

## TOVS Data Research and Application

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ABSTRACT: The research on satellite sounding theoretically was started in early 1970s at the Institute of Atmospheric Physics and the study on TOVS data was begun in 1980s. ITPP and PC TOVS package have done great help to the chinese users in the research institutions as well as the operational meteorological organizations. The current and future application are going to be concentrated on the impact study to the different scale of numerical models. The importance of TOVS data on the ocean and plateau region has been recognized. The careful study and comparison must be conducted before any certain conclusion can be drawn.

## I. Introduction

Since 1979 China has been able to receive the HRPT data from TIROS-N satellite. The main product is cloud pictures from facsimile machine. The computerization in satellite meteorology was started in 1983 when the first McIDAS was installed in the Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS), Beijing. Later the ground station set up by Satellite Meteorology Center (SMC), State Meteorological Administration (SMA) in Beijing is able to receive and process the AVHRR and TOVS data in real-time. The utilization of personal computer for satellite data display was begun in 1986 when the IBM PC/XT and PC/AT became available in China market. The analog data such as GMS LRFAX and NOAA APT have been digitized and images are displayed on IBM PC screen in CGA or EGA mode. The weather forecasters benefit from sequential imagery data in their decision making on the very-short range forecasting or nowcasting. On the other hand the TOVS data processing and application are more complicated. It requires bigger computer and qualified users. The ITPP-III prepared by CIMSS has been distributed to several universities and research institutions in China. It was also copied to the international colleagues in South Korea and Singapore when their people attended symposium held in Beijing in 1987. The TOVS PC package developed jointly by CIMSS and IAP has been installed at several units too and more requests are coming to us. It is expected that the number of TOVS data user will increase gradually in China in near future.

## II. TOVS data research and application

IAP is able to extract the TIP data correctly from HRPT data stream as early as 1980. Unfortunately there was no appropriate computer facility to process the TOVS data until the first MoIDAS arrived at IAP in 1983. The purpose of TOVS study at IAP is to improve the retrieval skill and to introduce the products to users in China. The first TOVS case study done on PRC MoIDAS was presented at ITSC-I in Igls, Austria in 1983(1). The cooperation between CIMSS and IAP on the development of PC TOVS package was started in 1985. The first version was released at ITSC-III in Madison, USA in 1986(2). The continual cooperation of two units led to the TOVS demonstration on PS-2 by R. Dedecker at ITSC-IV in Igls, Austria in 1988(3).

The TOVS PC package has been installed at the Institute of Tropical Meteorology in Guangzhou, China for their impact study on the tropical oceanic numerical prediction model. The TOVS data are transmitted from the satellite ground station nearby in real-time. One can see from Figure 1. There are quite a bit of radiosonde stations over south-eastern China and very few stations over south-east ocean. The TOVS retrievals can fill the gap on the ocean area (Figure 2). It is important for improving the weather prediction especially in forecasting the weather systems which come from south or/and east. Same situation can be found in the west part of China (Figure 3 & 4). The Tibet plateau has the least density of stations, but the topography complicates the TOVS data processing. The researchers and teachers in the Meteorological College of Chengdu, which is located in the west, are going to use the TOVS data for the atmospheric study over plateau area. They are now able to extract the TIP data from the local HRPT station. The TOVS PC package will be soon installed over there for such study. The US polar-orbiting satellite is more important in the west than the Japanese geostationary one for the poor coverage and low resolution of later one. Also there are no TOVS data provided by GMS satellite.

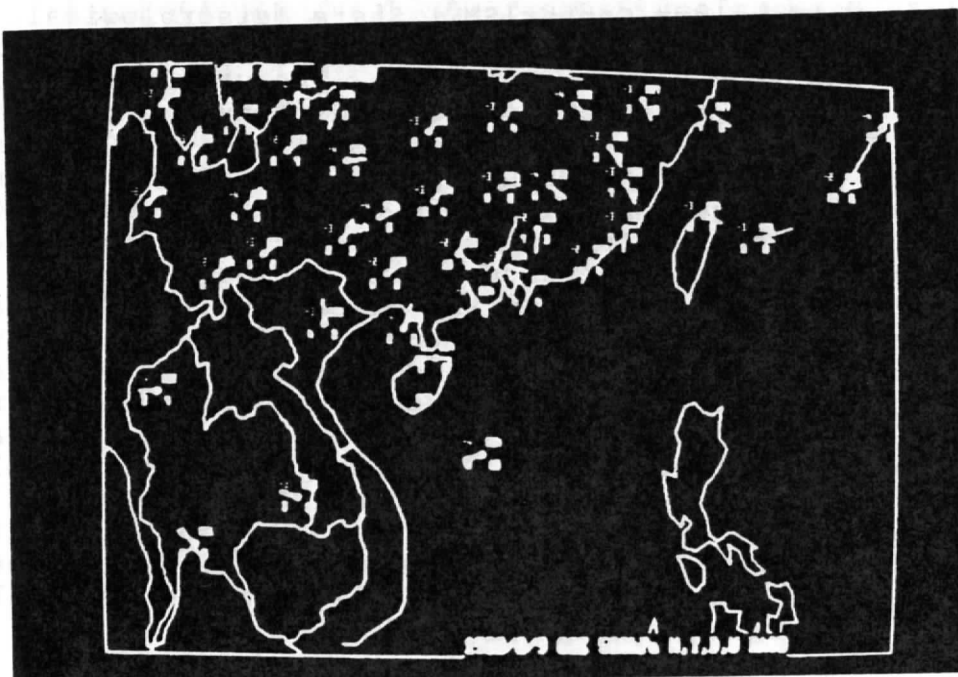


Figure 1 Radiosonde observations over South-east China

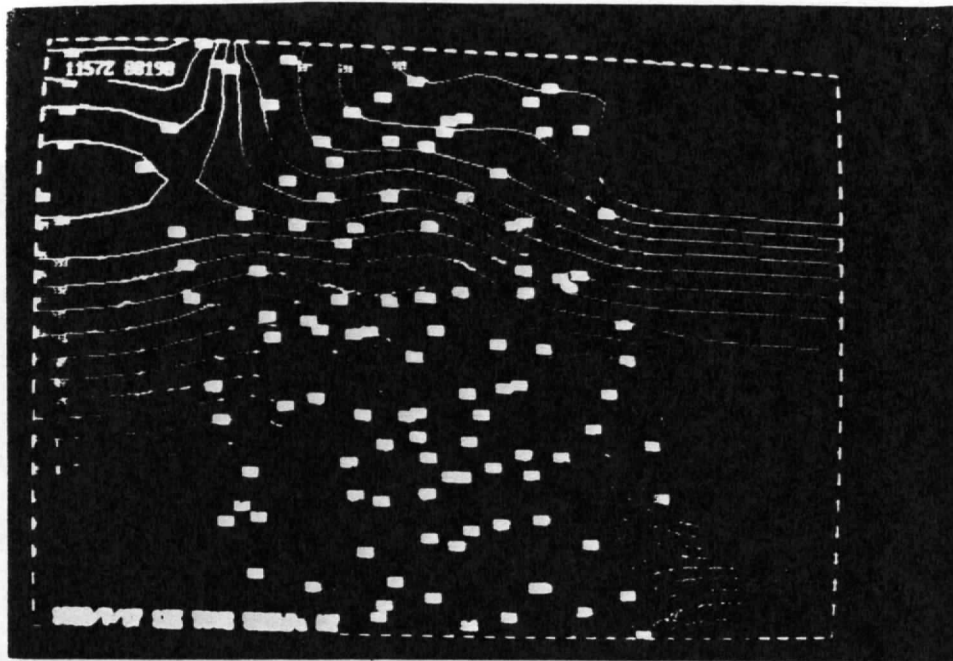


Figure 2 TOVS retrievals fill the data gap over ocean.

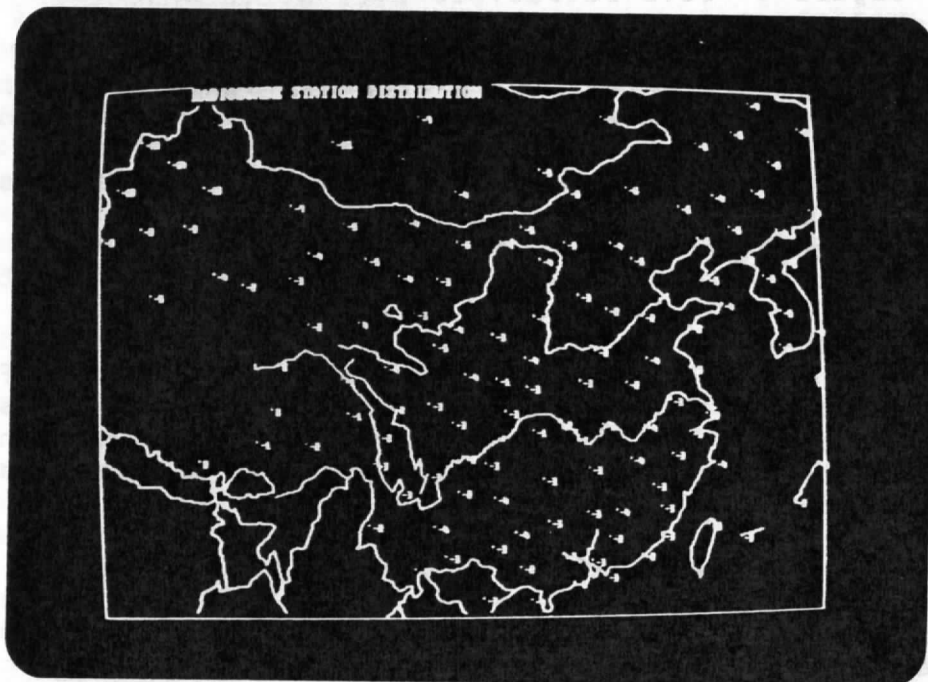


Figure 3 Radiosonde station distribution in China

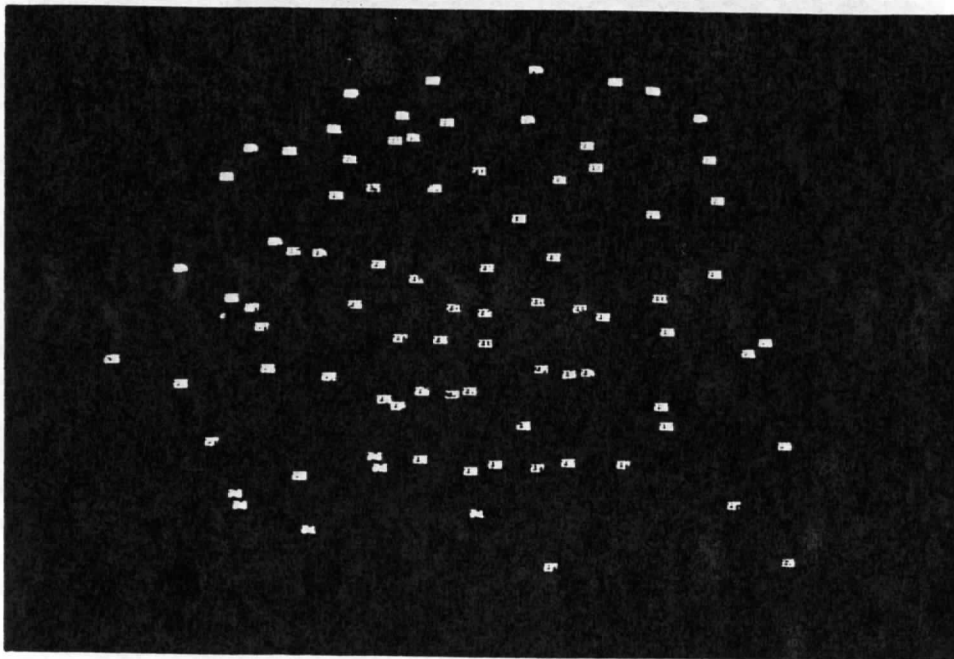


Figure 4 TOVS retrievals over North-West region

In IAP the scientists are also doing the TOVS data impact study based on the limited area numerical model developed by themselves. Some interesting results have been obtained. Including the TOVS retrievals in the initial data set has the positive effect both on general circulation pattern and individual parameter such as rainfall amount prediction. TOVS data can help to locate the ridge and trough more correctly and to simulate the reasonable rain belt position. The score shows that the forecasting result at 500 hPa is better than at 700hPa. It might be the reason that the TOVS retrievals at 500 hPa are less influenced by the topography. Further study is necessary. Right now the scientist from IAP is working together with the Australia scientists on TOVS impact study to the meso-scale numerical model.

The collaboration between SMC/SMA and NOAA/NESDIS on impact study has lasted for several years. The model used is the Northern Hemisphere numerical model which is currently run operationally at NMC/SMA. Both NESDIS and SMC/SMA TOVS products are used for experiments. Their conclusion is that the satellite data have the positive impact on the numerical weather forecast. The TOVS retrievals have not been used by NMC/SMA for operational numerical forecast yet.

Another TOVS application will be on atmospheric study over ocean. The Chinese Academy of Sciences has organized an experiment over West Pacific Tropical area. It is for investigation of the air-sea interaction over that region. The experiment has already lasted for four years and has more years to go. Two ships equipped with various kinds of instruments work for one to two months each year in Fall to Winter period over 5 to 15 latitude and 125 to 150 longitude area. The ships release balloon 2 to 4 times a day and there are dual-channel microradiometer (8 mm and 1.35 mm) to measure the total precipitable water and liquid water in the cloud. As mentioned above there are very few radiosonde stations over the west Pacific ocean, so it is quite difficult to compare the measurements on ships with the conventional observations. The TOVS soundings are considered as the supplemental data. The TIP data have been collected during the last year's experiment. It was in October. The PC package is used to process the TOVS data. Carefully comparison between two data sets will be carried out soon.

### III. New case studies

The case study data for ITSC-V were received from H. M. Woolf and J. F. LeMarshall. Due to the time limitation only one orbit of each case was processed. The retrievals were done on IMB PC/AT. It took about 30 minutes to get one retrieval. The data processing was started from the INGEST file. The ORBIT file was not used. After the data were transferred from tape to PC disk, the byte reverse must be done before any processing. The next step is executing the program MSUPRP to have MSUPREPR.BIN file ready for the retrieval. Then for the PC package the Maximum Line Number (e.g. LINMAX=100) should be put into HIRS Header Record (Record 1, word 54). Name the INGEST file as TOVSINGO.BIN (Equivalent to TOVS 1B data) and do TOVPRE before retrieval. The last two steps are to run the programs TOVRT1 and TOVRT2. For saving time, 5 x 5 field of view was set and the regression guess was selected for retrieval. There are about 200 retrievals for each case. The careful check and comparison with the conventional data have not been done yet. Figure 5 and 6 show the results of case studies. It is done by display programs such as TOVPLT, TOVANL etc. Again there is no editing to the retrievals.

### IV. Summary

The Chinese scientists have interests on satellite sounding as early as in 1970s. The papers and books published describe the research on channel selection, transmittance calculation, development of retrieval algorithm and so on. The research and application of TOVS data was started in mid-1980s when the first McIDAS was installed in IAP/CAS and the satellite ground system was set up at SMC/SMA. Due to the ITPP and PC TOVS package being available, the regional and provincial HRPT stations being operational and the computer facility being popular, more and more users will be interested in satellite soundings besides the

cloud pictures which have been used for decades. IBM PC AT or 386 type computers are currently used by most users for TOVS processing except the operational running at SMC/SMA where IBM 4861 does the job. The modellers in the research institutions and regional meteorological centers are interested in having TOVS data in their models. Because of lacking experience the international cooperation on four-dimensional assimilation and the treatment of topography in retrieval etc. are expected to stimulate the TOVS application in China.

#### v. References

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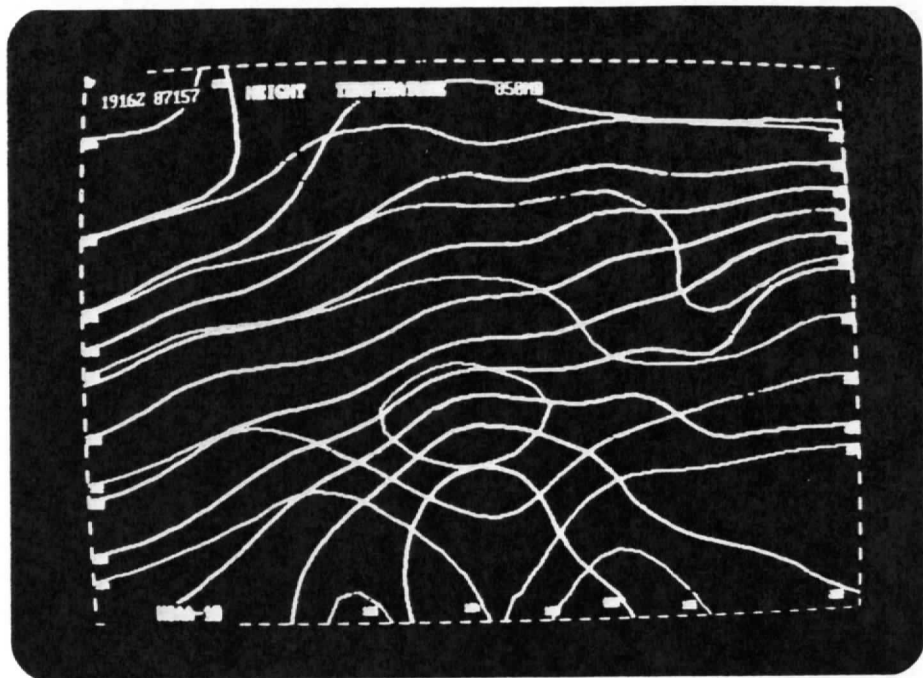


Figure 5 350 hPa Geopotential height and temperature of European case

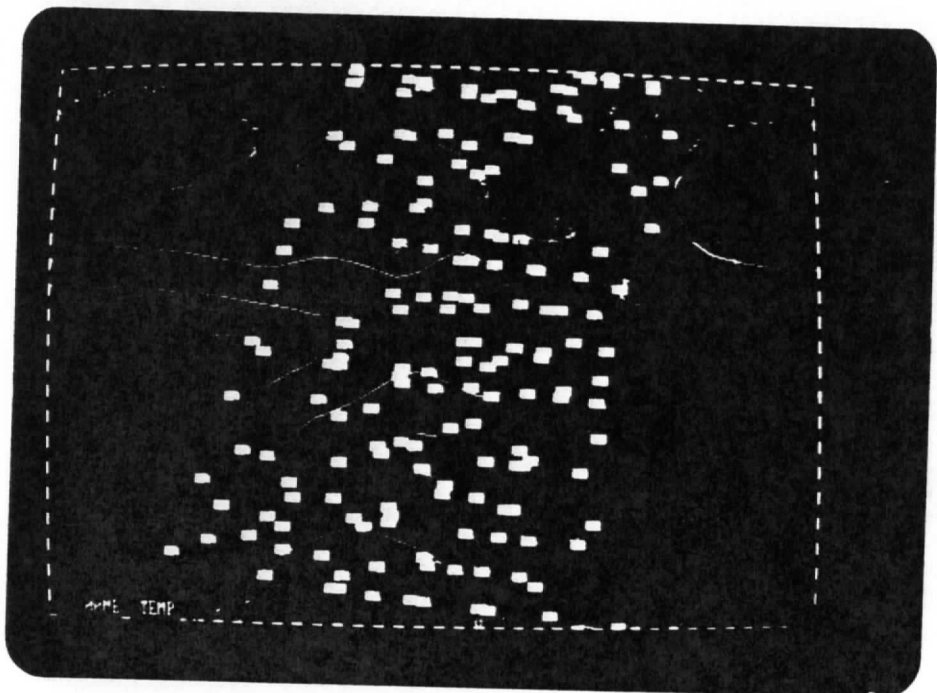


Figure 6 One orbit retrievals over Australia ( Temperature at 700 hPa )

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