

SATELLITE SOUNDING APPLICATIONS IN 1990'S

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Abstract: With the availability of computer facilities the satellite data have been playing more and more important role in weather and hydrological services in China. Imagery data from both geostationary and polar orbiting satellite are widely used for monitoring and predicting the tropical cyclone, flash flooding, forest fire etc. in 1980's and the social and economical benefits have been achieved. But the utilization of sounding data still remains in research and experimental stage. In last three years the computer systems in both national and regional meteorological centers were greatly upgraded and different time and space-scale numerical models were developed. Since the TOVS products processed by SMC have not been distributed to local users through the communication line several HRPT stations were established lately in provinces and regional centers to receive the real-time TOVS data as well as the AVHRR data. Thus the condition is favourable to process TOVS data and do the assimilation locally for improving the numerical forecasting. The scientists in SMC and IAP are facing the task to transfer the TOVS data processing technique to local users and train them. In addition they should also be prepared to deal with the AMSU data in 1990's.

1. INTRODUCTION

As stated by author (Zhou, 1989) China has been able to receive HRPT data stream from TIROS—N series satellite since 1979. The main products are the cloud pictures from facsimile machine. The important position of AVHRR data in monitoring and predicting the weather systems was shortly replaced by visible and infrared imageries transmitted by Japanese Geostationary Meteorological Satellite (GMS) due to its higher time resolution. The AVHRR data are currently used for producing the sea surface temperature, vegetation index, detecting the forest fire and flooded area, estimating the crops output and so on. The TOVS data were

neglected till the first McIDAS (Man-computer Interactive Data Access System) was brought into China through the cooperation between SSEC (Space Science and Engineering Center), University of Wisconsin and IAP (Institute of Atmospheric Physics), Chinese Academy of Sciences in early 1980's. The retrieval algorithm was tested on IBM 4331 and some preliminary results were presented at ITSC—I in Igls, Austria (Zhou et al. , 1983). Later a group of scientists at SMC (Satellite Meteorological Center in Beijing) started to implement the statistical regression method on IBM 4361 for TOVS data retrieval. Now it becomes the routine job at SMC but on IBM 4381 computer.

The collaboration between IAP and CIMSS (Cooperative Institute for Meteorological Satellite Studies) in mid-1980's made the PC—TOVS package available to world wide users (Zhou et al. , 1986; Dedecker, 1988). The ITPP software (both IBM and VAX version) distributed by CIMSS attracted more users at universities and research institutions in China. The most of studies on intercomparison of different retrieval skills, initial guess experiment, retrieval improvement over Tibet plateau and so forth were done by SMC scientists due to their responsibility and advantage of exchange programs among the satellite centers in the world (Zhang et al. , 1989).

2. RECOGNITION OF IMPORTANCE OF SATELLITE SOUNDING

Although the mainland China is one of areas with the most dense radiosonde network the west desert and plateau region remain data sparse and only a few stations are distributed over East and South China Sea. Twice a day observation limits the time resolution of conventional data. Awareness of uneven distribution and low time resolution of RAOB data the scientists and meteorologists started to seek help from satellite remote sounding. The modellers at IAP, SMC and NMC (National Meteorological Center in Beijing) did the impact studies on the operational Northern Hemisphere short-range numerical forecasting model and limited area research model by use of NESDIS and local produced TOVS products in recent years. The preliminary optimistic results encourage them to do further studies and experiments. The satellite sounding data assimilation and impact study will be considered as a sub-project of five year (1990 — 1995) national key project called "The Improvement of Two to Three day Typhoon and Heavy Rainfall Prediction". The recognition of importance of satellite sounding and availability of funding will greatly push forward the application of sounding data on numerical prediction. IAP equipped with CONVEX and NMC with recent installation of CYBER computer system will be the major points to do the assimilation and impact studies.

TOVS data also attract the local users at several regional meteorological centers such as Shanghai, Guangzhou and Wuhan Met. Offices. Their ambitious plans are to include the satellite retrieval products in their tropical oceanic model, typhoon model and heavy rainfall model within next five years. For these purposes several HRPT stations have been established lately for timely abstracting the TIP data and process them locally. Having upgraded computer facilities (VAX 3000 and up) make them able to at least experiment the TOVS data and to see the usability and problems. The NESDIS TOVS products via GTS (Global Telecommunication System) will not be utilized by the regional limited area forecasting model for the low space resolution and time delay. The centrally retrieved results by SMC will also hardly reach to local users due to the current limitation of the communication capability. So the construction of having central and local processing ability to satellite sounding data will remain for a while.

3. STATUS OF SOUNDING DATA RESEARCH AND APPLICATION

In early 1970's a group of scientist at IAP headed by Q. C. Zeng was devoted to theoretical studies of satellite sounding including research on atmospheric molecular absorption bands, channel selection and various retrieval algorithms development for temperature and moisture profiles. A book named "Principle of Infrared Remote Sounding of Atmosphere" (Zeng, 1975) and many related papers were published. The major efforts in 1980's were concentrated on implementing and experimenting the statistical and physical retrieval methods including the simultaneous and 3I (Improved Initialization Inversion) techniques developed outside. The improvements of algorithms are also based on the imported package to satisfy the national condition. Very limited application up to now and relatively small user community mean a long way to go from research to operation of sounding data utilization. As said by J. Eyre (Eyre, 1989) "the international progress on TOVS processing has been greatly facilitated by the availability of standard processing package" it is true to the China case. China has benefited from the various exchange programs and ITSC forum. The principle of sharing the international success and cooperation between countries will be followed in 1990's but more research efforts will be placed on the retrieval skill development and satellite sounding application in different fields by increasing the qualified researchers at both research and operational institutions.

4. CHALLENGE IN 1990'S

Though the TOVS data have been available for more than ten years the application of TOVS products has not been seriously started in China due to the limitation of computer facility, communication capability as well as the low interest on poor accuracy of retrieved prod-

ucts. The increasing request from modellers and improved receiving and computing equipments make the condition favourable to deal with the TOVS data. The ATOVS (Advanced TOVS) scheduled on NOAA—K in 1993 creates the new prospect in providing improved profiles in cloudy area. Chinese meteorologists should first experience with the relatively simple and current available TOVS data then get ready to face the ATOVS data. Not much time is left to do transition. Furthermore the AIRS (Atmospheric InfraRed Sounder) will be put up on the NASA polar-orbiting platform in late 1990's, which will greatly improve the vertical resolution and provide 1 degree accuracy of temperature retrieval. The new era is coming for satellite data utilization in weather forecasting.

Rapid progress of international space program and successful launch of Chinese polar-orbiting meteorological satellite FY—1 (Zou, 1990) stimulate the enthusiasm of continuing efforts on Chinese satellite and instrument development. A prototype instrument similar to TOVS with more infrared and microwave channels is under development in research laboratory. FASCODE software developed by AFGL (Air Force Geophysics Laboratory) is used for channel selection and atmospheric radiation transfer studies. More advanced instrument is under consideration. The present job of scientists in IAP and SMC is helping the regional meteorological center to have capability of processing TOVS data locally and interface TOVS products with assimilation system and different models. Since lack of experience in dealing with quantitative satellite data especially the sounding data the workload to train the operational users will be heavy. The availability of ATOVS and AIRS data in near future and our own sensor development also require hard work. So the satellite meteorologists and engineers in China will face both challenge and opportunity in 1990's. The international cooperation is critical and welcome in future.

5. REFERENCES

- Dedecker R. , 1988; Introduction to PC TOVS. A Report on the Fourth International TOVS Study Conference, Igls, Austria, 16—22 March 1988.
- Eyre J. , 1989; Planning for ATOVS data. Tech. Proc. of the Fifth International TOVS Study Conf. , A. Chedin, (ed.), 112—124
- Zeng Q. C. , 1975; Principle of Infrared Remote Sounding of Atmosphere. (in Chinese) Edited by Chinese Academic Press.
- Zhang F. , Dong C. , Ma X. , Li G. , Zheng B. , Liu Q. , Ran M. , Wu B. , Zhang W. , Zhao S. , Zhang B. and Shi S. , 1989; Recent TOVS studies and applications. Tech. Proc. of the Fifth International TOVS Study Conf. , A. Chedin, (ed.), 410—438.

- Zhou F. X. and Zhao G. X. , 1983; Some preliminary results from the polar-orbiting satellite data retrieval. Tech. Proc. of the First International TOVS Study Conf. , W. P. Menzel, (ed.), 345—352.
- Zhou F. X. and Qu Y. N. , 1986; IBM PC package for TOVS processing and display. Tech. Proc. of the Third International TOVS Study Conf. , W. P. Menzel, (ed.), 344—349
- Zhou F. X. , 1989; TOVS data research and application. Tech. Proc. of the Fifth International TOVS Study Conf. , A. Chedin, (ed.), 439—445.
- Zou J. M. , 1990; The meteorological satellite programme of China. Presented at the Operational Satellites; Sentinels for the Monitoring of Climate and Global Change (OPSAT 90), October 16—19, 1990, Washington D. C.

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