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Understanding atmosphere feedbacks during ENSO: the role of a modified convection scheme

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The too diverse representation of ENSO in coupled GCM limits our ability to describe future change of its properties and the associated global impacts. Several studies pointed to the key role of atmosphere feedbacks in contributing to this diversity. These feedbacks are analyzed in two simulations of a coupled GCM that differ only by the parameterization of deep atmospheric convection and the associated clouds. Using the Kerry-Emanuel scheme in the IPSL-CM4 model (simulation KE), ENSO has about the right amplitude whereas it is almost suppressed when using the Tiedke scheme (TI). Quantifying both the dynamical Bjerknes feedback and the heat flux feedback in KE, TI and the corresponding AMIP atmosphere-only simulations, it is shown that the suppression of ENSO in TI is due to a doubling of the damping via the heat flux feedback. As the Bjerknes positive feedback is weak in both simulations, the KE simulation exhibits the right ENSO amplitude due to an error compensation between a too weak heat flux feedback and a too weak Bjerknes feedback. Similar analysis is applied to the CMIP3 models which exhibit a large diversity of simulated heat flux feedbacks, mostly due to the cloud induced shortwave component. It is argued that a systematic and detailed evaluation of atmosphere feedbacks during ENSO is a necessary step to fully understand its simulation and its predictability in coupled GCMs.