Wind Stress Variability in the Northern California Current System

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Summary

Wind Stress fields, derived from the SeaWinds scatterometer from January 2000 to December of 2005 are shown. High variability in wind stress strengths and directions characterize the northern CCS. In the seasonal climatology, local wind forcing is downwelling-favorable from November-February and upwelling-favorable from May-September. March, April and October are transition months, with downwelling (upwelling) north (south) of Cape Blanco (~43°N). See the Figure 1 caption for more details. Figures 2 and 3 present the monthly 2005 wind stress fields and the monthly, non-seasonal anomalies. These highlight continued downwelling in March-May and weak upwelling in June as the anomalous conditions leading up to July 2005.

Coastal (124.75°W) and oceanic (125.75°W) times series of N-S wind stress at 44.0°N are shown in figure 4 (left). The date of the spring transition is indicated on these time series with circles. Time integrals of the N-S wind stress are shown in Figure 4 (right), starting at the date of the spring transition.

In Figure 5 the altimeter monthly geostrophic velocity and displacement are shown. While in Figure 6 (right half of poster), stick plots of 8-day wind stress means are shown for 2000-2005 at oceanic and coastal locations (see map), presenting all of the wind stress data at these locations. Compare the wind stress during March-June 2005 with the same period during other years (grey bands).

Results

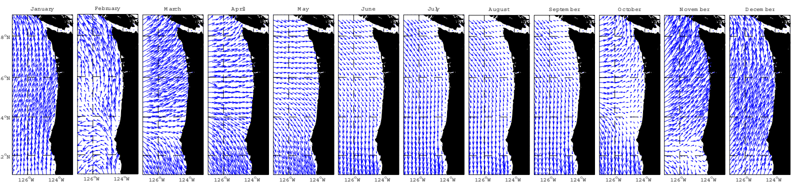


Figure 1: Regional climatologies (6 years of monthly means)

·Winter downwelling conditions begin in October north of 44°N, strengthen and spread to 41°N by December, persisting through February.

· Summer upwelling conditions begin in March south of Cape Blanco (43°N) and spread to 49°N in May-June. Maximum upwelling conditions cover the northern California Current in July-September.

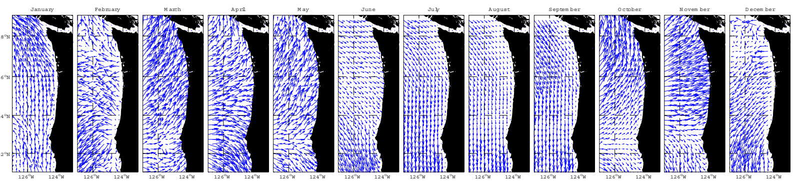


Figure 2: 2005 Monthly Means

· January-March wind stresses are directed more to the west than the climatology. Upwelling did not begin in the south in March and downwelling continued stronger than in the climatology.

·April- June wind stresses remain poleward or (in June) more weakly equatorward than usual. Upwelling begins in the south, but is weak.

· July-September are strongly equatorward everywhere, stronger than normal in some areas.

· Downwelling begins suddenly in October, but weakens and reverses in November-December.

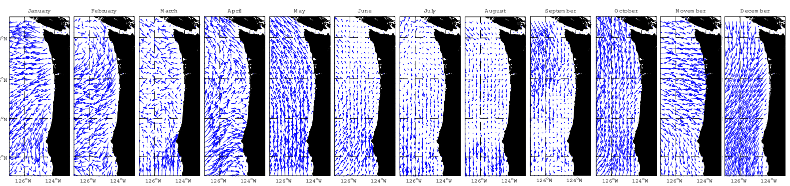


Figure 3: 2005 Monthly Anomalies

· These anomalies (individual 2005 monthly mean minus climatological monthly mean) make the above relationships easier to see.

· Perhaps the key differences occur in March-June, when downwelling remains stronger and longer than usual and upwelling in June is weak.

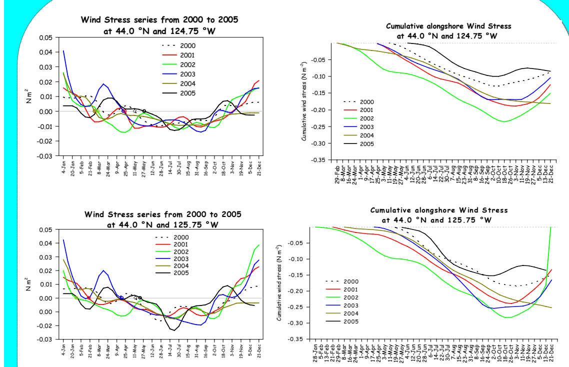


Figure 4: Smoothed time series of N-S wind stress at coastal (top) and offshore (bottom) locations at 44°N. Wind stress (left) and time integrated wind stress (right).

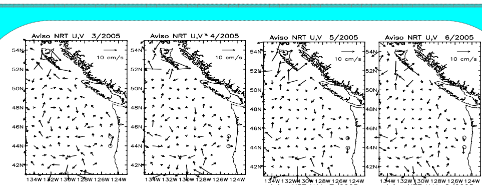
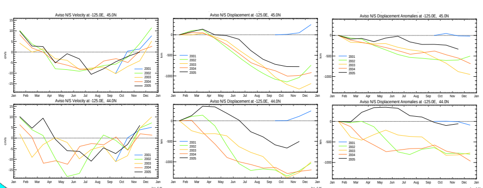


Figure 5: Altimeter Monthly Geostrophic Velocity & Displacements
Above are monthly geostrophic velocities calculated from gridded altimeter data from AVISO. Note poleward velocities in March 2005 and weak equatorward velocities in June. Below are the time series of geostrophic N-S velocity (left), accumulated displacement (middle) and the non-seasonal accumulated displacement (right) at 44°N and 45°N (circles above) for 2002-2005. In 2005, anomalous northward velocities in Feb-May leave water parcels 500km or farther north than usual. This may be a direct consequence of local winds, rather than currents generated elsewhere.



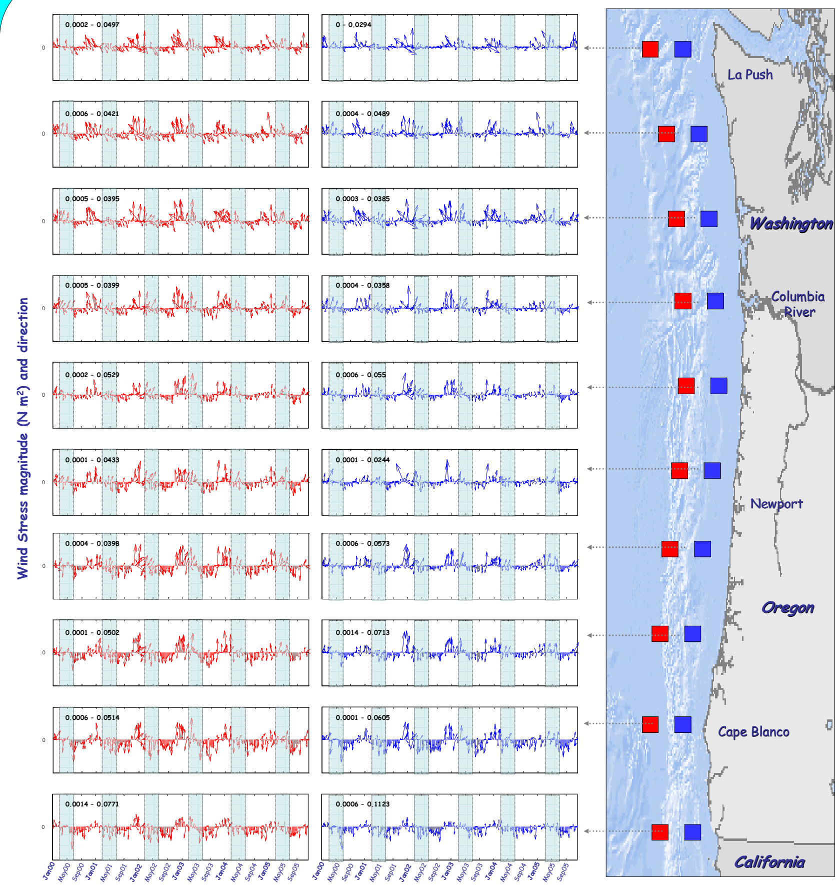


Figure 6: Wind stress magnitude and direction of oceanic (■) and coastal (■) locations.
Left top corner of each panel shows the minimum and maximum magnitude values. Shade areas highlight the March-June period to easier compare years. Stronger wind stress occurs south of Cape Blanco, decreasing to the north. 2005 shows weakness in wind stress magnitude during March-June.

Conclusions

- Anomalous wind conditions occurred in 2005, prolonging poleward winds through March and delaying upwelling until June. By July, upwelling winds were slightly stronger than normal
- Ambient geostrophic surface currents also remained poleward through March, only becoming strongly equatorward in July
- Anomalous 2005 wind conditions can also be observed at local scale along the Washington and Oregon coast
- 2005 Spring SST fields are consistent with this anomalous wind condition, where weakness in coastal upwelling occurs (not shown here)

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