Proceedings of the International SKYNET Workshop 2013 (and the 19th CEReS International Symposium on Remote Sensing)

July 4th (Thu) and 5th (Fri), 2013
Nishi-Chiba Campus, Chiba University, Chiba, Japan

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International SKYNET workshop 2013

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Scope of this workshop

(1) To discuss the administration and strategy of SKYNET as a GAW contributing network. SKYNET is planned to join contributing network of Global Atmosphere Watch (GAW) program of World Meteorological Organization (WMO) and to distribute data through the World Data Center for Aerosols (WDCA) of WMO/GAW.
(2) To present recent results and findings of studies related to science and technology in the field of aerosol-cloud-radiation interaction and to share their knowledge.

Remarks

In Science Sessions, each presentation has 12-min talk and 3-min discussion (15-min in total). Basically, speakers must use a projector provided at the venue and their own laptop computer. Please connect your computer to the projector and confirm the proper operation before your presentation. Ensure that your computer is equipped with the proper monitor connector (mini D-sub 15 pins). If your computer does not have it, please bring an appropriate converter with you. Be sure to bring an AC adaptor with you. Japanese standard AC voltage is 100V 50 Hz. The secretariat is not responsible for any projection troubles caused by computer technical difficulties. Your computer can be placed on a podium for your presentation. You should connect your computer to the projector during the previous presentation. Please pick up your computer at the podium after your presentation. Slide and overhead projectors will not be available.

Local Organizing Committee

*Hitoshi Irie (CEReS, Chiba Univ., Japan)
Kazuma Aoki (Univ. of Toyama,Japan)
Pradeep Khatri (CEReS, Chiba Univ., Japan)
Tomoaki Nishizawa (NIES, Japan)
Tamio Takamura (CEReS,Chiba Univ., Japan)
Nobuo Sugimoto (NIES, Japan)

International SKYNET Workshop 2013
(and the 19th CEReS International Symposium on Remote Sensing)

July 04 - 05, 2013

Multi-media Conference Room
Graduate School of Humanities and Social Sciences
Chiba University, 1-33 Yayoicho, Inage-ku, Chiba 263-8522, Japan

■Day 1, July 04, 2013 (Thu)

09:00-09:30 Arrival, Registration

09:30 Opening/Welcome, **H. Kuze** (Chiba Univ.)
09:40 Logi, etc., **H. Irie** (Chiba Univ.)

(Group photo)

Administration Session 1 [Chair: K. Aoki (Univ. Toyama)]
10:00 Thoughts for Skynet system development – toward future- & Proposal on administration and strategy of the SKYNET as a GAW contributing network, **T. Nakajima** (Univ. of Tokyo)
10:20 About WMO/GAW, **N. Sugimoto** (NIES)
10:30 Status in Japan, Thai, and Mongolia, **T. Takamura** (Chiba Univ.), **T. Boossarasiri** (Chulalongkorn Univ.), and **N.Tugjsuren** (Mongolian Univ. of S&T)
10:50 Status in China, **H. Che** (CAMS/CMA)
11:00 Status in Korea, **S.-W. Kim** (SNU) (on behalf of B.-J. Sohn)
11:10 Current status and future of the European Skynet Radiometers network, **V. Estellés** (Univ. of València) (on behalf of M. Campanelli)
11:20 Skynet-India: Preliminary results from Skyradiometer network of India Meteorological Department, **V. K. Soni** (IMD)

11:30 *Lunch break*
(A meeting of country/region representatives)

Administration Session 2
13:00 Discussion about the proposal, led by **T. Nakajima** (Univ. of Tokyo)

14:45 *Coffee break*

15:15 Concluding remarks, **T. Nakajima** (Univ. of Tokyo)

Science Session – Algorithm 1 [Chair: T. Nishizawa (NIES)]
15:30 Aerosol optical properties retrieved by SKYRAD.pack Version5 based on skyradiometer measurements of Beijing, China, **H. Che** (CAMS/CMA)
15:45 An estimation of single scattering albedo retrieved from SKYNET sky radiometer data and development of a quality control algorithm for the SKYNET data analysis, **M. Hashimoto** (Univ. of Tokyo)
16:00 Use of 315nm channel of sky radiometer to retrieve columnar ozone amount, **P. Khatri** (Chiba Univ.)

16:15 Column water vapor retrievals from skyradiometer (POM-02) 940nm channel data, **A. Uchiyama** (MRI)

16:30 Retrieval of calibration parameters for ground based Sun-Sky radiometric measurements of columnar water vapor using operational surface meteorological measurements, **V. Estellés** (Univ. of València) (on behalf of M. Campanelli
16:45 An improved cloud screening algorithm for skyradiometer measurement analysis and application to Asian dust detection, **H.-J. Song** (SNU) (on behalf of B.-J. Sohn)
17:00 Combined use of SKYNET observations for retrieving microphysical properties, **S. Katagiri** (Tohoku Univ.)
17:15 Development of a SKYNET based methodology for the CIMEL CE318 radiometer in the frame of the ESR network, **V. Estellés** (Univ. of València)

18:00 *Party at Restaurant CORZA*

■Day 2, July 05, 2013 (Fri)

Science Session – Algorithm 2 [Chair: K. Aoki (Univ. Toyama)]
08:30 Ground-based lidar network observation of aerosols and clouds in AD-Net, **T. Nishizawa** (NIES)
08:45 Development of an algorithm to estimate the aerosol vertical profile from Sky radiometer and Lidar measurements, **R. Kudo** (MRI)

Science Session – Cal/Val/Comparison [Chair: K. Aoki (Univ. Toyama)]
09:00 Calibration and performance of Prede Skyradiometer, **S. S. Ningombam** (Indian Institute of Astrophysics)
09:15 Comparison of aerosol optical properties between CE 318-1 of AERONET and POM-02 of SKYNET, **Y. Choi** (Hankuk Univ. of Foreign Studies)
09:30 The validation and comparison of aerosol properties retrieved by CARSNET algorithm with the AERONET, **H. Che** (Institute of Atmospheric Composition, CAMS/CMA)
09:45 Comparison of CALIPSO aerosol optical depth retrievals to sky radiometer and space-based passive measurements, and characteristics of the lidar ratio, **S.-W. Kim** (SNU)

10:00 *Coffee break*

Science Session – General 1 [Chair: R. Kudo (MRI)]
10:15 Aerosol variations in urban atmosphere: case studies in Beijing and Dunhuang, **B. Chen** (IAP/CAS)
10:30 Ground-based remote sensing of aerosol seasonal character over Hefei in East China, **Z. Wang** (AIOFM/CAS)
10:45 Sun-sky radiometer study of monsoon activity over Pune, India, **P.C.S. Devara** (Indian Institute of Tropical Meteorology)
11:00 Identification of aerosol types over the Indo-Gangetic Basin using ground-based sunphotometer measurements, **A. K. Srivastava** (Indian Institute of Tropical Meteorology)
11:15 Optical and chemical properties of atmospheric aerosols at Phimai in Thailand by surface measurements, CALIOP data, and the SPRINTARS model, **H. Tsuruta** (Univ. of Tokyo)

11:30 *Lunch break*

Science Session – General 2 [Chair: M. Kuji (Nara Women's Univ.)]
13:00 Sky-radiometer measurements for monitoring the aerosol optical properties in the Arctic and Antarctica, **M. Shiobara** (NIPR)

13:15 One year of measurements with a POM02 sun-sky radiometer at an Alpine Euroskyrad station, **H. Diémoz** (ARPA Valle d'Aosta)
13:30 Continuous ground-based observation of aerosol optical properties in Tsukuba, Japan, **A. Uchiyama** (MRI)
13:45 Characterization of atmospheric phenomena with SKYNET aerosol properties at Fukue-jima and Amami-Oshima islands, **S. Kitakoga** (Nara Women's Univ.)
14:00 Optical and in-situ measurements of aerosol, nitrogen dioxide, and water vapor in relation to weather and sky radiation conditions in Chiba, **H. Saito** (Chiba Univ.)

14:15 *Coffee break*

Science Session – Climate 1 [Chair: P. Khatri (Chiba Univ.)]
14:45 A study of vertical profiles of aerosol radiative parameters and aerosol direct effects over the East China Sea region using a combination of aircraft and ground based observation data, **P. Khatri** (Chiba Univ.)
15:00 Investigate the single scattering albedo of dust aerosols and their impact on climate in Northwest China, **J. Bi** (Lanzhou Univ.)
15:15 Cirrus clouds measurement by a three-wavelength lidar over Hefei in China, **D. Liu** (AIOFM/CAS)

15:30 *Coffee break*

Science Session – Climate 2 [Chair: P. Khatri (Chiba Univ.)]
16:00 Surface aerosol radiative forcing at the Observatory for Atmospheric Research, Thailand during 2009-2011, **T. Boossarasir** (Chulalongkorn Univ.)
16:15 Climate change trends and desertification in Mongolia, **N.Tugjsuren** (Mongolian Univ. of Science and Technology)
16:30 Cloud Radiative Effect on the Earth's Surface, **K. Yamada** (Tohoku Univ.)
16:45 The research on global anthropogenic heat release, **B. Chen** (Institute of Remote Sensing and Digital Earth, CAS)

17:00 Closing remarks, **T. Takamura** (Chiba Univ.)

Thoughts for Skynet system development -toward future-

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Abstracts

This paper discusses several my thoughts for future development of the Skynet system. The Skynet system is a grass roots initiative for networking the skyradiometer and accompanying instruments to measure the atmospheric aerosols and radiation budget. In the course of the development we have had several supporters such as JAXA ADEOS-II/GLI, GCOM-C and EarthCARE satellite projects, JST/CREST/APEX project, MOEJ/GER/ACECAP project, and MEXT Earth observation system development program. The Skynet has been also supported by the international society with user communities in Europe, China, Korea and recently India. This background made the Skynet recognized in 2013 as a contributing network of the WMO Global Atmospheric Watch program. I like to raise the following points to be discussed in this workshop for future development of the Skynet.

- Efforts for world's standardization: We should have more consistency in the protocols of operation and calibration similar to those of NASA Aeronet system, which is regarded as the world standard for the skyradiometer network. Two sided sky scanning is a good idea to assure the good quality of data. But, this needs faster scanning system to reduce the scanning time. A transfer of calibration constants from Aeronet will bring a benefit to Skynet to increase the reliability of long-term accuracy of solar direct irradiance and diffuse radiance measurements.
- Development of a better integrated system: International collaboration

has to be sought to establish better coordination of the management of the Skynet, such as establishment of the international steering committee, integrated data server structure and operation. Instrument calibration program has to be developed to assure the homogeneous quality of the instruments.

- Continued effort for improving the data quality: The accuracy of the aerosol single scattering albedo, water vapor, and ozone have to be improved through better radiometric calibration and better a priori aerosol models for the retrieval process.

- Expanding new sciences: Important are development of cloud retrieval system, comprehensive comparison with chemical data and satellite remote sensing data, use of data for aerosol data assimilation, and others.

Current status and future of the European Skynet Radiometers network

[1]Monica Campanelli, [2]Víctor Estellés, and [1] Gian Paolo Gobbi

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Abstract

The European Skynet Radiometers network (ESR, www.euroskyrad.net) is a volunteer European observational network of Prede POM sun sky radiometers federated with SKYNET and established and maintained by several universities and research institutes. ESR is also a "multi-instrumental" network, as radiometers other than Prede POM (such as Cimel CE318 or others) can take part. Actually the network consists of 13 sites, some of which are already operative. Thanks to the collaboration with the Italian Air Force, 3 more sites will be part of the network in the next future, even if more restricted access to their database will be necessary. ESR is able to provide two different daily data processing: 1) mirroring of the SKYNET inversion; 2) elaboration with the ESR.pack.

The present status of ESR web page and data processing system will be shown in detail, together with some aspects related to the future improvement of the procedure for analysing data. Particularly the following aspects will be discussed: a) the new code for the estimation of precipitable water vapour content will be presented b) critical points in the development of higher quality levels of the inversion products, related to the low aerosol optical thickness recorded in most of the ESR sites; c) many ESR sites are located in North Europe where clouds are more frequently present during the year . Since none of the ESR sites has co-located Pyranometer and Pyrgeometers (needed to apply the cloud screening procedure set up by SKYNET) it is important to discuss other methodologies for detecting clouds contaminated measurements of diffuse sky radiance; d) all the ESR POM-01 instruments are

now able to perform vertical measurements for deriving cloud optical thickness at 1020 nm, therefore there is a need to carry on the development of the dedicated software.

Another future development of ESR foresees the simultaneous presence of PREDE POM sun-sky radiometers and Lidar Ceilometers in some sites of Italy with the aim of providing a complete characterization of aerosol properties. The same possibility will be explored for the other ESR sites.

Skynet-India: Preliminary results from Skyradiometer network of India Meteorological Department

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*Corresponding author and presenting author

Abstract

Tropospheric aerosols have a short lifetime; as a result they have high degree of variability in both space and time in their composition, number and size distribution. The geography of India is quite diverse, with everything from mountains, deserts and rainforests. For a good assessment of aerosol characteristics such measurements have to be performed frequently in locations with different aerosol types and in varying meteorological conditions in automatic mode. In order to examine aerosol impact on the local and global climate in addition to understanding and modeling the impact of aerosol on radiation budget and precipitation efficiency, India Meteorological Department has established a network of sun-skyradiometer consisting of twelve stations located in different geographic regions and named as Skynet-India. The sun-skyradiometer POM-02 acquires direct solar spectral irradiance and circum-solar radiance distribution within a 1^o full field-of-view at eleven bands of 315, 340, 380, 400, 500, 670, 870, 940, 1225, 1600, and 2200 nm at every 10 minute. This paper presents the preliminary results from Skynet-India Network. The main properties of the aerosols which are being monitored from this network and important for climate studies are; Aerosol Optical Depth, Angstrom Exponent, Size Distribution of the aerosols, Scattering Phase Function, Single Scattering Albedo and Refractive Indices etc. Ranichauri is a high altitude background site with AOT as low as 0.03 on clear sky days. The Aerosol content is two to three orders lower as compared to Delhi. Single Scattering Albedo is more than 0.9 in all seasons as compared to Delhi where it is found to vary between 0.7 – 0.85. Rohtak is close to Delhi but the AOT is significantly lower and SSA higher as compared to Delhi. Jodhpur is located in desert area and shows significant variability in AOT, highest being during summer and lowest during rainy season. Guwahati is mostly affected by cloudy conditions but during clear sky conditions AOT as low as 0.1 is observed. Port Blair is an island station in the Bay of Bengal, Visakapatnam and Thiruvanantapuram are coastal stations and are dominated by sea salt aerosol as seen from the size distribution. Pune is located on leeward side of Western Ghats and relatively clean city with AOT values as low as 0.09 during clear sky days.

Aerosol optical properties retrieved by SKYRAD.pack Version5 based on skyradiometer measurements of Beijing, China

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Abstract

A PREDE POM-02 skyradiometer (SKYNET) has been installed in May 2008 at Chinese Academy of Meteorological Sciences (116.32˚ E, 39.93˚ N, 106.0 m) in Beijing, China to measure the aerosol optical properties. Both the version 4.2 and 5.0 of SKYRAD.pack code have been used to retrieve the columnar aerosol features. The intercomparison results of the aerosol optical properties from version 4.2 and 5show that aerosol optical depth (AOD) has good consistence each other. Single scattering albedo values from version 5 is lower than those from version 4. 2 systematically, but there have good consistence with R-square about 0.85. This difference of SSA suggests that more strict cloud screening implementation should be used in future. The volume size distribution from version 5 has been improved much comparing with that from version 4.2, especially for the coarse mode particles.

The aerosol optical properties at Beijing during May, 2008 to October, 2012 including monthly means of AOD, SSA, volume size distribution, refractive index have been analyzed. The elementery results show AOD is higher during spring and summer seasons but lower in fall and winter seasons. SSA is lower during fall and winer season but higher during spring

and summer seasions which indicates the aerosol particles have more absorption in winter than summer. This reflects the aerosol chemical composition of Beijing has significant distribution characteristics. Large coarse mode volume size distribution in spring at Beijing reprensent the dust aerosol particle contribution.

An estimation of single scattering albedo retrieved from SKYNET sky radiometer data and development of a quality control algorithm for the SKYNET data analysis.

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Abstract

It is important to accurately estimate the columnar aerosol optical properties in assessing the effect on the radiation budget associated with the aerosol direct radiative forcing. The SKYNET network is one of the ground-based aerosol monitoring networks for this purpose. In the SKYNET, the direct and diffuse solar irradiances are measured by using sky radiometer (Prede Co., Ltd, Tokyo, Japan), and the columnar aerosol optical properties, such as aerosol optical depth, single scattering albedo, real and imaginary part of refractive index and phase function, and size distribution, are retrieved by using its own inversion software called SKYRAD.pack version4.2 (Nakajima et al., 1996). However, it is pointed out that the value of single scattering albedo (SSA) from SKYNET is systematically larger than that from NASA AERONET (Holben et al., 1998), which is also well-known network similar to SKYNET, and that sometime SSA from SKYNET is unnaturally close to unity (Badarinath et al., 2011). To investigate the cause of above problems, we conducted sensitivity tests for the possible causes of error in SSA in the retrieval process of SKYRAD.pack. We also checked a difference in SSA between the inversion algorithms. From the sensitivity tests, it is found that error of -0.1 in surface albedo, -5% in solid view angle or -5% in the calibration constant result in errors of +3.0%, +2.3%, or +4.7% in SSA, respectively. As to the type of inversion method, this study used SKYRAD.pack version 4.2 with either the Phillips-Twomey method (Phillips, 1962; Twomey, 1963, standard method) or the maximum a posteriori (MAP) method (which is similar to the AERONET inversion algorithm). From the simulation results it is found that there are two cases of large deviation of the retrieved SSA from the true SSA value, i.e., 1) the Phillips-Twomey method overestimates the SSA value when cirrus particles clouds exist in the atmosphere because this method regards the cirrus particle size distribution as a coarse aerosol size distribution. 2) When aerosol a priori size distribution in the analysis

using the MAP method does not include the coarse particle mode, the SSA value is underestimated in the case the large coarse particles in the size range larger than 10 μm in radius exist dominantly. Then we analyzed the real data at Pune (18.6˚N/73.8˚E) and Beijing sites (36.0˚N/140.1˚E) and compared the results with those of AERONET. From the result, it is found that in cases of the cirrus contamination detected by CALIPSO lidar, the SSA values retrieved by SKYNET Phillips-Twomey method is lager than that from the MAP method and/or AERONET. And we found one significant dust case that Phillips-Twomey method seems to retrieved the size distribution of coarse dust particle mode more reasonably than that from MAP method with suppressed a priori particle size distribution in coarse mode. Therefore, we propose a new data screening method that rejects data in cases of 1) the aerosol optical depth at 0.5 μm is less than 0.4, 2) the reconstruction error of sun and sky irradiances is equal or larger than 7%, and 3) significantly large coarse mode size distribution. We applied above data screening to the data at Pune (April to December, 2008) and Beijing (February to September, 2004). Then, the case of the SSA values close to unity and the variability were reduced, respectively (Fig.1).

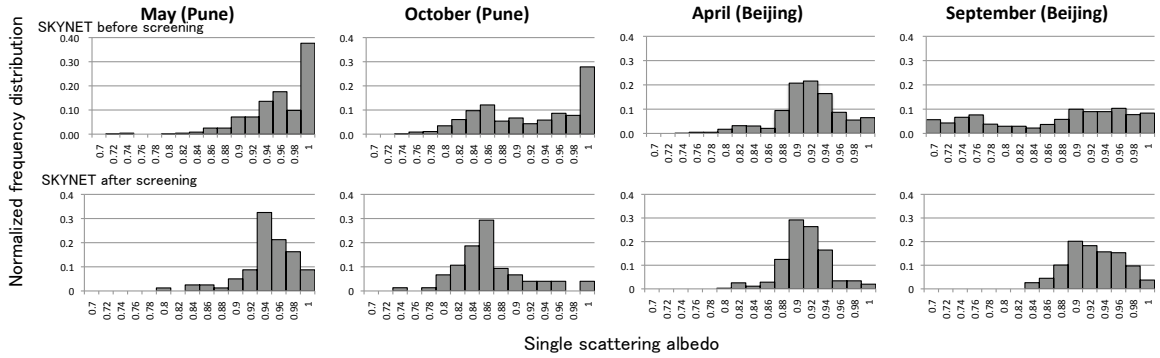

Fig.1 Normalized frequency distribution of SKYNET SSA before (upper panel) and after (lower panel) data screening in May and October 2008 at Pune and in April and September 2004 at Beijing.

Use of 315nm channel of sky radiometer to retrieve columnar ozone amount

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Abstract

Sky radiometer data are being used to study aerosol and cloud parameters as well as water vapor content of our atmosphere. In order to further extend the utility of this instrument to measure columnar ozone concentration, we propose ozone concentration retrieval method using 315nm channel data of sky radiometer. The proposed method consists of (i) calculating calibration constant of direct intensity at 315nm using *in situ* observation data, which is an alternation of traditional Langley method, and (ii) retrieval technique of ozone concentration using sky radiometer observation data. For the limited set of data, the retrieved ozone concentrations using proposed method agreed well with directly measured ozone concentration by Brewer Spectro-photometer with root mean square error (RMSE) of 0.02atm-cm, validating the reasonable accuracies of *in situ* calibration and ozone retrieval techniques. The proposed method will be further validated using more observation data.The error analysis study suggests that the proposed method can have low retrieval error at high solar zenith angle and vice versa. The retrieval error differs with magnitudes of error

associated with calibration constant, measured direct intensity and aerosol and Rayleigh optical thicknesses.

Column water vapor retrievals from skyradiometer (POM-02) 940nm channel data.

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Abstract

Skyradiometer (POM-02, Prede Co., ldt.) is used to retrieve aerosol optical properties and to estimate the radiative effect of aerosol properties on the surface solar irradiance. The skyradiometer (POM-02) has a 940nm channel in the water vapour absorption band. This channel data is not fully utilized until now. The column water vapour is one of the important factors to determine the surface radiation budget and in addition when we use the near infrared channels, 1225, 1627, 2200nm, the transmittances by water vapour in these channels are necessary. In this study, the 940nm channel was calibrated by the Langley method, which is taken into account of gas absorption. The relation between column water vapour is determined using the simulation data; McClatchey's (1972) five atmospheric models, U.S. standard atmosphere 1962, and four modified McClatchey's atmospheric models were used to calculate the transmittance at 10 different times in order to simulate a large range of path length. Once the transmittance is obtained, we can retrieve column water vapour using this relation. This method was applied to the data at Tsukuba, Japan in 2010 and the comparison between column water vapours from POM-02 and GPS was made. The results show that bias error is 0.09 (g/cm2), root means square error is 0.179(g/cm2), and correlation coefficient is 0.966. The coefficients of linear regression line (POM-02=C1*GPS+C2) between them are C1=0.957 and C2=0.169.

Retrieval of calibration parameters for ground based Sun-Sky radiometric measurements of columnar water vapor using operational surface meteorological measurements

[1]Monica Campanelli, [2]T. Nakajima, [3]P. Khatri, [3]T.Takamura, [5]A. Uchiyama, [4]V. Estelles, [1]G.L. Liberti, and [1*]V.Malvestuto

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* died on May 2011

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Abstract

Sun-sky radiometers are instruments created for aerosol study, but they can measure in the water vapour absorption band allowing the estimation of columnar water vapour *W* in clear sky simultaneously with aerosol characteristics, with high temporal resolution. A new methodology, cheap and easy to implement, is presented for estimating calibration parameters (i.e. characteristic parameters of the atmospheric transmittance and solar calibration constant) directly from the sun-sky radiometers measurements. To initiate the proposed methodology some seasonal independent measurements of columnar water vapour taken over a large range of solar zenith angle simultaneously with the sun-sky radiometer measurements, are needed. In this work the Surface Humidity Method (SHM) was developed allowing to initiate the procedure with columnar water vapour estimated by standard surface meteorological observation (temperature, pressure and relative humidity). The time pattern of columnar water

vapour from sun-sky radiometer was compared with simultaneous measurements from microwave radiometer and radiosondings showing respectively a total correlation of 0.98, 0.96 and a total median difference of 2.24 mm and -0.65 mm. The accordance with radiosondings was found within the uncertainty of the methodology (varying from 10 to 16 %) independently on the amount of atmospheric water vapour.

Results were also validated against the columnar water vapour estimated by using the procedure adopted by the University of Uchiyama, that is similar to the one adopted by AERONET network, and consists in retrieving the characteristic parameters from a fitting procedure of simulated transmittance versus the product mW, were m is the optical airmass. Also in this case the accordance against microwave radiometer and radiosondings is good for different water vapour classes, but we like to emphasize that the introduction of a water vapour dependence in the characteristic parameters of the atmospheric transmittance, improved the agreement with the Microwave Radiometer measurements especially in the cases with the lowest water vapour content.

An improved cloud screening algorithm for skyradiometer measurement analysis and application to Asian dust detection

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Abstract

Cloud screening algorithm including variability test and coarse mode test was developed for removing cloud-affected data in the skyradiometer measurements. The results compared to cloud amount from weather station reports and lidar measurements show that the variability test appears to effectively remove thick and low-level clouds. On the other hand, the use of size distribution appears to effectively remove thin and high-level clouds. The new algorithm based only on using skyradiometer measurements demonstrated that cloud screening can be improved in comparison to the SKYNET data processing algorithm.

The developed cloud screening method is then applied for the dust detection from skyradiometer measurements. Validating results with SYNOP dust reports and the yellow sand index from lidar measurements, it was shown that the developed cloud screening methods helps to detect dust cases, effectively removing cloud-contaminated signals from the dust signals that determined from current SKYNET algorithm. In turn this algorithm contributes to improved accuracy of the dust influence on radiative forcing and its efficiency by reducing uncertainties in the AOT and SSA retrievals.

Combined use of SKYNET observations for retrieving microphysical properties of cirrus clouds

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Abstract

SKYNET has been collecting radiation data for more than ten years with several instruments. Especially at the super sites such as Cape Hedo and Fukue Isle observatory, intensive measurements have been carried out with a lot of instruments (e.g. skyradiometer, pyrheliometer, pyranometer, pyrgeometer, microwave radiometer, sunphotometer, and lidar). Synergetic analysis of cloud and aerosol properties using these instruments together were not performed sufficiently. We will analyse optical properties of cirrus clouds by the synergetic use of several instruments and will compare the derived properties to the ones from MODIS analysis.

The first target is an improvement of the i-skyradiometer algorithm developed by Kikuchi (2006) to retrieve cirrus cloud microphysical parameters. The second is to use data taken by other instruments to reduce uncertainties caused by the existence of aerosols and/or broken clouds. Finally we would like to compare the results with MODIS results.

Development of a SKYNET based methodology for the CIMEL CE318 radiometer in the frame of the ESR network

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Abstract

The European Skynet Radiometers network was recently established by several European universities and research institutes as a volunteer network of Prede POM sun sky radiometers, federated with SKYNET in Asia for international homogeneity. However, ESR is also conceived as a "multi-instrumental" network in the sense that other sunphotometers than PREDE POM can be included in the network.

With this aim, in ESR we are developing specific algorithms for other instruments (such as the well-known CIMEL CE318 sunphotometer) based on the methodology proposed by SKYNET for the PREDE instruments, but including also the methodology proposed by AERONET for the CIMEL instruments (including cloud screening for direct and diffuse measurements). These algorithms are components of the so called ESR.pack, and can be currently applied to both CIMEL and PREDE datasets. In this way, we can homogeneously process data from both instruments within the network, providing a good benchmark for the synergistic analysis of other international networks such as AERONET, and the comparative analysis of both inversion algorithms from AERONET and SKYNET, reducing instrumental effects in the inversion process.

Specifically, the ESR.pack is composed of two main programs for the analysis of the direct sun and the diffuse sky radiance components. Both programs are named *sunrad* and *skyrad* (the later based on the SKYRAD.PACK version 4.2), respectively. In this presentation we will show the main results of the application of this software to the CIMEL CE318 sunphotometer, including the validation and comparison with AERONET derived properties. Furthermore, a comparison between results for PREDE and CIMEL is included. In this contribution we also show results from the application of the in situ improved Langley plot. We will also describe future developments, in relation with the cloud screening algorithms, estimation of aerosol radiative forcing, and cloud properties retrieval.

Ground-based lidar network observation of aerosols and clouds in AD-Net

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Abstract

The recent status and future strategy of the ground based lidar network observation in AD-Net is presented. We have constructed lidar network using dual-wavelength (532 and 1064nm) polarization (532nm) Mie lidars covering a wide area in East Asia (AD-Net: the Asian Dust and aerosol lidar observation NETwork) and conducted aerosol and cloud observation for more than ten years in cooperation with many researchers. Some sites in AD-Net have joined in SKYNET and provided information on vertical structures of aerosols and clouds. An algorithm to estimate vertical profiles of spherical aerosols (air pollution) and nonspherical aerosols (mineral dust) separately using the lidar data has been developed. The derived aerosol component data have been recently used in assimilation of numerical models and evaluation of impacts on human health and vegetation. Further, we have proceeded to improve the network lidar system by introducing more advanced lidar techniques (Raman lidar and High spectral resolution lidar techniques) in order to obtain more detailed optical properties of aerosols and clouds and to develop aerosol retrieval algorithms to classify more aerosol components using the lidar data. Synergy algorithms using data of the lidars and passive sensors such as a skyradiometer are essential for understanding complicated optical and microphysical properties of aerosols comprehensively. We will develop a synergy algorithm to estimate vertical distributions of several aerosol components and their vertically mean mode radii using lidar and skyradiometer data. In the workshop, we will present ideas of the synergy algorithms as well as reporting recent development of AD-Net.

Development of an algorithm to estimate the aerosol vertical profile from Sky radiometer and Lidar measurements

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Abstract

We have developed an algorithm to estimate the vertical profiles of refractive indexes and volume size distribution from the routine measurements of SKYNET (sky radiometer and dual wavelength polarization Mie lidar). Optical properties of aerosols such as extinction coefficient, single scattering albedo, and asymmetry factor are further evaluated from the derived refractive indexes and size distribution. The algorithm consists of two steps. In the first step, the refractive indexes (real and imaginary parts) at sky radiometer wavelengths (340, 380, 400, 500, 675, 870, 1020 nm) and the volume size distribution in the column are estimated from sky radiometer measurements. The size distribution is assumed to be bi-modal lognormal distribution. In the second step, the vertical profiles of the refractive indexes (real and imaginary parts) at lidar wavelengths (532, 1064 nm) and the size distribution are estimated from the attenuated back scatter measurements, and optical depth and single scattering albedo obtained from the results of the first step. The size distribution is also assumed to be bi-modal lognormal distribution. At each step, the aerosol parameters are estimated on the basis of the Maximum Likelihood Method. The developed algorithm was tested for vertically non-homogeneous profiles (e.g., dust in the upper layer). The vertical profiles of extinction coefficient, single scattering albedo, and asymmetry factor at 532 nm were well estimated but those at 1064 nm were not. The vertical profiles of the size distribution were also well estimated. We also developed the algorithm with HSRL (High Spectral Resolution Lidar) which is being developed in NIES. In the presentation, we will show the algorithm with HSRL, and the results for the actual observations of sky radiometer and Mie lidar.

Calibration and performance of Prede Skyradiometer

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Introduction:

Recently, skyradiometer (model, POM-01L), made of PREDE Co., Ltd, Japan was installed at a high altitude pristine station, Merak ($33^0 48^/$ N and $78^0 37^/$ E, 4310 m, amsl), in Ladakh region and of Jammu and Kashmir state of India. The station exhibits a cold-desert climatic condition with little snow cover and free from any kinds of anthropogenic activities. Further, the station is located adjacent to the Pangong Lake. The lake is surrounded by 5 km wide and 134 km long and it extends from India to China. Two thirds length of the lake lies in China. During winter, the surface of the lake is completely frozen. Since the station is located at a high altitude, having cold-desert and dry atmospheric conditions, the amount of water vapor present at the site is very low. Further, aerosol concentration at the station is very low and is similar with Hanle [$32^0 47^/$ N and $78^0 58^/$ E, 4500 m amsl], where another high altitude station in Ladakh region and the same instrument was operating for more than three years of continuous data as a part of astronomical site survey program [Veram et al., 2010]. Figure 1 shows the Prede Skyradiometer at the present observing station, located adjacent to the Pangong Lake.

Instrumentation:

The instrument consists of an automatic sun tracking system, a spectral scanning radiometer, a rain detector, and a sun sensor. It has seven filters (315, 400, 500, 675, 870, 940 and 1020 nm) with band widths ranging from 2 to 10 nm. The instrument measures both direct and diffuse sky radiances at pre-defined scattering angles at regular intervals. These data are further processed using Skyrad.Pack (version 4.2) code [Nakajima et al., 1998]. The code consists of a multiple scattering radiative transfer scheme in a plane-parallel atmosphere and an inversion procedure to retrieve aerosol optical depth (AOD), aerosol size distribution, aerosol phase function at several scattering angles, and single scattering aledo (SSA) from the direct and diffuse solar irradiance measurements in almucantar and principal plane geometries. The unique features of the instrument include an in-built calibration capability, an automatic solar disk scanner for calibration of solid view angle, and a single detector design. Further, AOD is measured on the basis of the Lambert-Bouger low including the calibration constant of the instrument, solid view angles of each channel, correction factor of Sun-Earth distance, correction for Rayleigh scattering and total column of ozone.

Results:

Calibration of skyradiometer is performed periodically by estimating solid view angle for each channel by performing disk scan and estimating the solar radiometer constant from the improved Langley method. Disk scan of each channel is performed in an area of 2 degree X 2 degree around the solar disk with an angular resolution of 0.1 degree. The disk scan is performed periodically for more than twice or thrice in a month and the result of the solid view angles for each channel is nearly stable with less than 0.5% deviation. The maximum and minimum pressure difference at the site is around 1% of daily mean. The difference of AOD due to 2% variation in station pressure is around 0.004 to 0.002 at 400 and 500 nm, respectively and rest of the filter shows negligibly small. The Calibration constants (F0Is)

obtained during two years of data shows drifting with a relative standard deviation (RSD) of 5.8 %, 4.7%, 4.4 %, 5.0 % and 3.9 % at 400, 500, 675, 870 and 1020 nm, respectively through the improved Langley method (Verma et al., 2010).

Figure 1: Prede Skyradiometer at the present observing station (Merak), located adjacent to the Pangong Lake.

Due to pristine and clean environment, the difference between improved and normal Langley plot is quite similar with a negligible difference. The ratio of the calibration constants obtained by the two methods varies in between 0.99 to 1.00. Due to pristine environment and far from any kinds of anthropogenic sources, these sites (Merak and Hanle) can be a considered as ideal stations like the Mauna Loa [3400 m amsl] in the Pacific Ocean for calibration of sunphotometer instruments.

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Comparison of aerosol optical properties between CE 318-1 of AERONET and POM-02 of SKYNET

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Abstract

The Distributed Regional Aerosol Gridded Observation Networks (DRAGON) campaign for comparison/validation of satellite aerosol products with ground-based aerosol retrievals was conducted in Korea between March and May 2012. During the campaign CIMEL sunphotometers were operated at around 20 sites throughout the country. The Hankuk University of Foreign Studies site (Hankuk_UFS, 37.02^{o}N, 127.16^{o}E, 167 m above sea level) is located about 35 km southeast of downtown Seoul. A PREDE skyradiometer (POM-02) was operated along with CIMEL sunphotometer (CE 318-1) to compare the aerosol optical properties derived from the two instruments. Intercomparison operation started with the DRAGON-Korea campaign and has continued for a year. POM-02 and CE 318-1 measured diffuse radiation at 11 wavelengths at 6-minute intervals and 4 wavelengths at 1-hour intervals, respectively. Aerosol optical depths (AOD) from these two instruments were compared at 440, 675, 870, and 1020 nm when the measurement time coincided within 3 minutes. Because AOD at 440 nm was not available for POM-02, it was obtained from interpolation of AOD at 400 nm and 500 nm. Other aerosol optical properties such as Angstrom exponent, single scattering albedo (SSA), absorption AOD, and absorption AE from the two instruments were compared in a similar way. AOD had a good correlation between the two instrument. However, SSA from the skyradiometer tended to be larger than that from sunphotometer. Larger SSAs seemed to be due to underestimation of absorbing

parameters such as imaginary part of refractive index. It was presumed that factors causing the difference were different assumption of retrieval algorithm of each network regarding refrative index, radii bin of volume size distribution, and the shape of aerosols.

The validation and comparison of aerosol properties retrieved By CARSNET algorithm with the AERONET

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Abstract: the 3 months data (15 Aug 2012 to 15 Nov 2012) retrieved by two CE-318 radiometers in the same position were used to validate the stability of the algorithm and the one-year outcome from Apr 2008 to Feb 2009 retrieved by the algorithm in Beijing (not the same position for AERONET station) were compared with data from the AERONET. For the stability validation, the algorithm showed a high stability for sun direct part but a little drift for sky inversion part. The slope of straight line fit close to 1.0 and correlations were all larger than 0.99 for aerosol optical depth (AOD) at all wavelength. The single scattering albedo (SSA) showed high similarity at AOD~1.01-1.33 and obvious difference at AOD~0.56-1.01. The volume size distribution at peak was inconsistent for the two instruments. The slopes of effective radius were 0.993, 0.899 and 0.728 for total, fine and coarse particles, respectively. The SSA was consistent at AOD~ 0.8-2.0 for the two algorithms. The volume concentration was agreed well. For the comparison with AERONET, the correlations of AOD were decreased to 0.98. The differences of volume size distribution and volume concentration become lager. These can be explained by the differences of the position of the two stations, the meteorological conditions and the parameters of two algorithms.

Comparison of CALIPSO aerosol optical depth retrievals to sky radiometer and space-based passive measurements, and characteristics of the lidar ratio

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Abstract

The aerosol optical depth (AOD) obtained by the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) level-2 aerosol product has been compared with the AOD from the Moderate Resolution Imaging Spectroradiometer (MODIS)-Aqua level-2 product. Such comparisons have been performed for five different aerosol subtypes namely, clean marine, dust, polluted dust, polluted continental, and biomass burning, over the ocean from June 2006 to December 2010. MODIS AOD at 550 nm (0.108 ± 0.081) for the collocated data pairs is about 61% higher than CALIOP AOD at 532 nm (0.067 ± 0.074). For the clean marine, MODIS AOD (0.107 ± 0.066) is almost twice the CALIOP AOD (0.056 ± 0.041), and the difference between the AOD values has a strong latitude dependence likely related to the surface wind speed over the ocean. The difference in AOD for dust (~12.4%) is observed to be the lowest among the five aerosols types under consideration, but it shows slight regional variation. The discrepancy of AOD for dust also shows strong dependency on the layer mean of the particulate depolarization ratio. The differences of AOD for polluted dust and polluted continental show similar tendency of higher CALIOP AOD than MODIS AOD for most part of the ocean. One of the possible reasons for the difference is the misclassification of clean marine as polluted dust and polluted continental in CALIOP algorithm. In addition, the

discrpency of AOD may suggest that assumptions made in satellite retrievals, such as the assumed lidar ratios (i.e., extinction-to-backscatter ratio) for CALIPSO retrievals, or the surface reflectance information and/or the aerosol model utilized by MODIS algorithm, are not appropriate. In the operational CALIPSO data analysis, lidar-derived aerosol optical depths are typically estimated using a single lidar ratio for each aerosol. type. Hence, we computed the lidar ratio at 532 nm using 4-year measurements of elastic backscatter lidar and SKYNET sky radiometer in Seoul, Korea. The annual mean lidar ratio (with standard deviation) is found to be 61.7±16.5 sr, and weak seasonal variations are noted with a maximum in summer (68.1±16.8 sr) and a minimum in winter (57.2±17.9 sr). The lidar ratios for clean, dust, and polluted conditions are estimated to be 45.0±9.5 sr, 51.7±13.7 sr, and 62.2±13.2 sr, respectively. While the lidar ratio for the polluted condition is appears to be consistent with previous studies (50-70), clean and dust conditions tend to have larger values, compared to previous estimates (clean: 30-40, dust: 40-50). Also, we used the SKYNET and AERONET retrievals to compute a lidar ratio climatology. Detailed results will be presented.

Aerosol Variations in Urban Atmosphere: Case Studies in Beijing and Dunhuang

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Atmospheric aerosols play important roles in climate and atmospheric chemistry: They scatter sunlight, provide condensation nuclei for cloud droplets, and participate in heterogeneous chemical reactions. To enable better understanding of the vertical physical, chemical and optical feathers of the aerosols in East Asia, using some atmospheric and chemical instruments on board the tethered-balloon system, a series of measurements were operated in some typical places of East Asia, incluing Dunhuang, which is located in the source origin district of Asian dust and Beijing, which is the representative of large inland city in the years of 2007-2011, some of which was compared with the simultaneous Lidar observations. The simultaneous observations over the districts of China, Japan and Korea by using the tethered balloon systems are highly expected.

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Ground-based remote sensing of aerosol seasonal character over Hefei in East China

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Atmospheric aerosols have a significant impact on climate due to their imporatant role in modifying atmosphere energy budget. The ground-based remote sensing instruments give great opportunity for better understanding of aerosol effects on climate. We start the long-term monitoring of aerosols by using a prede sky radiometer (POM-02) on SKYNET. The seasonal characters for aerosols are collected over Hefei Radiation Observatory (HeRO) from Mar. 2007 to Aug. 2012. The result shows that the seasonal mean aerosol optical depth (AOD) at 500 nm is 0.80, 1.01, 0.79, and 0.76 in MAM, JJA, SON, and DJF respectively. And the corresponding aerosol angstrom exponent (AAE) using spectral AOD from 340 nm to 1020 nm is 0.97, 1.24, 1.30, and 1.12. The averaged value of single scattering albedo (SSA) at 500 nm for all seasons is more than 0.95. The averaged asymmetry factor (ASY) at 500 nm is about 0.7 during each season. The frequency distributions of AOD and AAE for each season are shown, which indicate obvious seasonal variations, especially, on AAE. Due to dust events through North-West and/or North airflow, the aerosol loading contains much more lager particles of dust in MAM and DJF than in others. The relationship between AOD and AAE in different time span of day for each season is also discussed.

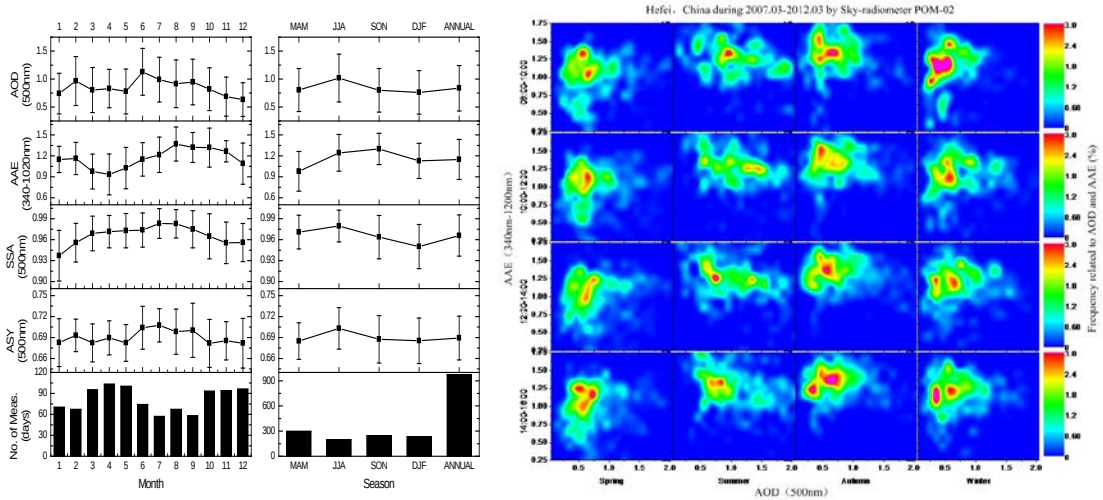

Fig. Averaged value of AOD, AAE, SSA and ASY monthly and seasonally (left), and relationship between AOD and AAE (right) over HeRO from Mar. 2007 to Aug. 2012

SUN-SKY RADIOMETER STUDY OF MONSOON ACTIVITY OVER PUNE, INDIA

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Abstract

Aerosol-cloud-radiation interactions modulate monsoon activity, and related studies could serve as indicators for possible prediction and assessment of weather and climate on different spatial and temporal scales through circulation. Besides several thematic campaigns utilizing a variety of platforms including satellites, ground-based networks have been established to improve our understanding of the role of aerosols in the changing monsoon climate. Two such widely known networks over the globe are 'SKYNET' and 'AERONET' with Sun-sky radiometer as the principal equipment that characterizes aerosols and gases over different geographical locations under varied air mass conditions. Pune ($18^{o}43'$ N, $73^{o}51'$ E, 559 m above mean sea level), a fast growing urban city in India, is one of the sites where Prede (POM-01L, SKYNET) and Cimel (CE-318, AERONET) Sun-sky radiometers have been in operation since 2004. These radiometers have been extensively used in several studies related to stand-alone and coupled aerosol-cloud-climate processes. The Prede instrument at this site is being augmented to the network of Global Atmospheric Watch (GAW) program of World Meteorological Organization (WMO) to facilitate data coordination through the World Data Center for Aerosols (WDCA).

The present study envisages to understand the response of atmospheric constituents, through simultaneous operation of the radiometers amongst others, to the rainfall activity over Pune during two contrasting monsoon years of 2008 (active / normal, 98% of long period average (LPA) rainfall over the whole country) and 2009 (break / drought, 78% of LPA). The synthesis of data indicates that, apart from excellent agreement between the direct sun

observations, both radiometers capture well the monsoon features within the instrument density and efficacy of data retrieval algorithms involved. The aerosol products from satellite data, meteorological fields from NCEP/NCAR re-analysis and NOAA-HYSPLIT air-mass trajectory analysis during the study period have also been utilized. The chief results of the study include the following:

- Relatively higher aerosol optical depths (AODs) associated with larger Angstrom exponents (dominance of smaller particles) during 2009 by both Sun-sky radiometers, which corroborate lower precipitable water content, higher ground temperature and lower rainfall amount during the period.

- Relatively greater asymmetry factor (g) and lower single scattering albedo (SSA) during 2008 and vice-versa during 2009 observed by the Prede radiometer and converse in the case of Cimel radiometer, which coincide with smaller real and imaginary parts of aerosol refractive index of Prede as compared to those of Cimel during 2008 and 2009.

- Similar contribution to the monsoon activity from fine-mode segments of volume size distribution observed by Prede and Cimel, while significantly larger contribution from coarse-mode segment in the case of Prede during both years under study.

- The association between AOD and Angstrom exponent revealed abundance of desert dust (about 25 per cent), next to urban industrial aerosols (about 70 per cent), over the experimental station during drought year (2009) as opposed to the active monsoon year (2008).

More results of the analysis of data, extending to other monsoon years, from both Prede and Aeronet Sun-sky radiometers and *in-situ* observations will be presented. Such results would be useful for multi-parameter mapping of aerosols and their role in climate change.

Identification of aerosol types over the Indo-Gangetic Basin using ground-based sunphotometer measurements

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Abstract

A discrimination of aerosol types over the Indo-Gangetic Basin (IGB) region during pre-monsoon period was made using multi-year ground-based sunphotometer measurements. Based on the measured aerosol parameters, five different aerosol types were identified as polluted dust (PD), polluted continental (PC), mostly black carbon (MBC), mostly organic carbon (MOC) and non-absorbing (NA) aerosols at the two typical locations over IGB. Study suggests high dust enriched aerosols (i.e. PD) were contributed more over the central IGB station at Kanpur (~62%) as compared to the eastern IGB station at Gandhi College (~31%). However, opposite was observed for polluted continental aerosols at these two stations, which contain high anthropogenic and less dust aerosols. Contributions of carbonaceous particles having high absorbing (MBC) and low absorbing (MOC) aerosols were found to be ~11% and 10%, respectively at Gandhi College. This was ~46% and 62% higher than the observed contributions at Kanpur. However, very less contribution of NA aerosols was observed only at Gandhi College (2%). Variability in aerosol types together with single scattering albedo (SSA) at both the stations suggests their strong association with emission sources. Results were well substantiated with the air mass back-trajectories and the fire products. The

estimated absorption Ångström exponent (AAE) values suggest relative dominance of absorbing type aerosols over the central part of IGB (due to dominant dust absorption) as compared to the eastern part during pre-monsoon period.

Optical and chemical properties of atmospheric aerosols at Phimai in Thailand by surface measurements, CALIOP data, and the SPRINTARS model

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Abstract

Atmospheric aerosols were measured at the Observatory of Atmospheric Research, in Phimai, Thailand, a station of SKYNET, during 2006-2008. The mass concentrations and major chemical components in fine and coarse aerosols were analyzed, and the optical properties

such as AOT and SSA were calculated from the data measured by skyradiometer. Surface wind data typically showed a wet season (from May to September), and a dry season (from October to April) which is divided into early (October-November), middle (December-early March), and latter (middle March-April) periods. In this paper, the following topics are summarized;

1. Chemical characterization: For $PM_{2.5}$ aerosols in the dry season, the air pollutants emitted by fossil fuel combustion was dominant in the early season, which was transported from east Asia. In contrast, in the latter period, the aerosols emitted by biomass burning in Indochina Peninsular were predominant. The middle period showed a mixture state between the early and latter periods. The concentration ratio of EC/nss-SO_4 showed a large difference between the early and latter periods, and which was consistent with the result simulated by the SPRINTARS model.

2. Optical properties: AOT in the field study showed a clear seasonal variation, and was much higher in the dry season than in the wet season. The AOT in the dry season could be positively correlated with the mass concentration of $PM_{2.5}$ near the surface. And SSA was compared with that independently calculated with a shell-core model using the measured chemical composition.

3. Comparison between the SPRINTARS model and the field measurements: The seasonal variation in the concentration of elemental and organic carbons, ammonium sulfate, sea-salt particles and dust particles, calculated by the SPRINTARS model generally showed a good agreement with the field measurements. The dust concentration in the dry season, however, was much lower in the model than in the measurements, and which may be attributed to the local dust particles which lifted up by thermal plumes generated from biomass burning.

4. Long range transport of dust aerosols in the wet season: Trace elements such as Si and Ti which are good indicators of dust aerosols showed high concentrations during 17-20 June 2008 even in the wet season, comparable with those in the dry season. CALIOP data and the result of the SPRINTARS model showed a large amount of dust aerosols over Indian Ocean up to the height of 5km, and backward trajectory analysis by using the NOAA HYSPLIT model showed a long range transport of polluted air massess rich in dust aerosols from the desert areas in west Asia/east coast of North Africa.

Sky-radiometer measurements for monitoring the aerosol optical properties in the Arctic and Antarctica

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Abstract

Atmospheric aerosol has a potential to change the global climate by direct and indirect effects on radiation balance in the planetary atmosphere. The direct effect is generally expected to be small in the polar regions, but the indirect effect may cause a large difference of cloud properties between the Arctic and Antarctic regions. National Institute of Polar Research (NIPR) promotes the atmospheric research in both polar regions, and employs remote-sensing instruments for aerosol and cloud studies. For investigating the aerosol optical properties, sky-radiometry based on a radiation inversion algorithm is powerful to retrieve the column-averaged aerosol volume size distribution, single scattering albedo and complex refractive index as well as aerosol optical thickness and Angstrom exponent. In order for long-term monitoring of the aerosol properties, NIPR operates Prede POM-02 sky-radiometers at both polar sites, i.e., Ny-Alesund Station (78.9N, 11.9E) in the Arctic and Syowa Station (69.0S, 39.6E) in Antarctica. And further we recently developed a new sky-radiometer POM-01 MK

III for ship-based measurements. In this paper, we will present a summary of the project and results from surface-based measurements in the polar regions and also those from ship-based measurements during the Antarctic cruises by the Icebreaking R/V Shirase for the Japanese Antarctic Research Expedition activities.

One year of measurements with a POM02 sun-sky radiometer at an Alpine Euroskyrad station

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Abstract

A new PREDE POM02 sun-sky radiometer was installed in Aosta (7.3570E, 45.7422N, 570 m a.s.l.), northern Italy, in May 2012. The site is located in an Alpine valley, in a semi-rural context, just out-of-town and partially influenced by anthropogenic activity both on local (emissions from vehicles, heating systems, steel mill) and regional (advection from the Po Valley) scales. Local meteorological phenomena such as thermal inversions, mountain-valley breezes and Föhn winds strongly condition the aerosol load at the measurement site.

The instrument, managed by the Environmental Protection Agency (ARPA) of the Aosta Valley, is used as ancillary instrumentation in the framework of the research at the solar observatory and as a fundamental data source for radiative transfer modeling. Furthermore, it represents an original link between solar and air quality monitoring programs. Indeed, measuring the aerosol optical properties may help in identifying possible sources of particulate matter and in characterizing it.

The site has joined the EuroSkyRad network (www.euroskyrad.net) and both Skyrad 4.2 and ESR.pack inversion products are daily available. Retrievals from Skyrad 4.2 are obtained by using both direct and diffuse radiation measurements, mirroring the Skynet inversions (atmos.cr.chiba-u.ac.jp). The products (aerosol optical thickness, Angstrom exponent, single scattering albedo, refractive index and volume size distribution) are presently provided at Level L0 and Level L1.1, since the cloud screening by means of measurements of pyranometer/pyrgeometer instruments needed in order to provide Level 1.2 data can not be

performed, yet. Retrievals from ESR.pack are obtained by using only direct measurements (Sunrad module) and cloud screening is performed according to Estelles et al. (2012).

The inversion of direct-only measurements resulted very important in the Aosta site. Indeed, two typical effects of the Alpine region prevent the inversion of almucantar scans, strongly reducing (>50%) the number of measurement days: the recurring presence of scattered clouds due to the complex orography and the mountain obstruction for solar zenith angles larger than 70°.

First results from one year of measurements (processed by both Skyrad4.2 and ESR/Sunrad) will be presented. Correlations with in-situ measurements of fine particulate matter (PM), wind direction and speed and long-range trajectories will be shown based on several case studies. Finally, AOD measurements by our POM02 and a colocated Brewer spectrophotometer will be compared in the UV and visible range.

V. Estelles, M. Campanelli, T. J. Smyth, M. P. Utrillas, and J. A. Martınez-Lozano, *AERONET and ESR sun direct products comparison performed on Cimel CE318 and Prede*

Continuous ground-based observation of aerosol optical properties in Tsukuba, Japan

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Abstract

In order to investigate optical properties of aerosol, scattering coefficients and absorption coefficients have been continuously measured since January, 2002 using integrating nephelometer (TSI model 3563) and absorption photometer (Radiance Research PSAP, PSAP3λ) on dry condition at Tsukuba, Japan. Using these data, the recent 10 years trend of aerosol properties and climatology was investigated.

The results show that the aerosol characteristics have seasonal variation and the tendencies to decrease or increase. These tendencies were significant in the confidence level 95%. The extinction, scattering, and absorption coefficients (1/m) had trends to decrease in the period from 2002 to 2012; -6.05x10-6, -4.94x10-6(1/year) at wavelength of 550nm and -1.11x10-6(1/year) at wavelength 526nm, respectively. The Single scattering albedo has the trends to increase in the same period; 4.27x10-3(1/year) at wavelength of 550nm. Asymmetry factors have the trends to decrease in the same period; -2.22 x10-3(1/year) at wavelength 550nm. The extinction Ångström exponent has the tendency to increase, and the effective radius has the tendency to decrease. These tendencies are consistent with the tendency of asymmetry factor. The values of absorption Ångström exponent were about 1.0 and have seasonal variation. The absorption Ångström exponent had the trend to increase in the period from 2006 to 2012; 1.15x10-2(1/year). The change of absorption Ångström exponent suggests the change in the composition of light absorbing aerosol.

Characterization of atmospheric phenomena with SKYNET aerosol properties at Fukue-jima and Amami-Oshima islands

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Abstract

Recently, it is apprehended that aerosols emitted from factories, vehicles and slash-and-burn farming influence environment in East Asia. Atmospheric phenomena such as haze, mist and yellow sand, accompanied with aerosols, have been observed by eye at meteorological observatories and reported operationally for a long time because they usually cause severe visual hindrance. Many studies pointed out that yellow sand phenomena contained not only dust but also air pollution materials such as sulphate particles from megacities in East Asia. Accordingly, it is important to characterize the atmospheric phenomena quantitatively with mechanical or optical observation. In this study, characteristics of the aerosol with the atmospheric phenomena were investigated with sky radiometer observation at Fukue-jima island, Nagasaki (32.75°N, 128.68°E) and Amami-Oshima island, Kagoshima (28.44°N, 129.70°E) from 2003 to 2004.Statistical analyses were carried out with the retrieved aerosol optical properties in 9:00, 12:00, 15:00 (Japan Standard Time; JST=UTC+9) when meteorological data were available. Further, clear sky data with cloud amount less than unity were selected to suppress cloud contamination.As a result of the statistical analyses, it turned out that the average ± standard deviation for aerosol optical depth τ, Ångström exponent α, and single scattering albedo ω were 0.56 ± 0.19 (0.48), 1.26 ± 0.09 (0.69), and 0.97 ± 0.02

(0.99) for four haze events (for a yellow sand event), respectively. Comparing the results, it is suggested that haze consisted of smaller particles from the Ångström exponent α, while light-absorptivity is stronger with the haze events than the yellow sand one, even with fewer events around western islands in Japan from 2003 to 2004. Additional results of the synergetic data analyses with Optical Particle Counter (OPC) and LIDAR, and so on, will be carried out and discussed in terms of the aerosol characteristics in detail.

Acknowledgment: The authors are grateful for a lot of useful comments to Prof. Tadahiro Hayasaka in Tohoku University, Dr. Kazuma Aoki in Toyama University, Prof. Tamio Takamura and Dr. Pradeep Khatri in Chiba University, Dr. Akihiro Uchiyama in Meteorological Research Institute / Japan Meteorological Agency, Dr. Nobuo Sugimoto and Dr. Atsushi Shimizu in National Institute for Environmental Studies, and Ms. Yoshimi Azuma in Nara Women's University. The aerosol optical properties and meteorological data were kindly provided by SKYNET project and Japan Meteorological Agency, respectively.

Optical and in-situ measurements of aerosol, nitrogen dioxide, and water vapor in relation to weather and sky radiation conditions in Chiba

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Abstract

Aerosols and trace gases affect air quality in large cities. Theri monitoring is important also from the viewpoint of radiation budget studies. Although ground-based, in-situ sampling measurenment can provide local data on air pollutants, such data do not always represent the actual condition in a wider region. In this paper we report our recent results of differential optical absorption spectroscopy (DOAS) measurement conducted at Chiba University. Both nitrogen dioxide (NO_2) and aerosol can be continuously measured along an optical path of several kilometers using a xenon flashlight as a light source. The results are compared with the data from government-operated sampling stations located nearby. Also, aerosol characterization data taken with a three-wavelength nephelometer and optical particle counter are compared with the DOAS data to study if the sampling process in such instruments influences the aerosol quality in relation to the humidity difference between the atmospheric and laboratory conditions. In addition, data from a weather monitor, a multi-wavelength lidar system, a sunphotometer, and imaging measurements of the solar irradiance and sky radiance are exploited for the interpretation of the air quality data obtained from DOAS and related schemes.

A study of vertical profiles of aerosol radiative parameters and aerosol direct effects over the East China Sea region using a combination of aircraft and ground based observation data

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Abstract

We studied the vertical profiles of aerosol radiative parameters and aerosol direct effects over the China Sea region in the spring season using a combination of aircraft and ground based observation data. A method was developed to retrieve the vertical profiles of aerosol radiative parameters by fully utilizing the precious data collected by aircraft and a wide range of ground based instruments. Thus retrieved vertical profiles of aerosol radiative parameters were then used to study the vertical profiles of aerosol direct effects. Our results suggest that dust aerosols may prevail in the free troposphere of the East China Sea region in the spring season, though there appears no dust event near the surface and aerosols are not optically very thick. With the increase of dust aerosol volume fraction, we observed the increase in light absorption capacity of aerosol mixture, which indicates the important implication of Asian dust on aerosol climatology. The study shows that not only aerosols near the surface, but also aerosols above the boundary layer can play important roles on aerosol direct effects in this region in the spring season. The study also discusses the necessity of taking into account the vertical profiles of aerosol radiative parameters while estimating aerosol direct effects.

Investigate the single scattering albedo of dust aerosols and their impact on climate in Northwest China

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Abstract

Arid and semi-arid areas comprise about 30% of the earth surface. Changes in climate and climate variability will likely have a significant impact on these regions. Gobi and desert region over Northwest China is one of major dust aerosol sources in East Asia. To improve our understanding of the impact of dust aerosol on climate, an intensive field experiment has been conducted by Semi-Arid Climate & Environment Observatory of Lanzhou University (SACOL) in Dunhuang (40.49°N/94.95°E, 1061m ASL) over Northwestern China from April 1th to June 30th, 2012. There are two sites deployed in Dunhuang: SACOL's mobile facility (SMF) is set up nearby the farmland (located in the Gobi Desert), and a set of spectra and broadband radiometers are installed at the top of a three-floor building (about 10 meter above the ground and 1 km away from the SMF). A suite of active and passive ground-based remote sensing instruments are deployed in the field campaign, such as Micro-Pulse Lidar (MPL), Cimel sun photometer (CE318), Prede sky radiometer (POM-01), grating spectroradiometer (MS-700) and Multi-Filter Rotating Shadowband Radiometer (MFRSR). We can retrieve aerosol optical depth, Ångström exponent, volume size distribution, single scattering albedo, and asymmetry factor from these ground-based

measurements. Furthermore, aerosol optical properties can be inter-compared and validated for each other. Surface radiation quantities estimated from SBDART radiative transfer model can be compared with a dozen of the state-of-the-art ground-based radiometers' observations. The dust aerosol radiative forcing and heating rate in Gobi desert over Northwest China are estimated using the Fu-Liou radiative transfer model. This campaign is vital to understand the characteristics and variations of dust aerosols in East Asian so that we can evaluate more accurately the effect of mineral dust aerosols on global and regional climate change in the future.

Keywords: Dust aerosols, aerosol optical properties, regional climate effect, field campaign

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Cirrus clouds measurement by a three-wavelength lidar over Hefei in China

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Abstract

Cirrus clouds play an important role in Earth-atmosphere radiation budget through absorbing long-wavelength outgoing radiation from the earth and scattering short-wavelength incoming solar radiation which determined by their optical property. The optical parameters such as scattering and extinction of the cirrus clouds are related to their microphysical properties such as the complex refractive index, shape, and size distribution. A three-wavelength lidar is built in Hefei in China to study the optical and microphysical properties of the cirrus clouds which is a bistatic lidar system transmitting three laser beams at 355nm, 532nm and 1064nm wavelength simultaneously with a receiving Cassegrainian 14-inch telescope in diameter.

For optical thin cirrus clouds, a transmittance method (Young 1995) combined by the Fernald (1984) backward interactive method is used to retrieve the optical depth and the backscatter coefficient of the cirrus clouds. Fig. 1(a) shows the attenuated backscatter of the measured cirrus clouds at three wavelengths, demonstrating that the cirrus cloud altitude is approximately 13 km with a physical depth of about 1.5 km. Using the previously introduced methods, three backscatter color ratios (β_{1064}/β_{532}; β_{532}/β_{355}; β_{1064}/β_{355}) are given in Fig. 1(b), and the retrieved optical depth and the lidar ratio are summarized in Table 1.

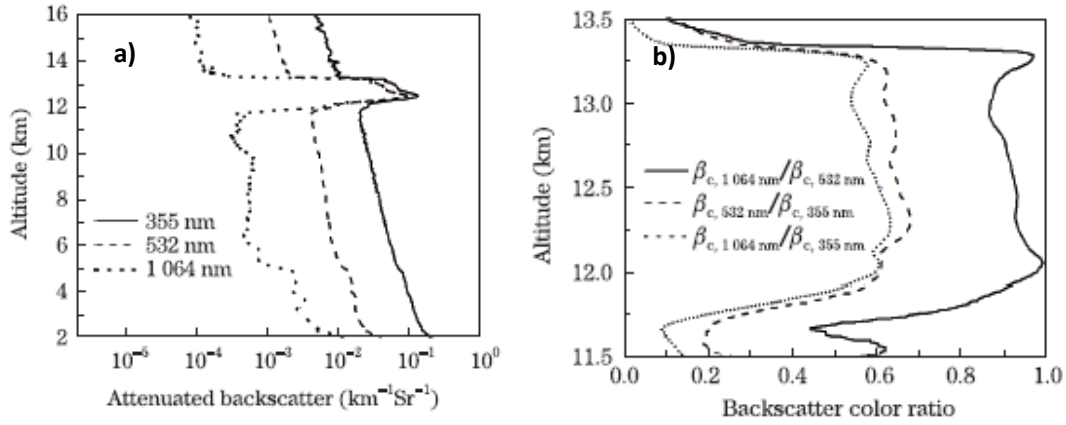

Fig 1 Attenuated backscatter(a) and backscatter color ratio(a) profiles

Table 1 retrieved parameters of the measured cirrus clouds

	355 nm	532 nm	1 064 nm
Optical Depth	0.30±0.01	0.31±0.02	0.28±0.03
Lidar Ratio (Sr)	25±1	39±3	39±7

For the optical thick cirrus clouds, attenuated backscatter color ratio is good to approximate the backscatter color ratio. From January to October in 2011, we selected the cirrus lidar data of 51 days to analysis the statistic pattern of the three different wavelength pairs as showing in Fig. 2. We found that these three pairs of color ratios almost in normal distribution mode with different peak locations, i.e. color ratio of the peak value of β_{1064}/β_{532}, β_{532}/β_{355} and β_{1064}/β_{355} is 0.9, 0.7 and 0.6.

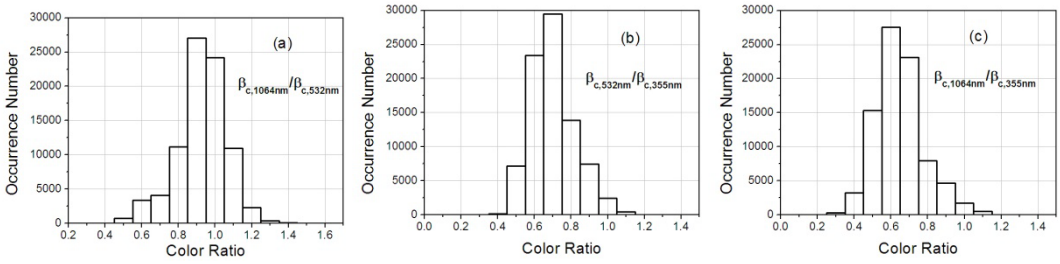

Fig 2 the statistic of the color ratio of the three different wavelength pairs

Assuming the Γ distrbution of the cirrus particle size, the ray tracing method (Yong 2000, 2005) is used to calculate the optical parameters of the six difference shapes (aggregate, bullet rosette, dendrite, solid column, hollow column and plate) of the cirrus clouds. From the relation between the color ratio and the mean effective radius as shown in Fig. 3, one can tell that the measured cirrus clouds over Hefei in this period most likely in the aggregate shape with the mean effective radius greater than 20 um.

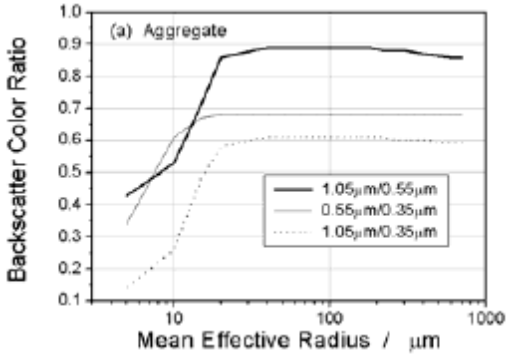

Fig 3 the relation between cirrus backscatter color ratios of aggregate shape and the mean effective radius

Surface aerosol radiative forcing at the Observatory for Atmospheric Research, Thailand during 2009-2011

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ABSTRACT

Surface radiation measurements were made at Phimai Observatory for Atmospheric Research, Thailand between 2009 and 2011 aimed to assess the impact of aerosols on the climate. The study area is located in agricultural activities surround the observatory. There are cassava field around there. The remaining crop during/after harvesting are burnt then more aerosols were released through the atmosphere. Downwelling total, direct, and diffuse radiative fluxes were measured. Aerosol optical depth measurements at 500 nm were also made by using a skyradiometer. Surface radiative forcing values were determined during 14 days of clear-sky conditions in the period of study. The maximum of aerosol optical depth was in summer in the range between 0.772 ± 0.368 and followed by winter (0.255 ± 0.151) and rainy season (0.255 ± 0.151) in respectively. Single scattering albedo in 500 nm average was 0.946 ± 0.037. It implied that aerosol in the study area has optical properties as non-absorbing aerosol. From the 14 days clear sky condition, the diurnal forcing efficiency, determined by taking the slope of the best linear fit through the flux versus optical depth plot, was found to be -32.590 ± 9.264 watts per square meter in November 2010 and , -33.429 ± 11.368 watts per square meter in December 2010.

CLIMATE CHANGE TRENDS AND DESERTIFICATION IN MONGOLIA

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Abstract

World climate change and global warming became one of the causes to have low precipitation in Mongolia. As a result, the intensive desertification were causing damages to our economy and society, as well as environment. The main factors affecting land degradation and desertification of land are reduction of precipitation due to the climate change, increase in transpiration, reduction of water supply, thus leading to poor vegetation. The focus of this study is: to analyze present and future tendency of degradation and desertification of the drylands of Mongolia. The results of continuous study on Mongolia's climate reveal that on a average the air temperature on surface from 1940 to 2012 has become warmer by 2.1^0C throughout the whole territory; by 1.9-2.3^0C in the mountainous regions; and 1.6^0-1.7^0C in Gobi and steppe regions. The warmer climate was observed in all seasons; however, the colder seasons of the year had temperature increases of 3.6^0C, spring and fall seasons had temperature increases of 1.8^0-1.9^0C. In summer season, the temperature increase was 1.1^0C. Rapid increases in the air temperature in warmer seasons and no significant increases in the level of precipitation are the main reasons for desertification in Mongolia.

Even tough, through the history, Mongolian agricultural activities such as animal husbandry and arable land development have adapted continuously to the risks associated with climate variability, the climate change requires the government efforts to increase the diversity of crops and innovate the technologies. Due to geographical shift in the agricultural land base, pasture availability and land development could be changed, and some farmers may benefit locally improved yields while others might suffer from high investment to adjust farming to climate change. The climate change may raise the competition for water in water limited region which may affect the welfare of people. There are still many uncertainness in direct and indirect effects of climate change on natural resource base and agriculture components, in evaluation and development adaptation options, and in adaptation technologies.

Cloud Radiative Effect on the Earth's Surface

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Abstract

Cloud has strong influence on radiation budget at the surface. For shortwave radiation, cloud reflects downward shortwave radiation (DSR) and shows cooling effect on surface atmosphere. On the other hand, cloud absorbs upward longwave radiation and emits downward longwave radiation (DLR). The absorption and emission make surface atmosphere warm up. The cooling and warming effects offset each other. Warming effect is strong in the low latitude because of frequent appearance of high cloud. Conversely, low cloud causes cooling effect stronger than warming effect, especially in the high latitude (Slingo and Slingo, 1988). On the global average, the cooling effect is greater than the warming effect. However, our understanding of the cloud effect on surface radiation budget is limited because cloud microphysics, cloud amount, and cloud position are sensitive to the local climate condition.

In the present study, we quantify cloud radiative effect (CRE) both on DSR and DLR. CRE is defined with the subtraction of the calculated value assumed clear-sky from the observed value under all-sky condition. To calculate radiation at the surface, we use mstrnX (Sekiguchi and Nakajima, 2008), which is two-stream one-dimensional radiative transfer calculation model considering vertical profiles of temperature and humidity obtained with radiosonde observation. Observation sites are eight stations of Baseline Surface Radiation Network (BSRN; Ohmura et al. 1998) from the subtropics to polar regions. Observation period is from 1994 to 2012 and each station has at least 1 year data. Calculated value is compensated with the subtraction of the average under clear-sky condition.

Cloud cover (CC) is one of the factors which affect on CRE both on shortwave and longwave. For longwave radiation, the average of CRE increased with the increment of CC, but the CRE

varies largely with climate condition. The effect of CC on DSR is more complex than DLR because the cloud position is important for reflection of sunlight. Therefore, in order to estimate CRE on shortwave radiation, we evaluated the cloud position using sunshine duration.

CRE on DSR normally takes negative value because cloud reflects incoming solar radiation. However, CRE on DSR sometimes took positive value because of three-dimensional effects. If cloud does not obstruct direct shortwave radiation, sunlight reflected at the cloud side and global solar radiation becomes strong. The three-dimensional effects were getting more intense and occurred more frequently with increase of CC, but positive value was almost never under complete cloudy condition without instrumental error.

For DLR, cloud base height (CBH) and cloud base temperature (CBT) are important factors because thick cloud can be assumed to be block body and emits longwave radiation from cloud base. However, the variation in CBT was small when CC is less than half of 8 oktas. Height of cloud is not directly important, but albedo of water cloud is generally larger than ground albedo without ice surface.

Atmosphere is transparent but opaque for longwave radiation. Water vapor is one of the important absorbers. CRE on longwave increased with increase of precipitable water amount (PW) under dry condition, such that PW is less than 10 mm. In areas where PW is 10-40 mm, CRE weakened with increasing PW. Under wet condition, which PW is larger 40 mm, CRE was almost invariable. In comparison with CRE of A-train product by Stephens et al. (2012), the present study showed large negative value under very dry condition and very small value at the region with small PW around 10 mm. The former discrepancy was caused by strong temperature inversion near the surface at polar regions, and the latter was caused by small amount of CC which satellite missed. These discrepancies showed the importance of the local and small climate condition which is too small for satellite resolution for CRE.

The research on global anthropogenic heat release

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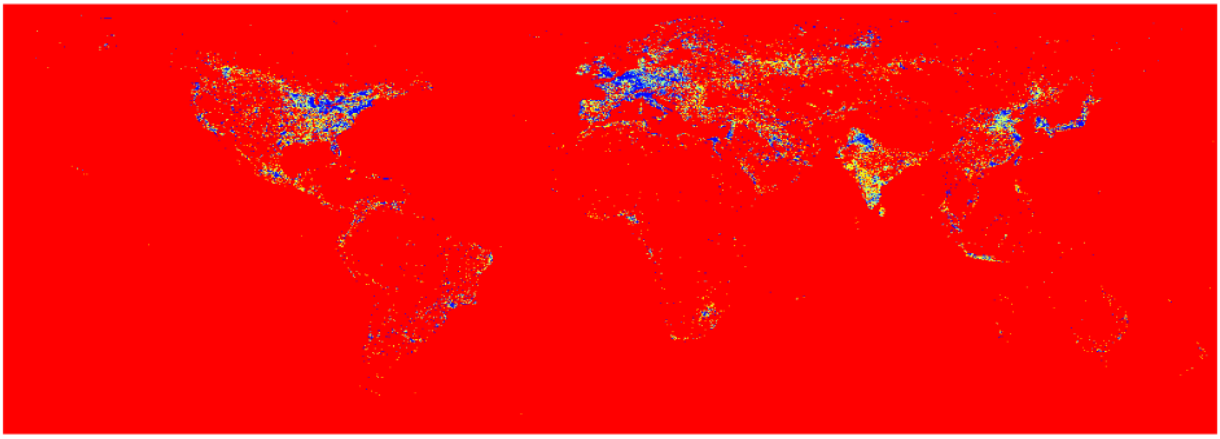
Abstract

Anthropogenic heat is important in the research for climate change caused by human activities. The NOAA DMSP/OLS satellite data is used to estimate the distribution of global anthropogenic heat release from 1992 to 2009. Additionally, the distribution of global anthropogenic heat release in the future will be discussed. The climate effect by anthropogenic heat in global climate model GAMIL will be discussed. The results show that global anthropogenic heat will affect global climate despite only in regional climate.



The climate forcing due to anthropogenic heat release

2009

Value

High : 20.49

Low : 0