SST Green’s functions for regional precipitation

Andrew Williams
University of Oxford
Intro

• SST Green’s function are most often considered in the context of TOA flux changes and the time-evolution of the radiative feedback parameter

• However, we know that SST patterns are important for regional climate and precipitation!

• This work is an initial attempt to gauge the “skill” of a Green’s function approach in reproducing historical changes in regional precipitation
Method: a climateprediction.net ensemble

- Data from Baker et al., 2019

- HadGEM atmosphere-only model run 5000 times using distributed computing.

- Each of the 5000 ensemble members is forced with climatological SSTs plus a "random SST perturbation field"
  - like this ---------------------->>>

- These ensemble members can be used to construct a Green’s function analogously to that done using ‘SST patches’

Baker et al., 2019; Li and Forest, 2014
Method

• Essentially, a linear-regression at each gridpoint between the SST anomalies and the change in the ‘target variable’

• For example, target variable could be ‘average precipitation over the Mediterranean’
The plots are pretty, but do the reconstructions have skill???

- Approach: Generate an SST Green’s function for the precipitation in each 5x5deg grid-box!
  - E.g., this box over Central Africa

- Then, reconstruct the historical precipitation in that region by multiplying by the HadISST SST data

- Does the reconstructed precip match the reanalysis precip?
Correlation between HadISST precip reconstructions and ERA-20C

- There's a lot in these plots, but the idea is quite simple

- The color shows the correlation between the reconstructed precip and "true" precip (from ERA-20C) at each 5x5deg gridbox

- Crosses are plotted where the correlation is insignificant
Correlation between HadISST precip reconstructions and ERA-20C

- For some regions, it actually does very well!
  - E.g.
  - North America during DJF
  - South America during JJA
  - But there’s a negative correlation with Sahel precip?
Where is the skill coming from?

• To isolate where the skill is coming from, we can try reconstructing the precip at each gridbox using the sensitivities from each basin.

• Here is this skill coming from the Pacific basin.

• (Practically, I’ve just zeroed out the Green’s function everywhere outside of the Pacific)
Where is the skill coming from?

- The Atlantic basin mostly gives skill locally, particularly during JJA.
Where is the skill coming from?

- The Indian Ocean actually drives a lot of ‘spurious’ skill (i.e., predicts anomalously wet years, when in reality it was anomalously dry)
Conclusions

• It seems like this approach has a reasonable skill, particularly in the tropics and when focusing on individual seasons.

• More work is needed to establish whether the mechanisms driving this skill are physically plausible, and whether the Green’s function approach also works well for climate change.

• Also, does this approach work well with the SST patch approach? Perhaps GFMIP can help out with this!

Any questions? Please do reach out! 😊

andrew.williams@physics.ox.ac.uk