Effects of Biomass Burning Emission Factors on CO modeling

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Global fire modeling

Role of fires in atmospheric chemistry:

- One of the major sources of trace gases and aerosols
- Contribution to interannual variability (IAV) in growth rates of many trace gases

Role of fires in global mortality:

- Influencing human health (reduced air quality)

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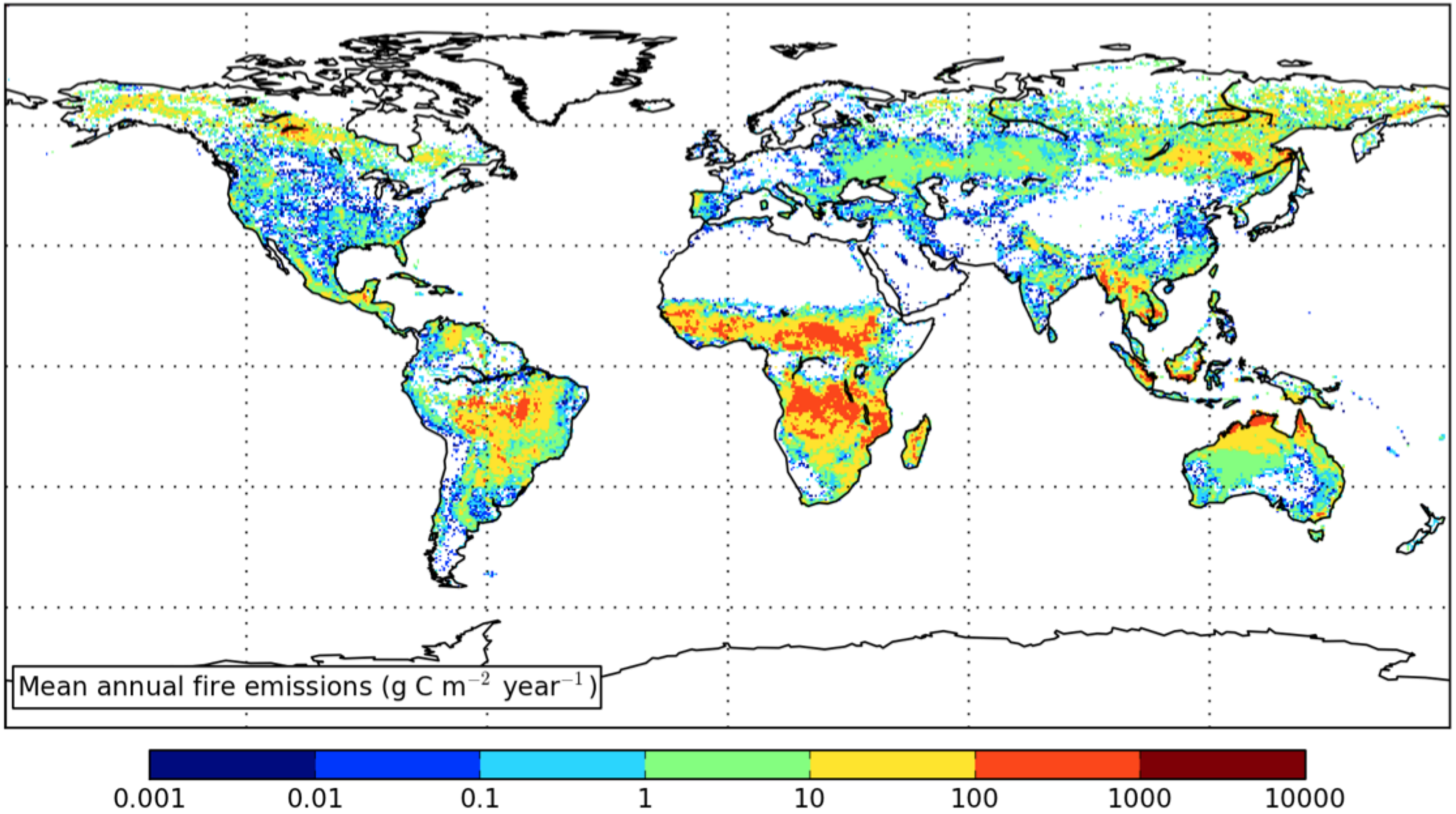
GFED fire emissions

burned area × fuel load × combustion completeness × emission factor

Integrated over time and space of interest



Van der Werf et al. (2010), ACP

GFED fire emissions

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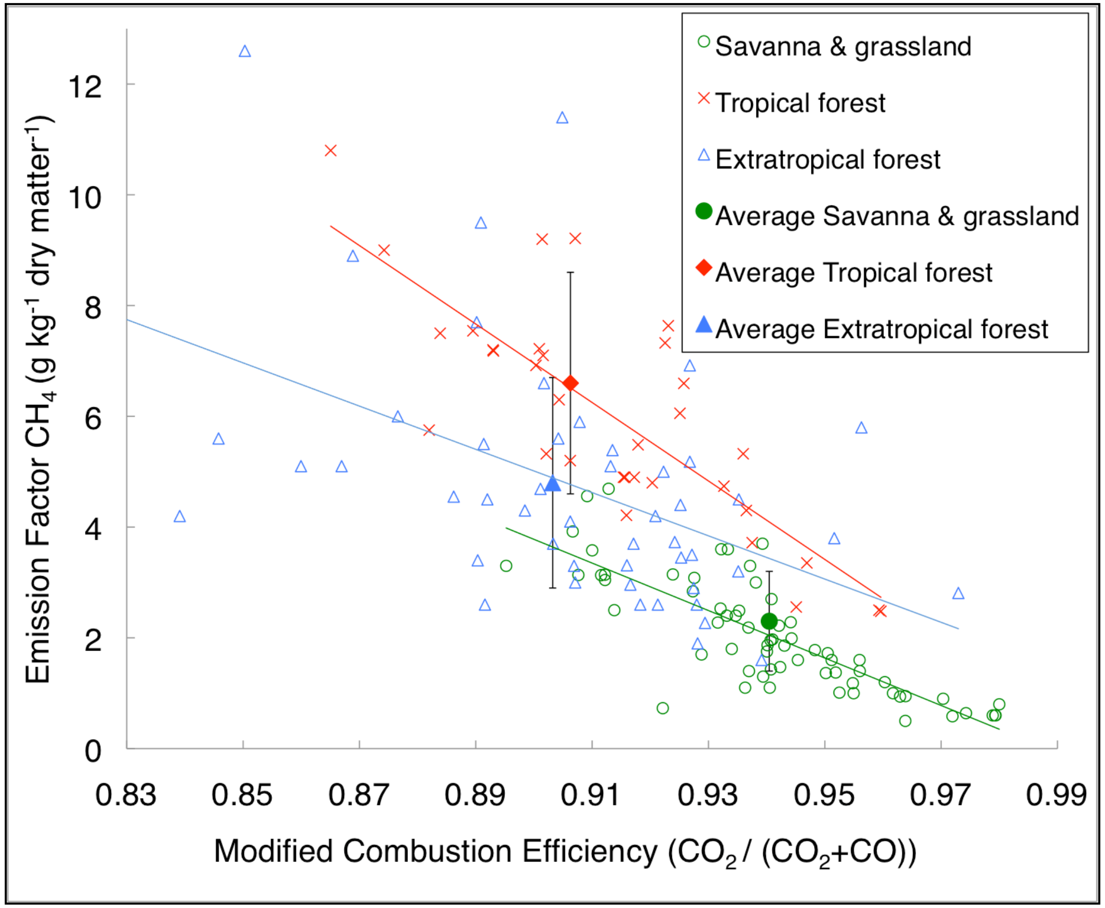
	Deforestation[1]	Savanna and Grassland[1]	Woodland[2]	Extratropical forest[1]	Agricultural waste burning[1]	Peat fires[3]
Carbon[4]	489	476	483	476	440	563
CO_2	1626	1646	1636	1572	1452	1703
CO	101	61	81	106	94	210
CH_4	6.6	2.2	4.4	4.8	8.8	20.8
NMHC	7.00	3.41	5.21	5.69	11.19	7.00
H_2	3.50	0.98	2.24	1.78	2.70	3.50
NO_x	2.26	2.12	2.19	3.41	2.29	2.26
N_2O	0.20	0.21	0.21	0.26	0.10	0.20
$PM_{2.5}$	9.05	4.94	7.00	12.84	8.25	9.05
TPM	11.8	8.5	10.2	17.6	12.4	11.8
TC	6.00	3.71	4.86	8.28	6.19	6.00
OC	4.30	3.21	3.76	9.14	3.71	4.30
BC	0.57	0.46	0.52	0.56	0.48	0.57
SO_2	0.71	0.37	0.54	1.00	0.40	0.71

Most global emissions assessments rely on static and biome-averaged EFs from the compilation of Andreae and Merlet (2001), including annual updates

Large natural variability in EFs measured



Van Leeuwen et al. (2011), ACP

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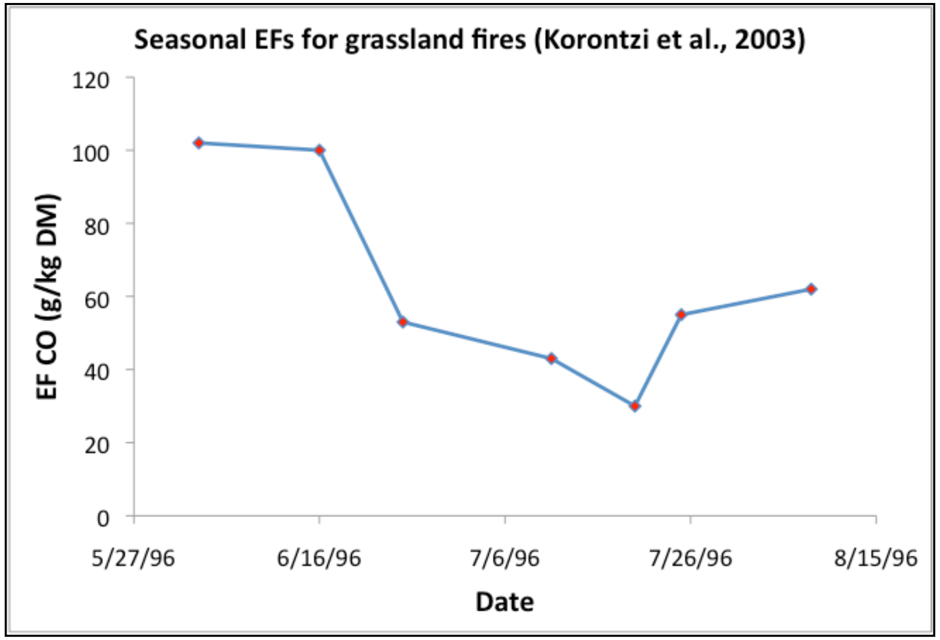
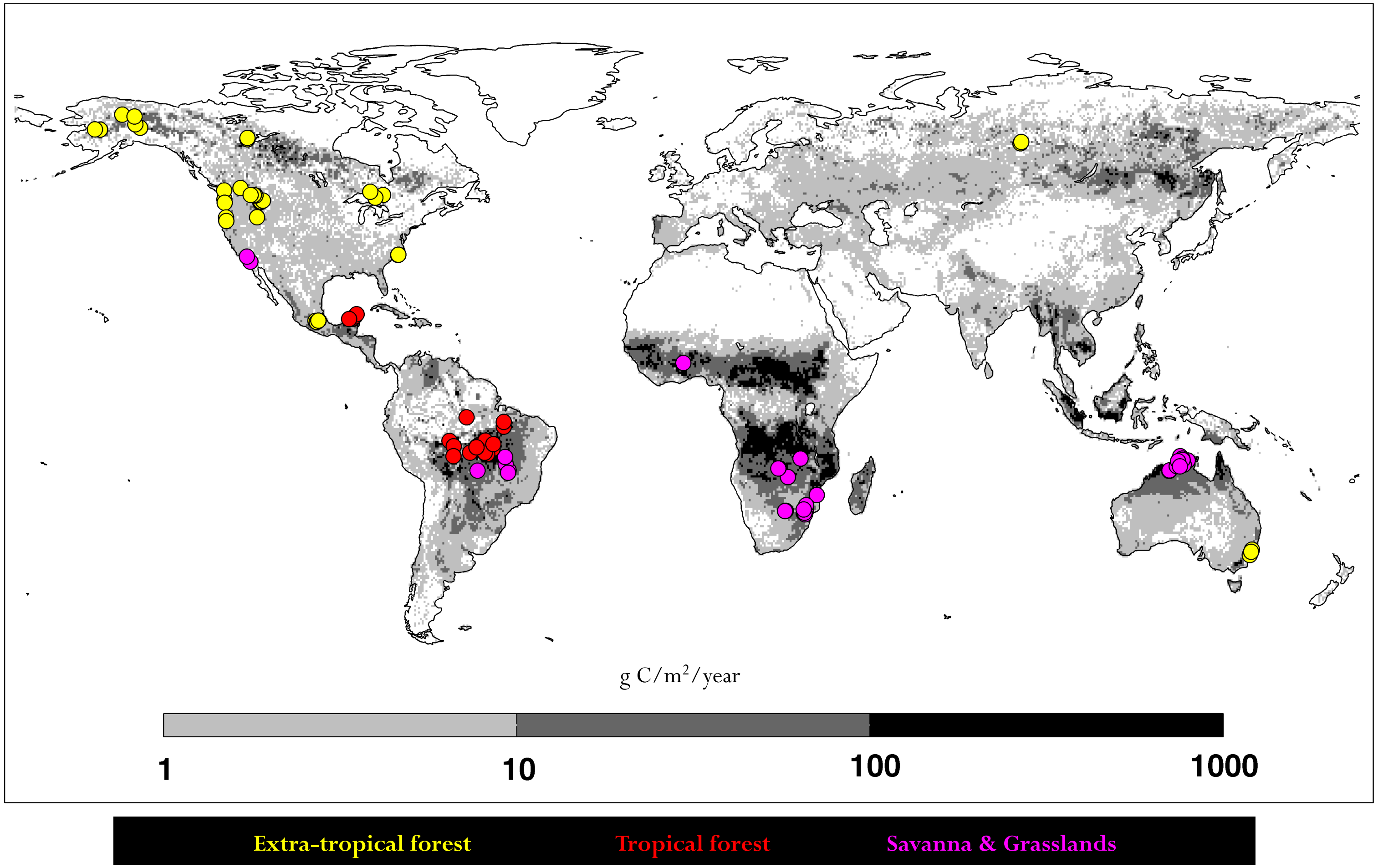


Korontzi et al. (2003), JGR

EF measurement representativeness



Van Leeuwen et al. (2011), ACP

New EF scenarios for CASA-GFED

	EF Scenario	EF dataset	Temporal variability	Spatial mapping	Additional information
1	GFED-A&M	A&M[a]	No	0.5° 5 biomes	Currently used in GFEDv3
2	GFED-AKAGI	AKAGI[b]	No	0.5° 7 biomes	In addition to GFED-A&M 3 biomes were added: chaparral, temperate and boreal forest
	ENVI-A&M	A&M	Monthly	0.5°	Driven by a suite of environmental parameters (Van Leeuwen et al. (2011))
	ENVI-AKAGI	AKAGI	Monthly	0.5°	Driven by a suite of environmental parameters (Van Leeuwen et al. (2011))
	MCE-STATIC	BOTH[c]	No	0.5° 7 fuel types	Pre-defined MCE[d] in GFED modeling framework
	MCE-SEASON	BOTH	Monthly	0.5° 7 fuel types	Pre-defined MCE in GFED modeling framework

Van Leeuwen et al. (2013), JGR-Atmospheres

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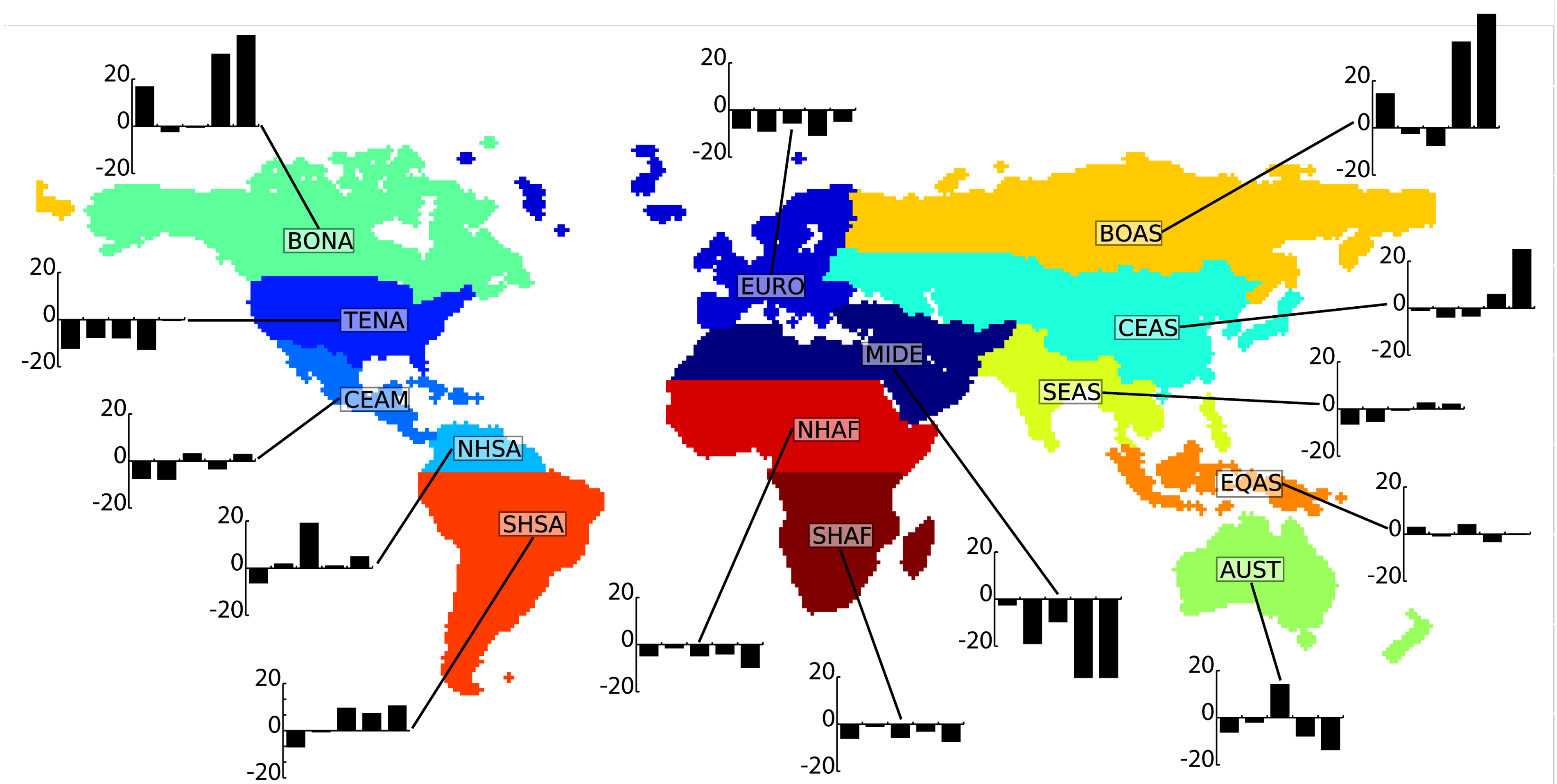
Van Leeuwen et al. (2013), JGR-Atmospheres

Bottom-up CO emissions

Differences (%) in mean annual CO emissions for the different EF scenarios



Van Leeuwen et al. (2013), JGR-Atmospheres

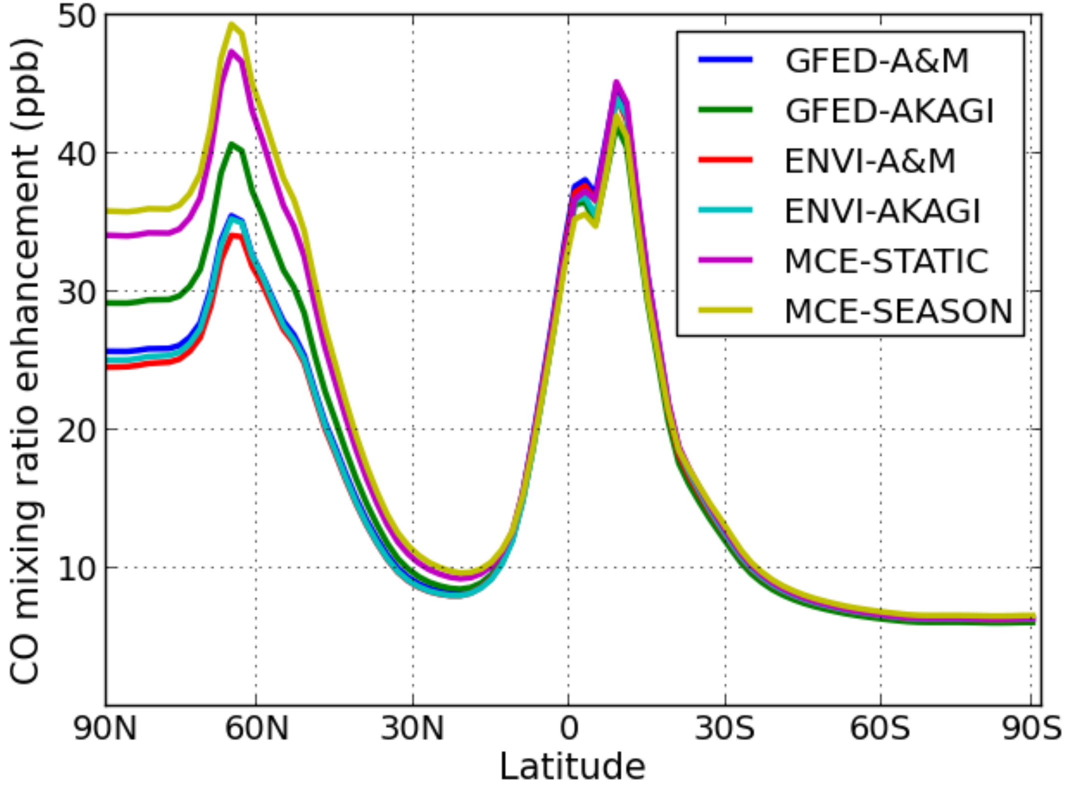
TM5 setup

- Same setup as Hooghiemstra et al. (2011; 2012)
- OH based on a rescaling factor of 0.92 (Spivakovsky et al., 2000)
- CO+OH loss rates as in Huijen et al. (2010)
- Removal of CO by dry deposition
- Production of CO from oxidation of NMVOC and CH_4

- CO emissions from 4 different categories:

- Anthropogenic (EDGAR 4.1)
- Natural: plants and oceans (Houweling et al., 2008) and NMVOC
- CH_4 mixing ratio field (Bergamaschi et al., 2005)
- Biomass Burning (based on the different EF scenarios)

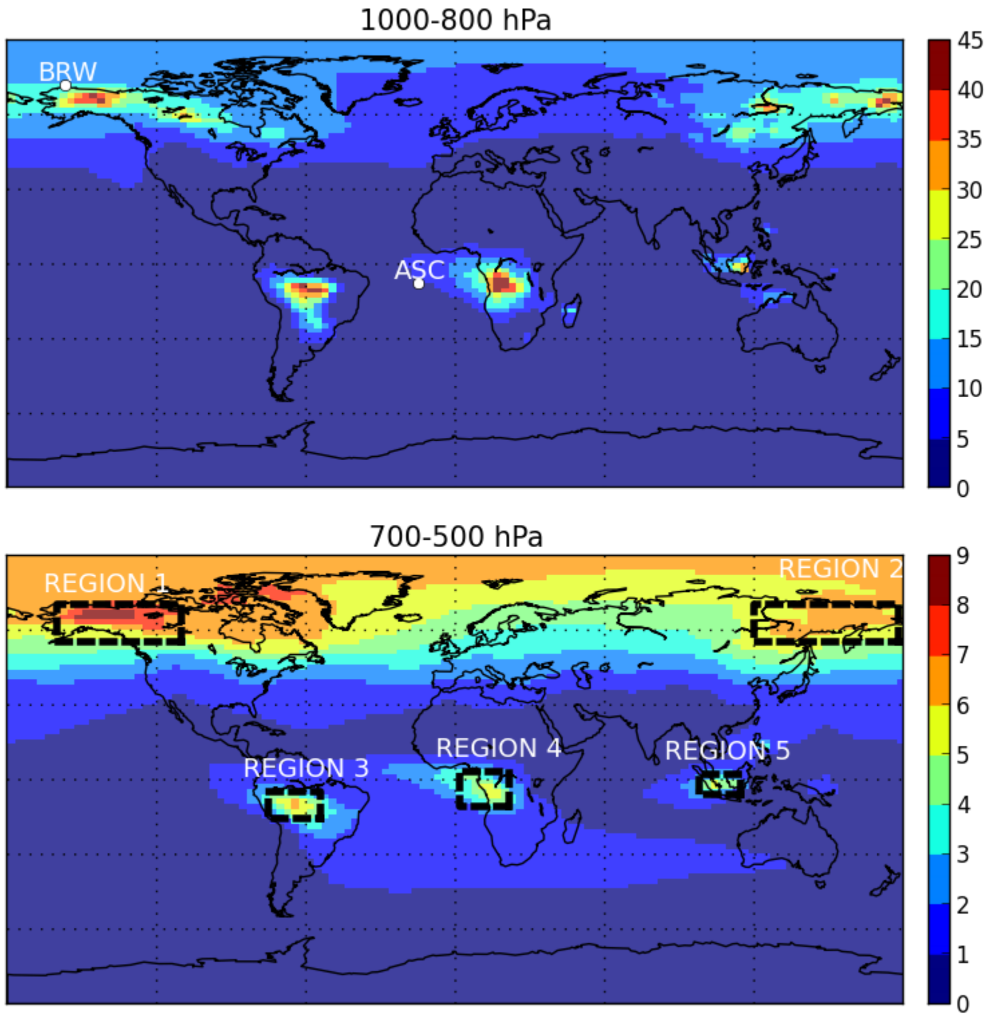
Impact on atmospheric CO mixing ratios



Van Leeuwen et al. (2013), JGR-Atmospheres

Impact on atmospheric CO mixing ratios

Range of CO mixing ratios (ppb) for the different EF scenarios



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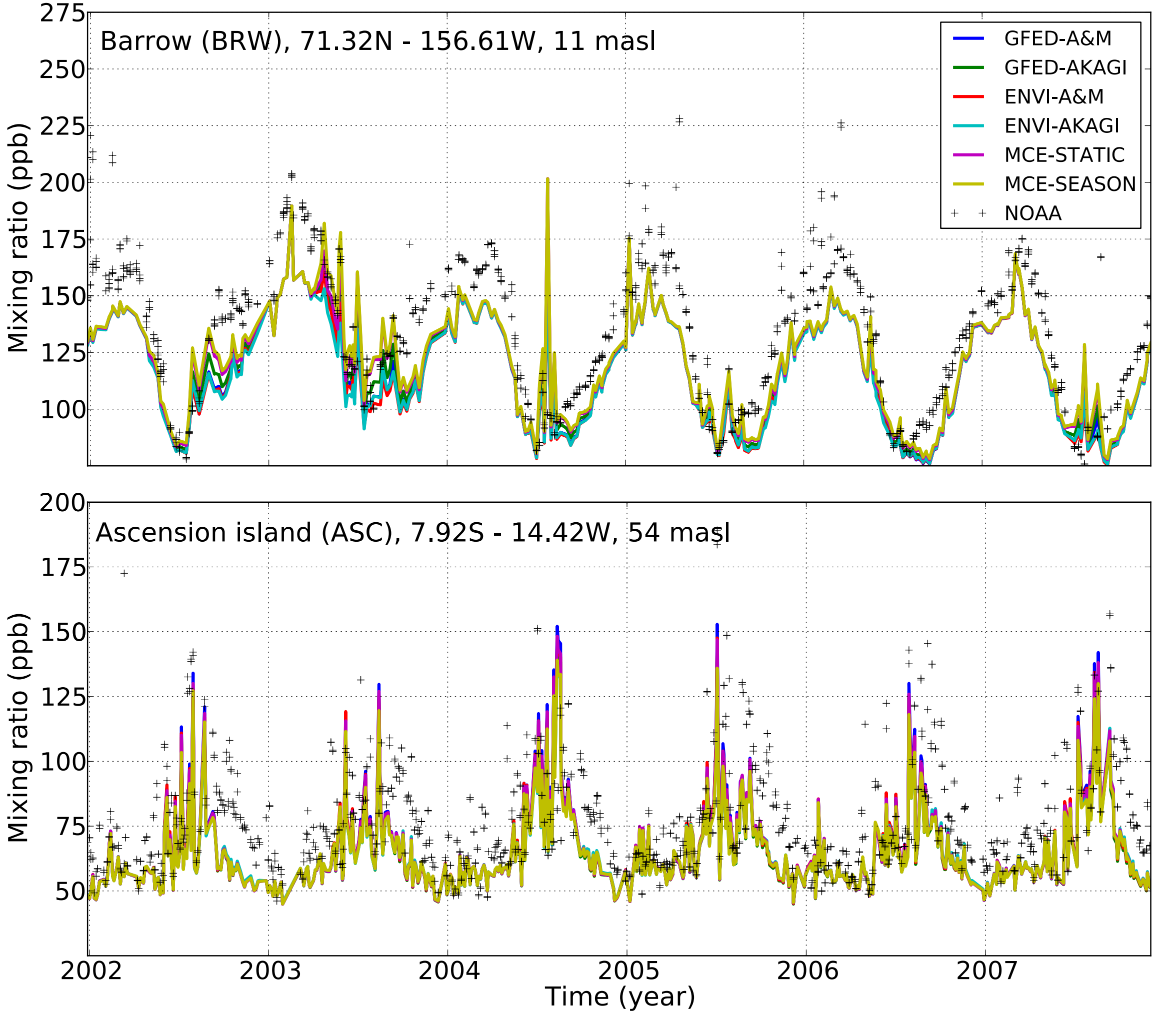
Validation: NOAA stations



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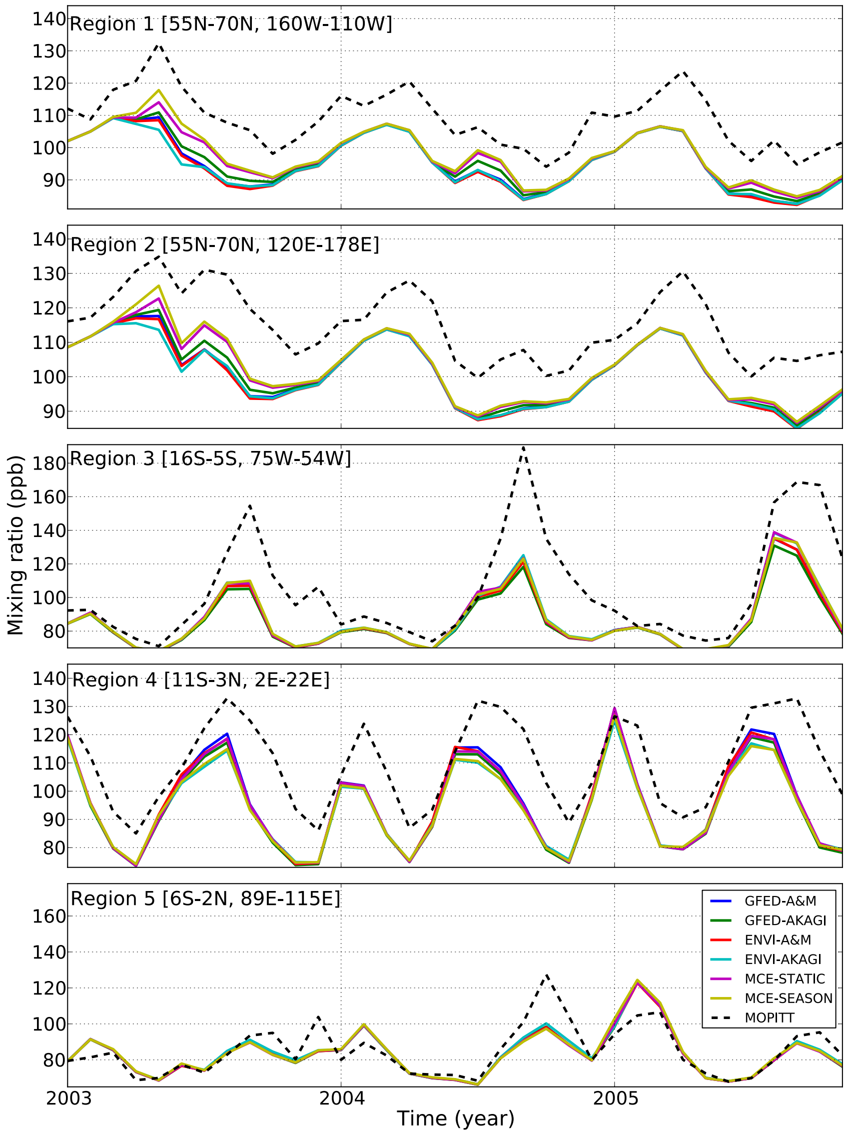
Validation: MOPITT CO



Van Leeuwen et al. (2013), JGR-Atmospheres

Wrapping up

- Dynamic EFs can have a significant impact on fire emissions
- Validation of different EF scenarios was difficult:
- TM error likely to be too large to constrain EFs
- Significant uncertainty within other GFED quantities
- Insufficient overlap between inverse modeling studies (BB CO)

<u>Future Research:</u>

- We need more EF measurements through the season, with a focus on ambient conditions and regions important from a fire perspective
- Focus on higher resolution EF modeling
- Multidisciplinary approach: setup of more biomass burning experiments where emission ratios are simultaneously measured from ground, air, and space