Developing an ICOADS Value-added Database (IVAD) to Support Climate Research

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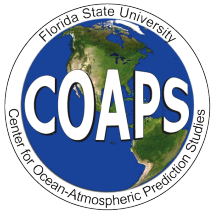


What is IVAD?

A database solution to link individual marine reports from ICOADS with state-of-the-art adjustments, bias corrections, and/or additional information (e.g., advanced quality control) to support future marine climate research.

- Adjustments based on documented research and recommendations of experts in the marine climate community
  - Adjustments would be time varying
- User access supported with web services
- Archival of individual reports and adjustments would use an extended International Marine Meteorological Archive (IMMA) format

Why Develop IVAD?

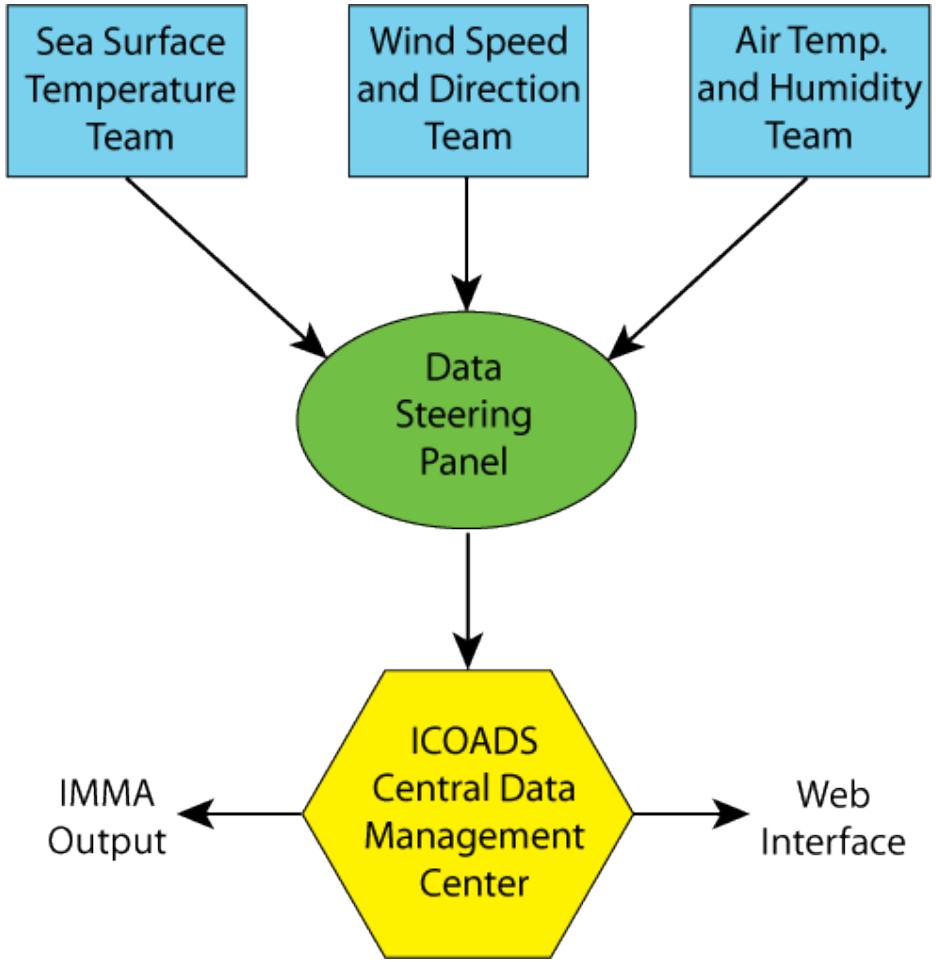
- Members of the marine climate community have expended time and resources to develop and publish adjustments
  - Need to ensure these efforts not lost
  - Ease application of adjustments by future users
- IVAD will be extendable
  - Changes to adjustments can be made as sciences behind the adjustments evolve
- Once available, IVAD will support a wide user community

Potential Users

- **Satellite community** – aiding the development of new retrieval algorithms and simplifying developing satellite to in situ collocations
- **Atmospheric and ocean reanalysis** – important to ensure that these groups are using "best" bias-adjusted marine observations (not simply raw GTS observations)
- **Air-sea fluxes** – improving and enhancing SST and flux products
- **Radiation budget** – essential to have access to cloud observations, humidity, and SST, along with an understanding of their biases within ICOADS
- **Climate change assessment** (global and regional) – identifying trends (or other statistics) with instrument and vessel-dependent biases removed
- **Climate monitoring** – leveraging monthly updates to ICOADS
- **Hurricane activity patterns** – need enhanced air temperature and humidity climatologies
- And many more…

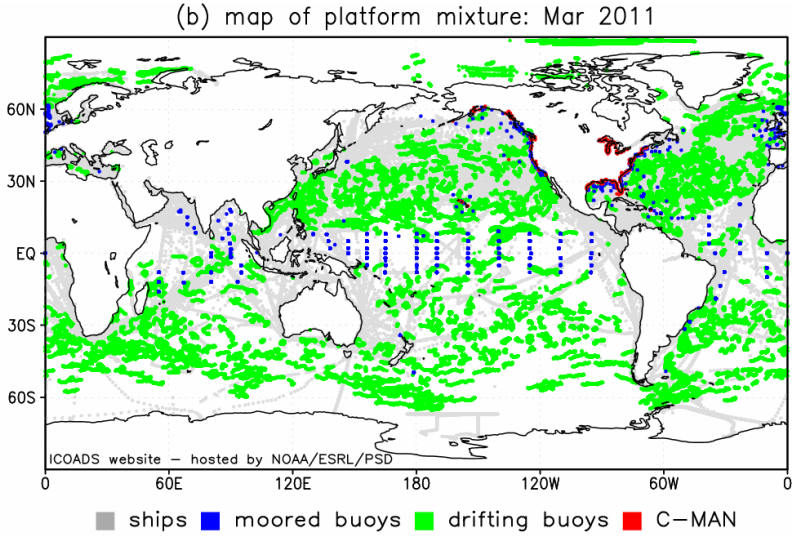
Proposed Structure

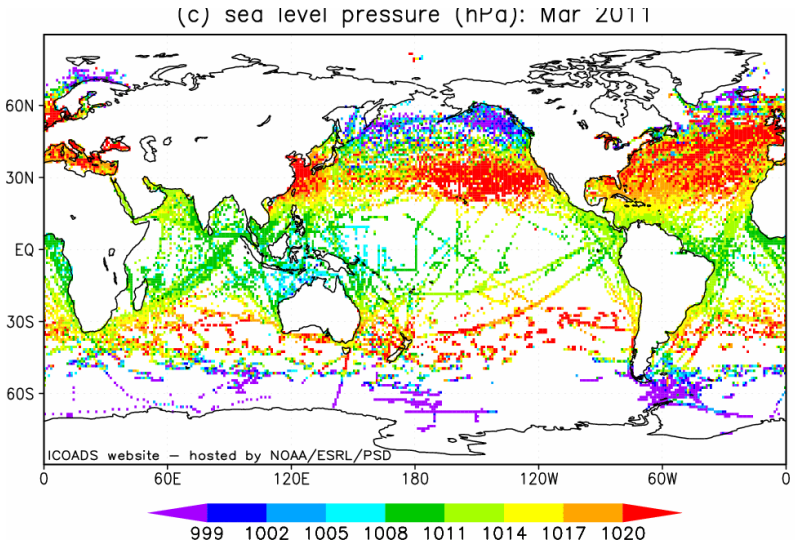
1. ***Defining correction factors:*** Teams with expertise in various parameters within ICOADS (e.g., SST, AT, waves, clouds, etc.) would create and recommend adjustments.
2. ***Steering Panel:*** A panel of experts whose primary purpose is to approve adjustment factors prior to their inclusion IVAD.
3. ***Central data management:*** Focus on technical aspects of data formats, database development, storing the adjustment factors, distribution, archival, etc.
4. ***Metadata augmentation:*** Critical to the development of adjustments and corrections to ICOADS.
5. ***Quality control:*** Develop and implement new methods (e.g., track checking, multivariate checks) that expand or augment the current ICOADS quality evaluation.
6. ***Product development:*** Research and operational groups focused on developing climatologies, models, indices, and other products to support marine climate community.

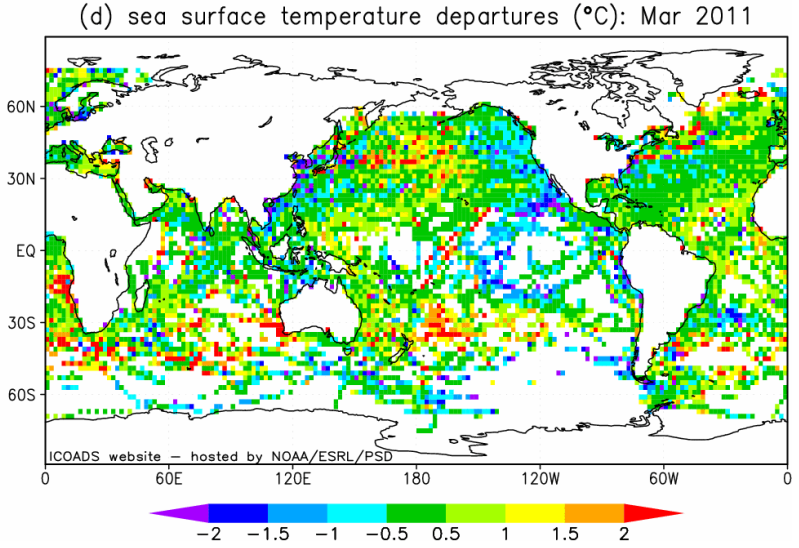


What parameters?

- Focus on parameters of primary interest for marine climate
  - Start with ECVs (Air Temperature, Wind, Water vapor, Pressure, SST)
- Select parameters for which adjustments already exist
  - Work with adjustment developers to implement in IVAD
- Augment metadata and investigate known platform type issues

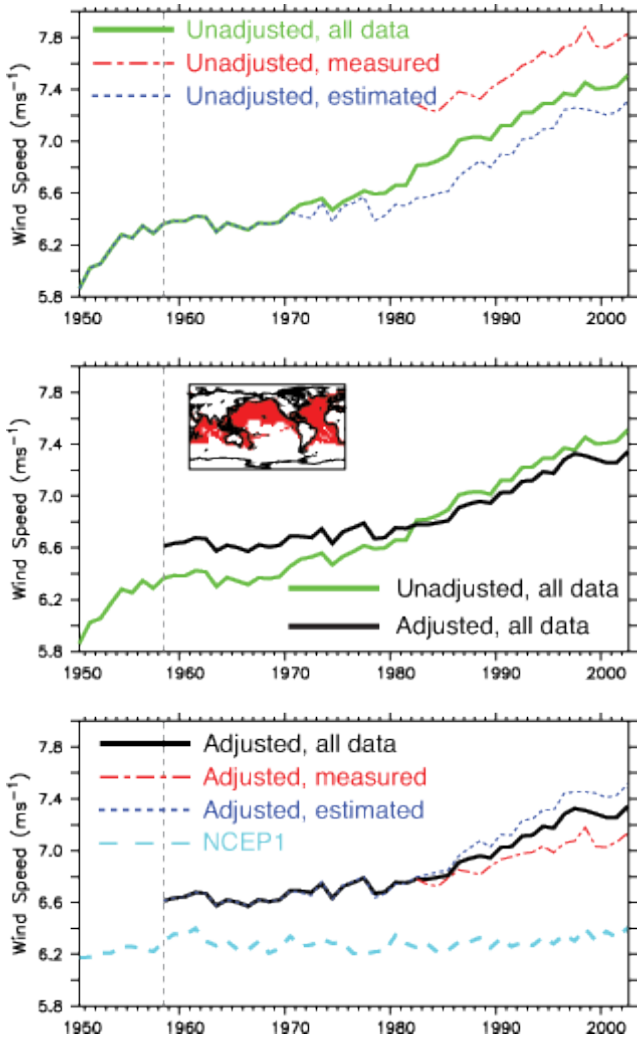






Potential Adjustments

- Ship heating (Berry et al. 2004)
- Beaufort winds (Lindau 1995)
- Instrument height (Thomas et al. 2008)
- Variations in instrumentation (e.g., bucket vs. intake SST; Kent and Taylor 2006)
- Differing platform types (Kent and Taylor 2006, Rayner et al. 2006)
- Enhanced metadata (Kent et al. 2007)
- Improved QA/QC procedures (Smith and Reynolds 2003)
  - spurious rejection of extreme climate events = "trimming" problem
  - incorrect platform ID vs. type



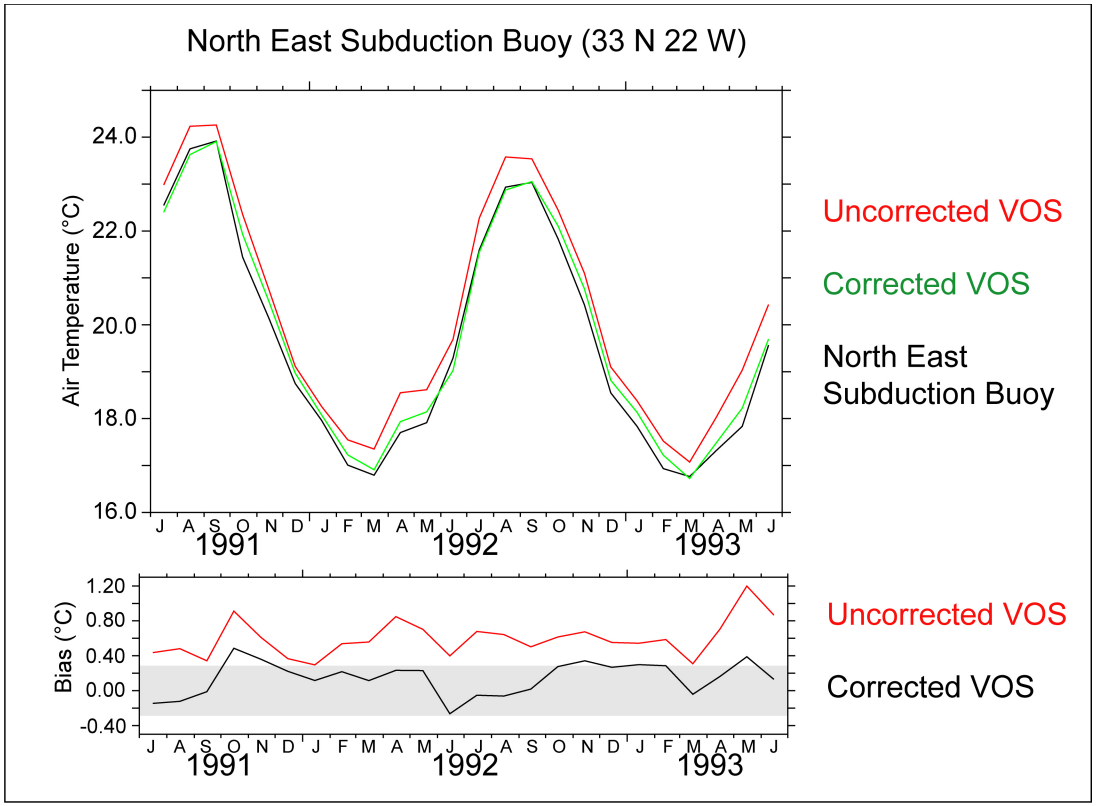
Thomas, B.R., Kent, E.C., Swail, V.R. and Berry, D.I. (2008) Analysis of monthly mean marine winds adjusted for observation method and height. *International Journal of Climatology*, **28**: 747–763. DOI: 10.1002/joc.1570

Effect of heating errors on ICOADS Air Temperature

- Uncorrected air temperatures are biased high due to solar heating of instruments and instrument environment.
- Applying the bias adjustment (Berry et al. 2004) brings data into much better agreement with moored buoy air temperatures.
- Mean bias:

  Before adjustment = +0.6 °C

  After adjustment = +0.1 °C

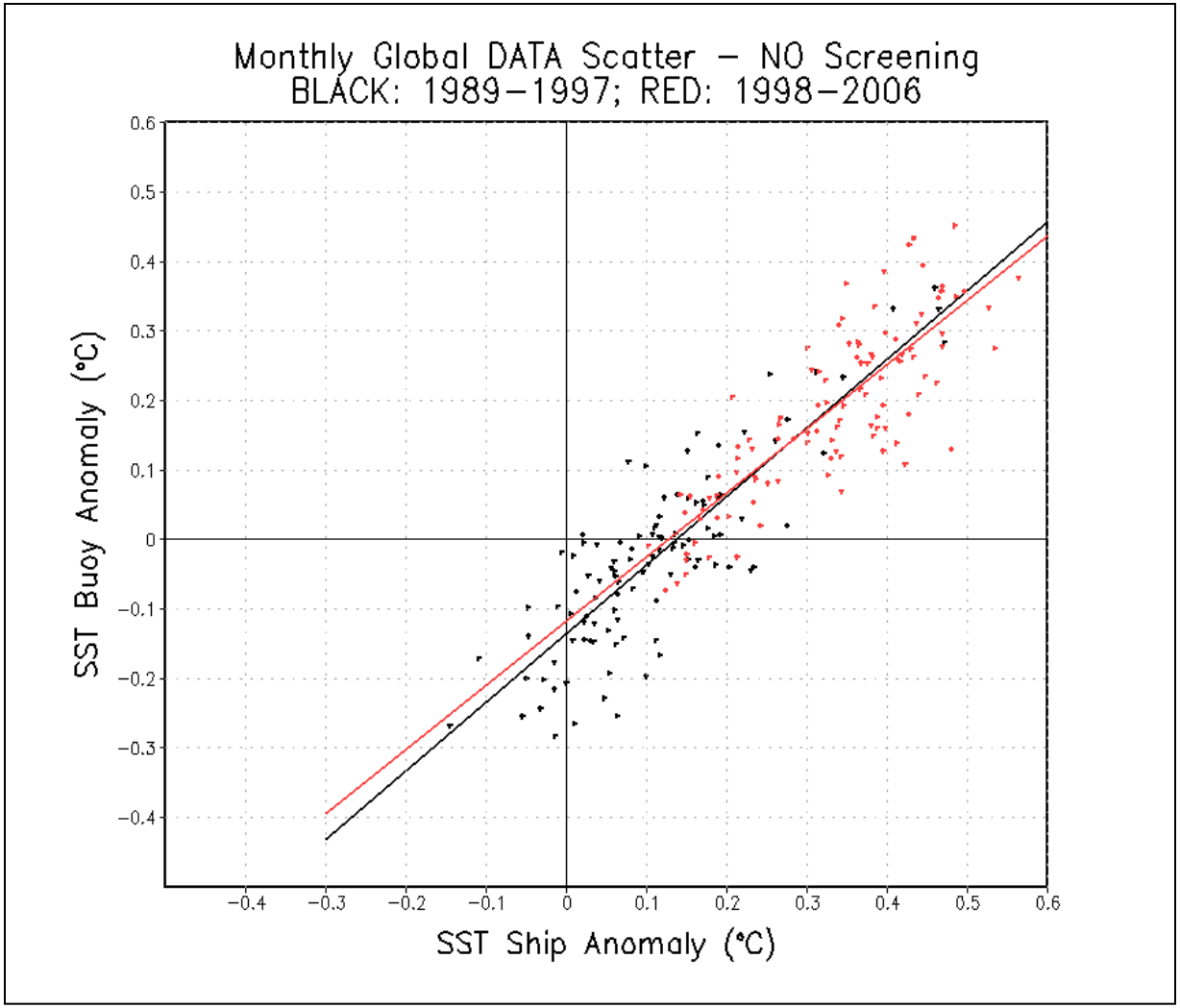


Berry, D.I., Kent, E.C. and Taylor, P.K., 2004: An analytical model of heating errors in marine air temperatures from ships. J.Tech., 21 (8), 1198-1215.

SST Bias Example

Monthly Averaged Collocated Buoy and Ship Anomaly SSTs

- Buoy vs. Ship: data and fit
  - Red: 1998-2006
  - Black: 1989-1997
  - 2 Periods similar
- Clear ship-buoy bias of 0.14°C



Data Management Concepts

Modifications to IMMA

- Current plan based on IMMA format
  - Core, Attachments, and the Supplemental Attachment
- Planned new fields for IMMA include:
  - Unique record identifier (UID)
  - ICOADS release identifier
  - Relative humidity value and indicator
  - Also planning to add sea surface salinity
- A new attachments will be developed to store adjustments
  - Field number reference
  - Adjusted value in units of linked field
  - Adjustment method and reference (e.g., DOI)
  - Additional QC and method

Data Management Concepts

Data handling infrastructure

- A database management system (DBMS) will be used to integrate adjustment from partners
  - Keyed on UID
  - UID and record-change dates permit provenance tracking and version control

- All components of the updated IMMA will be stored in the DBMS

- Since DBMS not suitable for archival and preservation
  - Periodically create IVAD reference archive in IMMA
  - Replicate at other world data center (e.g., NCDC)
  - Analogous to the current ICOADS release versions

Data Management Concepts

User Access - two methods

1. Download IMMA formatted archive files, software, and documentation
2. Web interface with features:
   - Spatial, temporal, parameter sub-selection (as currently)
   - Select desired level of quality control
   - Original versus adjusted values
   - ASCII output
   - Archive user transaction

- The default would be to provide both the original and adjusted values in separate fields.

Data Management Concepts

Example

- Currently, users select how various flag and trimming are applied
- This case,
  - All observations (day and night)
  - All platforms (ships + buoys + others)
  - 4.5 sigma trimming
  - *Three additional flag and QC options*

day night options	☑ day night obs.	☐ night obs. only	☐ day obs. only	
platform type options	☐ ships obs. only	☑ ships + buoys + others		
source exclusion flags	☑ used	☐ ignored		
composite QC flags	☑ used	☐ ignored		
outlier trimming level	☐ 2.8 sigma	☐ 3.5 sigma	☑ 4.5 sigma	☐ untrimmed
if trimming flag=11	☐ reject obs.	☑ use obs.		☐ no effect

Adjustments, new QC, or enhanced metadata could be handled similarly

NCAR

Data Management Concepts

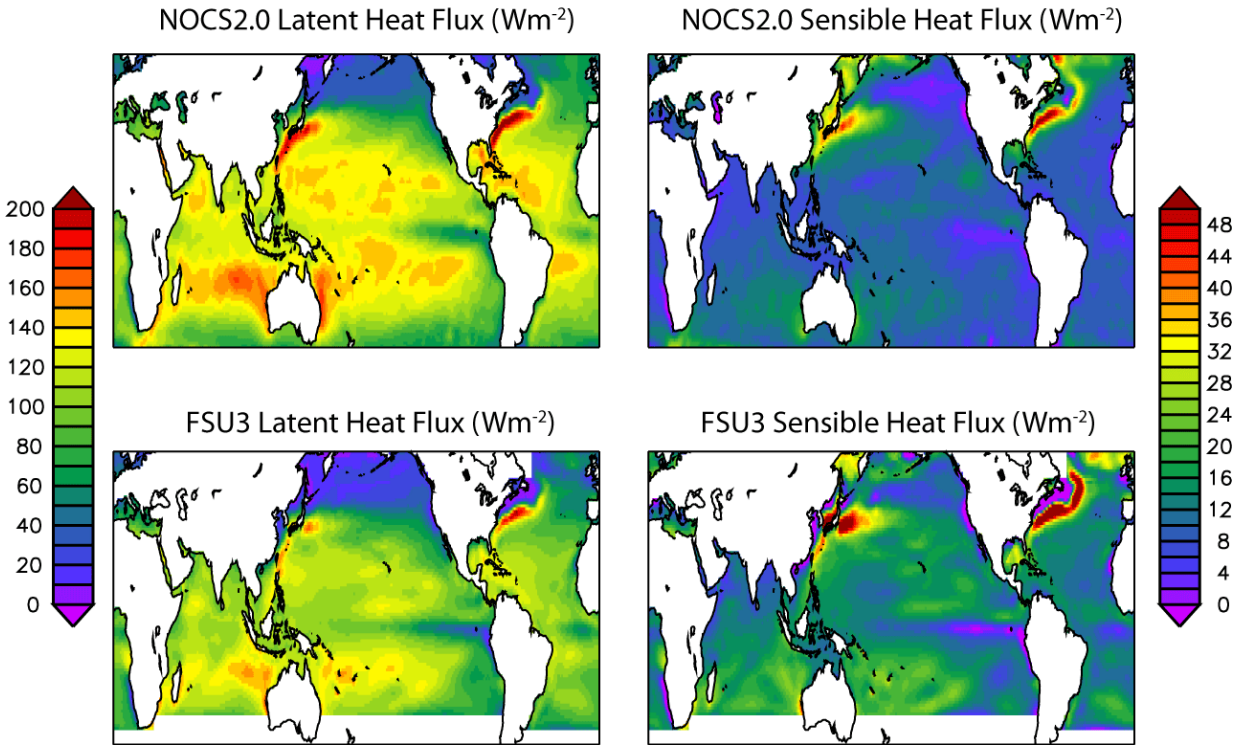
Challenges

- Design of bias correction attachment(s)
  - What fields are needed (correction, version, documentation pointer, etc.)
- Rectify existing QA/QC flags with new adjusted values
- Create unique ID scheme and codes that define what corrections have been applied, on a record by record basis
- Work with providers to validate bias correction actions before opening service to users
- Create informative documentation to accompany each data request
- Record user access history and insure reproducible data selection outcome for a changing database
- Managing VAD content through new ICOADS Releases
  - New records added throughout period of record
  - Re-do VAD analysis or allow percentage of VAD records to drop
  - Extending VAD analysis forward in time?

Products and Deliverables

Potential products include:

- New ICOADS statistics (e.g., monthly summaries)
- Improved climatologies based on IVAD
- New flux products using common corrections from IVAD
- Characterization of climate change
  - Hurricane trends
  - 5-year averages to assess long term trends
- Enhanced climate indices.



Status of IVAD

- Anticipated to be an international effort
  - Central data facility requires adequate resources to meet current and future needs
  - Individual adjustments can be funded through national agencies

- U.S. team submitted proposal to NOAA in 2010 to
  - Coordinate the marine climate community regarding the IVAD implementation (e.g. planned selection of value-added variables).
  - Develop the data management infrastructure to store and distribute value-added variables alongside the original ICOADS observations.
  - Expand the IMMA format to include IVAD attachments
  - Ensure that the expanded IMMA records are routinely archived at NCDC and NCAR.
  - Compare estimates of air-sea flux and select climate indices using original and adjusted marine reports in the IVAD.

- Consider option for JCOMM pilot project (ETMC recommendation)

Summary

- The proposed IVAD development would include the U.S. ICOADS group and any interested international partners to
  - develop a "climate-quality" surface marine data set
  - create products based on this new resource

- The effort will provide a legacy of the hard work done by our marine climate community
  - Corrections and adjustments developed over the years will exist not only in the literature
  - Provide easy access to adjusted marine data
  - Expandable design for inclusion of new or better adjustments

- Note: Additional discussion will occur during Plenary 3:

  Challenges and solutions to enhance ICOADS