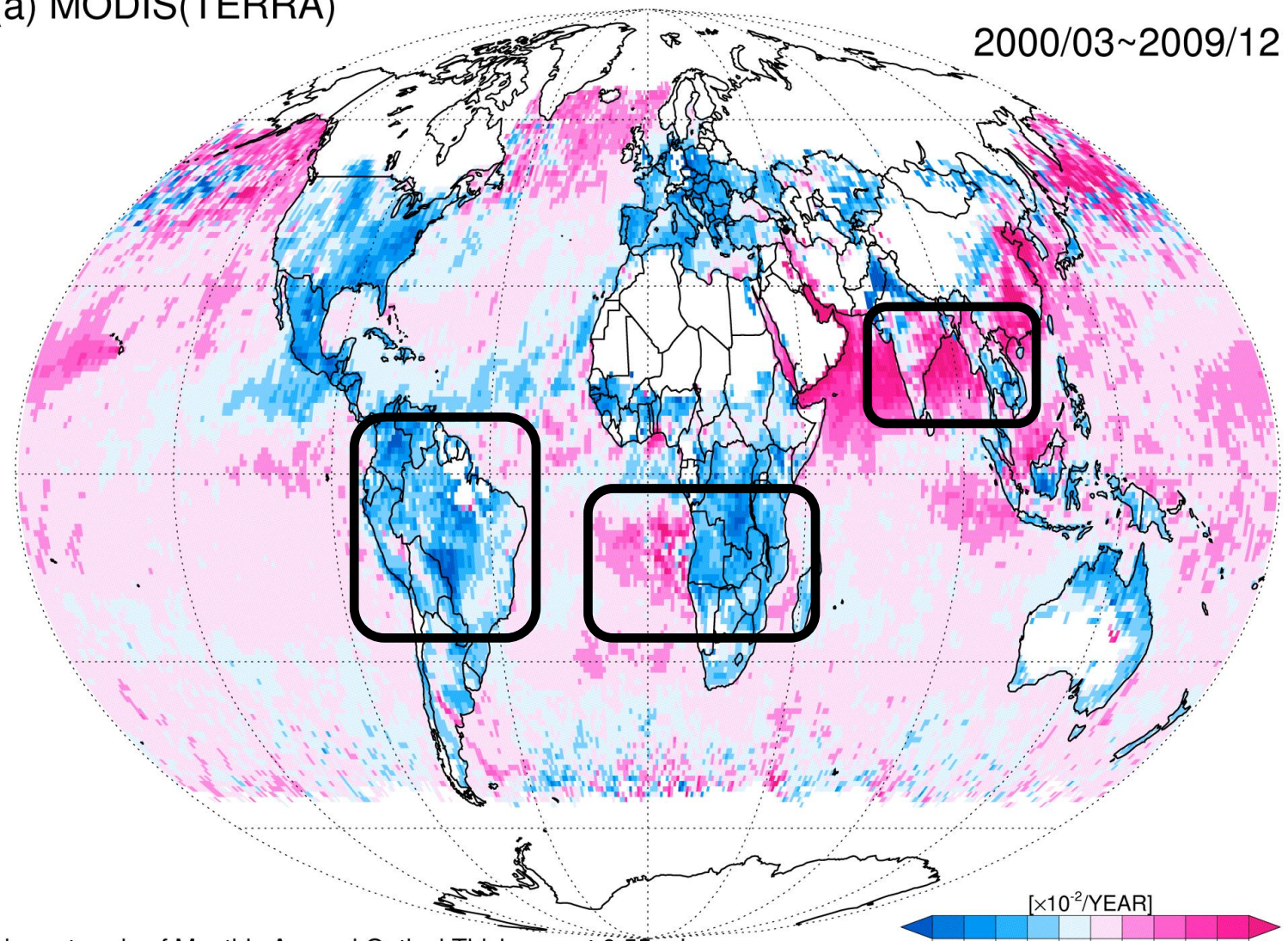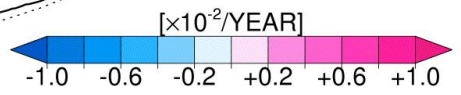# ? Something strange?

(a) MODIS(TERRA)

2000/03~2009/12

[×10⁻²/YEAR]

Linear trends of Monthly Aerosol Optical Thickness at 0.55 microns

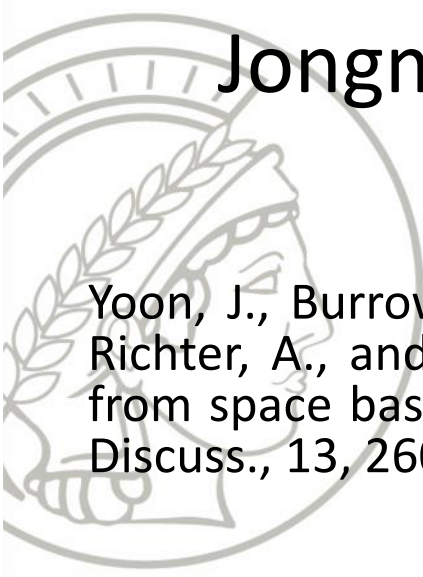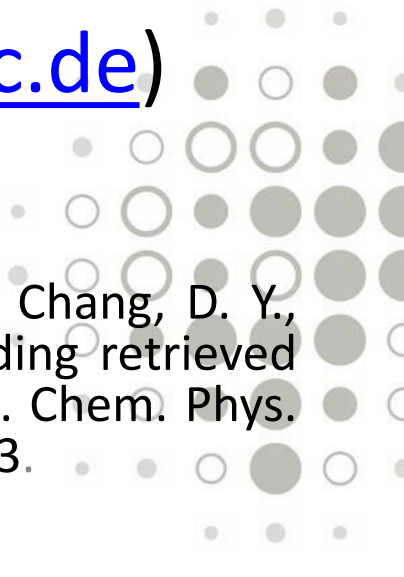-1.0   -0.6   -0.2   +0.2   +0.6   +1.0

Changes in atmospheric AOT retrieved from MODIS (on board Terra and Aqua), MISR (Terra), and SeaWiFS (OrbView-2) during the past decade

Jongmin Yoon (jongmin.yoon@mpic.de)
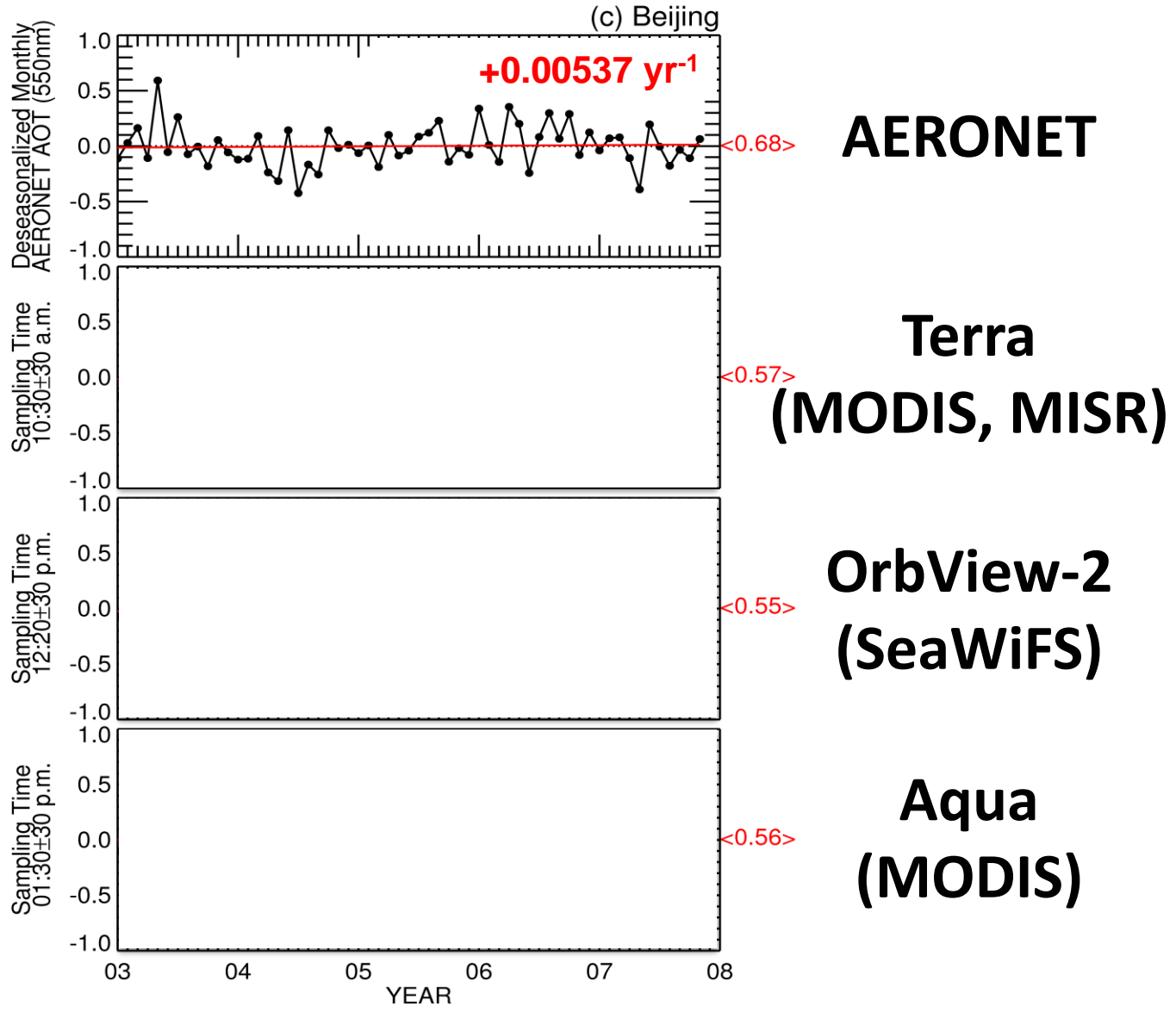
Max Planck Institute for Chemistry

Key words

➢ Limited temporal sampling

- Polar-orbiting satellite

- Local equatorial crossing time:

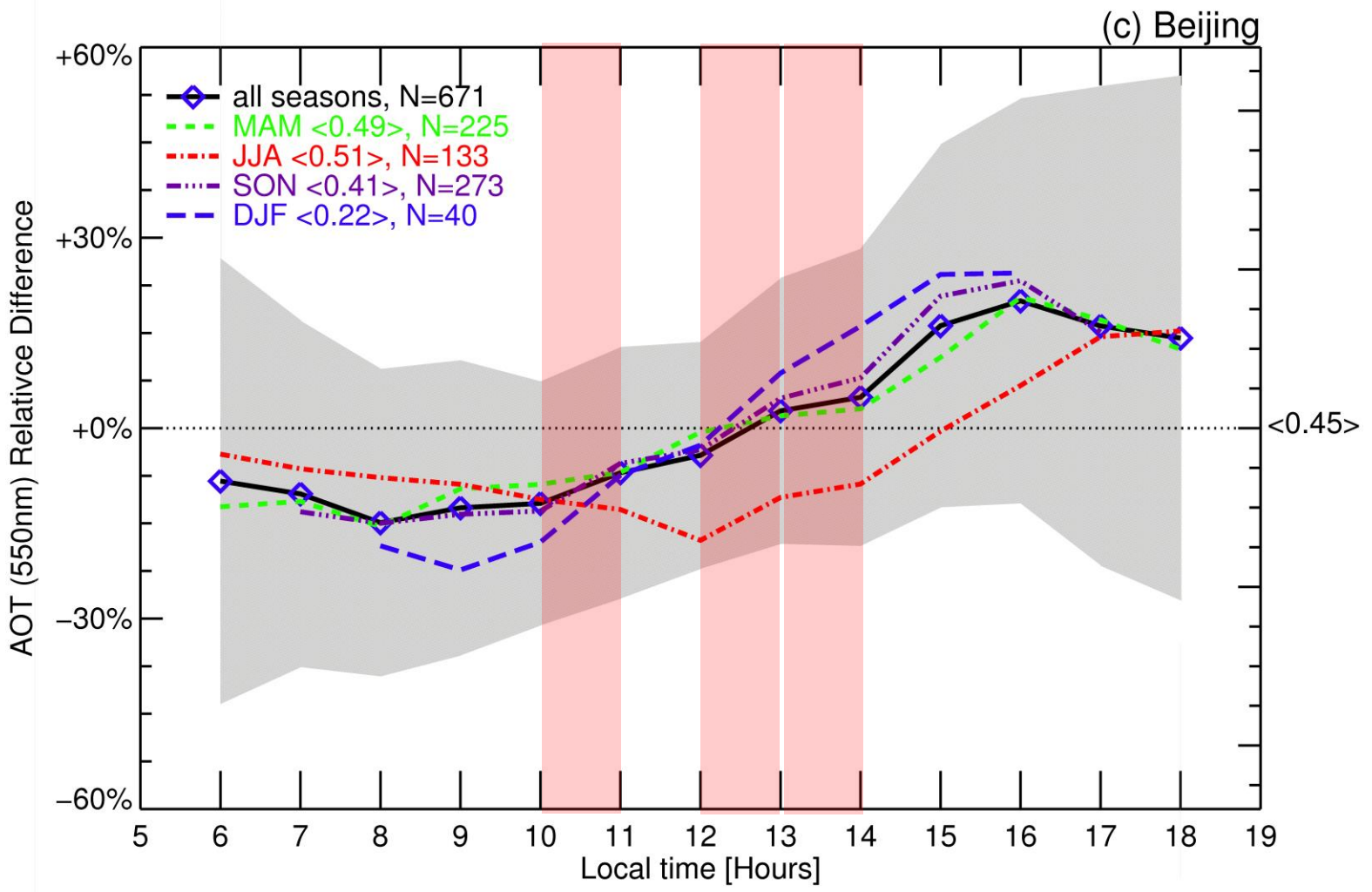　　10:30 a.m.(Terra), 12:20 p.m.(OrbView-2), 01:30 p.m.(Aqua)

➢ Cloud-free Aerosol Optical Thickness

- Passive visible sensor

- Cloud occurrence-> no AOT retrieval ->

　　small number of retrievals -> climatological means

　　(e.g. monthly, seasonal, and annual means)

　　without statistical representativeness

Different trend estimates

(c) Beijing

+0.00537 yr^{-1}

Deseasonalized Monthly AERONET AOT (550nm)

<0.68> **AERONET**

Sampling Time 10:30±30 a.m.

<0.57> **Terra (MODIS, MISR)**

Sampling Time 12:20±30 p.m.

<0.55> **OrbView-2 (SeaWiFS)**

Sampling Time 01:30±30 p.m.

<0.56> **Aqua (MODIS)**

YEAR

Diurnal cycle

Interim conclusions

" There is a good chance of deriving different trends from the limited samplings. "

" Therefore, we need to analyze the trends of atmospheric aerosols from multiple satellite observations to estimate the trend close to actual trend. "

Cloud occurrence

(c) Beijing

Removal ratio of cloud

Removal ratio of quality-unassured

Yoon et al., 2012 (AMT)
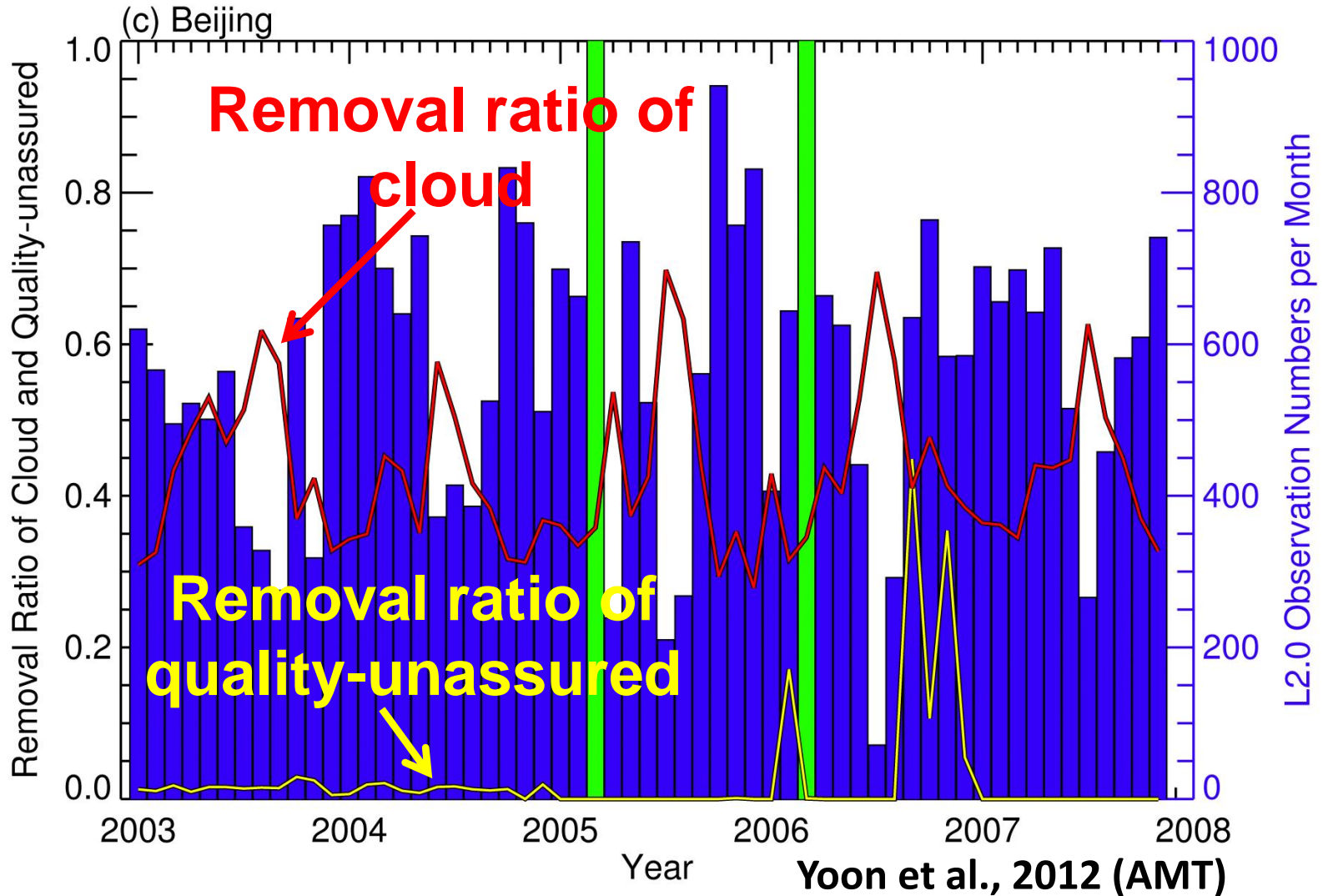
New weighted trend model

- The monthly AOTs are used for fitting the linear regression where R^2 is minimized by

$$R^2(A, B) = \sum_{t=1}^{T} \left(wt_t \times \left(y_t - A - Bx_t - \tilde{y}^m \right) \right)^2$$
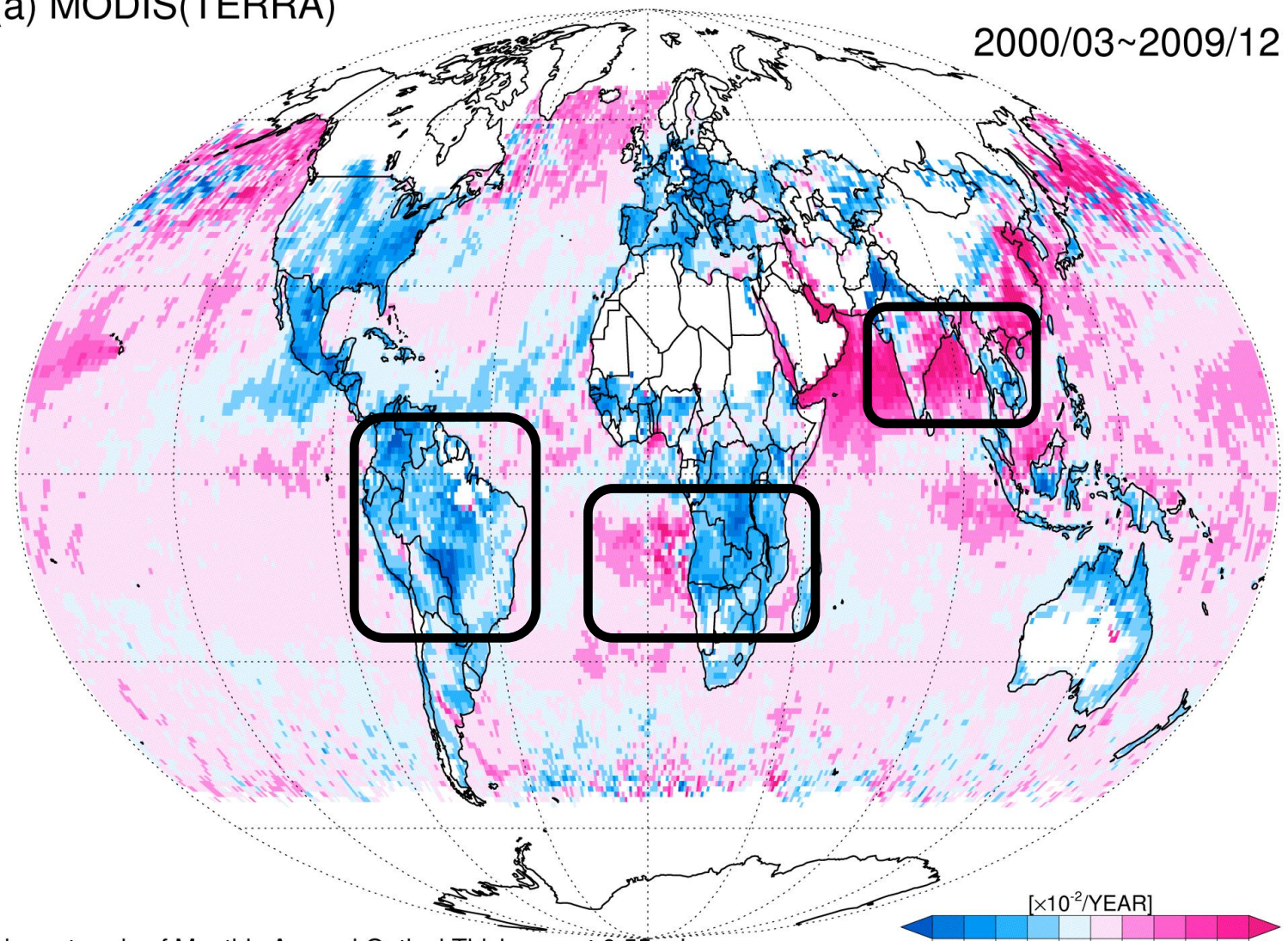
, where

$$wt_t = \begin{cases} 1, & \text{for simple linear (unweighted) trend} \\ \sqrt{n_t} / (\sigma_t / y_t) & \text{for weighted trend} \end{cases}$$
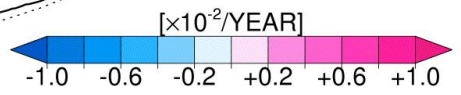
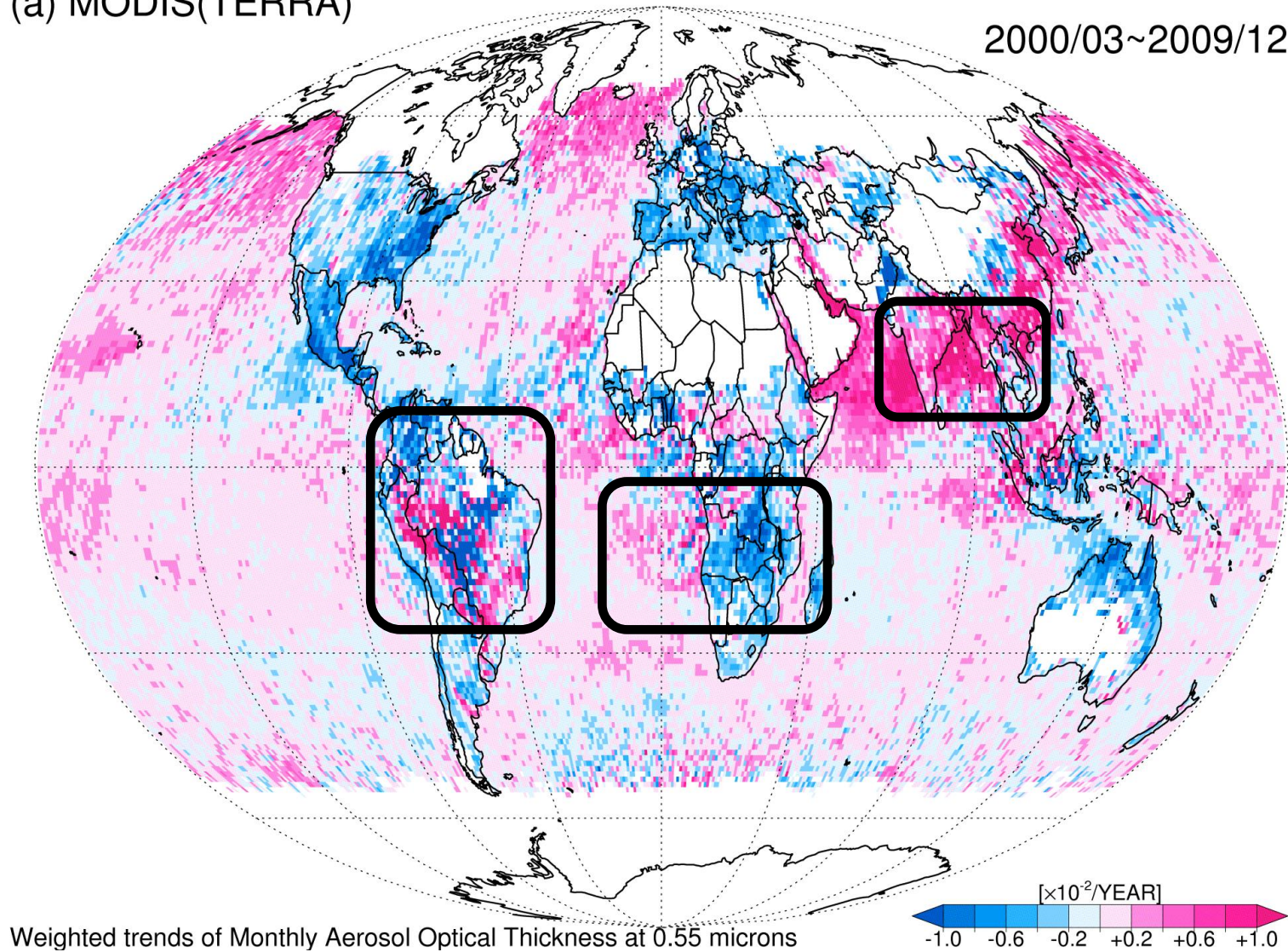# Simple linear trend

(a) MODIS(TERRA)

2000/03~2009/12

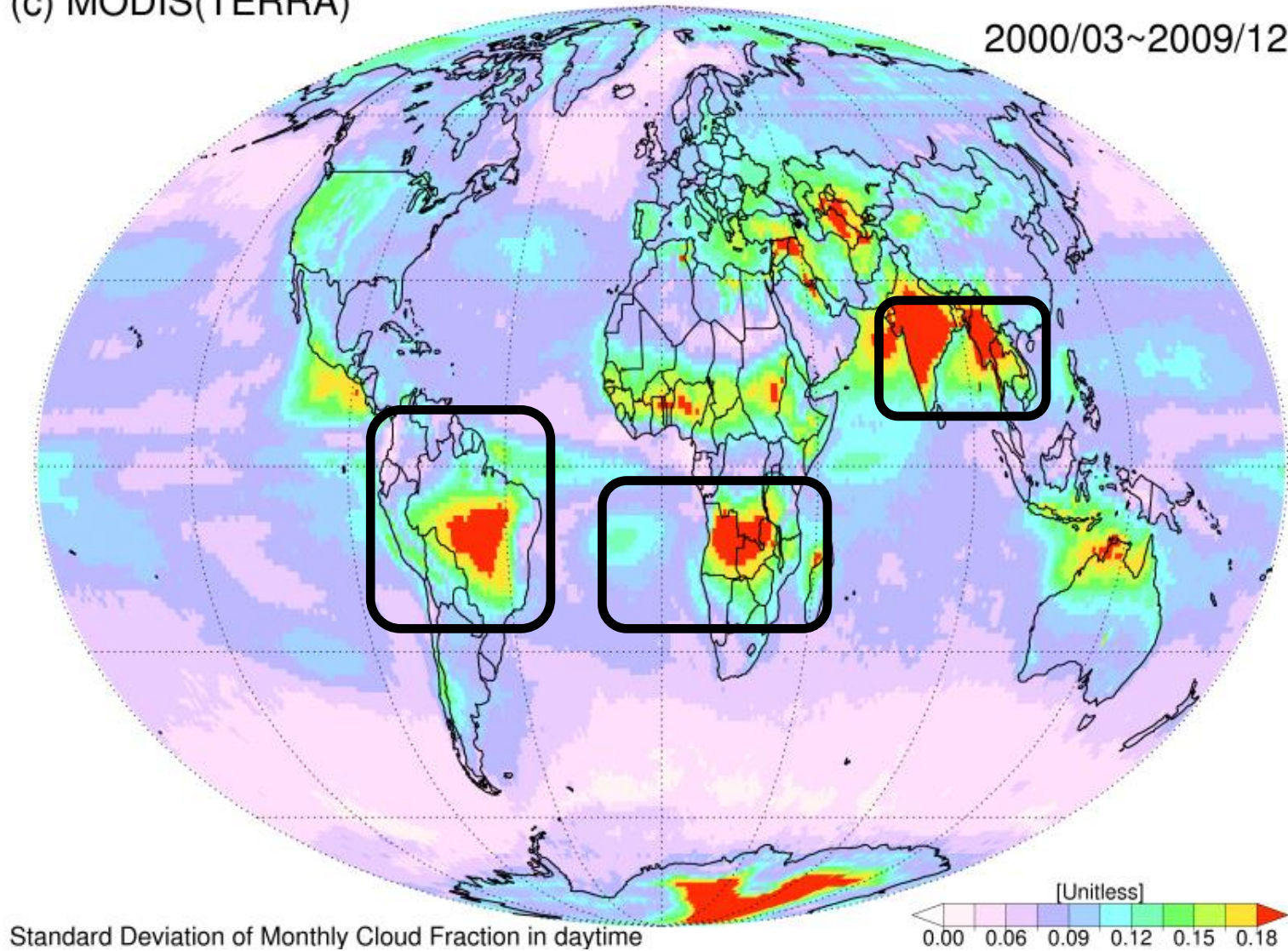Linear trends of Monthly Aerosol Optical Thickness at 0.55 microns

$[\times 10^{-2}/\text{YEAR}]$

-1.0 -0.6 -0.2 +0.2 +0.6 +1.0

Weighted trend

(a) MODIS(TERRA)

2000/03~2009/12

Weighted trends of Monthly Aerosol Optical Thickness at 0.55 microns

[×10⁻²/YEAR]

-1.0   -0.6   -0.2   +0.2   +0.6   +1.0

Cloud variation

(c) MODIS(TERRA)

2000/03~2009/12

Standard Deviation of Monthly Cloud Fraction in daytime

[Unitless]

0.00 0.06 0.09 0.12 0.15 0.18

Interim conclusions

" Cloud occurrence prevents to retrieve cloud-free AOT using a passive visible sensor, and therefore influences in calculating monthly means with statistical representativeness. "
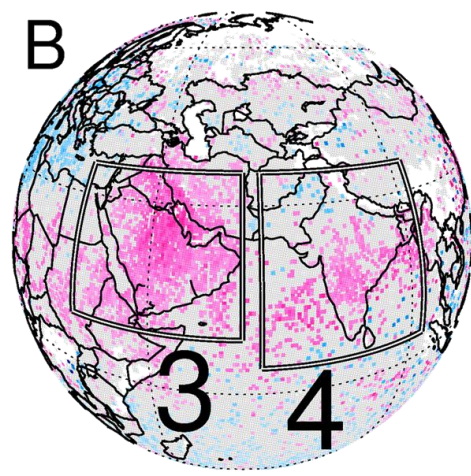
" A new trend model, i.e. weighted least squares regression, successfully reduces its uncertainty in the trend estimates. "
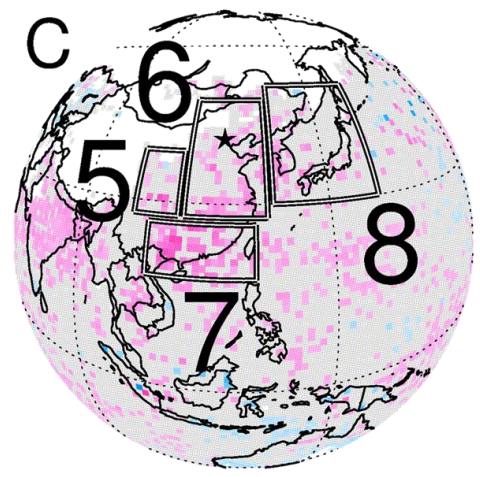
Significant regional trends
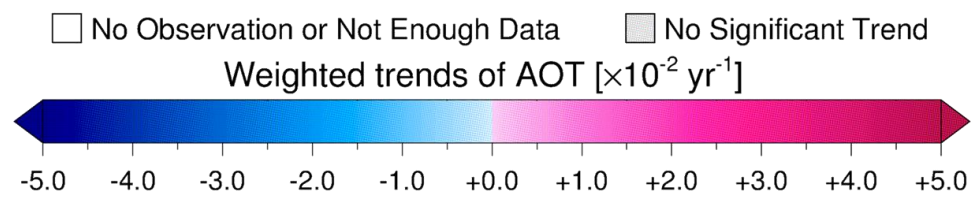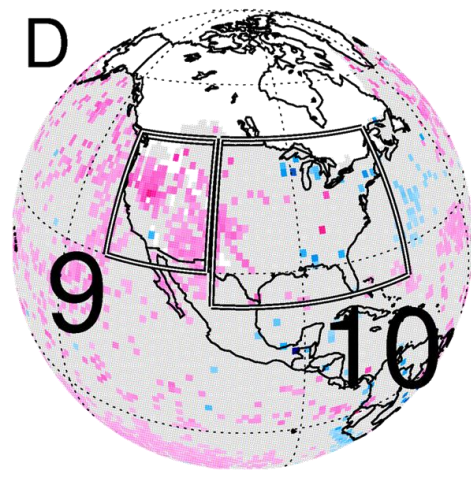
MODIS (Terra)
From 2000 to 2009
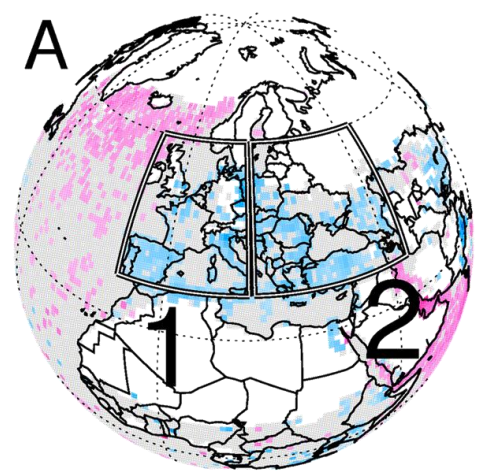
MISR (Terra)
From 2000 to 2010

SeaWiFS
(OrbView-2)
From 1998 to 2007

MODIS (Aqua)
From 2003 to 2008

□ No Observation or Not Enough Data   □ No Significant Trend
Weighted trends of AOT [×10⁻² yr⁻¹]

Significant regional trends
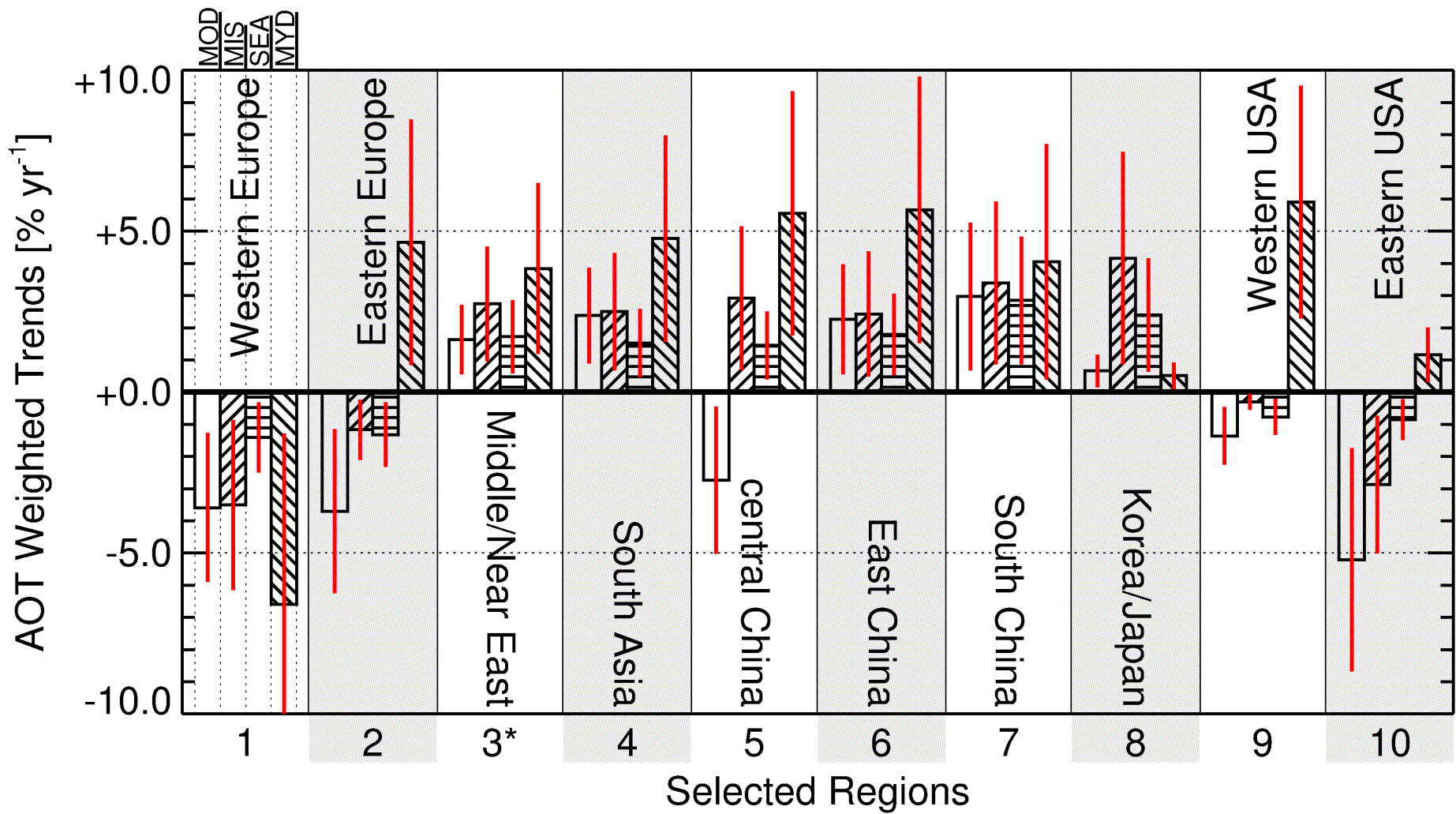
Trend estimates over East China

6. East China

Now in Seoul, South Korea

03.12.2013

PM

40%   10%

40%

[http://news.kbs.co.kr]
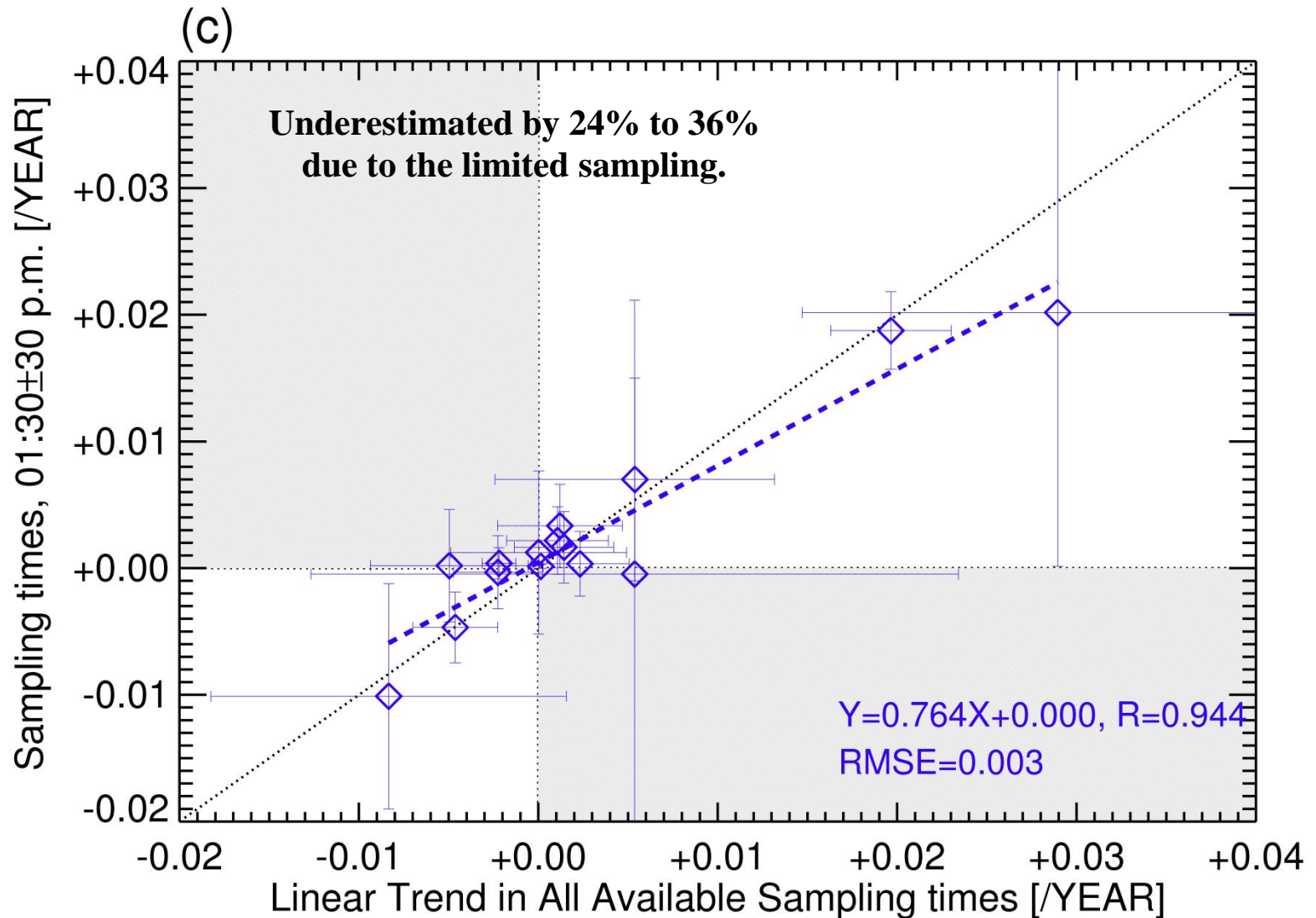
KBS1

[http://article.joins.com]
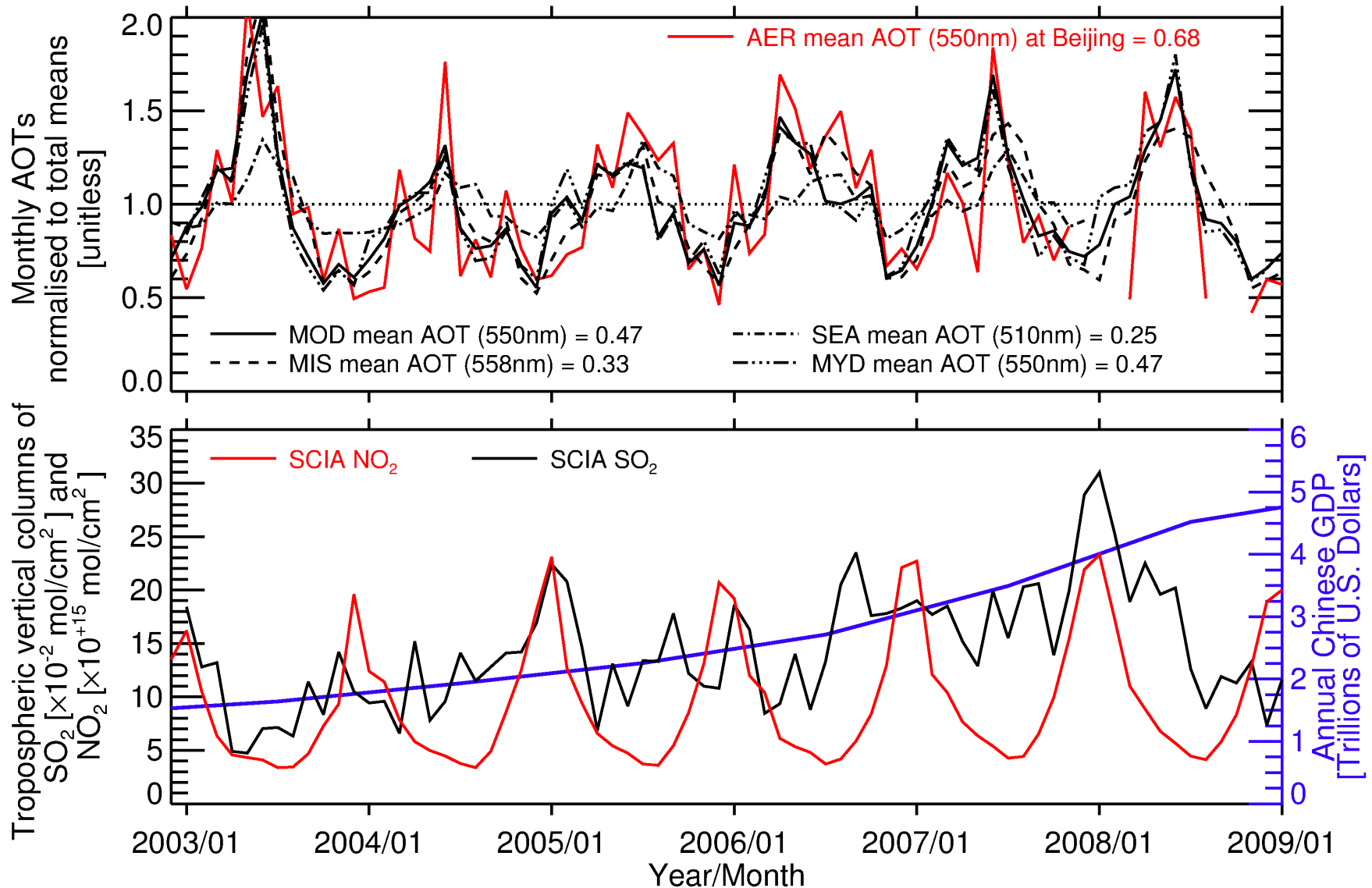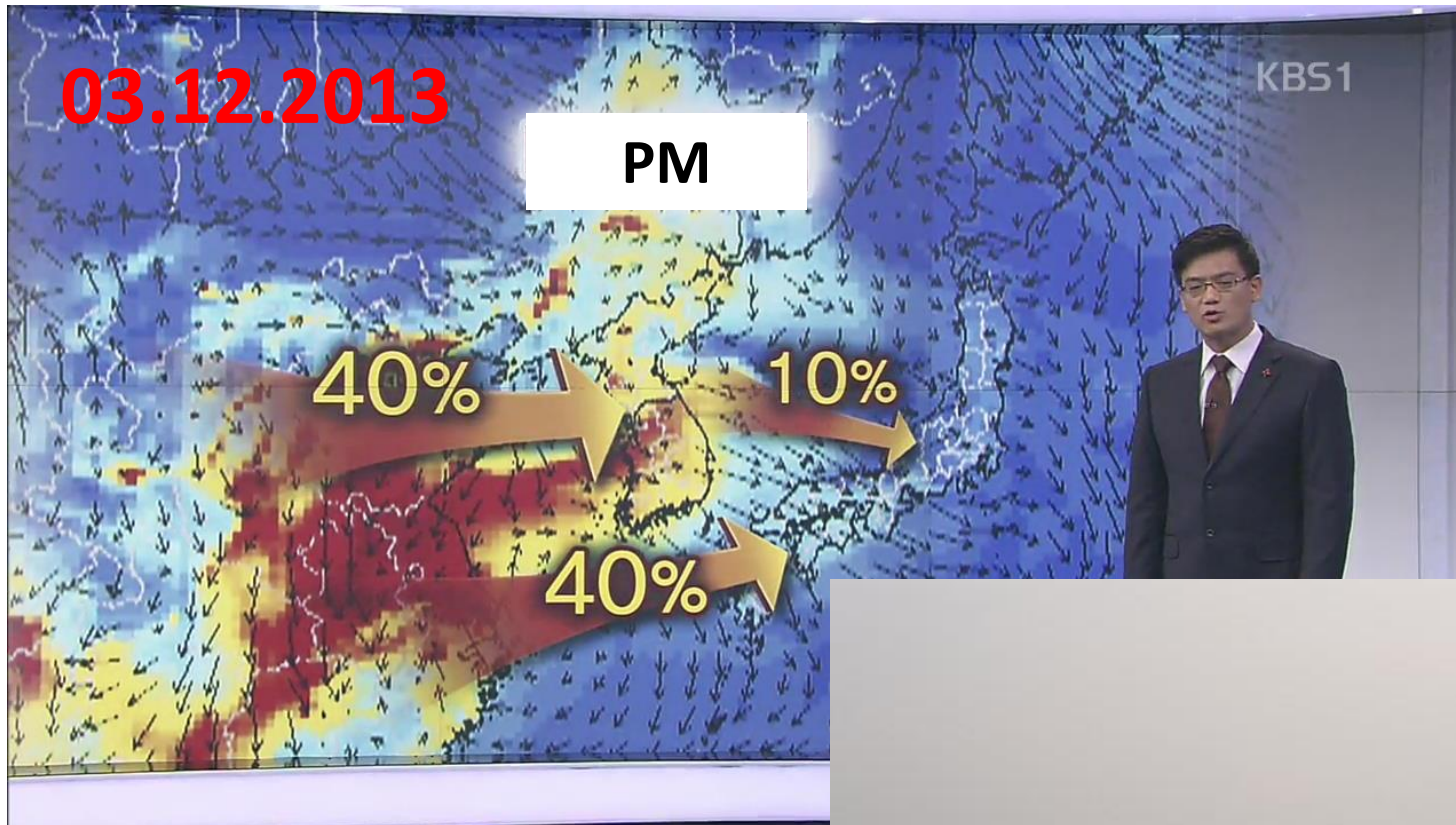
Highlights of this talk

➢ This study shows the uncertainty from limited temporal sampling and cloud occurrence in trend estimates of cloud-free aerosol optical thickness.

➢ Further studies about global AOT trends using multiple satellite data and weighted trend model are needed to know the actual change in global aerosols.
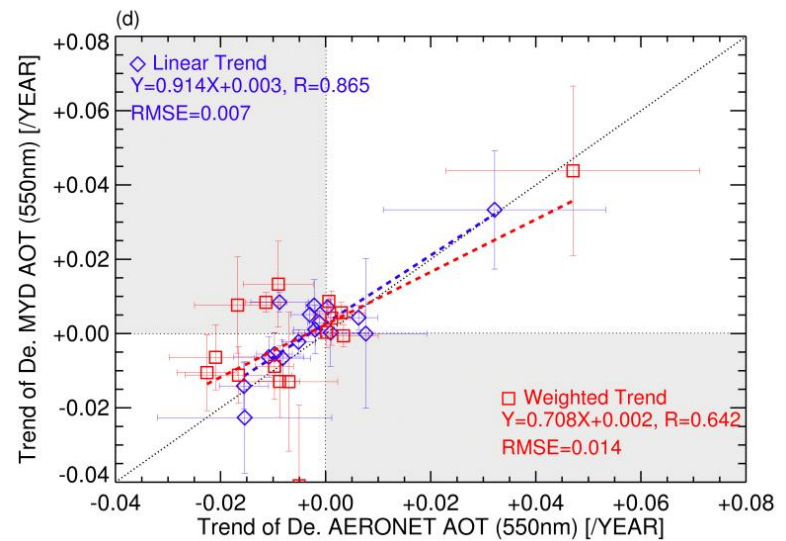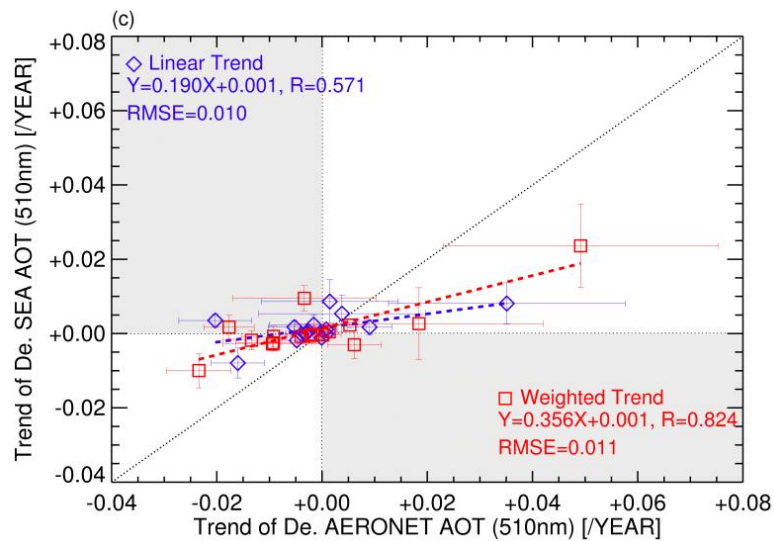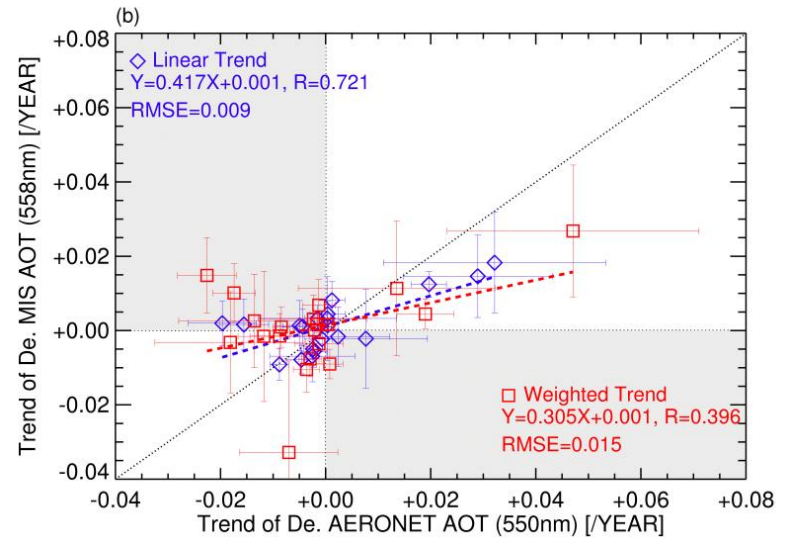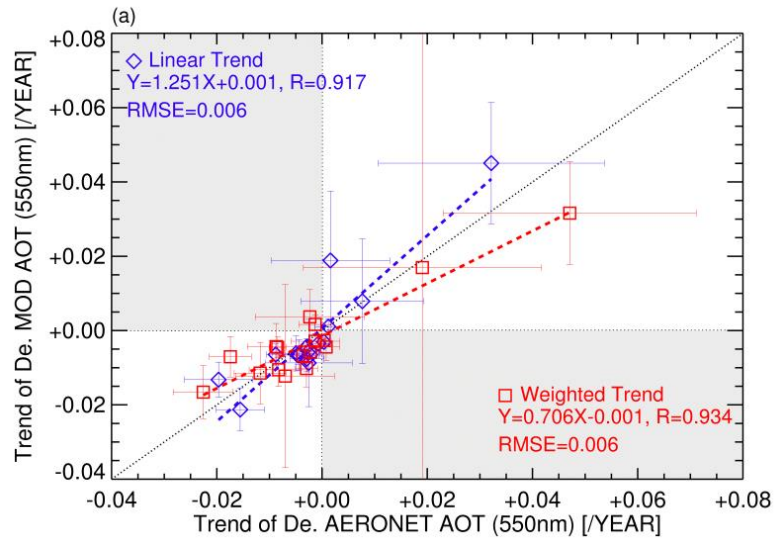
Merry Christmas and Happy New Year!!!

[http://www.theweddinginvitation.co.uk/blog/2011/seasons-greetings/]

Comparison between different samplings

(c)

Underestimated by 24% to 36% due to the limited sampling.

Y=0.764X+0.000, R=0.944
RMSE=0.003

Sampling times, 01:30±30 p.m. [/YEAR]
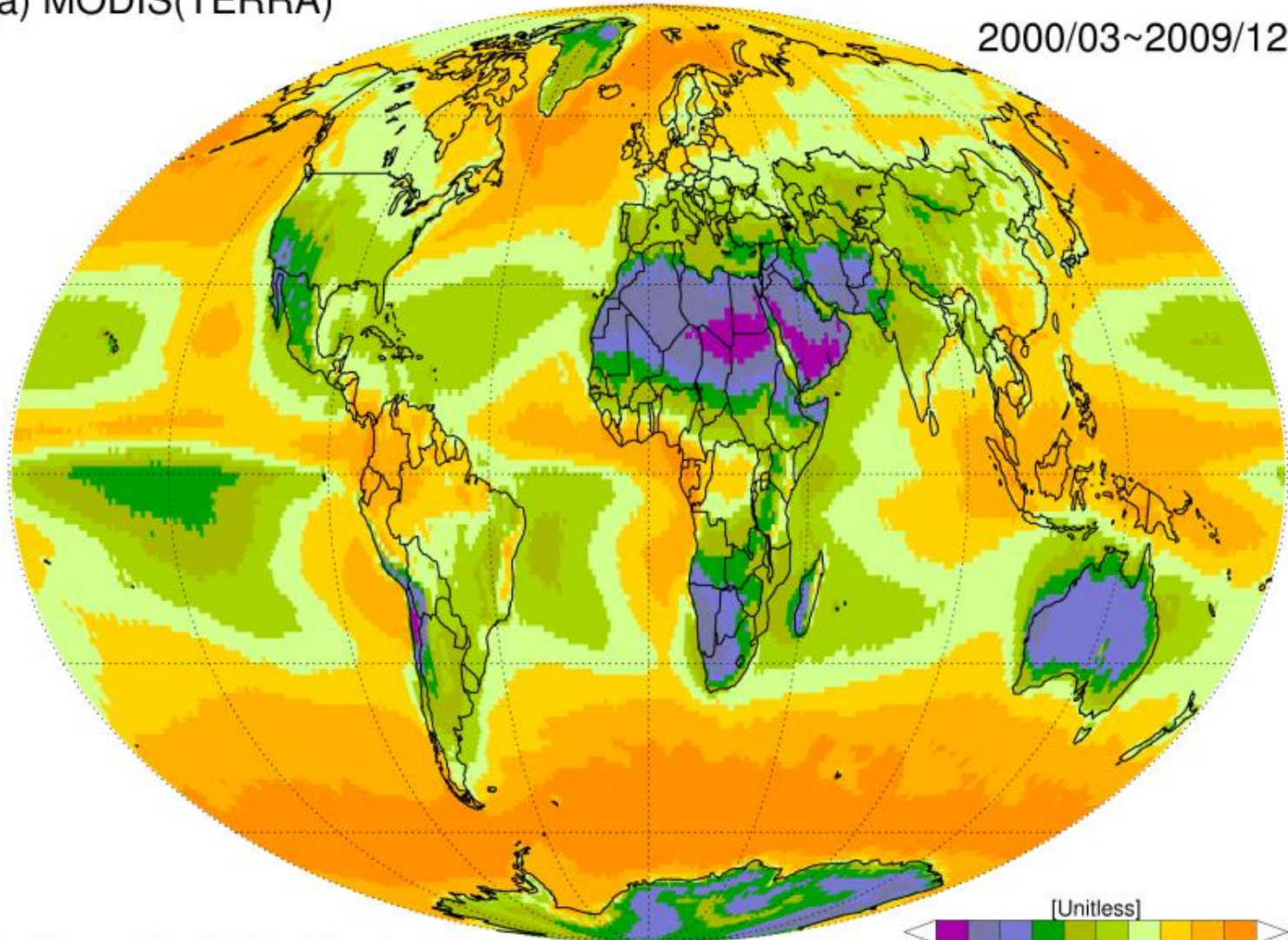
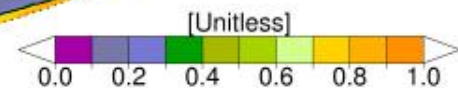Linear Trend in All Available Sampling times [/YEAR]

Trend validations with AERONET

Global Cloud Fraction

(a) MODIS(TERRA)

2000/03~2009/12

Total Mean of Monthly Cloud Fraction in daytime

[Unitless]

0.0 0.2 0.4 0.6 0.8 1.0

Time series of MYD AOT