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Partial Whitening SVD Analysis and its application to tropical-extratropical teleconnections

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Various multivariate statistical methods have been established and proven useful for isolating relationships between datasets. Many popular linear methods are based on Singular Value Decomposition (SVD) and include Canonical Correlation Analysis (CCA), Maximum Covariance Analysis (MCA), and Redundancy Analysis (RDA). In this study, Partial Whitening SVD Analysis (PWSVD) is introduced as a new technique that maximizes the squared covariance between partially-whitened variables. Applied as a pre-filter, the partial whitening transformation acts to decorrelate and normalize individual variables to a fractional degree that is specified prior. Particular PWSVD solutions include a new and effective regularization for CCA as well a variance bias correction for MCA. Also, given some crude prior expectation of the signal-to-noise, asymmetric PWSVD solutions can provide significant benefit, and the full range of solutions bridges those of CCA, MCA and RDA. After deriving PWSVD, it is used to linearly relate precipitation in the tropical Pacific with Northern Hemisphere extratropical circulation during boreal winter, and solutions are contrasted with those of traditional methods. It is demonstrated that PWSVD produces a highly robust representation of the dominant teleconnections, namely ENSO and ENSO Modoki, or flavors of ENSO. Lastly, the practical use of PWSVD is encouraged for a range of applications.