A Project to Create Bias-Corrected Marine Climate Observations from ICOADS

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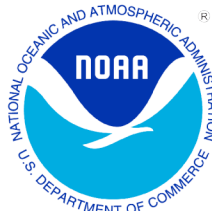
[2]NOAA Earth System Research Laboratory, USA

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Overview

Objective

Develop a set of individual marine reports from ICOADS that are adjusted (or corrected) in a manner that represents the current state-of-the-art.

End products

- Master in-situ marine climate data set analogous to existing land based climate records

    - Include bias adjustments and uncertainty estimates

- Updated marine climatologies

- New or enhanced monthly summary statistics (MSS)

- Marine climate indices

Potential Adjustments

- Ship heating (Berry et al. 2004)

- Beaufort winds (Lindau 1995)

- Instrument height

- Adjustments for known instrument variations (e.g., bucket vs. intake SST)

- Improved QA/QC procedures
  - spurious rejection of extreme climate events = "trimming" problem
  - incorrect platform ID vs. type

The plan would allow for new adjustments to be incorporated into ICOADS as they are developed
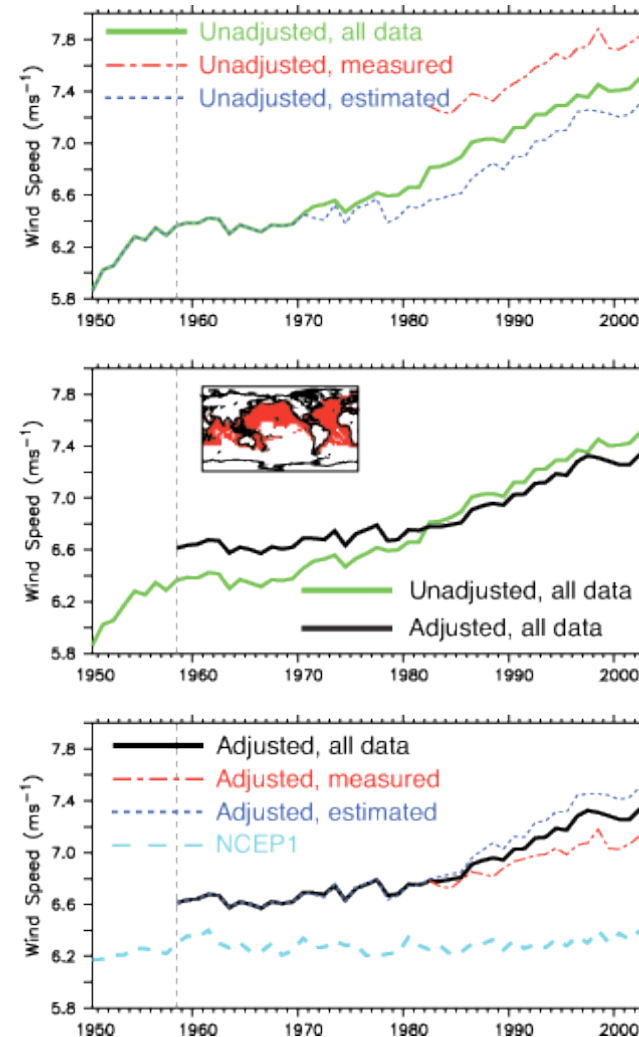
Thomas, B.R., Kent, E.C., Swail, V.R. and Berry, D.I. (2008) Analysis of monthly mean marine winds adjusted for observation method and height. *International Journal of Climatology*, **28**: 747–763. DOI: 10.1002/joc.1570
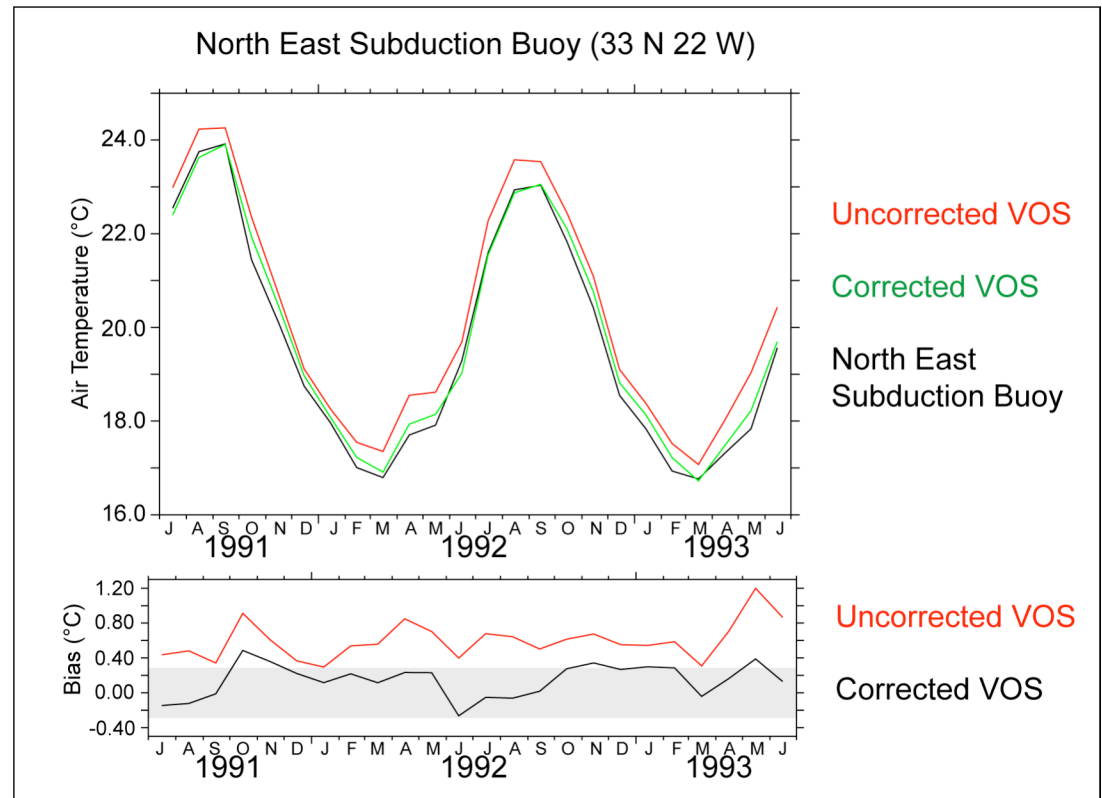
Effect of heating errors on ICOADS Air Temperature

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

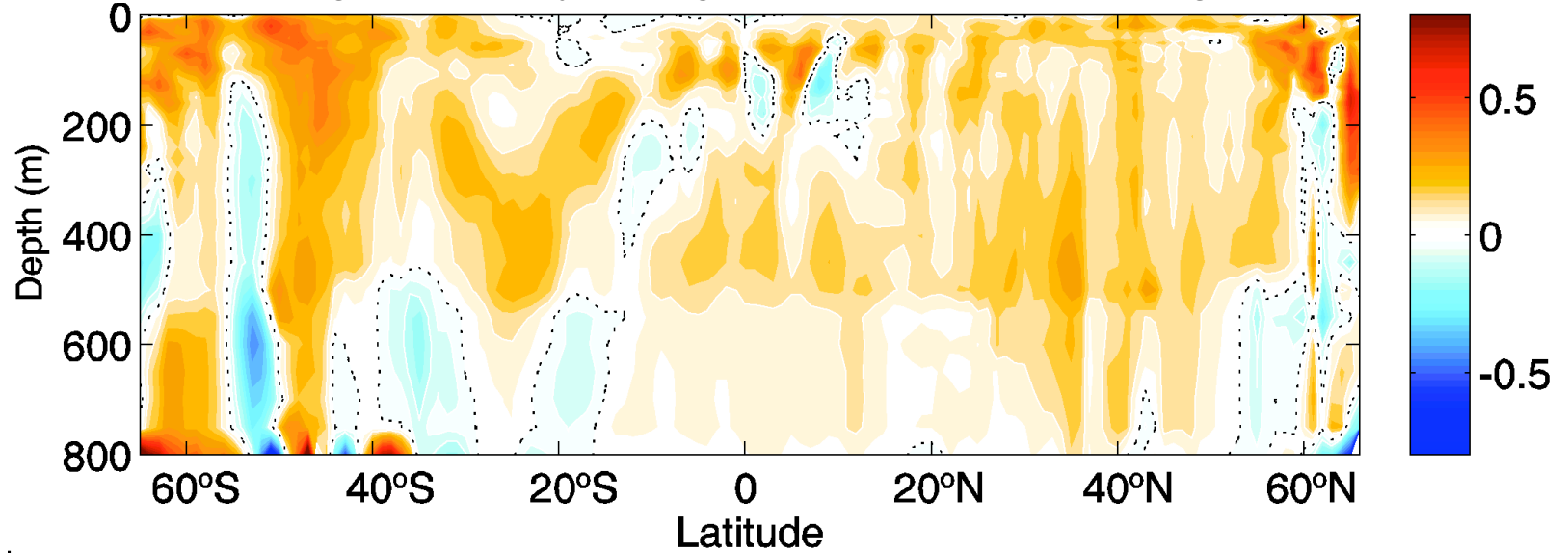**Monthly Averaged Collocated Buoy and Ship Anomaly SSTs**

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

Monthly Global DATA Scatter – NO Screening
BLACK: 1989–1997; RED: 1998–2006
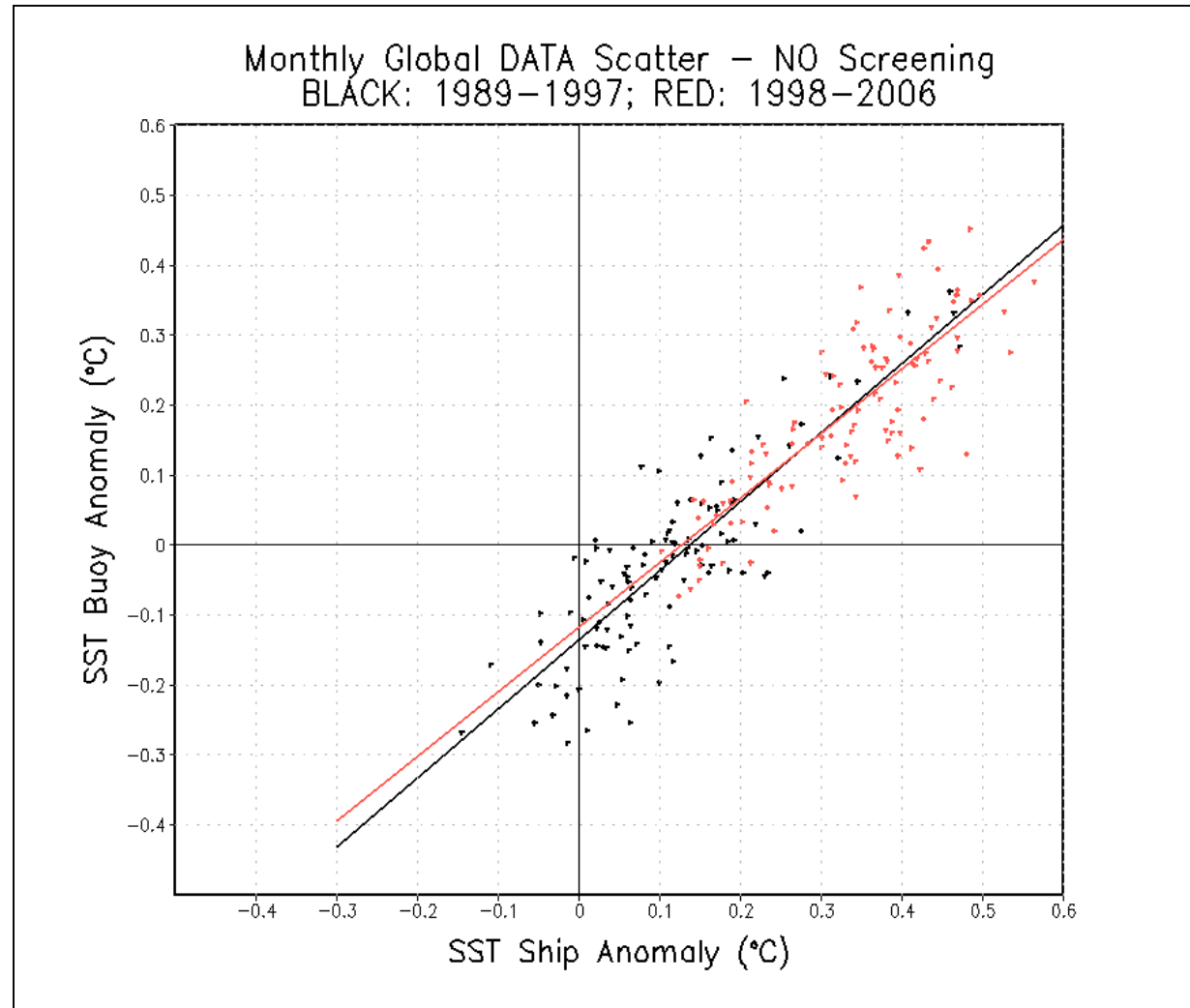
Instrument Dependent Ocean Temperature Bias

Difference of global zonally averaged ocean temperature (deg C) : XBT - CTD

- Parallel problem to correction of surface meteorological fields for instrumental bias occurs with sub-surface measurements of ocean temperature.

- Comparison of Expendable Bathythermograph (XBT) temperatures with more accurate CTD temperatures has revealed a warm bias.

- Caused by changes in sensor characteristics over time which lead to reported depth being too large.

- Correction now being developed. Significant implications for climate change related trends in sea level and ocean heat content.

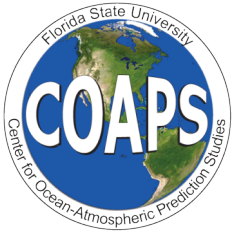**Wijffels et al, in press, J. Climate**

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 into ICOADS.

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:** Including, but not limited to, developing new climatologies, indices, and summary statistics.
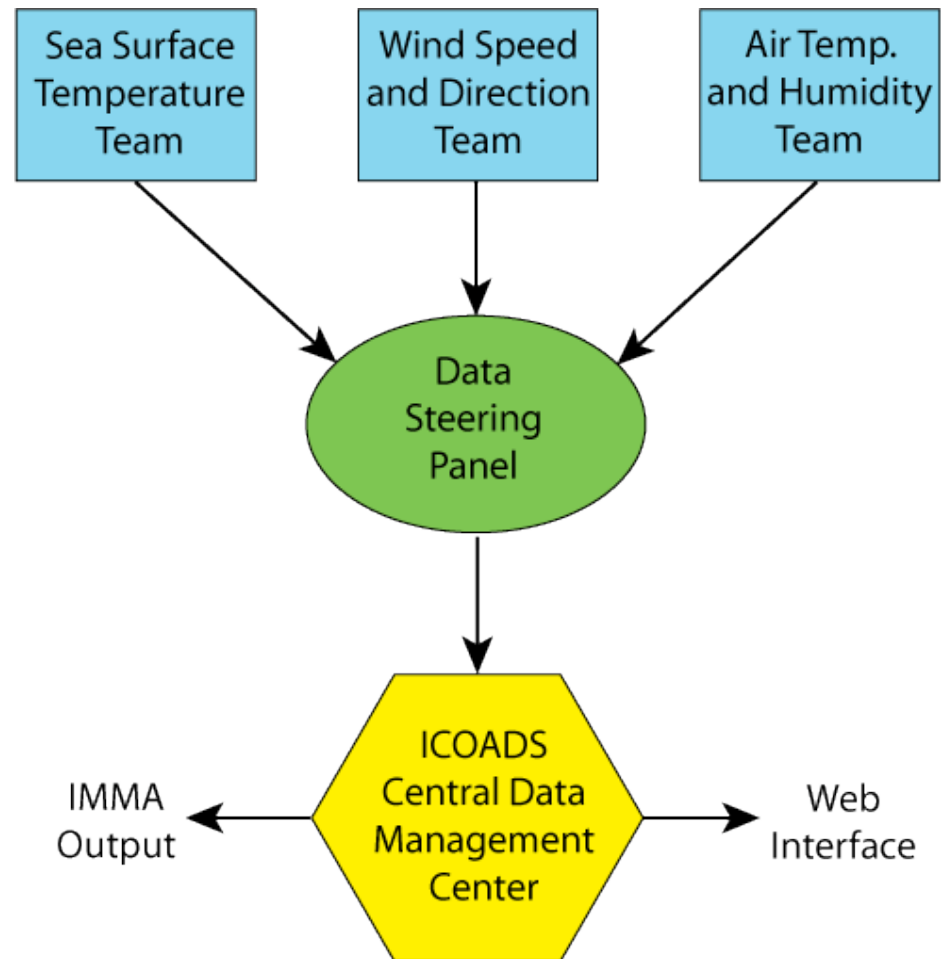
Data Management Concepts

Data handling infrastructure

- Based on IMMA format

    - Core, Attachments, and the Supplemental Attachment

- Permanent Unique ID for each record

    - Essential to allow blending of adjustment factors created by multiple topic area experts

- A database (MySQL) used to integrate bias adjustment attachments from partners

    - Keyed on Unique ID

- Bias correction attachments to include necessary tracking and implementation (e.g., order of adjustments) information

- Periodically create ICOADS reference archive in IMMA

    - Analogous to the current ICOADS release versions

Data Management Concepts

User Access - two methods

1. Download IMMA formatted archive files, work with bias correction attachments directly
2. Web interface with features:
   - Spatial, temporal, parameter sub-selection (as currently)
   - Parameter level selectable bias correction
   - ASCII output
   - Archive user transaction

- The CLIMAR community is encouraged to suggest alternative distribution formats to meet their applications
   – E.g., binary, netCDF, etc.
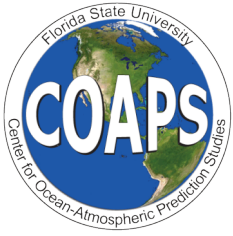
Data Management Concepts

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

Bias corrections 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 bias correction actions

- 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

- Opportunity to create a new attachment for additional data, e.g. Sea Surface Salinity or change the Core layout (within IMMA)

Defining Adjustments

- A range of atmospheric and oceanic parameters exist in ICOADS

  - Wind direction and speed

  - Air temperature

  - Atmospheric pressure

  - Moisture (humidity)

  - Clouds (cover, type, height)

  - Weather codes

  - Sea temperature

  - Waves and Swell

  - Ice information

  - Etc.

- Initial plan would select a subset of these parameters to have adjustments included in ICOADS

  - The selection would be based on the needs of the user community

  - Also dependent upon funding

- Topic Area Experts would define adjustment factors and uncertainties

- A science and data panel would review the adjustments prior to inclusion into ICOADS

Products and Deliverables

Potential products include:

- New ICOADS including height adjustments, bias-corrections, and enhanced metadata

- New ICOADS statistics (e.g., monthly summaries)

- Improved climatologies based on corrected ICOADS

- New flux products from NOCS and FSU using corrected ICOADS

- Characterization of climate change using corrected ICOADS.
  - Hurricane trends
  - 5-year averages to assess long term trends

- Enhance or reproduce common climate indices.

Latent Heat Flux
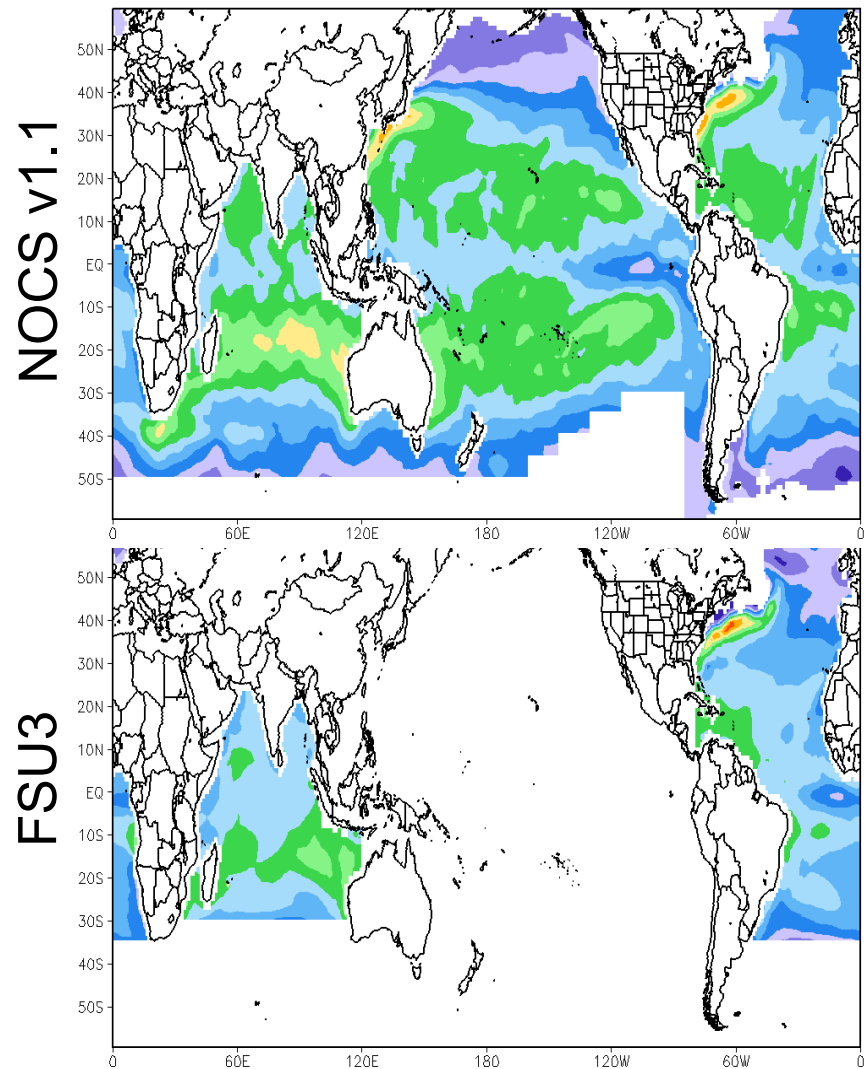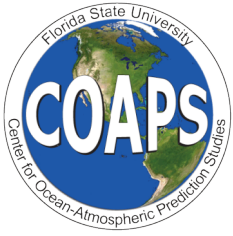
Potential Users

- **Atmospheric reanalysis** – important to ensure that these groups are using "best" bias-adjusted marine observations (not simply raw GTS observations)

- **Ocean analysis and reanalysis**

- **Air-sea fluxes** – improving and enhancing SST and flux products

- **Radiation budget** – involves an assessment of cloud observations and their biases within ICOADS

- **Satellite data validation** – aiding the development of new retrieval algorithms

- **Climate change assessment** (global and regional) – identifying trends (or other statistics) with instrument and vessel-dependant biases removed

- **Climate monitoring** (assuming bias-corrected ICOADS can be updated in a timely manner)

- **Hurricane activity patterns** – need enhanced air temperature and humidity climatologies
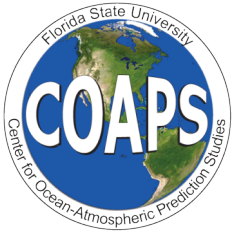
- And many more…

Concept Plan

Funding and Support:

- Anticipated to be an international effort
  - Central data facility must be adequately resourced to meet current and future needs
  - Individual adjustments can be funded through national agencies

- Important to seek input / support from WMO, IOC, WCRP panels
  - JCOMM task and expert teams
  - CLIVAR panels
  - WCRP working groups

The current time line for program planning includes:

- *Summer 2008*: Combining feedback from CLIMAR-III with current concept to develop a final program plan (white paper)

- *August 2008*: Circulate white paper to
  - interested collaborators
  - funding agencies

- *End of 2008*: Develop and submit initial proposals
  - depending upon national target dates

- Target OceanObs 2009 for announcement of program
  - 21-25 September 2009

Summary

- The proposed plan would involve the core ICOADS group and several international partners to

  - develop a "climate-quality" surface marine data set
  - create products based on this new resource

- The plan would take advantage of the expertise within the CLIMAR community

- 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

- Comments and input from the CLIMAR3 attendees is desired

  - Note: Plenary A (Marine Data & Data Quality) will continue this discussion