Agenda

Ministry of Environment
National Institute of Environmental Research

Science Team Telecon

AOGS 2018

KORUS-AQ publications

Science Presentations

- **Louisa Emmons**
- **Hyun Cheol Kim**

April Contest Question

Session AS40: Results from the 2016 KORUS-AQ and Related Field Studies in Asia

Complete program available at:
https://www.meetmatt-svr3.net/aogs/aogs2018/mars2/timetable2.asp

Posters on Monday evening and oral presentations on Wednesday AM and PM

Publications

Ministry of Environment
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Going forward, here are a few requirements that will help us to keep track of science team progress and ensure consistency among the published findings:

1) **Anyone in the draft stage of manuscript writing should email their title and full author list to Jim Crawford. We will keep the list updated and shared at each monthly webex.**
2) **Authors are highly encouraged to present a summary of their analysis and findings during a monthly webex before submitting the paper.**
3) **Authors should also identify the target journal for their paper. We have not yet decided on whether a special issue will be commissioned, but this information may help us to decide whether to have a special issue or allow our papers to span many journals.**
4) **Double check to be sure that the most recent data is being used in your analysis (e.g., LARGE-APS size distribution data for DC-8 was updated today).**
5) **KORUS-AQ data doi's will become available in the near future. Please these doi's to reference the data used in your paper.**
6) **Intercomparison analyses of measurements are underway and will be presented in a future webex. If you are using variables measured by multiple groups, please be aware of and prepare to cite intercomparison results.**

Publications (1)

Authors	Title	Journal	Status
Hwajin Kim, Qi Zhang, Jongbae Heo	Influence of Intense secondary aerosol formation and long range transport on aerosol chemistry and properties in the Seoul Metropolitan Area during spring time: Results from KORUS-AQ	Atmospheric Chemistry and Physics	Under Review
Najin Kim, Minsu Park, Seong Soo Yum, Jong Sung Park, Hye Jung Shin, Joon Young Ahn	Impact of urban aerosol properties on cloud condensation nuclei (CCN) activity during the KORUS-AQ field campaign	Atmospheric Environment	Under Review
W. Hu, D.A. Day, P. Campuzano-Jost, B.A. Nault, T. Park, T. Lee, P. Croteau, M.R. Canagaratna, J.T. Jayne, D.R. Worsnop, J.L. Jimenez	Evaluation of the new capture vaporizer for Aerosol Mass Spectrometers (AMS): Elemental composition and source apportionment of organic aerosols (OA).	ACS Earth Space Chemistry	Under Review
W. Hu, D.A. Day, P. Campuzano-Jost, B.A. Nault, T. Park, T. Lee, P. Croteau, M.R. Canagaratna, J.T. Jayne, D.R. Worsnop, J.L. Jimenez	Evaluation of the new capture vaporizer for Aerosol Mass Spectrometers: characterization of organic aerosol mass spectra	Aerosol Science and Technology	Under Review
Wenfu Tang, A. F. Arellano, J. P. DiGangi, Yonghoon Choi, G. S. Diskin, A. Agustí-Panareda, M. Parrington, S. Massart, B. Gaubert, Youngjae Lee, Dan-bee Kim, Jinsang Jung, Hong Jinkyu, Yugo Kanaya, Mindo Lee, A. M. Thompson, J. H. Flynn, and Jung-Hun Woo	Evaluating High-Resolution Forecasts of Atmospheric CO and CO2 from a Global Prediction System during KORUS-AQ Field Campaign	Atmospheric Chemistry and Physics	In prep
Wenfu Tang, L. K. Emmons, A. F. Arellano Jr., B. Gaubert, C. Knote, S. Tilmes, R. R. Buchholz, G. G. Pfister, D. R. Blake, N. J. Blake, J. P. DiGangi, Yonghoon Choi, G. S. Diskin, Jung-Hun Woo	Source Contribution to Carbon Monoxide during KORUS-AQ Using CAM-chem Tagged Tracers	Atmospheric Chemistry and Physics	In prep

Publications (2)

Authors	Title	Journal	Status
Eric Heim, et al.	Asian Dust Observed during KORUS-AQ Facilitates the Uptake and Incorporation of Soluble Pollutants during Transport to S. Korea; The Hwangsa Anthropogenic Model	TBD	In prep
Dan Goldberg, et al.	A high-resolution OMI NO2 product for Korea during KORUS-AQ and using it to derive NOx emissions in Seoul	TBD	In prep
Myungie Choi et al.	Assessment of aerosol optical properties from GOCI, MODIS, VIIRS, and MISR measurements over East Asia during 2016 KORUS-AQ campaign	TBD	In prep
Myungje Choi, Seoyoung Lee, et al.	Assessment of 3-D aerosol distribution for long-range transport and local emission using GOCI and ground, airborne, and satellite lidar measurement during 2016 KORUS-AQ	TBD	In prep
Heesung Chong, Seoyoung Lee, et al.	PCA-based trace gas retrievals from GeoTASO airborne measurements during KORUS-AQ	TBD	In prep
Heesung Chong, et al.	Surface NO2 volume mixing ratio estimated from total column observations of Pandora spectrometer during KORUS-AQ	TBD	In prep
Seoyoung Lee, Ja-Ho Koo, et al.	Regional transport effect to explain the aerosol concentration and variation in the Korean peninsula	TBD	In prep
Sujung Go, et al.	Imaginary part of refractive index derived from UV-MFRSR in Seoul, and implications for retrieving UV Aerosol Optical Properties for GEMS measurements	TBD	In prep
Hyungkwan Lim, et al.	Aerosol loading height retrieval from AHI using spatiotemporal variability during KORUS AQ	TBD	In prep

Publications (3)

Authors	Title	Journal	Status
Hyungkwan Lim, et al.	Intercomparison of aerosol optical depth data using AHI, GOCI and MI from Yonsei AErosol Retrieval (YAER) algorithm	TBD	In prep
Yeseul Cho, Ja-Ho Koo, et al.	Spatiotemporal properties of O3 and NO2 in the Seoul Metropolitan Area: comparison among total column, vertical profile, and surface patterns	TBD	In prep
Sang Seo Park, et al.	Temporal variation of total ozone without its variations at surface and stratosphere	TBD	In prep
Paul Romer, Ron Cohen, et al.	Constraints on aerosol nitrate photolysis as a potential source of HONO and NOx	TBD	In prep
W. Hu, P. Campuzano-Jost, D. A. Day, B. A. Nault, T. Park, T. Lee, A. Pajunoja, A. Virtanen, P. Croteau, M. R. Canagaratna, J. T. Jayne, D. R. Worsnop, J. L. Jimenez	Size distributions and ambient quantifications for organic aerosol (OA) in aerosol mass spectrometer (AMS) instruments with the new capture vaporizer (CV)	Journal of Aerosol Science	In prep
B. A. Nault, 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, A. Fried, L. G. Huey, M. J. Kim, C. J. Knote, K. D. Lamb, T. Lee, D. D. Montzka, T. Park, A. E. Perring, S. E. Pusede, P. S. Romer, E. Scheuer, J. P. Schwarz, K. L. Thornhill, P. O. Wennberg, A. J. Weinheimer, A. Wisthaler, J. H. Woo, P. J. Wooldridge, and J. L. Jimenez	Secondary Organic Aerosol Production over Seoul, South Korea, during KORUS-AQ	Atmospheric Chemistry and Physics	In prep

Publications (4)

Authors	Title	Journal	Status
B. A. Nault, P. Campuzano-Jost, D. A. Day, J. C. Schroder, D. R. Blake, M. R. Canagaratna, J. A. de Gouw, F. Flocke, A. Fried, J. B. Gilman, T. F. Hanisco, L. G. Huey, B. T. Jobson, W. C. Kuster, B. Lefer, J. Liao, D. D. Montzka, I. B. Pollack, J. Peischl, B. Rappenglueck, J. M. Roberts, T. B. Ryerson, J. Stutz, P. Weibring, A. J. Weinheimer, E. C. Wood, and J. L. Jimenez	Quantification of the Rapid Photochemical Secondary Organic Aerosol Production Observed across Megacities around the World	Nature Geosciences or PNAS	In prep
B. A. Nault, P. Campuzano-Jost, D.A. Day, W. W. Hu, B. B. Palm, J. C. Schroder, R. Bahreini, H. Bian, M. Chin, S. L. Clegg, P. Colarco, J. Crounse, J. A. de Gouw, J. Dibb, M. J. Kim, J. Kodros, F. D. Lopez-Hilfiker, E. A. Marais, A. Middlebrook, J. A. Neuman, J. B. Nowak, J. Pierce, J. M. Roberts, E. Scheuer, J. A. Thornton, P. R. Veres, P. O. Wennberg, and J. L. Jimenez	Global Survey of Submicron Aerosol Acidity (pH)	Nature Geosciences or PNAS	In prep
D. Jeong, R. Seco, D. Gu, Y. Lee, B. Nault, C. Knote, T. Mcgee, J. Sullivan, J. L. Jimenez, P. Campuzano-Jost, D. Blake, D. Sanchez, A. Guenther, D. Tanner, G. Huey, R. Long, B. E. Anderson, S. R. Hall, Y.-J. Lee, D. Kim, J.-Y. Ahn, A. Wisthaler, and S. Kim	Integration of Airborne and Ground Observations of Nitryl Chloride in the Seoul Metropolitan Area and Its Impact on the Regional Oxidation Capacity During the KORUS-AQ 2016 Field Campaign	TBD	In prep
D. Sanchez, R. Seco, D. Gu, A. Guenther, D. Jeong, J. Mak, Y.-J. Lee, D. Kim, D. Blake, S. Herndon, D. Jeong, T. Mcgee, and S. Kim	OH Reactivity Budget Analysis at the Taehwa Research Forest During KORUS-AQ 2016	TBD	In prep

Publications (5)

Authors	Title	Journal	Status
Isobel Simpson, et al.	Characterization and source apportionment of VOCs in the Seoul Metropolitan Area	TBD	In prep
Kara Lamb, et al.	Regional influences on the direct radiative forcing from black carbon observed over S. Korea	JGR-Atmospheres	In prep
Jinkyul Choi, Rokjin J. Park, Hyung-Min Lee, Seungun Lee, Duseong S. Jo, Jaein I. Jeong, Daven Henze, Jung-Hun Woo, Soo-Jin Ban, Min-Do Lee, Cheol-Soo Lim, Mi-Kyung Park, Hye J. Shin, Seogju Cho, and David Peterson	Source attribution of PM2.5 for Korea during the KORUS-AQ campaign using GOES-Chem adjoint model	TBD	In prep
Yujin Ok, Rokjin J. Park, Donald R. Blake, William H. Brune, Andrew J. Weinheimer, Alan Fried, James Crawford, and Jason Schroeder	Evaluation of simulated VOCs during the KORUS-AQ campaign and their effect on ozone production in Korea	TBD	In prep
Hyeonmin M. Kim, Rokjin J. Park, Jaein I. Jeong, Daun Jeong, Saewung Kim, and Seogju Cho	Effect of nitryl chloride chemistry on oxidation capacity in East Asia	TBD	In prep
Hyung-Min Lee, Rokjin Park, Hyeong-Ahn Kwon	Top-down estimate of isoprene emissions in East Asia using inverse modeling: implication of satellite retrievals from GOME-2 and OMI formaldehyde with KORUS-AQ aircraft observations	TBD	In prep
David Peterson, et al.	Meteorology Influencing Pollution Regimes and Transport during KORUS-AQ	TBD	In prep

Publications (6)

Authors	Title	Journal	Status
K. Miyazaki, T. Sekiya, D. Fu, K. W. Bowman, S. S. Kulawik, K. Sudo, T. Walker, Y. Kanaya, M. Takigawa, K. Ogochi, H. Eskes, F. Boersam, B. Gaubert, J. Barre, and L. Emmons, and the KORUS-AQ team	Evaluation of a multi-constituent chemical reanalysis during KORUS-AQ: Role of dynamics and emissions	JGR-Atmospheres	In prep
Changmin Cho, Jason. M. St. Clair, Glenn. M. Wolfe, Jin Liao, Sukhan Jung, Dae il Kang Jinsoo Choi, Myung-Hwan Shin, Jinsoo Park, Thomas. F. Hanisco, Kyung-Eun Min	Top-down estimation of volatile organic compounds (VOCs) emission rates in petrochemical complex using airborne in-situ formaldehyde (HCHO) observation	Atmospheric Environment or ACP	In prep
Minsu Park, Najin Kim, Seong Soo Yum, Lee Thornhill, Bruce Anderson, Dong-Su Kim, Hyun-Jae Kim, Ha-Eun Jeon, Yun-Seo Park, Sang-Bo Lee	On the submicron aerosol distributions and CCN activity in and around the Korean Peninsula measured onboard the NASA DC-8 research aircraft during the KORUS-AQ field campaign	TBD	In prep

Tagged NOx-O3 in CAM-chem

Louisa Emmons

NCAR

Ozone source attribution procedures

- HTAP: 20% perturbations of emissions, assuming that small changes in NOx levels will be linear in ozone changes (but change in NO emissions changes OH, HO2, RO2 and thus both production and loss rates of ozone)

- Tagging of NOx and VOCs (Tim Butler, GMD Discussions: https://www.geosci-model-dev-discuss.net/gmd-2018-59/)

- Tagging of ozone when it is produced in a specified region (Wang et al., 1998; and others)

Ozone attribution by tagging NOx *[Emmons et al., GMD, 2012]*

A NOx source or region is traced through NOy species to the photolysis of NO2, leading to a tagged O, which makes tagged O3.

XNO + HO2 -> XNO2 + HO2 (tagged reactions don't affect chemistry)

XNO2 + hv -> XNO + XO

XO + O2 -> XO3

XO3 + hv -> XO

XNO2 + CH3CO3 + M -> XPAN + CH3CO3

XPAN + M -> XNO2

XNO + O3 -> XNO2

NO + XO3 -> NO

{similarly for HNO3, organic nitrates, etc.}

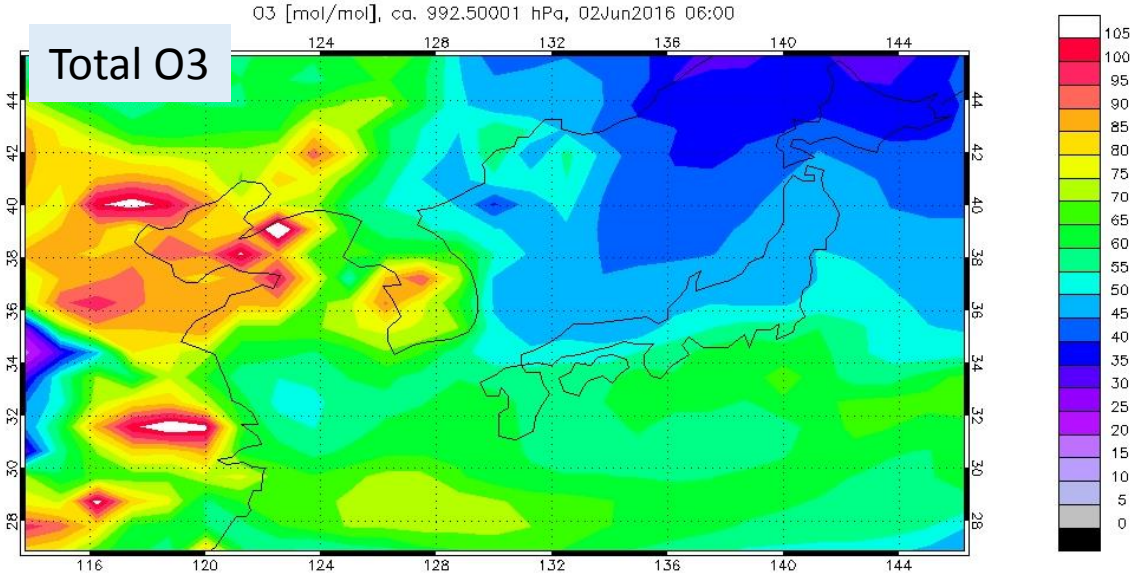
{tagged ozone does not create tagged NOx}

CAM-chem simulation

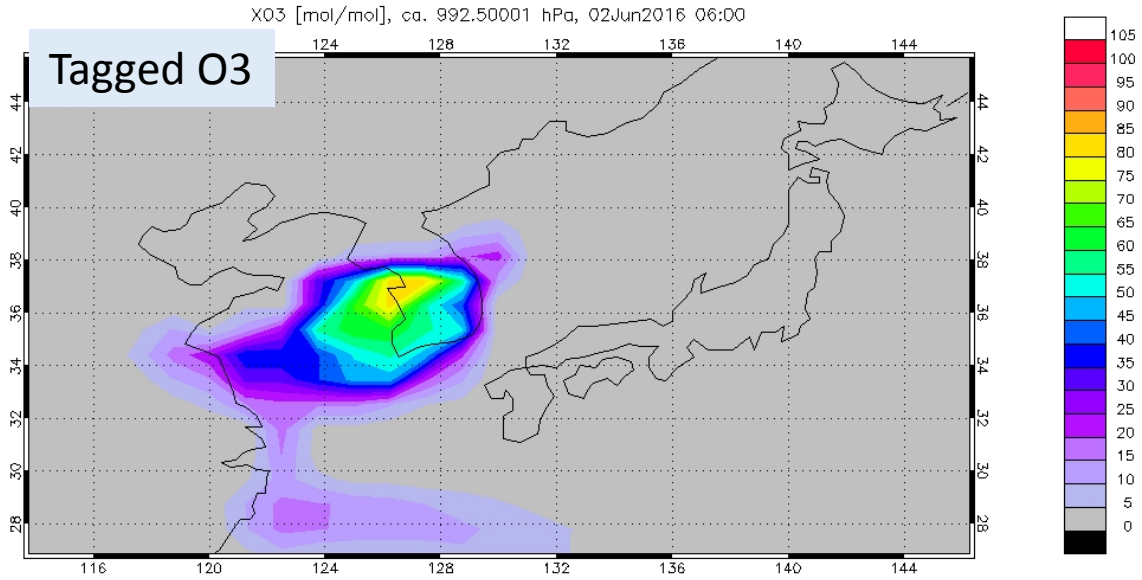
1 deg horizontal resolution
Tagged NO anthropogenic emissions in Korea (KORUS-V2 emissions)

Surface - June 2, 6Z

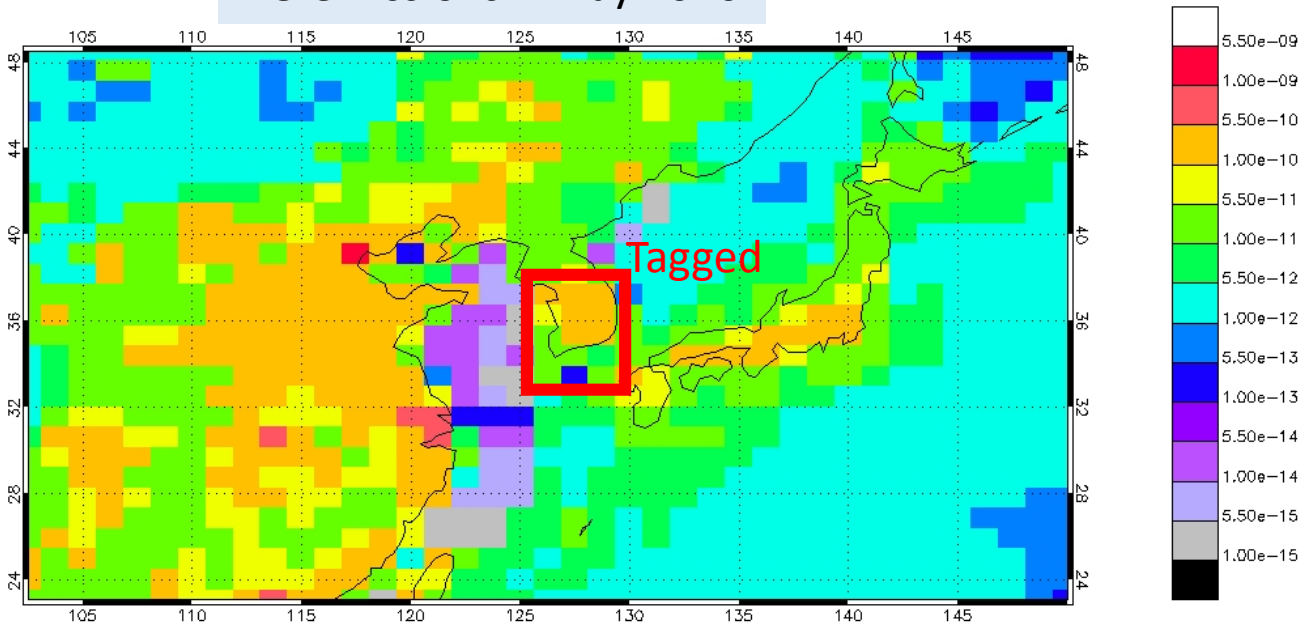
Total O3



Tagged O3



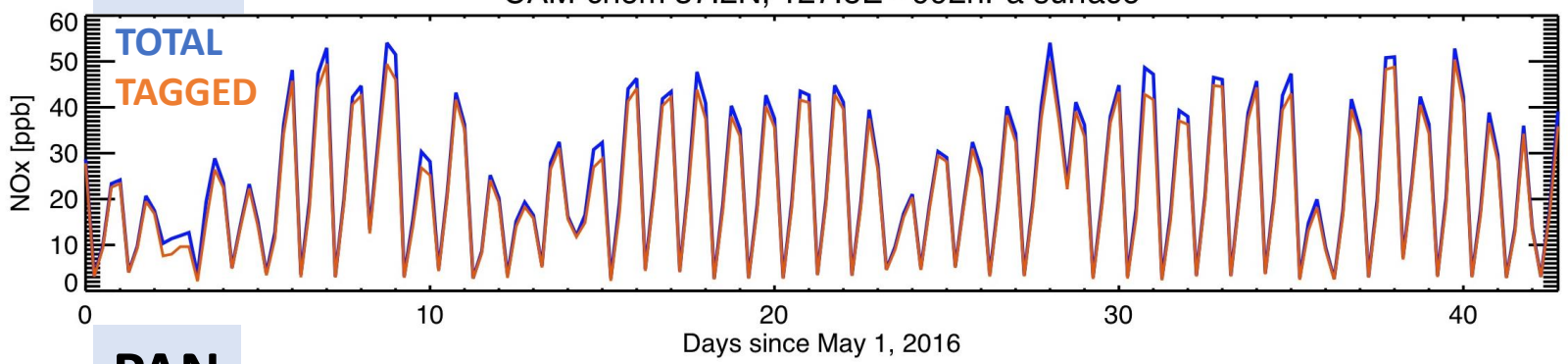
NO emissions – May 2016



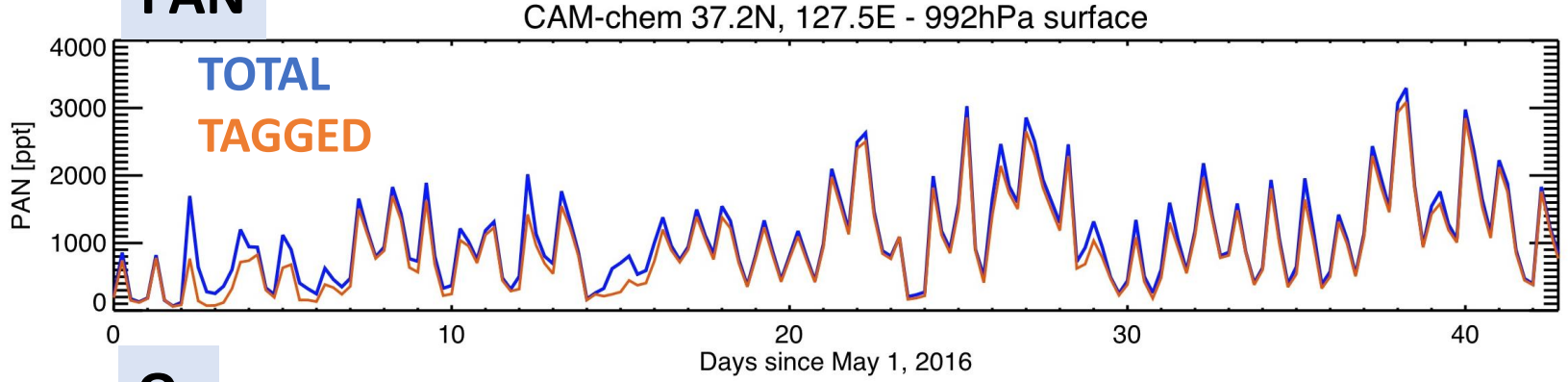
CAM-chem simulation

1 deg horizontal resolution
Tagged NO anthropogenic emissions in Korea (KORUS-V2 emissions)

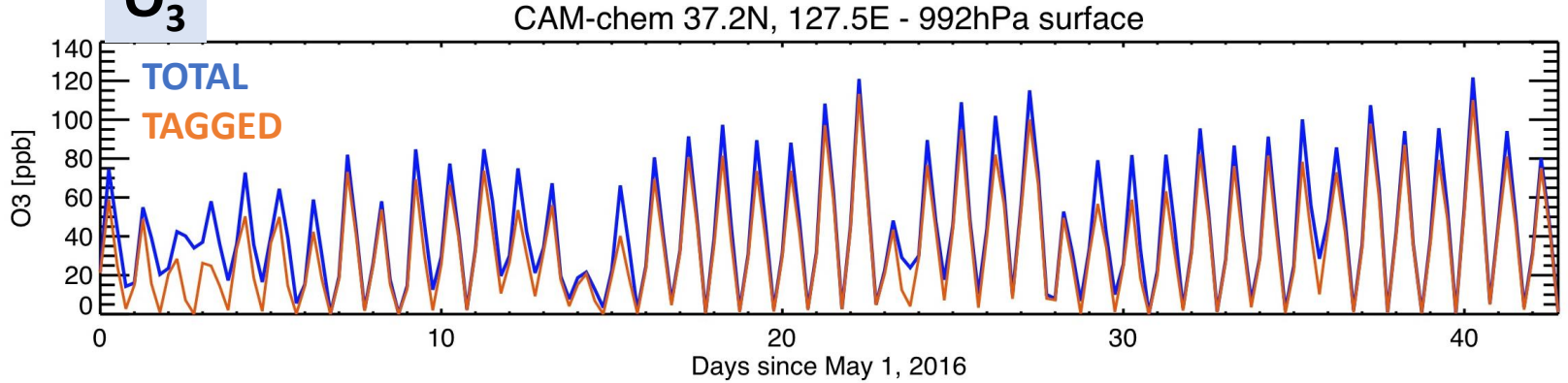
NOx



PAN



O_3

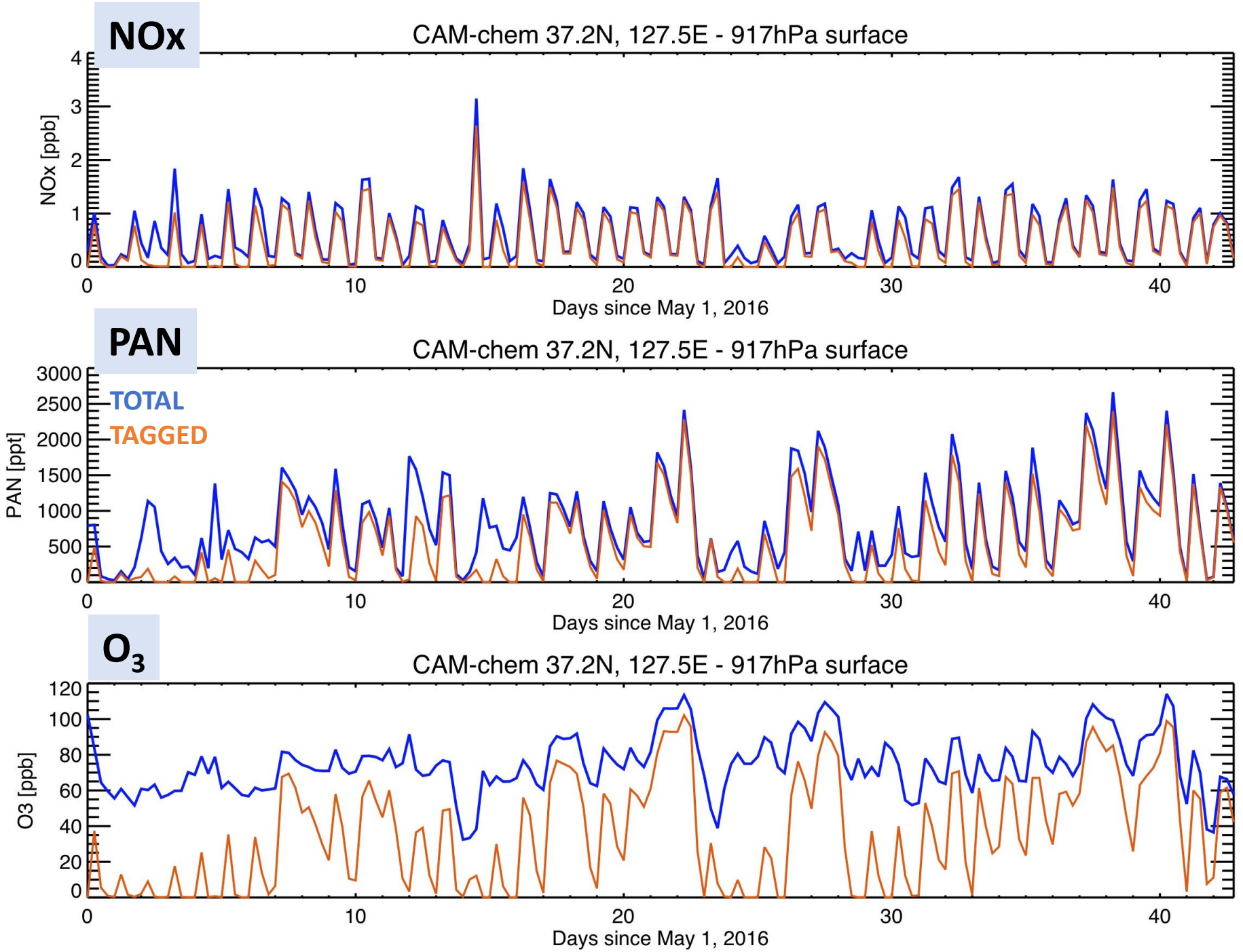


At model grid box over Seoul, all NOx is local

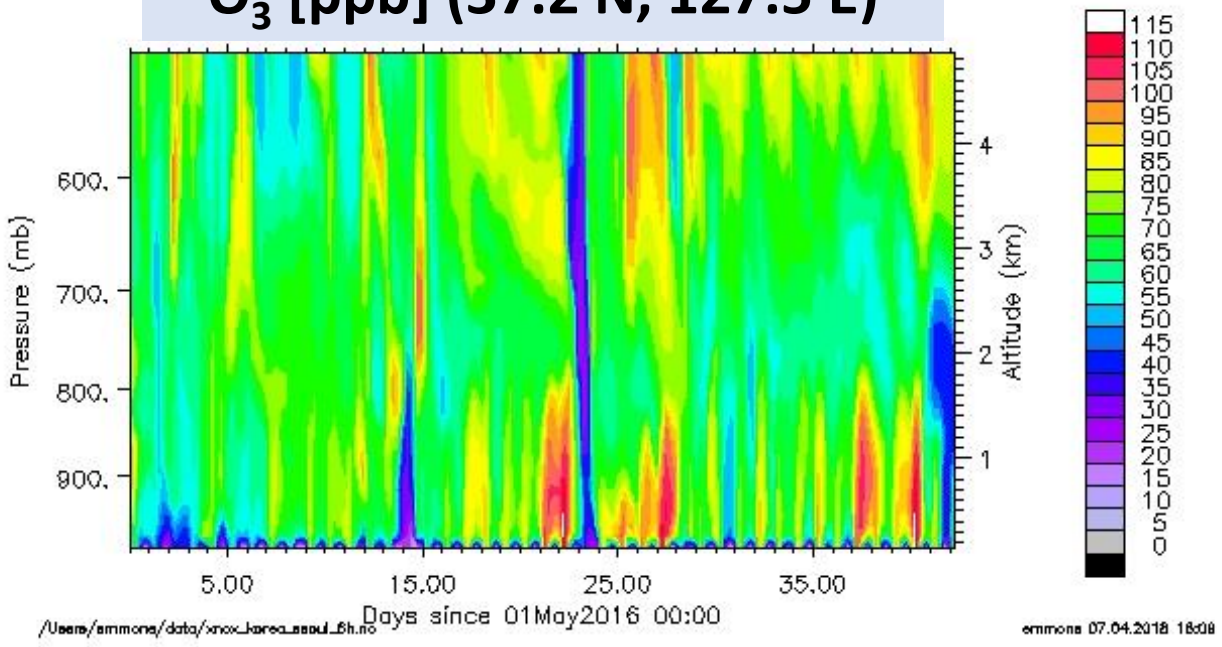
PAN is also dominated by local anthro sources

On a few days ozone has some contribution from elsewhere

Only a few levels above the surface, ozone from non-Korea sources becomes much more important

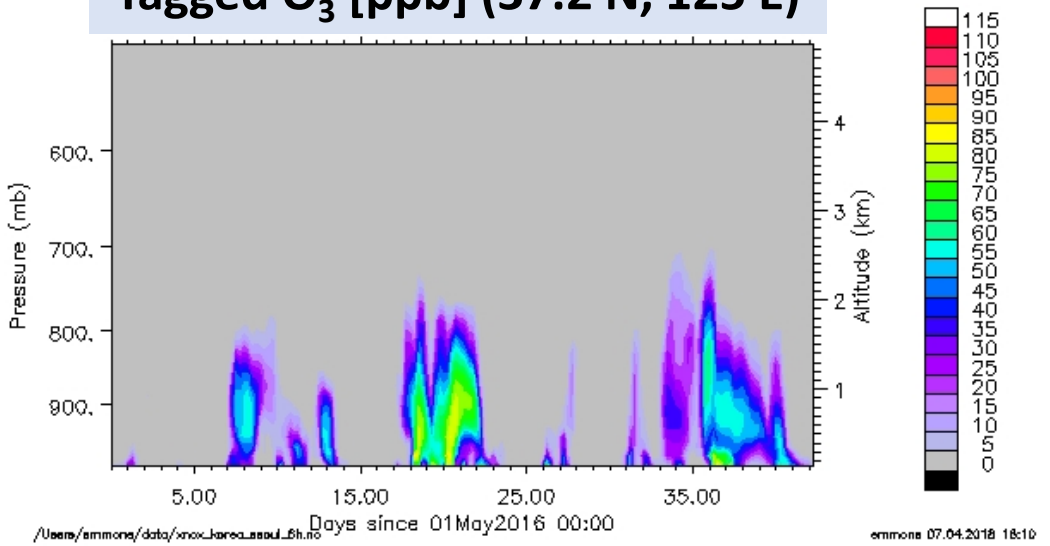


O_3 [ppb] (37.2 N, 127.5 E)

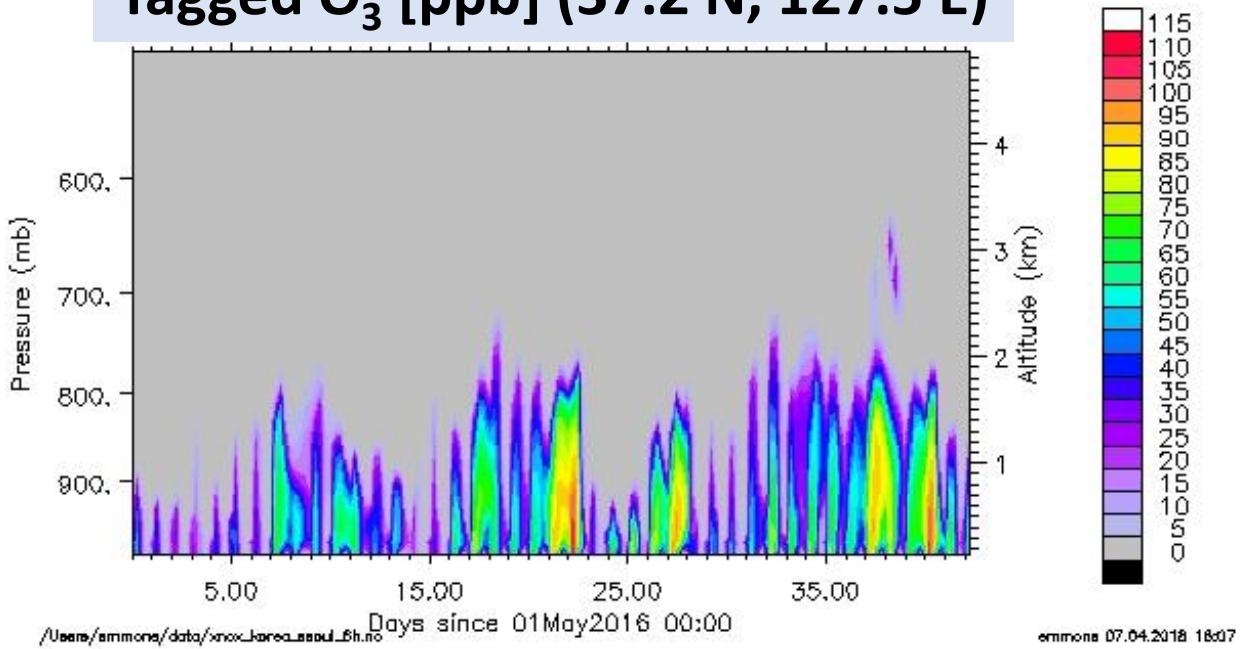


West of Seoul

Tagged O_3 [ppb] (37.2 N, 125 E)

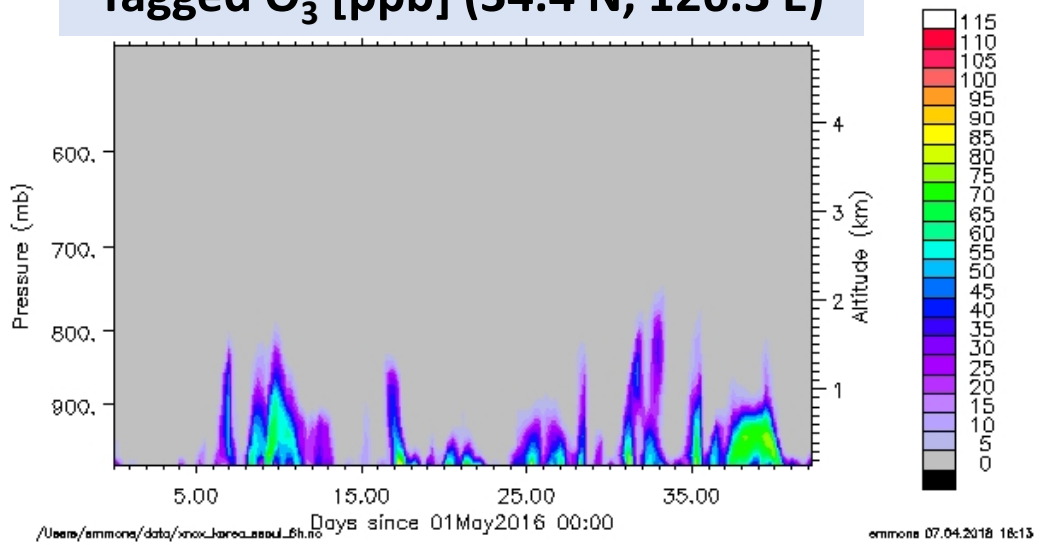


Tagged O_3 [ppb] (37.2 N, 127.5 E)

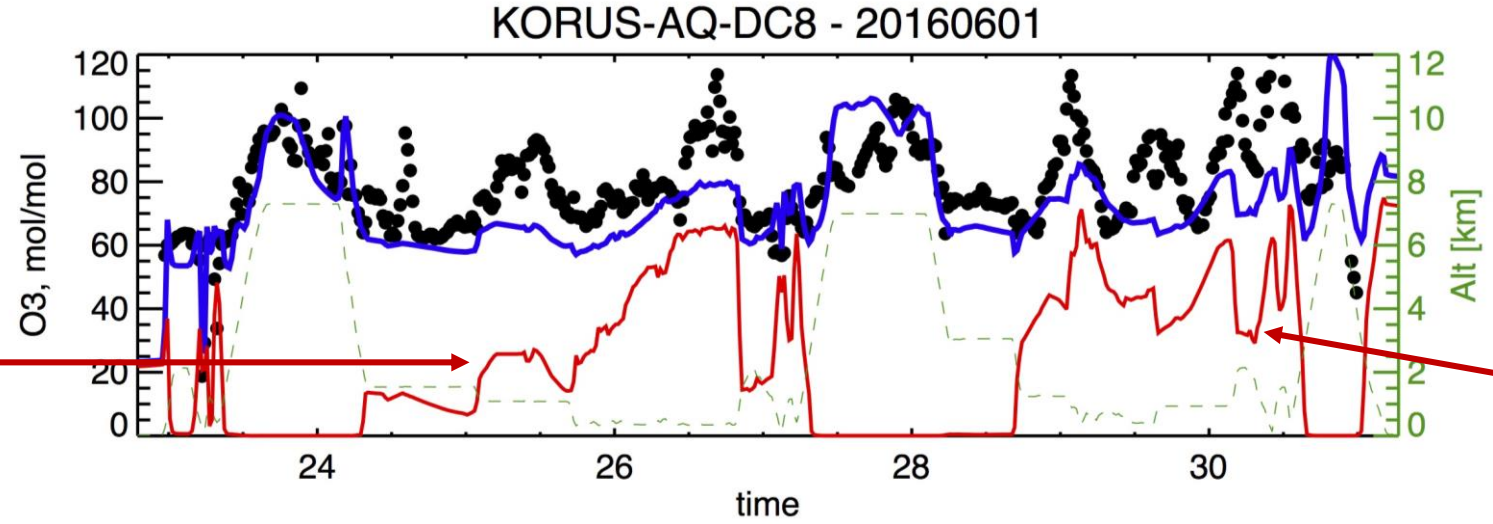


Jeju Island

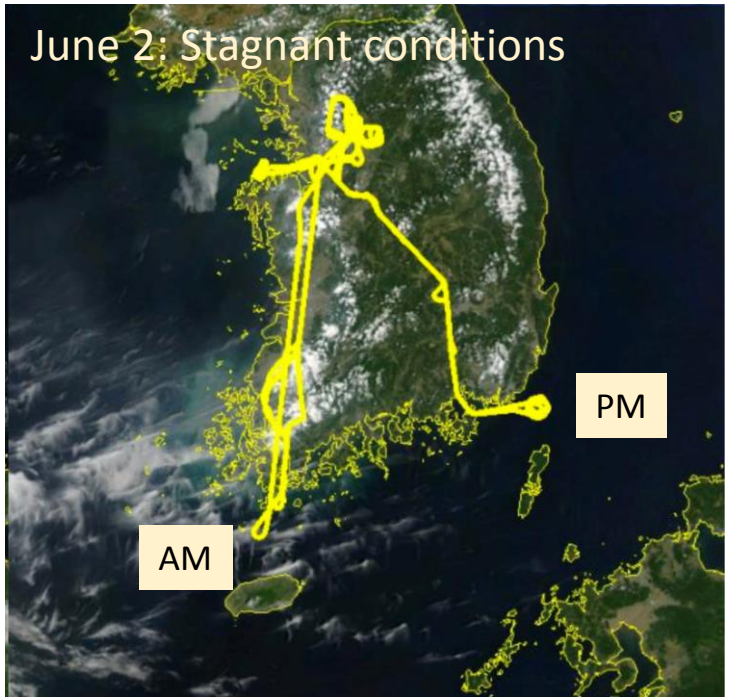
Tagged O_3 [ppb] (34.4 N, 126.3 E)

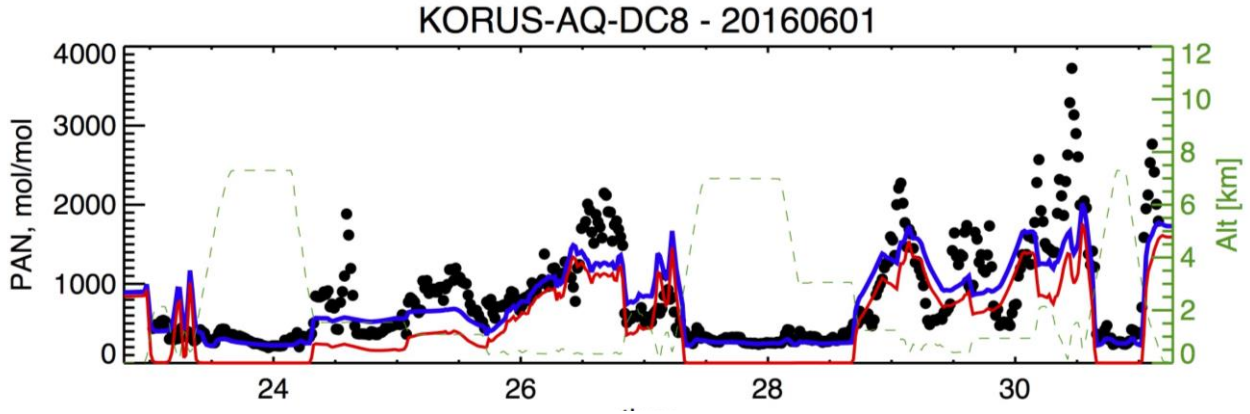


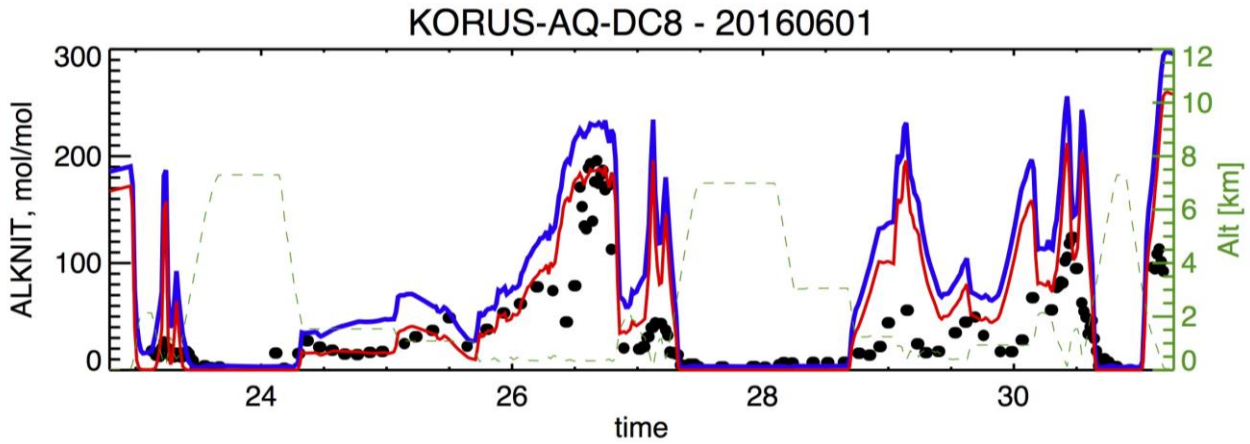
Morning leg shows low influence from Korean emissions at altitude and away from Seoul



Afternoon low altitude segments near Busan and Seoul have higher tagged O3







Shorter lived PAN, alkyl nitrates have high contribution of Korean emissions

On-going work

- Further analysis of this simulation
- Tagging of other regions (e.g., China, India, Japan)
- Effect of changing emissions (to match observations, or future scenarios)
- Compare to other source attribution studies for consistency

Space-borne Monitoring of NO_x Emissions from Cement Kilns in South Korea

Hyun Cheol Kim[1,2], Changhan Bae[3], MinAh Bae[3], Okgil Kim[3,4], Byeong-Uk Kim[5], Chul Yoo[4], Jinsoo Park[4], Jinsoo Choi[4], Jae-bum Lee[4], Barry Lefer[6], Ariel Stein[1] , and Soontae Kim[3]

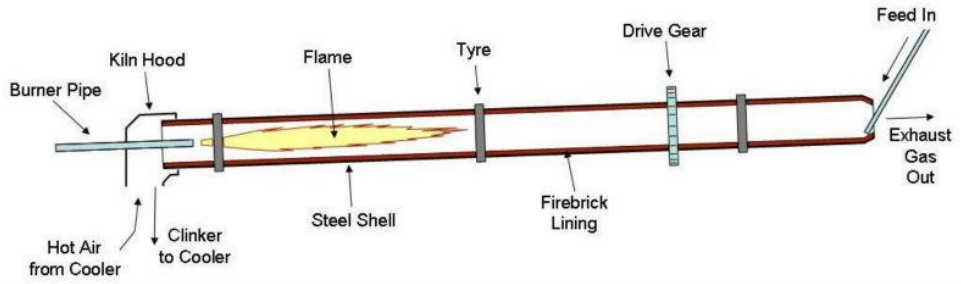
[1]Air Resources Laboratory, National Oceanic and Atmospheric Administration, College Park, MD
[2]Cooperative Institute for Climate and Satellites, University of Maryland, College Park, MD
[3]Department of Environmental and Safety Engineering, Ajou University, Suwon, Korea
[4]Climate and Air Quality Research Department, National Institute of Environmental Research, Incheon, Korea
[5]Georgia Environmental Protection Division, Atlanta, GA
[6]Tropospheric Composition Program, National Aeronautics and Space Administration

Motivation

- Emissions from cement industry is a serious issue in regional air quality and public health.
- Monitoring of emissions from cement kilns
  - Can Satellite detect small scale local emissions such as cement kilns?
  - Is current emission inventory correct?
  - Is regulation policy working? (in terms of long-term trend)
  - Do we have appropriate surface monitoring sites? (number & location)

Background: Cement Industry & Air Quality

- Due to the nature of cement production, cement kilns require temperatures of 2000^{o}C in their main burner.
- Emissions: NO_x, CO, CO_2, SO_2, Dust, and other toxics (Dioxins, Furans, PCB, PAH, BTEX, HCl and HF)
- NO_x emission from cement kilns is important pollutant by itself, but it is also a good indicator of other emissions.



SUNGSHIN Cement Co Ltd DANYANG factory

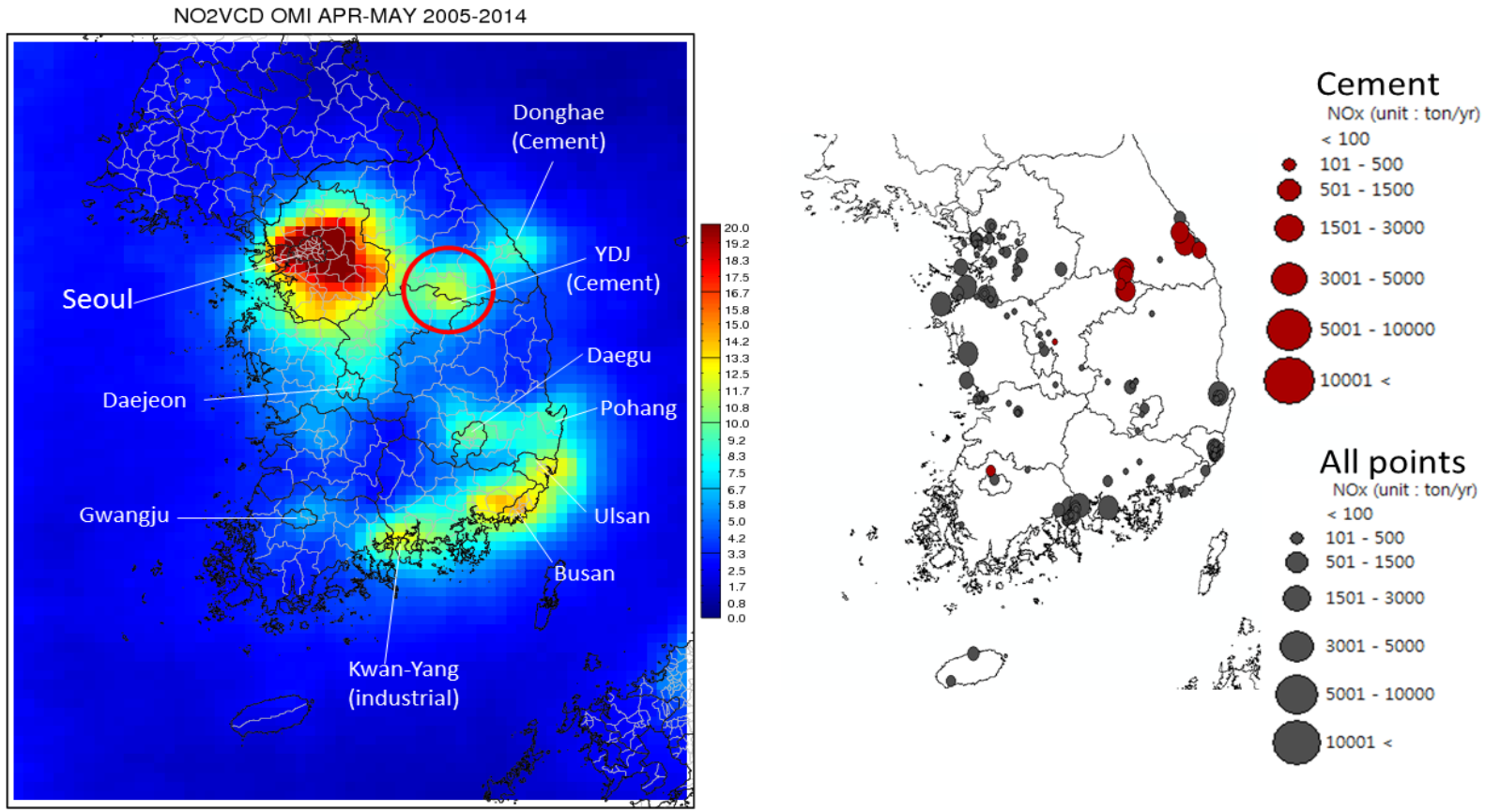
Model & Data

- Satellite: OMI NO_2 Vertical Column Density
- Model:
  - Meteorology: WRF
  - Emission: SMOKE using CAPSS (2007, 2010 & 2013)
  - Chemistry: CMAQ (9-km)

NO_2 VCD & NOx emissions in South Korea

(A) OMI NO2 VCD

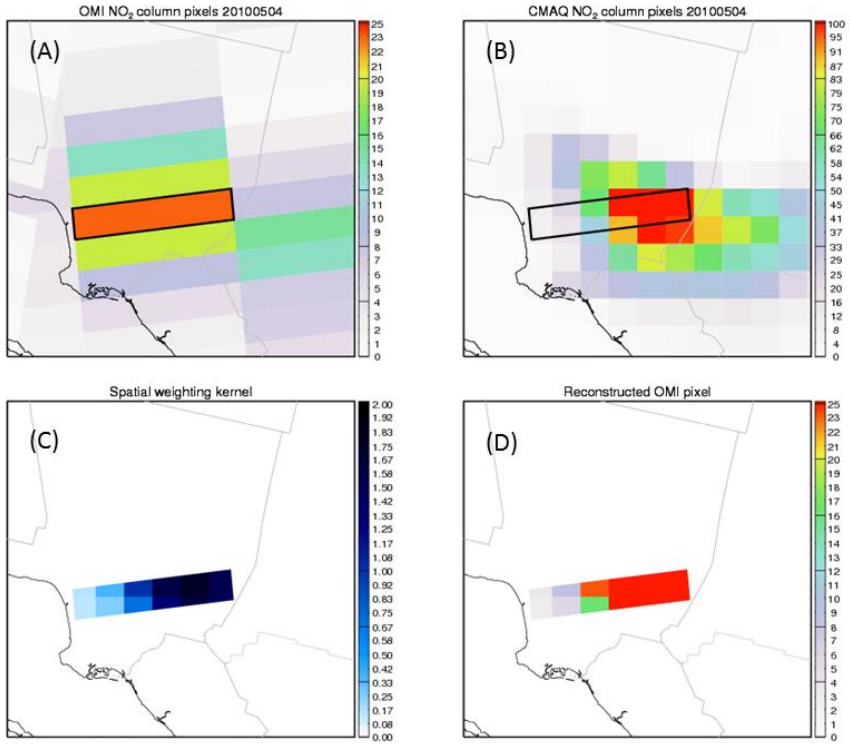
(B) NO_x emissions point sources



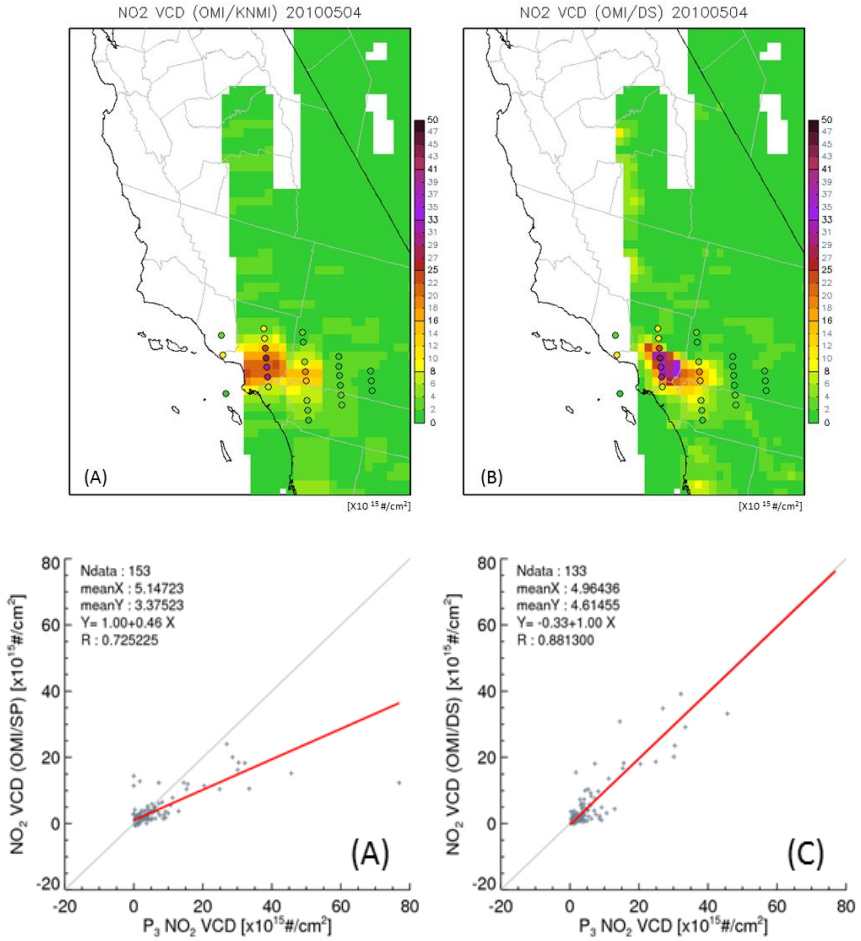
Spatial distributions of (a) OMI NO_2 VCD, (b) NO_x emissions from the CAPSS 2010 emission inventory

Downscaling Technique: OMI NO_2 VCD data processing

Conservative Downscaling of OMI NO2 VCD

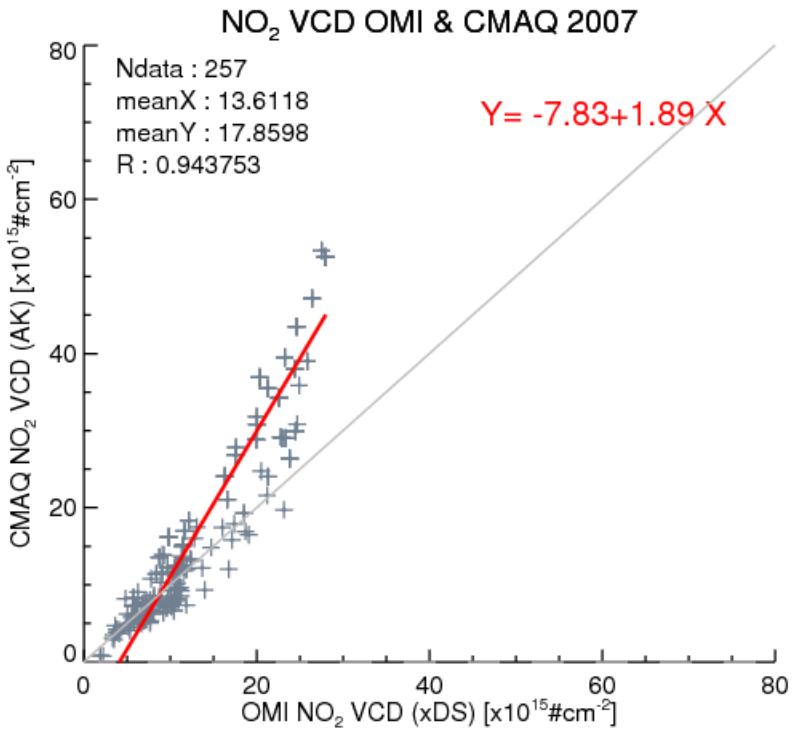


OMI pixels are *conservatively* reconstructed using fine-scale model's spatial information

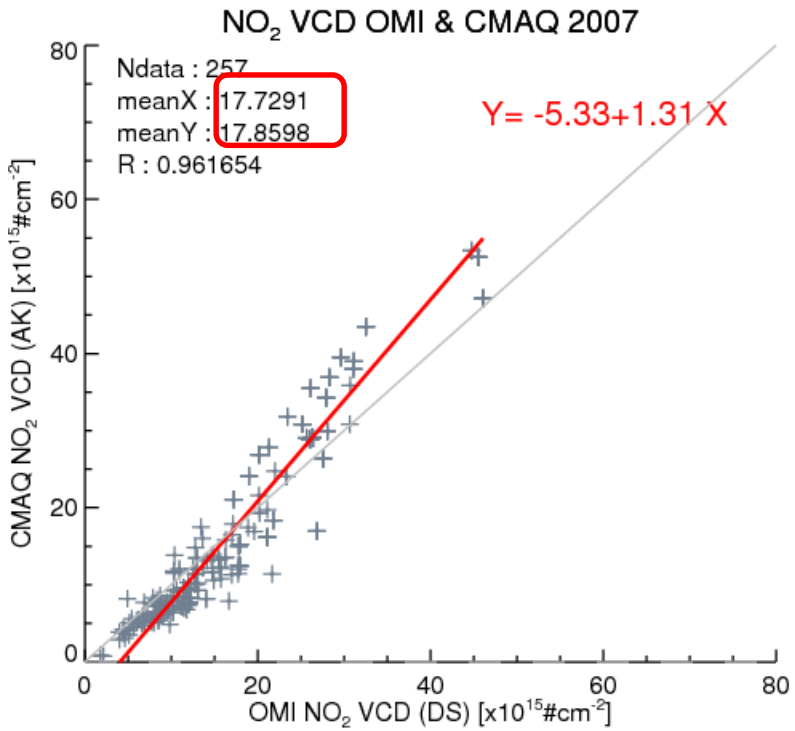


CALNEX 2010 campaign (Kim et al., 2016, GMD)

How the DS method works: Comparison with 2007 CAPSS emission inventory

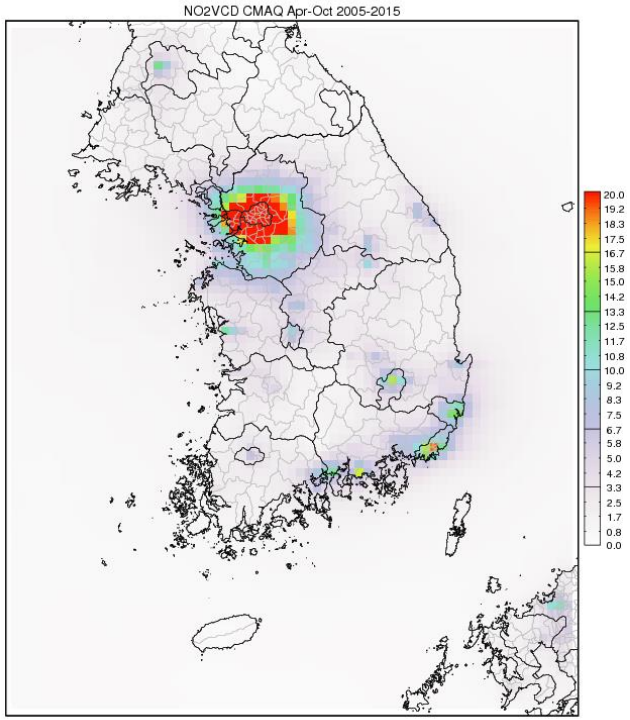


Before Downscaling

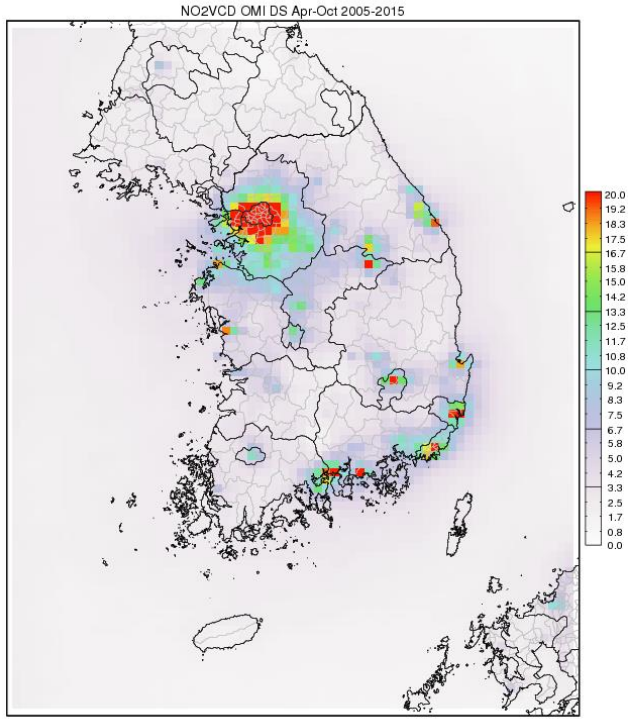


After Downscaling

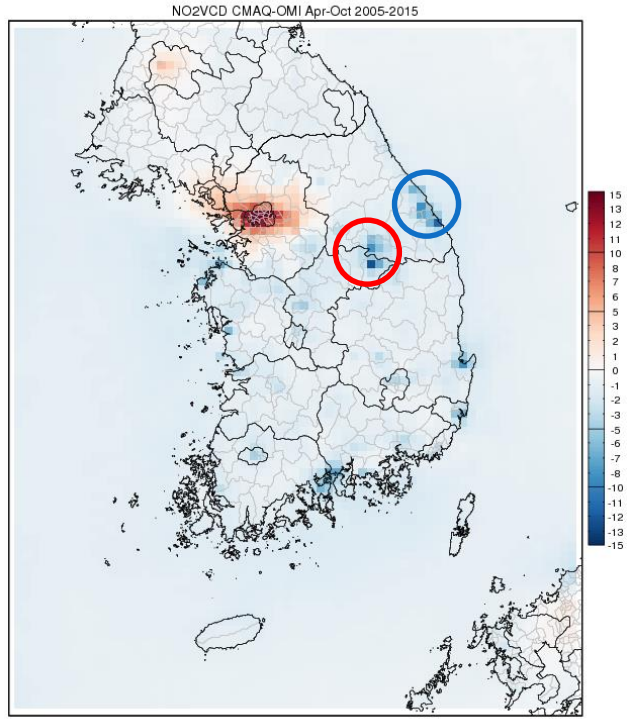
Comparison of model & satellite NO_2 VCD



CMAQ/CAPSS 2007

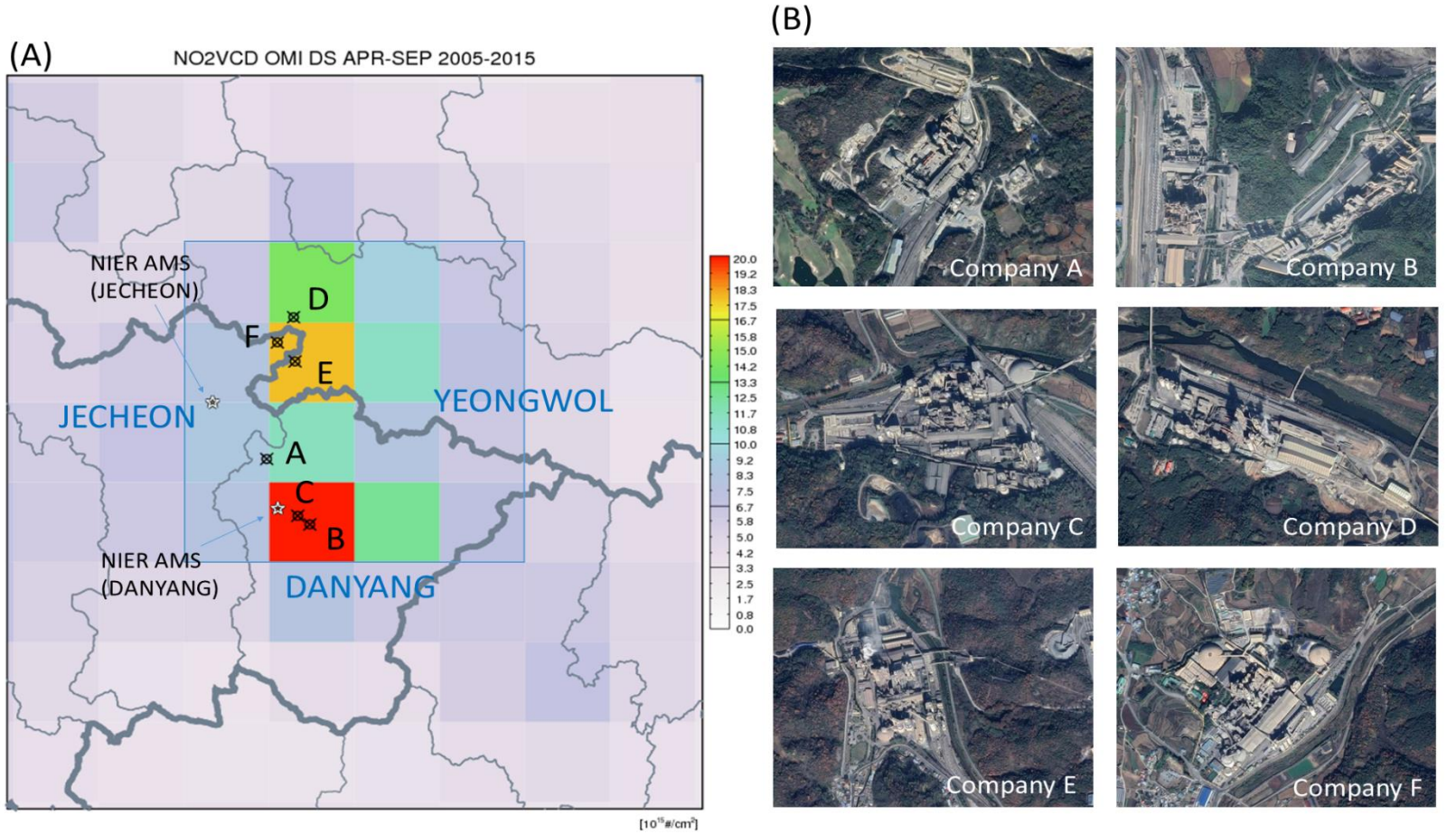


OMI



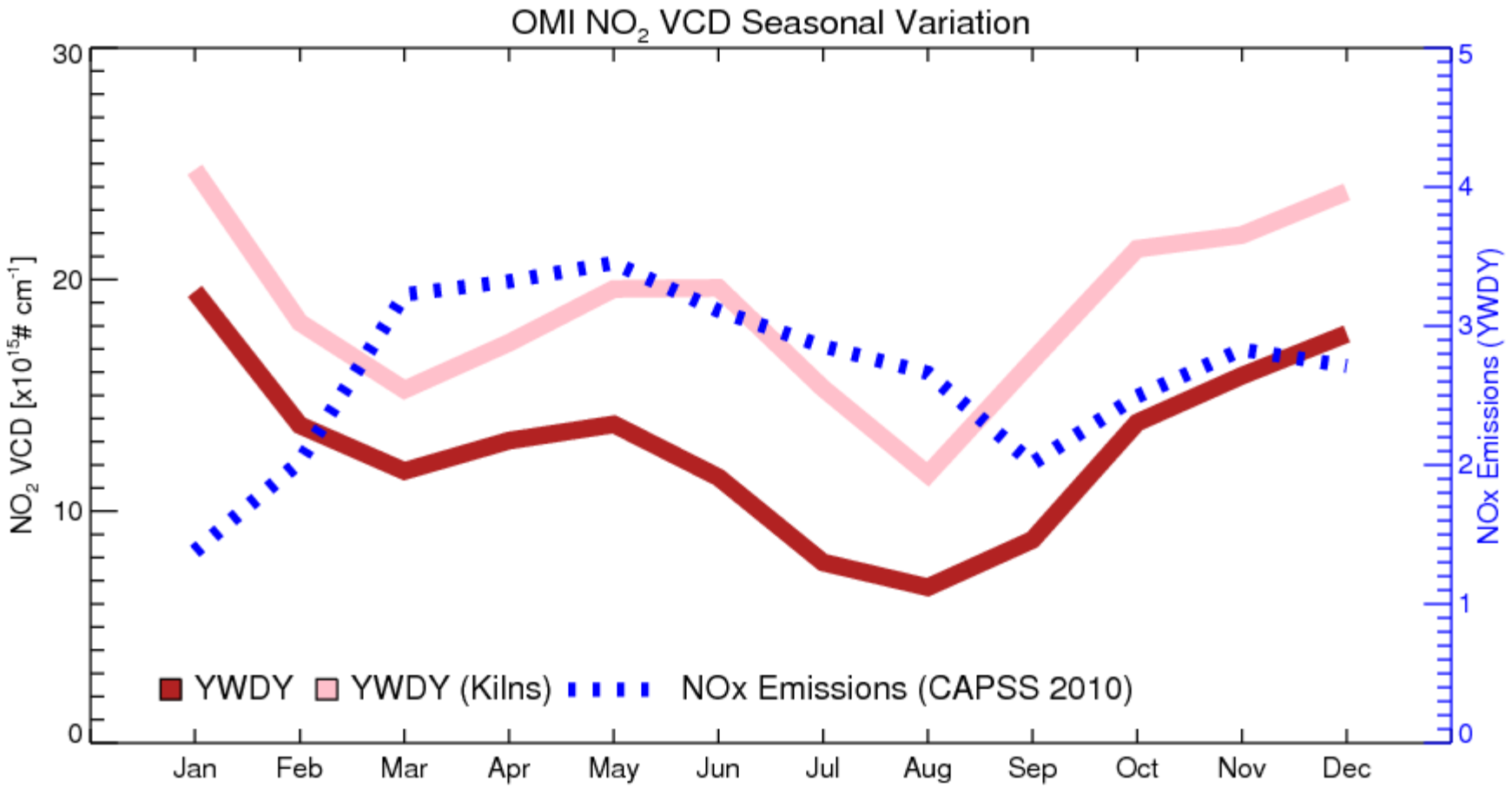
CMAQ - OMI

Cement Kilns in Danyang, Youngwol & Jecheon

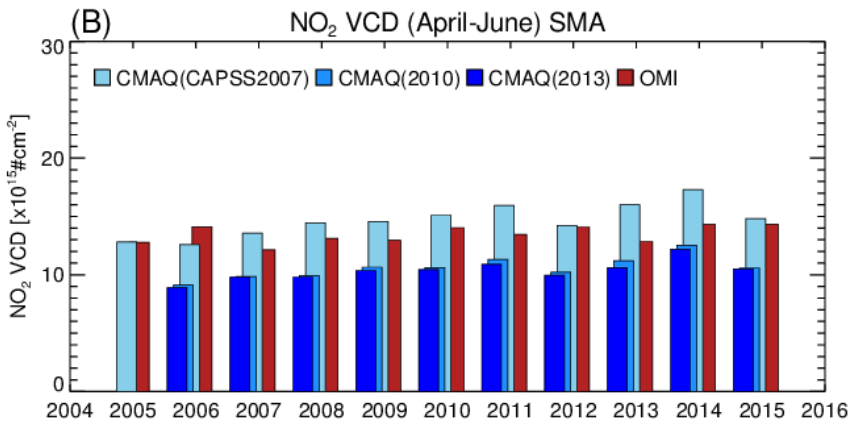


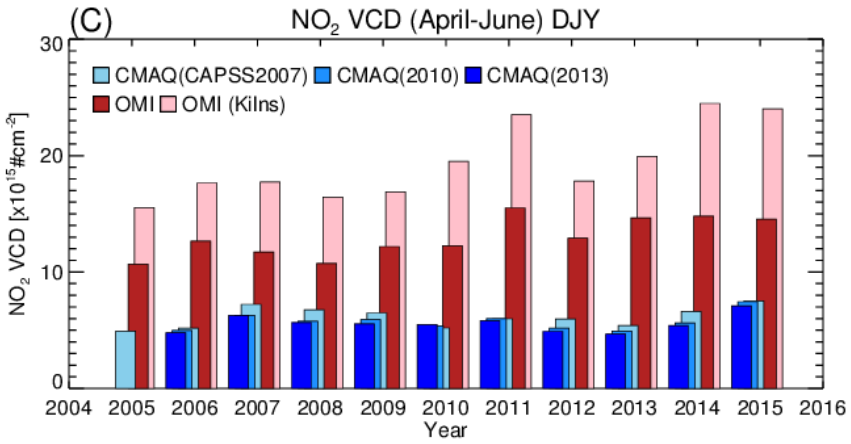
(a) Geographical locations of six cement factories in the YDJ region and of NIER AMS surface-monitoring sites (Jecheon and Danyang) over the OMI NO_2 VCD distribution (April–September average from 2005 to 2015). (b) Satellite pictures of factories.

OMI NO_2 VCD Seasonal Variation



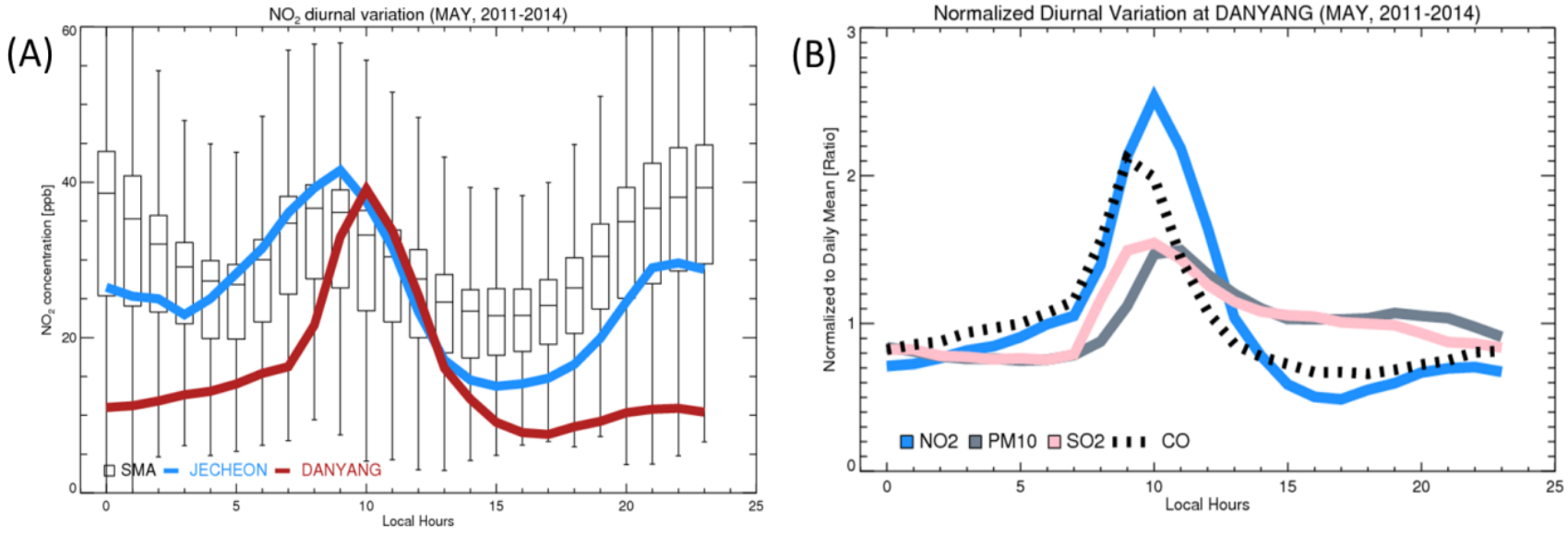
Interannual variation of NO_2 VCD



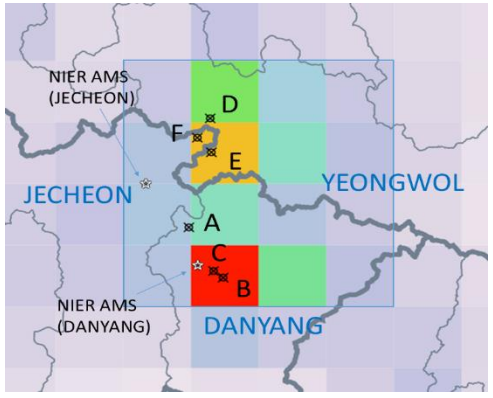


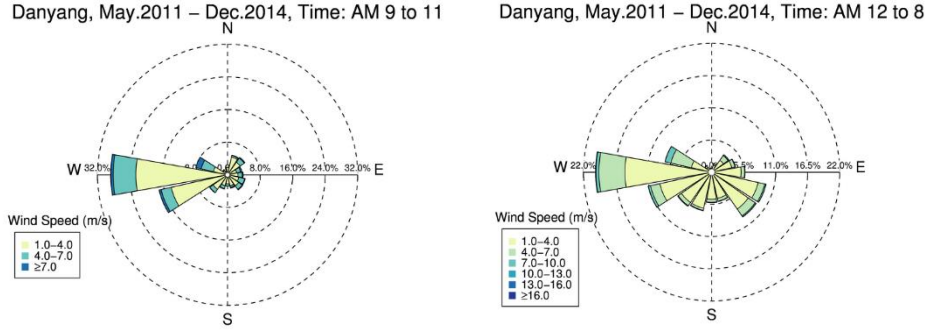
- Modeled NO_2 VCD is slightly higher than OMI NO_2 VCD in the SMA, implying possible overestimation of current emission inventory.
- In YW-DY region, there are considerable underestimations in modeled NO_2 VCDs.

Surface monitors (Jecheon & Danyang)



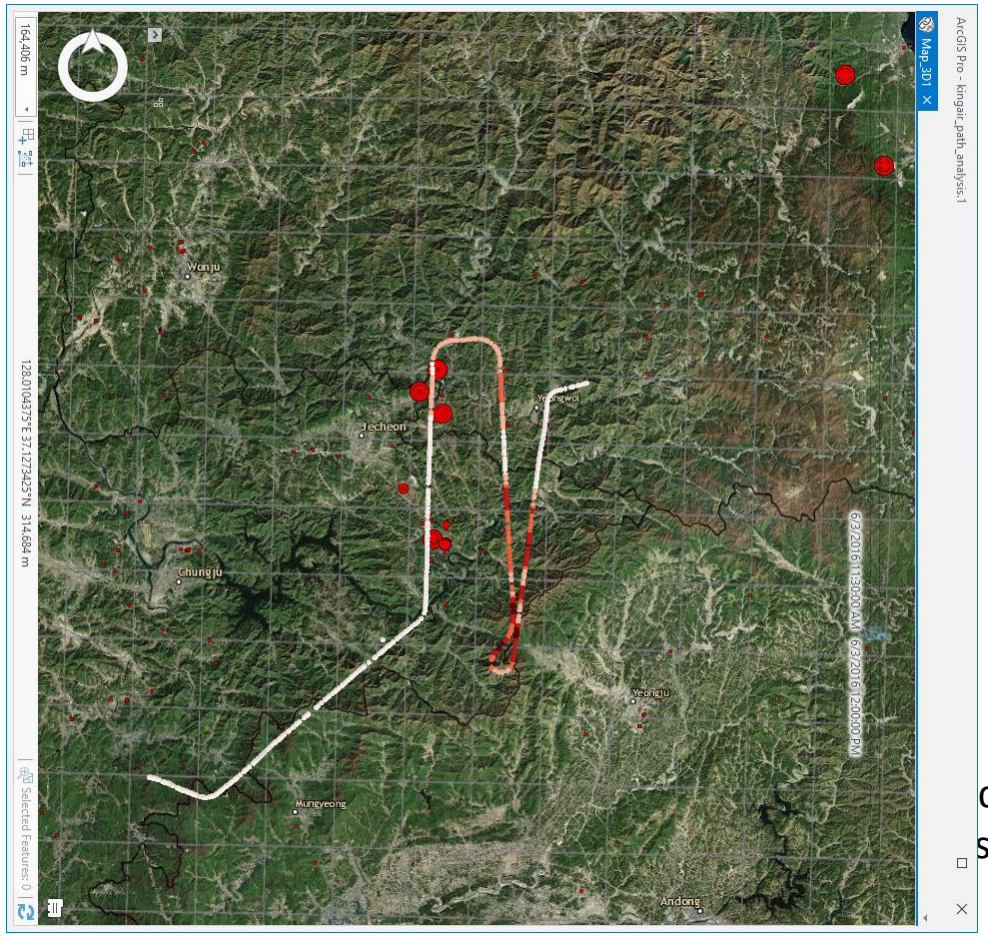
(a) Diurnal variation of NO_2 concentrations over the Jecheon (blue), Danyang (red), and the SMA (whisker boxes) regions, and (b) normalized diurnal variations from the Danyang site for NO_2, PM_{10}, SO_2, and CO concentrations.

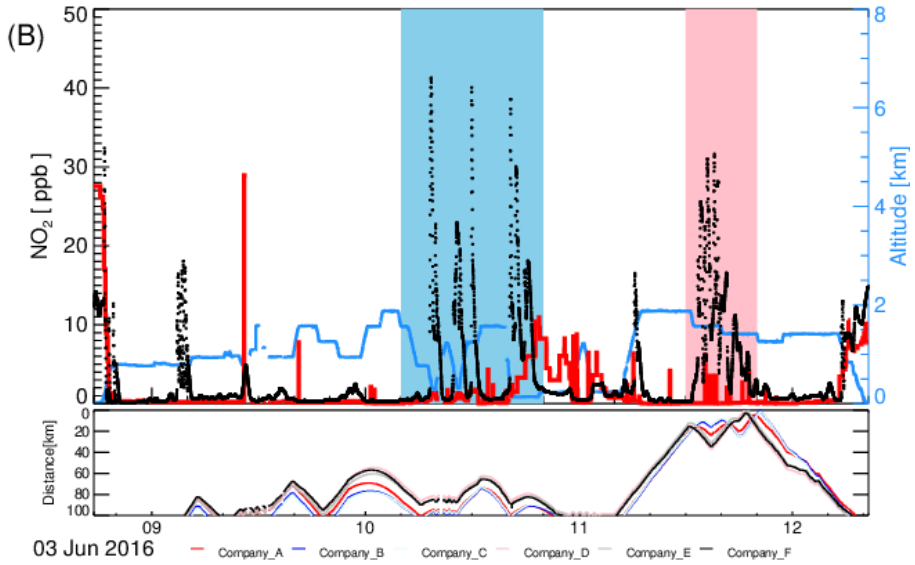




Wind rose analyses at the Danyang surface-monitoring site.

Observations from King-Air (KORUS-AQ)





of NO_2 concentration measured by King-Air aircraft
d campaign. The thick red line shows modeled NO_2
stances from the aircraft to six YDJ cement factories

Impact assessment by model

- Two CMAQ simulations
  - CEMENT1 : Impact of cement industry emissions (CAPSS 2013)
  - CEMENT2 : X2 cement emissions

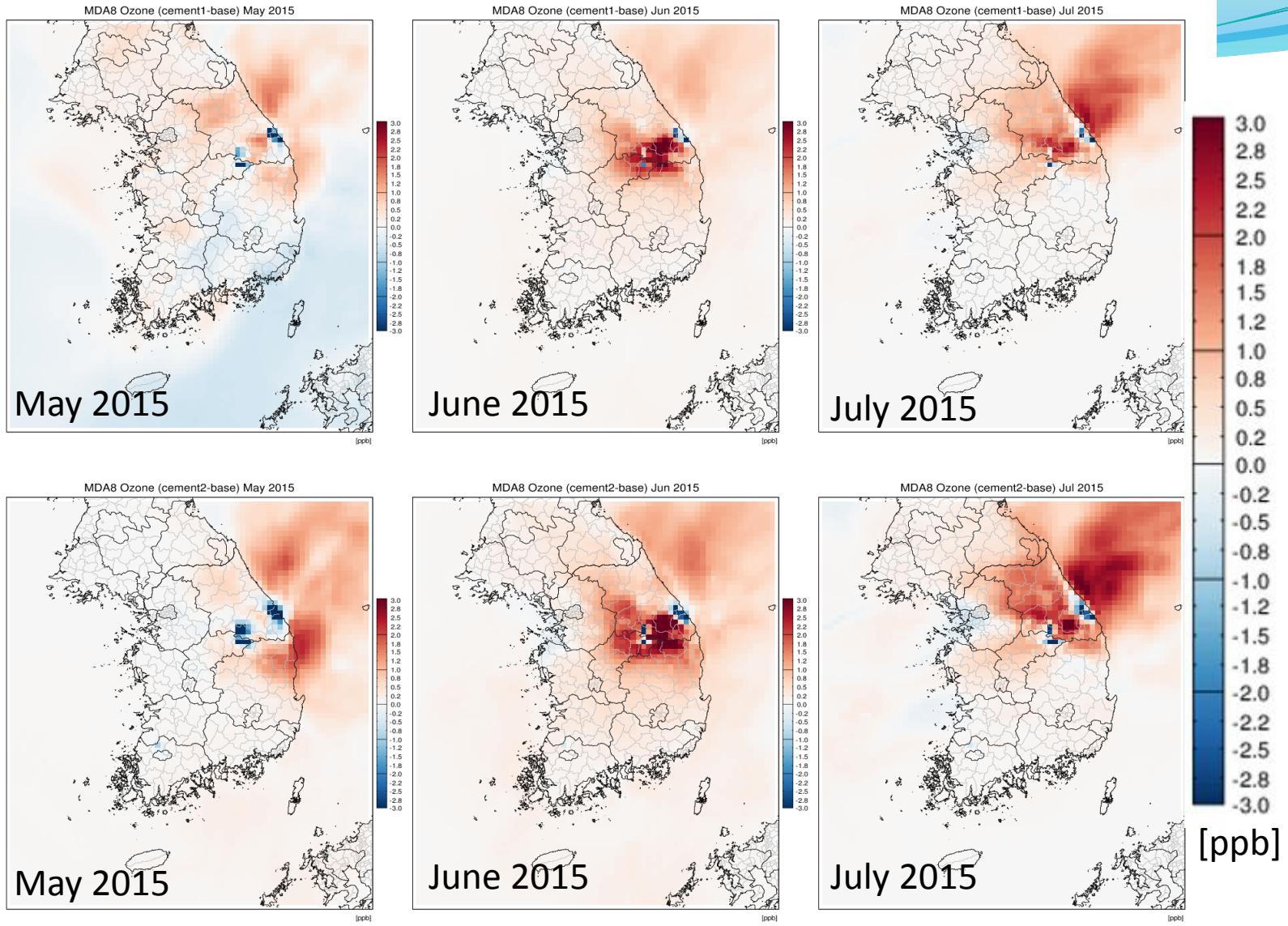
Code	SCC1	SCC2	SCC3	SCC4
03021300	Industrial Combustion	Furnace	Cement	
03022000	Industrial Combustion	Furnace	Misc.	
03010100	Industrial Combustion	Combustion facilities	1-3 class boiler	
04990201	Industrial processes	Misc. manufacturing	Cement (Carbon removing)	Point source
04080202	Industrial processes	Ammonia consumption	SNCR	Industrial
09010201	Waste disposal	Waste incinerator	Industrial waste	< 200kg/hr

CAPSS Source Classification Codes corresponding to emissions by the cement industry.

MDA8 Ozone

Cement (CAPSS 2013)

2X Cement (CAPSS 2013)

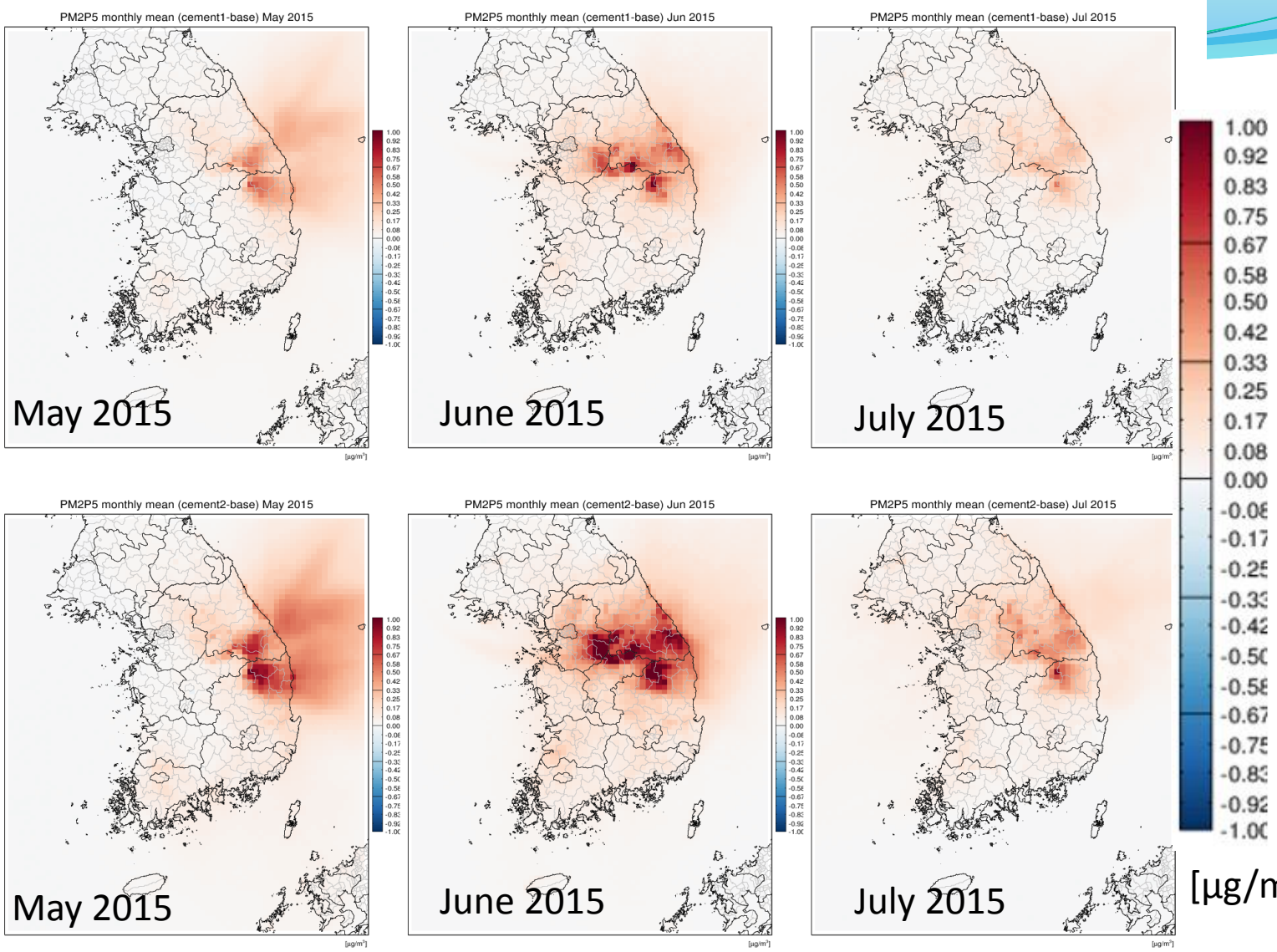


Impact of emissions from the cement industry on MDA8 O_3 during May to July, 2015. Simulated impacts are shown based on the current CAPSS 2013 emissions inventory (upper) and satellite measurements (lower).

MDA8 Ozone

Cement (CAPSS 2013)

2X Cement (CAPSS 2013)



Impact of emissions by the cement industry on monthly averaged $PM_{2.5}$ concentration during May to July, 2015. Simulated impacts are shown based on the current CAPSS 2013 emissions inventory (upper) and satellite measurements (lower).

Conclusions

- *Can Satellite detect small scale local emissions such as cement kilns?* Yes. Especially, the downscaling technique can help enhance fine structures of satellite observations for fair satellite-to-model comparison.
- *Is current emission inventory correct?* Maybe not. NO_2 VCD comparisons suggest that current NOx emission inventory might be seriously underestimated.
- *Is regulation policy working?* Maybe not. Recent data show slightly increasing signal, which is contrast to decreasing NOx emission trends, especially in the SMA.
- *Do we have appropriate surface monitoring sites?* Maybe not. Need monitors on the downwind side to properly represent emissions from cement industry.

KORUS-AQ CONTEST QUESTION FOR APRIL

How good is a 14 day weather forecast? Temperatures in April have been all over the place.

Earth Day is April 22nd and we all would like for it to be a nice day. The current forecast predicts a high of 70F/21C in Seoul and 51F/11C in Washington, DC

Give me your best forecast for these two cities, and let's see who gets closest. Answers can be provided in either F or C (or K).

To enter the contest, answers must be emailed to James.H.Crawford@nasa.gov before noon (eastern time) on Tuesday (10 April)

If you are in another time zone, do the math…