Zeng's Gamma

- References:
  - Zeng, X., M. Barlange, C. Castro, and K. Fling, 2010: Comparison of land-precipitation coupling strength using observations and models. J. Hydrometeor., 11, 979-994, doi: 10.1175/2010JHM1226.1.
- Principle:
  - Closely related to the index of Guo et al. (2006): $\Gamma = r(P',E')\frac{\sigma(E')}{\sigma(P')}$ is the correlation between evaporation and precipitation scaled by the standard deviation of the evaporation and normalized by the standard deviation of precipitation to keep the index dimensionless. Each term is an anomaly versus the climatological annual cycle.
  - It is assumed that P is a proxy for soil moisture, so in fact P is the forcing and E the response. It is further assumed soil moisture is not well enough observed to be used directly.
- Data needs:
  - Time series of the two variables: precipitation and evaporation; the original study used monthly means and focused on interannual variability, but the method can be adapted to shorter period means (down to daily means) as has been done for other indices; although using shorter time periods exacerbates the time scale differences between precipitation and soil moisture. It would be better in such case to use soil moisture directly instead of P.
  - The original study focused on model output: reanalyses, which do not close the surface water budget; and free-running models that do.
- Observational data sources:
  - Point and gridded observed precipitation data sets are readily available.
  - Comparable evaporation data sets generally are not. There are point measurements at flux towers (e.g., FluxNet) and various remote sensing based products that may be accurate enough for use with longer period means (balanced against the relatively short records for remote sensing platforms).
- Caveats:
  - Normalization by $\sigma(P')$ makes the index dubious in arid regions and seasons.
  - The assumption that P is a proxy for soil moisture is time-scale dependent (see above).
  - Using soil moisture in place of P and removing the scaling by $\sigma(P')$, this reduces to the terrestrial coupling index of Guo et al. (2006) and Dirmeyer (2011).

Supported by NASA/MAP Grant: NNX13AQ21G