GHRSST-PP

GODAE High Resolution Sea Surface Temperature Pilot Project

NOAA and the GODAE High Resolution SST Project

Presented By Ken Casey (NESDIS/NODC) and
Gary Wick (OAR/ESRL)

http://www.ghrsst-pp.org

Motivations

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- To inform the NOAA SST community about our current involvement in GHRSST
- To discuss how NOAA can play leading roles in future "G"HRSST:

  GODAE → Global/GEOSS
- To prepare for the Nov 28 US-GHRSST meeting discussing coordinated US involvement

Overview

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- What is the GHRSST-PP?
  - Overview
  - Goals
  - Collaboration Challenges
  - Scientific Challenges
- What does GHRSST Produce?
  - L2P, L4, CDR, Diagnostic Data Sets
  - Integrated data stewardship
- How is NOAA already involved?
  - Scientific contributions (ORA, ESRL, NCDC)
  - Long Term Stewardship and Reanalysis (NODC)
- How might NOAA be involved in the future?

What is the GHRSST-PP?

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- GODAE is an international project dedicated to the development of *operational global ocean analysis and prediction systems*
- GODAE depends on high-quality SST data products to *constrain upper ocean circulation and thermal structure of ocean models*
- Global coverage SST data products need to:
  - be **accurate** (to better than 0.5K),
  - be **operationally available** in near real time (daily),
  - have **high spatial resolution** (<10km), and
  - have **high temporal resolution** (6-12 hours).
- In 2000, there were no SST products that could satisfy these requirements: so the IGST initiated the GHRSST-PP

GHRSST-PP Goals

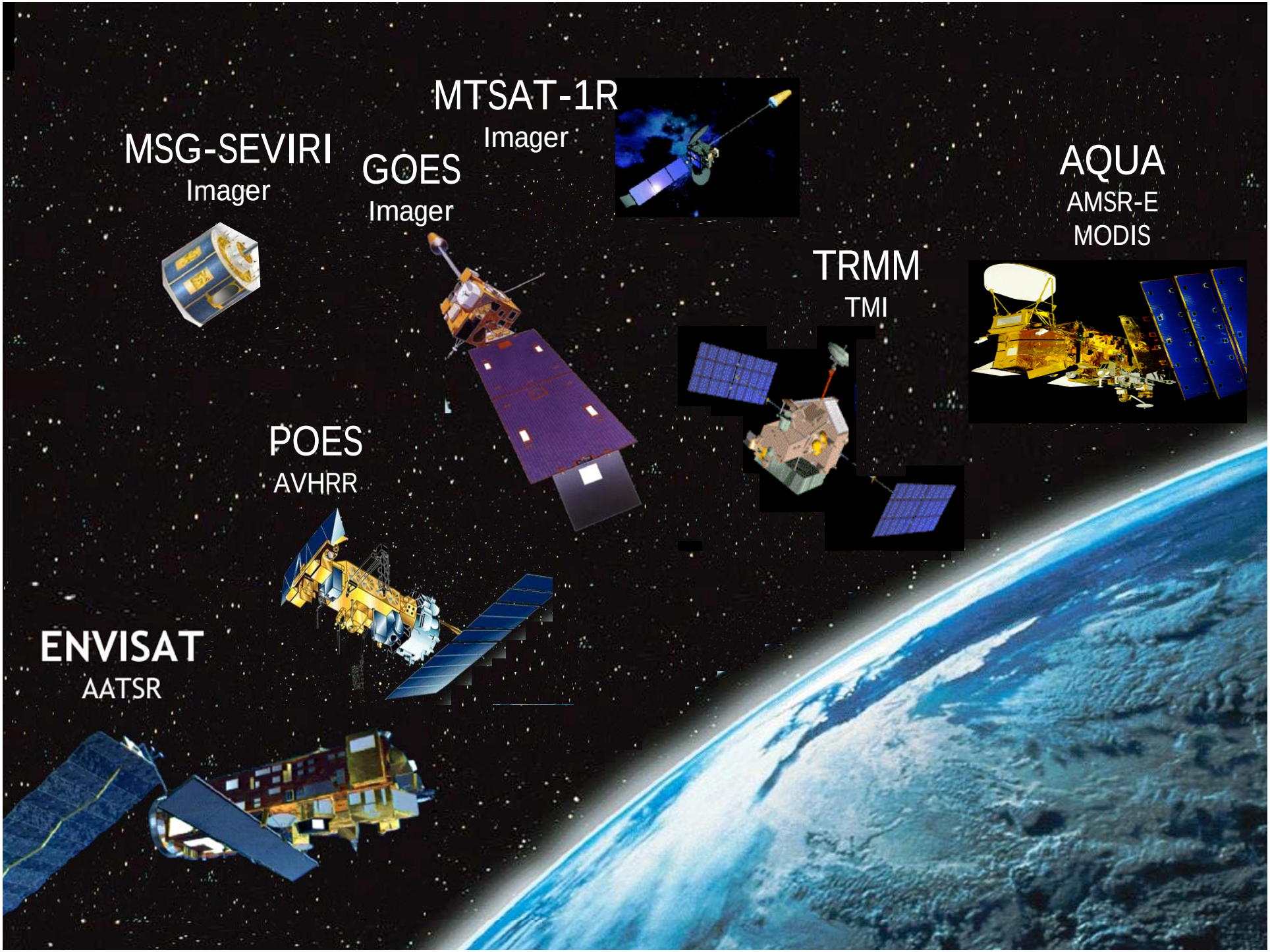
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Provide the next generation of global SST products for operational and climate users
  - Create integrated common format products (SST, Sea Ice, uncertainties, auxiliary QC)
  - Create operationally efficient and scientifically valid methodologies for real time fusion of SST data
  - Deliver products to applications in national, regional and international communities
  - Minimize duplication of activities within the global SST Community
  - Develop comprehensive real-time *and* retrospective systems


MTSAT-1R
Imager
MSG-SEVIRI
Imager
GOES
Imager
AQUA
AMSR-E
MODIS
TRMM
TMI
POES
AVHRR
ENVISAT
AATSR

Collaboration Challenges

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- How do you get everyone to work together?
  - Different missions
  - Different user requirements
  - Different data access philosophies
  - Different institutional requirements
  - Different budgets
  - Different technical experience

Regional/Global Task Sharing

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

Regional Data Assembly Centres (RDAC)

RDAC | RDAC | RDAC | RDAC | RDAC

SST data products (L2P, L4)

↓

Ingestion, Dissemination and Processing Service (IDPS)

Global Data Analysis Centre (GDAC)

Product Rolling Archive | Metadata repository (MMR) | HR-DDS archive | USA | EU | Matchup database (MDB)

↓

Global L4 analysis systems…

Global coverage L4 SST products

↓

GHRSST-PP Long Term Stewardship and Reanalysis Facility (LTSRF) at NODC

Historical time series SST CDR products

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A working demonstration of GEOSS!

Scientific Challenges

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Quantify the uncertainty in the SST observations due to:
  - SST algorithms
  - Atmospheric transmission models
  - Cloud/aerosol contamination in IR
  - Rain/RF/sidelobe contamination in microwave
  - Sea Ice impacts on SST in marginal ice zone
  - In situ vs. Satellite SST differences
  - Diurnal variability
  - Instrument stability and calibration
  - Optimal data analysis/merging system
- Validation is a key issue for GHRSST-PP!

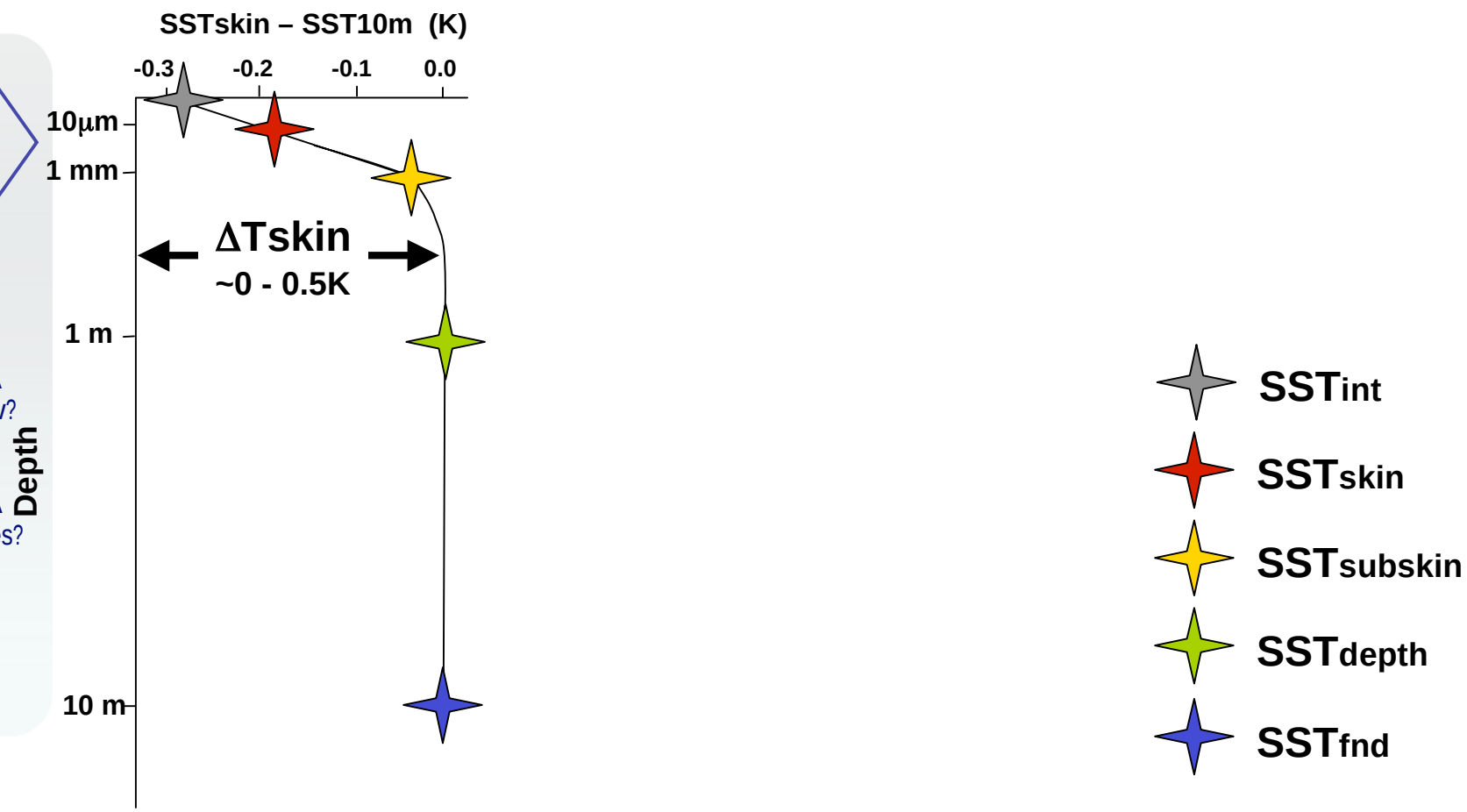
Definitions of SST

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



(a) Night time situation, light wind

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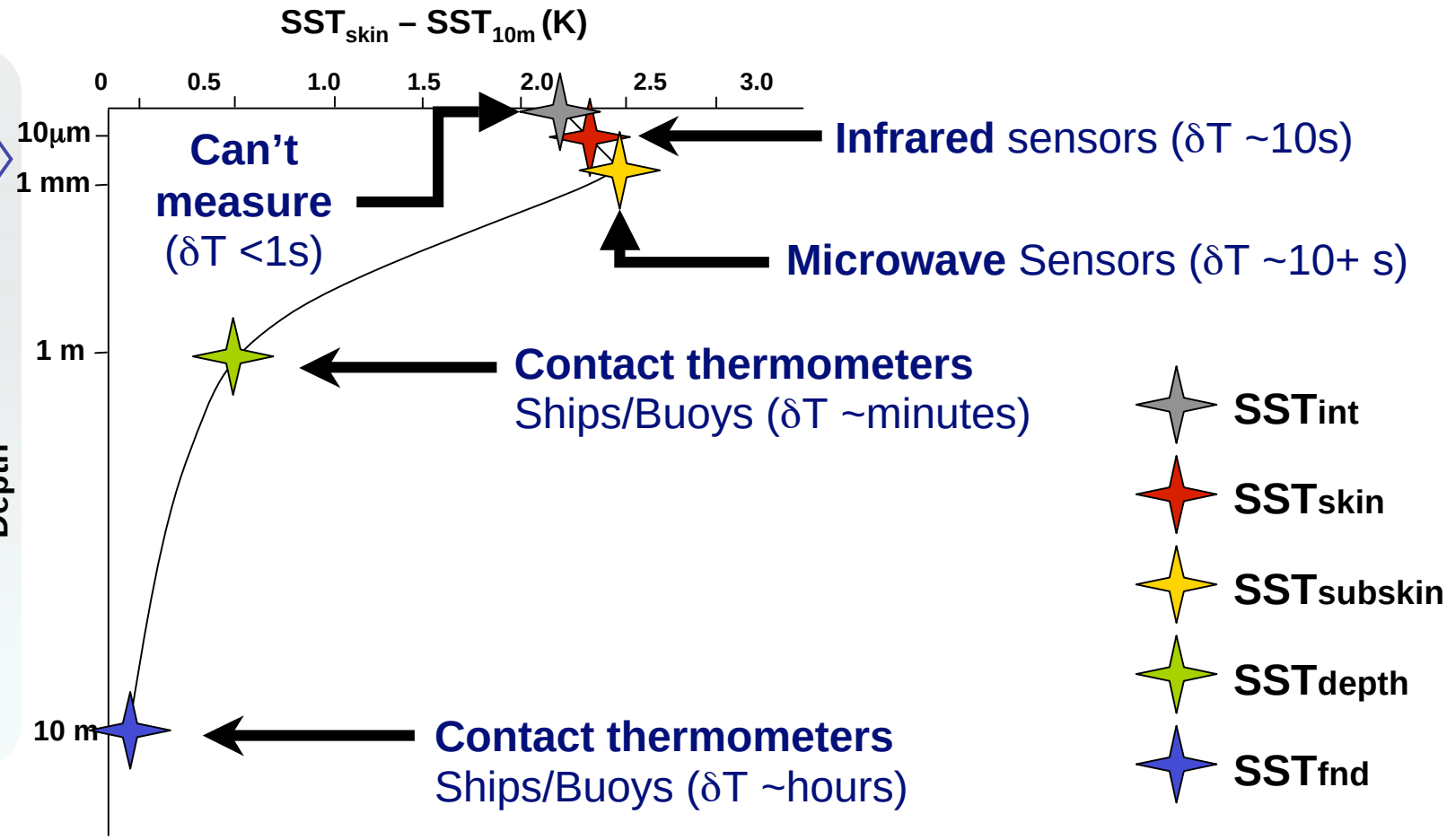
Measurements of SST

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



Day time situation, strong solar radiation and light winds

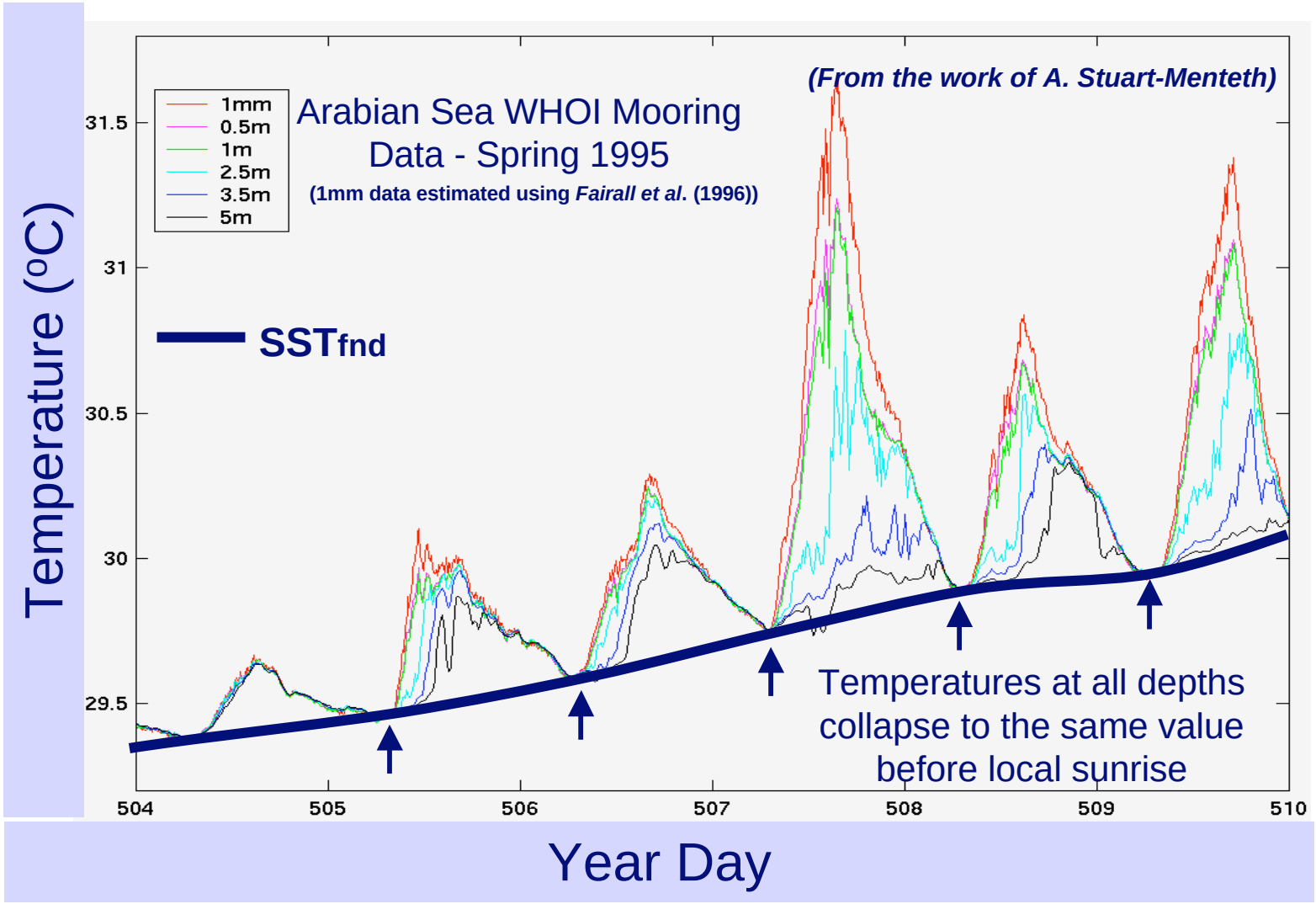
Foundation SST

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



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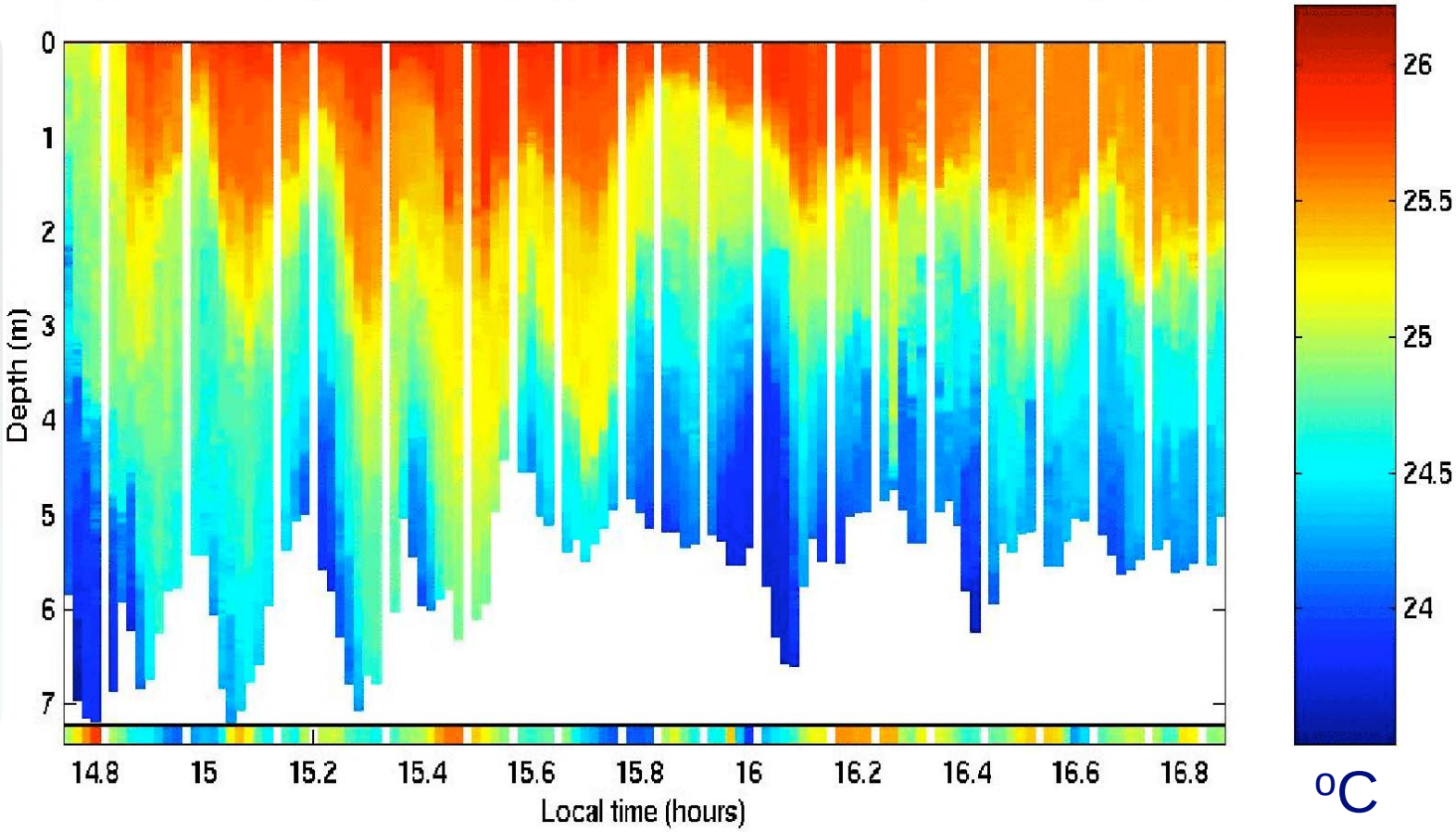
Time Evolution of Near-Surface Thermal Gradients

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



SkinDeEP profiles on 12 October 1999. Off Baja California, R/V *Melville*.,
From Ward, B. and P. J. Minnett, 2001

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GHRSST-PP Products

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- A comprehensive suite consisting of individual sensor SSTs and gap-free analyses, in real time and delayed mode:
  - Operational real time SST Observations (L2P)
  - Operational real time SST Analyses (L4)
  - Delayed mode Climate Data Records (CDR)
- Plus products, tools and systems for their validation, delivery, and stewardship:
  - Diagnostic Data Sets (DDS)
  - Matchup Database (MDB) and Master Metadata Repository (MMR)
  - Integrated product delivery and stewardship

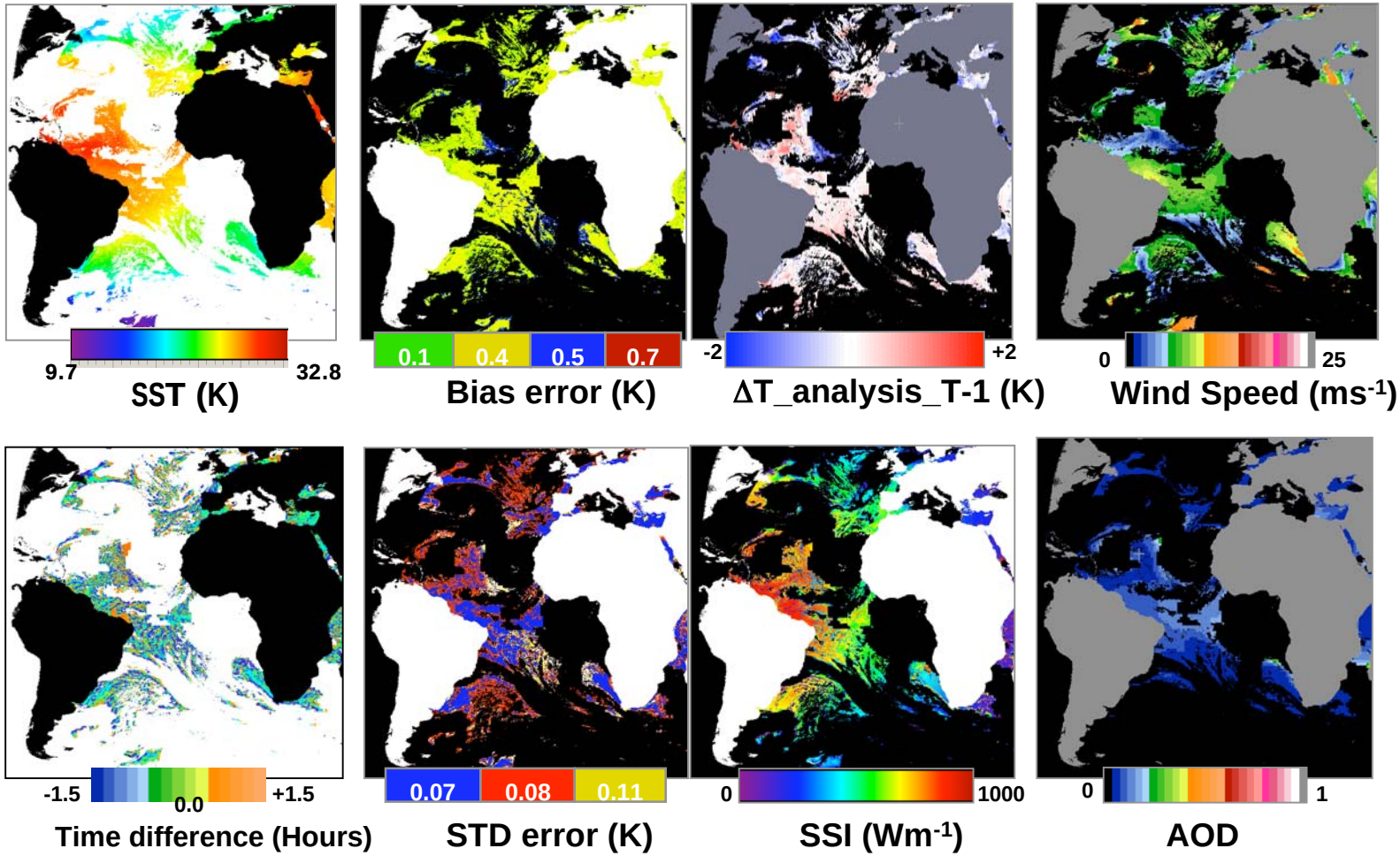
L2P Operational SST Products

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



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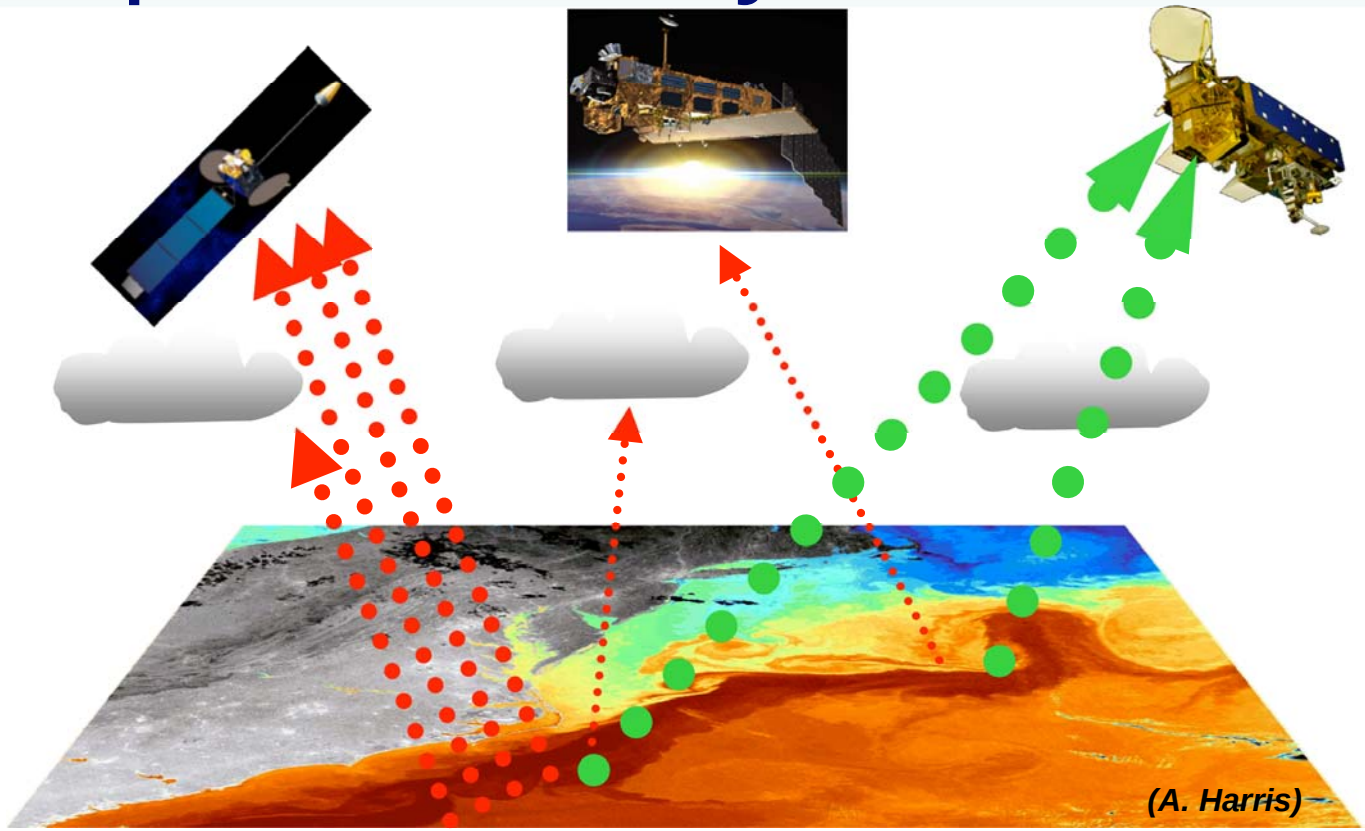
L4 Gap-Free Analysis Products

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



- Polar Orbiting infrared has *high accuracy & spatial resolution*
- Geostationary infrared has *high temporal resolution*
- Microwave Polar orbiting has *all-weather capability*

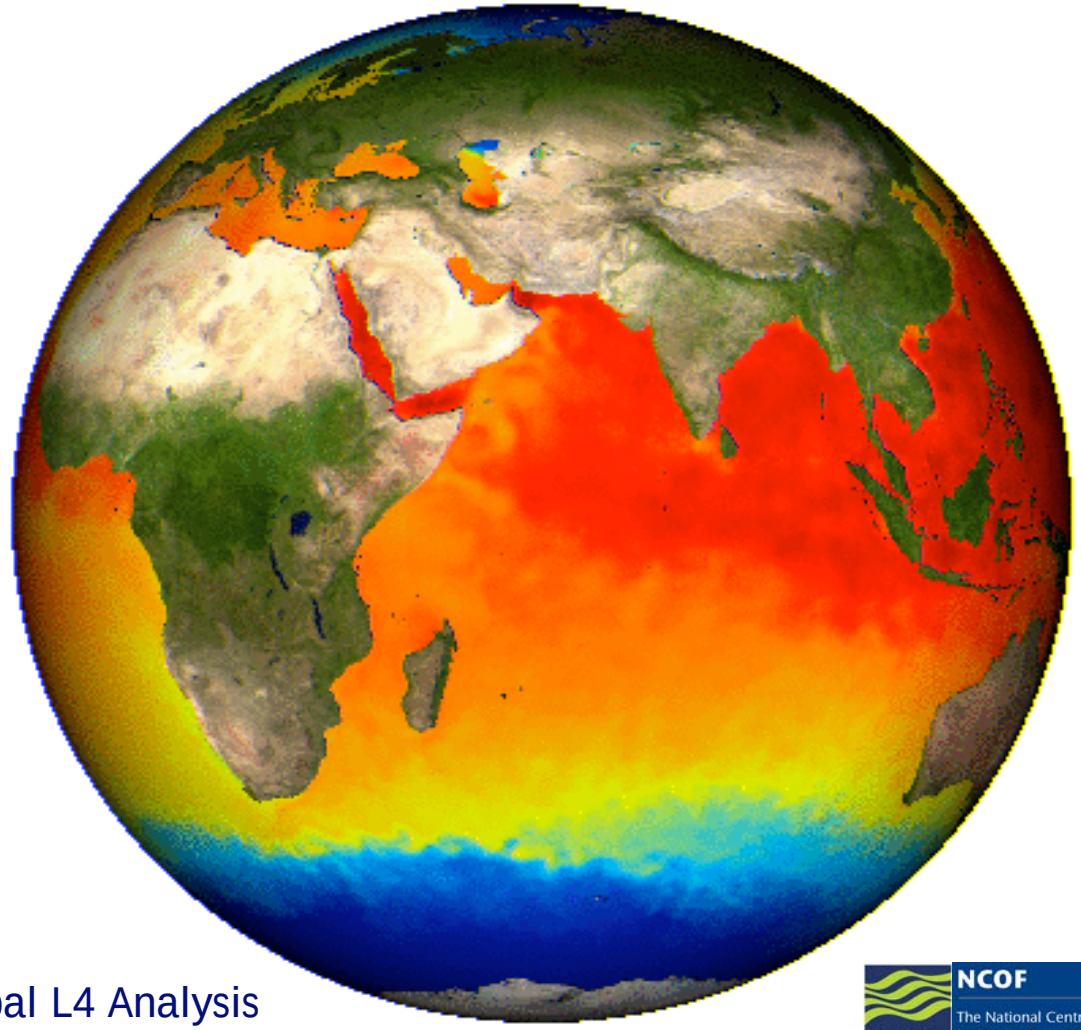
L4 Analysis Products

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



OSTIA Global L4 Analysis

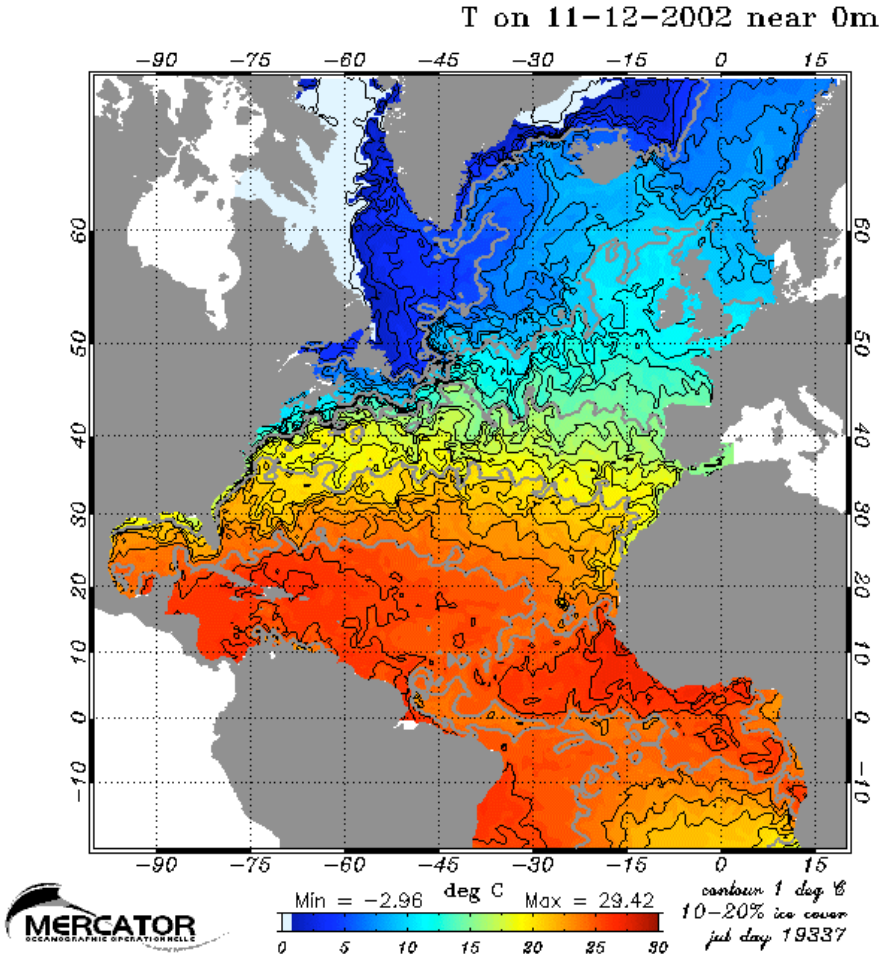
L4 Analysis Products

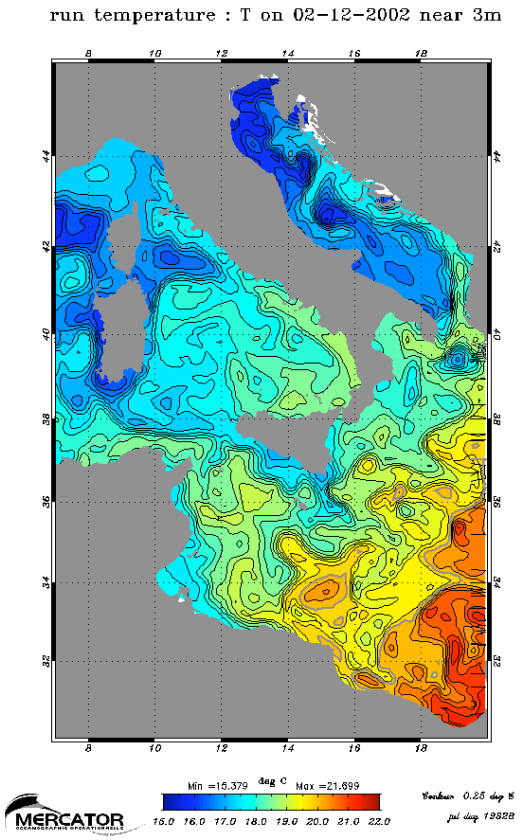
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?





Basin scale and Ultra-High Resolution regional L4 Analyses

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L4 Reanalysis CDRs

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Effort led by international Reanalysis Technical Advisory Group
- Create delayed mode products with higher accuracy and consistency - *Climate Data Records (CDRs)*
- Link to longer term climate records
- Enable a <u>sustained</u> reprocessing capability
  - Build on the implementation experience of NOAA/NASA Pathfinder

L4 Reanalysis CDRs

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

Reanalysis can take advantage of…

- New uncertainty estimates – consider more detailed systematic sensor dependent errors rather than just statistical errors
- New in situ/L2P data that didn't make it into the real-time operation
- Retrospectively reprocessed data like Pathfinder
- New L4 analysis systems and techniques

And…

- Aims to reprocess back to early 1980s based on Pathfinder AVHRR, (A)ATSR, and other single sensor reprocessing efforts

The Need for Reanalysis CDRs

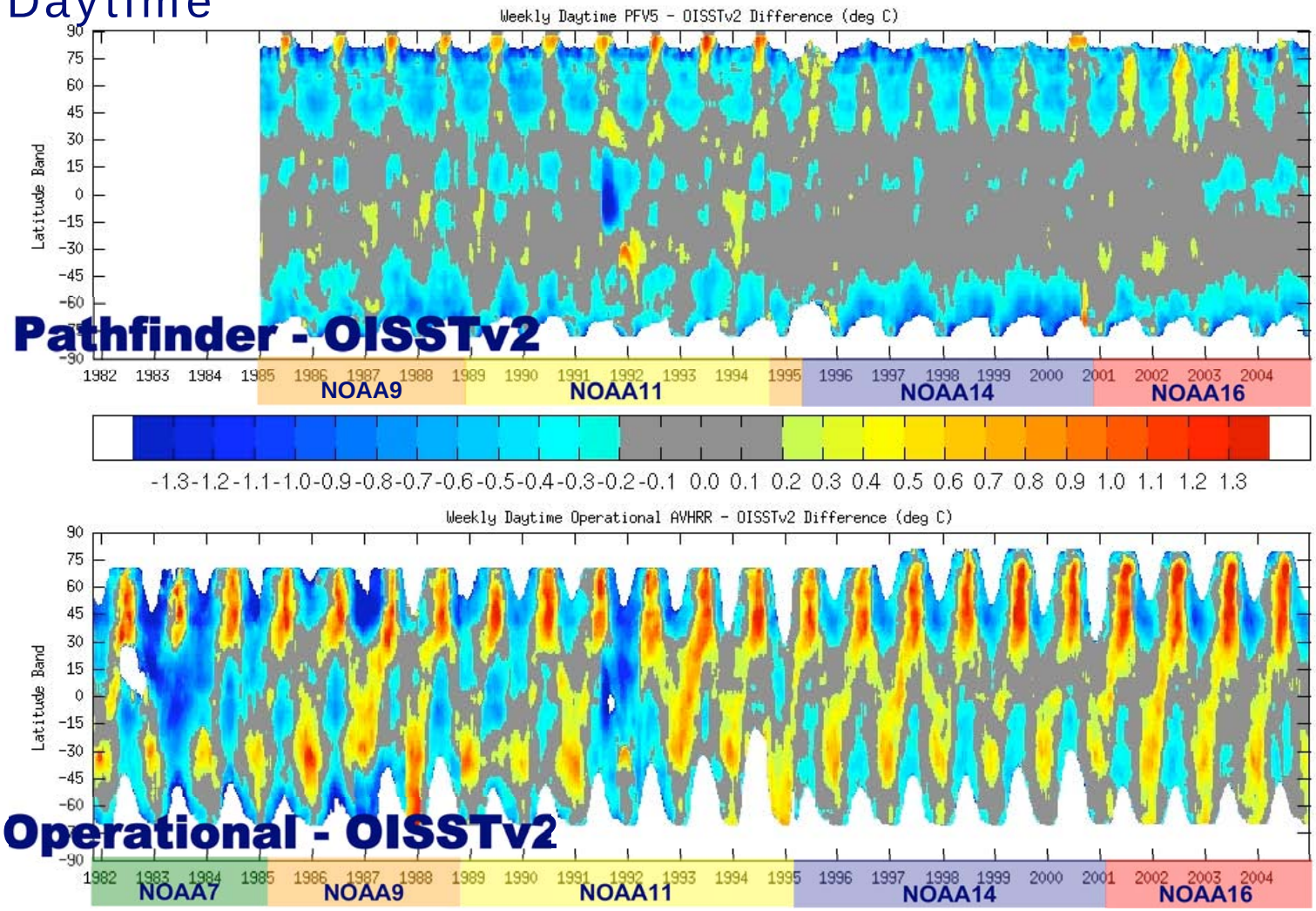
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

Daytime



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Diagnostic Data Set Systems

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- GHRSST Diagnostic Data Set (DDS) Systems consist of:
  - Retrospective diagnostics, intercomparisons, and ensembles
  - Real time, operational high resolution intercomparisons (HR-DDS)

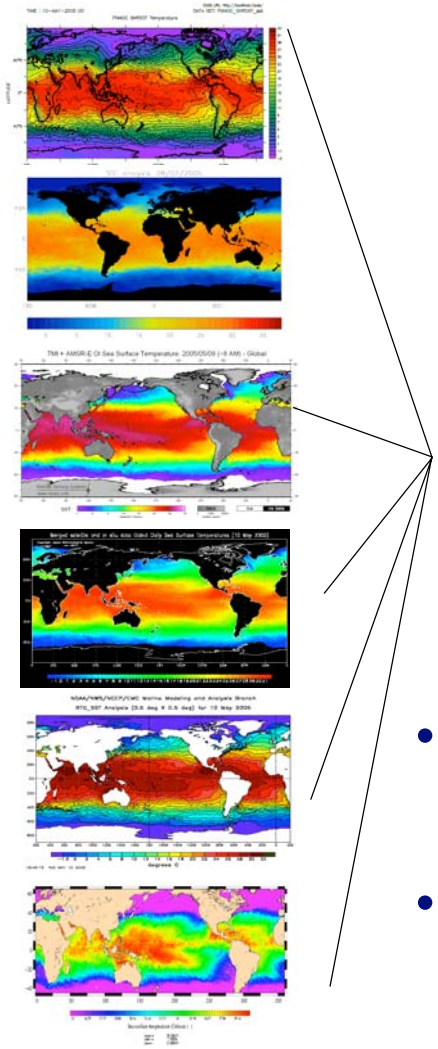
L4 Ensembles + Intercomparisons

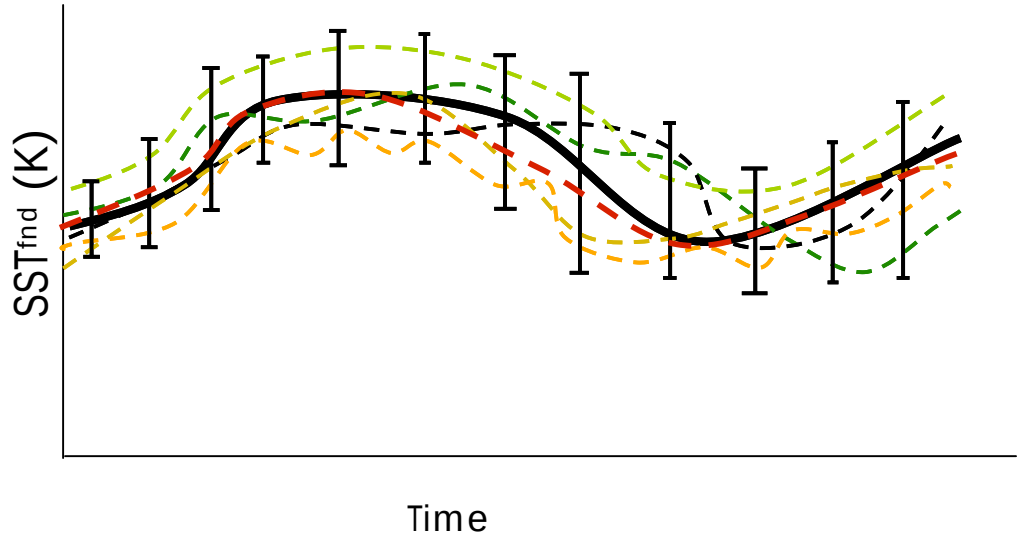
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?





- Initial ensemble approach - preserves individual autonomy, stimulates better products and science
- Framework to deliver the ensemble products and intercomparisons under development

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Operational High Res - DDS

What is GHRSST?

GHRSST Products?

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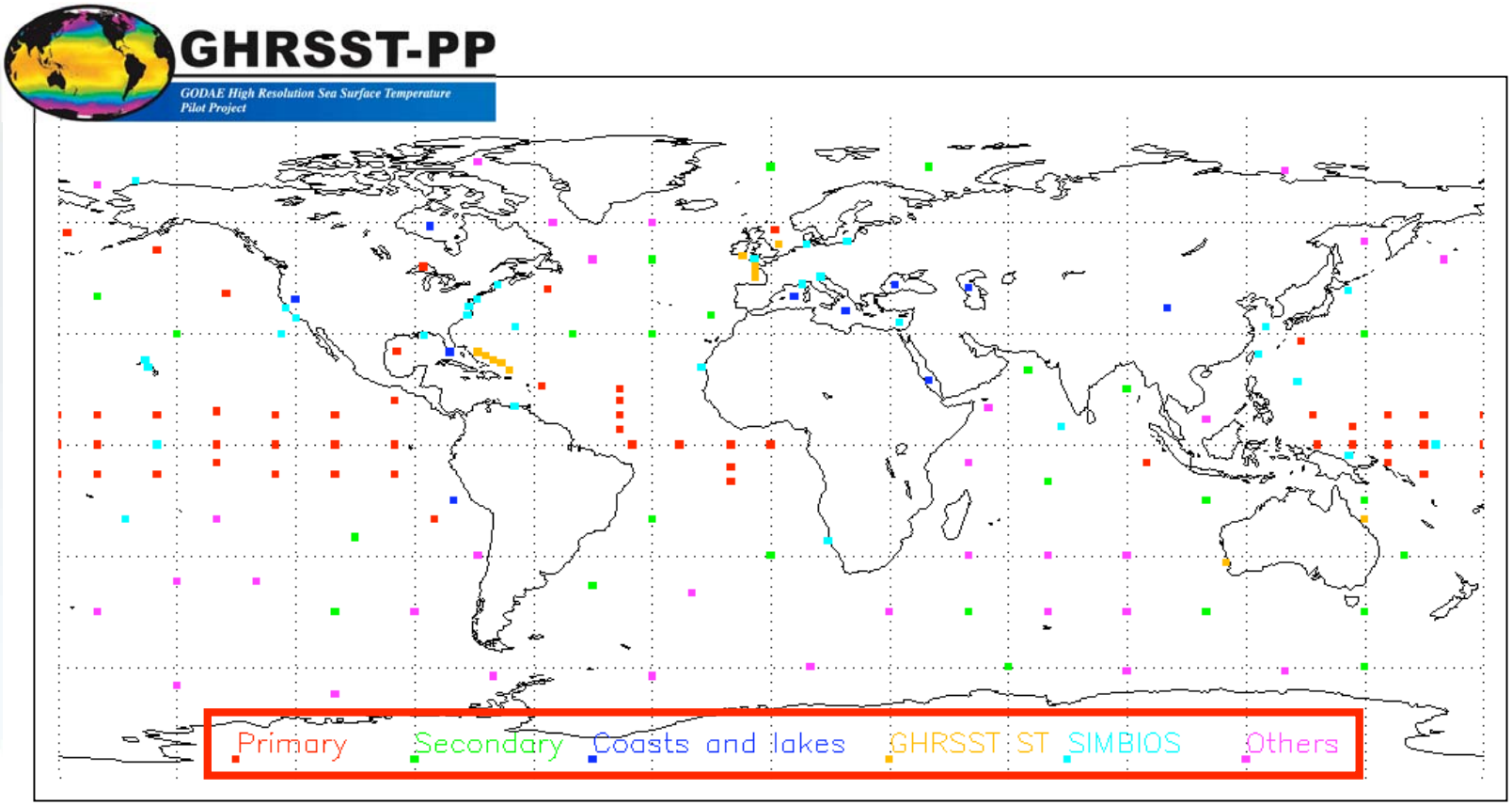
Future NOAA Opportunities?



- High resolution subsets facilitate L2P and L4 intercomparisons in real time

QC tools: http://www.hrdds.net

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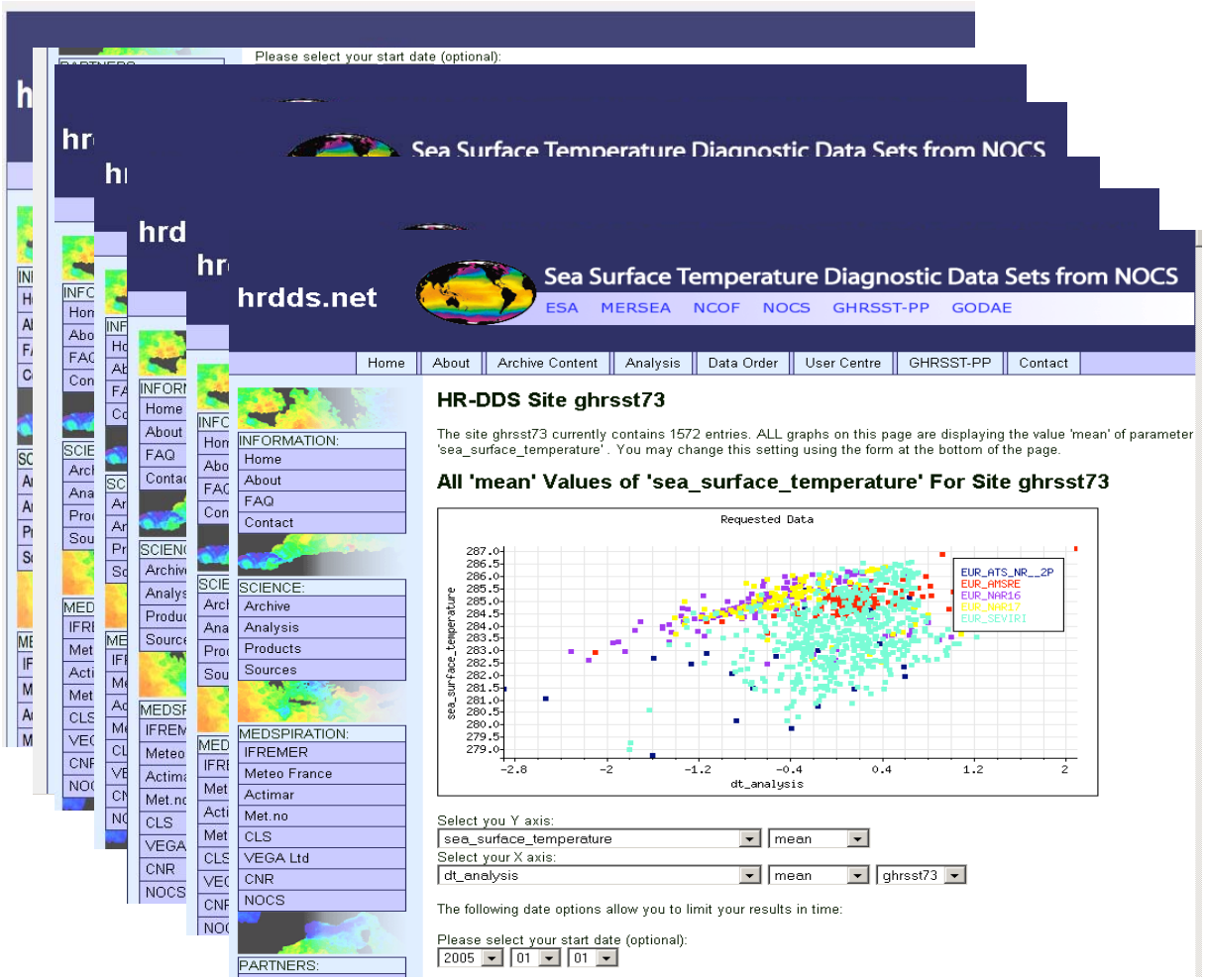
Future NOAA Opportunities?



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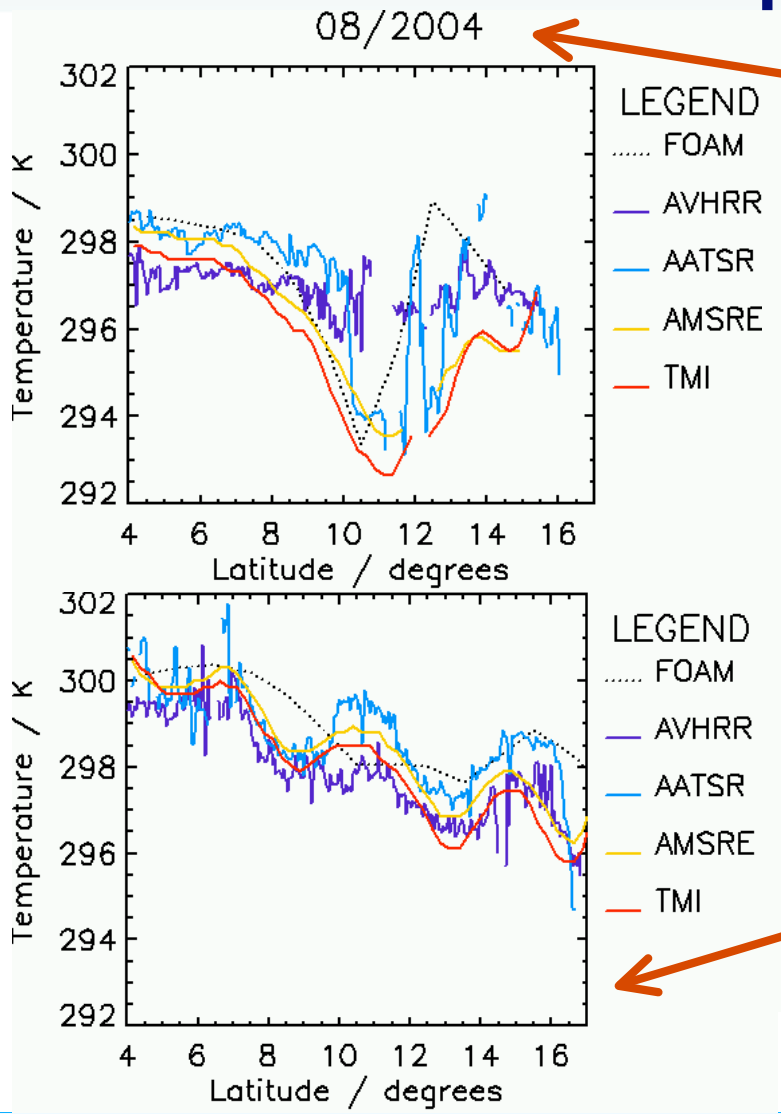
Detailed Comparisons

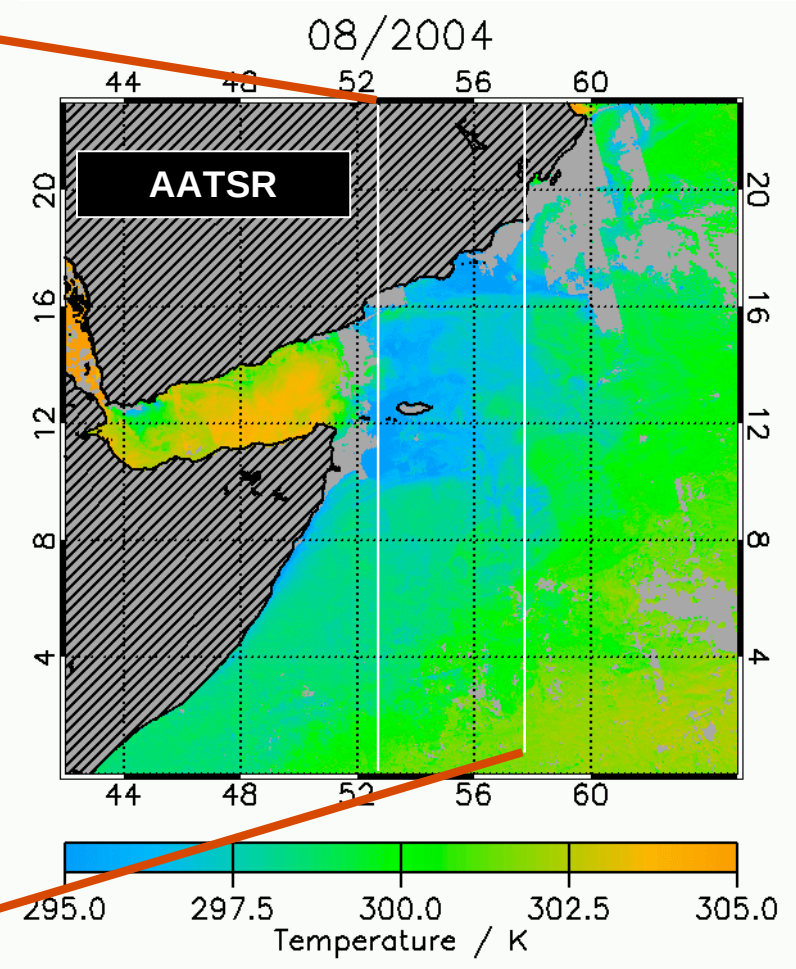
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?





(S. Good, Univ. Leicester)

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Integrated Data Stewardship

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- GHRSST products conform to specified standards: netCDF with CF, DIF, FGDC metadata and GDS-documented contents
- Online Master Metadata Repository
- Meets Integrated Ocean Observing System (IOOS) Data Management and Communications (DMAC) protocols
  - Online browse via Live Access Server
  - Data access via OAS, ftp, http, OPeNDAP
  - Archive at NODC Long Term Stewardship and Reanalysis Facility (LTSRF)
  - Comprehensive metadata

GHRSST-PP Recap

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- GHRSST is a large user and producer of SST ~$10 million USD invested globally
- GHRSST prepares the next generation of real time SST and integrated CDR products (L2P and L4)
- GHRSST focuses on the context of SST measurement… QC is fundamental for all operations
- GHRSST provides data manipulation and access tools on-line (at no cost!)

Current NOAA Involvement

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- NOPP-funded Multi-sensor Improved SST (MISST) for GODAE project
  - NOAA/NESDIS/ORA
  - NOAA/OAR/ESRL
- NOAA base-funded activities at
  - NOAA/NESDIS/NCDC
  - NOAA/NESDIS/NODC

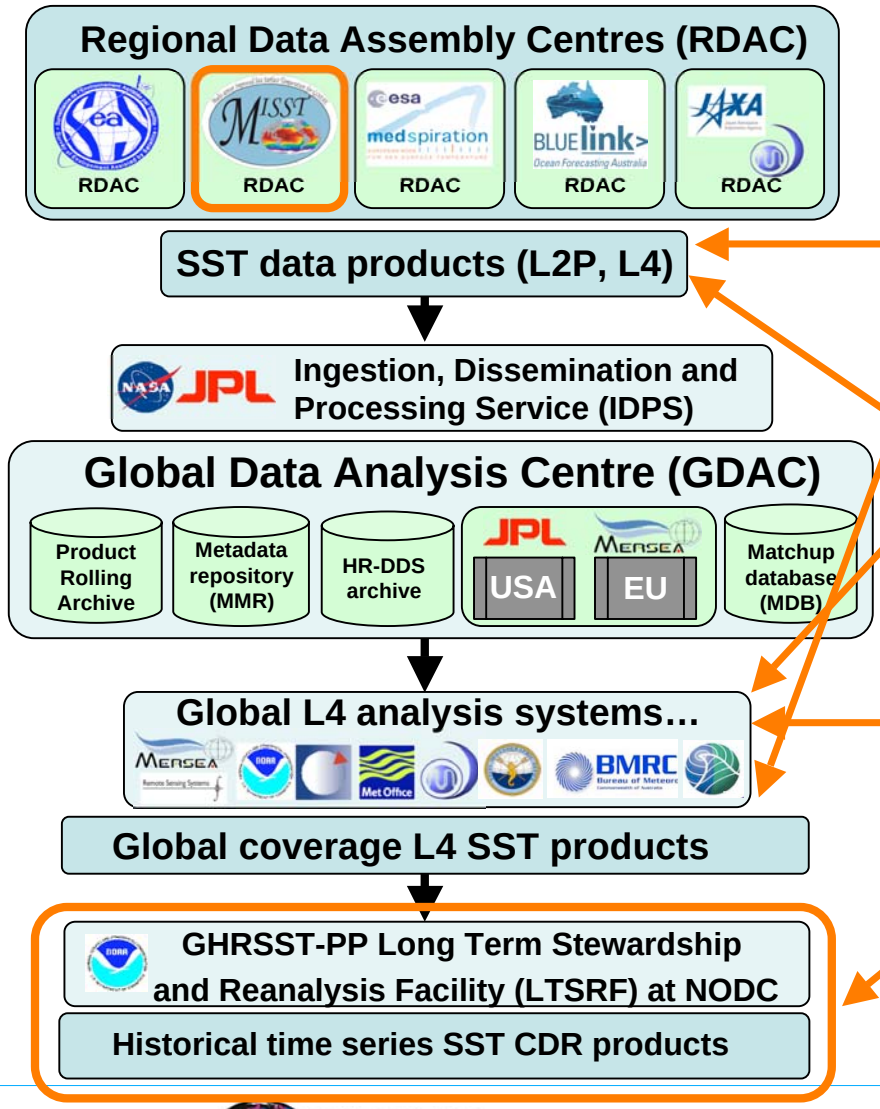
Current NOAA Involvement

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?



ORA: real time GOES L2P and POES/GOES analysis

ESRL: Optimal analysis algorithms, diurnal variability, error characterization

NCDC: Optimal analysis and blending algorithms

NODC: Archive, long term stewardship, and reanalysis CDRs

GHRSST LTSRF at NODC

What is GHRSST?

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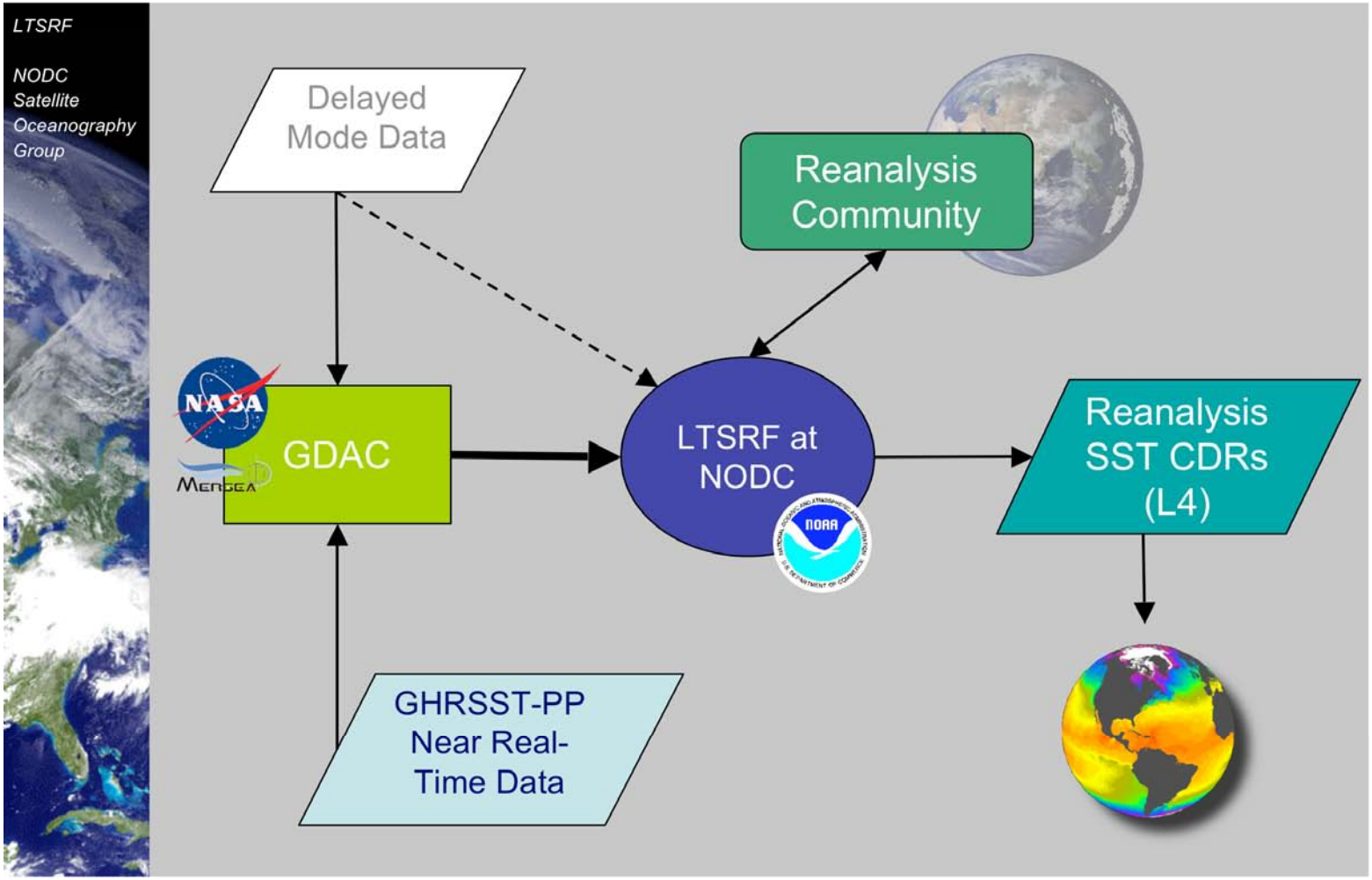
Future NOAA Opportunities?



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Status of LTSRF at NODC

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Daily, NODC acquires all data >30 days old from GDAC
- Current L2P and L4 from: AMSRE; AVHRR16 GAC, LAC, and HRPT; AVHRR17 GAC, LAC, and HRPT; SEVIRI, AATSR, and TMI
- Data from ~ 2900 accessions ingested to date (~73000 files, ~850 GB)
- Data rate growing quickly to ~30 TB/year
- Successfully encouraged Europe to do (A)ATSR retrospective reformatting *and* Pathfinder-like reprocessing

Ongoing LTSRF Activities

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Reanalysis User Requirements Document being developed
- Reanalysis intercomparison framework being developed in conjunction with GCOS SST and Sea Ice Working Group
- Reanalysis facility being scoped
- Full automation of ATDB and NMMR metadata ingest being completed
- Chairing 2006 Ocean Sciences Meeting special session on Ocean Climate Data Records from Space

Status of OI Analysis at NCDC

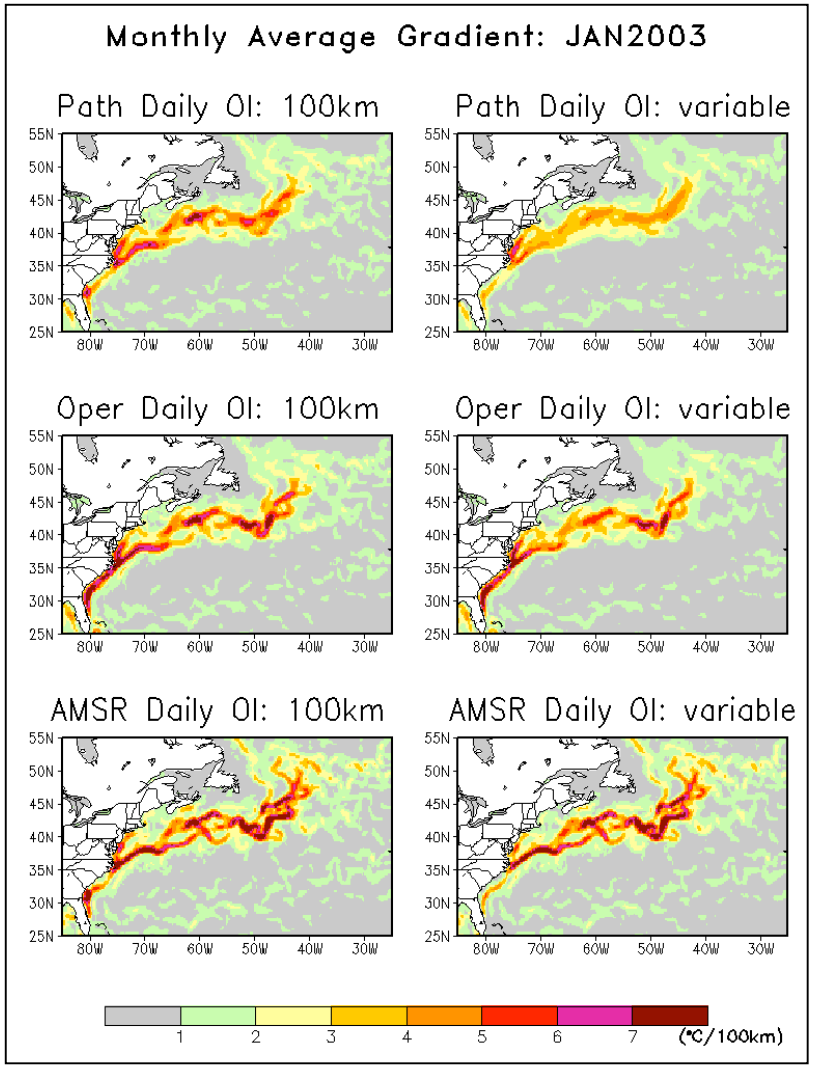
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- AMSR gradients not sensitive to scale changes
- Operational AVHRR shows some reduction with increasing scales
- Pathfinder AVHRR shows the strongest reduction because Pathfinder data are the sparsest at QF=7
- As data become sparser, OI gradients weaken more as scales increase



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Status of OI Analysis at NCDC

What is GHRSST?

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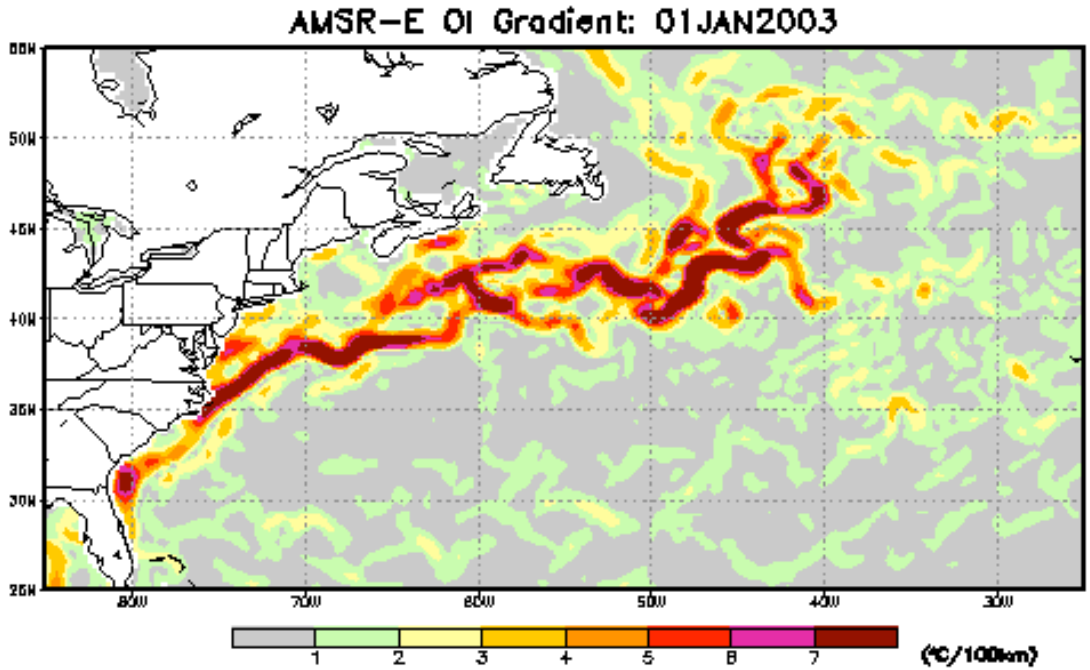
How is NOAA Involved now?

Future NOAA Opportunities?

- Gradients are quasi stationary due to topography
- Thus, limited AVHRR data are useful!



Gradients in Daily OI using AMSR for January - March 2003

Error Characterization at ESRL

What is GHRSST?

GHRSST Products?

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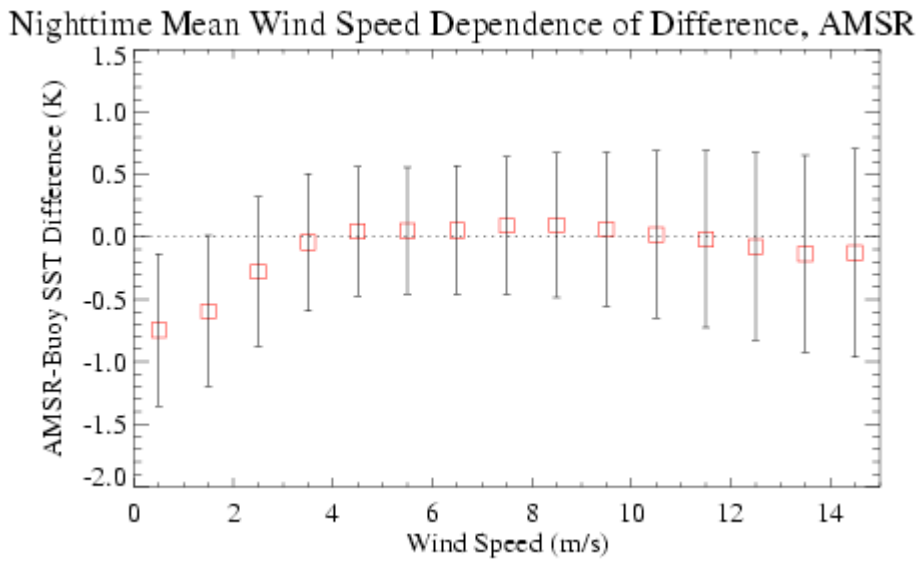
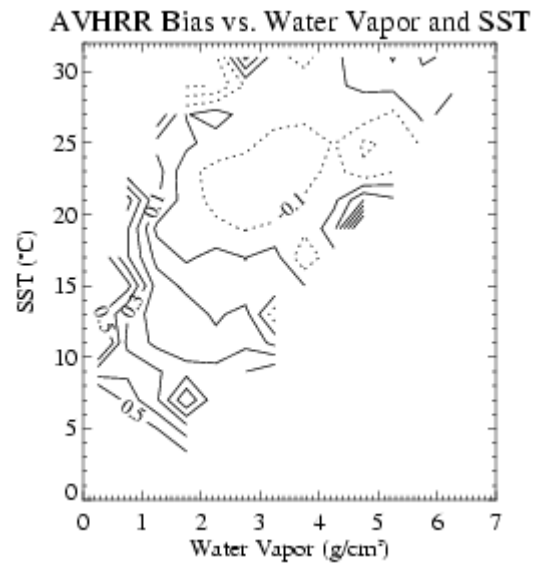
Future NOAA Opportunities?





- Developing improved single sensor error statistics
- Bias and variability quantified as a function of significant parameters

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Surface Process Treatment at ESRL

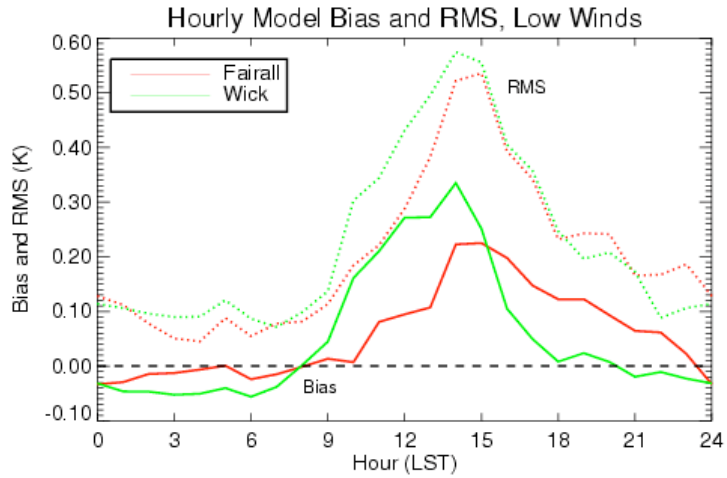
What is GHRSST?

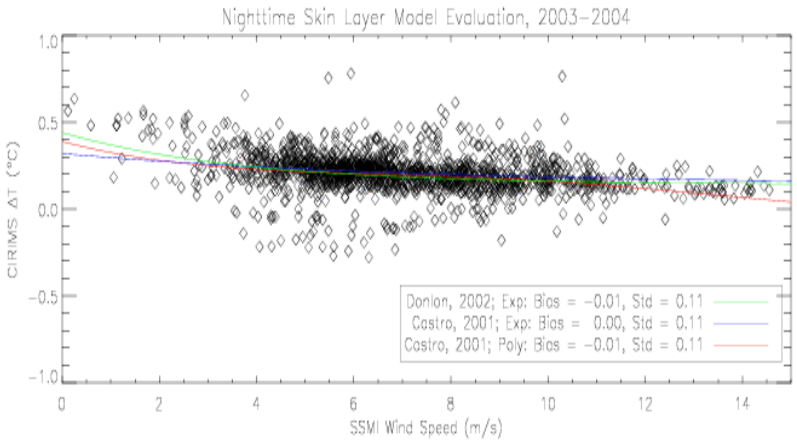
GHRSST Products?

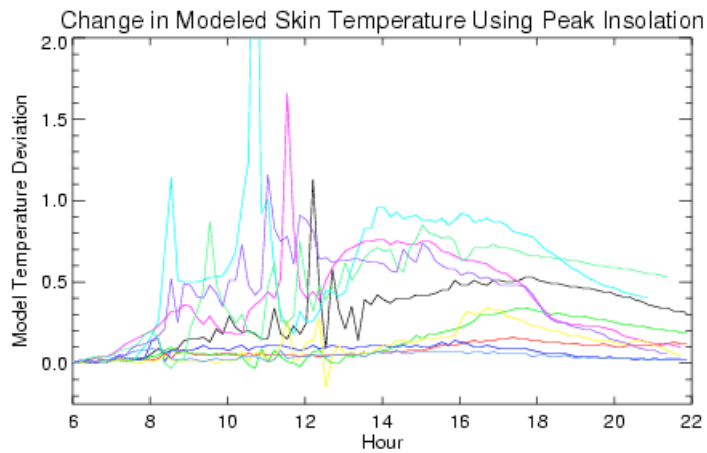
How is NOAA Involved now?

Future NOAA Opportunities?

- Implementing and evaluating corrections for diurnal warming and skin layer effects
- Model bias and sensitivity studies







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Aerosol Impact Status at ORA

What is GHRSST?

GHRSST Products?

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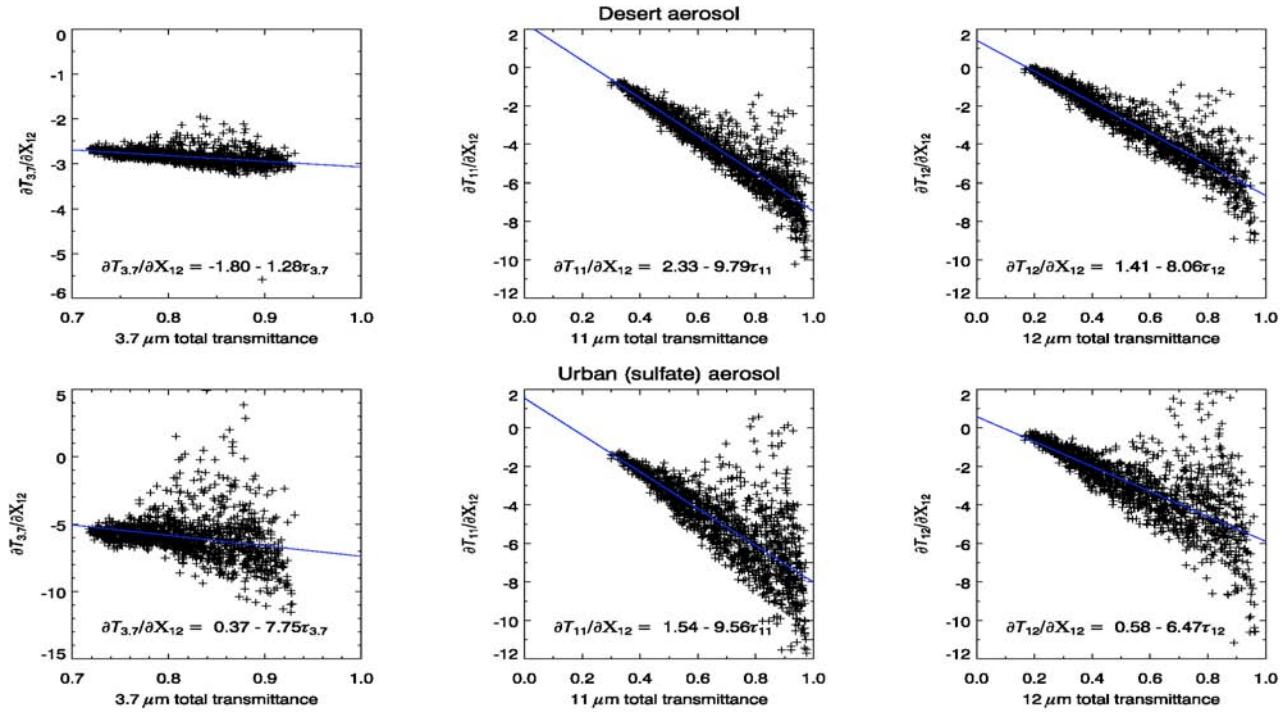
Future NOAA Opportunities?



- Studies underway to quantify impact of aerosols on infrared retrievals
- Optical depth not enough; Type of aerosol has a large impact

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GHRSST Status at ORA

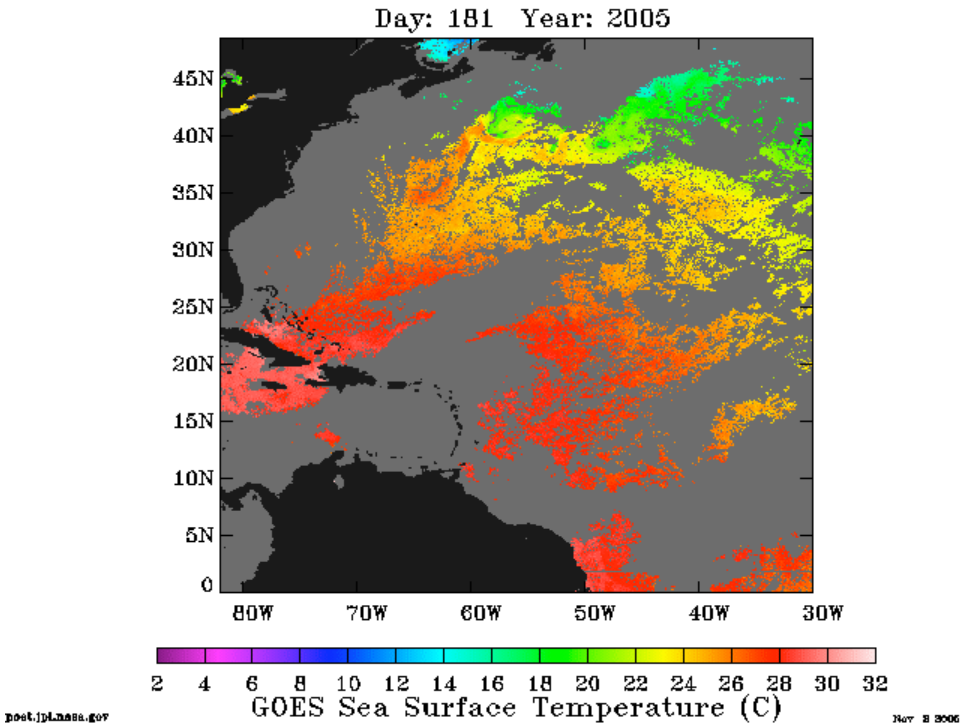
What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Production of L2P format data for GOES
- Development of blending methodologies as part of GOES/POES analysis



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User Feedback Needed

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- Next major revision of GHRSS Data Processing Specifications to incorporate user input
- GHRSST Reanalysis also developing a climate users requirement document
- Input coming in (user meetings in Europe) but more is required (particularly from the US)
- Next Science Team Meeting to target user interactions
  - NOAA ESRL, Boulder, CO
    March 27-31, 2006
  - Attend if you can!

Future Opportunities for NOAA

What is GHRSST?

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How is NOAA Involved now?

Future NOAA Opportunities?

- Handling AVHRR GAC L2P globally instead of Navy?
- Getting GOES(-R) into L2P?
- NPP/NPOESS EDRs into L2P? A question for NDE?
- Sustained CDR production at NODC LTSRF - including AVHRR Pathfinder in L2P as baseline?
- New products: Ultra-high resolution analyses for US Coasts/EEZ?

Future Opportunities for NOAA

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

- CoastWatch provision of AVHRR LAC/HRPT in L2P? Connections with MODIS L2P production with GSFC OBPG?
- Transition to CLASS Archive? GHRSST's structured data, metadata, and delivery mechanisms should make this straightforward?
- Expanded Scientific input and improvements?

For More Information

What is GHRSST?

GHRSST Products?

How is NOAA Involved now?

Future NOAA Opportunities?

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