AATSR SST and LST Validation

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AATSR Products

- **Current operational:**
  - Sea surface temperature
  - Land surface temperature
  - NDVI

- **Under development:**
  - Cloud optical parameters
  - Aerosol optical parameters
Retrievals by radiative transfer modelling
Usually of the form:

\[ a_0 + \sum_{1}^{n} a_n BT_n \]

where \( n \) is the number of channels

For AATSR we have 2 channels during day and 3 during night

- 3.7 µm not used during day owing to solar contamination
- We have two views, so we have four SST retrievals in total

Four Possible Retrievals:

- Nadir 2-channel N2
- Nadir 3-channel N3
- Dual 2-channel D2
- Dual 3-channel D3
Definitions of SST

(a) Night time situation, light wind
AATSR 3 channel

(b) Day time situation, strong solar radiation and light winds
AATSR 2-channel

Infrared sensors ($\delta T \sim 10s$)

Contact thermometers
Ships/Buoys ($\delta T \sim$minutes)

From Craig Donlon (Met Office)
Requirement and Approach to AATSR SST Validation

Requirement:
- Demanding accuracy in SST - better than 0.3 K globally, with a 'highest accuracy' target of 0.1 K
- Must be able to verify the accuracy globally
- Must be able to achieve higher levels in selected areas
- Global validation requires representative seasonal and geophysical variation in observing sites

Approach:
- Continuous checks of global fields by inter-comparison with drifting buoy data, analysis fields and data from other satellite sensors
- Continuous autonomous in situ radiometric measurements of SST from ship-borne platforms
- Opportunistic in situ radiometric measurements at selected sites
The AATSR SST Validation Programme

- AATSR is required to measure global SST values to within 0.3 K (1σ) in single point coincidences and over 0.5° (30´) x 0.5° (30´) averages
- ATS_NR__2P
  - Gridded 1km by 1km global product
  - Against in situ radiometer measurements
  - Against in situ buoy measurements
- ATS_AR__2P
  - Spatially averaged products at various resolutions (30´; 10´; 50 km; 17 km)
  - Against in situ buoy measurements
  - Against other satellite sensor measurement
- Two types of validation
  - How accurate is AATSR?
  - What is the accuracy of the data?
- The validation uses truly independent data sets - there is no tuning to in situ
- The validation uses the operational AATSR data - there is no post-processing
Validation With In Situ Radiometers

- In situ radiometers directly measure skin SST
- Only independent method to test the absolute accuracy of AATSR SST retrievals

Four radiometers used
- DAR011 - Ian Barton (CSIRO)
- ISAR - Ian Robinson (NOCS) Craig Donlon (Met Office)
- M-AERI - Peter Minnett (University of Miami)
- SISTeR - Tim Nightingale (RAL)

All radiometers were inter-compared at the 2001 Miami experiment
- All agreed to < 0.15 K with very small biases ~ few mK (Barton et al., J. Atmos. Ocean Tech., 2004)
- Other inter-comparisons since
Where were we?

At MAVT 2003 we had:

- Approximately 2,500 match-ups between the AR product and the in situ buoy network
  - Global biases, poor coverage in some regions

- 24 match-ups between the NR product and in situ radiometer data
  - Poor coverage, low statistics, poor range of temperatures
Where are we now?

At MAVT 2006, we have:

- Over 60,000 match-ups between the AR product and the in situ buoy network
  - Regional breakdown, most regions now covered (50 S - 50 N)

- Over 1000 match-ups between the NR product and in situ radiometer data
  - Better coverage, much improved statistics, increased range of temperatures

- This is excellent progress, and AATSR has by far the most comprehensive validation programme of any space-borne SST sensor
  - Requirement for long term validation data sets is clear
**Issues**

- **Cloud and aerosol contamination**
  - Use of the D-N test for improved data quality
  - Affect on the climate SST?

- Nearly all data presented will be comparisons to pre-launch coefficients
  - Updated coefficients now available (07/12/2005)
  - Removes D2/D3 bias (offset - latitudinal correction now available)

- Do not have a well defined error budget
  - Adopt GHRSSST-PP SSES
Ongoing Activities

- Continuation of existing validation activities for long term statistics
  - Global analysis of the spatially averaged SST product by comparison with buoys networks and operational analysis fields (Met Office)
  - Ongoing analysis of data from the M-AERI instruments in the on the Royal Caribbean cruise ship and other opportunistic cruises (UL/RSMAS)
  - Continued operation of ISAR onboard the Pride of Bilbao ferry, operating up and down the Bay of Biscay (NOCS)
  - Beginning autonomous operations with SISTeR (RAL)
- To establish a core validation data set
- To address priority action items concerning AATSR validation
  - Identification of aerosol and cloud contamination
  - Development of an error budget for AATSR
  - Identification of other anomalies or critical areas of AATSR performance
  - Ensure, through QWG, that appropriate remedial action is put in place
The AATSR LST Product

- First LST product from the ATSR mission
- Algorithm developed by Fred Prata and Andrew Birks
- Operational since March 2004 (prototype available prior to this date)
  - Available since start of mission through reprocessing
- Provides 1x1 km gridded LST over the entire globe
  - Spatially averaged under consideration
- Target accuracy of 2.5 K in day (better results obtained at night, 1.0 K)*
- Land surface is classified into 14 biomes

The atmosphere and surface emissivity are temporally and spatially heterogeneous over land.

The LST product uses global ancillary data (some of which are seasonally dependent) to derive the atmospheric correction.

Brightness Temperatures from multiple channels are used to improve the atmospheric correction (split-window).
Validation of AATSR LST Retrievals

- Compare AATSR LST with *in situ* LST
- Compare AATSR LST with other satellite LST products
- Compare AATSR LST with model LST

- Categorise results in terms of biome, season and time of day
- Further investigations of anomalous data points using radiative transfer model
Validation Activities

Several validation activities carried out so far by:

- Fred Prata (CSIRO)
- Simon Hook (NASA-JPL)
- José Sobrino (U. Valencia)
- César Coll (U. Valencia)
- Julienne Stroeve (Colorado State)

Figure courtesy of Fred Prata
AATSR Surface Temperatures over the UK and Northern France

From Simon Good (UL)
This Afternoon

**SST**
- Ian Barton
- Craig Donlon
- Tim Nightingale
- John Remedios
- Thomas Blackmore

**LST**
- Lizzie Noyes
- Guillem Soria
- Cesar Coll