Development of a 28-Year (1987-2014) Climatology of Single and Multi-sensor Satellite-based Retrievals of Near-surface Humidity and Temperature.

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INTRODUCTION

Turbulent surface fluxes can be derived using combination of satellite observations and the bulk formula. This study shows the development of near-surface (10 m) temperature (T_a) and humidity (q_a) data set derived from satellite observations spanning the almost 30 years starting in 1987. This work is an extension of previous studies (Jackson et al., 2006, JGR; Jackson et al., 2009, JGR) but builds upon those efforts using intercalibrated satellite data and extend the data over a longer time period. This effort supports a NASA NEWS proposal for NASA Energy and Water Cycle Study with Dr. Mark Bourassa at Florida State University which seeks to develop high resolution turbulent energy and moisture flux satellite-derived data set.

DATA SETS

Satellite Data

- CSU FCDR Special Sensor Microwave/Imager (SSM/I) and Special Sensor Microwave Imager Sounder (SSMIS) data (1987-2014)
- STAR FCDR Advanced Microwave Sounding Unit (AMSU-A) data (1999-2014)
- Reynolds High-Resolution Optimally-Interpolated Sea Surface Temperature (AVHRR-only) data (1987-2014)

Ship Data

- Temperature and humidity data from Shipboard Automated Meteorological and System (SAMOS) Fluxes v2.0 data set (2005-2014) [Smith et al., 2016,Geoscience Data Journal]
- International Comprehensive Ocean-Atmospheric Data Set (ICOADS) version 2.5

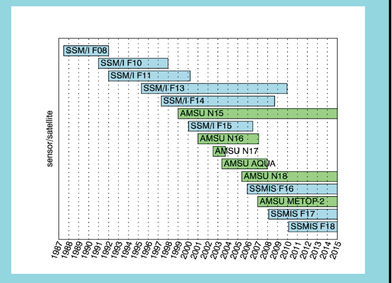
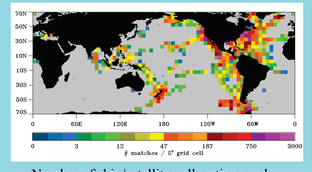
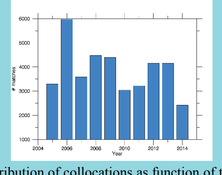


Figure shows various SSM/I, SSMIS, and AMSU sensors used to construct data set

SHIP/SATELLITE COLLOCATIONS



Number of ship/satellite collocations and their distribution globally

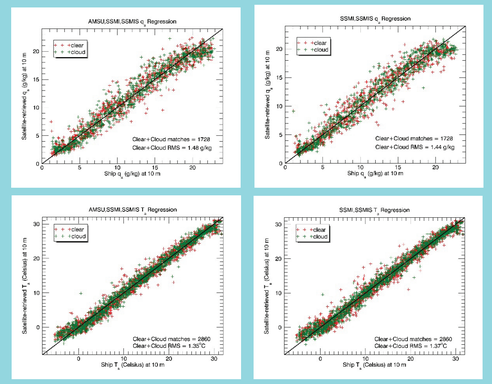


Distribution of collocations as function of time

- A new set of training data used to develop retrieval
- SAMOS ship observations were collocated with SSM/I, SSMIS, and AMSU-A satellite observations with 3 hour temporal and 50 km spatial requirement
- Collocated data derived from 21 ships found globally starting in 2005
- Ship data all height-corrected using Bourassa-Vincent-Woods flux algorithm
- ~ 50,000 collocated observations available for training regression algorithms
- Collocated observations are distributed evenly over the past 10 years

HUMIDITY AND TEMPERATURE REGRESSIONS

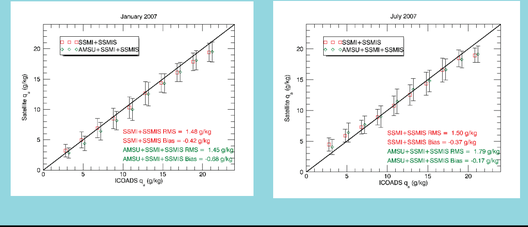
- Two multi-linear regression retrievals: (1) using SSM/I, SSMIS, and Reynolds SST, and (2) Also includes AMSU-A
- Training data set randomly selects matched 40 collocated observations in 1 g/kg for q_a and 1°C bins for T_a
- Seeking even distribution of observations to minimize tails on retrieved parameters
- Separate regression coefficients developed for clear-sky conditions (CLW < 0.025 mm) and cloudy conditions (0.025 mm < CLW < 0.25 mm). SSM/I retrieved CLW from Remote Sensing Systems version 7 data used to determine cloud content
- Satellite observations have little sensitivity for q_a observations > 20 g/kg and T_a observations < -5°C



RETRIEVALS

- Create 3 hourly, 0.25 degree brightness temperature data sets combining SSM/I and SSMIS data, and a second set of brightness temperature data with combined AMSU-A limb corrected data
- Use Remote Sensing Systems Version 7 cloud liquid water and rain rate retrievals are used to mask precipitation regions and identify cloud and clear sky regions
- Apply regression equations to form two sets of q_a and T_a outputs: (1) one set extends from 1987-2014 and uses only SSM/I and SSMIS data and (2) a second set extends from 199-2014 and adds AMSU-A lower tropospheric temperature channels 4 and 5 to the regression using SSM/I and SSMIS data
- Retrieval outputs of T_a and q_a are contained in 3 hourly grids from 70°N-70°S and reside on 0.25 degree

VALIDATION



- Independent validation conducted using ICOADS v2.5 ship observations
- q_a RMS differences similar to regression in January for both retrievals but higher for AMSU retrieval in July
- ICOADS ship data are not height-corrected which may contribute bias. This issue will be evaluated with an updated ICOADS height corrected data set

SUMMARY

- Developed a 28-year satellite-derived 0.25° /3-hour resolution data set of T_a and q_a
- Utilized intercalibrated quality-controlled FCDR SSM/I, SSMIS, and AMSU-A satellite observations
- Used collocated height-adjusted SAMOS ship observations and satellite observations to construct regressions
- Analyzed retrieved T_a and q_a data show a consistent data record of near-surface temperature and humidity

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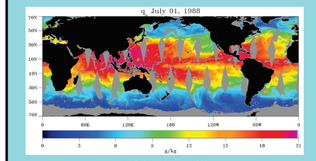
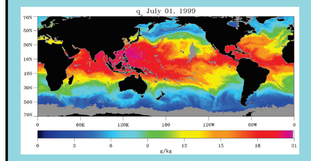
HUMIDITY AND TEMPERATURE DATA

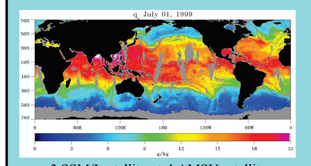
10 m Humidity



1 SSM/I satellite



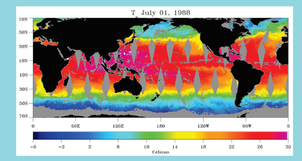
3 SSM/I satellites



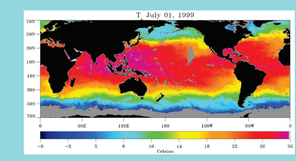
3 SSM/I satellites + 1 AMSU satellite

- T_a and q_a daily maps show global coverage with different combinations of satellites
- One satellite coverage during early period leaves gaps in subtropical regions
- Retrieved grids at 0.25° spatial resolution
- No retrievals in precipitation areas which is most evident on grid with 1 satellite
- Using AMSU satellite does reduce data coverage particularly when only 1 AMSU satellite is available

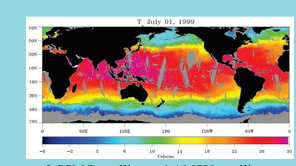
10 m Temperature



1 SSM/I satellites



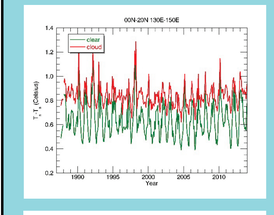
3 SSM/I satellites

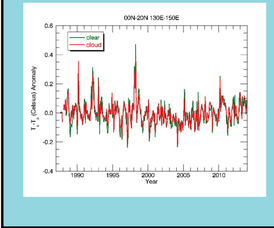


3 SSM/I satellites + 1 AMSU satellites

TIME SERIES COMPARISON

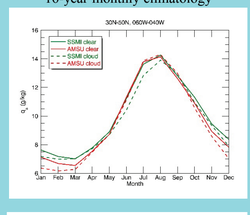
Tropical West Pacific Region
T_s-T_a using SSM/I-only retrieval

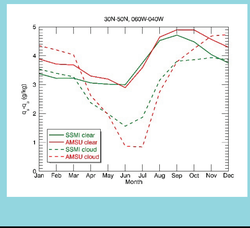




North Atlantic Storm Track Region
AMSU+SSM/I vs SSM/I-only q_s-q_a retrieval comparison

16-year monthly climatology





Cloud-sky vs Clear-sky anomaly