QPE

Bob Kuligowski
NOAA/NESDIS/STAR

Walt Petersen
NASA-MSFC

GOES-R Science Meeting

Outline

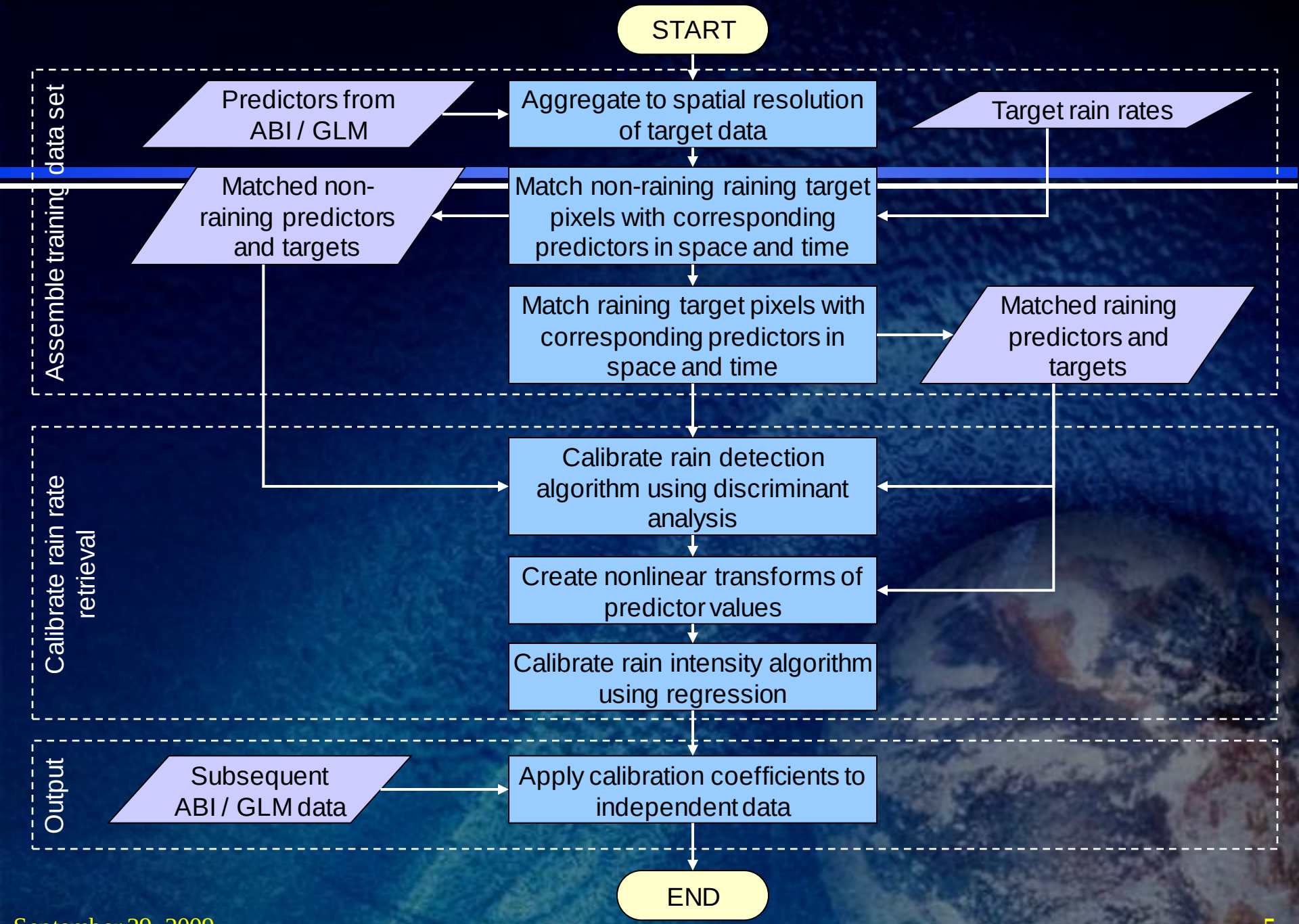
- SCaMPR Review and Plans
- GOES-RRR Proposal: Improved MW Retrievals
- MSFC QPE Work
- Questions / Discussion (all)

SCaMPR Review

- Self-Calibrating Multivariate Precipitation Retrieval
- Calibrates IR predictors to MW rain rates
- Updates calibration whenever new target data (MW rain rates) become available
- Selects both best predictors and calibration coefficients; thus, predictors used can change in time or space
- Flexible; can use any inputs or target data

SCaMPR Overview (cont.)

- Two calibration steps:
  - Rain / no-rain discrimination using discriminant analysis
  - Rain rate using stepwise multiple linear regression
- Classification scheme based on BTD's (ABI only):
  - Type 1 (water cloud): $T_{7.34}<T_{11.2}$ and $T_{8.5}-T_{11.2}<-0.3$
  - Type 2 (ice cloud): $T_{7.34}<T_{11.2}$ and $T_{8.5}-T_{11.2}>-0.3$
  - Type 3 (cold-top convective cloud): $T_{7.34}>T_{11.2}$


START
Assemble training data set
Predictors from ABI / GLM
Aggregate to spatial resolution of target data
Target rain rates
Matched non-raining predictors and targets
Match non-raining raining target pixels with corresponding predictors in space and time
Match raining target pixels with corresponding predictors in space and time
Matched raining predictors and targets
Calibrate rain rate retrieval
Calibrate rain detection algorithm using discriminant analysis
Create nonlinear transforms of predictor values
Calibrate rain intensity algorithm using regression
Output
Subsequent ABI / GLM data
Apply calibration coefficients to independent data
END

SCaMPR Plans

- Incorporate numerical model moisture fields to handle hydrometeor evaporation
- Correct for orographic effects on rainfall
- Incorporate convective life cycle information (i.e., changes in rain rate vs. cloud properties during convective cycle)
- Incorporate Lagrangian (cloud-following) Tb changes
- Incorporate retrieved cloud microphysics (i.e., cloud-top particle size, phase)

Outline

- SCaMPR Review and Plans
- GOES-RRR Project: Improved MW Retrievals
- MSFC QPE Work
- Questions / Discussion (all)

GOES-RRR Project Summary

- Proposal Team: N. Wang, E. Bruning, R. Albrecht, K. Gopalan, M. Sapiano (UMD/ESSIC); R. Kuligowski, R. Ferraro (NESDIS/STAR)
- Objectives:

(1) To improve microwave (MW)-based precipitation estimates by connecting the ice-phased microphysics commonly observed by GOES-R lighting and GPM MW instruments.

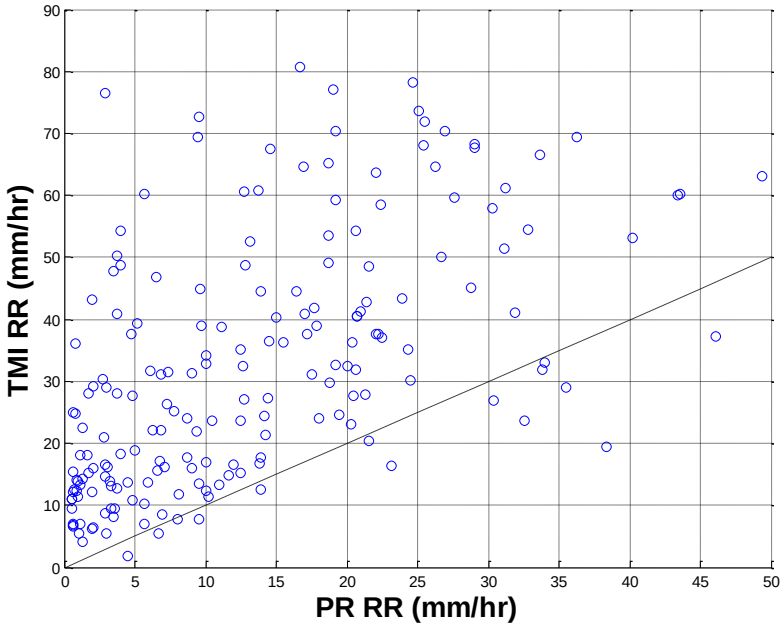
(2) To improve the GOES-R rain-rate (QPE) algorithm by using these estimates as input.

Basic Problem and Approach

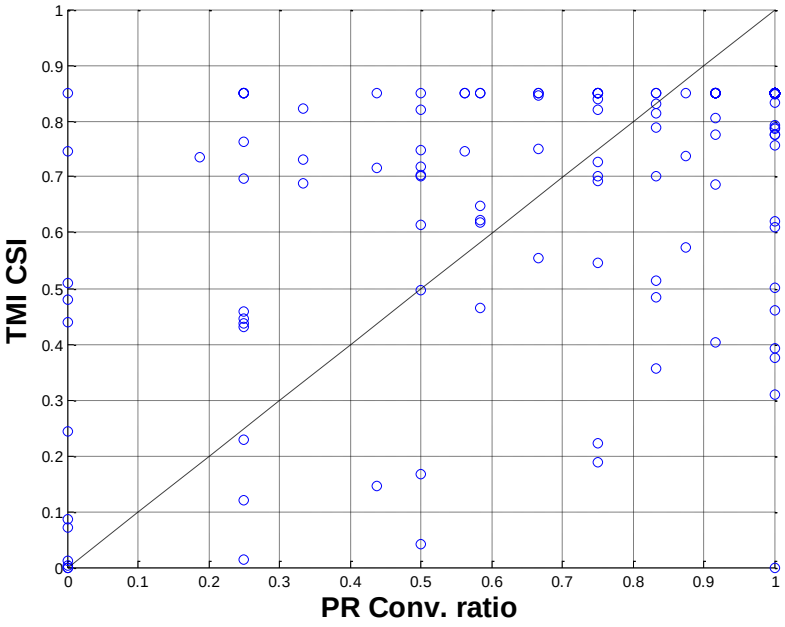
- Problem:
  - Since the GOES-R rain-rate algorithm uses MW-derived rain rates for calibration, errors in the MW rain-rates are reflected in the GOES-R rain rates.
  - The MW rain-rate algorithm over land has problems of properly identifying convective/stratiform rain type, which causes errors in rain-rate retrievals.
- Planned approach:
  - Use GOES-R GLM lighting data to constrain the MW convective/stratiform classification and thus reduce the misclassification of rain type.
  - Use the improved MW rain-rates to produce better calibration for the GOES-R rain rate algorithm.

Errors in Current TRMM Algorithm

TRMM PR v.s. TMI rain-rates



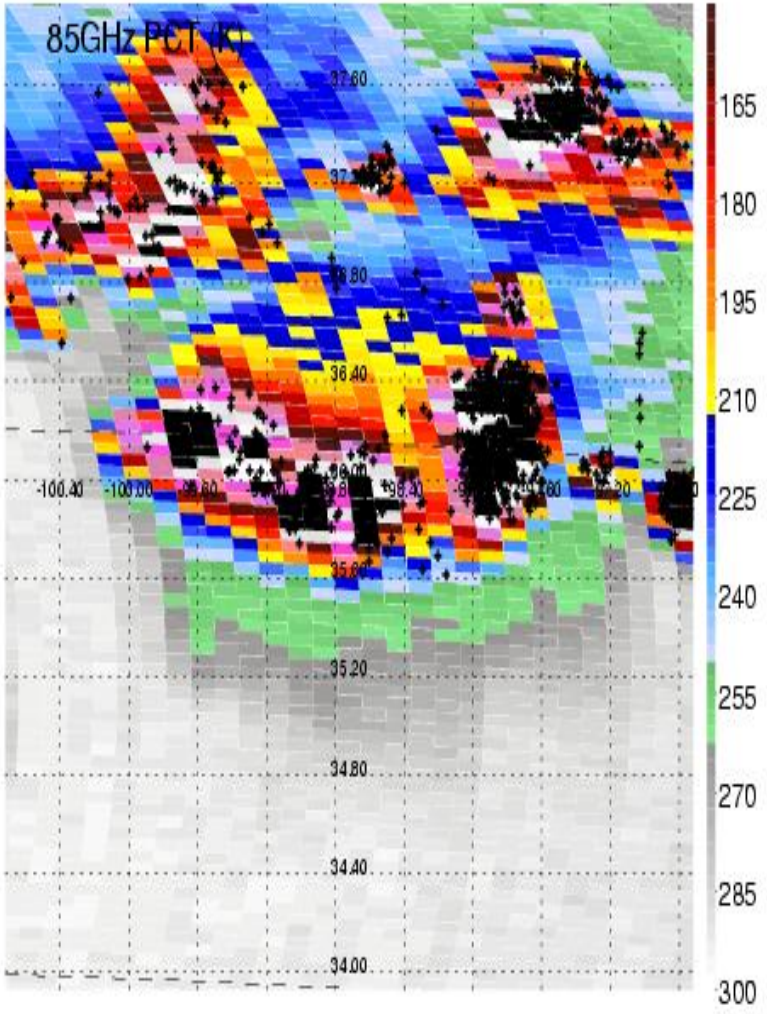
TRMM PR v.s. TMI convective ratio



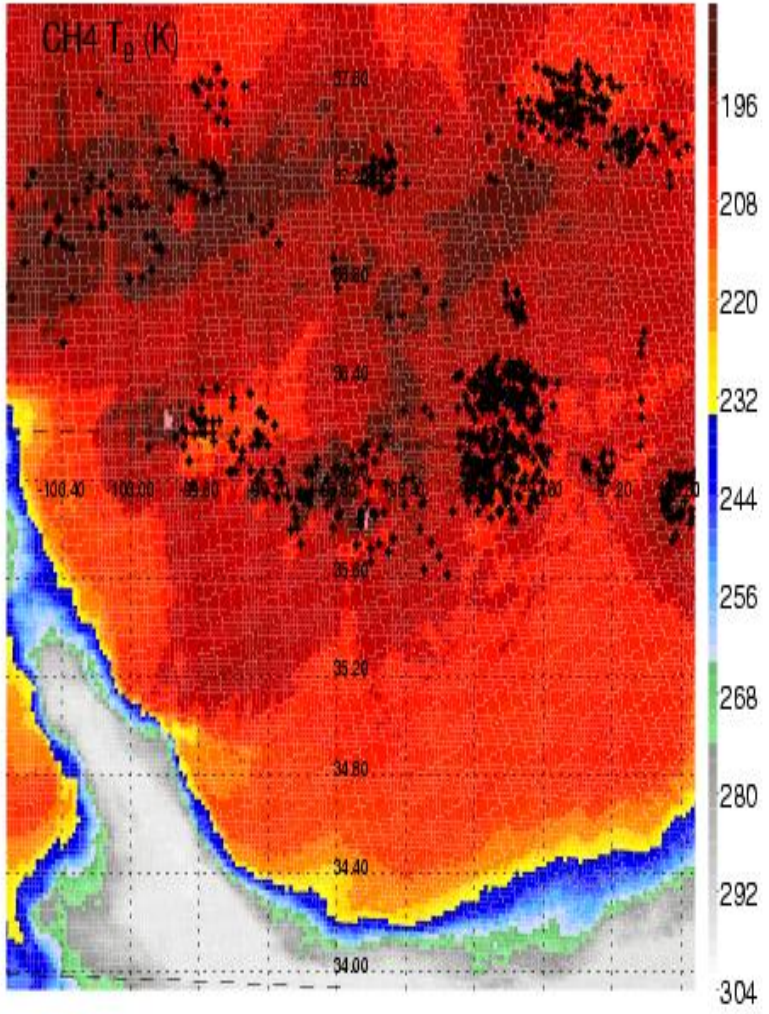
Improved convective/stratiform classification should lead to more accurate MW rain rate retrievals.

Potential Improvement to Current MW Algorithm

TMI 85GHz PCT+ LIS flashes

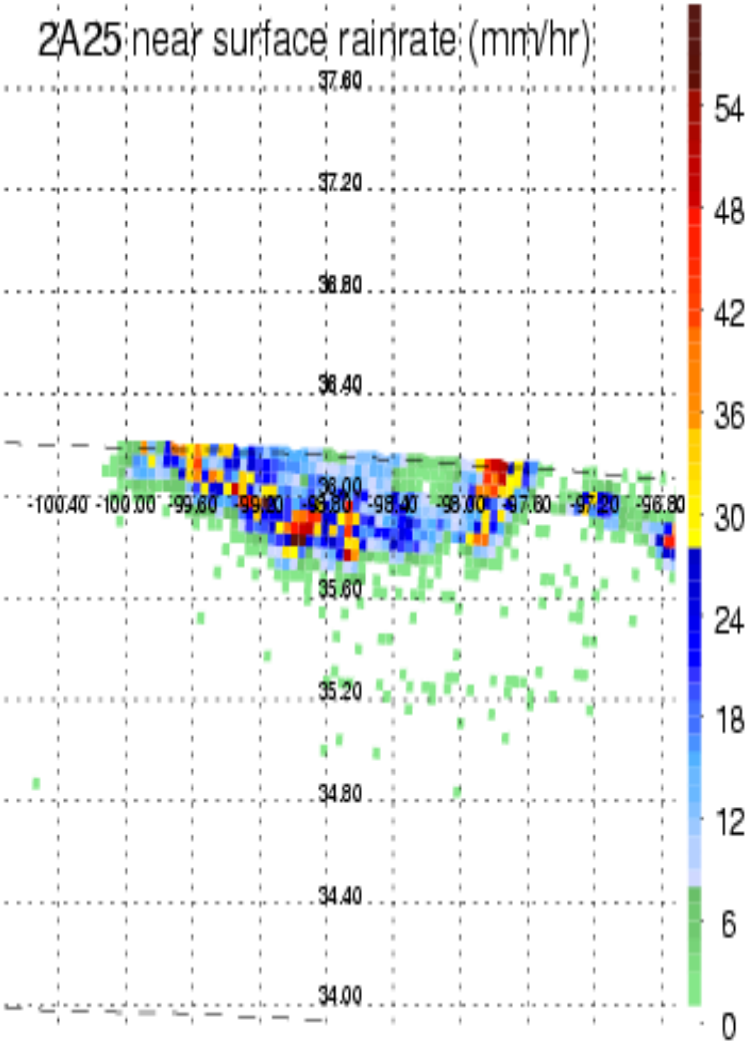


VIRS 10.8 μm + LIS flashes

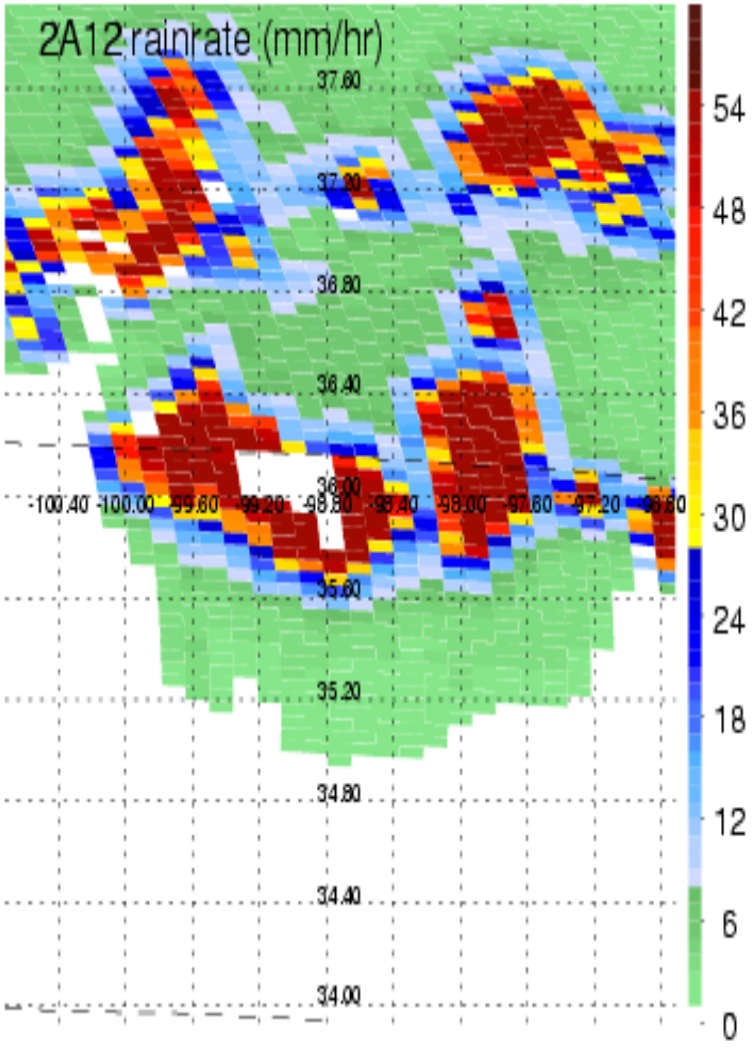


Potential Improvement to Current MW Algorithm

PR rain rates



TMI rain rates



Outline

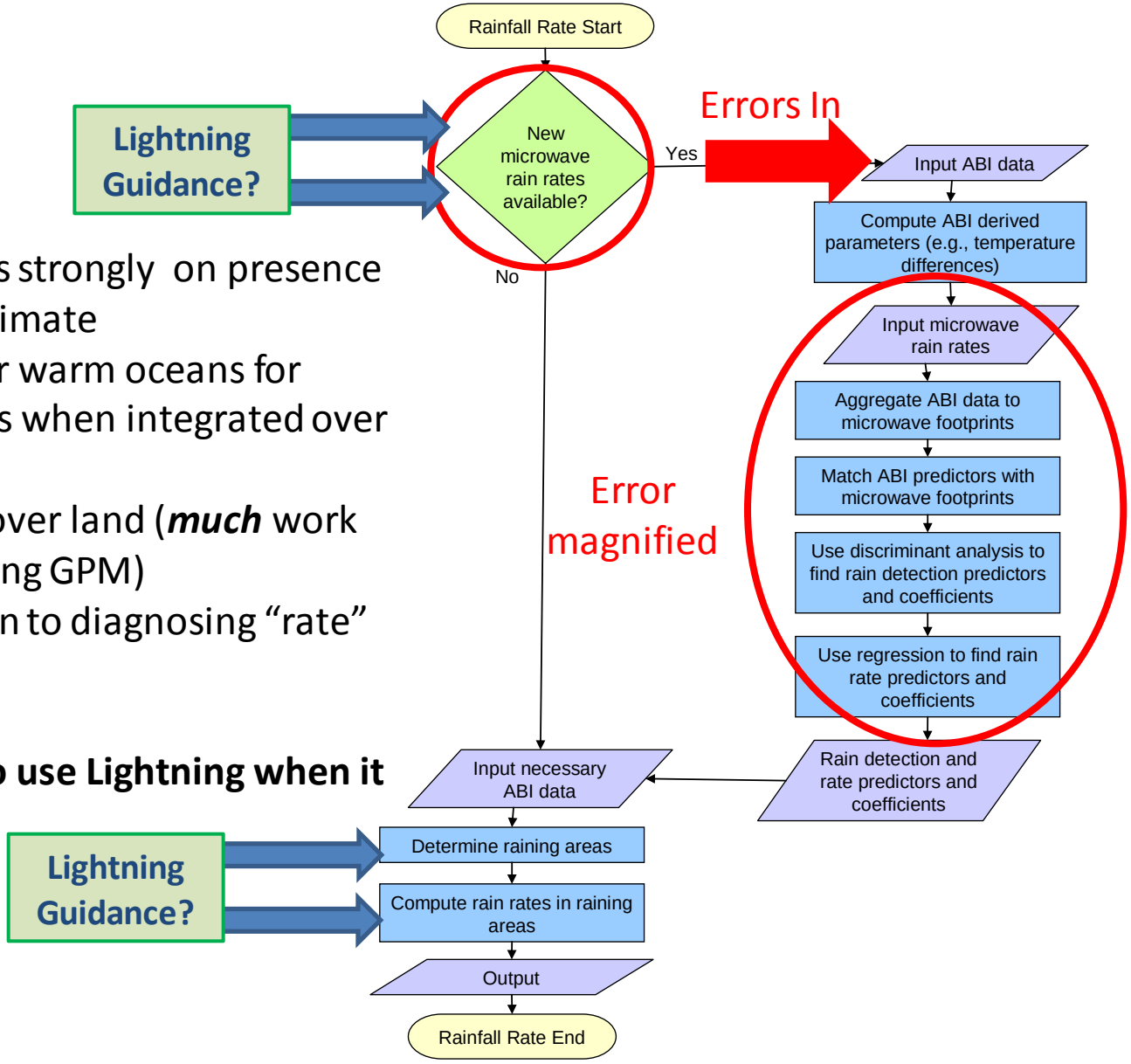
- SCaMPR Review and Plans
- GOES-RRR Proposal: Improved MW Retrievals
- MSFC QPE Work
- Questions / Discussion (all)

Lightning Input to SCaMPR Flow

Current algorithm depends strongly on presence of a "calibrating" PMW estimate

- OK at O(1x1°) areas over warm oceans for emission based methods when integrated over longer time intervals
- Questionable accuracy over land (***much*** work to be done prior to/during GPM)
- Questionable application to diagnosing "rate" at GOES-R pixel level.

Overarching focus: How to use Lightning when it occurs.



What kind of guidance?

1) Rainfall Detection and Convective and Stratiform (C/S) Precipitation

- C/S partitioning in most state of the art radar algorithms (problematic for satellite algorithms)
- "Low-hanging fruit"- Lightning is a "rain certain" parameter and by virtue of its origin, facilitates better C/S partitioning of rain area/volume (Grecu et al., 2000; Morales and Anagnostou, 2003)

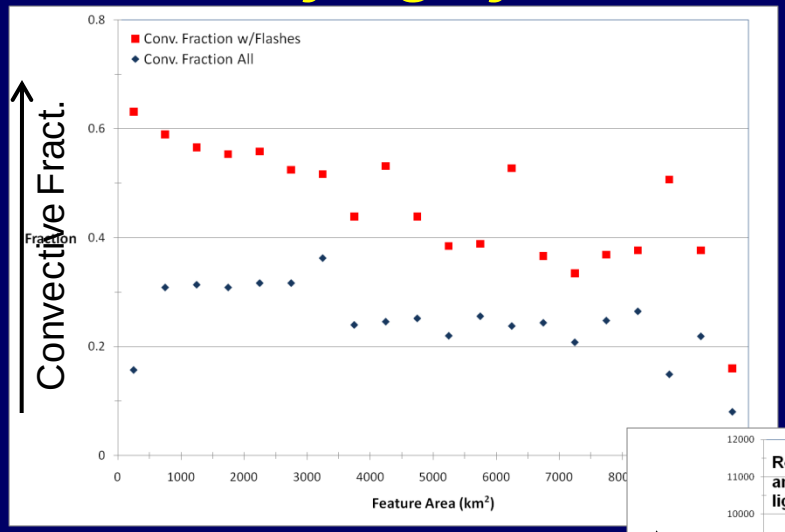
- ***Focus: Presence/amount of lightning for identifying systematic differences (e.g., constraints) in cloud-system-wide C/S precipitation behavior***

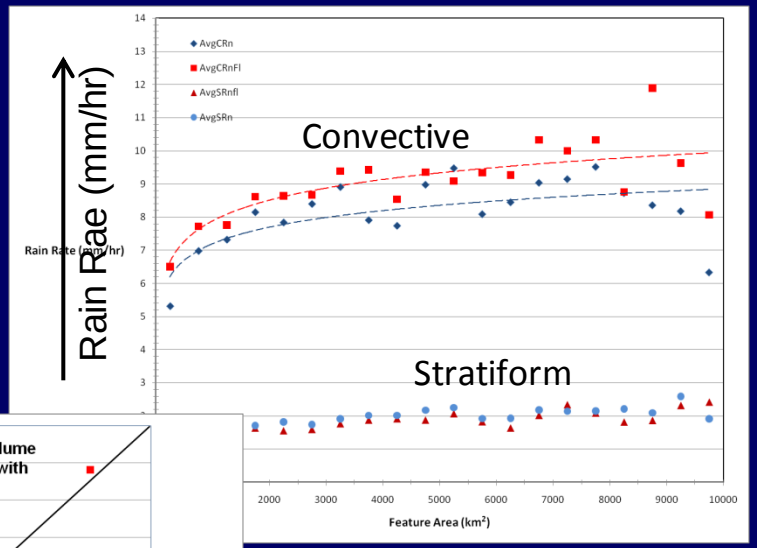
2) Application to Passive microwave (PMW) rainfall retrievals

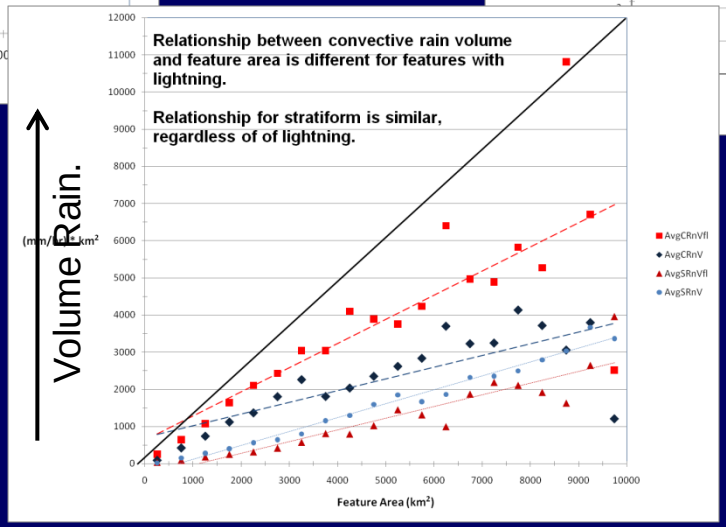
- Most lightning occurs over land- land focus for QPE application
- PMW rain estimates over land are "iffy"- algorithms empirically driven by assumed ice-scattering relationship to rain water content w/some inclusion of weak physics (e.g., GPROF
- Problem: As in the case of IR retrievals, even if the ice is there rainfall is often not coupled to the ice phase; not even a guarantee it will be useful in "big" rainfall events (e.g., spectacular failures of satellite QPE in shallow-convective environment floods).

- ***Focus: Identify specific situations where lightning occurs with systematic PMW bias or can "nudge" the answer- thus affecting error reduction in the SCaMPR calibration***

Identifying Systematic C/S behavior in TRMM Features





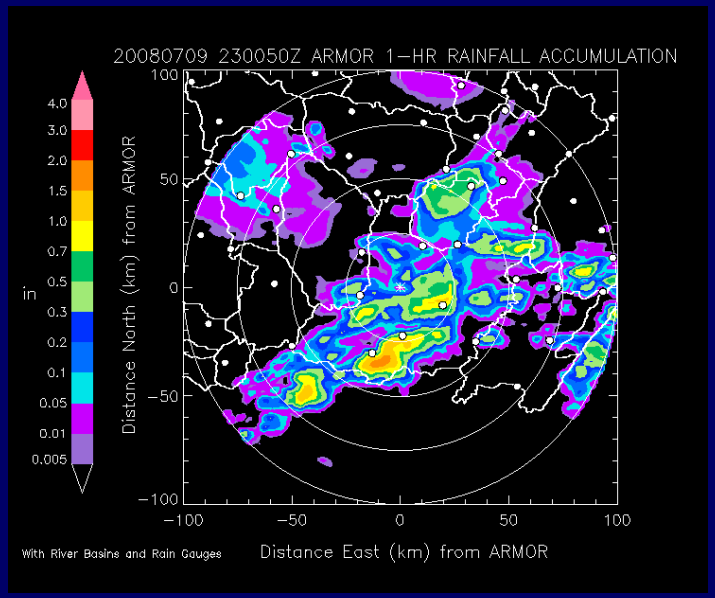


When lightning present, *clear increase in convective area-fraction, feature rainrate, and convective rain volume regardless of "feature" area*.

Stratiform behavior virtually identical between lightning/non-lightning cases

Ongoing Work

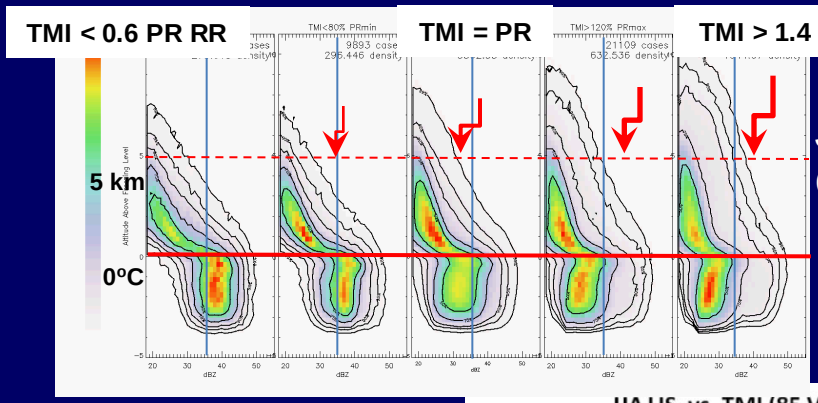
C/S in N. Alabama Testbed

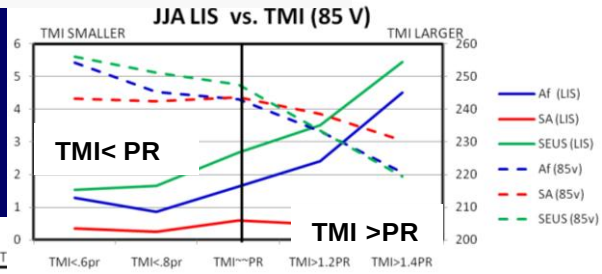


Ground Validation Case Work (To be done in near future)

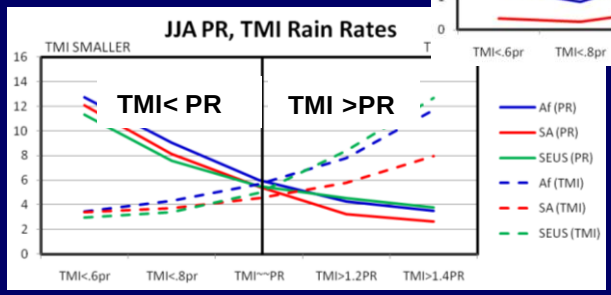
- **Dual-pol rain map (done) + C/S partitioning with new GLM *Proxy***
- **Relate C/S and flash behavior over time integrals and *lifecycles, compared to TRMM "snapshots".***
- **Match to GOES IR Tb areas (Morales and Anagnostou approach)**

TRMM PMW: When TMI > (<) PR rain rate, deeper (shallow) convection, lightning flash count larger (smaller), 85 GHz colder (warmer)





JJA LIS FD (solid)
85 GHz TB_v (dash)



JJA PR RR (solid)
TMI RR (dash)

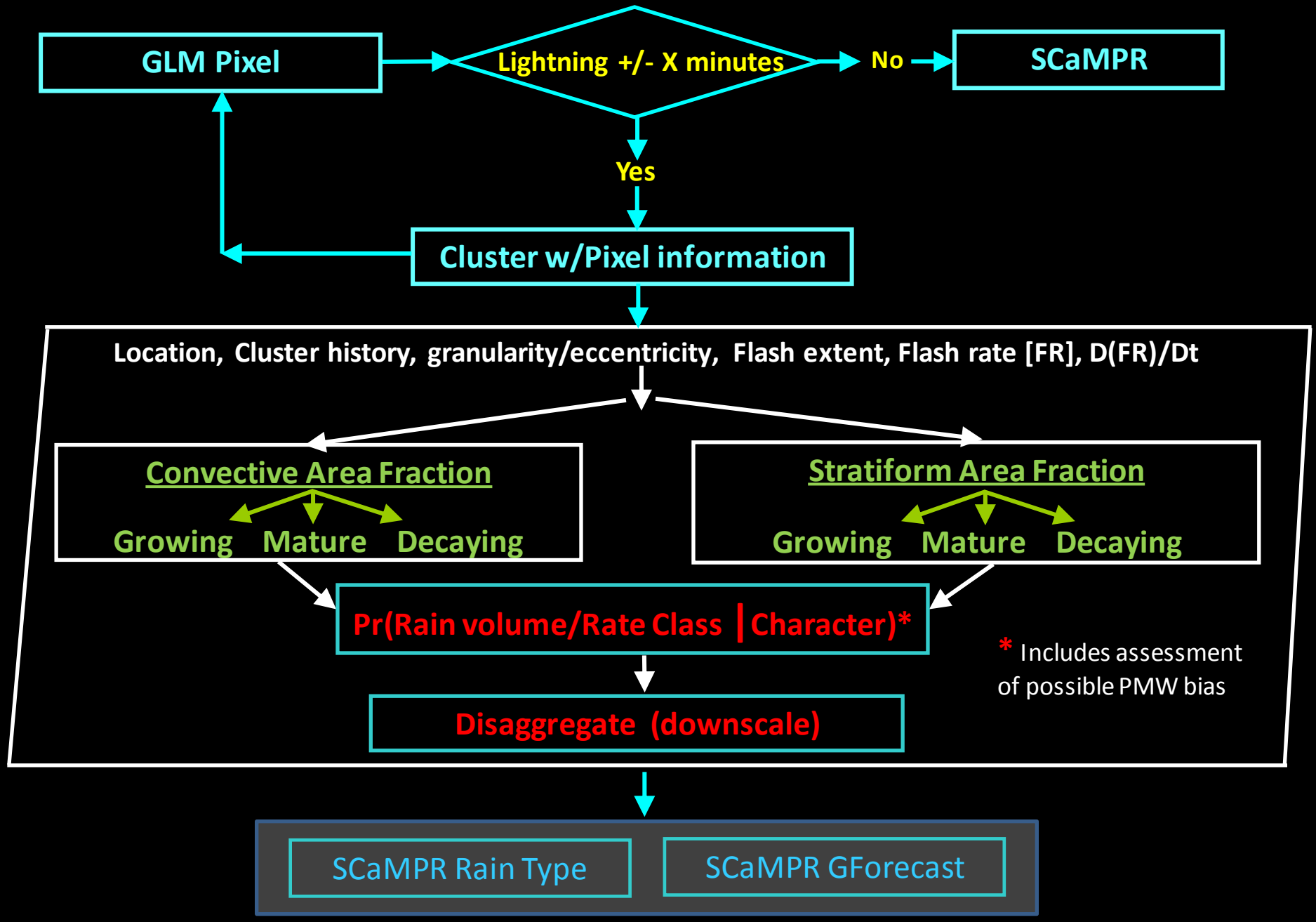
TRMM Work

- **3-D ASCII features and pixels for the globe**
- **Identify PMW biases sensitive to lightning character**
- **Extend C/S study to global domain**

SCaMPR Plans: Lightning

- Provided SCaMPR source code and documentation to R. Albrecht/Petersen for collaborative work
- Consider using lightning both as an aid to classification (i.e., convective vs. stratiform), rain rate prediction, PMW "nudging"
- Current challenges:
  - » Resolution of GLM is coarser than ABI—how to best use lightning data without creating an overly smooth output?
  - » Difficult to obtain total lightning over a large enough area and long enough time for reliable SCaMPR calibration (GV?)
  - » Where to insert lightning inputs?
- No final answers yet on several of these issues

FUTURE: A "STRAWMAN FRAMEWORK" FOR GOES-R GLM QPE ALGORITHM:



Petersen, 9/29/2009

Questions / Discussion?