Laboratoire Inter-universitaire
des Systèmes Atmosphériques

ON THE EXPECTED ADDED VALUE OF A IASI-NG-TYPE OBSERVING SYSTEM IN LOWER TROPOSPHERIC OZONE MONITORING

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SUMMARY

1. Motivation
2. IASI and IASI-NG pseudo observations
3. Error analysis
4. Vertical sensitivity
5. LT ozone distributions
6. Conclusions

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1. Motivation

- Present LEO TIR satellite instruments to monitor AQ (LT ozone):
  - up to 1.5/0.6 DOFs in the troposphere/LT (surface-6 km);
  - separate LT only at favourable conditions.

- New generation instruments envisaged (e.g., **IASI-NG**: phase A).

- We developped a **PO simulator**.

- Performance analyses to evaluate the expected added value of **IASI-NG**.

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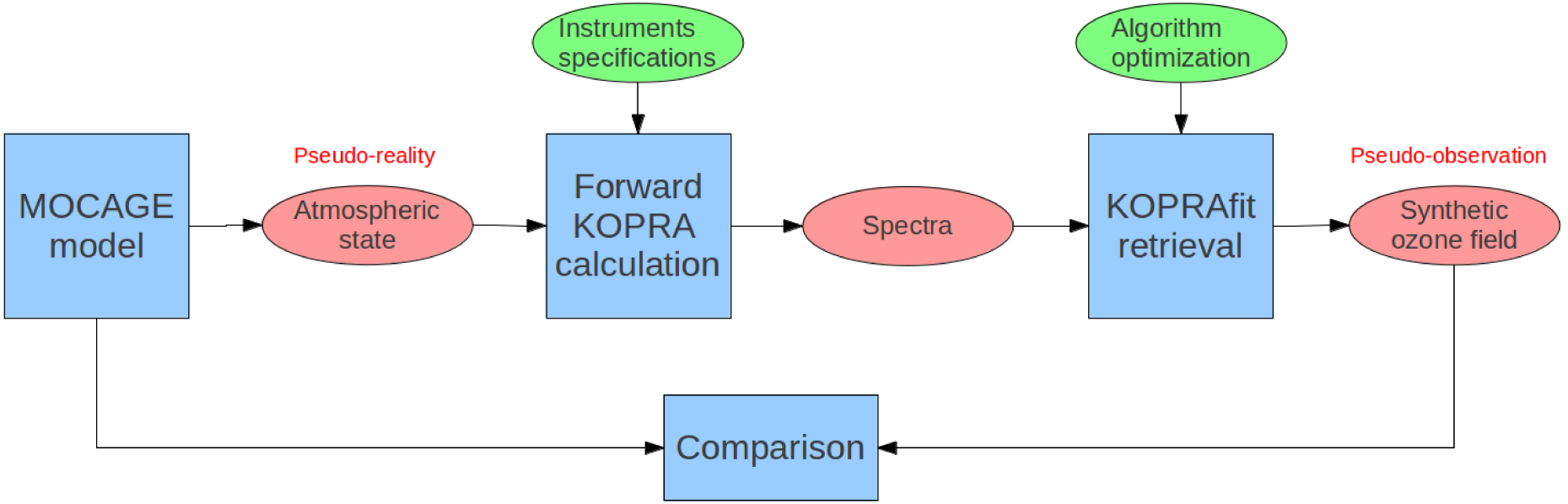
2. IASI and IASI-NG pseudo observations (1/3)
Simulator set-up

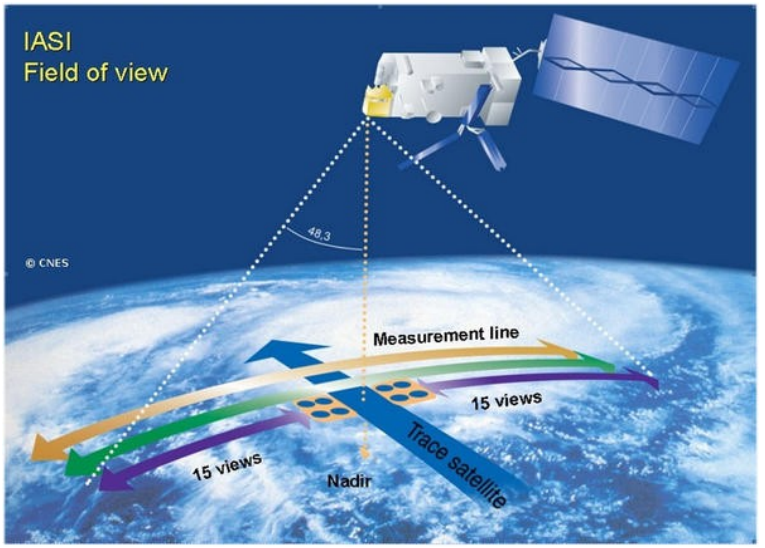
- PR: **MOCAGE** CTM
- Forward TIR RT: **KOPRA**
- Inversion algorithm: **LISA T-P(z)** embedded into **KOPRAFIT**



2. IASI and IASI-NG pseudo observations (2/3)
Instrumental characterisation

IASI → flying on MetOp-A/B spacecrafts
IASI-NG → phase A completed, EPS-SG
PIs: C. Clerbaux, C. Crevoisier

	IASI	**IASI-NG/IRS2** (Ph.A–2020)
SSI (cm-1)	**0.25**	**2 * IASI**
NESR (nW/cm^{2}srcm^{-1})	**20.0**	
SNR	**230**	
Rev. Time	**2 Ovp/day**	
Pixel Size (km)	**12**	



Observation geometry:
IASI/IASI-NG →
real IASI pixels

Complete RT calculation
1 month (August 2009)
AM/PM overpasses
ROI: Europe

2. IASI and IASI-NG pseudo observations (3/3)
Inversion scheme

- Altitude-dependent regularization method:
  - Tikhonov-Philips;
  - Altitude-dependent constraints:

$$\mathbf{R} = \alpha_0(z)\mathbf{L}_0\mathbf{L}_0^T + \alpha_1(z)\mathbf{L}_1\mathbf{L}_1^T + \alpha_2(z)\mathbf{L}_2\mathbf{L}_2^T$$

Constraints optimized to maximize the DOFs and minimize the error at LT

7 spectral windows in the 975–1100 cm^{-1} spectral region

Full retrieval approach optimized for IASI real observations (LISA algorithm)

Dufour, G., Eremenko, M., Griesfeller, A., Barret, B., LeFlochmoën, E., Clerbaux, C., Hadji-Lazaro, J., Coheur, P.-F., and Hurtmans, D.: Validation of three different scientific ozone products retrieved from IASI spectra using ozonesondes, Atmos. Meas. Tech., 5, 611-630, doi:10.5194/amt-5-611-2012, 2012

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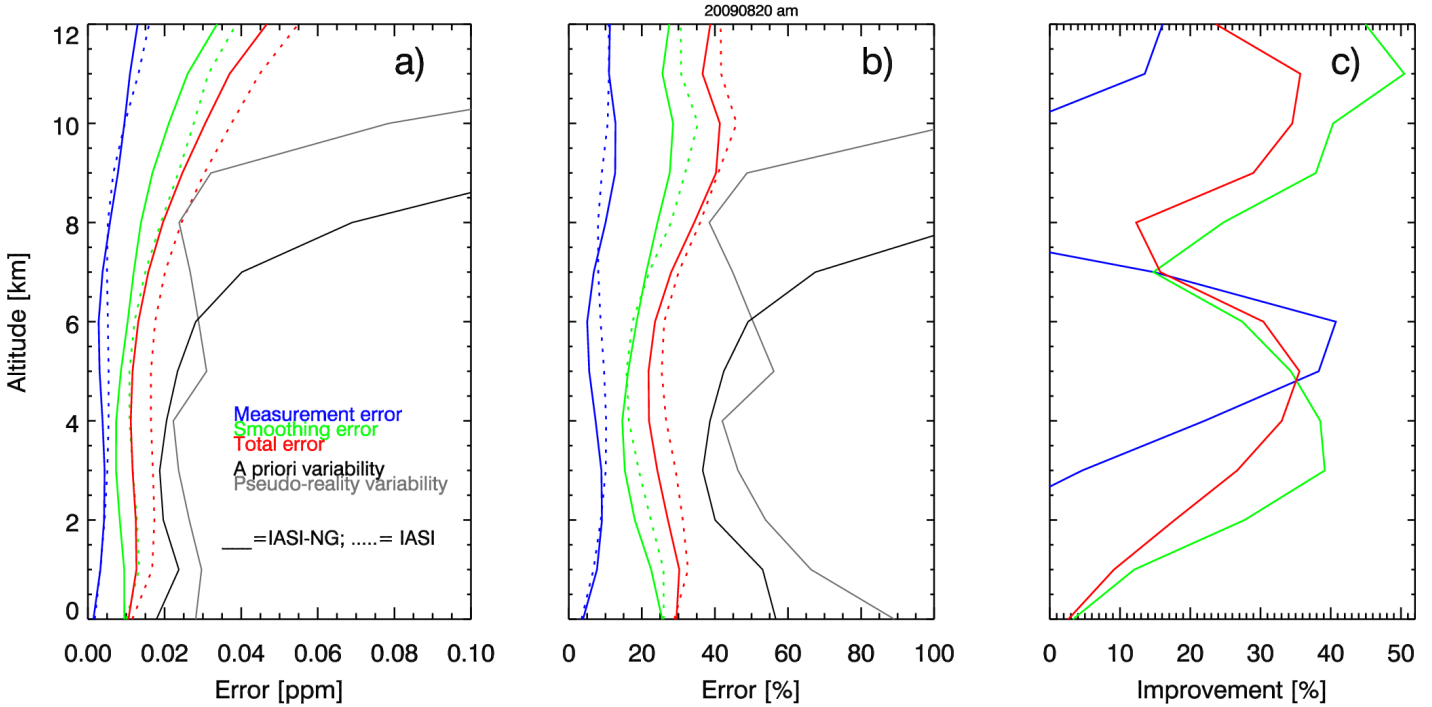
3. Error analysis

$$S_e = (I - A) S_a (I - A)^T + G S_m G^T + G K_{syst} S_{syst} (G K_{syst})^T$$



	Surf-12 km TOC total error	Surf-6 km TOC total error
IASI	**3.81 DU (10.51%)**	**2.49 DU (14.01%)**
IASI-NG	**3.12 DU (8.41%)**	**2.06 DU (10.71%)**

- **Smoothing error** dominant;
- **IASI-NG/IRS2** improves of up to 35% (at 5 km) on the **total error**;
- Total error on surface-6 km TOC < 20% for **IASI-NG**.

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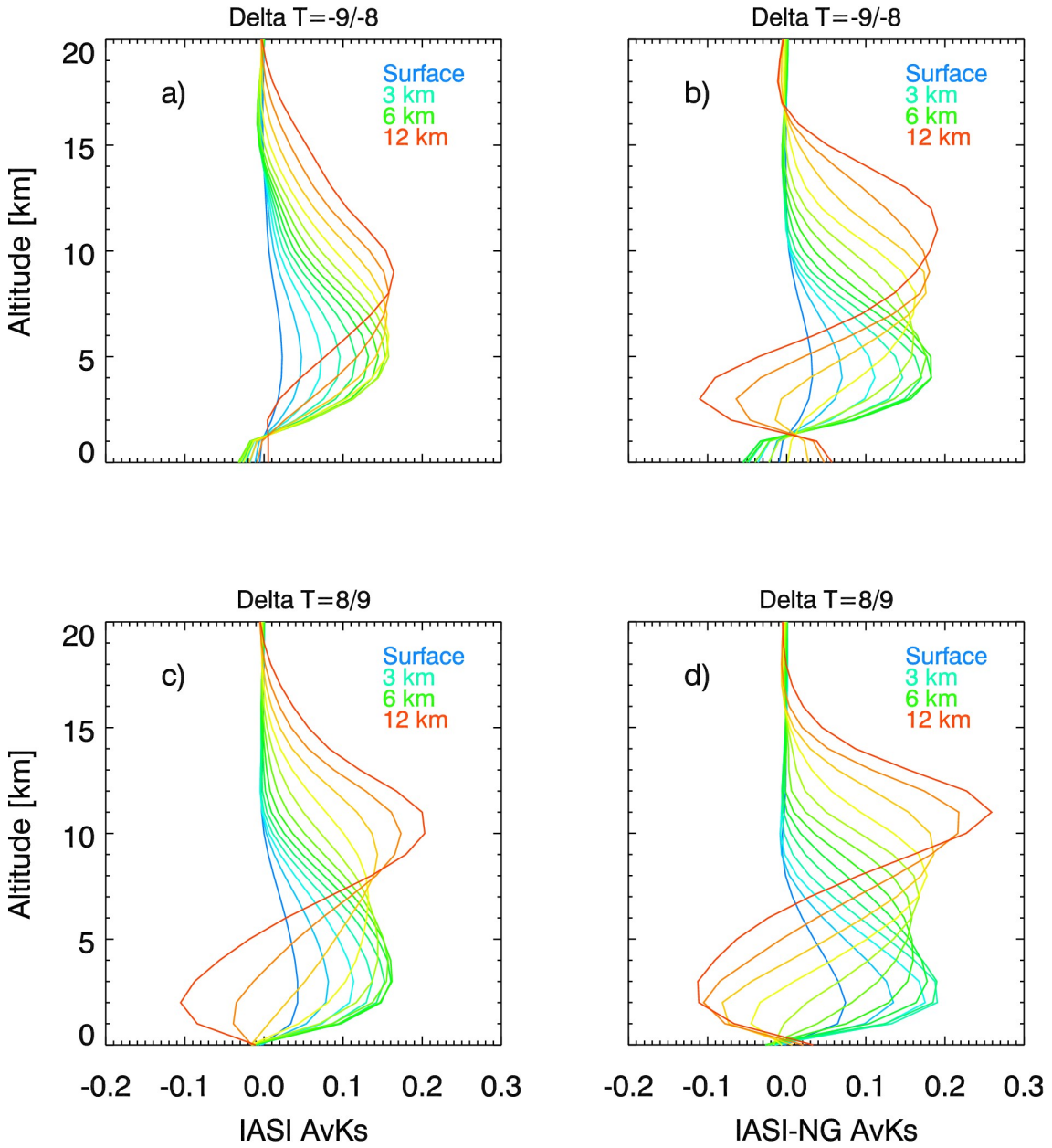
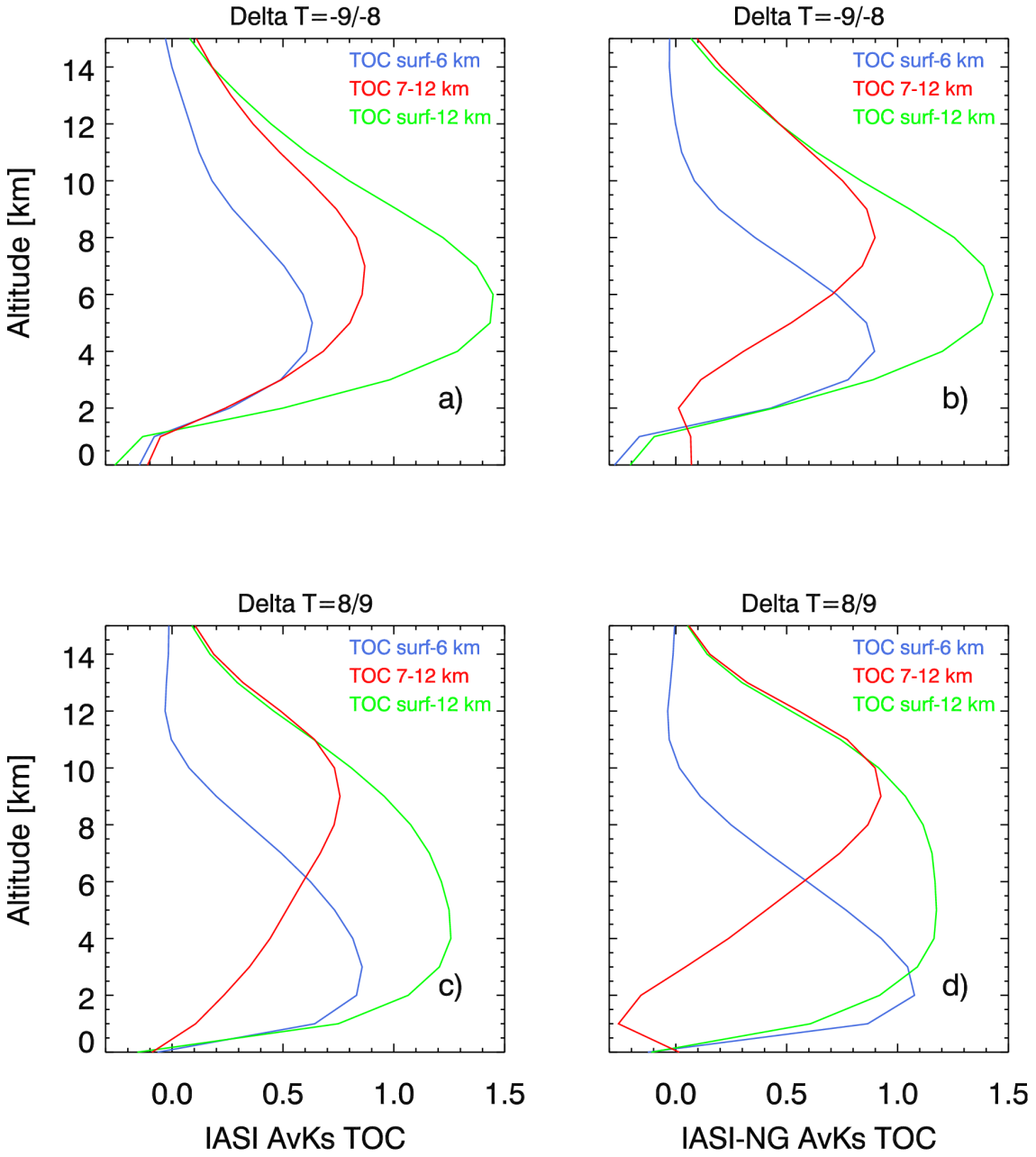
4. Vertical sensitivity (1/3)



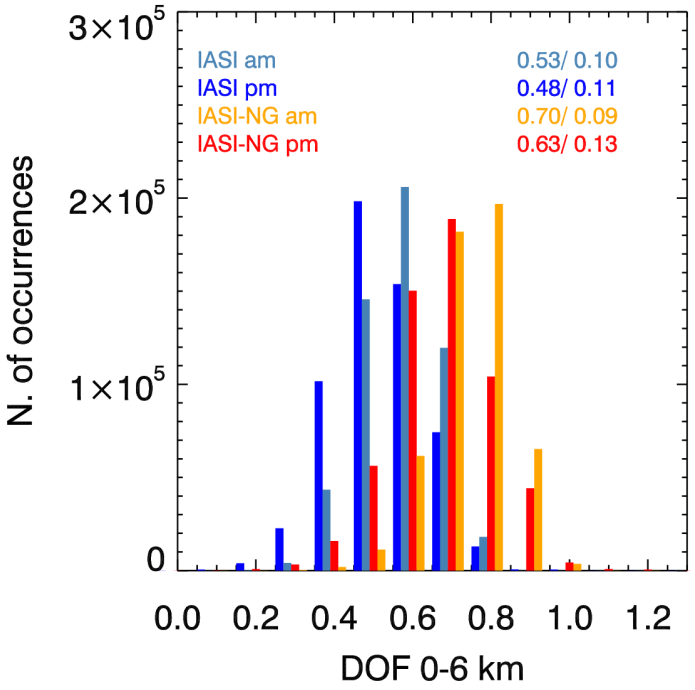
Greatest added value of IASI-NG for the low sensitivity scenarios

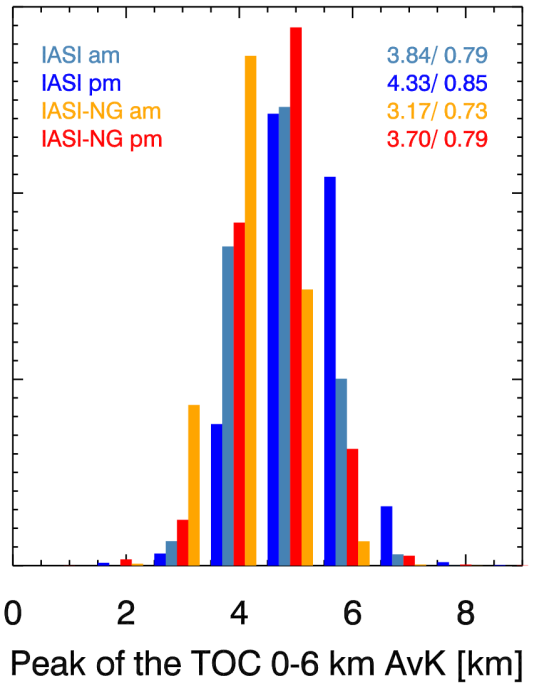
4. Vertical sensitivity (2/3)



IASI-NG
is able to separate LT from UT also at unfavourable conditions

4. Vertical sensitivity (3/3)





IASI
AM - 0.53±0.10
PM - 0.48±0.11

IASI-NG
AM - 0.70±0.09
PM - 0.63±0.13

IASI
AM – 3.84±0.79 km
PM – 4.33±0.85 km

IASI-NG
AM – 3.17±0.73 km
PM – 3.70±0.79 km

IASI-NG vs IASI:

- more info in the LT: **DOF surf-6 km > 30% wrt IASI**
- sensitive to lower altitudes: **max sensitivity at 0.5 km lower altitudes**
- sensitivity of IASI-NG at PM comparable to that of IASI at AM

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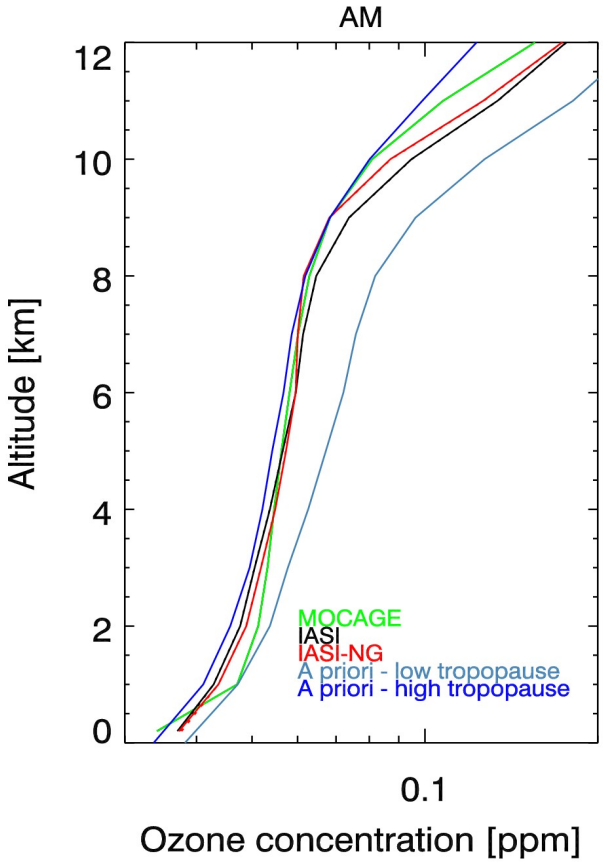
5. LT ozone distributions (1/4)

General characterization of the POs

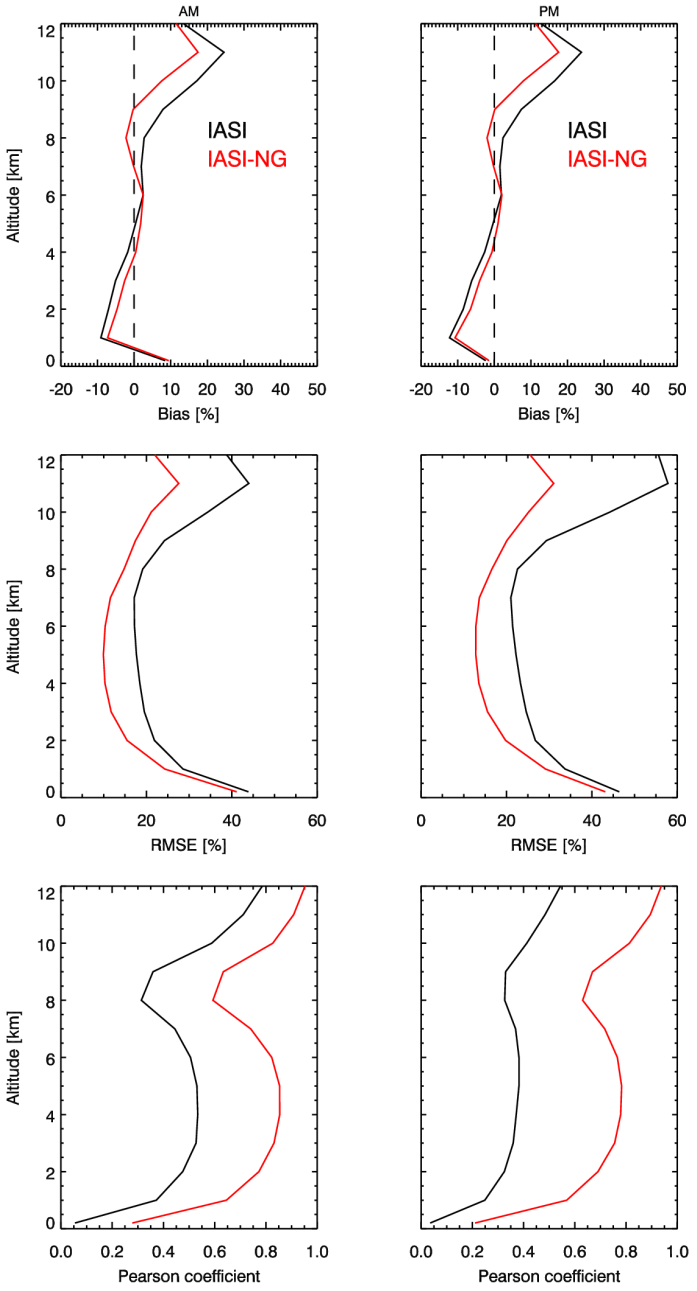


Underestimation at 1-4 km; no significant bias at 4-8 km; overestimation at 9-12 km.

Both biases are reduced of over the 50% by **IASI-NG.**

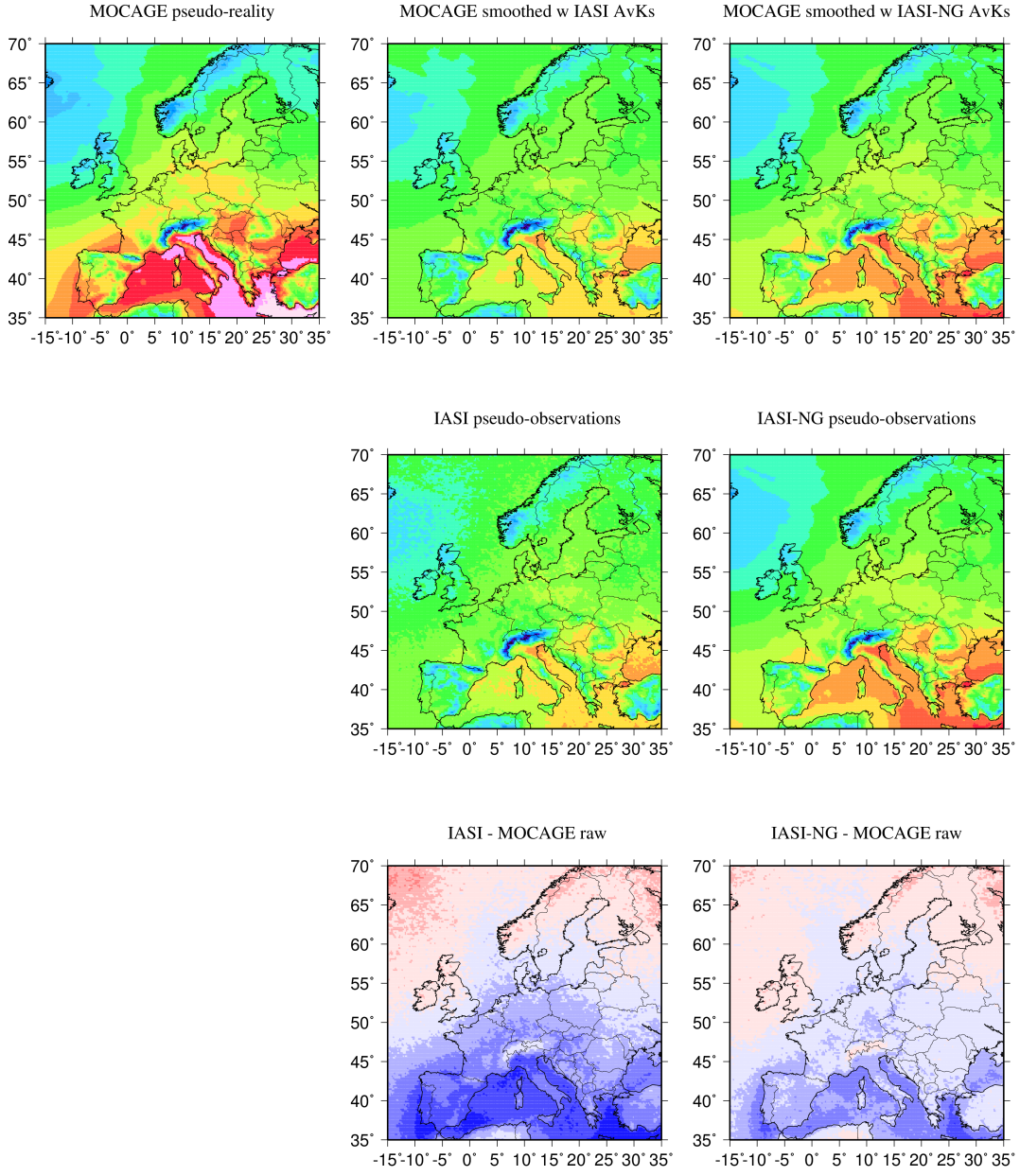
Minimum RMSE at 2-8 km (20% for **IASI** and 10% for **IASI-NG**).

Pearson coefficient for **IASI-NG** reaches 0.95 at 5 km.



5. LT ozone distributions (2/4)

Mean distribution at continental scale

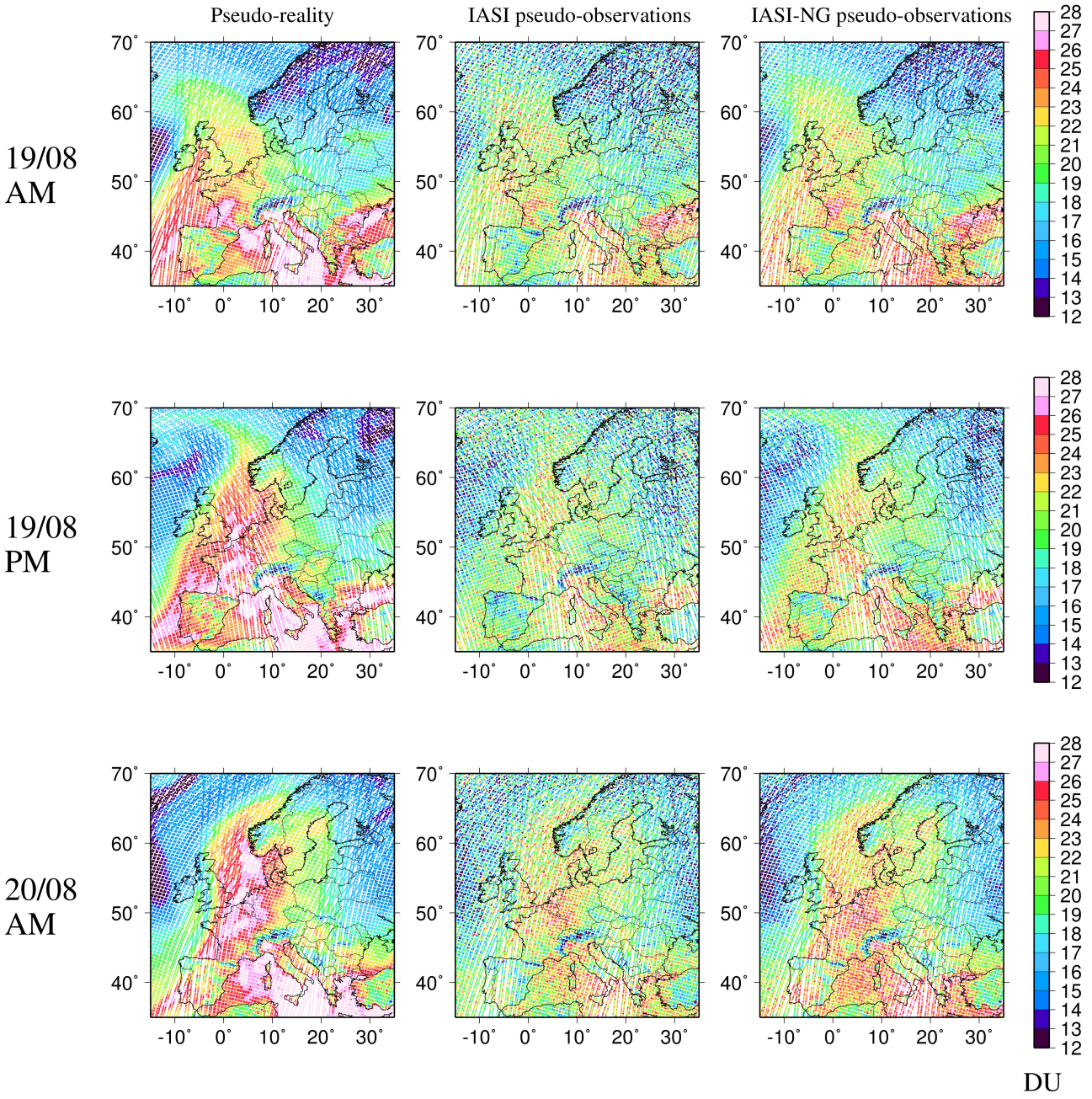


- Underestimation at Southern Europe;
- overestimation at Northern Europe.

- Areas of under/overestimation less extended for **IASI-NG**, and deviations smaller

5. LT ozone distributions (3/4)

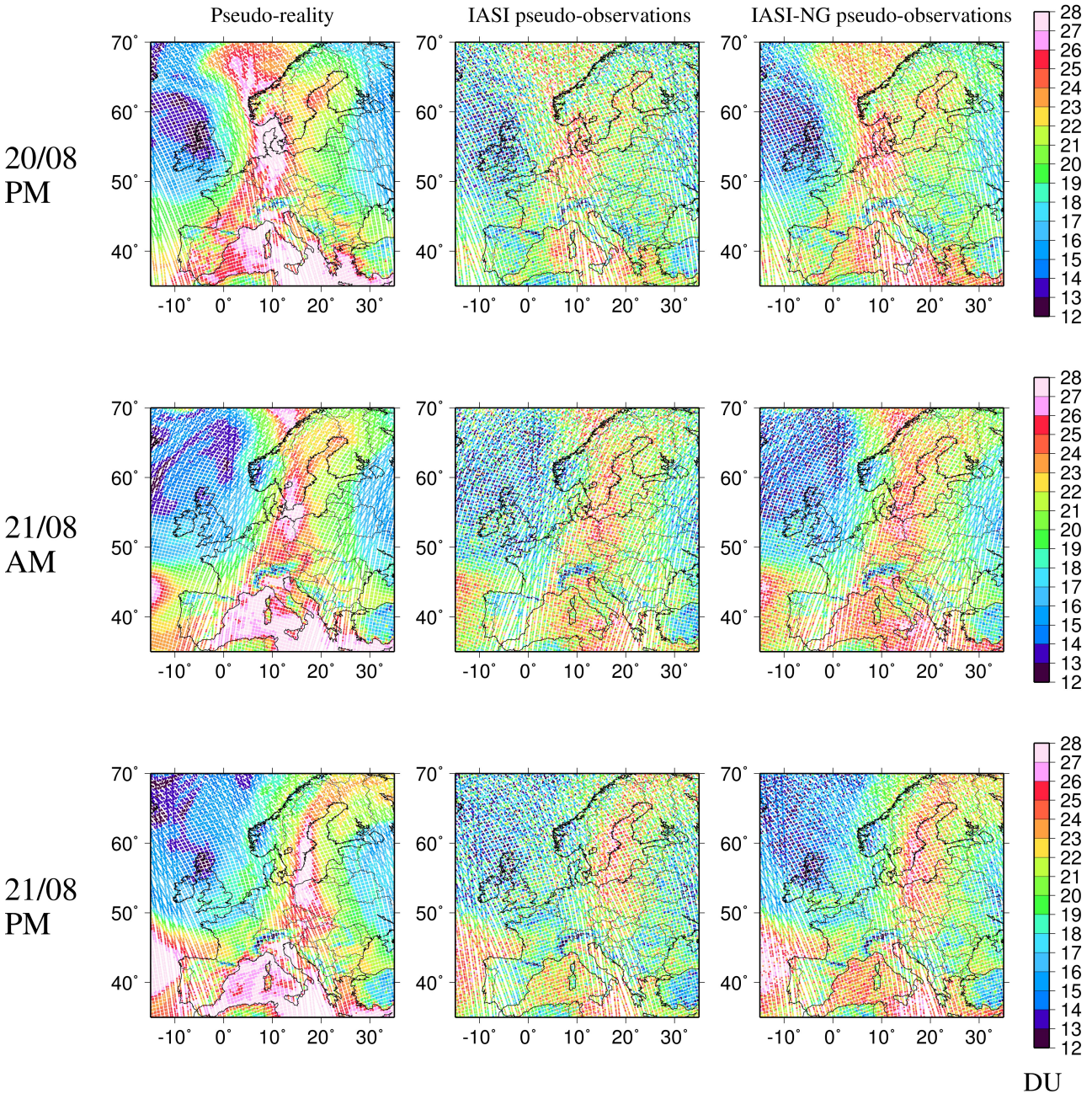
Evolution at regional scale



IASI-NG better suitable to follow the spatiotemporal evolution of the ozone plume 19-21/08

5. LT ozone distributions (3/4)

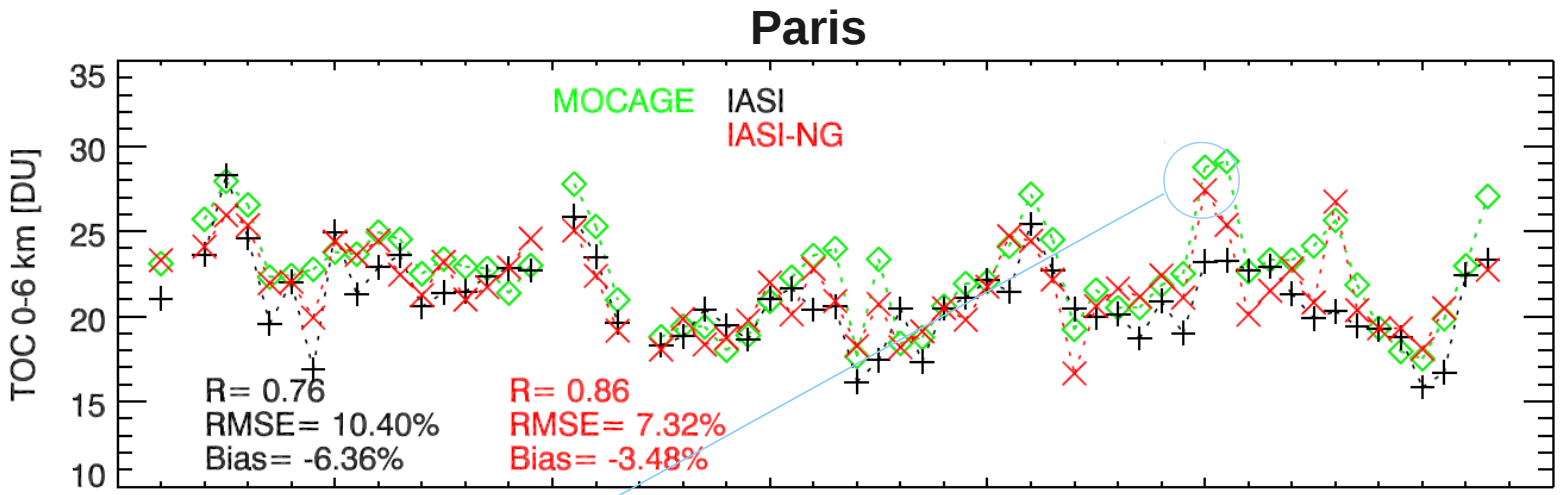
Evolution at regional scale

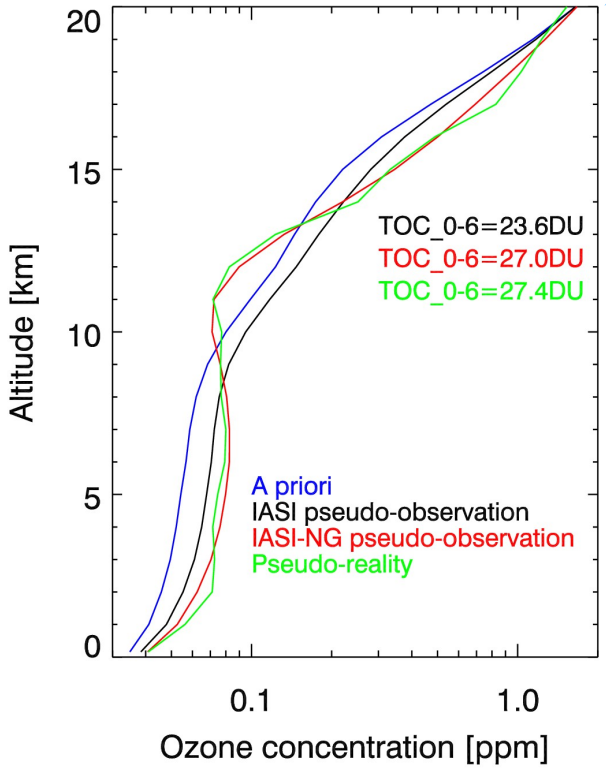


IASI-NG better suitable to follow the spatiotemporal evolution of the ozone plume 19-21/08

5. LT ozone distributions (4/4)

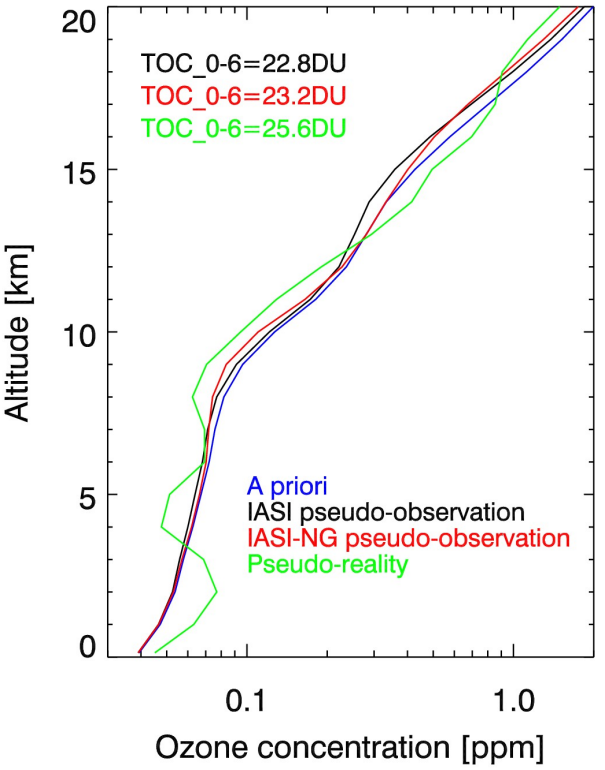
Distribution at local scale





IASI-NG has better performances in the LT: better vertical resolution

The vertical resolution is still insufficient to detect features < 5km



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5. CONCLUSION

- **Summary**:
  - Simulation of Observing Systems starting from MOCAGE CTM pseudo-reality;
  - Comparison of **IASI/IASI-NG** (IASI-NG/IRS2) tropospheric ozone retrievals;
  - Specific analysis of surface-6 km TOCs;
  - Spatial domain: Europe; Temporal domain: August 2009.

- **Conclusions:**

  IASI-NG has (with respect to **IASI**):
  - **better resolving power** of LT, also at unfavourable conditions;
  - **finer vertical resolution** (5 km vs 7 km);
  - **reduced biases** (both on the vertical and spatial distributions);
  - **better capability to discriminate short-term evolutions** (a few days) at regional and local scale

  ! IASI-NG is expected to be a great step forward towards AQ monitoring !

5. CONCLUSION

- **Future work**:
  - **Assimilation** into CTM (CHIMERE) and **OSSEs**;

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Thanks for your attention!

Acknowledgements