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Sea Level and Chlorophyll-*a* Variability in the Kuroshio Extension from Altimeter and SeaWiFS

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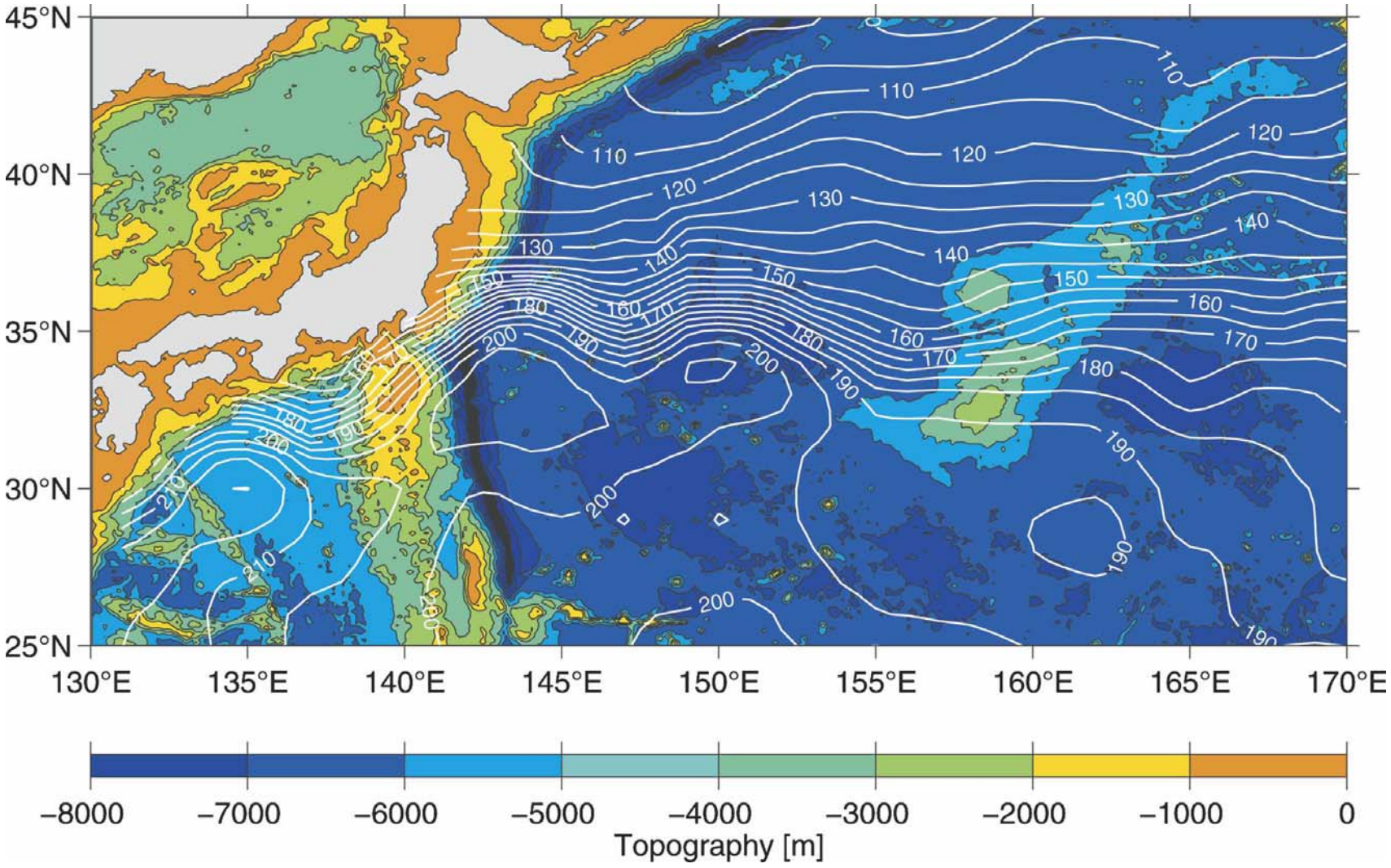
Mean Surface Dynamic Height
170 cm Contour → Kuroshio Extension (KE)
(Qiu & Chen 2005 JPO)



Kuroshio Extension (KE)

- To the east of Japan the Kuroshio swings eastward to form the Kuroshio Extension. The branching of this current in the region of 160° E results in the movement known as the North Pacific Current.

- The Kuroshio Extension (KE) current carries warm water at nearly 140 million cubic meters per second (140 Sv) eastward into the North Pacific.

Purpose of the Study

- To examine the seasonal variability of SeaWiFS chlorophyll-*a* (Chl-a)

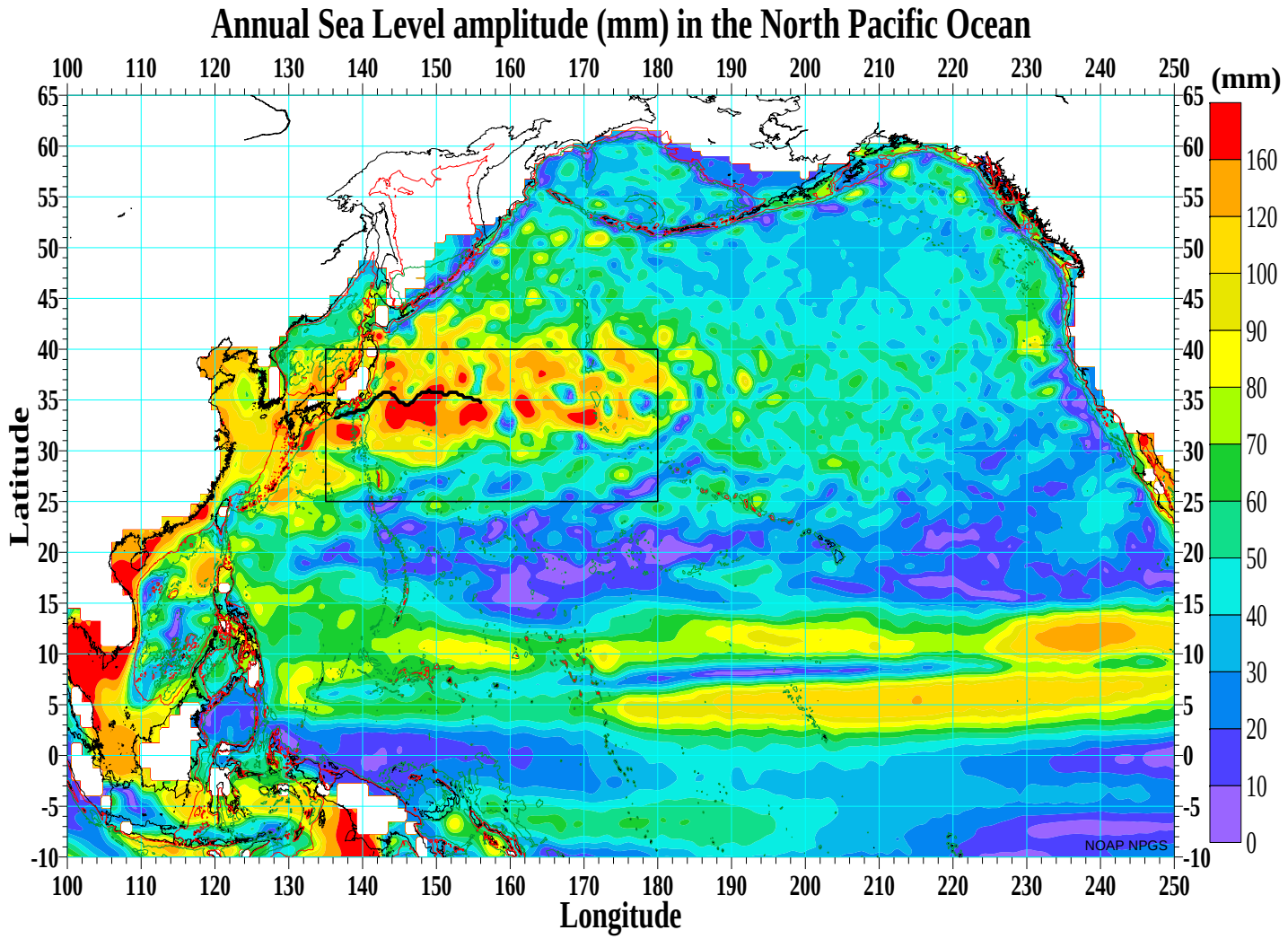
- To identify the Rossby wave propagation along the KE axis

Sea Level Anomaly (SLA)

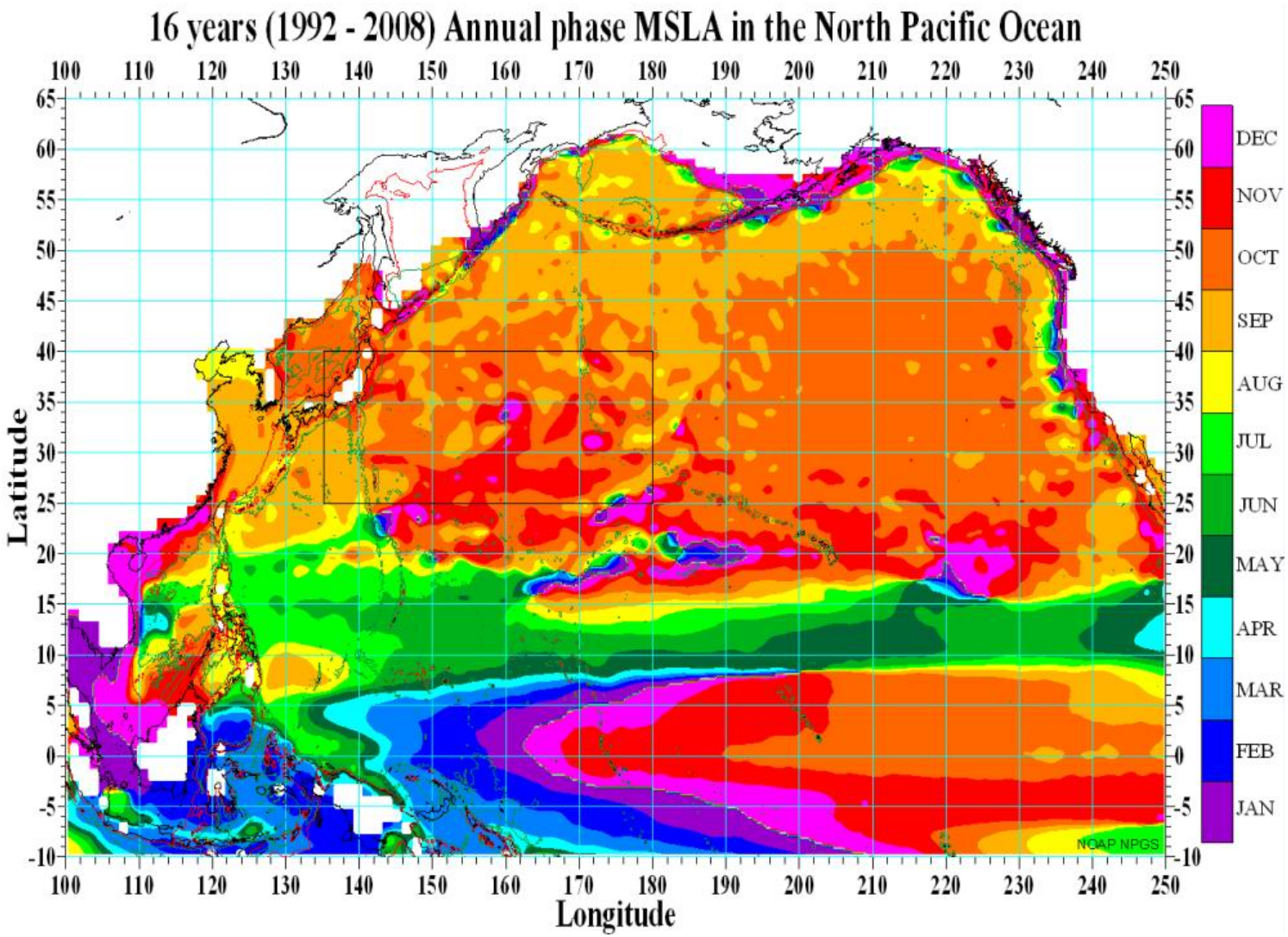
- SLA is measured by ERS 1/2 and TOPEX/Poseidon satellites at 7-day intervals.

- SLA has evident annual cycle and mesoscale structure dominated by eddy or Rossby waves.

Annual Sea Level amplitude (mm) in the North Pacific Ocean. The Kuroshio Extension route is associate with large annual amplitudes



Phase of the Annual Sea Level change in the North Pacific Ocean (1992-2008)



Annual Signal of SLA

- (1) The annual signal is influenced partially by the ocean circulation and partially by the rise and fall of the sea surface that arises from the expansion and contraction of the ocean due to its heating and cooling with seasonal climatic change.

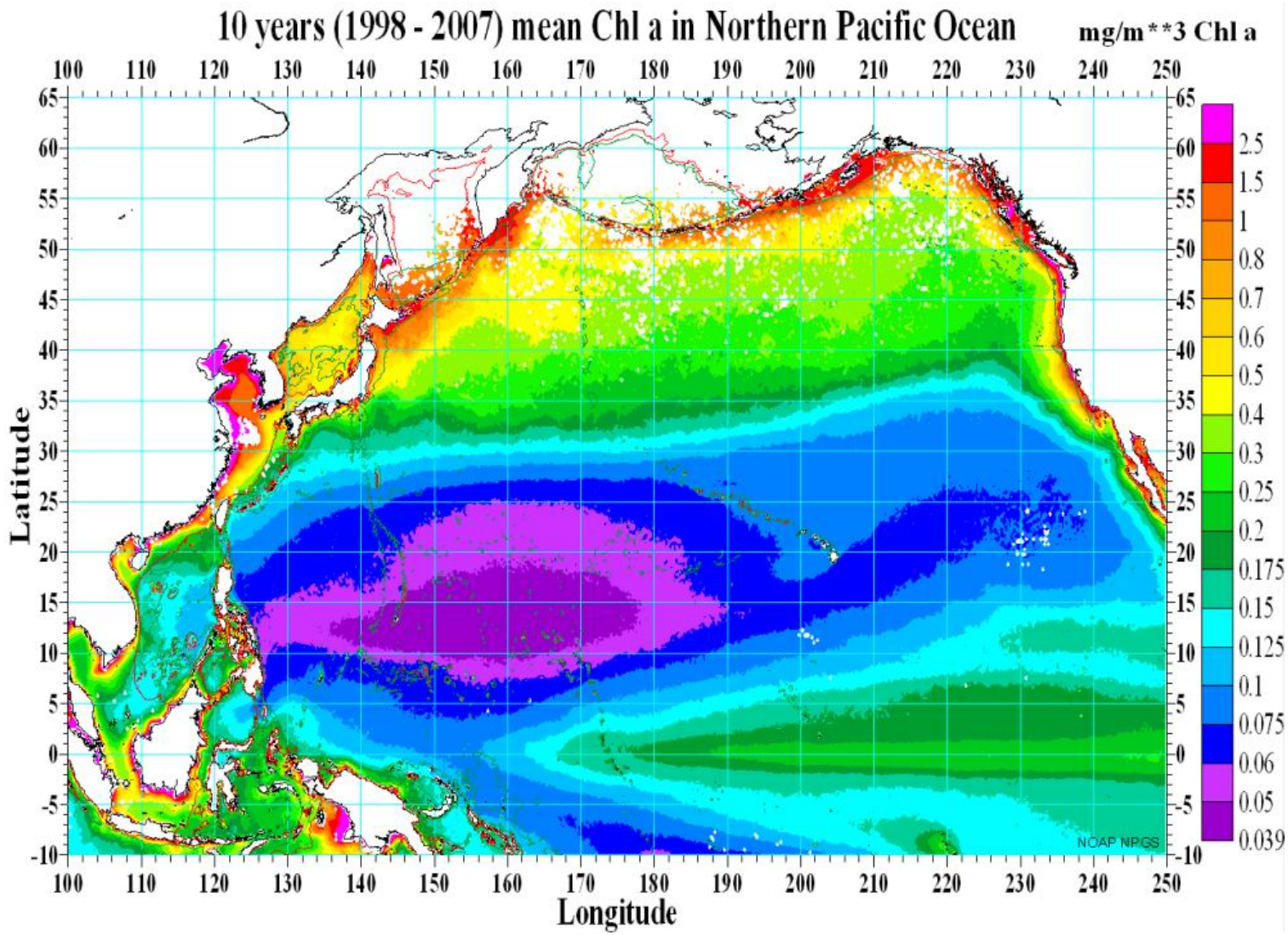
- (2) Maximum annual elevation change is about ±20 cm

Chl-*a* Concentration

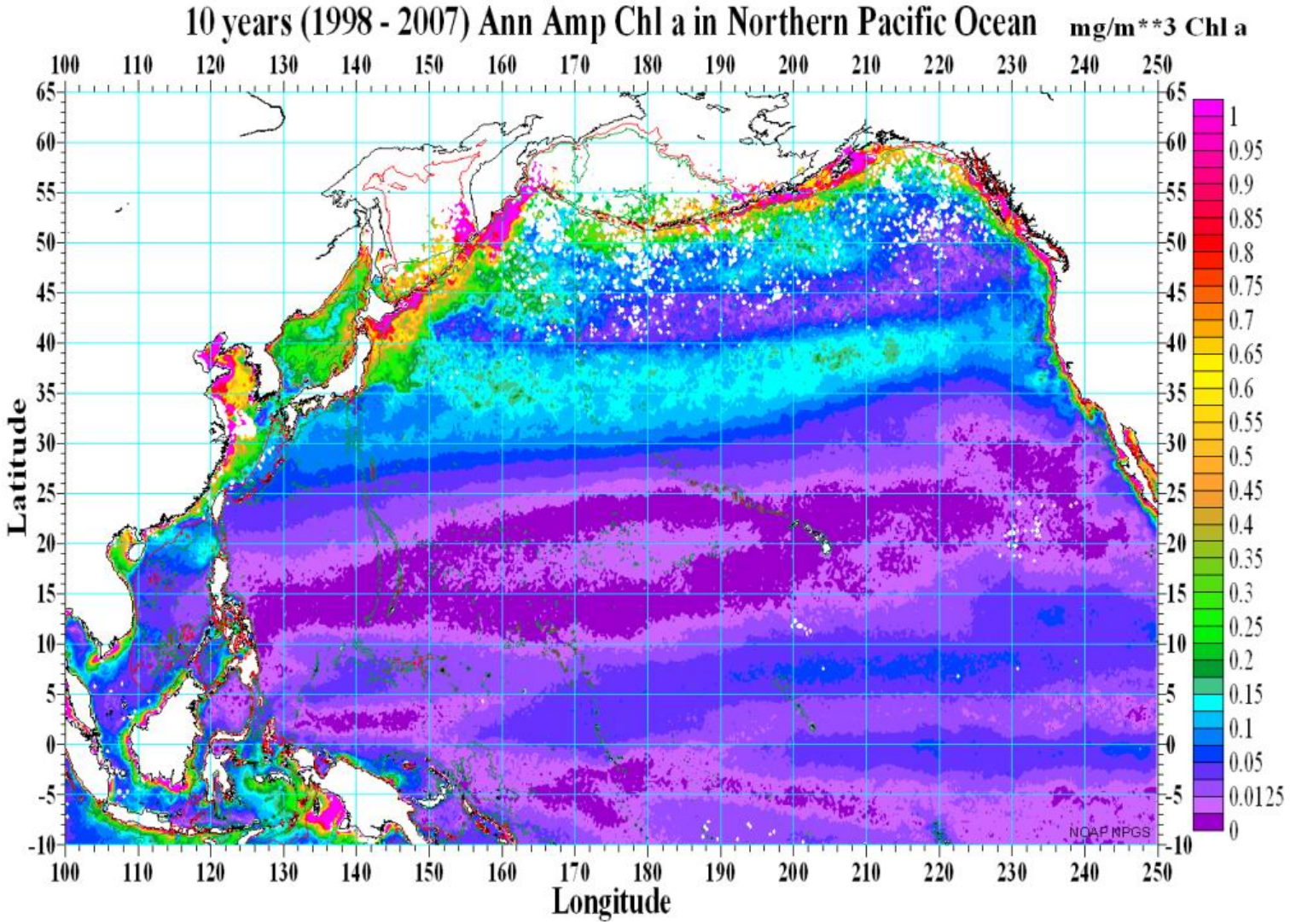
- Chl-*a* concentration is computed from the ratio of radiances measured in band-3 (480–500 nm) and band-5 (545–565 nm) according to the following NASA algorithm,
-

$$C_a = \exp\left[0.464 - 1.989\,\mathrm{Ln}(L_{WM}\,490 / L_{WM}\,555\right]$$

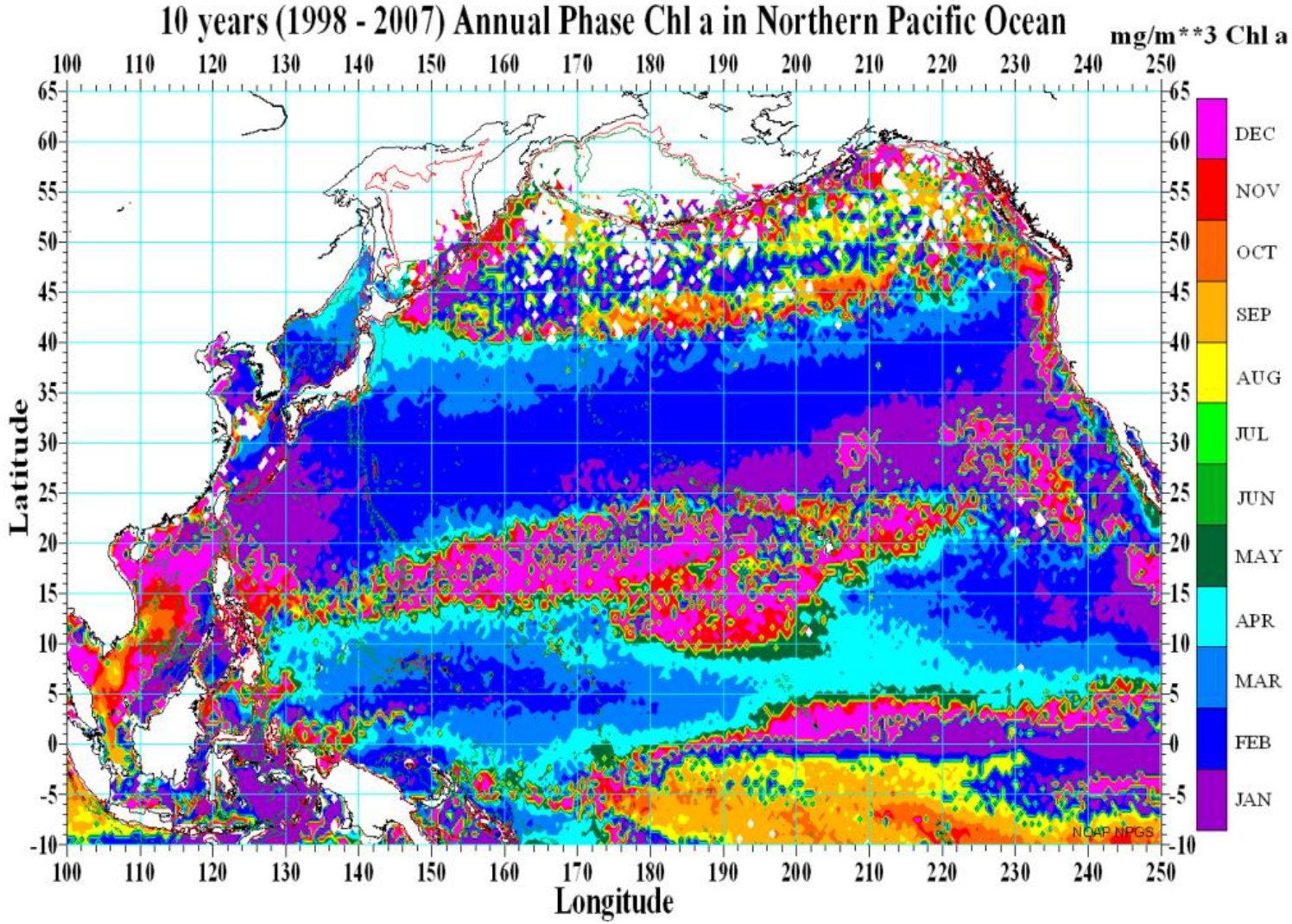
Mean Chl-*a* concentration (mg/m^3) in the North Pacific (1998-2007)



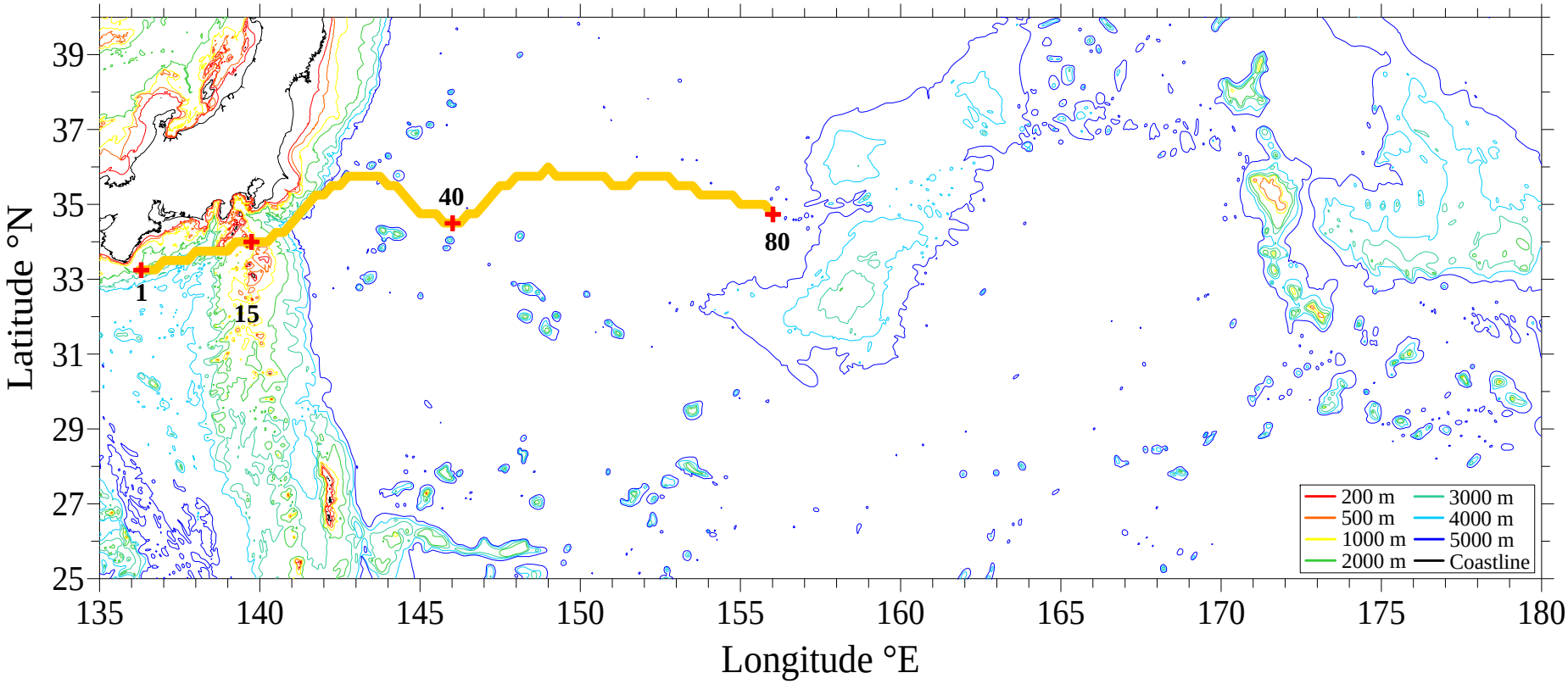
Annual Chl-*a* concentration Amplitude (mg/m^3) in the North Pacific (1998-2007)



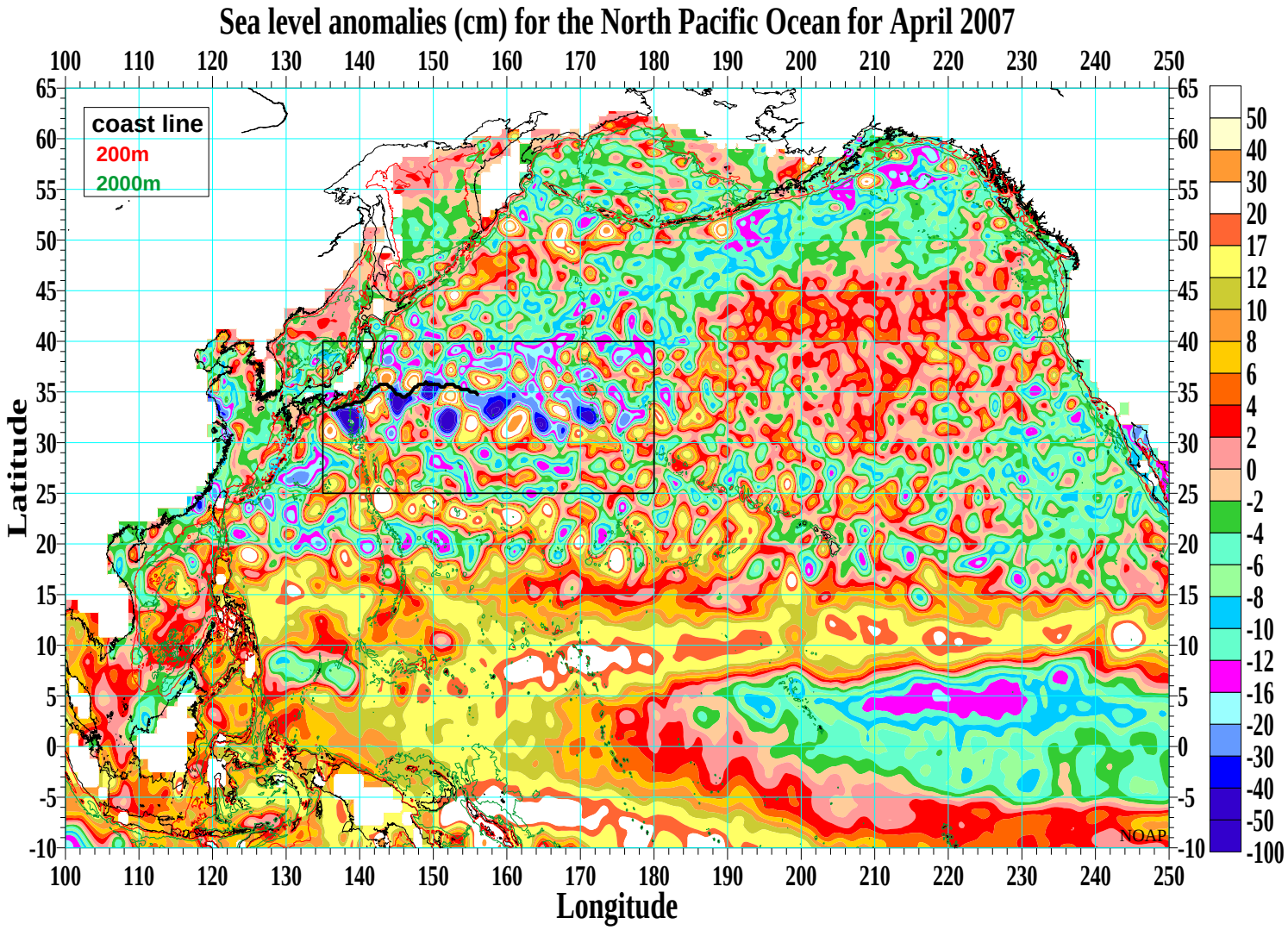
Phase of the Annual Chl-*a* Change in the North Pacific (1998-2007)



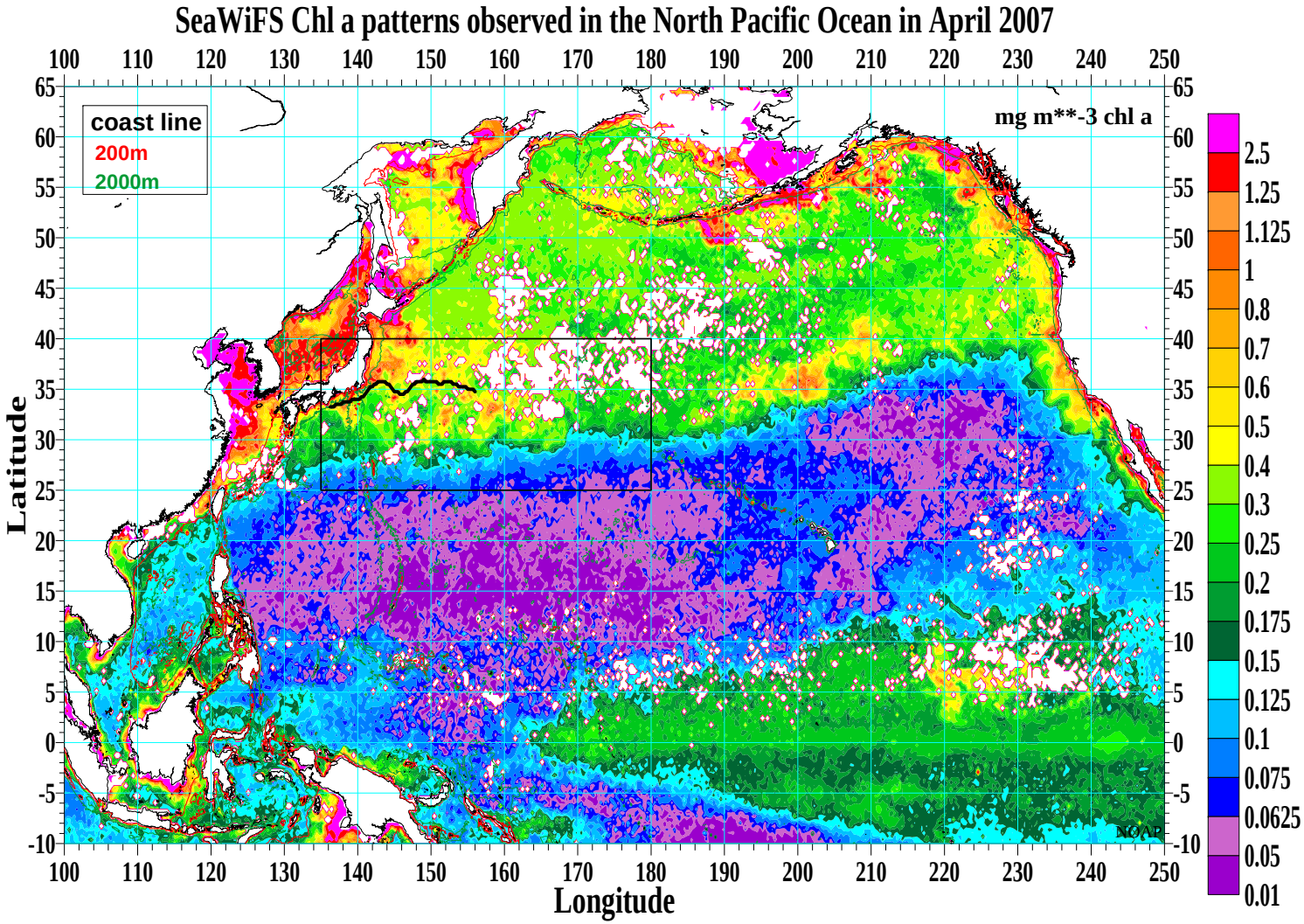
Topography of the studied area and Kuroshio Extension axis (marked orange) adopted for the present study. Stations positions 1, 15, 40 and 80 are marked.



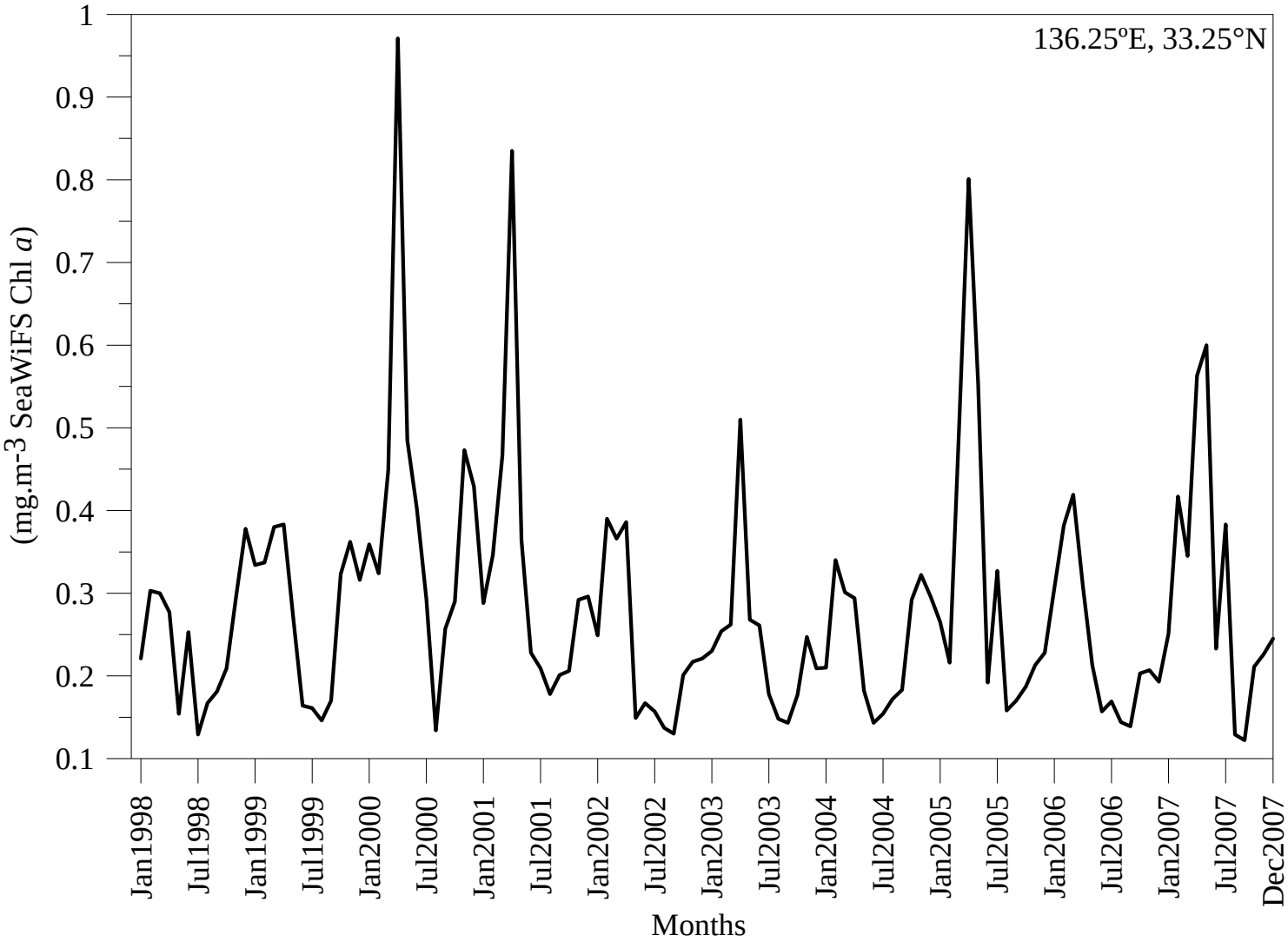
Satellite observed sea level anomaly (cm) in the North Pacific in April 2007



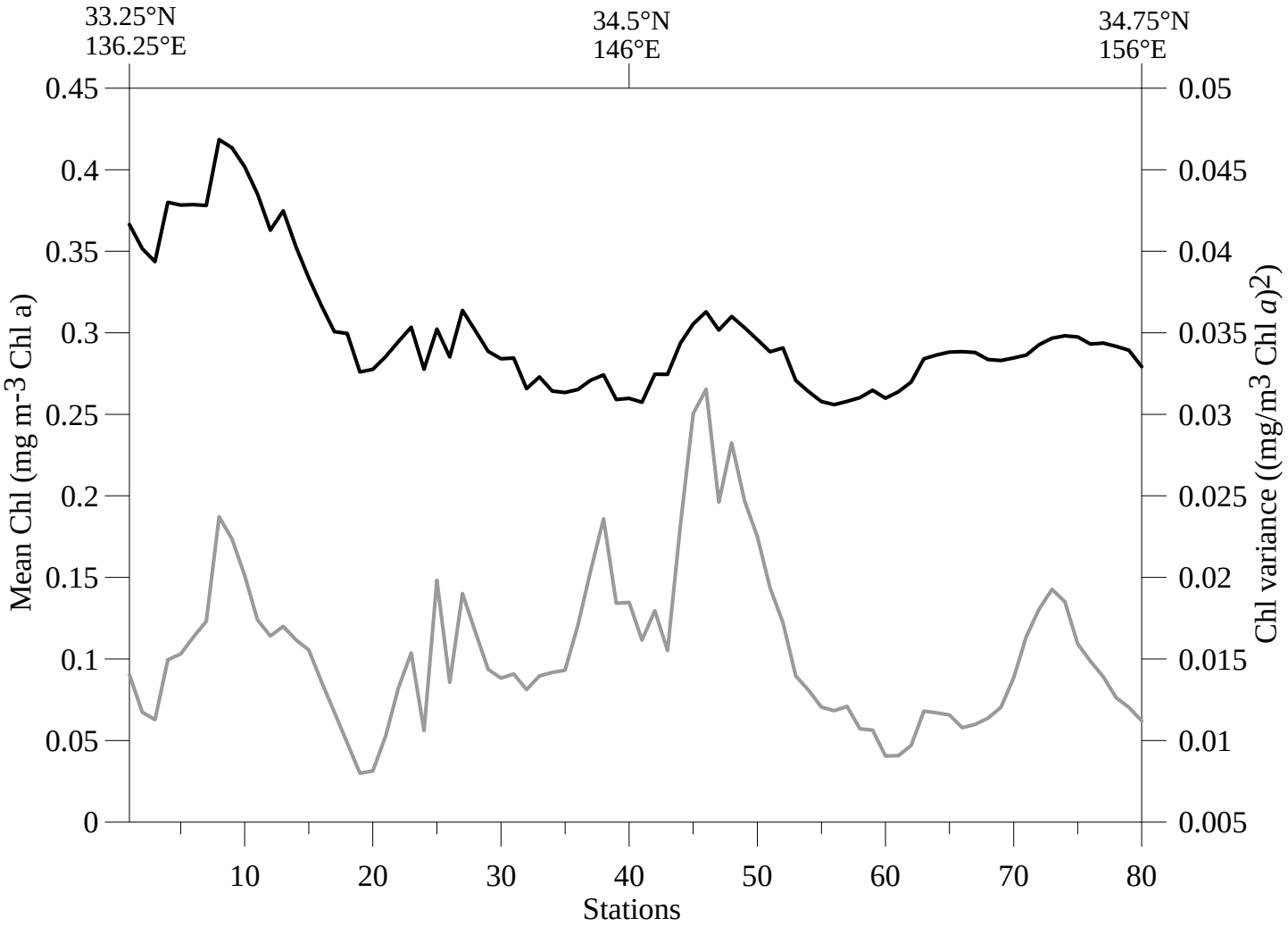
Satellite observed Chl-*a* concentration (mg/m^3) in the North Pacific in April 2007.



Temporal variation of Chl-*a* concentration (mg m^{-3} Chl *a*) at Stn-1 (136.25E, 33.25N)



Mean of Chl-*a* (mg m^{-3} Chl-*a*; black curve) and variance (seasonal cycle removed) of Chl-*a* ([mg m^{-3} Chl *a*]^2; grey curve) along the route of the Kuroshio Extension for a 10 years period (1998-2007)

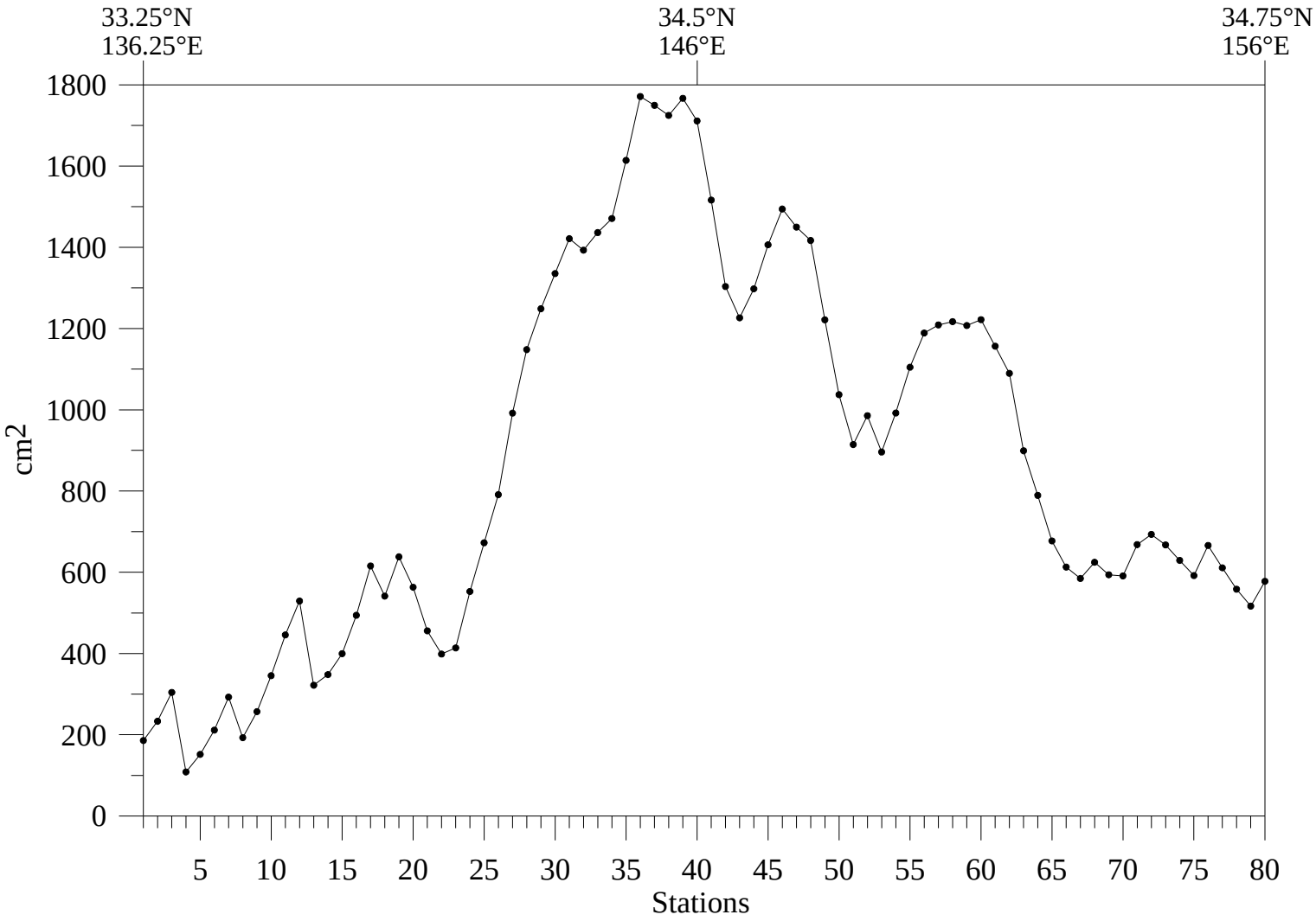


Mean Chl-a concentration in western (stns 1-15) and eastern (stns 16-80) KE

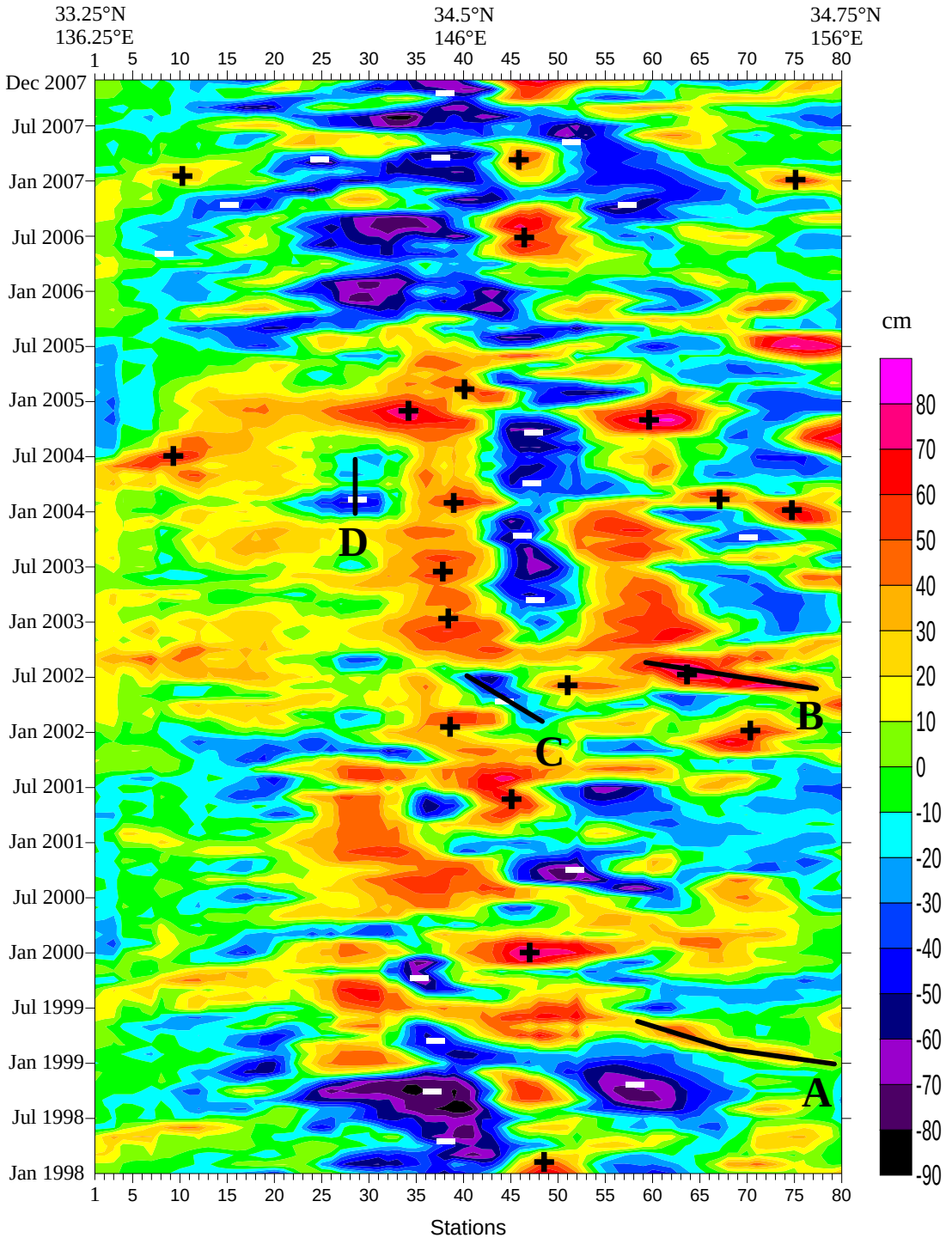
Western → $\overline{x}_{Chla} \pm \sigma = 0.37 \pm 0.02 \text{ mg m}^{-3}$

Eastern → $\overline{x}_{Chla} \pm \sigma = 0.28 \pm 0.02 \text{ mg m}^{-3}$

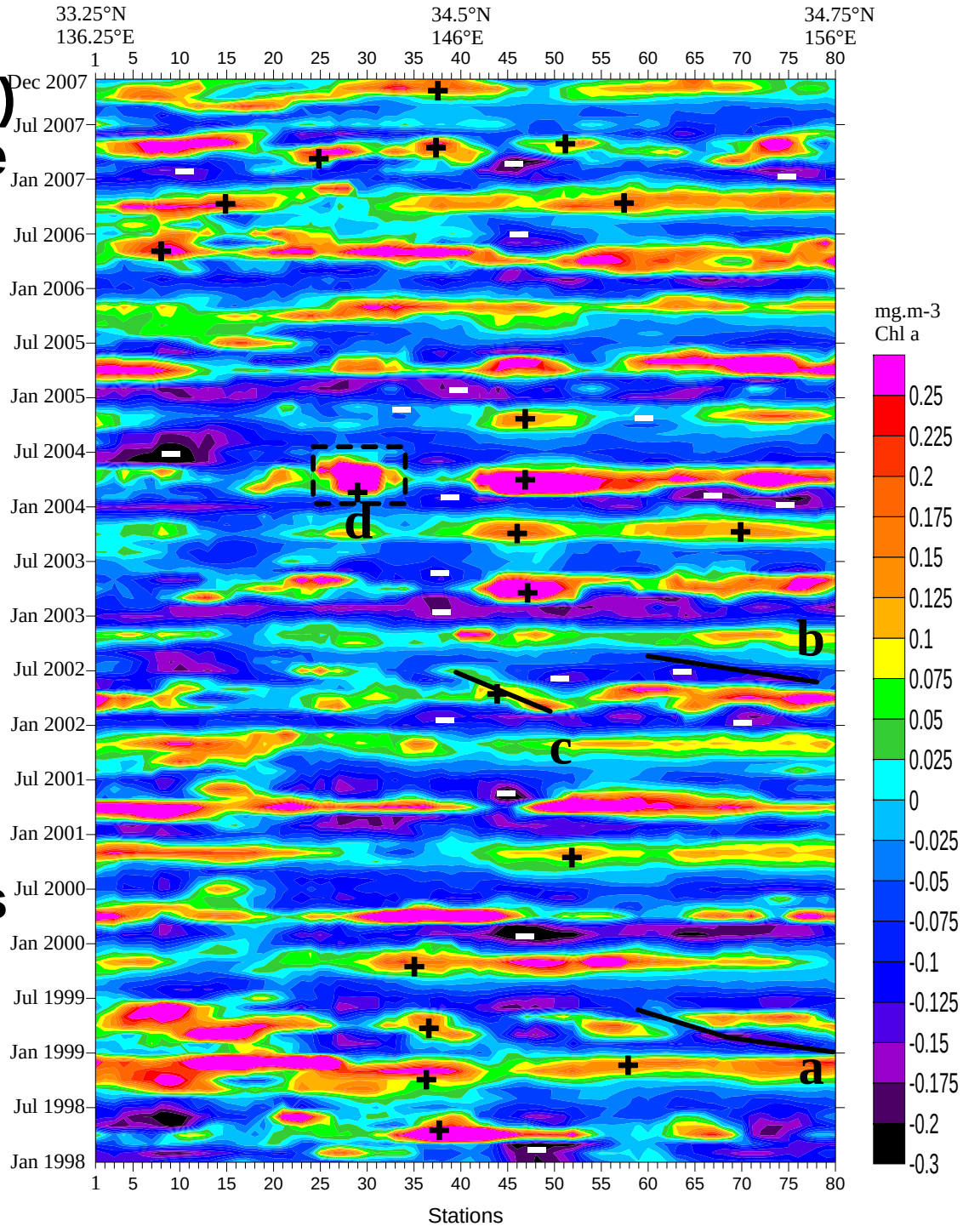
Variance (annual component removed) of sea level anomalies (cm^2) along the route of the Kuroshio Extension for a 10 years period.



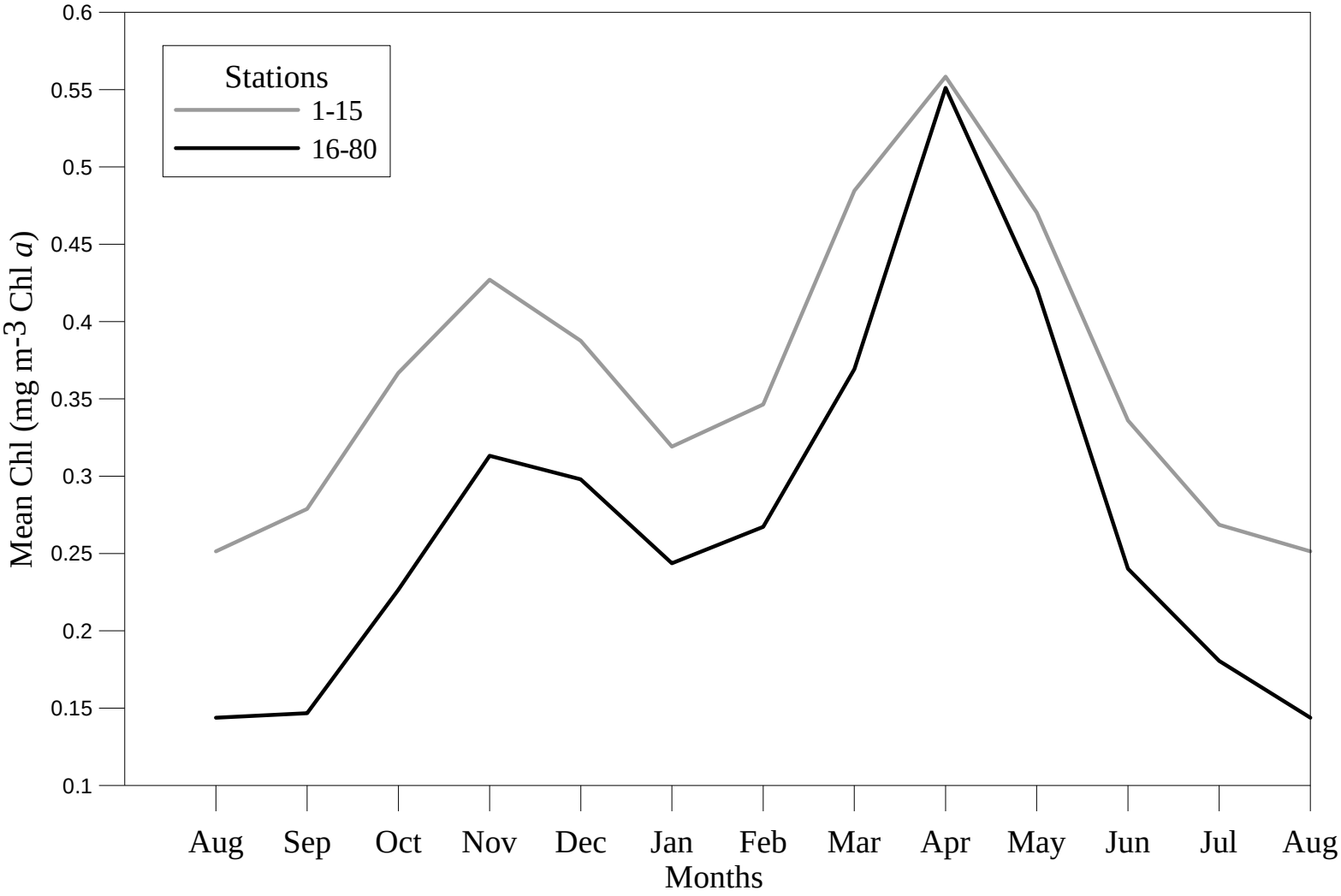
- **The altimeter signal is the SLA (cm) with the annual signal removed.**
- **Anticyclonic (A, B) and cyclonic (C, D) eddies have been followed in time and space.**
- **Negative sign indicates position of a low SLA associated with elevated Chl-*a* anomaly**
- **Positive sign indicates position of a high SLA associated with lower Chl-a anomaly**



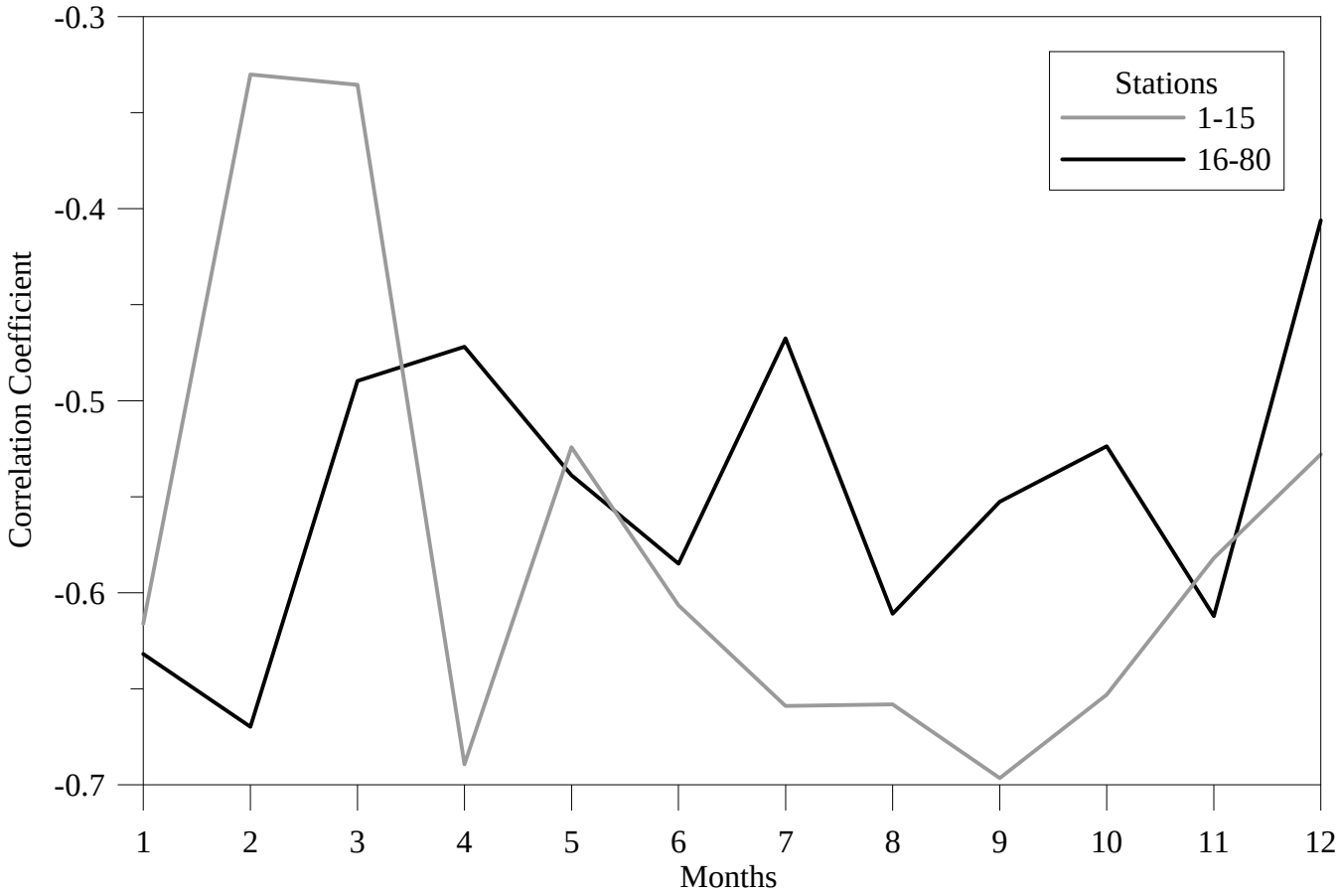
- **The Chl-*a* signal is the SeaWiFS Chl-*a* (mg m^{-3}) with the seasonal cycle removed.**
- **The high Chl-*a* (c, d) correspond to cyclonic eddies (C, D) and the low Chl-*a* (a, b) correspond to anticyclonic eddies (A, B).**
- **Positive sign indicates position of elevated Chl-*a* anomaly**
- **Negative sign indicates position of lower Chl-*a* anomaly associated with high SLA**



Chl-*a* (mg m^{-3} Chl *a*) seasonal cycle along the route of the Kuroshio Extension. The results for station 1-15 are in grey and for station 16-80 in black



Monthly correlation coefficient between Chl-*a* anomalies and SLA residuals for stations 1-15 are in grey and in black for stations 16-80
Low correlation in Feb - March



Conclusions

- (1) Seasonal Variability of SLA and Chl-a was identified.
- (2) Rossby wave propagation along the KE axis was detected.
- (3) SeaWiFS chlorophyll-*a* concentrations are redistributed by eddy.