Asia, as one of the world’s largest greenhouse gas (GHG) emitters, has a responsibility to play an important role to turn the goals of Paris Agreement into reality. Urgent needs in Earth observations for GHGs are to reduce uncertainties in their source and sink estimations and to identify current knowledge gaps and requirement for further international collaboration. Estimating anthropogenic and natural emissions based on observations for GHGs has a great potential for providing additional sources of information that can support estimating the impacts of mitigation actions. Discussions will be focused on current status and challenges from Japan’s relevant GHG observation and analysis to improve up-to-date analysis systems and data coverage particularly in Asia–Oceania for better estimation of the distribution of anthropogenic and natural sinks and sources with sufficient accuracy.

**Ground-based Monitoring**

Atmospheric concentrations of GHGs at near-ground levels

- Observation components: (e.g. Hateruma station): CO₂, CH₄, N₂O, CO, O₃, H₂O, SO₂, NOₓ, CO, O₃, FC, CN, aerosol, NOₓ, halocarbon, SO₂, POPs.
- Rikubetsu TCCON site at Rikubetsu Integrated Stratospheric Observation Center NIES, Rikubetsu, Asahoro, Hokkaido
- Atmospheric CO₂, CO, and CH₄ concentrations observed by TCCON

**Ship-based Monitoring**

GHG and ocean surface CO₂ monitoring in the western North Pacific by Volunteer Observing Ships

- Data: SOCAT https://www.socat.info/

**Airborne-based Monitoring**

CONTRAIL (Comprehensive Observation Network for Trace gases by Airliner)

- Powerful high-precision data for verifying models and satellite observations
- Vertical distribution of CO₂ concentration and its seasonal change
- Delft, India
- Tokyo (Narita), Japan
- Umezawa et al. (2018), Umezawa et al. (2015)

- Flight paths and the number of vertical profile observations of CO₂


**Satellite-based Monitoring**

Whole-atmosphere monthly mean CO₂ and CH₄ concentrations based on GOSAT observations

- Comparison of methane column-averaged dry-air mole fraction (XCH₄) between GOSAT and GOSAT-2 data acquired on the same day.

Data: GOSAT Data Archive Service (GDAS) https://data2.gosat.nies.go.jp/index_en.html

- Global distribution of methane column-averaged dry-air mole fraction (XCH₄) retrieved by the proxy-method from FTS-2 data acquired from March 5 to April 3, 2019.

**Data Integration and Inverse Model Estimation of GHG Sources and Sinks**

CO₂ concentration distribution at 125 km (250 hPa) estimated using NICAM-TM and CONTRAIL flight data

- NICAM-TM (Nonhydrostatic ICosahedral Atmospheric Model-based Transport Model), NIES et al., (2017a)

- Inversion analysis with CONTRAIL data improved the reliability of the results. Strong correlation was observed between the data and the data in the model, and some sites, were retrieved.

**Collaboration Among Japanese Agencies and Institutions to Contribute to the Global Stocktake (tentative)**

- Japan Platform
- Data: Atmospheric GHGs & SLCFs, ocean/terrestrial surface fluxes, GHG Inventories Information Platform: Satellites, aircraft, ships, ground stations, Analysis systems: Inverse models, flux upscaling, bottom-up inventories

**Summary**

- Japanese institutions and agencies for GHG observation and analysis cooperate to improve up-to-date analysis systems and data coverage globally and in Asia–Oceania for better estimation of the distribution of anthropogenic and natural sinks and sources with sufficient accuracy.
- Urgent international cooperation is needed to improve reliability in the global datasets.
- Technological development is still required for:
  - separation of anthropogenic and natural emission
  - near-future prediction of impacts of mitigation actions.