Keynote

DYNAMICAL INFLUENCE OF THE STRATOSPHERE ON THE TROPICAL TROPOSPHERE

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Abstract

The Equatorial Atmosphere Radar (EAR), which was built two decades ago under a collaboration between Kyoto University and Indonesia National Institute of Aeronautics and Space (LAPAN), has been a powerful tool to observe vertical coupling processes in the equatorial atmosphere. The dynamical influence of the stratosphere on the extratropical troposphere has been intensively studied in the last two decades or so, and consequent improvement of scientific understanding has already helped for exploiting in weather forecasting and climate prediction. The standard paradigm for interpreting and explaining such stratosphere-troposphere dynamical coupling in the extratropics is based on balanced dynamics; i.e., the non-local aspects of potential vorticity inversion in planetary wave propagation and wave-mean flow interaction in both troposphere and stratosphere. On the other hand, stratosphere-troposphere coupling in the tropics has no such comparable interpretive paradigm. Recent observational and numerical model studies point to an important stratospheric influence on tropical convection and convective systems, and the multi-scale dynamics of these systems is likely to play a vital role in determining the tropical response to spatio-temporal variations in the stratosphere.

In this talk, the international collaborative activity of Stratospheric And Tropospheric Influences On Tropical Convective Systems (SATIO-TCS) is reviewed; SATIO-TCS challenges such a research subject of the dynamical influence of the stratosphere on the tropical troposphere through multi-scale dynamics of tropical convective systems, under WCRP/SPARC project, (http://www-mete.kugi.kyoto-u.ac.jp/SPARC_SATIOTCS/index.html). A study on the influence of the equatorial quasi-biennial oscillation (QBO) in the stratosphere on the global monsoon systems is introduced as a recent outcome of international SATIO-TCS collaborations. Composite difference analysis of the monsoon systems between opposite QBO phases shows several statistically significant differences in precipitation, its proxies (OLR and specific humidity), and circulation fields in the tropics and subtropics with dynamically consistent relationships for boreal summer and austral summer.

Keynote

THE PAST AND FUTURE USE OF THE EQUATORIAL ATMOSPHERE RADAR IN ATMOSPHERIC RESEARCH IN INDONESIA

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ABSTRACT

The equatorial continent-maritime region receives significant amount of solar energy, and therefore rich in heat and moisture, which drives active atmospheric convection coupled with convergence zone, producing precipitation hotspots that affect local and global weather and climate. Due to small Corriolis effect and large Rossby radius, the atmospheric dynamics in the region is governed mainly by hydrostropic balance between gravity and buoyancy forces, and hence dominated by complex interaction between atmospheric convection and waves. The region is mostly agrarian and vulnerable to various hydro-meteorological disasters related to extreme rainfall such as floods, landslides, and tornadoes, and also vulnerable to drought. Therefore, accurate information on weather, season and climate, as well as hydro-meteorological disaster early warning system, are important for the community and related authorities in the region. However, rainfall prediction in this region is a challenge due to complex and turbulent nature of atmospheric dynamics in the region.

Advancement of knowledge in atmospheric physics and dynamics in the equatorial continent-maritime region, including temporal and spatial multi-scale dynamic interaction, is the key to improve our understanding and prediction accuracy in the region. The Equatorial Atmosphere Radar (EAR) was developed at Kototabang Hill, Agam District, West Sumatra, Indonesia, by close and long term collaboration between Kyoto University of Japan and the National Institute of Aeronautics and Space (LAPAN) of Indonesia. The radar consists of around 560 Yagis antenna arranged in hexagonal array configuration with the overall aperture radius of around 110 m.

The radar can detect and measure vertical profile of atmospheric dynamics from around 2 km up to around 20 km height. The radar has been operating since 2001 up to now, and has produced many results and scientific findings which increase our understanding of the atmospheric dynamics in the equatorial region, including atmospheric convection, vertical coupling processes in the equatorial atmosphere, and troposphere-stratosphere interaction, ionospheric dynamics, etc. This presentation describe a brief summary of results from studies using the EAR and other supporting instruments conducted at the Research Center of Atmospheric Science and Technology, LAPAN-BRIN.

The use of the Radar has improved our understanding of atmospheric convection especially in the equatorial continent-maritime region and its interaction with atmospheric waves, vertical coupling processes, self organization of convection and precipitation, numerical modeling validation and improvement of convective parameterization, etc. The development of EAR and the plan for future development of EMU radar in the same location is inline with the Indonesia Space Master Plan, in which one of the medium and long term goals in space science is the development of an integrated space-atmosphere decision support system. This presentation also discusses potential use of EMU radar to support this goal by improving our understanding on the interaction between atmosphere and space as part of the sun-earth interaction.

Invited Speaker

OBSERVATIONS OF TURBULENT MIXING IN TROPICAL TROPOPAUSE LAYER (TTL)

Hiroyuki Hashiguchi, Momoko Hashino, Richard Wilson, Shinya Ogino and Junko Suzuki

The tropical tropopause layer (TTL) is a transition region between the troposphere and the stratosphere peculiar to the tropical zone. Physical and chemical processes in the TTL are important because they affect Stratosphere-Troposphere Exchange (STE). In this study, we analyzed small-scale turbulence near the TTL region and the associated transport using the data of observation campaign conducted in collaboration with STRATEOLE-2 (TTL / lower stratospheric observation project using super pressure long duration balloons). Observation campaign was conducted during November 21-December 6, 2019, and we continuously operated the Equatorial Atmosphere Radar (EAR) and launched some ozone and GPS sondes during the campaign. A turbulent layer that lasted for about 2 days was observed from the evening of December 1 by the EAR. The strong zonal wind shear and the west-tilted KH billow due to the distortion of the equatorial Kelvin wave were seen, and the deep convection system affected this, causing multiple fine KH instability and strong turbulence in the altitude range of 1 km. It was also shown that ozone fluctuations are mainly caused by fluctuations in the vertical distribution of temperature due to distortion or breaking of the equatorial Kelvin wave, and that turbulent mixing contributes secondarily. The altitude and intensity of the turbulent layer obtained by the EAR varies depending on the season, and affected by the activity of the equatorial Kelvin wave and convection, and the monsoon. These results suggest that the turbulent layer is caused by equatorial Kelvin wave distortion or breaking and that this wave distortion or breaking fluctuates the distribution of ozone. The turbulent layer observable by EAR with high vertical resolution may be an indicator of such large-scale disturbances.

Invited Speaker

SMALL SATELLITE RESEARCH & DEVELOPMENT AND ITS APPLICATIONS IN INDONESIA

Wahyudi Hasbi

Abstract

In 1976, Indonesia was the third country in the world, applying communication satellite technology for developing the country. Also, since 1971, Indonesia uses remote sensing satellite data for any application. The importance of the satellite application leads to LAPAN to develop satellite technology in Indonesia. As a developing country with many constraints and limitation, mastering the satellite technology is a challenge. However, Indonesia has launched three small satellites and having a roadmap for other small satellite development. Those small satellite used for several application as remote sensing, communication support during a disaster, maritime surveillance and also other technology demonstration in satellite technology. This talk will briefly describe the small satellite development and its application in Indonesia.

Invited Speaker

OVERVIEW OF THE SPARC REANALYSIS INTERCOMPARISON PROJECT (S-RIP) DURING 2013-2021

Masatomo Fujiwara, Gloria Manney, Lesley Gray and Jonathon Wright

Abstract

The Stratosphere-troposphere Processes And their Role in Climate (SPARC) project is one of the four core projects of the World Climate Research Programme (WCRP). Researchers interested in SPARC use global atmospheric reanalysis products to understand a wide range of processes and variability in the atmosphere, to validate chemistry climate models, and to investigate and identify climate change. The SPARC Reanalysis Intercomparison Project (S-RIP) was initiated in 2011 and officially started in 2013 to conduct a coordinated intercomparison of all major global atmospheric reanalysis data sets. The S-RIP has been aiming at writing up an assessment report in the SPARC report series (to be published by September 2021) (1) on overall quality of temperature, winds, ozone, and water vapor data, (2) on more process- and region-oriented evaluation of the Brewer–Dobson circulation, extratropical stratosphere-troposphere coupling, extratropical upper troposphere and lower stratosphere, the tropical tropopause layer, the quasi-biennial oscillation, polar processes, and the upper stratosphere and lower mesosphere, and (3) with a coordinated description of the reanalysis systems. We also have an inter-journal special issue on "The SPARC Reanalysis Intercomparison Project (S-RIP)" in Atmospheric Chemistry and Physics (ACP) and Earth System Science Data (ESSD). In the presentation, we will discuss key findings and recommendations as well as the evaluation of this first phase of the S-RIP activity.

Invited Speaker

HOW CLIMATE CHANGE DRIVES GLOBAL TERMITE DISTRIBUTION AND INVASIVENESS

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Abstract

Climate change and urbanization are the two most important issues in the recent global environment, that have severe direct and indirect consequences. From an urban entomologist perspective, those two phenomena are now being considered as the important driven factors that affecting the spread of exotic species, including termites. Termites are dominant insects in the terrestrial ecosystem that are distributed in tropical, subtropical, and warm temperate regions. They play an important role in ecosystems as well as significant economic impacts in urban areas where they attack buildings and structures. Twenty-eight termite species are considered global invasive species that have spread beyond their native ranges. Recent reports suggested that substantial economic and ecological damage caused by global invasive termites is likely to increase in the future, driven by dramatic climate change, rapid urbanization, and globalization.

Keywords: Climate change, termite, invasive species.

Invited Speaker Room 1 ATM

ATMOSPHERIC ENVIRONMENTAL RESEARCH BY ANALYZING THE CHARACTER OF INDONESIAN OZONE PROFILE USING AQUA_AIRS DATA

Ninong Komala

Abstract

Atmospheric environmental research in LAPAN is carried out using analysis in the laboratory, various equipment, and in situ measurements. The limitation of in-situ observation network compared to the wide of Indonesia area made satellite data has been playing an important role in research on atmospheric chemistry and Green House Gases which is one of a national need and is also a major competency of LAPAN that needs to be developed. Based on monthly data of AQUA-AIRS from 2003 to 2020, we examined the characteristic of ozone profile in Indonesia. We analysed the time series, trend in troposphere and stratospheric layer also the dominant period affected the ozone variation. The results obtained that in the period of 2003-2020 the ozone profile from 1000 hPa to 1 hPa varies between 15 ppb to 10500 ppb. Ozone in the troposphere has a tendency to increase and in the stratosphere there is a slight decrease. The periods that dominate the variation of Indonesian ozone are 6 months, 12 months and 30 months.

Invited Speaker Room 2 ATM

MECHANISMS OF DIURNAL PRECIPITATION OVER SUMATRA: MEASUREMENT AND CLIMATE MODEL PERSPECTIVES

Marzuki Marzuki, Helmi Yusnaini, Fredolin Tangang, Robi Muharsyah and Mutya Vonnisa

Abstract

This study examines the mechanism of diurnal variation in precipitation over Sumatra based on observational data and several atmospheric models. We have re-investigated the characteristics of diurnal variation of precipitation in terms of amount (PA), frequency (PF), and intensity (PI) using rain-gauge network data. It is found that the diurnal cycle of precipitation is significantly affected by the terrain elevation, stations' distance to the west coastline of Sumatra, and rain event duration. A slightly larger PA and PF appear over the middle and western sections of the Barisan mountains, in which the mean PI is smaller in these regions. Most stations with large rainfall amount also have large rainfall frequencies, indicated by a strong correlation between PA and PF. The prevailing afternoon and early-evening peaks, i.e., 1500-2000 LST, appear mostly over mountain ranges where the amplitude of PA and PF tended to increase with elevation. Generally, rain events with a long duration tended to have a peak occurring at a later time compared with those events of shorter duration. The diurnal cycle of precipitation from rain gauge data was compared with that obtained from Integrated Multi-Satellite Retrievals of GPM (IMERG). There are some differences in PA, PF, and PI's peak time from these two instruments. We also found a seasonal and intra-seasonal change of peak time of PA, PF, and PI over Sumatra. The physical and thermodynamic diurnal oscillation mechanisms are then studied using several climate models.

Invited Speaker Room 3

PRECISION HEAT MONITORING IN AGRICULTURE USING FUZZY LOGIC MODEL

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Abstract

We investigate predictive modeling in agriculture using a Machine Learning based on fuzzy logic. Fuzzy logic is a methodology that employs imprecise in the mapping of input to output. It is effective in using linguistic expressions to encode control rules for simulating multivariate non-linear systems. In this study, the heat index for a growth room is modeled with the temperature and relative humidity using fuzzy rules extracted from sensor data collected over a 20-day period using Arduino IoT infrastructure. Exploratory data analysis is also performed to uncover the prevailing weather conditions in the growth room for the interval of study. When evaluated on a test set, the developed model obtained R2 of 0.974 and RMSE of 0.084, and the results are statistically significant ($F_{1,5915} = 222900.858$, $p < .001$). Given the combination of linguistic rules and significant prediction accuracy, the fuzzy logic model is an efficient learning technique for heat control problems.

Keywords: predictive modeling, heat index, fuzzy logic, machine learning, agriculture.

Invited Speaker Room 4

EAR CONSTRUCTION MOTIVATION REVISITED: INDONESIAN COASTLINE REPRESENTING EARTH

Manabu D. Yamanaka

Abstract

It was 32 years ago when Prof. Kato and Prof. Fukao of Kyoto University, Pak Alex of LAPAN, Pak Chandra and Bu Tien of BPPT, and others including myself climbed Bukit Kototabang for the first time. After Prof. Habibie's very quick permission, followed by BMKG's GAW station, we needed a time before constructing the EAR in 2001. During these two decades, in addition to the EAR's initial targets concerning middle and atmospheric sciences, the significant role of the Indonesian maritime continent (IMC) for the global lower-atmospheric climate has been recognized. Many "mini-EARs" (wind profilers and weather radars mostly at BMKG stations) have revealed that the diurnal cycle (sea-land breeze circulation) along the world's longest coastline surrounding Sumatera and other major islands of IMC is the most robust mode of tropical cloud-rainfall generation. This process causes floods in stronger land-sea temperature gradients during remarkable monsoon (cold surge) and/or La Niña periods, and produces latent heat (amount of roughly 10–20 % of the green-house effect) compensating the global radiational-dynamical energy imbalance. Therefore, any modification of the land surface-hydrologic conditions such as urbanization and plantationization may change the diurnal cycle, local weather and also the global climate. It should be also noted that the diurnal-cycle circulation consists of equi-amplitude bidirectional (sea- and land-ward) internal gravity waves likely to cause the quasi-biennial oscillation (QBO) as the most robust mode in the stratosphere, or one of the most important initial targets of EAR. Indeed the coastline of IMC is the triple boundary maintained among land, sea and atmosphere of the earth, and the EAR and many mini-EARs listen sounds of the whole earth system.

Invited Speaker Room 5

BIOMASS UTILIZATION IN TROPICAL AREA FOR SUSTAINABLE DEVELOPMENT

Toshiaki Umezawa

Abstract

Lignocellulose biomass such as trees and large-sized grasses is indispensable for establishing sustainable societies. Trees are essential for producing of wood-based materials and paper, which account for half of the total tree lignocellulose biomass consumption, while the other half is for burning. A significant part of the tree biomass used for fuel depends on natural forest logging, and the deforested area has been largely converted to deteriorated grasslands. Therefore, a reduction of natural deforestation by exploitation of high-productivity biomass are strongly required for sustainable development in harmony with environmental conservation. Large-sized grasses greatly surpass trees in terms of lignocellulose biomass productivity. In this context, the conversion of the deteriorated grasslands in tropical and subtropical regions into grass biomass crop farmland would be valuable for renewable resource production in the era of bioeconomy. In addition, the conversion of the deteriorated grasslands to biomass crop farmland and/or plantation forests may lead to restoration of biodiversity. In this context, we have been conducting "the Project for Producing Biomass Energy and Material through Revegetation of Alang-alang (*Imperata cylindrica*) fields" of SATREPS project as a collaboration with Indonesian Institute of Sciences. This project is in line with the aim of The Sustainable Development Goals (SDGs) and of great importance for a sustainable development path of the world.

Keywords: Tropical degraded grassland, Lignocellulose, Grass biomass, International collaboration, Sustainable society.

Invited Speaker Room 6 ATM

IMPACTS OF THE 2019 ANTARCTIC STRATOSPHERIC SUDDEN WARMING EVENT ON THE EQUATORIAL THERMOSPHERE AND IONOSPHERE.

Yasunobu Miyoshi and Yosuke Yamazaki

Abstract

A sudden stratospheric warming (SSW) event occurred in September 2019 in the Antarctic region. By using an atmosphere-ionosphere coupled model (GAIA), impacts of the 2019 SSW on the equatorial thermosphere and ionosphere are studied. During the 2019 SSW, the neutral wind in the lower thermosphere, the equatorial electro jet (EEJ) and electron density fluctuate with a period of about 6 day. In this study, excitation mechanism of these 6-day oscillation in the equatorial thermosphere and ionosphere is shown. Our results are as follows. The 6-day wave is generated in the stratosphere during the 2019 SSW, and propagates upward into the lower thermosphere. The 6-day wave induces the modulation of the semidiurnal tide with a period of 6-day through the non-linear interaction between the 6-day wave and semidiurnal tide. Furthermore, the 6-day oscillations in the EEJ and electron density are caused by the 6-day fluctuation in the lower thermosphere through the E-region dynamo process.

Invited Speaker Room 7

INDONESIAN RADIO TELESCOPE AND ITS APPLICATION IN RADIO ASTRONOMY

Peberlin Sitompul, Timbul Manik, Mario Batubara, Musthofa Lathif, Farrahati Mumtahana
BRIN - ORPA

Abstract

Facilities for space research in Indonesia, particularly in the fields of astronomy and astrophysics is very important. Now, BRIN-LAPAN is developing a new National Observatory in Indonesia with many instruments such as Optic Telescope and Radio Telescope. The radio telescopes in Indonesia will provide many benefits such as capacity building in Technology, in Science of Astronomy, Geodesy, Atmospheric, skill to construct Radio Telescope, design of data processing and experiences in collaboration with international researchers. Currently, an optic telescope with a 3.8 m is being developed in Mount of Timau, Kupang, East Nusa Tenggara Indonesia since 2017, which is expected to be completed by the end of 2021. In addition to optical telescope, the studies and conceptual designs of radio telescope are being carried out on a frequency of around 1 - 50 GHz and 80-350 MHz. The steps of this project are divided to many years: in year 2021 of the study and design the radio telescope concept, in year 2022 for budget planning, and in the period of year 2023 of starting of the developing the radio telescope. The first steps in plan is to develop a 20m class parabolic radio telescope and in multi wavelength frequencies in the range of 1-50 GHz with preference in L, C, K, Q bands.

Keywords: Radio Telescope, National Observatory, Space Science, Astronomy, multi-wavelength.