An Intercomparison of Interdecadal Variability and Climate Shifts in Reanalysis Datasets and Climate Model Simulations

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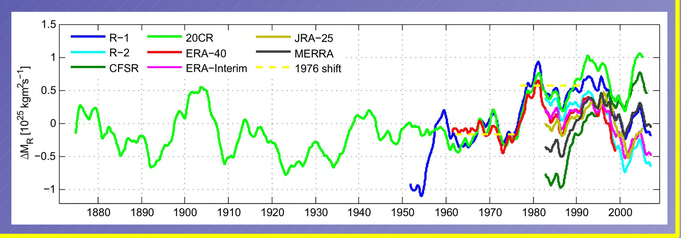
1. Summary

Using atmospheric angular momentum (AAM) as a climate index, the decadal-to-interdecadal variability and the 1976 climate shift event are compared among eight reanalysis datasets.
It is found that the decadal-to-interdecadal variability, extracted by band-pass filtering, is very similar among all of those datasets for the 2nd half of the 20th century. The timing and magnitude of the 1976 shift are also consistent across all datasets. The more noticeable discrepancies are in the long-term mean and the long-term trend. After removing these slowest components, the time series of the band-pass-filtered AAM in 20CR is almost indistinguishable from those in other datasets. After establishing our confidence in the reanalyses, they are used as observation to cross-validate the decadal-to-interdecadal variability in centennial climate model simulations in CMIP5.

2. Interdecadal Climate Shift

Figure 1 shows the 5-year low-pass filtered time series of global relative atmospheric angular momentum (AAM) calculated from the 3-D zonal wind of different reanalysis datasets. All of them exhibit the 1976/77 shift (to a warmer Tropics) and an overall upward trend for the 20th century.

Fig. 1



3. Detection of the climate shift events in CMIP5 simulations using criteria based on the amplitude and tendency of AAM

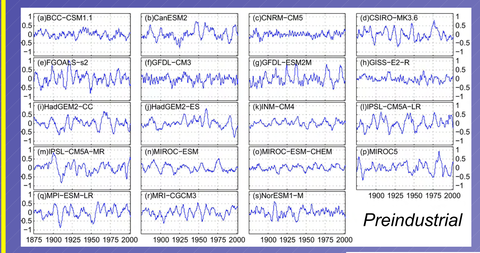
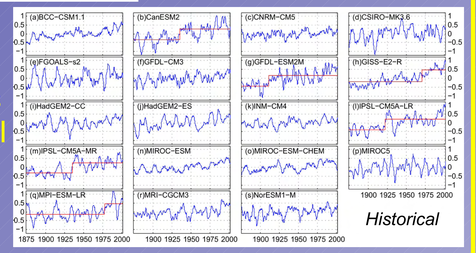
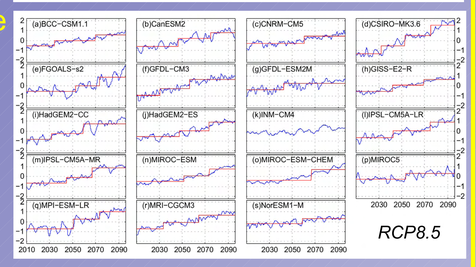


Fig. 2
Same as Fig.1 but for CMIP5 simulations.

CMIP5 runs exhibit a wide range of behaviors in the simulated decadal and interdecadal variability.

A sharp shift of AAM like the 1976 event is not found in PICNTRL, but they emerge in the Historical runs and become more common in the RCP8.5 runs.





4. Tropical SST pattern in CMIP5 simulations associated with the shift events

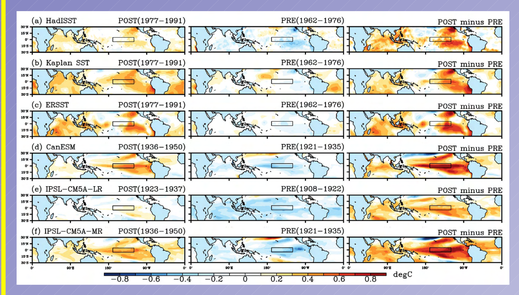


Fig. 3
Tropical SST associated with the shift events from observation and simulations.
The black box is the Nino3.4 region.

5. Comparison of the decadal-to-interdecadal variability in reanalysis and CMIP5 simulations.

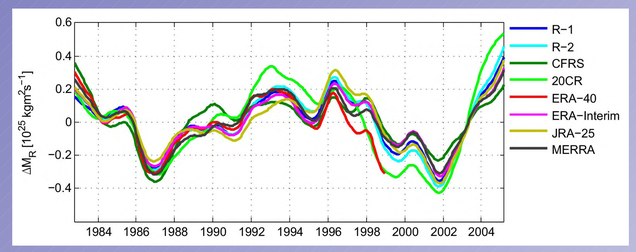


Fig. 4 Detrended time series of AAM for the post-1979 period (long-term mean and trend removed). A good agreement is found in the decadal-to-interdecal variability among different reanalysis datasets.

It is found that 15 out of 19 models simulated a decadal (7-12yr band) variance that is indistinguishable from observation at 95% significance level. The majority of the models underestimate the interdecadal (15-30 yr) variance but most of the differences between 20CR and CMIP5 are not at 95% significance level.

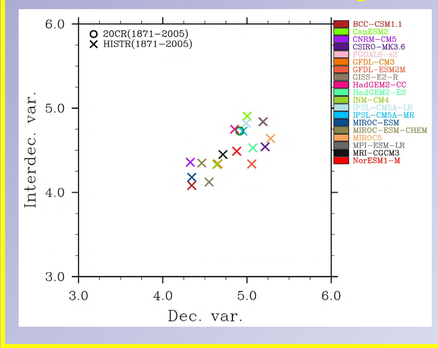


Fig. 5 Decadal and interdecadal variance of AAM in 20CR and CMIP5.

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