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Mitigation benefits of forestation greatly varies on short spatial scale

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Mitigation of global warming by forestation is controversial because of its linkage to increasing surface energy load and associated surface warming. Such tradeoffs between cooling associated with carbon sequestration and warming associated with radiative effects have been considered predominantly on large spatial scales, indicating benefits of forestation mainly in the tropics but not in the boreal regions. Using mobile laboratory for measuring CO_2, water and energy flux in forest and non-forest ecosystem along the climatic gradient in Israel over three years, we show that the balance between cooling and warming effects of forestation can be transformed across small spatial scale. While converting shrubland to pine forest in a semi-arid site (280 mm annual precipitations) requires several decades of carbon sequestration to balance the radiative warming effects, similar land use change under moist Mediterranean conditions (780 mm annual precipitation) just ∼200 km away showed reversal of this balance.

Specifically, the results indicated that in the study region (semi-arid to humid Mediterranean), net absorb radiation in pine forests is always larger than in open space ecosystems, resulting in surface warming effects (the so-called albedo effect). Similarly, depression of thermal radiation emission, mainly due canopy skin surface cooling associated with the 'convector effect' in forests compared with shrubland ecosystems also appears in all sites. But both effects decrease by about $\frac{1}{2}$ in going from the semi-arid to the humid Mediterranean sites, while enhanced productivity of forest compared to grassland increase about fourfold.

The results indicate a greater potential for forestation as climate change mitigation strategy than previously assumed.