**Extratropical Hurricane Mixing and the Equatorial Cold Tongue**

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**Funded by DoE (DE-FG02-06ER64238, DE-FG02-08ER64590), NSF (OCE-0550439) & Packard Foundation**

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**Introduction**

The impact of tropical cyclones (TC) on global climate is still debated. They rapidly mix the water column beneath them, bringing cold water to the surface. One way to parameterise this process in a climate model is to introduce an additional vertical diffusivity term, that can either be constant (Jansen & Ferrari, 2009) or dependent on the atmospheric state (Korty et al., 2008). Past greenhouse climates suggest weak meridional and zonal temperature gradients in the Tropics (Brierley et al., 2009), and therefore altered tropical cyclone distributions (Fedorov, 2010). Could this have had climate consequences?

**Method**

To determine the impact of a broad swath of TC mixing in the Pacific, we add increased ocean mixing to a coupled climate model (CCSM3). The background vertical diffusivity is increased tenfold to 1.1 cm$^2$/s (2). This additional mixing occurs in the top 200m and between 8$^\circ$-40$^\circ$N/S in all oceans (Fedorov et al., 2010).

**Warming of the Cold Tongue**

The additional TC mixing leads to a dramatic warming of the eastern equatorial Pacific (C) somewhat like a persistent El Niño-like state (Brierley et al., 2009).

**Hurricane - Climate Feedback**

The addition of hurricane mixing leading to a warming of the cold tongue implies a positive feedback between tropical cyclones and the ocean. If the strength of the positive feedback is sufficiently large, then it may explain the persistent El Niño-like state seen in the early Pliocene, by allowing multiple climate states to exist in the tropical Pacific. The proposed feedback between hurricanes and the ocean circulation involves three processes, as shown below.

**Robustness of Feedback**

The strength of the feedback depends on several uncertain parameters, such as the location of the tropical cyclones and the magnitude of their mixing and the crucially dependent on the tropical cyclone mixing.

**Conclusions**

- Tropical Cyclones are a source of vertical mixing in the ocean.
  - This mixing can warm the cold tongue in the Pacific.
  - We propose a feedback between tropical cyclones and the ocean that can sustain a warm tongue.
  - The amount and nature of these changes in heat transport are strongly dependent on the location of the mixing.

**References**

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