Updated Aerosol-Explicit POMINO Algorithm for Trace Gas Retrievals for OMI and TropOMI: Possible Collaborations with GEMS Teams

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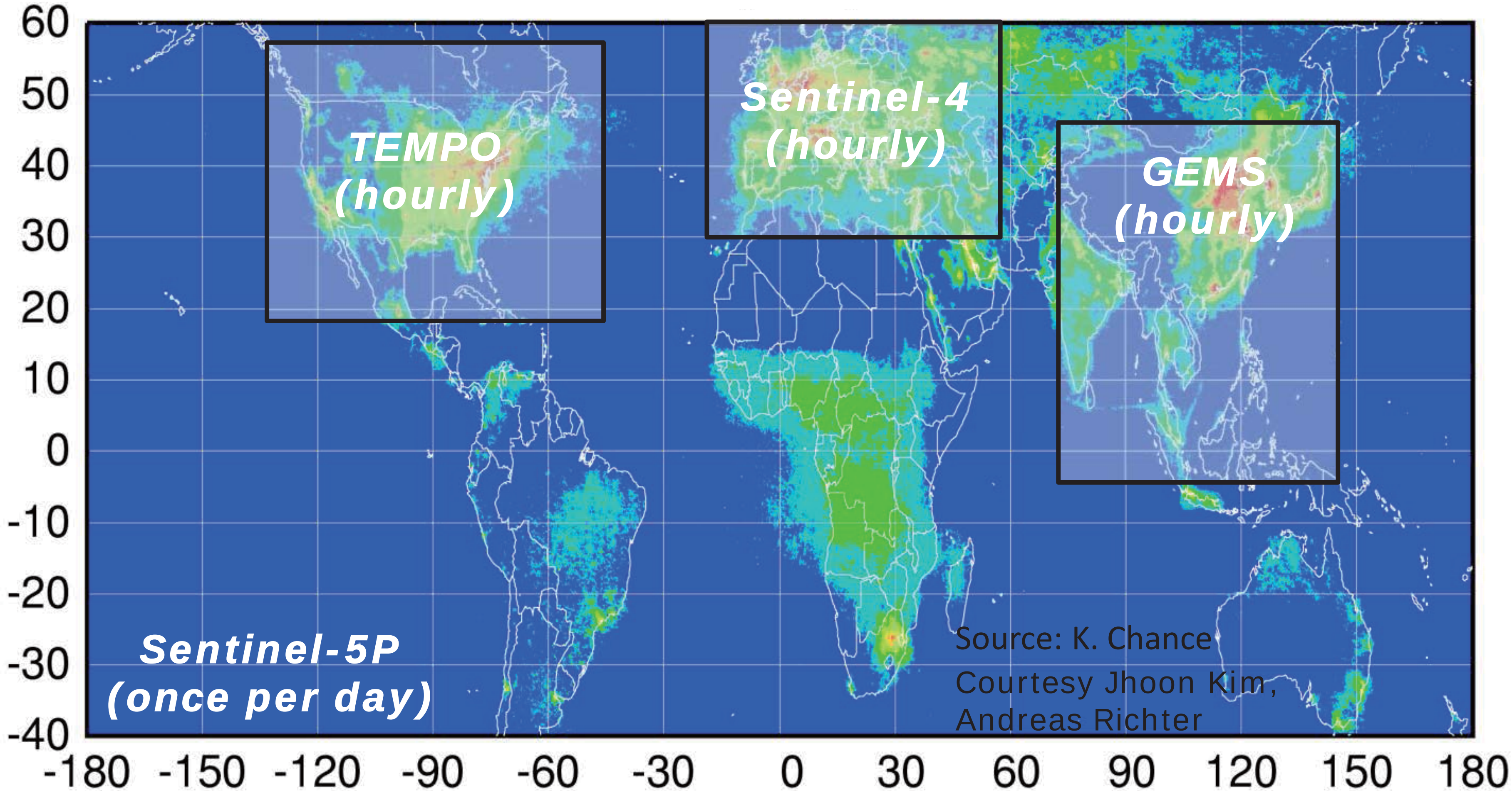
High-Resolution Geostationary and Polar Orbiting Satellite Measurements of NO_2 and Other Tracers



NO_2 sensors so far: GOME, SCIAMACHY, OMI, GOME-2A/B, TropOMI

NO_2 Retrieval Algorithm

Step 1: SCD from DOAS calc.
Step 2: Stratospheric NO_2
Step 3: Tropospheric AMF – *most important*

- Surface albedo; Surface air pressure
- Aerosol absorption and scattering
- Eff. cloud fraction and cloud top pressure
- Vertical profile of NO_2

SCD = F(radiance)
TSCD = SCD – SSCD
TVCD = TSCD / AMF

Prevailing NO_2 algorithms:

- Implicitly accounting for aerosol optics
- Inconsistent ancillary assumptions between NO_2 and cloud products
- (Typically) no geometric dependence of surface reflectance
- (Often) coarse-resolution NO_2 profile
- Use of look-up table

POMINO algorithm:

- Explicitly accounting for aerosols
- Same ancillary assumptions in retrieving NO_2 and clouds
- Accounting for surface reflectance anisotropy
- High-resolution NO_2 profile
- RTM calculation for each pixel

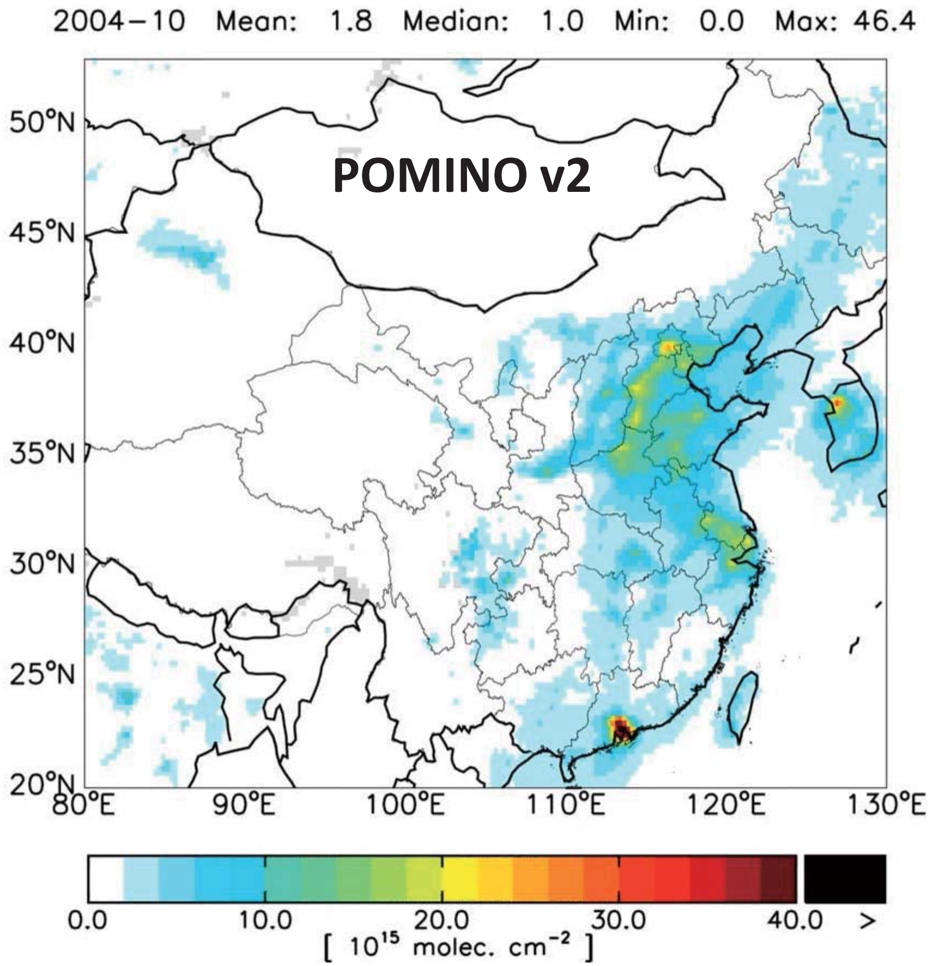
http://www.phy.pku.edu.cn/~acm/acmProduct.php#POMINO

Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

POMINO – Peking University OMI NO_2 Product

http://www.phy.pku.edu.cn/~acm/acmProduct.php#POMINO

All Level-2 and Level-3 data are freely available



Features:

- Explicit aerosols
- Coherent clouds
- Anisotropic Rs
- High-res NO_2 prof.
- Pixel-specific RTM

Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

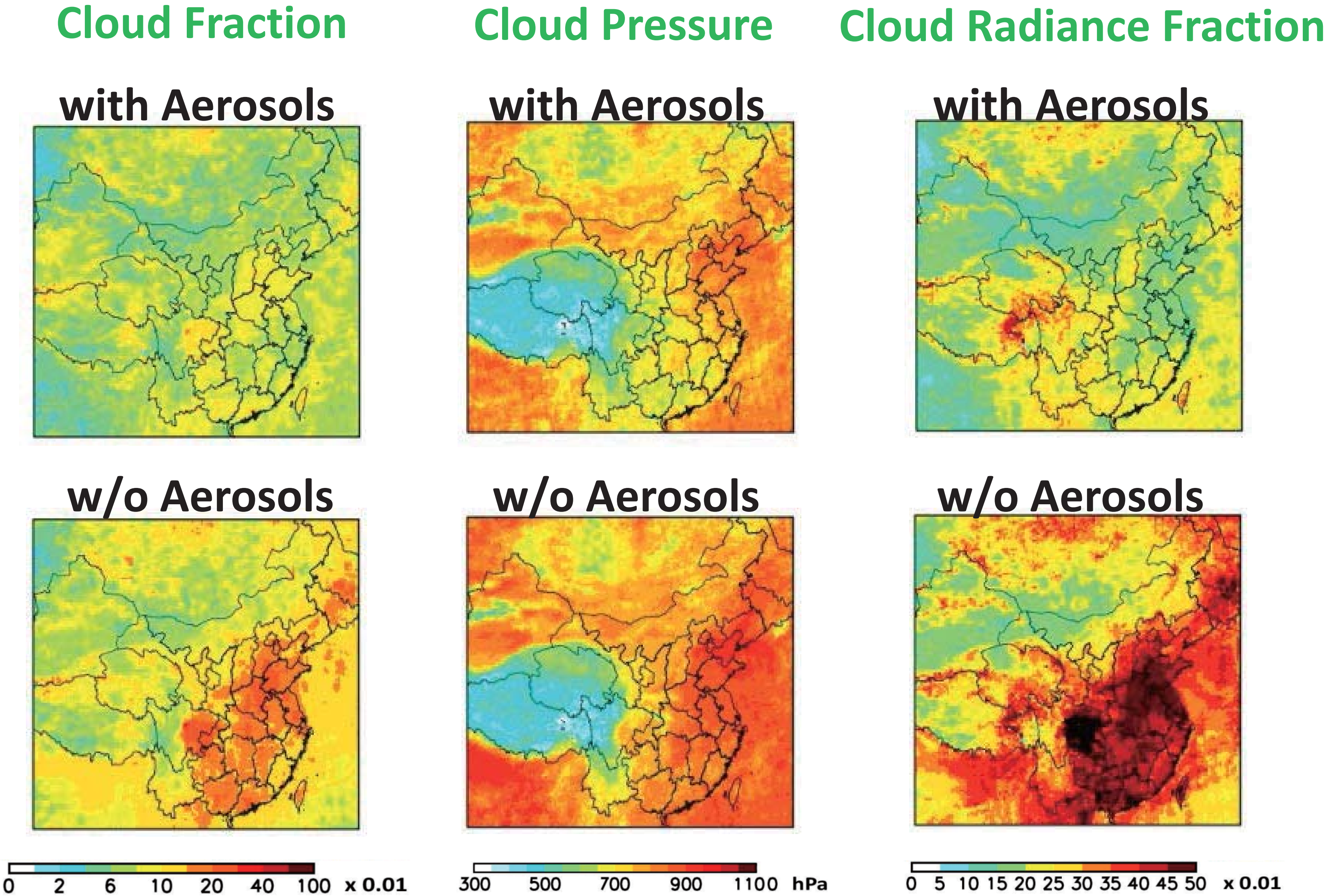
NO_2 Retrieval Algorithms for OMI

	DOMINO v2	POMINO v2
RTM	DAK v3.0 (polarized, parallel atmosphere)	LIDORT v3.6 (un-polarized, curved atmosphere)
Calculation for individual pixels	Interpolated from a look-up table	Pixel-specific radiative transfer modeling; no look-up table
Surface reflectance	OMLER v1 (3-year average; 0.5º)	BRDF; MCD43C2 Collection 6 (0.05º)
Surface pressure	TM4 (3° lon x 2° lat); adjusted by elevation	Nested GEOS-Chem (25–50 km); adjusted by elevation
Cloud fraction	OMCLDO2 v1.1.1.3; by look-up table	Derived here
Cloud pressure	OMCLDO2 v1.1.1.3; by look-up table	Derived here
Aerosol optics	Treated implicitly as 'effective' clouds	GEOS-Chem simulations; AOD is adjusted by MODIS, and aerosol vertical profile by CALIOP monthly climatology
Pressure levels, temperature profile, and NO_2 vertical profile	TM4 (3° lon x 2° lat; 34 layers with ~ 5 layers below 1.5 km)	Nested GEOS-Chem (25–50 km; 47 layers with ~ 10 layers below 1.5 km)

Cloud Retrievals From OMI

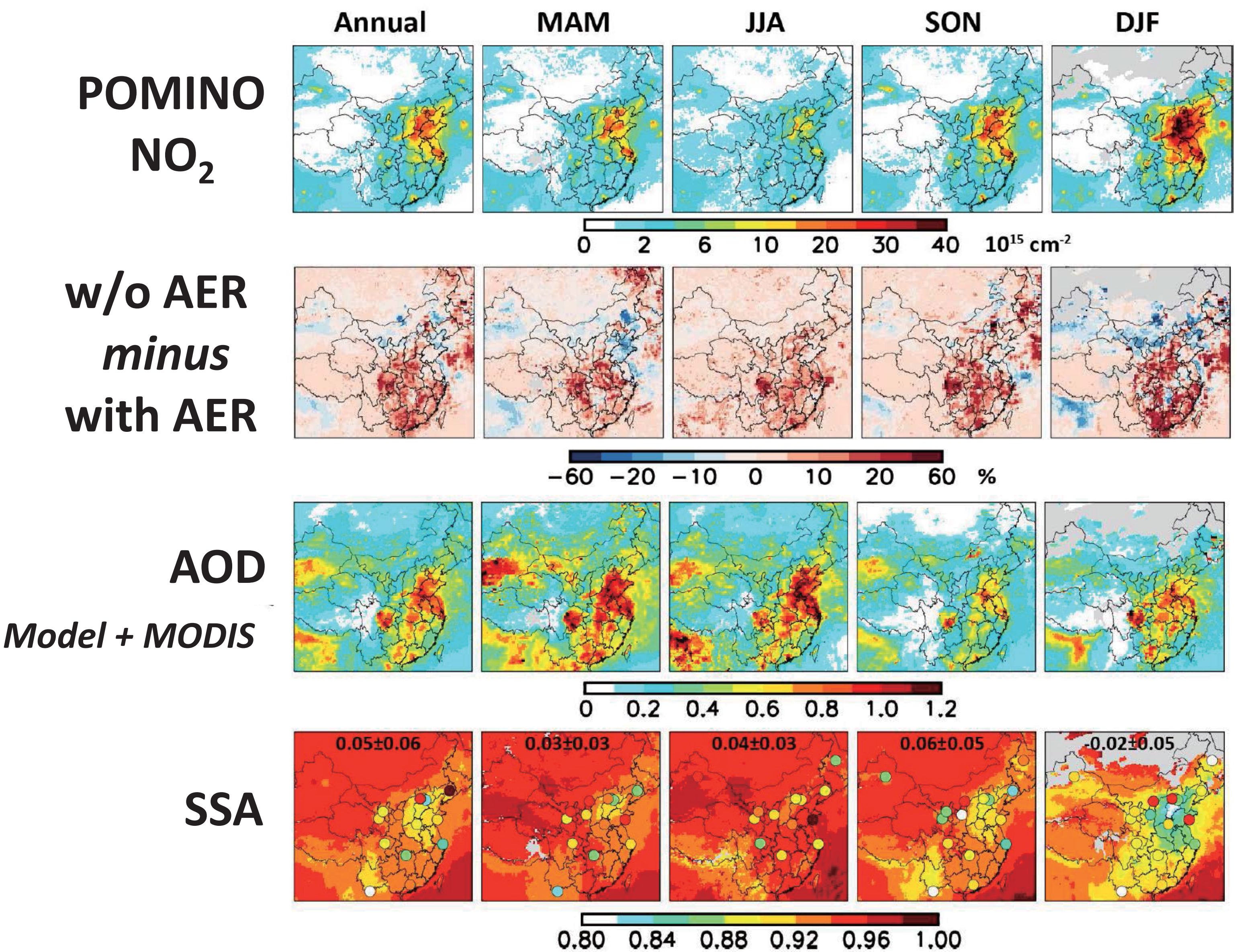
	OMCLDO2 v1.1.1.3	POMINO v2
RTM	DAK v3.0 (polarized, parallel atmosphere)	LIDORT v3.6 (un-polarized, curved atmosphere)
Calculation for individual pixels	Interpolated from a look-up table	Pixel-specific radiative transfer modeling; no look-up table
Surface reflectance	OMLER v1 (3-year average; 0.5º)	BRDF; MCD43C2 C6 (0.05º)
Surface pressure	Interpolated from a fixed pressure-height relation (midlatitude summer profile)	Nested GEOS-Chem (25–50 km); adjusted by elevation
Aerosol optics	No aerosols	GEOS-Chem simulations; AOD is adjusted by MODIS C6, and aerosol vertical profile by CALIOP monthly climatology
Pressure levels and temperature profile	Fixed dependence on height (midlatitude summer profile)	Nested GEOS-Chem (25–50 km; 47 layers with ~ 10 layers below 1.5 km)

Complex Effects of Aerosols on Cloud Retrieval



Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

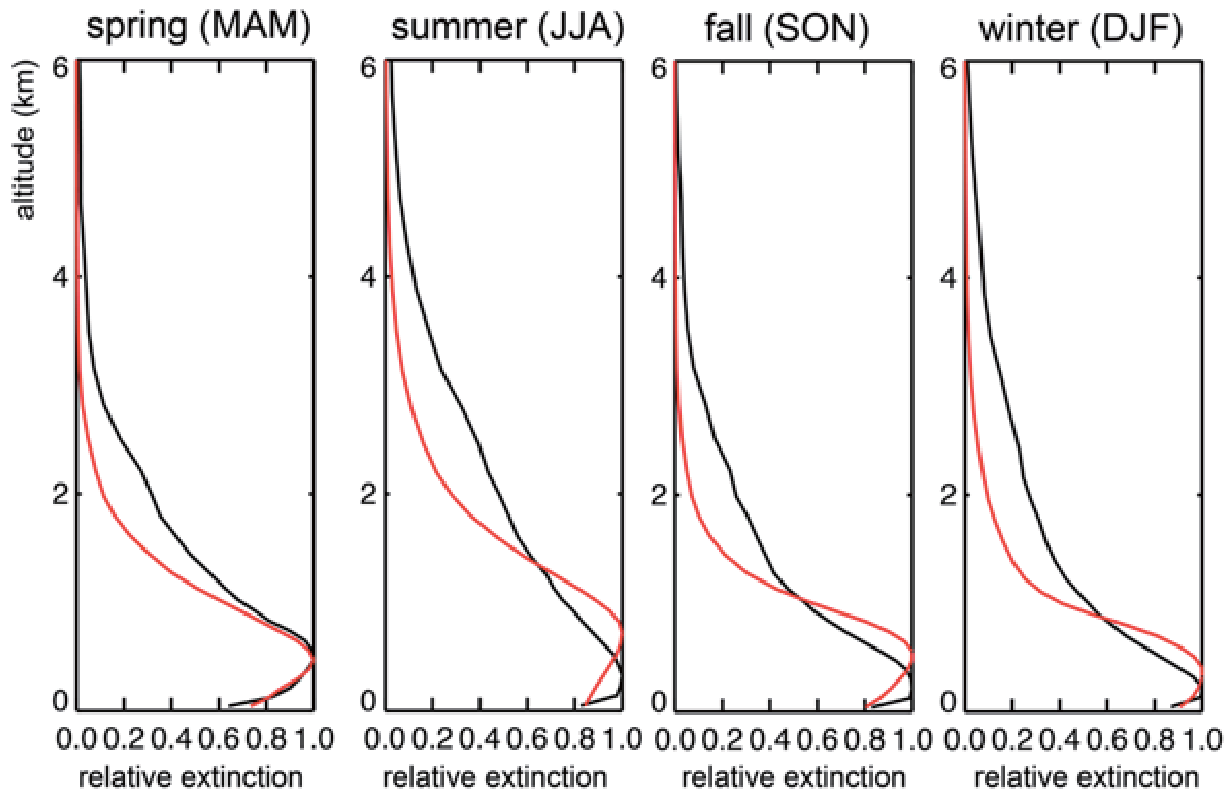
Explicitly Accounting for Aerosols is Critical



Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

Constraining Model Aerosol Profile by CALIOP

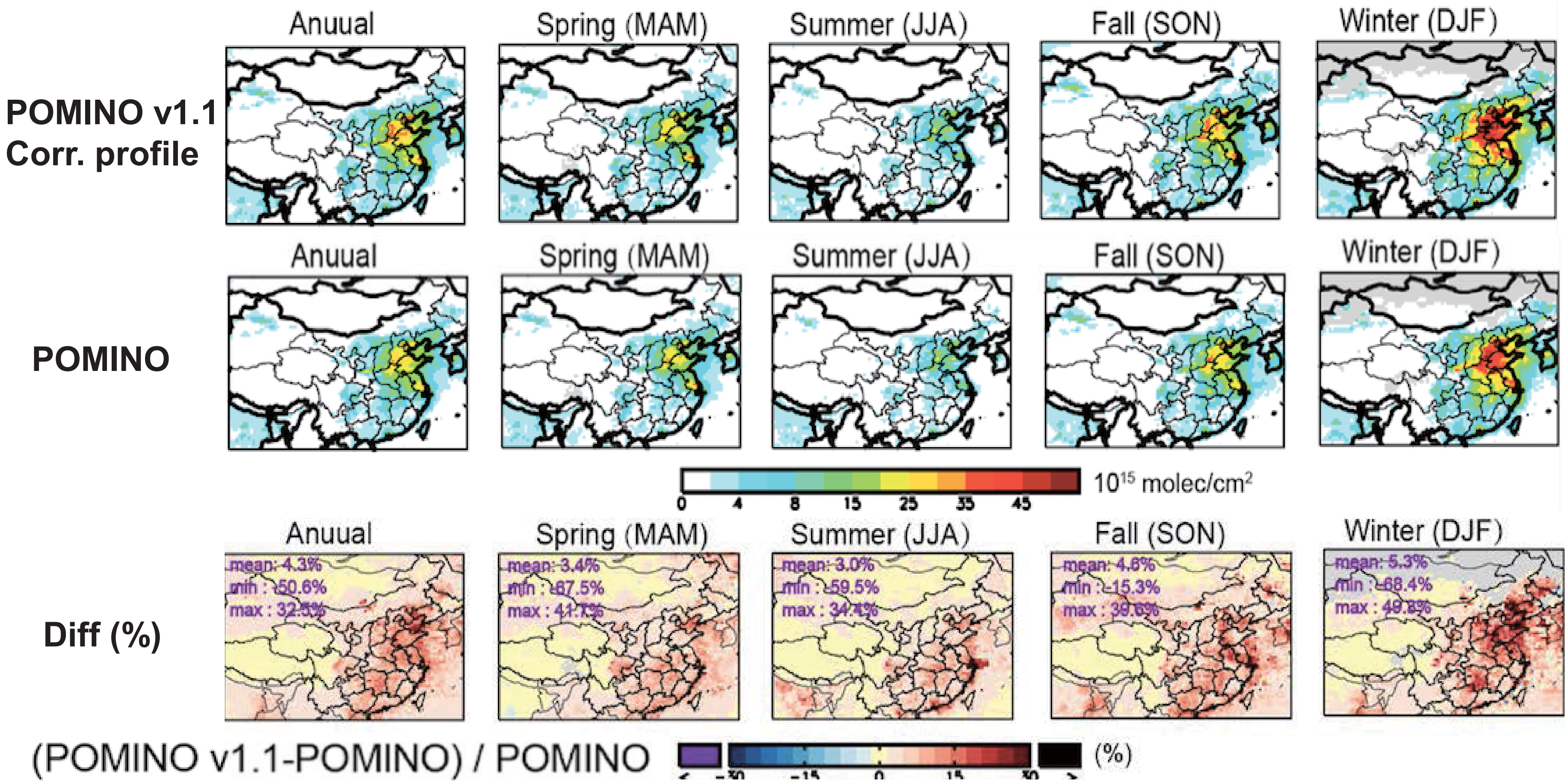
Aerosol extinction profile standardized by maxima of the profile (Northern East China, 2012)



(b)

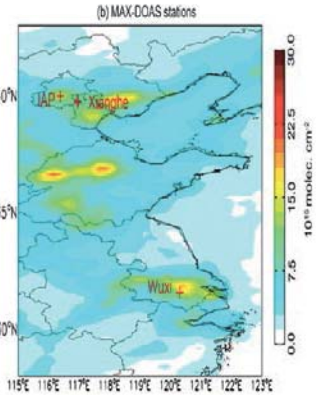
Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

Correcting Aerosol Profile Increases NO_2 VCD by ~ 15% Averaged over East China in 2012



Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

Comparison with MAX-DOAS Data

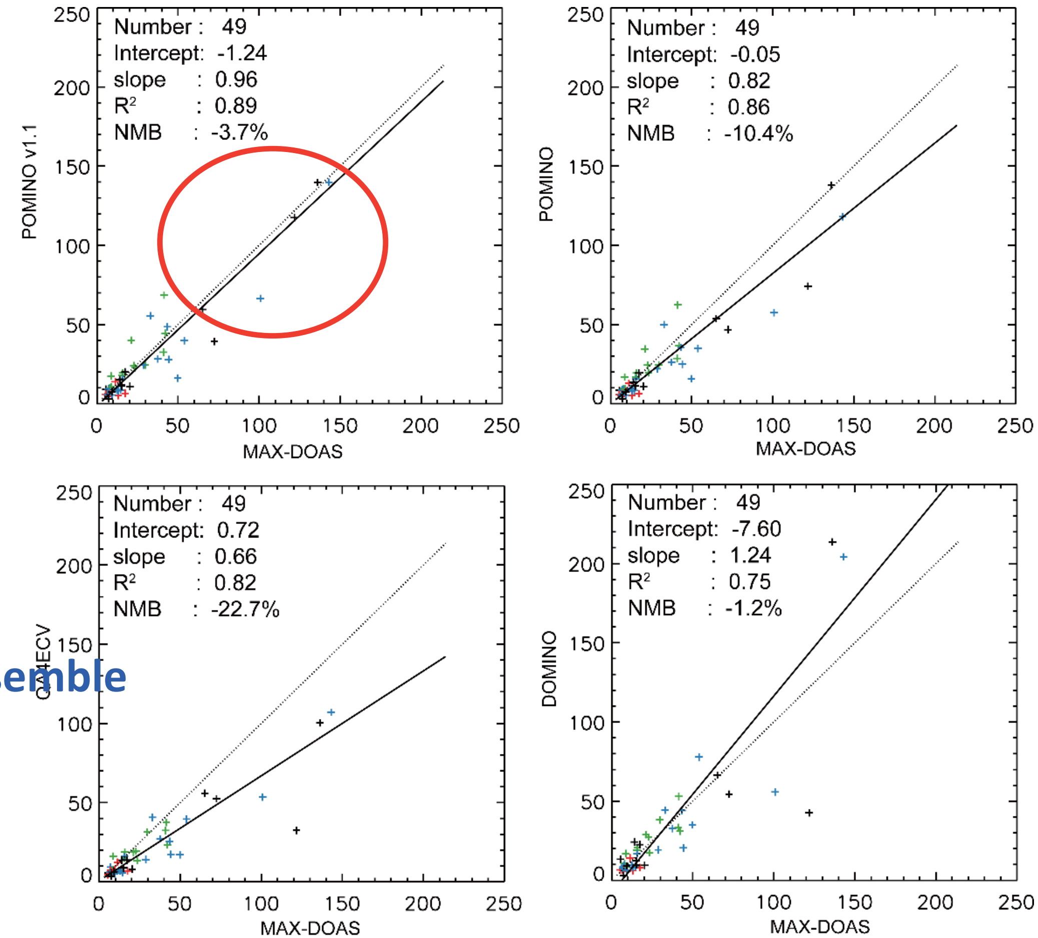


POMINO v1.1
MODIS AOD
+ CALIOP Profile

POMINO
MODIS AOD

QA4ECV
Satellite data ensemble
No aerosols

DOMINO v2
No aerosols

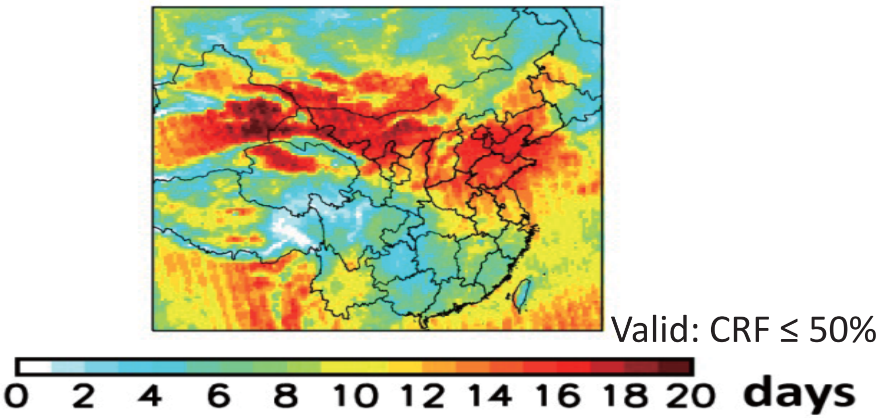


Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

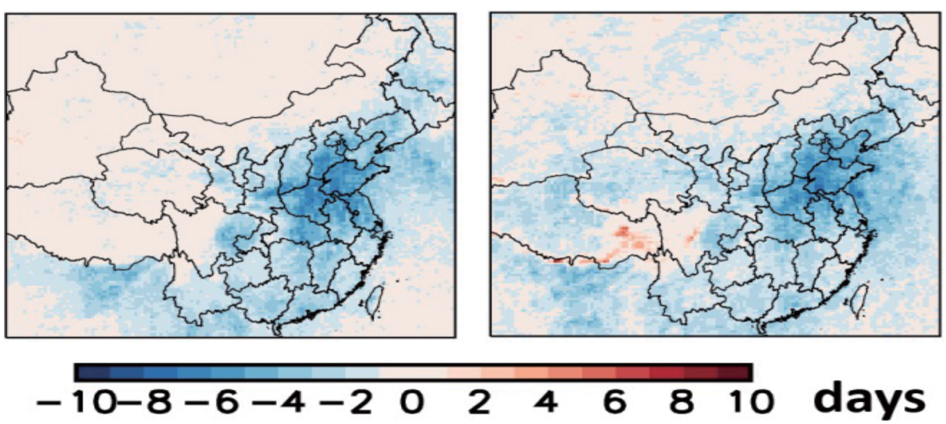
Explicit Aerosol Representation Reduces Sampling Low Bias by Better Accounting for Polluted Days?

Days per Month with Valid Data

POMINO (with AER)

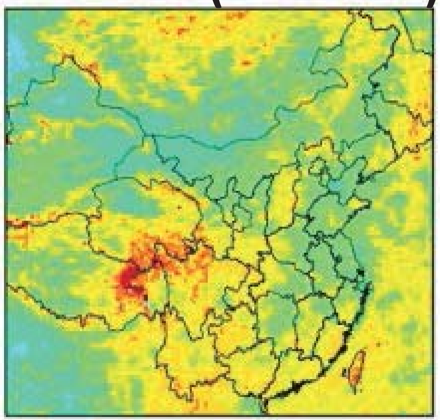


noAER – POMINO **DOMINO – POMINO**

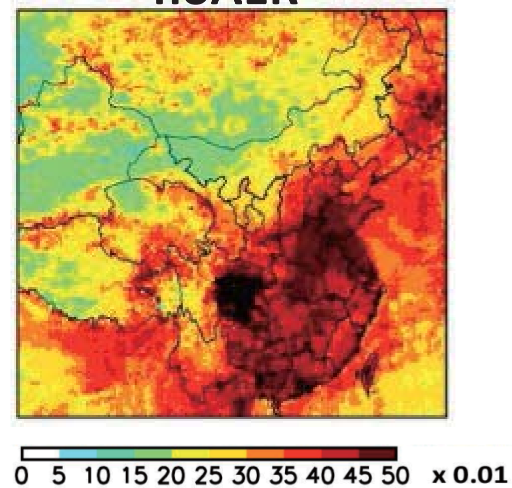


Cloud Radiance Fraction

POMINO (with AER)



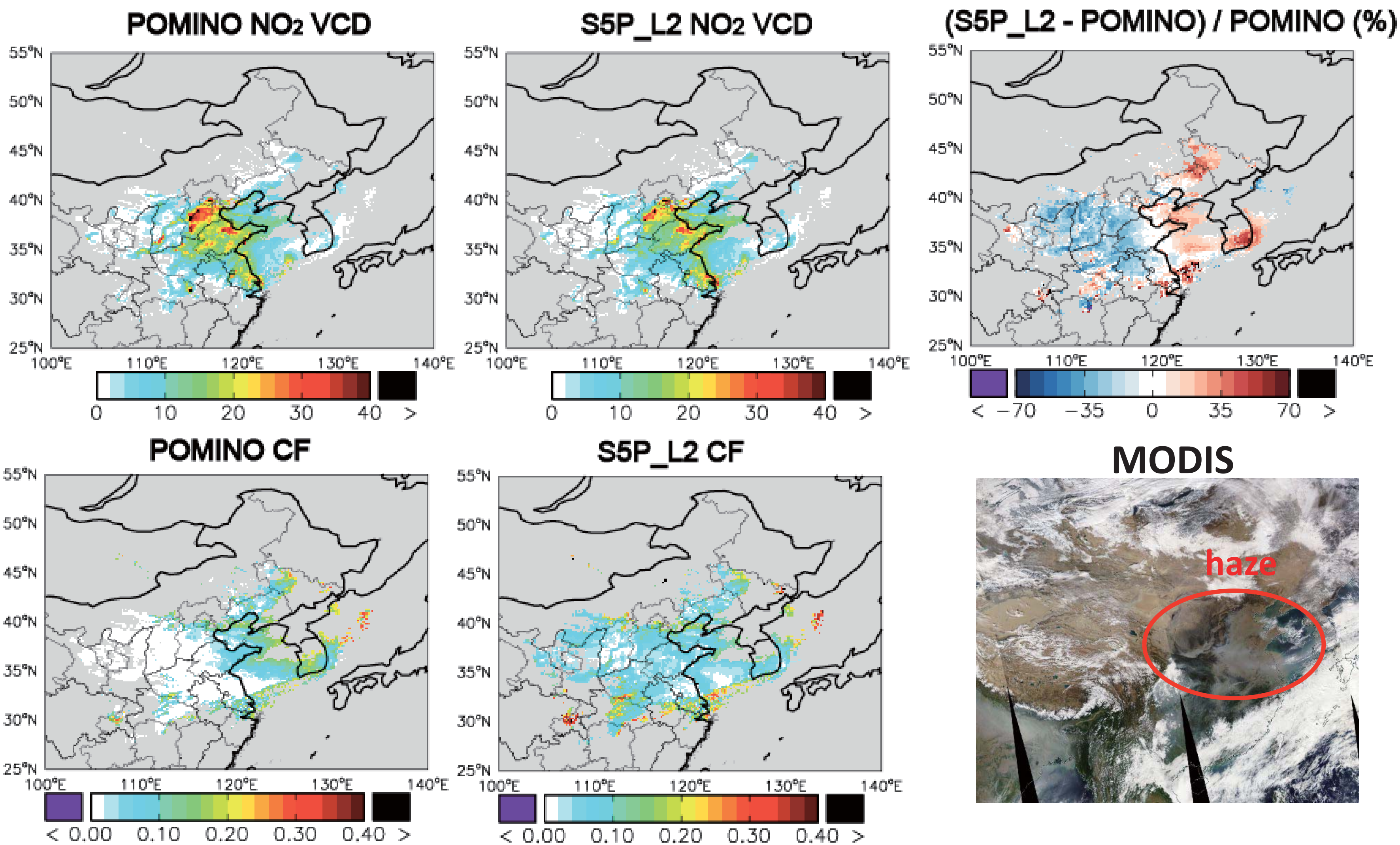
noAER



Lin et al., 2014 ACP; Lin et al., 2015 ACP; Liu et al., 2018 AMTD

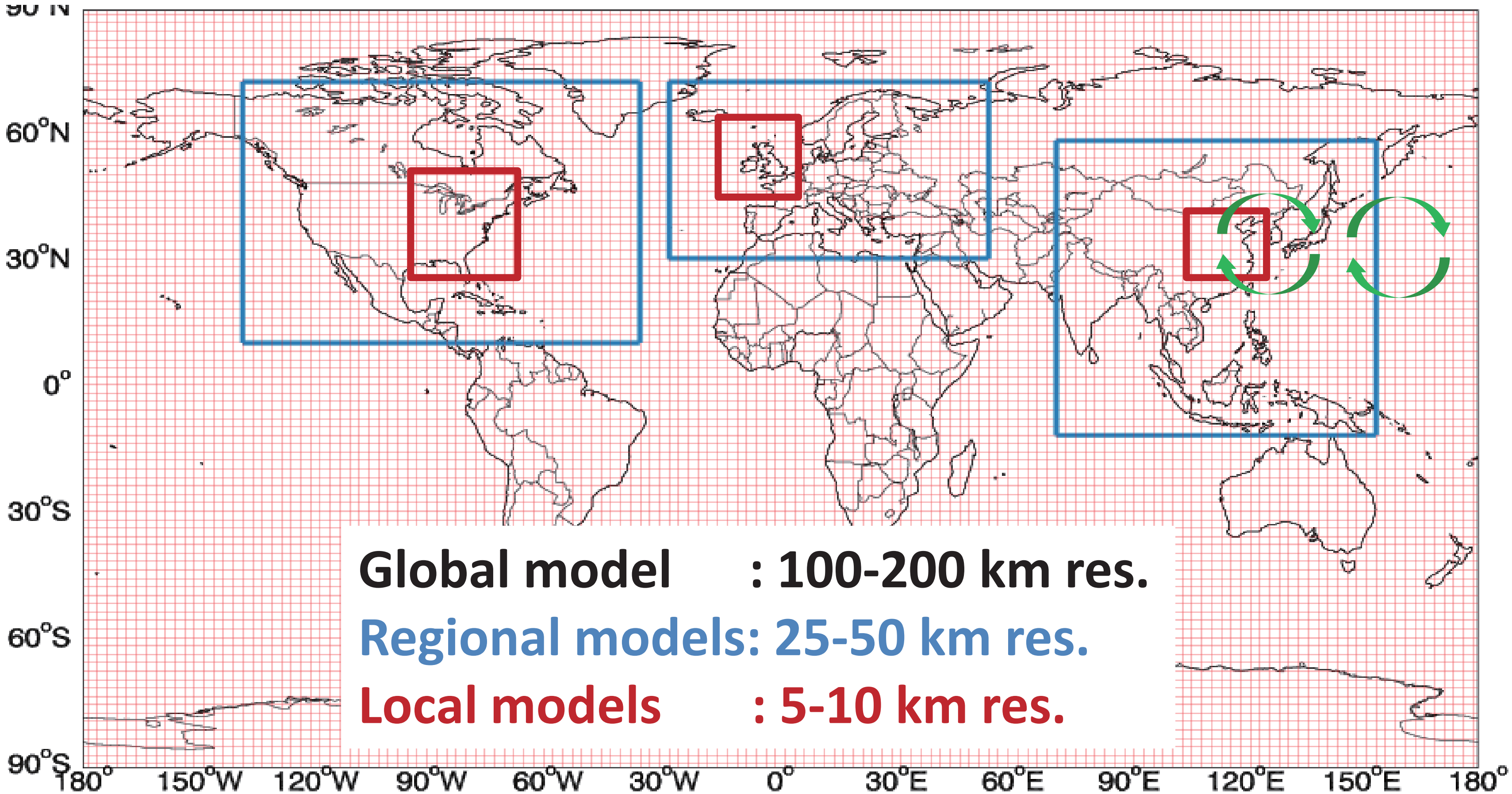
Initial Result for TROPOMI NO_2 Retrieval

2017/11/25



Liu et al., in prep

Global-Multi-Regional Multi-layer Two-Way Coupled Model System to Interpret Satellite Data



Yan et al., 2014 ACP; Yan et al., 2016 ACP; Ni et al., 2018 ACP

Summary

- POMINO NO_2 has several important features suitable for East Asia, in both clean and polluted situations.
- POMINO can also be applied to SO_2, HCHO and CHOCHO. We intentionally made the code easily extensible.
- We look forward to collaborating with GEMS teams on trace gas retrievals and model simulations.

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http://www.phy.pku.edu.cn/~acm/acmProduct.php#POMINO