TISA Edition4 LW Improvement Working Progress

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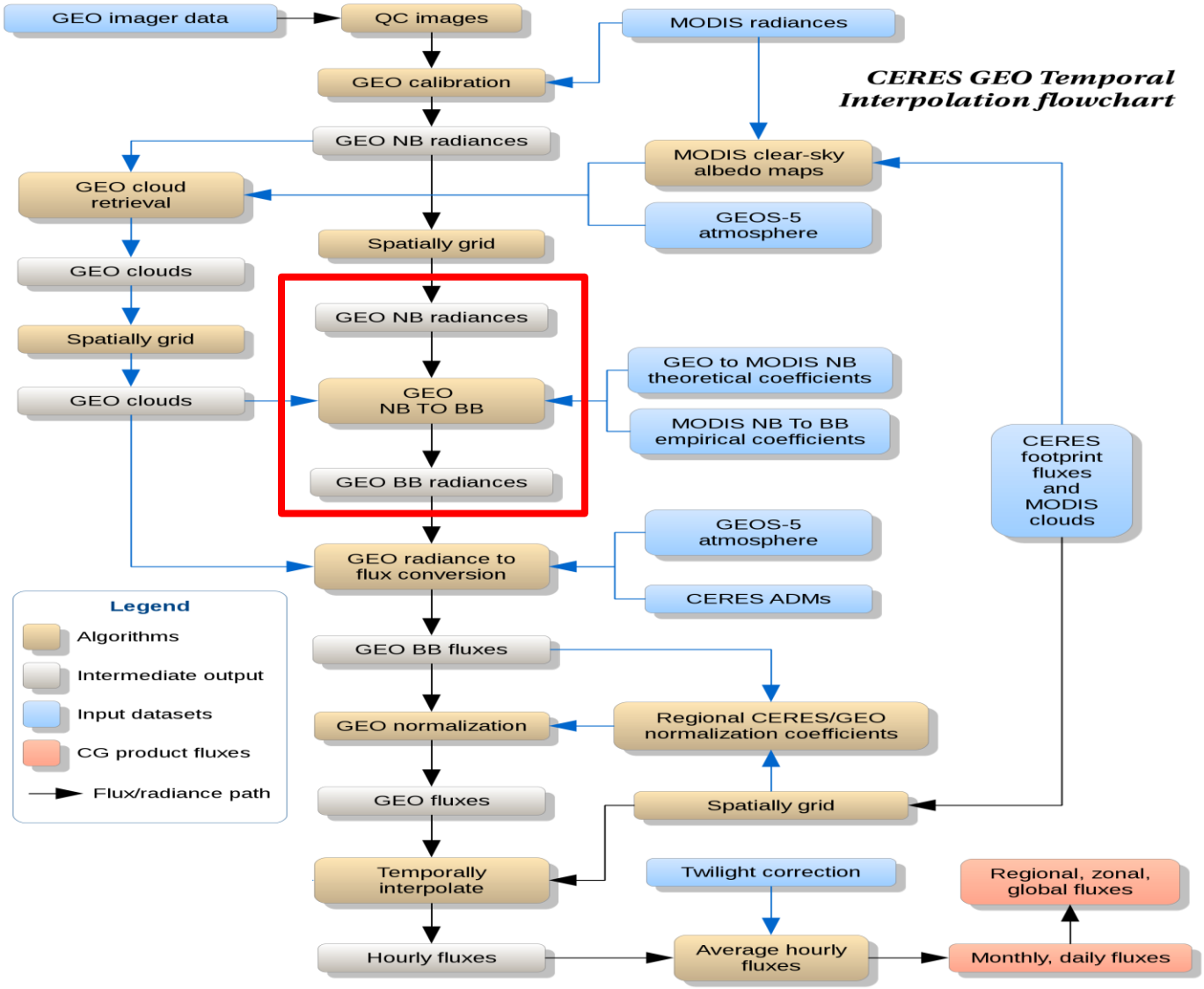
Outline

- Current GEO LW flux Status
- Ed4 NB-BB Radiance algorithm based on CERES
- Ed4 GGEO LW Flux: NB2BB, ADM, Normalization
- Preliminary Results
- Summary
- Future work

New stuff

- Procedures
- Validation: before vs. after
  - Map
  - A region
- Conclusion

CERES GEO LW Processing



Doelling

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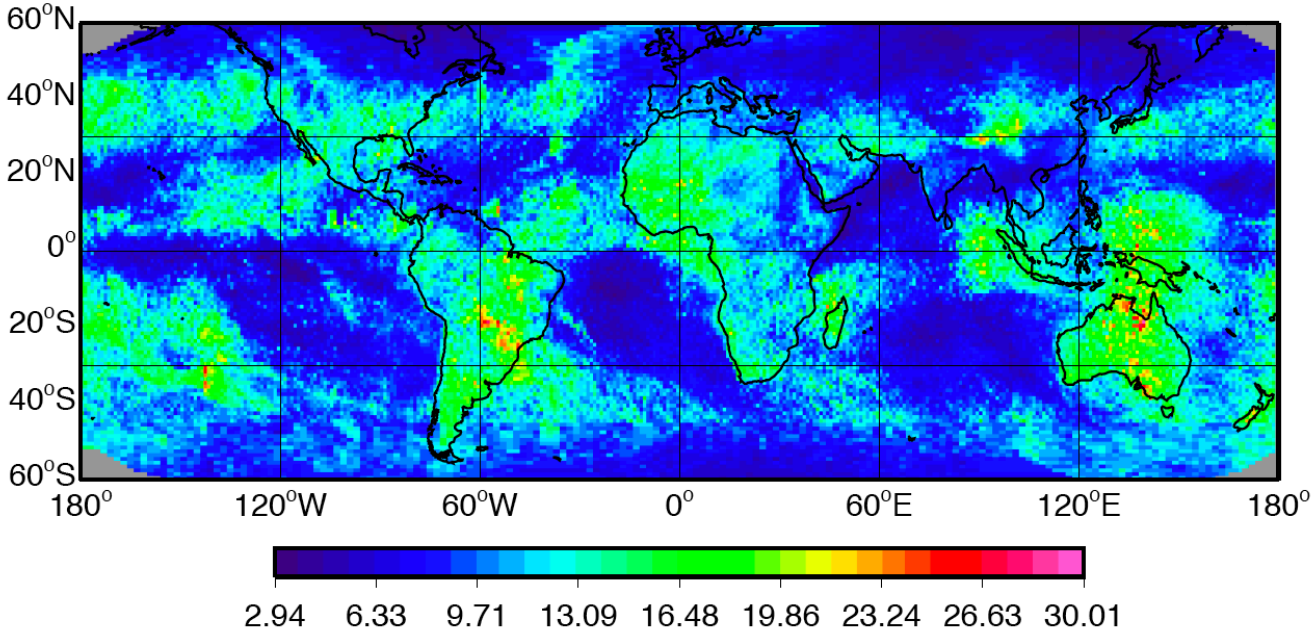
Current GEO NB-BB Flux
Matched GEO vs. Terra, January 2006



Global Mean RMS: 8.39

GEO LW and Terra LW Matched within 1.5 hours

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Current GEO LW NB->BB Flux Algorithm

- **WN => Nadir NB flux**

WN Rad, VZA

$$F_{NB} = 1.97\pi L_{WN}(\theta)/\gamma(\theta)$$

$$\gamma(\theta) = \begin{cases} 1 & \theta \le 11.7 \\ 1.000665 + 0.0324721\ln(\cos\theta) & \theta > 11.7 \end{cases}$$

Limb darkening function

- **NB flux => BB flux (OLR)**

Column Relative Humidity

$$OLR_{BB} = a_0 + a_1 F_{NB} + a_2 F_{NB}^2 + a_3 \ln(RH)$$

NB flux

a_0, a_1, a_2, a_3 *Coefficients for ocean and land separately*

Current GEO NB->BB Flux Algorithm

- The algorithm is based on Minnis et al. 1991 and not updated since then.
- Doelling et al. (1998 and 2003) validate the algorithm over ocean and land area and investigate the effects of different channels and relative humidity on RMS.
- LW RMS (~3-5%).

Areas for Improvement

- Use Ed4 GEO multiple channels vs. Ed2/Ed3 WN only
- Use WV channel to replace GEOS Relative Humidity
- Use ADM-like scene types vs. global land/ocean formula

Ed4 NB->BB Radiance Development

- Data: SSF-Ed4 (MODIS radiance and CERES flux)
- Test multiple channels:

  3.79μm (Night only), 6.72μm, 11.03μm, 12.02μm

- Create scene types:
  - **Ocean/land (6):** Ocean, Forests, Savannas, Grass-Crop, Dark and Bright Deserts.
  - **Day/Night (2)**
  - **Clear/cloud (2)**
  - **Precipitable Water (4):** 0-1, 1-3, 3-5, 5-10 cm
  - **Viewing Zenith Angle (7):** 0^o-70^o, every 10^o
  - **Total: 672 scene types**

Ed4 NB->BB Radiance Development

- For each scene type:

  Linear regress: CERES LW_{BB} *vs.* MODIS (Rad_{nb1} , Rad_{nb2} , Rad_{nb3})

$$LW_{est} = a_0 + a_1 Rad_{11\mu m} + a_2 Rad_{6.7\mu m} + a_3 Rad_{12\mu m}$$

- Evaluation of the algorithm:

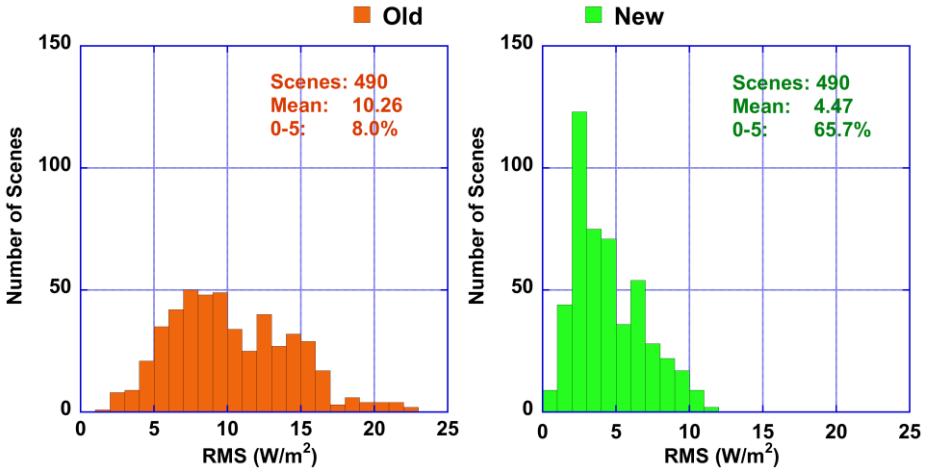
$$RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(LW_i^{est} - LW_i^{BB})^2}$$

NB Rad -> BB Flux Algorithm

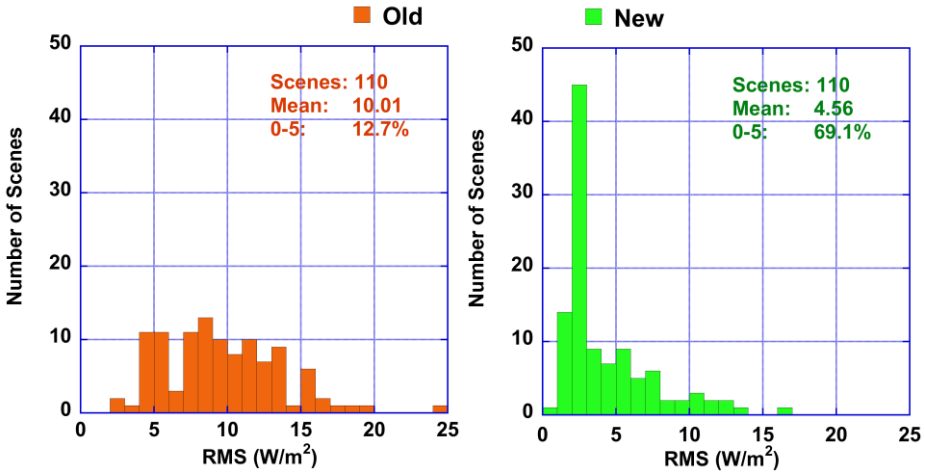
Method

1. Calculate NB-BB flux directly using 11.03µm and 6.72µm for all scenes.
2. Calculate NB-BB flux using current 11.03µm global formula and then sort the data according to the same scene types as in 1.

NB Rad - BB Flux
Land and Ocean



Land Scenes



Ocean Scenes

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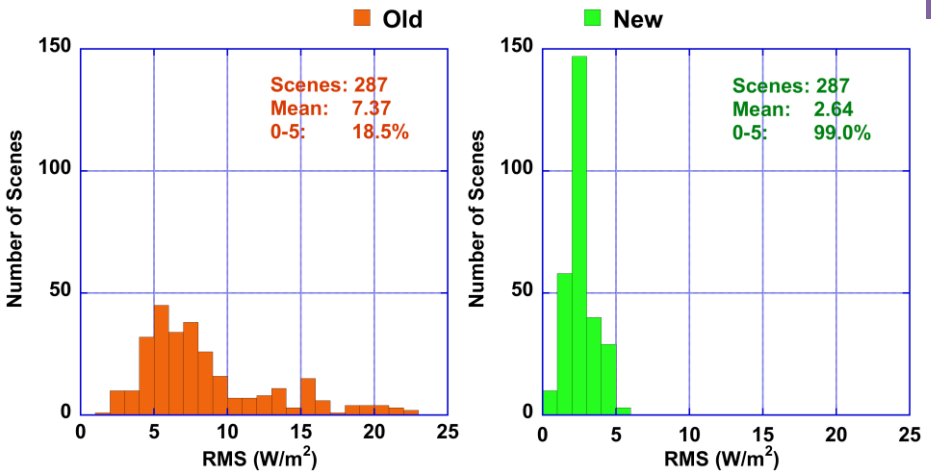
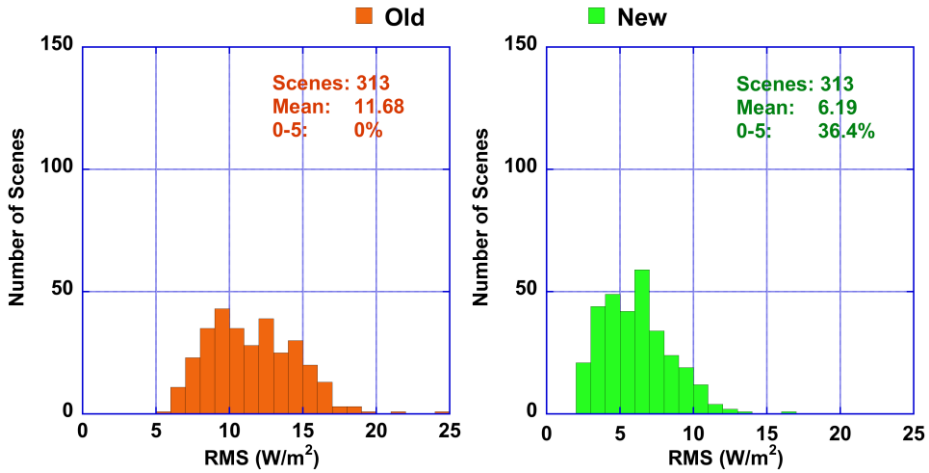
NB Rad -> BB Flux
Clear and Cloud



Clear Scenes



Cloud Scenes

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NB Rad -> BB Flux Table

Types	Total Scenes	Ed2/Ed3 WN-only		Ed4 WN + WV		Ed4 vs. Ed2/3 RMS diff (%)
		Mean RMS	(%) RMS < 5	Mean RMS	(%) RMS < 5	
All	600	10.21	8.8	4.49	66.3	**56.02**
land	490	10.26	8.0	4.47	65.7	**56.43**
ocean	110	10.01	12.7	4.56	69.1	**54.45**
day	296	11.18	11.5	5.59	49.0	**50.00**
night	304	9.27	6.3	3.42	83.2	**63.11**
clear	287	8.61	18.5	2.64	99.0	**69.34**
cloud	313	11.68	0.0	6.19	36.4	**47.00**

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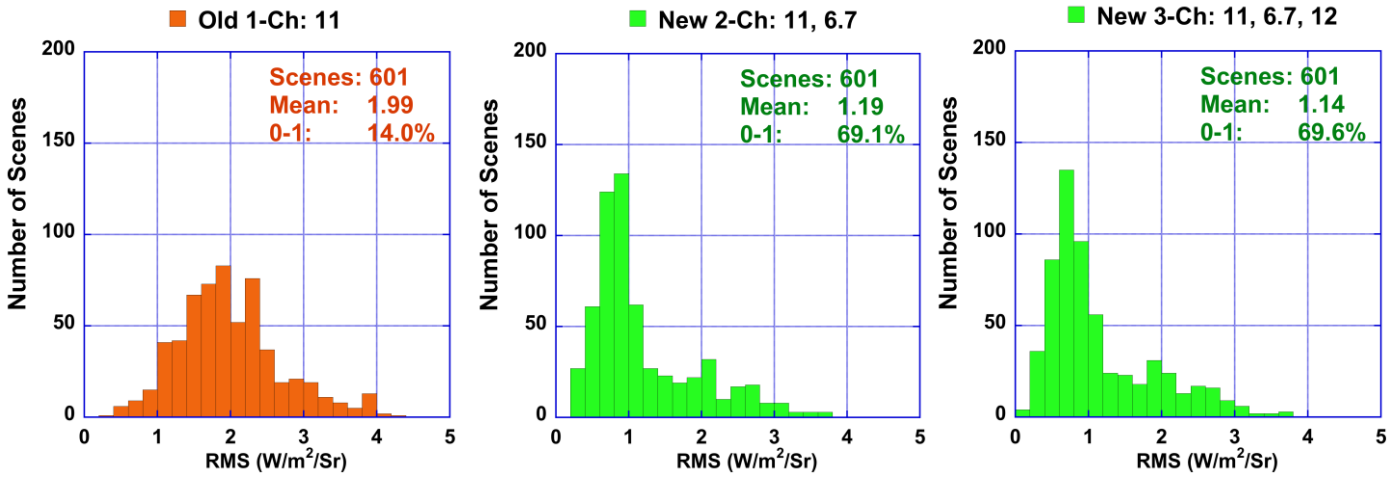
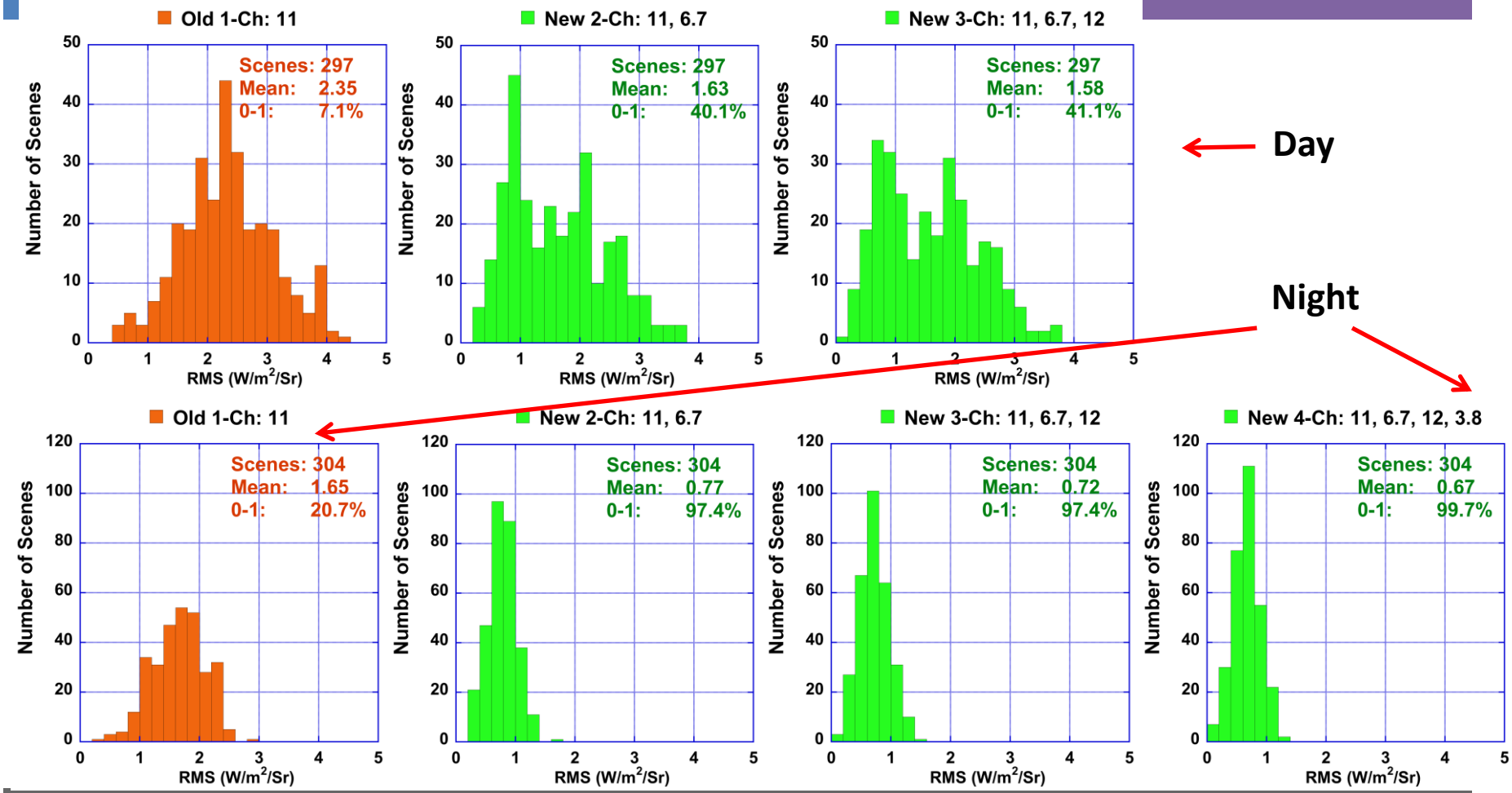
NB -> BB Radiance
All Scenes



April, 2000

NB Rad -> BB Rad
Day and Night, April 2000



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NB Rad -> BB Rad Table

Types	Total Scenes	Ed2/Ed3 WN-only		Ed4 WN + WV		Ed4 vs. Ed2/3 RMS diff (%)	Ed4 WN+WV+12μm	
		Mean RMS	(%) RMS < 1	Mean RMS	(%) RMS < 1		Mean RMS	(%) RMS < 1
All	601	1.99	14.0	1.19	69.1	**40.20**	1.14	69.6
land	490	2.03	13.1	1.22	66.3	**39.90**	1.17	66.9
ocean	111	1.84	18.0	1.08	81.1	**41.30**	1.02	81.1
day	297	2.35	7.1	1.63	40.1	**30.64**	1.58	41.1
night	304	1.65	20.7	0.77	97.4	**53.33**	0.72	97.4
clear	287	1.72	17.1	0.79	89.2	**54.07**	0.74	90.2
cloud	314	2.25	11.1	1.56	50.6	**30.67**	1.52	50.6

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Ed4 GGEO LW Flux Improvement

- LW Narrowband-Broadband Radiance Conversion
- LW BB Radiance-Flux Conversion by ADM (Angular Distribution Model)
- GGEO LW Flux Normalization

LW Narrowband-Broadband Radiance Conversion

- Apply MODIS-CERES based NB-BB coefficients to GGEO data assuming GGEO and MODIS have similar spectral response function (SRF).
- Problems:
  - GGEO and MODIS do have different SRF, this may cause some bias.

LW BB Radiance-Flux Conversion by ADM (Angular Distribution Model)

- Use current LW ADM to convert Broadband Radiance to Flux. Supposedly this is better than the current simple-limb darkening correction.
- Problems:
  - The ADM is based on CERES and may have problem applying to GGEO data.

GGEO LW Flux Normalization

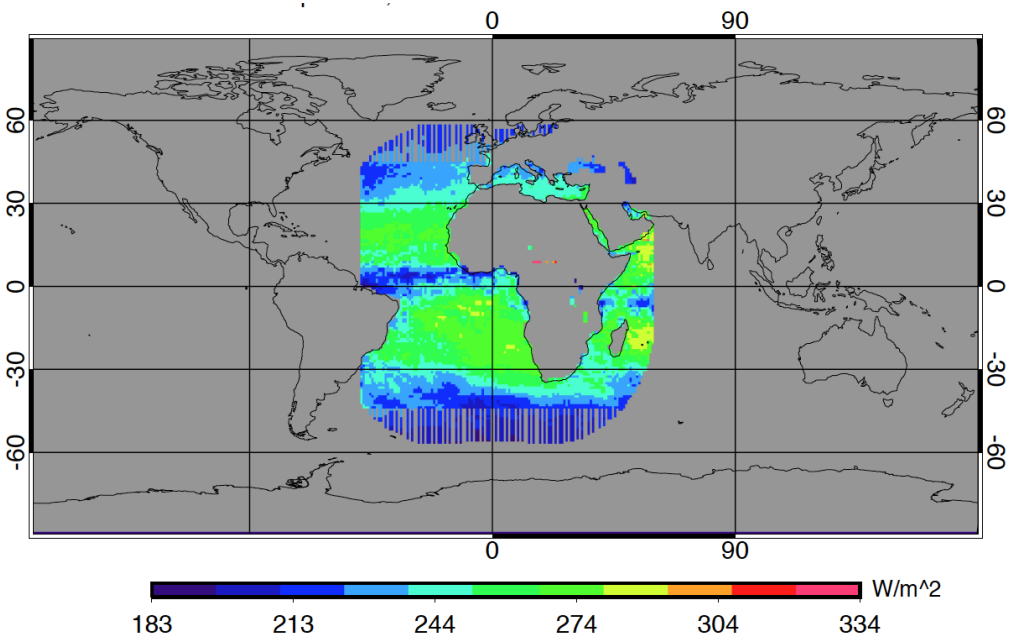
- Normalize the GGEO Flux against matched CERES flux.
- This method has been applied to SW and cloud properties and it shows great improvement.

Preliminary Results

- The results here are very preliminary and represent work in progress.

Preliminary Results

April 2010 CERES Flux over MET9 Satellite Area



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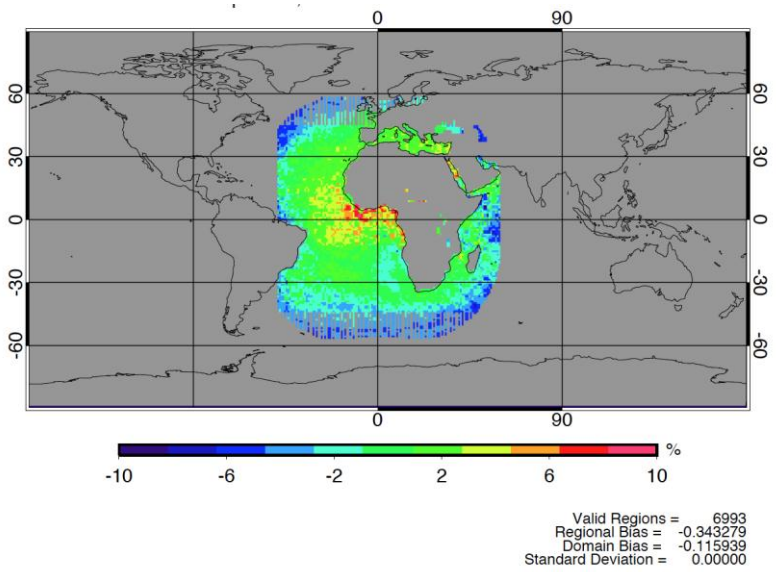
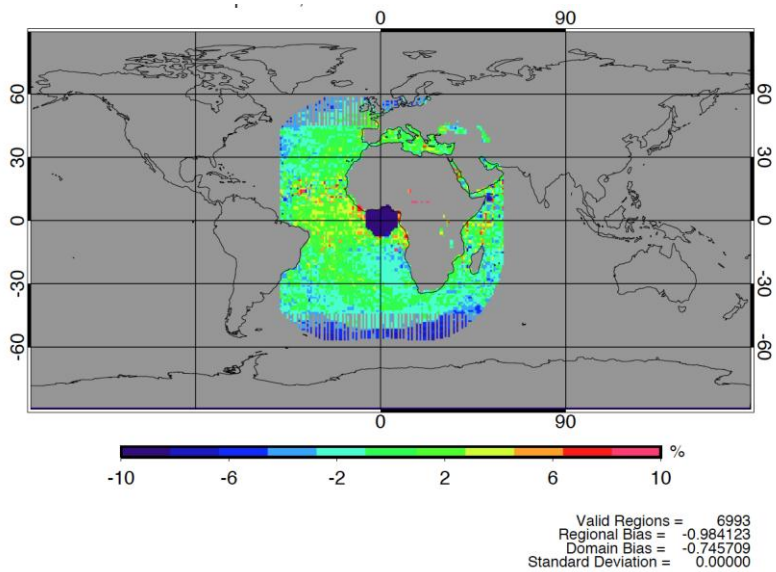
Preliminary Results
April, 2010 BIAS

Old GGEO – CERES Flux



New GGEO – CERES Flux



The new method shows regional improvement but not for the whole domain.

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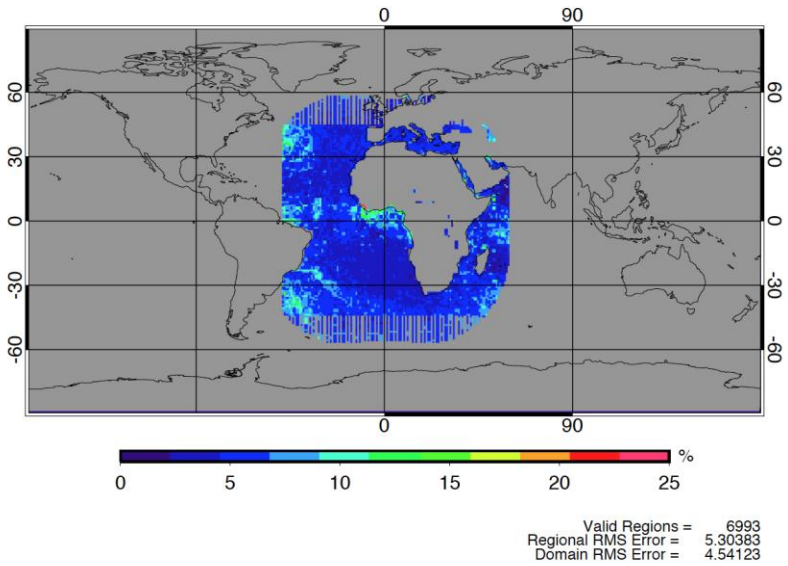
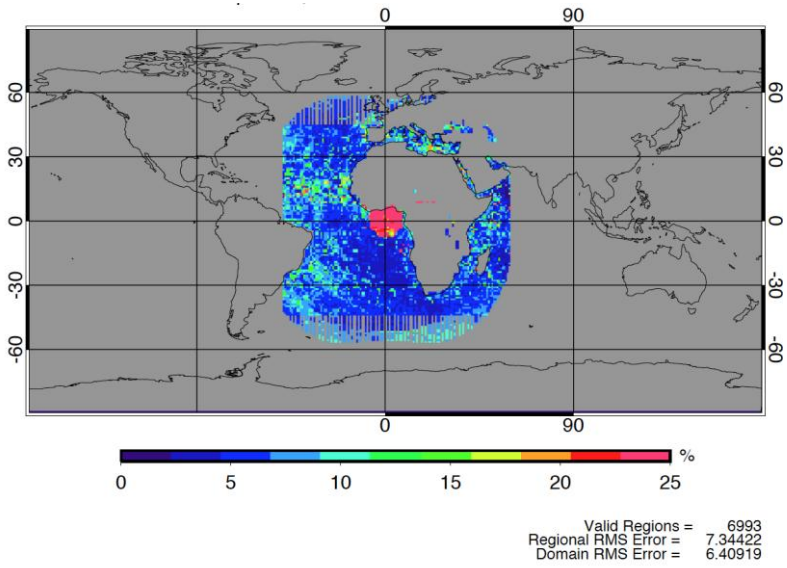
Preliminary Results
April, 2010 RMS

Old GGEO – CERES Flux



New GGEO – CERES Flux



The new method shows worse results, need to double check.

Summary

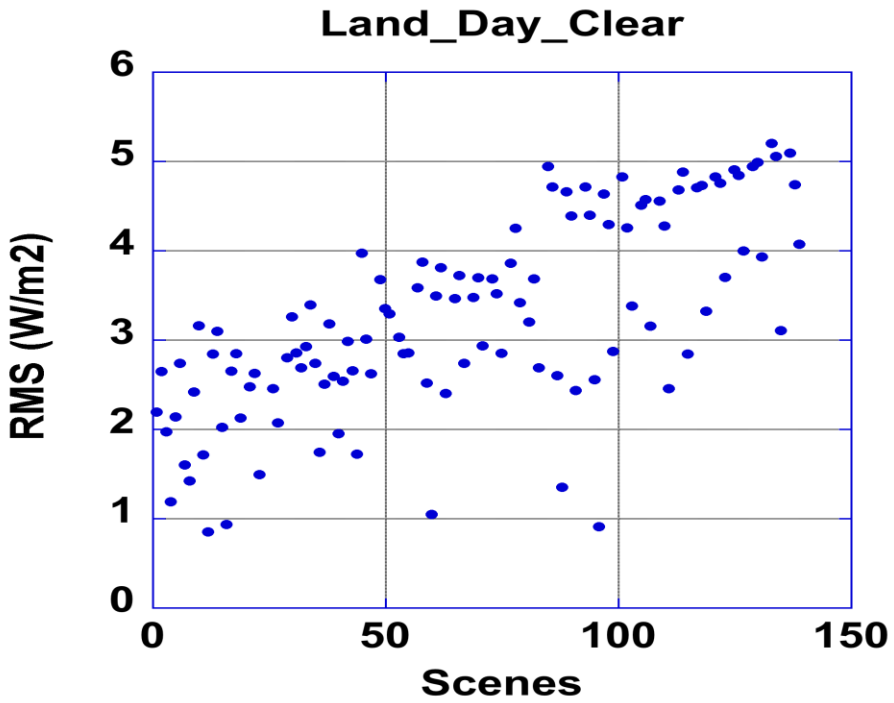
- For NB-BB radiance conversion, 2-channel algorithm reduce RMS by about 40% compared with 1-channel algorithm averaged for all scenes.
- Adding other channels to the 2-channel algorithm improves RMS only slightly.
- The New NB-BB Radiance algorithm combined with LW ADM show no improvement for this preliminary results. This needs further validation and code checking.

Future Work

- Continue to work on Ed4 GGEO LW algorithm to correct any bugs and refine algorithms to improve accuracy compared with current LW algorithm.

Thank You!

Backup



2-channel NB-BB flx
April, 2000