Deriving South America austral summer rainfall from upper level circulation seasonal predictions

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This study investigates the use of upper level circulation predictions produced by coupled ocean-atmosphere seasonal forecast models for producing South American rainfall seasonal predictions. The rationale behind this investigation is that if upper level circulation is well simulated by seasonal climate models and related to rainfall, it may then be possible to use upper level circulation predictions to produce rainfall forecasts for South America.

One-month lead austral summer stream function predictions at 200 hPa produced by the current operational versions of the European Centre for Medium-range Weather Forecasts (ECMWF) and the UK Met Office seasonal forecasting systems are used as representative variable of upper level circulation. A Bayesian approach know as forecast assimilation is used to objectively combine and calibrated upper level circulation predictions produced by these two dynamical coupled models for producing austral summer (December-January-February) South American rainfall predictions. This calibration and combination procedure uses retrospective predictions (hindcasts) for the period from 1987 to 2005 and is based on the maximum covariance analysis (also known as singular value decomposition) of the cross-covariance matrix between upper level circulation predictions and observed rainfall. The first three leading modes of this analysis are used in the procedure. The leading mode accounts for 78.8% of the squared covariance between predicted stream function and observed rainfall and represents the El Niño-Southern Oscillation phenomenon. The circulation pattern of this mode has a signature of two symmetric anomalous anti-cyclones over the equatorial Pacific during El Niño years and a signature of two symmetric anomalous cyclones over the equatorial Pacific during La Niña years. This leading mode is consistent in both ECMWF and UK Met Office models and is related to a dipole pattern of reduced rainfall in northern South America and increased rainfall in southeastern South America during El Niño years. During La Niña years this rainfall pattern is reversed.

Results suggest that upper level atmospheric circulation modes of covariability with rainfall simulated by ECMWF and UK Met Office seasonal forecast models can be successfully used for producing skilful rainfall predictions for South America. Combined and calibrated circulation derived predictions obtained with forecast assimilation have comparable level of skill to single model (ECMWF and UK Met Office) rainfall predictions. This result indicates that upper level circulation predictions alone account for a large portion of the skill of coupled ocean-atmosphere model rainfall predictions in South America.