SLCF's emissions tracker:

from field observations to data assimilation/inversions assisting inventory methodology development & efficient emission

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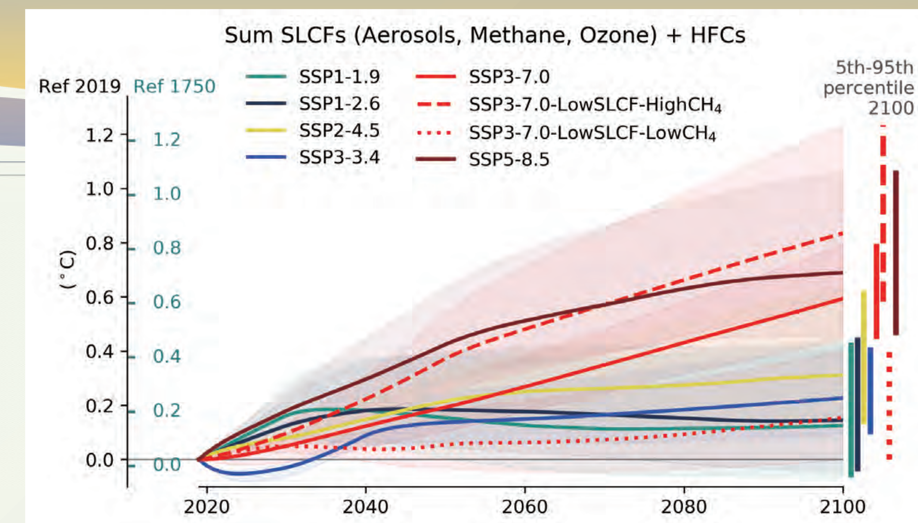


Figure 6.22, IPCC AR6 WG1

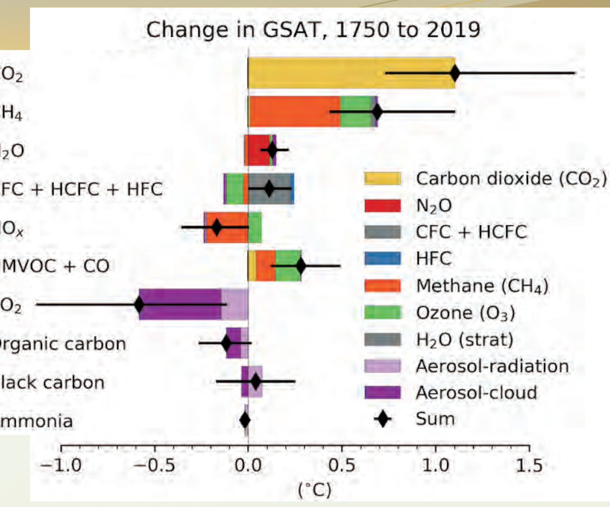


Figure 6.12, IPCC AR6 WG1

Summary

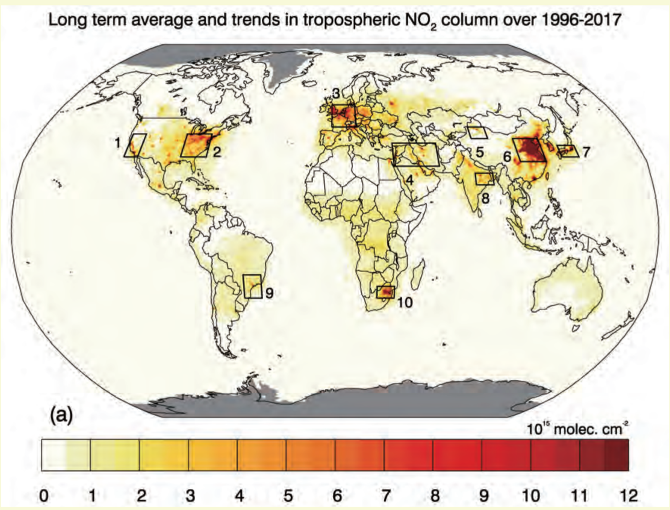
◆Future emissions of SLCFs (short-lived climate forcers), i.e., methane and air pollutants, could bring different levels of warmings by up to 0.8°C in 2100 relative to 2019 (IPCC AR6), and thus their reliable emission tracking system is necessary.

◆IPCC TFI has started to produce a methodology for SLCF emission inventories (besides GHGs) toward AR7 cycle; however, the bottom-up emission inventories are often associated with large uncertainties and thus constraints from top-down observational systems are essential.

◆Here, our activities relevant to such "top-down SLCF tracking system" are presented, consisting of in-situ high-precision observations in Asia/Arctic and satellite data assimilation/inversion model systems, providing top-down estimates of emissions and their changes.

1. Field & Satellite observations of SLCFs

Satellites



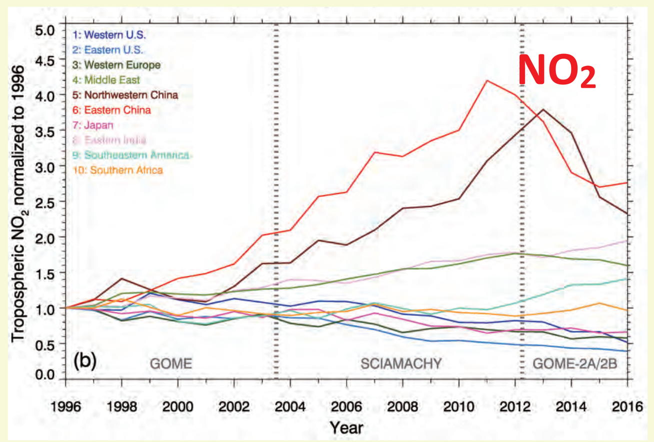
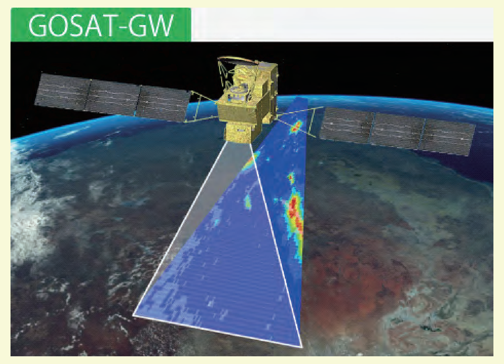


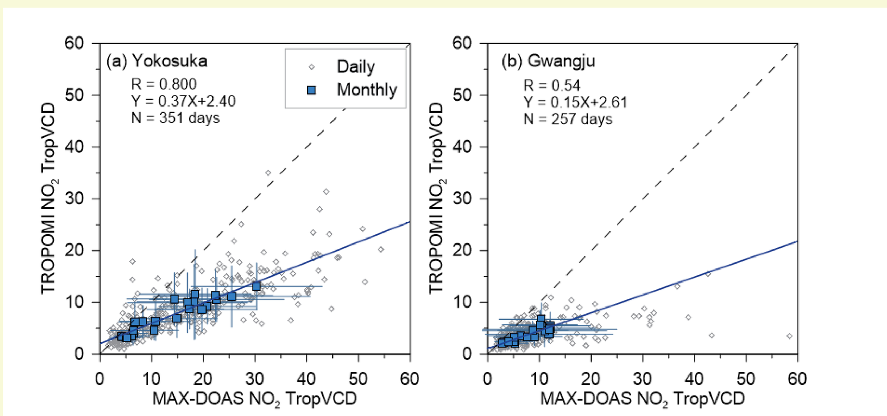
Figure 6.6, IPCC AR6 WG1



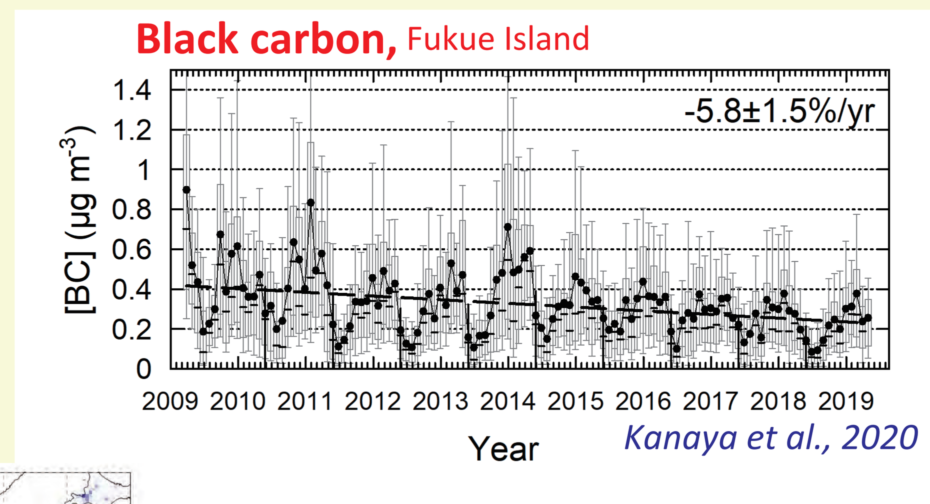
https://www.satnavi.jaxa.jp/ja/project/gosat-gw/index.html

Satellite observations of SLCFs (NO_2 as an example) are advanced and provide "real-time, real-world" information of the status of the Earth's atmosphere. Trends over 20 years are analyzed in the IPCC AR6 WG1 report. Finer resolution (~1km, TANSO-3/GOSAT-GW) and hourly observations (e.g., GEMS, Korea) are to be highlighted in the future missions.

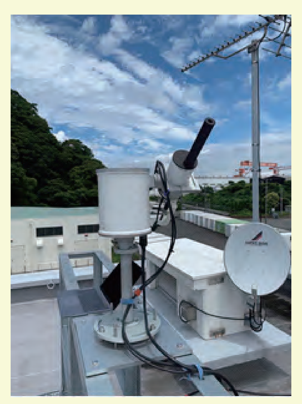
Ground-based

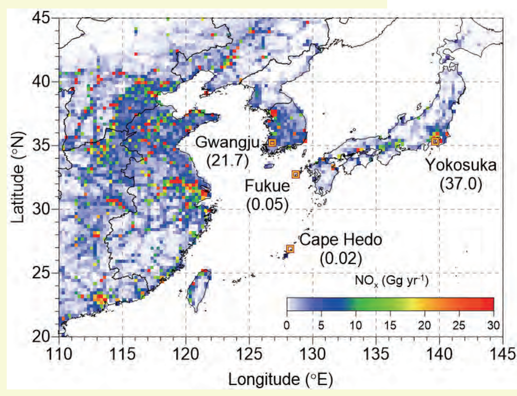


MAX-DOAS & Pandora, Yokosuka



Kanaya et al., 2020

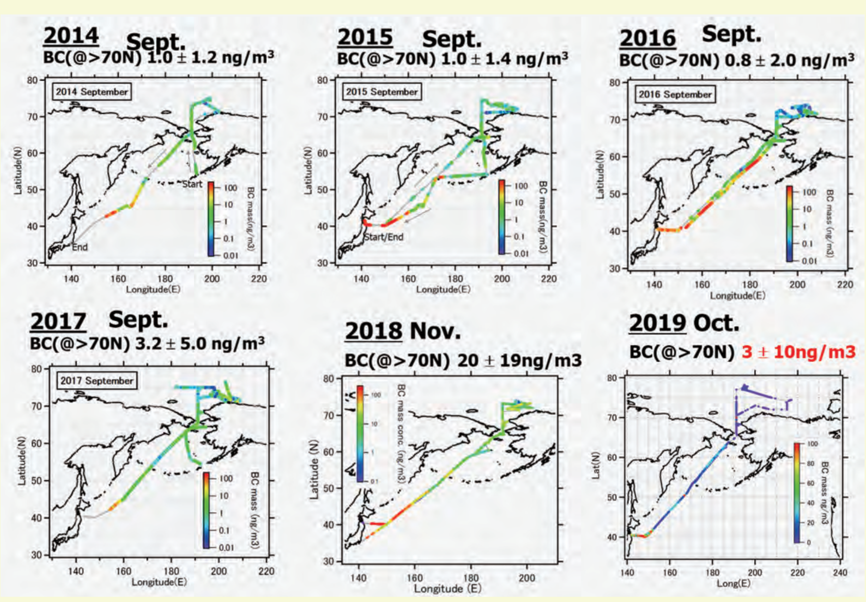




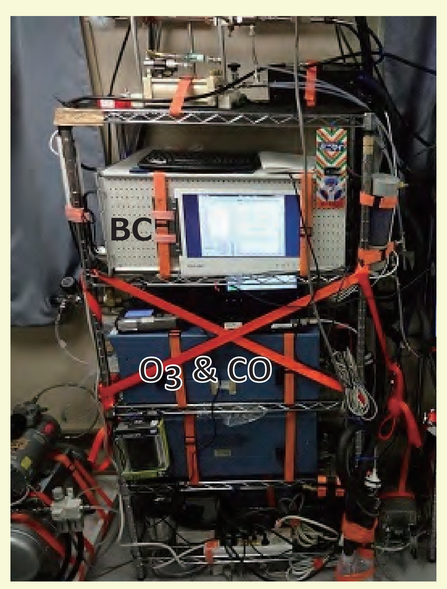
Choi et al., 2021

We operate ground-based remote sensing observations (MAX-DOAS and Pandora) for validating satellite observations under the international network frameworks (e.g., PGN). For compounds not measurable from satellites, field observations (e.g., black carbon) are conducted on a long-term basis to keep track on the Asian emissions changes.

Ship



Taketani et al., 2016

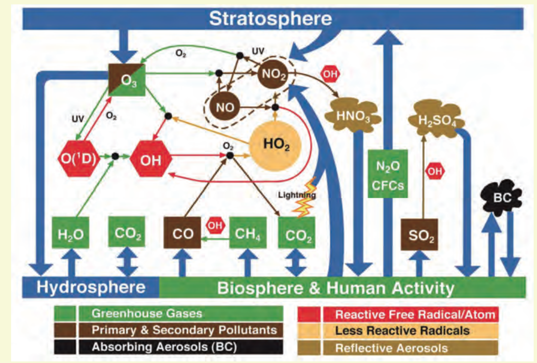


Black carbon is a key warming agent in the Arctic, as the snow/ice reflectance is reduced as the particles deposit. Ship-borne observations covering areas from Asia to the Arctic are regularly made to provide unique observational information.

Make the feedback cycle fast enough & reach best measures before 2030-2050!!

2. Inversion systems to derive "top-down" emission estimates

Atmospheric Chemistry Model Systems (e.g., data assimilation)



changes in chemistry, precipitation, wind patterns

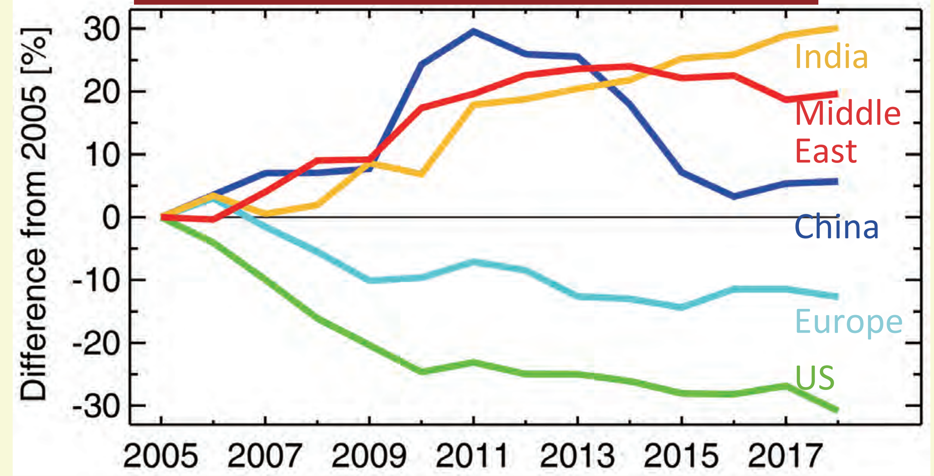
changes in emissions

Tropospheric Chemistry Reanalysis TCR-2

Variables	➢ Six-hourly (two-hourly for surface) Concentrations: O_3, NO_2, CO, SO_2, OH, NO, HNO_3, CH_2O, PAN, Aerosols (sulfate, NO_3, NH_4) ➢ Monthly Emissions: surface emissions of NOx, CO, and SO_2, lightning NOx
Horizontal resolution	1.1°×1.1°
Vertical layers	27 pressure levels (1000, 995, 980, 950, 900, 850, 800, 750, 700, 650, 600, 550, 500, 450, 400, 350, 300, 250, 200, 175, 150, 125, 100, 90, 80, 70, 60 hPa)
Assimilated satellite data	OMI NO_2 (QA4ECV), GOME-2 NO_2 (TM4NO2A v2.3), TES O_3 (v6), MOPITT CO (v7 NIR), and MLS O_3, HNO_3 (v4.2)
Time period	2005-2017 now extended to 2019

https://tes.jpl.nasa.gov/tes/chemical-reanalysis

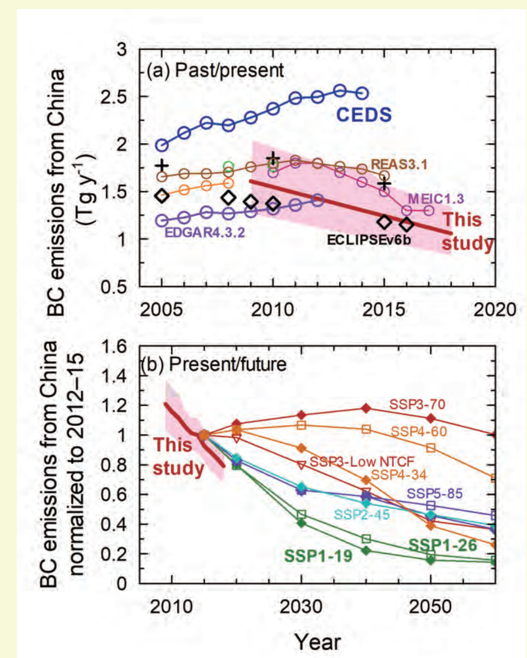
Regional & Global NOx emissions *(top-down best estimates)*



Miyazaki et al., 2020

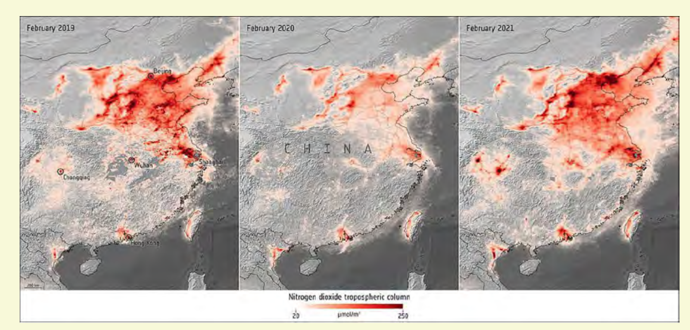
Chinese black carbon emissions *(top-down best estimates)*

A simpler chemistry-transport model is also useful to separate emission trend signals against transport/meteorological change effects.

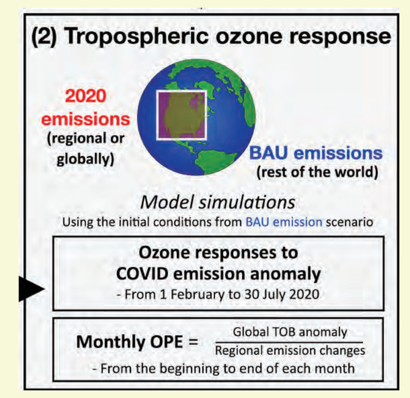


Kanaya et al., 2020

Fast-track analysis (e.g., COVID-19)

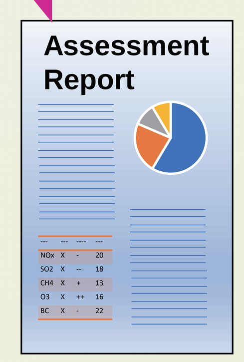


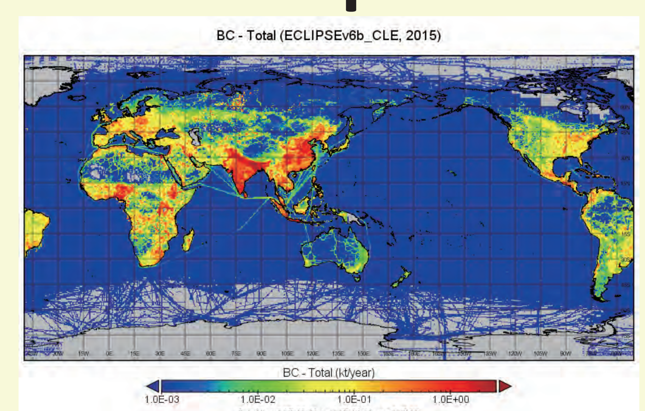
Copernicus Sentinel-5P satellite, show the monthly average NO_2 concentrations over China in February 2019, February 2020 and February 2021 (image credit: ESA, the image contains modified Copernicus Sentinel data (2019-21), processed by ESA, CC BY-SA 3.0 IGO)



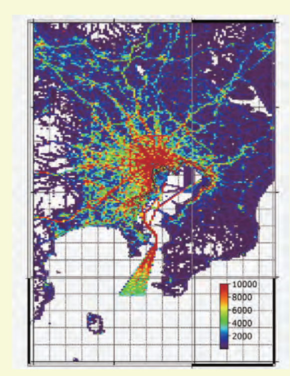
Miyazaki et al., 2021

3. Regular & joint report with "bottom-up" inventories





https://iiasa.ac.at/web/home/research/researchPrograms/air/ECLIPSEv6b.html

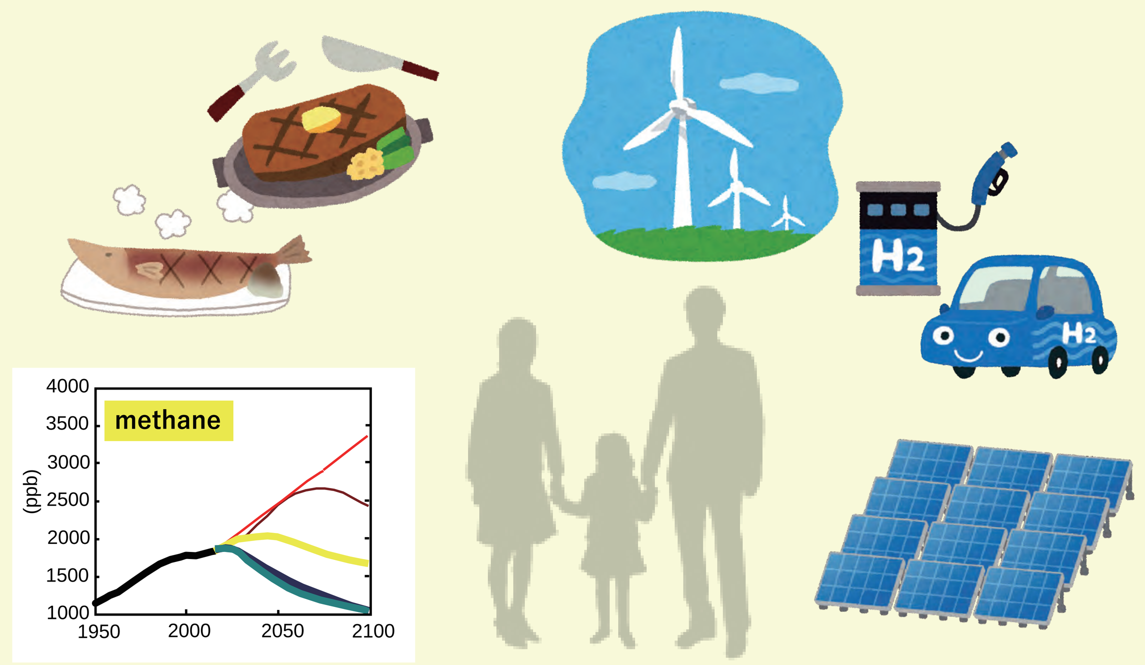


◆*"GCP-like"* annual/biannual SLCF scientific budget reports are to be targetted, covering global to point-source scales, with relevance to "SLCF inventory methodology" by IPCC TFI.

◆ Co-benefit with *air quality* and co-emission/co-control with *GHGs* are to be pursued.

measurements of the new state

4. Policymaking, our choices, mitigation actions



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