MULTI-SENSOR DATA PROCESSING METHOD FOR IMPROVED SATELLITE RETRIEVALS

(Xingwang Fan and Yuanbo Liu @ Chinese Academy of Sciences)
xwfan@niglas.ac.cn/ Nanjing Institute of Geography and Limnology (NIGLAS), Nanjing, China

1. INTRODUCTION

A growing number of satellite sensors provide large amounts of data in reflective solar bands. These data improve the temporal coverage of earth observations. It is now a high priority to develop robust methods to maximize the use of these archived data for satellite retrievals. The author primarily focuses on the following issues using multi-sensor data.

☛ sensor calibration <satellite level>
☛ aerosol optical depth <atmosphere level>
☛ NDVI consistency <surface level>

2. METHODS

Radiative transfer equation can be written as

$$\rho_{TOA} = Tg\left(\rho_a + \frac{\rho Ts Tv}{1-\rho S}\right) \quad (1)$$

where ρ_{TOA}—apparent reflectance, ρ_a—path reflectance, ρ—surface reflectance, T_g—atmospheric absorption, T_s-T_v—atmospheric scattering, S—atmospheric albedo.

Parameters values in EQ.(1) differ with sensor type, atmospheric and surface conditions. The ρ_a-T_g-T_s-T_v-S are functions of atmospheric parameters (including AOT). The ρ_{TOA} depends on sensor calibration. If differences in dual-sensor ρ data are eliminated, EQ.(2) holds.

$$\rho_{TOA,2} = \underbrace{\left(f_{2/1}\times\frac{Tg_2 Ts_2 Tv_2}{Tg_1 Ts_1 Tv_1}\right)}_{a}\times\rho_{TOA,1} + \underbrace{Tg_2\left(\rho_{a,2} - f_{2/1}\times\rho_{a,1}\times\frac{Ts_2 Tv_2}{Ts_1 Tv_1}\right)}_{b} \quad (2)$$

where f accounts for BRDF and sensor differences in surface reflectances, a and b are the two coefficients.

EQ.(2) is the relationship between dual-sensor observations, then the NDVI relationship is

$$NDVI_2 = \frac{(a_N + a_R)NDVI_1 + (a_N - a_R) + 2(b_N - b_R)/(R_1 + NIR_1)}{(a_N + a_R) + (a_N - a_R)NDVI_1 + 2(b_N + b_R)/(R_1 + NIR_1)}. \quad (3)$$

Simplifying (3) yields

$$NDVI_2 = \frac{n_1 \times NDVI_1 + n_2}{n_1 + n_2 \times NDVI_1}, \quad (4)$$

where n are coefficients.

3. RESULTS

3.1 Sensor intercalibration: know atmospheric and surface conditions—solve for sensor parameters

Study area: Dunhuang calibration site, China
Sensors: TERRA MODIS and NOAA-17 AVHRR
The parameter f calculated with desert reflectance

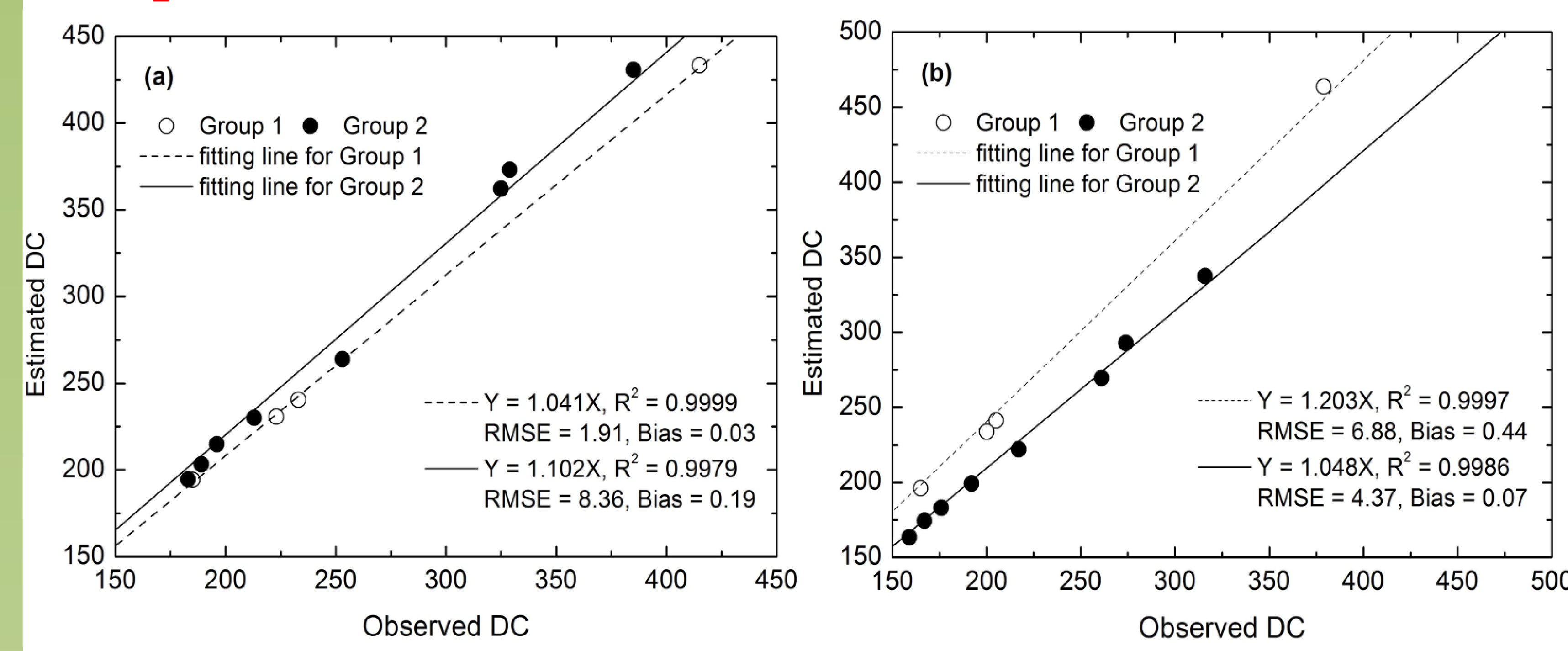

Figure 1. Calibration results

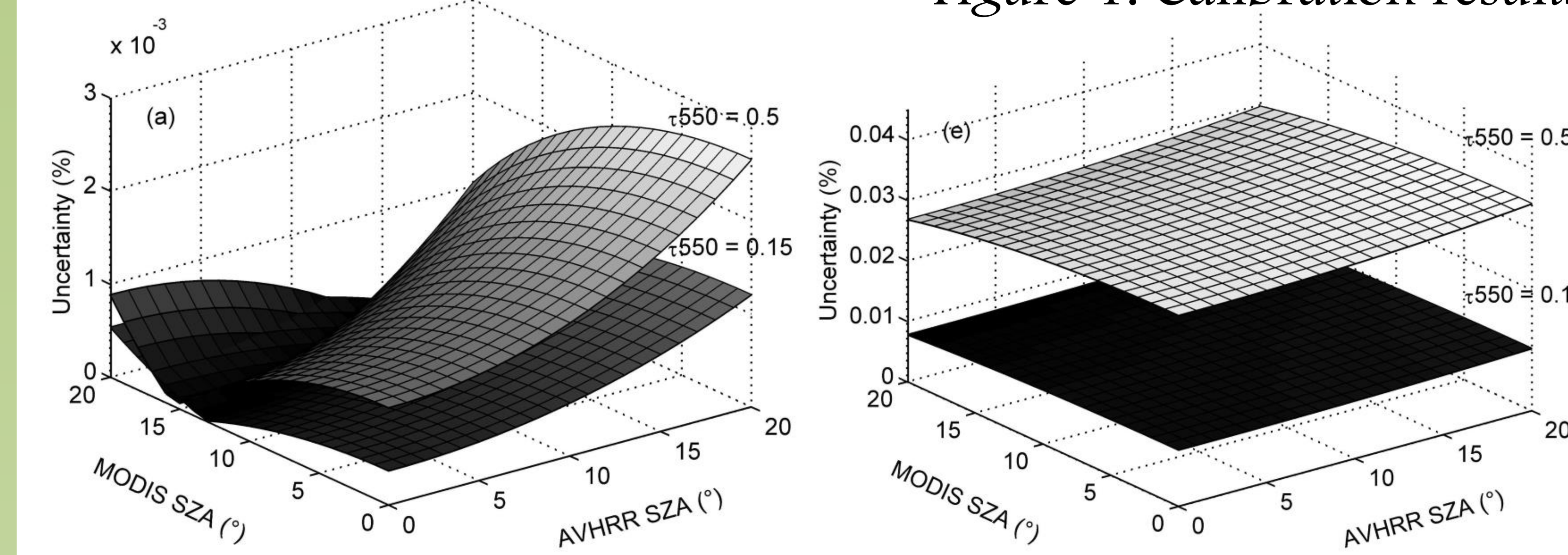

Figure 2. The effects of AOT

3.2 Aerosol retrieval: know sensor and surface conditions—solve for atmospheric parameters

Study area: Poyang Lake basin, China
Sensors: TERRA MODIS and AQUA MODIS
The parameter f calculated as SWIR band ratio

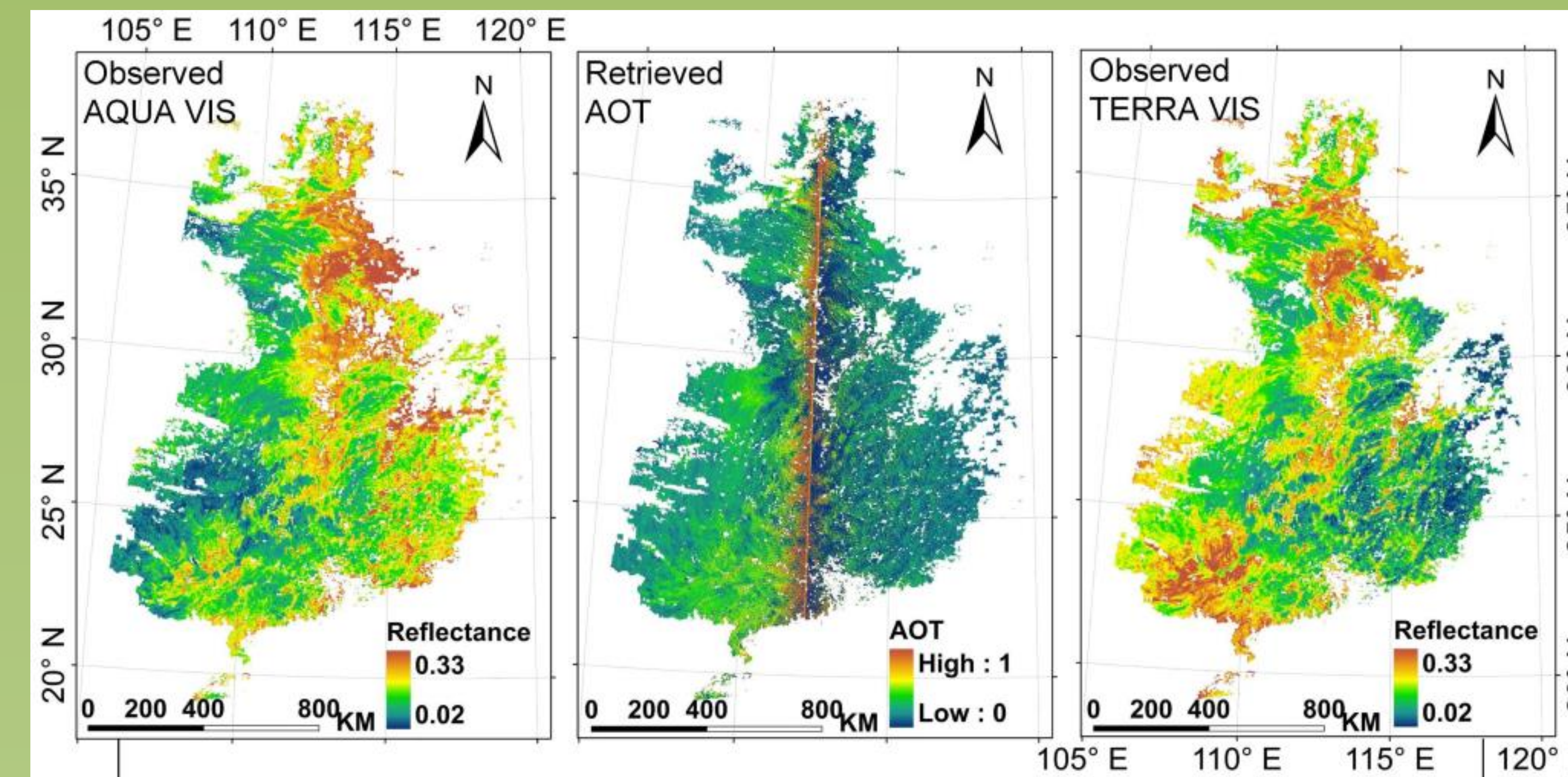

Figure 3. Comparison of aerosol data from (a) TERRA, (b) this method and (c) AQUA.

3.3 NDVI consistency: know sensor and atmospheric conditions—solve for surface parameters

Study area: the whole globe
Sensors: MODIS/NOAA-x AVHRR/NPP VIIRS
The parameter f calculated from MODIS reflectance

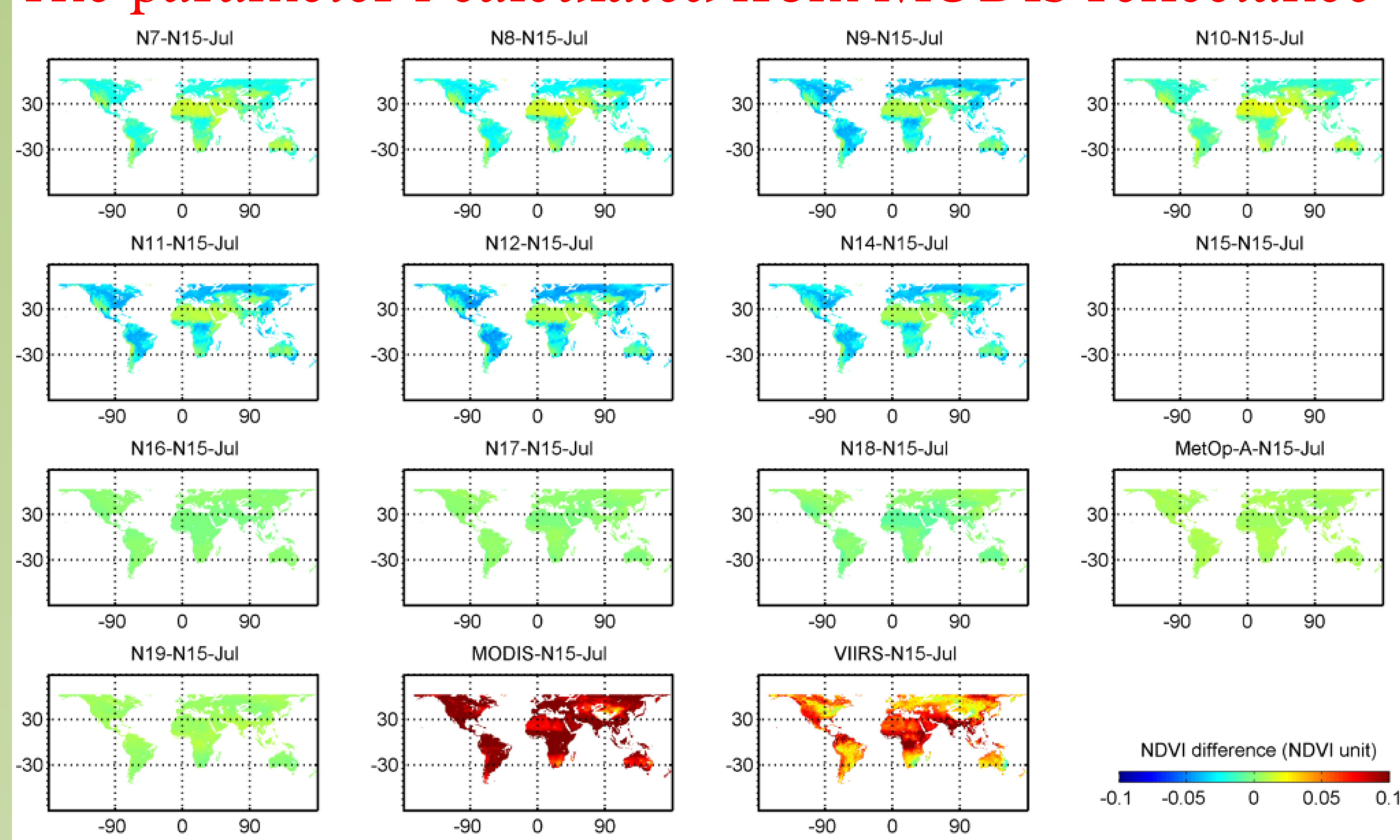

Figure 4. Simulated NDVI differences in relative to MODIS (July)

4. DISCUSSION AND CONCLUSIONS

☐ The RT methods quantified the effects of sensor, atmospheric and surface parameters on dual-sensor data.
☐ At site scale, we derived quality assured sensor calibration coefficients and quantified the total uncertainty.
☐ At basin scale, we obtained finer-resolution and more accurate aerosol retrievals than the MODIS product.
☐ At global scale, we analyzed the patterns of NDVI differences among moderate-resolution satellite sensors.