Locating The Most Suitable Reforestation Sites For Climate Change Mitigation Efforts

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1 Introduction

Forest growth can take up hundreds of Gts of CO_2[1]. In addition, trees have the ability to cool the local environment by up to several degrees Celsius through enhanced evapotranspiration[2]. Thus, reforestation and forest protection have been recognized to be one of our most compelling climate change mitigation options. Forests differ in their importance to the carbon and hydrological cycle (Fig. 1). I search for areas where the two positive effects, the carbon uptake and local cooling, intersect and are strongest. This will inform us where forests can achieve the best possible contribution to global mitigation efforts. I produce maps of reforestation (Fig. 3) and forest protection (Fig. 2) priorities to inform conservation organizations and mitigation policy.

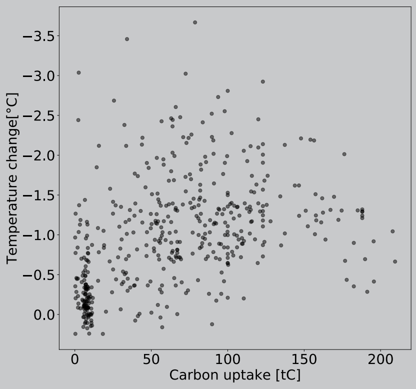

Fig. 1. Each dot represents a sample piece of land that might be reforested. The x-axis portrays the potential of that area to store carbon. On the y-axis, the local temperature change that is induced by a vegetation cover transition to a forest is depicted. The large spread in both dimensions highlights the necessity to search for the most suitable sites.

2 Results

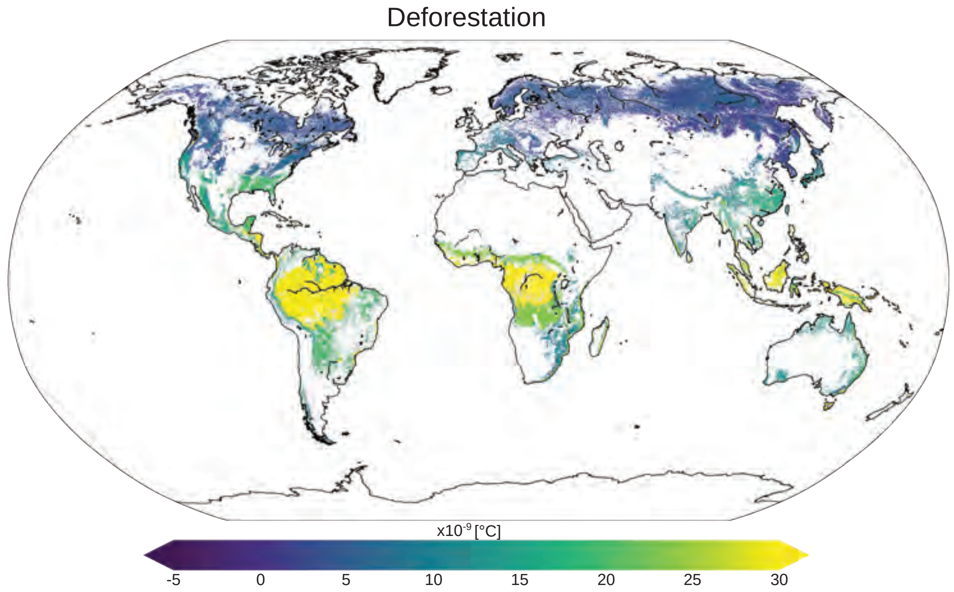

Fig. 2. The coloring shows the individual contribution of each currently forested 1 km² gridcell to global surface temperature change that would result from deforesting that site. Note that the deforestation of some high latitude and continental sites actually cool the local climate. The albedo change dominates over the potential carbon uptake and benefits from evapotranspiration at these locations. A loss of the same area of forest in the Amazon has the potential to warm the planet 3 to 6 times more than the same plot in Europe.

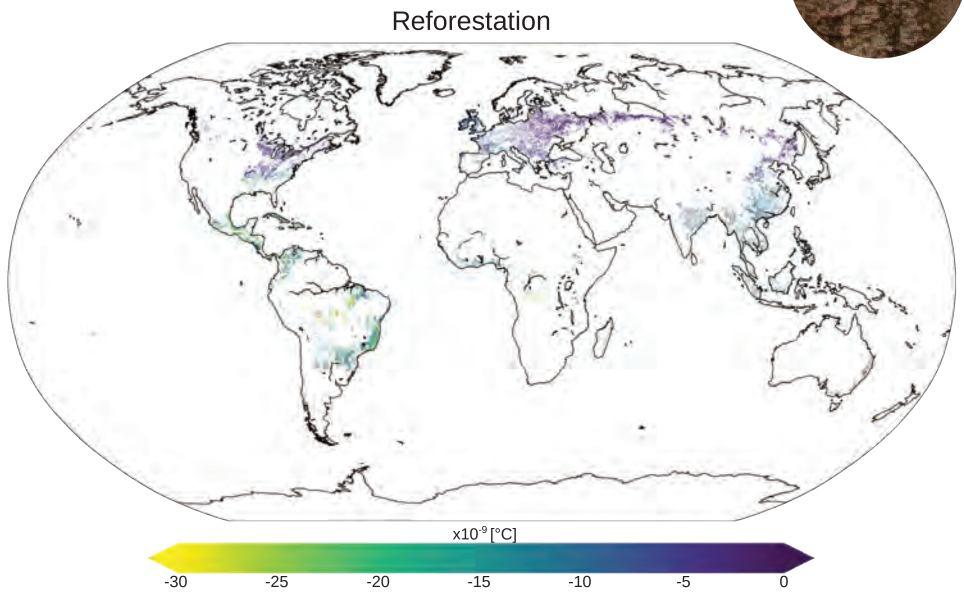

Fig. 3. The coloring shows the individual contribution of each 1 km² reforestation gridcell to global surface temperature change induced by the combined effect of carbon uptake and changes to albedo and evapotranspiration. The extent of reforestation is constrained by biodiversity, food and fibre demands[4]. 6 million km² are reforested taking up 144 Gt CO_2. The highest contributing gridcells are found in tropical evergreen forests on all continents. Notable exceptions are the oceanic forests of southern New Zealand, Tasmania and the Pacific Northwest which achieve similar numbers.

3 Data and Method

Each grid cell is assessed by its contribution to global surface temperature change. I convert the carbon uptake of a reforested cell to a decrease in temperature using the simulated global mean (Fig 4a). The biogeophysically induced local temperature change is modified to reflect its contribution to the global change (Fig 4b).

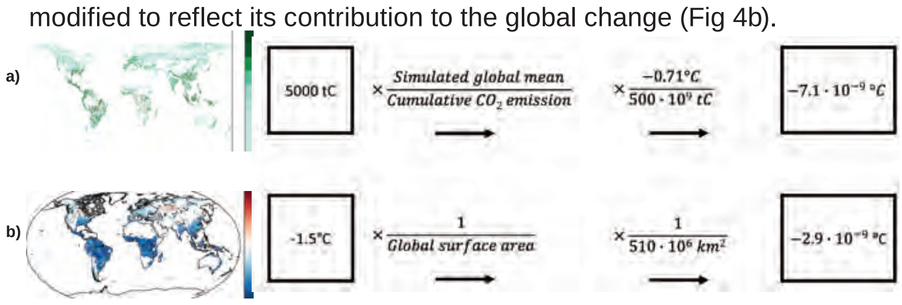

Fig. 4. Left: Sample global map of a) Potential carbon uptake [1,3]. and b) Local temperature change derived from [2,5]. Right: Method example for a 1 by 1 km gridcell. The resulting nano degrees of global surface temperature change will be added up to combine the effects of the carbon uptake and the change to the surface energy balance.

4 Conclusion

- Forest sites differ in their impact on climate by a large factor. A loss of 1 km² of forest in the Amazon contributes up to 6 times more to the global surface warming than the same plot in Europe.
- The climate benefit of forests is strongly dependent on latitude. However, a large spread persists even within the same latitude.
- Evergreen broadleaf forests in the tropics have the greatest potential climate benefit. Notable exceptions are very humid, oceanic forests like in the PNW or southern New Zealand and Tasmania

5 References

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