# The Assimilation of IASI ozone channels

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**Thanks to :**

**Rossana, Peter, Elias, Marco, Alan, …**

# Outline

- **Background of the study**
  - **It's a time to start the work**
- **Model bias or Observation bias?**
  - **dTb~ H(dxa) → <O-B> are mainly due to model bias**
- **Experiments**
  - **Baseline**
  - **Baseline+SBUV+OMI**
  - **Baseline+IASI ozone channels**
- **Verification against independent observations**
  - **MLS and sonde**
- **Summary and Discussions**

# Background

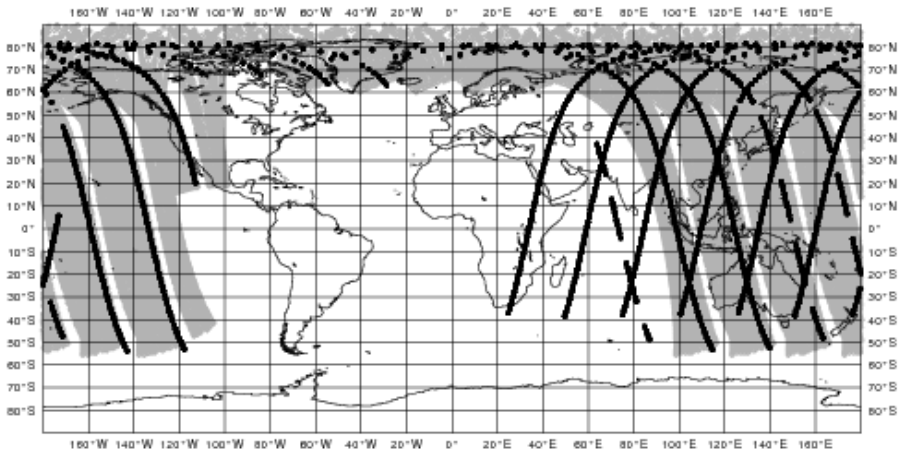
- **Ozone analysis**
  - **Importance**
    - ➔ Assimilation of radiances (IR channels)
    - ➔ Stratosphere(T,O3,wind), medium-range weather forecast
    - ➔ Reanalysis and Climate study
  - **Difficulty: Theare is NO unbiased obs. as backbone**
    - ➔ Observation:Realtime:(SBUV,OMI),Delay: (Sonde,MLS)
    - ➔ Model: simple photochemistry model(bias)
- **IASI observation information**
  - **321 oznone channels at 9.6um**
  - **Global and All day coverage, esp. for polar night**
  - **Improved RT model**
  - **Cloud detection (QC for IR)**

# The key issues

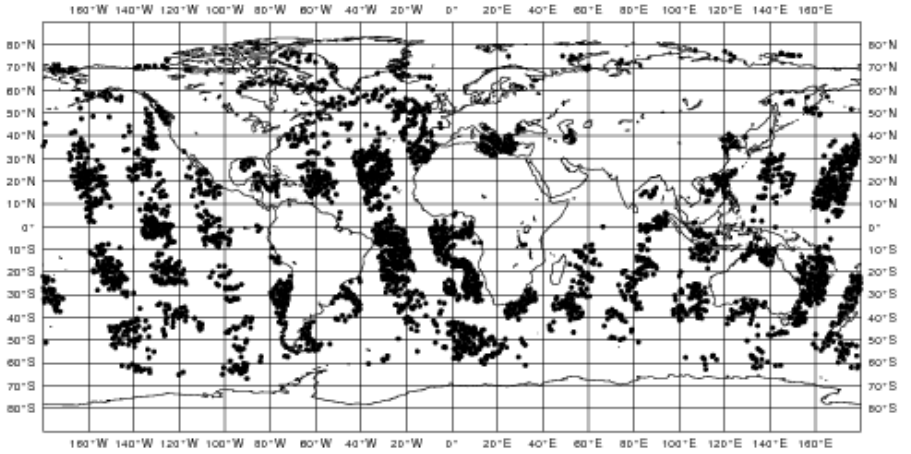
- **Model bias**
  - **simple photochemistry model(bias)**
- **Observation bias**
  - **Cal/Val**
  - **Non perfect Cloud Detection**
  - **RT model bias**
- **No anchoring**
  - **NO realtime unbiased Ozone Obs. AS BACKBONE**
- **Anchoring VARBC against model biases**
  - **Prior constraint on the Anchoring channel**
  - **VARBC to remove the interchannel bias**

# Ozone data coverage in 12h N.H. Summer

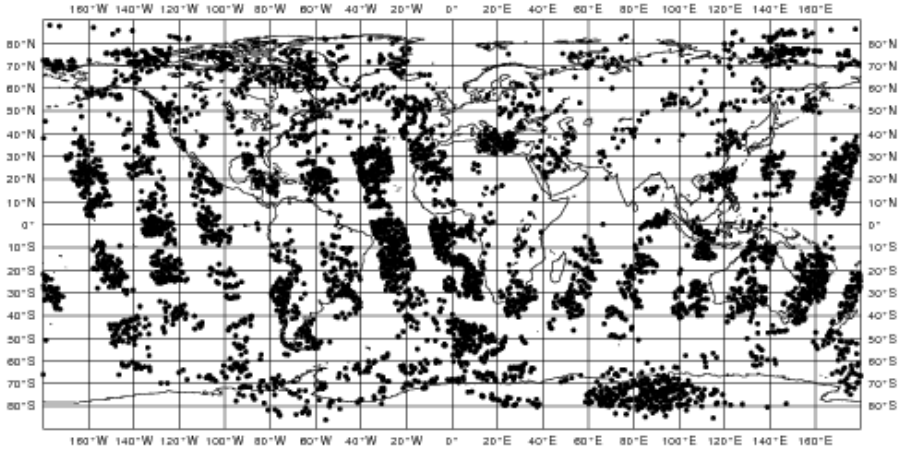
SBUV(Black)
and OMI(grey)



IASI over Sea

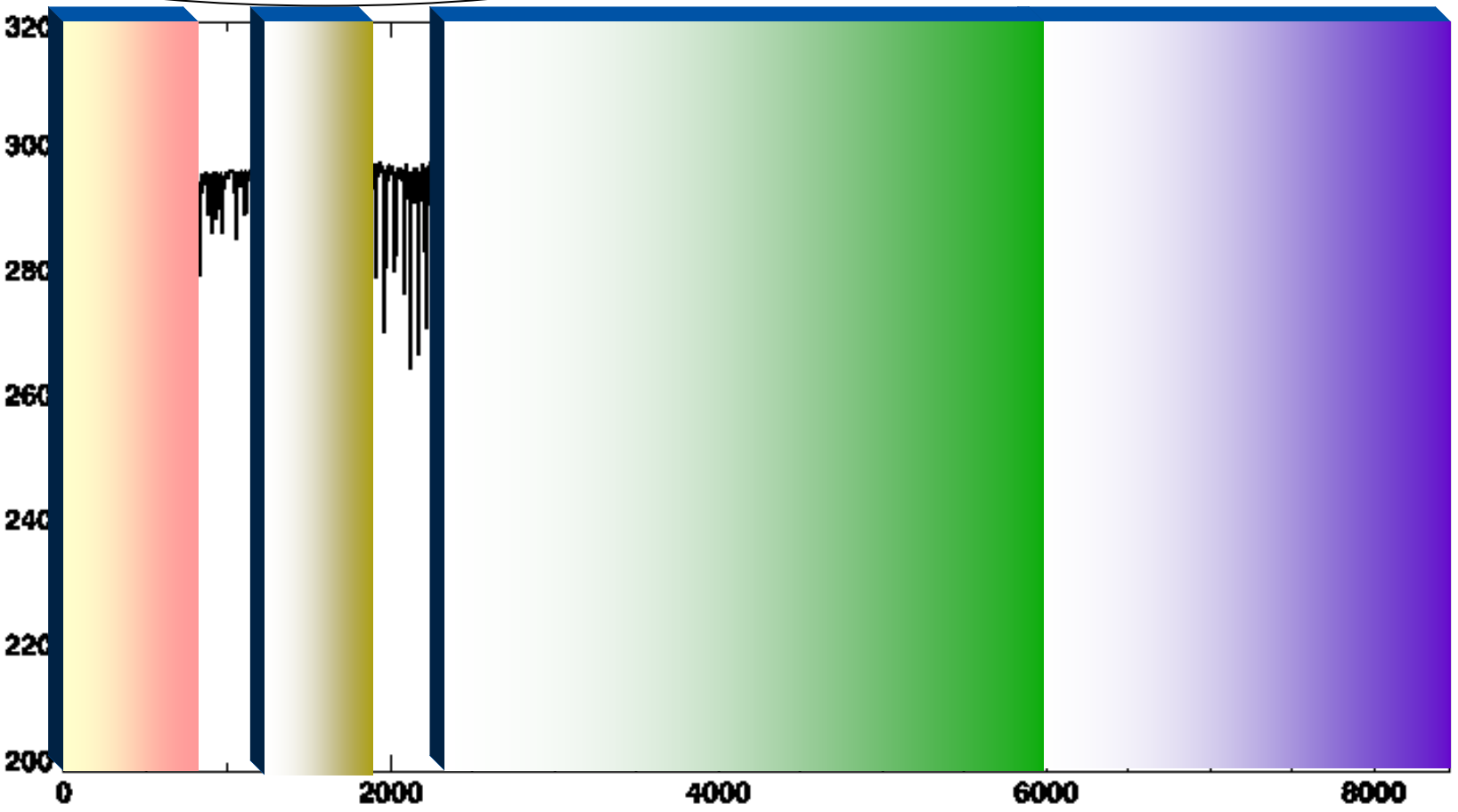


IASI over Sea
and sea ice and
LAND



# Use of the IR spectrum with IASI

## 321 OZONE CHANNELS

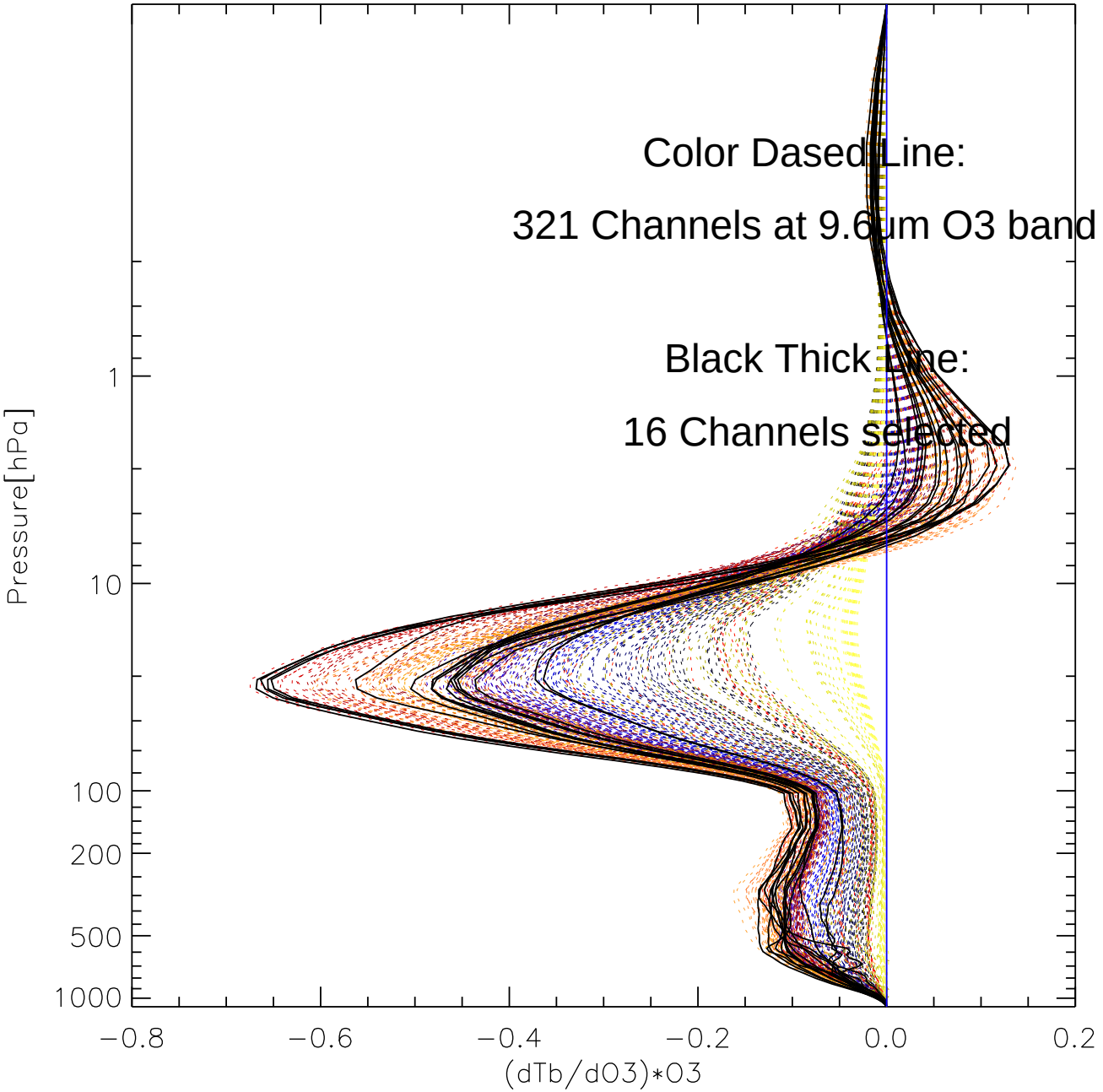



**153** Long-wave temperature

Water vapour

Short-wave temperature

# Jacobians and Active Channels



# BIAS analysis: OBS or BACKGROUND?

- **Operational against sonde**
  - **3 months**

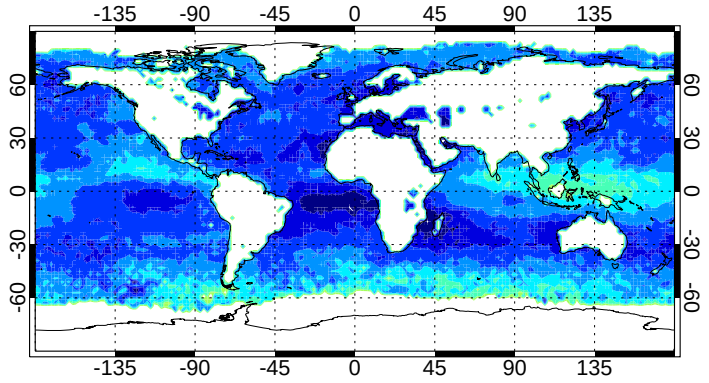
It's mainly the model bias

- **IASI O3 channel FG departures**
  - **In Spectral space**
  - **Geophysical and Seasonal Variation**
  - **Compare with other Channels**

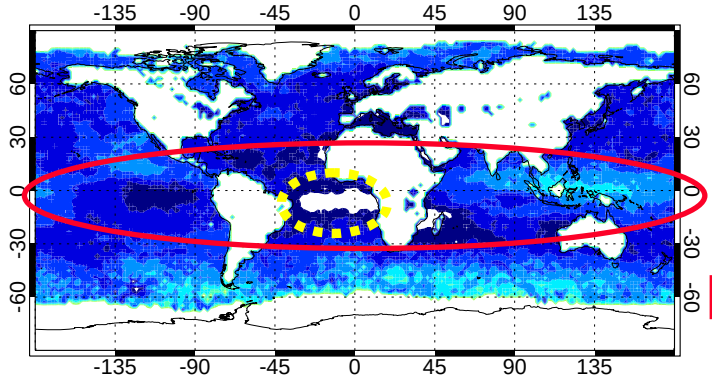
- **Offline RTTOV**
  - **H: dO3 → dTb**
  - **1DVAR: dTb→dO3**

IASI CH 1578,1585,1786 Mean FG Depart.(no bias cor.)
Active Data(f5li:2008080712-2008090712)

200808



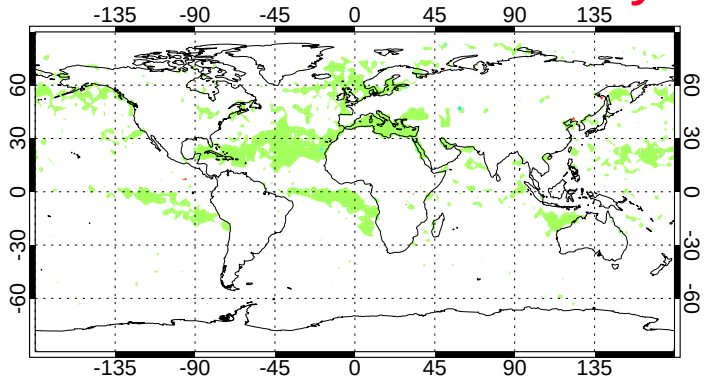

Ch1578
Strong
O3




Ch1585
Stronger
O3

Exp: f5li

The Assimilation system is FROZEN in this peroid




Ch1786
Window
Channel

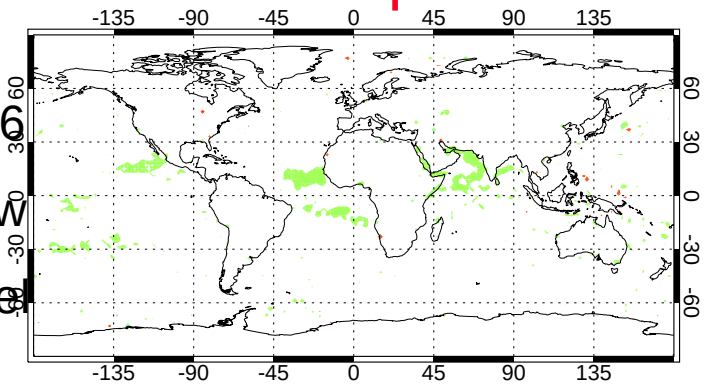
IASI CH 1578,1585,1786 Mean FG Depart.(no bias cor.)
Active Data(f5li:2009020112-2009022812)

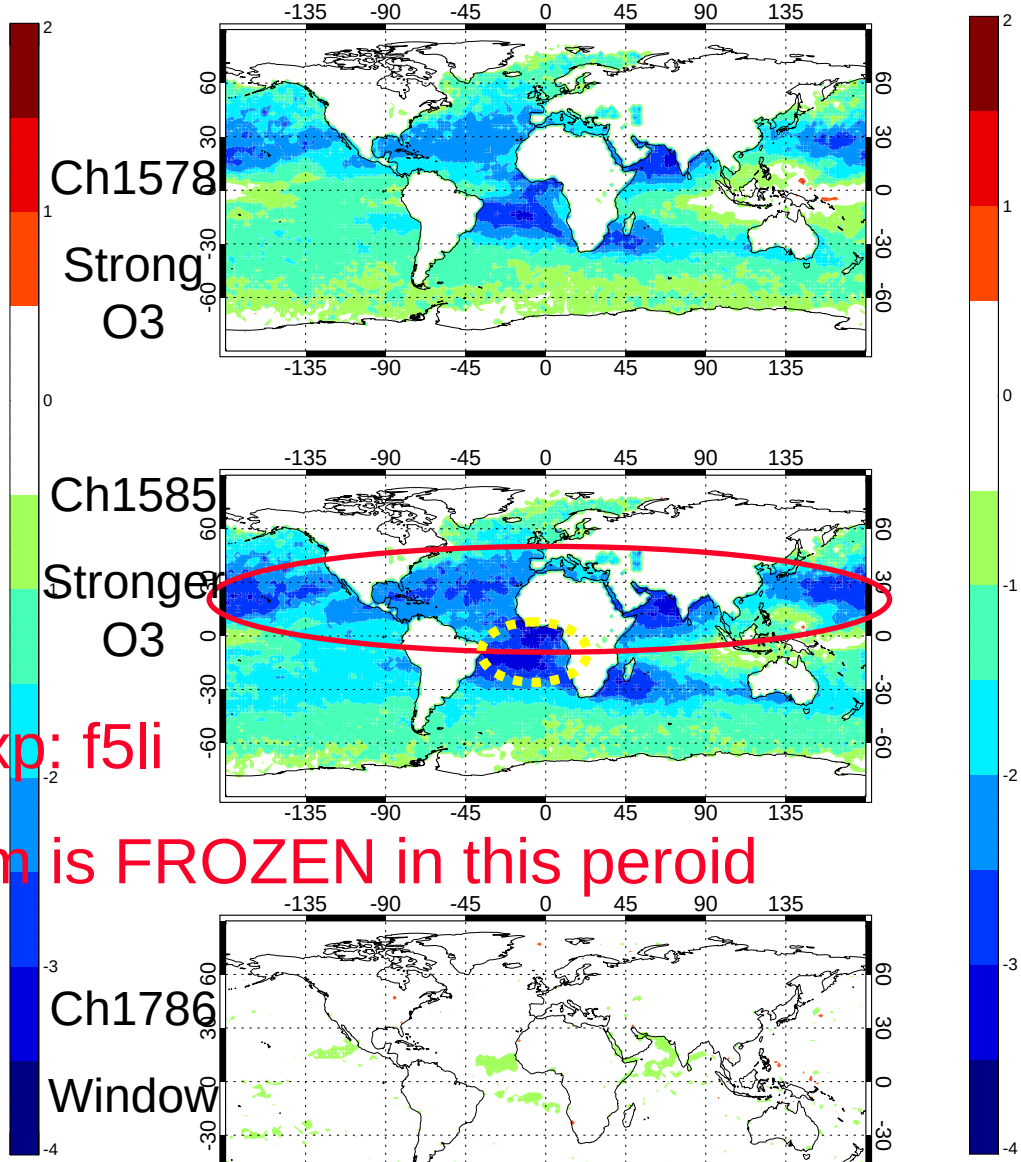
200902





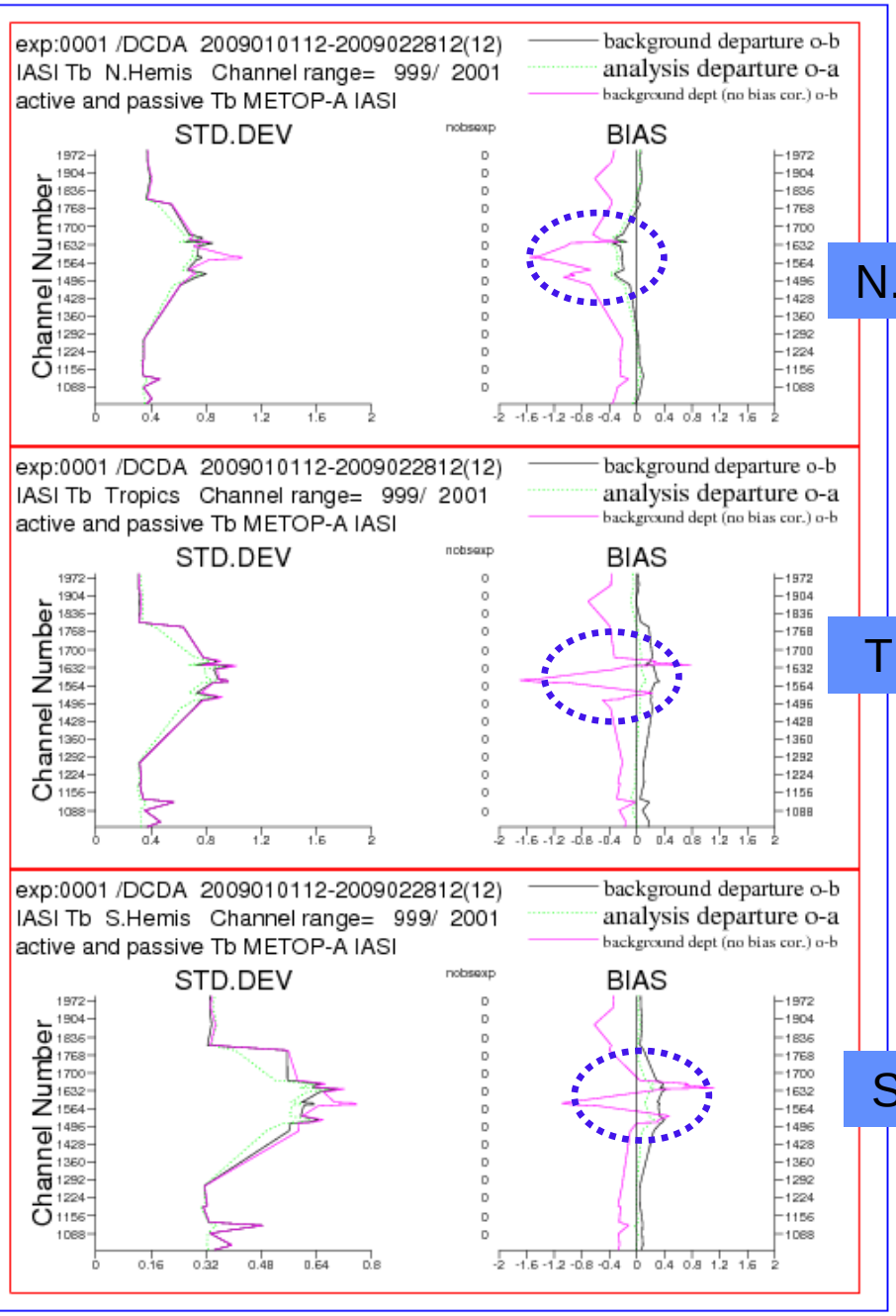




2009JF

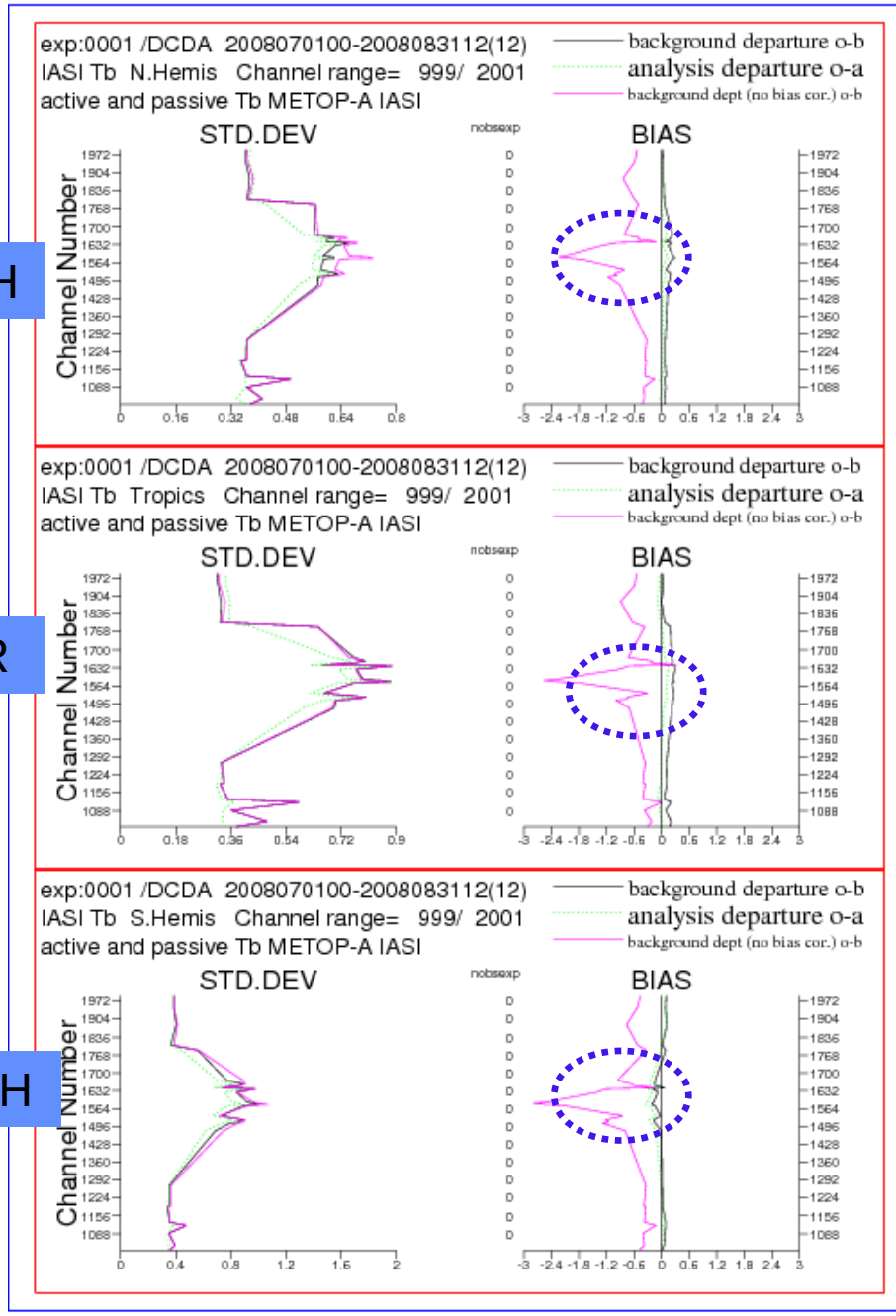
2008JA




N.H

TR

S.H



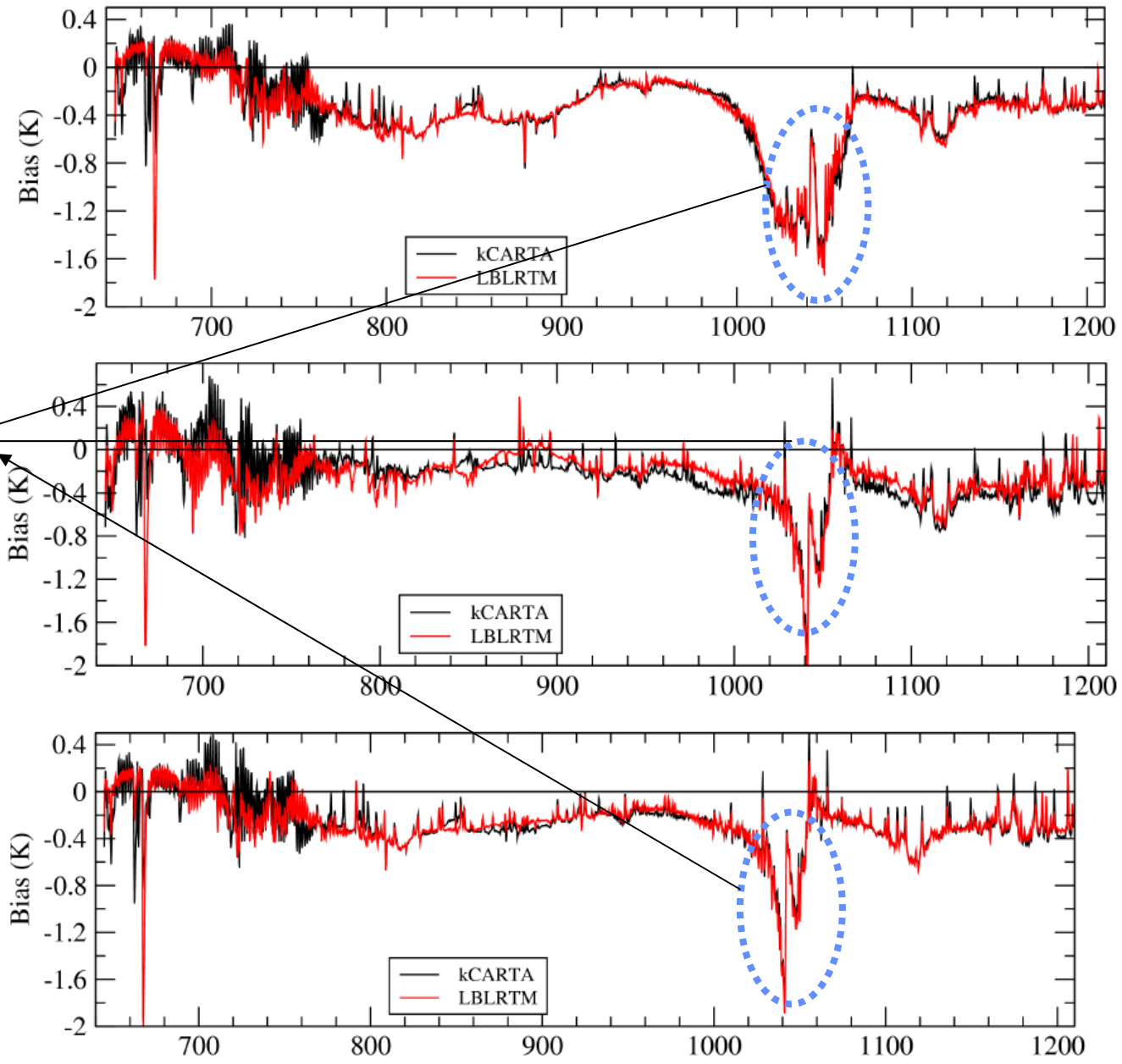
# Marco(2009) Monitoring Results cycle [CY33R1]

- **N.H**

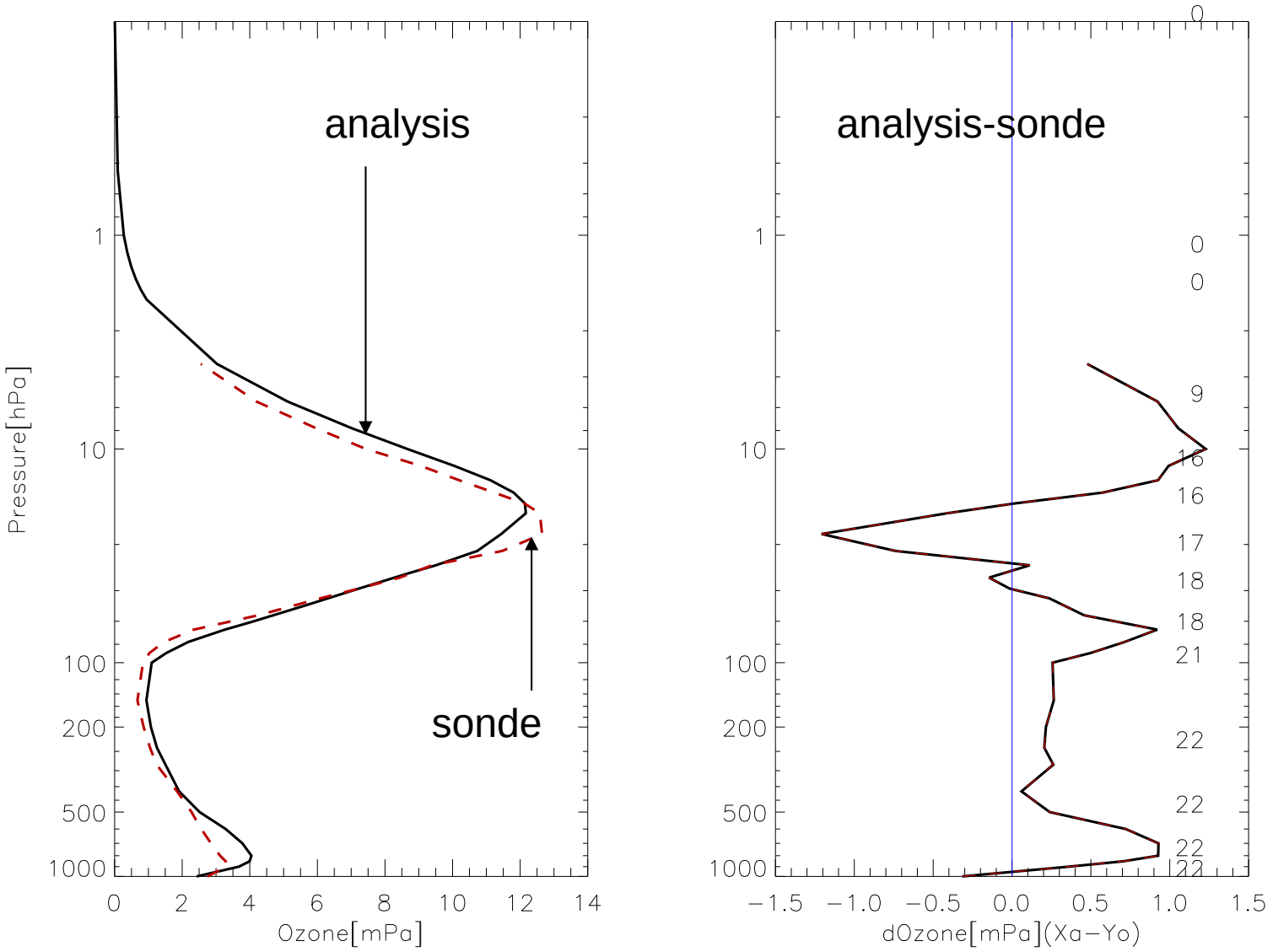
9.6 um band of O3

- **TR.**

- **S.H**



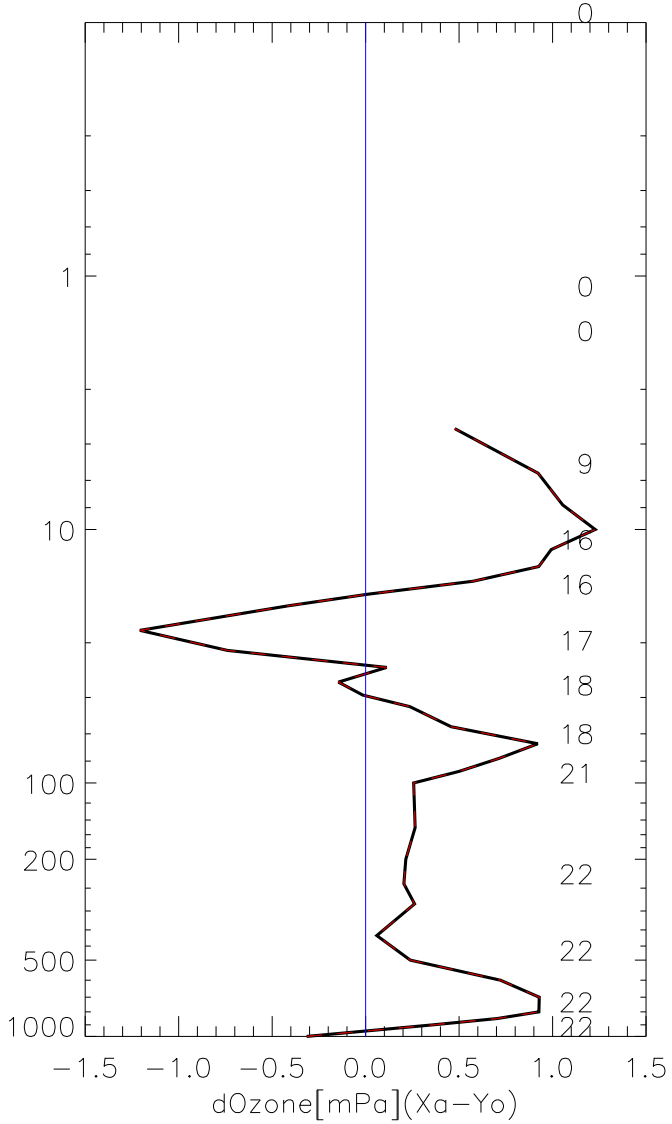
# 2008JF,0-30N, Sonde and Analysis

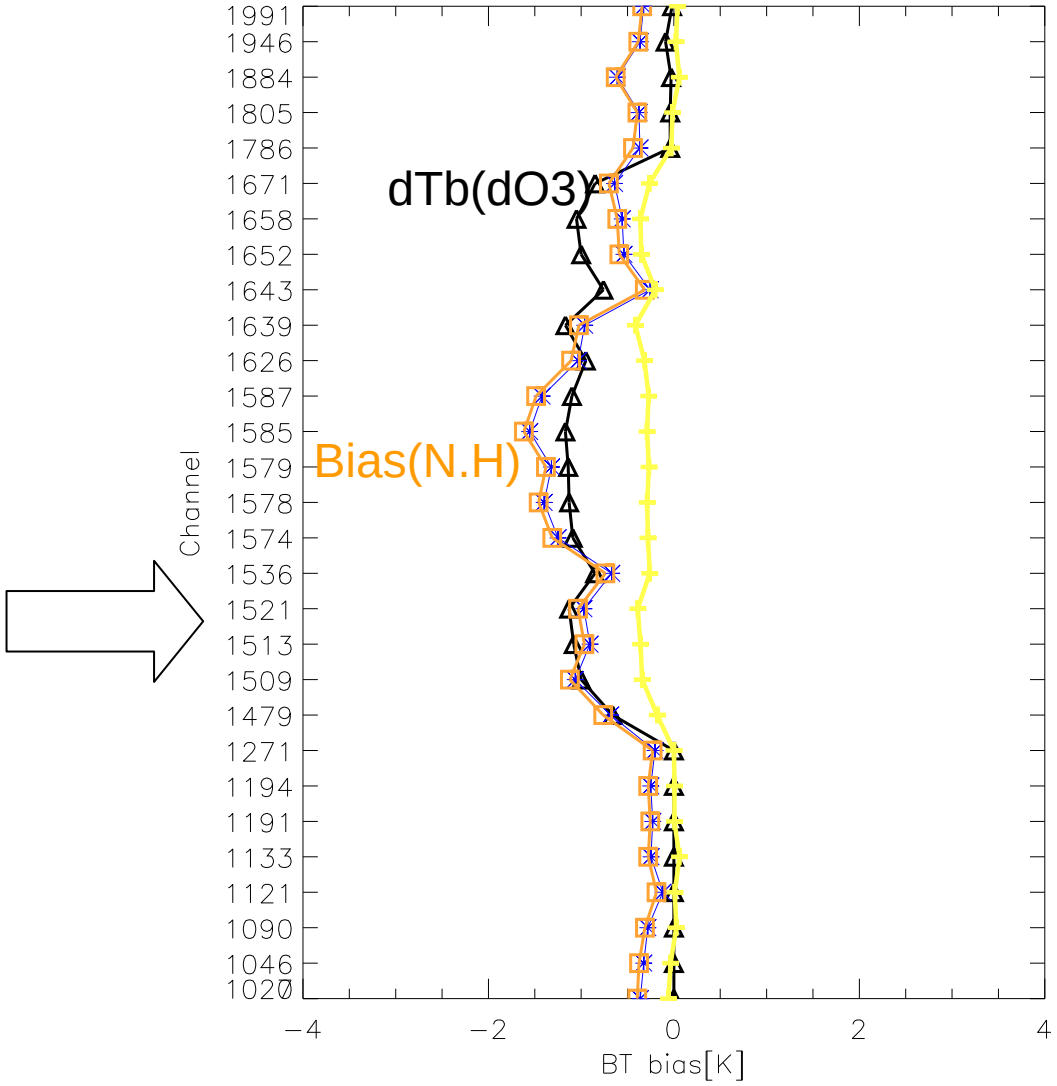


# Bias(Xa-Sonde)→Bias(Tb):

$$H(O-X) \sim dTb = Yo - H(xb)$$

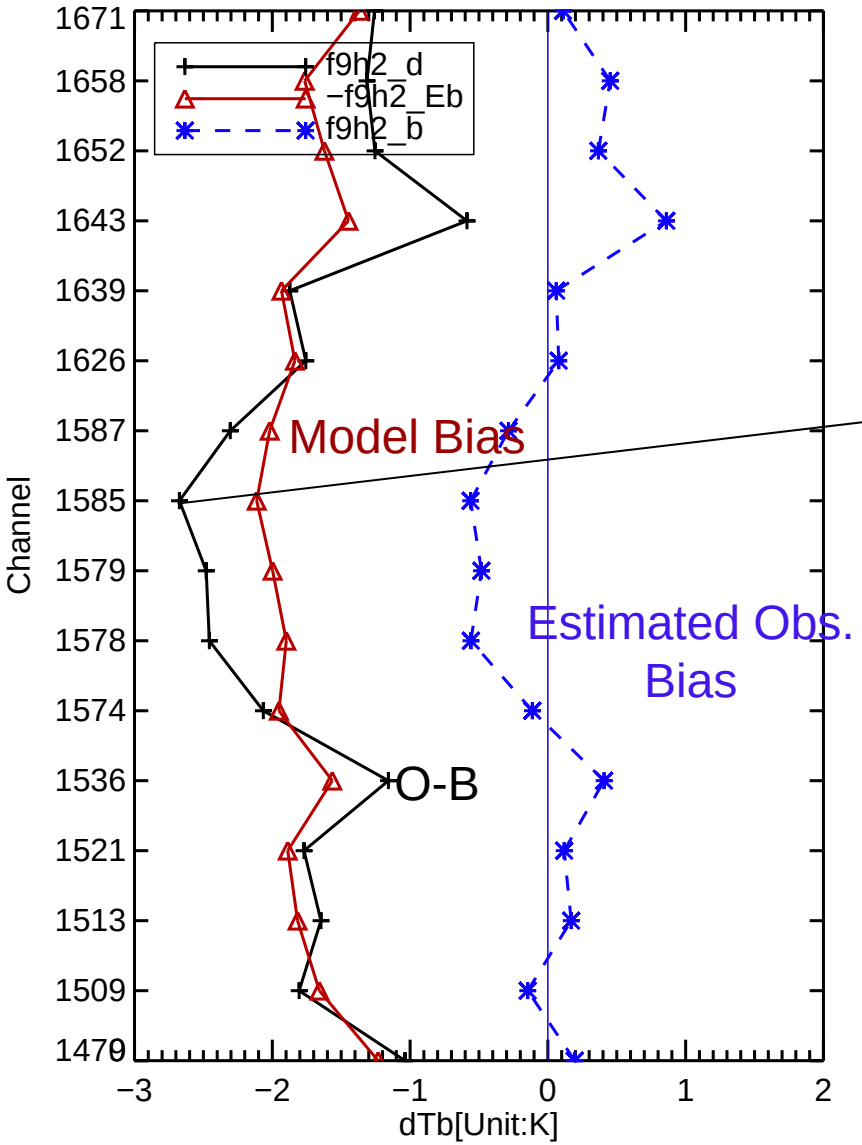
## Biases at IASI O3 band are consistent with biases of analysis



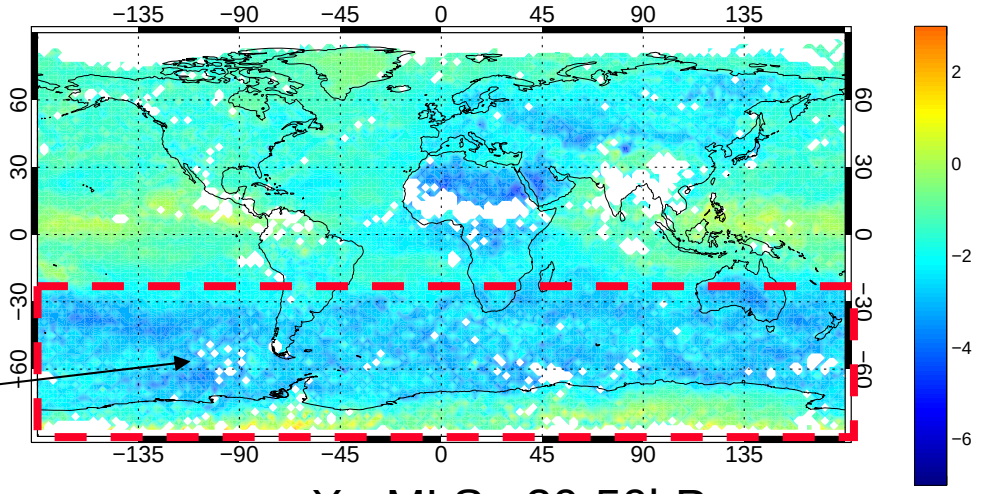
MLS→ Model Bias and Obs. Bias

d=Yo-Hx=(Yt+b)-H(Xt+Eb)
<d>=<b>-H(Eb)
<b>=<d>+ H(Eb)



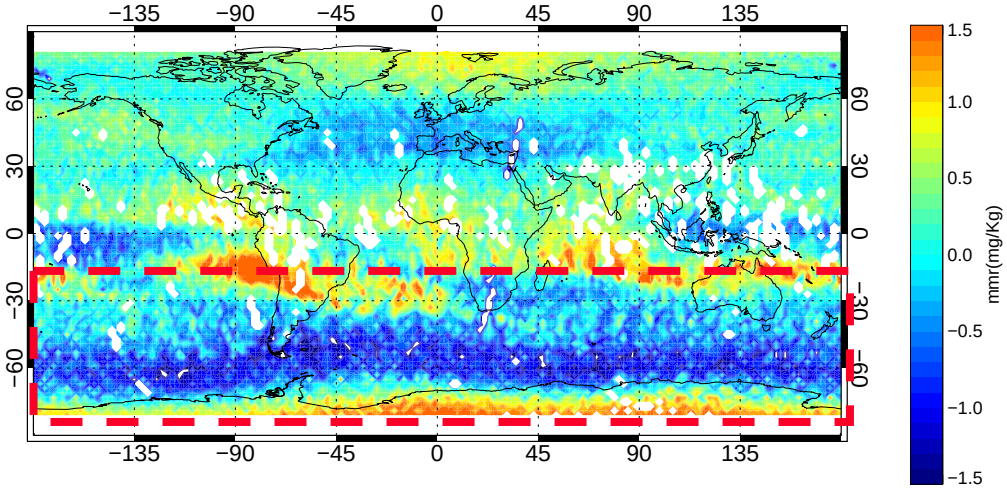

<O-B>,CH1585

20090615~20090630



<Xa-MLS>,30-50hPa

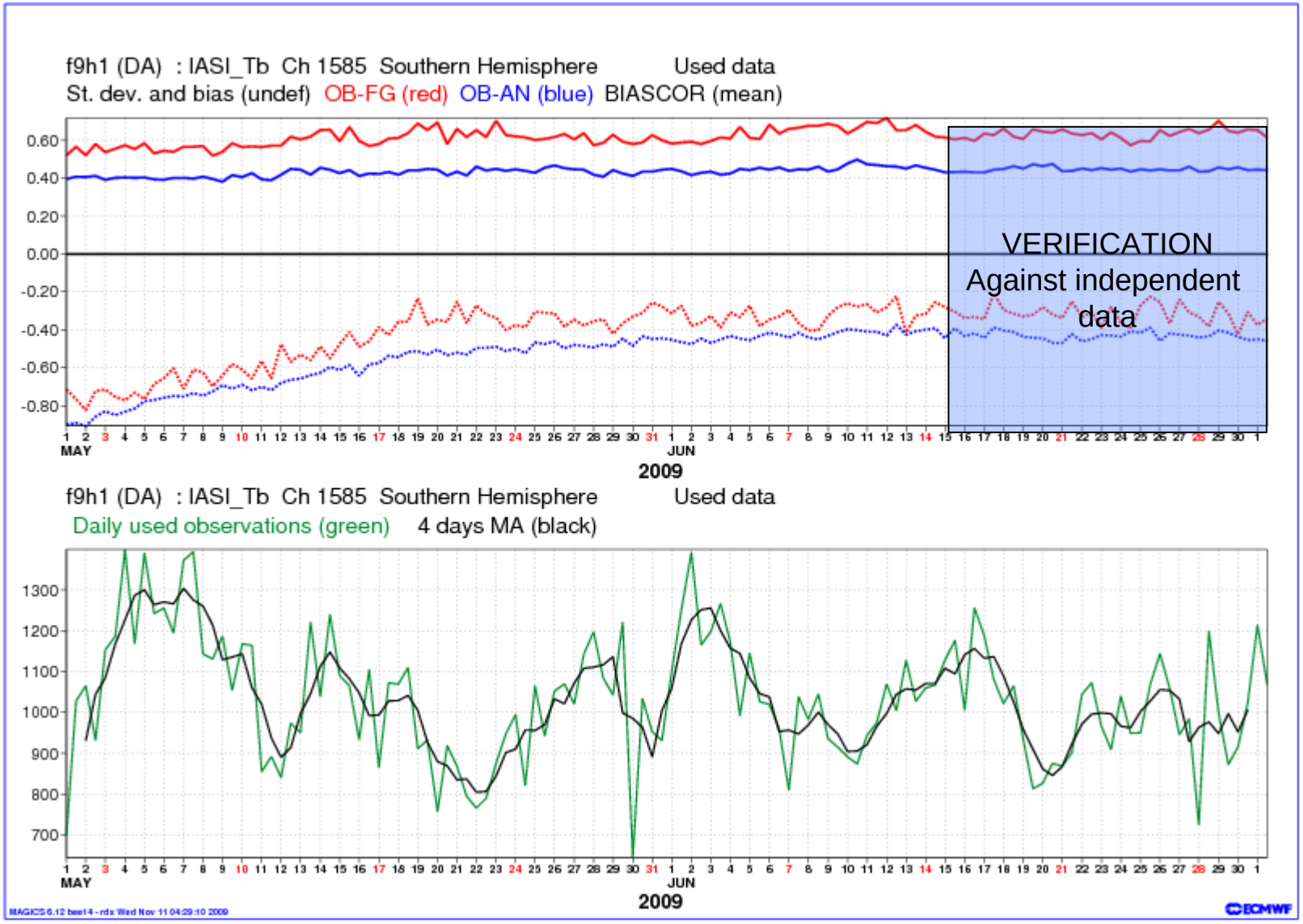
20090615~20090630



# OSE Experiments

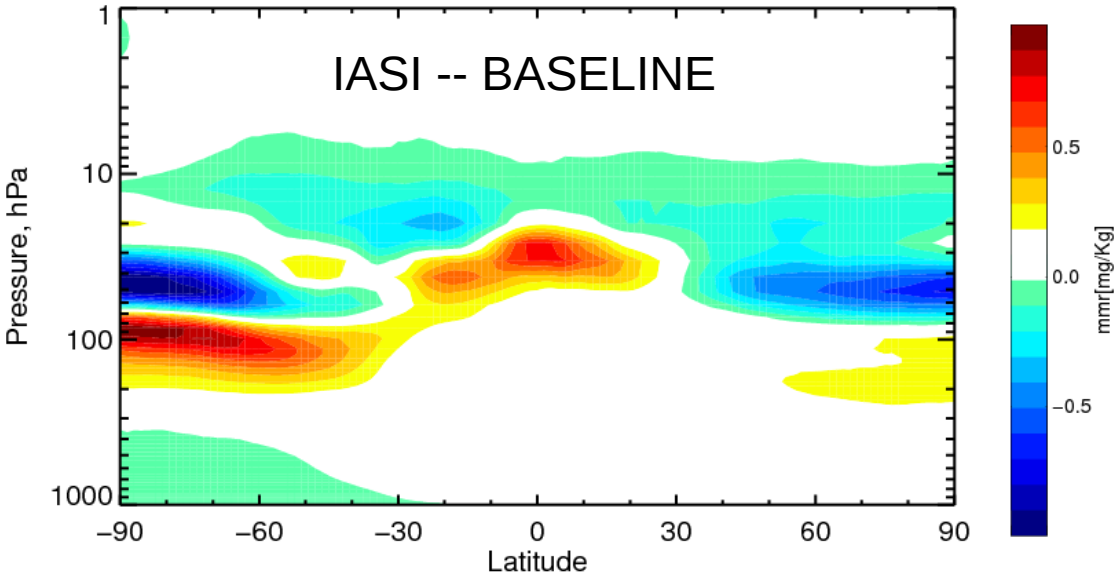
- **BASELINE: f9h2—No Ozone Observations**
  - **2 months :20090501-20090702**
- **EXP1: f9w4---Baseline+SBUV+OMI**
  - **SBUV: NOAA-17 and NOAA-18,6 Layers**
  - **OMI: Total Column**
- **EXP2:f9h1----Baseline+IASI Ozone Channels**
  - **Activate 16 O3 channels at 9.6um band**
  - **Zero bias correction for ONE channel(CH1585) to ANCHOR**
  - **VarBC applied to other 15 channels**
- **EXP3:f9hc---Use IASI Ozone Channels over land**
- **VERIFY against independent data**
  - **Sonde,MLS**
  - **2 weeks20090615-20090630**

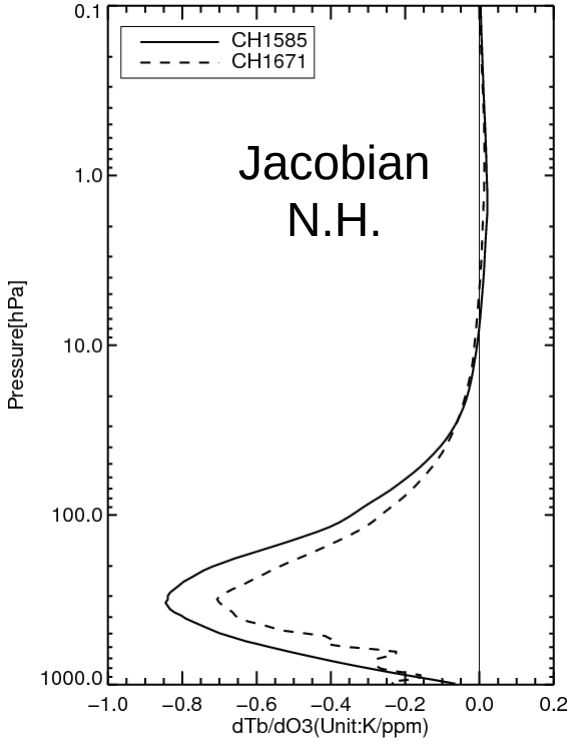
# Experiments period and verification period

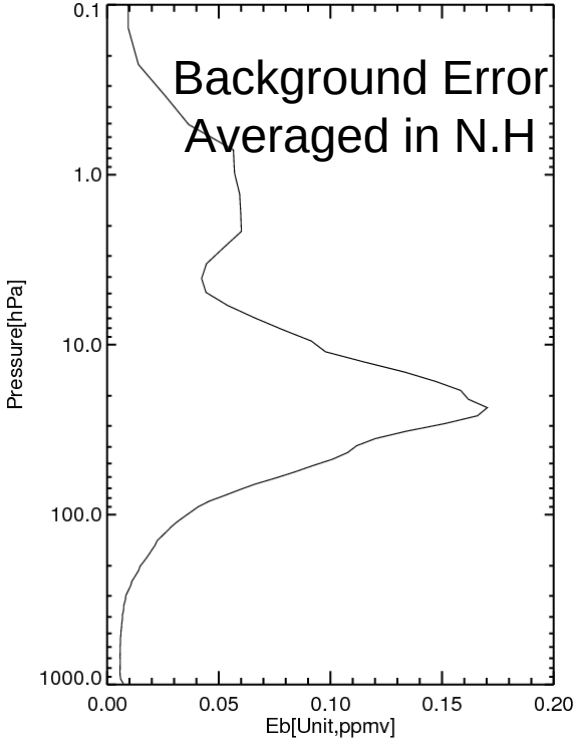


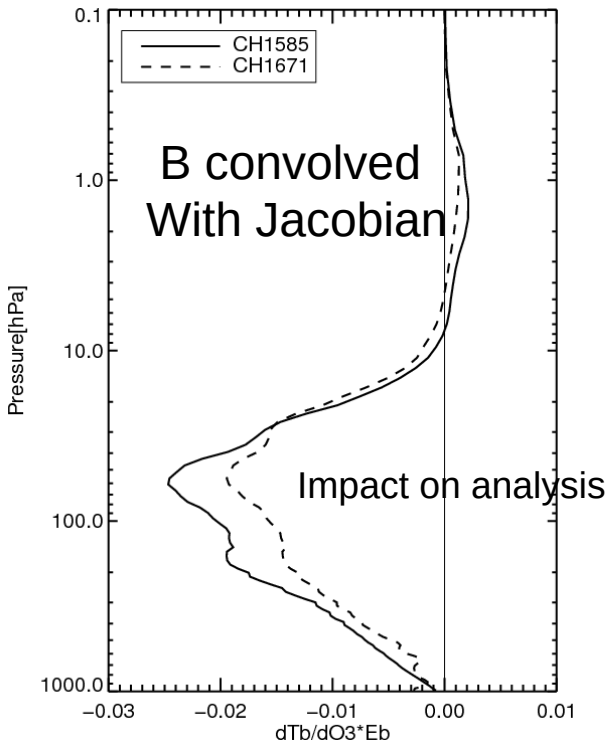
# Impact on analysis

- **Largest Impact**



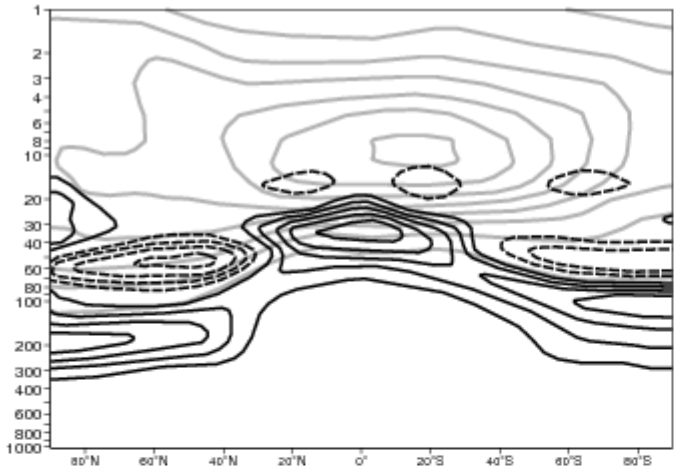



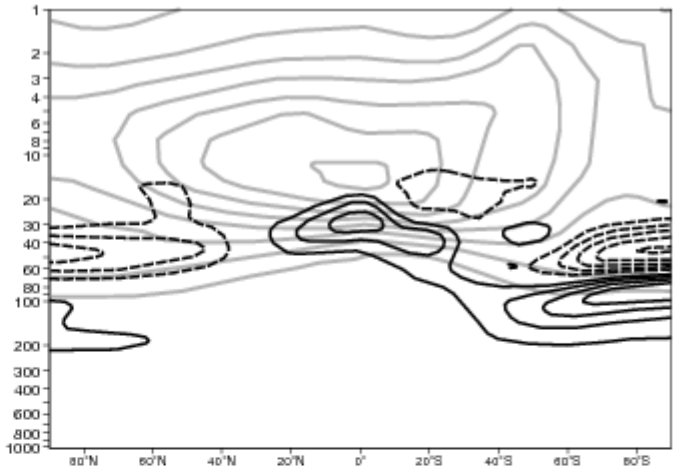
# Mean analysis difference

Winter

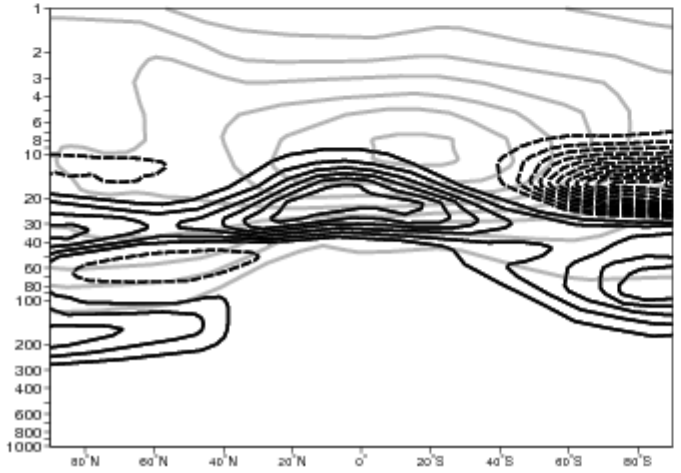
Summer

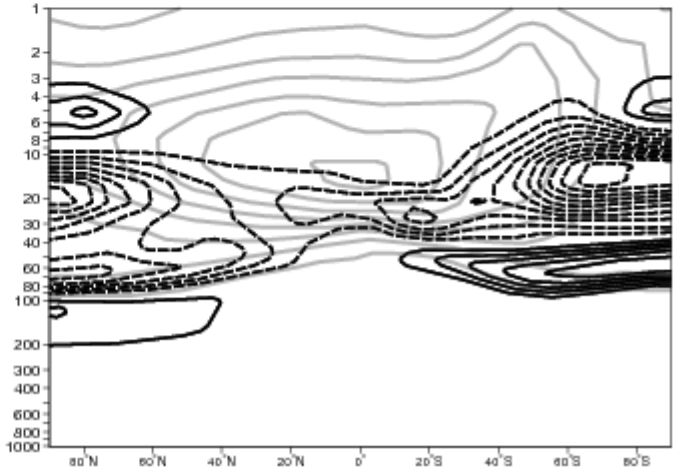
IASI-Baseline




UV-Baseline



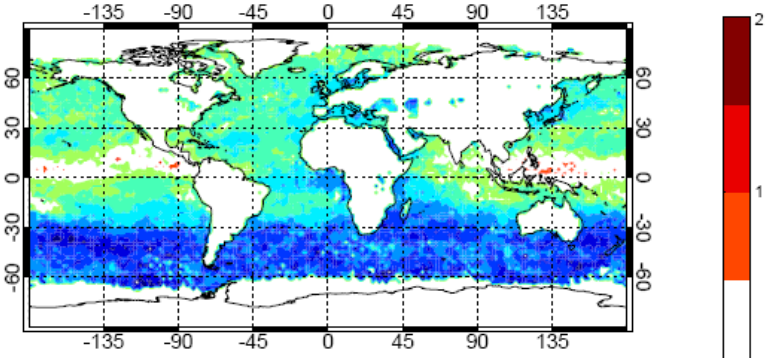



# IASI O-B

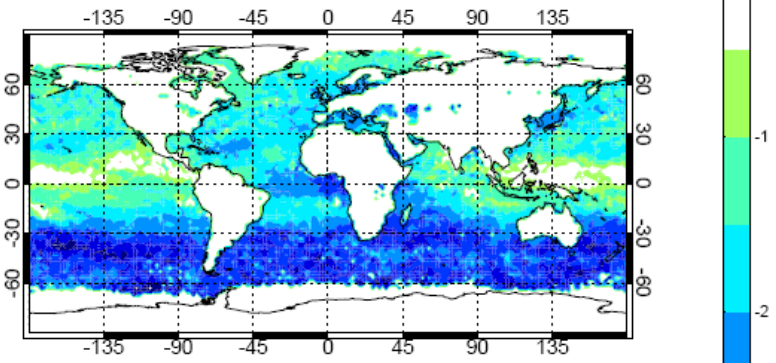
## BASELINE

IASI CH 1579,1585,1786 Mean FG Depart.(no bias cor.)
Active Data(f9h2:20090615-20090630)

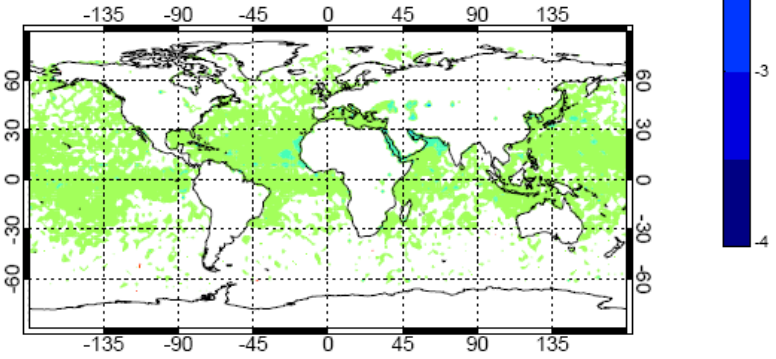
CH:1579




CH:1585

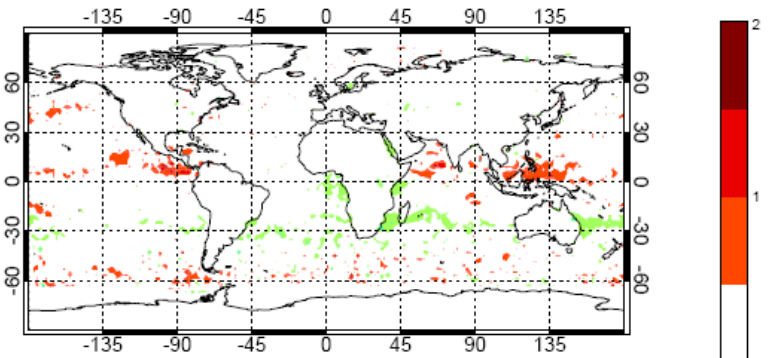


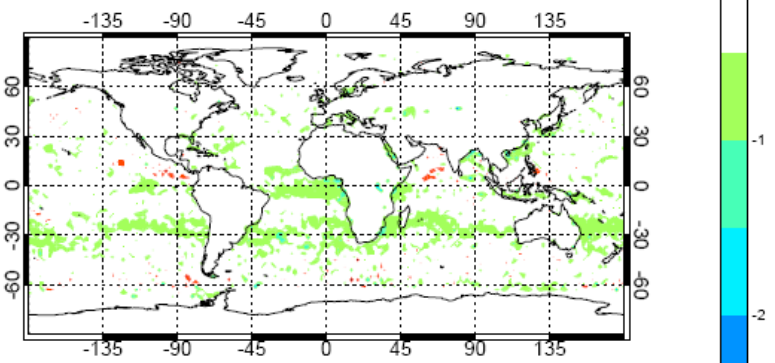

CH:1786

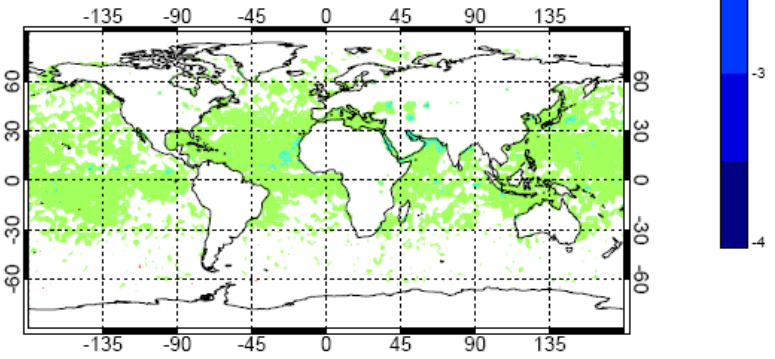



## BASELINE+IASI

IASI CH 1579,1585,1786 Mean FG Depart.(no bias cor.)
Active Data(f9h1:20090615-20090630)



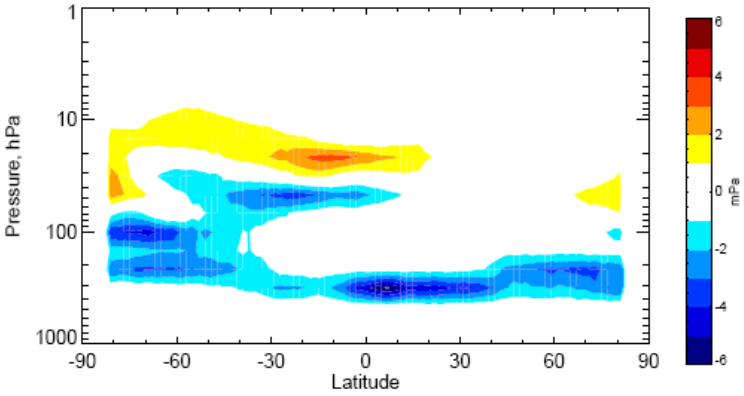
# Verify against MLS(2 Weeks,20090615-20090630)

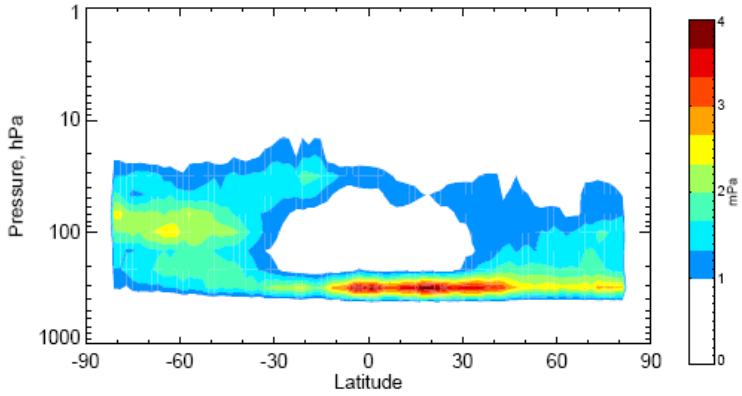
BIAS: <AN-MLS>

std: <AN-MLS>

BASELINE

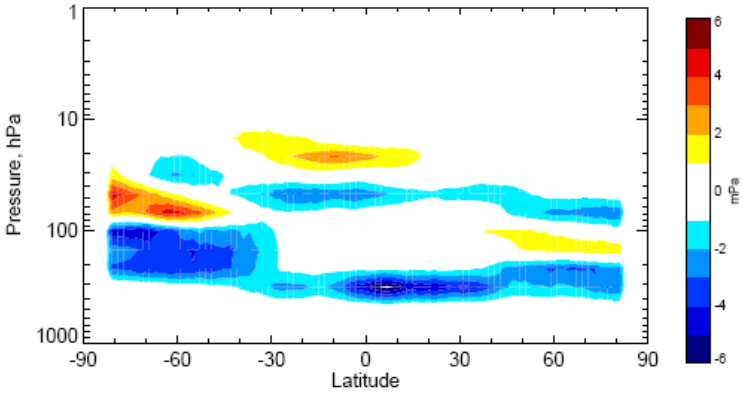
No O3 OBS

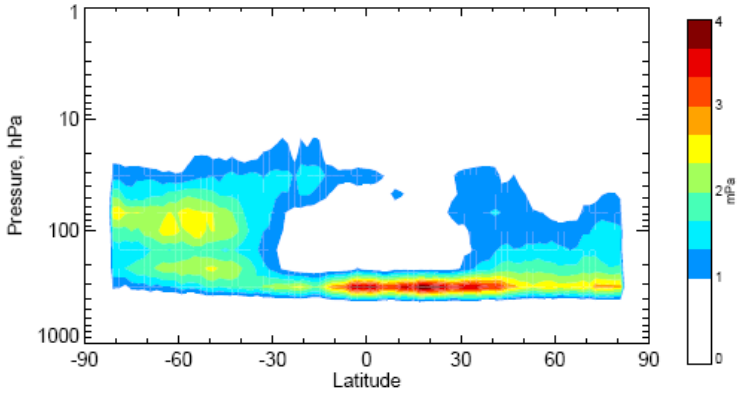



BASELINE

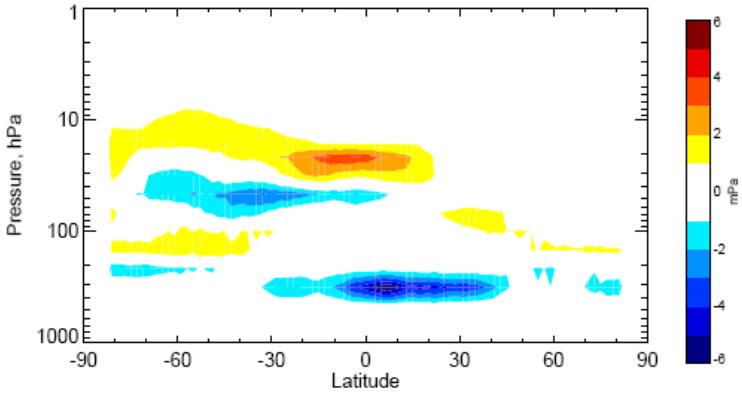
+SBUV+OMI

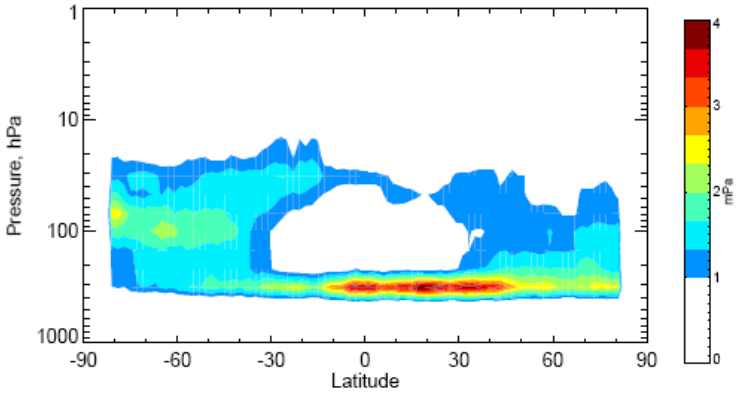



BASELINE

+IASI 16 O3 Channels

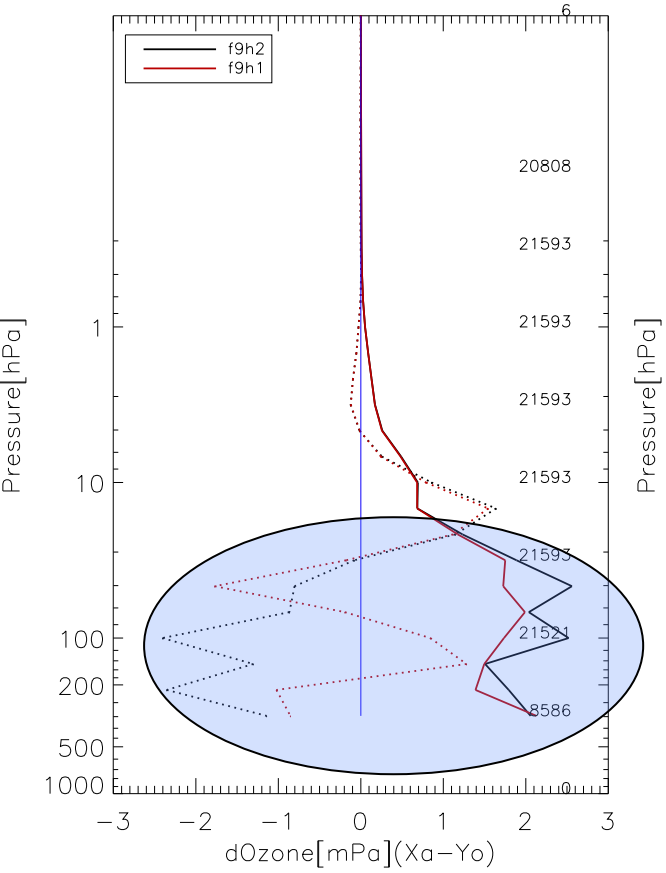


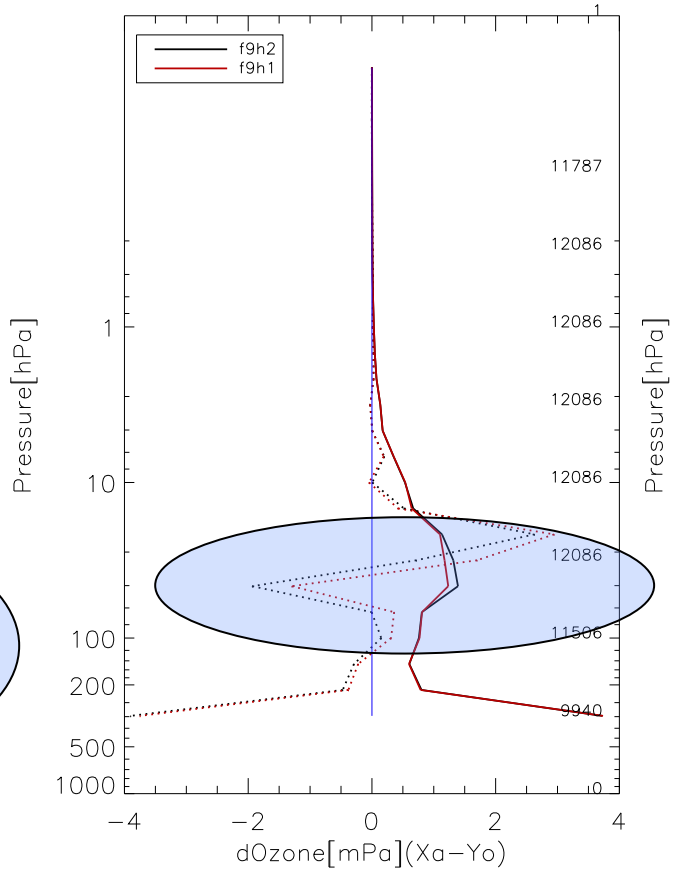
# Bias and std: verify against MLS

- **Black: BASELINE**
- **RED: BASELINE+IASI**

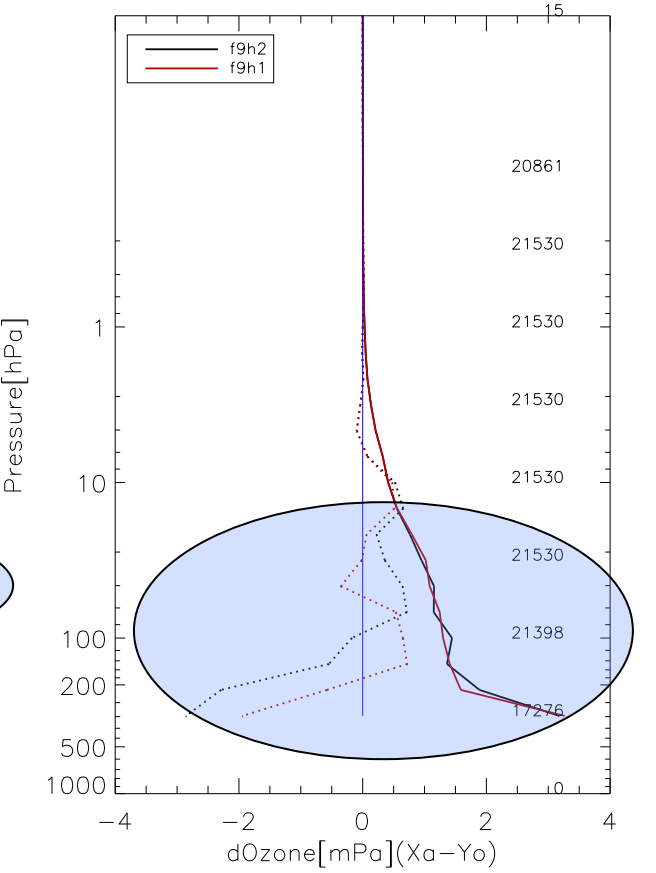
S.H




TR.




N.H

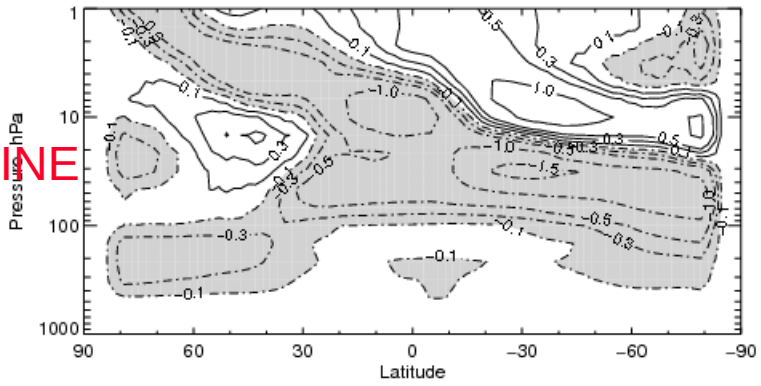


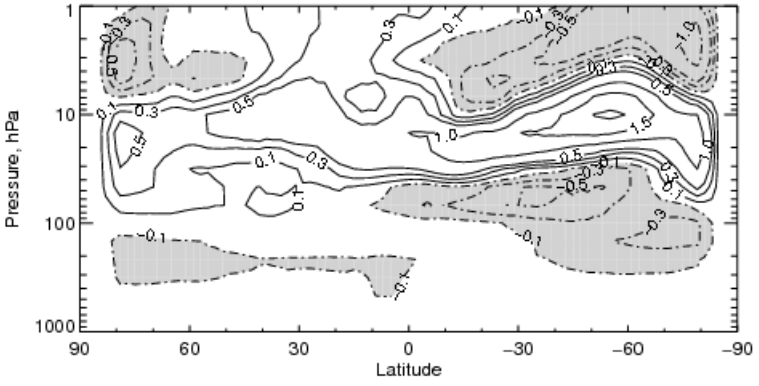
# Zonal Mean Bias

Winter

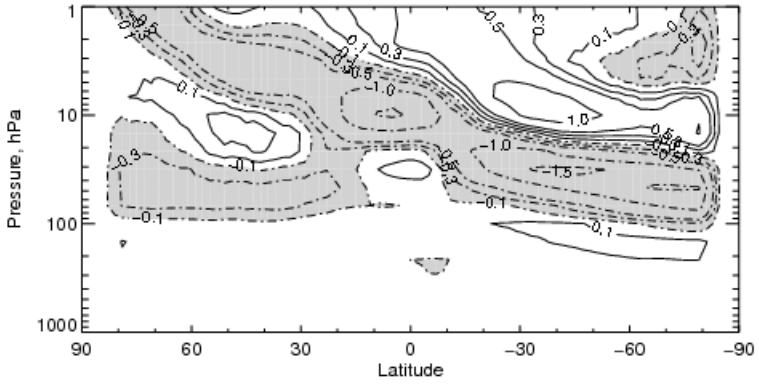
Summer

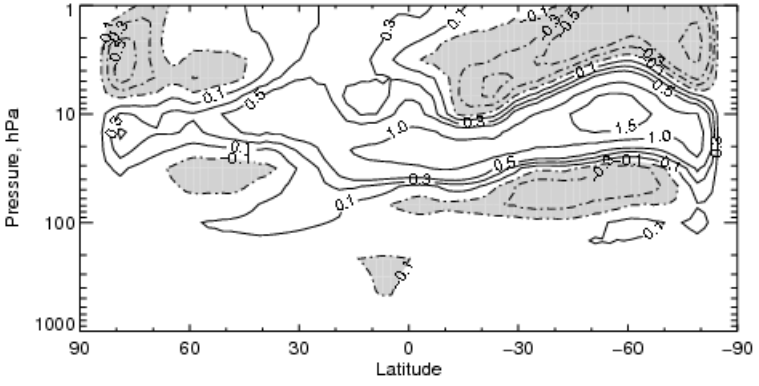
BASELINE



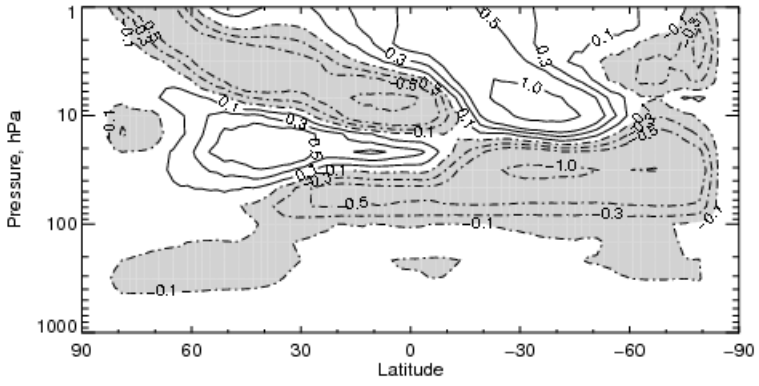



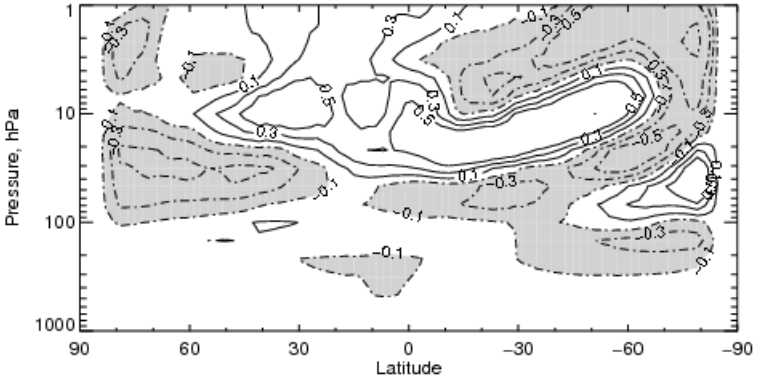

IASI



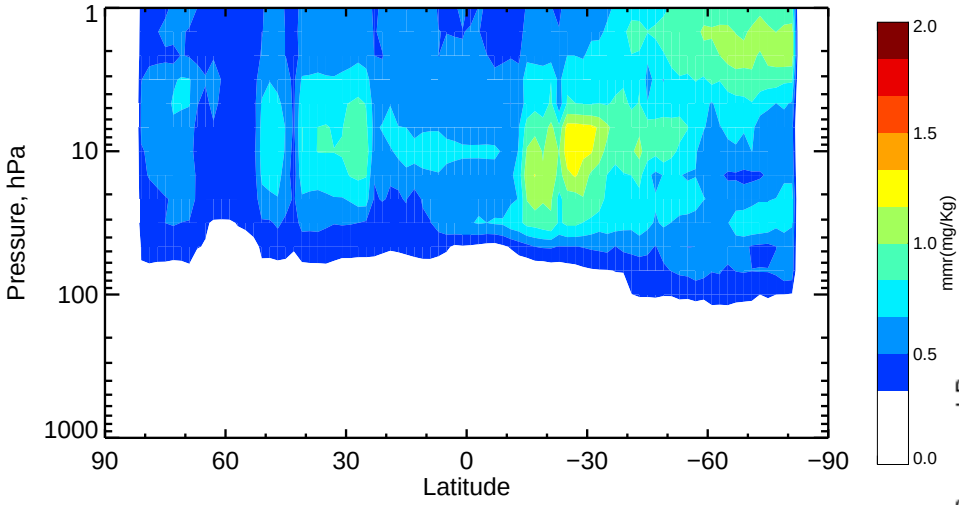

UV

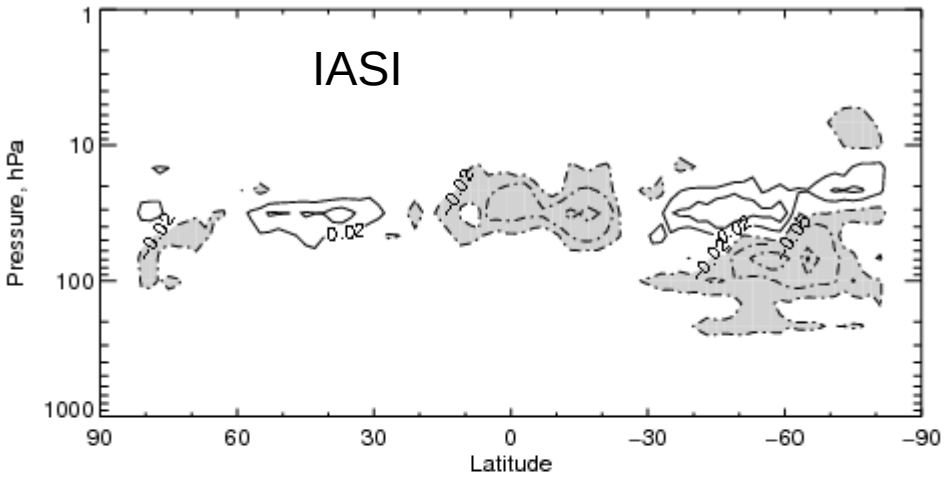


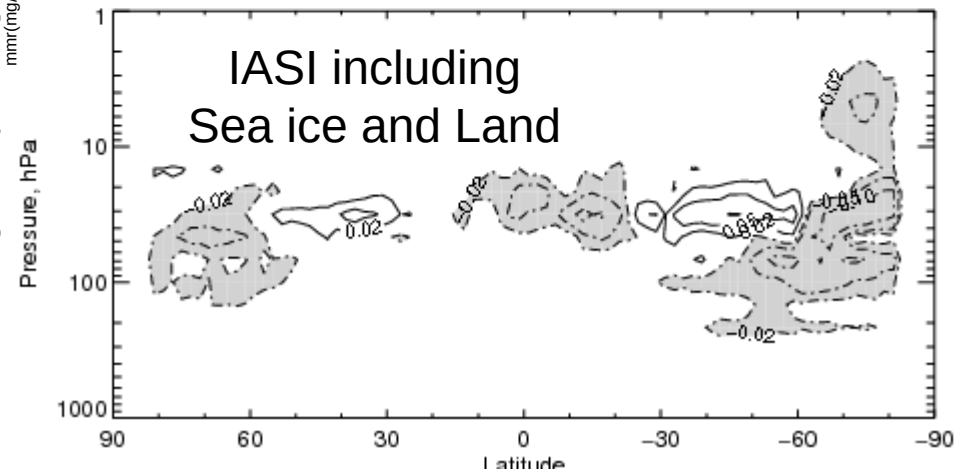



# Std. difference for summer period

Std. of Baseline




The standard deviation of baseline differences has been subtracted such that negative value indicate the degree of improvement relative to the baseline.

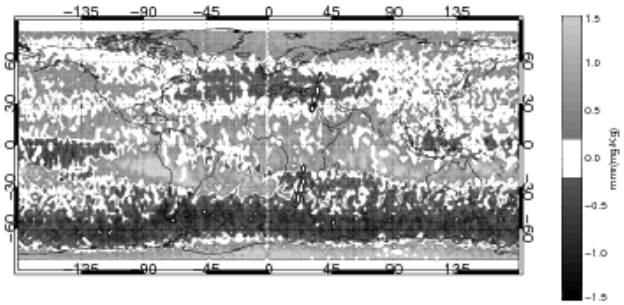
Verify against MLS

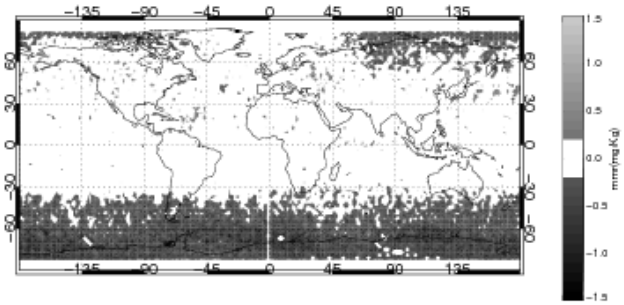
31.6hPa

100hPa

BASELINE

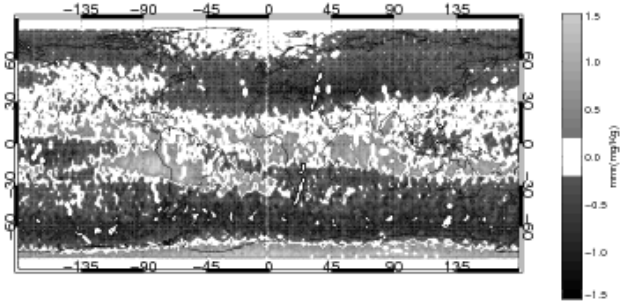
No O3 OBS

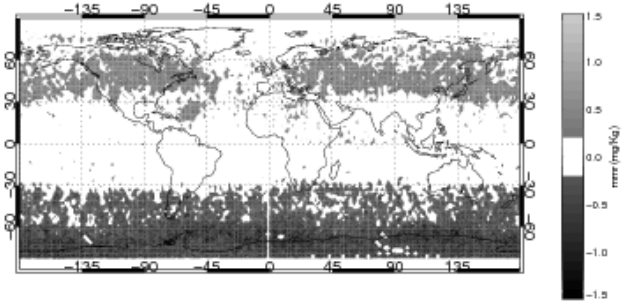




BASELINE

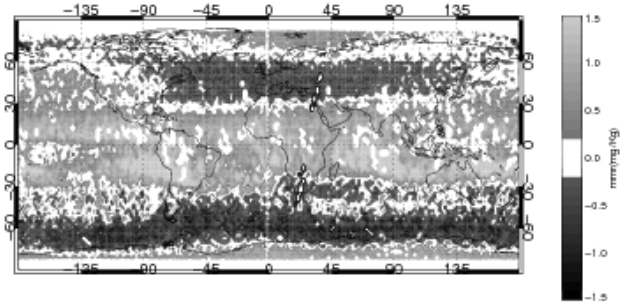
+SBUV+OMI

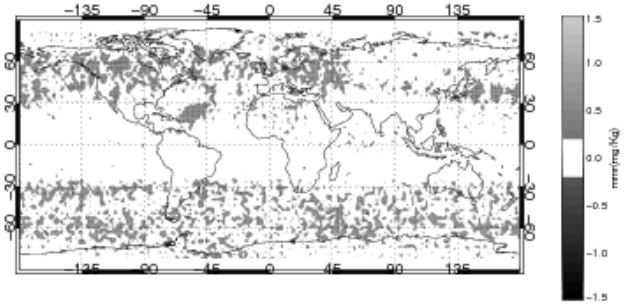




BASELINE

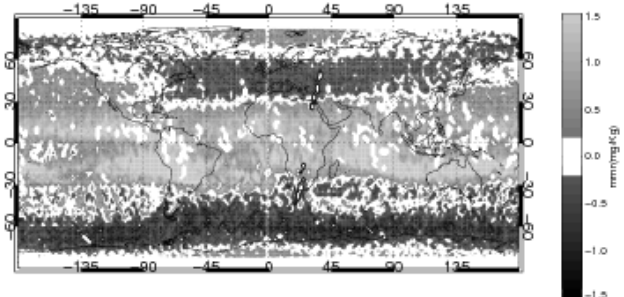
+IASI 16 O3 Channels

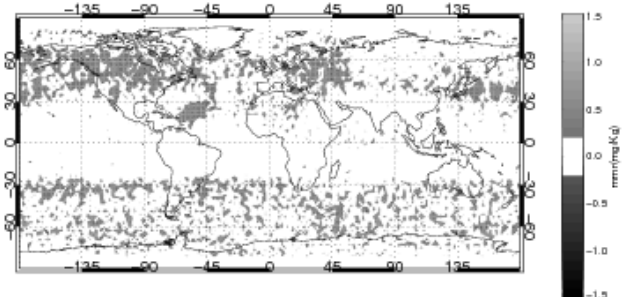




BASELINE

+IASI 16 O3 Channels+Land





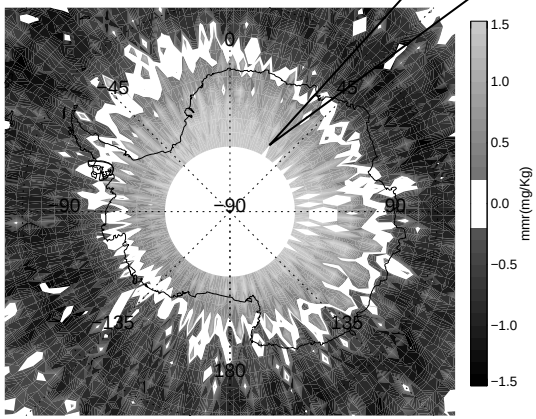
# Polar Night

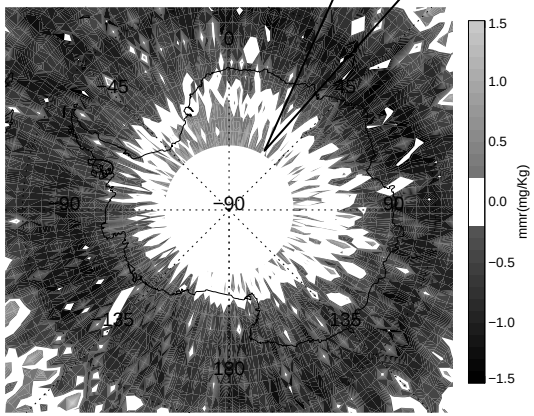
Positive bias in the Southern polar vortex

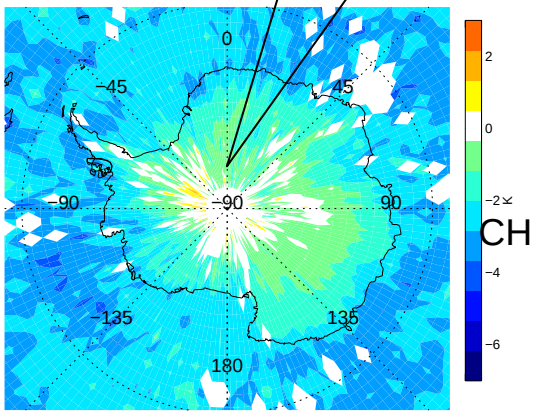
Positive bias becomes smaller

d=<Yo-H(xb)> Negative→Positive Reduce Ozone

31.6hPa



CH1585

BASELINE

IASI O3 Over antarctic

O3 -- BASELINE

TCO

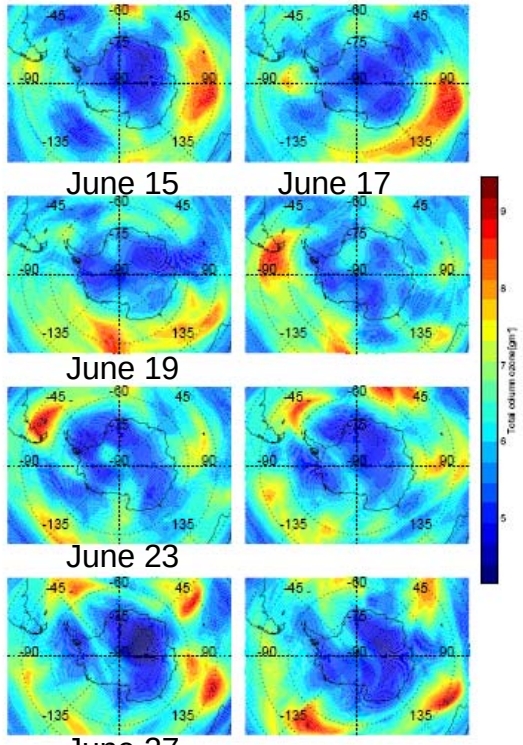
June 15

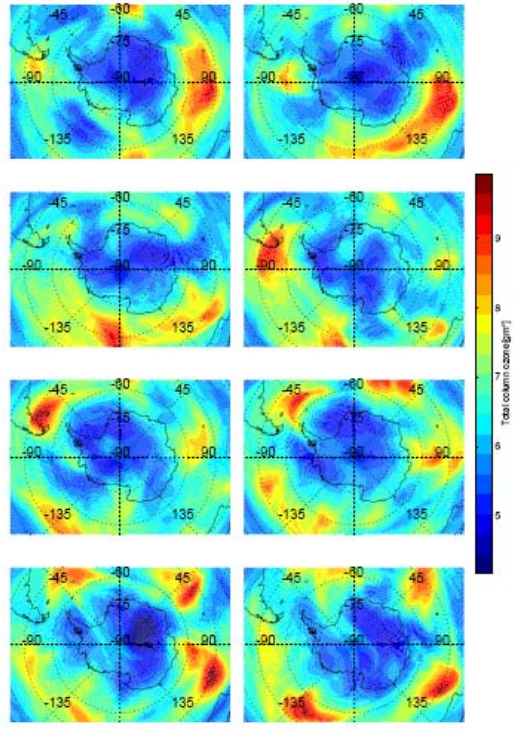
June 17

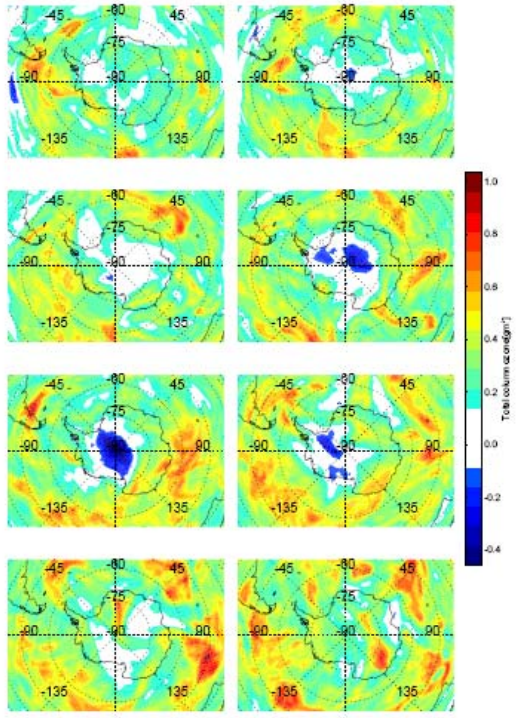
June 19

June 23

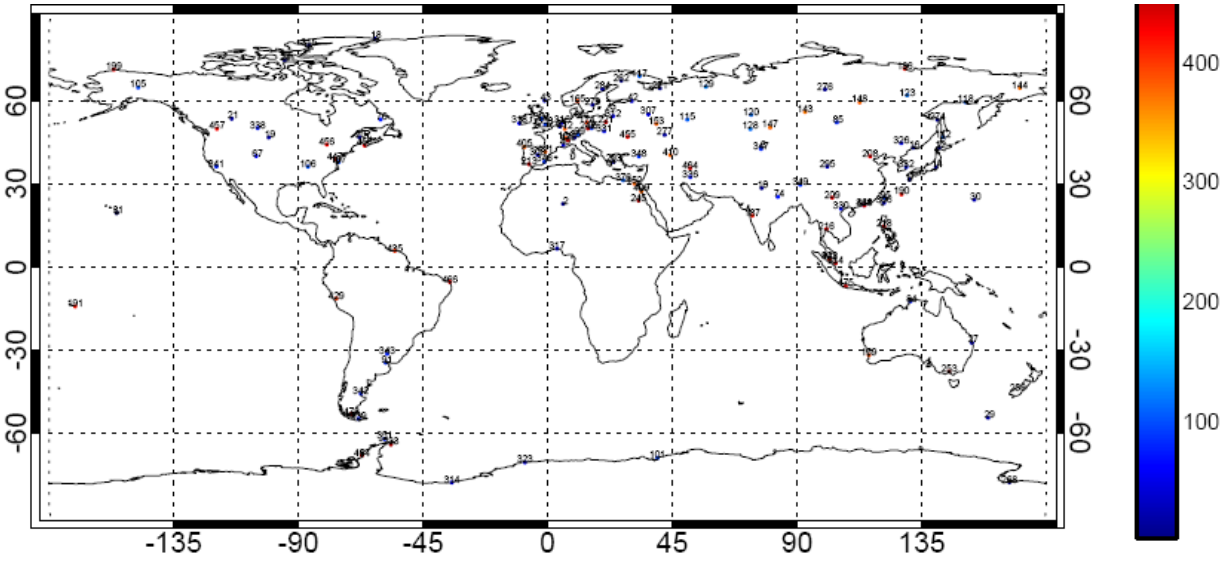
June 27

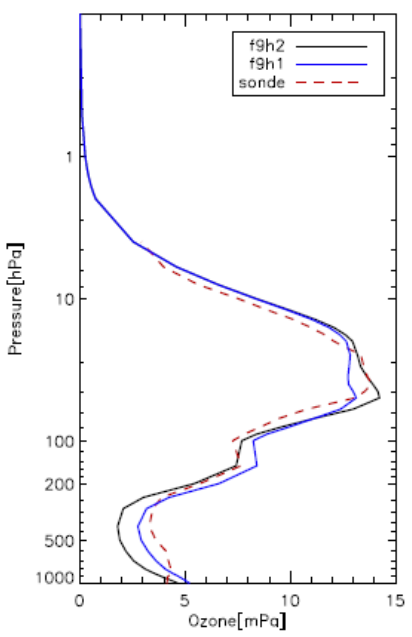


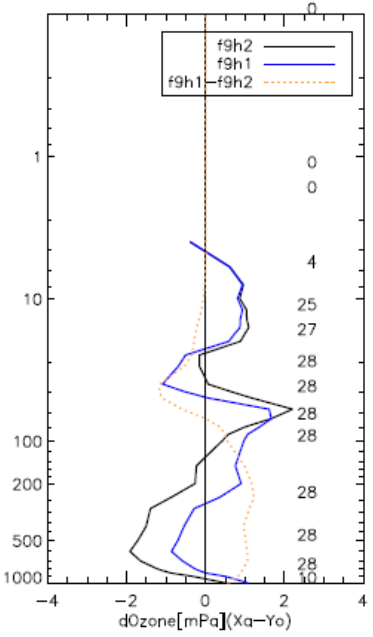


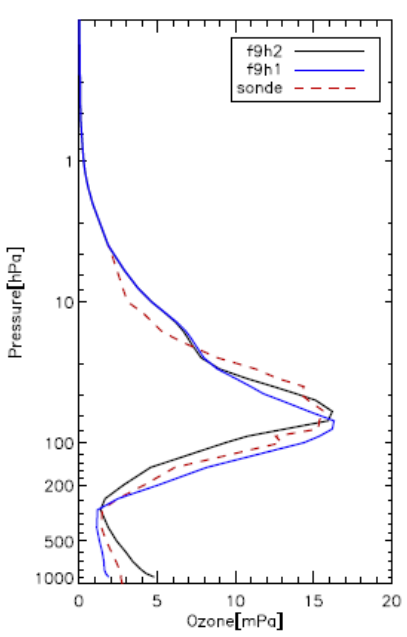


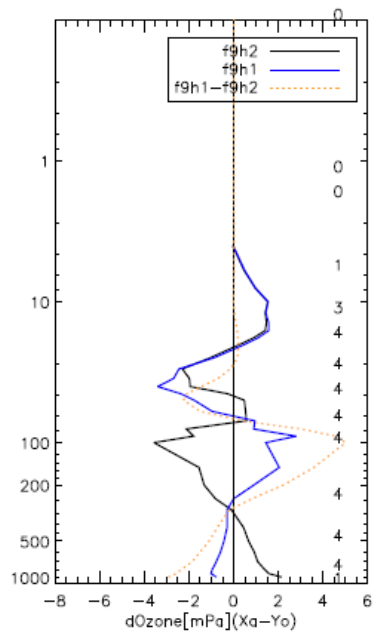
# Verify against sonde data in June 2009



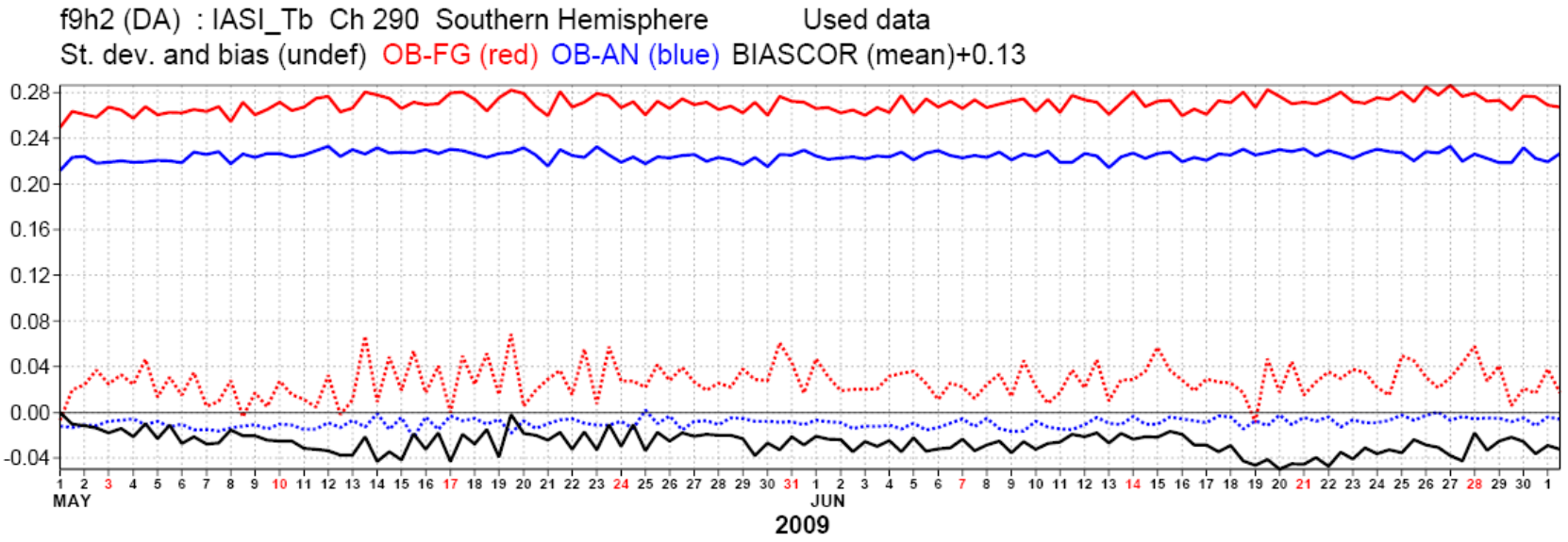



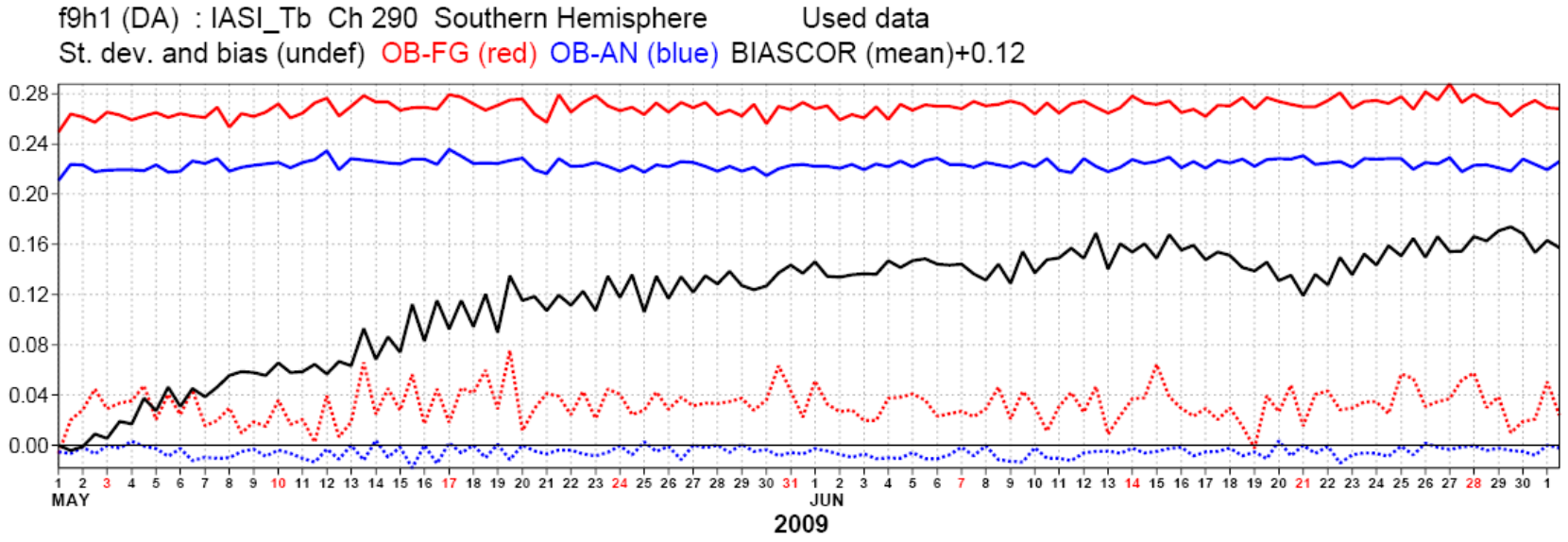



# Improve the fit to other IASI channel: CH290



# Summary and Discussions

- **BIAS analysis: OBS or BACKGROUND?**
  - **the Bias is maily from BACKGROUND: 75% VS 25%**
    - ➔ Activate the IR O3 channel in assimilation
    - ➔ Anchoring VarBC against model bias
- **Experiment Results**
  - **VERIFY against independent obs.**
    - ➔ SONDE: only about 10 stations, but better at UTLS
    - ➔ MLS: better in S.H and N.H. There is problem in Tropics
  - **Impact on other sounding channels**
    - ➔ IASI 290: improved the fit
  - **Polar night**
- **Future work**
  - **Bias Correction, Anchoring, UV+IR, Wind Coupling**

THANKS FOR YOUR ATTENTION

THANKS FOR

EUMETSAT NWP SAF VS project

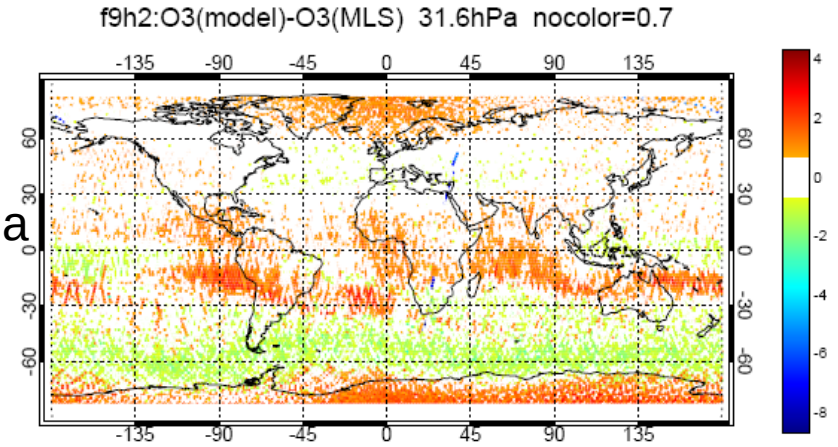
# Backup slides

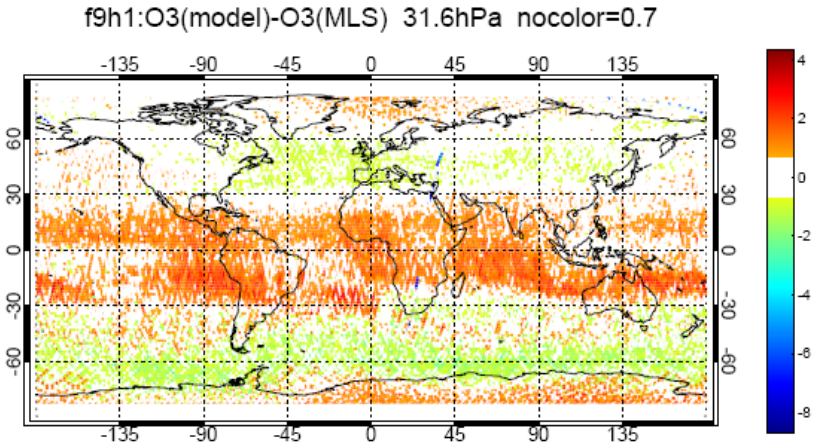
# Analysis Bias: verify against MLS

## BASELINE: No O3 OBS

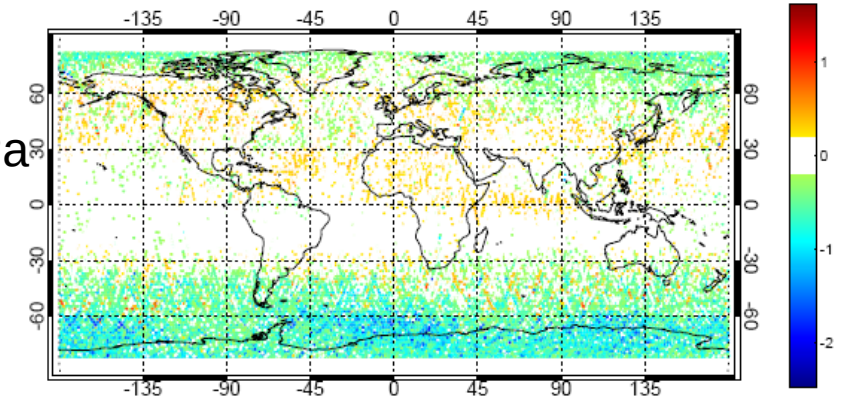
## BASELINE+IASI O3 Channels

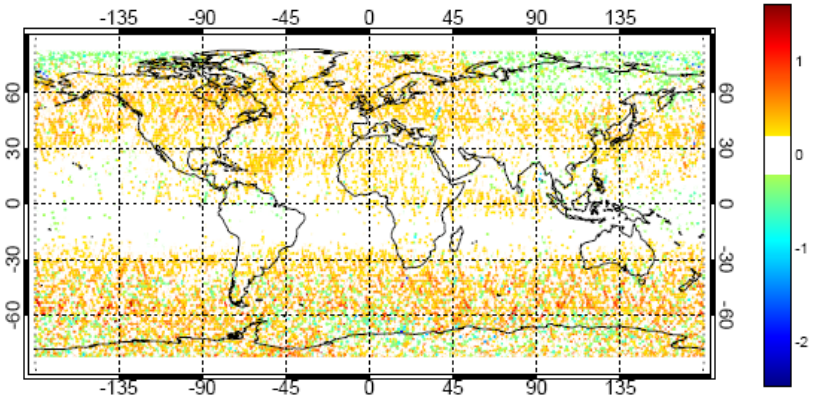
31.6hPa




100hPa



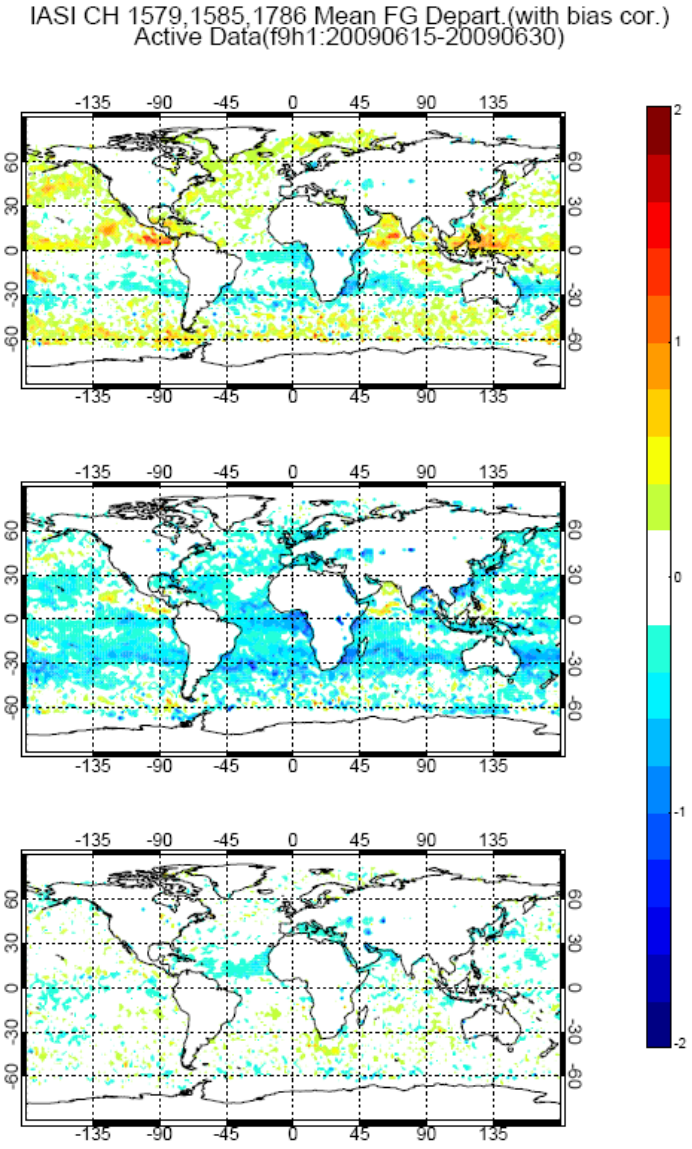
# How to anchor VarBC : next step

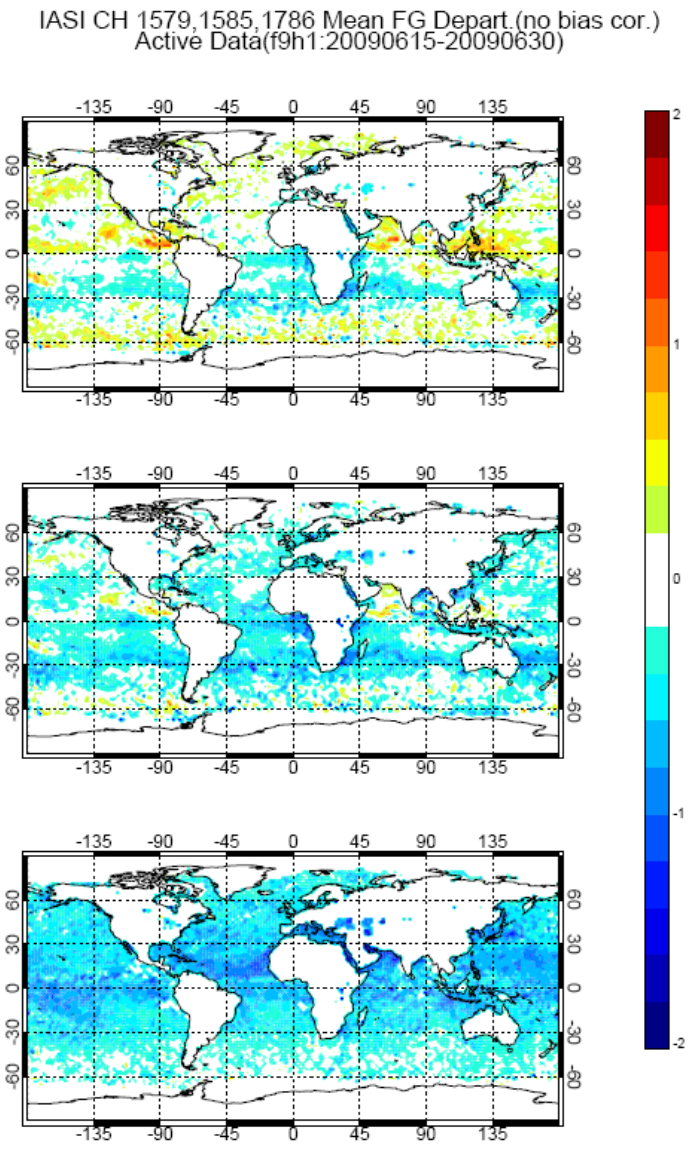
CH:1579

CH:1585

Anchoring:no bias correction

CH:1786

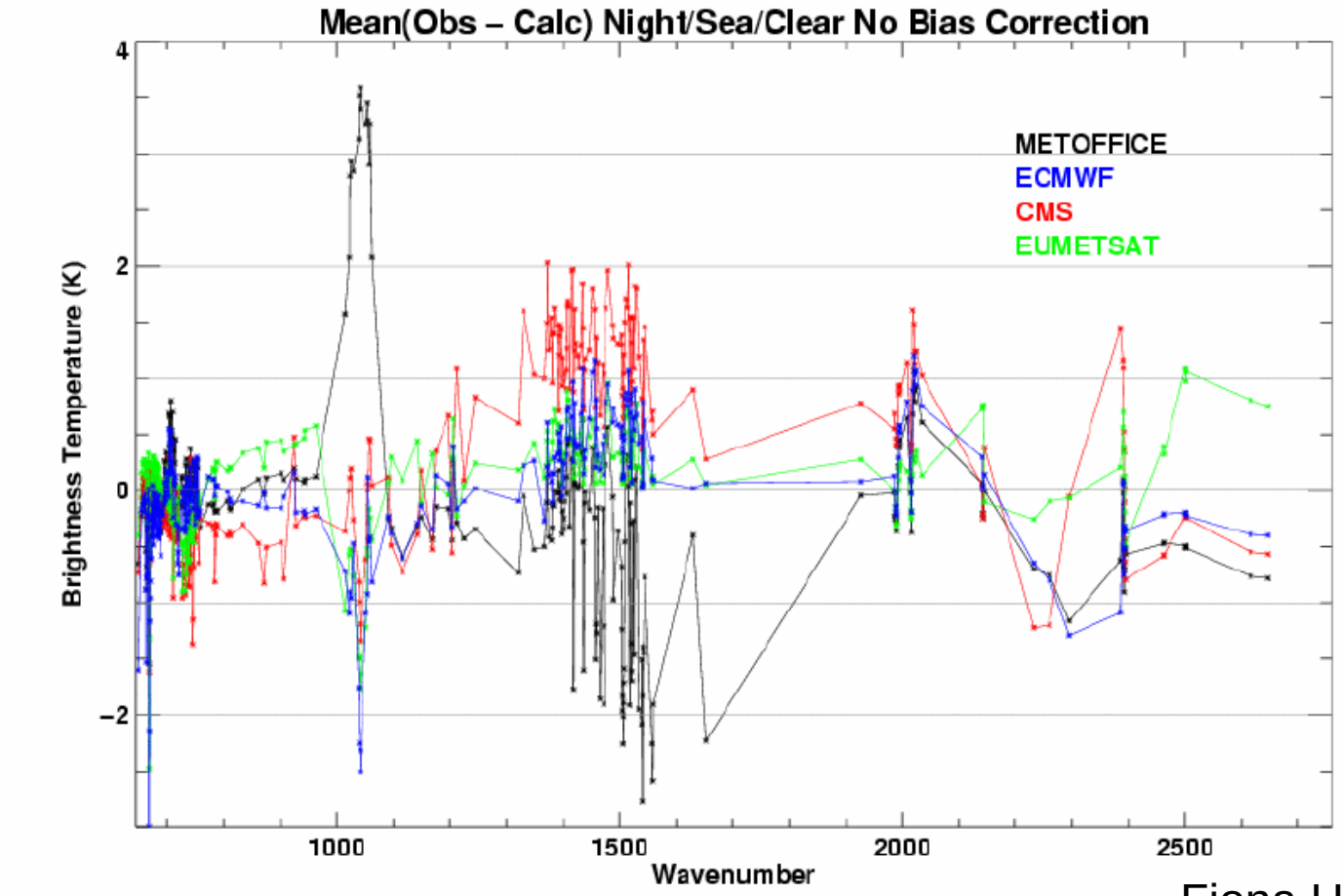


# Comparison of IASI radiances with NWP models from four operational centres

Fiona Hilton[1], Andrew Collard[2], Lars Fiedler[3],Lydie Lavanant[4]

[1]Met Office [2]ECMWF [3]EUMETSAT [4]Météo-France/CMS



# Interactive O3-Wind

- **Interactive ozone-wind coupling**

TL model:

$$\frac{\partial \delta O_3}{\partial t} + \vec{\mathbf{V}}^{b} \cdot \nabla \delta O_3 + \delta \vec{\mathbf{V}} \cdot \nabla O_3^{\,b} = 0$$

- **WHY turn it off?(Elias Holm)**
  - **Bias of the model**
  - **Thin layers observation**