Atmospheric correction for SGLI ocean color data

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  – Performance of Inter-band Radiance Combination index method (IRC)
Overview of atmospheric correction for SGLI

- Based on
  - Wang and Gordon (1994) for SeaWiFS
  - Siegel et al. (2000)
  - Stumpf et al. (2003)
  - Toratani et al. (2007) for GLI

- Correction of absorptive aerosol
- Consideration of high turbid area
Flowchart of atmospheric correction scheme

- Cloud detection in sunglint
- Sunglint correction
- Cloud detection
- Estimation of Total suspended matter concentration using NIR bands
- Rayleigh scattering correction
- Transmittance correction
- Aerosol model selection
- Aerosol scattering correction
- BRDF correction
- Whitecap correction
- CLAUDIA
- Cox & Munk
- High turbid
- Estimation of remote sensing reflectance at NIR bands
- Ozone
- Detect absorptive aerosol
- Absorptive aerosol correction
Comparison simulated aerosol with ground observation

Aerosol simulation
CFORS

Ground observation

Several type aerosol concentration

Aerosol optical thickness

Angstrom exponent
RIAM–CFORS

- Chemical weather FORecasting System
- based on 3D on-line regional scale chemical transport model fully coupled with RAMS (Regional Atmospheric Modeling System)

http://www-cfors.nies.go.jp/~cfors/outline.html

DUST
Sulfate : SO$_4$
Black Carbon: BC
Organic Carbon : OC
Microtops 2 Observation

- 2013/2/26–7/8
- 12 fine days
  - Dust : 7 days
- Wavelength
  - 380, 440, 675,
  - 870, 1020nm
- Calculate $\alpha(440, 675)$
Angstrom exponent vs Aerosol concentration

- **DUST**
  - Angstrom exponent $\alpha$ vs DUST concentration in $\mu g/m^2$ air-column

- **SO$_4$**
  - Angstrom exponent $\alpha$ vs SO$_4$ concentration in $\mu g/m^2$ air-column

- **OC**
  - Angstrom exponent $\alpha$ vs OC concentration in $\mu g/m^2$ air-column

- **BC**
  - Angstrom exponent $\alpha$ vs BC concentration in $\mu g/m^2$ air-column
Relationship between $\alpha$ and BC/SO$_4$
Relationship between $\alpha$ and DUST
Relationship between $\alpha$ and DUST

$\alpha$ (440,675)

DUST ($\mu g/m^2$) air-column

BC/SO$_4$

- (>0.3)
- (0.2-0.3)
- (<0.2)
Relationship between $\alpha$ and DUST

$$y = 1.4709 \times x^{-0.086551} \quad R= 0.82002$$
Dust quantity related $\alpha(440,675)$ except for the ratio BC/SO$_4$ was higher ($>0.2$). Requiring attention of component of fine mode, especially absorptive aerosol such as black carbon.
Comparison MODIS data with Radiative transfer simulation

- We need to fix aerosol model to make lookup tables for aerosol reflectance and transmittance correction.
Aerosol model

- Bimodal model
  - Aerosol model provided by atmospheric group
  - It derived from AERONET data

Proposed model
Fine mode
  \( r = 0.14 \quad \sigma = 1.86 \)
Coarse mode
  \( r = 3.42 \quad \sigma = 2.34 \)

Aerosol type
mixture model

Tropospheric: Sea spray = 40:60
Sampling Lt from MODIS/Aqua data

- Data in Jan. in 2013
- A2013003031000
- A2013005030000
- A2013007024500
- A2013008033000
- A2013009023500
- A2013010032000
- A2013015033500
- A2013016024000
- A2013017032500
- A2013019031000
- A2013021030000
- A2013024033000
- A2013027022500

Average Chl = 0.05mg/m^3
N=216
θ =15
θ₀=51
ΔΦ=120
τₐ(869)=0.15
Satellite radiance from MODIS/Aqua Jan. in 2013 on Pacific ocean

- \( N = 216 \)
- \( \theta = 15 \)
- \( \theta_0 = 51 \)
- \( \Delta \Phi = 120 \)
- \( \tau_A(869) = 0.15 \)

\[ \text{Lt}(869): 4.25 \]
\[ \text{Std.dev.: 0.45} \]
\[ (W/(m^2 \cdot sr \cdot \mu m)) \]
Satellite radiance from MODIS/Aqua Jan. in 2013 on Pacific ocean

N=216
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\tau_A(865) = 0.15

Lt_{(869)}: 4.25
Std.dev.: 0.45
(W/(m^2 \cdot sr \cdot \mu m))

Simulation result \quad Lt_{(869)} = 4.96
(W/(m^2 \cdot sr \cdot \mu m))
Aerosol model

• Initial model was not applicable.
• Sensitivity test of Parameters
  – Small particle radius
  – Std.Dev. of small particle
  – Large particle radius
  – Std.Dev. of large particle
  – Ratio of volume size
  – Wind speed
  – Relative humidity
• Comparison Lt(865)
Result of sensitivity test

Radius of fine mode

Radius of coarse mode
Result of sensitivity test

Sensitivity test of aerosol parameters shows that average radius of fine mode is sensitive.

Std.dev. of fine mode

Std.dev. of coarse mode
Cloud screening problems

- Highly turbid water
  - may trip the cloud mask
- Sub-pixel cloud (incl. cloud edge)
  - may affect atmospheric correction
- Cloud shadow
  - “low Rrs555” mask may not enough
    Bigger effect when
    - inter-band registration is not perfect
    - or
    - inter-band time difference is large

Manageable by two-step masking

cause erroneous L2 pixel value

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GLI, SGLI, …

GOCI, …
Anomalous features around cloud edge pixels
(from GLI chl-a image of May 24, 2003, south of Japan)

Normalized water-leaving radiance at 4 GLI bands.

a) Pixels sampled at cloud-free area, and
b) sampled at cloud-adjacent pixels with anomalous concentration estimate.
Inter-band Reflectance Consistency over a Weekly Global GLI Data

Basic Concept of "Spectral Consistency Test"

Valid region can be defined

ADEOS-II / GLI
June 10-17, 2003
8day data set
Sub-scene 1 (Typhoon case)

- Simple threshold
- GOCI standard
- 8-band threshold
- IRC
CSP Histogram for Typhoon Scene

- **Simple threshold**: Poor performance
- **GOCI standard**: Performs stable
- **8-band threshold**: Poor performance
- **IRC**: Performs stable

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Summary

• Spectral dependency of aerosol optical thickness
  - relationship between Angstrom exponent aerosol type
  - Dust quantity related $\alpha(440,675)$ except for the ratio BC/SO$_4$ was higher (>0.2).
  - Requiring attention of component of fine mode, especially absorptive aerosol such as black carbon.
Summary

• Aerosol model to make look-up tables for aerosol reflectance correction
  – Proposed aerosol model was not applicable in this study.
  – Proposal model and sensitivity test of aerosol parameters
    • Sensitivity test of aerosol parameters shows that average radius of fine mode is sensitive.

• Inter-band Radiance Consistency method for cloud masking had good performance.
Backup slide
Aerosol correction

- Now we are making aerosol look-up table.
  - Aerosol model provided by atmosphere group
  - it derived from AERONET data
  - Rstar6b (Radiative transfer code)

- Absorptive aerosol correction

Provided by Nakata, Sano and Mukai
(Kinki university)
Atmospheric correction for high turbid area

• Detection of high turbid area
  – Threshold of total suspended matter concentration (TSM)
  – We developed simultaneously estimation algorithm of TSM concentration, AOT and Angstrom exponent using three bands at NIR.
2013/5/3  TSM from MODIS three NIR bands
2013/5/3 TSM from MODIS three NIR bands
Problem for SGLI

- SGLI has three NIR bands (670, 765, 865).
- It is difficult to use 765nm band because of oxygen absorption.

- Consider for Oxygen absorption correction
- Or use constant of angstrom exponent
- Laughly TSM estimation