Revealing Issues for Improving VIIRS Land Surface Temperature Retrieval

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Introduction

The Visible Infrared Imager Radiometer Suite (VIIRS) on the Joint Polar Satellite System (JPSS) is one of the NOAA primary polar-orbiting satellite sensors. It can provide a series of Environmental Data Records (EDRs) including Land Surface Temperature (LST) product. The current VIIRS LST is generated from a surface-type dependent split window algorithm, which performs well for most surface types. There are still several issues which may causing uncertainties. Further improvements are necessary.

The satellites cross comparison between VIIRS and MODIS indicates that they agree with each other well under dry atmospheric conditions. However, the differences increase in wet regions, this is particularly true for daytime cases. We have performed some tests in different seasons over Australia to find the main factors related to high BT difference. We investigated the impacts of water vapor and emissivity on the LST retrieval. The results indicate that both water vapor and emissivity difference affect the BT difference, but water vapor is a dominant factor. We have also tested an emissivity explicit algorithm in VIIRS LST retrieval, and its computed LSTs is more closer to Aqua LST than VIIRS beta version LSTs. The algorithms including water vapor terms in several different ways are tested. Some preliminary results are presented. All these studies provide a basis for our future algorithm improvements.

BT difference Issue

The BT difference between split window channels is very large. We have performed some tests in different seasons over Australia to find the main factors related to high BT difference. We investigated the impacts of water vapor and emissivity on the LST retrieval. The results indicate that both water vapor and emissivity difference affect the BT difference, but water vapor is a dominant factor. Further studies should be done in order to improve our LST product.

Emissivity Impact on LST Algorithm Regression

In two emissivity datasets, IGBP types are represented by different emissivity pairs, which affects the simulation dataset regression process, and then affects the algorithm coefficients. The table shows the statistic comparison (Left: night; Right: daytime).

Algorithm Comparison

Simultaneous Nadir Overpass (SNO) comparison between Aqua and VIIRS computed LST from an emissivity explicit algorithm Eq. (1), as well as VIIRS beta LST.

In general, Ts from emissivity explicit algorithm is more closer to Aqua LST than VIIRS Beta version Ts.

Water Vapor and Emissivity Impact on BT difference

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Emissivity Explicit Algorithm

We have tested the emissivity explicit algorithm in VIIRS LST retrieval

\[ LST = C + A_1 T_{m1} + A_2 (T_{m1} - T_{m2}) + A_3 + A_4 (T_{m1} - T_{m2}) \cos \theta - 1 \]  

(1)

Where \( T_{m1} \) and \( T_{m2} \) are the brightness temperatures in 11.2 \( \mu \)m and 12.3\( \mu \)m bands, respectively. \( A_1 \) and \( A_2 \) are the spectral emissivity in the split window bands. \( C, A_3, A_4, A_5 \) are algorithm coefficients.

Summary and Future Work

We have evaluated the VIIRS LST using SNO comparison with Aqua LST. In general, VIIRS LST matches Aqua data well for dry condition. There are some significant bias over the wet regions for daytime cases. In such regions, the brightness temperature differences between split window channels are very large. Our analysis indicates that BT difference is affected by both water vapor and emissivity. Water vapor is a dominant factor, but the emissivity effect is still under investigation. Additional correction should be made to improve our LST product.

Impact of emissivity on the LST algorithm regression is also investigated. We have tested an emissivity explicit algorithm, and also add water vapor terms in the algorithm. The mean bias of LST is decreased. All these studies provide a basis for our future algorithm improvements.

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