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The IRIS feedback over the tropical oceans: implications for global climate sensitivity in an extended model

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Based on an analysis of geostationary satellite observations, Lindzen et al. (2001) have proposed that there exists a strong stabilizing (i.e., negative) cloud-area feedback (called the infrared IRIS feedback) on SST perturbations over the tropical oceans. Using a simple 3.5 box model of the global climate system, they show that this strong negative stability-altering feedback also necessarily acts as a strong negative sensitivity-altering feedback for global climate sensitivity to an external forcing (such as doubled CO2), and reduces the sensitivity to minimal values. In their model, the tropical and extratropical SST perturbations (T1 and T2) about equilibrium are forced to be equal. The effects of the IRIS feedback are here examined in an improved 3.5 box model in which T1 and T2 are allowed to vary independently, a simple parameterization of the dynamical heat transport between tropics and extratropics is included, and the parameters determining the clear-sky outgoing longwave radiation are set to be in better accord with observation. In the new model it is shown that: a) The stability criteria of the model are changed in such a way that the sensitivity to external forcing becomes much larger. b) The sensitivity-altering feedback provided by the combined IRIS and dynamical heat transport effects becomes highly nonlinear (the model feedbacks are no longer additive). c) The IRIS feedback, even if valid as a stabilizing feedback for the tropics, no longer necessarily diminishes global climate sensitivity, though for the best estimates of the model parameters it still does so. However, it no longer reduces the global climate sensitivity to the minimal values suggested by Lindzen et al.