ATOVS data assimilation for limited-area short-range forecasting

1. Introduction

In recent years, (A)TOVS data have been assimilated into the global medium-range forecasting systems at ECMWF, NCEP, Meteo France, UKMO, etc. and considered as the most important non-conventional data. However, for limited-area short-range forecasting, the evidence of significant positive impact from (A)TOVS data on the state of the art operational limited area modeling systems has not been well established. For example, the (A)TOVS-related research and development activities within the HIRLAM project have also a long history, dating back to HIRLAM-1 [1]. However, no HIRLAM operational system contains ATOVS data assimilation.

Recently, an intense effort has been made to include the ATOVS in the HIRLAM variational data assimilation system. Data assimilation experiments have been made and the results have so far been somewhat discouraging, impact being neutral or even slightly negative.

2. Area of research

A fundamental issue may need to be addressed: is it possible for the ATOVS data to give a significant positive impact on limited-area short-range forecasts as it is for global medium-range forecasts? The fact that few operational limited area forecasting system assimilate the ATOVS data also indicates such a need.

A practical issue has to be addressed: are there new problems in the use of the locally received ATOVS data compared to the use of globally processed data? Only the locally received ATOVS data can be used operationally due to the timing requirement for short-range forecasts. How to process the data within the cutoff time limit remains to be investigated.

3. Rationale, objectives and expected results

In the proposed project, the HIRLAM variational data assimilation system will be further developed and tested on the use of ATOVS data. In particular, the ATOVS observation screening module is currently missing. The bias correction and tuning of observational errors are also important tasks in the project.

In order to compare the impact on the global medium-range forecasts and that on the limited-area short-range forecasts, a series of experiments will be carried out using the ATOVS data from the ECMWF database. The idea is to choose a few periods over which significant positive impact from ATOVS data on ECMWF forecasts has been reported. Look into their results and find out whether the positive impact is also found for their short range. In the same time, use the same ATOVS data in

the HIRLAM system to address the limited-area issue, in particular short cutoff for receiving observations.

The locally received data from Smidsbjerg (Denmark) and Sdr. Strømfjord (Greenland) will be used in the project. An example of the data coverage for NOA16 level 1c for all passages on 27 May 2001 is given in Figure 1. The data are processed within $\frac{1}{2}$h of the passage. The potential of using these data for limited area models is clearly shown. Through the project, an operational dataflow will be established and a software chain will be built which links the locally received data to the variational assimilation system. The data error statistics will be accumulated and analyzed. Data assimilation experiments will be performed to give a final recommendation for the operational use of the data.

4. Name of the scientific supervisor of the project

The EUMETSAT fellow will join the data assimilation group at DMI, under the supervision of the group leader, Dr Xiang-Yu Huang.

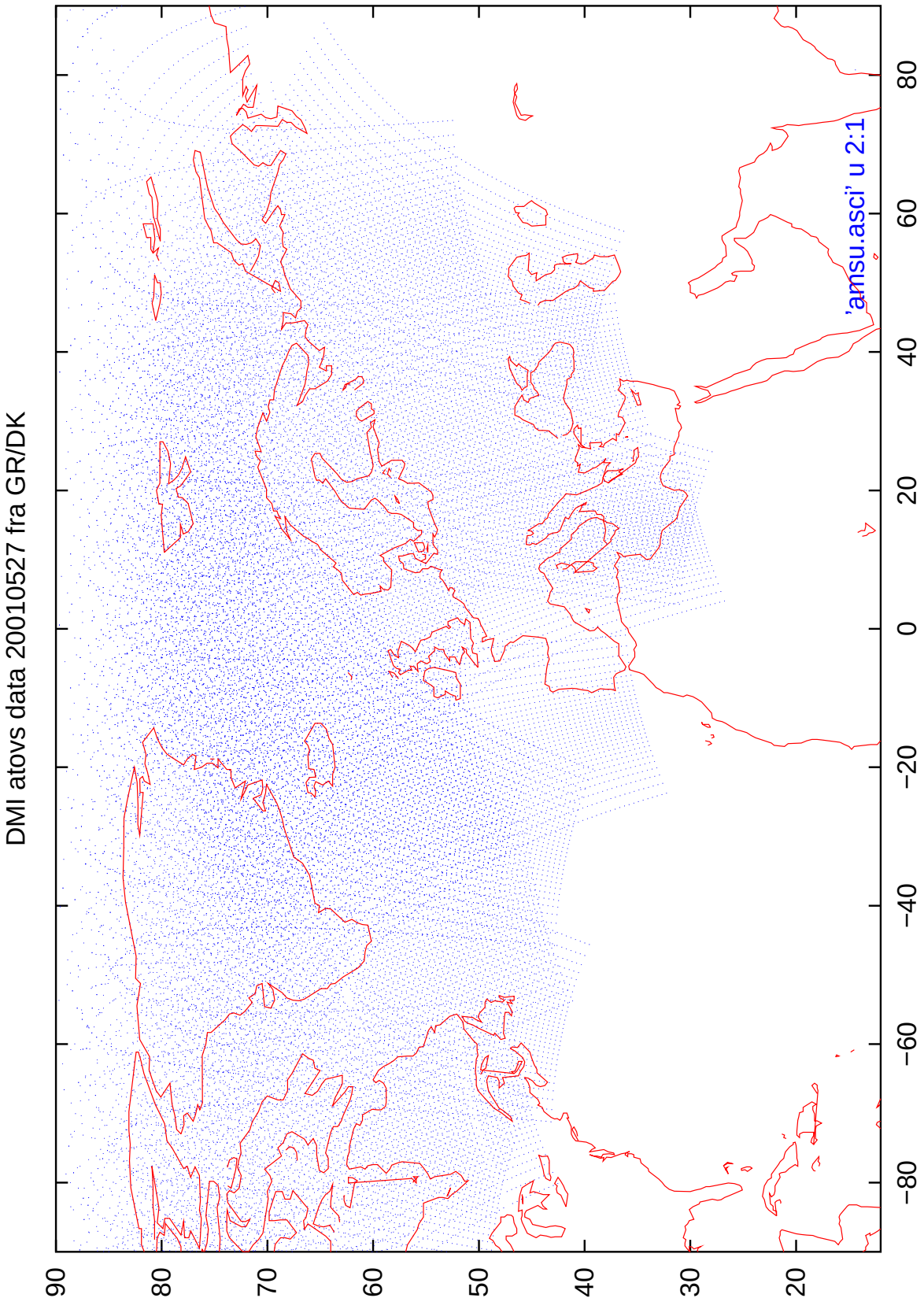
Dr Xiang-Yu Huang, Danish citizen, obtained his PhD 1988 from Stockholm University, became senior scientist at DMI in 1992, lead the DMI data assimilation group since 1996. He has long experience in dynamic meteorology [2,3], initialization [4,5], data assimilation [6,7], data impact studies [8]. He has also given a bachelor course on data assimilation at DMI for a number of years. He has been PI and DMI responsible scientist in several Danish, ESA and EU projects. Since 1988 he has been an active scientist in the international HIRLAM project and has been involved in the design and development of the HIRLAM variational data assimilation system.

5. Relevance of the research to existing and future EUMETSAT programmes

The proposed project can be considered as a complementary research to the EUMETSAT project "Assimilation of METEOSAT radiances" (EUMETSAT fellow Christina Köpken at ECMWF) which address the global model and medium range.

The proposed project will use the AAPP package for processing the locally received ATOVS data. This will contribute to EUMETSAT in accumulating experience of using its software and possible developing it.

With the planned EUMETSAT METOP, we see great potentials in using the radiance data for high resolution data assimilation. The proposed project will be useful preparation for the coming data.



Figur 1: Atovs data coverage for[3]May 27 2001 for AMSU-A data.

6. Benefits to operational community

The proposed project will help the operational community to assess the value of using the ATOVS data in the limited-area model for short-range forecasting. As mentioned in previous sections, few weather center uses this data in operational limited area data assimilation practice although many have the access to the data. We hope the significant positive impact, which has been found for global model on medium-range, to be found for limited-area model on short-range. We also hope that the proposed project will put the ATOVS data in the DMI data assimilation system, leading to improved operational forecasts.

7. Benefits to other users than the host

Almost all the national weather services need to provide local short-range weather forecasts. The proposed project will help them to decide the use of the ATOVS data in their data assimilation system. The experience in the processing chain linking the locally received data to the data assimilation system will be made available to all EUMETSAT users.

Furthermore, the HIRLAM system is used operationally in almost all HIRLAM member countries, all being EUMETSAT members. The development of the HIRLAM data assimilation system is for the collaboration and will lead to improved weather forecast in all aforementioned countries.

8. Work plan for the first year of the project

An overview of the work plan for the first year is given in Table 8.

Month	1	2	3	4	5	6	7	8	9	10	11	12
Review	+	+	+									
Assimilation I			+	+	+	+						
Data							+	+	+			
Assimilation II								+	+	+	+	+
Report		+				+						+

8.1. Review

For the first three month, the fellow will review the work on the ATOVS assimilation. This includes

- reviewing on published papers and reports on the topic;
- searching for ATOVS impact on short-range (even for global models);

- start learning the HIRLAM data assimilation system;
- start learning the available software for receiving and handling the local ATOVS data at DMI.

8.2. Assimilation I

To start data assimilation experiment, the quality controlled ATOVS (AMSU-A) data from the ECMWF database will be used to avoid possible problems in the locally received and processed data at DMI. This work starts at the third month and hopefully can be finished in the middle of the project with a short report. The fundamental issue raised should be addressed in the report, i.e., the global model and medium-range versus limited area model and short-range.

8.3. Data

The second half year will be devoted to the practical issue, starting from locally received data. The data handling and monitoring should be done together with other members of the DMI data assimilation group.

8.4. Assimilation II

One month after the data sub-project, assimilation experiments using the local data should start. This part of the work should lead directly to a possible operational implementation of the ATOVS data assimilation. The final report should also compare the results from using the local data and those from using ECMWF data.

8.5. Report

The first review and the second report are short ones, with the purposes mentioned in Review and Assimilation I.

The final report should be a proper publication.

9. Brief indication of goals and work foreseen beyond the first year

The full potential of the project could be realized if it can be extend beyond one year.

In the direction of research, the fundamental issue of global model and medium-range versus limited area model and short-range can be further investigated. The 4 months planned for the first year are not enough if in-depth understanding is required. The further study could lead to solid results and scientific publications.

In the direction of operation, data monitoring and forecast verification are continuous tasks and often suggest possible weakness in the data and the assimilation

systems. A major work for the second year is the pre-operational test and the operational implementation.

10. Relevant scientific expertise, facilities and logistic support

DMI is the Danish national center for operational meteorology, climate change monitoring and research of the atmosphere from the lower troposphere to ionosphere and magnetosphere. The research and development department of DMI has about 90 employees which is organized in five divisions. The data assimilation group belongs to the meteorology division, which has 18 scientists and is responsible for research and development in the area of numerical weather prediction and air pollution.

In the data assimilation group, there are 5 scientists and 1 PhD student. Most of the group members have worked with the HIRLAM variational data assimilation system for years. The tasks of the group include the following:

- management of the data assimilation module of the DMI operational system;
- monitoring of the data usage by the DMI operational system;
- system management of the variational data assimilation for the whole HIRLAM project;
- coordination of the 4-dimensional data assimilation development and responsible for the HIRLAM physics adjoint module;
- development and testing of GPS data assimilation module, participation in several GPS related Danish, ESA, EU projects;
- investigation of the impact of ozone data on data assimilation systems.

As the computer resource is concerned, DMI is among the leading national weather services. The current operational system as well as research projects run on a NEC SX-4 supercomputer. An ITT for a new computer is currently out.

In addition, DMI is a member of ECMWF. The computing power at ECMWF has also been shared by DMI and used for several computation demanding research projects.

The meteorology division holds comprehensive expertise in all aspects of operational weather forecasting including handling of observations and complicated software developments.

References

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