



# IASI carbon monoxide validation over the Arctic

**UPMC**  
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12 University of York, UK

*thesis grant from:*



- General description: *POLARCAT-France objectives*
- IASI
  - *Satellite instrument (METOP), retrievals, ...*
  - *CO observations: long-range transport*
- Aircraft measurements vs satellite observations
  - IASI CO compared to flight CO
  - Validation of IASI vertical CO profiles
  - Quantitative comparisons of total columns
- Conclusions & Perspectives

2 campaigns in 2008: April (Sweden) & July (Greenland)

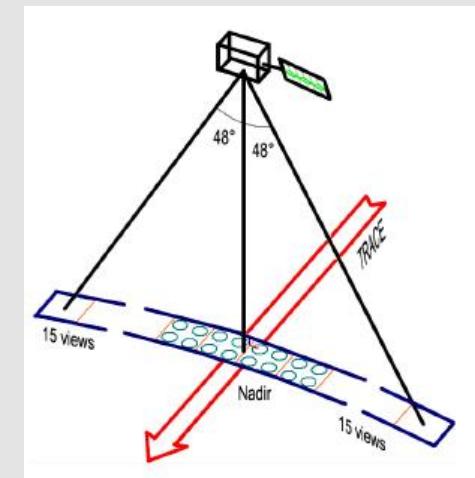
### Objectives:

- **Satellite validation in Arctic:** IASI and CALIPSO
- **Transport of pollutant plumes into/out of Arctic :** anthrop and BB  $\Rightarrow$  comparison between in-situ and satellite measurements (IASI) + global model (LMDz-INCA)
- **Impact of boreal forest fires in Arctic tropospheric chemistry**  $\Rightarrow$  O<sub>3</sub> budget
- **Aerosol properties** in pollutant-haze layers
- **Plume processing** - photochemistry and aerosols - Lagrangian analysis, plume dispersion, radiative impacts of aerosol layers
- **Deposition of pollutants** over Greenland (wet / dry) – link with Summit in-situ observations  $\Rightarrow$  **impact on Arctic climate**

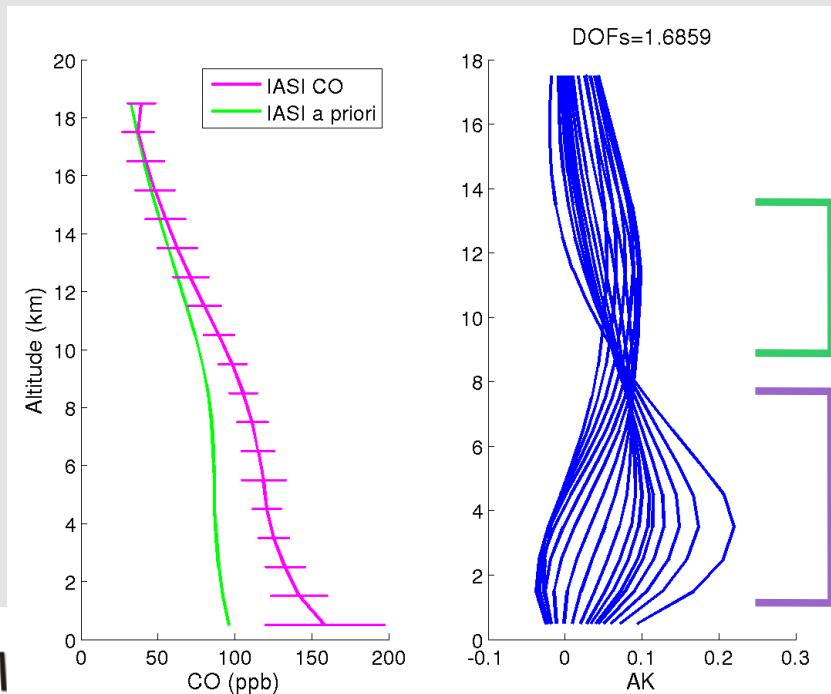
# Infrared Atmospheric Sounding Interferometer (IASI)

- spectral range = 645 to 2760  $\text{cm}^{-1}$  – CO~2143-2181 $\text{cm}^{-1}$
- spectral resolution = 0.5  $\text{cm}^{-1}$
- FORLI-CO software [Turquety et al., 2009, George et al., 2009]
- ➔ 2 CO products: profile, total column - see poster of J. Hadji-Lazaro
- based on Optimal Estimation Method [Rodgers, 2000]

IASI L1 & L2 on ether database: <http://ether.ipsl.jussieu.fr>



Clerbaux et al.,  
ACP, 2009

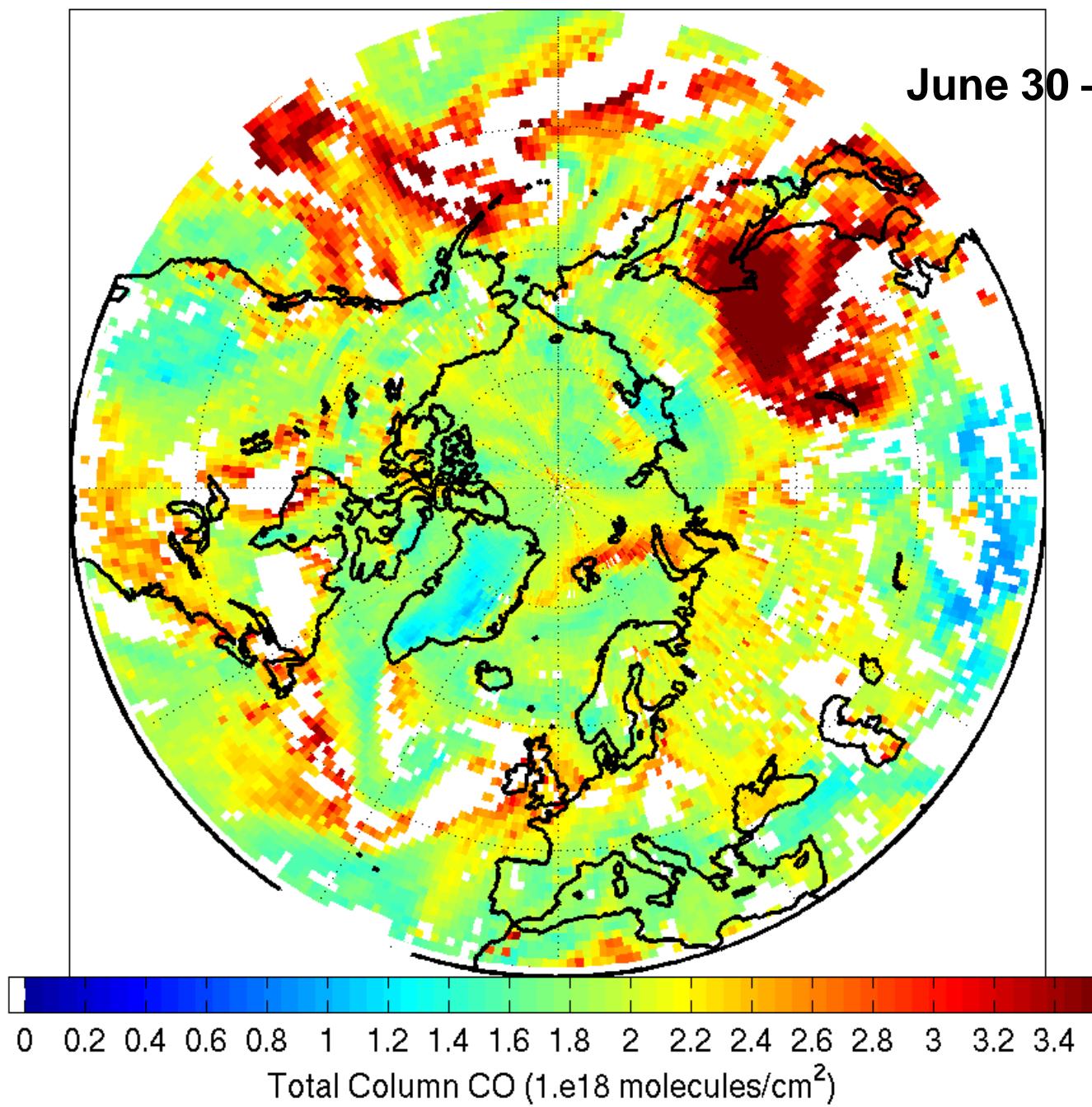


sensitivity decreases close to Pole  
sensitivity around 9-14km  
sensitivity around 1-7km  
Degree Of Freedom of Signal (DOFS)=[0.8 2.4]

George et al.,  
ACP, 2009

20080630 (day)

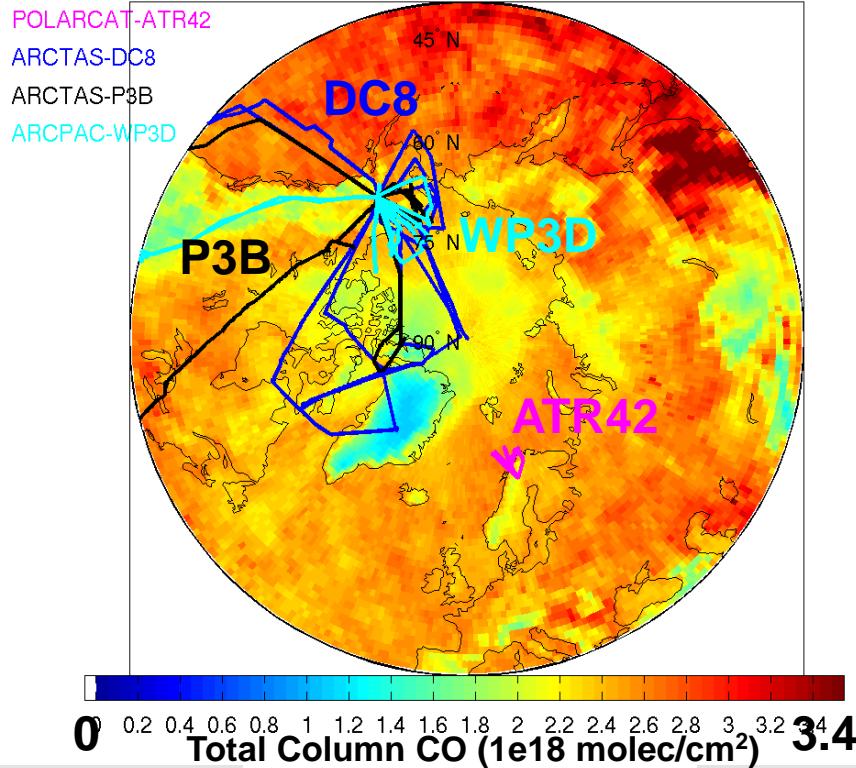
June 30 – July 14



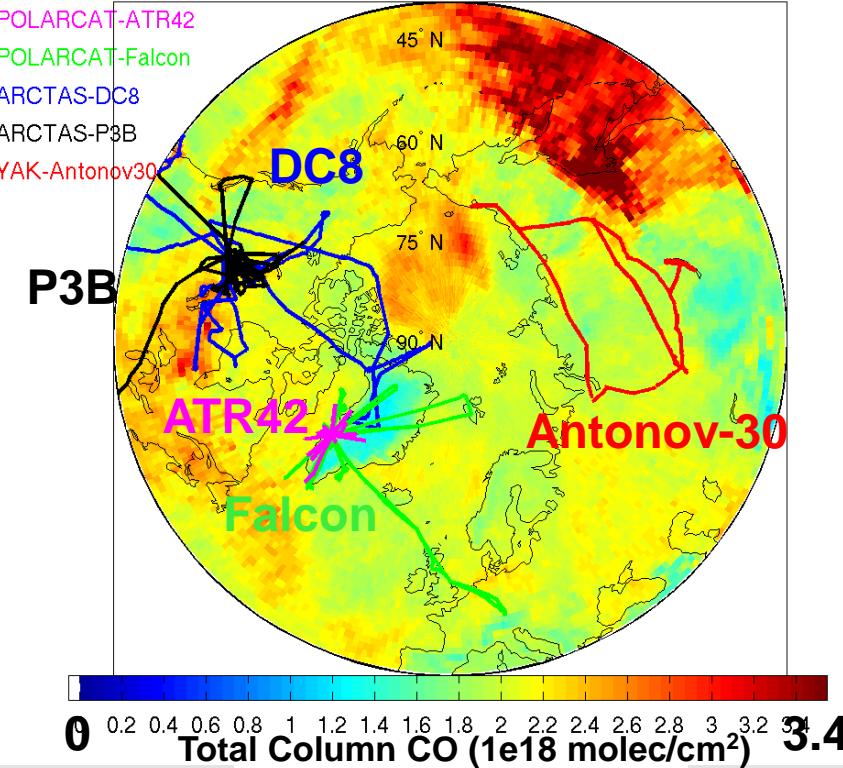
# Arctic sampling area



cks (spring campaigns) April 2008



flight tracks (summer campaigns) July 2008



number of profiles collocated with IASI used for each aircraft:

ATR-42: 15

DC-8: 32

P3-B: 5

WP-3D: 20

ATR-42: 8

Falcon: 16

DC-8: 19

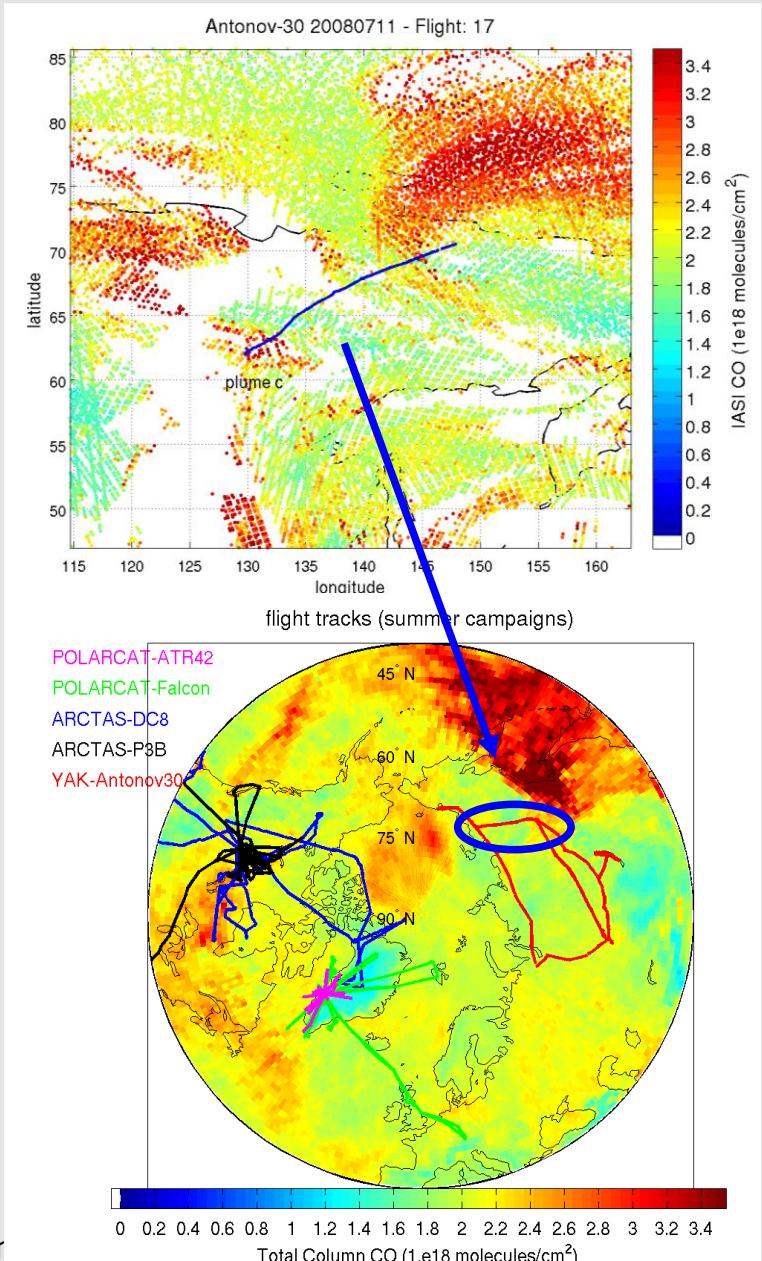
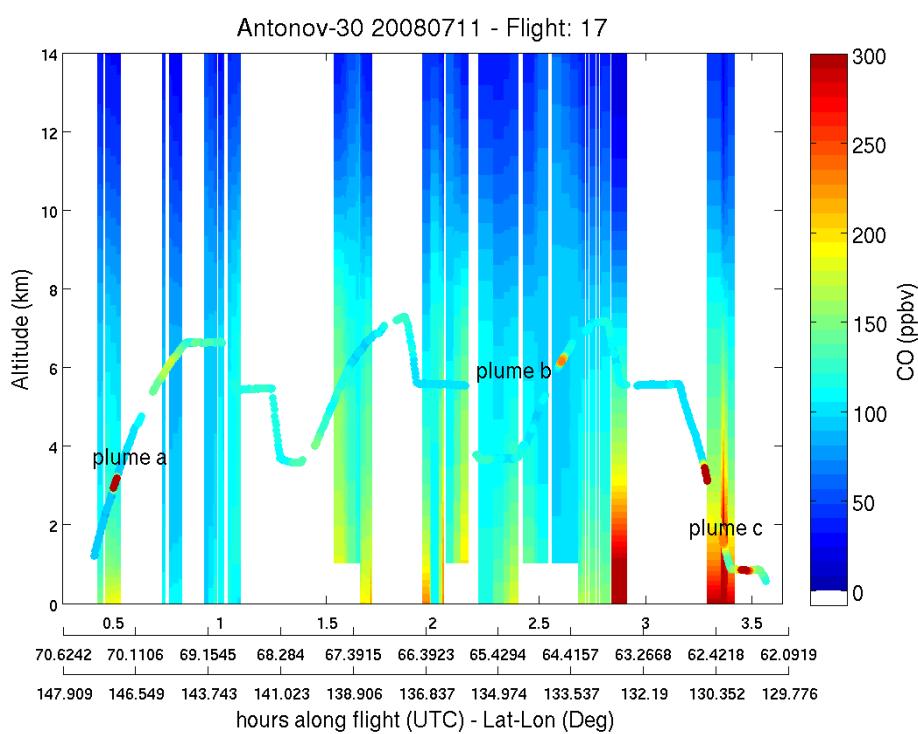
P3-B: 14

Antonov-30: 22

collocation: +/- 0.2° 1h

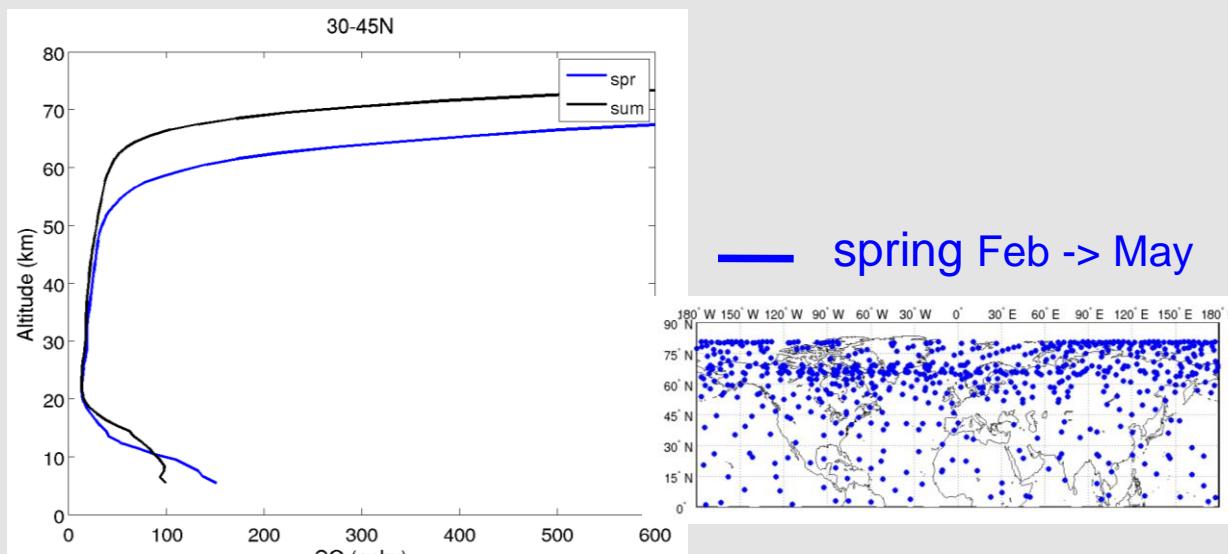
# Observation of vertical plume structure: Siberian BB

collocation: +/- 0.2° 1h  
Antonov-30 flight July 11 2008

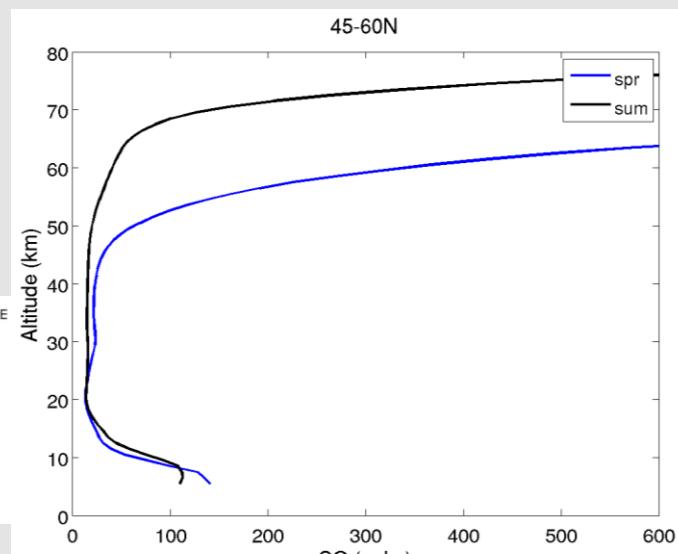


# ACE-FTS CO climatology (2004-2009)

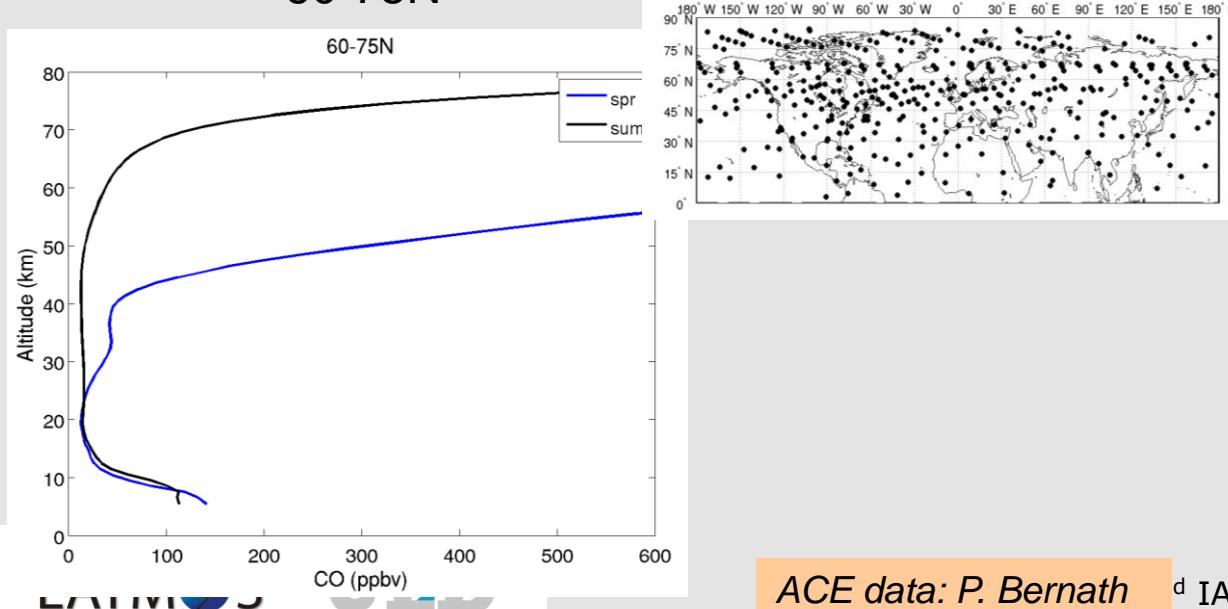
30-45N



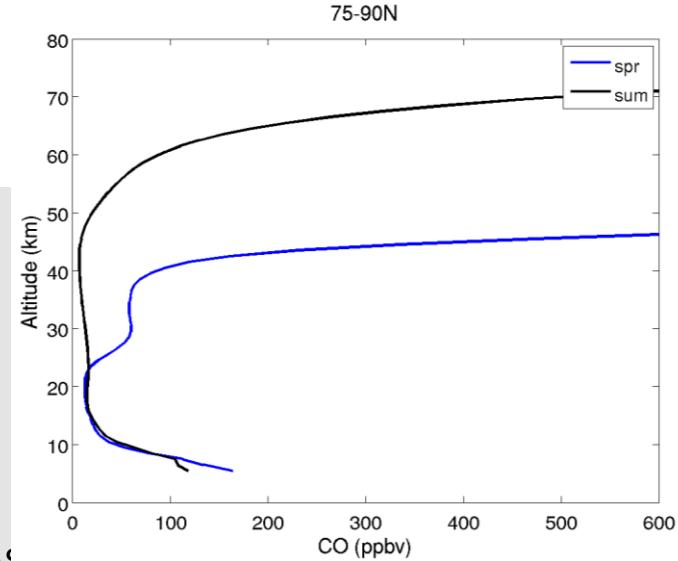
45-60N



60-75N

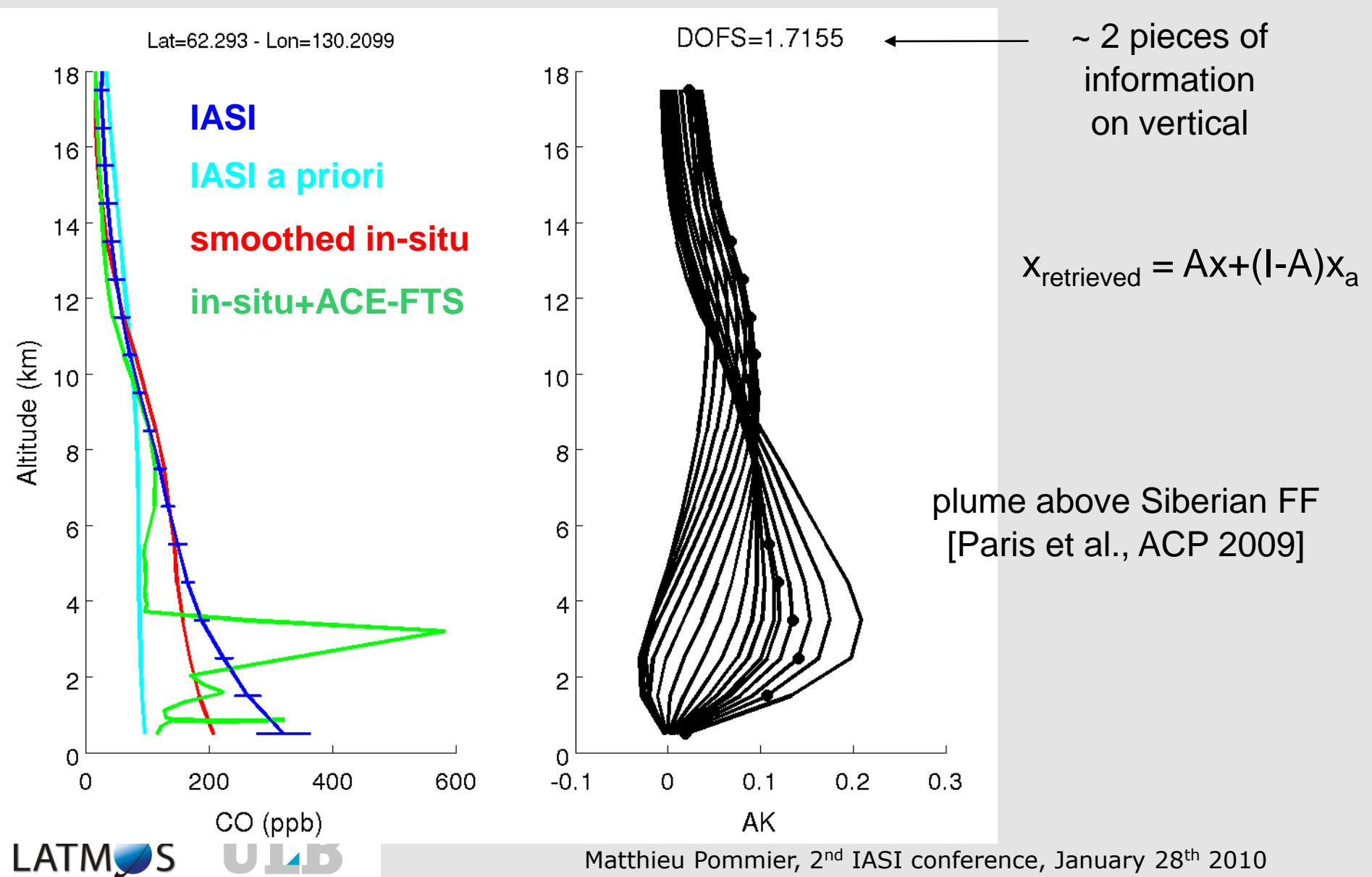


75-90N

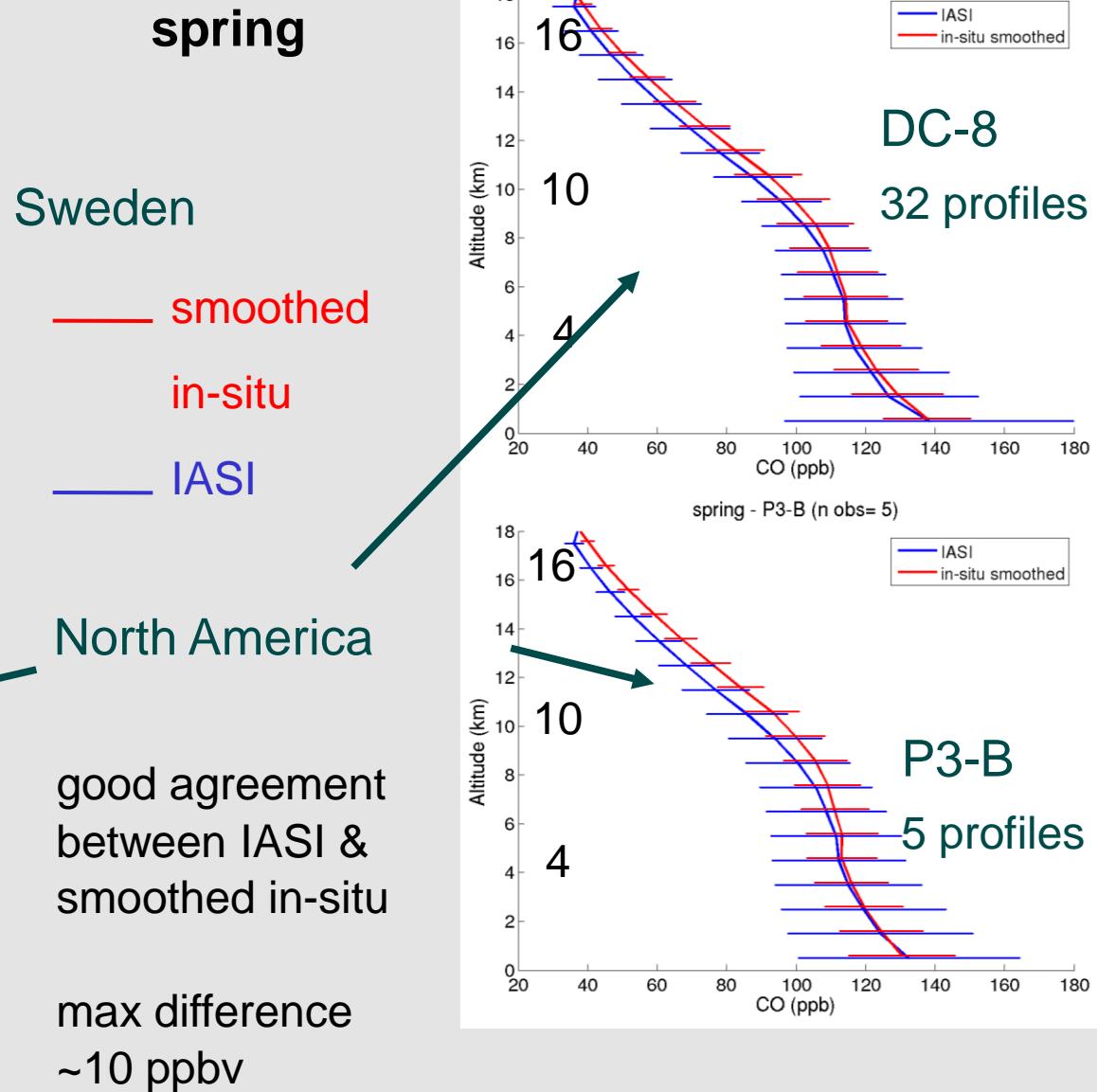
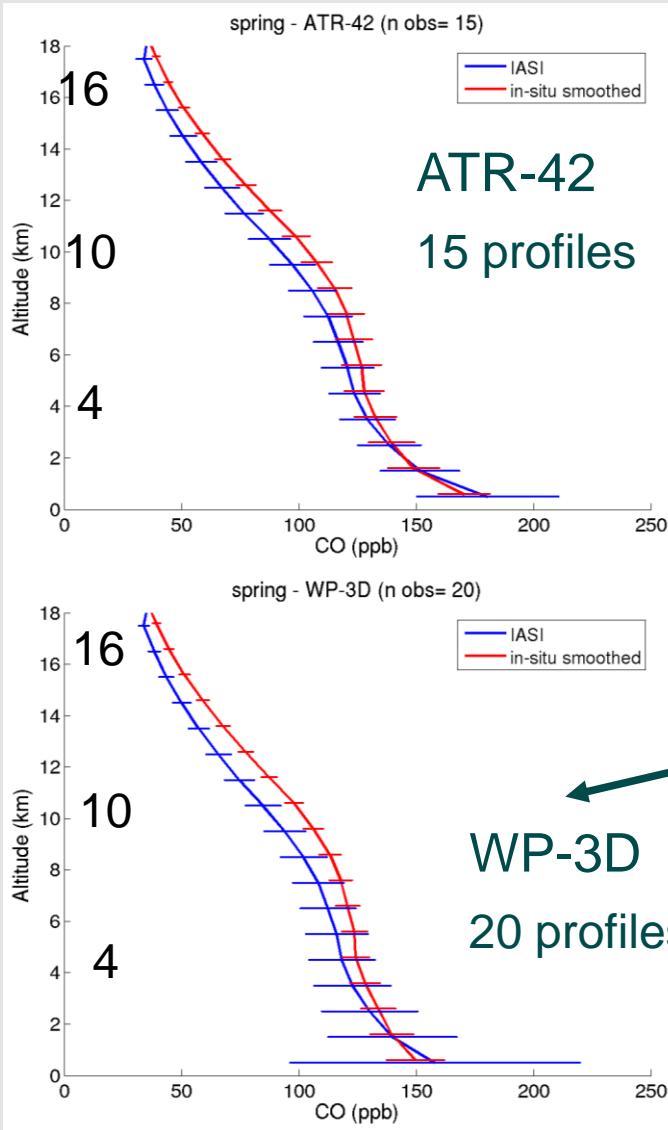


# Example of in-situ observations compared with IASI

Antonov-30 July 11 2008

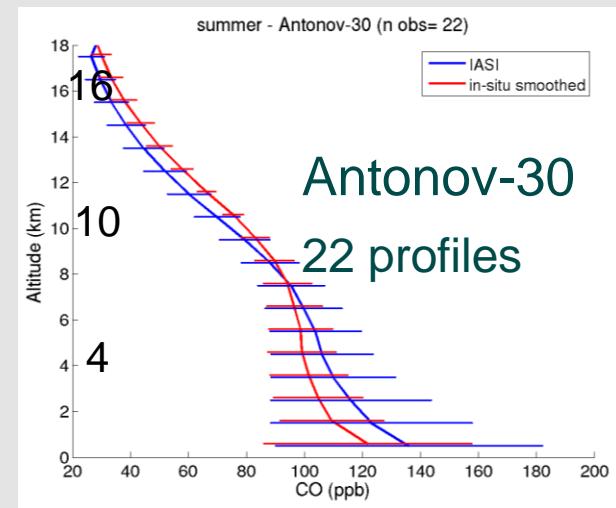
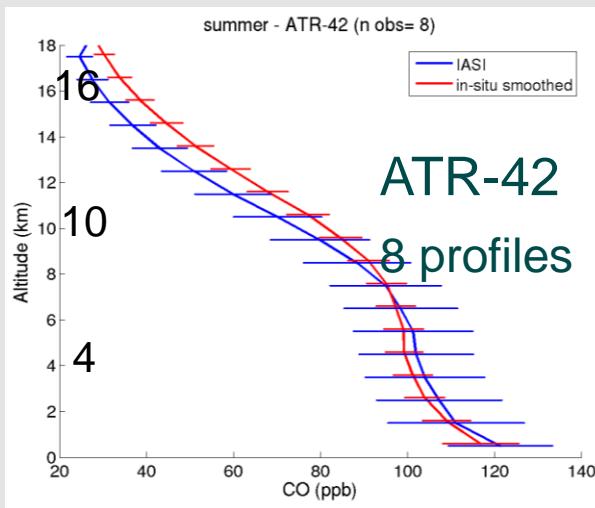
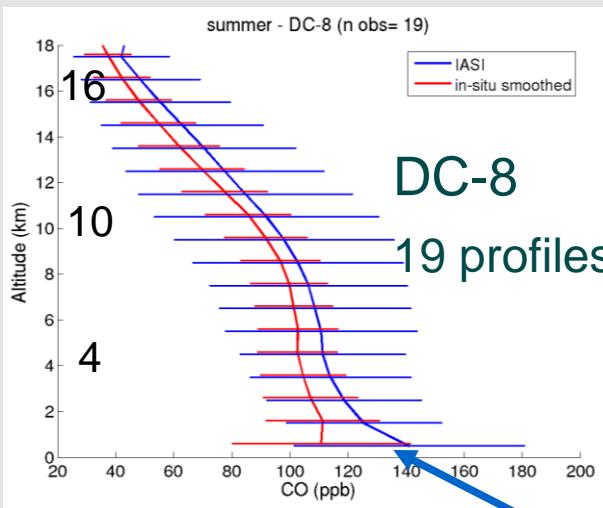


# Mean IASI and in-situ smoothed CO profiles for each aircraft

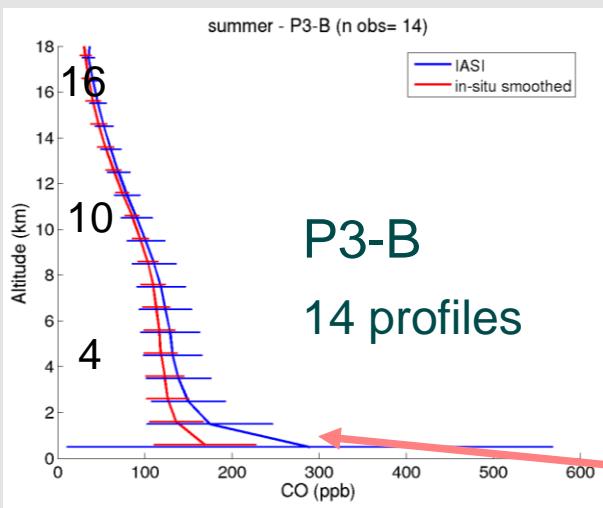


# Mean IASI and in-situ smoothed CO profiles for each aircraft

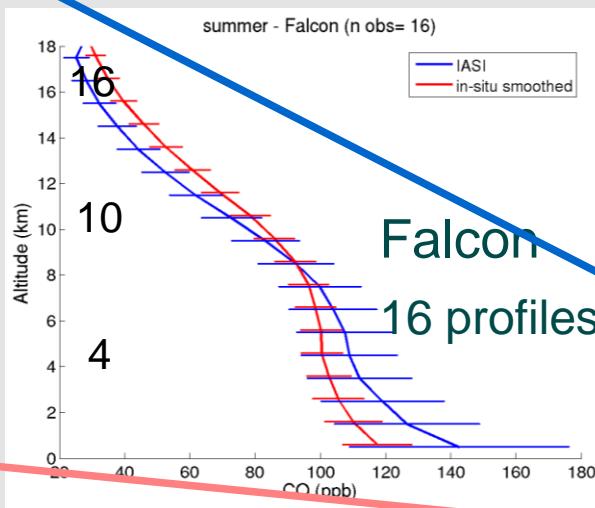
summer



North America



Greenland



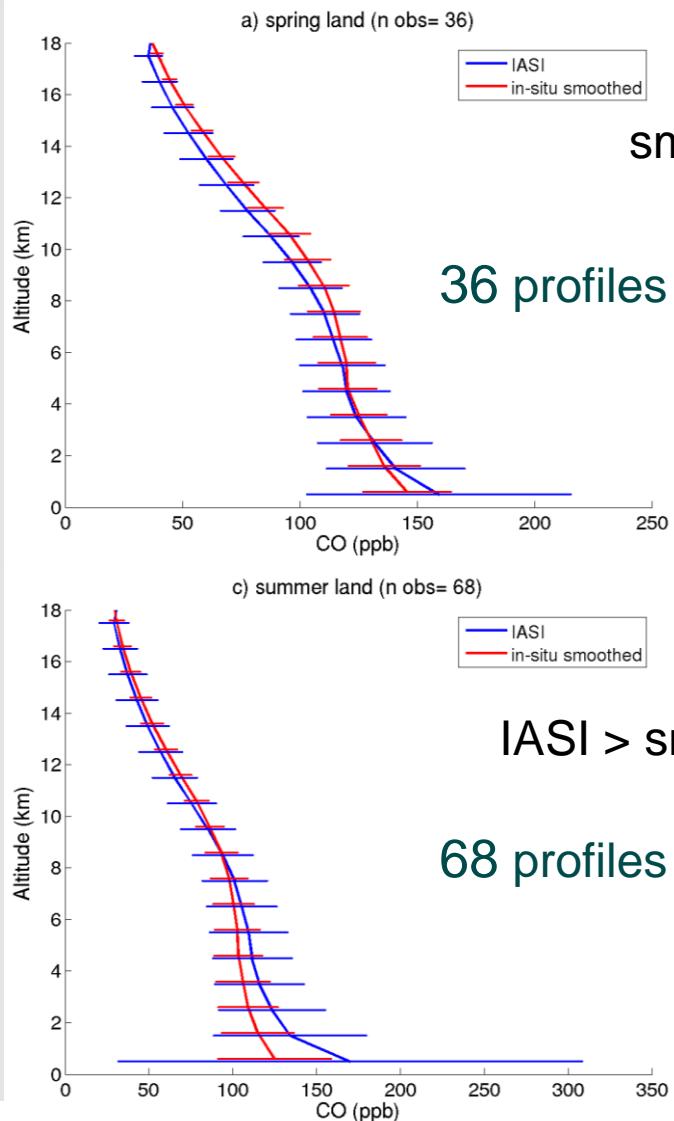
Siberia

IASI higher than in-situ smoothed below 8km in all examples →  
always in polluted cases  
(CO total column >  $3e18$  molec/cm<sup>2</sup>) – variable in other cases

max diff: 30 ppbv  
120 ppbv

# Mean IASI and in-situ smoothed CO profiles by type of surface

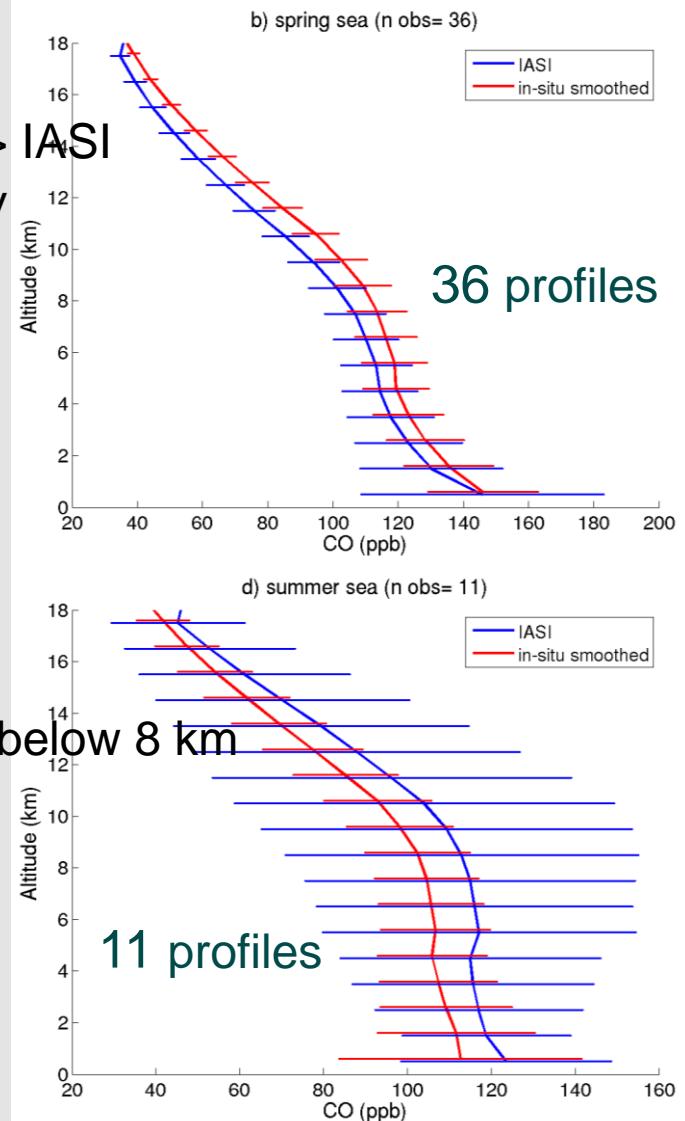
land



spring

smoothed in-situ > IASI  
diff < 10 ppbv

sea



summer

IASI > smoothed in-situ below 8 km

# Comparison of CO total column: IASI vs smoothed in-situ

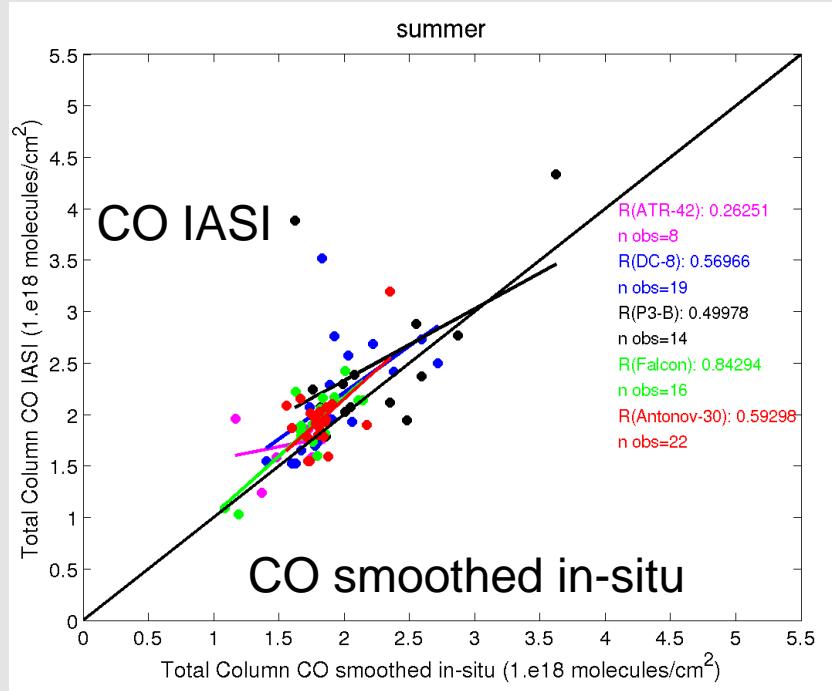
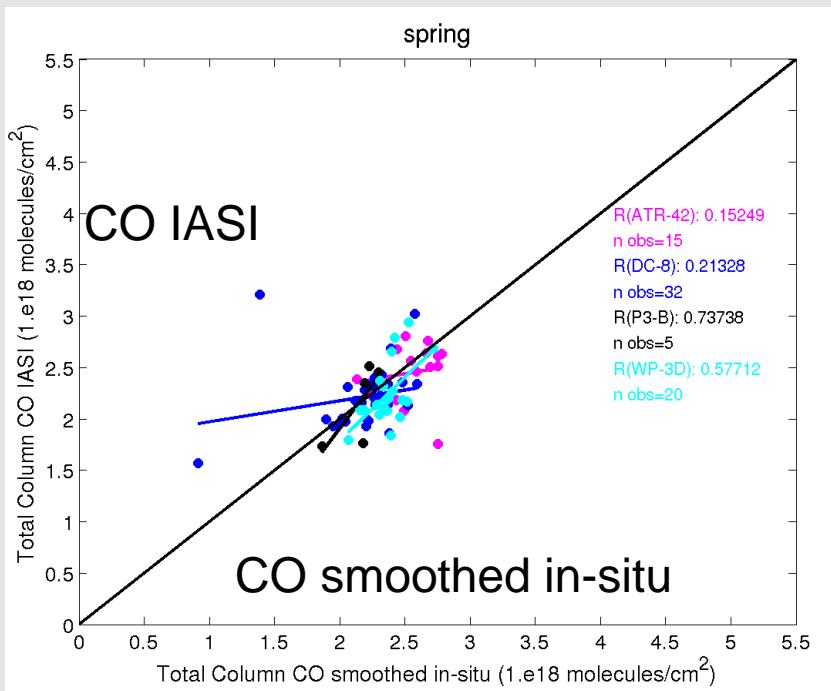
spring

ATR-42	DC-8	P3-B	WP-3D
0.15	0.21	0.74	0.58

min                          max

summer

ATR-42	DC-8	P3-B	Falcon	Antonov-30
0.26	0.57	0.50	0.84	0.59

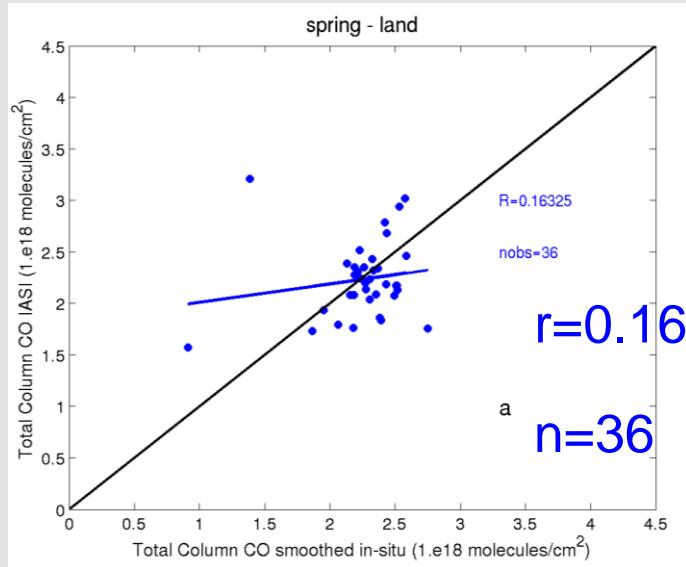


DOFS ~ 1.0

DOFS ~ 1.5

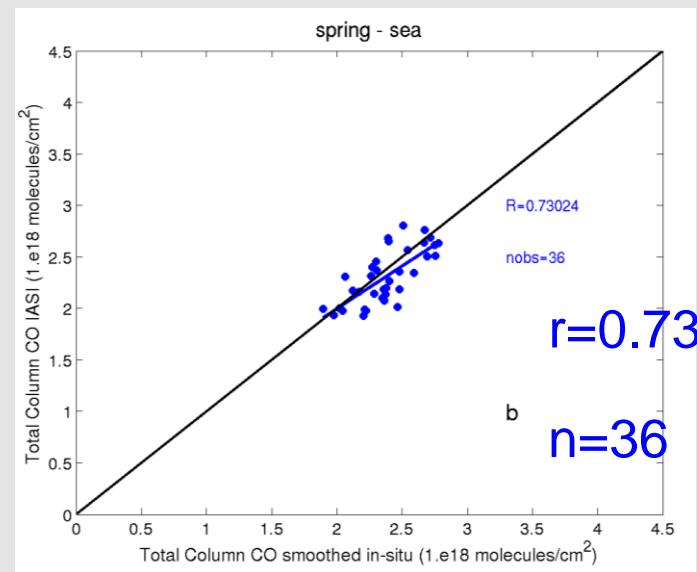
# Comparison of CO total column: IASI vs smoothed in-situ

land

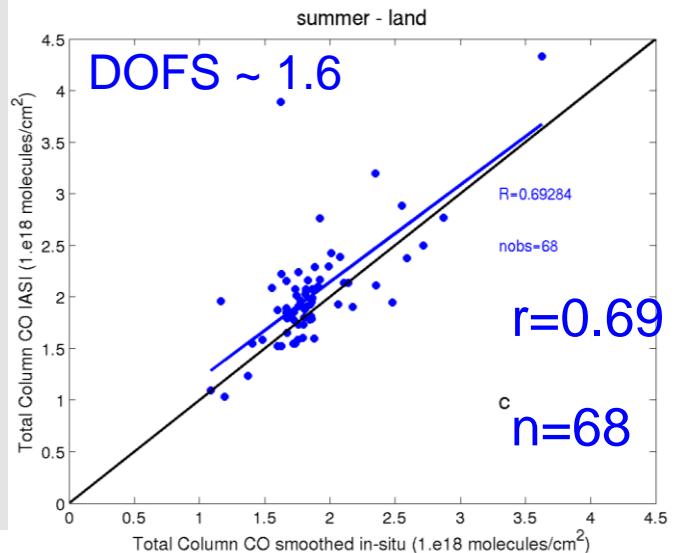


spring

DOFS  $\sim 1.0$

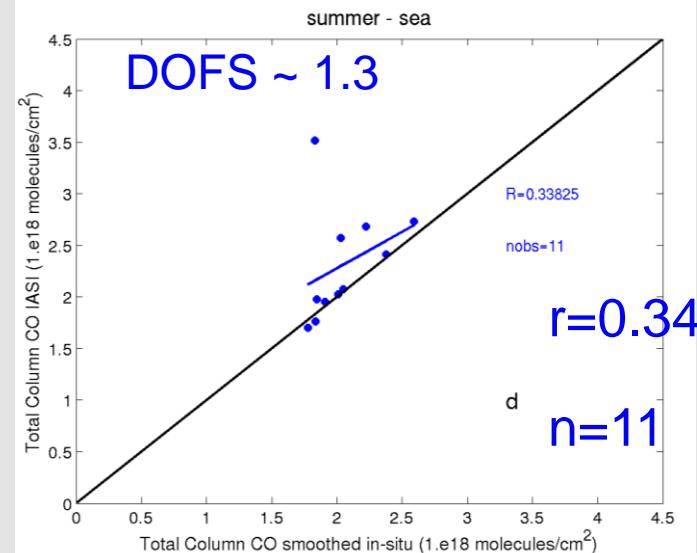


summer - land



summer

summer - sea



- **IASI** observed **long-range transport** + CO plumes in **boundary layer** -> observation on vertical structure: interesting for Lagrangian cases ?
- **Mixing ratio:** **Spring:** smoothed in-situ measurements > IASI (diff<10ppbv)  
**Summer:** IASI > smoothed in-situ measurements below 8 km (always in polluted events)
- **Total column:** correlation between IASI and smoothed in-situ CO :  
**spring= 0.15 to 0.74 – summer=0.26 to 0.84** (comparison by aircraft)  
**spring sea-summer land ~ 70%** - spring land=0.16 summer sea=0.34
- **DOFS** of IASI measurements used in this study: **~1.0 in spring, 1.3-1.6 in summer**  
*study in paper in prep. [Pommier et al., ACP]*

**next step :**

- Assimilate IASI CO (and O<sub>3</sub>) in LMDz-INCA