

# Data assimilation: Adding value to Envisat chemistry observations

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- Data assimilation: how it has added value to Envisat chemistry observations from *GOMOS*, *MIPAS* & *SCIAMACHY*
  - Examples from EU-funded *ASSET* project
- Lessons learnt for research satellite missions

Data assimilation: adding value:

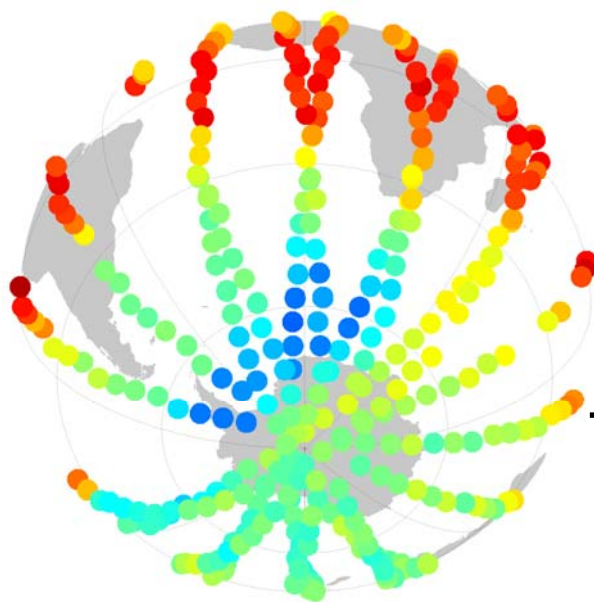
# Ozone 10hPa, 12Z 23 Sep 2002

Red: high ozone  
Blue: low ozone

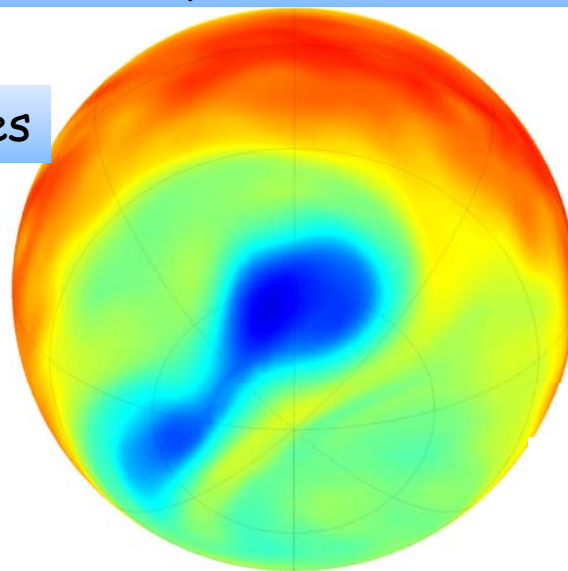
Analyses

DA adds value to both  
observations and model

*Geer et al., QJRMS, 2006*

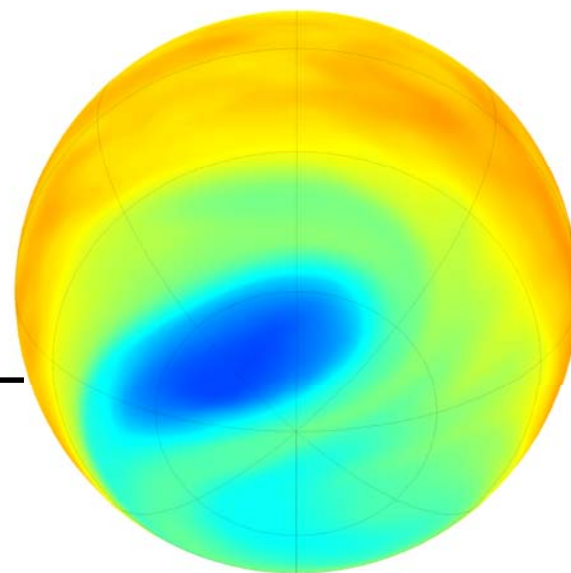


MIPAS observations



DA

Errors



6 day forecast

# Data assimilation and NWP:

**Key idea: Confronting models with observations**

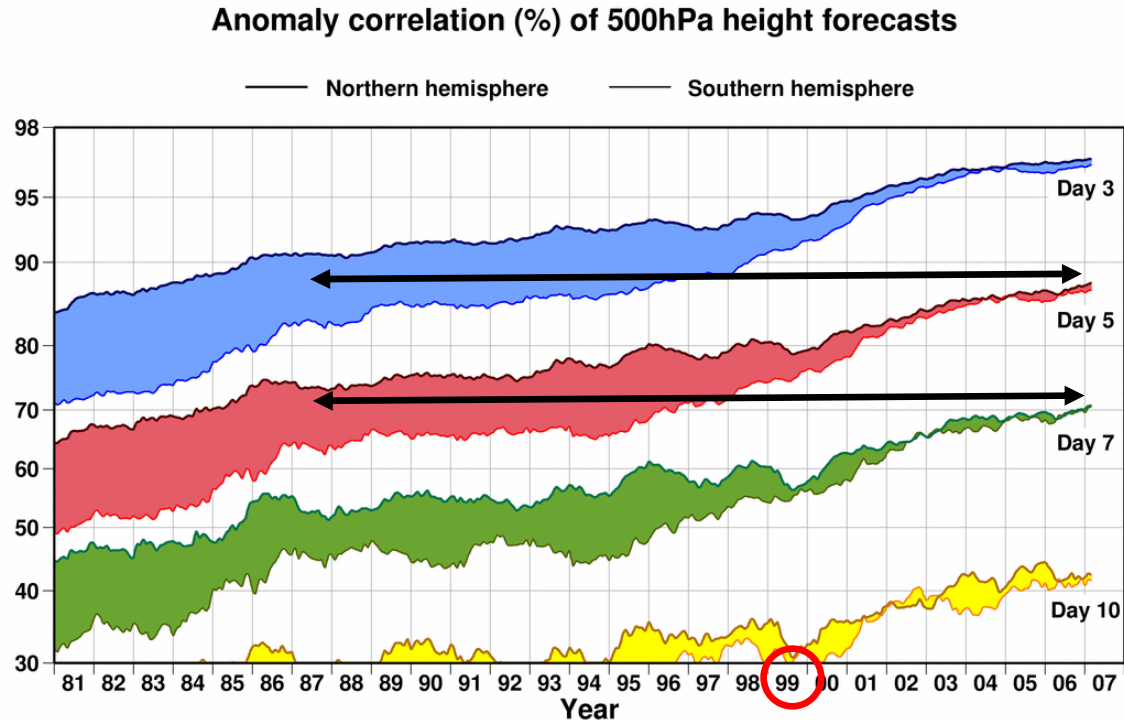
Progress in NWP has been a combination of:

- Better models: higher resolution, better processes
- Better observations: satellites
- Better use of observations: bias correction, quality-control, radiances
- Better computing power
- **Data assimilation**: better use of observations and models; use of 4d-var

This has allowed **observations and models** to be **evaluated and improved**

This has allowed **improvement in NWP forecasts** (e.g. ECMWF)

## NWP: success for data assimilation



AC coeffs, 3-, 5-, 7- & 10-day ECMWF 500 hPa ht forecasts for extra-tropical NH & SH, plotted as annual running means of archived monthly-mean scores for Jan 1980 - Nov 2006. Values plotted for a particular month are averages over that month & 11 preceding months. Colour shadings show differences in scores between two hemispheres at the forecast ranges indicated (After *Simmons & Hollingsworth, QJRMS, 2002*)

Impact of satellite observations, impact of data assimilation

Towards end of 1999: a more advanced 4D-Var developed & significant changes in the GOS mainly due to launch of 1<sup>st</sup> ATOVS instrument onboard NOAA satellites

## Applying NWP ideas to Envisat:

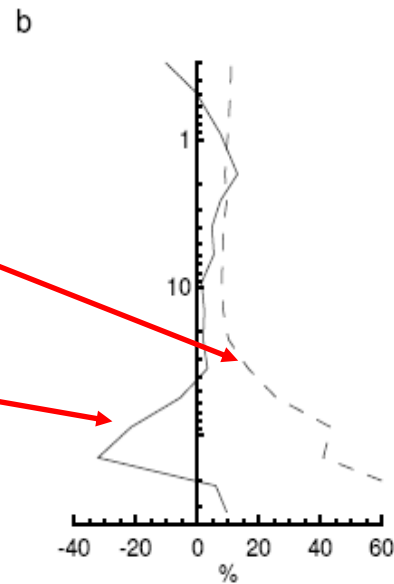
- Use data assimilation to add value to Envisat chemistry observations:
  - Fill in the gaps in the observations (use a model) & produce an "analysis" ("best" estimate given information)
    - Feedback to NWP centres
  - Evaluate the observations (error characteristics, bias)
    - Feedback to instrument teams
  - Evaluate models assimilating observations
    - Feedback to modellers
  - Learn how to make best use of EO data (past, current & future)
    - Feedback to space agencies

# Obs quality:

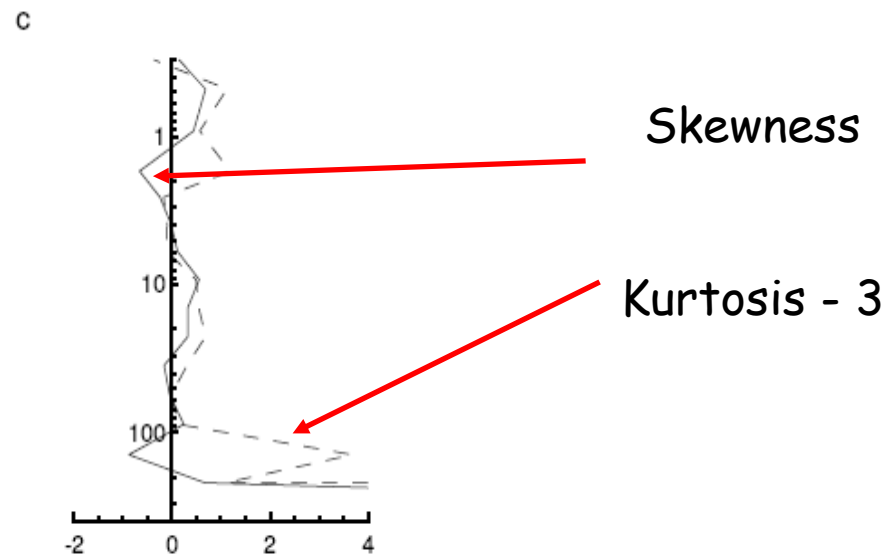
## DA: Self-consistency of MIPAS ozone data

Statistics: 14-28 Sep 2002

Obs (MIPAS) minus short-range Forecast (model),  $OmF$



$OmF \sim 0$  in stratosphere



Consistent with Gaussian errors in stratosphere

*Geer et al. QJRMS (2006); Struthers et al. JGR (2002)*

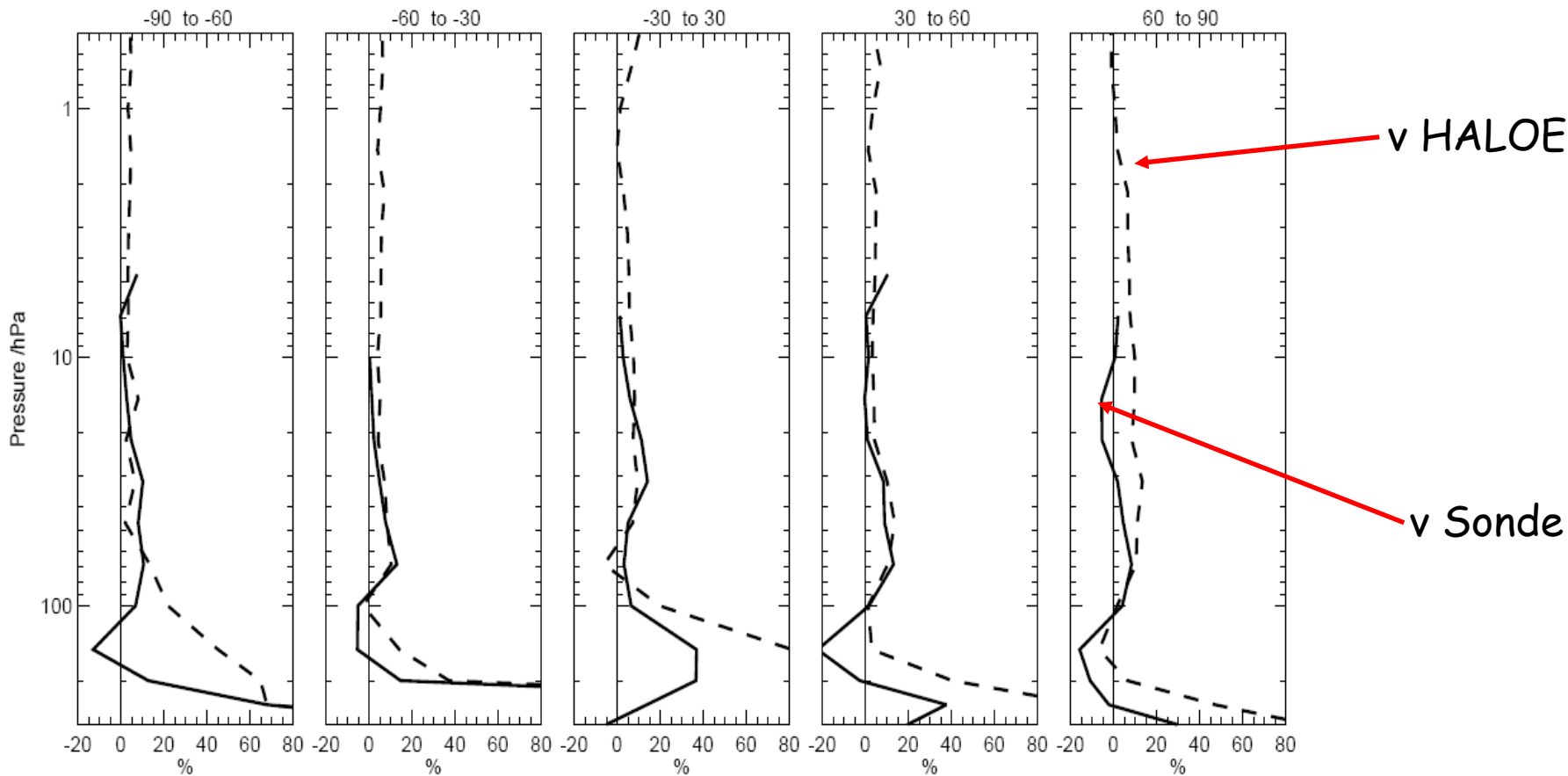
# Obs bias:

DA: Evaluation of MIPAS ozone using **independent data**

BASCOE used as "interpolating" analysis

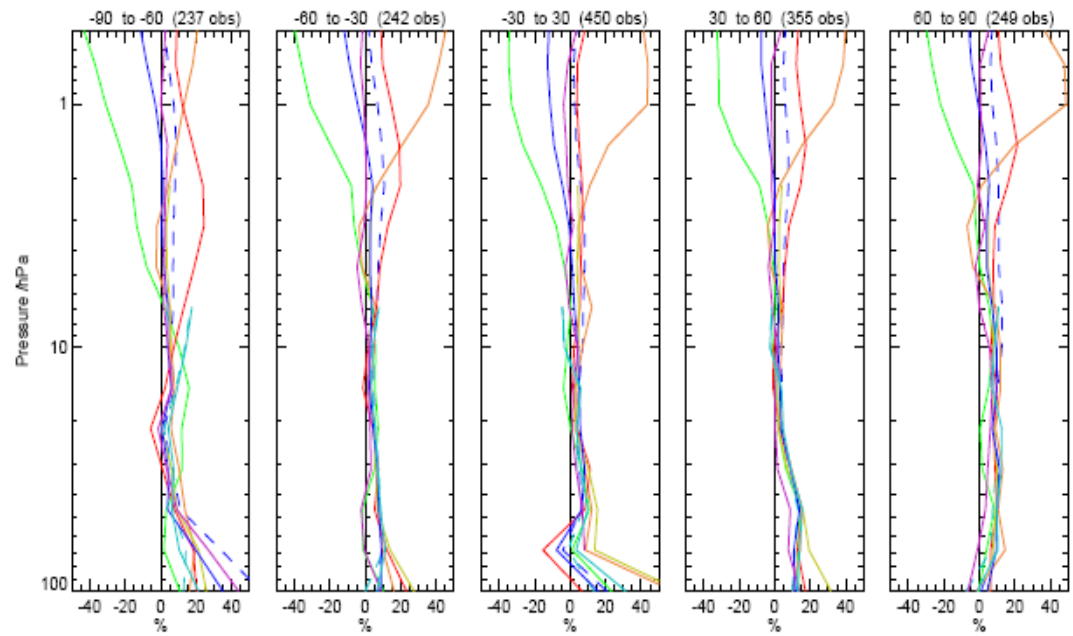
Statistics: 18 Aug - 30 Nov, (Obs1-Analysis) - (Obs2-Analysis):

*Geer et al. ACP (2006); Lahoz et al. ACP (2007), QJRMS (2006, 2007)*



**Bias in MIPAS ozone generally positive: ~5% - ~10% -> feedback to MIPAS team**





**Fig. 10.** Mean of analysis minus HALOE differences, normalized by climatology, for the period 18 August–30 November 2003. See Fig. 9 for colour key. The numbers in brackets indicate the HALOE/analysis coincidences within each latitude bin. Units: percent. These data are used to evaluate the performance of the ozone analyses. Based on Geer et al. (2006).