USING ICI AT THE NATIONAL SATELLITE METEOROLOGICAL CENTER OF CHINA

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1 INTRODUCTION

In recent years the physical retrieval scheme of National Satellite Meteorological Center (NSMC) has been updated several times (Dong, 1995 and Zhang, 1997). ITPP5.0 has been used for NOAA-14 since 1998 and more recently ICI, developed by Meteo-France/CMS, has been used for NOAA-15 since 1999. The performance of another regional retrieval package IAPP, developed by CIMSS, has been also evaluated in NSMC (Qiu, ITSC-11 presentation).

In this paper the implementation of AAPP and ICI will be described and the retrieval results are validated against both NWP analyses and radiosondes, the results with their statistics are presented with GMT free software in this paper. Preliminary result from the PC-ATOVS Windows display system of NSMC will also be shown.

2 AAPP AND ICI

The AAPP (Klaes, 1997) was obtained officially from EUMETSAT at the end of 1998 and installed successfully on a HP workstation of NSMC at the beginning of 1999. The HRPT data from the 3 receiving stations (Beijing, Guangzhou and Urumqi) as in Fig.1 have been processed by AAPP since July of 1999 in real time. The AAPP has been updated in NSMC according to the new HIRS calibration coefficient files and AMSU correction files. Progress has been made about the running of AAPP despite a few local problems (e.g. the time conflict of receiving FY-1C and NOAA-15 data with a common antenna, the low quality HRPT data of NOAA-15, etc.).

The AMSU-A/B and HIRS/3 data processed by NSMC using the AAPP package has all been archived. The NOAA-15 measurements are very useful for weather forecasting; for example, AMSU-B images can explain more details about the rainfall on the Chinese National Day of 1999, Fig2-4 are some examples from AAPP result.

ICI Version2.0 (Lavanant, 1999) was developed by Meteo-France/CMS and it has also been implemented in NSMC. All the interfaces for ICI input files (such as NWP and RAOB) are completed. The analysis of the Chinese regional NWP model HLAFS

(High-resolution Limited Area Forecasting System) is utilized to create a rolling library of vertical profiles over the last ten days and at a resolution of 10° by 10° degrees. This Chinese regional NWP model covers an area of 5N-64N/55E-145E and has 4 analyses per day (00, 06, 12 and 18GMT) with a resolution of 1 ° by 1° degree. HLAFS has 13 levels up to 50hPa. The 10 meter wind speed is used to estimate the microwave emissivity of the sea surface (English, 1998). The level 1-D brightness temperatures generated by the AAPP package are used as input. HLAFS forecasts for surface air temperature and surface pressure are also required by ICI. Since July of 1999, this package has been running in real time on a daily basis for NOAA-15 data from 3 HRPT receiving stations in China. The free display software GMT is used to display the output retrieval results and their validations. Currently the retrieval results are placed on the Meteo-France ICI Web site as in Fig.5 and updated on a regular basis:

http://www.meteorologie.eu.org/ici/

3 RETRIEVAL RESULT VALIDATION AND ANALYSIS

The ICI package can be run in many different configurations; for example, the retrieval could be done at full HIRS resolution or the data could be thinned to a lower resolution. In this application, ICI has been run at a thinned resolution of 2 by 2 HIRS pixels. The retrievals are separated due to surface types (sea, land or coastline) and cloud conditions. The cloud classification is based on AVHRR cloud cover and AMSU precipitation flag. There are four cloud classes: Clear, partially cloudy, cloudy and scattering. The channel combinations are different according to different cloud classes. In the current ICI retrieval procedure, AMSU-B measurements are not yet used. Only HIRS/3 channels and AMSU-A channels are used in the current ICI retrieval procedure. Fig.6 shows the errors between the RTTOV computed (Eyre, 1991) and observed brightness temperature for a ten-day period between 21 and 30 August 1999 for NOAA-15 over land. The errors are very stable as long as the onboard instruments perform better within the lifetime. Those channels (in green) with significant errors are not used in ICI, otherwise they could degrade the retrieval.

For monitoring and comparing the retrieval results and their statistics among different ICI users, a common visualization tool was developed, it is based on a free available graphic tool GMT (graphic software package). Fig.7 shows the statistics for the same ten day period as Fig.6 for NOAA-15 ATOVS retrievals over China. The average standard deviation is found to be about 2 degrees Kelvin on 40 pressure levels used by the original RTTOV model. Fig. 8a shows the same statistics as Fig.7 but on 7 layers; the standard deviation is about 1.5K on all layers for both clear and cloudy situation over sea. For land the standard deviation reaches 2K near the surface and is about 1.5K at 500hPa. Fig.8a shows a comparison between ICI retrievals and observations (NWP analyses plus RAOB measurements). In Fig.8b the comparison with RAOB only is shown and the standard deviations are about 0.5K higher.

However, the ICI results for CMS's acquisition zone (Lavanant, 1999) are much better than the ones of NSMC. It is mainly due to:

- The sophisticate topographic structure and surface characteristics in the Chinese mainland, and
- The low quality of Chinese regional NWP HLAFS model. Study is underway to improve HLAFS quality at National Meteorological Center of China.

In order to illustrate the comparison between ICI retrieval profiles and NWP analysis or RAOB profiles, a case study was carried out for the same period as above. Fig.9 shows the comparison between ICI retrieval and RAOB profile for a case over land. An example of the ICI retrieval field for 3 consecutive orbits over China together with the difference with the collocated Chinese NWP field is shown in Fig.10.

Fig.11 shows similar statistics but in RMS errors for the first half of year 2000. Statistics were computed over ten day periods and at RTTOV levels. The upper panel corresponds to cloudy situation, the lower one is for clear. Green color represents RMS between 1.0 and 1.8K, yellow is for RMS from 1.8 to 2.6K, Fig 11 is dominated by green and yellow, the RMS errors become larger (in red) near the surface.

At NSMC, A PC-TOVS image/graphic display system has been developed based on Visual C++ to visualize the results for the benefit of weather forecasters. The system works on Microsoft Windows 95/98/NT environment and displays the brightness temperature and plot the isolines. Fig.12 is an example from this display system, it shows ICI retrieval temperature and geopotential height at 500hPa.

4 CONCLUSIONS AND FUTURE WORKS

The implementation of AAPP and ICI is described in this paper. The retrieval results from ATOVS observation are validated against Chinese NWP analyses and radiosondes. These results show good agreement between ICI retrievals and observations. The ICI scheme has been running in real time for more than one year and is therefore considered reliable.

ICI version3.0 (Lavanant, ITSC-11 presentation) which includes the humidity retrieval from AMSU-B will be implemented early 2000. CMS and NSMC will continue the work to improve the accuracy of the ICI retrievals over China. It is planned to make effective use of the NOAA-L AMSU-B, which should not suffer from the same radio frequency interference problems as the NOAA-15 AMSU-B, and to prepare for the following NOAA polar orbiting meteorological satellites, i.e. NOAA-L/M/N,N'.

Many Chinese meteorologists are very interested in the retrieved atmospheric parameters for the weather analysis and forecasting etc. NSMC is planning to use ATOVS retrieval to estimate the typhoon intensity. The retrieval products are also needed to enable the assimilation of satellite data in the Chinese NWP model. A joint assimilation study of ICI retrieval in the regional Chinese NWP model HLAFS is underway in the framework of cooperation between NSMC and National Meteorological Center of China.

5 ACKNOWLEDGMENTS

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6 REFERENCES

Dong, C.H., Z.D. Wu, et al., 1995: Processing and research of TOVS data in the satellite Meteorology Center of the China Meteorological administration, Technical proceedings of the 8th International TOVS Study Conference, 5-11 April, Queenstown, New Zealand, pp158-168.

English, S.J., 1998: Hewinson T.J., A fast generic millimeter-wave emissivity model, Microwave Remote Sensing of the Atmosphere and Environment, SPIE, Vol.3503.

Eyre, J.R., 1991: A Fast Radiative Transfer Model for Satellite Sounding Systems, ECMWF Technical Memorandum No.176.

Klaes, K.D., 1997: ATOVS data processing in Europe, Technical proceedings of the 9th International TOVS Study Conference, 20-26 February, Igls, Austria,, pp267-274.

Lavanant, L., P. Brunel, G. Rochard, 1999: Noaa15 sounding profiles retrieved with ICI scheme, Technical proceedings of the 10th International TOVS Study Conference, Jan 26-Feb 2, Boulder, Colorado, USA, pp321-328.

Lavanant, L., P. Brunel, et al., 2000: ICI retrieval package: towards version 3, ITSC-11 proceeding, in press.

Qiu, H., W. J. Zhang, 2000: The Analysis and Evaluation of the Retrieving Results of IAPP in NSMC, ITSC-11 proceeding, in press.

Zhang, W. J., C. H. Dong, et al., 1997: TOVS operational system upgrading and application aspects in NSMC of China, Technical proceedings of the 9th International TOVS Study Conference, 20-26 February, Igls, Austria, pp555-566.

Fig.1: The receiving coverage of 3 HRPT stations in China

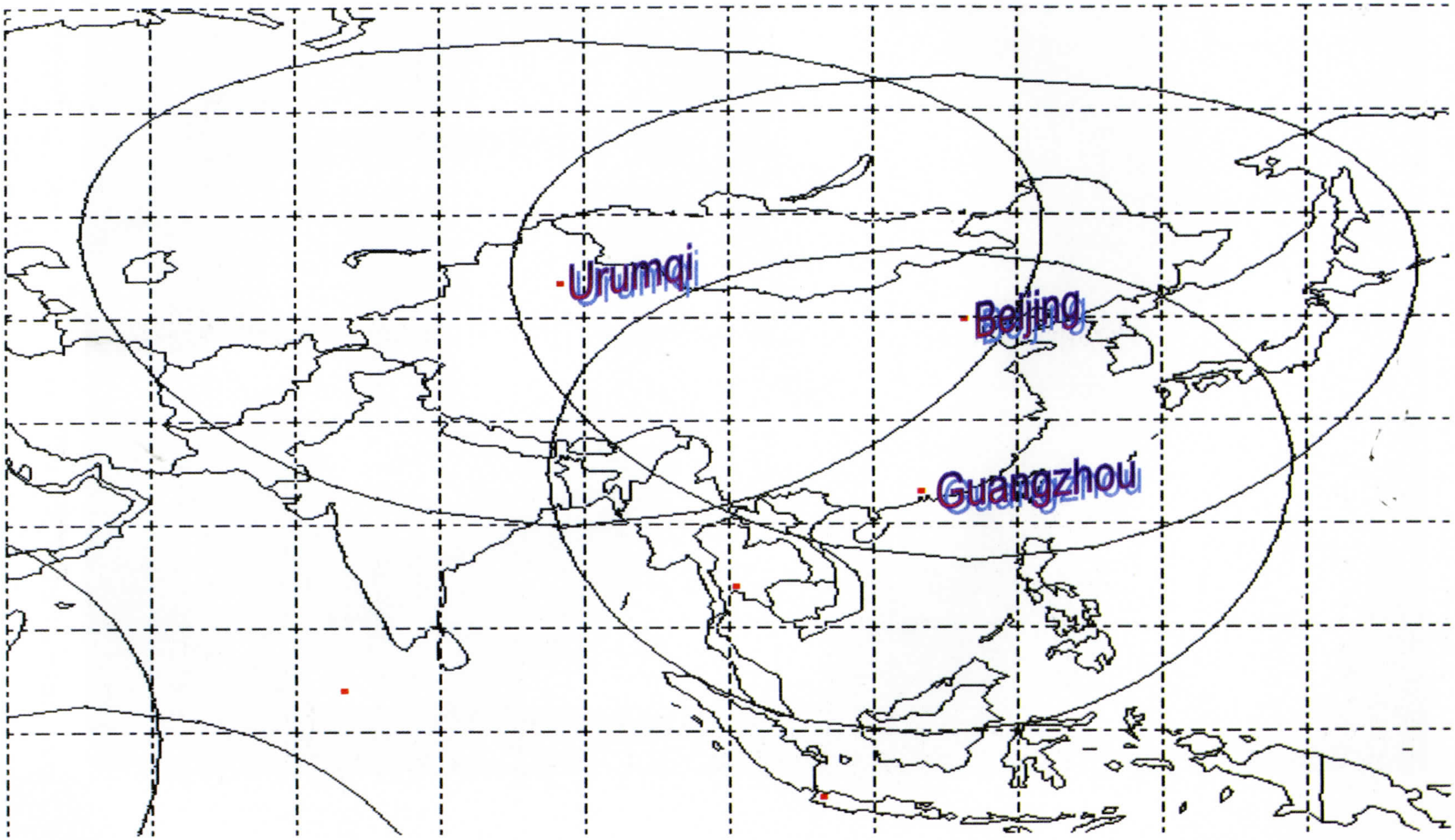


Fig.2 AMSUA Birghtness Temperature CH2
20000120 2232-0011-0150-0331UTC

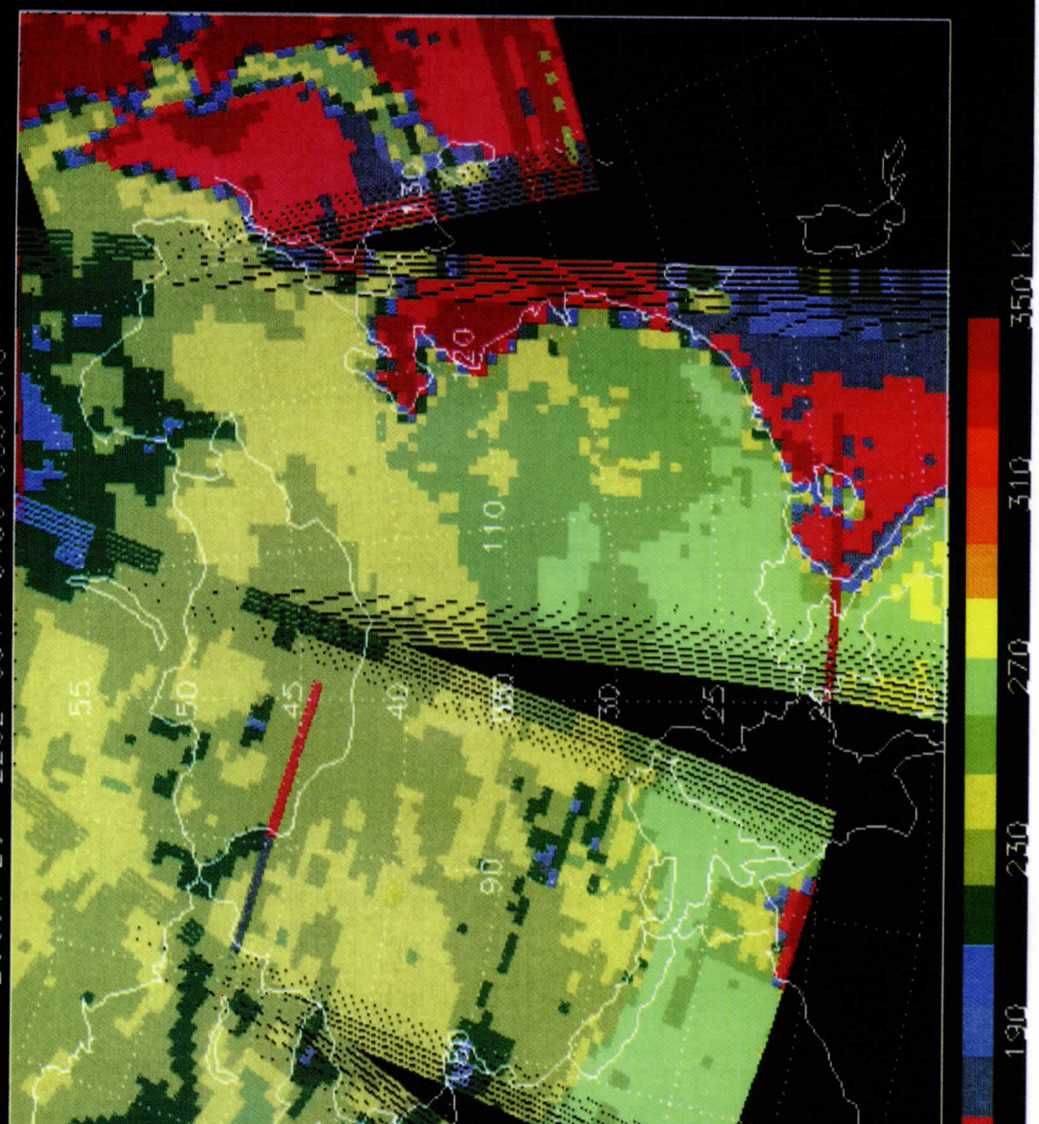
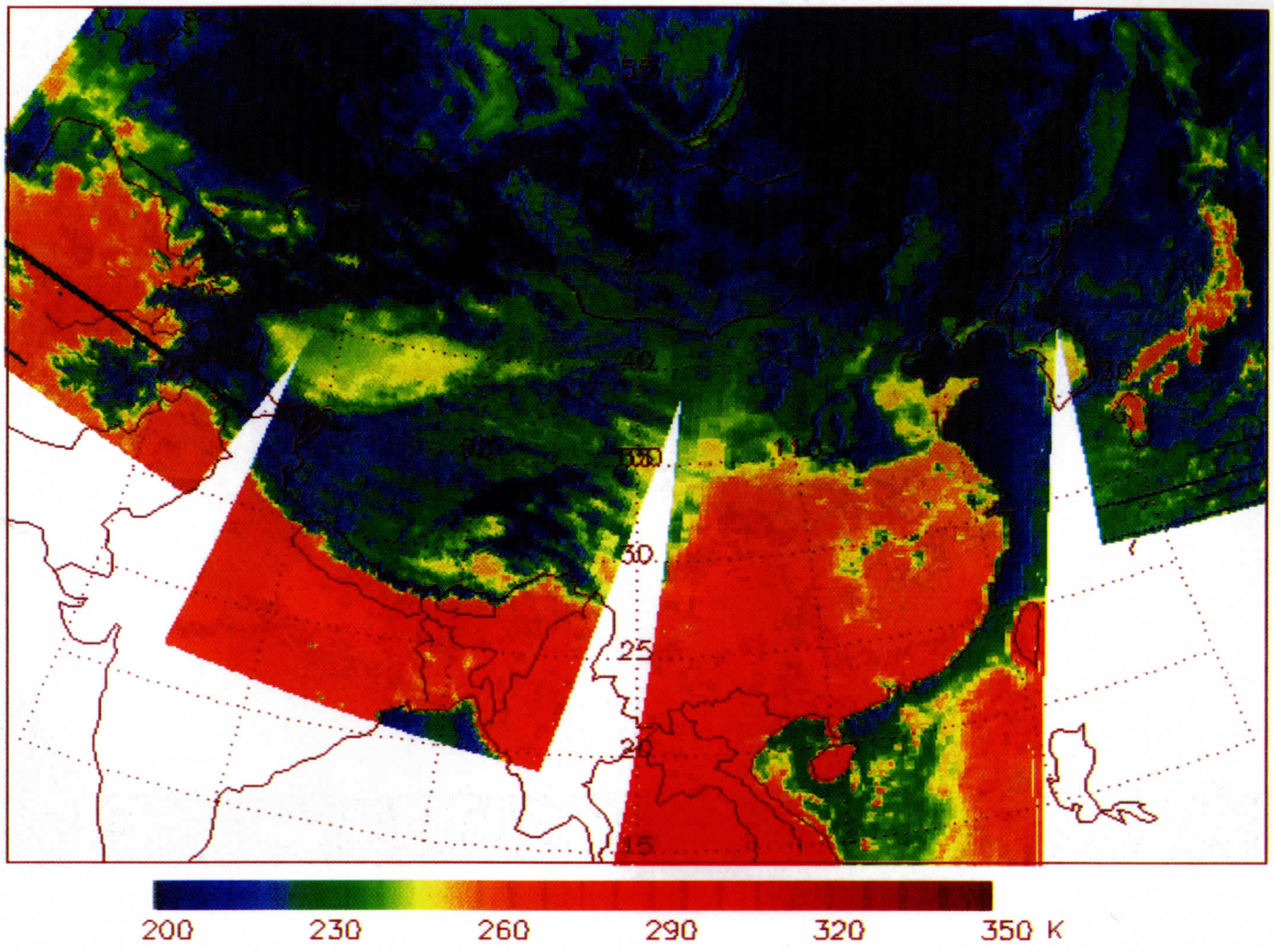


Fig.3 AMSUB Birghtness Temperature CH1
20000120 2231-0011-0150-0331UTC



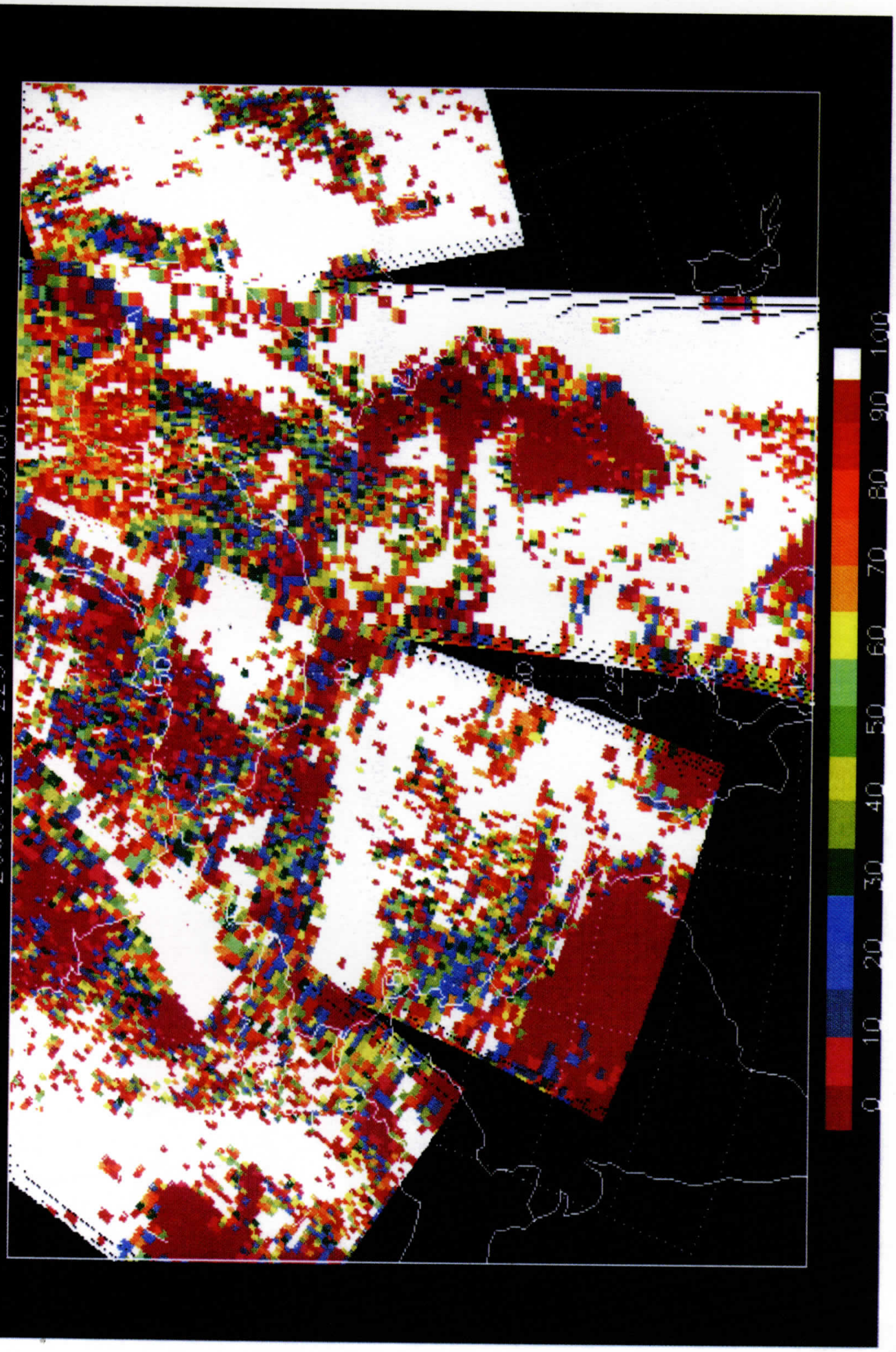


Fig.4 AVHRR Mean Cloud Cover % in HIRS/3 FOV
20000120 2231-11-150-331UTC

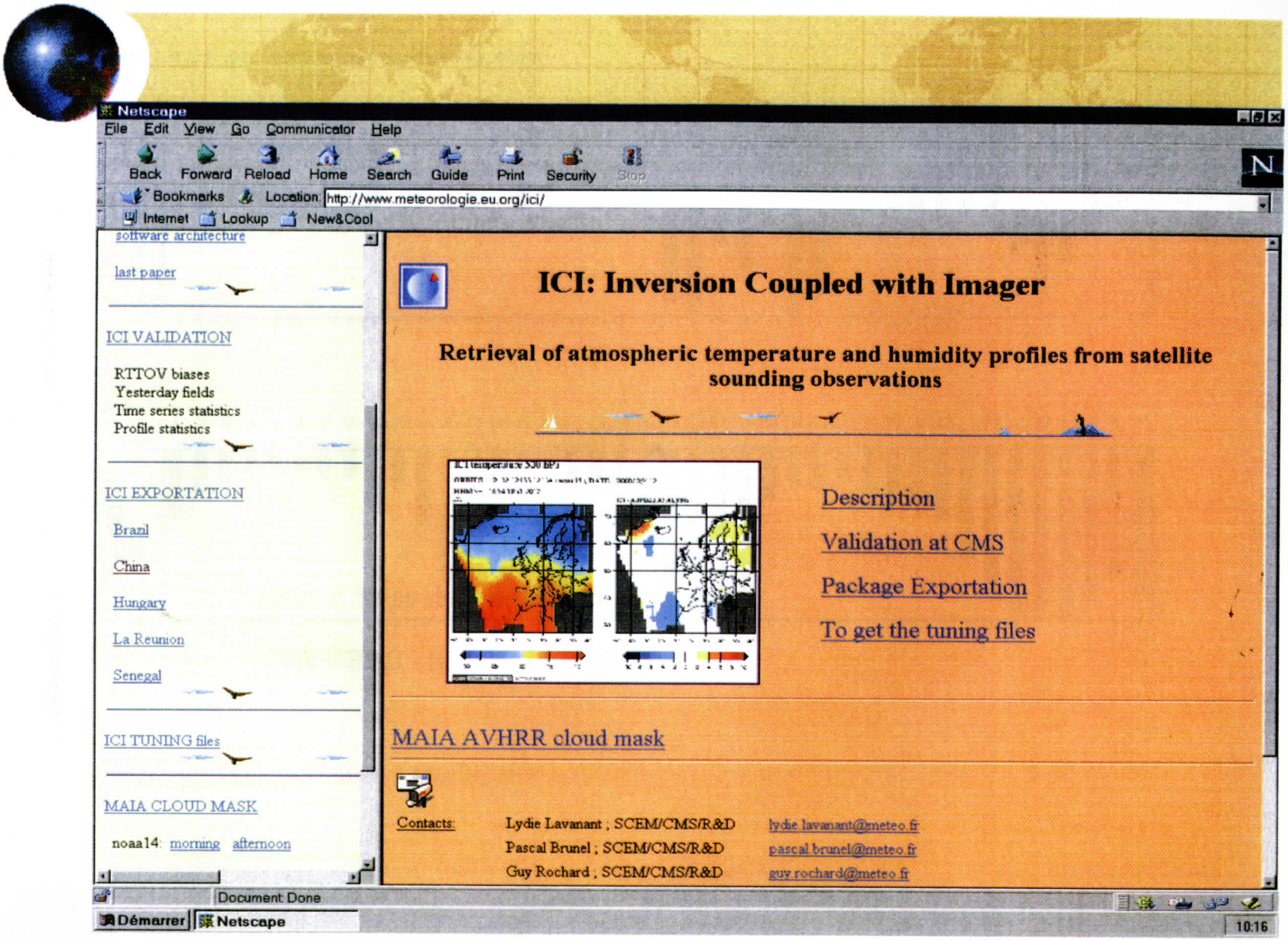


Fig.5 ICI Website of Meteo-France

Fig.6: RTTOV brightness temperature deviations for noaa15 over land

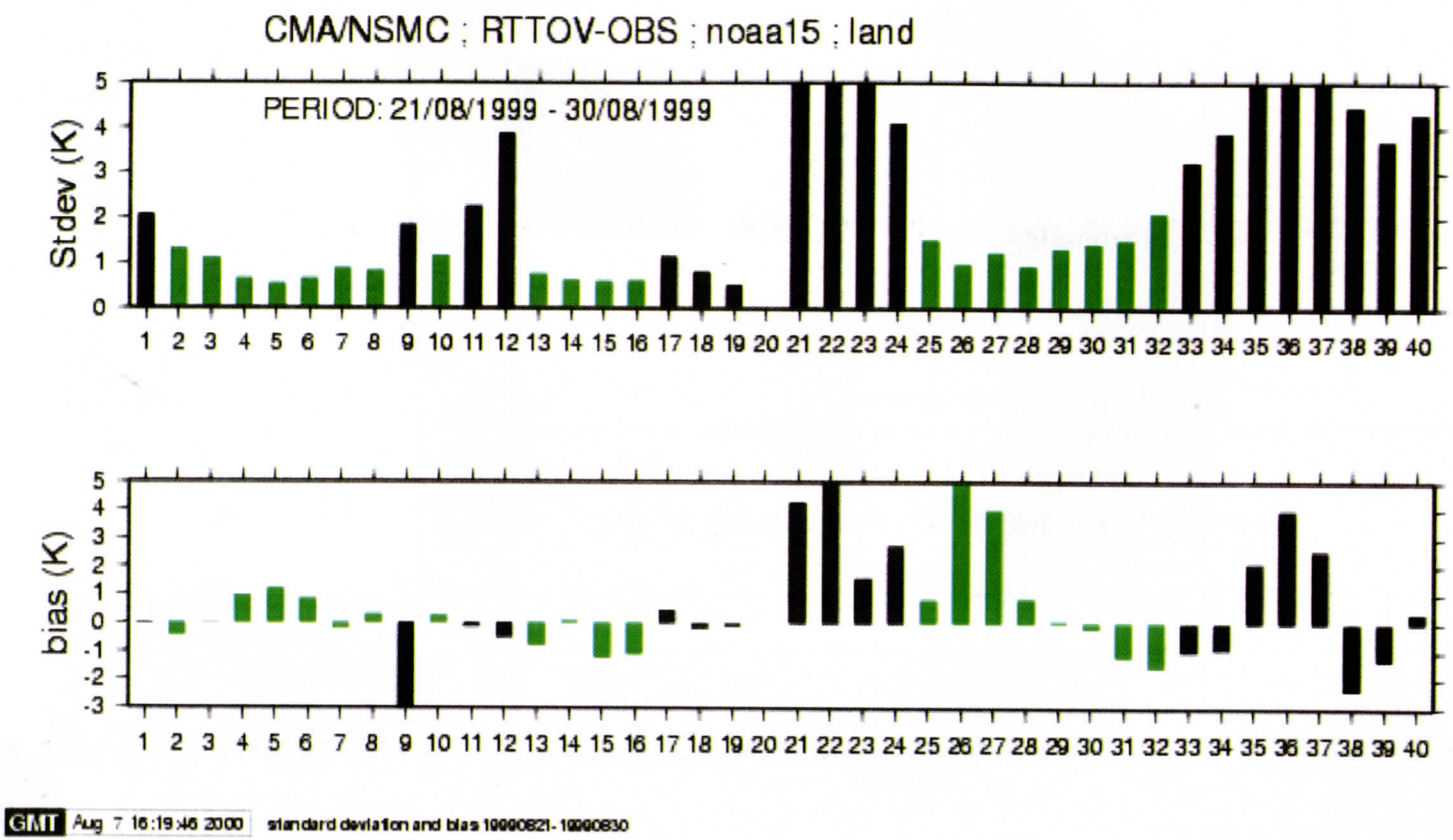


Fig.7: Accuracy of ICI retrievals for NOAA-15 between 21 and 30 August 1999 separately over land and sea. Mean and standard deviation of retrievals compared to the analyses and radiosondes are given at 40 RTTOV levels for two cloud classes with the numbers of collocation.

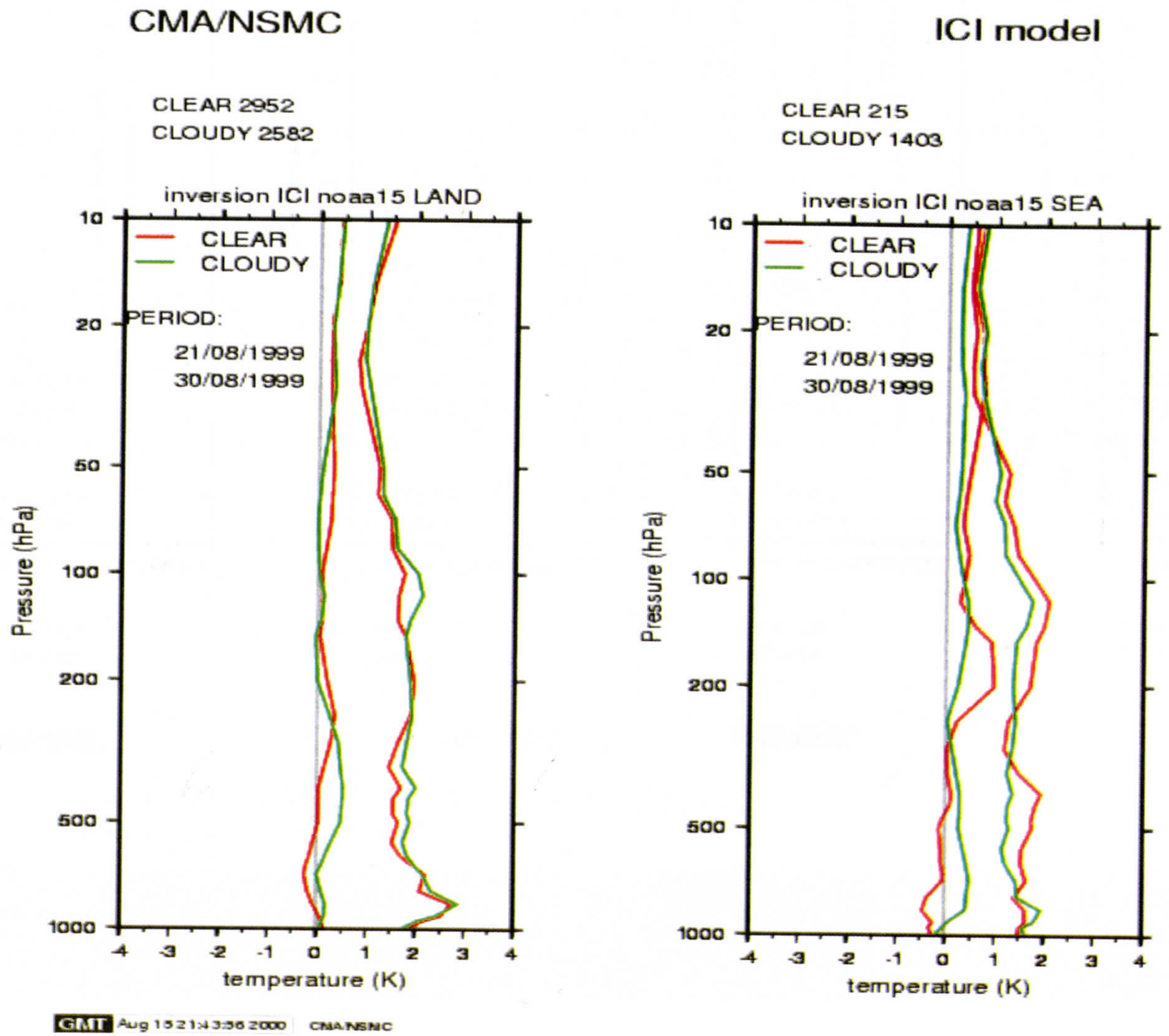


Fig.8a: Same as Fig. 7 but on 7 layers
Fig.8b: Same as Fig. 8a but for the comparison with RAOB only

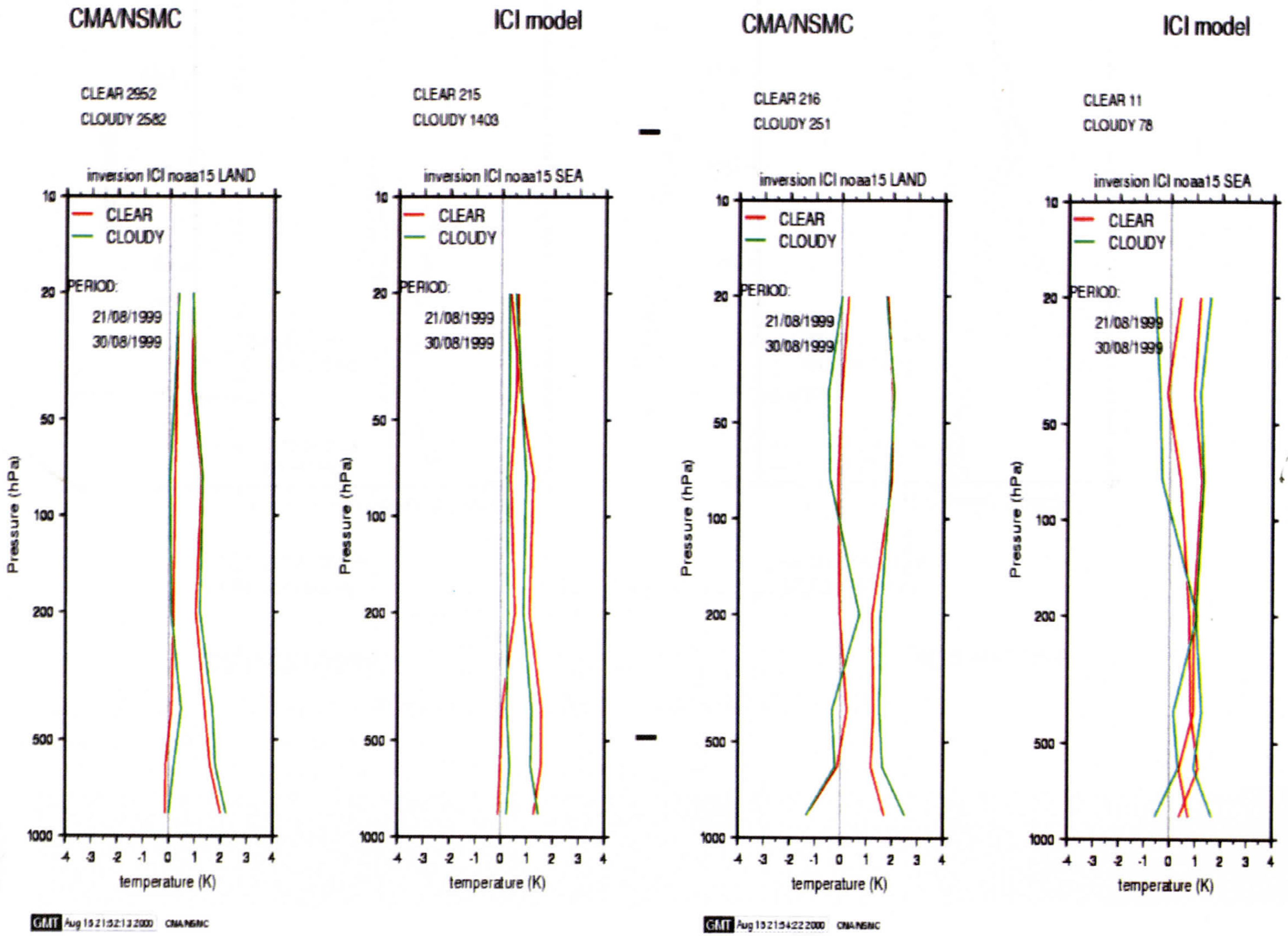


Fig.9: Comparison between ICI retrieval and RAOB profile for a case over land

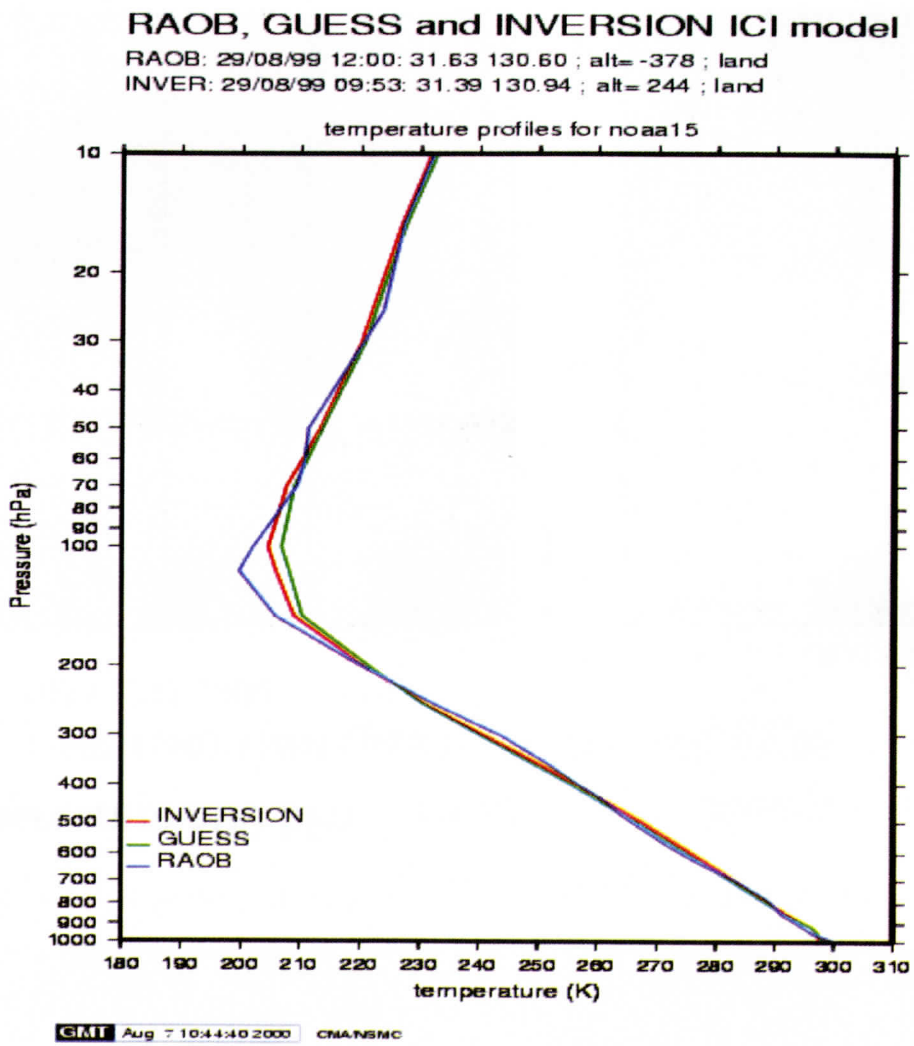


Fig.10: NOAA 15 retrieval field at 500hPa and the comparison to the collocated Chinese NWP analysis

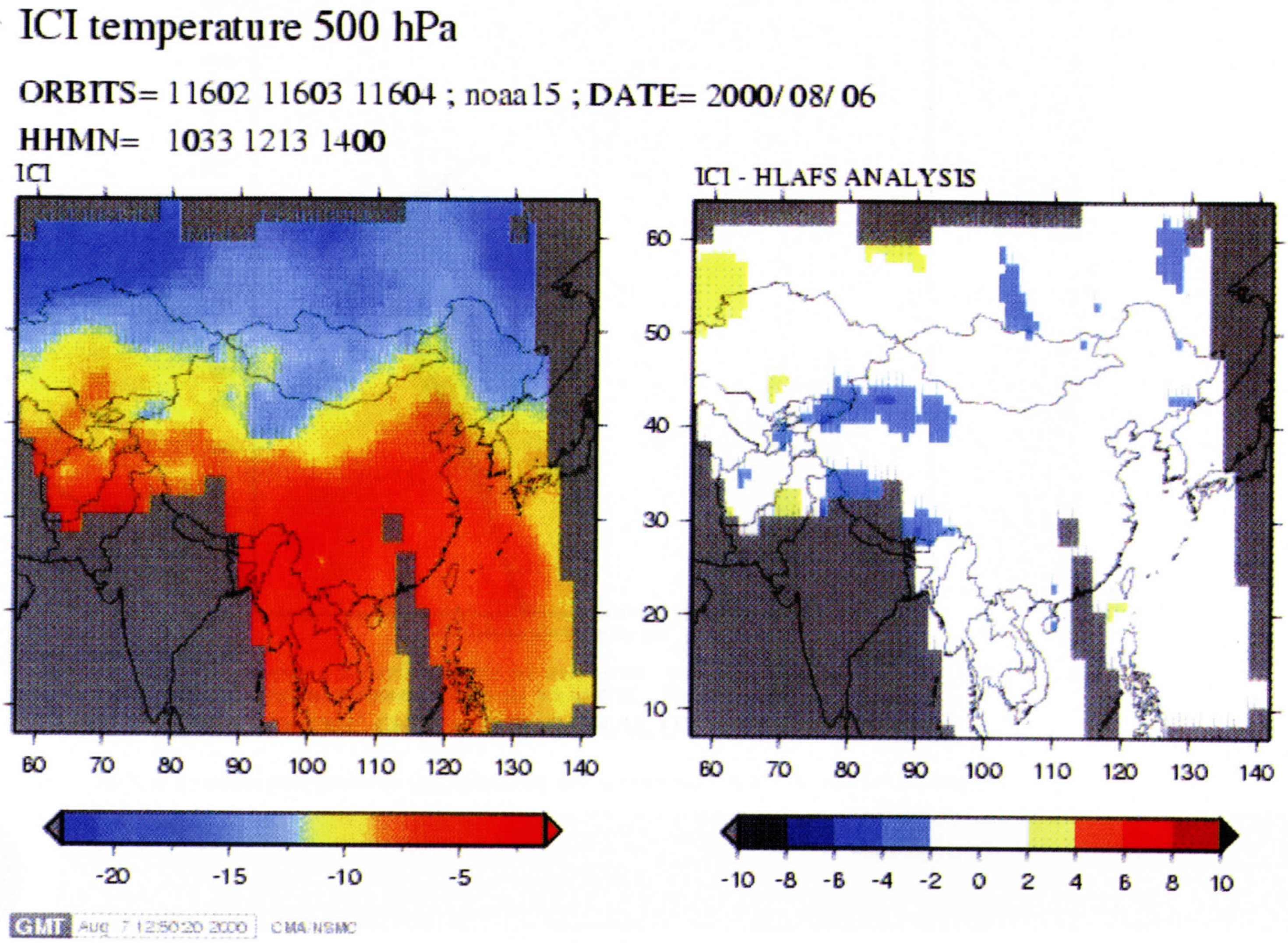


Fig.11: RMS errors on RTTOV levels between temperature retrievals and NWP analyses during the first 5 months of 2000

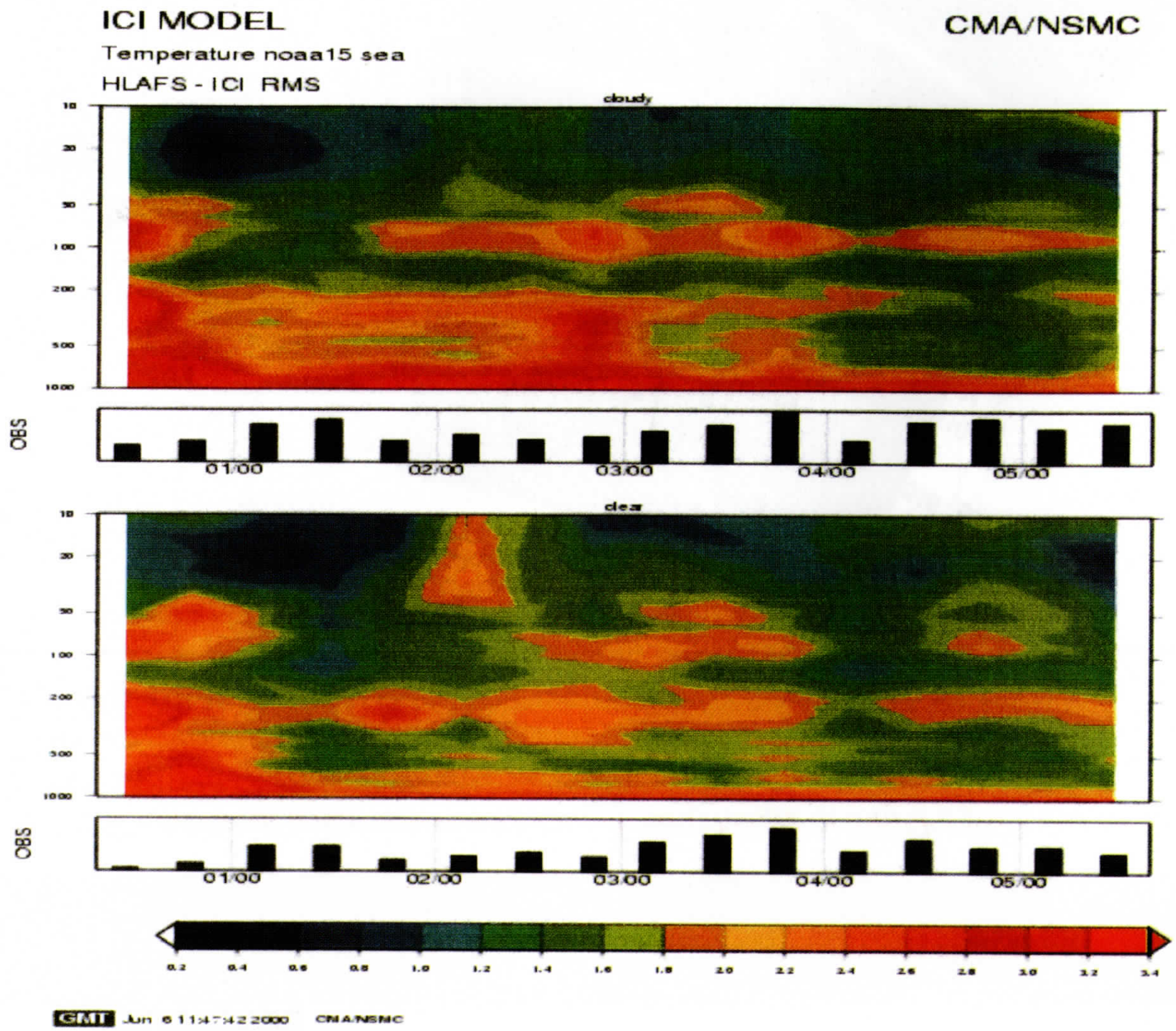
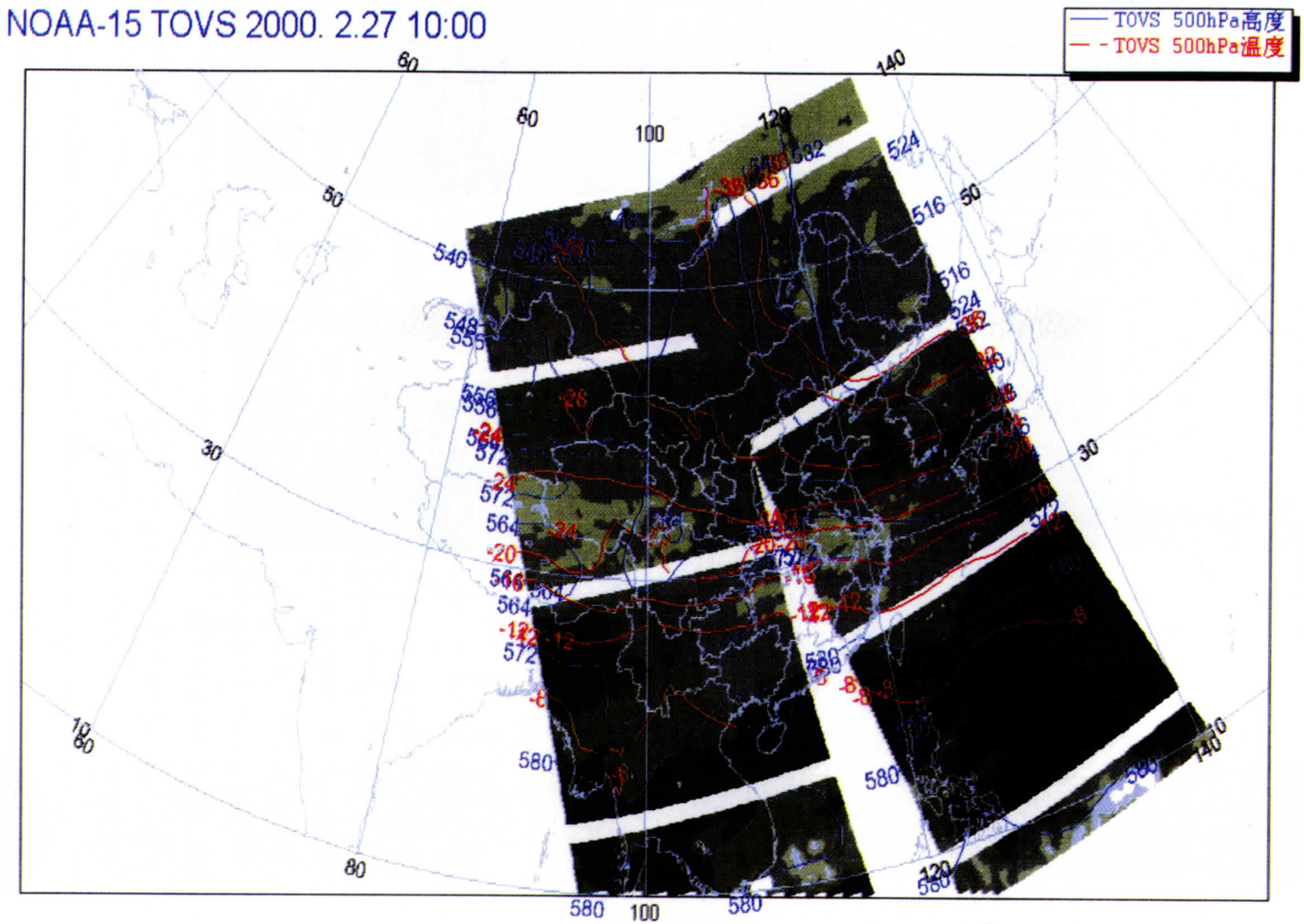


Fig.12: ICI retrieval temperature and geopotential height at 500hPa from our local PC-TOVS display system. Background is the brightness temperature of HIRS8



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