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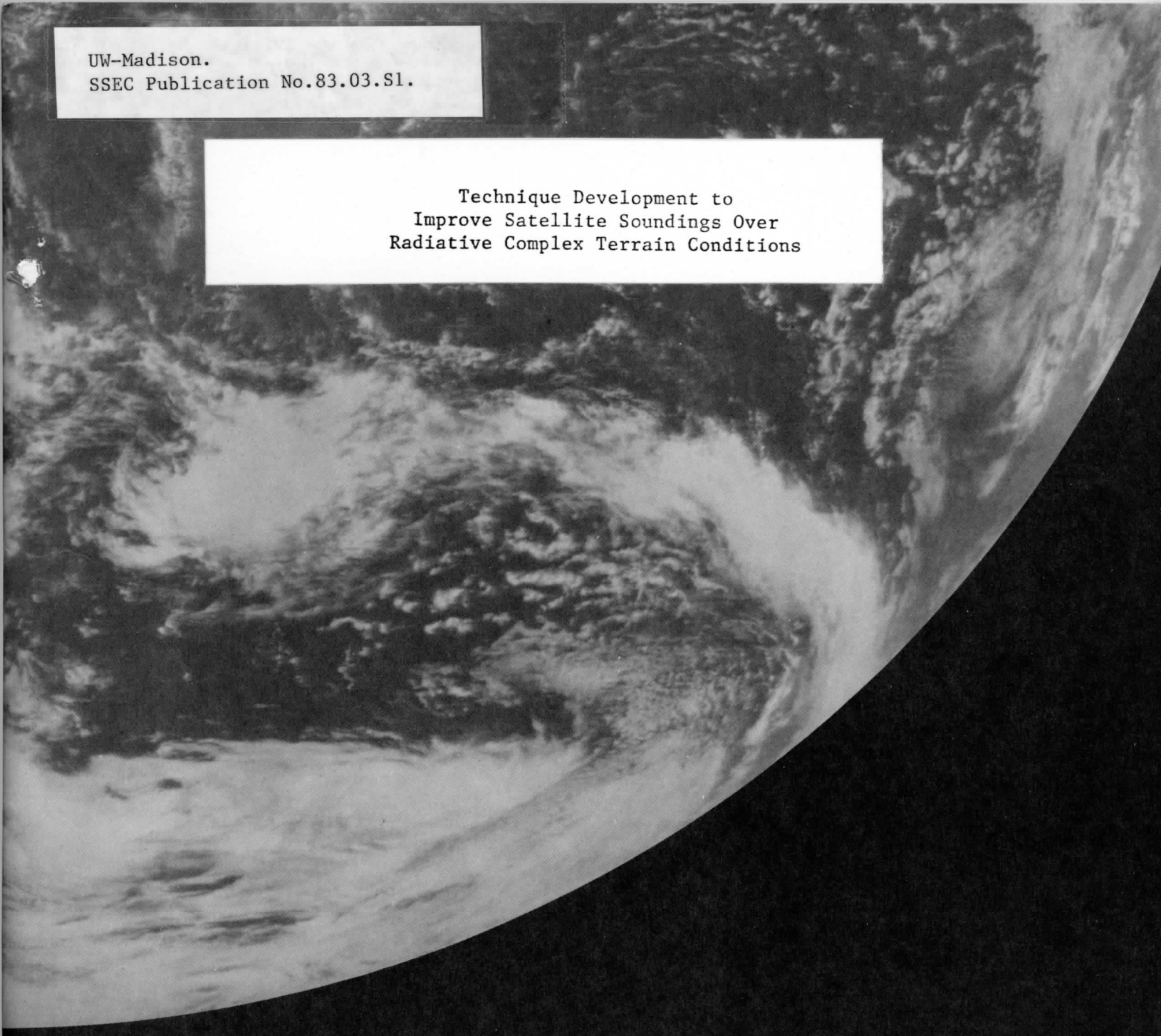
# Technique Development to Improve Satellite Soundings Over Radiative Complex Terrain Conditions



A REPORT

from the space science and engineering center
the university of wisconsin-madison
madison, wisconsin

# Technique Development to Improve Satellite Soundings Over Radiative Complex Terrain Conditions

A Progress Report to

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771



Contract Number NAG5-274

University of Wisconsin Account Number 144-S525

for the period of

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Submitted by

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March 1983

Summary

Since the beginning of the Alpex project, the major effort has been software development of TOVS processing on the IBM 4341, on Alpex data collection and preprocessing (i.e., calibration and earth location). Several software improvements have been implemented; (1) the inclusion of a high resolution topography of 15 km, (2) the formulation and implementation of a new technique for calculating surface skin temperature, (3) the improved method of handling the angular dependence of the HIRS and MSU radiances (limb correction), and (4) improvement in the method of accounting for MSU surface emissivity. NOAA-6 and NOAA-7 data corresponding to the first special observing period have been collected, along with ECMWF level III-a and II-a for the same time. There have been some problems acquiring METEOSAT imagery, but this should be alleviated shortly. Drs. Smith, Rizzi, Hayden, and Woolf have been and will continue to be actively involved in international coordination of the software development and intercomparison of results.

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## Introduction

This report summarizes the activities with respect to the ALPEX at the University of Wisconsin Space Science and Engineering Center. It is divided into four major categories (software development, data, work to be performed, and international coordination); giving a brief summary of what has been done and current areas of concentration. Some additional information, which was not appropriate to the main text, has been added as appendices.

## 1. Software Development

A major development undertaken under this contract was the acquisition and application of high resolution topography on the McIDAS system. The previous 100 km resolution terrain file has been improved to 15 km, which is better than the resolution of the HIRS instrument and therefore adequate for mesoscale sounding application. The high resolution topography is necessary for evaluating the surface contribution term of the radiative transfer equation which is required for the proper interpretation of the radiance measurements in terms of atmospheric profiles. It is also important in establishing a reference level for the pressure height profile.

A new technique for finding the surface skin temperature in the presence of cloud and reflected sunlight has been implemented with the Alpex retrieval software. The method uses the three window channels for two fields of view and involves the minimization of a function relating surface temperature, cloud temperature, cloud amount and reflectance. Comparisons using this method versus regression "split window" estimates of skin temperature are in progress.

The statistical limb correction used in operational TOVS processing is known to be deficient. Because a random sample of cloud conditions are included in the regression dependent data base, the statistical correction tends to overestimate the limb-correction for cloudy fields of view and underestimate it for clear fields of view. As a consequence, the statistical limb correction produces noise in the adjacent cloudy and clear fields of view. The Alpex software has been modified to account for the angular dependence of the radiances measured in the IR and MSU channels in a physical (rather than statistical) manner.

An algorithm for calculating the surface emissivity for the microwave channels has also been developed for the Alpex algorithm. Evaluation of the effectiveness of the emissivity calculation is also being evaluated.

In all of the Alpex processing it is intended that we maintain a standard benchmark version of the retrieval system against which to measure improvements. The benchmark version is essentially an operational iterative retrieval algorithm which does not include the refinements carried out under this grant. Our four principal Alpex orbits have been processed with the benchmark version and reprocessed with several of the improvements. However, a systematic evaluation of the efficiency of each improvement independently has not yet been accomplished. This is a primary goal for work during the remainder of the contract period.

As part of the verification effort, software has been developed to process ECMWF data (level II and III) on the McIDAS. These data can also be used to provide a first guess temperature profile though to date all retrievals have been made using a statistical first guess based on the NESDIS operational retrieval coefficients.

It should be noted that the new Alpex related algorithm development has been largely accomplished on the new McIDAS IBM 4341. The performance of this contract has provided the major impetus for transferring the TOVS man-interactive software to the new machine and thereby is providing continuity in the SSEC satellite retrieval research effort.

## 2. Data

Level 1-B data containing the raw radiances for all HIRS and MSU channels for NOAA-6 and 7 from the period 1 March-30 April 1982, which corresponds to the first special observing period, have been collected and preprocessed to produce earth located calibrated radiances. In addition, the ECMWF level III-a and level II-a data for specific cases have been received and are available on magnetic tape. The periods covered are: Level IIa; 1-10 March 1982 and

21-30 April 1982, Level IIIa; 1-9 March 1982 and 21-26 April 1982. In this case level IIa refers to a global observation data set for the area 30N-60N and 30W-37E. Level IIIa designates the operational global analysis for 0000, 0600, 1200 and 1800 GMT on 1.875° latitude/longitude grid for the standard levels from 1000 mb to 10 mb.

In support of the research carried out under this contract, the University of Wisconsin has sent out the following data sets to the various international Alpex working groups. A total of eight NOAA-7 overpasses or four pairs. Two pairs, each covering the continent of Europe at the nominal time of 4 March 1982 1300 GMT and 5 March 1982 0300 GMT; and two pair covering the Tasman Sea from the east coast of Australia to the International Date Line for the times 0300 GMT and 1500 GMT on 28 October 1982. In addition, software and coefficient files to read and process the ingested NESDIS TOVS 1-B data sets were included. A detailed description of the structure, format, and contents of the data is given in Appendix 1. A list of the recipients of the data is given in Appendix 2.

Meteosat data covering the period 4-5 March 1982 have been requested of the European Space Agency. Initial correspondence (November 1982) indicated there was some problem in processing the data due to a change in the archiving procedures. Since then the problems have been rectified, but instead of providing the image data, which was originally solicited, the satellite-derived cloud drift winds were sent. Also, because of poor quality, data for 1200 GMT on March 5 were not included. The imagery is still desired and hopefully it will be acquired before the First International TOVS Conference in August of this year.

3. Work to be Performed

During the final six month period it is intended to checkout the improved TOVS processing software on the McIDAS IBM. Along with this a systematic evaluation will be conducted on the impact of (1) high resolution topography, (2) improved surface temperature algorithm, (3) physical method of accounting for angular dependence of radiance measurements, and (4) the method of calculating microwave surface emissivity. Using both the "improved" and "benchmark" TOVS software systems, Alpex and Tasman Sea earth located calibrated radiances will be processed. As part of the University of Wisconsin's contribution to the Igls meeting in August, reports will be prepared demonstrating the results of the two software systems. In addition, magnetic tapes containing copies of the improved software and documentation will be distributed to users of the direct readout TOVS data. Finally, a report, describing the developments and results achieved under this contract will be prepared at the conclusion of the grant period.

4. International Coordination

Dr. Rolando Rizzi, visiting scientist from the University of Bologna, arrive June 20, 1982, stayed eight weeks and worked on transferring software to the IBM 4341 and coordinating University of Wisconsin and European efforts in the Alpex program. Many of the specific software changes for Alpex (e.g., high resolution topography and skin temperature calculation) were implemented during this period.

Dr. William Smith travelled to the Universities of Innsbruck and Bologna from 5-14 November 1982 to coordinate United States and Italian research on satellite soundings over variable terrain, and to make final arrangements for

an international meeting on satellite retrievals for oceanic and complex terrain conditions. A more detailed description of the trip and its accomplishments is included in Appendix 3.

From August 29 to September 2, 1983 the First International TOVS Study Conference on Intercomparisons of Satellite Derived Temperature Profiles will be held in Igls, Austria. The goal of this conference is to compare and discuss the accuracy achievable with temperature retrievals derived from polar orbiting satellites over the Alpine complex terrain. University of Wisconsin participants are William Smith, Christopher Hayden, Harold Woolf, and W. Paul Menzel. A detailed summary of the agenda is given in Appendix 4.

Appendix 1

USER'S GUIDE FOR TAPE "TOVSWG"

A. Structure and Format

1. Tape is 9-track, 1600 BPI, non-labeled. There are 21 files of information, followed by an extra file mark. It was written on the IBM 4341 with VS/FORTRAN.

2. Files one through five contain information in card-image format, with 25 logical records, each of 80 characters, per 2000-byte physical tape block. In IBM terms: DCB=(RECFM=FB,LRECL=80,BLKSIZE=2000).

3. Files 6 through 21 contain data in binary (unformatted) form, with nine 112-word (INTEGER*4, therefore 448 bytes) logical records per 4032-byte physical tape block. For DCB information, see the description of data-staging programs that follows.

B. Contents

1. File 1 contains FORTRAN source statements for the following applications:

(a) Transmittance-function and associated radiative-transfer computations for HIRS ... a set of subroutines that will produce, for a given atmosphere (temperature and water-vapor mixing ratio vs. pressure), total ozone amount*, and nadir (or scan) angle, the profile of transmittance for the specified channel. The algorithms and associated coefficients are adapted from those produced and utilized by NESDIS Operations (ref. NOAA Technical Report NESS 85, Transmittances for the TIROS Operational Vertical Sounder, Washington, DC, Sept. 1981). Also included are routines for the computation of radiance from temperature (FUNCTION PLANCK), and equivalent-blackbody (or brightness) temperature from radiance (FUNCTION BRIGHT). See item (c) of this section, and the description of File 2, for information regarding the coefficient file.

(b) Transmittance-function computations for MSU ... analogous to the preceding--same reference applies. See item (d) and description of File 3.

(c) A MAIN routine to illustrate the reading of HIRS transmittance coefficients from File 2 of this tape and writing them to a direct-access disk file. IBM-type job control languague (JCL) for the tape file is included as COMMENTs.

(d) Analogous to (c), structured for MSU.

* If actual ozone data are not available, the Standard Atmosphere value of 347 Dobson Units may be used.

(e) Analogous to (c) and (d), structured for reading from tape, and writing to disk, coefficients suitable for generating initial-guess temperature profiles if required for a particular retrieval method. As in the case of the transmittance data, these coefficients have been extracted from NESDIS Operations' database (ref. NOAA Technical Report NESS 83, Atmospheric Sounding User's Guide, Washington, DC, April 1981). See section 4 for further details.

(f) Two versions (IBM and non-IBM) of a MAIN routine suitable for reading "INGEST" (calibrated, earth-located) and "ORBIT" (also limb-corrected and HIRS/MSU amalgamated) data files from tape and writing to disk. These files occur as a pair for each satellite pass, as shown by the IBM-type JCL included as COMMENTs. Detailed descriptions of the data in each type of file are given in sections 5 and 6.

2. File 2 contains, in card-image form (FORMAT = 6E12.6), the coefficients for HIRS transmittance and Planck-function computations, to be written to disk by a program such as that described in item 1(c), and to be accessed by the software of 1(a). Please note that the coefficient-access routines contained in 1(a) and 1(b) were designed for a two-satellite system; data for NOAA-7 only (satellite 1) is supplied on this tape. This is reflected in the "ISAT=1,1" DO-loops in 1(c), (d), and (e).

3. File 3: as File 2, for MSU.

4. Files 4 and 5: as File 2, for generating initial-guess temperature profiles. As indicated in the software described in 1(e), the data for one satellite consists of five records, each containing 300 floating-point (REAL*4) words. The coefficients are generated from latitudinally-stratified colocations of radiosonde and satellite observations, and represent five latitude bands: record 1, band 1, 60N-90N; record/band 2, 30N-60N; record/band 3, 30N-30S; record/band 4, 30S-60S; and record/band 5, 60S-90S. The coefficients in File 4 are for the week of 1 March 1982, and relevant to ALPEX; those in File 5 are for the week of 24 October 1982 and pertain to the Australia-New Zealand situation.

The structure and usage of an individual record are as follows: Words 1-20 are the regression-sample average brightness temperatures in HIRS channels 1 through 17, and MSU channels 2 through 4 (words 18-20). THese are included as an aid to interpolation of coefficients between latitude bands, if the user desires to do so. Consider words 21 through 300 as a 7 x 40 array:

```
DIMENSION  CBUF(300),BBAR(20),COEF(7,40)
EQUIVALENCE (BBAR(1),CBUF(1),(COEF(1,1),CBUF(21))
```

Then for each of the 40 levels (see SUBROUTINE PREHIR (array PX) or SUBROUTINE PREMSU (array PP) for pressure values), the 7 coefficients have the following meaning: coefficients 1 through 3 are for HIRS channels 1 through 3; 4 through 6, MSU channels 2 through 4; and 7 is the additive constant. Thus a temperature profile can be constructed using FORTRAN coding similar to this:

```
      DIMENSION TBHIR(19), TBMSU(4), TBS(6), TGES(40)
      DO 110 I=1,3
  110 TBX(I)=TBHIR(I)
      DO 120 I=2,4
  120 TBX(I+2)=TBMSU(I)
      DO 140 J=1,40
      T=COEF(7,J)
      DO 130 I=1,6
  130 T=T+COEF(I,J)*TBX(I)
  140 TGES(J)=T
```

4. File 6 (also 8,10,...,20) - "INGEST" - HIRS and MSU data for each pass are extracted from the NESDIS TOVS 1-B Database. Calibration parameters included with the data are applied, and the supplied earth-location information appended. The structure of the file is as follows. All records are 112 INTEGER*4 (32-bit, signed, 2's complement) words in length.

(a) Record 1: HIRS header (documentation)

| WORD | CONTENT |
|---|---|
| 1 | satellite identifier (1 = NOAA-7) |
| 2 | number of records (following this one) that contain data (=NRECH) |
| 3 | direction of pass (1 = ascending, -1 = descending) |
| 4 | start time of data (seconds*64) |
| 5 | start date (YYDDD) |
| 6 | end time (seconds*64) |
| 7 | end date (YYDDD) |
| 8 | calibration (1 = occurred at least once) |
| 9 | logical sum of errors encountered |
| 10 | spare (=0) |
| 11 | number of records read from input file |
| 12 | number of undefined/unrecognized encoder positions |
| 13-112 | zero fill |

(b) Next NRECH records (2 through NRECH+1): Each record contains data for 4 individual fields of view (IFOVs). The last such record may not be full; unused locations are zero-filled.

IFOV sub-record (28 words):

| WORD(S) | CONTENT(S) |
|---|---|
| 1 | line*65536+spot (i.e., two 16-bit quantities) |
| 2-20 | brightness temperatures, channels 1-19 (degK*100) |
| 21 | channel 20 radiance ($mw/(m^2 srcm^{-1})$) |
| 22 | latitude (deg*100, 0-90, +N, -S) |
| 23 | longitude (deg*100, 0-180, +E, -W) |
| 24 | local zenith angle (deg*100) |
| 25 | flag-see below for meaning of specific bits |
| 26 | date (YYDDD) |
| 27 | time (seconds*64) |
| 38 | spare (=0) |

Consider the flag (word 25) as an array of 32 bits, with the most-significant (leftmost) designated 1, and the least-significant (rightmost) designated 32. Then the occurrence of a one (1) in one or more of the following bits denotes data that should be rejected: 25, 27, 32. Other bits may be turned on from time to time, but the conditions they represent do not affect the usability of the data.

(c) When NRECH is less than 1400, all records from NRECH+2 through 1401 contain zero fill.

(d) Record 1402: MSU Header

| WORD | CONTENT (units and conventions same as for HIRS) |
|---|---|
| 1 | satellite identifier |
| 2 | number of records output (=NRECM) |
| 3 | direction |
| 4 | start time |
| 5 | start date |
| 6 | end time |
| 7 | end date |
| 8 | spare (=1) |
| 9 | spare (=0) |
| 10 | number of records input (=word 2) |

(e) Next NRECM records (1403 through NRECM+1402):
Each record contains data for an entire scan line of 11 IFOVs, with 10 words for each. The last two words of the record are zero-filled.

IFOV sub-record (10 words):

| WORD(S) | CONTENT(S) (units and conventions same as for HIRS) |
|---|---|
| 1 | line*65536+spot |
| 2 | date |
| 3 | time |
| 4 | latitude |
| 5 | longitude |
| 6 | spare (=0) |
| 7-10 | brightness temperatures, channels 1-4 |

(f) Records NRECM+1402 through 1431 are zero-filled.

6. File 7 (also 9,11,...,21) - "ORBIT" - The data in the preceding file (INGEST) are operated on by a "preprocessing" program that performs the following functions:

...Correct MSU for antenna pattern, slant path, surface reflectivity, and liquid-water attenuation. This is a regression procedure, termed collectively "limb correction."

...Correct HIRS for slant path (limb), water vapor attenuation in the window channels, and - if daytime - fluorescence in channel 17 (2360 $cm^{-1}$) and reflected sunlight in channel 18 (2500 $cm^{-1}$).

...Colocate HIRS and MSU by interpolating, via localized objective analysis, the MSU data to the HIRS locations.

...Arrange the output so that the entire pass for one parameter occupies contiguous records on disk or tape, and is thus in the most efficient storage mode for imaging. The data are properly organized for display - that is, north is always at the top, and west at the left, regardless of the direction (ascending or descending) of the original pass. All records are 112 INTEGER*4 words in length.

(a) Record 1: header

| WORD | CONTENT |
|---|---|
| 1 | start date (YYMMDD) |
| 2 | start time (hhmmss) |
| 3 | end time (hhmmss) |
| 4 | number of lines, in the HIRS reference frame (=NLINES) |
| 5 | satellite identifier |
| 6 | spare (=1) |
| 7 | direction (1=ascending, 2=descending) |
| 8-112 | mostly zero fill, non-zero values relate to Madison processing and should be ignored |

(b) Data organization - the following parameters are output by the preprocessing program, in the order given (all angles and temperatures are in deg*100):

| WORD | CONTENT |
|---|---|
| 1 | latitude (0-90, +N, -S) |
| 2 | longitude (0-180, +E, -W) |
| 3 | solar zenith angle (0-90; all nighttime values are set to 90) |
| 4-22 | brightness temperatures, HIRS channels 1-19 |
| 23 | brightness temperature, MSU channel 1 (corrected for all except surface effects) |
| 24-27 | brightness temperatures, MSU channels 1-4 (corrected for all effects) |
| 28 | total outgoing longwave flux ($wm^{-2}$*100) |
| 29 | bidirectional reflectance (channel 20 radiance normalized to noon equator crossing) |
| 30 | brightness temperature, HIRS channel 18, adjusted for reflected sunlight |

For observations at night, parameters 29 and 30 are set "missing" (=999999).

Since there are 56 IFOVs in one HIRS line, one record contains data for two consecutive lines. The software and disk files used to process the information are configured for passes of up to 100 lines. Thus the header record is followed by 50 records of latitude, then 50 records of longitude, and so forth. When NLINES is less than 100, the unused records are filled with 999999. The HIRS calibration gaps have been retained in order to

preserve the spatial integrity of the dataset; in those areas there will (usually) be earth-location information and interpolated MSU data, while all HIRS-related parameters are set "missing."

An intermediate MSU dataset, consisting of limb-corrected longitude-ordered observations at the original spatial resolution (including the extra "window" channel), is also provided, in the 20 records from 1502 through 1521, should any user wish to employ a different HIRS/MSU amalgamation scheme. This information should be viewed as a 2240-word array, structured as follows:

| WORDS | CONTENTS |
|---|---|
| 1-280 | flags (1=land, 2=sea, 0=bad) |
| 281-560 | latitudes |
| 561-840 | longitudes |
| 841-1120 | channel 1 |
| 1121-1400 | channel 2 |
| 1401-1680 | channel 3 |
| 1681-1960 | channel 4 |
| 1961-2240 | channel 1 (surdace effects retained) |

As in other portions of this file, unused locations are filled with the 999999 "missing" indicator.

Questions or comments regarding the structure or contents of tape TOVSWG, or details of the INGEST and ORBIT processing, should be directed to:

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Appendix 2

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March 10, 1983

TO: Genevieve E. Wiseman, Grants Officer
NASA/Goddard Space Flight Center

WSS FROM: William L. Smith, Professor

SUBJECT: Report of European travel conducted under grant NAG5-274
5 November 1982--14 November 1982

GENERAL

The travel to University of Bologna and University of Innsbruck was conducted to (1) coordinate joint U.S. and Italian research on the improvement of satellite soundings over complex terrain conditions funded jointly by NASA and Italian Research Council grants, and (2) to make final arrangements for an international meeting on sounding retrieval from TIROS-N series satellites for oceanic and complex terrain conditions. The international meeting which is directly related to the grant research is to be held in August, 1983 and is supported by the World Meteorological Organization (WMO) and several European and U.S. space agencies. The travel was coordinated with a NOAA sponsored meeting held in England such that NOAA provided the overseas airfare. Only the travel and per diem within Europe associated with the sounding retrieval project were supported by the NASA grant.

ACCOMPLISHMENTS

(1) Role of U.S. and Italian scientists in the sppoerative research program were clarified.
(2) Computer software for TIROS-N data processing were exchanged.
(3) Theoretical approach to improving sounding retrieval algorithm for TIROS-N observations over the Alps was defined.
(4) List of invitees to the international meeting in IGLS, Austria, August 1983 was drawn up.
(5) Program for the IGLS meeting was constructed (see attachment).
(6) Data to be analyzed and report upon by each meeting participant was defined.
(7) Letters of invitation were written.
(8) Letters for soliciting financial support from WMO and several space agencies were completed.
(9) Meeting hall was selected and inspected at IGLS, Austria.
(10) I delivered several lectures to student and faculty members of the University of Bologna and the University of Innsbruck on the accomplishments of the U.S. Satellite Meteorological Observation Program.

Attachment: TOVS meeting cover letter and attachments
cc: Dr. Verner E. Suomi, SSEC
Mr. John P. Roberts, SSEC
Mr. Robert W. Erickson, Research Adminstration--Financial

INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC PHYSICS
International Radiation Commission
Working Group on TOVS Inversion Procedures

# THE FIRST INTERNATIONAL TOVS STUDY CONFERENCE: INTERCOMPARISONS OF SATELLITE DERIVED TEMPERATURE PROFILES

1. LOCATION: Igls, Austria

2. TIME: August 29 to September 2, 1983; August 31 free day

3. COSPONSORS: (Proposed) Austrian Solar and Space Agency, COSPAR, IAMAP-Radiation Commission, NASA, NOAA, USSR Hydrometeorological Service, WMO

4. GOAL: Analysis of the accuracy presently achievable with temperature retrieval methods and report to JSC on future necessary research.

   Satellite based temperature soundings within WWW have strong impact on numerical weather forecast and are essential for the assessment of horizontal heat transports through the atmosphere required within certain projects proposed for the WCRP. A review of the potential of satellite soundings was therefore requested by JSC-I and reconfirmed by JSC-III.

5. STRUCTURE OF THE MEETING: The meeting will be structured as a workshop to discuss methods and results of case studies specified by the IRC ad hoc WG on the use of TOVS-data achieved by the participating groups.

   Particular emphasis will be given to problems associated with the dependence of profile retrieval on:

   a) transmittance function computation,
   b) angular effects,
   c) type of retrieval algorithm,
   d) ancillary information (including conventional surface observations),
   e) surface effects (temperature, emissivity and elevation),
   f) cloud contamination.

   Further discussion is planned on the use of satellite retrievals in numerical analysis, climate research and prediction operations.

6. SPECIFICATION OF DATA AND KIND OF COMPARISONS TO BE CARRIED OUT

   A. Definition of the case studies

   Two geographical regions are selected: the ALPEX Outer Region and the Southern Pacific centered around New Zealand. For each region a day of particular meteorological significance will be selected. For the ALPEX Outer Region the day will belong to an Intensive Observational Period.

Each participating group will be provided by the Cooperative Institute for Meteorological Satellite Studies (at University of Wisconsin-Madison) with:

A satellite data set containing earth located and calibrated (Level IB) radiances for two consecutive NOAA-7 orbits for both a.m. and p.m. passes over the aforementioned regions on the selected days. Participants can use any ancillary data for their retrievals; the influence of the ancillary data is an important topic for discussion at the meeting.

B. Data sets to be produced

Participants are requested to produce results for at least one case study (i.e., either for the Alpex Region or the South Pacific). The processing of all four orbits for each case will enable the meteorological consistency of the results to be addressed.

Specific products for comparison:

1. Plot of 1000-700, 1000-500, 700-500, 500-300, 300-100, geopotential thickness;

2. Plot of total precipitable water vapor above the 1000 mb, 700 mb, and 500 mb levels;

3. (Optional) Isentropic cross-sections over specific locations.

C. Conventional data to be used for comparison

ECMWF will be asked to produce an analysis for each region using any information (conventional and non-conventional) which ECMWF considers useful to improve its already high quality operational products. ECMWF will be be asked to present their products at the Study Conference according to the formats specified on point B.

7. TIME SCHEDULE:

October 15, 1982: Scientists shall inform H. J. Bolle about their participation. Order forms for rooms and travel information will be sent.

November 15, 1982: The data set will be sent to participants by CIMSS.

August 29, 1982: A short report should be prepared by each participant and be ready by the start of the meeting. The report should contain a review of the retrieval procedures used addressing each of the six topics outlined in point 5 and a presentation of the results listed in B obtained for the two case studies.

8. CONFERENCE CO-CHAIRMEN

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9. LOCAL ARRANGEMENT:

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