The ATSR SST Time Series

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Acknowledgement to the AATSR QWG and the NEODC Archive Team particularly:
Gary Corlett, David Llewellyn-Jones et al., EOS, U. Leicester
Andrew Birks, Chris Mutlow, Dave Smith, Brian Maddison, Matt Pritchard, Jack Abolins et al., RAL
Chris Merchant, Edinburgh
Roger Saunders et al., Met. Office
Philippe Goryl et al., ESA
Hugh Kelliher, Space Connexions
ATSR and Sea Surface Temperature records

- Skin SST is the fundamental quantity derived from the thermal (ocean) radiances measured by the ATSR instruments.
- Skin SST drives the outgoing longwave radiation, along with the atmosphere.
- Skin SST is the boundary condition for the atmosphere, i.e., it is the interface temperature for ocean-atmosphere exchange of thermal heat fluxes and trace gases.
- Skin SST can be related to other “classes” of SST which are important for historical climate records, e.g., sub-surface temperatures measured by buoys. Currently, the Essential Climate Variable (ECV) is “bulk” temperature.
The (A)ATSR mission from an SST perspective

- **ATSR-1**
  - Launched July 1991; data until May 1996
  - 3.7 μm channel failed May 1992 so only 2 channel dual-view from that date
  - Other issues: pickup noise from cooler; detector temperate

- **ATSR-2**
  - Launched April 1995; data until Feb 2008
  - Scan mirror failure December 1995 to July 1996; ATSR-1 data available (for this analysis until end March)
  - ERS-2 Gyro failure in January 2001
  - Mid-January to mid-February 2001 no data; data distributed to June 2003

- **AATSR**
  - Launched March 2002; Data from August 2002
(A)ATSR data - Version 2

- First consistent processing of ATSR-1, ATSR-2, and AATSR data
- Coefficient based approach as first implemented for the ATSR-1 approach but coefficients refined to be much more robust to stratospheric aerosol (Merchant et al, 1999)
- Improved cloud detection
- Retrieval of 6 SST products
- Archive in consistent format of all ATSR data at NEODC

www.neodc.rl.ac.uk

ATSR Multi-mission Archive
# ATSR SST Products

<table>
<thead>
<tr>
<th>Retrieval</th>
<th>Characteristics</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Night Dual 3 channel</strong></td>
<td>Dual. Can use 3.7 μm channel;</td>
<td>Clouds – no visible channels</td>
</tr>
<tr>
<td><strong>Night Nadir 3 Channel</strong></td>
<td>Not dual but still 3.7 μm</td>
<td>Clouds – no vis. Use dual-view clouds etc.</td>
</tr>
<tr>
<td><strong>Day Dual 2 Channel</strong></td>
<td>Dual but no 3.7 μm channel</td>
<td></td>
</tr>
<tr>
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<td>Dual but no 3.7 μm channel</td>
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<tr>
<td>Day nadir 2 Channel</td>
<td>The most limited retrieval: no dual, no 3.7 μm</td>
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<td>The most limited retrieval: no dual, no 3.7</td>
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</table>
Global mean SST time series

- Gridding to level 3
  - (A)ATSR version 2 Level 2 spatially averaged SST products, binned to level 3, 10 arc minute “daily” averages.
  - Data are separated into day and night
  - Data are “quality” filtered using dual-nadir SST differences (cold limit applied everywhere; warm limit > 30° latitude)
Dual-nadir filtering

- Difference between dual and nadir SST tells us about residual atmosphere errors (+instrument and retrieval errors)
  - Clouds
  - Mt Pinatubo aerosols (volcanic in the stratosphere)
  - Tropospheric aerosols: Saharan dust [ASDI – Good et al, submitted, 2009]
Global mean SST time series

- This talk – data from 1994 onwards; cloud-clearing during Pinatubo (our method; consistent sampling)

- All time series are constructed from:
  - Monthly data sets on a 5 degree lat/long grid.
  - Requires valid days at a grid point for a monthly average
  - Global/regional time series use only grid points where all monthly points are valid; area weighted average.
  - Anomalies with respect to Reynolds climatology (1971-2000)
V2 global time series: no bias corrections
6 SST products: nighttime
Overlap periods: empirical correction of inter-instrument bias

- **ATSR-1 / ATSR-2**
  - Mean dual-2 differences: 0.13 K (day/night separately)

- **ATSR-2 / AATSR**
  - Mean dual-3 difference: 0.03 K; mean dual-2 = 0.22K (night)
## ATSR-1 vs ATSR-2

<table>
<thead>
<tr>
<th>Retrieval</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nadir daytime 2 Channel</td>
<td>-0.14</td>
<td>0.58</td>
</tr>
<tr>
<td>Nadir nighttime 2 Channel</td>
<td>-0.22</td>
<td>0.57</td>
</tr>
<tr>
<td>Dual daytime 2 Channel</td>
<td>0.13</td>
<td>0.53</td>
</tr>
<tr>
<td>Dual nighttime 2 Channel</td>
<td>0.13</td>
<td>0.49</td>
</tr>
</tbody>
</table>

### ATSR-1 minus ATSR-2 SST difference for overlap period

**DUAL**

**NADIR**

![Graph showing SST differences for ATSR-1 and ATSR-2](image-url)
<table>
<thead>
<tr>
<th>Retrieval</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day Nadir 2 channel</td>
<td>0.39</td>
<td>0.15</td>
</tr>
<tr>
<td>Night Nadir 2 Channel</td>
<td>0.42</td>
<td>0.16</td>
</tr>
<tr>
<td>Night Nadir 3 Channel</td>
<td>0.06</td>
<td>0.11</td>
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<tr>
<td>Day Dual 2 channel</td>
<td>0.17</td>
<td>0.24</td>
</tr>
<tr>
<td>Night Dual 2 Channel</td>
<td>0.22</td>
<td>0.25</td>
</tr>
<tr>
<td>Night Dual 3 Channel</td>
<td>0.03</td>
<td>0.18</td>
</tr>
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V2 global, multi-product, bias-corrected, anomaly time series:
inter-instrument bias corrections (10 arc min level)
6 SST products, nighttime

(A) ATSR time series of SST - Bias corrected data fields

- Day dual-view, 2 channel
- Day nadir only, 2 channel
- Night dual-view, 2 channel
- Night nadir only, 2 channel
- Night dual-view, 3 channel
- Night nadir only, 3 channel

Data (decimal years)
V2 global, multi-product, mean-adjusted anomaly time series: mean-adjusted, inter-instrument bias correction

6 SST products: nighttime
Most accurate V2 global anomaly time series: dual-3 night mean-adjusted, inter-instrument bias correction
V2 regional time series: mean-adjusted, bias correction

Dual-view, 3 channel nighttime

Tropical Pacific

North Atlantic
Summary

- Consistent SST record in archive
- Very good relative time series particularly in ATSR-2/AATSR period with excellent agreement between D3 and N3 [Filtering has to be applied]
- Validation evidence indicates very good stability and low mean bias (not shown).
- Influence of large El Nino, recent La Nina and El Nino evident modulating the underlying trend in temperature.
- (A)RC will make further improvements to cloud clearing and retrieval bias.

The time series work has been funded by DECC (formerly Defra)
V2 regional time series: inter-instrument bias correction  
Dual-view, 2 channel nighttime

The AATSR multi-product, relative anomaly time series