Weather Needs for UAS Operations

Brian Haynes - President

July 2016
UAS Weather Needs – Sensurion Perspective

Sensurion Background:

- 10-year company history
- Core team 20+ years working together
- Extensive manned aircraft experience
- Extensive weather experience
- Worked with NASA and NCAR in many areas, for many years
- Extensive UAS Experience
UAS Weather Needs –
*Sensurion Perspective*

Sensurion Background:

• Extensive manned aircraft experience
  • Major Airlines, GA, Military
  • Pilots, Operations, Management
  • Technology – Avionics, Airframes, Weather, Security, Communications, etc.
• Entrepreneurial Businesses
  • Weather Dissemination, Forecasting
  • Weather Observation / Collection
  • Weather Uplink and Downlink, Displays, Communications

*We understand how hard it is to operate aircraft safely and reliably – and yet profitably – and what it takes to do that, and how the manned aviation industry achieved those goals.*

*The UAS industry still has a long way to go in all three of those areas, and can learn a lot from the manned aviation industry – if it will...*
UAS Weather Needs – Sensurion Perspective

Sensurion Background:

• Extensive weather experience
  • Airline weather requirements, systems, & solutions
  • GA weather & flight planning systems
    • R&D, deployment and long-term ops of national systems
    • Preflight & in-flight
    • Dissemination and Collection Systems
  • R&D
    • Weather Radar Systems
    • Weather uplink, downlink, and cockpit displays
    • Turbulence, icing, Winds, Deicing
    • Data Observations & Collection From Aircraft

We can take advantage of experience in “traditional” weather & aviation, but must also avoid “default thinking”
**Typical sUAS Aircraft**

**TYPICAL Fixed-Wing sUAS:**
- Conventional Fixed Wing Design
- Hand, rail, or gear takeoff
- Flight durations 60-120 mins
- Multiple Payload options
- Best BLOS candidate
- 0-60 kts, stall speeds 10 kts
- 20 kt max l/d
- Full autoflight avionics
- Variety of recovery systems

**TYPICAL Multirotor sUAS**
- Ease of launch and flight
- Flight duration <15-45 min
- Visual/EO sensors
- 0-20 kts speed
- Strong reliance on GPS
- Manual Control
- Limited Autoflight
- About 90% current vehicles

*Sensurion Magpie MP-1*

*Sensurion MP-4*
MAGPIE MP-1
• Fixed-wing aerial sensor platform
• Commercial utility UAV for numerous applications
• Certified by FAA
  – 1st Special Airworthiness Certificate through FAA Test Range
  – 333 waiver for commercial operations
  – Registered (N#)s
  – Numerous COAs – airspace approval
  – FAA approved manuals
  • Operations
  • Maintenance
  • Training
  • Safety Checklist

**MAGPIE**

**MP-1 Fixed-Wing Specifications**

- **Model #:** MP-1
- **Endurance:** 1.5 hours
- **Weight:** 10–15 lbs.
- **Payload:** Up to 5 lbs.
- **Powerplant:** Electric/LiPo
- **Wingspan:** 95.75 inches
- **Length:** 62.50 inches
- **Landing Options:** Skid, wheels, skis
- **Datalink:** Configurable to operating environment, location, regulations
- **GCS:** Autoflight programming, graphical flight data, payload status/data, datalink, data storage, networking and weatherproof
MAGPIE MP-4 / MP-4T

- Multirotor aerial sensor platform
- Commercial utility UAV for numerous applications
- Simple to fly and program
- Manual or flight planned route
- GPS/WAAS centimeter precision positioning
- Tethered up to 200’/65m
- Tethered unlimited flight time
- Can launch / recover from small area

**SENTINEL**

**MP-4/MP-4T Multi-Rotor Specifications**

- **Model #:** MP-4/MP-4T
- **Endurance:** 27 min/indefinite (MP-4T)
- **Weight:** 6.5 lbs.
- **Payload:** 3 lbs.
- **Powerplant:** Electric/LiPo or tethered power — ground-battery/power

- **Body Diameter:** 39 inches
- **Tether Height:** Up to 200 feet
- **Datalink:** Configurable to operating environment, location, regulations
- **GCS:** Autoflight programming, graphical flight data, payload status/data, datalink, data storage, networking and weatherproof
How is “Weather” Relevant to sUAS Operations?

• Regulatory Requirement for certain operations

• Planning
  • Can I successfully conduct the mission? Safely?
  • Can I stay within required altitude, geofencing, and other limits for entire mission?
  • Can I successfully recover aircraft at the end of the mission period?
  • What impact will weather have on my mission duration capability?

• Direct Operational Impacts
  • Managing challenging or near-limit conditions
  • Reacting to changing conditions

• Contributing Data Back Into the Weather System
  • Alert other operators of changing conditions
  • TAMDAR-type observation input to forecast models
Weather Impacts on Practical sUAS Operations

- Scale Factors of sUAS vs Part 23 Aircraft Make Them Much More Susceptible to Turbulence and Wind Shear:
  - Wing loading is much lower
  - Mass is much lower
  - Wing/Rotor Spans are Much Shorter
- Stall and cruise speeds much lower than Part 23 and Part 25 – winds have a dramatically increased impact
  - Cruise speeds top out about where Part 23 begins
- Many lower boundary wind speeds can exceed forward flight speeds – thus creating a no-return scenario
- Many sUAS have Precipitation Restrictions
Weather Impacts on Practical sUAS Operations

- Most UAS are not intended for flight into IMC
  - Icing, precip, loss of Vis/CAVU all potential issues
  - Ability to maintain VLOS is key to planning and executing many missions
- How do we characterize ground-to-air “visibility”
- Lower boundary layer atmospherics hard to measure, much less model
- Dramatic wind shifts/shear from surface to 500’ for small UAS
- Effects of weather on ground-based (versus aircraft-based) operator
Weather Impacts on Practical sUAS Operations

- Temperature susceptibility of Li-Ion battery packs
- Effects of turbulence & winds on mission duration
  - Deviation limits can significantly vary impacts on mission duration
- Increasing levels of sUAS autonomy will require reduced weather uncertainty
- Tethered UAS Systems Present Additional Considerations, Including Lightning and Static Buildup
- A briefing is required – but where do the pilots get one?
  - FSS is not yet equipped to handle UAS briefing request
  - Typical sUAS operator will have limited weather training – will need simple, intuitive tools in the field
So... What Weather Information Will Be Needed - Specifically?

- Currently available WX information, tailored for sUAS users
- New products that provide much higher spatial and temporal resolution in the boundary layer area, including:
  - Winds, Turbulence and “Gustiness Factors”
    - We need to look at “Gusts” differently than classical turbulence in low-altitude, sUAS Ops contexts
    - Indexing Gusts/Turbulence to a radically different scale of airframe/limits
  - Visibility – referenced to VLOS-type operations
  - Probability of exceeding specific limit factors:
    - Max Winds versus aircraft return speeds
    - Gusts, Turbulence, Shear – Controllability AND Battery Life
    - Temperature & Density Altitude
    - Visibility variations
    - Precipitation / Icing
    - Variations in altimeter setting during a mission
    - Lightning/Static Buildup
So... What Weather Information Will Be Needed - *Specifically*?

• Leverage the UAS platforms themselves as a key part of the solution
  • Real-time observations of boundary layer conditions
    • Nowcasting
    • Research & modeling
    • Calibrate model metrics for individual aircraft types
  • Interaction between turbulence, deviation limits/range, and vehicle performance
  • Terrain and vegetation database updates
400,000 + UAVs will need easy weather access…

A Good Starting Point: We are teaming with others to develop an ADDS-like site for UAVs
Three levels of UAS weather services...

1. Basic Drone-WX™ mobile

2. Enhanced (fee for service model) Drone-WX™ mobile

3. EPIREP-like Downlinked weather

- Graphical, intuitive displays
- Red/Yellow/Green suitability categories based on user-entered limits
- Provision of observation data back into the system reduces user service fees
UAVs as a Weather-Collection Platform – “Micro” AMDAR/TAMDAR/MDCRS

Sensurion MP-1 or MP-4
Data and Sensor systems

- Sensurion sensor packages can be included for most data collection missions on MP-1, MP-4, or other type
- With its variable energy payloads, Magpie can be configured for short or longer endurance mission profiles

Sensor Options
- Airborne, fixed-point, & mobile sensors
- Optical
  - High-Definition optical imaging
  - Infrared (IR) / Enhanced IR
- Chemical / Radiological / Toxicity
- Atmospheric
  - Temperature / Pressure / Humidity
  - Wind direction / speed
  - Turbulence / Ride Quality

Data Management
- Cloud-based data management
- Atmospheric plotting
- Winds aloft profiling
- Plume modeling
- Carbon output monitoring
- Traffic monitoring
- Emergency communication provision
Using UAVs for HazMat Plume modelling

- Atmospheric modeling provides detail of hazard motion
- Hazard plume track and concentration data helps with emergency planning and during the event
- Expanded sensor network benefits all (private & government) hazard alerting & response
- UAVs can also find release point
Thank you!

6300 34th Ave South
Minneapolis, MN 55450
1-877-222-1599

www.sensurion.com