There were four separate breakout sessions devoted to the Diffuse Auroral Precipitation Focus Group at the 2009 GEM workshop. Each session was well attended with an average of 30–40 participants.

DAP 1: "Understanding Diffuse Auroral Structure"
Co-chaired by Marilia Samara and Robert Michell
Tu, 23 June, 1:30 p.m. - 3:00 p.m.

DAP 2: "Magnetospheric Dynamics Associated with the Diffuse Aurora"
Co-chaired by Eric Donovan, Marilia Samara and Robert Michell
Tu, 23 June, 3:30 - 5:00 p.m.

The first two sessions of the Diffuse Aurora Focus group dealt with observations and included initial attempts to infer useful quantities from those observations for the modeling efforts currently underway. In the first session the wide range of observable auroral structures, from both ground and space, was discussed. We had talks covering the smallest (sub-km) scale using narrow-field imagers, the medium (1–10 km) scale using both narrow-field and all-sky imagers, the large (10–100 km) scale using all-sky imagers, rockets and satellites and the very large (> 100 km) scale from satellite observations. The variety of structure, both small and large, present in the aurora illustrated how the term "diffuse aurora" has biased us to expect an unchanging fairly uniform optical manifestation, which is far from what observations show.

Marilia Samara presented several examples of narrow-field movies from a recent campaign at Poker Flat, AK. The advances in imaging technology, specifically the EMCCD imagers, have made it possible to quantify the very fine scale structures within the diffuse aurora. The sensitivity and dynamic range are such that temporal frequencies can be regularly measured (up to 16 Hz most often, $\sim$ 50–60 Hz is also possible.).

Elizabeth MacDonald showed an example of a rocket flight over pulsating aurora (PARX, 1997 PI: G. Parks) and discussed the speed and spatial extent of the pulsating aurora. The in situ particle data revealed the presence of high energy electron precipitation associated with the region of pulsating aurora.

Robert Michell presented results from those who wanted to contribute but did not make it to the workshop. Multi-spectral observations of black aurora from **Björn Gustavsson** revealed the differences between the emissions in the black aurora and the background diffuse aurora. All-sky FPI observations from **Mark Conde** reveal the changes in intensity and temperature caused by the aurora. The changes in neutral temperature are an indicator of joule heating and energy input and dissipation. **Trond Trondsen** sent an example of large-scale periodic black structures that formed within diffuse aurora, observed with multiple imagers using different fields of view (looking both at the smallest and largest structures). There was a specific example showing, on a small scale, the transformation of an unstructured boundary to a structured boundary.

Kaori Sakaguchi explored the event presented by Trondsen in detail. She extracted the periodicity and wavelength of the pulsating structures, verifying that they are curl features much larger that what had been observed previously. She asserted that they are caused by an interchange instability.

Geoff Mcharg presented work relating to flickering aurora observations from Toolik Lake, AK using a high speed PHANTOM intensified CCD imager that can easily detect frequencies up to 1 KHz. He quantified the frequencies as a function of time and wave number. These frequencies can be associated with ion cyclotron wave scattering of electrons into the loss cone.

The second session started with the three presentations that remained from the first session and then continued with some overlap of observation and modeling. The goal of the second session was to focus more on using the aurora as a tool for remote sensing the magnetosphere.

Eric Donovan presented observations of pulsating aurora with the THEMIS all-sky network.

He focused on observations from Athabasca, following the motions of patches to determine whether they are really consistent with ExB motion. He discussed the need for figuring out what causes patchy pulsating aurora and suggested an auroral workshop for sometime in the near future.

Sarah Jones presented pulsating aurora work from one of the students in Marc Lessard's group. The aim of that work is to identify the particle population responsible by first ordering pulsating events according to MLT and MLAT. The work utilizes THEMIS ASI observations and offers hope of, within a year or so, quantifying the spatial extent and spatio-temporal morphology of the region containing pulsating patchy aurora.

Thanasis Boudouridis showed results from 77 passes of twin DMSP satellites where he correlated the particle data from the two satellites with varying time lags. It was found that the ions were more correlated over time than the electrons indicating that the ion structures where longer lived. He also found that the small-scale electron features were less correlated over time, indicating that the small-scale features are more variable in time. This is the kind of analysis that we should be taking into consideration for future work.

Marianne Daae presented results primarily from IMAGE WIC. She quantified scale sizes of auroral giant undulations that occur at the equatorward edge of the diffuse aurora during very active times.

Jerry Goldstein presented TWINS as a new data source available for examining where the high-energy ion precipitation is occurring, based on stereo ENA observations.

Matt Gilson explored (bright) proton aurora, presenting initial results wherein the proton precipitation (assuming strong pitch angle diffusion when Kappa for the appropriate energy protons is $<\sim3$) is inferred from a self-consistent global simulation.

Aaron Ridley presented three different modeling attempts. The last one, using the Rice Convection model contains the most accurate physics of diffuse aurora. It produced the best looking precipitation patterns but did not seem to provide enough conductance to shunt the current, resulting in a very large cross polar cap potential.

Mike Liehmon presented modeling results that highlighted that the ring current can be very different just by shifting the auroral conductance a little bit. Implications discussed included the suggestion that dynamic arcs require large current, while diffuse 630.0 nm structures do not, and that any process that scatters plasmasheet electrons into the loss cone should produce 630.0 nm emissions, which could be used as a sensitive indicator of plasmasheet flows.

The final discussions for these two sessions centered on ways that the observations can be used to constrain or provide input for the models and the shortcomings of the current methods of modeling conductivity. It was decided that the ground observation researchers should attempt to come up with quantifiable information that modelers in the GEM community can use to advance the objectives of the GEM program. For example, the medium and large-scale structures give the latitudinal extent and location of the diffuse auroral precipitation and ULF wave frequencies can be extracted from pulsating auroral structures. That in turn will likely be useful in verifying the spatio-temporal evolution of a specific magnetospheric region in global models and simulations, or in constraining MI coupling as invoked in those models.

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DAP 3: "Modeling Electron Scattering Rates by ECH waves and Chorus"
Co-chaired by Richard Thorne and Binbin Ni
Tu, 23 June, 3:30 - 5:00 p.m.

This session concentrated on the global morphology, spectral properties, and variability of two classes of magnetospheric plasma waves, electrostatic electron cyclotron harmonic (ECH) and electromagnetic whistler mode chorus plasma waves, which are capable of scattering plasma sheet electrons, leading to diffuse auroral precipitation. Theoretical calculations of pitch-angle scattering rates from each class of wave were presented to assess their potential contribution to the global pattern of diffuse auroral precipitation.

Richard Thorne presented the global distribution of electromagnetic whistler-mode chorus waves and electrostatic electron cyclotron harmonic (ECH) waves based on the available wave observations of CRRES and THEMIS spacecraft. The presentation showed that the patterns of the chorus waves, ECH waves, and low-energy (100 eV–30 keV) are similar to the global morphology of the diffuse aurora, suggesting that both wave modes play roles in the occurrence of diffuse aurora.

Mike Schulz, starting from the diffusion operator and Jacobian, discussed the importance of inclusion of diffusion in both energy and pitch angle while dealing with wave-particle interactions. He suggested that both energy diffusion and energy-pitch angle mixed diffusion should be included for modeling accurately the radiation belt dynamics by solving numerically the Fokker-Planck equation.

Binbin Ni presented initial results of bounce-averaged diffusion coefficients for diffuse auroral precipitation due to chorus and ECH waves, using the statistical wave power distributions obtained from CRRES and the latitudinal wave normal variations computed from HOTRAY code. The presentation showed that chorus waves play much more important roles than ECH waves in driving diffuse aurora.

Richard Denton presented the results of 2-D modeling of whistler-mode chorus waves and suggested three options to investigate the generation and propagation of chorus waves in the magnetosphere, including a full particle method, conventional hybrid code, and hybrid-like simulation.

In addition **Gang Lu** presented modeled height-integrated ionospheric conductivities with and without proton precipitation. The presentation showed that the losses of protons to the upper atmosphere can contribute to changes by up to 38% for Pederson conductivity and by up to 36% for Hall conductivity, which suggests that proton precipitations make a difference for the buildup of the profile of ionospheric conductivities.

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DAP 4: "Required Inputs for Global Modeling: Plans for 2009-2010 Activities"
Co-chaired by Margaret Chen and Richard Thorne
Wed, 24 June, 1:30 - 5:00 p.m.

In this session **Pat Newell** presented data from the DMSP (F7) satellite of ion and electron precipitation flux, separating out the contributions from discrete and diffuse auroral precipitation. He demonstrated that the diffuse auroral precipitation contributes the dominant source of precipitation energy flux into the atmosphere (83%-75% depending on solar wind driving). The diffuse auroral precipitation triples during stronger solar wind forcing and the global pattern of diffuse electron precipitation (which dominates over diffuse ion precipitation) is similar to that anticipated from scattering by chorus emissions.

Vania Jordanova presented RAM model simulations of the global pattern of chorus excitation during the October 2002 magnetic storm. The RAM simulations followed the transport of plasmasheet electrons into the inner magnetosphere under the influence of enhanced convection electric fields, and evaluated the amplification of whistler-mode chorus waves due to the simulated electron distributions. The simulations showed a preference for chorus excitation on the dawn side similar to the statistical properties obtained earlier from CRRES data.

Margaret Chen presented modeling of the global distribution of electron precipitation using her ring current model with various assumptions on the electron scattering lifetimes. She was able to reproduce the general features of electron precipitation using a scattering model that assumed a rate of scattering less that that of strong diffusion. This is consistent with the scattering calculations presented in the earlier session by Binbin Ni.

The session was finally opened up for inputs from the participants on how the Diffuse Auroral Focus group could best provide information on particle precipitation to Global MHD modelers and other members of the GEM community. It was determined that our group should develop global models of electron and ion lifetimes as a function of geomagnetic activity.