| This substorm onset matrix shows relevance of various observations/modelings to various substorm- onset physical models. Comments and suggestions are very welcome. | merit | near-earth reconnection | flow braking | current disturption | ballooning/ interchange | convection reduction | Nishimura/ Lyons model | Alfven wave model | M-I coupling model |
|---|---|---|---|------------------------|---|-------------------------|--|----------------------|---|
| Below are from GEM Substorm FG presentations on June 28, 2011. | | | | | | | | | |
| session 1 (10:00-11:30) pre-onset signatures | | | | | | | | | |
| Larry Lyons: enhanced flow burst across polar cap boundary prior to PBIs observed by RISR-N, RANK polarDARN radar, and THEMIS ASI. | | | | | | | tail reconnection is triggered by the enhanced localized flow across the polar-cap boundary | | |
| Ping Zhu: ky=0 mode (axial mode, no structure in y- direction) can cause initial loss of equilibrium on closed field line at onset in the near-Earth tail in resistive 2D (X-2) MHD/OpenGGCM simulation, leading to subsequent tearing/reconnection. | | | | | speeding up the balooning instability? | | | | |
| Larry Lyons for Toshi Nishimura: Pre-onset arc is located as a localized upward current in the region 2 downward current system for two cases. | | | | | | | | | |
| Kazuo Shiokawa (Ryuho Kataoka): Pre-onset arc shows fine structures about 3-4 km (3-min before breakup) to more than 10 km scale (1-min before breakup) | | | | | | | | | possible role of the ionosphere for modulating the triggering process of the onset via the self-organization of the IAW turbulence associated with Kewin-Helmholtz and pressure-driven instabilities of the thin current sheet of auroral arc. |
| session 2 (11:30-12:00) relative timing | | | | | | | | | |
| Michael Shay: Super-Alfvenic flux transport by kinetic Alfven waves near the separatrix in the Hall MHD simulation. Vpara=1500-5500km/s in the magnetospheree, Poynting flux is 1-10 ergs/rm2/s at ionosphere enough to create visible aurora with a scale size of 6-70km in latitude and ~700km in longitudes. Confirmed by Cluster statistical study of Poynting flux distribution in V-B plane. | This process creates Alfvenic onset aurora | Alfvenix auora from reconnection | | | | | This reconnection Poynting flux may correspond to the pre- onset PBIs and/or expansion phase PBIs. | | |
| Joachim Birn: 3D MHD simulation of mid tail reconnection. Onset of reconnection -> several min -> onset of fast reconnection and entropy loss -> "2min -> > onset of SCW and penetration of low entropy to near tail, braking and diversion of flow. | | based on the NENL and flow braking senario | based on the NENL and flow braking senario | | | | | | |
| session 2 (13:30-15:30) relative timing | | | | | | | | | |
| Jim LaBelle: The MF radio wave burst (1-4 MHz) at the onset of substorm are associated with poleward-most expanding aurora. The burst starts from a middle frequency, showing C-shape in dynamic spectra. This can be explained by the wave generation by electron beam and density profile at the topside ionosphere. | observation suggests Alfvenic low-energy precipitation at the poleward edge arc. | | | | | | | | |

| Larry Lyons: Dipolarization fronts and associated flow bursts are associated with auroral streamers for 5 events in total 6 events. Azimuthal separation of spacecraft may create apparent time difference of timing. | | | | | |
|---|--|--|--|--|--|
| Russell Cosgrove: global correlation analysis among data of 24 magnetometers. The first disturbance has a broadband correlation signature, but later the pulsations coalesce to a few discrete frequencies. Correlation steeply increases and ceases, while power slowly grows, suggesting transition from linear to non- linear global instability as a whole magnetosphere- ionosphere system. | | | | | |
| session 3: flux, energy, and plasma transport | | | | | |
| Xiaoyang Xing: Observation of THEMIS ion spectra indicates that ion injection at the dipolarization front causes enhancement of azimuthal pressure gradient a few min before the onset, and causes enhanced upward FAC and intensification of thin onset arc. Ion parallel pressure increase is lager than the perpendicular pressure. | | | | | |
| Joo Hwang: particle energization associated with dipolarization front (DF)/BBFs. Fermi-acceleration makes bi-directional electrons. Then the electron beam cause whistler mode waves that energize particles at and around the DF. PIC simulation of DF and Cluster observation lon energy inceases while electron energy decreases after DF/BBF. | | | | | |
| Jian Yang: visualising the substorm injection boundary and related bubbles using 3D simulation. Two step flux enhancement, 1) high PV5/3 plasma ahead of bubble, and then 2) inside the bubble. | | | | | |
| Yasong Ge: ion and electron features at the dipolarization front. One case ESA shows earthward flow, while ST do not. The other case, both ESA/SST shows earthward flow. Dipolarization front can energize and reflect plasma sheet ions in field-aligned direction and cause proton aurroa in the ionosphere, | | | | | |
| session 3: flux, energy, and plasma transport (16:00- 18:00) | | | | | |
| Michael Shay for Penny Wu: How are the reconnection properties changes by lobe density. Dipolarization front amplitude and reconnetion rate increase linearly with increasing Nps/Nlobe. The reconnection occurs faster for lower lobe density. | | | | | |

| Feifei Jiang: preexisting arc observed by THEMIS, FAST, and ground ASI. The preexisting arc just before onset is located at the boundary between the dusk Region 1 and 2 current region. Preexisting arc is located at the poleward part of the energetic ion precipitation. preexisting arc corresponds to the inverted-V region. | | | | | |
|--|--|--|--|--|--|
| James Weygant: Locating the Harang discontinuity from equivalent ionospheric current using magnetometer arrays. The onset arc is close to the Harang discontinuity. The onset arc is mostly at the boundary between region 1 and 2 current systems. | mgnetometer array and radars can show location of Harang discontinuity and region 1/2 current. | | | | |
| Stefan Kiehas: A series of plasmoids observed by ARTEMIS at X=-56 Re and -70 Re. Two-satellite measurements give propagating velocity of the plasmoid. The plasmoid velocity increases for later times. B and V are highly correlated. | | | | | |

excuse, other explanations, critisism, comments

What makes the localized antisunward flow bursts? It may be related to the patchy dayside reconnection and/or polar-cap highdensity plasma patches.

breakup arc is located in the inner plasma sheet

| field-line mapping (correspondence between THEMIS and ground proton aurora) is difficult |
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| pre-existing arc is located in the inner plasma sheet | |
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