# The regionally varying effects of forests on cloud cover based on satellite observations

Yan Li[1*], Ru Xu[1], Adriaan J. Teuling[2], and Zhao Lei[3]

1. Beijing Normal University, Beijing, China. 2. Wageningen University, Wageningen, The Netherlands. 3. University of Illinois at Urbana-Champaign, USA. ***Email: yanli@bnu.edu.cn**

EGU2020-4649

## 1. Background

- Forest cover change impacts regional and global climate by modulating surface roughness, albedo, and evapotranspiration etc.
- Previous research mainly focused on the impact on temperature, there has been evidence of cloud enhancement over forests at the regional level.
- We utilized long-term cloud data from MODIS in junction with other satellite data sources to investigate the effects of forests on cloud cover in boreal summer months across the globe.

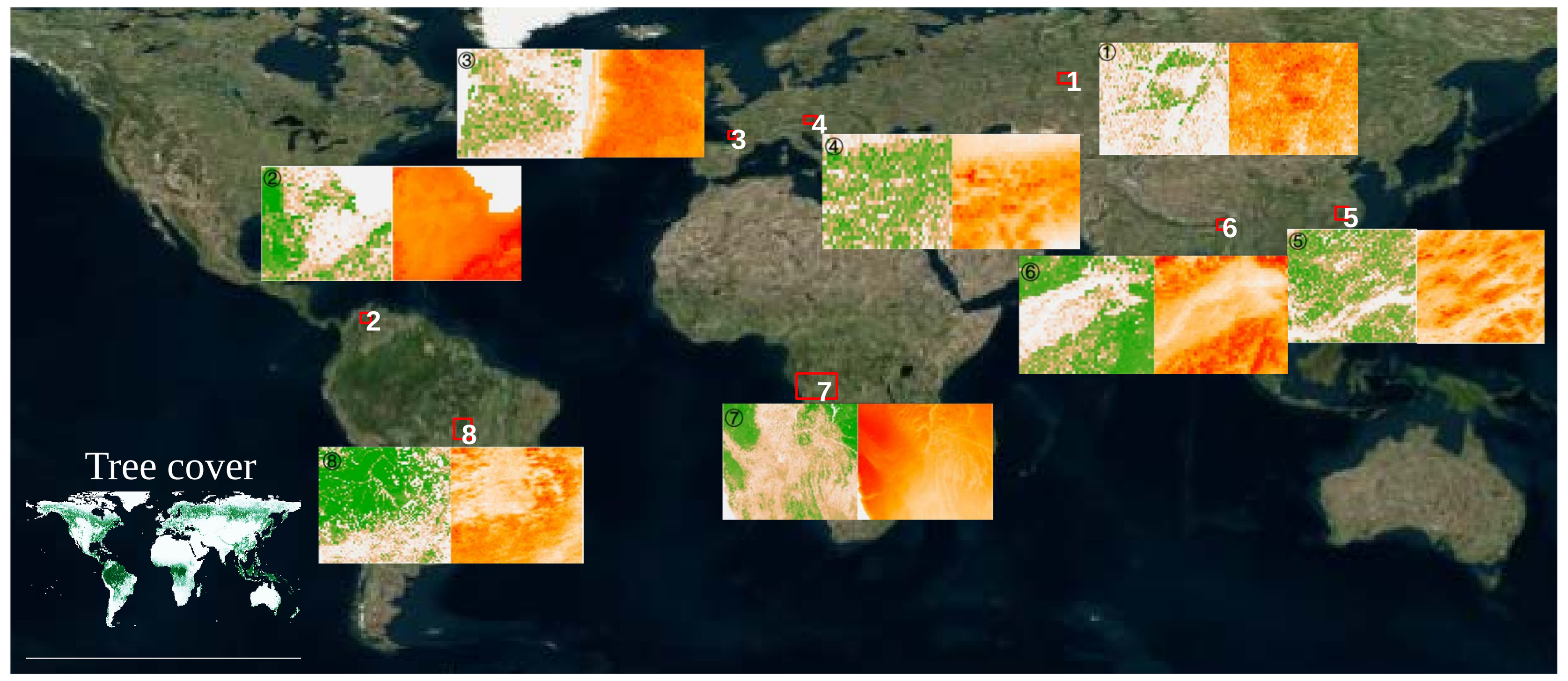



Fig 1. Comparison of tree cover (left) and cloud frequency (right) at selected locations across globe.

## 2. Materials and methods

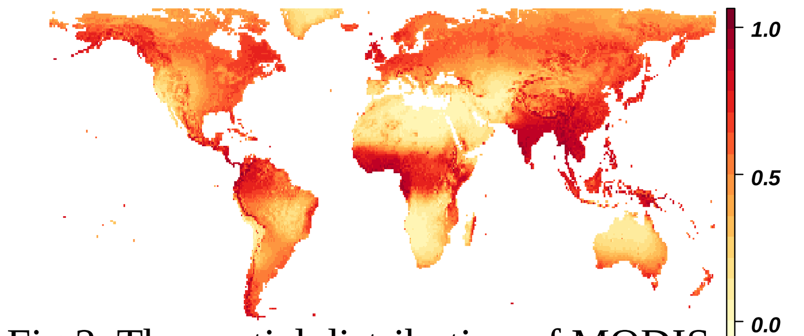



Fig 2. The spatial distribution of MODIS cloud cover frequency from 2002-2016 in JJA

Table 1. Datasets used in this research

| Data set | Spatial resolution | Temporal resolution |
|---|---|---|
| MYD09GA cloud cover | 1km | 13:30 local time, 2002-2016 |
| MSG cloud cover | 0.05 ° | Hourly, 2004-2013 |
| Global Forest Change | 30 m | Annually, 2002-2016 |

**Quantify effect of forest on cloud cover**

We apply a window searching strategy to find all available samples to compare forest with non-forest across the globe.

In a moving window, we calculate:
(1) **The potential effect of forests on cloud** as:
Potential effect = $\text{Cloud}_{forest}$ - $\text{Cloud}_{nonforest}$
**(2) Actual forest loss effect:** the cloud difference between forest loss and unchanged forest locations as:
Actual forest loss effect = $\text{Cloud}_{loss}$ - $\text{Cloud}_{forest}$
**Actual forest gain effect**: the cloud difference between gained forest and unchanged nonforest as:
Actual forest gain effect = $\text{Cloud}_{gain}$ - $\text{Cloud}_{nonforest}$

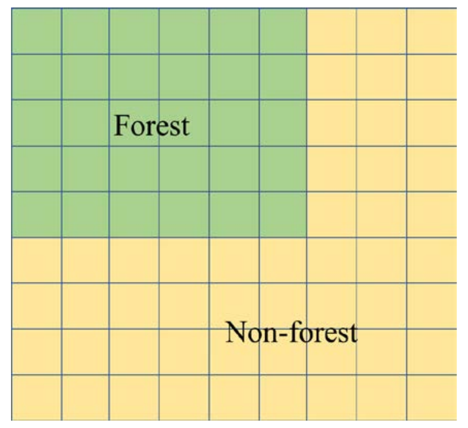



Fig 3.The schematic diagram of forest and nonforest in a moving window (9 by 9 pixels).

**Attribution of cloud effect of forest to tree cover and elevation**

Regression: Cloud = $\text{Slope}_{tree} \times$ tree + $\text{Slope}_{ele} \times$ elevation + intercept
Cloud effect: $\Delta\text{Cloud} = \text{Slope}_{tree} \times \Delta$ tree + $\text{Slope}_{ele} \times \Delta$elevation
Tree induced cloud: $\Delta\text{Cloud}_{tree} = \text{Slope}_{tree} \times \Delta$tree
Elevation induced cloud: $\Delta\text{Cloud}_{ele} = \text{Slope}_{ele} \times \Delta$elevation

## 3.1. Potential and actual effects of forests on cloud cover

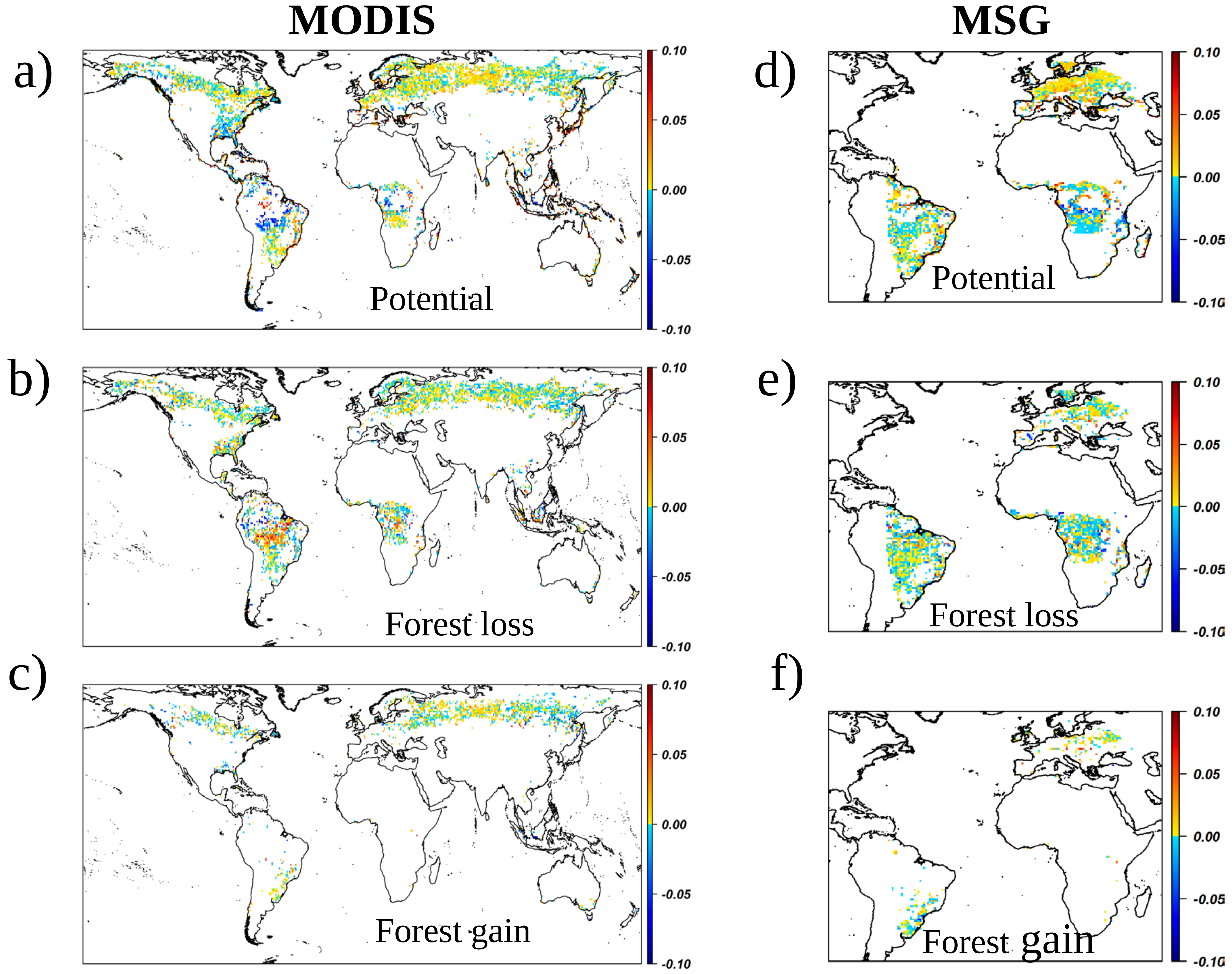



Fig 4. a) Potential effect, b) actual forest loss effect and c) actual forest gain effect on cloud cover based on **MODIS** (left column) and **MSG** (right column) data.

- The potential effect of forest on cloud varies regionally: tropical forests in southern Amazon and Africa decrease cloud cover by up to 9%; temperate forests in Europe increase clover cover by 8%.
- Deforestation in Amazon significantly increase cloud cover.
- MODIS and MSG cloud data exhibit similar patterns.

## 3.2. Mechanism of forest impact on cloud cover

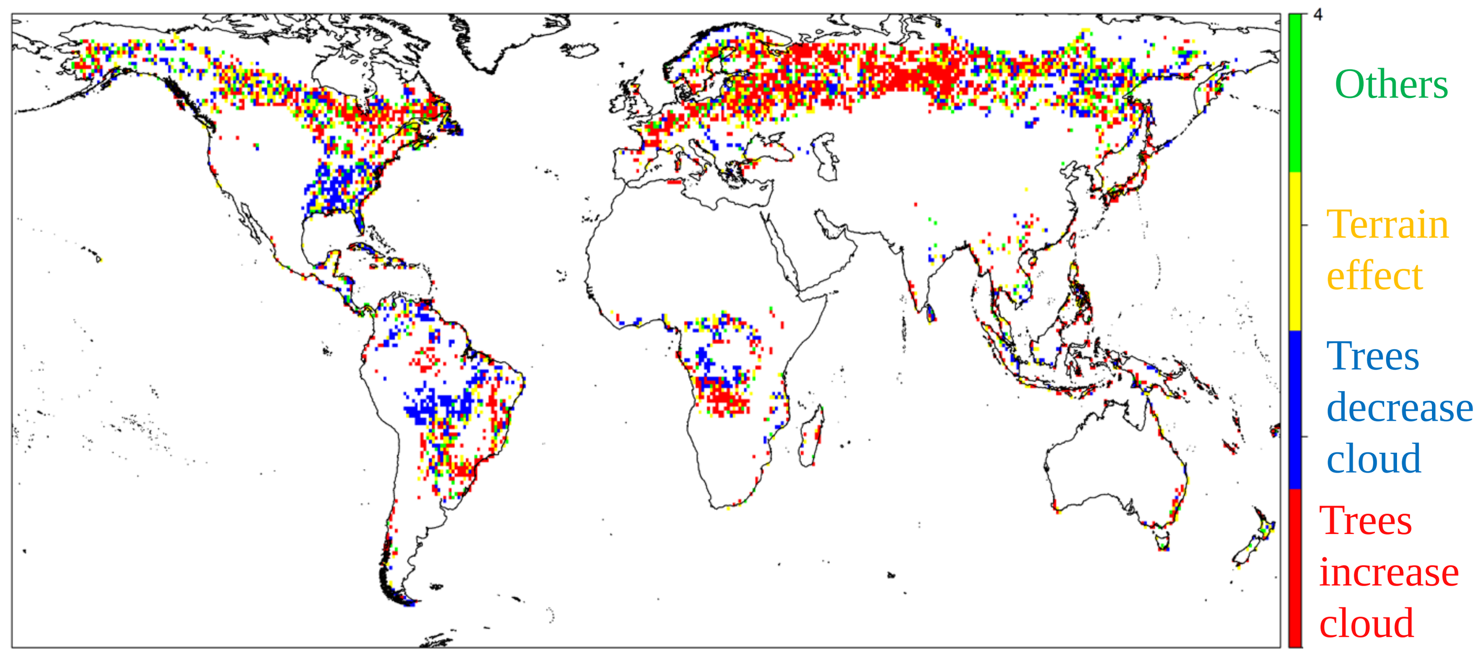
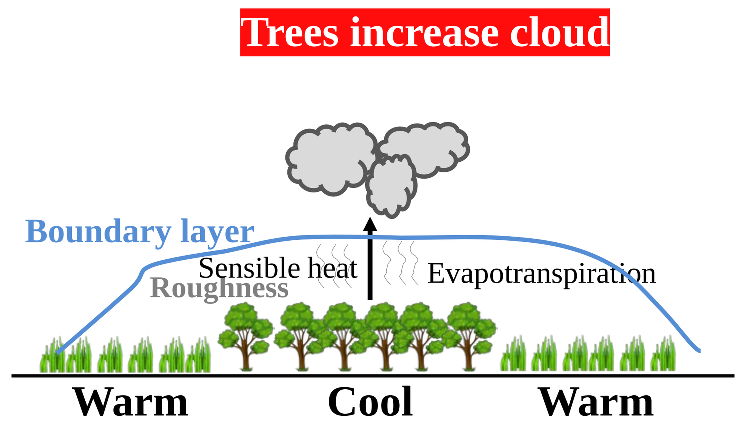
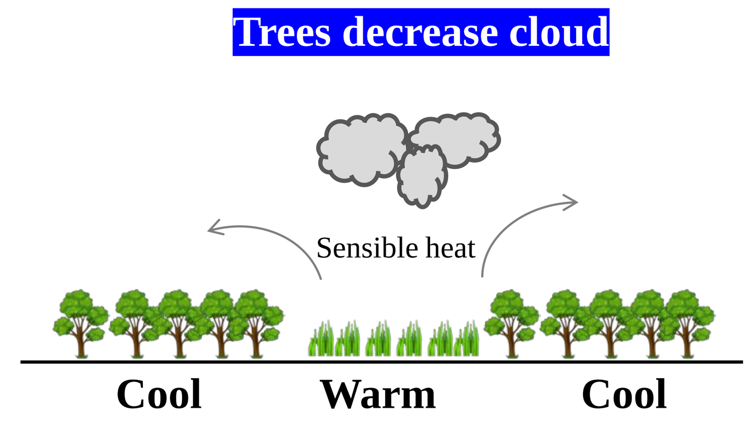
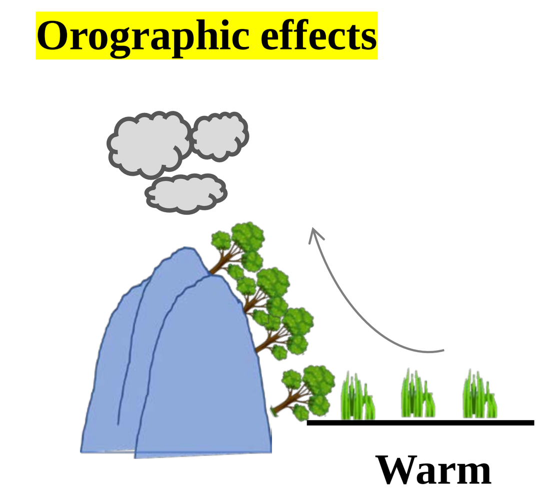



Fig 5. Dominate machinima of forest impact on cloud cover




**Possible mechanisms of the forest impact on cloud**

1. Trees increase cloud cover by ET, roughness, and height of boundary layer
2. Trees decrease cloud cover by meso-scale circulation
3. Orographic effects (trees grow at high elevation)

## 4. Conclusions

- Forests either increase or decrease cloud cover depending on the region and such effect exhibits considerable spatial heterogeneity.
- Forest loss increases cloud cover in central Amazon.
- The forest increase cloud cover occupy almost 43% of selected samples while the forest decrease cloud cover is 23%, orographic effect is 23% and others are 11%.