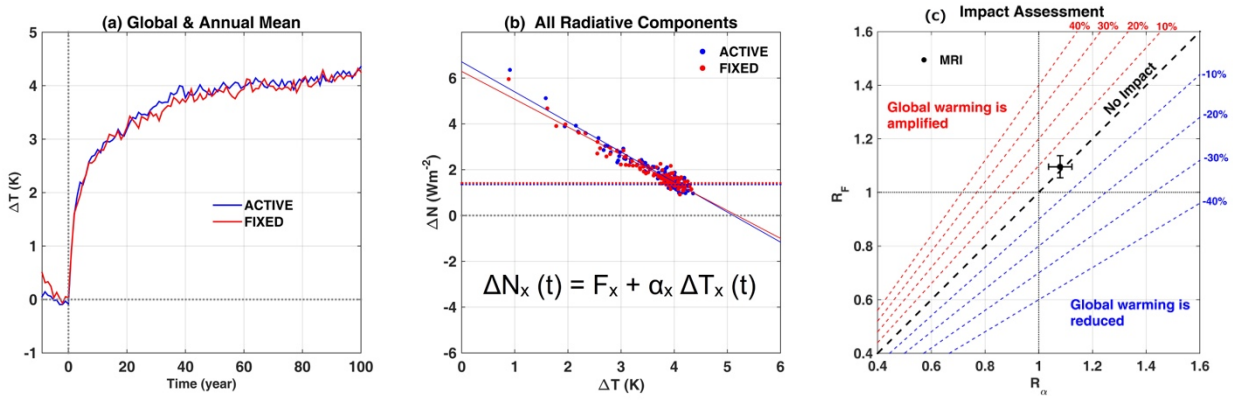
Jain, S., R. Chhin, R. M. Doherty, S. K. Mishra, and S. Yoden, 2021: A new graphical method to diagnose the impacts of model changes on climate sensitivity. *J. Meteor. Soc. Japan*, **99**, 437-448. https://doi.org/10.2151/jmsj.2021-021

**Plain Language Summary:** Equilibrium climate sensitivity (ECS) is defined as the change in global-mean surface air temperature (ΔT) due to the quadrupling of $CO_2$ in a climate model simulation (Fig.1a). In this paper, we propose a new graphical method, which is based on Gregory's linear regressions (Fig.1b), to visualize the impact of a model change on ECS, climate forcing ($\overline{R}_F$), and feedbacks ($R_\alpha$) in a single diagram (Fig.1c), and demonstrate its usefulness with an example of climate sensitivity simulations with interactive (ACTIVE) and prescribed (FIXED) chemistry model.




$$R_\alpha = \alpha_{ACTIVE} / \alpha_{FIXED} \; ; \quad \overline{R}_F = (\overline{\Delta N}_{ACTIVE} - F_{ACTIVE}) / (\overline{\Delta N}_{FIXED} - F_{FIXED})$$

Fig. 1 (a) Time series of the global-mean surface air temperature anomaly $\Delta T_x(t)$ in the abrupt $4\times CO_2$ experiments with ACTIVE or FIXED chemistry model. (b) Gregory's linear regressions between the net radiative flux at the top of the atmosphere $\Delta N_x(t)$ vs $\Delta T_x(t)$ for ACTIVE or FIXED chemistry model. (c) Graphical representation of the impact of ACTIVE model simulation compared to the FIXED model one on the ECS ($\overline{\Delta T}_{ACTIVE} - \overline{\Delta T}_{FIXED}$), climate forcing ($\overline{R}_F$), and climate feedbacks ($R_\alpha$) for Japan Meteorological Agency - Meteorological Research Institute (JMA-MRI) Earth System and coupled atmosphere-ocean models, as denoted by a black dot with standard errors. Here an overbar denotes a time average for the last 50 years.

- Using this visualization method, one can quantify (a) whether the model-change amplifies, or reduces the global warming, and evaluate (b) the percentage changes in ECS ($\overline{\Delta T}$), climate forcing ($\overline{R}_F$), and climate feedbacks ($R_\alpha$), and (c) ranges of the uncertainties in the estimated changes.
- This method can also be used to examine the spread in ECS, climate forcing, and climate feedbacks with respect to the multi-model mean (or one benchmark model) for multi-model frameworks like Coupled Model Intercomparison Project Phase 5/6 (CMIP5/6).