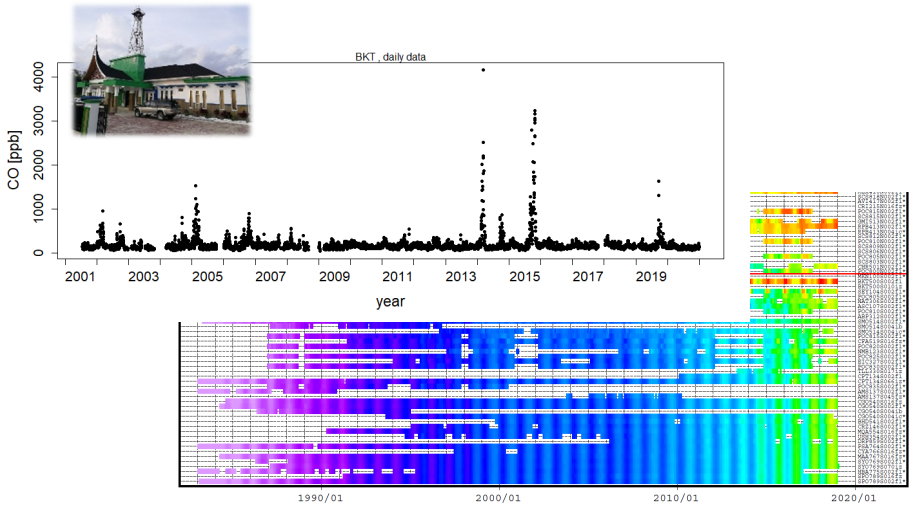
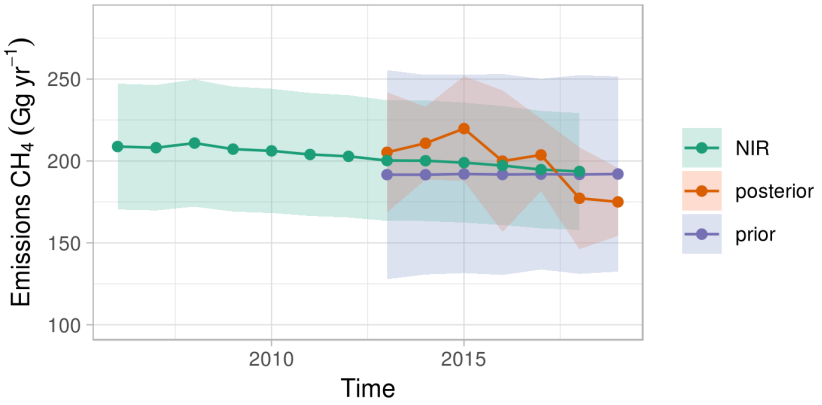
Continuous atmospheric composition observations and beyond
–
from measurements to climate services





Martin Steinbacher, Stephan Henne

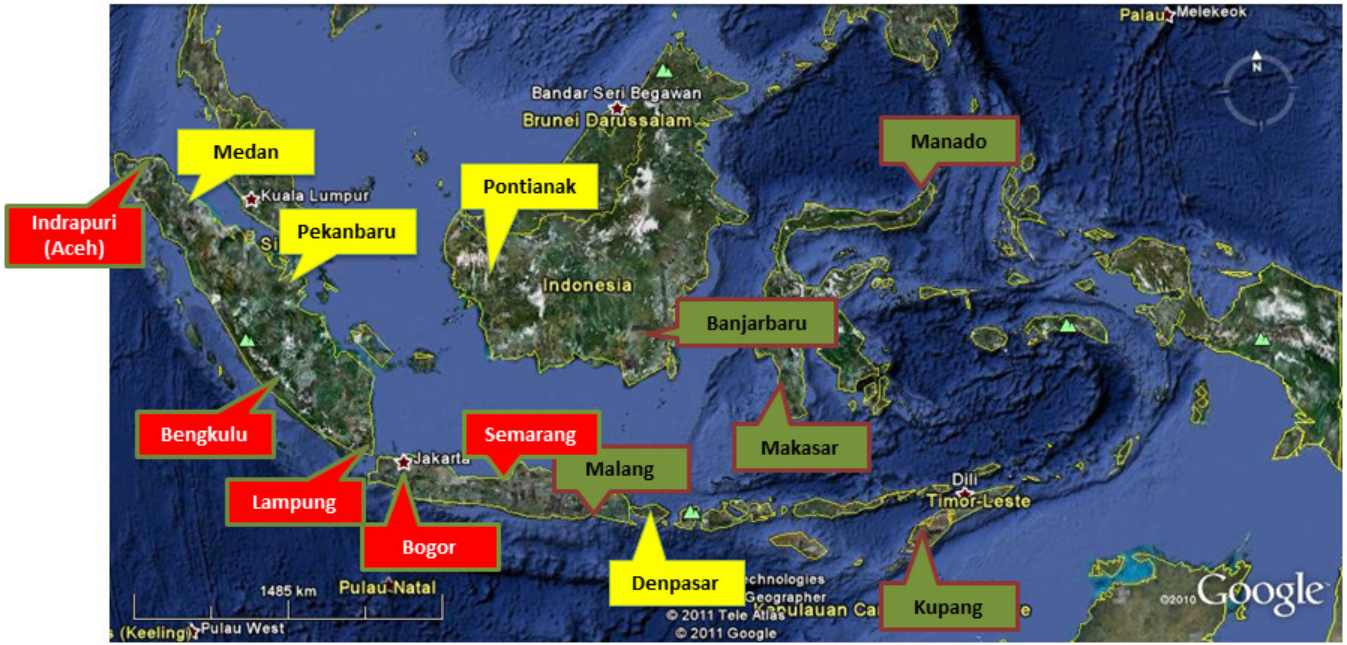
Empa, Laboratory for Air Pollution / Environmental Technology &
WMO/GAW Quality Assurance / Science Activity Centre Switzerland

BMKG webinar, 06 August 2021

Empa
Materials Science and Technology

BMKG's continuous monitoring stations

BMKG's (planned) greenhouse gas flask sampling network

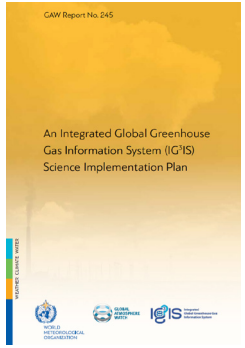


- most recent plans: tall tower network for GHG monitoring on Sumatra

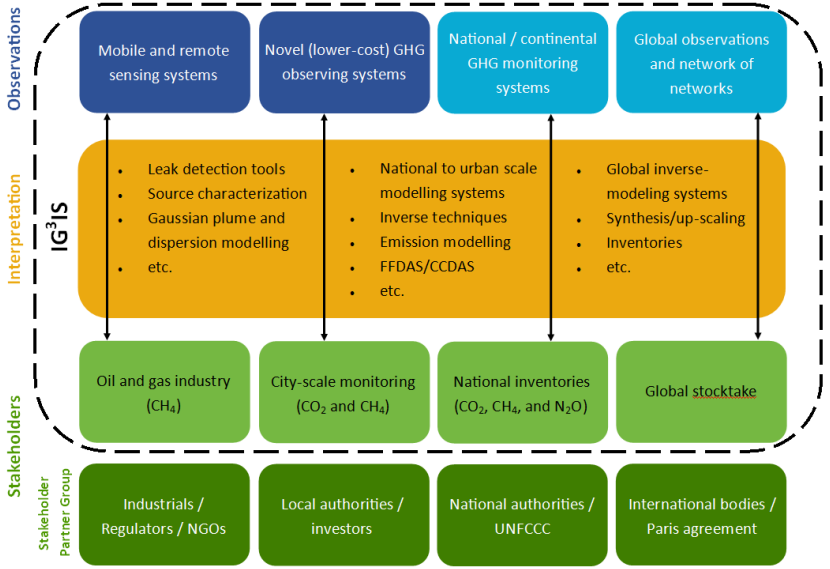
WMO's Integrated Global GHG Information System (IG3IS)

IG3IS supports …

- national stakeholders and national inventory preparation
- mitigation efforts of cities and other non-state actors
- Paris Agreement's global stocktake
- the detection, quantification, and mitigation opportunities of anthropogenic methane emissions



see the IG3IS webpage
https://ig3is.wmo.int/en
and the IG3IS implementation plan
https://library.wmo.int/doc_num.php?explnum_id=10034
for more information

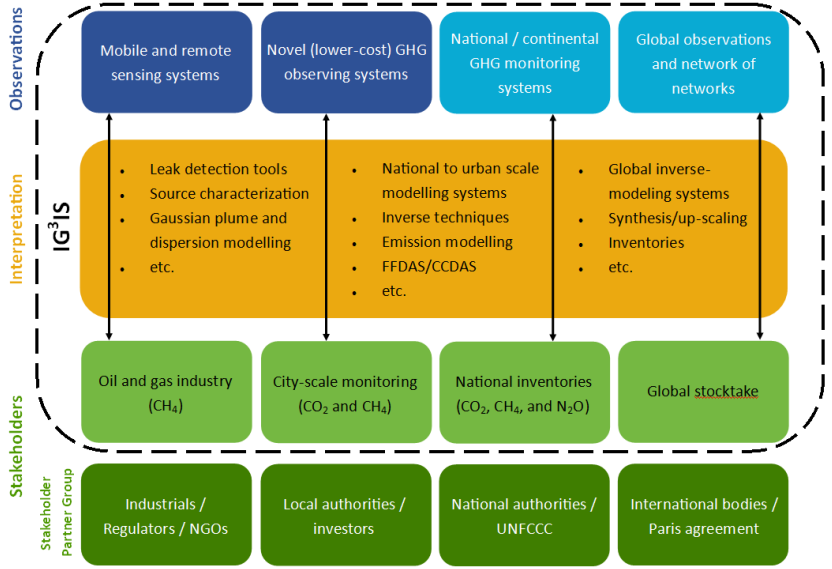


WMO's Integrated Global GHG Information System (IG3IS)

Increasing model complexity

Increasing measurement complexity

		Tier 1 Use established (global) model and inversion system, operated by external experts	Tier 2 Use established (global) model and inversion system; develop local expertise to operate the system	Tier 3 Taylored high-resolution modeling and inversion system, operated by local experts
Tier 1	Single representative station in country or station every 500-1000 km	Trend in total emissions in area of influence of site(s)	Total emissions and their trend in area of influence of site(s)	Total emissions and their trend with higher accuracy in area of influence of site(s)
Tier 2	Network of sites covering all parts of country, simple measurement infrastructure	Trend in country total emissions, no separation between anthropogenic and biospheric fluxes	Total country emissions and their trend, no separation between anthropogenic and biospheric fluxes	Total country emissions and their trend with higher accuracy, no separation between anthropogenic and biospheric fluxes
Tier 3	Network of sites covering all parts of country, additional tracers (radon, radiocarbon, isotopes)	Trend in country total emissions, separation between anthropogenic and biospheric fluxes, sector-specific information	Total country emissions and their trend, separation between anthropogenic and biospheric fluxes, sector-specific information	Total country emissions and their trend with higher accuracy, separation between anthropogenic and biospheric fluxes, sector-specific info.



IG3IS “pioneer study”

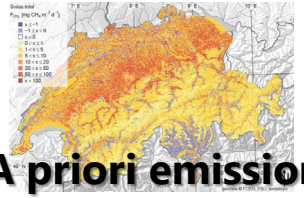
Atmos. Chem. Phys., 16, 3683–3710, 2016
www.atmos-chem-phys.net/16/3683/2016/
doi:10.5194/acp-16-3683-2016

Atmospheric Chemistry and Physics
Open Access
EGU

Validation of the Swiss methane emission inventory by atmospheric observations and inverse modelling

Stephan Henne[1], Dominik Brunner[1], Brian Oney[1], Markus Leuenberger[2], Werner Eugster[3], Ines Bamberger[3,4], Frank Meinhardt[5], Martin Steinbacher[1], and Lukas Emmenegger[1]

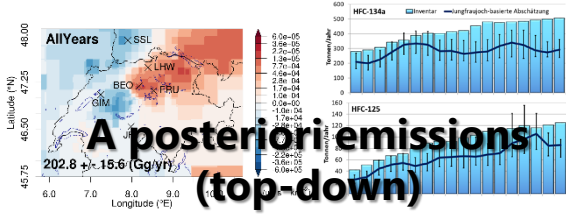
Aim: support of national bottom-up inventory reporting by using atmospheric observations, transport simulations and inverse methods to derive national total emissions and compare those to NIR reported values.



Inverse methods

Bayesian inverse modelling: CH_4, N_2O

Tracer ratio method: synthetic gases



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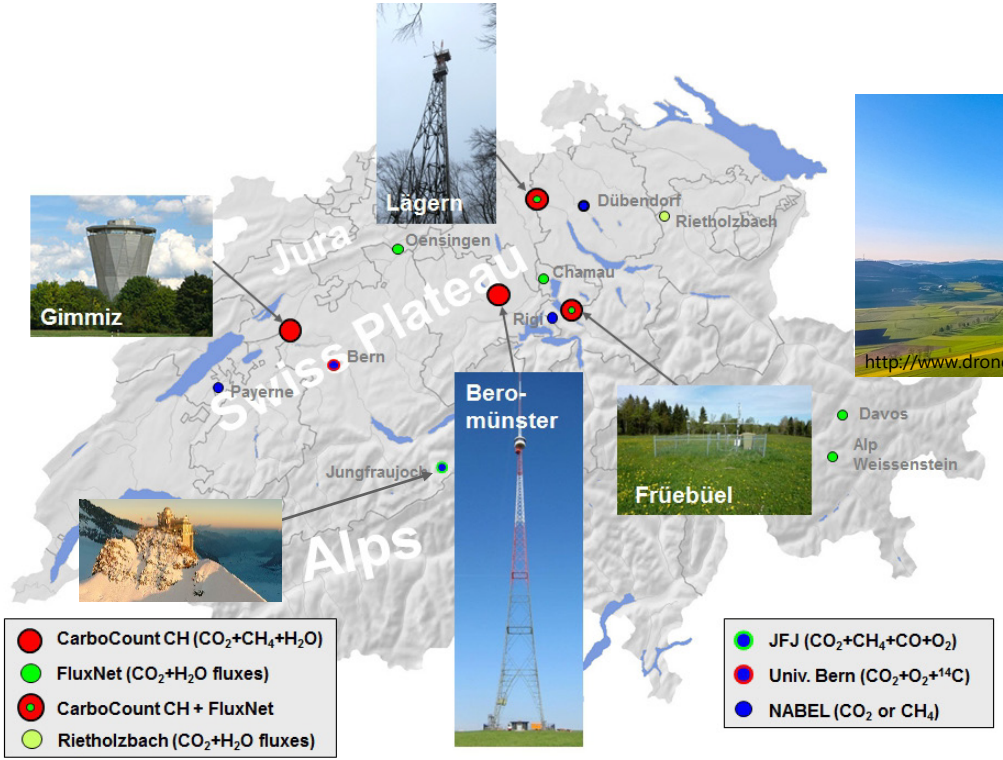
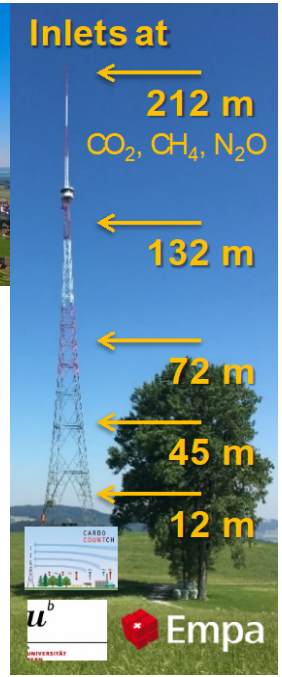
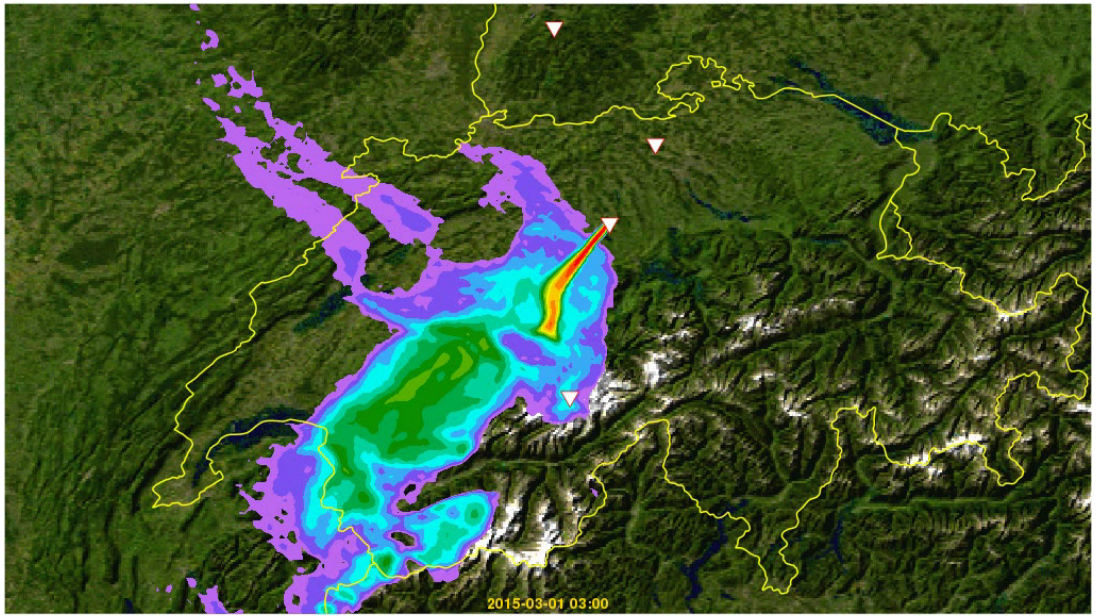
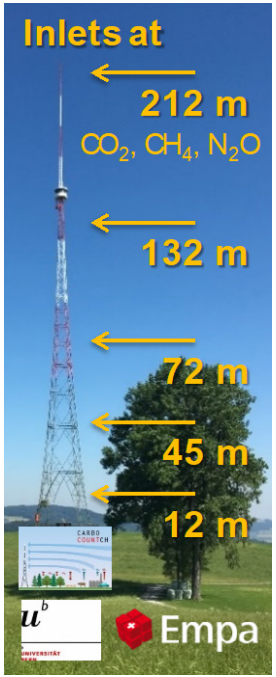




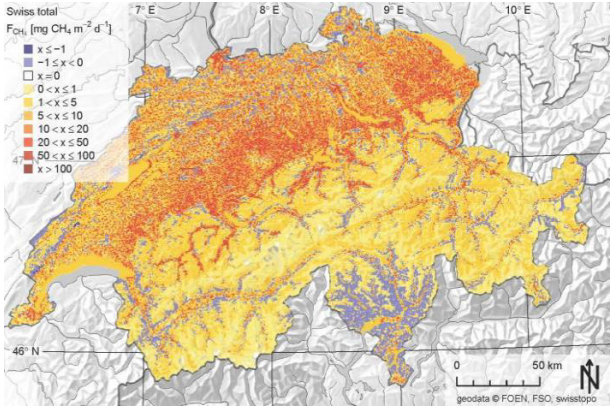
Simulated Footprints and Concentration Timeseries



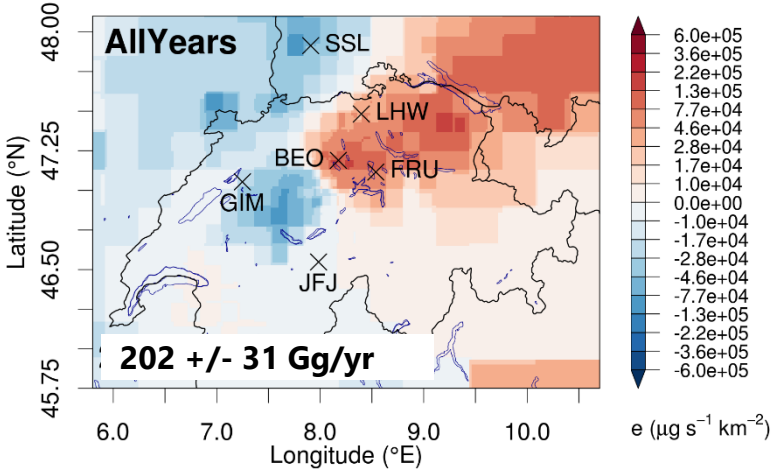


Swiss Methane Emissions (2013 – 2019)

A priori inventory *[Hiller et al., 2014]*



A posteriori difference



NIR (w/o 2019): 198 ± 36 Gg yr^{-1}, ±18 %

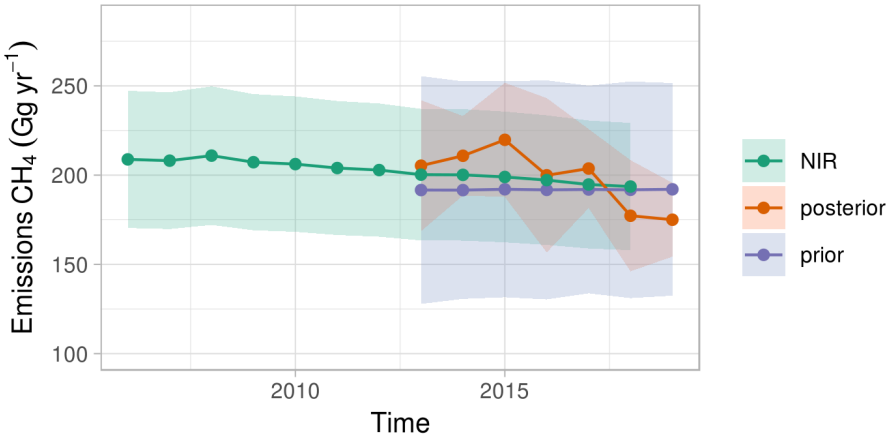
A posteriori: 202 ± 31 Gg yr^{-1}, ±15 %

95 % CI

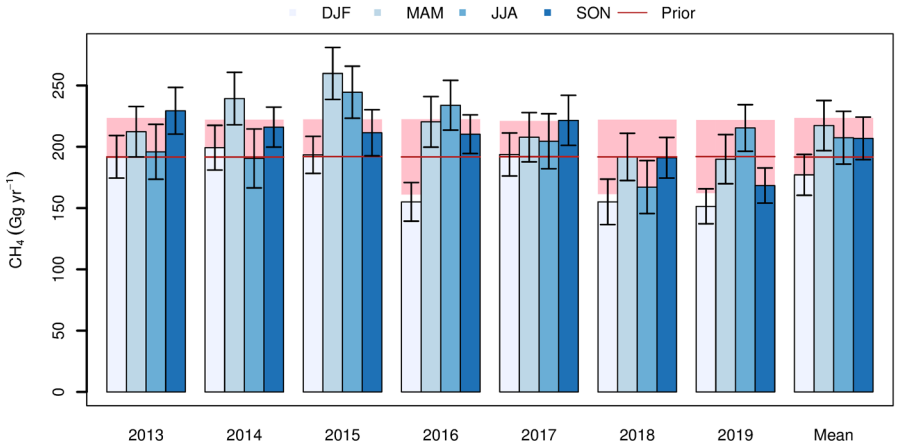
- National total very similar and well established by inversion
- Spatial distribution less well constrained by current network
- East/west shift in emission distribution (potentially boundary effect)

Swiss Methane Emissions (2013 – 2019)

Temporal evolution



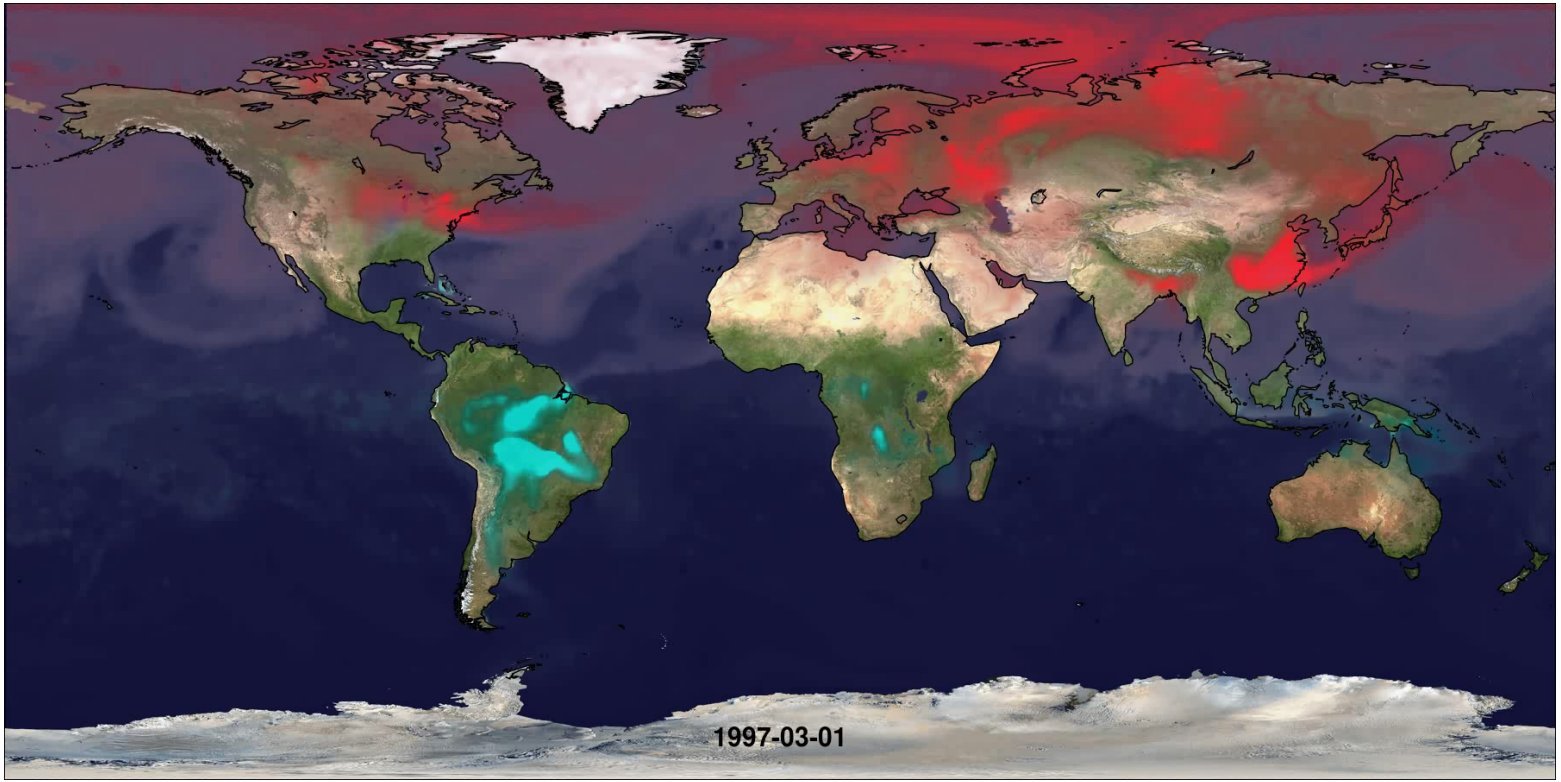
Seasonal variability



Spring maximum & winter minimum
Seasonal amplitude: ±20 %

Based on 8 sensitivity inversions per year

Global methane simulations – importance of biomass burning



simulation and visualization by Empa

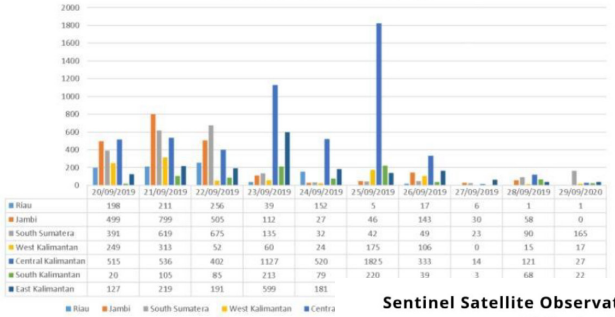
Biomass burning related services

Provision of critical weather information services to prevent and curb drought-induced forest fires

BMKG

NUMBER OF HOTSPOTS RECORDED IN EACH PROVINCE IN SUMATERA AND KALIMANTAN, SEPT 20 - 29, 2019

Numbers of Hotspots recorded in each Province in Sumatera and Kalimantan, Sept 20 - 29, 2019 (confident level >50%)

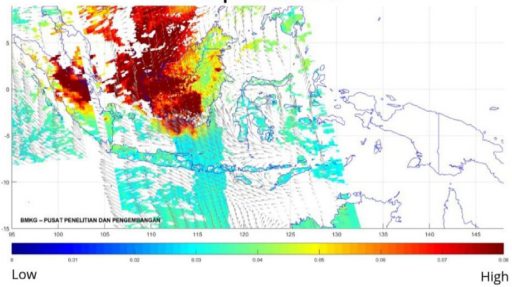


	20/09/2019	21/09/2019	22/09/2019	23/09/2019	24/09/2019	25/09/2019	26/09/2019	27/09/2019	28/09/2019	29/09/2020
Riau	198	211	256	39	152	5	17	6	1	1
Jambi	499	799	505	112	27	46	143	30	58	0
South Sumatera	391	619	675	135	32	42	49	23	90	165
West Kalimantan	249	313	52	60	24	175	106	0	15	17
Central Kalimantan	515	536	402	1127	520	1825	333	14	121	27
South Kalimantan	20	105	85	213	79	220	39	3	68	22
East Kalimantan	127	219	191	599	181					

Riau Jambi South Sumatera West Kalimantan Centra

BMKG news article released in 2019 on WMO webpage https://public.wmo.int/en/media/news-from-members/provision-of-critical-weather-information-services-prevent-and-curb-drought

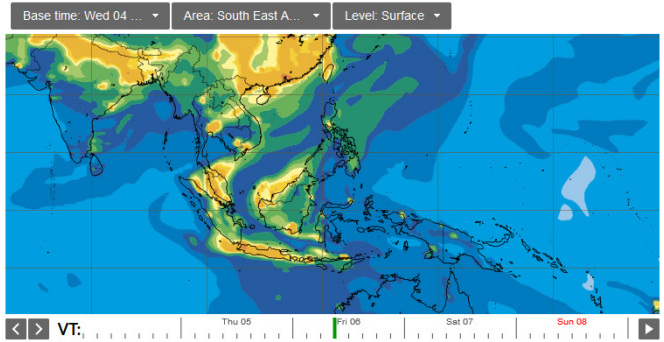
Sentinel Satellite Observation of CO Concentration on 20 September 2019



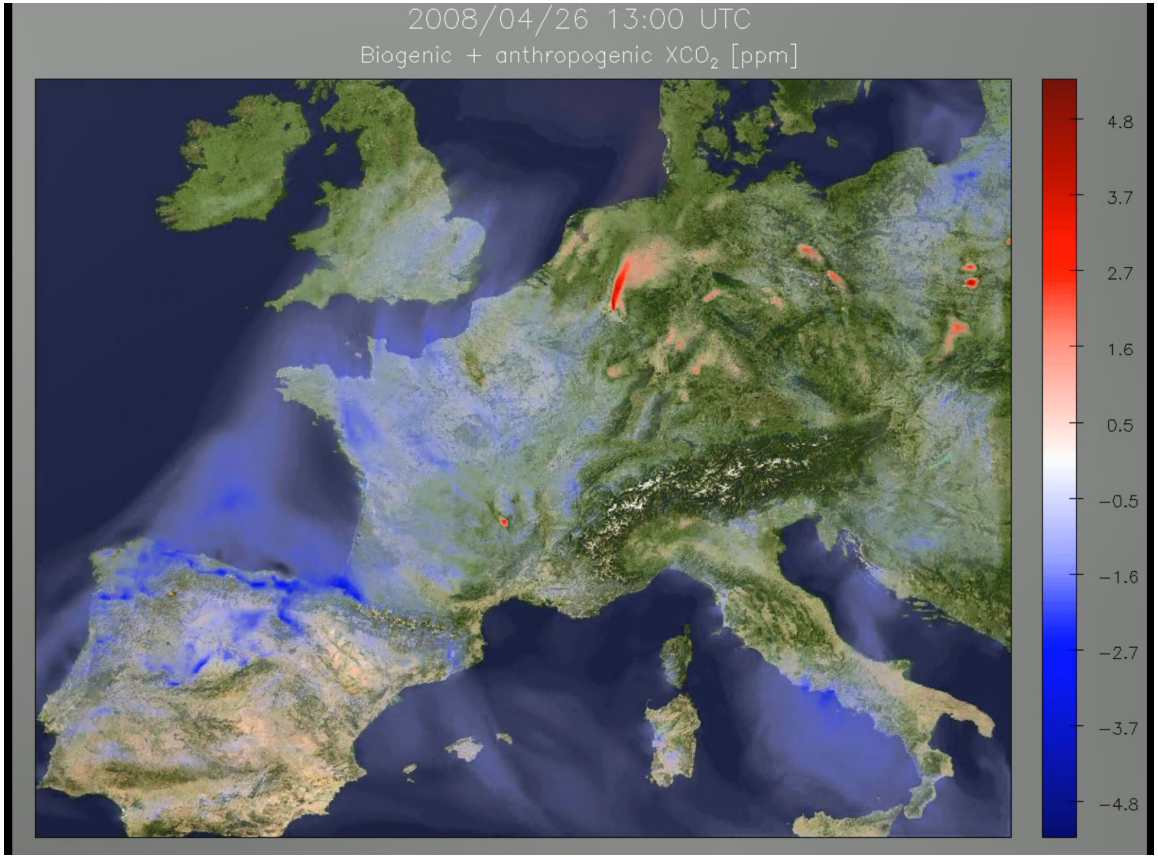
other resources:
e.g. Copernicus Atmospheric Monitoring Service
https://atmosphere.copernicus.eu/global-forecast-plots

Carbon Monoxide

Carbon monoxide (CO) is a pollutant in the atmosphere produced by the burning of fossil fuels as well as wildfires and biomass burning. It has an average life-time of several months and therefore clearly demonstrates long-range transport. The CAMS daily forecasts show how CO is distributed around the globe and how plumes from, for instance, wildfires are transported across continents by the prevailing winds.



Challenges when addressing CO2 – role of biosphere



Simulation: Yu Liu & Nicolas Gruber (ETH Zurich)
Animation: Dominik Brunner (Empa)

Anthropogenic CO_2: EDGAR v4.2 (JRC)
Biospheric CO_2: VPRM (MPI Jena)

Conclusions

- the availability of continuous good-quality atmospheric composition measurements in Indonesia is important and is a key prerequisite for related climate services
- observational data need to be combined with atmospheric transport models and socioeconomic data (anthropogenic emissions) and information on natural fluxes
- collaboration with existing modelling frameworks and/or use of available products is recommended
- reach out for support from the IG3IS office at WMO and its IG3IS Steering Committee

Thank you for your attention !