

PEM005-01

会場:303

時間:5月26日 14:15-14:35

Structural Growth of Magnetic Flux Systems and Solar Eruption Structural Growth of Magnetic Flux Systems and Solar Eruption

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Erupting magnetic structures seen in coronal mass ejections are of grand scales. There have been speculations that such structures are formed in the solar interior before their emergence out of the solar surface. However, the structures observed to emerge into the solar photosphere are usually of a much smaller scale than the coronal structures observed before eruption. In this paper, we examine the evolution of a group of small scale flux tubes into stepwisely larger scale flux systems while magnetic helicity is continuously injected into the corona. As magnetic helicity increases, individual flux tubes expand and reconnect with each other to create new field line connections between magnetic patches separated farther than the footpoint distance of the original connection. Thus created are new flux systems of larger scales, which are entwined with mutual magnetic helicity. When the system reaches a critical state, in which it can no more increase the footpoint distances by magnetic reconnection, the system must eject excessive magnetic helicity and energy away from the boundary. This process arises as an eruptive phenomenon in the solar corona. A relevant observation is presented and compared with the simulation. It is also found that a localized eruptive behavior may take place with a smaller helicity input through a ballooning instability when the plasma beta is relatively high (though still lower than unity).

キーワード: coronal mass ejections, magnetic reconnection, magnetic helicity, ballooning instability

Keywords: coronal mass ejections, magnetic reconnection, magnetic helicity, ballooning instability

PEM005-02

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リングカレントの消失機構 Loss of storm-time ring current

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The development of the ring current is the manifestation of magnetic storms. Decay of the ring current occurs when loss of particles trapped in the inner magnetosphere exceeds injection of particles. It had been thought that the charge exchange with geocoronal neutral hydrogen is the dominant loss process for the storm-time ring current. Recently, we have shown that pitch angle scattering due to violation of the 1st adiabatic invariant in a curved field line plays an important role in the rapid decay of the ring current by means of a numerical simulation. Hereinafter, we refer this to field line curvature (FLC) scattering. Some of the scattered particles are entered into the loss cone, and precipitated into the upper atmosphere, resulting in proton aurora. The power of precipitating protons is consistent with that obtained from the proton auroral observation for the large magnetic storm of August 12, 2000. However, a few issues remain to be solved with regard to the followings: When does the FLC scattering dominates the charge exchange? Why was the observed proton aurora expanded largely in comparison with the simulation? Is an inclination of the magnetic field at geosynchronous altitude good proxy for the equatorward boundary of the proton precipitation as was previously suggested? We will discuss these issues and role of the FLC scattering in the recovery of magnetic storms in detail.

キーワード: リングカレント, 消失, 磁気嵐

Keywords: ring current, decay, magnetic storms

PEM005-03

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Coronal disturbances unveiled with recent observations Coronal disturbances unveiled with recent observations

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Solar flares are very spectacular, and they are accompanied by various kinds of active phenomena. We also observe waves and wave-like coronal disturbances associated with flares. Moreton waves, which are seen traveling with the speed of about 1000 km/s in H-alpha images, are an example of flare-associated wave phenomena. They are thought to be the intersections of MHD fast shock front traveling in the corona with the chromosphere. As the coronal counterpart of Moreton waves, X-ray waves have also been studied. EIT waves (or EUV waves) are another major player in coronal disturbance studies. They are also expected to be the coronal counterpart of MHD fast shock, while the traveling speed is much slower of about 300 km/s than those for Moreton waves/X-ray waves. There have been, therefore, many discussions on the nature of EUV waves. I overview recent observations of flare-associated waves and wave-like coronal disturbances especially done by Hinode, STEREO, and SDO.

キーワード: 太陽フレア, コロナ, 彩層, MHD 衝撃波

Keywords: solar flare, corona, chromosphere, MHD shock

PEM005-04

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太陽風-放射線結合と外帯電子加速 Solar wind-radiation belt coupling via wave-particle interactions

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We investigate the solar wind-radiation belt coupling process, focusing on the large flux enhancement of outer belt electrons associated with high speed coronal hole streams. The flux enhancement tends to occur during the high-speed streams with predominantly southward interplanetary magnetic field (IMF). The IMF dependence can be understood as a result of the internal acceleration of relativistic electrons by wave-particle interactions as follows: The internal acceleration by wave-particle interactions is especially effective when a continuous source of hot electrons is maintained to produce chorus waves for several days. The continuous injection is enhanced during a prolonged period of intense convection and/or substorms associated with southward IMF in high-speed streams. Here we show evidence that the activities of hot electrons, whistler mode chorus waves, and convection/substorms during southward IMF events are clearly different from that during northward IMF events. Based on these results, we propose a model of solar-wind radiation belt coupling in which wave-particle interactions driven by continuous hot electron injections play an important role for the flux enhancement of outer belt electrons.

キーワード: 放射線帯, 太陽風, 電子加速

Keywords: radiation belts, solar wind, relativistic electron acceleration

PEM005-05

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太陽浮上磁場領域の活動性に関する「ひので」観測による知見 Hinode observations of activities in emerging flux regions

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長い太陽極小期を抜け、ゆっくりであるが太陽活動が徐々に上昇を続け、太陽黒点や活動領域が太陽表面に現れ始めた。黒点は、太陽面下からの磁気浮上によって形成される。浮上活動に伴い、頻繁に発生するマイクロフレアやジェットが観測され、フレアも発生する。さらに、大規模な浮上活動の場合、宇宙天気環境に影響を与える大フレアの発生を引き起こす場合がある。従って、磁気浮上およびそれに対する太陽大気応答を理解していくことは、宇宙天気研究にとって重要なテーマの一つとなっている。太陽観測衛星「ひので」は、今までにない高い解像度で光球磁場・彩層・X線コロナの連続観測を行うことで、浮上磁気活動と大気活動性について観測的研究に取り組んでいる。本講演では、2009年12月29日から31日かけて、浮上前から大きな黒点群の形成までの全過程を1日以上連続観測でとらえた例をもとに、浮上活動と大気活動性について議論する。宇宙天気環境に影響を与えるような大きなフレアは発生しなかったが、マイクロフレアやジェットなどを引き起こす磁場配位が良く分かる。特に、成長する黒点内部でマイクロフレアやジェットが高い頻度で起きていることが観測されており、今まで全く議論されていない磁場配位であり注目される。

キーワード: 太陽, 浮上磁場, フレア, ジェット

Keywords: Sun, Emerging Flux, Flares, Jets

PEM005-06

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アジア・オセアニア宇宙天気アライアンス構想 Asia-Oceania Space Weather Alliance

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21世紀に入り、我々の宇宙利用はますます進み、「21世紀は宇宙の時代」と言われている。宇宙空間に打ち上げられる衛星等の飛翔体はますます増えており、静止軌道にはすでに300以上の衛星が打ち上げられている。これらの宇宙飛翔体の安全な運用のためには、飛翔体近傍の電磁環境や高エネルギー粒子環境の予測は必須である。これらなしには、宇宙空間での人工物の運用を行うことは難しい。これらの環境情報は、地上の天気予報を模して「宇宙天気」と呼ばれている。

宇宙天気を実用的なサービスするためには、国際協力が不可欠である。衛星を1基打ち上げるのには100億円以上かかり、また地上観測はその地域性から国際協力なしには広いエリアでの観測はあり得ない。

宇宙天気のための科学研究と運用の協力体制の実現を目指して、現在、米国および欧州では、宇宙天気ワークショップ (Space Weather Workshop と Space Weather Week) が毎年開催されている。そこでは、地域的な協力体制を作るため、研究面と運用面の両面からの宇宙天気に関する情報交換が積極的に進められている。

残念ながら、これまで、アジア・オセアニア地域には、これに類する協力体制がなかった。そこで、昨年より、情報通信研究機構が中心となりアジア・オセアニア宇宙天気アライアンス (Asia-Oceania Space Weather Alliance) の提案を行っている。インドネシア及びタイにおいて2回のキックオフ会議を開催し、また、それ以外の国との個別の議論も進めている。これらを通じて、アジア・オセアニア地域の10以上の国 (日本、中国、韓国、台湾、ベトナム、マレーシア、インドネシア、インド、オーストラリア、タイ、フィリピンなど) からの参加者が集まり、議論を進めている。

発表では、AOSWAの趣旨についての説明を行い、またアライアンス立ち上げの現状について報告し、また、AOSWAへの参加を呼び掛ける予定である。



キーワード: アジア, オセアニア, 宇宙天気, アライアンス, 観測, シミュレーション

Keywords: Asia, Oceania, Space Weather, Alliance, Observation, Simulation

PEM005-07

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CME-driven Interplanetary Shocks and associated Sudden Commencement signatures observed at low latitudes CME-driven Interplanetary Shocks and associated Sudden Commencement signatures observed at low latitudes

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Interplanetary (IP) shocks driven by coronal mass ejections (CMEs) are indicative of powerful eruptions on the sun that accelerate to very high energies. Recently, it is reported that the radio-emission characteristics of 222 interplanetary (IP) shocks detected by spacecraft at Sun-Earth L1 during solar cycle 23 (1996 to 2006, inclusive) (Gopalswamy et al., 2009). A surprisingly large fraction of the IP shocks (~34%) was radio quiet (i.e., the shocks lacked type II radio bursts) compared to radio-loud (RL) shocks. These CME driven shocks arriving at Earth also compress the magnetosphere causing storm sudden commencement (SSC), which may be followed by a geomagnetic storm if the shock sheath and /or the driving IP CME (ICME) contains south-pointing magnetic field. We examined the properties of SSCs amplitude which observed at low latitude stations Alibag (ABG, 10. 17 N Geo.mag.Lat.) related to the IP/ICME/ CME shock speeds. We further analysed the categories of RL and RQ shocks and associated characteristics of SSCs. It is interesting to observe that the RL shocks have produced high amplitude SCs than RQ shocks and also investigated associated phenomena such as Ejecta and Magnetic cloud type and related shocks. The important results will be presented and discussed.

References

N. Gopalswamy et al., American Astronomical Society, 2009.

キーワード: Interplanetary shocks, sudden commencements, magnetic storms

Keywords: Interplanetary shocks, sudden commencements, magnetic storms

PEM005-08

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Observation and Physical Mechanism of Substorms Observation and Physical Mechanism of Substorms

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We present key features of substorm observation and their physical mechanism. In particular, we emphasize the fine structure in the breakup arcs and the associated magnetic fluctuations in Pi1 and Pi2 frequency ranges and their exponential growing behaviors before the arc breakup. We will discuss the possible physical mechanism of substorm onset in the magnetosphere and the formation of auroral breakup arc in the ionosphere. We will also discuss the turbulent states, the current disruption and magnetic field dipolarization processes and the dispersionless particle injection during the expansion phase.

キーワード: substorms

Keywords: substorms

PEM005-09

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Response of ring current ion dynamics during the storm recovery phase to different solar wind drivers

Response of ring current ion dynamics during the storm recovery phase to different solar wind drivers

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Geomagnetic storms, which are represented by the Dst index, show time profiles different between solar wind drivers such as Coronal Mass Ejections (CME) and Corotating Interaction Regions (CIR). A super-posed epoch analysis of Dst [Miyoshi and Kataoka, 2005, GRL] shows a distinct difference during the late recovery phase; Dst for CIR-driven storms is smaller than that for CME-driven storms. In addition, the flux of radiation belt electrons is higher for CIR-driven storms than for CME-driven storms.

It is well known that Dst development is strongly coupled with the evolution of the ring current which is mainly governed by ion pressure in the inner magnetosphere. The ring current spatial-temporal evolution results in distortion of the magnetic field configuration in the inner magnetosphere and accordingly can affect the dynamics of radiation belt electrons. In this study, we investigate the response of ring current ion dynamics during the storm recovery phase to different solar wind drivers, by comparing the temporal variations of energy spectra of energetic neutral atoms (ENAs) between CIR- and CME-driven storms.

We use ENA data obtained with the High Energy Neutral Atom (HENA) imager onboard the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) satellite. The ENA energy used in the present study ranges from 10 keV to 198 keV for hydrogen and from 29 keV to 222 keV for oxygen. We use ENA data integrated over image pixels; ENAs generated within HENA line-of-sights passing by close to the Earth are excluded in order to distinguish high-altitude emissions from low-altitude emissions. The ENA imaging enables continuous monitoring of spatial distributions and energy spectra of ring current ions.

Case studies of the temporal evolution of ENA energy spectra for three CME-driven storms [Keika et al., 2011, JGR, in press] suggested that the contribution from >60 keV H⁺ to the ring current intensity increases as a storm recovers. The ring current intensity was dominated by higher energy (>60 keV) H⁺ during the late recovery phase. This paper extends the study toward comparison between different solar wind drivers. We study possible differences in the dominant loss process and energy ranges that contribute most to the ring current energy. We also discuss the role played by the ring current in the difference in radiation belt electron flux between CIR- and CME-driven storms.

キーワード: 磁気嵐, リングカレント, 太陽風

Keywords: Magnetic storms, ring current, CME, CIR

PEM005-10

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太陽面上で生じる磁気消滅活動現象の駆動機構 A Possible Mechanism of Flux Cancellation via U-loop Emergence on the Sun

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We use a 3-dimensional MHD simulation to investigate a dynamic process producing flux cancellation on the solar surface. Our calculations are fully self-consistent in that any prescribed dynamic process is not applied on the surface, which is self-consistently generated via the emergence of a twisted flux tube. Most of the flux that emerges below the surface is in the form of Ω -loops (concave down geometry), so that dense photospheric plasma can drain down along the legs of the loop as it rises into the corona. We find, however, that some U-loops (concave up geometry) can also emerge. A U-loop geometry implies that a field line has a dip below the surface and a local peak somewhere above the surface on either side of the dip. Although the emergence of U-loops can produce flux cancellation on the surface, loops with such a geometry are not expected to emerge easily, due to the trapping of dense plasma in the dipped portion of the loops. Our results indicate that if one of the peaks is sufficiently low, of the order of the photospheric gravitational scale height above the surface, plasma can drain out of the dipped portion by a siphon-like mechanism, allowing the U-part of loops to emerge and resulting in the cancellation of magnetic flux on the surface. But if both peaks of a U-loop are high compared to the photospheric scale height, dense plasma simply settles in the dip of the loop, preventing the U-part from emerging, rather producing reconnection which is another possible mechanism of flux cancellation. We also discuss the implications of our results for observations.

キーワード: コロナ質量放出, プロミネンス噴出, 磁気浮上

Keywords: Coronal mass ejections, Prominence eruption, Flux emergence

PEM005-11

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太陽光球面磁極消滅現象頻度の磁束量依存性 Flux dependence of magnetic cancellation on the solar photosphere

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本発表では、観測時間の長い光球面磁場データを用いた磁極消滅現象頻度の磁束量依存性について報告をする。X線輝点やジェットなどの様々な太陽面活動は光球面磁極に起因しており、その磁束量分布を知ることは統計的性質を知る上で重要である。Parnell et al.(2009)により、光球面磁極の磁束量が活動領域から静穏領域までに渡り指数-1.85のべき分布をしていることが報告された。この磁束量分布は4つの磁極活動素過程、発生・合体・分裂・消滅の結果作られていると考えられるが、それらの頻度は定量的に調べられていなかった。2010年大会 PEM029-P08において、磁極活動素過程の自動判別コードを作成し、合体と分裂についての磁束量依存性を報告した。消滅・発生現象はその頻度が小さかったことから、判別された範囲の消滅・発生現象は磁束量分布に影響が小さいと結論した。しかし、判別限界以下の小さな磁極が支配的である可能性がある。その評価は磁束依存性を調べ、判別限界以下まで同様の依存性を仮定することで可能である。

観測データは太陽観測衛星「ひので」の可視光望遠鏡フィルタグラムによる視線方向磁場データを用いた。観測期間は2008年12月30日10:29UTから2009年1月5日5:37UT、時間分解能は5分、視野は121"x121"である。これは前回発表データ(観測時間3.5時間、視野100"x100")に対し十分に観測時間が長く、消滅現象の統計的性質が捉えられると考えられる。磁極判別、追跡については2010年大会 PEM029-P08と同様の手法を用いた。正負の磁極はそれぞれ約18000個、約13000個が判別された。これらによる消滅過程の磁束量依存性は指数-2.5のべき分布となった。

-2よりも急峻な磁束量依存性は、小さな磁極による消滅現象の方が総磁束量変化を担っていることを意味する。発表では、磁束量のべき指数と消滅現象のべき指数間についても議論する。

キーワード: 太陽, 光球, 磁場, 磁極消滅, 静穏領域

Keywords: the Sun, photosphere, magnetic field, magnetic flux cancellation, quiet Sun

PEM005-12

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ホイッスラーモード波およびEMIC波のトリガード・エミッション Whistler-mode and EMIC triggered emissions

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We develop a nonlinear wave growth theory of VLF whistler-mode emissions, taking into account the spatial inhomogeneity of the static magnetic field and the plasma density variation along the magnetic field line. We also derive theoretical expressions for the nonlinear growth rate and the amplitude threshold for the generation of self-sustaining rising tone emissions like chorus emissions. The theory is extended for electromagnetic ion cyclotron (EMIC) triggered emissions observed by Cluster spacecraft. We performed a self-consistent particle simulation, in which we inject triggering whistler-mode waves with a constant frequency. The resonant electrons are organized at the resonance velocity in the velocity phase space, and they are released from the triggering wave near the equator. Because of the organized phase structures, the electrons radiate a coherent wave with an increasing frequency that undergoes the nonlinear wave growth due to formation of an electromagnetic electron hole. Self-sustaining emissions become possible when the wave propagates away from the equator. The self-sustaining mechanism can result in rising tone emissions covering the frequency range below the equatorial electron cyclotron frequency. We also performed a hybrid-code simulation injecting EMIC waves as triggering waves. We found the nonlinear wave growth of EMIC triggered emissions below the proton cyclotron frequency. We obtain a pair of coupled differential equations for the wave amplitude and frequency. Solving the equations numerically, we can reproduce characteristics of whistler-mode chorus emissions and EMIC rising tone emissions observed in the inner magnetosphere.

キーワード: 波動粒子相互作用, ホイッスラーモード波, コーラス, 電磁イオンサイクロトロン波, 非線形, 放射線帯
Keywords: wave-particle interaction, whistler-mode wave, chorus, EMIC, nonlinear, radiation belts

PEM005-13

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GEMSIS-RC モデルに基づいた太陽風動圧変動に対する内部磁気圏応答の研究 Study of the inner magnetospheric response to pressure pulses in the solar wind based on the GEMSIS-RC model

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Geospace storms are the largest electromagnetic disturbance in near-Earth space and facilitate extensive particle acceleration in the inner magnetosphere, which causes development of the ring current and a drastic increase of relativistic electrons in the radiation belt. GEMSIS (Geospace Environment Modeling System for Integrated Studies) of STEL, Nagoya University, is the observation-based modeling project for understanding energy and mass transportation from the Sun to the Earth in the geospace environment. Aiming at understanding the dynamics of the inner magnetosphere during the geospace storms, the GEMSIS-Magnetosphere working team has addressed the development of new physics-based models for the global dynamics of the ring current (GEMSIS-RC model) and radiation belt (GEMSIS-RB model).

The GEMSIS-RC model is a self-consistent and kinetic numerical simulation code solving the five-dimensional collisionless drift-kinetic equation for the ring-current ions in the inner-magnetosphere coupled with Maxwell equations. It is demonstrated that the propagation of magnetohydrodynamic waves can successfully be described by the present model. It is also found that the self-consistent coupling could affect the transport of energetic particles especially at low energies as well as the intensity and spatial distribution of field-aligned currents. Our approach is unique in the sense that it includes MHD wave modes as well as deformation of magnetic field configuration due to the ring current self-consistently. In order to investigate responses of the inner magnetosphere to pressure pulses in the solar wind, time variation of magnetic and electric fields as well as the ring current ion distributions is simulated based on the GEMSIS-RC model with simple boundary conditions to mimic an abrupt compression of the inner magnetosphere. The effects of the pressure pulses on excitation of ULF waves, generation of FAC, and change in the pitch angle distribution of ring current ions will be discussed for several cases.

キーワード: 内部磁気圏, ULF 波動, リングカレント, 放射線帯, SC, 太陽風動圧

Keywords: inner magnetosphere, ULF waves, ring current, radiation belt, SC, solar wind dynamic pressure

PEM005-14

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Theoretical and statistical studies of the magnetic storm effects to ionosphere Theoretical and statistical studies of the magnetic storm effects to ionosphere

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Magnetic storm affects the ionospheric electron density structure through modifications of the ionospheric electric field, thermospheric neutral winds and compositions. The electric field disturbances are produced by prompt penetration electric field, shielding electric field and neutral wind disturbance dynamo, while the neutral wind and composition disturbances are produced by global circulation changes as a result of energy deposition at the high latitude/aurora region. The electric field disturbances modulate the equatorial plasma fountain and ionospheric height leading to ionospheric electron density disturbance. On the other hand, the neutral wind disturbance affects the plasma transport, and the composition change by reducing the [O]/[N₂] ratio speeds up the recombination loss process of the ionospheric plasma. As the electric field, neutral wind and composition effects are often mixed during the storm period, the resulting ionospheric plasma structure becomes complex. In this study, we first review theoretical simulations of these combined ionospheric storm effects by using the NCAR thermosphere ionosphere electrodynamics general circulation model (TIEGCM) and the Sheffield University Plasmasphere Ionosphere Model (SUPIM). From theoretical modeling tasks, relative importance of these disturbed ionospheric drivers and their combined effects are evaluated and studied. Based on the model results, we further examine the GPS-TEC observations of magnetic storms occurred during ten-year period of 1999-2009 to study the ionospheric disturbances under various storm conditions.

キーワード: Ionospheric storm effect

Keywords: Ionospheric storm effect

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RECENT ICME ANALYSIS USING SOLAR MASS EJECTION IMAGER DATA RECENT ICME ANALYSIS USING SOLAR MASS EJECTION IMAGER DATA

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The Air Force/NASA Solar Mass Ejection Imager (SMEI) placed in orbit on 6 January 2003 records whole-sky images over each 102-minute orbit. Once a large background from zodiacal light, starlight, and aurora is removed, these precise photometric images allow a nearly continuous measurement of the electron Thomson-scattering density component of the inner heliosphere. A tomographic technique then yields a 3-D analysis of this brightness allowing the measurement of the solar wind bulk density. We have refined our tomography program to analyze both corotating heliospheric structures and more time-dependent phenomena such as Interplanetary Coronal Mass Ejections (ICMEs). A portion of these observations and data access to the volumetric-analysis results are available on the UCSD Website at <http://smei.ucsd.edu>, and also at the Community Coordinated Modeling Center (CCMC) at the NASA Goddard Spaceflight Center. Here we highlight a study of two recent events that were measured by this instrumentation. The first event arrived at the STEREO-B spacecraft late in 20 January, 2010. A flux rope present at STEREO-B has an associated increase in density at its center that is reproduced well by the SMEI analysis, which in turn allows its orientation to be determined. The second event began to arrive at Earth on 3 August 2010: here the SMEI analyses map various portions of this complex ICME structure produced by multiple CME eruptions from the solar surface a few days earlier.

キーワード: Coronal Mass Ejections (CMEs), Interplanetary CMEs, Magnetic Flux Ropes, The Solar Mass Ejection Imager - SMEI, Space Weather, Solar Wind

Keywords: Coronal Mass Ejections (CMEs), Interplanetary CMEs, Magnetic Flux Ropes, The Solar Mass Ejection Imager - SMEI, Space Weather, Solar Wind

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太陽浮上磁場と活動領域形成に関する大規模3次元MHD数値実験 Large-scale three-dimensional MHD numerical experiment on the solar flux emergence and the formation of active region

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To study the formation of solar active regions, we perform three-dimensional magnetohydrodynamic (MHD) experiment on the flux emergence from a depth of 20,000 km.

It is widely thought that the flux generated at the bottom of the convection zone rises through the interior and appears at the surface to form an active region. Previous studies on flux emergence have been separated into two groups: one is the study on the emergence in the interior and the other on that above the surface. Thus, as a next step, we aim to research the flux emergence from the deep interior to the corona in a consistent manner.

In our preceding studies, we have carried out two-dimensional calculations on the flux emergence from -20,000 km and found the condition of the flux tube as field strength 10^4 G, total flux 10^{21} - 10^{22} Mx, and the sufficient twist $> 5.0 \times 10^{-4} \text{ km}^{-1}$. Using these values, we simulate the three-dimensional calculation and find the features as follows. (1) The emerging flux becomes flat beneath the surface. (2) Secondary evolutions to the corona occurs due to the interchange-mode instability. (3) The evolution is consistent with the AR observation by Strous and Zwaan (1999). On the basis of the results above, we newly suggest the model for the flux emergence and the formation of active region.

キーワード: 太陽, 磁場, 太陽内部, 光球, 彩層, コロナ

Keywords: sun, magnetic field, solar interior, photosphere, chromosphere, corona

PEM005-17

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磁気圏近尾部の磁気再結合領域と磁場双極子化開始領域の間におけるエネルギー解放過程とそのサブストーム開始に対する役割

Energy release between the tail magnetic reconnection and dipolarization regions and its role in the substorm onset

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The triggering mechanism of a substorm expansion onset is continually a major controversial issue in magnetospheric research. Various models, such as the near-Earth neutral line model and the current disruption model, have been proposed. These models "predict" different observational features in the initial process, its location, and the propagation direction of the resultant flows or waves. The critical issues for understanding the substorm onset mechanism include the relative timing and causal relationship between the magnetic reconnection and the current disruption as well as the processes midway between the regions of the two processes, such as fast earthward flows and waves. To solve these issues, we have performed statistical analyses and showed an overall picture of substorm-associated evolution of the near-Earth magnetotail. Namely, the magnetic reconnection occurs at $X \sim -16$ to -20 Re at least 2 min before onset to create a plasmoid tailward of $X \sim -20$ Re. Almost simultaneously with the magnetic reconnection, i.e., within 2 min, the dipolarization begins at $X \sim -7$ to -10 Re. Furthermore, we showed that the energy release occurs in the magnetic reconnection region and its surrounding regions, associated with substorm expansion onsets. Interestingly, the energy release is more significant between the regions of the magnetic reconnection and the initial dipolarization, rather than in the magnetic reconnection region, and is more widely seen than localized fast earthward flows. On the other hand, the energy increases in the initial dipolarization region at $X > -12$ Re. In the present study, we discuss what a large amount of the released energy in the midway region is spent in, where it is transported, and what is its role in the substorm onset.

キーワード: サブストーム, 磁気圏尾部, エネルギー解放, エネルギー輸送, 磁気リコネクション, 磁場双極子化

Keywords: substorm, magnetotail, energy release, energy transport, magnetic reconnection, dipolarization

PEM005-18

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サブストームにおける領域2型電流系の発達

Global ionospheric currents driven by Region-2 field-aligned currents during substorms

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The dawn-to-dusk convection electric field increases during the growth phase of substorms, driving DP2 currents composed of two-cell current vortices in high latitude and leading to an increase in the eastward electrojet (EEJ) at the dayside dip equator. During the expansion phase, electric field and currents are reversed in direction to the normal DP2 currents at subauroral to equatorial latitudes when the convection electric field reduces abruptly. The reversed current at the dayside dip equator appears as a counter-electrojet (CEJ) and causes an equatorial enhancement of the negative bay in the afternoon sector [Kikuchi et al., 2000]. In this study, by using magnetometer array data and SuperDARN (Super Dual Auroral Radar Network) convection maps, we deduce that the reversed electric field and currents often develop at the onset of substorms when the convection electric field increases and the auroral electrojet (AEJ) continues to move equatorward. These observations imply that the Region-1 and Region-2 field aligned currents (R1 and R2 FACs) increase in the afternoon sector concurrently with the current wedge responsible for the positive bay at midnight. The substorm-associated R2 FACs are strong enough to cause the reversed current at the subauroral latitude and the CEJ at the equator. We also deduce that the dayside equatorial CEJ begins simultaneously with the midnight positive bay while the positive bay onset is delayed by several minutes as the station departs from the midnight meridian. These observations suggest that the unloading process begins in the near-Earth magnetotail with the intensification of the asymmetric ring current that is responsible for the equatorial CEJ and R2 FACs on the dayside.

Keywords: substorm, Region-2 field-aligned current, Overshielding electric field, equatorial counter electrojet, substorm current

PEM005-19

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MHD 数値シミュレーションによるコロナ斜め磁場中の彩層蒸発ジェットの再現 Magnetohydrodynamic simulation of solar chromospheric evaporation jets in the oblique coronal magnetic field

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We reproduce solar chromospheric evaporation jets in the oblique coronal magnetic field by two-dimensional MHD simulation with heat conduction effect. The solar chromospheric evaporation jets are caused by the heat of the magnetic reconnection between the emerging flux and the preexisting coronal magnetic field. Miyagoshi & Yokoyama (2004) performed two-dimensional MHD simulation based on this scenario and succeeded in reproducing the evaporation jet. In this simulation, the preexisting coronal magnetic field was parallel to the convection zone to keep the initial condition. On the other hand, most of the observed chromospheric evaporation jets are thought to occur in the oblique coronal magnetic field. In our simulations, we assume the energy damping in the heat conduction and succeed in keeping the initial condition of the oblique coronal magnetic field and reproducing more realistic evaporation jets.

In the recently observation, EUV imaging spectrometer aboard Hinode observed hot jets and cool jets simultaneously and revealed the detailed structures of the velocity of the jets. Our simulations succeed in reproducing the high density jets and also show that hot jets and cool jets are exist simultaneously. We will compare the characteristics of the observation to our simulations and discuss the acceleration of the jets.

Keywords: MHD simulation, solar jet, chromospheric evaporation

PEM005-20

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太陽コロナのトリガプロセスに関するシミュレーション研究 Simulation Study on the Trigger Process of Solar Flares

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太陽圏において最も破壊的な爆発現象の一つでもある太陽フレアは磁気リコネクションを通じた太陽コロナ磁場のエネルギー解放過程であると広く認識されている。しかし、何が太陽フレアのトリガであるのかは未だに十分説明されていない。この問題は太陽コロナ活動の理解のためのみならず、宇宙天気予報可能性を向上させるためにも重要な課題である。我々は第1に、2006年12月13日のX3.4クラスフレアの発生過程に関するひので衛星観測データの解析から、強い磁気シアを持つ活動領域に異なるシアを持つ磁束システムが太陽光球面下から入射された結果として大規模フレアが発生するという仮説を提示する。第2に、この仮説を2種類の数値シミュレーションに基づいて検証することを試みた。第1のシミュレーションは線形フォース・フリー磁場を用いたモデル活動領域に磁束を入射させるものであるが、第2のシミュレーションでは観測されたベクトル磁場に基づく非線形フォース・フリー磁場を活動領域磁場モデルとして用いた。その結果、2つのシミュレーション共に、入射磁束がある一定の条件を満たす場合、仮説で提示された通り磁束上昇がフレアで見られるプラズマ放出と大規模な磁気リコネクションを発生させることを見出すことができた。この結果に基づき、太陽表面磁場の精密観測を利用したデータ駆動型数値シミュレーションを通してフレア発生を予測する可能性についても議論する予定である。

キーワード: 太陽フレア, トリガ, シミュレーション, リコネクション, MHD, ひので

Keywords: solar flares, trigger, simulation, reconnection, MHD, Hinode

PEM005-21

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The Incipient Stages of Solar Eruptions The Incipient Stages of Solar Eruptions

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Solar eruptions are the starting point of large, transient disturbances to the Heliosphere in the form of Coronal Mass Ejections (CMEs). Understanding the onset of solar eruptions therefore is vital to long-term Space Weather interests. Solar eruptions originate from locations on the Sun where magnetic polarity reverses across magnetic inversion lines. Filaments of cooler chromospheric material suspended in the hot corona frequently demarcate these inversion lines, with the onset of eruption of the filament itself being among the earliest indicators of the start of the overall solar eruption. In recent years we have been investigating the onset of solar eruptions by studying the dynamics of solar filaments just prior to and during eruption. In this talk we briefly review work by us and others on filament eruptions, mainly based on observational data from the SoHO, Yohkoh, TRACE, Hinode, and SDO satellites among other sources.

キーワード: Solar Eruptions, Solar Filaments, Solar Magnetic Fields, Solar Flares, CMEs

Keywords: Solar Eruptions, Solar Filaments, Solar Magnetic Fields, Solar Flares, CMEs

PEM005-22

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On the geo-effective CME and flare parameters On the geo-effective CME and flare parameters

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In this study we discuss geoeffective CME and flare parameters for the purpose of developing empirical space weather (geomagnetic storms, solar proton events, and solar flares) forecast models based on solar information. These models have been set up with the concept of probabilistic forecast using historical events. Our recent progress is as follows. First, we presented a concept of storm probability map depending on CME parameters (speed, location, and earthward direction parameter). Second, we demonstrate that the earthward direction parameter is important for the forecast of geomagnetic storms. Third, the importance of solar magnetic field orientation for storm occurrence was examined. Fourth, the importance of cone model parameters for geomagnetic storms and proton events was discussed. Fifth, a new proton event forecast method depending on flare parameters (flare strength, duration, and longitude) as well as CME parameters (speed and angular width) has been suggested. Sixth, we are examining the probability of solar flares depending on sunspot McIntosh classification and its area change (as a proxy of flux change). In addition, future prospect on this issue will be discussed.

キーワード: Coronal Mass Ejections, Flares, Geomagnetic Storms, Solar Proton Events

Keywords: Coronal Mass Ejections, Flares, Geomagnetic Storms, Solar Proton Events

PEM005-23

会場:303

時間:5月27日 11:05-11:20

周期変化する太陽風に対する磁気圏電離圏複合系の応答

Response of the magnetosphere-ionosphere compound system to periodic variation of the solar wind

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Recently, typical magnetospheric phenomena such as a substorm [Tanaka et al., 2010], a sudden commencement [Fujita et al., 2003], a theta aurora [Tanaka et al., 2004] have been investigated intensively by using a realistic global MHD model. These studies revealed the magnetospheric and ionospheric plasma processes occurred during these events in a self-consistent manner. In particular, global current circuits including the current generators are clearly presented at the first time in these studies. By investigating in detail generation mechanisms of the field-aligned current and related shear flow in the magnetosphere, we completely interpret the physical processes of these events. In this sense, generation of a new Region 2 current in the dayside magnetosphere associated with northward turn of the interplanetary magnetic field is a kind of a tutorial phenomenon for comprehension of the magnetosphere-ionosphere compound system. The current generator of this new R2 FAC is driven by plasma convection flow across pressure enhancement in the dayside cleft region. The pressure enhancement in the cleft is also supported by sunward return flow after northward turn of the IMF.

In the talk, we will present deformation of the magnetosphere-ionosphere compound system associated with periodic variations of solar wind IMF based on the concept of the magnetosphere-ionosphere compound system as explained above.

キーワード: 磁気圏電離圏複合系, グローバルシミュレーション, 太陽風周期変動, 磁気圏トポロジー

Keywords: magnetosphere-ionosphere compound system, global simulation, periodic solar wind variation, magnetospheric topology

PEM005-24

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磁気嵐時におけるグローバル地磁気変動 Global geomagnetic field variations during a geomagnetic storm

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It has been well-known that two-cell ionospheric convection in the polar ionosphere driven by a dawn-to-dusk electric field which carries the region-1 (R-1) field-aligned currents (FACs) are significantly intensified and expand to middle-low latitudes during the main phase of geomagnetic storms. The two-cell ionospheric currents produce negative and positive disturbances of the H-component of geomagnetic field in the morning and afternoon sectors, respectively. The dawn-to-dusk polar electric field penetrates to the magnetic equator, and drives the eastward equatorial electrojet current (eEJ) due to the Cowling effect in the daytime sector. During the recovery phase which is caused by the weakness of southward interplanetary magnetic field (IMF) or northward turning of the IMF, the two-cell ionospheric currents in the polar ionosphere are abruptly reduced and the equatorward boundary of auroral electrojet currents (AEJ) move to high latitude. In this case, the magnetic field at the magnetic equator shows a significant enhancement of negative variations of the H-component in the daytime sector produced by the westward equatorial electrojet current (wEJ) driven by the dusk-to-dawn electric field originating from the R-2 FACs. However, due to the lack of geomagnetic field data in the middle-low latitudes, detail relationship between the magnetic field variations of high-middle latitudes and at the equator during geomagnetic storms has not been clarified yet. In this paper, we investigated time and spatial evolution of global geomagnetic field variations from high-latitude to the magnetic equator during the geomagnetic storm occurred on May 23-24, 2002, using geomagnetic field data with time resolution of 1 minute obtained from the CARISMA, GIMA, IMAGE, MACCS, and NSWMC networks, and provided from WDC geomagnetism in Kyoto. In the present analysis, we first subtracted geomagnetic field variations during a magnetically quiet day (May, 31, 2002) from the disturbed field during the geomagnetic storm for each station. As a next step, we excluded the magnetic effects produced by magnetospheric currents (for example, ring current) by subtracting the low-latitude (10-20 degrees, GMLAT) geomagnetic field variation of the northward component. As a result, the equivalent current system showed that two-cell ionospheric currents are significantly enhanced in the daytime sector together with a strong enhancement of the eEJ at the daytime equator during the main phase of the geomagnetic storm. The centers of these vortices were located at 70 degrees and 65 degrees in the morning and afternoon sector, respectively. The two-cell ionospheric currents expanded to the low-latitude region of less than 30 degrees (GMLAT). In the nighttime sector of middle-low latitudes, the arrows of the equivalent current were directed in the northward direction. This signature indicates that the nighttime magnetic field signatures are produced by the magnetic effect of the R-1 FACs. On the other hand, during the recovery phase associated with strong northward turning of the IMF, the equivalent current system showed that the two new vortices different from two-cell ionospheric currents driven by the R-1 FACs system appear in the polar cap and middle latitude. The former led to the enhanced NBz current driven by the lobe reconnection due to the strong northward IMF, while the latter was generated by the enhanced R-2 FACs produced by the strongly asymmetric ring current flowing westward in the inner magnetosphere. In this case, the equatorial magnetic field variation showed a strongly negative signature produced by the wEJ current due to the dusk-to-dawn electric field. Therefore, it seems that the enhanced NBz current system plays an important role in the intensification of the dusk-to-dawn electric field from the middle-latitudes to the magnetic equator.

キーワード: 磁気嵐, 対流電場, 遮蔽電場, 沿磁力線電流, 地磁気変動, 惑星間磁場

Keywords: geomagnetic storm, convection electric field, shielding electric field, field aligned currents, geomagnetic field variations, interplanetary magnetic field

PEM005-25

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Pi2 の極赤道電流系

Pi2 current system at polar to equatorial latitudes

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It has been reported that the Pi2 appears at the dayside geomagnetic equator with an enhancement in amplitude (Shinohara et al. GRL 1997; Tokunaga et al., GRL 2007). The Pi2 at the dayside equator is explained by means of electrojets driven by an electric field transmitted from the polar ionosphere (Shinohara et al. GRL 1997). Simultaneous ground and spacecraft observations show that the relationship between the Pi2 on the ground and above the ionosphere is in phase on the nightside and out of phase on the dayside (Han et al., JGR 2004). These observations indicate that the dayside Pi2 is caused by ionospheric currents extending from high latitude to the equator, while the nightside Pi2 is attributed to cavity resonance of MHD waves in the plasmasphere. On the other hand, the period of the Pi2 does not depend on the latitude at around the plasmapause, which may not match the cavity resonance model (Tokunaga et al., GRL 2007). In this paper, we show that the equatorial Pi2 is well correlated with the nightside Pi2 with no time shift greater than several seconds and that the amplitude of the nightside Pi2 is larger at higher latitude. This local time and latitudinal features are similar to those of the main impulse (MI) of sudden commencement (SC), which is explained by means of Region-1 type field-aligned currents generated during the compression of the magnetosphere (Araki et al., EPS 2006; Shinbori et al., JGR 2009). We also show that the Pi2 at nightside auroral latitude is out of phase with the equatorial Pi2. We suggest that the Pi2 is explained by means of Region-1 type field-aligned currents which flow into the auroral ionosphere and further to the dayside equatorial ionosphere. The relationship of the equatorial Pi2 and substorm current wedge should be clarified to identify the source of the Pi2 currents.

キーワード: Pi2 地磁気脈動, サブストーム, 磁気赤道, 電離層電流, 沿磁力線電流

Keywords: Pi2 pulsation, substorm, magnetic equator, ionospheric currents, field-aligned currents

PEM005-26

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大気圏-電離圏結合モデル(GAIA)を用いた電離圏嵐の研究

A study of ionospheric storms using an atmosphere-ionosphere coupled model (GAIA)

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The ionosphere is controlled by the solar EUV and X-rays, and energy influx from the solar wind and the magnetosphere. In addition to the energy inputs from space, recent observations suggest that atmospheric waves from the lower atmosphere significantly affect the ionosphere. During magnetic storms, ionospheric disturbances are generated by electromagnetic energy and particle precipitation from the magnetosphere. Even if the same magnetospheric input is given to the ionosphere, the response of the ionosphere depends on ionospheric and thermospheric conditions. In the mid-latitude region, thermospheric winds driven by energy inputs from the magnetosphere might interact with atmospheric waves propagated from the lower atmosphere. Penetration electric fields from the polar region and dynamo electric fields generated by thermospheric winds might also overlap. In order to self-consistently include the effects of the magnetosphere as well as the lower atmosphere on the ionosphere, we developed an atmosphere-ionosphere coupled model "GAIA" (Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy), which includes the whole atmosphere and ionospheric dynamo processes. We will present simulation results of ionospheric storms using GAIA.

キーワード: 電離圏, 熱圏, 大気圏, 擾乱, モデル, 結合

Keywords: ionosphere, thermosphere, atmosphere, disturbance, model, simulation

PEM005-27

会場:303

時間:5月27日 12:05-12:20

ベキ分布に従うエネルギー注入に対するコロナループの応答

Numerical simulation of a coronal loop: response to impulsive heating with a power-law energy distribution

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We conducted one-dimensional numerical simulations of a 40 Mm length coronal loop heated by impulsive heating events (nanoflares) with a power-law energy distribution. The solar flares have a very wide energy range of about 10 orders of magnitude. There are a number of statistical studies on the occurrence frequency of solar flares so far, from which it has been concluded that the energy distribution of solar flares obeys to a power-law distribution (Lin et al. 1984, Shimizu 1995, Parnell & Jupp 2000). If the power-law index has a value which exceeds 2, numerous smaller flares, often called "nanoflares", contribute to the coronal heating instead of large, violent flares (Hudson 1991). Focusing on this point related to the longstanding enigma of coronal heating (see the review: Klimchuk 2006), many authors have investigated the power-law index of the energy distribution of solar flares. When putting it all together, their results indicate an index of 1.5-1.8 (Aschwanden & Parnell 2002). Therefore, in consideration of this result from previous studies, so called "nanoflares" cannot contribute to the heating of the solar corona. However, previous studies have implicitly assumed that the increment of thermal energy derived from observational data is same as the input energy to the solar corona. If this assumption is not correct, that is, there are discrepancies between the power-law index of input and that of observations, we must re-examine the interpretation of previous studies. In this study, synthetic observational data of a coronal loop heated by numerous impulsive heating events (nanoflares) with a power-law energy distribution are made by taking account of the filter response of Transition Region And Coronal Explorer (TRACE) satellite. We have analyzed synthetic data by the same method as previous studies and concluded that energy distribution derived from synthetic data differs from input power-law energy distribution in its shape, that is, convex upward distribution. This result is similar to the result of Antolin et al. (2008). The derived energy distribution can be fitted better by a double-power law than a single-power law. When the intervals of time between nanoflares are sufficiently long, the derived energy distribution appears similar to the input energy distribution.

キーワード: 太陽, コロナ, ナノフレア

Keywords: sun, corona, nanoflares

PEM005-28

会場:303

時間:5月27日 12:20-12:35

Active region outflows as a source of the slow speed solar wind: elemental abundance measurements by Hinode/EIS.

Active region outflows as a source of the slow speed solar wind: elemental abundance measurements by Hinode/EIS.

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The solar wind impacts the terrestrial environment and influences the propagation of disturbances such as coronal mass ejections towards Earth. Hydrodynamic models of the solar wind are very sensitive to the boundary conditions at the formation site. Locating the source region of the slow speed wind, however, is still an outstanding problem in solar physics. Recently, Hinode X-ray Telescope (XRT) and EUV Imaging Spectrometer (EIS) observations have shown that there are areas of high speed outflow at the edges of many active regions. It has been suggested that these outflows may line on open field lines that extend out to the heliosphere, and that they therefore could be a significant source of the slow speed wind. We present new direct evidence of a connection between these outflows and the solar wind from EIS elemental abundance measurements of AR 10978. We show that the enhancement factor of low first ionization potential elements is always 3-4. This is consistent with measurements made in situ in the solar wind. Furthermore, when the outflows were favorably oriented towards the Earth, the EIS measurements made on the Sun were found to match those made a few days later by the ACE Solar Wind Ion Composition Spectrometer at Earth. The agreement between spectroscopic and ion composition measurements, from two different instruments on two different spacecraft, suggests that the plasma in the outflows really contributes to the solar wind.

キーワード: Sun: corona, Sun: abundances, Sun: solar wind

Keywords: Sun: corona, Sun: abundances, Sun: solar wind

PEM005-29

会場:303

時間:5月27日 14:15-14:30

気象客観解析データ入力シミュレーションによる熱圏・電離圏変動

Simulation of thermosphere and ionosphere variations using meteorological reanalysis data

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The upper atmosphere is the region where space weather phenomena have direct impacts on human activities as we increasingly utilize this region through radio propagation from satellites. On the other hand, the ionosphere and thermosphere are observed to change on various temporal and spatial scales, so understanding and providing the information on these changes are important as a part of space weather research. Recent studies of the upper atmosphere have suggested that not only magnetospheric effects, but the lower atmospheric activities could also have large impacts on the upper atmosphere and cause both short and long-term scale changes. Recently, we have developed a whole Earth's atmospheric model (GAIA: Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy) by integrating several global models for different atmospheric regions, a whole atmospheric general circulation model, an ionospheric model and an electrodynamics model. We have shown the usefulness of the model, by reproducing the ionospheric longitudinal structure and day-to-day variations similar to the observations, which can be considered as lower atmospheric effects. Recently, we also started the simulation in which lower atmospheric reanalysis data is assimilated in order to reproduce realistic upper atmospheric variations. In this presentation, we will report recent upgrades of GAIA, and initial results of data-assimilated GAIA simulation.

キーワード: 電離圏, 下層大気, 領域間結合, シミュレーション, データ同化, 宇宙天気

Keywords: ionosphere, lower atmosphere, thermosphere, simulation, data assimilation, space weather

PEM005-30

会場:303

時間:5月27日 14:30-14:50

Propagation and evolution of nonlinear MHD disturbances in space Propagation and evolution of nonlinear MHD disturbances in space

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Propagation of nonlinear MHD waves is studied in the magnetosphere and the interplanetary space. As realistic variations of MHD disturbances in space become often nonlinear, it is important to examine time-dependent evolution of these fluctuations. We have examined how the fluctuations are changed by steepening processes and/or shock formation in both analytical and numerical approaches. Our results suggest that the pattern of disturbances tends to significantly change during the travel path between L1 and the Earth's magnetosphere unless the amplitude is extremely low or the disturbance time-scale is relatively long. It is shown how the initial profiles in the solar wind can be different from those observed near the near-Earth space owing to the nonlinear properties. Our theoretical model provides the time-dependent solutions at different locations, which can be useful in interpreting observations at the multiple locations.

キーワード: space weather, MHD waves, nonlinear waves

Keywords: space weather, MHD waves, nonlinear waves

PEM005-31

会場:303

時間:5月27日 14:50-15:05

カタパルト電流層緩和モデルによるサブストームオンセット Catapult current sheet relaxation model for substorm onset

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Based on the results of our superposed epoch analysis of Geotail data, we have proposed a catapult (slingshot) current sheet relaxation model in which earthward flows are produced in the central plasma sheet (CPS) due to the catapult current sheet relaxation, together with the rapid enhancement of Poynting flux toward the CPS in the lobe around $X \sim -15$ Re about 4 min before the substorm onset. These earthward flows are characterized by plasma pressure decrease and large amplitude magnetic field fluctuations. When these flows reach $X \sim 12$ Re in the magnetotail, they give significant disturbances to the inner magnetosphere to initiate some instability such as a ballooning instability, and the substorm starts. The occurrence of the magnetic reconnection is a natural consequence of the initial convective earthward flows, because the relaxation of a highly stretched catapult current sheet produces a very thin current at its tailward edge. Recently, Nishimura et al. [2010] reported that the substorm onset begins when a North-South (N-S) arc reaches equatorward quiet arcs. The region of earthward convective flows correlatively moves earthward prior to the onset. Thus, this region of the earthward convective flows seems to correspond to the N-S arc.

キーワード: 磁気圏, サブストーム, 磁気リコネクション, カレントディスラプション, オーロラ, プラズマシート

Keywords: magnetosphere, substorm, magnetic reconnection, current disruption, aurora, plasma sheet

PEM005-32

会場:303

時間:5月27日 15:05-15:20

サブストーム onset は磁気圏・電離圏結合域から始まる Substorm ignition in the M-I coupling region

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The sudden formation of parallel electric fields in the magnetosphere-ionosphere (M-I) coupling system is essential to complete substorm onset. From this standpoint, we focus substorm ignition on field-aligned acceleration, by studying the dynamical behavior of auroral kilometric radiation (AKR). Field-aligned auroral acceleration shows distinct two-step evolution at substorm onset: the activation of low-altitude acceleration ($h \sim 4000-5000$ km) which corresponds to auroral initial brightening, and subsequent abrupt breakout of high-altitude acceleration ($h \sim 6000-12000$ km) which corresponds to auroral breakup. Cases when only low-altitude acceleration (first step evolution) is activated are pseudo-substorms. This indicates that the second evolution of field-aligned acceleration divides full-substorm from pseudo-substorm. The statistical relationship between the plasma-flow burst in the plasma sheet and its response to the M-I coupling region shows that about 65 % of flow bursts cause pseudo-breakup/initial-brightening and one third of them develops into full-substorm, while the magnitude of flow velocity does not necessarily determine the substorm intensity. This suggests that some plasma flow bursts originate field-aligned current (FAC) which first enhance low-altitude acceleration, and the increasing field-aligned current induces second acceleration above the pre-existing low-altitude acceleration as a consequence of current/current-driven instabilities. In this sense, substorm is finally ignited in the auroral M-I coupling region.

キーワード: サブストーム, オーロラ粒子加速域, 電離圏・磁気圏結合領域

Keywords: substorm, auroral acceleration, M-I coupling region

PEM005-33

会場:303

時間:5月27日 15:20-15:40

Effects of nonlinear wave growth on radiation belt particle fluxes Effects of nonlinear wave growth on radiation belt particle fluxes

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In parallel with the emergence of the new science of space weather, there has been a resurgence of interest in radiation belt research in the last decade. Highly energetic electrons, which are typically generated in the outer radiation zone during geomagnetic storms, can cause serious malfunctions of orbiting satellites. Consequently, understanding the generation and dynamics of radiation belt particle fluxes has become a key feature of current space physics research. In this study we derive new relativistic formulae for the limiting electron flux for a general planetary radiation belt at a given L-shell. We compare the theoretical results on the trapped flux with observed energetic electron fluxes at Earth. We then incorporate the effects of nonlinear wave growth into the calculation of the limiting flux. Using model wave equations, we estimate nonlinear wave growth rates for a range of input parameters. We find that inclusion of nonlinear wave growth effects in specifying the wave power gain can significantly modify the limiting flux. Exact quantification of the effects of nonlinear wave growth on the limiting particle flux requires accurate information on the length scales for both linear and nonlinear convective wave growth. Unfortunately such data are not currently available from either experimental observations or computer simulations.

キーワード: radiation belts, nonlinear wave growth, stably trapped particle flux

Keywords: radiation belts, nonlinear wave growth, stably trapped particle flux

PEM005-34

会場:303

時間:5月27日 15:40-15:55

MAGDAS/CPMN データから得られた科学的な成果 Scientific Results Obtained from MAGDAS/CPMN Data

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The Space Environment Research Center (SERC), Kyushu University has deployed the MAGnetic Data Acquisition System (MAGDAS) at 54 stations along the 210- and 96-degree magnetic meridians (MM) and the magnetic Dip equator, and three FM-CW radars along the 210o MM during the International Heliophysical Year (IHY; 2005-2009) and the International Space Weather Initiative (ISWI; 2010-2012) (see <http://magdas.serc.kyushu-u.ac.jp/> and <http://magdas2.serc.kyushu-u.ac.jp/>). The goal of MAGDAS project is to become the most comprehensive ground-based monitoring system of the earth's magnetic field. It does not compete with space-based observation. Rather, this ground-based network complements observation from space. To properly study solar-terrestrial events, data from both are required.

This project intends to get the MAGDAS network fully operational and provide data for studies on Litho-space Weather. By analyzing these new MAGDAS data, we can perform a real-time monitoring and modeling of the ambient plasma mass density and the global current system (e.g. Sq, EEJ) for understanding the plasma and electromagnetic environment changes in geospace and lithosphere during helio-magnetospheric storms. In order to examine the propagation mechanisms of transient disturbances, i.e., sc/si, Pi 2, and DP2, relations of ionospheric electric and magnetic fields are also investigated by analyzing the Doppler data of our FM-CW ionospheric radar and the MAGDAS magnetic data.

A new EE-index (EDst, EU, and EL) was proposed by SERC for real-time and long-term geospace monitoring. The basic algorithm to obtain EE-index was constructed by Uozumi et al. (2008). EU and EL mainly represent the range of the EEJ (equatorial electrojet) and CEJ (equatorial counter electrojet) components, respectively. H-component magnetic variations observed at the MAGDAS/CPMN (Circum-pan Pacific Magnetometer Network) stations along the magnetic equator during each nighttime sector (LT = 18-06) were used as the baseline of EU and EL. The baseline value is defined as EDst and its variations are found to be similar to those of Dst. An empirical model of the quiet daily geomagnetic field variation has been constructed by Yamazaki et al. (2010), based on geomagnetic data obtained from 21 stations along the 210 Magnetic Meridian of the CPMN from 1996 to 2007 (Kp? 2+). Using the least-square fitting method, the quiet daily geomagnetic field variation at each station was described as functions of (1) solar activity SA, (2) day of year DOY, (3) lunar age LA and (4) local time LT. After interpolation in latitude, the model can describe solar-cycle and seasonal variations of both solar (S) and lunar (L) fields.

By using the MAGDAS/CPMN system and FM-CW radar array, we could obtain the following results; (1) Imaging of global 3-D current system, (2) Annual and semi-annual Sq and EEJ current variations, (3) A new EE-index and its long-term variation, (4) Estimation of plasma mass density, (5) Latitudinal dependence of Pc 3-4 amplitudes along 96o MM and Pi 2 along 210o MM, (6) Ionospheric electric fields of DP-2, sc, Pi2, and Pc 5 observations by FM-CW radar, and (7) anomalous magnetic daily and ULF variations associated with the great earthquakes observed near the MAGDAS/CPMN stations. In this paper, we will present the several scientific results obtained by the MAGDAS project.

Keywords: MAGnetic Data Acquisition System (MAGDAS), FM-CW radar, the International Heliophysical Year, the International Space Weather Initiative, MAGDAS/CPMN system

PEM005-35

会場:303

時間:5月27日 15:55-16:10

Morning-afternoon asymmetry of geosynchronous magnetic field Morning-afternoon asymmetry of geosynchronous magnetic field

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The present study examines the morning-afternoon asymmetry of the geosynchronous magnetic field strength on the dayside (MLT = 06-18 hours) using observations by the GOES satellites over a period of 9 years from February 1998 to January 2007. During geomagnetically quiet intervals ($K_p < 3$), we observed that a peak of the magnetic field strength is skewed toward the earlier local times (MLT = ~ 11.1 -11.6) with respect to local noon and that the geosynchronous field strength is larger in the morning sector than in the afternoon sector. That is, there is the morning-afternoon asymmetry of the geosynchronous magnetic field strength. We found that the peak location of the magnetic field strength is shifted toward the earlier local times as the ratio of the magnetic field strength at MLT = 18 (B-dusk) to the magnetic field strength at MLT = 06 (B-dawn) is decreasing. It is also found that the dusk to dawn B field ratio, B-dusk/B-dawn, is decreasing as increasing solar wind dynamic pressure. The morning-afternoon asymmetry of the magnetic field strength appears in Tsyganenko geomagnetic field model (TS-04 model) when the partial ring current is included in TS-04 model. Unlike our observations, however, TS-04 model shows that the peak location of the magnetic field strength is shifted toward the noon as the solar wind dynamic pressure grows in magnitude. This may be due to that the symmetric magnetic field associated with the magnetopause current, strongly affected by the solar wind dynamic pressure, increases. However, the partial ring current is not affected as much as the magnetopause current by the solar wind dynamic pressure in TS-04 model. Thus, our observations suggest that the contribution of the partial ring current at geosynchronous orbit is much larger than that expected from TS-04 model as the solar wind dynamic pressure increases.

キーワード: morning-afternoon asymmetry, geosynchronous magnetic field, partial ring current

Keywords: morning-afternoon asymmetry, geosynchronous magnetic field, partial ring current

PEM005-P01

会場:コンベンションホール

時間:5月26日 10:30-13:00

太陽風からみたSC

Geomagnetic sudden commencement(SC) seen from the solar wind

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地磁気急始変化 (Geomagnetic Sudden Commencement; SC) が太陽風衝撃波 / 不連続面の動圧増加によって作られる事は良く分かっている。しかし、動圧増加を伴う太陽風衝撃波 / 不連続面の全てが SC を作るかどうかは分かっていない。地上観測の SC リストから対応する太陽風を調べた研究は幾つかあるが、太陽風衝撃波 / 不連続面のリストから出発して、対応地上変化を詳しく解析した例はない。ここでは、それを調べる。

Takeuchi et al.[2002] は、動圧変化がほぼ同じ二つの太陽風衝撃波が異なる地上磁場変化を生じさせ、それが衝撃波波面の傾きの違いによることを見出した。衝撃波が斜め入射する場合は、磁気圏との相互作用時間が長くなって対応地上磁場変化が急始型でなくなるので SC と判定されない。これは、太陽風衝撃波 / 不連続面が磁気圏圧縮の有効サイズを通過する時間によって SC の rise time が決まるという考え方 [Araki, 2007] と合致する。

これが、他の多くの SC について成立するかどうかを、まず調べる。

キーワード: 地磁気急始変化, 太陽風, 惑星間空間衝撃波/不連続面, 磁気圏, 電離層

Keywords: Geomagnetic sudden commencement (SC), solar wind, interplanetary shock/discontinuity, magnetosphere, ionosphere

PEM005-P02

会場:コンベンションホール

時間:5月26日 10:30-13:00

マグネトポーズの位置を使ったリアルタイム磁気圏シミュレーションの解析 Analysis of real-time magnetosphere simulation data using location of magnetopause

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保存されているリアルタイム磁気圏シミュレーションデータを使うことにより、様々な太陽風の状態に対する磁気圏の応答を調べることができる。このデータを使って、AE 指数に関する観測値と計算値の比較（北村ほか、JGR、2008）や静止軌道の地磁気変動（亘ほか、2010 SGEPS 講演会）など、これまでいくつかの研究が行われてきた。

本研究ではリアルタイム磁気圏シミュレーションから得られるマグネトポーズの位置について解析を行った。マグネトポーズの位置に関して、動圧と太陽風の南向き IMF を考慮した Shue モデル（1997）と呼ばれる経験モデルがある。今回は、この Shue モデルを使って、リアルタイム磁気圏シミュレーションによって得られたマグネトポーズの位置の解析を行った。その結果、両者がよい一致を示すことがわかった。

キーワード: マグネトポーズ, 磁気圏, シミュレーション

Keywords: magnetopause, magnetosphere, simulation

PEM005-P03

会場:コンベンションホール

時間:5月26日 10:30-13:00

磁気嵐電場によるグローバル電離圏電流について Global ionospheric currents driven by storm-time electric fields

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During the strong southward interplanetary magnetic field (IMF), the convection electric field originating from the region-1 field-aligned currents (R1 FACs) causes a two-cell ionospheric current at high latitudes [Nishida, 1968]. The convection electric field penetrates to the magnetic equator, and drives the eastward equatorial electrojet (EEJ) [Kikuchi et al., 1996]. This condition is called an undershielding. Subsequently, when the southward IMF weakens, the reversed ionospheric current, equatorial counter electrojet (CEJ), is driven by the developed shielding electric field originating from the region-2 field-aligned currents (R2 FACs). Its condition is called an overshielding because the shielding electric field relatively overcomes the reduced convection field in lower latitudes of the R2 FACs [e.g., Kelley et al., 1979]. However, the temporal and spatial development of global ionospheric current has not been yet established in middle latitudes during storms. So, we have investigated global ionospheric current deduced by magnetic field variations in high-low latitudes in the 21 storm events. During the periods of EEJ, the influence of the Hall current expanded into the middle latitudes (around 40 degrees in corrected geomagnetic latitude) driven by the intensified convection electric field. While, during the periods of CEJ, the reversed Hall currents appeared in the middle latitudes due to the overshielding electric field. Based on the above results, we reconstructed a picture of the 3-D current system depending on undershielding/overshielding condition corresponding to the storm main/early recovery phase, including the middle latitudes. Moreover, it is found the observed life time of CEJ was longer than that of the overshielding current at the middle latitudes. This fact implies that the CEJ at the equator is driven by the ionospheric disturbance dynamo. We will talk about global ionospheric currents driven by the convection, shielding, and disturbance dynamo electric fields.

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PEM005-P04

会場:コンベンションホール

時間:5月26日 10:30-13:00

Space Weather: The International Journal of Research and Applications Space Weather: The International Journal of Research and Applications

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¹New Jersey Institute of Technology

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Since the era of development of the initial electrical telegraph systems in the early 19th century, the solar-terrestrial environment has influenced the design and operations of ever-increasing and sophisticated technical systems. James Van Allen reported in 1958 that the space environment around the Earth was not benign, but rather composed of high-intensity radiation. Engineers and scientists immediately recognized from this discovery that technical systems such as the communications satellites envisioned by Arthur Clark and John Pierce would require design and operations procedures (and therefore costs) that had not been otherwise anticipated. Space Weather: The International Journal of Research and Applications is an online publication devoted to the emerging field of space weather and its impact on technical systems, including telecommunications, electric power, and satellite navigation. The journal publishes (a) peer-reviewed articles presenting the latest engineering and science research in the field, including studies of the response of technical systems to specific space weather events, predictions of detrimental space weather impacts, and effects of natural radiation on aerospace systems; (b) news and feature articles providing up-to-date coverage of government agency initiatives worldwide and space weather activities of the commercial sector; (c) letters and opinion articles offering an exchange of ideas; and (d) editorial comments on current issues facing the community. The journal is published by the American Geophysical Union (AGU).

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