Simultaneous assimilation of ENVISAT/MIPAS and ODIN/SMR ozone profiles into a chemistry transport model

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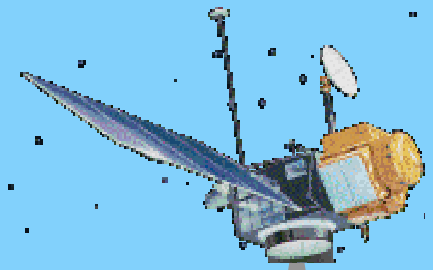
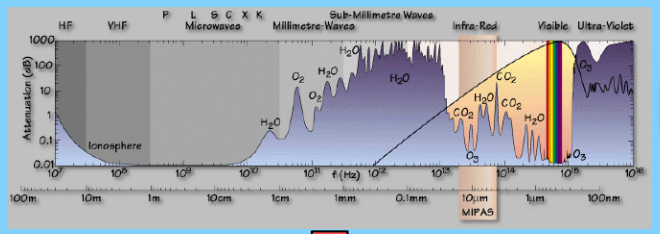
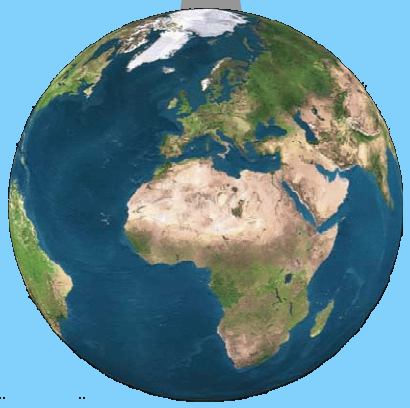
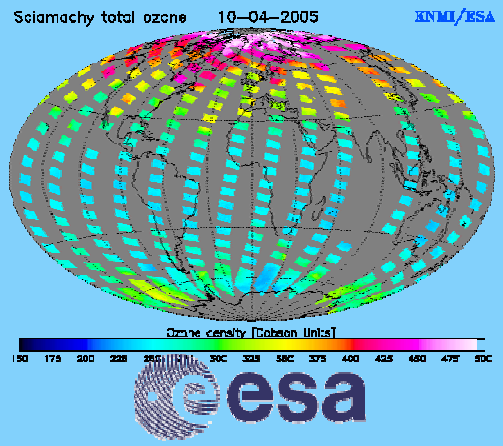
CONTEXT

ASSET
Assimilation of Envisat Data









Data assimilation

Chemistry Transport Model
Mocage:
☞ Control chemistry

Numerical Weather Prediction
Model Arpege:
☞ Control dynamic

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CONTEXT

ASSET
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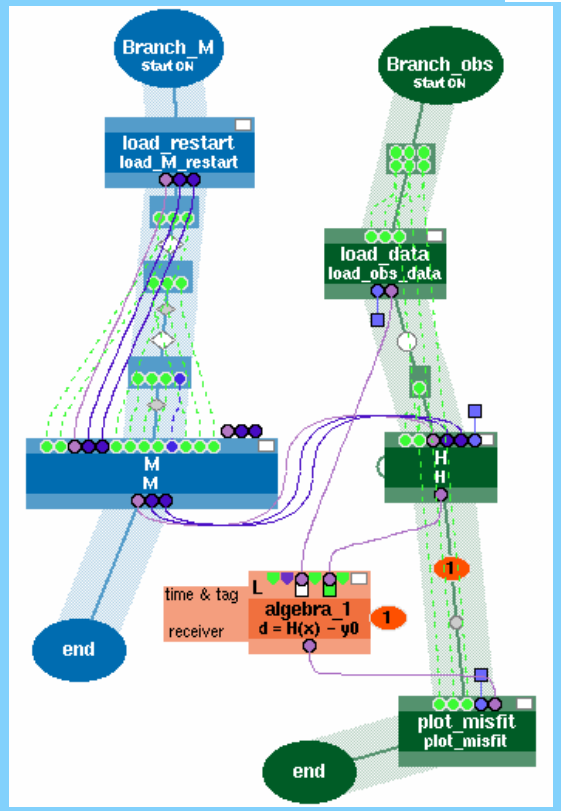
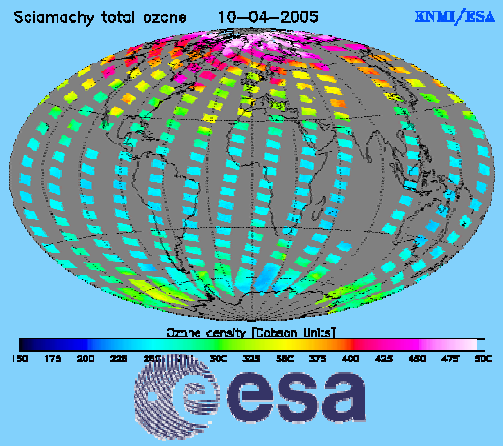


Data assimilation

Palm



Chemistry Transport Model
Mocage:
☞ Control chemistry

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Overview

- Assimilation system
  - ✓ MOCAGE-PALM suite
  - ✓ Expriment configuration
- Observations
  - ✓ ODIN/SMR
  - ✓ ENVISAT/MIPAS
- MIPAS analyse versus SMR analyse
  - ✓ Ozone concentrations
  - ✓ Observations Minus Analyses
- MIPAS & SMR analyse
  - ✓ Ozone concentrations
  - ✓ Total ozone
  - ✓ Observations Minus Analyses

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MOCAGE-PALM assimilation

- Vertical resolution:
  - 47 levels (ground ⇨ 5 hPa), dynamic from Arpège
  - 60 levels (ground ⇨ 0.1 hPa), dynamic from ECMWF
- Chemistry schemes:
  - Linear Cariolle scheme (v. 2.1)
  - REPROBUS (stratosphere)
  - RACMOBUS (troposphere + stratosphere)
- Methods:
  - 3D-FGAT
  - 4D-INC (Transport, Transport + chemistry)
- Observations:
  - GOME (KNMI ozone retrieval profiles)
  - ODIN/SMR (French retrievals, reference data set)
  - ENVISAT/MIPAS (version 4.62 from D-PAC)
  - ENVISAT/GOMOS
- Error correlation:
  - background (**B**) : diffusion operator [Weaver, 2001]
  - observation (**R**) : vertical correlation

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☞ Focus on the 1st month of the ASSET period: July.

✓ System
✓ Observations
✓ MIPAS / SMR
✓ MIPAS & SMR

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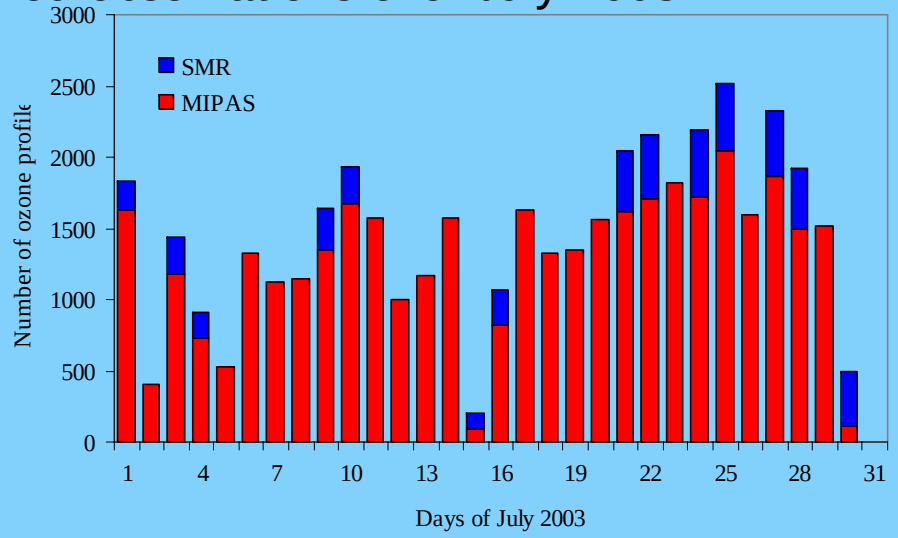
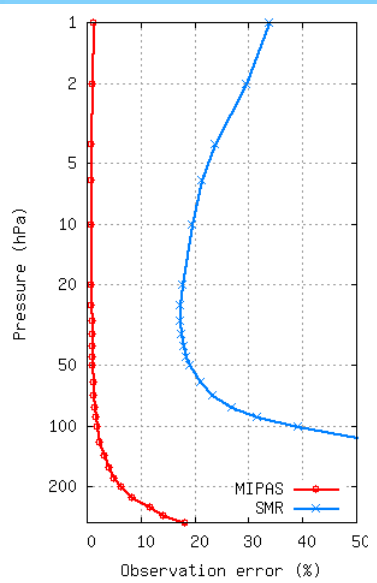
MIPAS & SMR observations

- Stacked observations over July 2003

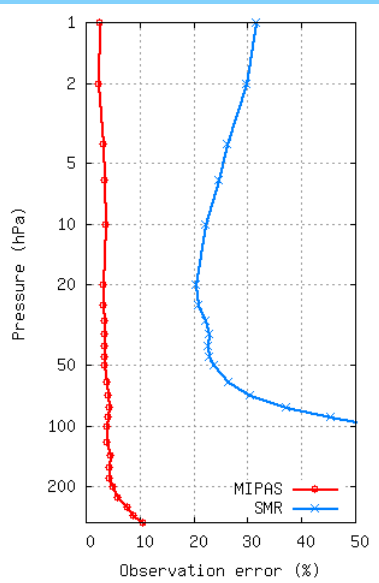


- Assimilation system observations errors (%)

90°S – 60°S



30°S – 30°N



- ✓ Average on July
- ✓ Normalized by climatology
- ✓ Tuned to be consistent with background errors

- ✓SMR errors lager than MIPAS ones
- ✓ large SMR errors under 100 hPa

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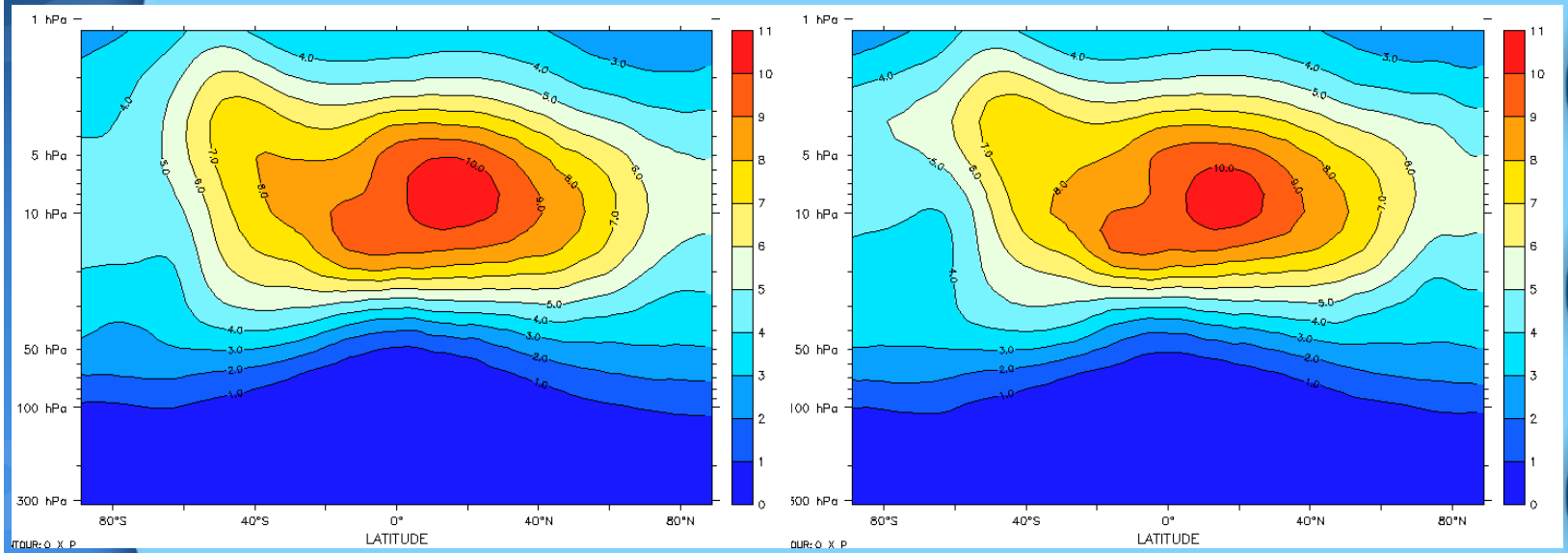
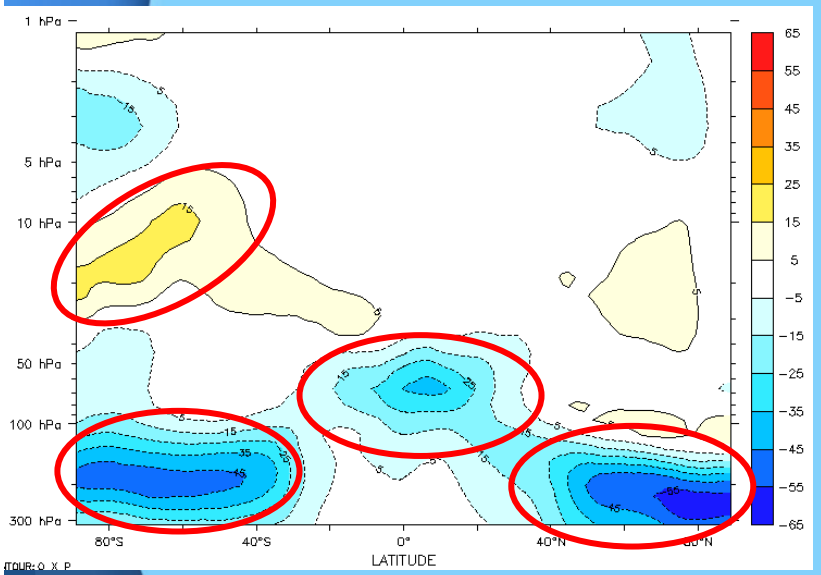
Average ozone concentration

(a) SMR analysis (July 2003)

(b) MIPAS analysis (July 2003)



[(a) – (b)] / (b) in %



Difference between SMR and MIPAS analysis (%):

- ✓ less ozone in the high latitudes UTLS ;
- ✓ less ozone in the tropical lower stratosphere
- ✓ more ozone in the southern stratospheric polar vortex

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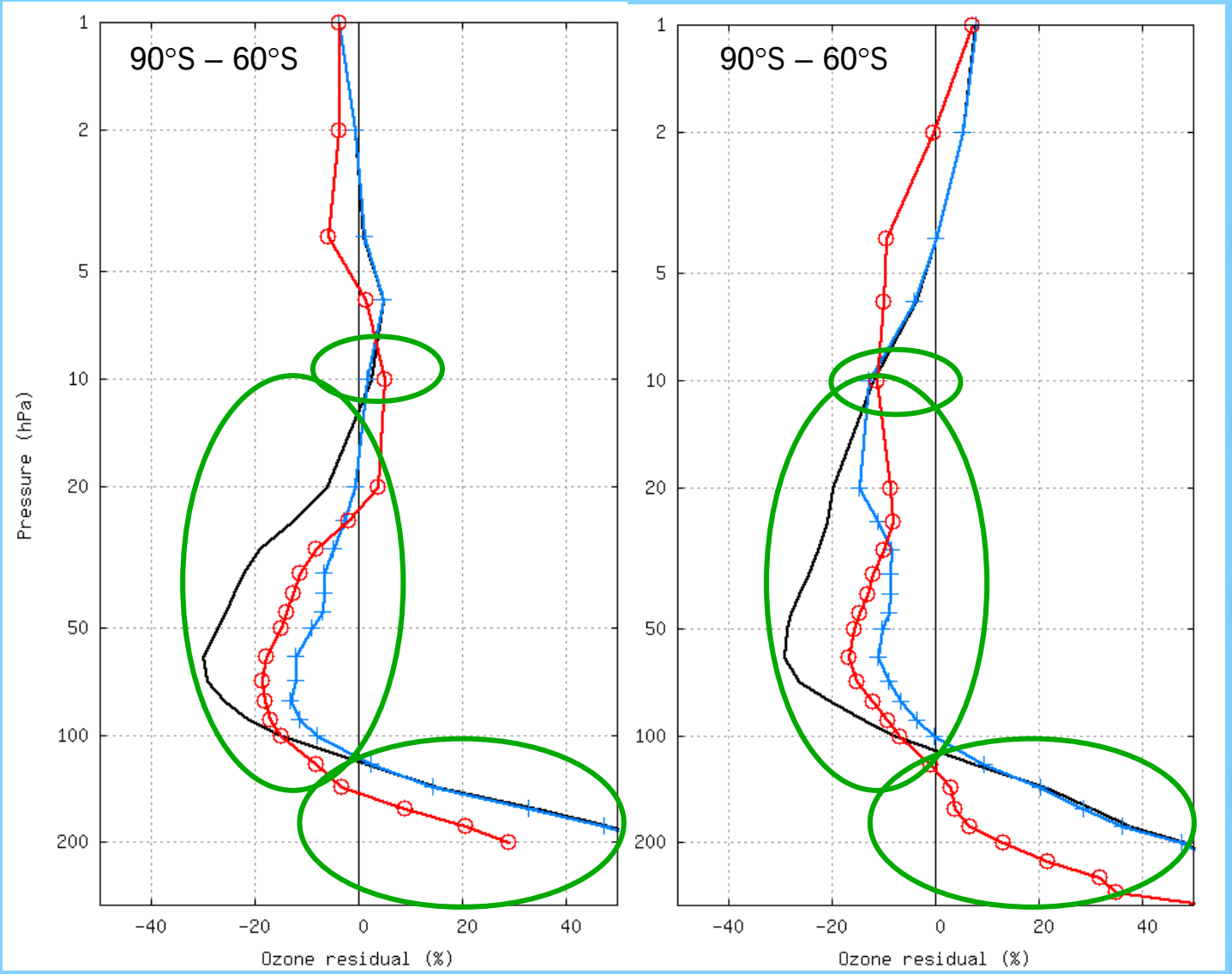
Average “Observation – Analysis”

(1) SMR minus analysis

(2) MIPAS minus analysis



- ✓ System
- ✓ Observations
- ✓ MIPAS / SMR
- ✓ MIPAS & SMR

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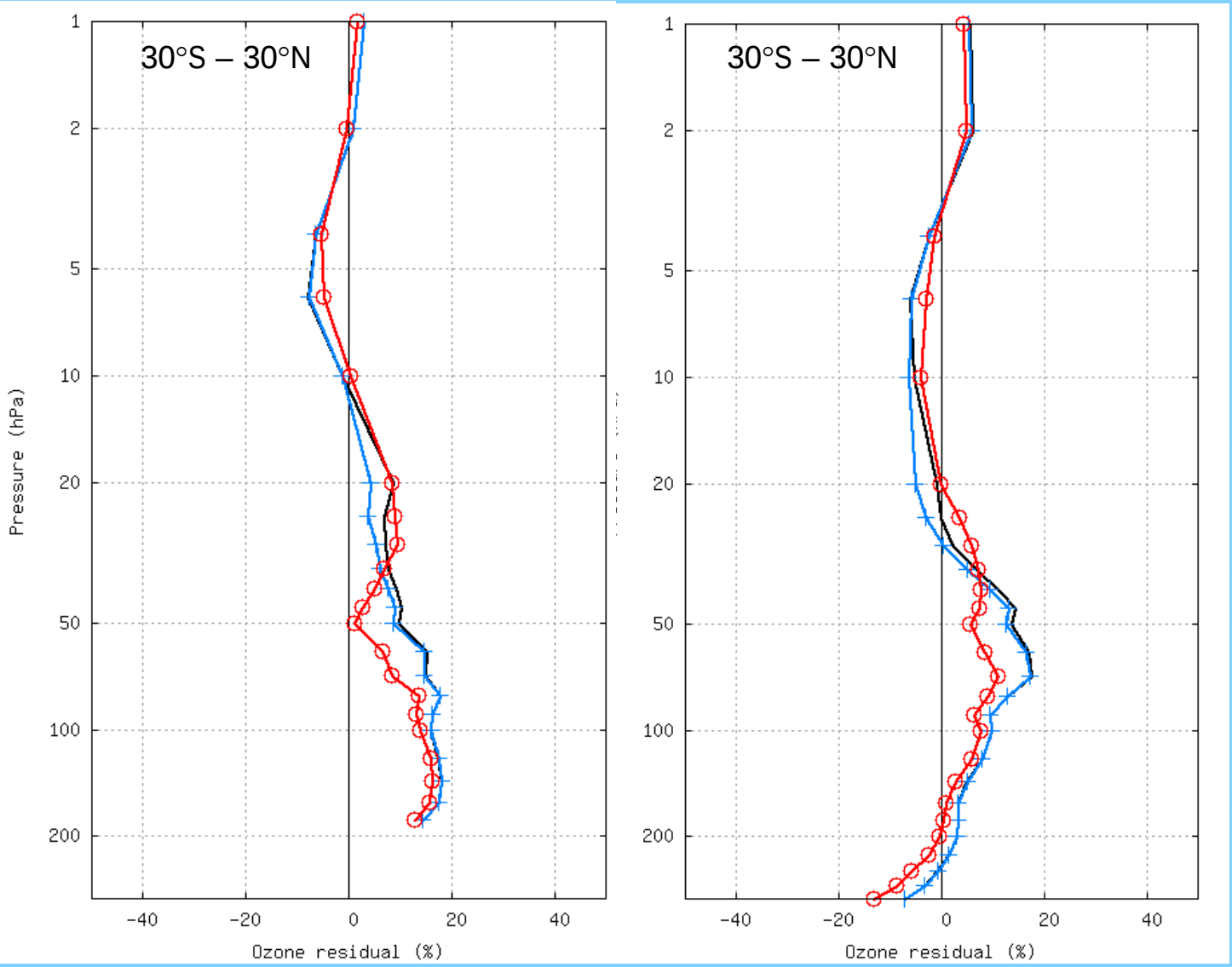
Average “Observation – Analysis”

(1) SMR minus analysis

(2) MIPAS minus analysis



Control run MIPAS analysis SMR analysis

- ✓ System
- ✓ Observations
- ✓ MIPAS / SMR
- ✓ MIPAS & SMR

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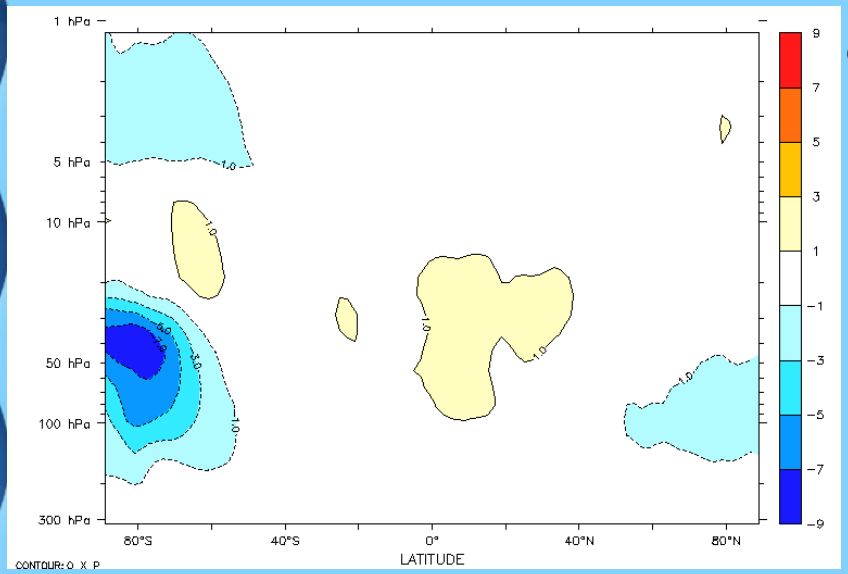
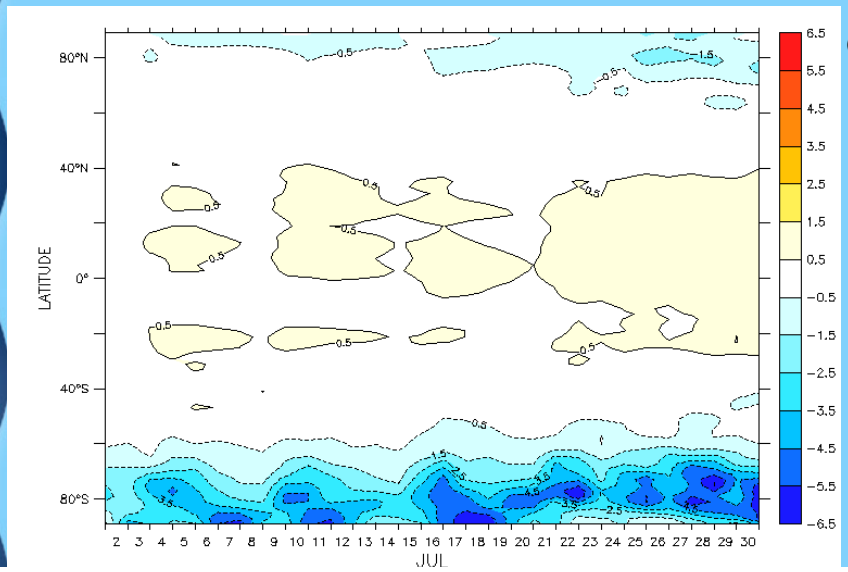
Combined MIPAS & SMR analysis



- Average zonal difference (in %) with MIPAS analysis

- ✓ decrease of 10 % between 30 to 50 hPa in the south polar region
- ✓ decrease of 1% between 50 to 150 hPa in the north polar region
- ✓ increase of 1% between 20 to 100 hPa near the equator



- Total ozone difference (in %) with MIPAS analysis

- ✓ decrease of 6 % between in the south polar region
- ✓ decrease of 1-2% in the north polar region
- ✓ increase of 0-1% near the equator

- ✓ System
- ✓ Observations
- ✓ MIPAS / SMR
- ✓ MIPAS & SMR

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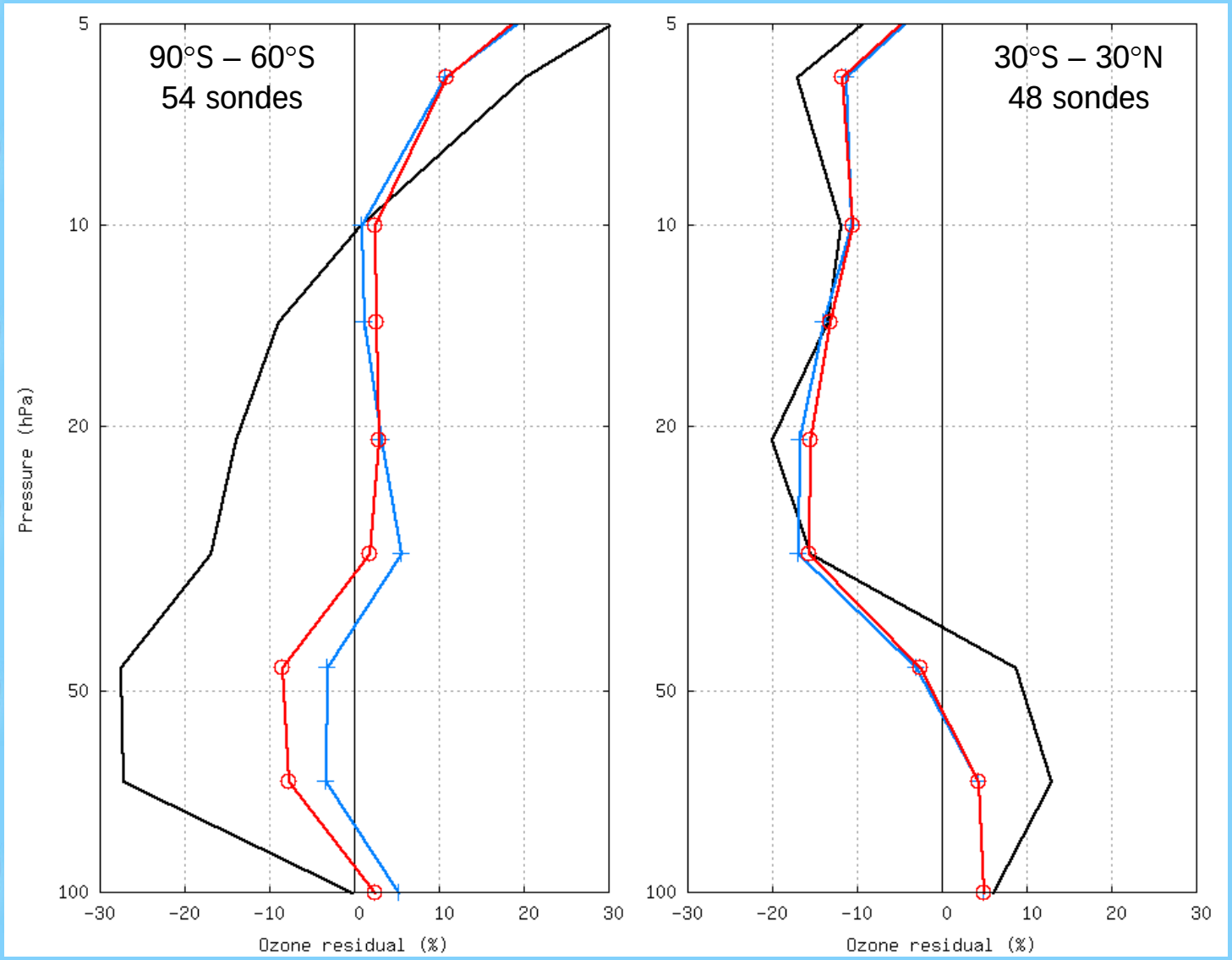
Comparison with independent data

Average of “ozonesondes minus analyses”



— Control run — MIPAS analysis — SMR & MIPAS analysis

- ✓ System
- ✓ Observations
- ✓ MIPAS / SMR
- ✓ MIPAS & SMR

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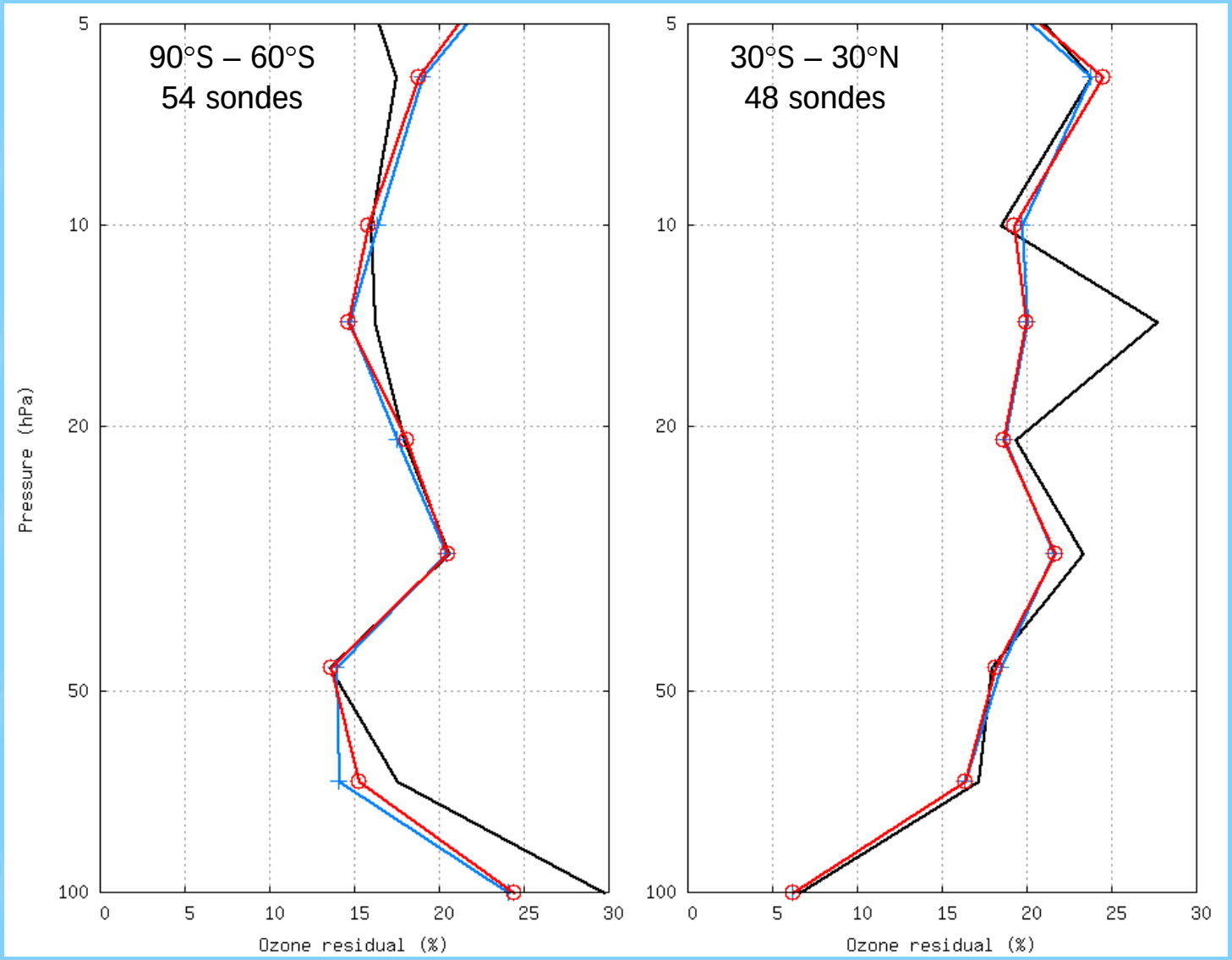
Comparison with independent data

Standard deviation of “ozonesondes minus analyses”



- ✓ System
- ✓ Observations
- ✓ MIPAS / SMR
- ✓ MIPAS & SMR

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Conclusions

- Successful analysis of MIPAS and SMR separately
- Successful analysis of MIPAS & SMR jointly **without any bias correction one with respect to the other**
- Adding SMR data to MIPAS ones improve the analysis quality in the stratospheric south polar vortex in spite of the sparser density of SMR
- Small impact of adding SMR elsewhere
- Bias with dependent and independent data reduced thanks to assimilation
- Standard deviation with independent data not really reduced
- Need to remove the observations bias