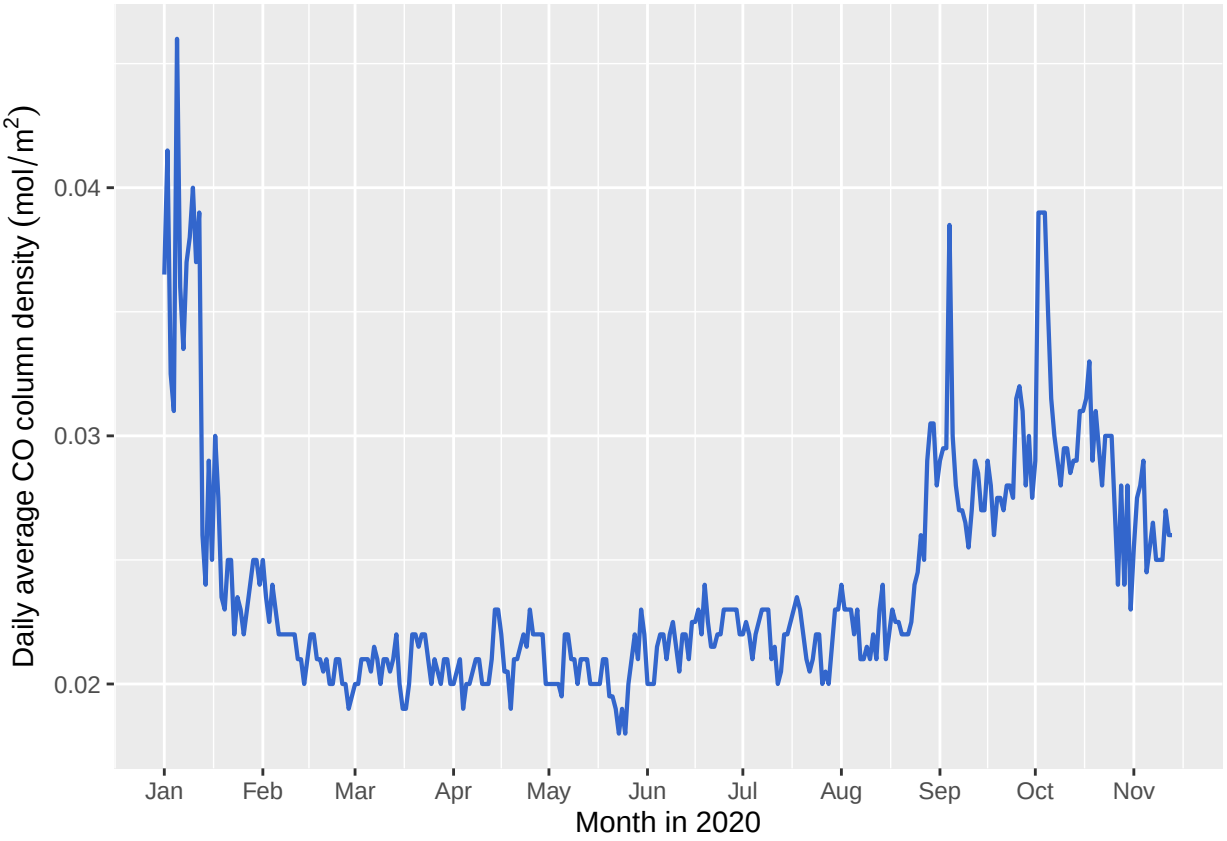
# PA7201_CO2_emissions

20/11/2020



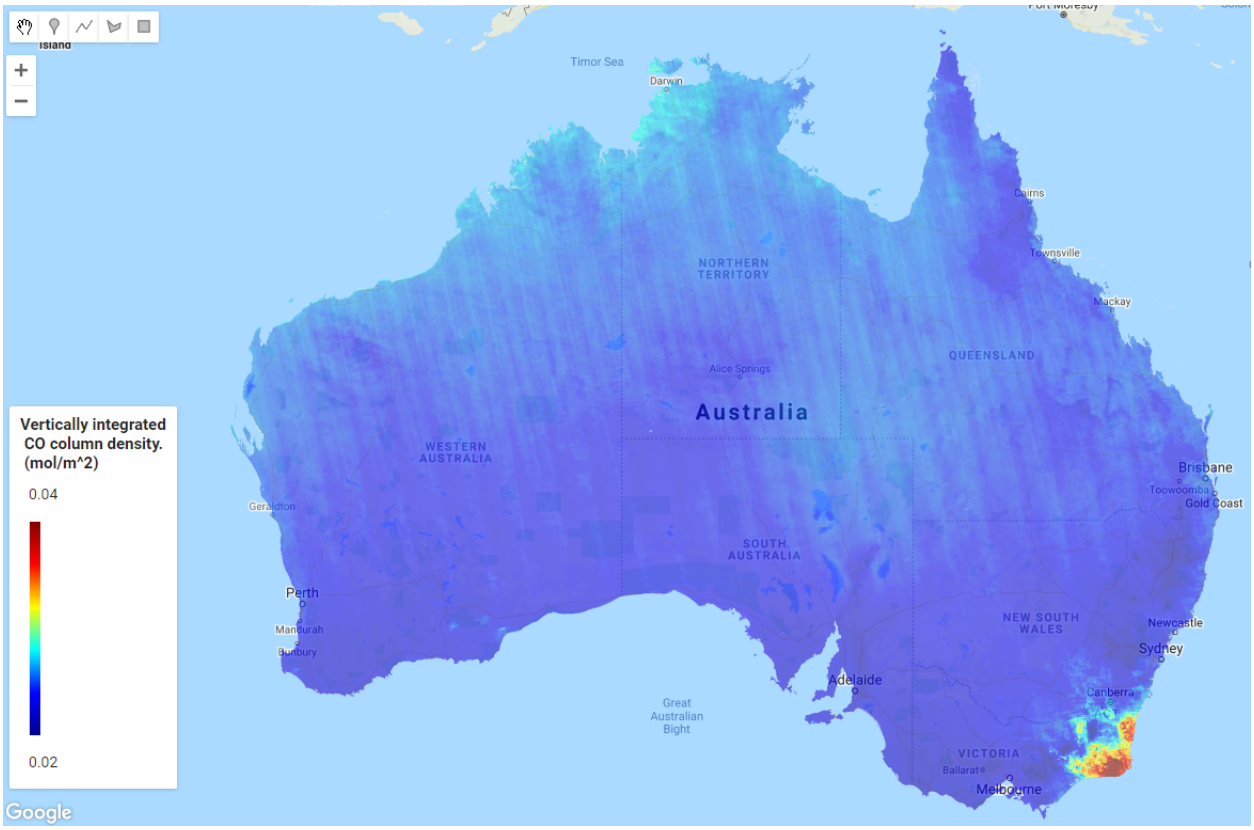



Figure 1: Time series of CO column density (mol/m$^2$) throughout 2020 in Australia (top) Area averaged map of CO column density (mol/m$^2$) throughout 2020 in Australia (bottom)

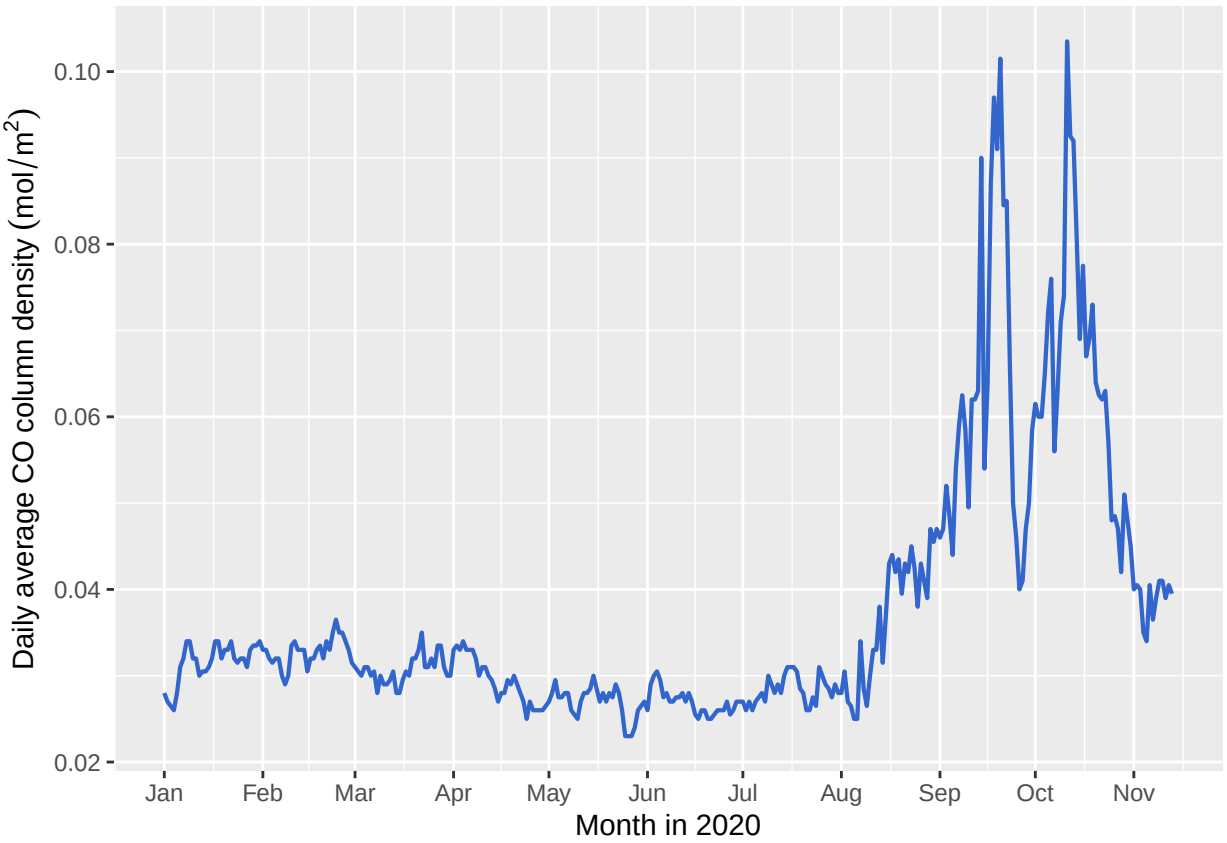



Figure 2: Time series of CO column density (mol/m$^2$) throughout 2020 in Brazil (top) Area averaged map of CO column density (mol/m$^2$) throughout 2020 in Brazil (bottom)

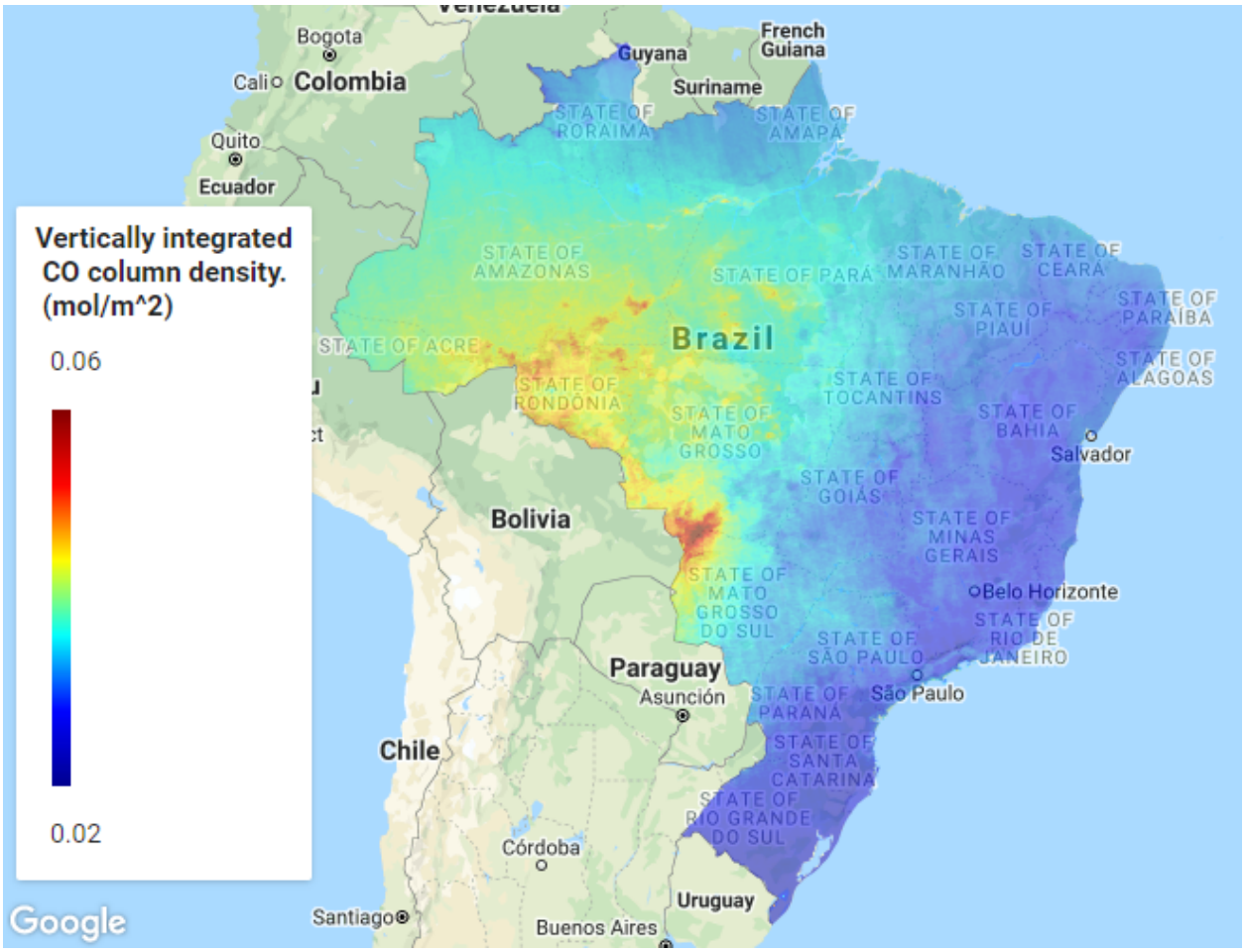



Figure 1: Brazil

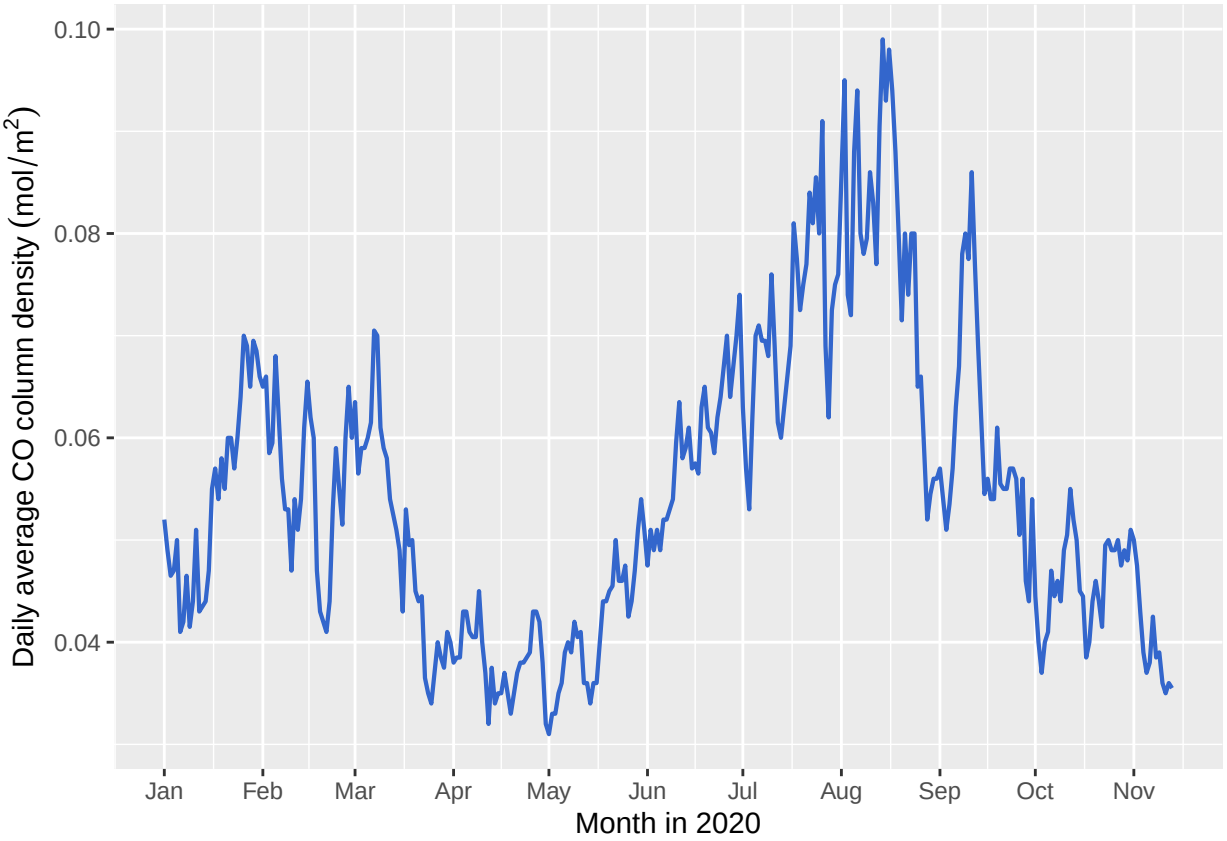



Figure 3: Time series of CO column density (mol/m$^2$) throughout 2020 in Democratic Republic of Congo (DRC) (top) Area averaged map of CO column density (mol/m$^2$) throughout 2020 in DRC (bottom)

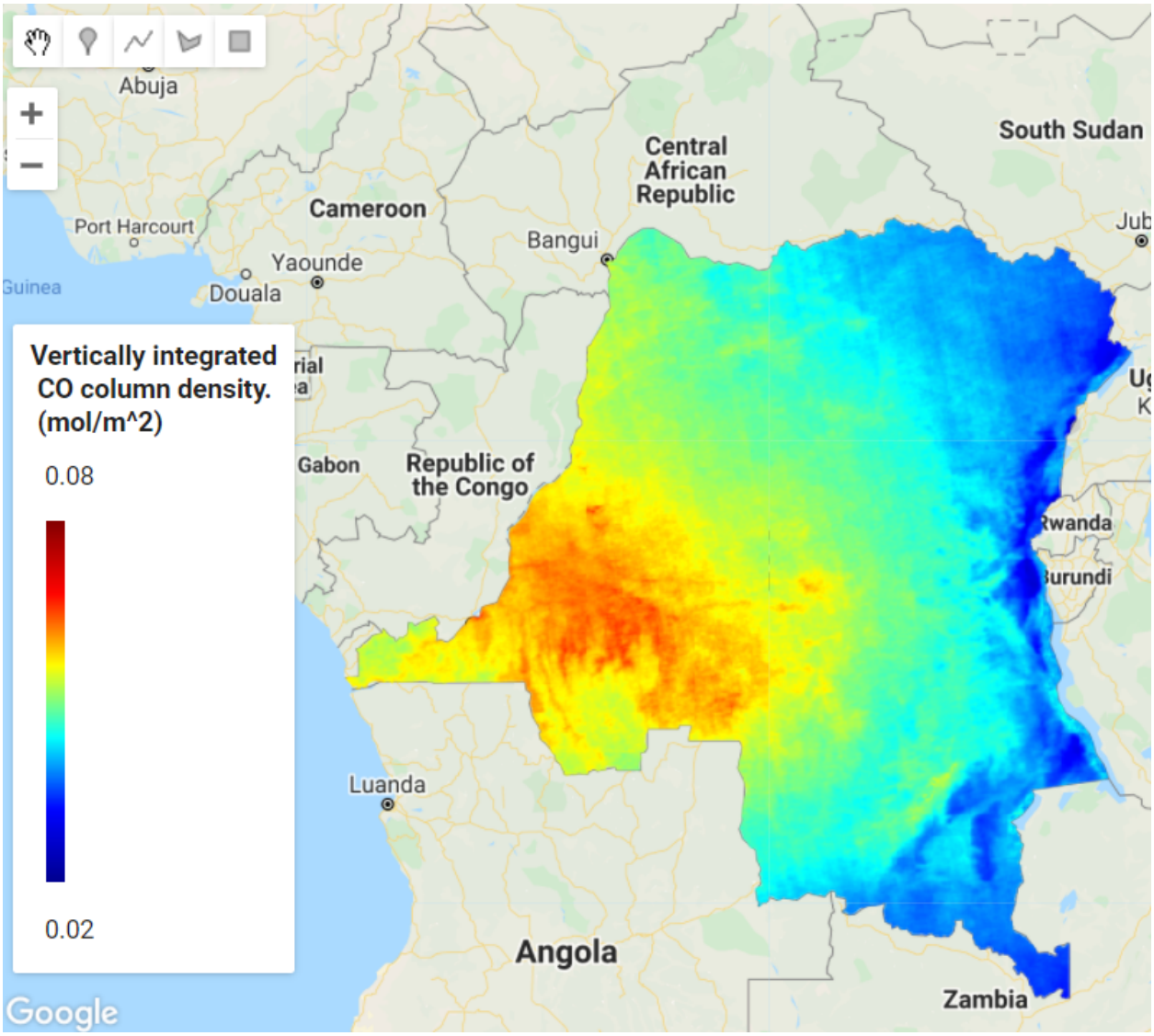
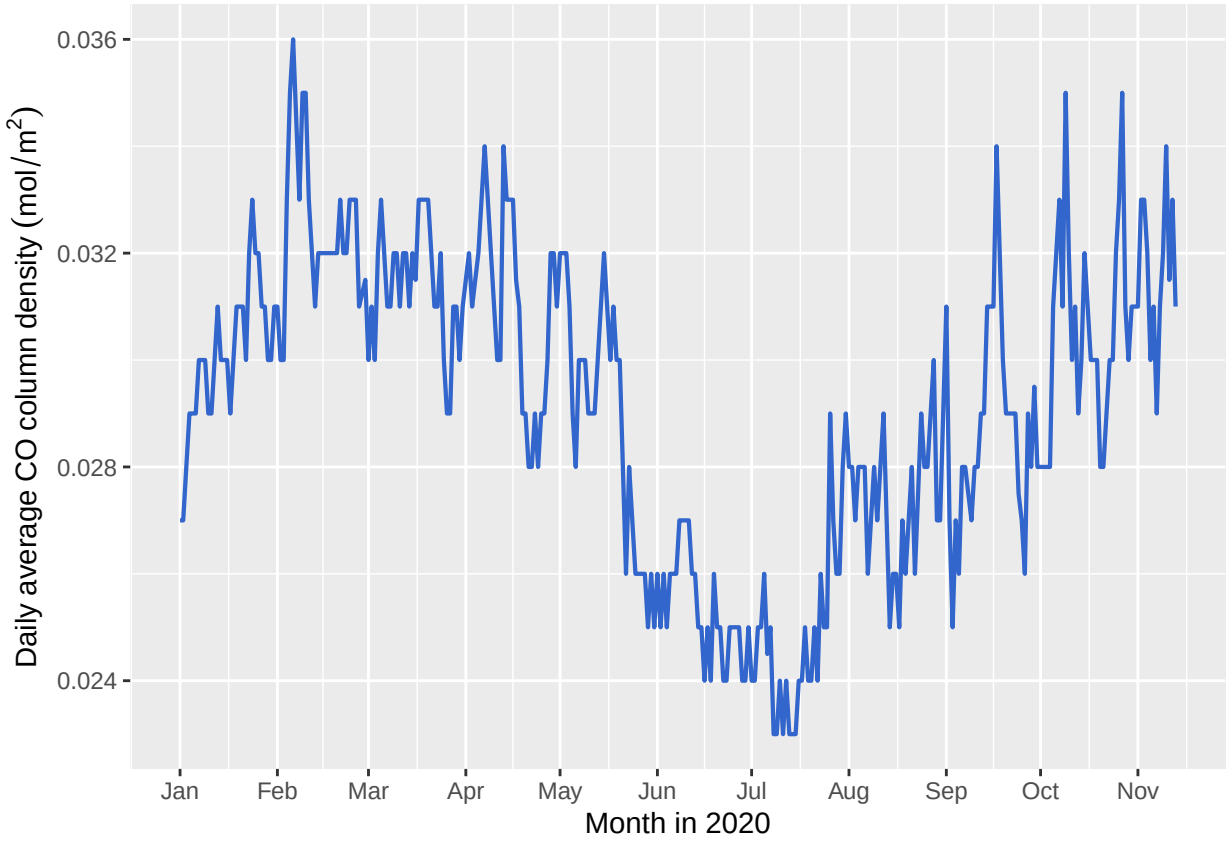

Abuja
Central African Republic
South Sudan
Cameroon
Port Harcourt
Bangui
Yaounde
Douala
Guinea
Vertically integrated CO column density. (mol/m^2)
0.08
0.02
Gabon
Republic of the Congo
Rwanda
Luanda
Angola
Zambia
Google

Figure 2: DRC



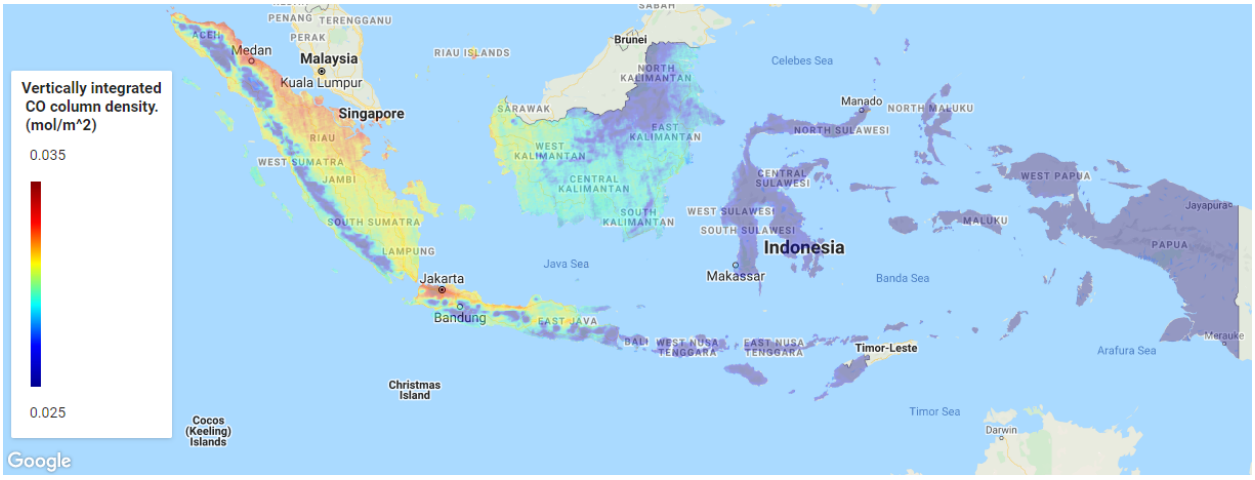




Figure 3: Indonesia

Figure 4: Time series of CO column density (mol/m$^2$) throughout 2020 in Indonesia (top) Area averaged map of CO column density (mol/m$^2$) throughout 2020 in Indonesia (bottom)

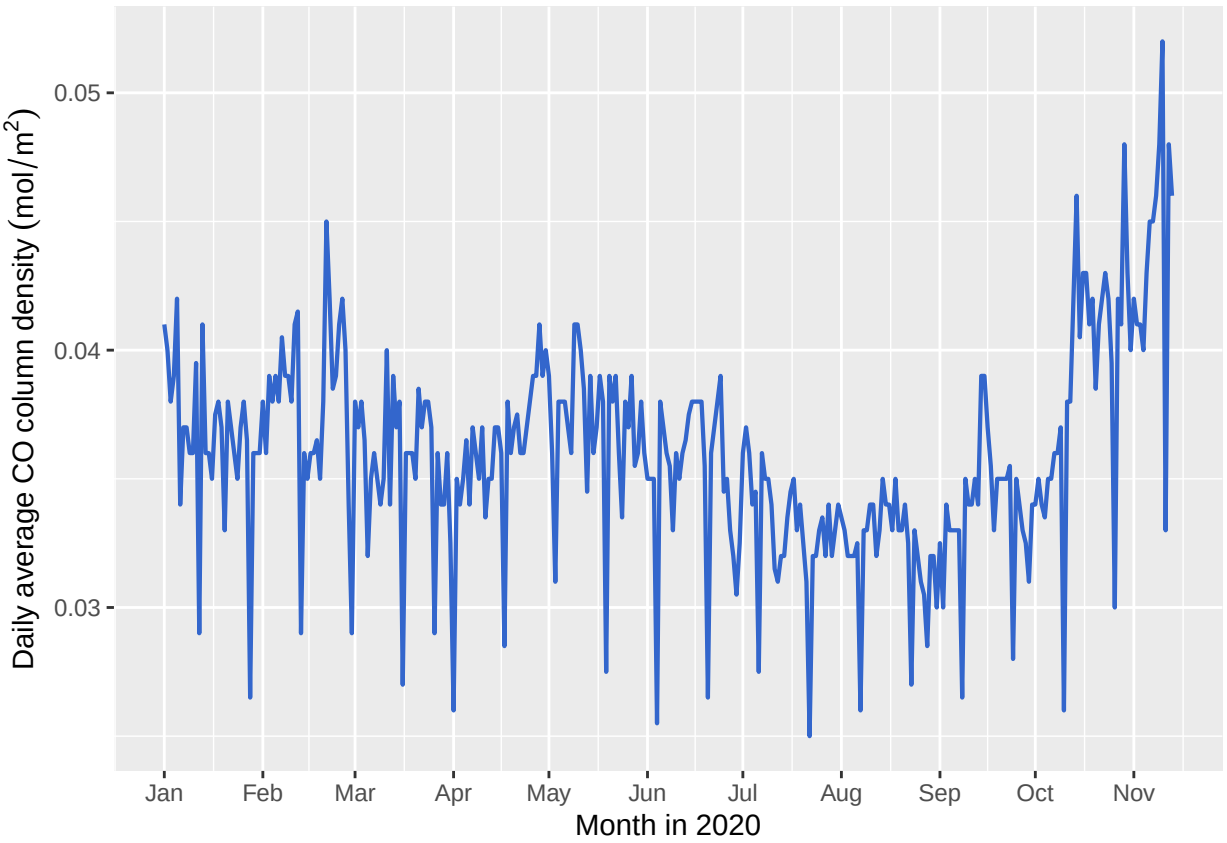



Figure 5: Time series of CO column density (mol/m$^2$) throughout 2020 in India (top) Area averaged map of CO column density (mol/m$^2$) throughout 2020 in India (bottom)

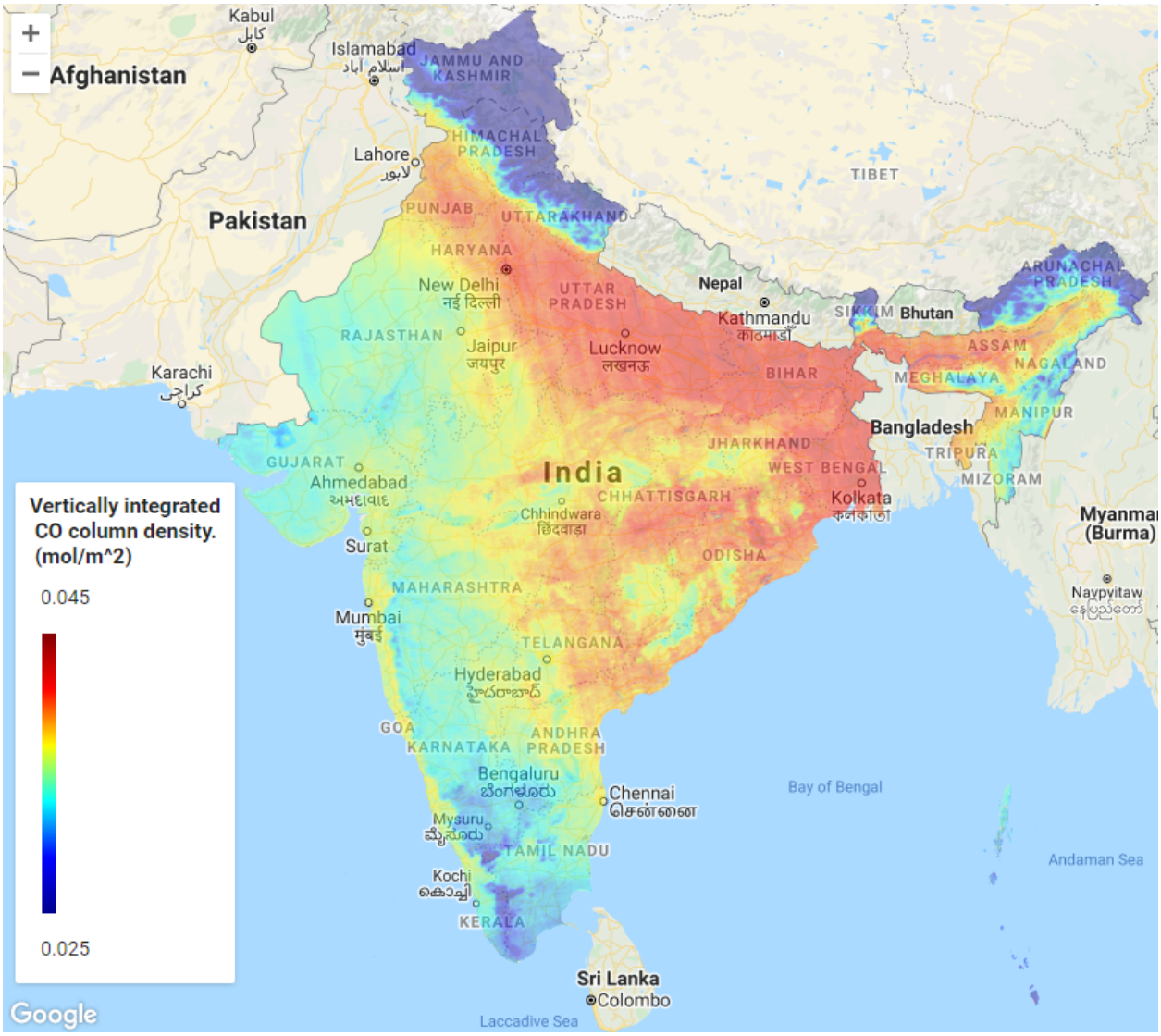



Figure 4: India

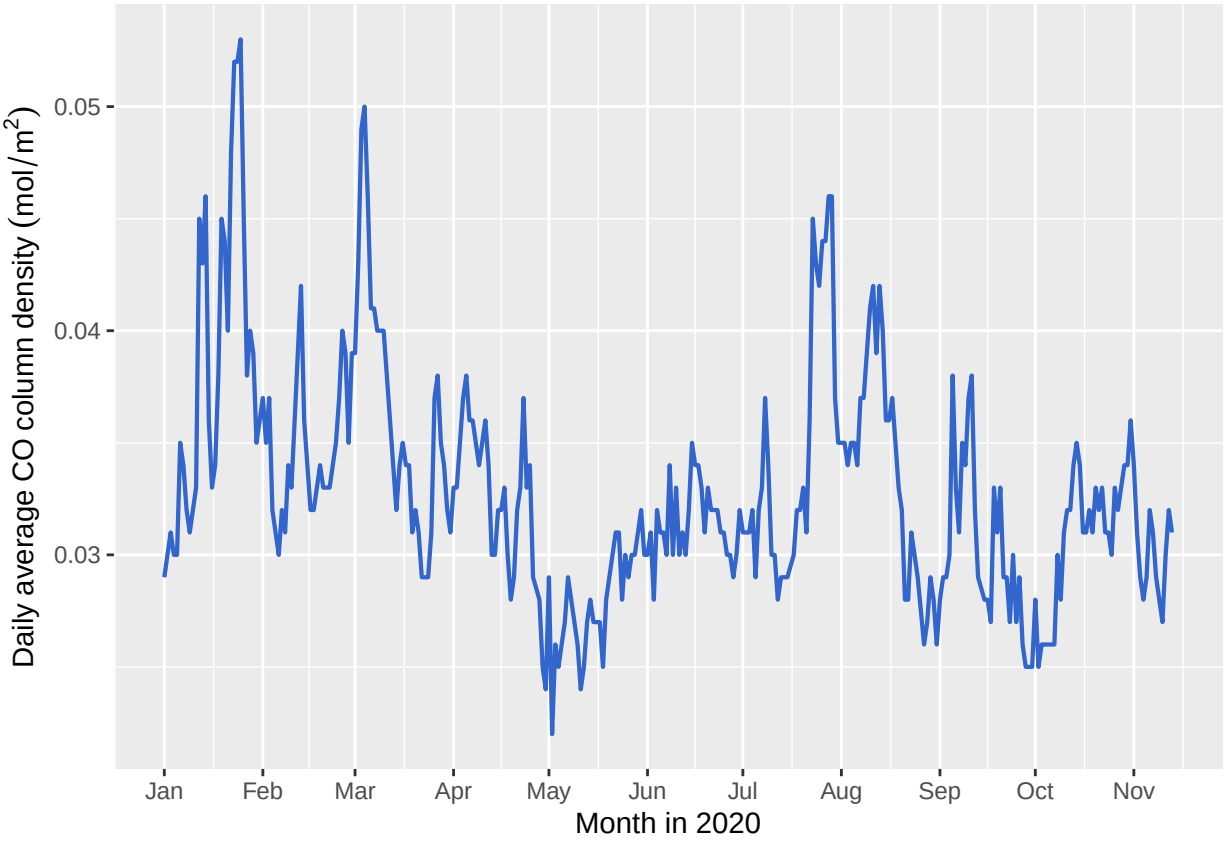



Figure 6: Time series of CO column density (mol/m$^2$) throughout 2020 in Uganda (top) Area averaged map of CO column density (mol/m$^2$) throughout 2020 in Uganda (bottom)

## Analysis

Carbon monoxide (CO) is a poisonous gas, released from incomplete combustion. The major source of CO is burnt fuel, originating from car exhausts or fire.

Australia displays maximum CO column density (CD) in January (0.045 mol/m2) and October (0.039 mol/m2). January 2020 brought a series of bushfires throughout Australia, leading to increased CO throughout the region (Filkov et al., 2020). CO levels were stable from February to August, ranging from 0.018 - 0.024. Bushfire season for 2020-2021 begins again in September and this is apparent due to increased CO CD during this period. Burning occurred in a concentrated region in South East Australia between Canberra and Melbourne.

Forest fires have raged throughout 2020 in Brazil (IPAM, 2020), but the most extreme events occurred in September and October as CO increased to 0.1 mol/m2. Outside these events, Brazil has a CO CD of approximately 0.03 mol/m2. Increased CO CD coincides with the Amazon basin to the west, further suggesting that wildfires were the source of the CO (IPAM, 2020). The surrounding coastline to the east displays significantly lower C0 levels (0.2-0.4 mol/m2), suggesting a lack of wildfires in this region.

The DRC displays a unique signal of CO CD. CO rises gradually from May to August before decreasing rapidly. The DRC does not show a 'baseline' density as CO changes sporadically throughout 2020. The cause of this CO is identical to that of Brazil, wildfires (Jenner, 2020). Interestingly, that also brings about similar levels of CO that were present in Brazil (~0.04-0.1). Increased CO CD to the West (0.7-0.8 mol/m2) suggests this was the location of the wildfires. CO decreases eastward throughout the region, until a minimum (0.02 mol/m2) is found at the eastern border.

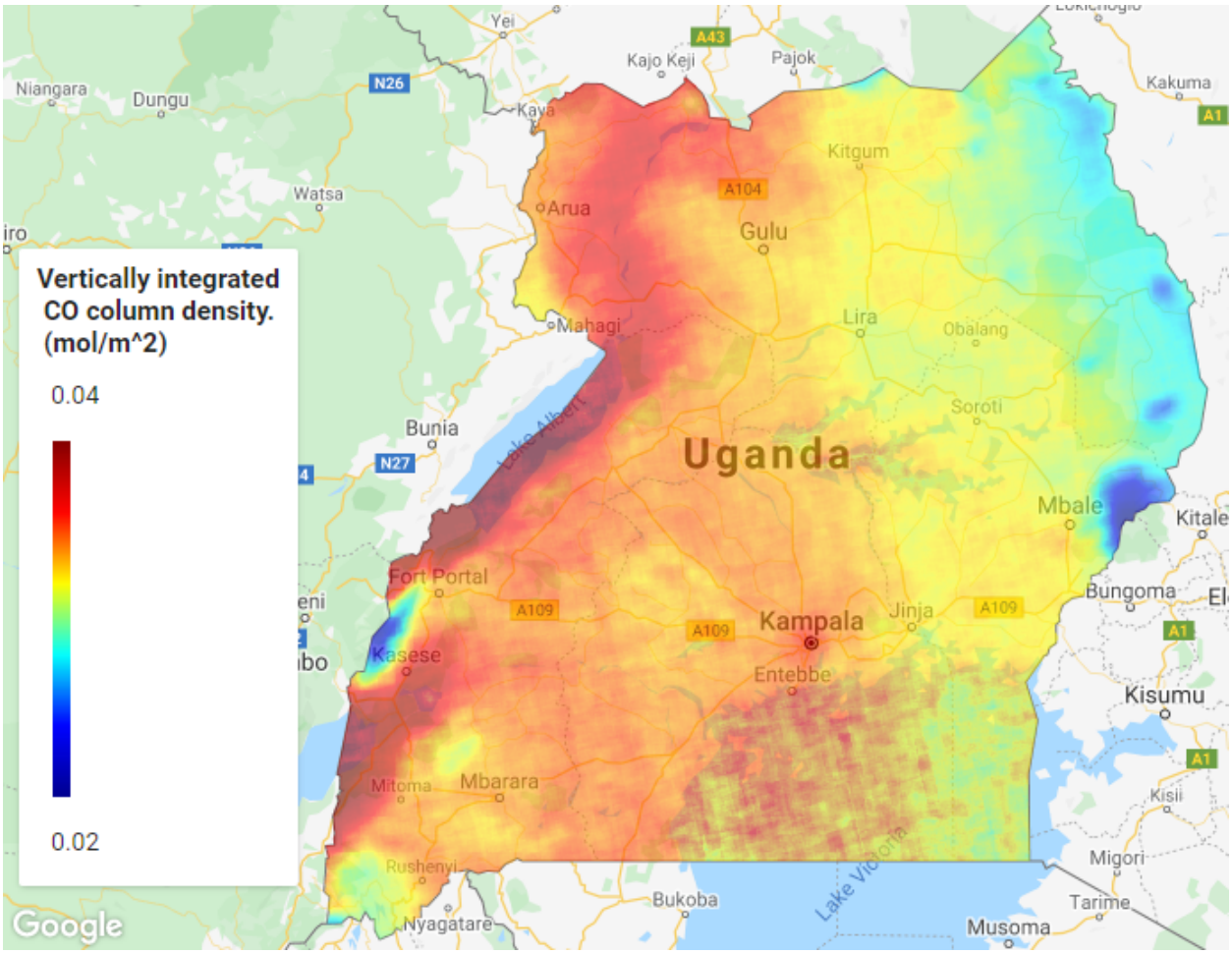



Figure 5: Uganda

CO CD in Indonesia is highlighted by a trough from May to September, possibly due to lockdowns enforced for the COVID-19 pandemic. Due to a lack of wildfires or burning, there are no sudden peaks in the data and the region displays a narrow range (0.01 mol/m2) of CO CD. Maximum CO CD is around Singapore and Jakarta, demonstrating the effect of urbanization on CO levels (Dewi et al., 2019).

India presents an extremely noisy dataset. CO CD falls within the range 0.03 to 0.04 though outliers consistently fall below 0.03 mol/m^2. CO CD has increased to 0.045 since October with outliers increasing it >0.05 mol/m2. The highest levels of CO CD are found throughout North India. Here, forest fires raged in Uttarakh and and Uttar Pradesh throughout May 2020 (Azad, 2020).

CO CD in Uganda ranges from 0.03 to 0.05. COVID-19 may have caused a decrease below 0.03 from May to June. Uganda's maximum CO CD is on its border with DRC, suggesting that DRC may be responsible for a fraction of Uganda's increased CO CD. An outlier within the region is Kampala as an increased concentration of wood stoves and cooking fires release excess carbon monoxide into atmosphere (Bede-Ojimadu et al., 2020). Minimum CO CD in the region coincides with Bokoro Wildlife Reserve and Mount Elgon National Park to the east and South east respectively.

References

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