INTERCOMPARISON OF TWO DIFFERENT STATISTICAL APPROACHES TO THE INITIALIZATION OF THE PHYSICAL INVERSION OF IASI RADIANCES FOR TEMPERATURE, WATER VAPOUR AND OZONE.
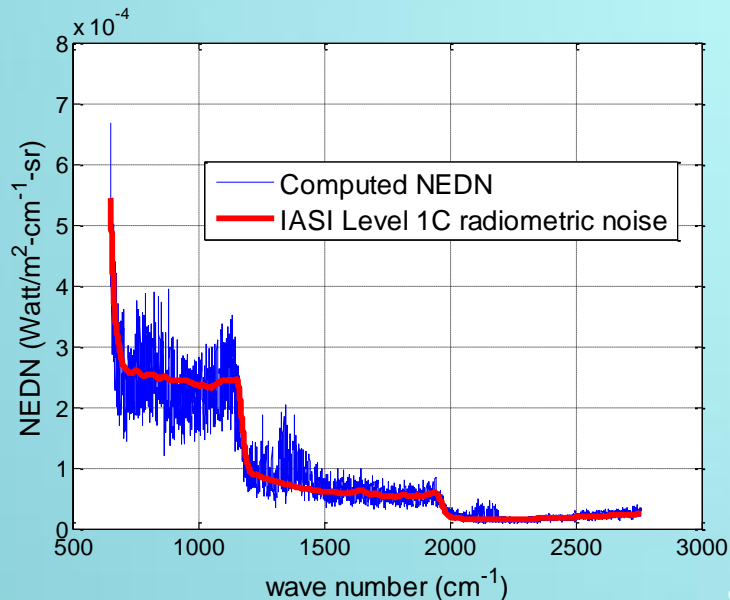
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U. Amato[2], I. DeFeis[2]
[1]DIFA, Potenza Italy
[2]IAC/CNR, Napoli, Italy

- Intercomparison of two different satistical tools to initialize the inversion of IASI spectral radiances for temperature, water vapour and ozone.
- Of specific interest here are the relative merits of the two initialisation methods for the retrieval of water vapour...
- ... and consistency among observed and fitted spectra

Objective

Flow charts
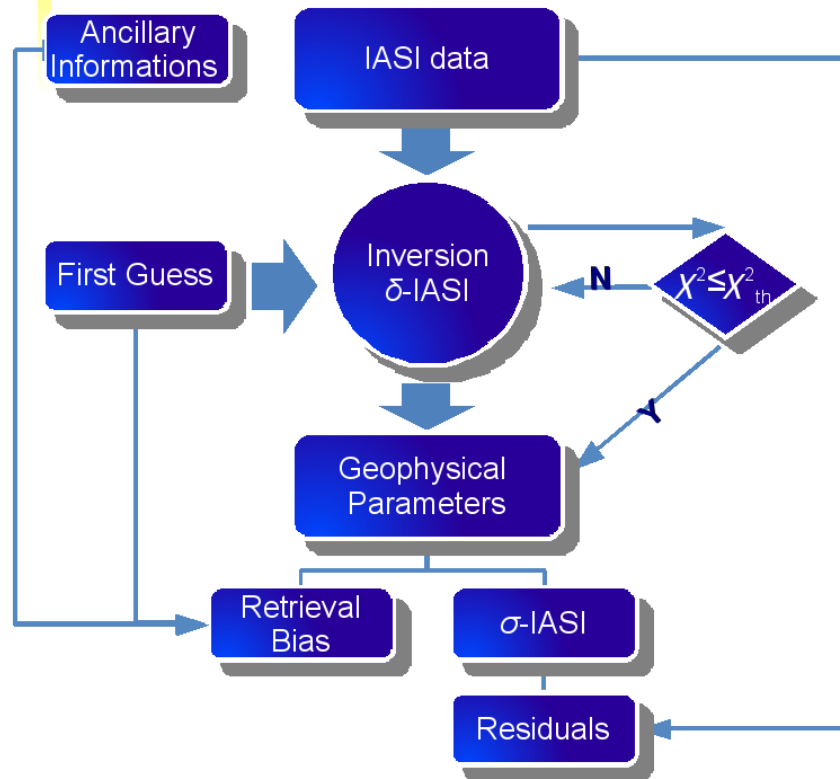
Tool: φ-IASI Package,
set up for radiance closure experiments

$$\chi^2_{th} = N_{ch} + 2\sqrt{2\,N_{ch}}$$

The φ-IASI package is not an opertaional system, it is mostly intended to address science issues such as:

- ◉ Impact over retrieval of new spectroscopy,
- ◉ Forward modeling issues,
- ◉ Retrieval strategy and retrieval perfomance,
- ◉ Sensitivity analysis with respect to:
  - • Atmospheric clear sky parameters: temperature, water vapour and gas species,
  - • Cloud and aerosol optical properties
  - • Spectroscopic parameters, such as continuum coefficients for CO_2 and H_2O

The phi-IASI FORWARD MODULE IS BASED ON LOOK-UP TABLE FOR THE MONOCHROMATIC OPTICAL DEPTH : the look table is based on LBLRTM version 11.3

- LBLRTM v. 11.3 released on November 2007. In this version the line parameters are obtained from the compilation aer_v_2.1 developed by AER Inc. of Massachusetts, USA. This line compilation is derived from HITRAN2004 and includes updates up to 01/01/2007 (e.g. for the water vapour it includes the diet of the air-broadened half-widths, Gordon et al., 2007). CO_2 continuum and line shapes have been developed based on the line coupling parameters from Hartmann's group.

The two initialization statistical regression tools of the inverse physical scheme, which are analysed in thi study

EOF and FSIR

Functional Sliced Inverse Regression (FSIR) method

- ## This is a research in collaboration with the

  - Institute of Applied Mathematics, CNR, Italy (and the net of this institute, which includes "*Laboratory Jean Kuntzmann, University Joseph Fourier, Grenoble, France*")

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Amato, U.; Antoniadis, A.; and De Feis, I.: Dimension reduction in functional regression with applications to, Comput. Stat. Data An., 50, 2422–2446, 2006.

Technical Note: Functional sliced inverse regression to infer temperature, water vapour and ozone from IASI data. Atmos. Chem. Phys., 9, 5321–5330, 2009

www.atmos-chem-phys.net/9/5321/2009/

EOF regression method

- An analytical scheme for the estimation of regression coefficients has been developed which assumes a generic signal-noise model.
- The scheme is completely analytical and does not need huge statistical training
- Details in a book article by C. Serio, G. Masiello, and G. Grieco, 2009
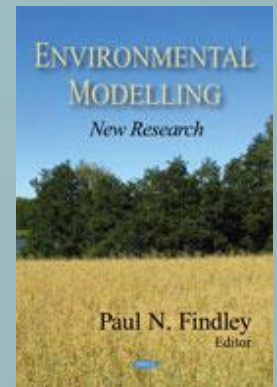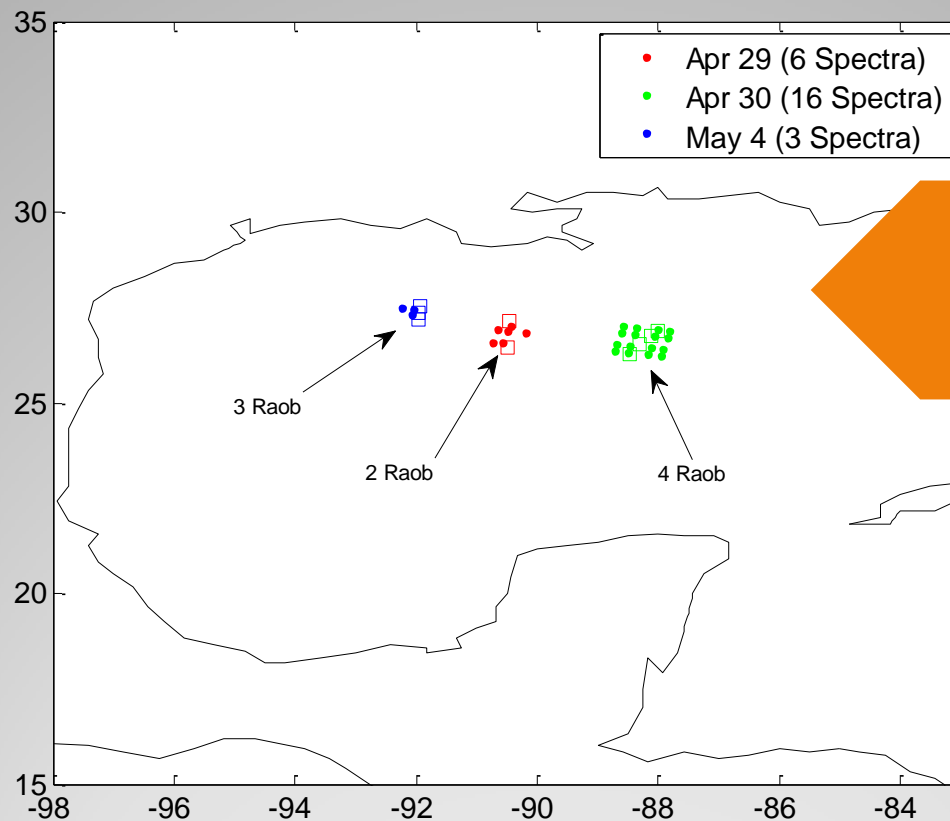
Case Study: JAIVEx data for the days: 29-30 April and 04 May 2007

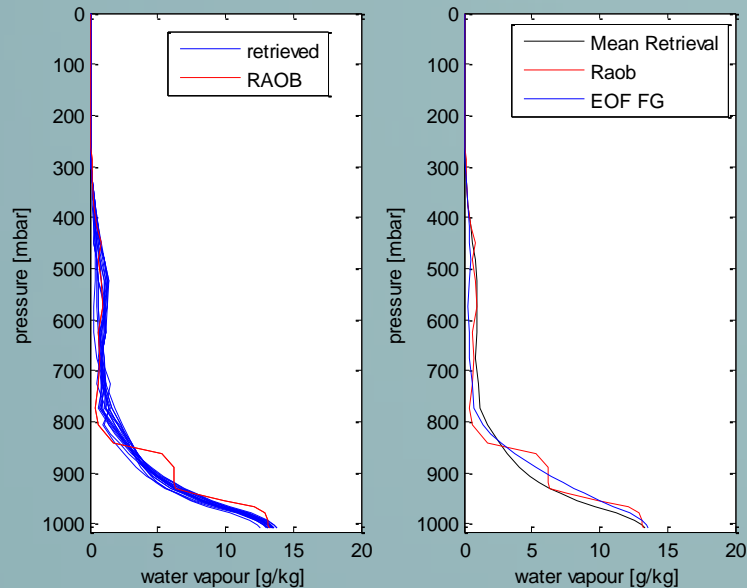# JAIVEX retrieval exercise: comparing physical inversion initialized with EOF and SIR day April 29, 2007

EOF INITIALIZATION
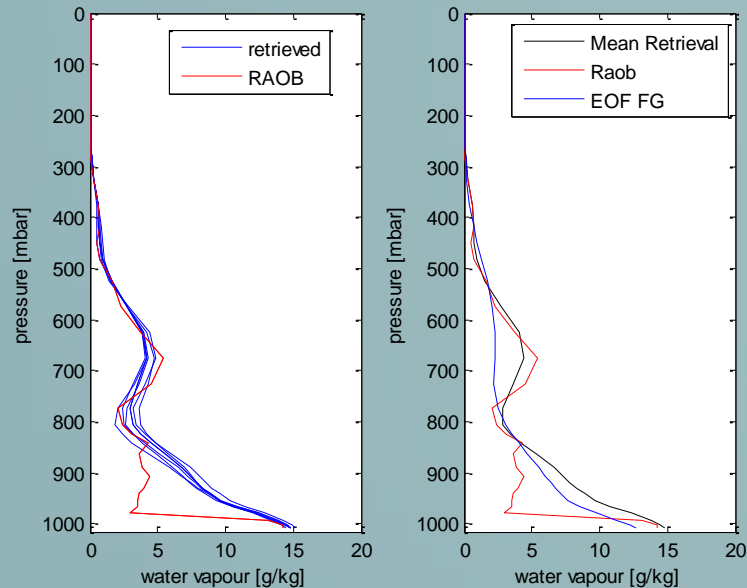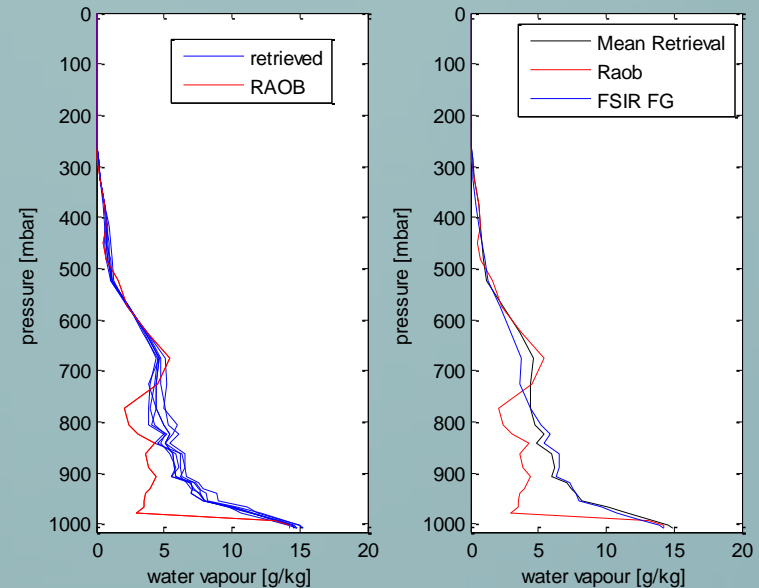
FSIR INITIALIZATION

JAIVEX retrieval exercise: comparing physical inversion initialized with EOF and SIR day April 30, 2007
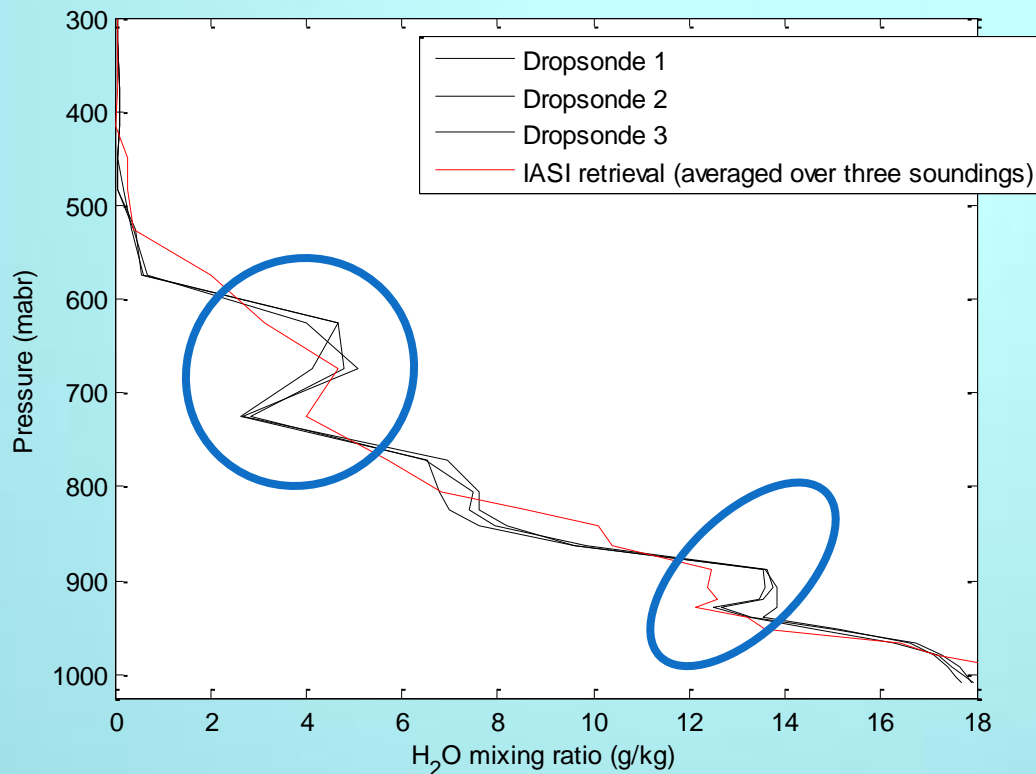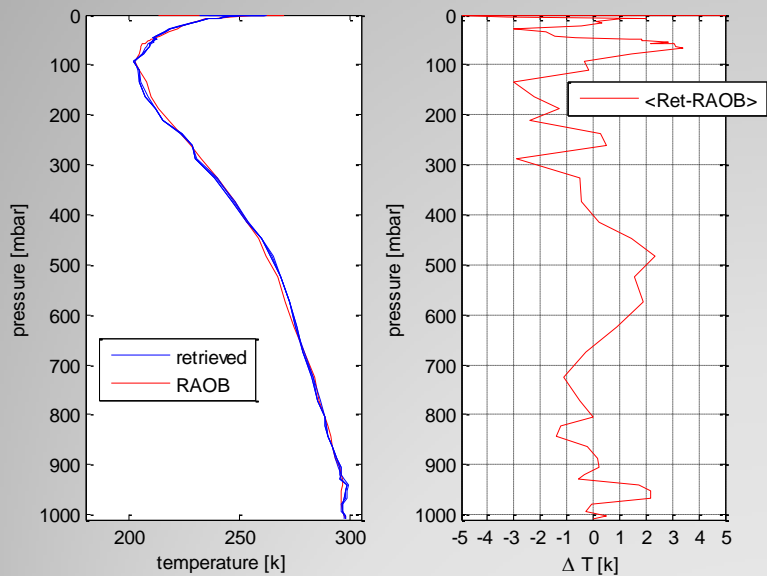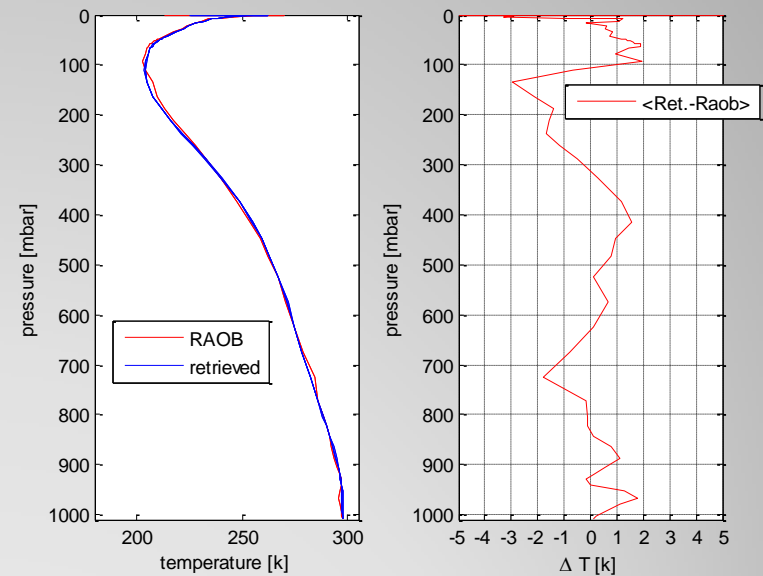
EOF INITIALIZATION
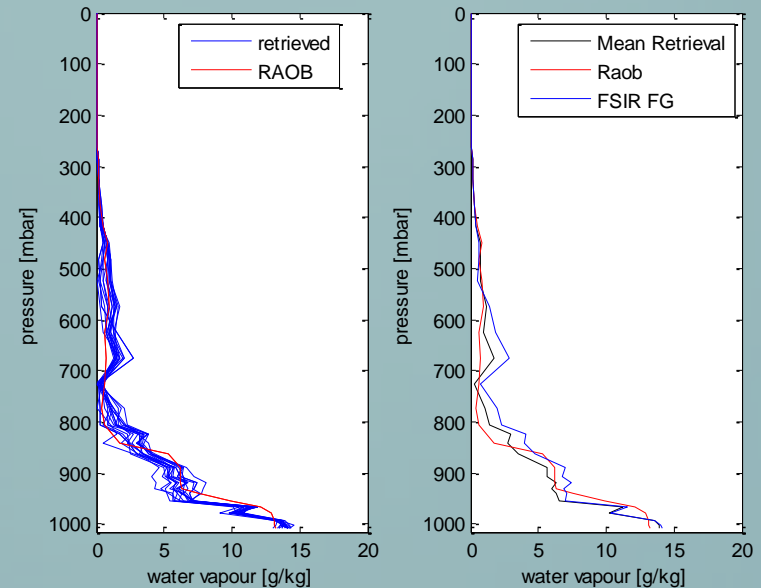
FSIR INITIALIZATION

JAIVEX retrieval exercise: comparing physical inversion initialized with EOF and SIR day May 04, 2007

EOF INITIALIZATION
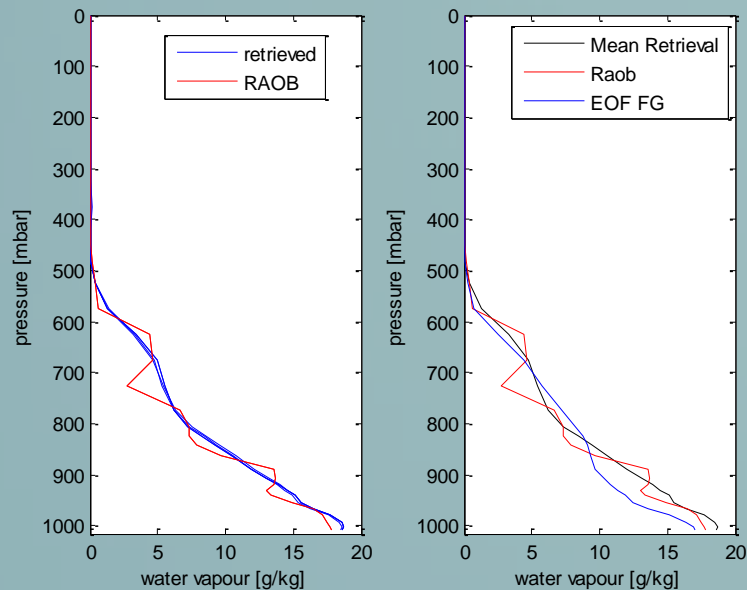
FSIR INITIALIZATION
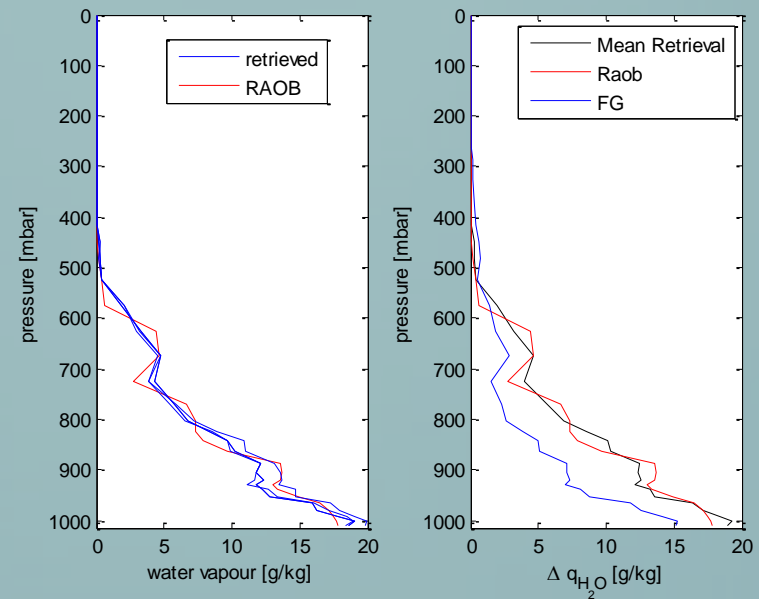
The case of 04 May 2007

δ-IASI, FSIR initialized, seems to resolve much better water vapour structures
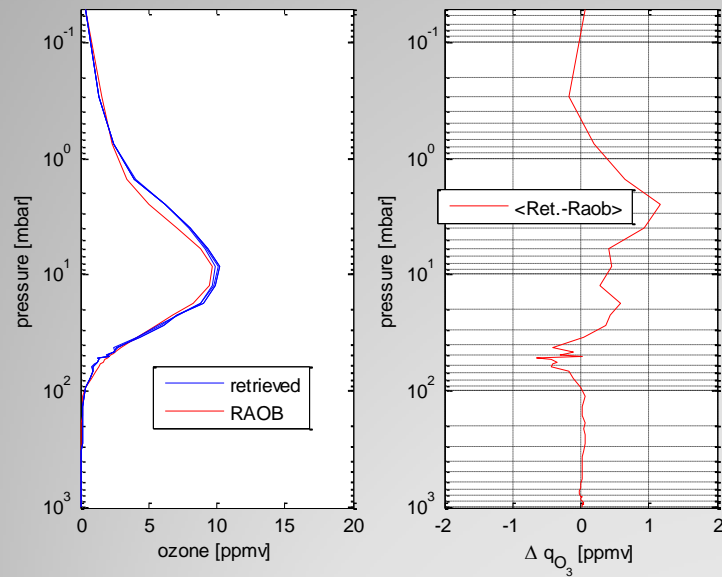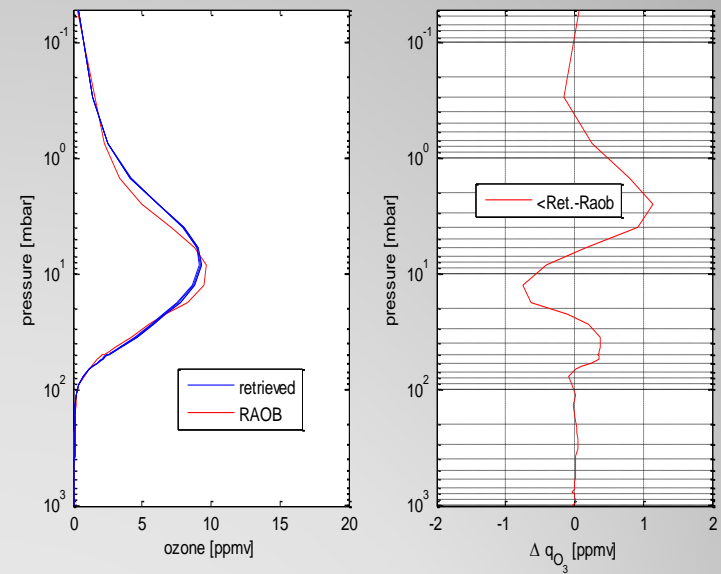
Temperature retrieval, FSIR
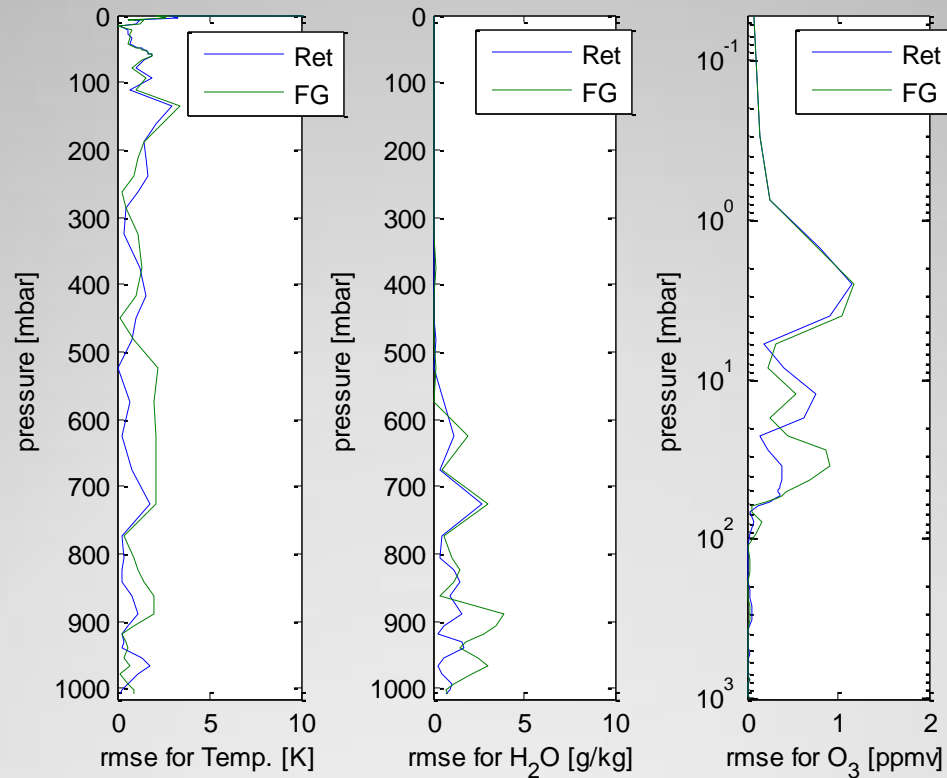
Temperature Retrieval, EOF

Day 04 May 2007

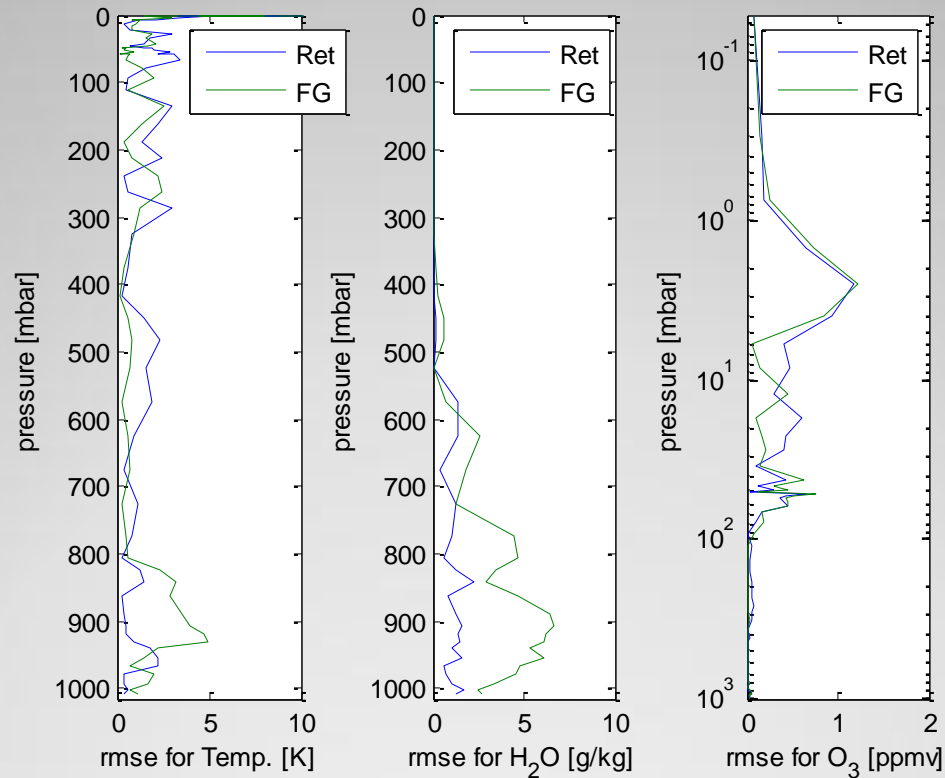# Ozone retrieval FSIR

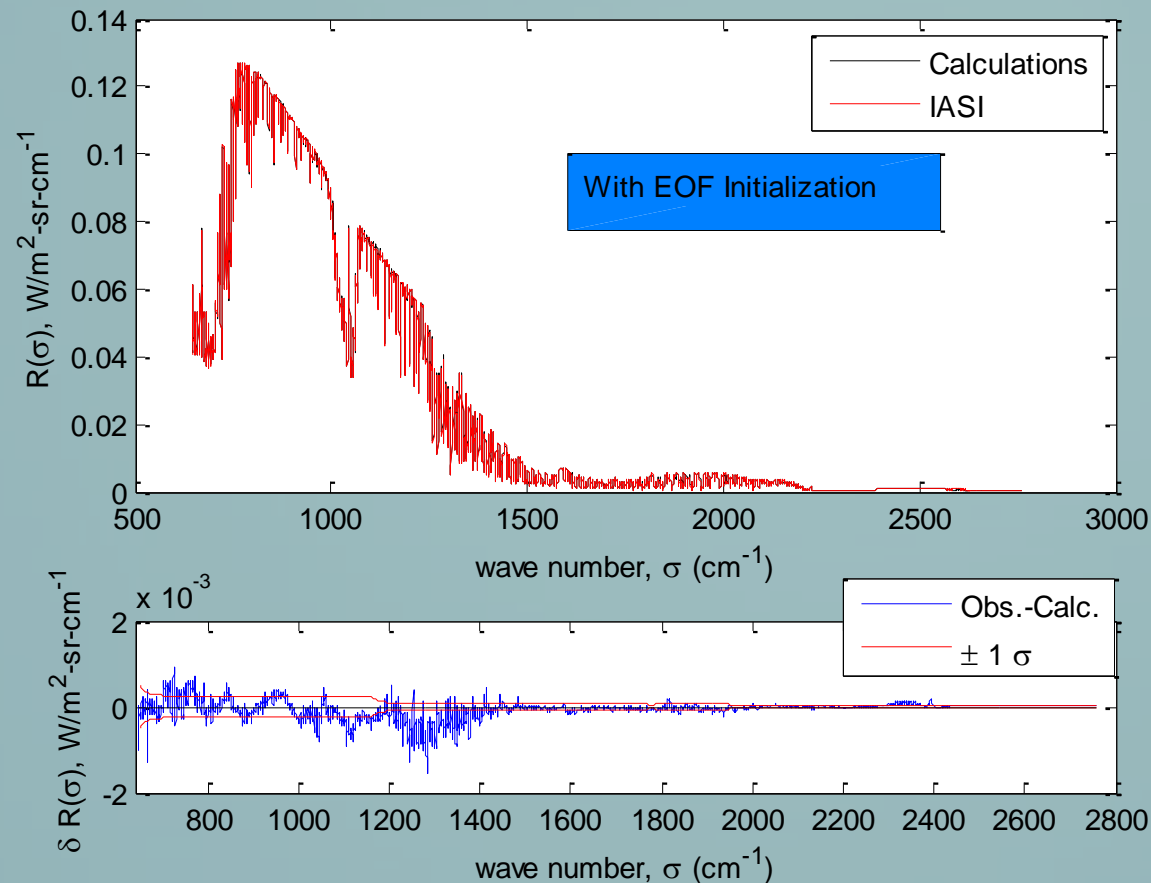# Ozone Retrieval EOF

Day 04 May 2007

Day 04 May 2007

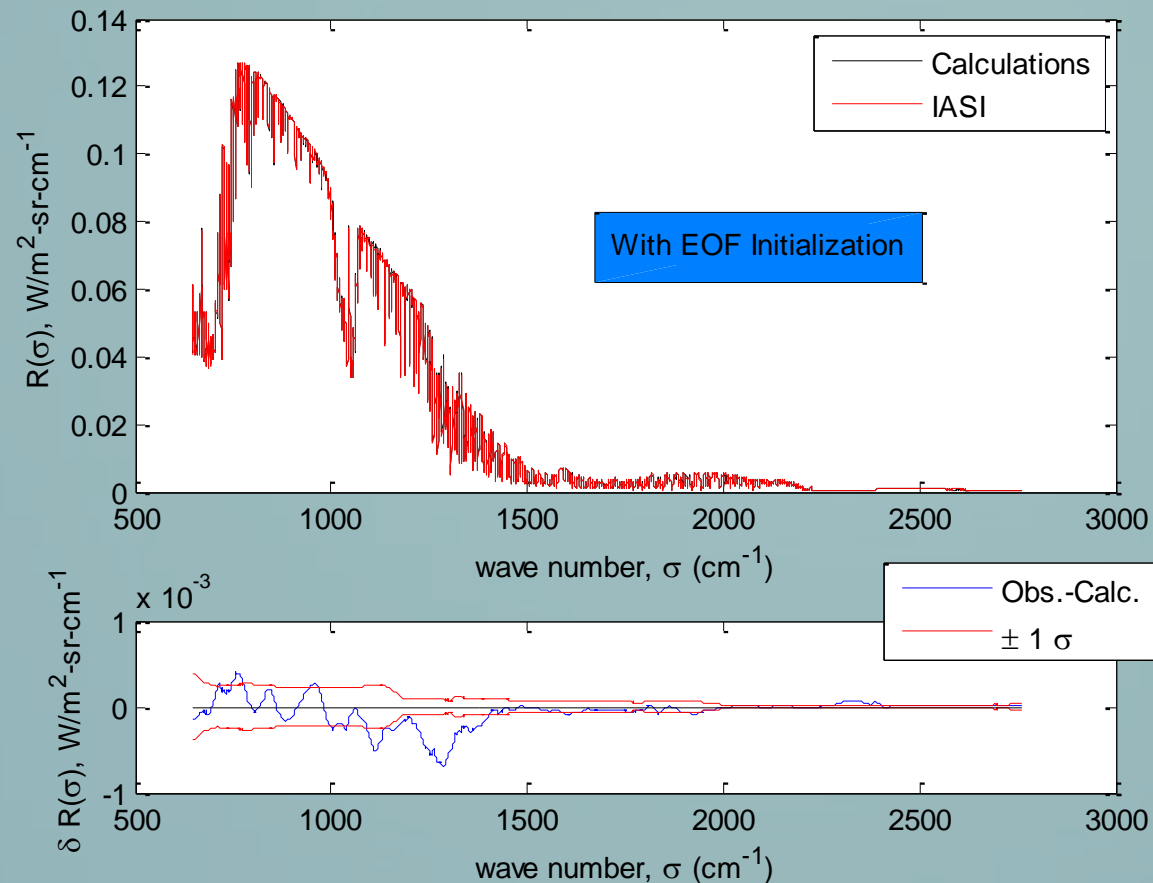Retrieval Performance, with EOF initialization

Day 04 May 2007
Retrieval Performance, with FSIR initialization

Comparing calculations to observations: How good do the retrieval fit the spectra? (average over the 25 JAIVEx spectra)
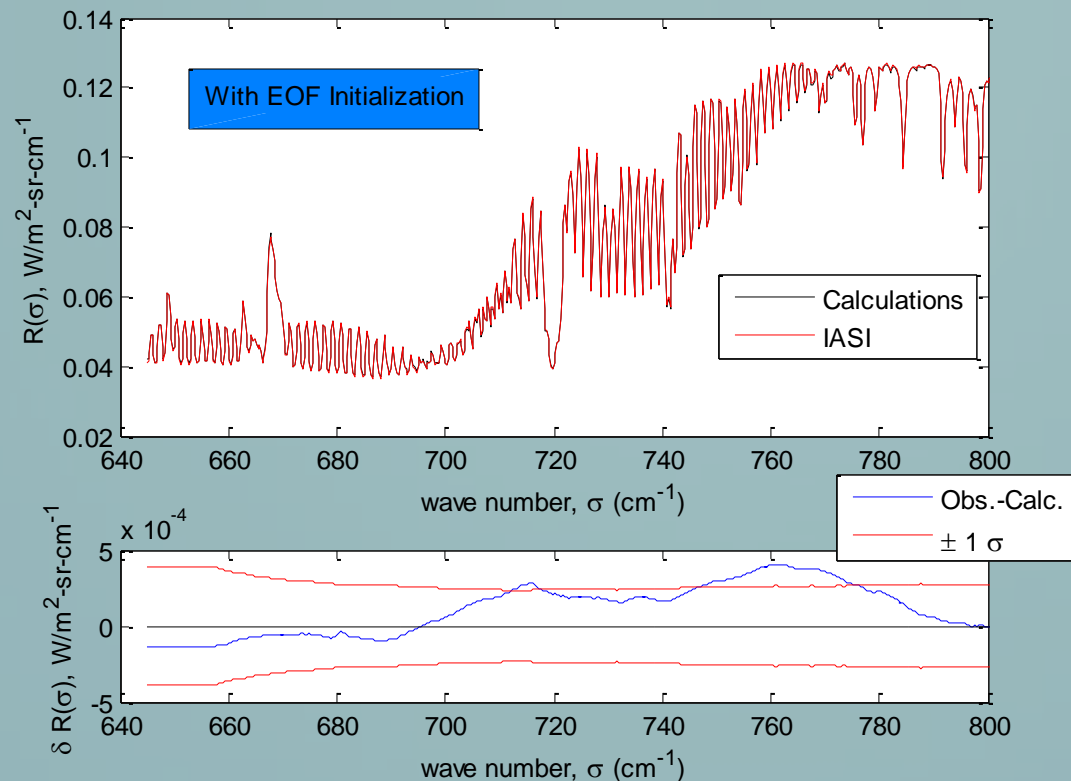
Same as before, but smoothing the residual with a moving average of length 12.5 cm⁻¹: (average over the 25 JAIVEx spectra)
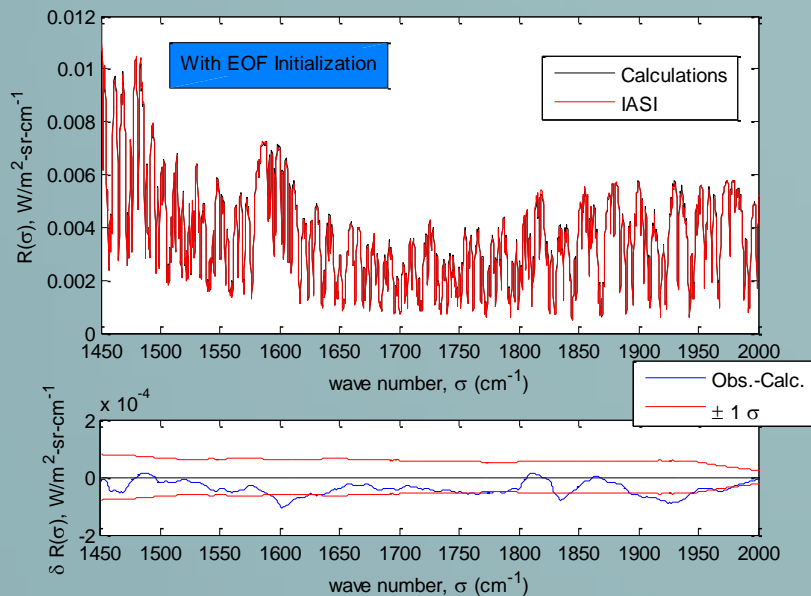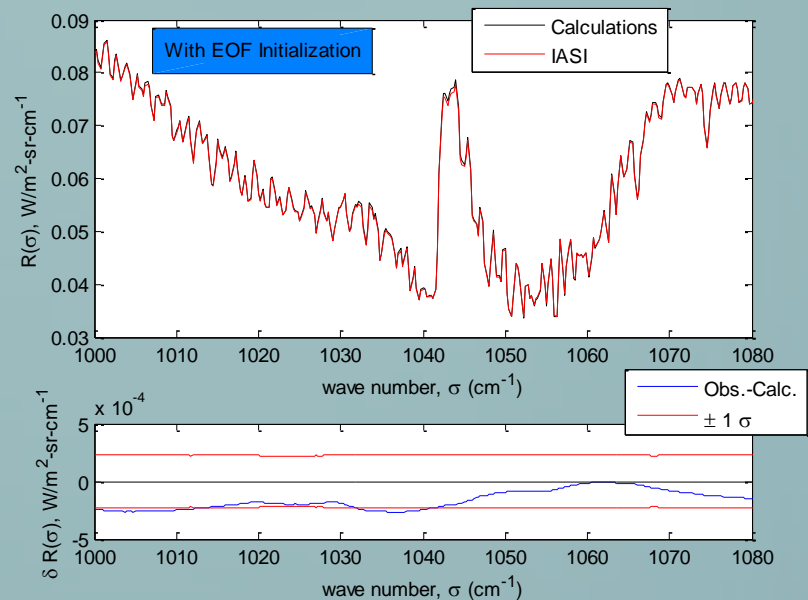
⦿ Co$_2$ spectral Region

Same as before, but smoothing the residual with a moving average of length 12.5 cm^{-1}: (average over the 25 JAIVEx spectra)
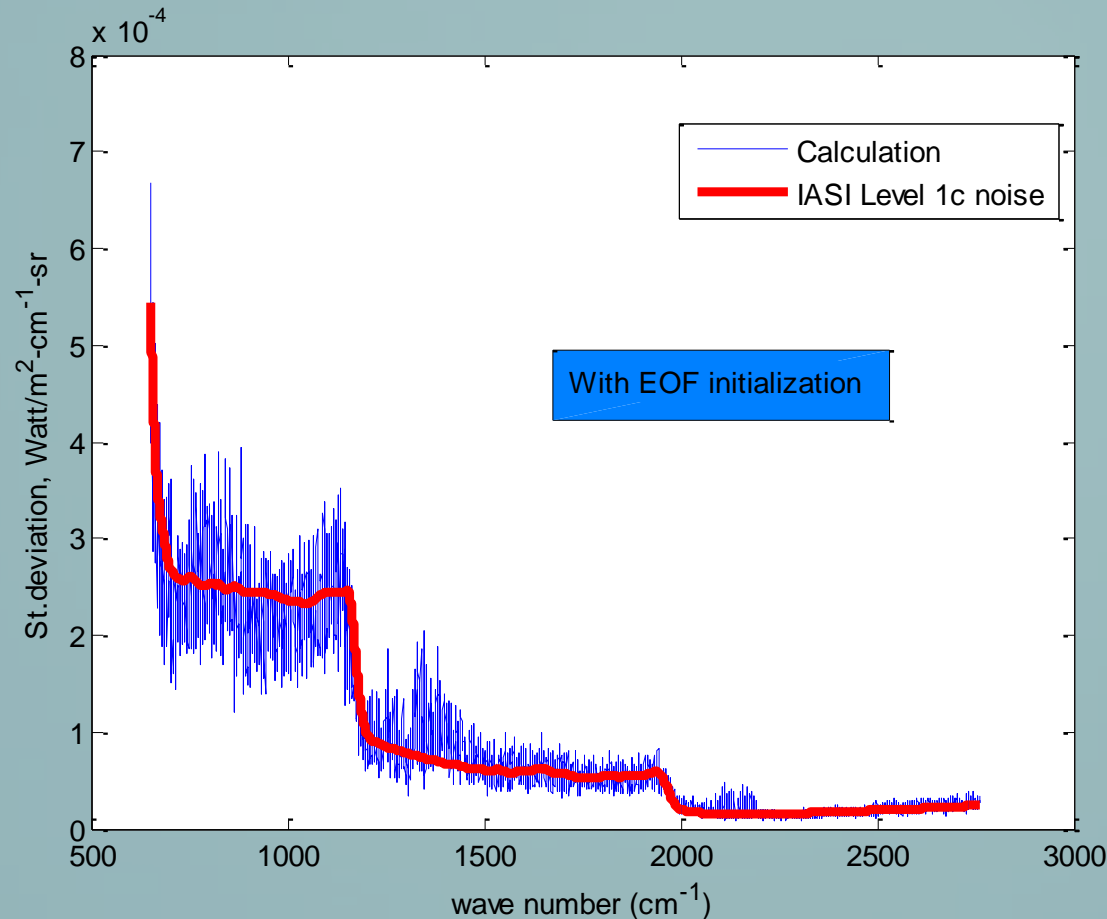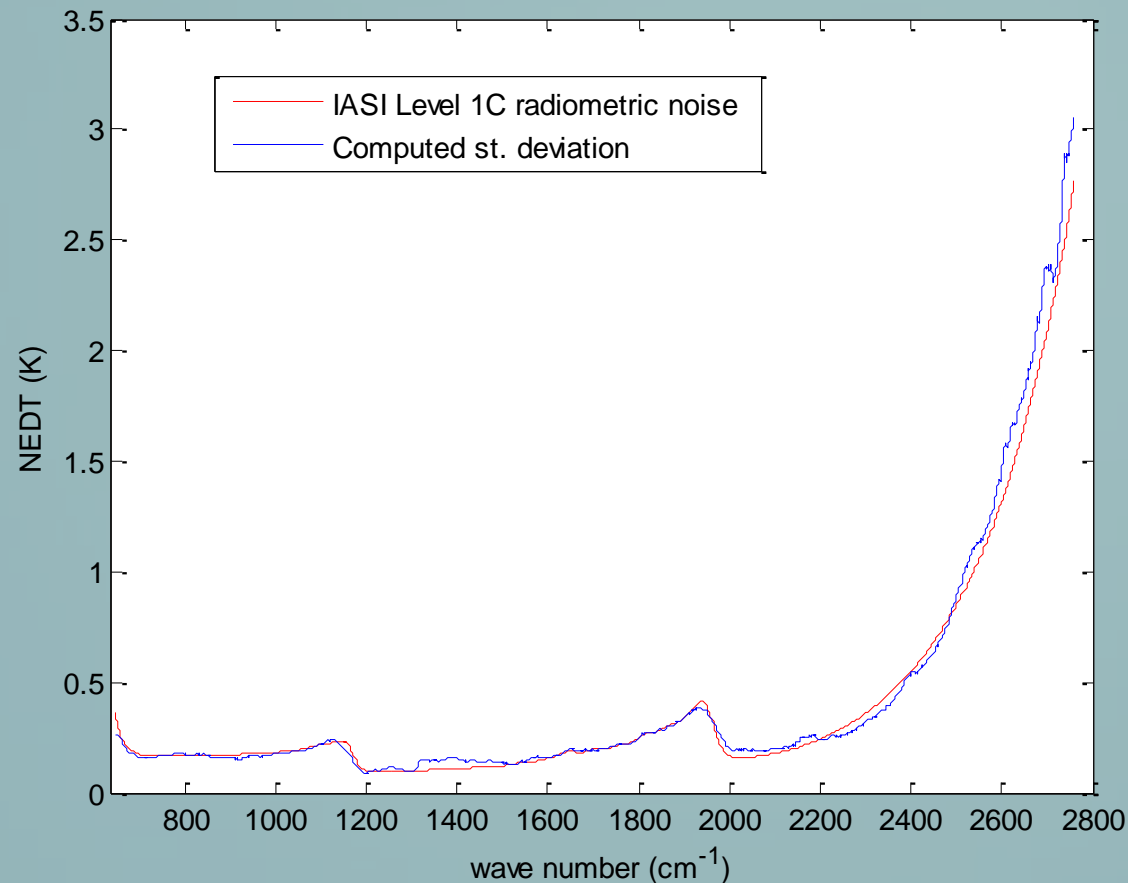
H$_2$0 SPECTRAL REGION

O$_3$ SPECTRAL REGION

Standard deviation of the spectral residual : How good do the retrieval fit the spectra? (average over the 25 JAIVEx spectra)
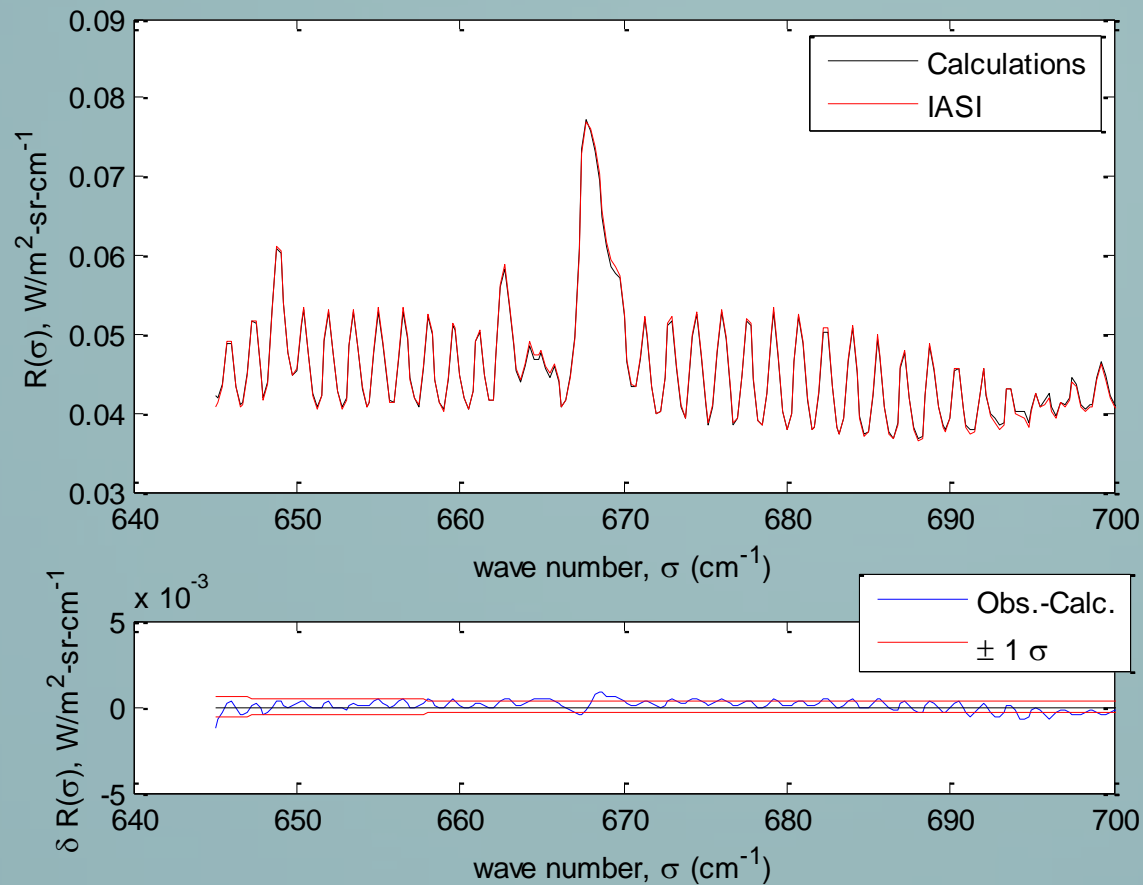
Same as before, but smoothing the st. deviation with a moving average of length 12.5 cm^{-1}: (average over the 25 JAIVEx spectra)
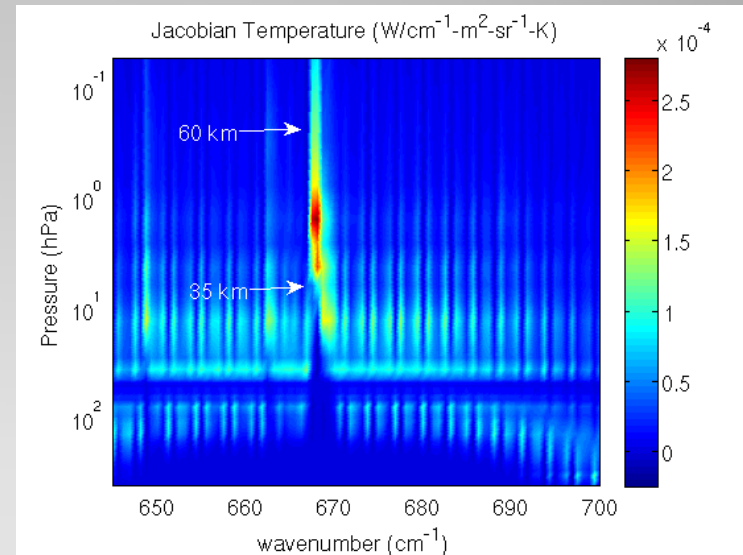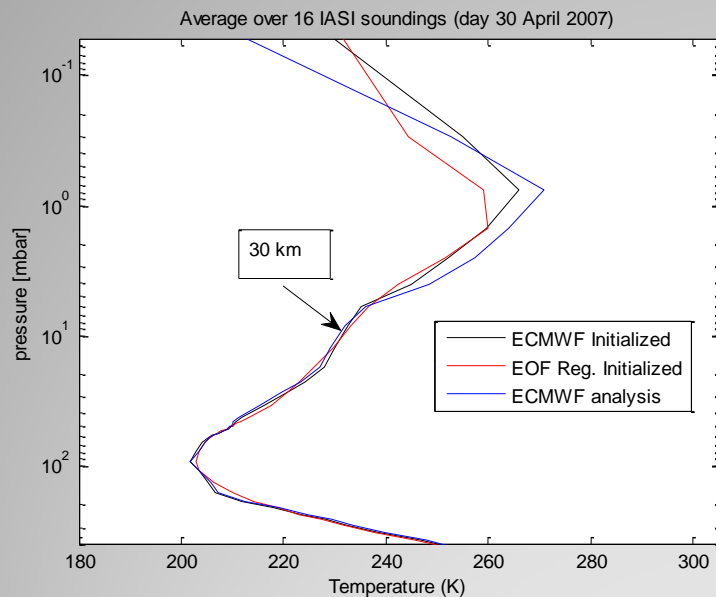
The anomaly detected in the C0$_2$ Q-Branch at 667 cm^{-1} is likely to be an artifact introduced by the ECMWF temperature analysys in the lower-to-upper stratosphere
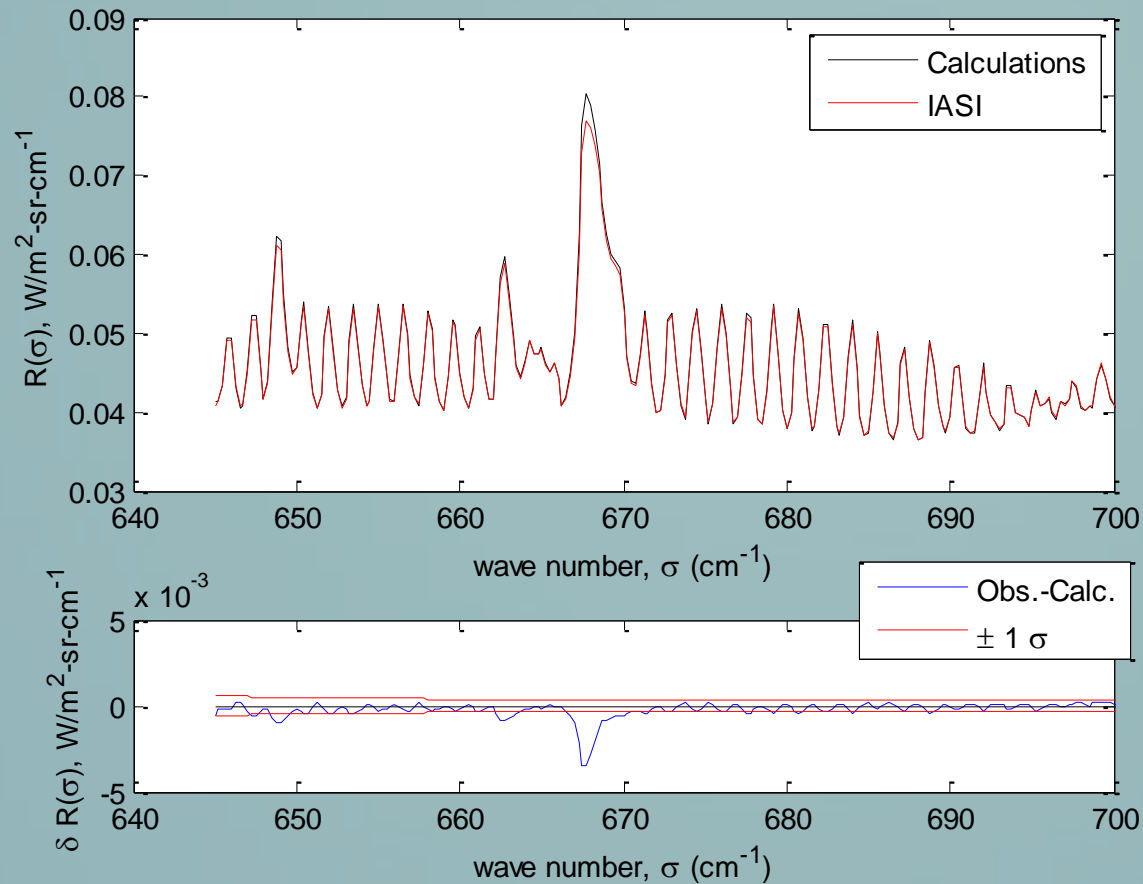
Analysis based only on IASI data: FG and physical retrieval

Where the difference in temperature develops

- An intercomparison between two different statistical methods to initialize the inversion of IASI data has been presented. We may conclude

- Basically the retrieval and therefore the vertical resolution, is dependent on the First Guess:
  - EOF regression provides a too much smooth initial constraint
  - FSIR seems to do a better job to reveal fine structures in the vertical water vapour profile
- The Physical iteration is needed to reach a good quality final product for water vapour

- The 667 cm^{-1} CO_2 Q-branch anomaly, which has been evidenced in IASI early studies, is likely to be an artifact introduced by the ECMWF analysis above 30 km.

Summary

- We thank our friend and *paesano* S. A. Clough and M. Shephard

Acknowledgements