[Coupling metrics to diagnose land-atmosphere interactions]

GLACE Coupling Strength ($\Delta\Omega$)

- References:
  - Koster, R. D., M. J. Suarez, and M. Heiser, 2000: Variance and predictability of precipitation at seasonal-to-interannual timescales. *J. Hydrometeor.*, **1**, 26-46, doi: 10.1175/1525-7541(2000)001%3C0026%3AVAPOPA%3E2.0.CO%3B2.
  - Koster, R. D., P. A. Dirmeyer, A. N. Hahmann, R. Ijpelaar, L. Tyahla, P. Cox, and M. J. Suarez, 2002: Comparing the degree of land-atmosphere interaction in four atmospheric general circulation models. *J. Hydrometeor.*, **3**, 363-375, doi: 10.1175/1525-7541(2002)003<0363:CTDOLA>2.0.CO;2.

- Principle:
  - If one component X (state variable, flux, boundary condition) of a model exerts control on another Y, specifying X identically across all members of an ensemble should reduce the intra-ensemble spread of Y, relative to a control ensemble where X evolves freely. The omega parameter is a measure of coherence among time series of different ensemble members:

$$\Omega_Y = \frac{n\sigma_{\hat{Y}}^2 - \sigma_Y^2}{(n-1)\sigma_Y^2}$$

    where $\hat{Y}$ is the ensemble mean. The difference in Ω between test and control ensembles, $\Delta\Omega$, is the coupling strength between X and Y.

- Data needs:
  - Time series of the potentially affected variables – typically some smoothing or averaging in time is applied, e.g., computed using pentad mean data.

- Observational data sources:
  - Cannot be determined observationally!
  - Has been correlated in models to quantities that can be observed.

- Caveats:
  - It is a characteristic of ensembles of model simulations. This makes it a very good metric to assess model behavior, compare models, explain predictability, etc., but has no real-world analogue or equivalent.
  - When the two cases compared do not differ by specification of a potential controlling component, but some other change (e.g., a different LSM), then $\Delta\Omega$ is not coupling strength but a measure of the change in coupling due to the model change.

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