Evaluation of Coastal Scatterometer Products

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Abstract

The routine retrieval of scatterometer vector wind data is not attempted within some distance of land, to avoid contamination of the winds by land reflections of the radar signals. At the Jet Propulsion Laboratory, the entire QuikSCAT data set is being reprocessed to retrieve coastal wind values from footprints that are partially covered by land. To evaluate these coastal winds, we compare measured winds (buoys and coastal land stations) to QuikSCAT winds from the new processing, as well as from the most recent traditional processing. Our initial comparison is for winter (December-February) along the U.S. West Coast. Since the newly reprocessed data set is global, our evaluation should provide guidance for applications of the new wind product in other regions.

Introduction

Nominal processing of the QuikSCAT data is done to avoid any possible land contamination with a fixed distance from coast threshold not taking into account the highly non-uniform spatial response function of the slices. If we consider the shape of the spatial response function for each QuikSCAT slice, we can obtain Ocean Vector Wind (OVW) estimates significantly closer to the coast than in the nominal processing.

We investigate two methods, the Land Contamination Ratio method (LCR) and the LCR Expected Sigma0 (LCRES) method. The LCR [1] is the ratio of the spatial response function of each slice over land to the total integrated spatial response. We use a 1/120° land mask to decimate land and ocean. This requires an integration of the spatial response over every slice, for every pulse, in every orbit of QuikSCAT data over 10 years. The LCR method is the less aggressive of our coastal processing methods and is a simple threshold on the LCR value for each slice. We have used the value 0.01 in our processing for rejecting possibly contaminated data. The LCRES method is the more aggressive of our coastal processing methods. This method builds upon the LCR method in that we compute the LCR value times the Expected Sigma0 (ES) for every slice. The ES is computed again using the spatial response functions, however, instead of integrating over each slice we project the slice sigma0 into a higher-resolution grid using each slice's spatial response function. The LCRES value is then compared to a threshold and rejected if larger. Thus this method will discard less measurements near low σ_0 land areas, conditioned on the observation geometry, as compared to the LCR method.

Land Contamination Ratio Processing Status and Evaluation

We have completed the LCR processing for the entire 10 year mission, requiring nearly 1700 CPU days of computer time, and have already made a portion of this data available to our co-investigators for preliminary validation studies.

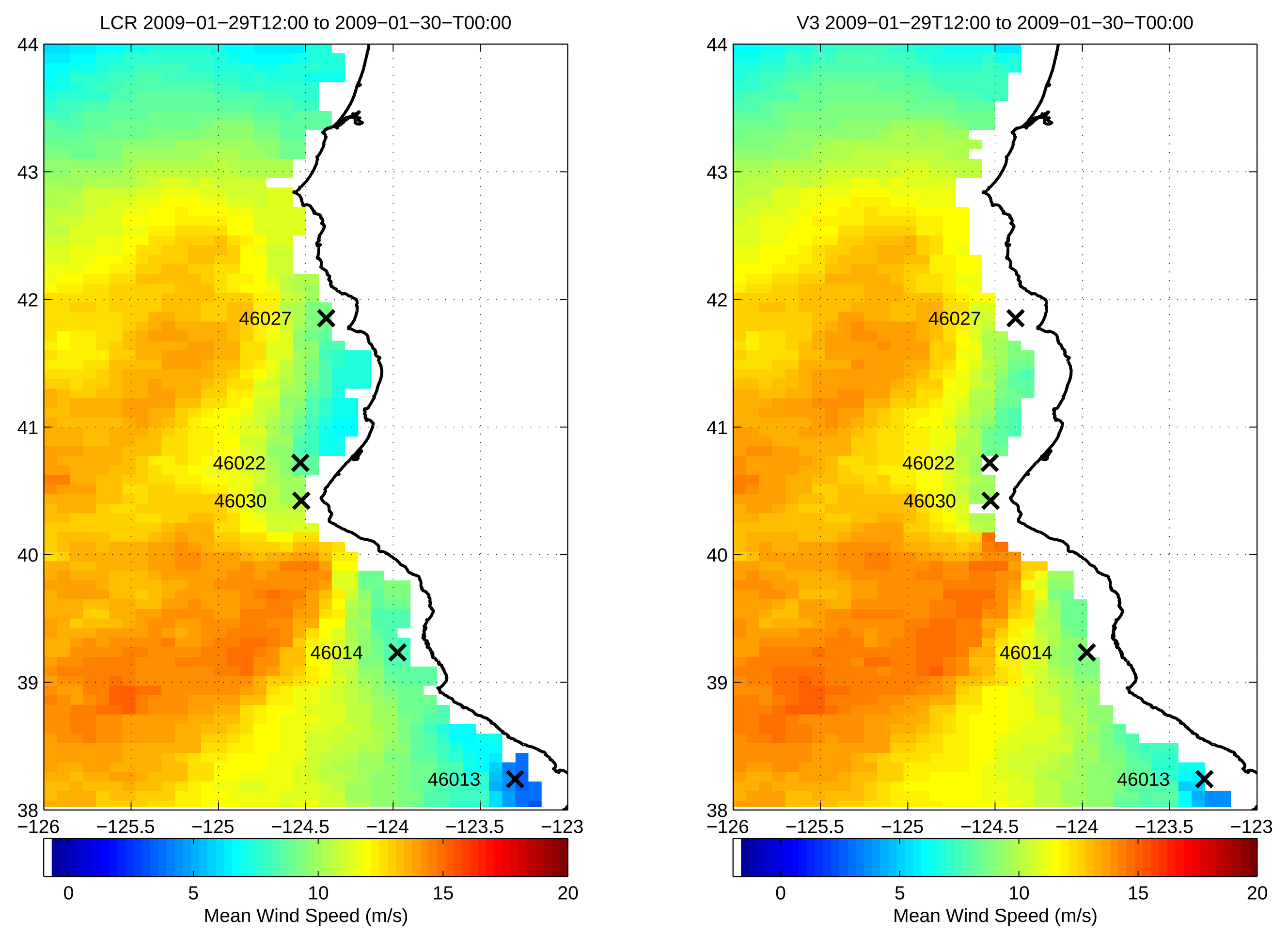

Figure 1: 12-hourly composite wind image of the west coast of US, (left) the LCR coastal data product and (right) the nominal V3 data product. Note the increased closeness to coast in the LCR map as compared to V3 map with no obvious increase in speed bias due to land contamination. We also label each of the buoys used in the buoy comparisons.

In Figure 1 we show a 12-hour speed composite images using the LCR method and the nominal V3 product, where we can clearly see the improved closeness of the scatterometer observations to the coastline.

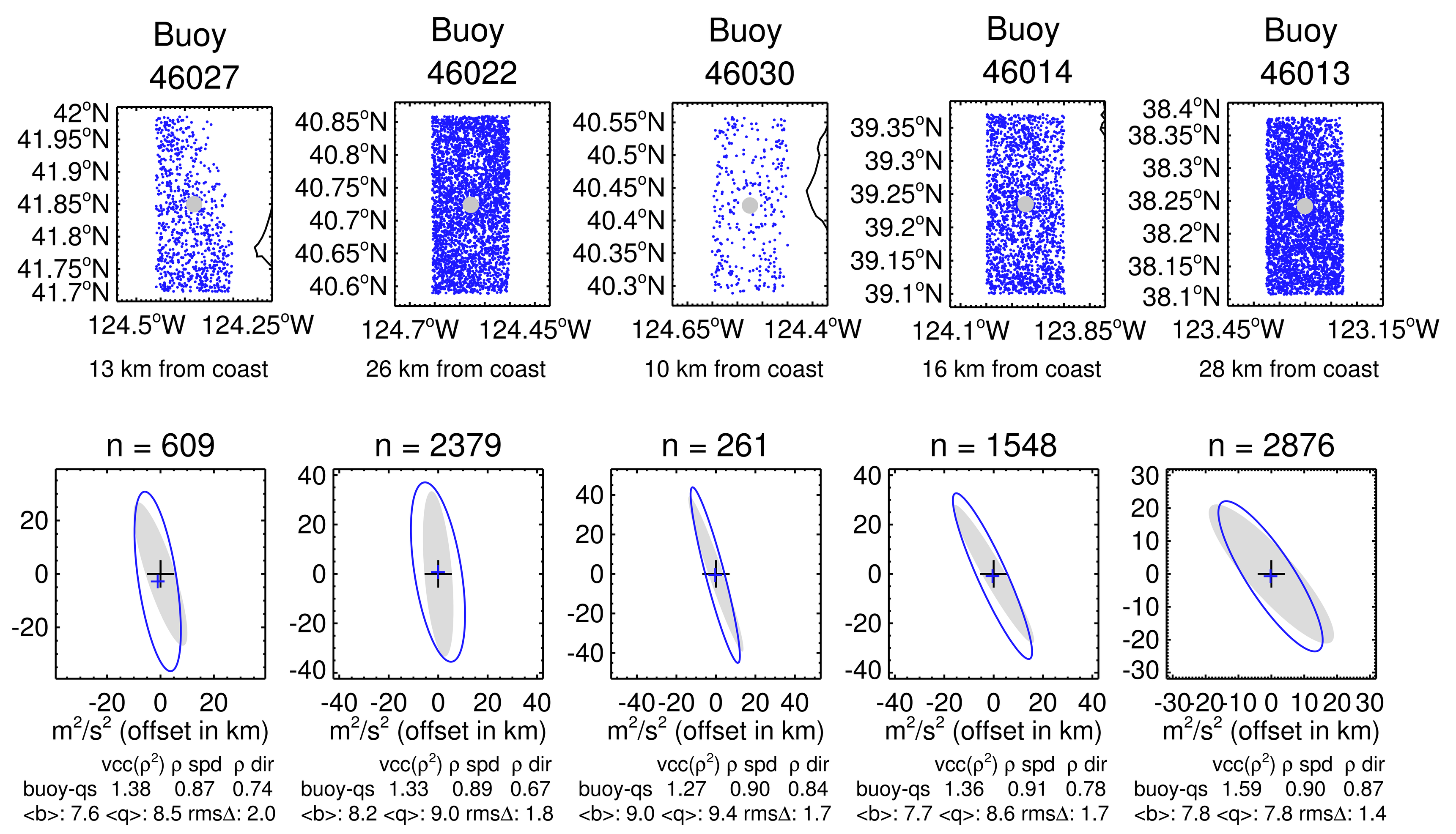

Figure 2: Comparisons on new LCR coastal wind product versus buoys near the west coast of the US for 10 years of winter QuikSCAT (December-February). We plot all of the wind vector cells (WVC) collocated with each buoy in space and time. (top) location of buoy (gray dot) and WVC match-ups (blue points), (bottom) variance ellipses for buoy (gray) and QuikSCAT (blue). Each plot illustrates the number of matchup points, the vector correlation (vcc), the speed and direction correlations, the mean speeds for each, and finally the RMS vector difference. The buoy locations are illustrated in Figure 1.

We also quantitatively analyze the coastal wind products using buoys that are labeled in Figure 1 for the winter months (December-February). In Figure 2 we perform a comparison of the buoy data and the QuikSCAT data over the buoys 46027, 46022, 46030, 46014, and 46013. For each buoy we collocate the QuikSCAT data in time and space. The upper row of Figure 2 illustrates the spatial extent of QuikSCAT Wind Vector Cells (WVC) data matched-up with each buoy. The lower row of Figure 2 contains variance ellipses for each data set, where the semi-major and minor axes are the eigenvalues of the wind covariance matrix for each time series, and the orientation of the axes of the ellipse represents the projection of the eigenvectors of the covariance matrix along the zonal and meridional axes. We find that the covariances of the buoy data and QuikSCAT data are in very good agreement with no major degradation even for buoys 46030 and 46027, which are within half a beam-width of the coast.

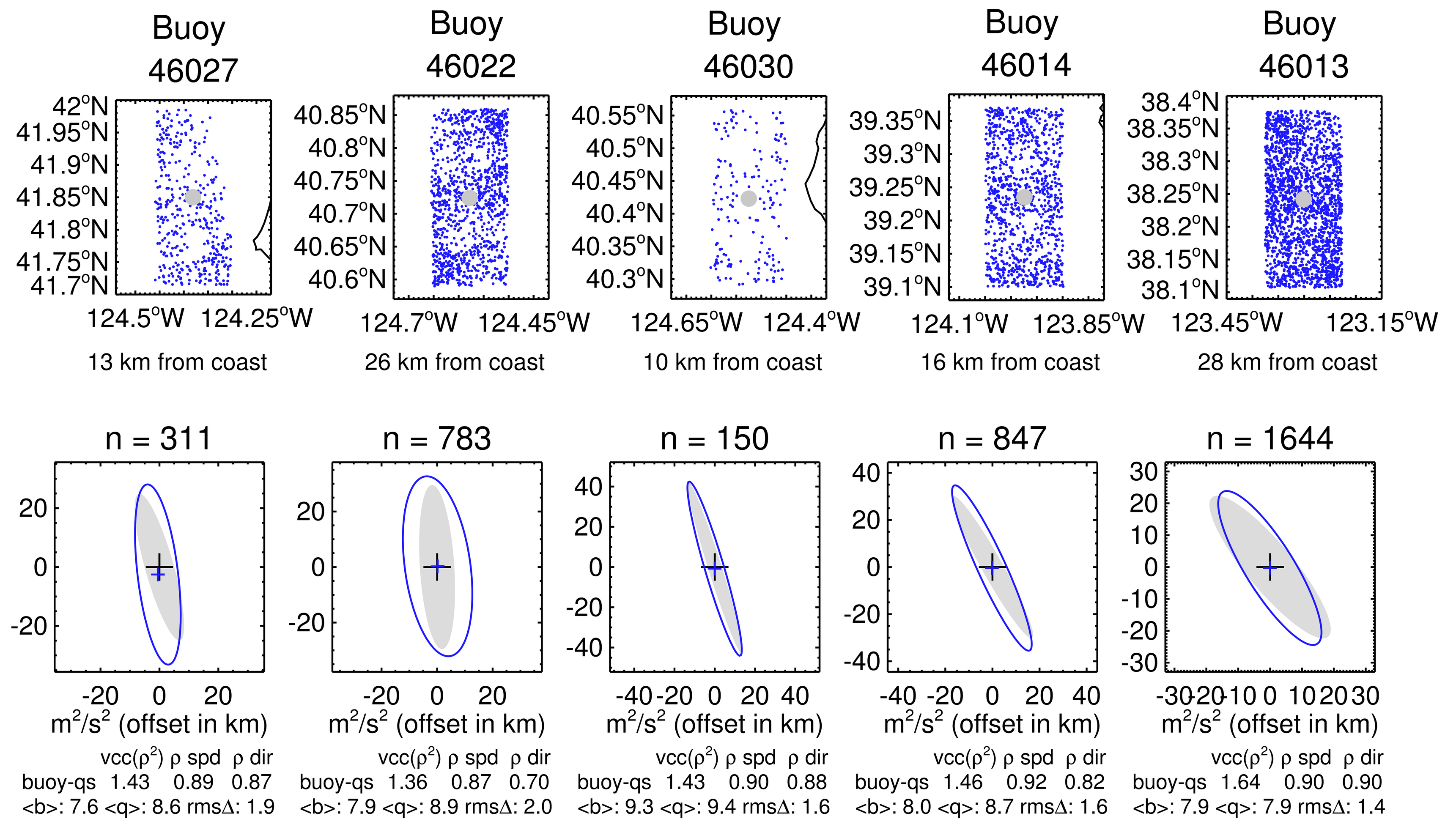

Figure 3: Same as Figure 2, however, we only plot WVCs in new coastal product not contained in nominal V3 QuikSCAT product.

In Figure 3 we plot the same analysis, however, it only uses WVCs which are in the LCR coastal product but not in the nominal V3 product. Comparing this plot to Figure 2 we see that the LCR coastal processing produces new wind estimates near the coast that are adding value in the buoy comparisons.

Land Contamination Ratio Expected Sigma0 Processing Status

We have also begun the generation of the expected σ_0, which again requires the same full X-factor computation for every slice, from every pulse, for every orbit of QuikSCAT. We have already completed processing of the LCRES maps for 2008 and we expect the LCRES map processing to be complete by mid June 2016. After completion of the LCRES maps we will begin parameter studies for choosing the LCRES thresholds for flagging and possible land correction.

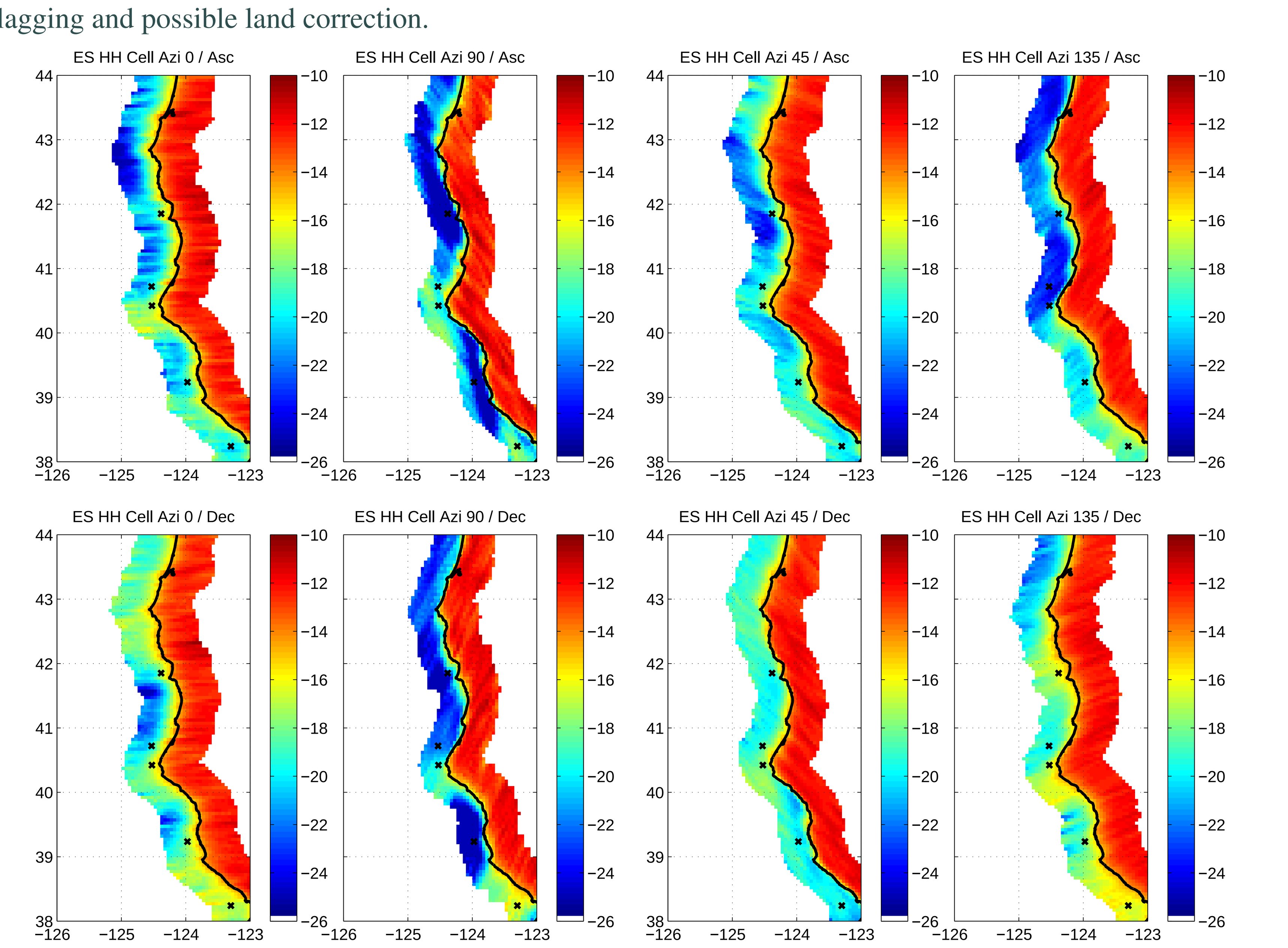

Figure 4: Images of Expected Sigma0 (ES) for the west coast of United States for December, January, and February 2008. We plot the ES for cell azimuths 0, 90, 45, and 135 (left to right) for ascending (top) and descending (bottom). The slices orientations depend on not only the cell azimuth angle but also ascending / descending since the slices are limited by frequency not range. This plot illustrates the highly variable slice ES as a function of cell azimuth, relative coastline orientation, and ascending / descending. We also show the buoy locations (black x) as well.

Progress

- Full-mission reprocessing with LCR method complete.
- Generation of LCRES map underway.
- Buoy analysis of LCR shows added value of wind estimates close to coast.

Next Steps

- Full-mission validation of LCR processing.
- Evaluate QuikSCAT winds at different distances offshore against land stations.
- Make LCR data available to public.
- Finish generation of LCRES maps.
- Begin study of LCRES threshold values.

References

[1] M. Owen and D. Long. Land-contamination compensation for QuikSCAT near-coastal wind retrieval. *Geoscience and Remote Sensing, IEEE Transactions on*, 47(3):839–850, March 2009.

[2] O. Tange. GNU Parallel - the command-line power tool. *;login: The USENIX Magazine*, 36(1):42–47, February 2011.

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