THE AATSR VALIDATION PROGRAMME: AN OVERVIEW

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ABSTRACT

The Advanced Along Track Scanning Radiometer (AATSR) is designed to measure sea surface temperature (SST) on a global scale to accuracies of better than 0.3K ± 1 sigma. To ascertain whether this is being achieved, a comprehensive validation programme is in place and underway. In addition to the validation of the AATSR SST product, validation of the visible and near infrared channels is also being undertaken comparing AATSR data to data from other sensors such as ATSR-2, MERIS and SCIAMACHY. This paper describes the AATSR validation programme, giving details of the activities that have taken place in the period up to the Validation Workshop, 9-13th December 2002. It stresses the need to continue validation into 2003 and throughout the entire mission, monitoring long-term trends and assessing the accuracy of data in an increasing range of geographic sites and seasons.

1. INTRODUCTION

The Advanced Along Track Scanning Radiometer (AATSR) is designed to provide precise, accurate measurements of global sea surface temperature (better than 0.3K ± 1 sigma), required for climate research and global climate change prediction. It continues the work of ATSR on the ERS satellite and ATSR-2 on ERS-2, and will lead to a 15+ year data record of accurate sea surface temperature measurements. The instrument is funded primarily by the UK Department for Environment, Food and Rural Affairs (DEFRA). Figure 1 shows spatially averaged AATSR sea surface temperature (SST) data for September 2002.

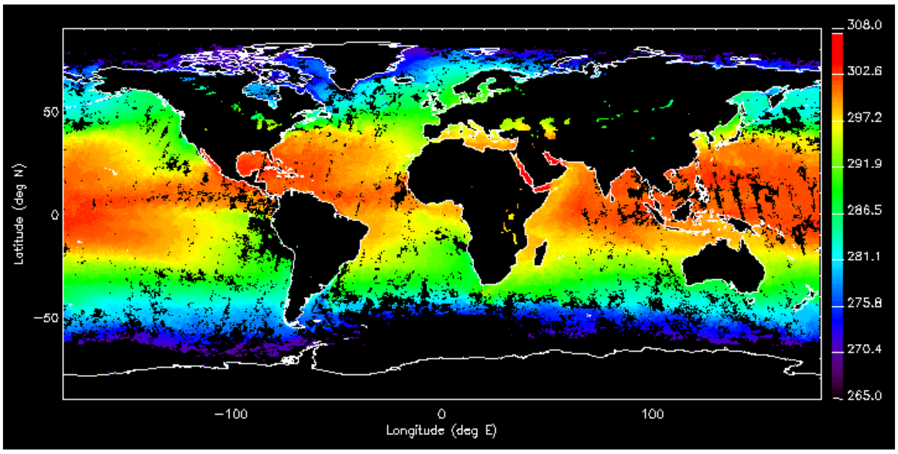

Figure 1: Spatially averaged AATSR SST data, for September 2002

Validation is an essential component of any successful satellite mission, and a comprehensive validation programme is in place for the validation of data from AATSR. This paper gives a broad overview of the AATSR validation programme to date, providing details of the AATSR validation strategy and approach. More details of the validation programme can be found in the AATSR Validation Implementation Plan [1]. Results from the individual validation activities can be found in validation workshop papers by the PI's concerned.

2. APPROACH AND OBJECTIVES

The AATSR validation programme is split into two parts, initial and ongoing validation. Initial validation is described as validation which takes place during the commissioning phase and up until the validation workshop at launch + 9 months. During this period, the objectives are: -

?? To determine whether the AATSR instrument is returning an acceptable global skin SST.
?? To make an initial assessment of the quality of the AATSR SST products in a limited number of sites and seasons. Making timely use of any tandem ATSR-2/AATSR operations, this should include determination of any bias difference between the measurements made by ATSR-2 and AATSR.
?? To assess the accuracy of AATSR data retrieved over land.

To enable the use of AATSR data in climate change research, it is essential that AATSR validation continues over the course of the whole mission. Ongoing validation is defined as validation that takes place during the lifetime of the mission. Specifically the aims are: -
?? To make a detailed assessment of the quality of the AATSR SST data products in an increasing number of sites and seasons.
?? To monitor the quality of the AATSR data products over the duration of the mission. It is important to ascertain any instrument drift and decouple it from any real changes in SST as a result of climate change.
?? To validate any new AATSR data products. This includes validation of an AATSR land surface temperature product.

By its definition, this paper concentrates on initial validation activities.

3. ALGORITHM VERIFICATION

Algorithm verification is an important component of the AATSR validation plan. Verifying the AATSR data products themselves, specific objectives include: -
?? To verify that the algorithms used by the AATSR Operational Processor work correctly when presented with AATSR data.
?? To verify that the AATSR products are being correctly generated.
?? To verify and if necessary regenerate, auxiliary data files used by the AATSR Operational Processor.

Algorithm verification is being carried out by A. Birks of the Rutherford Appleton Laboratory. It is ongoing, being carried out simultaneously with geophysical validation.

4. VALIDATION OF THE AATSR LEVEL 2 PRODUCTS

There are three AATSR level 2 products as listed in Table 1.

Product Name	Product ID	Description
Gridded Surface Temperature (GST)	ATS_NR__2P	Full resolution nadir only and dual view SST over sea. Full resolution 11?m BT and NDVI over land.
Averaged Surface Temperature (AST)	ATS_AR__2P	Spatially averaged ocean, land and cloud parameters. Spatially averaged TOA BT/reflectance.
Meteo Product	ATS_MET_2P	Subset of spatially averaged SST and TOA BT at 10-arc min resolution.

Table 1: AATSR Level 2 products

Validation of AATSR level 2 SST products takes place on three levels.

4.1 Early indication of gross errors in the spatially averaged AST product

The Met Office UK, have been receiving the METEO product since 19th August 2002 and performing near-real-time monitoring of the product against in situ buoy data and SST analyses. These comparisons, on a global scale, provide a gross check on instrument performance. As the validation activity that received AATSR data first, this activity has been invaluable in providing early validation results.

4.2 Validation using in situ measurements from precision radiometers running autonomously

Validation is also taking place using precision radiometers running autonomously on merchant ships and ferries. Included in this category are the following activities: -

a. The Infrared Sea surface temperature Autonomous Radiometer (ISAR-5C)
The Infrared Sea surface skin temperature (ISAR-5-IR) is a precision, autonomous, self-calibrating radiometer. Operated by the University of Southampton, it has been deployed on two passenger ferries operating in the Bay of Biscay region. The first deployment on the Brittany ferry, the Val de Loire was very successful with the collection of a number of validation points. The second deployment on the P & O Ferry, the Pride of Bilboa, suffered from technical problems in the early stages. These are now understood and in situ measurements of SST are being collected.

b. The Rottnest Island ferry in Perth
In situ validation measurements are being collected by a radiometer fitted to a passenger ferry operating on a daily basis between the Perth coast and Rottnest Island, 25km offshore. Built and operated by CSIRO, the radiometer is based on a Tasco radiometer and calibrated by means of a portable black body target.

c. The Great Barrier Reef ferry in Townsville
Another radiometer operated by CSIRO, in conjunction with AIMS (Australian Institute of Marine Science), is installed on a passenger ferry that runs between Townsville and Kelso Reef. This activity aims to collect validation measurements on 5-6 transects per week, although currently the radiometer is under repair.

d. The MAERI on the Royal Caribbean cruise liner
The University of Miami has three Marine Atmosphere Emitted Radiance Interferometers (M-AERI) [2]. One is deployed autonomously on a cruise liner operating in the Caribbean on a weekly circuit from Miami. It collects in situ measurements of SST for the validation of a number of instruments including AATSR.

4.3 Validation using precision radiometers on dedicated cruises

In addition to autonomous radiometers, there are a number of precision instruments that are deployed on research vessels and ships of opportunity with an experienced scientist. The instruments in this category involved in AATSR validation are: -

a. SISTeR
The Scanning Infrared Sea surface Temperature Radiometer, SISTeR, is a precision radiometer developed and operated by T. Nightingale of the Rutherford Appleton Laboratory. It has been used for the validation of ATSR and ATSR-2 [3], and most recently, has been deployed on a validation cruise for AATSR. Funded by the Natural Environment Research Council, the SCIPIO cruise took place from 31st May 2002 to 11th July 2002 in the West Indian Ocean (latitude 0-25ºS, longitude 50-70ºE).

b. DAR011
The DAR011 is another precision radiometer, operated by I. Barton of CSIRO. During the initial validation period, it has been deployed on four validation cruises in Australian waters, collecting a number of validation points. Two of the validation points have been compared to AATSR data, and show excellent agreement.

c. MAERI
In addition to the MAERI operating on the Royal Caribbean Cruise Liner, there are two MAERI instruments that are deployed periodically on research vessels and ships of opportunity. In the initial validation period, three dedicated validation cruises have taken place. There were on the Canadian Icebreaker Pierre Radisson in the Arctic, from 18th September to 24th October, on the Urania in the Mediterranean from 21st September to 9th October, and on the Polar Sea from Seattle to Sydney, from 4th November to 2nd December. Unfortunately the MAERI on the Polar Sea had to be taken off the ship after a bad storm damaged it, but the other validation cruises ran well and a number of validation points were collected. Comparison of the in situ data to AATSR data is still being undertaken.

5. VICARIOUS VALIDATION OF VISIBLE AND NEAR-INFRARED CHANNELS OVER LAND AND CLOUD

The two AATSR L1b products are described in Table 2. Validation of the browse product is performed as part of the algorithm verification exercise. Validation of the visible/near infrared channels is performed comparing reflectances to those from other instruments, particularly MERIS, ATSR-2 and SCIAMACHY.

Product Name	Product ID	Description
Gridded Brightness Temperature/ Reflectances	ATS_TOA_1P	Full resolution TOA BT/Reflectance
Browse Product	ATS_AST_BP	3 band colour composite derived from 4*4 km sampling of GBTR.

Table 2: AATSR L1b products

5.1 Vicarious validation of AATSR and MERIS using terrestrial targets

D. Smith of the Rutherford Appleton Laboratory is comparing AATSR and MERIS top-of-the-atmosphere radiances for a range of stable sites, monitoring the long-term stability of the instruments. These include sites in Australia where F. Prata of CSIRO is also making field measurements. Where possible, comparisons will also be made to ATSR-2.

Liasing with D. Smith, O. Hagolle of CNES is comparing AATSR and MERIS top-of-the-atmosphere radiances for a range of stable sites, as part of the MERIS validation activities.

5.2 Vicarious validation of AATSR with MERIS and SCIAMACHY

P. Stammes of KNMI is performing vicarious validation of AATSR with MERIS and SCIAMACHY, as part of SCIAMACHY validation activities.

6. SUMMARY AND CONCLUSIONS

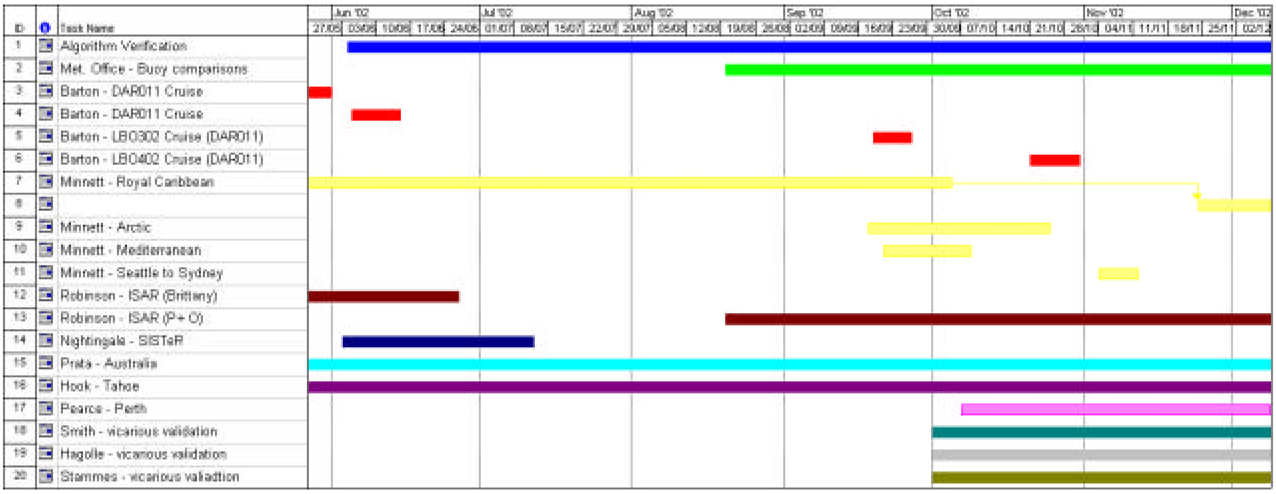

Figure 2: AATSR validation activities up until the validation workshop 2002

There have been a large number of AATSR validation activities in the first nine months of the Envisat mission. These are summarised in Figure 2. Indications from early validation results suggest that AATSR is performing well and meeting its specifications for retrieved SST accuracy. More results will be generated over the next months as more AATSR data become available and data processing and analysis are carried out.

For AATSR data to be useful for the global climate record, it is essential that validation activities continue for the duration of the AATSR mission. Validation campaigns must be ongoing encompassing an increasing number of geographic locations and seasons, and long term monitoring to ascertain any instrument drift must be preformed over stable sites. To establish the continuity of AATSR, ATSR-2 and ATSR, cross validation between ATSR-2 and AATSR in the overlap period of the ERS-2/Envisat missions is also very important. It will be given high priority in the next months as the validation programme continues.

7. ACKNOWLEDGEMENTS

Marianne Edwards works as the AATSR Validation Scientist, supported by DEFRA. David Llewellyn-Jones is the AATSR Principal Investigator (also supported by DEFRA). The authors would like to thank members of the AATSR validation team for their work for the AATSR validation programme, and Hannah Tait of VEGA PLC for her work supporting the AATSR validation team on behalf of ESA.

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