



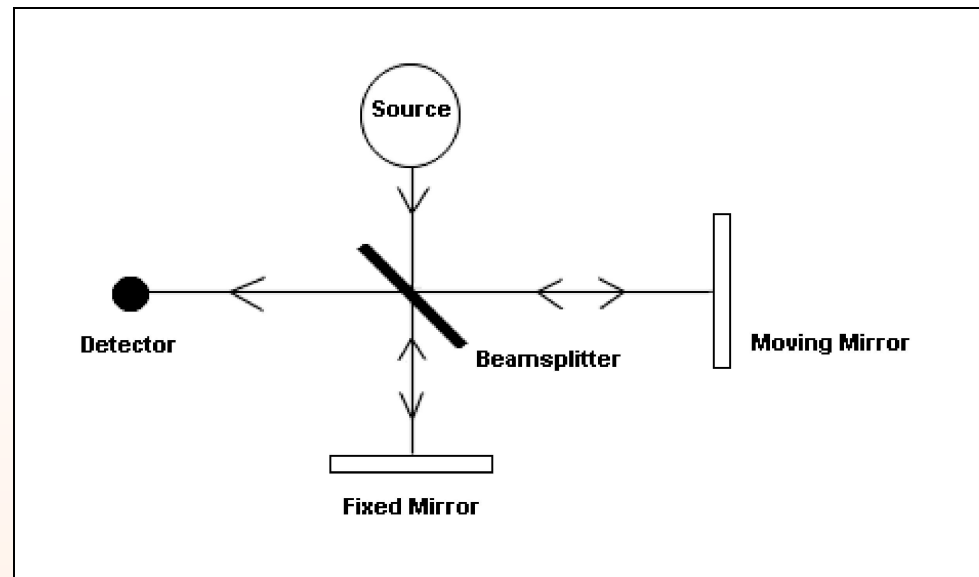
Comparisons of in situ HIPPO minor gas measurements with ground-based MIR spectroscopically retrieved VMR profiles

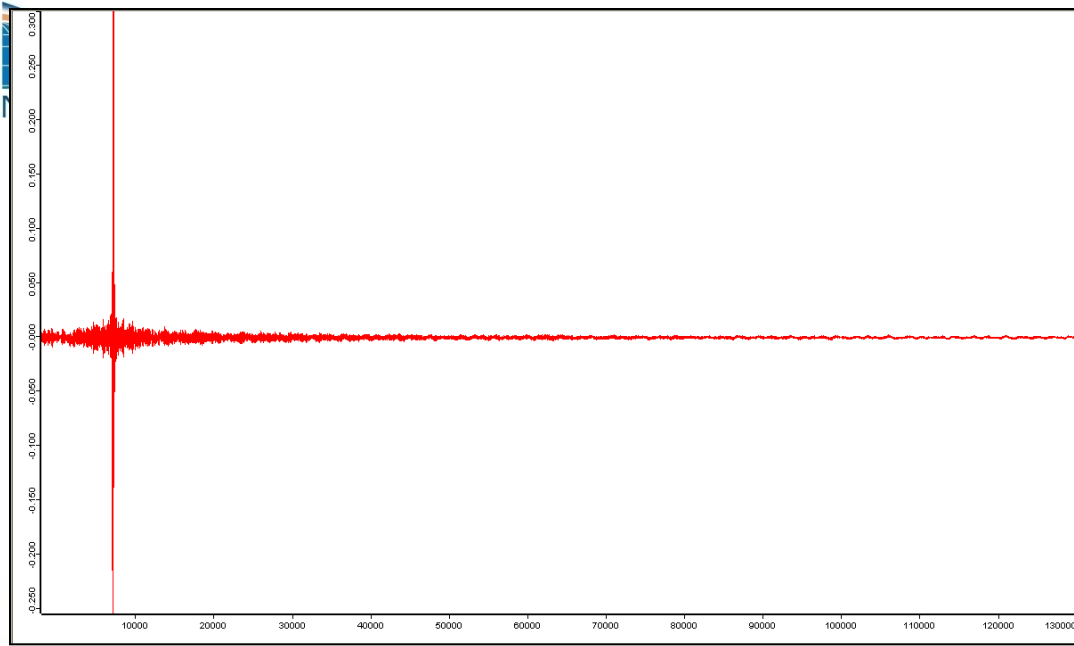
Rebecca Batchelor¹, Jim Hannigan¹,
Mike Coffey¹, Akiko Kagawa² and Yasko
Kasai²

1.NCAR, Boulder 2.NICT, Japan

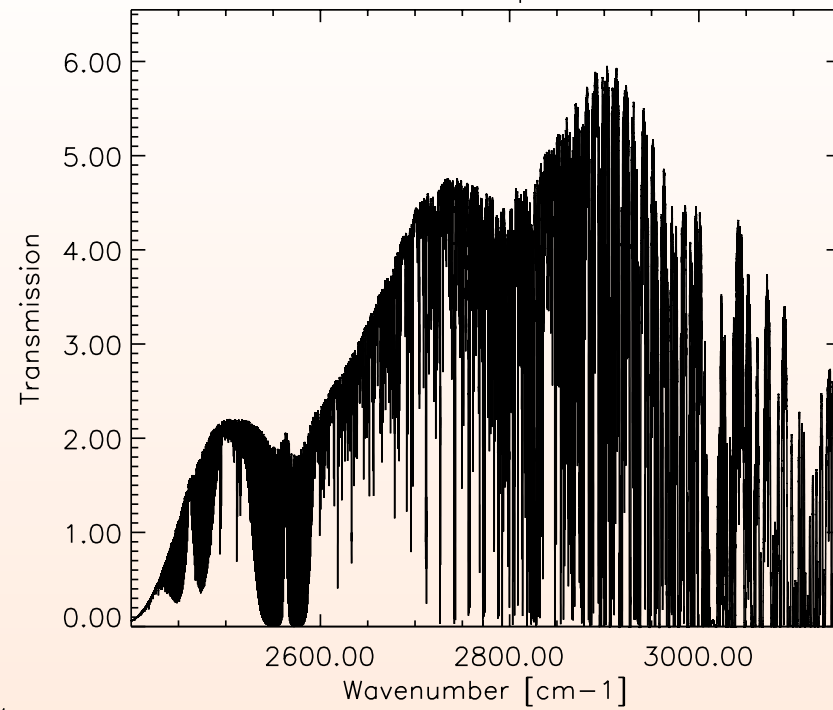
NCAR is sponsored by the National Science Foundation

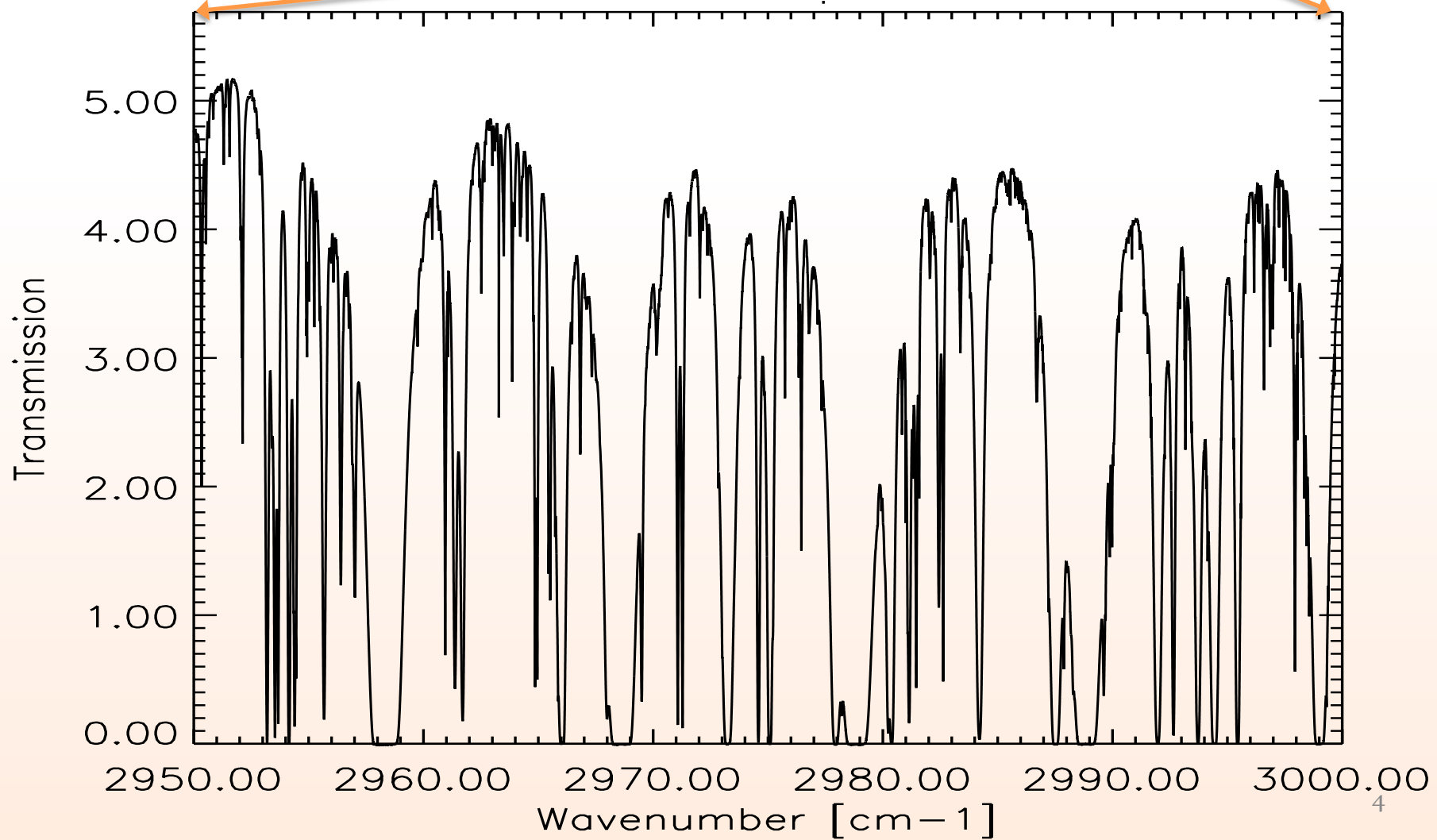
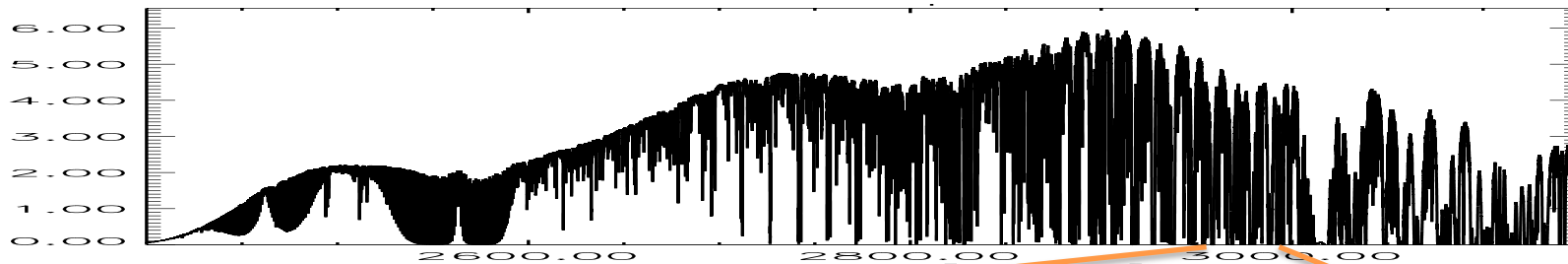
A very brief intro to FTIR spectroscopy

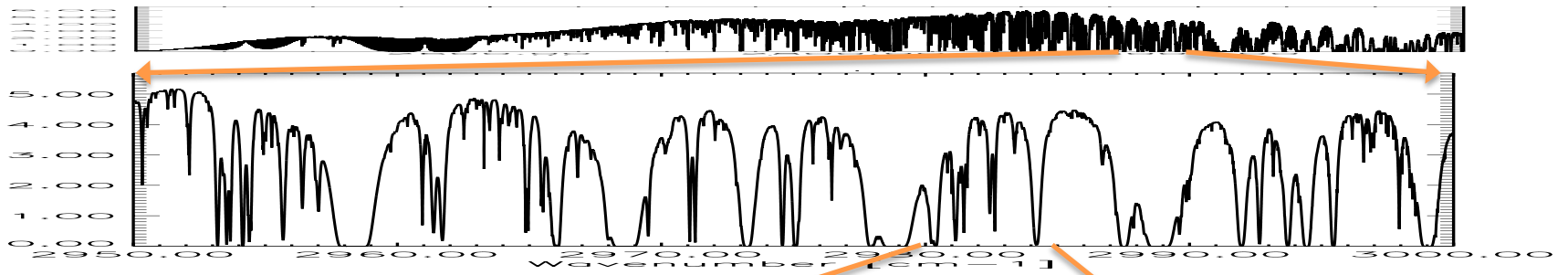




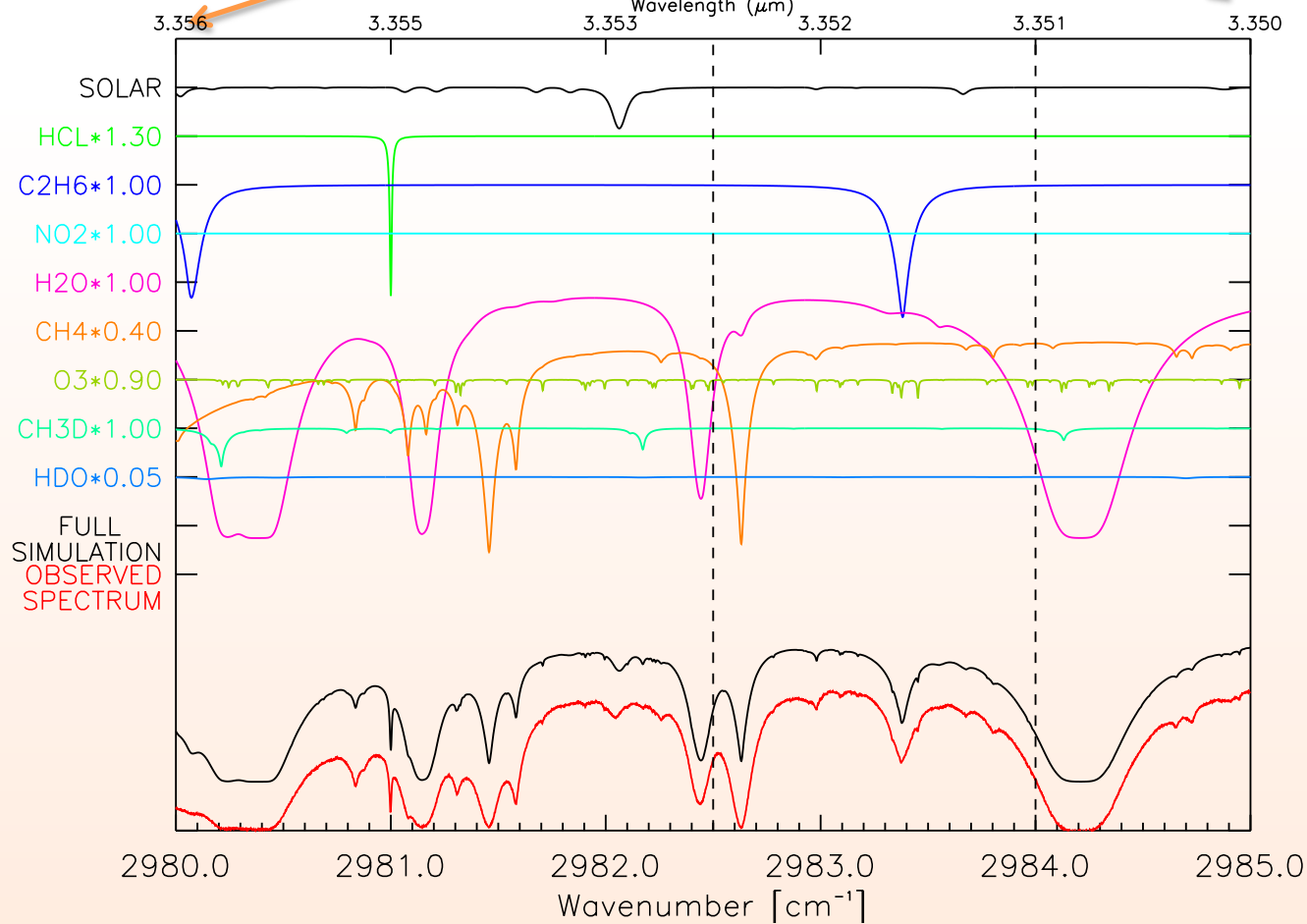
Fourier
transform







Simulation for NCAR/NDACC FTS Thule, GR
03/16/2004 20:28:53UT Z:83.913 A:56.834 D:615.63 R:0.0035 P:BX F:2.9545m



The retrieval

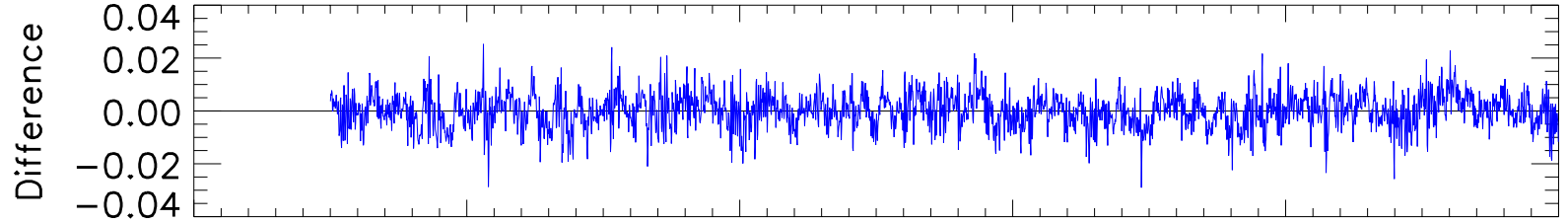
We determine the ‘best’ mixing ratio profile to fit the data in an iterative way (optimal estimation) using:

- the spectrum
- our knowledge of the noise in the spectrum
- an ‘a priori’ profile (in this case, from WACCM)
- an estimate of the uncertainty/correlation in the a priori
- knowledge of line parameters, the instrument line shape, interfering species and solar effects

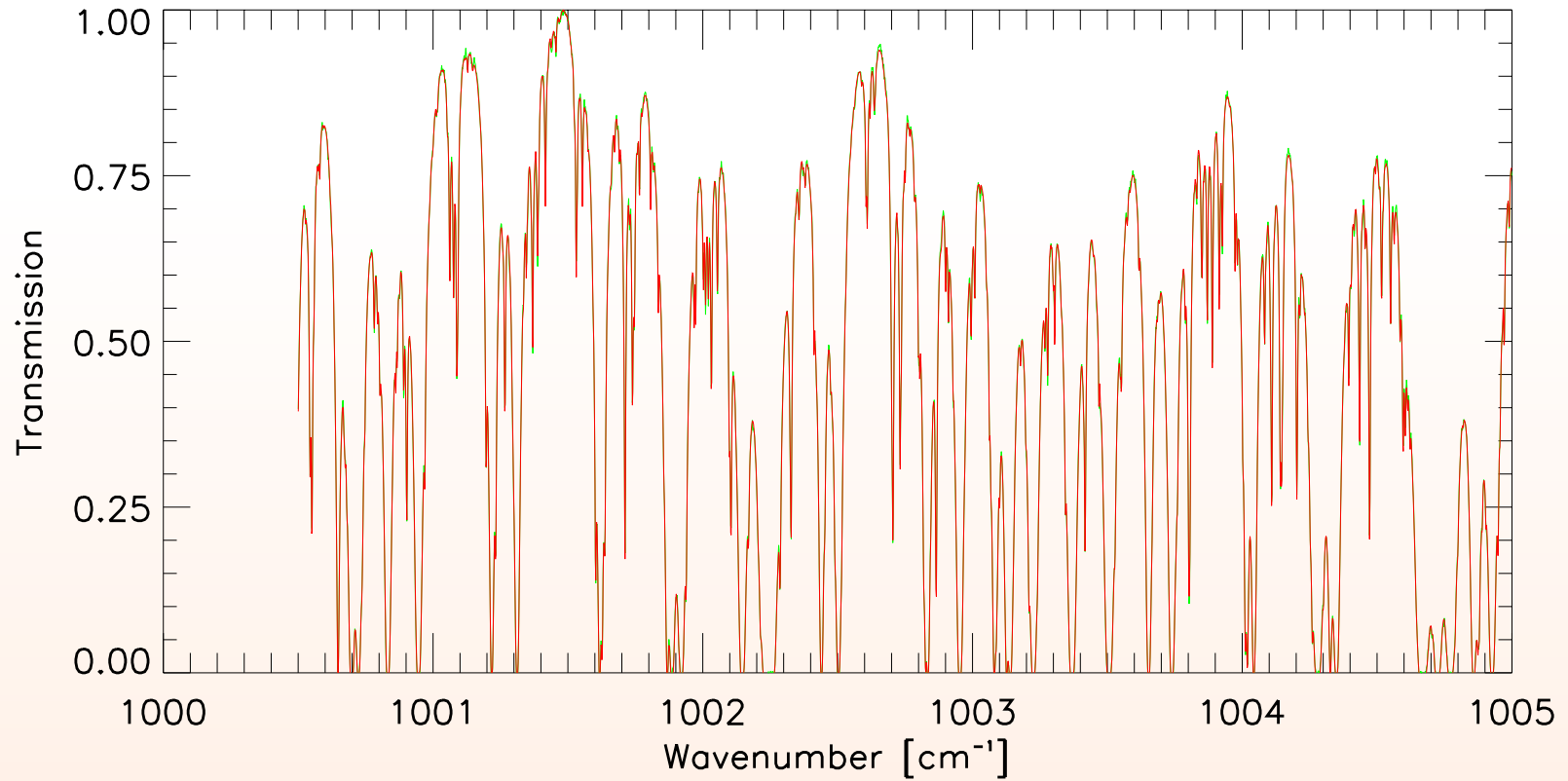
There are multiple factors in the retrieval, as there are many solutions to the retrieval problem. We continually work on improving our retrievals to give us the best profiles.



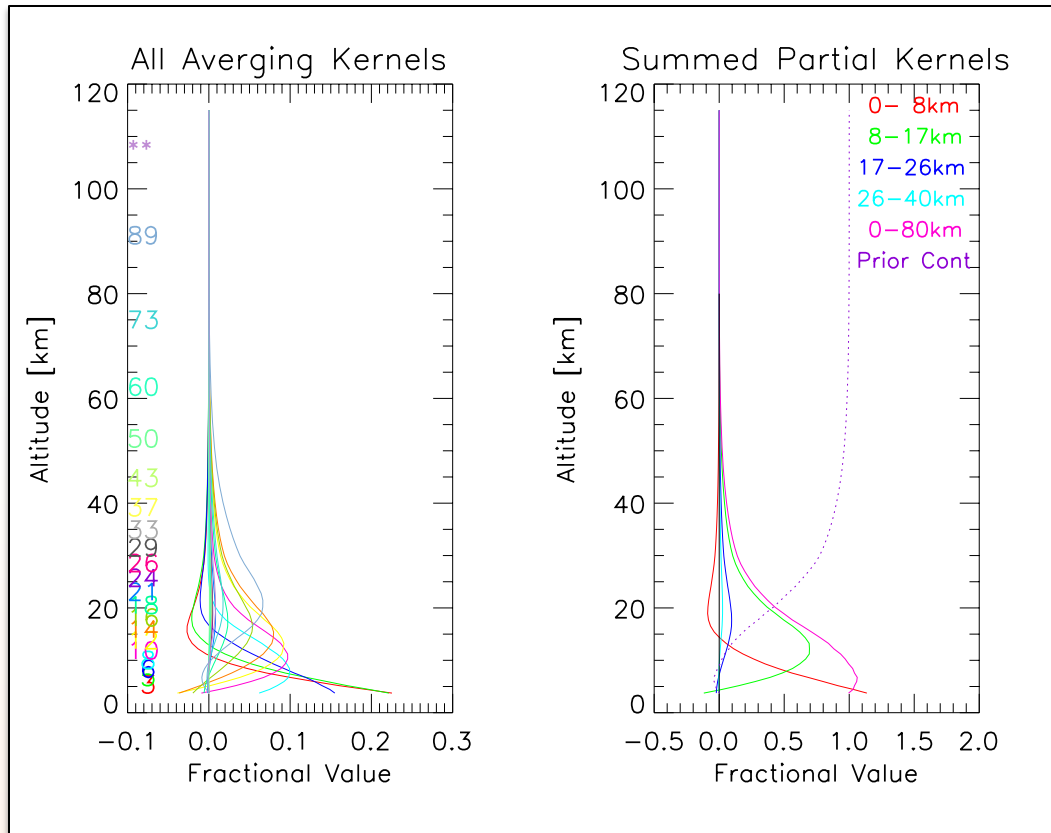
NCAR FTS, GR Retrieval : O₃



Observed Calculated Difference



O₃ Spectral Fit



CO retrieval at Mauna Loa ~ 2 DOFS

The Mauna Loa mid IR data set goes back to 1995, giving excellent climatological information about a number of species.

Altitude Resolution Depends on:

- ✓ *Vertical profile*
- ✓ *Spectroscopy*
- ✓ *Interfering species*
- ✓ *Spectral Resolution & SNR*
- ✓ *Solar zenith angle*

Typical data products are column or partial column measurements. Recently we've been investigating the quality of our retrieved profiles, which are to be archived in the NDACC database.

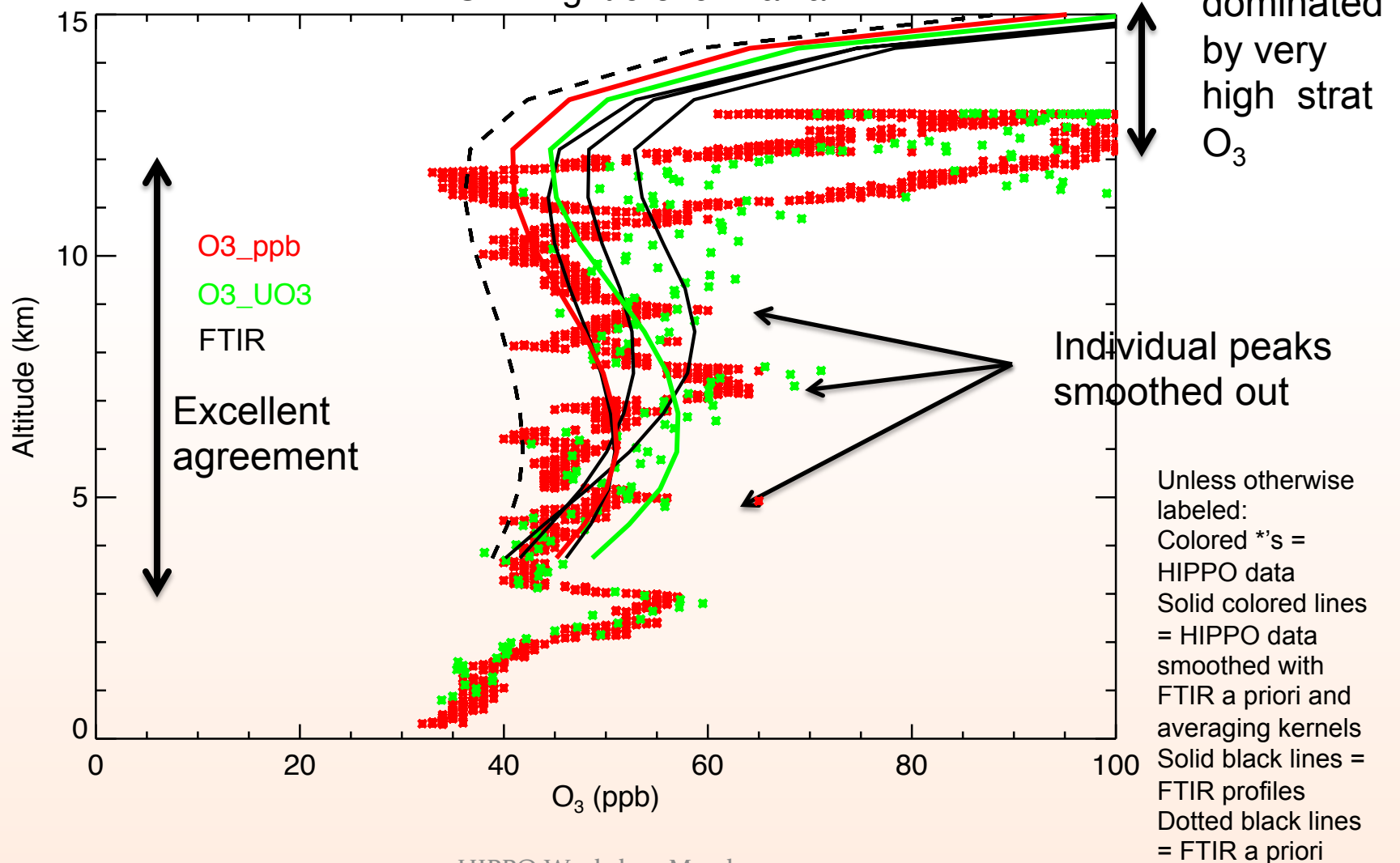


Comparisons over Hawaii

- Coincident measurements at Mauna Loa were available for flights 3 (11/04/09), 8 (11/16/09) and 9 (11/19/09)
- Multiple spectra were recorded on each of these days
- HIPPO measurements within 5° lat/lon (a box approximately 1000 km square) were compared with those taken at Mauna Loa
- HIPPO_2_merge_20110219.tbl merge file has been used for these comparisons

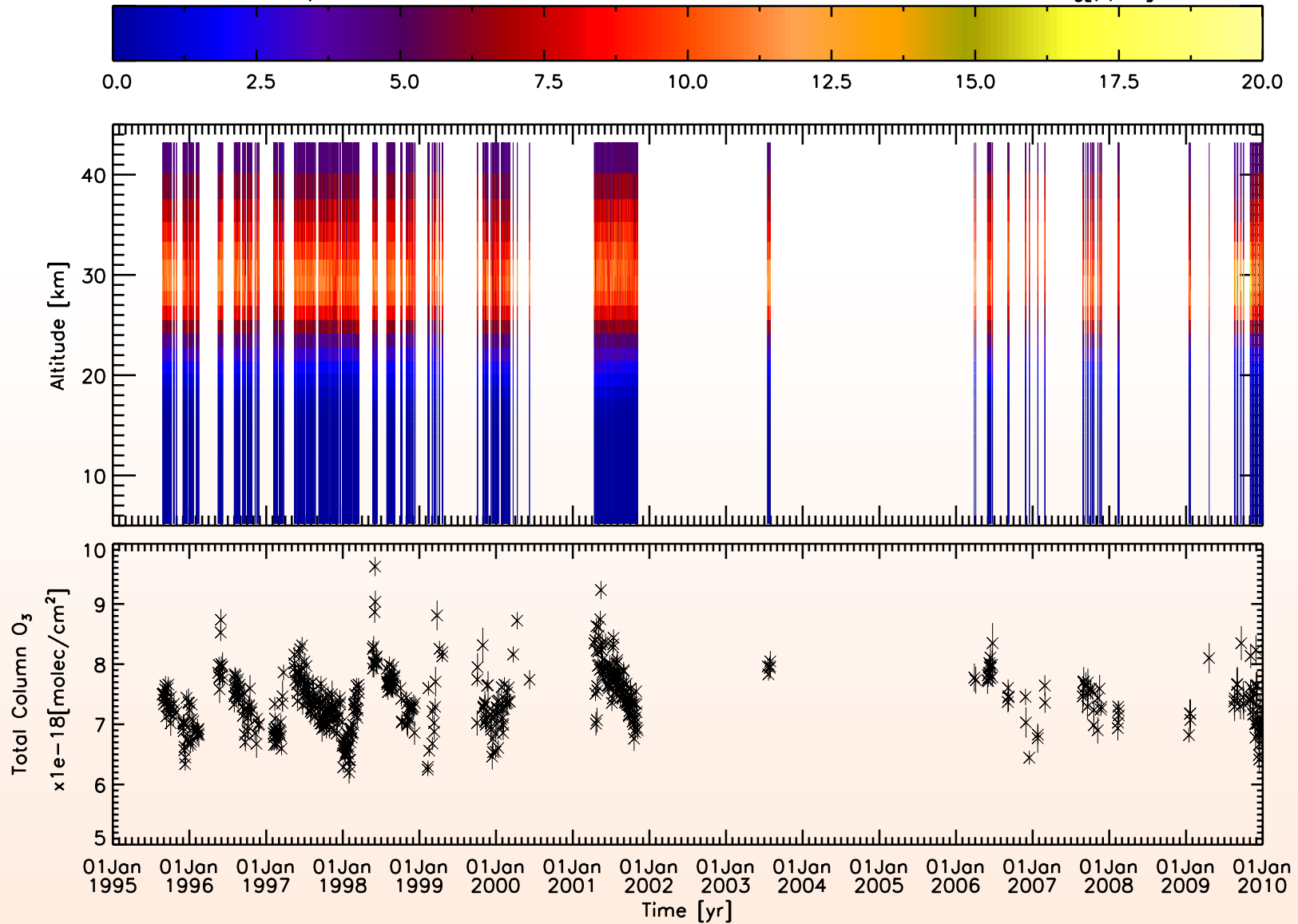
O₃

HIPPO-2 Flight 9 over Hawaii



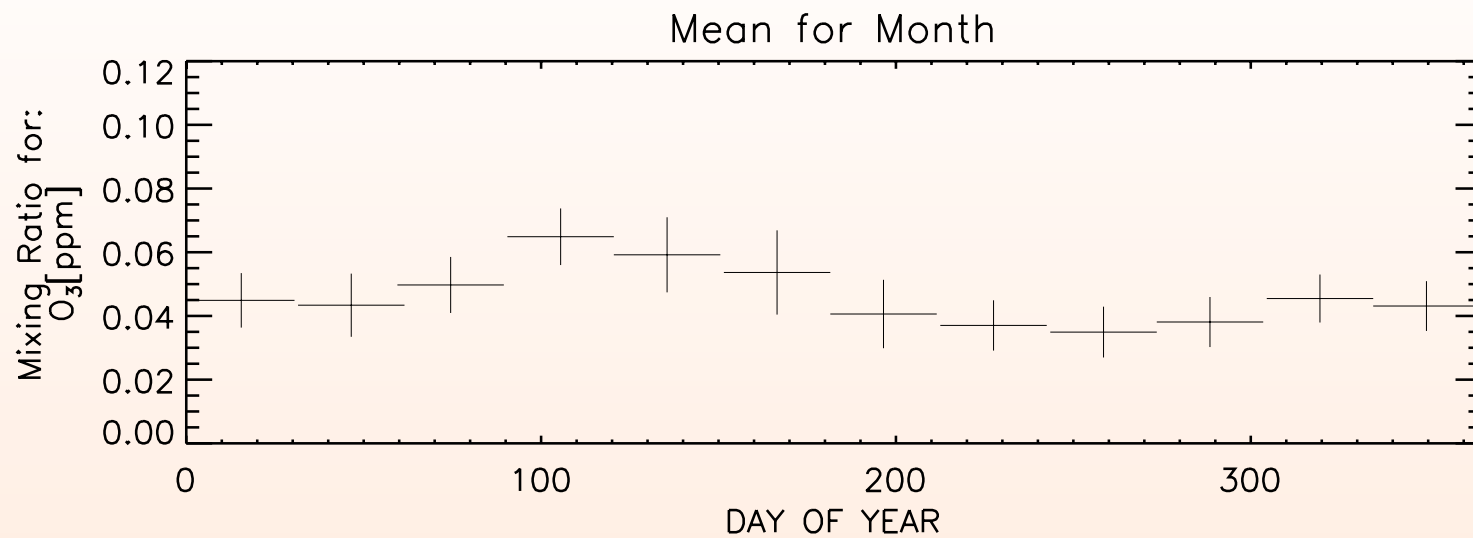
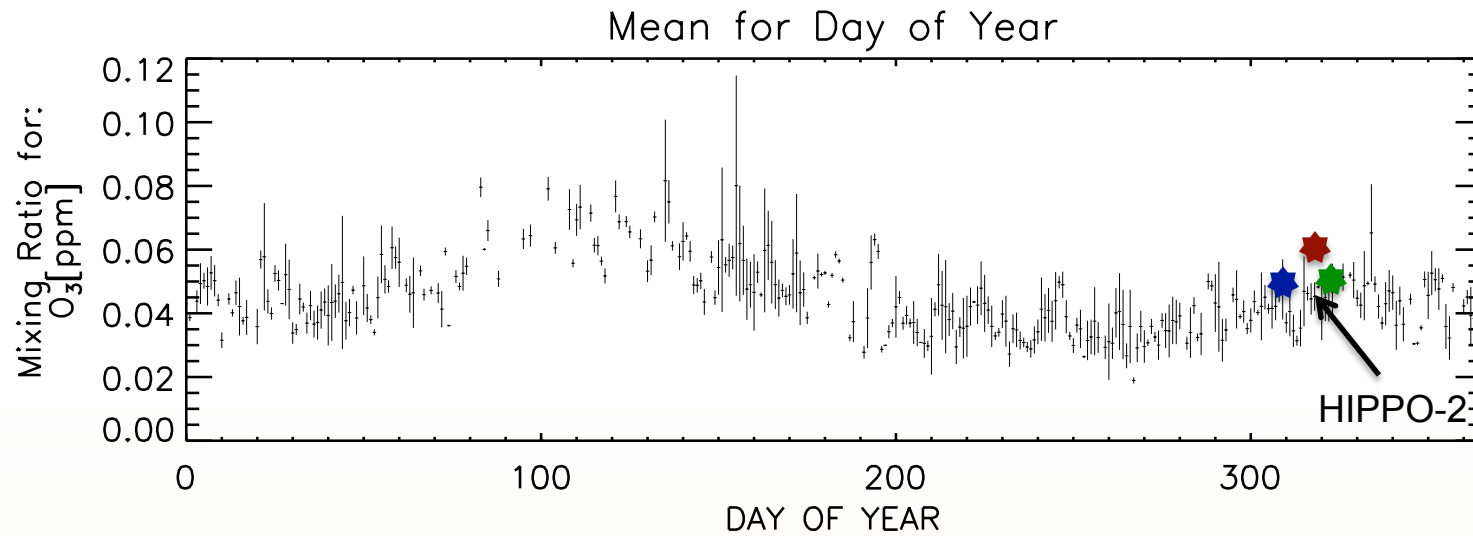
HIPPO-2 O₃ in context

NDACC / NCAR MLO, FTS Total Column & Profile Retrieval Trends for O₃[ppm]



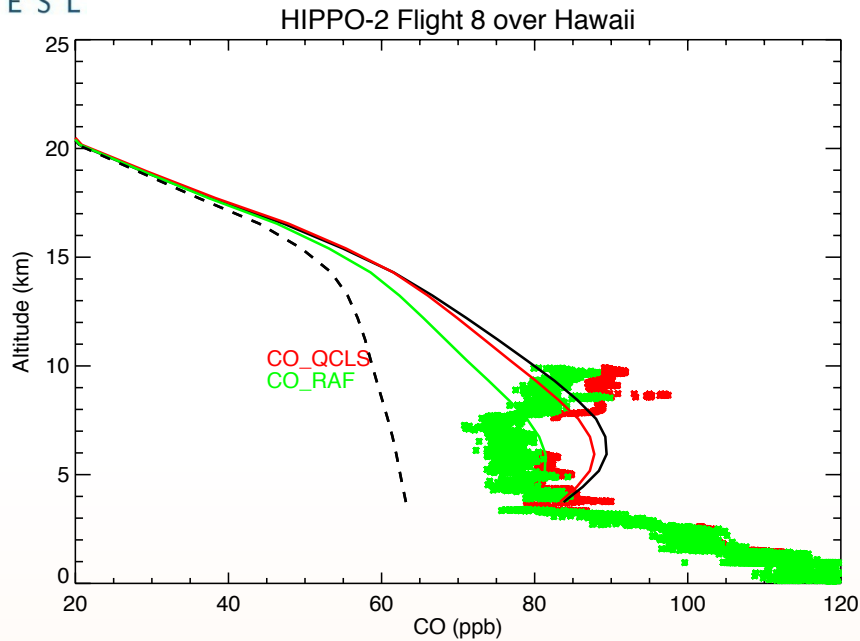


Climatology – mean tropospheric VMR



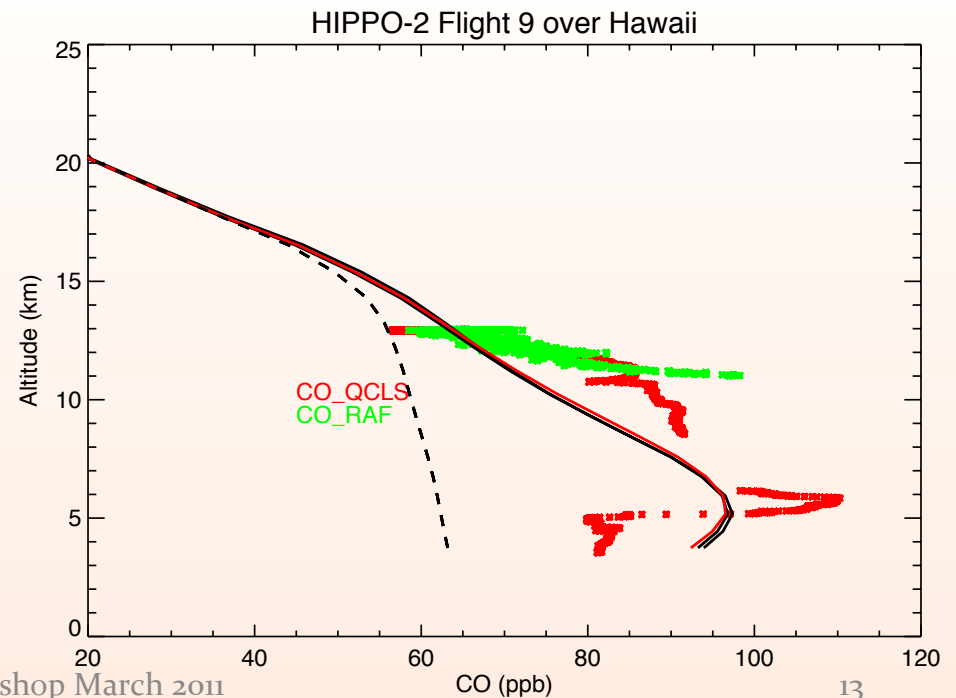


CO

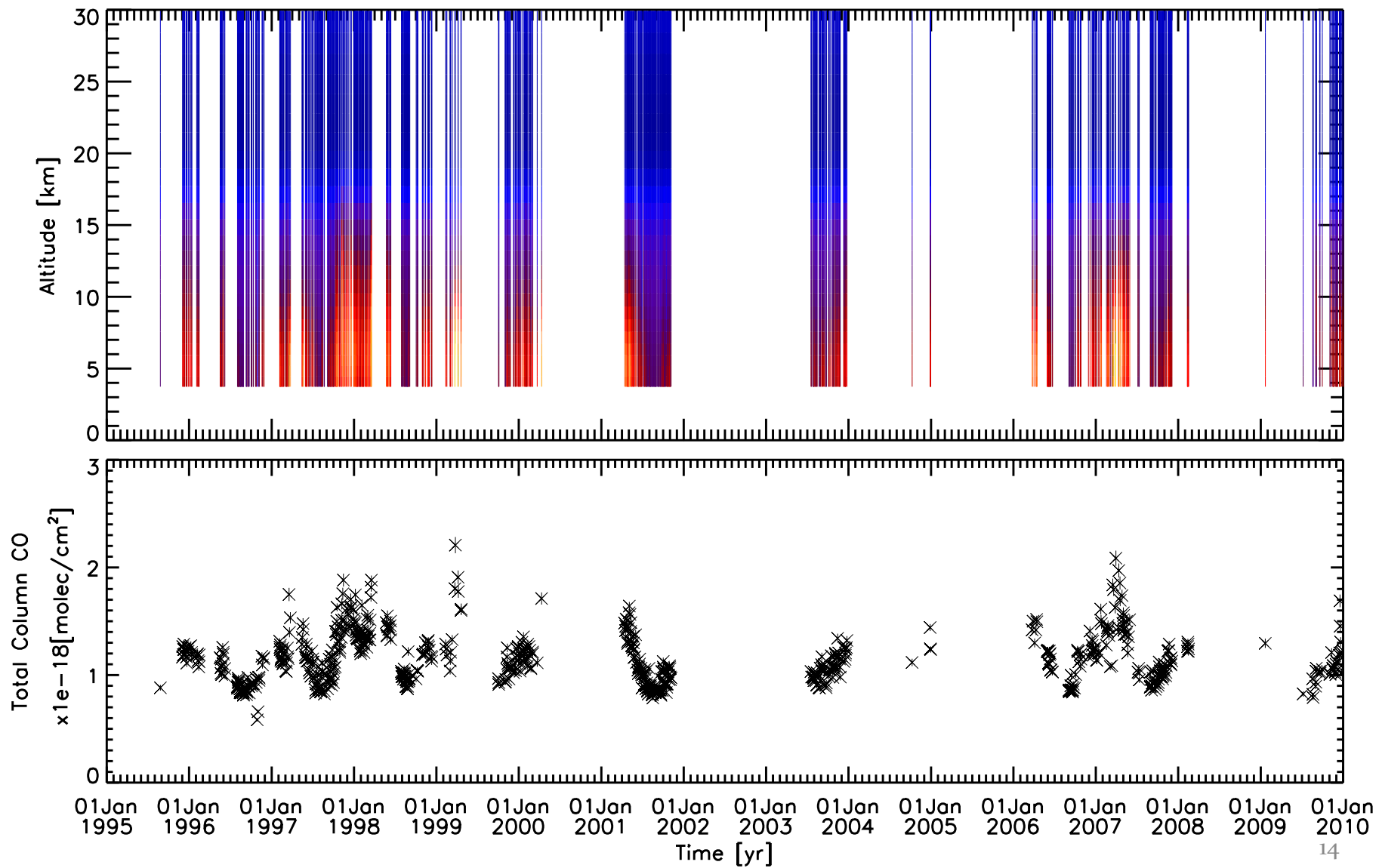
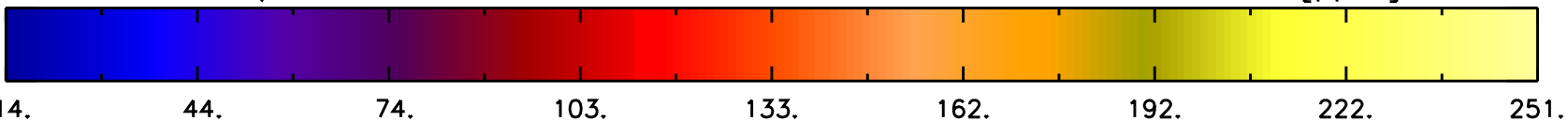


There is not as much information in the CO FTIR measurements as for O₃, but the retrieval moves to the correct amount and identifies the enhancements.

Smoothing the aircraft data is complicated by how best to handle regions above/below the aircraft measurements.

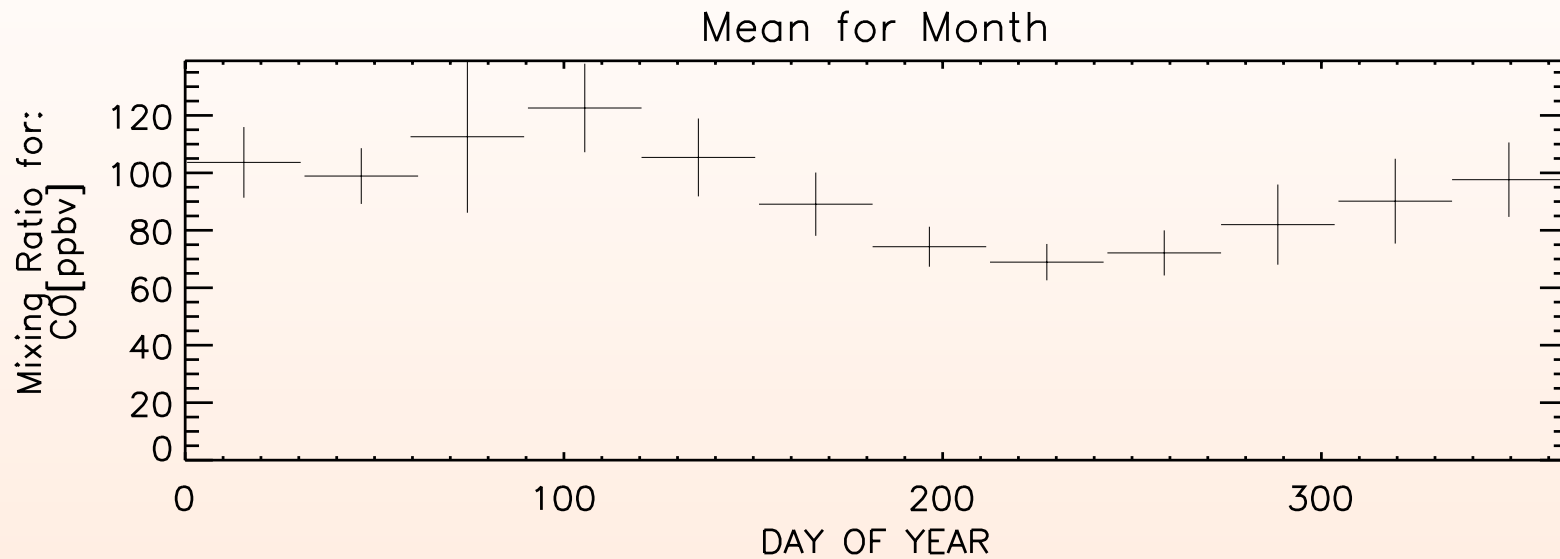
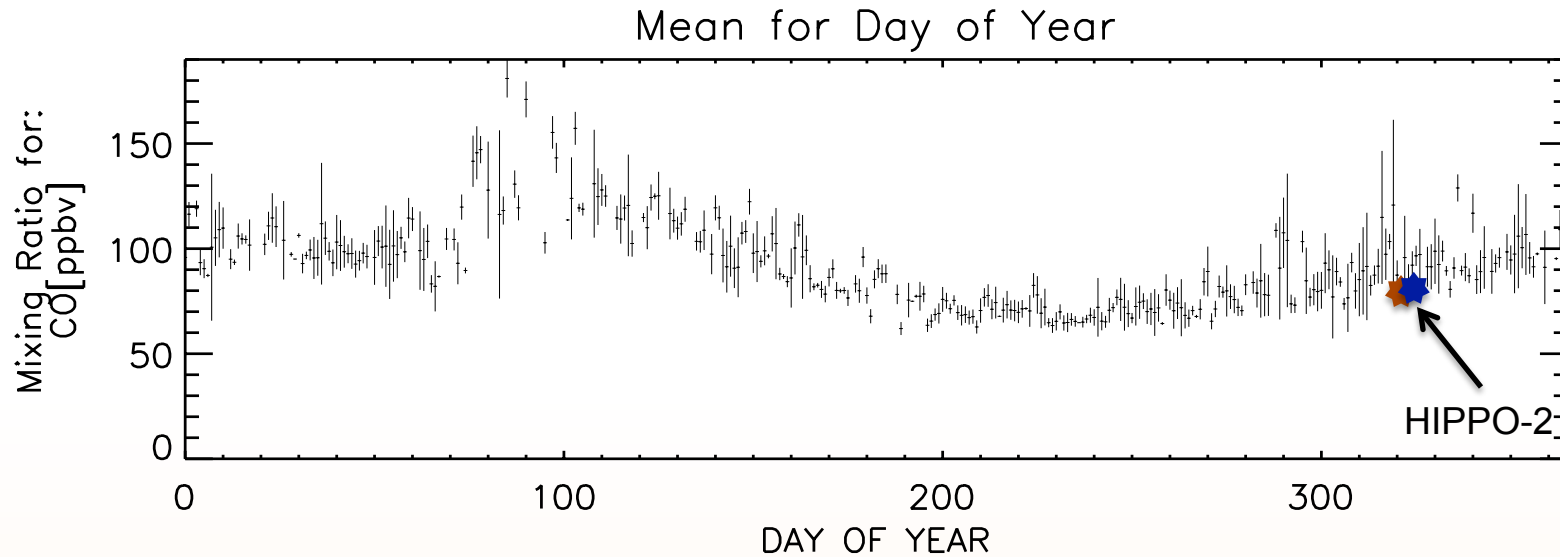


NDACC / NCAR MLO, FTS Total Column & Profile Retrieval Trends for CO[ppbv]





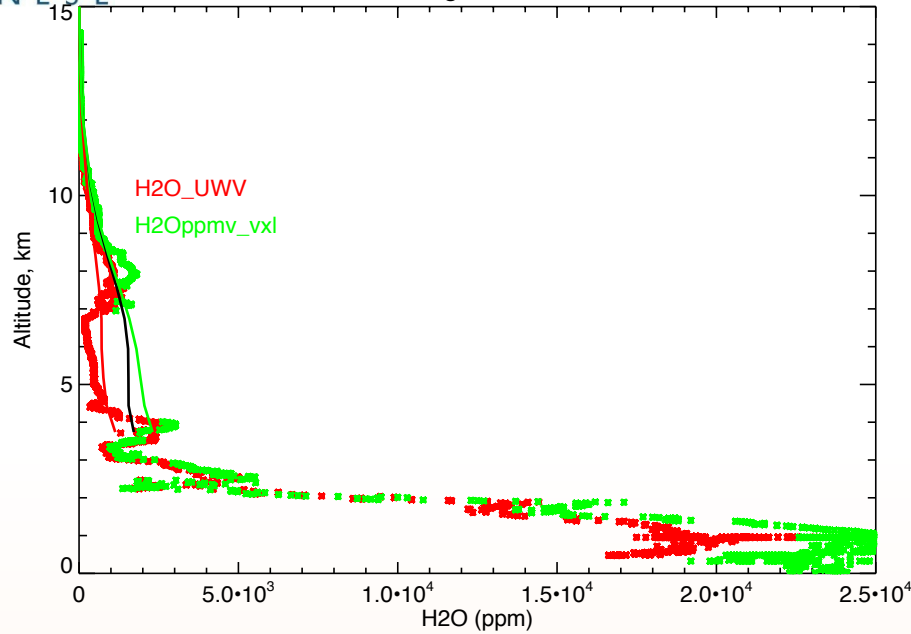
Climatology – mean tropospheric VMR



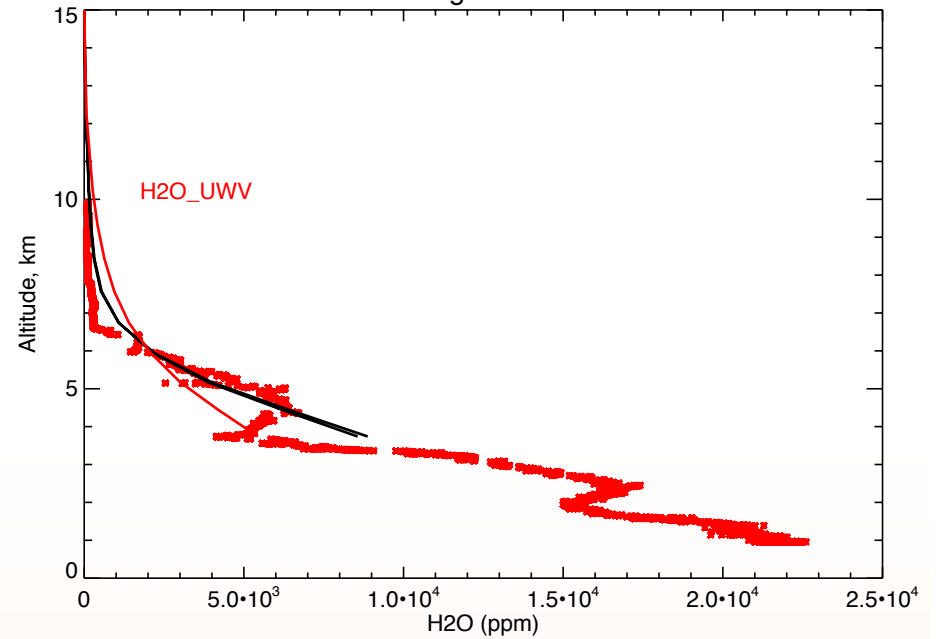


H₂O

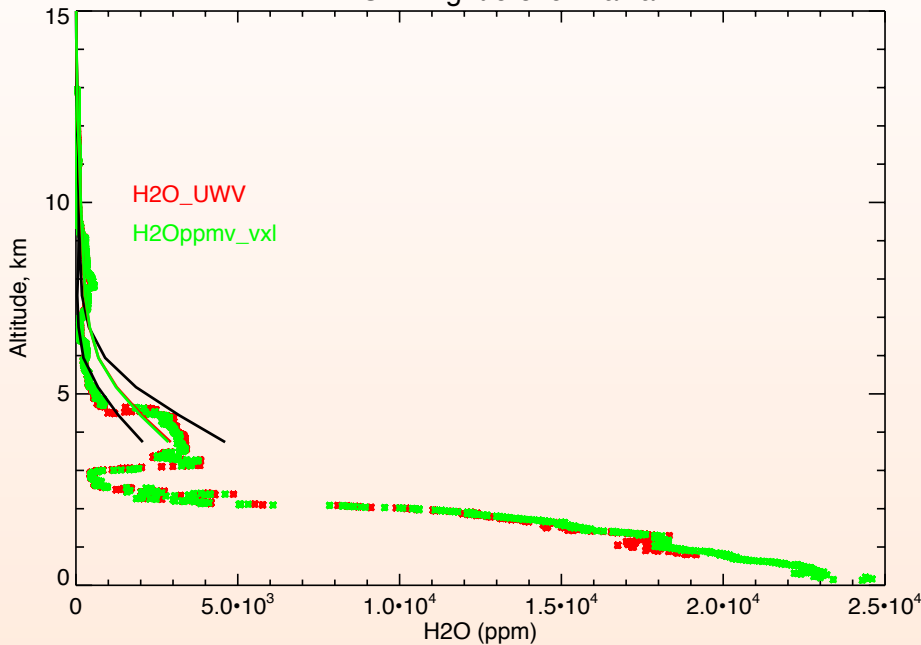
HIPPO-2 Flight 3 over Hawaii



HIPPO-2 Flight 8 over Hawaii

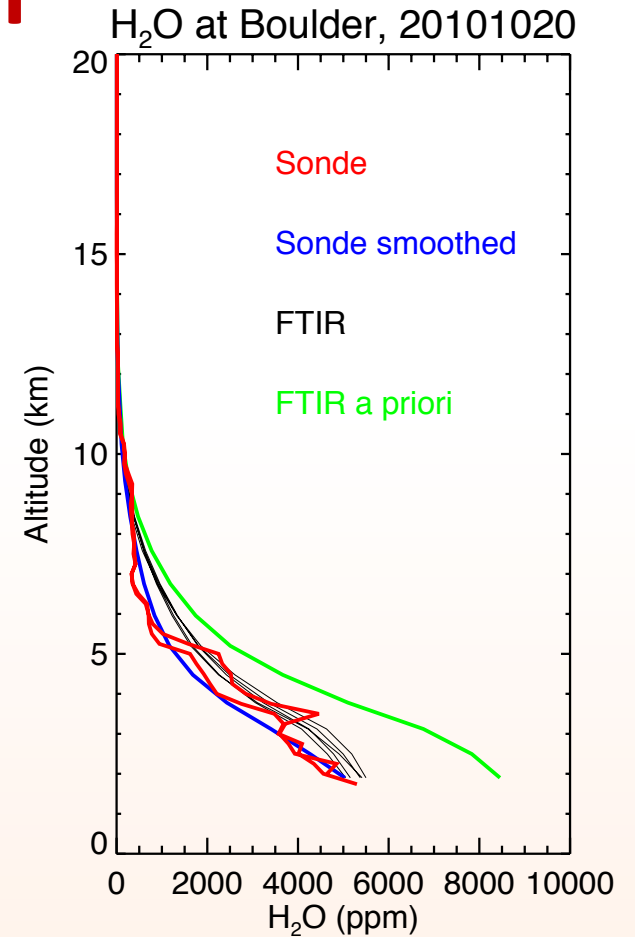
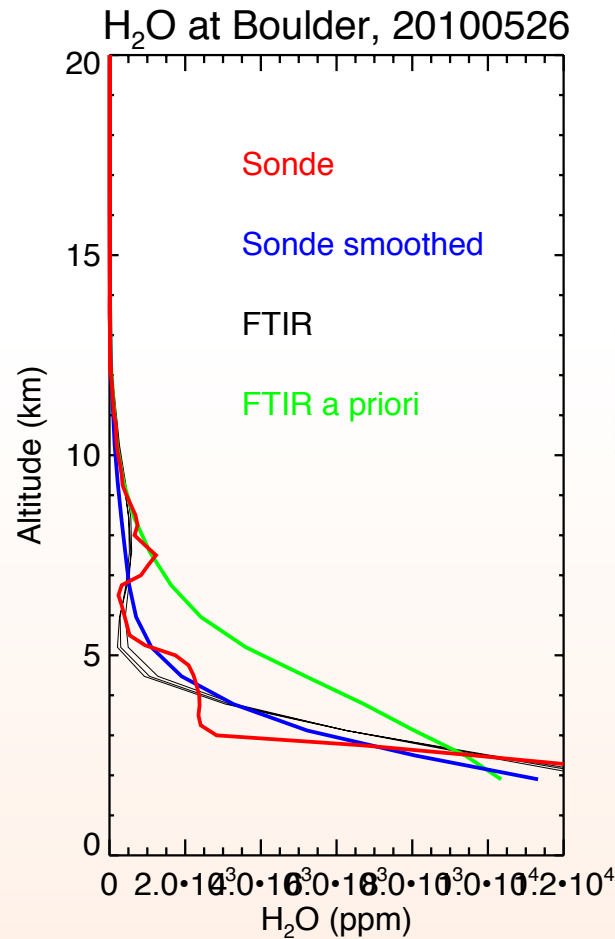
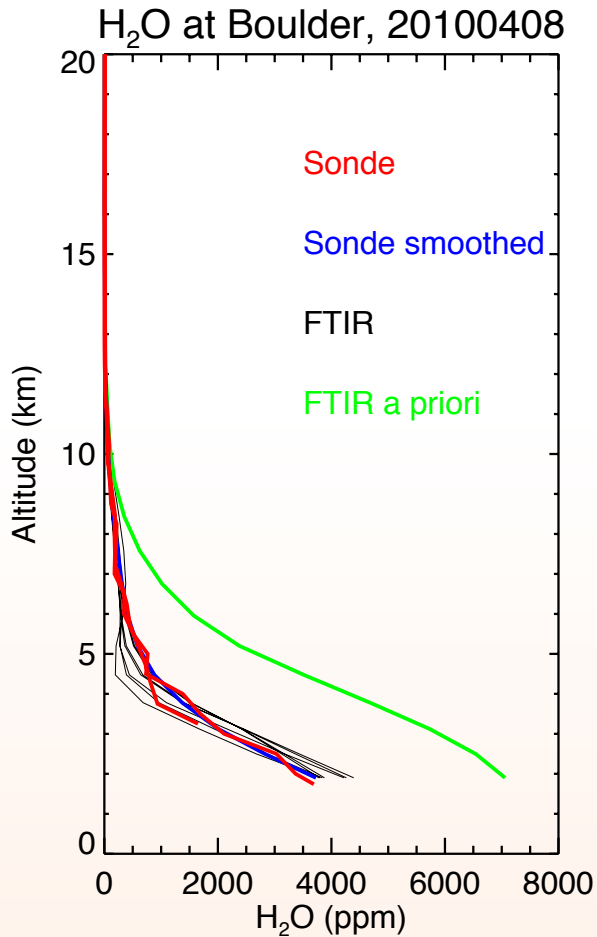


HIPPO-2 Flight 9 over Hawaii



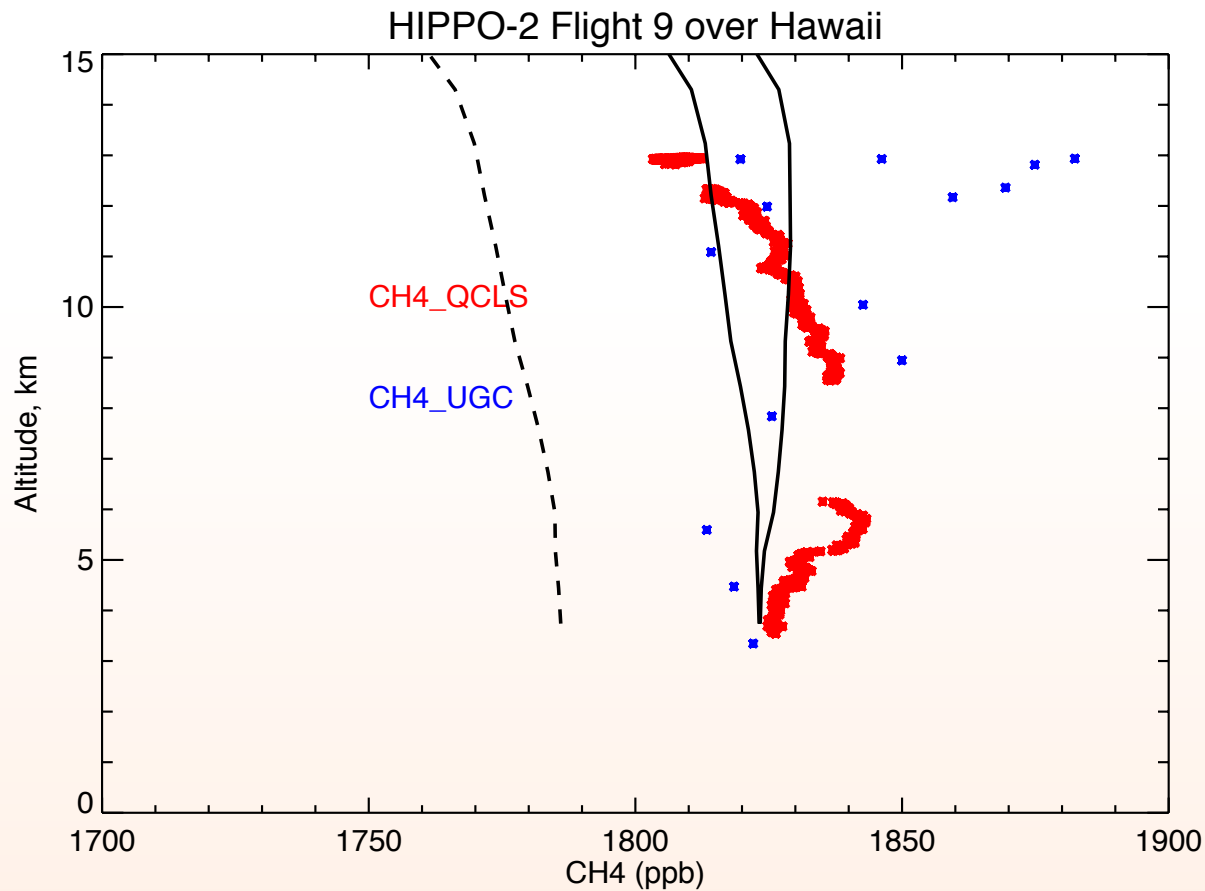
While FTIR can't resolve the small scale features in the H₂O measurements, we do a really good job of capturing the magnitude of free-tropospheric water.

H₂O in Boulder



Comparisons of similar H₂O retrievals with our instrument in Boulder show excellent agreement with the NOAA frost point hygrometers, over a significant range of water quantities. This work is ongoing.

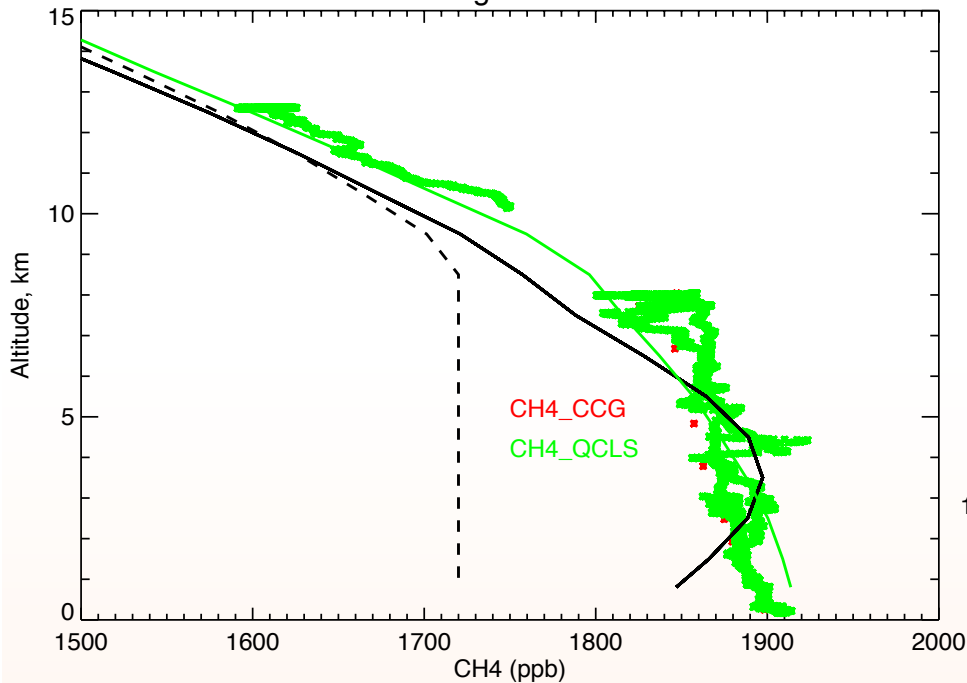
CH₄



CH₄ retrievals are complicated by poor lab spectroscopy in the mid-IR region. HIPPO CH₄ profiles have been very valuable for finding the best retrieval strategy for this important gas. A tight constraint is used to restrict oscillations, though this loses some of the small-scale variability.

CH₄ at Poker Flat during HIPPO-3

HIPPO-3 Flight 2 over Alaska

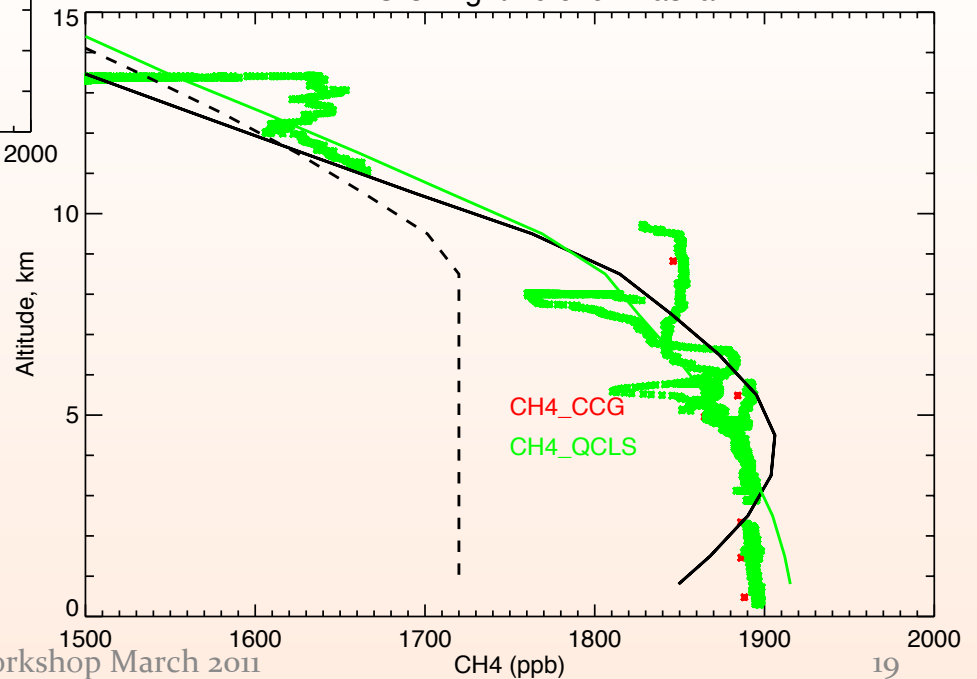


HIPPO data from
HIPPO_3_merge_20110202.tbl

CH₄ profiles provided by Akiko
Kagawa and Yasko Kasai, NICT,
Japan

Doing well at moving away
from the a priori and to the
right amount in the
troposphere; non-ideal at the
surface.

HIPPO-3 Flight 10 over Alaska



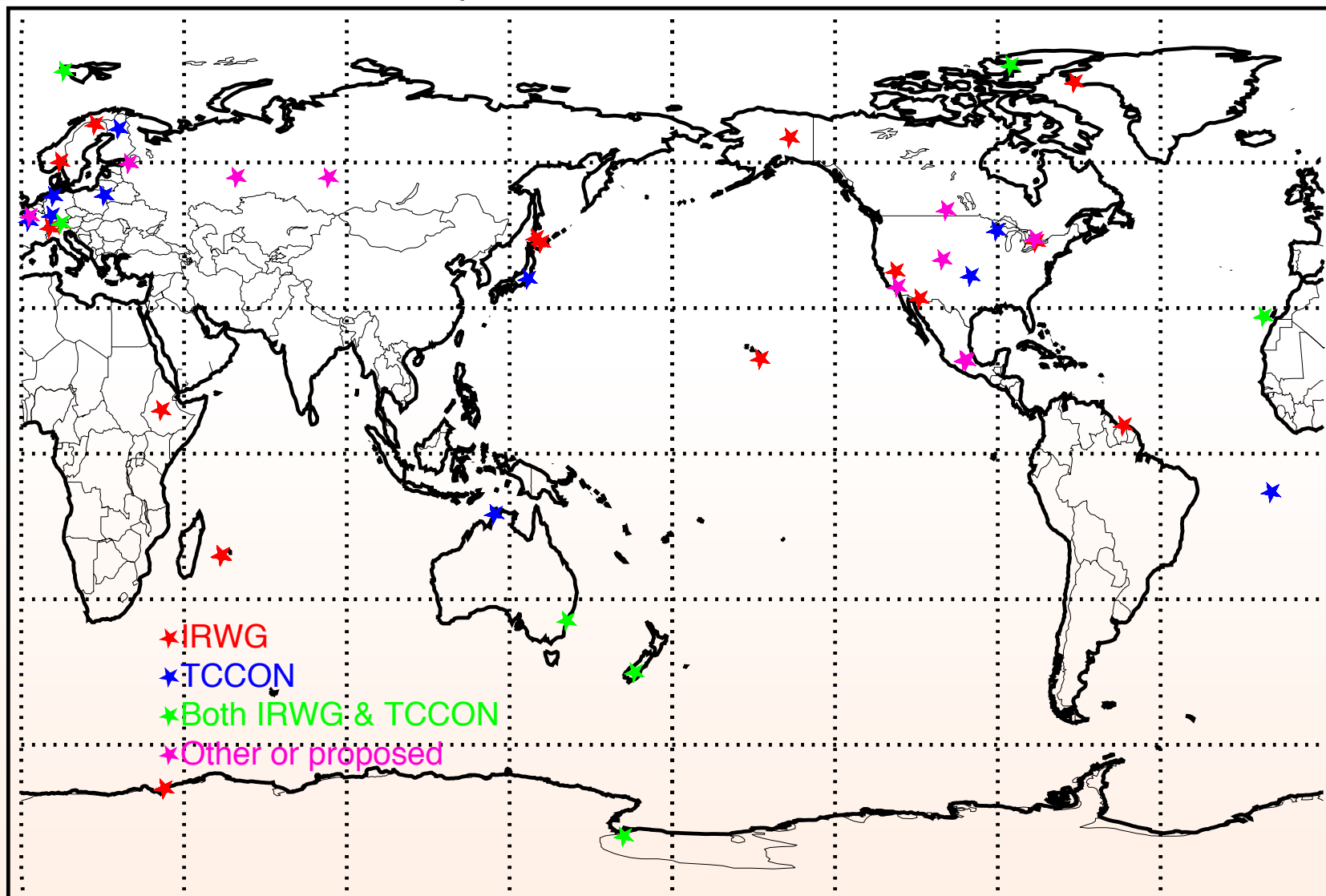
Other gases and FTIRs

From our spectra, we can also retrieve:

- N_2O , CFC-11, CFC-12, HCFC-22, CO_2 , COS and SF_6 (though we didn't get to all of those here)
- Your profiles help enormously for evaluating the quality of these more challenging retrievals
- And our measurements can help provide climatological information for you

There are other FTIR's all around the world!

FTIR spectrometers around the world



See www.ndacc.org for more information



Thank You

The NESL Mission is:
To advance understanding of weather, climate, atmospheric composition and processes;
To provide facility support to the wider community; and,
To apply the results to benefit society.

NCAR is sponsored by the National Science Foundation