cause its glaciers lie within the variable influence of three major weather systems: the "sub-Mediterranean" regime of mainly winter, westerly storms; the summer monsoon; and the Tibetan Plateau anticyclone. Winter storms are the main source of glacier nourishment at present. However, nearly one-third of high-elevation snow accumulation we have measured occurs in summer. It has been argued that general patterns of glacier advance in this important glacier region, and the problems posed by its glaciers.-Kenneth Hewitt, Cold Regions Research Centre, Wilfrid Laurier University, Ontario, Canada

References

An electronic supplement to this article by the author may be obtained at Web site http://www.agu.org/eos_elec as 97106e.html.

Interdisciplinary Scientists Gather for Plasma Structure Workshop
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Two of the most exciting papers presented at the Third Peaceful Valley Workshop were on the nature of plasma structure found in the nighttime midlatitude E and F regions. The first was from a coordinated rocket campaign called Sporadic E Experiment over Kyushu (SEEK) dedicated to the understanding of puzzling quasi-periodic radar echoes that have been detected in association with sporadic E layers. In-situ probes on two rockets measured localized electric fields as large as 20 mV/m, confirming theoretical predictions of strong polarization processes that may result from wave like distortions imposed on normally stratified sporadic E layers. An unexpected result was the discovery of a large localized wind of 150 m/s at E region altitudes and the associated velocity shear, which was likely to lead to Kelvin-Helmholtz instability.

The second paper concerned the return of solar minimum conditions in recent years, which has allowed the resumption of radar investigations of backscatter "plumes" in the nighttime midlatitude F region, a phenomenon that was not detected since the last solar minimum period.

These papers were presented in the first session of the workshop, the subject of which was midlatitude irregularities. Papers were presented by scientists from four different countries on midlatitude plasma structures. Topics ranged from a method to determine large-scale horizontal gradients over Argentina to the role of finite spatial wave numbers along magnetic field lines on the growth and decay of plasma-density irregularities in the ionosphere.

Meeting jointly at the workshop were the National Science Foundation (NSF) Coupling Energetics and Dynamics of Atmospheric Regions (CEDAR) High Latitude Plasma Structures (HLPS) working group, and the international STEP Global Aspects of Plasma Structures (GAPS) working group.

The second high latitude session on irregularity was directed primarily toward high latitude irregularity structures with wave lengths ranging from meters to kilometers. Observations of scintillations of VHF signals from polar beacon satellites showed the unique k-spectrum characteristics of scintillations in the ionospheric cusp, suggesting that the irregularities were associated with strong velocity turbulence. In the cusp, during the current solar minimum period, Global Positioning System receivers barely detected scintillations but were able to record large scale (tens of km) phase variations associated with electron density structures.

A statistical study of the spatial distribution of kilometer-scale irregularities in the auroral zone and polar cap showed significant summer/winter variation, attributed to seasonal dependence of the instability process. In all cases, this study found the strongest density and velocity turbulence to occur in the cusp. Two theoretical modeling studies focused on the gradient drift instability. The first was a three-dimensional simulation of the gradient drift instability in a polar cap patch environment showing that the spatially unconfined instability has slower growth rates than the previous one- and two-dimensional growth rate calculations. This implies that the instability probably does not have adequate time on its polar cap transit to grow enough to break up large patches into smaller scale structures. The second was a plan for modeling the high latitude distribution of irregularities produced by the gradient drift instability, which suggested that this procedure would be capable of predicting scintillation disturbances at high latitudes.

SuperDARN radar data were used to test two existing models for polar cap patch formation, and it was found that the synthesis of the two models best explains the observations. Specifically, changes in the interplanetary magnetic field (IMF) Bz can cause parcels of high latitude plasma to move between the dawn and dusk convection cells, thereby creating patches of higher density plasma. Observations of the onset of plasma structuring in the vicinity of a polar cap arc and the effects that it has on the Doppler spread of backscattered HF radar signals were presented.

Polar cap arcs were the topic of the third session. Contrary to the prior workshop emphasis of IMF Bz northward conditions and polar cap locations, the presentations emphasized on the arc association with the changing IMF Bz, auroral oval, and even substorms. More attention was paid to the transition period between northward IMF and southward IMF. Time delays for the appearance and disappearance of polar cap arcs when IMF Bz changes and the electroly dynamics in the polar cap during such transition periods was a common topic. These lead to the quantitative conclusion that polar cap arcs are no longer to be considered as only a northward IMF phenomenon. The relationship between substorm activity in the oval and the Theta aura, as well as the polar cap arcs, drew significant discussion. One new development in HLPS/GAPS polar cap arc studies were the AGO observations from the South Pole, which provide the potential for future conjugate studies. There is a continued emphasis on using multi-instrument
plasma and combining data from several stations to produce global pictures of polar cap aurora.

The fourth session was devoted to methods by which ionospheric plasma patches may be formed and characterized. It is now well appreciated that a steady, two-cell convection pattern can deliver a tongue of high density into the polar cap. Patches, defined as enhancements in ion density above a background, may be formed by breaking up or otherwise distorting this tongue of ionization. Both time-varying convection patterns and high velocity plasma vortices located in the cusp region can distort the tongue of ionization and cause patch formation. The relative contribution of these mechanisms to patch formation still requires investigation, but both have been successfully incorporated into ionospheric models.

The ionospheric density enhancements, which characterize a patch, observed by direct measurement of the ion density at a fixed height, by measurement of the $F$ peak density from ionosondes, and by measurement of airglow enhancements, were reported. These different measurement techniques were used to establish the attributes of patches, such as their spatial size, relative magnitude, and occurrence frequency, as a function of location and interplanetary magnetic field. While some of the characteristics from these different sources are fortably similar (e.g., spatial size), there are some striking differences in relative magnitude and occurrence frequencies as witnessed by the results presented. This has prompted intense investigation of the limitations of the observing techniques and the differences in algorithms for patch identification which is an ongoing topic of much debate and re-analysis by HLPS/GAPS scientists. Of particular importance in this regard is the role played by neutral air motions in raising and lowering the $F$ peak. While the region where the $F$ peak is lower may appear as an airglow patch, it will be associated with a region of ion density depression about the $F$ peak. Finally, it was emphasized that irregularities are important to communication and navigation systems only when the patch density is high (greater than 5 x $10^{5}$ cm$^{-3}$).

Structure in the thermosphere and its consequence for ionospheric structuring was the topic of the first half of the fifth session. The influence of gravity waves (GW) upon the ionosphere was discussed from two different experimental points of view. Polar cap, CAD, observations of $h_{m}F_{2}$ showed $\pm 30$ km amplitude modulations of wave trains of 3 or 4 oscillations on 15 occasions during one winter observational season. Smaller amplitude oscillations of these 30-min waves were found more frequently. Using two or three station triangulation, the apparent source location was inferred to be in the noon dusk sector of the polar cap-auroral regions. These large amplitude modulations also changed $N_{m}F_{2}$ and, in turn, modulated the Pedersen conductivity by up to 80%, which leads to other wave-electrodynamic effects. The SuperDARN observations showed, on almost a daily basis, wave trains of two to three oscillations moving equatorward from the auroral electrojet region. These waves are an Earth-reflected wave mode. Although $h_{m}F_{2}$ is clearly modulated by these wave trains, it is unclear whether significant $N_{m}F_{2}$ and conductivity modulation result from these waves. Their source regions also appeared to be in the noon-dusk sector of the oval polar cap regions. The HLPS/GAPS community now has a quantitative basis from which to begin observation-model studies of the extent to which GW are involved in high latitude plasma structuring, an exciting new task for the working groups. In addition, model results of thermospheric structuring due to imposed ionospheric patch and sun-aligned arc structures were presented. These simulations indicated that the dynamic range to be expected for such interactions is characterized by: 120 m/s changes in the neutral wind, temperature changes of $\pm 70^{\circ}$, and neutral density changes of $\pm 10\%$ at 300 km.

The second half of the fifth session introduced additional topics of debate and relevance to polar cap structures. Energized solar wind observations from Akebono satellite were integrated over space and time to show that more than five tons per day of hydrogen and oxygen were removed from the ionosphere. Ionosonde data from both the northern (Dixon) and southern (Vostok and Mirny) hemispheres showed the surprising result that $f_{p}F_{2}$ at noon was correlated with a combination of solar wind pressure and IMF orientation, but not with the geomagnetic $K$ index. Over one winter of observation, this showed that $f_{p}F_{2}$ varied from 3 to 12, while the magnetopause standoff distance varied from 7 to 14 $R_{E}$.

The sixth session of the workshop was a roundtable discussion of goals for the HLPS/GAPS community for the next two years. These were formulated as challenges that involved both the experimental and modeling community and focused on analysis that would resolve present day uncertainties and ambiguities. Challenges were established in several areas: patch definition, patch source, polar cap arc-oval morphology, theta aurora versus polar cap arc, gravity wave source, and gravity wave impact on the ionosphere. In addition, specific note was made that monitoring and modeling scintillations over a large region were important, the time evolution of the global convection problem was crucial, and the solar wind pressure and IMF orientation control of the noon sector $f_{p}F_{2}$ was clearly going to affect polar cap structure, and hence, needed further study.

Once again, the Peaceful Valley Workshop has set goals for the next few years for the HLPS/GAPS community, as well as summarized the successes following the prior two workshops. With the announcement that the NSF-sponsored polar cap observatory (PCO) is to become a reality, the HLPS/GAPS scientists look forward to yet more milestones in understanding polar cap plasma structures. In this context, forward-looking planning of HLPS/GAPS campaigns identified ways in which the PCO will prove invaluable.

This workshop was supported by the NSF through the CEDAR Program and the Center for Atmospheric and Space Sciences at Utah State University. The HLPS working group is co-chaired by J. Sojka and E. Weber, while the STEP GAPS working group is chaired by Sunanda Basu. The long-term objectives of these working groups are the physical understanding and modeling of the development of large-scale (100 km) ionospheric structures, the generation of instabilities leading to small-scale (m to tens of km) irregularities from the large structures, and the adverse space weather effects caused by the irregularities. As with the two prior workshops (in 1994 and 1992), this workshop brought together international representation from the observational, modeling, and theoretical communities. In all, 48 participants are present, which included 12 foreign scientists and four graduate students.—Jan J. Sojka, Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah, USA

The Peaceful Valley Workshop was held at the Peaceful Valley Ranch and Conference Center in Lyons, Colorado, from June 15-17, 1997.