# Status of the Combined ASTER and MODIS Emissivity over Land (CAMEL) Product

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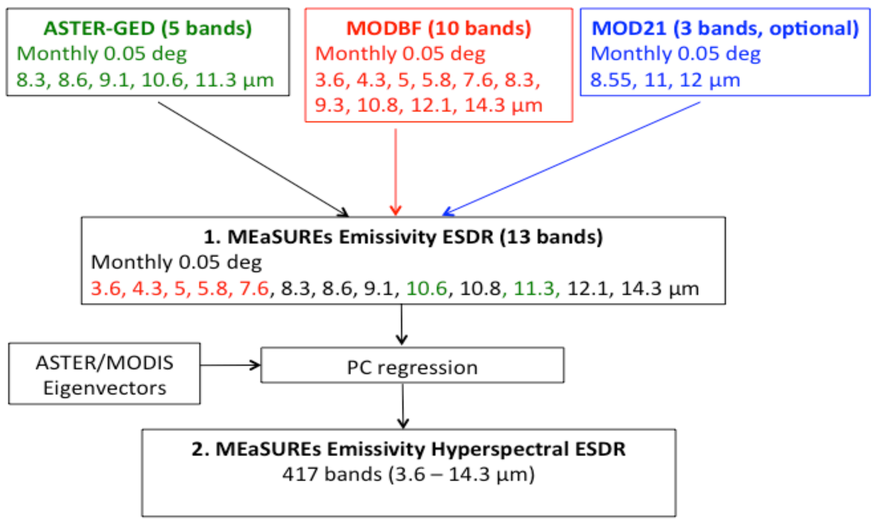
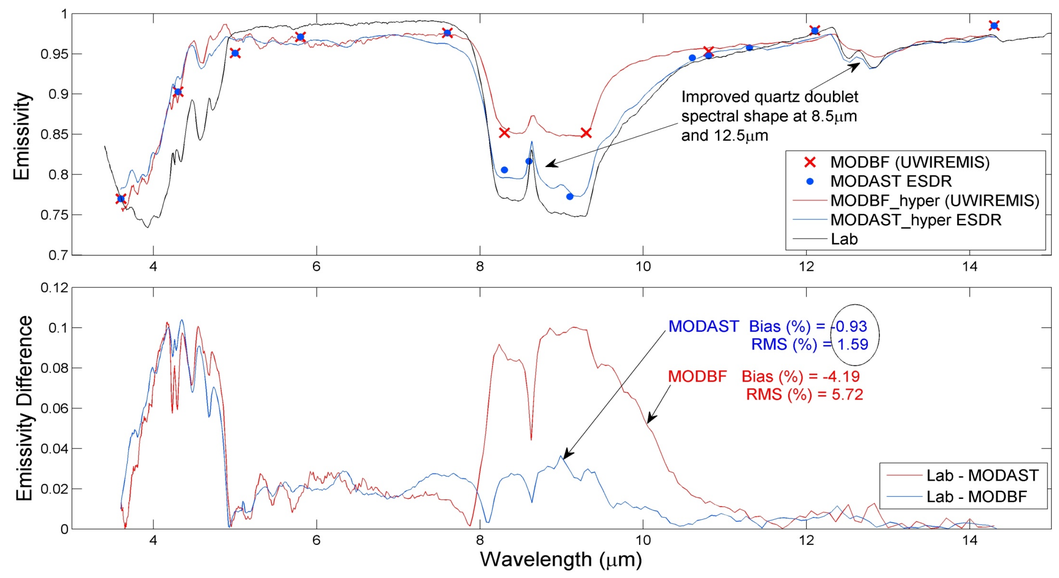
## CAMEL COMBINES NASA MODIS AND ASTER EMISSIVITY PRODUCTS




**CAMEL Emissivity ESDR wavelengths:**

3.6 µm= MODBF (3.6µm)
4.3 µm= MODBF (4.3µm)
5.0 µm= MODBF (5.0µm)
5.8 µm= MODBF (5.8µm)
7.6 µm= MODBF (7.6µm)
8.3 µm= COMBO
8.6 µm= COMBO
9.1 µm= COMBO
10.5µm= ASTER (10.6µm)
10.8µm=COMBO
11.3µm= ASTER(11.3µm)
12.1µm= MODBF (12.1µm)
14.3µm= MODBF (14.3µm)

COMBO: combination of ASTER(8.3µm) ASTER(8.6µm) ASTER(9.1µm) MODBF(8.3µm)

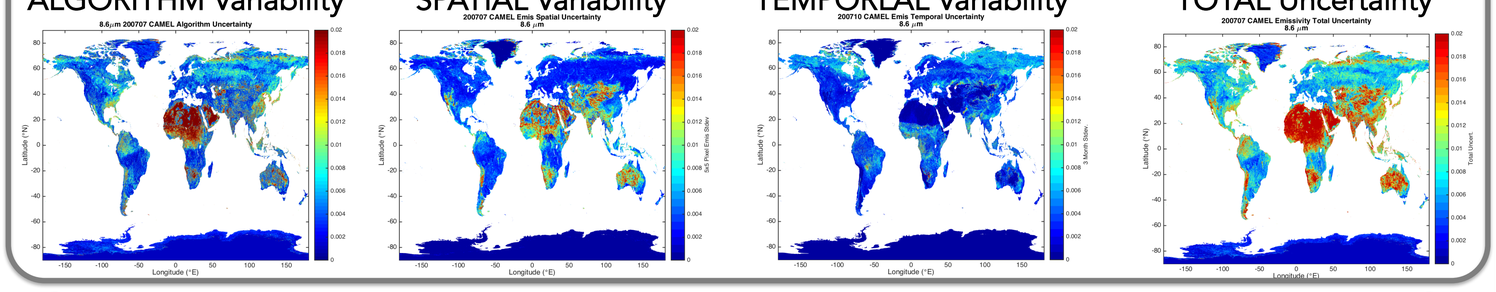



**Left:** MEASURES CAMEL Emissivity ESDR flowchart. **Right:** the images show a comparison of the CAMEL emissivity ESDR (blue), the UW Baseline Fit and High Spectral Resolution Database (red), and laboratory spectra (black) of sand samples collected over the Namib desert for January 2004. The unified CAMEL emissivity ESDR product results in significant improvement over the UW Baseline Fit (MODBF) product when compared to in situ measurements.

## PRODUCT UNCERTAINTY

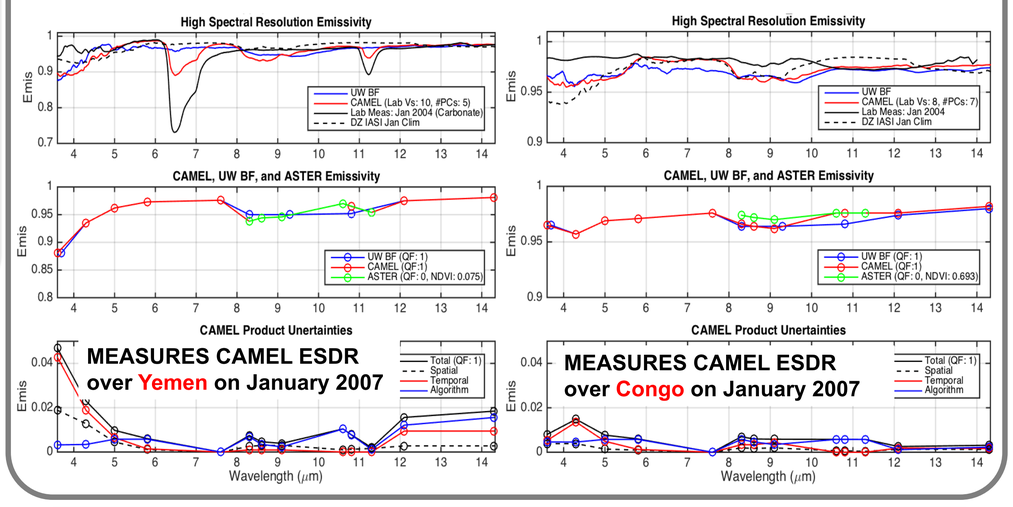
The product uncertainty is estimated by a total emissivity uncertainty that comprises 3 independent components of variability—a temporal, spatial, and algorithm variability. Each measure of uncertainty is provided for all 13 channels and every latitude-longitude point.

ALGORITHM Variability | SPATIAL Variability | TEMPORLAL Variability | TOTAL Uncertainty




## VALIDATION

The MEASUREs CAMEL products are routinely validated with ground based measurements of emissivity over locations with different surface types. Validation over Yemen and Congo is shown here.



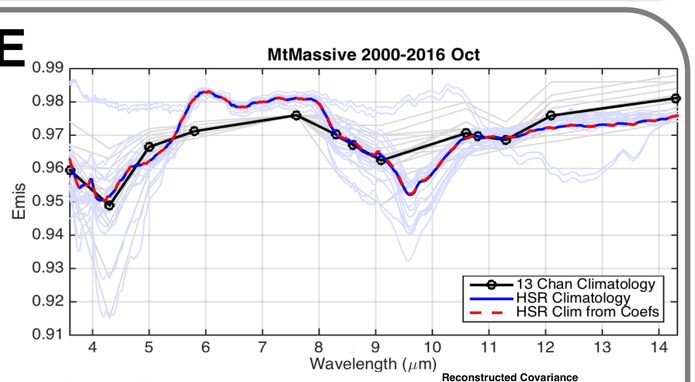

## CLIMATOLOGY & COVARIANCE

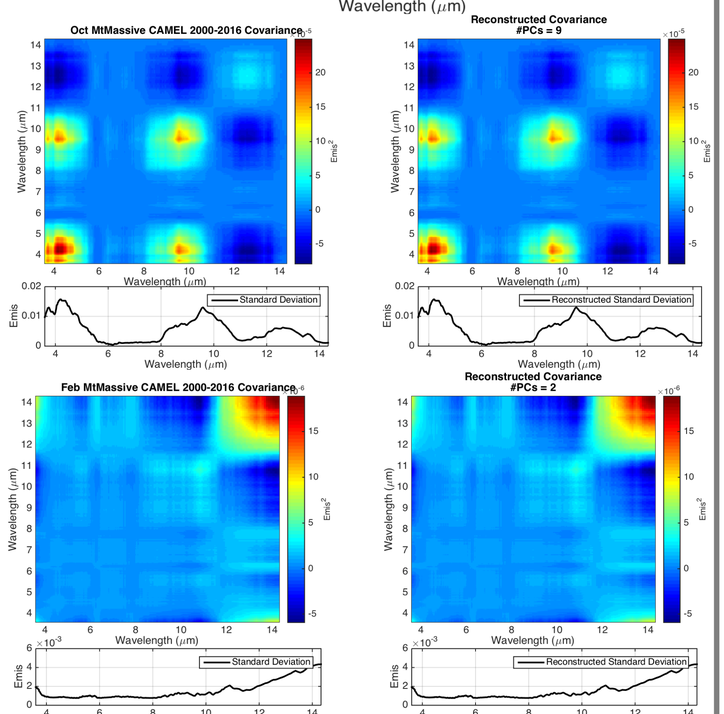
Work is under way to provide a climatology of the CAMEL product over the years 2000-2016. Monthly mean climatologies will be provided for:
1] the 13 channel emissivity,
2] the 13 channel emissivity uncertainty, and
3] the coefficients, which will be provided with a software package to compute the HSR climatology.

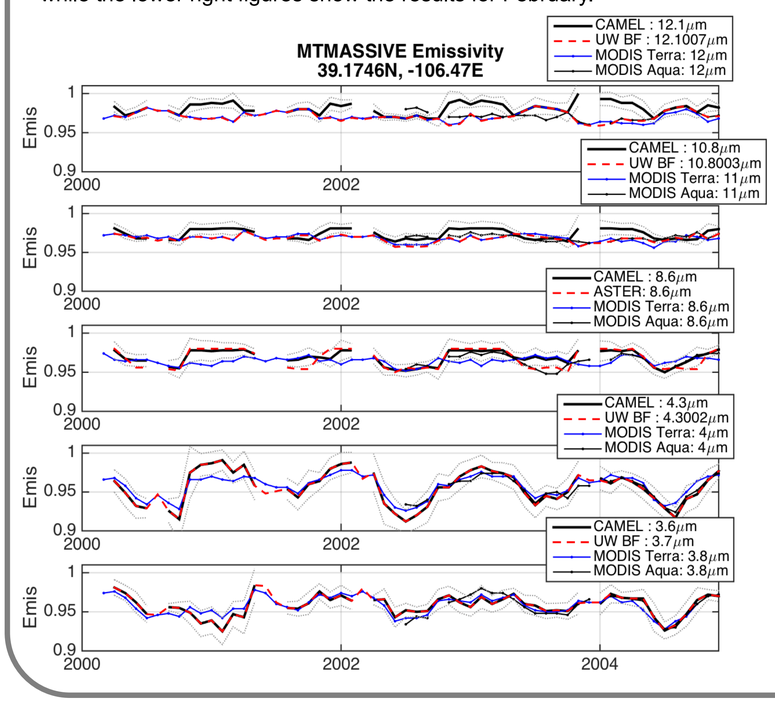
**The figure to the upper right** shows the 13 channel and HSR emissivity climatology for the month of Oct for a case site within the Rocky Mountains.

Additionally, a monthly climatology covariance will be provided for:
1] the coefficients, and
2] the HSR emissivity in the form of PCs and coefficients.
For all sites and months investigated, when PCA is used to compress the covariance matrix, the same number of coefficients which are needed to compute the HSR spectra are needed to reconstruct the HSR covariance.

**The figures to the right** show the Oct actual and reconstructed HSR covariance for the same Rocky Mountain case site as depicted above, while the lower right figures show the results for February.



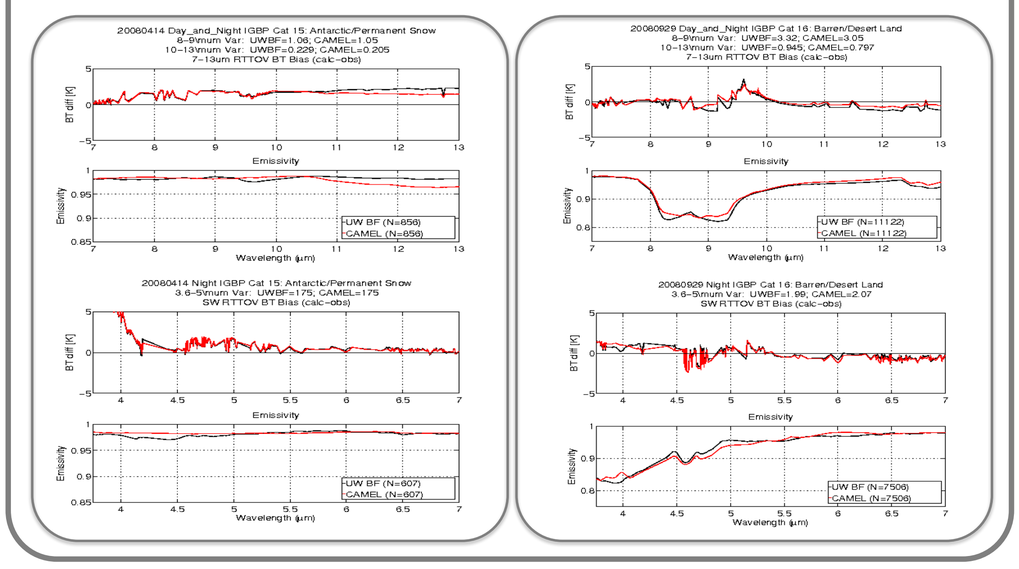




The CAMEL dataset which is currently available for the years 2003-2015 makes use of the Aqua MODIS data as input to the 13 channel product. It is planned to extend the dataset back through 2000, the Terra MODIS data is used for the months of 2000 through Feb. 2004. Time series of the CAMEL, ASTER, UWBF and MODIS emissivity (**figure left**) is shown to the left and demonstrates consistency between the Aqua and Terra products over the example Rocky Mountain case site.

## RTTOV SIMULATION STUDY

IASI observed brightness temperatures were compared to the calculated ones using the RTTOV Forward Model for four selected global days representing each season: Jan 15, April 14, July 15 and Sept 29 2008. Tow sets of simulated BTs have been calculated and compared to each others: (1) using the RTTOV UW IR emissivity module based on the UW BF emissivity Database and (2) the new IRemis module based on the combined CAMEL emissivity database. De-biased variances over the 3.6-5, 8-9 and 10-13 µm spectral regions are calculated (see in title) and used as the indicator for a better emissivity estimate. Figures below illustrates the mean BT differences for Antartic/Parmanent Snow IGBP category on April 14, 2008 (left) and Barren/Desert Land one on Sept 29, 2008 (right). The CAMEL emissivity over the UW IR emissivity database improves the brightness temperature calculation for those surface types. CAMEL is available with RRTOV-12.




## SUMMARY

A global land surface emissivity database, Combined ASTER and MODIS Emissivity over Land (CAMEL) is being made available as part of the NASA MEASURES Unified and Coherent Land Surface Temperature and Emissivity (LST&E) Earth System Data Record (ESDR). The CAMEL database has been created by merging the UW MODIS-based baseline-fit emissivity database (UWIREMIS) developed at the University of Wisconsin-Madison, and the ASTER Global Emissivity Database (ASTER GED V4) produced at JPL.

The CAMEL database is publicly available from NASA at:
https://lpdaac.usgs.gov/about/news_archive/release_nasa_measures_camel_5_km_products

The UW BBE dataset and other products are available from:
http://cimss.ssec.wisc.edu/iremis/

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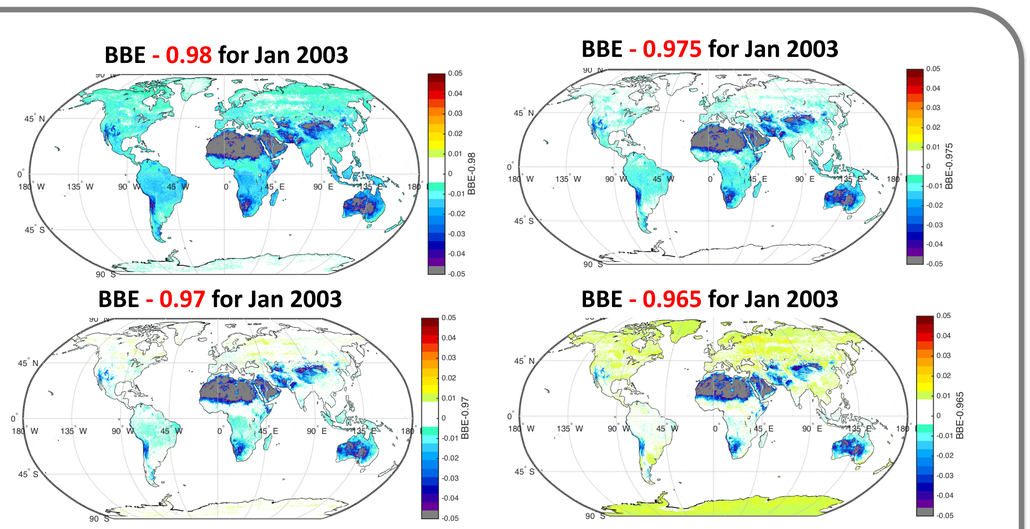
## BROAD BAND EMISSIVITY

Monthly, ~5 km resolution BBE is calculated over the globe for 2003-2015. BBE is computed over two wavelength ranges—the full available CAMEL spectrum of 3.6-14.3 µm and 8.0-13.5 µm, which has been determined to be an optimal range for computing the most representative all wavelength, longwave net radiation (Ogawa and Schmugge, 2004; Cheng et al, 2013). This dataset provides the advantages of being consistent with the MEaSUREs CAMEL HSR emissivity and not requiring regression schemes.




BBE is set to a single, global constant value of 0.98 over time and space in some land surface models. The difference maps below suggest 0.97 is a more proper choice for a BBE constant for the month shown. The use of a BBE value that varies over time and land cover classifications could potentially improve such surface radiation modeling.