

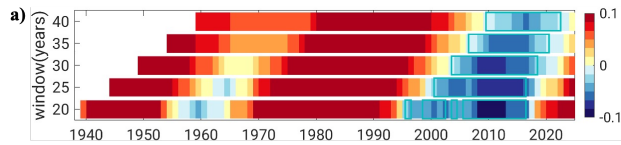
Exploring the Role of Southern Hemisphere Ozone Depletion in Southern Ocean and Tropical Cooling Trends in High-Resolution CESM Historical Simulations

Xue Liu, Ping Chang, Frederic S. Castruccio, Travis Prochko, Dan Fu, Gokhan Danabasoglu, et al.

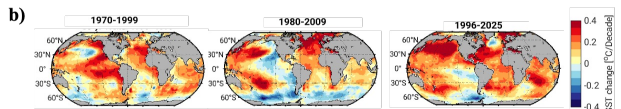


Observation

Observed area-mean Southern Ocean SST trends



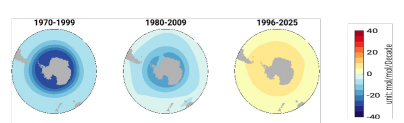
Observed 30-year SST trends



Ozone timeseries



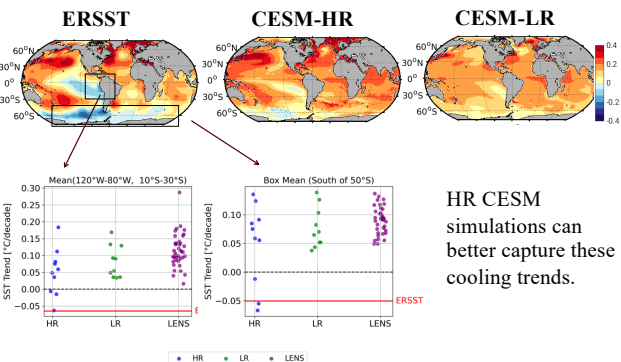
Ozone Trends



Scientific Question

What drives the unusual recent Southern Ocean cooling, and why does its emergence lag the period of strongest Antarctic ozone depletion?

HR CESM Better Captures Cooling



Experiment

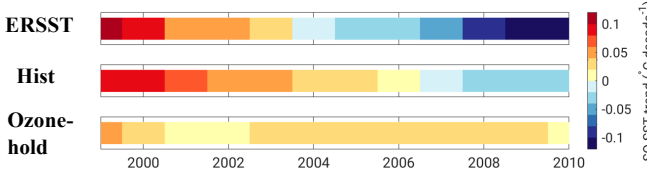
HR CESM Coupled Simulations

• **Historical + RCP8.5:** Fully forced historical simulations from 1920–2005, followed by RCP8.5 simulations from 2006–2100.

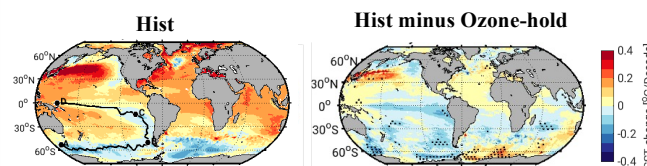
• **Ozone-hold:** Six-member ensemble in which stratospheric ozone is held fixed at 1970 levels south of 40°S, while all other external forcings evolve normally.

Ozone Shapes Cooling and Propagation

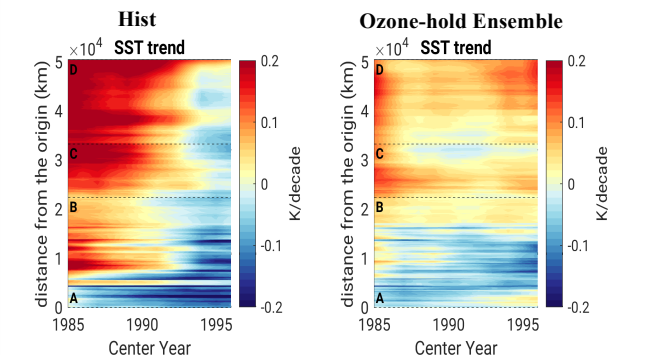
Observed cooling in SO is better reproduced with evolving ozone



Ozone-driven cooling extends beyond the SO

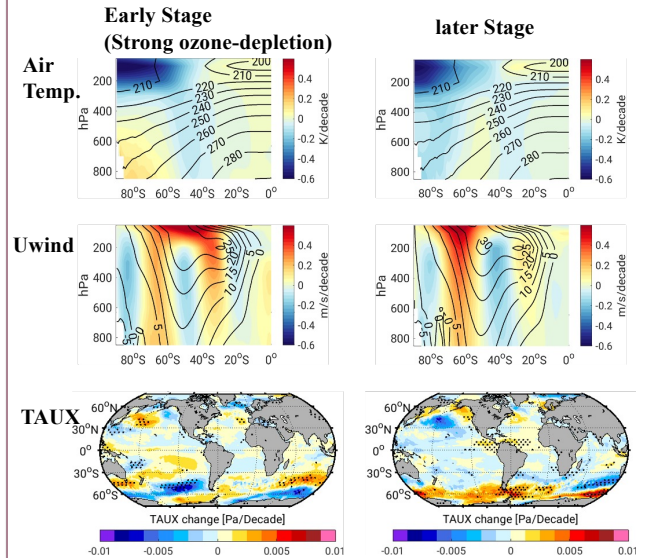


Equatorward propagation appears in Historical but is strongly weakened/lost in Ozone-hold



Evolution of Ozone-Driven Response

Hist minus Ozone-hold



The response evolves from an initial ozone-forced signal to a deeper, more vertically coherent circulation response.

Surface Heat Loss Sustains the Cooling

Surface heat loss strengthens markedly during the later stage, helping sustain the Southern Ocean cooling response.

