Overview on recent research at Fudan University for the PEEX domainResearch

Bo Yao

April 14, 2026

Outline

✓General Introduction

✓Recent research highlights

Fudan historical landmarks

Dr. Ma Xiangbo
First President

1905 Establishment

1984
1/10 Nation's
key University

2000
Merged with
Shanghai
Medical College

2022
20 First-Class disciplines

Multi-disciplinarily world-class university

6 disciplines rank top 1‰ in the world

- *Material Science*
- *Chemistry*
- *Clinical medicine*
- *Molecular Biology & Genetics*
- *Pharmacology & Toxicology*
- *Biology & Biochemistry*

21 disciplines rank top 1% in the world

- *Mathematics*
- *Multidisciplinary*
- *Microbiology*
- *Engineering*
- *Environment/ Ecology*
- *Immunology*
- *Psychiatry/ Psychology*
- *Geosciences*
- *Computer Science*
- *Physics*
- *Agricultural Sciences*
- *Social Science*
- *Neuroscience & Behavior*
- *Plant & Animal Science*
- *Economics & Business*

Data from Essential Science Indicators [SM] Database, Clarivate Analytics, updated on Mar, 2023

Establishment of AOS/IAS

Prof. Renhe Zhang and Prof. Mu Mu joined Fudan University in Mar 31st 2016

Institute of Atmospheric Sciences was established in April 29th 2016

Department of Atmospheric and Oceanic Sciences was established in April 20th 2018

Platforms

Key laboratories/research centers

- CMA-FDU Joint Laboratory of Marine Meteorology
- Shanghai Frontiers Science Center of Atmosphere-Ocean Interaction
- Shanghai Key Laboratory of Ocean-land-atmosphere Boundary Dynamics and Climate Change
- Key Laboratory of Polar Atmosphere-ocean-ice System for Weather and Climate, Ministry of Education

Platforms

International Centers

- World Meteorological Organization(WMO) –Fudan University MoU
- Integrated Research on Disaster Risks (IRDR) International Center of Excellence research and educational activities
- WMO Monitoring, Analysis and Prediction of Air Quality

WMO

极端天气气候与健康风险互联和治理国际卓越中心

IRDR ICoE Integrated Research on Disaster Risk International Centre of Excellence

Risk Interconnectivity and Governance on Weather/Climate Extremes Impact and Public Health (RIG-WECEIPHE)

MAP-AQ 亚洲区域办公室

ASIAN OFFICE SHANGHAI

Monitoring, Analysis and Prediction of Air Quality

PEEX Participation

Memorandum of Understanding on Cooperation

between
Institute for Atmospheric and Earth System Research (INAR) at the University of Helsinki
and "Atmosphere and Climate Competence Center (ACCC)"
and "Pan-Eurasian Experiment (PEEX) Program" coordinated by INAR

and
Department of Atmospheric and Oceanic Sciences (AOS),
Institute of Atmospheric Sciences (IAS),
Fudan Integrated Research on Disaster Risks International Center of Excellence (FDU IRDR ICoE)
FUDAN UNIVERSITY

MoU was signed in August 2024

- ✓ Establishing institute contact point for the collaboration
- ✓ Actively participating in the relevant PEEX labelled activities, such as PEEX meetings and conferences, working groups and new funding proposals, and FDU International Summer School on Climate Change and Related Risks (FDU long -term project 2024-2034)
- ✓ Making PEEX Program visible in their countries through development and implementation of relevant mega-city pilot/demonstration projects
- ✓ Exchange visiting scholars and students regularly.

Four major research directions

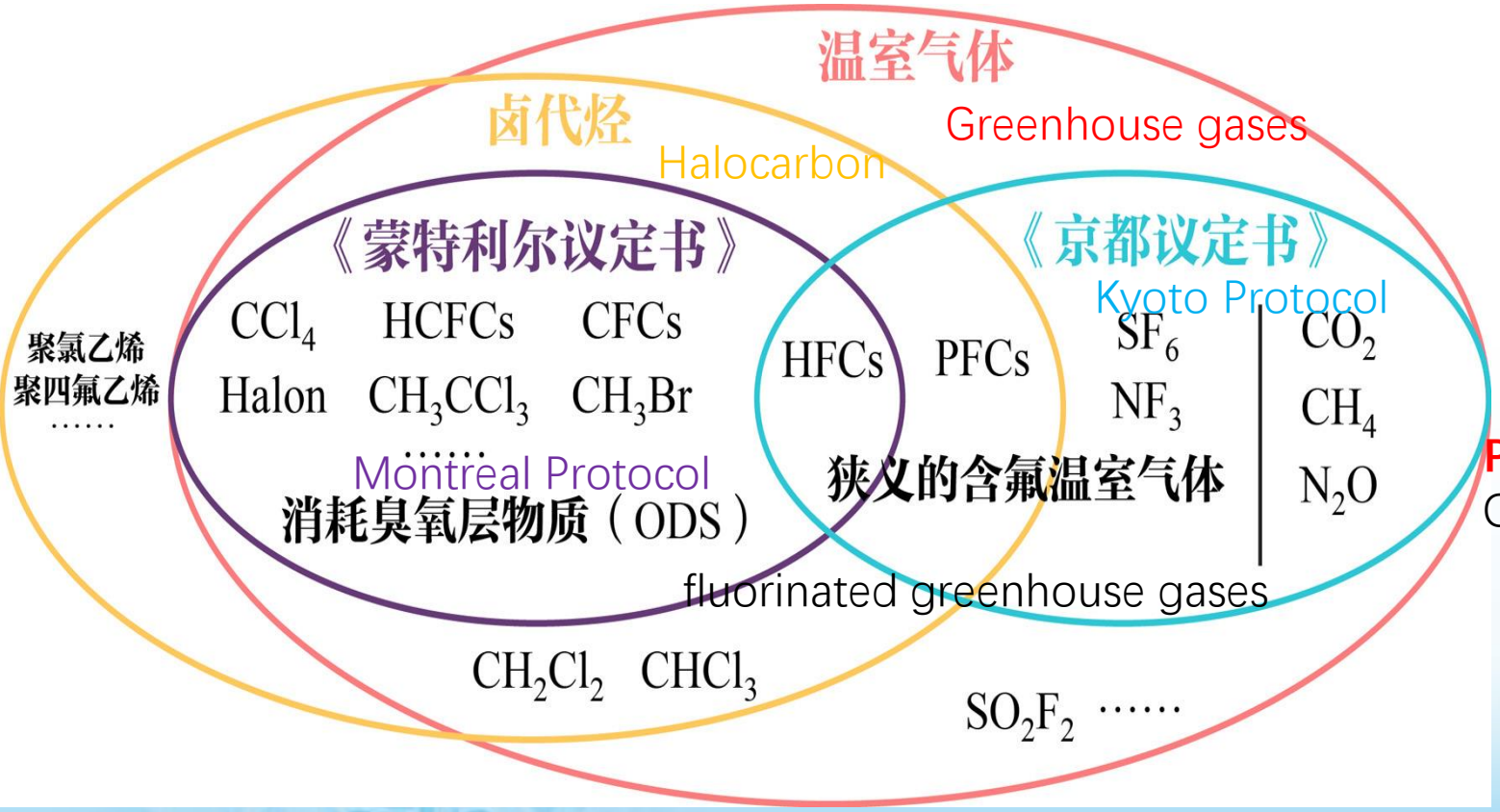
- **Meteorology and air pollution**
- **Climate variability and climate change**
- **Physical and Chemical processes in Atmosphere**
- **Marine meteorology and Physical Oceanography**

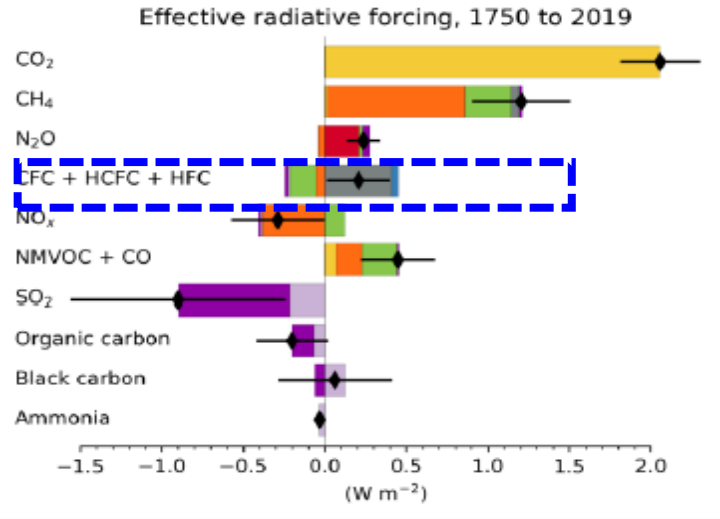
Outline

✓General Introduction

✓Recent research highlights

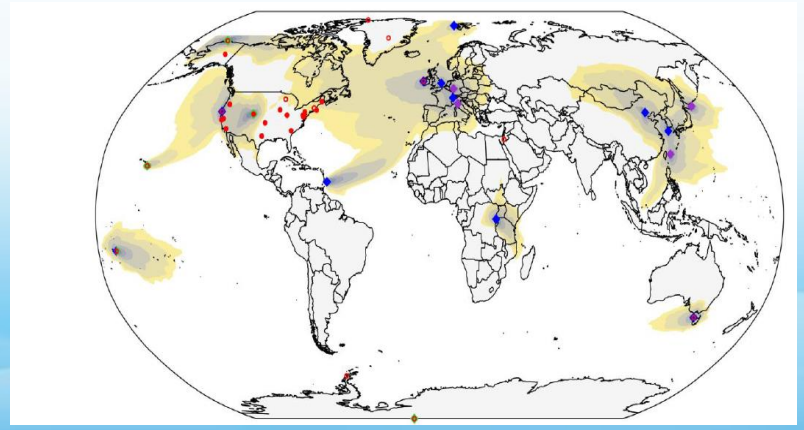
3.1 Measurement system development of halogenated Greenhouse gases and application





Potential source regions not sampled

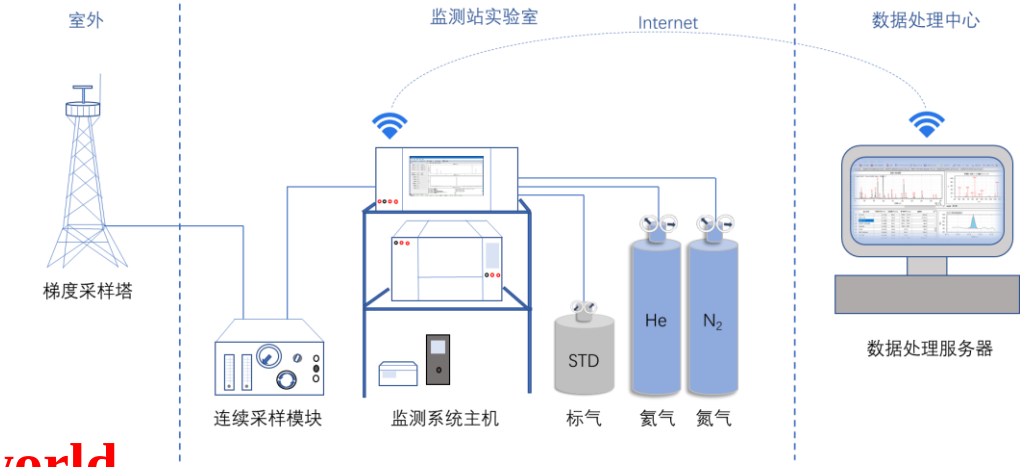
Only State-of-art instruments made by scientists

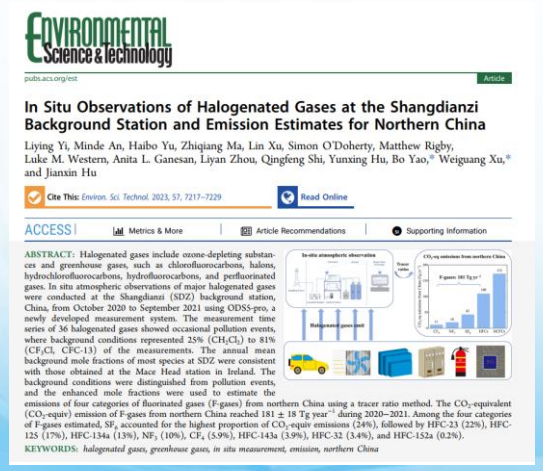


halogenated Greenhouse gases contribute significantly to ozone depletion and climate change

Development of in-situ system for halogenated greenhouse gases

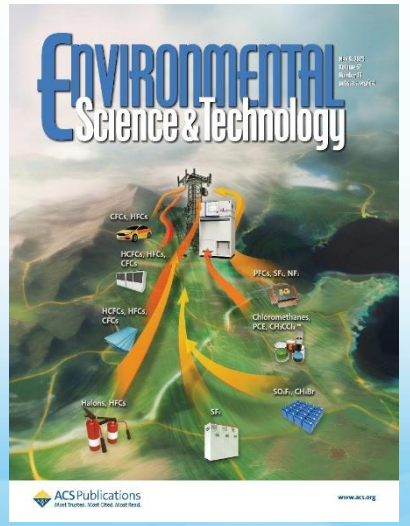
- ✓Supported by Chinese National Key R&D Projects (2019YFC0214500 & 2023YFF0714600)
- ✓Totally >50 compounds were detected including CFCs, HCFCs, HFCs, PFCs, SF_6, NF_3, Halons, etc
- ✓Detection limit<10 ppq
- ✓Typical precision 1% at 100 ppt
- ✓**First commercial system for halogenated GHG in the world**
- ✓**Applied at more than 20 sites or analysis lab since 2023**



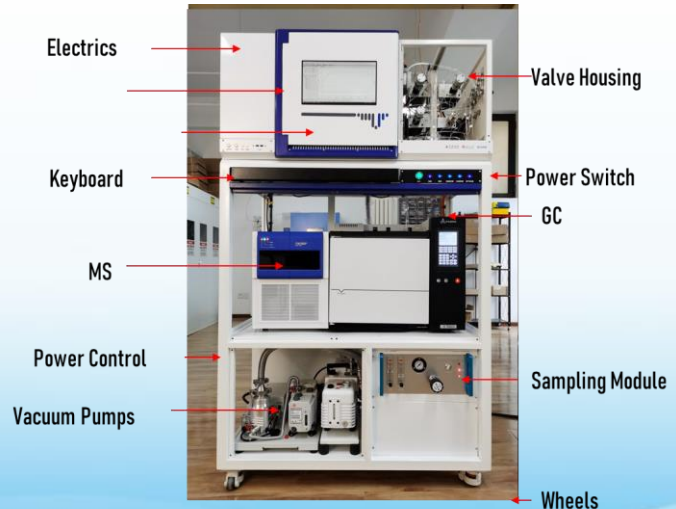

Environmental Science & Technology

In Situ Observations of Halogenated Gases at the Shangdianzi Background Station and Emission Estimates for Northern China

Liying Yi, Minde An, Haibo Yu, Zhiqiang Ma, Lin Xu, Simon O'Doherty, Matthew Rigby, Luke M. Western, Anita L. Ganesan, Liyan Zhou, Qingfeng Shi, Yunxing Hu, Bo Yao,* Weiguang Xu,* and Jianxin Hu



Yi, et al., 2023@EST



Tianji ODS5-Pro

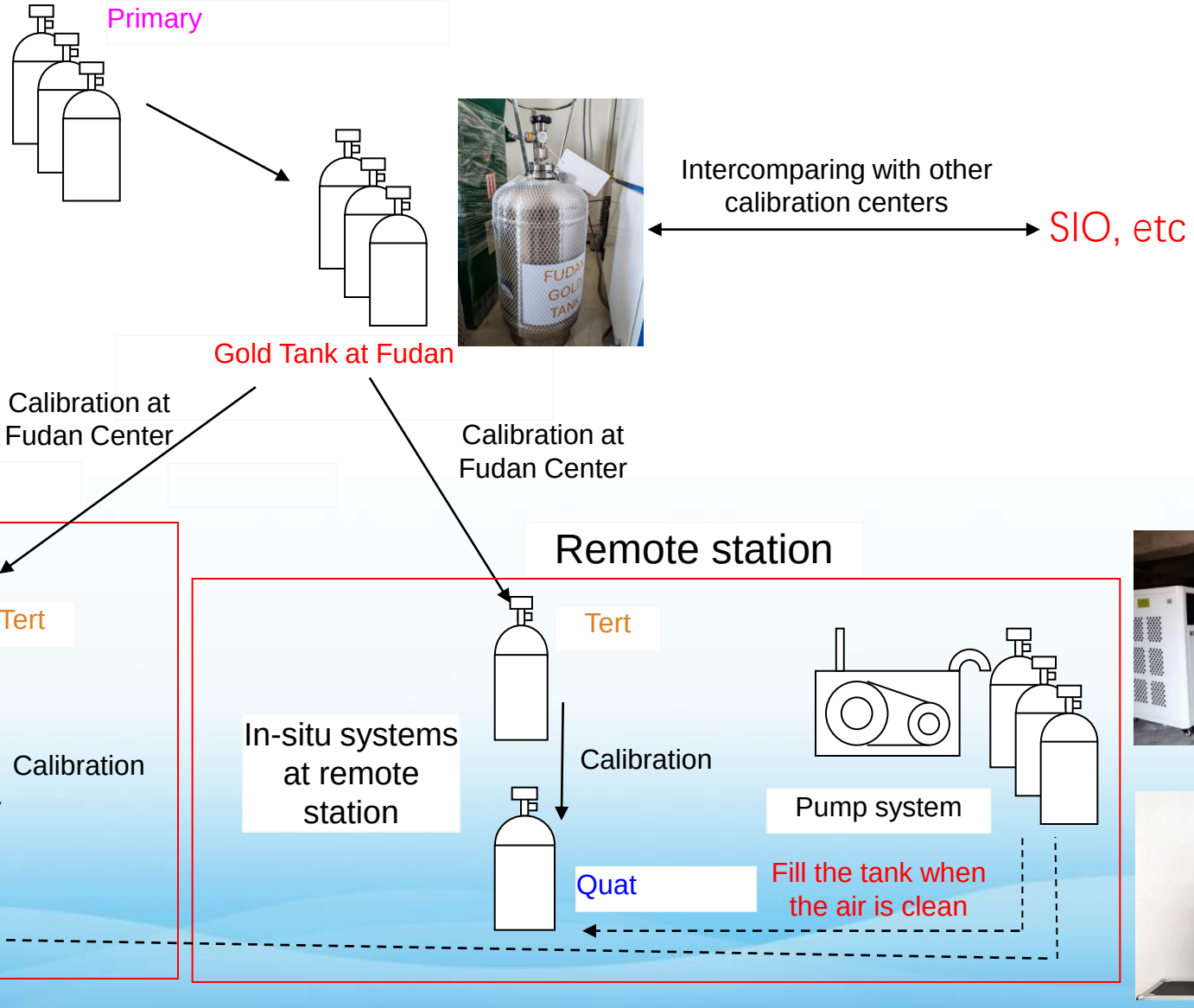
Tianji ODS6-Pro

Leading Fluorinated GHG Alliance
6 in-situ stations in China
Since 2024

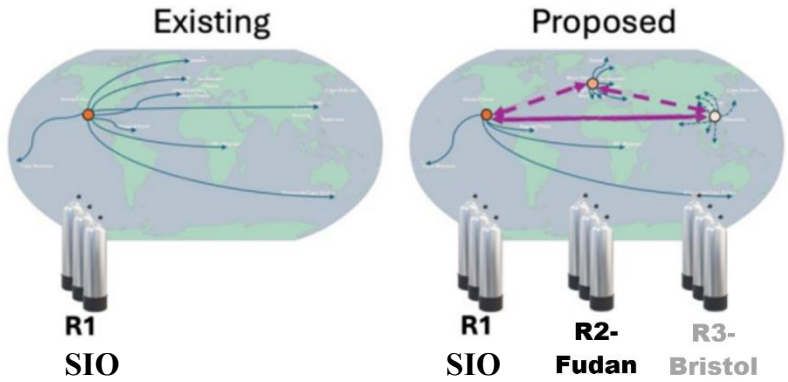
Fudan monitoring network
2 in-situ station+7 sampling stations
Since 2023

Establishing Research and Calibration Center for Halogenated Greenhouse Gases, Fudan University in 2025

復旦大學含卤温室气体研究与标校中心
RESEARCH AND CALIBRATION CENTER FOR HALOGENATED GREENHOUSE GASES
FUDAN UNIVERSITY



Apply for regional calibration center for international network



Two regional calibration centers were discussed at AGAGE meeting in November 2025

Fudan University & U. Bristol

72nd Meeting of AGAGE Scientists and Cooperating Networks
Hosted by Fudan University
Shanghai, China
17-21 November 2025

Agenda V3 20251118

Meeting Location:

The meeting will be held in-person in Du Dingyou Hall, located on the first floor of the Lee Shau Kee Library on the Jiangwan Campus of Fudan University. Please refer to the AGAGE72 Travel Tips document for details on the location and a campus map. The meeting will have a hybrid option to accommodate remote attendance. All times listed in the agenda are in China Standard Time (CST/UTC+8).

Remote Access – https://espo.webex.com/espo/j.php?MTID=ma2e46742c4cfbce813e7d587d1d12339
Please see the end of this document for additional information.

16:00-17:30 3. AGAGE calibration and data quality

a. AGAGE vs. AGAGE-derived calibration standards. Updates from regional working groups. **(Yao, O'Doherty, Weiss)**

ACTION O'Doherty and Vollmer (European Initiative) and Yao and Zhu (Chinese Initiative) desiring to establish regional centers for the propagation of AGAGE calibration standards to work with the SIO central calibration lab (mainly Harth, Salameh and Kim) to develop propagation protocols and agree to implement them. SIO and SC to review proposal and publish protocols to AGAGE website.

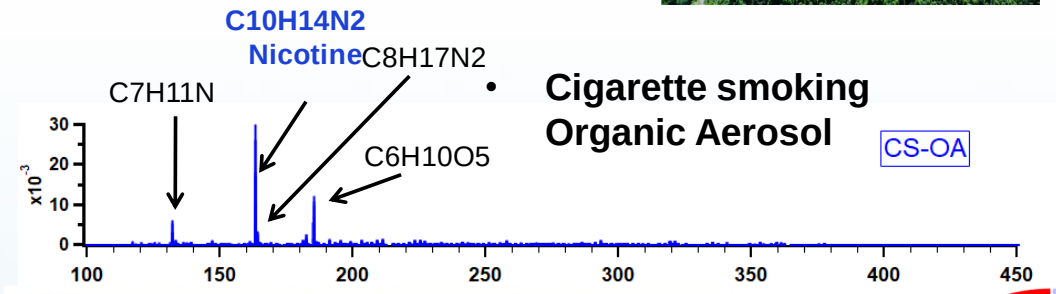
Key findings based on long-term halogenated GHG observation and inverse modelling

- Find rapid increasing of CH_2Cl_2 for the first time and its potential threat to the ozone layer (Nat.Commun., 2021), which was listed in Future Policy Considerations by Scientific Assessment of Ozone Depletion 2022
- Rapid increase in perfluorinated GHG emissions, ～100% higher than national inventory (PANS, 2024; Nat.Commun., 2024; ES&T 2024, ES&T Letters, 2024)
- Sustained emission of CCl_4 in China and the unexplained emission gap between top-down and bottom-up emissions showed a declining trend from 2011-2021 (Nat. Geosci., 2025)
- Non-Annex I countries (mostly developing countries under the UN climate framework) excluding China accounted for 61.3% of the global HFC emissions growth during 2011–2020 (Nat. Geosci., 2026)

3.2 Observations of organic aerosol in various environment

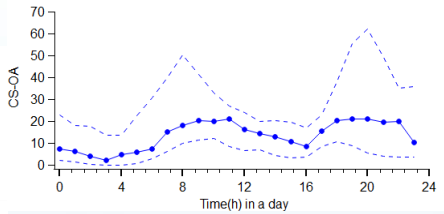
- Motivation:
  - Molecular composition and source of OA in many regions are not clear.
- Investigation:
  - Measured OA chemical composition on molecular level in urban, rural, mountain and remote sites (Shanghai, Zhejiang, Tibet etc.) and did source apportionment.

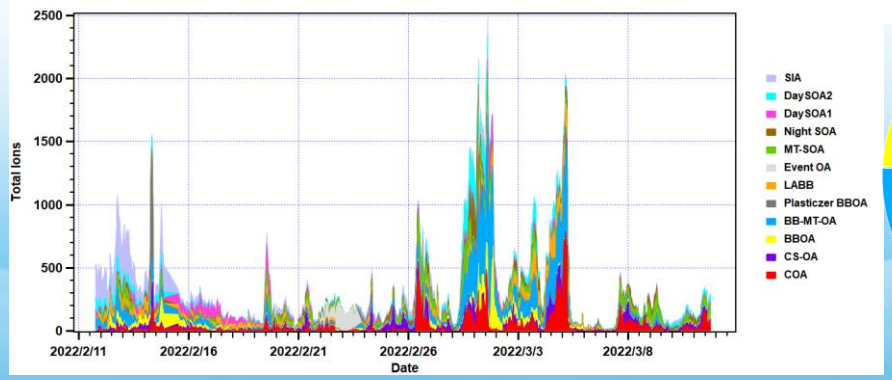
- Findings:
  - Measured >1000 compounds.
  - Identified new species and sources, e.g. plasticizers, highly oxygenated compounds in biomass burning, and cigarette smoking OA, cooking OA.
  - Identified new processes, e.g. nighttime NO_3 oxidation of alkenes.

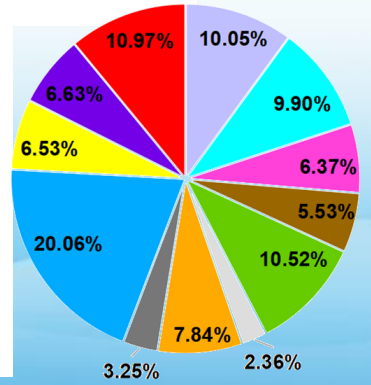


- **Cigarette smoking Organic Aerosol**

CS-OA

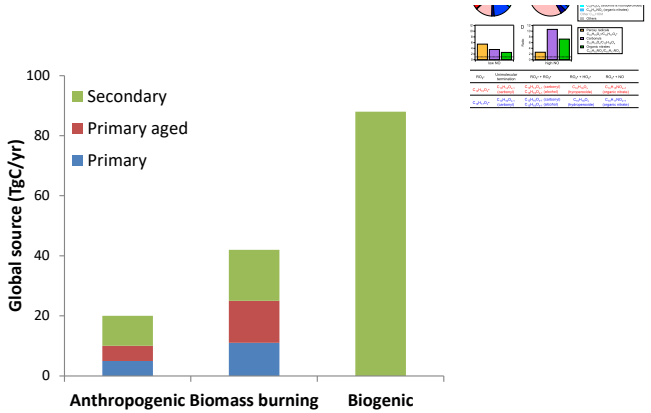




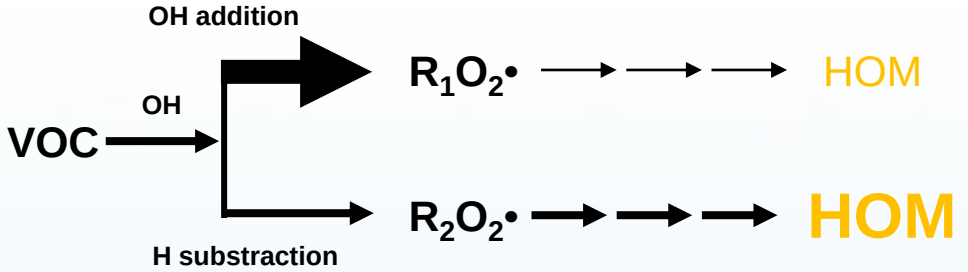


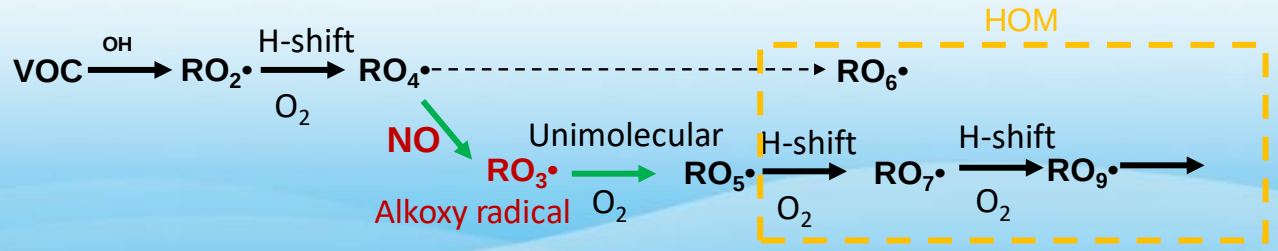
3.3 Mechanism of oxygenated organic molecules in SOA formation

- Motivation:
  - Biogenic secondary organic aerosol from monoterpene oxidation is a major fraction of global BSOA. However, the formation mechanism of HOM is elusive.
- Investigation:
  - Monoterpene($C_{10}H_{16}$)+OH/NO_3 oxidation in atmospheric reaction chambers
- Findings:
  - HOM from α-pinene OH oxidation is mostly contributed by a minor initial channel （“minor channel, major contribution”）In ambient atmosphere in presence of NOx
  - Unimolecular reaction of RO• promotes autoxidation and play an important role in OOM formation （“fast track”）, which is mediated by NO.

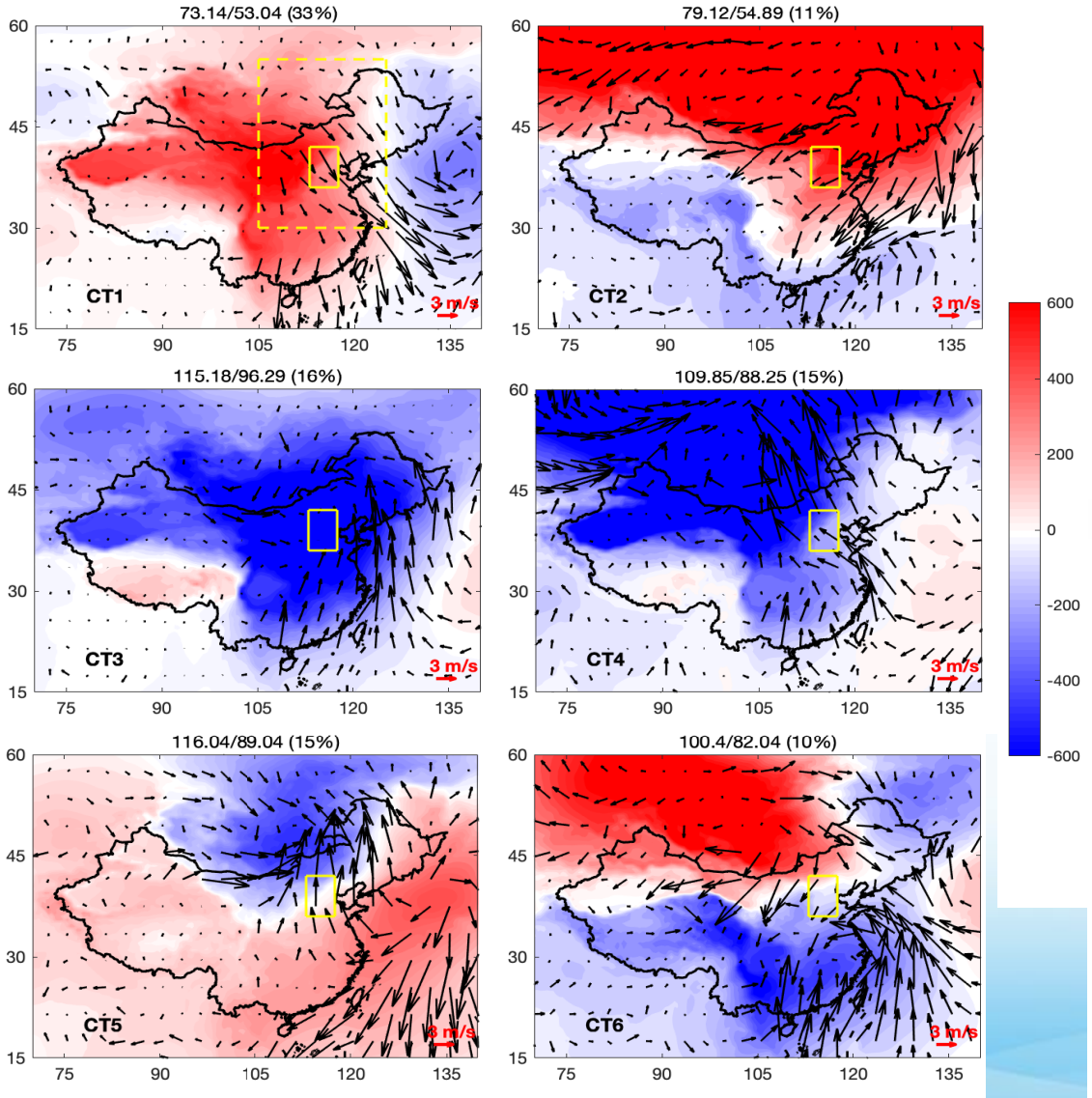


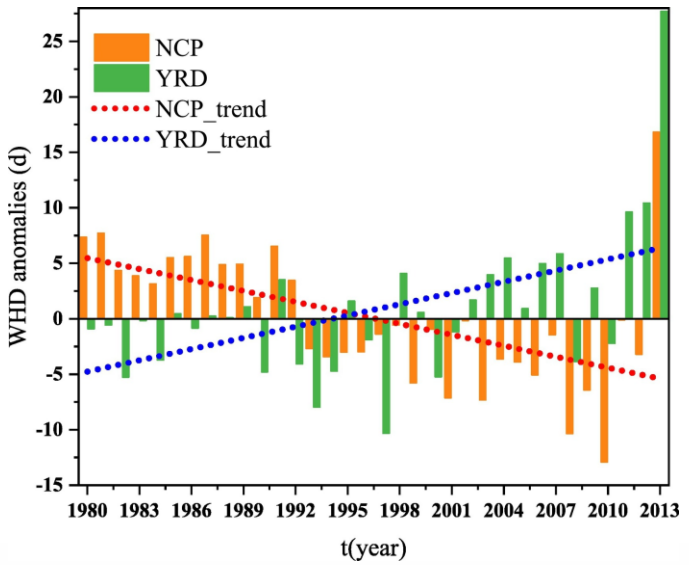
Shen et al. Science Adv. 2022

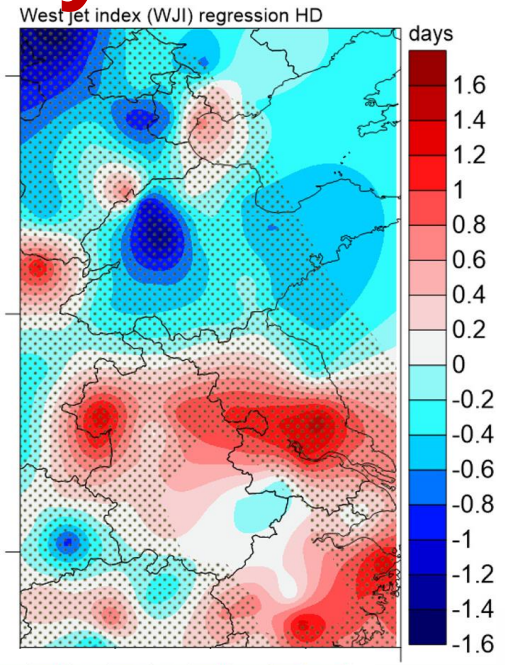


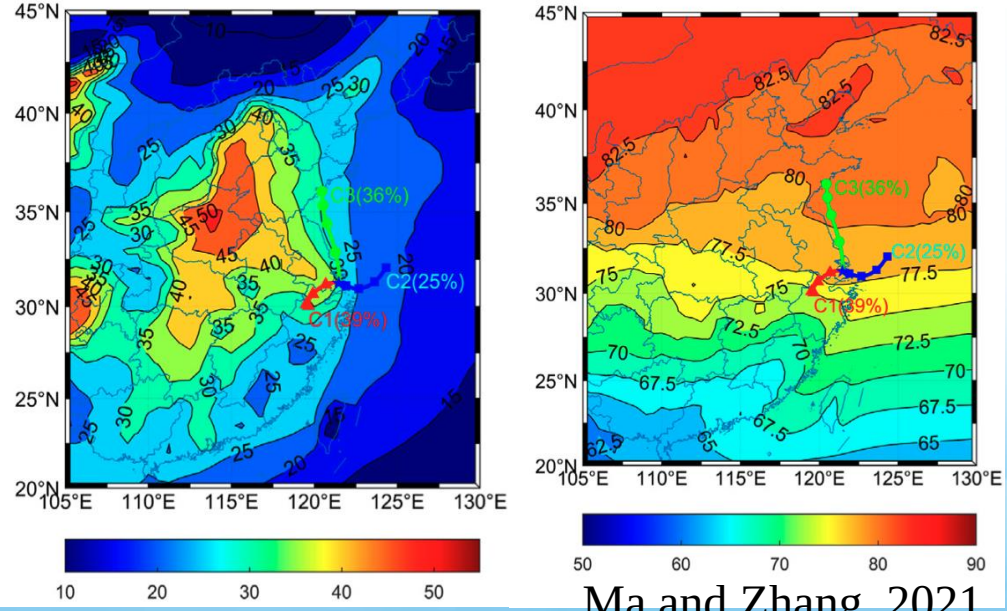


3.4 Weather/Climate Effect on Air Quality









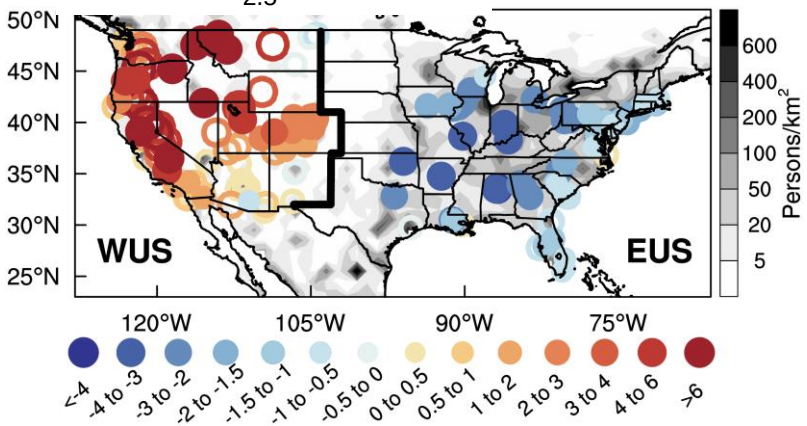
Wang et al., 2021, ACP

Ma and Zhang, 2021, STOTEN

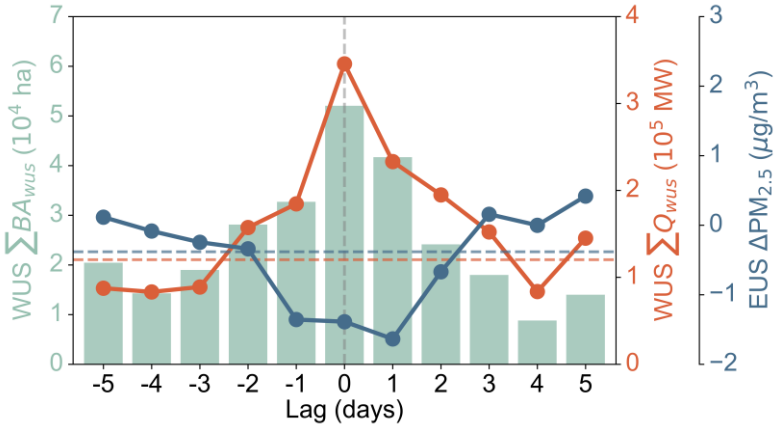
3.5 Fire heat affects the impacts of wildfires on air pollution in the United States

During extreme wildfire events over the western US in observations

In-situ $PM_{2.5}$ anomalies

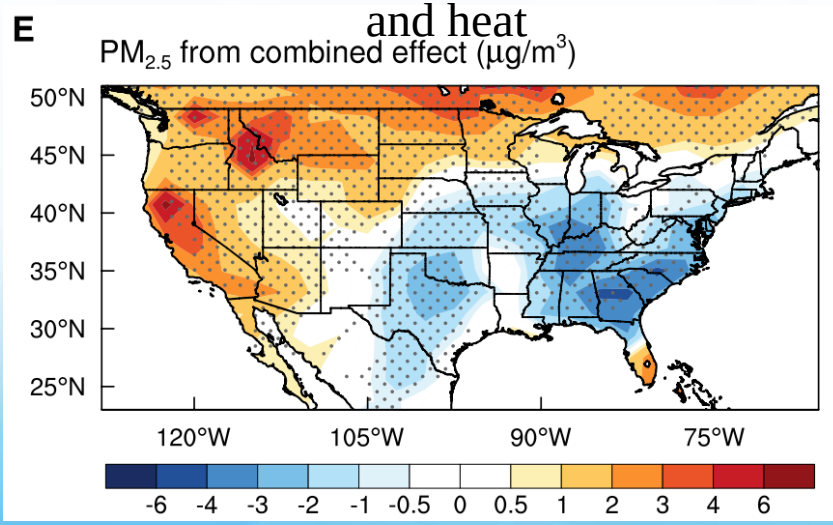


Temporal variation of in-situ $PM_{2.5}$ anomalies

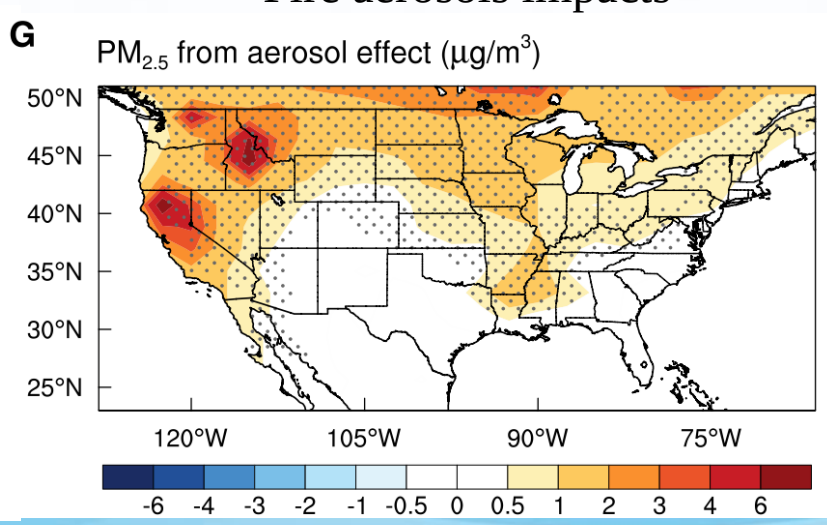


Evidence from model simulations with observed daily fire heat incorporated in CESM2

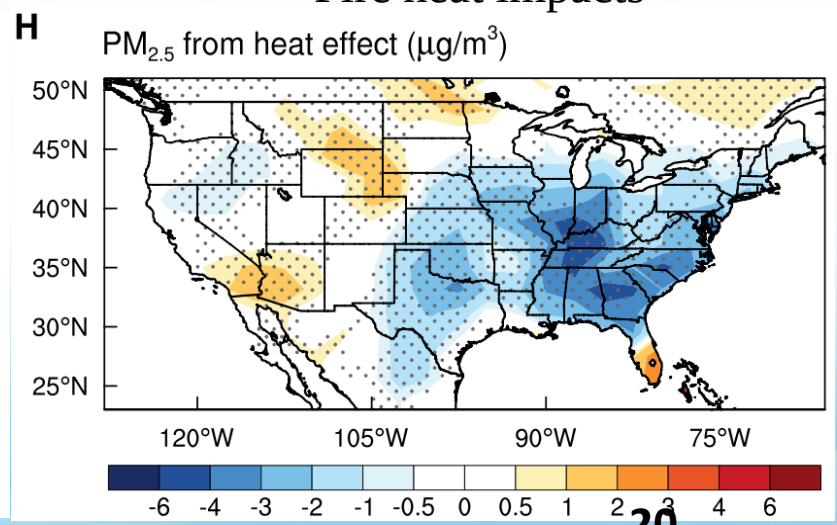
Combined impacts of fire aerosols and heat



Fire aerosols impacts

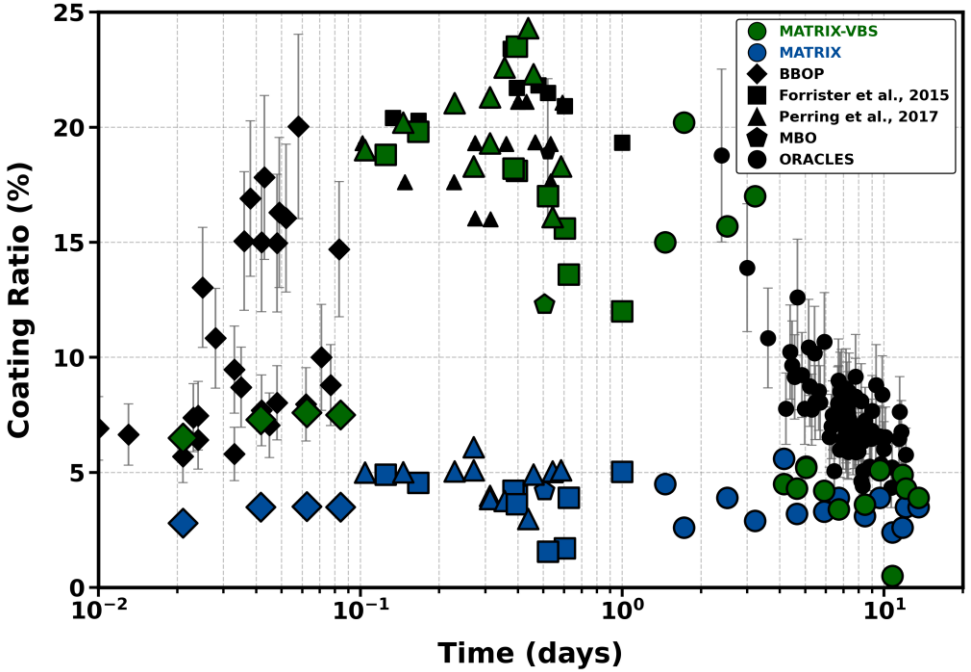


Fire heat impacts



Ma†, Wei†, **Wang*** et al. (2025, *Science*)

3.6 Biomass Burning Mixing State & Stratospheric Aerosol Injection



BB Mixing State (Gao et al., 2026, GRL)

Captured the observed three-phase BC coating evolution: rapid growth → equilibrium → gradual loss

Global application reveals universal pattern with regional variation

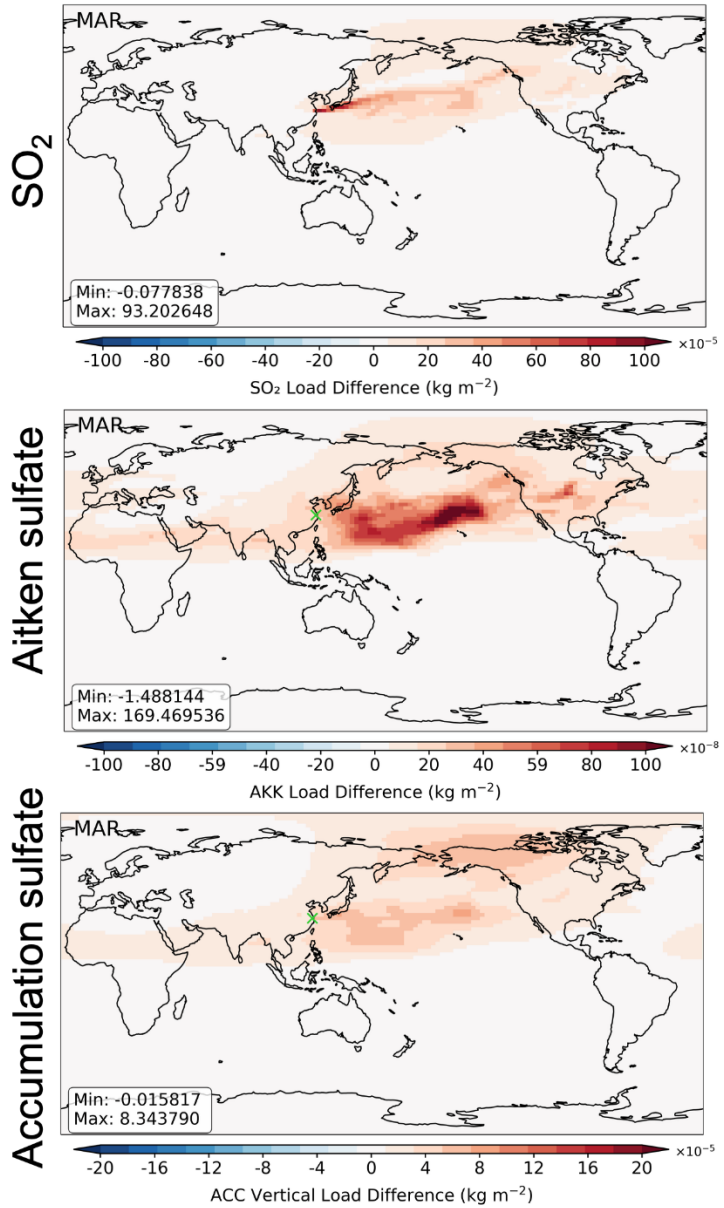
Current: SAI Microphysics

Exploring H_2O + SO_2 co-injection for stratospheric aerosol injection (SAI)

Co-injection accelerates new particle formation; particles grow to accumulation mode ~1 month faster

More optically active aerosols, sooner → implications for radiative effects & SAI design

A source of uncertainty most models have not yet resolved




Warmly welcome to Fudan University
THANKS FOR YOUR ATTENTION!