Observations of airglow and geomagnetic pulsations at Paratunka and Stecolny

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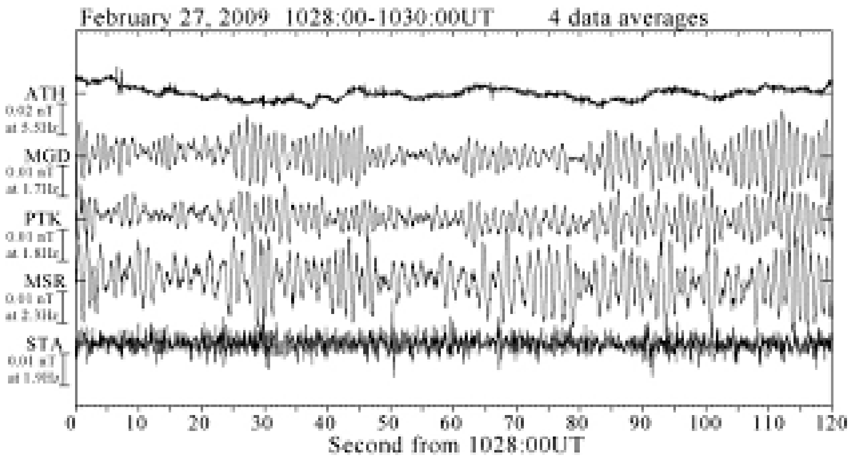
Introduction

We have conducted observations of airglow images and geomagnetic pulsations using two all-sky cooled-CCD imagers and two induction magnetometers at Stecolny near Magadan (MGD, 60.05^{o}N, 150.73^{o}E, November 4, 2008-) and Paratunka (PTK, 52.97^{o}N, 158.25^{o}E, August 17, 2007-) in order to measure ionospheric/atmospheric disturbances and geomagnetic pulsations in the longitudes of Far-Eastern Asia. Several results of gravity waves, medium-scale traveling ionospheric disturbances and Pc1 geomagnetic pulsations obtained from these observations has been reported, such as that reported at the previous conference in Shiokawa et al. (2010a). In this paper, we show some results regarding the waveform and polarization characteristics of Pc1 geomagnetic pulsations obtained at MGD, PTK, and two Japanese stations, Moshiri (MSR, 44.4^{o}N, 142.3^{o}E) and Sata (STA, 31.0^{o}N, 130.7^{o}E), based on the results reported by Shiokawa et al. (2010b) and Nomura et al. (2011).

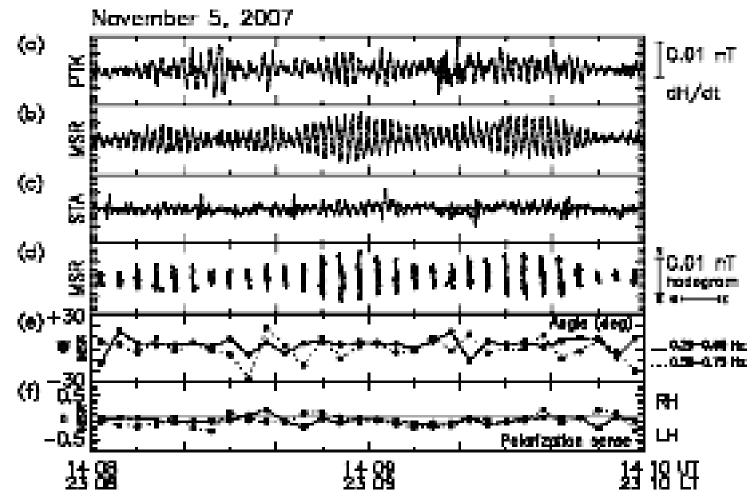


Results

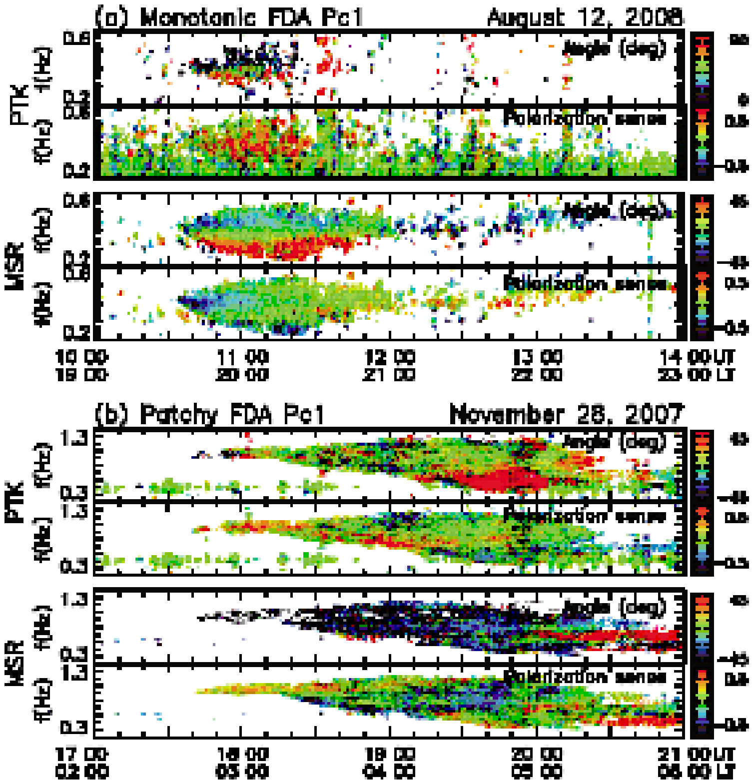
Figure 1 shows the waveforms of the H component of the Pc1 geomagnetic pulsations observed at five ground stations at 1028:00-1030:00 UT on February 27, 2009, as reported by Shiokawa et al. (2010b). The vertical scale at the left of the panel is calculated at the peak sensitivity of each station. Clear sinusoidal Pc1 waves were observed at MGD, PTK, and MSR\null. In the STA data, similar sinusoidal wave signatures with smaller amplitudes can be recognized, although the data contains considerable noise at higher frequencies, indicating attenuation of Pc1 waves during duct propagation in the ionosphere from high to low latitudes. Pc1 pulsations were not observed at Athabasca, (ATH, 54.7N, 246.7E), since ATH is in different longitudes in Canada.

The Pc1 waves observed at MGD, PTK, and MSR constitute packet-like structures with repetition periods of 10-20 s, which are known as pearl structures. Although these Pc1 packets appear nearly simultaneously at MGD, PTK, and MSR, a closer inspection of the data reveals timing differences between these packet structures with a delay of about half a cycle between MGD-PTK and PTK-MSR, indicating propagation of the Pc1 waves from a high-latitude source region to lower latitudes through an ionospheric duct with a phase velocity of 1600-2300 km/s. In Figure 7, we also noticed that the Pc1 packets are slightly modulated as they propagate from MGD to MSR through PTK (e.g., 1028:25 UT and 1029:40 UT). In other words, the packet shapes are somewhat dissimilar at these three stations. This fact suggest modulation of the Pc1 pearl structure during the propagation of the ionospheric duct, or generation of the Pc1 pearl structure itself due to mixture of different waves during the propagation.

The idea of Pc1 pearl structure as the mixture of several waves with different frequencies was further investigated by Nomura et al. (2011). Figure 2 shows another comparison of Pc1 waveforms observed at 1408:00-1410:00UT on November 5, 2007. One can notice that the beginnings of the Pc1 pearl structure at 1408:30 UT and 1409:20 UT were coincident with the time when the polarization angle in Figure 2e changes significantly. This fact is expected if the pearl structure is caused by a superposition of a number of waves with different frequencies as theoretically suggested by Pope (1964). Thus Nomura et al. (2011) proposed that the Pc1 pearl structure observed at low latitudes is a beat generated by the superposition of waves with slightly different frequencies.



Nomura et al. (2011) also found an interesting variation of Pc1 polarization angle depending on frequency. Figure 3 shows two examples of such variations. The angle of polarization ellipse orientation at PTK and MSR gradually decreases from $\sim$+40 $^\circ$ to $\sim$0 $^\circ$ as the frequency increases from 0.2 to 0.5 Hz (Figure 3a). The polarization sense at MSR also varies from ~ -0.5 to $\sim$0.5 at 1030–1200 UT, but shows no evident monotonic frequency dependence in contrast to the angle behavior. In Figure 3b, the polarization angle variations at PTK and MSR in the band 0.4–1.2 Hz are not regular both in frequency and in time. The variations are not fully random but show patchy structures. The polarization sense also shows patch-like features in frequency and time. Based on these results, Nomura et al. (2011) suggested that spatially distributed Pc1 waves at high latitudes with frequencies depending on longitude or latitude propagate in the ionospheric duct to cause the frequency dependence of polarization parameters at low latitudes. This suggestion also implies that the Pc1 pearl structures with a repetition period of ∼5–30 s observed at low latitudes are produced as a beat of these waves with slightly different frequencies.



Concluding Remarks

The measurements by all-sky airglow imagers and induction magnetometers at Far-Eastern Russia and Japan have been continued for more than 5 years. Quick-look plots of data obtained by these instruments are opened at the homepage at http://stdb2.stelab.nagoya-u.ac.jp/omti/ (for imagers) and at http://stdb2.stelab.nagoya-u.ac.jp/magne/ (for magnetometers). These continuous observations will contribute latitudinal difference and propagation of traveling ionospheric disturbances and geomagnetic pulsations. The observation at Stecolny at subauroral latitudes will give a complementary data to the ERG satellite, which will be launched in December 2015 to investigate plasma dynamics in the inner magnetosphere and radiation belts.

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Наблюдения за свечением атмосферы и геомагнитными пульсациями в Паратунке и Стекольном

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Мы выполняем наблюдения за свечением атмосферы и геомагнитными пульсациями в Паратунке (52.9N, 158.3E, MLAT=46.0N, с августа 2007) и в Стекольном (60.0N, 150.9E, MLAT=52.2N, с ноября 2008) недалеко от Магадана на Дальнем Востоке России, используя две панорамные охлаждаемые CCD камеры для свечения атмосферы и два индукционных магнитометра с выборкой 64 Гц. В данной презентации мы делаем обзор наших недавних результатов, полученных с помощью этих непрерывных наблюдений. С помощью изображений свечения атмосферы мы наблюдаем гравитационные волны и ионосферные возмущения в районе мезопаузы и в ионосфере на высотах 80-100 км и 200-300 км, соответственно. С помощью изображений свечения ионосферы в Паратунке была получена климатология направления распространения гравитационных волн. Среднемасштабные перемещающиеся в ночное время ионосферные возмущения (MSTIDs) часто наблюдаются в изображениях свечения атмосферы 630 нм. Было выполнено сравнение со скоростями плазмы, наблюдаемыми с помощью радара SuperDARN Hokkaido для того, чтобы понять детали динамики плазмы в MSTIDs. С этих двух станций поступают данные о вариациях угла поляризации геомагнитных пульсаций Pc1 в пределах частотной полосы, которые предполагают пространственное распределение ионосферных источников Pc1 на субавроральных широтах. Пульсации Pc1 вызывают потерю релятивистских электронов в радиационном поясе Земли, таким образом, исследование пульсаций заслуживает внимание для изучения космической погоды.