Commission H (Waves in Plasmas) Activity Report

November 9th , 2010
T. Okada, and Y. Omura

Research Topics

<Akebono>

Sato et al. (2010) reported on the first observation of polarization features and the source region of MF/HF auroral radio emissions emanating from the topside ionosphere. These emissions are called “Terrestrial Hectometric Radiation (THR)” and regarded as a counterpart of auroral roar and MF burst which are observable from the ground. THR typically occurs in either or both of two frequency bands near 1.5–2.0 MHz and 3.0–4.0 MHz, whose polarization features correspond to the L-O and R-X mode.

The R-X mode, which has never been reported as auroral roar and MF burst, can be attributed to nonlinear coupling of two upper hybrid waves. The Akebono satellite observation shows THR emissions merge with upper hybrid waves in a frequency – time diagram under the matching condition fUH ~ 2fce. This observation suggests that plasma instability enhances the upper hybrid waves under this condition, and then they are converted into MF/HF auroral radio emissions.

<REIMEI>

Miyoshi et al. (2010) proposed a model for the energy dispersion of electron precipitation associated with pulsating auroras, considering the wave-particle interactions with propagating whistler mode waves from the equator. Since the resonant energy depends on the magnetic latitude, the pitch angle scattering of different energy electrons can occur continuously along the field line. Considering the energy-dependent path length and the precipitation start time of the precipitating electrons, the transit time of whistler mode waves, and the frequency drift, they calculated the precipitation of electrons observed at the topside ionosphere. Note that higher energy electrons precipitate into the ionosphere of the opposite hemisphere earlier than lower energy electrons. As a result, an energy dispersion of precipitating electrons is observed at the topside ionosphere, even though the modulation of low energy electrons occurs prior to that of high energy electrons.

Using the model, they conducted a time-of-flight (TOF) analysis of precipitating electrons observed by the REIMEI satellite, assuming an interaction with the whistler mode chorus rising tone. The TOF analysis suggests that the modulation region of the pitch angle scattering is near the magnetic equator, whereas previous models expected that the modulation region is far from the magnetic equator. The estimated parameters, such as wave-frequency and latitudinal distribution of the modulation region, are consistent with previous statistical studies of whistler waves at the magnetosphere.

<ERG>

Miyoshi et al. (2010) described the mission profile of small-satellite mission for geospace exploration ERG (Energization and Radiation in Geospace) that aims at understanding the acceleration process of relativistic electrons and dynamical variations of the space storm. The project consists of not only the satellite mission but also ground-based observations and integrated studies/simulation teams. The satellite will be launched into the inner magnetosphere around the next solar maximum. In efforts to understand the cross-energy coupling process that is essential to generate relativistic electrons and the dynamical evolution of space storms, the satellite is equipped with instruments for comprehensively observing plasma/particles, fields and waves.

<BepiColombo>

Millilo et al. (2010) described the mission profile of BepiColombo for Mercury exploration. Mercury possesses a weak, internal, global magnetic field that supports a small magnetosphere populated by charged particles originating from the solar wind, the planet's exosphere and surface layers. Mercury's exosphere is continuously refilled and eroded through a variety of chemical and physical processes acting in the planet's surface and environment. Using simultaneous two-point measurements from two satellites, ESA's future mission BepiColombo will offer an unprecedented opportunity to investigate magnetospheric and exospheric dynamics at Mercury as well as their interactions with solar radiation and interplanetary dust. The expected data will provide important insights into the evolution of a planet in close proximity of a star.

Many payload instruments aboard the two spacecraft making up the mission will be completely, or partially, devoted to studying the close environment of the planet as well as the complex processes that govern it. Coordinated measurements by different onboard instruments will permit a wider range of scientific questions to be addressed than those that could be achieved by the individual instruments acting alone. Thus, an important feature of the BepiColombo mission is that simultaneous two-point measurements can be implemented at a location in space other than the Earth. These joint observations are of key importance because many phenomena in Mercury's environment are temporarily and spatially varying.

<Sounding Rocket>

Ion sheath which is formed around an electrode significantly affects the impedance of the probe immersed in a plasma. Suzuki et al. (2010) examined the sheath capacitances obtained from impedance probe measurements for application to plasma diagnoses. They compared analytical calculations of the sheath capacitance with measurements from impedance probes onboard ionospheric sounding rockets. The S-520-23 sounding rocket experiment, which was carried out in mid-latitude, demonstrated that the observed sheath capacitances agreed well with those of the calculations. They concluded that the sheath capacitance measurements allow for estimation of the electron temperature and the electron density of a Maxwellian plasma. On the other hand, the sheath capacitances obtained from the S-310-35 rocket experiment in the auroral ionosphere showed lower values than expected. Auroral particles precipitations should modify the probe potential.

Uemoto et al. (2010) presented direct observation of the impact of the lithium releases on the ionospheric electron density during the WIND (wind measurement for ionized and neutral atmospheric dynamics study) campaign conducted on 2 September 2007 in Japan. The direct observation is unique in that the electron density enhancement was observed by using the NEI (number density of electrons by impedance probe) which can measure accurately the absolute value of the electron density, and the distance between the NEI and the LES (lithium ejection system) was very close (several tens of meters). Data analyses of the NEI on-board the sounding rocket S-520-23, which was launched from Uchinoura (31.3 N, 131.1 E) at 19:20 JST (JST = UT + 9 h), clarifies that lithium releases performed in the descending phase increased the electron density up to approximately 7×10^5 cm^{-3}. A simple model calculation performed under the assumption that the increased electron density equals the photoionized lithium ion density indicates that the observed electron density enhancements cannot be explained by considering each lithium release as an instantaneous one, but rather by considering a convolution of very short-time intermittent releases. The model calculation is verified by comparison with the observation of the lithium resonance scattering light from the ground.

<Computer simulation>

Tao et al. (2010) developed a new numerical model of the Jovian magnetosphere-ionosphere coupling current system in order to investigate the effects of diurnal variation of ionospheric conductance. The conductance is determined by ion chemical processes that include the generation of hydrogen and hydrocarbon ions by solar EUV radiation and auroral electrons precipitation. The model solves the torque equations for magnetospheric plasma accelerated by the radial currents flowing along the magnetospheric equator. The conductance and magnetospheric plasma then change the field-aligned currents (FACs) and the intensity of the electric field projected onto the ionosphere. Because of the positive feedback of the ionospheric conductance on the FAC, the FAC is the maximum on the dayside and minimum just before sunrise. The power transferred from the planetary rotation is mainly consumed in the upper atmosphere on the dayside, while it is used for magnetospheric plasma acceleration in other local time (LT) sectors.

Further, the simulations show that the magnetospheric plasma density and mass flux affect the temporal variation in the peak FAC density. The enhancement of the solar EUV flux by a factor of 2.4 increases the FAC density by 30%. The maximum density of the FAC is determined not only by the relationship between the precipitating electron flux and ionospheric conductance, but also by the system inertia, i.e., the inertia of the magnetospheric plasma. A theoretical analysis and numerical simulations reveal that the FAC density is in proportion to the planetary angular velocity on the dayside and to the square of the planetary angular velocity on the nightside. When the radial current at the outer boundary is fixed at values above 30 MA, as assumed in previous model studies, the peak FAC density determined at latitude 73°-74° is larger than the diurnal variable component. This result suggests large effects of this assumed radial current at the outer boundary on the system.

References:

Milillo, A., M. Fujimoto, E. Kallio, S. Kameda, F. Leblanc, Y. Narita, G. Cremonese, H. Laakso, M. Laurenza, S. Massetti, S. McKenna-Lawlor, A. Mura, R. Nakamura, Y. Omura, D.A. Rothery, K. Seki, M. Storini, P. Wurz, W. Baumjohann, E.J. Bunce, Y. Kasaba, J. Helbert, A. Sprague, and Hermean Environment WG members, The BepiColombo mission: An outstanding tool for investigating the Hermean environment, Planet. Space Sci., 58, 40-60, 2010.

Miyoshi, Y., K. Seki, K. Shiokawa, T. Ono, Y. Kasaba, A. Kumamoto, M. Hirahara, T. Takashima, K. Asamura, A. Matsuoka, T. Nagatsuma, and ERG working group, Geospace Exploration Mission: ERG project, Trans. Japan Soc. Aeronautic. Space Sci., 8, ISTS27, Tm_1-6, 2010.

Miyoshi, Y. Y. Katoh, N. Nishiyama, T. Sakanoi, K. Asamura, and M. Hirahara, Time of flight analysis of the pulsating aurora electrons, considering the wave-particle interactions with the propagating whistler mode waves, J. Geophys. Res., 115, A10312, doi:10.1029/2009JA015127, 2010.

Sato, Y., T. Ono, N. Sato, and R. Fujii, MF/HF auroral radio emissions emanating from the topside ionosphere, Geophys. Res. Lett., 37, L14102, doi:10.1029/2010GL043731, 2010.

Suzuki, T., T. Ono, J. Uemoto, M. Wakabayashi, T. Abe, A. Kumamoto, and M. Iizima, Sheath capacitance observed by impedance probes onboard sounding rockets: Its application to ionospheric plasma diagnostics, Earth Planets Space, 62, 579-587, 2010

Tao, C., H. Fujiwara, and Y. Kasaba, Jovian magnetosphere-ionosphere current system characterized by diurnal variation of ionospheric conductance, Planet. Space Sci., 58, 351-364, 2010.

Uemoto, J., T. Ono, T. Yamada, T. Suzuki, M.-Y., Yamamoto, S. Watanabe, A. Kumamoto, and M. Iizima, Impact of lithium releases on ionospheric electron density observed by impedance probe during WIND campaign, Earth Planets Space, 62, 589-597, 2010.

<GEOTAIL>

Geotail spacecraft has observed many chorus emissions mainly in the Earth's dayside outer magnetosphere. Mori et al. [2010a, b] have analyzed the waveform data of the chorus emissions and examined the relationship between the frequency sweep rates, frequencies and the amplitudes of the chorus emissions. As shown in Fig. 1, they have found an interesting positive correlation between the frequency sweep rates and the "frequencies multiplied by amplitudes." Such correlation is consistent with a nonlinear theory for chorus generation which has recently been developed and confirmed by computer experiments, so that it may be an experimental evidence to support the nonlinear theory.

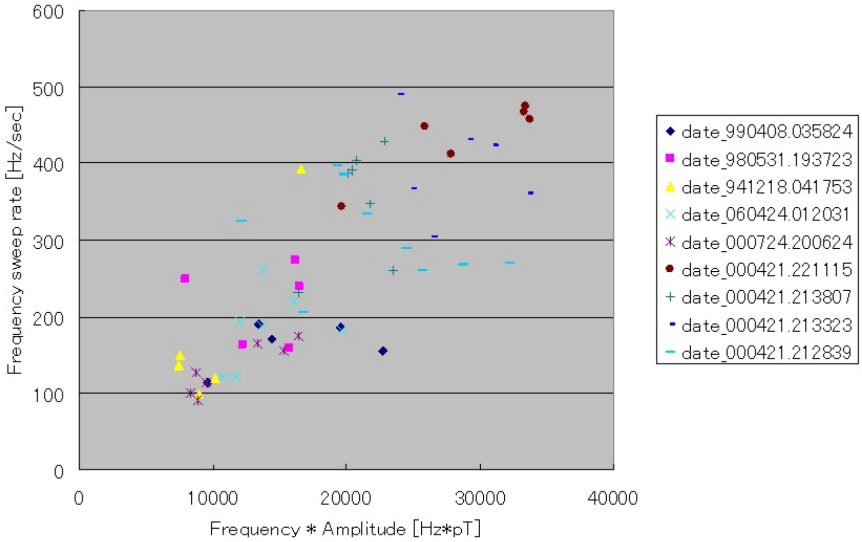

Fig.1: Correlation between frequency sweep rates and "frequencies multiplied by amplitudes" of chorus emissions

References:

Mori, S., S. Yagitani, M. Hikishima, and H. Kojima, "Frequency and amplitude variation of chorus emissions observed by GEOTAIL," Proc. AP-RASC'10, Toyama, Japan, September 2010a.

Mori, S., S. Yagitani, M. Hikisima, and H. Kojima, "Frequency and Amplitude Variation of Chorus Emissions Observed by GEOTAIL," 128th SGEPSS, October 31 – November 3, 2010b.

<Sensor development>

Tanaka et al. [2010] have developed a new wideband search-coil magnetometer for plasma wave observation by next-generation scientific satellites. Traditional search-coils, which are mounted on many spacecraft for example GEOTAIL and BepiColombo/MMO, have been used for frequencies below a few tens of kHz. They have devised a search coil having a specific structure using a concept of "variable inductance." The performance of the developed search coil has been validated with theoretical analysis and measurement. The fabricated prototype of the search coil has achieved the magnetic sensitivity of 1 fT/sqrt(Hz) at two frequencies, 100 kHz and 1 MHz.

Reference:

Tanaka, R., S. Yagitani, and M. Ozaki, "Wideband triaxial search-coil magnetometer for next-generation scientific satellite," 128th SGEPSS, October 31 – November 3, 2010.

<Antenna analysis>

Knowledge of the characteristics of wire antennas onboard scientific satellites in space plasmas is necessary to determine the absolute intensity and the phase of the electric field wave because the observation data about electric field are available as voltage signal. One of important characteristics is the antenna impedance. Determination of the impedance can be especially difficult since the impedance depends on the medium surrounding the antenna, and the impedance is affected primarily by the plasma sheath created around the antenna. In Higashi et al. [2010], according to the statistical analysis of measurement results of the antenna impedance for 15 years on Akebono, the rough dependence of the antenna impedance on the altitude (the electron density) of the satellite orbit is found, as plotted in Fig. 2.

On the other hand, Imachi et al. [2010] have analyzed the method to estimate the characteristics of the wire antenna theoretically. In their analysis, the electric field is assumed to be a distribution of electrostatic potential, and the environment surrounding the wire antenna, including the structure of the wire and the receiver is written into an equivalent circuit. Using the analysis, they can estimate the characteristics of the wire antenna, such as the effective length, the impedance and the pickup factor, including the effect of the detailed structure of the wire, such as the wire insulator and the noise reduction shield.

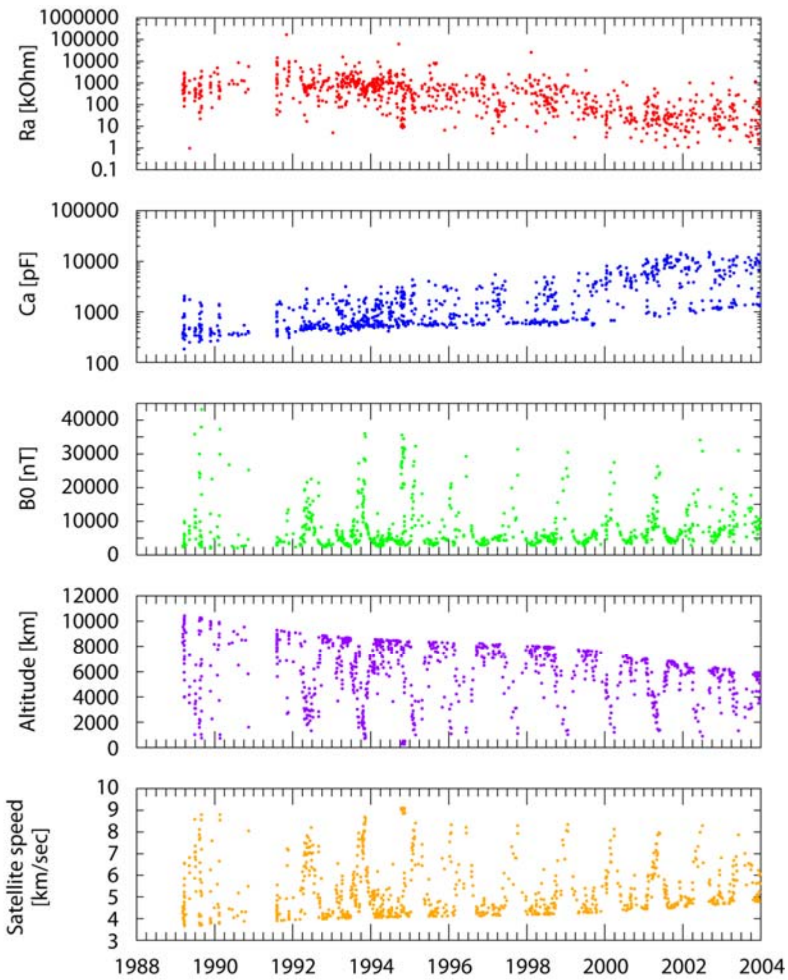

Fig. 2: Measurement result of antenna impedance of wire antenna on Akebono

References:

Higashi, R., T. Imachi, Y. Kasahara, S. Yagitani, and I. Nagano, "Statistical analysis of antenna impedance onboard akebono satellite," Proc. AP-RASC'10, Toyama, Japan, September 2010.

Imachi, T., S. Yagitani, R. Higashi. and I. Nagano, "Characteristics of wire antenna for plasma wave o bservation at low frequencies," Proc. AP-RASC'10, Toyama, Japan, September 2010.

KAGUYA (SELENE)

The Japanese lunar explorer "KAGUYA" was launched on September, 14, 2007 and the operation was successfully performed until KAGUYA was impacted to the south-east of near side of the moon on June 10, 2009. The Lunar Radar Sounder (LRS) is one of the scientific instruments onboard the KAGUYA main orbiter. The LRS consists of two orthogonal 30 m tip-to-tip antennas and three subsystems; the sounder observation (SDR), the natural plasma wave receiver (NPW), and the waveform capture (WFC). The SDR is designed to investigate the surface and subsurface structures of the moon using an HF radar technique, and the NPW and WFC are designed to measure natural plasma waves around the moon and in interplanetary space.

One of the most interesting phenomena revealed by the WFC data is the dynamics of lunar wake as a result of solar wind-moon interaction. Kasahara et al. (2010) reported the spatial structure of lunar wake and its electron density profile derived from electron plasma frequency (f_p) detected by the WFC. Varieties of frequency transition of f_p were recognized depending on the orbital condition of KAGUYA. In the lunar wake region, electron density decreases less than a few percents of that in the solar wind. They also reported that an asymmetric structure of electron density profile at the lunar wake boundary was sometimes observed.

It is also noted that there are number of small crustal fields which have large magnetic anomalies, and presence of mini-magnetospheres is suggested over them. Kitaguchi et al. (2010) investigated plasma waves observed around lunar magnetic anomalies and showed that intense wave activities below several kHz were often recognized over the magnetic anomalies. They statistically analyzed spatial distribution of wave activity and found that the wave activity becomes larger when the magnetic anomaly is located around the terminator of the moon especially in the solar wind downstream. This fact suggests that mini-magnetosphere sometimes extends up to an altitude region of ~100 km and intense plasma waves are generated in the downstream while the effects of mini-magnetosphere are restricted in the lower altitude region around the subsolar point because of the solar wind pressure.

Hashimoto et al. (2010) introduced observations of electrostatic solitary waves (ESWs) near the Moon in the solar wind and in the lunar wake. ESW observations are categorized into three types depend on the observed conditions: ESW generated by the electric field in the wake boundary (Type A), strong ESW generated by the solar wind and bi-streaming electrons mirror-reflected over the magnetic anomaly (Type B), and ESW generated in the solar wind when the local magnetic field is connected to the lunar surface (Type C). ESW of Type C often alternate with Langmuir waves. Sugiyama et al. (2010) derived velocity distribution functions of electrons and ions from the particle data obtained by the particle detector named PACE onboard KAGUYA and compared them with wave data. They suggested that the electric field is fluctuated and BEN or Langmuir waves are observed when the ambient direction of magnetic field line connects to the moon.

Shiraishi et al. (2010) made an analysis of low frequency plasma waves less than 1 kHz obtained by the WFC-L. They found 91 examples of characteristic plasma waves with narrowband spectra less than electron cyclotron frequency in the data obtained from April to June 2008. They suggested that these plasma waves are correspond with ion-plasma oscillation.

Oike et al. (2010) evaluated the performance of an operation mode named "automatic filter selection (SELECT)" implemented for the WFC-L on the onboard software. This operation mode makes it possible to downlink the significant waveform to the ground in shorter time duration and to capture new series of waveform data with higher duty ratio. They demonstrated that automatic selection process and the parameters adopted on the WFC-L onboard KAGUYA were basically adequate, but more efficient algorithm to grasp characteristics of waveforms would be needed for the future exploration mission.

References:

Hashimoto, K., Hashitani, M., Kasahara, Y., Omura, Y., Nishino, M. N., Saito, Y., Yokota, S., Ono, T., Tsunakawa, H., Shibuya, H., Matsushima, M., Shimizu, H., and Takahashi, F., Electrostatic solitary waves associated with magnetic anomalies and wake boundary of the Moon observed by KAGUYA, Geophys. Res. Lett., 37, L19204, doi:10.1029/2010GL044529, 2010.

K. Hashimoto, M. Hashitani, Y. Kasahara, Y. Omura, M.N. Nishino, Y. Saito, S. Yokota, T. Ono, H. Tsunakawa,H. Shibuya, M.Matsushima, H. Shimizu, and F. Takahashi, Electrostatic Solitary Waves near the Moon Observed by KAGUYA, Proc. AP-RASC'10, Toyama, Japan, September, 2010.
Y. Kasahara, A. Muro, K. Kanatani, Y.Goto, K.Hashimoto, Y. Omura, A. Kumamoto, T. Ono, and H.Tsunakawa, Lunar Wake Structure and its Electron Density Profile in the Solar Wind Observed by KAGUYA LRS/WFC, Proc. AP-RASC'10, Toyama, Japan, September, 2010.
S. Kitaguchi, Y. Kasahara, Y. Goto, K.Hashimoto, Y. Omura, A.Kumamoto, T. Ono, and H. Tsunakawa, Plasma Waves over Lunar Magnetic Anomalies Observed by LRS/WFC onboard Kaguya, Proc. AP-RASC'10, Toyama, Japan, September, 2010.
Y. Oike, Y. Kasahara, Y. Goto, K.Hashimoto, A. Kumamoto, and T. Ono, Evaluation of Data Selection Algorithm Implemented in the LRS/WFC onboard KAGUYA, Proc. AP-RASC'10, Toyama, Japan, September, 2010.
T. Shiraishi, T. Miyake, K. Ishisaka, T.Okada, Y.Kasahara, Y. Goto, K. Hashimoto, A.Kumamoto, T. Ono,H. Tsunakawa, K. M.-L. Team, M. N. Nishino, Y. Saito, S.Yokota, Analysis of Low-Frequency Plasma Wave Observed by Waveform Capture (WFC) onboard KAGUYA, Proc. AP-RASC'10, Toyama, Japan, September, 2010.
H. Sugiyama, M. Hashitani, Y. Omura, K. Hashimoto, Y. Saito, M. Nishino, H. Tsunakawa, and Y. Kasahara, Data Analysis of Non-thermal Plasma Particles Observed by KAGUYA Spacecraft Orbiting around the Moon, Proc. AP-RASC'10, Toyama, Japan, September, 2010.

Nakagawa, T., F. Takahashi, H. Tsunakawa, A. Nakayama, H. Shibuya, H. Shimizu, M. Matsushima, Magnetic fluctuations produced by the solar-wind interaction with the Moon observed by Kaguya spacecraft, COSPAR Scientific Assembly 2010, B01-0060-10, Bremen, Germany, July 23, 2010.
Nakagawa, T., 2-D particle-in-cell simulation on the solar wind interaction with a non-magnetized body, The 128th Meeting of Society of Geomagnetism and Earth, Planetary and Space Science, Okinawa, November, 2010
Nakayama et. al., Generation mechanism of the 100-second magnetic field variations observed by Kaguya around the moon, The 128th Meeting of Society of Geomagnetism and Earth, Planetary and Space Science, Okinawa, November, 2010

<SCOPE>

In the fields of solar-terrestrial measurements, it is well known that there is a severe limitation of in-situ observation using a single satellite. This is because it is quite difficult to distinguish between spatial and temporal variation of plasma environment in the magnetosphere by single satellite. Therefore, a simultaneous multi-point observation using multi-satellite are very important to understand the spatial and temporal variety of the geo-space environment. The SCOPE is a Japanese future mission to investigate the multi-scale plasma physics using multiple satellites. In the SCOPE mission, formation flying will be made up of a mother satellite, a daughter satellite in the near distance, and two or three daughter satellites in the long distance from the mother.

To achieve a co-operational observation efficiently with formation-flying satellites, Takenaka et al. (2010) developed a system using LAN-connected PCs in order to simulate inter-communication among satellites and onboard data processing functions. On the simulator, they simulate co-operational observation under the direction of mother satellite according to the observational reports from daughter satellites.

Observation data from the waveform capture (WFC) onboard the KAGUYA spacecraft were used in order to simulate co-operational observation functions under realistic condition. They studied some patterns of decision algorithm and evaluated the performance of co-operational observation.

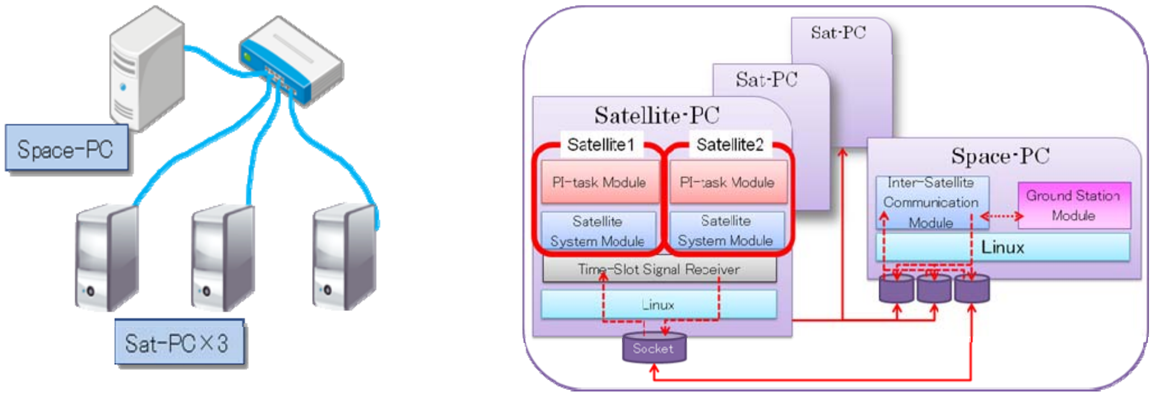

Figure 3: Network configuration and its software design of the formation-flying simulator.

References:

S. Takenaka, Y. Kasahara, H. Kojima, and T. Imachi, Development of a Co-operational Observation Simulator for Formation-flying Magnetospheric Exploration Mission, Proc. AP-RASC'10, Toyama, Japan, September, 2010.

<Modeling of Electron Density Profile in the Plasmasphere>

It is well-known that the plasmasphere is filled with relatively dense core plasmas which are predominantly provided from the ionosphere. Goto et al. (2010) have proposed a realistic density model of the Earth's plasmasphere by incorporating large data sets of VLF whistler dispersions obtained by the Akebono satellite and GPS-derived TECs into the global core plasma model (GCPM). They constructed a density model represented by a combination of the original GCPM and an adaptable portion which represents GCPM errors. By assuming smoothness prior to the errors in multi-dimensional parameter space of the GCPM, they estimate distribution of the errors in order that theoretically derived whistler dispersions or TECs agree with the observed ones. This combination model makes it possible to reflect the characteristics of the waves to the profile without varying the parameters in the physical base model.

Following the study done by Goto et al. (2010), Hayashi et al. (2010) examined the accuracy of the GCPM by comparing lightning whistler dispersions observed by the Akebono in solar active years from 2000 to 2002 with theoretical ones derived from GCPM model by ray tracing method. They concluded that good accuracy cases are found in daytimes and in evenings from January to April while poor accuracy cases are found in evenings and night times all over the years.

References:

Y. Goto, Y. Kasahara, S. Hayashi, and T. Ide, Modeling of the Plasmaspheric Density Profile from Large Data Sets of VLF waves and GPS signals, Proc. AP-RASC'10, Toyama, Japan, September, 2010.

S. Hayashi, Y. Goto and Y. Kasahara, Examination of Validity of the Global Core Plasma Model using Whistler Dispersions Obtained by the Akebono, Proc. AP-RASC'10, Toyama, Japan, September, 2010.

<Lightning-generated sferics observations>

To extract information on return stroke from sferics, Ozaki et al. [2010a, b] have been investigating a technique for estimating return stroke current. The current amplitude is simply determined by the horizontal distance of the lightning location and the return stroke velocity. The lightning location can be estimated from sferics. However, the return stroke velocity has been an unknown parameter and an average value (i.e., 50-70 % of the light speed) has been used for the current estimation. This ambiguity is a serious problem in the return stroke current estimation. For this problem, they have succeeded in obtaining information on discharge time (equivalent to discharge channel divided by return stroke velocity) of the return stroke from the sferic spectrum feature. By the numerical simulation, the estimation error of the current moment is significantly improved and becomes less than 10% for the horizontal distances over 100 km from the lightning.

Miyazaki et al. [2010] have evaluated validation of single-site lightning location technique by using theoretical sferic waveforms. The distance error rate increases at westward horizontal distance of more than 300 km from the lightning. This is caused by the effect of the Brewster's angle for the reflected wave in the ionosphere, which appears for westward propagation. Sferics having large incidence angles are susceptible to the Brewster's angle, thus they have considered lightning location technique without the first reflected wave, which has the largest incident angle. This method improves the estimation accuracy and the distance error rate becomes less than ±5 %.

References:

Miyazaki, K., M. Ozaki, S. Yagitani, and I. Nagano, "Validation analysis of single-site lightning location technique by VLF sferics waveforms," 128th SGEPSS, October 31 – November 3, 2010

Ozaki, M., S. Yagitani, T. Koide, Y. Itoh, and I. Nagano, "Extracting return stroke current moment based on sferic spectrum," Proc. AP-RASC'10, Toyama, Japan, September, 2010a.

Ozaki, M., S. Yagitani, Y. Itoh, and I. Nagano, "Lightning current moment estimation for solving ambiguity of the return stroke velocity," 128th SGEPSS, October 31 – November 3, 2010b.

<ULF Waves>

Omura et al. [2010] developed a nonlinear wave growth theory of electromagnetic ion cyclotron (EMIC) triggered emissions (in the frequency range of Pc 1 pulsations), observed in the inner magnetosphere. Starting from Maxwell's equations and the momentum equations for electrons and ions, they obtained equations that describe the nonlinear dynamics of resonant protons interacting with an EMIC wave. They then obtained a set of ordinary differential equations that describe the nonlinear evolution of a rising tone emission generated at the magnetic equator. Using the physical parameters inferred from the wave, particle, and magnetic field data measured by the Cluster spacecraft, they determined the dispersion relation for the EMIC waves. Integrating the differential equations numerically, they obtained a solution for the time variation of the amplitude and frequency of a rising tone emission at the equator. Assuming saturation of the wave amplitude, as is found in the observations, they found good agreement between the numerical solutions and the wave spectrum of the EMIC triggered emissions.

Shiokawa et al. [2010] reported on the Solar-Terrestrial Environment Laboratory (STEL) induction magnetometer network which has been developed to investigate the propagation characteristics of high-frequency geomagnetic pulsations in the Pc1 frequency range (0.2−5 Hz). Five induction magnetometers were installed in the period 2005-2008 at Athabasca in Canada, Magadan and Paratunka in Far East Russia, and Moshiri and Sata in Japan. The sensitivity of these magnetometers is between 0.3 and 13 V/nT at turnover frequencies of 1.7-5.5 Hz. GPS time pulses are used for accurate triggering of the 64-Hz data sampling. They showed examples of PiB/Pc1 magnetic pulsations observed at these five stations, as well as the harmonic structure of ionospheric Alfven resonators observed at Moshiri. They found that the Pc1 packets are slightly modulated as they propagate from high to low latitudes in the ionospheric duct. They expect that these network observations will contribute to our understanding of Pc1-range magnetic pulsations and their interaction with relativistic electrons by combining the obtained results with future satellite missions that observe radiation belt particles.

Saka et al. [2010] examined the temporal variations of the nightside geomagnetic field and geosynchronous energetic ions during substorms by using a superposed epoch analysis timed by Pi2 onset.

They reported that the first 10 min interval of Pi2 onset was a transitional state of the substorm dominated by MHD processes associated with earthward flow and its bifurcation. Intervals following the first 10 min were associated with field line variations that were well organized by dipolarization (substorm current wedge) due to the reduced cross-tail current. They also reported that energetic ion regions localized in the local time sector from 2000 to 0000 LT in the first 10 min intervals of Pi2 onset expanded to the post-midnight sector, reaching 0400 LT, within 20 min after Pi2 onset. They concluded that the expansion of the energetic plasma regions could be attributed to the inflation of the inner magnetosphere during dipolarization.

References:

Omura, Y., J. Pickett, B. Grison, O. Santolik, I. Dandouras, M. Engebretson, P. M. E. Decreau, and A. Masson, Theory and observation of electromagnetic ion cyclotron triggered emissions in the magnetosphere, *J. Geophys. Res.*, 115, A07234, 10.1029/2010JA015300, Jul. 31, 2010.

Shiokawa, K., R. Nomura, K. Sakaguchi, Y. Otsuka, Y. Hamaguchi, M. Satoh, Y. Katoh, Y. Yamamoto, B. M. Shevtsov, S Smirnov, I. Poddelsky, and M. Connors, The STEL induction magnetometer network for observation of high-frequency geomagnetic pulsations, *Earth Planets Space*, 62, pp.517-524, Jul 2010.

Saka, O., K. Hayashi, and M. Thomsen, First 10 min intervals of Pi2 onset at geosynchronous altitudes during the expansion of energetic ion regions in the nighttime sector, J. Atmos. Solar-Terr. Phys., 72, pp.1100-1109, SEP 2010.

Conferences and Meetings

1) 2010 Western Pacific Geophysics Meeting22-25 June 2010, Taipei, Taiwan
Meeting web site: http://www.agu.org/meetings/wp10/
2) Second International Symposium on Radio Systems and Space Plasma, August 25-27, 2010, Sofia, Bulgaria
3) 2010 Asia-Pacific radio Science Conference (AP-RASC'10), Toyama, September 22-26
4) The 128th Meeting of Society of Geomagnetism and Earth, Planetary and Space Science, Okinawa, November, 2010

Acknowlegement

The editors thank Dr. Y. Kasahara, Dr. S.Yagitani, Dr. H. Kawano, Dr. T. Nakagawa, and Dr. A. Kumamoto for their contribution to this report.