Tropospheric ozone: IASI vs models

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AT2 follow up meeting
Mainz, June 22, 2009
Outline

1) Motivation of this study
2) First results (summer 2007 over Europe)
3) Validation using $O_3$ sondes
4) Comparison with models (GEMS)
5) Conclusions and outlook
Motivation of this study

- Tropospheric ozone is a key species in tropospheric chemistry
- Tropospheric ozone is also an important greenhouse gas
- Air pollution forecast is based on surface networks
- Problems: spatial coverage, vertical extension
- Advantages of IASI: spatial coverage, vertical sensitivity
First results

- Tropospheric $O_3$ over Europe during the heat wave in July 2007
Tropospheric ozone distributions over Europe during the heat wave in July 2007 observed from infrared nadir spectra recorded by IASI

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Received 27 May 2008; revised 17 July 2008; accepted 5 August 2008; published 23 September 2008.

[1] First partial tropospheric ozone columns (0–6 km) derived from radiances observed by the IASI instrument aboard the MetOp-A platform over Europe during summer 2007 are presented. They were retrieved using an altitude-dependent regularization method. Comparison with measurements from balloon sondes shows excellent agreement. Space-borne observations show large lower tropospheric ozone amounts over South-Eastern Europe during the heat wave period, which are also displayed by simulations with a regional chemistry-transport model CHIMERE. Citation: Fremenko, M., G. Dufour, G. Foret, C. Keim, J. Orphal, M. Beekmann, G. Bergametti, and J.-M. Flaud (2008), Tropospheric ozone distributions over Europe during the heat wave in July 2007 observed from infrared nadir spectra recorded by IASI, Geophys. Res. Lett., 35, L18805, doi:10.1029/2008GL034803.

[4] Here, we present first results of tropospheric O₃ measured with the Infrared Atmospheric Sounding Interferometer (IASI) launched in October 2006 onboard the satellite MetOp-A. The used retrieval method allows separating the tropospheric O₃ columns into two semi-independent columns and demonstrates the potential of IASI to measure the lower tropospheric O₃ variability. The IASI observations used here focus on the heat wave in July 2007 over Europe. These observations are compared to O₃ balloon sonde measurements and to predictions from the CHIMERE model for validation and interpretation.

2. The IASI Instrument

[5] The IASI instrument [Clerbaux et al., 2007] is an operational meteorological instrument. In addition to temperature and humidity profiles and cloud information, providing partial distributions of O₃ is one of the objectives.
Validation using ozone sondes

- Focus: midlatitudes

- Differences in the vertical resolution
  - Smoothed = a priori + residual

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

- Details: Keim et al., Atm. Chem. Phys. Discuss., 2009
Preliminary validation using European ozone sondes
Validation using ozone sondes

Our product:
• small bias < errors

Operational products (v4.2)
• significant bias in the lower troposphere
• similar to scientific product for tropospheric column

NB: other scientific products (LATMOS/ULB, Clerbaux/Coheur) show similar performances than our scientific product.

details: Keim et al., Atm. Chem. Phys. Discuss., 2009
Comparison with GEMS-RAQ simulations

Use IASI tropospheric ozone observations for evaluation of GEMS-RAQ simulations, in particular for free troposphere

Specific questions to be answered:

- Are spatial structures of tropospheric ozone columns well reproduced by CTMs, consistent with IASI.
- Role of the boundary conditions?
- Relate differences in free troposphere ozone between models to differences in surface ozone
Comparison IASI – smoothed simulated 0-6km columns

09.06.2008
Attempt for explanation of observed structures

Cross-section through CHIMERE simulations (9/06/2007)

500 hPa geopotential  

ozone

Importance of the middle/upper troposphere synoptical situation? 
Stratosphere/troposphere exchange?
Conclusions and Outlook

- Tropospheric ozone can be retrieved from IASI with good confidence in the lower troposphere
- Validation with ozone sondes shows good agreement
- Comparison with photochemical models (GEMS)

Next steps
- Assimilation of IASI Ozone columns in CHIMERE
- Other regions of the world subject to strong pollution
- Important demonstration for future projects (e.g. GEO)
- Inverse modeling activities: NOx and isoprene emissions in Europe (GOME, SCIAMACHY, GOME-2, OMI)
Acknowledgements

Thanks to

- EUMETSAT, CNES, industry, scientists – for the IASI instrument
- CNES (IASI–TOSCA project lead by C. Clerbaux)
- INSU/CNRS and CNES for the ETHER database
- the many colleagues from the WOUDC (O₃ sondes)
- ACCENT – TROPOSAT2 (EU NoE, 2005-2008)
- the colleagues from FZK IMK-ASF for the KOPRA codes