Developments for data assimilation over Antarctica and monitoring of Concordia and Dumont d'Urville soundings

Overview

- 1. Data Assimilation over Antarctica
  - Infrared sensor assimilation
  - Microwave sensor assimilation
  - Forecast Results

- 2. Monitoring of Concordia and Dumont d'Urville soundings
  - Statistics
  - Comparison with model

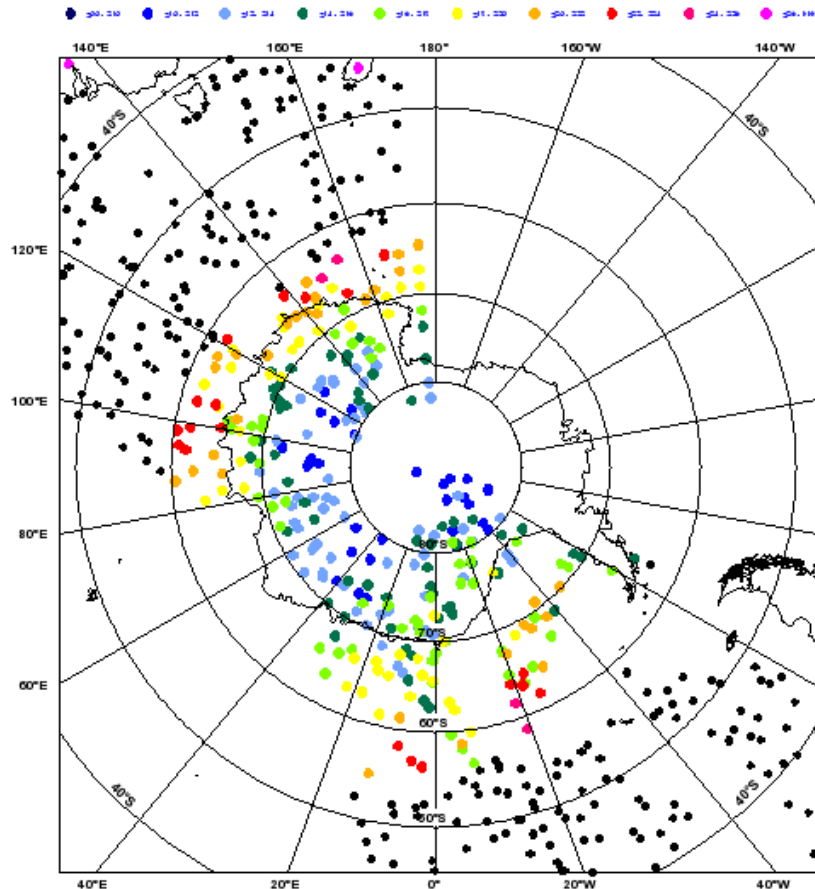**METEO FRANCE**
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1. Data Assimilation over Antarctica (1)

- Assimilation of infrared sensor :

   Assimilation of IASI and AIRS over polar areas (sea ice and land)

   (see V. Guidard presentation)

   Below an example of the increase of data over polar area :

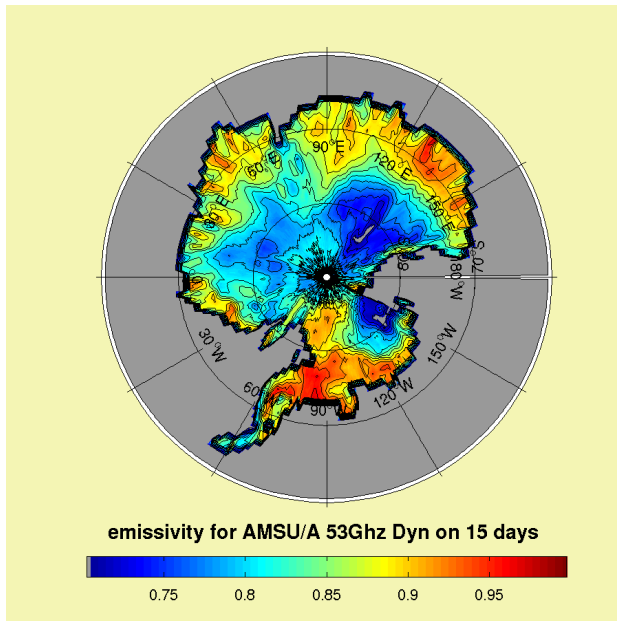IASI (1/10/2008 (r0) & channel 246)

Black point : operational

Color point (Tb) : assimilation of IASI over land and sea ice for high peaking channels

1. Data Assimilation over Antarctica (2)

- Assimilation of microwave sensor :

  Use of F. Karbou's approach (Karbou 2006)

emissivity for AMSU/A 53Ghz Dyn on 15 days

- Old emissivity operational scheme : Grody (1998) or Weng(2001) depending on frequency, used until july 2008

- Dynamical approach for the estimation of the emissivity from Satellite observations over land

  → Emissivity derived from AMSU/A ch3 and AMSU/B-ch1 are assigned to the temperature & humidity soundings channels respectively

- The estimation of emissivity has been adapted to Antarctica : snow and sea ice surface
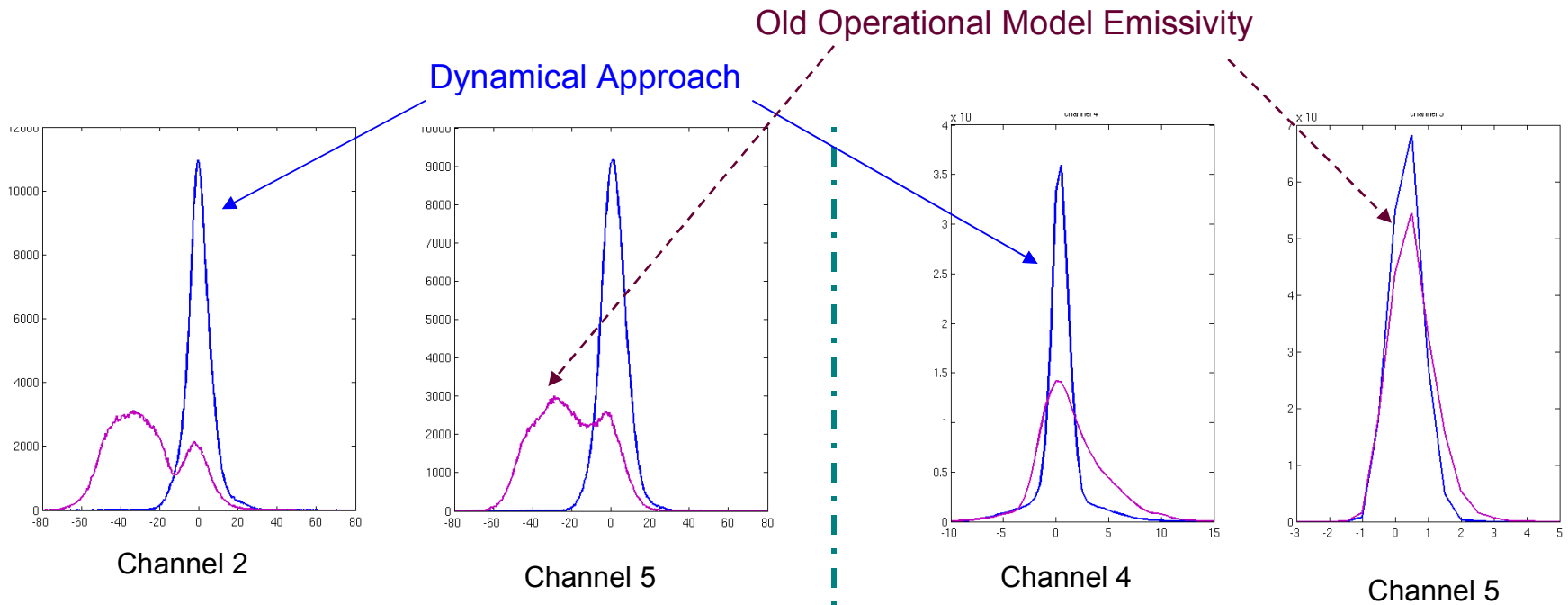
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- Assimilation of microwave sensor :

Comparison of the new emissivity calculation with the old operational emissivity scheme

Study over land   Study over sea ice

Old Operational Model Emissivity

Dynamical Approach

Channel 2

Channel 5

Channel 4

Channel 5

Fg-departure (K) (obs- first guess) histograms for **AMSU-B**, ch2 &5 (2 weeks over Antarctica) (with no bias correction applied)

Fg-departure (K) (obs- first guess) histograms for **AMSU-A**, ch4 &5 (2 weeks over Sea Ice) (with no bias correction applied)
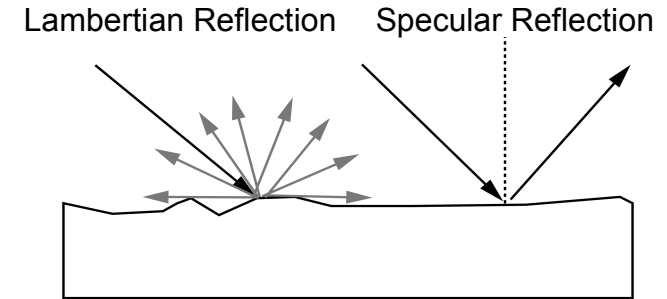
Modelisation of surface emissivity

→Tests of different approximations (1 year of emissivity calculation using AMSU data):
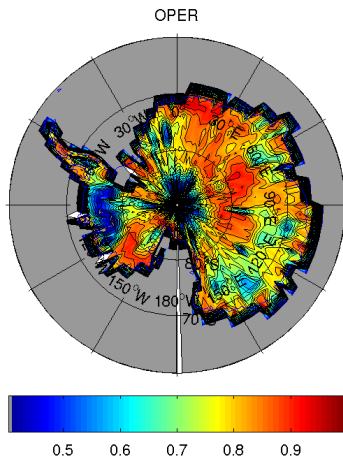
Lambertian Reflection   Specular Reflection

Specular, Lambertian, Semi-lambertian

The specular assumption is used in operational model ARPEGE.
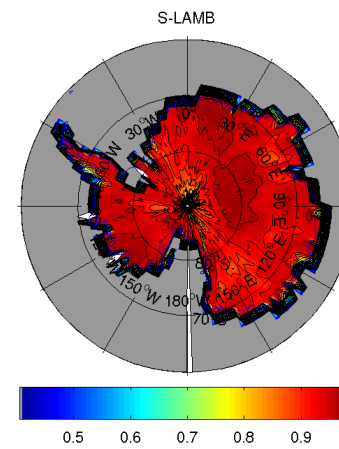
SPEC

The old emissivity scheme (Grody /weng)

OPER

SPEC

Dynamical Approach

SPEC
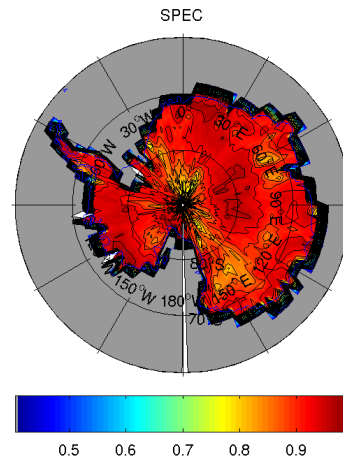
SEMI-LAMB
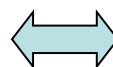
S-LAMB

Correlations map (Tbs_obs vs Tbs_sim) for AMSU-A, ch4 (1 month (january 2007) over Antarctica, with no bias correction applied)

| 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |

Improvement of simulated Tbs   ⟷   Better estimation of emissivity

- ## Summary on data assimilation over polar areas:
  - List of the additional data (infrared and microwave sensor) compared to the operational assimilation system at Météo France (ARPEGE)

Use of microwave sensor

○ *means that the channel is used in the oper assimilation*
● *Additional data*

AMSUA

Conditions of use	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Open Sea					○	○	○	○	○	○	○	○	○		
Land — Chan. 5: Oro< **1,5km/500m**; Ch. 6: Oro<**2km/1,5km**					● / ○	● / ○	○	○	○	○	○	○	○		
Sea Ice						●	○	○	○	○	○	○	○		

AMSUB

Conditions of use	1	2	3	4	5
Open Sea			○	○	○
Land — Ch4 &ch5 : orography <**1,5km**; Ch3 orography <**3km**			○	○	●
Sea Ice			●	●	●

Use of infrared sensor

AIRS

	Number for operational	Number of channel assimilated EXP
Sea Ice	0	22
Land	0	51
Open Sea	54	54

IASI

	Number for operational	Number of channel assimilated EXP
Sea Ice	0	33
Land	0	50
Open Sea	50	65

- Fit to observations :

Comparison with (black) and without additional data (red) to RS

U component

Temperature

Specific Humdity

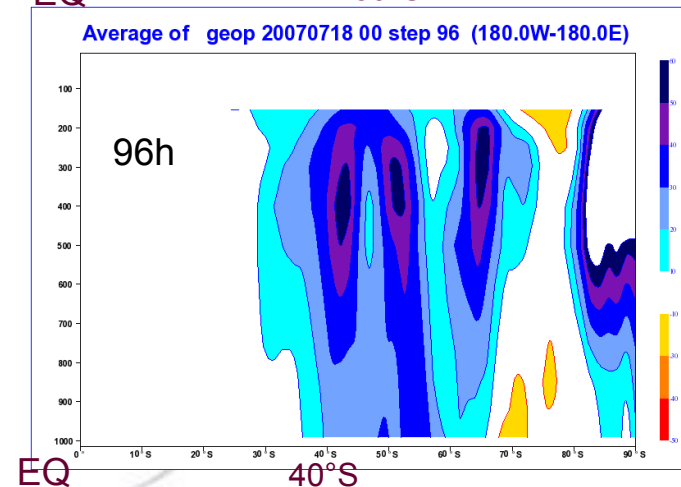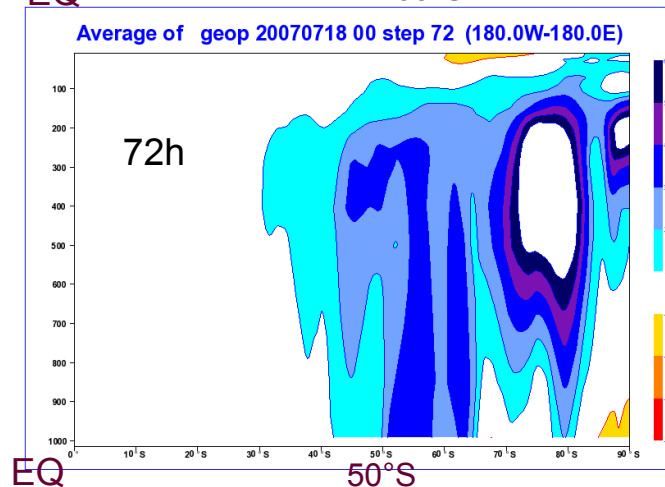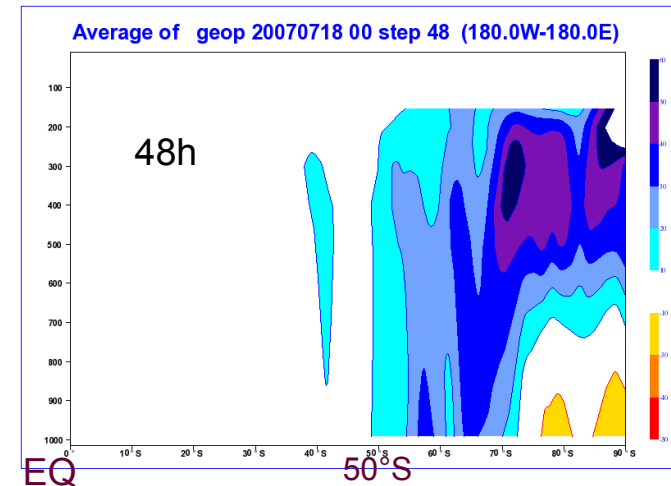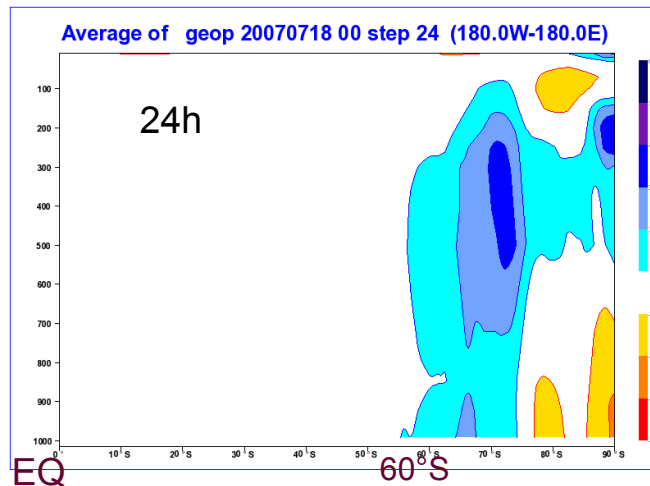**METEO FRANCE**
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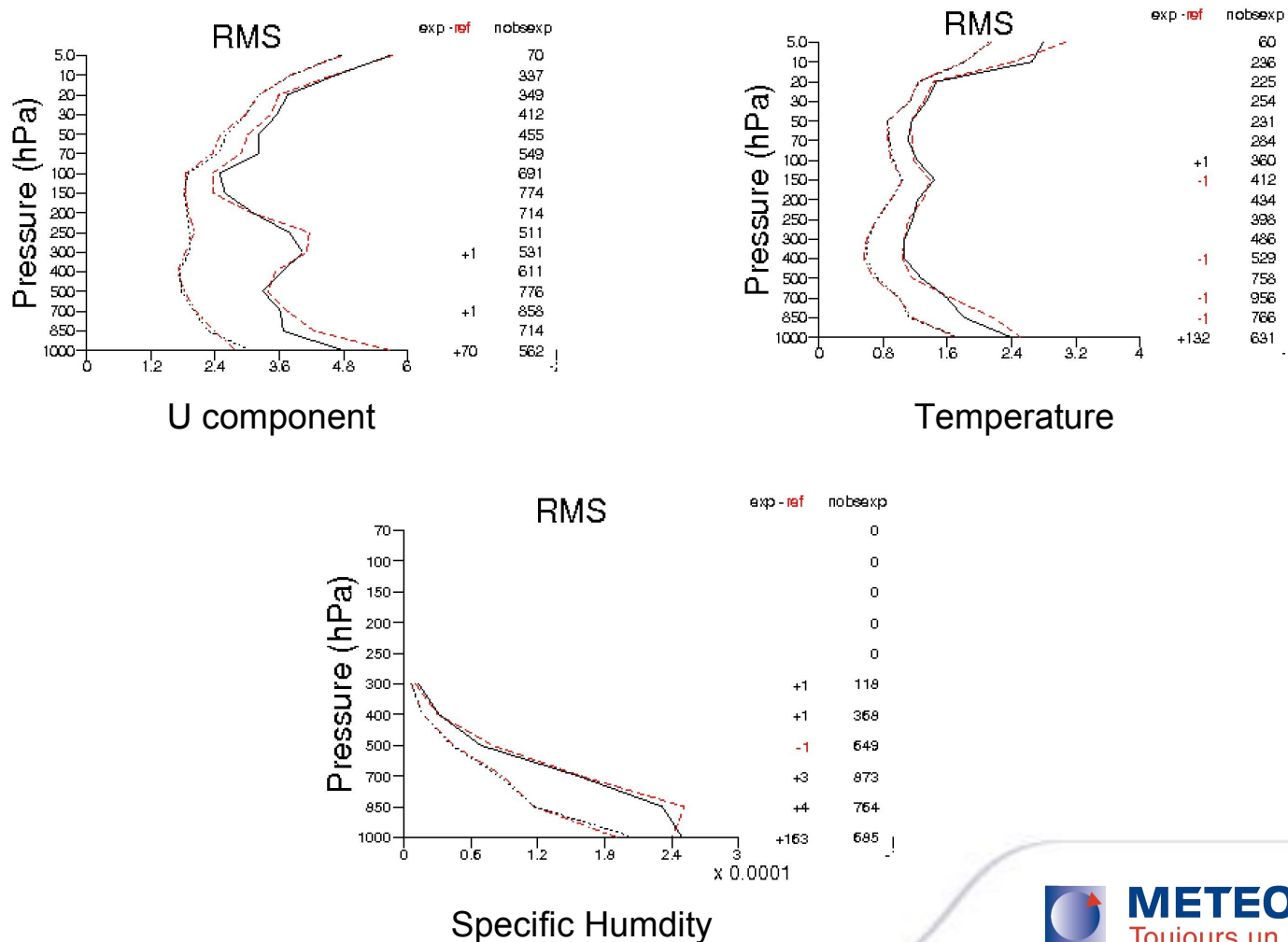
- Impact of the data assimilation over high latitudes:

Comparison of rmse (DATA-AC) – rmse (ADD_DATA-AC) at 4 steps (24h, 48h, 72h & 96h)

- ADD_DATA : experiment with additional data (AMSUA/B, AIRS, IASI)
- DATA : reference (without additonal data)
- AC : analysis of ECMWF

Average over latitude, over 20 days (20/07/07--> 8/08/07)

Geopotential data

2. DomeC and DDU soundings (1)

- <u>Statistics</u>

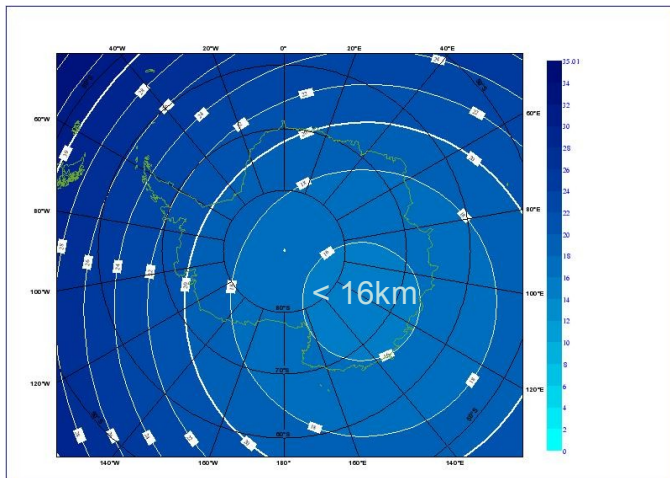## Dumont d'Urville (66,40°S;140°E)

- Usual hour of RS launch : 0hTU

- Addiational RS for Concordiasi : 12hTU

- Statistics of meteorological conditions over 149 cases:

    - 35% cirrus

    - 39% Ac/As

    - 48% Stratocumulus
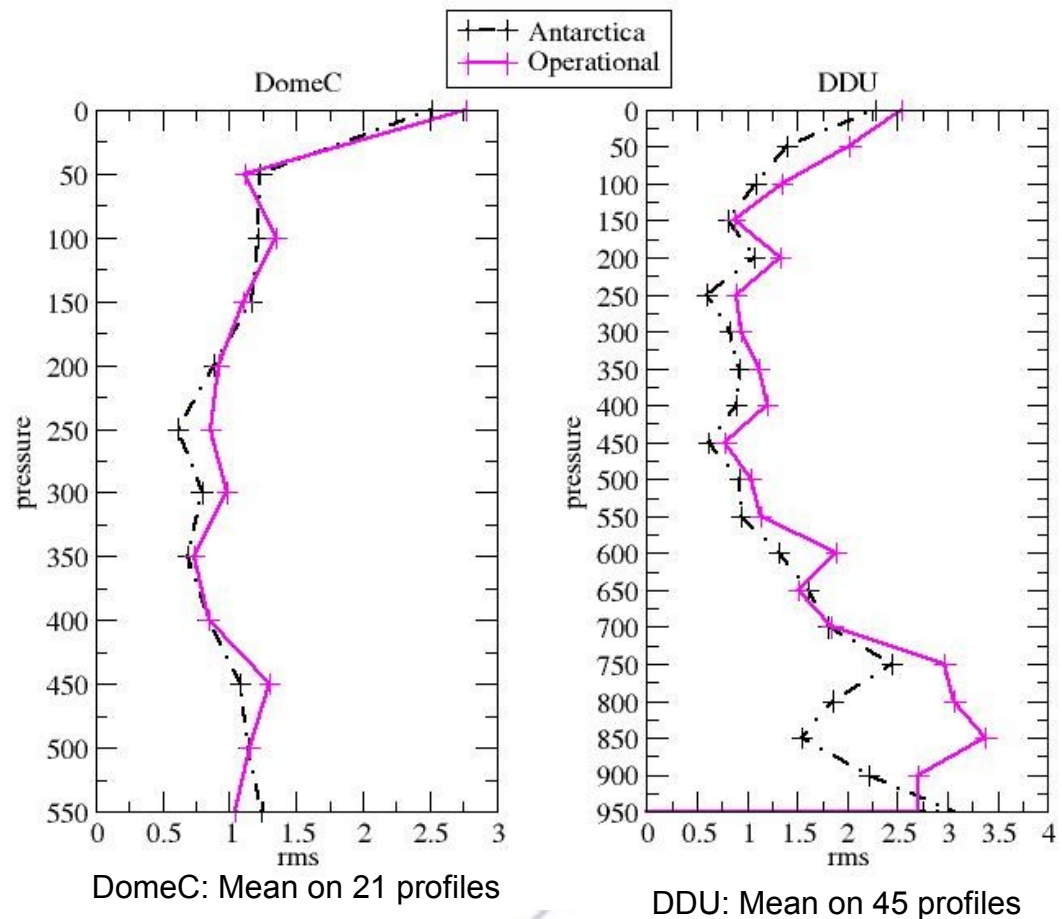
    - 19% clear

DomeC (75°S;123°E)

- Usual hour of RS launch : 12hTU

- Additional RS for Concordiasi : 0hTU

- Stat meteo over 120 cases:

    - 62% clear

    - 29% almost cloudy

    - 10% cloudy

Concordiasi Website: http://www.cnrm.meteo.fr/concordiasi-dataset/

- Difference between observations and first guess for the temperature (K)
  - Operational (pink) and stretched Antarctica with additional data (black)
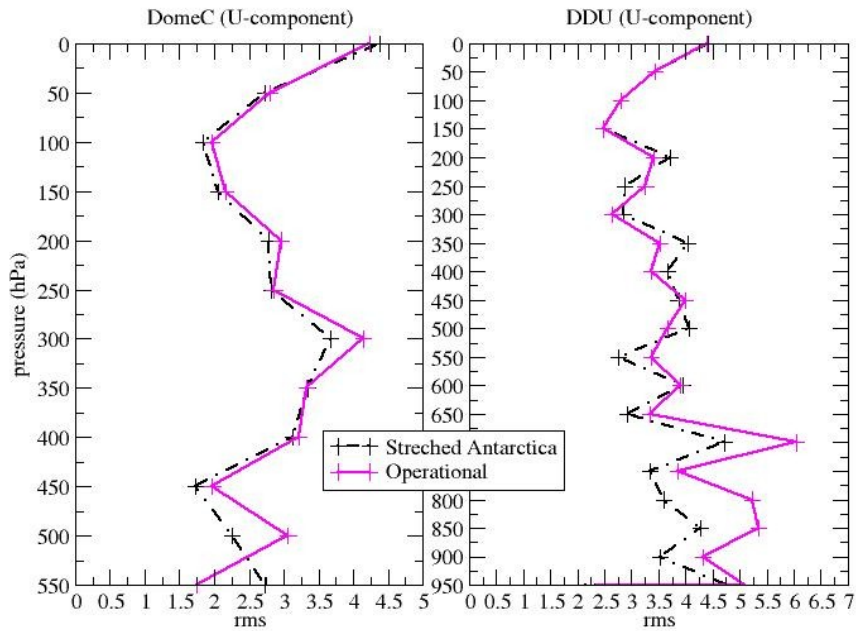 - Mean on a time period: 15/09/08 to 06/10/08

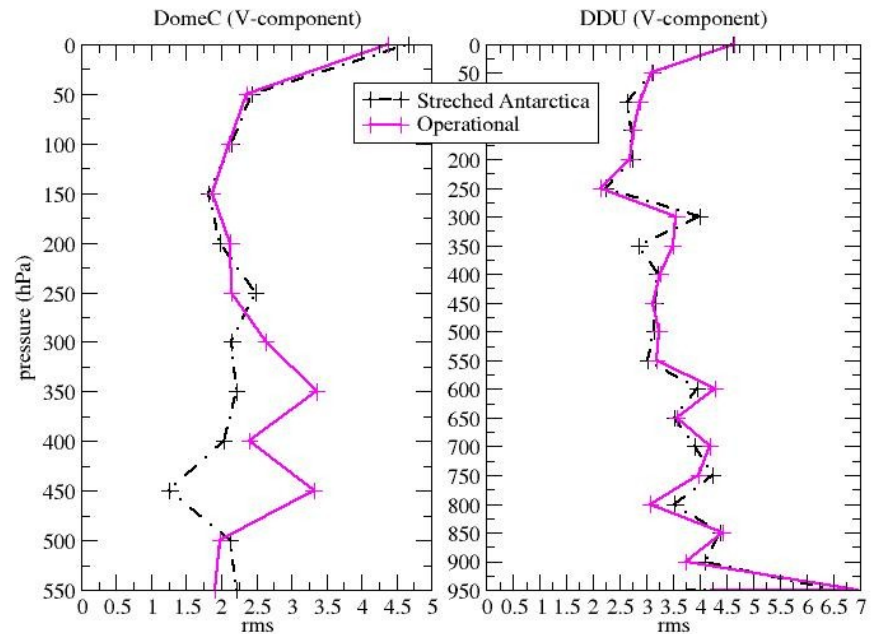Resolution of ARPEGE, streched Antarctica (centred on DomeC) (isoline : 2km)

DomeC: Mean on 21 profiles

DDU: Mean on 45 profiles

- Difference between observations and first guess for others parameters (u, v) at DomeC station

Operational (pink) and stretched Antarctica with additional data (black)
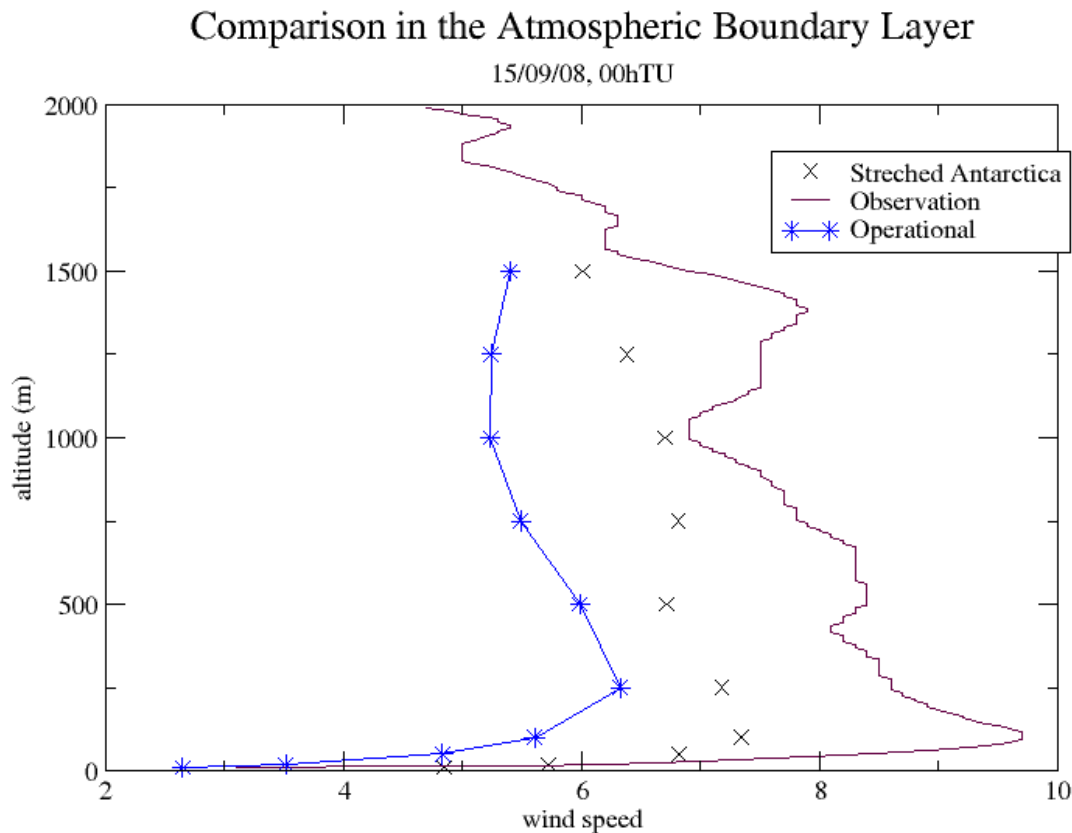

Zonal wind (U)

Meridional wind (v)

Use of High resolution soundings :

→ example : study in the Atmospheric Boundary Layer at DomeC

Profile of wind speed in the Boundary Layer

Comparison in the Atmospheric Boundary Layer
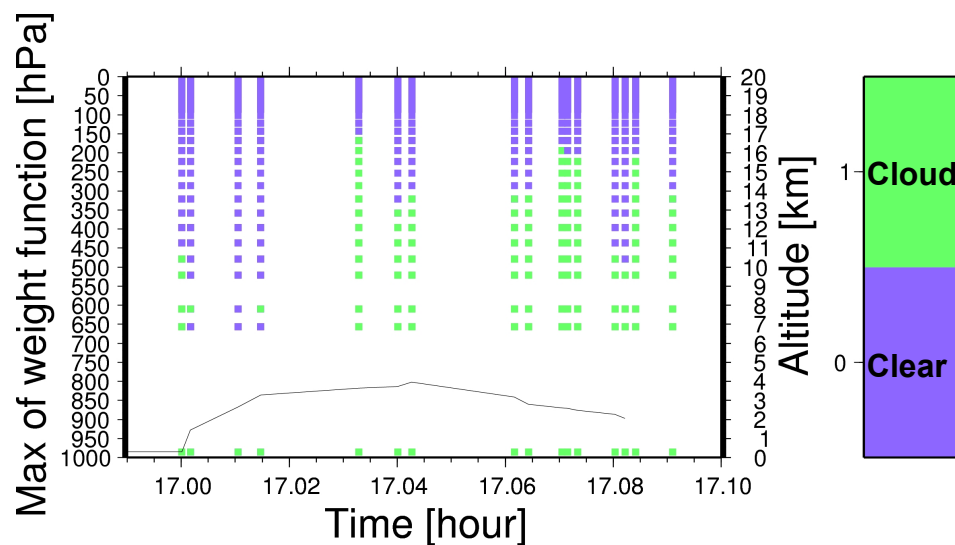15/09/08, 00hTU

Future Work

- Studies have begun for the cloud detection over Antarctica
  - Cloud detect method (Mc Nally and Watts, 2003) used in operational model
    Example : case of the 10/01/2008, along the track of AIRS sensor
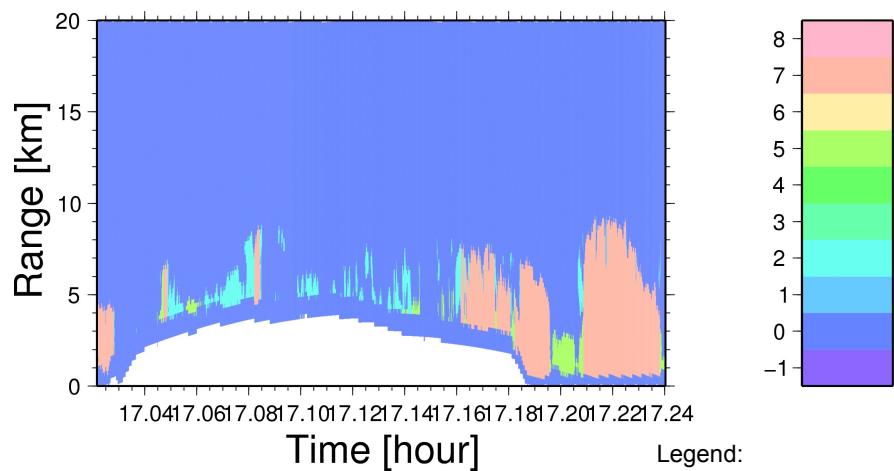
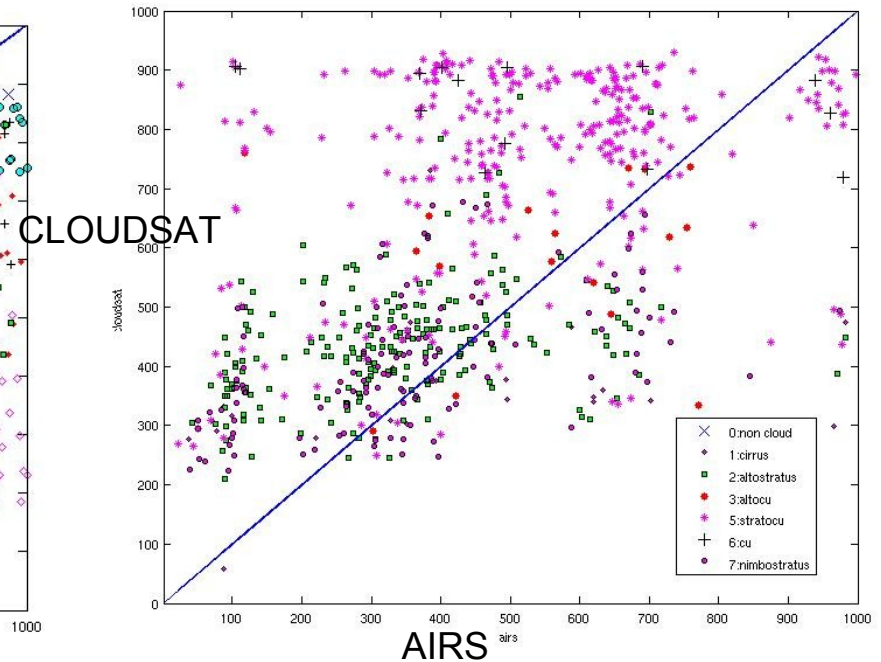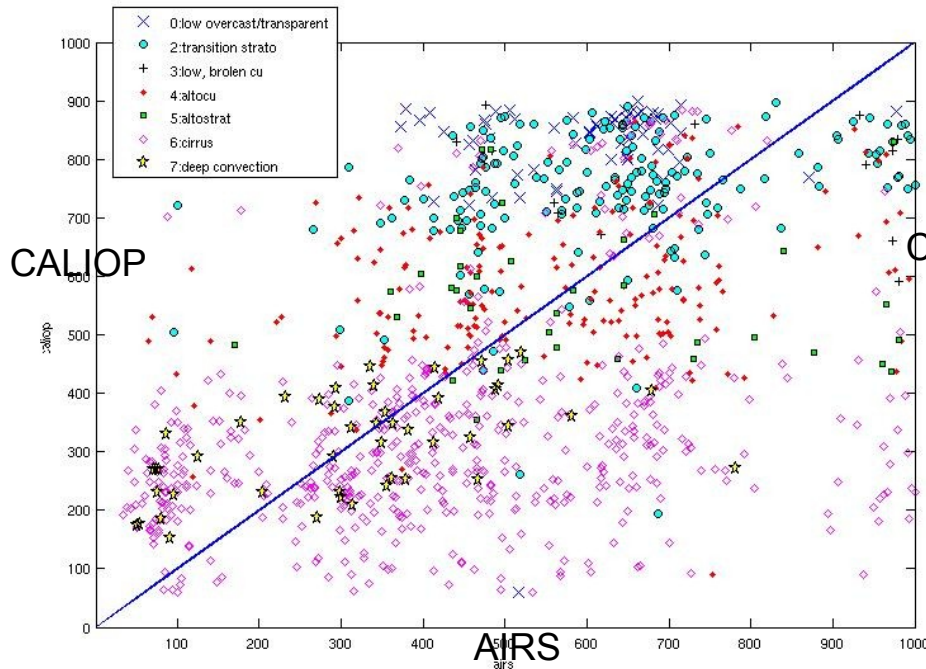Legend:

8: Deep convection

7: Nimbostratus

6: Cumulus

5: Stratocumulus

4: Stratus

3: Altocumulus

2: Altostratus

1: Cirrus

0: Clear

Cloudsat

ARPEGE

Future Work

- Example of the comparison of the cloud detection from ARPEGE and Cloudsat and Calipso data (along the AIRS' track) (15/07/07 to 4/08/07)

→ Difficulties and Problem to validate cloud detection over Antarctica

→ Validation and test will be done using high resolution profiles of RS/study in 1D-VAR:

    → tests on radiance, emissivity, surface temperature and cloud detection

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