



Updates of the aerosol prediction of the Japan Meteorological Agency

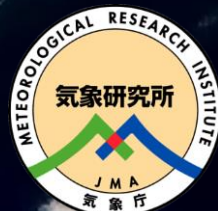
Taichu Y. Tanaka*, Akinori Ogi†, Keiya Yumimoto\$*, Shokichi Yabu†, Toshinori Aoyagi†, Makoto Deushi*, Mizuo Kajino*, Naga Oshima*, Tsuyoshi T. Sekiyama*, Takashi Maki*

**Meteorological Research Institute, Japan Meteorological Agency*

†Global Environment and Marine Department, Japan Meteorological Agency

\$ Kyushu University, Research Institute for Applied Mechanics

10th ICAP working group meeting, Exeter, UK, June 2018



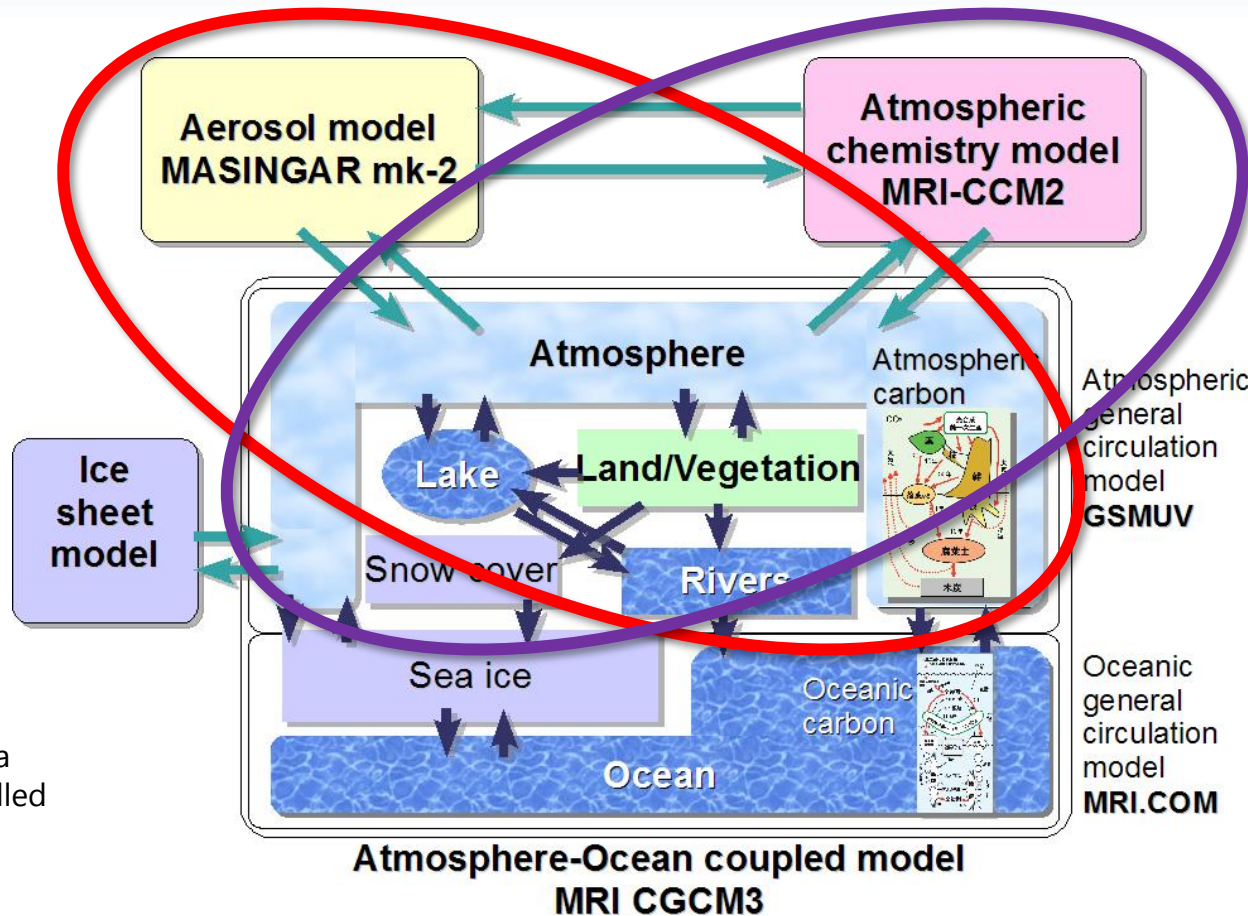
Outline

- Brief introduction of JMA's CTM development
- Updates of JMA/MRI global aerosol model and Himawari-8
- Updates of JAXA EORC satellite products
- Recent aerosol episodes
 - Asian dust flow / March 22 Saharan dust
- Data assimilation
 - Observation error estimates of JAXA Himawari-8 AOD
 - 3D-VAR lidar data assimilation with Siberian fire smoke
 - A case study of data assimilation experiment of a recent dust episode

Atmospheric composition forecast models based on a climate model

JMA's atmospheric composition forecast models are based on a global climate model MRI-ESM.

Aerosol
(Aeolian dust)
prediction
model



UV prediction
and Air
quality model

The model components are connected using a coupler library called SCUP.

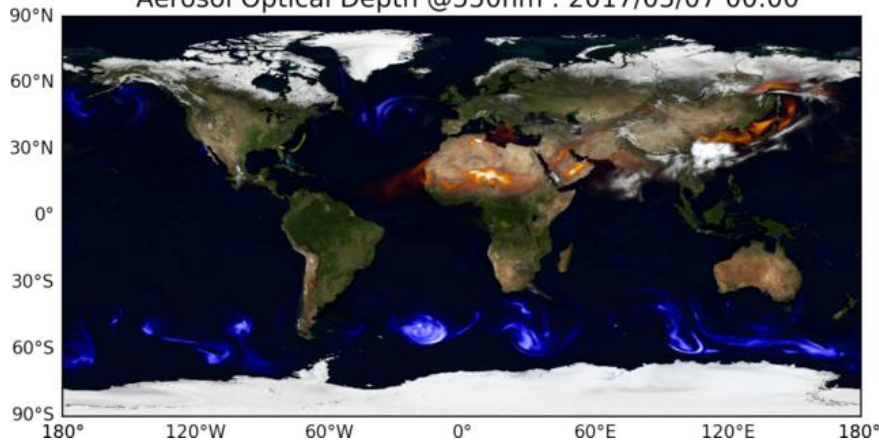
The models are developed in Meteorological Research Institute.

JMA Aeolian dust Information

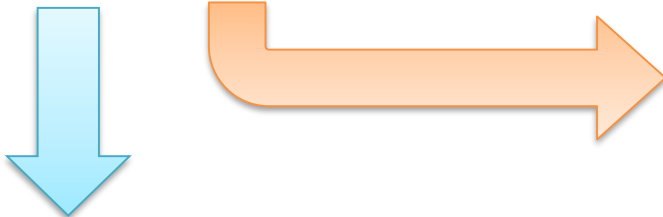
JMA has been providing Aeolian dust information based on numerical forecasts and observations since January 2004.

Global aerosol model MASINGAR

Aerosol Optical Depth @550nm : 2017/05/07 00:00



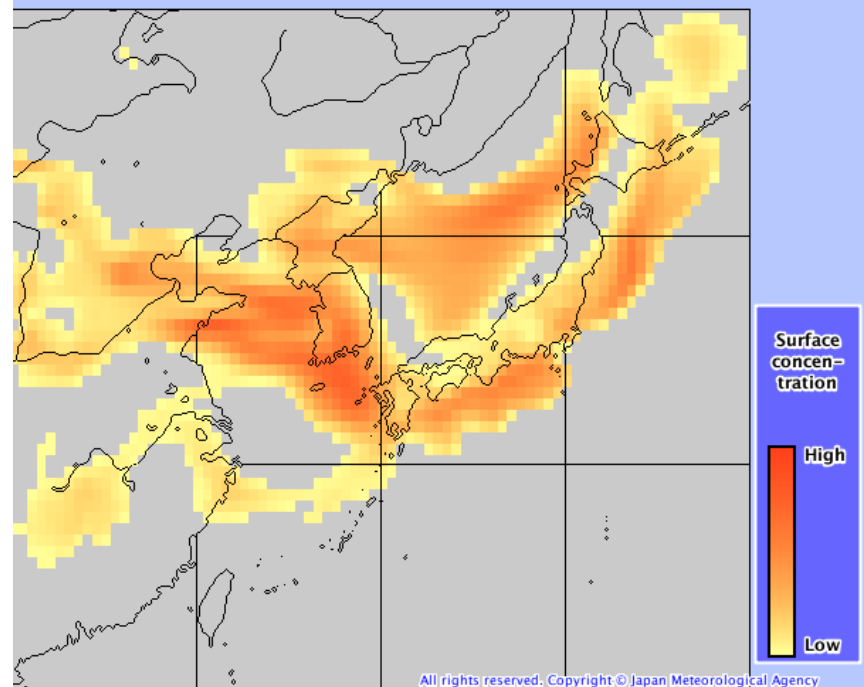
Research & Development in MRI/JMA



Climate Projection model
(e.g., CMIP6, CCMI)

JMA Aeolian dust prediction

Analyzed surface concentration for 09:00 JST, 7 May 2017



<http://www.jma.go.jp/en/kosa>

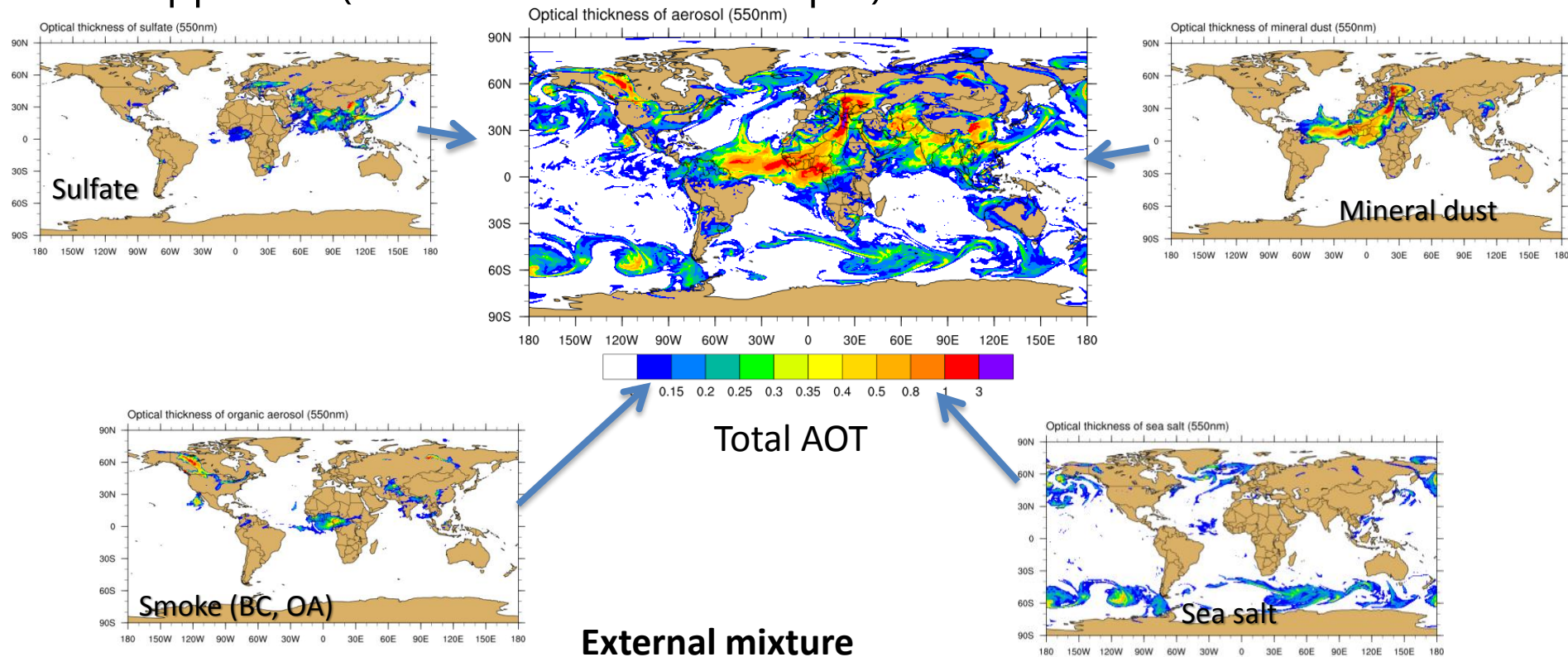
Aeolian dust advisory information

JMA also provides aeolian dust prediction results (GPV : GRIB2 format) for private weather services via the Japan Meteorological Business Support Center (JMBSC).

Aeolian dust prediction model

(Model of Aerosol Species in the Global Atmosphere: MASINGAR)

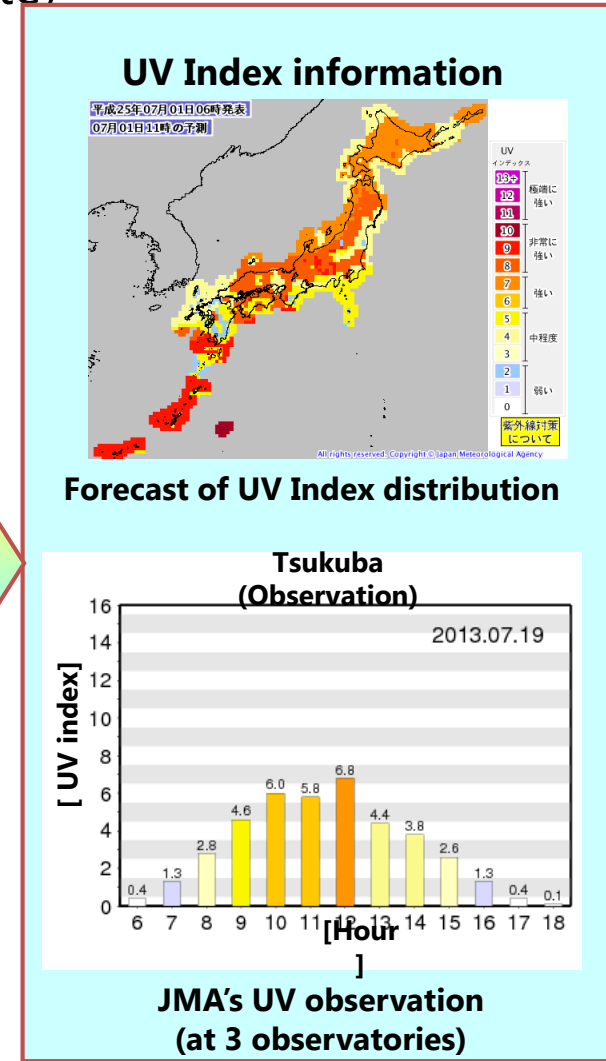
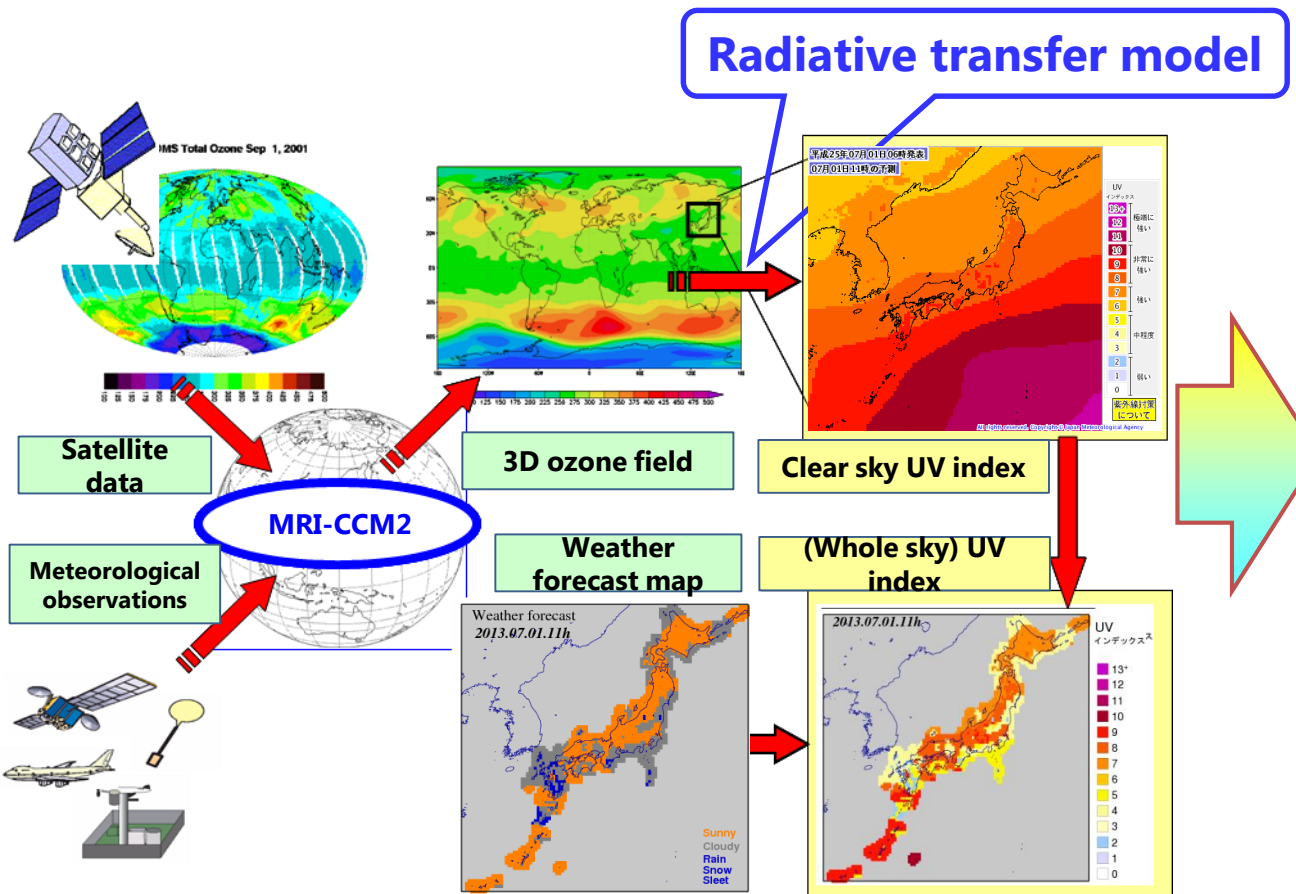
- Sulfate, black carbon, organics, sea salt, and mineral dust are included
 - The emission flux of sea-salt, mineral dust, and dimethylsulfide are predicted based on the surface properties calculated by the atmospheric model.
 - Particle size distributions of sea salt and dust are expressed by sectional approach (10-bins from 0.2 to 20 μm)



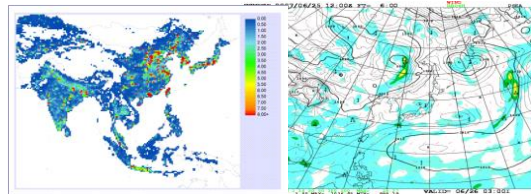
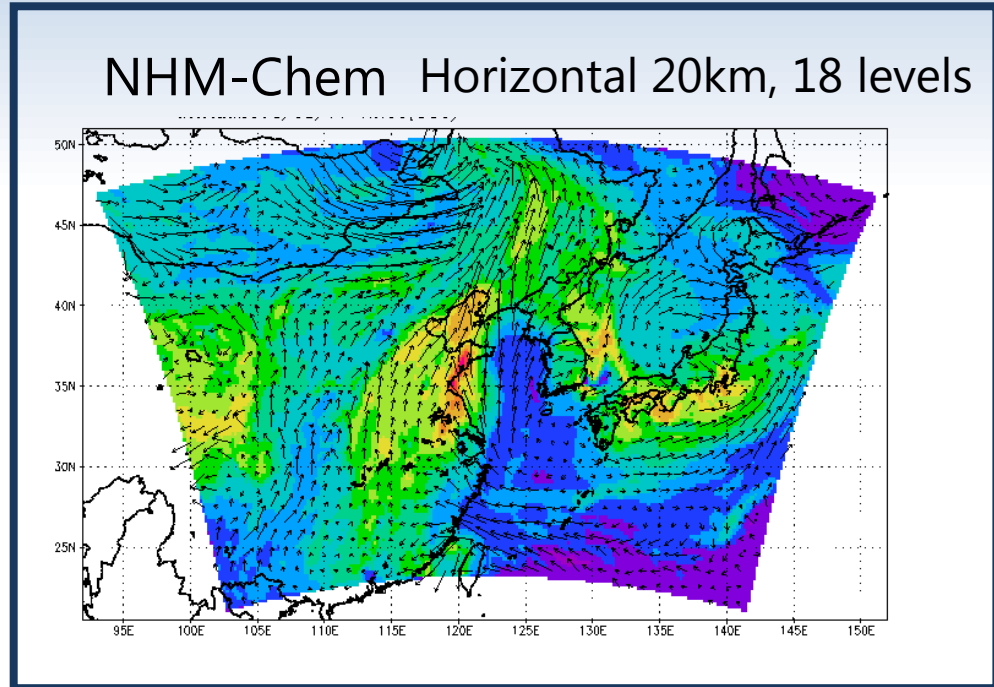
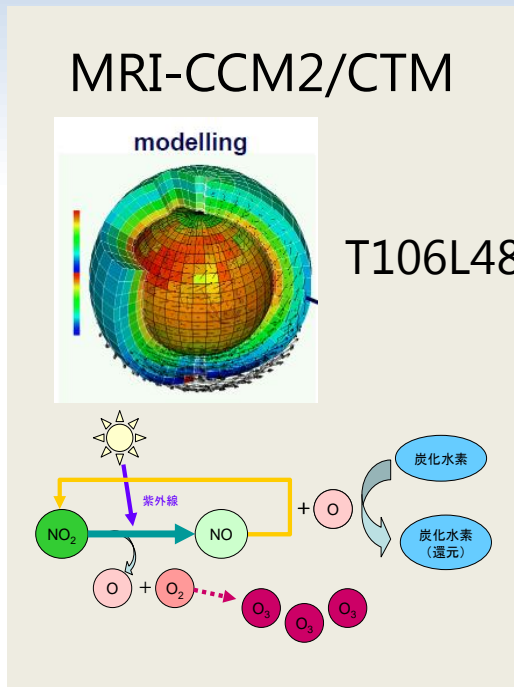
UV index forecast with a global chemical transport model

JMA releases UV index information using a global CTM since May 2005. (<http://www.jma.go.jp/en/uv/>)

- UV information (forecast, analysis, and current state)
- Total ozone amount

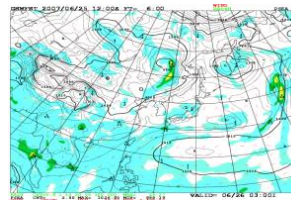
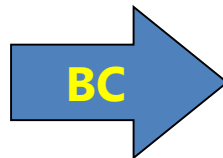


Photochemical oxidant advisory in Japan: using nested global and regional CTM



Emission inventories

Global model analysis and forecast by JMA



Non hydrostatic model by JMA (20km)



Emission inventories

News of JMA/MRI aerosol model development and forecast

- **Keiichi Kondo** joined our team in MRI from 1 Dec. 2017.

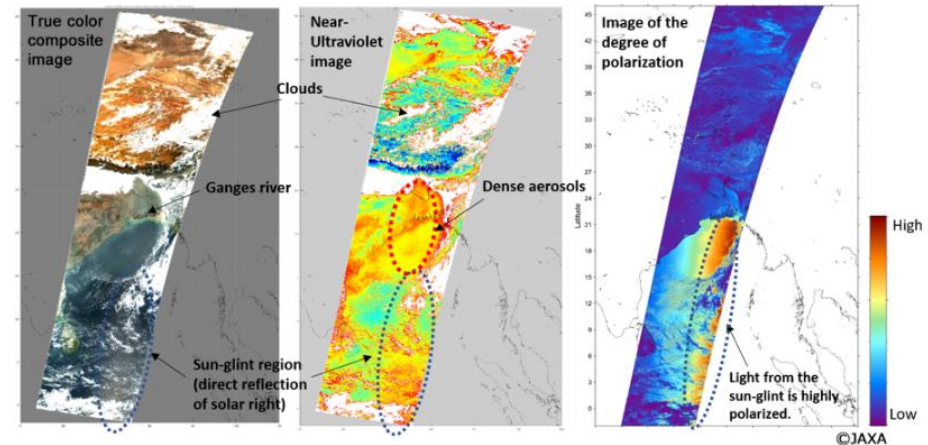
- Supercomputing system in JMA was upgraded from Hitachi SR16000M1 to **Cray XC50 (18 PFlops)**, and operation started from 5 June.



- JMA exchanged a letter with CMA to provide its dust forecast data to SDS-WAS Asia.
- MRI's climate model, MRI-ESM2 is now producing climate projection experiments.
 - Global aerosol model MASINGAR mk-2 rev.4c is coupled.

News from JAXA EORC: Himawari ARP v2 and GCOM-C

- A new version of Himawari-8 **Aerosol Property products (version 2.0)** and the level-3 of Wild Fire products were released on 5 Feb.
- A Paper on "Common Retrieval of Aerosol Properties for Imaging Satellite Sensors" published. <https://doi.org/10.2151/jmsj.2018-039>
- **GCOM-C** (Global Change Observation Mission - Climate "SHIKISAI") was successfully launched on December 23, 2017. First images are obtained on 1 Jan. 2018 (press release: Jan. 12, 2018).
- GCOM-C products (including aerosol properties) will be available from JAXA EORC on Dec. 2018 (TBD).



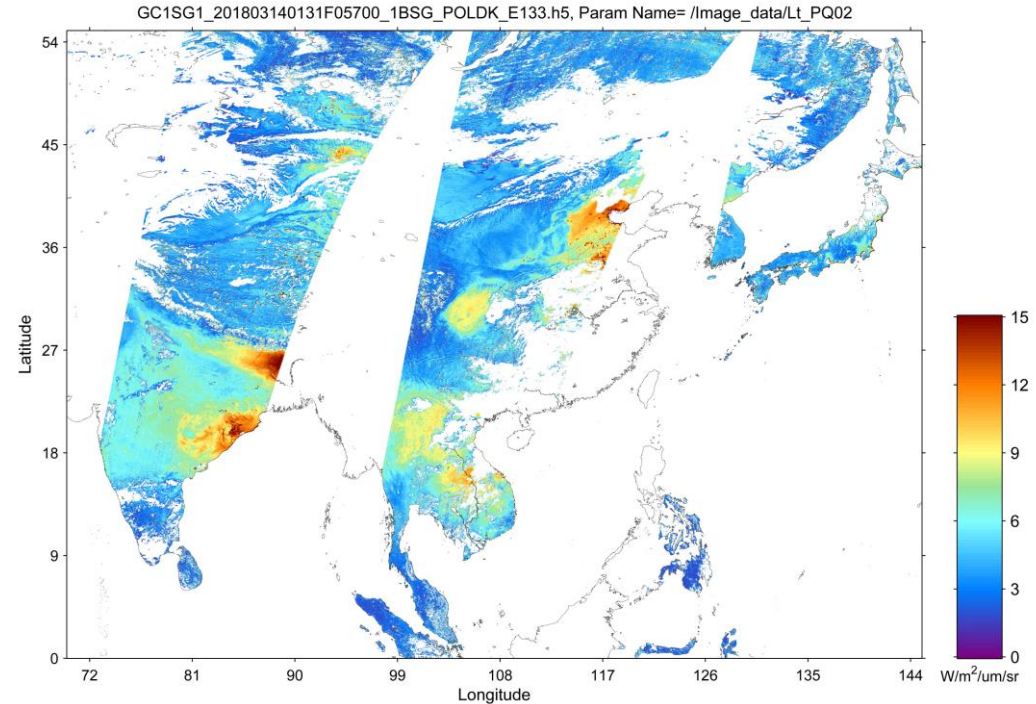
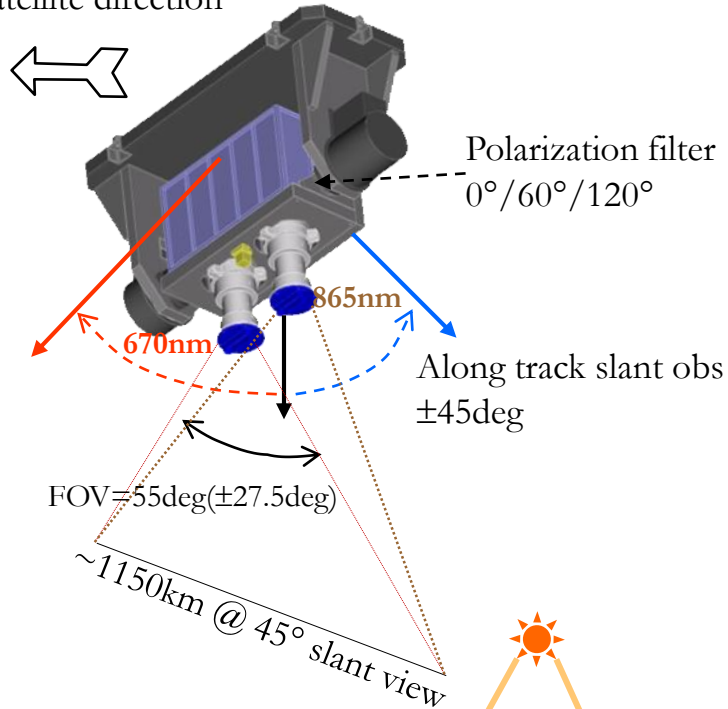
The images are (left) a true color composite* image, (middle) near-ultraviolet (NUV) image, and (right) degree of polarization (DPOL) image captured over Ganges river, India with SGLI onboard the SHIKISAI around 11:40 on January 3th 2018 (JST). Dense aerosols are seen around the mouth of Ganges river to coastal ocean in the NUV image. In the DPOL image the solar light reflected at ocean surface are seen to be highly polarized. SGLI can observe aerosols over land and ocean using the functions of NUV and polarization observations.

http://suzaku.eorc.jaxa.jp/GCOM_C/monitor/gallery/20180112.html

1. GCOM-C/SGLI:

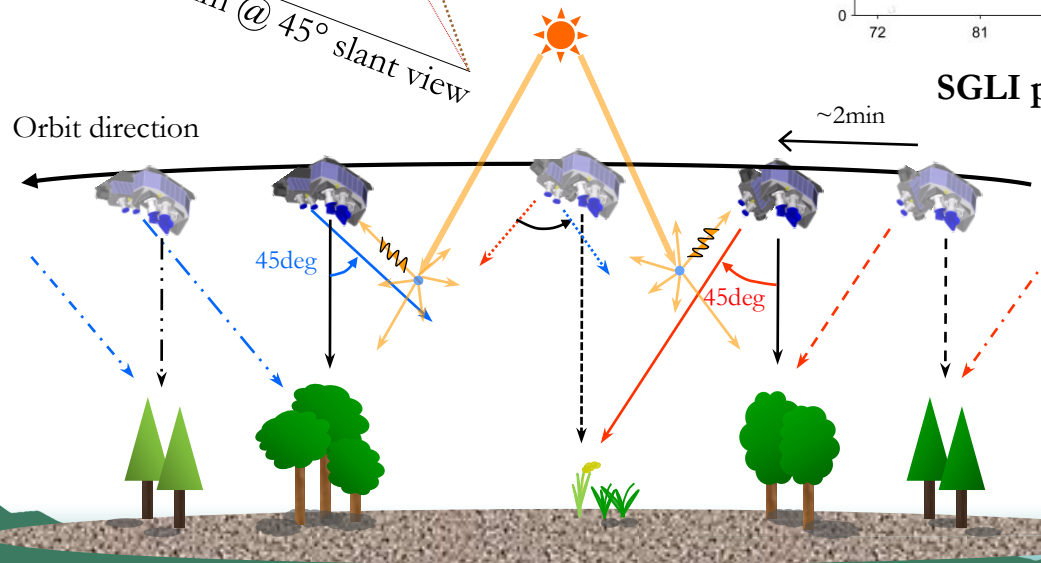
SGLI slant-view polarization observation

Satellite direction



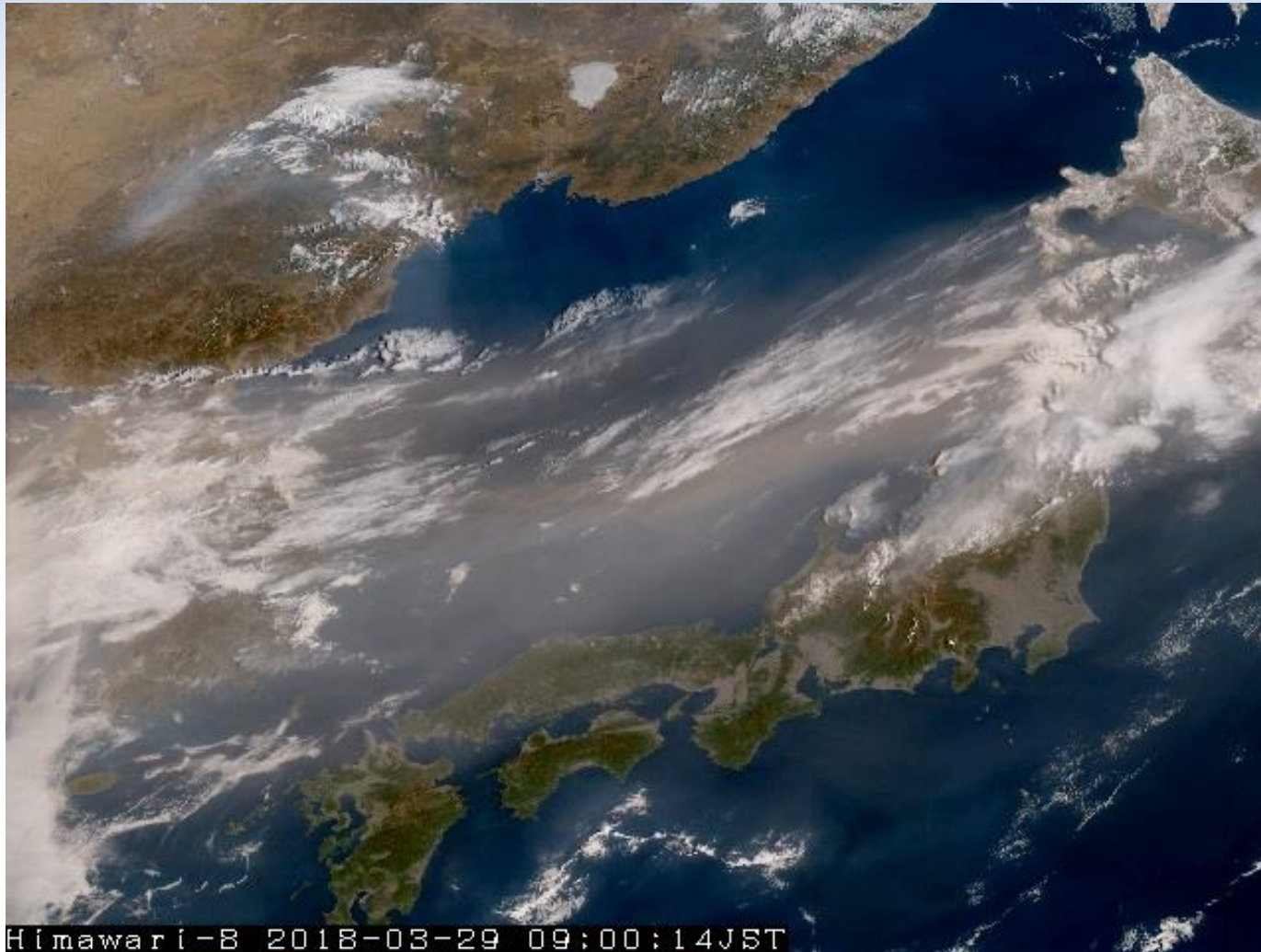
SGLI polarization radiance at 867nm (PL02)

Orbit direction



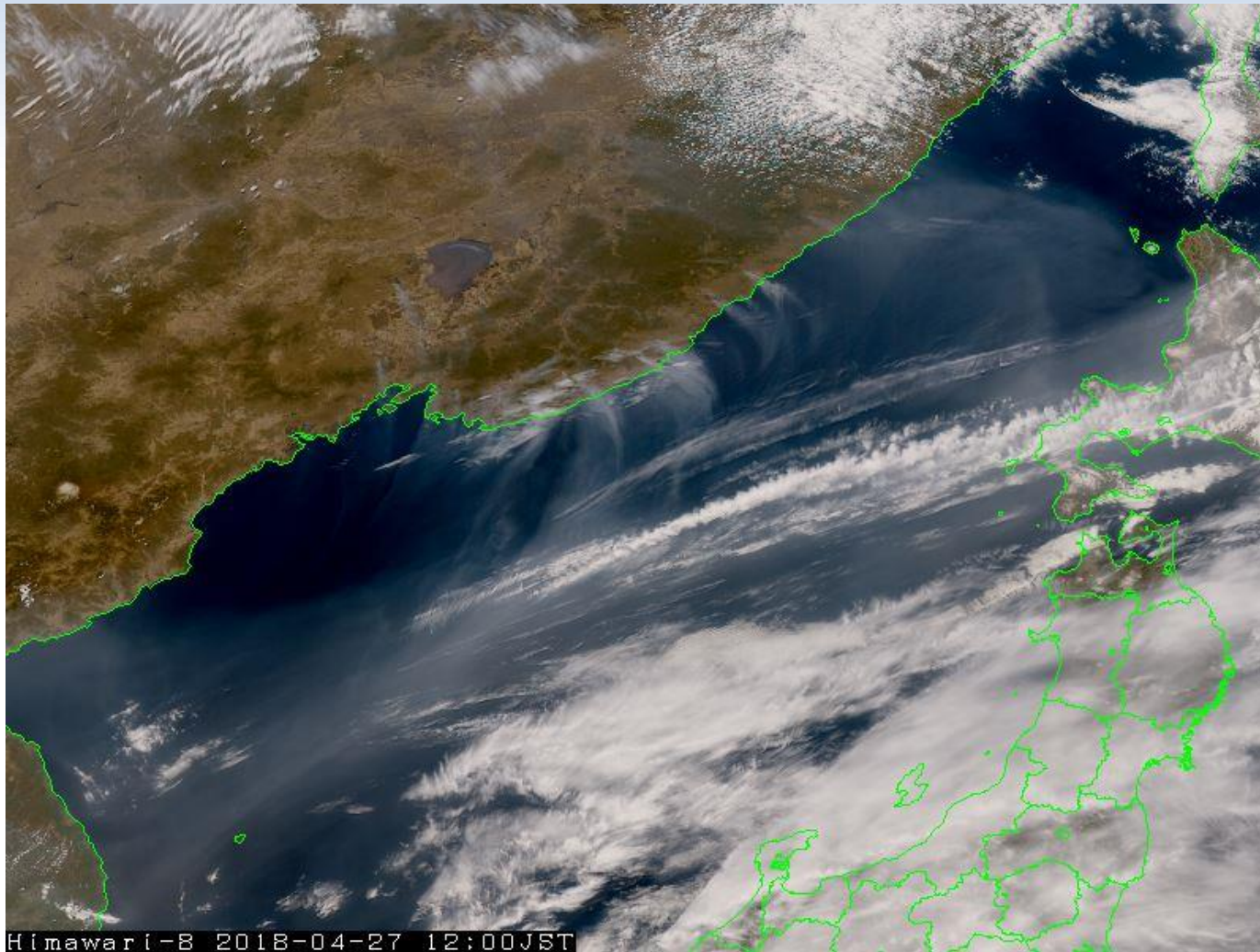
Along-track $\pm 45^\circ$ tilt for polarization observation of the atmospheric scattering

Asian dust flowing over Japan: 28 Mar. 2018



- <http://www.data.jma.go.jp/video/data/kansoku/himawari/2018/j20180328.mp4>

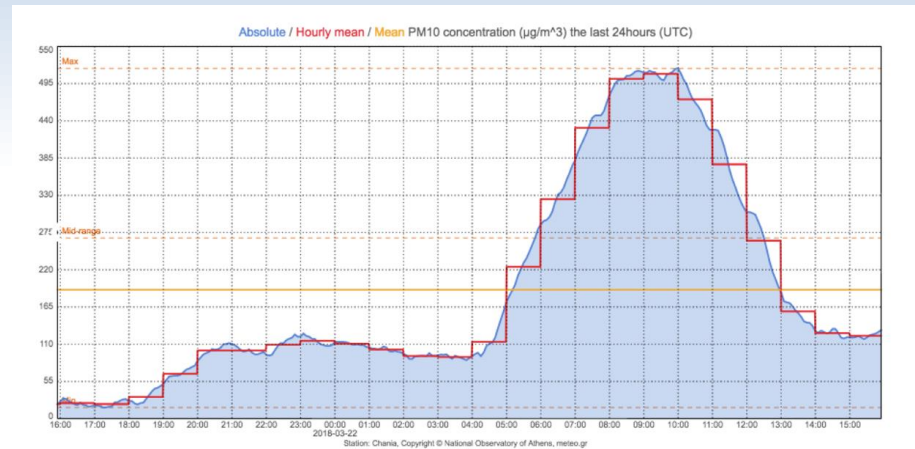
Biomass burning smoke from Russian fires: 26 Apr. 2018



- <http://www.data.jma.go.jp/video/data/kansoku/himawari/2018/j20180426.mp4>

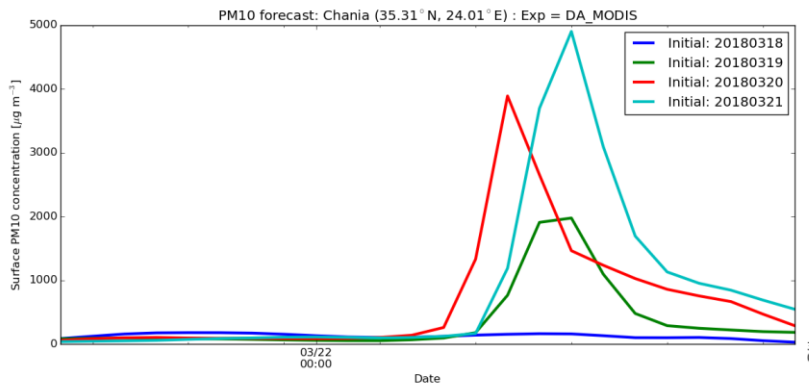
InDust: Forecast of Mar. 22 dust in Greece

- High dust concentration was observed on 22 Mar. in Greece.

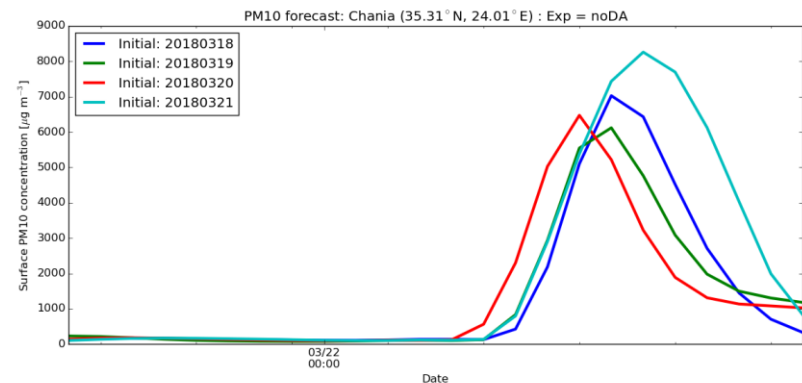


From COST InDust ML posted by Dr. Vassiliki KOTRONI

Our system forecasted the event with 3-days lead time, but the predicted concentrations were too high.



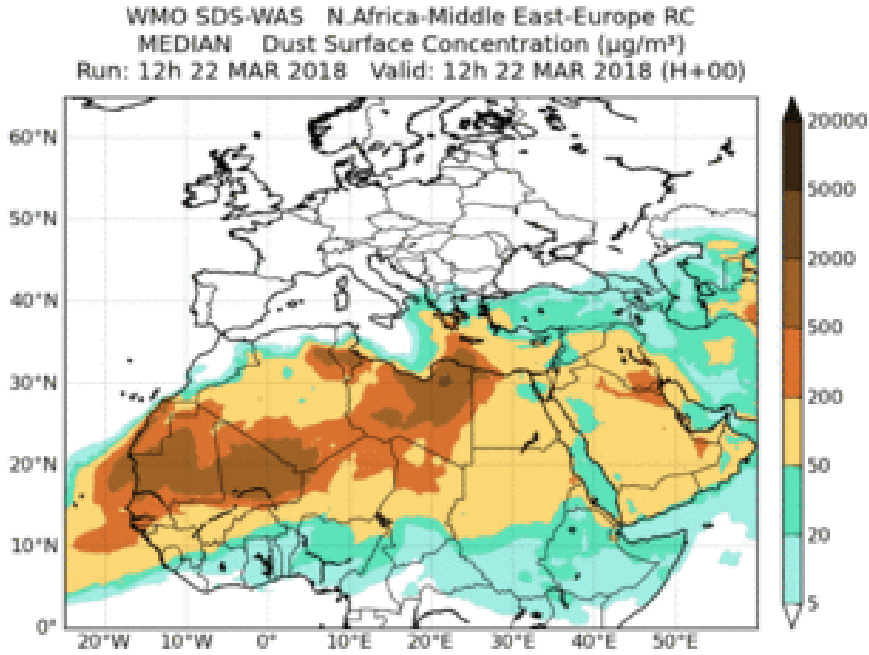
With MODIS AOD data assimilation



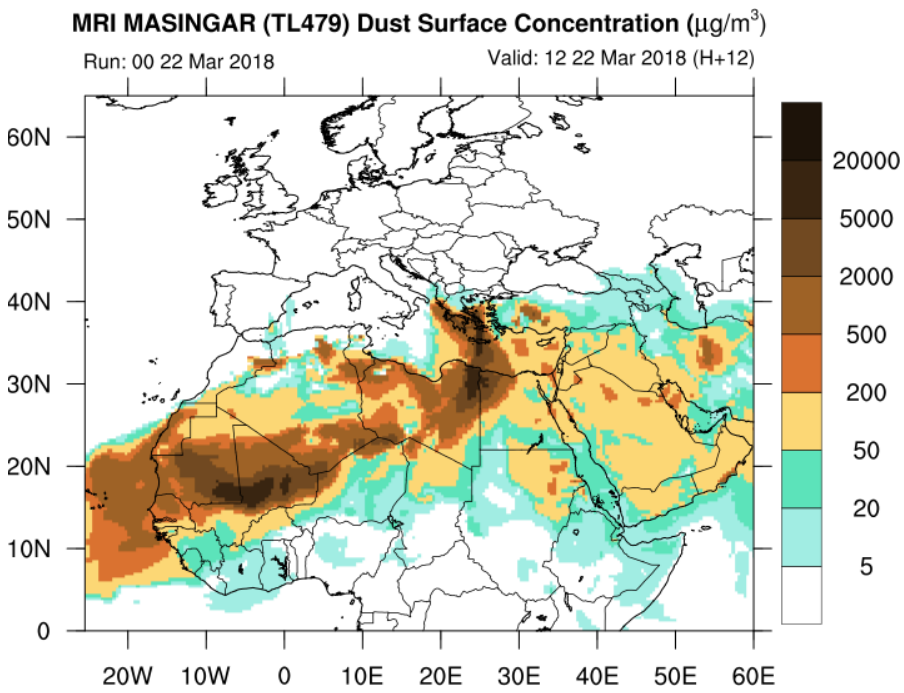
Without data assimilation

Dust event: Surface dust concentration

SDS-WAS NAMEE MADIAN



MASINGAR DA_MODIS



Updates of aerosol data assimilation

- **NRT 2D-VAR AOD data assimilation**
 - MODIS AOD retrieval change (Dec 2017): MODIS Collection 6 MxAODHD
- Investigations of the observation and background errors for the AOD data assimilation
 - JAXA aerosol product include the AOD errors; however, it only includes retrieval error estimates (very small!)
- 3D-VAR lidar data assimilation experiments with a Russian fire smoke event.

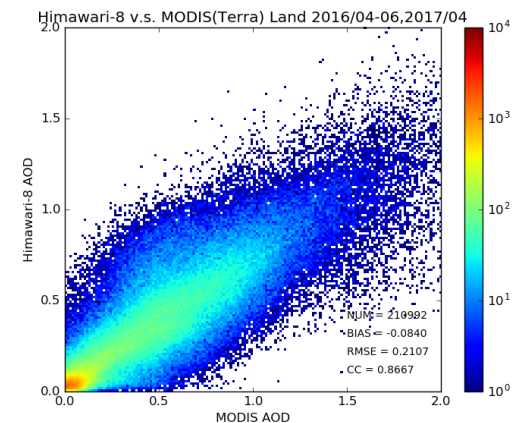
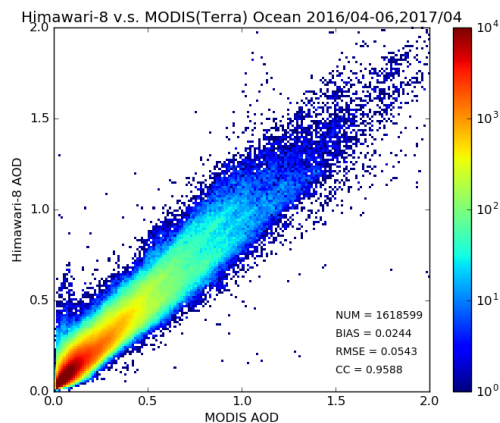
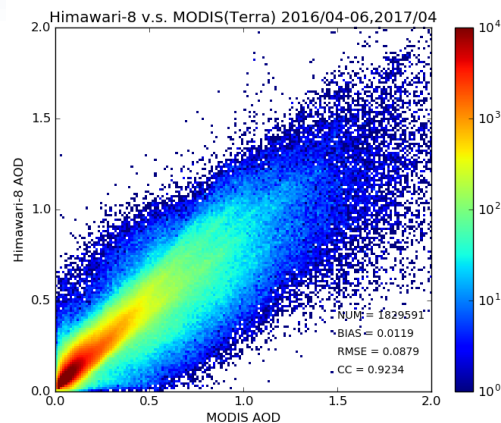
Comparison of JAXA Himawari-8 AOD with MODIS AOD

Ocean and land

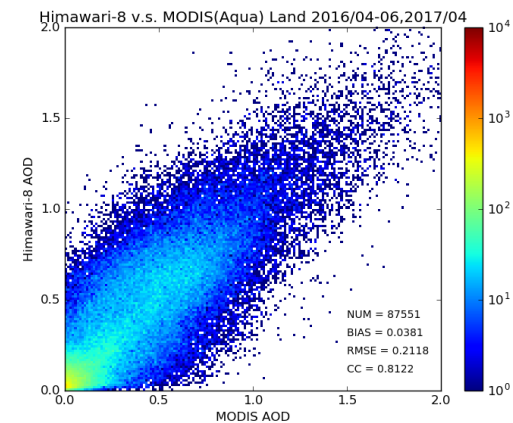
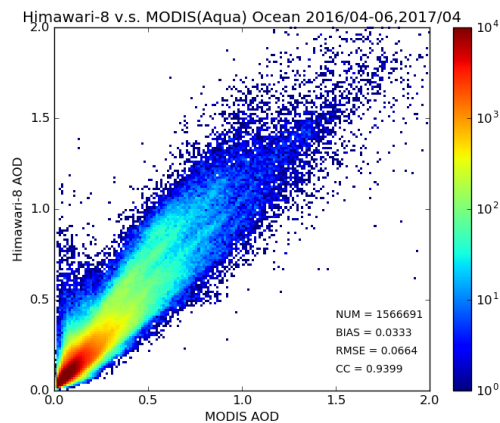
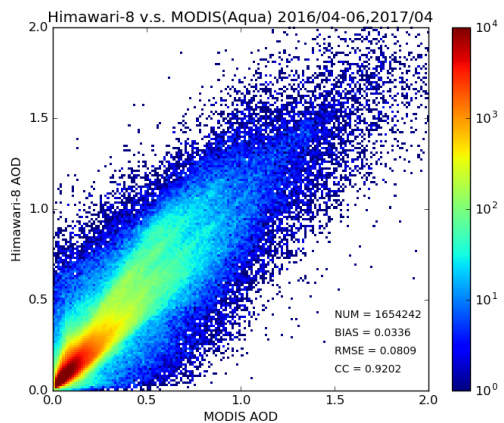
Ocean only

Land only

Terra



Aqua

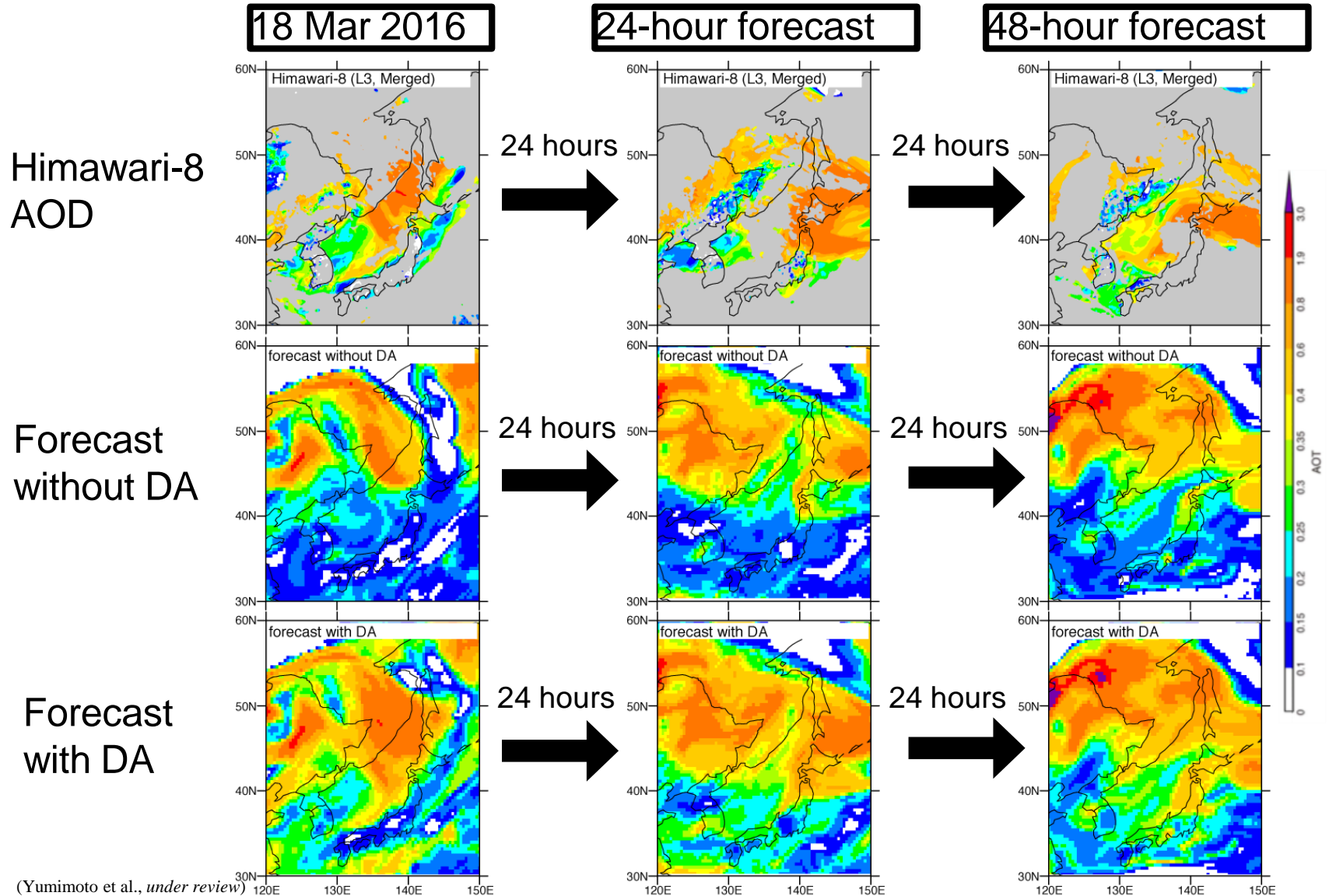


Currently estimated observation errors

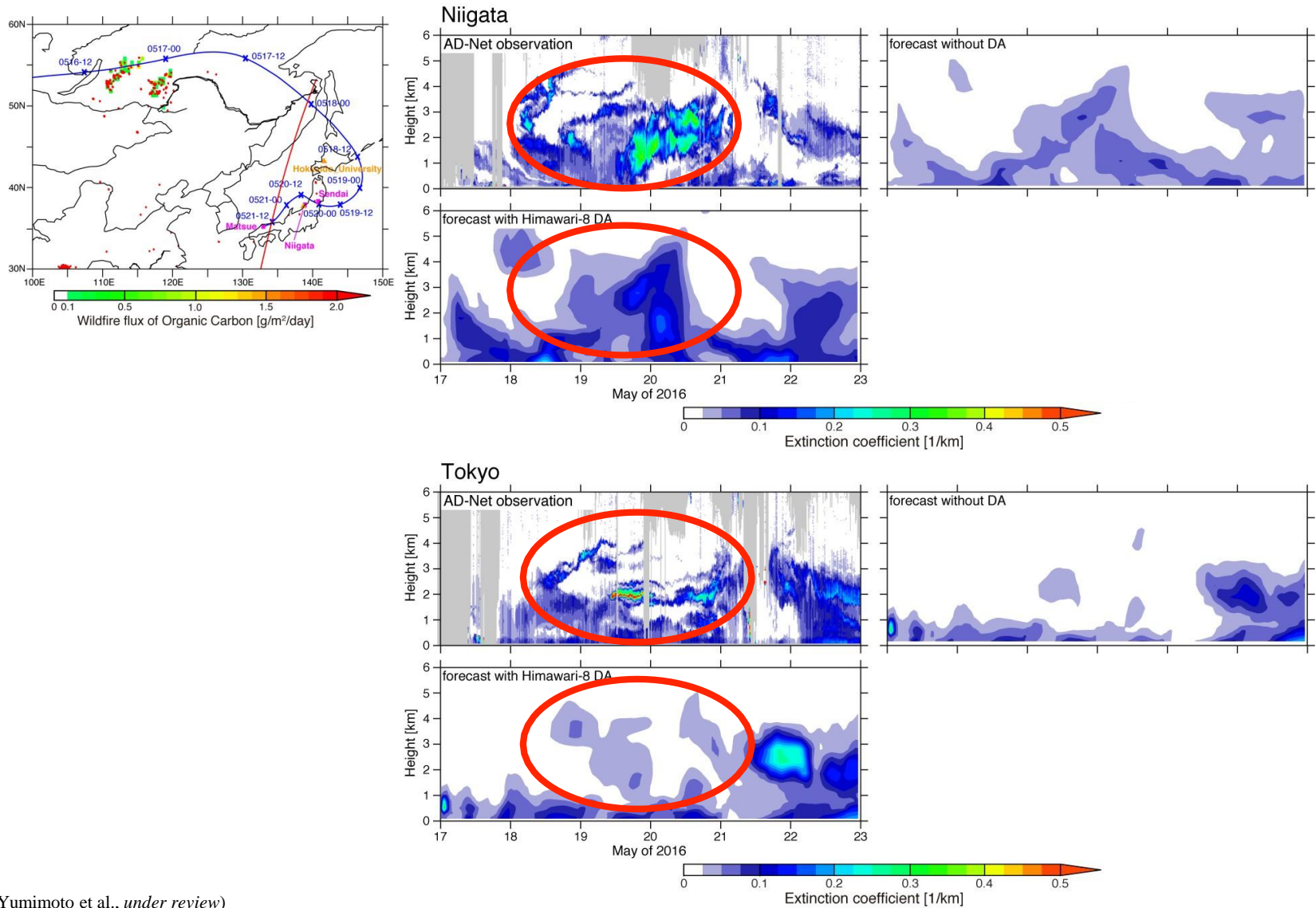
The currently estimated observation errors in the JAXA Himawari-8 against Aqua MODIS AOD:

- Aqua/all : $\sigma = 0.1151 * \tau_{H08} + 0.0673$
- Aqua/Land all : $\sigma = 0.0701 * \tau_{H08} + 0.1676$
- Aqua/Sea all : $\sigma = 0.1133 * \tau_{H08} + 0.0392$

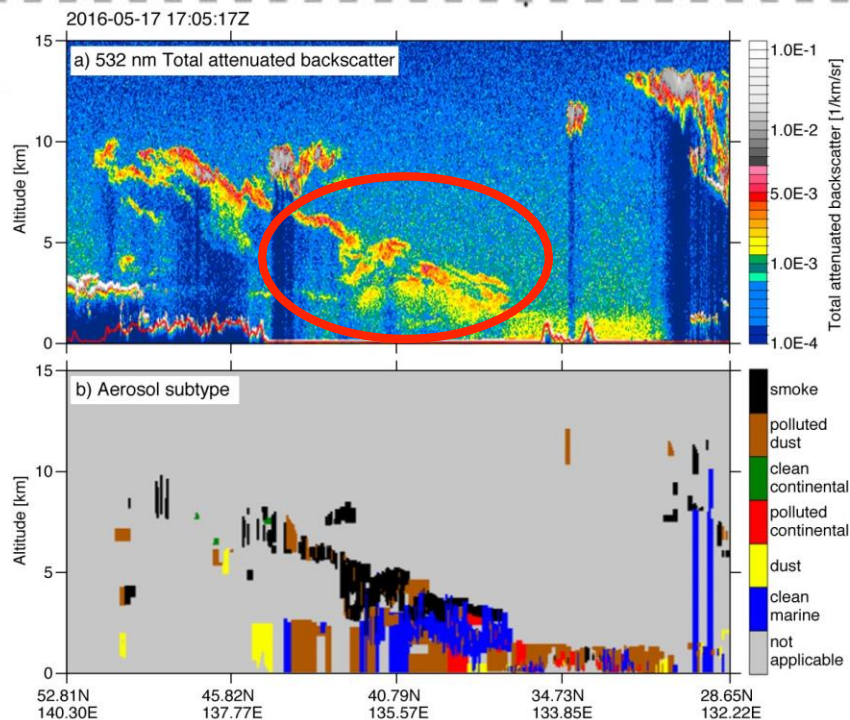
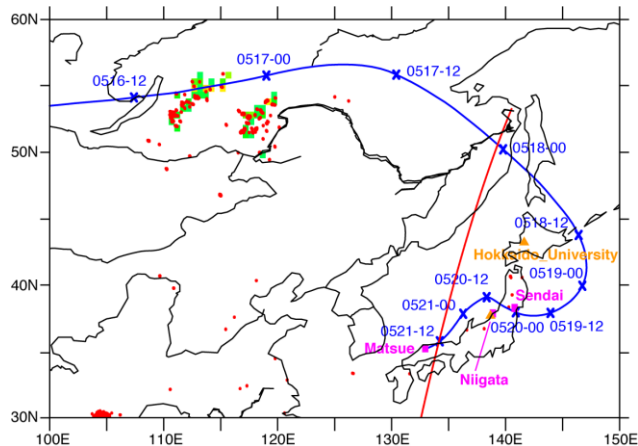
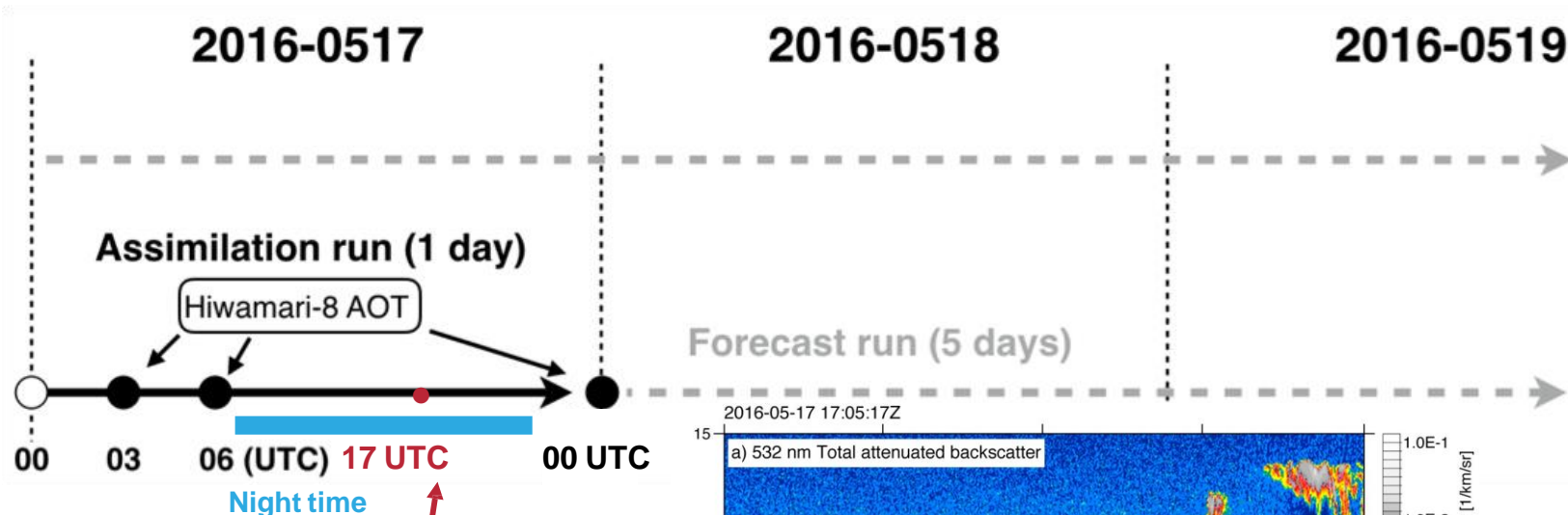
Assimilation/Forecasting for Smoke from Siberian Wildfire



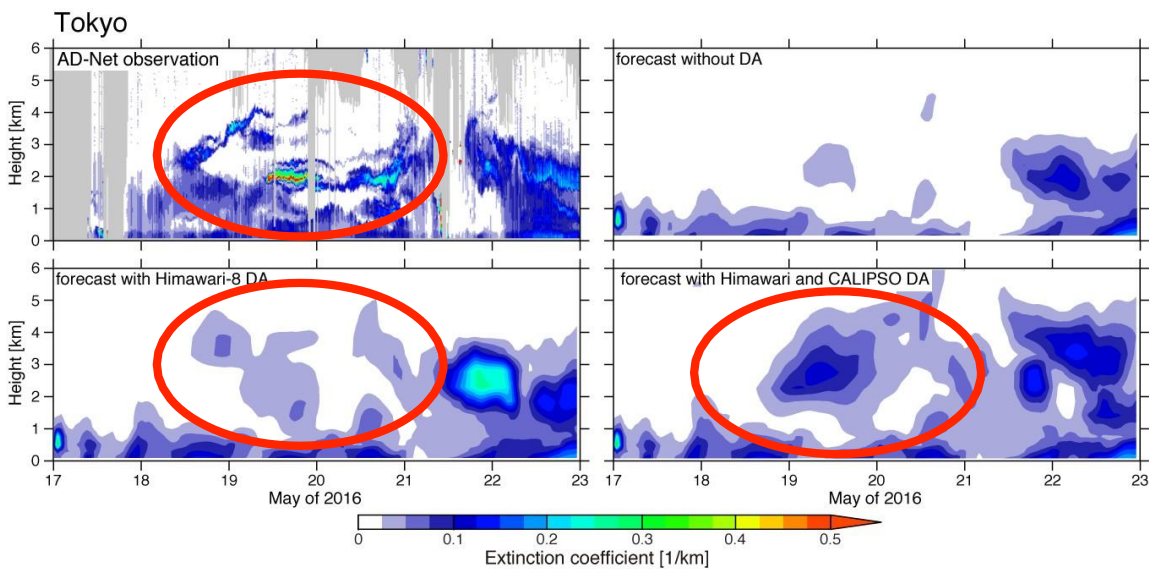
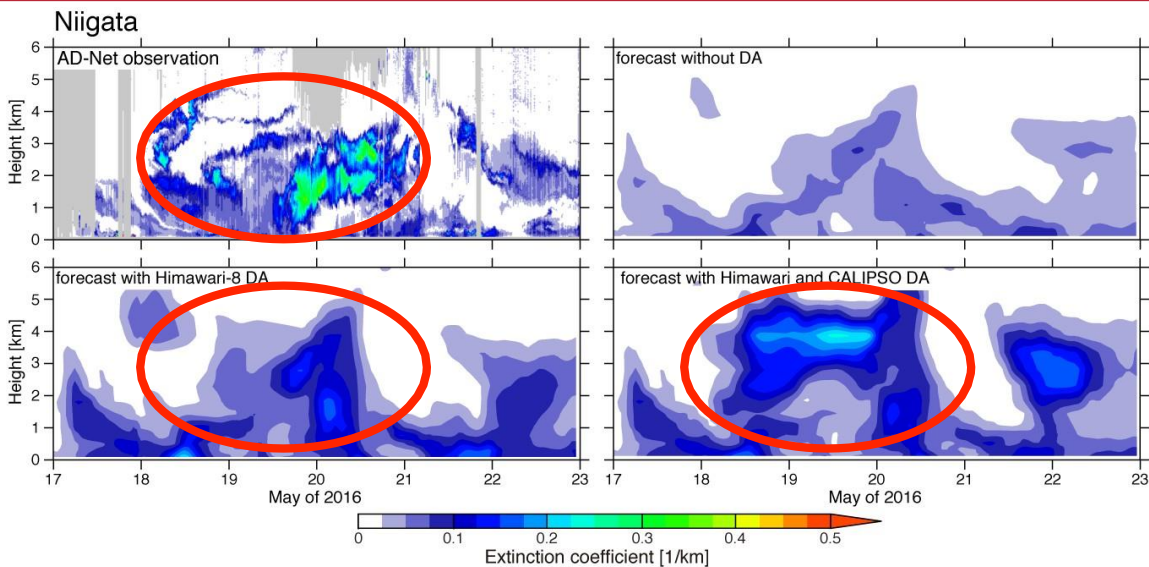
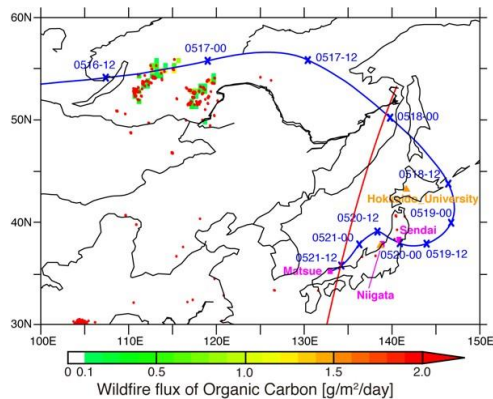
Validation with AD-Net Lidar Observations



Add Assimilation with CALIPSO Ext. Coef.



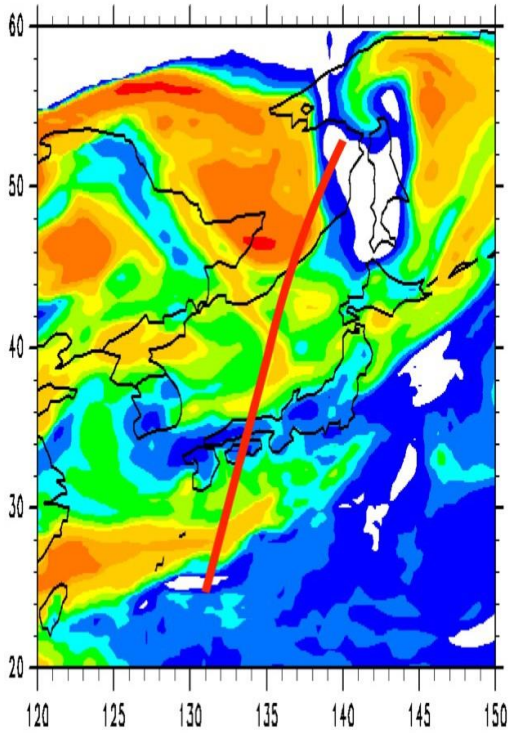
Further Improvement by CALIPSO DA



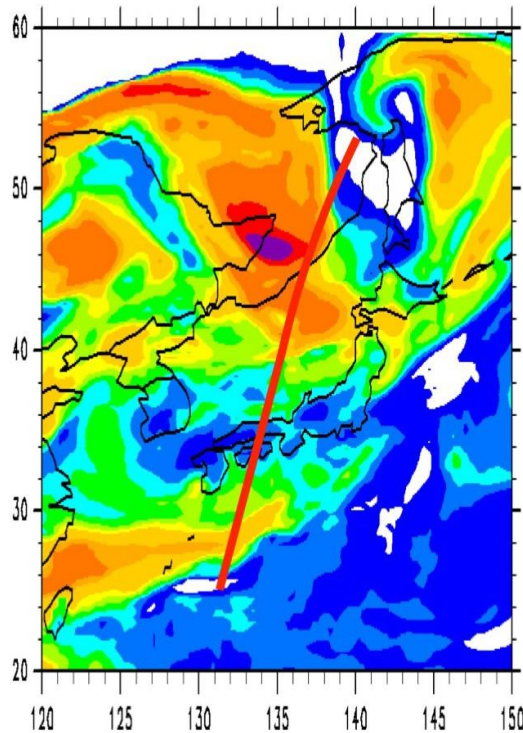
Vertical profiles and night time data from CALIPSO measurement can provide additional improvement in the forecast
(unpublished data)

Further Improvement by CALIPSO DA

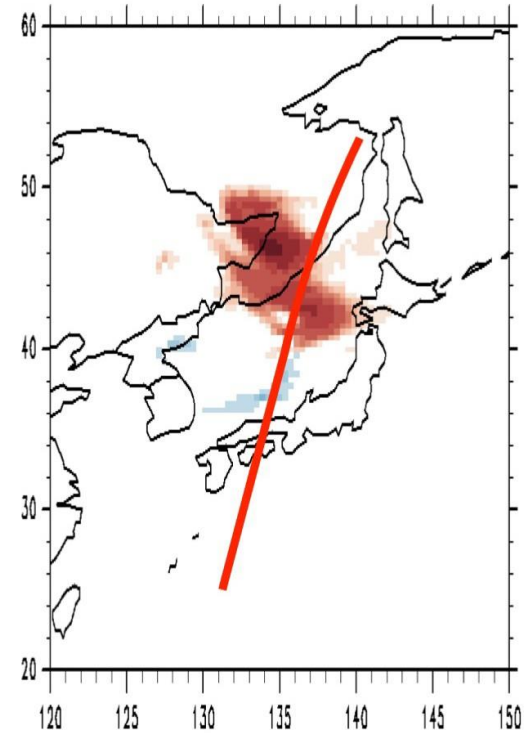
**First guess
(before DA)**



**Analysis
(after DA)**



**Increment of AOD
(CALIPSO DA)**



(unpublished data)

Future tasks

- Integrated approach with our regional chemistry model
 - Modal approach for aerosol microphysics
 - Adding chemistry-interactions, nitrates
 - MASINGAR mk-3?
- Nesting of regional chemical transport model (NHM-Chem) for detailed prediction over targeted area (East Asia)
- We are preparing the JMA's Aerosol Reanalysis (JRAero) ver. 1.5 (longer period) and 2.0 (model version up and increasing horizontal resolution from TL159 to TL319).

JRAero Atlas

JRAero Atlas provides quick look (map) of aerosol properties via web

JRAero Atlas

Daily aerosol maps produced by the Japanese Reanalysis for Aerosol (JRAero V1.0)

AEROSOL OPTICAL THICKNESS

GLOBAL

EAST ASIA

SURFACE PM2.5 CONCENTRATION

GLOBAL

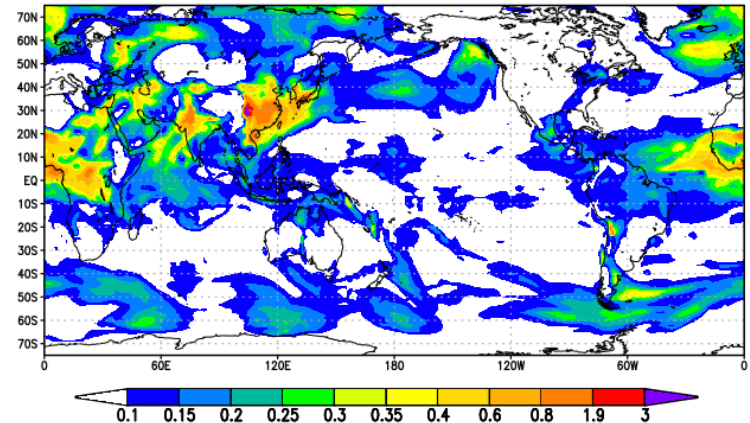
EAST ASIA

DUST DEPOSITION (DRY + WET)

GLOBAL

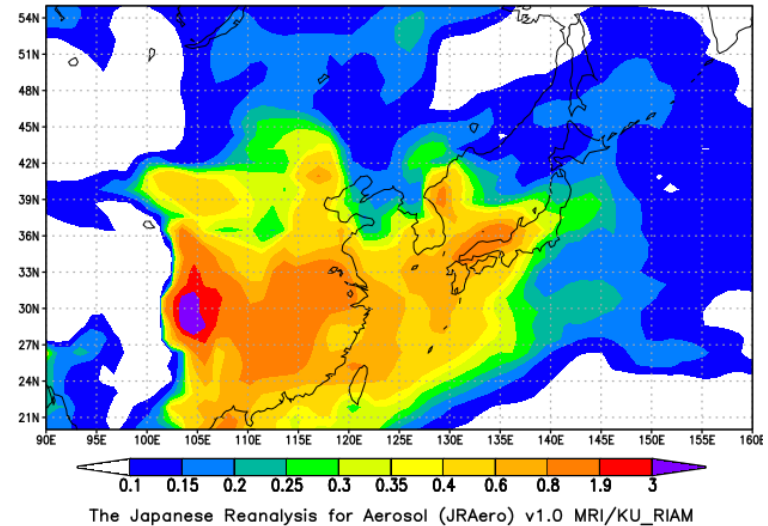
EAST ASIA

Daily Averaged AOD: 01Jan2012



The Japanese Reanalysis for Aerosol (JRAero) v1.0 MRI/KU_RIAM

Daily Averaged AOD: 01Jan2012

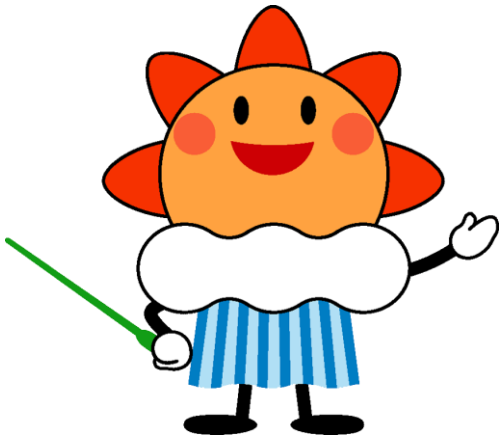


The Japanese Reanalysis for Aerosol (JRAero) v1.0 MRI/KU_RIAM

<https://www.riam.kyushu-u.ac.jp/taikai/JRAero/atlas.html>



Thank you very much for your attention.



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- ***Atmospheric Environment Division, Global Environment and Marine Department, JMA***
- ***Meteorological Satellite Center, JMA***