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Satellites reveals the biophysical effects of forest cover change on climate at diurnal, seasonal and inter-annual time scales

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Changing the planet's forest cover can have a profound impact of the climate system by altering its role as a carbon sink. However, deforestation and afforestation also changes the biophysical properties of the surface such as albedo, roughness and root depth, thus altering the energy balance and the resulting surface and air temperature. The result of these competing biophysical processes varies spatially and seasonally, and can lead to either warming or cooling depending on which process dominates. The main tools to characterize such plant-climate interactions for both the past and future are land surface models embedded in larger Earth System models, yet their capacity to model biophysical effects accurately across the globe remains unclear due to the complexity of the phenomena. Alternatively, with appropriate methodologies, the climate impacts of the biophysical effects of forest cover change can be derived from space by satellite measurements of surface temperature and energy fluxes. Here we present the confrontation of two dedicated assessments that have been specifically generated for this scope with contrasting methodologies. The first is based on identifying an actual change in the local climate following an observed forest cover transition. Although it directly measures the desired effect, this method can only be applied to the places where vegetation change has effectively occurred. The second method relies on a 'space-for-time' approximation that identifies the potential impact of a plant cover transition from differences in climate amongst neighboring areas with contrasting vegetation. We show how both approaches reinforce and complement each other to provide a consolidated result across diurnal, seasonal and inter-annual time scales. We anticipate that these evidences derived from satellite records may support the benchmarking and development of Earth system models and support the inclusion of vegetation-driven biophysical processes in climate mitigation and adaptation actions.