The Development of a 20-year Database of Ocean Surface and Near-Surface Properties

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Outline

- Project Description
- Production and QA Approach
- Applications
- Schedule & Issues
Near-surface air temperature and humidity
- Roberts et al. (2010) neural net technique
- SSM/I only from CSU brightness temperatures (thus only covers 1997 - 2006)
- Gap-filling methodology -- use of MERRA variability – 3 hour

Winds
- Uses CCMP winds (cross-calibrated SSM/I, AMSR-E, TMI, QuikSCAT, SeaWinds)
- Gap-filling methodology -- use of MERRA variability – 3 hour

SST
- Pre-dawn based on Reynolds OISST
- Diurnal curve from new parameterization
- Needs peak solar, precip

Uses neural net version of COARE
Available at http://seaflux.org
Project Description

- sea surface temperature and near-surface parameters of wind speed, temperature, and humidity → determination of the air-sea turbulent heat fluxes

- Source Data
  - AVHRR/AMSR (Reynolds +)
  - SSM/I
  - Supporting data: solar radiation, ice flags

- Adaptations for CDR program (Version 1.1)
  - Corrections for EIA
  - Creation of NetCDF files
  - Extension to entire SSM/I record
  - No use of CCMP winds
## Project Description

<table>
<thead>
<tr>
<th>CDR(s) (Validated Outputs)</th>
<th>Period of Record</th>
<th>Spatial Resolution; Projection information</th>
<th>Time Step</th>
<th>Data format</th>
<th>Inputs</th>
<th>Uncertainty Estimates (in percent or error)</th>
<th>Collateral Products (unofficial and/or unvalidated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST</td>
<td>1998-2007</td>
<td>0.25° equal angle</td>
<td>3 hours</td>
<td>Binary</td>
<td>Reynolds, diurnal warming parameterization, SRB, GPCP</td>
<td>&lt; 0.2° C</td>
<td></td>
</tr>
</tbody>
</table>
| Near-surface air humidity, winds, & temperature | 1998-2007        | 0.25° equal angle                           | 3 hours   | Binary      | SSM/I, ice flags, land flags | Ta: < 0.1 °C  
Qa: 0.26 g/kg  
U: < 0.2 m/s  
LHF: 14 W/m²  
SHF: 6 W/m² |
| Latent and sensible heat fluxes | 1998-2007        | 0.25° equal angle                           | 3 hours   | Binary      | SST, Ta, Qa, Winds |                                                |
Production Approach: U, Ta, qa

- Use of neural net technique from SSM/I fields (Roberts et al. 2010)
- Gridding into equal-angle grids
- Interpolation using model gradients
Approach: SST

- Creation of pre-dawn SSTs
  - Currently Reynolds +
- Diurnal cycle inclusion
  - Estimation by parameterization – done for entire time period
- Production of final gridded SST datasets
Validation & Quality Assurance

- Uncertainty analysis by comparisons with IVAD (ship-based data, not used in production of data)
- Propagation of errors, simple sampling theory
- Uncertainty estimated at each time step and location for all products
  - Calculation of both systematic and random uncertainties
  - Uncertainties shown in product table are total over the 1998 – 2007 time period

\[
\sigma_{LHF} = \left[ \left( \rho_a L_v U(Q_s - Q_a) \sigma_{c_{sys}} \right)^2 + \left( \rho_a L_v C_E (Q_s - Q_a) \sigma_{U_{sys}} \right)^2 + \left( \rho_a L_v C_E U \sigma_{(Q_s - Q_a)_{sys}} \right)^2 + 2r_{(Q_s - Q_a)U} \left( \rho_a L_v C_E \right)^2 (Q_s - Q_a) U \sigma_{(Q_s - Q_a)_{sys}} \sigma_{U_{sys}} \\
+ \left( \rho_a L_v U(Q_s - Q_a) \sigma_{c_{ran}} \right)^2 + \left( \rho_a L_v C_E (Q_s - Q_a) \sigma_{U_{ran}} \right)^2 + \left( \rho_a L_v C_E U \sigma_{(Q_s - Q_a)_{ran}} \right)^2 + 2r_{(Q_s - Q_a)U} \left( \rho_a L_v C_E \right)^2 (Q_s - Q_a) U \sigma_{(Q_s - Q_a)_{ran}} \sigma_{U_{ran}} \right]^{1/2}
\]
Comparisons with IVAD data (courtesy of E. Kent)

SeaFlux = 0.7 * Obs + 2
Bias: -0.21 m s\(^{-1}\)
Std Error: 2.17 m s\(^{-1}\)

SeaFlux = 1 * Obs + 0.879
Bias: 0.37 °C
Std Error: 1.67 °C

SeaFlux = 0.98 * Obs + 0.39
Bias: 0.09 °C
Std Error: 1.43 °C

SeaFlux = 0.97 * Obs + 0.0372
Bias: 0.33 g kg\(^{-1}\)
Std Error: 1.69 g kg\(^{-1}\)

Clayson et al. 2013
Evaluating uncertainty using IVAD data

Wind Speed

Qs - Qa

Ts-Ta

Clayson et al. 2013
Instantaneous fields
SeaFlux Uncertainty Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Global uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHF (W m(^{-2}))</td>
<td>13.9 (15.4%)</td>
</tr>
<tr>
<td>SHF (W m(^{-2}))</td>
<td>5.7 (32%)</td>
</tr>
<tr>
<td>Windspeed (m s(^{-1}))</td>
<td>0.12 (1.6%)</td>
</tr>
<tr>
<td>Qa (g kg(^{-1}))</td>
<td>0.26 (2.2%)</td>
</tr>
<tr>
<td>SST (°C)</td>
<td>0.1 (&lt; 1%)</td>
</tr>
<tr>
<td>Ta (°C)</td>
<td>0.01 (&lt; 1%)</td>
</tr>
<tr>
<td>Ts - Ta (°C)</td>
<td>0.23 (16.1%)</td>
</tr>
<tr>
<td>Qs - Qa (g kg(^{-1}))</td>
<td>0.15 (4.1%)</td>
</tr>
</tbody>
</table>
Outside analysis of specific humidity

Prytherch et al. (2013)
Uses and Applications

- Science user communities
  - GEWEX, SeaFlux, CLIVAR, SOLAS, NASA NEWS, GHRSSST, UK MET
  - energy and water cycle studies, climate analyses, modelers (presentations to teachers, students, Eastman Chemical Company board)

- Several examples
  - An analysis of extremes, for instance hurricanes/mid-latitude storms
  - Comparisons with MERRA. Starting work with NASA GEOS modelers to evaluate/improve coupling for weather to seasonal scales.
  - New global analyses of water, heat cycles (NASA NEWS, Stephens et al 2012)
  - Understanding of distributions of near-surface properties including fluxes and how they evolve over time

Roberts et al. (2012)
**Improved hurricane fluxes**

- High-resolution structure of the lower atmosphere including heat and water air-sea exchanges during storms

Liu et al. (2011)
Global mean water fluxes (1,000 km$^3$/yr) at the start of the 21st century. Best guess estimates from observations and data integrating models. When water balance is enforced, uncertainty decreases. Trenberth et al. (2007) for comparison.
Regional Water Budgets

Brown and Kummerow 2013
Schedule & Issues

- **Accomplishments over past year and project status**
  - Submission and now revisions of paper outlining complete approach, uncertainty analysis, seasonal and diurnal variability
  - Uncertainty analysis finalized, uncertainties now available
  - Comparisons of CSU/Wentz TBs, inclusion of EIA

- **Milestones (with dates) to finish development & testing.**
  - Research data available to public, being used in current research and analysis programs
  - Over the next year: Sending of CDR version to CDR team, creation of appropriate documents including workflow, ATBD, etc.

- **State any risks or concerns**
  - Nothing major at this time

- **How can the CDR Program better assist you?**
  - At end of this workshop meet with production team to make sure we have all appropriate contact information to start process of handover