Earth Observation Science

Report from the University of Leicester

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CEOS WORKING GROUP ON CALIBRATION & VALIDATION

Leicester & Cal/Val

- Historical Notes
  - The ATSR Series
  - Programme at Leicester
- The ATSR Approach to Calibration
- The ATSR Approach to Validation
- GHRSST – a more generic approach to satellite data-products and to Validation

Historical Notes

- In 1980's at RAL:
  - Proposed ATSR
  - Participated in WGCV
- In 1990's:
  - ATSR-1 launched (1991)
  - AATSR *(ATSR-3)* funded by UK Dept Environment (now DECC)
  - Moved to University of Leicester (1993)
  - ATSR-2 Launched (1995)
- In 2000's
  - AATSR Launched (2002)
  - GHRSST Pilot Project starts Operating 2007

EO Programme at Leicester

- Inter-disciplinary Research Programme
  - Based in Physics (J Remedios), with Chemistry (P S Monks) and Geography (H Baltzer)
- Programme Involves:
  - Scientific Analysis & Research
  - Validation
  - New Sensor development

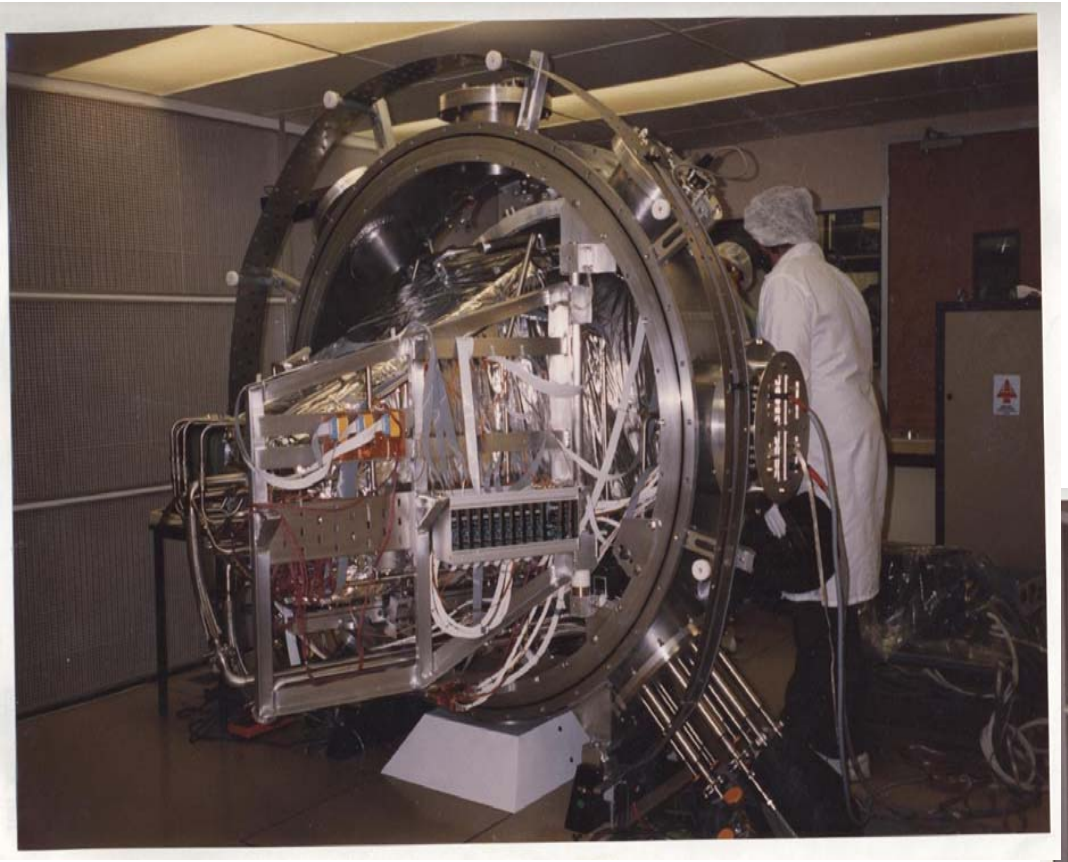
Leicester EO Research Programme main features

- SST and LST measurements (AATSR)
  - AATSR PI Validation team (on behalf of DECC)
  - Retrieval techniques
  - Product validation
  - Long-term trend analysis
- Detection of Atmospheric Aerosols from Space (AATSR)
  - Using AATSR two-angle view
- Atmospheric Carbon and other constituents from Space and Ground-based observations

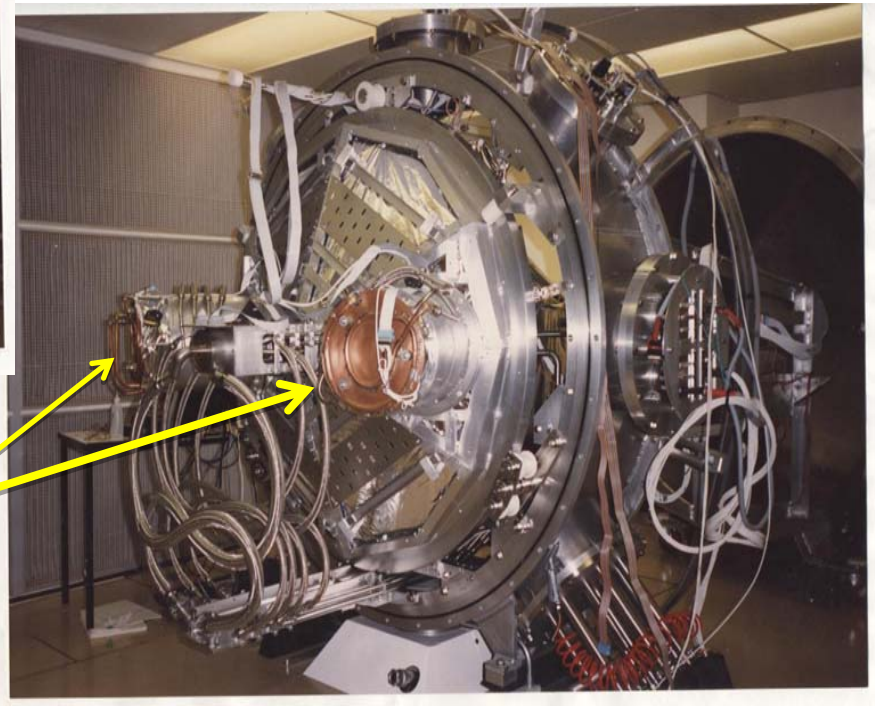
The ATSR Approach to Calibration

- Pre-launch Calibration is a Customer Responsibility, part of acceptance treating
- Constructor Should support and participate in but not direct the Calibration Programme
- In high-quality Environmental simulator need:
  - Representative Thermal environment
  - Traceable. Well-monitored calibration target(s)
- Procedures Consistent with most of the QA4EO guidelines

ATSR-1 Calibration



ATSR , clad in heat shield,
in the tank (Oxford University
Atmospheric Physics Dept)



Calibration BB Targets,
on rotating panel, to cover
ATSR's scanning range

ATSR-1 Calibration - 2

Instrument Field0-of-View in each of the 4 channels

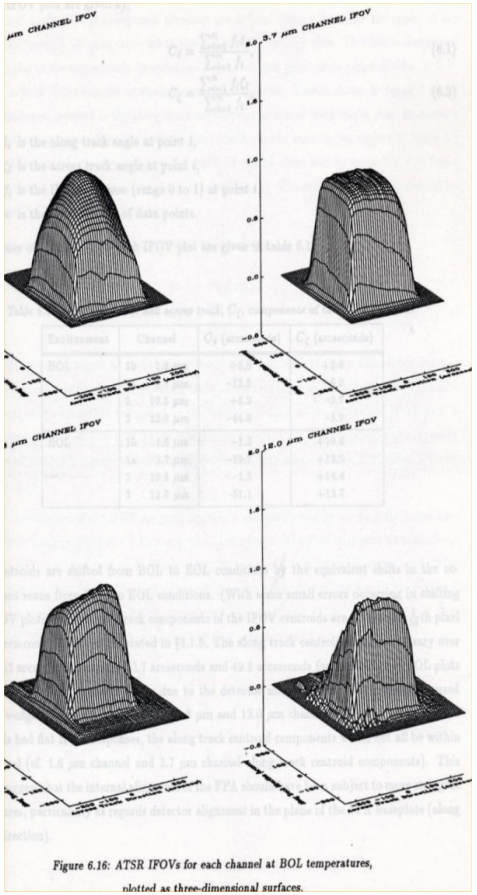
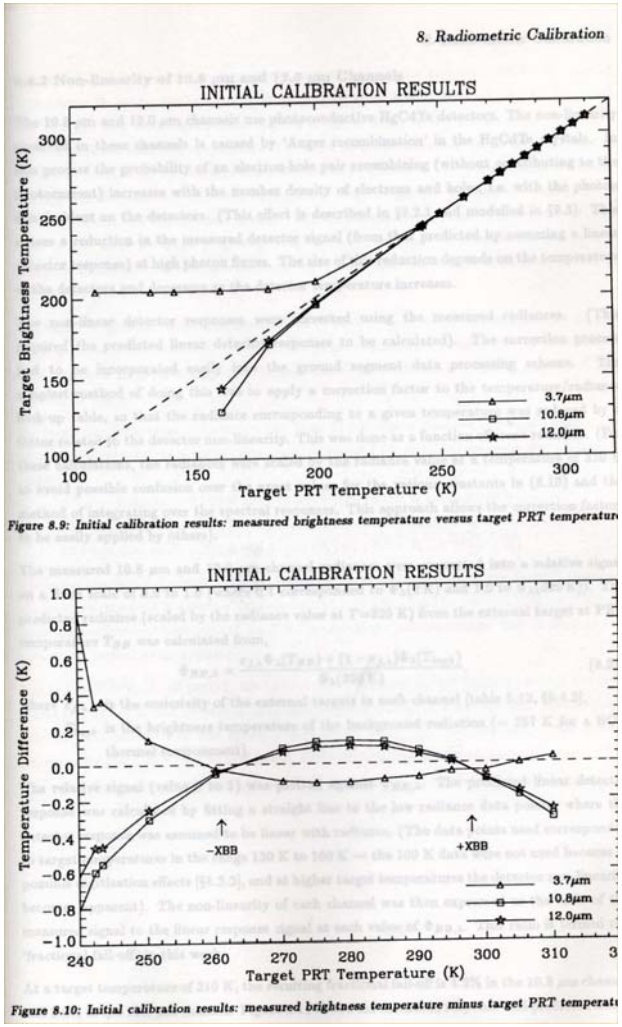


Figure 6.16: ATSR IFOVs for each channel at BOL temperatures, plotted as three-dimensional surfaces.

ATSR-1 Calibration - 3

Radiometric Response
and
Linearity



ATSR-1 Calibration - 3

Round-the-Orbit Simulations

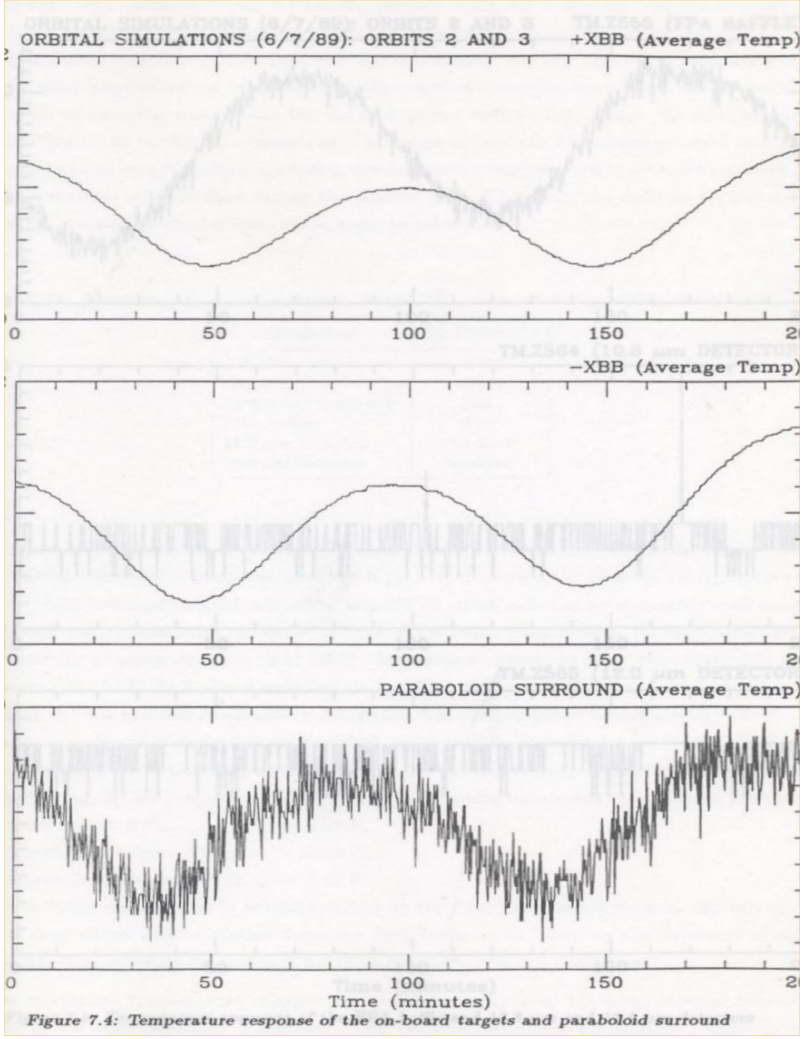
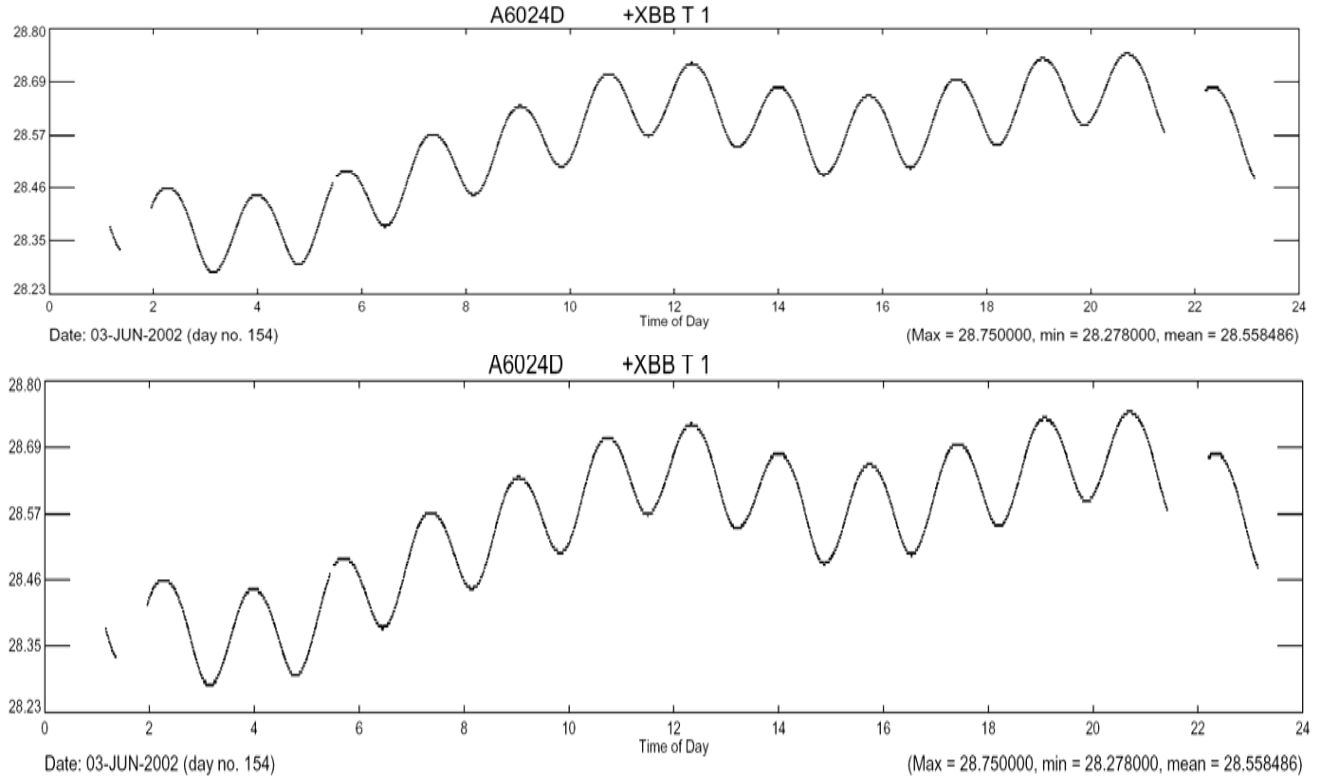


Figure 7.4: Temperature response of the on-board targets and paraboloid surround

AATSR Black-body Temperature records showing variations over one day with near-sinusoidal orbital variations superimposed



A single orbit record of AVHRR Black-body temperature passing the terminator

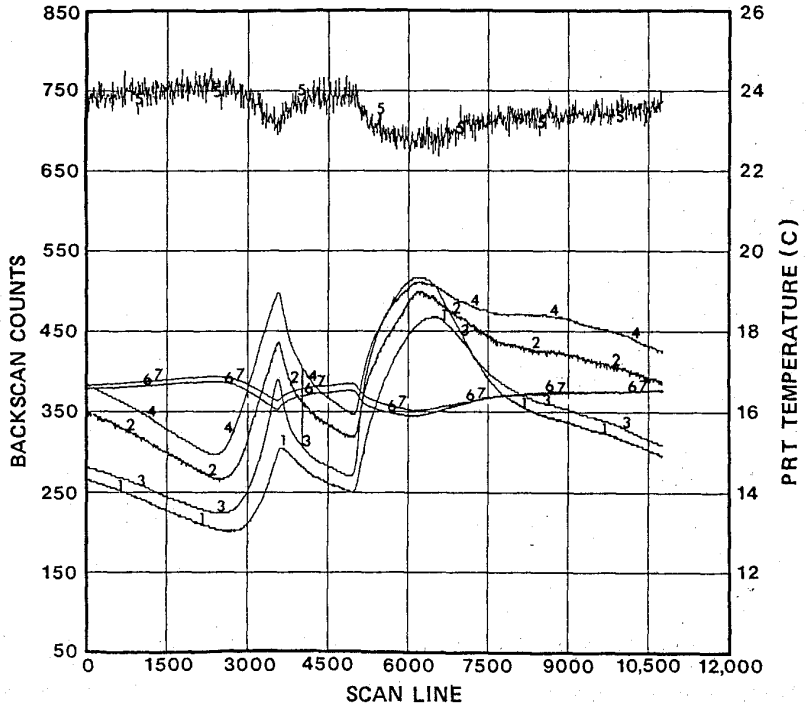
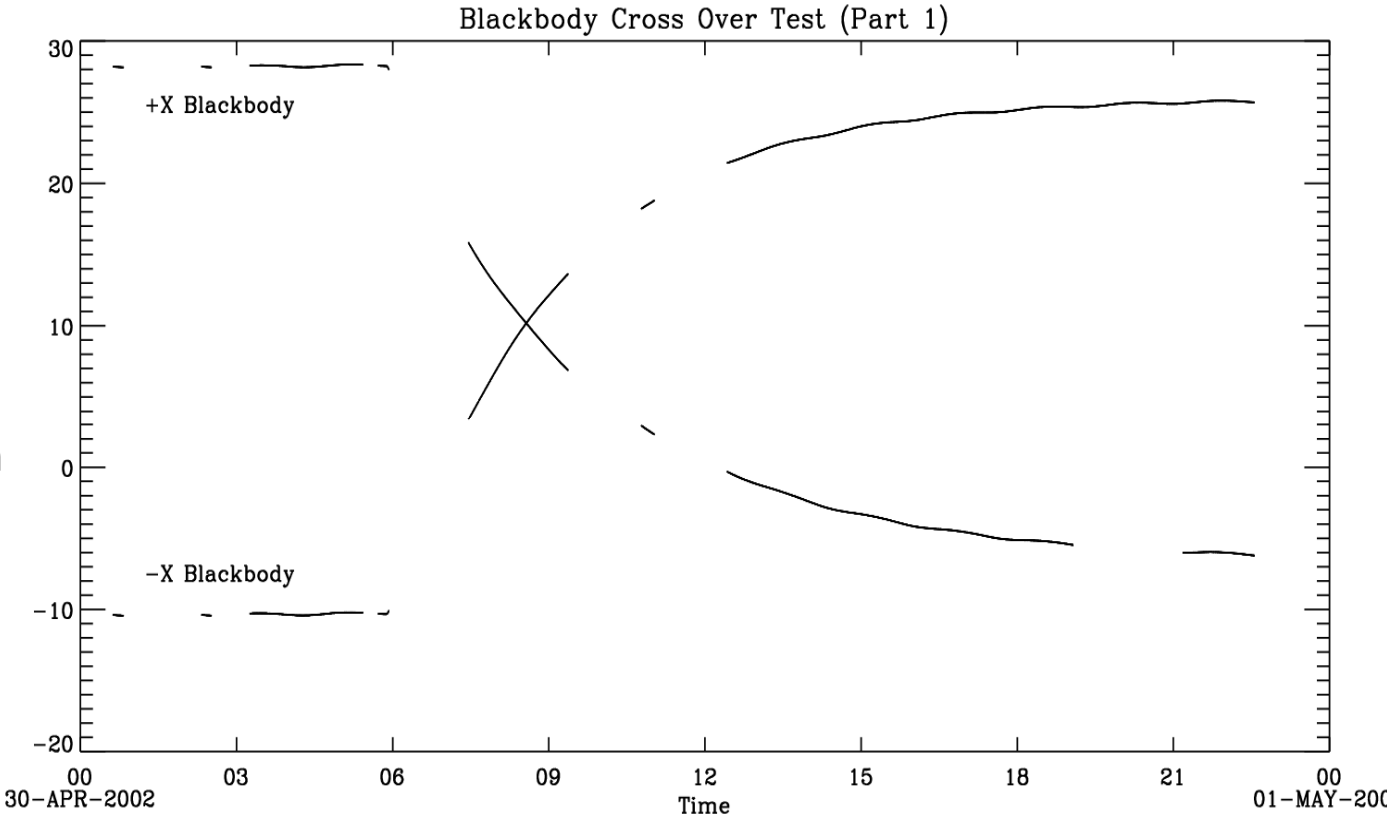


Fig. 6. Time series plot of observed PRT temperature for one orbit on NOAA 7. These data were taken on October 2, 1984, starting at 1732 UT. Numbers 1–4 identify temperatures for PRT's 1–4; temperature values are indicated on the right ordinate. Numbers 5, 6, 7 identify backscan counts for channels 3, 4, 5, respectively; count values are indicated on the left ordinate.

AATSR Black-body ‘crossover’

This plot identifies the time at which both sets of black-body temp sensors indicate the same temperature.
At this time both BB’s give same signal to within <30mkK



Results show discrepancies of less than 30mK

ATSR In-flight Calibration

- Two on-board black-body reference targets
- Temperatures close to limits of geophysical range
- Well-protected thermal environment
- No space view
- Occasional ‘Crossover tests’ enable detection of degradation

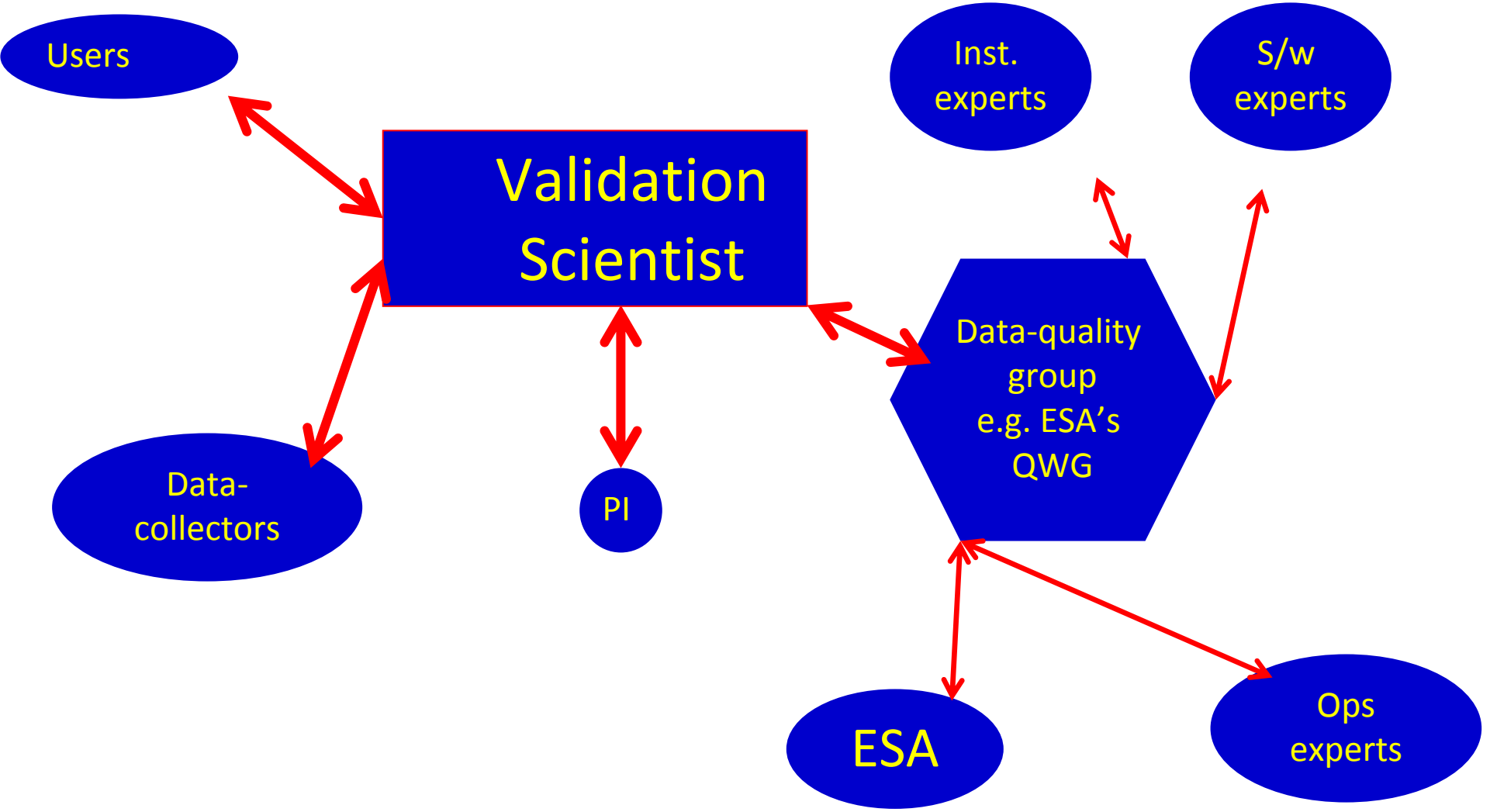
ATSR Calibration – Summary

- Most of QA4EO boxes can be ticked
  - (Possible Spectral response issues)
- Important ‘User Acceptance’ function
- An example for QA4EO Implementation

AATSR Approach to Validation

- Pro-active Validation Scientist is Essential
  - Coordination *(Listens, persuades , cajoles)*
  - Analysis
  - Anomaly Reporting
- Should work for PI and Users
  - Not part of Instrument Team
- Must operate within a responsive ‘Reporting Loop’

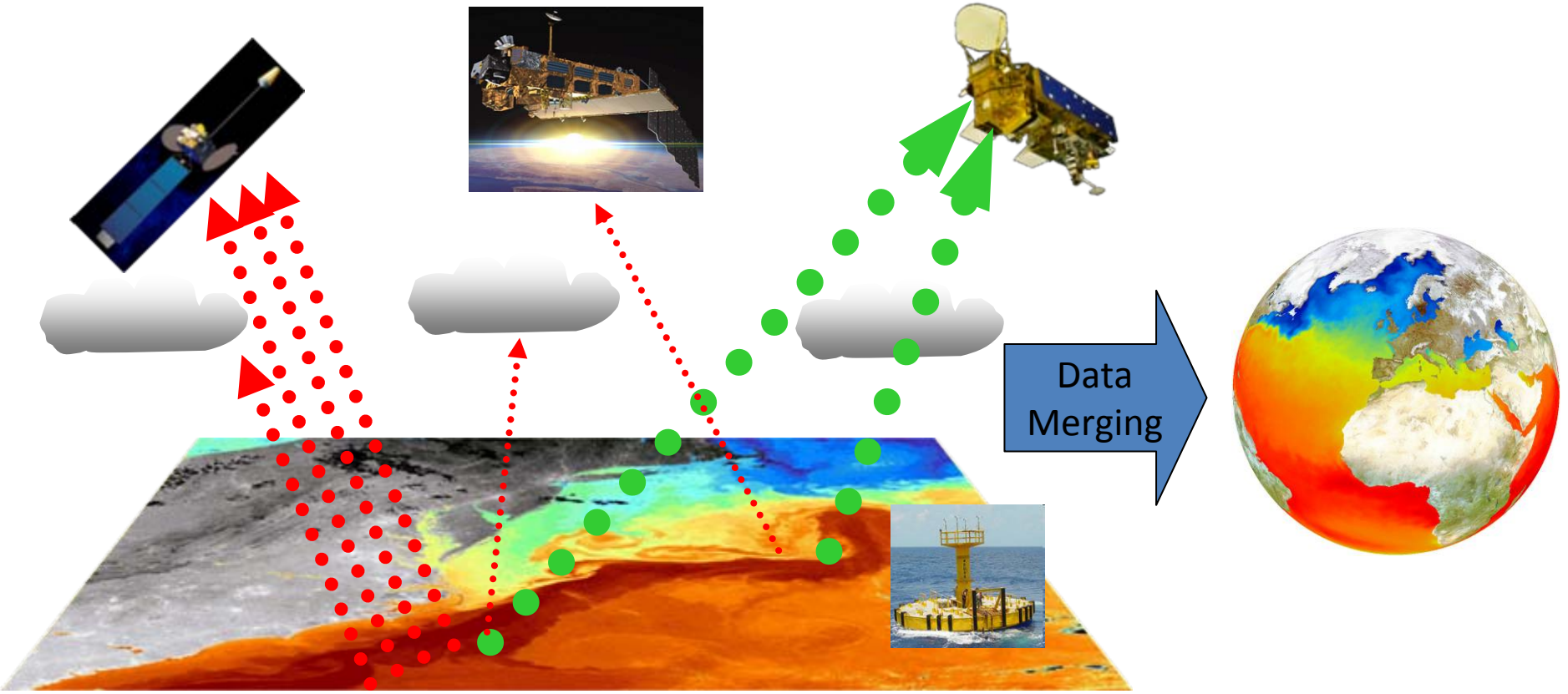
Validation Interfaces



T GHRSST stem

- The Group for High-Resolution SST
- Data collected from all available satellite sources + *in situ*
- All data re-formatted to L2p, based on NetCDF
- Single Sensor Error Statistics (SSES) computed for every pixel
- Timely daily delivery to operational users
- Project Office funded by ESA. US activities by NASA, NOAA, also other international partners

GHRSST - EO Complementarities

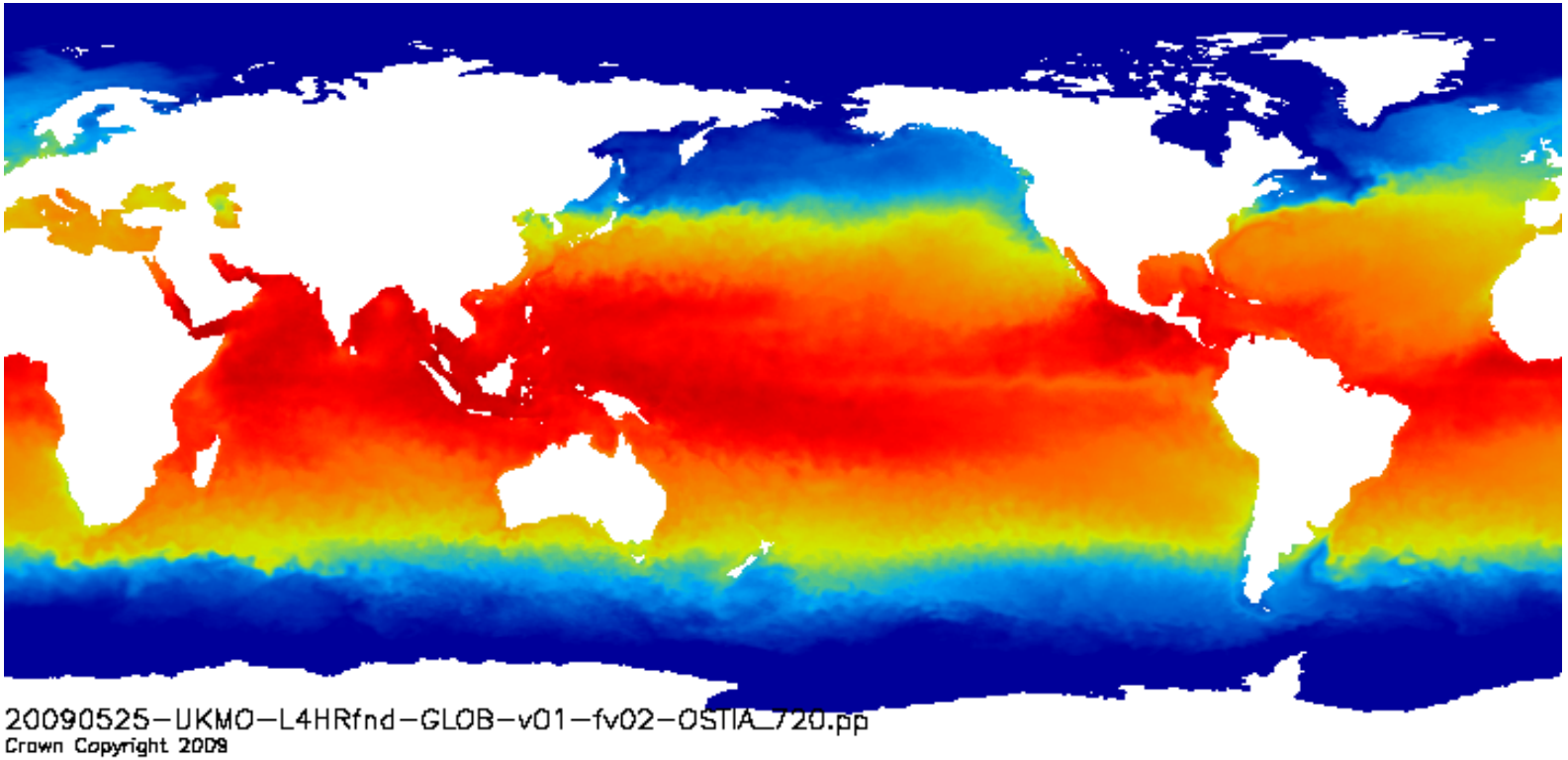


- Polar Orbiting infrared offers *high accuracy & spatial resolution*
- Geostationary infrared has *high temporal resolution*
- Microwave Polar orbiting has *all-weather capability*
- *In situ* data provide *the reference in all weather conditions*

OSTIA Daily SST Analysis

from UK Met Office

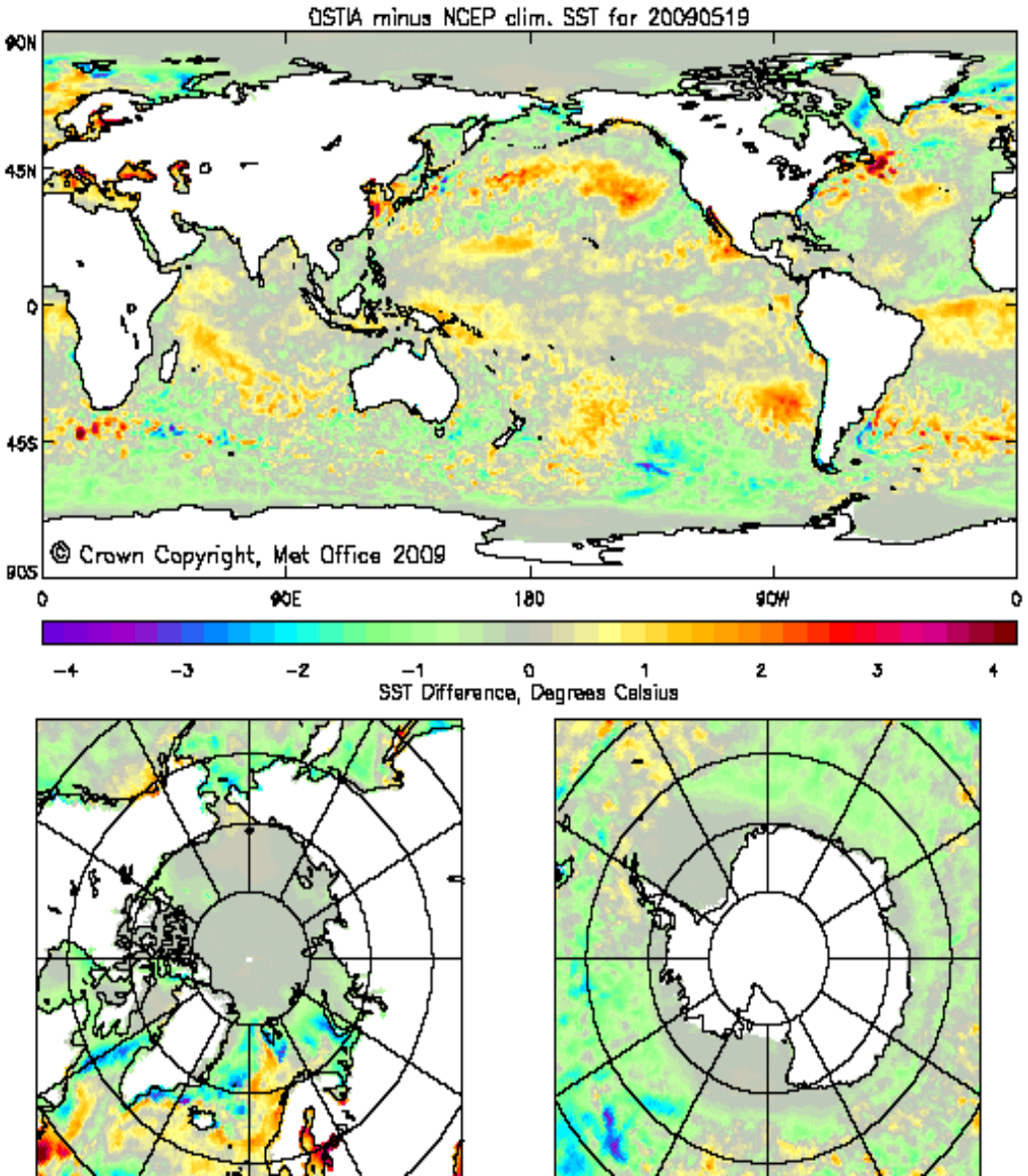
An Example of a GHRSST Level 4p Product



OSTIA is an OI daily analysis of all available GHRSST data, for NWP.

OSTIA SST Anomalies

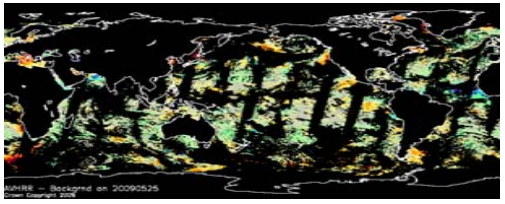
7 days of SST anomalies, derived by subtraction of Climatology

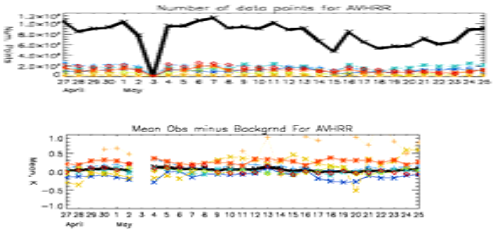


AMSRE

Elements of the SST 'Constellation'

25 May 2009





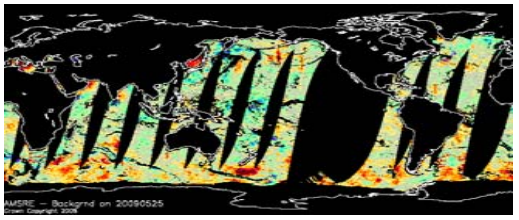
AVHRR

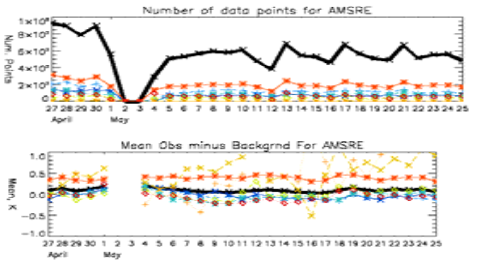
For 3 of the 8 data-sources used, plots show :

coverage for the day,

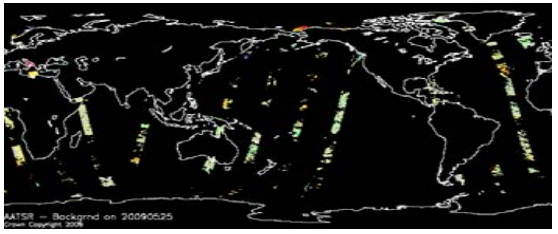
availability for month,

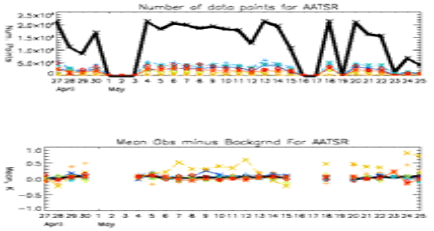
difference from background field for month





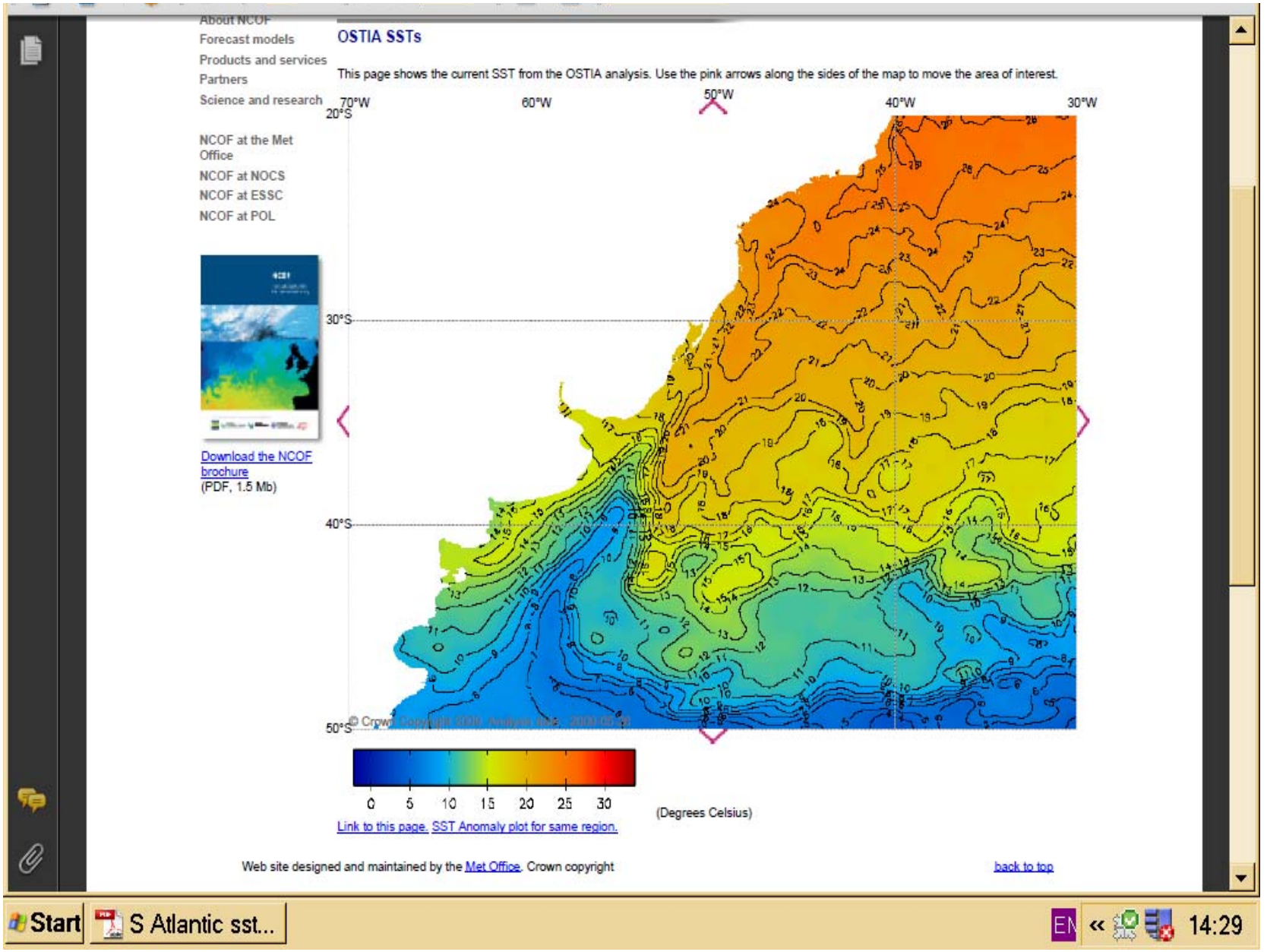
AMRSR-E (Aqua)





AATSR

OSTIA SST 27 May, 2009



GHRSST use of SOT Data

- The limited use of ship measurements by GHRSST is mainly due to a combination of their:
  - Non-uniform global data coverage, and
  - Relatively high uncertainty, in the case of non-radiometric measurements.
- The GHRSST project would like to establish closer links to the Ship Observations Team (SOT) to address both these issues, as improved coverage and uncertainties of SST data from ships would benefit a number of areas within GHRSST, not least in:
  - Satellite SST validation
  - Reanalysis
  - Diurnal warming studies

Summary & Conclusions

- For SST observations, GHRSST/OSTIA comprise, in effect, a CEOS Constellation
  - Should GHRSST be considered by WGCV to be an ideal example?
- Uniform Product Quality Requires consistent and stable validation
- There is a case for ‘Generic Validation’
  - But whole will pay for it?
  - What does WGCV think?