1. Introduction and Motivation

- Infrared (IR) land surface emissivity (LSE) is important for
  - deriving other products, such as atmospheric water vapor, cloud-top pressure, land surface temperature and radiation budget etc.
  - assimilating IR radiances
- IR LSE diurnal variations are poorly studied
- Laboratory measurements: emissivity increases by 1.7% to 16% with increased soil moisture content, most significantly for sandy soils in the 8.2–9.2 µm range.

2. SEVIRI LSE using GOES-R ABI algorithm

- Values during daytime and larger values during nighttime.
- Soil moisture during the day and recovery (or increased soil moisture) at night was observed.
- Expect: LSE has a diurnal wave-pattern variation with small values during daytime and larger values during nighttime.
- GOES-R ABI LSE algorithm + SEVIRI radiance measurements to demonstrate LSE diurnal variations
- Sahara Desert, sand soils
- Artifacts of algorithm? No. Evidences are provided
  - SEVIRI radiance observations
  - MODIS/Aqua radiance observations

3. LSE diurnal variation seen by SEVIRI

4. Method to prove LSE diurnal variation

\[ \delta R_{\sigma_1} = K_{\sigma_1} = K_{\sigma_1} - \left( K_{\sigma_1} - K_{\sigma_2} \right) \]

\[ \sum (K_{\sigma_3} - K_{\sigma_4}) \Delta T_{\sigma_4} \]

Due to the similarity of the three window channels, the double difference greatly reduces the sensitivity to the errors of LST, temperature/moisture profiles, but maintains the sensitivity to errors of LSE. The relative importance of these components are: \( \sigma_1 > \sigma_2 > \sigma_3 > \sigma_4 \). So Eq (1) can be simplified as

\[ \delta R_{\sigma_1} = K_{\sigma_1} \Delta \sigma_{\sigma_1} + K_{\sigma_1} \Delta \sigma_{\sigma_2} + (K_{\sigma_3} - K_{\sigma_4}) \Delta \sigma_{\sigma_4} \]

For any two times, \( t_1 \) and \( t_2 \), the difference is

\[ \delta \Delta R_{\sigma_1} = \delta K_{\sigma_1} \Delta \sigma_{\sigma_1} + \delta K_{\sigma_1} \Delta \sigma_{\sigma_2} + (K_{\sigma_3} - K_{\sigma_4}) \delta \sigma_{\sigma_4} \]

From Eq (3), there should exist a linear relationship between the temporal variation of 5R and the temporal variation of LSE, and temporal variation of retrieved LST bias.

4.1 Proof from SEVIRI observations

4.2 Proof from MODIS/Aqua observations

4.3 Consistency of SEVIRI and MODIS/Aqua

Sensitivity study shows

\[ \delta K = -0.13 \]
\[ \Delta \sigma_{\sigma_1} = \Delta \sigma_{\sigma_2} \]
\[ \Delta \sigma_{\sigma_4} \]

Solution is

\[ \frac{\Delta \sigma_{\sigma_4}}{K} = 0.12 \]

The estimated mean emissivity weighting functions are very close to each other, indicating both SEVIRI and MODIS/Aqua sees the LSE diurnal variations. The Daytime MYD11 LST appears to have negative bias compared to Nighttime, likely from the omission of LSE diurnal variation.

5. Summary

- Diurnal variation of LSE is seen by SEVIRI and can be proved by both SEVIRI and MODIS/Aqua observations.
- Omission of LSE diurnal variation could increase biases in
  - Deriving other products
  - Assimilating window channel radiances

6. Reference