Comments on ''Coastally Trapped Wind Reversals along the United States West Coast during the Warm Season. Part II: Synoptic Evolution''

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26 June 1996 and 22 October 1996

1. Introduction

The authors have done a service to the coastal meteorological community by publishing their climatology on coastally trapped events (Bond et al. 1996; Mass and Bond 1996). They are to be complimented for their useful research, which has long been needed but has not been done on account of the extensive effort required. Unfortunately, the authors make interpretative statements in Mass and Bond (1996) (hereafter referred to as MB) that do not seem to be supported. This comment expresses alternative views on some of these statements.

2. Discussion of the statement, ''This anomalous coastal troughing weakens . . . and establishes a pressure gradient is either flat or increases to the south. . . .''

The authors state in the abstract (p. 446) and the introduction (p. 447) that an ''alongshore pressure gradient is either flat or increases to the south'' in association with trapped events. However, in the context of the paper, they seem to be referring either to the pressure difference or the linear trend over some horizontal distance rather than the actual gradient. If they really were talking about the pressure gradient, then it would actually be possible for the absolute pressure to be lower to the south yet have the pressure gradient increase. Since this phenomenon would not support the intent of their discussion, it will be assumed that the real focus of MB is the absolute pressure change over some distance (or linear trend) rather than the pressure gradient.

When considering the atmospheric pressure, we should recall that land stations tend to be poor samplers of along-coast conditions, as most are separated from the coast by a coastal topography higher than the marine layer. In addition, ship reports are too few. The most important and, in some places the only, quantitative estimative of the pressure field along the United States west coast is obtained from National Data Buoy Center (NDBC) buoys positioned about 100 km apart. Further, if surface wind direction shifts are correlated with pressure differences between neighboring buoys during trapped events (Dorman 1985, 1988; C. Dorman et al. 1997, manuscript submitted to *Mon. Wea. Rev.*), then perhaps the useful along-coast scale is 200 km. This is great enough to yield pressure differences based upon at least two actual measurements yet is not so large as to miss the mesoscale sea level pressure structure that might be associated with most trapped events. Finally, MB seem to feel that the 200-km scale is an appropriate distance as they cite it when commenting about the pressure gradient in another part of their abstract. In this light, the pressure quantity under discussion is presumed to mean the surface pressure trend along 200 km of coast, centered on an NDBC buoy during a coastally trapped event. However, examining MB's sea level pressure composite fields as shown for buoys 27 and 13, at times of 00, +12, and +24 h after event passage, the pressures decrease to the south, in conflict with their assertions that the surface pressure increases to the south.

For buoy 27 off the northern California coast, MB's Fig. 6 shows that, for 00, +12, and +24 h after event passage, the surface pressure increases to the north. For example, at 00 h, surface isobars cross the coast at right angles, with higher pressure to the north. The 1016-hPa isobar is 125 km to the north, and the 1014-hPa isobar crosses over buoy 27, while the 1012-hPa isobar crosses the coast 190 km to the south. As a result, the alongshore pressure trend over buoy 27 is about 2.5 hPa over 200 km along the coast with higher pressure to the north.

At +12 h in Fig. 6, the 1016-hPa isobar crosses the coast 190 km to the north, and the 1014-hPa isobar is over buoy 27 (for a similar gradient and direction as at 00 h). While the pressure gradient is much weaker to the south, the pressure decreases about 1 hPa over 500 km. The average result is that the pressure increases by

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1.3 hPa to the north over the 200 km of coast centered around buoy 27.

At +24 h in Fig. 6, the pressure gradient is very weak, but pressure increases to the north of buoy 27 and the 1016-hPa isobar crosses over the buoy. About 200 km to the south, the 1014-hPa isobar intersects the coast. The pressure definitely decreases to the south, while the average pressure is about 1 hPa higher to the north over the 200 km of coast centered about buoy 27.

As shown in MB's Fig. 8, the pressure increases to the north along the coast at buoy 13. At 00 h, the 1014-hPa isobar crosses the coast about 190 km to the north and the 1012-hPa isobar crosses the coast about 190 km to the south, resulting in an alongcoast pressure trend of 1.1 hPa over 200 km of the coast, centered at buoy 13, with higher pressures to the north.

At +12 h after event passage in Fig. 8, for buoy 13, the pressure is higher to the north along the coast. The 1016-hPa isobar is 370 km to the north while the 1012-hPa isobar crosses over the buoy. To the south, the gradient is much weaker and difficult to estimate as the 1012-hPa isobar turns to the south, running almost parallel to the coast for about 300 km. However, it appears that the 1012-hPa isobar bulges away from the coast to the south, resulting in lower pressure along the coast to the south of buoy 13. The average pressure trend to the north, along 200 km of coast centered around buoy 13 at +12 h, is approximately 1.1 hPa.

At +24 h in Fig. 8, the pressure gradient is weak along the coast at buoy 13. The lack of a label in Fig. 8 for a closed isobar over central California also makes it difficult to compute the along-coast pressure trend centered at buoy 13. However, the curvature of the 1016-hPa isobar suggests that the along-coast pressure at buoy 13 is higher to the north.

The authors state that buoy 28 is similar to buoy 13 but do not provide a figure to support their claim. Taking them at their word, one would assume that the alongshore pressure centered over buoy 28 increases to the north at 00 and +12 h, and weakly increases to the north at +24 h as it does at buoy 13.

The composite surface pressure field shown in Fig. 3 for buoy 10 (off the Washington coast) has substantially weaker gradients, but two composites do have higher pressure to the south along the coast. At 00 h, the 1016-hPa isobar is 190 km to the north of buoy 10, while the 1014-hPa isobar is just a little north of buoy 10. Thus on the north side of the buoy the pressure increases to the north and the magnitude of the pressure is similar to the other buoys at 00 h. To the south of buoy 10, the along-coast pressure gradient is very weak, but it appears that there is lower pressure along the coast as the 1014-hPa isobar, extending 200 km to the south, continues to bulge offshore. The net result is a weakly (a small fraction of 1 hPa) lower pressure to the south along the 200 km of the coast centered along buoy 10. At +12 and +24 h, the 1014-hPa isobar bulges inland, suggesting that the along-coast pressure trend centered around buoy 10 has reversed sign but is of the same magnitude as that to the south of the buoy at 00 h and thus very weak.

Unfortunately, MB provide no discussion of the errors of the surface pressure composite charts (Figs. 3, 6, and 7). What is the threshold of significance for the alongshore component of the surface pressure trend? This might be greater than the values associated with buoy 10 at +12 h and +24 h and buoy 13 at +12 h and +24 h.

MB's composite figures show that the alongshore pressure, over distances of 200 km centered at buoys 27 and 13, and from inference, buoy 28 at times of 00, +12, and +24 h, decreases to the south. All of these buoys are along the California coast. Some of the composite cases have coastal gradients of the order 1 hPa per 200 km and appear to be resolvable by the technique employed by MB. Buoy 10 has a comparable pressure gradient, with higher pressure to the north at 00. However, buoy 10 may have higher pressure to the south, with an along-coast trend only a small fraction of 1 hPa over 200 km, at +12 and +24 h.

There seems to be a clear climatological difference for apparently trapped events along the California coast as compared to the Washington coast. This is consistent with Bond et al. (1996) in finding the nature of the transition at buoy 10 different than that at California buoys but is an entirely different conclusion than what is suggested by MB. All readers who consider the nature of the sea level pressure trend along the coast during trapped events to be important are urged to examine the figures themselves.

3. Discussion of the statement, ''Examination of the individual events revealed that virtually all of the trapped wind reversals are associated with the development of higher sea level pressure to the south along the coast, typically by 0.5–1 hPa over 200 km.''

This statement does not appear to agree with the authors' own figures. It is unsupported in the paper, and the authors' reason for including it is puzzling. It directly contradicts MB's composite Figs. 6 and 7 for buoys 27 and 13 at 00, 12, and 24 h. It also contradicts Fig. 3 for buoy 10 at hour 00 in which case, as pointed out above, the sea level pressure on each composite increases to the north. If their composite technique represents some sort of average, then we should expect some more extreme cases with even lower sea level pressure to the south.

This statement is made in the abstract (p. 446), the introduction (p. 447), and the discussion and conclusions (p. 457) with virtually no support in the main body of the paper. Not a single detail is provided in the main body of the paper about the gradients associated with the events. Furthermore, MB do not even discuss the alongshore pressure gradient around the buoys in section

3, which presents the composite pressure fields in Figs. 3, 6, and 8.

MB's statement that all of the cases they studied had increasing pressure to the south is a disturbingly sweeping statement without qualification. What is the scope of the ''study'' upon which this statement is based? What techniques were used over what time periods, scales, and areas? Were the alongshore pressure differences between the NDBC buoys computed for each of the events? What percent of the cases were ambiguous? What criteria were used to determine if the pressure gradient was significant? Until these questions are answered, the reader might wish to regard MB's statement as an interesting but unsupported hypothesis.

Coastally trapped events can be so complex that a single one can have different characteristics at different phases. An example is the 10–11 June 1994 coastally trapped event that advanced from Point Conception to Point Arena, California (C. Dorman et al. 1997, manuscript submitted to *Mon. Wea. Rev.*). It had a significant reversal of sign and rise in pressure behind the passage of the leading edge along the central California coast (Point Conception to Point Sur), which includes NDBC buoy 28. However, as the leading edge passed San Francisco, the pressure gradient did not reverse direction, although NDBC buoy 26 indicated a local pressure maximum. As a result, the pressure decreased in both directions along the coast. Along the northern California coast between Bodega Bay and Point Arena, the pressure field was uneven, weak, and with varying sign along the coast but usually lower to the south at NDBC buoy 13. Thus, at the leading edge of this trapped event and within 24 h after passing NDBC buoys, the surface pressure gradient was both positive and negative to the south and insignificant in different phases of the same event. It is not clear how MB's unspecified analysis would have handled these complexities.

4. Discussion of the statement, ''Second, the application of the hydrostatic equation indicates that the marine-layer depth cannot account for the observed pressure gradient.''

MB present a heuristic argument (p. 457) supporting the hypothesis that the variation in the marine layer depth could not account for the observed alongshore pressure gradient. This is in conflict with Dorman (1988) where it was shown from observations that the sea level pressure increase across the leading edge of a trapped front (1 hPa) and the sea level pressure trend along 300 km of the central California coast behind the leading edge of a trapped event (about 0.1 hPa over 300 km) were small. In this study we pointed out that if the colder marine air were replaced with the warmer air above, the constructed sea level pressure gradient would have been lower to the south. Thus, there has been published a case of a major trapped event whereby the variation of the marine-layer depth along the coast can have a significant effect on the structure and the sign of the alongshore, sea level pressure field behind the leading edge of a trapped event.

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