Surface Skin Temperature from Geostationary Satellite Data

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Introduction
The temporal and spatial coverage of geostationary sensors enable frequent retrieval of near-global surface skin temperature ($T_s$). In addition to cloud and other products (e.g., aircraft icing potential in figure below) developed from the globe, NASA Langley is producing estimates of $T_s$ by applying an inverted correlated-k distribution method to clear-pixel values of TOA infrared temperatures ($T_{IR}$). This method yields clear-sky $T_s$ values that are within ±2.0 K of measurements from ground-site instruments, e.g., the US Climate Reference Network (USCRN) and Atmospheric Radiation Measurement (ARM) climate research facility infrared thermometers. Comparison of the $T_s$ product with MODIS land surface temperature reveals a relative accuracy within ±1 K for both day and night. These data, especially the eventual pixel-level data, will be useful for assimilation with atmospheric models, which rely on high-accuracy, high-resolution initial radiometric and surface conditions. Models should find the immediate availability and broad coverage of these $T_s$ observations valuable, which can lead to improved forecasting for both regional and global numerical weather prediction models.

Background and Methodology
- Near-global radiometric and cloud microphysical property retrievals are achieved through the use of five GOESs:
- Nominal 8 retrievals per day, with potential for 24
- Modern-Era Retrospective Analysis for Research and Applications (MERRA) model forecasts provide $T_s$ and thermodynamic profiles used to compute the atmospheric transmissivity (via correlated-k distribution1); together yielding estimated near-surface to TOA layer temperatures
- CERES cloud mask compares with estimates of $T_s$ for visible-channel reflectance
- Mean observed properties are computed for clear and cloudy pixels in each 1.0° x 1.0° grid box: the cloud mask is repeated using the new clear-sky values
- Clear $T_s$ pixels are grouped into 0.3125° x 0.25° tiles and brought to the surface using a modified correlated-k distribution technique1,3,4,5, thus yielding surface-leaving brightness temperature ($T_{IR}$)
- Application of CERES emissivity ($\epsilon$) maps yields the near-global high-resolution skin temperature products (HRT)

High-Resolution Surface Temperature Compared with Ground-Site Measurements
- HRT $T_s$ retrievals from GOES-13 allow for frequent comparison with data taken at the Southern Great Plains (SGP) ARM 11.0 µm upwelling infrared thermometer (IRT; $T_{IR}$) and the Stillwater, OK and Avadonite, PA USCRN Apogee Precision InfraRed Thermocouple Sensors (IRTS-P; $T_{IR}$)
- Because of a viewing zenith angle (VZA) dependency, must correct surface temperature to be warmer to match ground sites

Development Toward a Real-Time Pixel-Level Skin Temperature Product
- More continuous near-global coverage compared to the HRTP
- Cloudy/clear decision on pixel level greatly reduces chances of filtering good data points
- Close to 24 nearly-full disk retrievals for each satellite per day
- Instances of pixel misclassification remain, however, effect can be diminished by applying a buffer around known cloudy pixels

High-Resolution Skin Temperature Compared to MODIS Land Surface Temperature
- MODIS Land Surface Temperature (LST; $T_s$) data averaged to same resolution as HRTP tiles and compared to spectrally corrected HRTP ($T_s$) values over two 15° x 15° regions for both day and night
- First region includes the SGP domain and second region is over the northeastern United States
- Disparity between HRTP and Terra-MODIS daytime LST could be due to different viewing and illumination geometry
- Average clear-sky $T_s$ anisotropy for the GOES-13 viewing and illumination angles at MODIS overpasses in SGP region is 0.5 - 4.0%
- Small differences can also, at least partially, be explained by atmospheric corrections

Conclusions and Future Work
- Except for certain viewing & illumination conditions, results comparable to MODIS to ±1 K, but with the added benefits of having consistent geometry and higher sampling frequency for any one location
- These nearly instantaneous, near-global datasets are available for assimilation in numerical weather prediction models
- Important step taken towards assimilation into the GEO-5 NWP system
- Need to better characterize angular and emissivity dependencies using nadir MODIS measurements
- Will employ the GMAQ GEOS-5 Model at finer resolution for pixel-level product, and globally validate near-real-time, near-global pixel-level skin temperature product by end of 2013
- Need to broaden the scale of data assimilation from Americas to all non-polar regions

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