Space Weather Activities in Ukraine
Summer 2013 Report

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Microsat/Ionosat-Micro
General description

Focus: Ionosphere-thermosphere interaction (waves)
Microsat is a small technology demonstrator platform (gross mass < 200 kg) aimed to flight-test new housekeeping systems and platform elements.
Orbit: dawn-dusk circular sun-synchronous LEO
Altitude: ~ 500 km
Launch date: 2014-2015
Launch location: Alcantara Space Center (Brasil)
Launcher: Cyclone-4 (maiden flight)
Microsat/Ionosat-Micro

Objects of study

– Spatial and temporal structure of the inhomogeneities in the thermosphere and in the ionosphere and their global distribution
– Global structure and dynamics of DC currents, electric and magnetic fields
– Waves and turbulence at different spatial and temporal scales
– Synchronous experiments with ground-based instruments – both active and passive ones
## Microsat/Ionosat-Micro Payload

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Measured value</th>
<th>Specifications</th>
<th>Designer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave probes (3 units)</td>
<td>Current density: 0.1 Hz ÷ 40 kHz, noise 10^{-12} A/cm^2Hz^{1/2}</td>
<td>Power: &lt; 0.25 W</td>
<td>L’viv Centre of Space Research Institute (LC ISR), Ukraine</td>
</tr>
<tr>
<td></td>
<td>Magnetic field: 0.1 Hz ÷ 40 kHz, noise 10^{-14} T/Hz^{1/2}</td>
<td>Weight: 0.225 kg</td>
<td></td>
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<tr>
<td></td>
<td>Electric potential: 0.1 Hz ÷ 40 kHz, noise 10^{-6} V/Hz^{1/2}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric probe</td>
<td>Electric potential: DC ÷ 200 kHz</td>
<td>Power: &lt; 0.15 W</td>
<td>LC ISR, Ukraine</td>
</tr>
<tr>
<td></td>
<td>Noise 10^{-6} V/Hz^{1/2}</td>
<td>Weight: &lt; 0.2 kg</td>
<td></td>
</tr>
<tr>
<td>Radiofrequency analyzer</td>
<td>High frequency variations, electric component</td>
<td>Power: &lt; 5 W</td>
<td>Space Research Centre (CBK), Poland</td>
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<tr>
<td></td>
<td>Frequency range 0.1 ÷ 15 MHz</td>
<td>Weight: ≤ 4 kg</td>
<td></td>
</tr>
<tr>
<td>Sensor of neutral &amp; charged particles DN-DE</td>
<td>Neutral particles density: 10^5 ÷ 10^{12} cm^{-3}</td>
<td>Power: ≤ 2 W</td>
<td>Institute of Technical Mechanics (ITM), Ukraine</td>
</tr>
<tr>
<td></td>
<td>Charged particles density: 10^3 ÷ 10^{11} cm^{-3}</td>
<td>Weight: ≤ 3 kg</td>
<td></td>
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<tr>
<td></td>
<td>Electron temperature: 0.1 ÷ 1.5 keV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC flux-gate magnetometer</td>
<td>Magnetic field: DC ÷ 1 Hz</td>
<td>Power: &lt; 0.3 W</td>
<td>LC ISR, Ukraine</td>
</tr>
<tr>
<td></td>
<td>Resolution 0.01 nT</td>
<td>Weight: ≤ 0.3 kg</td>
<td></td>
</tr>
<tr>
<td>TEC meter</td>
<td>Frequency L1 = 1217 ÷ 1265 MHz, L2 = 1565 ÷ 1615 MHz, 20 channels</td>
<td>Power: 2.4 W</td>
<td>IZMIRAN, Russia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight: ≤ 1.34 kg</td>
<td></td>
</tr>
<tr>
<td>Data processing unit</td>
<td>Information rate: 100 Mb/s (input), 64 Mb/s (output)</td>
<td>Power: &lt; 4 W</td>
<td>LC ISR, Ukraine</td>
</tr>
<tr>
<td></td>
<td>Onboard memory: up to 28 GB</td>
<td>Weight: ≤ 1.5 kg</td>
<td></td>
</tr>
</tbody>
</table>
Microsat/Ionosat-Micro Spacecraft layout
International missions with Ukrainian instruments onboard

See [http://isr.liviv.ua](http://isr.liviv.ua) for full description of the instruments

<table>
<thead>
<tr>
<th>Year</th>
<th>Mission</th>
<th>Instruments</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Chibis-M/MWC</td>
<td>2 wave probes, search-coil magnetometer</td>
<td>Currently in orbit</td>
</tr>
<tr>
<td>2013</td>
<td>ISS/Obstanovka-1/PWC</td>
<td>Delivered to the ISS on Feb 11</td>
<td>Installed on Apr 19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 wave probes, vector flux-gate magnetometer</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>RELEC/LFA</td>
<td>2 wave probes, vector flux-gate magnetometer, search-coil magnetometer</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Resonance</td>
<td>2 wave probes, vector search-coil magnetometer</td>
<td></td>
</tr>
</tbody>
</table>
New onboard instruments

Tiny vector magnetometers for cubesats:

- **Flux-gate**
  1. 20×20×20 mm, 25 g, <200 mW, -50..+80°C
  2. range ±65 μT, noise <15 pT/Hz\(^{1/2}\) at 1 Hz
  3. non-orthogonality <30', excitation freq. 8 - 16 kHz

- **Search-coil**
  - 19×19×19 mm, 12 g, <600 mW
  - freq. range 40 - 10000 Hz, flat curve
  - transformation factor 20 mV/nT
  - noise, pT/Hz\(^{1/2}\): 10 (100 Hz), 0.5 (1 kHz), 0.12 (10 kHz)
Central Europe Regional Ionospheric Model (CERIM)

CERIM outputs $n_e$, $T_e$, $T_i$, and the vertical component of plasma drift velocity in the altitude range 200-750 km.

Next step: improvement of CERIM based upon the new ISR data processing algorithms.
Problem-oriented Processing and Database Creation for Ionosphere Exploration (POPDAT)

**Project goal:**
Cataloging of ionospheric waves extracted from archived data to improve their scientific value for modern researchers

**Ukrainian contribution:**
- Formulation of the project idea
- Contribution to waveform extraction from data (with focus on thermospheric gravity waves)

The service is operational and available at [http://popdat.cbk.waw.pl/](http://popdat.cbk.waw.pl/)

**Acknowledgement**
The research leading to these results has received funding from the European Union’s Seventh Framework Programme (FP7/2007-2013) under the grant agreement n° 263240 (POPDAT).
Project goal:
Development of the first European space weather warning and forecasting system

Ukrainian contribution:
Real-time geomagnetic forecast service
- The product is currently at the pre-operational deployment stage.
- Operational status will be achieved by the end of 2013.
- Temporary link: http://swaciwebdevelop.dlr.de/geomagnetic-indices/dst-index/
**Upcoming SWx meetings in Ukraine**

- 13th Ukrainian Conference on Space Research, 2-6 September 2013, National Space Centre, Yevpatoria, [http://space-conf.ikd.kiev.ua](http://space-conf.ikd.kiev.ua)
- 2nd UK-Ukraine meeting on solar physics and space science, 16-20 September 2013, Kyiv, [http://swat.group.shef.ac.uk/Conferences/Ukraine_UK_2013/](http://swat.group.shef.ac.uk/Conferences/Ukraine_UK_2013/)
Thank you! Questions?

Space Research Institute [http://www.ikd.kiev.ua/](http://www.ikd.kiev.ua/)
- L’viv Center [http://www.isr.lviv.ua/](http://www.isr.lviv.ua/)

Main Astronomical Observatory [http://mao.kiev.ua/](http://mao.kiev.ua/)

Taras Shevchenko National University of Kyiv [http://univ.kiev.ua/](http://univ.kiev.ua/)
- Chairs of Astronomy and Space Physics [http://space.univ.kiev.ua/](http://space.univ.kiev.ua/)

Radioastronomical Institute [http://ri.kharkov.ua/](http://ri.kharkov.ua/)

V.N. Karazin Kharkiv National University [http://univer.kharkov.ua/](http://univer.kharkov.ua/)
- Space Research Sector [http://src.univer.kharkov.ua/](http://src.univer.kharkov.ua/)
- School of Radiophysics [http://www-radiophys.univer.kharkov.ua/](http://www-radiophys.univer.kharkov.ua/)


Crimean Astrophysical Observatory [http://www.crao.crimea.ua/](http://www.crao.crimea.ua/)