Local and long-range transport of dust aerosols over the Japan

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Motivation

- Dust aerosols play an important role in the Earth Climate Change of the Atmosphere.
- We are often influenced by natural and/or anthropogenic aerosols over the Japan.
- Especially, it is observed long-range transport of natural and anthropogenic dust in Spring and Autumn in Japan.
- However, on May 20, 2019, the Himawari-8 and GCOM-C have an image of a different type of dust aerosols in East Hokkaido, Japan.

Objectives: Aerosol optical properties are studied using data from ground-based and ship-borne sky radiometer measurements. We are seeking in this data information on the aerosol optical properties with respect to their temporal and spatial variability and validation of Satellite (ex. GCOM-C, Himawari-8) and numerical models (ex. SPRINTARS).
Why is observation important?

Aerosol model evaluation using two geostationary satellites over East Asia in May 2016

Goto et al., 2019, Atmos Res.

Aoki et al., 2013, AIP.

(a) AHI vs NICAM (115-155°E, 20-50°N)

Goto et al., 2019, Atmos Res.
GCOM-C/JAXA, mission aims to establish and demonstrate a global, long-term satellite-observing system to measure essential geophysical parameters to facilitate understanding the global radiation budget and carbon cycle mechanism, and eventually contribute to improving future climate projection through a collaborative framework with climate model institutions. The SGLI (Second-Generation Global Imager) is an optical sensor aboard GCOM-C. SGLI is an optical sensor capable of multi-channel observation at wavelengths from near-UV to the thermal infrared wavelength (380nm~12μm).

The GCOM-C satellite launched in 23 Dec, 2017.
Comparison between SKYRAD and SGLI at five sites
2018.09.01 to 2019.01.15

Sky radiometer observation at Japan site

Preliminary results by Nagao and Aoki, 2019

# AOT: Spatial average within 10 km from the site

* AOT(500nm)
How to measurements of solar aureole?

$$R(\Theta) \equiv \frac{E(\Theta)}{Fm\Delta\Omega} = \omega \tau P(\Theta) + q(\Theta)$$

- We observed only in daytime under clear skies at each site.
- Every 10 min/once (aureole)
- Every 1 min/once (direct)
- Data have been analyzed by an inversion software called SKYRAD.pack (Nakajima et al. 1996). Available version are SKYRAD.pack 4.2, L0, L1A and L2A.
  - **POM-01**: 0.315, 0.4, 0.5, 0.675, 0.87, 0.94, 1.02 μm
  - **POM-02**: 0.315, 0.34, 0.38, 0.4, 0.5, 0.675, 0.87, 0.94, 1.02, 1.627, 2.2 μm
Contents of Local and long-range transport dust study

- **Long-range transport:** Natural & anthropogenic dust
  - Maritime by using R/V Mirai, JAMSTEC
  - Mountain and Ground-based
- **Local dust** in Abashiri, East Hokkaido, Japan

*Images:*
- R/V Mirai, JAMSTEC
- Murodo-daira, Mt. Tateyama
  - Alt. 2450m
  - Snow depth: 6 to 7m/year
- Terra/MODIS image: May 20, 2019
Asian dust case from Ocean study
R/V Mirai, JAMSTEC Cruises MR10-02 to MR18-04


AOT(0.5)  SSA(0.5)  Alpha
Asian dust case from Snow study

Toyama (2011.03.21)

Toyama (2011.03.22)

2011.04.18

646 m

Maki et al., 2016

2013.09.26, Kazuma Aoki

2013.03.09, 19, 20 at Toyama
Local and long-range transport dust in Hokkaido

Abashiri, ABS
44.0N, 144.3E
since 2012

Tomakomai, TMK
42.7N, 141.6E
since 2015

Sapporo, SPK
43.1N, 141.3E
since 1997

Hokkaido Area

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Long-term record & Aeronet

Atmosphere – Cryosphere

Atmosphere - Land

Tomakomai, TMK & Sapporo, SPK
Asian dust event at 2016.03.07

18th AeroCom & 7th AeroSAT, BSC, Barcelona, Spain, 2019.09.26, Kazuma Aoki
Sea ice event at Abashiri (Photo: 2016.03.03)

- 2016.03.03
  - AOT = 0.30
  - Alpha = 1.73

- 2016.03.07
  - AOT = 0.32
  - Alpha = 0.69
Local dust event in East Hokkaido
2019.05.20

- no rain: about one week in this area
- dry soil due to before planting
- High wind: maximum 25.7 m/s from South
Local dust event in East Hokkaido
2019.05.20

Himawari-8/JMA
AOD

MASINGAR/JMA
AOD
12h
Local dust event in East Hokkaido

Aerosol optical properties

Abashiri_ABS_V42L0&L1A_20190520

Aerosol optical thickness at 0.5 μm & Ångström exponent

2019/5/20

Hour (Local Time)
Local dust event in East Hokkaido

Aerosol optical properties & wind speed

Graph showing aerosol optical thickness at 0.5 μm and Ångström exponent over time, with maximum wind speed indicated as well.
Local dust event in East Hokkaido

Size distribution of volume

GCOM-C/SGLI: 675 nm
2019/05/20 10:12 JST
Local dust event in East Hokkaido

Comparison between ground-based (skyradio) and satellite (GCOM-C)

Abashirius ABS_V42L0&L1A_20190520

GCOM-C: AOD=0.539

GCOM-C/SGLI: 675 nm 2019/05/20 10:12 JST
Local dust event in East Hokkaido

Preliminary results by Aoki and Okata, 2019
Summary

- Aerosols optical properties
  - More high AOT and low Alpha
- Size distribution of volume
  - Long-range (1 to 2 µm) < Local (5 to 8 µm)

Future plan

- Continuously of Aerosol climatology and quality control
- Improvement of AOT accuracy and observation method
- Comparison model, satellite and observation
  - Especially, AOD of clear sky and all sky
Mt. Fuji: Alt. 3776m

Thanks.

18th AeroCom & 7th AeroSAT, BSC, Barcelona, Spain, 2019.09.26, Kazuma Aoki