Bias Correction of PERSIANN-CCS Estimation using PMW Rainfall

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• PERSIANN-CCS in GPM IMERG
• PERSIANN-CCS Estimation
• Bias correction of PERSIANN-CCS estimation
• Validation
• Conclusions
Integrated Multi-satellite Retrievals for GPM (IMERG)

UC Irvine

IR Image segmentation
feature extraction
patch classification
precip estimation

Build IR-PMW precip calibration

Recalibrate precip rate

GSFC

Receive/store even-odd IR files

Import PMW data;
grid; calibrate;
combine
w/o GMI
w/ GMI

Forward/ backward propagation
w/ GMI
w/o GMI

CPC

Compute even-odd IR files
(at CPC)

Compute IR displacement vectors

Forward/ backward propagation

Apply Kalman filter

Build Kalman filter weights

Post-RT

Import mon. gauge;
mon. sat.-gauge combo.;
rescale short-interval datasets to monthly

Apply climo. cal.

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prototype5
Patch-based Approach (PERSIANN-CCS)

Patch Feature Extraction

Patch Classification

Rainfall Estimation

Feature vector ($\mathbf{v}$) $\in$ [patch coldness, patch geometry, patch texture]
Features Extraction

Patch Feature Extraction

$V \in \{\text{patch coldness, patch geometry, patch texture}\}$
Multiple vs. Single Curve Fitting Models

400 $T_b$-$R$ curves from PERSIANN-CCS model

(1) simple threshold
(2) Linear: single line
(3) Nonlinear: single curve
Near Real Time Global Precipitation Data

http://hydis.eng.uci.edu/gwadi/
Global PERSAINN-CCS Hourly Estimates
Six-Hour PERSIANN-CCS Rainfall
CCS & PMW Estimation (30-minute estimates)

16:00 UTC 01/03/2012

PERSIANN-CCS rain map
01/03/2012 1600 UTC mm/hr

PMW rain map
01/03/2012 1600 UTC mm/hr
Continue Development

- Adjust PERSIANN-CCS precipitation estimates using passive microwave rainfall
Calibration and Validation

• 4-year PMW data were used in the calibration of CCS estimation (2008~2011).

• Validation using NSSL Q2 radar rainfall data (2012) over CONUS
Adjustment of CCS Estimation to PMW Rainfall

CCS rainfall est. 0.04° x 0.04° Lat/Lon

Up-scale CCS rainfall est. 0.25° x 0.25° Lat/Lon

Separate whole study area into 5°x5° area coverage

Collect co-located sample (location & time) each month and each 5°x5° coverage

Rain prob. distribution of CCS & PMW rain by month and 5°x5° coverage

Map CCS rain to PMW rain (Prob. Matching Method)

Lookup table CCS rain → PMW rain (0.25°x0.25°; 5°x5° coverage)

5°x5° box

60°S-60°N

180°W-180°E
CDF: CCS Est. Before/After PMW Adjustment (January 2008-2011)

PMW and PERSIANN-CCS CDF for each 5X5 degree box
January-winter time
CDF: CCS Est. Before/After PMW Adjustment (July 2008-2011)

PMW and PERSIANN-CCS CDF for each 5X5 degree box
July-summer time

CDF Curve
- CCS Est.
- CCS Est. (PMW Adj.)
PERSIANN-CCS Hourly Estimates: Jan 4, 2012

CCS Estimation

CCS (PMW Adjusted) Estimation
Validation Over 2012

- **Time Period:** Estimation in 2012
- **Coverage:** CONUS
- **Data Used:**
  - PMW & Q2 radar estimates
  - CCS before & after PMW Adjustment
Validation CCS & PMW: CONUS January 2012

CDF Curve
- CCS Est.
- CCS Est. (PMW Adj.)
- PMW Est.

5 x 5 degree
Validation CCS & PMW: CONUS July 2012

CDF Curve
- CCS Est.
- CCS Est. (PMW Adj.)
- PMW Est.

5 x 5 degree
Validation CCS & Q2: CONUS January 2012

CDF Curve
- CCS Est.
- CCS Est. (PMW Adj.)
- Q2 Est.

5 x 5 degree
Validation CCS & Q2: CONUS July 2012

CDF Curve
- CCS Est.
- CCS Est. (PMW Adj.)
- Q2 Est.

5 x 5 degree
CCS & Q2: January 10, 2012, 13:15~14:15

13:00 Jan 10, 2012, PERSIANN-CCS

13:30 Jan 10, 2012, PERSIANN-CCS

14:15 Jan 10, 2012, PERSIANN-CCS

PMW adjusted PERSIANN-CCS

PMW adjusted PERSIANN-CCS

PMW adjusted PERSIANN-CCS

Q2 Estimates

Q2 Estimates

Q2 Estimates
CCS & Q2: July 24 2012, 11:45~12:45

11:45 July 24, 2012, PERSIANN-CCS

12:15 July 24, 2012, PERSIANN-CCS

12:45 July 24, 2012, PERSIANN-CCS

PMW adjusted PERSIANN-CCS

PMW adjusted PERSIANN-CCS

PMW adjusted PERSIANN-CCS

Q2 Estimates

Q2 Estimates

Q2 Estimates
Ongoing activities

• Planning for event based evaluation
• PDF calibration will be extended to longer period (5+ years)
• Moving window of 15-30 day adjustment will be tested
• Improving CCS warm rain estimation
LMODEL: Cloud Tracking and Rainfall Estimation

A Multi-satellite Cloud Motion Tracking and Rainfall Estimation system

- High resolution cloud advection tracking
- Synchronisation of PMW precipitation to IR clouds
- Conceptual model of precipitation development
- Kalman filter for state adjustment based on PMW rainfall observations

Bellerby et al., J. Hydrometeorology, 2009
Model Updating

4:15 UTC, August 26, 2006
MW & LMODEL 30-Minute Rainfall

LMODEL+KF: 23:15, 8/27/2006


Hourly Radar Rainfall

23:00-23:59 UTC
08/27/2006

0 5 10 15 mm/hr
Rain/No Rain Classification from GOES Image Channels

Ch 1: 0.6 µm    Ch2: 3.9 µm    Ch3: 6.5 µm    Ch4: 10.7 µm    Ch5: 13.3 µm

Hit Under Estimation Over Estimation

ETS=25  POD=74  FAR=45
ETS=29  POD=77  FAR=42
ETS=27  POD=78  FAR=44
ETS=36  POD=76  FAR=35
ETS=30  POD=80  FAR=42
ETS=30  POD=72  FAR=39
ETS=35  POD=79  FAR=37
ETS=37  POD=78  FAR=35
ETS=37  POD=80  FAR=36
ETS=48  POD=75  FAR=22
ETS=49  POD=79  FAR=24
ETS=48  POD=75  FAR=22
ETS=49  POD=79  FAR=24

Ali et al., J. Hydrometeorology, 2009
Few progress

- Include more channels:
  IR4 channel ⇔ IR4 + WV channels
- Include 3 time step features along cloud motion vector:
  $t, t-\Delta t, t-2.\Delta t; \quad \Delta t=30$ minutes
- Add on Kalman filter update when PMW estimation is available
Thanks !!