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Comparing seasonal forecast downscaling methodologies for the agriculture sector in South Eastern South America

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South Eastern South America (SESA) - comprising Uruguay, Paraguay, southern Brazil and northeastern Argentina - is one of the largest food producers of Latin America. Activities such as cereals, soybean and livestock productions are the basis for most of the regional economy (Baethgen and Magrin 2001). Additionally, this region is subject to strong interannual variability that is primarily driven by a strong El Niño-Southern Oscillation (ENSO) teleconnection (e.g., Ropelewski and Halpert 1996), and by the influence of the Indian Ocean Dipole (Chan et al. 2008) and the Southern Annular Mode (Zhou et al. 2001; Silvestri and Vera 2003). It is therefore quite clear that seasonal-to-interannual prediction is of great interest for SESA agriculture and climate risk management. Advances in ENSO forecasting and seasonal climate prediction systems do not necessarily translate in consistent improvements in the quality of seasonal forecasts for specific applications such as agriculture and water management. One of the largest constraints is given by the limited spatial resolution of the general circulation models (GCMs) and temporal aggregation of their outputs (e.g, Goddard et al. 2001). Several downscaling methodologies have therefore been developed, to translate the GCMs output into useful local-scale information.

This work presents a comparison of different downscaling methodologies to generate daily rainfall sequences from GCM output that can later inform climate risk management, for instance by being used as a forcing for crop or pasture models. Following Moron et al (2008), four methods will be tested using retrospective GCM predictions of spring (SON) and summer (DJF) precipitation for the period 1961-2010 and compared against a regional network of stations with daily rainfall records. The local downscaling methodology considers the closest grid point to each station to calibrate raw GCM daily precipitation, so that the climatological distribution of rainfall matches the observed one. The k-nearest neighbor and weather classification schemes resample historical station rainfall observations according to the similarity between a set of daily circulation fields (e.g., wind, geopotential heights) from an ensemble of GCM simulations and a historical library of the same fields from reanalysis. The non-homogenous hidden Markov model represents the relationship between daily station rainfall observations and low-pass-filtered simulated circulation patterns through a set of hidden states to simulate stochastic sequences of daily rainfall. Different verification metrics such as mean bias, correlation and root mean square error are used to assess the skill of the different methodologies to reproduce the seasonal statistics of daily rainfall, and the mean length of wet and dry spells.