Advanced Modeling and Flux Estimation Systems to Support Satellite Observations

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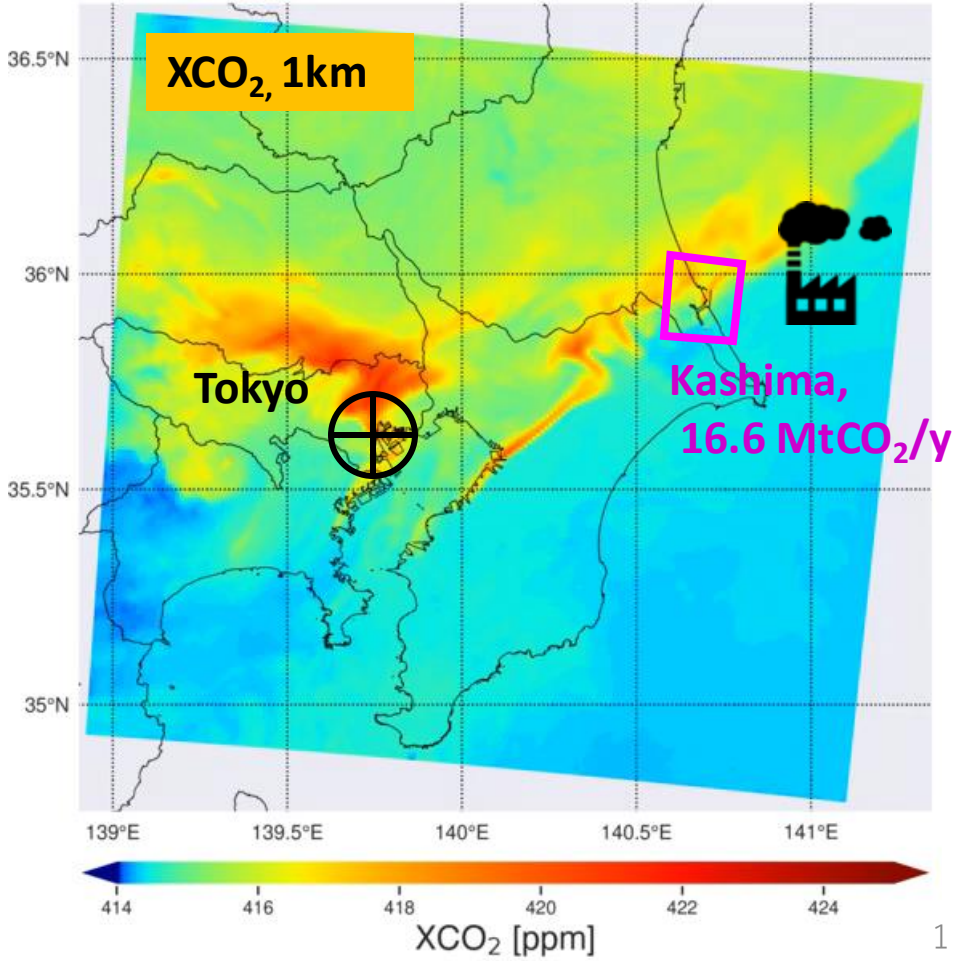
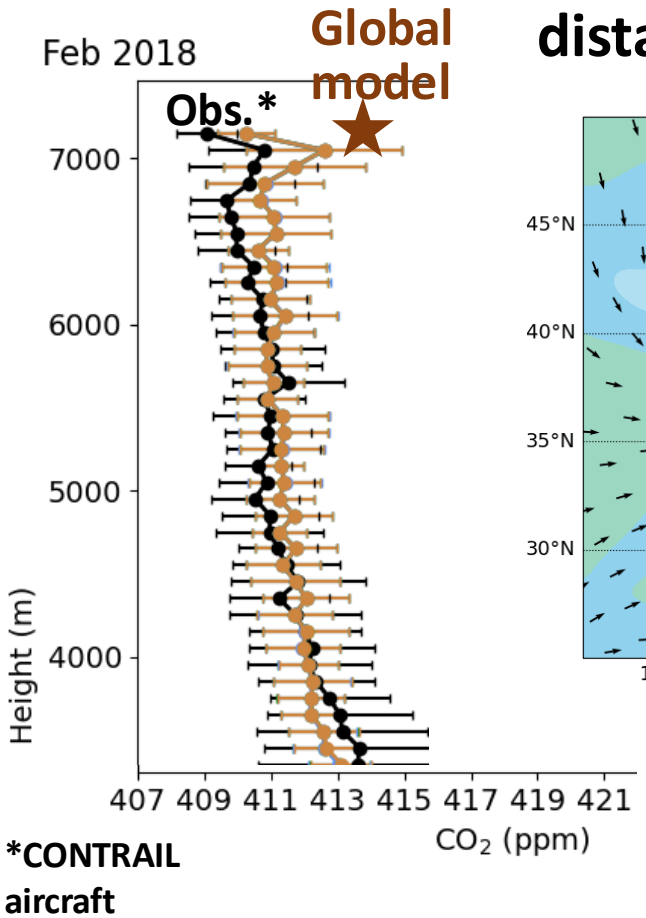
- Satellite images of column average CO_2 concentrations (XCO_2) are powerful to identify plumes, but caution is needed when converting them into **emission fluxes**
- Solution: **Two research-grade model systems combined:**
  1. 1km mesh, regional-scale modelWRF-GHG/Chem
  2. ***Global-scale*** *model (100km, MIROC4-ACTM)*

Focus on Kashima Industrial Zone, medium-sized point source



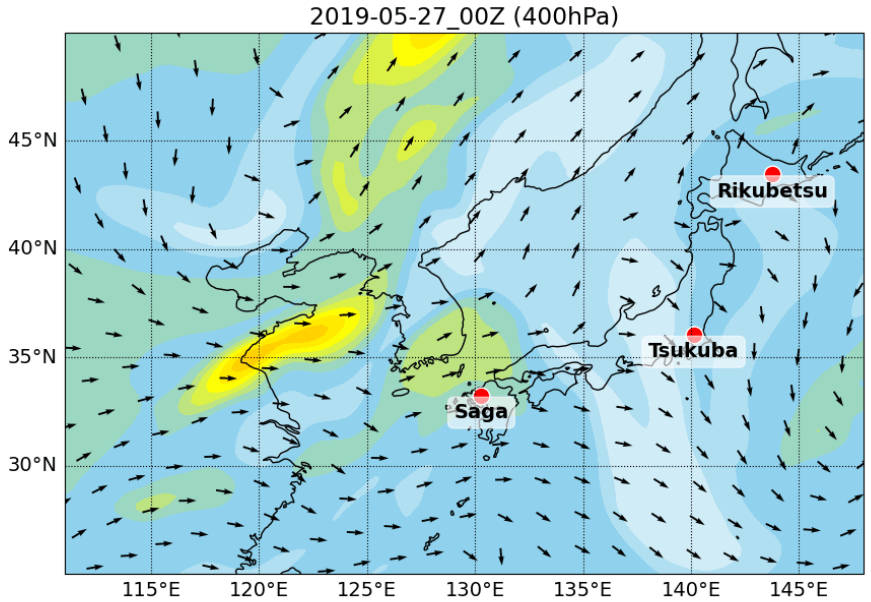
Psudo observations, 1x1km^2 GOSAT-GW demonstrator), greater Tokyo area before adding sensor noise
Takigawa, Yamaguchi, Bisht, Patra, Kanaya et al., 2024

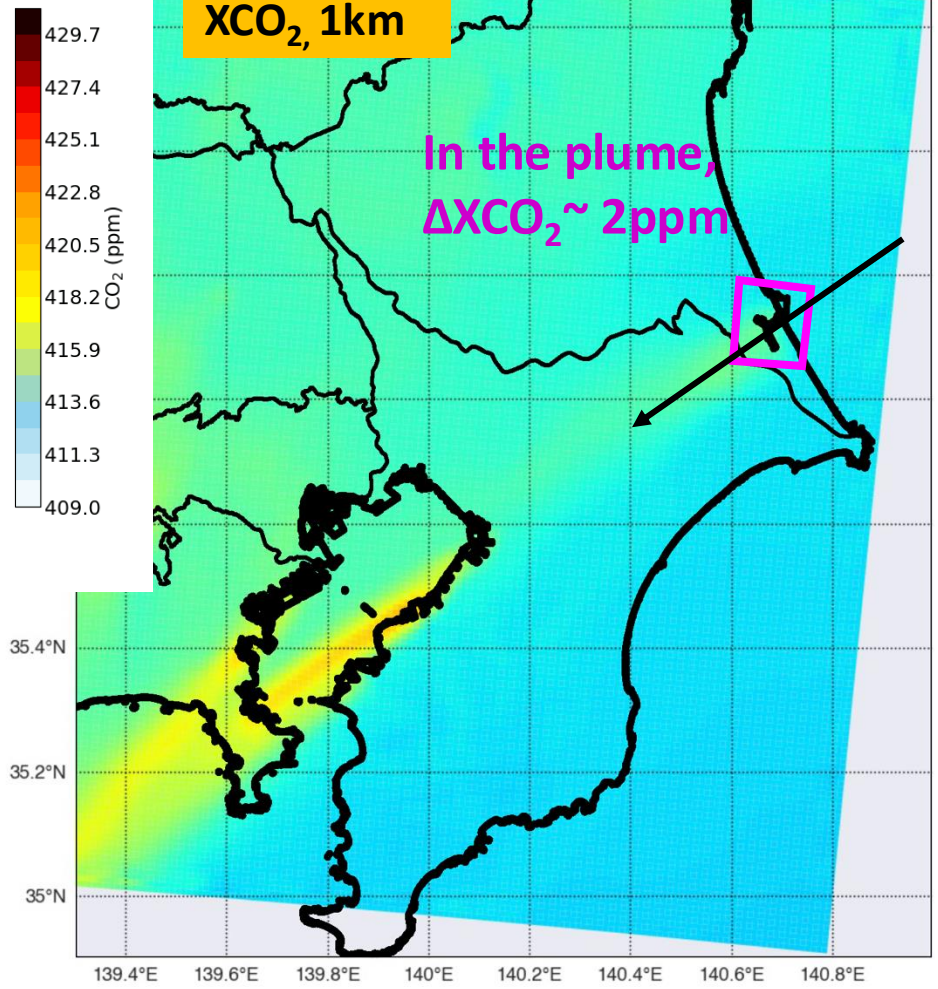
Local emission estimation, perturbed by distant sources

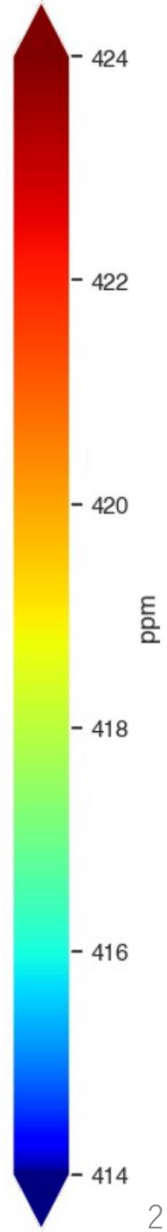


*CONTRAIL aircraft

Superimposed by larger plumes, from distant sources (at ~7km altitude from west)







*Our **Global-scale model** identifies such transport events and helps to select cases w/o risks*

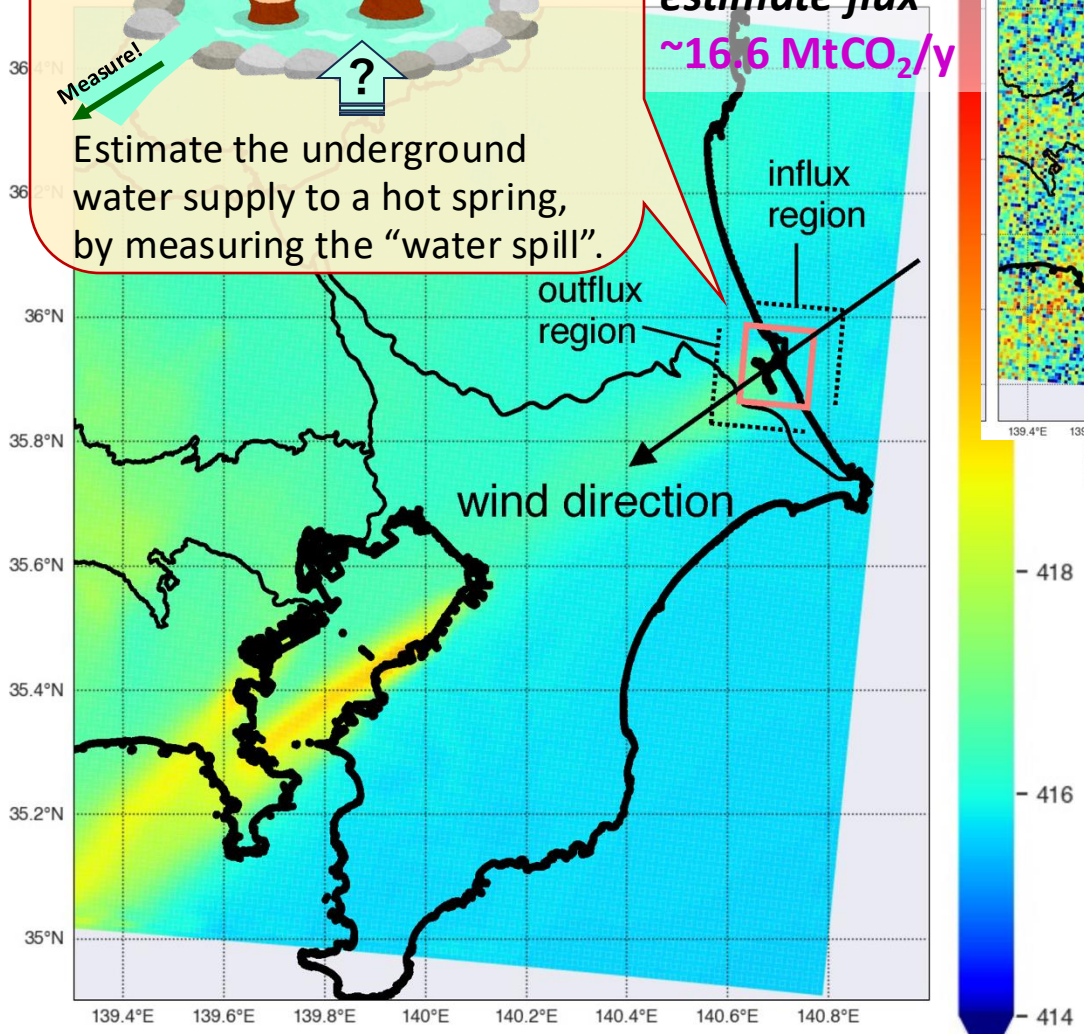
Bisht, Patra, Takigawa, Kanaya et al., in preparation

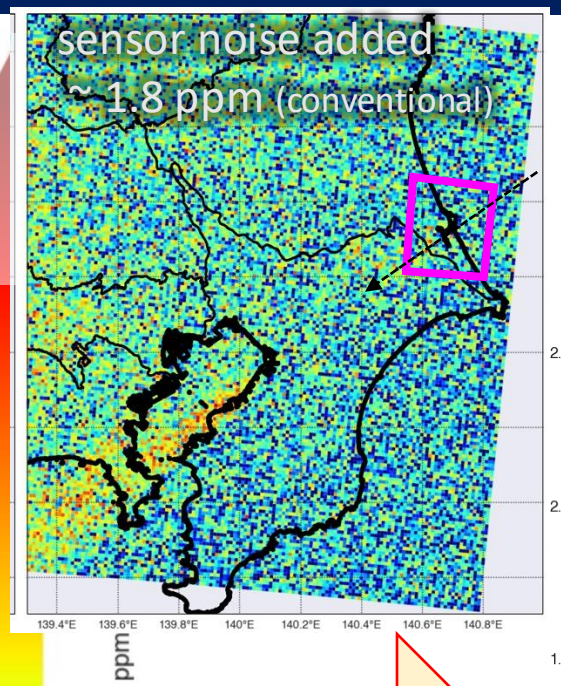
Estimate CO_2 flux from medium point sources and their uncertainties

Estimate the underground water supply to a hot spring, by measuring the "water spill".

"Divergence" method to estimate flux

~16.6 $MtCO_2$/y

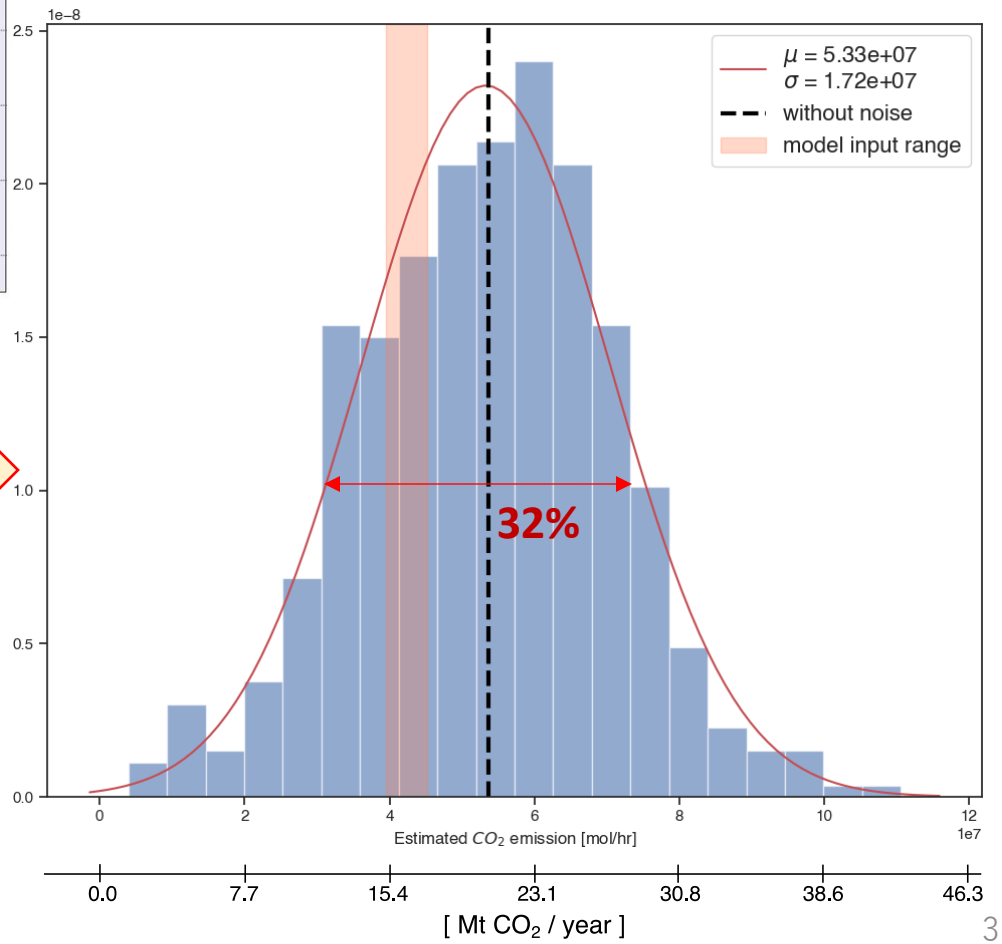




The flux estimation was repeated to obtain statistics:

500 sets of 30 observations, with different noise patterns

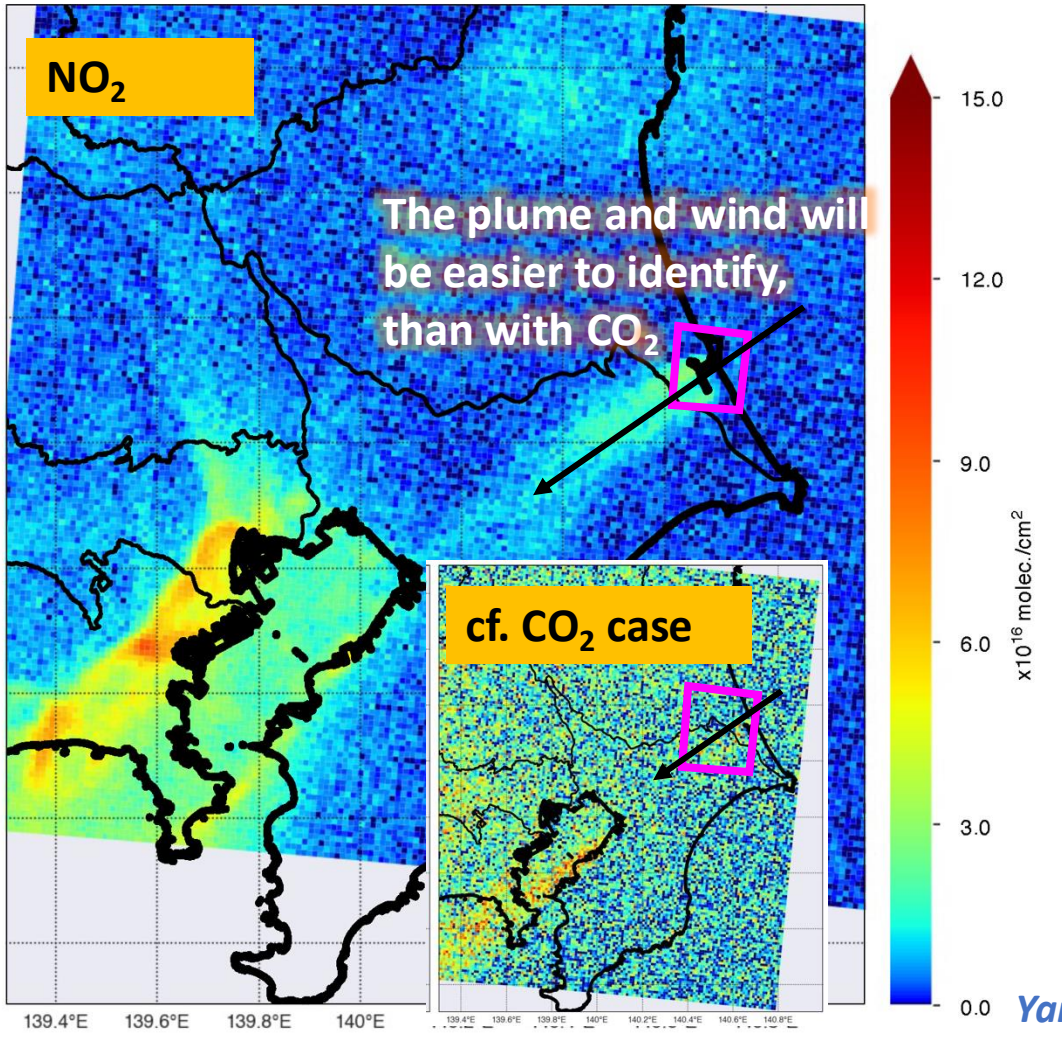
16.6$MtCO_2$/y source is to be estimated with 32% uncertainty after ~30 fine-mode observations, under clear-sky conditions (in ~90 days)



Yamaguchi , Bisht, Patra, Takigawa, Kanaya et al., 2024

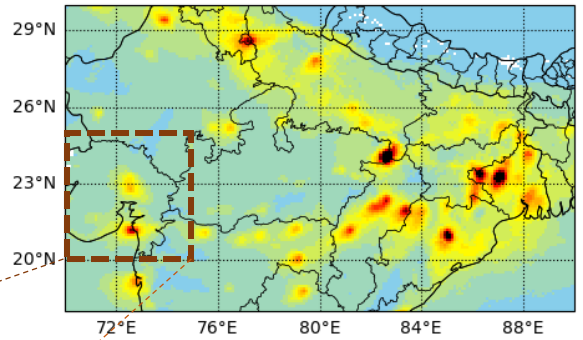
GOSAT-GW/TANSO-3 measures NO_2 together and will help on

(1) Wind characterization analysis

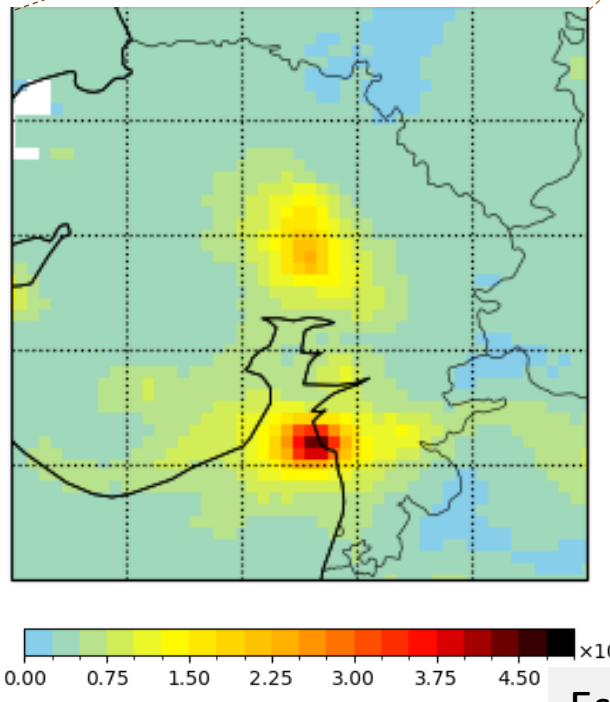


1x1km^2 GOSAT-GW demonstrator, sensor noise added

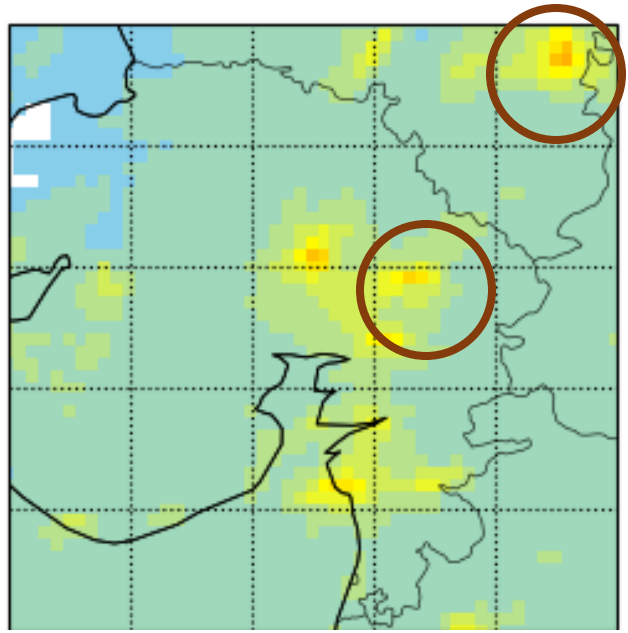
2) New emission source identification



The NO_2 simulation with known emissions



Satellite (TROPOMI) identifies new hotspots



Yamaguchi , Bisht, Patra, Takigawa, Kanaya et al., 2024

Estimate NOx emissions to explain the observations and then CO_2 flux, using NOx/CO_2 emission factor

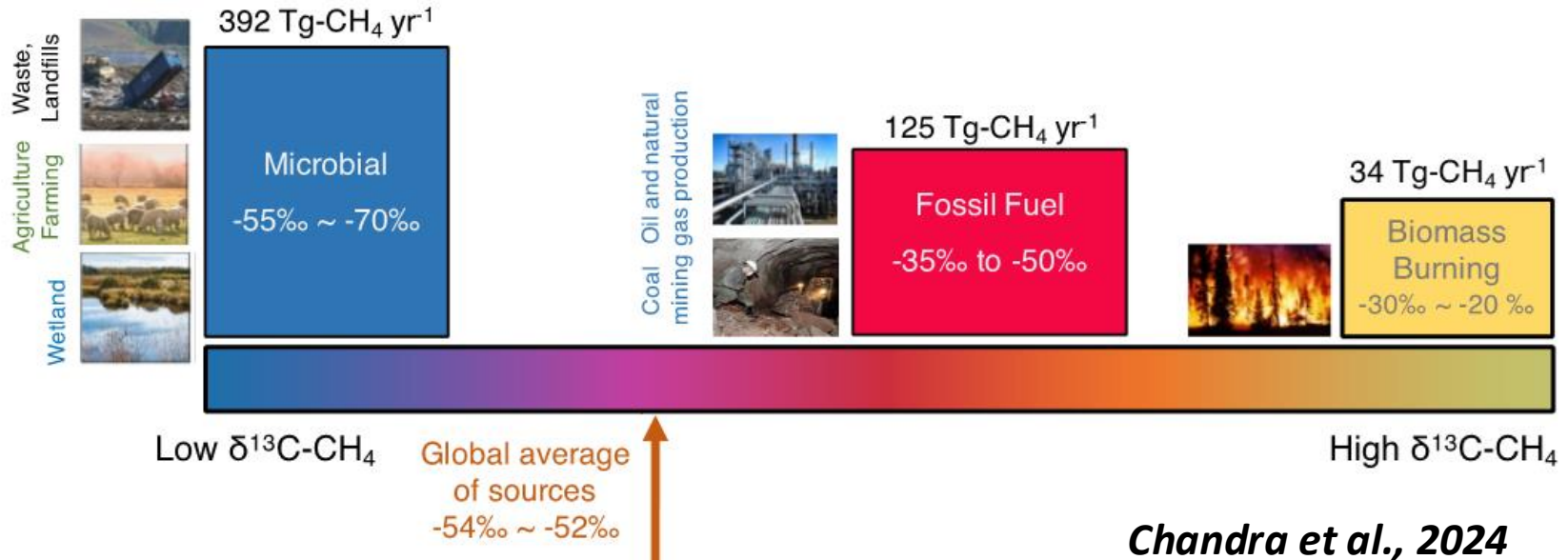
Summary

We provide flux estimates and hopefully their changes as a good indication of mitigation actions

using research-grade *Local + Global scale models*.

Challenges: *Sensor performance, interferences from vegetation uptake*

The MIROC4-ACTM global model was separately used, with "methane isotopes" information, suggesting 75% of recent-day global methane emission is from waste/landfill, agriculture, wetland



Chandra et al., 2024