KORUS-AQ

Agenda

Ministry of Environment
National Institute of Environmental Research

NASA

Science Team Telecon

- Data Archive Status Update
- Data Schedule and Sharing
- Fall AGU 2016
- Conference Opportunities
- Research Intentions Update
- Rapid Science Synthesis Report (RSSR)
- Science Team Meeting Update
- Science Presentation (Daun Jeong)

KORUS-AQ

Data Archival (1): DC-8 Status

Ministry of Environment
National Institute of Environmental Research

NASA

Current data status is shown in the table on the right.

New color scheme in the data tables differentiates Field Data (RA, RB, RC,…) from Preliminary Data (R0, R1, R2,…) that needs to be in the archive by the 15 January 2017 deadline.

DC-8 merges have not been updated since the last telecon.

Questions or comments?

PI-Group	5/1	5/3	5/4	5/6	5/10	5/11	5/12	5/16	5/17	5/19	5/21	5/24	5/26	5/29	5/30	6/1	6/2	6/4	6/8	6/9
Anderson-LARGE																				
Blake-WAS																				
Brune-ATHOS																				
Cohen-TD-LIF																				
Dibb-SAGA (mist chamber)																				
Dibb-SAGA (filters)																				
DiGangi-AVOCET																				
Diskin-DACOM																				
Diskin-DLH																				
Fried-CAMS																				
Hair-DIAL/HSRL																				
Hall-CAFS																				
Huey-GT-CIMS																				
Jimenez-HR-ToF-AMS																				
Kim-K-CIMS																				
Lee-K-AMS																				
Redemann-4STAR-AOD																				
Redemann-4STAR-Gases																				
Schwarz-HDSP2-BC-Mixing																				
Schwarz-HDSP2-BC-MMR																				
Weinheimer-NOxyO3																				
Wennberg-CIT-CIMS																				
Wisthaler-PTR-ToF-MS																				
Yang-Nav/Housekeeping																				
Yum-K-CCN																				
K-SP2, ACES, PTR-MS																				

Data Archival (2): Hanseo

PI-Group	5/2	5/3	5/4	5/6	5/7	5/10	5/11	5/12	5/16	5/17	5/18	5/19	5/20	5/21	5/22	5/25	5/26	5/28	5/29	5/30	5/31	6/2	6/3	6/4	6/5	6/8	6/9	6/10	Comment
Park-Nav	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	GPS Lat, Lon, Alt
Park-O3		1				1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	
Park-NO2	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	
Park-CO	1	1	1	1	1	1	2	1	1	2	1		1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	
Park-SO2						1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	
Park-LGR									1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	CO2, CH4, and H2O
Hanisco-CAFÉ	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	4	1	HCHO

Current data status is shown in the table above. Numbers of files for each flight date are noted since the aircraft often flew multiple sorties per day. Also remember that on a given local day, sorties could sometimes fall on two different UTC dates.

Data received since last webex: **NO CHANGE in data or merges**

Remaining Tasks:

-Flexpart trajectories to the Hanseo flight tracks

Questions or comments?

KORUS-AQ

Data Archival (3): Remote Sensors

Ministry of Environment
National Institute of Environmental Research

NASA

NASA King Air status:

-Navigational data is archived **(We are still waiting for missing files for 4/28 and 6/10. Data was submitted for 6/8 and 6/9 L1/L2 on 12/9)**

-Geo-TASO and MOS data are not yet archived.

Aeronet:

-Data from the AERONET-DRAGON deployment during KORUS-AQ are accessible independently through their website at: http://aeronet.gsfc.nasa.gov/new_web/DRAGON-KORUS-AQ_2016.html

-In addition to data products, daily summary maps during the campaign period are also available for download.

Pandora: (also see Jay's presentation at the end of this file)

-Data from the Pandora network have been consolidate on their ftp site and can obtained from:
http://avdc.gsfc.nasa.gov/pub/DSCOVR/Pandora/DATA/KORUS-AQ/

-Converson of Pandora data to ICARTT format is still not complete

Questions or comments?

Data Archival (4): Olympic Park

Current data status is shown in the table on the right.

New data uploaded on 11/29 by Jinsang Jung provides higher time resolution (5 min) for preliminary data.

Remaining Tasks:

-Merges for ground data are planned.

-We are hoping for higher temporal resolution whenever possible.

Questions or comments?

PI Group	Resolution	Dates	<-------4/21-6/17------->	Variables
Bae, Minsuk	10 min	4/21-6/17		WSOC
Cho, Seogu	1 hr	5/9-6/17		GC VOCs
Cho, Seogu	1 hr	5/9-6/17		HCHO
Cho, Seogu	1 hr	5/9-6/17		CO, O3, SO2, NOx, NO2, NO
Cho, Seogu	1 hr	5/9-6/17		OCEC
Cho, Seogu	1 hr	5/9-6/17		PM10, PM2.5, PM1
Cho, Seogu	1 hr	5/9-6/9		Trace Metals
Cho, Seogu	1 hr	5/9-6/17		Water Soluble Ions
Cho, Seogu	1 hr	5/9-6/17		Met: T, RH, WD, WS, Solar and UV Radiation
EPA, ORD	1 min	5/7-6/11		O3, NO, NO2, Nox
EPA, ORD	1 min	5/16-6/11		HCHO
Han, Jinseok	1 hr	5/9-6/11		Base gases: NH3, DMA, TMA
Jung, Jinsang	5 min	5/9-6/13		CO, SO2, O3, NOx (photo and moly NO and NO2)
Kang, Kitai	1 min	5/9-6/10		SMPS size distribution: 6-225 nm
Kim, Saewung	10 min	5/17-6/10		PAN, ClNO2, Cl2
Kim, Sunroul	1 min	5/8-6/13		BC: Aethalometer AE33 and AE51
Lee, Dongsoo	1 hr	5/9-6/10		Acid Gases: HCl, HONO, HNO3, H2SO4
Lee, Gangwoong	5 min	5/19-6/17		QCTILDAS: HONO, H2O2, N2O, CH4, CO2, H2O
Lee, Jae	5 min	5/8-6/13		O3 (UVA, CLD, and UVA-small), EC, OC, PM10, PM2.5
Lee, Jeonghoon	1 min	5/8-6/13		BC, Abs (Blue, Green, and Red)
Lee, Meehye	10 min	5/12-6/8		H2O2, CH3OOH
Lee, Meehye	15 min	5/17-6/10		HONO
Ro, Chulun	N/A	5/23-6/11		SPA Particle Images
Kim, Seongheon	1 hr	5/9-6/14		VOCs
Shin, Hye-Jung	not known	5/8-6/12		non-refractory PM1
Shin, Hye-Jung	not known	not known		VOCs
Yum, Seong-Soo	1 s	5/12-6/14		CCN, CPC10, CPC3
Yum, Seong-Soo	3 min	5/18-6/13		HTDMA

Data Archival (5): Taehwa/Other

Current data status for Taehwa is shown on the top right and for sites archived under Ground-Other on the bottom right.

NO CHANGE

Data for HCHO from EPA-Aerodyne is still missing. It would be helpful to confirm that this will complete the data set.

Next steps:

-Many sites show data beginning on 5/8, similar to Olympic Park. If data is available for earlier dates, it would be useful.

Questions or comments?

PI Group	Resolution	Dates	<--- 4/25-6/15--->	Variables
EPA-ORD	1 min	4/30-6/10		O3, NO2
Kim, Saewung	10 min	4/30-6/10		NO, NO2
Kim, Saewung	10 min	5/3-6/10		PAN, ClNO2, Cl2
Kim, Saewung	10 min	4/30-6/15		OH reactivity
Kang, Kitai	5 min	5/9-6/12		SMPS size distribution: 7-300 nm
Lee, Meehye	1 hr	5/19-6/11		VOCs
Lee, Meehye	5 sec	5/5-6/15		PAN (from tower at 5 levels from 4-39 m)
Lee, Youngjae	1 hr	5/9-6/11		O3, SO2, CO, Nox
Lee, Youngjae	1 hr	5/9-6/12		CO2, H2O
Lee, Youngjae	1 hr	5/8-6/9		OC, EC
Lee, Youngjae	1 hr	5/7-6/12		Met: WD, WS, T
McGee, Tom	1 min	4/25-6/13		O3, WD, WS, P, T, RH, Solar irradiance
McGee, Tom	not known	5/1-6/10		O3 lidar
Thompson, Anne	1 s	4/30-6/10		Ozonesonde (O3, met)

Site	PI Group	Resolution	Dates	Variables
AirKorea Monitors	NIER	1 hr	4/29-6/11	PM10, PM2.5, O3, CO, NO2, SO2
GIST	Park, Kihong	5 min	5/1-6/15	QAMS aerosol composition
GIST	Park, Kihong	5 min	5/1-6/15	SMPS and OPC size distribution
Gosan	Kim, Sang-Woo	15 min	5/1-6/15	Mie Lidar backscatter and depolarization
Gosan	Kim, Sang-Woo	1 hr	5/8-6/19	SMPS size distribution
Gosan	Kim, Sang-Woo	1 hr	4/30-6/15	Equivalent BC (AE-31 Aeth)
HUFS	Ghim, Young-Sung	1 min	5/8-6/12	BC (MAAP)
HUFS	Ghim, Young-Sung	1 min	5/8-6/12	PM10, PM2.5, PM1 (OPC)
HUFS	Ghim, Young-Sung	5 min	5/8-6/12	SMPS size distribution
KIST	Kim, Hwajin	6 min	5/1-6/11	HR-AMS aerosol composition
KIST	Kim, Hwajin	2 min	5/1-6/11	SMPS number and volumn
Kunsan	Kim, Deug-Soo	5 sec	5/8-6/11	NOx, NO2, NO, NOy
Pyeongtak Power Plant	Kim, Youngj	90 sec	6/2-6/3	MAX-DOAS SO2
SNU	Kim, Sang-Woo	15 min	5/1-6/18	HSRL backscatter and depolarization
SNU	Kim, Sang-Woo	15 min	5/1-6/15	Mie Lidar backscatter and depolarization
Yonsei	Hong, Jinkyu	30 min	5/4-6/9	CRDS CO2, CH4 and carbon isotope ratios
Yonsei	Hong, Jinkyu	30 min	5/1-6/28	Ceilometer BL and Cloud Heights

Data Archival (6): Supersites

Site	PI Group	Resolution	Dates	PM10	PM2.5	Scat	Abs	SMPS	APS	BC-Aeth	OC, EC	Sulfate	Nitrate	Ammonium	Metals	VOCs	O3	CO	NOx	SO2	PAN	NOy	NH3	TMA
Bulkwang	Shin, Hye-Jung	1 hr	5/8-6/12																					
Baengnyeung	Han, Jinseok	1 hr	4/28-6/11																					
Baengnyeung	Kang, Kitai	5 min	5/9-6/13																					
Baengnyeung	Lee, Mindo	1 hr	5/8-6/12																					
Baengnyeung	Lee, Meehye	5 sec	4/30-6/14																					
Daejeon	Yu, Jeongah	1 hr	5/8-6/12																					
Gwangju	Lim, Cheol-Soo	1 hr	5/8-6/12																					
Ulsan	Park, Mikyung	1 hr	5/9-6/12																					
Jeju	Ban, Soo-Jin	1 hr	5/8-6/12																					

NO CHANGE

It would help to confirm that this data is complete.

Data Archival (7): Ships and Japanese Data

Ship data with locations for the RV Kisang that have been archived by Meehye Lee under "All Others"

No ship data has been put into the archive so far for the Onnuri and the Jang Mok.

Ship data are still pending agreements on data for international waters versus inland sea. We will be updated after discussions at the GOCI meeting.

Yugo Kanaya has turned in data for Fukue Island for 4/14-7/26 which includes O3, CO, BC, PM2.5, jNO2, and jO1D.

NO CHANGE

Data Archival (6): Needs

Data Flags for the DC-8 and Hanseo Merges:

-Data flags are useful for identifying profiles and overflight of ground sites

-Flags become part of the data merges and are useful for filtering specific data

-Current suggestions include flags for the profiles over Seoul and adjacent to Taehwa as well as overflight of the Olympic Park and Taehwa sites. Flags should also be included for overflight of the ships, other ground sites, and point sources.

-Data Flagging is underway, but still not completed.

Model Results:

-WRFChem Model Results from the Carmichael/Emmons group have been recently uploaded. Results have been interpolated to the 10s and 60s merges. Please consider how they might be useful in your research and provide feedback.

-WRF-Chem simulations (with full MOZART-T1 chemistry and MOSAIC aerosol) are expected to be finished before Christmas

Flight kml files:

Flight track kmls were uploaded and are now available on the archive website alongside the flight summaries

Data Schedule and Sharing (1)

The following table shows the data schedule discussed at the Science Team meeting in October 2015:

Mission Phase	Data Type	Data Repository	Submission Deadline	Access Control
Field Deployment	Field Data	NASA	24 hour after each flight or cal. Day	Science team and Partners
		NIER		
Post-Deployment	Preliminary Data	NASA	January 15, 2017	Science team and Partners
		NIER		
Public	Final Data	NASA	June 15, 2017	Public
		NIER	June 15, 2018	

As presented during the Science Team meeting in October 2015, the data sharing policy is as follows:

Final data should be submitted to the archive prior to any presentation at scientific conferences (e.g. AGU, AMS) or manuscript preparation, unless explicit authorization is obtained from the program managers

In addition, the following expectations also apply to the professional courtesies expected of the science team:

- **Consult with PIs when using their data in conference/data workshop presentations and/or manuscript**
- **Invite PIs of any data used to be co-authors (particularly during post-deployment research phase)**
- **PIs should be available to answer questions about their data**

Fall AGU 2016 Abstracts

MONDAY, 12 DECEMBER 2016			
09:15 - 09:30	Kara Lamb	A11Q-06 HD-SP2 Measurements of Black Carbon Containing Aerosols in South Korea during KORUS-AQ	Moscone West - 3010
TUESDAY, 13 DECEMBER 2016			
08:00 - 12:20	HoJun Rhee	A21C-0067 The formation of high-O3 episodes derived from atmospheric conditions in Seoul	Moscone South - Poster Hall
	Limseok Chang	A21C-0056 Is urban ozone in Korea increasing?	
WEDNESDAY, 14 DECEMBER 2016			
08:00 - 12:20	Yungu Lee	A31I-0178 Analysis of Biogenic VOCs Emissions During the MAPS-Seoul Aircraft Field Campaign	Moscone South - Poster Hall
	Chanjong Bu	A31I-0179 Initial Analysis of VOCs Speciation in CREATE Emissions Inventory using the MAPS-Seoul Aircraft Field Campaign	
16:00 - 16:15	Caroline Nowlan	A34B-01 Trace Gas Measurements from the GeoTASO and GCAS Airborne Instruments: An Instrument and Algorithm Test-Bed for Air Quality Observations from Geostationary Orbit (Invited)	Moscone West – 3002
THURSDAY, 15 DECEMBER 2016			
08:00 - 12:20	Patrick Hillyard	A41F-0114 Using Airborne In-Situ Profiles to Evaluate TCCONData from Armstrong Flight Research Center	Moscone South - Poster Hall
	Seoyoung Lee	A41A-0021 Characteristics of aerosol optical properties and total amount of trace gases over Korea during the 2015 MAPS-Seoul campaign using AERONET and Pandora spectrometer	
	Aubrey Beach	IN41C-1669 Providing Data Management Support to NASA Airborne Field Studies through Streamlined Usability Design	
	Heesung Chong	A41A-0020 NO2 inter-comparison between Pandora spectrometer and in-situ measurements during MAPS campaign in 2015	
13:40 - 18:00	Michelle Kim	A43E-0279 Observational Comparison of Hydroxynitrates from the Southeast United States and the Korean-US Air Quality (KORUS-AQ) Mission	Moscone South - Poster Hall
	Sanghee Lee	A43B-0215 Analysis of cloud base height from ceilometer measurements in Seoul of Korea	
FRIDAY, 16 DECEMBER 2016			
08:00 - 12:20	Jiwon Eom	A51D-0088 Measurements of Water Soluble Acidic Gases in Seoul Metropolitan Area during the Pre-campaign Period of KORUS-AQ	Moscone South - Poster Hall
	Najin Kim	A51D-0079 Urban aerosol hygroscopicity and CCN activity measured during the MAPS-Seoul 2016 campaign	
	Pilho Kim	A51J-0209 Comparison of Aerosol Volume Size Distributions between Surface and Ground-based Remote Sensing Measurements Downwind of Seoul, Korea during MAPS-Seoul	
	Minsu Park	A51D-0080 Airborne measurement of submicron aerosol number concentration and CCN activity in and around the Korean Peninsula and their comparison to ground measurement in Seoul	
11:20 - 11:35	Ed Hyer	A52B-05 How well do satellite observations and models capture diurnal variation in aerosols over the Korean Peninsula?	Moscone West - 3004
14:25 - 14:40	Limseok Chang	A53H-04 An overview of the KORUS-AQ field study (Invited)	Moscone West - 3010

AOGS 2017

Our Session Proposal was accepted and is listed as

AS40: Results from the 2016 KORUS-AQ Field Study

Abstract submission is open through 15 February 2017

http://www.asiaoceania.org/aogs2017/public.asp?page=home.htm

The Third Workshop on Atmospheric Composition and the Asian Monsoon (ACAM)

5-9 June 2017 Jinan University Guangzhou, China

https://www2.acom.ucar.edu/acam/guangzhou-2017

Research Intentions

42 total responses from 22 research teams (roughly half of the teams)

Responses are well distributed across the categories

Responses provide important information for planning the Science Team Meeting

Please continue to share your research intentions!

Research Category	Primary	Secondary
Remote Sensing: Improvement and Usage	14	6
Factors Controlling Ozone Air Quality	5	12
Factors Controlling Aerosol Air Quality	4	14
Emissions and Source Attribution	6	10
Radiation and Aerosols	6	5
Model Assessment and Improvement	5	13
Validation and Intercomparison	2	18

Rapid Science Synthesis Report (RSSR) Scientific Questions

1. How significant is the impact of the large point sources (power plants and petrochemical plants) along the west coast to the air quality of SMA temporally and spatially?

2. Can we identify 1) what portion of aerosol is derived from secondary production in SMA and across Korea, 2) major sources and factors controlling its variation?

3. Is ozone formation in SMA NOx limited or VOC limited? Can we determine the biogenic or natural contributions to ozone production?

Rapid Science Synthesis Report (RSSR) Scientific Questions (cont.)

4. How is SMA affected by transport of air pollution from sources from regional to continental to hemispheric scales?

5. In SMA, the emission contribution to NOx by transportation and VOCs by solvent usage is estimated to be 68% and 71%, respectively. Are these estimates corroborated by the KORUS-AQ observations and model analyses?

Please take these questions into consideration as you conduct your analyses.

KORUS-AQ **Science Team Meeting** Ministry of Environment National Institute of Environmental Research NASA

Venue: National Institute of Meteorological Sciences

Hotel: Ramada Encore Jeju Seogwipo

Dates: 27 February – 3 March 2017

- 15 January – Submit your title and abstract for the meeting
- 10 February – Agenda finalized and distributed, with oral/poster decisions
- U.S. investigators need to identify travelers ASAP. Funding is available for two per PI group. Names are needed to establish the SSAI support task. **Please send names to Jim Crawford.**
- Please make sure that your passport and visa are still valid. You will need to have a passport expiration at least 6 months past your date of return

KORUS-AQ Outreach Videos

Ministry of Environment
National Institute of Environmental Research

Chapter 1: Introduction to KORUS-AQ https://youtu.be/5jBr6Mu55Z8

Chapter 2: Air Quality https://youtu.be/VOuXlwSqU5o

Chapter 3:Mission in Korea https://youtu.be/kMuFCCbXTRs

Chapter 4: Airborne Laboratory https://youtu.be/J9UdsWr6f-s

Chapter 5: Science on the Fly https://youtu.be/fh_6DM2OVeY

Chapter 6: Legacy https://youtu.be/vOakWBBMrNE

Initial reviews: Two thumbs up! Just in time for the holidays! A great stocking stuffer! Collect them all!

Preliminary Diagnosis of the Roles of Nitryl Chloride ($ClNO_2$) in the Regional Oxidation Capacity

Daun Jeong[1] (daunj1@uci.edu), Roger Seco[1], Youngro Lee[1], Alex Guenther[1], Dasa Gu[1], Dianne Sanchez[1], David Tanner[2], Greg Huey[2], Junyoung Ahn[3], Saewung Kim[1]

[1] Department of Earth System and Science, University of California, Irvine
[2] School of Earth and Atmospheric Sciences, Georgia Institute of Technology
[3] Climate and Air Quality Research Department, National Institute of Environmental Science

KORUS-AQ AGU Fall meeting, Dec. 13th 2016

Halogen Chemistry in the Troposphere

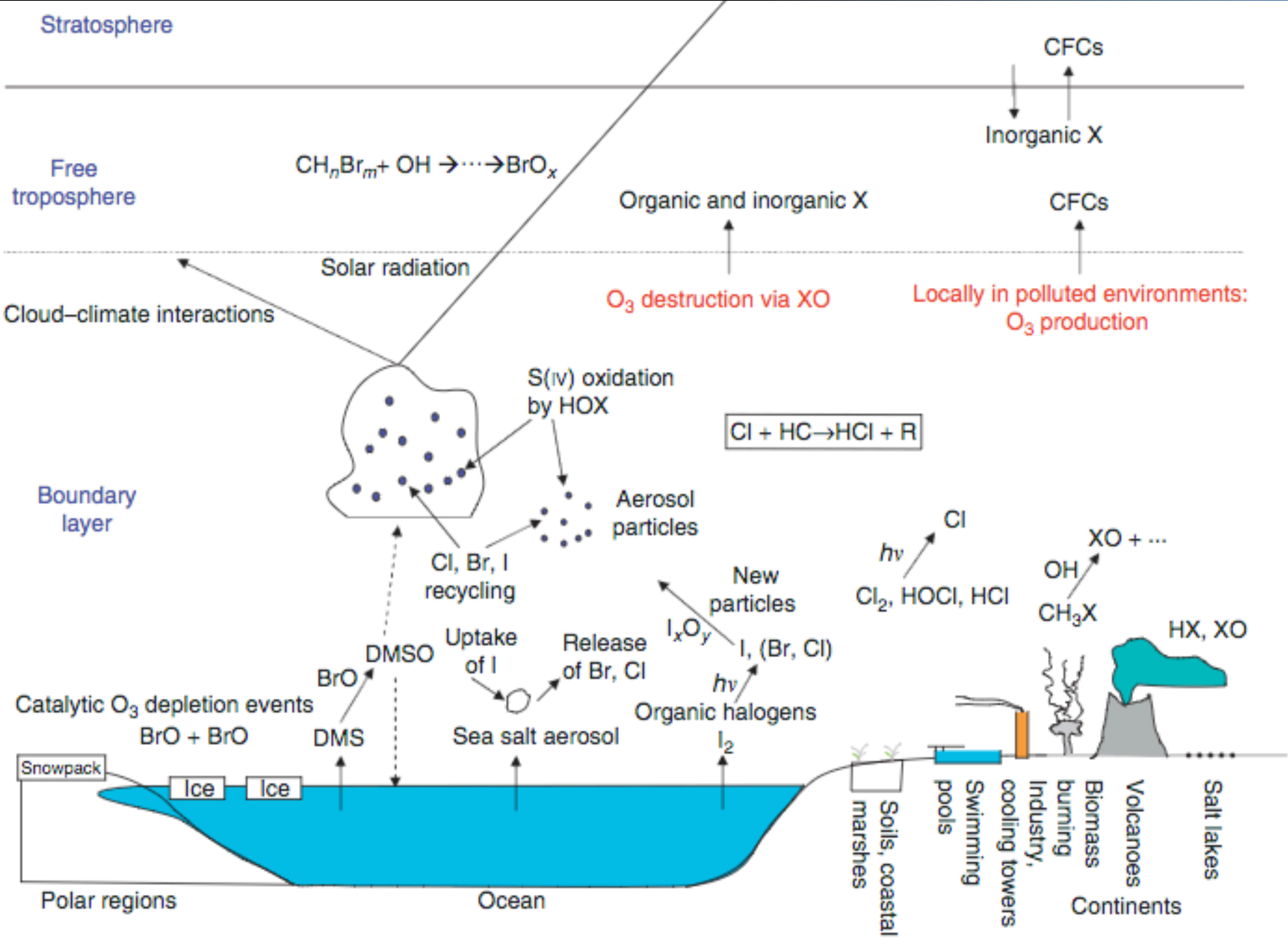


Figure 1 Schematic depiction of the most important halogen-related processes in the troposphere.

- ✓ Halogen compounds play important roles in the troposphere
- ✓ Influence the oxidation power of the troposphere by affecting the levels of O_3 and OH

(Von Glasow and Crutzen, 2003)

Halogen Chemistry in the Troposphere

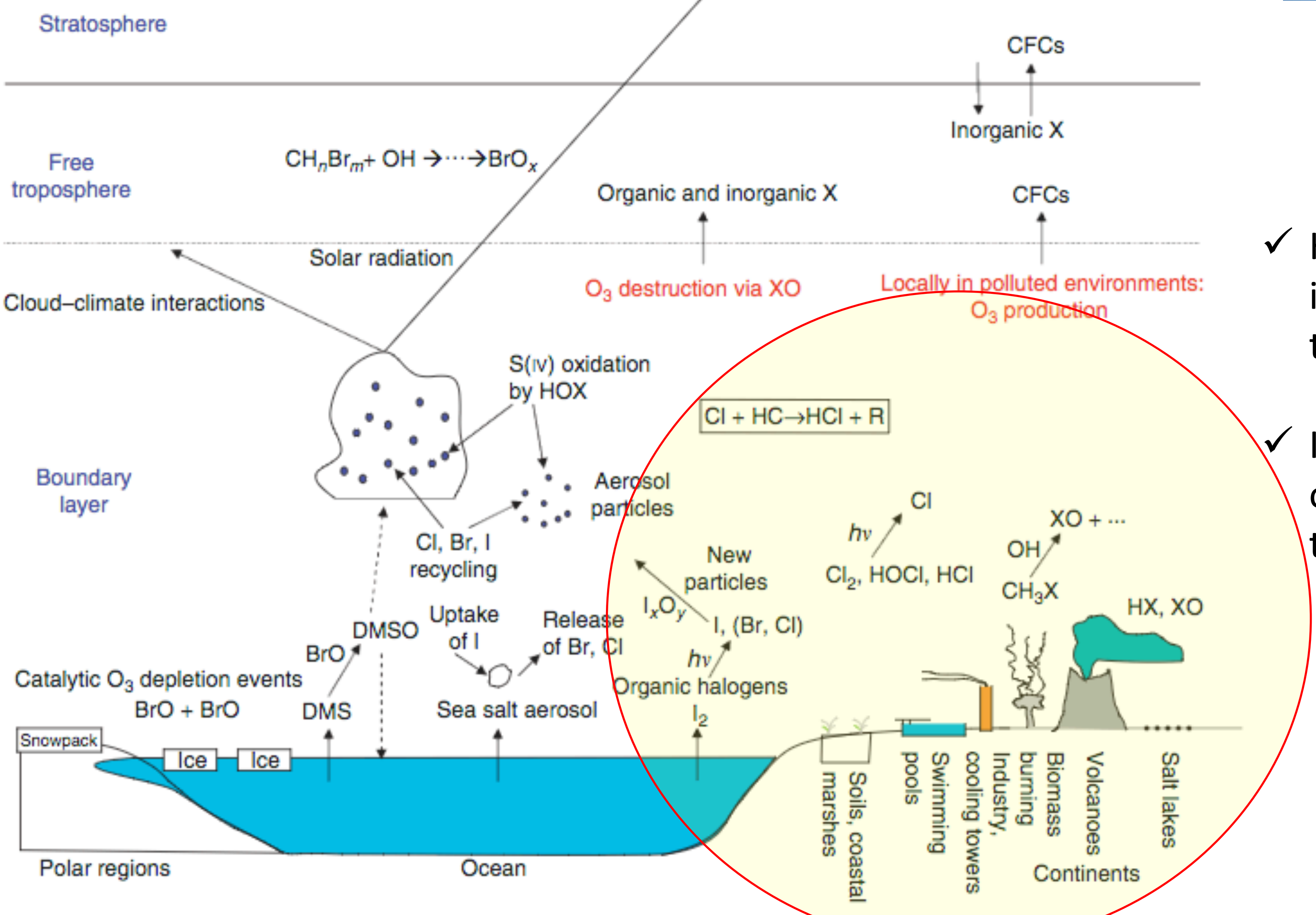


Figure 1 Schematic depiction of the most important halogen-related processes in the troposphere.

- ✓ Halogen compounds play important roles in the troposphere
- ✓ Influence the oxidation power of the troposphere by affecting the levels of O_3 and OH

(Von Glasow and Crutzen, 2003)

Cl, an Important Oxidant in the Troposphere

✓ To date, there has been **no studies on direct observation of Cl radicals.** Therefore, ***precursors*** are measured

Anthropogenic sources:
Coal combustion, power plants, pulp and paper manufacturing, water treatment, incineration, steel making, cooling towers, swimming pools etc…

Natural sources:
sea spray aerosol (from wave breaking actions in the ocean), volcanoes (HCl), biomass burning

HCl

Cl_2

$ClNO_2$

$ClONO_2$

ClNO

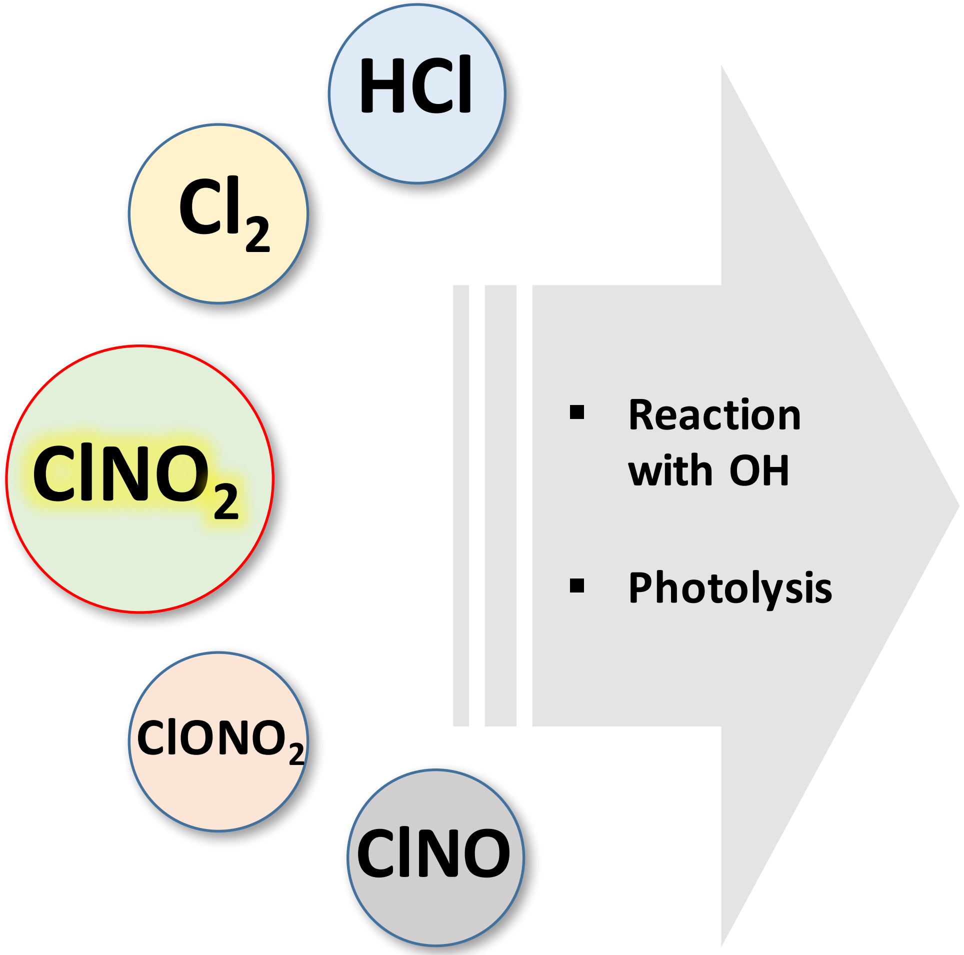
(*Blanchard, 1985; woodcock 1953*)
(Von Glasow and Crutzen, 2003)

Cl, an Important Oxidant in the Troposphere

- ✓ To date, there has been **no studies on direct observation of Cl radicals.** Therefore, ***precursors*** are measured
- ✓ Enhancement of **regional oxidation capacity** leading to **production of O_3** and **degradation of trace gases**
- ✓ Cl has a **much higher reactivity towards VOCs than OH,** especially for alkane (two orders of magnitude)

Anthropogenic sources:
Coal combustion, power plants, pulp and paper manufacturing, water treatment, incineration, steel making, cooling towers, swimming pools etc…

Natural sources:
sea spray aerosol (from wave breaking actions in the ocean), volcanoes (HCl), biomass burning



$$Cl + RH \rightarrow HCl + R$$

$$RO_2 + NO \rightarrow NO_2 \rightarrow \rightarrow O_3$$

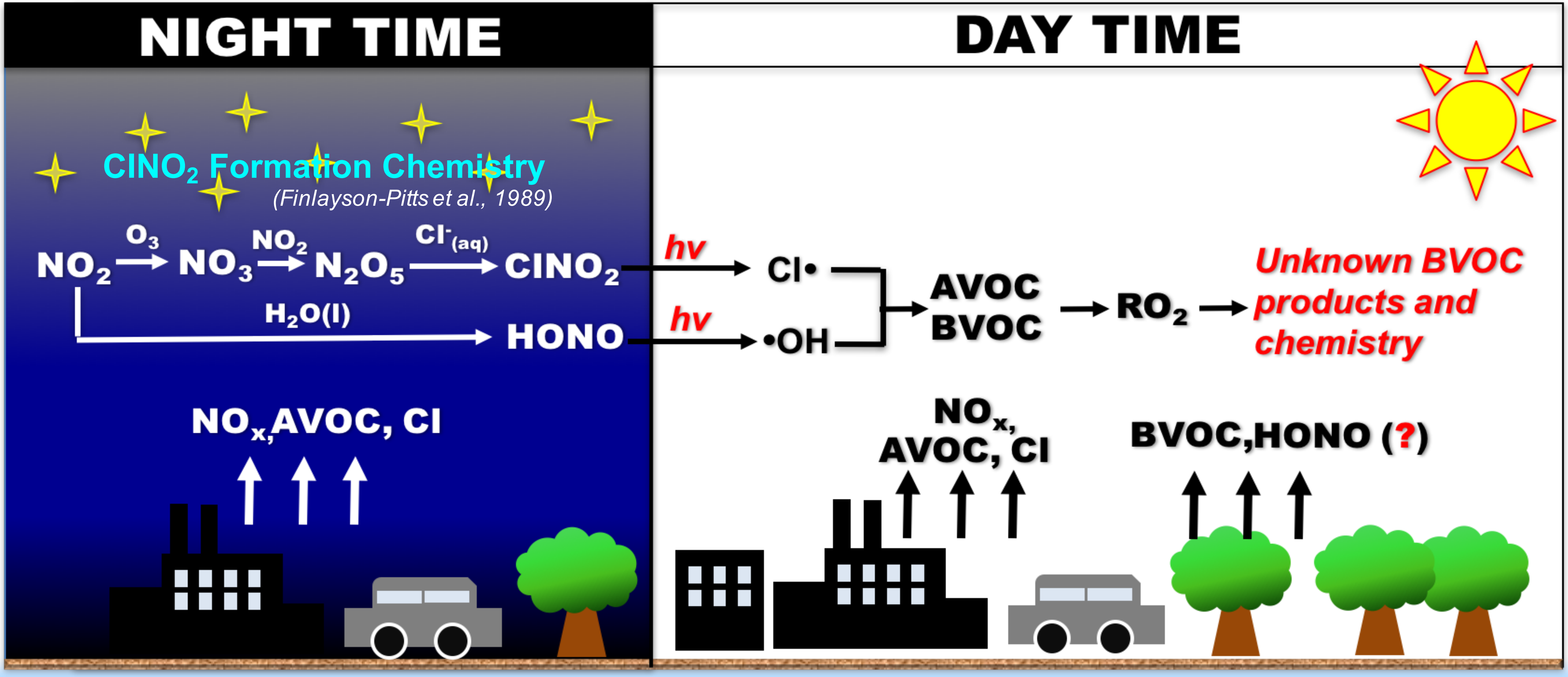
Further produce OH

(Hov, 1985)

(*Blanchard, 1985; woodcock 1953*)
(Von Glasow and Crutzen, 2003)

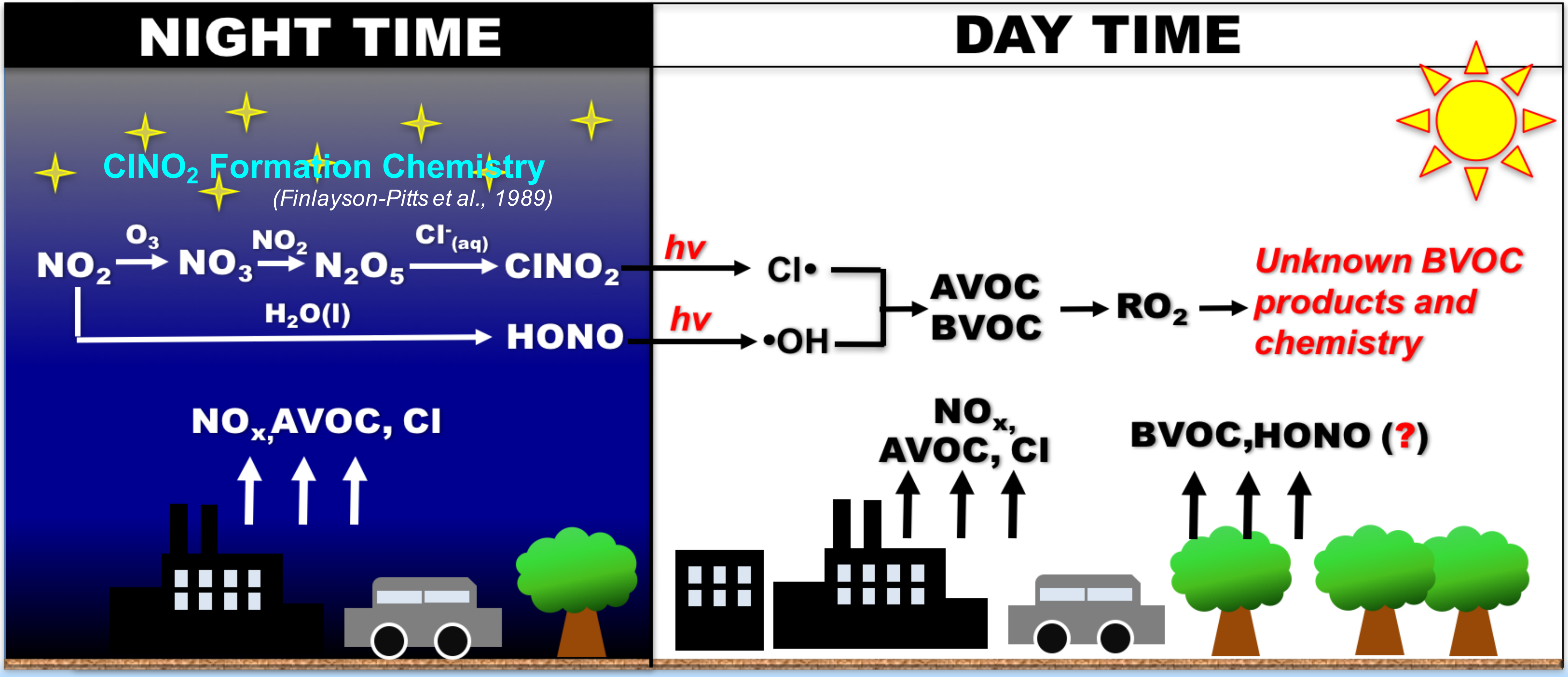
$ClNO_2$ Formation in Korea

- ✓ Formation of $ClNO_2$ requires **high NO_x , O_3** and **Cl containing aerosols**



$ClNO_2$ Formation in Korea

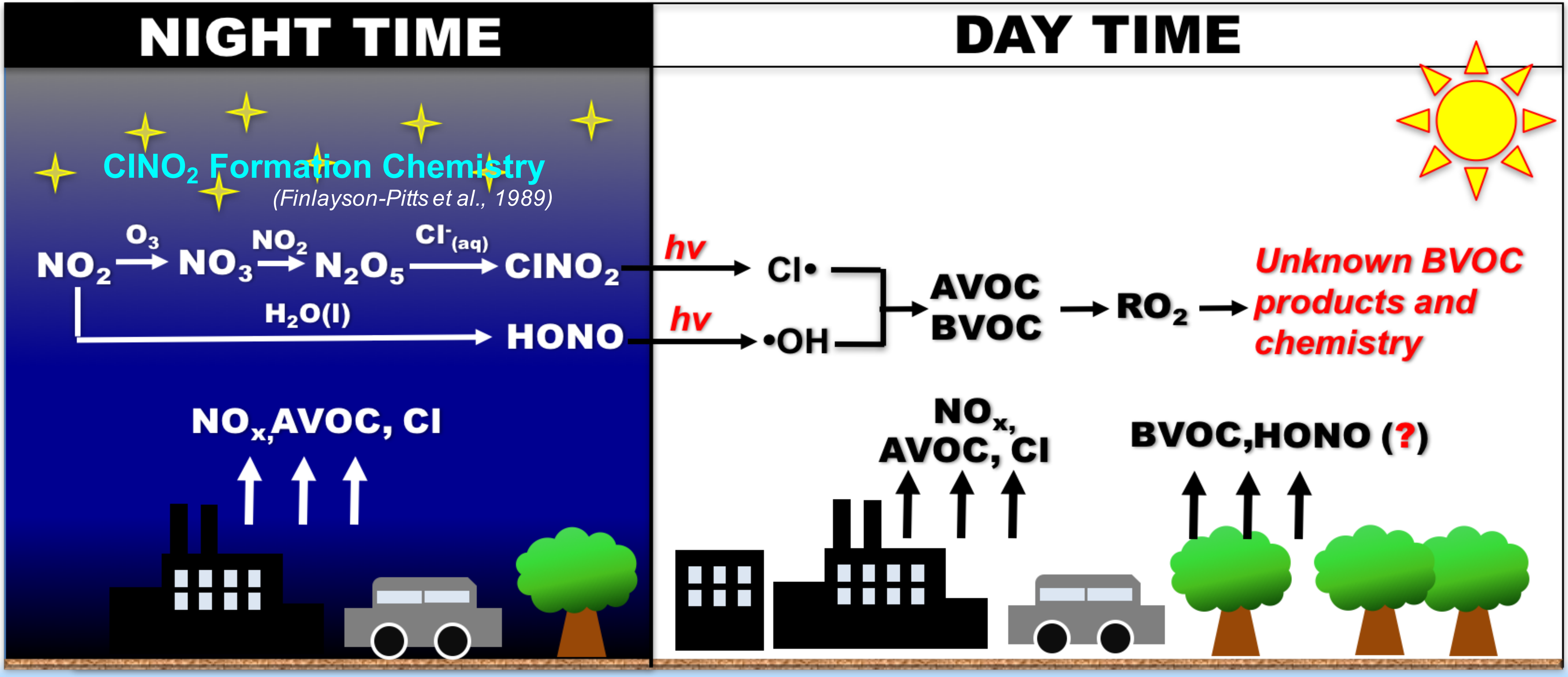
- ✓ Formation of $ClNO_2$ requires **high NO_x , O_3** and **Cl containing aerosols**
- ✓ The **two ground sites (Olympic park and Taehwa Research Forest)** are about **50 km from the nearest coastline (ocean is the largest natural Cl source)**
- ✓ Many **industrial activities** around Seoul Metropolitan Area (SMA) produce reactive Cl



$ClNO_2$ Formation in Korea

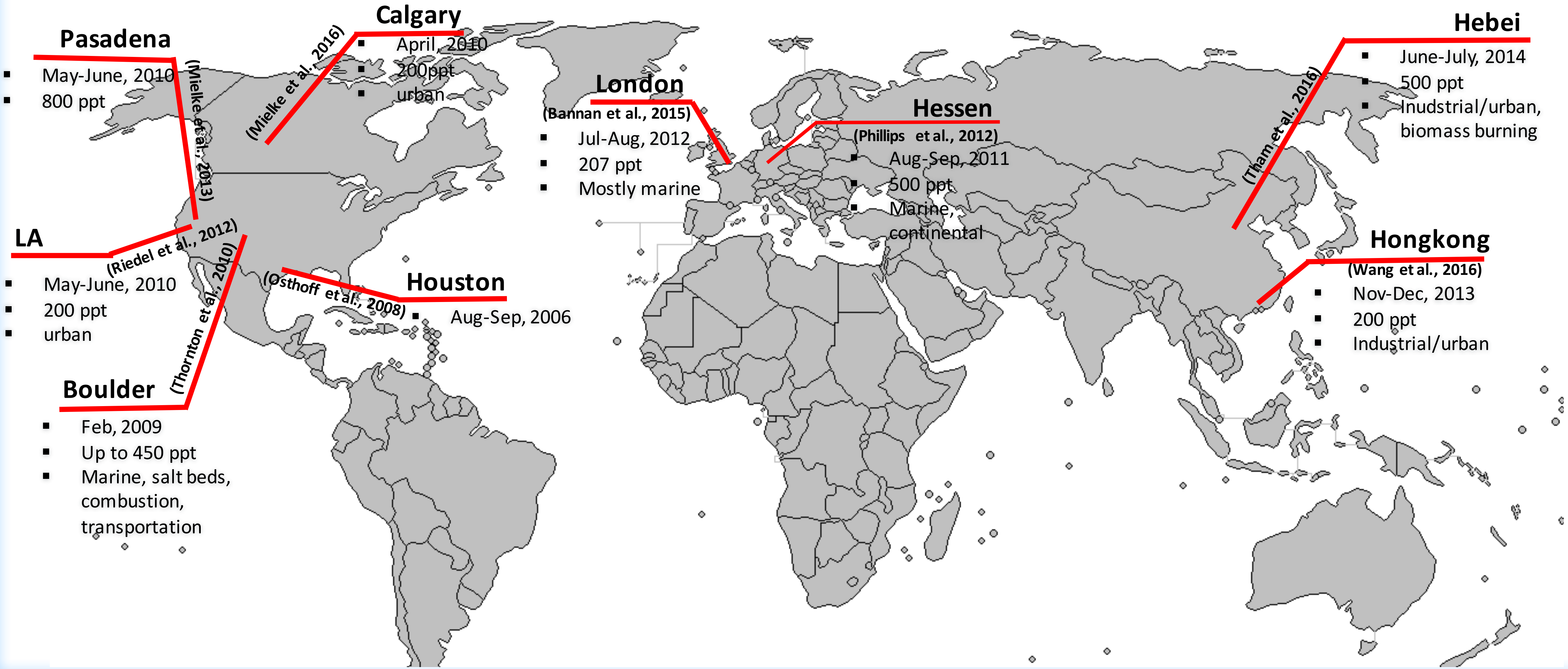
- ✓ Formation of $ClNO_2$ requires **high NO_x , O_3** and **Cl containing aerosols**
- ✓ The **two ground sites (Olympic park and Taehwa Research Forest)** are about **50 km from the nearest coastline (ocean is the largest natural Cl source)**
- ✓ Many **industrial activities** around Seoul Metropolitan Area (SMA) produce reactive Cl

However, sources of Cl (anthropogenic v.s. natural) Cl is not well constrained causing uncertainties in assessing regional air quality in East Asia



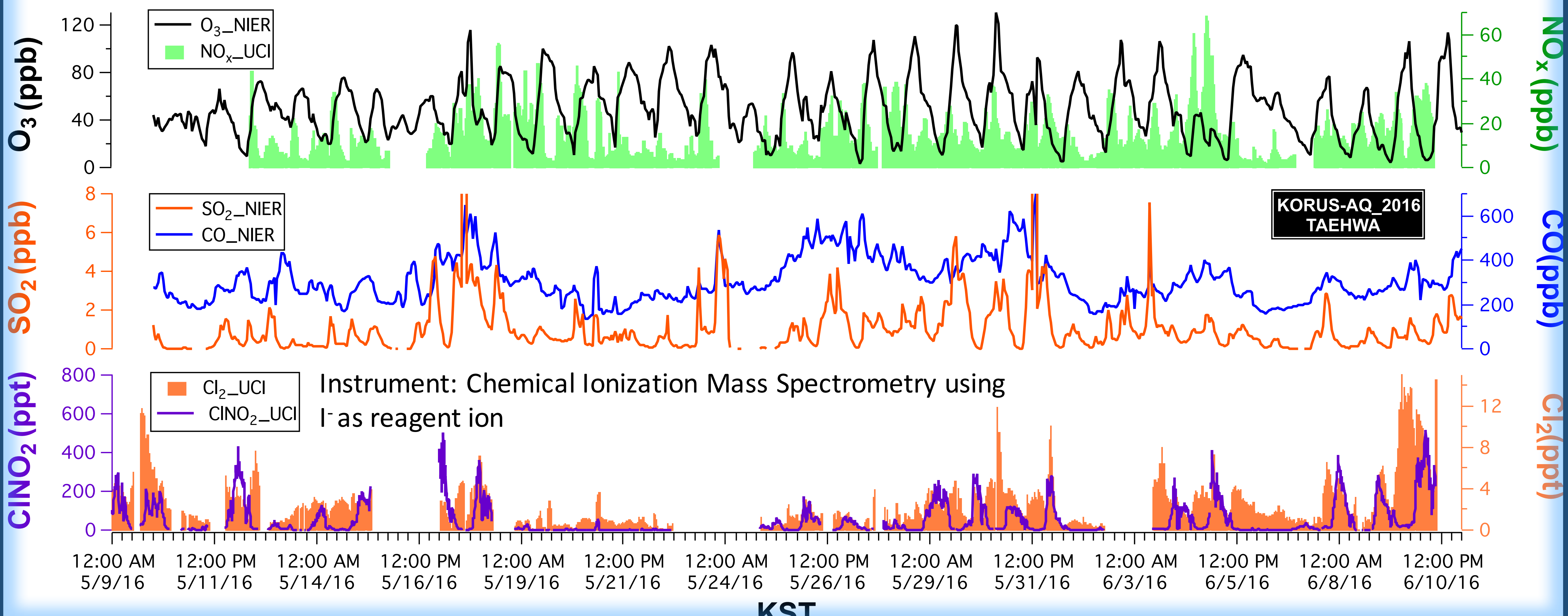
Previous Observations of $ClNO_2$

- ✓ Surprisingly, regions with different environmental conditions (pollution level, vicinity to the coastline etc.) showed comparable levels of $ClNO_2$ (a few hundred ppt to almost 1 ppb)
- ✓ Sources of Cl (anthropogenic v.s. natural) is not well constrained -> uncertainties in regional air quality assessment



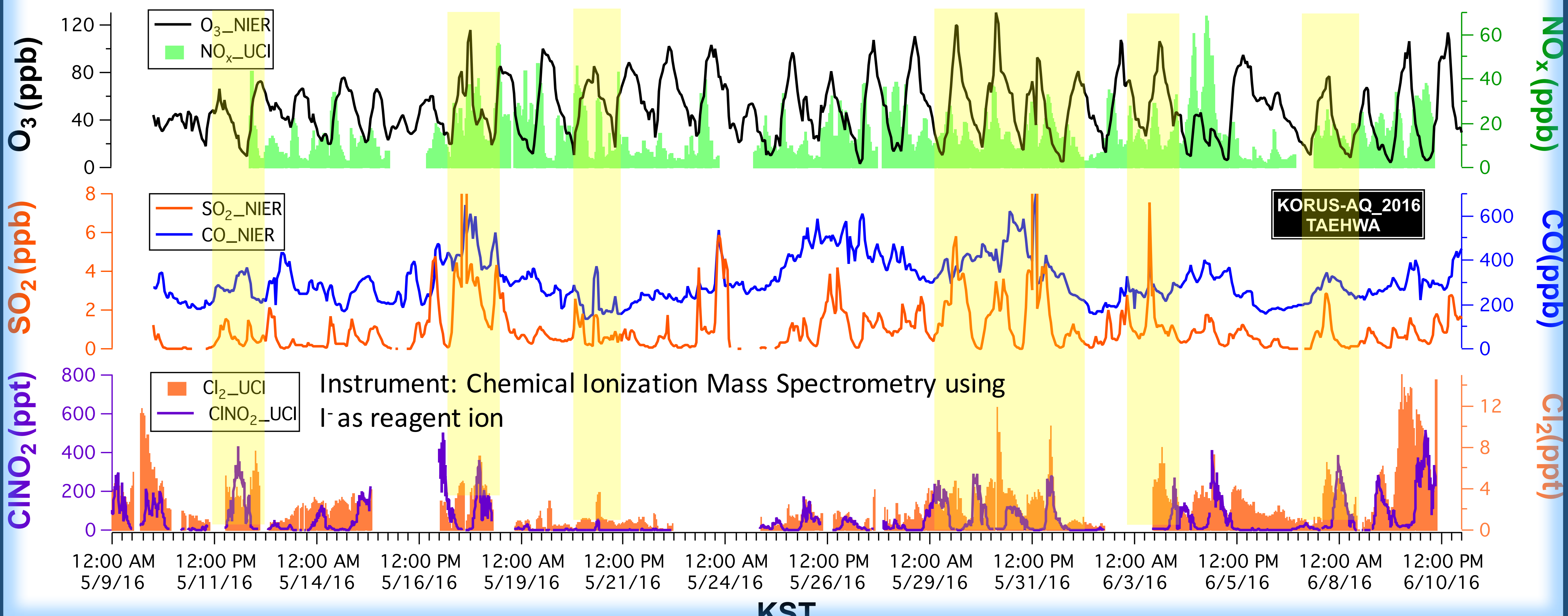
Nitryl Chloride ($ClNO_2$) at the TAEHWA Ground Site

- ✓ Maximum levels of $ClNO_2$ was observed between **4 am to 9am** (max **: 800ppt** not shown in the graph) and was around **300-400ppt** during the whole campaign)



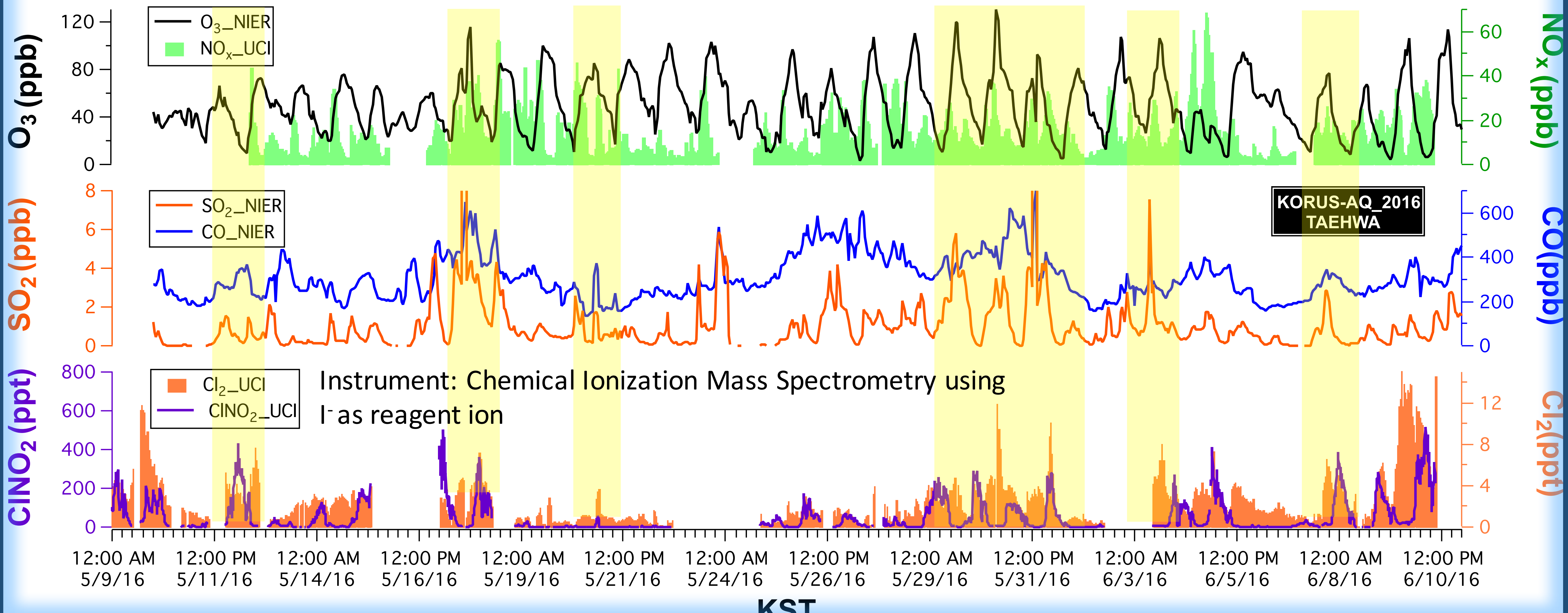
Nitryl Chloride ($ClNO_2$) at the TAEHWA Ground Site

- ✓ Maximum levels of $ClNO_2$ was observed between **4 am to 9am** (max **: 800ppt** not shown in the graph) and was around **300-400ppt** during the whole campaign)
- ✓ (**yellow shade**) Cl_2 and $ClNO_2$ correlated well for some days and didn't for others -> **various source of reactive chlorine**



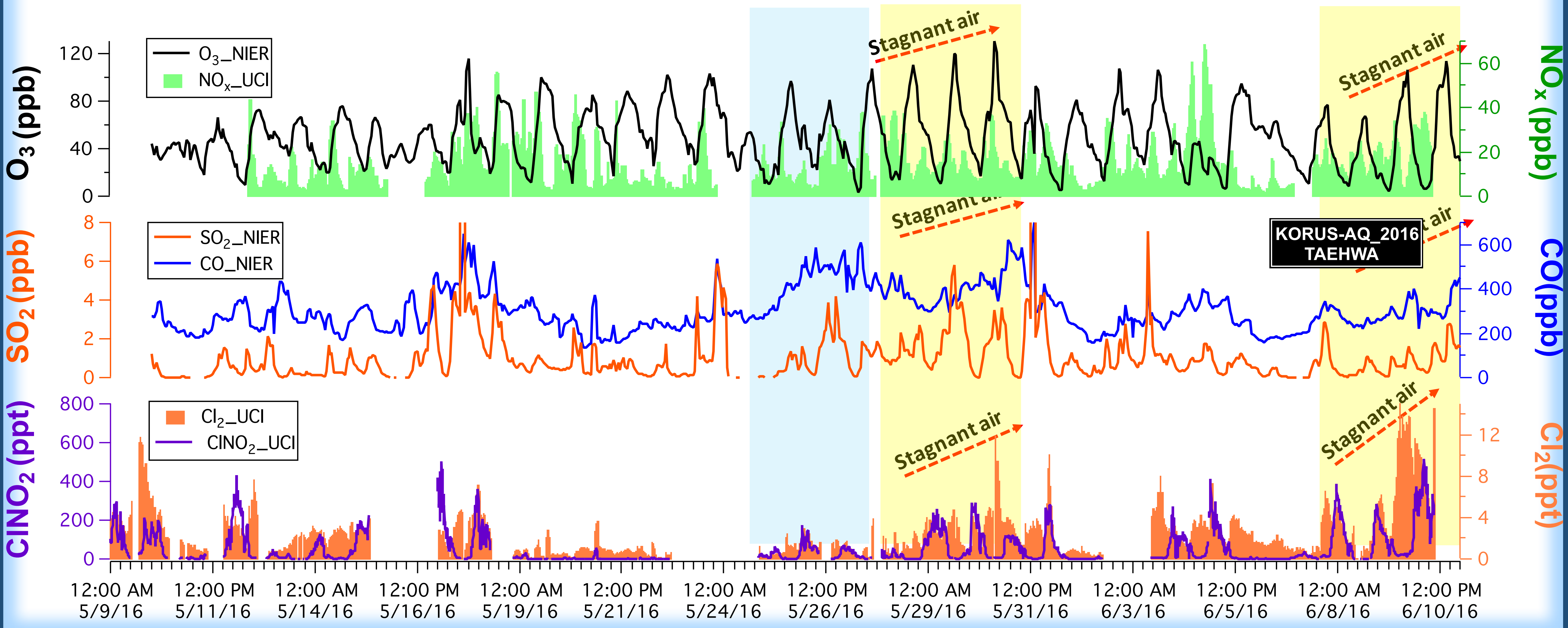
Nitryl Chloride ($ClNO_2$) at the TAEHWA Ground Site

- ✓ Maximum levels of $ClNO_2$ was observed between **4 am to 9am** (max **: 800ppt** not shown in the graph) and was around **300-400ppt** during the whole campaign)
- ✓ (**yellow shade**) Cl_2 and $ClNO_2$ correlated well for some days and didn't for others -> **various source of reactive chlorine**
- ✓ SO_2 peaks correlated well with Cl_2 for some days which indicates possible **anthropogenic sources of Cl_2**
  -> should check **back trajectory** to see the origin of air (natural and/or anthropogenic)



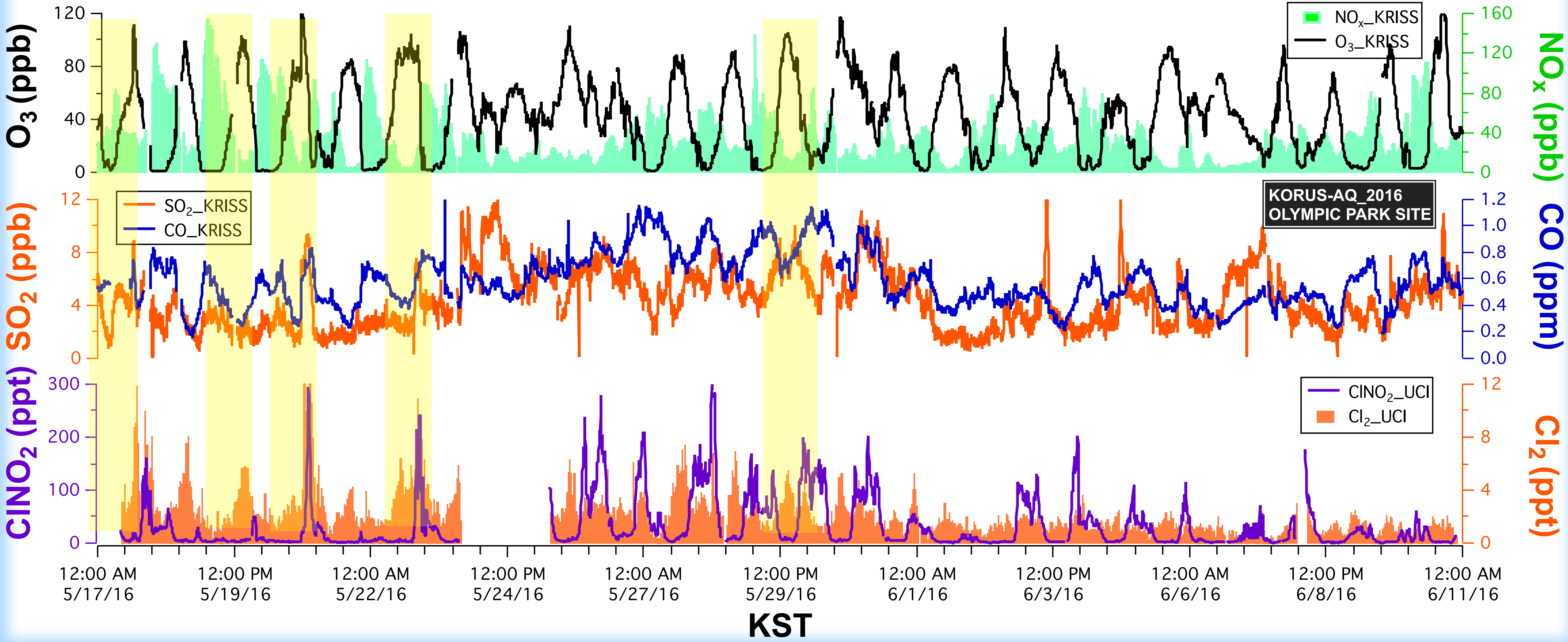
Nitryl Chloride ($ClNO_2$) at the TAEHWA Ground Site

- ✓ O_3 as a tracer for photochemical activities and CO as an indication for regional stagnation
- ✓ (blue shade) Stagnation air (CO increasing) with relatively low O_3 **-> relatively low $ClNO_2$ formation**
- ✓ (yellow shade) Stagnant air with relatively high O_3 **-> relatively high $ClNO_2$ formation**



Nitryl Chloride ($ClNO_2$) at the Olympic Park Ground Site

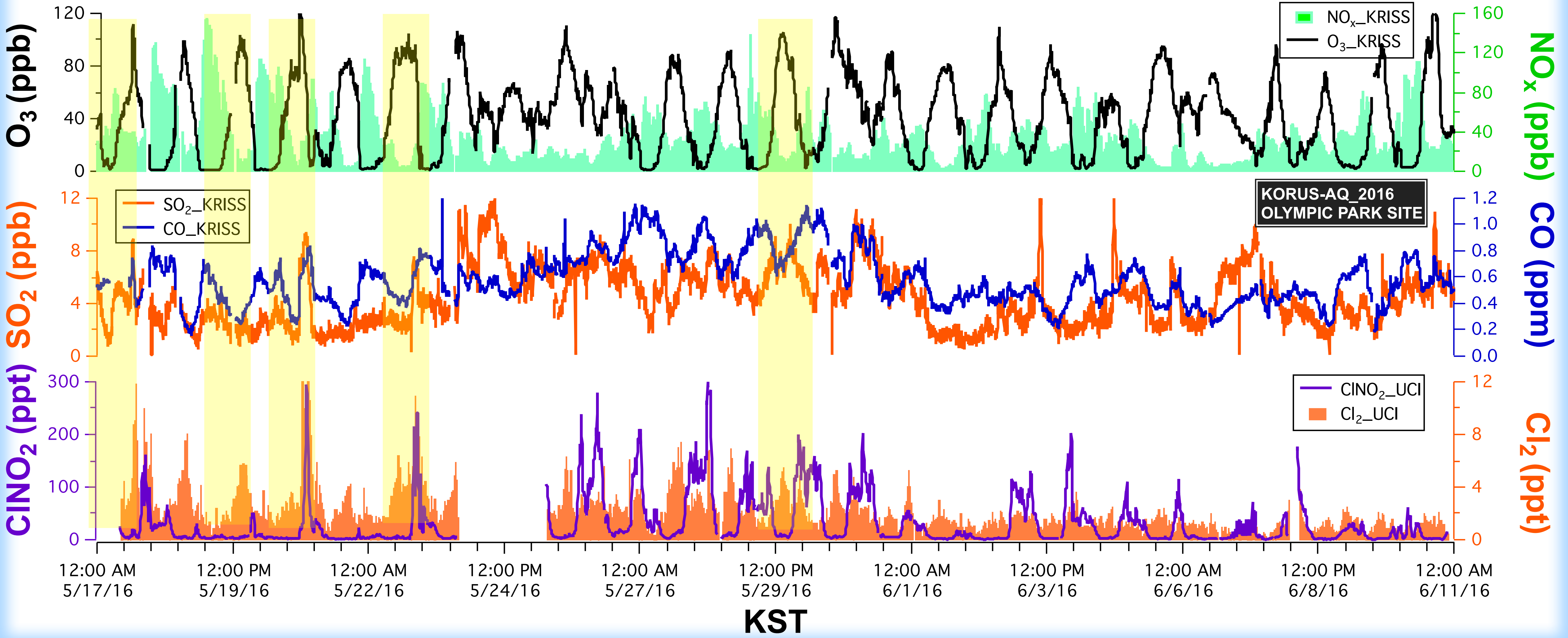
- ✓ (yellow shade) Cl_2 and $ClNO_2$ correlated well for some days and didn't for others -> various sources of reactive Chlorine
- ✓ SO_2 peaks correlated well with Cl_2 for some days indicating **anthropogenic sources of Cl_2 : back trajectory required**



Nitryl Chloride ($ClNO_2$) at the Olympic Park Ground Site

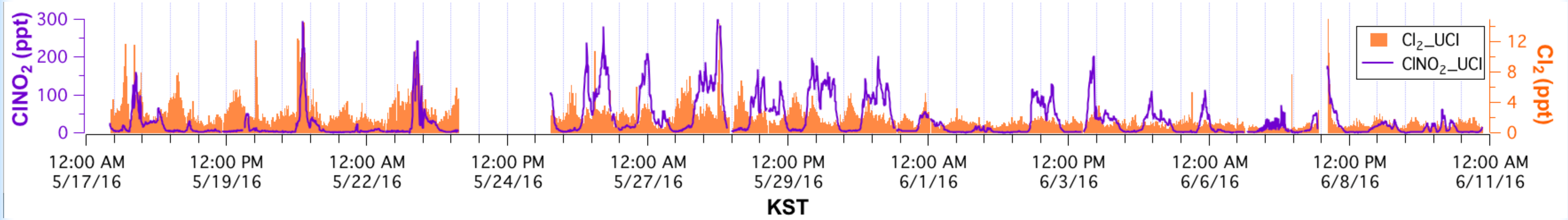
- ✓ (yellow shade) Cl_2 and $ClNO_2$ correlated well for some days and didn't for others -> various sources of reactive Chlorine
- ✓ SO_2 peaks correlated well with Cl_2 for some days indicating **anthropogenic sources of Cl_2 : back trajectory required**

" various factors contributing towards $ClNO_2$ formation (aerosol, various reactive chlorine source, etc…). We will further investigate on their sources and impact on regional air quality"

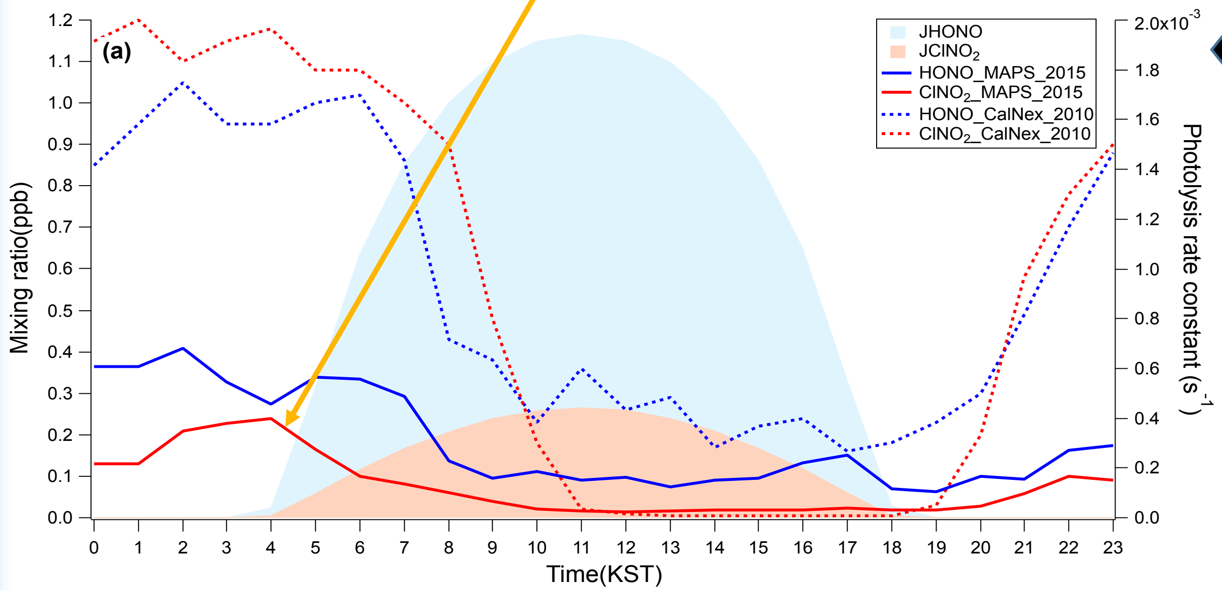


$ClNO_2$ Comparison between MAPS and KORUS-AQ

$ClNO_2$ during 2016 KORUS-AQ: Olympic Park, SEOUL (max: 300 ppt, campaign avg max around 200 ppt)



$ClNO_2$ during 2015 MAPS: KIST, SEOUL



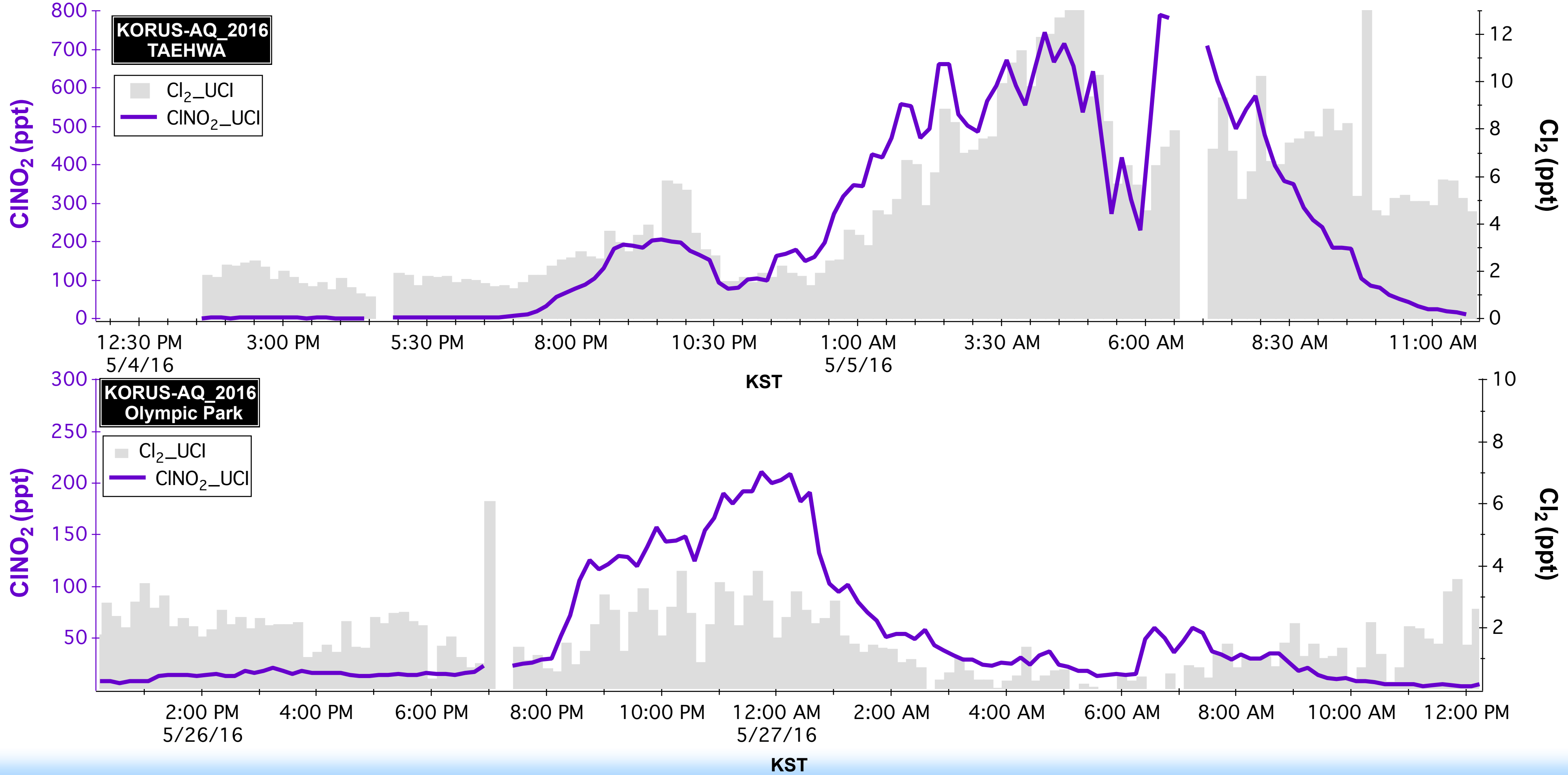
HONO and $ClNO_2$ from CalNex taken from Young et al., 2012

Diurnal averages of observations made from 5/31 to 6/2 and from 6/8 to 6/10, 2015 at KIST, Seoul

- ✓ **$ClNO_2$ levels during the night was comparable between MAPS and KORUS-AQ:** around **200 ppt**
- ✓ Higher $ClNO_2$ oberved at Taehwa : maximum levels were observed between 4 am to 9 am with average max around **300-400ppt** during the campaign (max: **800ppt**)

Sustained $ClNO_2$ in the Morning

- Typical diurnal variation of $ClNO_2$ show decline upon sunrise. At Taehwa, **$ClNO_2$ was sustained for about 4 h after sunrise** for most of the observation days (also observed at Olympic park for some of the days).
- **Previous studies that showed sustained $ClNO_2$ in the morning**
  : Texas, U.S. (Faxon et al., 2015), London, England (Bannan et al., 2015), Wangdu, China (Tham et al., 2016)
  : two possibilities suggested **1) entrainment of $ClNO_2$ from residual layer** and **2) in-situ generation of $ClNO_2$**



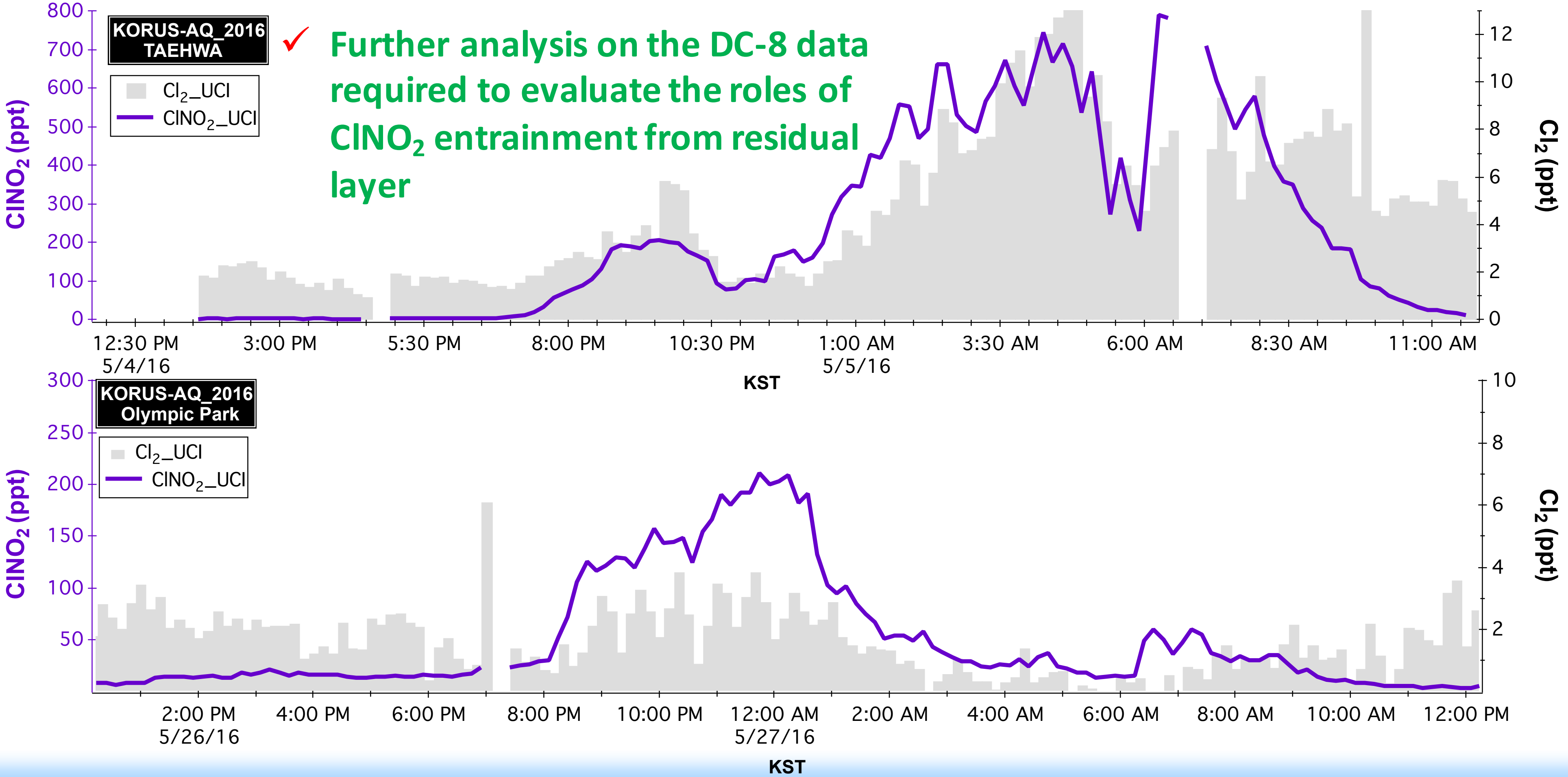
Sustained $ClNO_2$ in the Morning

- ✓ Typical diurnal variation of $ClNO_2$ show decline upon sunrise. At Taehwa, **$ClNO_2$ was sustained for about 4 h after sunrise** for most of the observation days (also observed at Olympic park for some of the days).
- ✓ **Previous studies that showed sustained $ClNO_2$ in the morning**

: Texas, U.S. (Faxon et al., 2015), London, England (Bannan et al., 2015), Wangdu, China (Tham et al., 2016)

: two possibilities suggested **1) entrainment of $ClNO_2$ from residual layer** and **2) in-situ generation of $ClNO_2$**

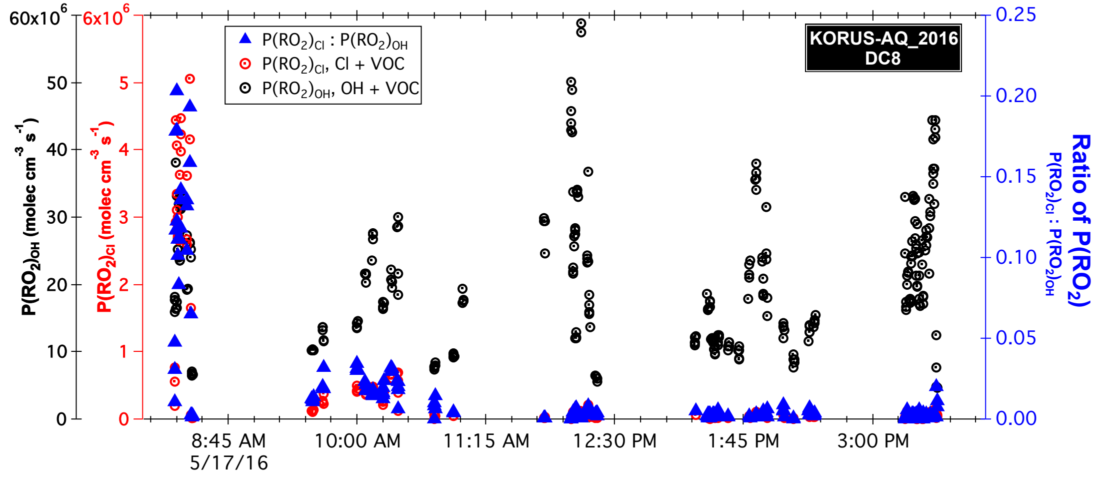
- ✓ **Further analysis on the DC-8 data required to evaluate the roles of $ClNO_2$ entrainment from residual layer**

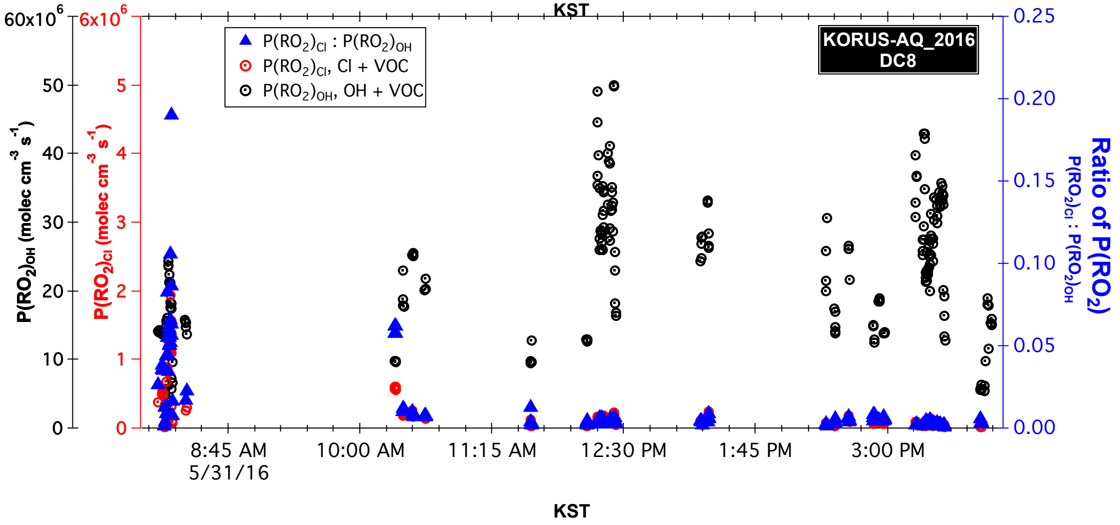


RO_2 Production Rate: Implications for O_3 formation

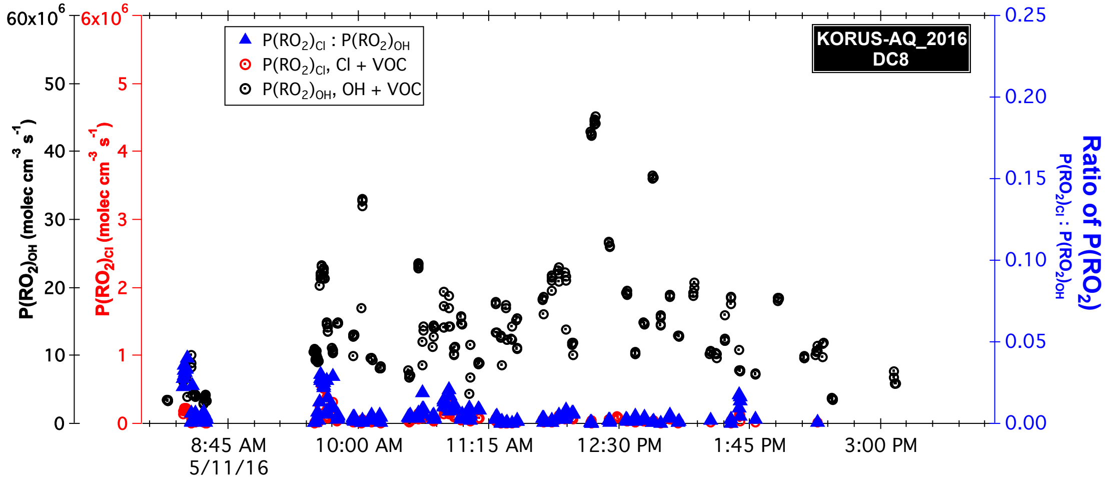
Airborne $ClNO_2$ (DC-8)_GaTech - UCI - NIER

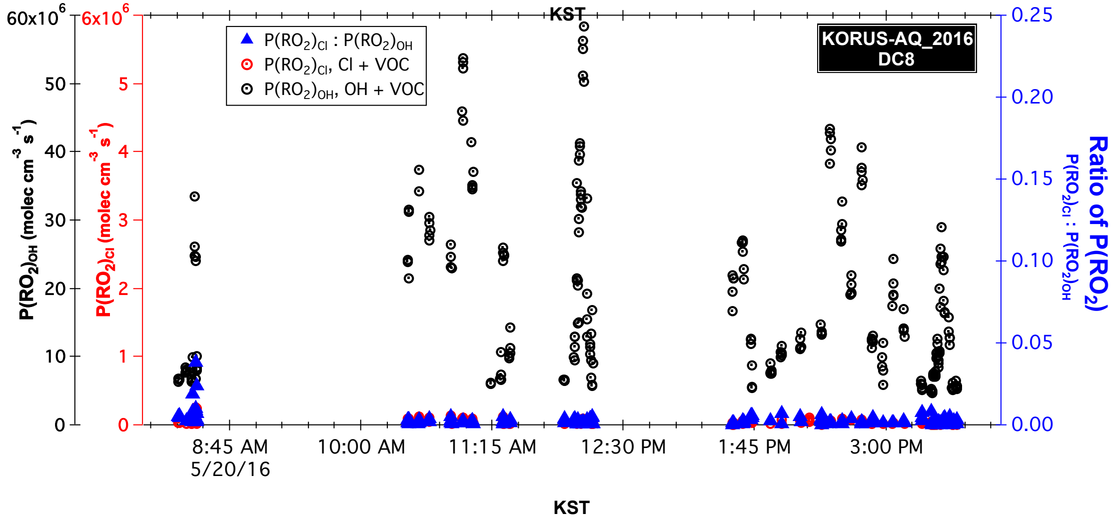
More polluted days





Less polluted Days





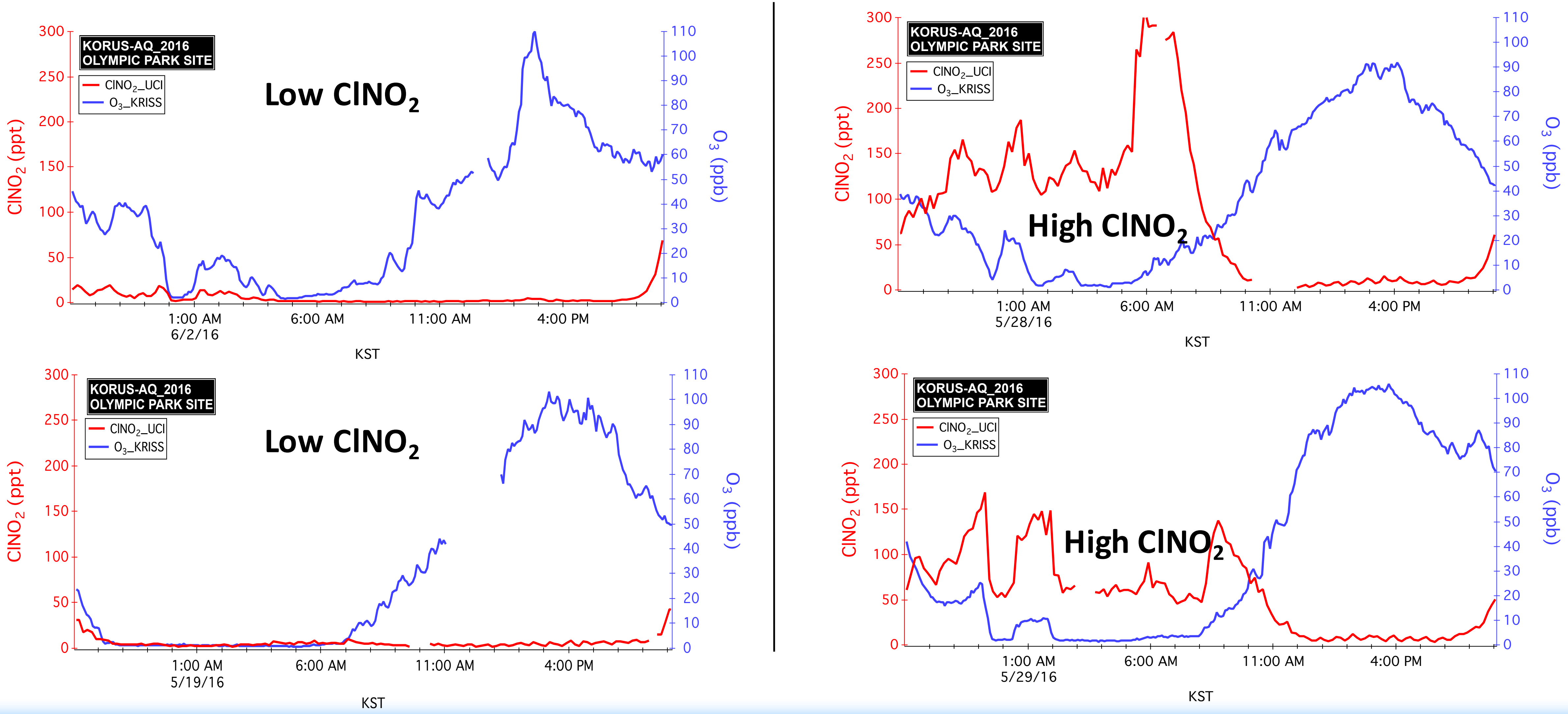
* Calculated from VOC data collected from the UCI (the Blake group) whole air samples, University of Oslo (the Wisthaler group) PTR-MS, NASA Langley Research Center (Diskin, Glenn S.) DACOM. Observed OH was collected with the Penn state (the Brune group) ATHOS instrument. Photolysis frequencies calculated from NCAR CAF (Hall, Samuel R.)

$ClNO_2$ could cause prolonged exposure to O_3

- ✓ Accumulation of $ClNO_2$ during the night will release Cl upon sunrise and contribute to production of O_3 in the early morning.
- ✓ This might cause prolonged exposure to O_3 (EPA's National Air Quality Standard: 70 ppb)

$$Cl + RH \rightarrow HCl + R$$

$$RO_2 + NO \rightarrow NO_2 \rightarrow \rightarrow O_3$$



Conclusion

- ✓ $ClNO_2$ level at peaked between 4am – 9 am (up to 800 ppt at Taehwa and 300 ppt at Olympic park)

- ✓ For some days, observed $ClNO_2$ correlated well with Cl_2. However, sometimes didn't which implies various source of reactive chlorine and other factors contributing to its formation (e.g., aerosol loading, O_3 etc..)

- ✓ Cl_2 sometimes correlated well with SO_2 which could be a good indication of its anthropogenic origin

- ✓ Sustained $ClNO_2$ 4 h after sunrise?
  : One possibility is the entrainment of $ClNO_2$ from residual layer. Further analysis on the DC-8 data is required

- ✓ RO_2 production rate from Cl + VOC was about 20 % of that generated from OH +VOC
  -> implications toward early O_3 formation and prolonged exposure






THANK YOU