WG2 summary:

(Monday PM): Working group 2's first session focused on the question of whether ***"CMEs are driving the solar wind at solar maximum, or along for the ride?"*** **Ian Richardson** (GSFC) noted that although ICMEs do dominate during short intervals of high activity, during most of the solar maximum, the ICME rate is typically only ~2-3 ICMEs/solar rotation. The remaining solar wind is "normal" solar wind that exhibits solar cycle variations in the IMF strength, He/p and geomagnetic (aa) activity that are therefore independent of ICMEs. **Matt Owens** (Boston University) examined whether the increase in the IMF strength approaching solar maximum might be associated with ICMEs that remain attached to the Sun for an extended period before being opened by interchange reconnection near the Sun. He concluded that to account for the solar cycle variation in the IMF, the rate of ICME field opening would need to be too fast to be consistent with Ulysses estimates of the opening rate. **Sue Lepri** (Michigan) came to similar conclusions. **Janet Luhmann** (SSL/UCB) discussed how sources of near-ecliptic solar wind change from polar coronal holes near solar minimum to low latitude coronal holes near solar maximum, with a mixture of sources at intermediate stages of the solar cycle. She noted that magnetogram-driven MHD models must have sufficient spatial resolution to resolve low-latitude sources if they are to do a good job of modeling the near-ecliptic solar wind at solar maximum. **Justin Kasper** (MIT) discussed solar cycle variations in the solar wind He/H ratio, which varies linearly with solar wind speed at solar maximum, but is nearly independent of speed at solar maximum. A 6-month variation in He/H was noted, correlated with the helio-latitude of Earth. Justin suggested that there are two sources of slow wind (near the neutral line and elsewhere), the magnetic field strength moderates the proton flux and He/H, and that the absence of solar wind slower than ~275 km/s is a consequence of the He concentration.

(Tuesday AM/PM): A Joint Session of working groups 2 and 2 was held on ***"Modeling and Observations of Interplanetary Shocks, (I)CMEs and SEPs"***. **Hilary Cane** (GSFC) reviewed how energetic particles can be used to understand the characteristics of ICMEs and the associated shocks, emphasizing multi-spacecraft observations. She noted that variations in particle events with longitude and radial distance should be taken onto account when attempting to model such events; successfully fitting a "typical" profile is insufficient. **Justin Kasper** (MIT) and **Adam Szabo** (GSFC) discussed the "art and science" of inferring shock parameters from in-situ data. Justin emphasized the value of analyzing data from individual spacecraft using various methods to obtain best estimates of the shock parameters. Adam used a complementary approach of combining and comparing shock observations from multiple spacecraft to infer the larger scale structure of shocks. Results are frequently inconsistent with a planar shock front and may suggest that shocks are curved or corrugated on spatial scales of the inter-spacecraft separation. **Chip Manchester** (Michigan) discussed an ICME model which suggested that the forward-reverse shock pairs and flux-rope-like structures observed by Ulysses may be artifacts of the solar wind being deflected around the ICME, and lie outside the ICME itself, rather than be signatures of over-expanding ICMEs. **Jozsef Kota** (Arizona) combined his solar energetic particle acceleration and transport model with the model discussed by Chip Manchester, and concluded that particle acceleration might occur in draped field lines in the sheathes of ICMEs, increasing the acceleration efficiency over that attainable by the ICME-driven shock. The session ended with a contributed presentation by **Ryuho Kataoka** (GSFC) on structures in the sheath downstream of ICME-driven shocks that included planar magnetic structures.

(**Tuesday PM**): A Joint Session of Working Groups 1 and 2 was held on ***"Origin and Evolution of the Solar Wind"***. The purpose of this session was to discuss: (1) how well do we understand the physical connection from the photosphere through the corona to the heliosphere?; (2) what is the topology of the open magnetic field of the Sun, and how does it evolve?; and (3) what are the sources for heating and acceleration of the solar wind? **Len Fisk** (Univ. of Mich.) discussed the diffusion of open magnetic flux of the Sun and its consequences. His theory uses three constraints of heliospheric observations to describe the diffusion of open magnetic flux of the Sun, namely: (1) open magnetic flux is well organized throughout the solar cycle and there is a single current sheet; (2) little evidence of disconnection of open magnetic flux of the Sun; and (3) composition of slow and fast solar wind is distinctly different. The theoretical argument is that there is no disconnection of open flux and there is no adding to it; there is simply a redistribution over the solar cycle. The open flux moves around the Sun, i.e., one deals with a transport problem. In his theory, five diffusion processes govern the transport of open flux: convective motions, differential rotation, reconnection at the base of coronal loops, reconnection at the canopy, and braiding and twisting of open field lines in the corona. The most important result of this theory is that for a diffusing magnetic field, the correlations between the random plasma velocities and the magnetic field fluctuations produce a large-scale electric field. This electric field leads to heating and acceleration of the solar wind. The future plan is to incorporate the theory into a numerical model and compare with observations. **Spiro Antiochos** (NRL) presented the solar perspective of the problem. His theory neglects the small-scale rapidly varying structure in the photospheric field, and the model assumes that no large-scale, long-lived current sheets are present in the closed field corona. In this case, the topology of coronal holes constrained by: (1) Uniqueness theorem: every photospheric polarity region can contain at most one coronal hole (showed a few examples demonstrate it); (2) Embeddedness theorem: every embedded polarity region (EPR) is surrounded by all open or all closed field - predicts narrow channels of open flux surrounding EPR; and (3) Nestedness theorem: coronal holes of nested polarity regions must themselves be nested. As a result, a quasi-steady model implies strong constraints on topology of Sun-Heliosphere connection, namely: there is one coronal hole per polarity inversion line (uniqueness); coronal hole corridors may explain open field in seemingly closed regions; embedded polarity bounded by all open or all closed field (embeddedness); and nested polarities imply nested coronal holes (nestedness). Future numerical tests coupled with observations will determine the validity of the model. **Nathan Schwadron** (Boston Univ.) presented observational evidence of departures from the Parker spiral in the heliosphere, particularly in rarefaction regions, and discussed the physical cause of this process. The key mechanism he proposed is footpoint motions at the Sun, which result in sub-Parker structure of the heliospheric magnetic field. The footpoint motions are driven by differential motion and through interchange reconnection between large coronal loops. The implications are that the magnetic field is stretched and less transverse in rarefaction regions of CIRs. He concluded that the heliospheric field structure and solar wind sources are intrinsically linked through footpoint motions at the Sun. Also, the sub-Parker spiral indicates field line connection between fast and slow wind via footpoint motions through coronal-hole boundaries. **Scott McIntosh** (SwRI) presented recent results from the TRACE Inter-Network Oscillation (INO) program, which is intended to study the interplay of the chromospheric magnetic environment and the ubiquitous 5-minute oscillations. Specifically, he searched for heliospheric impact of the chromosphere. The data analysis showed that different regions of the Sun have different travel-time (TT) signatures: AR TTs are "compressed"; QS TTs are "normal"; and CH TTs are "stretched". Regions where separation is small correspond to regions of slow, hot solar wind. The atmosphere is "compressed" in and around active regions. Regions where separation is large correspond to regions of fast, cool solar wind. It appears as though the atmosphere is "stretched thin" in coronal holes. He then studied the correlation of chromospheric structure with in-situ measurements of the solar wind. As a result, there appears to be a strong correlation between chromospheric structure and U_{SW}, T_p, T_{alpha}, and anti-correlation with O^{7+}/O^{6+} in the solar wind. The study also concluded that, as yet, it is unclear why the chromosphere should care about the magnetic topology above whether it is "open" or "closed" to the heliosphere. **General Discussion:** Are present numerical models of global solar corona and wind consistent with recent theories and various observations (both solar and heliospheric)? What needs to be done to improve these models? **or** Come up with better models that describe the transport of open magnetic flux of the Sun and associated heating and acceleration of the solar wind? (**Spiro)** Present MHD models are too diffusive (numerical) to describe the real Sun (highly conducting plasma in the corona). Is there a better approach? (**Pete**) Empirical models like the Wang-Sheeley-Arge model (based on PFSS model) well describe the solar wind properties at 1AU over the solar cycle. (**Len**) We need to come up with numerical models that incorporate the transport of open flux and satisfy both solar and heliospheric observations. The heating and acceleration of the solar wind is a natural consequence of the diffusion of open flux (resulting in a large-scale electric field). The empirical models (e.g., WSA model) that are widely used should be a natural consequence of such self-consistent models.

(**Thursday AM/PM**): A Joint Session of Working Groups 1, 2, and 3 was held on ***"End-to-End Modeling of CMEs and SEPs"***. The purpose of this session was to discuss: (1) what are the progress and challenges in modeling CMEs and SEPs from the Sun to the Earth?; (2) how solar particles are accelerated at CME-driven shocks and transported in interplanetary space?; and (3) what needs to be done to improve present models of CME initiation and evolution in the low corona? **Janet Luhmann** (SSL/UCB) presented an overview of CISM efforts toward modeling the coupled Sun-to-L1 system. She discussed the recent progress made by team members toward the development of a realistic model corona and resulting solar wind structure, a realistic CME initiation and propagation capability, a SEP injection and transport scheme that utilizes MHD model results, and a solar wind and SEP coupling to geospace. Also, she described the near-term CISM goals, which are: Archive Codes capable of providing regular MHD simulations of the quiet corona and solar wind, the Cone Model code for CME events (including an integrated SEP code module), as well as codes for coronal/solar wind/SEP event simulations for examples of realistic CME initiation. In addition, the CISM team will introduce a geospace coupler scheme for solar wind, shocks, and SEPs. **Chuck Goodrich** (Boston Univ.) presented an overview of CISM efforts toward development of a framework for coupled solar/heliospheric/magnetospheric models. He described two philosophies of framework design: the loosely coupled framework (e.g., CISM), and the tightly coupled framework (SWMF). The relative advantages and disadvantages of each approach were discussed. He also emphasized the importance of "minimal changes" when incorporating models into a loosely coupled framework. **Discussion in AM Session:** Can we test the two approaches to determine their relative strengths and weaknesses by performing an identical Sun-to-Earth coupled simulation? Many suggestions were put forward -- the May 1997 event was mentioned by several attendees as a reasonable demonstration because of its relative simplicity. An important cautionary note (**MacNeice**): The extent to which a framework succeeds or fails is ultimately related to the amount of effort that the individual modelers (those providing the components of the framework) are willing to contribute to the project. A great framework with sub-standard modules likely will give a worse result than a sub-standard framework with great modules, e.g., how do you test the framework separately from the modules? How best we can include the broader community in these demonstrations was also discussed. In the afternoon session, **Igor Sokolov** (Univ. of Mich.) presented results on coupling a realistic CME model with a model for SEP acceleration and transport (FLAMPA). The FLAMPA adopts Lagrangian coordinates, thus reducing the spatial dimensionality of the kinetic equation to be solved, but with the disadvantage that cross-field diffusion cannot be incorporated. Also, he presented a new statistical code based on the Monte-Carlo approach to study the particle transport. In this new code, a statistical weight function is introduced to better represent the high-energy particles. Cross-field diffusion can be included. He showed results for the 1998 May 2 event and how the two particle transport models compare. He was eager to provide time-series of shock wave parameters to the broader community to drive alternative particle transport codes. In future investigations, he and co-workers will develop an Alfvén turbulence model that will reduce the dimensionality of the transport equation for the waves in the same manner as is done for the kinetic equation. **Gang Li** (UCR) developed a model to explain the strong correlation between high particle intensity SEP events and the existence of preceding CMEs. The main assumption in his model is that the enhanced particle intensity is due to the presence of multiple shocks in the heliosphere. He argued that a preceding shock accelerates particles from, say 10 keV to 10 MeV, while the following shock can only accelerate particles of 10 MeV to 20 MeV or so, if the acceleration time scales are the same. Further, he pointed out that the particles escaping from the following shock would propagate in the turbulence-enhanced "downstream" region of the preceding shock wave (unless separation between two shocks is too large -- turbulence may drop to background level). His presentation concluded with a secret recipe, which is: (1) take some truth from observations; (2) add some beauty from a simple theory; and (3) perform a model calculation till exhausted. **David Ruffolo** (Mahidol Univ. - Bangkok) presented a study in which he employed the Finite-Time Shock Acceleration (FTSA) approach to explain the ion spectra in energetic storm particle (ESP) events (three events from the sample of Desai et al., 2004). The FTSA calculations demonstrated a power-law spectrum at low energy and faster than observed dropoff at high energy (possible cause: assumed constant mean free path of particles). For the three events, he was able to simultaneously fit measurements of C, O, and Fe ions. He also discussed key processes of interplanetary transport, like scattering, focusing, convection, and adiabatic deceleration. The goal was to quantitatively explain profiles of intensity and anisotropy versus time by: (1) specifying the magnetic configuration; (2) solving the pitch-angle transport equation; and (3) fitting the SEP data (both intensity and anisotropy vs. time). He then showed results for fitting GLE events (Bastille Day event of 2000, Easter event of 2001, and three other events), which were in very good agreement with the observations. **Peter Mac Neice** (NASA/GSFC) summarized recent additions to solar and heliospheric model support at the CCMC. He outlined the CCMC vision of it role in supporting community efforts to develop the ultimate modeling framework. The CCMC goal is to help the community frameworks (SWMF and CISM) to succeed. The Center will support end-to-end modeling by: (1) offering model developers lower buy-in overhead into frameworks; (2) exercising the main frameworks and providing feedback; and (3) offering coupled model runs to support data analyses. **Discussion in PM Session:** We all agreed to have a numerical demonstration of frameworks in the next SHINE meeting (in 2006). The goal is demonstrate how well the two community frameworks (SWMF and CISM) can serve the scientific purposes of end-to-end modeling. We selected a simple event to model, namely the1997 May 12 SHINE Campaign Event. We agreed on common setup (BCs, ICs) at one end (Sun), and we will compare the results at the other end (Earth) and in between.