Influence of decadal variability on extremes

and

how the detection/attribution crowd might analyze the decadal predictions
The North Pacific Index

SLP over North Pacific, similar to neg PDO (Deser)

NPI index

Composite indices for extremes for positive and negative phases (test for significance)

Kenyon+Hegerl, J Climate
NPI influences the number of warm (TN90) and cold nights (TN10) in boreal cold season.

Correlation up to 0.8 W US for cold extremes.
This is more interesting than just a shift

data: daily Greensboro NC

Days in NPI+ winters

Days in NPI- winters
NPI also influences precipitation

- Precipitation during 5 wettest days of winter. (1 wettest similar)
- Nonlinear, correlation highest in SE $\sim 0.6$
Daily max and mins are similar
How could proposed runs be analyzed

1. Tools from seasonal/interannual
2. Detect hindcasted space-time patterns in observations
3. Check if model simulates right pattern and magnitude of change in response to forcing (ie if difference is consistent with nonresolved variability)
4. Separate response to initial conditions from response to forcing
Example

1. compare ranges
2. test if agreement could be spurious (detection)
3. Estimate what magnitude of model space-time pattern present in observations
4. (with errorbars, >0? Consistent with 1?)

Fig 9.5/TS-23
What do we need?

- observation
- \( F_1 = F_{\text{forc}} + F_{\text{ic}} \) fingerprint (space-time pattern eg. trend pattern, ensemble average) for hindcasted response (all forcings + ICs)
- \( F_2 = F_{\text{forc}} \) Fingerprint for forcing only
- realizations of climate noise – from inter-ensemble variability, (noise will be smallest early on for \( F_1 \) and short leads, and increase towards full climate internal as in \( F_2 \))

Simple analysis: correlate observations with \( F_{\text{forc}} + F_{\text{ic}} \), significant? Pattern right?
Attribution

- observation
- F1 = \( F_{forc} + F_{ic} \) fingerprint
- F2 = \( F_{forc} \) Fingerprint for forcing only response

Compose \( \text{Obs} = a \ F_{forc} + b \ F_{ic} + \text{res} \) (best linear unbiased)

- Errorbars for a and b, for long leads b may encompass zero (ie no longer be significant) depending on variable (also possible for a!)
- This helps your forecast (particularly if b not 1!!) and can produce uncertainty estimates

Done so far to distinguish between different forcings: shows that even enhanced solar very unlikely explains more warming than CO2
Example where $a > 1$: zonal precipitation change over 20$\text{th}$ century; NH SLP change

- Multi-model ensemble: signal more robust
- Possibly more detectable
- Possibly (?) more skill

- Other analysis: Find pattern in forced run average that differs from inter-ensemble noise (signal to noise EOFs)
Noise estimates

- AR4 and studies assessed: Model internal variability does generally modes (NAM, PDO etcetc)
- for SAT has right structures, amplitude consistent with observations
- Precipitation variability underestimated (or observations too noisy!)
- Inter-IC run variability would have different structure and provide a bit of a challenge
Research questions

- How does the IC signal persist (i.e., is it separable from forcing)?
- Do IC runs tell us more about extremes than forced runs and on what timescale (temperature/drought)?

Remaining question: what timeslice to compare between decadal predictions?