



## Feedback parameter $\lambda$

- 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](https://doi.org/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](https://doi.org/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:

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- 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.