THREE-DIMENSIONAL COHERENT RADAR IMAGING: EXPERIMENTAL AND MODEL COMPARISON OF TECHNIQUES

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We have implemented an eight-antenna module configuration at Jicamarca, to perform a three-dimensional imaging of the atmospheric brightness distribution, particularly at tropospheric (7 to 12 km) and *E* region heights (95-105 km). Four different methods have been implemented to solve for the inverse problem, i.e., to get the atmospheric brightness from visibility samples on the ground. We have used a Fourier-based, Capon and Maximum Entropy (MaxEnt) methods. In addition, we have implemented a fitting technique where a brightness distribution, characterized by a number of anisotropic Gaussian blobs, is assumed. It is important to note that with our current configuration we can characterize up to six anisotropic Gaussian blobs. These four methods are compared using experimental and model data. For the experimental part, we have taken advantage of the good knowledge that we have on the mean position, orientation and aspect sensitivity of the equatorial electrojet (EEJ).

A model of a known brightness distribution, characterized by a number of anisotropic Gaussian blobs, has been used to generate visibility samples on the "ground". In Figure 1, we present some model results using brightness functions consisting of two, three and four two-dimensional anisotropic Gaussian functions. The estimated images have been obtained using Maximum Entropy and Capon methods on configurations consisting of eight and four receiving antennas.

From the experimental and model comparisons we conclude that: (1) there is a good agreement between Capon and MaxEnt methods, particularly when the signal-to-noise ratio (SNR) is high; (2) under low SNR, MaxEnt works better than the other techniques; and (3) our fitting technique using Gaussian blobs works very well, but is very sensitive to the initial conditions needed to start the fitting procedure.

Finally, the tropospheric images indicate that the troposphere over Jicamarca was too homogeneous within the antenna beam-width and little gain was attained when more than three-receiving antennas are used, particularly when long integration times were used. Long integration smears any existing details within the observation volume and thus reduces the number of degrees of freedom to those corresponding to the largest structures. In the limit, it shows only the antenna pattern. Short integration times will increase the statistical fluctuations of the estimates and thus the significance of the results. The technique should be more revealing if larger observational volumes (wider beam antennas) are used.

Details on the experimental setup and results can be found in *Chau and Woodman* [2000] ("Three-dimensional coherent radar imaging at Jicamarca: Comparison of different inversion techniques", *J. Atmos. Sol. Terr. Phys., in press,* 2000).

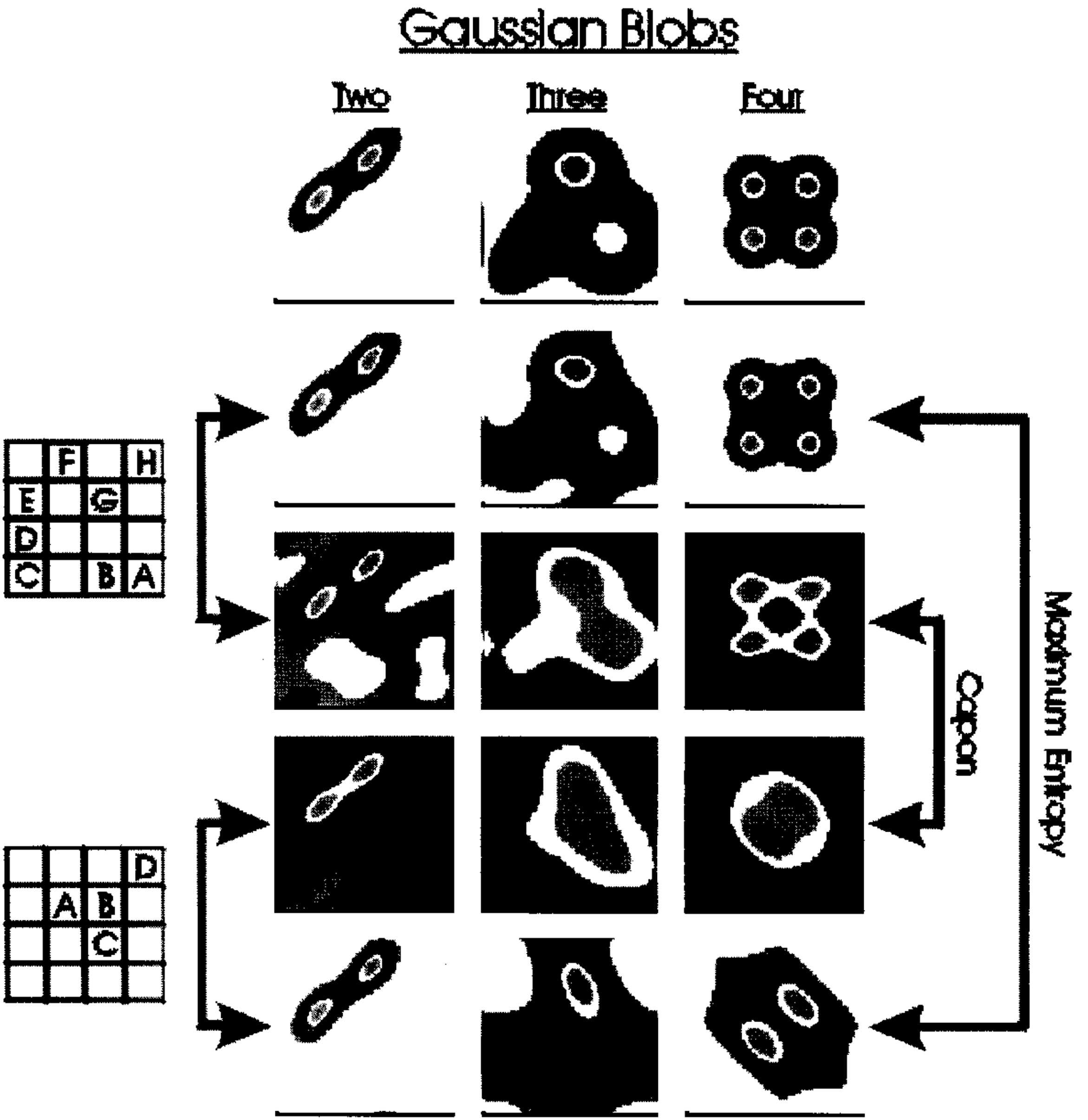

Figure 1. Model brightness distribution consisting of two, three and four anisotropic Gaussian functions. Estimated images have been obtained using Maximum Entropy and Capon methods on configurations consisting of eight and four receiving antennas.