Remote Sensing Systems
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Continued Monitoring of Atmospheric Temperature Using Data from Microwave Sounding Instruments

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Outline

- Brief Project Overview
- Approach
- Results/Accomplishments
- Validation Strategy/Results
  Algorithm/Product Maturity
- Issues/Risks & Work-Off Plans
- Schedule
- Research-to-Operations or Delivery Plan
- Resources

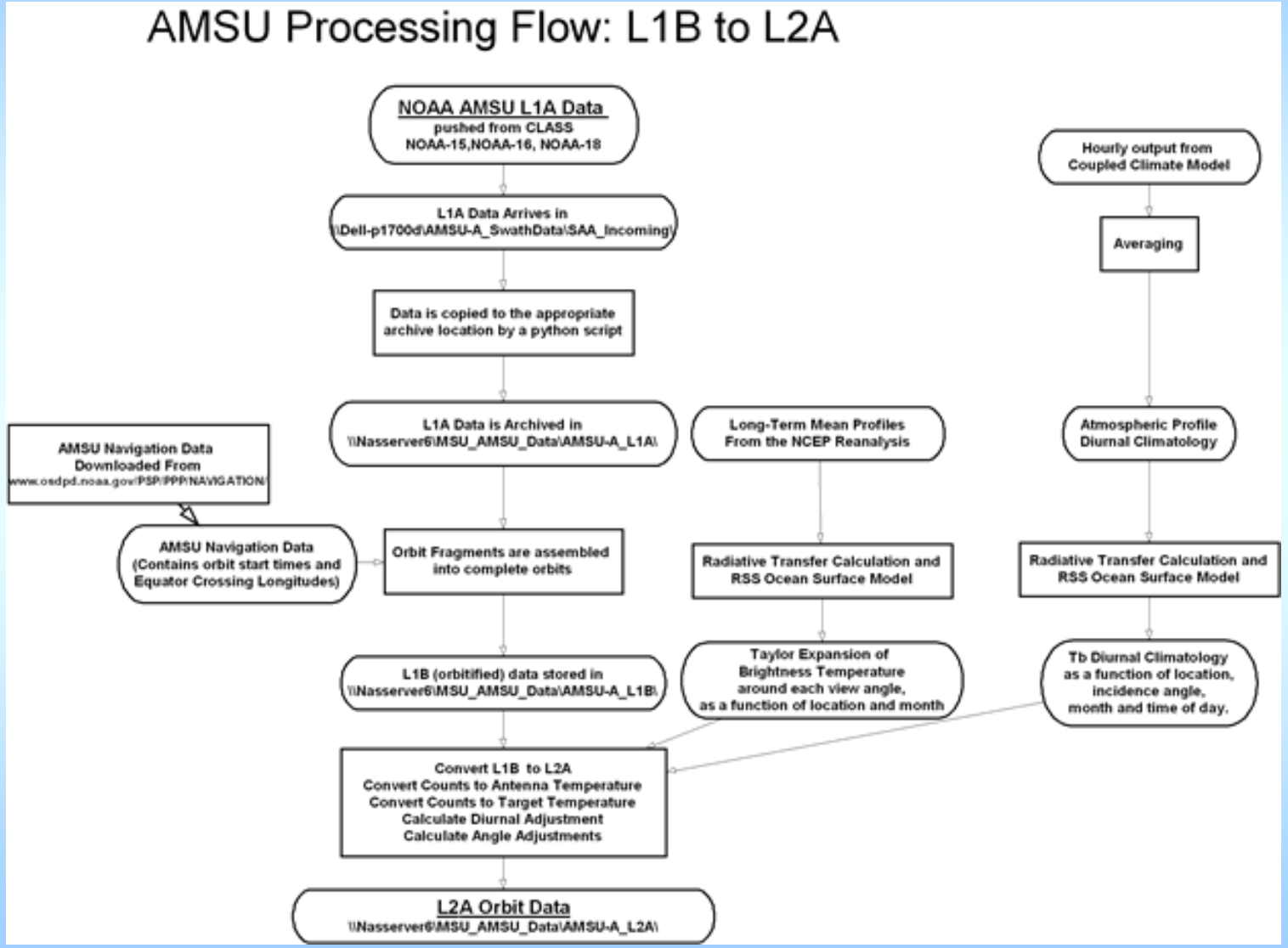
Overview

- Goals
  - Continued Monitoring of Atmospheric Temperature
  - Comprehensive Error Estimates
  - Streamlined Processing
- Source Data
  - MSU and AMSU on NOAA, NASA, and ESA satellites
- Deliverables
  - EVC datasets, error estimates, comparison to other datasets.
- ECVs addressed
  - Monthly gridded datasets of atmospheric temperature for 4 atmospheric layers (TLT, TMT, TTS, TLS)
- Current/expected user communities.
  - Global Change Research Community
  - Blogosphere

Approach – Dataset Production

- Ingest L1B data from satellites
- Apply adjustments to account for changes in orbital parameters
  - Orbital height – Earth incidence angle
  - Equator crossing time – Local time of observation – Diurnal Cycle
- Assemble measurements into monthly gridded averages
- Investigate differences between satellites to look for evidence of calibration problems
  - Offsets
  - Hot calibration target temperature effects
- Apply calibration adjustments
- Merge data from different satellites together

Approach – Dataset Production



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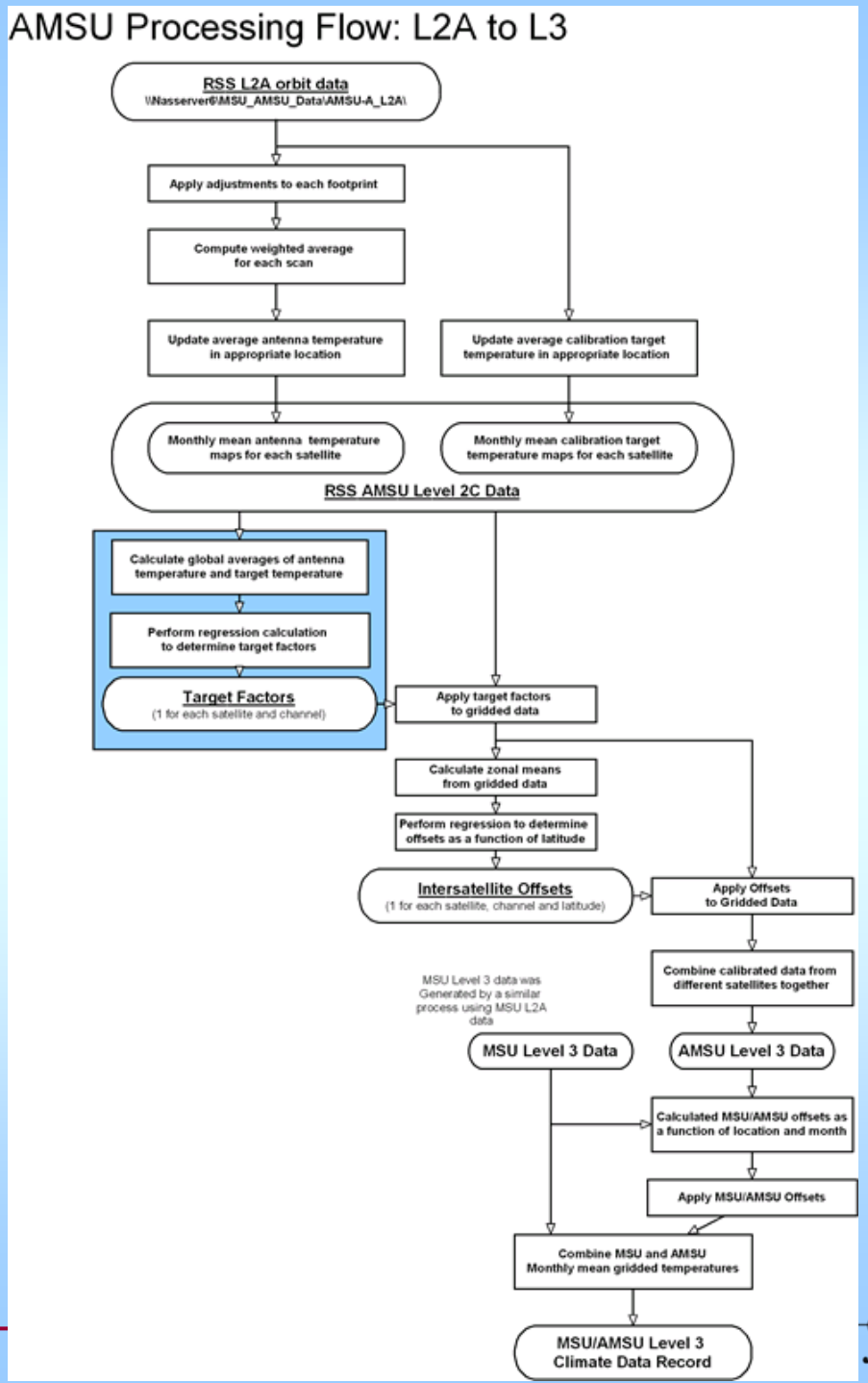


Approach – Error Estimation

- Errors in the merged dataset are complex in that they are strongly correlated in both time and space.
- Difficult to described using simple statistical ideas e.g. std. dev. of the estimated error for a single monthly measurement
- Full Monte-Carlo simulation of error process in all aspects of the merging algorithm, including
    - sampling noise
    - error in the diurnal cycle adjustment
    - the effect of these on the merging procedue
- RESULT – 400 random realizations of the expected error in the dataset.
- This result can be interrogated to estimate the error in any product derived from the dataset (More later)

Results/Accomplishments

- Current version of the merging algorithm is now fully documented in the referred literature.

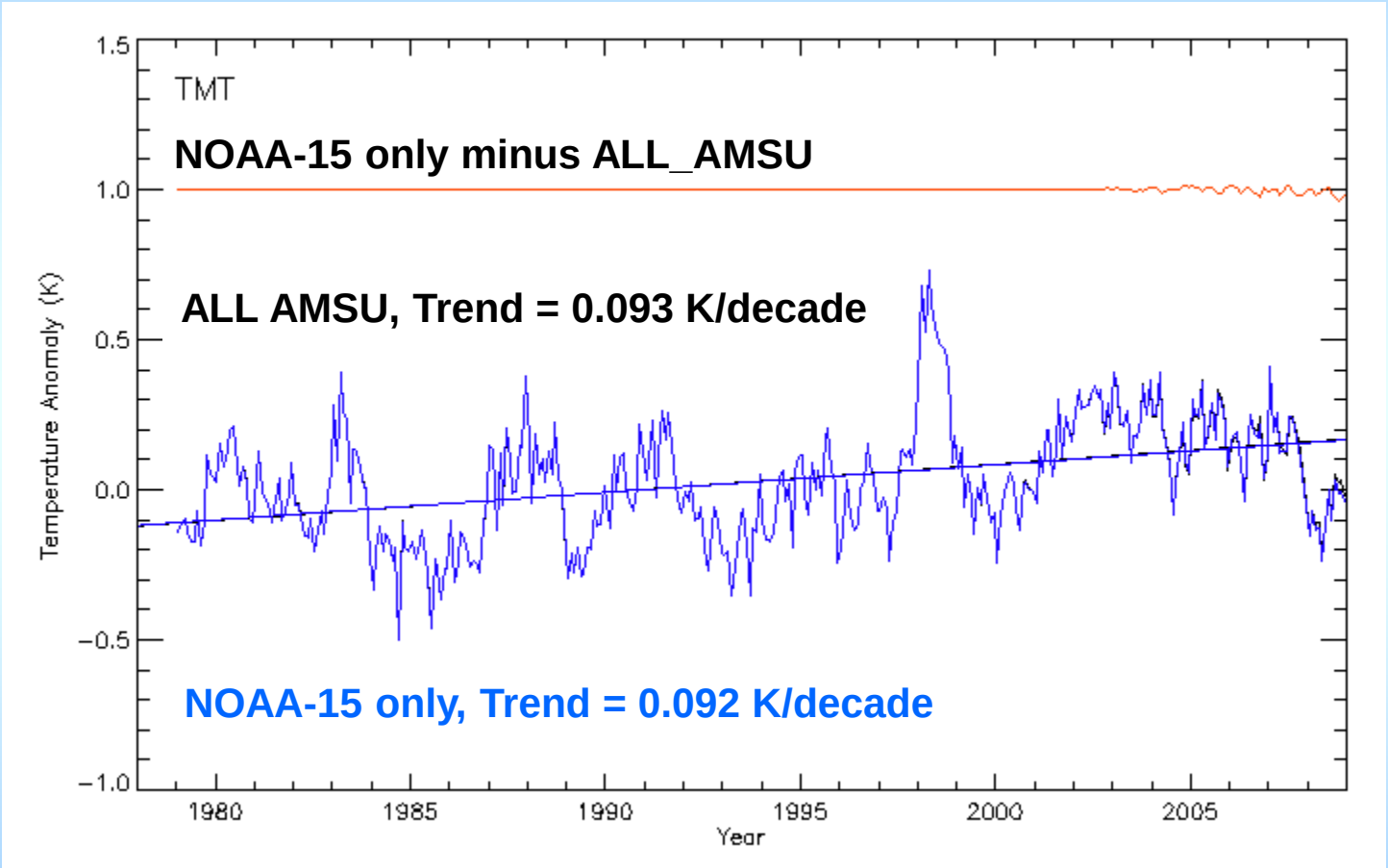
Mears, CA, FJ Wentz, 2009, Construction of the RSS V3.2 lower tropospheric dataset from the MSU and AMSU microwave sounders, *Journal of Atmospheric and Oceanic Technology*, 26, 1493-1509.

Mears, CA, FJ Wentz, 2009, Construction of the Remote Sensing Systems V3.2 atmopsheric temperature records from the MSU and AMSU microwave sounders, *Journal of Atmospheric and Oceanic Technology*, 26, 1040-1056.

- Data from NOAA-18, MetOP-A, and AQUA are ready to be included in the published dataset.
- Data from NOAA-19 are currently begin ingested – we will for 1 year of data before including in the merged dataset.

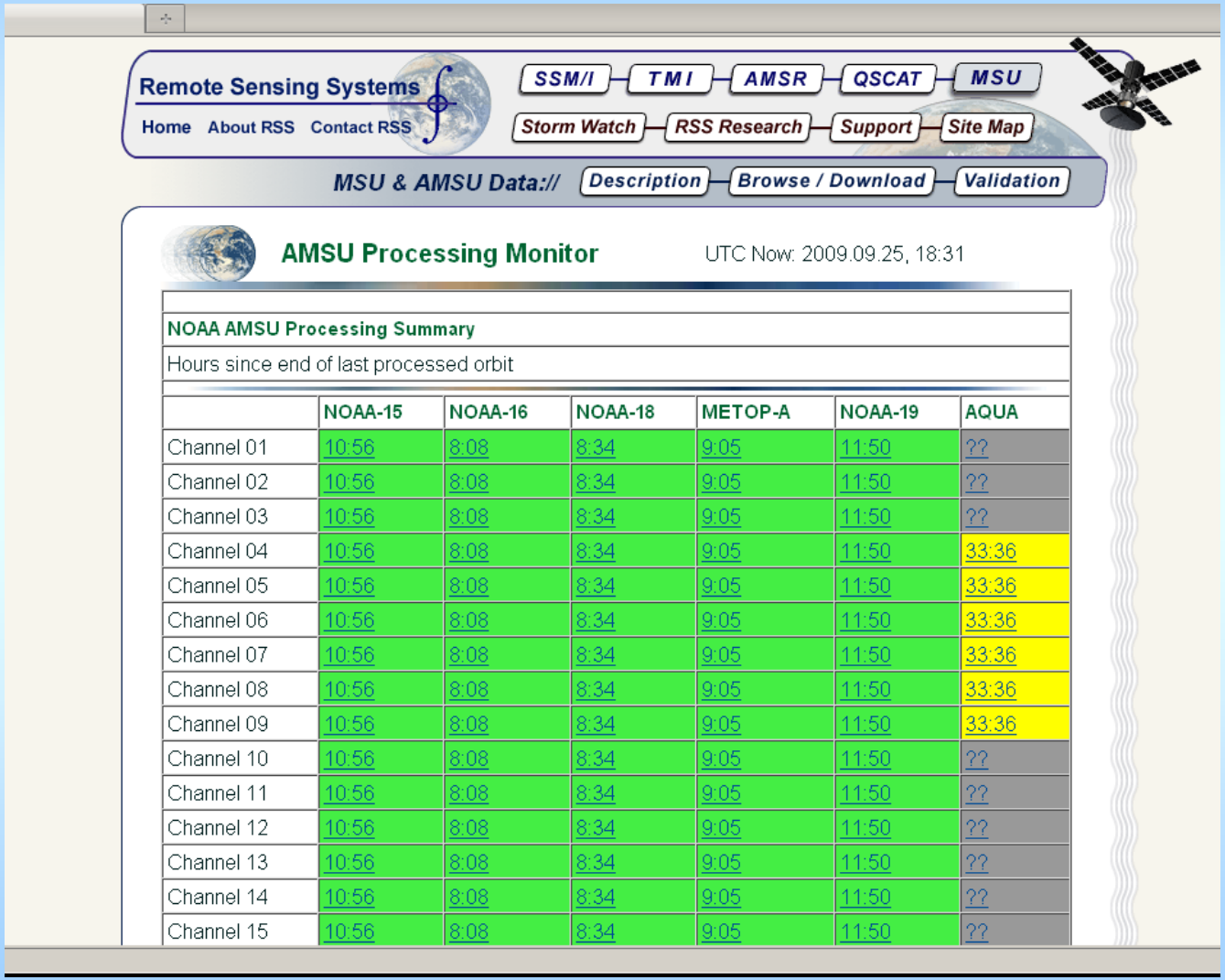
Results/Accomplishments

Including NOAA-18, MetOP-A, and AQUA makes little difference in Global Time Series



This is good news!

Web- based Processing Monitor



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Storm Watch RSS Research Support Site Map

MSU & AMSU Data:// Description Browse / Download Validation

AMSU Processing Monitor

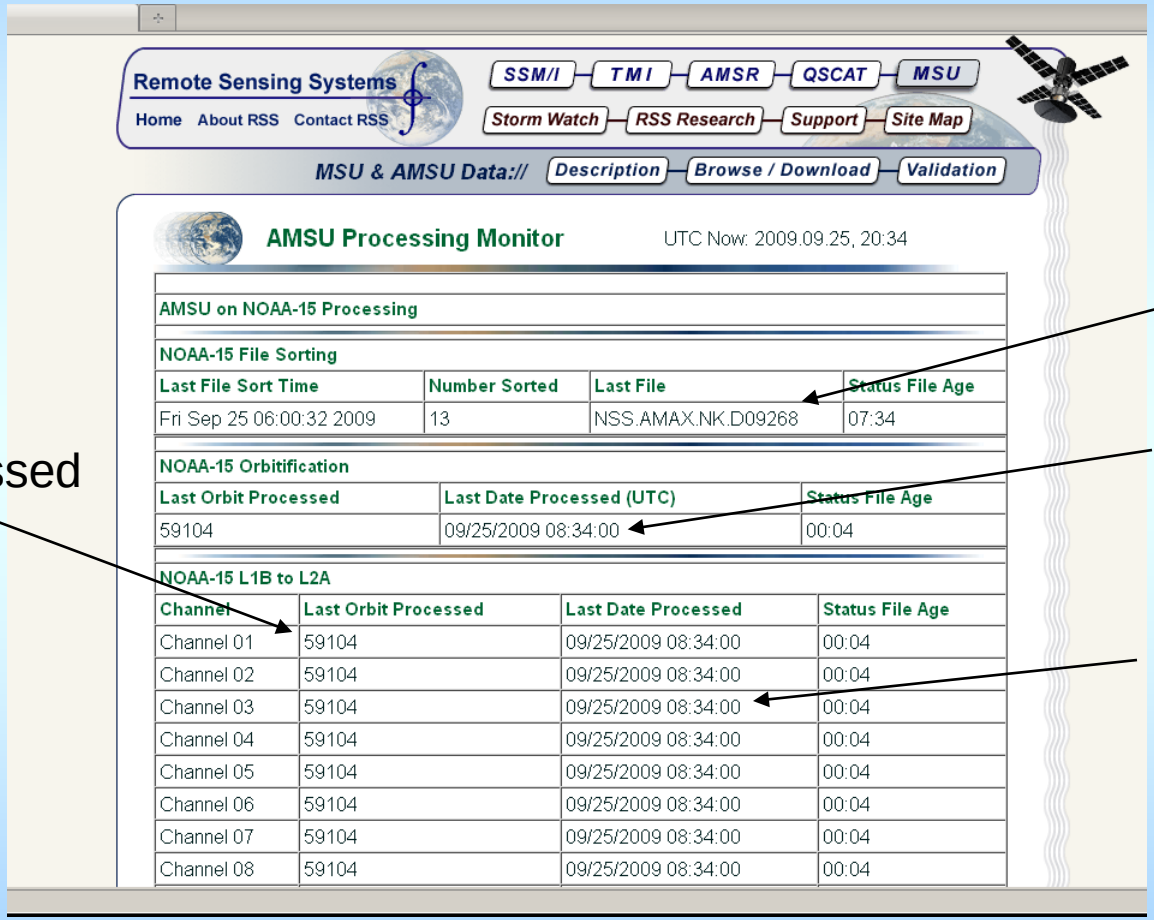
UTC Now: 2009.09.25, 18:31

NOAA AMSU Processing Summary

Hours since end of last processed orbit

	NOAA-15	NOAA-16	NOAA-18	METOP-A	NOAA-19	AQUA
Channel 01	10:56	8:08	8:34	9:05	11:50	??
Channel 02	10:56	8:08	8:34	9:05	11:50	??
Channel 03	10:56	8:08	8:34	9:05	11:50	??
Channel 04	10:56	8:08	8:34	9:05	11:50	33:36
Channel 05	10:56	8:08	8:34	9:05	11:50	33:36
Channel 06	10:56	8:08	8:34	9:05	11:50	33:36
Channel 07	10:56	8:08	8:34	9:05	11:50	33:36
Channel 08	10:56	8:08	8:34	9:05	11:50	33:36
Channel 09	10:56	8:08	8:34	9:05	11:50	33:36
Channel 10	10:56	8:08	8:34	9:05	11:50	??
Channel 11	10:56	8:08	8:34	9:05	11:50	??
Channel 12	10:56	8:08	8:34	9:05	11:50	??
Channel 13	10:56	8:08	8:34	9:05	11:50	??
Channel 14	10:56	8:08	8:34	9:05	11:50	??
Channel 15	10:56	8:08	8:34	9:05	11:50	??

Web- based Processing Monitor



Last orbit
Number processed

Last L1A File Processed

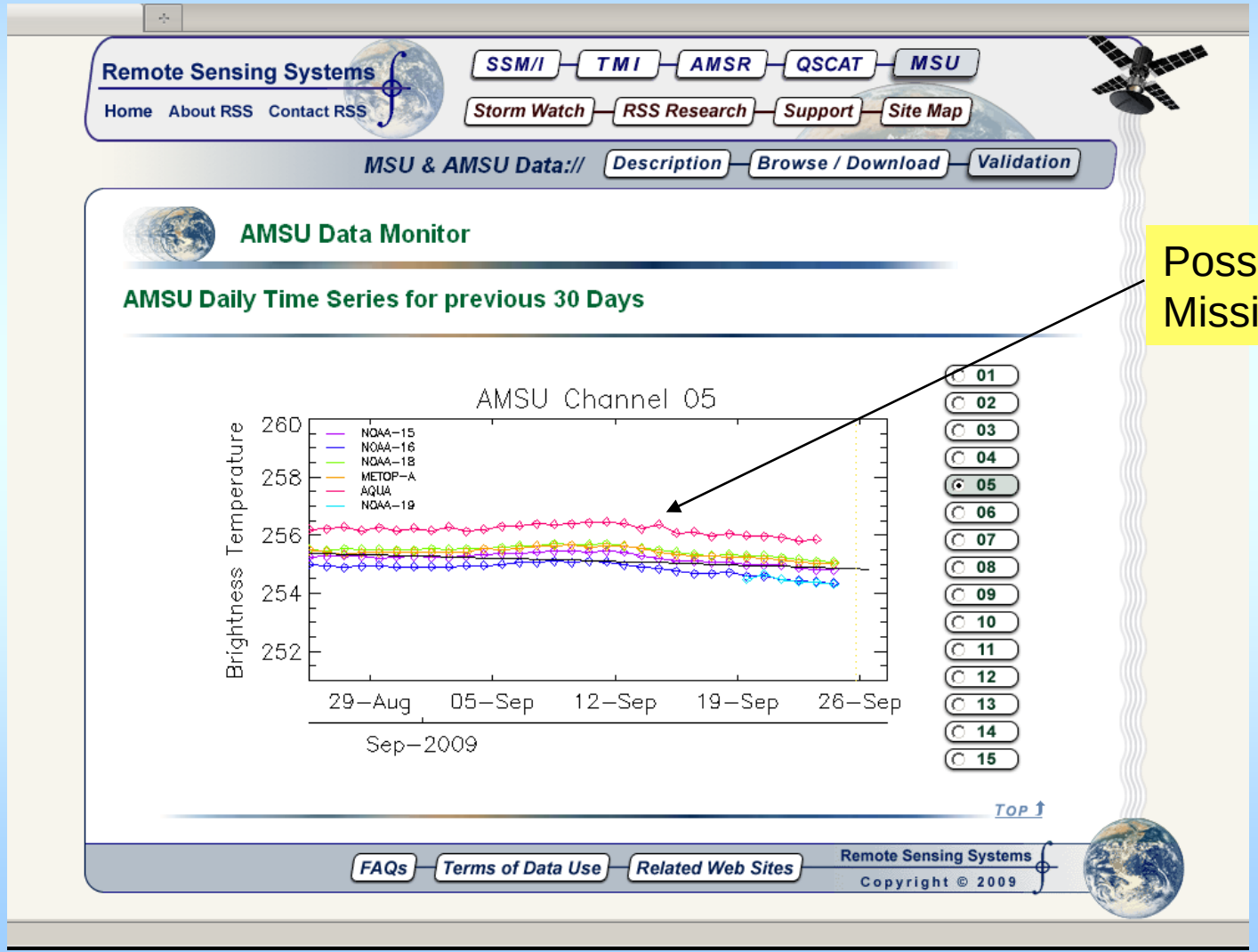
Date and time of last L1B swath

Date and time Of last L2A swath

Detailed yet easy to digest information makes it easy to spot processing problems

Web- based Processing Monitor

Daily time series can also help spot processing issues



Possible Missing Data

Validation Strategy/Results

- Compare Satellite results to adjusted radiosonde results
  - Can be done using the final monthly products
  - Four adjusted radiosonde datasets
    - HADAT (based on LKS) (Thorne et al)
    - RAOBCORE (uses ERA-40) (Haimberger et al)
    - RICH (no use of ERA-40) (Haimberger et al)
    - IUK (Sherwood et al)
  - Need to account for sampling (unlike CCSP, IPCC)

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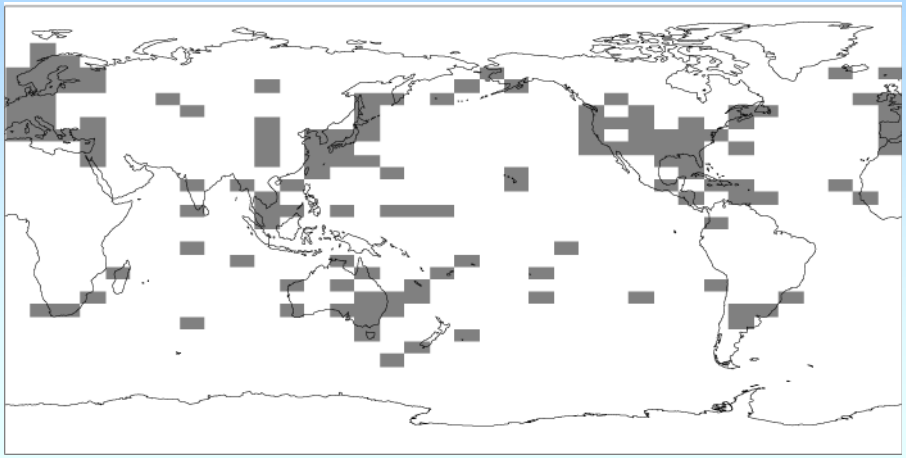
  - Need to account for spatial sampling.

Validation Strategy/Results

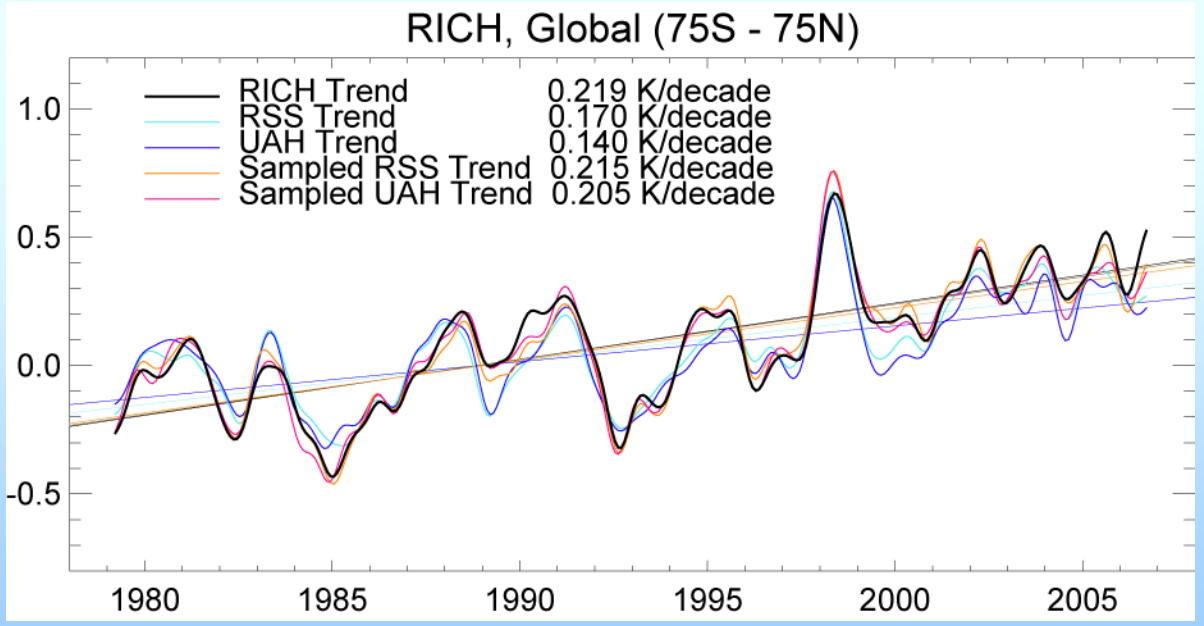


Typical Radiosonde Sampling (RICH)

Northern Hemisphere/Land-centric

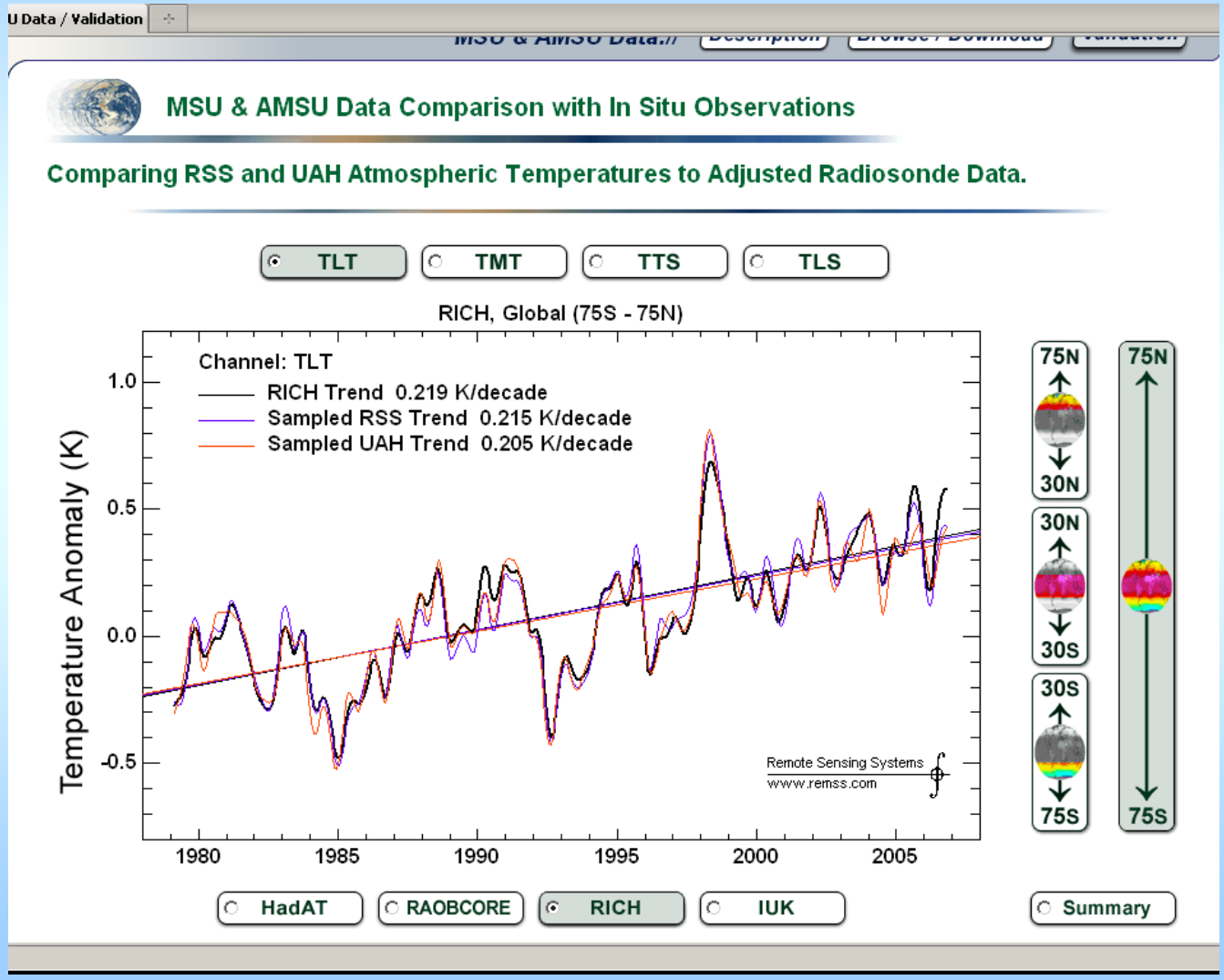
Miss main ENSO region, high southern latitudes

Agreement tends to improve on both short and long time scales after sampling is included.



Validation Strategy/Results

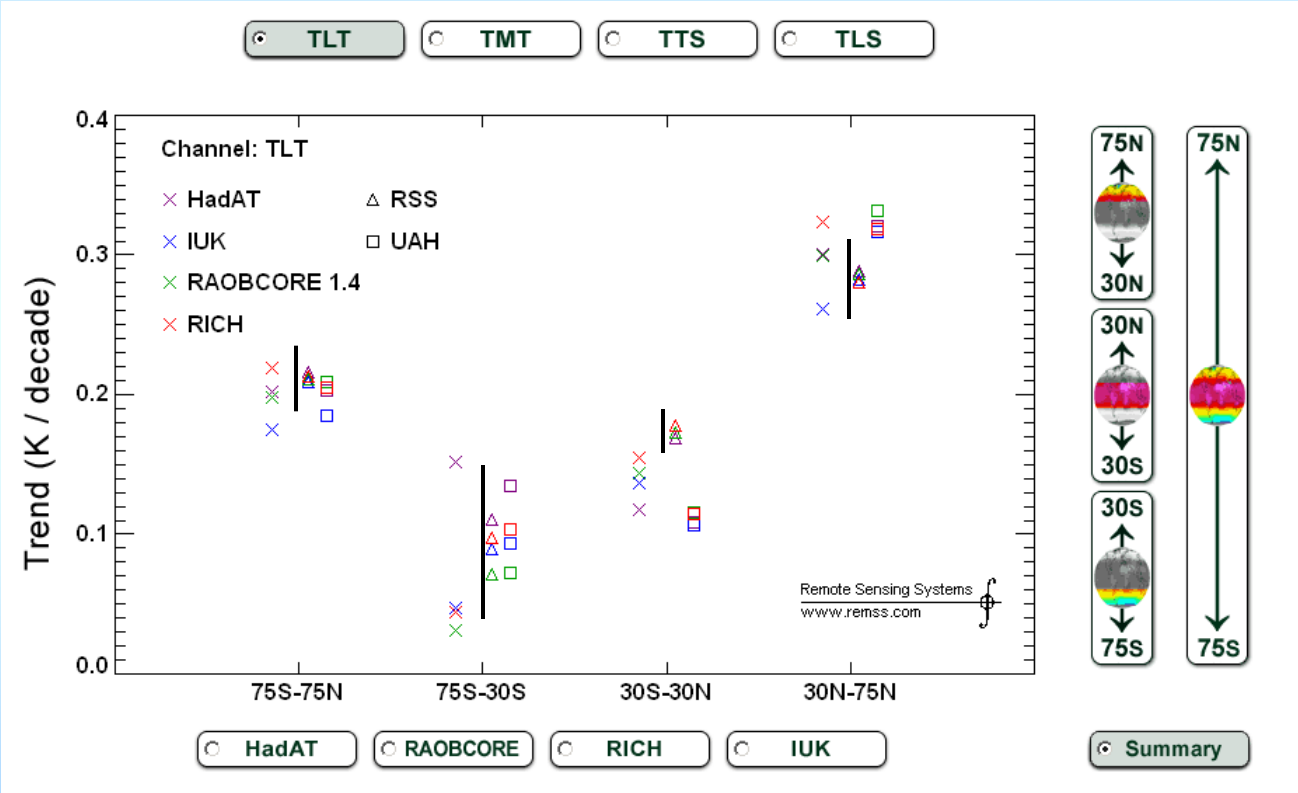
All results available on our website.



Validation Strategy/Results

Comparison with Homogenized Radiosonde Datasets

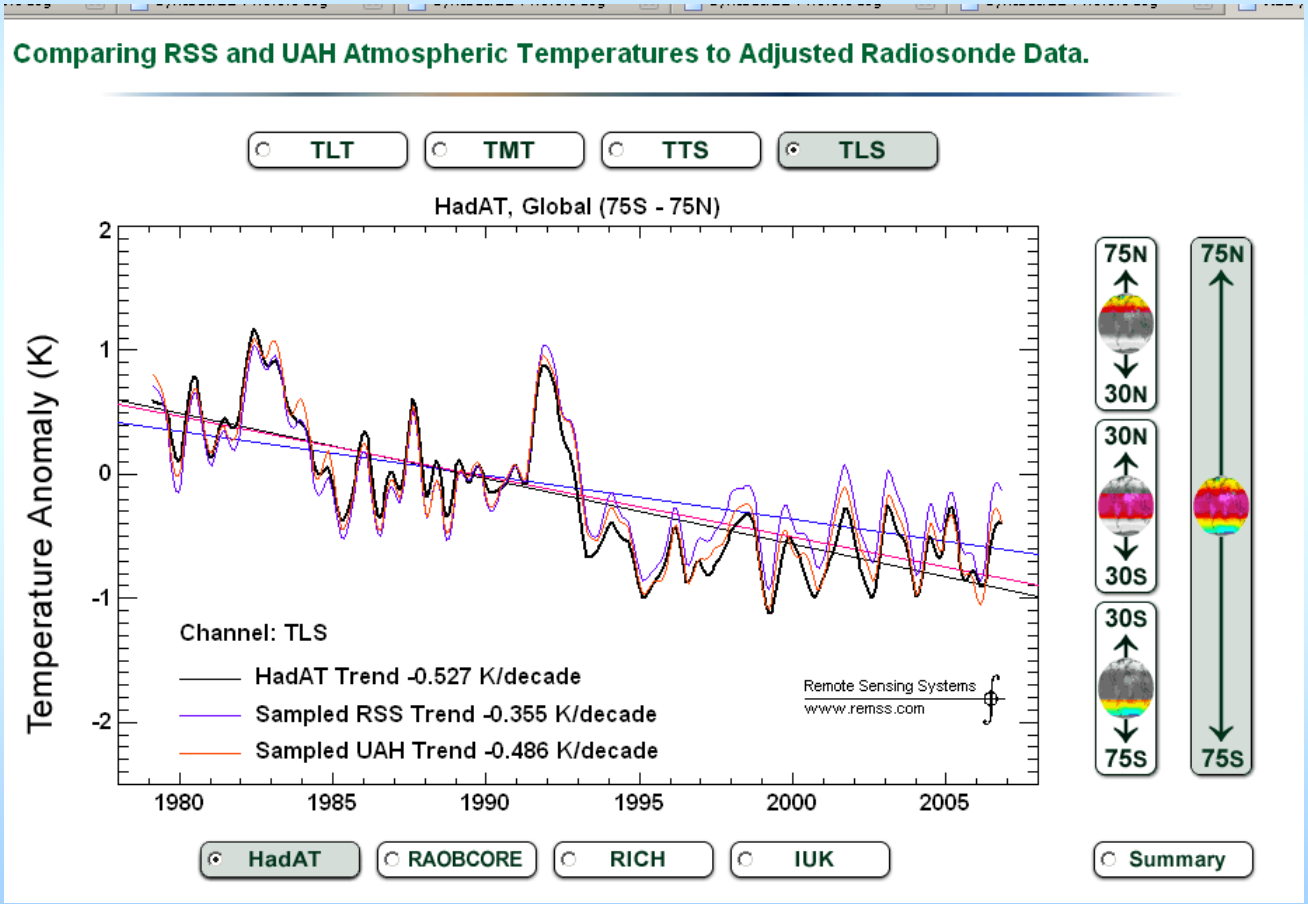
Summary of Trends.



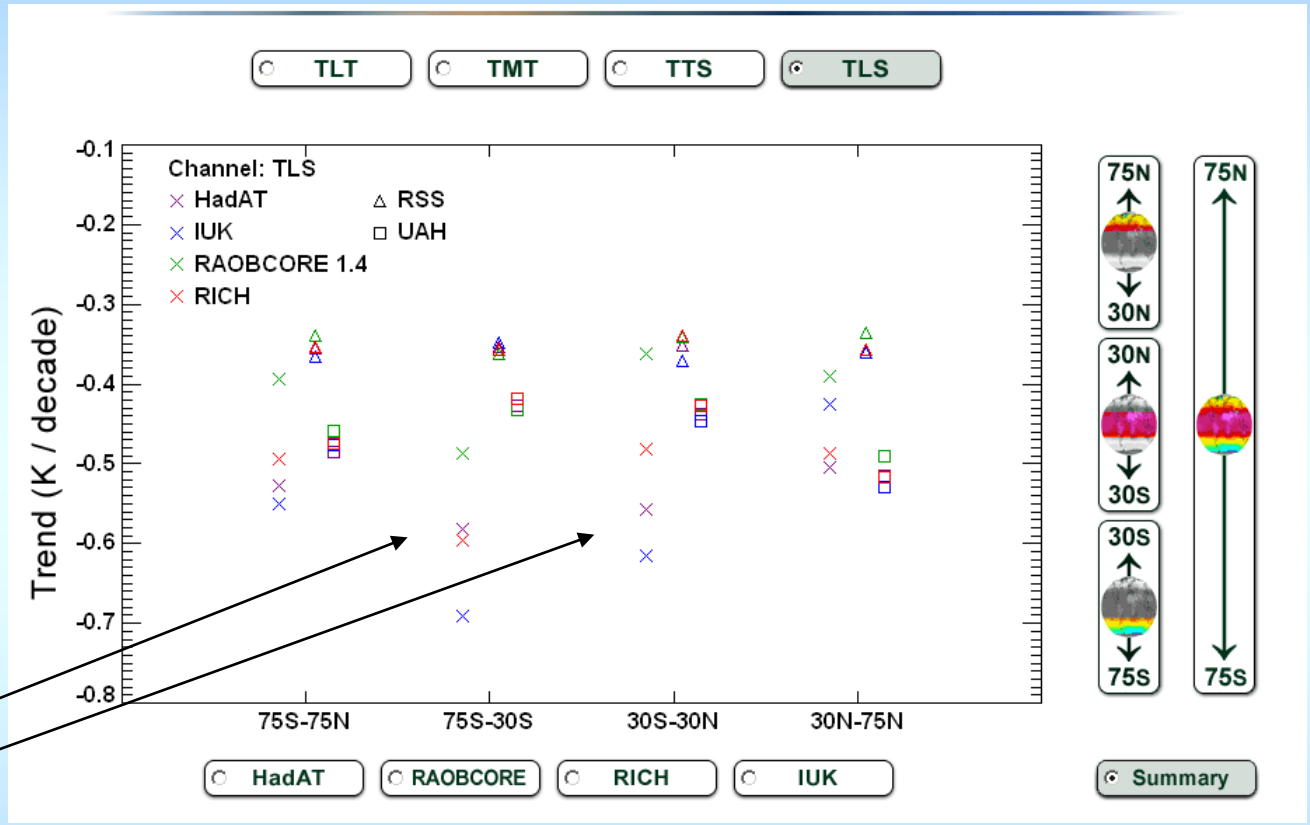
These plots are available on the web for all 4 channels

Validation Strategy/Results

Agreement not so good in the Stratosphere



Validation Strategy/Results



Radiosonde Trends large and negative in the tropics and southern latitudes

Probably a problem with the radiosondes

Product Maturity

Sensor Use	5	All relevant research and operational missions; unified and coherent record demonstrated across different sensors
Algorithm Stability	4	Minimal Changes Expected
Metadata and QA	3	Research grade (extensive); Meets international standards (CF compliant in netcdf form)
Documentation	~4	Peer- reviewed algorithm and product descriptions.
Validation	~4	Uncertainty estimated over widely distribute times/locations AND timescales by ONE investigator.
Public Release	4 (5 soon)	Multi- mission record is publicly available with associated uncertainty estimate.
Science Applications	6	Used in various published applications and assessments by different investigators (IPCC, CCSP, etc)

Issues/Risks & Work- Off Plans

Issues: No current issues

Risks:

Satellite Failure

5 satellites currents in operation – risk minimal

Computer Failure/Internet Attack

Entire system (including all data) backed up in 3

sets of drives, in 2 locations, one set is not installed.

None are “visible” to outside world

Random calibration walk

Eventually current scheme of calibration via overlap analysis will yield too-large errors. Reference sondes.

Defunding/Hit by Bus

????

Schedule

Next few months:

1. Release Version 3.3, which included data from AMSU on NOAA-18, AQUA, and MetOP-A
2. Submit paper on error analysis

Next 18 months:

1. Streamline and modularize processing system – port as many components as possible to python. (HDF-EOS4??)
2. Get ready for ATMS on NPP – Jan 2011 launch?
3. Improve monitoring tool/automatic report generation

Research- to- Operations or Delivery Plan

By the end of this cycle of SDS funding, the processing system will be ready to start thinking about conversion to an operational system.

QUESTIONS:

Would we begin at low-level processing – e.g. L1B to L2A?

(a quality controlled L2A dataset might be useful to many researchers)

Procedures for algorithm and code review? Version control?

Who is responsible for decisions after operationalizing?

How long should dataset continue to be valid after PI demise/distraction?

Resources

- Number of personnel employed for project
  - 3 Total, 0.45 FTE
- Key equipment or observatories used
  - AMSUs on NOAA, NASA, and ESA satellites
- Key collaborating projects or personnel
  - Cheng-Zhi Zou, NOAA
    - My hope is that this project functions like a product-based science team.
- Target NOAA Data Center (if known)
  - NCDC, presumably