Leading Graduate School Program on Global Safety
Tohoku University-DLR Workshop
– Extreme Robotics and Aviation Safety Frontier –

Aviation Safety Frontier Session: Aviation Safety and Climate Impact

Date: 14 (Tue), October, 2014

Place: Large lecture room, 5th floor, 2nd-building, Institute of Fluid Science, Tohoku University

Abstract of presentation

Title:	HALE UAS for national resilience
Authors:	Kenya Harada, and Daisuke Kubo (JAXA)
Abstract:	Civil use of Unmanned Aircraft System (UAS) for safe and secure society is an important research area of JAXA. Over the past several years we have conducted R&D of small UASs for disaster response, and recently we have started working on High- Altitude Long-Endurance (HALE) UAS, which could complement and reinforce the mission capabilities of satellites and manned aircraft as an all-weather long-duration remote sensing platform or communications relay. This presentation will provide an overview of the system concept of HALE UAS and a wide range of research activities to make it feasible.

Title:	Research of aerodynamics on JAXA experimental airplanes to connect real-flight with ground testing
Authors:	Kazuyuki Nakakita, Mitsuru Kurita, Rie Tagai, Makoto Ueno, Kanako Yasue, and Masaru Naruoka (JAXA)
Abstract:	The Japan Aerospace Exploration Agency (JAXA) is starting basic aerodynamics researches to acquire aerodynamic characteristics and phenomena on the JAXA experimental airplanes, Queen Air and "Hisho". Pressure-sensitive paint measurement was applied to acquire pressure distribution on the main wing of the Queen Air. Model deformation method (MDM) to acquire the deformation of the main wing during the flight was applied to Queen Air and Hisho to identify the actual configuration of the wing. Identification of the aerodynamic characteristics like CD and CL were also started to future comparison

	of the aerodynamic data between real-flight and ground testing including wind tunnel test and CFD. Present progresses of these three research activities in JAXA are introduced in detail.

Title:	Measuring stability derivative in a wind tunnel using magnetic suspension balance system
Authors:	Ryu Andoh, Takamasa Matsumoto (Electro-Communication University), Hiroki Sugiura (JAXA), and Takeshi Miyazaki (Electro-Communication University)
Abstract:	In order to measure dynamic stability parameters of reentry capsule used in Mars/asteroid exploration missions, we developed new stability measurement technique using magnetic suspension balance system (MSBS). In order to avoid huge sting interference of capsule-type models, a wind tunnel model was magnetically levitated and forcedly oscillated so as to measure dynamic stability derivatives. As a first step, pitch stability derivative of an archery arrow was measured using the technique in JAXA 60cm by 60cm MSBS wind tunnel. The measured derivatives, forces and moments were compared with calculated values using slender-body theory.

Title:	Novel weather observation technologies for next integrated terminal weather system (ITWS)
Authors:	Eiichi Yoshikawa, Atsushi Kanda (JAXA), Tomoo Ushio (Osaka University), and Kenichi Kusunoki (Meteorological Research Institute)
Abstract:	The Japan Aerospace Exploration Agency (JAXA) has started feasibility studies to develop a new ITWS with the cooperation of Osaka University and Meteorological Research Institute in order to enhance safety and efficiency of airport operation. Newly developed phased array weather radar (PAWR) accomplishes several times faster scanning speed than formal weather radars (full-volume scan of 60-km radius in 30 sec), which has great potential to offer accurate detection and prediction of airport hazardous phenomena such as microburst, tornado, lightning, and icing cloud. The research overview of the next ITWS will be introduced in the presentation.

Title:	Development of low-level turbulence advisory system for aircraft operation
Authors:	Naoki Matayashi, Tomoko Iijima, Eiichi Yoshikawa (JAXA), and Tomoo Ushio (Osaka University)

Abstract:	The Japan Aerospace Exploration Agency (JAXA) has developed the LOw-level Turbulence Advisory System (LOTAS) together with Osaka University. LOTAS introduces new features such as low-cost Doppler radar/lidar, landing difficulty estimation, short-term prediction of radar echo distribution and text message uplink using ACARS to resolve issues related to existing low-level windshear detection and warning systems. Operational evaluation results indicate that LOTAS is an effective aid for alerting aircraft operators to low-level turbulence and also for making decisions on the appropriate timing for landing.

Title:	Global air traffic modeling for climate assessment of routing strategies
Authors:	Hiroshi Yamashita (Institute of Atmospheric Physics, DLR)
Abstract:	Aviation contributes to climate change e.g. via carbon dioxide, ozone and contrail-cirrus. Mobility becomes more and more important to society and hence air transportation is expected to grow significantly over the next decades. Mitigating the climate impact from aviation is needed. Currently, a number of studies suggest to avoid climate sensitive regions by re-routing either vertically or both horizontally and vertically. These mitigation options have a great potential in reducing the climate impact, since most of the climate impact arises from non-CO2 effects, which are short-lived and vary regionally. However, currently no assessment platform exists, with which different mitigation options can be assessed. Here we introduce a climate-chemistry model to which an air traffic model is coupled, enabling the assessment of re-routing strategies as well as technological options. A modeling strategy is presented, how re-routing strategies can be tested and may lead to recommendations for air traffic management.

Title:	Detection of convection and waves in the free atmosphere using a 3D-scanning coherent Doppler lidar
Authors:	Yasushi Fujiyoshi (Institute of Low Temperature Science, Hokkaido University)
Abstract:	Since layer clouds are formed near the discontinuous layer of air density and wind shear, kinematic and thermo-dynamic instabilities would be expected to occur. However, there have been a limited number of studies on the organized disturbances formed near the cloud base. Using a 3D-scanning Coherent Doppler Lidar (3D-CDL), we found a new-type of organized turbulent air motion below cloud

	base. This strange curly pattern began to develop near the base of optically thin cirro- or altostratus cloud. This organized pattern often caused strong downdraft (about 8 m/s) in the free atmosphere. This downdraft, however, was not able to reach the ground surface because of the hammock effect of the atmospheric boundary layer. This process is the good contrast with rising thermals that cannot overshoot the top boundary of the atmospheric boundary layer. The author will also briefly introduce in-situ measurements of aerosol, radiation, and turbulence by using a two-manned glider at Takikawa Sky Sports, Hokkaido, where the 3D-CDL and many other remote sensors are operating.

Title:	Global analysis of cloud microphysics by space-borne active sensors: from A-train to EarthCARE
Authors:	Hajime Okamoto (Research Institute for Applied Mechanics, Kyushu University)
Abstract:	We first introduce our current activities of analyses of space borne active sensors onboard CloudSat and CALIPSO satellites that fly as part of a constellation of satellites (A-train). And we also describe a future satellite mission (EarthCARE) that will carry Doppler cloud profiling radar and high spectral resolution lidar (HSRL) in space for the first time. Space borne active sensors, 94GHz cloud radar on CloudSat and dual wavelength-polarization lidar, CALIOP, on CALIPSO have been operated since 2006 and have provided relatively long trend of macro-scale and microphysical properties of clouds. Synergetic analysis of ice microphysics has been conducted for the whole observation periods. Main aim of the study is to understand the relation between the atmospheric environmental condition for the cloud formation and cloud microphysics. Key feature of the algorithm is that the three parameter retrievals, i.e., effective radius, ice water content and fraction of oriented ice plates, are possible by using radar reflectivity factor from CloudSat, backscattering coefficient and depolarization ratio from CALIOP (Okamoto et al., 2010, Sato and Okamoto 2011). Global analysis of cloud microphysics has been carried out and year to year variability has been analyzed. Earth Cloud, Aerosol, Radiation Explorer (EarthCARE) mission has been developed by Japan and Europe. The EarthCARE will carry 94GHz Doppler cloud profiling radar (CPR), HSRL with the wavelength of 355nm (ATLID), multi-spectral imager (MSI) and broad band radiometer (BBR). The algorithms to use single or multiple sensors have been developed to provide clouds, aerosol and radiation products. EarthCARE is scheduled to be lunched in the end of 2016. Unique

	feature of the EarthCARE mission is as follows; the CPR will have the first Doppler capability in space. It is expected to provide accurate information of clouds and precipitation microphysics and also vertical motion of clouds. The ATLID is a high spectral resolution lidar at the wavelength of 355nm and it also has a capability of polarization. These new information are used to retrieve aerosols and clouds properties.

Title:	Contrail properties inferred from satellite-based measurements
Authors:	Hironobu Iwabuchi (Graduate School of Science, Tohoku University)
Abstract:	Aviation is responsible to climate change by emitting greenhouse gases and generating contrails and induced cirrus. Recent estimate of global-mean radiative forcing of contrails in year 2011 is estimated to be about 0.01 W/m2, and effects of induced cirrus are estimated to be significantly larger and very uncertain because the observational quantification is difficult. Regional climate impacts are significantly larger. Radiative forcing of contrail and induced cirrus depend on optical, microphysical and macroscopical properties of the clouds. In this talk, contrail properties inferred from satellite-based passive and active sensor measurements will be presented. Possible researches to better quantify the radiative forcing of induced cirrus will be discussed.

Title:	Evaluation of microphysical processes of a cloud-resolving model using in-situ and satellite observations
Authors:	Taro Shinoda (Hydrospheric Atmospheric Research Center, Nagoya University)
Abstract:	We conduct daily simulations using our own cloud-resolving model (Cloud Resolving Storm Simulator: CReSS) since 2005. We show some problems on much number concentrations of cloud ice (ice crystals) in the upper cloud (i.e., cirrus or anvil clouds) in comparison with satellite observations (infrared brightness temperature and CloudSat CPR) and balloon-based hydrometeor videosondes (in-situ observations). Possible plan of the aircraft observations on the cloud microphysics will be proposed in the presentation.