Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-01 Room:211 Time:April 29 09:00-09:15

Promotion of Scientific Research on Atmosphere and Climate System Using Aircrafts: Proposal of MSJ to SCJ

NIINO, Hiroshi[1*] ; KONDO, Yutaka[2] ; SATOH, Masaki[1] ; KOIKE, Makoto[2]

[1]Atmosphere and Ocean Research Institute, The University of Tokyo, [2]Graduate School of Science, The University of Tokyo

Aircraft observation systems along with artificial satellite and ground-based measurement systems are one of the most important tools for earth observations. Rapidly on-going climate change is already influencing our social and economic activities and water and food resources, which are bases for the civilization. Therefore it is important to understand the current status of the earth system and make reliable predictions of its future to avoid serious risks caused by the climate change.

The Working Group for Earth Observation Promotion, Subdivision on Research Planning and Evaluation, the Council for Science and Technology of the MEXT has summarized critical scientific issues for understanding of the global change in its annual guidelines in 2013. These include circulation and budget of the greenhouse gases, cloud and precipitation processes, changes in tropospheric species, climate change in polar regions, and changes in water circulation. The necessity of establishing aircraft observation system for conducting well organized long-term research of the global change is also mentioned. In-situ measurements by the state-of-the-art instruments on board aircraft provide accurate data of key parameters with high spatial resolutions, which lead to improved understanding of the critical processes.

The needs for research aircrafts have long been discussed among the Japanese research communities of atmospheric science and earth science. The Meteorological Society of Japan recently proposed a research project entitled "Promotion of Scientific Research on Atmosphere and Climate System Using Aircraft" as a candidate for Master Plan of Large Research Project announced by the Japan Council of Science. This presentation gives a brief overview of the proposal. We plan to further polish up the research plans in the proposal and enrich the proposal by including possible subjects from other fields of earth science.

Keywords: Atmospheric Science, Climate System, Research Aifrcrafts, Meteorological Society of Japan, Science Council of Japan, Master Plan of Large Reserach Projects

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-02 Room:211 Time:April 29 09:15-09:30

Long-term Observation of Atmospheric Greenhouse Gases using Aircraft

MACHIDA, Toshinobu[1*] ; MATSUEDA, Hidekazu[2] ; SAWA, Yousuke[2] ; MORIMOTO, Shinji[3] ; AOKI, Shuji[3]

[1]National Institute for Environmental Studies, [2]Meteorological Research Institute, [3]Graduate School of Science, Tohoku University

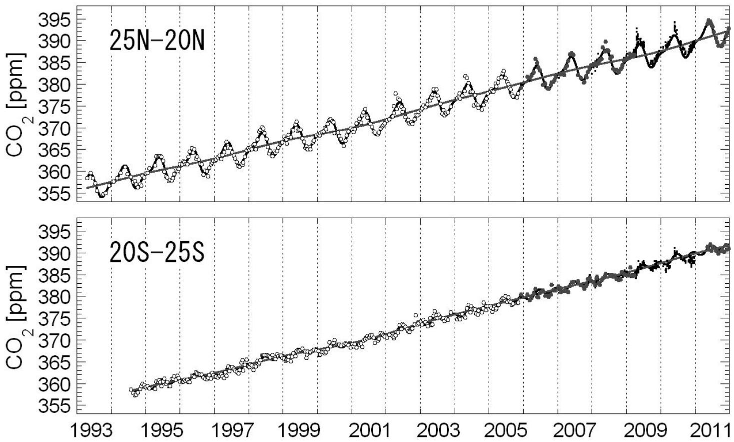
The more reliable prediction for future level of atmospheric greenhouse gases such as carbon dioxide (CO2) requires the quantitative understanding of global cycles in these gases. Comprehensive observation in atmospheric mixing ratios of trace gases can reduce the uncertainties of emission and absorption of these gases at earth's surface. The atmospheric observations, however, are not enough in several areas in the world, especially observations in upper atmosphere are quite limited compared to surface measurements.

Aircraft is one of the most reliable tools to observe the atmospheric compositions in troposphere and lower stratosphere. Several activities have been conducted to understand the 3-dimensional distribution and temporal variation of atmospheric greenhouse gases.

Mixing ratios of atmospheric CO2 have been measured from 200 to 10,000 m over Japan using chartered and commercial airliner since 1979 by Tohoku University (TU). Obtained data set is the longest record for CO2 mixing ratio in upper air. Latitudinal distributions of CO2 in upper troposphere are observed by commercial airliner operated by Japan Airlines (JAL) between Sydney, Australia and Narita, Japan, and Narita and Anchorage, USA from 1984 to 1985 by TU. The JAL observation in Australia-Japan route started again in 1993 using an Automatic Air Sampling Equipment (ASE) by Meteorological Research Institute (MRI). The new JAL observation named "Comprehensive Observation Network for Trace gases by AIrLiner (CONTRAIL)" have been done using improved ASE and Continuous CO2 Measuring Equipment (CME) since 2005 by National Institute for Environmental Studies (NIES) and MRI. Time series of CO2 mixing ratio in upper troposphere observed by old ASE and improved ASE are shown in the Figure. CONTRAIL-CME provides a large amount of CO2 data in upper air which contribute to solve global carbon cycle, atmospheric transport, model validation and satellite validation.

When dedicated aircraft is introduced in Japan, we propose to make a long-term observation for atmospheric greenhouse gases using above techniques and instruments.

Keywords: Greenhouse gases, Aircraft, CO2, Long-term observation, Troposphere



Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-03 Room:211 Time:April 29 09:30-09:45

Elucidation of atmospheric chemistry of reactive gases from airborne observations

KANAYA, Yugo[1*]

[1]JAMSTEC

Knowledge on spatio-temporal variations in the concentrations of tropospheric NOx, CO, and VOC is critical for closing the budget of OH radical, controlling oxidative capacity, and of O3, as a pollutant and a warming substance. Although recent satellite observations of tropospheric NO2, for example, have revealed regional/global distribution and seasonal features, they are based on column concentrations and thus limitation is present regarding information on vertical profiles and also on the spatial resolution.

In-situ airborne observations could provide complementary information with improved resolution in space, critical for validation of chemical transport model simulations. Validation of future satellite observations based on multi-spectral approach (e.g., O3 and CO), which could provide a piece of vertical profile information, is also important. Successful retrieval of near-surface concentrations, having impact on health and ecosystems, should be targeted.

Remote sensing from aircraft could enhance spatial (horizontal and vertical) coverage and resolution. For example, an airborne multi-channel imaging spectrometer in a nadir view could detect detailed inhomogeneity of NO2 and other gases present within cities at a 100-m resolution, contributing to studies on meso-scale atmospheric chemistry and physics. Limb observations in multiple angles could provide detailed vertical profile information.

In the presentation, observations of halogen and other unprecedented species, and observations to reveal air-sea or air-land interactions are also highlighted.

Keywords: vertical profile, nitrogen oxides, carbon monoxide, ozone, remote sensing from aircraft, spatial resolution

U04-04 Room:211 Time:April 29 09:45-10:00

Aerosol measurements by aircraft and modeling studies

OSHIMA, Naga[1*] ; KONDO, Yutaka[2] ; KOIKE, Makoto[2] ; MOTEKI, Nobuhiro[2] ; TAKEGAWA, Nobuyuki[3] ; KITA, Kazuyuki[4] ; NAKAMURA, Hisashi[3]

[1]Meteorological Research Institute, [2]Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, [3]Research Center for Advanced Science and Technology, The University of Tokyo, [4]Faculty of Science, Ibaraki University

Most aerosol components scatter solar radiation; however, black carbon (BC) aerosols efficiently absorb it and lead to heating of the atmosphere. Because of these effects, the role of BC particles in the climate system has been recognized to be particularly important. However, there remain large uncertainties in the calculations of the spatial distributions of BC and its light absorption in current global models. One of the main causes is considered to be large uncertainties in the vertical transport and wet removal processes of BC adopted in aerosol models. Understandings of the vertical transport and wet removal processes of BC are critically important because they directly controls spatial distribution of BC and its radiative effects. To improve our understanding of these processes, aircraft measurements covering the entire altitude range of the troposphere are needed; however, there have been no aircraft observations of BC measurements covering the entire altitude range of the troposphere over East Asia since the ACE Asia and TRACE-P campaigns in spring 2001.

The Aerosol Radiative Forcing in East Asia (A-FORCE) aircraft campaign was conducted over the Yellow Sea, the East China Sea, and the western Pacific Ocean in March-April 2009 (Oshima et al., 2012; Moteki et al., 2012; Koike et al., 2012; Takegawa et al., 2013). During the campaign, 120 vertical profiles of BC particles, carbon monoxide (CO) concentrations, aerosol number concentrations, and cloud microphysical properties were measured at 0-9 km in altitude. The A-FORCE measurements showed that concentrations of BC were greatly enhanced in the free troposphere (FT) over the Yellow Sea. In this study (Oshima et al., 2012), the transport efficiency of BC (namely the fraction of BC particles not removed during transport) for sampled air parcels was estimated from changes in observed BC-to-CO ratios, because CO can be used as an inert combustion tracer within a timescale of a few weeks. The transport efficiency of BC decreased primarily with the increase in the precipitation amount that air parcels experienced during transport, and its value was about 70-90% and 30-50% at 2-4 km and 4-9 km levels, respectively.

Vertical transport and removal processes of BC over East Asia in spring were examined through numerical simulations for the A-FORCE campaign using a modified version of the regional-scale three-dimensional chemical transport model WRF-CMAQ (Oshima et al., 2013). The simulations reproduced the vertical distributions of the transport efficiency of BC observed by the A-FORCE campaign reasonably well, indicating the validity of the treatment of the wet removal processes of aerosols in the model. We identified three major transport pathways for BC export from East Asia to the western Pacific in spring. One pathway was the planetary boundary layer (PBL) outflow through which BC was advected by the low-level westerlies without uplifting out of the PBL (weak BC removal). The second pathway was through uplifting from the PBL to the FT by migratory cyclones over northeastern China and the subsequent eastward transport in the lower FT (moderate BC removal). The third pathway was orographic uplifting and/or convective upward transport from the PBL to the FT over inland-southern China followed by westerly transport in the mid-FT (strong BC removal).

We will introduce our studies with a particular focus on the importance of the aerosol measurements by aircraft and its importance for modeling studies in this presentation.

References

Koike, M., et al. (2012), J. Geophys. Res., 117, D17205, doi:10.1029/2011JD017324.
Moteki, N., et al. (2012), Geophys. Res. Lett., 39, L13802, doi:10.1029/2012GL052034.
Oshima, N., et al. (2012), J. Geophys. Res., 117, D03204, doi:10.1029/2011JD016552.
Oshima, N., et al. (2013), J. Geophys. Res. Atmos., 118, 13175-13198, doi:10.1002/2013JD020262.
Takegawa, N., et al. (2013), Aerosol Sci. Technol., 47(10), 1059-1065.

Keywords: Aircraft measurements, Aerosols, Black carbon, Aerosol model, Transport, Removal

U04-05 Room:211 Time:April 29 10:00-10:15

Aircraft measurements of aerosol-cloud interactions

KOIKE, Makoto[1*] ; MOTEKI, Nobuhiro[1] ; KONDO, Yutaka[1] ; TAKEGAWA, Nobuyuki[2]

[1]Graduate School of Science, University of Tokyo, [2]Research Center for Advanced Science and Technology, University of Tokyo,

1. Importance of aerosol ? cloud interactions

By serving as cloud condensation nuclei and ice nuclei, aerosols affect cloud droplet number concentrations and phase of cloud particles. These cloud microphysical changes cause cloud albedo changes and cloud adjustments (fast cloud response), such as changes in cloud liquid water path and/or cloud fraction. However, there are large uncertainties in estimations of these aerosol ? cloud interactions

2. Aircraft measurements

Satellite measurements can provide global view of the aerosol ? cloud interactions, however, quantities retrieved from satellite measurements are limited. Several artifacts are also known. Although aircraft measurements are limited in space and time, they can provide critical information to study aerosol ? cloud interactions, namely, aerosol and cloud droplet number size distributions. In fact, aircraft measurements have been intensively made over off the coast of California, Peru, and West Africa, tropical Pacific, Indian ocean, and Arctic ocean. Aircraft measurements act as a driving force to study aerosol ? cloud interactions.

3. Aircraft measurements in Asia

Aerosol concentrations in Asia are highest level in the world and they can potentially affect clouds forming over the Western Pacific. However, a number of aircraft measurements is limited. In this paper, results from aircraft measurements made over the Western Pacific during the A-FORCE-2009 and 2013S campaigns are shown. Future science of aerosol ? cloud interactions using aircraft is also discussed.

Keywords: aerosol, cloud, aircraft measurement, Asia

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-06 Room:211 Time:April 29 10:15-10:30

Evaluation of a result of a coupled atmosphere-ocean model around a tropical cyclone center using aircraft observations

SHINODA, Taro[1*] ; KUBO, Keishi[1] ; AIKI, Hidenori[2] ; YOSHIOKA, Mayumi[3] ; KATO, Masaya[1] ; TSUBOKI, Kazuhisa[1] ; UYEDA, Hiroshi[1]

[1]HyARC, Nagoya Univ., [2]JAMSTEC, [3]CAOS, Tohoku Univ.

Aircraft observations are enable us to understand the dynamical, thermodynamical, and microphysical structure of an inner region of TCs, such as their eye and eyewall. Numerical simulation is also a useful tool to clarify the structure of TCs, however, the reproducibility around the inner region of TCs could not be confirmed. This study shows an application of aircraft observations to evaluate the structure of a simulated TC using a coupled atmosphere-ocean non-hydrostatic model, Cloud Resolving Storm Simulator (CReSS) and Non-Hydrostatic Ocean model for Earth Simulator (NHOES), CReSS-NHOES.

The target typhoon is T1013 (Megi) developed over the tropical western Pacific Ocean in October 2010. During the Impact of Typhoons on the Ocean in the Pacific (ITOP), 200 dropsondes are dropped into and around T1013, including its eye and eyewall regions, from a height of about 2.5 km. Dropsondes can observe a vertical profile of pressure (height), temperature, humidity, wind direction, and wind speed. The profiles of these parameters are used to evaluate the simulation result using CReSS-NHOES. A simulation with horizontal grid resolution of 0.02 degree (approximately 2 km) is conducted for 7 days from 00 UTC on October 14, 2010, after one day of the formation of the T1013.

The simulation well reproduces its track and the tendency of the minimum central pressure. The reproduced minimum central pressure is 889 hPa and corresponds the observed one (885 hPa). To conduct the direct comparison between dropsonde observations and the simulation result, the target time of the simulation to compare with the observed one is determined to consider the value of minimum central pressure and its tendency. At the observed target time when conducted the dropsonde observations, the observed TC center is determined by the linear interpolation of the best track data provided by Japan Meteorological Agency. The simulated TC center at the target time is defined by the application to the Braun's method to the CReSS-NHOES output data. The location of the simulated profiles are determined by that of the dropsonde observations relative to the center of the TC at the simulated target time.

The eyewall region in this study is defined as the region that relative humidity of all layers is greater than 95% and maximum wind speed exceeds 25 m s^{-1} below a height of 2 km. The eye and outer region are defined by the inner and outer ones of the eyewall. The simulated potential temperature, mixing ratio of water vapor, and wind speed in the outer region are in the range of 1-sigma (standard deviation), thus, the simulated thermodynamic parameters are well reproduced statistically. After the rapid intensification of T1013, weak and maximum wind speed regions are reproduced in the eye and lower level of the eyewall, respectively. High potential temperature in the low-level of the eye is also reproduced. Thus, qualitative properties of the TC are well reproduced in the simulation. However, the simulated potential temperature is 3 K greater than that in the observation. And the simulated wind speed is 25 m s^{-1} lesser than that in the observation. The quantitative differences are expected to be caused by the difference of the structure of the eye. The problem on the structure of the eye appears in comparison with the application of the aircraft observations for the first time.

Keywords: aircraft observation, tropical cyclone, cloud-resolving model, coupled atmosphere-ocean model, model evaluation

U04-07 Room:211 Time:April 29 10:30-10:45

Aircraft observations over the Sea of Japan and the Sea of Okhotsk in winter

FUJIYOSHI, Yasushi[1*]

[1]Inst. Low Temp. Sci., Hokkaido Univ.

It is well known that the Sea of Okhotsk is one of the southernmost seasonal sea ice zones in the Northern Hemisphere. The importance of the relationship between the Sea of Okhotsk ice cover and regional/global climate has long been recognized. Indeed, recent research work has tied the extreme maximum and minimum wintertime extents of sea ice cover to large scale changes in atmospheric circulation patterns. Recent studies suggest that a possible origin of the North Pacific Intermediate Water (NPIW) is produced in the Sea of Okhotsk. Thus, there are important climate issues that are associated with the Sea of Okhotsk. It is also known that Japan, especially along the coast of the Sea of Japan, is one of the heaviest snowfall regions in the world. Snowfall is brought by banded snow clouds formed when winter monsoon air from Siberia is supplied latent and sensible heat from the Sea of Japan. These banded snow clouds are also frequently formed in the lee side of the sea ice over the Sea of Okhotsk, and play an important role in the growth of the sea ice.

Despite of the scientific importance of these areas in regional/global climate system, in-situ observations there are extremely few, especially in winter. This is due to the fact that the wintertime environment is generally harsh and is not conductive to making high quality measurements. However, in recent years instrumentation and technology have improved to the point where it is now possible to make the requisite wintertime measurements. In this regard, we conducted aircraft observations over the Sea of Okhotsk and the Sea of Japan.

We had deployed an X-band Doppler radar at Monbetsu on November of 2005, and started observation on 16 January of 2006. The height of sea-ice is different from place to place. Air-born laser altimeter is only the tool that can make horizontal distribution of the height of sea-ice. However, this method is very expensive and severely affected by weather condition. We tried to make a three dimensional display of sea-ice and suggested that our radar system could be used to study the irregularity of the height of sea-ice. Therefore, we measured horizontal distribution of height of sea-ice by using aerial cameras and compared it with 3Dimages of our X-band radar.

Keywords: snow clouds, sea ice, marine boundary layer

U04-08 Room:211 Time:April 29 11:00-11:15

Use of Aircraft for Coastal and Oceanographic Research and Observations

ISHIZAKA, Joji[1*]

[1]Hydrospheric Atmospheric Research Center, Nagoya University

Aircraft should be useful to observe coastal and ocean environments, including physical, chemical and biological properties, especially under the raid, unexpected and dangerous conditions, such as typhoon or volcanic eruption, where ship operation is difficult. It is expected that there are two methods of observations from aircraft, other than seaplane, for oceanographic research; one is remote sensing and another is use of air-deployable sensors or platforms. Various remote sensing sensors are available using visible, infrared, microwave and sound waves. They have advantage to satellite-based remote sensors with high resolution and more flexible overflight, and they should be useful for coastal applications. Most of the remote sensing sensors can only obtain surface information; however LIDAR can detect vertical profiles of some parameters such as plankton distribution. Air-deployable sensors have been used for measurements of vertical profiles of temperature (AXBT; Airborne eXpendable BathyThermograph), salinity (AXCTD; Airborne eXpendable Conductivity Temperature and Depth probes), and current (AXCP; Airborne eXpendable Current Profilers). More recently, vertical profiling floats are developed and deployed for Argo project. There were attempts to deploy one of the vertical profiling floats, Electromagnetic Autonomous Profiling Explorer (EX-APEC), from airplane for typhoon observation and obtained profiles of temperature, density and currents. Autonomous profiling floats are now developing equipped with chemical, optical and biological parameters, and should be deployable from aircraft. Other various types of small autonomous underwater vehicles (AUV) are also underdevelopment and may be deployable from airplane in future. Combination studies of those physical, chemical, and biological parameters in coastal and ocean environments with atmospheric information, such as weather condition and chemical properties, are necessary to understand coupled atmospheric-ocean system.

Keywords: aircraft, coast, ocean, remote sensing, float, typhoon

U04-09 Room:211 Time:April 29 11:15-11:30

Earth Observation by using airborne SAR

URATSUKA, Seiho[1*] ; UEMOTO, Jyunpei[1] ; KOJIMA, Shoichiro[1] ; UMEHARA, Toshihiko[1] ; SATAKE, Makoto[1] ; KOBAYASHI, Tatsuharu[1] ; MATSUOKA, Takeshi[1] ; NADAI, Akitsugu[1]

[1]National Institute of Information and Communications Technology

Pi-SAR2 and Pi-SAR are high resolution airborne SAR. We will present possibilities of these sensors for application to the erath science.

Keywords: Synthetic Aperture Radar, Polarimetry, Interferometry, Pi-SAR2

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-10 Room:211 Time:April 29 11:30-11:45

Applicability of airborne remote sensing to terrestrial ecosystem sciences

SUZUKI, Rikie[1*]

[1] Japan Agency for Marine-Earth Science and Technology

Although the airborne remote sensing generally cannot be conducted repeatedly for a region during a multi-year long time period like satellite (space borne) remote sensing, the airborne remote sensing has many advantages in the observation of terrestrial ecosystem. One of them is, of course, the spatial resolution of the airborne remote sensing can be much higher than that of the satellite because the airborne platform flies at much lower altitude than satellite. Although WorldView-2 and GeoEye-1 provide high resolution images of land surfaces, it is practically hard to identify the individual tree in a forest, while the image of airborne remote sensing allows us to observe the tree crown structure and the forest floor condition. In 2000, an airborne remote sensing was conducted from spring to summer over forests around Yakutsk, eastern Siberia, and forest images were recorded by the onboard video camera from heights of 100 to 150m above the land surface. We examined the presences of green leaves in the crown of forest and the snow cover on the floor, and the spectral reflectance of the forest was investigated in relation to those conditions. The result suggested the reflectance from the forest floor significantly influenced the satellite-derived vegetation index (e.g. NDVI) in case of sparse boreal forests. The airborne remote sensing at a further lower height, several tens meters, enables us to indentify the individual leaf and insect, and subsequently, to study the biodiversity on individual basis. Recently, the remote sensing technique by airborne hyperspectral camera and LiDAR has explored a feasibility to identify species and retrieve the chemical trait and structure of vegetation. This methodology made a breakthrough for investigating the ecosystem function and biodiversity. Another advantage of airborne remote sensing is the capacity to select the observation geometry such as the incident angle of solar illumination and the view angle of the sensor. This capacity leads a robust development of radiative transfer model of vegetation based on the bidirectional reflectance distribution function (BRDF).

Keywords: forest ecosystem, LiDAR, ecosystem function, biodiversity

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-11 Room:211 Time:April 29 11:45-12:00

Ground Truth of Earth Observation Satellites using UAV

HONDA, Yoshiaki[1*] ; KAJIWARA, Koji[1] ; TANIGAWA, Satoshi[1] ; ONO, Yusaku[2]

[1]Center for Environmental Remote Sensing, Chiba University, [2]Earth Observation Research Center, Japan Aerospace Exploration Agency

Japan Aerospace Exploration Agency (JAXA) is going to launch new Earth observation satellite GCOM-C1 in near future. The core sensor of GCOM-C1, Second Generation Global Imager (SGLI) has a set of along track slant viewing Visible and Near Infrared Radiometer (VNR). These multi-angular views aim to detect the structural information from vegetation canopy, especially forest canopy, for estimating productivity of the vegetation. SGLI Land science team has been developing the algorithm for 10 standard products (above ground biomass, canopy roughness index, shadow index, etc).

In this paper, we introduce the ground observation method developed by using Unmanned Aerial Vehicle (UAV) in order to contribute the algorithm development and its validation. Mainly, multi-angular spectral observation method and simple BRF model have been developed for estimating slant view response of forest canopy. The BRF model developed by using multi-angular measurement has been able to obtain structural information from canopy. In addition, we have conducted some observation campaigns on typical forest in Japan in collaboration with other science team experienced with vegetation phenology and carbon flux measurement. Primary results of these observations are also be demonstrated.

Keywords: UAV, Second Generation Global Imager (SGLI), Multi-angular observation, Forest canopy, Vegetation productivity

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U04-12 Room:211 Time:April 29 12:00-12:15

New phase remote sensing stimulated by the use of airborne observation

KUZE, Hiroaki[1*]

[1]Center for Environmental Remote Sensing, Chiba University

Center for Environmental Remote Sensing (CEReS), Chiba University, is processing, archiving, and disseminating satellite data and related ground observation data to wide communities in remote sensing and environment-related areas. In the field of atmospheric remote sensing, we have established a radiometer network (SKYNET), which contributes to satellite data validation through characterization of atmospheric aerosols and clouds in East Asia. Also, the radiometer data are valuable for studying air pollutants due to anthropogenic activities when coupled with data from lidar and high spectral resolution spectroradiometer observations. Quantitative analysis of global biomass can be implemented by means of vegetation remote sensing. Methodology for obtaining highly accurate vegetation reflectance has been sought using satellite- and ground-based observations, as well as directional observation using unmanned helicopters. This approach has been exploited for developing an algorithm to be used for GCOM-C1, JAXA's next-generation satellite. In the field of microwave remote sensing, sensors based on circularly polarized synthetic aperture radar (CP-SAR) technique have been developed for both small satellites and unmanned aircraft applications.

Currently a new cooperative study plan is being discussed among university research institutes/centers based on chartering a manned airplane for scientific observation purposes. Through this initiative, it is expected that atmospheric science and climate system studies (University of Tokyo), cloud and precipitation system studies (Nagoya University), as well as high-level scientific application of remote sensing data (Chiba University) will be promoted. The primary goal of CEReS activity will be to achieve highly accurate remote sensing of vegetation, snow and ice fields, and coastal areas through the realization of high-precision atmospheric correction of satellite data, which would have been impossible without resorting to aircraft observation.

As more and more high resolution satellite data are becoming available, needs are growing for high-precision retrieval of physical quantities such as land or ocean surface reflectance. The largest obstacle for this improvement is the spectral changes due to atmospheric scattering and absorption. The influence of air molecules (Rayleigh scattering) can be corrected relatively easily. In contrast, correcting the effects of clouds and aerosols (Mie scattering) tends to be much more difficult, due to their temporal and spatial variability. Conventionally, network observation using a number of sunphotometers and skyradiometers has been implemented for measuring the optical properties of atmospheric aerosols and clouds. Also helicopter and unmanned air vehicle (UAV) measurements have been undertaken covering altitude ranges lower than 150 m above ground. Still, it is difficult to carry out the validation of satellite remote sensing imagery over an extended region.

The aircraft project currently under discussion will enable the measurements of radiation quantities and surface reflectance from high altitudes. The radiometer and hyperspectral camera measurements from both unmanned (low altitude) and manned (high altitude) platforms will allow us to improve radiative transfer algorithms indispensable for high-precision atmospheric correction. This, in turn, will contribute to dramatically improving the accuracy of algorithm for estimating biomass amount based on reflectance measurements. In addition, all-weather and both day- and nighttime surface observation can be demonstrated by equipping the CP-SAR instrumentation.

Keywords: remote sensing, airborne observation, vegetation, atmosphere, microwave sensor