Activities at NOAA/NESDIS in support of v5.0 trace gas retrievals

Eric Maddy, Chris Barnet,
Xingpin Liu, Xiaozhen Xiong,
Murty Divakarla, Walter Wolf,
Lihang Zhou, Mitch Goldberg

Tackling the CO_2 problem

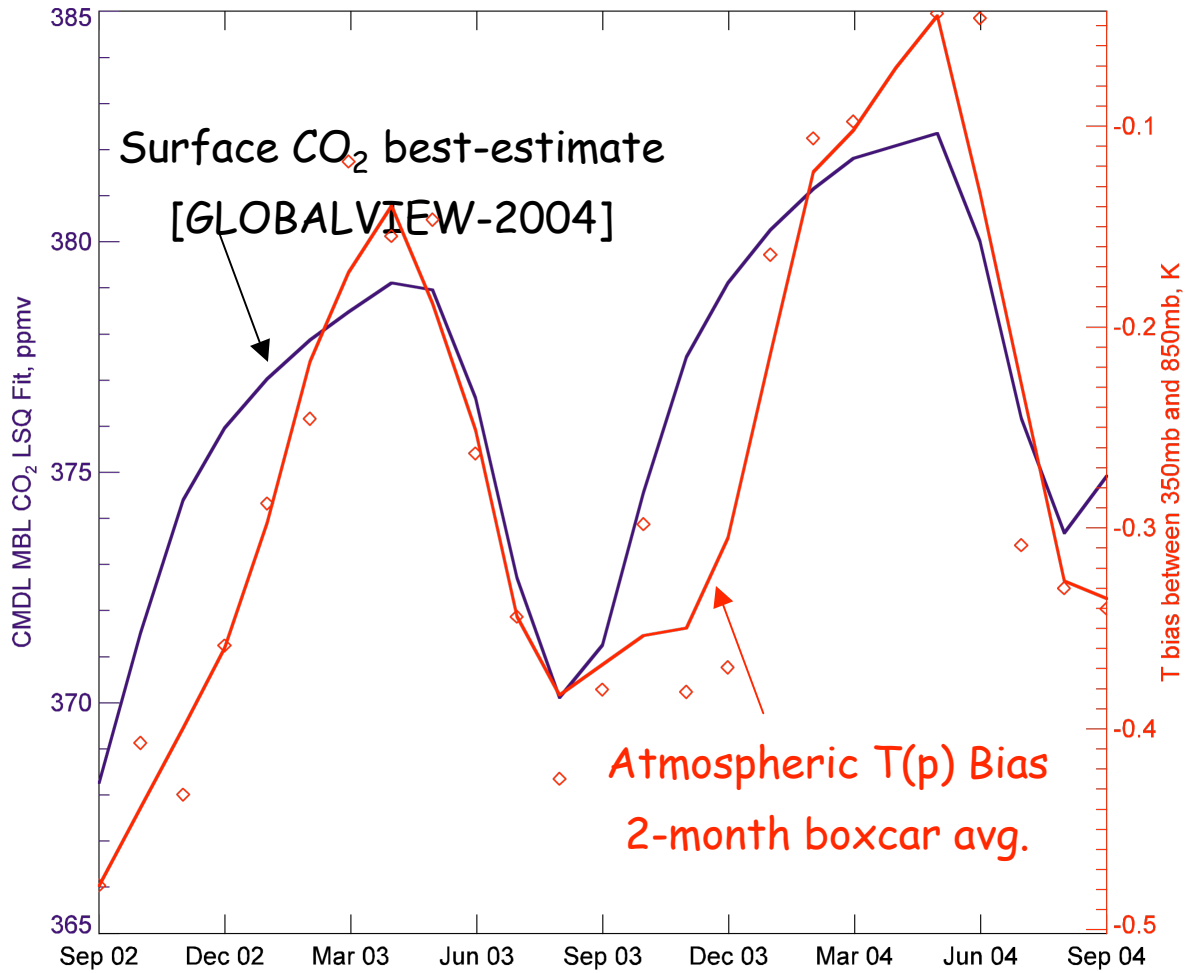
- Remove/Reduce CO_2/T(p) interference
  - CO_2 climatology - working with Larrabee
  - CO_2 perturbation in T(p) noise covariance
- Evaluate retrieval algorithms
  - Development Datasets:
    - CMDL/JAL Matsueda
    - UMBC single FOV rtps
    - NOAA unique 3^ox3^o grids
    - RAOB matchups (Murty Divakarla)
  - Where are we sensitive to CO_2?

AIRS T(p) Retrieval Biases vs. RAOBS and Surface CO_2: 90S_90N,

Apparent:

- Phase shift and amplitude reduction of seasonal cycle:
  0.1434K +/- 0.01K ->
  2.9ppmv +/- 0.2ppmv

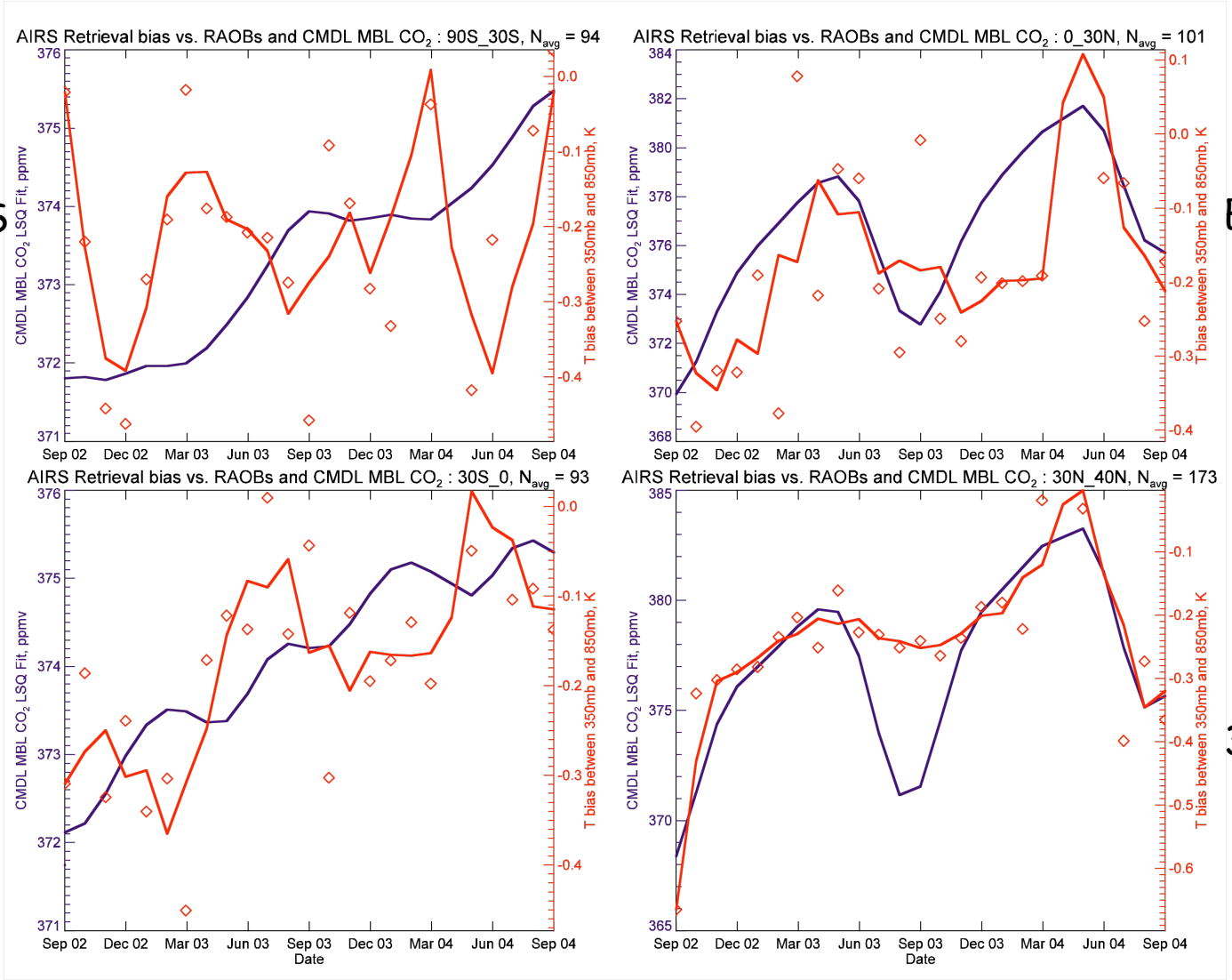
- Annual increase:
  0.063K +/- 0.03K ->
  1.26ppmv +/- 0.6ppmv



[Maddy, *et al. OSA HISE-FTS*, 2005.]

AIRS Zonal Biases

90°S-30°S



EQ-30°N

30°S-EQ

30°N-40°N

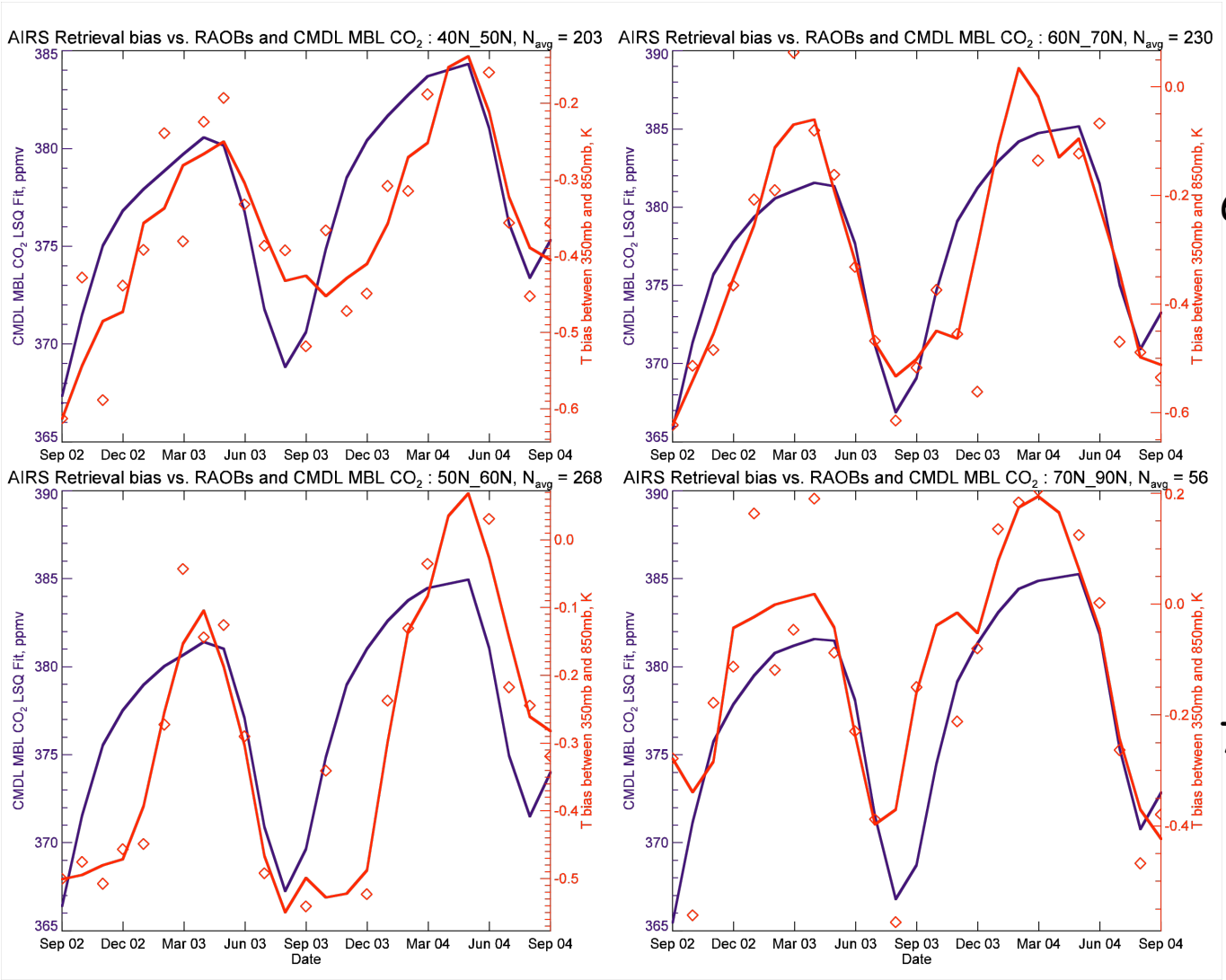
AIRS Zonal Biases

40°N-50°N

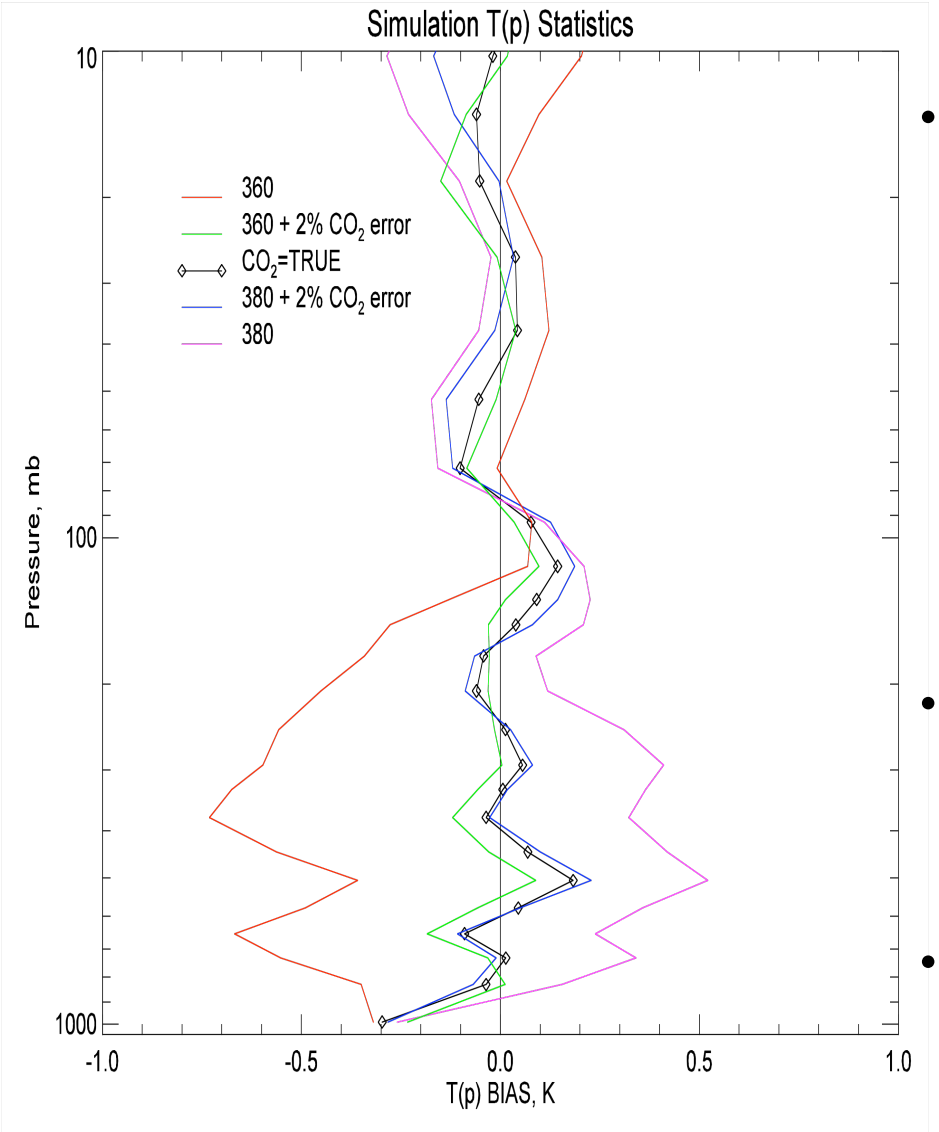
60°N-70°N

50°N-60°N

70°N-90°N



Simulation T(p)/CO_2 Interference

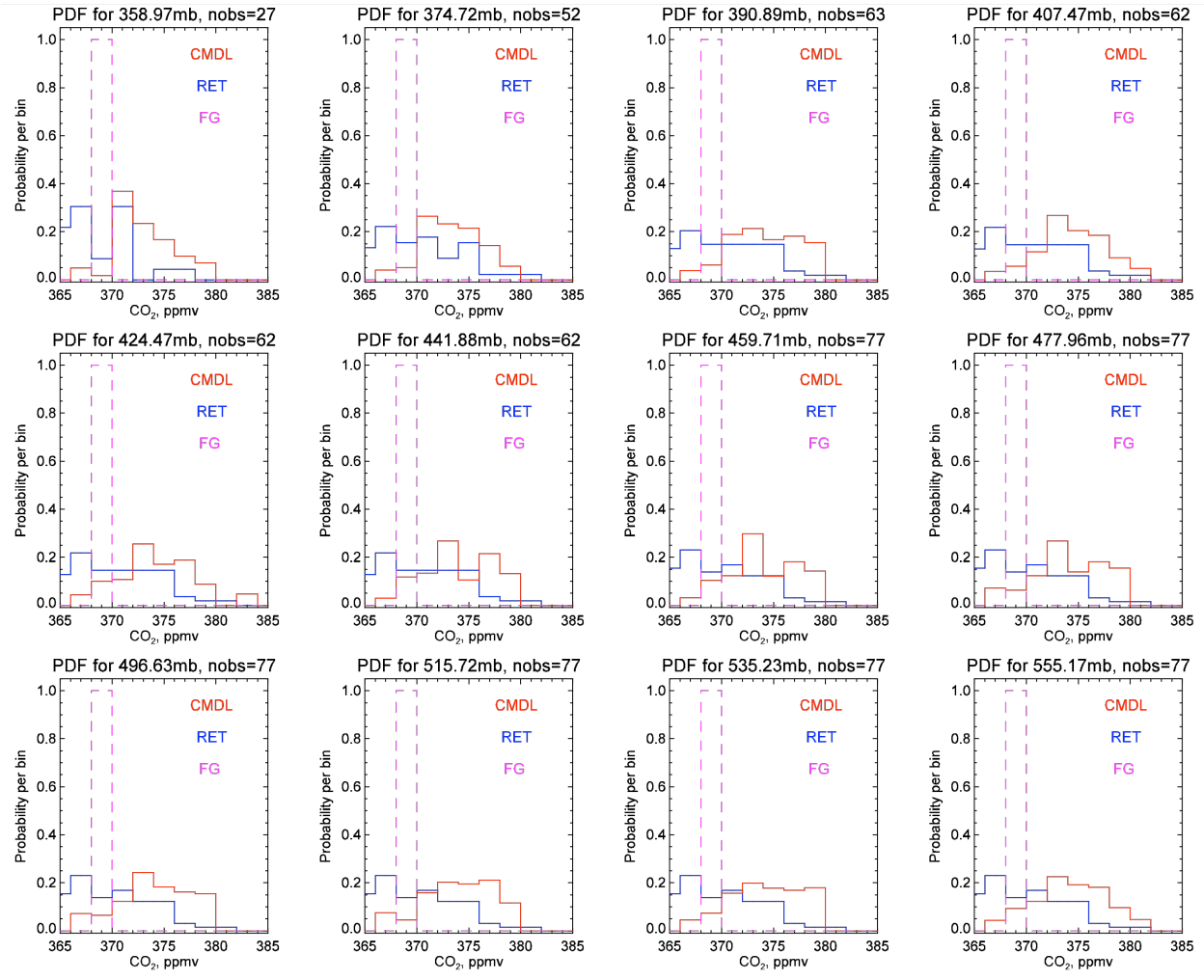


- Simulation temperature biases resulting from CO_2 FG error.
  - With 2% CO_2 error in T(p) NCV (**green**, **blue**)
  - Without CO_2 in T(p) NCV (**red**, **purple**)
- RMS not shown as CO_2 FG errors do not dominate this statistic.
- We are investigating this further with Murty's RAOB

Development Datasets

Dataset	Use
CMDL/ Matsueda	Evaluate performance and vertical weighting of profiles. Small number of matchups. (Sept. 2002-Present).
UMBC .rtp's	Evaluate performance of retrieval in **clear** atmospheres over ocean. (Sept. 2002-Present).
RAOBs	Enable independent separation of T(p)/CO_2. CO_2 climatology. (Sept. 2002-Present).
3^ox3^o grids	Evaluate retrieval modifications globally. **Quick turnaround** ~1 $\frac{1}{2}$ yrs data/1 week!!! (Aug. 2003-Present).

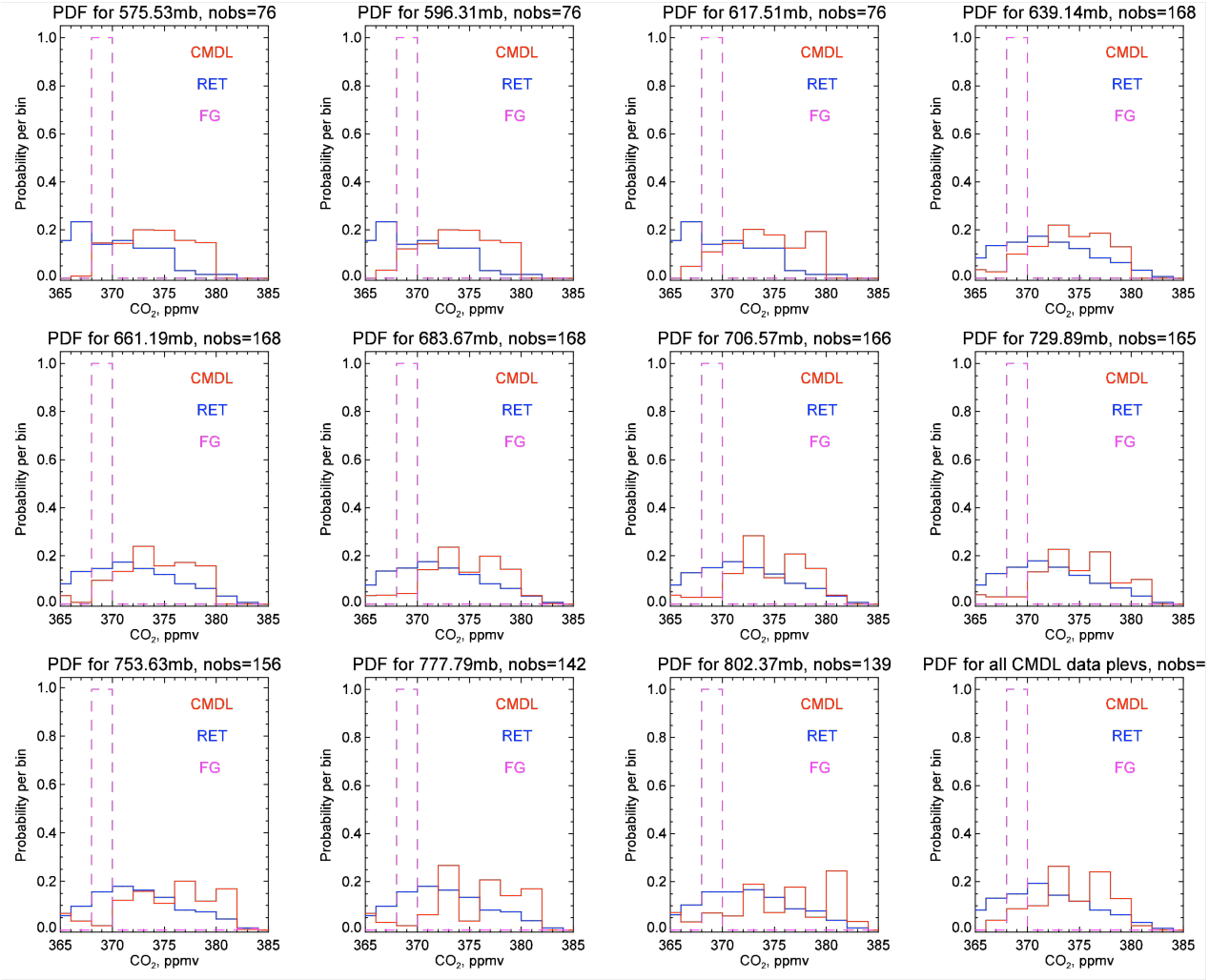
CMDL CO_2 FG = 370



Some variability is captured, but the retrieval is unable to make necessary correction.

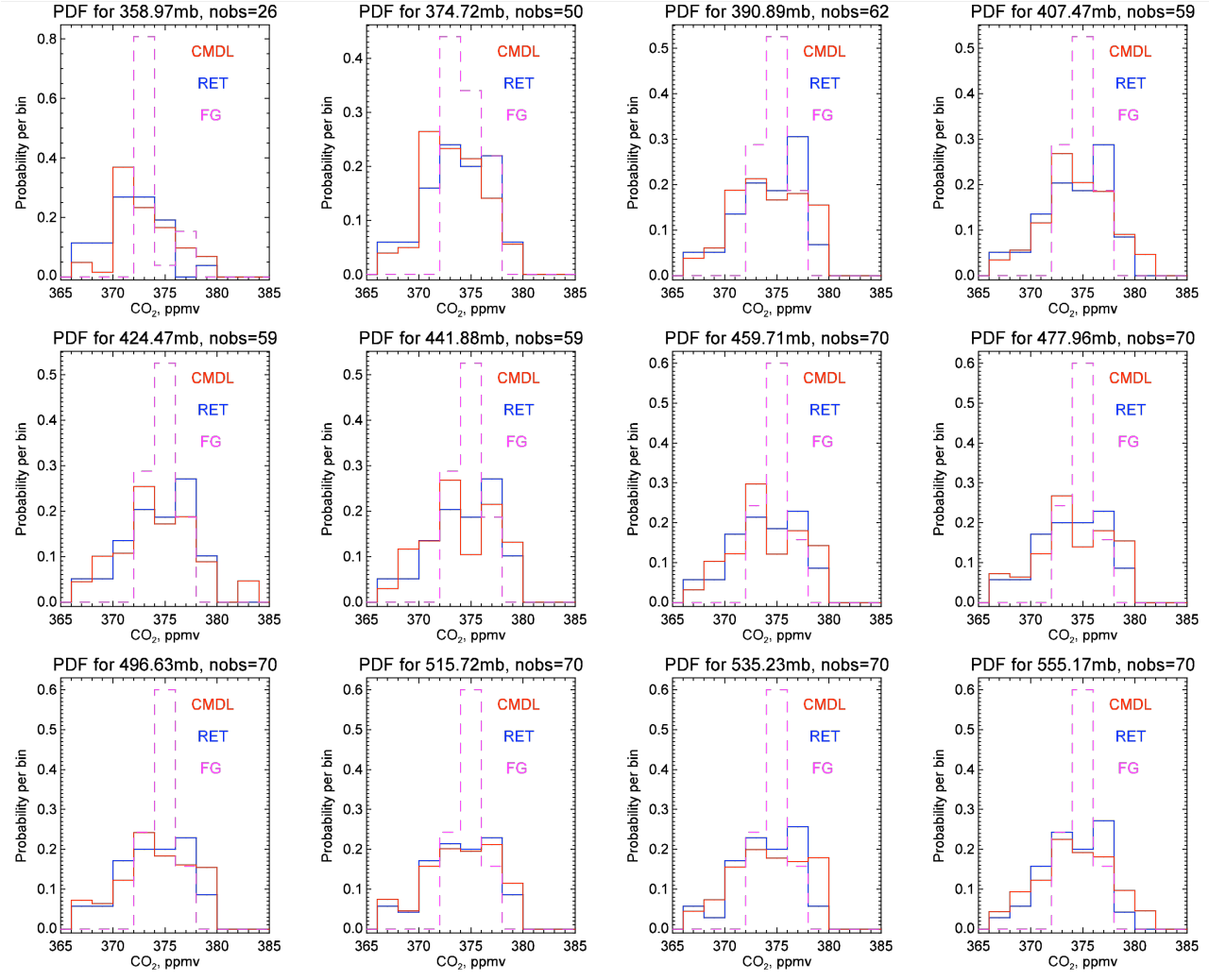
And …

CMDL CO_2 FG = 370



We have lost all indication of where we are sensitive to CO2

CMDL Vertical CO_2 functions+linear CO_2 FG trend

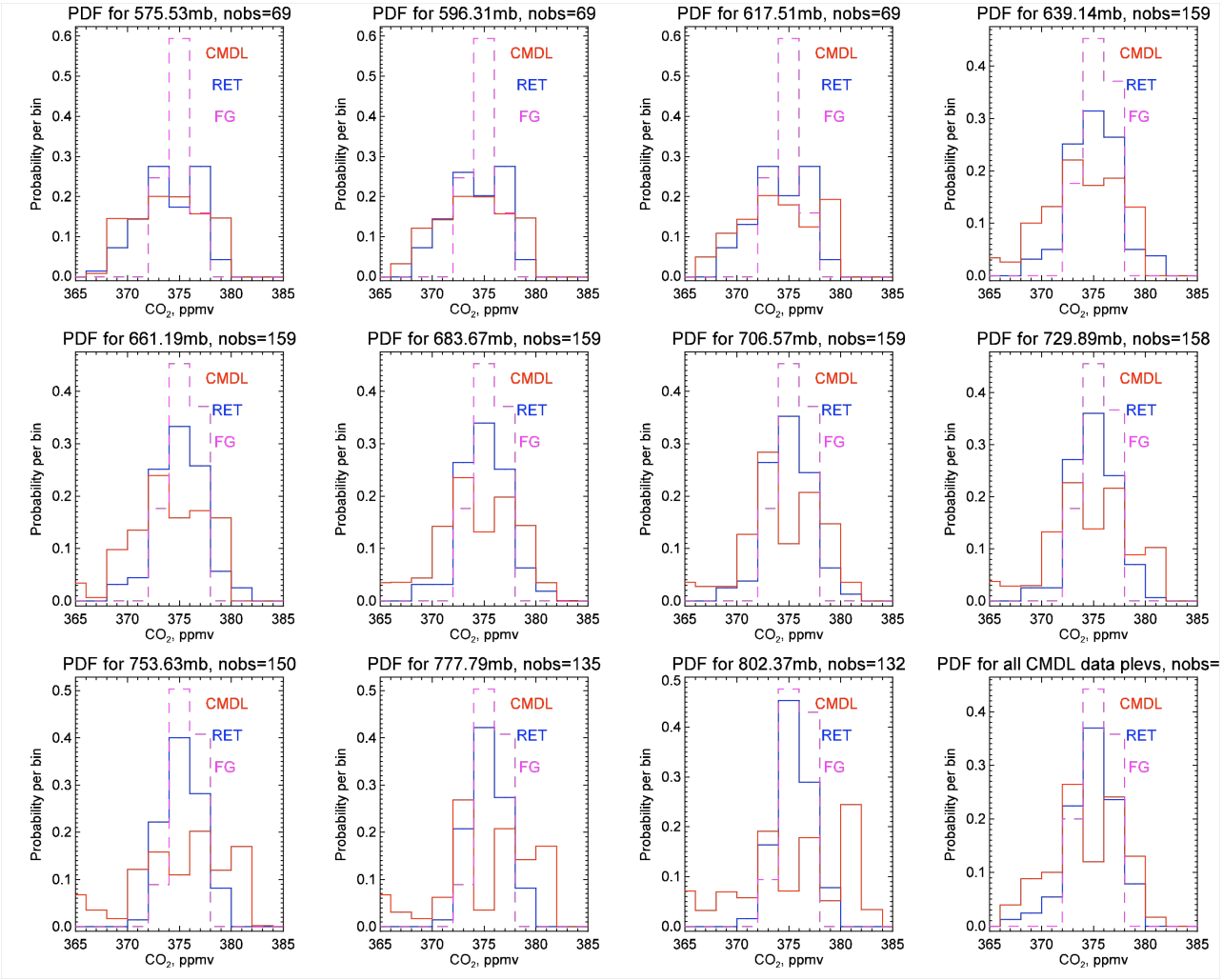


Functional Form :

$CO_2(lat,t)=$
$a_0(lat)+a_1(lat)*t$

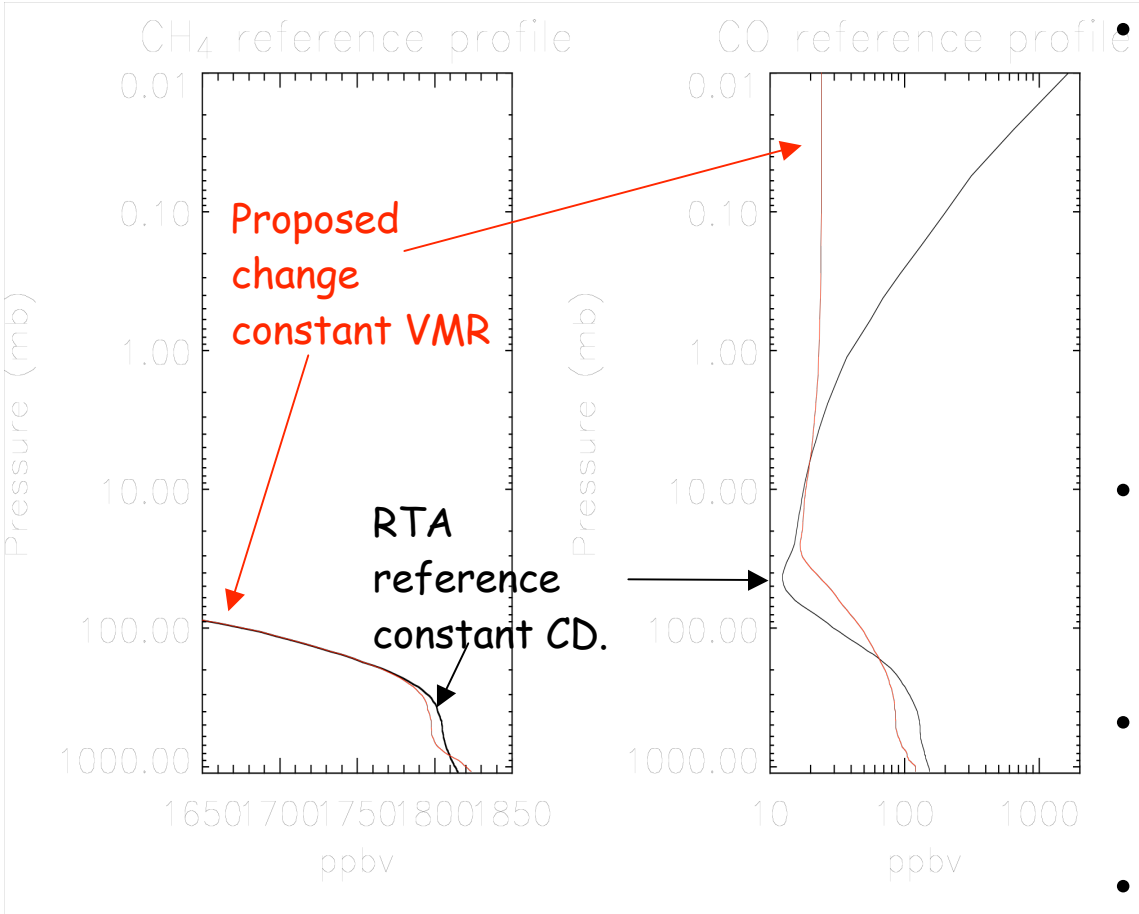
Mid troposphere retrieved CO2 matches CMDL variability!

CMDL Vertical CO_2 functions+linear CO_2 FG trend



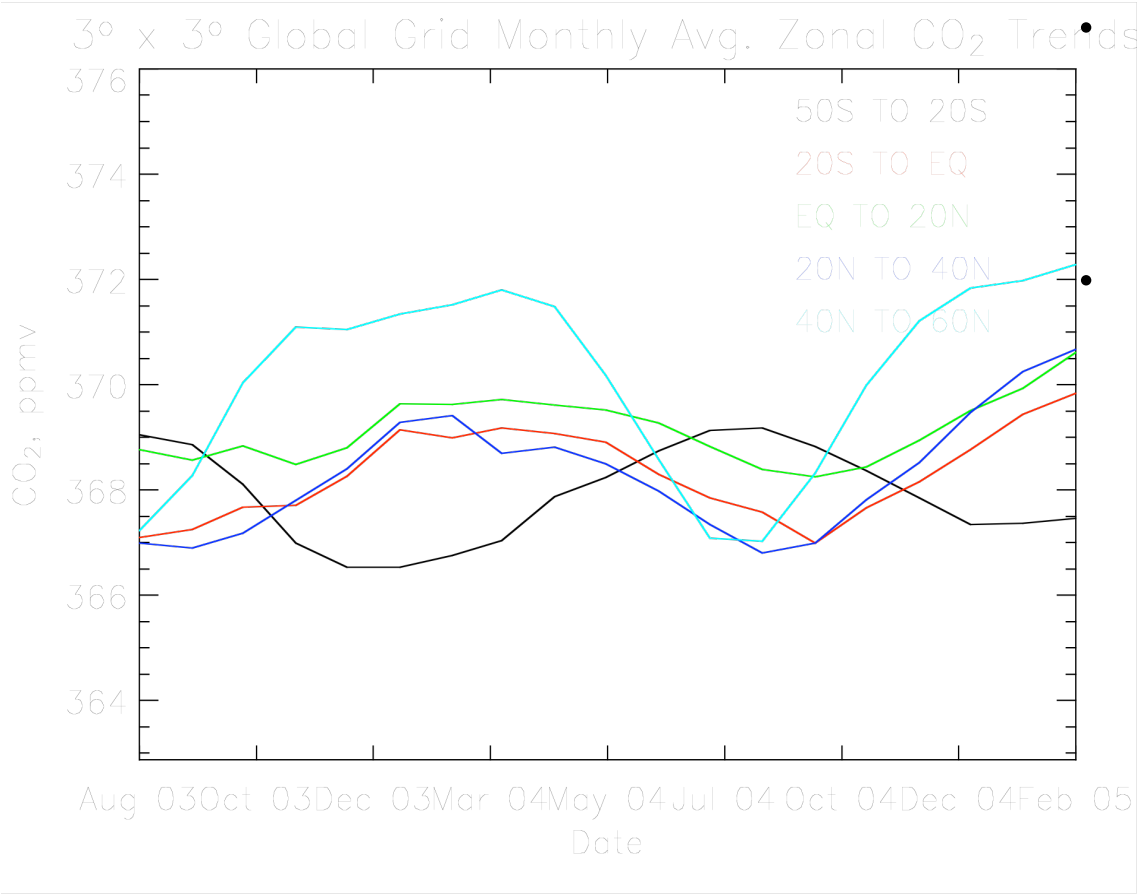
Retrieval relaxes back to FG toward the surface

Trace Gas First Guess



- CO_2 – keep it simple
  - 1st order polynomial
  $CO_2(t) = a0 + a1*t$; f(lat)?
  Use sonde database or Larrabee's CO_2 bias correction.
- CO and CH_4 variability tied to H_2O due to RTA ref. constant CD profile!
- CO
  - See WWM CO talk.
- CH_4
  - Created using CMDL aircraft profiles.

CO_2 Grids Movie Notes



With a constant FG $CO_2(t)$ = 370.0 ppmv

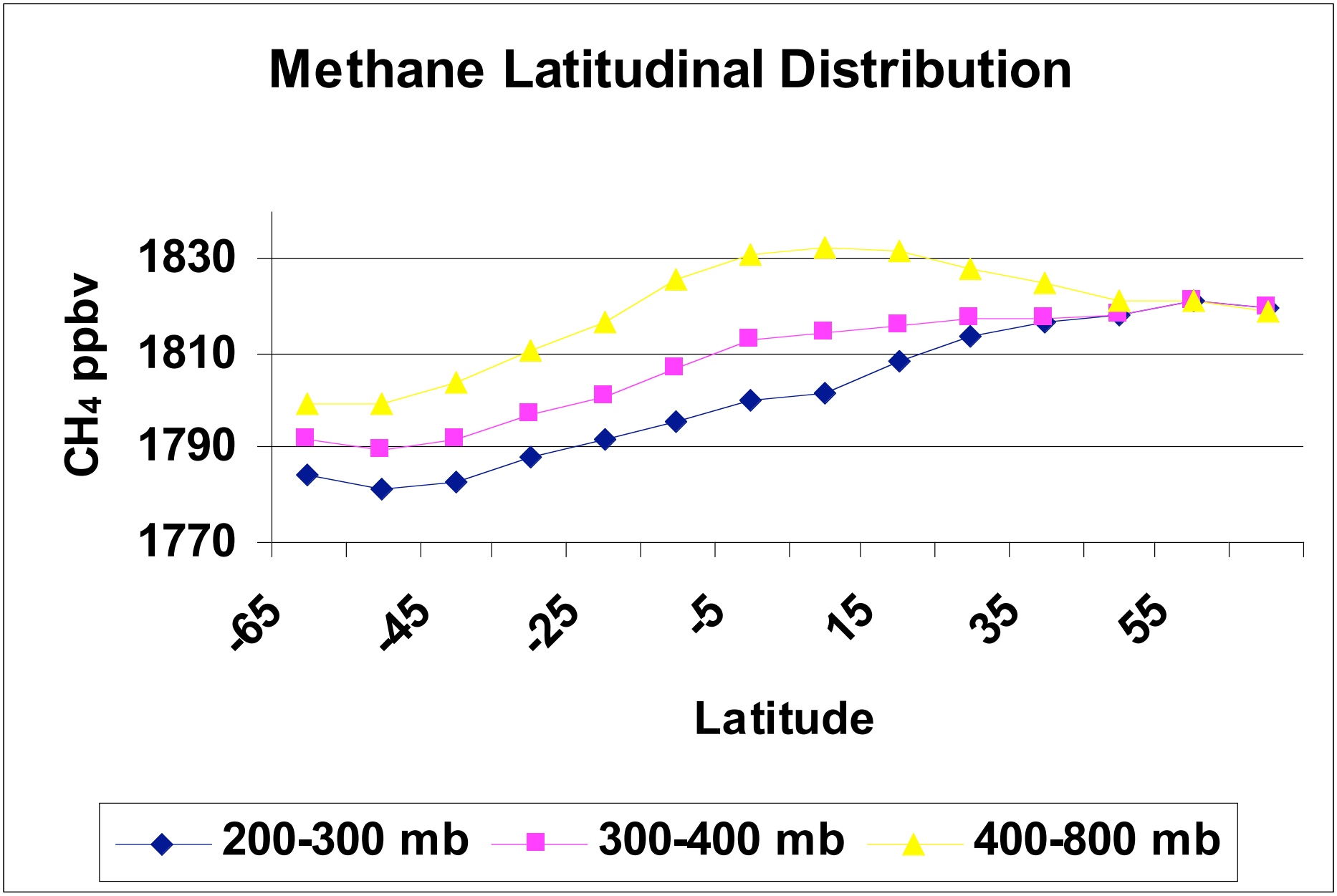
CO2

- N. Hemispheric and S. Hemispheric seasonal cycle apparent in CO_2 trends; however we are biased low.
- We see a land/ocean boundary due to our information content analysis.
  - Retrieval perceives that it is easier to retrieve CO2 over ocean.
  - This also looks to be correlated with humidity.
  - Can really be seen in the S. Hemisphere off the west coast of S. America and between S. America and Africa.

Methane Notes

CH_4 (Xiaozhen Xiong)

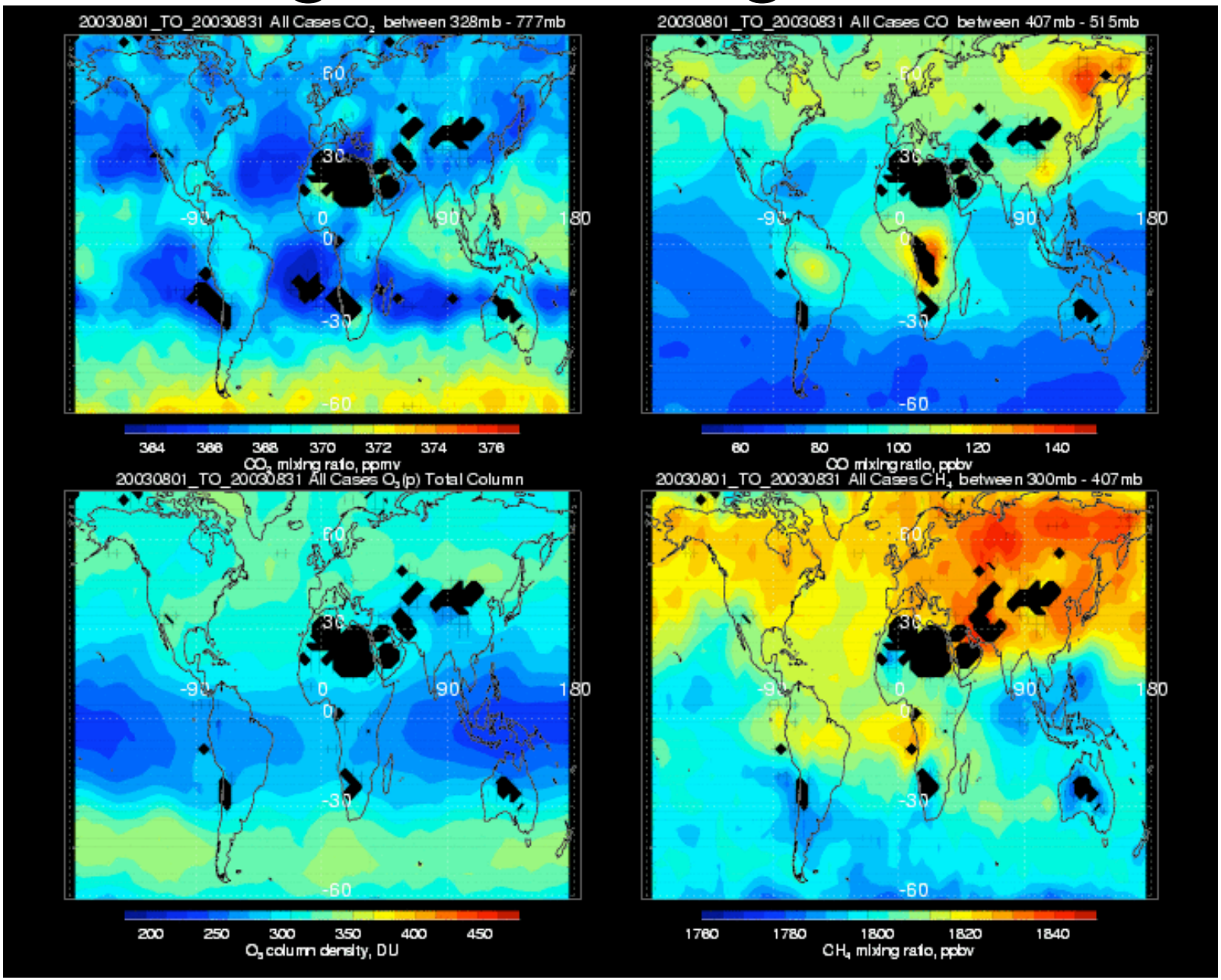
- Latitudinal variation increases with latitude as expected.
- Seasonal variation of zonal averages looks good
  - Variation in the tropics smaller than N./S. Hemisphere.
  - Phase of cycles is different in different zones and it seems consistent with large CH_4 emission from rice paddies (Sept. in China and around Dec. in India).


Methane Latitudinal Distribution
CH4 ppbv
1830
1810
1790
1770
-65
-45
-25
-5
15
35
55
Latitude
200-300 mb
300-400 mb
400-800 mb

Recommendations for v5.0

- Include CO_2 perturbation in T(p) retrieval noise covariance.
- Trace Gas Climatologies
  - CO_2 FG: Include a simple CO_2 function e.g.

    $CO_2(t) = a0 + a1*t$ as f(lat) ?

  CO and CH_4 Switch to a constant VMR.
  - CO FG: MOPITT FG option or other FG options (See WWM CO talk).
  - CH_4 FG -- CMDL average.
- Turn on CH_4

3°x3° grids trace gas movie