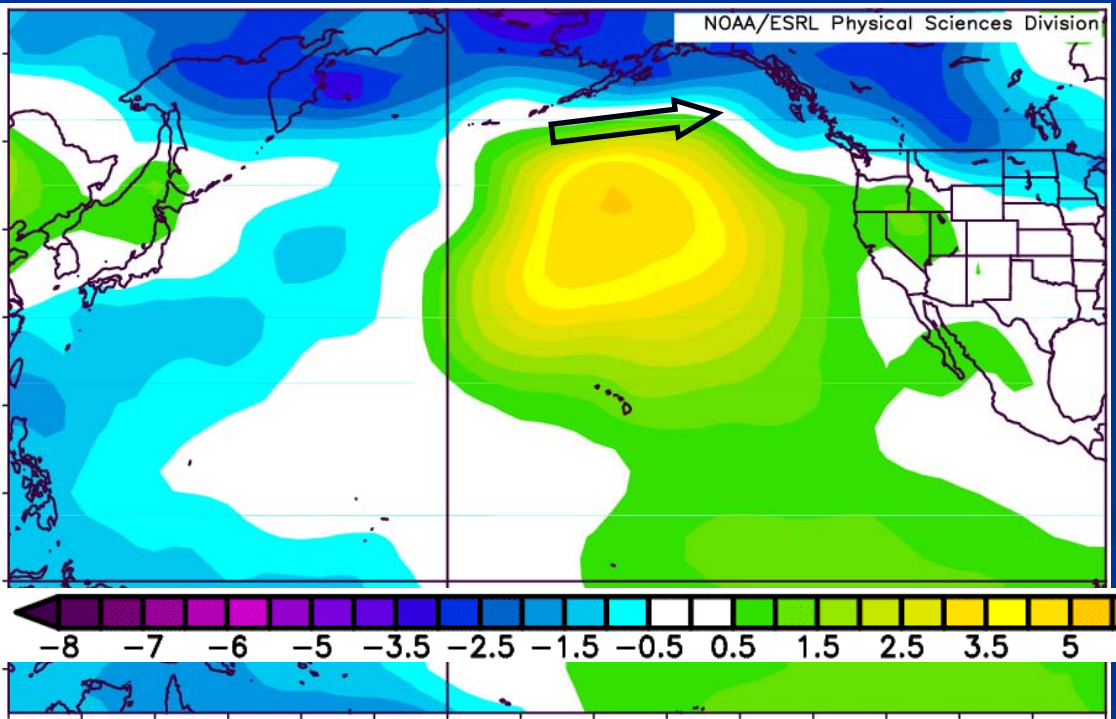


4 Weak flow
Feb 2006 – Sep 2006

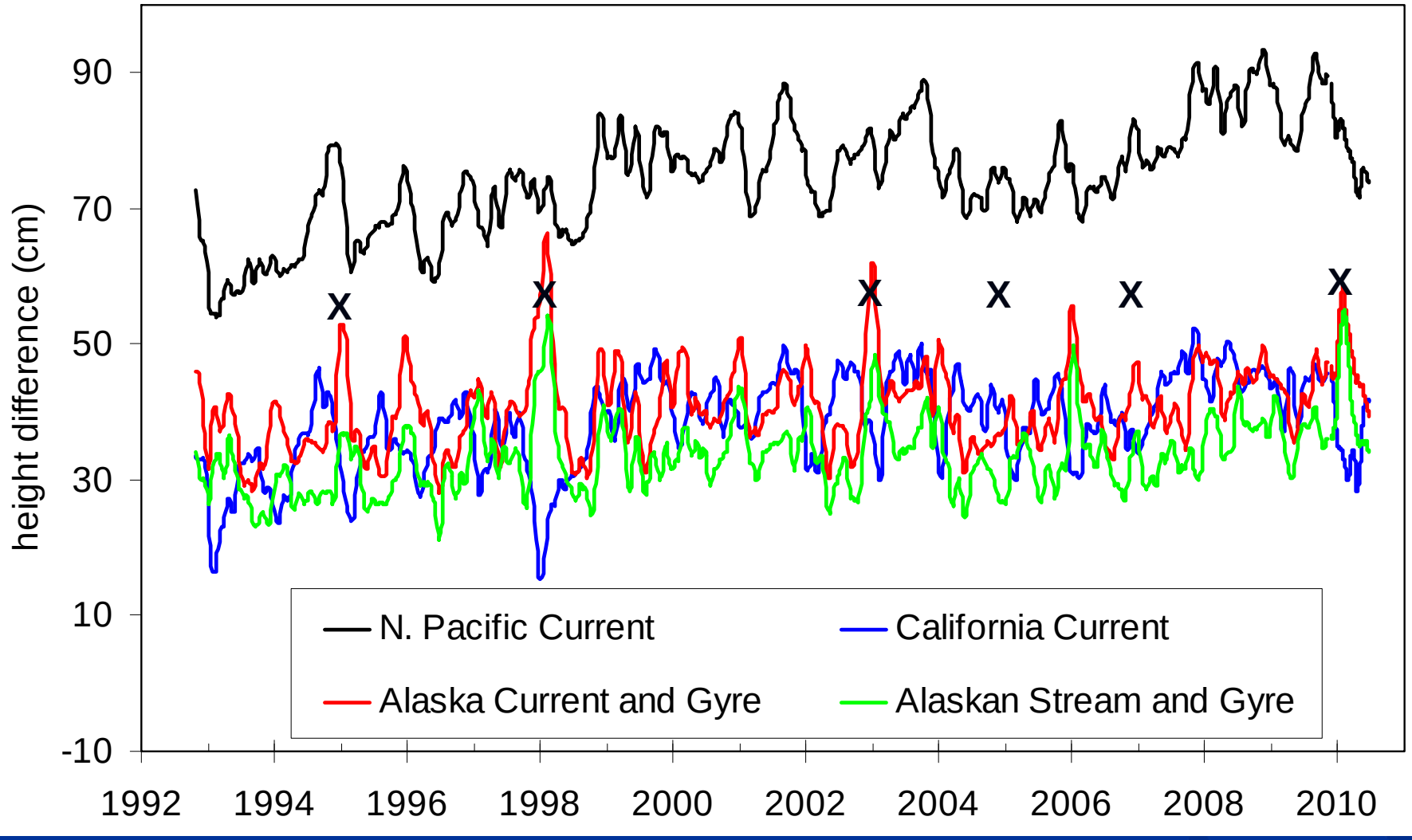


Air pressure anomaly at sea surface, from NOAA/ESRL Physical Sciences Division

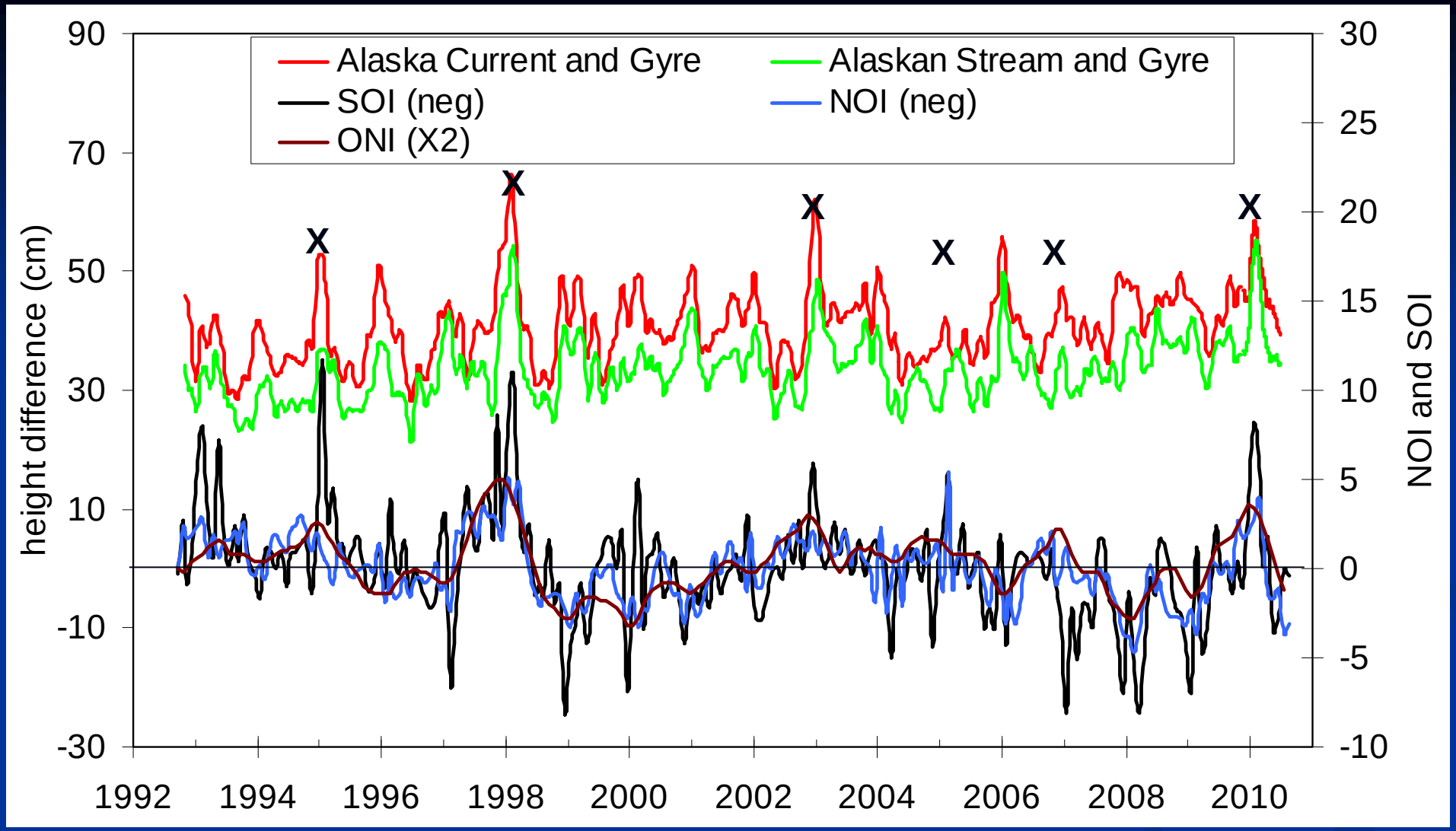
5* Weakest Flow
Jan 1992 – Dec 1996
All months

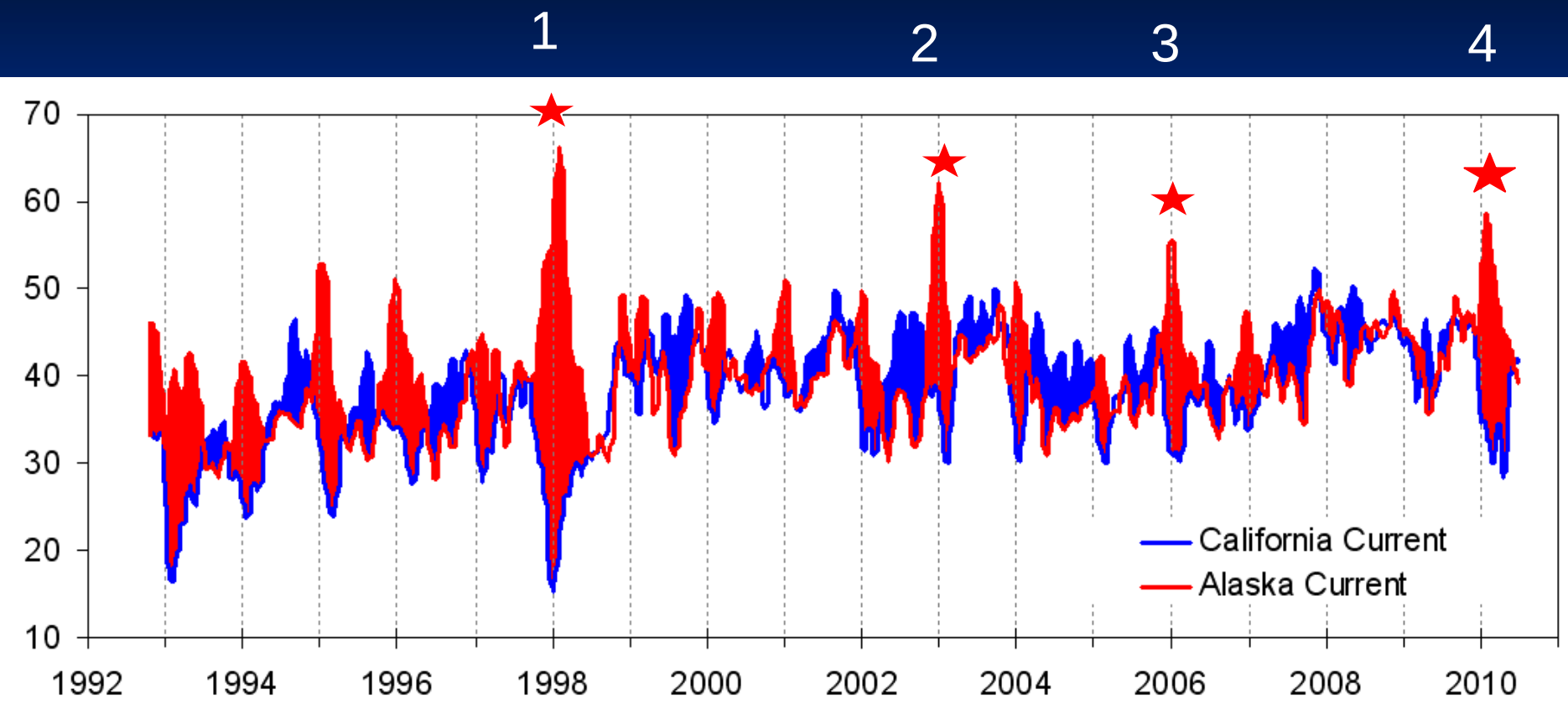


1* Strongest flow
Oct 2007 – Feb 2008



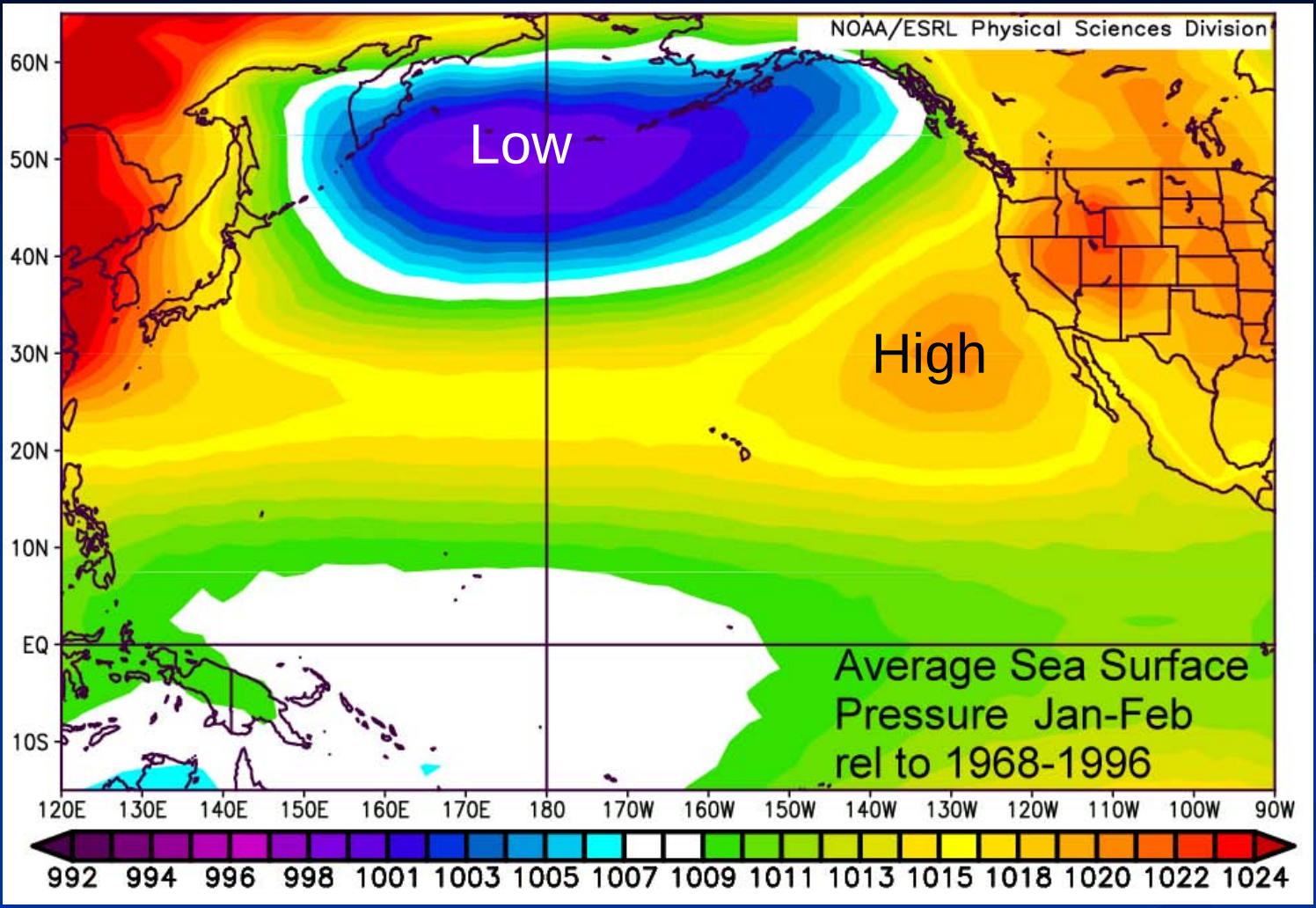
Note the peaks in Alaska Current and Alaskan Stream in El Niño winter.
Major peaks coincide with a drop in California Current.
Some align with El Niño (X based on ONI), but a significant number do not.
Variable correspondence with North Pacific Current.

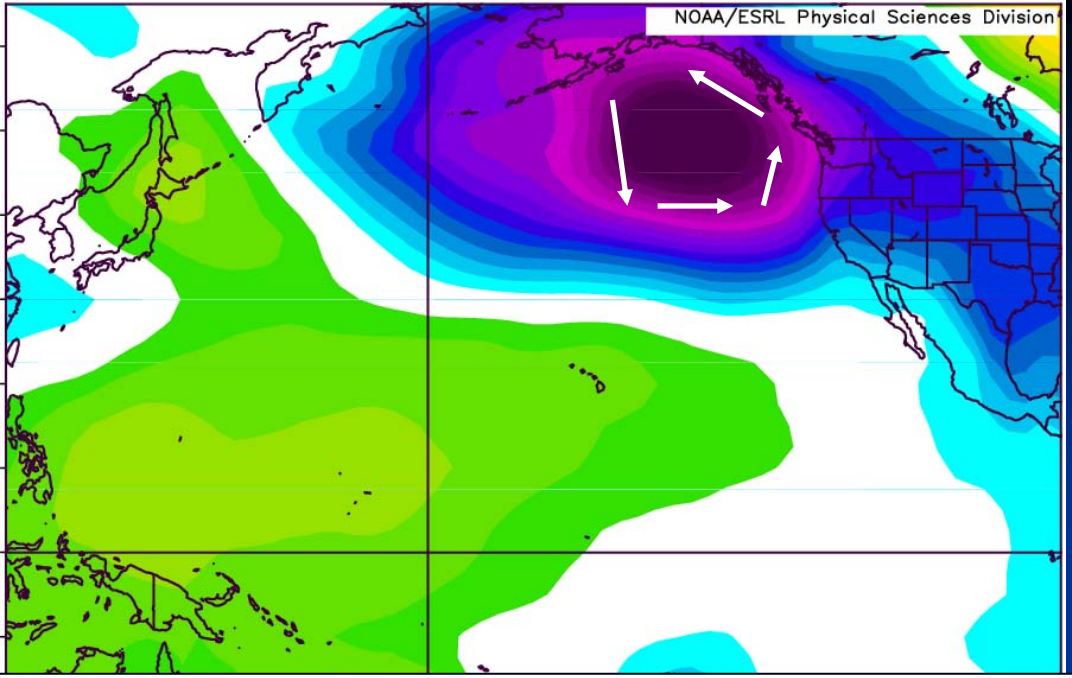

Alaska Current and Gyre
Alaskan Stream and Gyre
SOI (neg)
NOI (neg)
ONI (X2)
height difference (cm)
NOI and SOI
90
70
50
30
10
-10
-30
30
25
20
15
10
5
0
-5
-10
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
X
X
X
X
X
X



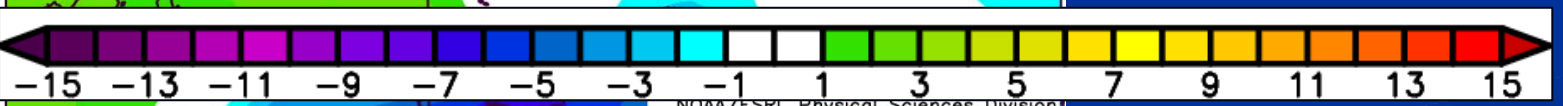
Let's look at air pressure anomalies in the months up to the **maximum** Alaska flows and **minimum** California flows, labelled with ★

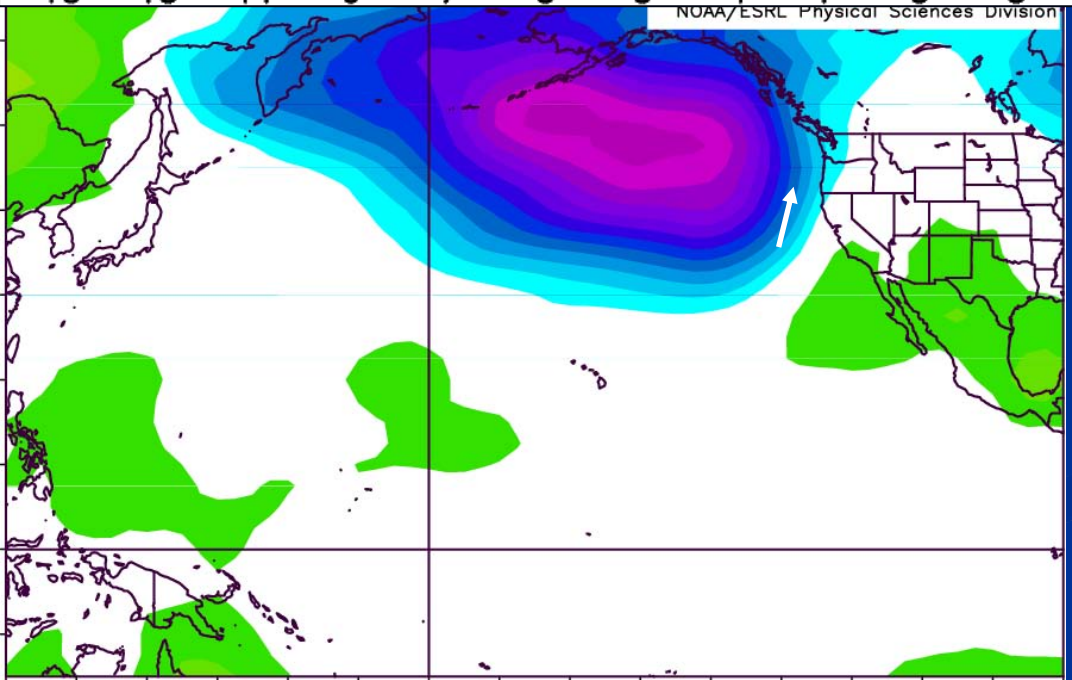
Average sea level air pressure in Jan-Feb





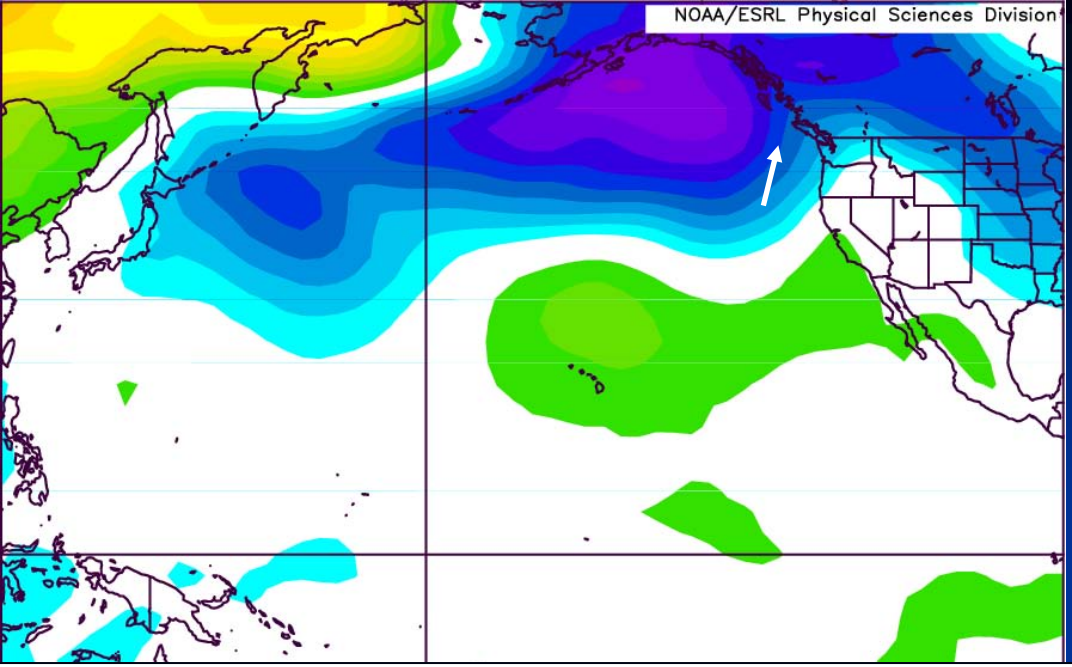
1 Strongest Alaska Flow
Jan 1998 - Feb 1998



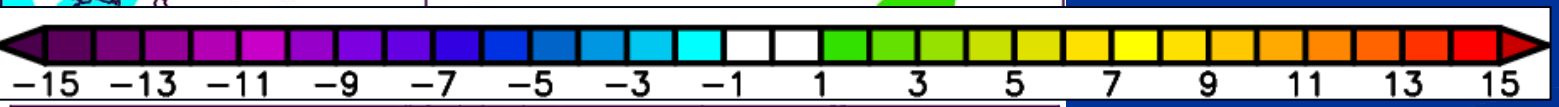


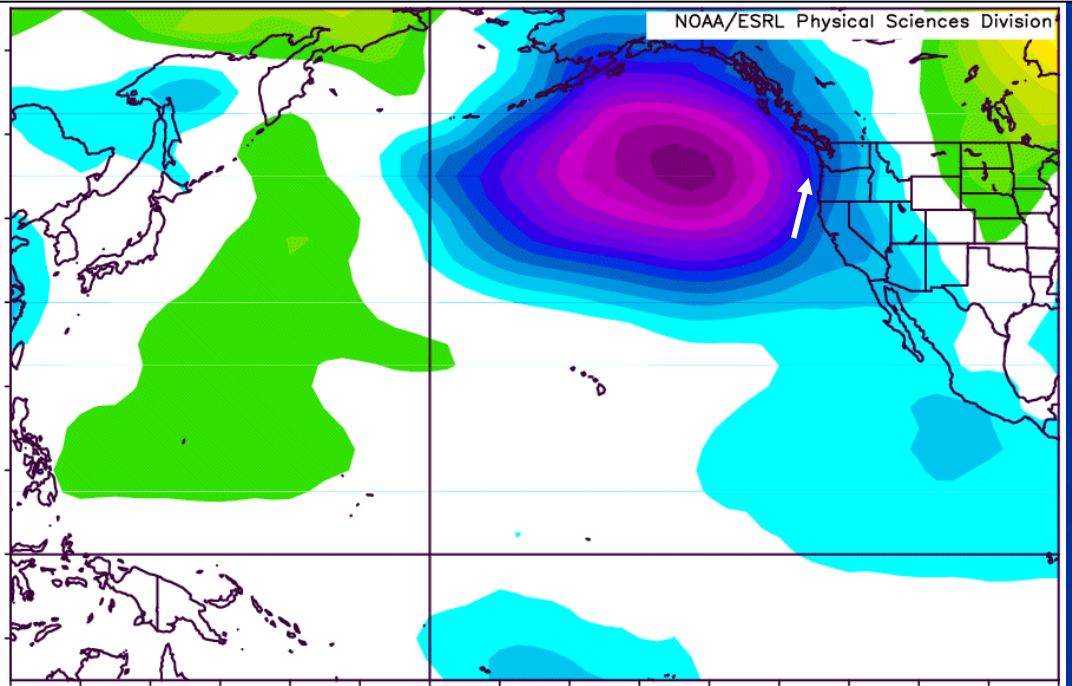
2 Strong Alaska flow
Dec 2002 – Jan 2003

Anomaly of Sea Surface Air Pressure over two months

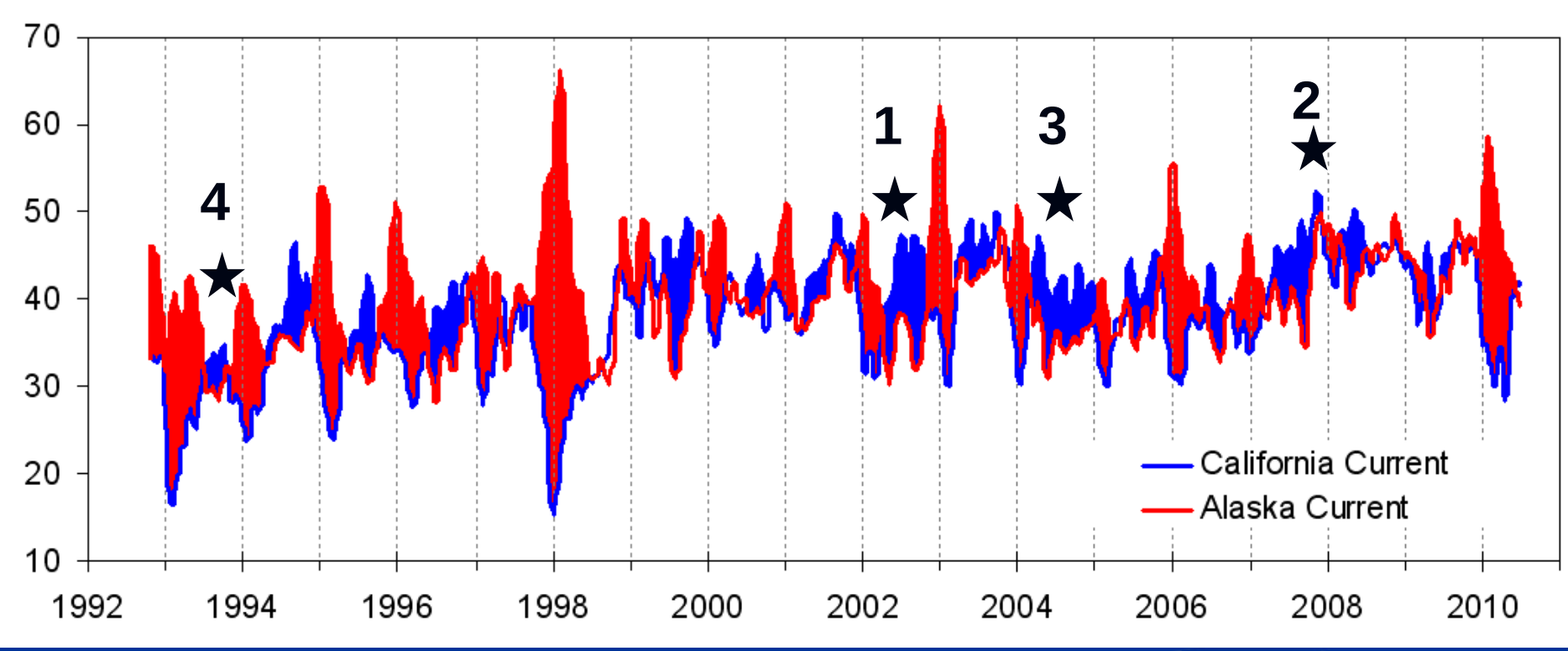


3 Strong Alaska flow
Dec 2005 - Jan 2006





4 Strong Alaska flow
Jan 2010 - Feb 2010

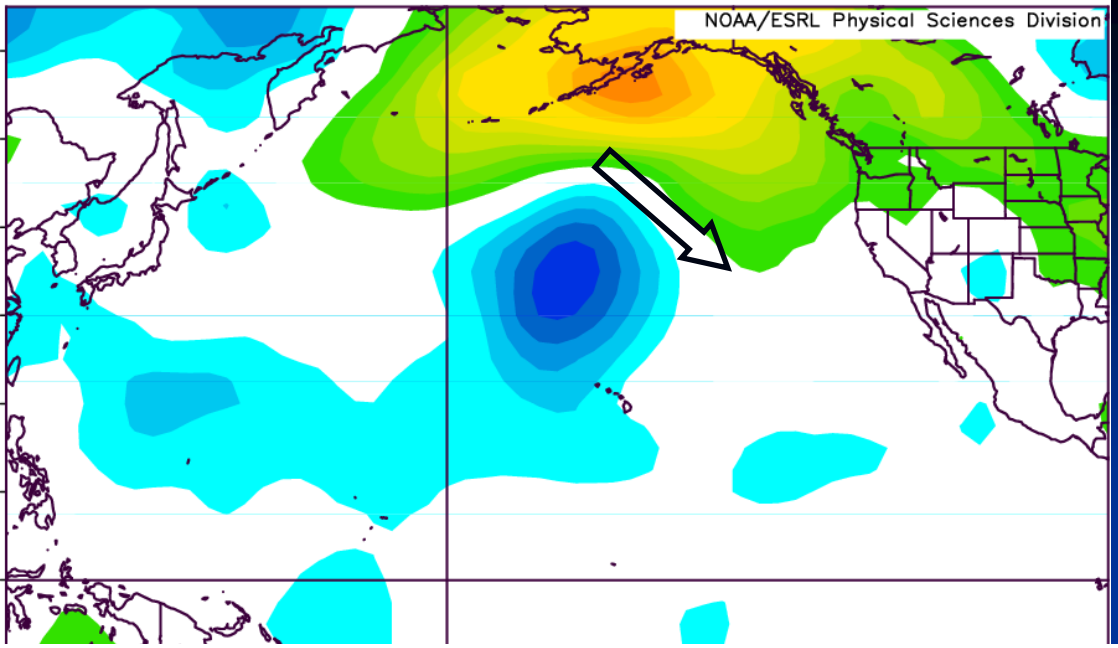


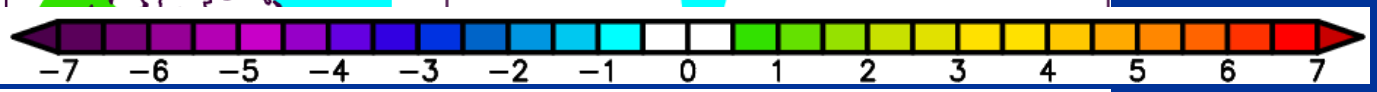
1 Strong Calif. Current, weak Alaska Currents in summer 2002.

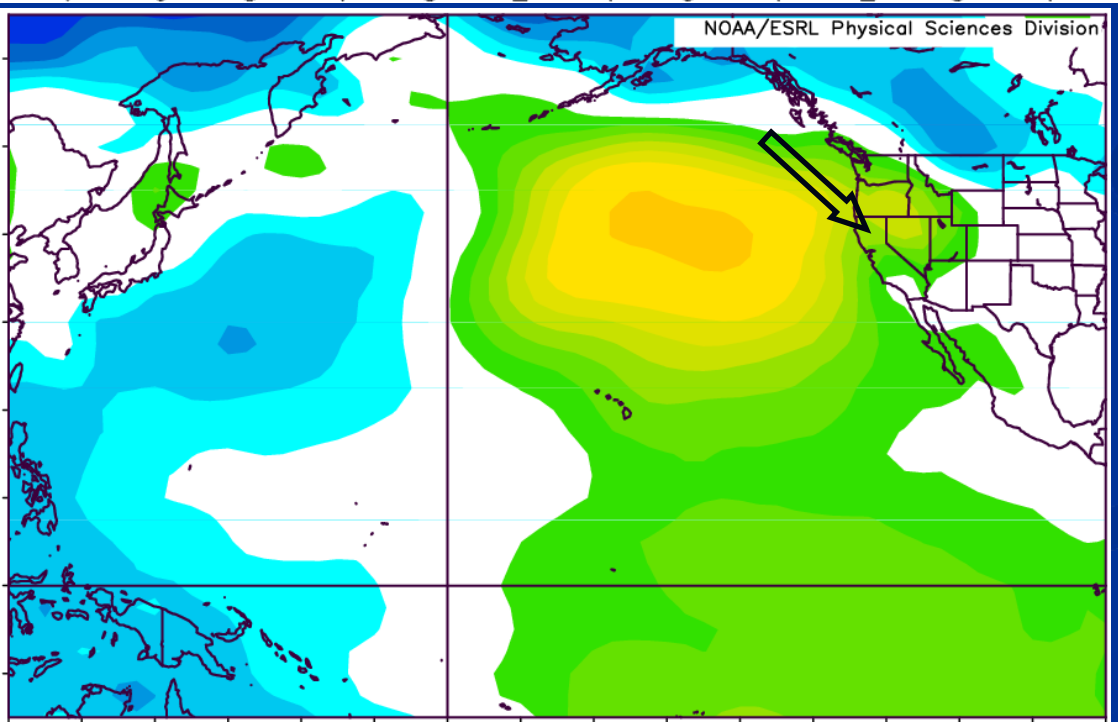
2 Strongest Calif. Current in autumn 2007 and spring 2008.

3 Moderate Calif. Curr. and weak Alaska Curr. in summer 2004.

4 Weak California Curr. and weak Alaska Curr. in summer 1993.

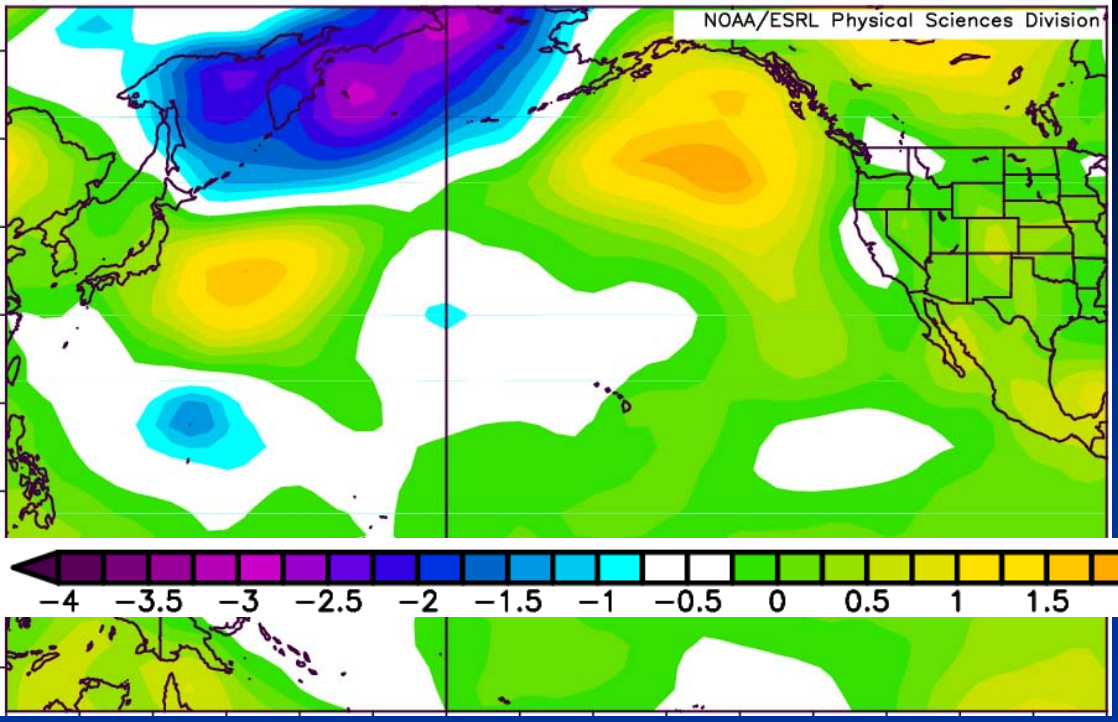




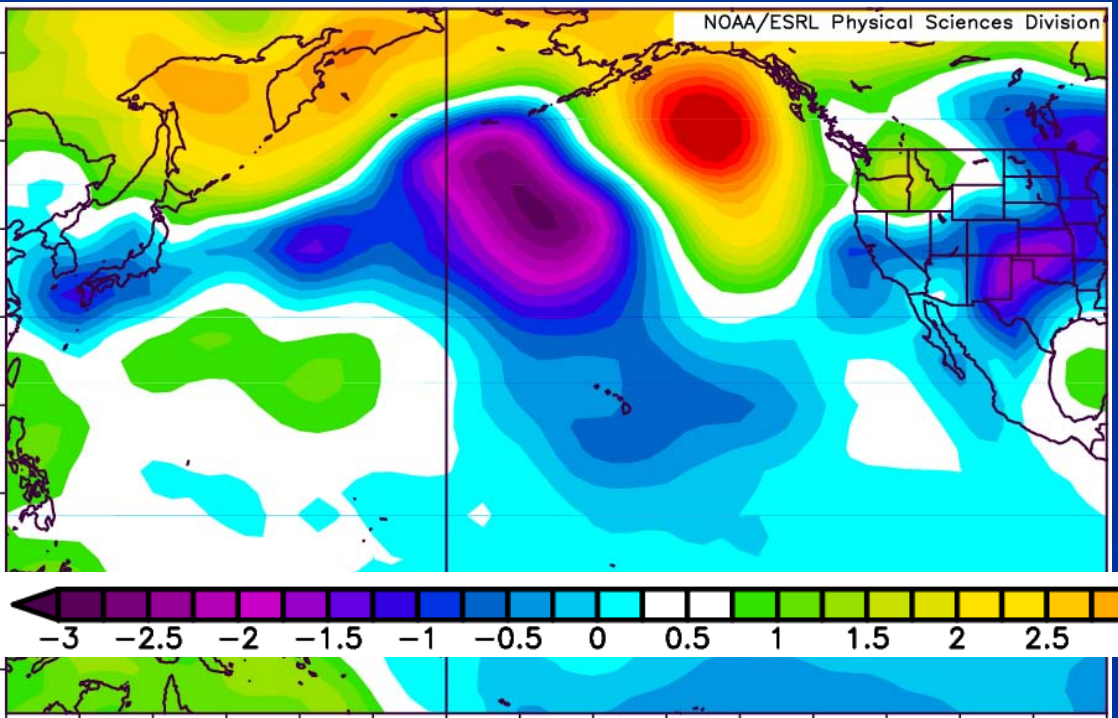


1 Strong Cal, Weak AC
Mar 2002 – Sep 2002

2 Strongest Cal
Oct 2007 - Apr 2008



3 Moderate Cal and AC
Apr 2004 – Dec 2004



4 Weak Cal and AC
Jul 1993 – Aug 1993

Summary:

With satellite altimetry and Foreman et al. (2008) absolute sea level maps we can determine strength of major currents in Gulf of Alaska. I plotted these currents as sea level differences.

North Pacific Current has decadal variability that aligns with the North Pacific Gyre Oscillation. The increase in its flow since the beginning of continuous altimetry in 1992 is likely due to a minimum in its flow in 1992 compared to the previous 50 years. Extremes of this current tend to vary with position and strength of N. Pac High and Aleutian Low Pressure Systems.

Alaska and California Currents have relatively larger interannual variability that seems to be governed by both position and strength of the Aleutian Low Pressure System and North Pacific High Pressure System in the previous few months.

Features of the Northeast Pacific Ocean

William Crawford
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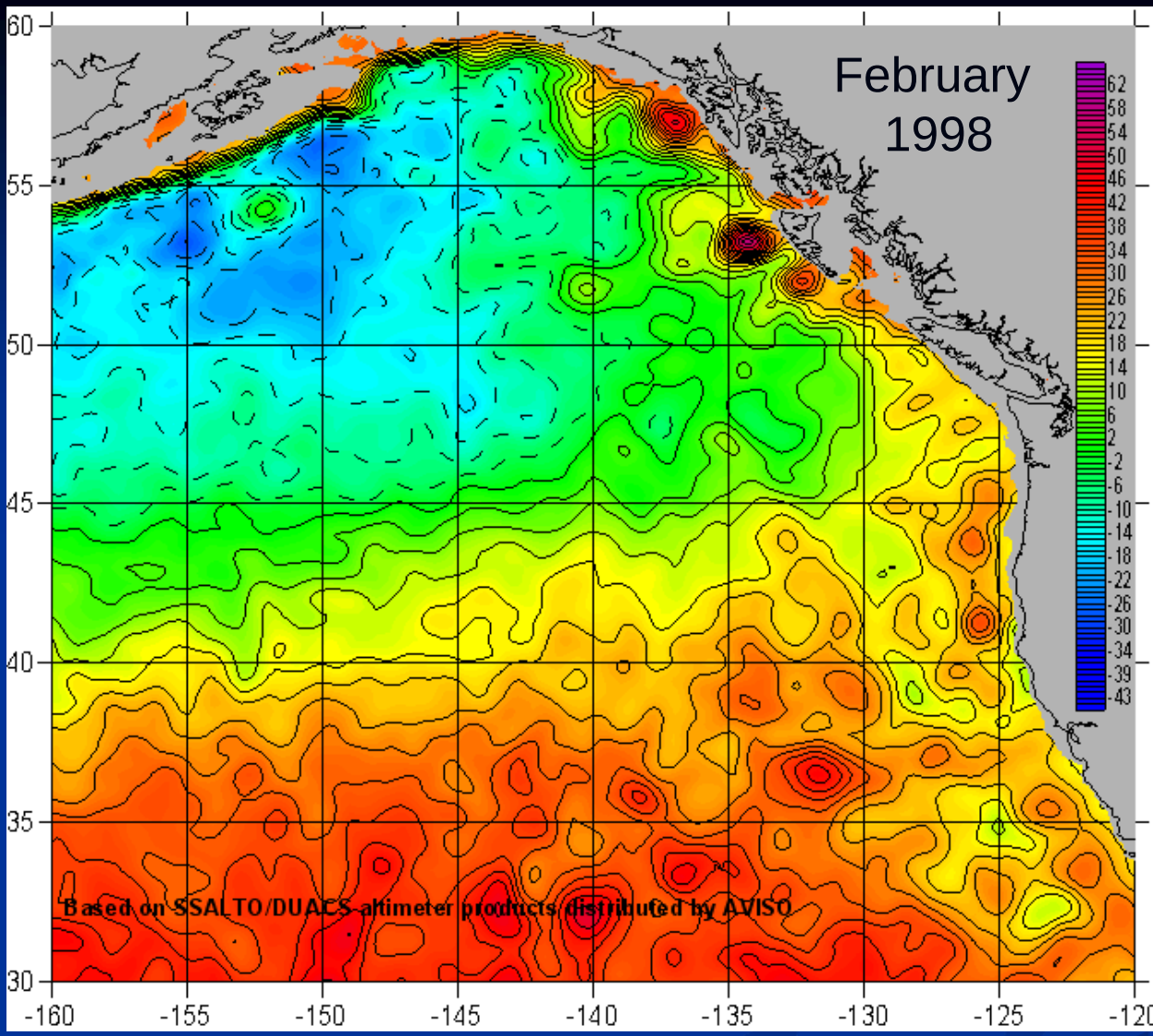

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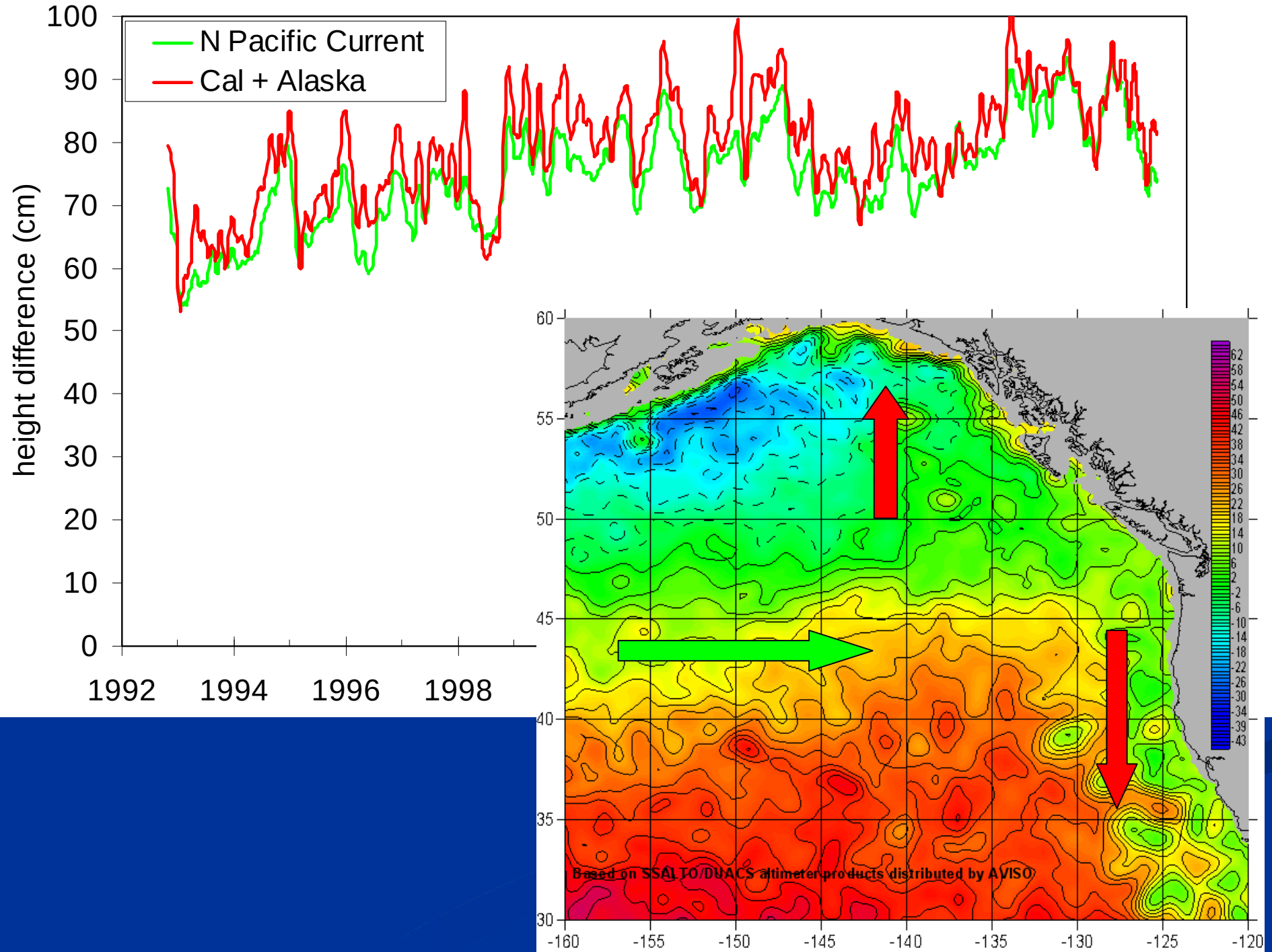
N Pacific Current
Cal + Alaska
height difference (cm)
100
90
80
70
60
50
40
30
20
10
0
1992
1994
1996
1998
60
55
50
45
40
35
30
-160
-155
-150
-145
-140
-135
-130
-125
-120
62
58
54
50
46
42
38
34
30
26
22
18
14
10
6
2
-2
-6
-10
-14
-18
-22
-26
-30
-34
-39
-43
Based on SSALTO/DUACS altimeter products distributed by AVISO