

Statistical description and prediction(?) of decadal variability

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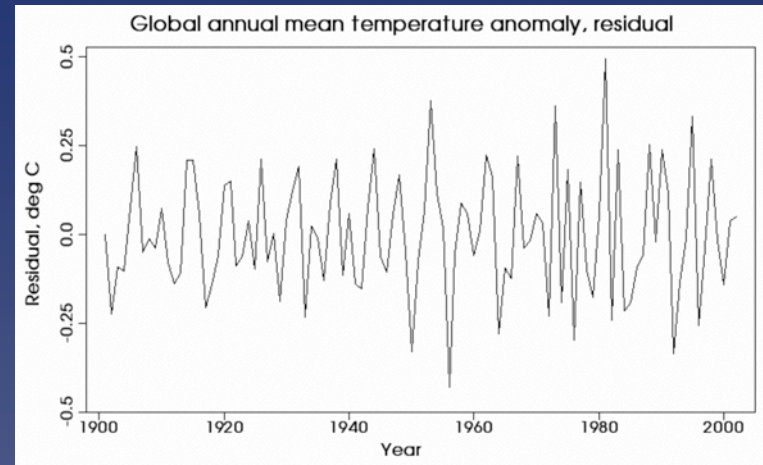
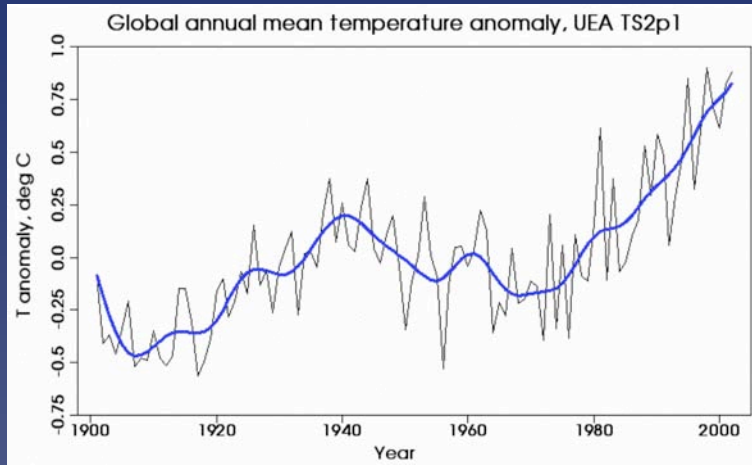
Aspen Global Change Institute, June 2008

Outline

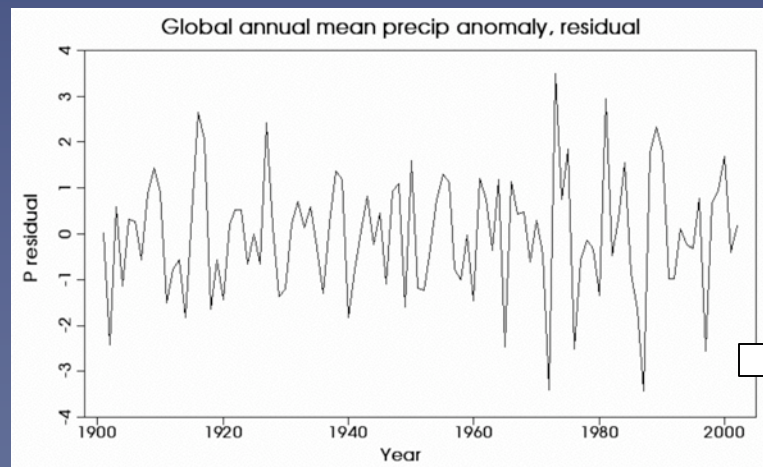
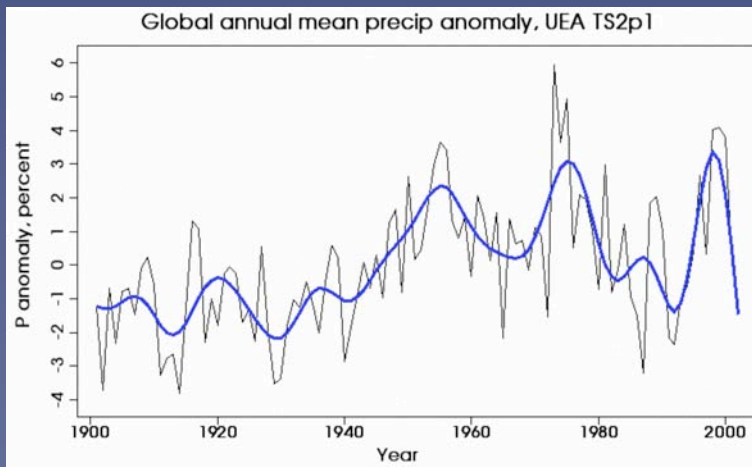
- Filtering and the variability of higher-frequency signal components
- Modes, dimension reduction, independence
- Attribution: Significance for prediction
- Periodicity, predictability, persistence
- Applications

One decade = 10 yr

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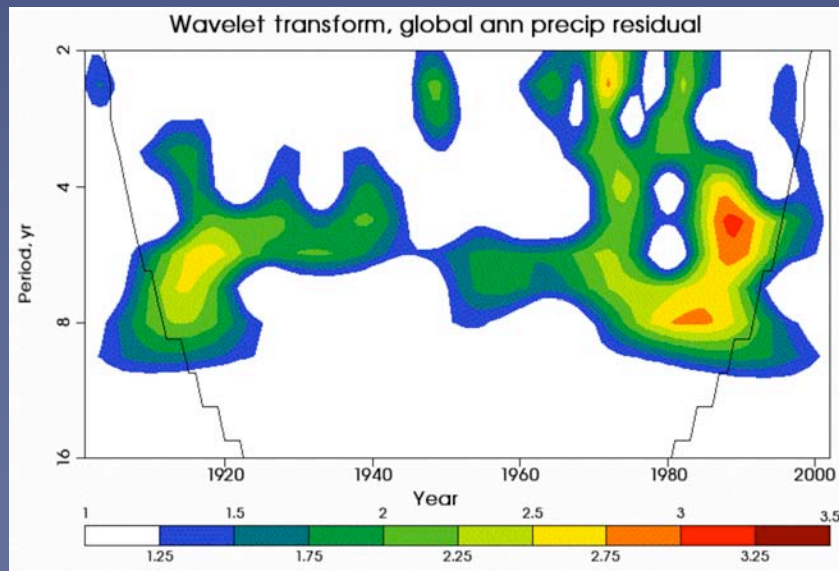
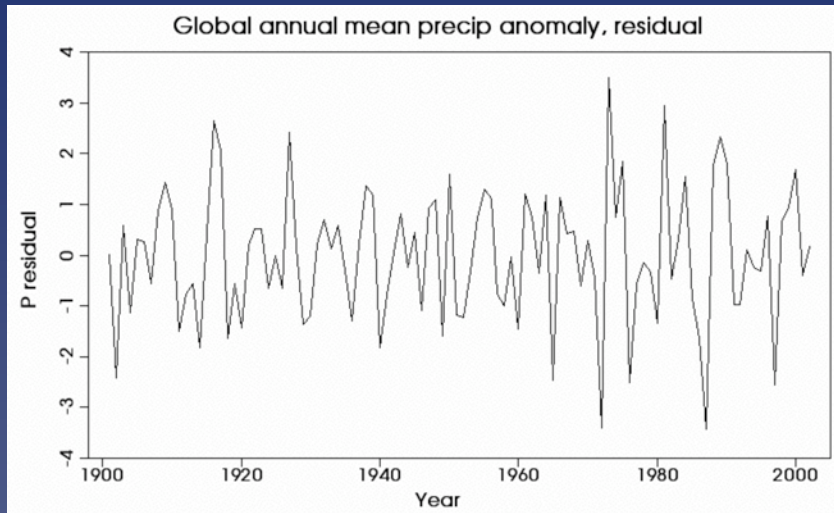
Annual means and lowpassed

residuals



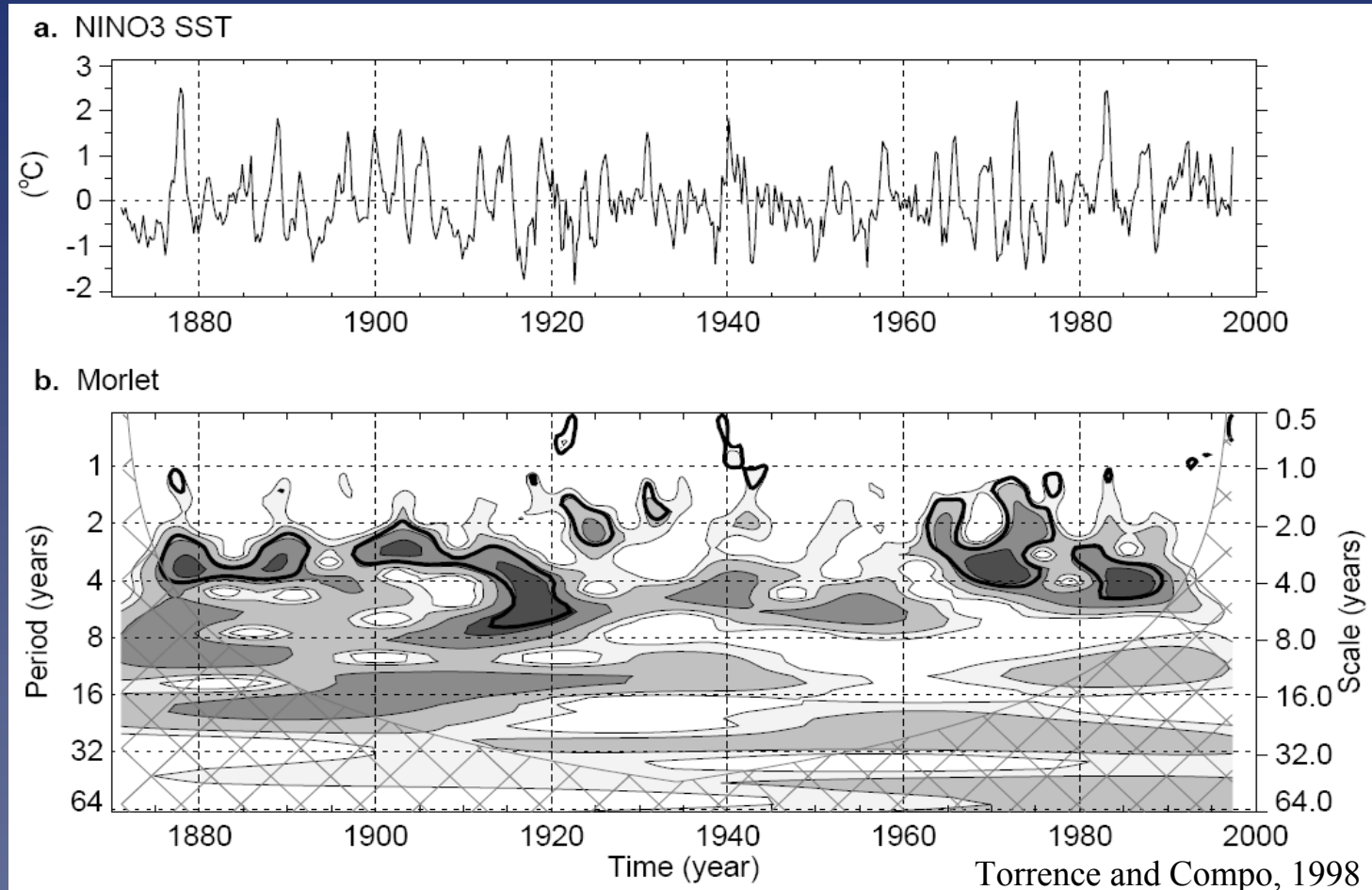
Nominally, the decadal signal can be recovered by filtering... but this view excludes potentially interesting variations in higher-frequency components

Decadal fluctuations in subdecadal signals



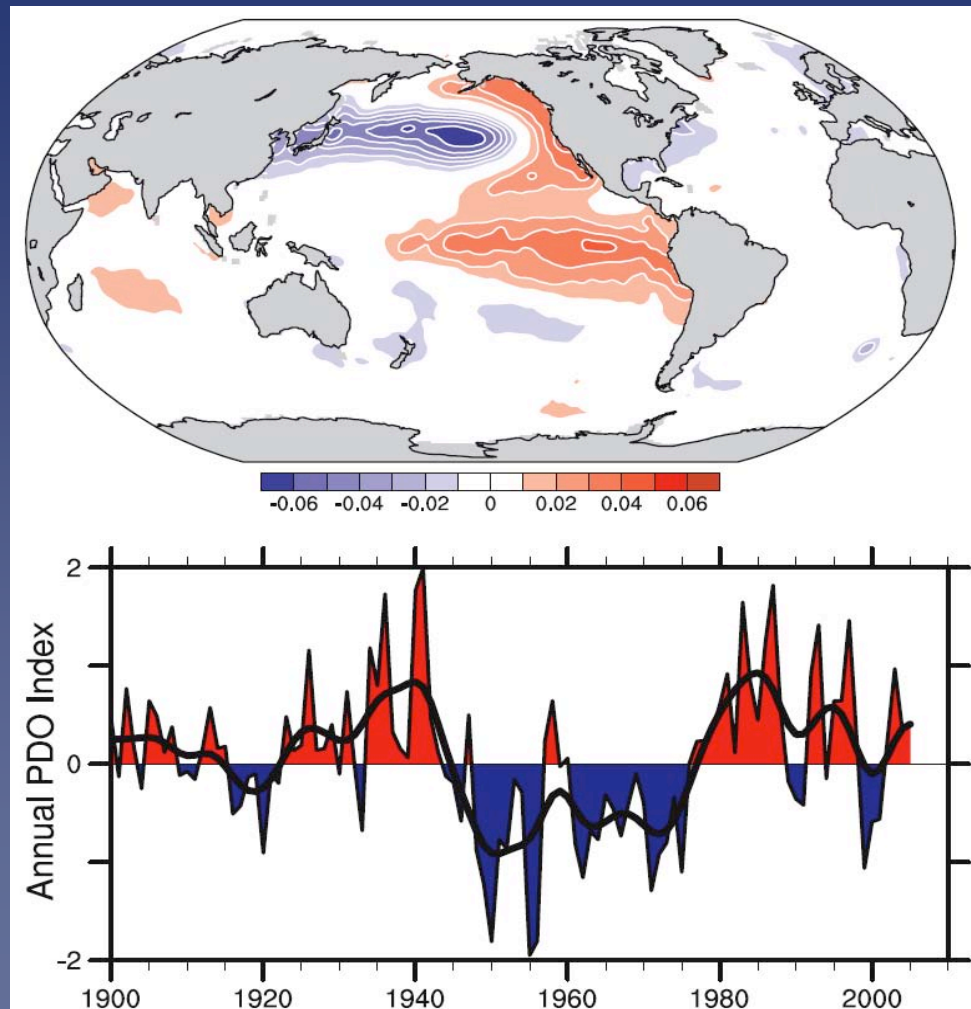
- Suppressed by filtering
- Here, a step increase in variance occurs in 1970s
- Evident also in variance of NH glacier mass balance
- Relevant for projections: decadal shifts in ENSO

Decadal changes in ENSO variance



- Attenuated in mid-century
- Decadal variability of higher moments (i.e., distribution shape parameters) may also have relevance for applications

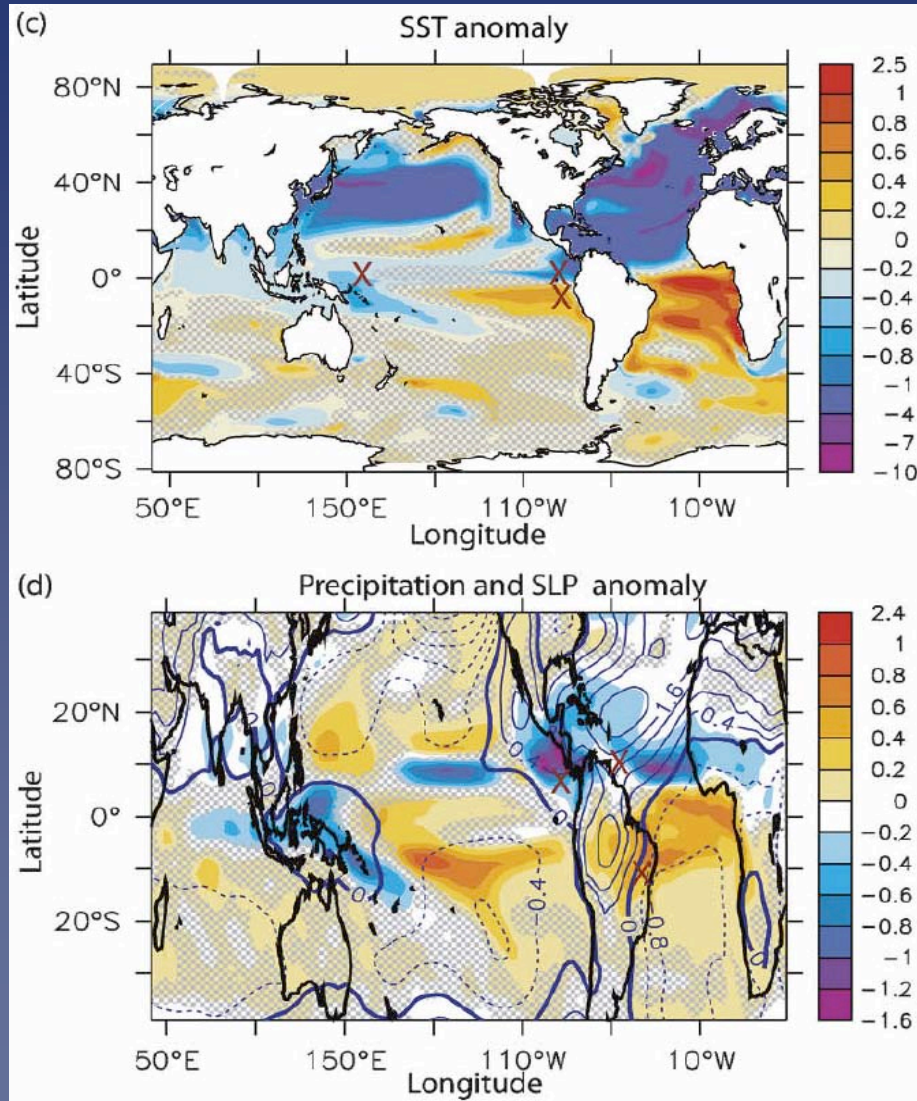
Decadal *modes*



IPCC AR4

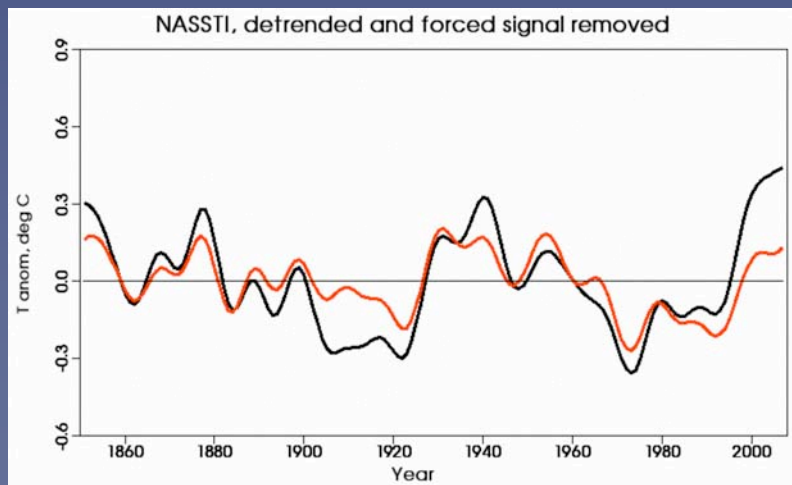
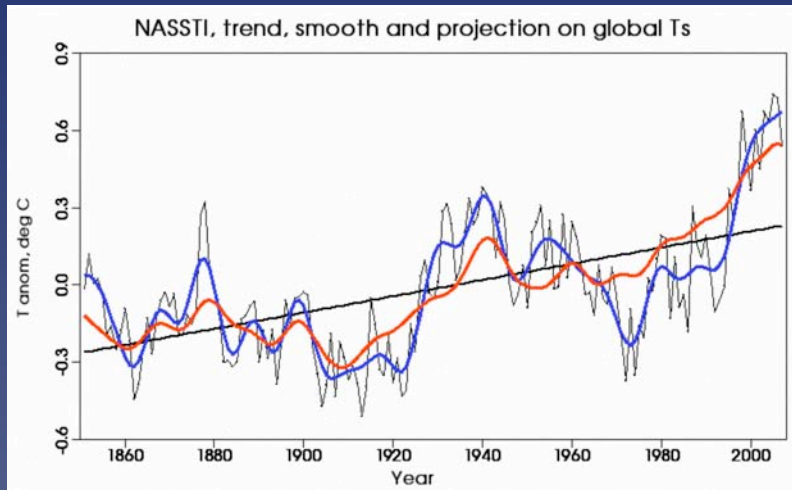
- Time series distill the evolution of complex, three-dimensional processes
- Corollary: Degrees of freedom are lost:
 - Several EOFs may capture most of the variance, but...
 - Detailed structure is lost
- Interannually, there are many excursions to the opposing phase (variability on short time scales is superimposed); may have significance for projections

Modes may not be independent...



- “... the NAO, TAV and MOC are intimately connected on a wide range of time scales and should therefore be considered together.” (Marshall et al., 2001)
- “... a substantially weakened THC leads to significant and persistent remote responses outside the Atlantic (figure). (Zhang and Delworth, 2005)

Separation of forced, natural variability



- Forced component of AMO can be estimated as (a) linear trend or (b) globally averaged T_s^* , with differing implications:

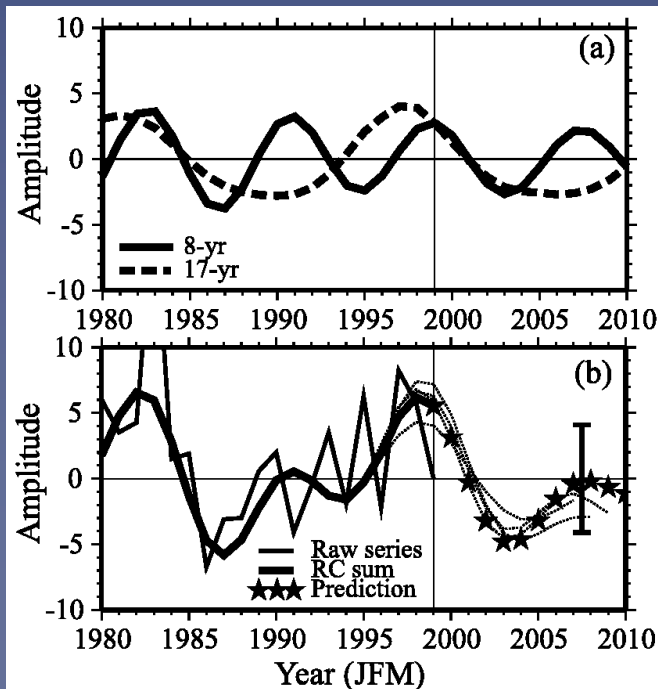
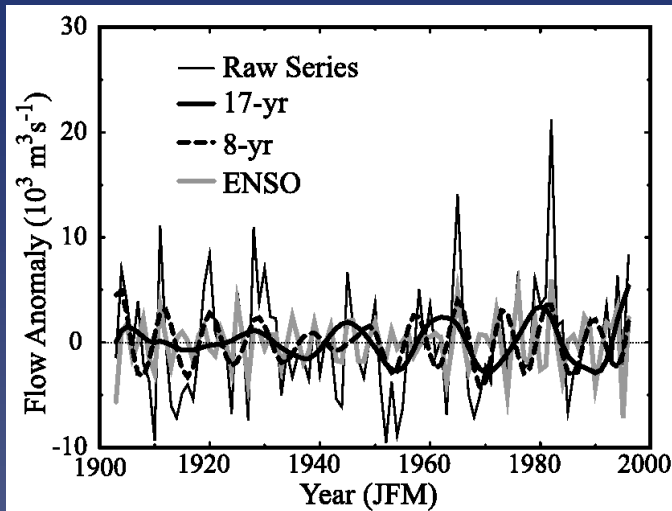
- If internal component is at historically high levels, a decrease seems most likely
- If “near-neutral,” increase or decrease may be equally likely

- This constitutes a low-order strategy for statistical prediction, of the unforced component

- Important for verification of decadal forecasts

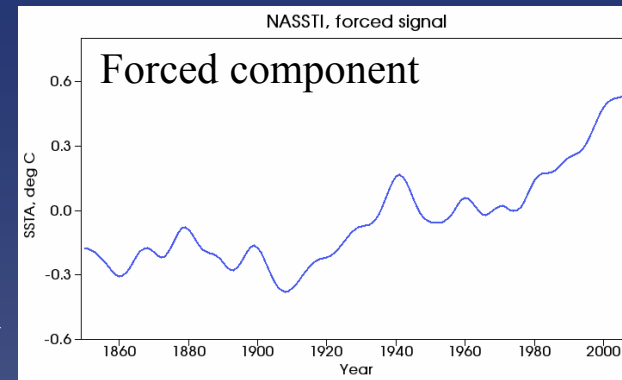
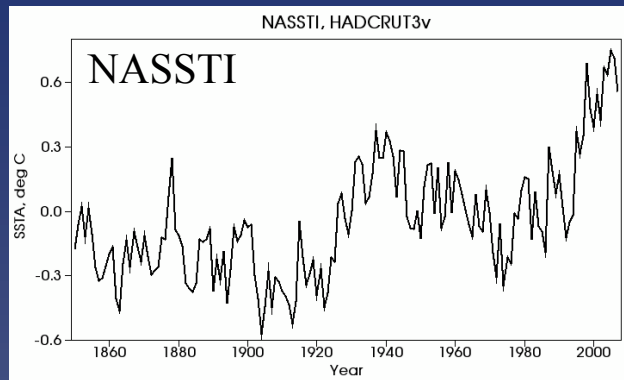
*Trenberth and Shea, 2005

Periodic = predictable? A possible model

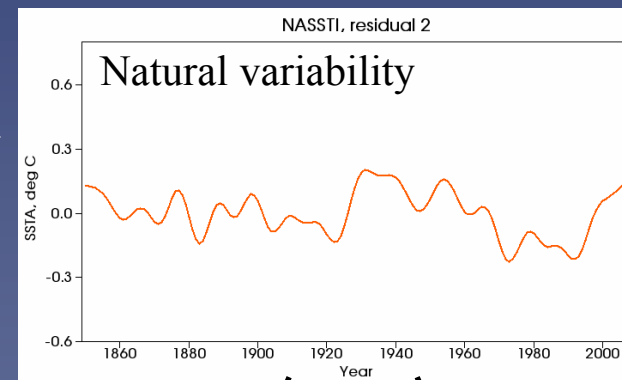
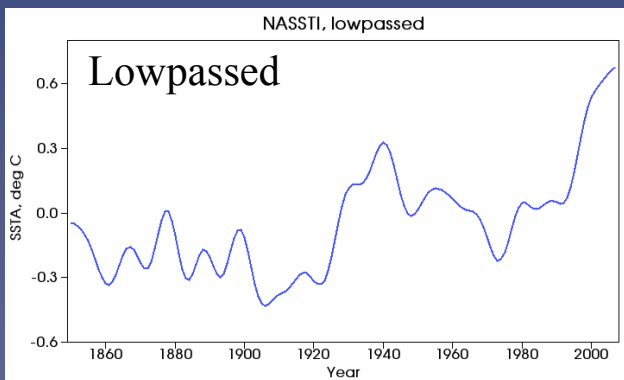


- Periodic components of Paraná river streamflow are identified using SSA, then projected forward in time (plot (b), stars)
- ENSO treated as interannual uncertainty (i.e., noise)
- No trend found (JFM)
- Inferred mechanisms: NAO, SACZ/LLJ
- As a case study, could be uncharacteristically cooperative
- Persistence of periodicity? Some reassurance offered via attribution

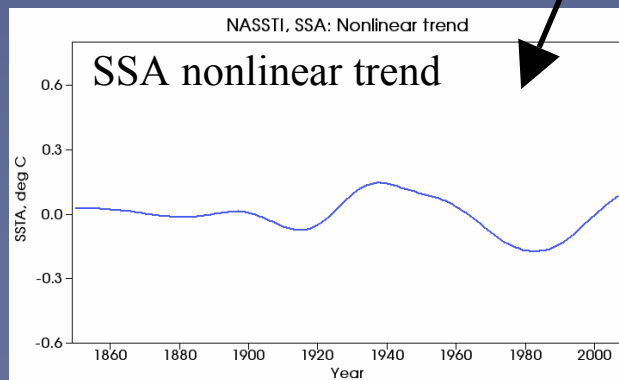
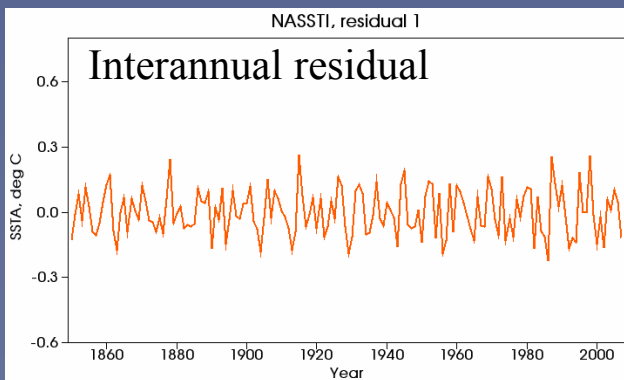
AMV disassembly



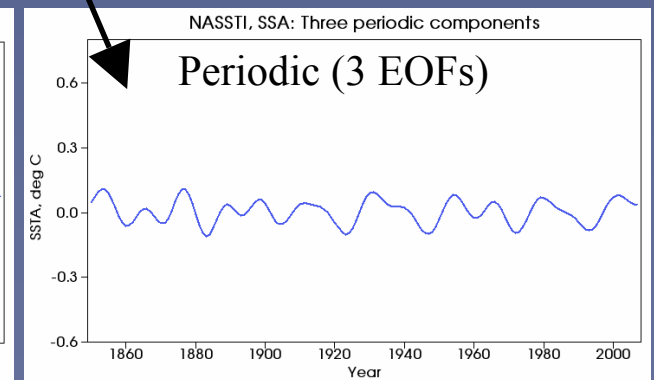
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Intersection with user needs

- For water management, aggregated streamflows are required; 20-yr outlooks would be helpful
- More generally, applications often require information for which current AOGCMs may not be optimized: (Monsoon) onset dates, dry-spell lengths, temperature or precipitation extremes...
- Not clear how decadal variation of such parameters is related to forced response
- Statistical techniques may aid in bridging the gaps between applications and model simulations

Summary

- Decadal fluctuations in higher-frequency components may be significant, in particular for applications
- Indices simplify analysis, but at the cost of spatial information
- Mutual dependence of large-scale modes
- Separation of forced, natural variability useful, if not essential, for prediction, verification
- Periodic components also helpful for prediction, but:
- Confidence in persistence of periodic behavior is increased by demonstration of plausible physical mechanisms
- Applications often require higher-order statistics; not clear how decadal variability here is related to CC

Thank you!