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Spectral biases in climate proxies and reconstructions

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External forcing and internal dynamics result in sub-daily to multi-centennial climate system variability. Climate variables can behave differently in certain frequency ranges, e.g low-frequency temperature variability based on solar forcing may not cause coherent low-frequency precipitation changes. Hence, time series can correlate stronger and weaker in distinct frequency ranges. Nevertheless, many state-of-the-art reconstructions methods routinely use hydroclimatic proxies to reconstruct temperature, possibly blurring differences in the variability continuum of temperature and precipitation prior to the instrumental period. Therefore, we assess the spectral characteristics of temperature and precipitation variability in observations, model simulations, proxy records and proxy based reconstructions. We find that while an ensemble of different general circulation models represents patterns captured in instrumental measurements, such as land-ocean contrasts and enhanced low frequency tropical variability, proxy data do not. Furthermore, the observed tendencies for dominant inter-annual fluctuations in precipitation are not reflected in hydroclimatic proxy records, nor is enhanced mid- to low-frequency temperature variability consistently captured by all temperature-sensitive proxies. These spectral biases in the proxy records propagate into multi-proxy compilations, for which we observe an over(under)estimation of low(high)-frequency variability. We will present why attention to a proper representation of the high to low frequency spectrum in proxy records is needed to reduce uncertainties in future climate reconstruction efforts.