Impact of Amazonian Fires on Atmospheric CO_2

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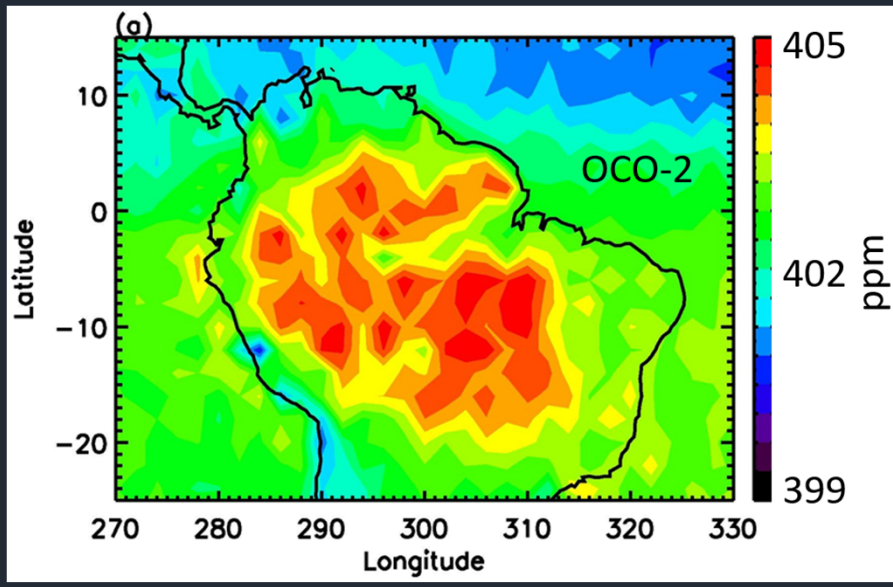
Key take-aways:

- Amazon is the biggest biospheric sink of CO_2 but the expected increase in fires in the Amazon region is going to reduce this sink significantly in the next few decades.
- We need a real-time monitoring system of fires in Amazon.



- The *unique* meteorological system over Amazon allows the CO_2 emitted from biomass burning to accumulate and be detectable from space.
- OCO-2 reveals ~2 ppm higher CO_2 over western Amazon than the surrounding during the dry season (Aug–Oct) due to biomass burning in the region.

Why study Amazon fires?

- As of 2018, ~20% of the Brazilian Amazon, which contains ~60% of the Amazon Basin, has been deforested (da Cruz et al., 2020), primarily for subsistence activities, soybean planting, cattle raising, timber logging, and mineral mining.
- Cascading effects of fragmentation, droughts, fires and global warming lead to more fires in the future [Brando et al., 2020]

Two impacts of loss of forest on climate

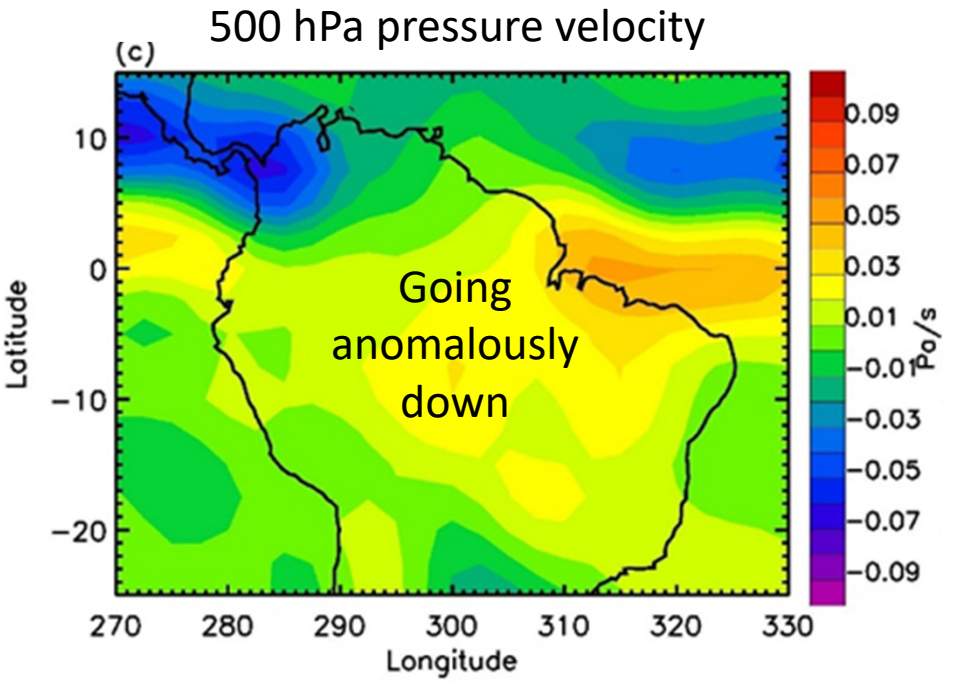
- The direct increase of atmospheric CO_2 due to conversion of biomass
- Indirect influence through a subtle alteration of the hydrological cycle due to the changes in the surface types (e.g. from a forest to bare surface or from trees to savannas) and the atmospheric vertical structure.

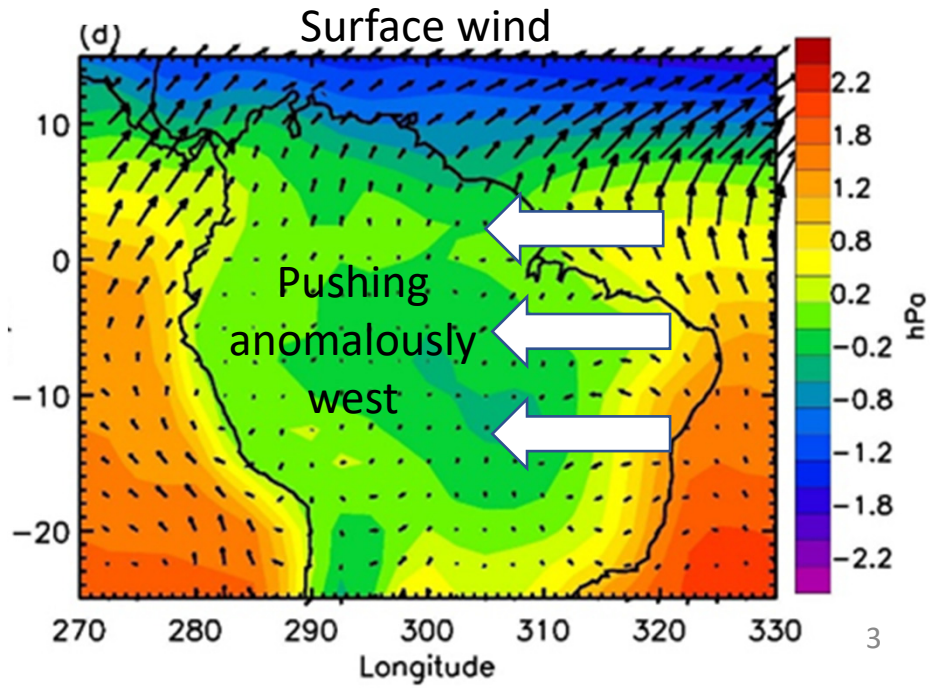
https://www.usatoday.com/in-depth/news/2019/08/23/amazon-rainforest-six-charts-explain-why-fires-matter/2096257001/

Results (1):

2015-2019 Aug-Oct seasonal anomaly relative to the climatological mean

- There is anomalously downwelling over the Amazon
- Surface wind converges towards the western Amazon from Atlantic
- These two factors form a trap of pollutants over the Amazon





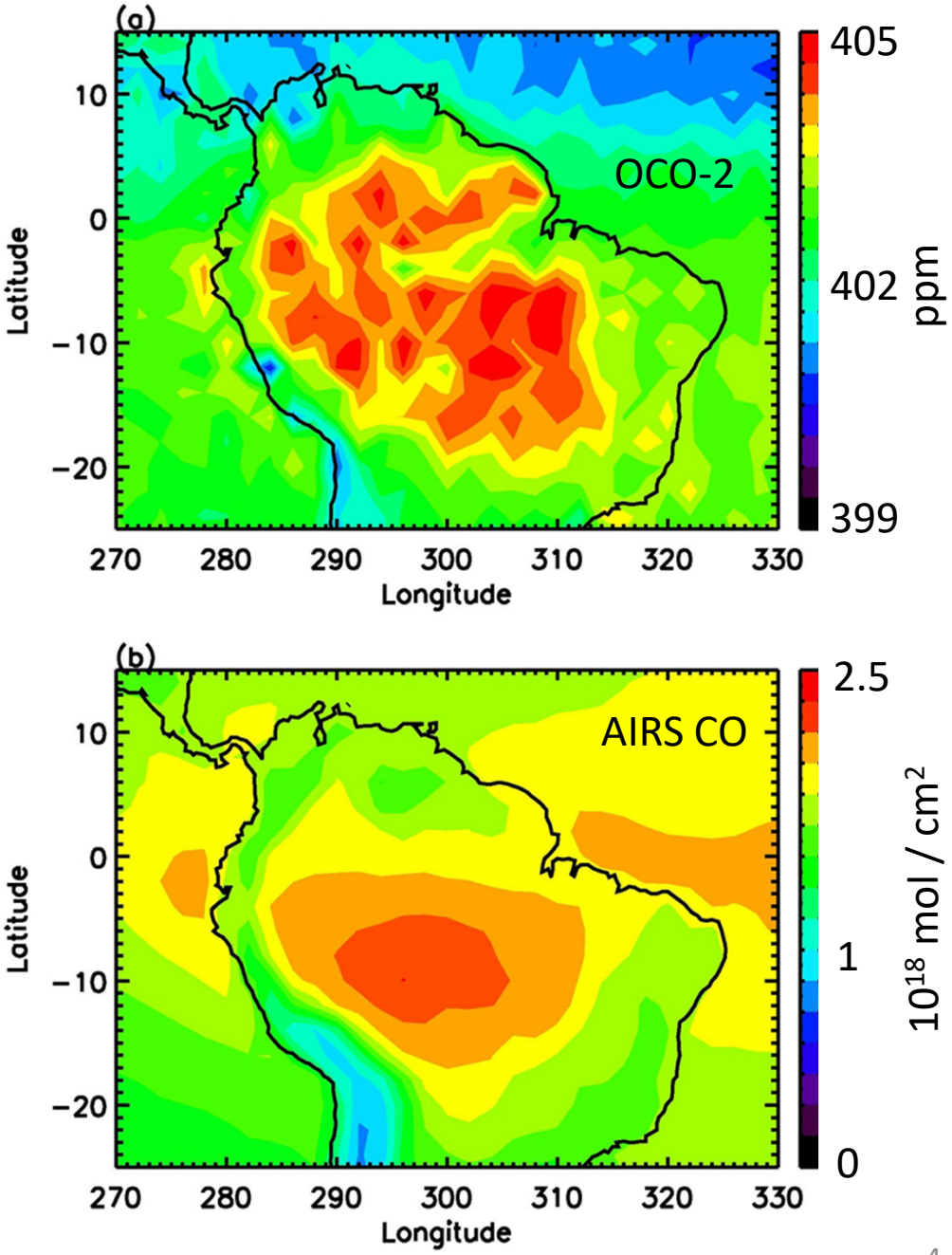
Results (2):

2015-2019 Aug-Oct Average

- CO_2 over western Amazon is 2 ppm higher
- AIRS CO indicates the CO_2 emission is related to biomass burning

Mechanism:

- Surface wind and sinking air over eastern Amazon help to trap CO2 and CO at Amazon

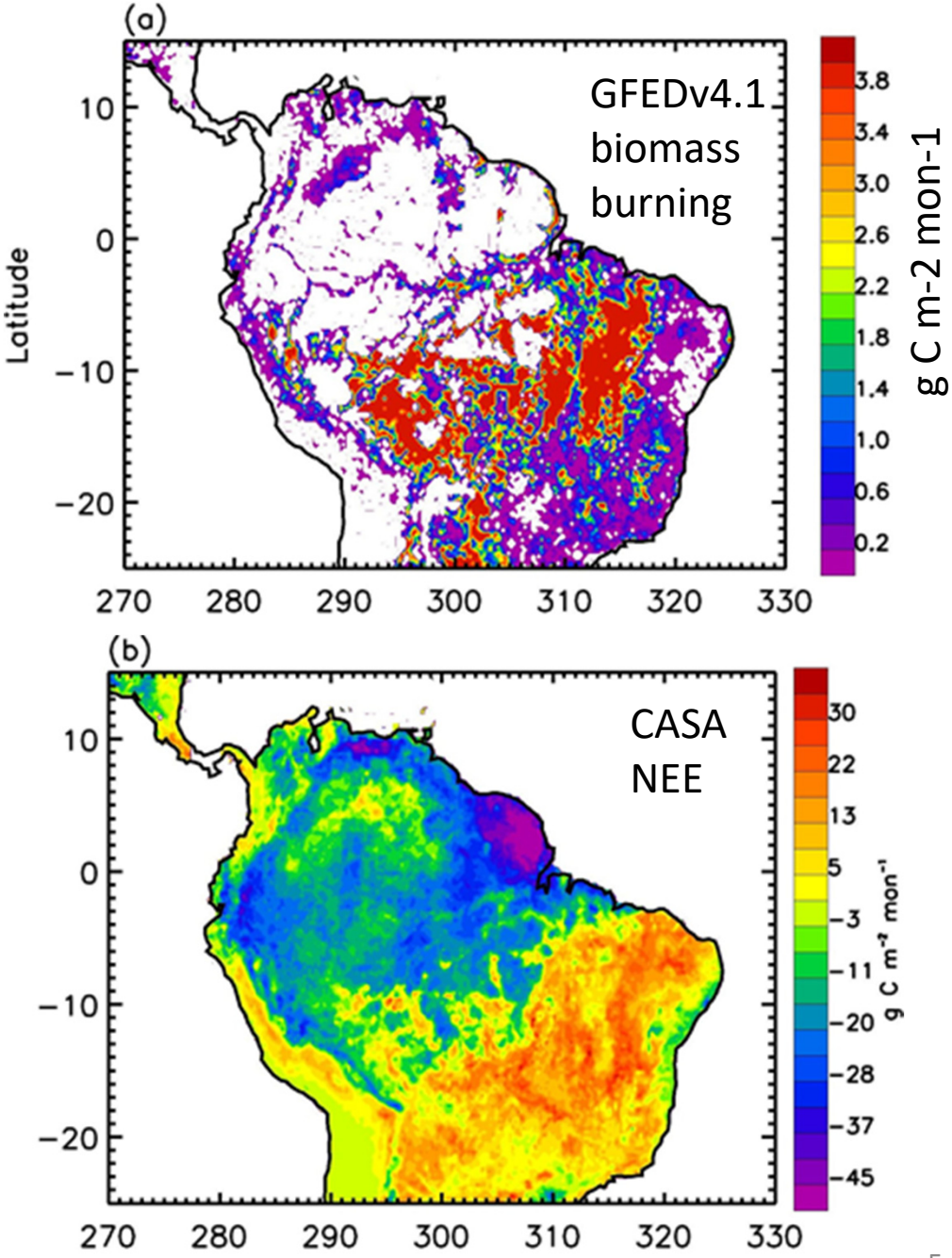


Results (3):

2015-2019 Aug-Oct Average

- Both the GFED and CASA models suggest biomass burnings and release of CO_2 from biosphere at the south rims of Amazon

- Fire activities are also clear in the fragmented regions



Results (4):
2015-2019 Aug-Oct Average

- Top panel:
  - Boreal summer is the dry season.
  - Downwelling during summer
  - Upwelling during winter

- Bottom panel:
  - CO_2 and CO covary with the vertical pressure velocity, except 2016 DJF, the historically strong ENSO.
  - DJF CO did not follow (likely because DJF is wet)

- Mechanism [Chatterjee et al., 2017; Liu et al., 2017]:
  - ENSO modulates DJF CO_2 through biospheric responses