Retrieval of MODIS SST with Optimal Estimation

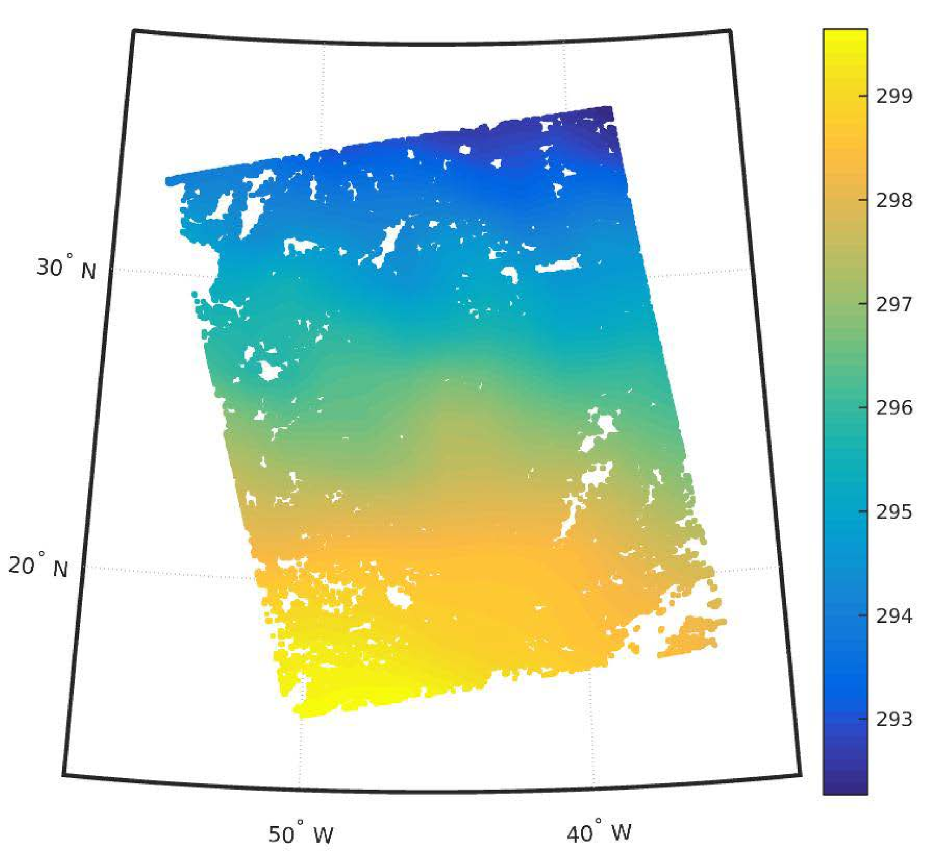
UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE & ATMOSPHERIC SCIENCE

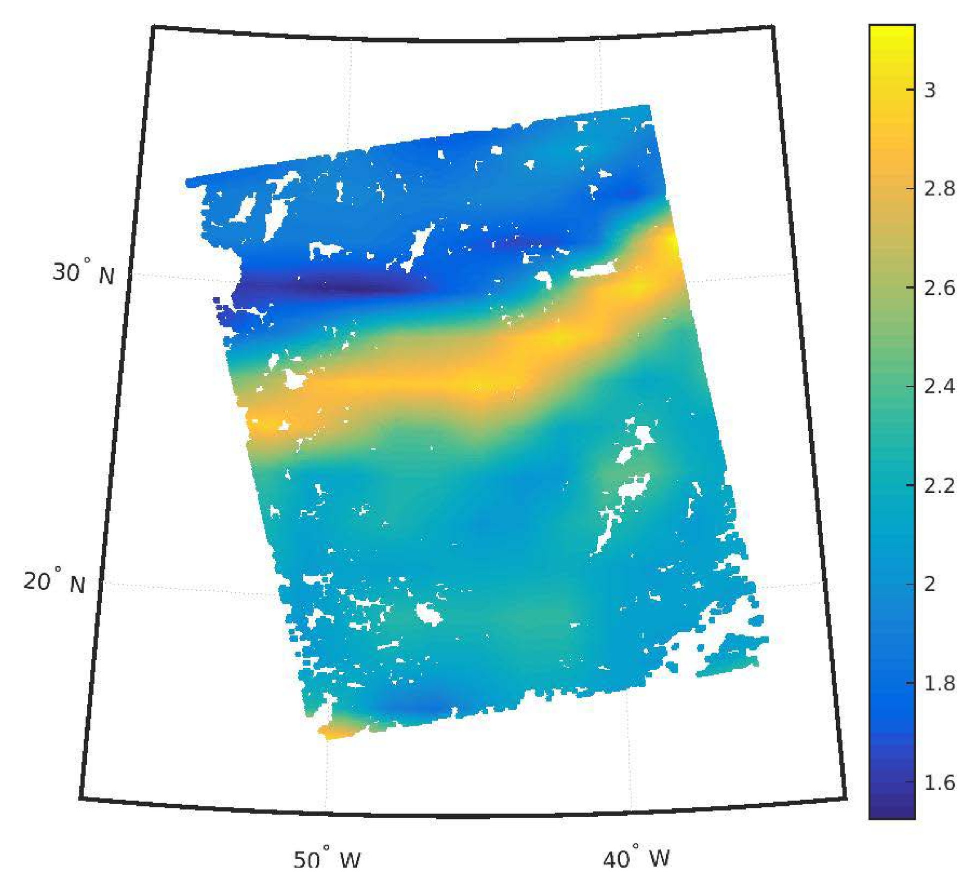
Goshka Szczodrak and Peter J. Minnett
Department of Ocean sciences
Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, USA

An Optimal Estimation (OE) method is used to retrieve skin sea surface temperature (SST) from MODIS channel 31 and 32 radiance measurements (λ = 11μm, 12μm). The Optimal Estimation (OE) approach uses a priori knowledge or estimation of the state of a system as an input of a forward model to simulate 'observations' (known as priori observations). The difference between these simulated observation and actual measurements reflects the difference between the assumed a priori state of the system and the actual state and thus provides an estimate of the actual state. Prior knowledge is a state vector consisting of European Center for Medium Range Weather Forecast (ECMWF) interim reanalysis fields of sea surface temperature and column water vapor, and the prior observations is a set of MODIS channel 31 and 32 predicted radiances calculated using line-by-line radiative transfer model (LBLRTM) of Clough et al., (2005) for all prior state vectors.

The LBLRTM was also used to compute the partial derivatives of the channel 31 and 32 radiances with respect to the elements of the state vector (Jacobian matrices). Firstly, a set of base Jacobians were calculated representative of the five standard atmospheres (Tropical, Mid-Latitude Summer and Winter, and Subarctic Summer and Winter) and in each case for a range of SST and Total Column Water Vapor (TCWV) values. These base Jacobians were used to build Jacobian matrices for the individual state vectors by selecting the appropriate model atmosphere based on location and interpolating to the SST and TCWV of the a priori state.

The results of the MODIS OE SST retrieval applied to test granules are compared with the SSTs derived using the current MODIS non-linear SST (NLSST) version 6 retrieval algorithm. Bi-linear interpolation of the a priori fields to the time and position of the satellite data is used. The difference between the OE SSTs and the a priori SSTs is sensitive to the noise assigned to the a priori knowledge. Averaging the measurements and Jacobians in 3x3 arrays improves the OE retrievals, but much high resolution viability is not represented. TCWV is also be retrieved.



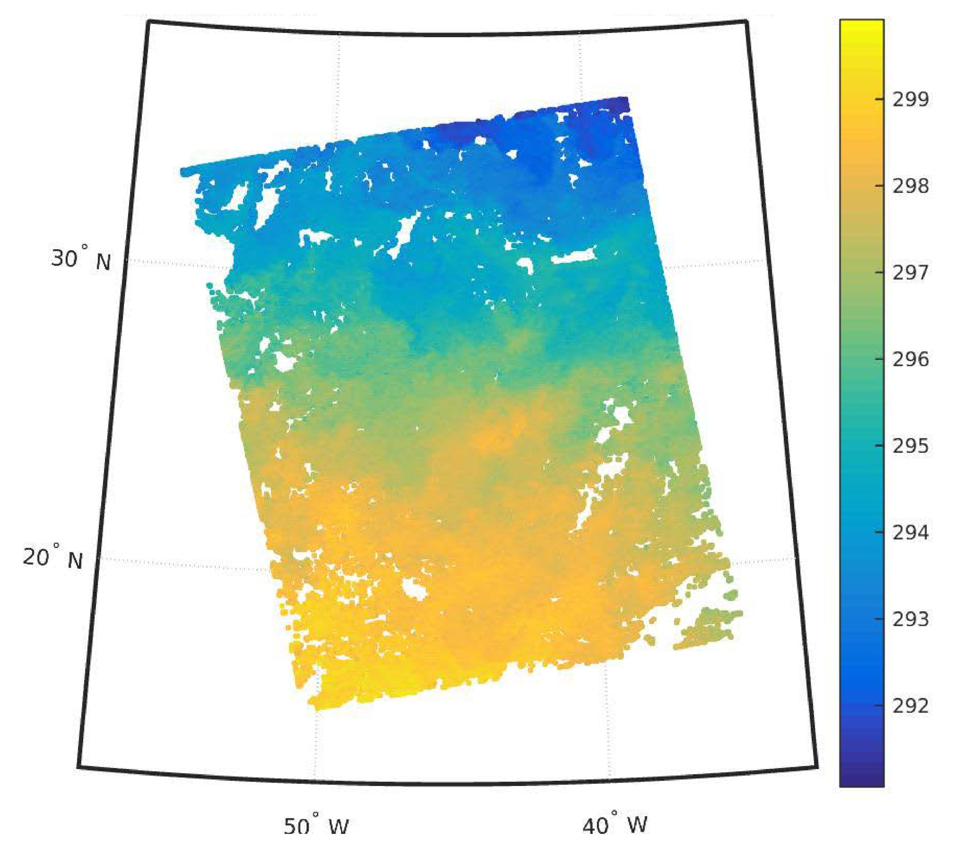


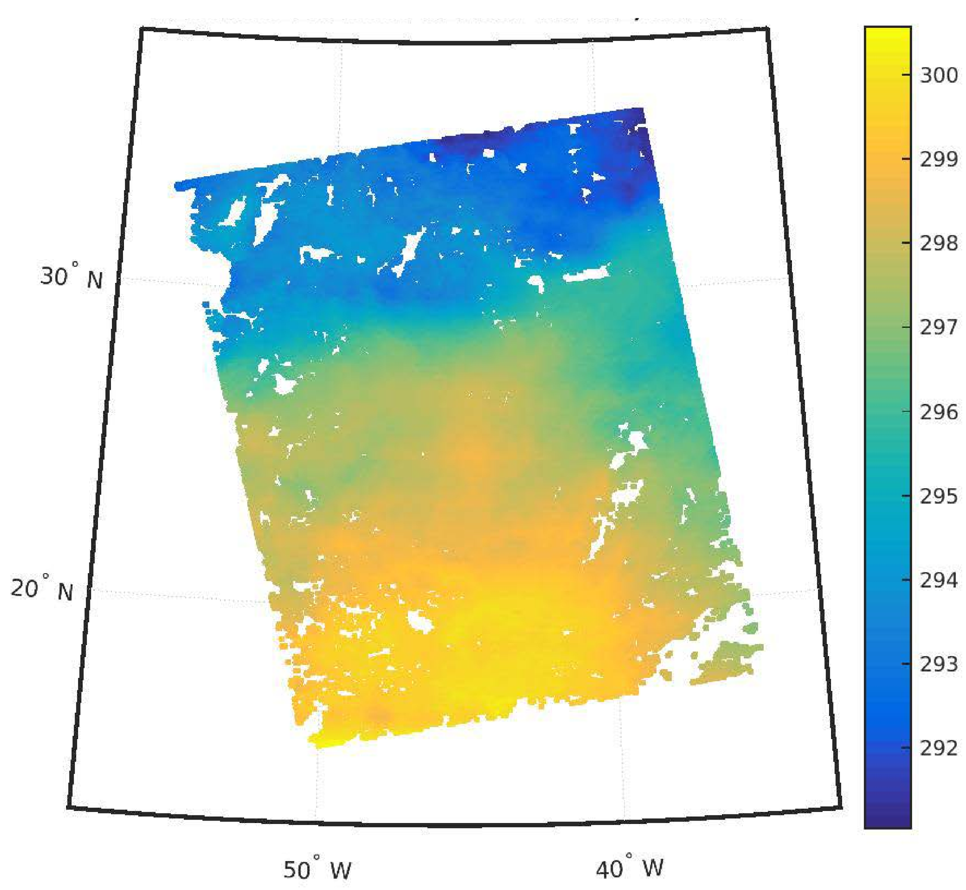
A priori fields

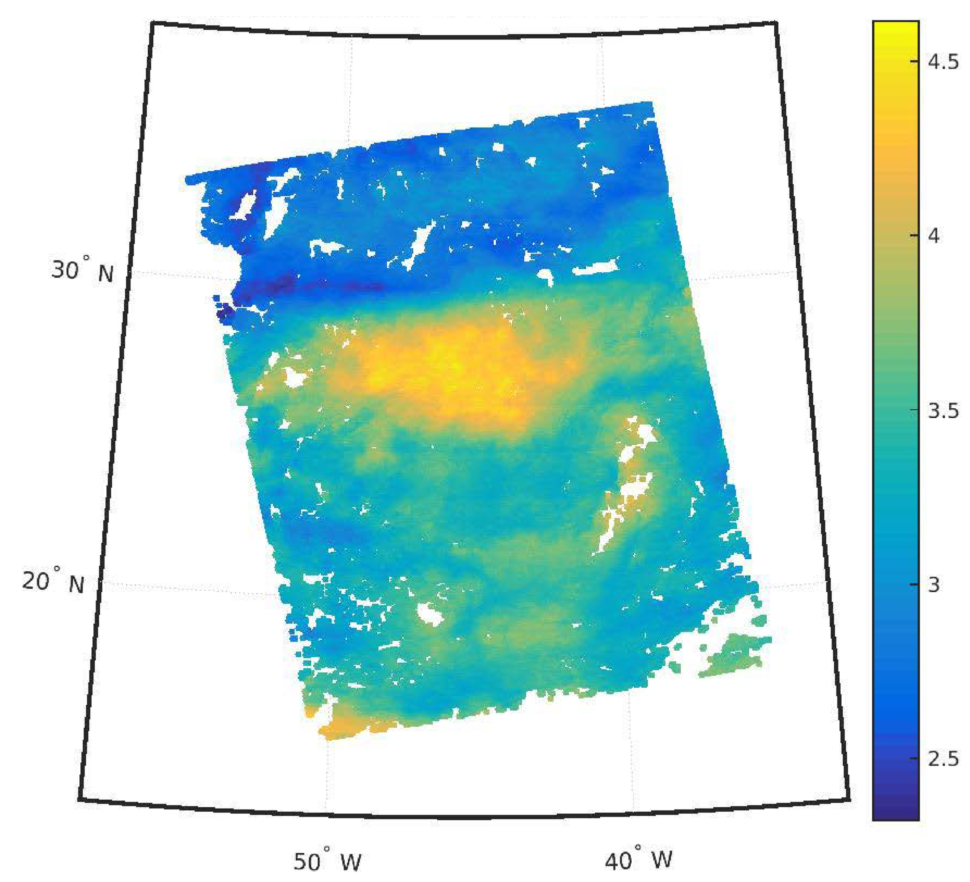
Left: ECMWF SST [K]
Center: ECMWF TCWV [kg m^{-2}]

Comparison field

Right: MODIS V 6 skin SST [K]





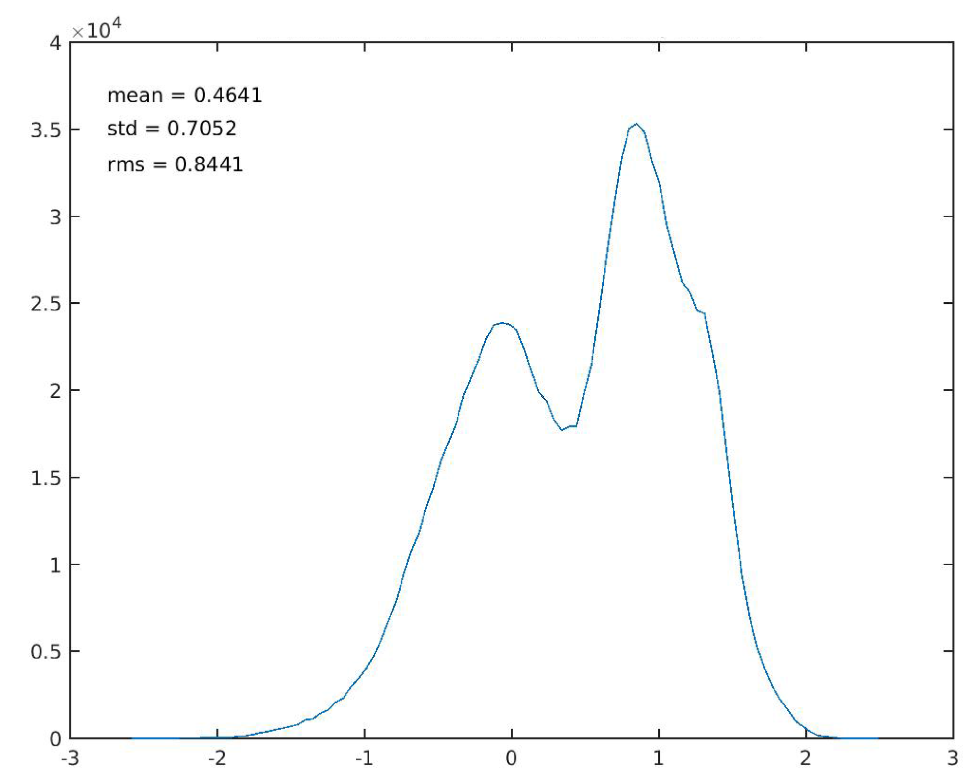


OE retrieved fields

Left: SST [K]
Center: TCWV [kg m^{-2}]

SST differences

Right: Histogram OE - MODIS V6 skin SST [K]



The lack of small scale features in the current OE fields renders them unsuitable for certain applications, such as the location and study of fronts, but for applications where high resolution is not required, such as for climate studies, the OE SST fields may be suitable.

The discrepancies between OE and MODIS V6 SSTs are influenced by the TCWV.

A thorough assessment of the accuracy of the OE SSTs will be made using in situ measurements, including those from ship radiometers.

Reference

Clough, S. A., M. W. Shephard, E. J. Mlawer, J. S. Delamere, M. J. Iacono, K. Cady-Pereira, S. Boukabara, and P. D. Brown, Atmospheric radiative transfer modeling: a summary of the AER codes, Short Communication, *J. Quant. Spectrosc. Radiat. Transfer,* 91, 233-244, 2005.

GHRSST Group for High Resolution Sea Surface Temperature
17th International Science Team Meeting (GHRSST XVII)
6th-10th June 2016

Acknowledgement: Funding from NASA Physical Oceanography Program