Recent Walker circulation changes seen from satellite measurements, CMIP and AMIP simulations: The role of static stability

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There is a persistent uncertainty in how the Pacific Walker circulation (PWC) will change in response to increased greenhouse gas warming. On average, climate models predict that the PWC will weaken. Observational evidence is mixed, some supporting the models while others do not. In this presentation, insight into the PWC trend is provided by examining the tropical dry static stability, a quantity which is inversely proportional to the strength of the PWC. For a 1979-2012 period, the static stability increased markedly in all Coupled-Model-Intercomparison-Project-Phase-5 (CMIP5) models, far more so than in the satellite and global reanalysis data which show a strengthening of the PWC. The stabilization is greater for a subset of models that simulate a significant weakening of the PWC.

With observed sea surface temperature as the lower boundary condition, atmospheric models that belong to the weakening-PWC-CMIP5 models produce a greater stabilization than those that belong to the strengthening-PWC-CMIP5 models. Compared with the latter group, the former group of atmospheric models simulates weaker trade winds over the western and central tropical Pacific and, consistent with the Bjerknes mechanism; the corresponding CMIP5 models produce a weaker west-east gradient in tropical SST. Given that the models' convective parameterizations over-stabilize the atmosphere compared with an explicit convection (Holloway et al. 2012), the findings here suggest that models' representation of tropical convection and stability contribute to the models' tendency to simulate weakening of the PWC and El-Niño-like SST.

Key words: Pacific Walker circulation, dry static stability, Bjerknes feedback, SST

References

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