



# AIRS CO, CH<sub>4</sub> Update: v5, v6, Global Trends, AIRS v IASI

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Supported by NASA AIRS, EOS Validation, and Tropospheric Chemistry Programs

**Thanks to the entire AIRS Team, NDACC Colleagues,  
Steve Wofsy and the HIPPO Science Team,  
and Chris Barnet and the NOAA CLASS archive**

# Outline

- v5 CO Validation: writing up now
- **AIRS vs. IASI: just started, looks good**
- v6 CO:
  - Half-bottom true vs. false
  - NOAA CO Optimal Estimation algorithm?
- L3 CO averaging kernels: evaluating
- Validation with HIPPO data: started
- v5 CH4 Validation update
- **CO and CH4 global trends**



# v5: INTEX-A/B CO Validation

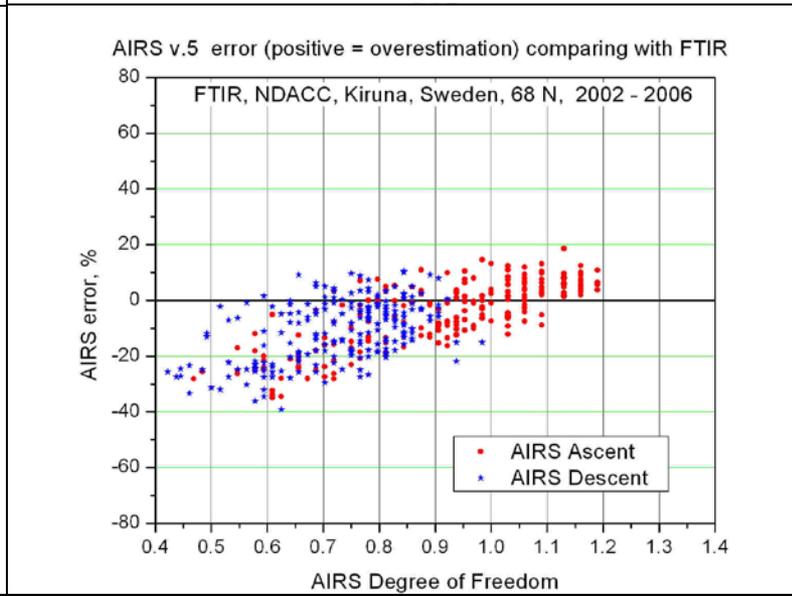
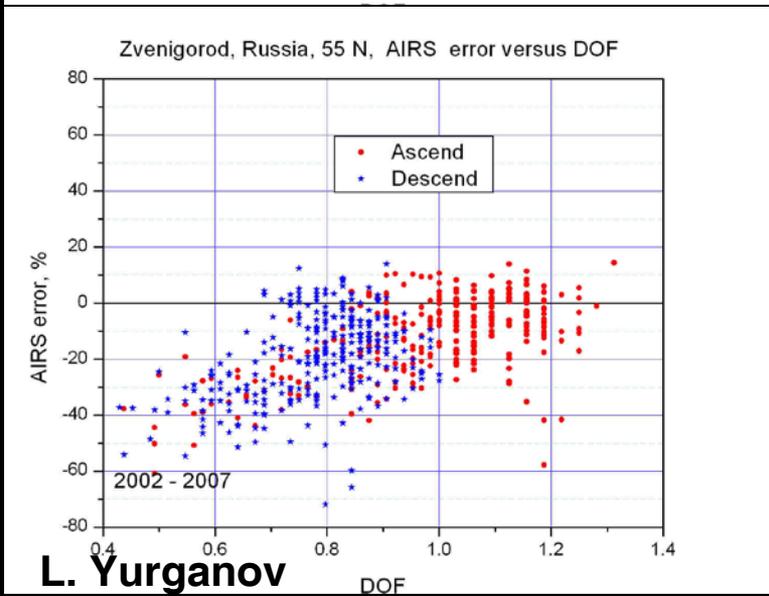
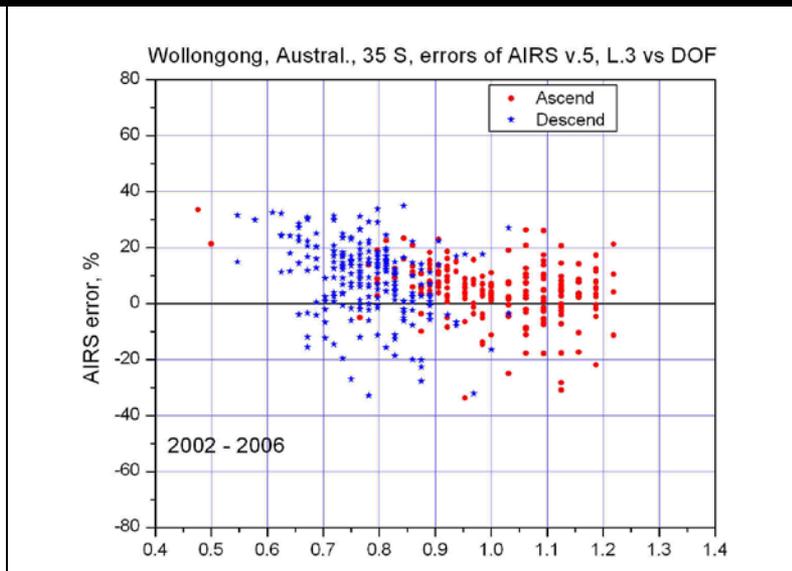
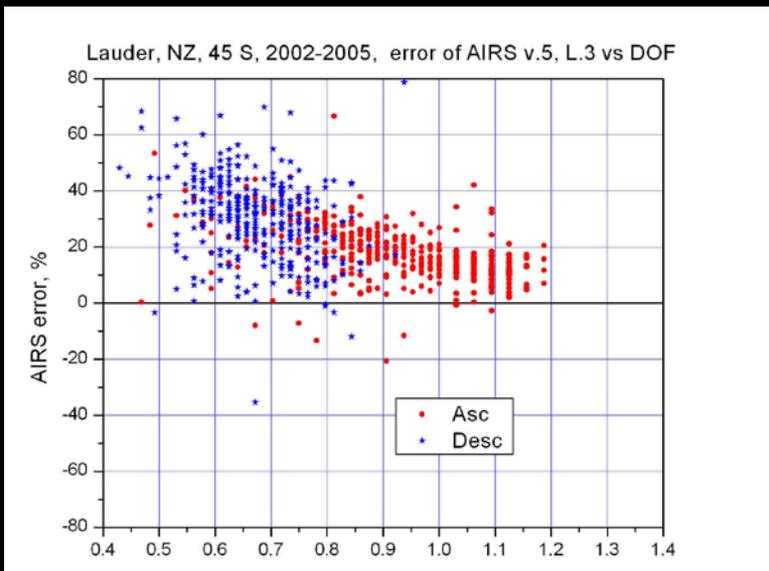
## AIRS biased high vs. in situ



trapezoid pressure	# profiles <sup>†</sup>	Bias (%)	Std (%)
	A/B	A/B	A/B
350 mb	64/36	7.7/8.5	7.7/5.9
500 mb	83/55	7.7/10.7	7.5/7.3
700 mb	84/54	6.4/8.6	5.3/7.0
850 mb	64/47	3.8/5.1	3.2/6.4

<sup>†</sup> Spiral validation profiles + in transit science profiles

# v5: CO Total Column



L. Yurganov

DOF

AIRS Degree of Freedom

# v5 CO Val SUMMARY

- **v5 improved over v4!**
  - v4: only 500 mb validatable: 8% high  $\pm$  5%
  - v5: 350, 500, 700, 850 mb: 4-11% high  $\pm$  7%
- **AIRS 500 mb vs. in situ**
  - INTEX (138 profs): AIRS 9% high bias  $\pm$  7.5%
  - ESRL (2005): AIRS 6% high bias  $\pm$  12.5%
- **AIRS total column vs. ground-based FTIR**
  - AIRS 10% high bias for DOF > 0.8
  - AIRS bias larger in the southern hemisphere

# AIRS vs. IASI CO



Recently submitted to ACPD IASI special issue  
(manuscript# acp-2009-103)

- Carbon monoxide distributions from the IASI/METOP mission: evaluation with other space-borne remote sensors
  - M. George, C. Clerbaux, D. Hurtmans, S. Turquety, P.-F. Coheur, M. Pommier, J. Hadji-Lazarou, D. P. Edwards, H. Worden, M. Luo, C. Rinsland and W. McMillan.

**Nominally, IASI CO DOF ~ 1.5, AIRS ~ 0.8**

# AIRS vs. IASI CO

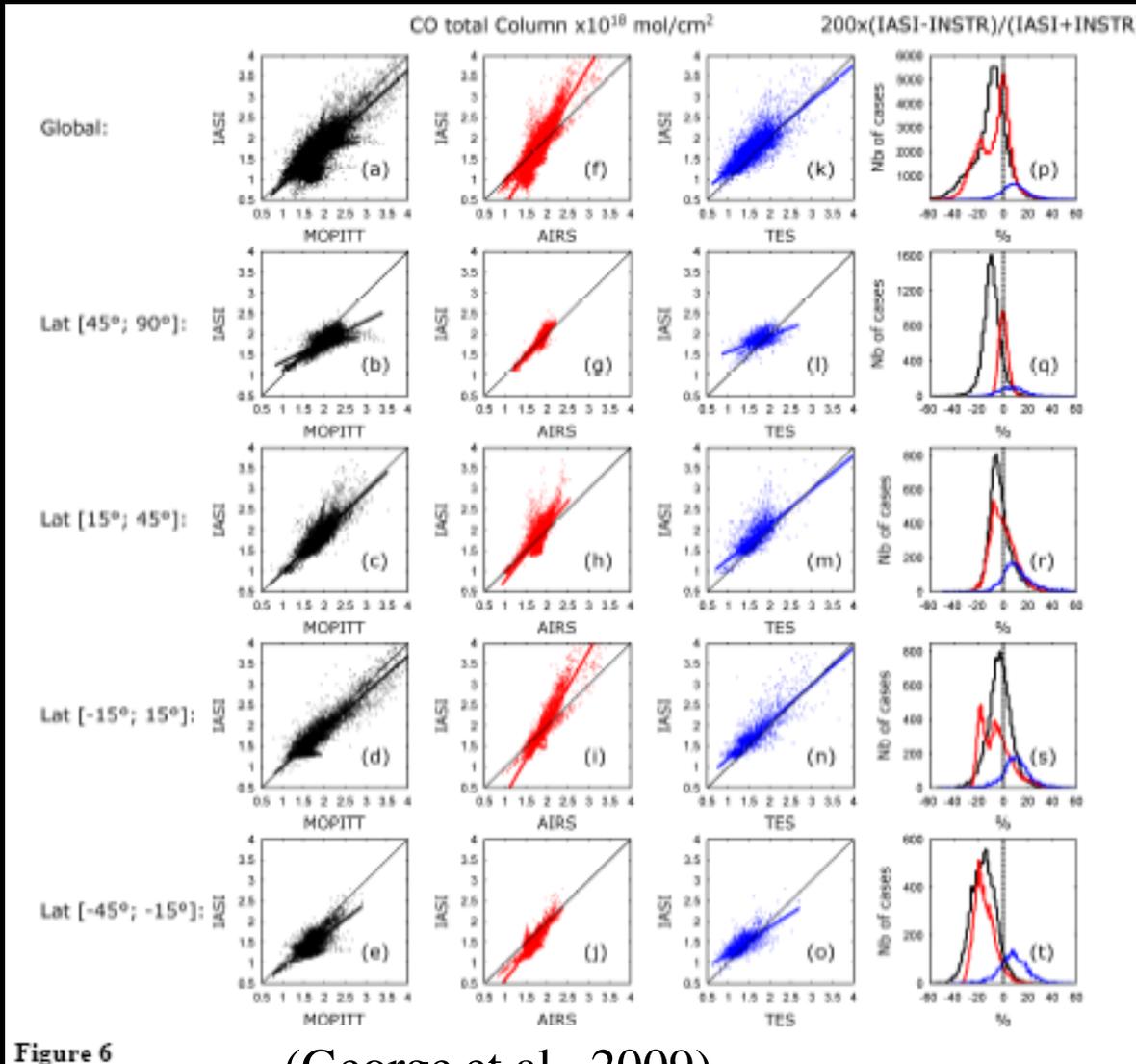
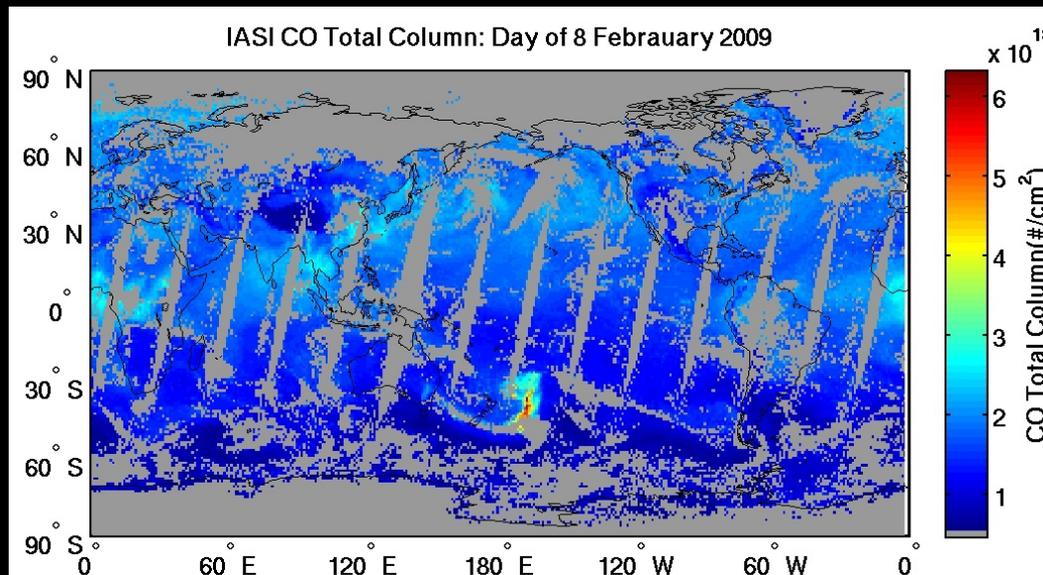
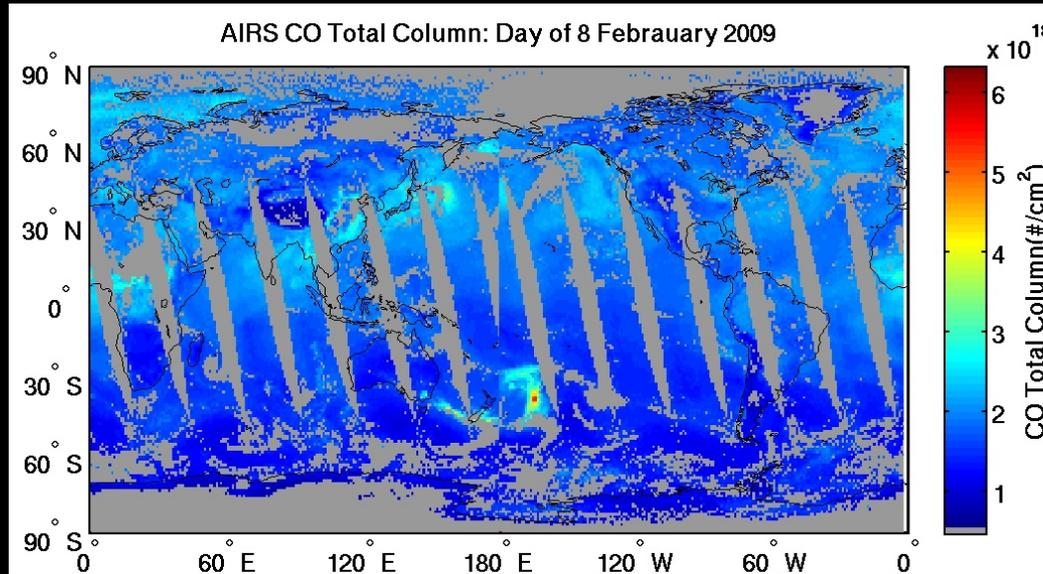


Figure 6

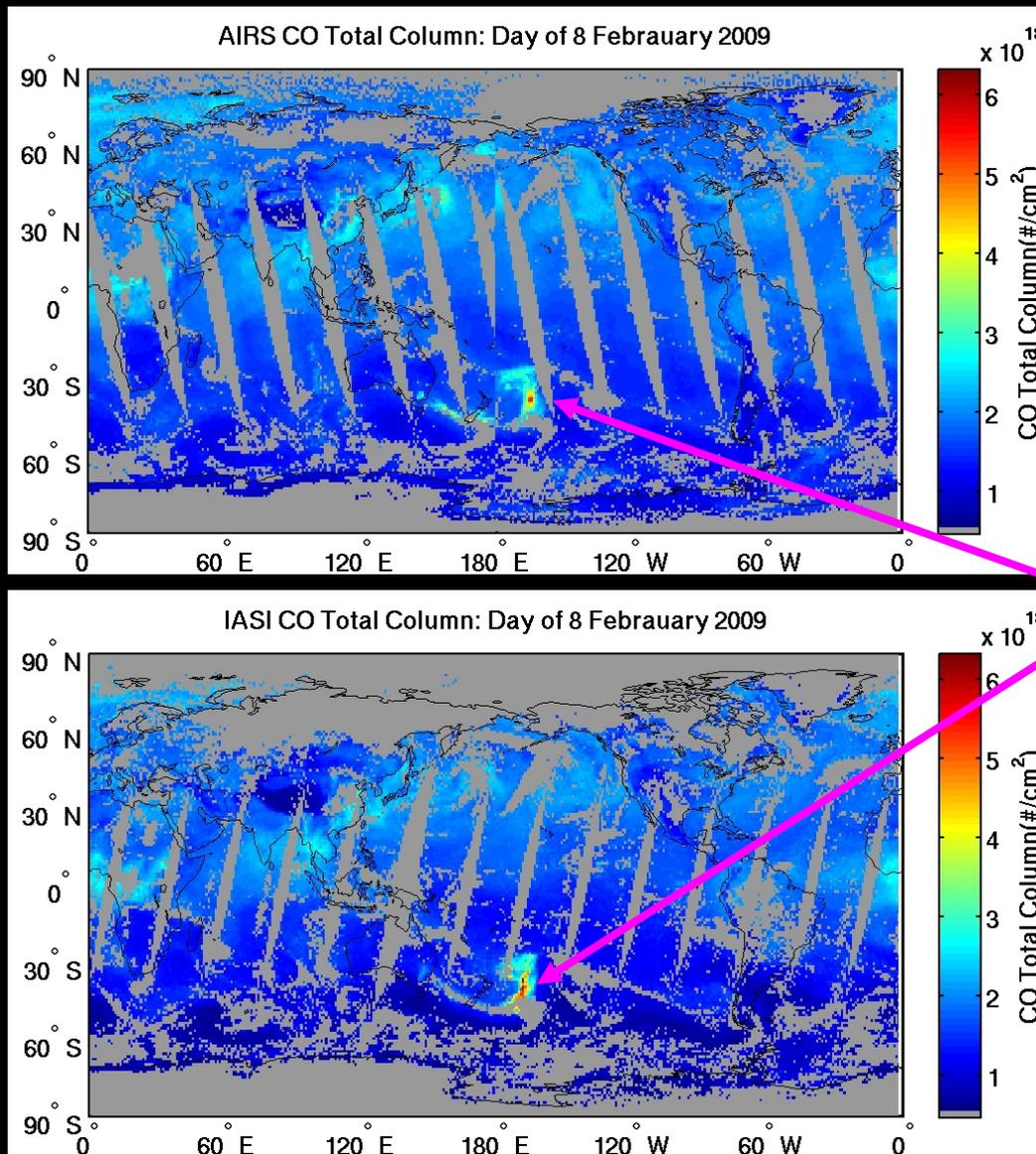
(George et al., 2009)

- August 2008
  - French retrieval
  - Cloud-free IASI
  - 1 deg bins
- MOPITT vs. IASI
  - 12% high
  - R = 0.81
- AIRS vs. IASI
  - 15% high in S
  - R = 0.91
  - skewed
- TES vs. IASI
  - 8.7% low
  - R = 0.83

# AIRS vs. IASI CO

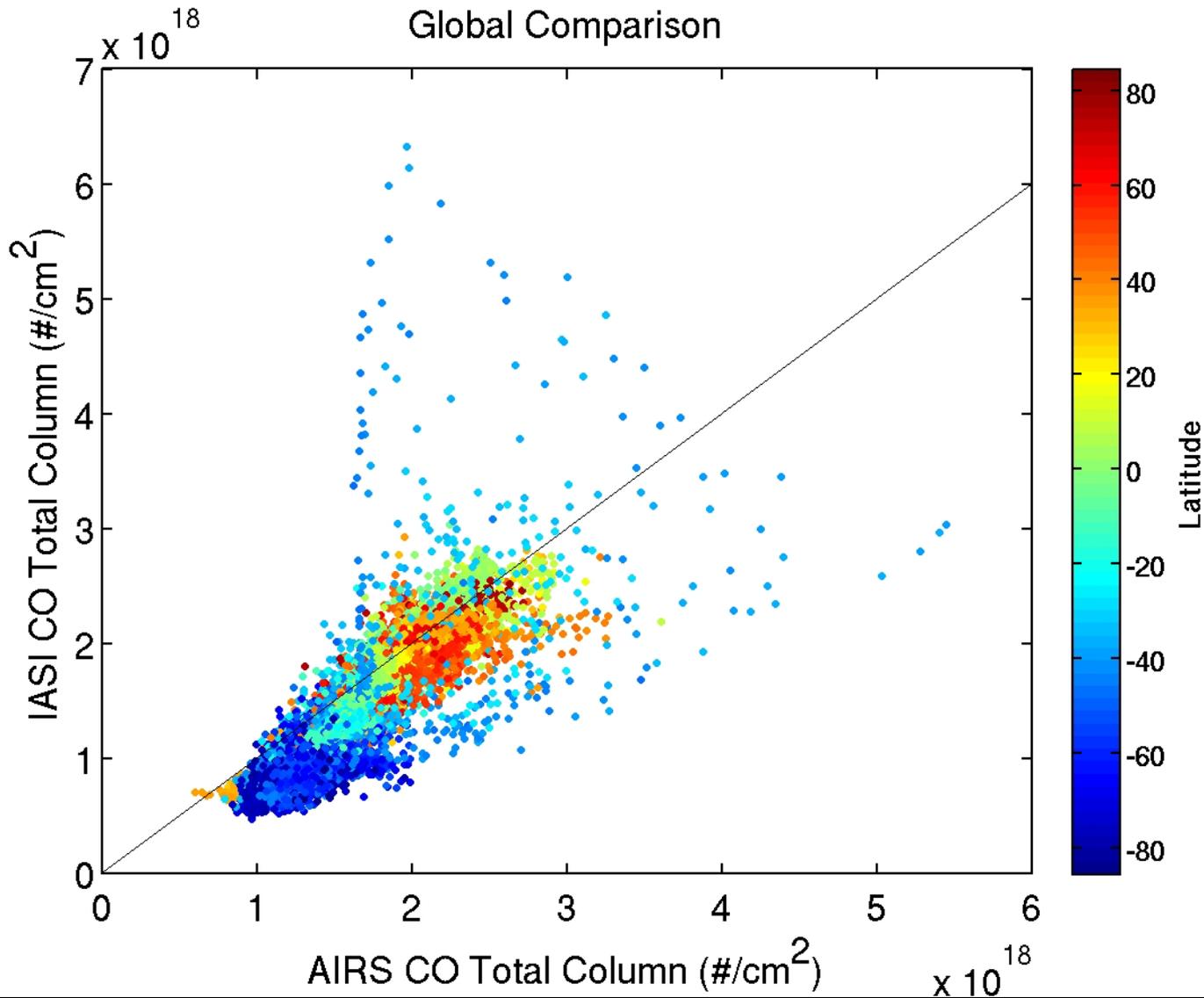


# AIRS vs. IASI CO

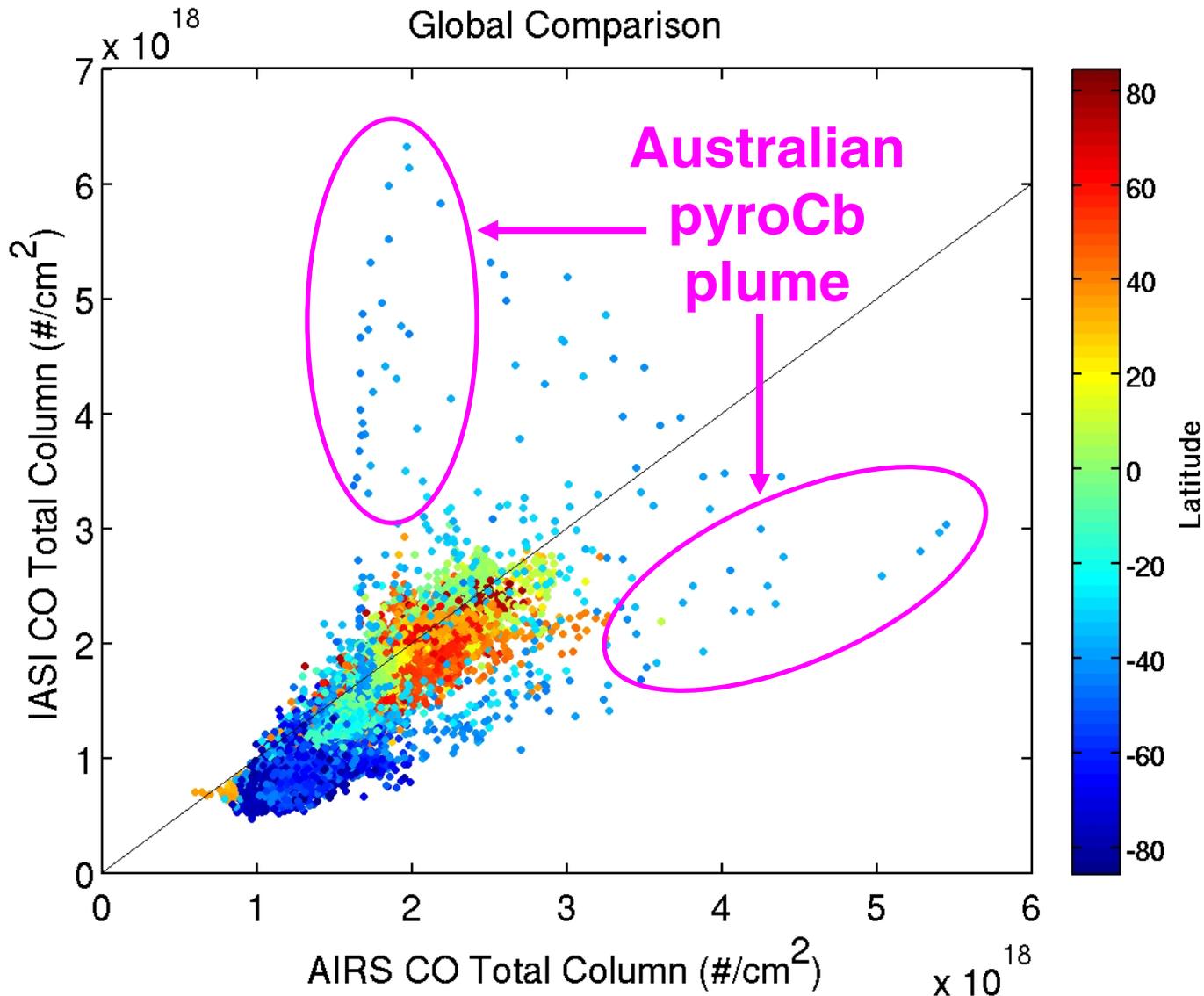


Australian  
pyroCb  
plume

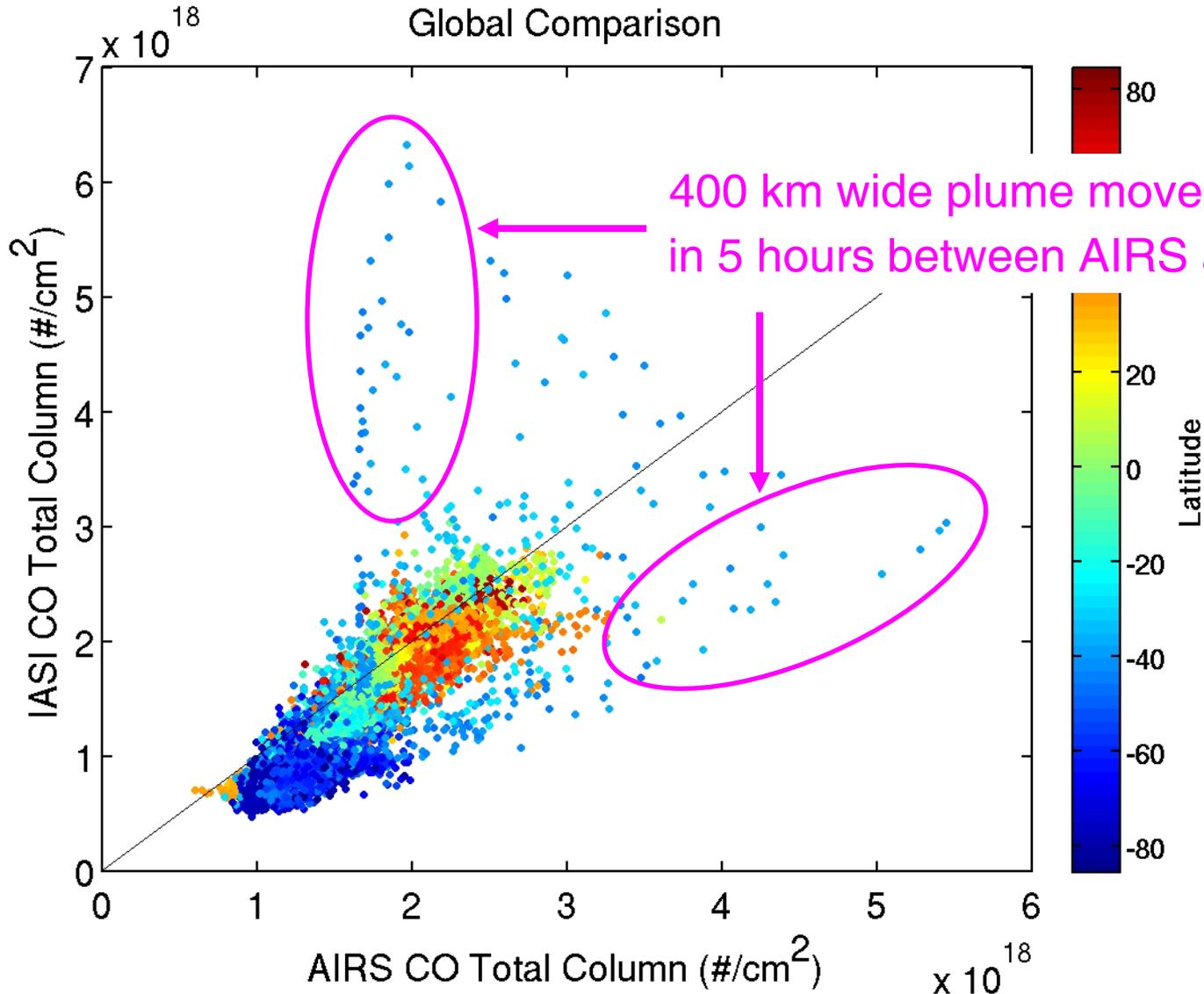
# AIRS vs. IASI CO



# AIRS vs. IASI CO

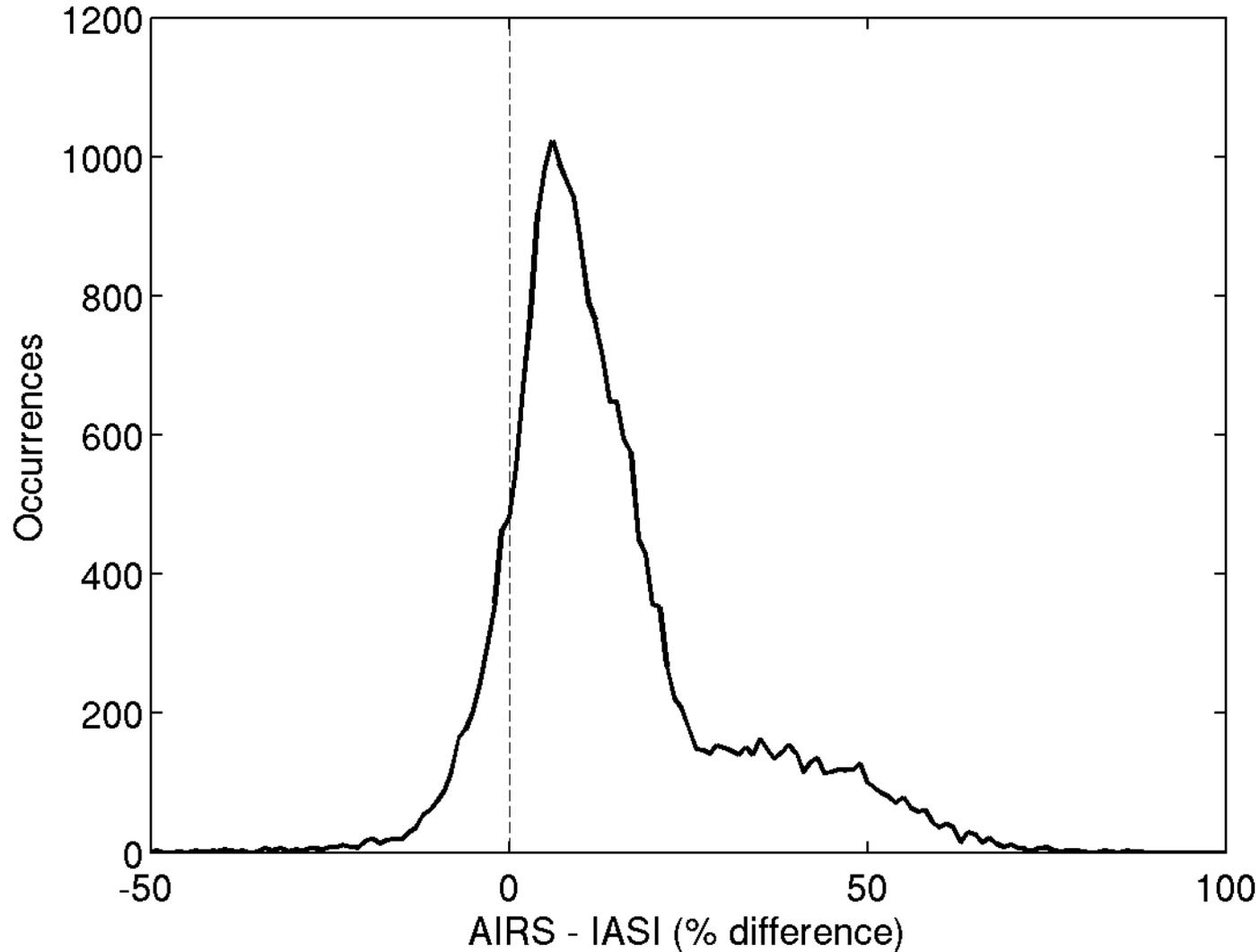


# AIRS vs. IASI CO



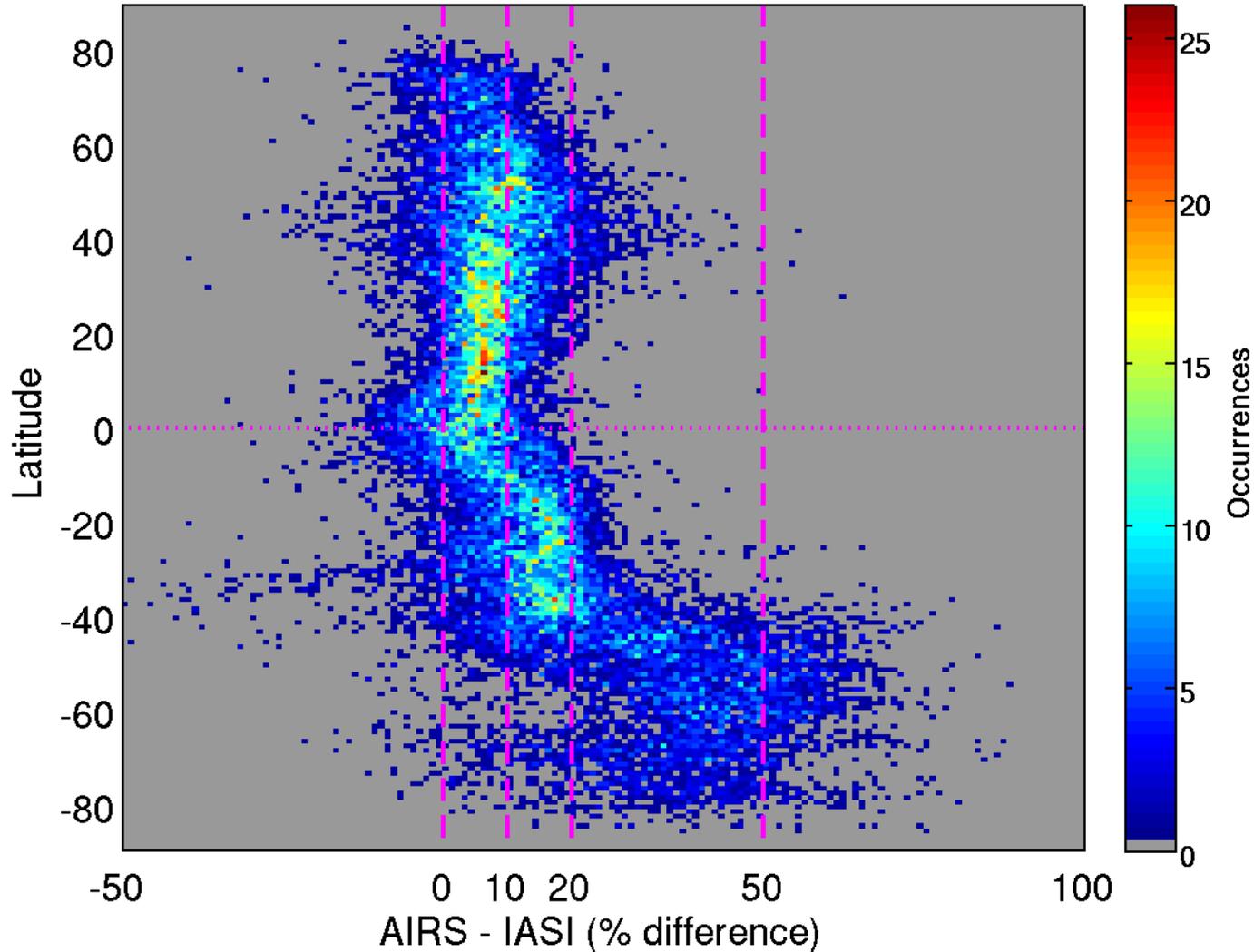
# AIRS vs. IASI CO

Global AIRS vs. IASI: Day of 8 February 2009



# AIRS vs. IASI CO

AIRS vs. IASI: Day of 8 February 2009



# AIRS vs. IASI CO



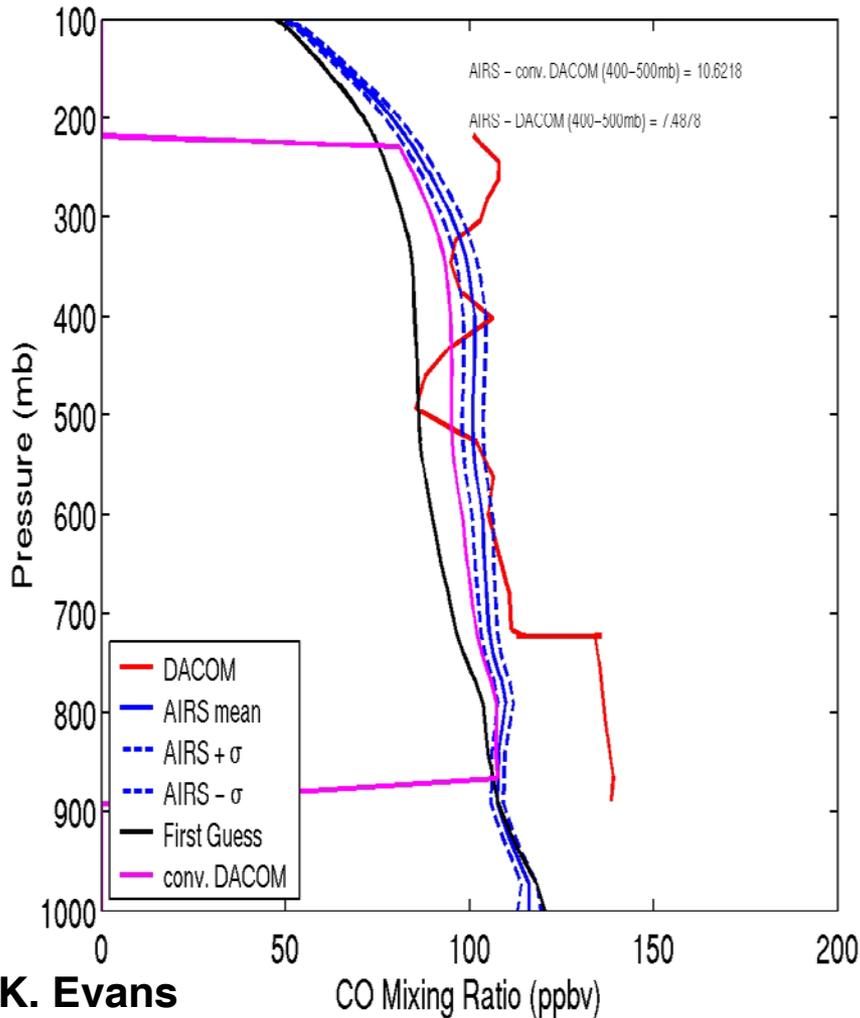
- One day of AIRS vs. IASI CO consistent with George et al. → AIRS is high
  - 80N to 10S → AIRS is 6-8% higher than IASI
  - 10S to 40S → AIRS is 10-20% high
  - 40S to 80S → AIRS is 20-60% high
  - **AIRS first guess is too high in the south where the atmosphere is cleaner**
  - **AIRS dynamic range is smaller → lower DOF**
  - **(AIRS – IASI) ~ (AIRS – validation)**
  - Transport effects are readily evident

# v6: Half bottom true vs. false

Half bottom = false

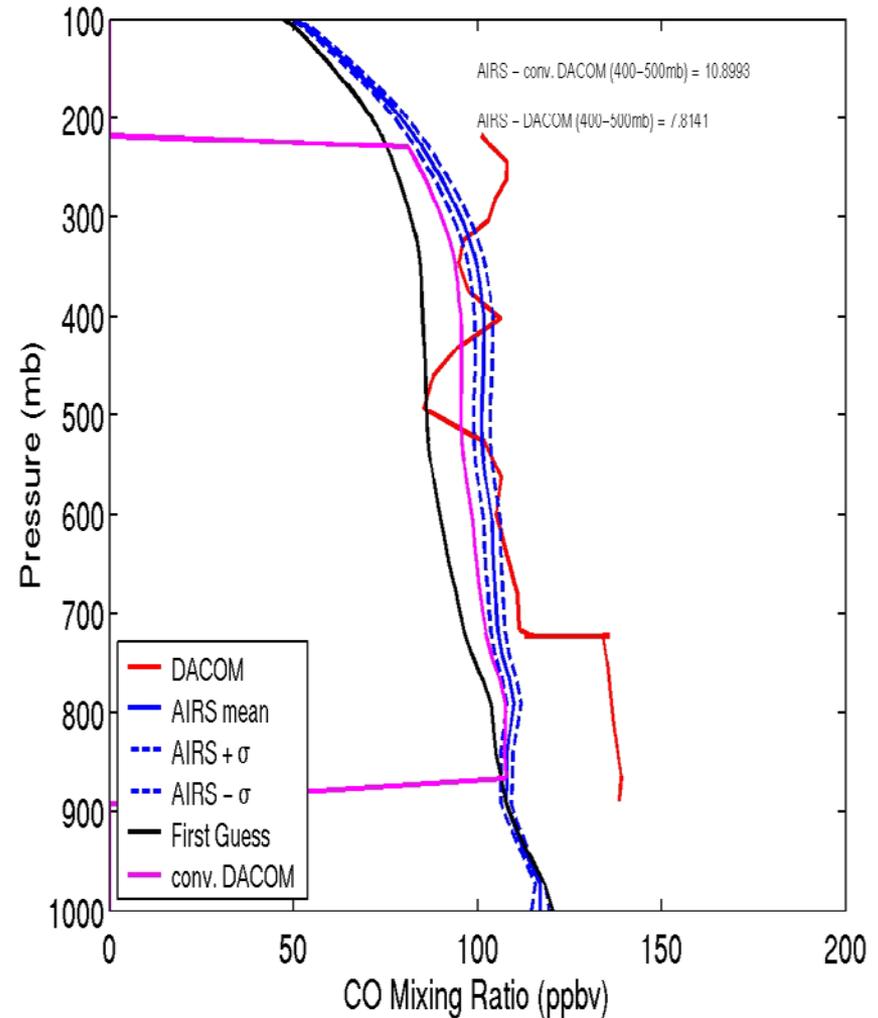
Half bottom = true

Retrieved vs. In Situ on 20040706

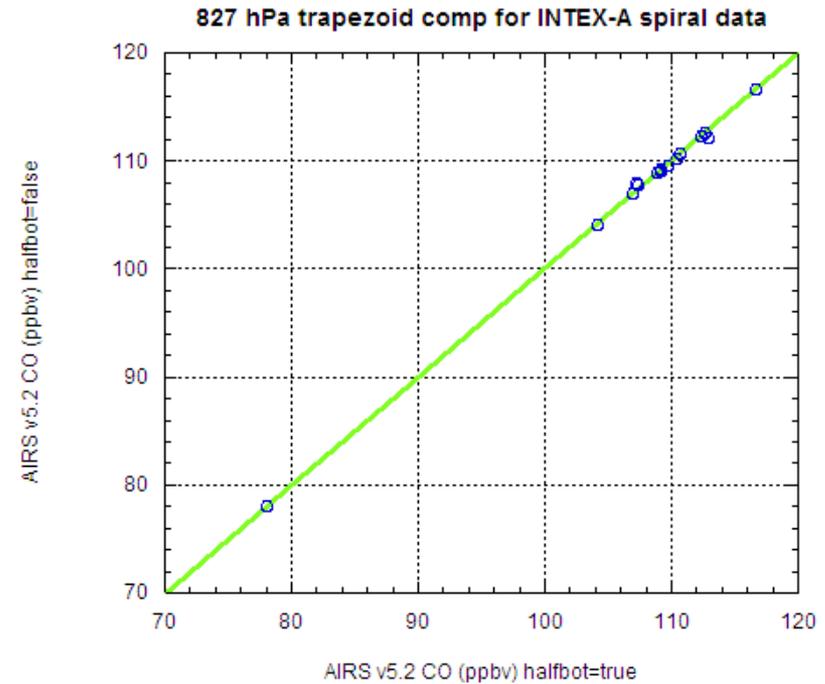
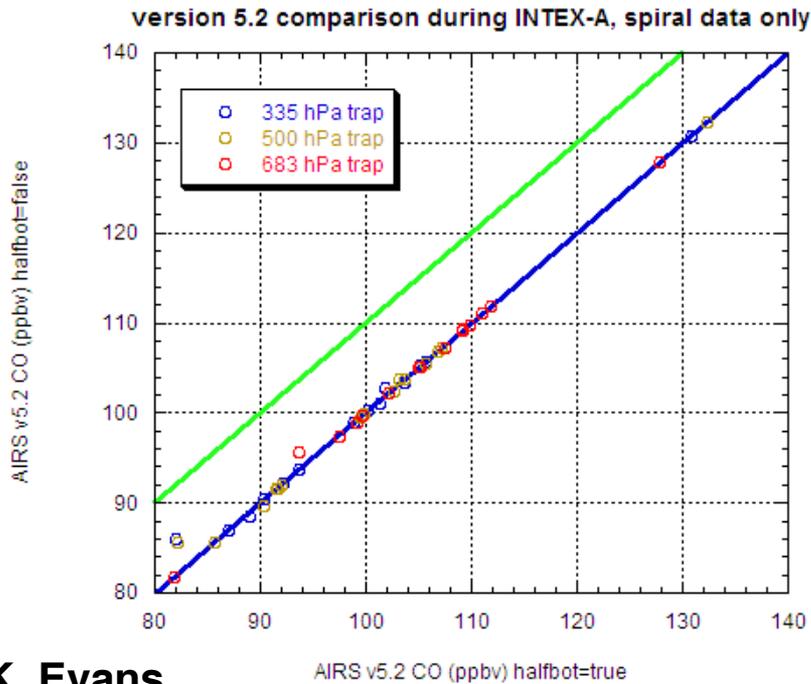


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Retrieved vs. In Situ on 20040706



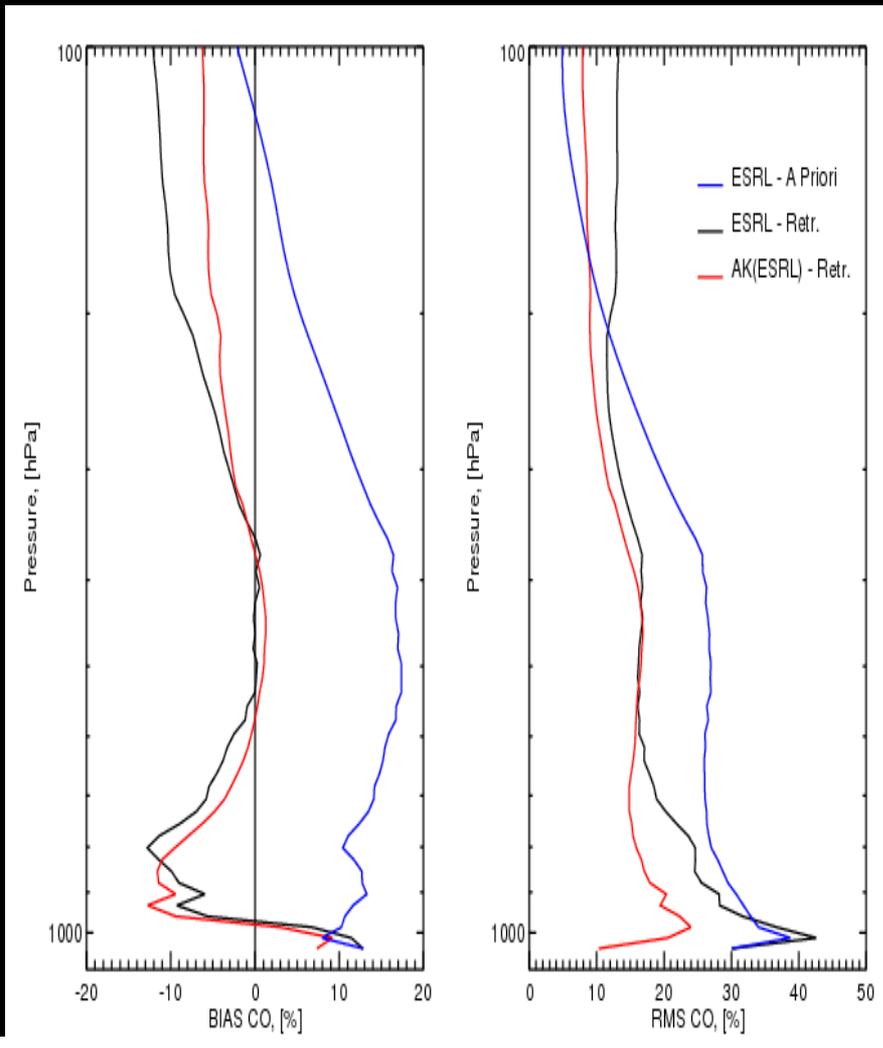
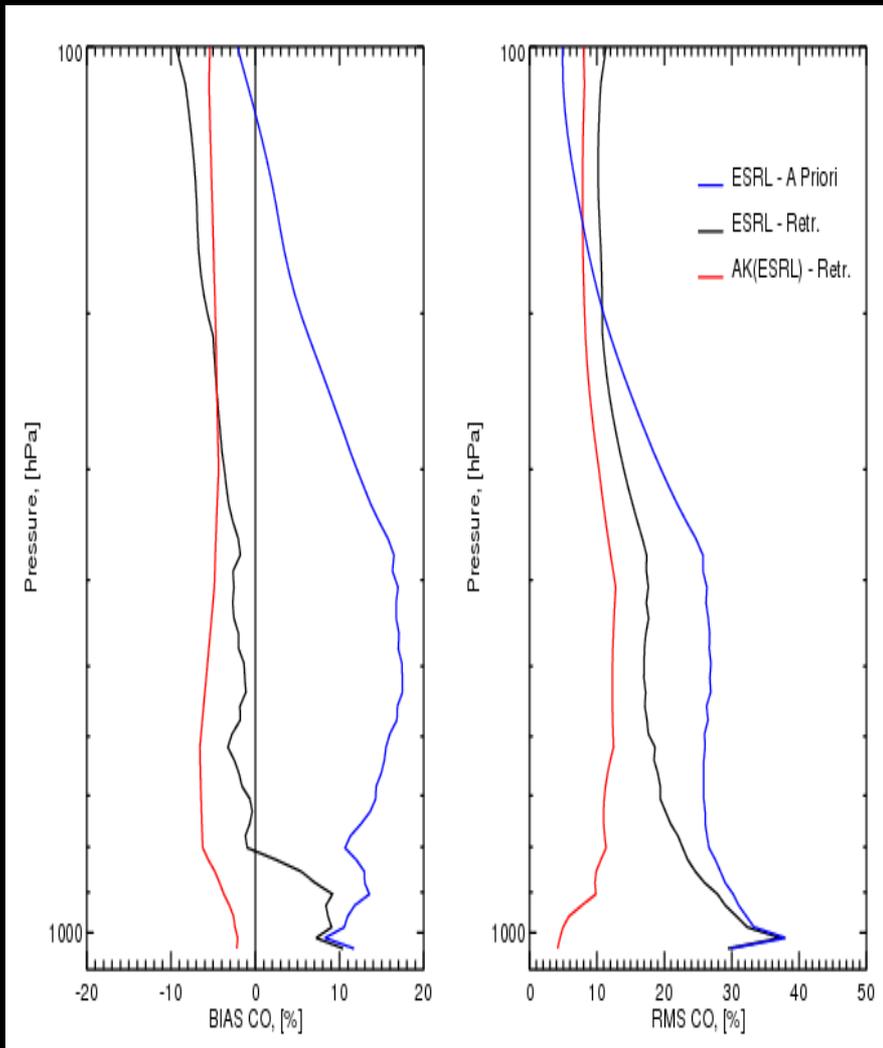
# v6: Half bottom true vs. false



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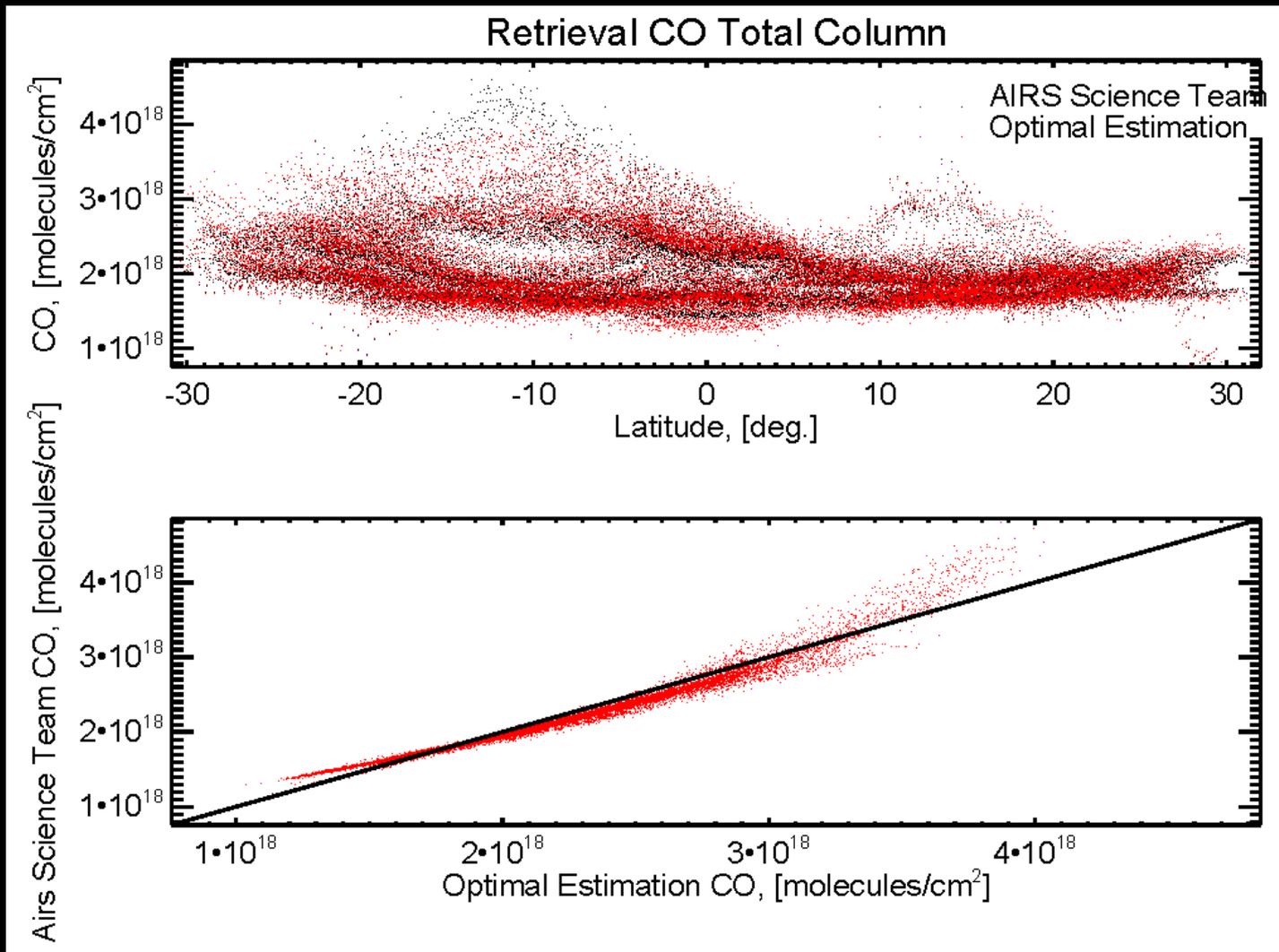
- Essentially no difference between half bottom true and false.
- Half bottom false yields true averaging kernels for retrieval.

# v5.0.14.0 vs. O-E



Eric Maddy (380 profiles, 24 sites 1/1/05-1/1/06)

# v5.0.14.0 vs. O-E



Eric Maddy

# v6 CO

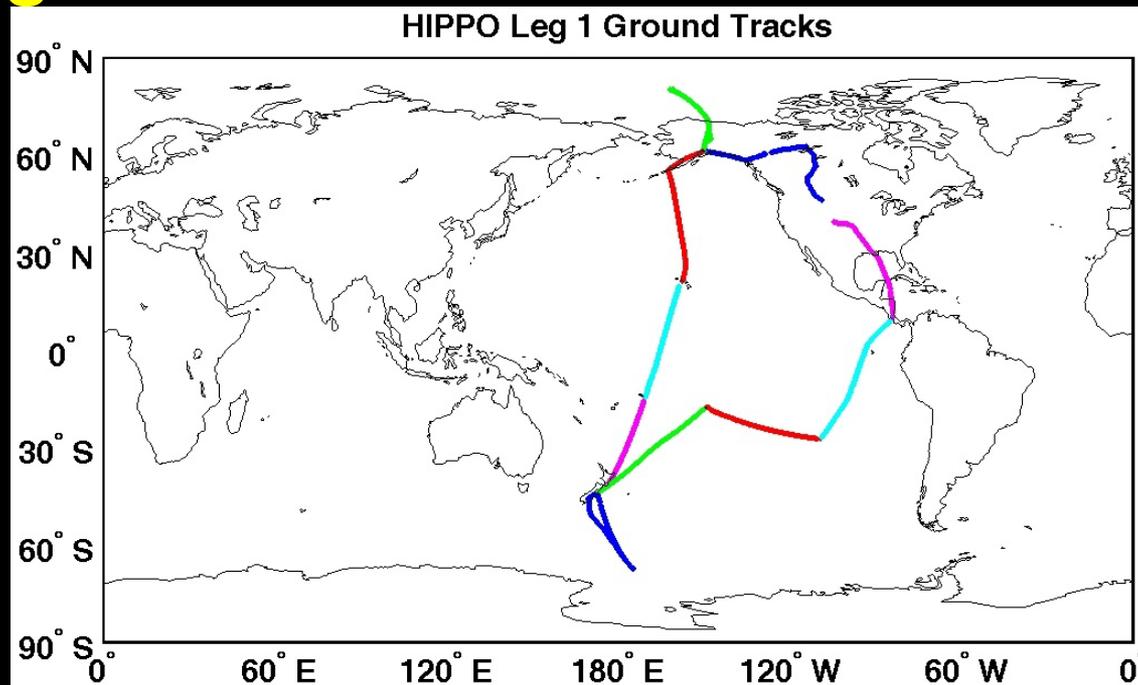
- **Change to half-bottom = false**
  - No significant impact on CO retrievals
  - Provides better averaging kernels (trapezoids sum to 1 everywhere)
- **When available from NOAA, evaluate CO optimal estimation for v6**
  - Should provide better error estimates
  - Appears comparable to v5 for total column
  - Appears unbiased at 500 mb

# L3 Averaging Kernels

- Requested by a modeling collaborator to ease comparison of model to AIRS
- Will compare convolution of model with L2 AK vs. L3 AK
  - Test is 8 days in August 2006, global coverage
  - Results expected in early summer
  - Could lead to new L3 CO output file
- Would like to see 0.25° AIRS L3 for tracer-tracer correlation and land use studies

# HIPPO

- Haper Pole to Pole Observations:  
NSF project using NCAR Hiaper aircraft
- First Leg January 2009
  - **10 flights covered 80N to 67S in three weeks**



# HIPPO

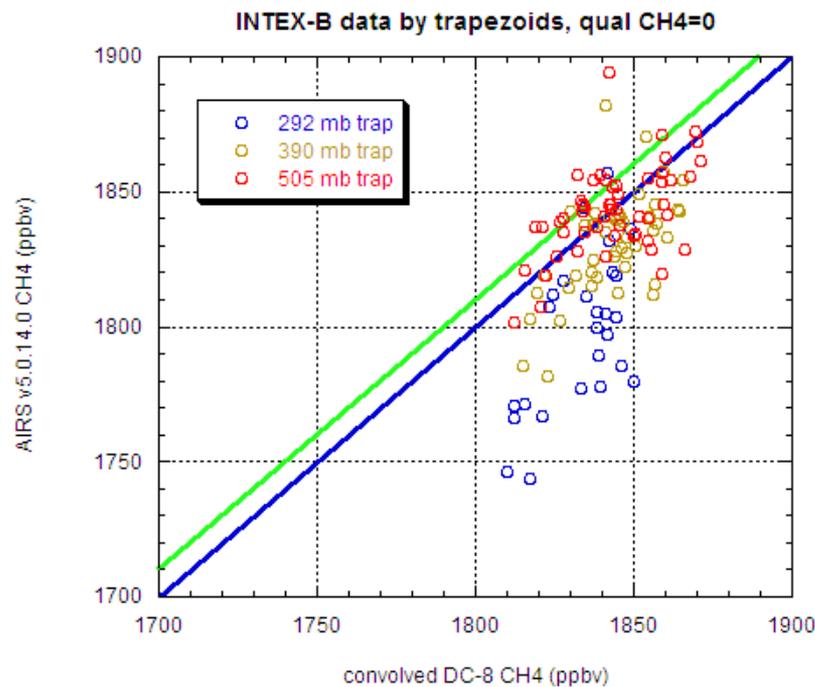
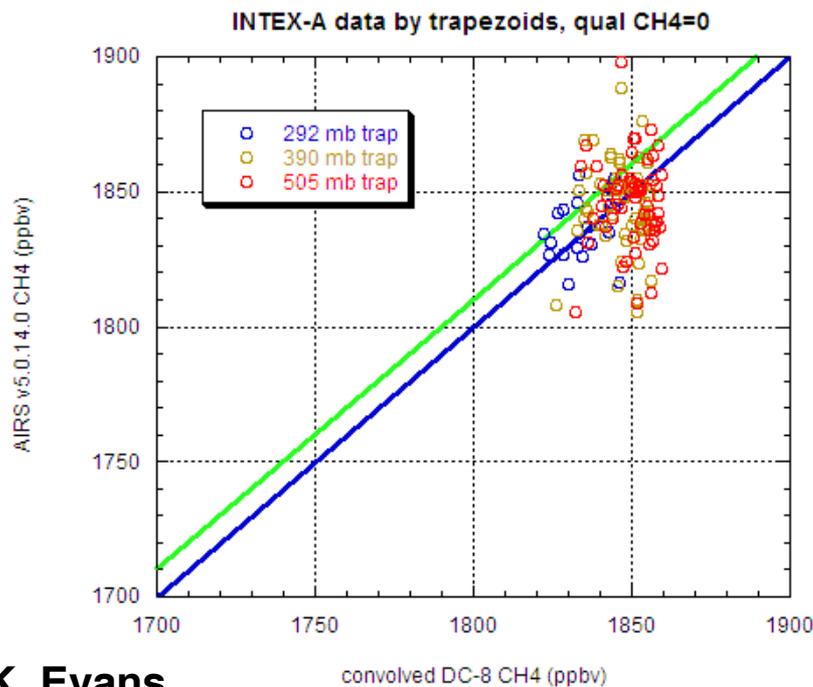


- Hiaper Pole to Pole Observations:  
NSF project using NCAR Hiaper aircraft
- First Leg January 2009
  - 10 flights covered 80N to 67S in three weeks
  - 134 profiles: 34 to 200 mb, 100 to 350 mb
  - Preliminary CO, CH<sub>4</sub>, and CO<sub>2</sub> data in hand
- 4 more legs planned in next 3 years in different seasons

# v5: INTEX-A/B CH<sub>4</sub> Validation

- INTEX-A (59 profiles) results marginally better than INTEX-B (56 profiles)
- Little systematic difference between spiral (29) and in-transit (86) profiles
- 292, 390, and 505 mb trapezoids look good
- 770 mb trapezoid poorly correlated to in situ
- Error correlates with DOF but not Latitude
- No correlation with Qual  $T_{\text{bottom}}$  or  $T_{\text{skin}}$  error over ocean

# v5: INTEX-A/B CH<sub>4</sub> Validation

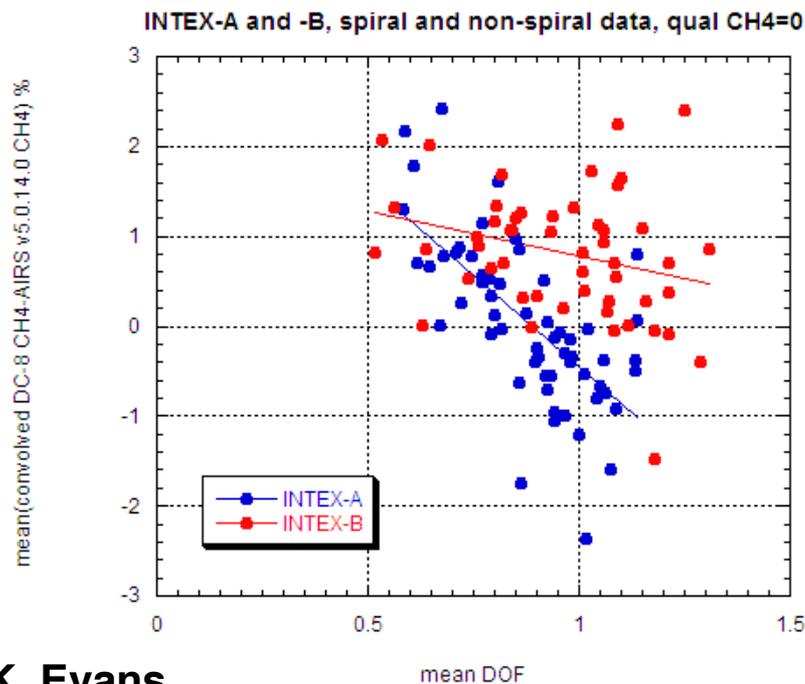


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- Upper and middle tropospheric (200-600 mb) CH<sub>4</sub> looks good
- Lower tropospheric CH<sub>4</sub> trapezoid shows poor validation

# v5: INTEX-A/B CH4 Validation

- 200-600 mb average (3 trapezoids)

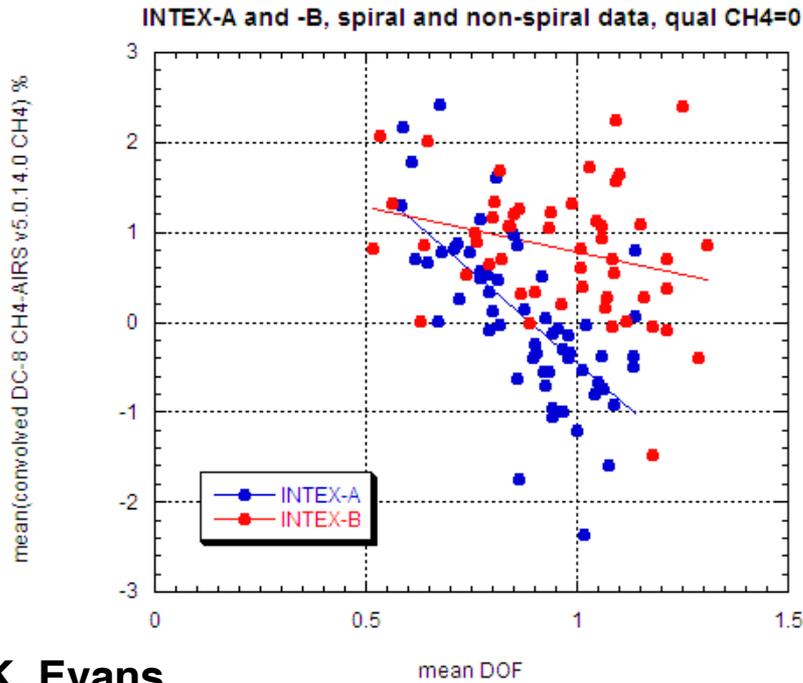


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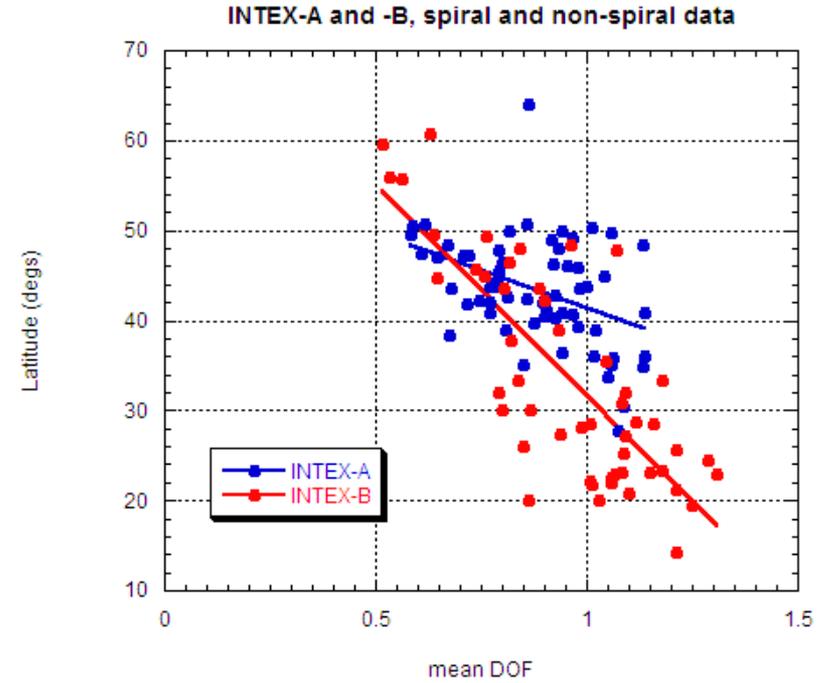
- INTEX-A shows trend, INTEX-B does not
- Xiaozhen Xiong suggested we examine DOF vs. Latitude

# v5: INTEX-A/B CH4 Validation

- 200-600 mb average (3 trapezoids)



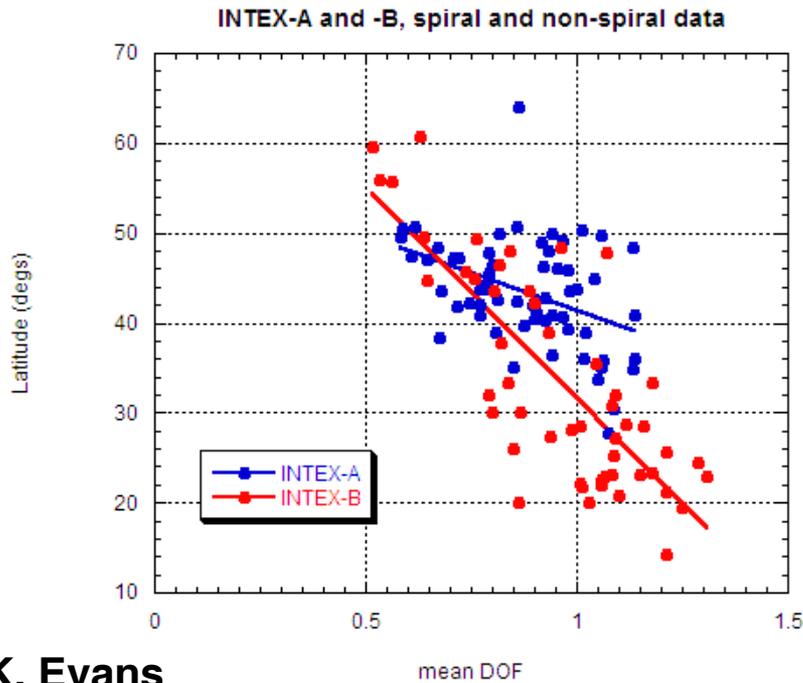
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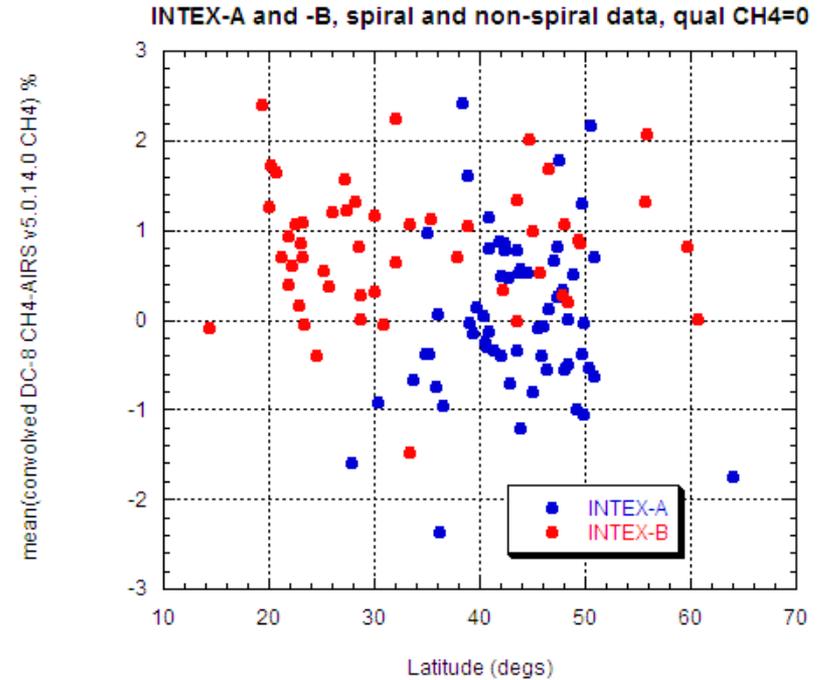
- INTEX-A shows trend, INTEX-B does not
- Xiao Zhen suggested we examine DOF vs. Latitude

# v5: INTEX-A/B CH4 Validation

- 200-600 mb average (3 trapezoids)



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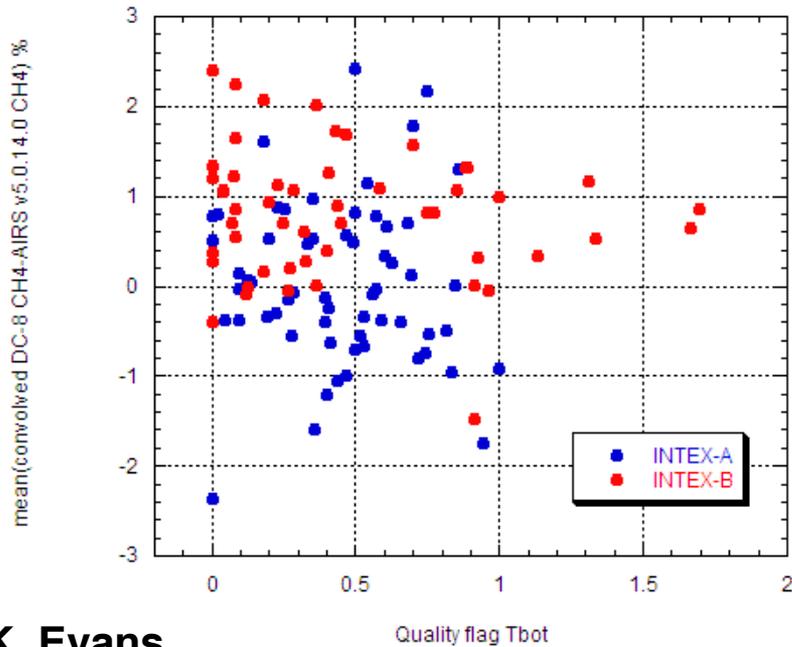


- 200-600 mb average (3 trapezoids)
- INTEX-B shows strong DOF(lat), but not a trend in errors!

# v5: INTEX-A/B CH4 Validation

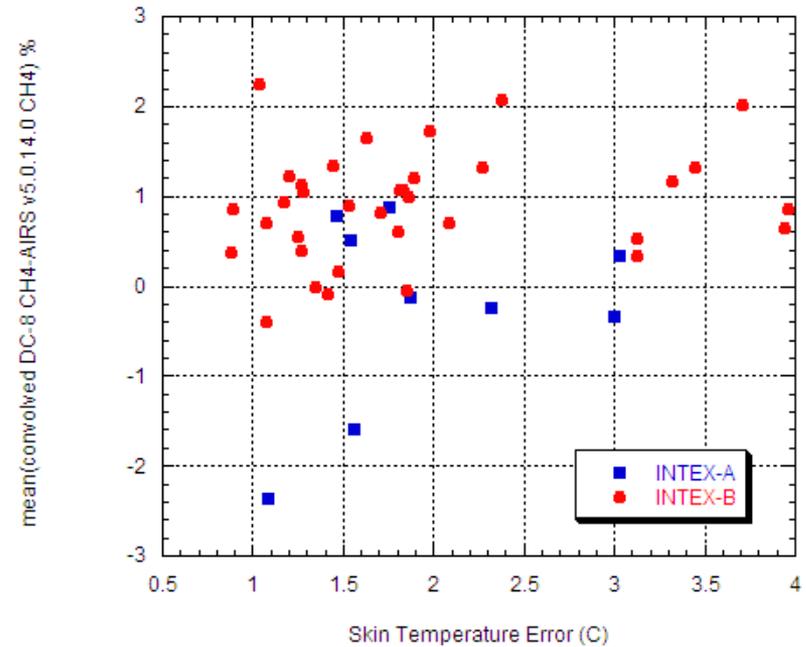
- 200-600 mb average (3 trapezoids)

CH4 quality flag = 0



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Only ocean data, qual flag ch4 = 0

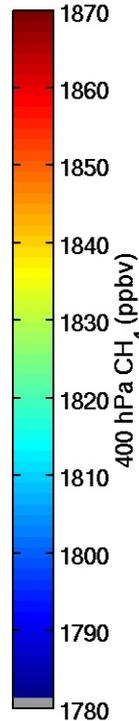
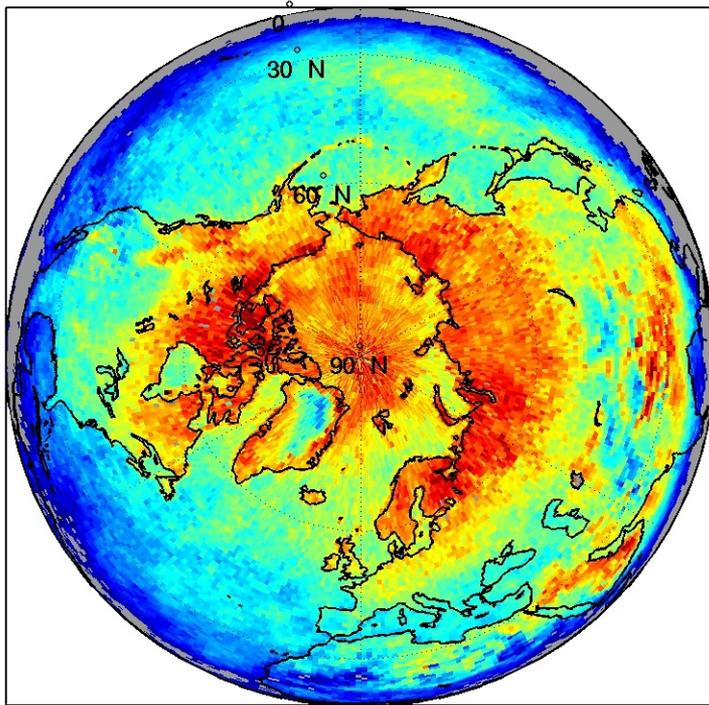


- Bill Irion suggested we examine surface temperature impacts
- No trends with Qual\_T\_bot or Tskin error

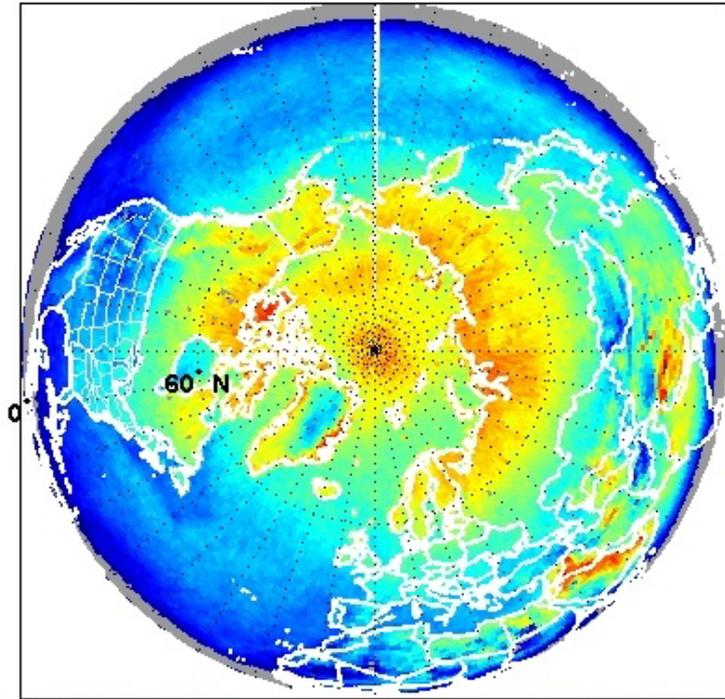
# CO and CH<sub>4</sub> Global Trends

Presented by Leonid Yurganov at last AIRS STM

AIRS CH<sub>4</sub>: 09/2008

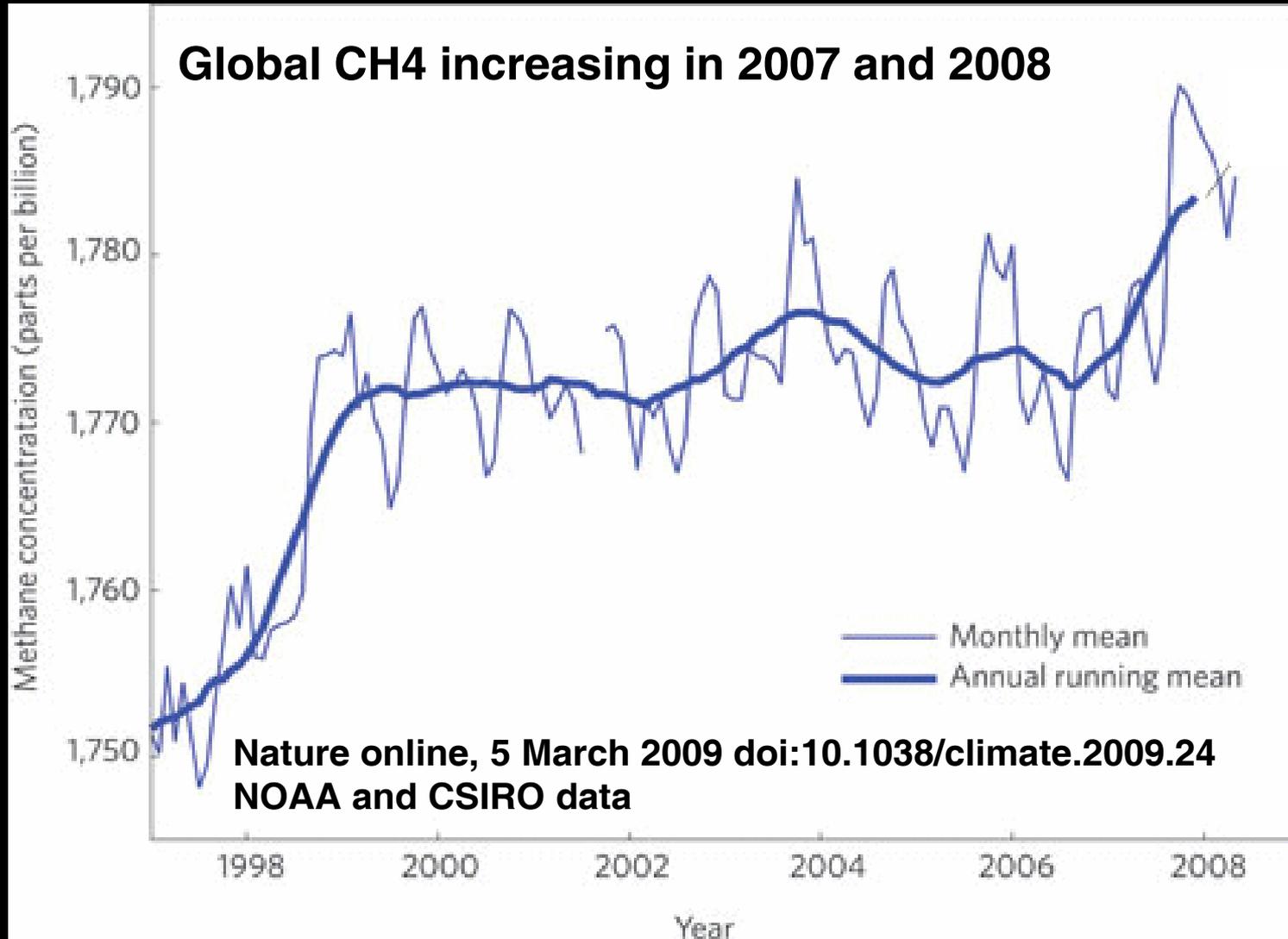


AIRS multi-year mean CH<sub>4</sub> at 400 mb for mon=.09.



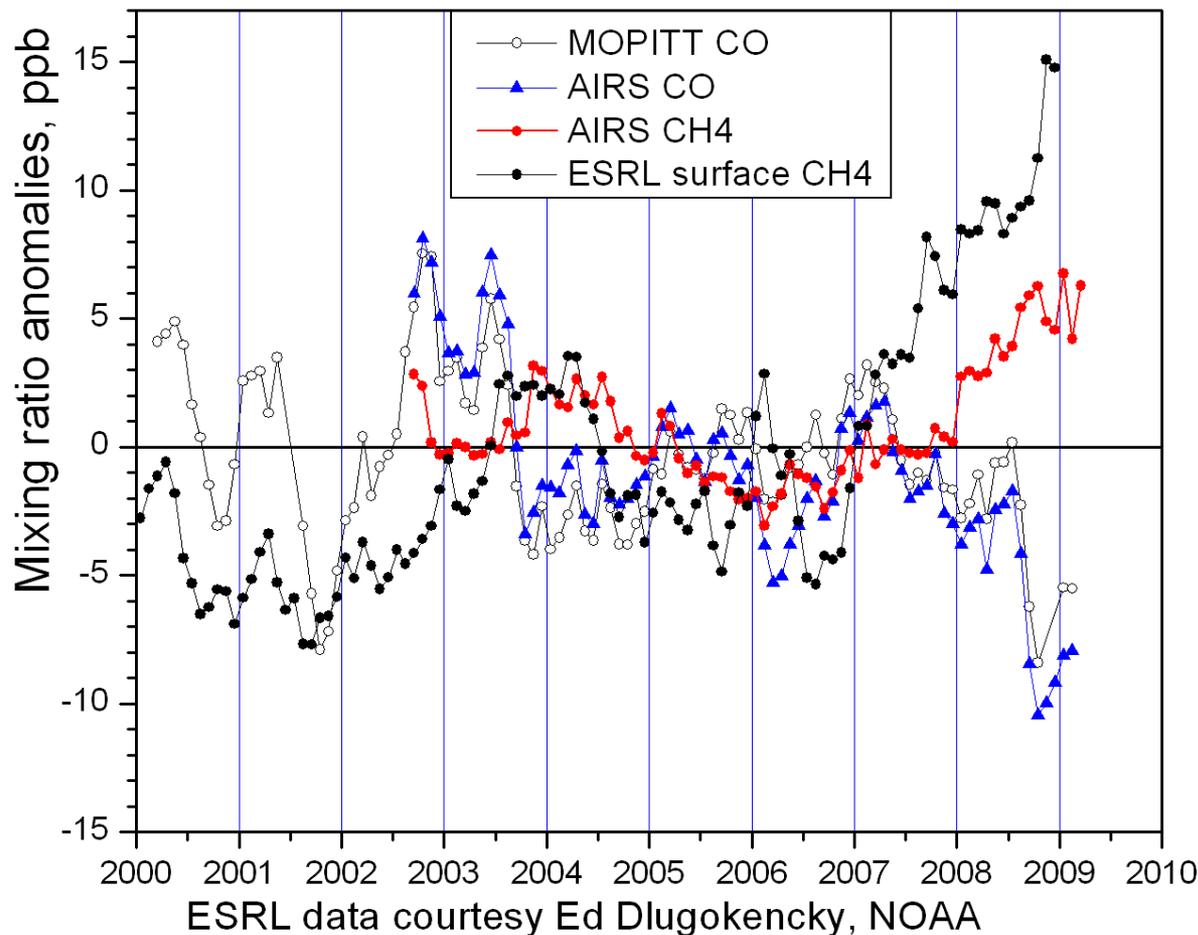
Apparent large increase in Arctic CH<sub>4</sub> during late summer

# CO and CH4 Global Trends



# CO and CH<sub>4</sub> Global Trends

Global anomalies of CO (500 mb) and CH<sub>4</sub>(400 mb), referred to 2003-2007

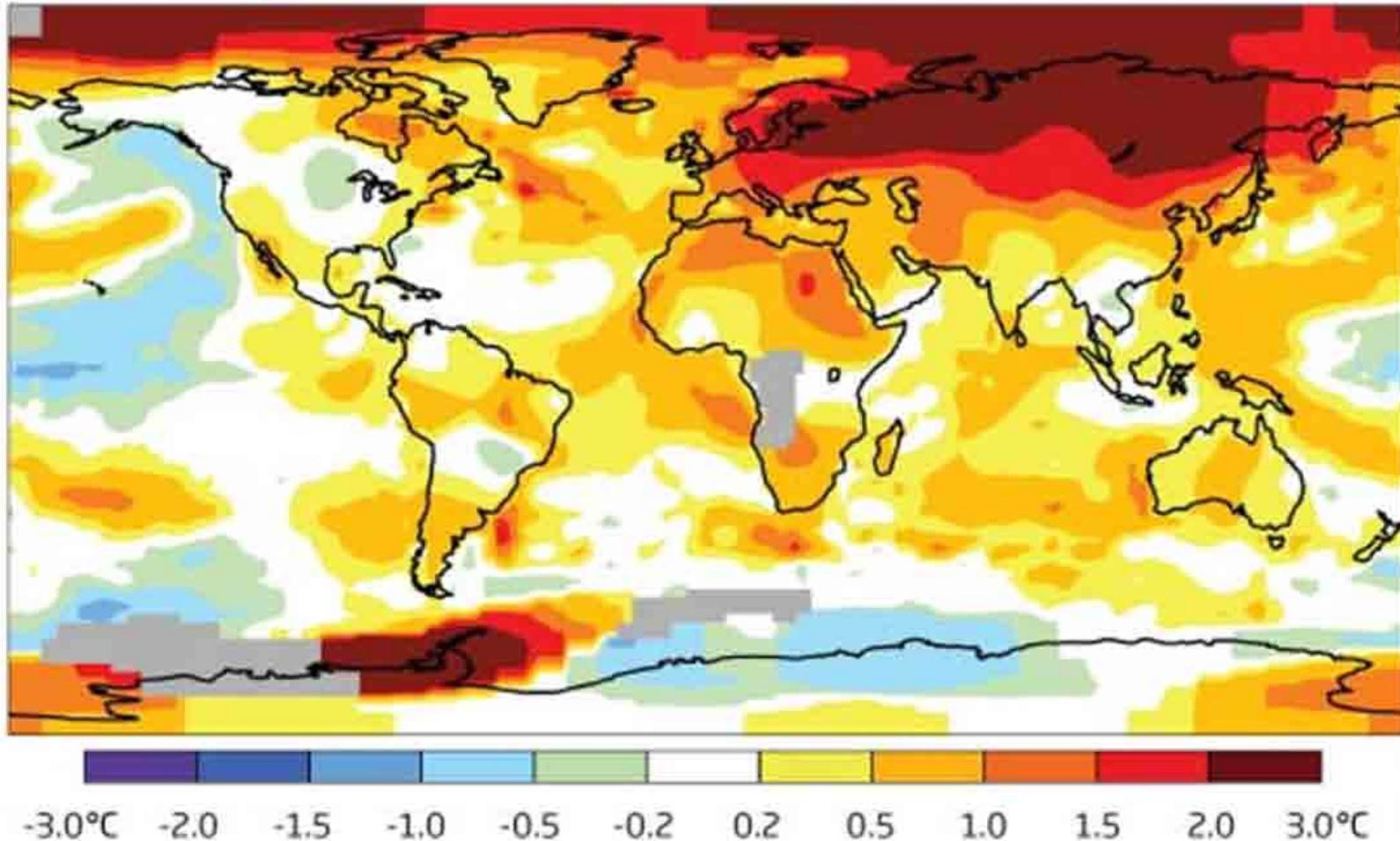


L. Yurganov

# CO and CH<sub>4</sub> Global Trends

In 2008, temperatures across much of the far north were more than 2 °C higher than the 1951-1980 average

(Pierce, *New Scientist*, 2009)



# CO and CH<sub>4</sub> Global Trends



- **Globally in 2008**
  - **CH<sub>4</sub> was up sharply**
    - Free troposphere (AIRS) lagged surface (NOAA)
    - Polar warming?
  - **CO was down sharply in mid-2008**
    - AIRS and MOPITT see similar trend
    - No apparent decrease in fire activity
    - Global economic slowdown?
    - Recovering in late 2008 and early 2009?

# Summary



- v5 CO Validation: writing up now
- **AIRS vs. IASI: just started, looks good**
- v6 CO:
  - Propose to use Half-bottom = false
  - NOAA CO Optimal Estimation algorithm?
- L3 CO averaging kernels: evaluating
- Validation with HIPPO data: started
- v5 CH4 Validation: 200-600 mb good
- **2008 Global: CO down, CH4 up**