WP4 - Task 4.2

Parallel measurements of formaldehyde (H_2CO) at the Jungfraujoch station: Preliminary FTIR results and first comparison with MAXDOAS data

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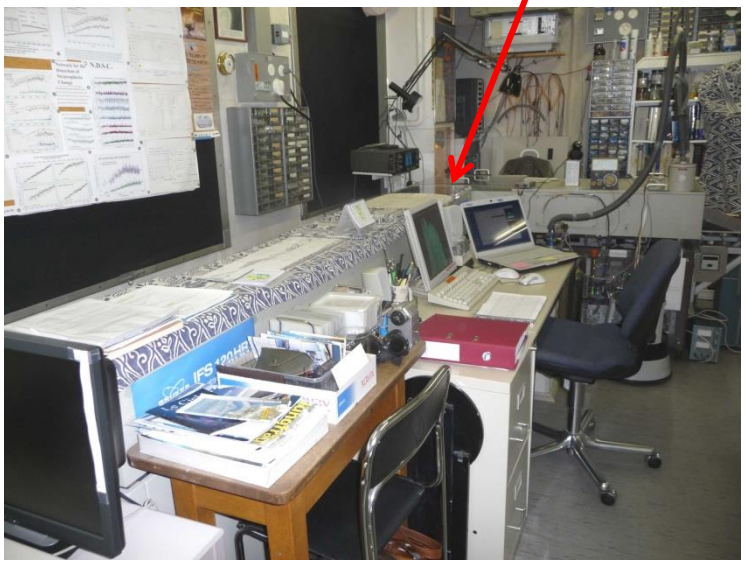
[2]Belgian Institute for Space Aeronomy (BIRA-IASB), Brussels, Belgium

BIRA-IASB, Brussels, October 17th 2013

The Jungfraujoch station (Swiss Alps, 46.5° N, 8.0° E, 3580m a.s.l.)

- Site of the NDACC network
- Ground-based FTIR measurements performed year-round
- Using high-resolution FTIR spectrometer BRUKER 120HR
- Remote operation of the BRUKER instrument since late 2008



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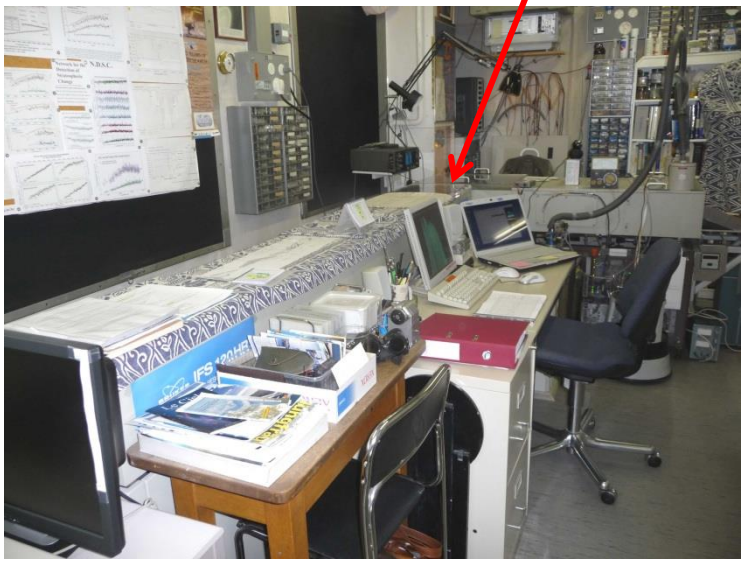
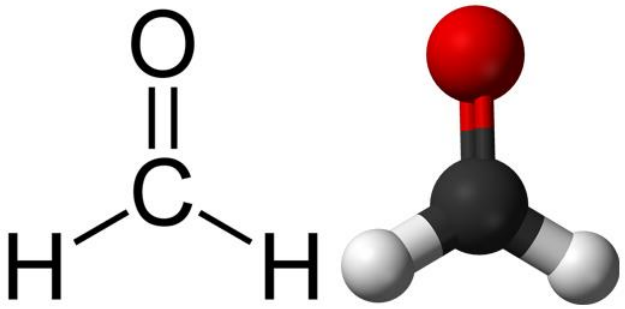


- FTIR regular cloud-free observations since 1984, ~120 days yr^{-1} on average since the mid-1990s
- grating spectra recorded from 1976 to 1989, covering narrow IR intervals

→ more than 35 years of uninterrupted IR monitoring in the Alps
→ more than two dozen stratospheric and/or tropospheric retrieved species

Formaldehyde: H_2CO

- Sources → photochemical oxidation of CH_4 and other carbonic compounds
- Sinks → photolysis, oxidation by OH and deposition
- Lifetime → a few hours
- Absorption → very weak in IR domain (< 1%)



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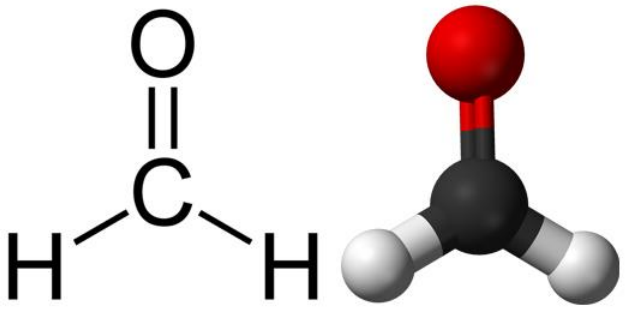

FTIR and MAX-DOAS observations of H_2CO at Réunion Island (21° S, 55° E)

Vigouroux et al., Atmos. Chem. Phys., 9, 9523-9544, 2009.

Microwindows (cm^{-1})
2763.425 – 2763.600
2765.725 – 2765.975
2778.200 – 2778.590
2780.800 – 2781.150
2810.000 – 2810.350
2855.650 – 2856.400

Largely influenced by **biomass burning** and **fossil fuel combustion**

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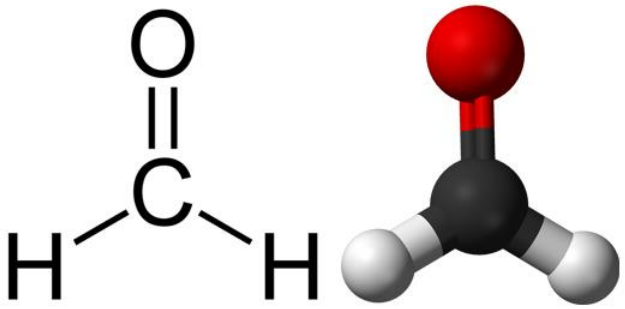

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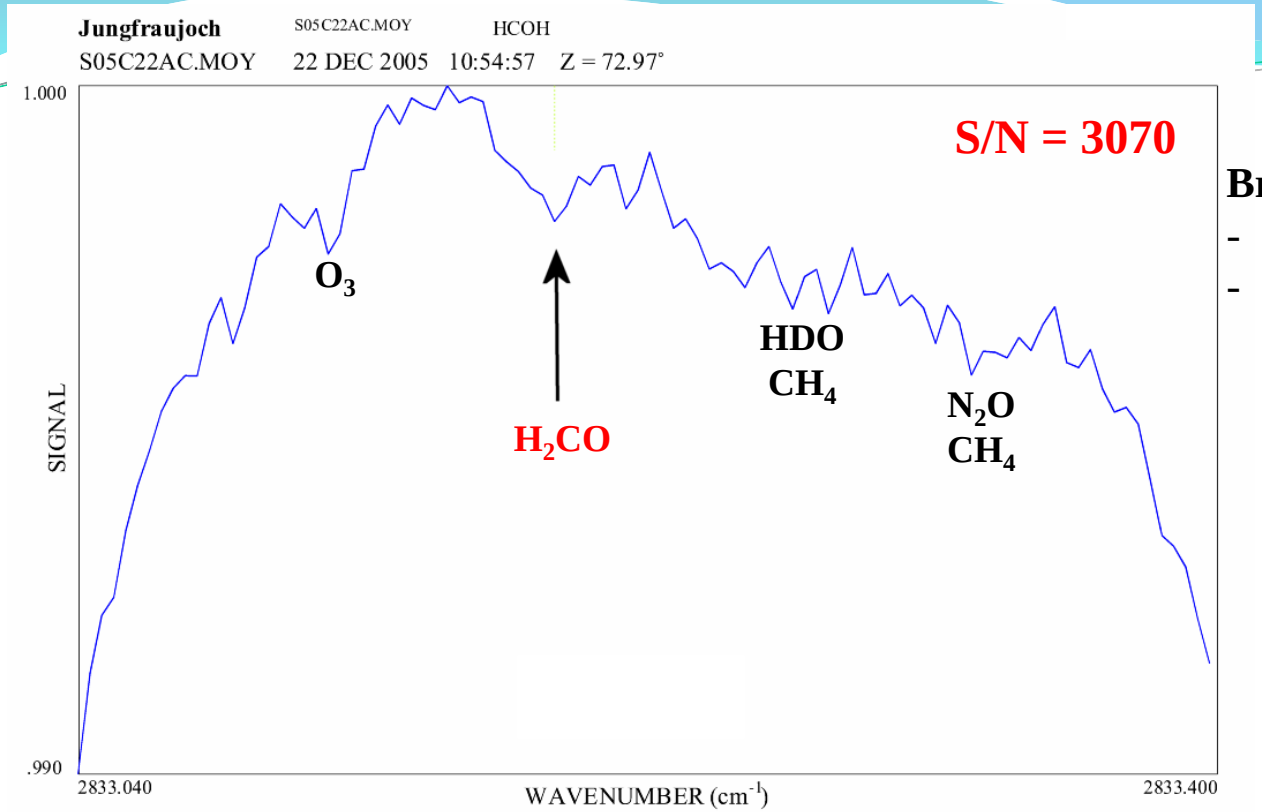
Jungfraujoch station (46.5° N, 8.0° E, 3580m a.s.l.)

2833.070 – 2833.350 cm^{-1}

Tunable optical filter improving the S/N ratio since 2005

2. RETRIEVAL STRATEGY



Broad bandpass optical filter

- **from 2400 to 3000 cm^{-1}**
- **aperture = 1.1 mm**

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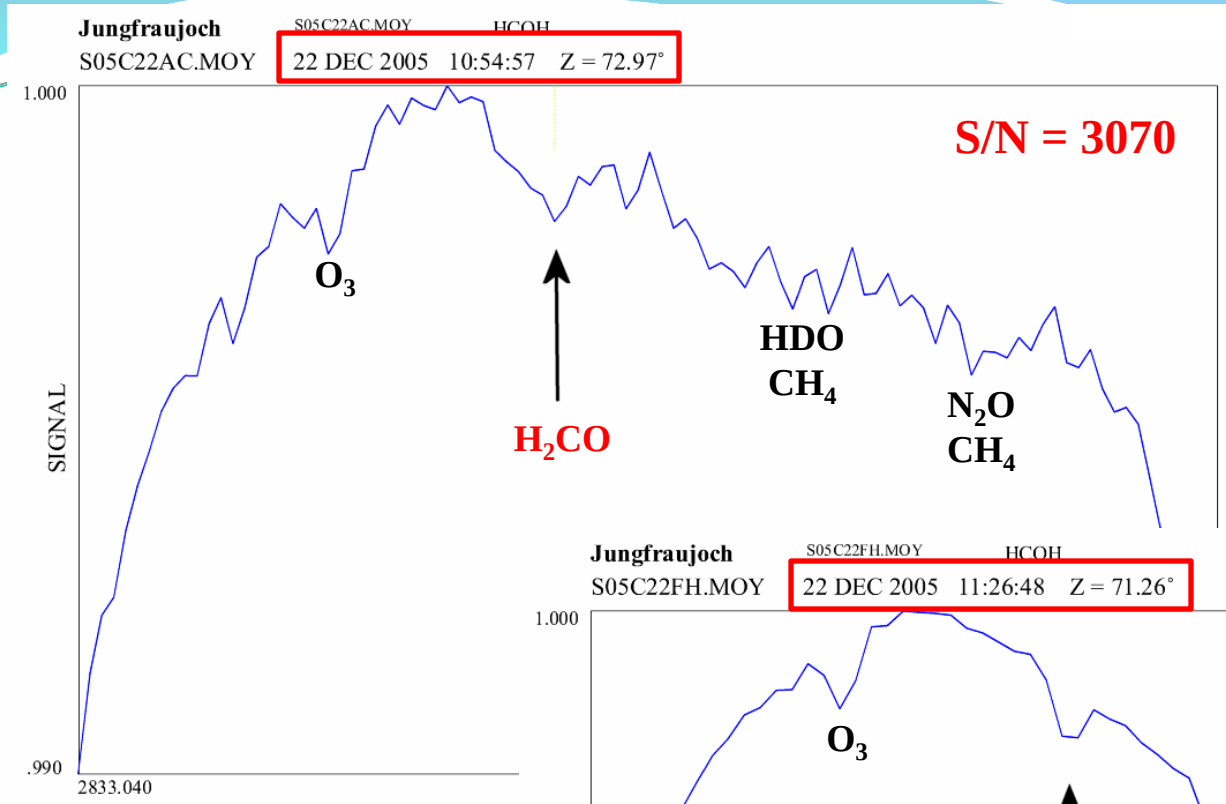

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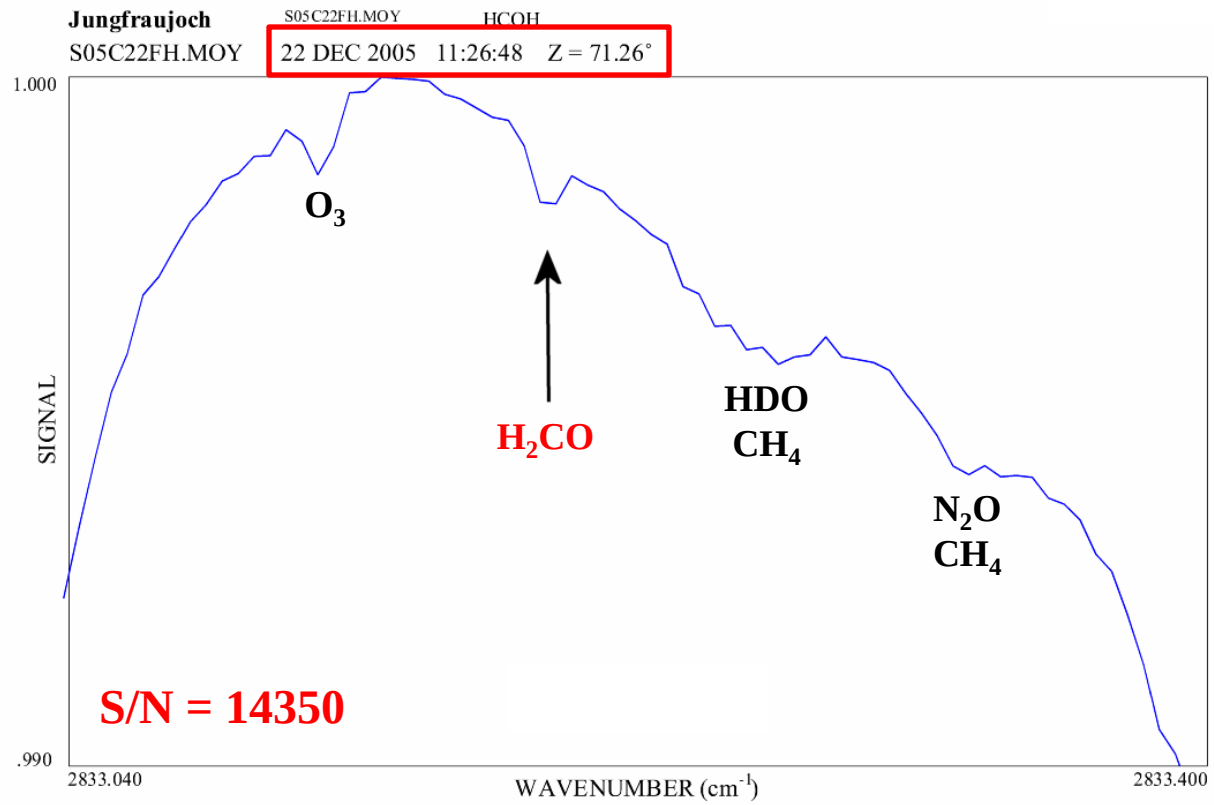
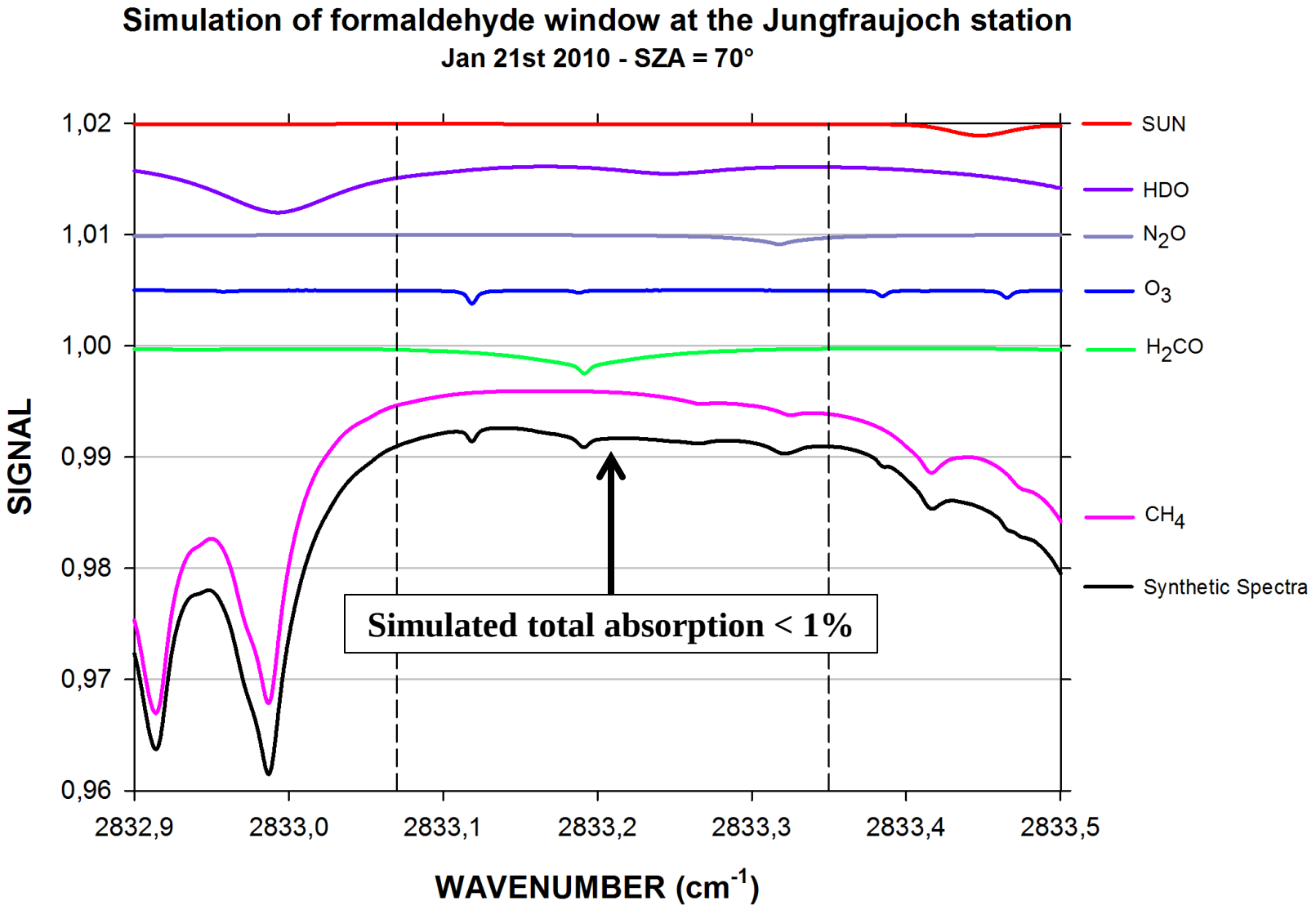


Narrow bandpass optical filter
- **from 2810 to 2850 cm^{-1}**
- **aperture = 1.45 mm**

Enhanced S/N ratio

2. RETRIEVAL STRATEGY



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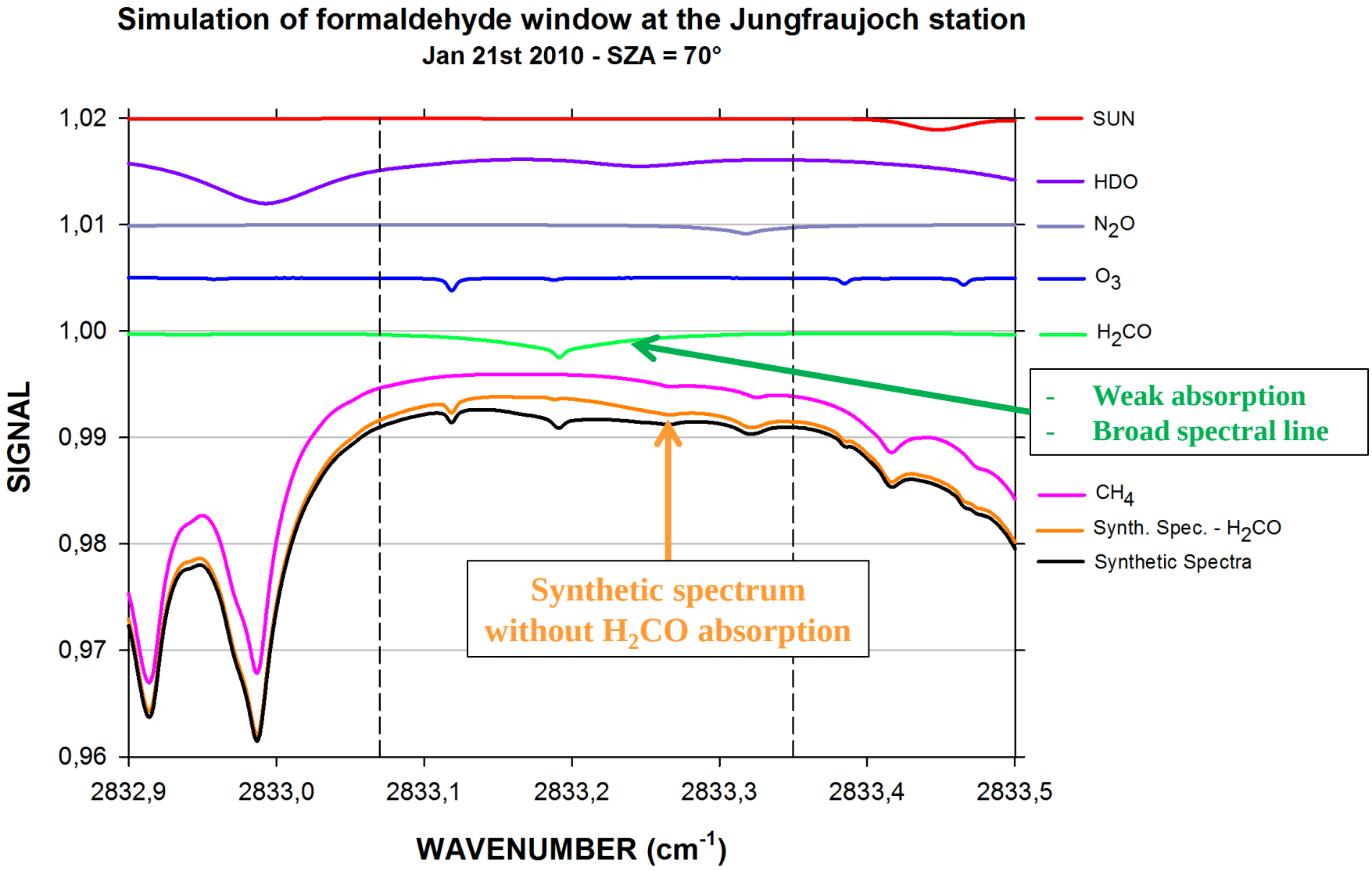

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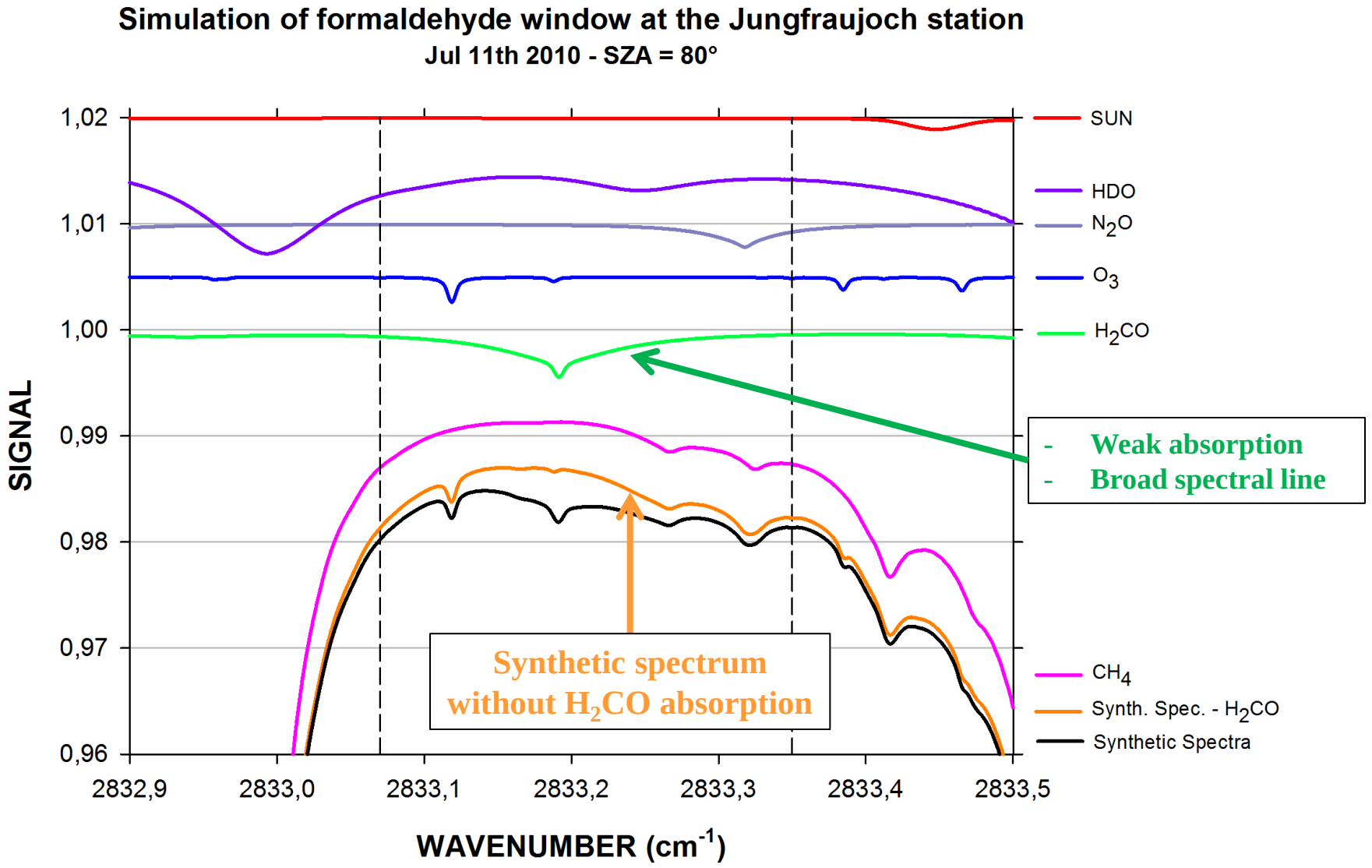

H_2CO retrieval strategy at the Jungfraujoch station

- Retrieval with the SFIT-2 algorithm (v3.91)
- Microwindow: 2833.070 – 2833.350 cm^{-1}
- Spectral resolution: 0.005 cm^{-1}
- Interfering species: CH_4, HDO, O_3 and N_2O
- Spectroscopic parameters:
  - HITRAN 2004 for interfering species
  - HITRAN 2008 for H_2CO
- Data set: 2343 solar spectra from December 2005 to April 2013

***A priori* profile ?**

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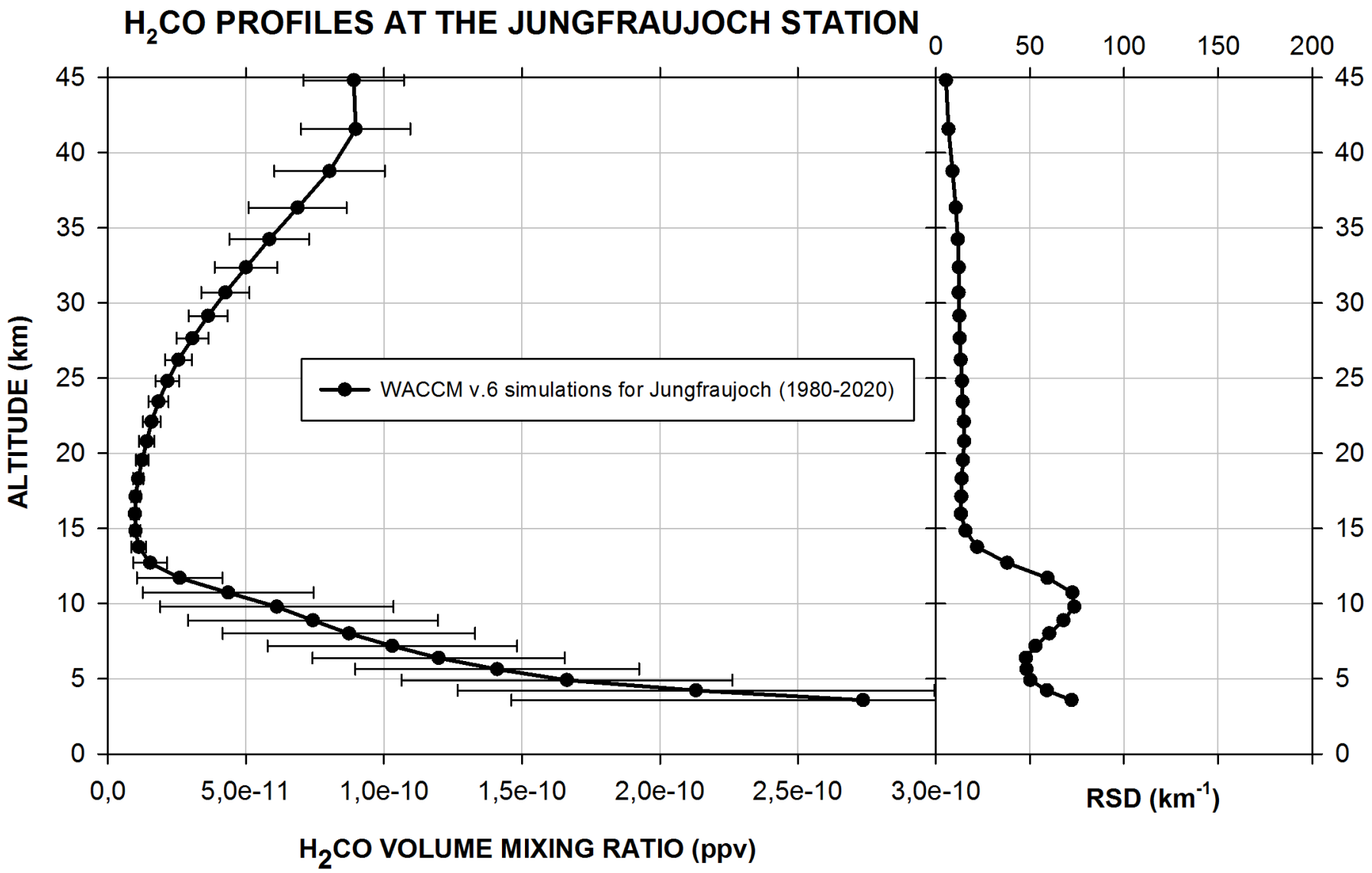

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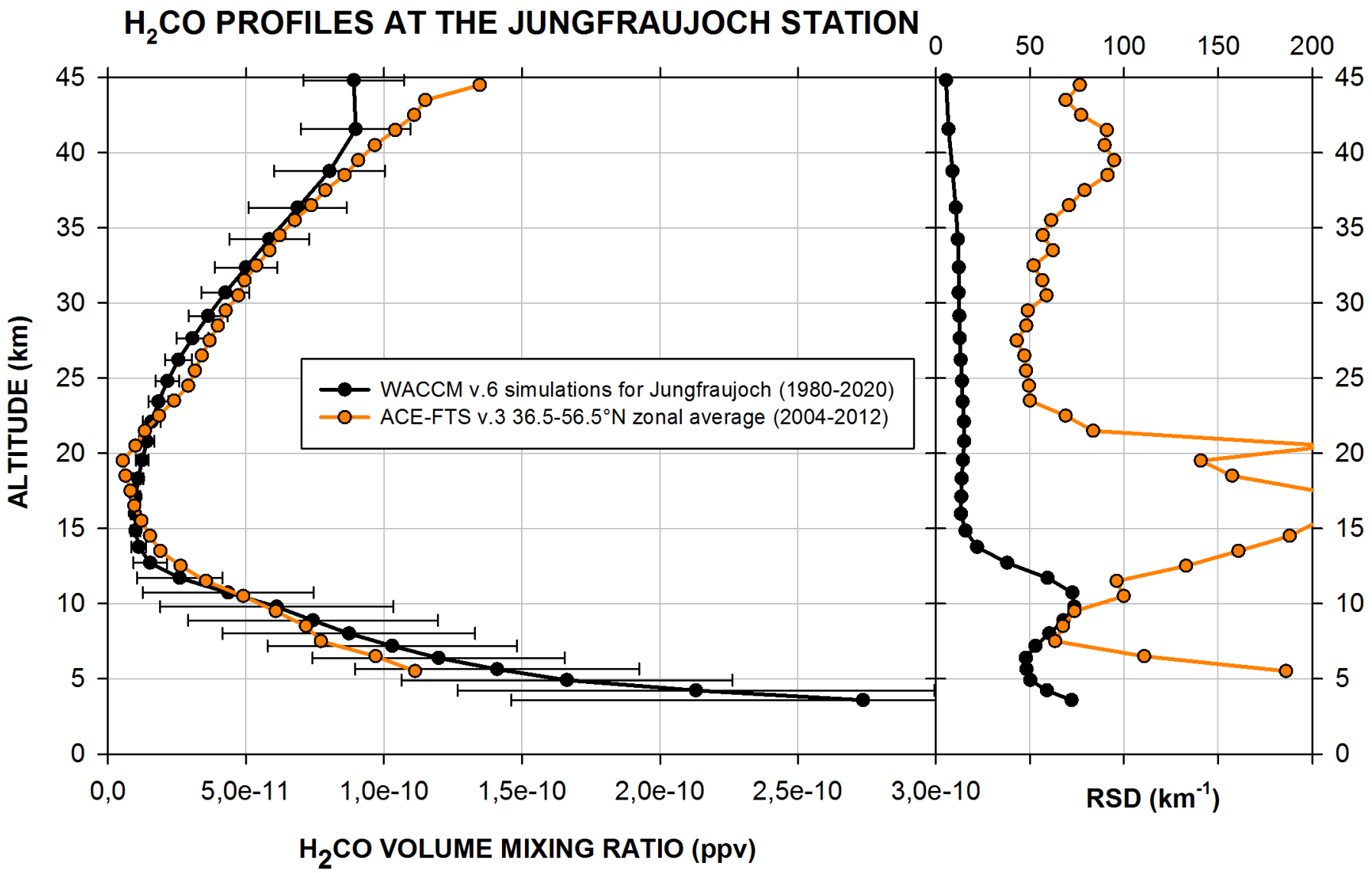

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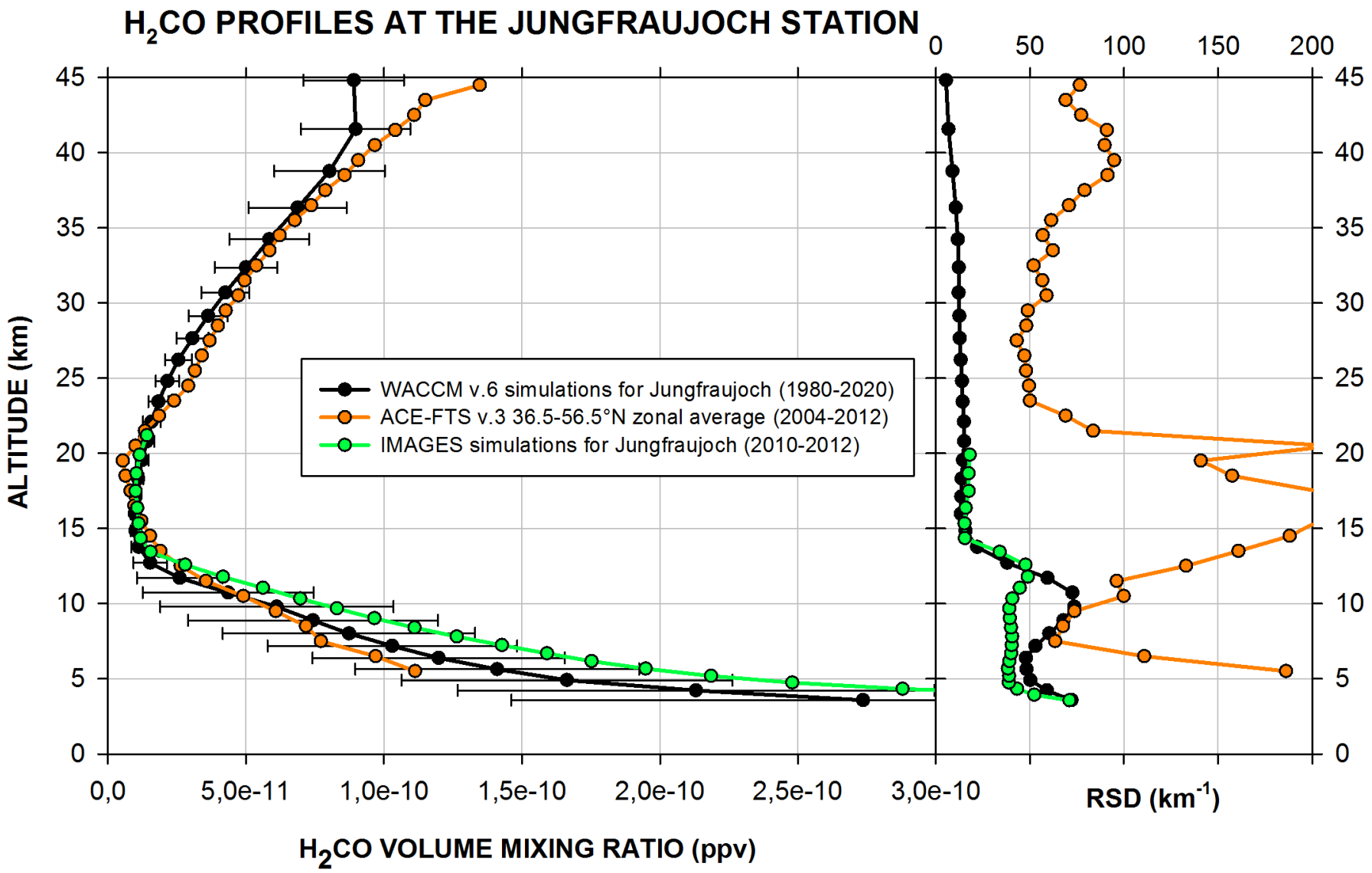

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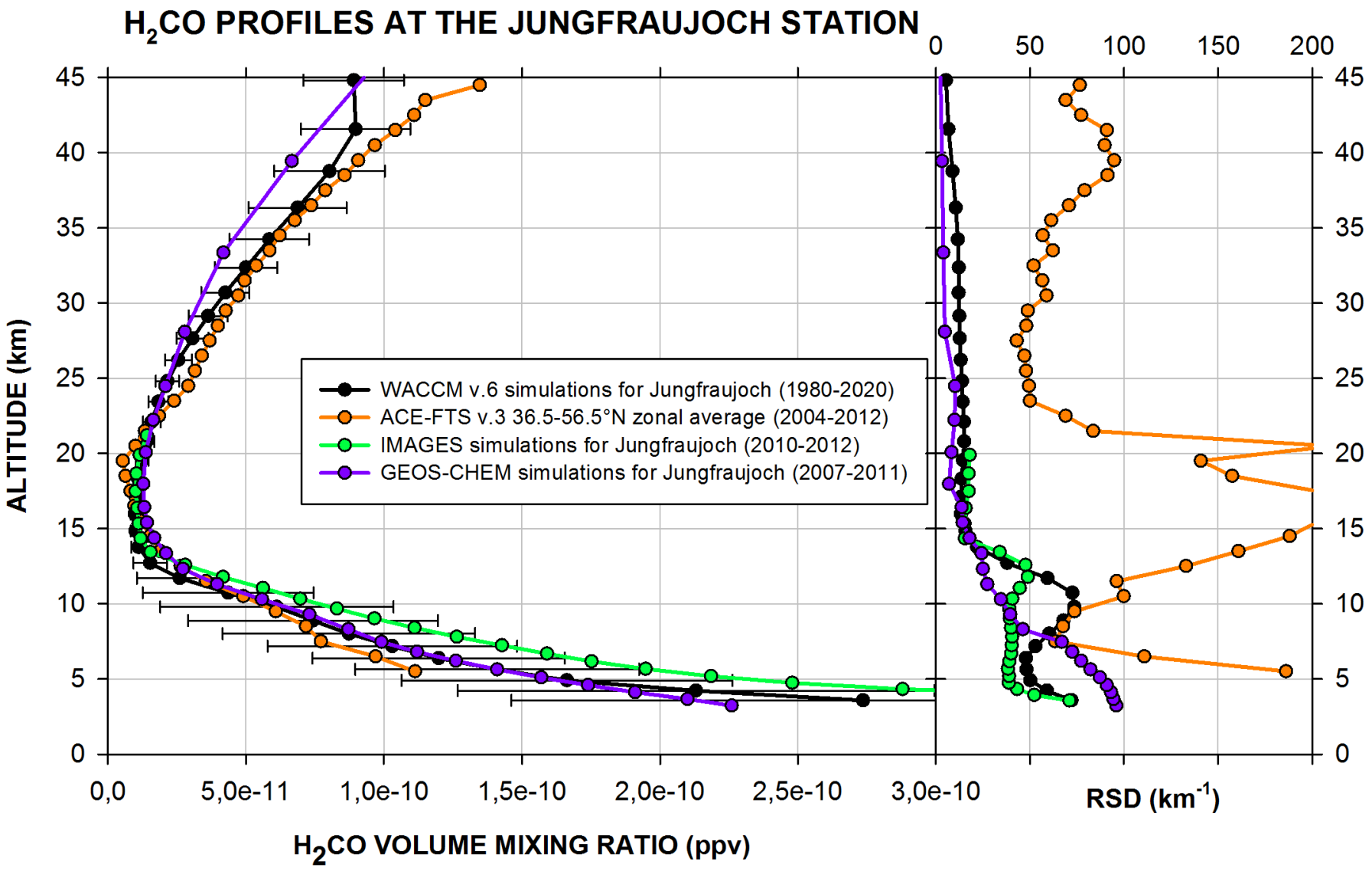

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- *A priori* profile from WACCM v.6

→ **Tikhonov type L_1 regularization** Constraint matrix $\mathbf{R = \alpha L_1^T x L_1}$

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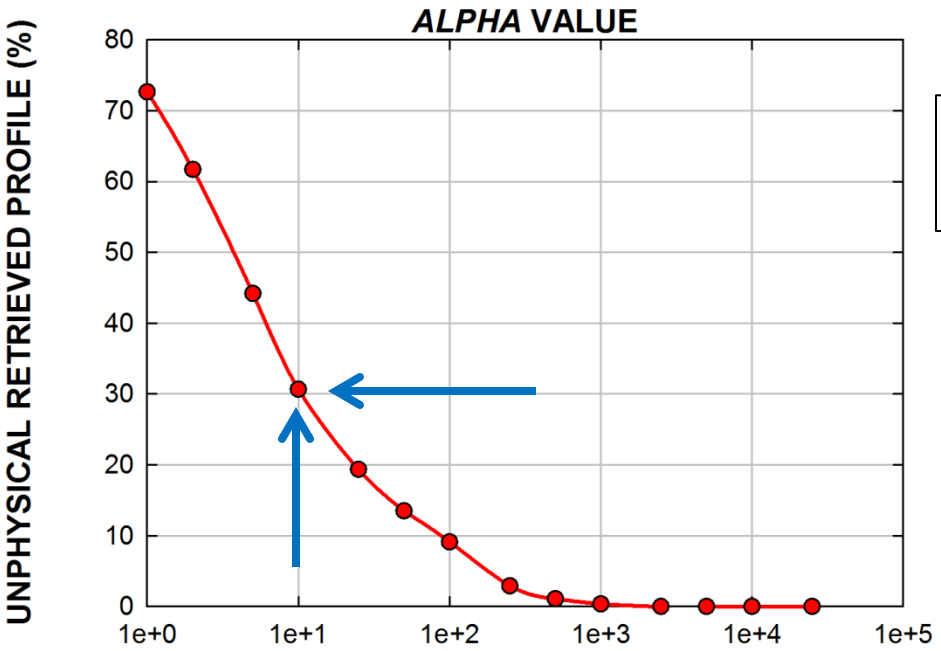

Determination of α (regularization strength) based on H_2CO retrievals for 2010

274 solar spectra

New subset: spectra with « positive » retrieved profile only, when using α = 10

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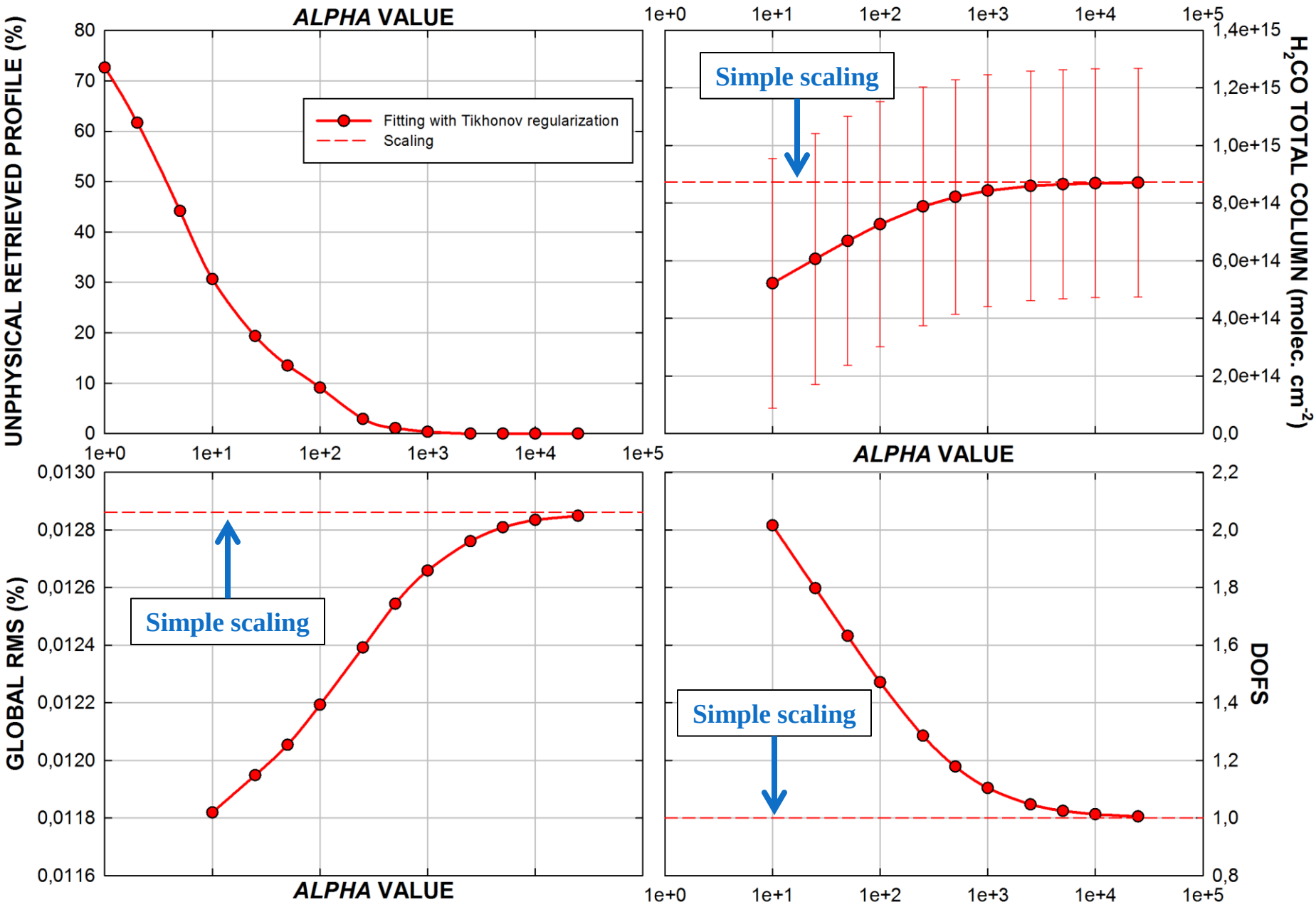

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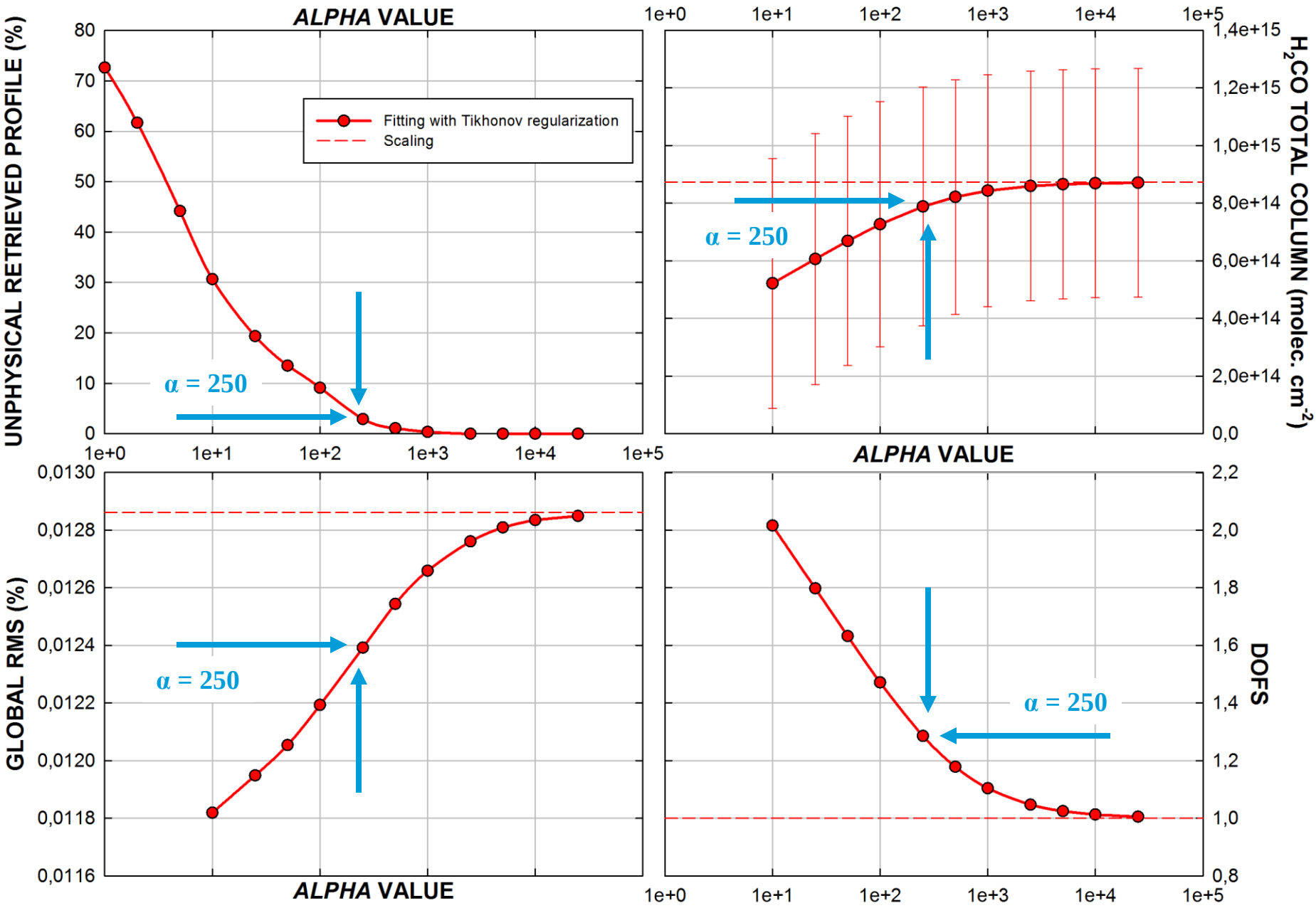
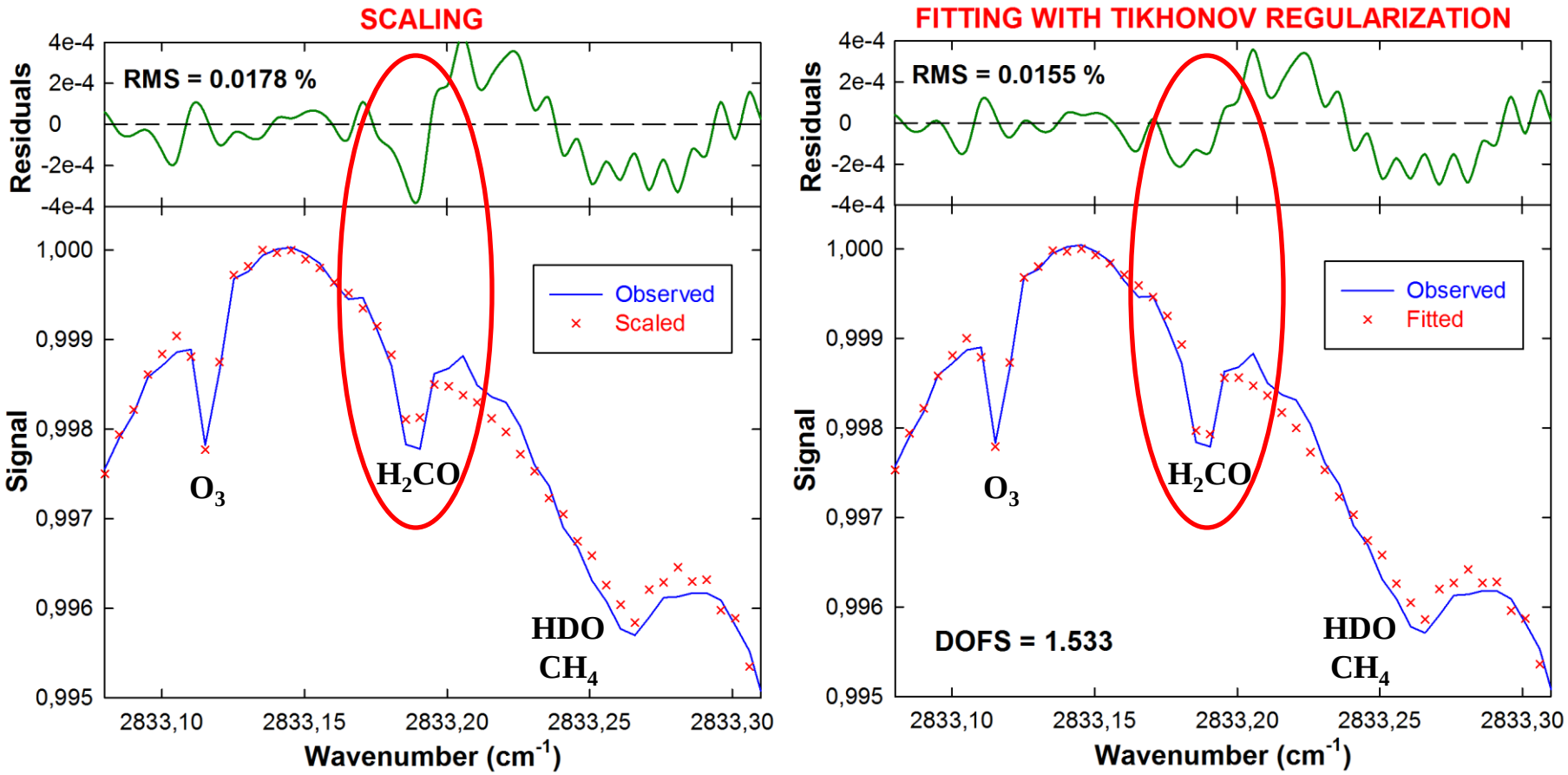


3. PRELIMINARY RESULTS



June 23rd 2010 – SZA = 77° - S/N = 17354

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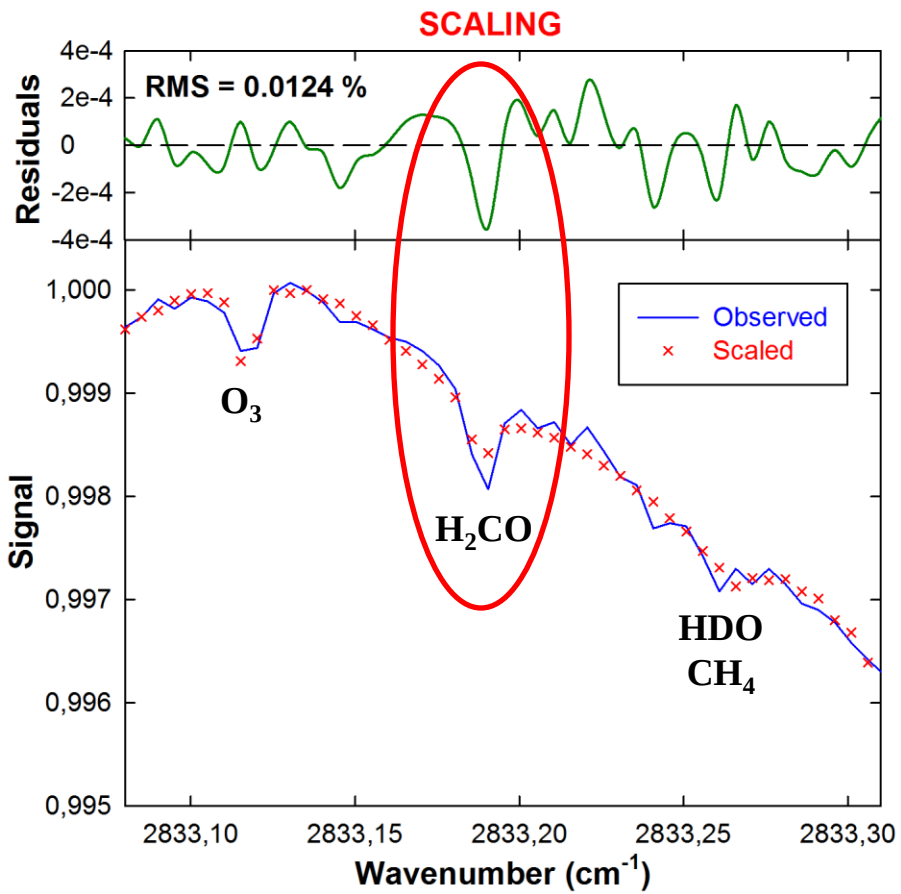

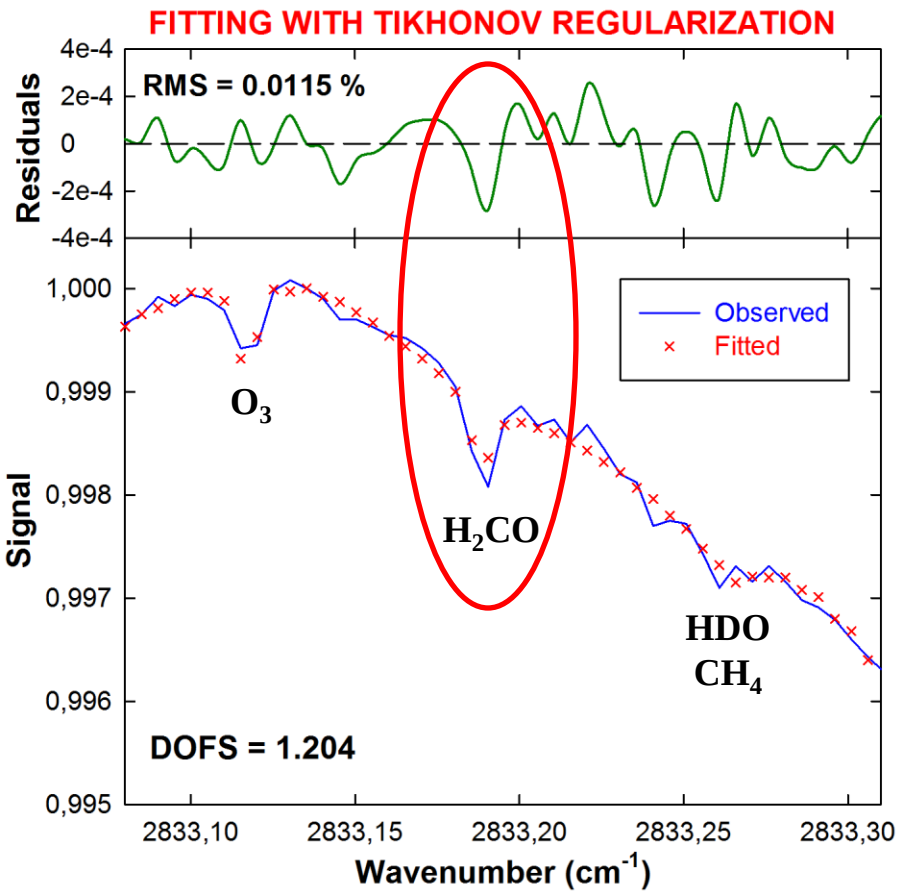

October 18th 2010 - SZA= 61° - S/N = 9701

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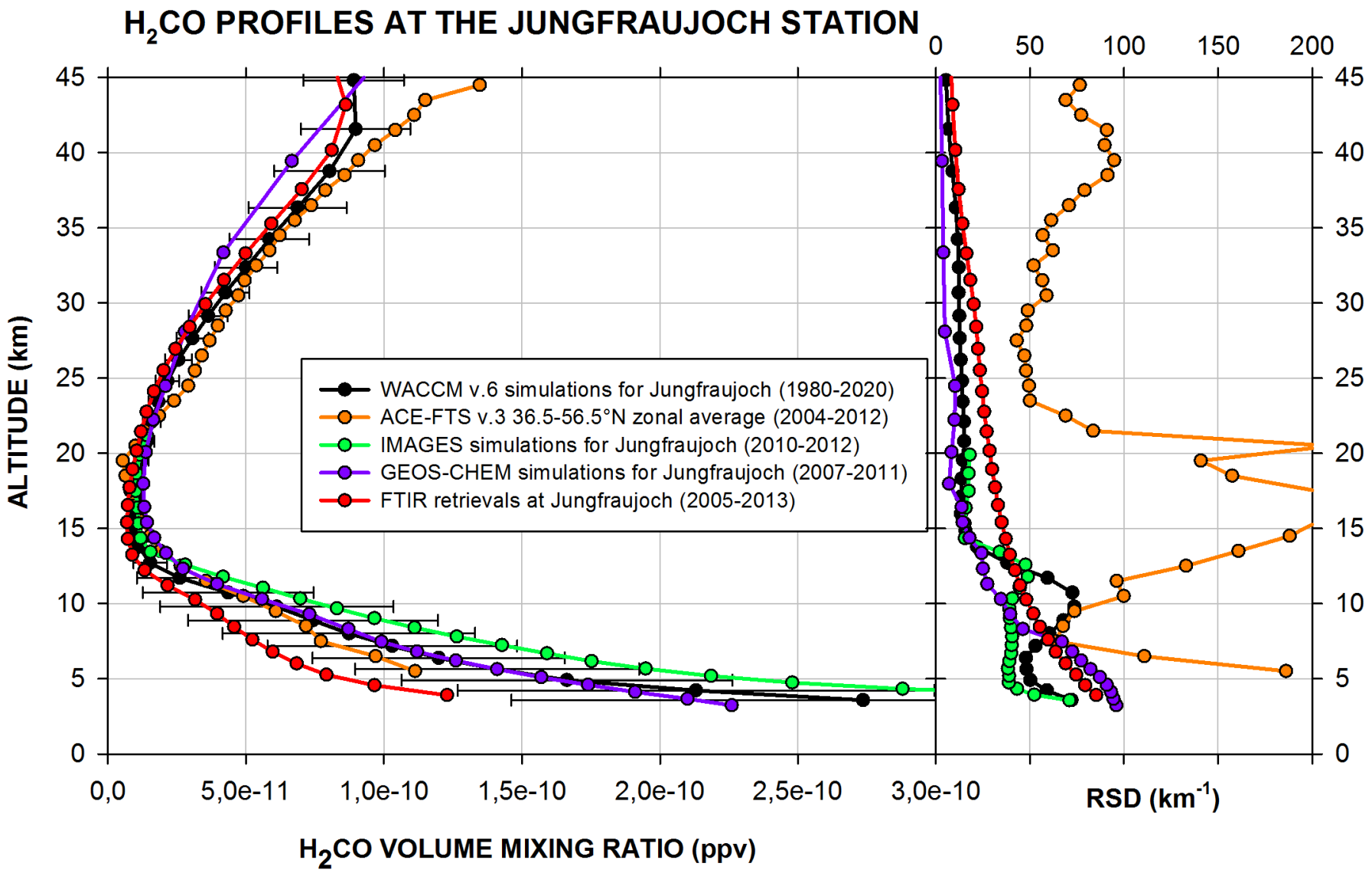

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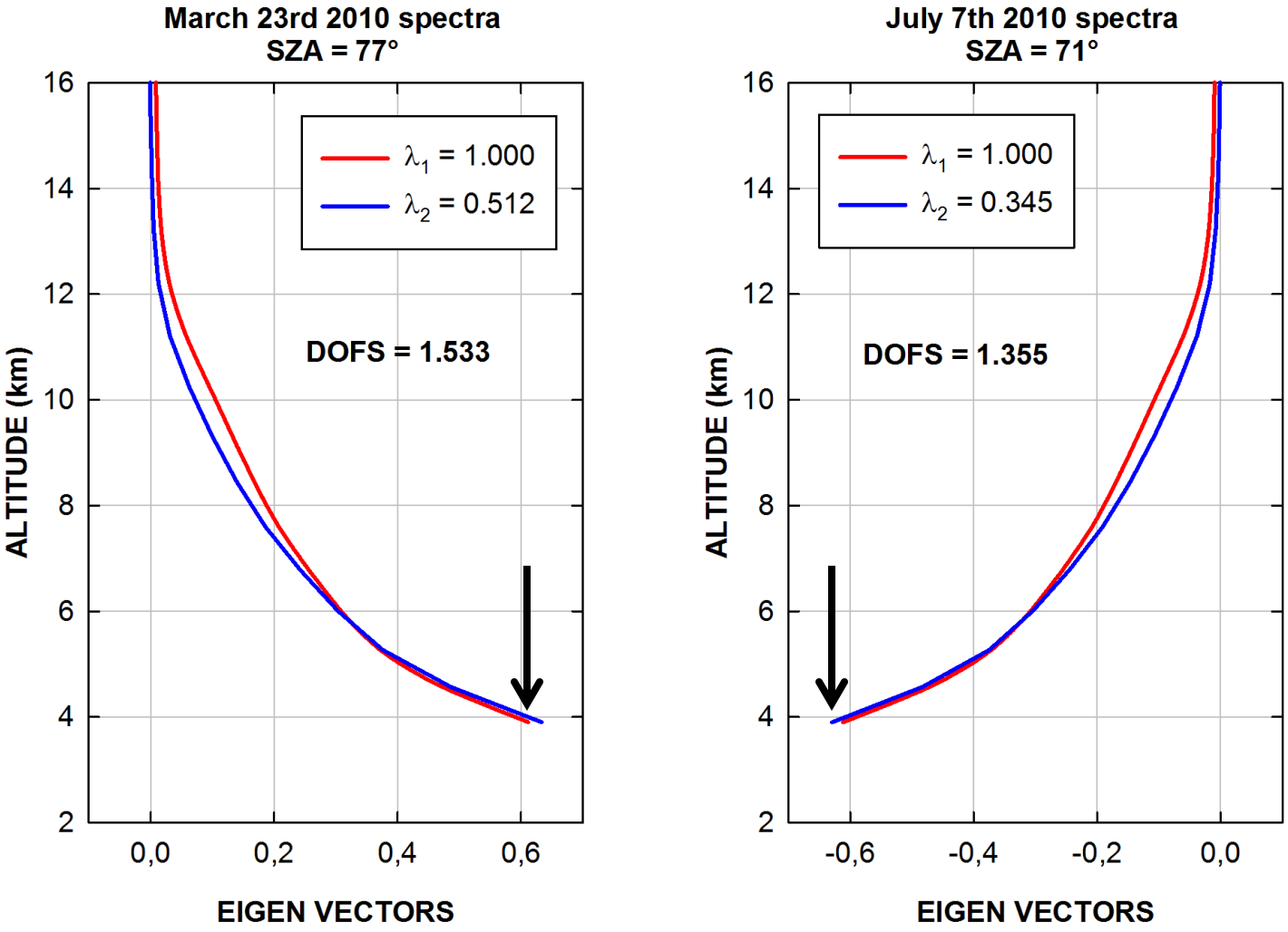
EXAMPLE OF H_2CO EIGEN VECTORS AT JUNGFRAUJOCH



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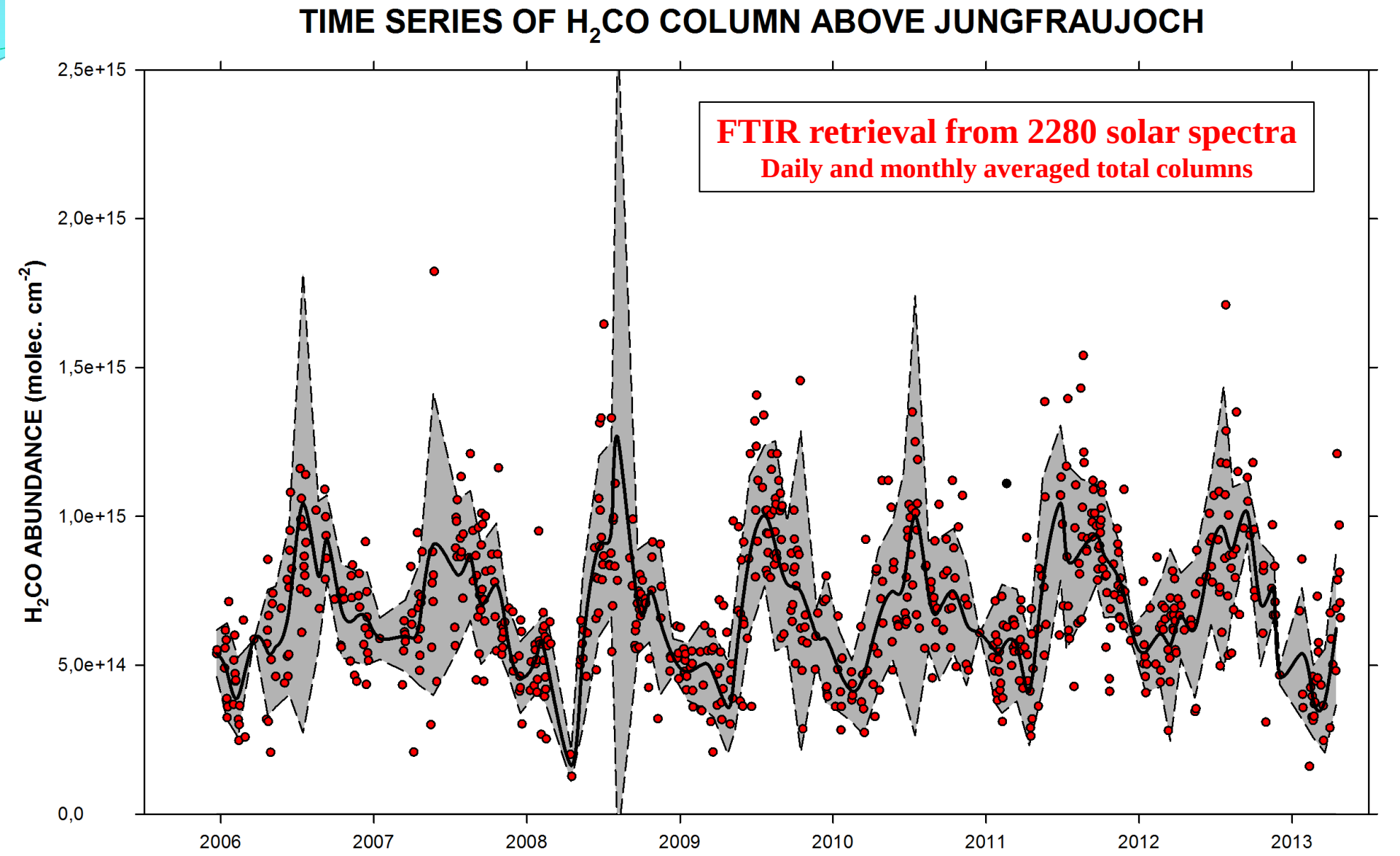

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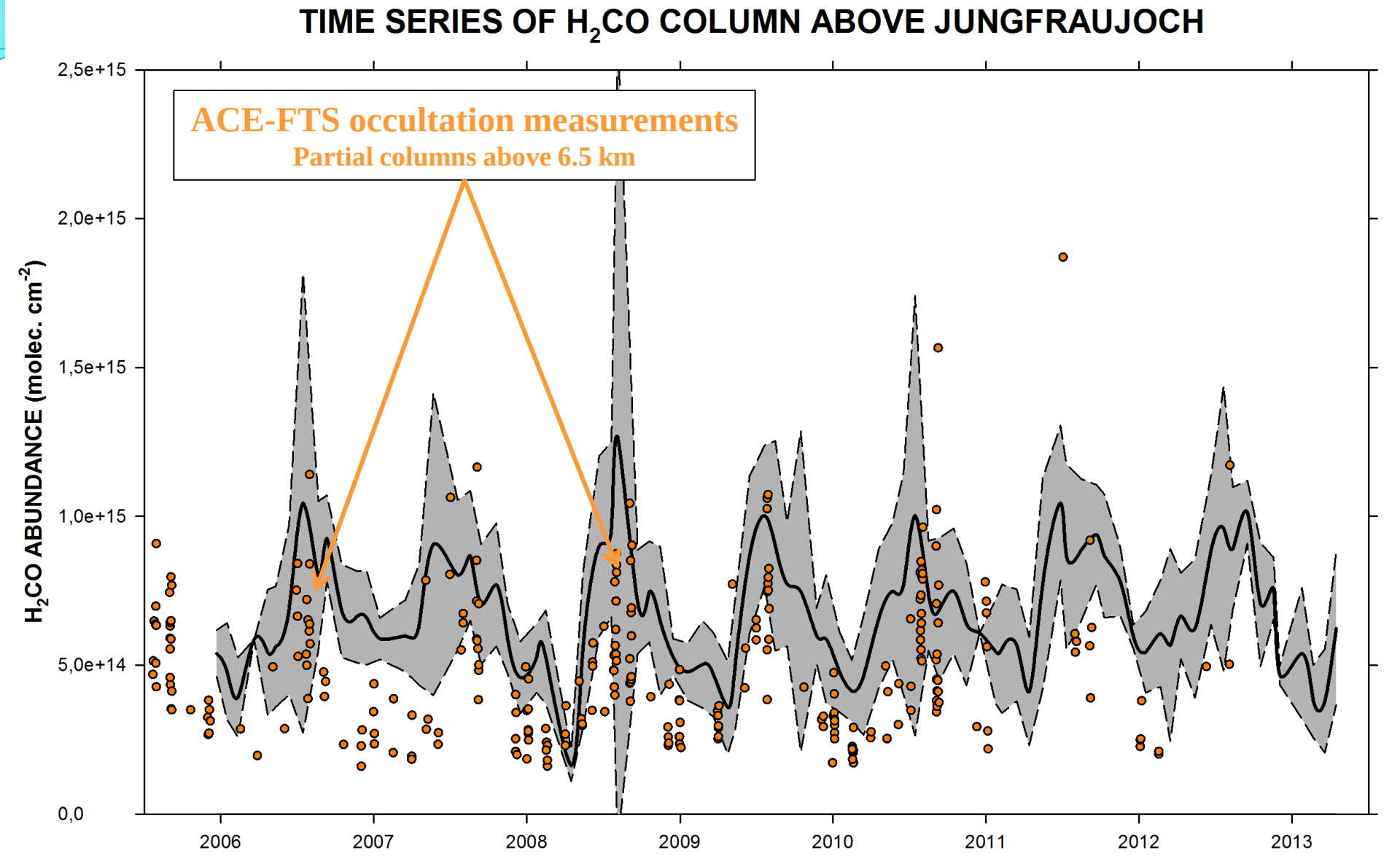

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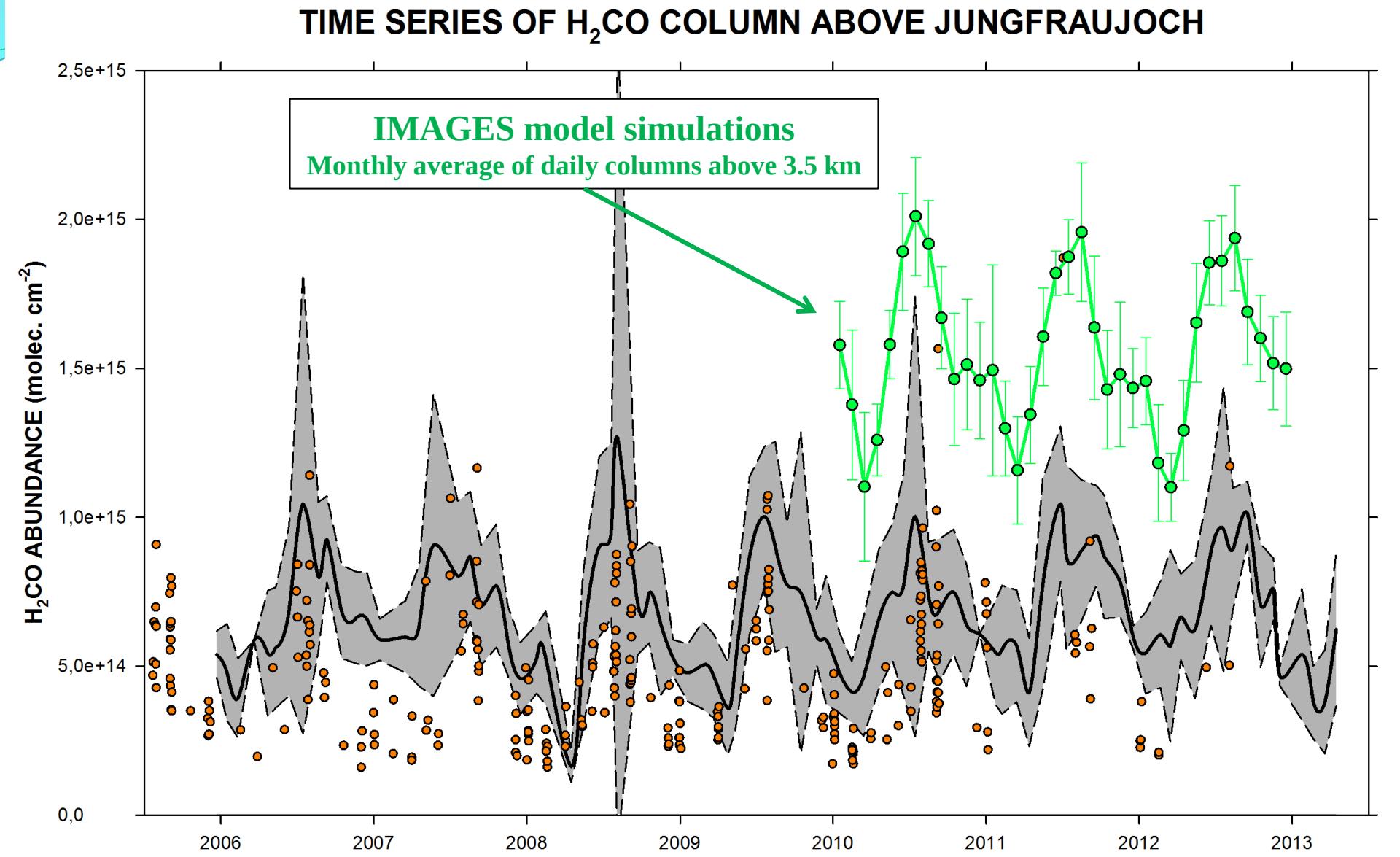

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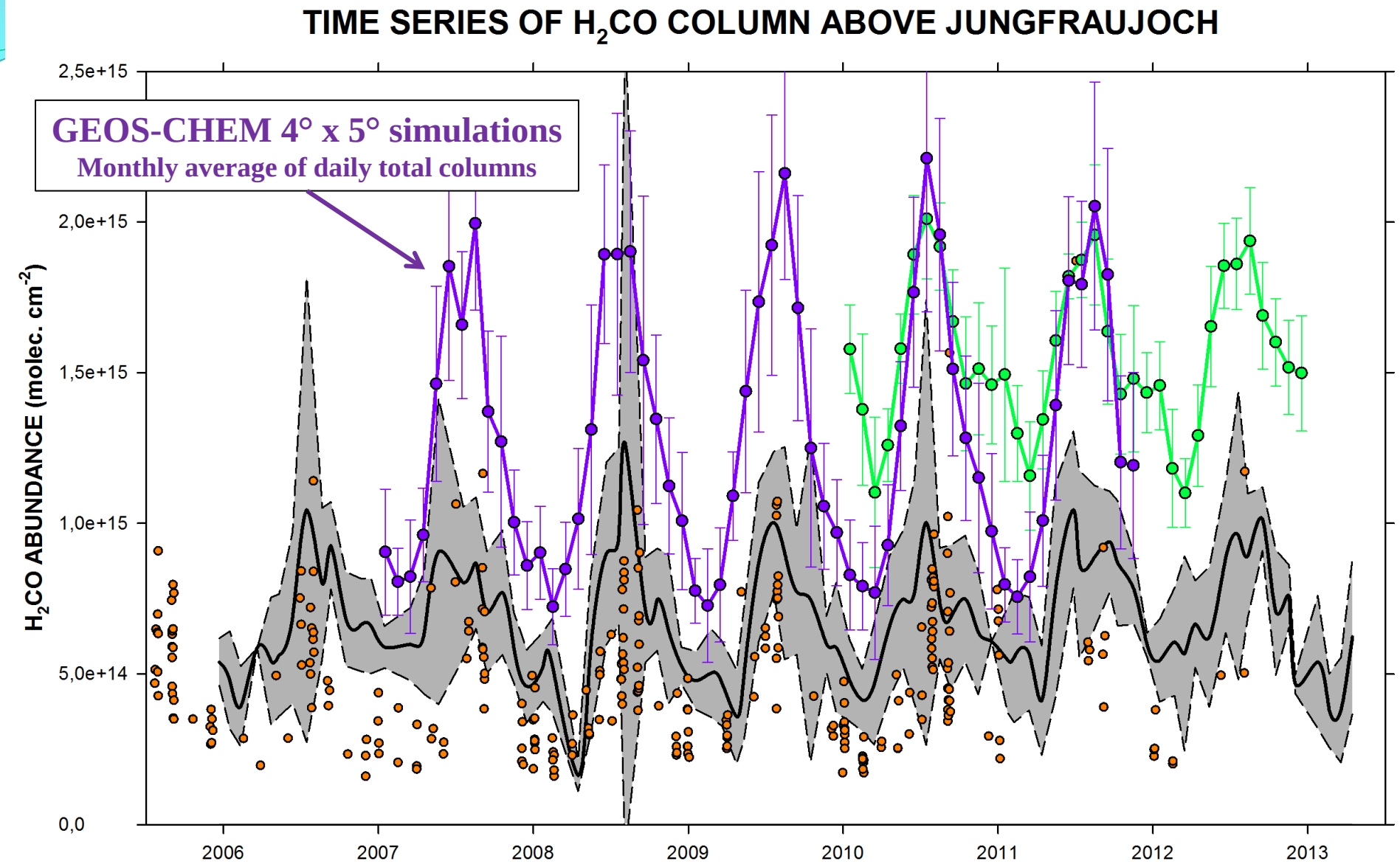

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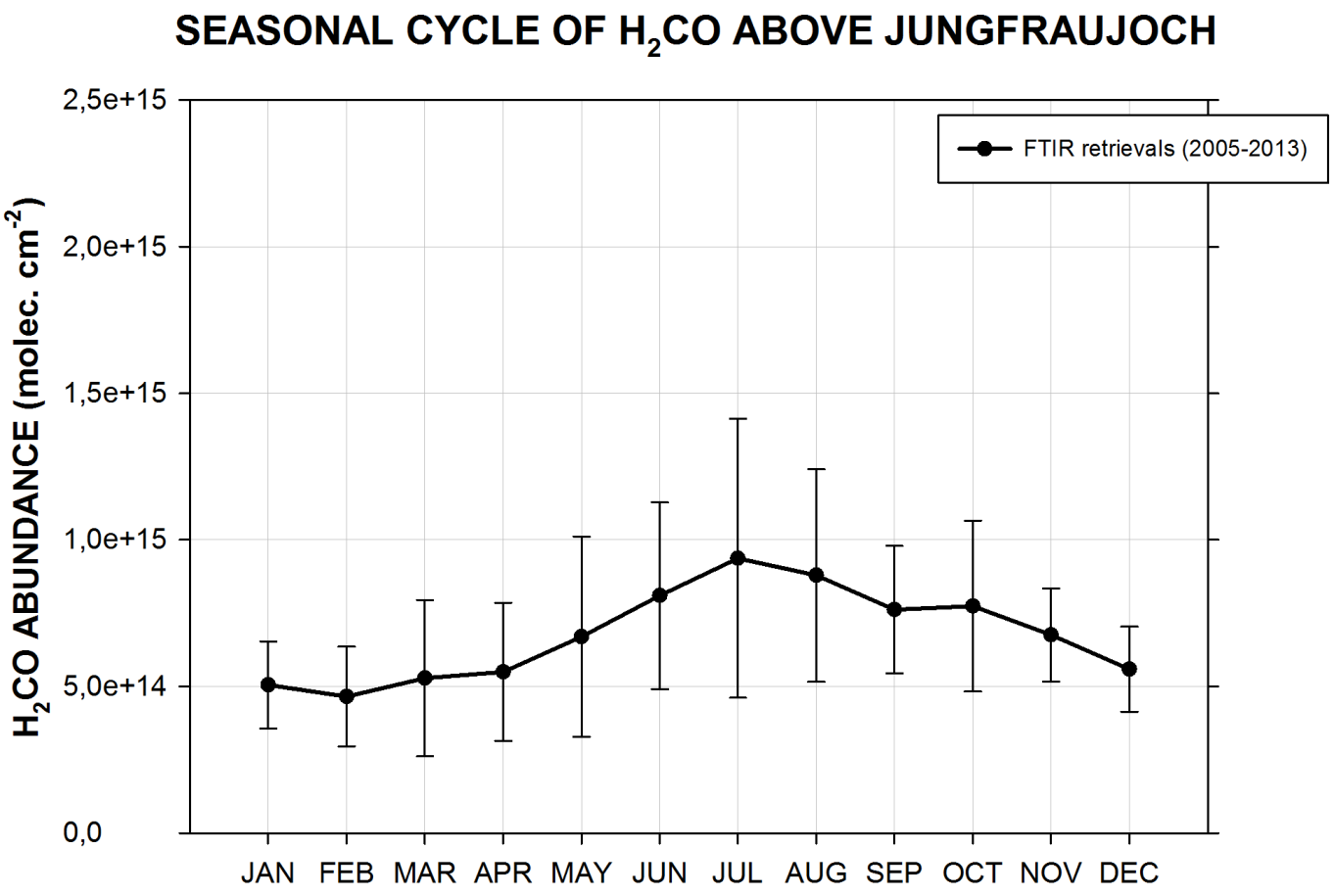

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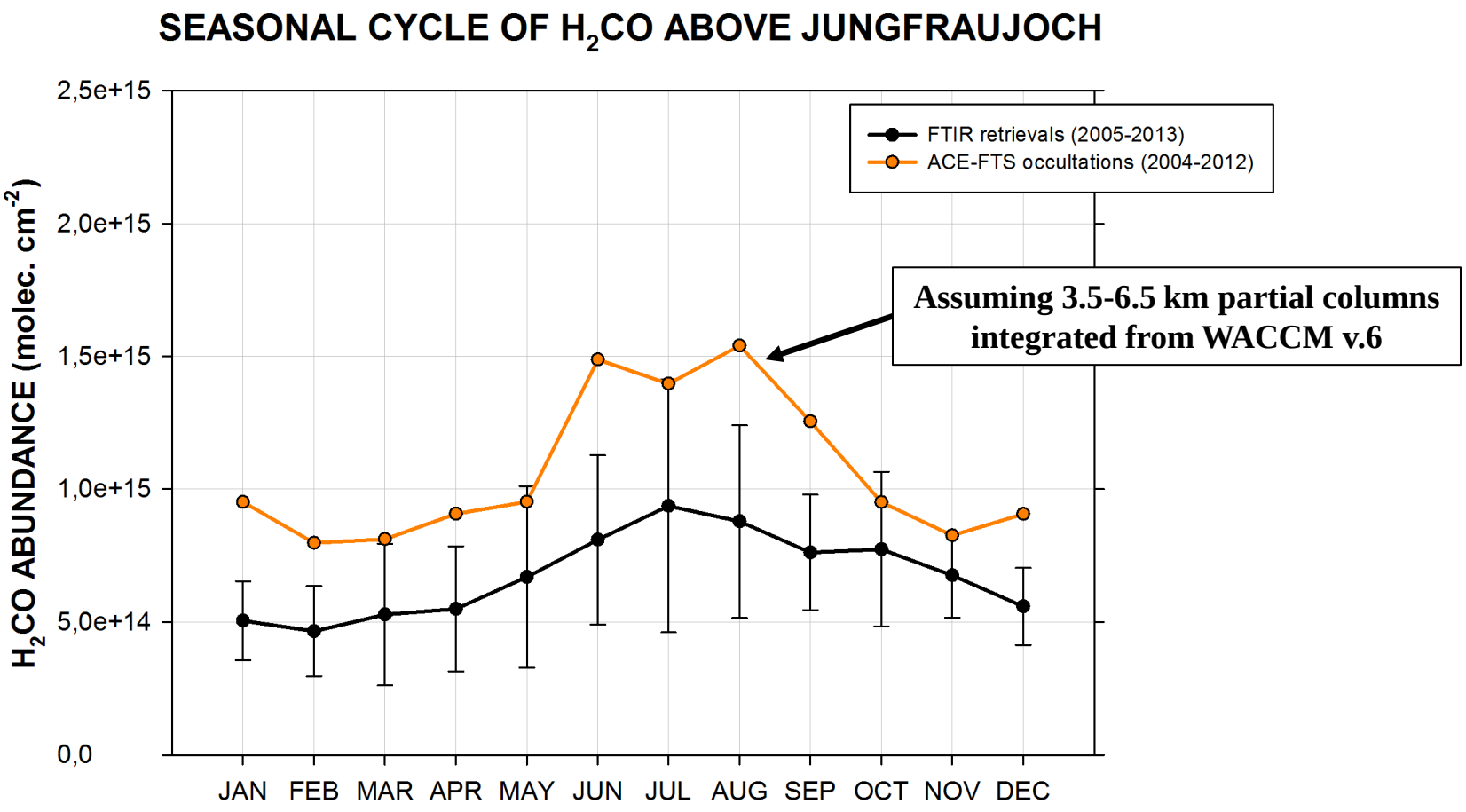

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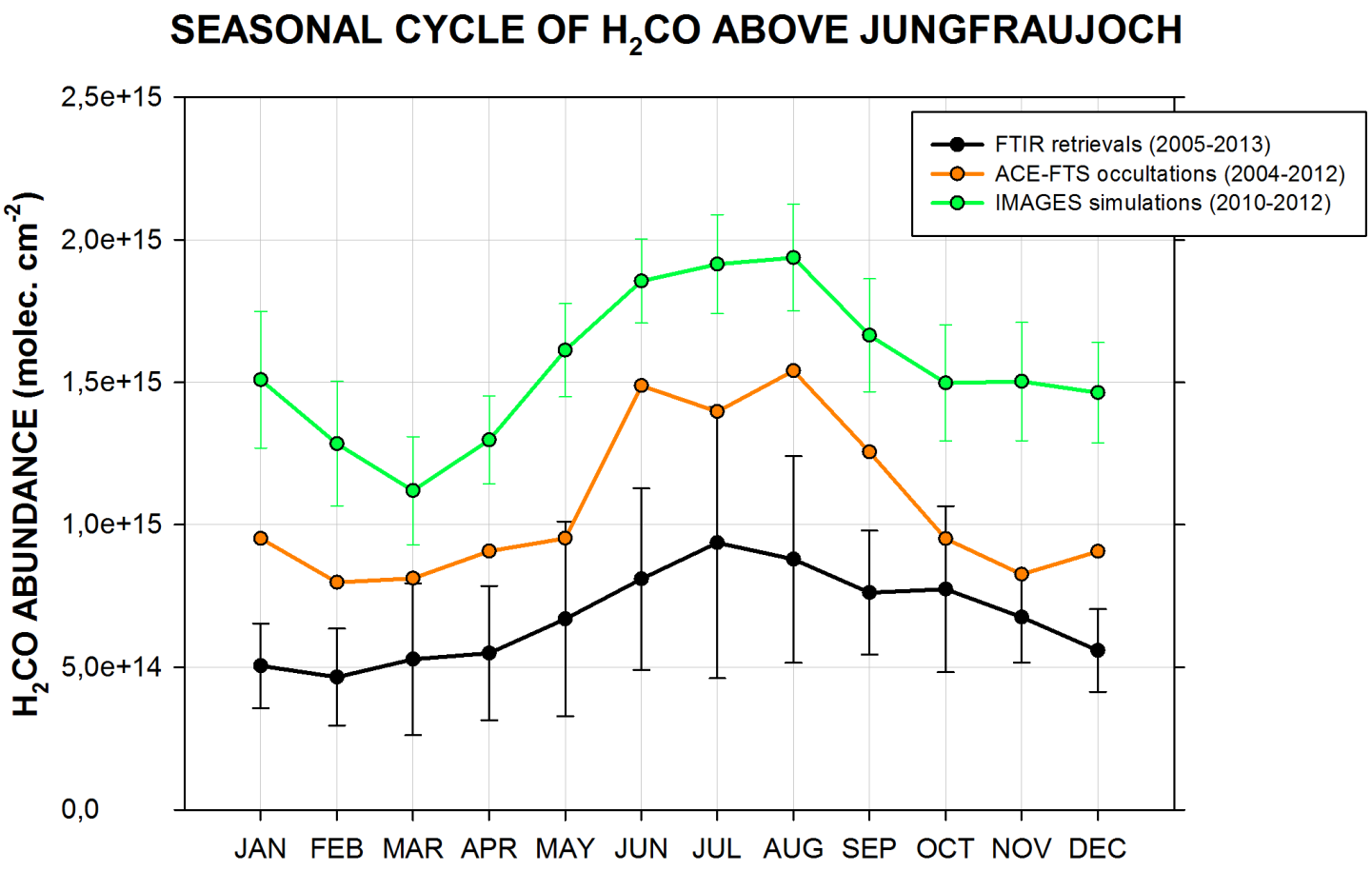

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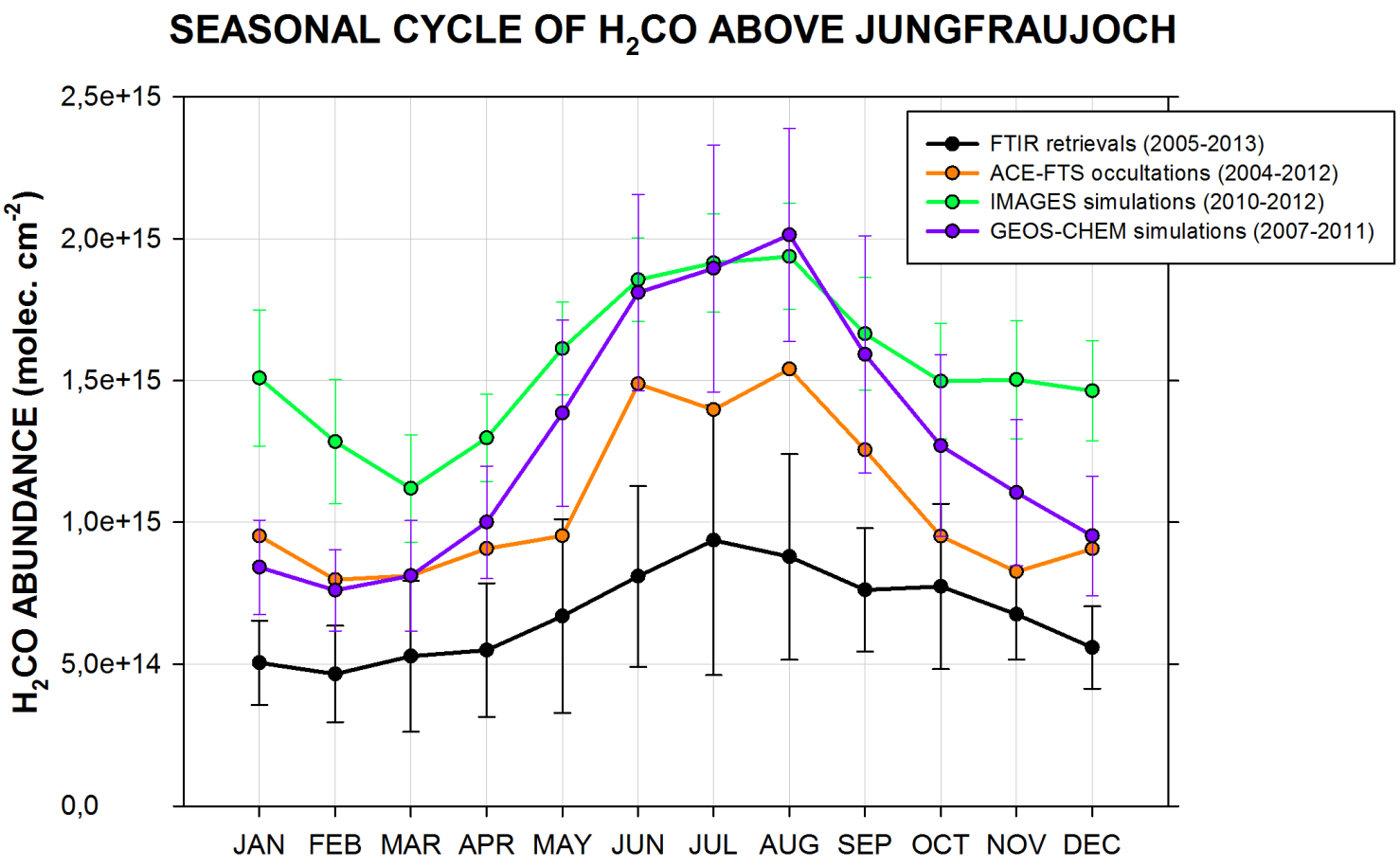
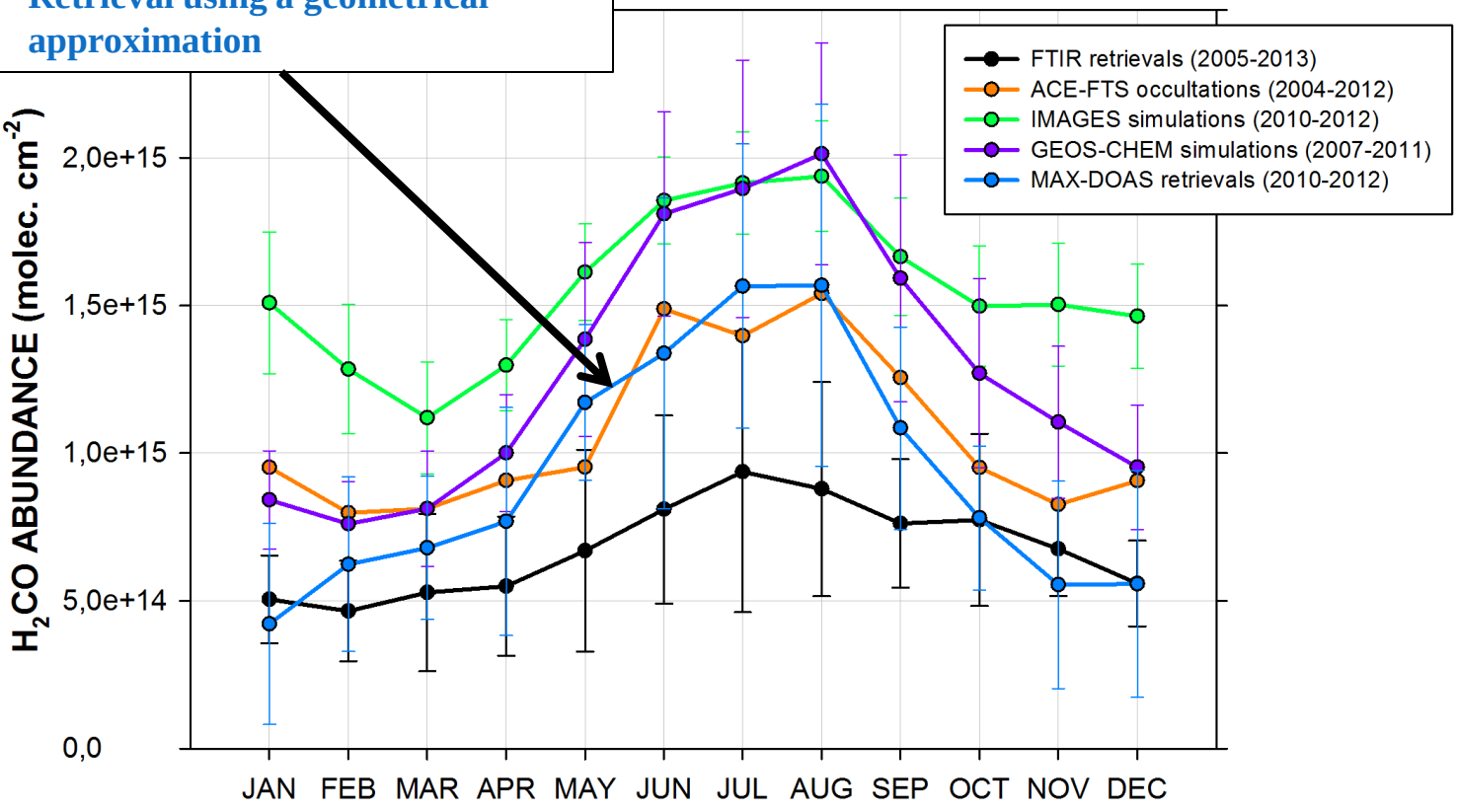


3. PRELIMINARY RESULTS

- **Preliminary results from UV-visible MAX-DOAS observations**
- **Retrieval using a geometrical approximation**



FTIR total columns appear to be low during summertime…

Forthcoming research and developments

Retrieval strategy with the 2833.070 – 2833.350 cm^{-1} microwindow

- Spectroscopic parameters → contribution to the error budget ?
  → HITRAN 2012 with updated H_2CO line parameters

- Two consecutive runs → first run for the interfering species
  → second run to fit H_2CO only

- Optimal Estimation Method instead of Tikhonov regularization ?

Retrieval strategy with 6 microwindows from Vigouroux et al., 2009 ?

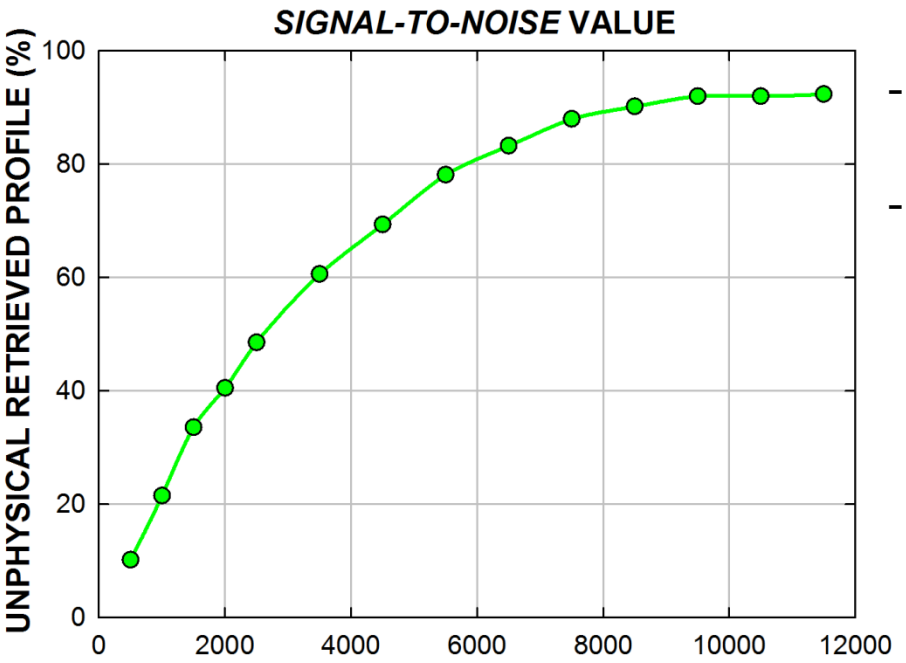
… but using broad-band spectra !

Thanks for your attention

Special thanks to *Michel Van Roozendael, François Hendrick, Jenny Stavrakou, Isabelle De Smedt* and *Gaia Pinardi* for the IMAGES and MAX-DOAS data

4. CONCLUSION AND DISCUSSION

Investigating an Optimal Estimation Method for the H_2CO retrieval strategy

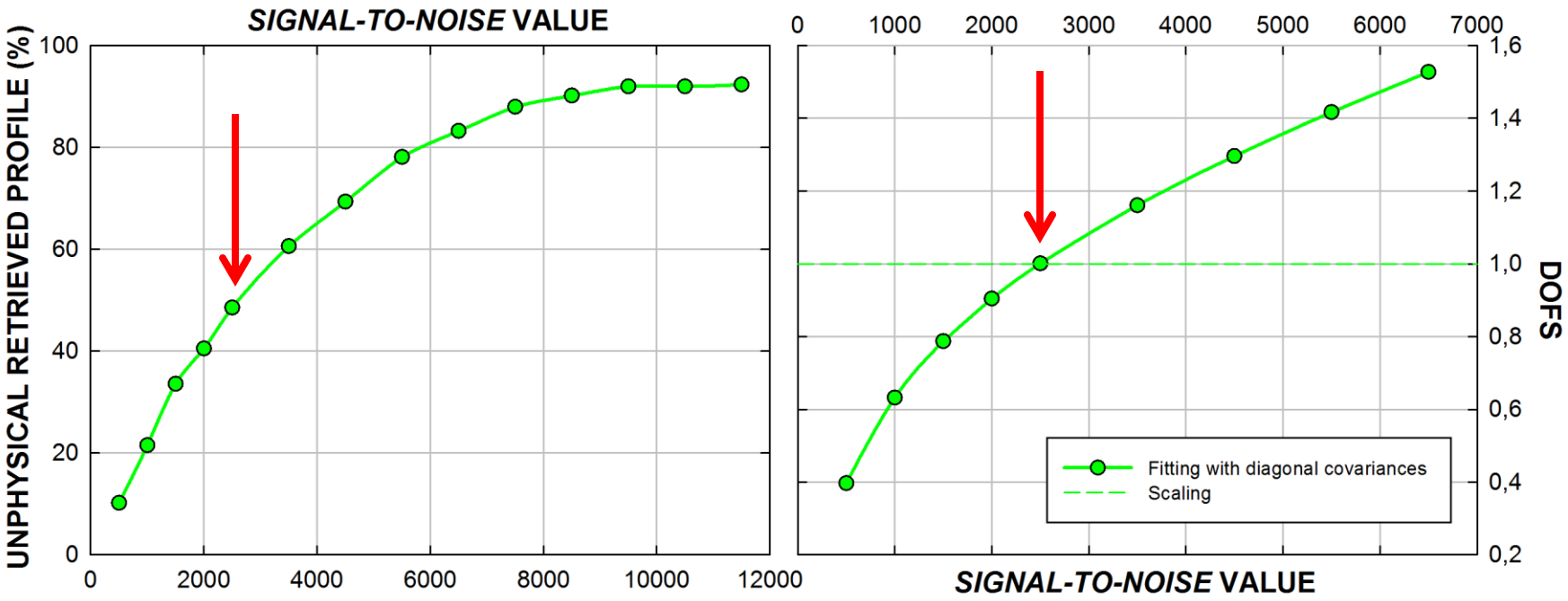


- Making use of climatological conditions
- Applying diagonal covariances deduced from ACE-FTS (v3) occultation measurements

⇨ Further experiments to fix the inter-layer correlation are still required

4. CONCLUSION AND DISCUSSION

Optimal Estimation Method for the H_2CO retrieval



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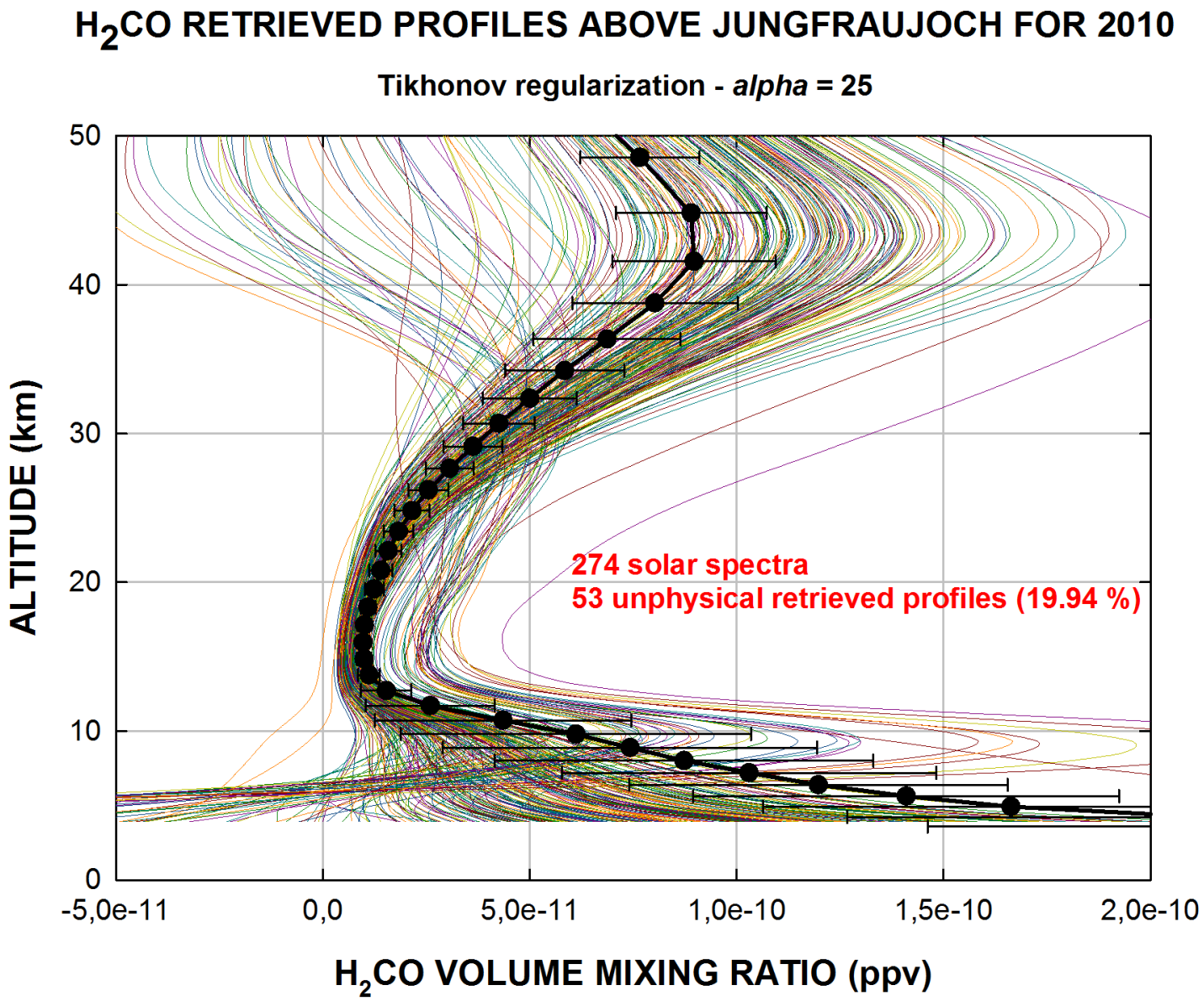
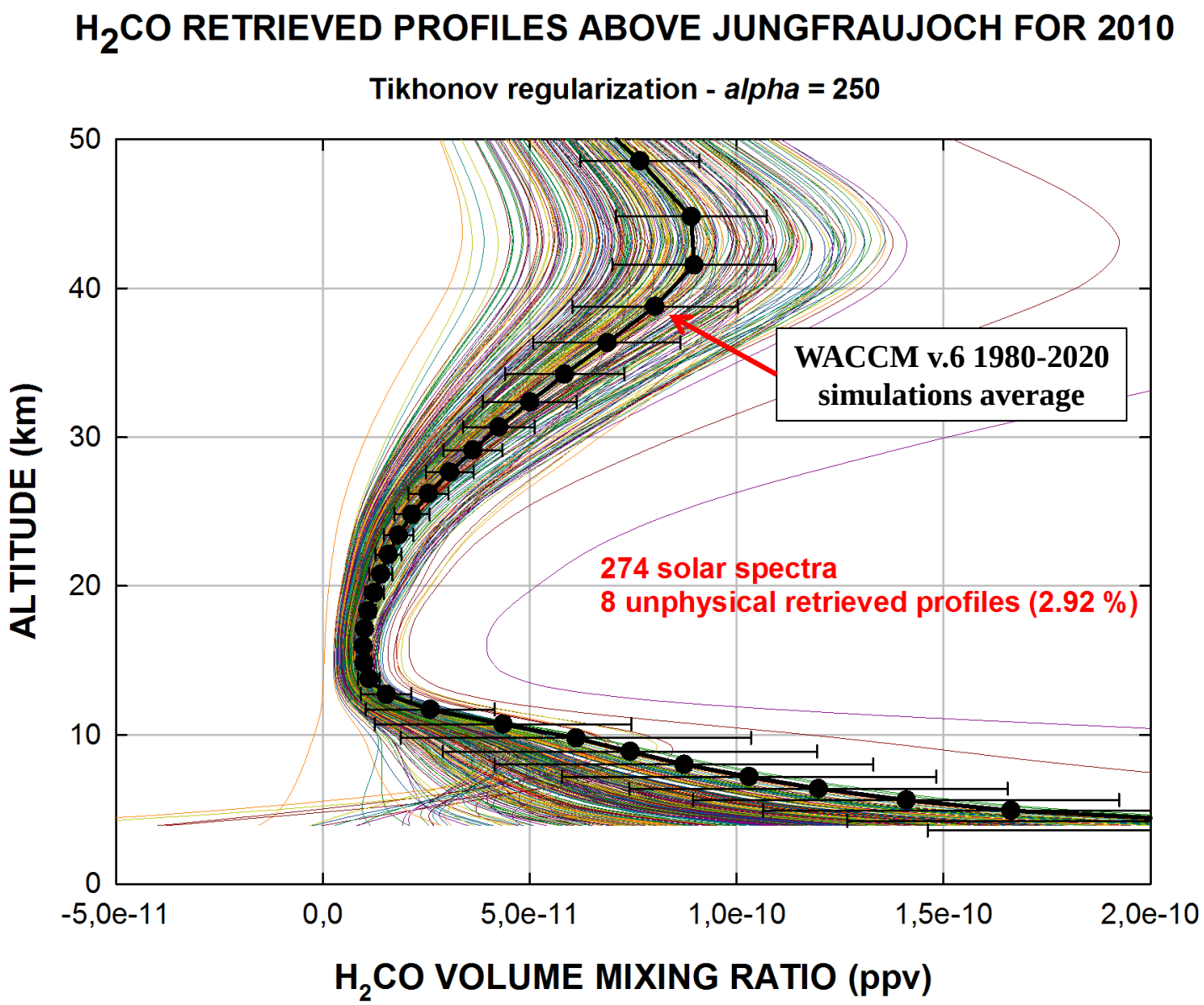
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