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

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Outline

- Brief Project Overview
- Approach (1-2 slides)
- Results/Accomplishments (1-3 slides)
- Validation Strategy/Results (1-2 slides)
- Algorithm/Product Maturity
- Issues/Risks & Work-Off Plans
- Schedule
- Transition Plan
- Societal Benefits (2 slides)
- Resources (1-2 slides)

Overview

- Goal: Production of 22 years of sea surface temperature and near-surface parameters of wind speed, temperature, and humidity from a combination of satellite observations, with a focus on the use of these variables towards determination of the air-sea turbulent heat fluxes. The fluxes will have consistent, homogeneous errors that have been subjected to a rigorous error analysis.

Overview

- Goal
- Source Data
  - AVHRR
  - AMSR
  - TMI
  - SSM/I
  - AIRS/AMSU/AMSR
  - NSCAT/QuikSCAT/SeaWinds
  - Supporting data: solar radiation; ice flags; aerosols

Overview

- Deliverables: all variables developed over the global oceans (excluding regions within 25 km of land or ice)
  - Skin surface temperature
  - Near-surface winds, air temperature, and specific humidity
  - Sensible and latent heat fluxes
- All datasets will share a constant time and grid spacing (3-hourly and 0.25° resolution)
- Additionally swath-level data will be made available
- Uncertainty estimates will also be provided

Overview

- Goal
- Source Data
- Deliverables
- ECVs addressed (used GOOS)
  - near-surface air temperature
  - sea surface temperature
  - near-surface wind speed
  - near-surface water vapor (in our case specific humidity)
- Review Product Description matrix

Overview

- Goal
- Source Data
- Deliverables
- ECVs addressed (used GOOS)
- Review Product Description matrix - still valid

As of October 18, 2010

Count	CDR Variable Name	Essential Climate Variable		Algorithm Name	Collateral Products	Responsible Team Member	Source Data Sensors	Future Source Data Sensor	Spacecraft	Channels	Spatial Resolution	Temporal Resolution			Product Units	Projection	Output Format	Metadata Standard	Other Characteristics	Key publication reference	Existing User Groups	Expected User Groups	Outcome	Impact	Community Workshop Status
Sequential id. number to count products, 1,2,3. Please list only one variable per row of the spreadsheet.	e.g. Level 1B radiance, albedo, cloud top height, SST, etc...			Please include a name that may be recognizable in the Climate community, e.g. ISCCP, GPCP, GRHSST, PATMOS-x, etc...	List all in one cell. Collateral Products are those which are not proposed as CDRs and are not yet considered to be climate quality, but which are routinely generated as secondary/intermediate outputs from the CDR algorithm. NOAA's CDR Program does not ensure or test the availability or reliability of Collateral Products. Users can contact the code developers for further information.	Please identify which member of your team is primarily responsible for development of this particular product.	List the space sensors which provided the raw data from which your product(s) were generated.	If you plan to provide CDR continuity from existing sensors to future sensors (e.g., from JPSS or other missions), please identify the mission and sensors to be used. NOTE: if you did not propose to address future sensors or data sets, please state "N/A"	Please list all spacecraft from which source data were used (e.g., NOAA-8, GOS Terra, SeaWiFS, GOES-14). Please follow the order used in the list of source data sensors.	Please list all channels used for each type of source data sensor.	Please use a new row for each unique resolution (spatial or temporal) -- Please include the units of the resolution (e.g., mbars, km, degrees).	Please use a new row for each unique resolution (spatial or temporal) - please include the units of the resolution (e.g., mbars, km, degrees)	As applicable, e.g., + early morning + mid-morning + afternoon	Start of Record: Month/Year	End of Record: Month/Year please say "present" if it is ongoing. note any gaps if they exist (e.g., Feb 2003)	e.g. Reflectance (unitless), degrees Kelvin, Radiance: W/m*2/sr, etc...	If gridded, what is your projection?	e.g. NetCDF, binary, HDF4, HDF5 etc...	Is your Metadata compliant with any standards or conventions? e.g., Climate Forecast (CF) Convention, FGDC Standards, ISO 19115-2, etc. If not adhering to a standard, please state "research"	Other Characteristics	Please provide a full bibliographic reference for 1 or 2 (only) key publicly available publications that describe your data set or process, if available.	Existing User Groups	Expected User Groups	Outcome	Impact	Community Workshop Status
		Domain	Variable								Horizontal	Vertical	Orbits	Start Date	End Date										
1	SST	Oceanic	Sea-surface temperature	SeaFlux	Diurnal variability, cloud mask, ice mask	Carol Anne Clayson	AVHRR, TMI, AMSR-E, MODIS	N/A	NOAA-9, NOAA-10, NOAA-11, NOAA-12, NOAA-14, NOAA-15 (AVHRR/3), Aqua, TRMM, Terra	AVHRR: Channels 3,4,5; TMI: all, AMSR-E: all, MODIS: Bands 20 - 23	25km	N/A	All orbits	July 1987	present	degrees Celsius	equal angle	binary	research	oceans only	Clayson, C. A. and D. Weitlich, 2007: Variability of tropical diurnal sea surface temperature. J. Climate, 20, 334-352.	SeaFlux community, GEWEX, ISCCP, SRB	GCM modeling groups, Ocean modeling groups, water cycle analysts, heat budget studies	Satellite climate record community enabled to address societal outcomes and impacts	Increased public understanding of global warming due to improved ocean surface temperatures; improved understanding of IPCC model results	No. Currently plans are underway considering a joint meeting with the next AMS Air-Sea Interaction Conference, to be held in roughly 18 months from now
2	Surface Air Temperature	Atmospheric	Surface Air Temperature	SeaFlux	Sensible heat flux	Carol Anne Clayson	SSM/I, AMSU-A, AIRS, AMSR-E	N/A	F08, F10, F11, F13, F14, F15, Aqua	SSM/I: all, AMSR-E: all, AMSU-A: Channels 1- 8, AIRS Level 2 product	25km	N/A	All orbits	July 1987	present	degrees Celsius	equal angle	binary	research	over oceans only	Roberts, J. B., C. A. Clayson, F. R. Robertson, and D. Jackson, 2010: Predicting near-surface characteristics from SSM/I using neural networks with a first guess approach. J. Geophys. Res., (in press).	SeaFlux community, GEWEX, ISCCP, SRB	GCM modeling groups, Ocean modeling groups, water cycle analysts, heat budget studies	Satellite climate record	Increased public understanding of global warming due to improved near-surface air temperatures; improved understanding of IPCC model results	No. Currently plans are underway considering a joint meeting with the next AMS Air-Sea Interaction Conference, to be held in roughly 18 months from now
3	Surface wind speed	Atmospheric	Surface wind speed	SeaFlux	N/A	Mark Bourassa	SSM/I, NSCAT, SeaWinds (QuikSCAT), SeaWinds (Midori2)	N/A	NSCAT, QuikSCAT, Midori2, F08, F10, F11, F13, F14, F15	SSM/I: all, SeaWinds : all	25km	N/A	All orbits	July 1987	present	m/sec	equal angle	binary	research	over oceans only	Bourassa, M. A., and P. J. Hughes, 2009: Impacts of High Resolution SST Fields on Objective Analyses of Wind Fields, and Practical Constraints Related to Sampling. International GHRSST User Symposium, 2 p.	SeaFlux community, GEWEX, ISCCP, SRB	GCM modeling groups, Ocean modeling groups, water cycle analysts, heat budget studies	Satellite climate record	Increased public understanding of the water budget and changes to the water cycle; improved understanding of IPCC model results	No. Currently plans are underway considering a joint meeting with the next AMS Air-Sea Interaction Conference, to be held in roughly 18 months from now
4	Surface humidity	Atmospheric	Water Vapor	SeaFlux	Latent heat flux	Carol Anne Clayson	SSM/I, AMSU-A, AIRS, AMSR-E	N/A	F08, F10, F11, F13, F14, F15, Aqua	SSM/I: all, AMSR-E: all, AMSU-A: Channels 1- 8, AIRS Level 2 product	25km	N/A	All orbits	July 1987	present	g/kg	equal angle	binary	research	over oceans only	Roberts, J. B., C. A. Clayson, F. R. Robertson, and D. Jackson, 2010: Predicting near-surface characteristics from SSM/I using neural networks with a first guess approach. J. Geophys. Res., (in press).	SeaFlux community, GEWEX, ISCCP, SRB	GCM modeling groups, Ocean modeling groups, water cycle analysts, heat budget studies	Satellite climate record	Increased public understanding of the water budget and changes to the water cycle and heat flux variability; improved understanding of IPCC model results	No. Currently plans are underway considering a joint meeting with the next AMS Air-Sea Interaction Conference, to be held in roughly 18 months from now

Approach

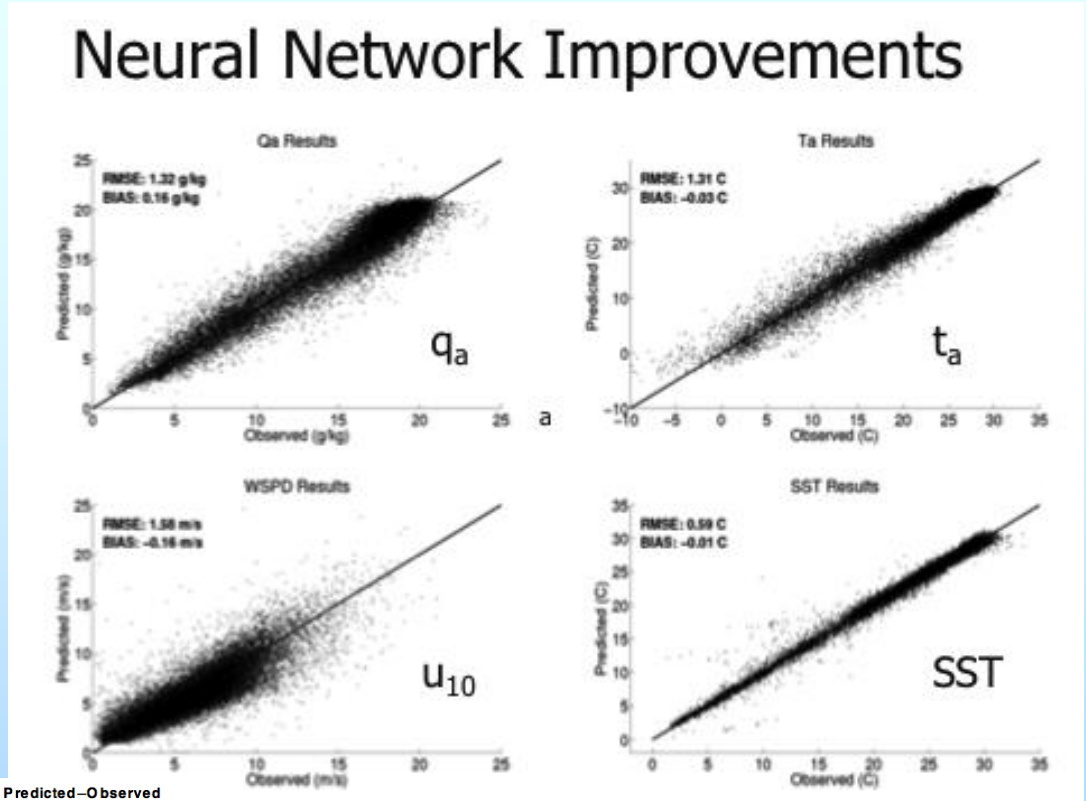
- Swath-level analyses of individual satellite/combinations
- Evaluation of errors
- Gridding of fields of SST, etc. from various satellites into one SST field with weighting of inputs
- Calculation of turbulent fluxes

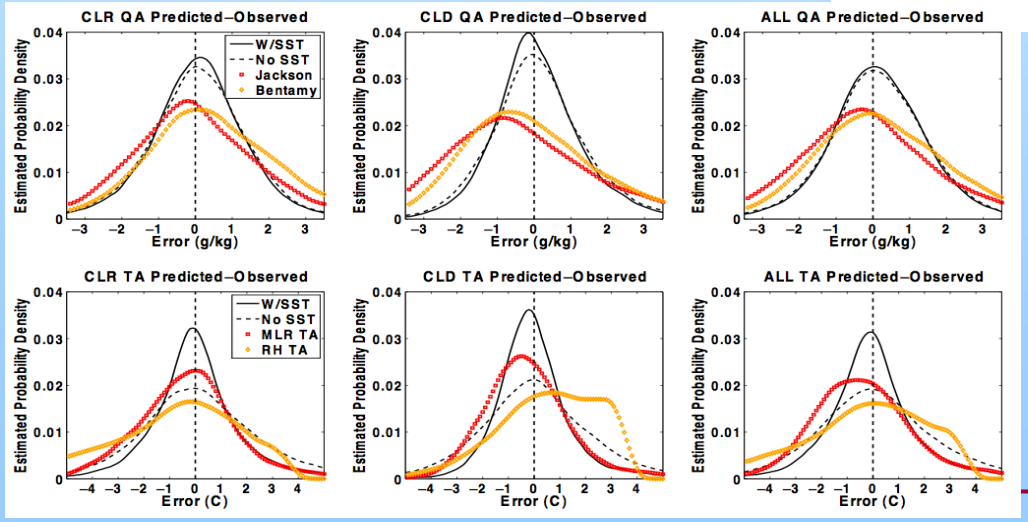
Approach: SST

- Creation of pre-dawn SSTs
  - Use optimal estimation method for AVHRR: combines RTM approach with bias correction
  - Provides point-by-point error characterization
- Diurnal cycle inclusion
  - Estimation by paramaterization
  - Objective gridding of additional satellite information (AMSR, TMI, SSM/I)
- Production of final gridded SST datasets

Approach: U, Ta, qa

- Use of neural net technique from SSM/I fields (Roberts et al. 2010)





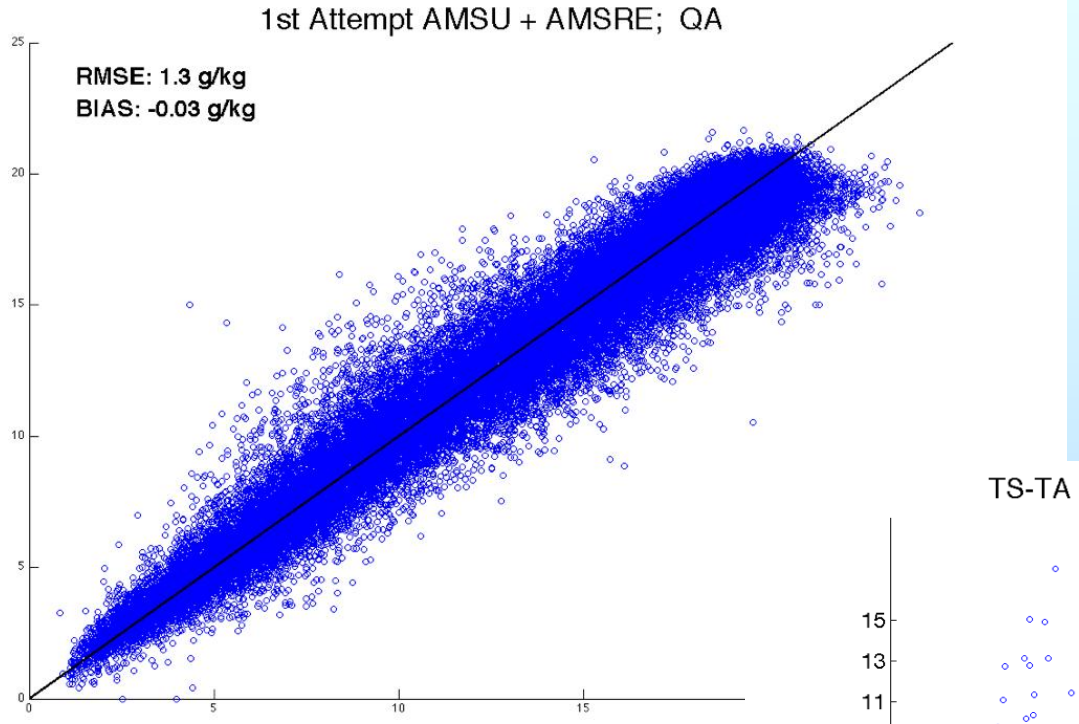
Approach: U, Ta, qa

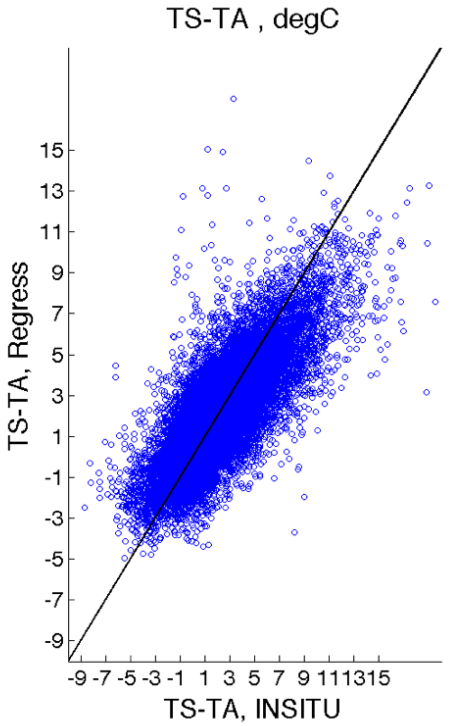
- For gridded fields: improved AIRS/AMSU/AMSR fields, using neural-net developed specifically making use of those data
- Use of variational gridding technique which allows for different types of inputs retaining error characteristics and information for weighting
- Interpolation using model gradients

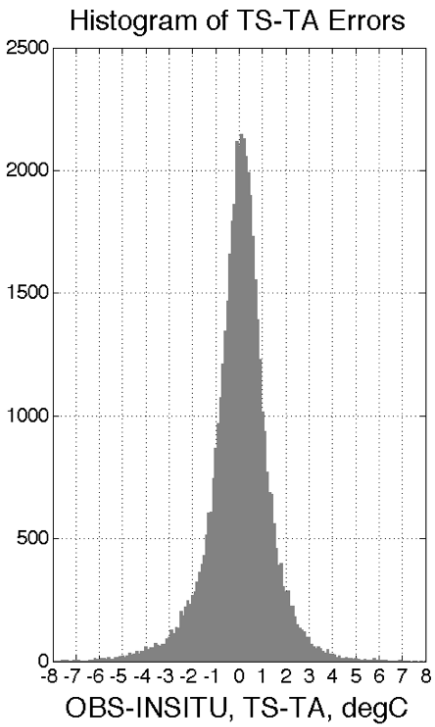
Results/Accomplishments: SeaFlux Version 1 – beta version released

- Uses SSM/I inputs only for entire data set
  - Currently using CSU calibrated values; will include uncalibrated values when they are in similar format (extending dataset back to mid-1987)
  - Have downloaded and performed new initial neural net retrievals of full RSS brightness temperature dataset
  - Have just received information from CSU regarding now available new calibrated values -- will download and compare
- Currently covers Dec 1997 – 2006
- q_a and t_a using neural net technique
- Winds: CCMP winds -- but with caveats
- Uses improved version of SeaFlux Diurnal SST
- Uses neural net version of COARE

Results: RSS TBs + AMSU/AMSRE

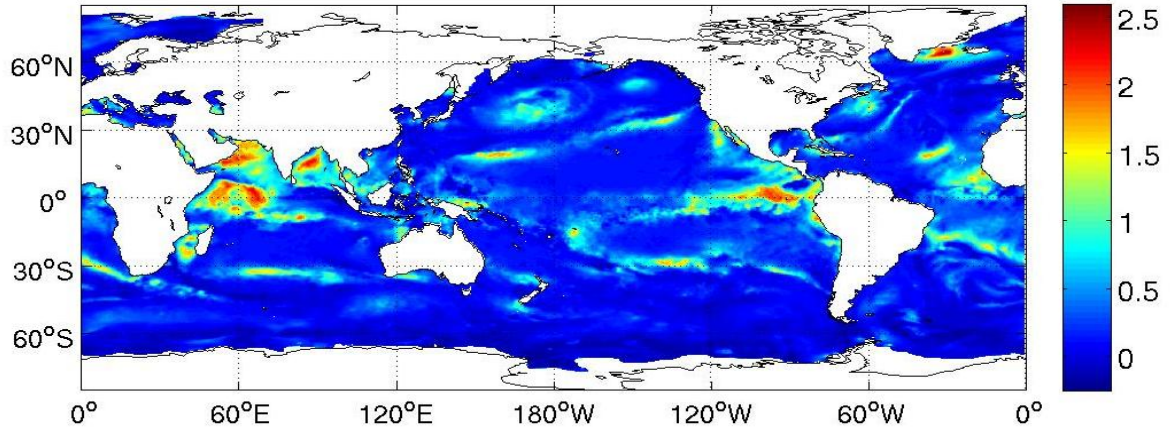


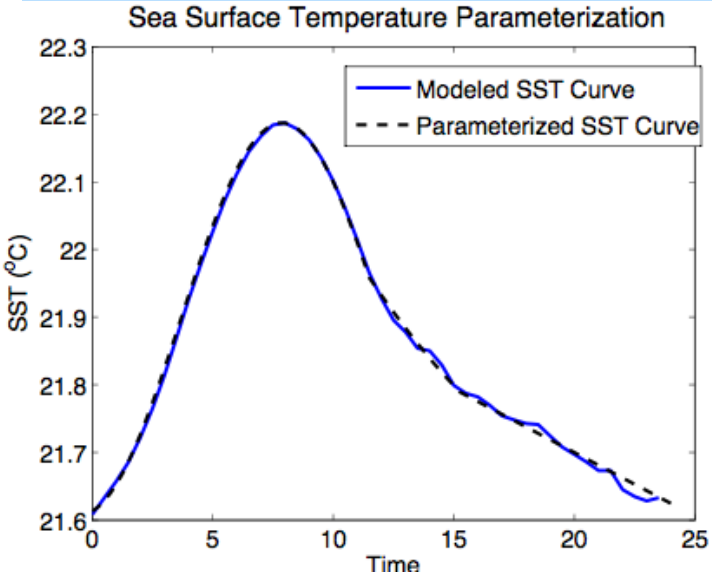




Results: new diurnal SSTs

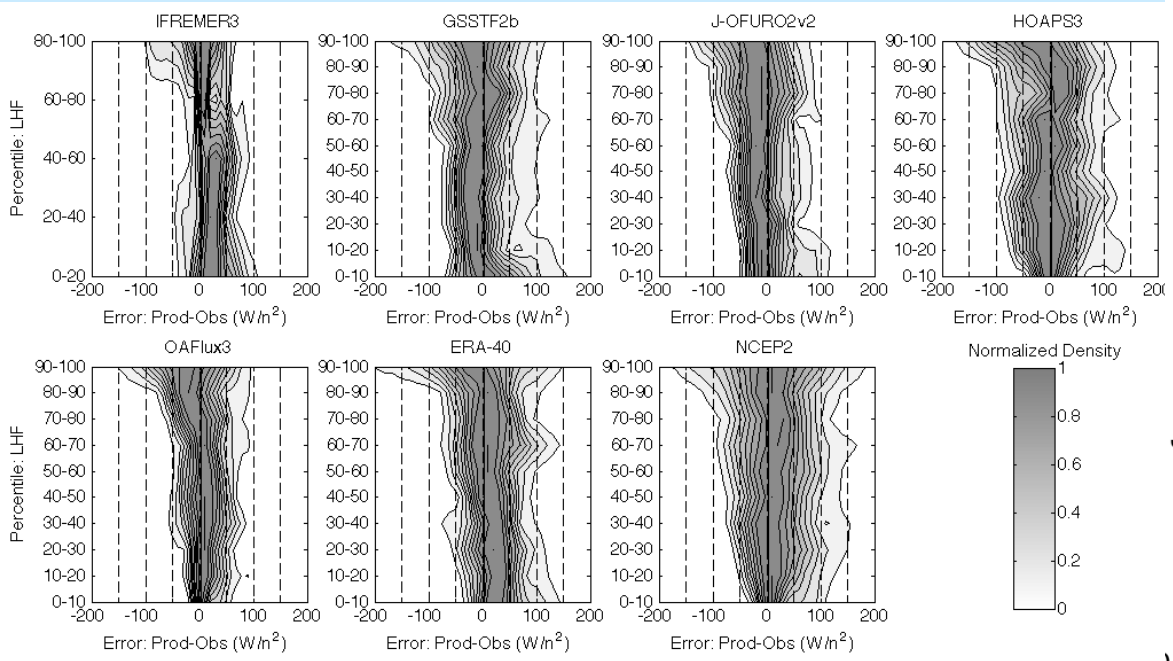
- improved model
- improved parameterization
  - better SST diurnal curve
  - improved high diurnal warming events
  - non-linear regression

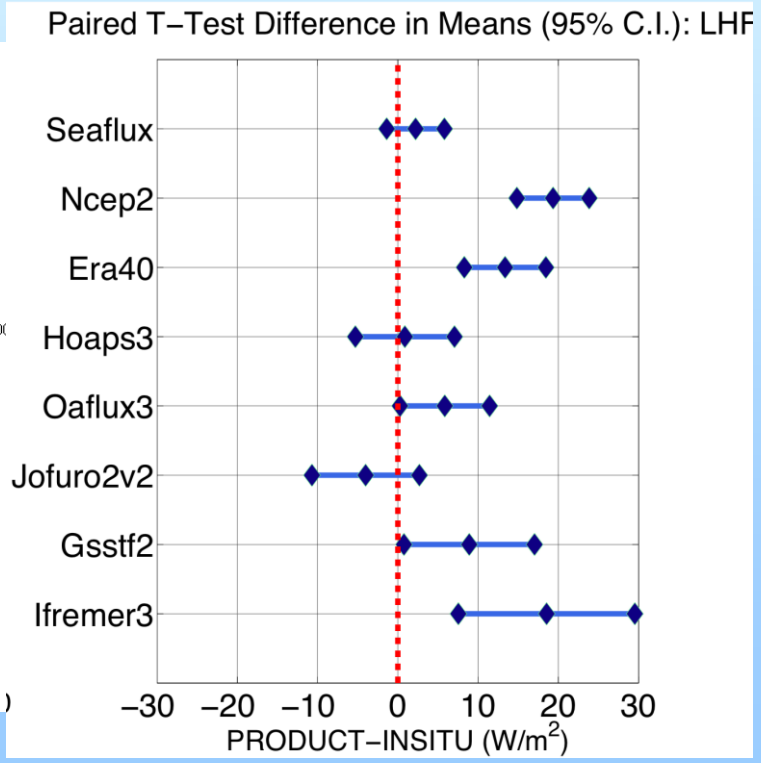




Validation Strategy/Results

- Will continue to use SeaFlux validation dataset for comparison (nearly 500,000 data points from flux research vessels, high quality flux buoys)
- Includes ship of opportunity data from Research Vessel Surface Meteorology Data Center at FSU





Issues/Risks & Work-Off Plans

- Transition of PI to new location -- delay in hiring of personnel
  - firm transition date; personnel in place
- Winds: role of CCMP; rain contamination
- Calibrated TBs -- coordination with fundamental CDR teams
    - work is proceeding with microwave; less activity with other CDR teams -- need to coordinate (especially SST)
- Further community discussion -- through SeaFlux workshops, continued discussions with product users
  - This is ramping up as beta version released

Schedule

- Work is moving forward, but about 6 months behind where I would like to be
  - Plans to finish checking out CSU/RSS brightness temperatures, resolve issues
  - Create swath-level data for the entire SSM/I time period
- Produce objectively gridded sea surface temperature fields
- produce gridded Qa, Ta, and U fields
- Begin calculations of surface flux fields
- Begin estimations of uncertainties, errors in data sets
- Adjust as appropriate from community discussions
- Start work on preparing code, documentation for transfer

Transition Plan

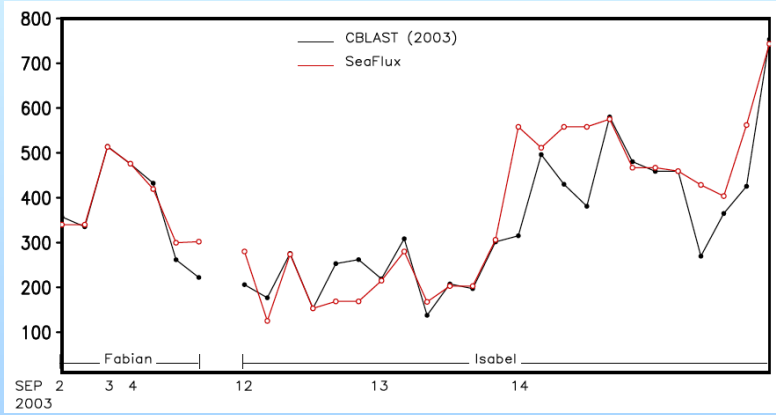
- DOCUMENTATION (initial: summer 2012)
  - Climate Algorithm Theoretical Basis Document (C-ATBD)
    - Am working on development of this document, but will wait until final determination of inputs/procedures are finalized
  - Data Flow Chart and Maturity Matrix
    - Maturity matrix available, data flow chart awaiting full decisions on available inputs
- DATA SET(S)
  - What format are you using (note: prefer NetCDF) -- currently in multiple formats, including NetCDF
  - Quality of Metadata -- good
  - Size of data set current ~1 TB -- will grow larger as earlier years are added
- SOURCE CODE
  - Level of Documentation -- currently low
  - Language -- MATLAB, but can convert to Fortran or others as needed
  - README -- none at the moment
- CONCERNS
  - Have not made connections for those to whom this would be handed off

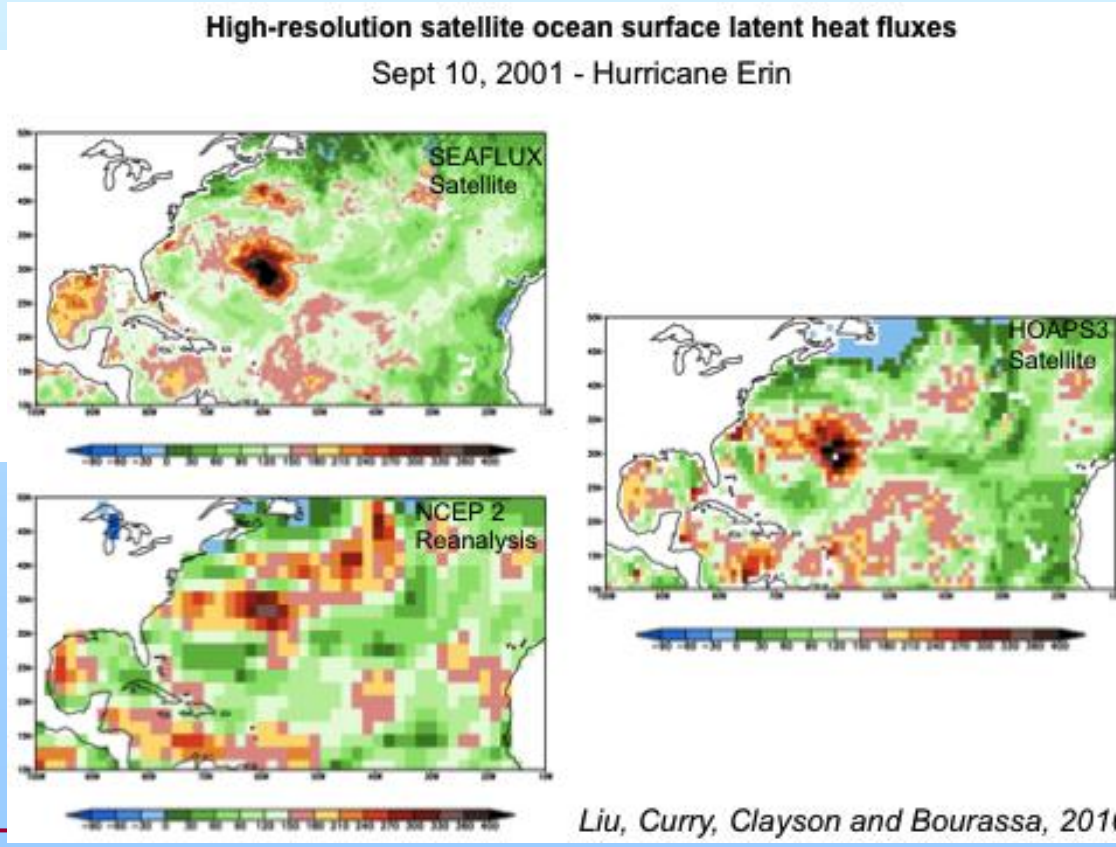
Benefit to the Science Community

- Discuss science user communities who will benefit.
  - GEWEX, SeaFlux, CLIVAR, SOLAS, NASA NEWS, GHRSST
  - ocean modelers
  - climate modelers and those analyzing output
  - energy and water cycle studies
  - climate analyses
- Give several practical examples where your data will make a difference –i.e. how?
  - An analysis of extremes, for instance hurricanes (see Lu et al. 2011)
  - Comparisons with MERRA (Roberts et al. 2011)
  - New global analysis of water cycle in NEWS project (paper in preparation; discussions with Fasullo and Trenberth, etc.)
  - Understanding of distributions of near-surface properties including fluxes and how they evolve over time (we are just ramping up this work)

Benefit to Society

- Discuss at least one practical application of your product.
  - High-resolution structure of the lower atmosphere including heat and water air-sea exchanges during storms
    - ➢ Hurricanes (Lu et al. 2011)
    - ➢ Mid-latitude storms (Scott et al. 2011)





Benefit to Society (potential)

- Indirect climate benefits
  - Extremes, and their distributions, may be changing over time. High-quality climate data including surface parameters are needed to evaluate this possibility.
- Energy
  - Improved winds, boundary layer stability information is of value to off-shore wind farms
  - Future wave energy retrieval will be affected by quality of the surface information driving the ocean models
- Water
  - Long-term changes in the water cycle driven to a large extent by ocean evaporation can more carefully be determined. The effects of regional versus global changes as well as the importance of changes in the number and intensity of severe storms to the overall water budget are of potential interest to water management types.
- Transportation
  - Optimum Ship Track Routing

Resources

- Number of personnel employed for project
  - Roughly 2 FTE (Clayson, Bourassa, post-doc, programmers)
- Key equipment or observatories used
  - significant data storage for satellite observations (still to be purchased)
  - SAMOS and SeaFlux in situ comparison datasets
- Key collaborating projects or personnel
  - AVHRR, SSM/I, AMSU/TMI calibration; ice flags, cloud flags, precipitation fields
  - Ferrraro for AMSU, Kummerow for SSM/I, etc., Mittaz for AVHRR, Key for ice flags
- NOAA points-of-contact or collaborators, as applicable
  - J. Privette, NCDC
  - Huai-Min Zhang, NCDC
  - K.Casey, S. Ignatov (NOAA)
- Target NOAA Data Center: NCDC