Role of tropical wetlands in renewed growth since 2007 & 2013

Drivers & uncertainties

Methane Workshop 2017

Acknowledgements : WETCHIMP & GCP wetland modelers

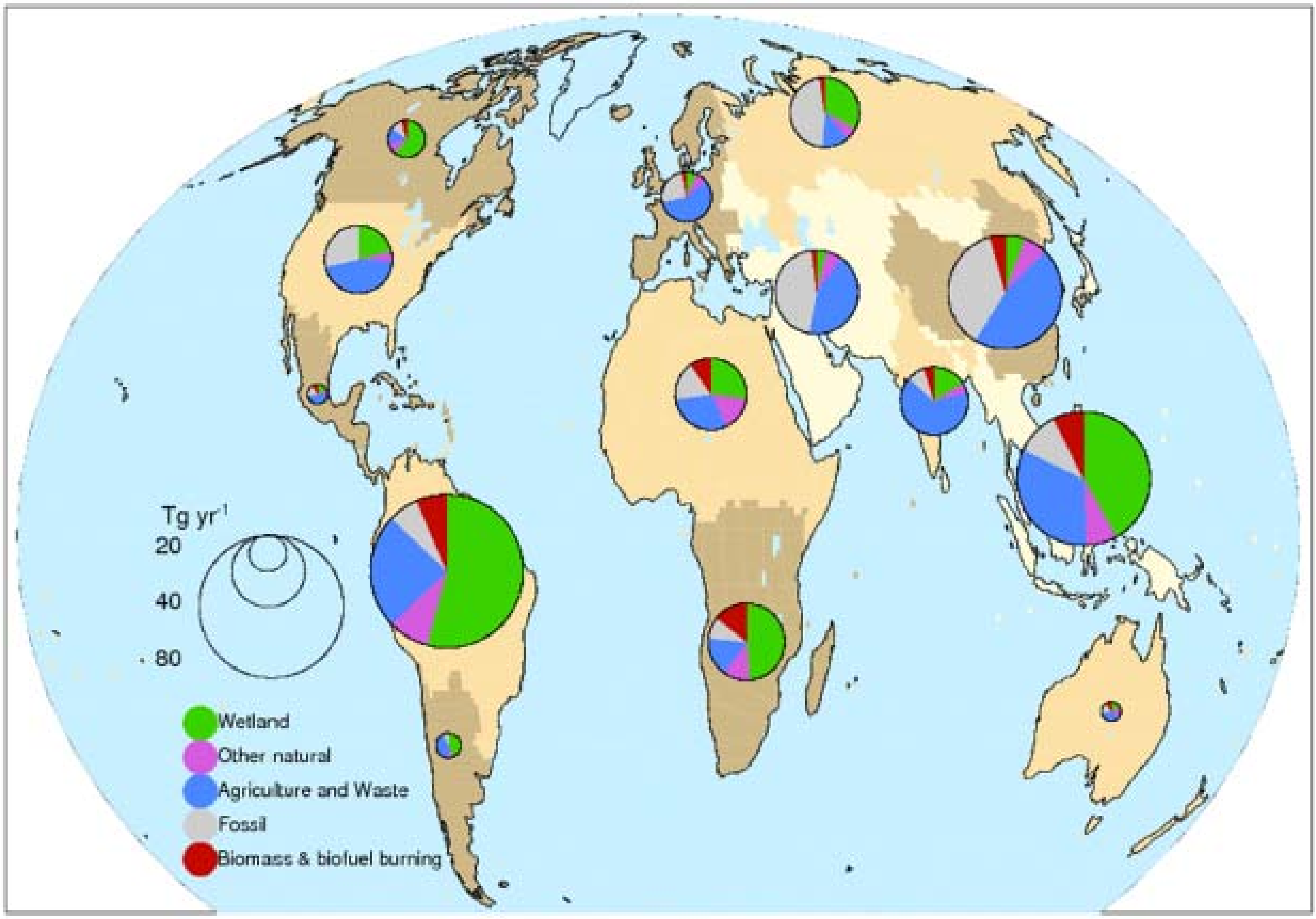
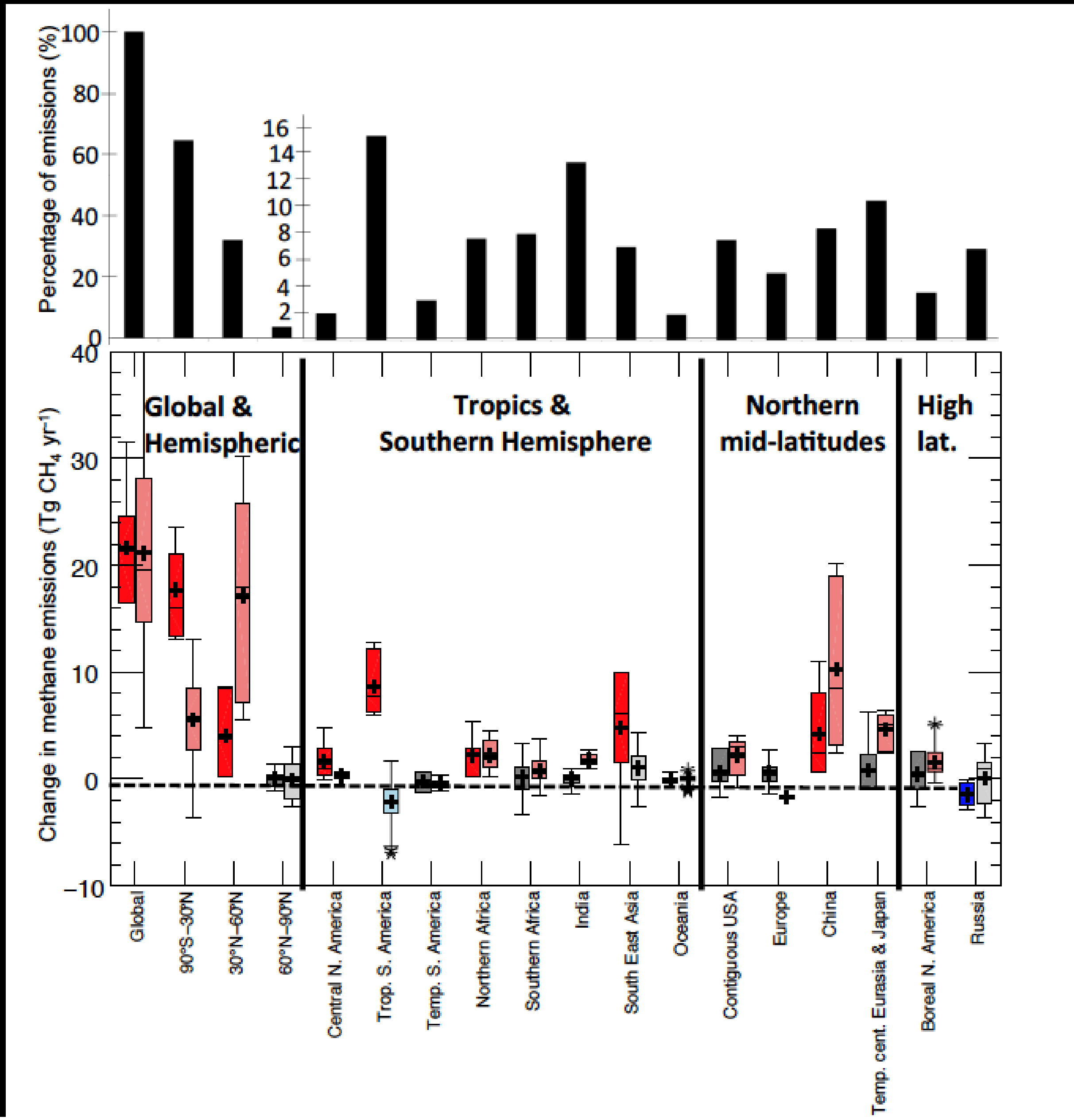


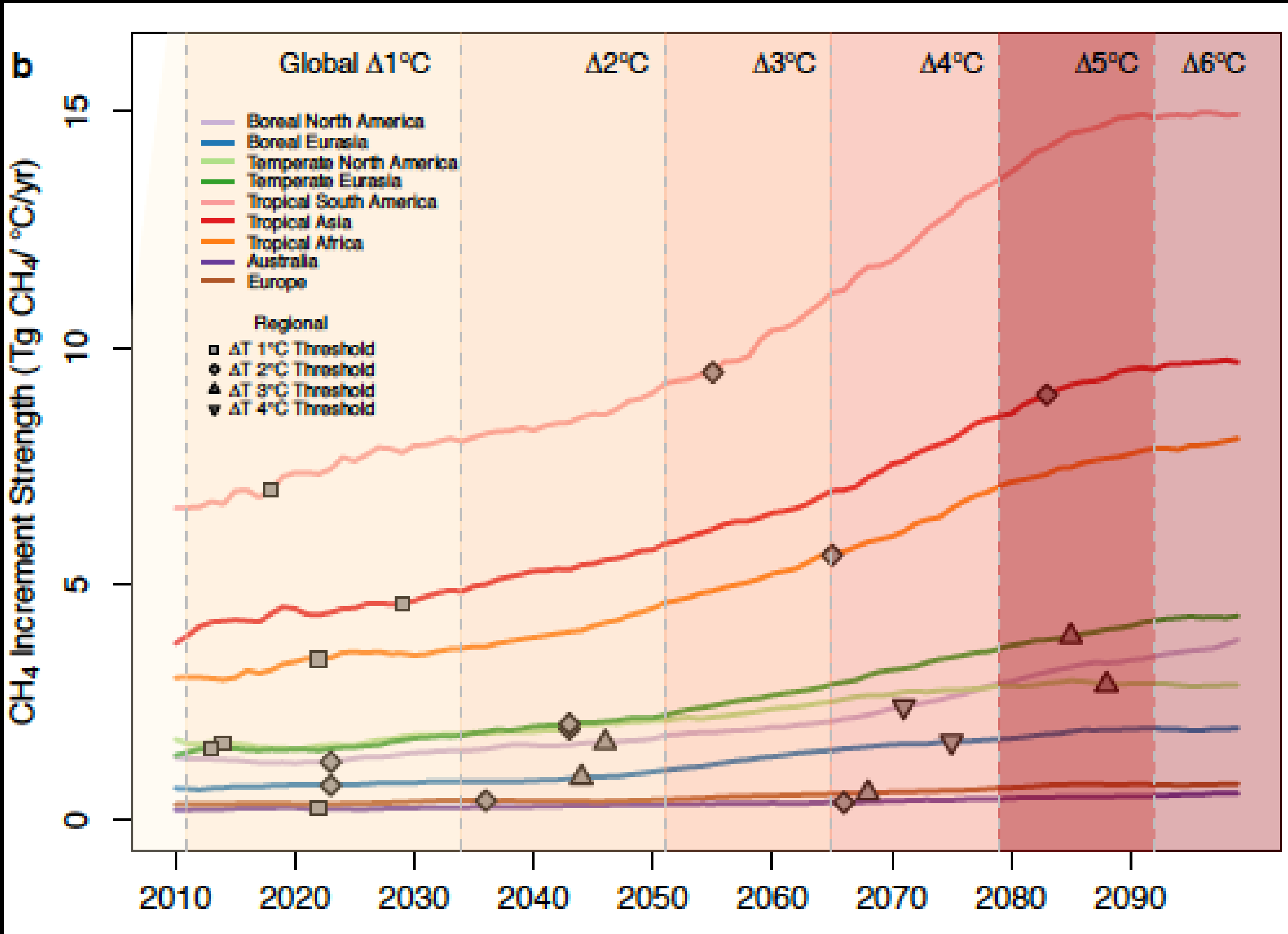
Figure 2. Annual methane emissions (in $Tg\,yr^{-1}$ for the 2003–2012 decade) for fourteen continental regions and five emission categories. Estimations are the average of an ensemble of top-down inversion models described in Saunois *et al* (2016).

Change in tropical CH_4 emissions



Saunois et al. 2017

Tropical CH_4 emission feedback



LPJ-wsl + TOPMODEL, permafrost, 106 RCP*GCM combinations

Zhang et al in review

Discussion topics for tropical wetlands

1. Distribution and dynamics of tropical wetlands
2. Climate sensitivity of tropical CH4 emissions
3. Current tropical CH4 monitoring networks
4. Optimizing monitoring requirements to reduce uncertainties

1. Distribution & dynamics of tropical wetlands

Definitions

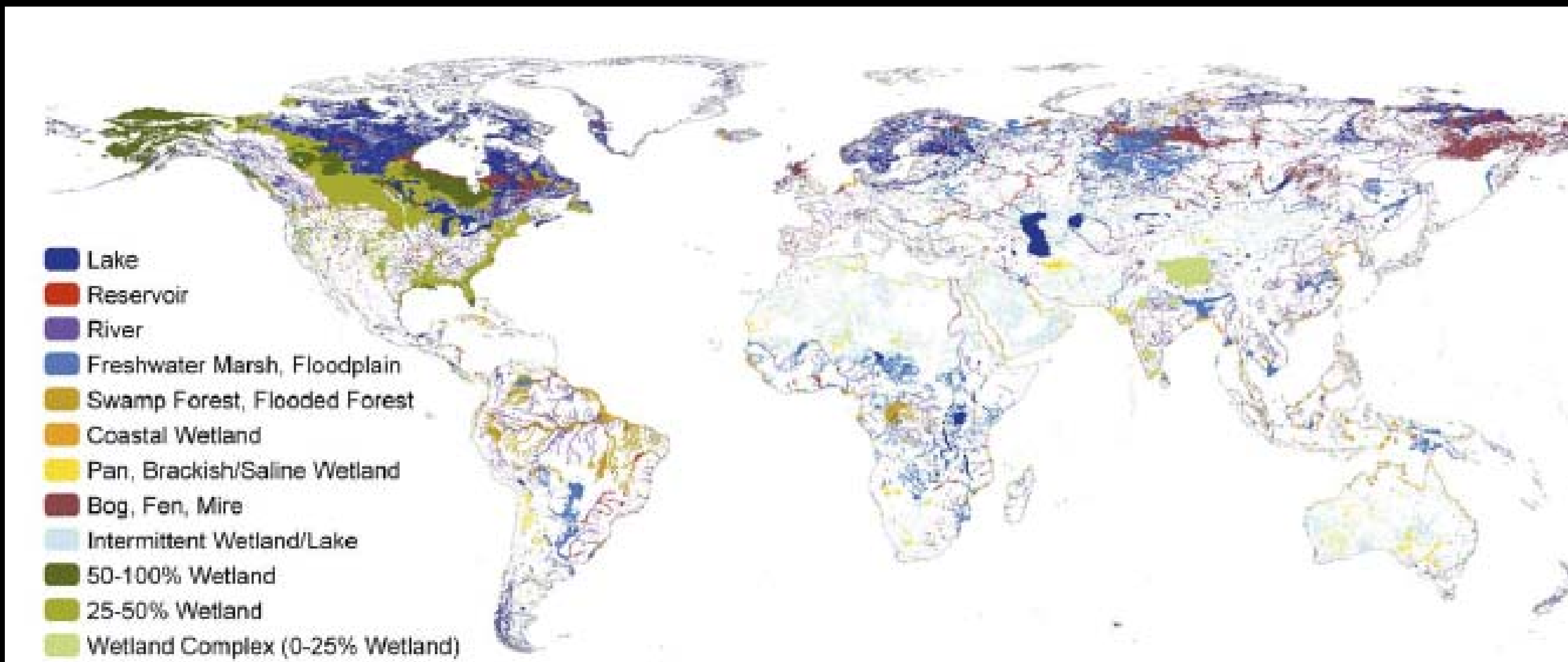
- Surface inundation
- Classification approaches (legal, AMSAR, USFWS…)

Wetland Classification Chart

Major Categories	*General Location*	*Wetland types*
Coastal Wetlands:		
Marine (undiluted salt water)	*Open coast*	*Shrub wetland, salt marsh, mangrove swamp*
Estuarine (salt/freshwater mix)	*Estuaries (deltas, lagoons)*	*Brackish marsh, shrub wetland, salt marsh, mangrove swamp*
Inland Wetlands:		
Riverine (associated w/ rivers and streams)	*River channels and floodplains*	*Bottomlands, freshwater marsh, delta marsh*
Lacustrine (associated w/ lakes)	*Lakes and deltas*	*Freshwater marsh, shrub and forest wetlands*
Palustrine (shallow ponds, misc. freshwater wetlands)	*Ponds, peatlands, uplands, ground water seeps*	*Ephemeral ponds, tundra peatland, ground water spring oasis, bogs*

1. Distribution & dynamics of tropical wetlands

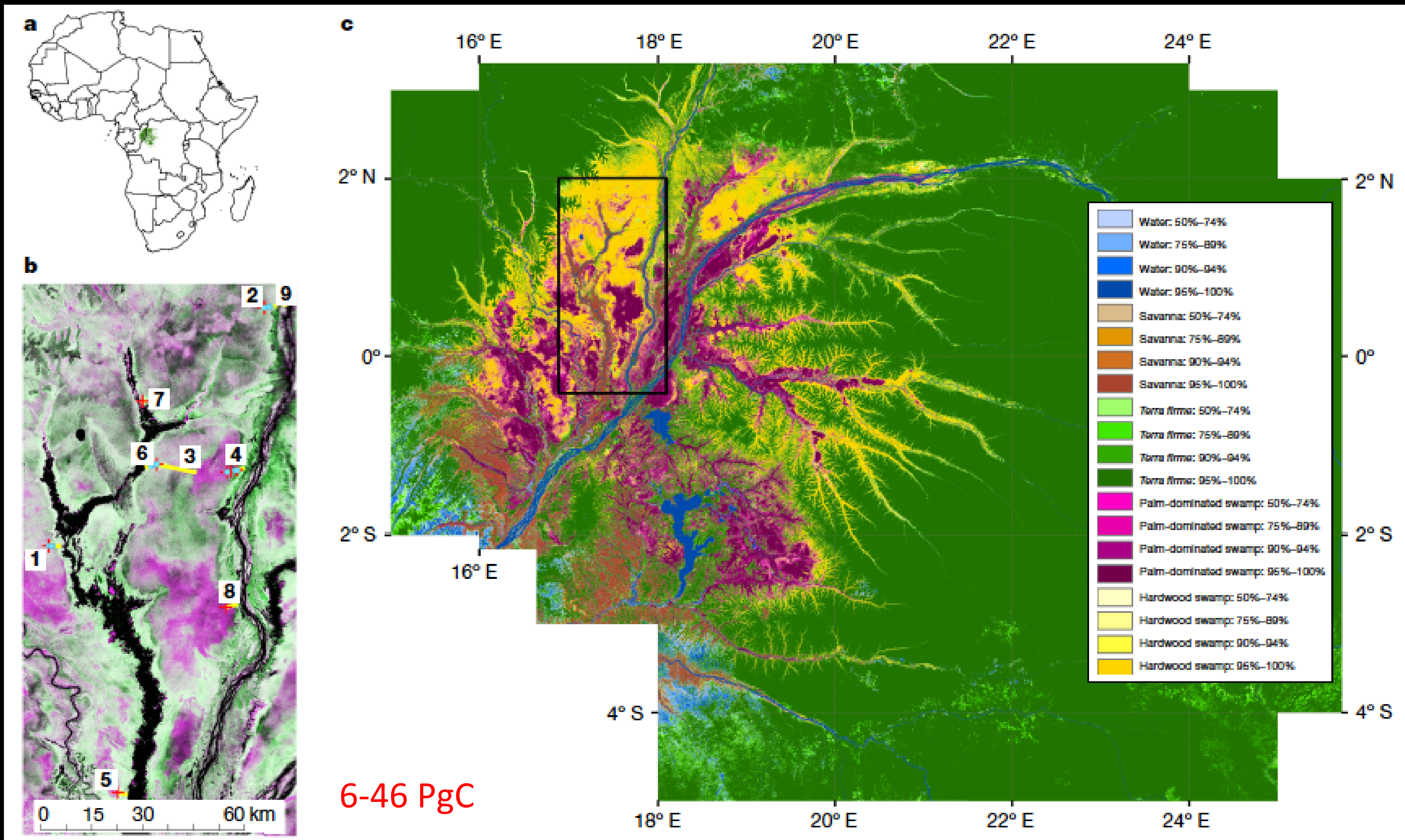
Static Maps



Lehner and Doll et al. 2004

1. Distribution & dynamics of tropical wetlands

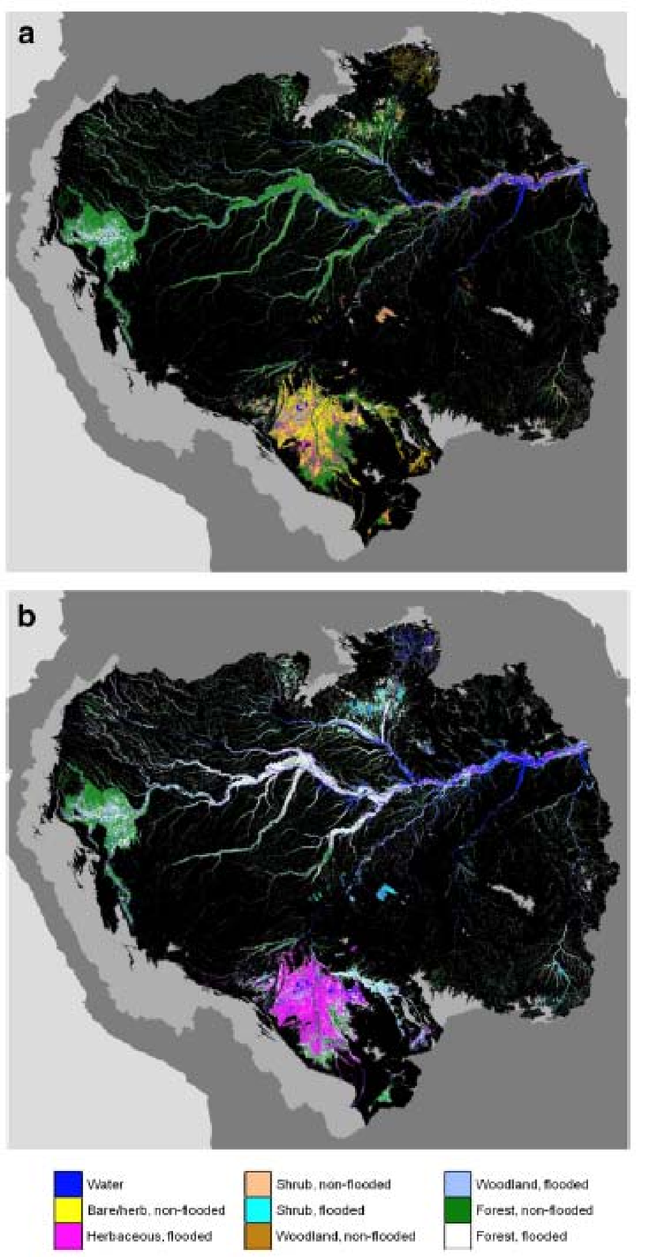
Static Maps



Dargie et al. 2017

1. Distribution & dynamics of tropical wetlands

Static Maps

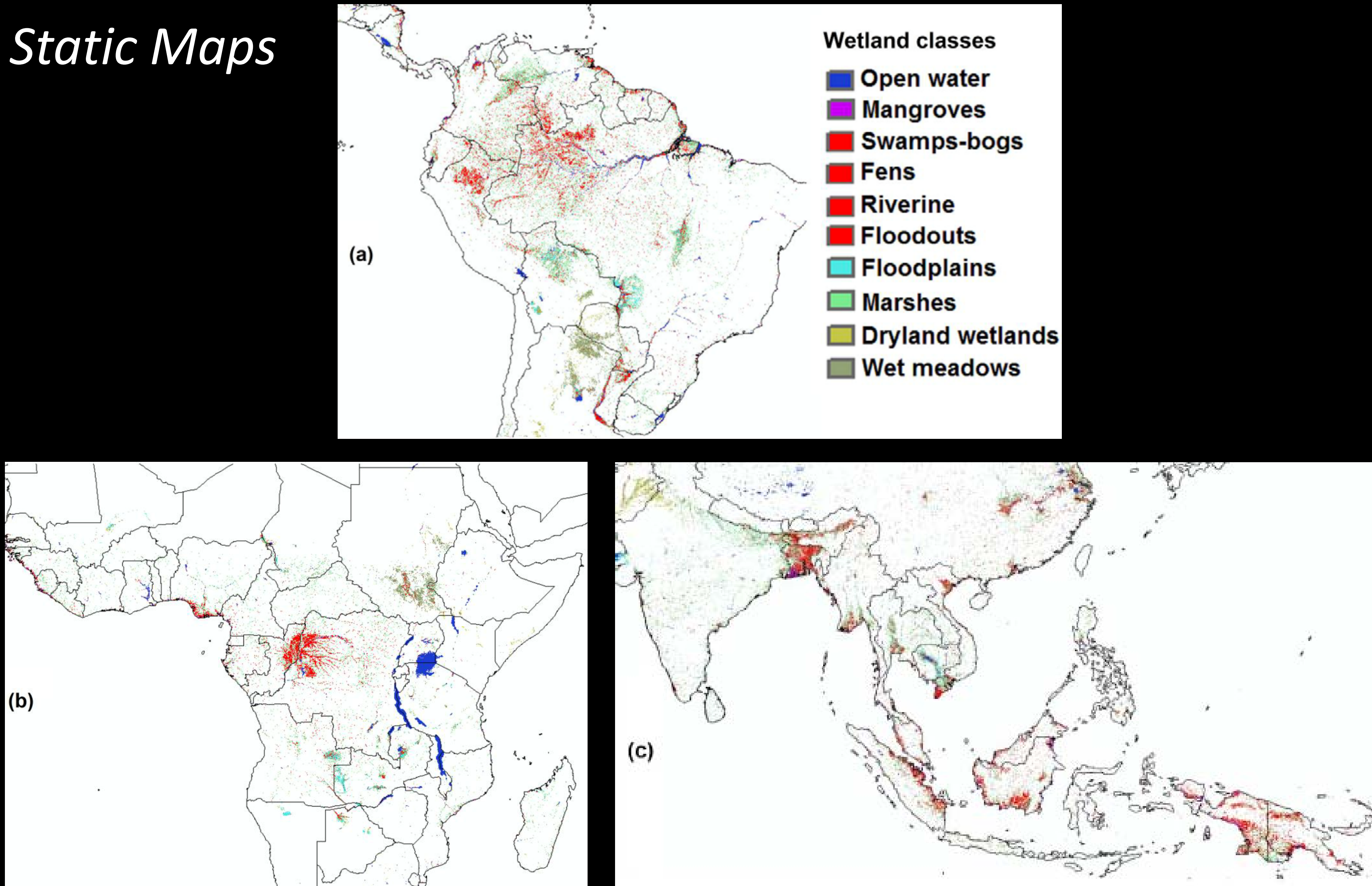


L-Band radar

Hess et al. 2015

1. Distribution & dynamics of tropical wetlands

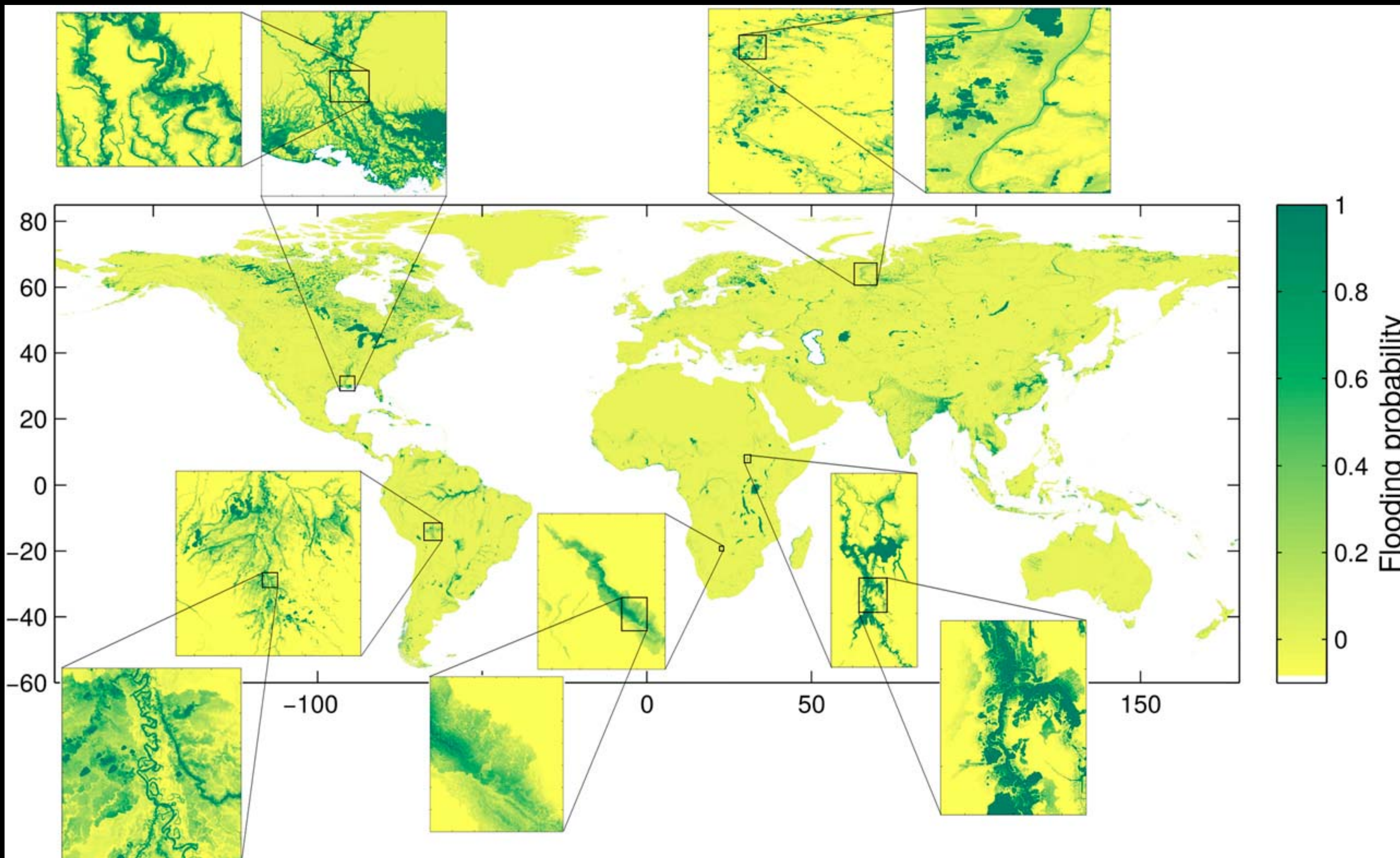
Static Maps



Gumbricht et al. 2017

1. Distribution & dynamics of tropical wetlands

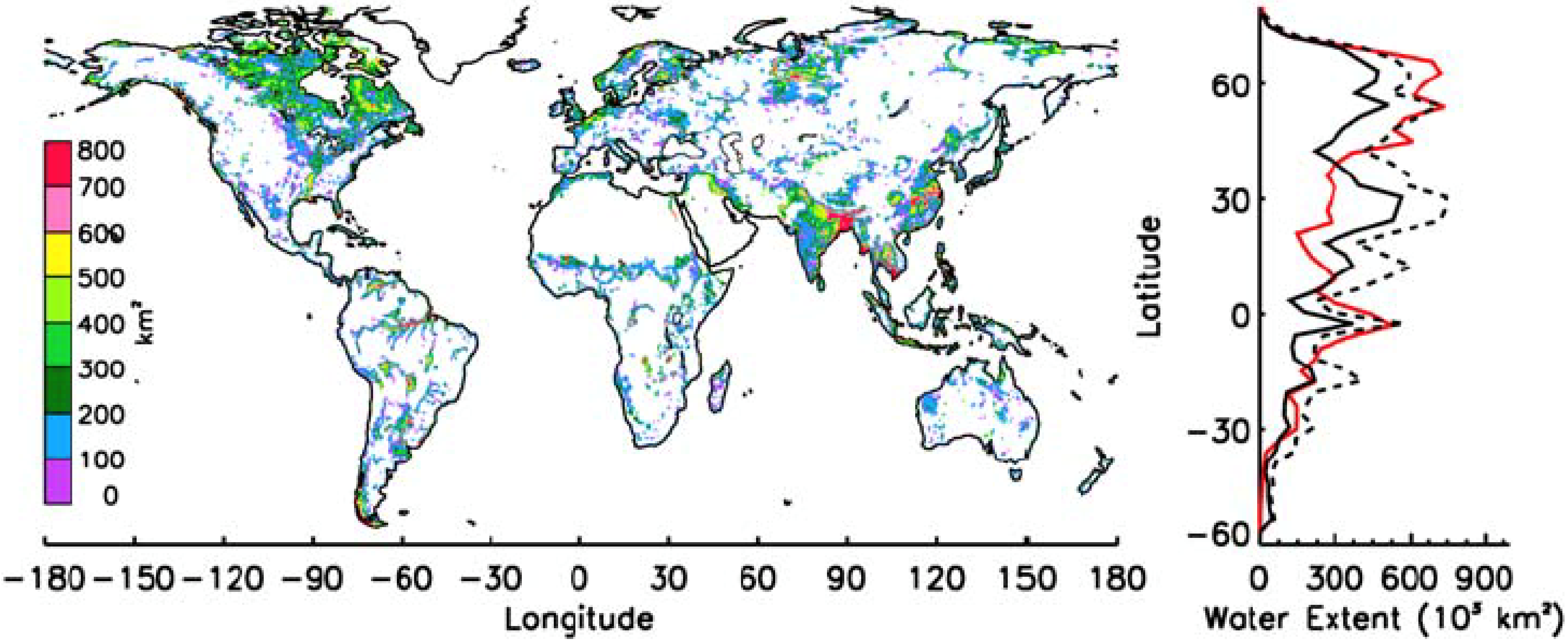
Static Maps



Aires et al. 2017

1. Distribution & dynamics of tropical wetlands

Dynamic Maps

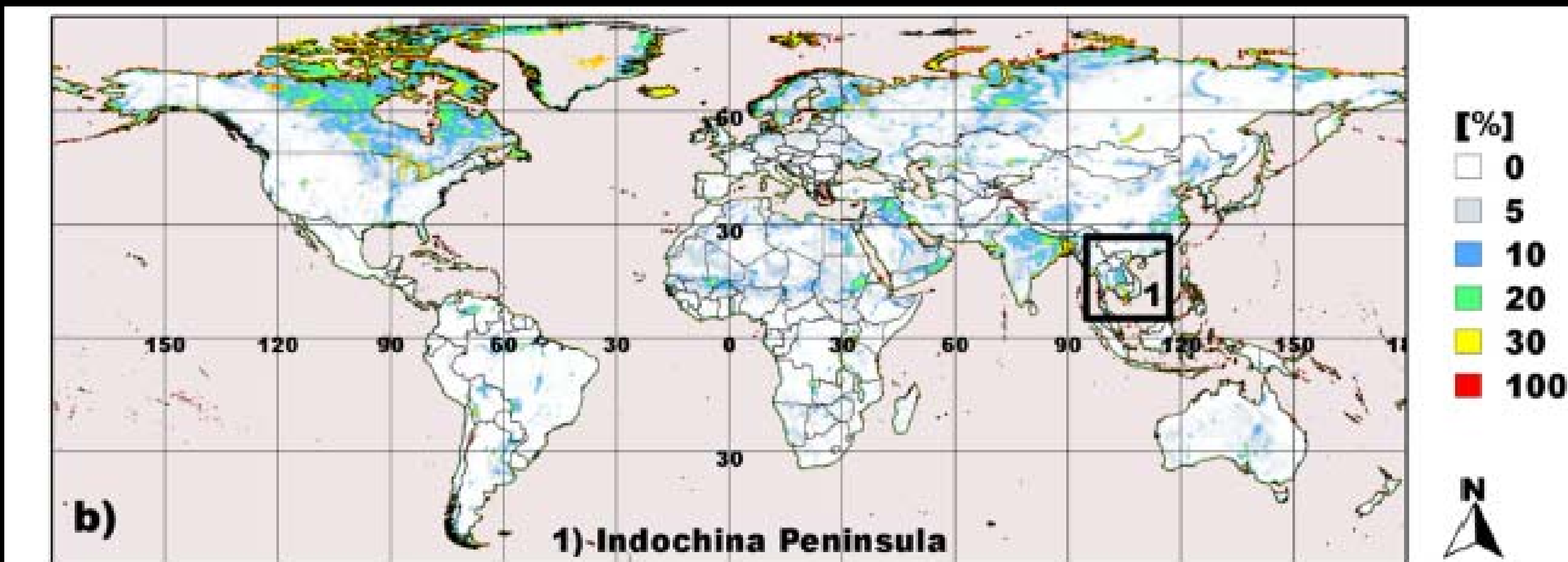


C & K-Band radar

Prigent et al. 2007

1. Distribution & dynamics of tropical wetlands

Dynamic Maps

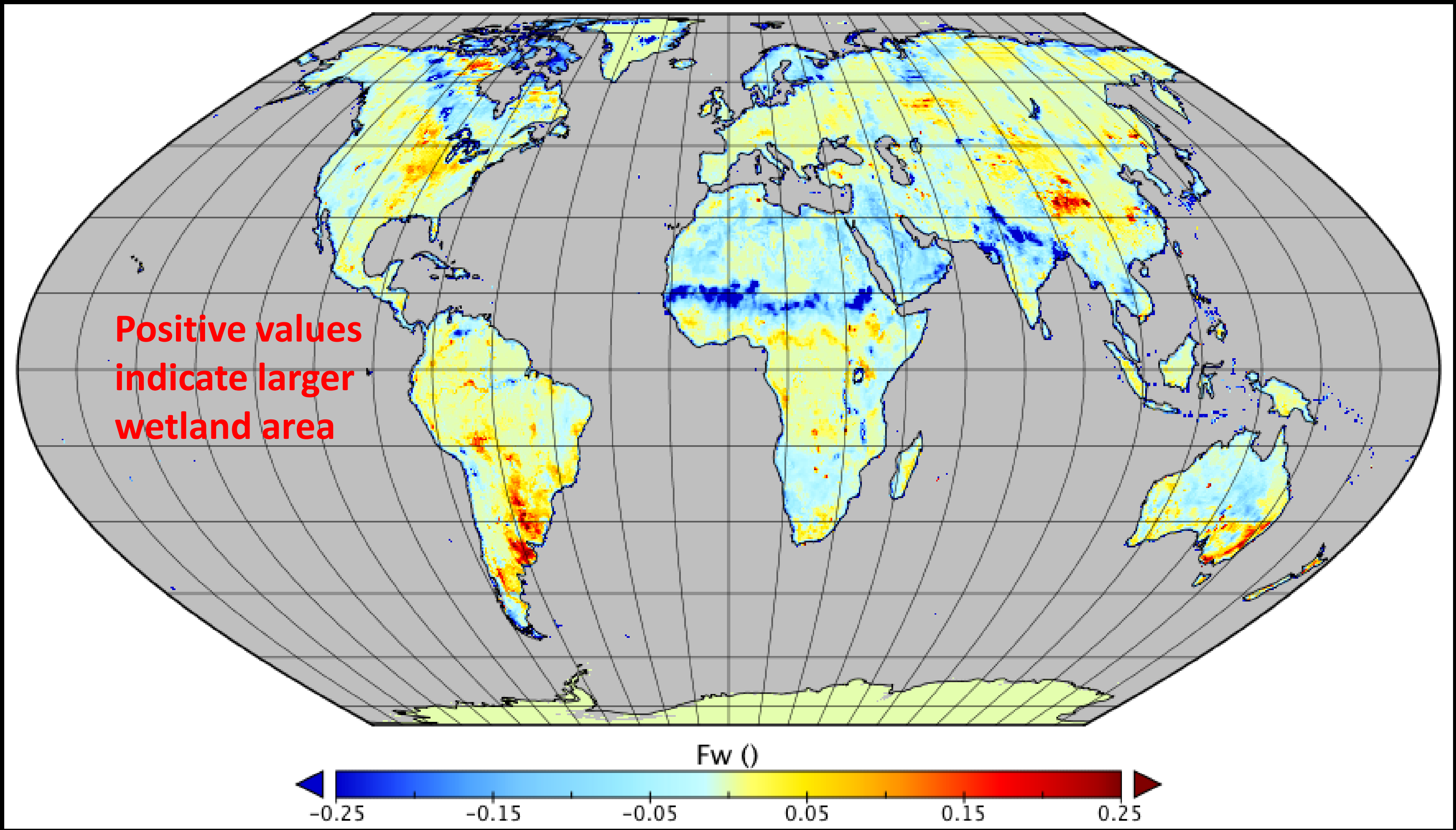


C & K-Band radar

Schroder et al. 2016

1. Distribution & dynamics of tropical wetlands

Dynamic Maps (difference between SMAP and SWAMPS)



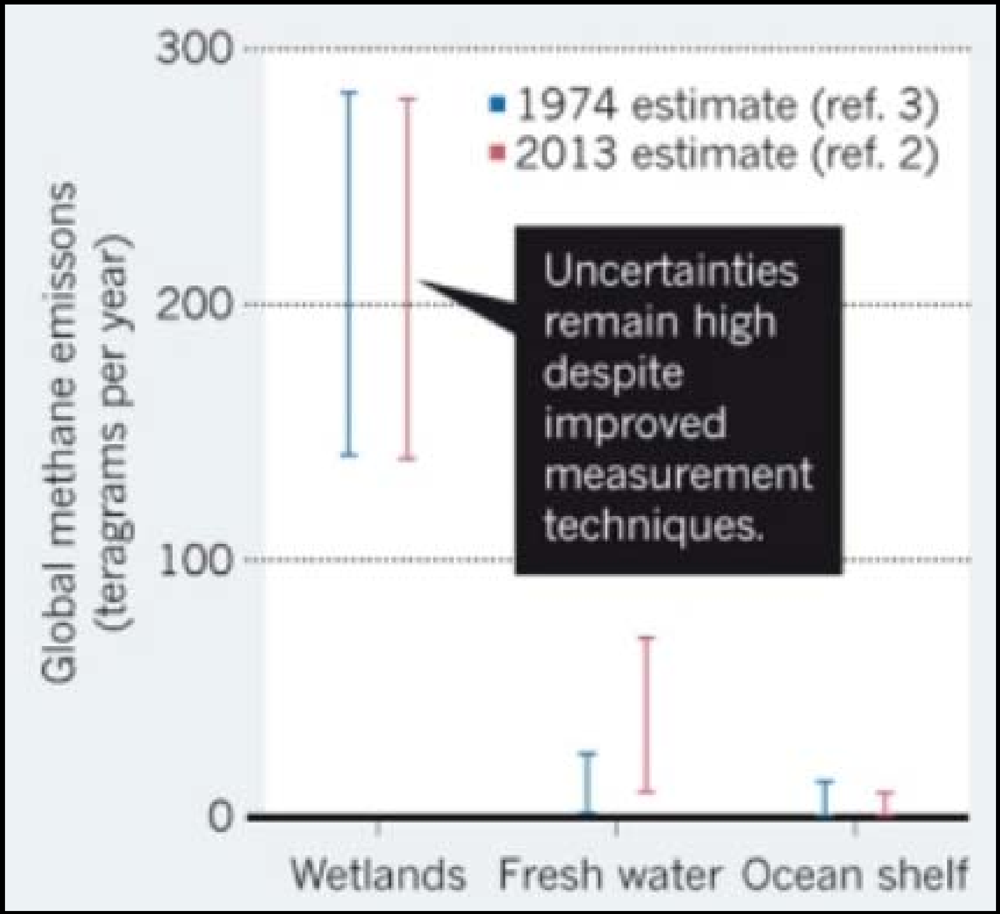
Kimball (in prep)

2. Climate sensitivity of tropical CH_4 emissions

Model	Resolution (long. × lat.)	Coverage	Wetland determination scheme	CH_4 flux parameterization (see table footnotes)**	Principal references
CLM4Me	2.5° × 1.9°	Global	Model-simulated runoff and water table depth used in diagnostic equation that was parameterized for best fit to the GIEMS dataset.	$F = (R_{het} r_{CH4:C} f_{pH} f_{pE} Q_{10} - O) f_{transport} - O_{atm}$	Riley et al. (2011)
DLEM	0.5° × 0.5°	Global	Maximal extents from inundation dataset with simulated intra-annual dynamics.	$F = (P_{max} C_{labile} f_T f_{pH} f_{\Theta} - O_{trans} - O_{soil}) f_{transport} - O_{atm}$	Tian et al. (2010, 2011); Xu and Tian (2012)
IAP-RAS	0.5° × 0.5°	Global	Prescribed extents from land cover dataset (CDIAC NDP017).	$F = f_T f_{\Theta} Q_{10}$	Mokhov et al. (2007); Eliseev et al. (2008)
LPJ-Bern	0.5° × 0.5°	Global	Prescribed peatlands and monthly inundation. Simulated dynamic wet mineral soils (saturated, non-inundated).	Peat: $F = (R_{het} r_{CH4:C} f_{root} f_{WTP} - O) f_{transport}$ Wetlands: $F = R_{het} r_{CH4:C}$ Wet soils: $F = R_{het} r_{CH4:C} f_{\Theta} - O_{atm}$	Spahni et al. (2011)
LPJ-WHyMe	0.5° × 0.5°	Peatlands (> 35° N)	Prescribed peatland extents (Tarnocai et al., 2009) with simulated saturated/unsaturated conditions.	$F = (R_{het} r_{CH4:C} f_{root} f_{WTP} - O) f_{transport}$	Wania et al. (2009a,b, 2010)
LPJ-WSL	0.5° × 0.5°	Global	Prescribed from monthly inundation dataset.	$F = R_{het} r_{CH4:C} f_{ecosys}$	Hodson et al. (2011)
ORCHIDEE	1.0° × 1.0°	Global	Mean yearly extent over 1993–2004 period scaled to that of inundation dataset with model calculated intra- and inter-annual dynamics.	$F = (R_0 C_{labile} f_{WTP} f_T Q_{10} - O) f_{transport}$	Ringeval et al. (2010, 2011) Ringeval (2011) Ringeval et al. (2012)
SDGVM	0.5° × 0.5°	Global	Independently simulated extents.	$F = R_{het} r_{CH4:C} f_{WTP} f_T Q_{10} - O$	Hopcroft et al. (2011) Singarayer et al. (2011)
UVic-ESCM	3.6° × 1.8°	Global	Independently simulated extents.	n.a.	Avis et al. (2011)
UW-VIC	100 km*	W. Siberian lowlands	Prescribed peatland extents with inundation dataset dynamics modulated by internally calculated saturated/unsaturated conditions.	$F = (R_0 f_{NPP} f_{root} f_T Q_{10} - O) f_{transport}$	Bohn et al. (2007); Bohn and Lettenmaier (2010)

Melton et al. 2013

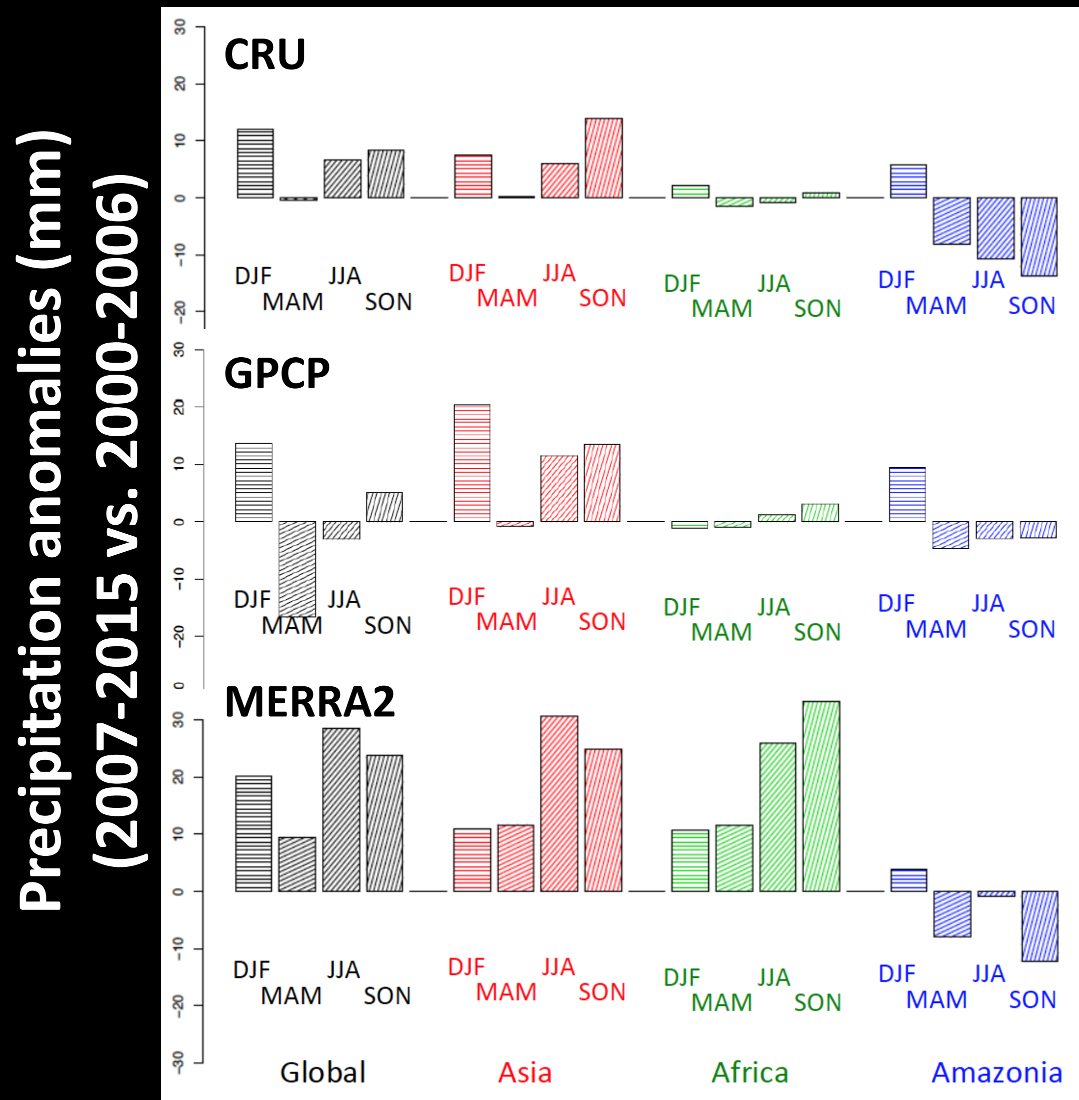
2. Climate sensitivity of tropical CH_4 emissions



Christensen 2014

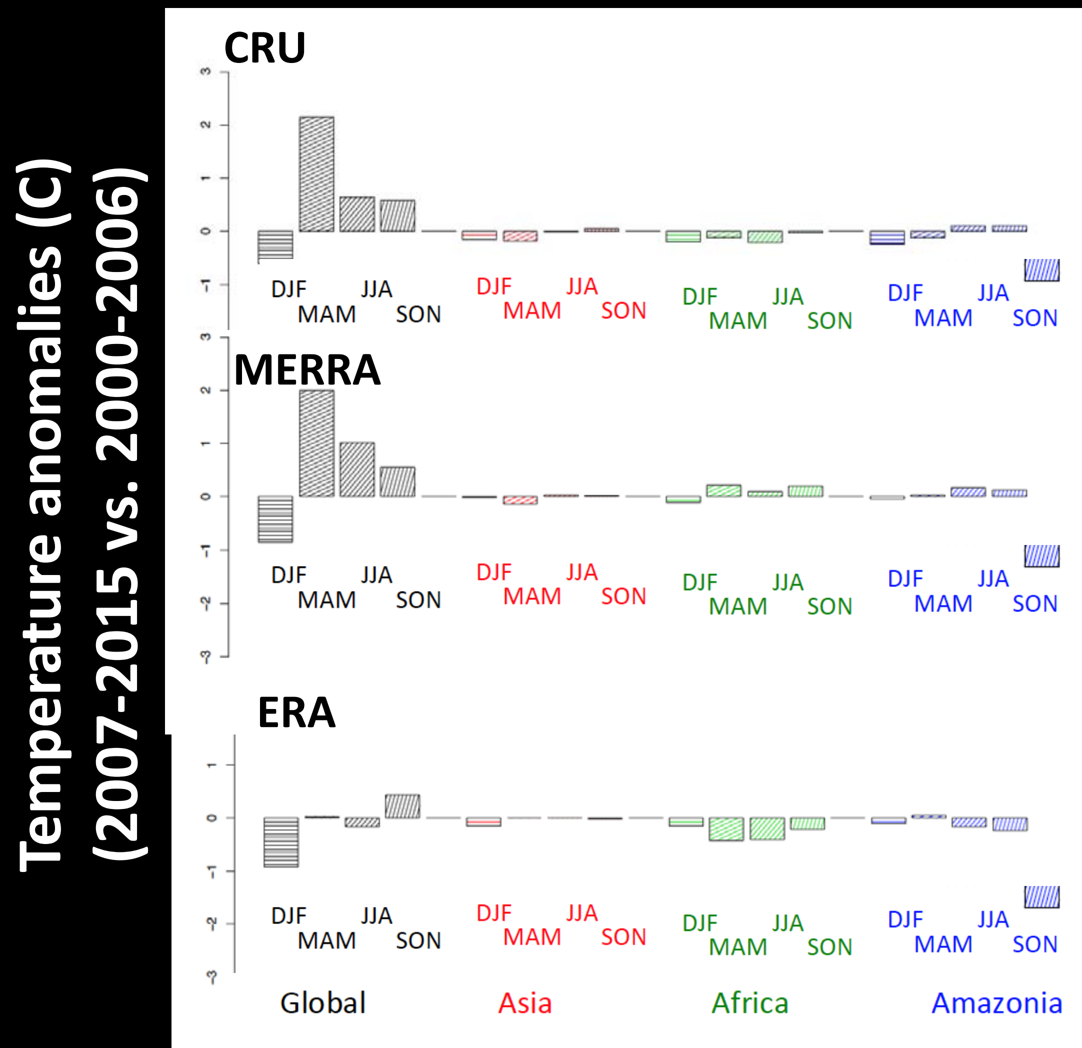
2. Climate sensitivity of tropical CH_4 emissions

Meteorological data uncertainty



2. Climate sensitivity of tropical CH_4 emissions

Meteorological data uncertainty



2. Climate sensitivity of tropical CH_4 emissions

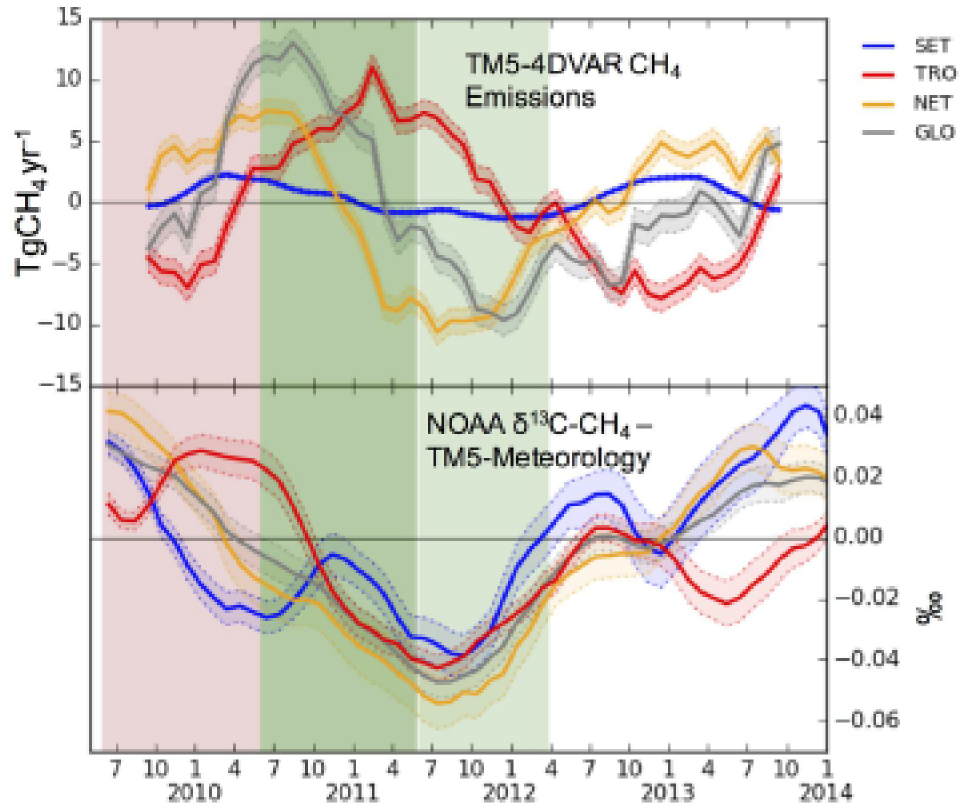
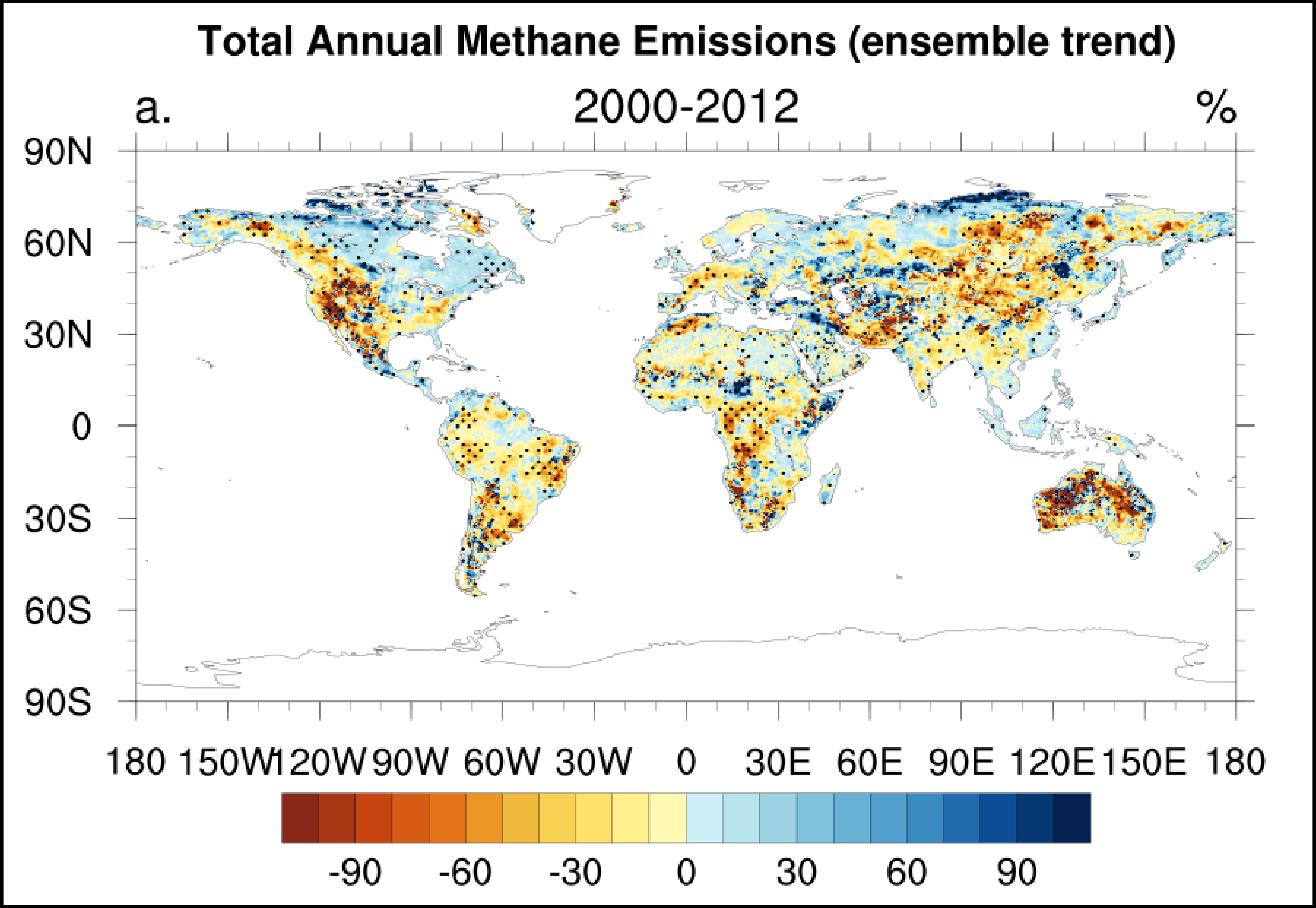


Figure 2. (**a**) Detrended and smoothened CH_4 surface emissions estimates from TM5-4DVAR for the same regions as in Fig. 1. The variability of GFED4s biomass burning emissions has been subtracted. (**b**) $\delta^{13}C$-CH_4 measurements[54] corrected for the influence of transport using a meteorology-only TM5 simulation of $\delta^{13}C$-CH_4[32]. The light shaded regions represent the $\pm 1\sigma$ uncertainty of the respective time series.

Pandey et al. 2017

2. Climate sensitivity of tropical CH_4 emissions



Poulter et al. in rev.

2. Climate sensitivity of tropical CH_4 emissions

Time series for global wetland emissions

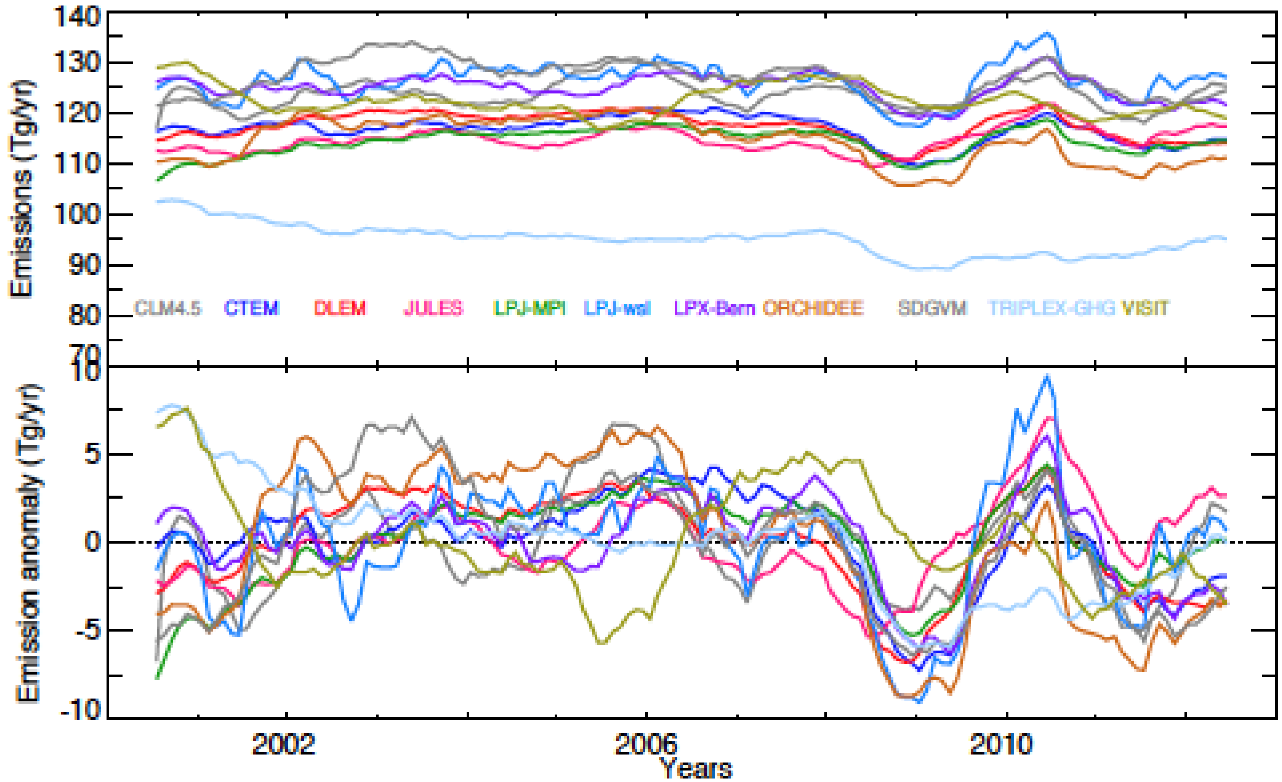
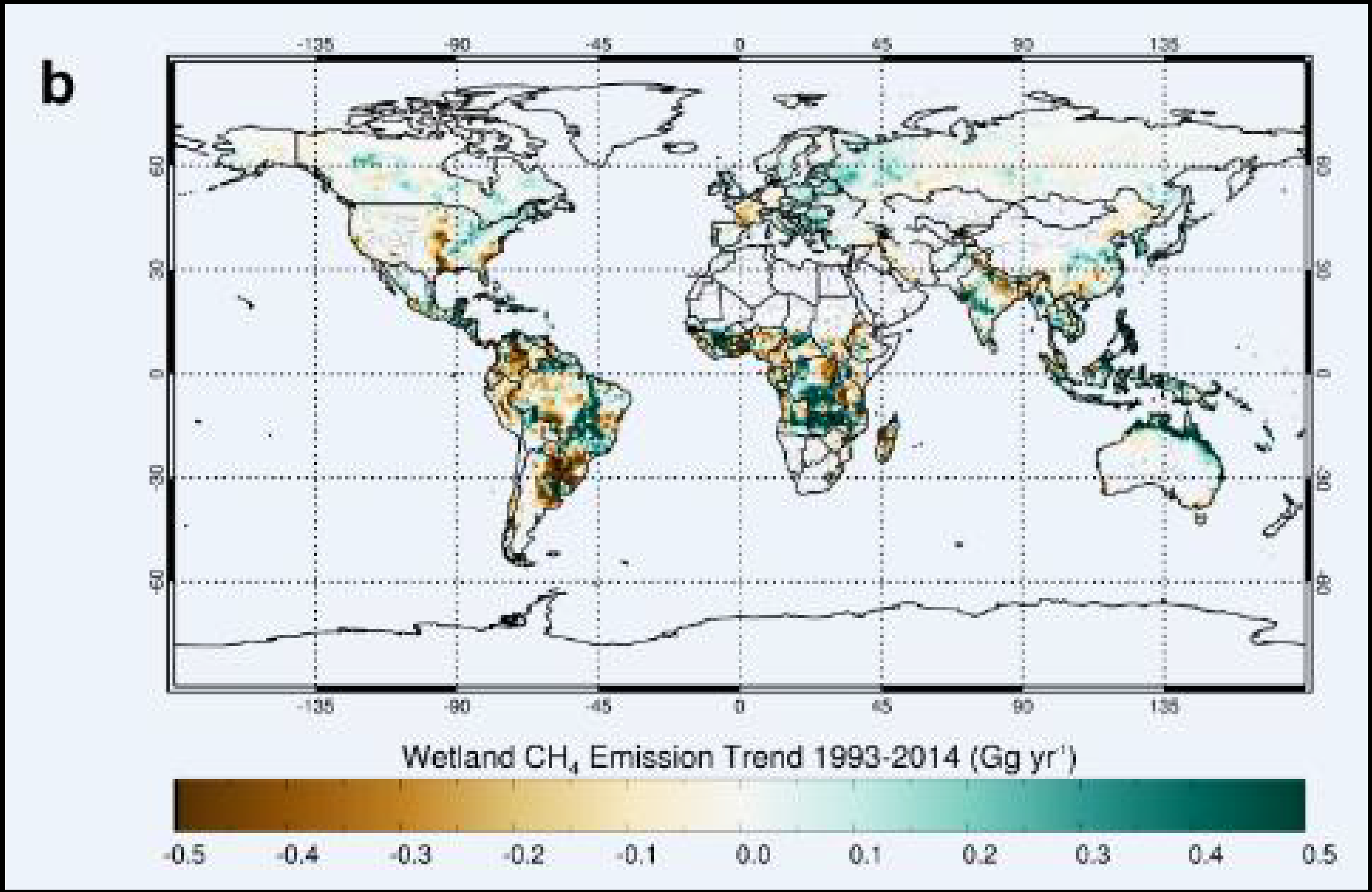


Figure S11: Emissions (top) and emission anomaly (bottom) from wetland (Tg CH_4 yr^{-1}) inferred by the 11 surface land models.

Poulter et al. in rev.

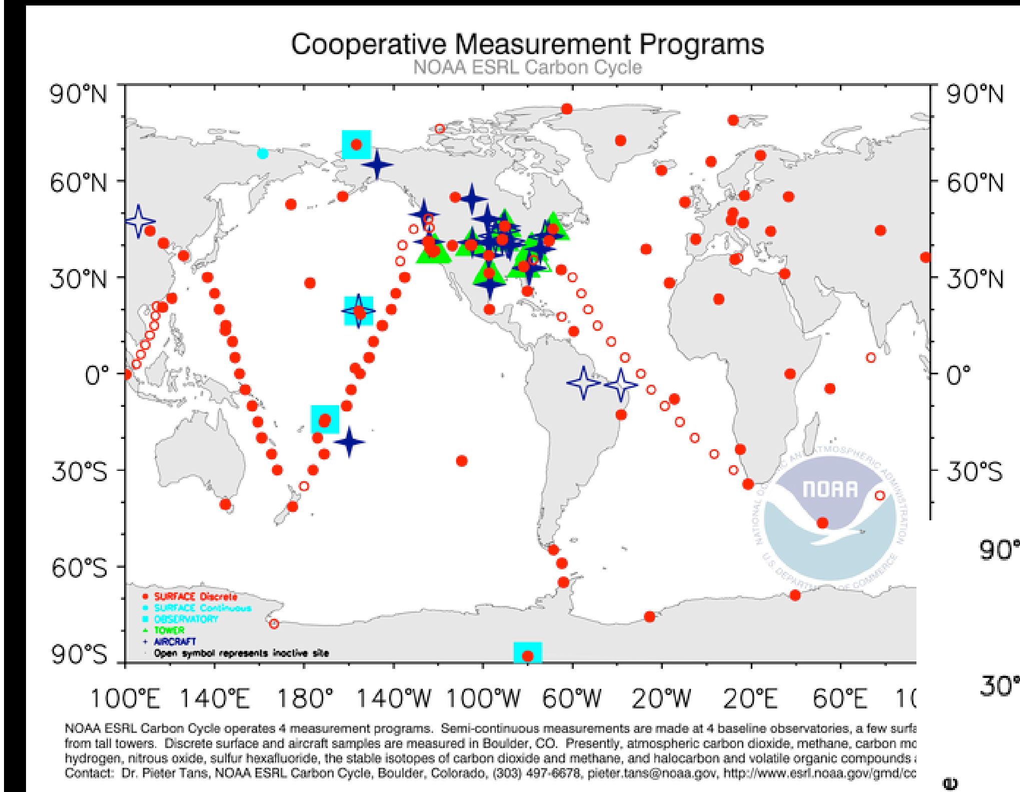
2. Climate sensitivity of tropical CH_4 emissions

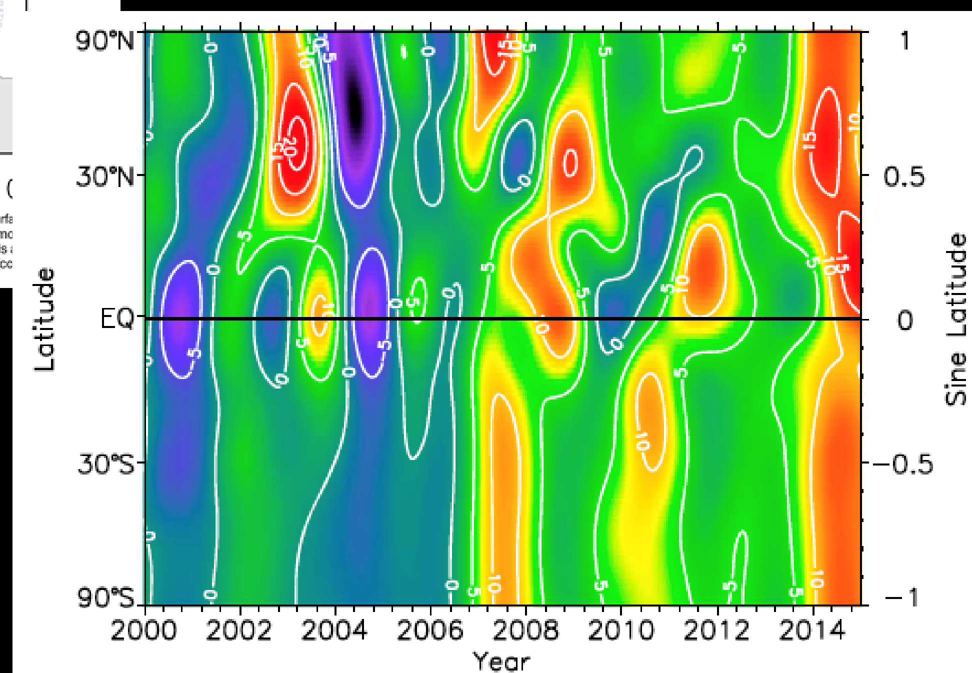


~4 Tg CH4 increase from 2007 onward from wetlands

McNaughton et al. 2016

3. Current tropical CH4 monitoring networks





Nisbet et al. 2016

3. Current tropical CH4 monitoring networks

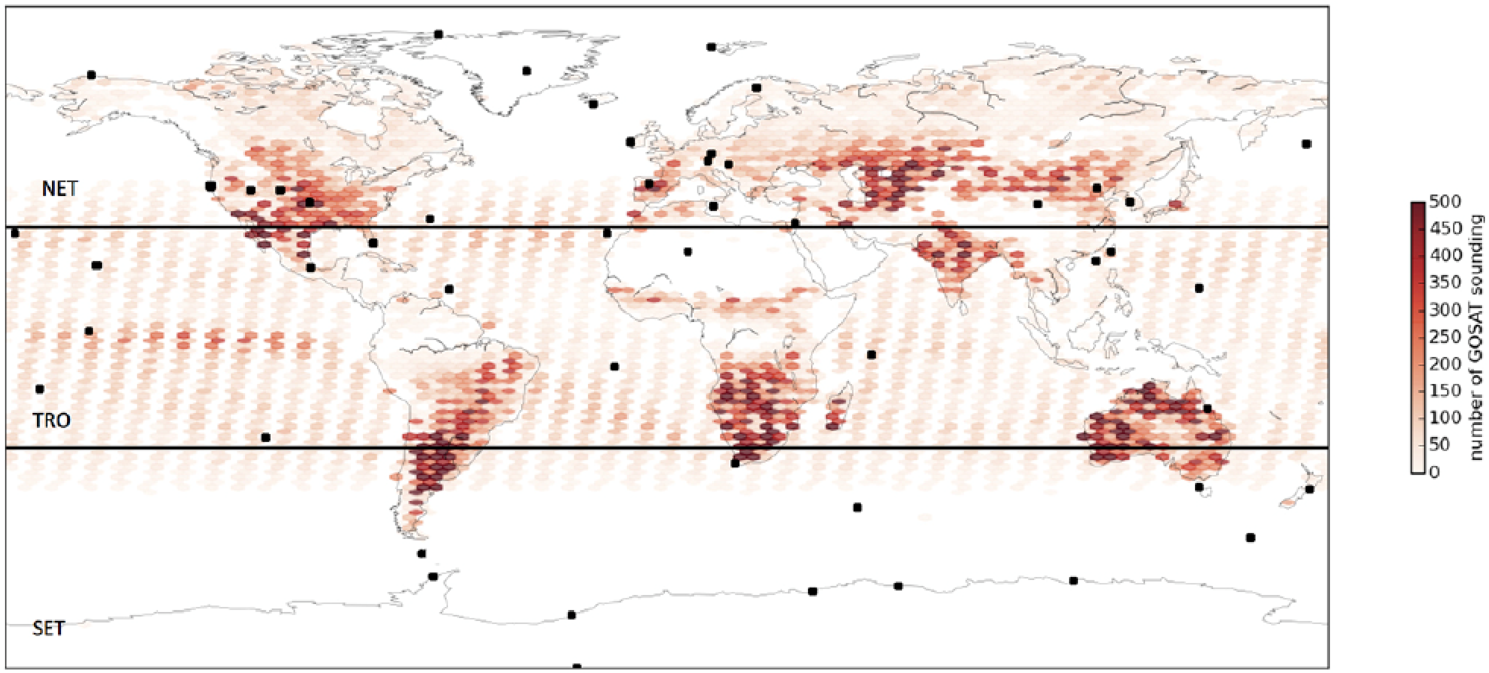


Figure 2: Coverage of GOSAT RemoteC full-physics XCH_4 and the NOAA and CSIRO surface air sampling sites (black dots) that were used. Only surface sites with continuous coverage between 2009-2015 and at least monthly temporal resolution were used. This map was generated using python v2.7 with matplotlib-basemap library [*Hunter*, 2007]

Pandey et al. 2017