Space-weather Data and its Application to Earthly Challenges

ASTRA utilizes data for fundamental scientific research, technology development, and generation of operational products.

Our sensors produce lots of data!

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CubeSat Missions
- NSF: DICE & LAICE
- AF: DIME, SIPS & TSS
- NASA: SORTIE & MiRaTa

Plug-N-Play Avionics
- CubeSat Instruments
  - Scanning UV Photometer
  - E-field Double Probe
  - RF Waves & Sounder
  - Wind Profiler
  - GPS-based Space Weather Monitor
  - Magnetometer & Langmuir Probe

Hosted Payloads

Celebrating our 11th Anniversary
• Simulated OPIR radiances for a range of cloud properties

• Developed and demonstrated prototype retrieval algorithms

• Classified Program – ASTRA has clearances

• Algorithms can be applied to NOAA GOES data as well as OPIR radiances
What is Space Weather?

- Space Weather is “variability in the space environment”
- Much of it is driven by Solar variability (but not all)
- 93 Million miles from Sun
- Solar effects propagate to earth, driving variability in magnetosphere, thermosphere and ionosphere
What is Space Weather?

- Space Weather is “variability in the space environment”
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- NOAA: 80% of Users care about the Earth’s Ionosphere
Who Cares about Ionosphere?

- HF Radio communication (Radio Hams)
- Positioning and Navigation (GPS)
- Surveillance Radars
- Timing (GPS)
Simulating the Ionosphere

ASTRA works closely with customers to transition research codes to operational status.
First Principles ‘Full-Physics’ Models
What is Data Assimilation?

Produce a coherent and objective ‘picture’ of the space environment by combining the physical model with the data.
What Are The Data Sets?

- Ionosondes
- Ground-based TEC
- In situ Ne
- UV
- HF oblique sounders
- Over-satellite TEC
- GPS Radio Occultation
- HF backscatter sounders
- Radio Beacon
- HF Vertical sounders
How Useful Are The Data Sets?

Do we have the right data types? Ground-based or space-based?
Do we have enough data? Do we have more than we need?
Do we have data in the right locations? Would more data be helpful?
Is the data quality adequate? Should we invest in new measurements or new systems?
Over the past 7 years the size, weight, and power of ASTRA’s GPS receivers have been reduced significantly.

GAMMA provides real-time TEC & scintillation monitoring from moving platforms. Sets a new standard in size, weight, and power for TEC & scintillation monitors.
ASTRA’s Real-time Operational GPS Array

ASTRA’s GPS receivers successfully operated unattended in remote Alaska locations since 2012.
“No one else in the World has done this...”
– recent quote from Technical Director of a multi-Billion dollar International Commercial Services company that provides marine data services

- Real-time data from moving platform (e.g. buoy)
- Data Products: TEC, scintillation, system health
- Programmable data cadence & latency (Nominal 5 minutes)
- Ground link via Iridium or cell towers.
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<th>Other: Plug-n-Play Avionics</th>
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<td>DICE (NSF)</td>
<td>2011 launch&lt;br&gt;&lt;i&gt;Flown – first successful observations of SED’s and FAC’s from a CubeSat&lt;/i&gt;&lt;br&gt;Fastest comm. rates achieved by scientific CubeSat</td>
<td>• Two Langmuir probes to measure in-situ ionospheric plasma densities.&lt;br&gt;• Science and attitude magnetometers&lt;br&gt;• Four electric field probes on 5-meter cable booms</td>
<td>SIPS Scanning Imaging Photometer Systems (UV Imager)</td>
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<td>Form: Two 1.5U CubeSats</td>
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<td>Form: 6U</td>
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<td>DIME (Air Force)</td>
<td>Currently being built for the Air Force.&lt;br&gt;DIMESat is a Constellation pathfinder mission for monitoring electric fields in Low-Earth Orbit implementing lessons-learned from on-orbit experience with DICE.</td>
<td>Other Instruments:&lt;br&gt;• Scanning UV Photometer (SIPS)&lt;br&gt;• RF Waves &amp; Sounder&lt;br&gt;• RF Waves &amp; Sounder&lt;br&gt;• Wind Profiler&lt;br&gt;• GPS-based Space Weather Monitor</td>
<td>Low cost and versatile sensor for UV remote sensing of the ionosphere&lt;br&gt;Capable of providing almost continuous monitoring of the night-side ionosphere. Resolves ionospheric structures at 1 vertical TEC unit (better than GPS TEC)&lt;br&gt;• UV Detector (photometer)&lt;br&gt;• Scanning mirror</td>
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<td>SORTIE (NASA)</td>
<td>Est. launch 2018&lt;br&gt;NASA LCAS. SORTIE will provide information on the distribution of wave-like structures in the plasma density of the ionospheric F-region.</td>
<td>• Miniaturized Ion Velocity Meter for measuring ion drifts&lt;br&gt;• micro-Planar Langmuir Probe for measuring small-scale plasma structures</td>
<td>Topside Sounder&lt;br&gt;Low power FMCW HF Sounding instrument to make topside measurements of the ionosphere from a CubeSat platform.</td>
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Space Mission Competencies

ASTRA Core Competencies for Satellite Missions

- Scientific Concept / Mission Development
- Mission Design
- Mission Management
- Mission Systems Engineering
- Instrument Development
- Algorithm Development
- Data Analysis and Interpretation
- Product Development

ASTRA staff have decades of combined space flight & space science heritage, and have developed, tested, and flown systems on more than 20 orbital and sub-orbital space missions.
Bathymetry & Small-object Detection

Small size, weight and power allows use on UAVs and small aircraft
SUMMARY

Cloud Remote Sensing

Ionospheric Assimilation

Small-Sats

GPS TEC & Scintillation

Bathymetric Lidar