Agenda

Ministry of Environment
National Institute of Environmental Research

Science Team Telecon

Fall AGU 2017 Update

AOGS 2018

Science Presentations

- **-Eric Heim (SAGA)**
- **-John Hair (DIAL/HSRL)**
- **-Kara Lamb (HD-SP2)**
- **-Ben Nault (HR-ToF-AMS)**

KORUS-AQ

Ministry of Environment
National Institute of Environmental Research

NASA

AGU FALL MEETING
New Orleans
11-15 Dec. 2017 What will *you* discover?

Relevant Sessions

Monday

Observational Studies of East Asian Air Quality: Constraints on Emissions, Chemistry, and Transport

(three oral sessions and one poster session with some overlap between oral and posters)

Wednesday

Monitoring, Analysis, and Prediction of Air Quality from Urban to Regional to Global Scales

(Two oral sessions on Wednesday and one poster session on Friday)

Friday

Advances in an Integrated Observing System for Air Quality

(Two oral sessions and one poster session)

KORUS-AQ

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Dr. Douglas D. Davis (1940-2016)

While Fall AGU rules do not allow sessions to be dedicated or named, I am hoping that many of you will join me in honoring Doug Davis by placing his picture on your poster or in your talk. This is purely voluntary.

You need not mention him specifically. Many will recognize him and others will ask about him if they see his picture everywhere.

Doug is one of those rare individuals who ties us all together in the family tree of atmospheric scientists. It is not an exaggeration to say that he started the whole business of airborne measurements of atmospheric chemistry in the late 1970s and led the field through the 1980s and 1990s.

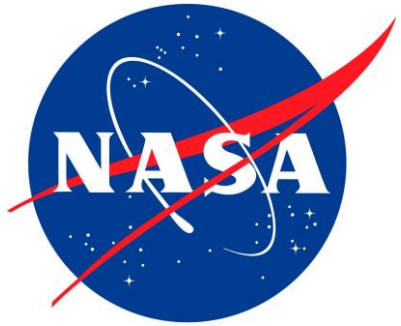
There are many colorful stories about Doug, so let's take some time at AGU to remember him and tell some stories.

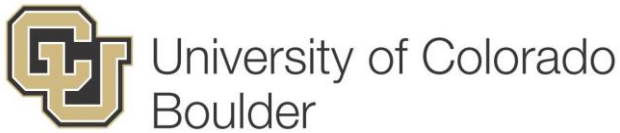
Session Proposal for KORUS-AQ has been accepted

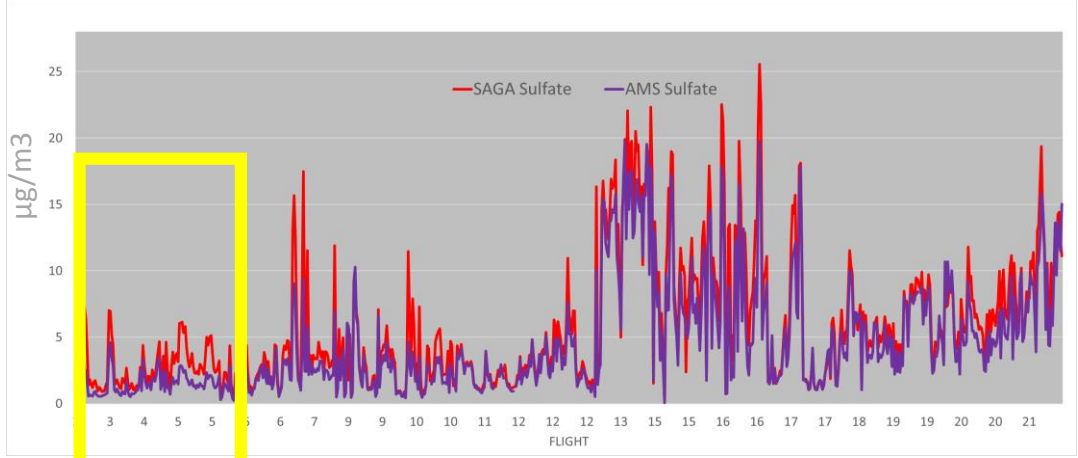
Abstract submission is now open with a deadline of 19 January 2018

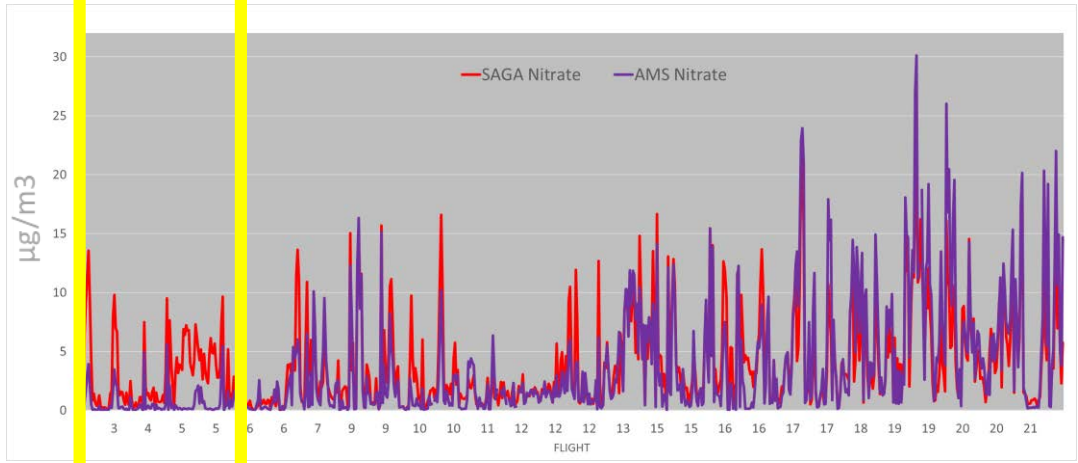
Please consider submitting an abstract. Atmospheric chemistry needs to establish a stronger presence at this meeting.

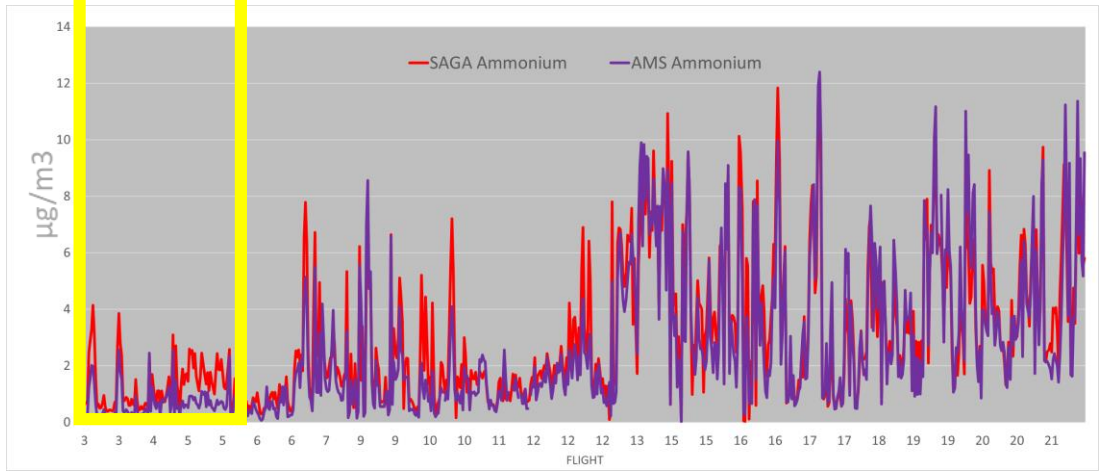
Asian Dust Observed during KORUS-AQ Facilitates the Uptake and Incorporation of Soluble Pollutants





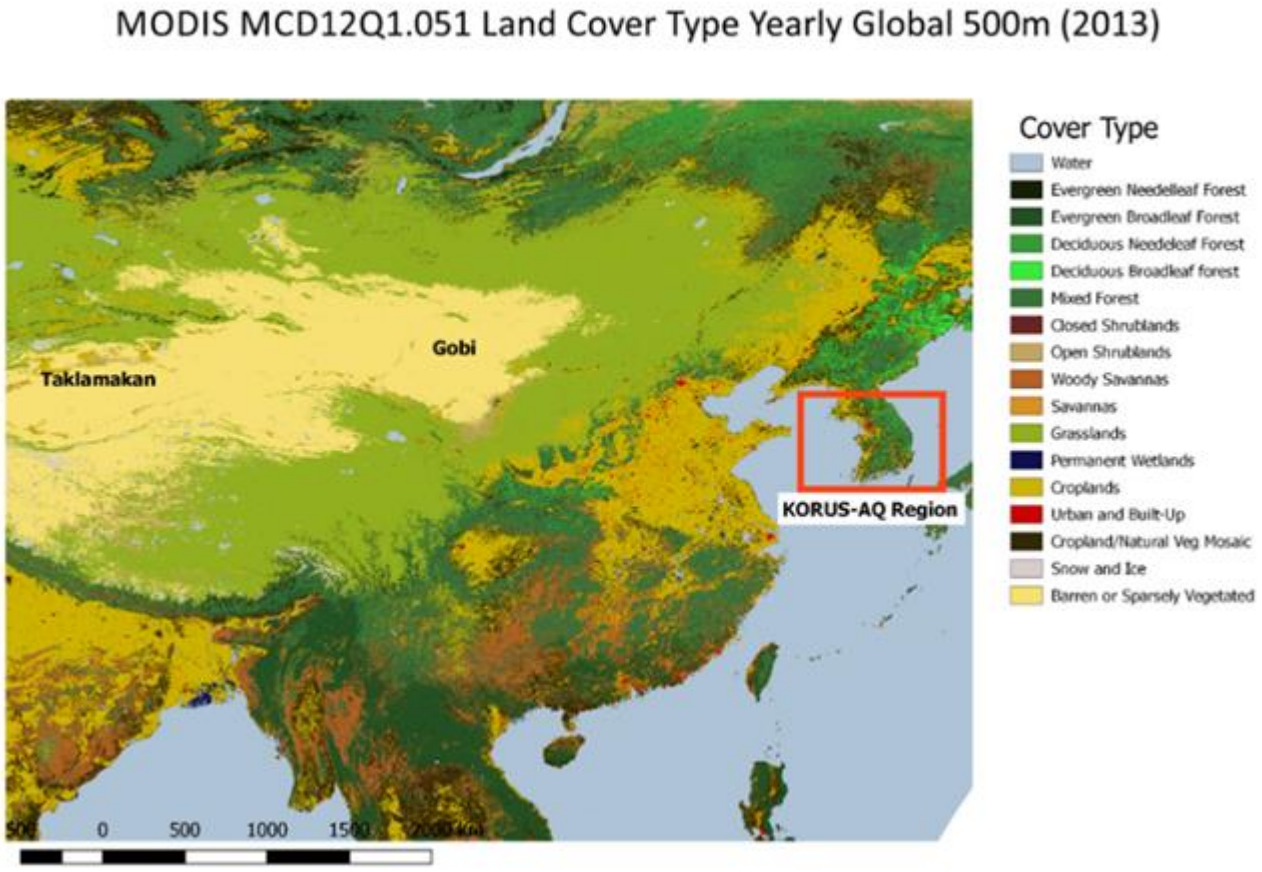

SAGA Sulfate
AMS Sulfate
µg/m3
FLIGHT


SAGA Nitrate
AMS Nitrate
µg/m3
FLIGHT


SAGA Ammonium
AMS Ammonium
µg/m3
FLIGHT


SAGA Sulfate
AMS Sulfate
SAGA Nitrate
AMS Nitrate
SAGA Ammonium
AMS Ammonium
µg/m3

Conditions were metrologically favorable during this initial portion of the mission for transport of dust from China to Mongolia. (See David Peterson's Presentation)



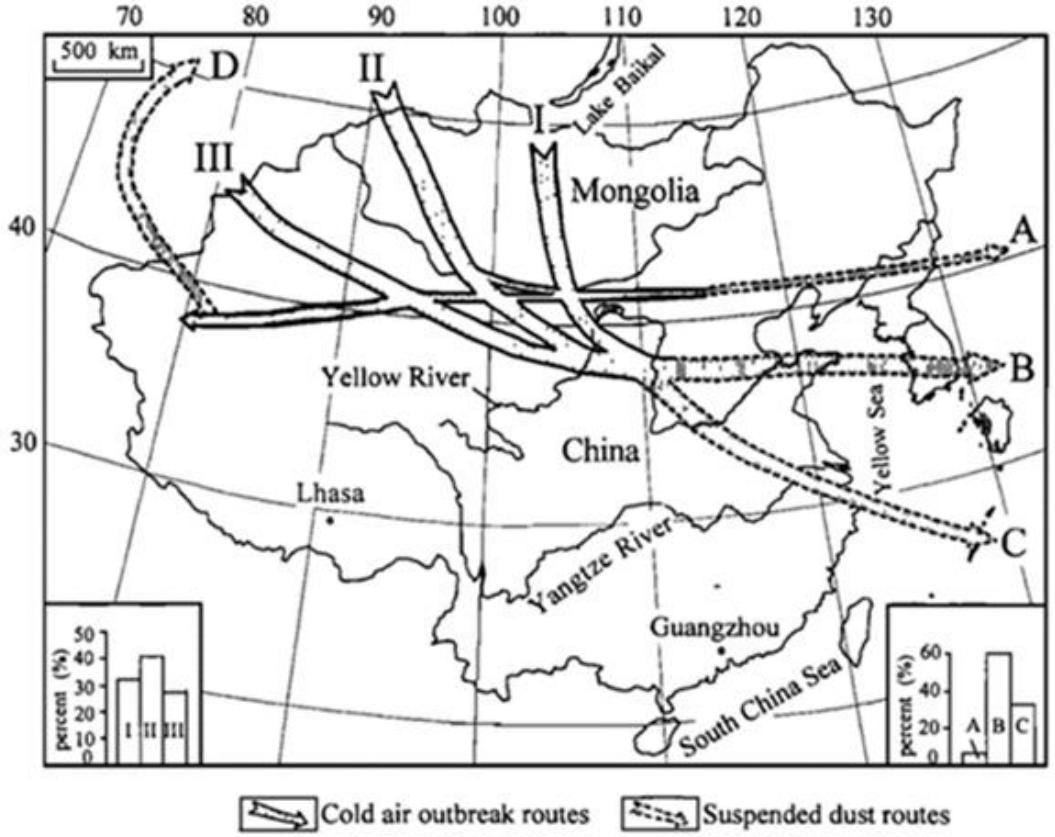
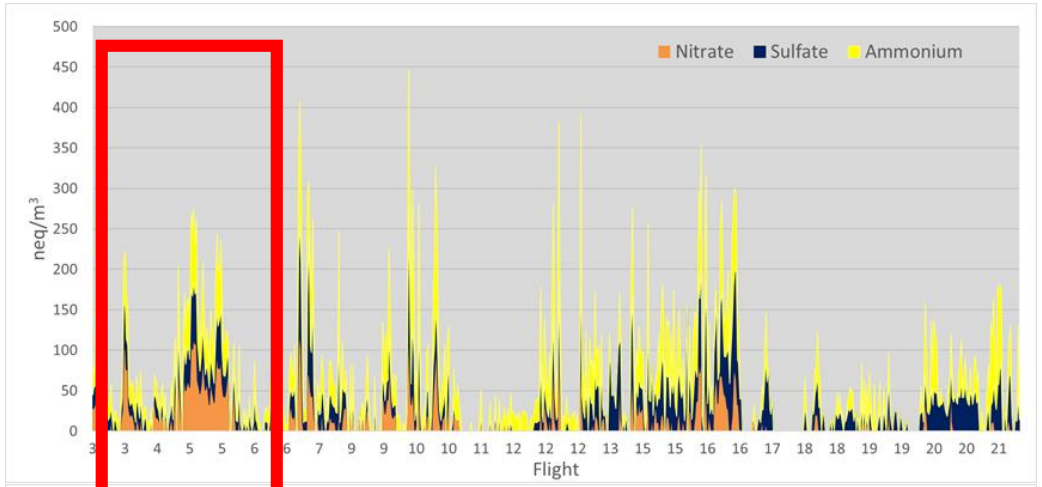
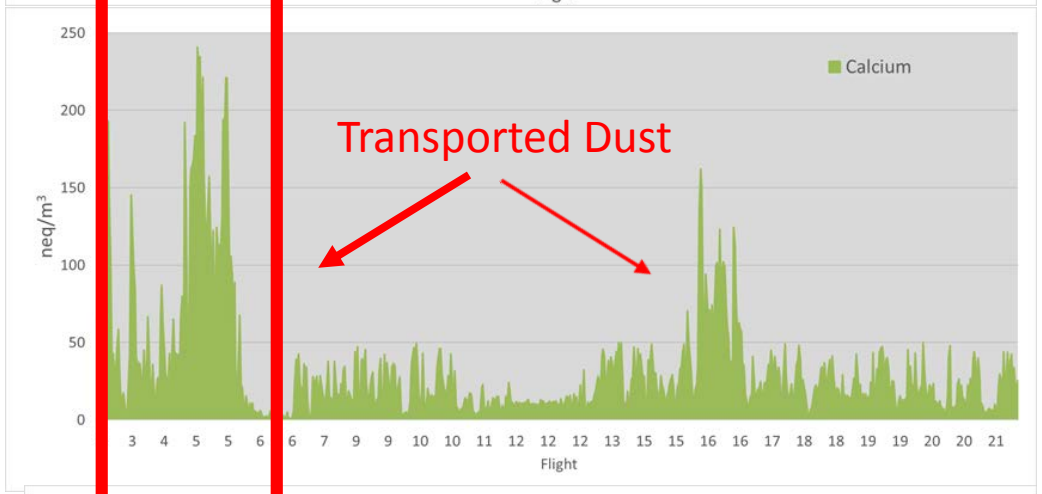
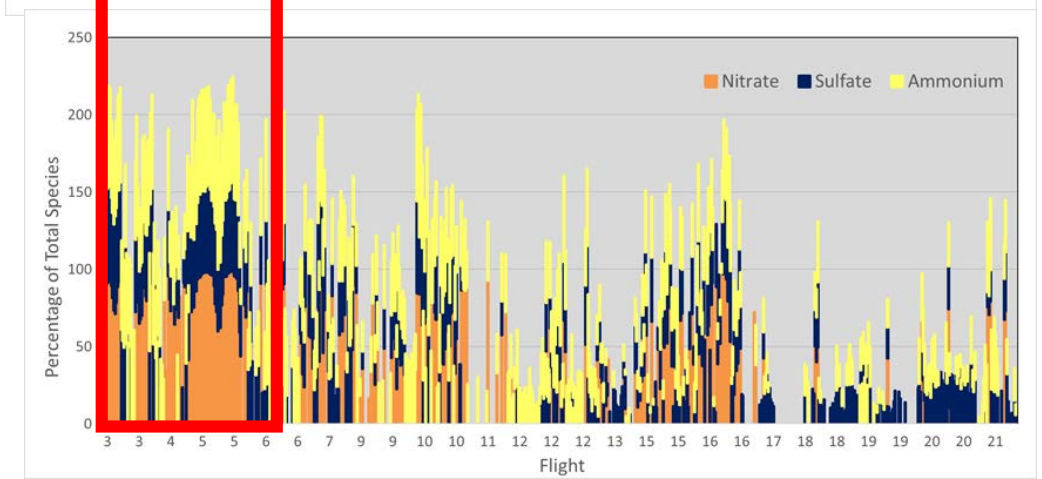
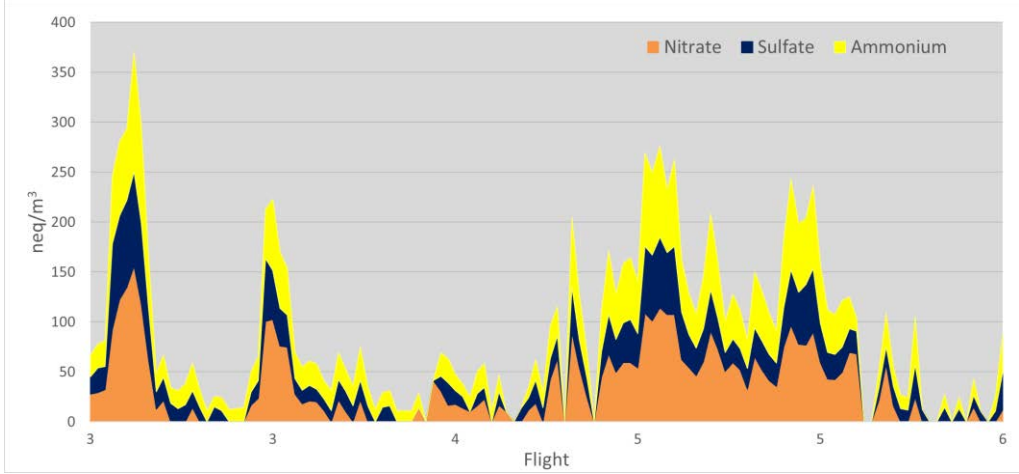


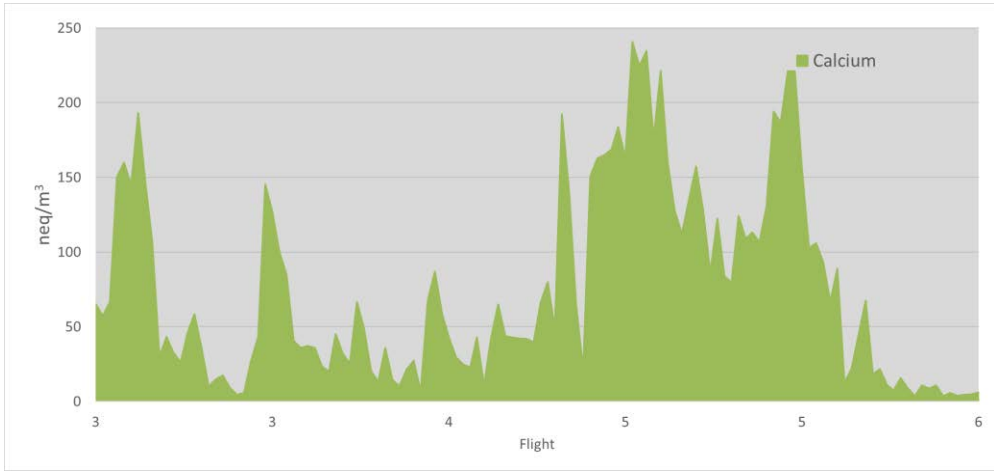
Figure adapted from (Sun, Zhang, & Liu, 2001)

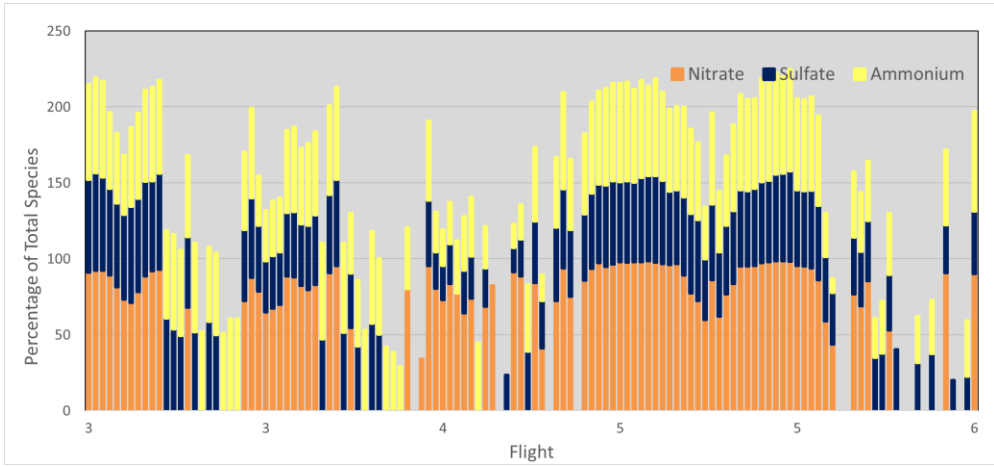

Nitrate
Sulfate
Ammonium
neq/m³
Flight

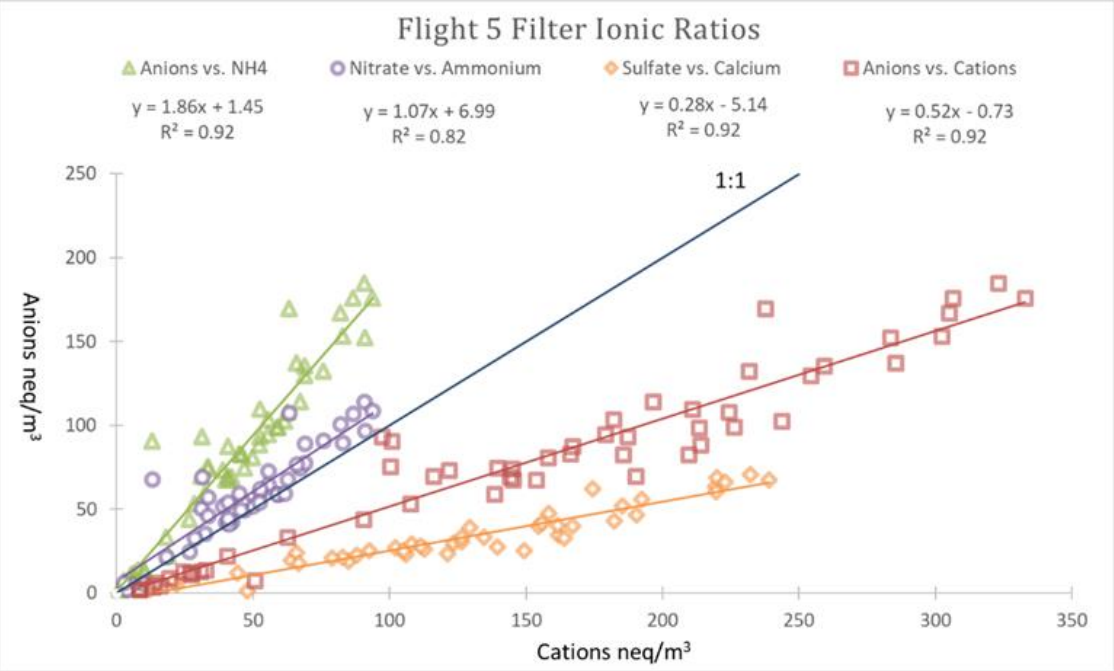

Calcium
Transported Dust
neq/m³
Flight


Nitrate
Sulfate
Ammonium
Percentage of Total Species
Flight


Nitrate
Sulfate
Ammonium
neq/m³
Flight

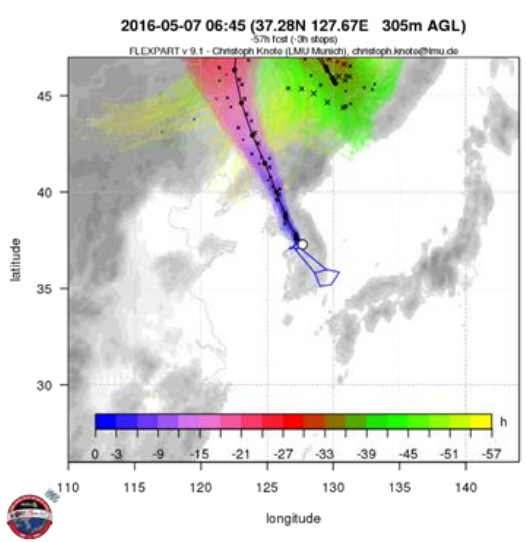

Calcium
neq/m³
Flight

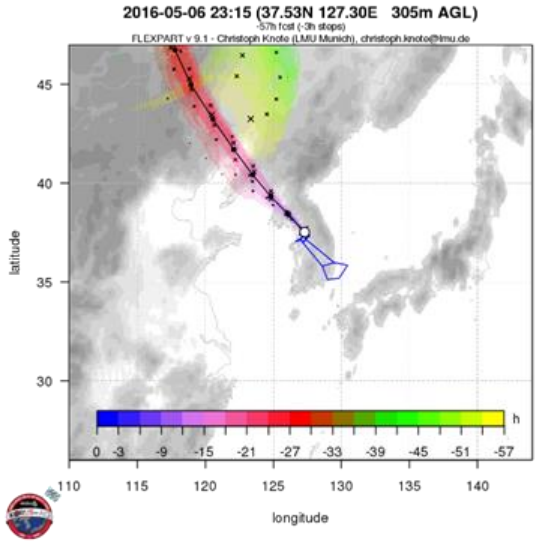

Nitrate
Sulfate
Ammonium
Percentage of Total Species
Flight

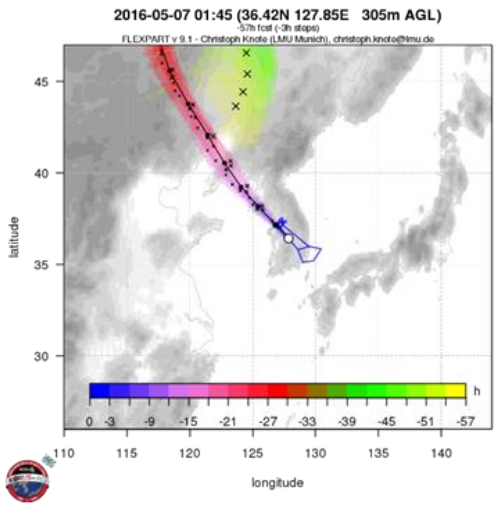


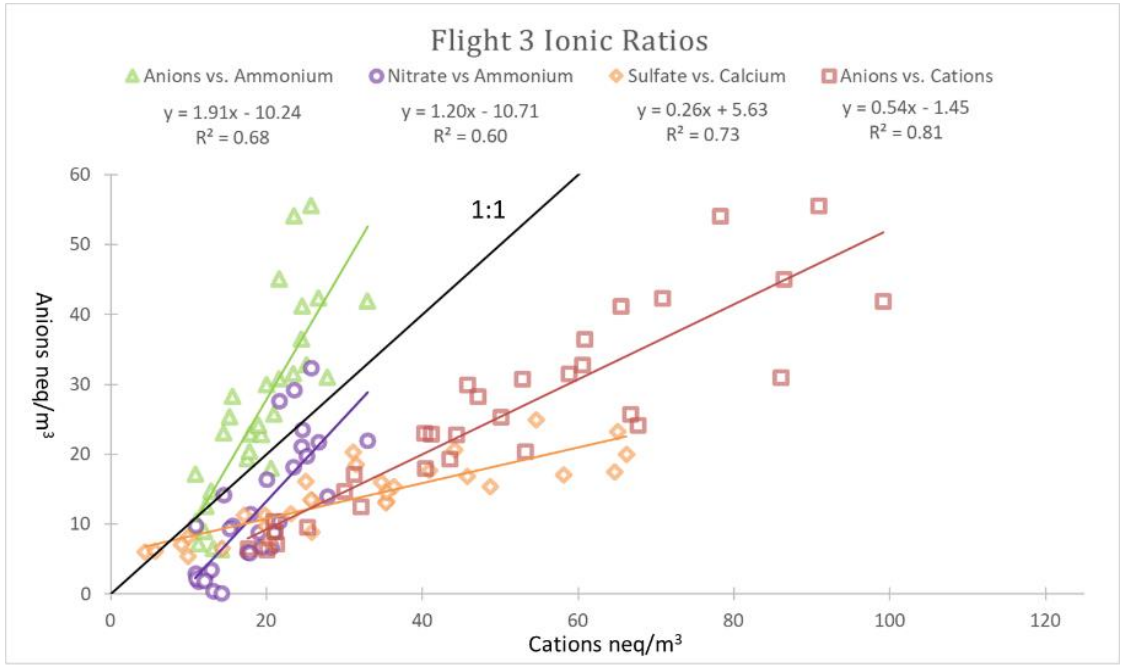
- Flight 5 (May 7th) filters had constant dust influence.
- Backtrajectories suggest transport from dust source regions
- Supermicron species had strong correlations throughout flight 5.
- Supermicron ammonium balances more than half the anions.

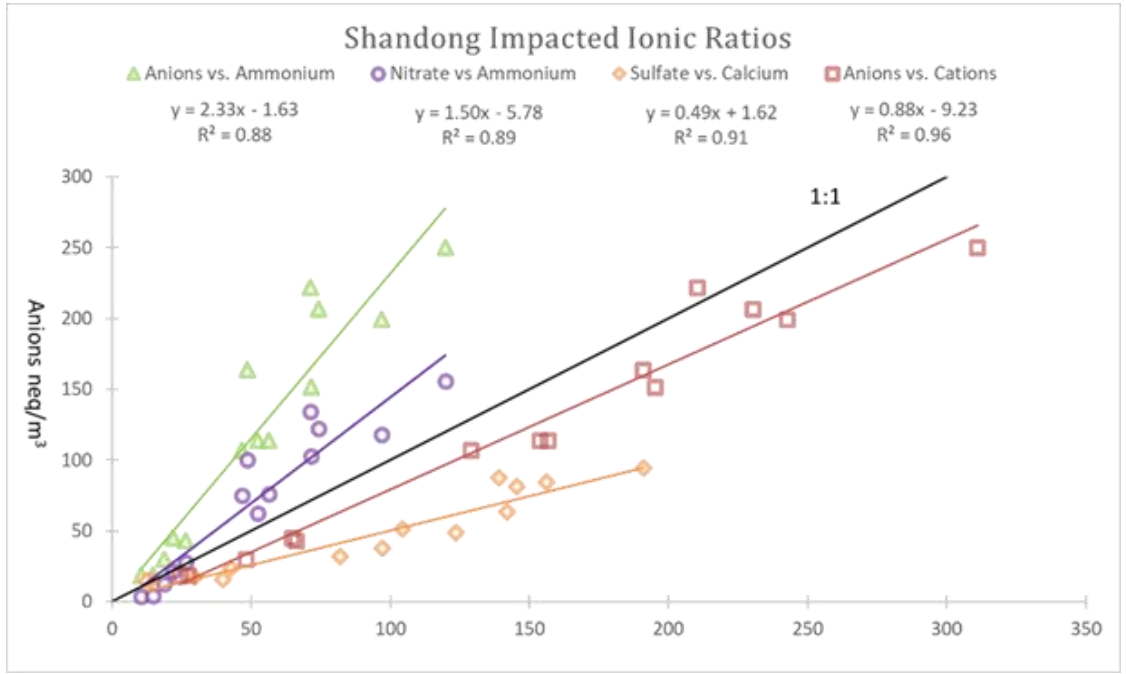
$$Dust\ Saturation\ Ratio = \frac{Supermicron\ Sulfate + Supermicron\ Nitrate}{NSS\ Calcium + Supermicron\ Ammonium}$$

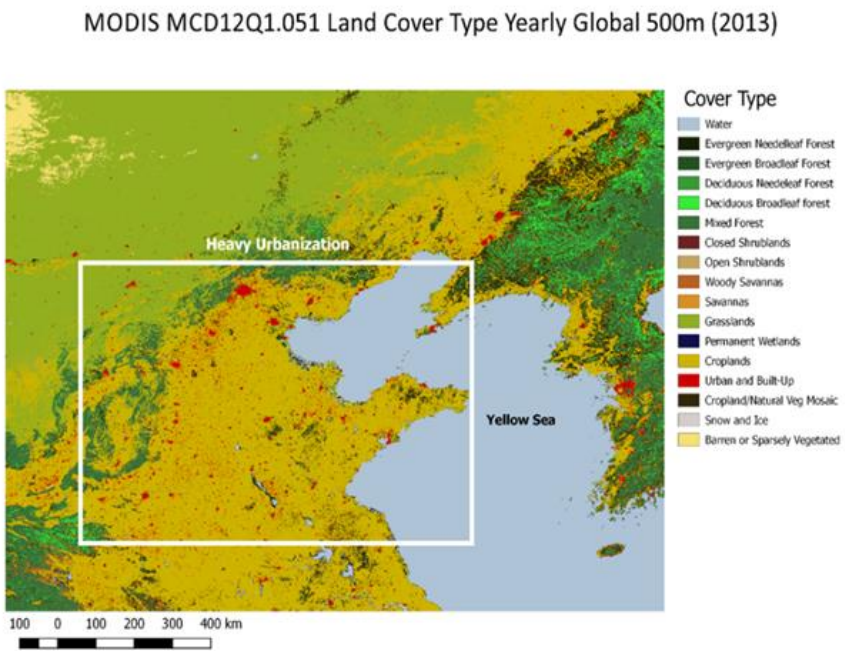


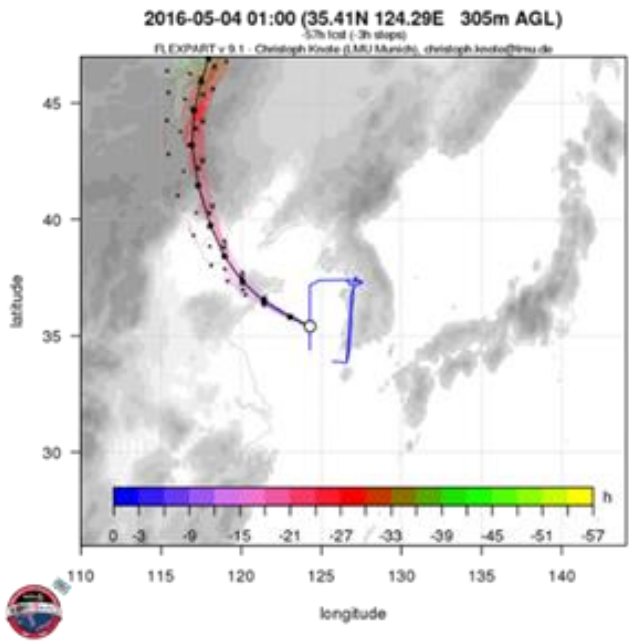


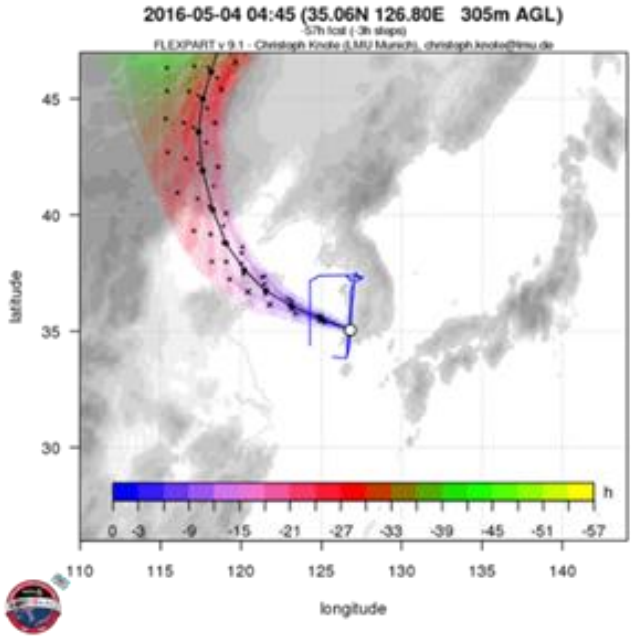


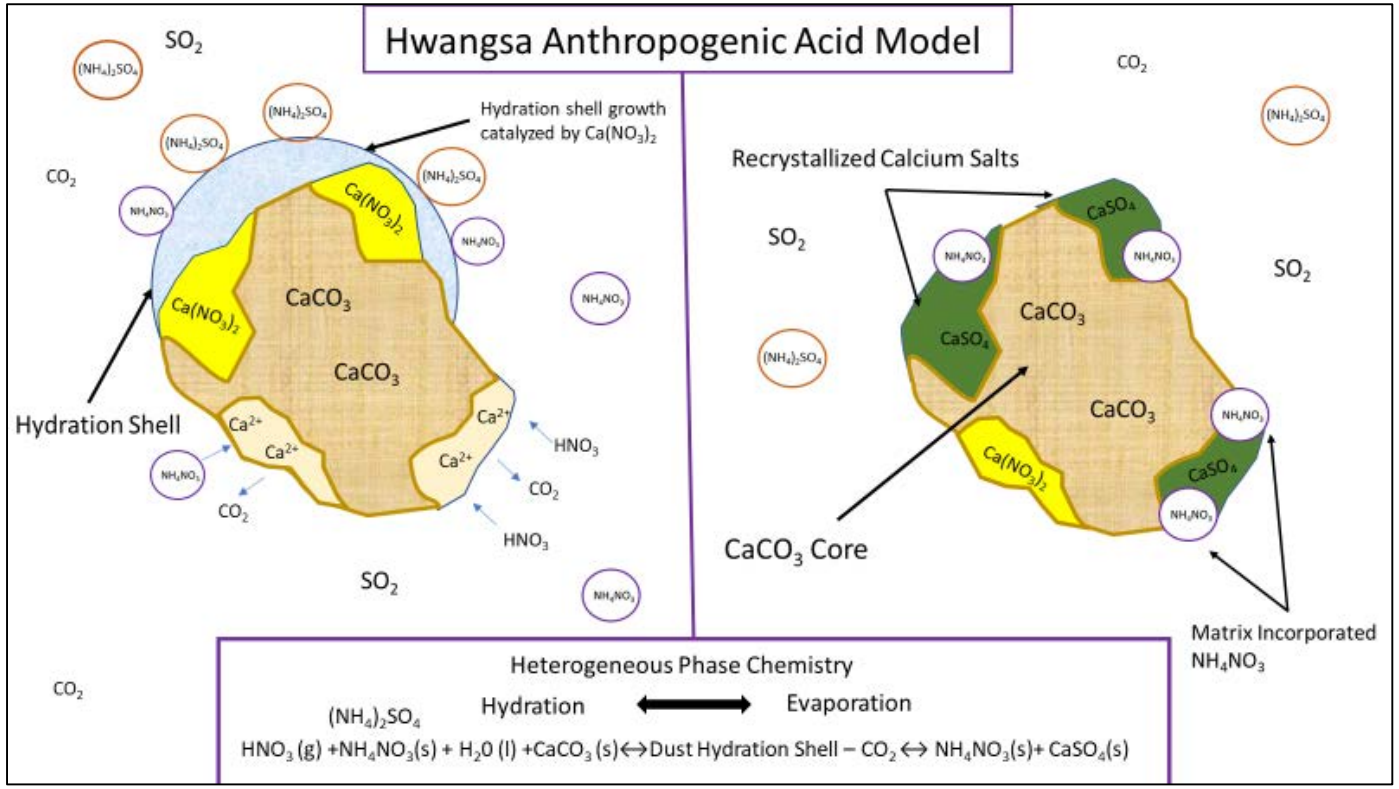

Flight 3 Ionic Ratios
Anions vs. Ammonium
Nitrate vs Ammonium
Sulfate vs. Calcium
Anions vs. Cations
y = 1.91x - 10.24
R² = 0.68
y = 1.20x - 10.71
R² = 0.60
y = 0.26x + 5.63
R² = 0.73
y = 0.54x - 1.45
R² = 0.81
1:1
Anions neq/m³
Cations neq/m³

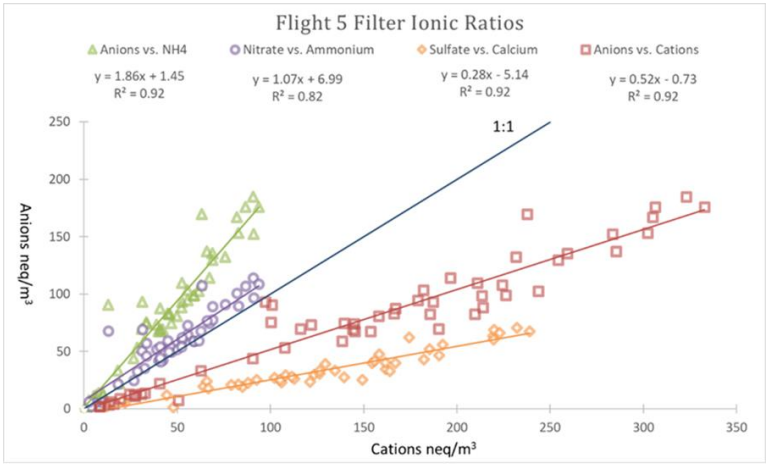

Shandong Impacted Ionic Ratios
Anions vs. Ammonium
Nitrate vs Ammonium
Sulfate vs. Calcium
Anions vs. Cations
y = 2.33x - 1.63
R² = 0.88
y = 1.50x - 5.78
R² = 0.89
y = 0.49x + 1.62
R² = 0.91
y = 0.88x - 9.23
R² = 0.96
1:1
Anions neq/m³

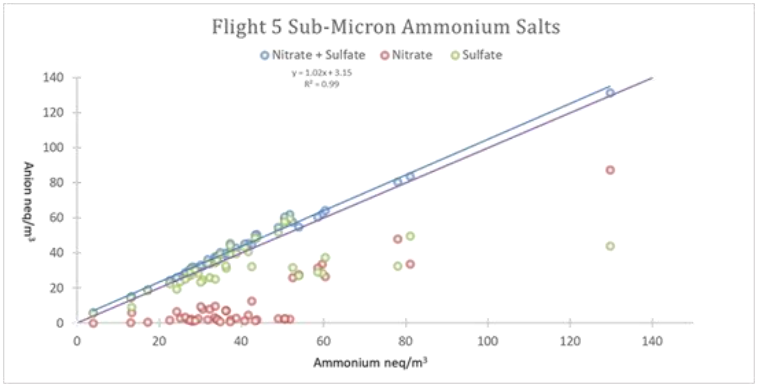

MODIS MCD12Q1.051 Land Cover Type Yearly Global 500m (2013)
Heavy Urbanization
Yellow Sea
Cover Type
Water
Evergreen Needleleaf Forest
Evergreen Broadleaf Forest
Deciduous Needleleaf Forest
Deciduous Broadleaf forest
Mixed Forest
Closed Shrublands
Open Shrublands
Woody Savannas
Savannas
Grasslands
Permanent Wetlands
Croplands
Urban and Built-Up
Cropland/Natural Veg Mosaic
Snow and Ice
Barren or Sparsely Vegetated
100 0 100 200 300 400 km


2016-05-04 01:00 (35.41N 124.29E 305m AGL)
latitude
longitude
h


2016-05-04 04:45 (35.06N 126.80E 305m AGL)
latitude
longitude
h







Key Points:

- Supermicron sulfate, nitrate, and ammonium represent significant portions of total aerosol loading during the transport period.
- Supermicron sulfate is present as recrystallized CaSO4.
- Ammonium nitrate is internally mixed in the recrystallized $CaSO_4$.
- Dust saturation indicates pollution levels dust has interacted with.

Future work

- Can DIAL curtains or Aeronet give an optical correlation with variance in dust saturation ratios/microphysical properties?

  -Depolarization (rounded vs. irregular)

- Can we see particle size evolution (DC-8 LARGE) via dust hydroscopic growth relative to pollution saturation?

Any suggestions?

Matching DIAL-HSRL data to those made in situ on the aircraft

KORUS-AQ

John Hair

Marta Fenn

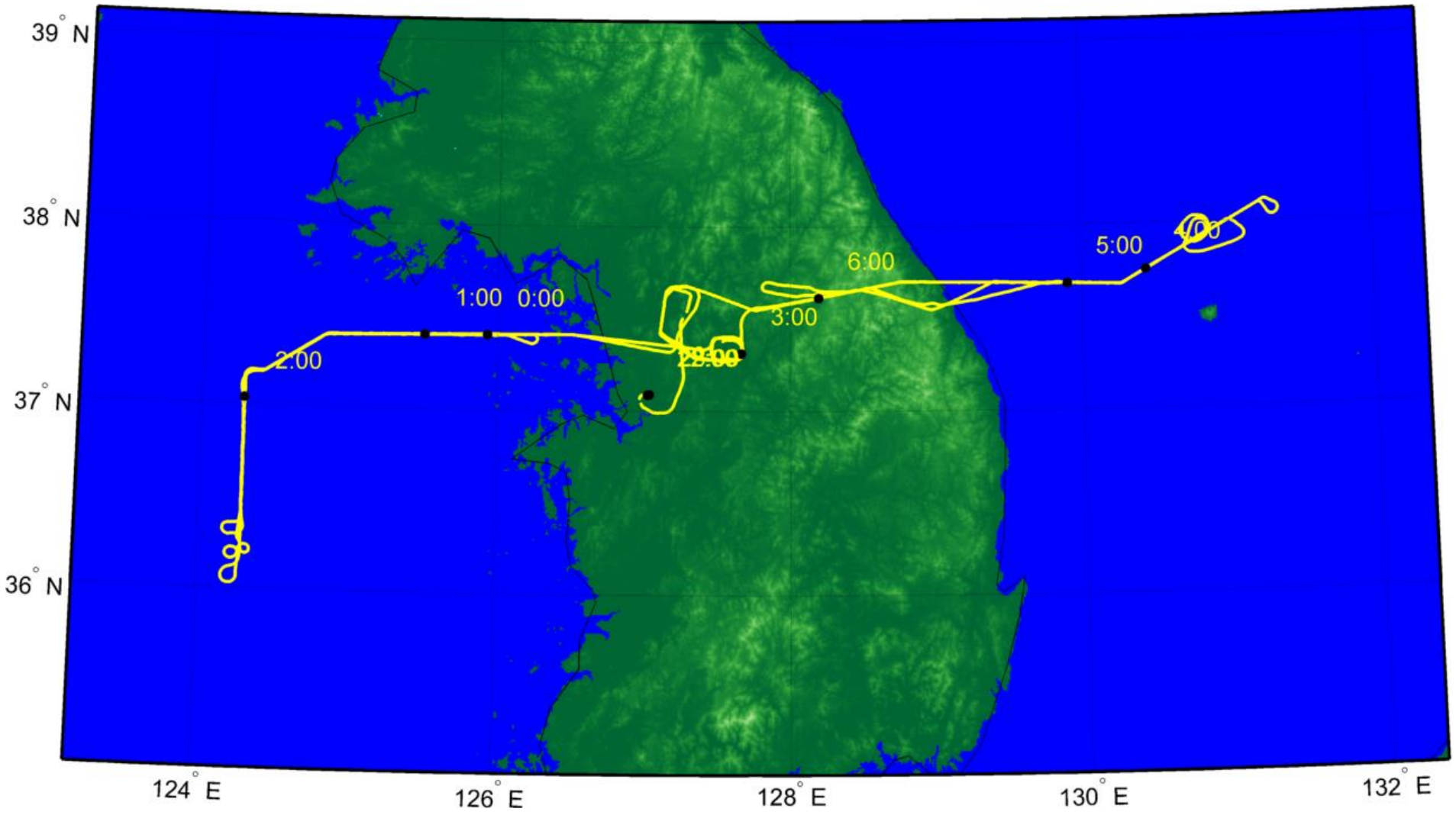
METHODOLOGY

For each KORUS-AQ non-transit flights, utilize the 10 second merge data file (korusaq-mrg10-dc8-merge-2016*mmdd*_R3.ict)
And the corresponding HSRL/DIAL data file (korusaq-DIAL_DC8_2016*mmdd*_R1.h5)

1) Match aircraft location information from the 10 second merge data set .
2) Find all the records in the HSRL data set that match each merged data point within specified limits:
   Time **separation** (e.g. 2 hours), horizontal range separation (e.g. 10 km), vertical range separation within 15 m, and roll angle within 4 degrees.
3) Within a set of contiguous matching HSRL records, always choose the one that is closest in range.
4) Accumulate up to ten HSRL matches for each merged record and append them to the merged data file itself, calling it an "extended_merge" data file. Record the time difference and range difference for each match.
5) For each match, add the HSRL measurement parameter of interest to the extended_merge data file. (e.g., 532nm data products from HSRL are added to the extended_merge_data file).
6) For a check on the processing, we calculate correlation between any merged in situ data field and an HSRL data field. (e.g., 532nm extinction from HSRL will be compared to LARGE 532nm ambient extinction in this presentation. In this case, the HSRL horizontal resolution is 60 seconds, to the LARGE data is smoothed to match.)

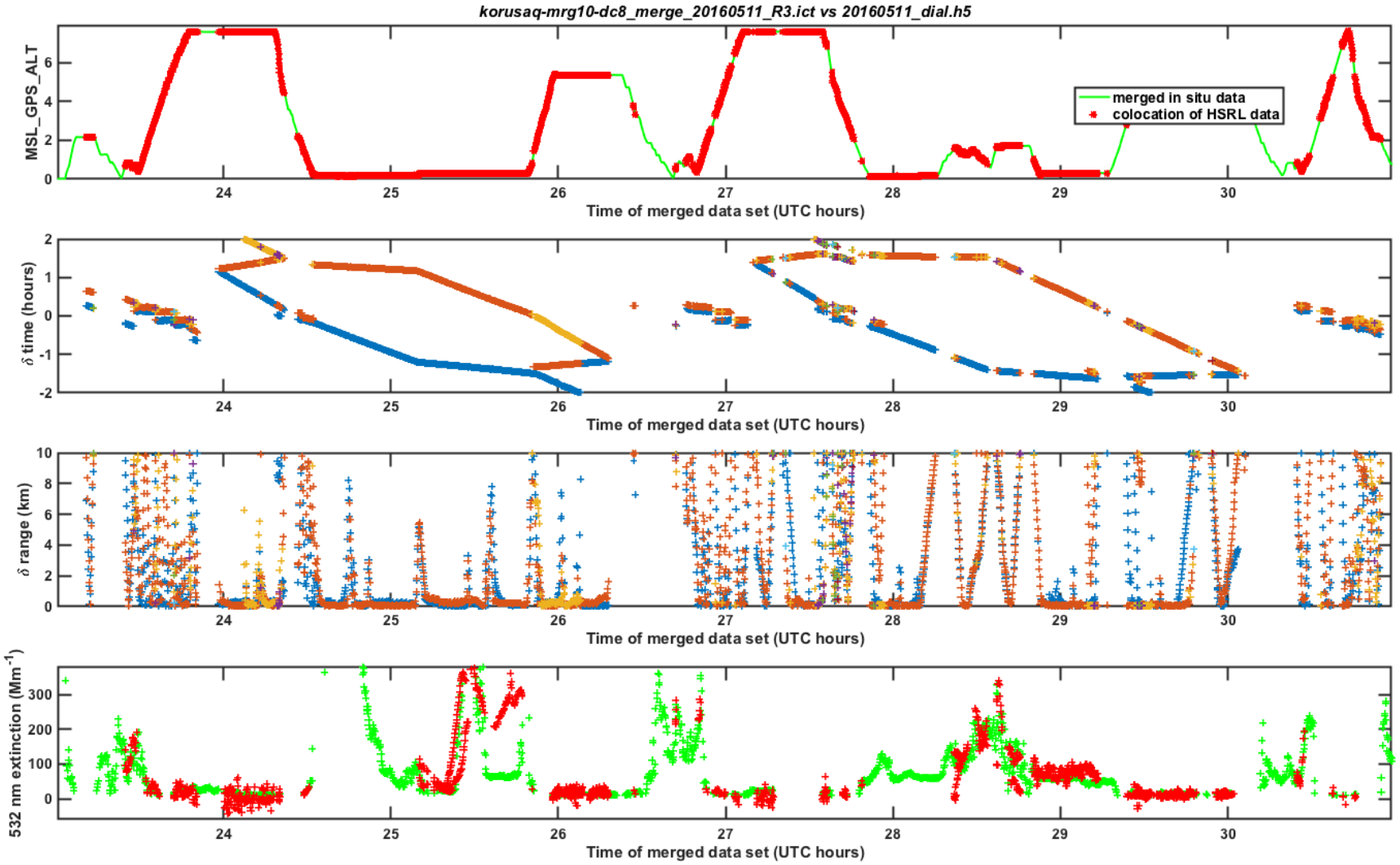
Bottom line – we co-locate the lidar measurements to the aircraft location using the best spatial and temporal location

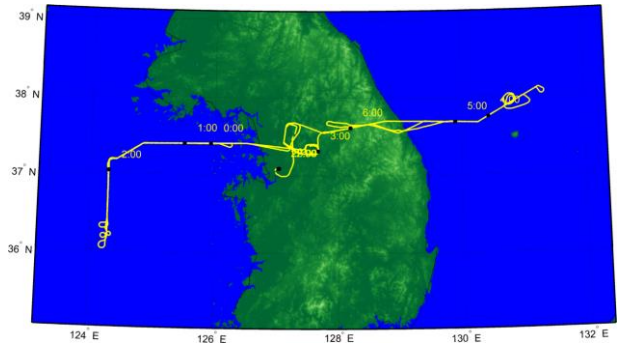
Example: May 11, 2016



Case study: May 11, 2016

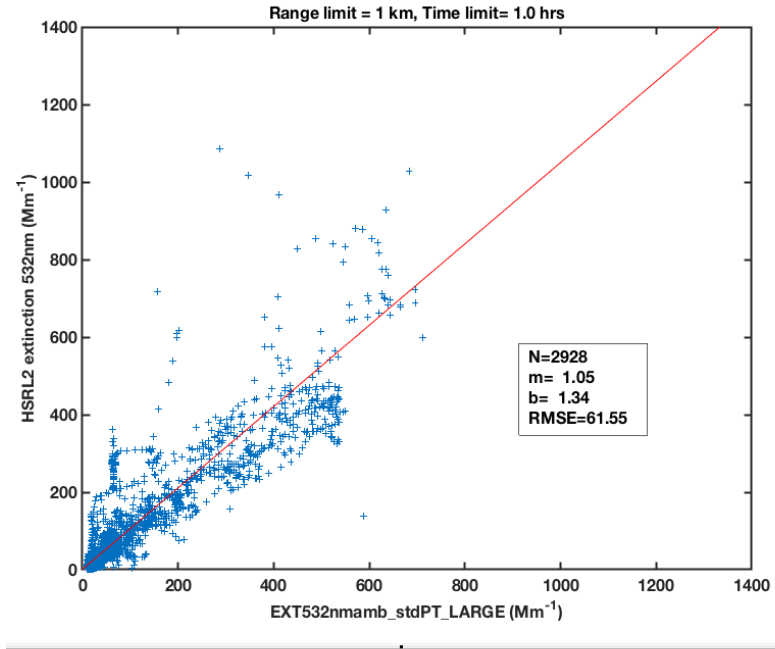
Coincident points over the full flight. (Focus portion on next slide)

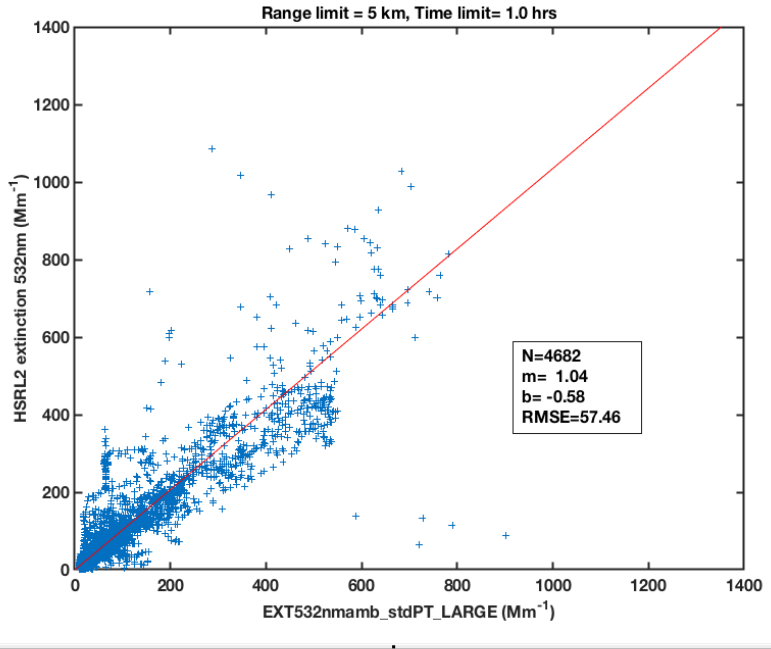


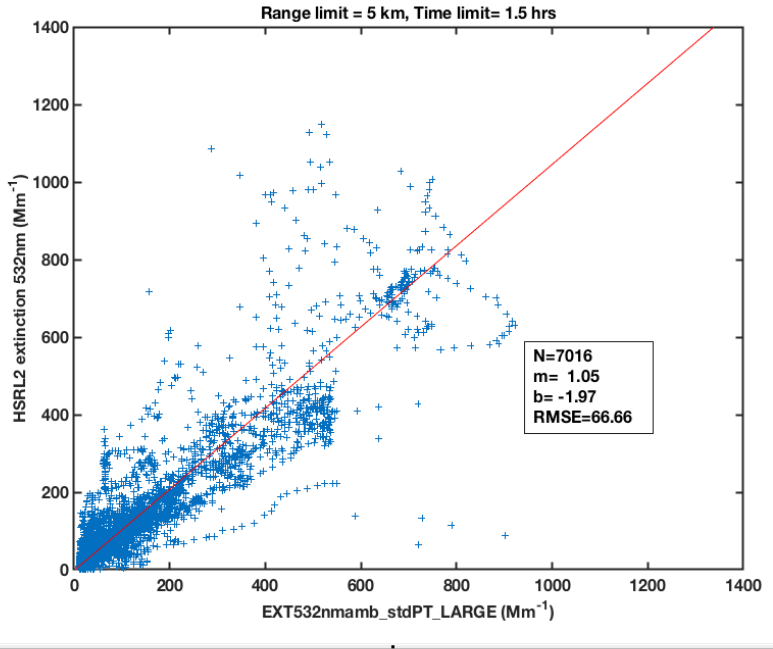


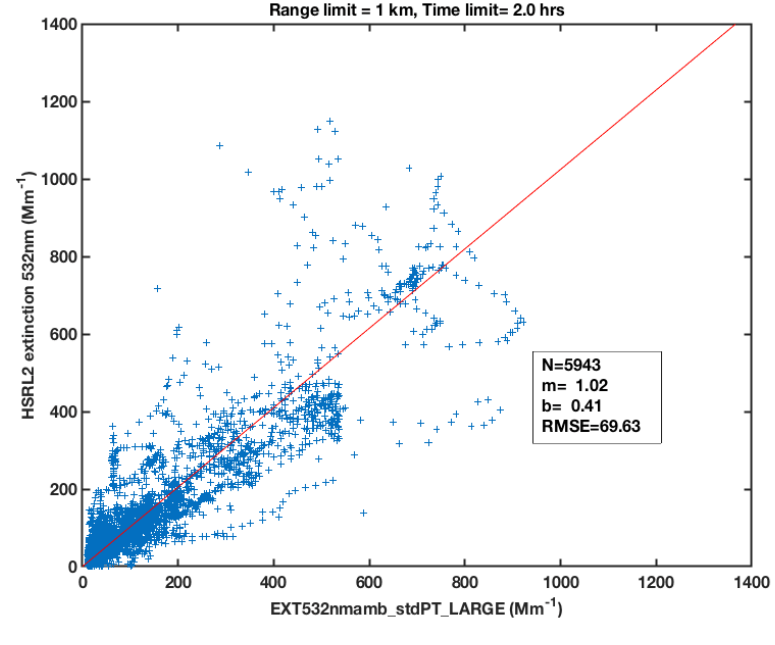
Co-locating in situ measurements with remote measurements within 10 km range and 2 hours

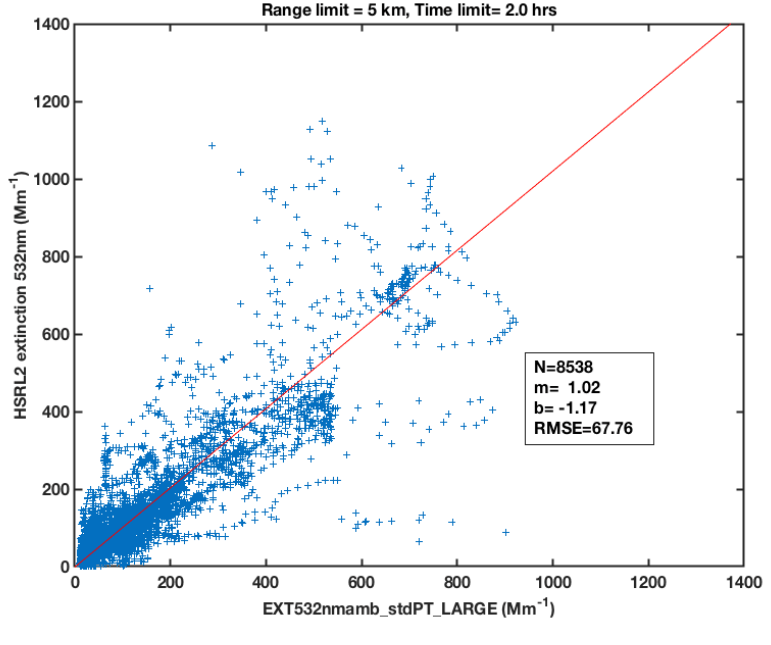
Correlations between LARGE in situ measurements and HSRL remote measurements, varying time and range limits

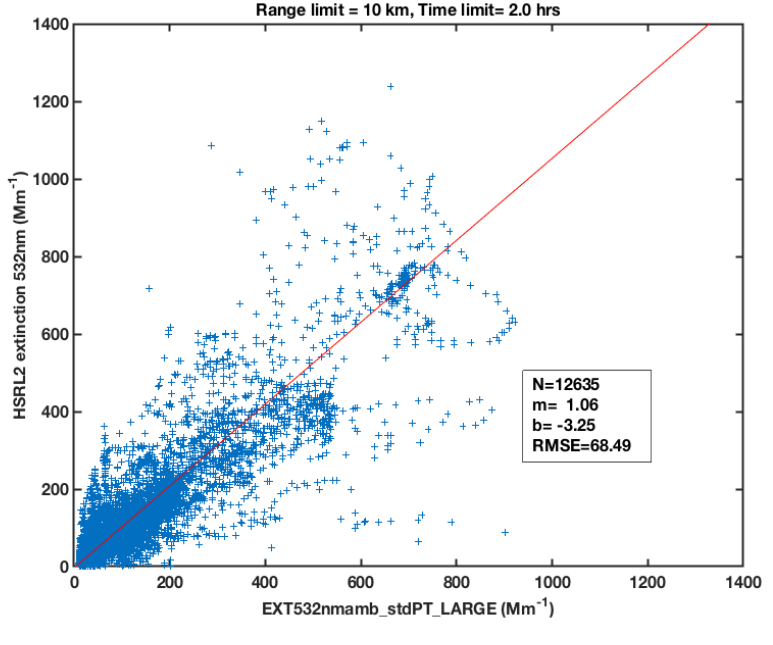












Summary

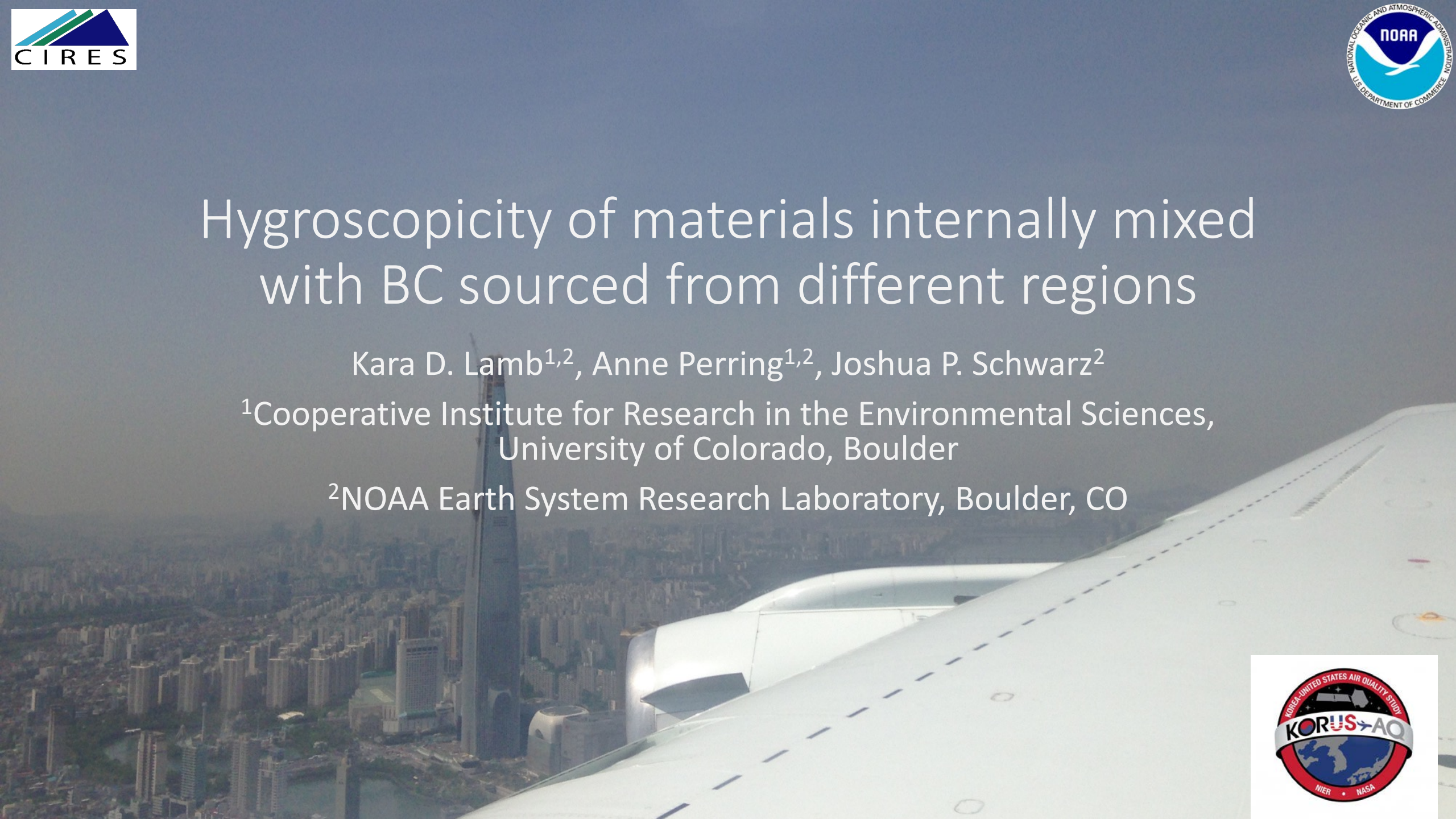
1. We can provide co-located data for the lidar measurements during KORUS. Please contact us if there is an interest (marta.a.fenn@nasa.gov)
2. We can provide these in a format similar to the 10sec Merge dataset and include the various aerosol and ozone data products from DIAL-HSRL.
3. The data can be further limited based on the particular application – for example tighter tolerances on the spatial overlap and time can be done from the merge dataset.
4. Examples that might be useful to the KORUS community
    A. The depolarization data might be useful in identify when dust was present.
    B. Might enable to look at some evolution of the boundary layer. We have provided estimates of the Mixed Layer Height similar to DISCOVER-AQ

Hygroscopicity of materials internally mixed with BC sourced from different regions

Kara D. Lamb[1,2], Anne Perring[1,2], Joshua P. Schwarz[2]

[1]Cooperative Institute for Research in the Environmental Sciences, University of Colorado, Boulder

[2]NOAA Earth System Research Laboratory, Boulder, CO



HD-SP2 measurements of black carbon on the NASA DC-8

Humidified dual single particle soot photometer

Two Single particle soot photometers (SP2s) run in parallel, one with a humidification system *[Schwarz et al. 2015, Perring et al. 2017, Oshima et al. 2015]*

Optical sizes of dry vs. humidified aerosol populations used to determine hygroscopicity of materials internally mixed with BC

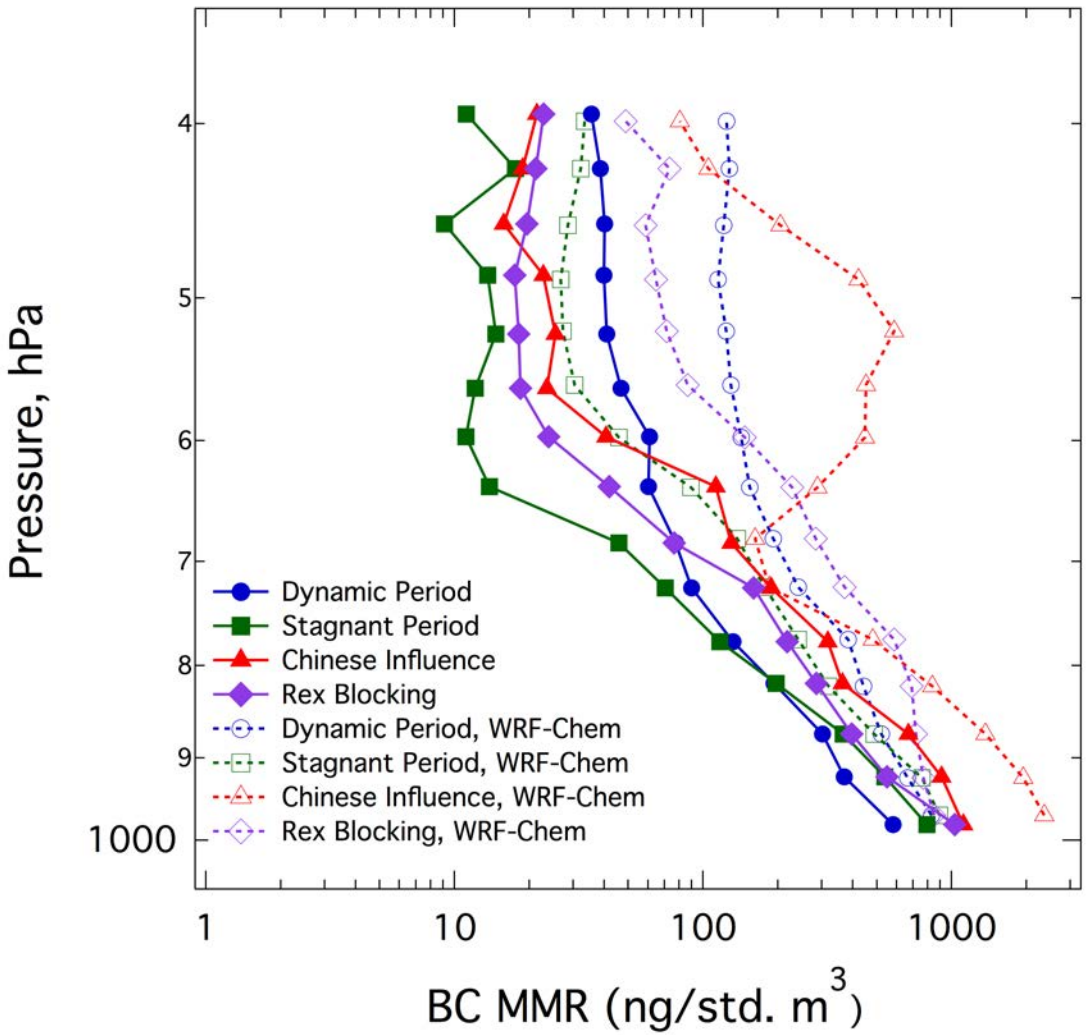
1 second data:

- BC mass loadings
- Avg. coating thickness (4-6 fg BC cores)
- Avg. coating state (relative number of coated to uncoated particles)

1 minute data:

- BC size distribution (100-550 nm)
- BC f(RH) – ratio of humid to dry scattering at RH=80% for BC containing aerosol population

BC loadings observed in S. Korea vary with meteorology



HD-SP2 observations compared with WRF-Chem forecast modeling

- overestimates BC loadings at higher altitudes, particularly for measurement period strongly influenced by Chinese transport
- wet removal not well-represented ?

Wet removal may mediate impacts of transport on BC loadings in S. Korea

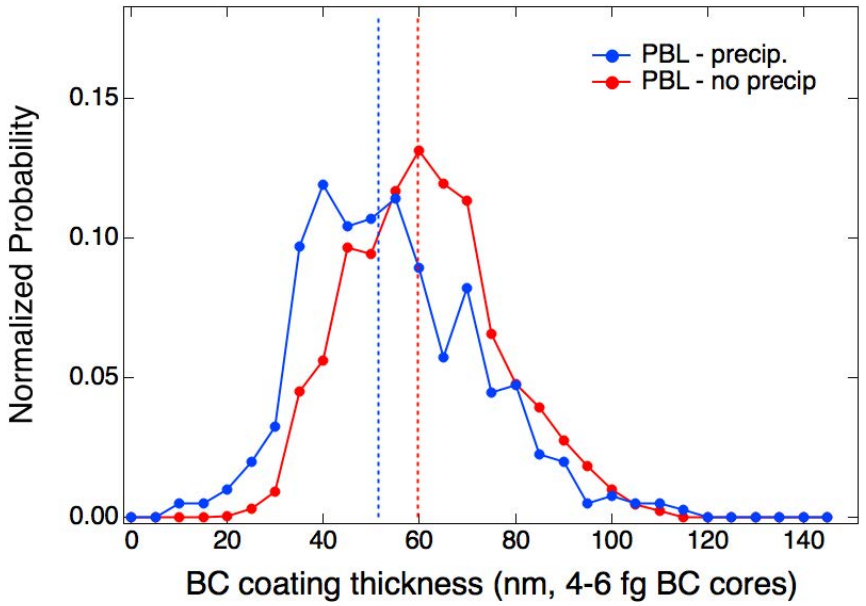
- Wet removal is likely most important removal mechanism for BC [*Miyakawa et al. 2017*]
- Bare BC is typically hydrophobic
- Initial hygroscopicity of BC containing particles impacted by source, co-emitted species
- BC aging also influences how hygroscopic it is – which can determines its CCN activity [*McMeeking et al. 2011*]

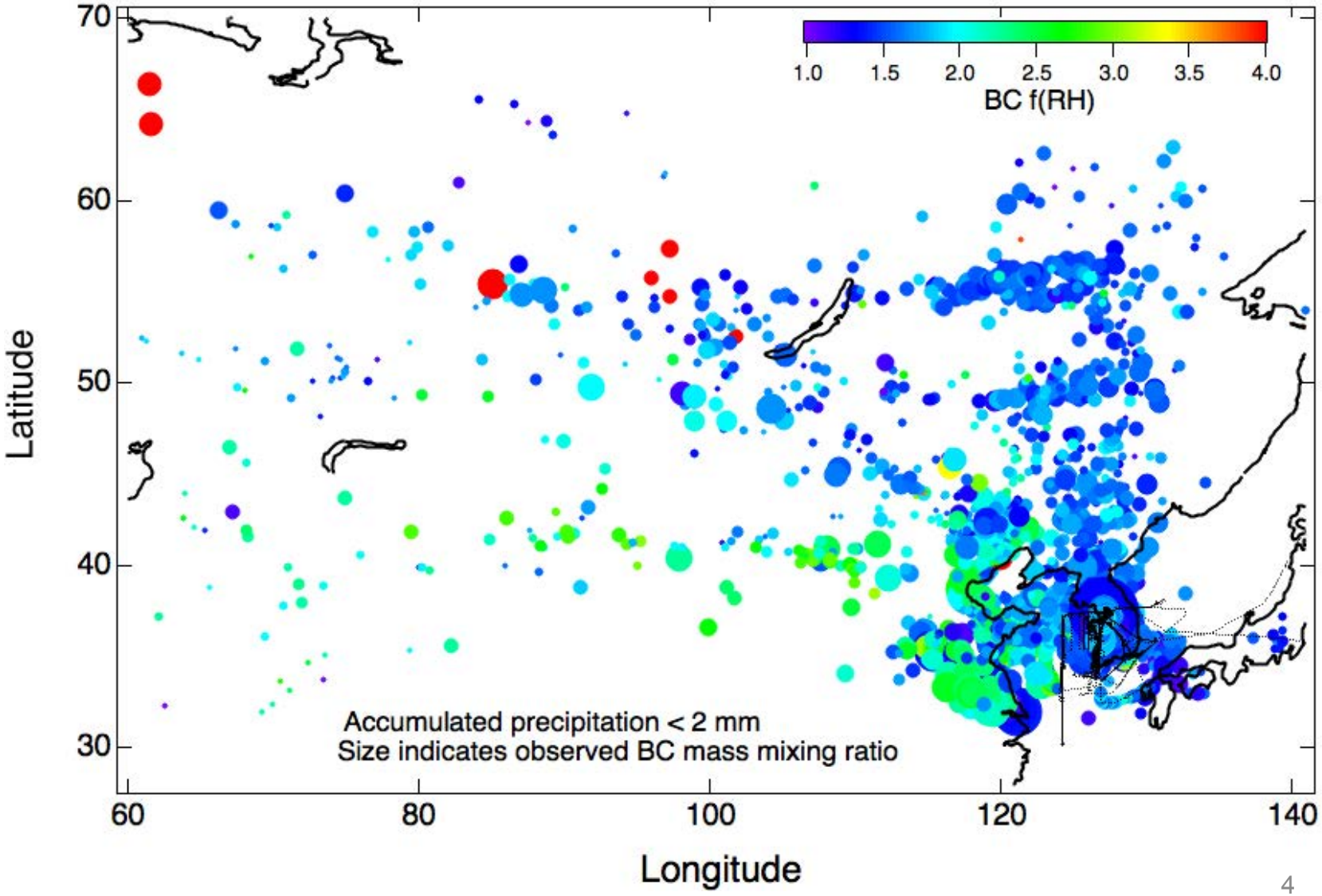
BC f(RH) strongly dependent on source region

Hysplit back trajectories, 1 min. flight path (GDASOP5 meteorological data, 0.5 degree resolution, 55 vertical layers)

- Last time in PBL = source region
- Accumulated precipitation along the back trajectory, [Matsui et al. 2011; Oshima et al 2012]

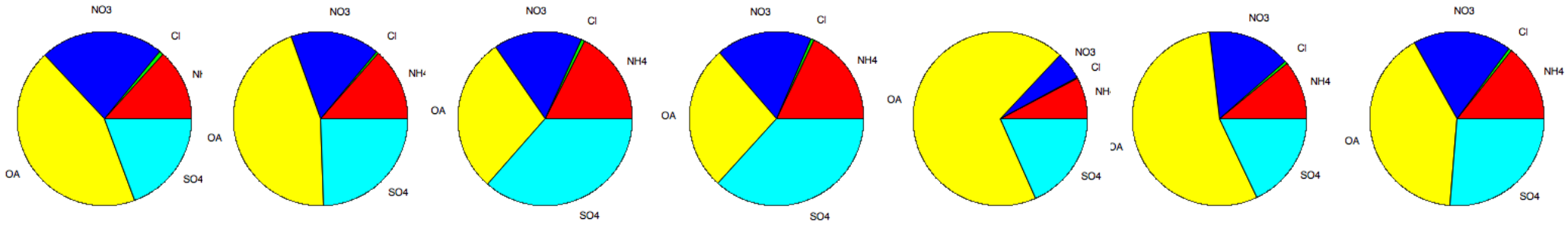
Precipitation removes thickly coated BC

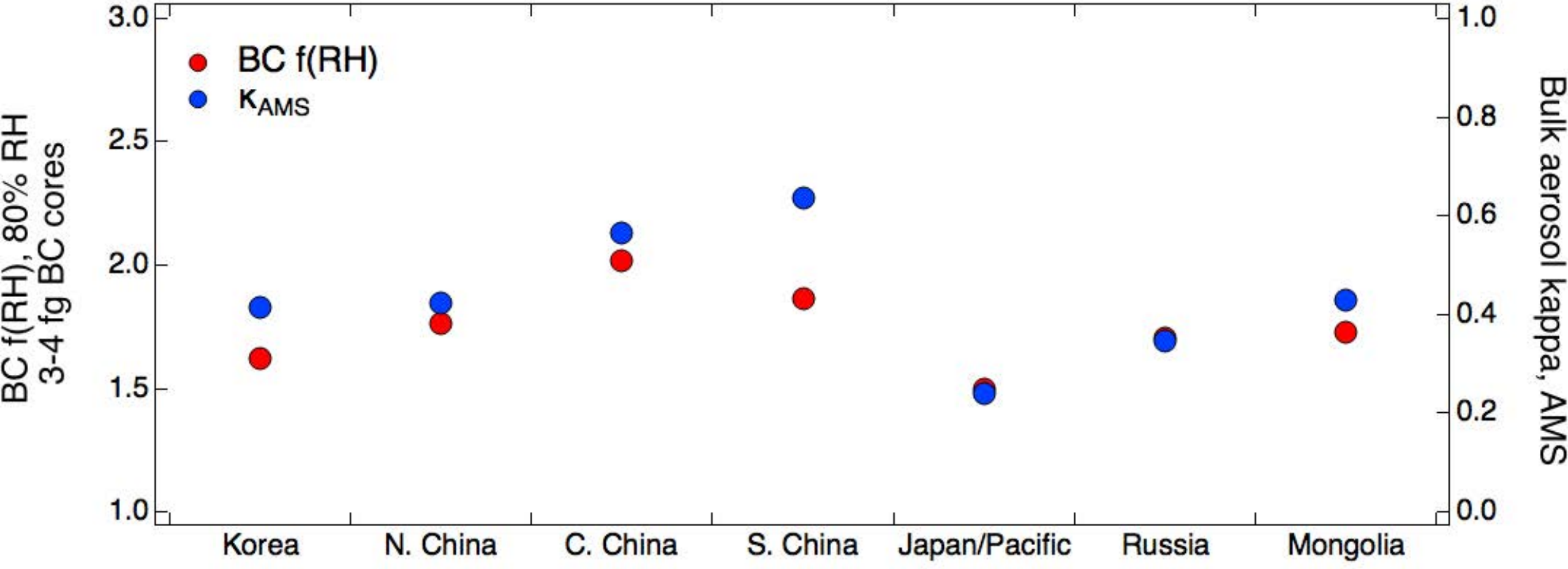




Aerosol composition varies by source region

OA, **κ**=0.01
NO_3, **κ**=0.53
Cl, **κ**=0.7
NH_4, **κ**=0.7
SO_4, **κ**=0.57





Connecting BC microphysics to absorption

Internal mixing and BC hygroscopicity could impact BC radiative absorption through lensing *[Jacobson 2001]*

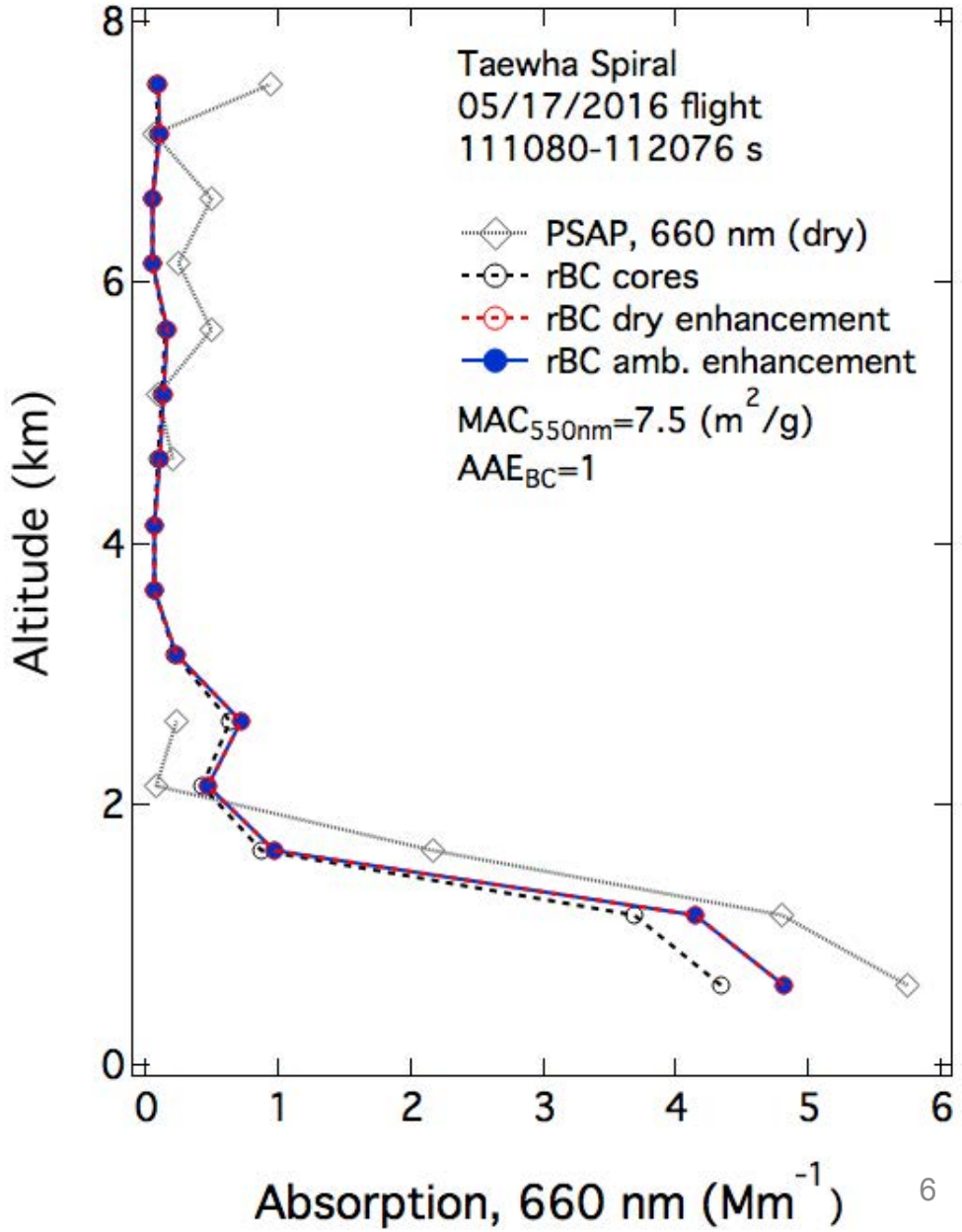
DC-8 measurements during spiral over Taewha Reseach Forest provide vertical sampling of *in situ* aerosol properties & total aerosol absorption from ~300 m to 8000 m

Using measurements from the HD-SP2, Mie theory, and kappa-Köhler theory, estimate impacts of hygroscopicity on absorption enhancement for BC

***See our poster at AGU to learn more!**

A53A-2195 *Black carbon's contribution to aerosol absorption optical depth over S. Korea (Friday 13:40-18:00)*

Thanks to LARGE, Pablo Saide, AMS for data



Secondary Organic Aerosol Production over Seoul during KORUS-AQ

Benjamin Nault

13/14 November 2017

KORUS-AQ Telecon

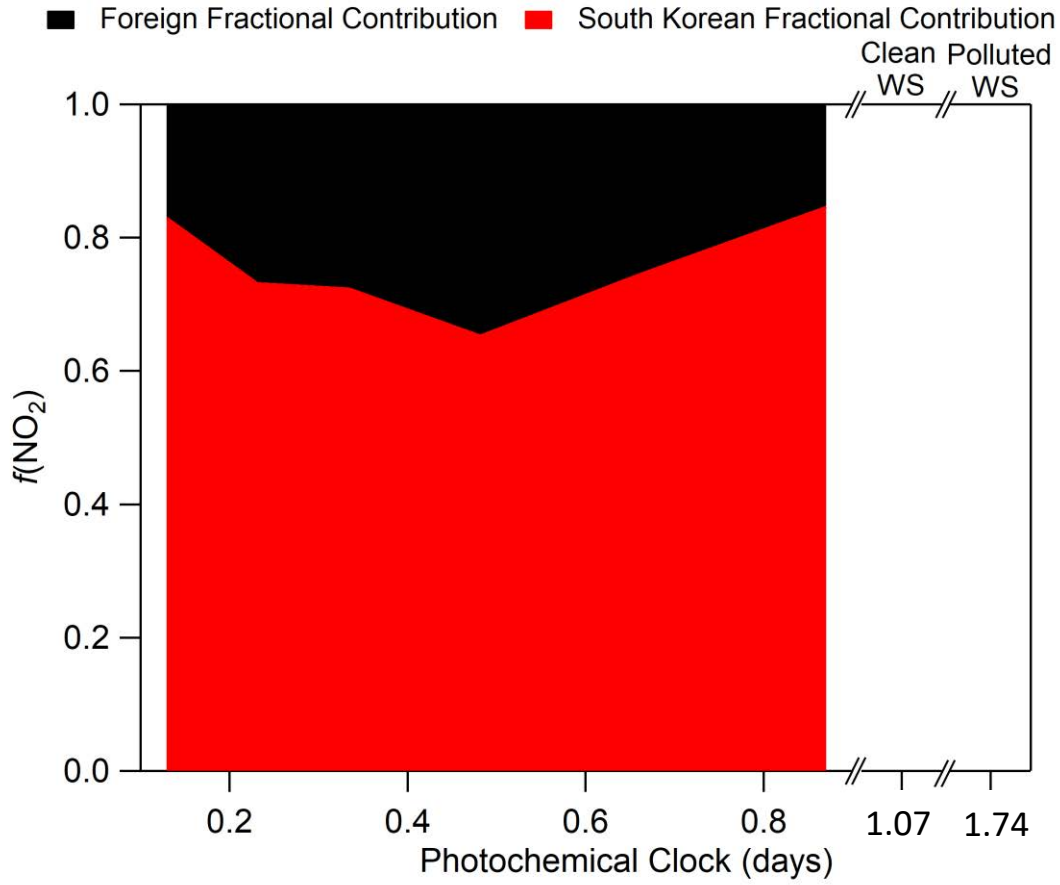
Collaborators/Potential Co-Authors for Paper: P. Campuzano-Jost, D. A. Day, J. C. Schroder, B. Anderson, A. Beyersdorf, D. R. Blake, W. H. Brune, J. D. Crounse, R. C. Cohen, Y. Choi, C. Corr, J. A. de Gouw, J. Dibb, J. P. DiGangi, G. Diskin, F. Flocke, A. Fried, T. F. Hanisco, L. G. Huey, M. J. Kim, C. J. Knote, K. Lamb, J. Liao, T. Lee, D. D. Montzka, T. Park, A. E. Perring, S. E. Pusede, B. Rappenglueck, J. M. Roberts, P. S. Romer, E. Scheuer, J. P. Schwarz, K. L. Thornhill, P. O. Wennberg, A. J. Weinheimer, A. Wisthaler, P. J. Wooldridge, and J. L. Jimenez

Secondary Organic Aerosol (SOA) Production over Seoul during KORUS-AQ

- One of the big questions for KORUS-AQ was “What are the most important factors governing ozone photochemistry and aerosol evolution?”.

- In particular, I’ve been investigating what controls the OA production observed over Seoul during KORUS-AQ, with the following questions:
  - What is the contribution of OA transported into Seoul?
  - What is the contribution of SOA precursors transported into Seoul?
  - What is the contribution of local emissions on the SOA production over Seoul?

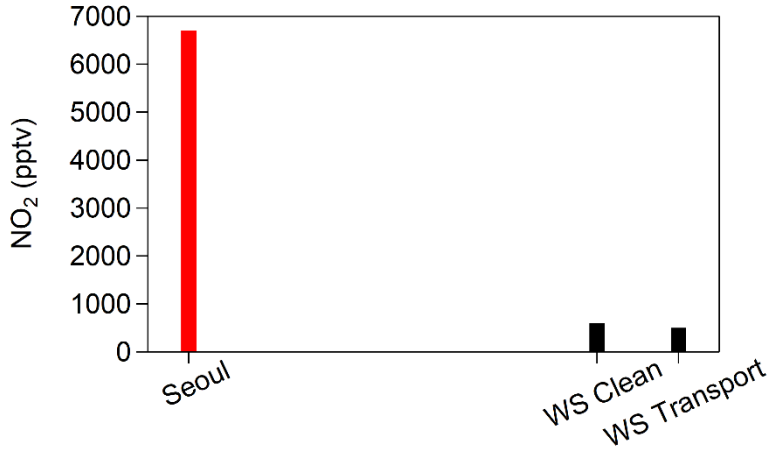
Where are the short-lived compounds that contribute to SOA production coming from?



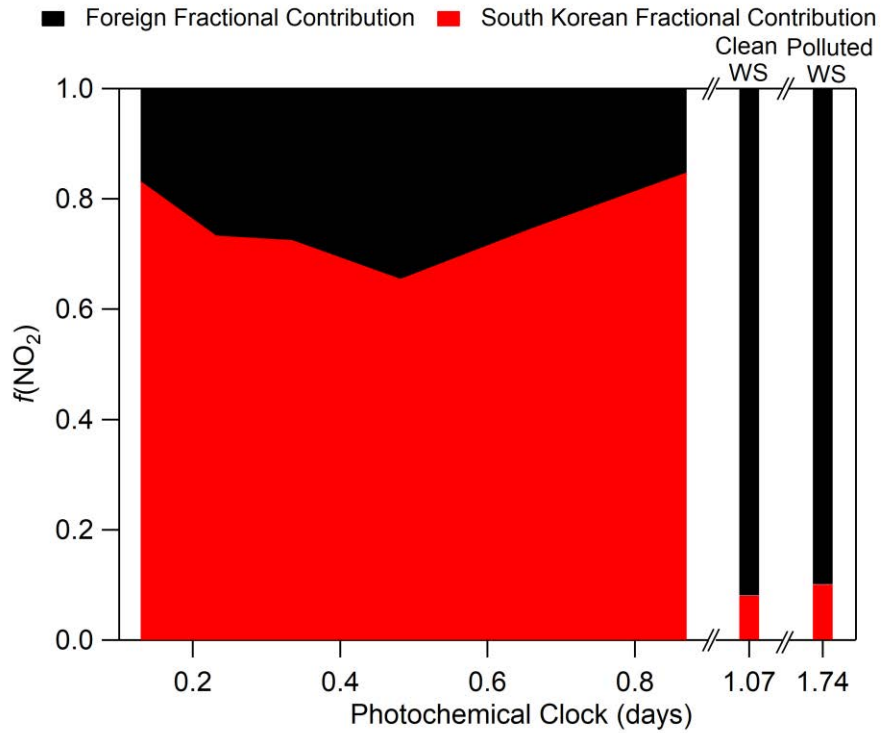
- SOA formation is nearly complete after 1 day (DeCarlo et al., ACP, 2010; Hayes et al., JGR, 2013; Hu et al., JGR, 2016; Schroder et al., in prep.)
- NO_2 has a similar lifetime to both the SOA precursors and SOA production since its photochemical lifetime is on order 1 day
- Using FLEXPART NO_2 source contribution, from Christoph Knote, the observations over Seoul during KORUS-AQ would be expected to be dominated by South Korean emissions and remain constant with photochemical age.
- Thus, emissions in and around Seoul likely dominate the SOA precursors and SOA production.

Where are the short-lived compounds that contribute to SOA production coming from?

Average Measurements

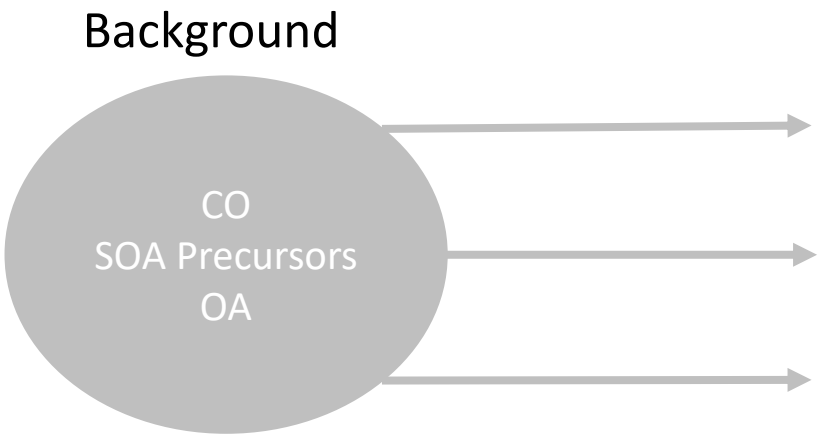


FLEXPART Analysis

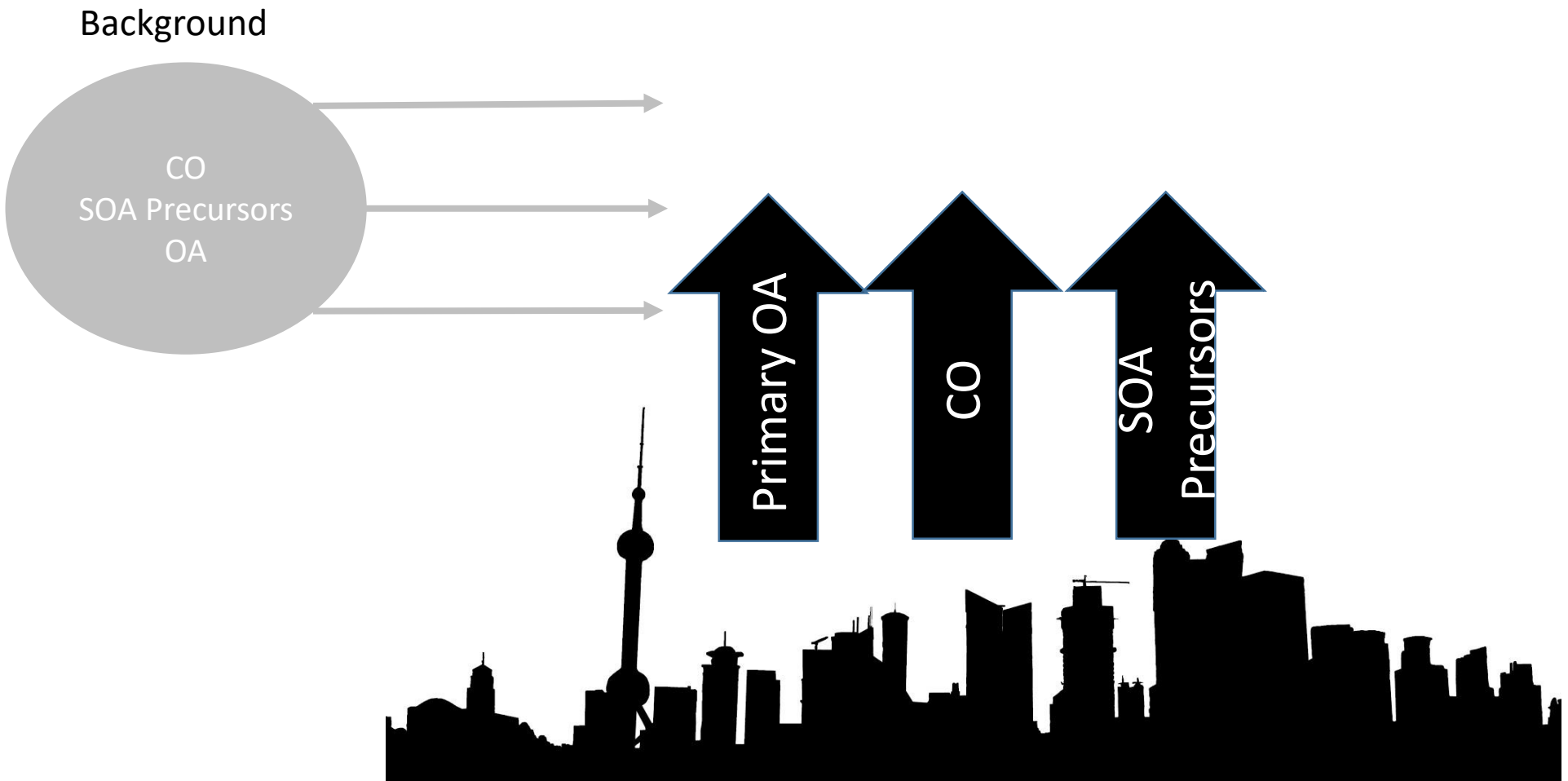


- Source contribution over West Sea indicates that most of the NO_2 comes from foreign sources, for both the Polluted Event (RF12, 25 May 2017), and average of all other West Sea observations during the campaign (Clean WS).
- There is a large **increase** (*decrease*) in **local** (*foreign*) contribution between observations over Seoul compared to over West Sea.
- This further indicates that a large fraction of the SOA precursors come from local emissions.

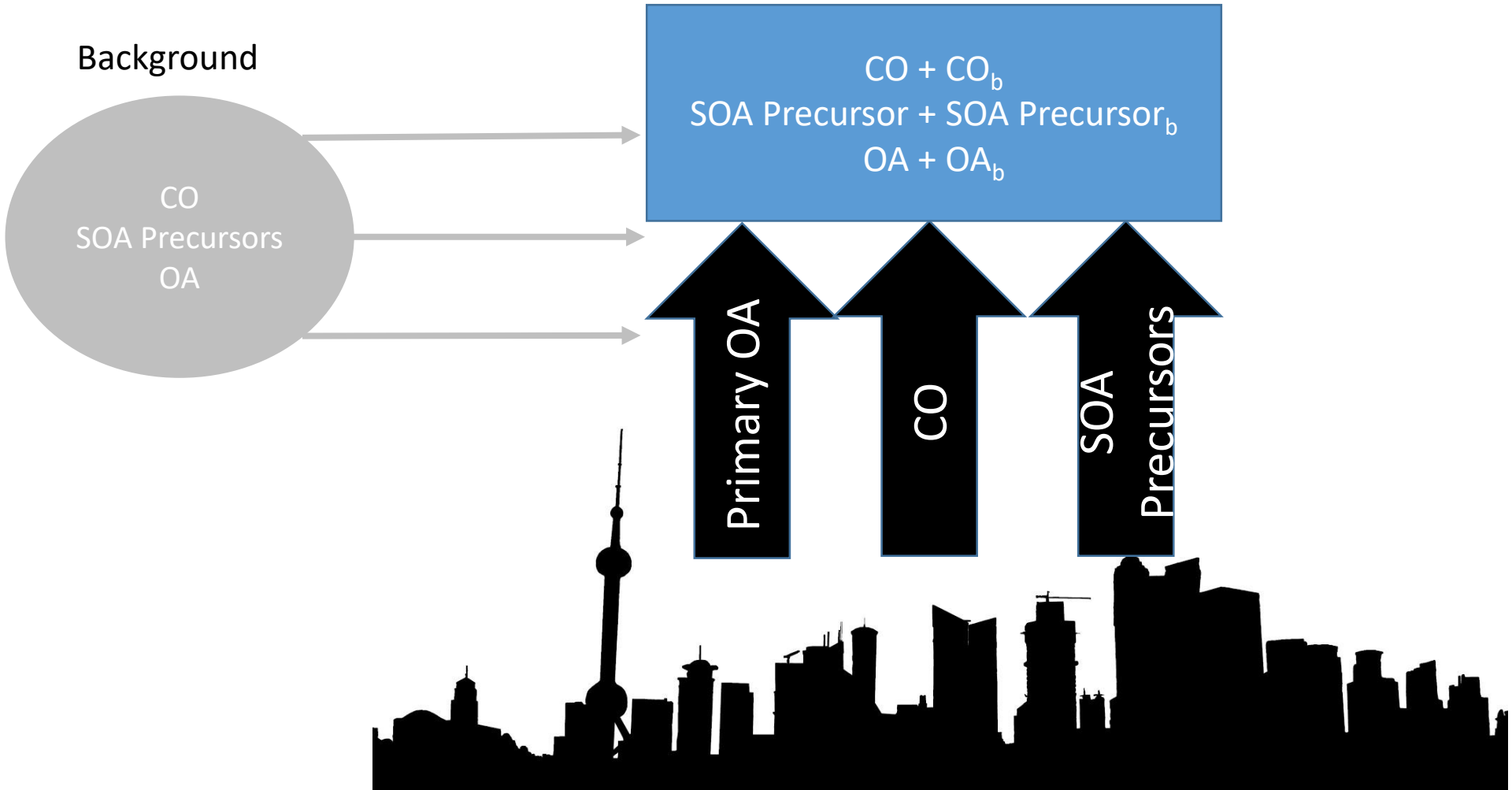
SOA production over an urban area



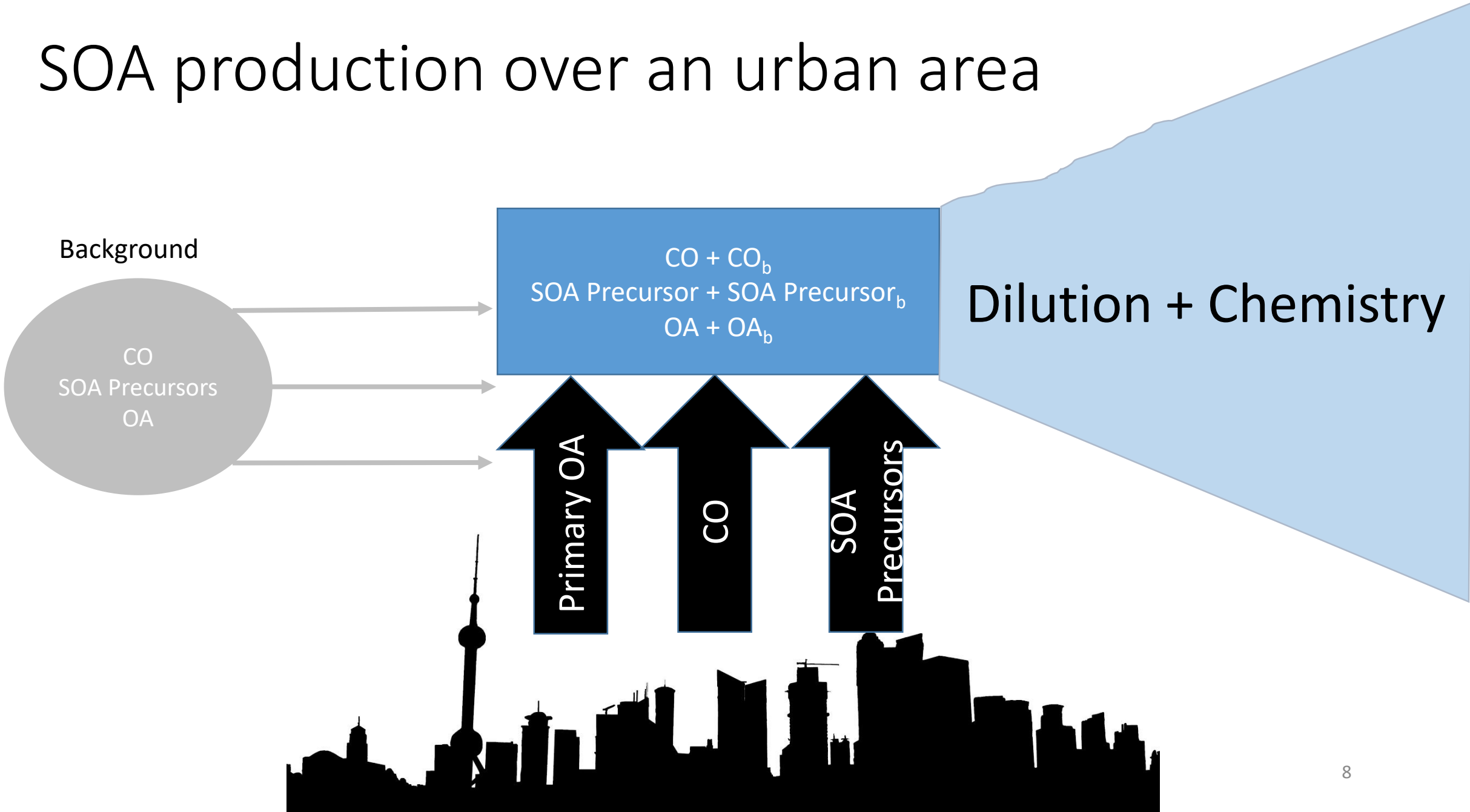
SOA production over an urban area



SOA production over an urban area



SOA production over an urban area



SOA production over an urban area

Background

CO
SOA Precursors
OA

$CO + CO_b$
$SOA\ Precursor + SOA\ Precursor_b$
$OA + OA_b$

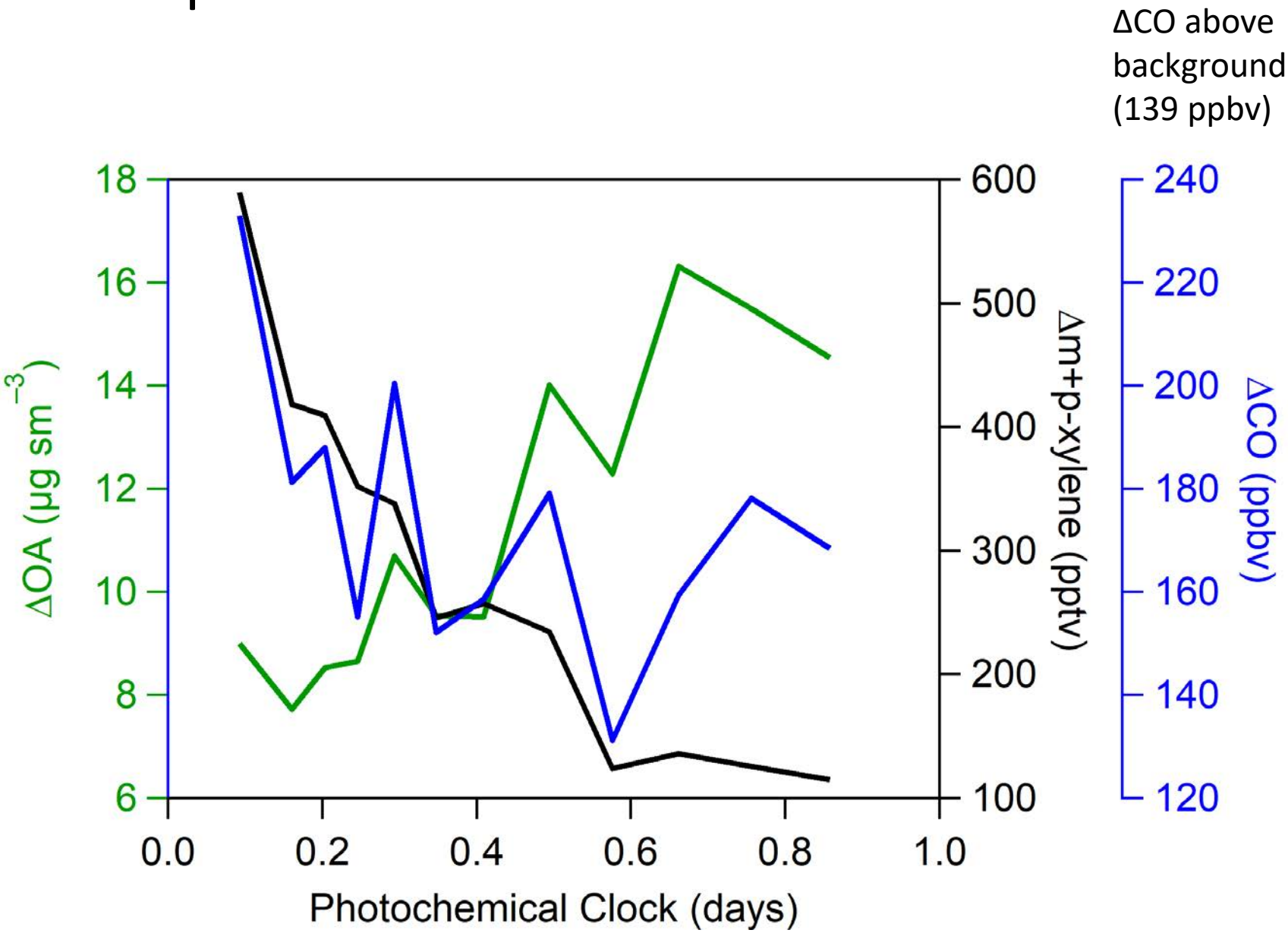
Dilution + Chemistry

Primary OA

CO

SOA Precursors

SOA production over Seoul



- Average evolution of OA (green), m+p-xylene (black) and CO (grey) observed over Seoul during KORUS-AQ (all flights). The values are background subtracted.

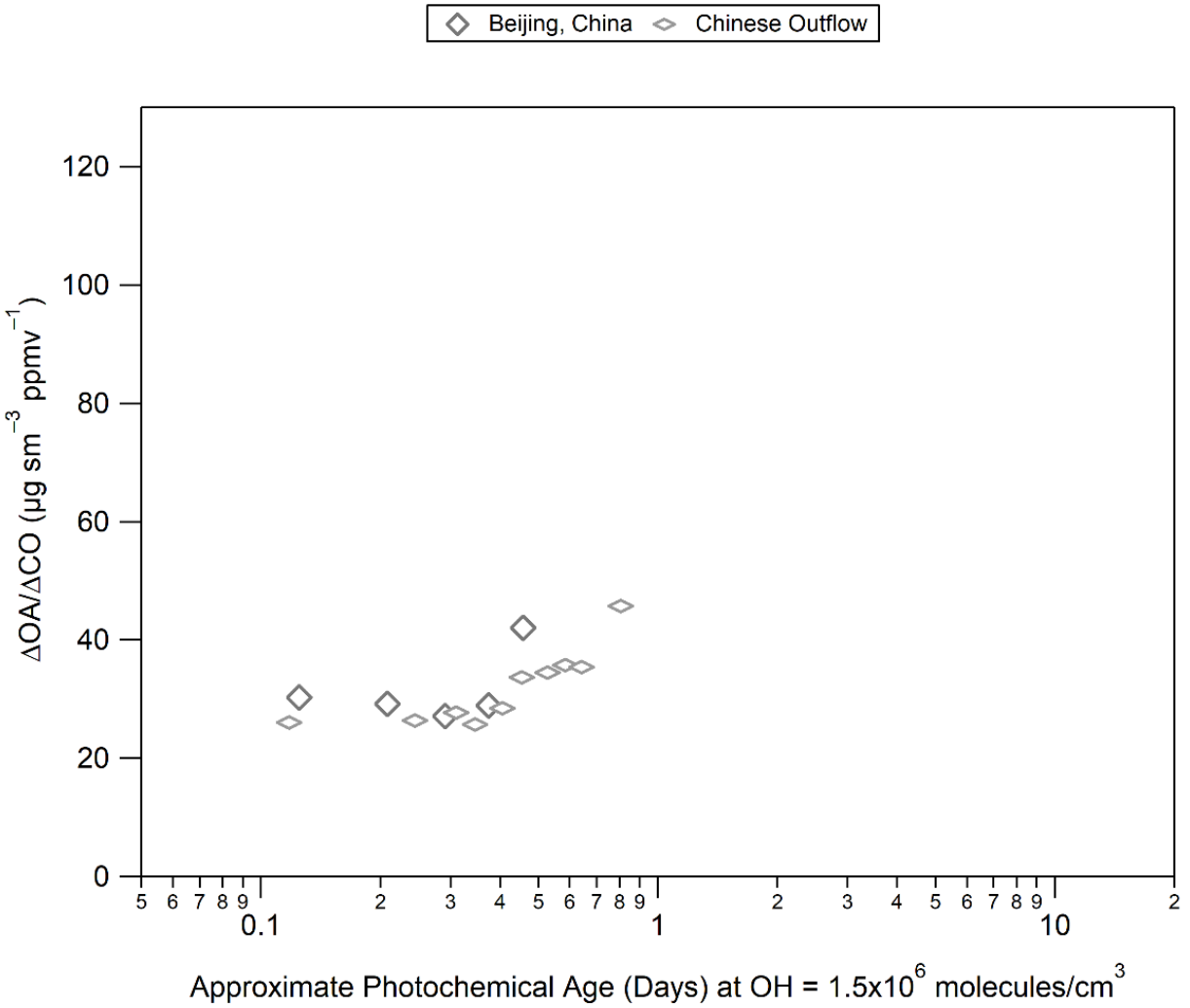
CO is *decreasing* with time due to *dilution*.

m+p-xylene is *decreasing* with time due to combination of *dilution and chemistry*.

OA is *increasing* with time due to *chemistry*; however, **dilution reduces the total increase**.

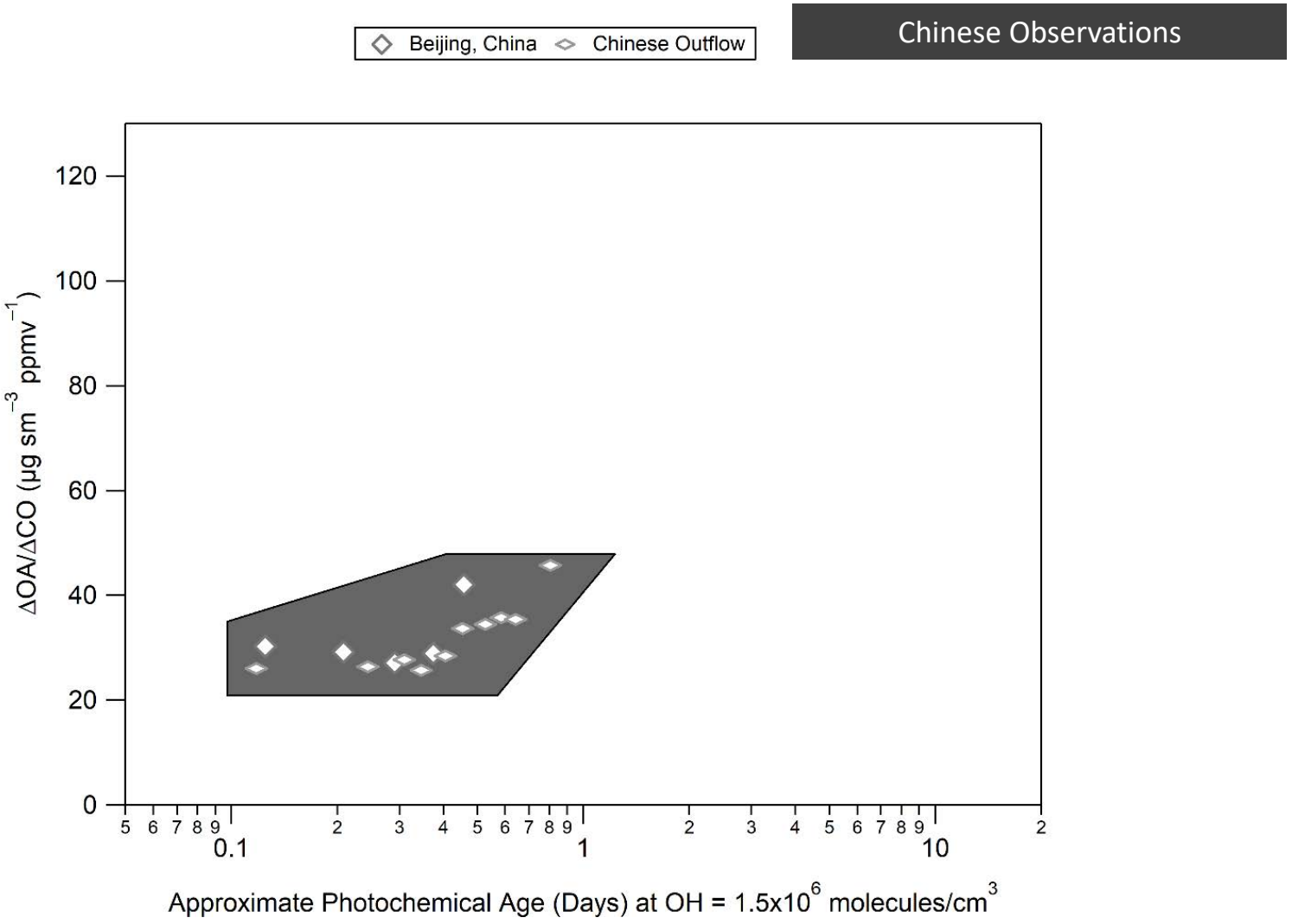
Thus, to normalize for dilution, ΔOA is divided by ΔCO.

Observed OA production for Chinese campaigns



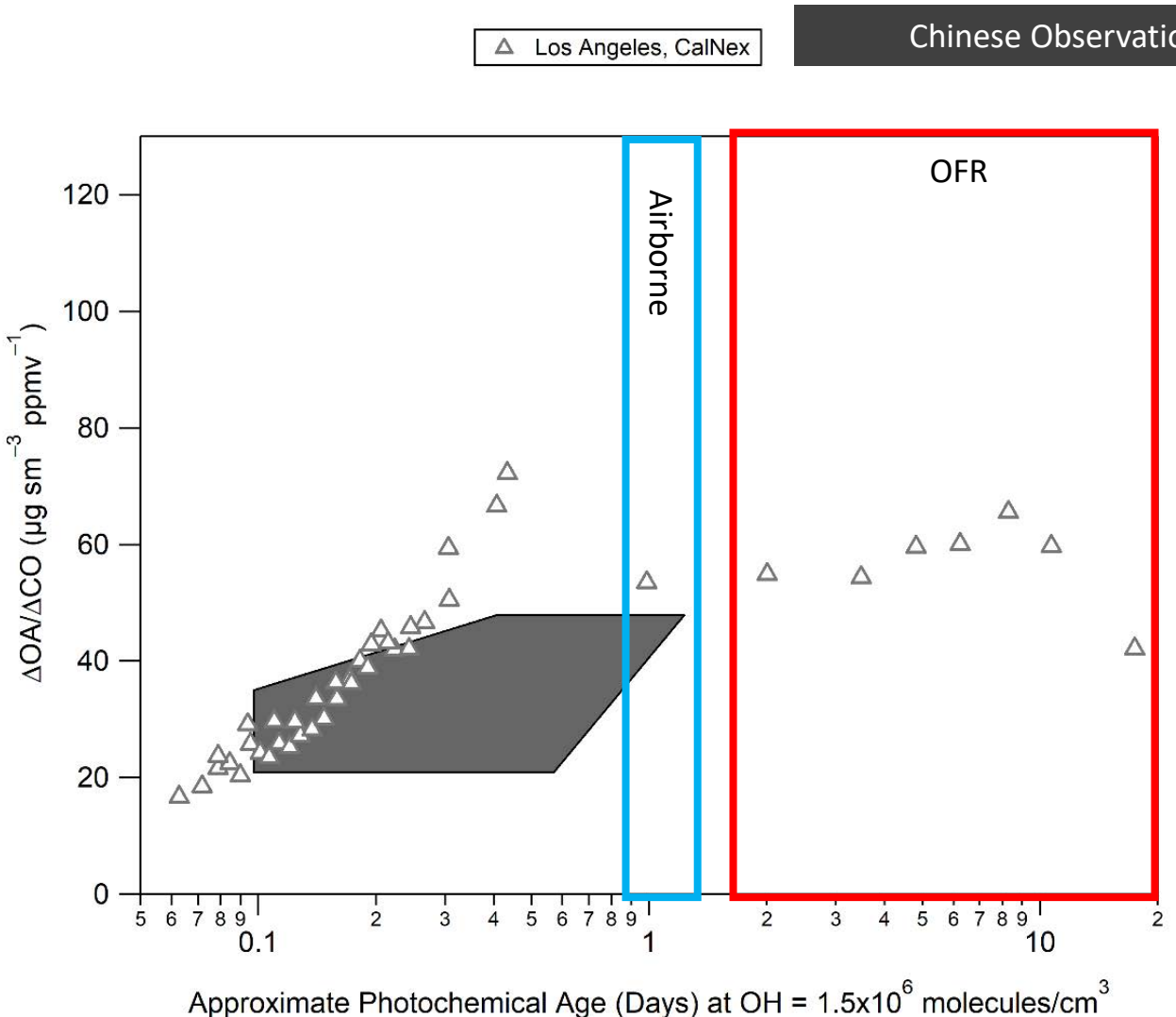
Hu et al., ACP, 2013; Hu et al., JGR, 2016

Observed OA production for Chinese campaigns



Hu et al., ACP, 2013; Hu et al., JGR, 2016

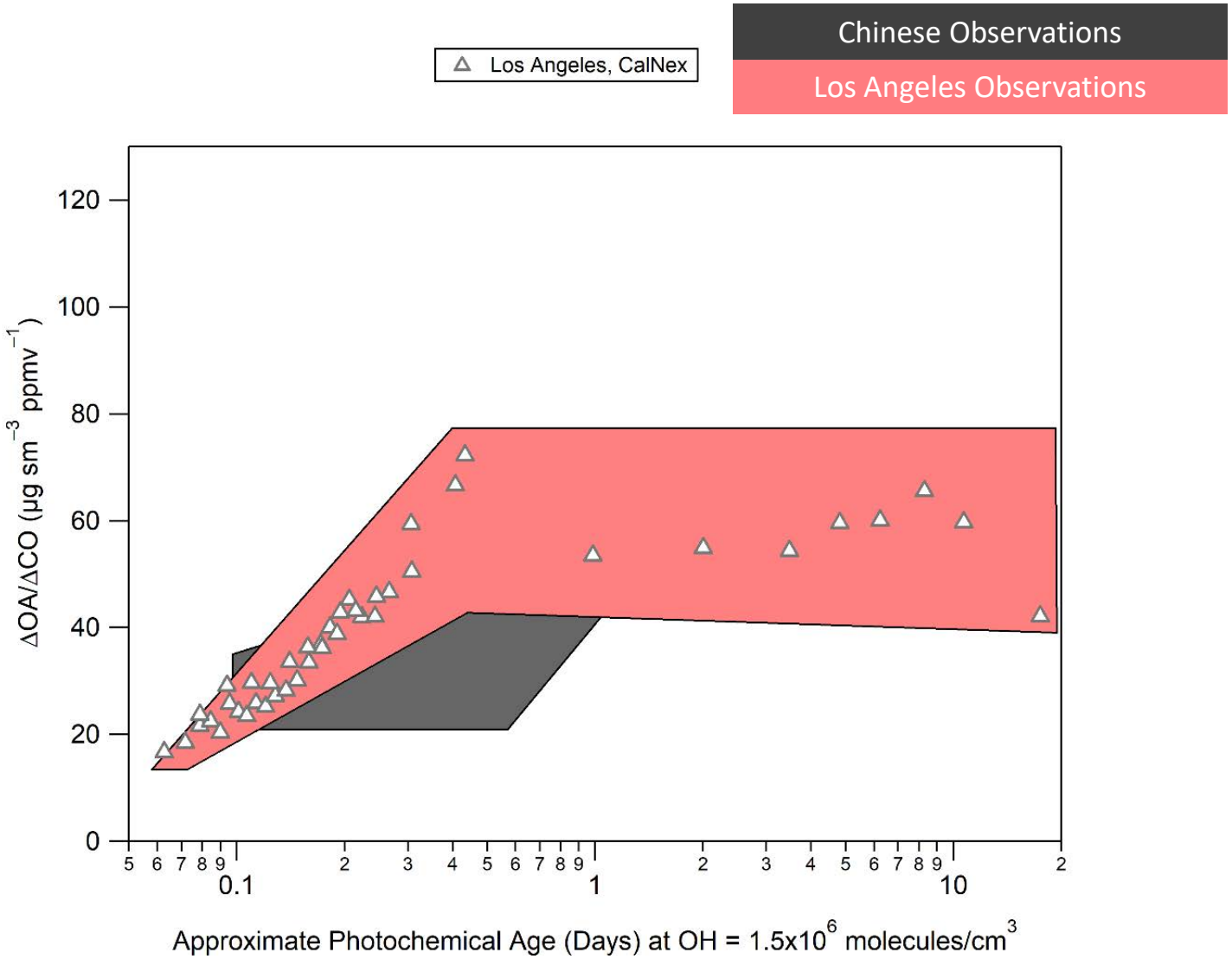
Observed OA production for Los Angeles



- Filled grey in background represents range of ΔOA/ΔCO observed for Chinese campaigns (Hu et al., ACP, 2013; Hu et al., JGR, 2016)
- Observations for Los Angeles, including from the oxidation flow reactor (ages > 2 days) and airborne measurements (age ~ 1 day) show more efficient OA production per CO emitted.

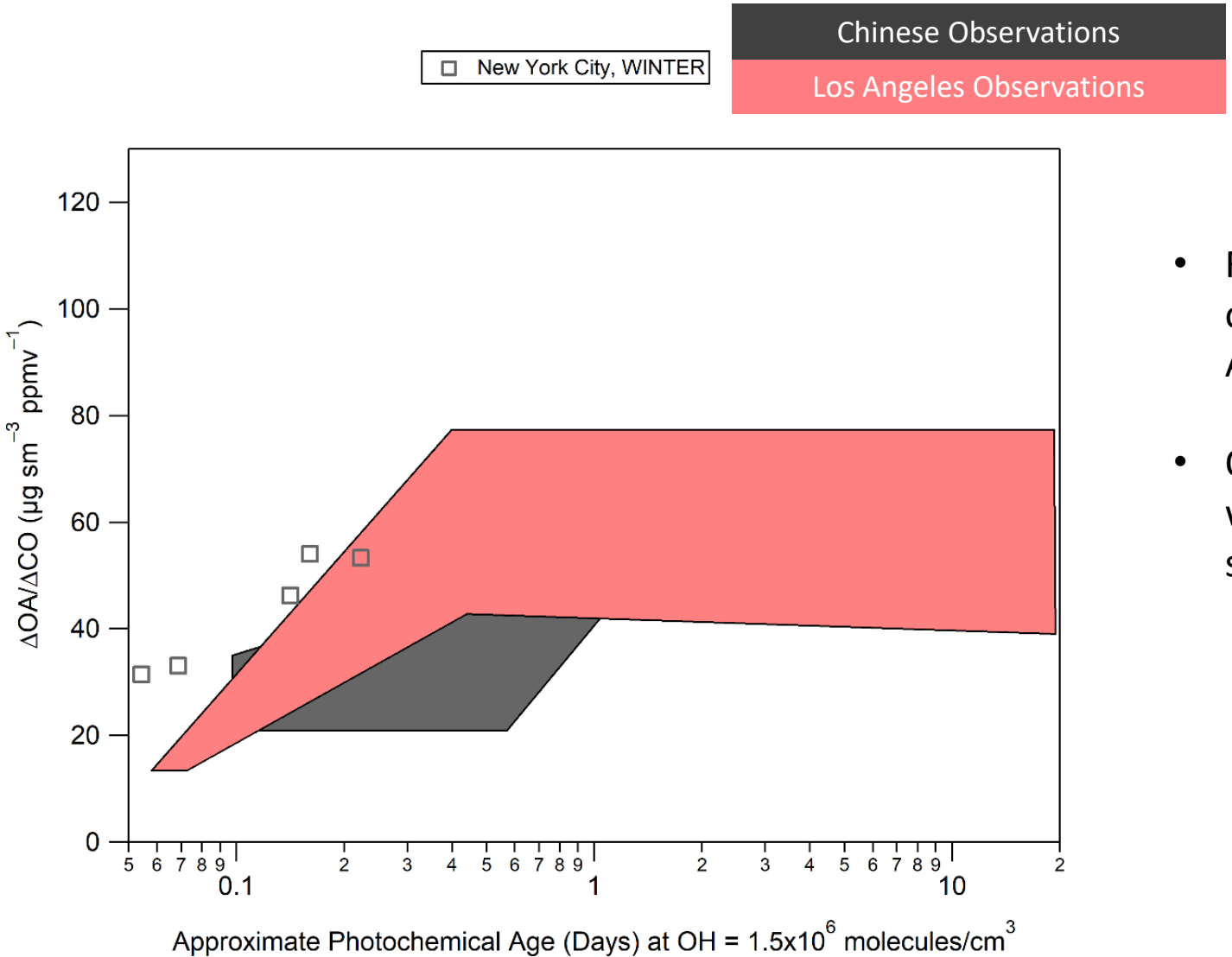
Hayes et al., JGR, 2013; Ortega et al., ACP, 2016

Observed OA production for Los Angeles



Hayes et al., JGR, 2013; Ortega et al., ACP, 2016

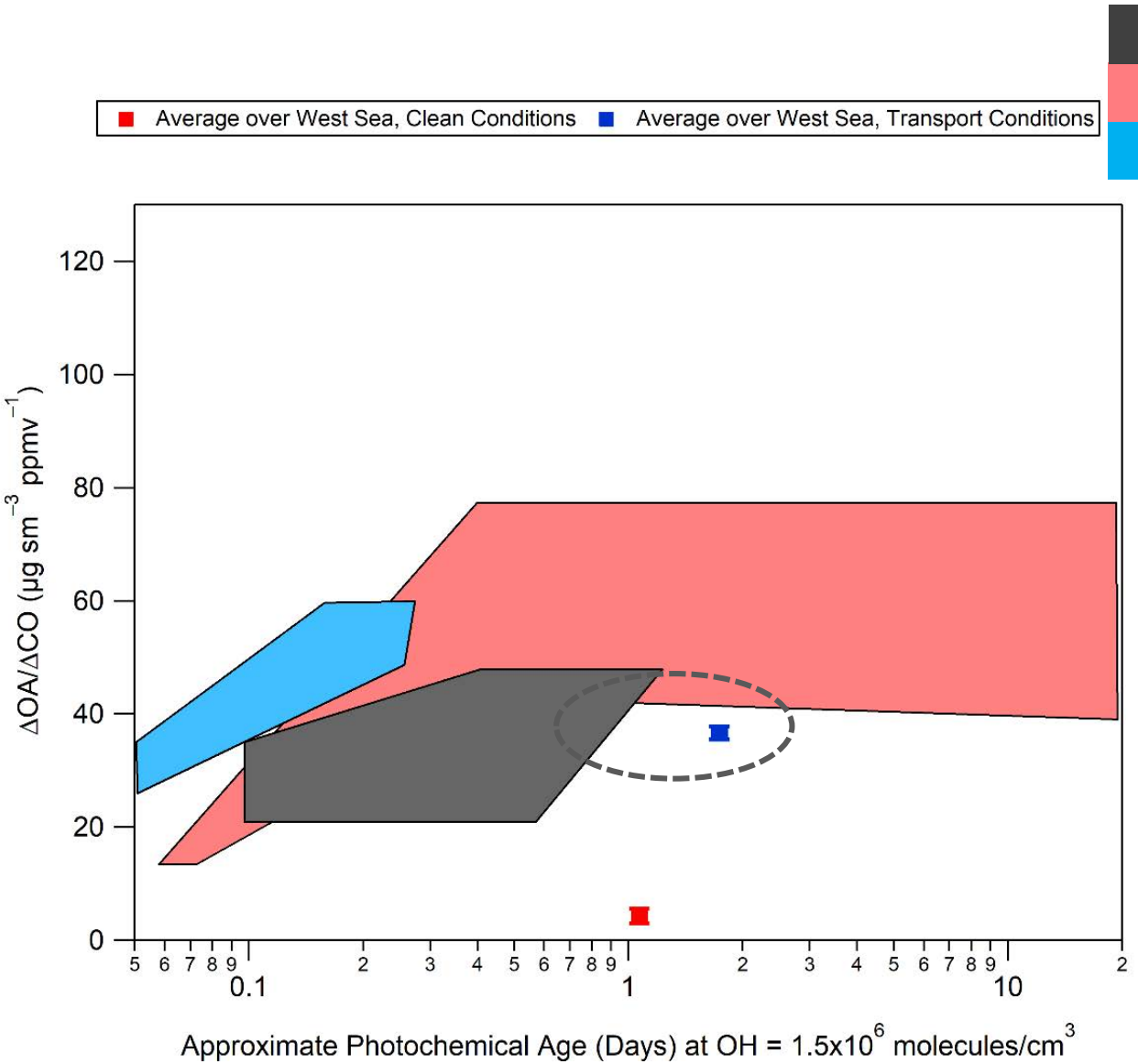
Observed OA production for New York City during winter



- Filled red in background represents range of ΔOA/ΔCO observed for LA (Hayes et al., JGR, 2013; Ortega et al., ACP, 2016)
- Observations for New York City, even during wintertime, show more efficient OA production per CO, similar to the observations in Los Angeles.

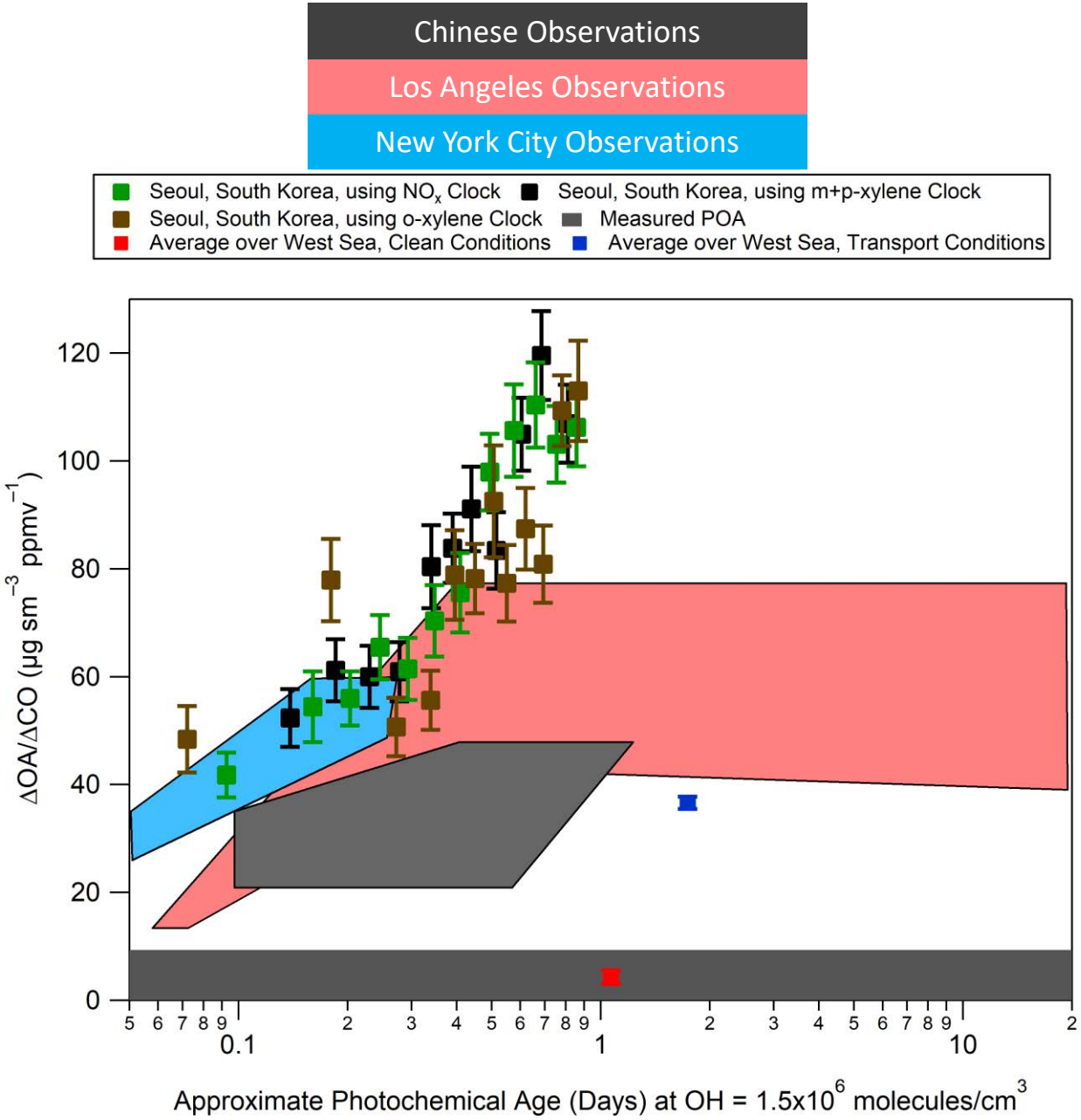
Schroder et al., in prep.

Comparison of OA production over West Sea during transport event (RF12, 25/May/2016) and rest of campaign



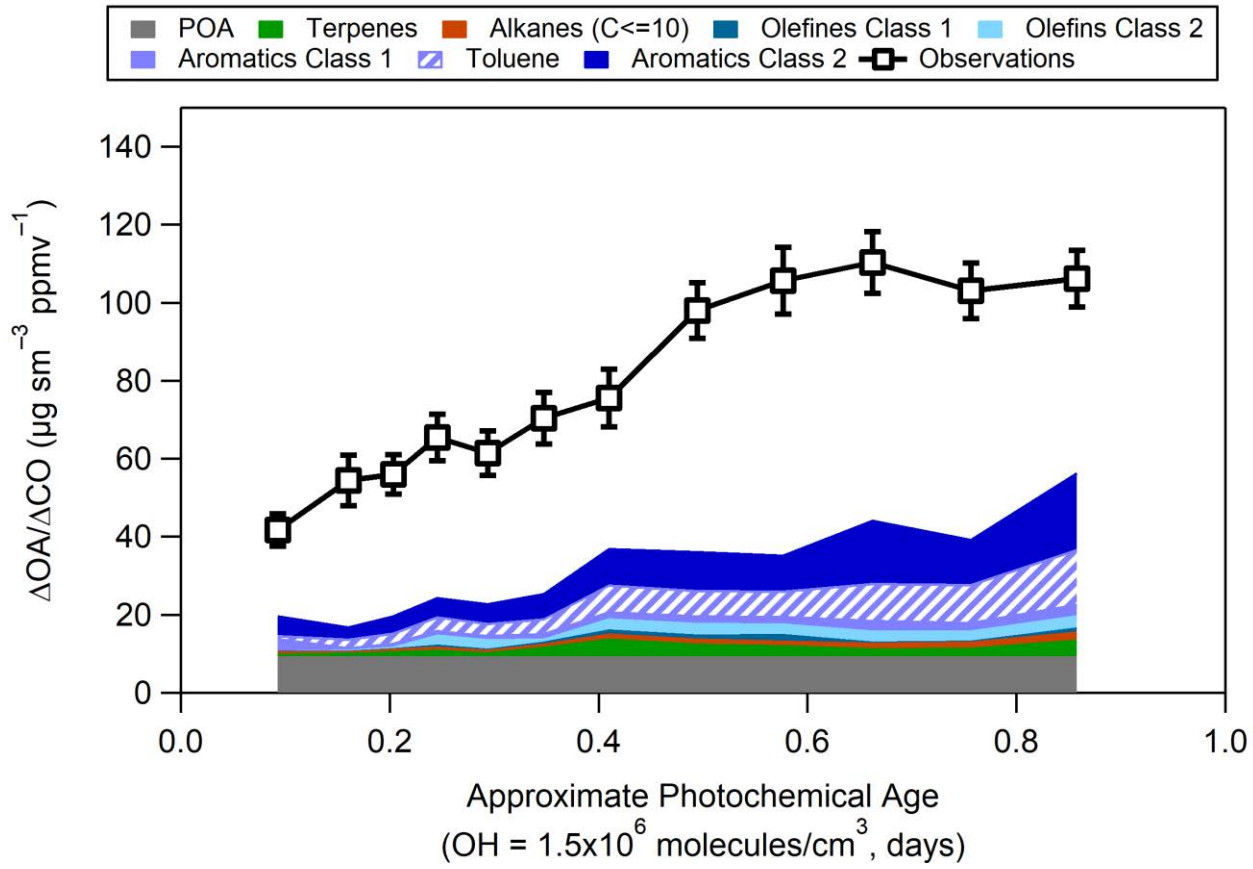
- For the transport event sampled over the West Sea during KORUS-AQ, the average value (blue) is comparable to the plateaued values observed in Hu et al. (2013, 2016).
- For the rest of the observations over the West Sea during KORUS-AQ, the production was very low (red).

Observed OA production for Seoul during KORUS-AQ



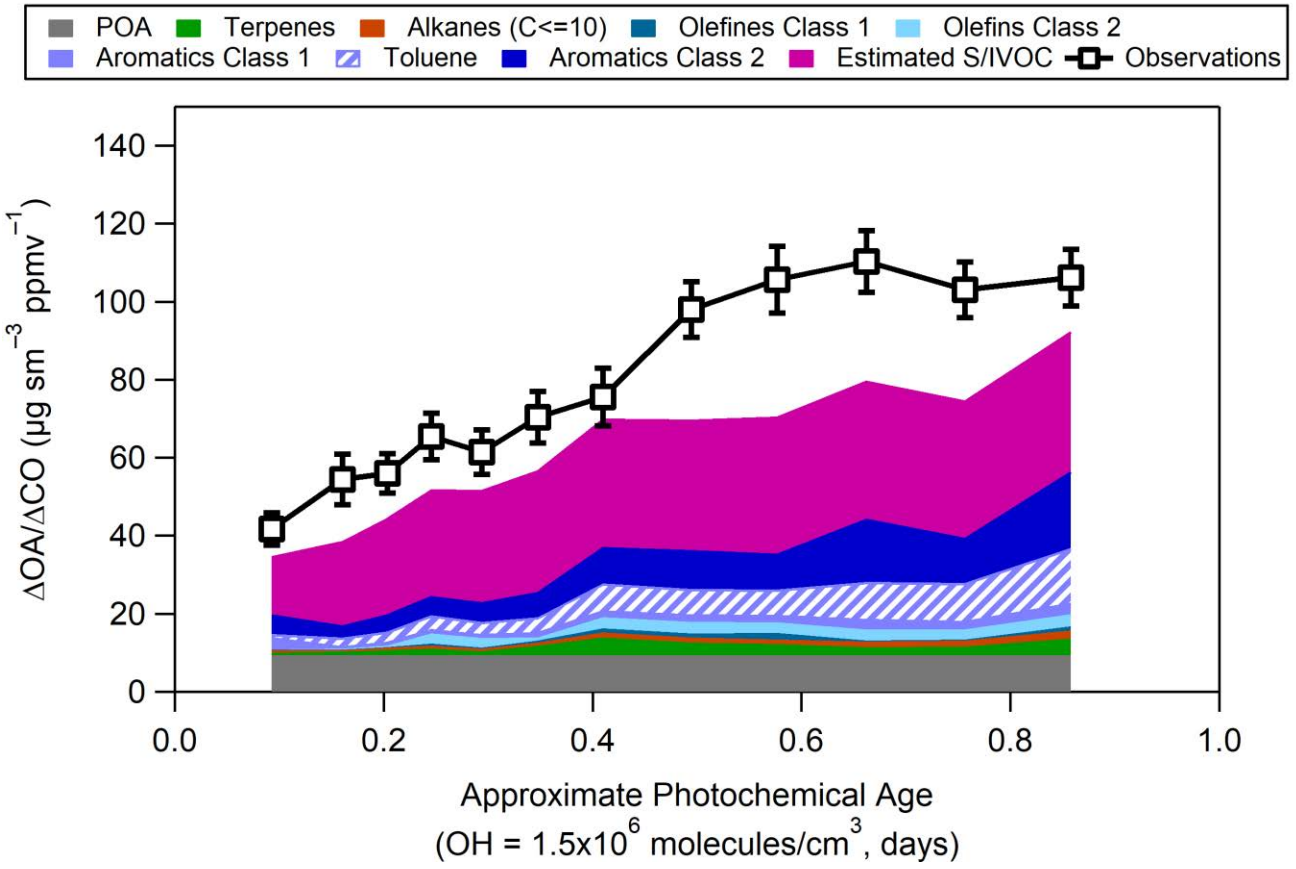
- The values over Seoul represent all overpasses near Seoul during the campaign.
- Using different photochemical clocks results in the same answer about SOA production over Seoul during the campaign
- The ΔOA/ΔCO observed over Seoul during KORUS-AQ are similar to the observations for Los Angeles and New York City, showing very efficient OA production per CO.
- SOA production over Seoul is the highest that we have observed
- For both the transport event and normal West Sea conditions, the OA production is lower than what was observed over Seoul during all of KORUS-AQ.
- Analysis of PMF results show production of SOA and steady primary OA over Seoul, further supporting photochemical production of OA.

Hydrocarbons contributing to SOA production over Seoul



- The hydrocarbon contribution is calculated using hydrocarbon observations on the DC-8, photochemical processing from the NO_x/NO_y clock, and aerosol yields for each species from Ma et al., ACP, 2017.
- Though important, toluene only accounts for 3 – 15% (average 10%) of the calculated SOA.
- The measured hydrocarbons on the DC-8 account for 30 – 55% of the measured OA production over Seoul

Hydrocarbons contributing to SOA production over Seoul



- We used the relationship between gas-phase and particle-phase emissions with primary organic aerosol (Robinson et al., Science, 2007; Dzepina et al., ACP, 2009) to estimate the amount of gas-phase semi- and intermediate-volatile organic compounds (S/IVOC) over Seoul.

- Within the error of the measurements and of the calculations, the estimated SOA production from S/IVOC accounts for the remaining observed OA production over Seoul.

- The compounds that contribute the most to the observed OA production over Seoul have photochemical lifetimes less than 1 day, and many have lifetime on order hours.

Conclusions

- I have been working on understanding the contributions of transport, both of OA and OA precursors, versus local emissions on the observed OA production over Seoul during KORUS-AQ

- The observed OA production over Seoul is more similar to observations over North American cities (Los Angeles & New York) than observations in China.

- Results from FLEXPART source analysis and hydrocarbon contributions both indicate that gas-phase species with photochemical lifetimes less than 1 day dominate the OA production

- Other analysis not shown, including results from the Oxidation Flow Reactor and comparisons with short-lived compounds known to be produced from photochemistry, further suggest that the observed OA production comes from local emissions and not transport.

- These results are in line with the conclusions from Hwajin Kim's ACPD 2017 paper that just came out about KORUS-AQ (https://www.atmos-chem-phys-discuss.net/acp-2017-947/).

Questions?

- Come talk to me at my poster **A13G-2178**: Secondary Organic Aerosol Production over Seoul, South Korea, during KORUS-AQ during the Monday afternoon session

- Or if you want to learn about other KORUS-AQ work I'm doing, come to my other poster **A11G-1946**: Global Survey of Submicron Aerosol Acidity (pH)