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# 1. EXECUTIVE SUMMARY

## 1.1 INTRODUCTION

The Twelfth International TOVS Study Conference ITSC-XII was held in Lorne, Australia from 27 February – 5 March 2002. One hundred and four participants attended the Conference and provided scientific contributions. Twenty one countries, four international and many national organizations were represented: Australia, Brazil, Canada, China, France, Germany, Hungary, India, Indonesia, Italy, Japan, Kenya, New Zealand, Norway, Philippines, Poland, Russia, Switzerland, the United Kingdom, the United States of America, ECMWF, EUMETSAT, WMO, the IRC, NASA and NESDIS.

The agenda for ITSC-XII can be found at Appendix A. Most of the meeting was occupied with scientific presentations on a range of issues: Radiative Transfer Modelling; the application of TOVS and ATOVS data in numerical weather prediction (NWP) and climate studies; preparations for Advanced Sounders; and relevant plans of operational satellite agencies and international issues.

Section 4 of this report records the abstracts of all scientific contributions. The corresponding papers are published separately as the *Technical Proceedings of The Twelfth International TOVS Study Conference*, available through the co-chairs of the International TOVS Working Group (ITWG).

Working Groups were formed to consider five key areas identified prior to the Conference: Radiative Transfer and Surface Property Modelling; TOVS and ATOVS in Numerical Weather Prediction; TOVS and ATOVS in Climate Studies; Advanced Sounders; and International Issues Future Systems; and Satellite Sounder Science and Products. The Working Groups reviewed recent progress in these areas, made recommendations on key areas of concern and identified items for action. Working Group reviews and recommendations comprise Section 2 of this report.

During the Conference, a session on Status Reports considered summaries of allied meetings and activities that had taken place since ITSC-XI. It also reviewed progress on the Action Items identified by ITSC-XI Working Groups. Many of these items formed the basis for further discussion by Working Groups at ITSC-XII.

Several technical sub-groups met during ITSC-XII to discuss developments and plans concerning specific software packages, shared and in common use in TOVS, ATOVS and Advanced Sounder processing centres. Brief reports on these sub-group meetings are recorded in Section 3.

Overall, the meeting documented significant gains in many areas and noted areas for future activity. In particular, it noted that:

1. Considerable benefits have been demonstrated from ATOVS in NWP and other applications;
2. Continuing excellent results are being demonstrated from advanced data assimilation techniques;
3. Firm evidence continues to emerge of the utility of the TOVS/ATOVS data over land in NWP;
4. Preparations for Advanced Sounder have progressed markedly since ITSCXI.
5. Although a significant amount of work has been done since ITSC-XI in the area of radiative transfer modelling - radiative transfer modelling (including clouds), surface property modelling

and calibration are areas still requiring attention;

6. The intercomparison of radiative transfer calculations is important and needs to be continued;
7. There is a continued need to emphasise climate activity and establish links with climate community;
8. NASA is to be complimented for their continued support of an advanced geostationary sounder. This sounding system provides an opportunity for operational agencies to include information from this system in the development of their plans;
9. There is a need to develop further, the interface between ITWG and the CBS of WMO;
10. The development of community software for ATOVS processing has progressed well. The free distribution of ATOVS processing software has been essential in the use of ATOVS in the meteorological community;
11. The development of community software for AIRS is proceeding well with a requirement for ingest software still outstanding. The development and distribution of this software is essential for the effective use of AIRS data in the meteorological community;
12. The requirement for near real time AIRS and MODIS data remains important;
13. The GTS/DDS bandwidth needs to be increased to carry advanced sounder data.
14. The SSMI/S will provide significant upper atmospheric observations. Access to SSMI/S data and the related data archive is important; and
15. Easy access to radiance data at NOAA/NESDIS after the transition to NPOESS needs to be established.

Conclusions and recommendations are summarised below.

## **1.2 CONCLUSIONS AND RECOMMENDATIONS**

As a result of the activities of the Working Groups and their reports to the Conference, the following major conclusions and recommendations were adopted as a summary of the ITWG meeting at ITSC-XII. More details and specific technical recommendations and actions are given in the Sub-Groups full reports in Section 2 and the reports of the Technical Sub-Groups in Section 3.

# ACTIONS AND RECOMMENDATIONS

## **RADIATIVE TRANSFER AND SURFACE PROPERTY MODELLING:**

### **Atmospheric profile datasets for Radiative Transfer (section 2.1.1)**

#### **Recommendation**

The next definitive LbL transmittance computation for fast RT model training should be on the AIRS 101 levels to facilitate use by all users.

#### **Recommendation**

A standard set of interpolation routines should be provided to optimally convert from level to layers (and vice versa).

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### **Instrument characteristics required for RT modeling (section 2.1.2)**

#### **Action**

T. Kleespies (NESDIS) to make HIRS and AVHRR filter response functions available to ITWG before NOAA-M launch.

P. Brunel (CMS Météo-France) to contact Tim Schmidt (CIMSS) to clarify GOES information still required (GOES-9, GOES-12).

P. Menzel (NOAA/NESDIS) to provide contact point for AQUA MODIS response functions.

R. Saunders (Met. Office, Bracknell) to raise early METEOSAT filter response function matters with EUMETSAT.

F. Weng (NEDSIS) to inform group of any information on AMSR and WINDSAT channel characteristics.

#### **Recommendation**

That instrument builders provide response functions in digital form and at the actual spectral resolution it was measured.

#### **Recommendation**

RT modelers document clearly which filter responses were used in their simulations (e.g. by including them in the output files).

#### **Action**

T. Kleespies to announce the new NOAA set of fundamental constants to the Working Group.

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### **Line by Line (LbL) model status (section 2.1.3)**

#### **Recommendation**

The EUMETSAT Line by Line intercomparison is a valuable attempt to document biases in LbL models. It should be extended to more airmass types.

#### **Action**

S. Ravindranathan (Univ. of Bremen) to provide web site on

new microwave RT model inter-comparison work at Bremen University.

#### **Action**

R. Armante (LMD, Ecole Polytechnique) to provide information to the Working Group on the STRANSAC-2000 study on microwave simulations.

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### **Fast RT models (section 2.1.5)**

#### **Action**

The web site maintained by MSC on the fast model intercomparison is a valuable resource for fast model development and should be maintained at least until the next ITWG meeting. (L. Garand, AES/MS).

#### **Recommendation**

The RT community is encouraged to continue to develop and improve fast models for new and existing sensors. It must be recognized however that NWP centers prefer to only have one RT model for all sensors in their assimilation code so new developments should be able to feed through to existing RT models in NWP Centres.

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### **Surface Property Models (section 2.1.6)**

#### **Action**

S. Ravindranathan (Univ. of Bremen) to report to the Working Group on work on surface models at Bremen.

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### **Infrared emissivity (section 2.1.6.2)**

#### **Action**

R. Saunders (Met. Office, Bracknell) to circulate to the group, a draft copy of the note composed by F. Prata (CSIRO) on issues regarding surface temperature and emissivity retrieval from satellite sounders.

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### **Proposal for group web page (section 2.1.7)**

#### **Actions**

Co-chairs to prepare a web page for the Radiative Transfer and Surface Property Modelling WG.

All ITWG members to provide links to co-chairs which can be included on the web pages.

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## **TOVS/ATOVS DATA IN CLIMATE:**

### **Contribution of TOVS to climate studies (section 2.2.1)**

#### **Recommendation**

ITWG encourages use of satellite sounder data, including the historical TOVS/ATOVS and the next generation high spectral resolution data sets, for retrieval of column CO<sub>2</sub> amounts.

#### **Recommendation**

ITSC scientists are encouraged to prepare a set of comparisons of long term trends and variability from the TOVS long-term archive for specific fields. Comparisons to be prepared include temperature and moisture (Bates), clouds (Stubenrauch, Wylie-Menzel), O<sub>3</sub> (Kaifel), CO<sub>2</sub> (L. McMillin), SO<sub>2</sub> (F. Prata).

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#### **Relations to international climate programs (section 2.2.2)**

##### **Recommendation**

An invited presentation to be given to the ITWG on IPCC results and plans at next ITSC meeting.

##### **Recommendation**

That Space Agencies/Satellite Operator reports to the next conference include the relationship of plans to the Karl principles.

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#### **Pathfinders and re-analysis (section 2.2.3)**

##### **Recommendation**

Continued production of long-term TOVS climate data sets as envisioned by the NOAA/NASA Pathfinder projects with the goal of achieving a 25 year dataset 'TOVS 25'. The TOVS 25 data set would represent a best effort to use all 25 years of TOVS data for climate studies.

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#### **Calibration, validation and quality control monitoring (section 2.2.4)**

##### **Recommendation**

Past and present calibration issues are currently being addressed. This is a very important activity. These issues should be fully documented, and the related data and software needs to be placed in long term archives. Further software also should be developed and shared (L. McMillin, T. Achtor, D. Klaes, J. Bates)

##### **Action**

Develop, archive and make accessible a complete audit trail of all TOVS calibration issues and their resolution (J. Bates, NOAA).

##### **Action**

T. Reale (NESDIS) and T. Achtor (CIMSS/SSEC) to compile links from the TOVS/ATOVS Data in Climate Working Group web page to sites containing calibration and validation data, including ARM CART sites, WODC/UV sites, GEWEX CEOP sites, etc.

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#### **Data access and archive (section 2.2.5)**

##### **Action**

EOSDIS is the first attempt to deal with the quantum leap in data volume from the next generation environmental satellite sensors. Space agencies/satellite operators should be invited to provide a summary of their plans in relation to this experience in providing data archive and access for next generation satellite instruments (Co-chairs to CGMS).

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## **THE USE OF TOVS/ATOVS IN DATA ASSIMILATION / NUMERICAL WEATHER PREDICTION (DA/NWP)**

### **Evaluation and use of TOVS/ATOVS in DA/NWP (section 2.3.2)**

#### **Recommendation (to DA/NWP Centers)**

The Working Group recommends the continued exchange of monitoring results and encourages each Center to develop their own Web page to post their results. A master document linking all Web pages has been developed and will reside on the NWP SAF site with a link to the ITWG Web site at CIMMS so everyone can easily examine and compare results from other groups to theirs.

#### **Recommendation (to DA/NWP Centers)**

The Group recognizes the difficulty in implementing and validating radiance/retrieval data in a DA/NWP system and recommends that those that have prepared so-called one-observation experiment in the development of their assimilation system post them on their Web page. Since there is more than one fast RTM used, it will indirectly measure the ability of each RTM to project radiance data information onto the atmospheric state variables. Indirectly, this will also indicate what are the effective measures of background and observational error statistics used at each Center. (Action: C. Chouinard to coordinate).

#### **Recommendation (to DA/NWP Centers)**

Encourage the preparation of OSE's at various NWP Centers to be presented at the next ITWG meeting and post these results on the ITWG website.

#### **Recommendation (to ITSC)**

The Group recommends that the McNally survey summary grid be continued and posted on the ITWG Web site. When changes are made at various NWP centers on the use of data, that McNally be advised, the grid updated accordingly, and the changes be logged on the Web page. (Action: T. McNally to coordinate).

#### **Recommendation (to NOAA/NESDIS and EUMETSAT)**

The Group recommends that the data provider do quality assurance of all data, including level 1b and level 1d. The quality of the data (including e.g. navigation) should be monitored at all stages including the final stage, which may have been reformatted. The provider should attempt to identify and flag questionable or poor quality data. Data providers, e.g. EUMETSAT and NOAA/NESDIS are encouraged to use NWP monitoring results to help them in diagnosing data problems. The Group recognizes that it is easy to identify gross errors, while subtle errors are more difficult to detect. Action: V. Tabor (NESDIS), D. Klaes (EUMETSAT).

#### **Action**

Evaluate and improve the current procedures to convert antenna temperatures to brightness temperatures (NESDIS and DoD).

#### **Action**

Determine why different navigation information is being

distributed in comparison with that being used in operations (V. Tabor, NESDIS).

**Action**

Encourage the collaboration between the local readout software developers and the data producers to minimize the differences between the global and local calibrated and navigated data (AAPP developers, space agencies).

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**Forward Modelling (section 2.3.3)**

**Recommendation**

We encourage the developers of new instruments to either expand or enhance current RT code, or develop general codes applicable to all instruments and make it available.

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**ADVANCED SOUNDERS:**

**Status of plans for advanced sounding instruments (section 2.4.1)**

**Action**

J.Eyre (Met. Office, Bracknell) to compile summary information on advanced sounders, for posting on ITWG web site.

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**New initiatives for geostationary sounding (section 2.4.2)**

**Recommendation (to CGMS)**

ITWG recommends that a geostationary millimetre/sub-millimetre radiometer mission should be pursued as a technology demonstrator, with priority towards measurement of precipitation, cloud water/ice and humidity at high temporal frequency in support of nowcasting and short-range forecasting, and as a potential future contribution to the Global Precipitation Mission.

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**Distribution of simulated datasets for advanced sounders (section 2.4.3)**

**Recommendation (to CGMS)**

The ITWG notes the high value of simulated AIRS data, distributed in near-real time, in assisting NWP centres to make effective preparation for real AIRS data, and it recommends that similar services should be established as part of the preparatory activities for other advanced sounders.

**Action**

M.Goldberg (NOAA/NESDIS/ORA) to draft short paper for CGMS describing the AIRS data simulation system and its use.

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**Data processing, inversion and assimilation (section 2.4.4)**

**Recommendation (to CGMS)**

ITWG recommends that responsible agencies establish focal points to ensure that:

- ingest and pre-processing code for future advanced sounders (and their complementary imagers) is provided, in a form suitable for use with locally-received direct read-out data, and yielding output consistent with global data, and
- activities are undertaken to integrate this code into processing packages available for international distribution in a timely manner.

**Recommendation (to IPO and NASA)**

ITWG recommends that ingest code for NPP instruments (CrIS, ATMS and VIIRS), to be made available by IPO, should be integrated into a processing package for locally received data.

**Recommendation (to NASA)**

It is important that NASA continue to provide MODIS instrument status, navigation and frequently-updated calibration information in a timely manner to users and developers, to maximise the benefit of MODIS data for environmental monitoring and weather forecasting.

**Recommendation (to IPO)**

ITWG recommends that the user community be provided with and invited to review the draft specifications (content and format) for the raw data records (RDRs) and sensor data records (SDRs) for NPOESS/NPP instruments.

**Action (H.Bloom, NPOESS/IPO)**

To inform ITWG members, through the ITWG list server, of the location of draft specifications of RDRs and SDRs for NPOESS/NPP instruments.

**Action (J.Eyre, via ITWG co-chairs)**

To co-ordinate feedback to IPO from ITWG members on the draft specifications (content and format) for the raw data records (RDRs) and sensor data records (SDRs) for NPOESS/NPP instruments.

**Recommendation**

ITWG encourages research into the assimilation of cloud-affected infra-red radiances, as this may be crucial to the effective exploitation in NWP of advanced sounder data from meteorologically sensitive areas. It encourages investigation of a wide variety of methods including: (1) assimilation of cloudy radiances in “simple” cloud conditions (i.e. homogeneous, low-level clouds), and (2) assimilation of cloud-cleared radiances.

**Recommendation (to NOAA)**

ITWG encourages NOAA to re-examine the requirements on field-of-view size for CrIS.

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**Characterisation of spectral response (section 2.4.5)**

**Recommendations (to space agencies)**

ITWG recommends that the spectral responses of advanced

sounders should be characterised:

- to a level at which the associated error does not cause the total noise budget of the instrument to be exceeded,
- and, where achievable at reasonable cost, to a level at which the associated error is a negligible contribution to the total system noise.

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## INTERNATIONAL ISSUES AND FUTURE SYSTEMS:

### Data monitoring (section 2.5.4)

#### Recommendation

WMO should conduct a review of its “lead centre” for data monitoring process. As a initial step in the review, WMO should characterize the scope and intent of data monitoring for its purposes. The review should then be guided by that characterization. (D. Hinsman to inform Chairman OPAG IOS for discussion by CBS Management Group, deadline 1 April 2002).

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### Radio frequency matters (section 2.5.8)

#### Action

A. Gasiewski (NOAA) and G. Rochard (CMS) to prepare a draft two page paper, to be developed through email, containing scientific justification for specific RM values for radiance observed from space. (Deadline: June 2002)

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### Radio occultation sounding Working Group (section 2.5.9)

#### Recommendation (to CGMS)

EUMETSAT should invite scientists involved in atmospheric sounding using radar occultation, in particular those participating in CHAMP, to submit a progress report for a future CGMS.

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## SATELLITE SOUNDER SCIENCE AND PRODUCTS:

### Actions and Recommendations (section 2.6.3)

#### Action

Promote activity to append level 1b raw satellite observations to existing historical datasets of collocated radiosonde and TOVS and ATOVS observations, and to encourage such methods in current and planned operational systems (T. Reale, NESDIS).

#### Action

Write and distribute a statement asking Web Site

contributors to help broaden participation by contacting others in their country / region or others in their discipline and encouraging them to contribute to the SSSP web site (T. Reale and T. Achtor).

#### Action

Provide information for the SSSP Web Site on NOAA data resources, availability and access information (V. Tabor, NOAA/NESDIS/IPD).

#### Action

Provide link(s) for the SSSP Web Site to Direct Broadcast software packages and data (T. Achtor, CIMSS/SSEC and L. Lavanant, CMS).

#### Action

Provide routine information for the SSSP Web Site on current operational and research instrument status (T. Reale, NESDIS).

#### Action

Divide SSSP Web Site contributors by research (technique) vs. operations (product) (T. Achtor, CIMSS/SSEC).

#### Action

Design and conduct studies in conjunction with current and planned calibration/validation experiments (e.g. DOE ARM Sites) to quantify the usefulness of conventional upper air (i.e., radiosonde, profiler, etc) data to monitor polar satellite radiometer performance, their impact on climate and weather applications, and to provide recommendations concerning long term needs for continuous, global monitoring of environmental satellite data (J. Bates, NOAA and T. Reale, NESDIS).

#### Action

Actively promote product validation and intercomparison studies (e.g., among product and/or software developers) (T. Reale, L. Lavanant and T. Achtor).

#### Action (to the SSSP)

Take an active role to identify important research topics involving current weather satellites, including topics for continued and/or expanded investigation (to be developed through interaction with other ITWG sub groups) (T. Reale, T. Achtor, and other Working Group Co-Chairs).

#### Action

Promote consideration of the use of gridded file product formatters in routine operational data processing at NESDIS, including time averaged (monthly) gridded files for selected, conventional data poor parameters (M. Chalfant, NESDIS).