Combining GLM and ABI Data for Enhanced GOES-R Rainfall Estimates

Robert Adler, Weixin Xu, Nai-Yu Wang
ESSIC/CICS, University of Maryland, College Park, MD. Email: radler@umd.edu

A. Lightning-enhanced Infrared Rainfall Estimates

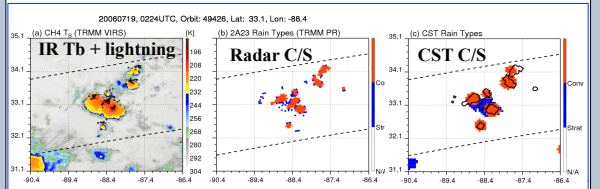
1. Introduction

This study uses TRMM data to develop the basis and eventually the algorithms to combine GOES-R ABI Infrared (IR), Geostationary Lightning Mapper (GLM) data, and microwave calibrator to provide an improved geosynchronous rainfall product. A simple IR-lightning rainfall algorithm is developed through coupling lightning measurements into the Convective/Stratiform (C/S) technique (CST) proposed by Adler and Negri (1988).

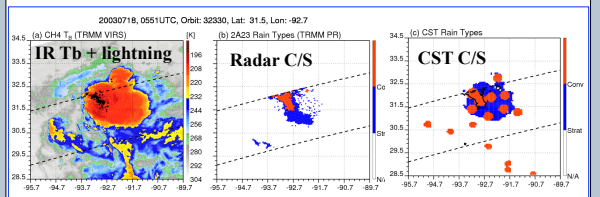
Preliminary results show that CST is improved by more than 30% in retrieving convective (or heavy) rainfall after lightning observations are coupled. Specifically, lightning information can aid in identifying convective cores missed by the IR-only technique (improving detection), eliminate misidentified convective cores (lowering false alarms), and more correctly assign heavy convective rainfall rates. The IR-lightning technique will be further tested and adjusted through the comparison with other satellite rainfall estimates (e.g., SCaMPR)) and in-situ observations.

2. IR-based C/S Technique (CST)

CST algorithm tuned from Adler and Negri (1988)
a. Conv. core defined by local Tb minima that pass slope test;
b. Conv. core area is a function of Tb minima.



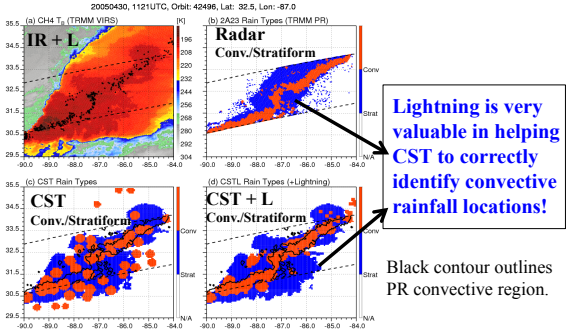
CST (and most IR techniques) does a GOOD job in catching young convective cells.



CST (and most IR techniques) becomes VAGUE as mesoscale convective systems develop (too many convective cores).
Question: Could lightning aid to remove these falsely defined convective cores?

3. Lightning-enhanced CST (CSTL)

a. Conv. cores w/o lightning in mature systems are removed;
b. Conv. areas (with flashes) missed by CST are added.

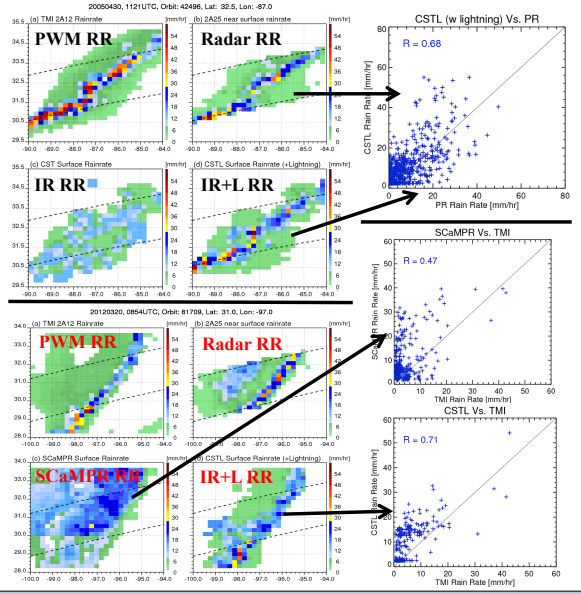


Lightning is very valuable in helping CST to correctly identify convective rainfall locations!

Black contour outlines PR convective region.

4. CSTL Rainfall Estimates

a. Stratiform: 2.5 mm/hr; 2: Convective:12.5 mm/hr;
b. CSTL is assigned discretely with flashes in 20 km;



B. Enhanced Microwave Rain Estimates

1. Introduction

A combination of existing project under Wang dealing with microwave/lightning relations and new proposal by Adler on IR/ lightning rain estimation, both focused on improving GOES-R Baseline rain algorithm (Kuligkowski). Improvement of Passive Microwave Retrievals (as Calibrator) would help improve IR Baseline algorithm.

One of the major difficulties in microwave rainfall retrievals over land is to delineate convective and stratiform precipitation from clouds. This study is to investigate the lightning and microwave connections through the ice microphysics and convection strength, and use these connections to improve the microwave segregation of rainfall in convective and stratiform.

2. Algorithm Description

Microwave rain-rate

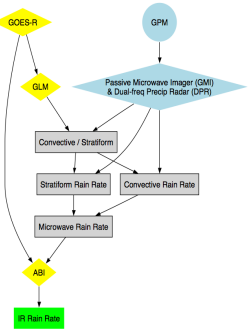
$$RR = RRconv\ P(C) + RRstrat\ (1 - P(C))$$

where P(C) is convective ration, and RRconv and RRstrat are convective and stratifrom rain-rates, respectively.

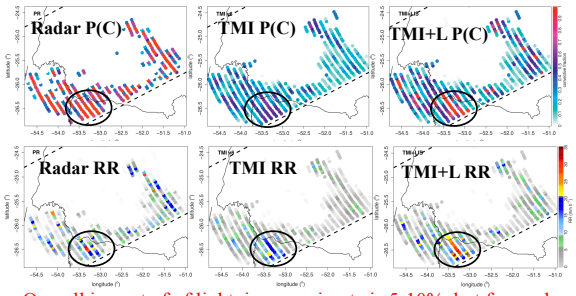
$$P(C) = a_1\ TB10V + a_2\ (TB37V+TB85V)/2 + a_3\ NPOL + a_4\ STDEV + a_5\ MINIMA + k$$

Lightning information is used to:

a. Sort pixel-by-pixel microwave TBs and convective fractions P(C) with relate to lightning flash rates;
b. Convective fraction P(C) coefficients are trained for lightning frequency categories.



3. Performance of Enhanced Algorithm



Overall impact of of lightning on rainrate is 5-10%, but focused on highest rainrates!