Distinguishing the roles of natural and anthropogenically forced decadal climate variability: Implications for prediction

ESRL/PSD's contribution to The US CLIVAR Decadal Predictability Working Group

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Objectives of The US CLIVAR Decadal Predictability Working Group:

◇ *To define a framework to distinguish natural variability from anthropogenically forced variability on decadal time scales for the purpose of assessing predictability of decadal-scale climate variations.*

◇ *Work towards better understanding of decadal variability and predictability through metrics that can be used as a strategy to assess and validate decadal climate prediction simulations.*

Scientific Focus #1:

Does the response to external forcing project onto or physically interact with natural climate variability?

Climate model simulations of the 20th Century indicate that the climate change signal may project on natural variability--Dominant pattern fluctuates on decadal timescales with an amplitude that varies from model to model and is larger than observations. In addition, note the differences in spatial patterns across models.
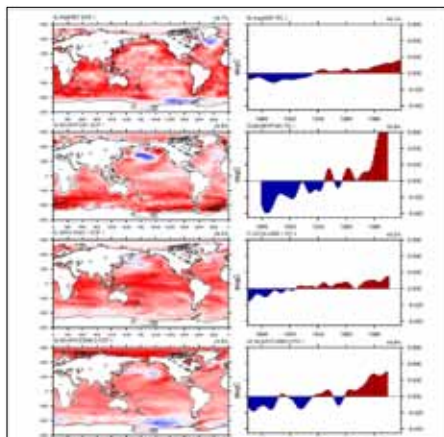
First EOF and associated time series of 10-year low-pass annual mean sea surface temperature from observations and three 20th Century simulations for years 1890-1999. (A,B) HadISST (C,D) NCAR/PCM1 (E,F) GFDL/CM2.1 (G,H) NCAR/CCSM3.0. From Solomon et al. (2010).

Scientific Focus #2:

Given that on regional scales the magnitude of natural decadal variations may rival that of anthropogenically forced climate change, how do we quantify predictable variability in decadal forecasts?
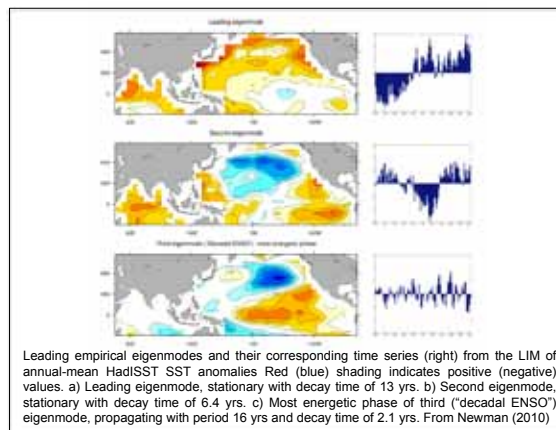

Leading empirical eigenmodes and their corresponding time series (right) from the LIM of annual-mean HadISST SST anomalies Red (blue) shading indicates positive (negative) values. a) Leading eigenmode, stationary with decay time of 13 yrs. b) Second eigenmode, stationary with decay time of 6.4 yrs. c) Most energetic phase of third ("decadal ENSO") eigenmode, propagating with period 16 yrs and decay time of 2.1 yrs. From Newman (2010)

Scientific Focus #3:

Do we have robust estimates of observed (or simulated) decadal trends?

Different mechanisms disagree on the expected sign of change in the zonal SST gradient in tropical in response to anthropogenic forcing. The observational record does little to clarify the situation, as trends in different observed SST records differ in even their sign, motivating further study with focused model experiments.
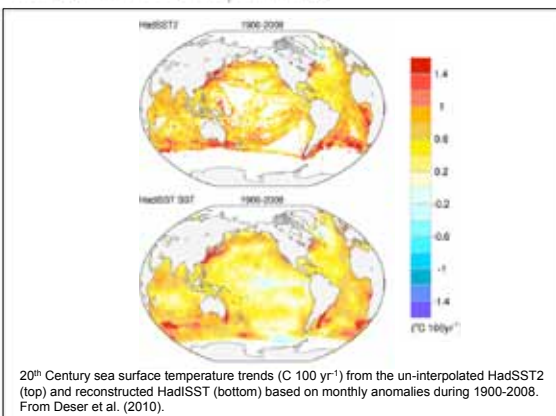
20th Century sea surface temperature trends (C 100 yr^{-1}) from the un-interpolated HadSST2 (top) and reconstructed HadISST (bottom) based on monthly anomalies during 1900-2008. From Deser et al. (2010).

Scientific Focus #4:

To develop a suite of metrics to assess CMIP5 near-term climate forecasts

For the purpose of:
➡Assessing the expectations for added regional climate information and skill achievable from initialized decadal predictions
➡Identifying physical processes or modes of variability that are important to the decadal prediction and predictability problem and whether their relevance may evolve with time
➡Attributing regional changes in the current climate to natural climate variations or anthropogenic forcing

An example of a metric to isolate externally-forced variability that is predictable on decadal timescales and can be used to assess the response of climate models to external forcing

2014-2058 DJF Surface Temperature Trends calculated using 28 CCSM3 A1B Simulations
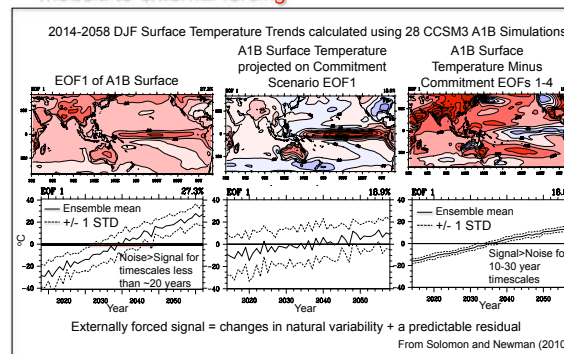
Externally forced signal = changes in natural variability + a predictable residual
From Solomon and Newman (2010)

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see http://www.usclivar.org/wgdp.php for more details

References:

Deser, C., A.S. Phillips, and M.A.Alexander, 2010: A re-assessment of 20th Century sea surface temperature trends over the tropical Pacific. *GRL*, under review.
Newman, M., 2007: Interannual to decadal predictability of tropical and North Pacific sea surface temperatures. *J. Climate*, **20**, 2333–2356.
Solomon, A. and Coauthors, 2010: Distinguishing the roles of natural and anthropogenically forced decadal climate variability: Implications for prediction. *BAMS*, under review.