



Advancement of PLoarimetric Observations: calibration and improved aerosol retrievals



MERSI onboard Chinese Fengyun-3: quantitative ability for aerosol retrieval

Leiku Yang¹, Xiuqing Hu², Han Wang¹, Xingwei He²

1 Henan Polytechnic University

2 National Satellite Meteorological Center of China

yanglk@hpu.edu.cn

Lille, Nov. 04, 2019





Outline :

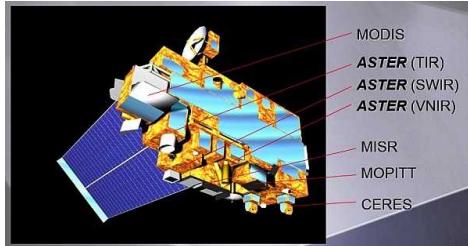
1. Satellite/Senor
 2. Aerosol Algorithm
 3. Result & Validation
 4. Month Mean
 5. Test with MERSI-II
- 
- FY-3C MERSI-I



1. Satellite/Senor

Polar- Orbit

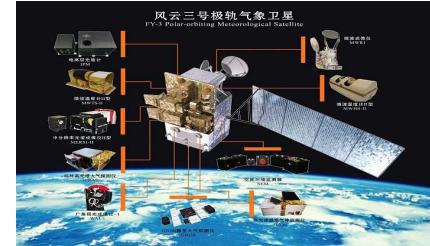
MODIS



VIIRS



MERSI



Onboard:

Terra

Aqua

S-NPP

FY-3A

JPSS-1

FY-3B

JPSS-x

FY-3C

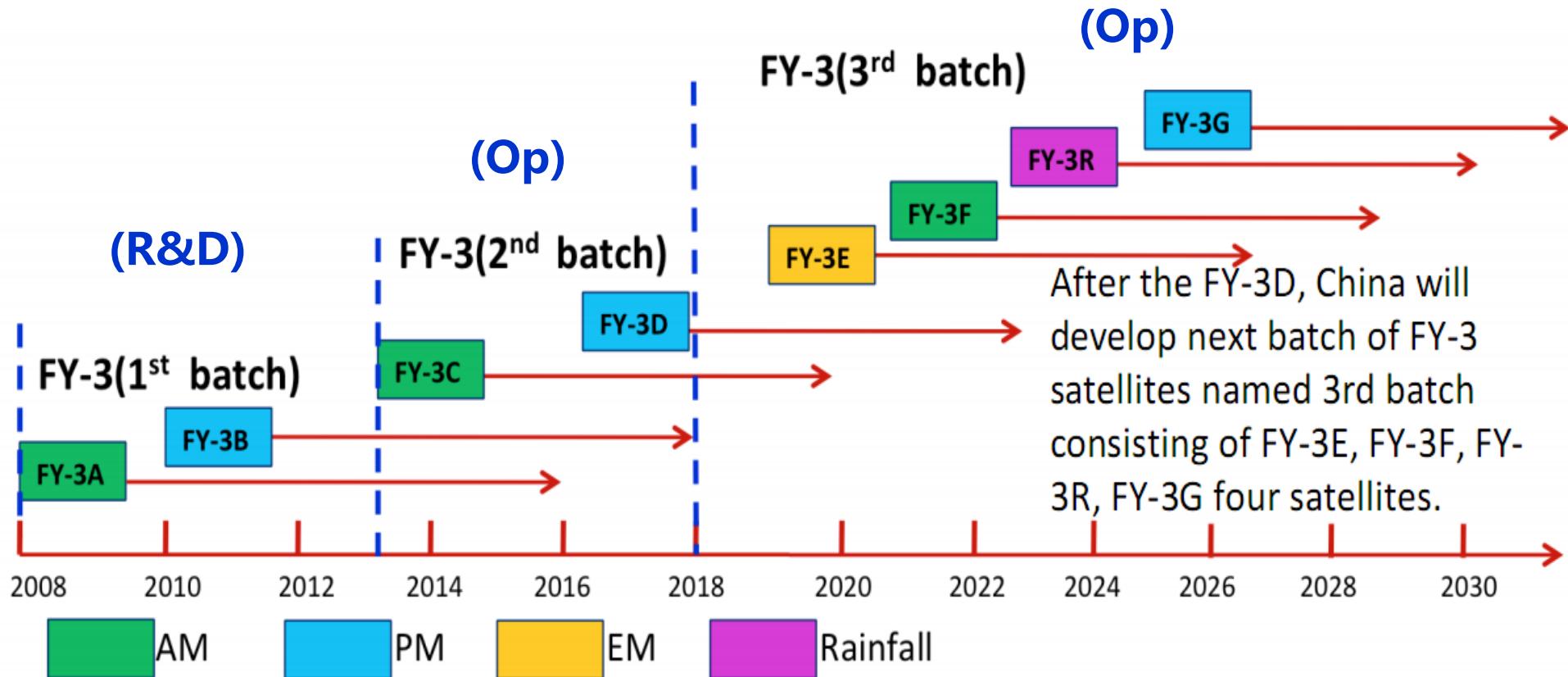
FY-3D

FY-3x



1. Satellite/Senor

The schedule (2008~2028) of FY-3 satellite series





1. Satellite/Senor

Satellite	TERRA	AQUA	S-NPP	JPSS-1	FY-3C	FY-3D
Orbit altitude	705km	705km	825km	825km	836km	836km
Equator crossing time	10:30	13:30	13:30	13:30	10:30	13:30
Sensor	MODIS	MODIS	VIIRS	VIIRS	MERSI-1	MERSI-2
Swath width	2330km	2330km	3040km	3040km	2916km	2916km
Sensor zenith angle range	±64°	±64°	±70°	±70°	±55.4°	±55.4°
Launch Date	1999	2002	2011	2017	2013	2017

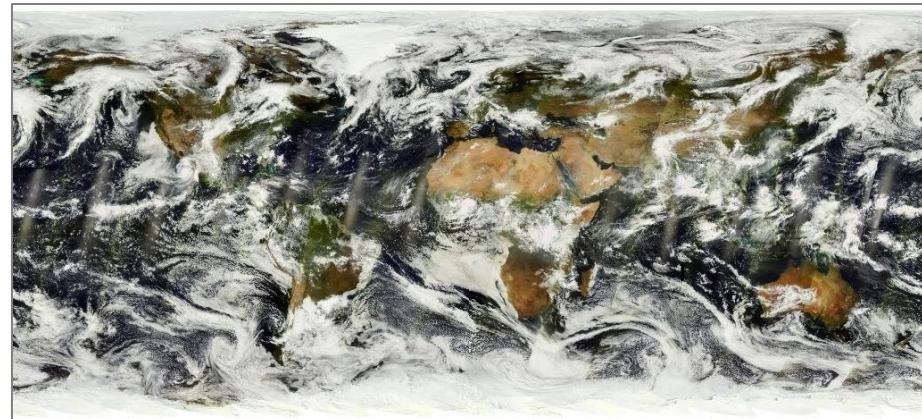
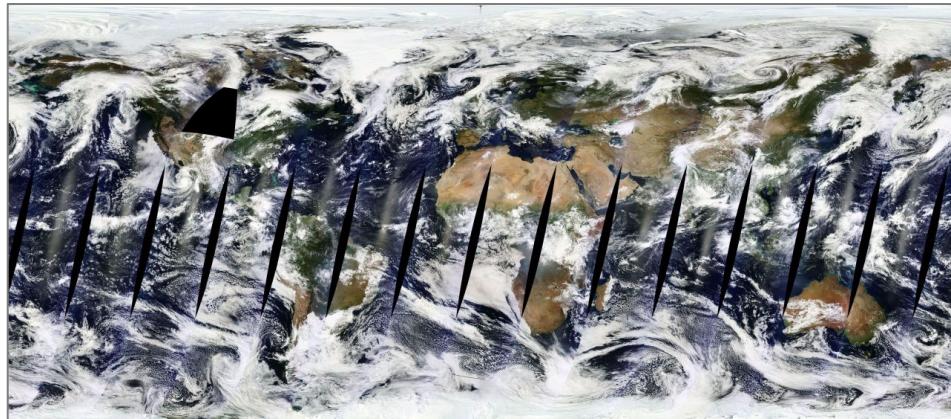


1. Satellite/Senor

MODIS			VIIRS			FY-3C MERSI (-I)			FY-3D MERSI-II		
Band	Central Wavelength (μm)	Spatial Resolution (m)	Band	Central Wavelength (μm)	Spatial Resolution (m)	Band	Central Wavelength (μm)	Spatial Resolution (m)	Band	Central Wavelength (μm)	Spatial Resolution (m)
3	0.466	500	M3	0.488	750	1	0.476	250	1	0.471	250
4	0.554	500	M4	0.555	750	2	0.552	250	2	0.555	250
1	0.645	250	M5/I1	0.672	750/375	3	0.650	250	3	0.654	250
2	0.856	250	M7/I2	0.865	750/375	4	0.861	250	4	0.869	250
5	1.24	500	M8	1.24	750	20	1.03	1000	19	1.03	1000
6	1.63	500	M10/I3	1.61	750/375	6	1.64	1000	6	1.64	1000
7	2.11	500	M11	2.25	750	7	2.13	1000	7	2.13	1000
8	0.412	1000	M1	0.412	750	8	0.412	1000	8	0.411	1000
9	0.443	1000	M2	0.445	750	9	0.443	1000	9	0.444	1000
26	1.38	1000	M9	1.378	750		no	no	5	1.38	1000
31	11.0	1000	M15/I5	11.45	750/375	5	11.3	250	24	10.8	250
32	12.0	1000	M16	12.01	750		no	no	25	12.0	250



1. Satellite/Senor



MODIS/TERRA

Sep 05 2014

MERSI/FY3C



1. Satellite/Senor



Similar quality of visual effects.



How about quantitative ability?
And to what extent?

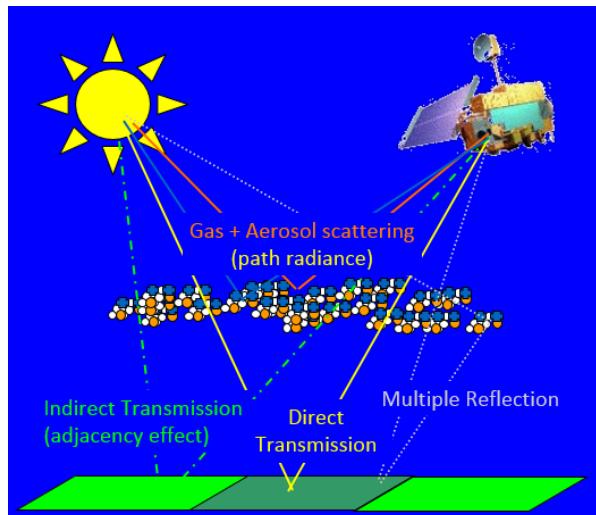
MODIS/AQUA

Mar 11 2018

MERSI-II/FY3D

2. Algorithm

$$\rho^* = T_g \cdot \left(\rho_{R+a} + \frac{T_{R+a}^\downarrow \rho T_{R+a}^\uparrow}{1 - \rho S} \right)$$

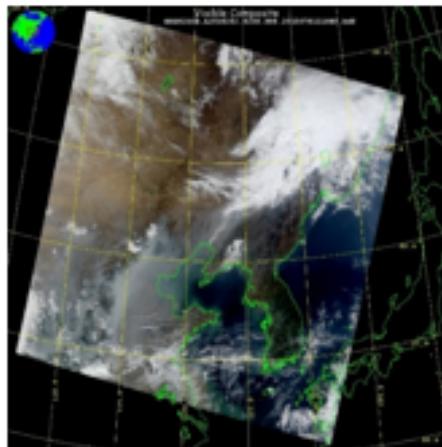
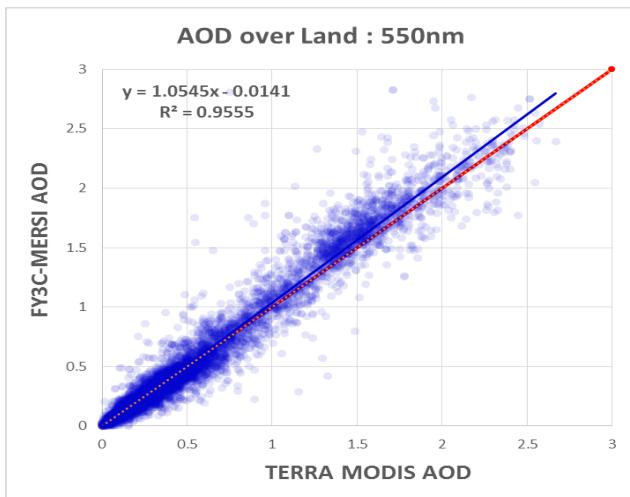


- 1) Gas absorption correction
- 2) Cloud mask
- 3) Pixel aggregation
- 4) Surface estimation
- 5) Look-Up table

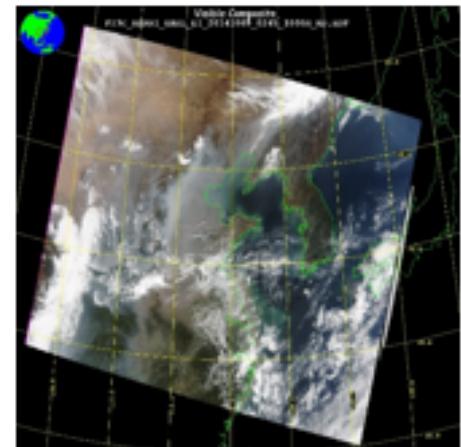
Our algorithm keep consistent as much as Dark Target (DT).

3. Result and validation

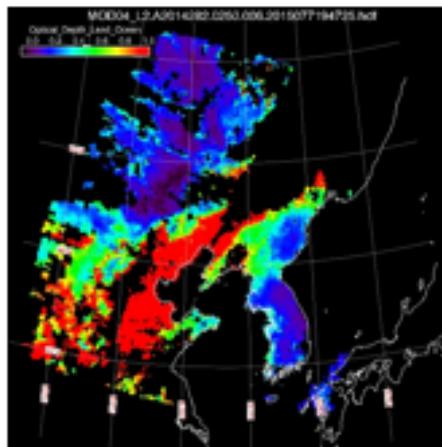
3.1 Example of One granule Retrieval



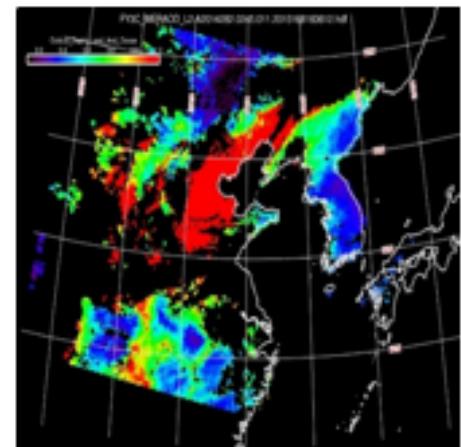
MODIS RGB



MERSI RGB



MODIS AOD

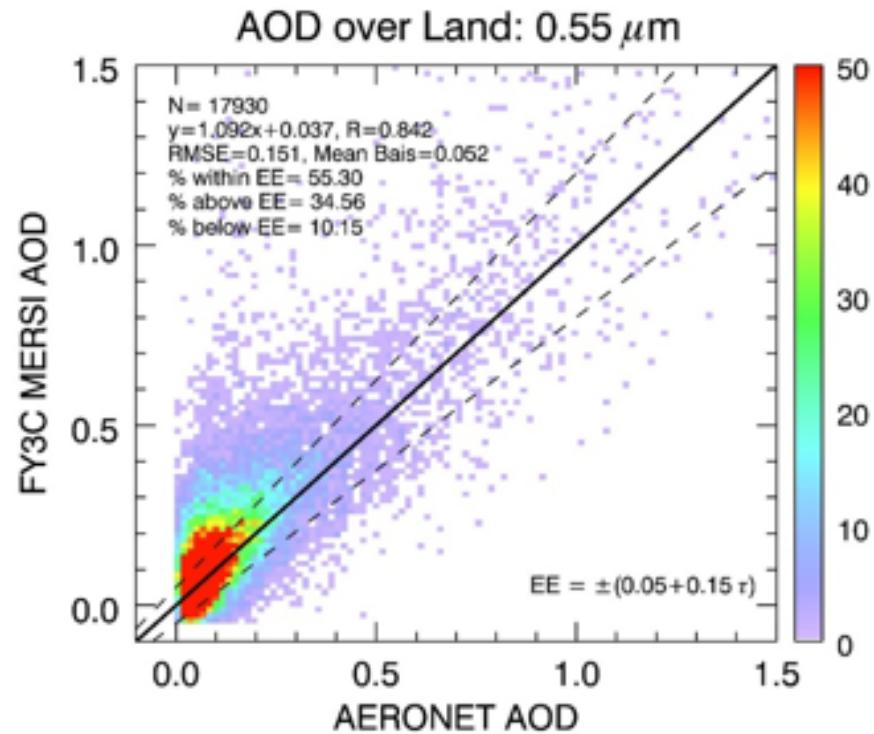
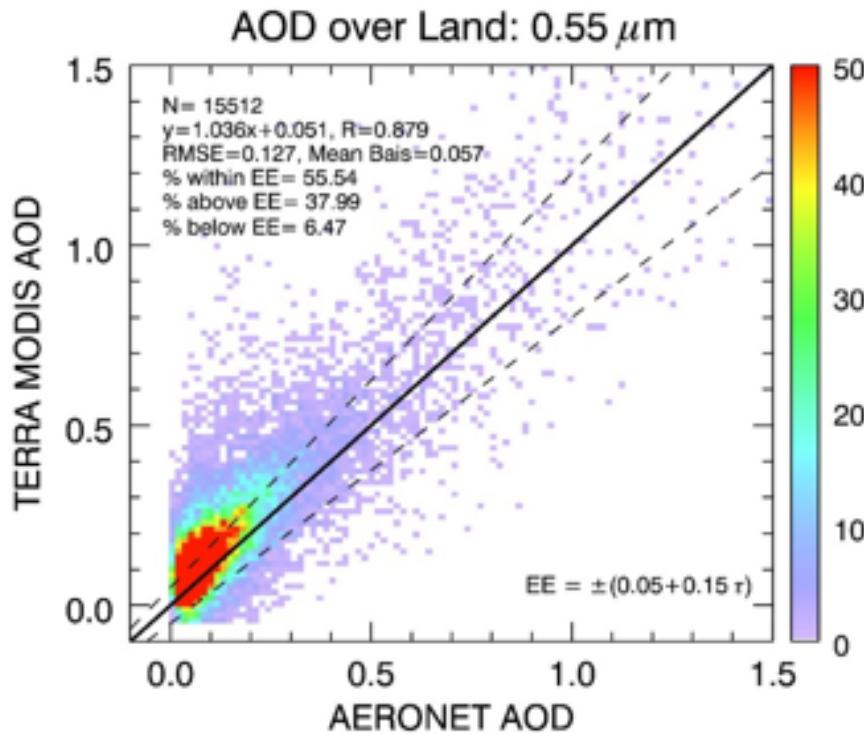


MERSI AOD

3. Result and validation

3.2 Global validation

data : 201406~201505



MODIS/TERRA **C6**

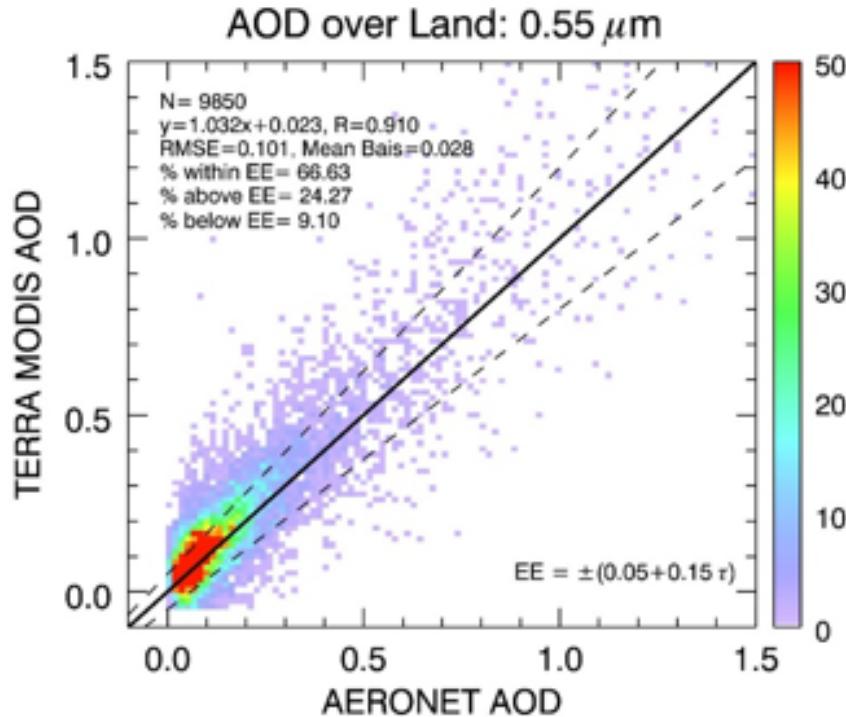
QA=AI

MERSI/FY3C

3. Result and validation

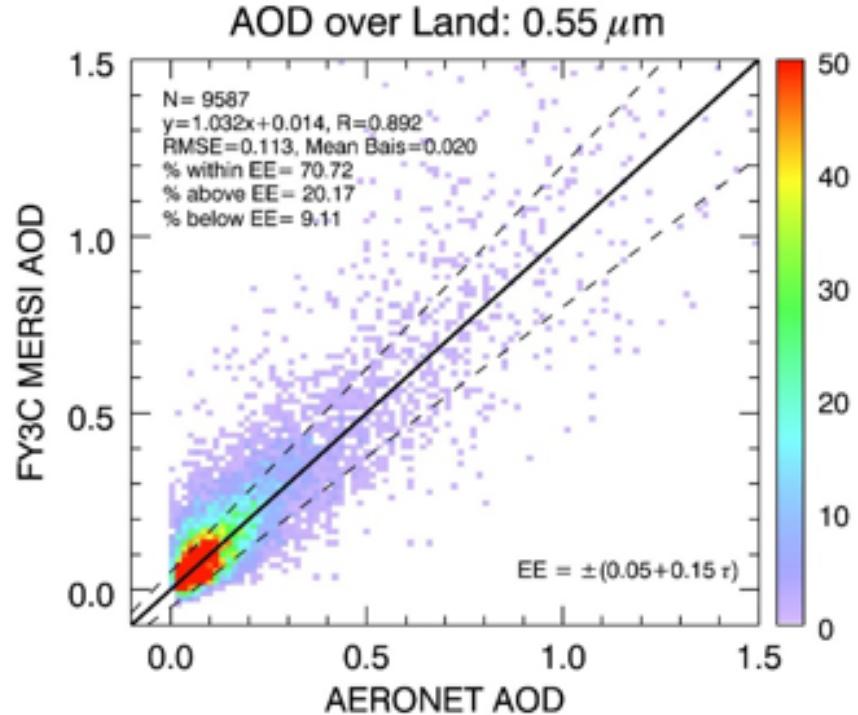
3.2 Global validation

data : 201406~201505



MODIS/TERRA **C6**

QA=3

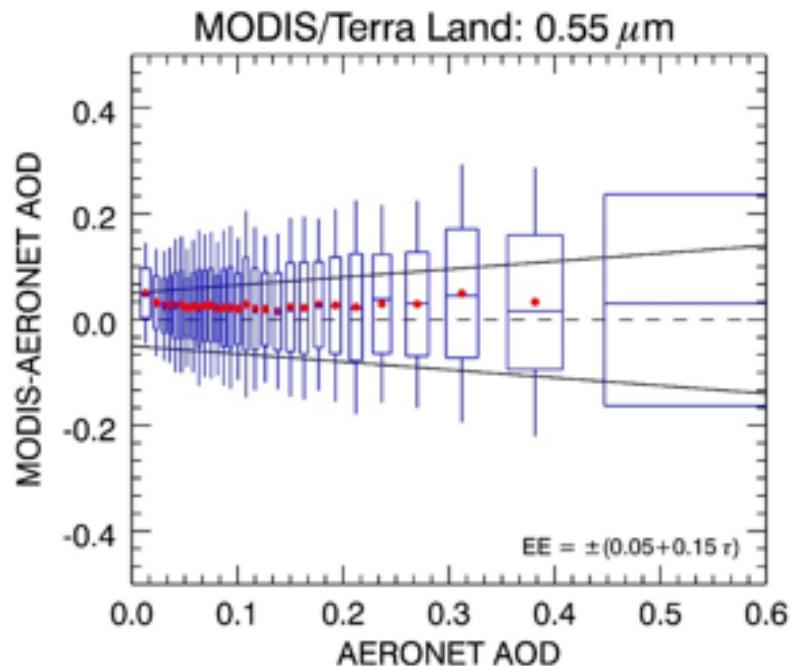


MERSI/FY3C

3. Result and validation

3.2 Global validation

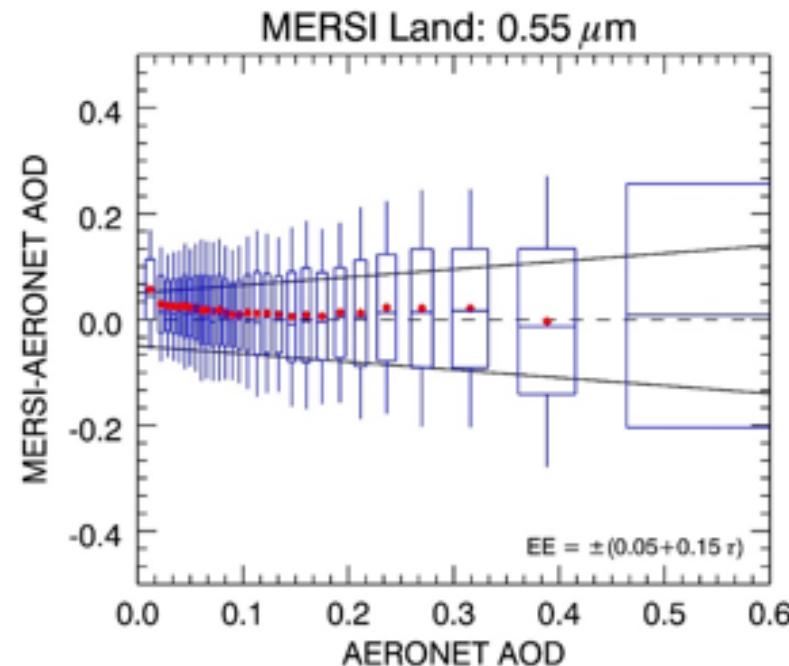
data : 201406~201505



MODIS/TERRA C6

QA=3

MERSI Land: 0.55 μm



This box plot shows the difference between MERSI Land AOD at 0.55 μm and AERONET AOD. The x-axis represents AERONET AOD from 0.0 to 0.6. The y-axis represents MERSI-AERONET AOD from -0.4 to 0.4. The plot includes blue box plots for different AERONET AOD bins, red dots for individual data points, and two grey lines representing the expected error range ($\pm(0.05+0.15r)$). The data shows significant scatter and some outliers.

AERONET AOD

MERSI-AERONET AOD

$\text{EE} = \pm(0.05+0.15r)$

MERSI/FY3C

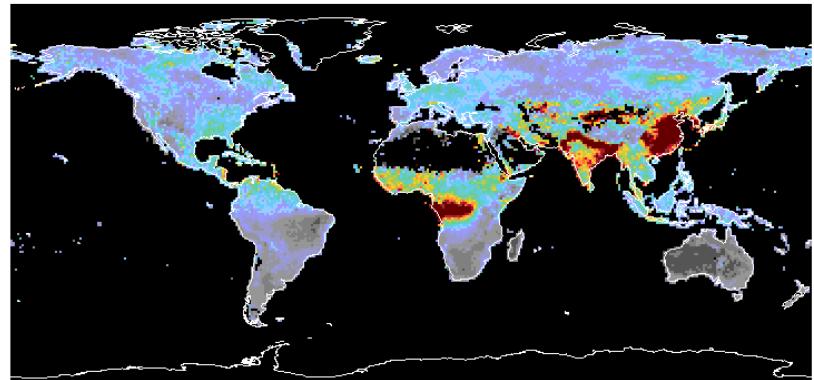


4. Month mean

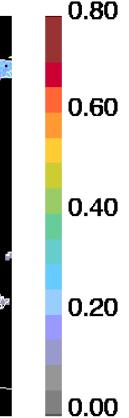
1) AOD_Month_Mean (wait gif...)

data : 201406~201505

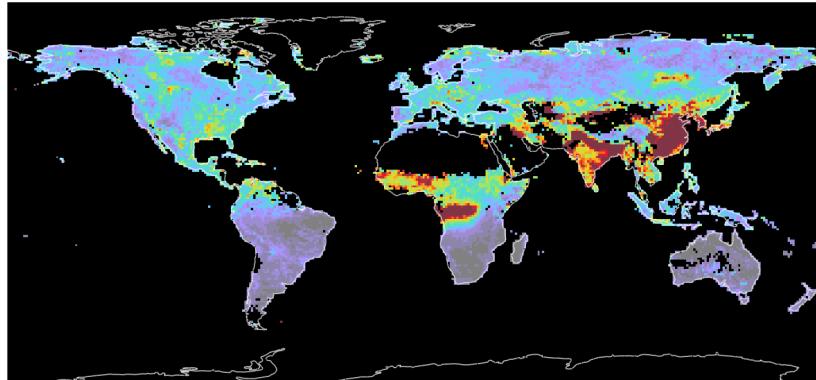
Aerosol_Optical_Depth_Land_Mean_Mean



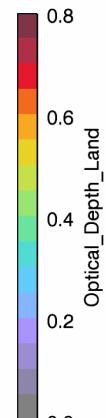
01Jun2014



Aerosol_Optical_Depth_Land_Mean_Mean



Jun2014



MODIS/TERRA

MERSI/FY3C

QA=All

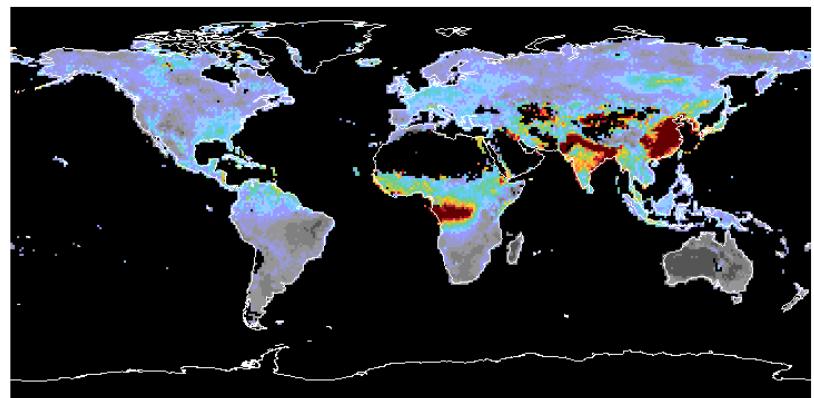


4. Month mean

2) AOD_Month_QA_Mean (wait gif...)

data : 201406~201505

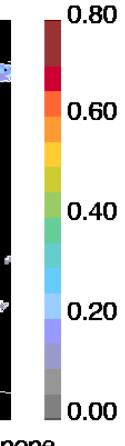
Aerosol_Optical_Depth_Land_QA_Mean_Mean



MODIS/Terra

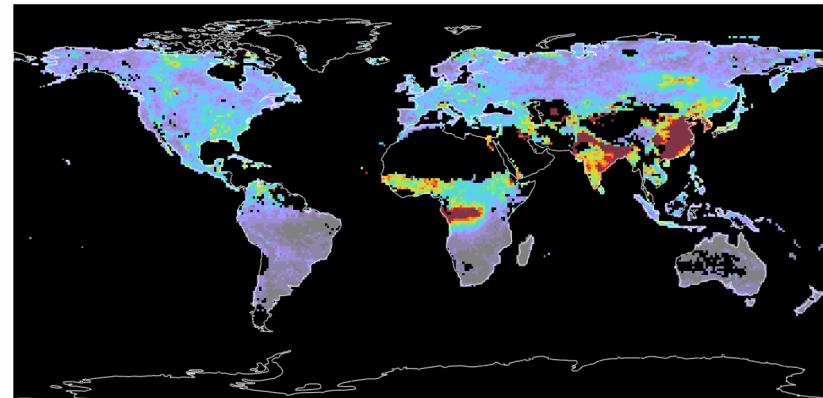
MOD08_M3.A2014152.006.2015076164523.hdf

01Jun2014



none

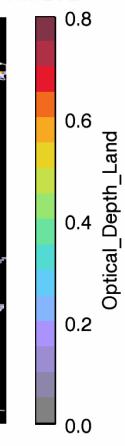
Aerosol_Optical_Depth_Land_QA_Mean_Mean



MERSI/FY3C

FY3C_MERAOD_M1d.201406.011.hdf

Jun2014



MODIS/TERRA

MERSI/FY3C

QA=1、2、3



Aerosol and haze retrieval over land from FY-3 MERSI: Quantitative ability test

5. Preliminary test with MERSI-II

Onboard FY-3D

Since Dec., 28, 2017



5. Preliminarily test with MERSI-II

5.1 Algorithm

FY-3C MERSI (-I)			FY-3D MERSI-II		
Band	Central Wavelength (μm)	Spatial Resolution (m)	Band	Central Wavelength (μm)	Spatial Resolution (m)
1	0.476	250	1	0.471	250
2	0.552	250	2	0.555	250
3	0.650	250	3	0.654	250
4	0.861	250	4	0.869	250
20	1.03	1000	19	1.03	1000
6	1.64	1000	6	1.64	1000
7	2.13	1000	7	2.13	1000
8	0.412	1000	8	0.411	1000
9	0.443	1000	9	0.444	1000
	no	no	5	1.38	1000
5	11.3	250	24	10.8	250
	no	no	25	12.0	250

1) Cirrus mask: With $1.38\mu\text{m}$

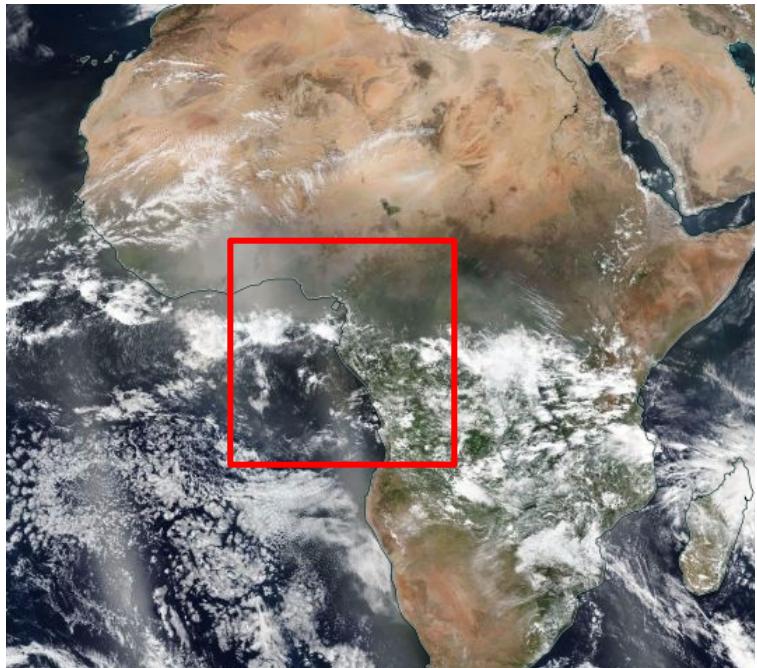
$$\rho_{1.38}^* > 0.03 \text{ or } \sigma_{1.38} > 0.003$$

2) surface band ratio:

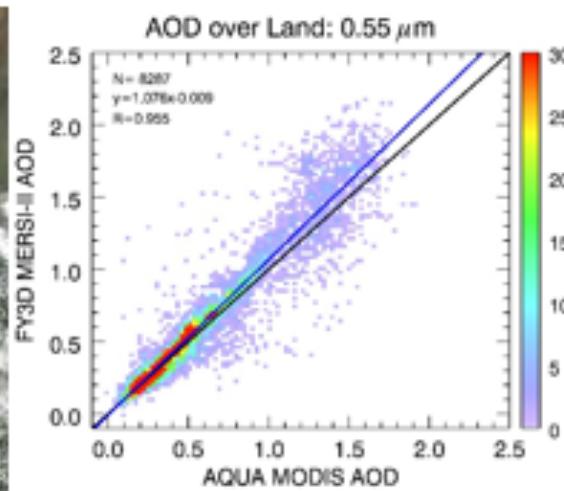
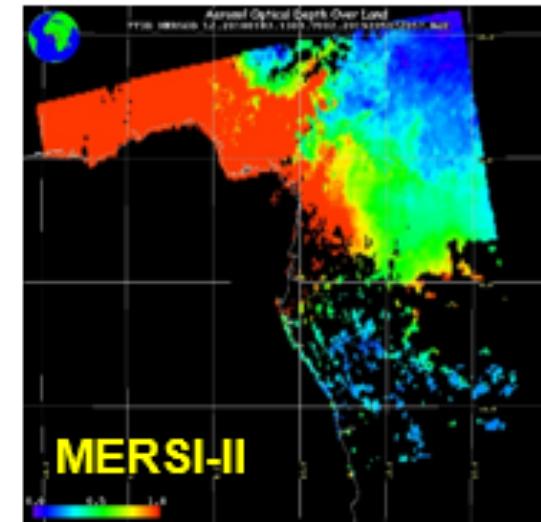
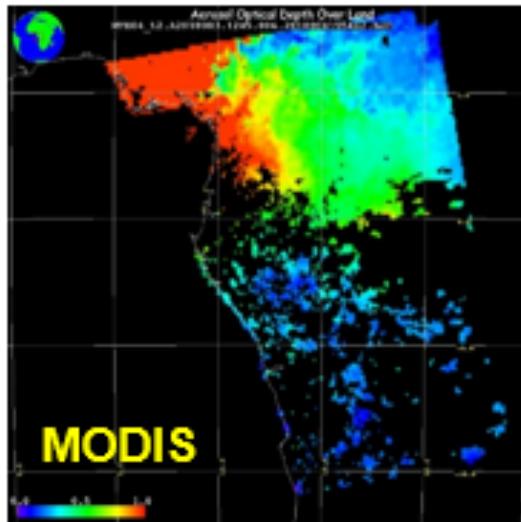
$$\begin{cases} \rho_{0.65}^s = f(\rho_{2.12}^s) = 0.5 * \rho_{2.12}^s \\ \rho_{0.47}^s = g(\rho_{0.65}^s) = 0.5 * \rho_{0.65}^s \end{cases}$$

5. Preliminarily test with MERSI-II

5.2 Example of One granule Retrieval -1



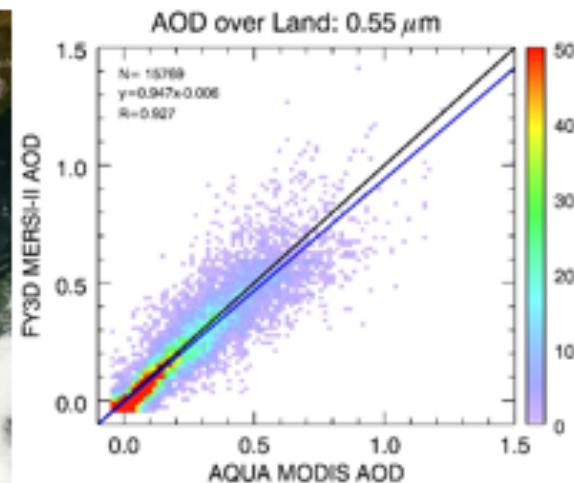
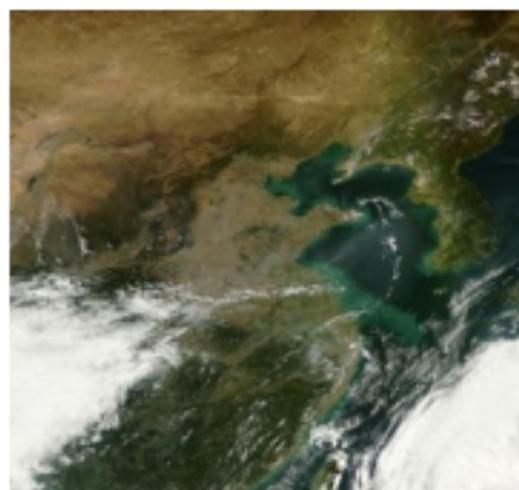
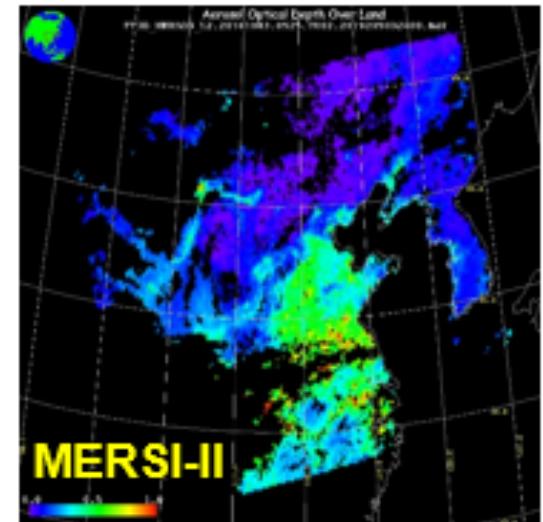
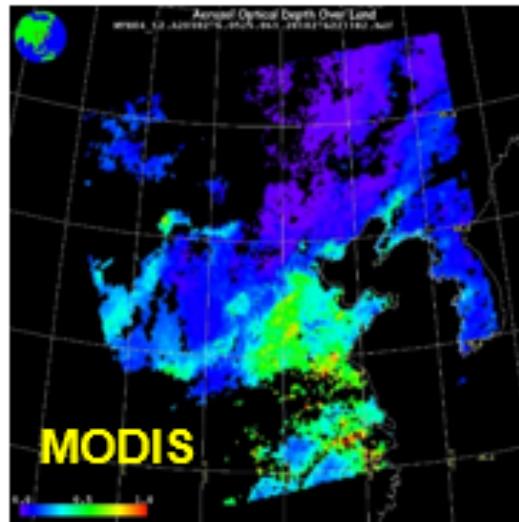
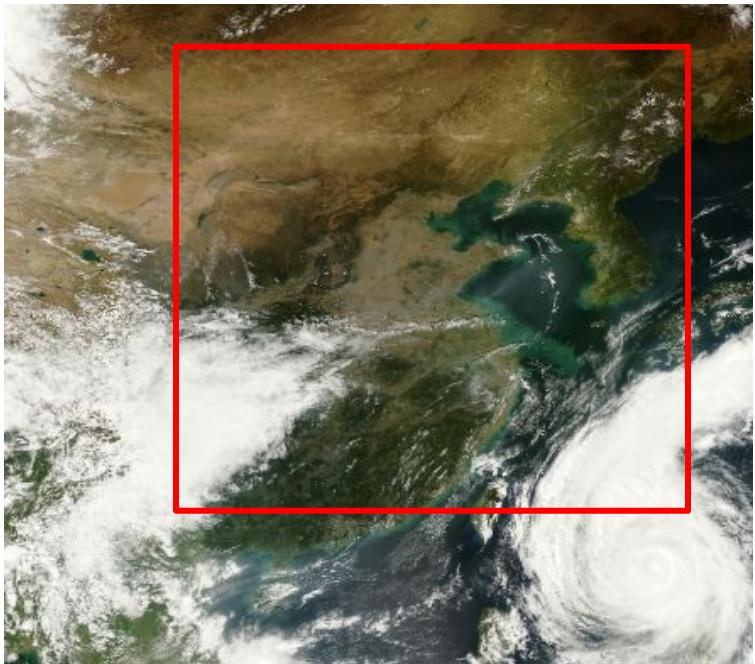
Feb.,03,2018, west Africa





5. Preliminarily test with MERSI-II

5.2 Example of One granule Retrieval -2



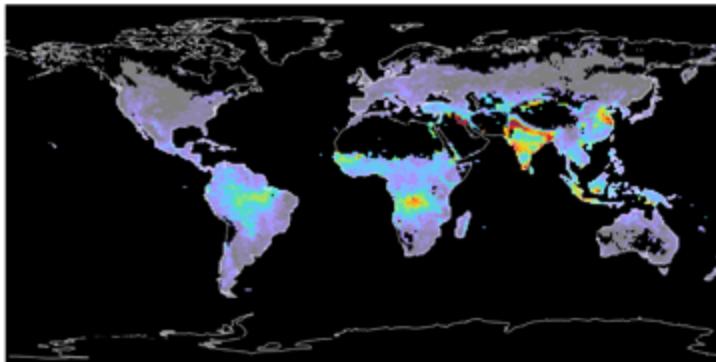
Oct., 03, 2018, east China



5. Preliminarily test with MERSI-II

5.3 Month mean

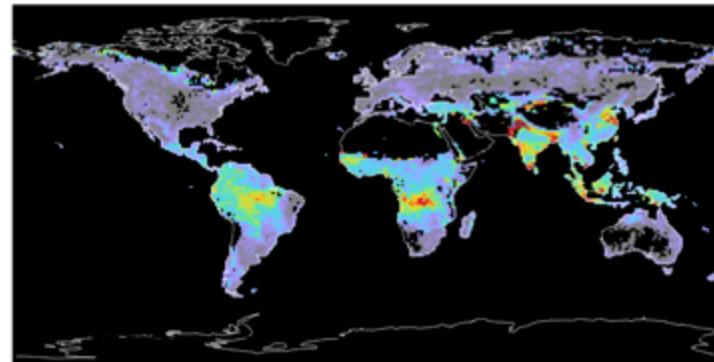
Aerosol_Optical_Depth_Land_QA_Mean



MODIS/Aqua MYD04_M1d.201810.061.hdf

Oct2018
Optical_Depth_Land

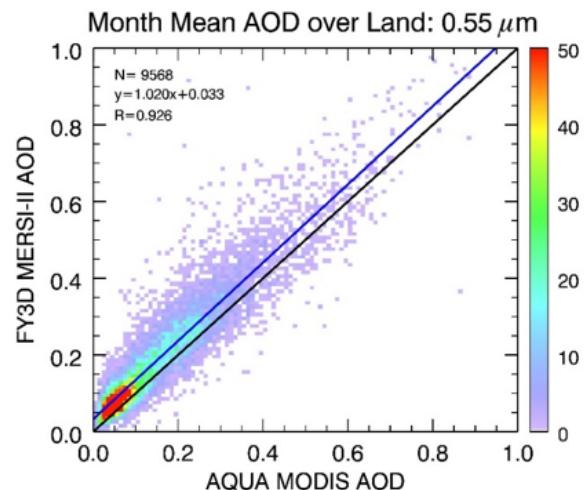
Aerosol_Optical_Depth_Land_QA_Mean



MERSI-II/FY3D FY3D_MERAOD_M1d.201810.V002.2019206080559.hdf

Oct2018
Optical_Depth_Land

MODIS/Aqua C61

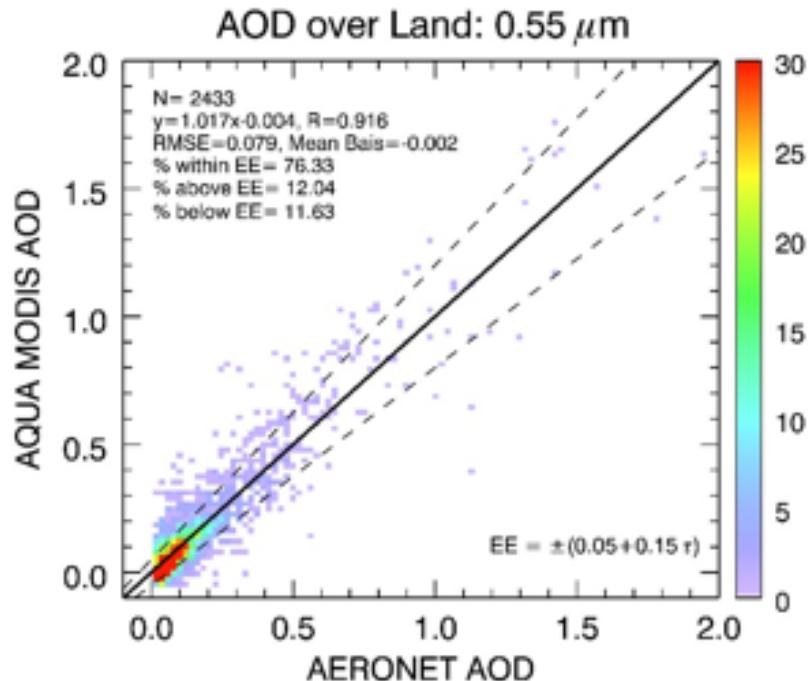


MERSI-II/FY3D

5. Preliminarily test with MERSI-II

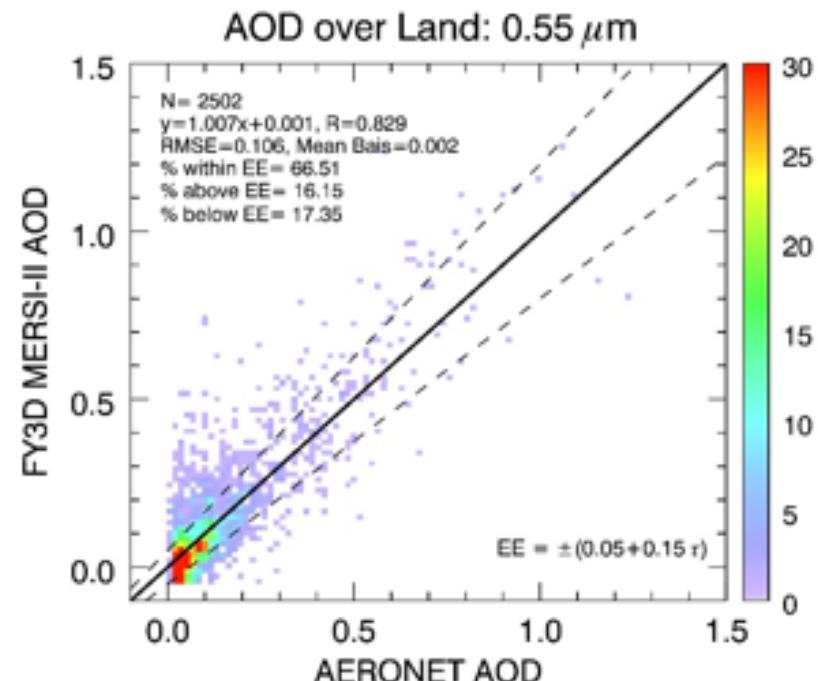
5.4 Global validation

data : Oct., 2018



MODIS/Aqua C61

QA=3



MERSI-II/FY3D



Summary

- How about the quantitative ability of MERSI? [What do you think about?](#)
- The validation result of AOD from MERSI-I/FY-3C is close to MODIS.
- More efforts are needed for the new sensor MERSI-II/FY-3D, especially calibration and new surface reflectance band ratio. [Can MERSI-II catch up with MODIS?](#)



Advancement of PLoarimetric Observations: calibration and improved aerosol retrievals



Merci de votre attention!!!

Leiku Yang¹, Xiuqing Hu², Han Wang¹, Xingwei He²

1 Henan Polytechnic University

2 National Satellite Meteorological Center of China

yanglk@hpu.edu.cn

Lille, Nov. 04, 2019

