



**Gosan Station (Jeju Island, Korea)**

Measurements of greenhouse gases  
and halogenated compounds at Gosan  
for understanding emissions in East Asia

Jooil Kim  
Seoul National University

# Summary and Conclusions

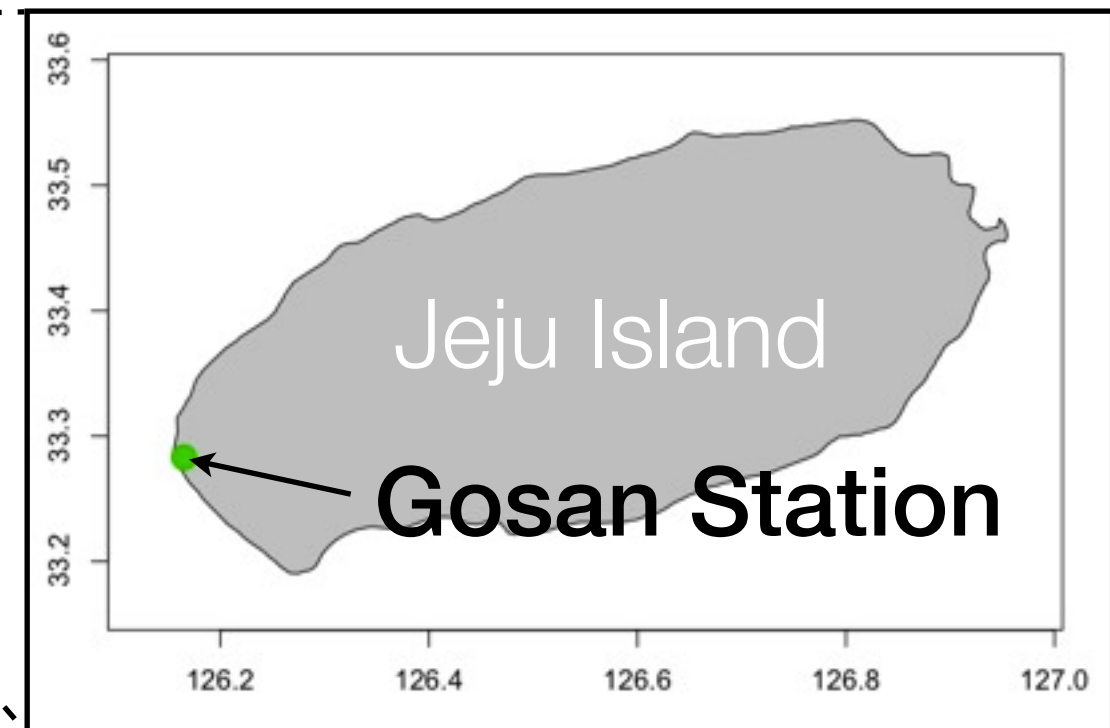
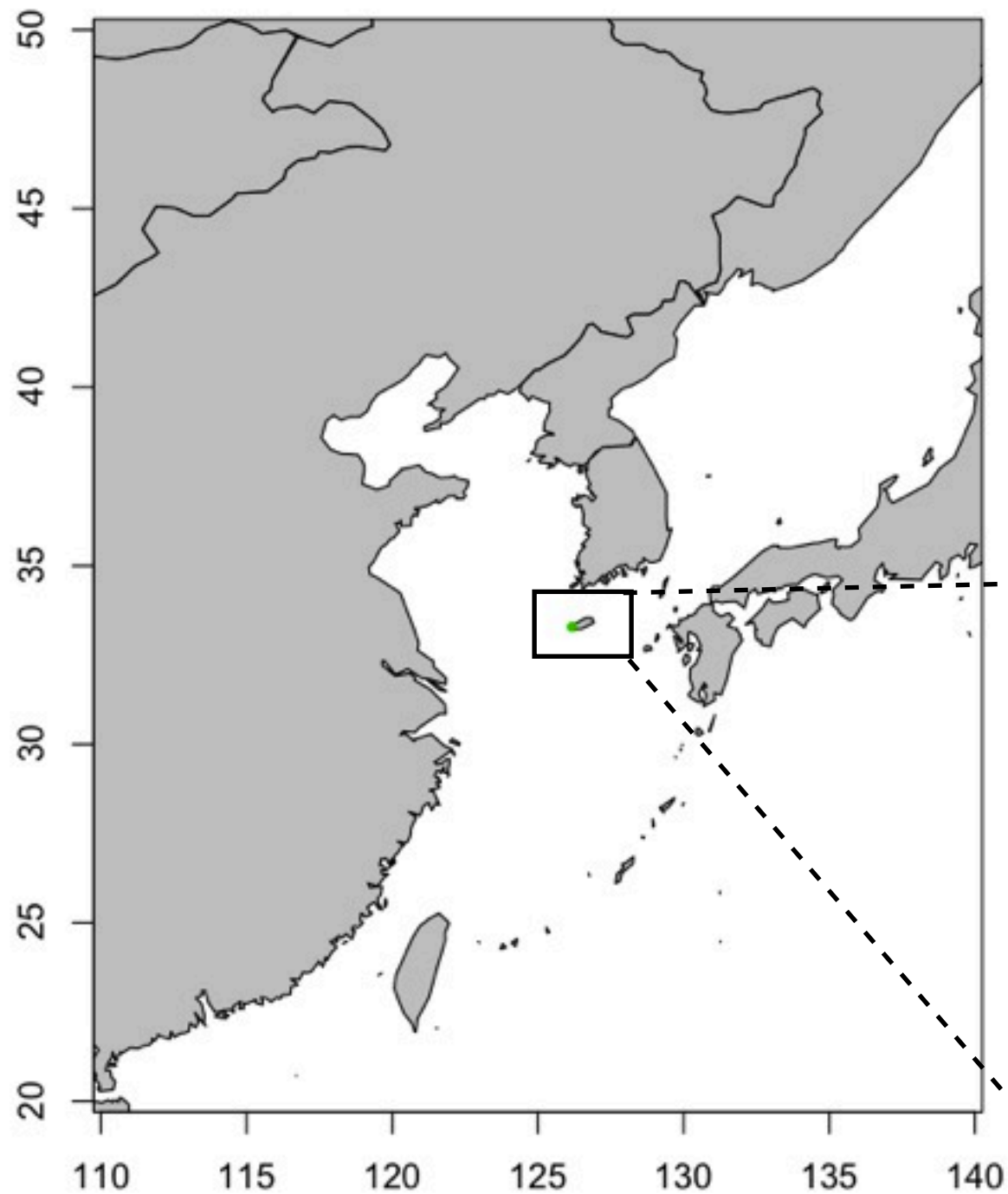
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- **High-frequency, high quality measurements of key GHGs for monitoring emissions in East Asia at Gosan**
  - CO<sub>2</sub>, in collaboration with the Scripps CO<sub>2</sub> Program (Ralph Keeling)
  - Halogenated compounds (CFCs, HCFCs, HFCs, PFCs, SF<sub>6</sub>, etc), in collaboration with the AGAGE Network
- **Gosan measurements are very useful for monitoring GHG emissions in the East Asia region**
  - Clear background trajectories + pollution trajectories from China, Korea, Japan (some from Taiwan region?) during non-summer months.
  - Emissions estimated using both ratio-based and inversion modeling techniques reveal importance of East Asian emissions to global budgets in halogenated compounds



# Introduction

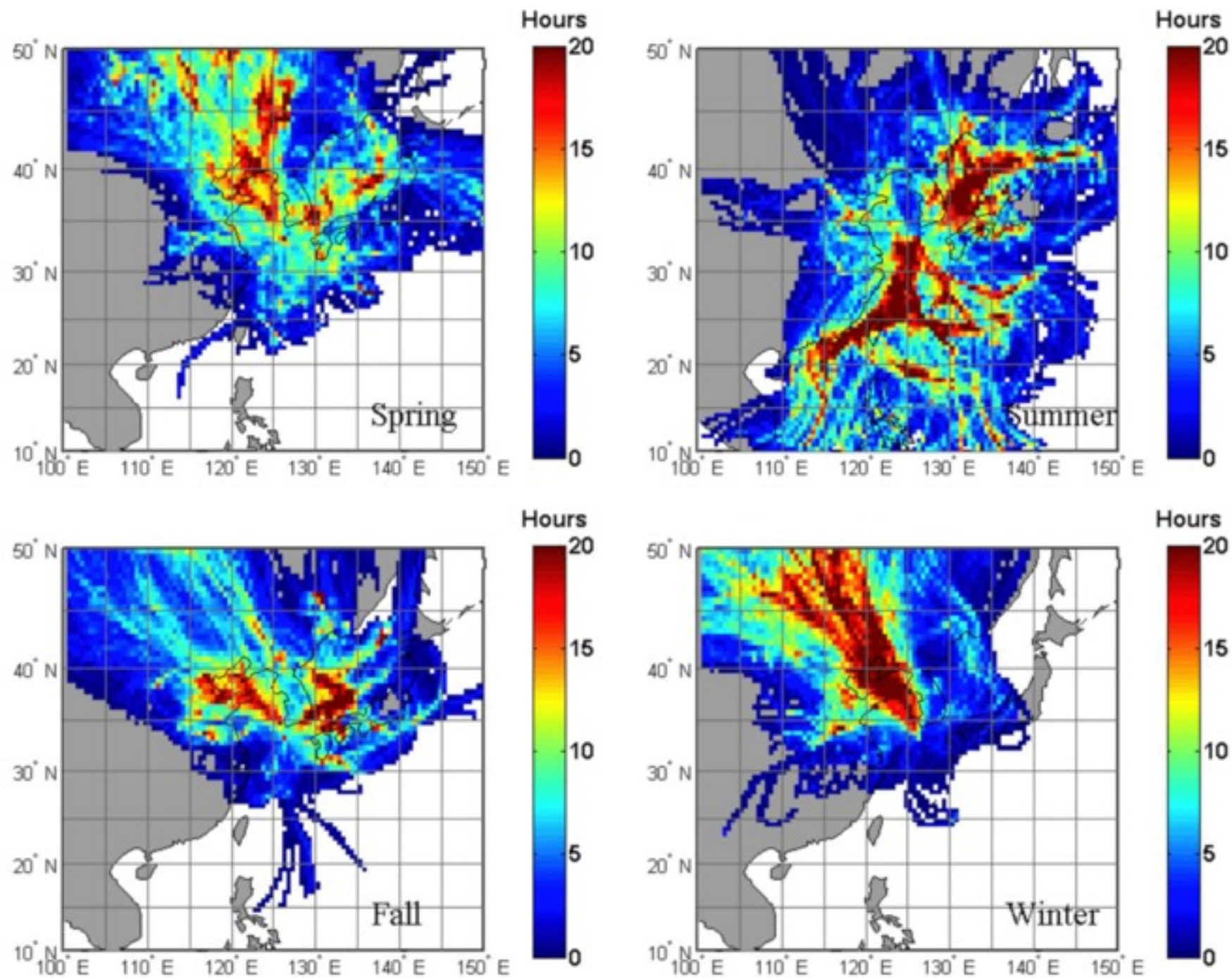
## Gosan Station (Jeju Island, Korea)



# Introduction

## Seasonal Wind Patterns

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HYSPLIT residence time analysis, for 2008



# Introduction

## CO<sub>2</sub> Measurements

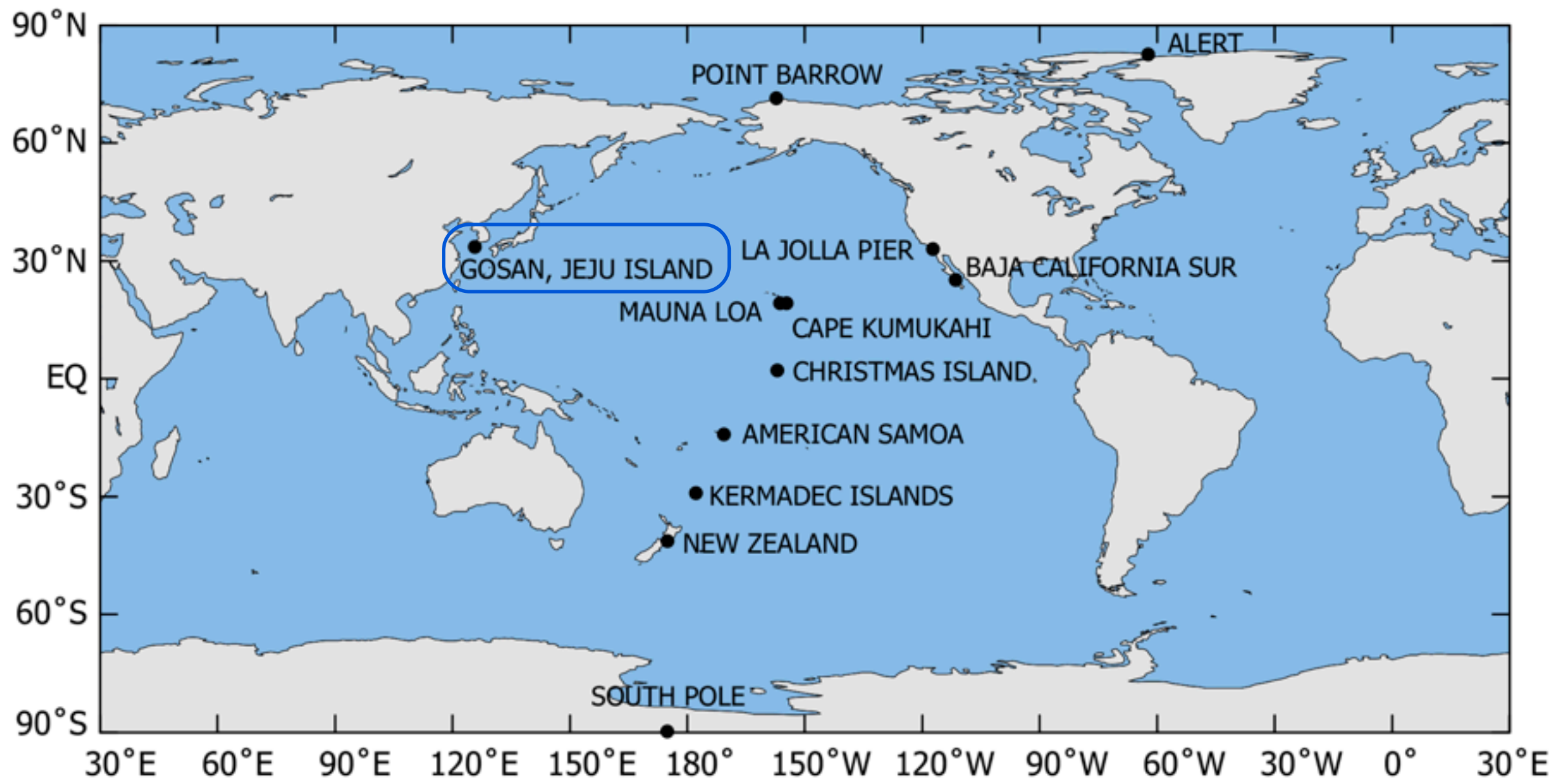
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- Flask Sampling ('90~)
  - Sampling 1~2 times per week
  - C<sup>12</sup>/C<sup>13</sup>/C<sup>14</sup> isotope analysis
  - **Scripps CO<sub>2</sub> Network**
- LOFLO CO<sub>2</sub> Analyzer ('07 Nov.~)
  - 1min ~ 1hr average meas.
  - NOAA Reference Scale

# Introduction

## Scripps CO<sub>2</sub> Network (Ralph Keeling)



<http://scrippsco2.ucsd.edu/>



# Introduction

## Halogenated Species Measurements

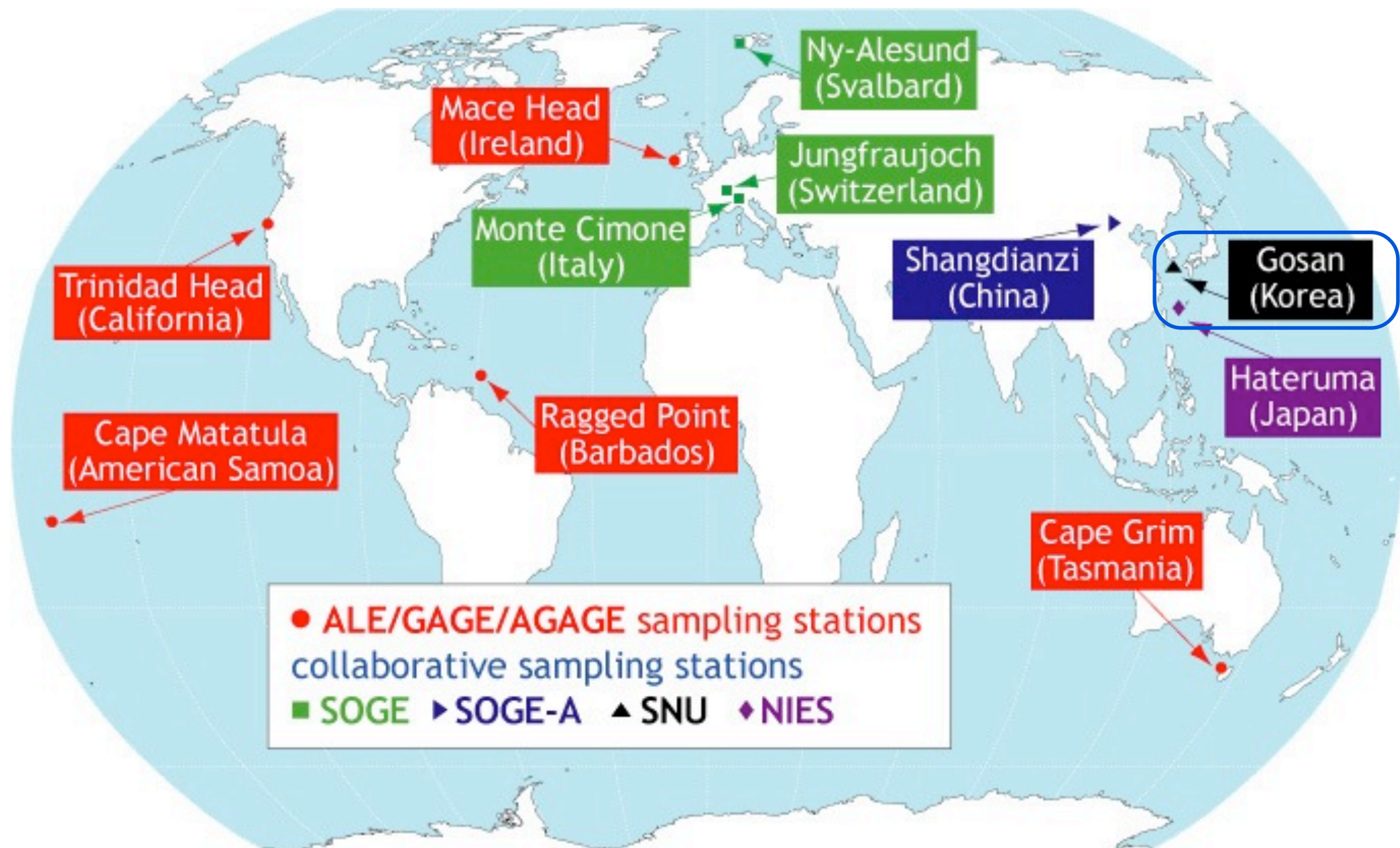
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- Medusa GC-MS ('07~)
  - 2hr interval ambient measurements
  - CFC-11/-12/-113, HCFC-22/-141b/-142b, HFC-23/-32/-152a/-125, PFCs(CF<sub>4</sub>/C<sub>2</sub>F<sub>6</sub>/C<sub>3</sub>F<sub>8</sub>), SF<sub>6</sub>
  - Operations, calibrations in the **AGAGE Network**

# Introduction

## AGAGE(Advanced Global Atmospheric Gases Experiment)

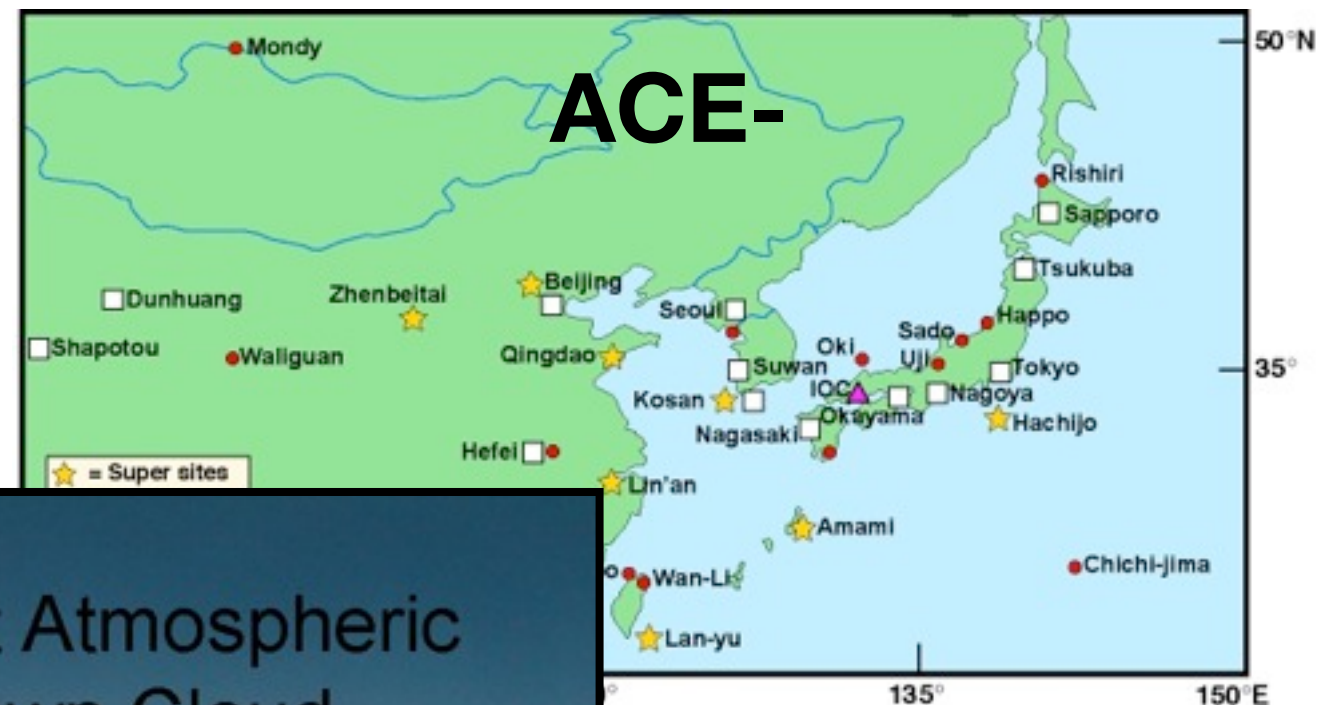
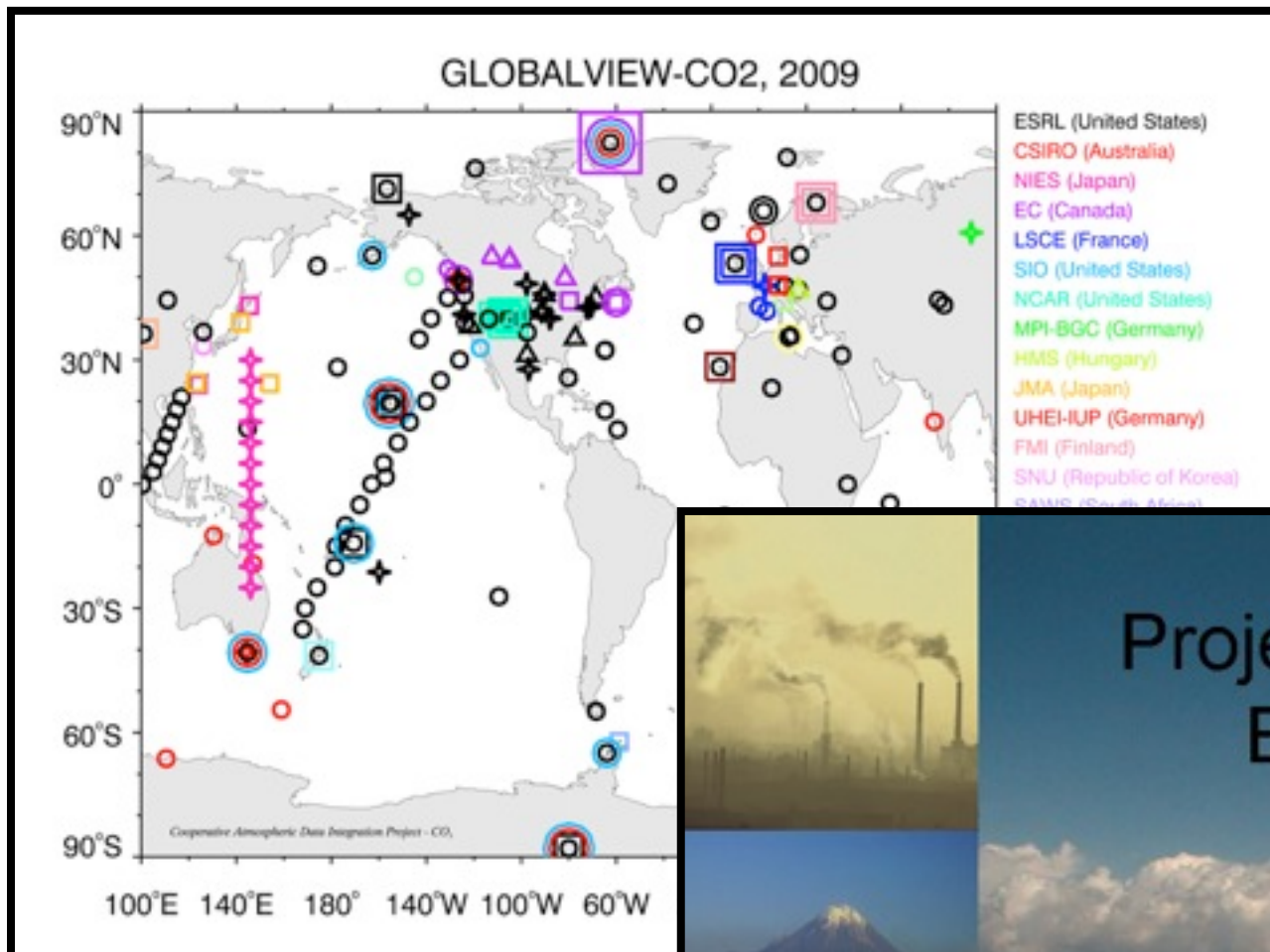


[agage.eas.gatech.edu/](http://agage.eas.gatech.edu/)



# Introduction

## International Research At Gosan



### Project Atmospheric Brown Cloud

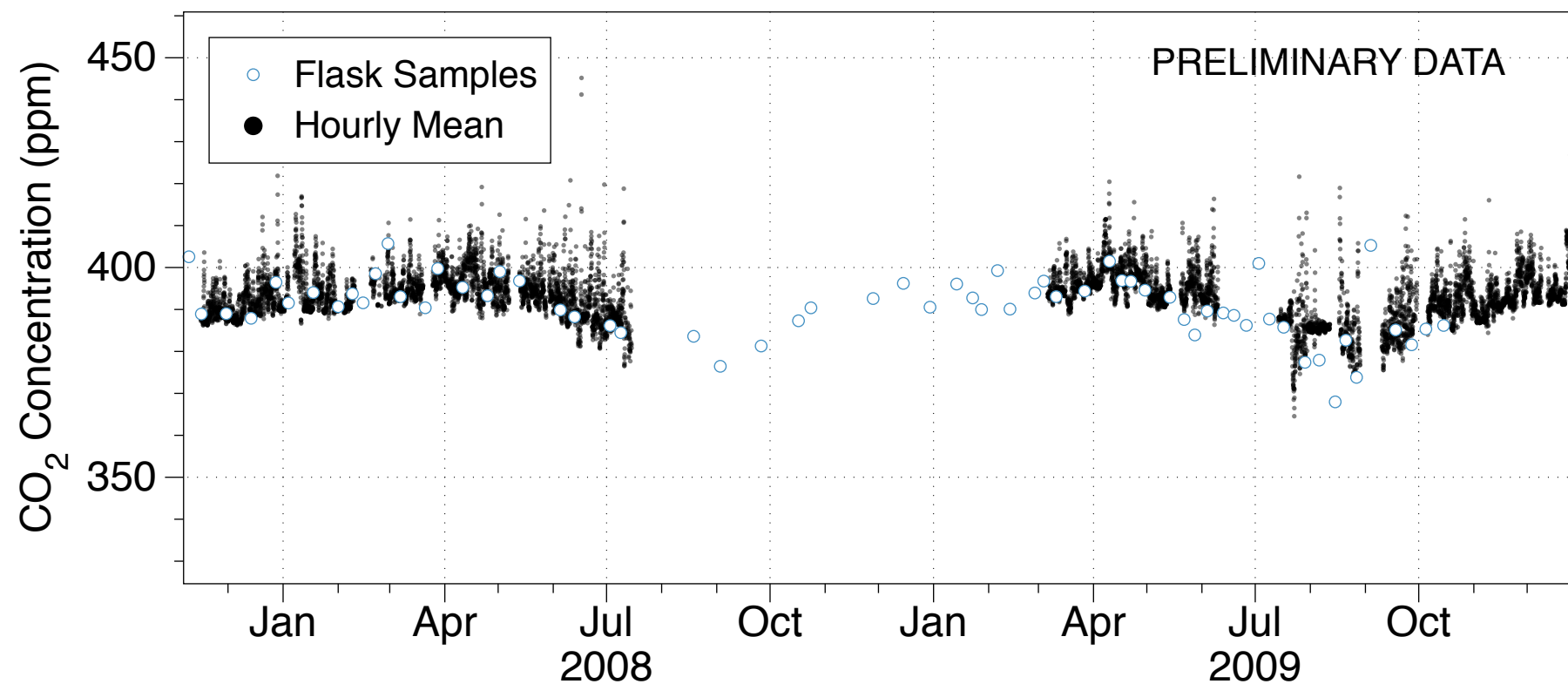
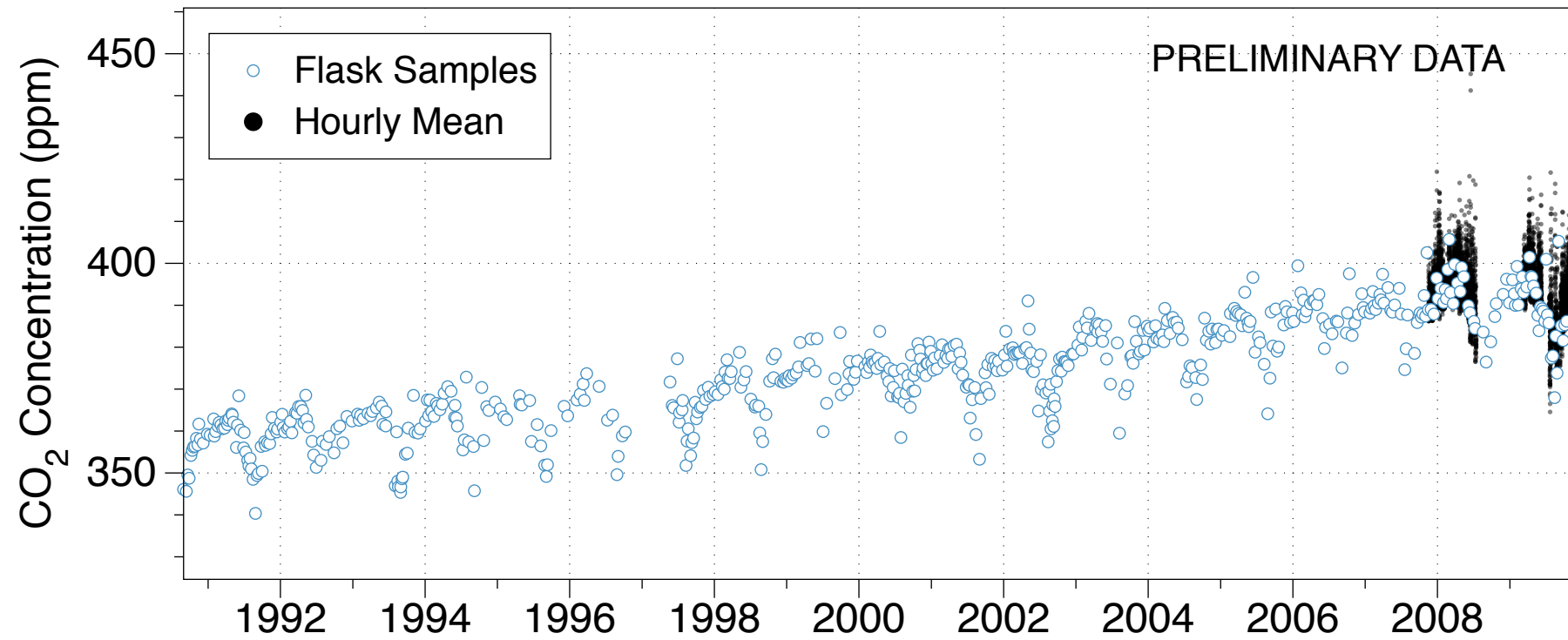
*The Integration of Air Pollution and Climate Science to Assess the Impacts on the Environment and Society*

**V. Ramanathan, USA, Chair**  
**H. Rodhe, Sweden, Vice Chair**

**CHINA:** Shi Guang-Yu, Zhang YuanHang  
**JAPAN:** Hajime Akimoto, Teruyuki Nakajima  
**INDIA:** R.K. Pachauri, A.P. Mitra  
**KOREA:** K.-R. Kim, S.C. Yoon  
**EUROPE:** P. J. Crutzen, Nobel Laureate, Germany  
Jos Lelieveld (The Netherlands)  
**USA:** Gregory R. Carmichael  
**WMO:** Leonard A. Barrie

# Part 1. Measurements of GHGs at Gosan

## CO<sub>2</sub>, flask and continuous measurements



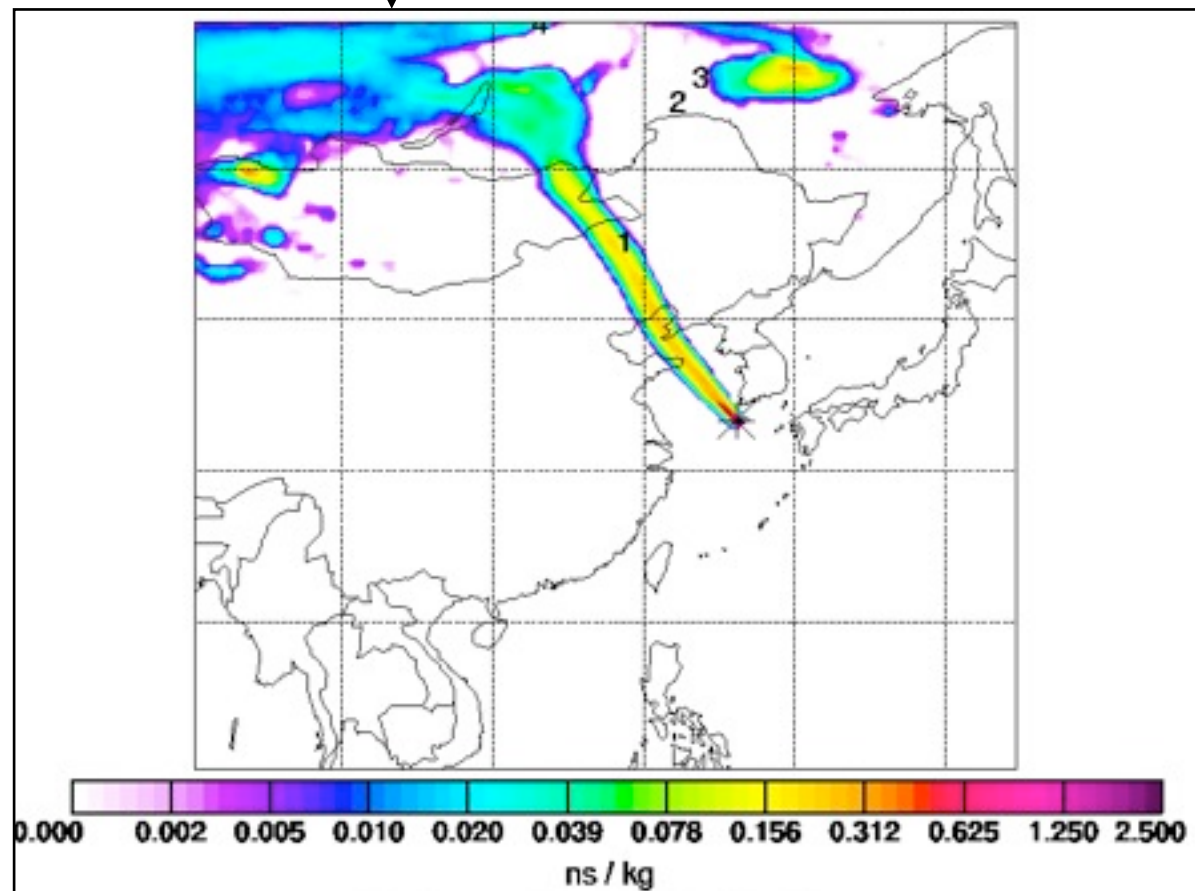
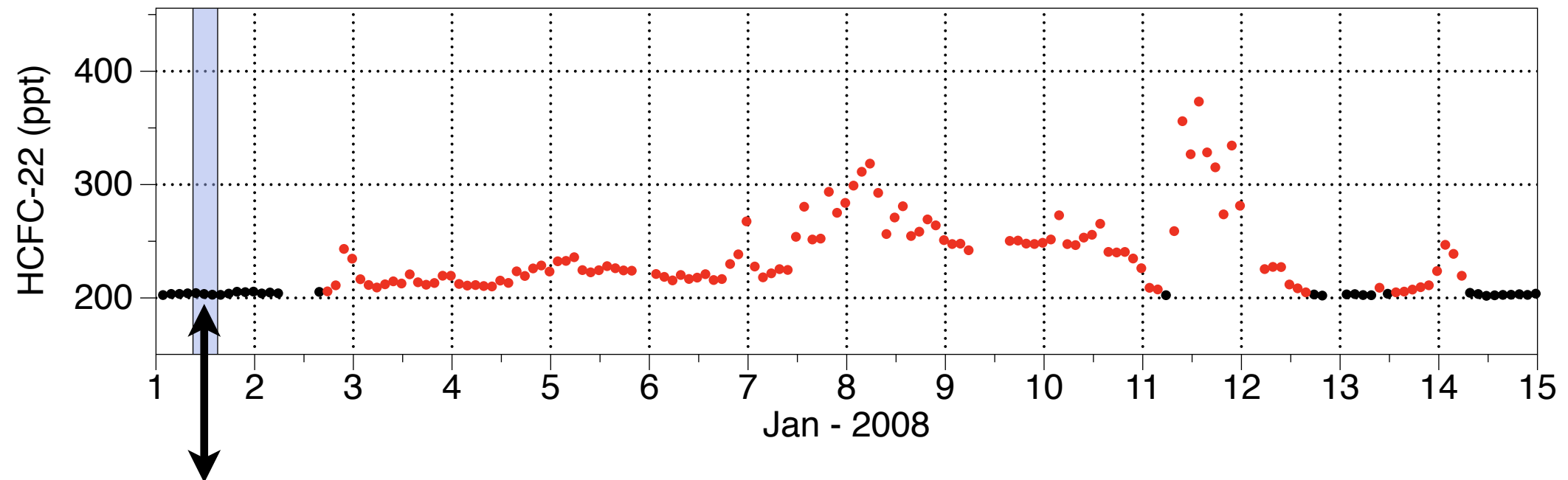


# Part 1. Measurements of GHGs at Gosan

## Halogenated Species



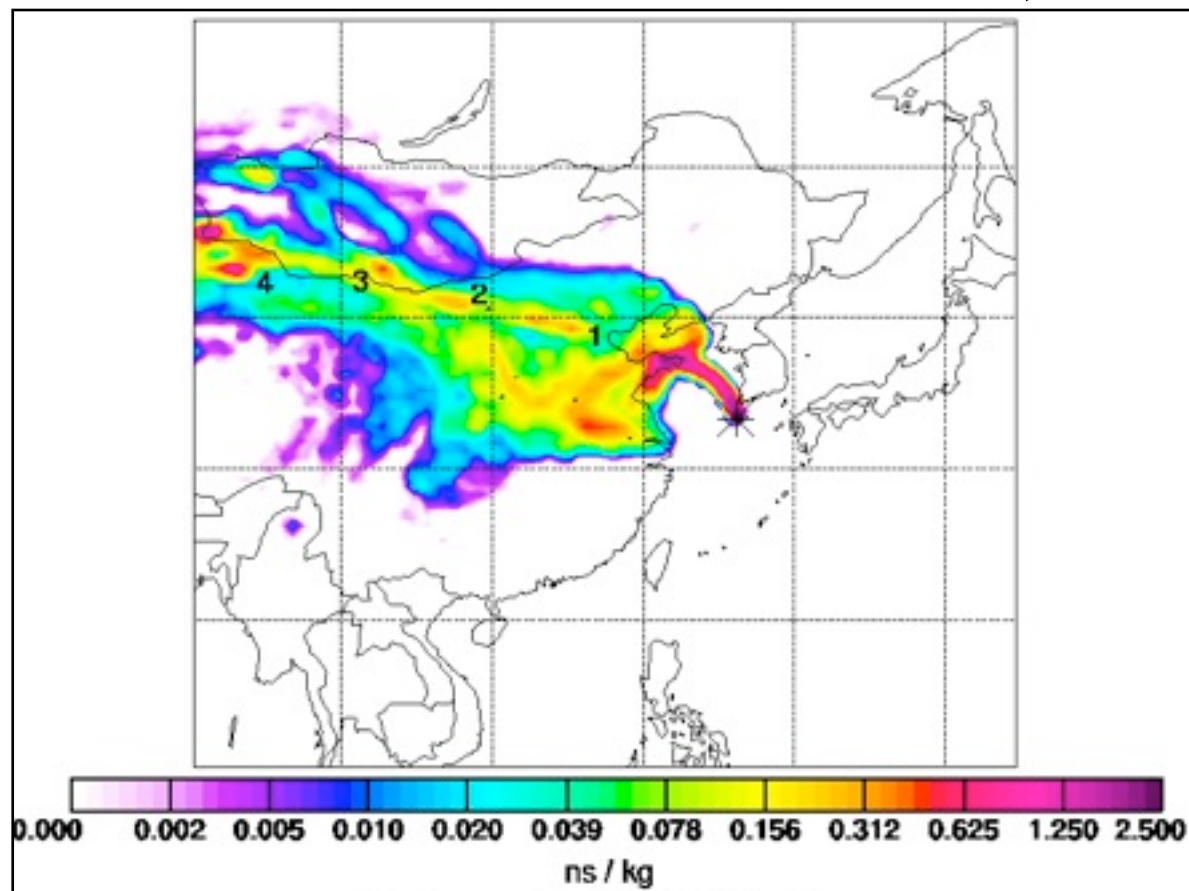
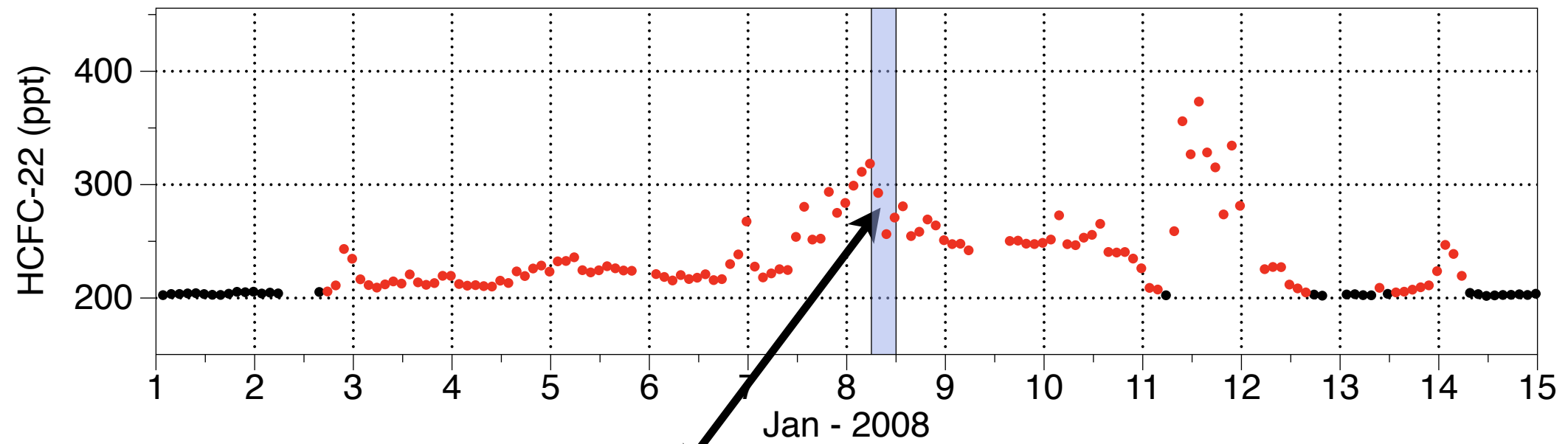
# Part 1. Measurements of GHGs at Gosan Pollution and Trajectories, Jan. '08



Winter background  
trajectories  
coming from  
northern Asia

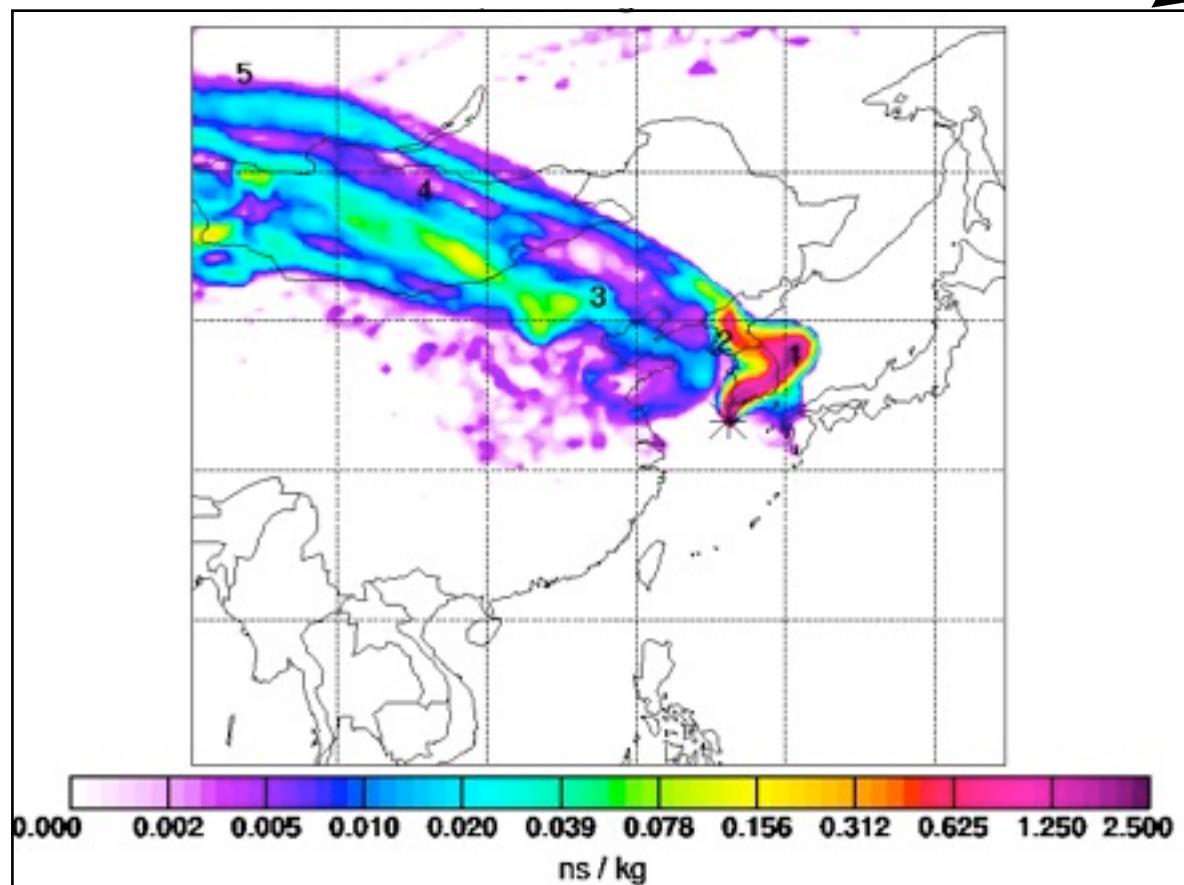
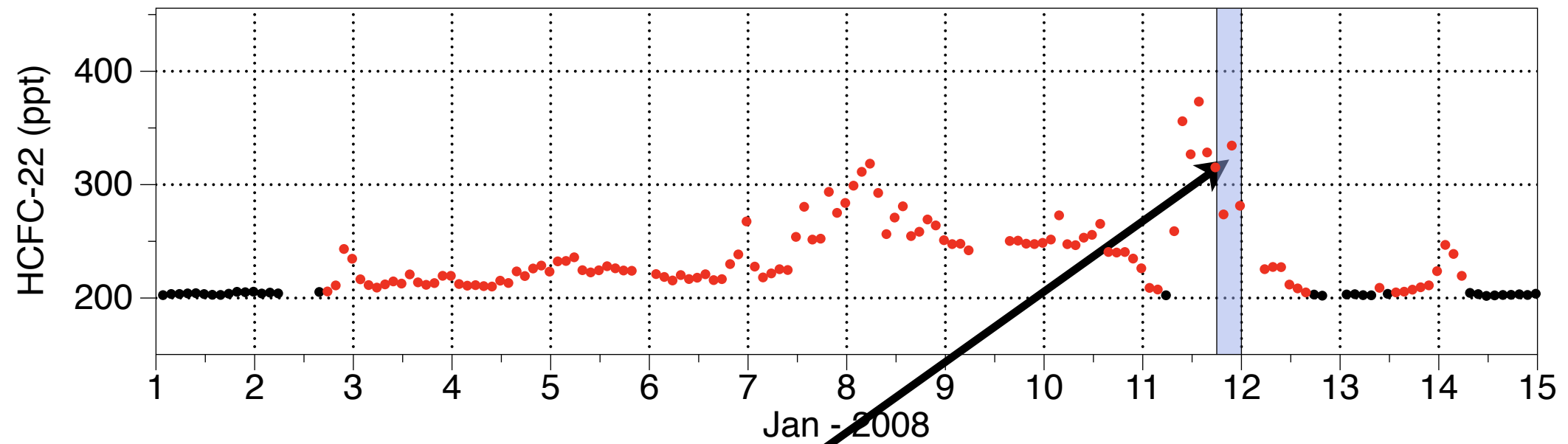


# Part 1. Measurements of GHGs at Gosan Pollution and Trajectories, Jan. '08



Pollution from China

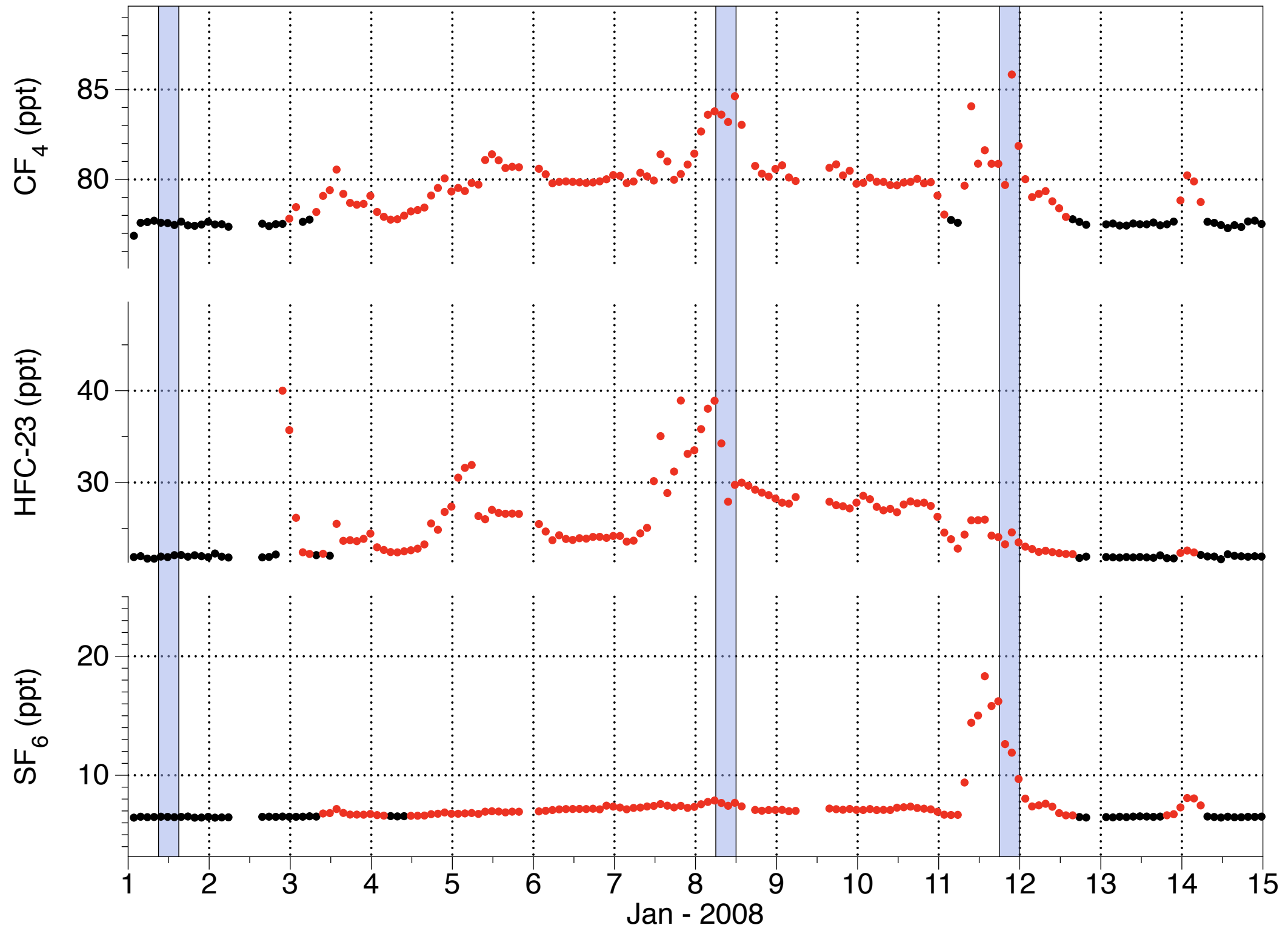
# Part 1. Measurements of GHGs at Gosan Pollution and Trajectories, Jan. '08



Pollution from Korea



# Part 1. Measurements of GHGs at Gosan Pollution and Trajectories, Jan. '08



# Part 2. Top-down Estimates of Emission Rates

## Ratio-based technique with HCFC-22 as tracer

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### Regional Atmospheric Emissions Determined from Measurements at Jeju Island, Korea: Halogenated Compounds from China

Jooil Kim<sup>1+</sup>, Shanlan Li<sup>1+</sup>, Kyung-Ryul Kim<sup>1,2\*</sup>, Andreas Stohl<sup>3</sup>,  
Jens Mühle<sup>4</sup>, Seung-Kyu Kim<sup>1</sup>, Mi-Kyung Park<sup>1,2</sup>, Dong-Jin Kang<sup>5</sup>,  
Gangwoong Lee<sup>6</sup>, Christina M. Harth<sup>4</sup>, Peter K. Salameh<sup>4</sup>, and Ray F. Weiss<sup>4</sup>

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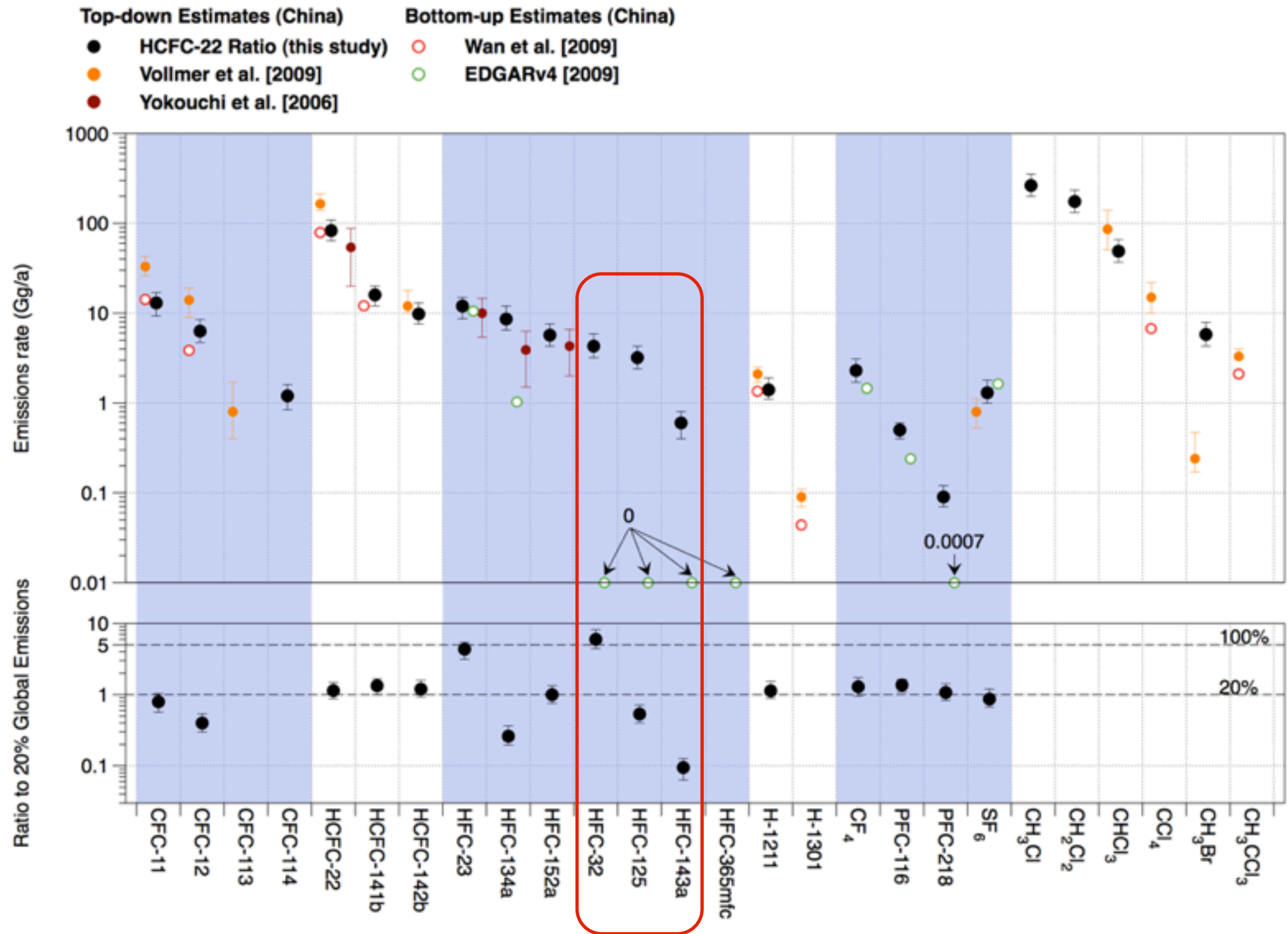
<sup>5</sup> Korea Ocean Research & development Institute, Ansan Kyung-gi 426-744, Korea

<sup>6</sup> Hankuk University of Foreign Studies, Gyeonggido 449-741, Korea

Geophysical Research Letters, 2010, *accepted*

# Part 2. Top-down Estimates of Emission Rates

## Figure 2, Kim et al., 2010 (GRL, *accepted*)

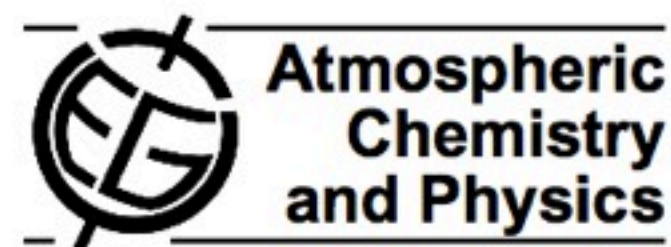




# Part 2. Top-down Estimates of Emission Rates Direct Inversions of HCFCs and HFCs

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Atmos. Chem. Phys., 10, 3545–3560, 2010  
www.atmos-chem-phys.net/10/3545/2010/  
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the Creative Commons Attribution 3.0 License.



## **Hydrochlorofluorocarbon and hydrofluorocarbon emissions in East Asia determined by inverse modeling**

**A. Stohl<sup>1</sup>, J. Kim<sup>2</sup>, S. Li<sup>2</sup>, S. O'Doherty<sup>3</sup>, J. Mühle<sup>4</sup>, P. K. Salameh<sup>4</sup>, T. Saito<sup>5</sup>, M. K. Vollmer<sup>6</sup>, D. Wan<sup>7</sup>, R. F. Weiss<sup>4</sup>, B. Yao<sup>8</sup>, Y. Yokouchi<sup>5</sup>, and L. X. Zhou<sup>8</sup>**

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Received: 18 November 2009 – Published in Atmos. Chem. Phys. Discuss.: 1 February 2010

Revised: 3 April 2010 – Accepted: 13 April 2010 – Published: 16 April 2010

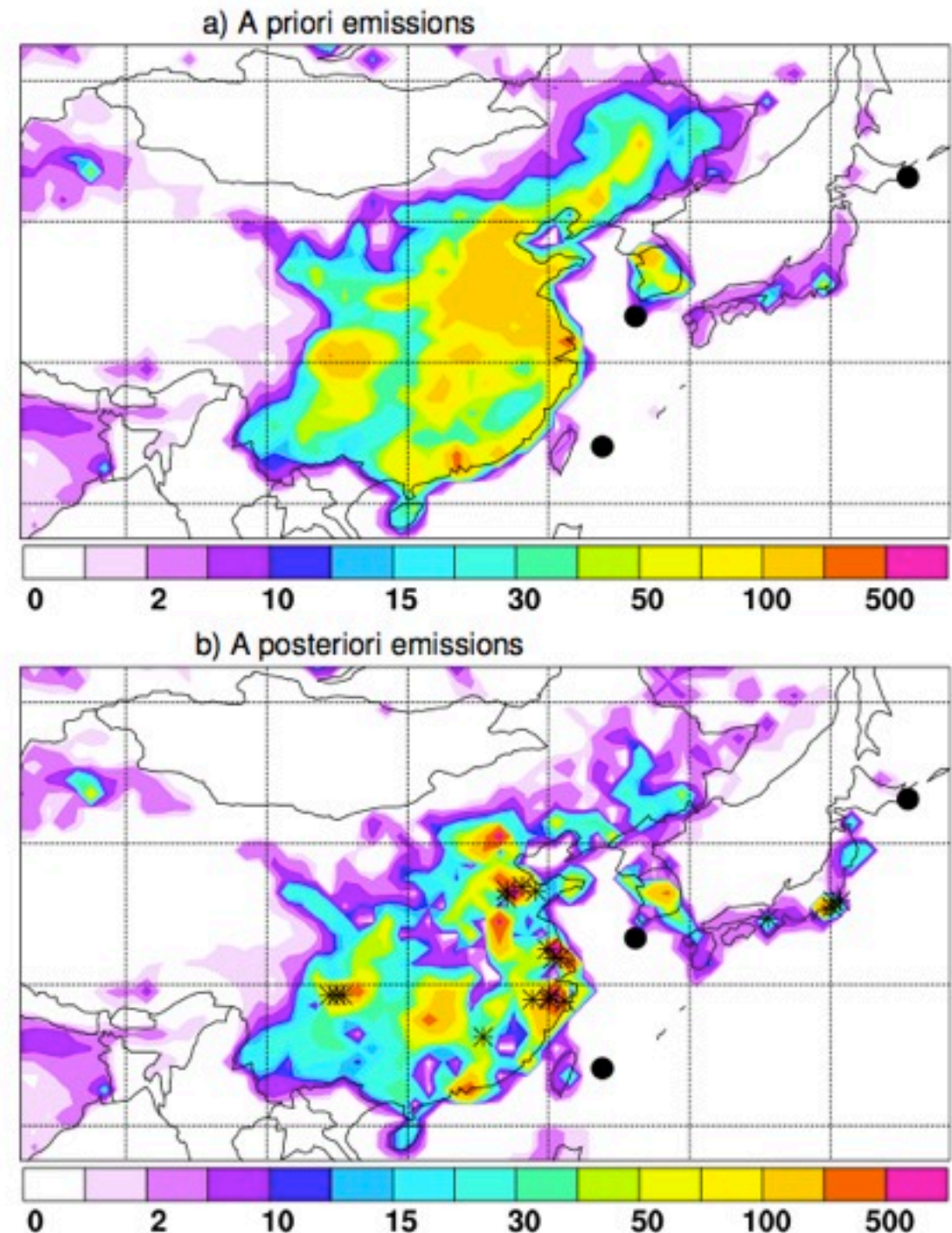
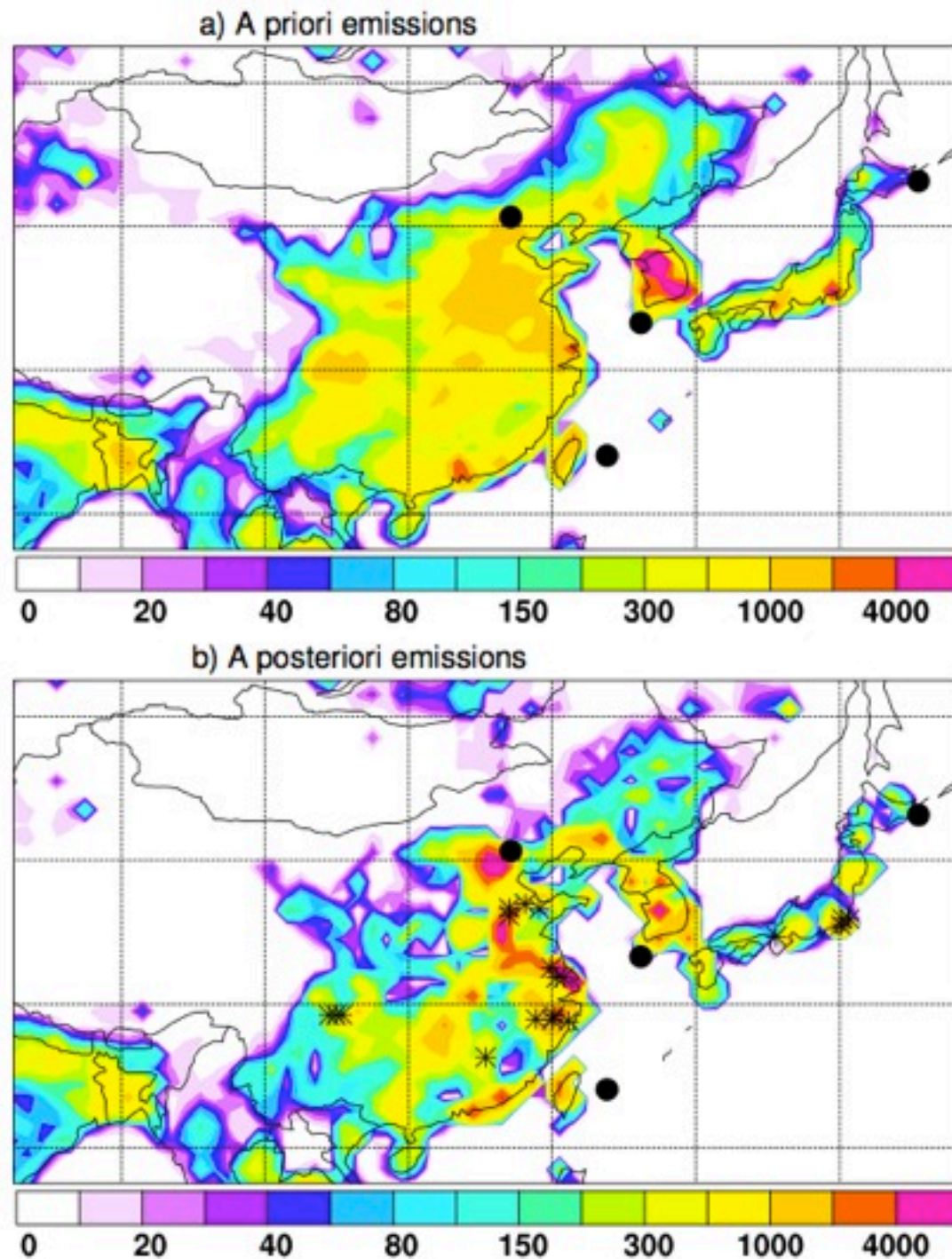


# Part 2. Top-down Estimates of Emission Rates

Stohl et al., 2010 (*ACP, in press*)

## HCFC-22

## HFC-23



# Co-authors and Colleagues

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- Kyung-Ryul Kim, Shanlan Li, Mi-Kyung Park, Seung-Kyu Kim (Seoul National University), Dong-Jin Kang (Korea Ocean Research Development Institute), Gangwoong Lee (Hankuk University of Foreign Studies), Meehye Lee (Korea University), Kyung-Sik Kang (Jeju University)
- Ray F. Weiss, Jens Muhle, Christina Harth, Peter Salameh (AGAGE, Scripps Institution of Oceanography, UC San Diego)
- Ralph Keeling, Alane Bollenbacher (Scripps CO<sub>2</sub> Program, Scripps Institution of Oceanography, UC San Diego)
- Andreas Stohl (Norwegian Institute for Air Research)



Thank You.