Monitoring and investigation of geospace disturbances along the 120E/60W longitudes: 
International Meridian Circle Project

Shunrong Zhang¹, MIT Haystack Observatory
Chi Wang², National Space Science Center, CAS
John Foster¹, MIT Haystack Observatory
Weixing Wan³, Institute of Geology and Geophysics, CAS
Why 120E/60W Meridian Circle?

- Local time is 12 hr off
  - Noon ↔ Midnight
  - Darn ↔ Dusk
- East Asia and North America Sectors
  - Geomagnetic latitude – geographic latitude = +/- 10 degrees
Meridian Circle International Observation: A *Partial* Network (polar view)
Meridian Circle International Observation: A Partial Network

World ISRs and MP sites
Soundrestrom ISR
Millstone Hill ISR

$N_e$
$T_e$
$T_i$
$V_0$
Ion composition

$T_n \leftrightarrow T_{ex}$
EXB
U
MISA: Super-wide Coverage
Irkutsk Incoherent Scatter Radar (IISR)

- Horn Antenna 246x12 m
- 2 sub-horns
- f=154-162 MHz
- Frequency beam steering
- Polarization filter
- Pt <3MW
- Beam 0.5x10 deg

IISR used to measure electron densities, electron and ion temperatures, and plasma drift velocities.

Medvedev et al. (ISTP)
IISR Observation

Day-to-day variations of electron density, electron temperature, ion temperature, and drift velocities at 300 and 350 km (Irkutsk ISR data)

Dusk effect is seen in (1) electron density enhancement, (2) decrease (relative to other days at 12 UT) in electron temperature, and (3) increase in upward drift velocity.

Medvedev et al. (ISTP)
MU radar (Japan)
MU Radar plasma drifts during 2015 St Patrick’s Day
Qujing Incoherent Scatter Radar
Qujing ISR elevation scans
Sanya ISR, under construction

- **Scan zenith:** ±48°
- **Altitude Range:** 50-2000 km (possible 5000 km)
- **Observables:** $[O^+]$, $T_i$, $V_i$

Operational in 2018

Simulated super fountain: $O^+$ Upflow
<table>
<thead>
<tr>
<th>Frequency</th>
<th>Peak Power</th>
<th>Antenna Gain</th>
<th>Scan (azimuth)</th>
<th>Scan (zenith)</th>
<th>Max Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>440 MHz</td>
<td>2 MW</td>
<td>43 dB</td>
<td>0 ~ 360°</td>
<td>0 ~ 48°</td>
<td>2000 km</td>
</tr>
</tbody>
</table>

SYISR Phase Array

Totally 4096 units, 2 MW

128 sub-arrays

32 units

0.5 kW
SYISR Extension in Meridian Project Phase 2 (MP2)

- Double the phase array
  - 4096 → 8192 units
  - 2 MW → 4MW total power
- Setup additional 2 receive stations
MP2: Hainan Key Monitoring

子午工程二期之海南低纬重点监测

Stations:
- SanYa (SY)
- FuKe (FK)
- HaiKou (HK)

Instruments:
- ISR (ISR-T/R)
- HF radar (HF)
- VHF radar (VHF)
- Digisonde (DPS)
- GNSS-TEC (TEC)
- He Lidar array (HeL)
- Rocket
Key Instruments

Advanced Modular ISR

Multi-function LIDAR

SuperDAWN Radar

Solar Radio Heliograph
Australia ionospheric stations

Wang (Australia Space Weather Service)
# Australia's Space Weather Stations Located in IMCP Belt

Table 1. Australia’s space weather stations list and observations

<table>
<thead>
<tr>
<th>Station</th>
<th>Latitude (°)</th>
<th>Longitude (°)</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocos Islands</td>
<td>12.20 S</td>
<td>96.80 E</td>
<td>Ionosonde, magnetometer</td>
</tr>
<tr>
<td>Darwin</td>
<td>12.45 S</td>
<td>130.95 E</td>
<td>Ionosonde, magnetometer, ISM*</td>
</tr>
<tr>
<td>Weipa</td>
<td>12.63 S</td>
<td>141.88 E</td>
<td>ISM*</td>
</tr>
<tr>
<td>Townsville</td>
<td>19.63 S</td>
<td>146.85 E</td>
<td>Ionosonde, magnetometer</td>
</tr>
<tr>
<td>Learmonth</td>
<td>22.25 S</td>
<td>114.08 E</td>
<td>Ionosonde, magnetometer, solar, spectrograph</td>
</tr>
<tr>
<td>Culgoora</td>
<td>30.28 S</td>
<td>149.58 E</td>
<td>Magnetometer, solar, spectrograph</td>
</tr>
<tr>
<td>Perth</td>
<td>31.94 S</td>
<td>115.95 E</td>
<td>Ionosonde</td>
</tr>
<tr>
<td>Camden</td>
<td>34.05 S</td>
<td>150.67 E</td>
<td>Ionosonde, magnetometer</td>
</tr>
<tr>
<td>Canberra</td>
<td>35.32 S</td>
<td>149.00 E</td>
<td>Ionosonde, magnetometer</td>
</tr>
<tr>
<td>Launceston</td>
<td>41.44 S</td>
<td>147.15 E</td>
<td>Magnetometer</td>
</tr>
<tr>
<td>Hobart</td>
<td>42.92 S</td>
<td>147.32 E</td>
<td>Ionosonde, magnetometer, cosmic ray</td>
</tr>
<tr>
<td>Casey</td>
<td>66.30 S</td>
<td>110.50 E</td>
<td>Ionosonde, magnetometer, riometer</td>
</tr>
</tbody>
</table>

*ISM=ionospheric scintillation monitor
China-Brazil Joint Lab for Space Science
Canadian Magnetometers

AUTUMNX
(AUTUMN eXtension)

Labrador City NL

URL
http://autumn.athabascau.ca/
Data also sent to CDAWeb via THEMIS, SuperMAG

NRCan, MACCS, THEMIS
Neighbors (BGS)
Near Hydro-Québec

Conners (Athabasca U.)
MIT GPS TEC system
Meridian Circle Campaigns

• 2014
  – March 31 – April 4
  – September 24 – 29

• 2015
  – March 17-22, 2015 (St Patrick’s Day)

• 2016
  – March 13 — March 18, 2016

• 2017
  – Sept 13-24, 2017 (window)

• 2018 (June 2018)
DEADLINE: today in 10 hours

Session ID#: 26657
Session Description:
For the first time in 26 years, a total solar eclipse will occur in the North American on 21 August 2017. During the eclipse-induced sudden interruption in solar illumination, the upper atmosphere will undergo significant changes beyond what a normal sunset and sunrise process would generate. Although eclipse effects have been studied for many decades, recent major advances in modern observational techniques can provide timely new information on eclipse upper atmospheric system response. Global numerical models have become more capable of capturing important coupling processes on various scales. This session will review existing theories and knowledge of eclipse upper atmospheric effects, examine these against modern eclipse observations, in particular during 21 August 2017, and identify unresolved and challenging problems for future research. We welcome contributions addressing scientific questions of the ionospheric, thermospheric and mesospheric variations during a solar eclipse using ground-based and in situ measurements as well as numerical models.

Please note, the regular AGU abstract submission deadline comes before the 2017 eclipse. Submissions related to this event must be submitted by the 2 August deadline, however for this session, revision to the submitted abstracts will be possible until September 15, allowing the latest results to be incorporated into the submitted abstracts.

Primary Convener:
Shunrong Zhang, MIT Haystack Observatory, Westford, MA, United States

Conveners:
Larisa P Goncharenko, Massachusetts Institute of Technology, Cambridge, MA, United States and Libo Liu, IGG Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China