PROGRAMME OF THE EUROPEAN UNION

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Evaluating a consistent data set of tropospheric NO_2 columns from GEMS and TROPOMI

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GEMS

The GEMS instrument

Instrument

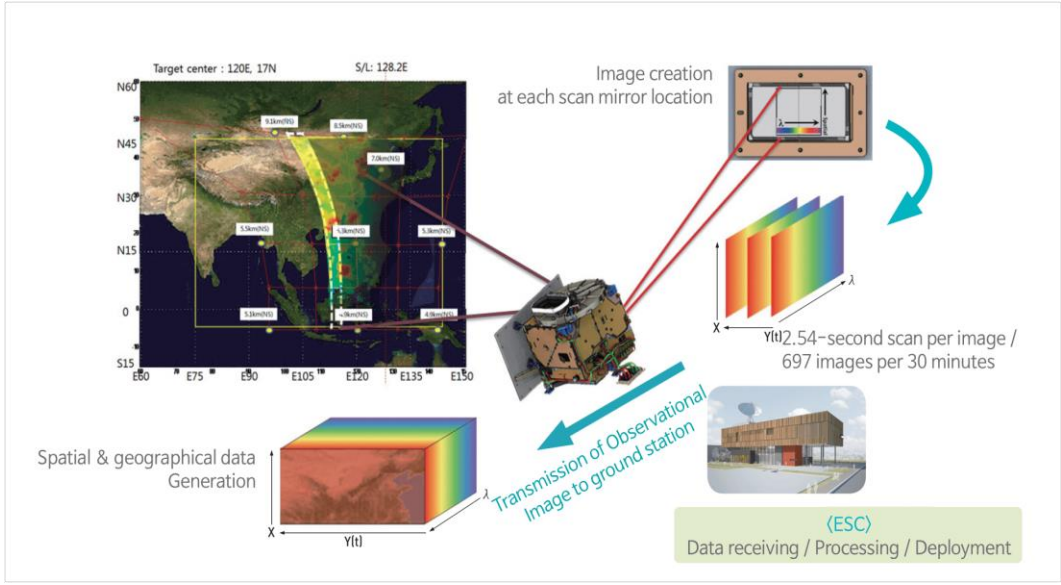
- Geostationary orbit
- Scan from east to west
- One scan per hour
- 300 – 500nm @ 0.6 nm
- Spatial resolution: 3.5 .. 8 km

Mission:

- Launch February 2020
- 10 years

Dataproducts

- **NO_2**, SO_2, HCHO, CHOCHO, O_3, aerosols, clouds, …



https://nesc.nier.go.kr/satellite/info

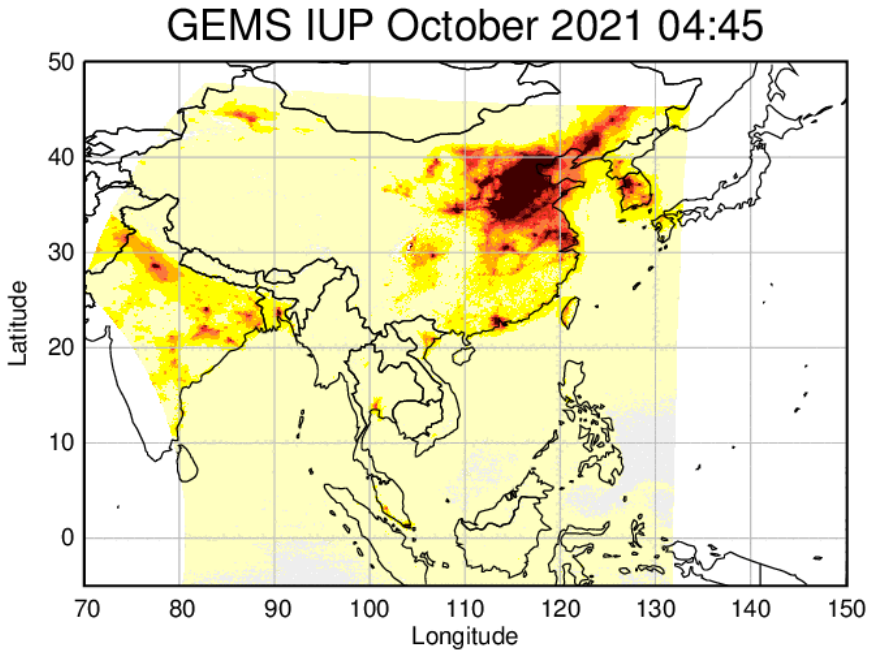
S4 NO_2 breadboard algorithm

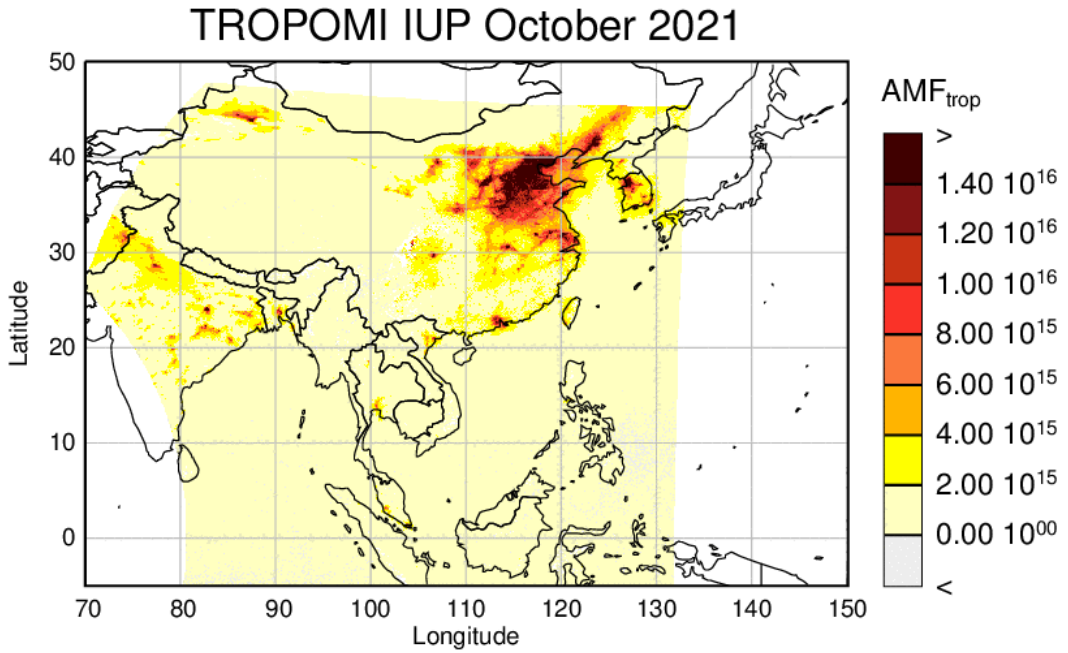
Mission

- Sentinel 4 is the European geostationary satellite
- Launch 2024, coverage Europe
- Idea: Test algorithms on GEMS data

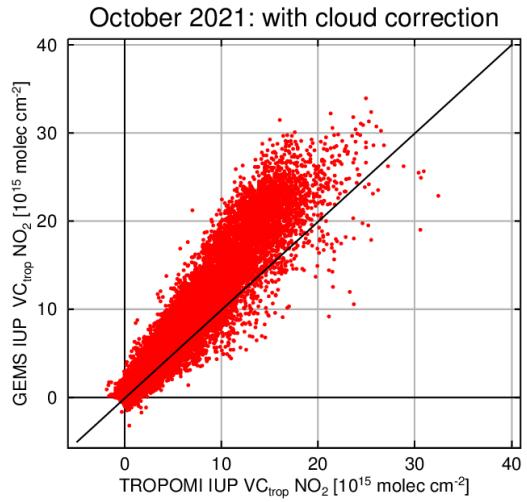
S4 NO_2 Algorithm

- DOAS NO_2 retrieval
- 405 – 485 nm
- Stratosphere from STREAM (Beirle et al., 2016)
- NO_2 *a priori* from TM5
- OMI surface reflectivity
- Cloud correction using lv2 cloud data
- No aerosols
- No BRDF



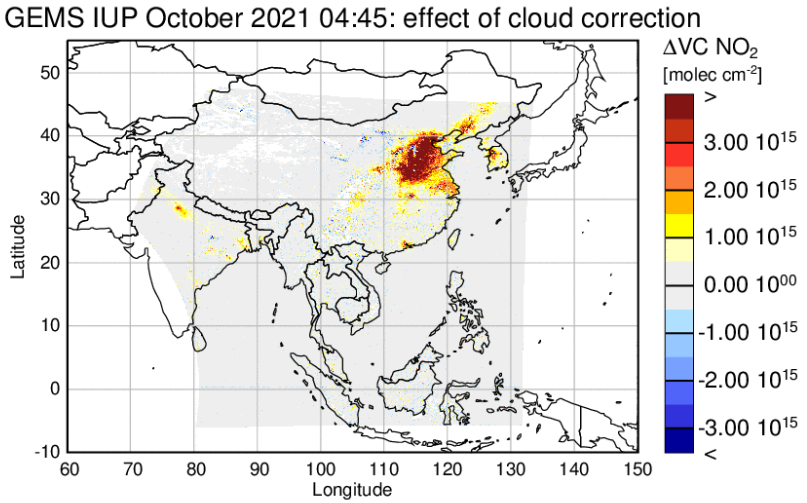


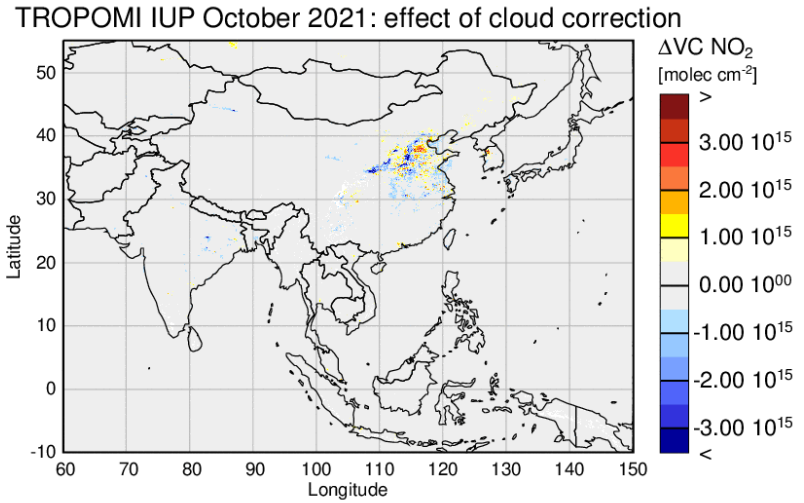
- Very similar patterns
- Very similar NO_2 levels
- But is that really good agreement?
  - GEMS overestimation
  - Significant scatter



Why no better agreement with TROPOMI?

- Slant column fit: similar
- Stratospheric correction: similar approach
- Surface reflectance: same climatology
- Atmospheric profiles: both from TM5
- Clouds:
  - TROPOMI: FRESCO wide + cloud fraction from NO_2 lv2 file
  - GEMS: O2-O2 from GEMS cloud lv2 file





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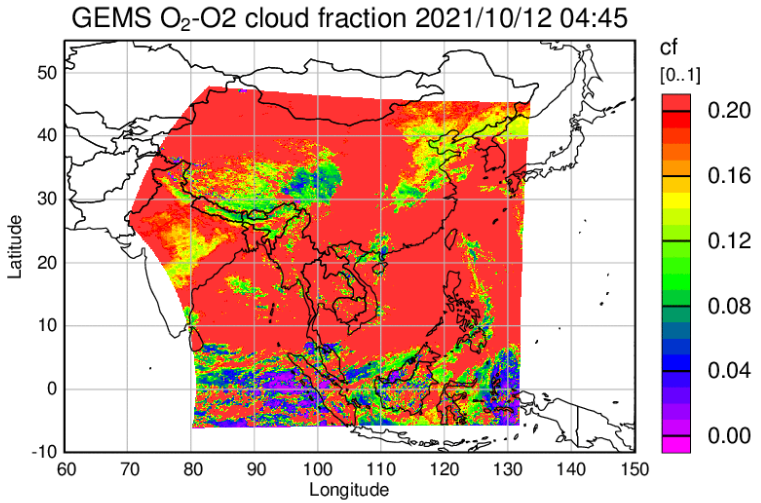
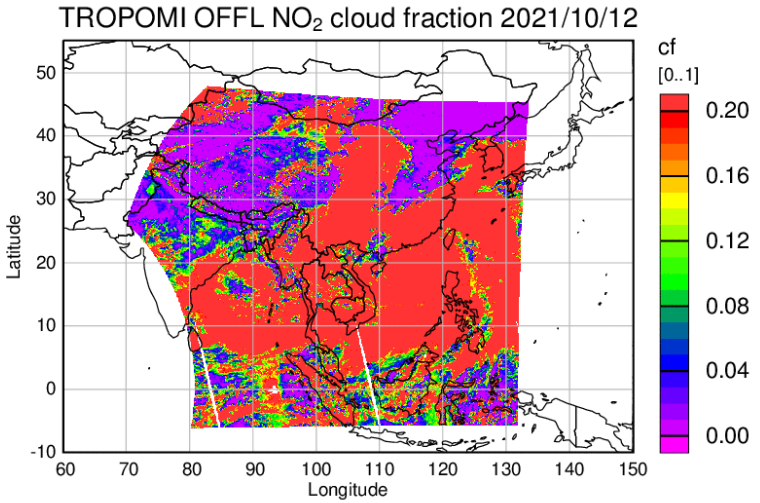
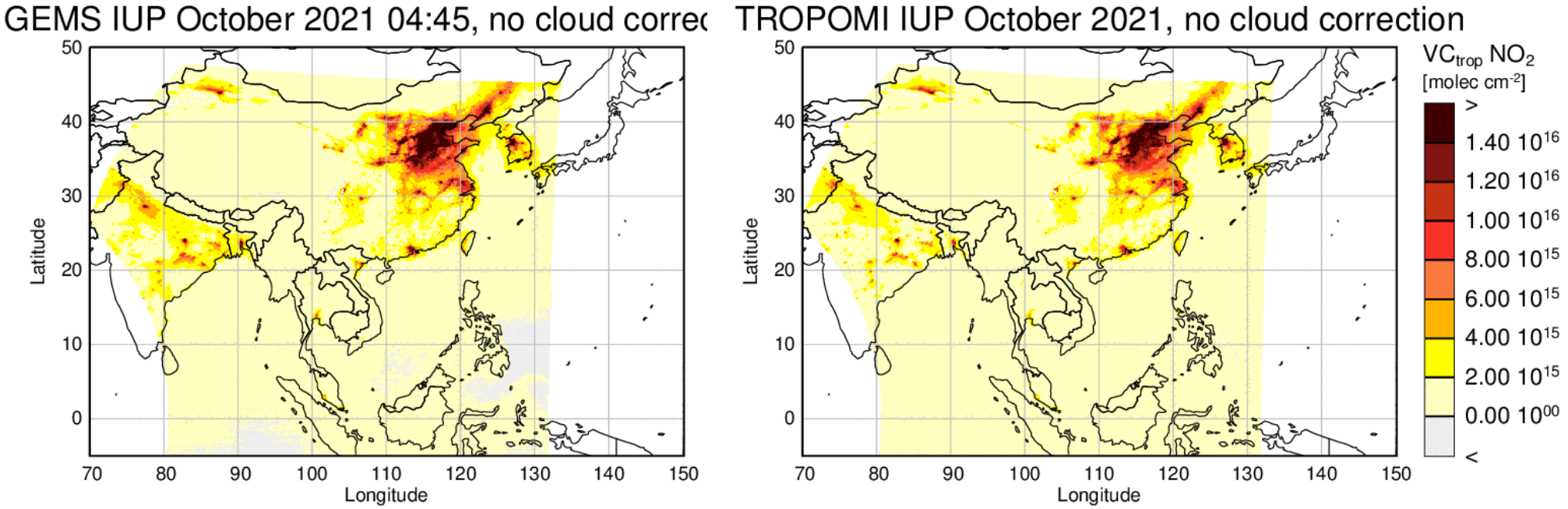
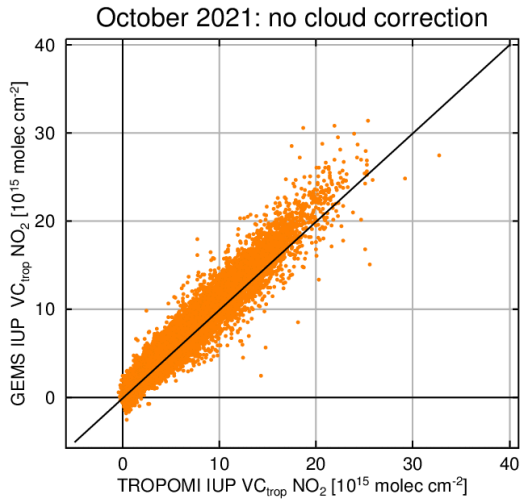




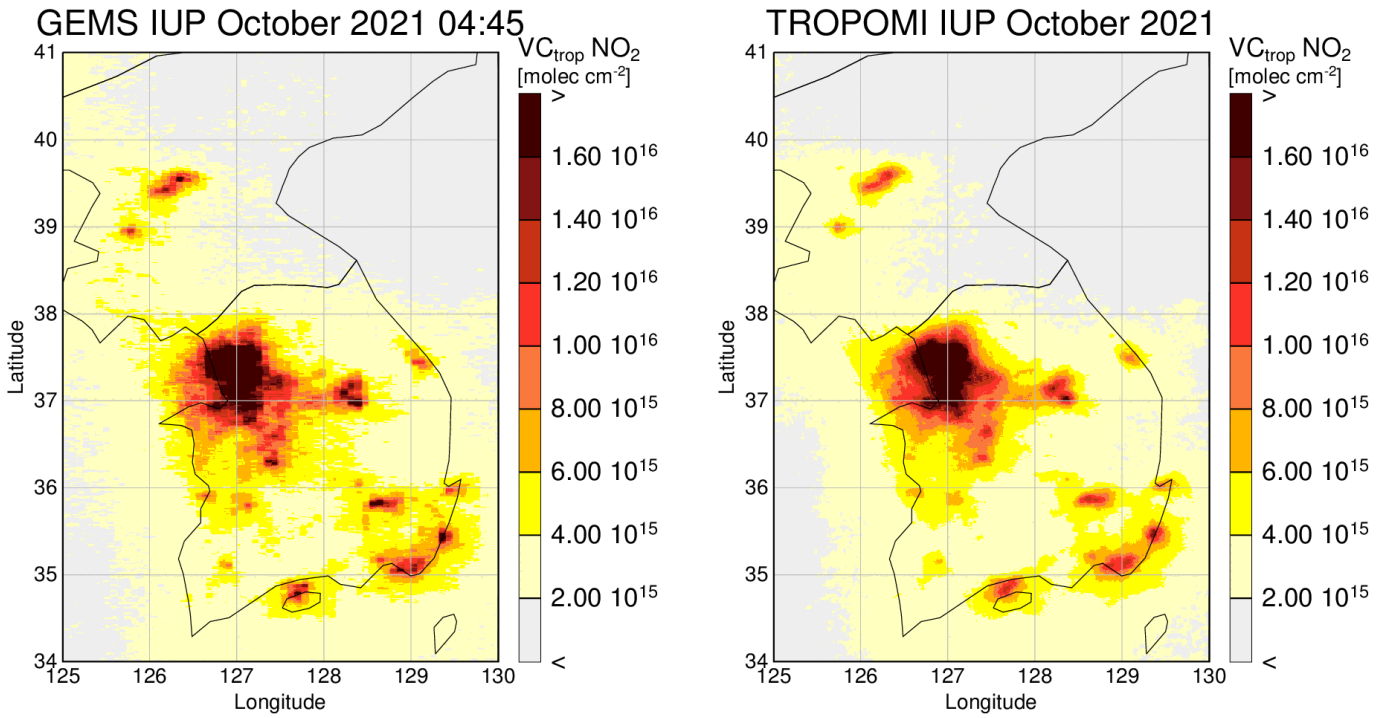


- Cloud correction switched off
- Only using filtering on cloud radiance fraction:
  - TROPOMI: <= 50% CRF
  - GEMS: <= 60% CRF



A few percent GEMS overestimation remain

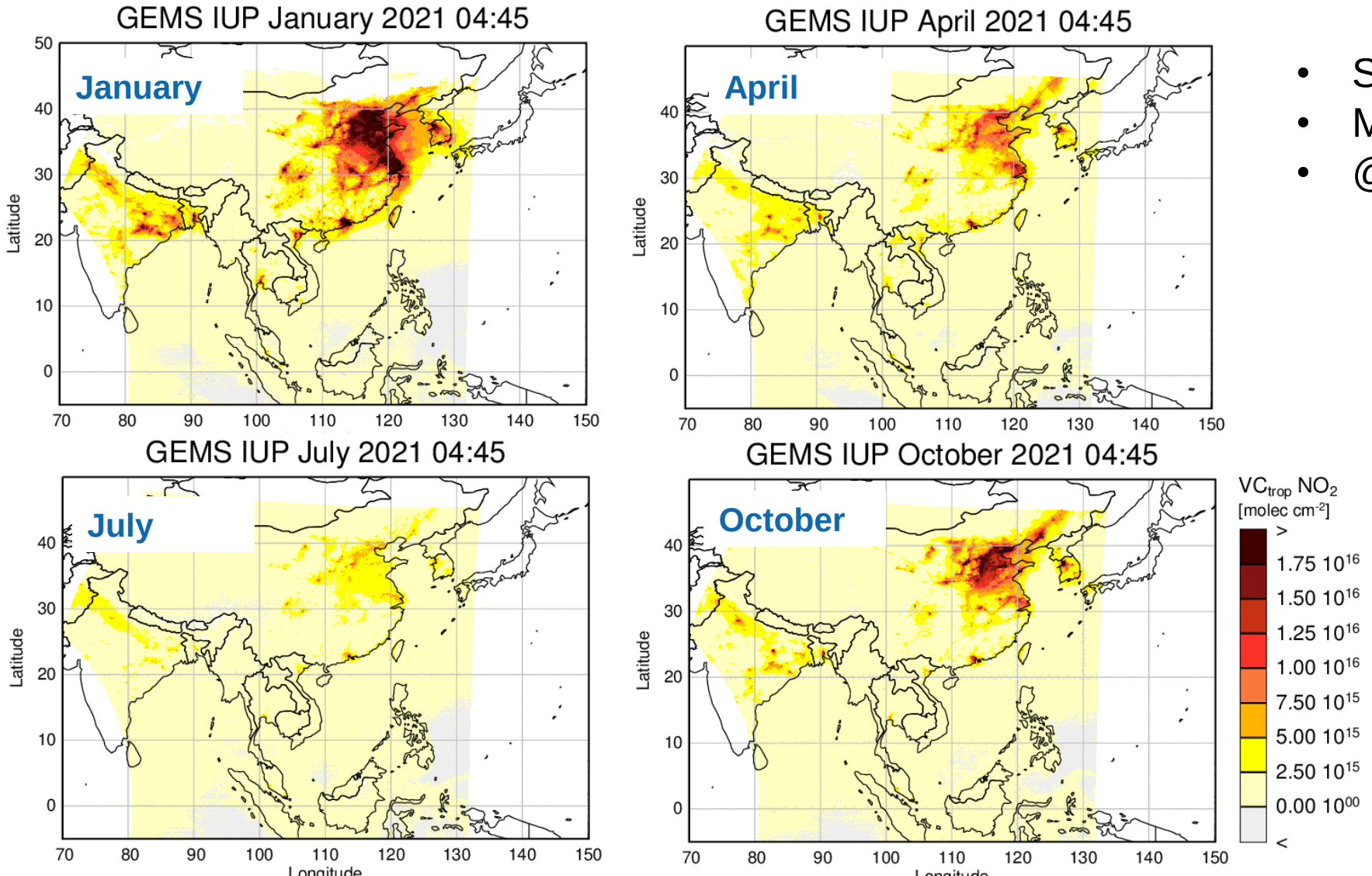
Oversampling



Data was sampled at 0.01° resolution

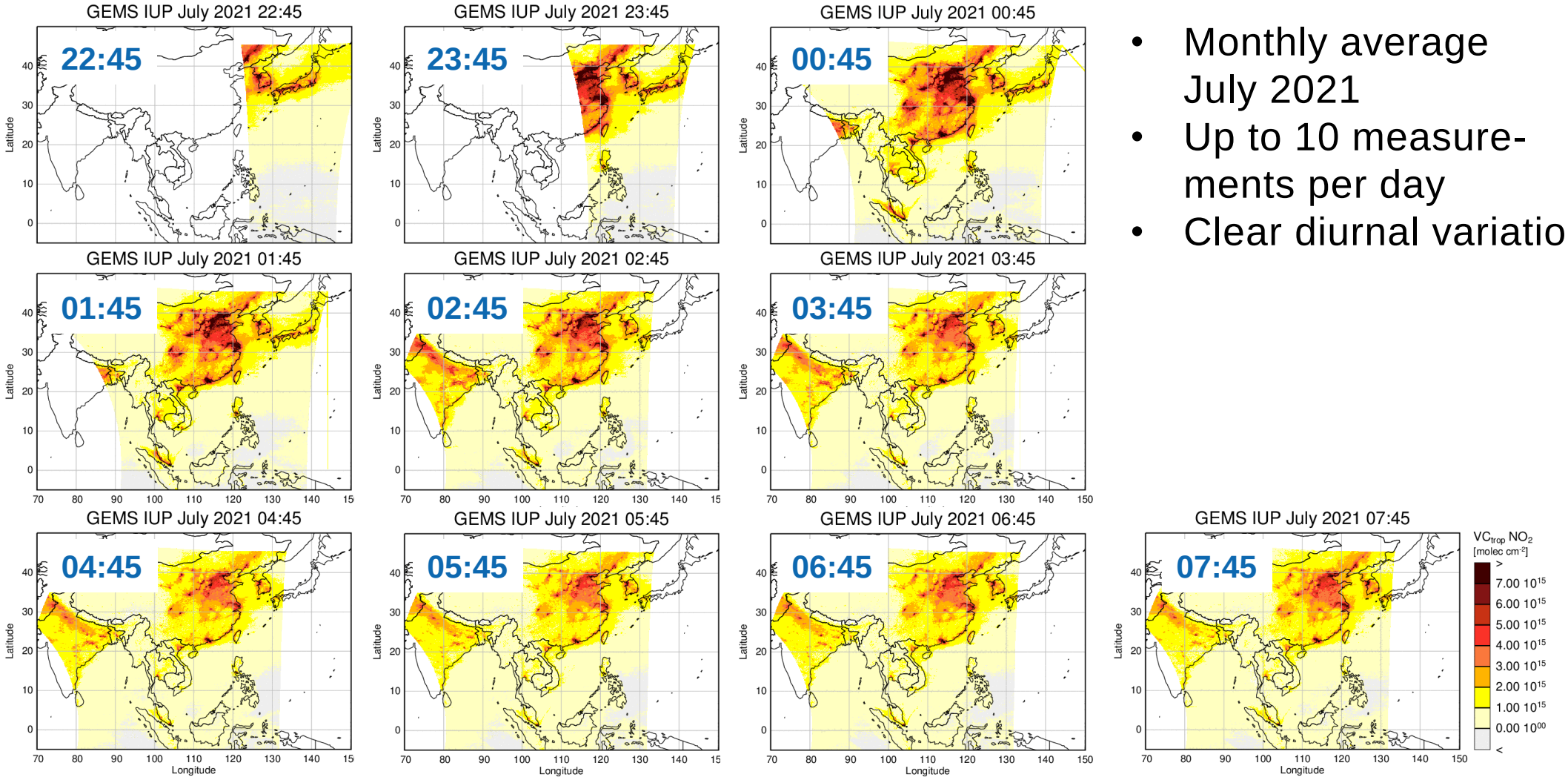
- Sampling pattern remains visible in GEMS averages
- Less smoothing, no oversampling

GEMS tropospheric NO_2 examples



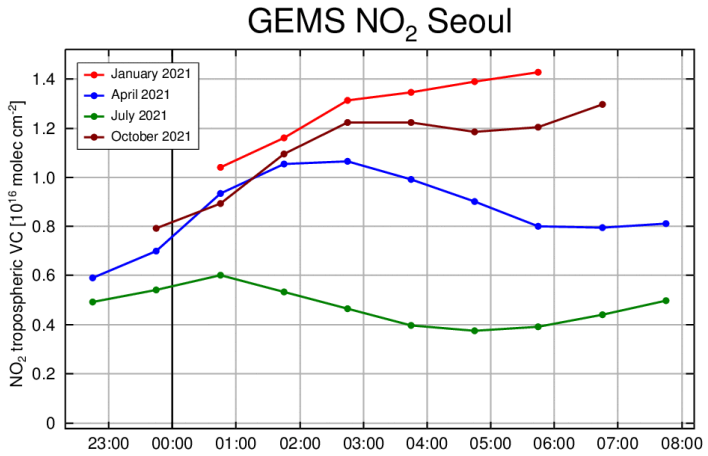
- S4 algorithm
- Monthly average
- @ 04:45 UTC

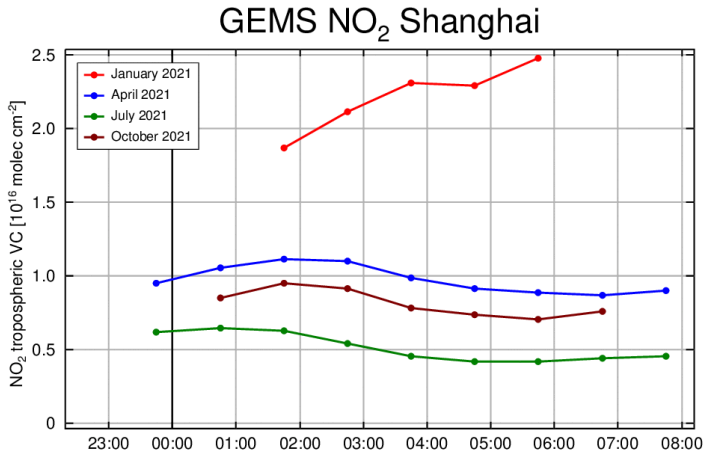
GEMS NO_2 diurnal variation

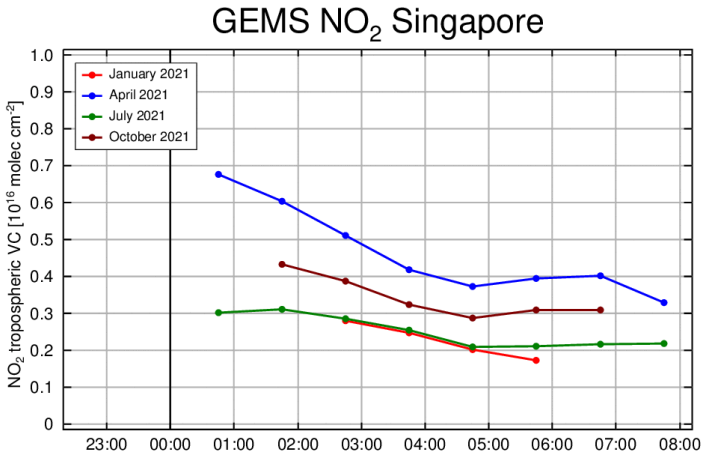


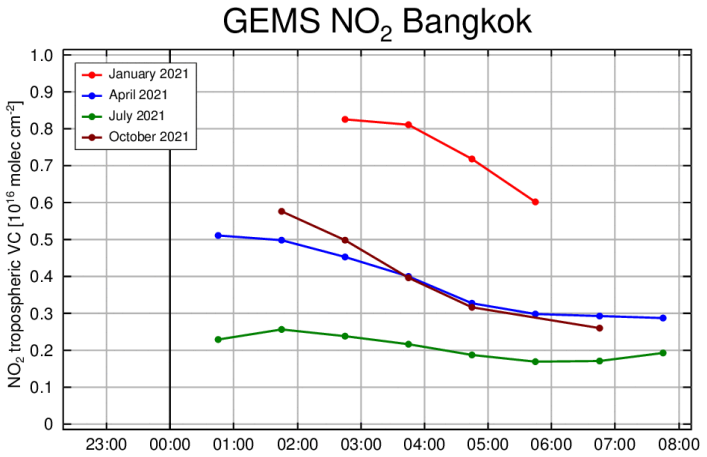
- Monthly average July 2021
- Up to 10 measure-ments per day
- Clear diurnal variation

GEMS NO_2 diurnal variation





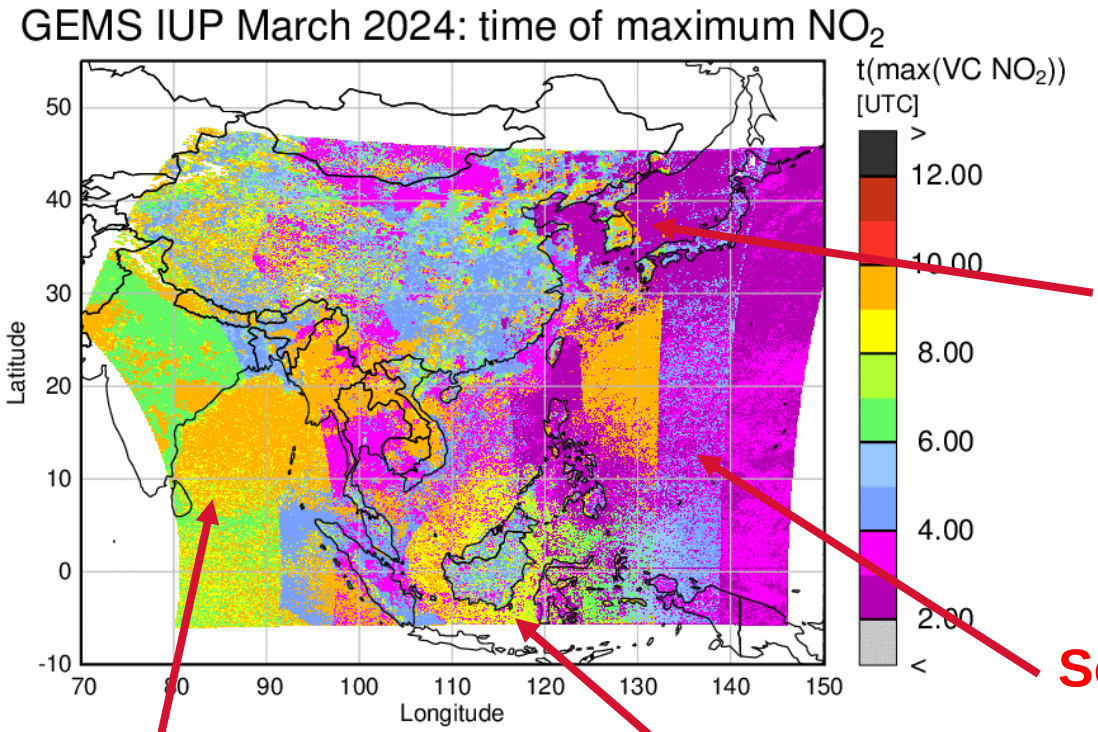




- Smooth diurnal variations
- Depend on location
- Depend on season

- Times are UTC
- Coverage depends on position in GEMS FOV
- Less measure-ments in winter

Time of NO_2 maximum



- GEMS scan pattern can be seen
- Sea-land contrast
- Sun glint

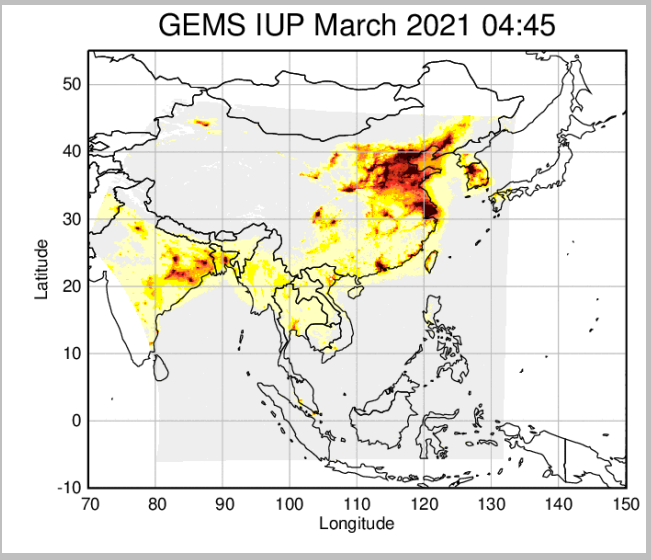
Sea-land contrast

Scan pattern

Scan pattern

Sun glint

Not seen



Need to separate **observation related effects** from **atmospheric composition effects**

Summary and Outlook

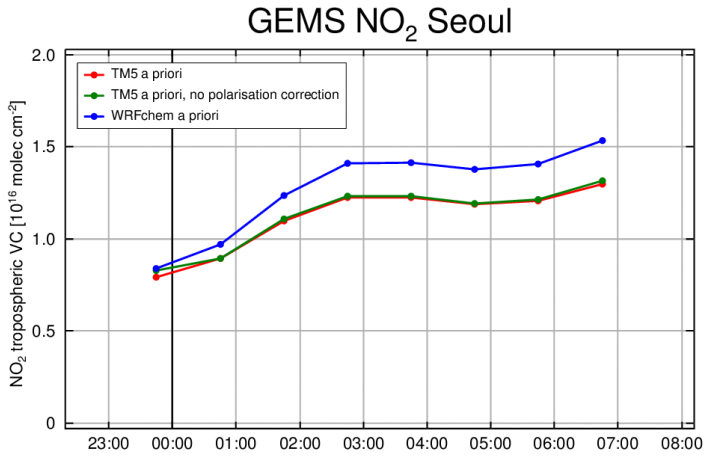
- The Korean GEMS satellite provides high resolution data over Asia with hourly resolution
- The S4 NO_2 breadboard algorithm was successfully applied to GEMS and TROPOMI data
- Excellent agreement is found between GEMS and TROPOMI data if cloud correction is not used

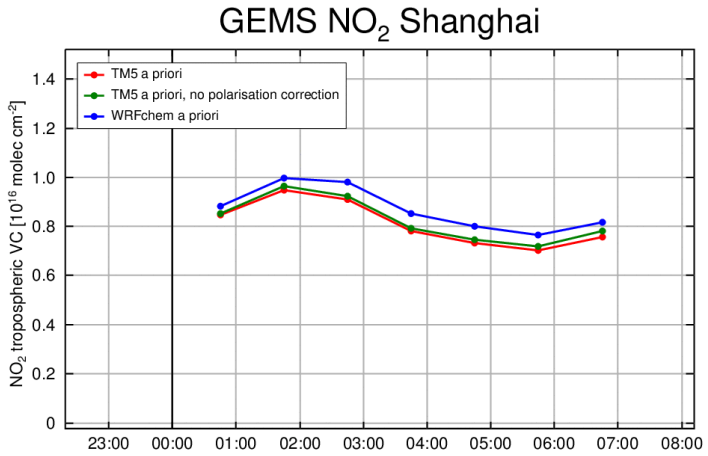
- Large and variable diurnal profiles of NO_2 are observed over source regions in Asia
- Time of maximum NO_2 columns shows many instrument and observation related patterns

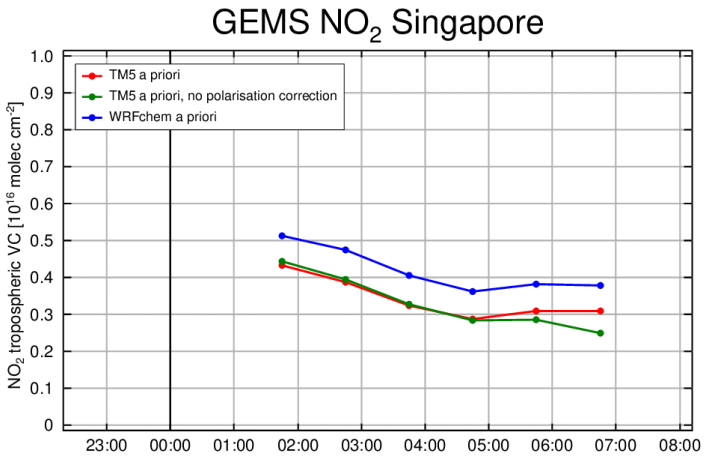
- Caution is needed when interpreting GEMS diurnal NO_2 variation

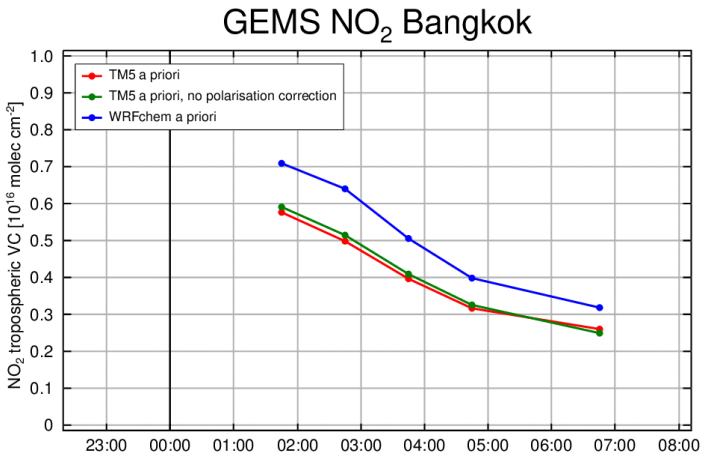
A big **Thank You** to the GMAP and GEMS teams for providing data, financial and scientific support, and an excellent collaboration atmosphere!

GEMS NO_2 diurnal variation: Sensitivity









- Correction of polarisation dependency has small impact only
- Change of a priori to high resolution WRFchem increases values and for some locations also diurnal variation