Natural and Human Influences on Changing Zonal-Mean Precipitation

Motivation

Anthropogenic increases in greenhouse gases and stratospheric ozone depletion are expected to lead to a latitudinal intensification and redistribution of global precipitation. Detecting these mechanisms in the observational record is complicated by strong climate noise and model errors.

Approach

- Define indicators of thermodynamic T(t) and dynamic D(t) change at peaks and throughs of zonal average P.
- Calculate from climate simulations the multivariate fingerprint $F_M(D,T)$ (expected response to human forcings).
- Projects observed and simulated data onto $F_M(D,T)$.
- Eliminates strong climate noise and model errors.

Impacts

- Our approach shows, for the first time, that:
- The simultaneous changes global precipitation predicted by theory are detectable in observation.
- These observed changes are unlikely to arise purely from natural climate variability.
- External influences, probably anthropogenic in origin, are responsible.

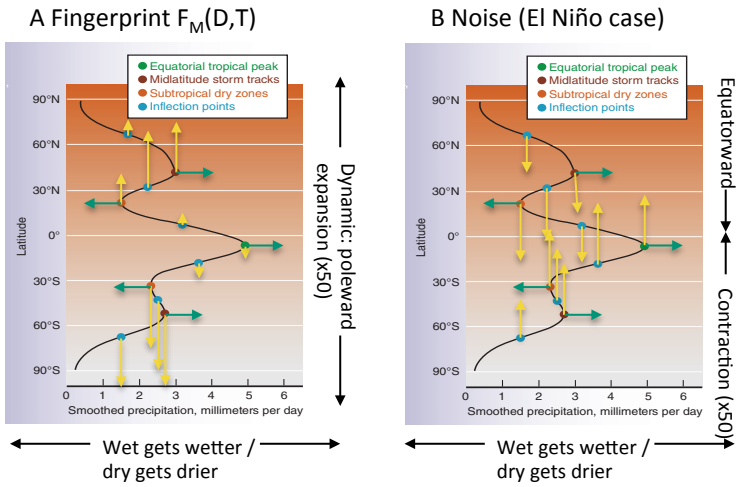

Fig. 1: Fingerprint: leading EOF of the cross-variance matrix of the multi-model average $D_H(t)$ and $T_H(t)$ from historical simulations forced by human activities. B. Primary noise mode (ENSO). Arrows: distortion of the curve that result from the fingerprint and noise functions.

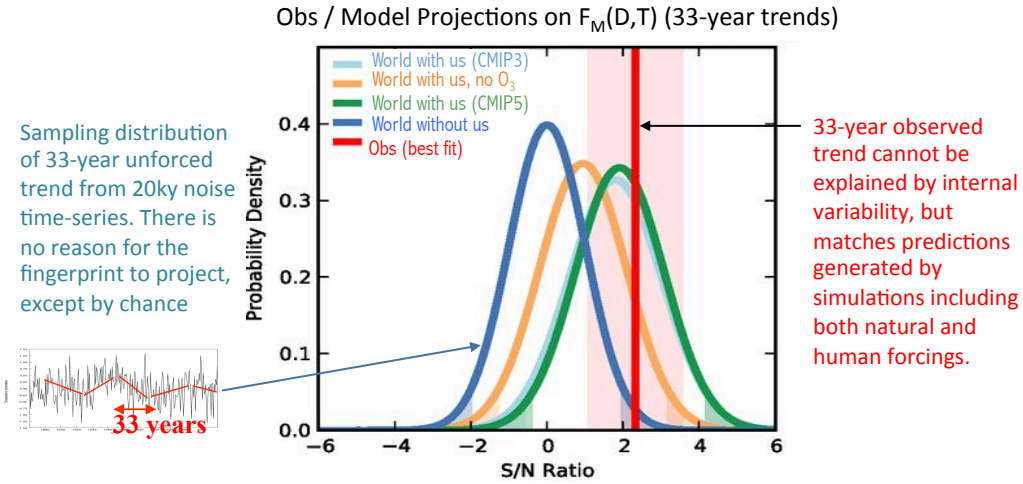

Fig. 2: Signal-to-noise ratio of forced P change in observations (red line) and various sets of climate simulations.

Marvel K and C Bonfils 2013: Identifying External Influences on Global Precipitation. *PNAS*, 110, 19301–19306.