Abstract:
Surface air temperature is a critical variable to describe the energy and water cycle of the Earth-atmosphere system and is a key input element for hydrology and land surface models. It is a very important variable in agricultural applications and climate change studies. This is a preliminary study to examine statistical relationships between ground meteorological station measured surface daily maximum/minimum air temperature and satellite remotely sensed land surface temperature from MODIS over the dry and semiarid regions of northern China. Studies were conducted for both MODIS-Terra and MODIS-Aqua using year 2009 data. Results indicate that the relationships between surface temperature and remotely sensed land surface temperature are statistically significant. The relationships between the maximum air temperature and daytime land surface temperature depends significantly on land surface types and vegetation index, but the minimum air temperature and nighttime land surface temperature has little dependence on the surface conditions. Based on linear regression relationship between surface air temperature and MODIS land surface temperature, surface maximum/minimum air temperature are estimated from 1km MODIS land surface temperature under clear sky conditions. The statistical errors (sigma) of the estimated daily maximum (minimum) air temperature is about 3.8°C (3.7°C).

I. Motivation:
Traditionally, surface air temperatures (Tmax and Tmin) are obtained from meteorological stations at 2 meters above the ground. In general, meteorological stations are distributed sparsely that is not enough for higher resolution regional model. Recent studies [1-3] have shown that estimated minimum air temperatures (T_min) from MODIS Land Surface Temperature (T_s) are statistical meaningful over Africa, US Mississippi, and in Alpine areas, but the estimated maximum air temperature (T_max) has large errors at some regions. In supporting research of Monsoon Asia Integrated Regional Study (MAIRS) project, NASA GES DISC has processed standard 8-day 1km MODIS land surface temperature by mosaic-ing and re-projecting 10x10 degree tiled data files (MOD11A2.005 and MYD11A2.005) over the entire monsoon Asia region (50°S–50°N, 0–60°N) and made data accessible easily for any user through the online visualization and analysis system, Giovanni. The question is how accurate T_min and T_max are over the Monsoon Asia region. This work is to examine that over the dry and semiarid regions of northern China.

II. Data and Processing:

Location of Stations

Daytime T_s and Maximum Air Temperature

Time series show surface air temperatures (black solid line) and MODIS T_s from Terra (blue data) and Aqua (red data).

Scatter plots show that a) correlations are high, passing 0.01 significance level; b) the linear regression coefficients (slope and offset) varies significantly from one station to another for both daytime (left) and nighttime (right). The slope varies from 0.61 to 1.01 for daytime.

It is found that the linear regression slope of daytime T_s and T_max is associated with land surface type of the station location and vegetation index (NDVI). Stations are grouped into 5: urban-1 (NDVI>4.5), urban-2 (NDVI=2.5-4), grassland, cropland, barren spices vegetated. Other land types have only one or two stations.

IV. Estimation of T_min and T_max from MODIS T_s:

For each station, calculated estimated air temperatures by applying linear regression equation: T_s = a + b * T_s, and then, a and b depend on surface types:

<table>
<thead>
<tr>
<th>Station Type</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barren</td>
<td>0.72903 ± 0.00315</td>
<td>0.48102 ± 0.00158</td>
</tr>
<tr>
<td>Grassland</td>
<td>0.77304 ± 0.00551</td>
<td>0.25782 ± 0.00251</td>
</tr>
<tr>
<td>Cropland</td>
<td>0.82861 ± 0.00825</td>
<td>0.30909 ± 0.00250</td>
</tr>
<tr>
<td>Urban</td>
<td>0.785 ± 0.037</td>
<td>0.65 ± 0.037</td>
</tr>
</tbody>
</table>

V. Summary:
Statistical relationships are investigated between MODIS T_s and surface air temperature (T_max) and minimum (T_min) by using 2009 data for 75 stations over dry and semiarid region of northern China. Results are summarized as follows:

- MODIS land surface temperature of daytime (T_sday) and nighttime (T_snight) from both Terra and Aqua are correlated significantly (p<0.001) with air temperatures T_max and T_min.
- The correlation between Tmax and T_max is slightly higher than that between Tmin and T_min.
- The slope of the linear regression equation of T_s and T_min depends on land surface type and vegetation index;
- Combining estimated temperatures from Terra and Aqua reduces the measurement error;
- Estimated air temperatures have errors of about 3.7°C for T_max and 3.8°C for T_min.

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GES DISC MAIRS portal: http://disc.gsfc.nasa.gov/mairs/