Further Analysis of SIR-C Antenna Patterns for Radiometric Corrections: Use of New Calibration Areas

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Abstract—Radiometric applications of images from the SIR/X-SAR missions depended and depend on accurate removal of the effect of the antenna pattern. Since the flights we have determined the elevation patterns of the radars for several modes using backscatter from the Amazon rain forest as a standard. Because the X-SAR antenna was stable and used only one mode, we did not consider it in the present work Since the last reports on this [1], [2], [3] we tested the use of less-homogeneous areas than the Amazon forest as standard targets, and found that many such areas can be used.

This permitted use of areas in many parts of the world, where possible solar distortions of the antenna would be different. Moreover, use of other areas allowed much better calibration of the various beam-spoiling modes on SIR-C. Consequently, we have a far more complete catalog of SIR-C performance that can guide investigators attempting to use SIR-C radiometry for their analyses and interpretations of SIR-C images.

BASIC APPROACH

The basic approach used for SIR-C/X-SAR as for SIR-B uses the signal returned from a relatively flat, homogenous, area in which scattering is nearly independent of angle of incidence over the narrow range of angles used by the radar. In previous work we restricted ourselves to the Amazon rain forest because it is the largest, most homogenous, flat area of nearly isotropic scatterers in the world. Even in the Amazon basin, however, small regions differ from the uniform forest scatter; for example, rivers and occasional villages. To remove these effects we obtain histograms of the returned signal as corrected using the standard JPL correction. We then discard the outliers from the data set before removing the standard correction and averaging of the data to obtain the antenna patterns.

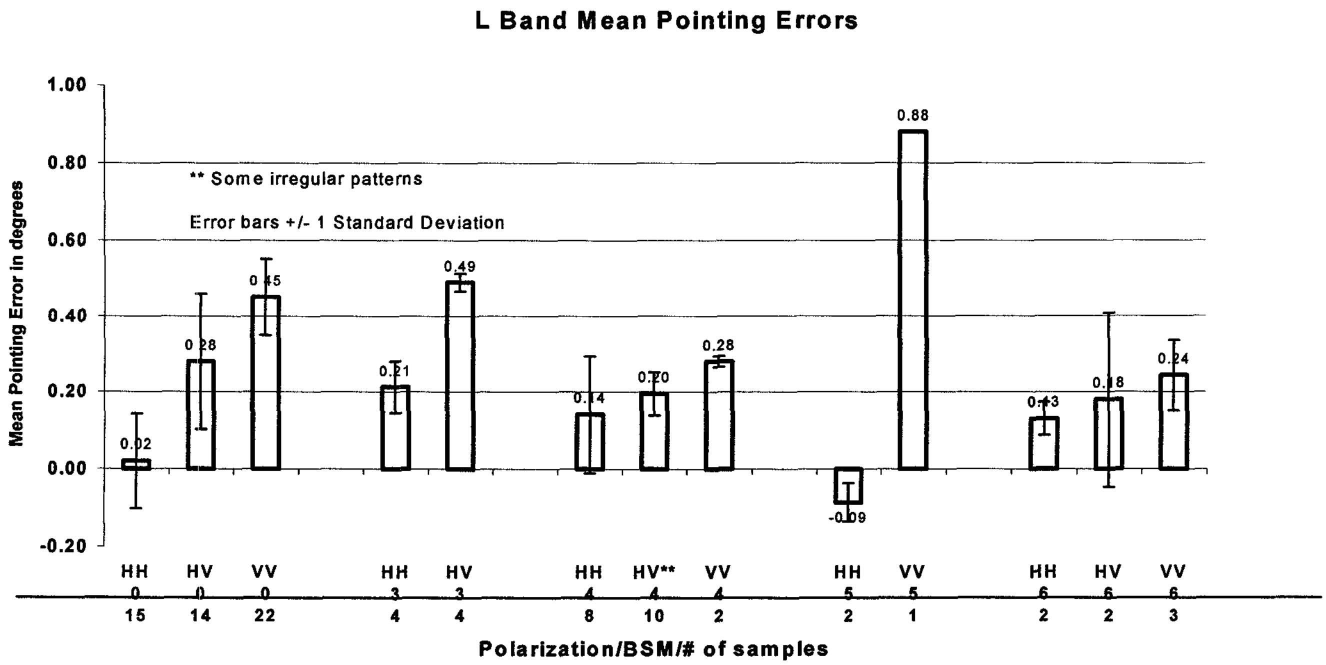
Outliers are relatively infrequent in the Amazon basin, but in some areas they are much more common. For example, African rain forests have more clearings than those in the Amazon. We also find that we can use this method in areas with hills (not mountains) to remove the bright echoes on the forward slopes and the dark ones in the shadowed regions. The method also appears to work well in farmland areas. As a consequence we find that we can use many previously omitted areas for pattern measurement and consequent changes to the radiometric corrections. Tropical forests in Africa contribute significantly to the present calibrations. Moreover farmlands in several places were used successfully. We find that the outlier removal permits accurate pattern determination even where many bright areas (buildings, front side of hills, unusually bright fields) and dark areas (water bodies, backs of hills) are present. By not confining ourselves to the South American area, we obtained measurements for a wider range of solar conditions that might have resulted in mechanical distortions of the antenna and therefore the beam.

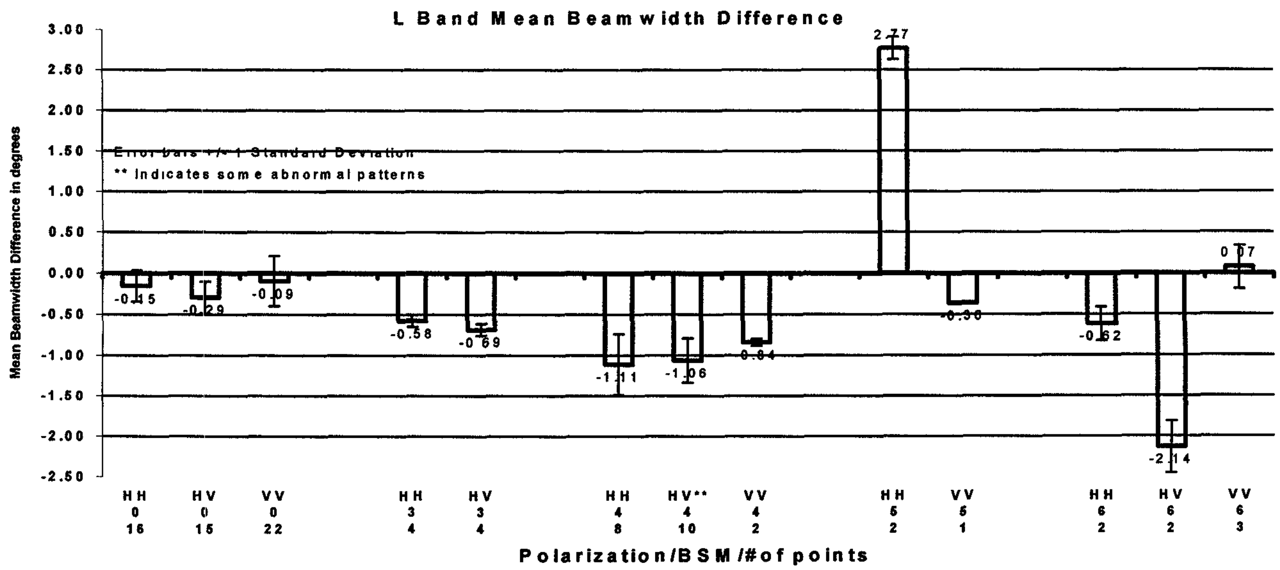
SUMMARY OF RESULTS

The work described here refers primarily to the second SIR-C/X-SAR flight. We previously reported on some of the measurements with both flights of the radar, but use of additional target areas allowed calibration of more beam-steering modes of the radar and further refinement of the patterns for the basic mode (Beam Steering Mode 0). Also we were able to expand the data greatly in less-used polarizations.

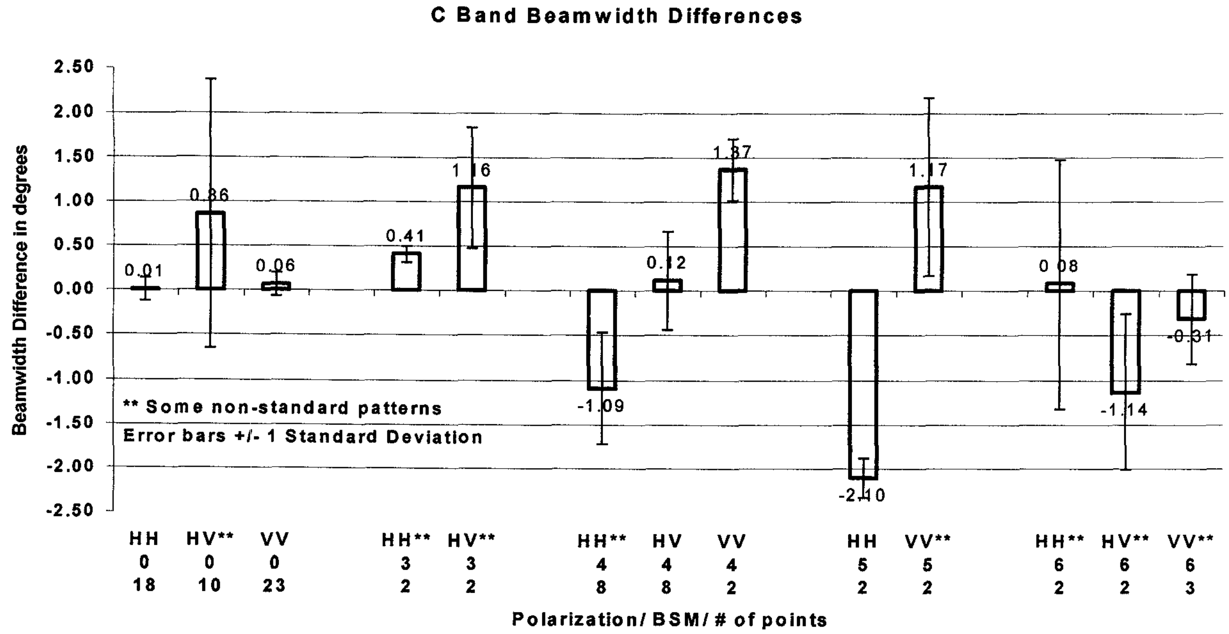
For each flight segment processed we determined the difference in apparent pointing angle between that used for the JPL-supplied corrections and the measured data. Often the effects of pointing errors are clearly evident in the images; overcorrection leads to bright bands in the images and undercorrection to dark bands. The higher-numbered beam-steering modes (BSMs) often resulted in patterns that did not follow the usual $\cos^n$ form, and some of them were quite irregular near the peak of the beam. We indicate when these odd patterns contribute to the average data.

Here we summarize graphically the results for the different modes and polarizations. Since most passes used the BSM 0, we presented results for each BSM together for the different polarizations. For some BSM/polarization combinations, the number of data points is quite small The number of points in each average is indicated.

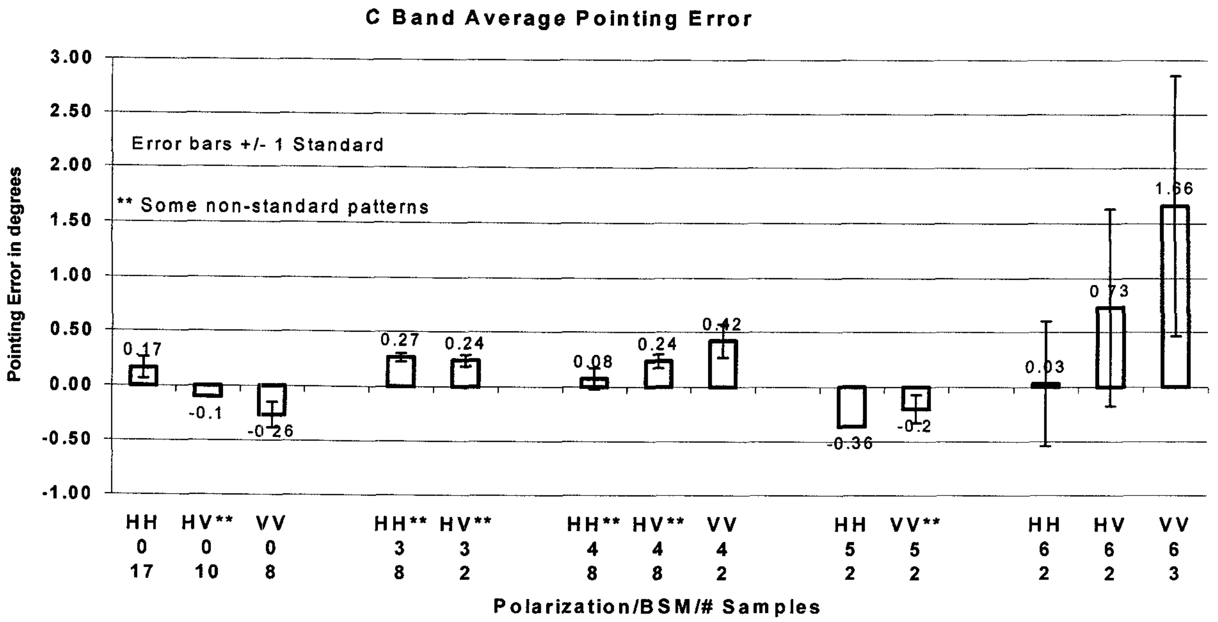




The general conclusion remains the same as in the previous, more limited studies Beam-spoiling mode 0 has fewer significant errors than the other modes, with the biggest problems being pointing errors (this is more so on the second mission). For beam-spoiling modes other than one, the errors can be quite large and sometimes the antenna patterns are significantly distorted.



Detailed curves from the studies of the different passes are available for use on our Web site to be found at http://www.rsl.ukans.edu/~sirc/antenna.html. Users should consult this to see if a pass they wish to use is on the site, and, if it is not, to determine if a similar enough pass is reported so that conclusions may be estimated.



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