Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

ATT34-01 Room:202 Time:May 20 14:00-14:15

Data assimilation system for food production estimation

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Recent progress in satellite data productions, such as solar radiation, precipitation rate, soil water contents, enable us to generate more usefull information through the data assimilation systems. In addition, next generation satellites will improve both time and spatial resolution. Thus data assimilation system with terrestrial modeling will be make the output for food production estimation in the near of future. We will try to discuss the role of super-high resolution optical sensors and SAR data for data assimilation system, and how to establish the validation system including in-situ observation networks.

Keywords: Terrestrial Studies, Remote Sensing, Data Assimilation

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

ATT34-02 Room:202 Time:May 20 14:15-14:30

The possibility of new science program creation for the land under the operational satellite programs

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Operational satellite projects, such as weather satellites and disaster monitoring satellite is always required in the future, also easy to obtain public understanding. Discussion point this presentation is examination of the possibility of creating a researchers community of plan to create a new science field of land at the beginning of these satellite projects.

Keywords: land, satellite program

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

ATT34-03 Room:202 Time:May 20 14:45-15:00

Satellite Mission Proposal for Ocean Color Observation in the Next Generation

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The Coastal Zone Color Scanner (CZCS) onboard Nimbus-7, which is the first satellite sensor specifically targeting ocean color observation, is launched by the National Aeronautics and Space Administration (NASA) on 24th October 1978. Since then, biological and biogeochemical observation in coastal and oceanic waters has dramatically changed from economically-oppressing and time-consuming in situ observation to the automated global observation. The satellite ocean color observation is practically only the way to observe biological and biogeochemical variables in the ocean globally, and therefore the success of the satellite ocean color observation has highly been appreciated among biological and biogeochemical oceanographers. Japan Aerospace Exploration Agency (JAXA) also launched an ocean color sensors such as the Ocean Color and Temperature Scanner (OCTS) onboard the Advanced Earth Observation Satellite (ADEOS) in 1996, and the GLobal Imager (GLI) onboard the ADEOS-II in 2002. From these missions, not only valuable global data of ocean color was obtained but also domestic and oversea ocean color scientists were teamed up and young students specifically in the ocean color science were educated, which led to the most recent mission, the Global Climate Observation Mission-Climate (GCOM-C). On the other hand, ocean color observation itself is evolving. Until GLI, the main product obtained from the color observation was a phytoplankton pigment called Chlorophyll-a, which is often used as an index of phytoplankton biomass in the ocean. In the recent missions (including GCOM-C) in the world, however, novel attempts to retrieve new products (e.g. marine productivity, phytoplankton functional types, harmful algae bloom or red tide, particulate organic carbon, particulate inorganic carbon, particle size distribution, light absorption and scattering properties of biogeochemical matters, euphotic zone) have also been begun. Thus, the satellite ocean color observation has great potential to derive many products to contribute to a wide variety of applications. In aim to apply the ocean color observation to those issues related to climate change, coastal environment issue, inland water issue, fisheries resource and management, harmful algae, marine disaster, a new ocean color mission will be proposed in this presentation and a hardware requirement for the next generation ocean color observation will be discussed.

Keywords: ocean color, satellite observation, New Mission

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

ATT34-04 Room:202 Time:May 20 15:00-15:15

The next step of the satellite remote sensing of sea ice

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Satellite remote sensing is a powerful tool for monitoring sea ice, which is difficult to observe in the field. Especially, temporal and spatial variability of large-scale sea-ice extent and ice motion have revealed mainly by using data from passive microwave sensors. However, variability of ice thickness and contribution of small-scale ice processes have not yet been understood well. Those are essential for understanding sea ice nature and predicting the future change of ice cover.

Efforts to detect the ice thickness have been carried out using the passive microwave sensors based on the relation between ice thickness and ice surface condition. Additionally laser altimetry measuring the freeboard height of sea ice is also used for the ice thickness observation. On the other hand, there already are high-resolution sensors such as AVNIR-2, which provide the data sufficient to examine the small-scale ice processes. In these observations, a major problem is low frequency of observation. Based on these considerations, we will propose the new monitoring system of sea ice.

Keywords: satellite remote sensing, sea ice

Japan Geoscience Union Meeting 2012
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ATT34-05 Room:202 Time:May 20 15:30-15:45

Towards the realization of spaceborne lidar mission program in Japan

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Various atmospheric phenomena cross borders and have undesirable effects on earth environment issues such as global warming, long-range air pollutant, acid rain, ozone destruction, and so on. An aerosol particle derives from human activities, sea spray, dust, and biogenic activities, and it play an important role in the local and global and local circulations. The aerosol particle can scattering and absorb the light and it has highly influence directly on the Earth's energy balance. Water soluble aerosol can serve as cloud condensation nuclei and it determines the initial concentration, distribution, phase of cloud. The aerosol particles can have influence indirectly on the Earth's energy balance. The chemical reactions affect optical properties of aerosol particle. It also results in the influence of the radiation budget from the microscopic view. The network of aerosol observatory as meteorological weather stations is limited. The aerosol observation form space is one of the promising methods for the earth observation. Lidar is one of the most useful active remote sensing techniques that can be used to detect small particulates. The lidar can be used to detect molecules, aerosols and clouds, water vapor, minor atmospheric constituents, and wind. The National Space Development Agency of Japan which was the predecessor of the Japan Aerospace Exploration Agency planned the Experimental Lidar in Space Environment (ELISE) loaded onto the mission demonstration satellite II. The ELISE program was a two-wavelength backscatter lidar and it was a first full-scale spaceborne lidar mission program. One of objectives of the ELISE program was to observe tropospheric and stratospheric aerosol particles, multiple-layered cloud, and cirrus. The ELISE program was aborted through some reasons. Japanese spaceborne lidar mission programs for the purposes of the atmospheric science have not been planned since the ELISE mission program. The ideas on the Japanese earth observation mission program after 2020 are discussed in the land, oceanic and atmospheric disciplines. In the atmospheric discipline, Doppler wind lidar, high spectral resolution lidar, multi-wavelength polarization backscatter lidar, scanning lidar, and differential absorption lidar for green gases are discussed as candidates for future spaceborne lidar mission programs. In presentation, we will report on the ideas of the future spaceborne lidar mission program, and also discuss the ideas with various scientific and engineering experts interested in the active optical remote sensing technique.

Keywords: spaceborne observation, lida, aerosol/cloud, wind, trace gas

Japan Geoscience Union Meeting 2012
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ATT34-06 Room:202 Time:May 20 15:45-16:00

New proposlas for observing atmospheric environment from space - GMAP-Asia and APOLLO

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Tropospheric ozone has been increased in the northern hemisphere in recent years, although emission of precursor gases has been reduced in Japan, Europa and US. The increase of tropospheric ozone and aerosols may cause the increase of mortality risk and the climate change. In Japan, surface ozone concentration often exceeds the environmental standard at most monitoring sites. Recently, the frequency of photochemical smog alert increases in Kyushu and prefectures face to the sea of Japan, implying that the transboundary transport from China and other Asian countries significantly contributed to the increase of the tropospheric ozone.

Remote sensing from space is quite useful for measuring regional-global distribution of the atmospheric constituents. The tropospheric species such as NO2 was measured with sensors onboard a low, sun-synchronous orbit satellite. However, there are some defects for these observation. In the Japan society of atmospheric chemistry, a working group was made for examining next-generation satellite observation of atmospheric environment from the space. This group with some other institutes (NNIES, MRI and others) proposed the Geostationary missions for Meteorology and Atmospheric pollution over Asia (GMAP-Asia), which measure tropospheric ozone, aerosol an their precursors from the geostationary orbit. Spatially and temporary continuous measurement by an geostationary satellite observation will enable us to understand both photochemical and transport processes on the ozone and aerosols, especially long-range/transboundary transport of pollutants. This observation will also enable us to understand the diurnal variation of emission of precursor gases. By assimilation of the observed data, this observation will improve the model simulation of atmospheric environment.

As a complimentary mission, this group also proposes the Air Pollution Observatory (APOLLO) mission from the international space station (ISS). A very low, non-sun-synchronous orbit of ISS provides us another unique observation of the atmospheric ozone and aerosols. The low orbit enables us to observe with higher horizontal resolution (4km by 4km) to understand ozone and aerosol concentration as well as the precursor emissions at urban, suburban, agricultural areas more precisely. Non- sunsynchronous orbit enables us to measure these species at various local times. In addition, simultaneous observation of tropospheric ozone and carbon monoxide (CO) with full-wavelength, UV/visible/SWIR/MIR/sub-mm, is planned in APOLLO mission for separating lower/middle/upper tropospheric ozone and CO. It is essential to measure the lower tropospheric ozone separately to estimate mortality risk by the ozone. Separate measurement of middle and upper tropospheric ozone and CO enable us to understand the long-range/transboundary transport of pollutants and the climate influence.

Keywords: Geostationary satellite, International space station, lower tropospheric ozone

Japan Geoscience Union Meeting 2012
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ATT34-07 Room:202 Time:May 20 16:00-16:15

Future GEO missions for cloud and precipitation measurements by microwave instruments

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Earth observing satellites fly in either a low Earth orbits (LEO) or the geostationary orbit (GEO). GEO satellites make temporally continuous observations at the expense of limitation in spatial resolution due to its great distance from the Earth. Only visible and infrared imagers are feasible for GEO instruments at present. On the other hand, LEO satellites, orbiting much closer to the Earth, have the advantage to accommodate technologically challenging remote sensors such as spaceborne radars.

While visible and infrared images are unable to directly detect rain drops below overlying cloud layers, microwave radiation penetrates the cloud layer to reach rainfall beneath. Extreme rainfall events, developing quickly within a half to one hour, are difficult to detect directly by the current GEO satellites because of the lack of microwave sensors. LEO microwave instruments, however, are not optimal for such purposes either since the revisit frequency of LEO satellites is no better than twice daily. Microwave remote sensing from the GEO orbit, if realized, would bring a breakthrough to the monitoring of extreme meteorological events from the space.

In this paper, major challenges and expected impacts of GEO microwave remote sensing on the social and research communities will be discussed.

Keywords: Satellite remote sensing, cloud and precipitation measurements, future satellite missions

Japan Geoscience Union Meeting 2012
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ATT34-08 Room:202 Time:May 20 16:15-16:30

A Proposal on low inclination orbit SAR system for tropical rainforest monitoring

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1. Background

Mitigation and adaptation of climate change caused by greenhouse gases have been a serious issue for more than decades and forest has been focused in the context of REDD. In particular, the roll of tropical rainforest is more important than ever as a vast reservoir of carbon dioxide. Since monitoring area is global and wide, satellite is a key to realize true monitoring. This paper shows a result of a parametric study on SAR system to realize frequent and consistent monitoring based on our experience of a forest monitoring project in Brazil.

2. Requirement

Most of tropical rainforests lie in areas which are covered by thick cloud during rainy season and optical sensors are useless to realize timely monitoring. Time series analysis of tropical rainforest is a key technology to detect changes happening in the forest. We set the time series monitoring as well as frequent monitoring first priority in this proposal.

3. Proposed Solution

A space borne SAR sensor is the most possible and realistic instrument to meet the requirement. In order to maximize the information extracted from SAR data and track deforestation and degradation, capability of full polarimetry and differential interferometry is needed. In addition, P-band or L-band is preferable to detect volume scattering from tree canopy. The required specification of space borne SAR system can be summarized as below.

a. Ground resolution is 20-30m.
b. Revisit time to a certain area of interest is around 2 weeks.
c. Time series of differential interferometry must be conducted within 3 month time difference.
d. Full swath and full polarimetry in arbitrary incident angle.
e. Ascend and descend coverage of arbitrary target area.

4. Proposed Orbit

In order to realize more frequent observation and cover tropical rainforest areas with limited observation resources, lower orbit inclination is preferable.

In the case of low orbit inclination, the direction of satellite orbit rotation will be opposite to the earth rotation direction around the sun. But it is possible to make sub orbit locus on the earth returns to same place in some time intervals, which makes SAR enable to provide repeated path interferometry pairs.

In our case study, an example of orbit inclination is 25.12 degree, which can meet the requirement and its recursion time is 49 days and locus distance is 23.7km. If the swath of SAR sensor onboard is designed as 120km, arbitrary target point in the orbit coverage is observed 5-10 times in different incident angle per recursion cycle, which means almost every 10 days target area is observed with out affected by cloud cover.

5. Proposed SAR antenna

The cylindrical parabola antenna (Not phased array) is preferable in order to make it simple and reduce its weight and power consumption. The parameter of the antenna will be as below.

Mass: 500-1,000kg
Solar power: 2kw (SAR power = 750w with 50% margin)
3 axis stabilized (apply yaw maneuver)
SAR antenna: extendable dual polarized antenna

6. SAR Interferometry

Interferometry pair can be obtained with recursion cycle data pairs because the satellite orbit is designed to revisit same point every recursion cycle. Since a target area is observed 5-10 times with different incident angle, interferometry pair, which was obtained 49 days before, is frequently obtained for different incident angles as well. Frequent interferometry pair will provide more accurate change detection with differential interferometry and coherence evaluation.

7. Full polarimetry in full swath
To realize full polarimetry, SAR signal transmission polarization must be switched like H pol to V pol and vise versa. Our study for full polarimetry is to operate pol. switch as burst mode, which realizes full swath in full polarimetry in any designed incident angles.

8. Conclusion
Low inclination orbit SAR system without phased array antenna can realize frequent tropical rainforest observation with full polarimetry in full swath and provide frequent interferometry pairs.

Keywords: SAR, Tropical Rainforest, polarimetry, interferometry

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ATT34-09 Room:202 Time:May 20 16:30-16:45

Future cloud and precipitation observation mission

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The Tropical Rainfall Measuring Mission (TRMM) is Japan-US joint satellite mission that equips world first spaceborne precipitation radar (PR) as well as microwave imager (TMI) and has been producing very valuable precipitation data more than eleven years. This long term precipitation record from TRMM made it possible to provide not only the precise global precipitation amount but also improve the understanding the mesoscale tropical and sub-tropical weather system revolutionary. For example, diurnal cycles of rainfall is revealed by several studies using PR data both land and ocean. It is worth to note that the mesoscale climatology developed from PR data is used to evaluate the global cloud-resolving model such as NICAM. The follow-on mission of TRMM, which is called the global precipitation measuring (GPM) mission, is planned to start in 2014. GPM mission is consist of Core satellite which equips dual frequency (14 GHz and 35 GHz, the former is same frequency as TRMM/PR) radar to improve the estimation accuracy of rainfall and to observe the light rain and snowfall and constellation satellites which equip microwave radiometer to gain the sampling of precipitation. On the other hand, satellite cloud remote sensing started with optical sensors to estimate the effective radius of cloud and so on. In 2006, NASA's CloudSat satellite was launched to observe the cloud structure using 95-GHz cloud radar. CloudSat has been providing the vertical structure of clouds and even light rain and enables us to see the cloud and precipitation properties at the same time. In Japan, spaceborne cloud radar similar to the CloudSat but upgraded in terms of sensitivity, long life time and the additional Doppler capability is being developed for EarthCARE mission which is JAPNA-ESA joint program aiming to reveal the aerosol-cloud processes to realize more precise Earth radiation budget estimation using cloud radar and lidar.

Beyond the GPM and the EarthCARE targeting 2018, post-GPM mission is discussed under the GPM science team. First, scientific paradigm toward 2018 and beyond in discussed. For example, global water circulation and impact of global warming to the rainfall are recognized as very important study theme. In addition, long term accurate global rainfall record by spaceborne radar is also recognized as important. The importance of comprehensive and frequent of extreme events, especially for typhoons and hurricanes is pointed out. Based on these scientific requirements, sensor requirements are discussed and concluded the needs of both the cloud radar and the precipitation radar with Doppler measurement capability and wind measurements by Doppler Lidar. Alternative approach to the wind measurement is multiple satellites concept (e.g. train satellites) to see the development process of cloud-precipitation system by observing in a short time intervals. In the sensor requirement study phase, development item of the sensors are also summarized (e.g. pulse compression radar, scanning W-band radar). Base on the sensor requirements, several missions are proposed. For example, multiple satellite system is one of the solutions to fulfill the scientific requirements and the typhoon observation from geostationary orbit (it is recognized as the mission more than 10 years from now). With the help of JAXA's system engineering group, preliminary mission feasibility study was also performed. Based on these studies, detailed sensor study and trade-off will be done.

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ATT34-10 Room:202 Time:May 20 16:45-17:00

Earth Observation Strategy by Small Satellites

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New strategy for earth observation by Small Satellites will be presented.

Keywords: Small Satellite, Small Scientific Satellite Bus, ASNARO, SDS, Microsatellite, Peer Review

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ATT34-P01 Room:Convention Hall Time:May 20 15:20-15:30

Earth observaiton satellites missions by JAXA

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This paper explain the plan and status of JAXA's earth observation satellite missions.

Keywords: Earth observation

Japan Geoscience Union Meeting 2012
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ATT34-P02 Room:Convention Hall Time:May 20 15:20-15:30

A Study on the earth observation mission for human society

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We began to discuss the future of the earth observation mission along with the JAXA form 2011 FY. This paper is a summary report of the discussion about land area. We hope that this report becomes the beginning of discussion among many people.

In 2011, the world's population has reached 7 billion people. According to the white paper, the world's birth rate is declining, but the population will continue to trend increase in the future. It is estimated that in 2050 the world population will reach 9 billion people, in the year 2090 will reach 10 billion people. In Malthus's population theory (published in 1798), He said that the big problem for human beings will arise, when the balance of food and population collapses remarkably. We thought it would be this problem to arise in 21st century. We began to discuss the earth observation mission involved in food production.

Keywords: earth observation

Japan Geoscience Union Meeting 2012
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ATT34-P03 Room:Convention Hall Time:May 20 15:20-15:30

A proposal for high resolution observations of the ocean surfaces using a large aperture antenna

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Sea surface observations of a high spatial resolution (approximately 5 km) by a passive and active microwave sensor with a large aperture antenna (5-10 m diameter) are proposed. The microwave sensor with the large aperture antenna will provide us with physical parameters of the air-sea boundary with a high spatial resolution of 5 km, which resolves oceanic phenomena of spatial scales greater than the Rossby radius of deformation (approximately 10 ? 30 km in mid latitudes). The sensor carried on a sun-synchronous polar orbit satellite with an orbital altitude of 7-800 km conically scans the earth's surface with a wide swath of approximately 1600 km, achieving a temporal sampling of 2 times/day. The microwave radiometer (passive) utilizes frequency bands of 1.4, 6.9/7.3, 10.6, 18.7, 23.8, 36.5, 89.0, and 160 GHz (V and H pol.), while the scatterometer (active) is operated in the L-, C-, and Ku-band (VV and HH pol.). The radiometer channels other than 1.4 and 160 GHz are identical to AMSR2 on GCOM-W1. The 1.4 GHz channel is added to observe the sea surface salinity, and the 160 GHz channel is added for observation of solid precipitation. The microwave instrument will measure the physical parameter of the ocean surfaces, such as the sea surface temperature (SST), marine surface vector wind, sea surface salinity (SSS), and sea ice concentration. Typical spatial resolution and temporal sampling would be 5 km and 2 times/day for SST, winds, and sea ice, and 25 km and 5 day average for SSS, respectively. The goal of accuracy is 0.5 K for SST, 1 m/s and 20 deg. for vector winds, 0.2 psu for SSS, and 10 % for sea ice concentration. The microwave sensor will be also applicable to observations of the atmosphere (e.g., integrated water vapor, liquid cloud water, and liquid and solid precipitations), and land (e.g., soil moisture, and snow depth). The sea surface observation with the high spatial resolution and high accuracy will allow us to explore the mesoscale and sub-mesoscale oceanic phenomena, which are difficult to observe conventional techniques and previous spaceborne sensors. The observed data will also be directly applicable to the operational oceanic monitoring and prediction, the safety and economical efficiency of ship routes, fishery and conservations of marine environment, especially in the ocean and seas around Japan, together with operational weather forecasts and disaster preventions.

Keywords: Remote sensing, Observation of oceans from space, Microwave radiometer, Microwave scatterometer, Large aperture antenna, Air-sea interactions

Japan Geoscience Union Meeting 2012
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ATT34-P04 Room:Convention Hall Time:May 20 15:20-15:30

Conceptual study on Japanese altimetry mission

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[1]Japan Aerospace Exploration Agency

Measurement of sea surface height is important in satellite measurement of ocean as well as sea surface temperature, ocean color, sea surface wind velocity, etc. JAXA has started a conceptual study on a new altimetry mission. In the mission, using a interferometric synthetic aperture radar (In-SAR) with two antennas, wide-swath measurement of sea surface height is aimed. Studies on target specification and system feasibilities are ongoing.

The main four purposes of the mission are as follows;

Forecasting of the ocean current;
The aim is to improve the tidal model and forecasting of the ocean current especially in coastal regions and marginal seas using four-dimensional assimilation. Improvement of ocean current forecasting is expected for estimation of current drift caused by ocean accidents, efficiency of marine navigation, and diffusion of radioactive material.

Fishery;
The aim is to observe ocean phenomena related to fishery places, such as Kuroshio-front and ocean surface topography from mesoscale to submesoscale.

Disaster;
The aim is to improve Tsunami forecast model using inversion method through the observation of Tsunami waves caused by an earthquake in far region.

Geoid and seafloor topography;
The aim is to improve sea floor topography model through improvement of geoid model.

We will present current status of the conceptual study.

Keywords: altimetry, ocean current, fishery, disaster, geoid, interferometric synthetic aperture radar

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ATT34-P05 Room:Convention Hall Time:May 20 15:20-15:30

Satellite Remote Sensing of the Atmosphere: Past and Future

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The observation of the Earth from space started in 1959 by the satellite Explorer 6 launched in the United States of America, which took the picture and measured the radiation budget although the orbit was highly elliptical. Since then, NASA and NOAA of USA have continued to develop and launch the Earth observing satellite. Various types of sensor have been developed to observe the atmosphere up to now. Radiometers on board satellite cover the wavelength from UV to microwave spectral region to observe the air temperature, water vapor profile, clouds, aerosols, and so on. In addition to the radiometers, active sensors such as lidar and radar were launched and used to observe vertical profiles of cloud and aerosol, and precipitation from space. Japanese geostationary meteorological satellite so called Himawari was launched in 1977 for the first time and it continued the present MTSAT series.

The algorithm to retrieve atmospheric properties has also been developed and advanced as well as hardware development. However, it looks almost completed at present except for a few special sensors such as hyper-spectral radiometer active sensors, and a new algorithm development is difficult for visible and infrared imagers since the standard products obtained from them are already highly sophisticated. Atmospheric parameters related to climate change, for example, water vapor, cloud microphysics and aerosols properties are available like objective analysis meteorological data. Data assimilation analysis is also being carried out recently by using satellite observation data and GCMs. A limited number of scientists are concerned with basic hardware and algorithm developments in Japan.

With the above background, the future of satellite observation of the atmosphere has been discussed in a research community in Japan. The new frontier of satellite remote sensing of atmosphere will be limited to a few fields, that is, hardware and algorithm developments for active sensors, more sophisticated combinations of active and passive sensors, utilization of geostationary satellite to observe cloud, water vapor, and chemical properties of atmosphere with a high temporal resolution. Based on the above preliminary discussion, I will discuss more about the perspective of satellite remote sensing of atmosphere in the future.

Keywords: Atmosphere, Satellite remote sensing

ATT34-P06 Room:Convention Hall Time:May 20 15:20-15:30

Possibility of Microsatellite

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As a remote-seising tool, 50-kg class micro-satellite has following great potentials compared to existing big satellite, namely, 1) Low cost fabrication compared to middle- or large sized satellite, namely, few M EUR including bus and mission payloads. The launch cost will be 1+ M EUR as piggyback, 2) quick fabrication: about one year for flight model, enabling application of the latest technologies, 3) Constellation flight, enabling frequent monitoring from low altitude, 4) On-demand operation, taking detail information at point of focus, according to requirement of users. Here we introduce the latest technologies for remote sensing, which will be launched onboard micro-satellites developed in universities, including high functional 5-m resolution telescopic camera, which can select any colors from 400-700 nm or 650-1050 nm at 1 nm step, and a bolometer array camera. We would suggest applications of micro-satellite and its constellation in order to monitor every subject which has dynamical variations, such as, cloud structure, hydrology including CO2 flow, lightning, vegetation, agriculture, forest fire and smoke detection, dust, atmospheric and oceanic pollution, biology in ocean, glacier, and natural disasters. We should consider the best mix of micro and big satellites as a strategy of all Japan community.

Keywords: micro-satellite, remote-sensing, on-demand, constellation

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ATT34-P07 Room:Convention Hall Time:May 20 15:20-15:30

A Propsal of the ELMOS Constellation

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The outline of the ELMOS small satellite constellation will be presented.

Keywords: GPS ocultation, Electron Density, Electron Temperature, Weather Forecast, Atmosphere, Ionosphere