MIS02-01 会場:201A 時間:5 月 26 日 09:00-09:15

Earthquake Prediction with Satellite Cloud Image

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Russian scientists has found some linear clouds in tectonic active area in 1980s, while few papers about this topic were published in the following 30 years except Russian scientists. One of the reason may be that clouds are difficult to be described with numbers or formulas, it is qualitative, and qualitative researches are difficult to be published. After years observation, we found that clouds related with seismic activity have three features, first their shape are linear, second they are often over fault systems, third they often stay over fault systems for hours and do not move with winds. Such clouds are found in Japan, Italy, Bulgaria and New Zealand. With the help of satellite, we have made several successful predictions about these countries earthquakes. We think that clouds are reliable earthquake precursors, while if you want to make an accurate prediction, satellite clouds images are not enough, and it is better to combine other geophysical data to get an accurate result.

キーワード: Earthquake Prediction, Clouds, Satellite
Keywords: Earthquake Prediction, Clouds, Satellite

Discriminating satellite IR anomalies associated with the Ms 7.1 Yushu earthquake in China

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In the process of exploring pre-earthquake thermal anomalies using satellite data, Blackett et al. (2011) found that the reported anomalies before the 2001 Mw 7.7 Gujarat earthquake, in India, were related to positive biases caused by data gaps. They supposed that such effects could also be responsible for other cases. We noted a strip-shaped TIR anomaly on 17 March 2010, 28 days before the Ms 7.1 Yushu earthquake (below figure). Here we again investigate multi-year infrared satellite data in different bands to discriminate whether the anomaly is associated with the earthquake, or is only normal bias caused by the data gaps. From the water vapor images, we find lots of clouds that have TIR anomalies. However, on the cloudiness background, there is an obvious strip-shaped gap matching the tectonic faults almost perfectly. In particular, the animation loops of hourly water vapor images show that the cloud kept moving from west to east, while they never covered the strip-shaped gap. We consider that the cloud with this special spatial pattern should have implied the abnormal signals associated with the seismogenic process. Based on current physical models, the satellite IR anomalies both on TIR and water vapor bands can be explained using synthetic mechanisms.

キーワード: earthquake, satellite, anomaly, thermal, remote sensing
Keywords: earthquake, satellite, anomaly, thermal, remote sensing
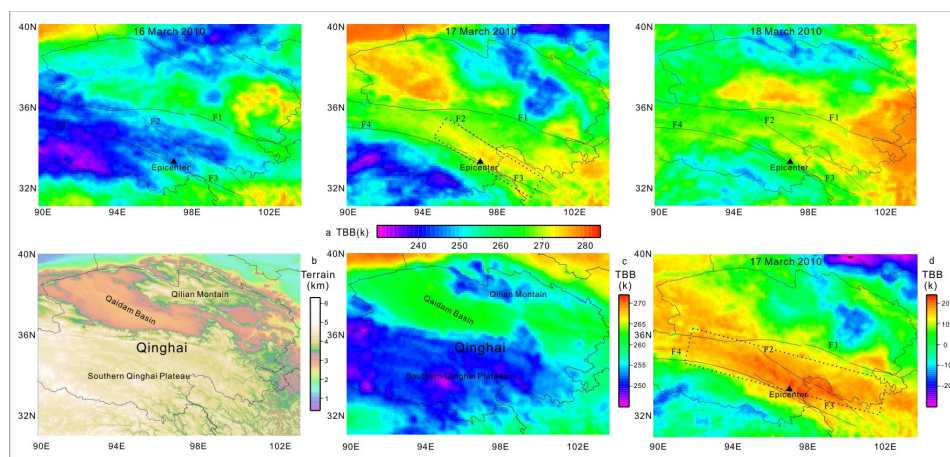
Onsite earthquake early warning techniques and its applications at schools in Taiwan
Onsite earthquake early warning techniques and its applications at schools in Taiwan

HSU, Ting-yu[1*] ; WU, Shyu-yu[1] ; HUANG, Shieh kung[1] ; CHIANG, Hung-wei[1] ; LIN, Pei-yang[1] ;
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Regional earthquake early warning (EEW) system is not suitable for Taiwan due to most of the destructive seismic hazard comes from in-land earthquakes, thus makes the lead-time before destructive earthquake wave arrives provided by the regional EEW system can be null. On the other hand, on-site EEW system can provide more lead-time at the region close to an epicenter since only the seismic information on the target site is required. Instead of leveraging the information of several stations, the on-site system extracts some P-wave features from the first few seconds of vertical ground acceleration of a single station and performs the prediction of the coming earthquake intensity at the same station according to these features. Recently, a new method of estimating seismic intensity using the support vector regression (SVR) has been developed. However, till now, most popular on-site algorithms are TauC-Pd-Attenuation (TPA) method and Pd-Threshold method (PdT). The objective of this study is to evaluate the performance of these three methods using earthquake data of the Taiwan Strong Motion Instrumentation Program and the earthquake data of EEW stations of National Center for Research on Earthquake Engineering in Taiwan. The results show that SVR method can provide more reliable and accurate EEW among these three methods.

キーワード: earthquake early warning, on site, single station
Keywords: earthquake early warning, on site, single station

MIS02-04　　　　　　　　会場:201A　　　　　　　　　　　時間:5 月 26 日 09:45-10:00

Earth observation using the GAIA-1 and GAIA-2 satellite platforms

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Earth observation from space provides a vantage point unlike any other. Global Navigation Satellite System (GNSS) and GPS satellites orbiting the planet are all emitting microwave signals. These signals can be exploited using the radio occultation (RO) technique which can be used to sense minute changes in the atmosphere. By studying these changes it is hoped that natural phenomenon such as earthquakes can be predicted before they occur. With that in mind we have a long term plan to launch a satellite with a GNSS-RO sensor called GAIA-1 to seek out the possibility of this potential prediction. Lessons learnt from GAIA-1 will be applied to it's next generation GAIA-2, where the primary payload will be a synthetic aperture radar (SAR) system. This presentation will introduce both satellites and their respective payloads, mission plan, and system architecture.

キーワード: radio occultation, GPS, GNSS, synthetic aperture radar, satellite
Keywords: radio occultation, GPS, GNSS, synthetic aperture radar, satellite

日本付近における地震に先行する電離圏擾乱の統計解析に関する研究
Statistical study on short-term earthquake forecast using TEC anomalies over Japan area

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　近年，地震活動に先行する様々な電磁気現象が報告されており， 地震の短期予測の可能性が指摘されている．先行研究によって，中磁気緯度地域の日本において，地震の前に正の TEC 異常が有意に出現することが明らかとなっている．先行研究では地磁気嵐に起因する TEC 異常を除去するために，統計的に定めた地磁気擾乱期間を解析除外期間としていた．しかしより正確な期間を取り除くためには，地磁気嵐期間ではなくそれに基づく電離圏擾乱期間を除去する必要がある．そこで本研究では地磁気嵐に起因する電離圏擾乱期間を定め解析除外期間とし，地震と TEC 異常の関連性を統計的に調査して先行研究と比較した．

　地磁気嵐に起因する電離圏擾乱期間を解析データから除外するために，まず 1998〜2013 年に発生した 294 個の地磁気嵐をその大きさ（較差）とローカルタイムで分類をした．この分類クラスごとに地磁気嵐に起因する電離圏擾乱の平均的な変動を調査するために，GIM-TEC$*$時系列データを用いて地磁気嵐発生日の 2 日前から 5 日後のデータを抽出した．ブートストラップ法 (復元抽出回数 10000 回) を用いて同 時刻の TEC$*$値の平均値を算出し，閾値 ($+$ 2 σ) を超える期間を除去期間として定めた．

　次に地震に先行する TEC 異常の統計解析を，SEA を用いて行った．本研究では，1998/05〜2013/12 の期間に発生した，M $\geqq$ 6.0，D $\leqq$ 40 km の地震（87 個）を SEA 解析の対象とした．この解析結果から，地震発生の 1〜5 日前に統計的に有意な正の TEC 異常が発生することがわかった．しかし地震の発生後にも閾値を超える正の TEC 異常が見られた．この異常は余震の影響である可能性があるので，前後 30 日間地震が起こっていない独立した地震（25 個）についても解析した結果，地震発生後の TEC 異常が取り除かれ，地震に先行するもののみが顕著に表れた．

　さらに地震に対する TEC 異常の前兆性を調査するため，Molchan's Error Diagram (MED) を行った．これは解析対象期間内の TEC$*$の異常があった 1〜5 日後を予測日として，予測に成功した割合を縦軸 (Detection rate)，解析期間に対し予測を行った割合を横軸 (Alarm rate) としたもので，ランダムに予測をした場合の結果を表す直線から上に凸の曲線であるほど予測の精度がよいことを表す．MED 解析の結果，先行研究で用いられてきた地磁気擾乱期間を除去するよりも，本研究で定めた電離圏擾乱期間を除去したほうがより前兆性が高まったことが分かった．

キーワード: 統計解析, 地磁気嵐, 電離圏擾乱, 地震, Ｓ Ｅ Ａ解析, モルチャンエラーダイアグラム
Keywords: statistical analysis, geomagnetic storm, TEC anomalies, earthquake, SEA, Molchan's Error Diagram

MIS02-06　　　　　　　　会場:201A　　　　　　　　　　　時間:5 月 26 日 10:15-10:45

Seismo-ionospheric precursors of the 11 March 2011 M9.0 Tohoku Earthquake
Seismo-ionospheric precursors of the 11 March 2011 M9.0 Tohoku Earthquake

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SU, Y. Z.[1]
LIU, Jann-yenq[2*] ; LEE, I. T.[3] ; CHEN, C. H.[4] ; HATTORI, K.[5] ; CHEN, Y. I.[6] ; HUANG, C. S.[1] ;
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In this paper, the total electron content (TEC) of the global ionosphere map (GIM) is used to observe seismo-ionospheric anomalies associated the 11 March 2011 M9.0 Tohoku earthquake, while the Thermosphere Ionosphere Electrodynamics General Circulation Model (TIEGCM) is applied to simulate and understand the observed anomalies. The GIM TEC associated with M>=6.0 earthquakes in Japan are statistically examined during 1998-2011. It is found that the GIM TEC significantly enhance day 3 before the earthquakes. On the other hand, the TEC over the epicenter also significantly and continuously enhances on 6-8 March 2011, 4-2 days before the Tohoku earthquake. The agreement between the statistical result and the event anomaly implies that seismo-ionospheric precursor related to the Tohoku earthquake might be observed. The spatial analysis further is further conducted to find that the enhancement anomaly specifically and persistently appears in the northern epicenter area. Simulation results well agree with the observations, which suggest that the electric potential around the epicenter has been distorted and significantly affects the TEC during the earthquake preparation period.

キーワード: Seismo-ionospheric precursors, Tohoku Earthqauke
Keywords: Seismo-ionospheric precursors, Tohoku Earthqauke

MIS02-07   会場:201A   時間:5 月 26 日 11:00-11:30

Validation of pre-earthquake atmospheric signals and their connection with major seismicity

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We are presenting a new approach of utilizing multi-parameters space and ground observations to study pre-earthquake processes related to major earthquakes. In this study we are exploring the potential of atmospheric and ionospheric signals to alert for large earthquakes. To achieve this, we start validating retrospectively and prospectively anomalous ionospheric /atmospheric signals. Our method for validation is based on a joint analysis of several physical and environmental parameters (Satellite thermal infrared radiation (STIR), electron concentration in the ionosphere (GPS/TEC), VHF-bands radio waves, radon/ion activities, air temperature and seismicity patterns) that were found to be associated with earthquakes. The science rationale for this methodology is based on the concept of Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) [Pulinets and Ouzounov, 2011], which explains the synergy of different physical processes, usually named short-term pre-earthquake anomalies.

Our validation include continuous retrospective analysis performed over two different regions with high seismicity- Taiwan and Japan for 2003-2011 .The retrospective tests show STIR and GPS/TEC anomalous behavior in advance for most of these events with false positives less than 25%. The prospective tests for Honshu and Hokkaido (Japan) started in 2014. Our initial test results suggest systematic appearance of STIR anomalies, one to several days in advance to major events, including the two largest earthquakes for that period - M7 of July 12, 2014 and M6.9 of Feb17, 2015 in Eastern Honshu. The proposed is multi-parameters approach and new observations could be further integrated into and the synergy of these parameters implying their connection with the earthquake preparation processes.

キーワード: earthquake forecasting, pre-earthquake signals, Thermal amomaly, GPS/TEC, radon, LAIC
Keywords: earthquake forecasting, pre-earthquake signals, Thermal amomaly, GPS/TEC, radon, LAIC

Statistical Analysis of ULF Seismo-Magnetic Phenomena in Kanto, Japan
Statistical Analysis of ULF Seismo-Magnetic Phenomena in Kanto, Japan

Han Peng[1*] ; Hattori Katsumi[1] ; Zhuang Jiancang[2]
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In order to clarify and verify the ultra-low frequency (ULF) seismo-magnetic phenomena, we have performed statistical studies on the geomagnetic data observed at several stations, in Japan, during 2001-2010. They are Kiyosumi (KYS), Uchiura (UCU), Fudago (FDG), Seikoshi (SKS), Mochikoshi (MCK), Kamo (KAM), and Kakioka (KAK). KAK is a standard geomagnetic station operated by JMA (Japan Meteorological Agency) and the others are operated by us. We investigated the energy of ULF geomagnetic signals of the frequency around 0.01Hz using wavelet transform analysis. To minimize the influences of artificial noises and global geomagnetic perturbations, we used only the geomagnetic data observed at nighttime (LT 2:30am-4:00 am). In this abstract, we describe the results of KAK as an example. As for KAK data, we utilized observations from a remote station, Kanoya (KNY), as a reference. Statistical results of superposed epoch analysis have indicated that ULF magnetic anomalies are more likely to appear before sizeable earthquake events (Es>108) rather than after them, especially 6-15 days before the events. Further statistical investigations show clearly that the ULF geomagnetic anomalies at KAK are more sensitive to larger and closer events. Finally, we have evaluated the precursory information of ULF geomagnetic signals for local sizeable earthquakes using Molchan's error diagram. The probability gain is around 1.6 against a Poisson model. The above results have indicated that the ULF seismo-magnetic phenomena at KAK clearly contain precursory information and have a possibility of improving the forecasting of large earthquakes. The statistical results for the other stations also show similar tendency. These facts suggest that ULF magnetic anomalies have a significant correlation and precursory information on a sizable earthquake

キーワード: ULF seismo-magnetic phenomena, statistical test, short-term earthquake forecast
Keywords: ULF seismo-magnetic phenomena, statistical test, short-term earthquake forecast

Detectability of seismic network: an approach of the probability-based magnitude of completeness method

Detectability of seismic network: an approach of the probability-based magnitude of completeness method

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The magnitude of completeness is a key quantitative index to assess the detectability of regional seismic network. This paper deals with the detectability of the Capital-circle Seismic Network in China by adopting the probability-based magnitude of completeness (PMC) method which can reveal the detailed spatio-temporal characteristics of regional seismic network detectability. The earthquake data (2002-2009) and station information are from China Earthquake Administration (CEA). We estimated the network detectability and discussed the possibility of improving the network detectability according to the spatio-temporal distribution of completeness magnitudes and the simulation results. The results show that the detectability of the Capital-circle Seismic Network is high in most regions, although the detectability in a few regions needs to be enhanced. Simulation results suggest that increasing stations may further enhance the detectability of the seismic network. This study may be helpful for the optimization of the regional seismic network.

This study is supported partially by the National Natural Science Foundation of China (41025014).

キーワード: Probability-based magnitude of completeness (PMC), seismic network, detectability
Keywords: Probability-based magnitude of completeness (PMC), seismic network, detectability

Earthquake Monitoring and case study by using Multi-parameters Remote Sensing information in China

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In the last ten years, a few national research plans and scientific projects on remote sensing application in Earthquake monitoring research are implemented in China and some progress were achieved on EQ-related ionospheric and RS precursors extracting and distinguishing by statistical research, case study and real-time monitoring experiments on historical or recent earthquakes. The LAI coupling models were computed and checked also, which laid the foundation for gradually promoting the practical use.

Focusing to advance earthquake monitoring capability and to search for the way of earthquake prediction, the prototype data processing and application platform of satellite-based EQ monitoring system, which integrate mainly GNSS, electromagnetism, infrared RS and D-InSAR technologies were developed systematically. and integrated earthquake remote sensing application system has been designed comprehensively.

On the basis of these works, the first space-based platform in earthquake stereoscope observation system in China, which named as China Seismo-Electromagnetic Satellite (CSES) now is on his phase of electrical model and qualifying model. According to the schedule, the 1st CSES will be launched before the end of 2016 and 2nd CSES will come into review soon.

キーワード: Earthquake monitoring, China Seismo-Electromagnetic Satellite, LAI coupling, remote sensing application
Keywords: Earthquake monitoring, China Seismo-Electromagnetic Satellite, LAI coupling, remote sensing application

Multiple seismo-anomalies associated with three major earthquakes in China, Japan and Taiwan

CHEN, Chieh-hung[1]* ; ZENG, Xiaoping[2] ; HATTORI, Katsumi[3] ; LIU, Jann-yenq[4]
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Seismo-crustal deformation, groundwater (containing levels, temperature and radon), geomagnetic and ionospheric anomalies are integrated together to investigate pre-earthquake anomalous phenomena associated with the M6.1 Ludian earthquake, China, the M9.0 Tohoku-Oki earthquake, Japan and the M7.6 Chi-Chi earthquake, Taiwan. Seismo-crustal deformation and groundwater anomalies generally lead the other promising parameters because stress accumulation in crust is one of the major driving forces of earthquakes. Uplift and depression groundwater levels are exactly related with compression and tension stress loading in the crust, respectively. Decreases of groundwater temperature and radon concentration are resulted from uplift groundwater levels. Meanwhile, groundwater would infuse into fracture zones of faults once cracks are developed before earthquakes that can enhance conductivity near hypocenters and/or faults affecting electromagnetic fields and electron total electron contents in the ionosphere. Those aforementioned relationships can be utilized to eliminate anomalies which are unrelated with earthquakes to further increase of the accuracy and understand causal mechanisms of pre-earthquake anomalous phenomena in seismogenic processes.

キーワード: Groundwater, Electromagnetic field, Total electron content, Crustal deformation, Earthquake forecast
Keywords: Groundwater, Electromagnetic field, Total electron content, Crustal deformation, Earthquake forecast

Space-borne observations of pre-earthquake atmospheric signals associated with major seismicity in Xinjiang, China
Space-borne observations of pre-earthquake atmospheric signals associated with major seismicity in Xinjiang, China

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We are presenting the latest development in multi-sensor observations of short-term phenomena preceding major earthquakes. The purpose of this study is to verify if satellite thermal infrared radiation (STIR) anomalous can be found retrospectively in association with three major earthquakes in XinJiang province China (M6.9 of 02.12.14; M6.2 of 08.12.2012; M7.2 of 03.20.08) by systematically analyzing multi-sensor satellite and ground temperature/ humidity observations for the period of 2008-2014. Meteorological satellite data include NOAA polar orbit POES and Chinese geostationary satellite FY2D. In the case of M6.9 of 02.12.14, NOAA STIR data for January ?February shows building an atmospheric anomaly 10-20 days before the main shock. FY2D STIR data show similar trend by revealing anomalous value with persistency of more then 9 hours on Jan 31, 2014. The 2012 (M 6.2) and 2008 (M7.2) event shows similar STIR anomalies over the major Altyn Tagh fault lines within 10-15 days before the seismic event. This probably is connected with the geochemistry gas increase, which can provide additional source for flux emission near major faults in the area. The hourly in-situ atmospheric observation show similarly in the air temperature increases and drop in the relative humidity, probably as result of additional atmospheric ionization observed before the three earthquake events. Our initial results suggest that systematic use of multi-parameter observations can be used for additional physical validation of pre-seismic processes associated with the major earthquake events.

キーワード: short-term earthquake forecasting, pre-earthquake signals, Thermal amomaly, GPS/TEC, radon, LAIC
Keywords: short-term earthquake forecasting, pre-earthquake signals, Thermal amomaly, GPS/TEC, radon, LAIC

MIS02-13 会場:201A 時間:5 月 26 日 14:45-15:00

Multi-sensor monitoring network for earthquake precursors and preparation process near subduction zone at Boso, Japan

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内匠 逸 [8] ; 安川 博 [9] ; 安藤 芳晃 [10] ; 園田 潤 [11] ; 酒井 英男 [12]
HATTORI, Katsumi[1*] ; HAN, Peng[1] ; MOGI, Toru[2] ; GOTO, Tada-nori[3] ; TAKANO, Tadashi[4] ; IZUTSU, Jun[5] ;
KAMOGAWA, Masashi[6] ; YAMANAKA, Chihiro[7] ; TAJUMI, Ichi[8] ; YASUKAWA, Hiroshi[9] ; ANDO, Yoshiaki[10] ;
SONODA, Jun[11] ; SAKAI, Hideo[12]

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New observations from ground and space have provided multiple evidences of pre-earthquake signals and the latest studies show their statistical significance, repeatability, and universality. In this project, to understand the preparation process of large earthquakes and slow-slip events in subduction zone, especially to clarify the nucleation stage of the earthquake cycle, we plan to establish a dense observation network in Boso, Japan, where large subduction earthquakes are expected soon.

Since the subsurface fluid flow may play an important role in the preparation process of subduction activities, we intend to employ electromagnetic approaches including oceanic and continental MT survey to monitor the underground resistivity structure which is sensitive to the dynamics of fluid. Other geophysical monitoring such as ULF geomagnetic and geoelectrical observations, radon measurements, and inland GPS movements, will be incorporated to help to understand the preparation process and evaluate the applicability of various pre-earthquake signals towards short term earthquake forecasting.

Keywords: multi-sensor monitoring network, earthquake precursors, earthquake preparation process, short-term earthquake forecast

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NPO 法人地震前兆総合観測センター設立と地震発生予測実験
Establishment of NPO Japan Earthquake Precursor Comprehensive Observation Center and Experiment of earthquake prediction

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　１．概要
　NPO 法人地震前兆総合観測センターは平成 27 年 1 月 7 日に設立認可された。
　当センターは、観測装置開発のハードウェア技術者、データ収集・表示システム開発のソフトウェア技術者と観測点を設置する一般民間人にて運営される。
　多方式・多点観測を実施し、まず実際の地震と各方式の異常の相関関係を検証する。当初は植物生体電位観測、多周波数帯電磁気 2 周波同時観測でスタートし、将来は地震発生予測を行う。潮位偏差、大気イオン濃度、大気中ラドン濃度、等の民間観測グループとの連携も行う。
　運営資金は公的、民間助成金、寄付、会員会費等で、観測装置は原則自前で手配する予定。
　観測電磁気の周波数帯は VLF 帯 (3～30kHz、開発中)、LF 帯 (30～300kHz)、MF 帯 (300～3MHz)、VHF 帯 (30MHz～300MHz)、UHF 帯 (300MHz～3GHz、開発中) にて近傍の 2 周波にて同時観測を実施。
　現在全国で 9 か所で植物生体電位、電磁気等を観測している。

　２．役員
　理事 5 名、監事 1 名 (すべて観測点運営者)、理事の一人は早川正士氏。社員 12 名 (すべて観測点運営者)。

　３．観測点設置計画
　１）実地震と異常データ検証のために地震発生が多い宮城～茨城県太平洋沿岸に 2 か所
　２）関東直下地震前兆観測
　房総半島太平洋側、千葉県内、三浦半島、神奈川県県央、多摩地区、埼玉県、各地に 1 か所づつ
　３）東海地震前兆観測
　静岡県函南町 (設置済)、浜松市 (設置済)、石廊崎、御前崎
　４）東南海・南海地震前兆観測
　渥美半島、潮岬、室戸岬、足摺岬、宮崎県
　５）将来構想
　全国 100km メッシュ、離島に観測点を設置し全国をカバーする

　４．予知情報の発信方針
　１）M=5 級以上を予測する
　２）学術的分野では"見逃しはしょうがない、空振りはいけない"であるが、当センターは実用的防災情報発信を目指し、"空振りはいい、見逃しはいけない"とのポリシーで実施
　３）空振りを恐れず積極的に予測をする
　４）根拠となる異常データは必ず公開する
　５）来なかったら"来なくてよかった"と思っていただく (台風進路予測と同様)
　・予知情報は自己責任で使う
　・来なかったら（空振り）損害賠償を請求しようと思う人は予知情報を使わなくて結構

　５．Data Processor (Data Logger) の仕様
　５－１ 構成
　Data Processor ユニット (dSPIC とワンボードマイコンにて処理)、キーボード、マウス各一台
　DVI-D または HDMI 入力の液晶ディスプレイは別途ご用意願う。(中古品の供給は可能)

　５－２ 仕様
　１）入力：Buffer 付き、DC 0V～+3.7V (± 5V Type も可能)、10 Channel
　２）Sampling Time：1kHz

３）出力：1 分に 1 回、1 分間の最大値、最小値、平均値を出力、1 日 1440 行の CSV Format
４）1 日 1 回 Auto Reboot(CPU の Hang up 頻度を下げるため)
５）太陽光給電、Wi-Fi 対応可能 (商用電源、インターネット環境のない所用)
６）最大 2 か所の Web Server への自動転送 (1 時間に 1 回)
７）CSV Data を USB Stick Memory への手動格納

６．おわりに
・観測点設置にご協力いただきたい。
・研究者が M=6 級以上の地震を予測した場合は是非ご連絡をいただき、多方式統合の情報発信をしたい。

キーワード: 地震予知, 植物生体電位, 電磁気現象, 潮位偏差, イオン濃度, ラドン濃度
Keywords: prediction, bio potential, EM, tidal, ion, radon

房総半島を対象としたMT探査と予察的考察
MT survey and its preliminal result at Boso Peninsula, Japan

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KOIZUMI, Naoki[1*] ; HAN, Peng[1] ; YMAZAKI, Tomohiro[1] ; YOSHINO, Chie[1] ; HATTORI, Katsumi[1] ;
OKUDA, Mao[2] ; MOGI, Toru[2]

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A magnetotelluric (MT) survey is one of the methods to understand the underground electric properties. In Boso area, Japan, there are three main topic to perform the MT survey; (1) to estimate underground resistivity structures related to the plate boundaries, seamount, asperities, and slow slip events, (2) to obtain a regional realistic resistivity structure for the numerical simulation in generation and propagation mechanisms of electromagnetic precursors, and (3) to develop a new MT technique to reduce the cultivated noises such as DC driven trains. In these aims, we decided to carry out the MT survey in Boso area, Japan during 2014-2016. Due to sensing down to 100 km depth, we use induction and fluxgate magnetometers. The first MT survey in 2014-2015 had 21 and 6 stations for induction and fluxgate type magnetometer, respectively. We checked the observed data and analyzed the local midnight time (02:00-04:00(JST)) data because of noises and performed 1D inversion.

The preliminarily results show that we can presume the resistivity structure about 80 m-2 km depth from the surface. A typical resistance down to 200 m depth was 1-10 ohm-m and below 200 m depth, a specific resistance was estimated at 0.1-1 ohm-m at many stations. This suggests that there is a geological boundary around 200 m depth. In comparison with the geologic structure interpreted by the reflection seismology data, the upper part seems to be the Shimousa Group, and the lower, the Kazusa Group (Earthquake Research Committee, 2005).

To presume resistivity structure at the deeper depth, it is necessary to remove the artificial noises from observed MT data. These observed noises have characteristics of transient signals and processes in time domain are required such as singular spectrum analysis and neural network analysis. Further preprocessing will be essential.

キーワード: 地磁気地電流法, 房総半島
Keywords: MT method, Boso Peninsula

MIS02-P03　　　　　会場:コンベンションホール　　　　　時間:5 月 26 日 18:15-19:30

地震に先行する地磁気日変化異常
investigations of geomagnetic diurnal variations associated with the 2011 off the Pacific coast of Tohoku earthquake

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As one of the most promising candidates for short-time earthquake forecasting, the seismoele-ctromagnetic phenomena have been intensively studied for several decades. Recently, Xu et al. (2013) have reported unusual behaviors of geomagnetic diurnal variations in the vertical component prior to the 2011 off the Pacific coast of Tohoku earthquake (Mw9.0). In this study, we carry out further studies by investigating the spatial distribution of the anomalous geomagnetic diurnal variations associated with the Tohoku earthquake.

Ratios of Z component diurnal variations between the target station and the remote reference station Kakioka have been computed. After removing seasonal variations revealed by wavelet transform analysis, the 15days running mean of the ratio shows a clear anomaly exceeding the statistical threshold about 2 month before the mega event in Esashi and Mizsawa stations, which are close to the Mw9.0 earthquake epicenter. These results indicate that the location of the anomalies is consistent with the epicenter. Moreover, other independent geophysical parameter such as seismicity and crustal deformation also show clear unusual changes simultaneously, which suggests these anomalies might be related with the mega event.

Visualization of Groundwater Motion Using Self-Potential Tomography for Indoor Rainfall-Induced Landslide Experiment

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As it increases in the frequency of the local heavy rain in recent years, the occurrence number of the landslide also increases. It's an important problem to elucidate the process of the landslide caused by rainfall and monitor the slope and forecast the occurrence time to reduce damages. To achieve this, we need to monitor groundwater movement. In this study, we try to develop the early warning system with SP method to predict/monitor rainfall-induced landslide.

The relationship between the SP fluctuation, the movement of water, and the displacement of soil is confirmed by the former interior flume experiments. We adopt the PRESS-aided Philips-Tikhonov regularization to develop the SP tomography and sand-box experiments to apply the tomography successfully show the water levels and flows. To expand the SP tomography approach to the flume tests, we perform the numerical simulation to visualize the underground water condition. The size of the slope is depth 9.0 m, height 4.8 m and width 1.0 m. And the height of the soil stratum is 0.7 m. We assume a rectangular reconstruction area and we divide the area into a 0.2 m x 0.1 m pixel, and compute the value of electric charge every pixel. In addition we assume the electric charge outside of the slope area is 0 and the permittivity in the analyzed area is uniform. Checkerboard-like positive and negative electric charges are generated and the number of electrodes was changed with 16-85. An error of 10% of the observation value has been added to data observed at electrodes.

We found the following results; (1) it's possible to reconstruct the structure of charge distribution with scale of 1.2 times greater than the inter-electrode distance. (2) the objective selectivity of the optimal reconstructed image with minimum PRESS criterion fails in the case of sparse electrodes.

Keywords: Self-Potential Tomography, PRESS-aided Philips-Tikhonov regularization, visualize underground water condition

Multiple geophysical observations for earthquake monitoring in Kanto, Japan
Multiple geophysical observations for earthquake monitoring in Kanto, Japan

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In order to understand the preparation process of large earthquakes and clarify the mechanisms of Lithosphere-Atmosphere-Ionosphere (LAI) coupling, an observation network are established in Kanto, Japan. Multiple geophysical parameters such as geomagnetic field, geoelectric field, radon concentration, ion concentration, and atmospheric electric field are monitored. The meteorological data at each station are also recorded. These data may provide some new knowledge of earthquake process. We will demonstrate the observation system and some recent data in our poster.
Keywords: multiple geophysical observations, earthquake monitoring, preparation process of large earthquakes, mechanisms of Lithosphere-Atmosphere-Ionosphere coupling