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Retrieval Of SO_2 Profiles From MIPAS, Below The Tropopause

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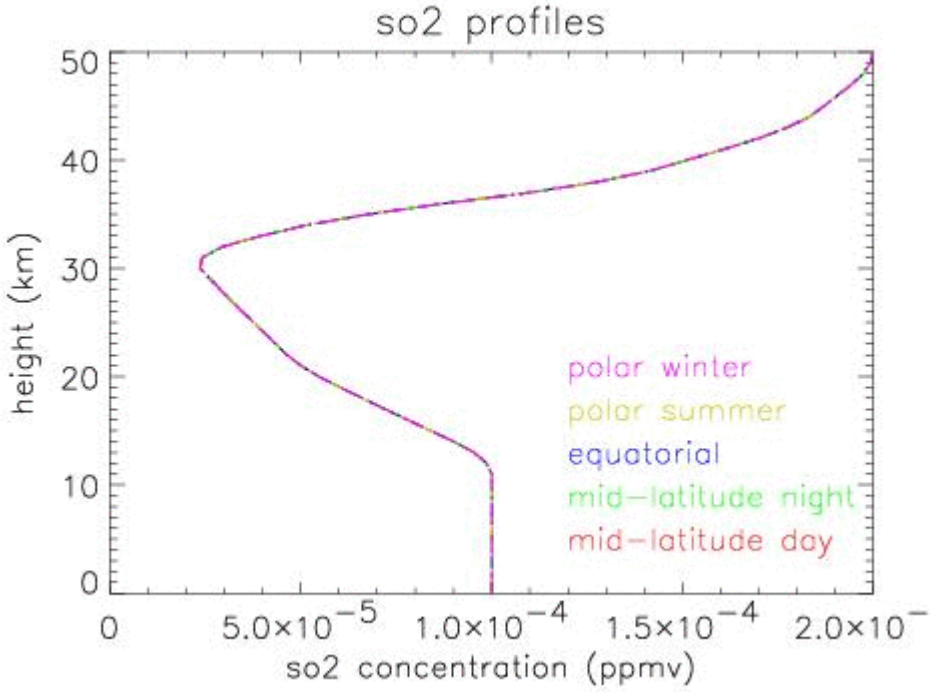
Introduction

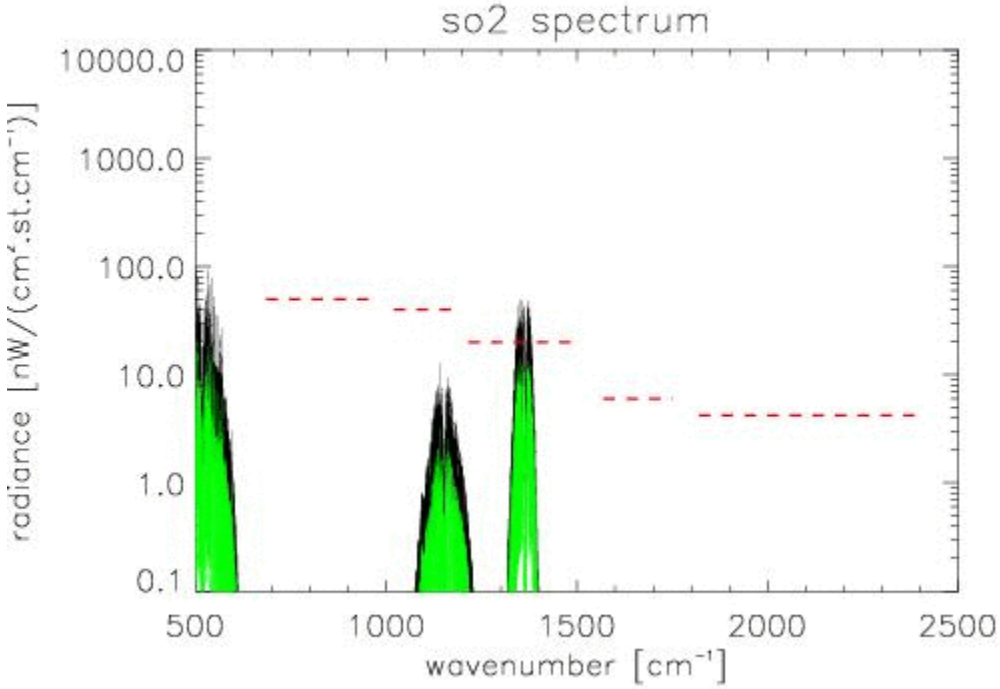
- Seek trace species of scientific interest and importance within MIPAS bands.
- One considered species was SO_2
- Sources (**variable**)–
  - Currently ~80% Anthropogenic
  - Remainder mainly vulcanism
  - Total about 100Tg/year
  - depends on volcanic activity
- VMR 10^{-4}-10^{-5} ppmv.
- No routine information on profiles available



Assess Feasibility

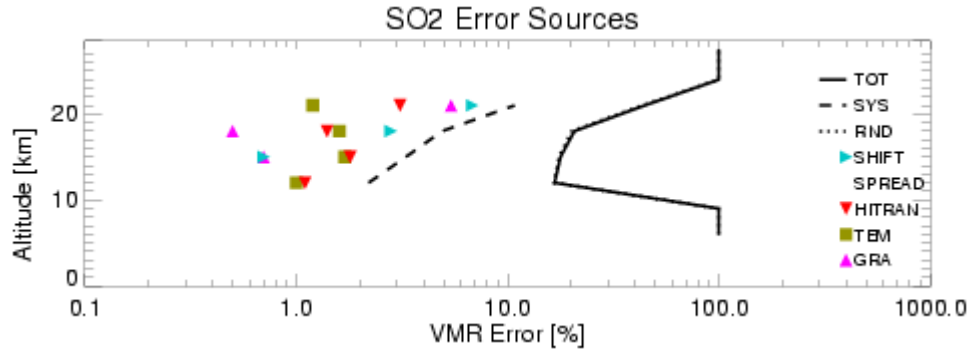
Investigate spectroscopy

- Where SO_2 radiance > NESR
- SO_2 region: 1350cm^{-1} - 1375cm^{-1}
- MIPAS, band **B**:1190cm^{-1} - 1540cm^{-1}



Investigate error contributions

- Random
- Systematic, such as
  - Spectroscopic uncertainty
  - Retrieved temperature error
  - ILS …
- Likely interfering species
  - H_2O -> lines in same region



Retrieval – Optimal Estimation

To take a first look

- Assess quality of spectra
  - Cloud contamination? – Cloud thresholds. Many fail the test.
- Retrieve appropriate PT and H_2O profiles for the region
  - The Oxford retrieval tool, OPTIMO, uses optimal estimation method to retrieve profiles.
- Check profiles for quality
  - Chi^2 convergence values
  - Retrieved random error
- Retrieve SO_2 profile, using the retrieved PT and H_2O profiles.
- Check the retrieval diagnostics of this profile for quality

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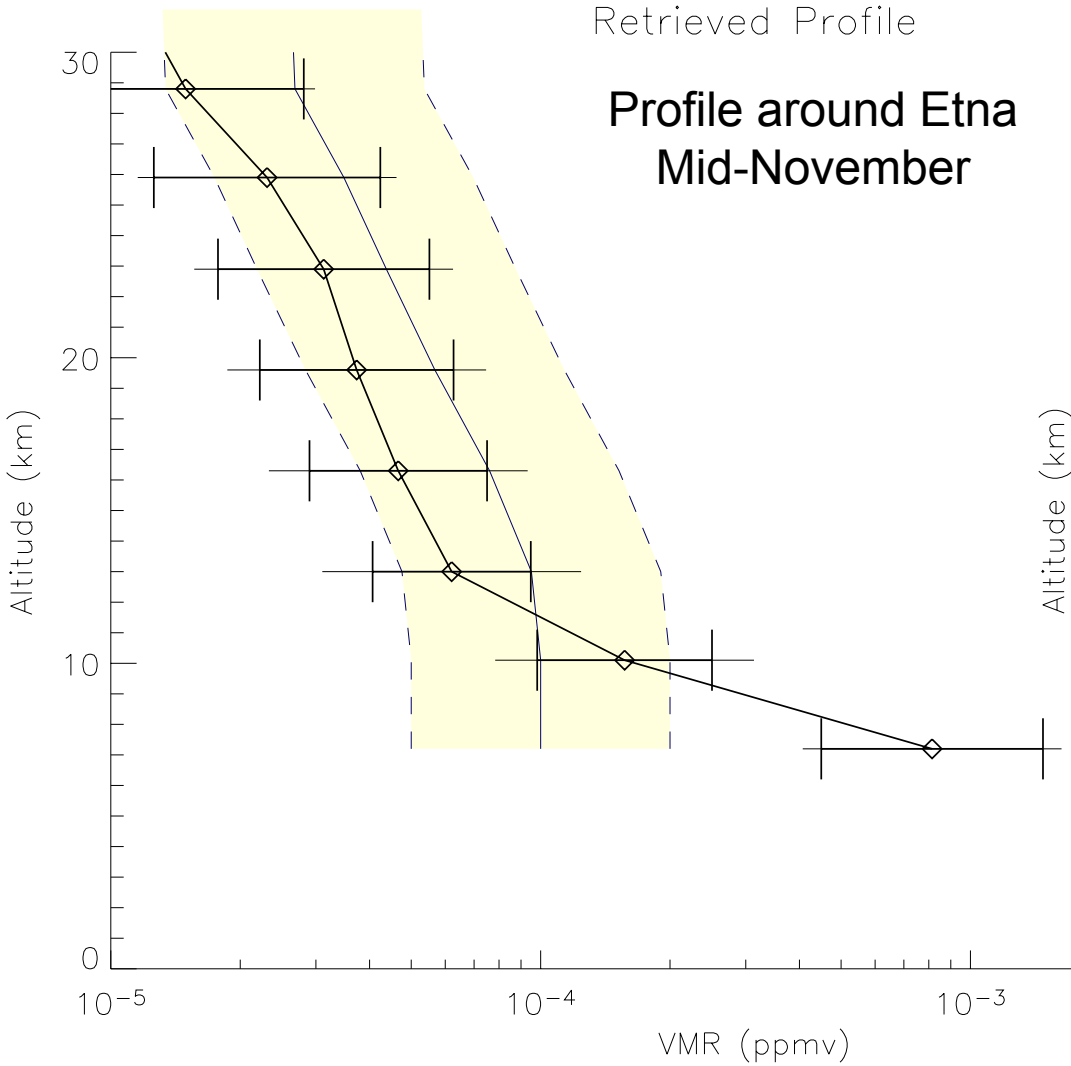
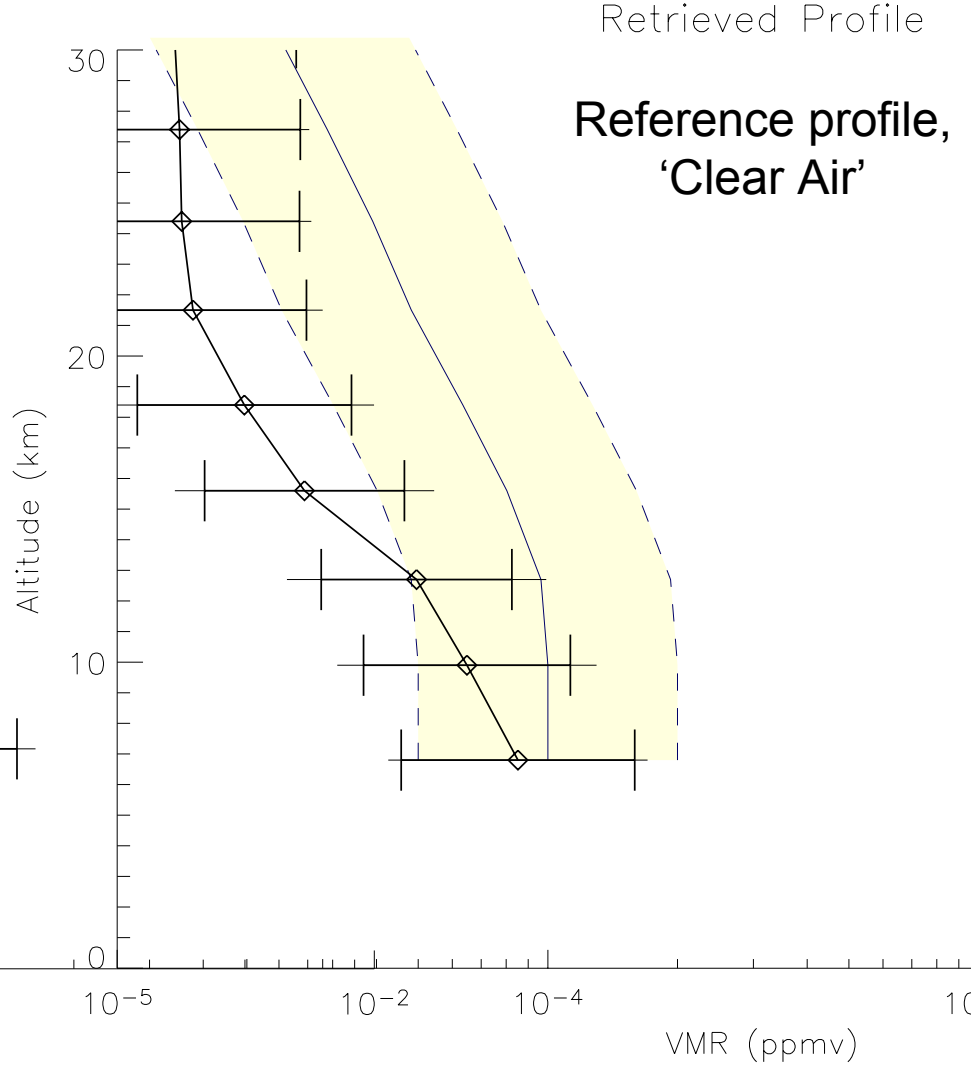
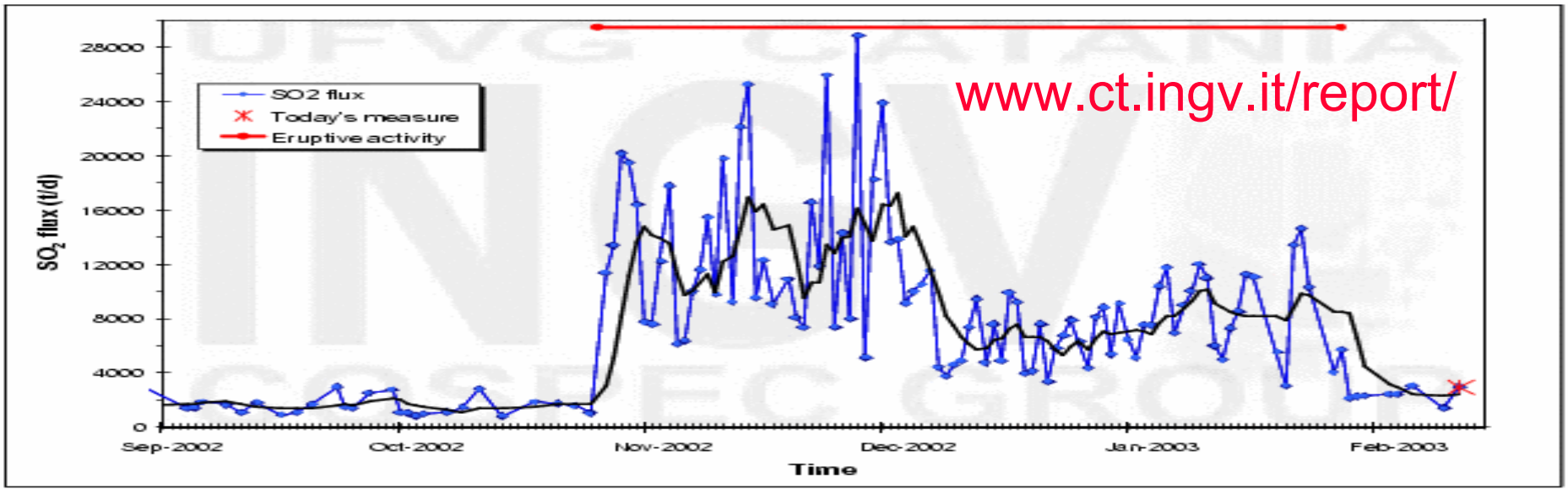
SO2, over ETNA, November 2002



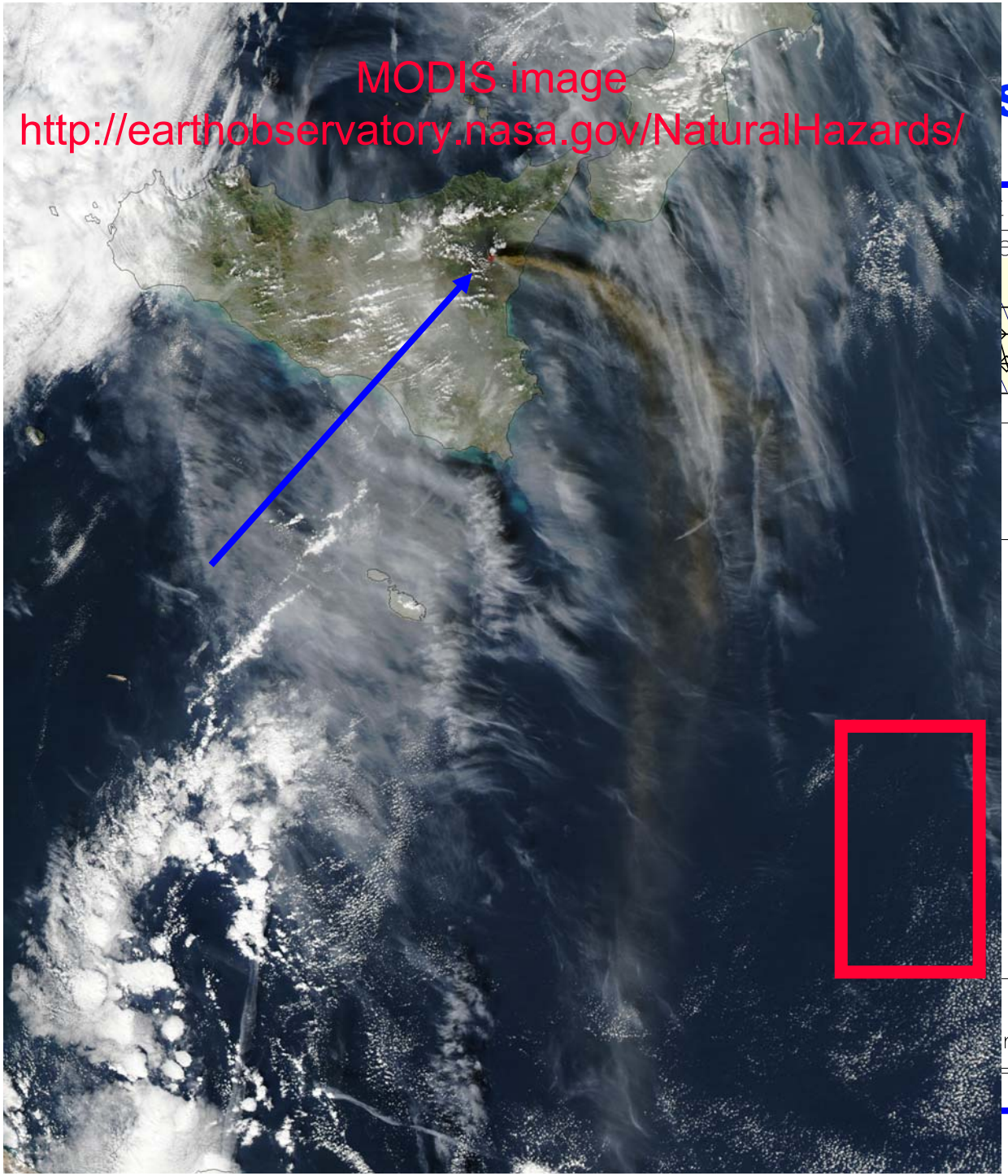


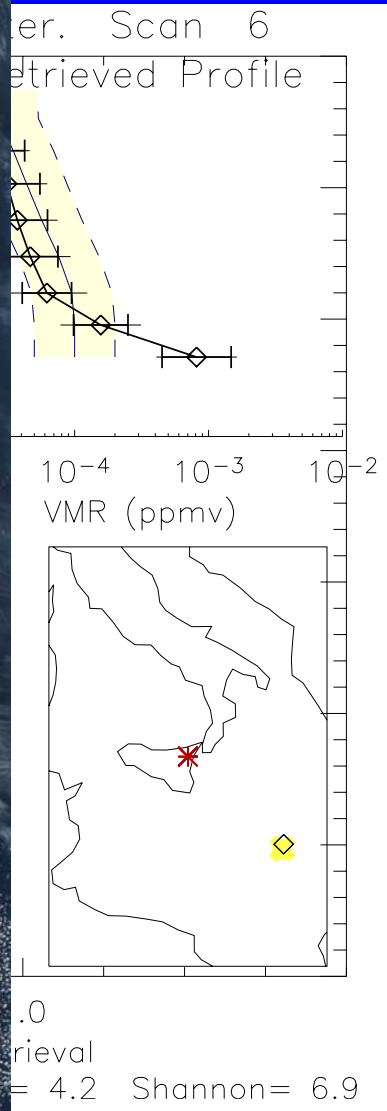
Comparison with other data

- The SO_2 flux has been measured (below) [by INGV].
- Look at retrieval diagnostics
- Compare trends for this Etna region against a 'null' region.
- What mass of SO_2 is in the MIPAS view volume? Is this consistent with the eruption?
  - 1ppb~0.2DU in 3km layer. 30x300x3km^3 view @ 0.2DU gives ~50 t of SO_2 in view volume. Mean November Measured Flux was 500-1000t/hour



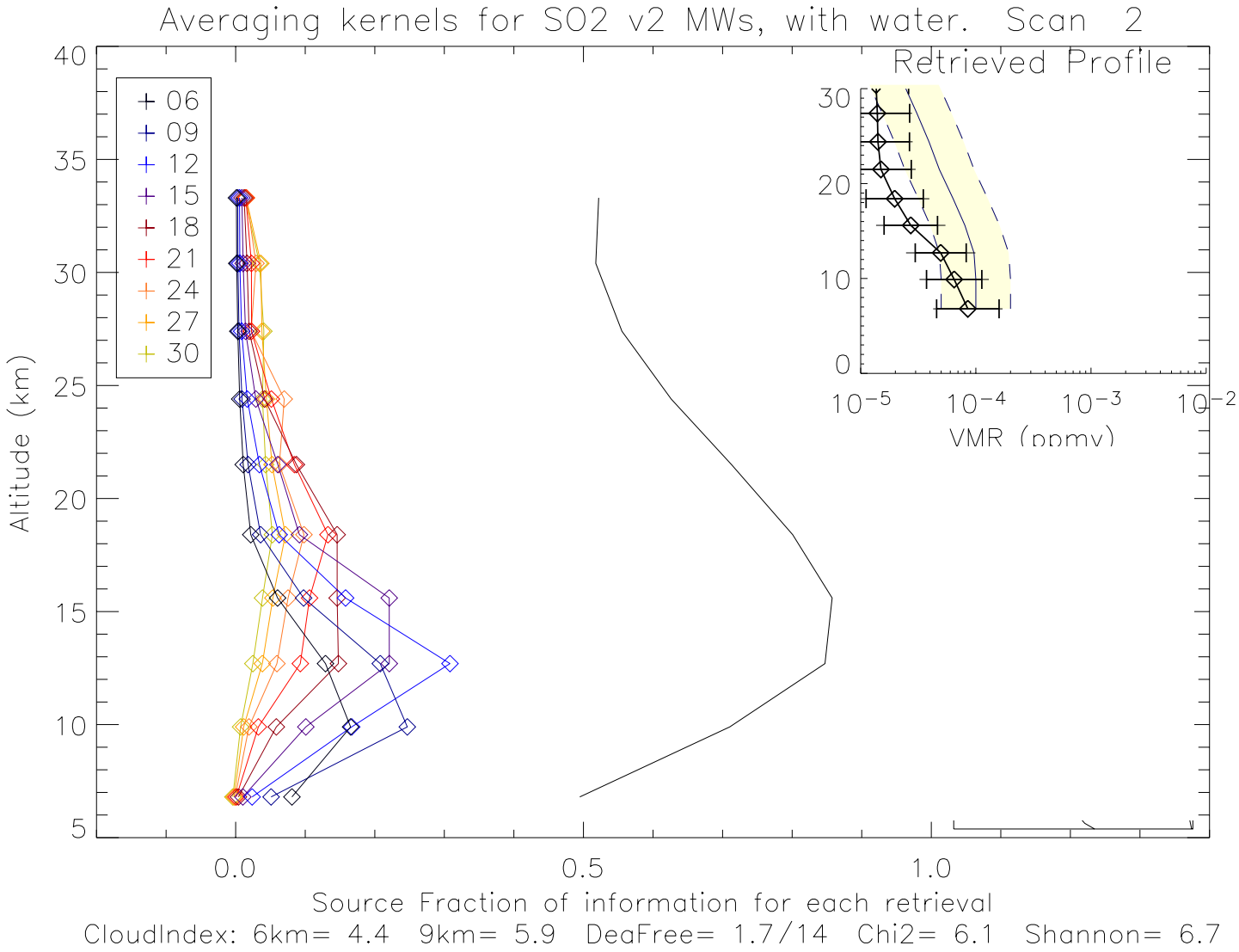
s – Etna (Nov 2002)





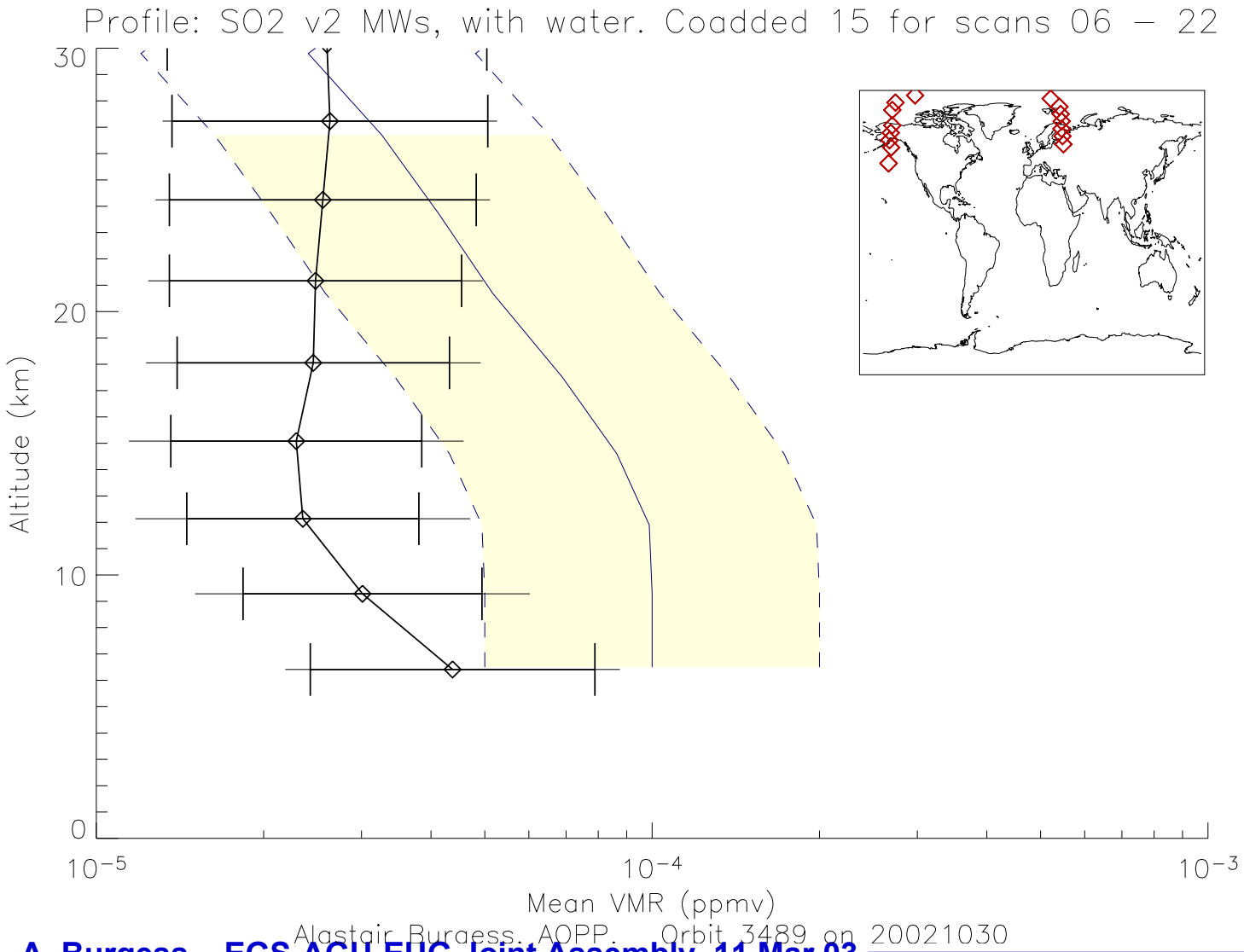
- What is the *A priori* contribution to our retrieved value?
- Investigate averaging kernels, **A**, a function of the retrieval covariance matrix, **Ŝ**

Diagnostics – 'Clear Air' (Oct '02)



- This profile shown earlier
- Located at eastern edge of Mediterranean
- Expect anthropogenic background only

Mean Profiles (Oct '02)



- Cloud-Free scans selected within one orbit.
- Away from anthropogenic sources

Conclusions

- Reliability determined from retrieval diagnostics
- Cloud has significant negative effect on retrievals
- Accurate water very important
  - Investigate cross-correlations and consider joint retrievals
- Lacking correlative data:
  - Only a few MIPAS files of the region available during November, which saw maximum SO_2 flux.
  - Search for other volcanoes / sources with good MIPAS coverage.
- Initial indications favourable, but more work required –
  - Above 12km, retrieval essentially stable.
    - But only adds (up to) 30% to prior knowledge
    - Retrieved profiles consistently less than *a priori* (climatology).
  - SO_2 appears retrievable <15km, for clear skies
    - Expect improved accuracy for larger eruption / SO_2 loading…especially into the stratosphere.

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