COMMERICALLY AVAILABLE WEATHER SOLUTIONS & ASSOCIATED CHALLENGES

PRESENTED BY: ANUJ AGRAWAL & MARK HOEKZEMA
## ABOUT EARTH NETWORKS

<table>
<thead>
<tr>
<th>Founded</th>
<th>1993</th>
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<tbody>
<tr>
<td>Headquarters</td>
<td>Germantown, Maryland, USA</td>
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<tr>
<td>Largest Global Environmental Observation Networks</td>
<td>12,000+ global weather stations</td>
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<td>Global Presence</td>
<td>Offices in EU and Asia</td>
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<tr>
<td>Creators of WeatherBug Applications</td>
<td>Sold Brand in November 2016</td>
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WHAT WE DO

We automate decisions to help global organizations mitigate financial, operational, and human risk by integrating environmental intelligence into their operations.

Powered by the world’s largest, most hyperlocal, proprietary data network
Industry estimates vary widely (PWC estimates a $127B market by 2020), however the vertical markets of Inspection (including Construction, Insurance, Utilities) and Agriculture are generally seen as the initial high growth markets.
COMMERCIAL APPLICATIONS & INVESTMENT TRENDS

Jobs for Drones
As more industries look at drone technology, the list of jobs drones can do—or could do—is growing. But what’s real?

**DEVELOPMENT STAGE**
- **Early**
  - Mail/small package delivery
- **Mid**
  - Construction/real estate
  - Images and monitoring
  - Emergency management
  - Filmmaking/other media
  - Infrastructure monitoring
  - Oil and gas exploration
  - Weather forecasting/meteorological research
  - Wildlife/environmental monitoring
- **Late**
  - Aerial photography
  - Border patrol
  - Precision agriculture
  - Public safety

Money Is Moving to Software
Drone investments are moving away from the hardware and operators and toward the software and services. Autonomous drones will push this trend even further.

<table>
<thead>
<tr>
<th>Year</th>
<th>Software</th>
<th>Services</th>
<th>Operators</th>
<th>Hardware</th>
</tr>
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<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>75</td>
<td>25</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2016</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>1Q 2017</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

**SOURCE**
- DRONE INDUSTRY REPORT, OPPENHEIMER & CO., FEBRUARY 2016
- DRONEII.COM
HOW WEATHER AFFECTS DRONE OPERATIONS

**Pre-Flight Planning**
- Forecasted Clear Days
- Optimal Time of Day

**In-Flight**
- Path Direction
- Flight Elevation
- Mission Duration
- Image Capture Overlap
- Geo-fencing
- Minimize Loss of Connectivity Impact

**Post-Flight Analysis**
- Weather & Damage Correlation
- Insurance Claim Verification
EARTH NETWORKS DATA & TOOLS FOR DRONE OPERATIONAL EFFICIENCY

Pre-Flight Planning

SEVERE WEATHER DETECTION
- Professionally managed and operated weather networks
- Automated Dangerous Thunderstorm Alerts for mission locations

WEATHER VISUALIZATION
- Track incoming storms
- Make go/no-go mission decisions

In-Flight

HOURLY FORECASTING
- 6-Day and 15-Day
- Point-Based (Lat/Long)
- Forecasted metrics include wind speed and direction up to 400 feet, temperature, visibility, etc.

MOBILE ALERTING
- Alerts based on location and threat
- Access to weather visualization on-the-go

Post-Flight Analysis
Does available data provide the necessary information for flight planning and operations?
UNIQUE WEATHER THREATS

Drones have unique weather dangers which make most available surface and aviation observations and forecasts less than optimal inputs for flight planning

• Much greater sensitivity to turbulence and shear than what NOAA aviation products address

• Operations in lower Planetary Boundary Layer (10 – 400 feet) where current forecast and observation data is not widely available

• Flights in unique geographic environments – urban and mountainous regions are poorly modeled and observation data is of poor resolution
WEATHER AND FORECAST CHALLENGES FOR DRONE OPERATORS
WIND, CLOUD LEVELS, VISIBILITY, LIGHTNING, RADAR, WIND SHEAR, TURBULENCE

Current Conditions

Surface
- Sparse Observations Points
- Irrelevant Observation Points
- Delayed/Old Observations

Boundary Layer/Flight Level
- Very Few Observations
- Delayed/Old Observations
- Low Resolution

Forecast Conditions

Surface
- Low Model Resolution
- Low Resolution Topography
- Urban Detail

Boundary Layer/Flight Level
- Insufficient Vertical Resolution
- Lack of Verification
- Temporal Resolution
WEATHER AND FORECAST CHALLENGES – SOLUTIONS?

Current Conditions

• On-site observations – real time access to weather data, radar, lightning

• Access to more relevant observation points

• In-flight measurements – confirming forecasts and flight safety

Forecast Conditions

• Custom, high-resolution models – high resolution output for boundary layer

• High-resolution data inputs to models – more data points

• Flight observations feed back into models to improve accuracy
THANK YOU

QUESTIONS AND COMMENTS?