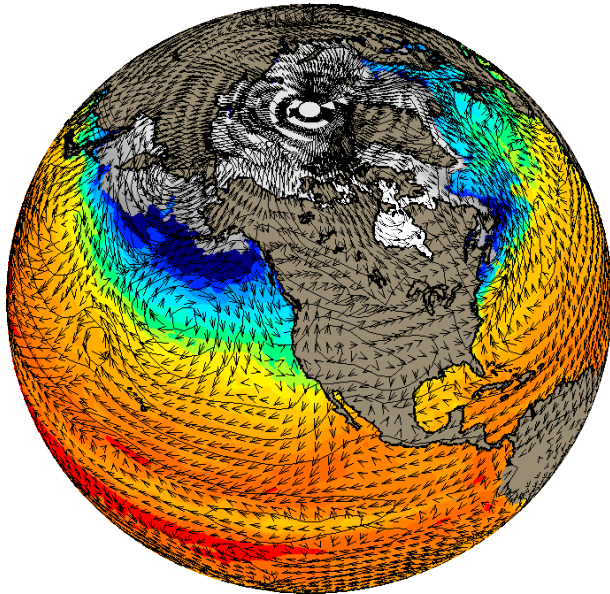


Fundamentals of Decadal Climate Prediction

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Boulder, CO



“Decadal Climate Prediction” is a new field in climate science

Decadal timescale (10-30 years in the future)

Factors that influence decadal prediction:

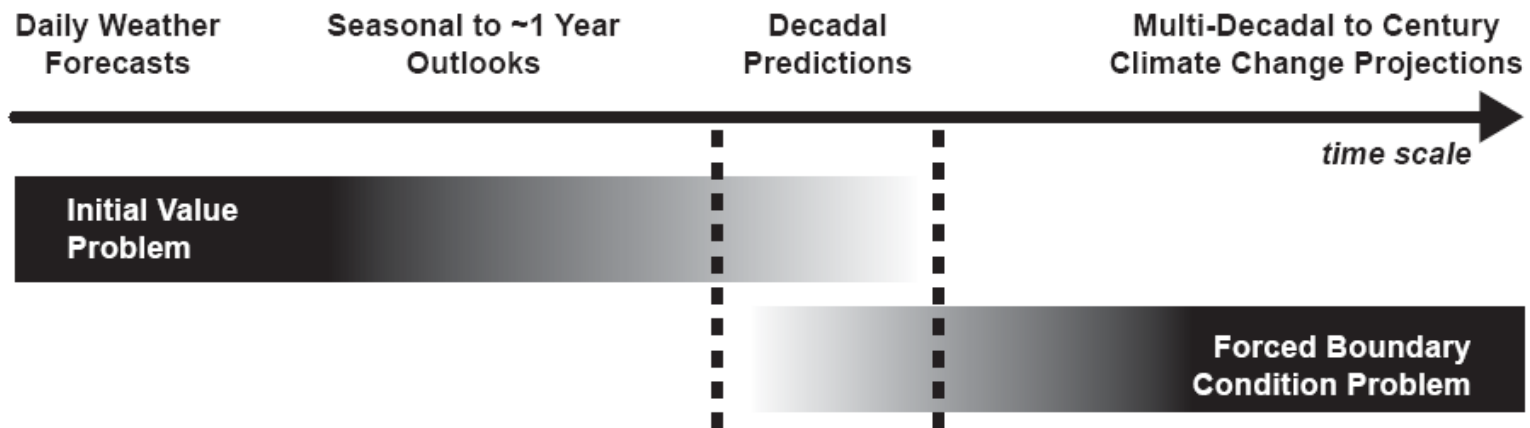
1. Climate change commitment
2. External forcing (anthropogenic and natural)
3. Internally generated variability (e.g. PDO/IPO, AMO, MOC)

Initializing the climate system is key, and observations are crucial

Experimental framework incorporated in CMIP5 experiments

(Meehl, G.A. L. Goddard, J. Murphy, R.J. Stouffer, G. Boer, G. Danabasoglu, K. Dixon, M.A. Giorgetta, A. Greene, E. Hawkins, G. Hegerl, D. Karoly, N. Keenlyside, M. Kimoto, B. Kirtman, A. Navarra, R. Pulwarty, D. Smith, D. Stammer, and T. Stockdale, 2009: Decadal prediction: Can it be skillful? *Bull. Amer. Meteorol. Soc.*)

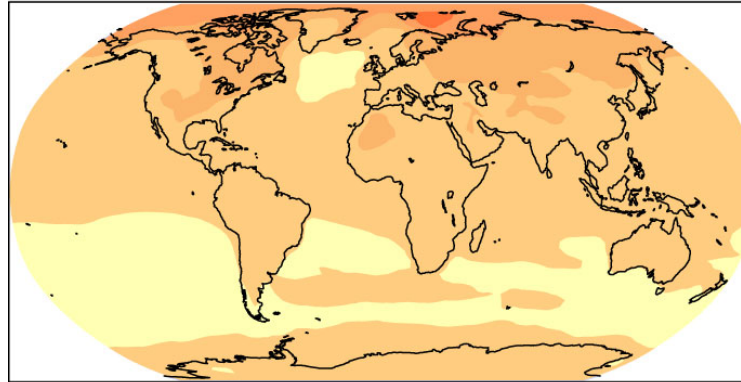
Decadal prediction lies between initialized weather or ENSO forecasts, and forced future climate change projections



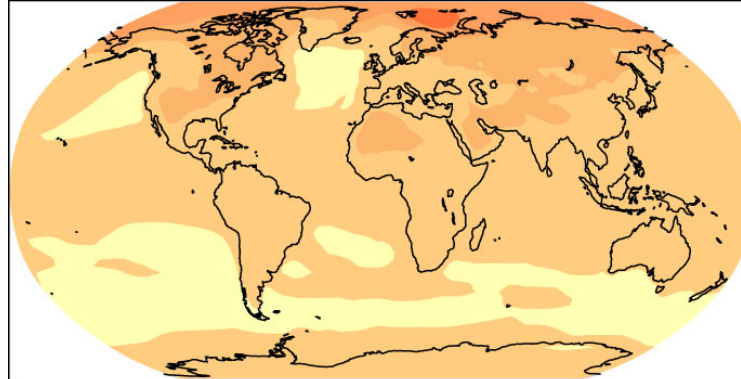
IPCC AR4

Multi-model
ensemble from
uninitialized
projections

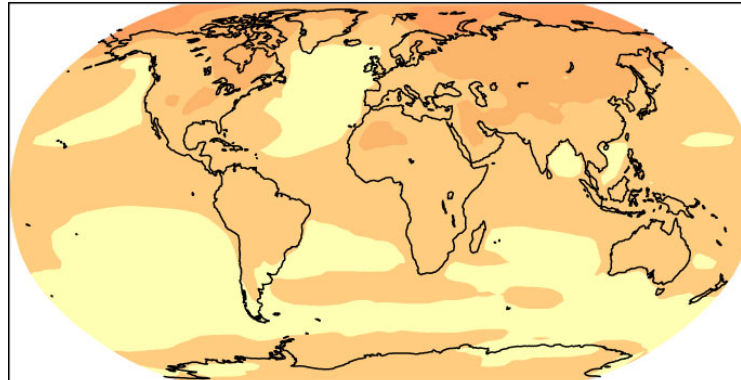
B1: 2011-2030



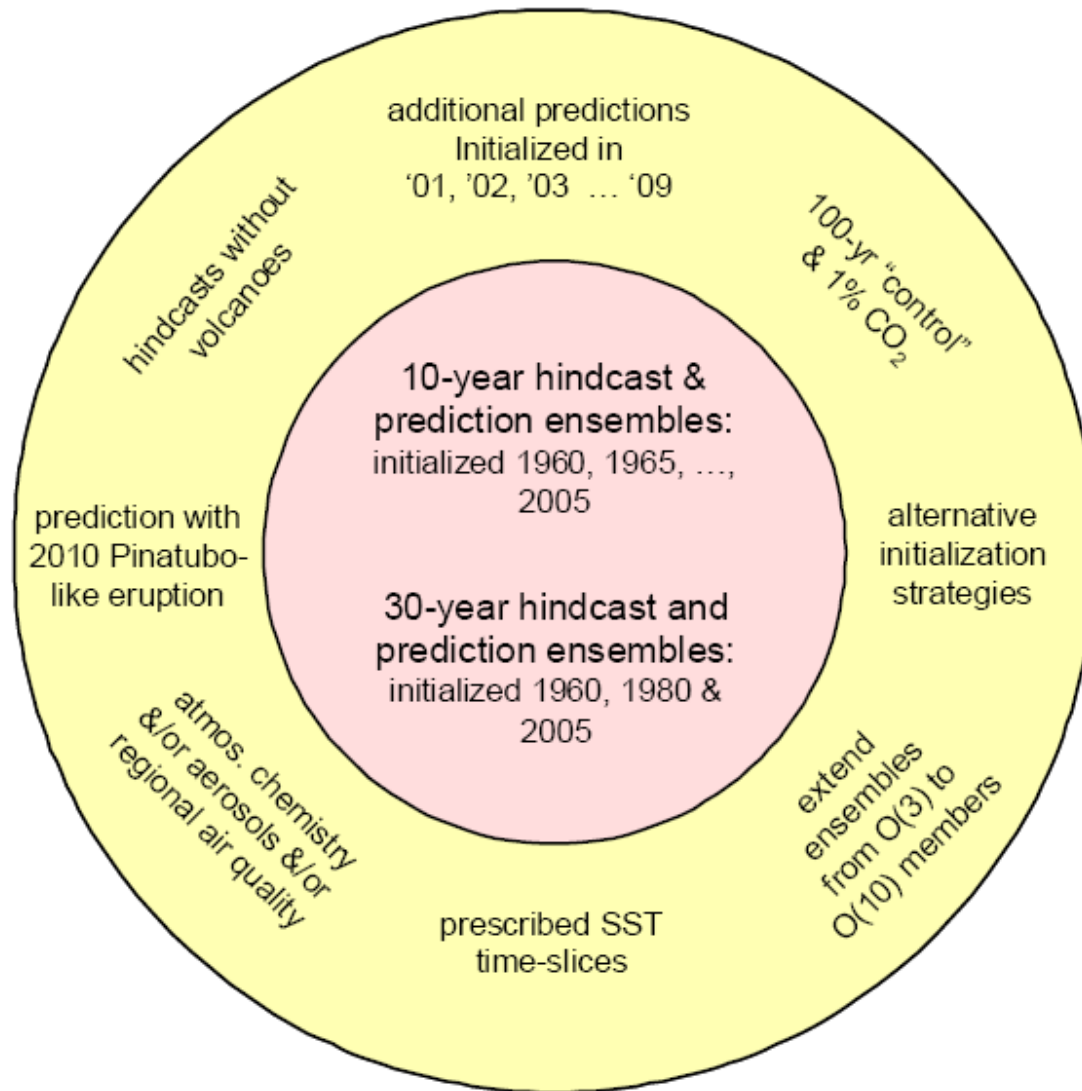
A1B: 2011-2030



A2: 2011-2030



CMIP5 Decadal Prediction (out to 2035)



Decadal climate prediction science questions (a sample)

How best to initialize a decadal climate prediction system?

How many ensemble members are needed?

Are there certain initial states that provide better predictive skill than others?

How best to evaluate skill of decadal climate predictions?

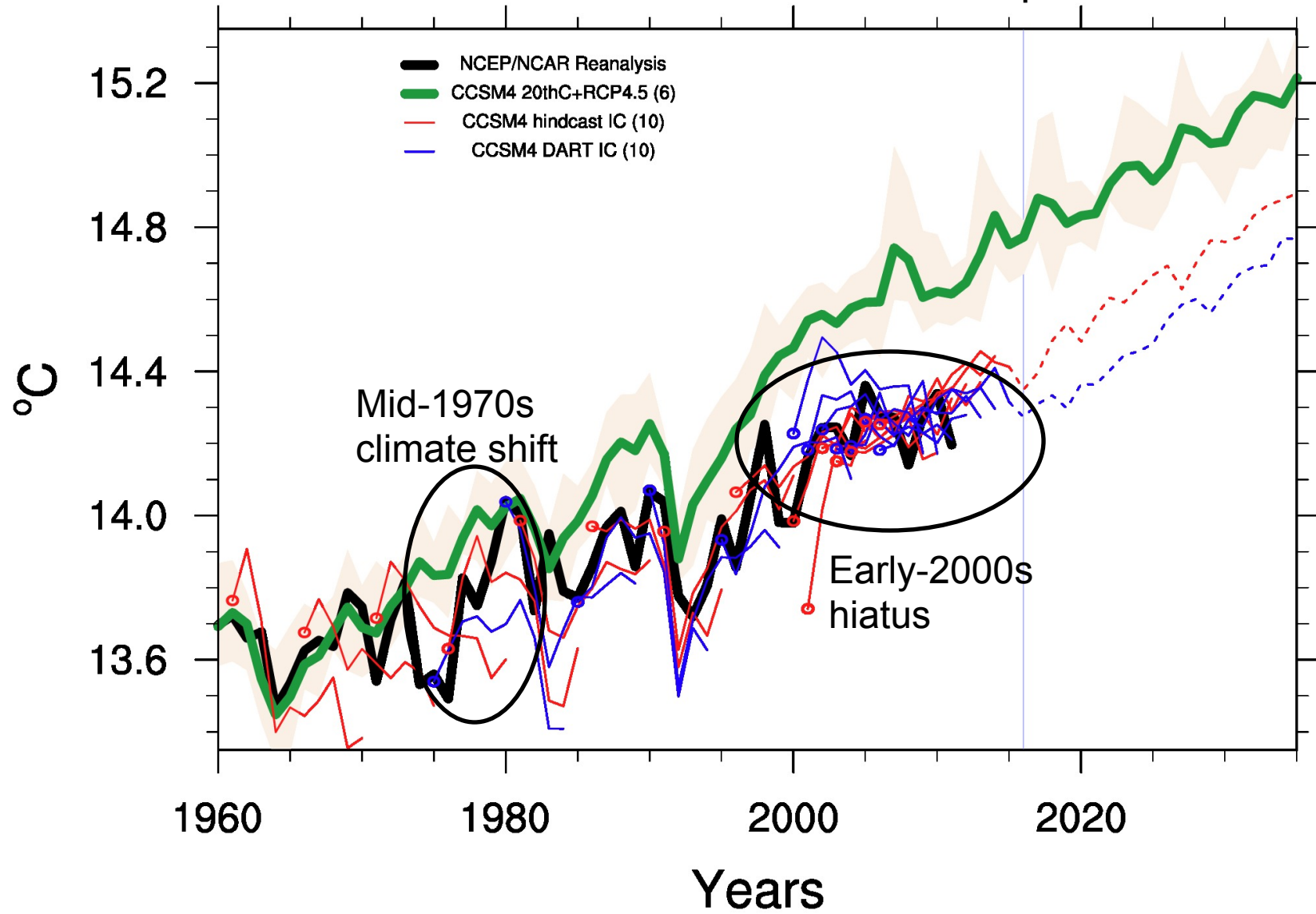
How best to account for solar variability and volcanoes in hindcasts and predictions?

How skillful does a decadal climate prediction need to be before it is actually used?

How much decadal variability is forced and how much is internally generated?

An example of decadal hindcasts and predictions: two initialization methods with one model (CCSM4), bias adjusted ten member ensemble averages (red and blue lines) compared to observations (black line) and free-running 20th and 21st century simulations with CCSM4 (green line)

Global Annual Mean Surface Air Temperature

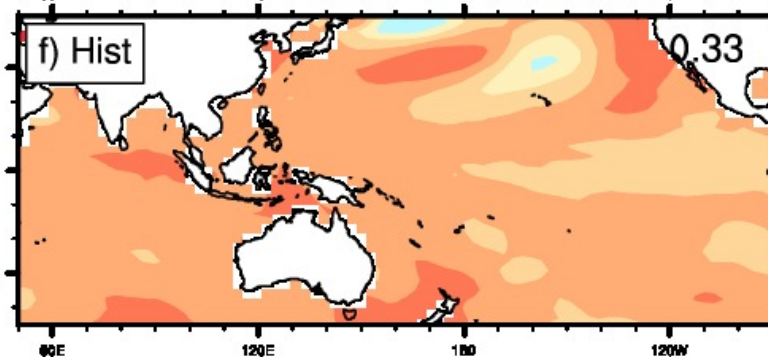
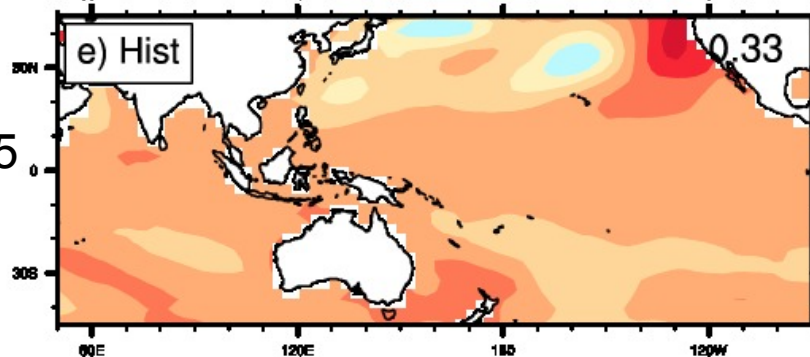
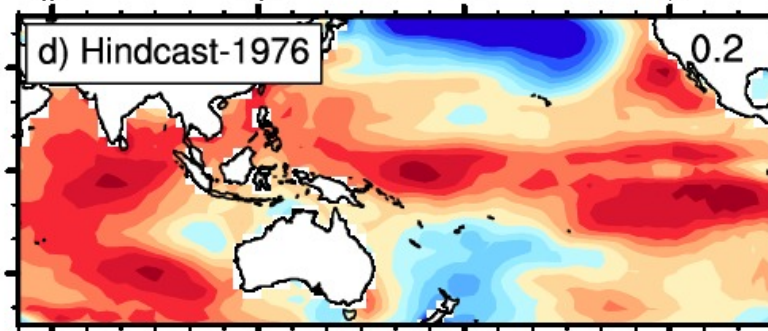
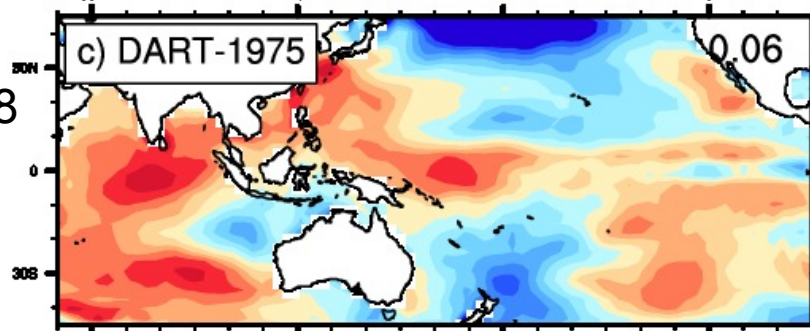
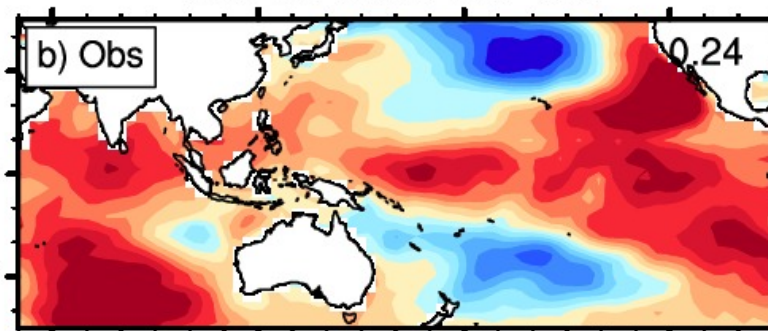
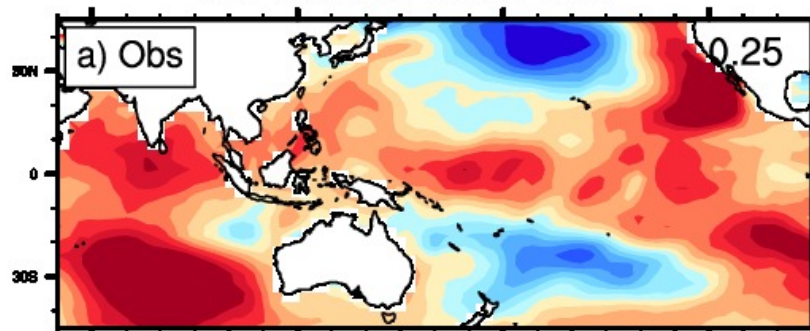


Pacific Ocean decadal timescale sea surface temperature patterns affect precipitation over the southwest U.S., Australia, and south Asia (Meehl and Teng, 2012)

Mid-1970s shift

1977-1981 minus 1960-1974

1978-1982 minus 1961-1975



+0.68

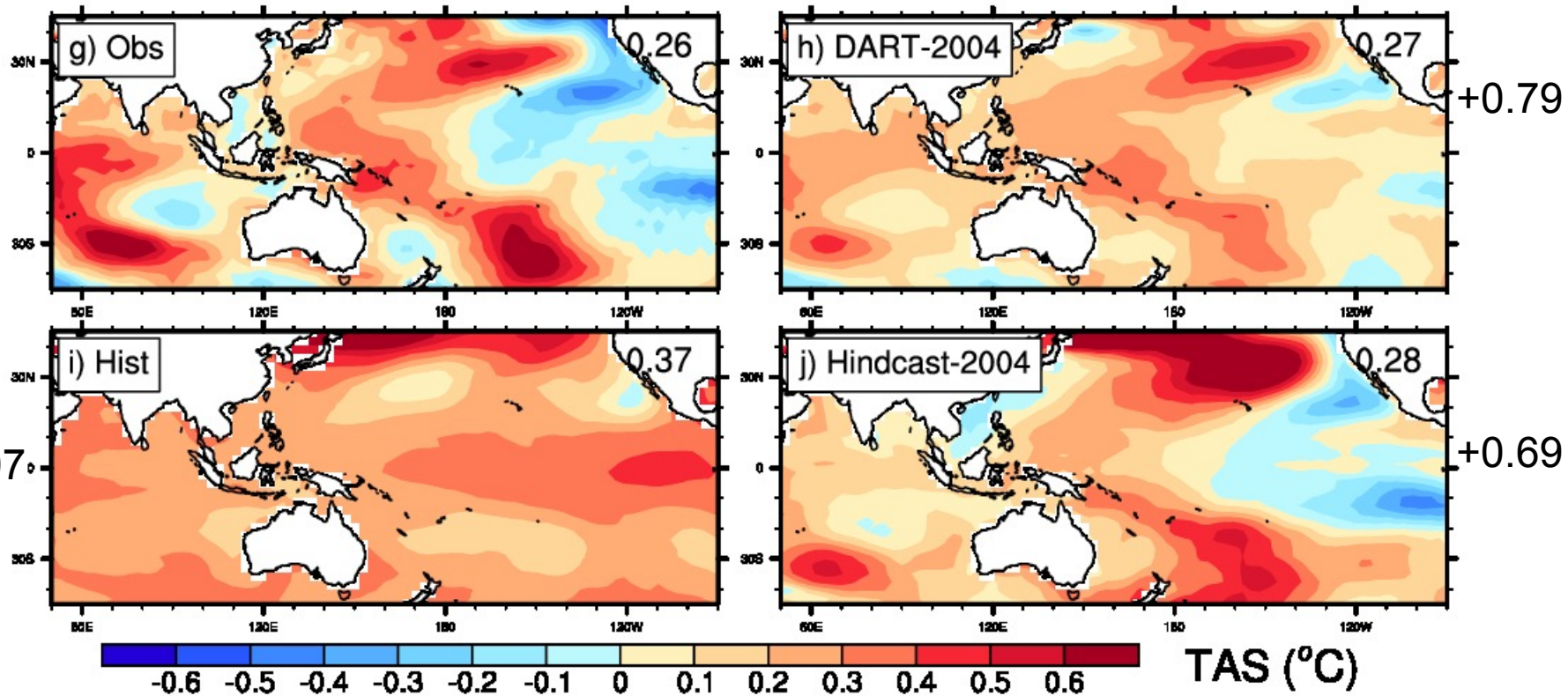
+0.79

+0.45

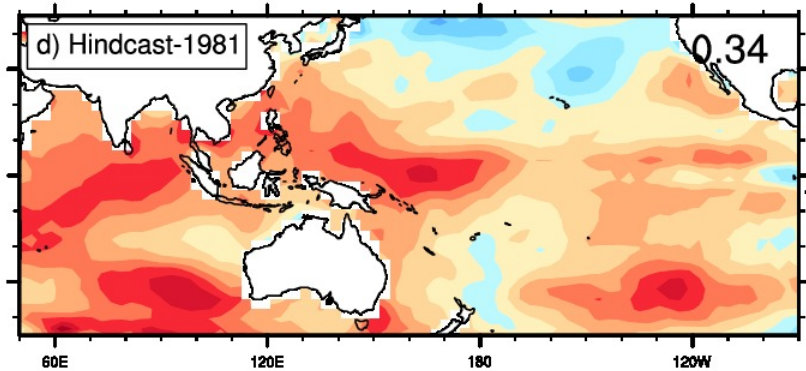
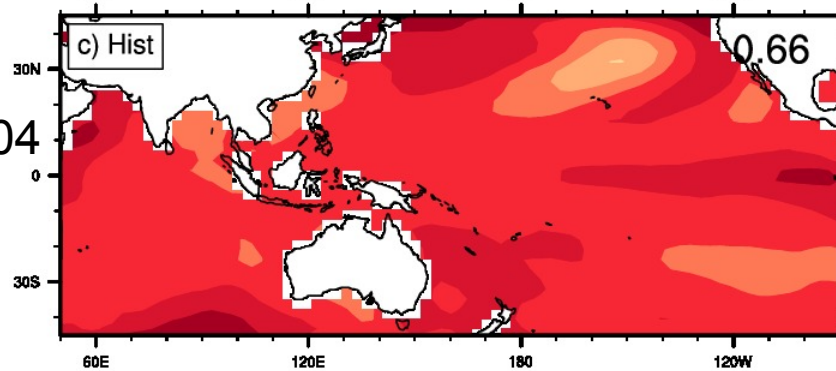
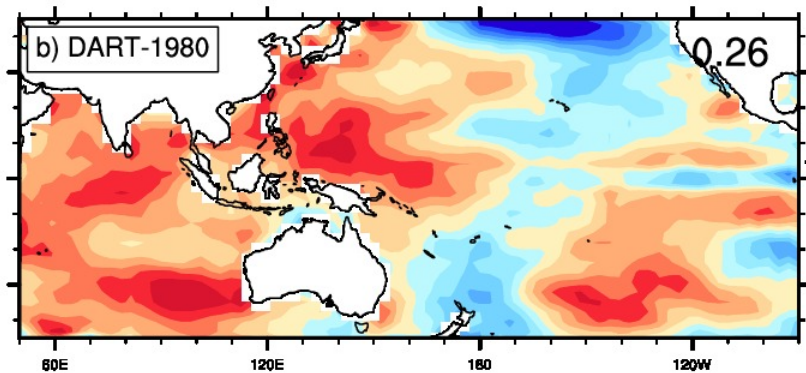
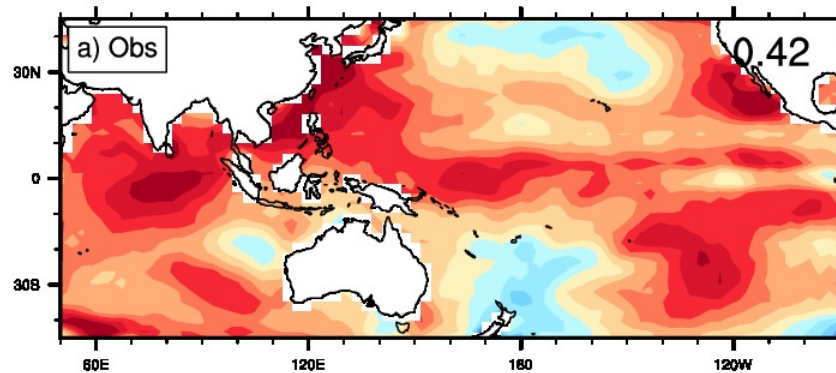
+0.17

Early 2000s hiatus

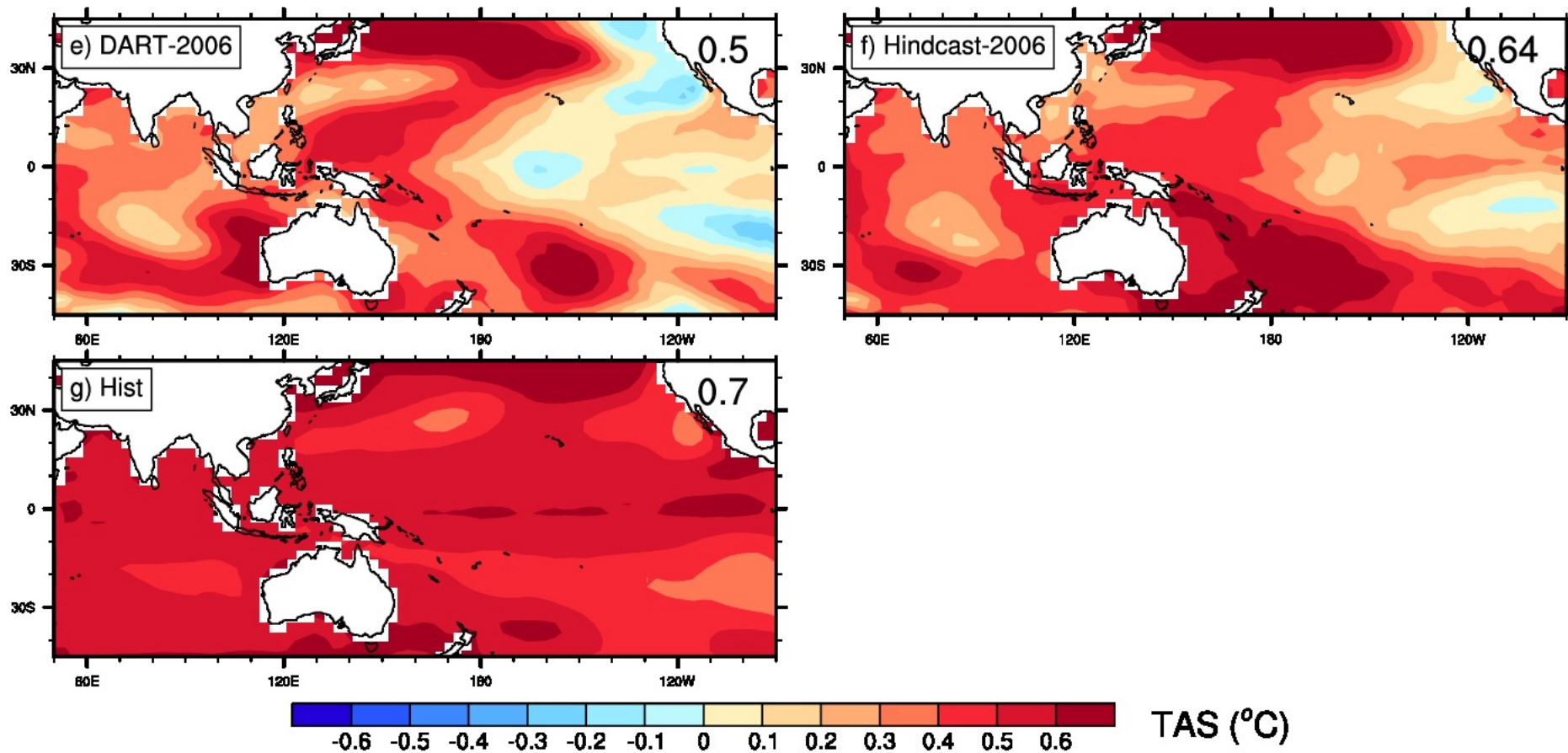
2006-2010 minus 1989-2003



30 year hindcast:1990-2009 minus 1960-1979



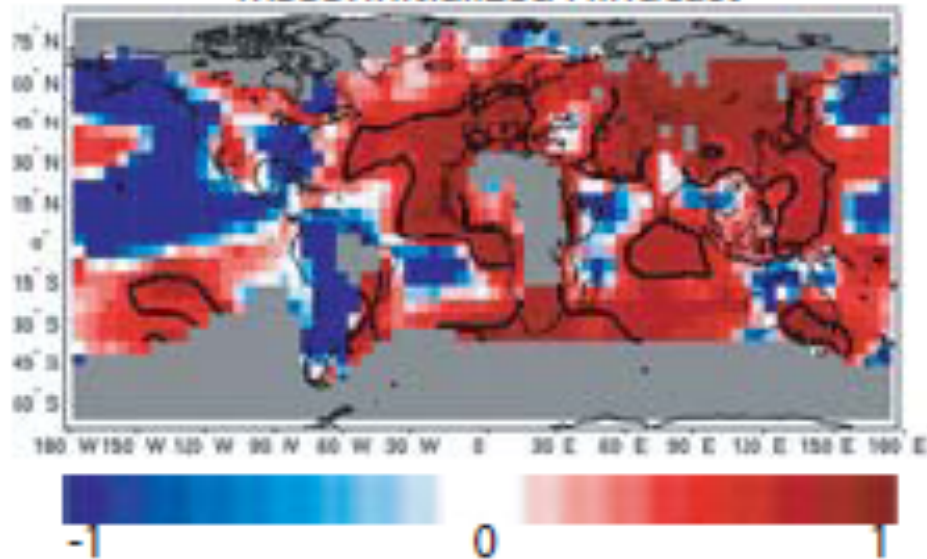
30 year prediction:2016-2035 minus 1986-2005



An example of a multi-model ensemble showing some regions that on average have more predictive skill than others (years 2-9 of initialized hindcasts) (Goddard et al., 2012)

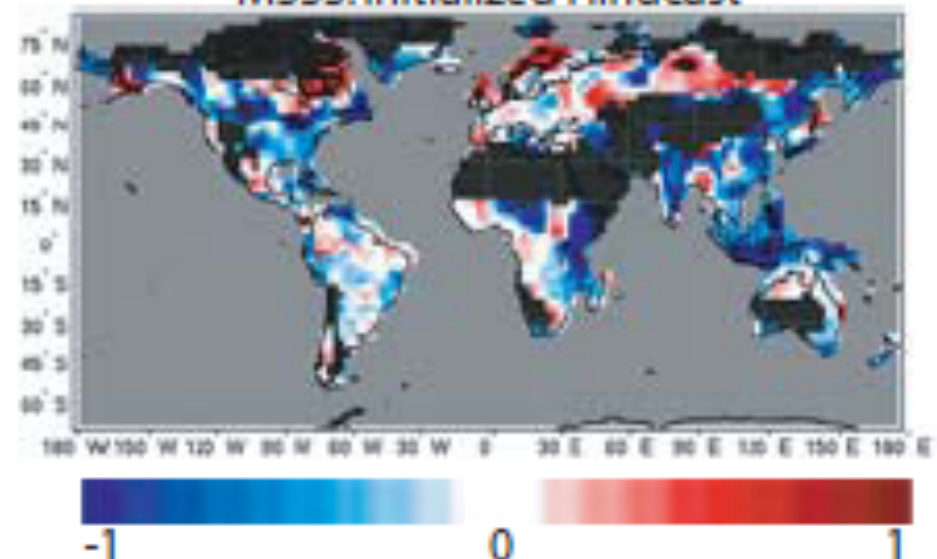
Temperature

MSSS: Initialized Hindcast



precipitation

MSSS: Initialized Hindcast



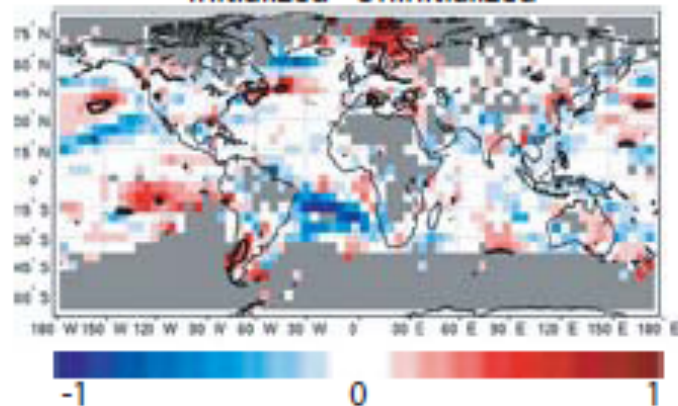
Summary

Decadal climate prediction is a new field for climate science, and the first generation set of multi-model hindcasts and predictions have just been run for CMIP5 and are being assessed for the IPCC AR5

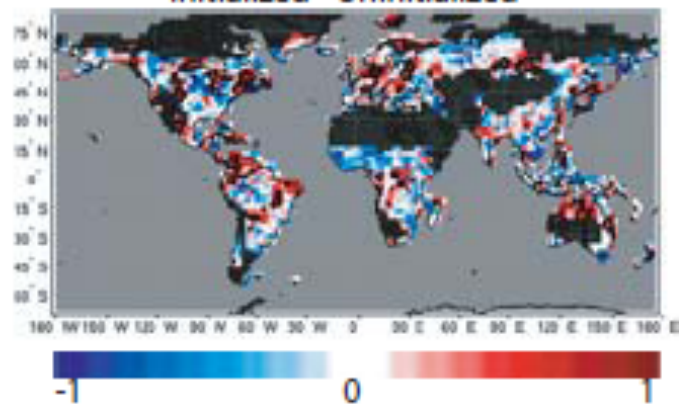
Initialization with observations produces some improvements over the traditional free-running 20th century simulations compared to observations

Initialized predictions for early 21st century show somewhat different results to the free-running projections

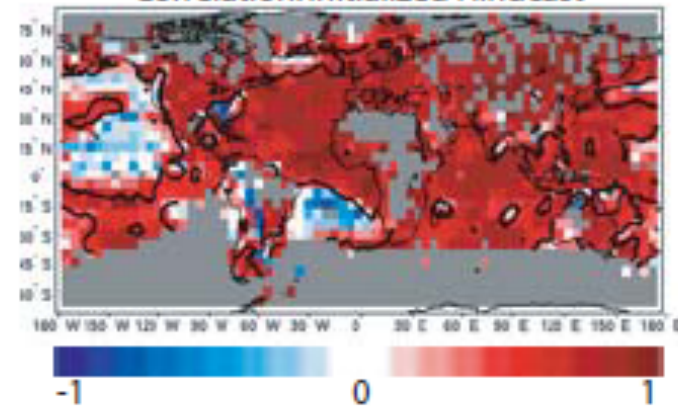
Initialized - Uninitialized



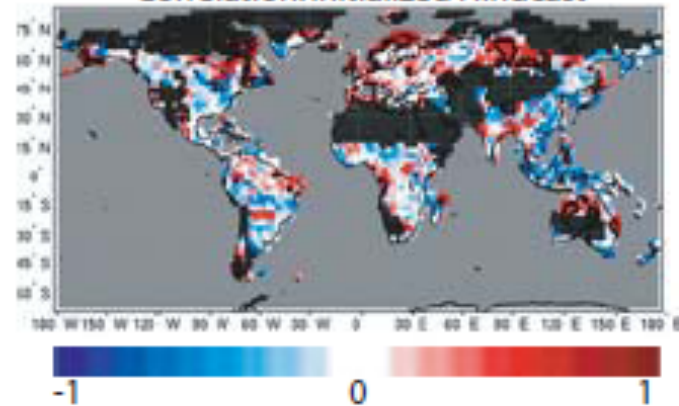
Initialized - Uninitialized



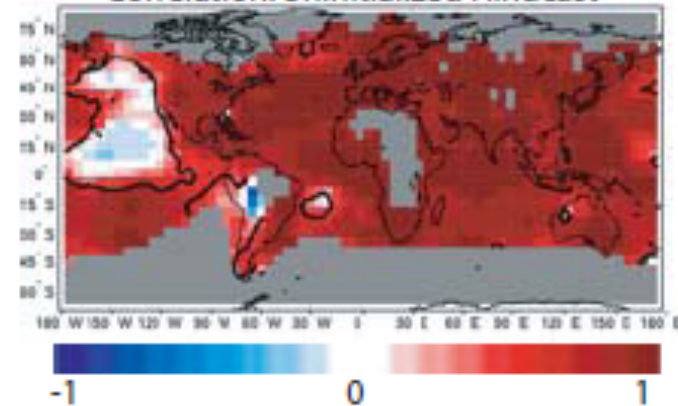
Correlation: Initialized Hindcast



Correlation: Initialized Hindcast



Correlation: Uninitialized Hindcast



Correlation: Uninitialized Hindcast

