



Recent paper published on ACP about feasibility of retrieving CO_2 using N_2 continuum absorption (Foucher et al.)

P.-Y. Foucher, (LMD, France), A. Chédin (LMD, France), G. Dufour (LISA, France), C. Boone (U. Waterloo, Canada) and P. Bernath (U. York, UK)



Objectives

N_2 collision-induced absorption
continuum at $4\mu\text{m}$
accuracy and a 2km vertical resolution
2ppm

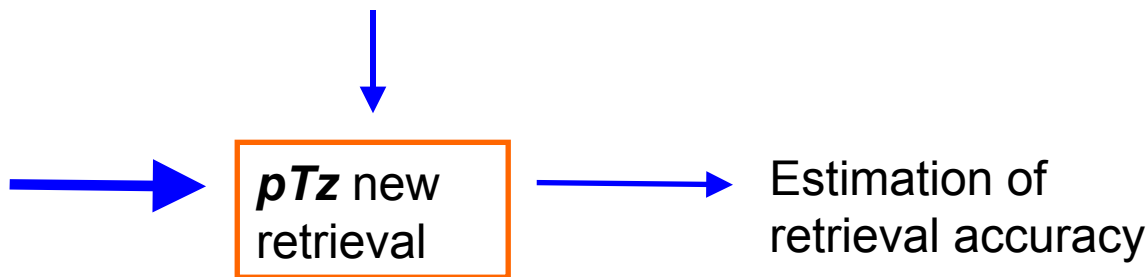
Interests



ACE v2.2 pTz CO_2 dependent

1st step

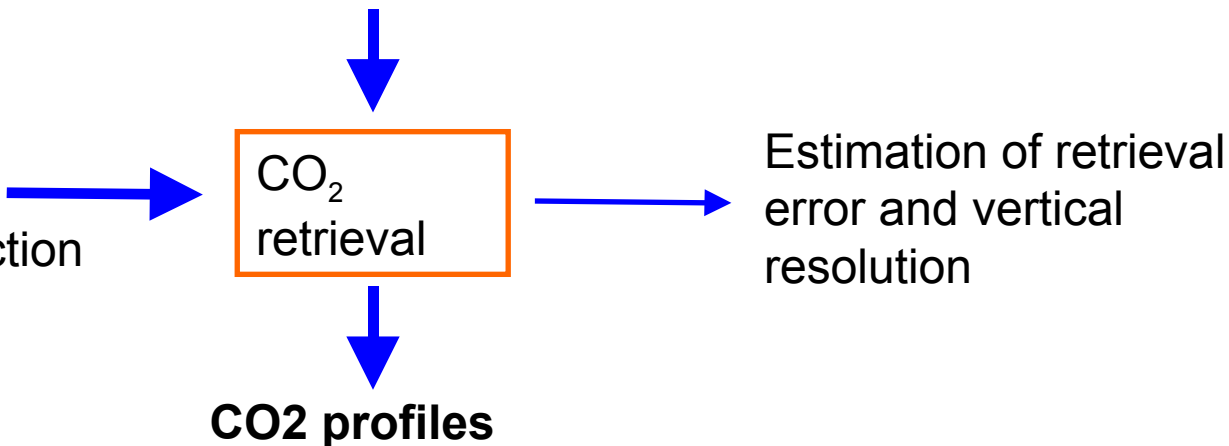
N₂ continuum :
Model + sensitivities



pTz free from CO_2 a priori

2nd step

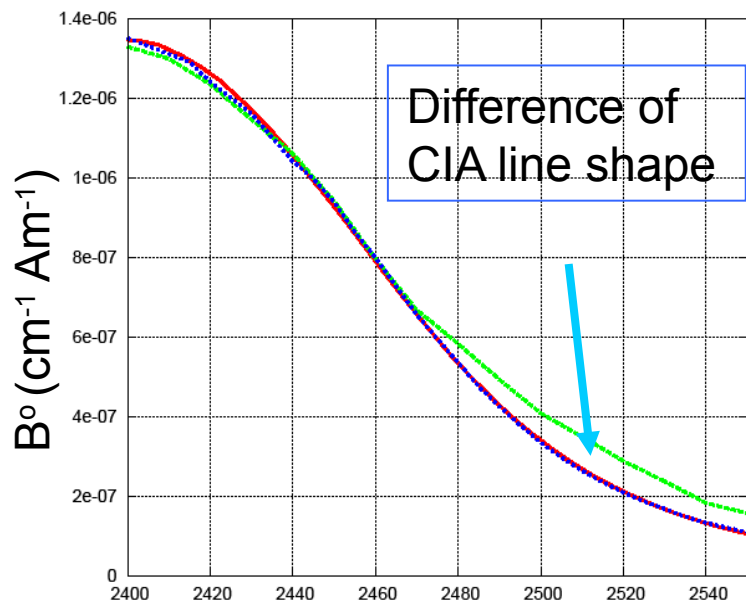
4A/OP (RTM)
 CO_2 spectral mw selection
Regularization





$$B_N - N \sigma T = B \sigma \frac{\beta}{T} - \frac{\sigma}{T}$$

Fit of B°



Fit using:

Lafferty
Measurements



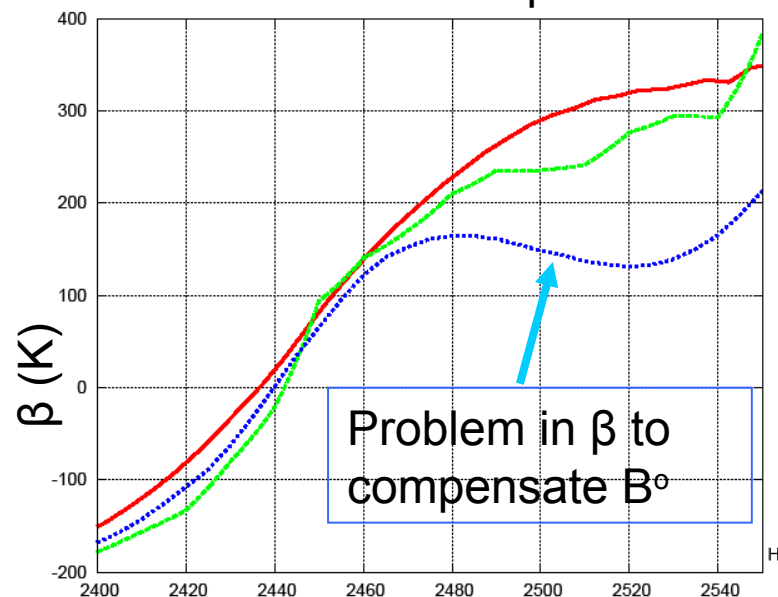
Menoux
Measurements



Old parameters
from Hartman



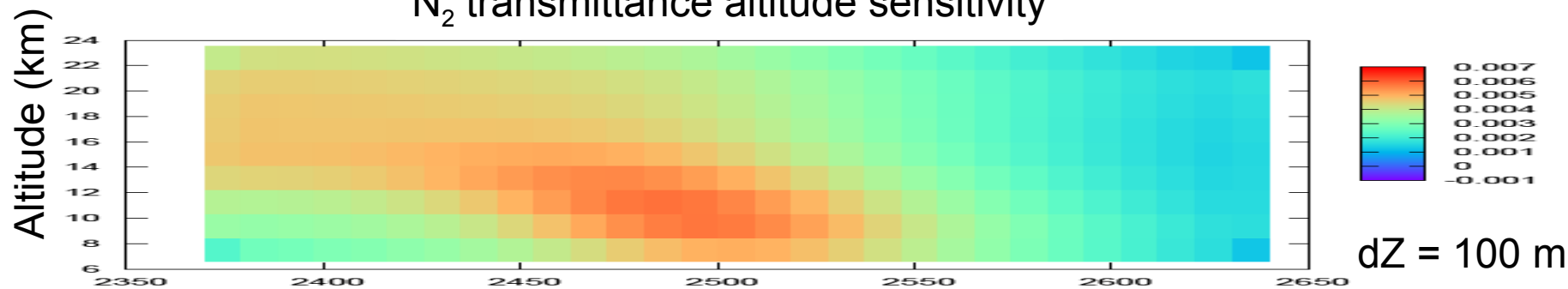
Fit of β



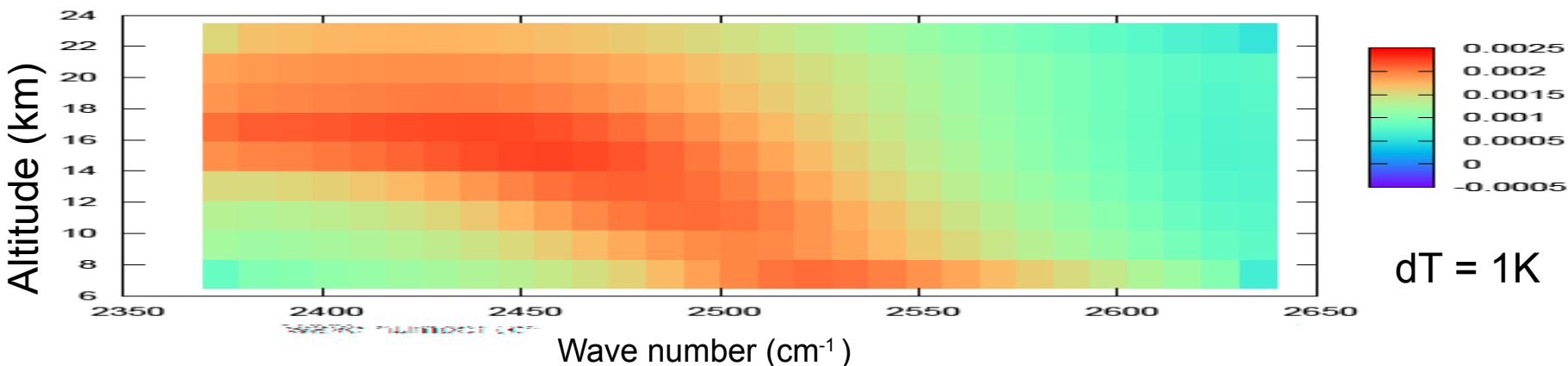
Recent discussion with Lafferty : agreement on this conclusion



N_2 transmittance altitude sensitivity



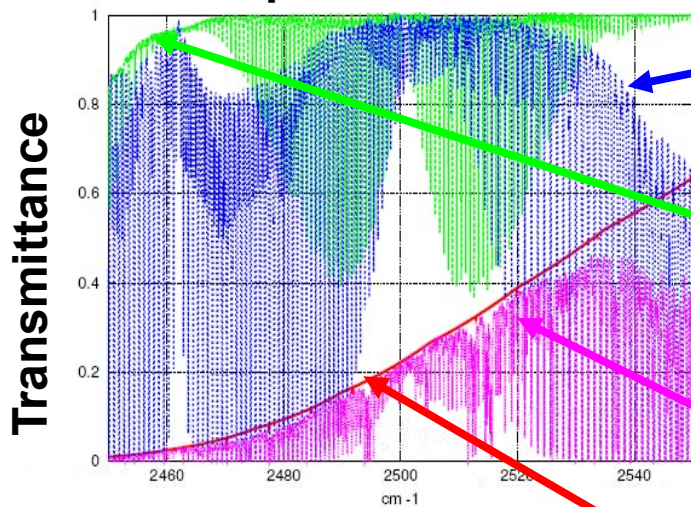
N_2 transmittance temperature sensitivity



The sensitivity to 100m can be 3 times more important than sensitivity to 1K



Example at 7.5 km



N₂O peaks +
linemixing

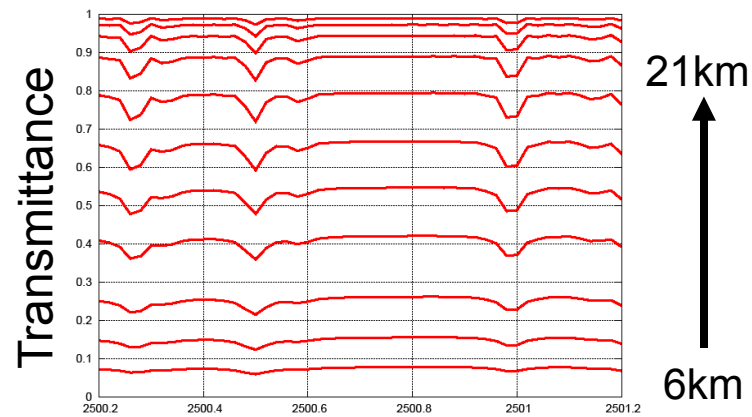
CO₂ peaks +
linemixing

All species

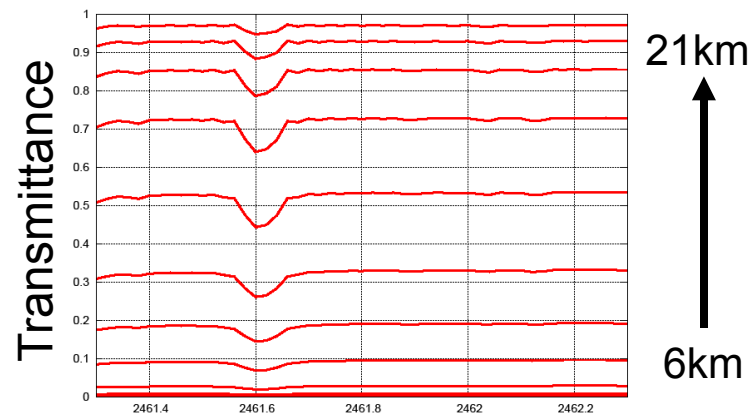
N₂ base-
line

Wave number cm⁻¹

Mw center 2500.7 cm⁻¹ : 6-12km

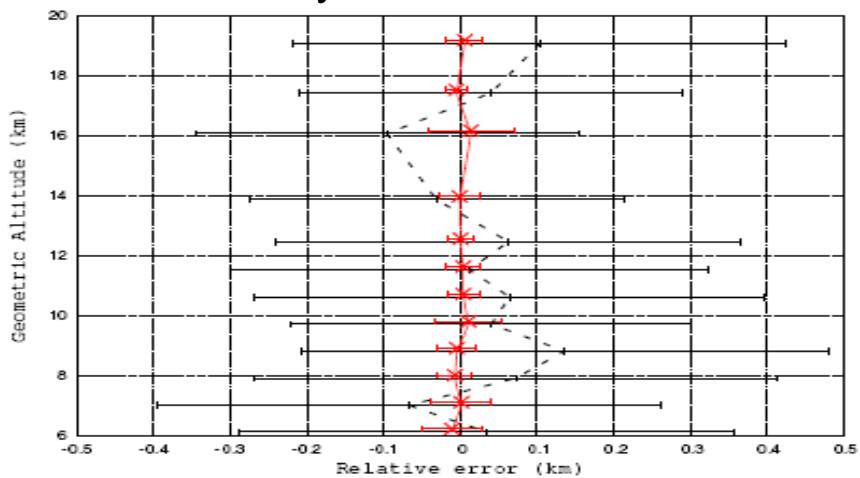


Mw center 2461.8 cm⁻¹ : 12-20km





Synthetic Z retrieval



Initial tangent height error :
dispersion $\sim 200\text{m}$

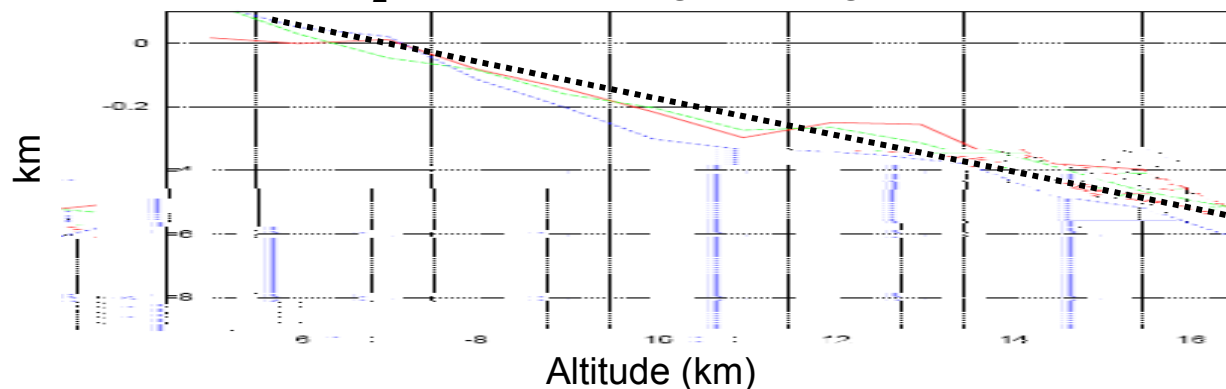
Retrieved tangent
height error

Random noise

Error < 30m

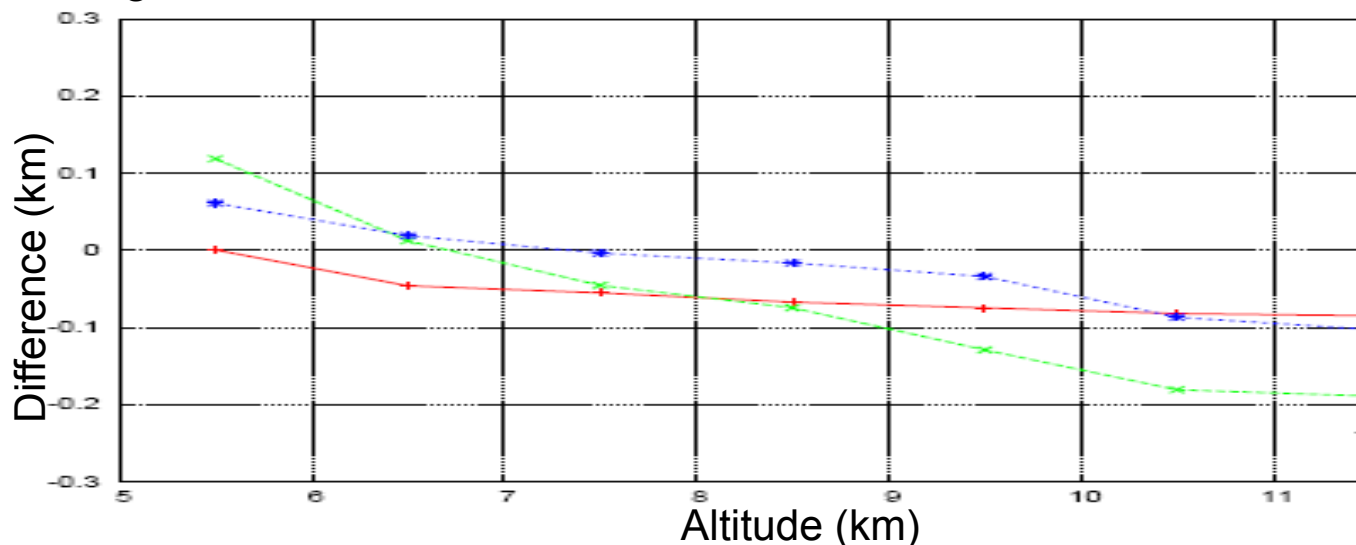


Difference between N_2 retrieved tangent height and ACE v2.2 products :



North hemisphere
latitude band 50°
2005-2007

Averaged difference from 2004 to 2008 between 5 and 12 km:



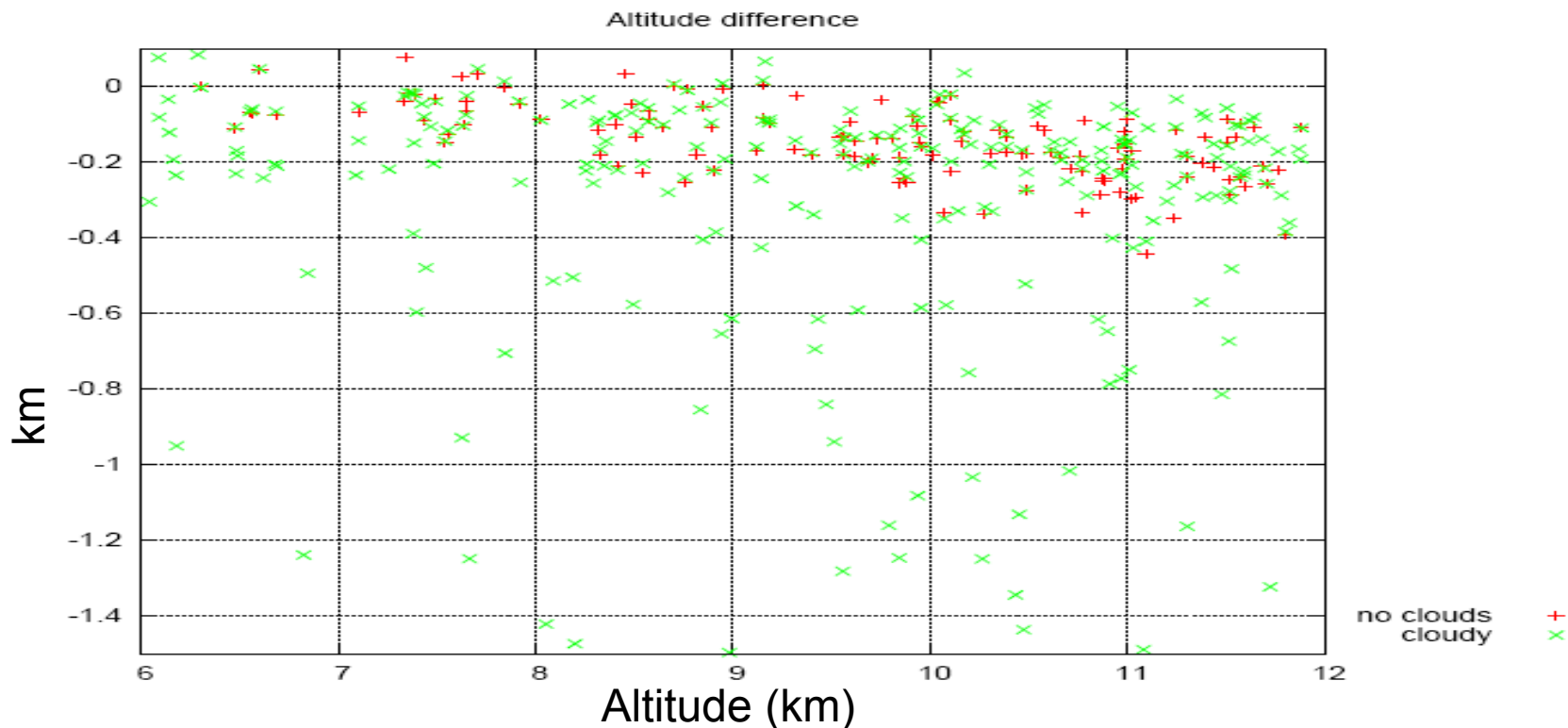
Tropical area :
30°N-30°S
North latitude
area : 30°N-
60°N
South latitude
area : 30°S-60°S



Example of cloud effect on altitude differences for the North latitude band at 40°N :

Green points : tangent height differences with no cloud rejection

Red points : tangent height differences with cloud rejection





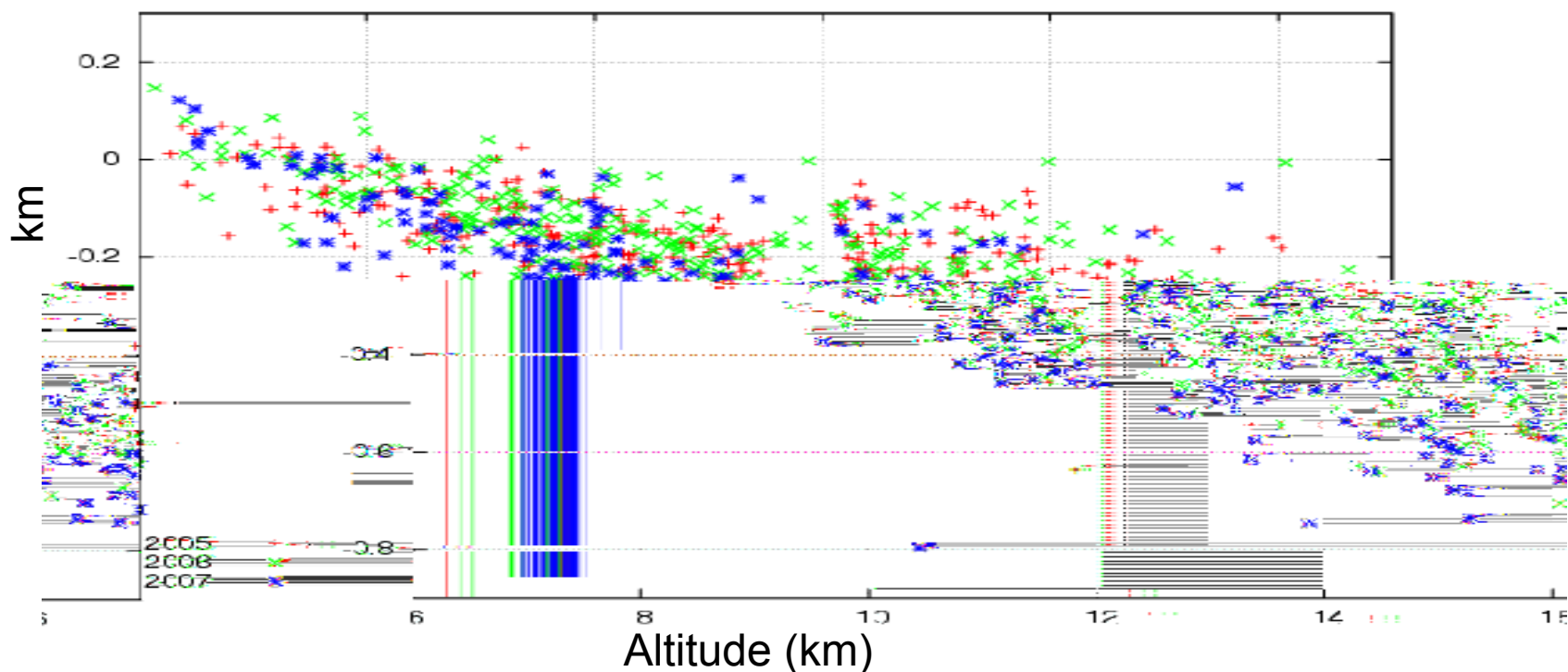
North latitude band 50° from 2005 to 2007

Dispersion of difference with ACE v2.2 tangent heights:

6-12 km ~ 200m / 12-18 km ~ 300m

Expected dispersion due to CO₂ ~ 150m

Altitude difference

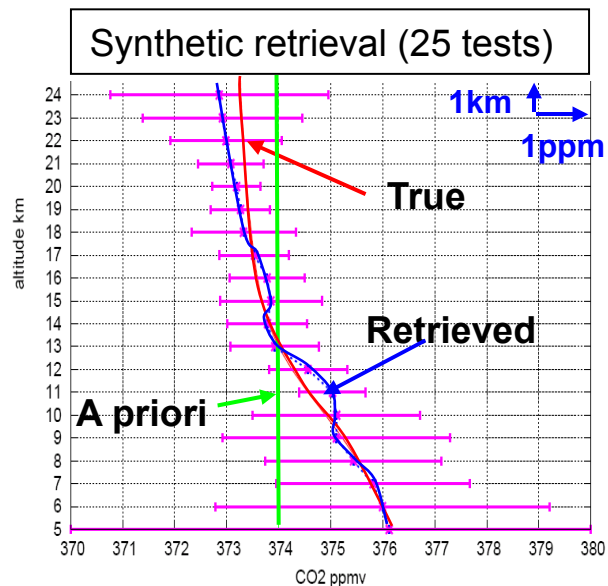






L L

$$R = \alpha \cdot \text{diag}_a \cdot L^T L$$



10 microwindows (iso 3) 5-13km

15 microwindows (iso 1) 10-25km

Noise : Instrument + model + Temperature

Mean dispersion ~ 2.5 ppm

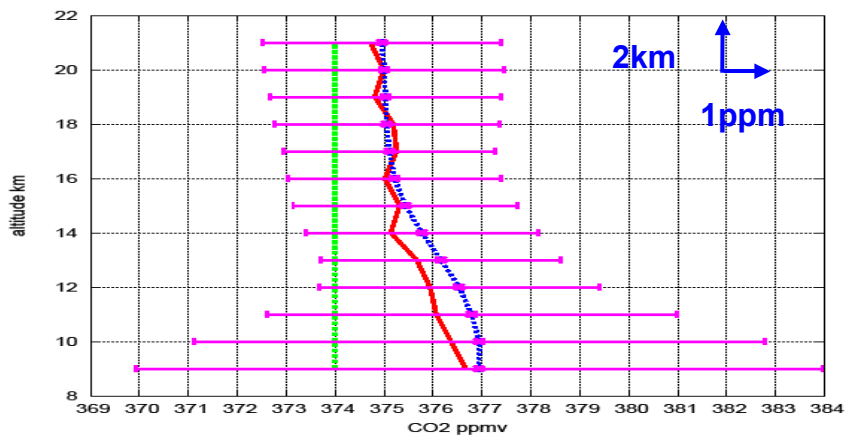
Retrieved CO₂ error < 1 ppm

Vertical resolution ~ 2km

Problem : CO₂ microwindows from isotopologue 1 and isotopologue 3



Synthetic retrieval (20 occ)



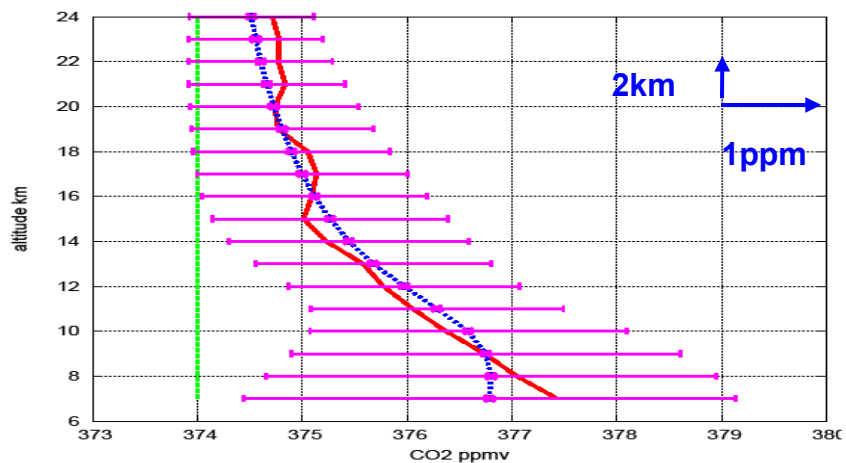
A priori



True profile



Synthetic retrieval (20 occ)

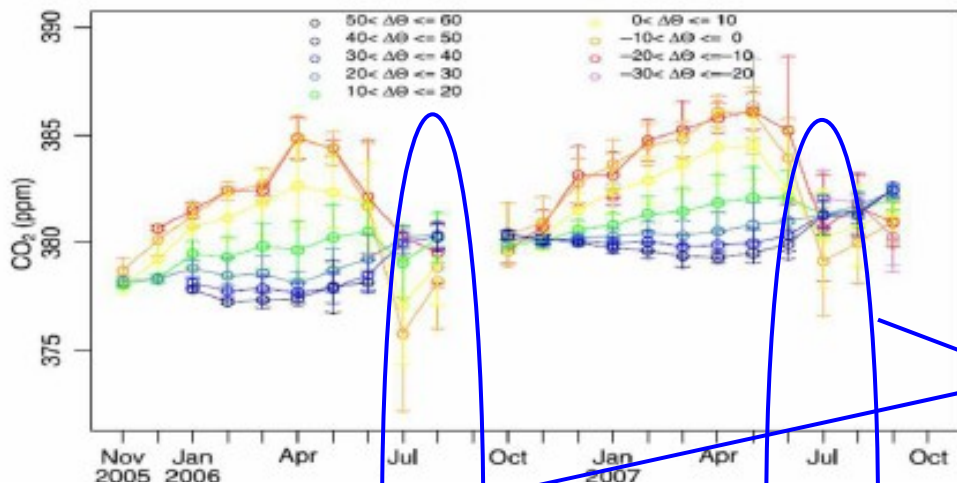


Retrieved



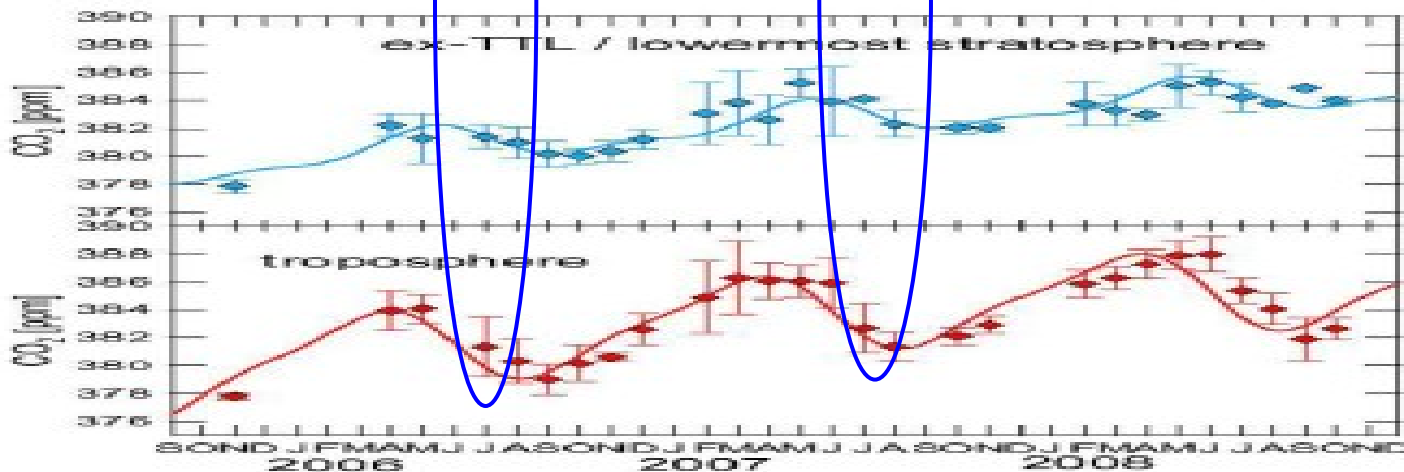
Dispersion





CONTRAIL measurements
(Matsueda et al., 2002, Sawa et al., 2008).

Troposphere CO₂ value is greater than Lower Most stratosphere value in summer

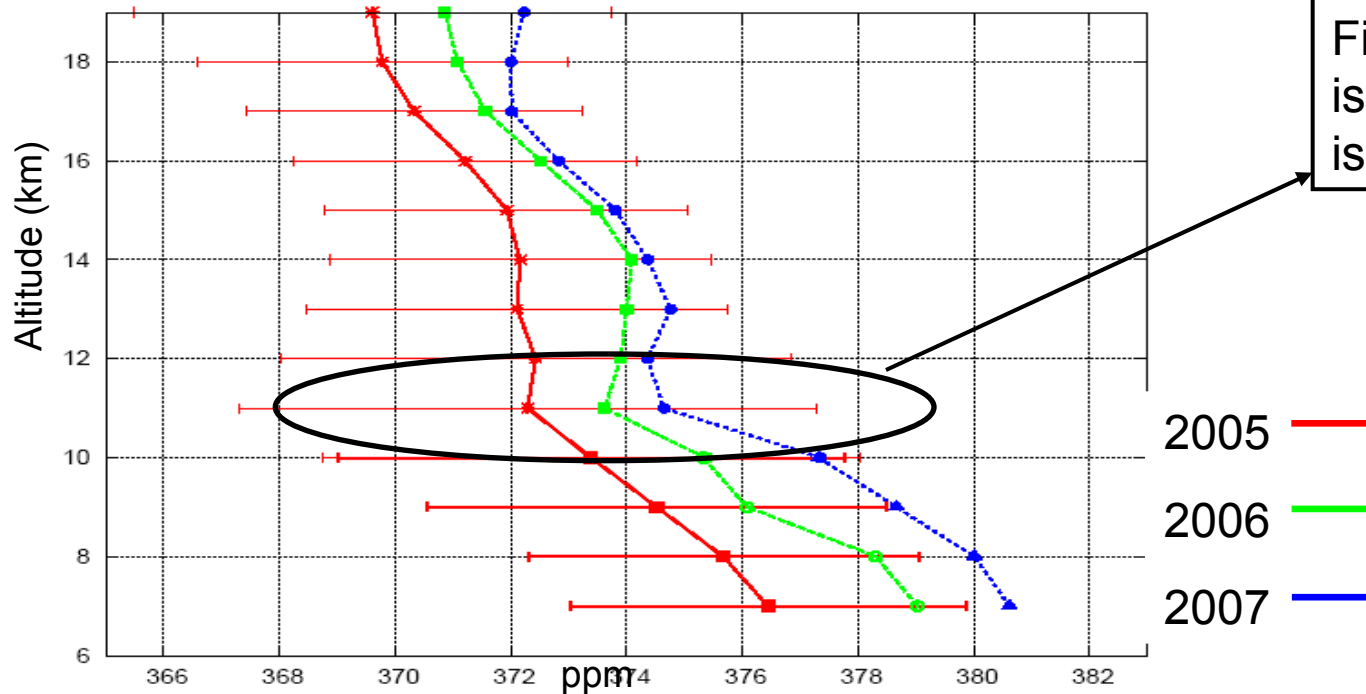


CARIBIC
measurements

Brenninkmeijer et al., 1999, Schuck et al., 2009)



Averaged CO₂ profiles



Mean Trend ~ 2ppm/year ; Negative 7-15 km mean gradient ~ 4.5ppm

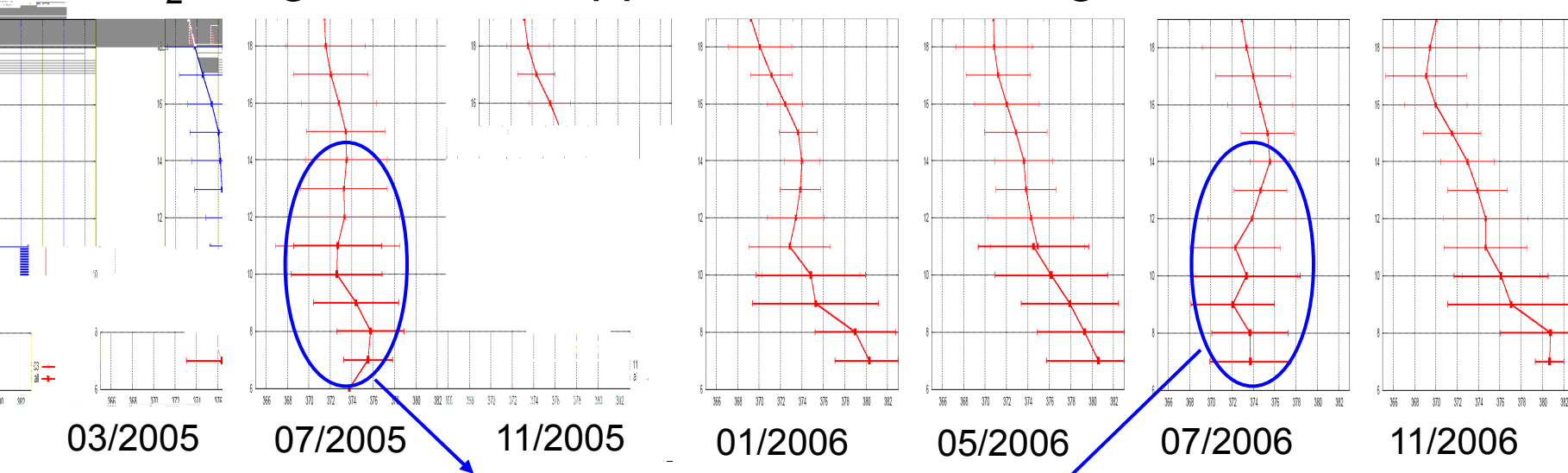
Standard deviation ~ 4-5 ppm

Problem : 2007 for altitudes > 12km



Monthly averaged profiles from March 2005 to November 2006 for 50°N latitude band.

CO₂ range: 366-382 ppm / Altitude range: 6-18km



Change of the 6-14 km vertical gradient shape in Summer

