
IASI measurements of tropospheric ozone over megacities

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Outline

- Tropospheric ozone retrieval
- Validation of our product
- Tropospheric ozone over Chinese megacities
 - Monthly variations
 - Daily variations

Retrieval and data processing at LISA

- IASI L1 data through the ETHER database (France)
- RTM: KOPRA and associated retrieval code (KOPRAFIT)
- Filtering for clouds using
 - Surface temperature
 - Baseline distortion
- Temperature profiles using CO₂ bands (instead of L2 data)
- O₃ profiles using an altitude-dependent regularization based on Tikhonov-Philips method.
- details: *Eremenko et al., Geophys. Res. Lett. , 2008*

First validation exercise using ozone sondes

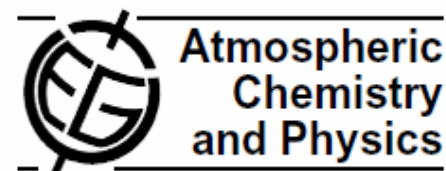
- Focus: midlatitudes
- Coincidence criteria
 - Spatial: ± 100 km
 - Temporal 12 hours
- Differences in the vertical resolution \rightarrow smoothing the sonde profiles

$$\mathbf{x}_{\text{smoothed}} = \mathbf{x}_{\text{a priori}} + \mathbf{A}(\mathbf{x}_{\text{sonde}} - \mathbf{x}_{\text{a priori}})$$

- Comparisons with ozone sondes but also intercomparisons with other scientific and operational products
-

First validation exercise using ozone sondes

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Tropospheric ozone from IASI: comparison of different inversion algorithms and validation with ozone sondes in the northern middle latitudes

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⁷Richard-Aßmann-Observatorium, DWD, Lindenberg, Germany

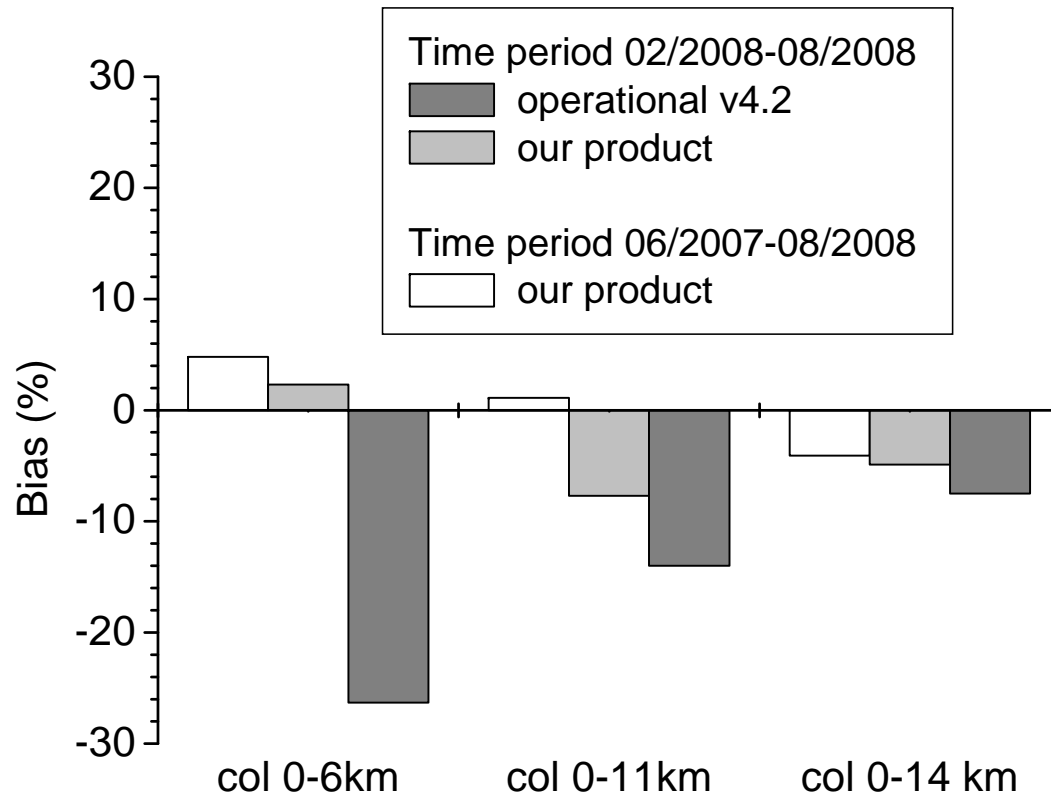
⁸NOAA/ESRL, Boulder, CO, USA

⁹Department of Applied Physics, Eindhoven University of Technology, Eindhoven, The Netherlands

¹⁰Finnish Meteorological Institute, Sodankylä, Finland

◆ see poster of A. Griesfeller

Results - northern midlatitudes



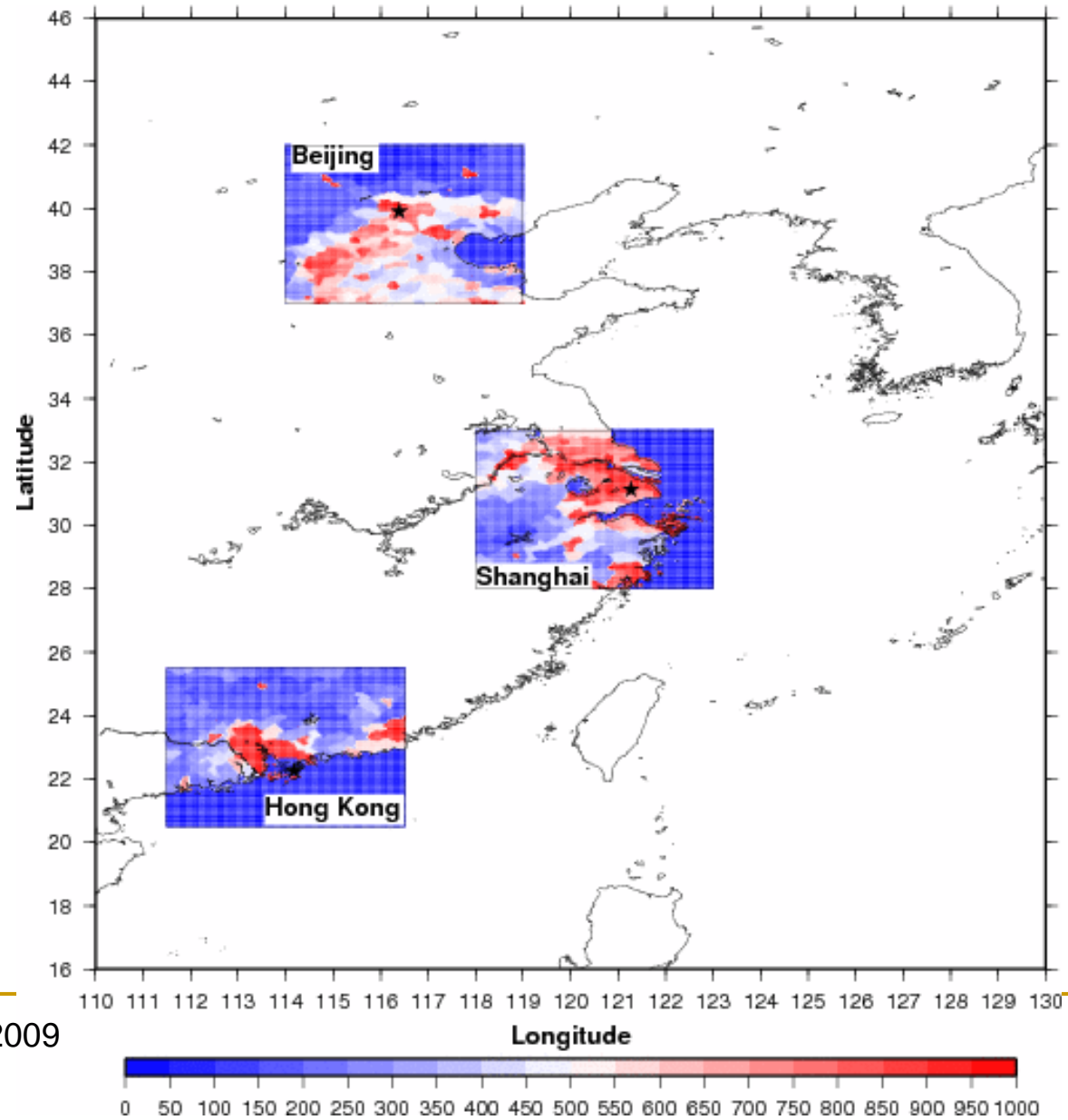
Our product:

- small bias < errors
- std ~ errors

Operational products (v4.2)

- significant bias in the lower troposphere
- similar to scientific product for tropospheric column

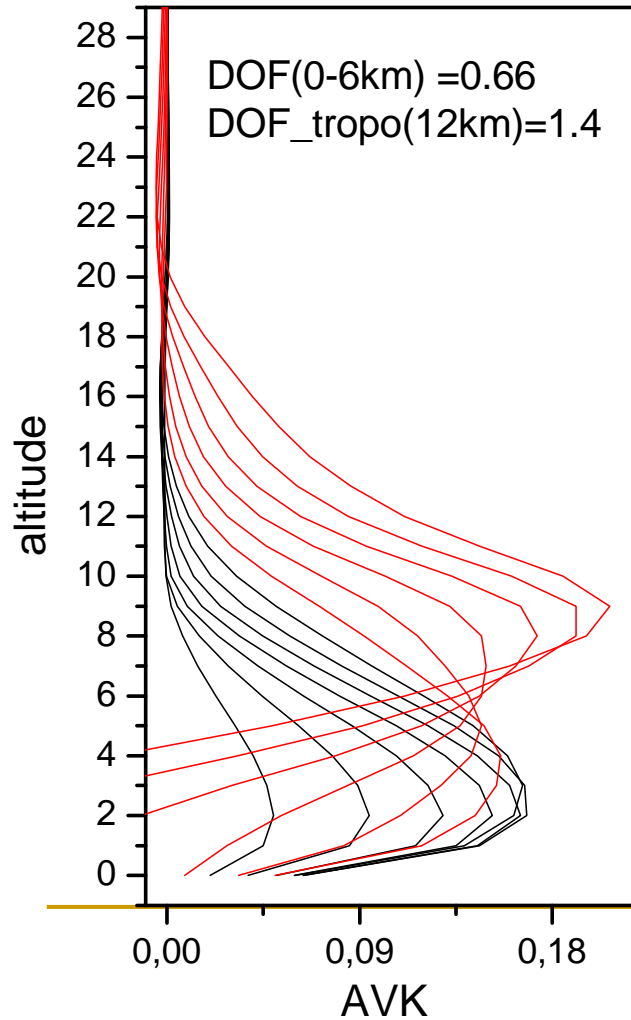
Chinese Megacities



Vertical sensitivity

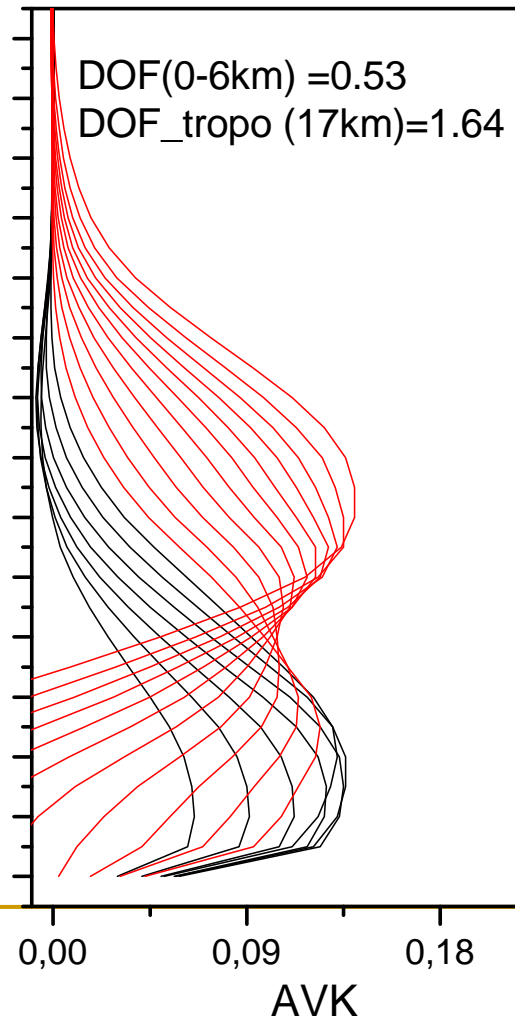
Beijing 16.04.2008

$T_{\text{surf}}=302.5 \text{ K}$
 $\Delta T=17.7 \text{ K}$



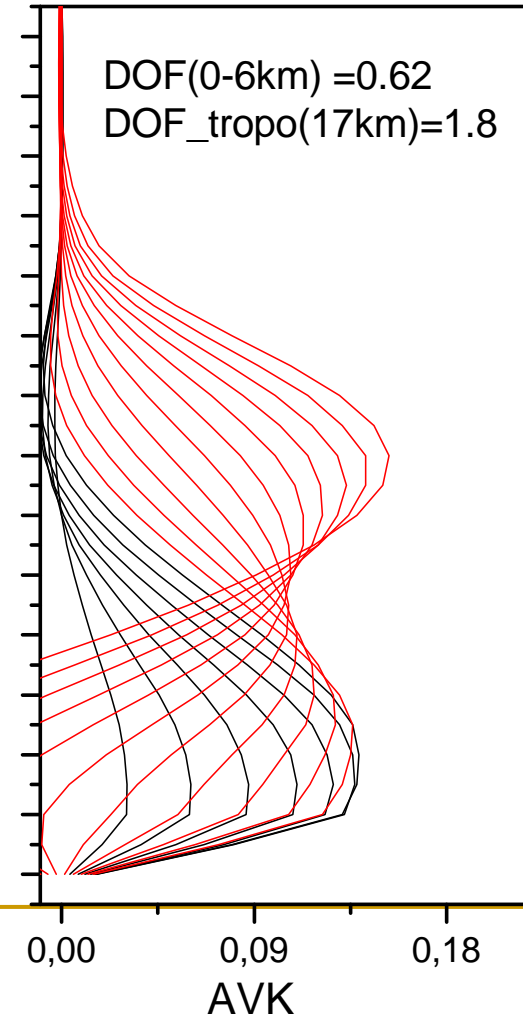
Shanghai 4.06.2008

$T_{\text{surf}}=298.9 \text{ K}$
 $\Delta T=11.0 \text{ K}$

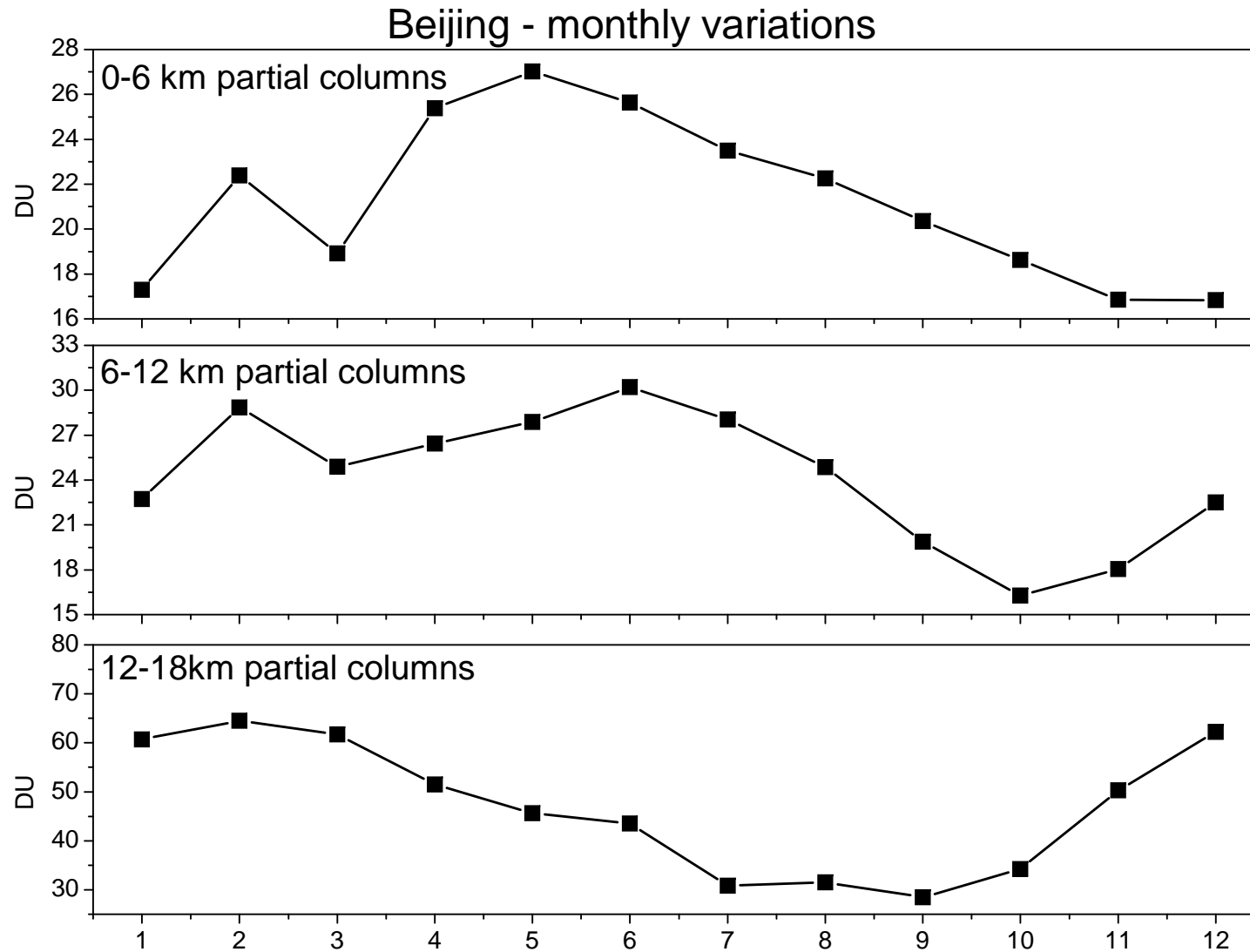


Hongkong 12.05.2008

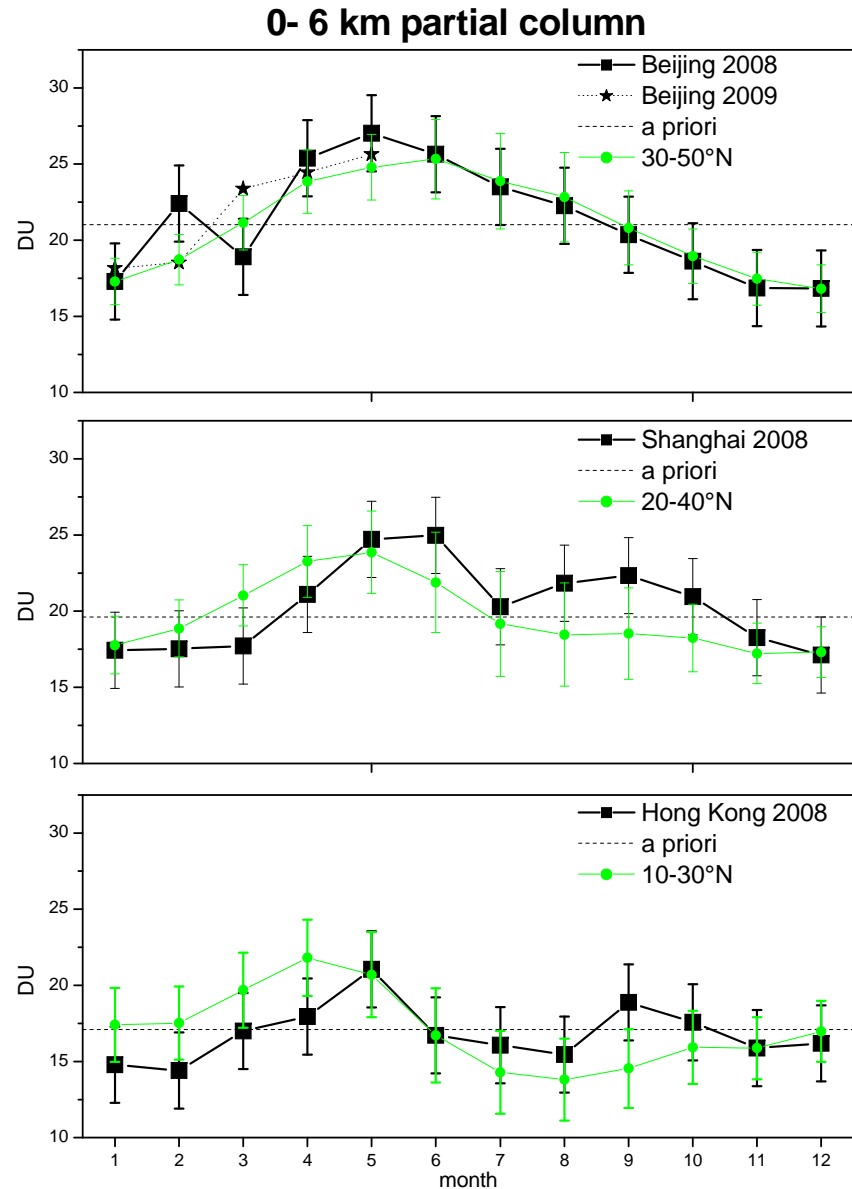
$T_{\text{surf}}=298.5 \text{ K}$
 $\Delta T=8.9 \text{ K}$



Columns in the LT and in the UT/LS



Monthly variations



- Sharp maximum in late spring and early summer

- Early summer decrease in Beijing

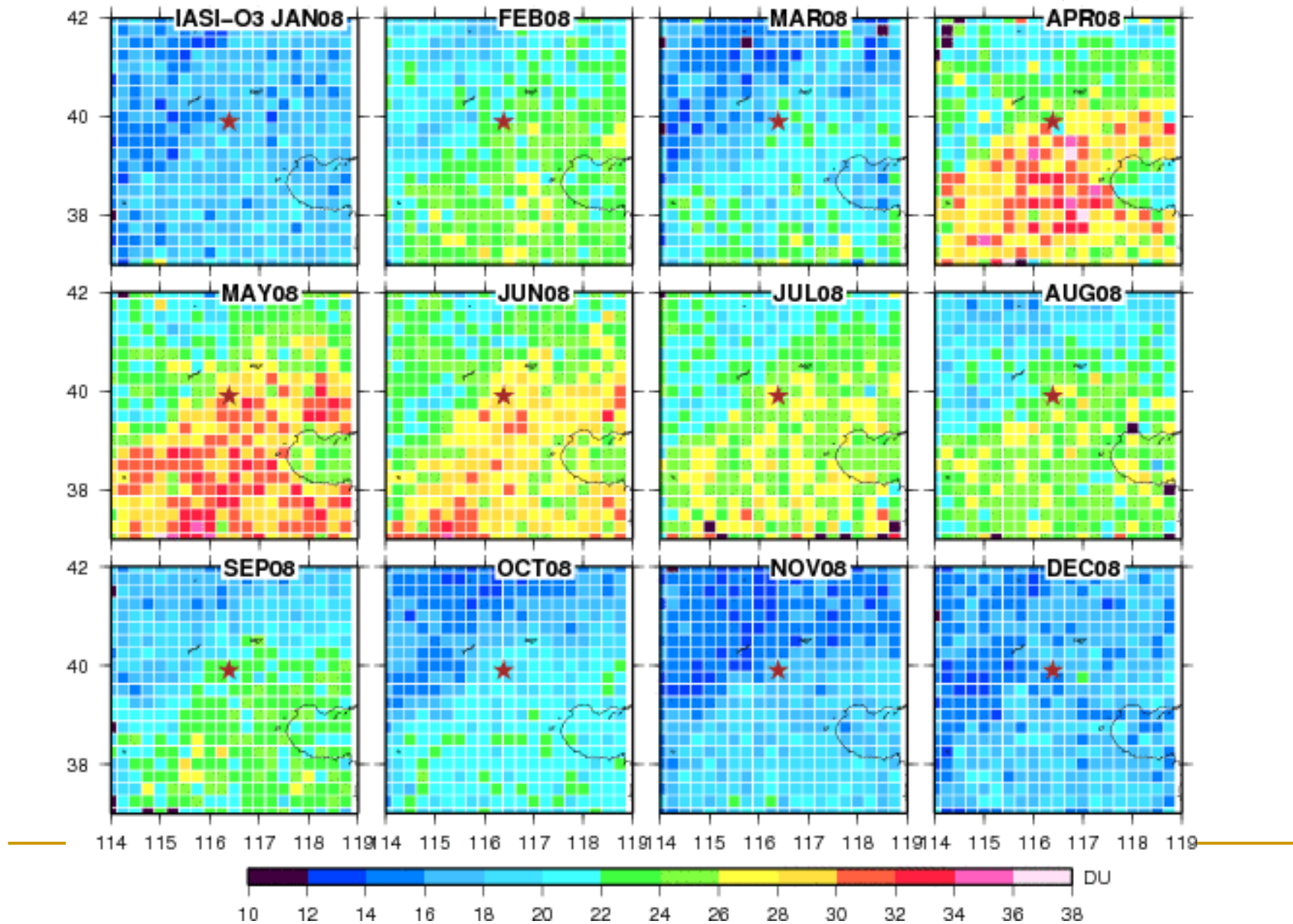
- Summer minimum in Shanghai and Hong Kong

➔ Asian summer monsoon influence

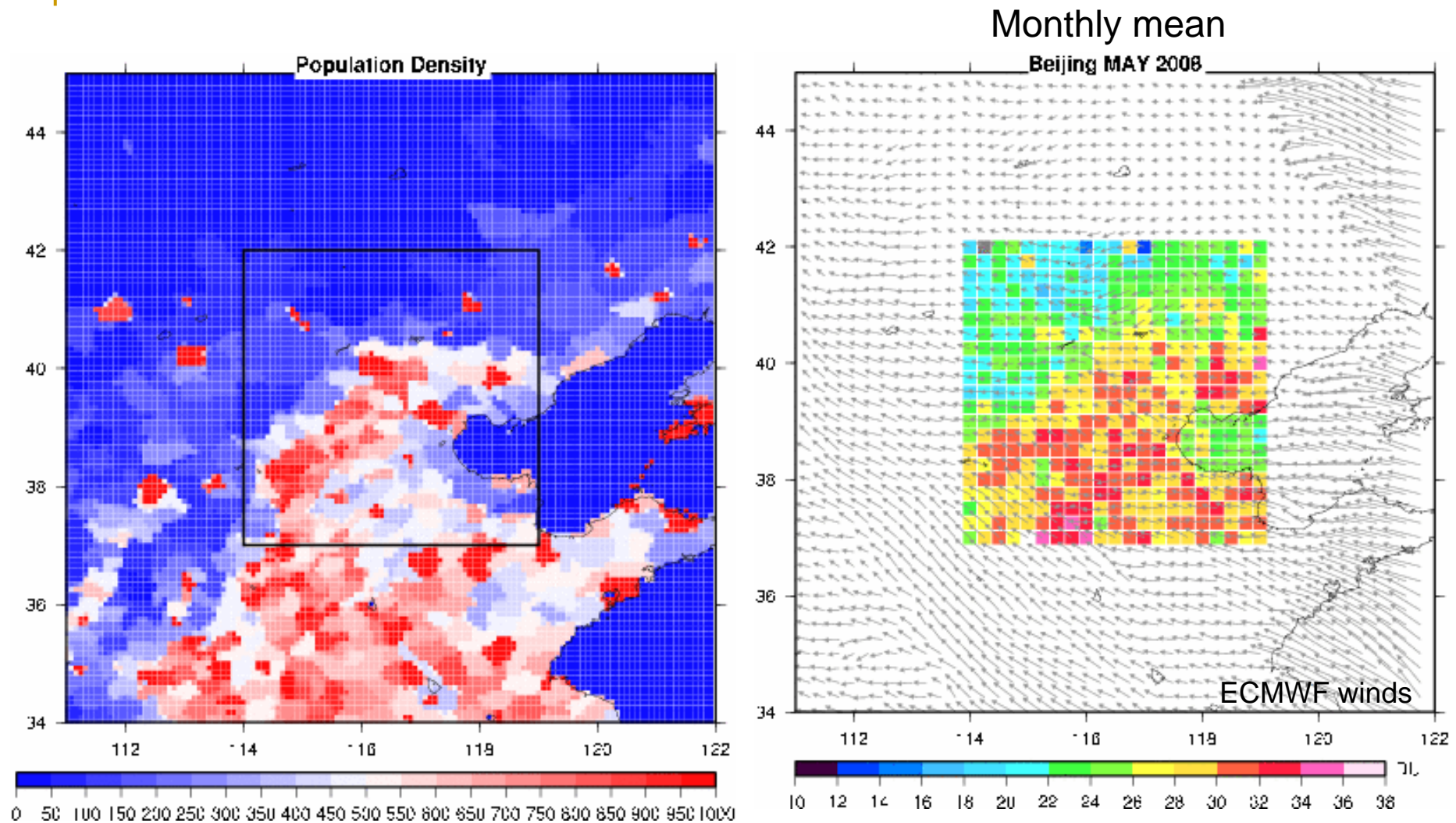
- Second maximum in fall in Shanghai and Hong Kong:

- enhanced photochemical production due to polluted period?

Spatially resolved monthly variations - Beijing

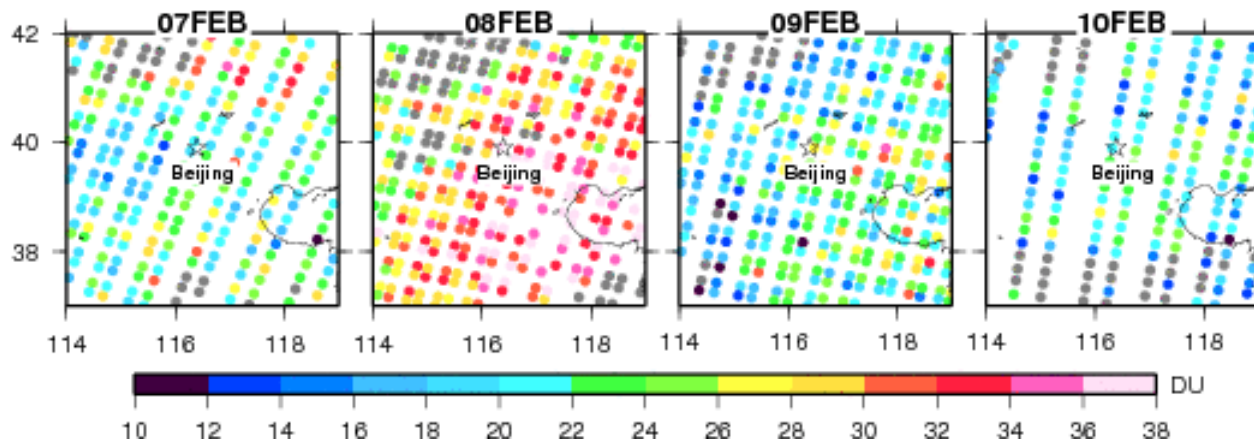
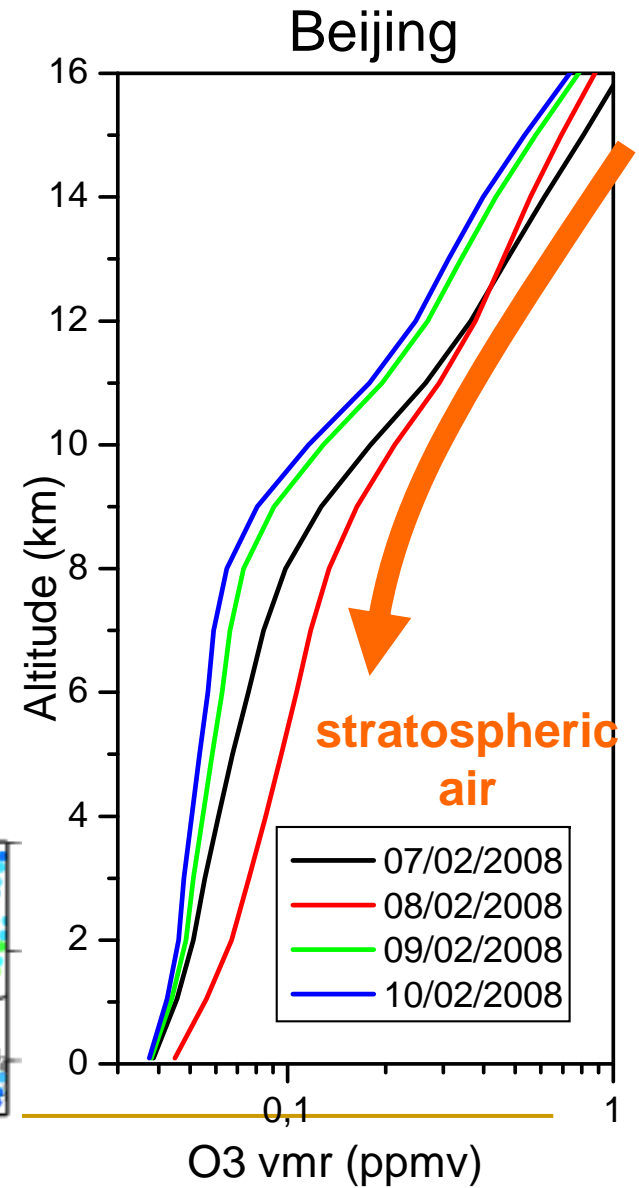
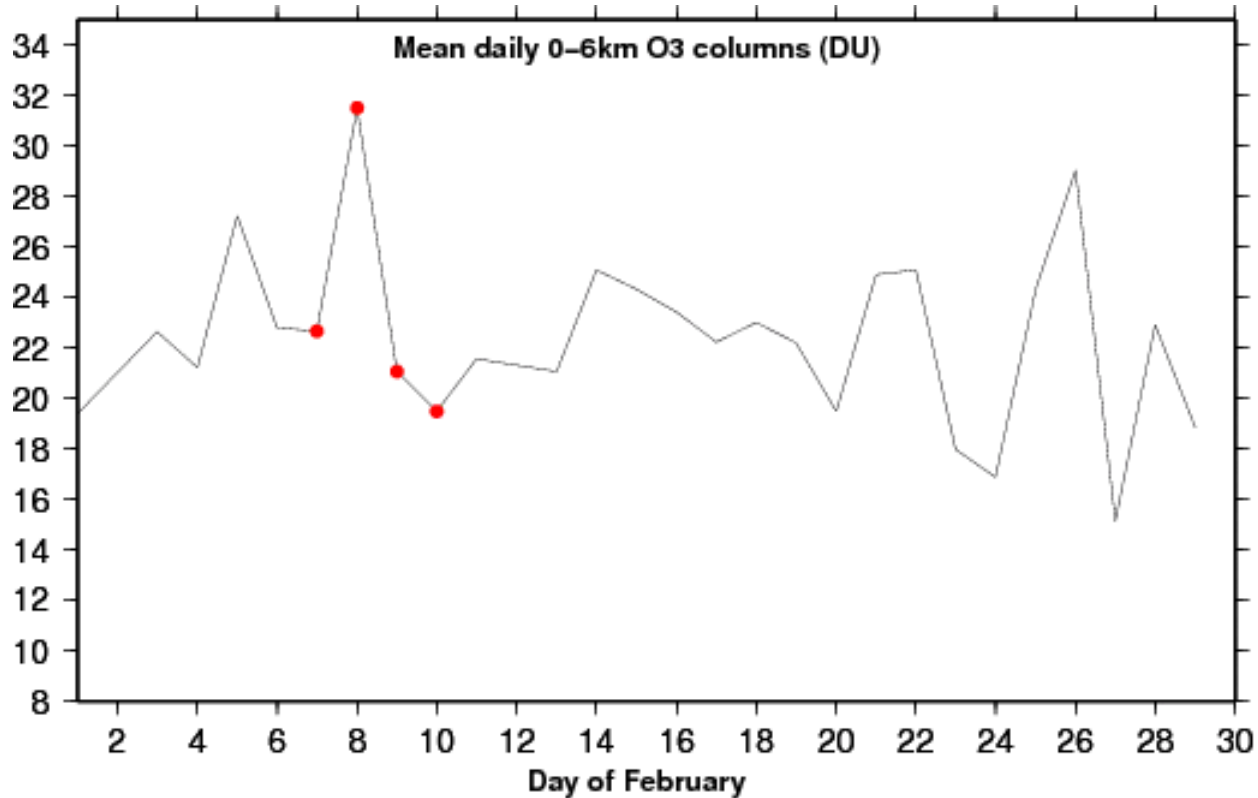


Comparison with population density



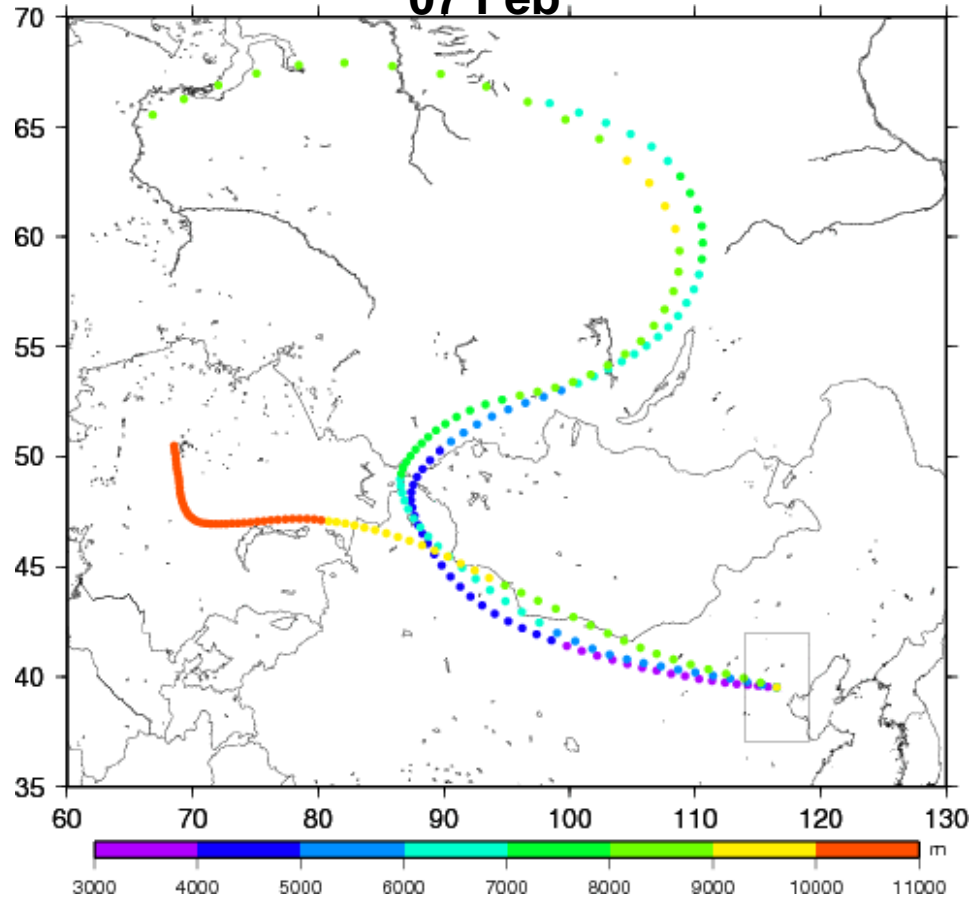
Consistency between population density, wind direction and large ozone
Anthropogenic and/or biomass burning origin of the large ozone values

Daily variations – Beijing – stratospheric origin



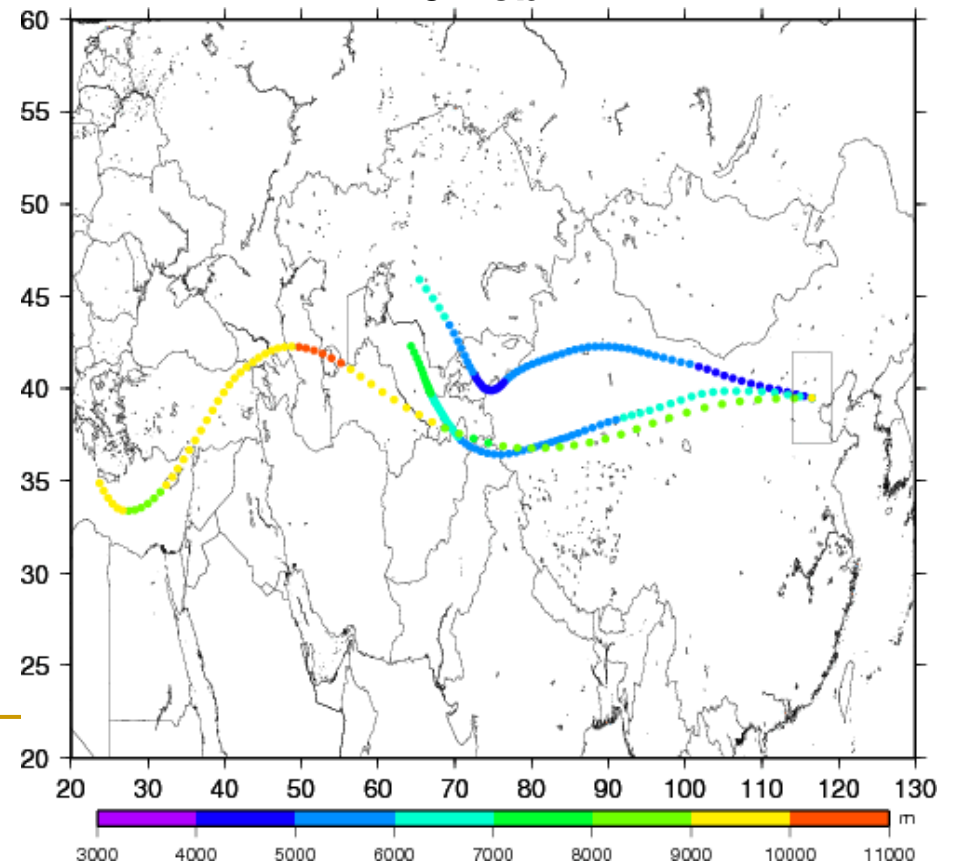
Backtrajectories at 4, 6 and 9 km

07 Feb



On February 7th, air masses are coming from North West and from higher altitudes

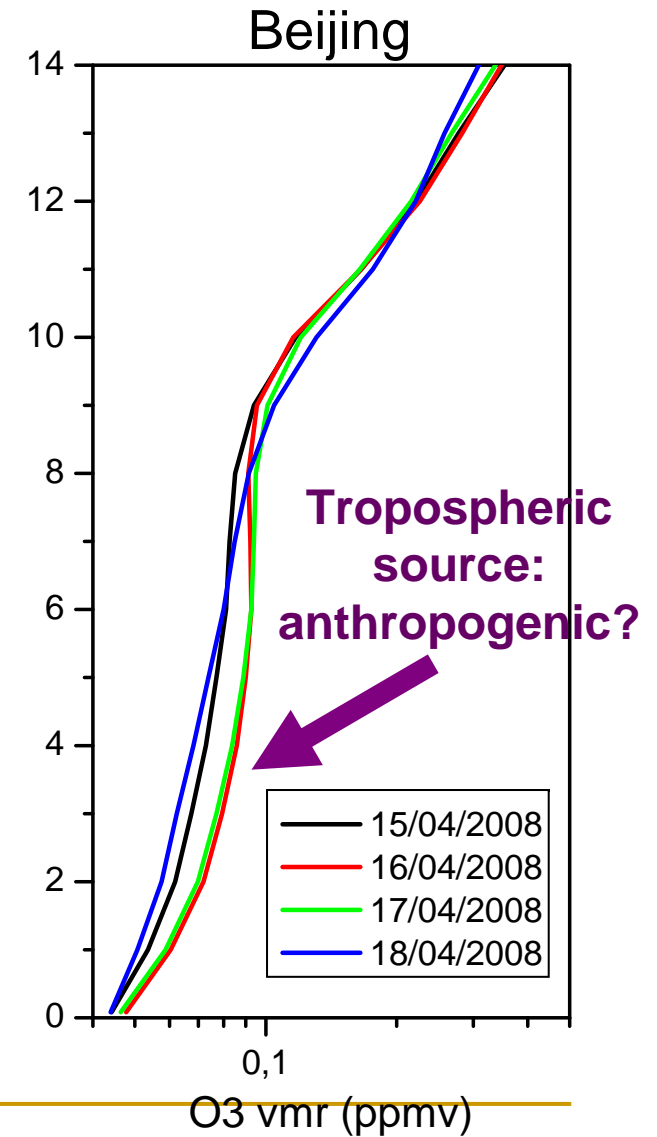
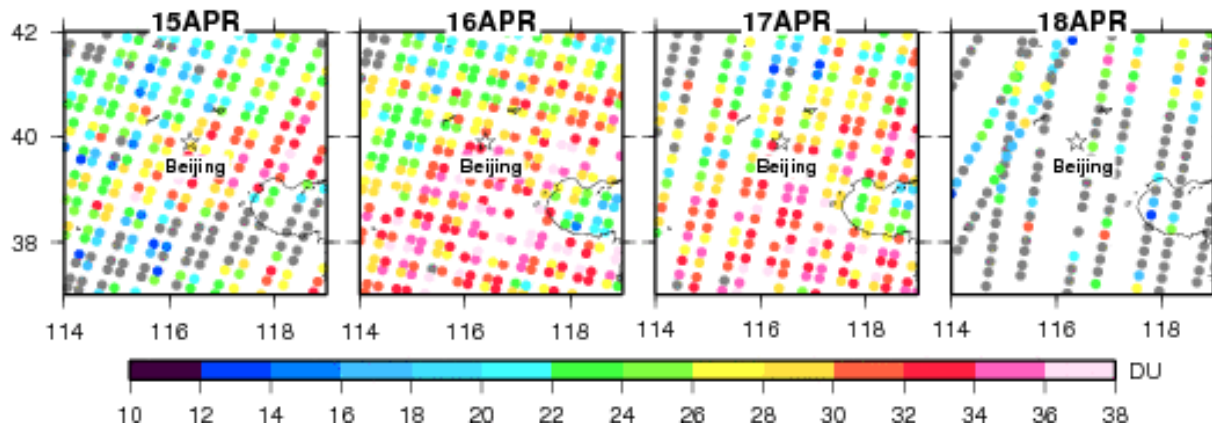
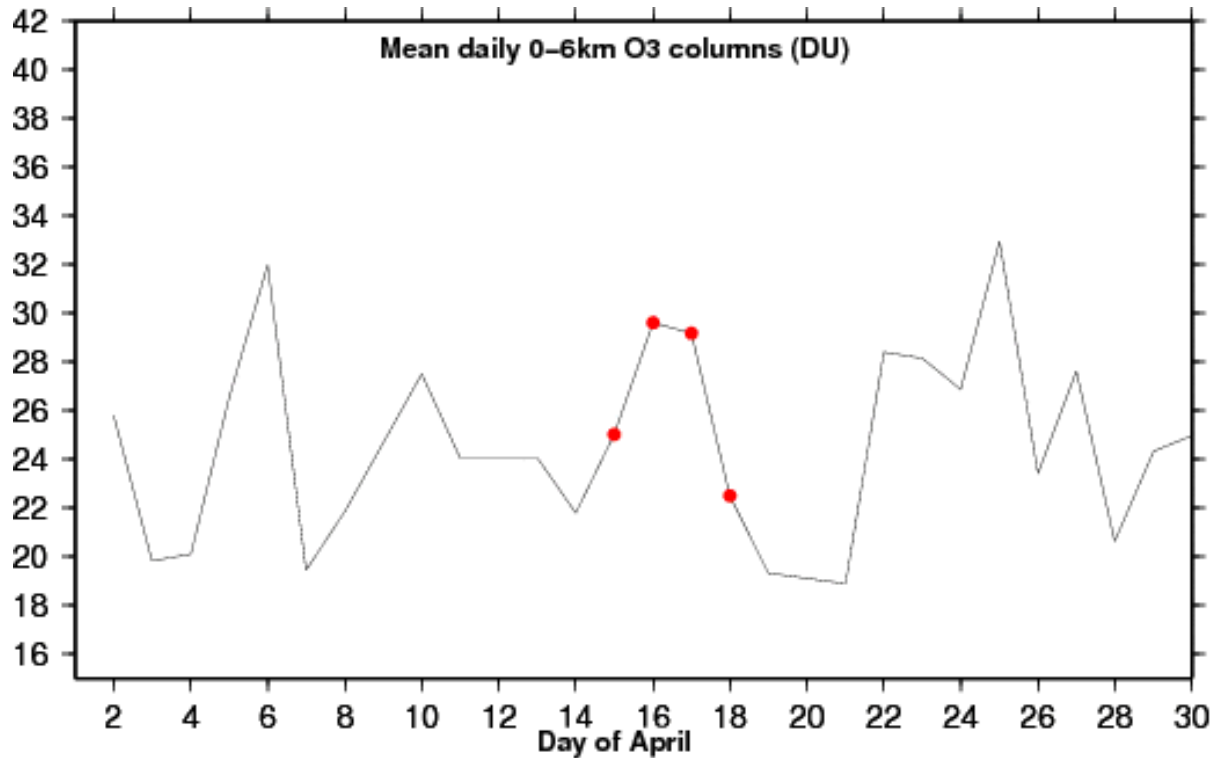
10 Feb



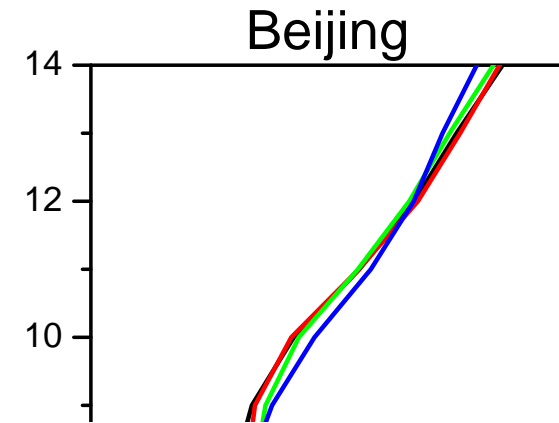
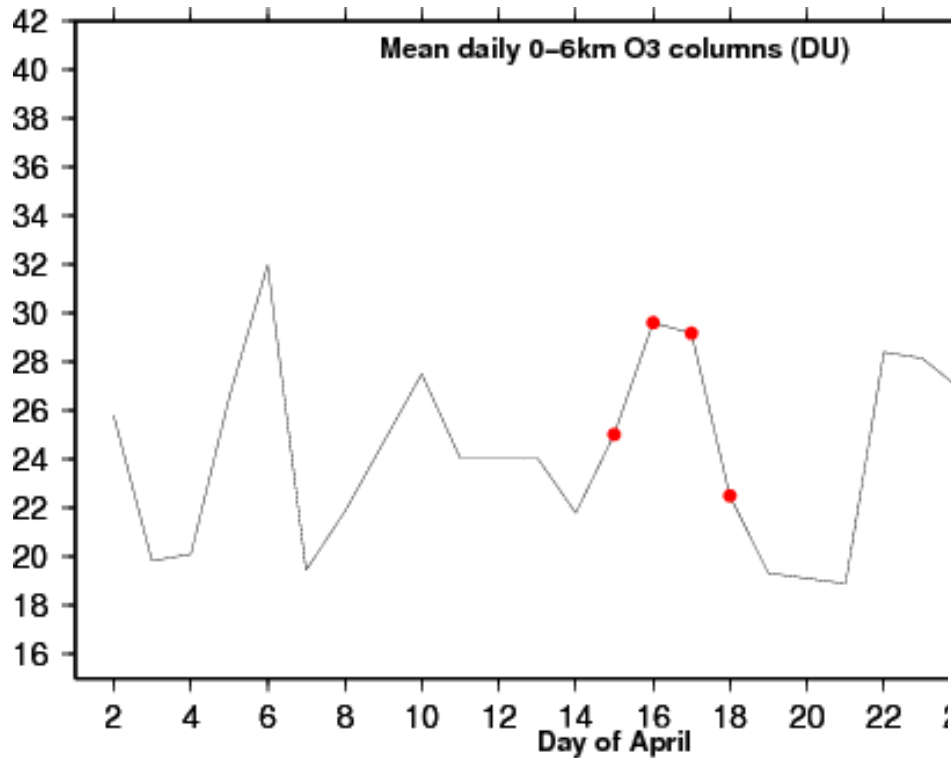
On February 10th, air masses are coming from West without changes in altitude

HYSPLIT model

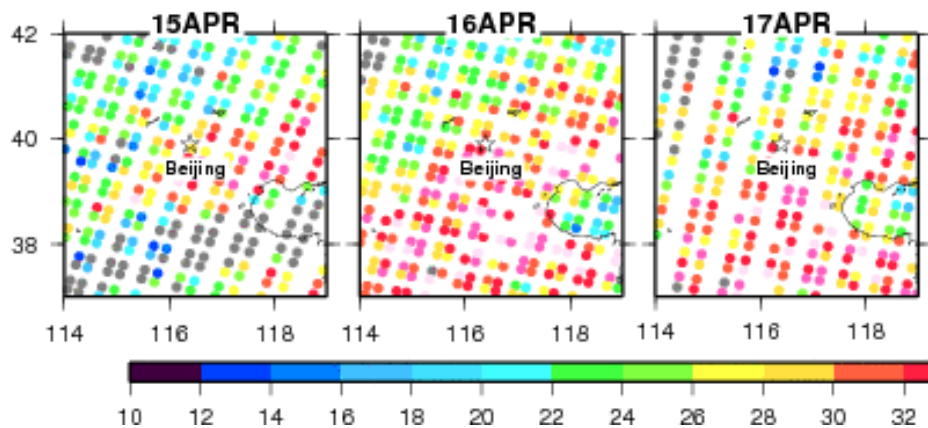
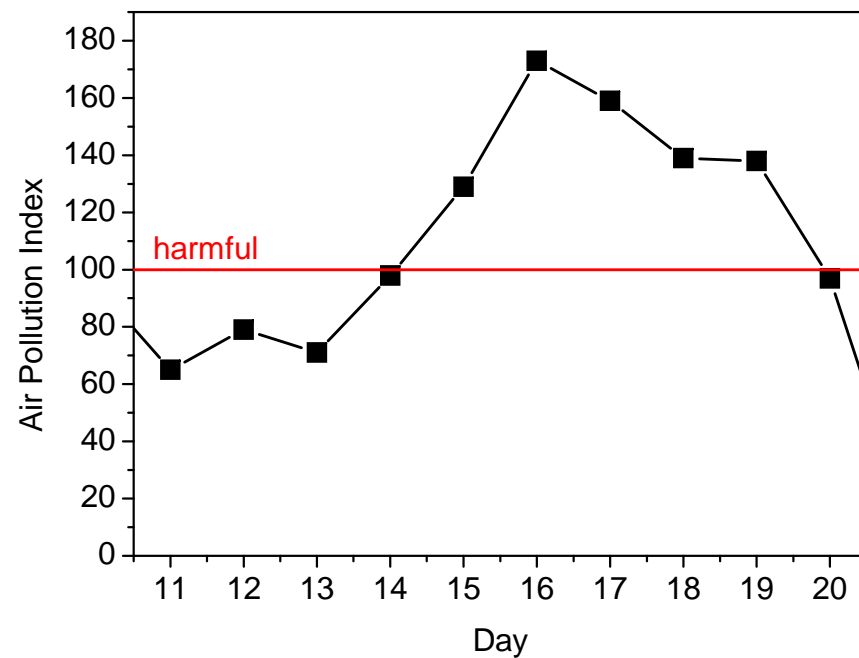
Daily variations – Beijing – anthropogenic origin



Daily variations – Beijing – anthropogenic origin

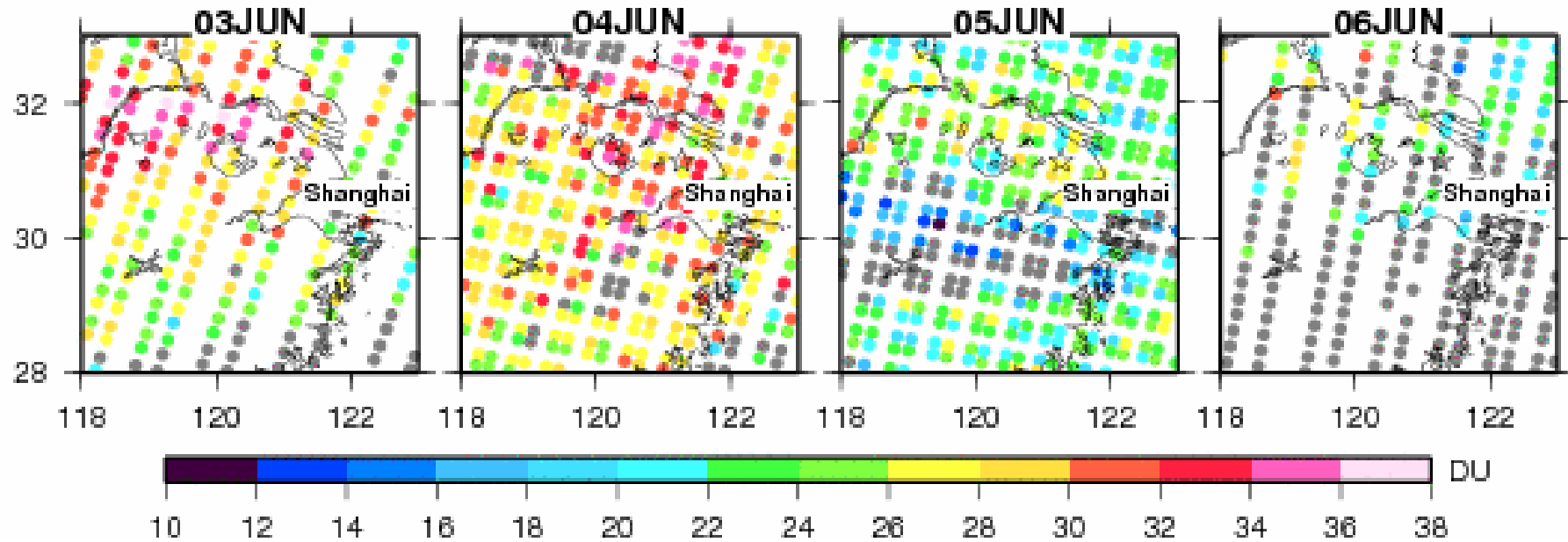


Air Pollution Index - Beijing - April 08



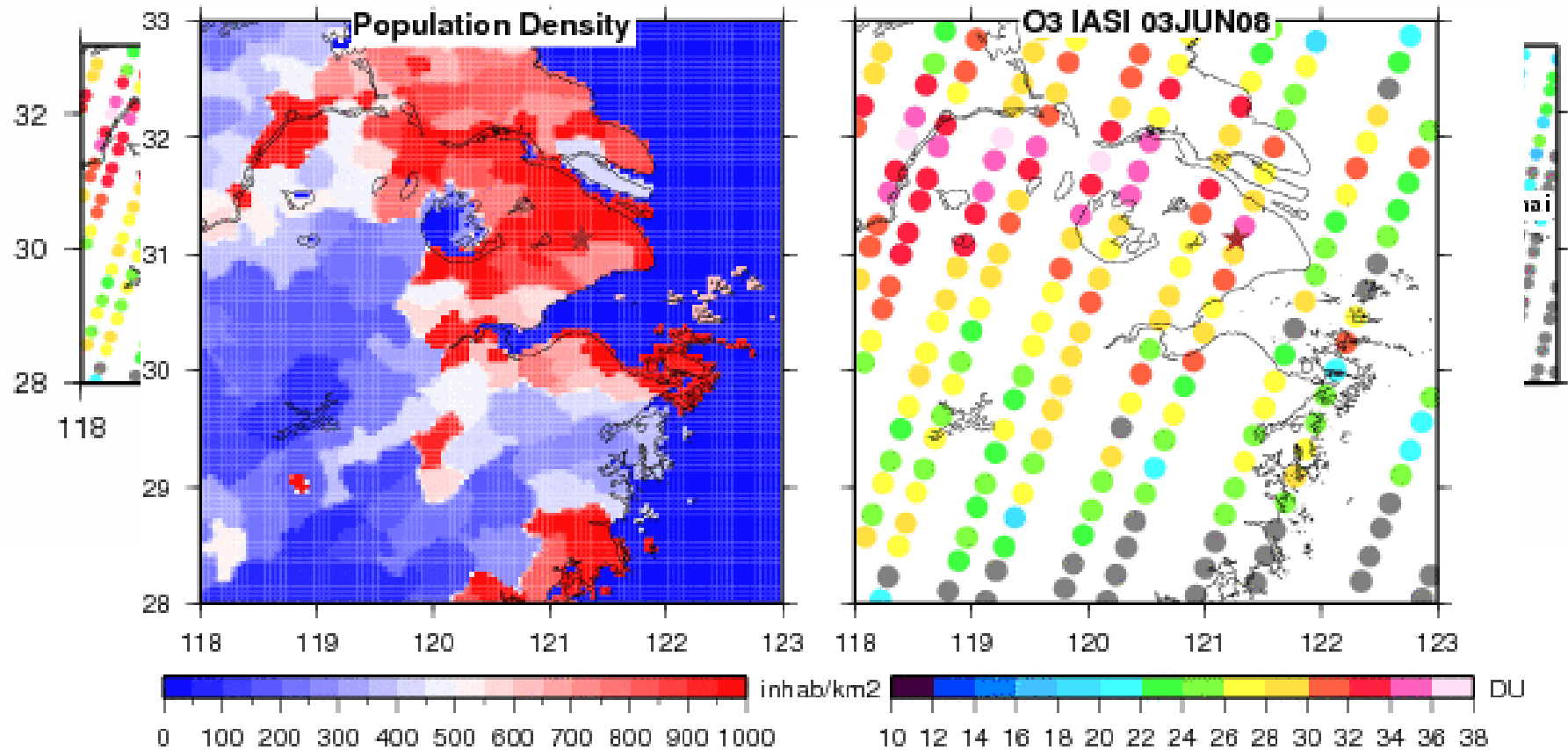
Daily variations – Shanghai – anthropogenic origin

Shanghai



Daily variations – Shanghai – anthropogenic origin

Shanghai

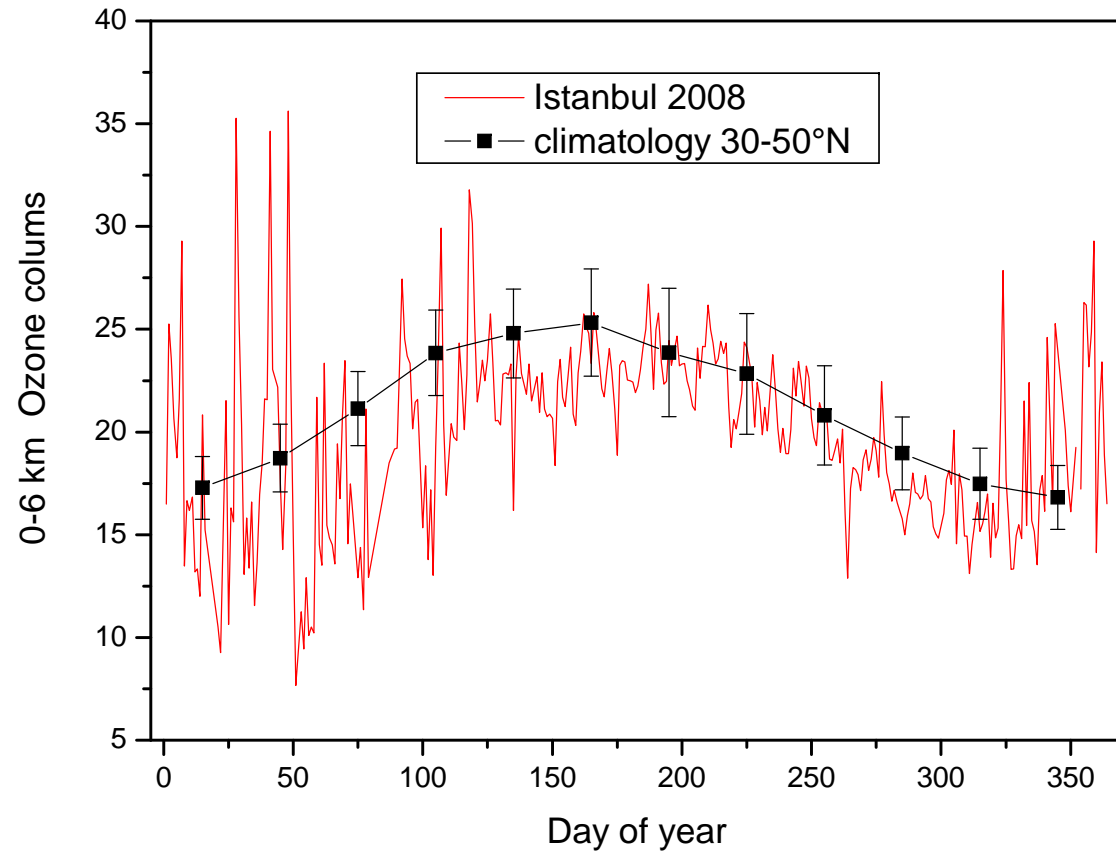


Consistency between population density and large ozone values on individual days



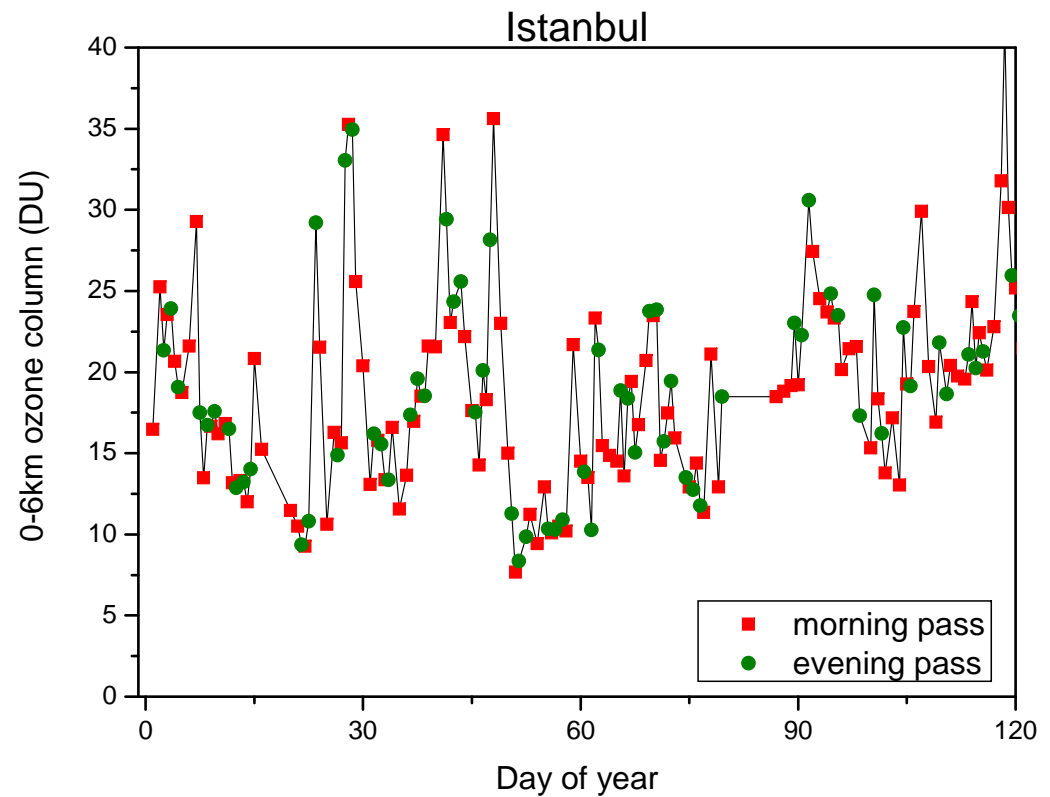
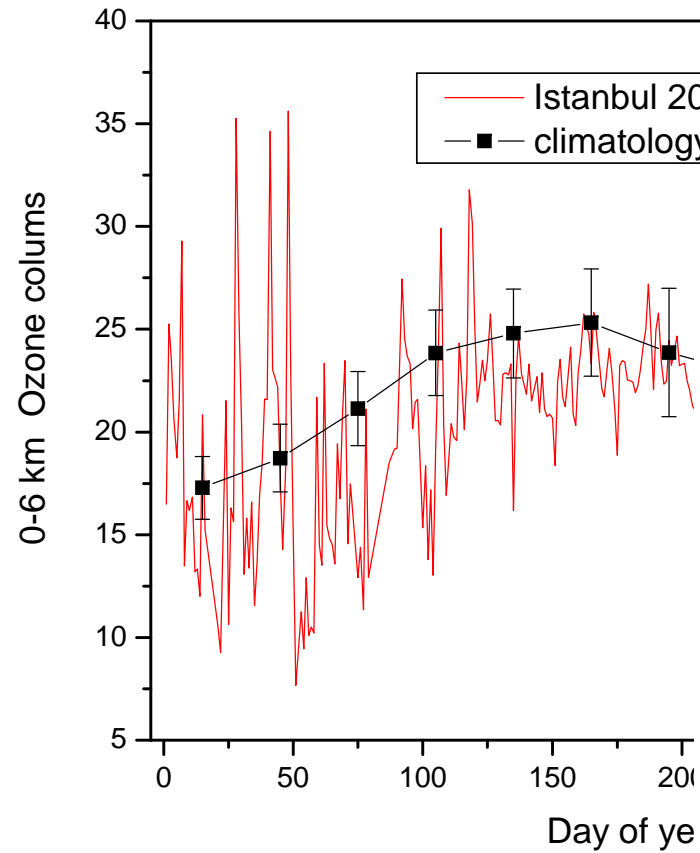
Anthropogenic origin ?

Twice daily coverage – Istanbul case



Preliminary results !

Twice daily coverage – Istanbul case



Preliminary results !

Conclusions and perspectives

- Tropospheric O₃ is retrieved from IASI with good quality
 - Validation with ozone sondes shows good agreement
 - Bias < 5% for the different tropospheric partial columns

 - Ability of monitoring tropospheric ozone with IASI at the regional scale and to resolve
 - Monthly variations
 - Daily variations

 - Analyses over Chinese megacities
 - Influence of the Asian summer monsoon (clean air masses during summer)
 - Large ozone observed during winter of stratospheric origin
 - Large ozone observed during spring/summer of tropospheric/anthropogenic origin

 - Future work
 - Comparison with CTM
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Aknowledgements

