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Footprint of the dynamical amplifier of global warming from space

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The largest warmings over the last several decades were observed in high latitudes. Cai (2005) proposed that part of the large amplitude climate warmings in high latitudes could be explained by the so-called "dynamical amplifier" feedback. The dynamical amplifier feedback results from a net increase of poleward heat transport due to an increase of greenhouse gases. The dynamical amplifier theory for the rapid warmings in high latitudes predicts an upward trend of the net radiation surplus (deficit) at the TOA in low (high) latitudes forced by anthropogenic greenhouse gases. This paper provides observational and modeling evidences to validate the dynamical amplifier theory. We have analyzed the radiation budget at the top of the atmosphere (TOA) using the ERA40 and NCEP/NCAR reanalysis and climate model simulations forced by anthropogenic radiative forcings made at various centers. Our diagnostics using the two independent reanalyses indicate that both the radiation energy surplus in low latitudes and deficit in high latitudes at the TOA have been strengthened over the last several decades. Such an intensification of the radiation energy imbalance at the TOA is also confirmed by some of the climate model simulations we have examined. It is known that the net radiation budget at the TOA cannot be alternated by local thermodynamical feedbacks (including the ice-albedo feedback), but a change in the poleward heat transport by the atmosphere and oceans. Therefore, these results strongly suggest that the dynamical amplifier feedback indeed has taken place in nature and is captured by climate models, which is partially responsible for the observed rapid climate warmings in high latitudes due to anthropogenic greenhouse gases.