

Reconstructing a data stream for Climate Modeling from sparsely sampled signals - Fourier domain works, but is there a better way?

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Wednesday, April 30, 2014
Room: MATH 111. Time: 4:00pm.

ABSTRACT. Statistical Climate Model Downscaling (downsizing large-scale climate modeling data to a regional or local scale) correlates local meteorological conditions with large-scale Global Climate Model parameters, and uses those correlations to produce projections of future local climate conditions. Daily max and min temperature are two important historical parameters used in downscaling, and we need to derive equivalent values from GCM outputs to produce future predictions. Unfortunately we only get an undersampled temperature signal series, and extracting Tmin and Tmax directly underestimates the daily temperature range. Fourier domain filtering can be used to reconstruct an approximation of the daily temperature profile and resample to better estimate the daily Tmax and Tmin from the typical 3-hour GCM temperature outputs. Tests using downsampled Mesonet data shows that we can reduce the RMS error between 3-hour sampling and 5-minute sampling by 60-70%. However, analysis of the Mesonet data shows that the basic shape of the daily signal is not well approximated with only a few Fourier terms. I.e., it is not bandwidth-limited to below the Nyquist limit imposed by 3-hour sampling, and the resulting reconstruction is not perfect. An alternate set of orthogonal functions other than sinusoids would do a better job of reconstructing the signal from a limited set of samples, Gramm-Schmidt orthogonalization provides one framework for creating an alternate set of orthogonal functions, but is dependent upon the selection of the initial function. For simple linear feature vectors, PCA (principal component analysis) provides a method for determining an optimal (in a least-squares sense) set of orthogonal (linear) axes for scatter-plot data. Is there an equivalent method to determine an "optimal" set of orthogonal functions, which would reduce the RMS error even more than we get with Fourier resampling?