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Effects of Landcover Type on Trace Gas Emissions from Biomass Burning

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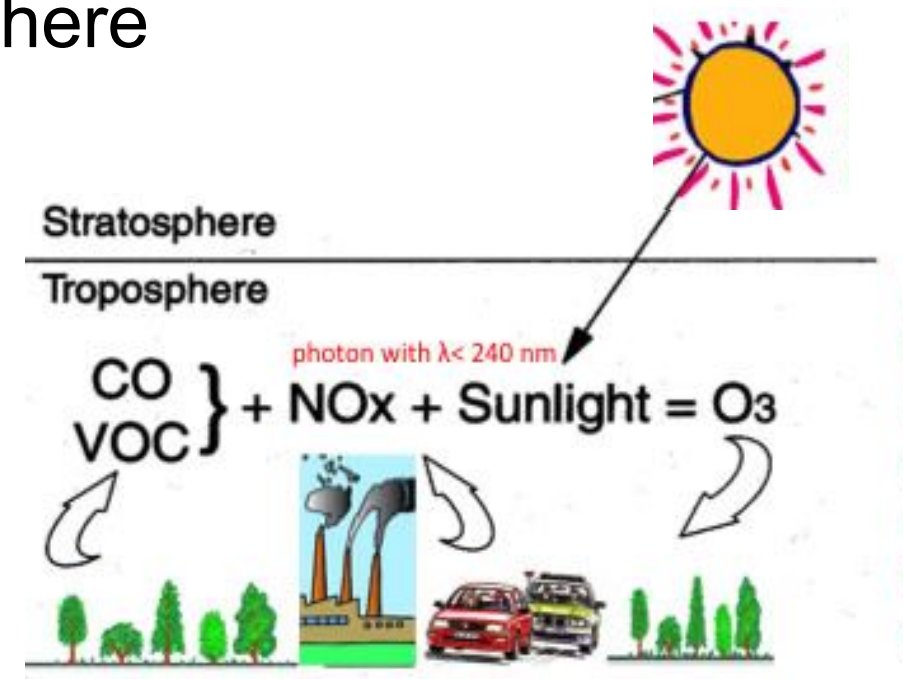
Trace gases in the atmosphere

- Many negative impacts of VOCs in atmosphere:
  - Environment
  - Human health
  - Climate
- Formaldehyde (HCHO) and glyoxal (CHOCHO) two trace gases
  - Anthropogenic and biogenic sources



http://techalive.mtu.edu/envengtext/ch12_criteria.htm

Explanation of biomass burning events

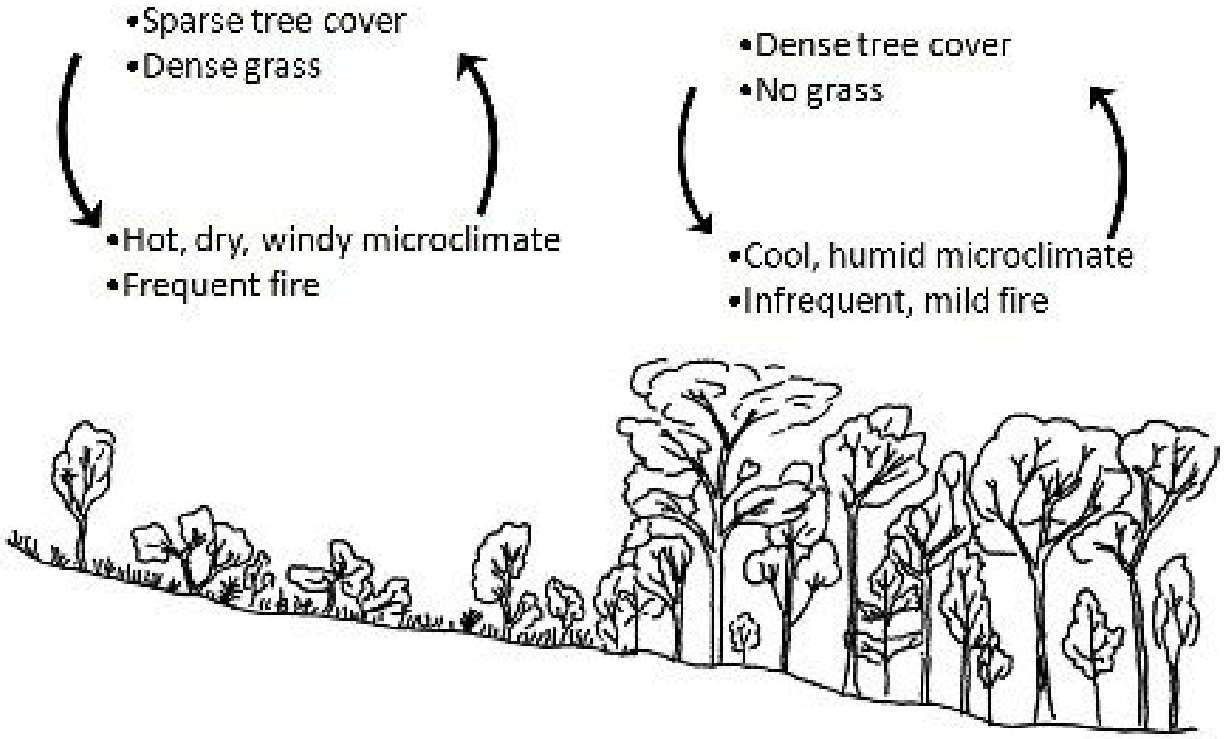
- Biomass burning: combustion of non-fossilized organic fuel
- Fuel: portion of biomass that can burn
- Natural or unnatural sources
- Emissions depend on fire type, fuel type, meteorological conditions, other unknown factors

http://www4.ncsu.edu/~wahoffma/FireEcology/FireEcology.html

Fire type: flaming versus smoldering

http://www.gettyimages.com/detail/video/fire-in-the-cornfield-after-harvest-burning-biomass-stock-footage/461956356
http://www.gettyimages.com/detail/video/fire-in-the-cornfield-after-harvest-burning-biomass-stock-footage/462087734

Environmental influence



http://www4.ncsu.edu/~wahoffma/FireEcology/FireEcology.html

Tropical forest fire emissions

CO_2 (g/kg fuel)	1643	1686	1585
Isoprene (C_5H_8)	0.13	0.039	0.38
Formaldehyde (HCHO)	1.73	0.73	2.08
NO_x	2.55	3.9	3.11

Table modified from Akagi et al. 2011
Image: http://news.mongabay.com/2008/03/chinas-tropical-rainforests-decline-67-in-30-years/

Savanna and grassland fire emissions

CO_2 (g/kg fuel)	1643	1686	1585
Isoprene (C_5H_8)	0.13	0.039	0.38
Formaldehyde (HCHO)	1.73	0.73	2.08
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Table modified from Akagi et al. 2011
Image: https://en.wikipedia.org/wiki/Savanna

Cropland and pasture fire emissions

CO_2 (g/kg fuel)	1643	1686	1585
Isoprene (C_5H_8)	0.13	0.039	0.38
Formaldehyde (HCHO)	1.73	0.73	2.08
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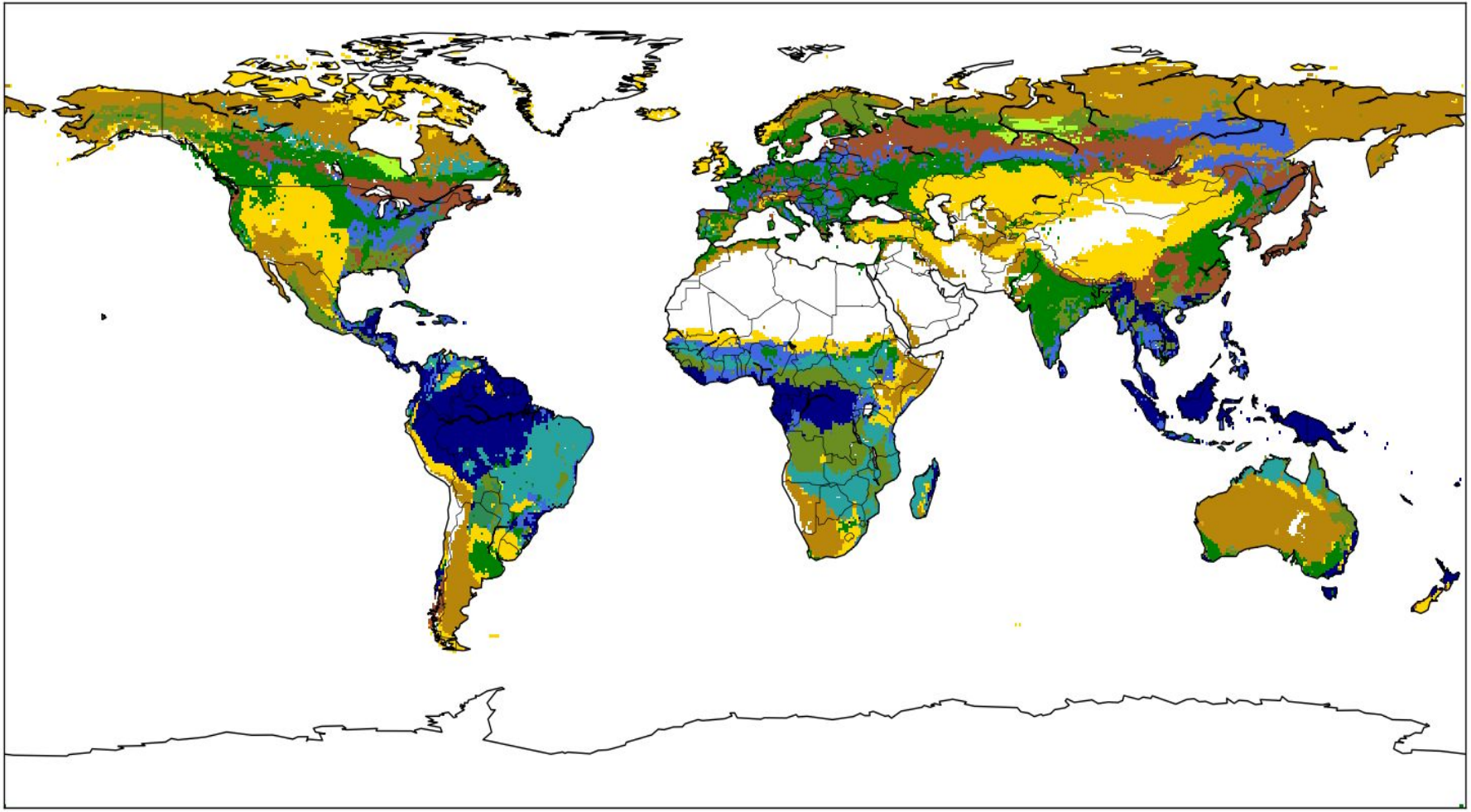
Table modified from Akagi et al. 2011
Image: http://farmindustrynews.com/business/top-7-tips-how-renegotiate-old-farmland-lease-or-find-new-one

Questions:

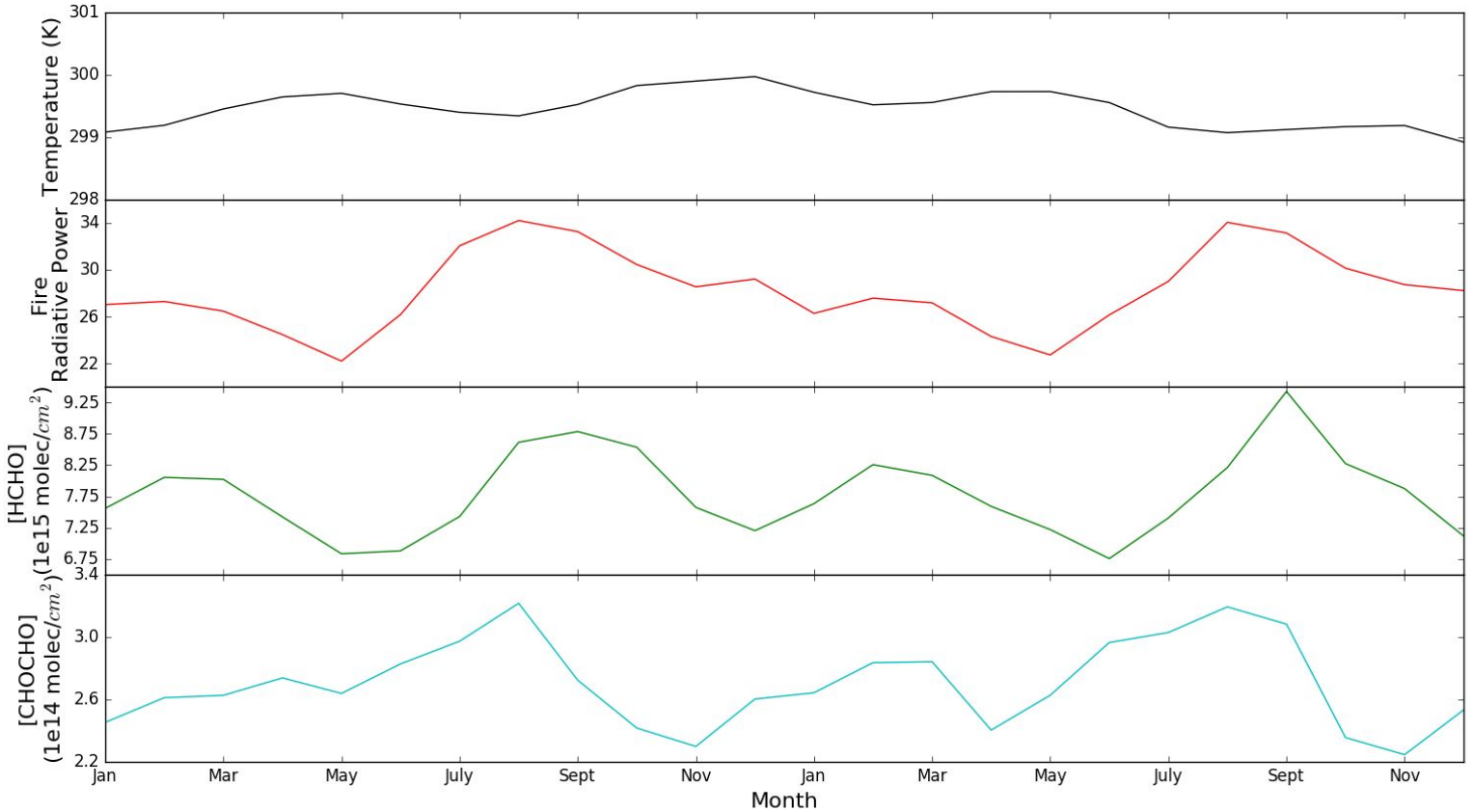
1) Is there a seasonal relationship between biomass burning and formaldehyde or glyoxal emissions?
2) Does landcover type influence formaldehyde and glyoxal concentrations?
3) Which landcover type is related to what chemical ratio signature? Why?

Data

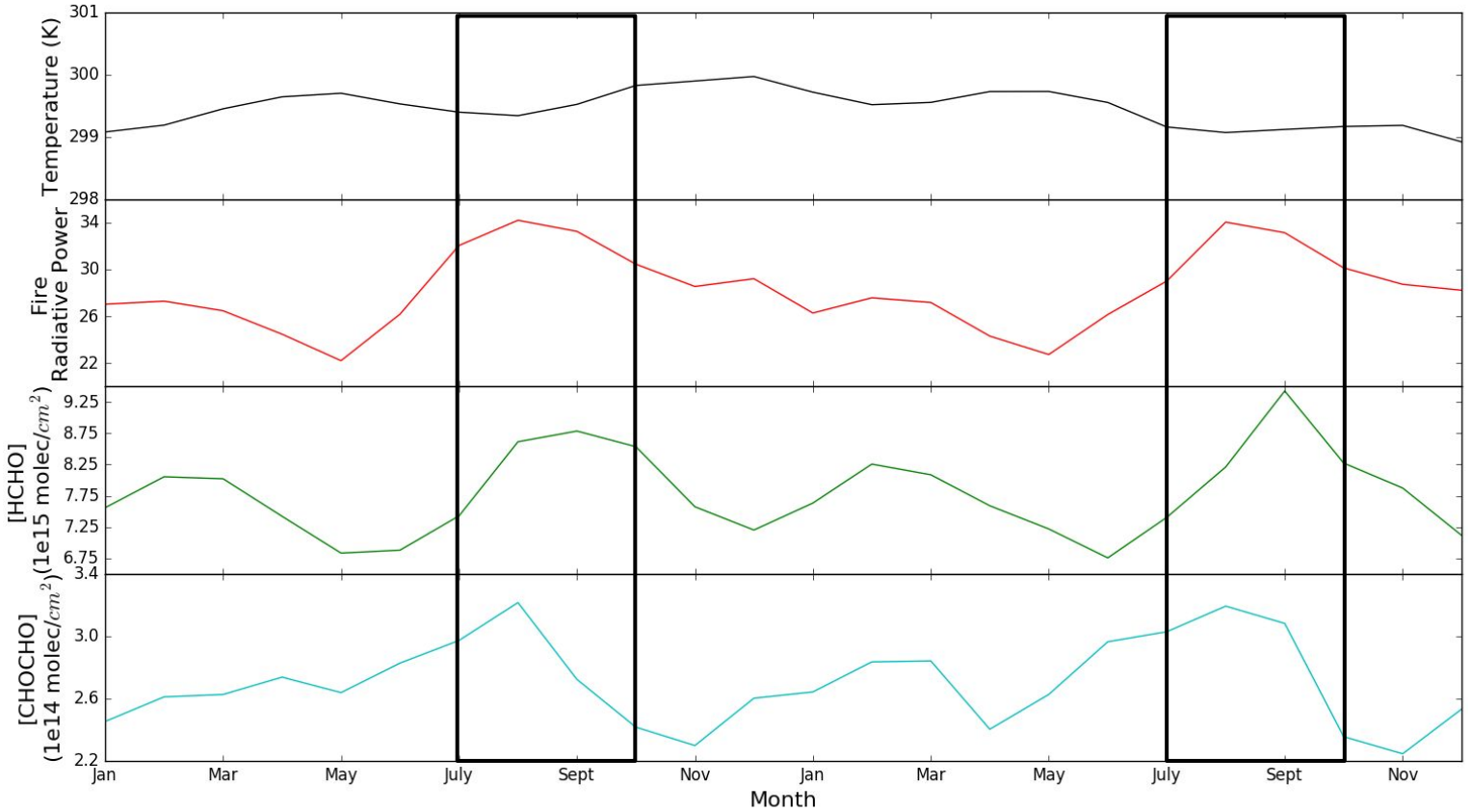
- Formaldehyde: SAO OMI HCHO retrieval (L3) [Gonzalez Abad et al., 2015]
- Fire radiative power: MODIS active fire product from Aqua (L3, Collection 5) [Giglio et al. 2003]
- Landcover: MODIS Land Cover Types Yearly L3 Global 0.05 Deg CMG
- Glyoxal: SAO OMI CHOCHO retrieval (L3) [Chan Miller et al., 2014]
- Temperature: ERA-Interim (reanalysis product) [Dee et al., 2011]
- Years 2006-2007



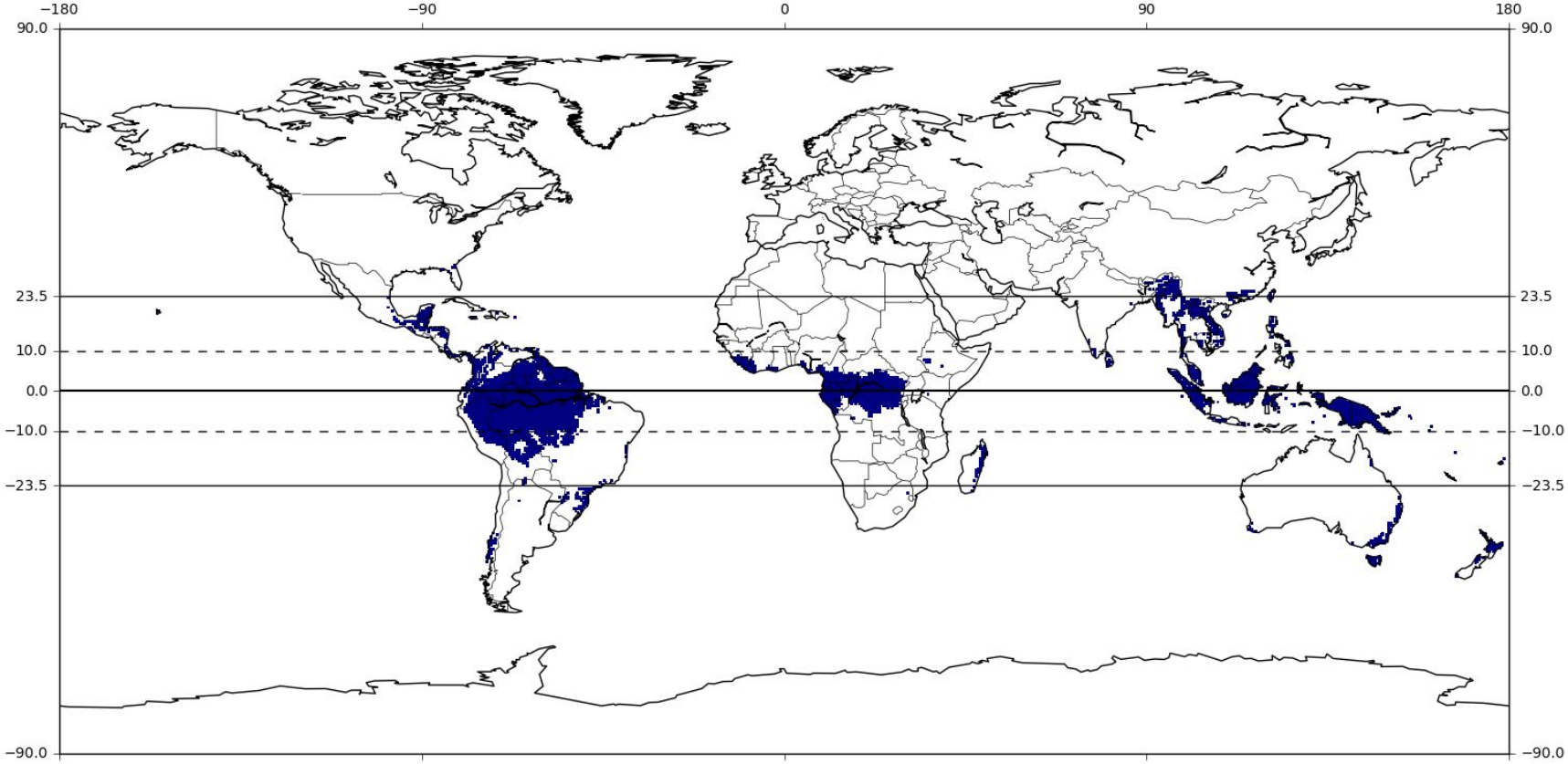
Global 10˚N-10˚S all landcover types



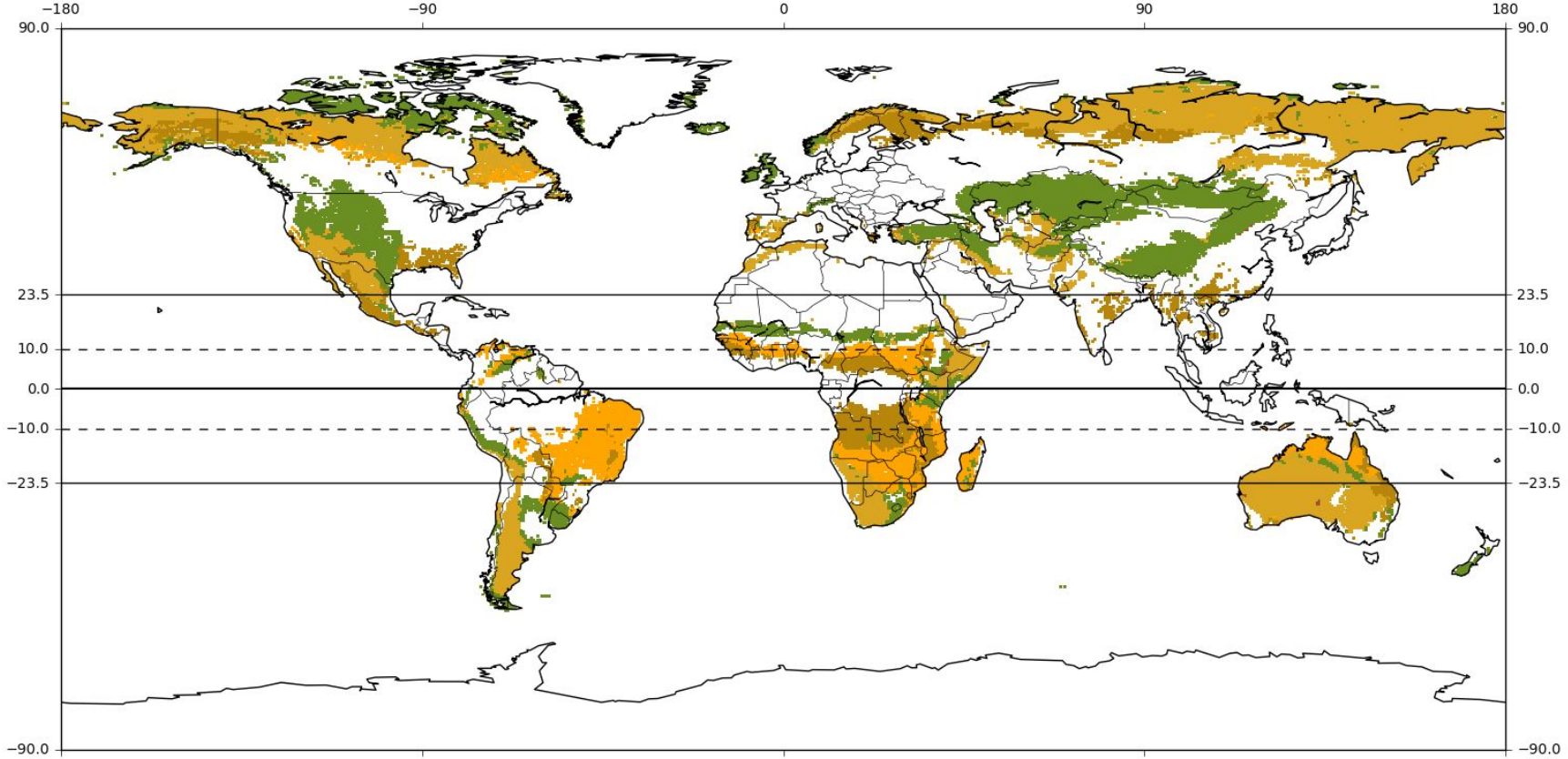
Global 10˚N-10˚S all landcover types



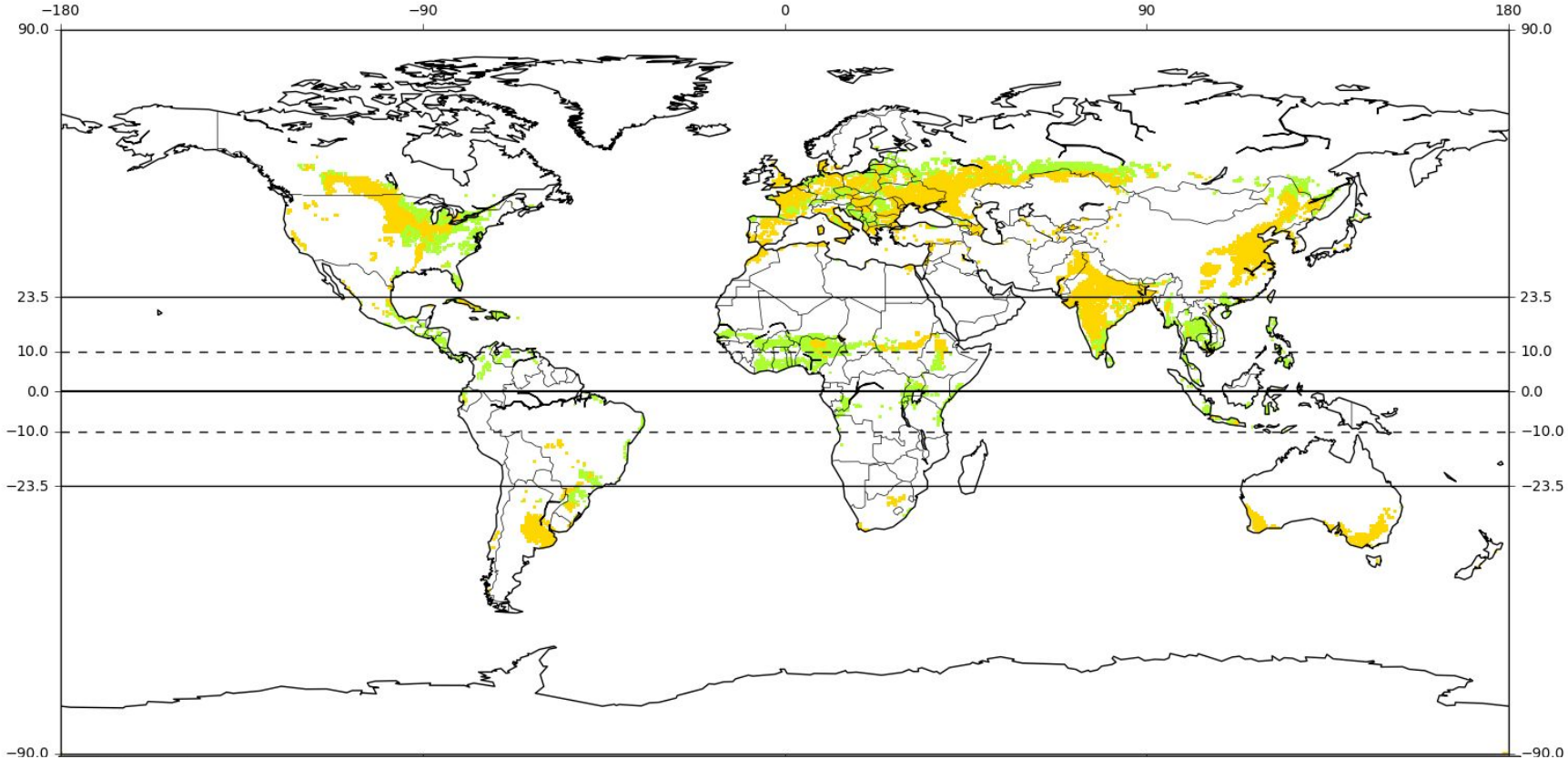
Tropical forest



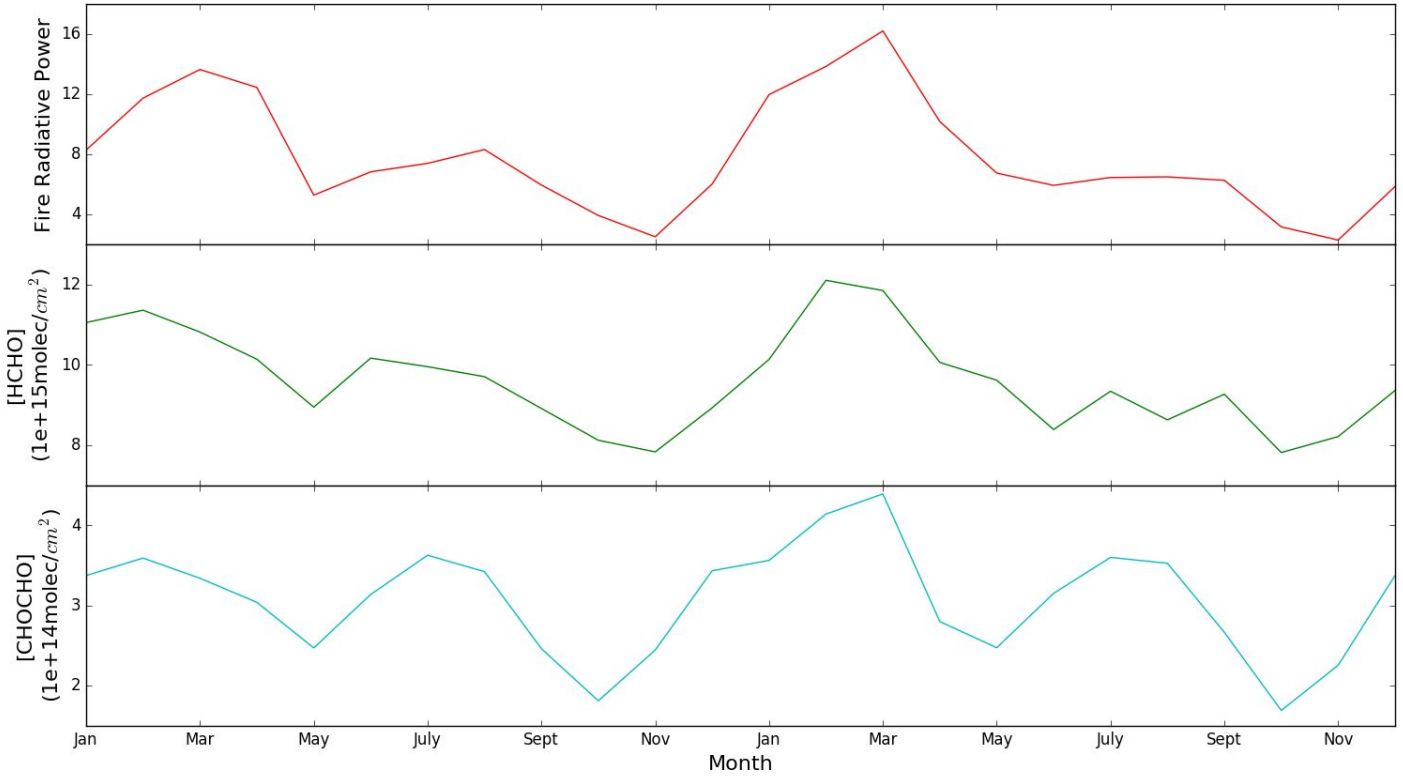
Savanna

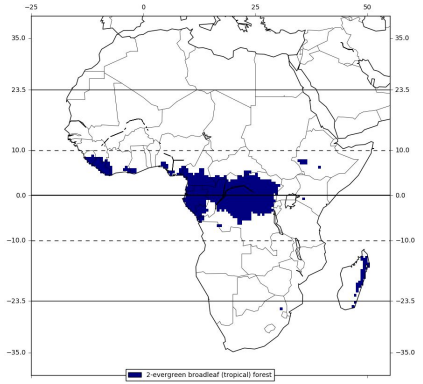


Cropland

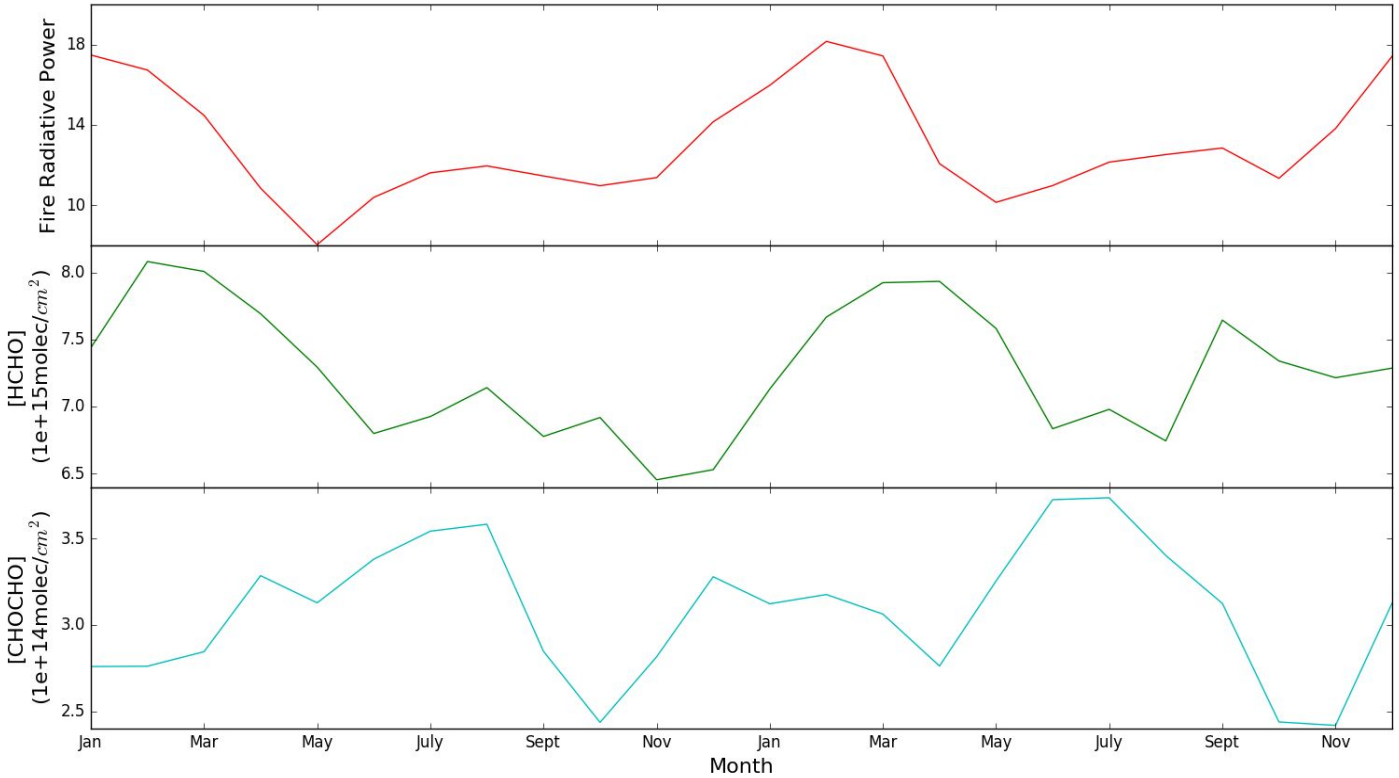


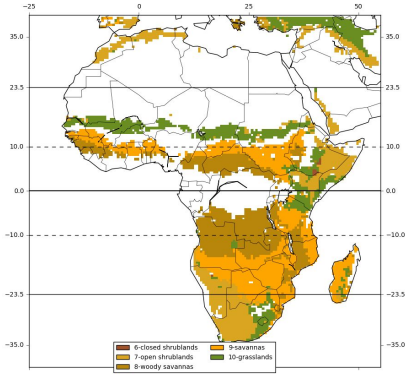
African tropical forests 10˚N-10˚S



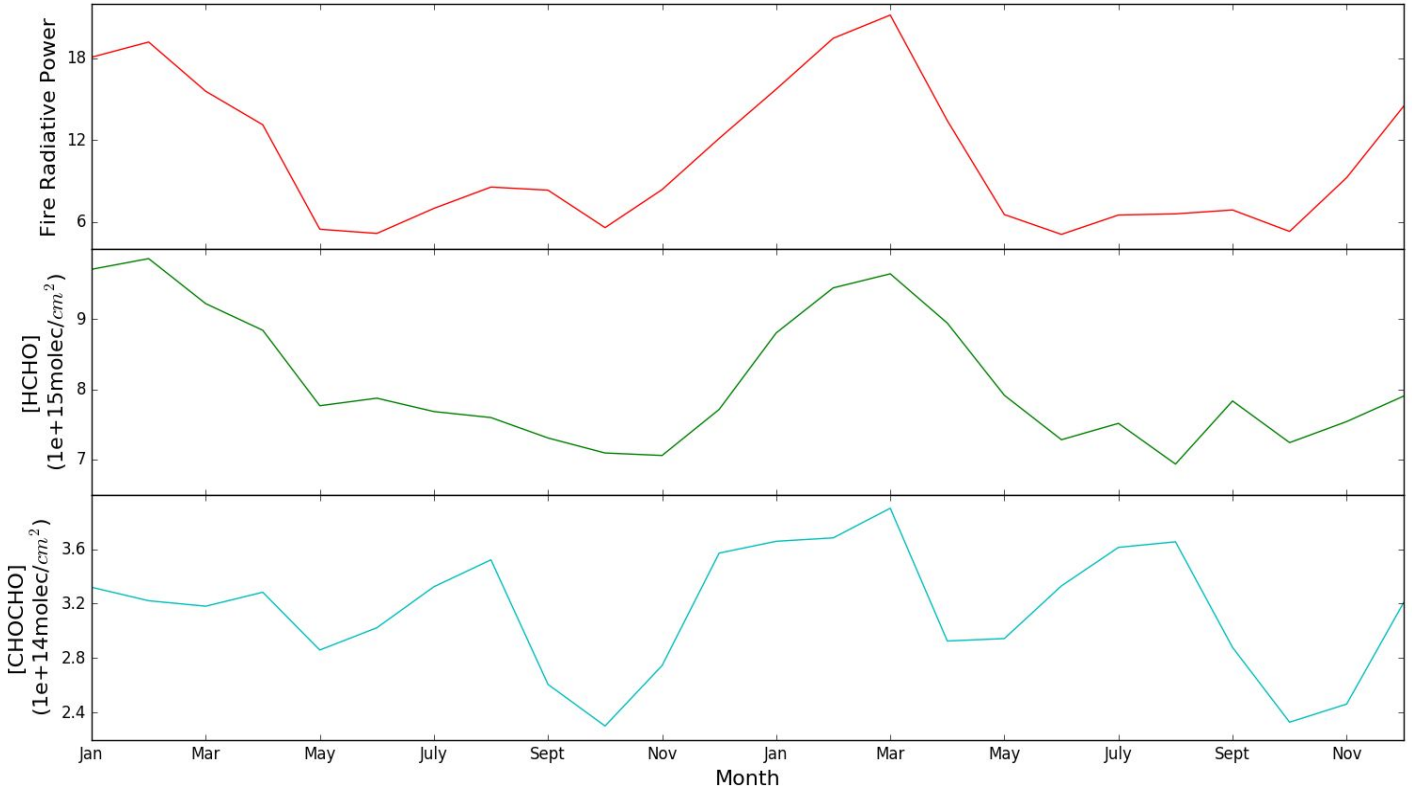


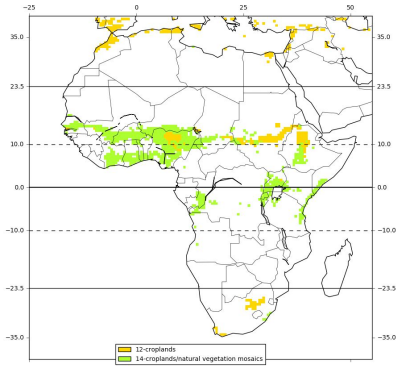
African savanna 10˚N-10˚S



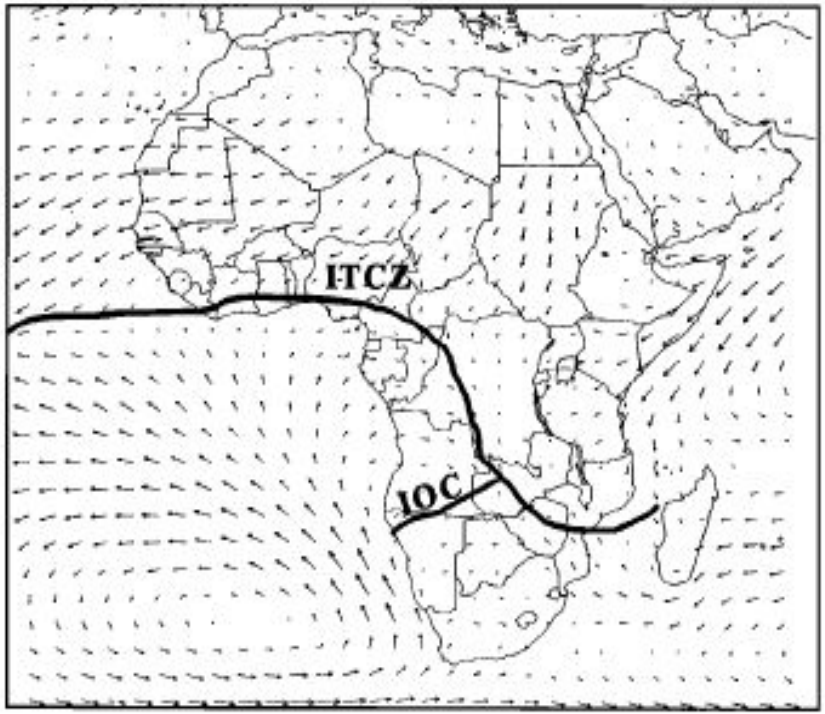


African croplands 10˚N-10˚S





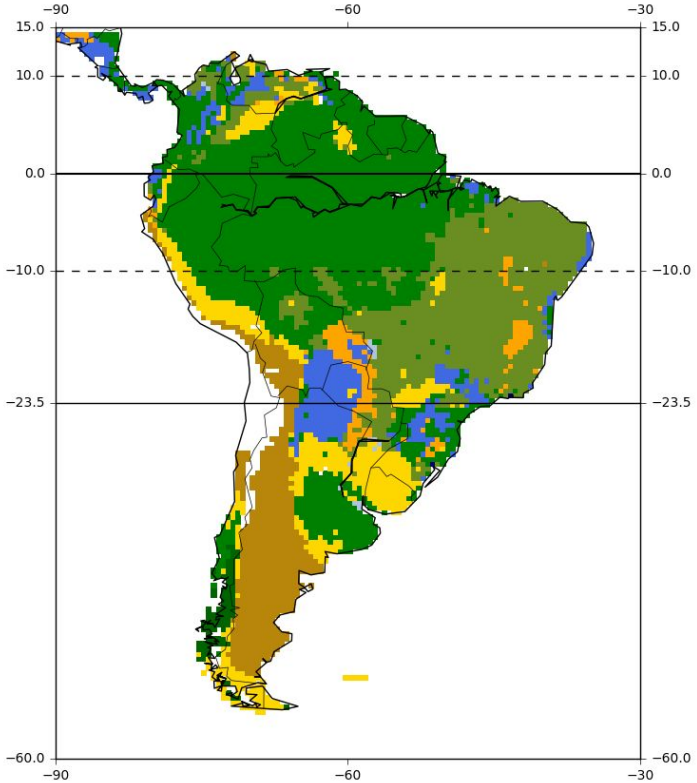
Discussion of HCHO peak delay



Delmas et al. 1999

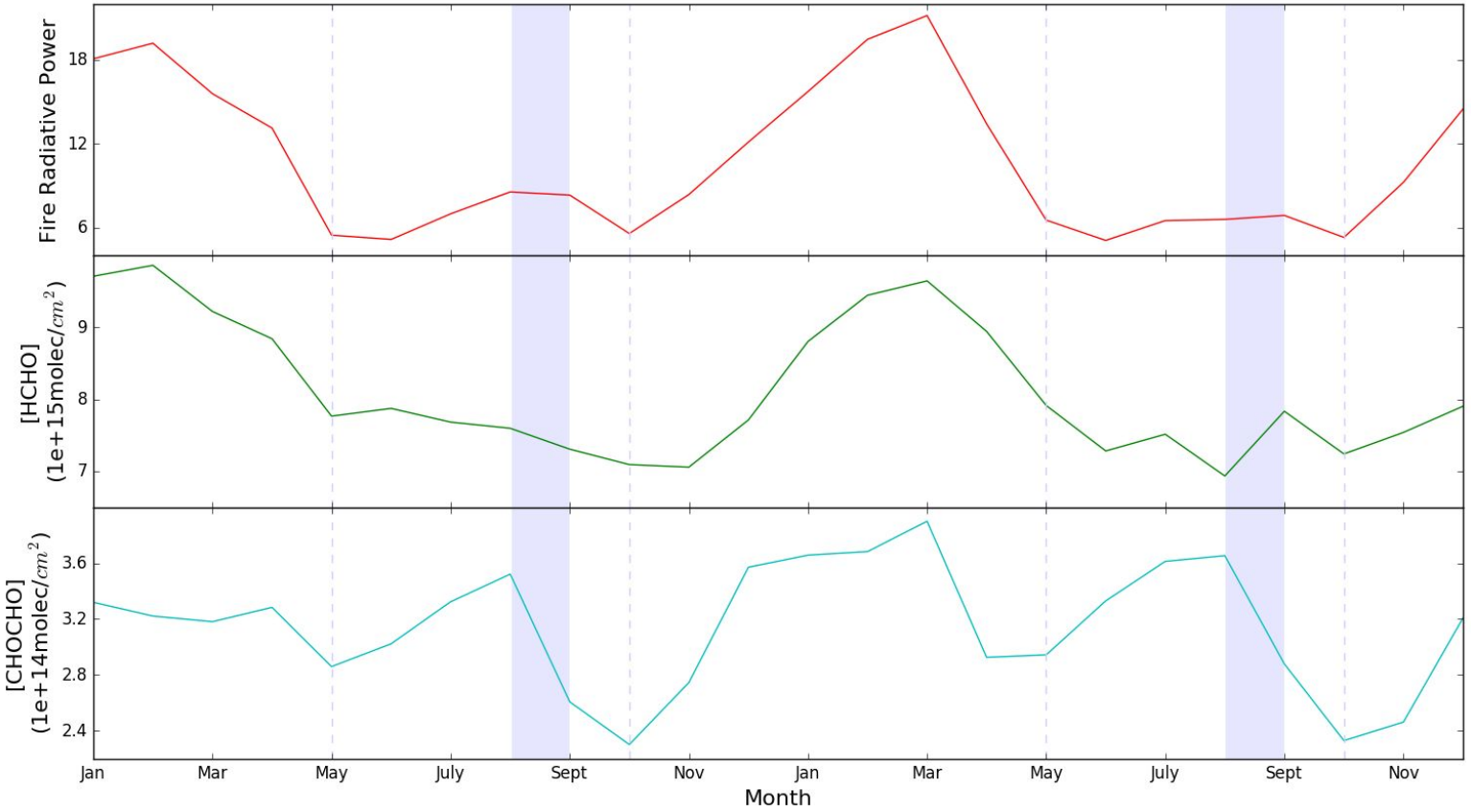
- Delay in savanna HCHO not from wind transport
- Fire type and fire emissions don’t correlate
- Above-ground fuel type and fire emissions don’t correlate
- Below-ground fuel contribution unknown
- Possible human intervention/causation

Further study of HCHO



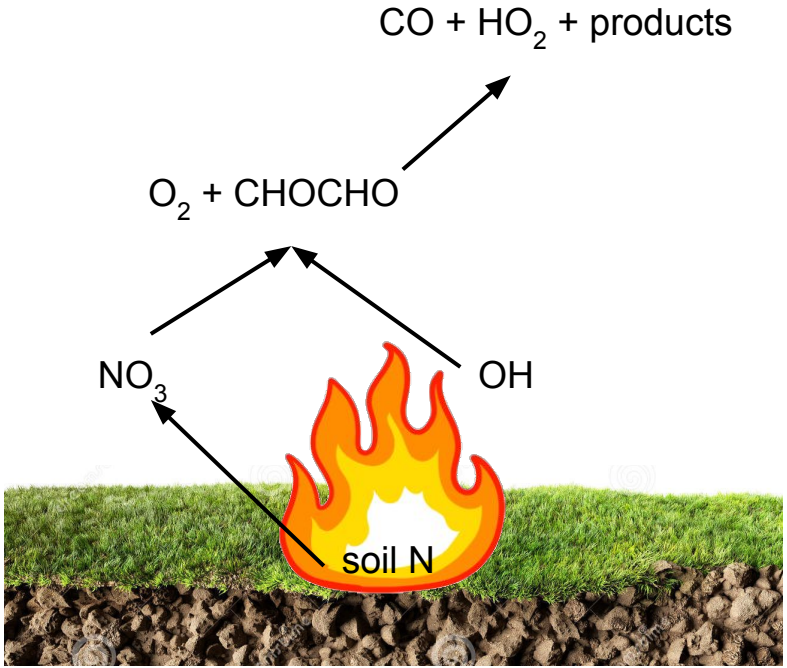
- South America
- Divide Northern and Southern Hemispheres
- Landcover maps
- Soil types and below-ground fuel
- Human influence in seasonality

African croplands - glyoxal



Glyoxal discussion

- CHOCHO + OH
  - Only 23% of CHOCHO uptake
- Glyoxal variance w/ VOCs
  - Isoprene and monoterpenes
  - Secondary organic aerosols
- Other CHOCHO sinks
  - Soil nitrogen
- Long-range transport of other reactive species?



$$\bullet OH + CHOCHO + O_2 \rightarrow 2CO + HO_2 + H_2O$$

$$CHOCHO + NO_3 + O_2 \rightarrow 2CO + HNO_3 + HO_2$$