[Coupling metrics to diagnose land-atmosphere interactions](#)

## Feedback parameter λ

- References:
  - Notaro, M., 2008: Statistical identification of global hot spots in soil moisture feedbacks among IPCC AR4 models. *J. Geophys. Res.*, **113**, D09101, doi: [10.1029/2007JD009199](#).
  - Orlowsky, B., and S. I. Seneviratne, 2010: Analysis of land-atmosphere feedbacks and their possible pitfalls. *J. Climate*, **23**, 3918-3932, doi: [10.1175/2010JCLI3366.1](#).

  - The influence of a slowly-varying variable $X$ at time $t$ on a faster atmospheric variable $Y$ at future time $t + dt$ can be estimated with a feedback parameter:
  $$\lambda = \frac{\text{cov}[X(t - \tau), Y(t)]}{\text{cov}[X(t - \tau), X(t)]}$$ where $\tau$ is a time scale $> dt$. The denominator is proportional to the lagged autocorrelation of $X$, or its memory.

- Data needs:
  - Time series of the two variables - well suited to large model output data sets. The larger the sample, the more robust and stable the results.

- Observational data sources:
  - Time series of the two variables - well suited to large model output data sets. The larger the sample, the more robust and stable the results.

- Caveats:
  - With finite data sets there will be sensitivity to the choice of $\tau$.
  - As with all correlation-based metrics, causal relationships are not guaranteed. This is not a process-level metric.
  - Likewise, the metric isolates only linear relationships. Nonlinear or categorical (threshold) relationships may not be well captured.