The Land/Ocean Temperature Contrast in Natural Variability

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Introduction
The Land/Ocean Temperature Contrast exists for global warming and interannual variability. In general circulation model (GCM) sensitivity experiments forced with SSTs, perturbations from the ocean are amplified over continents leading to land/ocean contrast values similar to observations [3]. This study investigates the land/ocean contrast in simplified one and two-dimensional models, and compares the results to GCMs.

Land/Ocean Contrast in observations and models

- Amplification of SST perturbations over land
  - Add 1K to global SSTs, continental surface temperature response is greater than 1K.
  - Initial perturbation is amplified leading to a land/ocean contrast similar to that seen in global warming.

- Continental amplification seen in natural variability
  - Leading to a Land/Ocean Temperature Contrast.
  - Land/Ocean temperature contrast investigated with single column and two-dimensional models.

- Regressions coefficient to quantify the land/ocean Constrast
  \[ R_{l/o} = \rho_{land}\sigma_{land} + \rho_{ocean}\sigma_{ocean} \]

- Typical values for observations and models: 1.2 – 1.5.

Two-Dimensional Model
- Model details
  - Radiative-Convective Model (RCM) in two-dimensions [1].
  - Each atmospheric column with either specified SST or responsive land surface.
  - The domain is oriented east-west, column size 500km-3000km.

- Experiment Setup
  - SST varied around mean for each latitude, model run to equilibrium.
  - Sensitivity experiments on Evaporative Fraction.

- Tropospheric profiles
  - Tropospheric temperatures of land/ocean columns regressed onto ocean surface temperature.
  - 1K perturbation in SST leads to 2K increase in upper troposphere and 1.2K increase over land.
  - Amplification of land surface temperature occurring below LCL.
  - 2D model similar to GCM results below 500hPa.

- Evaporative Fraction/Latitudinal dependence
  \[ R_{l/o} \text{ values with increasing evaporative fraction and latitude.} \]

Comparison of RCM with GCM

- Comparison of land amplification of SST forcing in GCM to 2D model.
  - Values of evaporative fraction and latitude from GCM used to create map with corresponding \( R_{l/o} \) values from 2D model.
  - Amplification only present in 2D model in very dry areas, GCM also shows amplification
  - Comparison of RCM with GCM

Conclusions

- Amplification of SST variability exists in RCM. Value of \( R_{l/o} \) 1.1 to 1.6.
- Land/Ocean contrast due to larger change lapse rate over land with increasing/decreasing SST.
- Difference in land/sea lapse rate due to moisture availability.
- Regional \( R_{l/o} \) values of RCM do not correspond well to GCM.

References