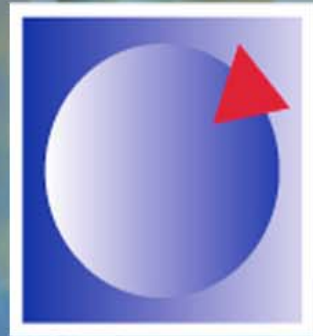


# First results of AIRS assimilation at



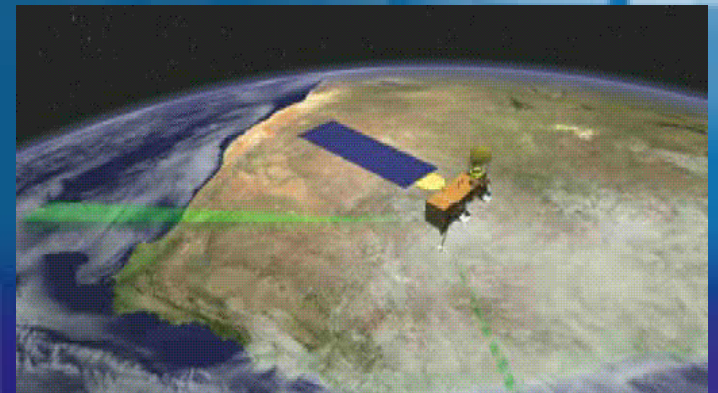
**METEO  
FRANCE**

Thomas Auligné  
Florence Rabier, Lydie Lavanant, Mohamed Dahoui

AIRS (Atmospheric InfraRed Sounder) aboard  
AQUA platforme:

2378 channels (3.74 -> 15.4  $\mu\text{m}$ )

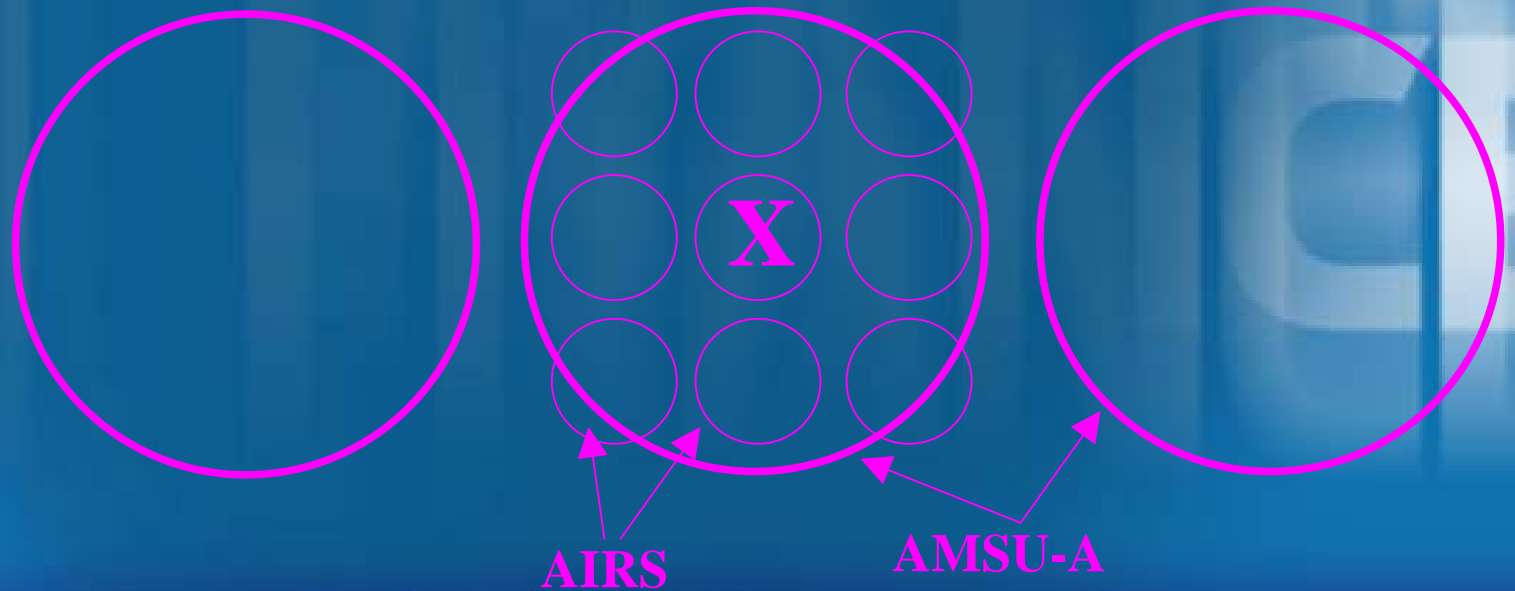
1.1° FOV collocated with AMSU(golf ball)



EOS  
AQUA  
↓  
NESDIS

# Introduction

Constant subset of 324 channels for  
center of every other golf ball (1/18 pixels)



# Introduction

EOS  
AQUA

NESDIS

Met Office

Météo-France D.B.

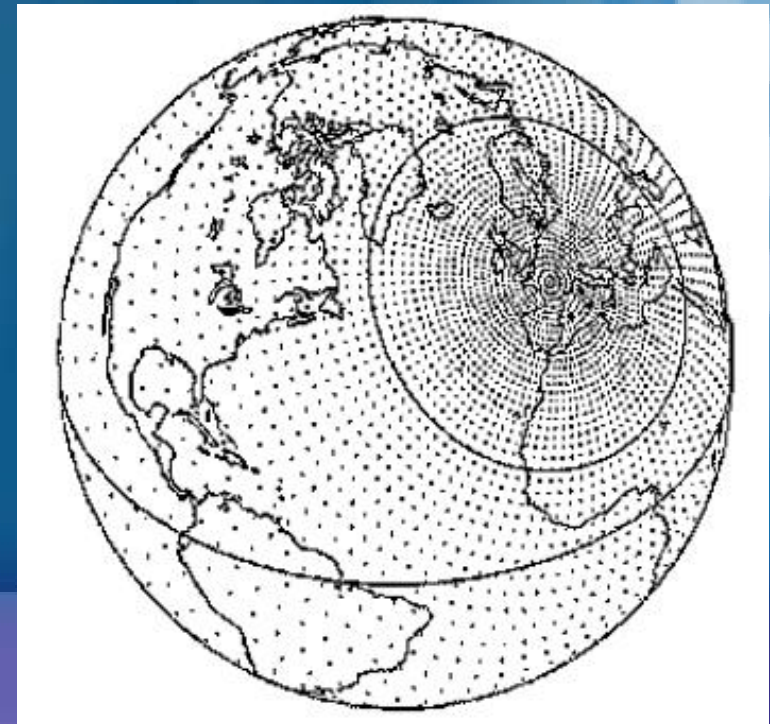
**Radiances / Tb observations**

ARPEGE NWP  
operational model

ARPEGE : global spectral model

T358, C2.4, 41 vertical levels

Associated grid: 23km (France) to 133km  
(antipodes)



# Introduction

EOS  
AQUA

NESDIS

Met Office

Météo-France D.B.

**Radiances / Tb observations**

4D-Var Data Assimilation  
Screening (obs-fg)  
Minimisation

**First Guess**

ARPEGE NWP  
operational model

6-hour assimilation cycling:

00, 06, 12, 18 UTC

Multi-incremental 4D-Var:

T107 & T161, 41 L

# Introduction

EOS  
AQUA

NESDIS

Met Office

Météo-France D.B.

**Radiances / Tb observations**

4D-Var Data Assimilation

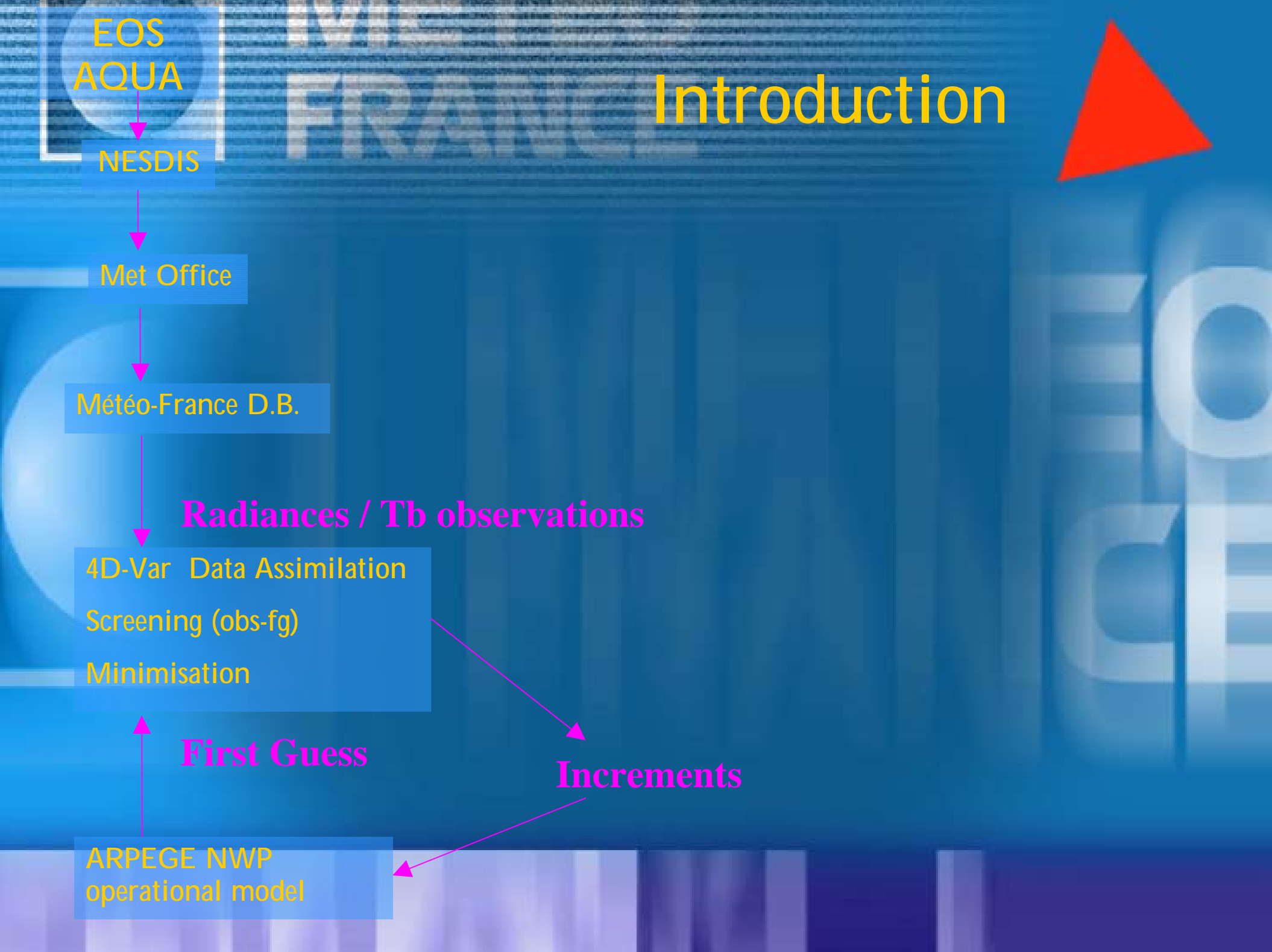
Screening (obs-fg)

Minimisation

**First Guess**

**Increments**

ARPEGE NWP  
operational model





IVIE  
FRANCE

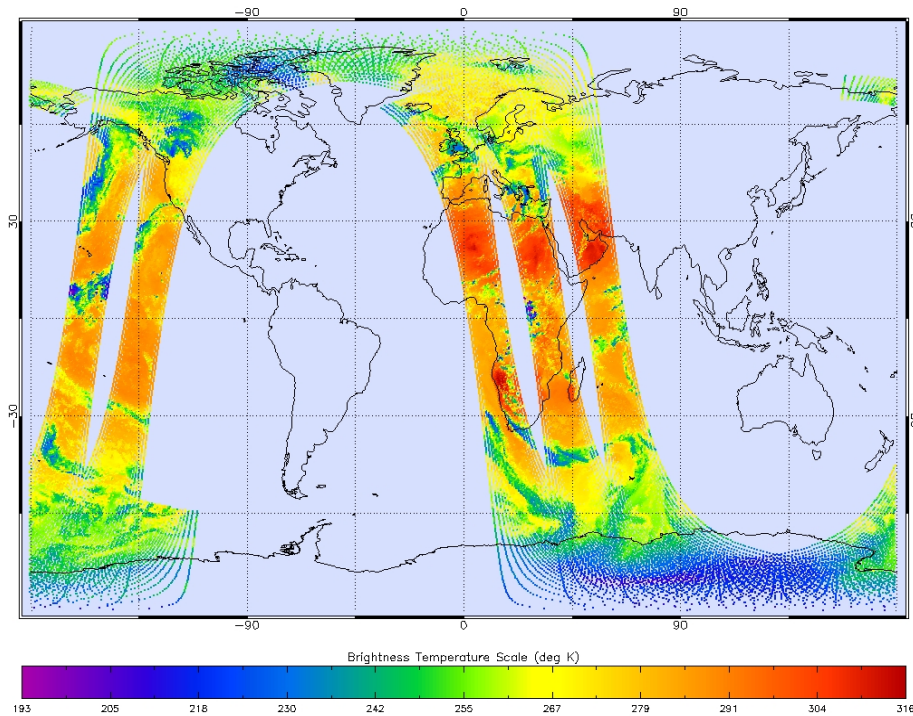
# Contents



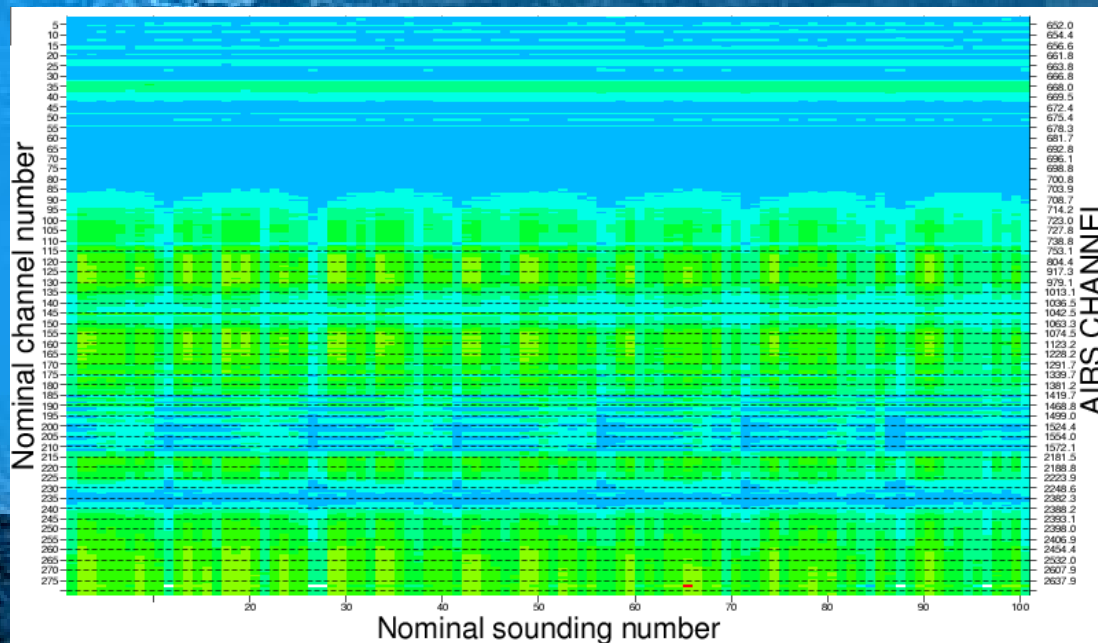
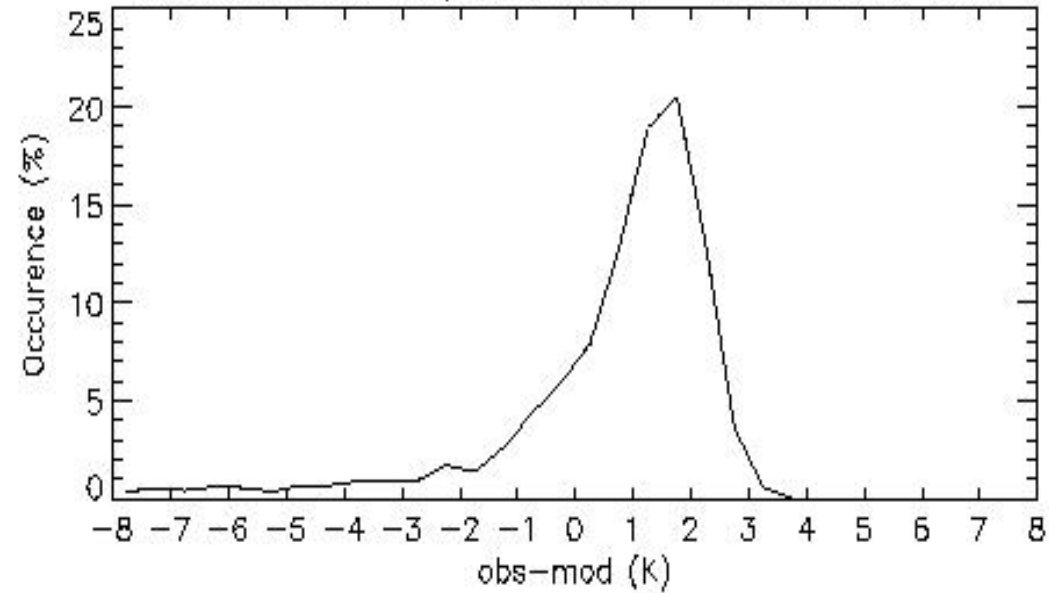
A conservative assimilation suite  
First impact study  
Work under development  
Conclusion and perspectives

ECO  
CE

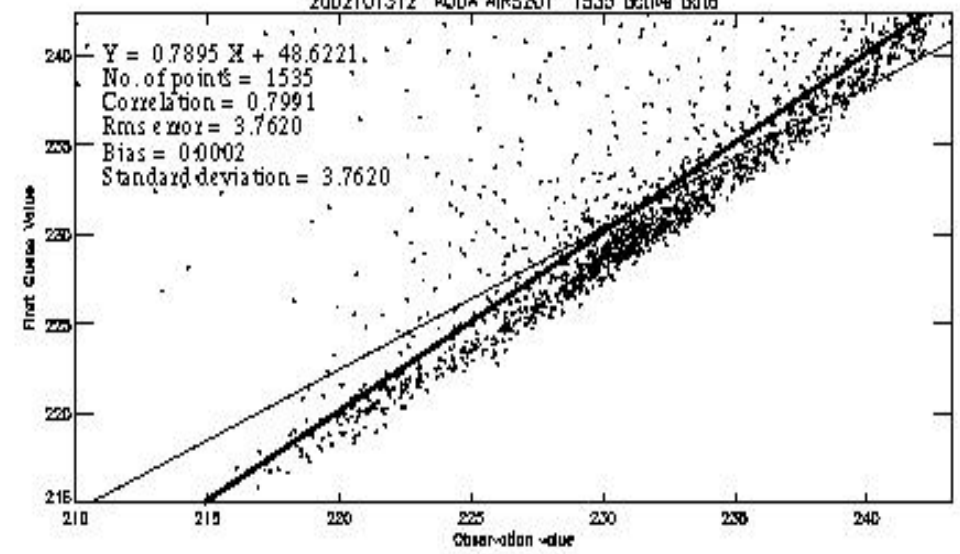
AIRS Level-1B Quicklook Image



2002101312 AQUA AIRS201 1535 active data



2002101312 AQUA AIRS201 1535 active data

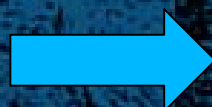




# Assimilation suite

## ✓ Channel selection

- ✓ Gross check :  $150 < T_b < 350$  &  $(\text{obs} - \text{fg}) < 20$
- ✓ First-guess check :  $(\text{obs} - \text{fg})^2 < \alpha (\sigma_o^2 + \sigma_b^2)$
- ✓ Channels in  $O_3$  and SW bands, over land, peaking above/near model cloud top (1hPa), at edges of scan are blacklisted



**176 channels used**

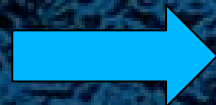
# Assimilation suite

## ✓ Cloud detection

Mitch Goldberg cloud detection scheme:  
based on thresholds recomputed for ARPEGE model

- ✓ LW window channel:  $T_b(965.43\text{cm}^{-1}) > 270\text{ K}$
- ✓ Model SST versus SW window channel ( $2616.095\text{cm}^{-1}$ )  
(night only)
- ✓ Model SST versus predicted SST (from channels  $918.65$ ,  $965.32$ ,  $1228.09$ ,  $1236.40\text{ cm}^{-1}$ )

VIS/NIR imager: less than 10 % cloud in pixel (day only)



**Information on a pixel basis**

# Assimilation suite



## ✓ Bias correction

Flat bias correction for each channel calculated over all active data

## ✓ Observation error estimation

Basic definition for  $\sigma_o$ :

- 0.6 K for upper temperature channels
- 1 K for lower temperature channels
- 2 K for water-vapor channels

# Impact study



Period of 19 days: 2003.08.01 → 2003.08.19

CTRL = latest ARPEGE suite (including HIRS)

EXP = CTRL + AIRS (all data in 6h assimilation window)  
+ more iterations in the 2<sup>nd</sup> 4D-Var minimisation

# Forecast range

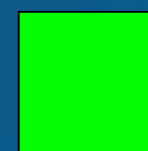
Pressure

$$RMS_{CTRL} - RMS_{EXP}$$

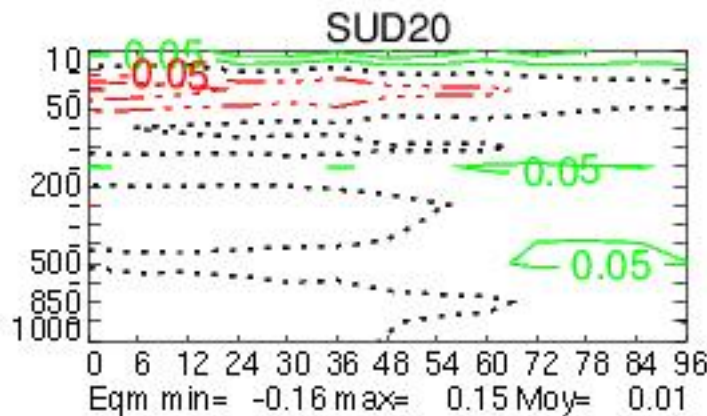
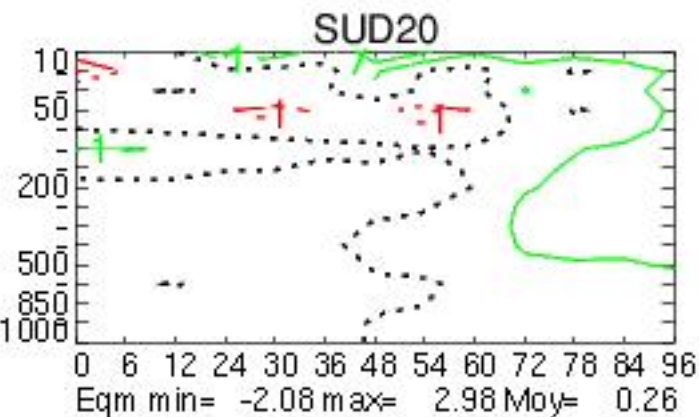
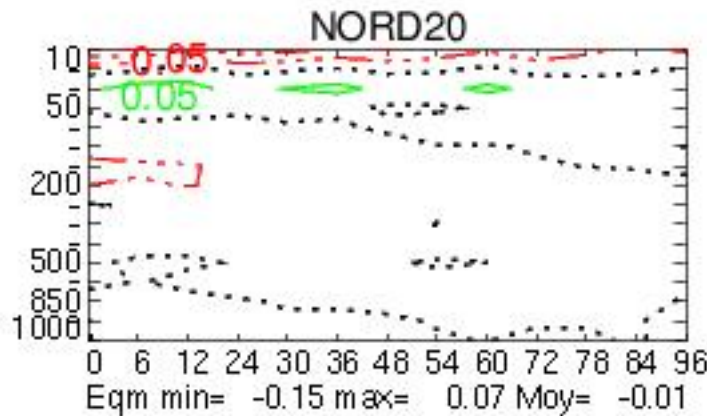
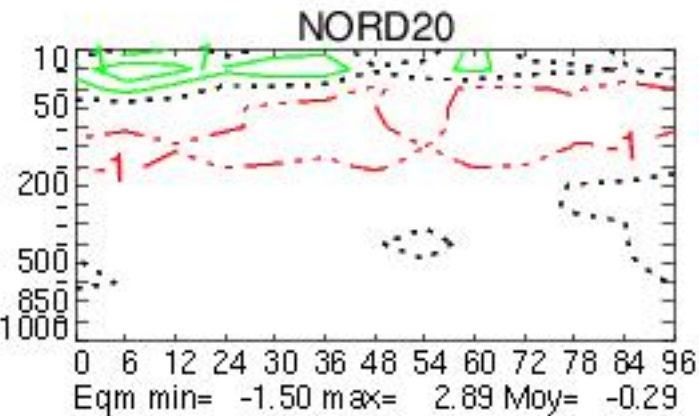
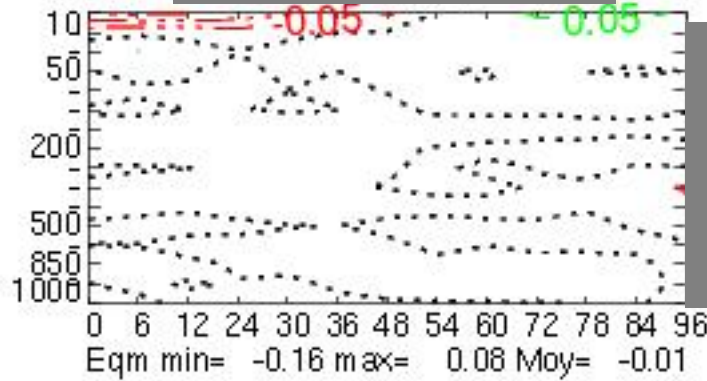
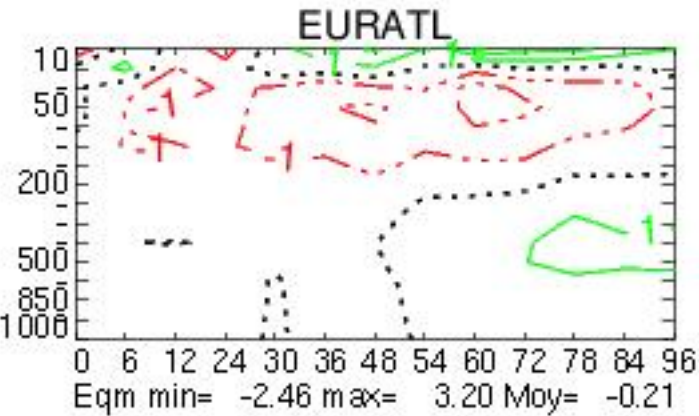
VERIF =  
ECMWF analysis



=



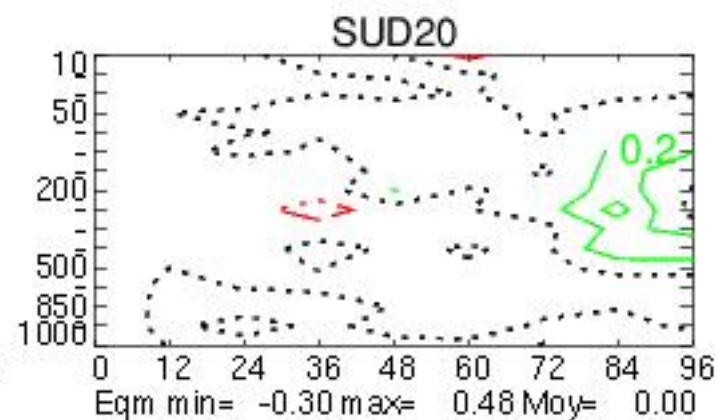
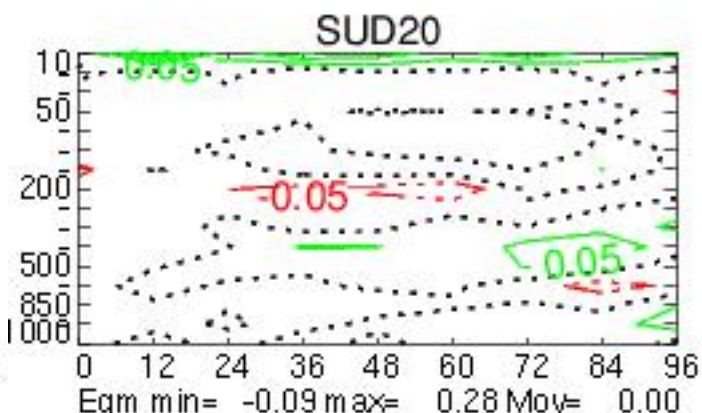
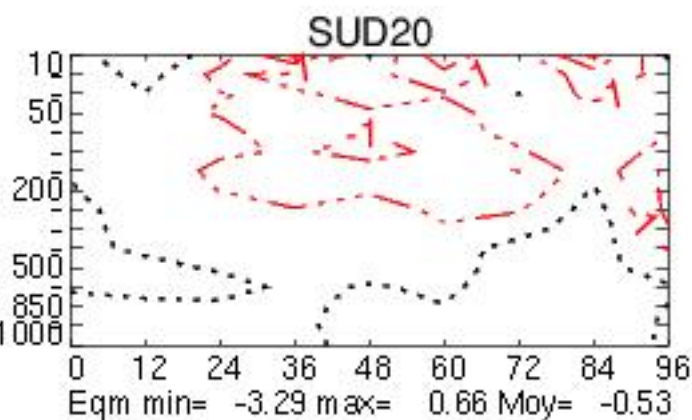
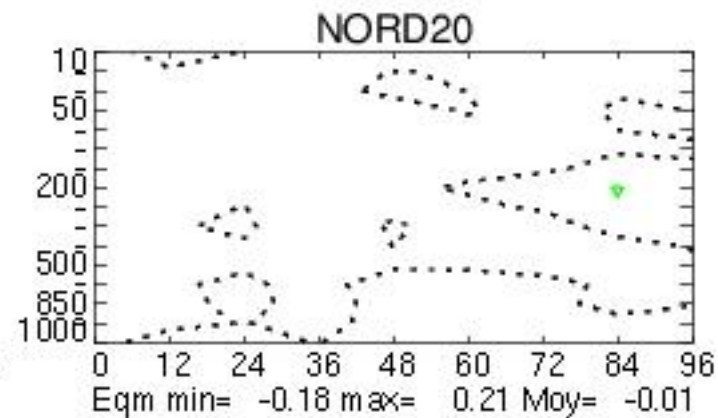
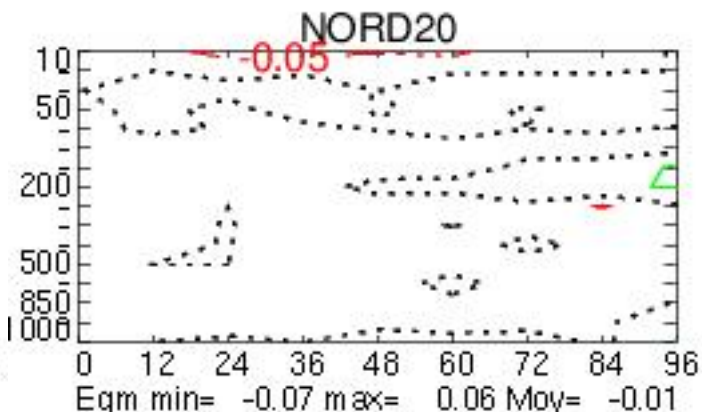
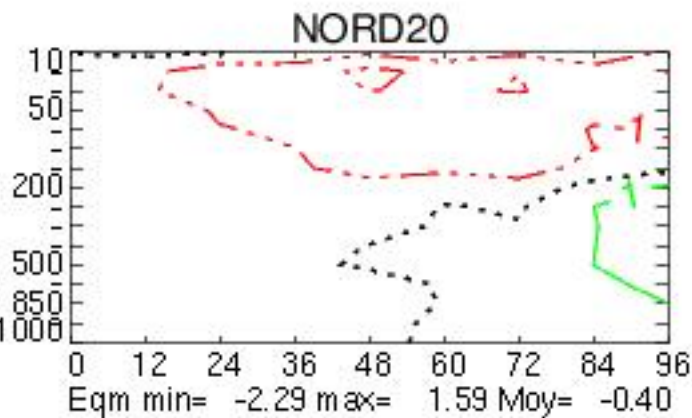
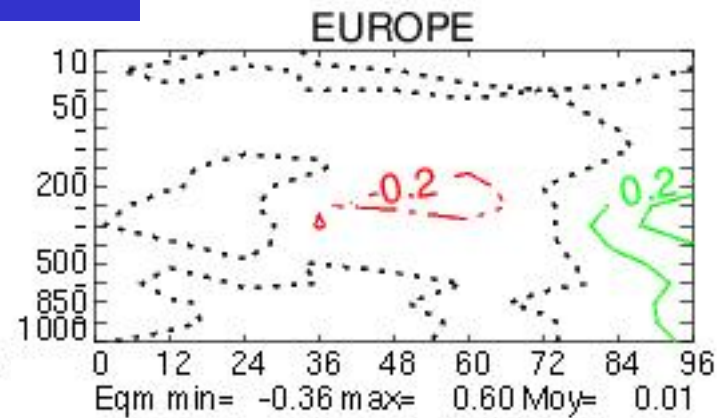
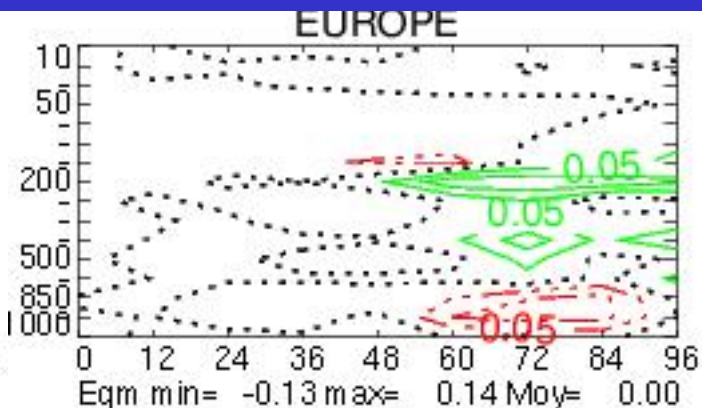
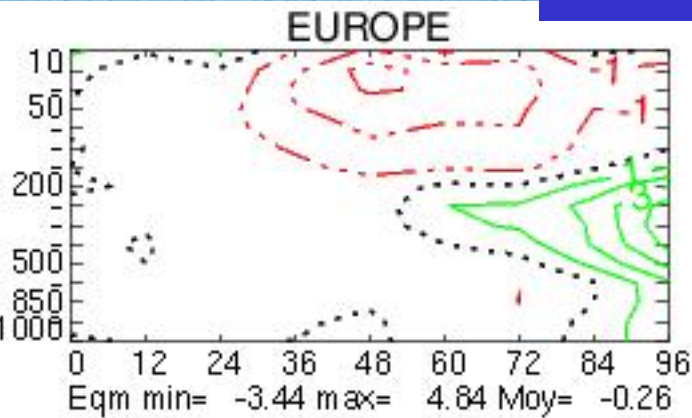
=



Geopotential

Temperature

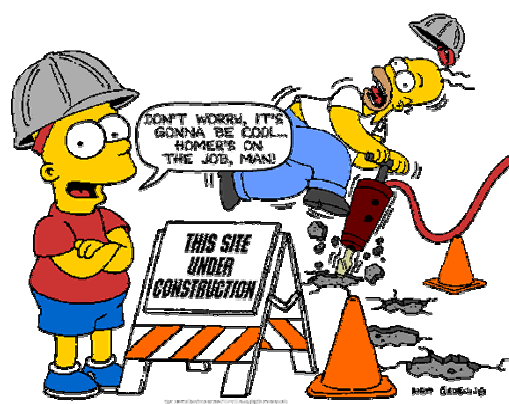
# VERIF = TEMP observations



**Geopotential**

**Temperature**

**Humidity**



# Work under development

✓ Bias correction

→ Neural Network

## PREDICTORS:

- ✓ Ps
- ✓ Ts
- ✓ Land/Sea mask
- ✓ Sat zenith angle
- ✓ Latitude
- ✓ Obs → Tb
- ✓ T profile
- ✓ Q profile  
(43 RTTOV levels)

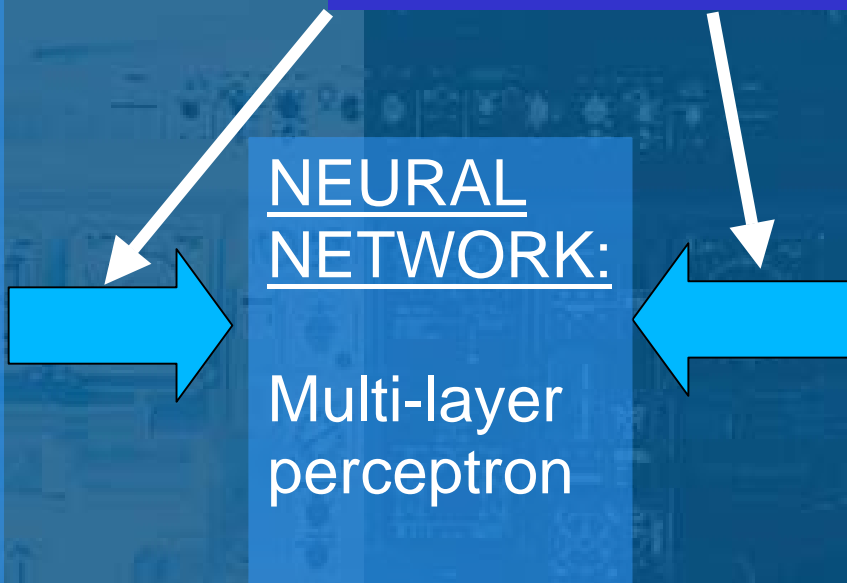
## LEARNING PROCESS

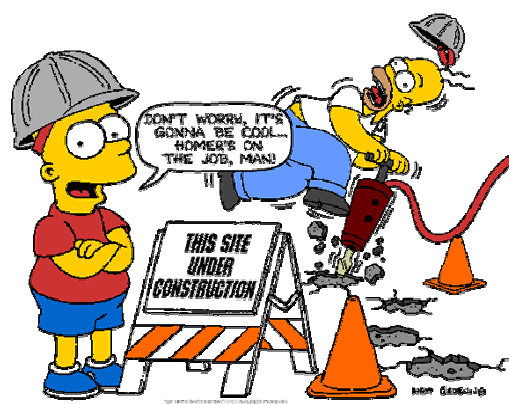
### NEURAL NETWORK:

Multi-layer perceptron

### OBSERVED BIAS :

Obs-Guess





# Work under development

✓ Bias correction

→ Neural Network

## PREDICTORS:

- ✓ Ps
- ✓ Ts
- ✓ Land/Sea mask
- ✓ Sat zenith angle
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(43 RTTOV levels)

## NEURAL NETWORK:

Multi-layer perceptron

## PREDICTED BIAS :

Obs-Guess

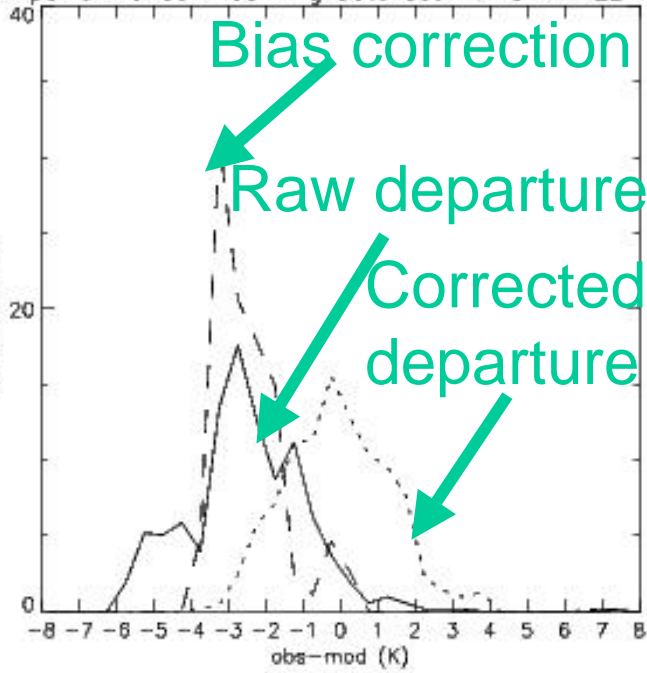
## SENSITIVITY :

For each predictor

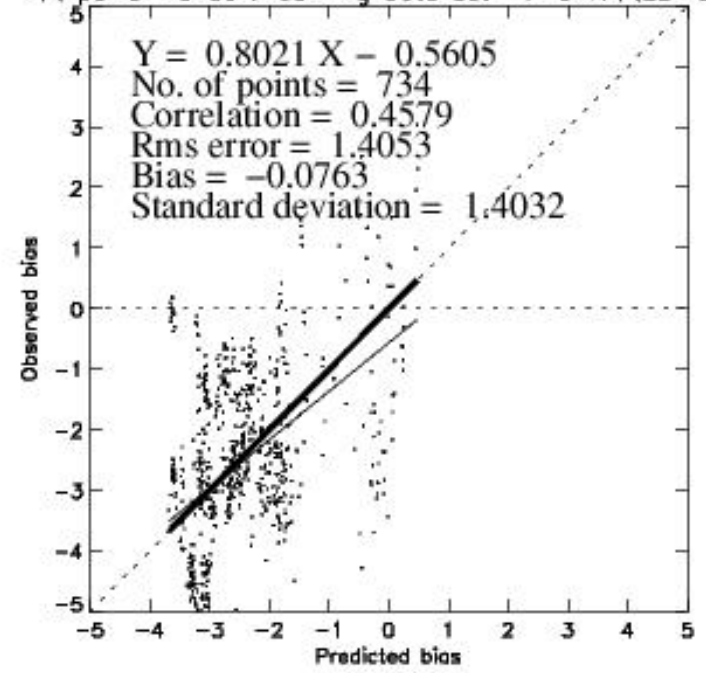


# LEARNING DATASET

NN performance : learning data set -> CHANNEL 1266

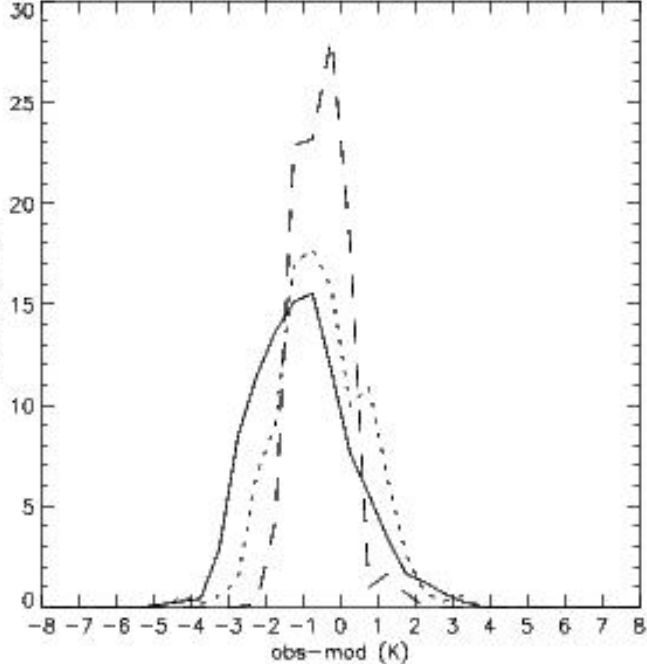


NN performance : learning data set -> CHANNEL 1266

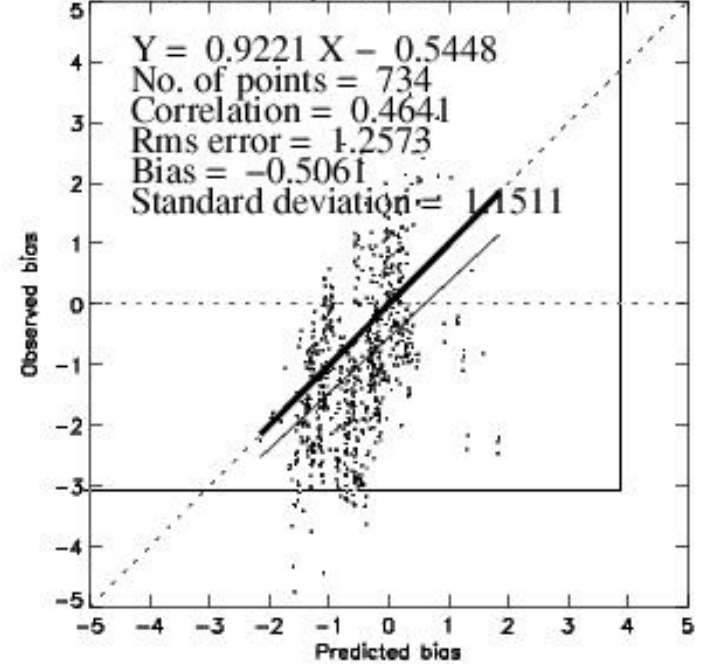


# TEST DATASET

Neural Network performance : test data set



Neural Network performance : test data set

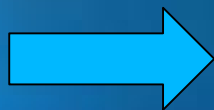




# Conclusion



“Conservative” assimilation  
(only 176 channels, over clear pixels, flat bias correction)  
is neutral/slightly positive for summer experiment  
→ To be confirmed/improved with more extensive testing



**Pre-operational by spring 2004**



# Perspectives



- ✓ New bias correction based on observation-analysis statistics near Radiosondes
  - (Harris & Kelly or NN)
- ✓ Cloud detection on a channel basis instead of pixel (McNally & Watts, ECMWF)
  - Validation of cloud detection schemes with MODIS (Lydie Lavanant)



# Perspectives



- ✓ 1D-Var studies for assimilation of AIRS cloudy radiances

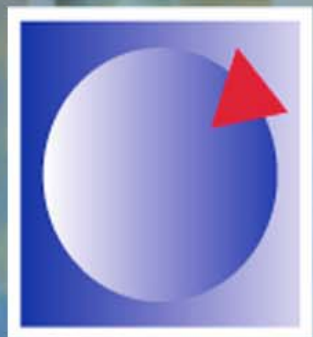
ARPEGE stratiform & shallow convection diagnostic cloud scheme included: T, Q  $\rightarrow$  Cloud Cover, Cloud Liquid Water & Ice

RTTOV-Cld radiative transfert model

- ✓ Investigate the benefit of cloud-cleared radiances in assimilation

- ✓ Data mining: usage/assimilation of PCA scores

Thank you for your attention



**METEO  
FRANCE**

[thomas.auligne@meteo.fr](mailto:thomas.auligne@meteo.fr)

International TOVS Study Conference, 13<sup>th</sup>, TOVS-13, Sainte Adele, Quebec, Canada, 29  
October-4 November 2003. Madison, WI, University of Wisconsin-Madison, Space Science and  
Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2003.