VARIABILITY OF FRONTAL ZONES IN THE NORTH PACIFIC

D. Adamec
(NASA/Goddard Space Flight Center, USA)

Time filtering is a powerful tool for studying the general circulation. Here, the geostrophic flow is estimated from TOPEX altimeter data and filtered to produce low-pass and high-pass fields, with a period of 6 months used as the demarcation between low- and high-pass signals.

Of particular interest is a derived quantity called S, by Hoskins et al. [1983], which is a measure of the mechanical forcing of transient eddies on the mean flow. There is an interesting difference in the seasonal variation of S. The strongest mechanical forcing occurs for the winter low-pass eddies. Most of the forcing is concentrated in a dipole structure off the coast of Japan with cyclonic forcing to the south and anticyclonic forcing to the north. The strongest effect on the flow is a strong northwestward acceleration of the mean flow, opposite to the sense of the mean Kuroshio Extension. The forcing by high-pass eddies in winter is cyclonic forcing off almost the entire coast of Honshu. During the summer, the effect of low-pass eddies is much the same as during winter, except that the mechanical forcing is weaker relative to forcing during winter. The dipole structure off Honshu is reduced somewhat in the cyclonic forcing and very markedly in the anticyclonic forcing in the north which has almost disappeared relative to values seen during winter. Hence, the mean flow is not as hindered during the summer as it is in winter from forcing from the low-pass eddies. This perhaps provides a mechanism for the maximum in observed transport during summer as reported by Kawabe [1988], i.e., a lack of mechanical forcing to decelerate the mean flow during summer that is very evident during winter. This is fairly surprising as the actual low-pass eddy energy is strongest during summer, but apparently does not interact with the mean flow as much as during winter.

In a separate study of a low eddy kinetic energy event in the Kuroshio Extension during 1994, eddy heat advection is shown to play a major role in that event. The sea-surface height and temperature fields for August of 1993, 1994 and 1995 are shown in Figure 1. During August 1993, the Kuroshio Extension is clearly discernible in the SSH meandering mainly eastward away from Honshu at about 36°N. The subtropical gyre south of the Extension, between 130°E and 155°E, is very warm (near 30°C) due to summer heating. At this time, it appears that the Oyashio penetrates far enough to the south so that the Oyashio and Kuroshio fronts are blended.

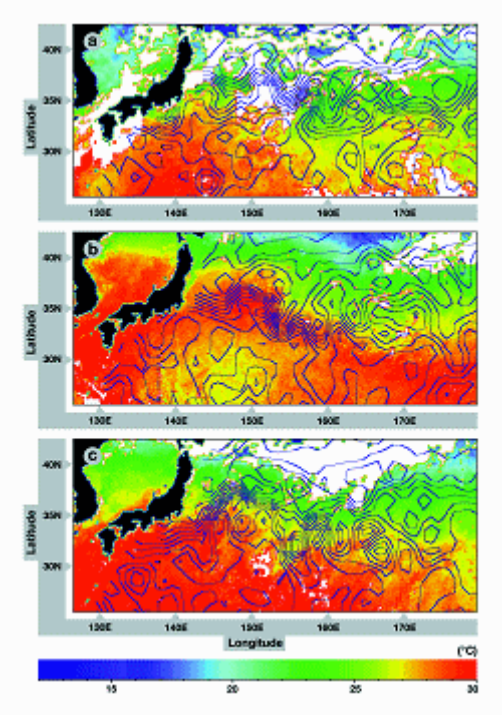

Figure 1
Sea Surface Height (shown as contour lines, with a 10-cm interval) and temperature fields (color scale, in °C) for August 1993 (a), 1994 (b) and 1995 (c)

(164 Kb)

There are marked differences during mid-August 1994. The sea-surface height gradient associated with the Kuroshio Extension is remarkably coincident with a stream of warm surface water extending away from Japan with a more southeastward orientation during summer 1993. There is no evidence of an offshore meander in the thermal data, and the temperatures south of the Extension between 130°E and 155°E are locally 2-3°C lower than in 1993. During mid-August 1995, the subtropical gyre is warmer relative to the same time in mid-August 1994, and locally 0.5°C warmer than mid-August 1993, and the zonal extent of the warm surface water is greater than occurred during mid-August 1993.

An interesting feature that is being pursued currently is the difference in temperatures in the Sea of Japan during 1993 and 1995, and 1994. During mid-August 1994, the surface temperatures are much higher (up to 10°C) than occurred in 1993 and 1995, and temperatures in the southern half of this small basin during 1995 are up to 6°C higher than for 1993.

References :

- Hoskins, B.J., I.N. James, and G.H. White, 1983: The shape propagation and mean-flow interactions of large-scale weather systems, *J. Atmos. Sci., 40,* 1595-1612.
- Kawabe, M., 1988: Variability of Kuroshio velocity assessed from the sea-level difference between Naze and Nishinoomote, *J. Oceanogr. Soc. Jpn., 44*, 293-304.