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Variational Data Assimilation via Sparse Regularization

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We examine the role of regularization in variational data assimilation (VDA) problems. Specifically, we focus on data assimilation of noisy and down-sampled observations while the geophysical state of interest exhibits a sparse representation in a properly chosen basis. We show that as long as sparsity holds (which we demonstrate holds for several variables of interest in the spatial domain such as precipitation, soil moisture, topography, etc. and in the time domain such as in the presence of weather fronts), L1-norm regularization produces more accurate and stable solutions than the classic methods. Examples are provided via assimilating observations into the linear Burgers' equation in the wavelet and discrete cosine domains.