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Atmospheric Measurement Techniques
Discussions

Interactive comment on “Evaluation of multifrequency range-imaging technique implemented on the Chung–Li VHF atmospheric radar” *by* J.-S. Chen et al.

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The paper presents a statistical study of calibration parameters for frequency domain range interferometry using the the Cung-Li VHF radar. The method is similar to astronomical radio imaging using spaced receivers to obtain high resolution images. However, instead of angular resolution, the method goes after range resolution with spaced frequencies. As with radio astronomical imaging, some assumptions of sparseness of the image is required to obtain super-resolution of the target. In this case, the assumption is that the target can consist of narrow layers smaller than occupied bandwidth would otherwise allow \Delta R = $c/(2(f_max-f_min)$.

Super-resolution is an important topic of research for radar engineering. However, the

topic is not easy. As stated in the paper, good calibration of the system is important. Another important topic is regularization of the imaging, and the effects that it can have on the data products.

The paper presents a large statistical study of the calibration parameters and provides several examples of range imaging data products. The paper also attempts to explain the features in the histograms for these parameters, but fails to provide a conclusive explanation to the features in the data.

The paper would greatly benefit from more information on the imaging method. In current form, the imaging algorithm is not very well described. The authors state that they utilize the Capon method. At the same time, there is also a cost function, which resembles Tikhonov regularization using first order differences (equation 1) of neighbouring image pixels in range. How are these two methods combined? It is also not clear if the range weighting function parametrized using σ_z is part of the radar target model or if it is used to model the range ambiguity due to transmit pusle shape and receiver filters, or perhaps both.

Line 19 states a threshold of -9 dB for power. What is this relative to? It should be stated. The negative value implies that this coherent integration and pulse compression is used, but what is the signal procesing gain?

The paper states that σ_z is dependent on SNR and approaches 100 m with high SNR. The paper does not explain why this is. Perhaps the explanation is the following: The utilized experiments in most cases span 1.5 MHz of bandwidth. Due to the used pulse lengths and frequency spacings, this bandwidth is actually fully populated. One can therefore obtain a non-imaging resolution simply by using $c/(2B)$, where $c=3e8$ and $B=1.5e6$, which happens to be 100 m. The Tikhonov first order differences cost function encourages smoothness of the image. In low SNR cases, there is nothing to image and therefore the solutions tend towards smooth solutions with large σ_z, and in high SNR cases σ_z approaches the intrinsic range resolution of 1.5 MHz.

Figure 4. shows a comparison of adaptive calibration parameters vs. fixed parameters during heavy precipitation. The results are significantly better when σ_z and phase are allowed to vary. Again, the paper does not fully describe why. The refractive index of the medium should be non dispersive (frequency independent), so it is difficult to justify that this effect is due to different propagation delays in the medium itself, as hinted in the paper. The only explanation left is the same as the previous section: the calibration parameters are part of the radar range image model – not fully independent radar calibration parameters independent of the radar target.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 10097, 2015.