Weather Stream
Empowering humanity and managing environmental risk with real-time global weather intelligence

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Weather Stream specializes in the delivery of weather data and insights for the disaster management, insurance and reinsurance, and risk & resilience industries.

Our proprietary satellite data features

• The highest spatial resolution passive microwave radiometer ever flown

• Low-latency, global coverage of precipitation, temperature, and humidity.

• When fully deployed, data at 15-minute revisit rates for any point on Earth.
The need for satellite data

Key regions for disaster response and preparedness have no or limited precipitation coverage. This includes:

- Tropical cyclone and hurricane development over oceans.
- Storms over much of South America, Africa, and Asia
- Drought monitoring over much of Africa, central Asia

Rain gauges and radar are not sufficient for global precipitation monitoring and disaster management
Global Satellite data coverage

- The current constellation of publicly-backed satellites provides the most complete low-latency global record of precipitation.
- Consists of 8-10 large, multi-sensor satellite platforms
- Looking at the underlying data reveals large parts of the world are under-sampled
- Data gaps in-filled by geostationary IR data – reliance on cloud top observations, lower reliability of precipitation observations
What is Passive Microwave?

The US Naval Research Laboratory research demonstrates passive microwave has the largest contribution to numerical weather prediction accuracy of any observation type.
GEMS: Proprietary passive microwave technology

Key characteristics:

- Miniaturized microwave radiometry instrumentation
- 15 km spatial resolution
- 1600 km swath width
- Temperature profiling from sea level to ~40 km
- Humidity profiling from 1 to 12 km

Constellation achieves improved spatial and temporal resolution over heritage government programs
GEMS Storm Tracker: 3-D Passive Microwave Imagery

GEMS is a multi-channel sensor – each channel is sensitive to a different altitude.

Passive microwave at these frequencies can be thought of as 3D radar, with slices through the atmosphere.
Proprietary passive microwave technology

- GEMS IOD-1 on orbit 2019 – 2021. Collected over 4000 20-45 minute acquisitions
- Acquisitions targeted major storms and typhoons.
- Unprecedented resolution of storm internal structure from a cubesat platform
GEMS Storm Tracker: 3-D Passive Microwave Imagery

Data acquired over storms can show the 3D structure of the storm through clouds.

Observing the warm core and the temperature profile within the core is crucial in understanding storm rapid intensification – important for forecasting storm intensity and track!

3-D imagery of Typhoon Hagibis. Different Channels represent different altitudes in the atmosphere.
Case study: Hurricane Michael, 2018

- Slow moving storm which made landfall near Mexico Beach, FL, on October 10th 2018.
- Resulted in an estimated $25.5 billion in damages
- Geostationary infrared data (GOES) shows the structure of cloud tops (animation)
- Passive microwave shows the detail of rain bands within the storm – although currently, observations are 2-4 hours apart (animation)
Case study: Hurricane Michael

- Passive microwave gives us a detailed, 3D view of the structure and the evolution of storms.
  - Development and temperature of the warm core could be monitored - key indicator of rapid intensification
  - Tracking of individual rain bands to assess the worst-hit areas for disaster response and resilience

The GEMS constellation will enable near-real time, low latency updates of storm internal structure estimated precipitation
Weather Anomaly detection

- Very low-latency approach to identifying anomalies
- Anomalies in L1 MW data can be used as an indicator for very heavy rainfall.
- Enables monitoring without requirement for more expensive processing
What’s next?

- GEMS 2 instrument
  - Improvements: lower power consumption, allowing continuous acquisition
  - Increased number of channels, giving higher vertical resolution
- Minimum 2 launches in 2022
- Development of machine learning-based retrievals for near-instantaneous precipitation estimations
- Targeting continuous, high-resolution monitoring of precipitation within 4 years

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current government satellite data</th>
<th>GEMS (1-2 years)</th>
<th>GEMS (2-4 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of satellites</td>
<td>10</td>
<td>10</td>
<td>~48</td>
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<tr>
<td>Latency</td>
<td>1.5 – 6 hrs</td>
<td>&lt; 1 hour</td>
<td>30 mins</td>
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<tr>
<td>Update time (global average)</td>
<td>4-6 hours</td>
<td>1 hour</td>
<td>15 min</td>
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<td>Resolution</td>
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<td>0.1°</td>
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<tr>
<td>Satellite weight</td>
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<td>5-10 kg</td>
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<tr>
<td>Total cost per satellite</td>
<td>&gt;$200 million</td>
<td>$2 million</td>
<td>&lt;$2 million</td>
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</tbody>
</table>
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