EMS Annual Meeting Abstracts
Vol. 13, EMS2016-108, 2016
16th EMS / 11th ECAC

Consistent bias correction/downscaling of different climate variables

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Impact models often require information for more than one meteorological variable. If this information is obtained from observations, consistency is insured through the measurements of all needed variables at the same location along a common time period. But in climate change impact studies, information obtained from climate model simulations, although consistent in the model world, have to be bias corrected and downscaled at the desired impact location. Generally, bias correction and downscaling are made independently for each variable, which cannot guaranty that consistency is preserved. Different authors have suggested methodologies for consistent multivariate bias corrections (Piani and Hearter 2012, Vrac and Friederichs 2015, among others). In this study, a new approach, based on the same ideas of conditional densities and rank correlations will be presented and illustrated. Applications to the downscaling of ERA-Interim reanalysis for two variables (temperature and wind) will be detailed, comparing empirical and kernel density estimations. Then extensions to three and more variables will be discussed, together with their strengths and limitations.

Piani C., Hearter J.O.: Two dimensional bias correction of temperature and precipitation copulas in climate models, Geophysical Research Letters, 2012, DOI: 10.1029/2012GL053839
Vrac M. Friederichs P.: Multivariate -inter-variable, spatial and temporal- bias correction, Journal of Climate, January 2015, DOI: 10.1175/JCLI-D-14-00059.1