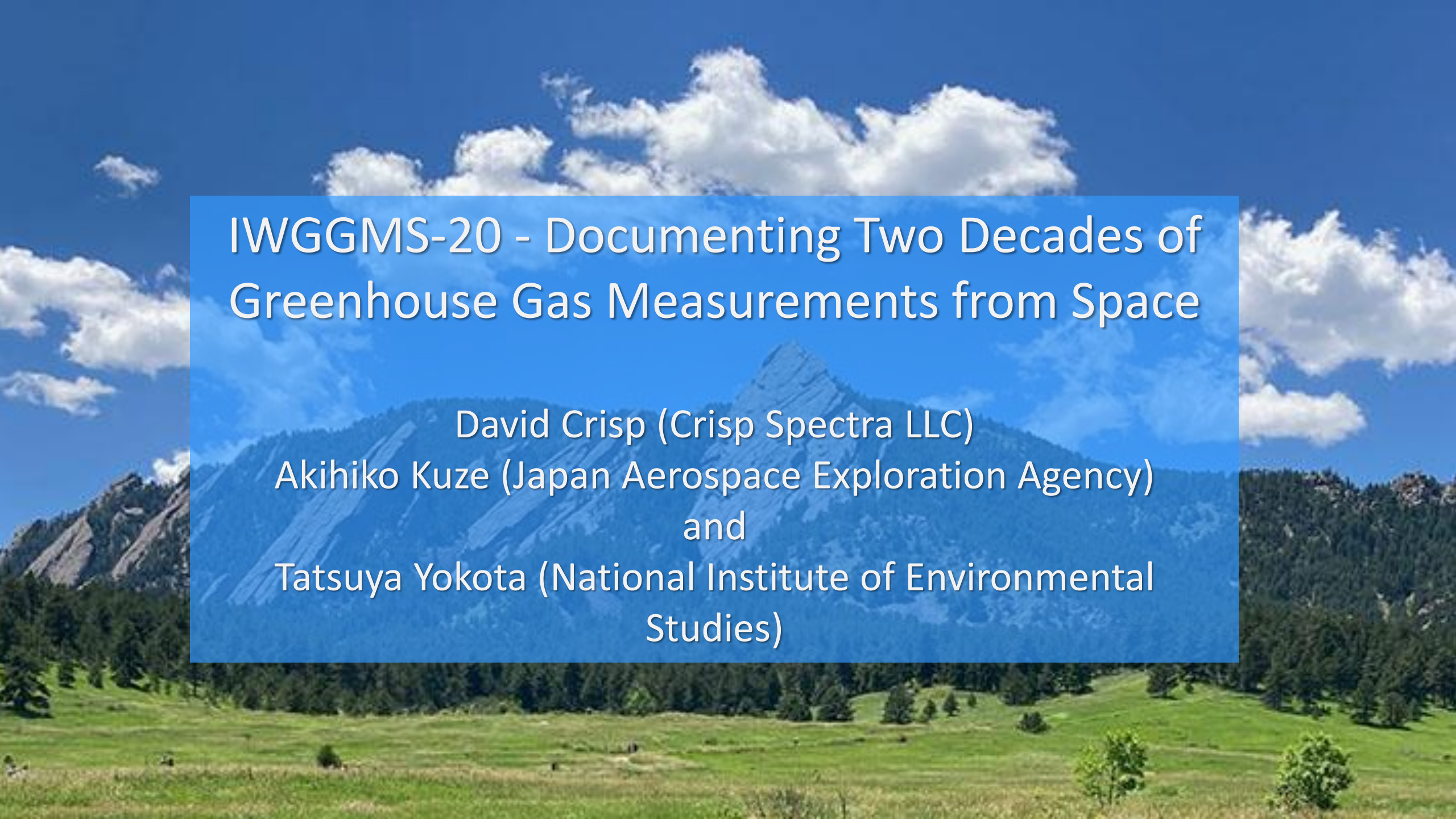
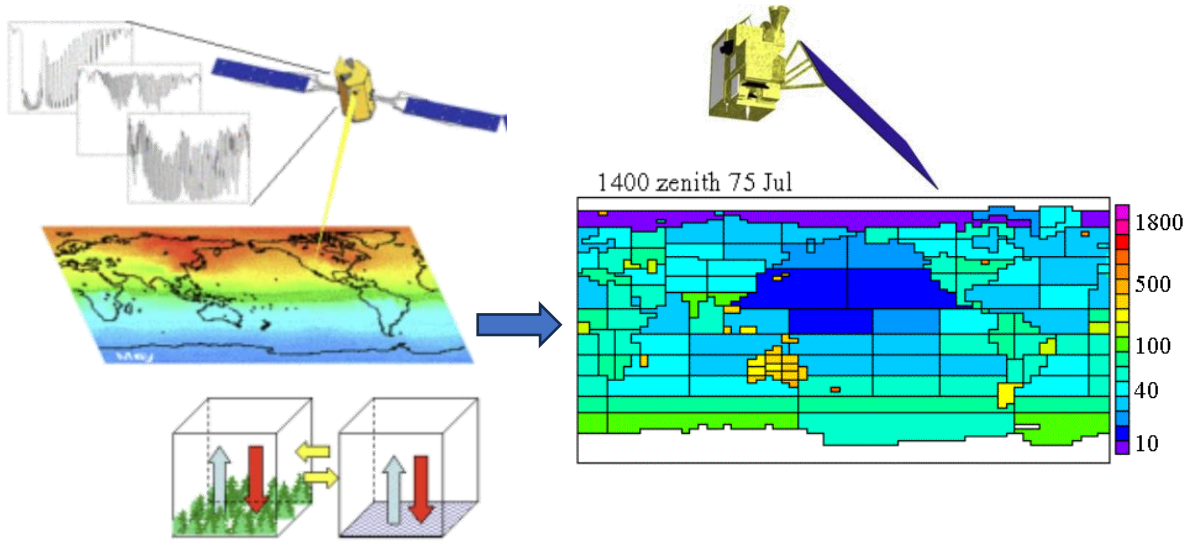


IWGGMS-20 - Documenting Two Decades of Greenhouse Gas Measurements from Space

David Crisp (Crisp Spectra LLC)
Akihiko Kuze (Japan Aerospace Exploration Agency)
and
Tatsuya Yokota (National Institute of Environmental Studies)

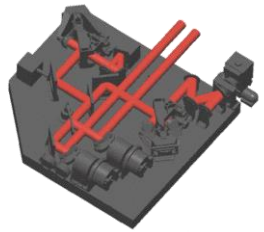
The First IWGGMS – JAXA HQ 2004

- In 2004, a small group assembled at JAXA headquarters in Tokyo for the first International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-1).
- There were no dedicated greenhouse gas (GHG) missions in flight, but SCIAMACHY was making XCO_2 and XCH_4 measurements and OCO and GOSAT had just been approved for development
- Discussions focused on:
  - Instrument design and measurement approach
  - Calibration
  - Level 2 Retrieval Algorithm development
    - Sources of bias - aerosols
  - CO_2 and O_2 line parameters
  - Validation approach – TCCON vs Aircraft

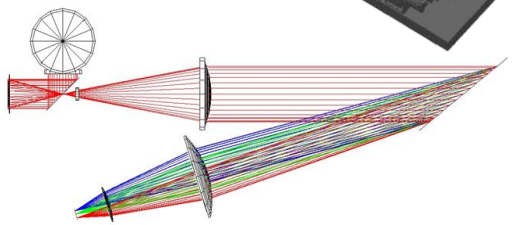


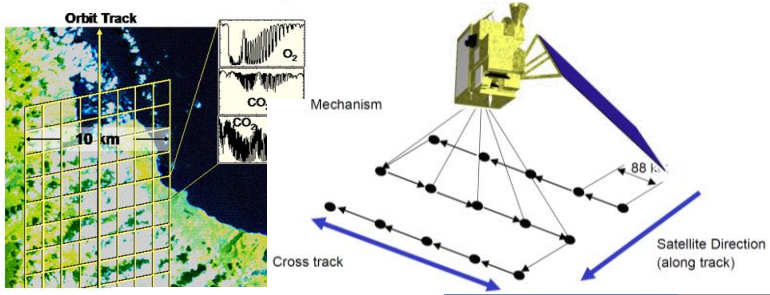
- The most important outcome of that first meeting was an agreement to collaborate to
  - Maximize the accuracy and coverage of the combined data products
  - Accelerate their acceptance of their products by the scientific community

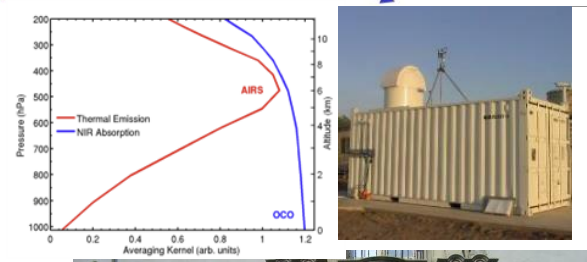
The First Half Decade of IWGGMS 2004 - 2009



- During its first half decade, IWGGMS focused on fostering a science community that could
  - Develop space-based CO_2 and CH_4 instruments
  - Use their data for carbon cycle science and policy applications
- Instrument development and pre-launch testing
  - OCO grating spectrometer vs GOSAT FTS
  - Information content of NIR/SWIR vs TIR
  - Measurement strategies (nadir, glint, target)
- Development and intercomparison of Retrieval algorithms for XCO_2 and XCH_4
- Validation approaches – ground-based, vs airborne
- Updates to flux inversion algorithms to accommodate much larger, but less accurate space-based datasets







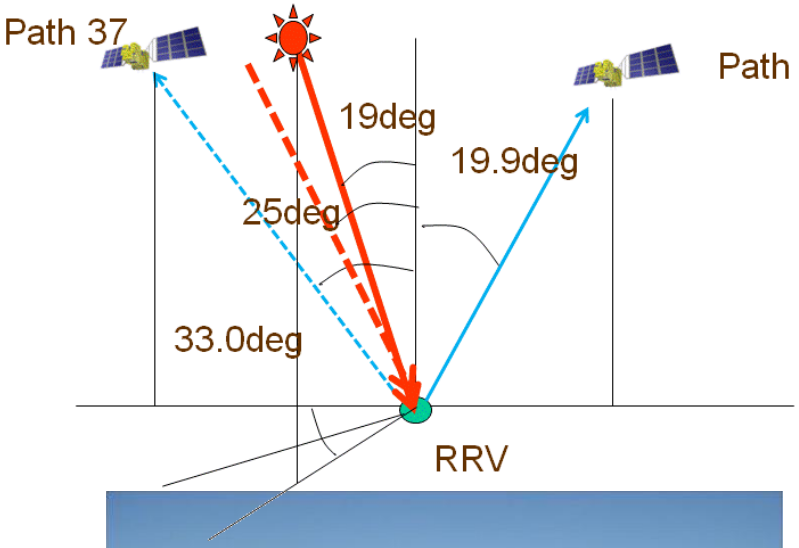
IWGGMS-2 Scope – still relevant

- Overview of Ongoing Greenhouse Gas Monitoring Missions
  - EOS MOPITT, AIRS, TES, and ENVISAT SCIAMACHY
- Future Space Based Measurement Approaches (GOSAT/OCO)
  - Instrument designs / Mission designs / sampling approaches
- Calibration Objectives and Approaches
  - Pre-launch / On-orbit
- Remote Sensing Retrieval Algorithms
  - Forward models / Retrieval approaches / Error analysis and characterization
  - Supporting laboratory measurements
- Validation Methods
  - Ground-based /Sub-orbital (aircraft, balloon, UAV)Inter-spacecraft comparison and validation
- Collaborative GHG Science
  - Coordinated measurement opportunities / Exploiting combined data sets
- Retrieving Sources and Sinks
  - Inversion and Data Assimilation Methods
  - Cross Validation of space based and sub-orbital Data

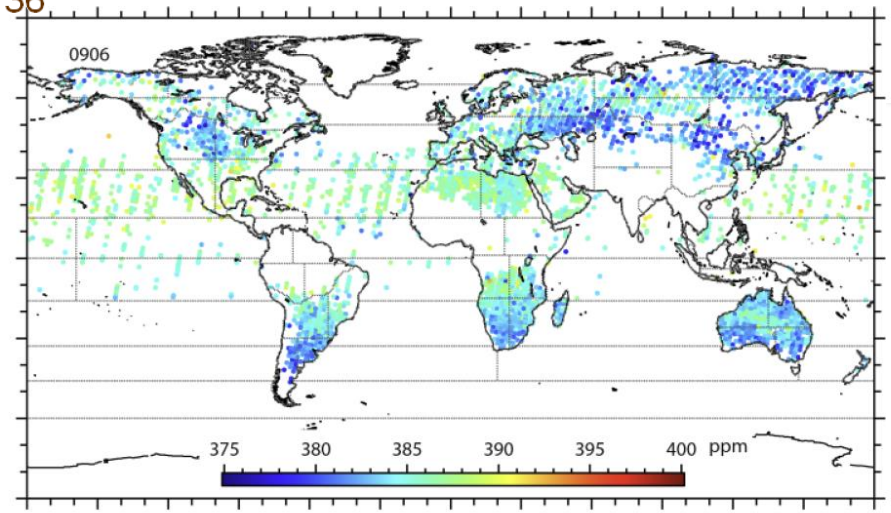
2009 – Launch of GOSAT, Loss of OCO

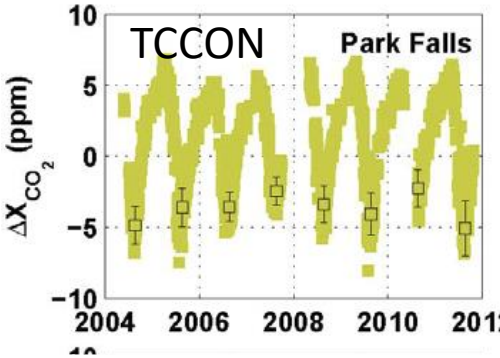
- In January of 2009, GOSAT was successfully launched
- One month later, OCO was lost when its launch vehicle failed to reach orbit
- The strong OCO/GOSAT collaboration, fostered in part by the IWGGMS, provided a path forward
- NASA reformulated the OCO science team as the Atmospheric Carbon Observations from Space (ACOS) task to
  - collaborate with its GOSAT partners
  - recover some of the science knowledge expected from OCO

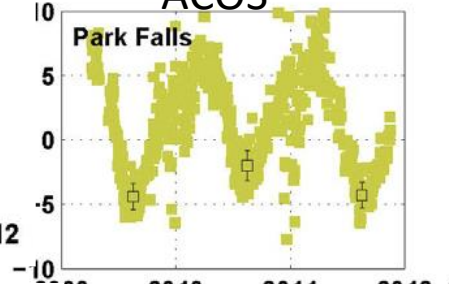
2009 – 2015 Learning to Work with GOSAT Data

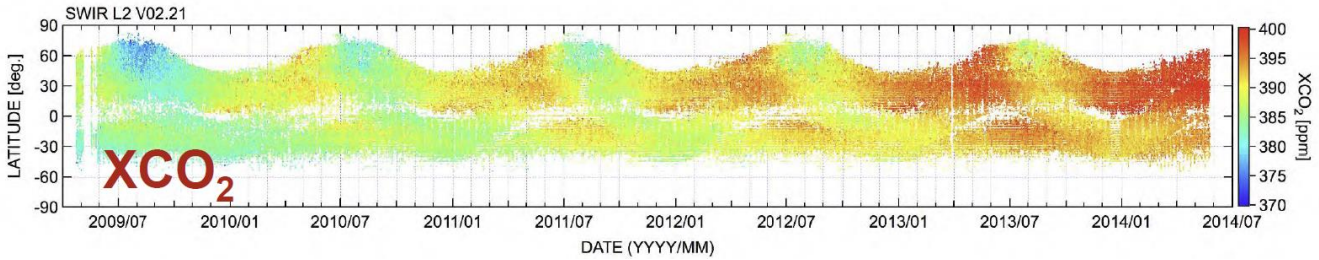


XCO_2 Retrievals

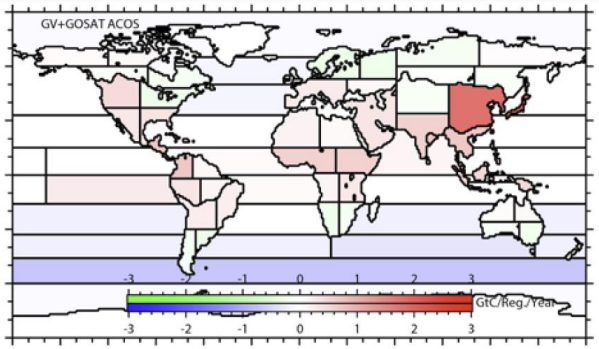




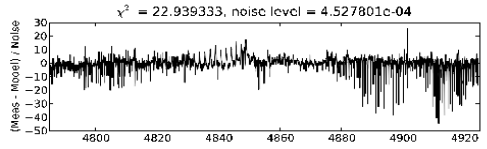


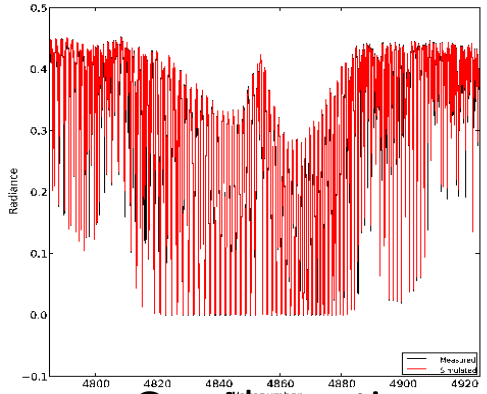


Preliminary Flux Inversions



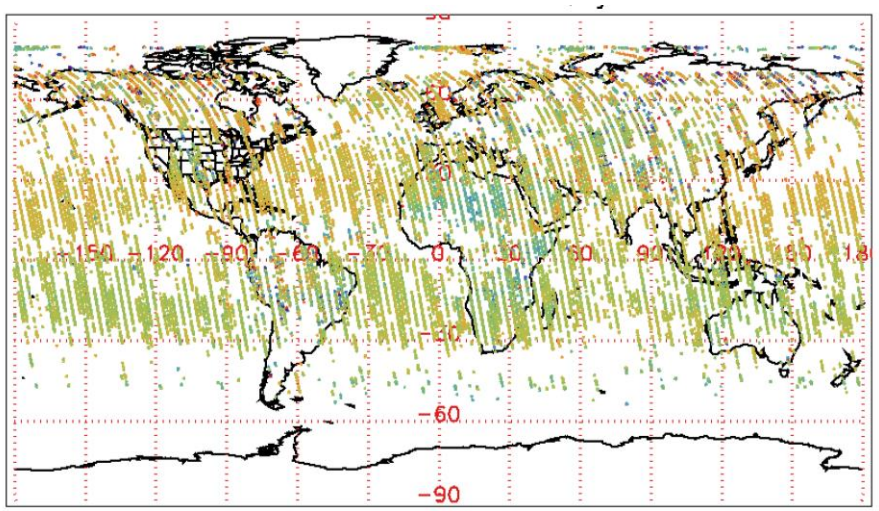
ACOS B2.9
Net: 4.92
Bio: -1.53
Ocn: -2.39

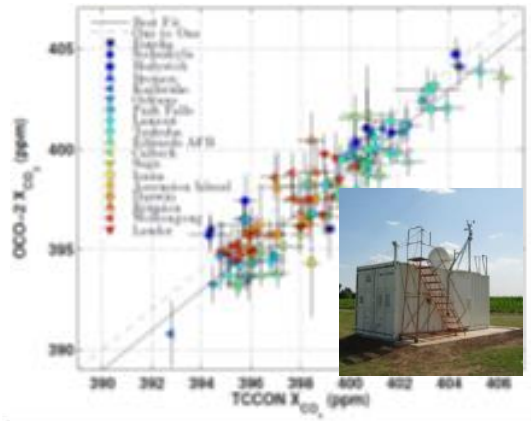


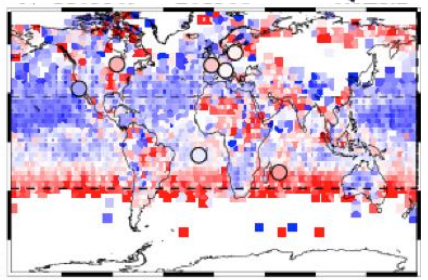


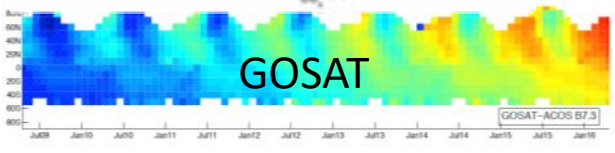
Gas Absorption Parameters

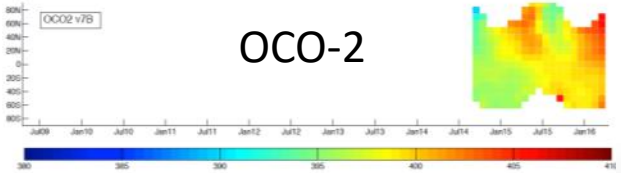
2015-2018 – Learning to Work With OCO-2 Data

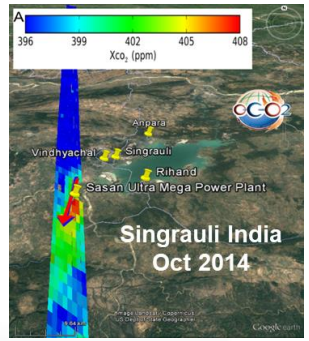


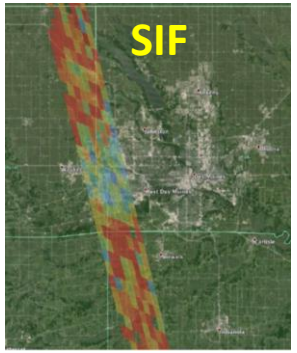


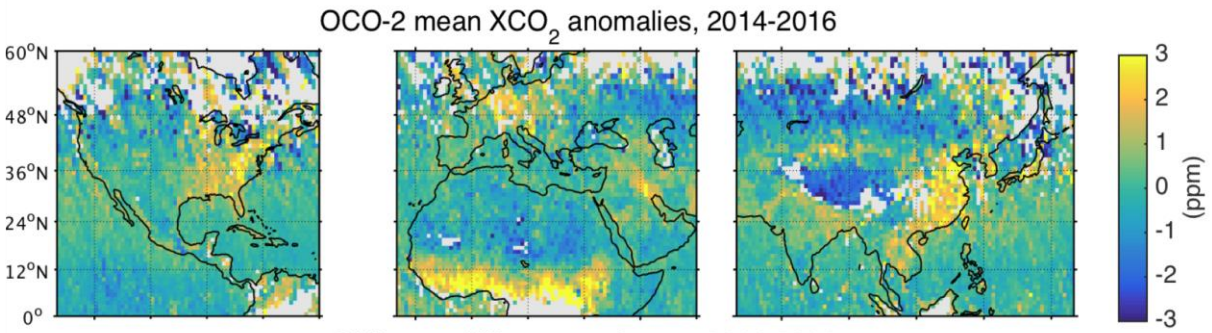


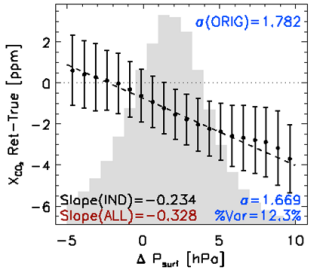


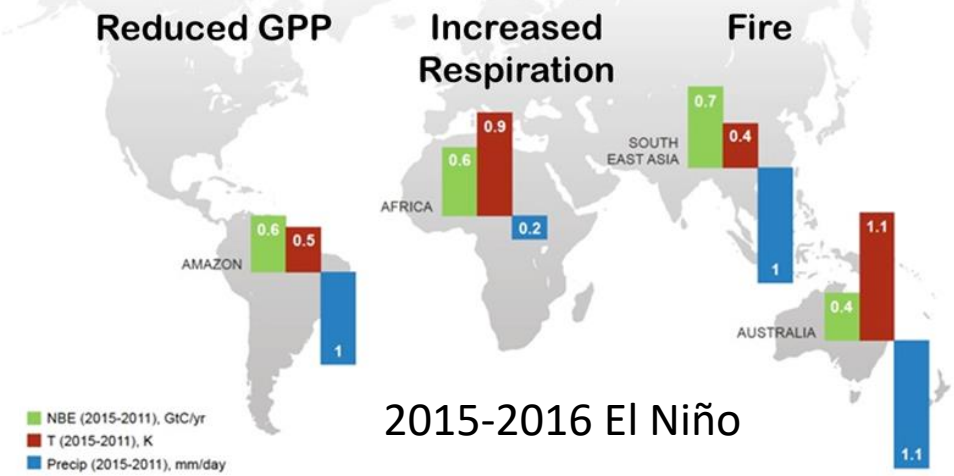






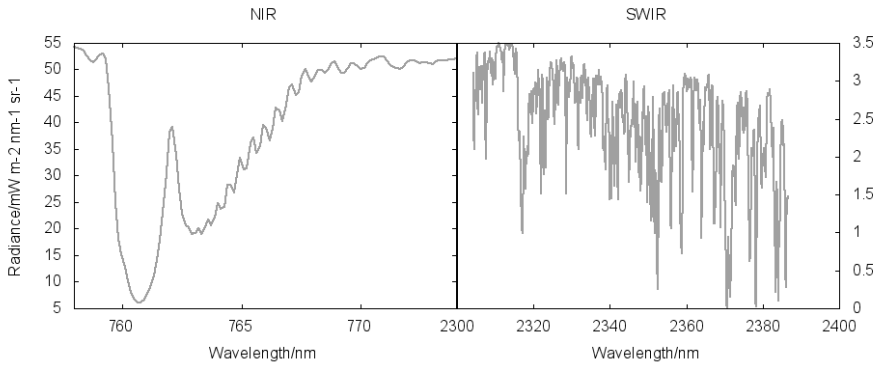


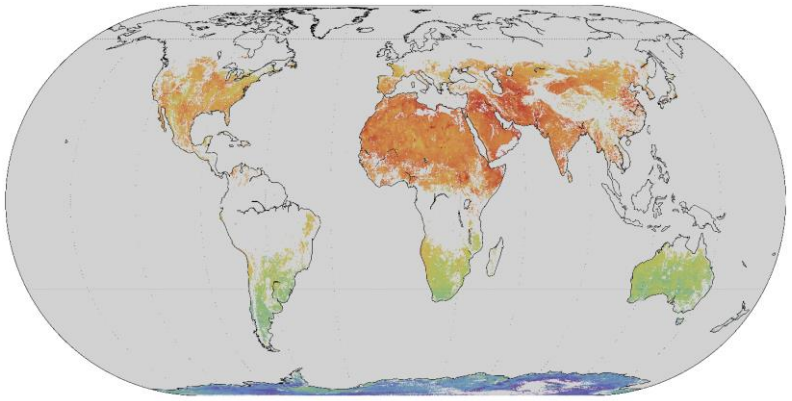


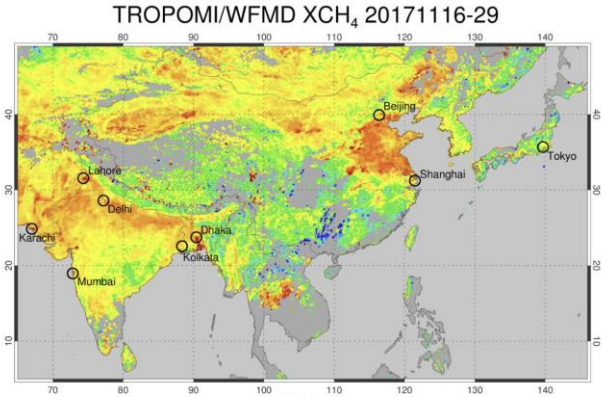


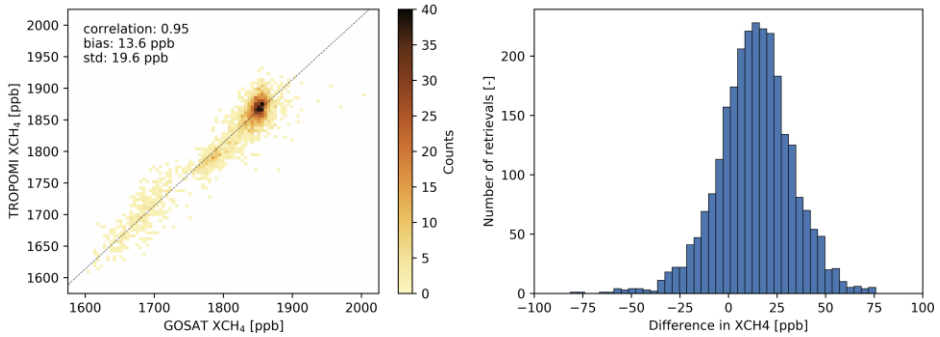
2015-2016 El Niño

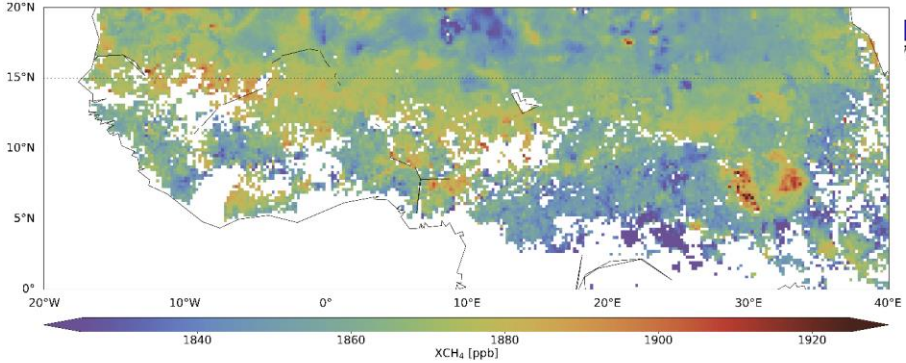
2018+ Learning to Work with TROPOMI Data

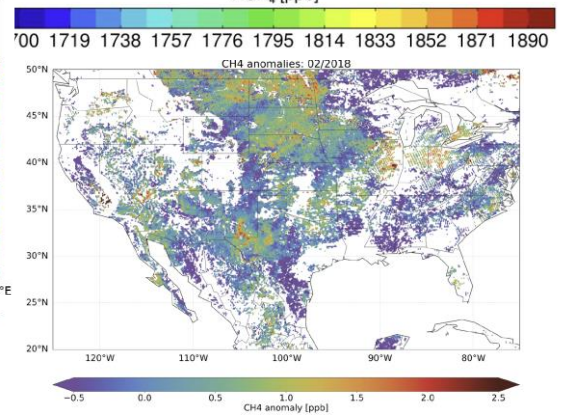


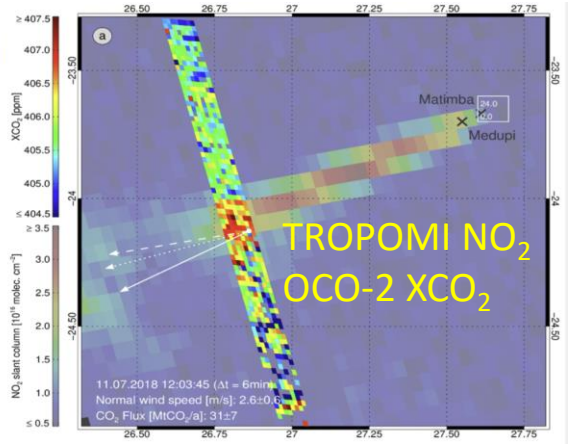


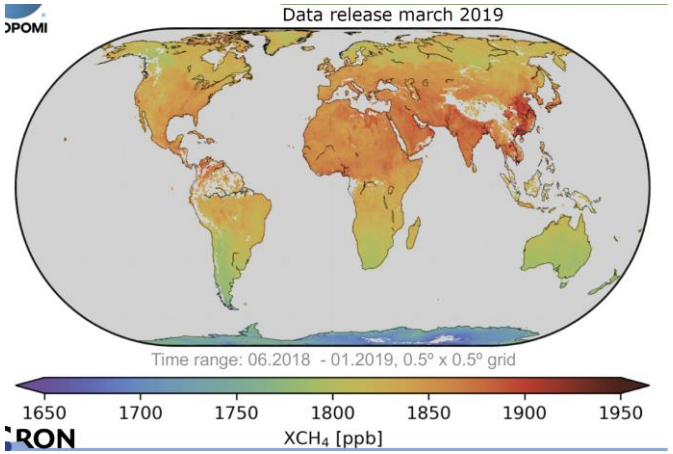


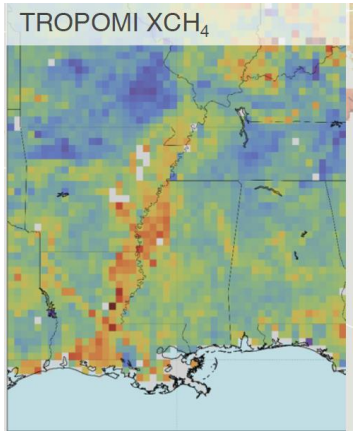


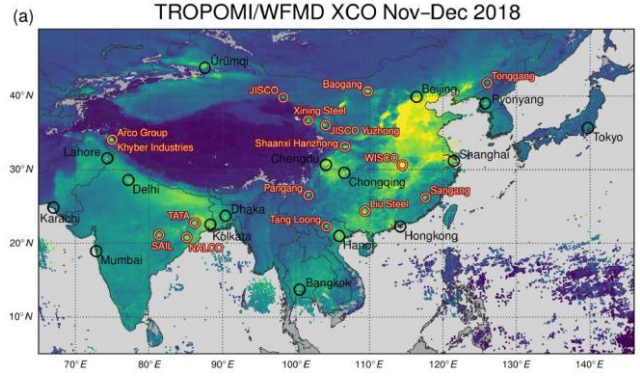




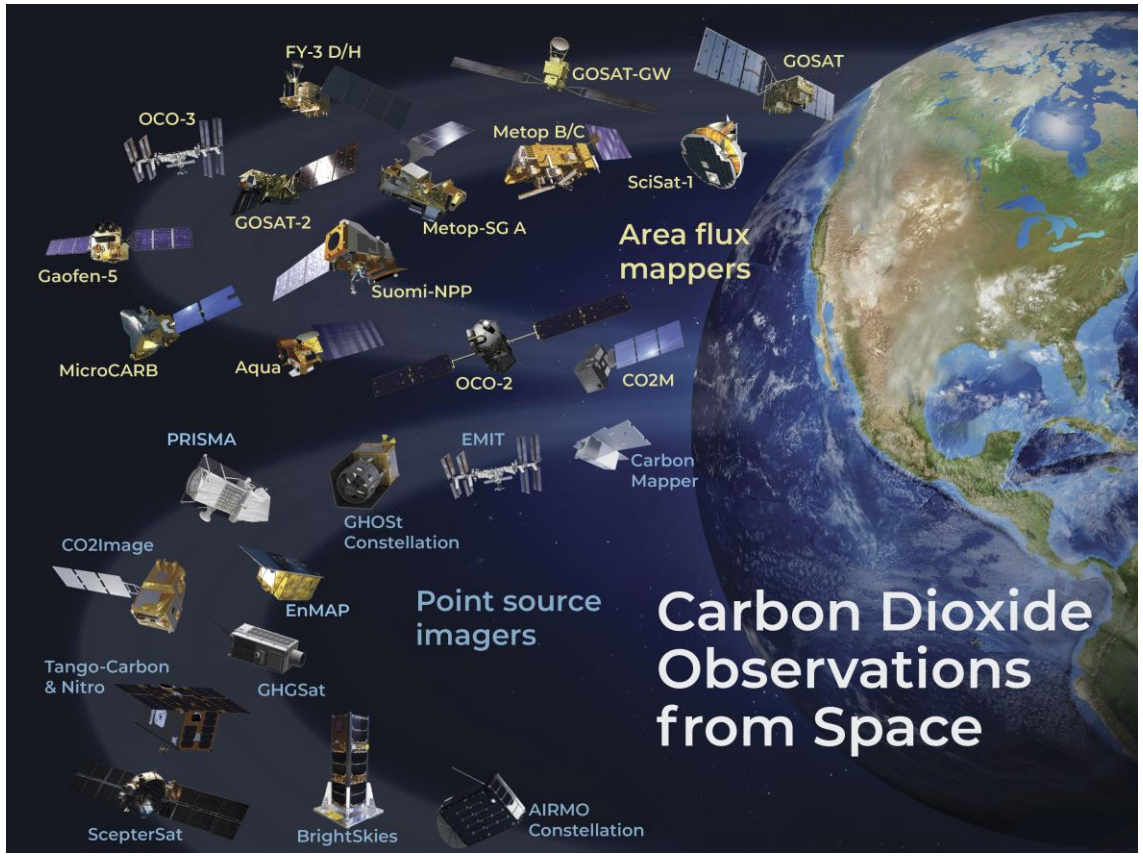


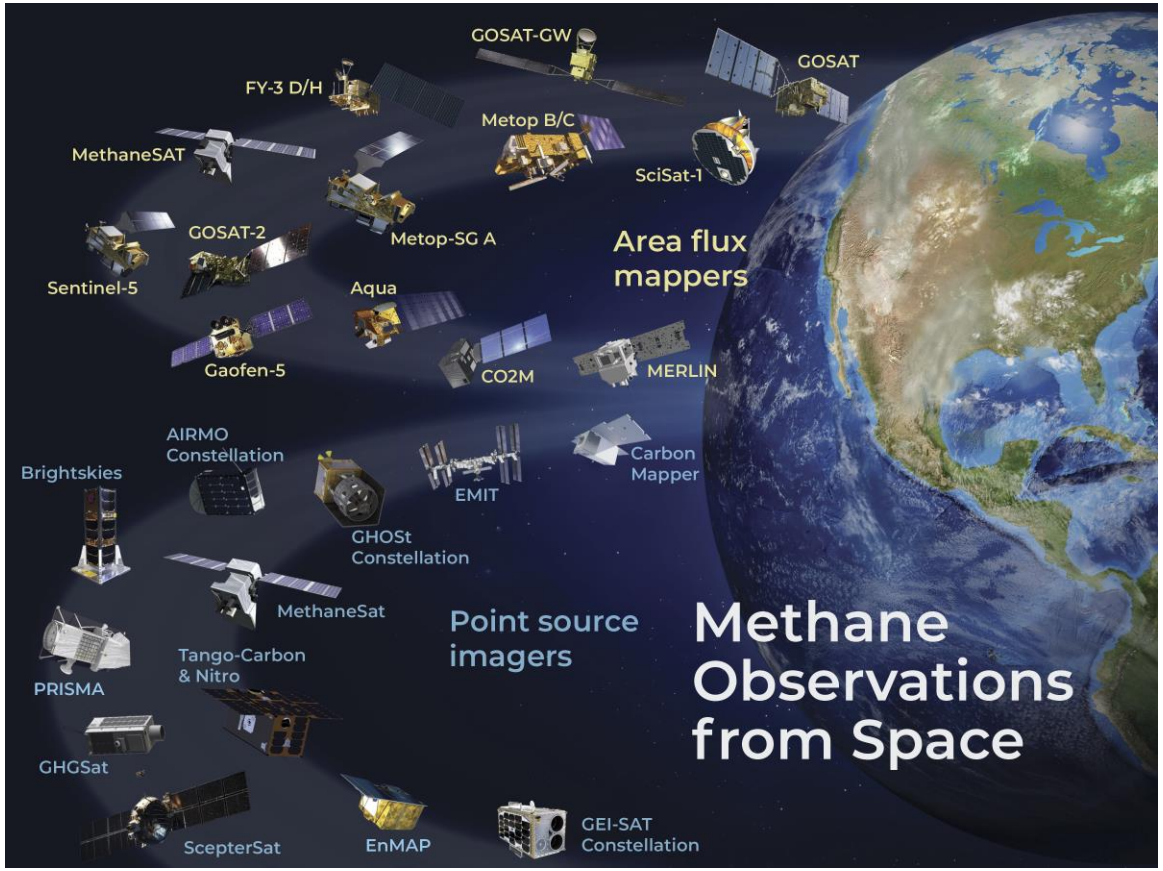


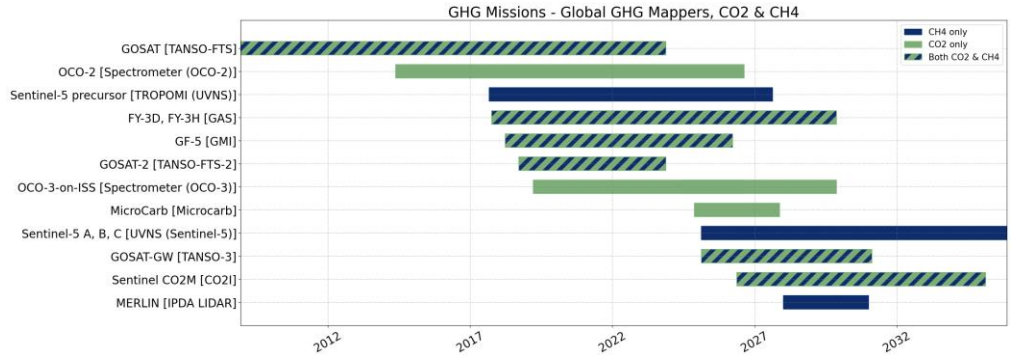


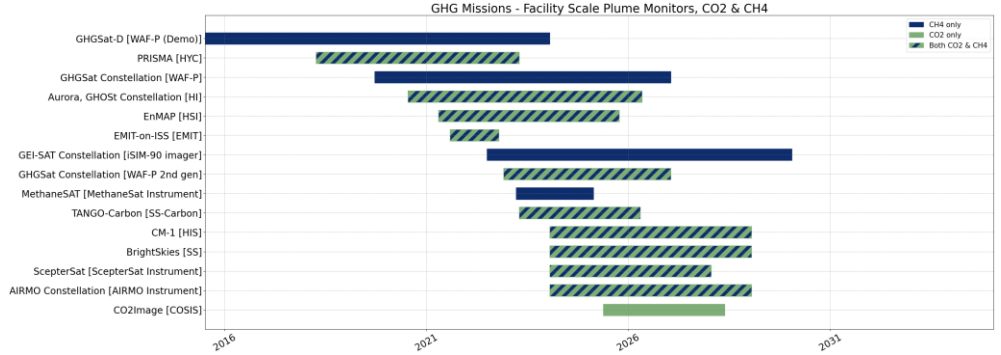


The Growing Fleet of GHG Mappers









The Growing IWGGMS Community

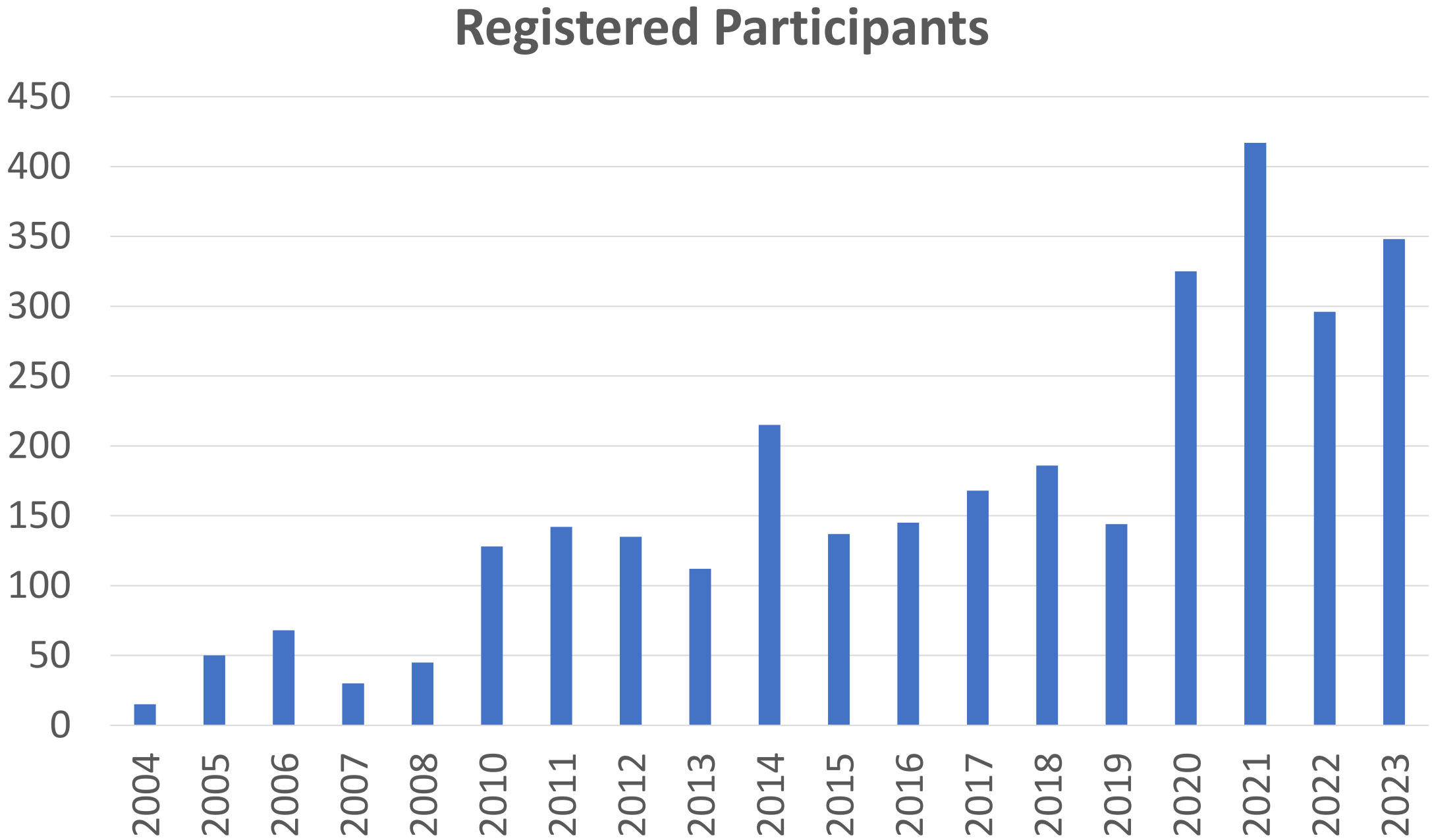
IWGGMS-16
EUMETSAT
Virtual

IWGGMS-17
GSFC
Virtual

IWGGMS-18
NIES
Virtual

IWGGMS History

	Year	Month	Venue	City		Participants
IWGGMS-1	2004	April	JAXA/EORC	Tokyo	Japan	15
IWGGMS-2	2005	March	Caltech	Pasadena	USA	50
IWGGMS-3	2006	May	Center for Institutes	Tsukuba	Japan	68
IWGGMS-4	2007	June	CNES HQ	Paris	France	30
IWGGMS-5	2008	June	Caltech	Pasadena	USA	45
IWGGMS-6	2010	January	Internatioal Conference Center	Kyoto	Japan	128
IWGGMS-7	2011	May	University of Edinburgh	Edinburgh	UK	142
IWGGMS-8	2012	June	Caltech	Pasadena	USA	135
IWGGMS-9	2013	June	Industrial Trade Center	Yokohama	Japan	112
IWGGMS-10	2014	May	ESA/ESTEC	Noordwijk	Netherlands	215
IWGGMS-11	2015	June	Caltech	Pasadena	USA	137
IWGGMS-12	2016	June	Kyoto University	Kyoto	Japan	145
IWGGMS-13	2017	June	University of Helsinki	Helsinki	Finland	168
IWGGMS-14	2018	May	University of Toronto	Toronto	Canada	186
IWGGMS-15	2019	June	Hokkaido University	Sapporo	Japan	144
IWGGMS-16	2020	June	EUMETSAT	Darmstadt/Virtual	Germany	325
IWGGMS-17	2021	June	NASA/GSFC	Greenbelt/Virtual	USA	417
IWGGMS-18	2022	July	NIES	Tsukuba/Virtual	Japan	296
IWGGMS-19	2023	July	CNES HQ	Paris	France	348
IWGGMS-20	2024	May	NCAR	Boulder	USA	


Registered Participants
450
400
350
300
250
200
150
100
50
0
2004
2005
2006
2007
2008
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

Summary and Prospectus

- IWGGMS has become the primary international forum for the exchange of scientific and technical information about greenhouse gas measurements from space
  - Instrument development, calibration, level 2 algorithms, validation, flux inversion modelling, applications …
- Since 2004, this meeting has grown from a small, interactive workshop to a large scientific conference
- To date, it has been hosted by Japan, Europe, & North America, in sequence
  - Without registration fees
  - Without parallel sessions
- Have we outgrown this format?
  - Hybrid in-person/virtual attendance has been accommodated
  - Are there other approaches that we should be considering?

Suggestions?