The retrieval sensitivity of GEMS HCHO measurements to Air Mass Factor (AMF)

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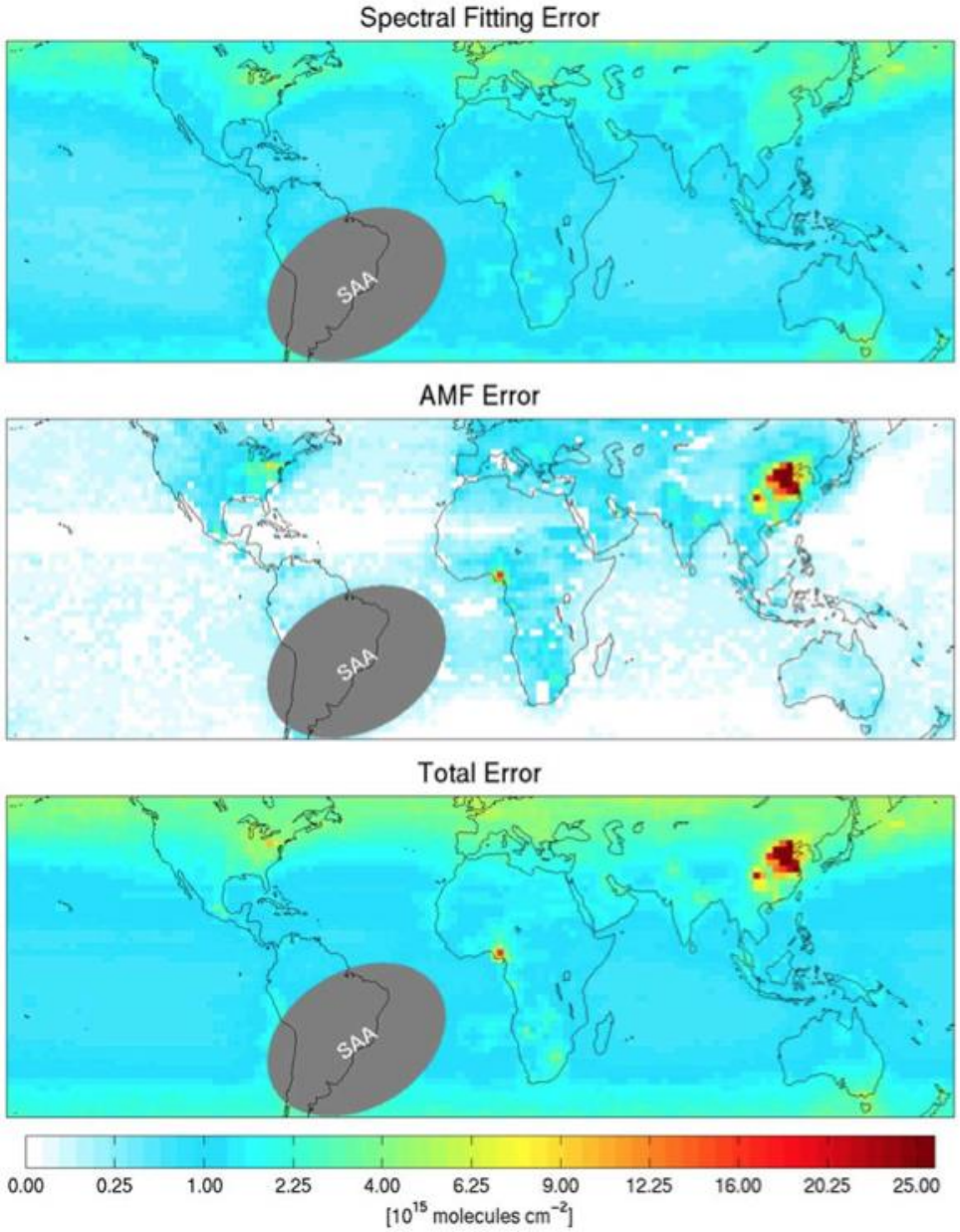
SO_2 retrieval error from SCIAMACHY and OMI

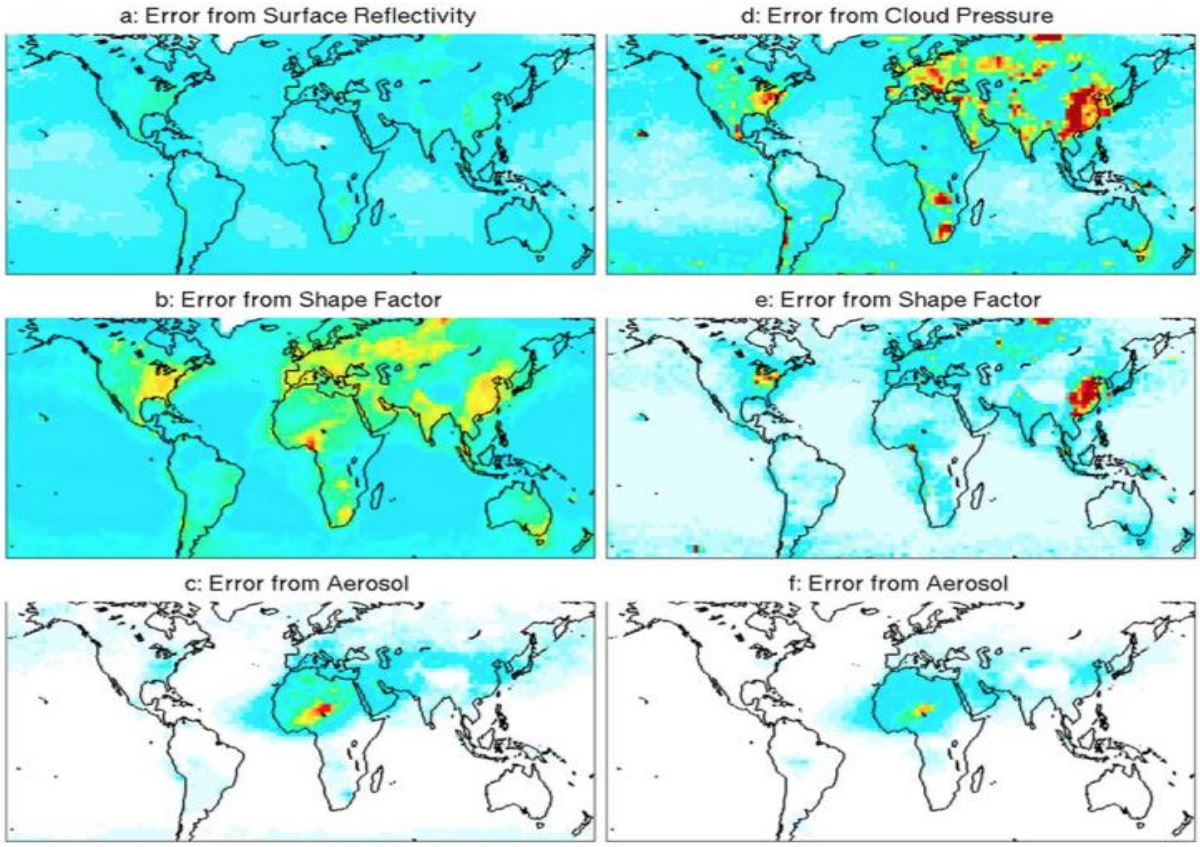


The retrieval error is dominated by the spectral fitting precision over remote regions.

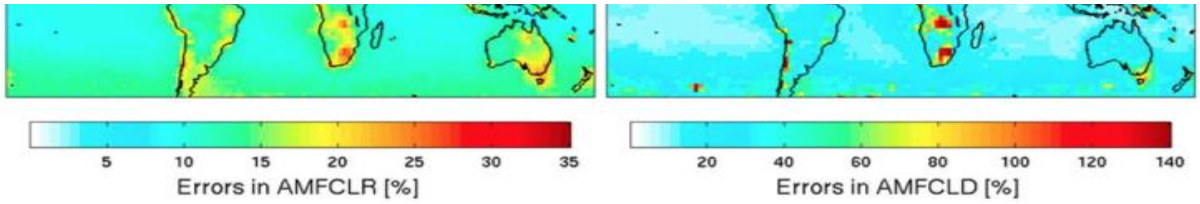
The AMF calculation becomes a more important contributor to the total error, especially in East Asia where large SO_2 emissions occur.

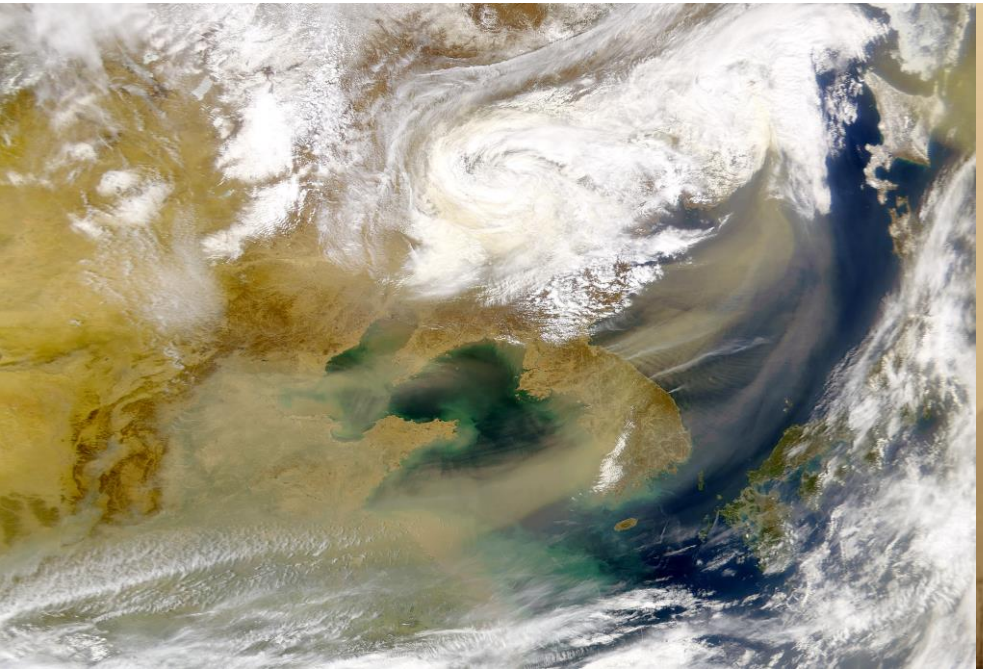
Lee et al. (JGR, 2009)

AMF errors are due to uncertainty in clouds, SO_2 vertical profiles, surface albedo, and aerosols.

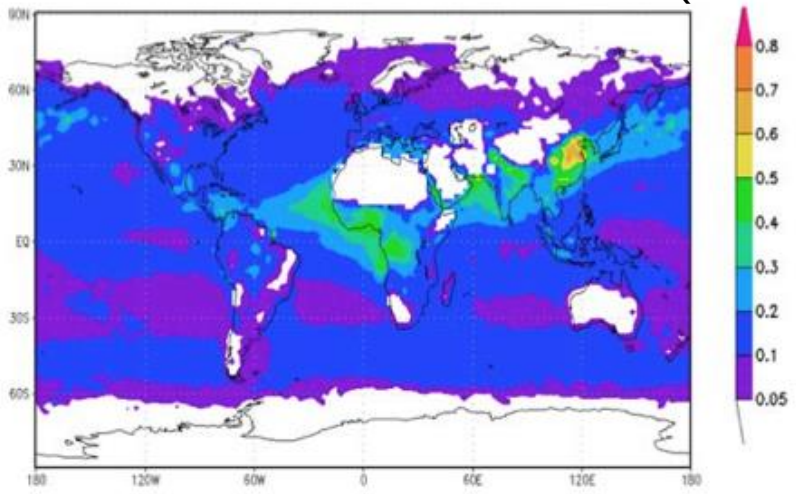


The largest contributor to the annual mean AMF error is the SO_2 shape factor (Lee et al., 2009).



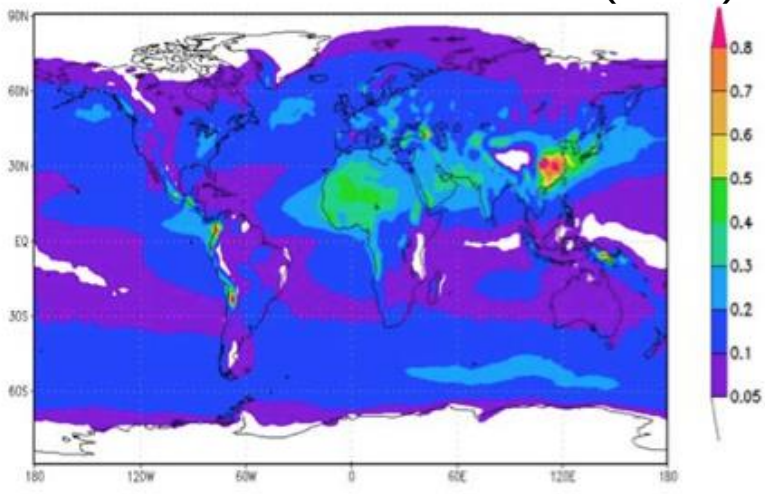


Annual AOD from MODIS/Terra (2001)



(a)

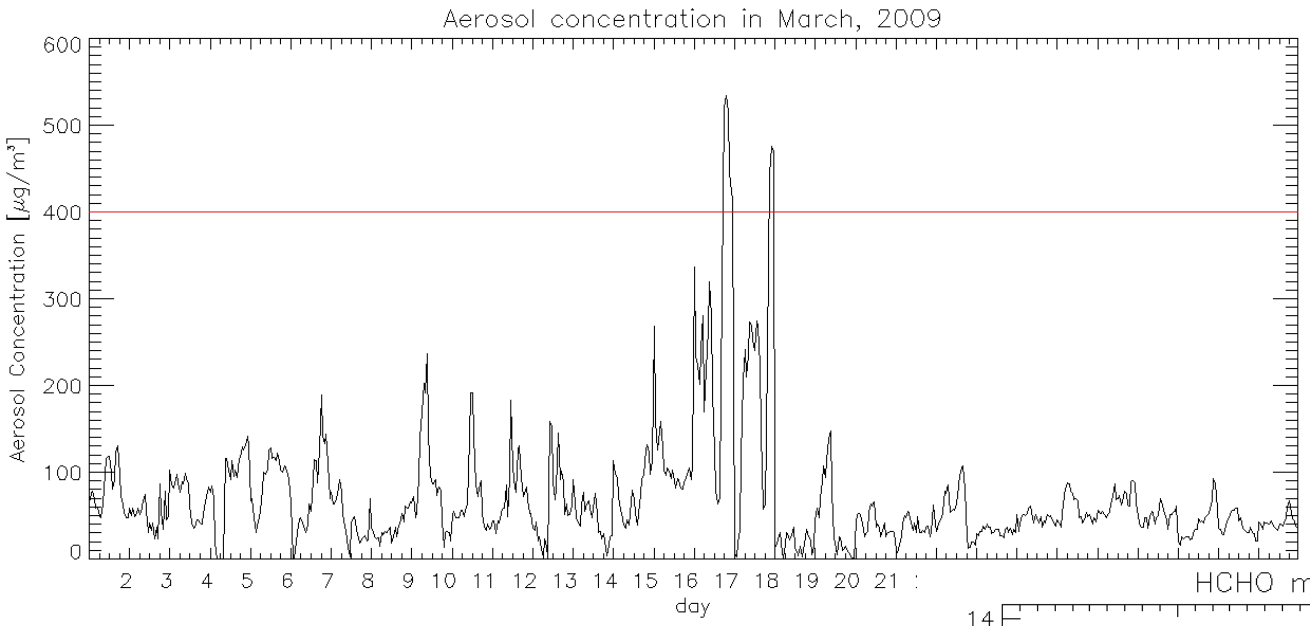
AOD from IMPACT model (2001)



(b)

Feng et al. (ACPD, 2013)

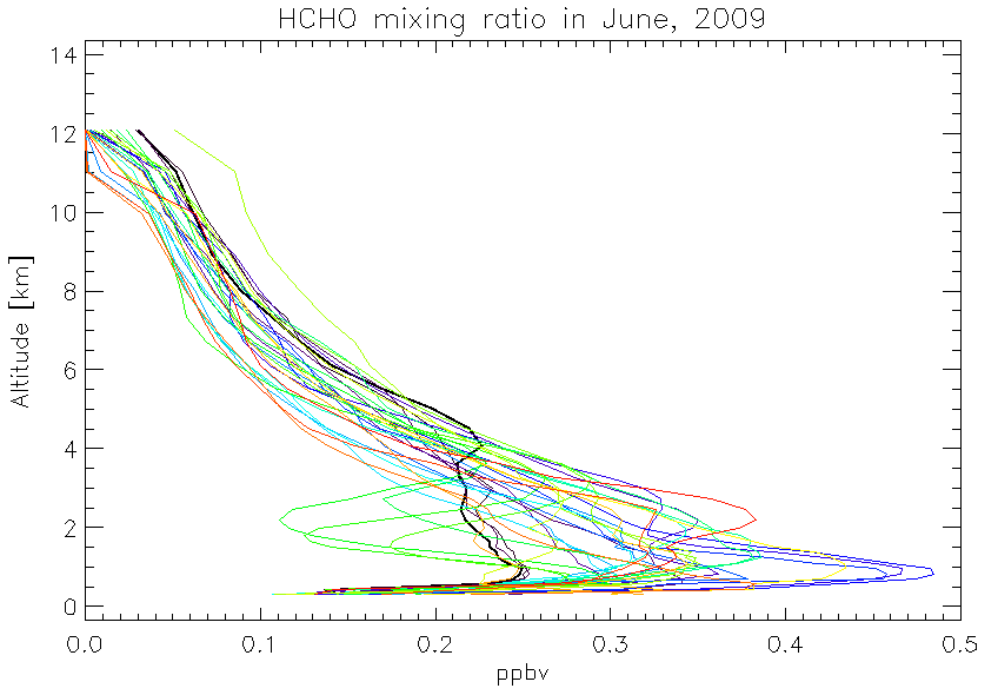
Variation of Aerosol and HCHO vertical profile



- ✓ Dust storm often occurs over East Asia in Spring

- ✓ HCHO vertical profiles can vary over time

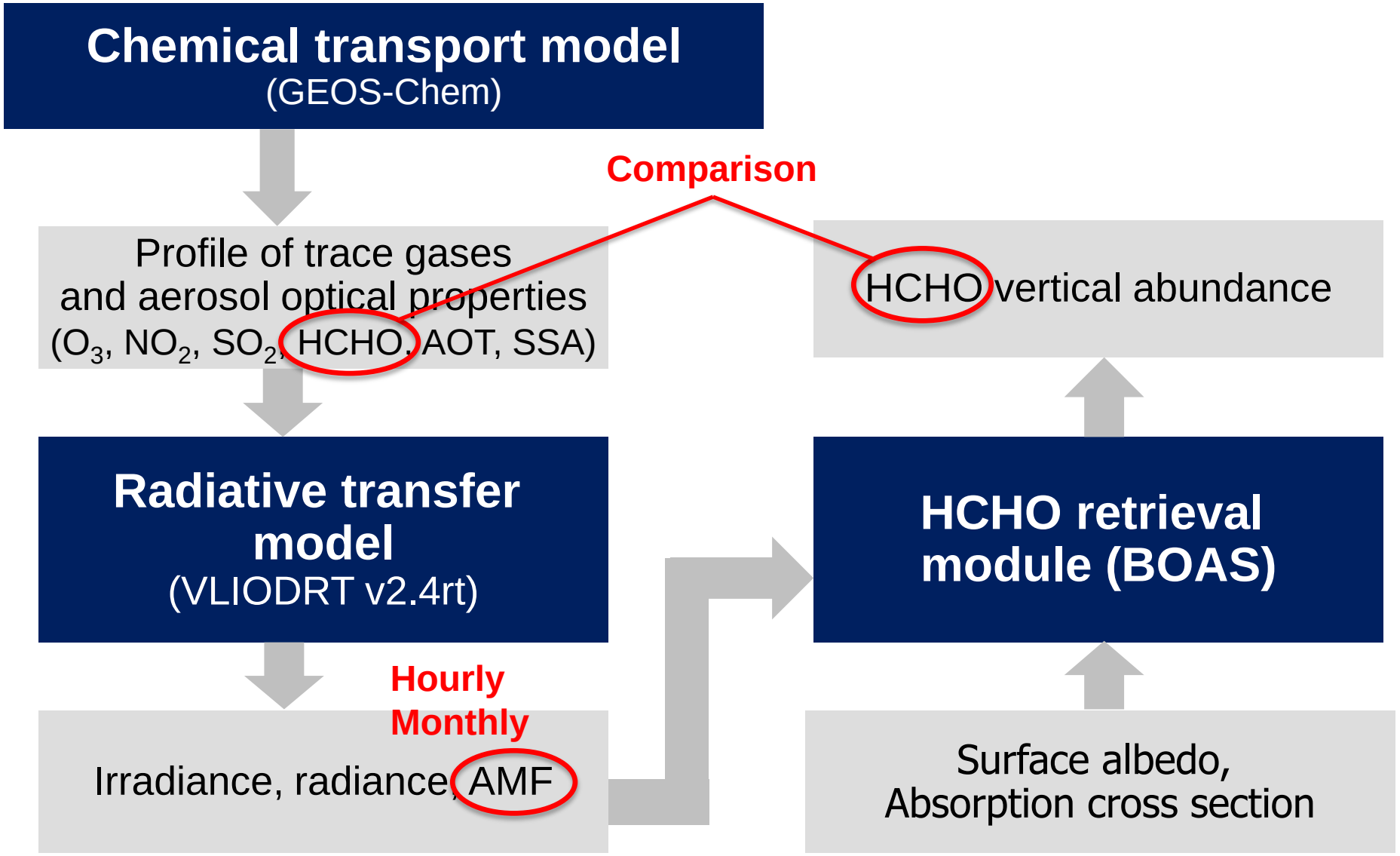
Aerosols and vertical profiles of HCHO vary hourly.



Objectives

- Examine the sensitivity of GEMS HCHO measurements in East Asia with respect to local AMF calculations focusing on temporal variability.
- Examine the factors (shape vs. aerosol) affecting AMF calculations in East Asia.

Synthetic simulation of HCHO retrieval



Model descriptions and retrieval options

Chemical transport Model

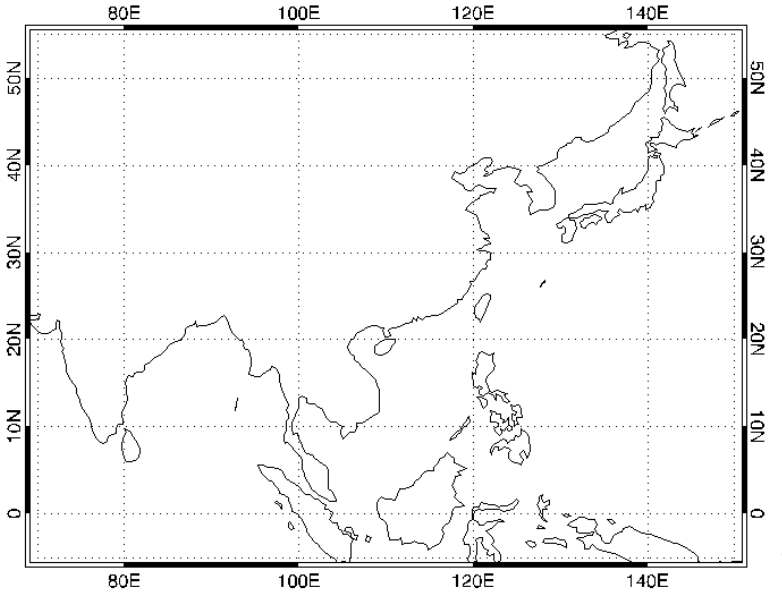
- GEOS-Chem version 9.1.2
- Meteorological field : GEOS5, MERRA
- Simulation period : June (2006, 2009)
- Resolution : 2x2.5
- Anthropogenic emissions from Streets et al. (2006)
- Biogenic emissions from MEGAN
- Biomass burning emissions from GFED3

Radiative transfer Model

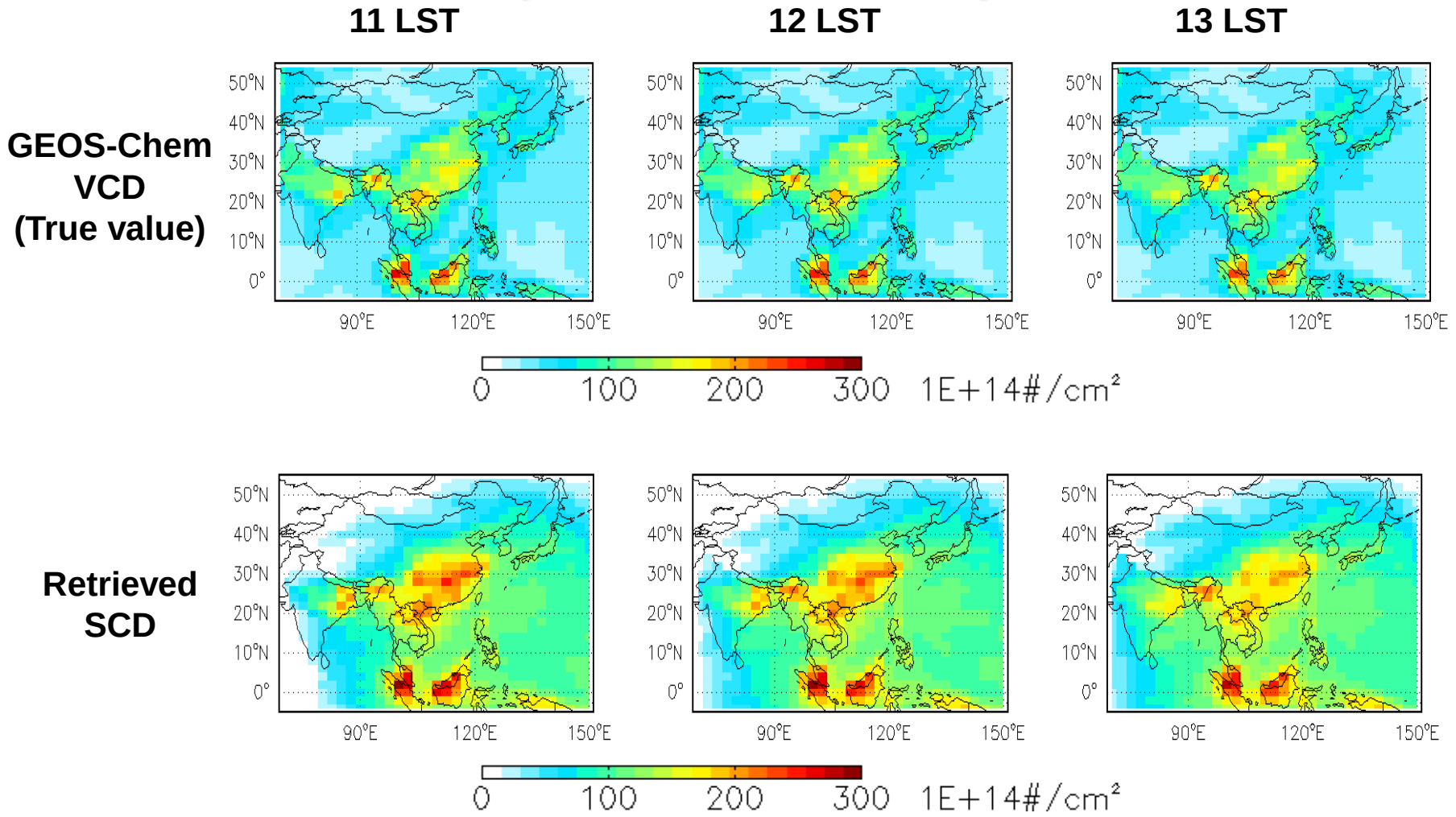
- VLIDORT v2.4rt (R.J. Spurr, 2006)
- 300-500 nm with 0.2 resolution (No convolution and no any errors)
- surface albedo : 0.05
- O_3, NO_2, HCHO, SO_2 (Use O_3 of SCIATRAN data in the stratosphere)
- AOD, SSA, ASYM at 300, 400, 600, 999 nm

Retrieval options

- Fitting window : 327.5-358.0 nm
- Reference spectra
  Computed ring spectrum
  O_3 at 228, 273 K (Brion)
  NO_2 at 220 K
  HCHO at 300 K

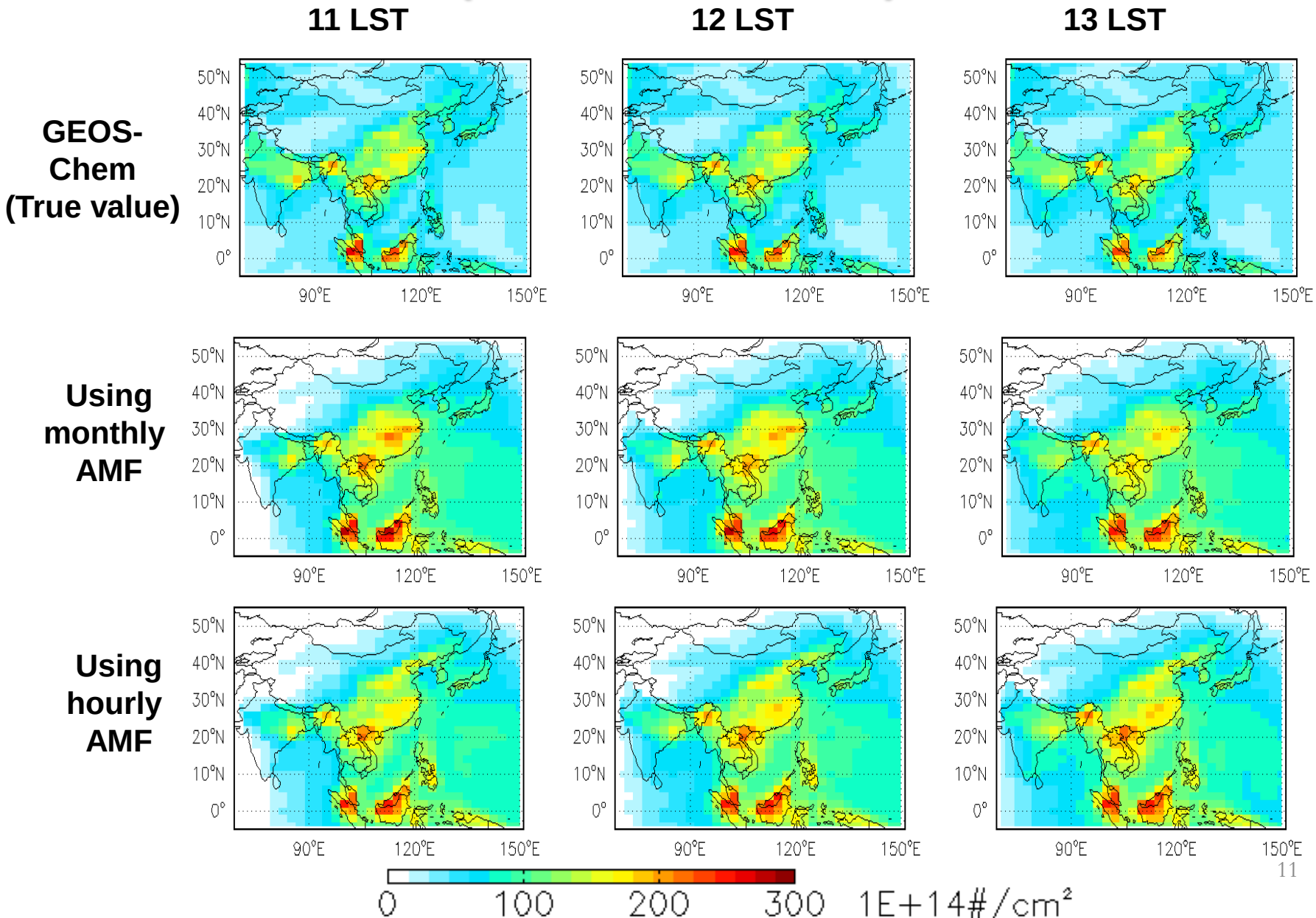


Simulated HCHO VCD and retrieved SCD (June 21, 2009)



We apply monthly mean AMF and hourly mean AMF to the SCD.

Hourly mean HCHO vertical abundance (June 21, 2009)



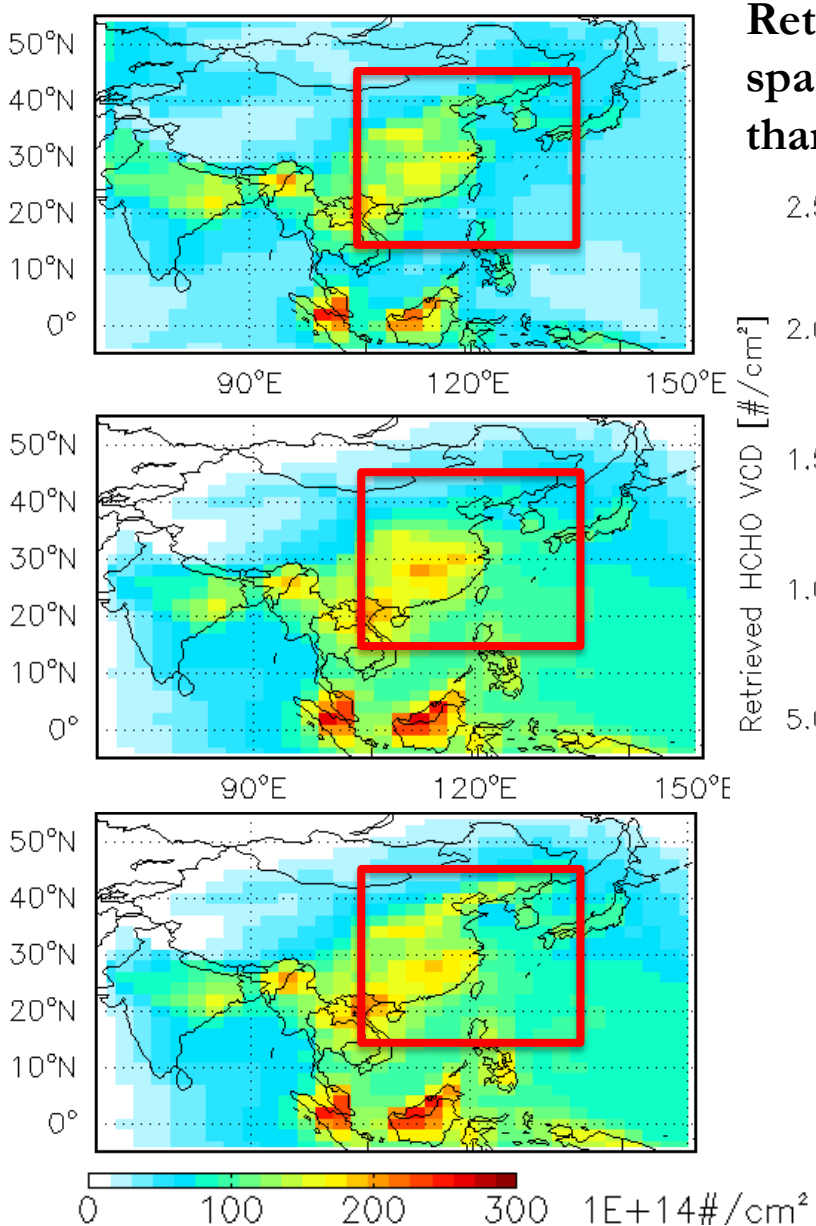
Comparisons between the true vs. retrieved HCHO VCD

11-13 LST mean

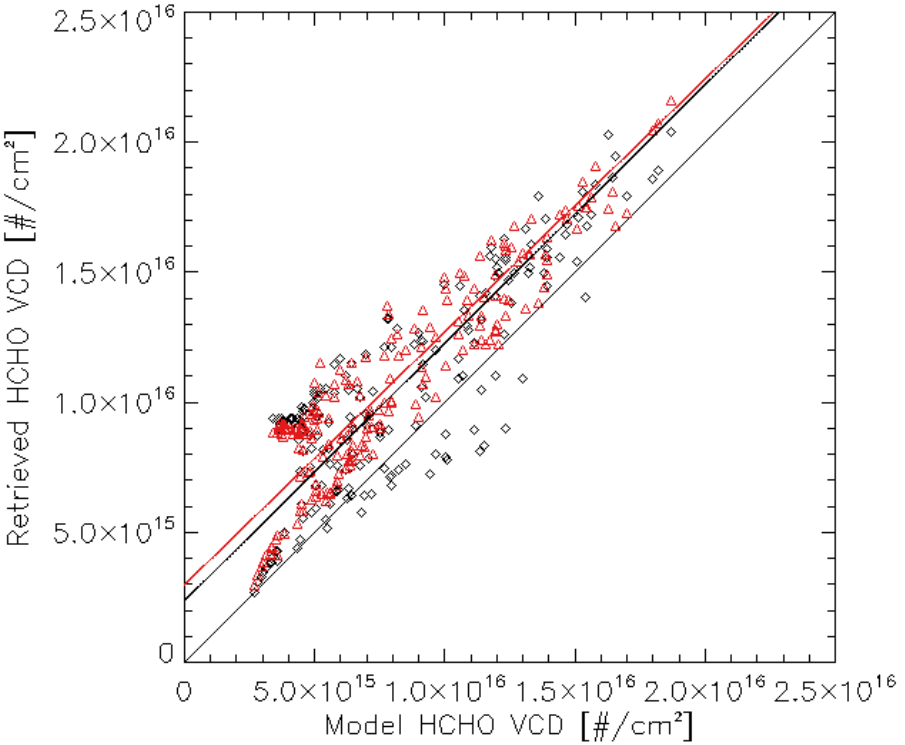
GEOS-Chem (True value)

Using monthly AMF

Using hourly AMF

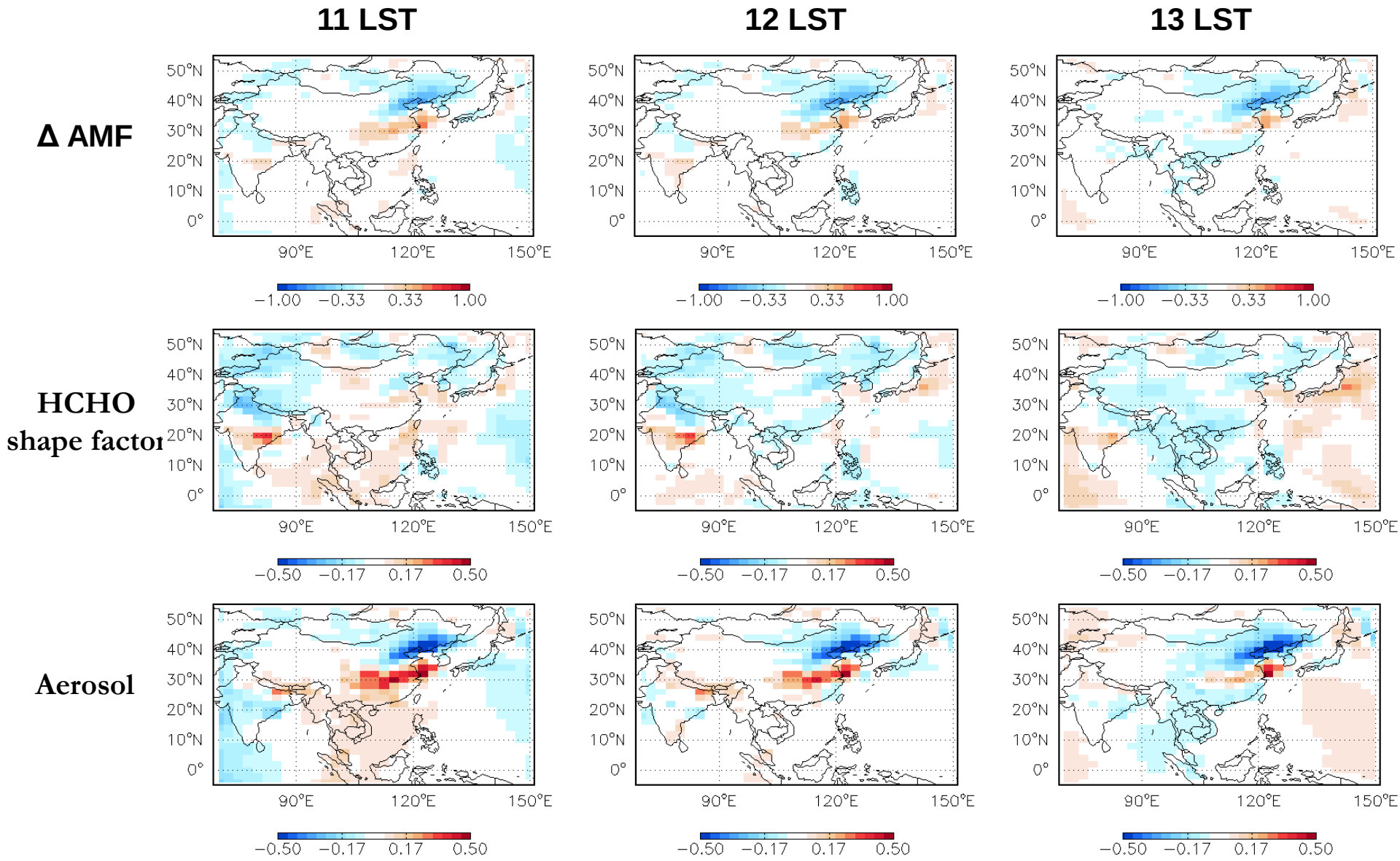


Retrieval with hourly AMF reproduces the spatial variability of HCHO VCD better than that with monthly AMF.

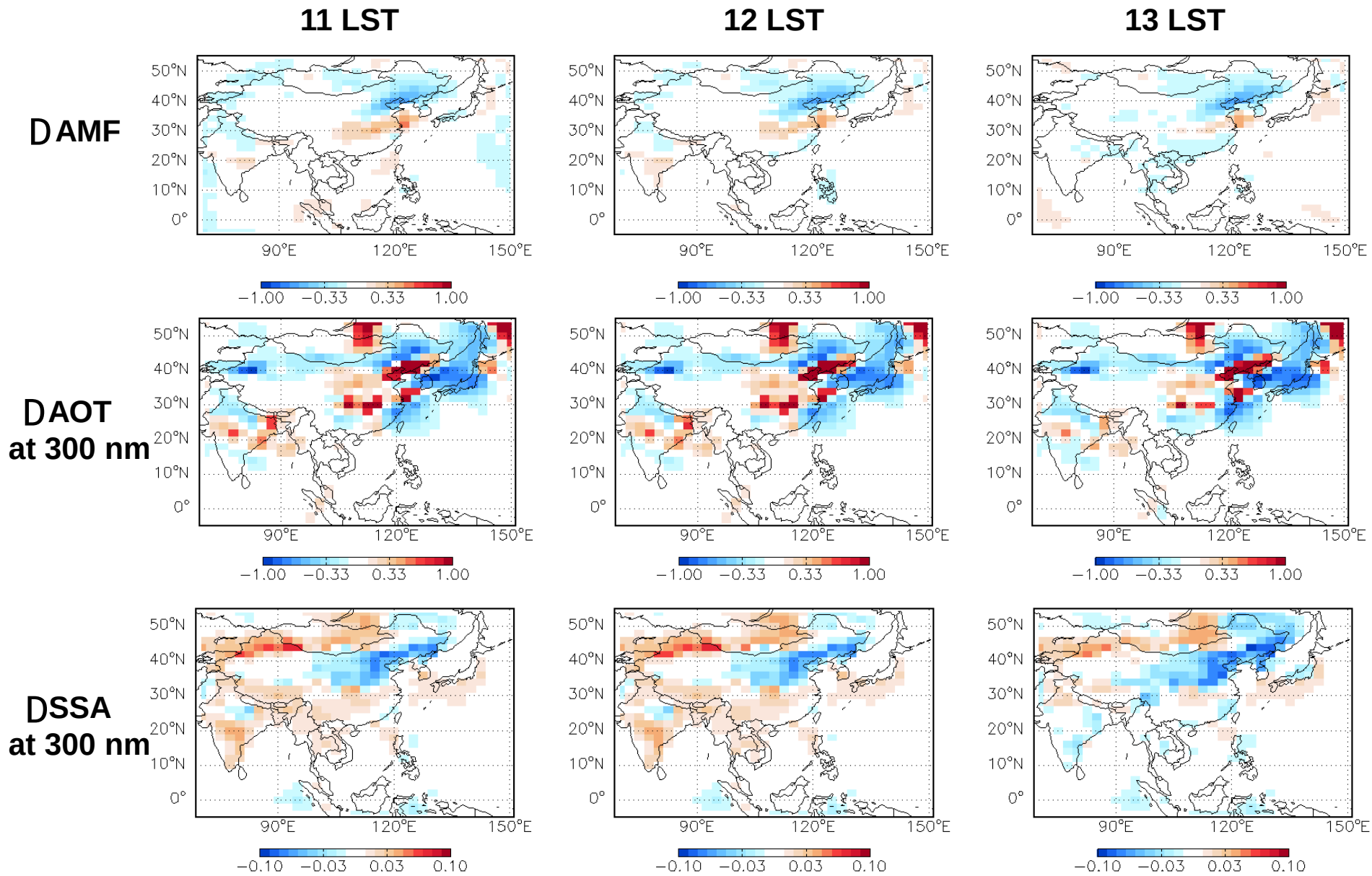


Monthly AMF	**Hourly AMF**
R=0.84	R=0.91
Slope=0.99	Slope=0.97

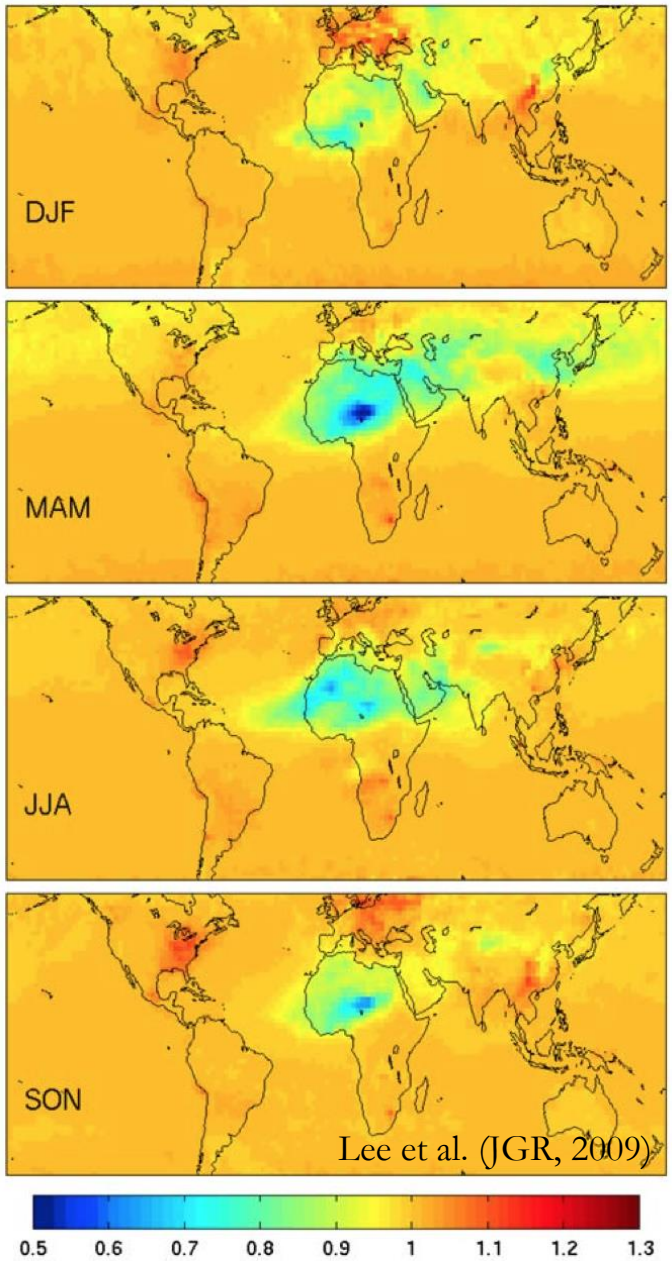
Differences (Hourly-Monthly) between monthly and hourly AMF values are mainly due to the presence of aerosols



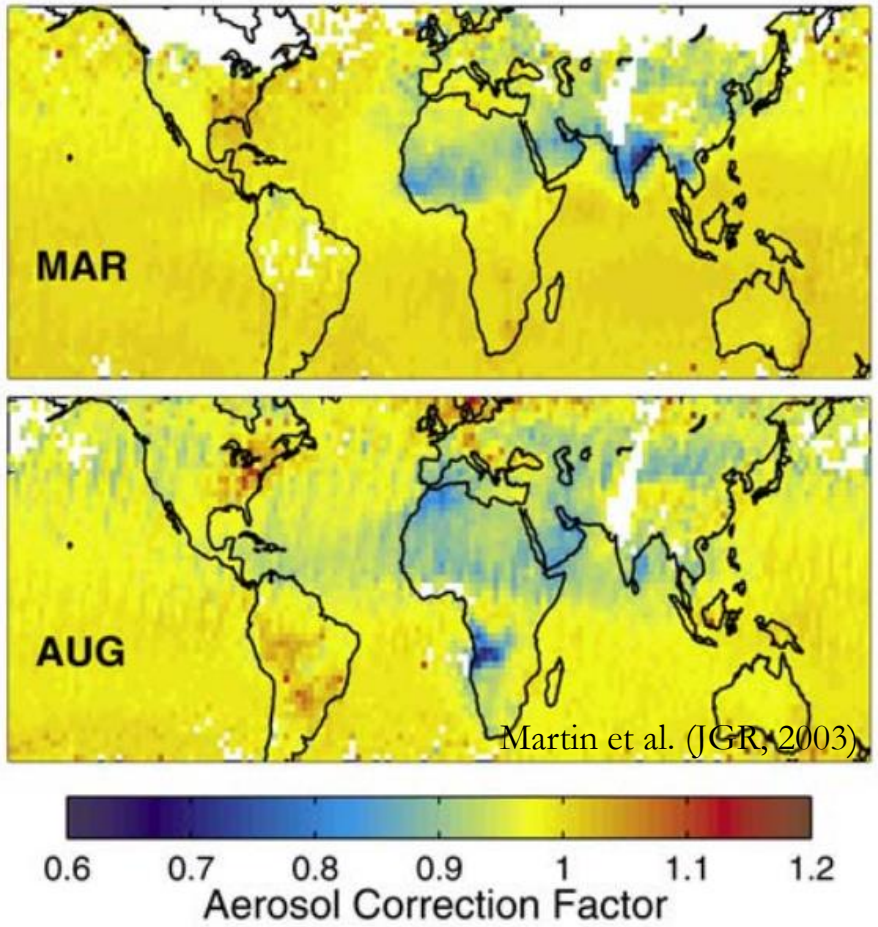
Differences (Hourly–Monthly) of AMF, AOT, SSA



Aerosol correction factor

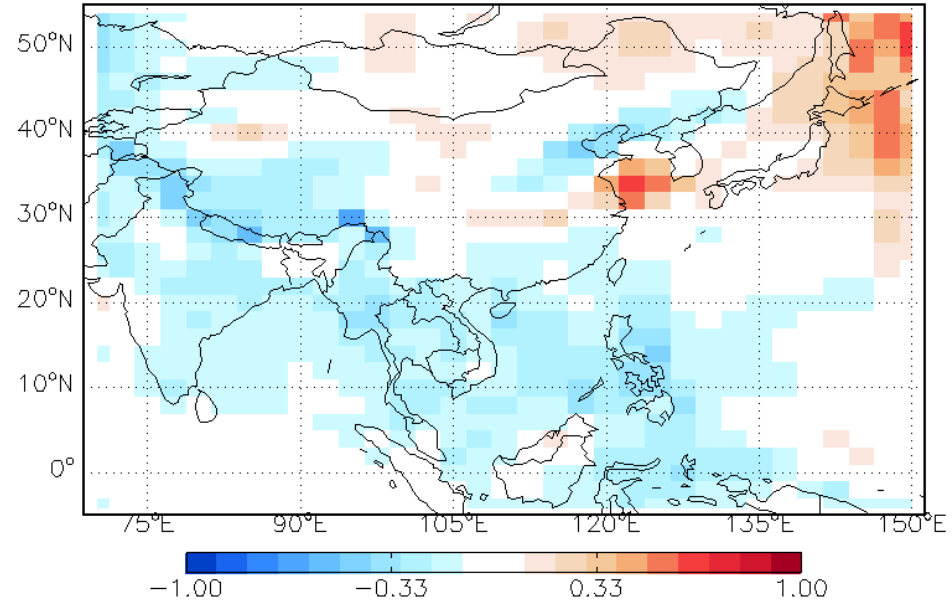


- ✓ AOT↑, SSA↓ (absorbing) => AMF↓
  AOT↑, SSA↑ (scattering) => AMF↑
- ✓ **Fine temporal AMF should be required for geo-satellite.**

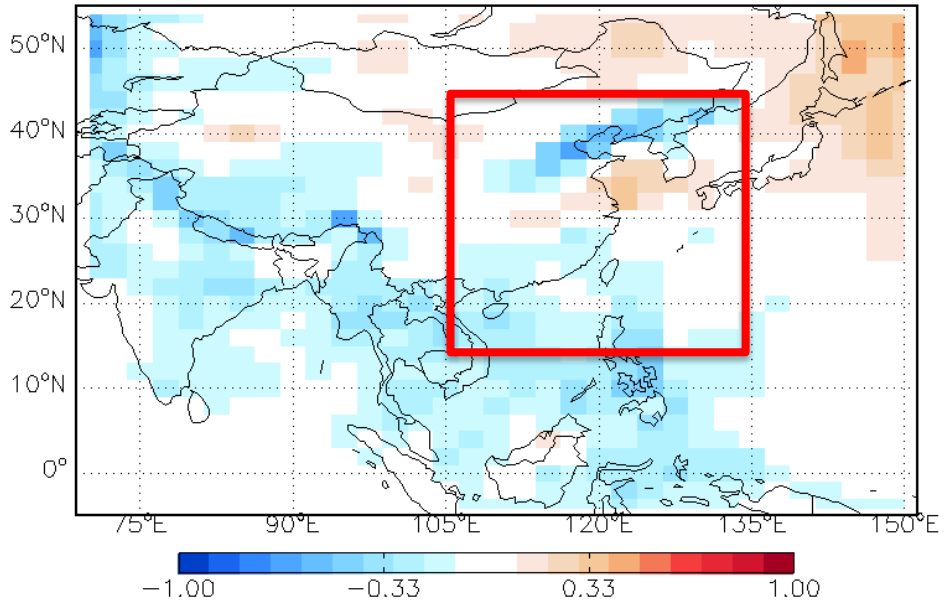


Difference between hourly AMF and OMI AMF in 12 LCT (20090621)

Hourly AMF – OMI AMF (Clear sky)



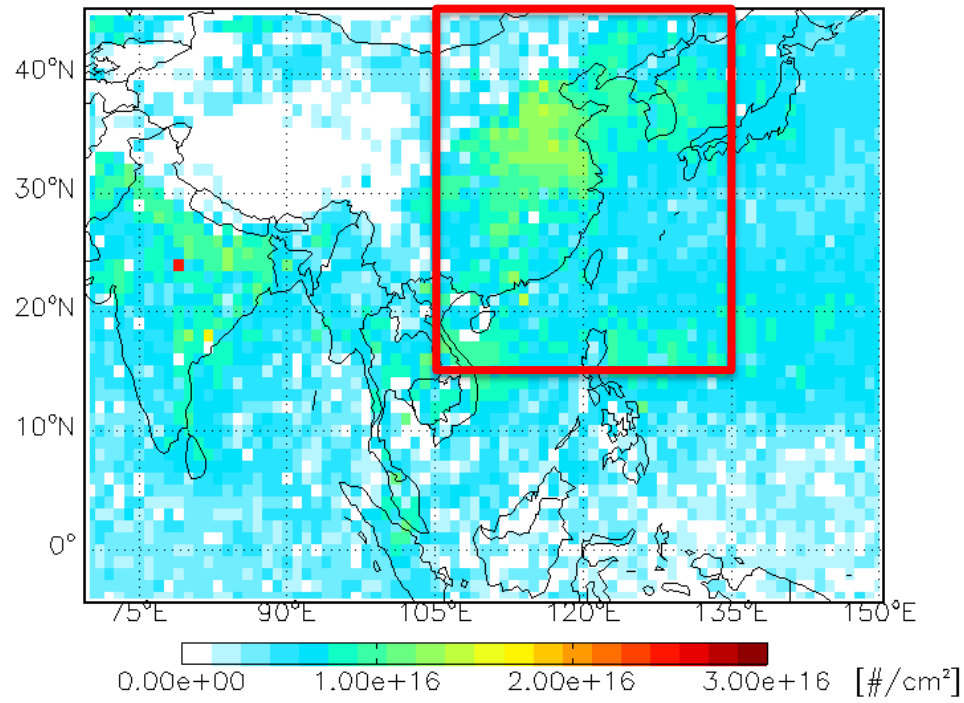
Relative error



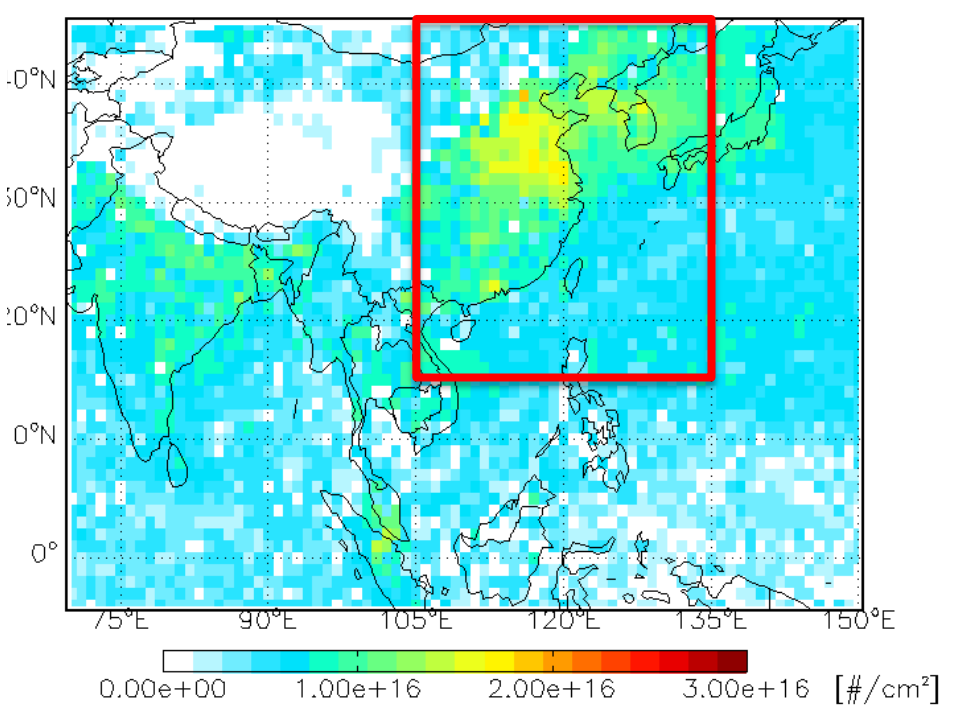
	Whole domain 70E-150E -4S-54N	East Asia 105E-135E 15N-45E
Max. relative error	36 %	36 %
Min. relative error	-71 %	-71 %

Monthly mean OMI HCHO VCD: composite on 1°x1° for June, 2006

HCHO VCD with hourly AMF



OMI HCHO VCD



- The figures shows the composite of OMI HCHO VCD for a month (June,2006)
- We calculated local hourly AMF at 14 LCT and applied it to OMI SCD to obtain OMI VCD.
- **Difference between our calculation and the OMI standard product is 19 % for the domain average.**

Summary

- Presence of aerosols may have a significant effect on AMF calculation for the HCHO observations by GEMS in East Asia.

- Not only the total aerosol loading (AOD) changes but also chemical composition (SSA) changes could be an important factor to AMF estimation; Better to account for high temporal variability.

- When we apply hourly AMF to OMI results for a month (June, 2006), our estimation decreases by 19% relative to the OMI standard products in East Asia (need to be further validated by comparing with other independent observations)

Future work

- Validate by comparing our calculation with other independent ground or aircraft observations in the GEMS domain.
- Hourly variation of aerosol optical properties needs to be accounted for in AMF calculation for GEMS.
- How do we accomplish this? Using satellite retrieved optical properties of aerosols can be an option.
- How can we deal with uncertainties of satellite measured aerosol optical properties (e.g. SSA)?