Passive Optics activity in Japan

1. Instruments

1.1 FPI

Optical measurements with ground-based Fabry-Perot Interferometers for observing the thermosphere and mesosphere region are active in Tohoku University, NIPR, NICT and Nagoya University in Japan. STE laboratory, Nagoya University has a domestic observation with a FPI routinely at the Shigaraki observatory, Kyoto University from September 1998. Tohoku University has the longest history of airglow and aurora measurements with passive optics in Japan, and has been operating their FPI at the Zao observatory intermittently. NICT (former CRL) has a cooperative project with Geophysical Institute, University of Alaska Fairbanks from 1993, so called “Alaska Project” and deployed their instruments in two sites of GI/UAF: Poker Flat Research Range (PFRR) and the Eagle observatory. NIPR installed their FPI and have a routine observation at the Syowa base, Antarctica since 2001.

1.2 ASI

Japanese ASIs for observing aurora are at Syowa and South Pole, operated by NIPR, and at PFRR operated by NICT. There are various kinds of imagers in Syowa: All-sky monochromatic imager (OI557.7, OI630.0, N2+427.8, NaD589, Hb, OH(8-3) etc.) since 1998, All-sky panchromatic imager since 1978, and all-sky panchromatic video camera since 1986. In Alaska, NICT operates two all-sky monochromatic imagers at PFRR since 2000. They have some campaign-based cooperative observations in FRONT (see next).

Tohoku University operates ASI for observing sprites.

1.3 Photometer and others

STE lab. operates several photometers (Shigaraki, Sata, Rikubetsu and Koto Tabang) routinely as a part of OMTI. Niigata Univ. has a long history to observe airglow with photometers but now campaign base only. Tohoku Univ. used multi-anode array for observing sprites.

NIPR operates aurora spectrograph meridian spectral imager, which can measure auroral distribution (FOV: 180 deg) with their spectral between 420 and 730 nm at Longyearbyen since 2000. STE lab. operates SATI (Spectral Airglow Temperature Imager) at Shigaraki since 1998.

<table>
<thead>
<tr>
<th>Institute</th>
<th>FPI</th>
<th>ASI</th>
<th>Photometer</th>
<th>Others</th>
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<tbody>
<tr>
<td>Tohoku Univ.</td>
<td>Zao (D)</td>
<td>Campaign base (for obs. Sprite)</td>
<td>Campaign base (multi-anode array x 2)</td>
<td>Image-intensifies CCD Camera (2 sets), Watec CCD Camera (up to 40 sets collaborating with high schools)</td>
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<tr>
<td>NIPR</td>
<td>Syowa (D)</td>
<td>Syowa(ASI,ASC,A TV), South Pole</td>
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<td>Longyearbyen (aurora Spectrograph Meridian Spectral Image)</td>
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<tr>
<td>Campus</td>
<td>(ASI)</td>
<td>Campaign base</td>
<td>Campaign base</td>
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<td>NICT</td>
<td>Eagle (D), PFRR (S)</td>
<td>PFRR (ASIx2)</td>
<td>PFRR (aurora Web Camera)</td>
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<td>Niigata Univ.</td>
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<td></td>
<td>Campaign base (scanning)</td>
<td>Campaign base (Filtered CCD, monochromatic CCD)</td>
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<td>Shigaraki (D=&gt;S)</td>
<td>Shigaraki, Sata, Rikubetsu, Darwin, Koto Tabang</td>
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<tr>
<td>Kyoto Univ.</td>
<td>Indonesia, Colorado, Misato</td>
<td>Shigaraki (Tilt) Sata (Temp) Rikubetsu (Tilt x2, temp x1) Koto Tabang (temp)</td>
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</table>

**Campaign observations**

2.1 The FRONT Campaign

The FRONT (F-region Radio and Optical measurement of Nighttime TID) campaign was designed to detect nighttime TIDs in a wide area and with multiple instruments in order to clarify the temporal and spatial variations of TIDs as well as the physical mechanism responsible for them. All-sky cameras were installed at five sites in the first campaign period (FRONT-1: May 16-24, 1998) six sites in the second campaign (FRONT-2: August 8-18, 1999) and seven sites (five in Japan and two in Australia) in the third campaign (FRONT-3: May 26-June 7, 2003). During the first FRONT campaign, this cluster of all-sky CCD imagers were used to investigate large-scale structure of the 630nm band airglow over Japan [Kubota et al., 2000; Saito et al., 2001] and spatial extent of mesospheric gravity waves [Shiokawa et al., 2000]. GEONET, a GPS receiver network operated by the Geographical Survey Institute, was used to observe the total electron content (TEC) of the ionosphere over Japan with a 30 second time resolution [Saito et al., 1998]. In addition to these wide-coverage observations, the MU radar was used to observe coherent echoes from F-region field-aligned irregularities at 46.5 MHz frequency. The MU radar was also operated in the incoherent scatter mode. The height profile of the ionospheric electron density was derived with a time resolution of about five minutes. The bottomside of the ionosphere was also measured by the ionosonde network operated by the Communication Research Laboratory. The velocity of the neutral wind was measured at two locations by Fabry-Perot interferometers using the 630nm band airglow.

The second FRONT campaign was held in August 1999 in order to obtain southwestern edge of the MSTID propagation. Although only a limited amount of data were obtained due to cloudy-sky condition, Shiokawa et al. [2002] suggested on the basis of airglow imaging observation in the southern island of Japan that there is a possible limit of southwestward MSTID propagation around
After the FRONT-2 campaign, simultaneous observations of medium-scale traveling ionospheric disturbances (MSTIDs) at geomagnetic conjugate points in both hemispheres were conducted, using two all-sky airglow imagers at Sata (31.0° N, 130.7° E; magnetic latitude 24° N) in Japan and at Darwin (12.4° S, 131.0° E; magnetic latitude 22° S) in Australia. This setup allowed to investigate the geomagnetic conjugacy of airglow structures. From this conjugate observations, Otsuka et al. [2002; 2004] found that both high-altitude plasma bubbles and mid-latitude MSTIDs show clear geomagnetic conjugacy at both hemispheres.

The FRONT-3 campaign was held in May-June 2003 to investigate the geomagnetic conjugacy of the mid-latitude MSTIDs further, using seven 630-nm airglow imagers (five in Japan and two in Australia). The MSTIDs were observed all the nights at Renner Springs, Australia, indicating that they are a common feature in the mid-latitude ionosphere in the northern hemispheric summer season in the Japanese-Australian Longitudinal sector. All of them show one-to-one correspondence of the MSTID wave structures between the northern and southern hemispheres with comparable amplitudes. This fact indicates that strong electrodynamic coupling occurs between the two hemispheres through geomagnetic field line during the MSTIDs.

### 2.2 The WAVE2000 campaign

The WAVE2000 campaign (Waves in Airglow Structures Experiment over Kagoshima in 2000) was held on January 2000 around Kagoshima, Kyushu, Japan. The purpose of this campaign is to investigate propagating waves in the mesosphere with rocket and ground-based measurements with radio and optics. The rocket-born measurements provide the vertical information such as O density, electron density and airglow emission rate profiles. The ground-based all-sky imagers provide the horizontal information of waves such as wavelength, period, phase speed, propagating direction, phase difference among airglow emissions, and the radars provide wind speed information. By combining them we expected a new understanding of the formation process of waves in airglow structures from both dynamical and chemical aspects. Another purpose of this campaign is to examine the validity of the ground-based triangulation to estimate the airglow layer height by comparing with the rocket data.

The rocket-born measurements were as follows:

1. O density measurement at 70-180km by the resonance lamp method.
2. Electron density measurement at 70-180km by the glass-sealed Langmuir probe method.
3. O558nm line, O2 Atmospheric (0,0) band and OH(6,2) band airglow emission rate measurements at 70-120km by filter photometers.
4. Wind measurement at 90-95km by the chaff method.
The ground-based measurements were as follows:
1. All-sky imaging of the O558km line, O2 Atmospheric (0,1) band and OH band airglow emissions at KSC (Kagoshima Space Center; 31.25N, 131.08E), Yamagawa (44km west of KSC) and Ohsumi (40km north of KSC).
2. OH rotational temperature measurement at KSC.
3. Wind measurement at 80-100km by middle frequency (MF) radar at Yamagawa.
4. Wind measurement at 80-100km by middle and upper atmosphere (MU) radar at Shigaraki (600km northeast of KSC).

The rocket experiment was carried out at KSC at 20:50UT (05:50JST) on 9 Jan. 2000. This measurement found that waves in the airglow were seen even though an analysis suggests that they were not freely propagating upward from below because of the presence of a critical layer below the main airglow emission peaks. Although the atomic oxygen density distribution was atypical, the current understanding of the airglow excitation process appears to be still applicable. The airglow layer height from the ground-based triangulation and the rocket-born measurements agreed within 2km. More detailed analysis can be found in e.g., Iwagami et al. [2002].

References:


