Comparison of radar imaging methods

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Abstract:

In this work, we are conducting a comparison of different methods to solve a one-dimensional aperture-synthesis radar imaging problem based on simulations. For this purpose, we are going to consider the geometry of the Jicamarca ionospheric radar. These methods are going to be applied to the generation of images of field-aligned plasma irregularities in the equatorial ionosphere, particularly, to the case of Spread-F phenomena. Following previous comparison work of [Harding & Milla 2013] and [Hysell et al. 2019], we make a comparison based on the methods: direct Fourier inversion [Kudeki & Sürücü 1991], Capon's method [Palmer et al. 1998], Maximum entropy method [Hysell & Chau 2006] and compressed sensing [Harding & Milla 2013]. In compressed sensing, we are going to use, as in previous work, the daub2, daub3 and daub4 basis; and we are adding the Haar and Battle-Lemarie basis, and some wavelet packet basis which have a better performance than each one of the mentioned basis. In this case, we are assuming that the brightness function of the spread-F echoes has a sparse representation and is Gaussian shape. The different methods will be compared based on the following metrics of the reconstructed images: normal correlation, total variation, linear mean error, quadratic mean error and quadratic mean error on signals measured in decibels; these metrics are also used to choose the wavelet packet basis.

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References:

- [Harding & Milla 2013] Harding, B. J. & Milla, M (2013). Radar imaging with compressed sensing, Radio Sci., 48, 582{588, doi:10.1002/rds.20063.

- [Hysell & Chau 2006] Hysell, D.L. & Chau, J.L. (2006). Optimal aperture synthesis radar imaging, Radio Sci., 41, RS2003, doi:10.1029/2005RS003383.

- [Hysell et al. 2019] Hysell, D. L., Sharma, P., Urco, M., & Milla, M. A. (2019). Aperture-synthesis radar imaging with compressive sensing for ionospheric research. Radio Science, 54(6), 503-516.

- [Kudeki & Sürücü 1991] Kudeki, E. & Sürücü, F. (1991). Radar interferometric imaging of field aligned plasma irregularities in the equatorial electrojet, Geophys. Res. Lett., 18(1), 41-44, doi:10.1029/90GL02603.

- [Palmer et al. 1998] Palmer, R. D., S. Gopalam, T.-Y. Yu, and S. Fukao (1998). Coherent radar imaging using Capon's method, Radio Sci., 33(6), 1585{1598, doi:10.1029/98RS02200.

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