ISDA-Online

November 05, 2021, 07 – 09 UTC

“Chemistry and Aerosols: Modelling, Observations, and DA”

Organizers/Conveners: Ting-Chi Wu (RIKEN, Japan), Thomas Sekiyama (JMA/MRI, Japan), and Benjamin Gaubert (NCAR/ACOM, USA)

Program (UTC):

07:00 – 07:10	**Welcome**
07:10 – 07:30	**Toward Aerosol-aware Data Assimilation System: Accounting for Aerosol Transmittance Effects on Radiance Observation Operator** Shih-Wei Wei
07:30 – 07:50	**A Fast Visible-wavelength 3D Radiative Transfer Model for Numerical Weather Prediction Visualization and Forward Modeling** Louie Grasso, Steve Albers, Steven D. Miller
07:50 – 08:10	**Satellite Imagery and Products of the 16-17 February 2020 Saharan Air Layer Dust Event over the Eastern Atlantic: Impacts of Water Vapor on Dust Detection and Morphology** Louie Grasso, Daniel Bikos, Jorel Torres, John F. Dostalek, Ting-Chi Wu, John Forsythe, Heather Q. Cronk, Curtis J. Seaman, Steven D. Miller, Emily Berndt, Harry G. Weinman, Kennard B. Kasper
08:10 – 08:30	**Aerosol Data Assimilation using the Four-Dimensional Local Ensemble Transform Kalman Filter** Tie Dai
08:30 – 08:50	**Constraining Vertical Allocation of Wildfire Emissions using Airborne DIAL-HSRL Observations during FIREX-AQ** Xinxin Ye, Pablo Saide, John Hair, Marta Fenn, Taylor Shingler, Amber Soja, Emily Gargulinski, Elizabeth Wiggins
08:50 – 09:00	**Closing: Information on Upcoming Sessions**

Please note:

- When you login to the session before 07:00 UTC, and everything is quiet, this is most likely because we muted the microphones.
- The times in UTC are approximate. In case of technical problems, we might have to change the order of the presentations.
  Time Zones: 07 – 09 UTC
  07 – 09 am GMT (London) | 08 – 10 am CET (Berlin)
  03 – 05 pm CST (Shanghai) | 04 – 06 pm JST (Tokyo) | 06 – 08 pm AEDT (Sydney)
  00 – 02 am PDT (San Fran.) | 01 – 03 am MDT (Denver) | 03 – 05 am EDT (New York)

Toward Aerosol-aware Data Assimilation System: Accounting for Aerosol Transmittance Effects on Radiance Observation Operator

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Aerosol radiative effects, both direct and indirect, have been extensively studied using climate and numerical weather prediction models. However, the aerosol impacts on radiance in the context of data assimilation (DA) have received less research attention. Prior studies have shown that the brightness temperature (BT) in the thermal infrared (IR) window region can be reduced considerably by aerosols. Despite its effects on IR radiance, aerosol information is not considered in most DA systems.

Without considering the aerosol transmittance effects on IR radiance, the representation errors arise from the inconsistent aerosol representations among the numerical model, radiance simulations, and observations, especially over aerosol-laden regions. This inconsistency would introduce errors into the analysis. To constrain the effects of aerosols on IR observations in DA systems, a common approach is to reject the aerosol contaminated observations. Alternatively, proper considering the aerosol transmittance effects on IR observations could exploit the aerosol-affected observations over aerosol-laden regions. This presentation will discuss the impacts of aerosol transmittance effects in radiance observation operator on following perspectives: (i) the BT simulations and Jacobians and (ii) the meteorological analysis. Some preliminary results about enhancing the quality control to assimilate aerosol-affected IR observations will be discussed as well.

A fast visible-wavelength 3D radiative transfer model for numerical weather prediction visualization and forward modeling

Louie Grasso[1], Steve Albers[2], Steven D. Miller[1]

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Simulated Weather Imagery (SWIm) is a new, fast, and physically based visible-wavelength three-dimensional radiative transfer model. Given the location and intensity of the sources of light (natural or artificial) and the composition (e.g., clear or turbid air with aerosols, liquid or ice clouds, precipitating rain, snow, and ice hydrometeors) of the atmosphere, SWIm describes the propagation of light and produces visually and physically realistic hemispheric or 360˚ spherical panoramic color images of the atmosphere and the underlying terrain from any specified vantage point either on or above the earth's surface. SWIm is subsequently applied to two different numerical simulations.

Application of SWIm is conducted as part of a Multi-disciplinary, University-led Research Initiative (MURI) conducted under the auspices of the Office of Naval Research (ONR)—the Holistic Analysis of Aerosols in Littoral Environments (HAALE-MURI). A diverse team comprising expertise in numerical modeling, atmospheric aerosol physics, satellite-based passive and active remote sensing, and data assimilation, has been assembled to gain a fundamental understanding of the principal driving factors governing aerosol distribution, aerosol optical properties, and aerosol microphysical properties in coastal regions. Numerical simulations are provided by the Colorado State University-Regional Atmospheric Modelling System (CSU-RAMS) for two cases: 3-4 August 2016 over Saudi Arabia and 17 September 2019 over the Philippines. SWIm imagery from each of the two simulations are shown.

Satellite Imagery and Products of the 16-17 February 2020 Saharan Air Layer Dust Event over the Eastern Atlantic: Impacts of Water Vapor on Dust Detection and Morphology

Louie Grasso[1], Daniel Bikos[1], Jorel Torres[1], John F. Dostalek[1], Ting-Chi Wu[1,2], John Forsythe[1], Heather Q. Cronk[1], Curtis J. Seaman[1], Steven D. Miller[1], Emily Berndt[3], Harry G. Weinman[4], Kennard B. Kasper[5]

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On 16-17 February 2020, dust within a Saharan Air Layer (SAL) from western Africa moved over the eastern Atlantic Ocean. Satellite imagery and products from ABI on GOES-16, VIIRS on NOAA-20, and CALIOP on CALIPSO along with retrieved values of layer and total precipitable water (TPW) from MiRS and NUCAPS, respectively, were used to identify dust within the SAL over the eastern Atlantic Ocean. Use of various satellite imagery and products were also used to characterize the distribution of water vapor within the SAL. There was a distinct pattern between dust detection and dust masking and values of precipitable water. Specifically, dust was detected when values of layer TPW were approximately 14 mm; in addition, dust was masked when values of layer TPW were approximately 28 mm. In other words, water vapor masked infrared dust detection if sufficient amounts of water vapor existed in a column. Results herein provide observational support to two recent numerical studies (Banks et al 2019; Miller et al. 2019) that concluded water vapor can mask infrared detection of airborne dust.

Aerosol Data Assimilation using the Four-Dimensional Local Ensemble Transform Kalman Filter

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Aerosol analyses with a geostationary satellite can advance our understanding of the rapid spatiotemporal evolution of aerosols, which is especially critical for studies of air pollution and its mechanisms. To assimilate asynchronous observations and avoid frequent switching between the assimilation and ensemble aerosol forecasts, the Local Ensemble Transform Kalman Filter (LETKF) is extended to the four-dimensional LETKF (4D-LETKF). The hourly aerosol analyses are evaluated with both the assimilated Himawari-8 AOTs and independent Moderate Resolution Imaging Spectroradiometer (MODIS)- and AErosol RObotic NETwork (AERONET)-retrieved AOTs. All evaluations show that the assimilations positively affect the model performances and produce simulated AOTs that are closer to the observations. The analyses correctly reduce the significantly positive biases and root mean square errors (RMSEs) of the control experiment, especially over East China and Australia. The performance of the 4D-LETKF, even with an assimilation window time of 24 hours (4D-LETKF-24H), is generally comparable to that of the LETKF.

Constraining Vertical Allocation of Wildfire Emissions using Airborne DIAL-HSRL Observations during FIREX-AQ

Xinxin Ye[1], Pablo Saide[1], John Hair[2], Marta Fenn[2], Taylor Shingler[2], Amber Soja[2], Emily Gargulinski[2], Elizabeth Wiggins[2]

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Biomass burning is one of the most significant emission sources of aerosols and trace gases, which greatly affects the atmospheric chemical and optical properties. The height of plume injection and vertical allocation of wildfire smoke emissions play an important role in simulations and predictions of biomass burning smoke aerosol distributions and downwind air pollution exposure. Based on aerosol extinction profiles observed by the airborne Differential Absorption Lidar (DIAL) - High Spectral Resolution Lidar (HSRL), we developed an inverse modeling framework to estimate the vertical allocation of smoke emissions. Three wildfire events in summer 2019, i.e., the Williams Flats, Shady, and Tucker fires, which are intensively observed during the Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) field campaign are examined, covering major fuel categories of temperate forest and grassland. The results show variable proportion of emissions with respect to the total that gets injected into the upper troposphere, which deviates from the constant proportion depending on fuel category that is usually used in plume rise models. The updated vertical emission allocations are implemented in an air quality model to show the impact on the simulation of transported and aged smoke distributions. These results provide insights on improving wildfire smoke simulations.