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WITH
CERTAINTY

National & International Regulations for Airspace Integration – Weather Requirements

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8 May, 2017

Important Lesson Learned

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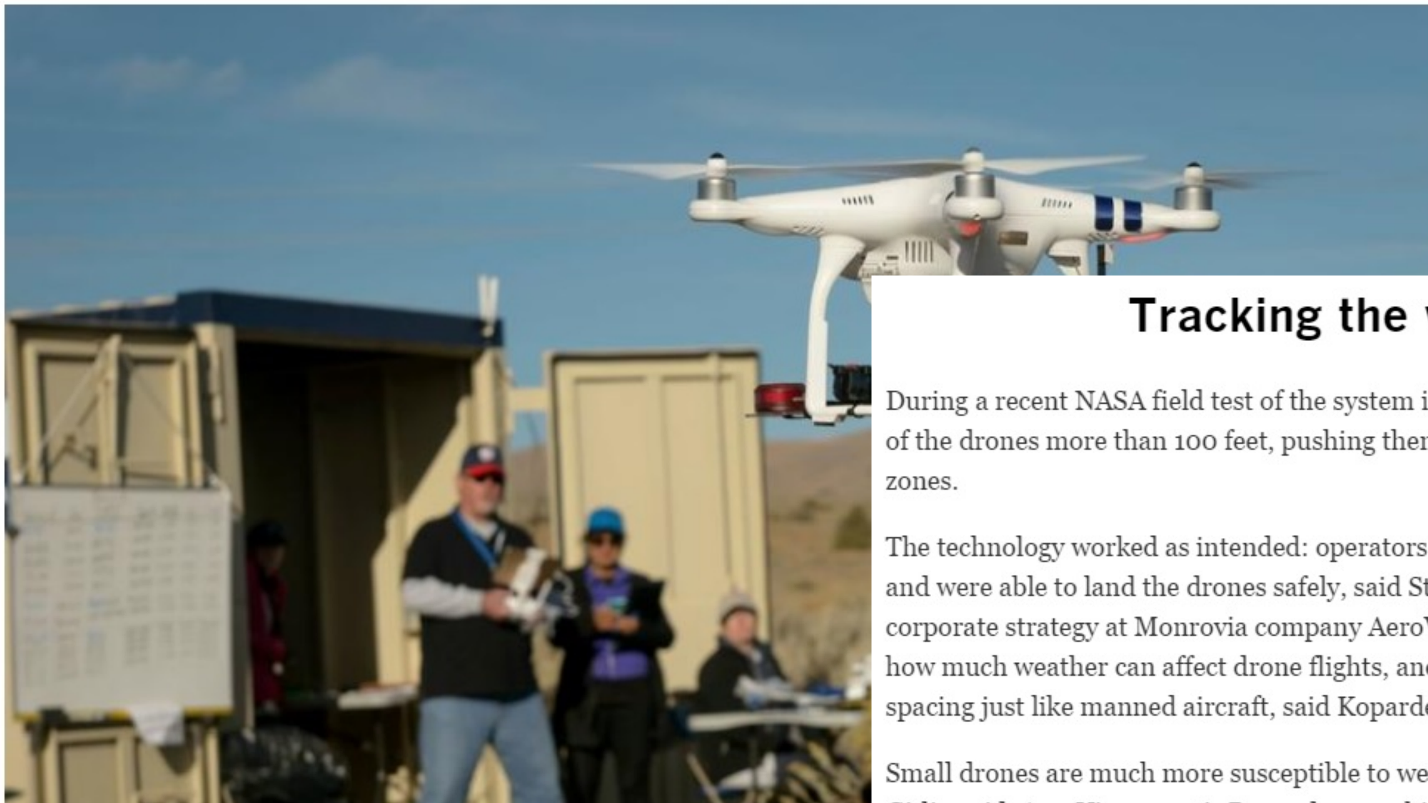
Wing Loadings and Inertias

- UAS generally have a very low wing loading
- Low Wing Loading = "***Sticks to the Air***"
- UAS have small rotational inertias
- Small Inertias = "**Susceptible to very small scale air currents**"

Aircraft	Wingspan (feet)	Weight (pounds)	Wing Loading (psf)
Boeing 747	211'	>735,000	150
Cessna 172	36'	2450	14.7
ScanEagle	10'	40	3.3
Puma	9'	15	~2
Helios	247'	2320	~1

Los Angeles Times
BUSINESS

Air traffic control for drones is coming. Here's how it could work



Drone Co-habitation Services operates a Phantom 3 commercial drone, one of 11 vehicles in the
Ames)

By Samantha Masunaga
Contact Reporter

MAY 5, 2017, 7:00 AM

Tracking the weather

During a recent NASA field test of the system in Reno, a gust of wind tossed some of the drones more than 100 feet, pushing them out of their designated operating zones.

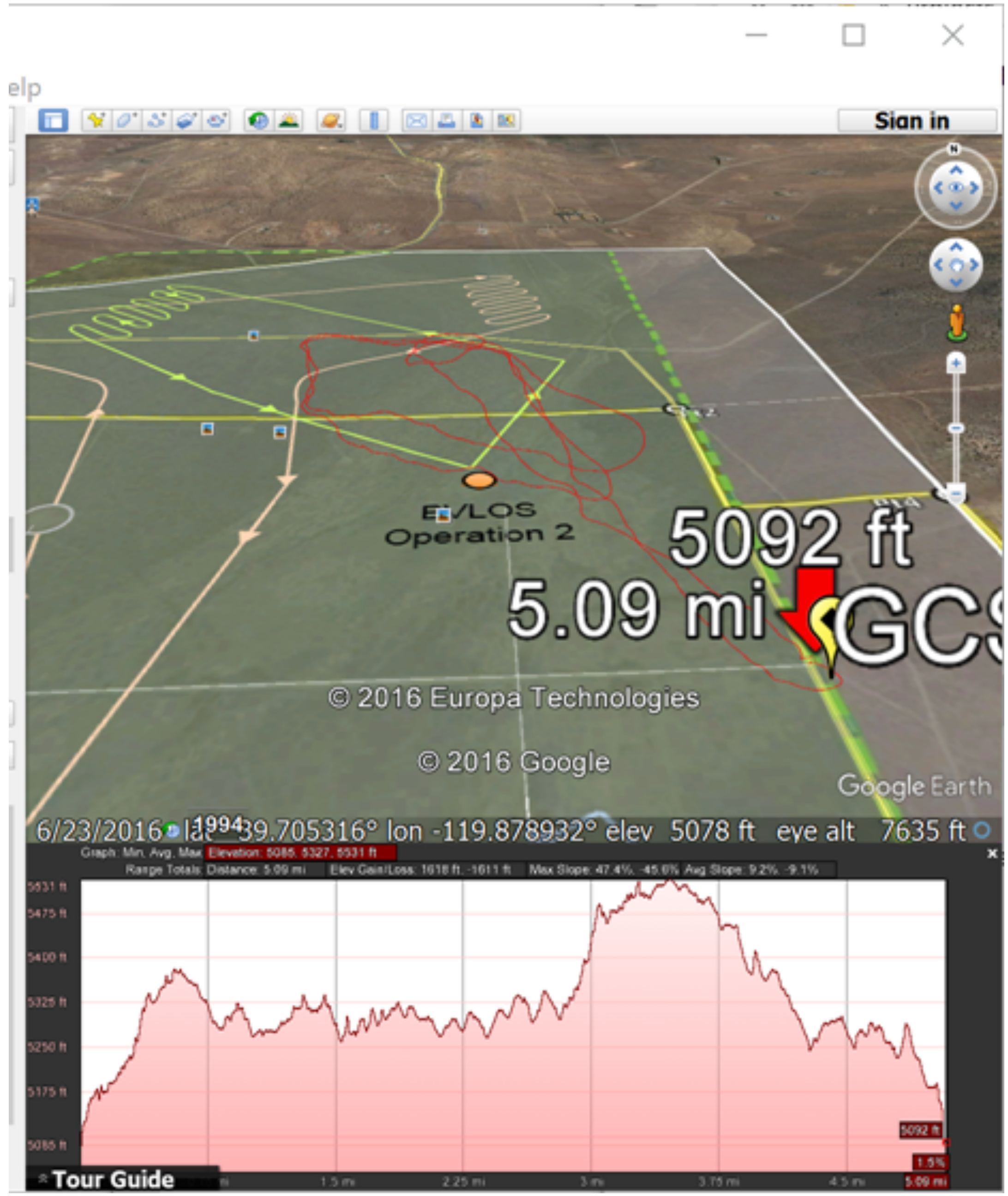
The technology worked as intended: operators received notice of the conditions and were able to land the drones safely, said Steve Gitlin, vice president of corporate strategy at Monrovia company AeroVironment Inc. The test showed how much weather can affect drone flights, and that the devices need proper spacing just like manned aircraft, said Kopardekar of NASA.

Small drones are much more susceptible to weather changes because they fly low, Gitlin said. AeroVironment's Puma drone, which looks like a miniaturized Cessna private plane, took part in the NASA test in Reno.

NASA partners with organizations such as the National Oceanic and Atmospheric Administration to pull in weather data for the project. But tools have not yet been developed to predict how weather will affect small drones flying around obstacles such as buildings or hills at such low altitude, Gitlin said.

Puma in TCL2

- Puma flight path during that NASA UTM TCL
- Hit some lift and took a ride up 200’
- UTM did the right thing and declared the Puma “rogue”,
- Small UAS are very reactive to what the air mass is doing!



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Part 107

- **§107.23 Hazardous operation.**
- **No person may:**
  - **(a) Operate a small unmanned aircraft system in a careless or reckless manner so as to endanger the life or property of another; or**
  - **…**

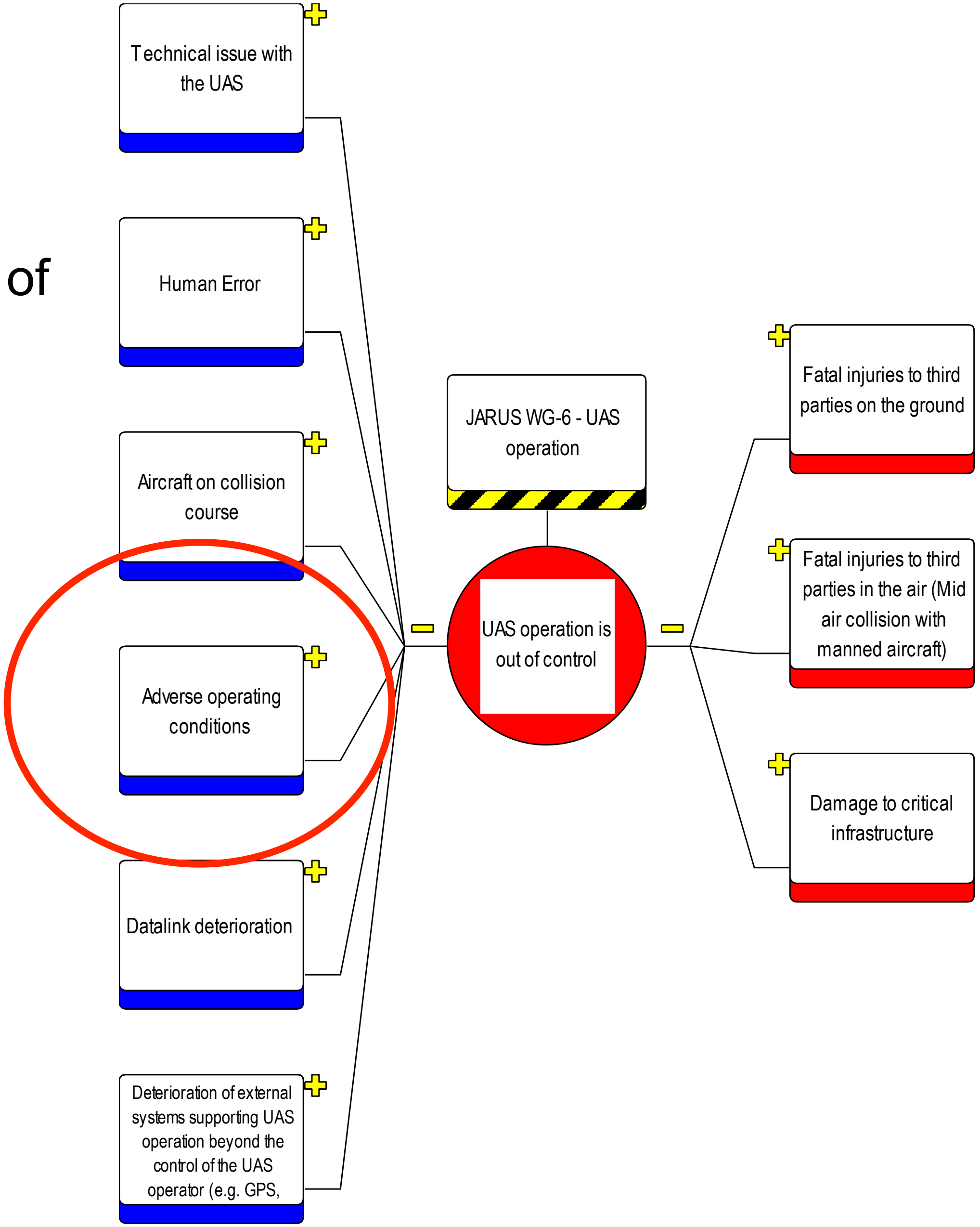
- AC 107-2

5.18 **Careless or Reckless Operation.** As with manned aircraft, remote PICs are prohibited from engaging in a careless or reckless operation. We also note that because sUAS have additional operating considerations that are not present in manned aircraft operations, there may be additional activity that would be careless or reckless if conducted using an sUAS. For example, failure to consider weather conditions near structures, trees, or rolling terrain when operating in a densely populated area could be determined as careless or reckless operation.

JARUS SORA

- Weather identified as one of the six primary "threats"

Adverse operating conditions
Operational procedures are defined, validated and adhered to
The remote crew is trained to identify critical environmental conditions and to avoid them
Environmental conditions for safe operations defined, measurable and adhered to
UAS designed and qualified for adverse environmental conditions (e.g. adequate sensors, DO-160 qualification)



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Part 107 Waiver Guidance

- **Weather impacts are a potential "Hazard" for sUAS**
- **Waiver to VLOS clearly requires the applicant to understand and plan for weather impacts**

§ 107.31 Visual line of sight aircraft operation.

(a) With vision that is unaided by any device other than corrective lenses, the remote pilot in command, the visual observer (if one is used), and the person manipulating the flight control of the small unmanned aircraft system must be able to see the unmanned aircraft throughout the entire flight in order to:

(1) Know the unmanned aircraft's location;

(2) Determine the unmanned aircraft's attitude, altitude, and direction of flight;

(3) Observe the airspace for other air traffic or hazards; and

(4) Determine that the unmanned aircraft does not endanger the life or property of another.

Part 107 Waiver Guidance

- **Weather impacts are a potential "Hazard" for sUAS**
- **Waiver to VLOS clearly requires the applicant to understand and plan for weather impacts**

Performance-Based Standards

1. Applicant must provide the method by which the remote pilot will be able to continuously know and determine the position, altitude, attitude, and movement of their sUA and ensure the aircraft remains in the area of intended operation.
2. Applicant must provide a method for the remote pilot to avoid other aircraft, people on the ground, and ground-based structures and obstacles at all times.
3. Applicant must provide a method to increase conspicuity of the sUA to be seen at a distance of 3 statute miles unless a system is in place that can avoid all non-participating aircraft.
4. Applicant must provide a means by which the remote pilot is alerted of a degraded sUAS function.
5. Applicant must provide a method to assure all required persons participating in the operation have relevant knowledge of all aspects of operating a sUA that is not in visual line of sight of the remote pilot.

AC 107-2

- **Great description of the need for detailed "nano" weather**
- **But, not really adequate sources for small UAS**

B.4.1 Wind. Wind speed and direction are important as they affect takeoff, landing, and cruise of flight operations. Geological features, trees, structures, and other anomalies can affect the wind direction and speed close to the ground. In particular, ground topography, trees, and buildings can break up the flow of the wind and create wind gusts that change rapidly in direction and speed. The remote PIC should be vigilant when operating UAS near large buildings or other man-made structures and natural obstructions, such as mountains, bluffs, or canyons. The intensity of the turbulence associated with ground obstructions depends on the size of the obstacle and the primary velocity of the wind. This same condition is even more noticeable when flying in mountainous regions. While the wind flows smoothly up the windward side of the mountain and the upward currents help to carry an aircraft over the peak of the mountain, the wind on the leeward side does not act in a similar manner. As the air flows down the leeward side of the mountain, the air follows the contour of the terrain and is increasingly turbulent. This tends to push an aircraft into the side of a mountain. The stronger the wind, the greater the downward pressure and turbulence become. Due to the effect terrain has on the wind in valleys or canyons, downdrafts can be severe.

AC 107-2

- **Great description of the need for detailed "nano" weather**
- **But, not really adequate sources for small UAS**

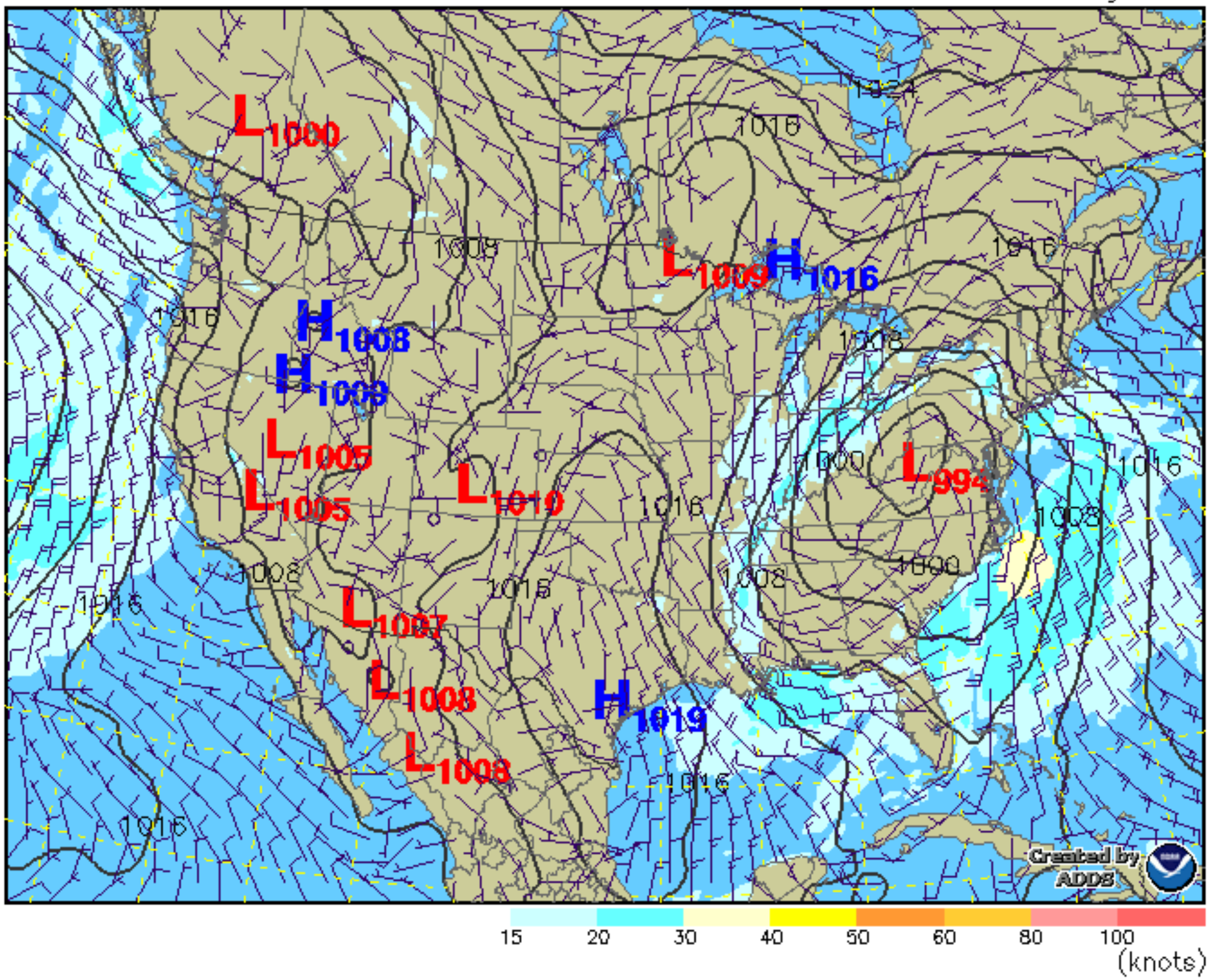
B.3 **Sources of Weather Information for Small UA Operations.** Remote PICs are encouraged to obtain weather information prior to flight from Flight Service by using the Web site www.1800wxbrief.com. Remote PICs can create a free account in order to use the briefing service. While Flight Service does offer a telephone-based service, it is intended for manned aircraft pilots only.

B.3.1 National Weather Service (NWS). Remote PICs are also encouraged to visit the NWS's Aviation Weather Center (AWC) at www.aviationweather.gov. This free, Web-based service does not require registration and offers all of the weather products important to a remote PIC, such as Aviation Routine Weather Reports (METAR) and Terminal Aerodrome Forecast (TAF). While reviewing the weather for your intended operation, it is also critical that the remote PIC review any temporary flight restrictions (TFR) at the FAA's TFR Web site, which can be found at http://tfr.faa.gov.

B.4 **Weather and the Effects on Performance.** Weather is an important factor that influences aircraft performance and flying safety. Atmospheric pressure and density, wind, and uneven surface heating are factors that affect sUAS performance and must be considered prior to flight.

Sea-level pressure (mb) / surface wind speed (kts)

01–hour forecast valid 1700 UTC Fri 05 May 2017



ADDS temp/wind charts supplement, but do not substitute for, the official winds and temperatures aloft forecast contained in the FB product.

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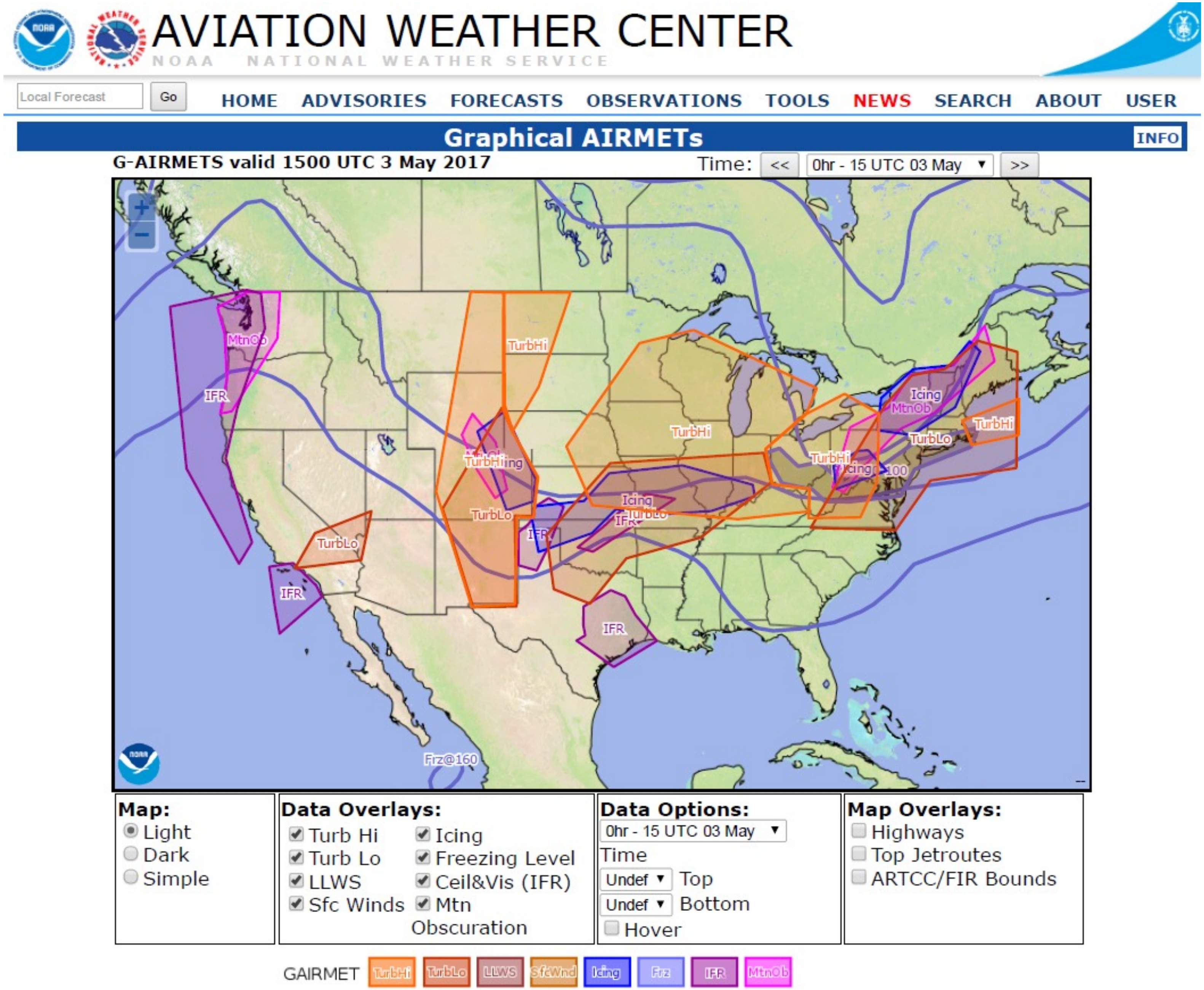

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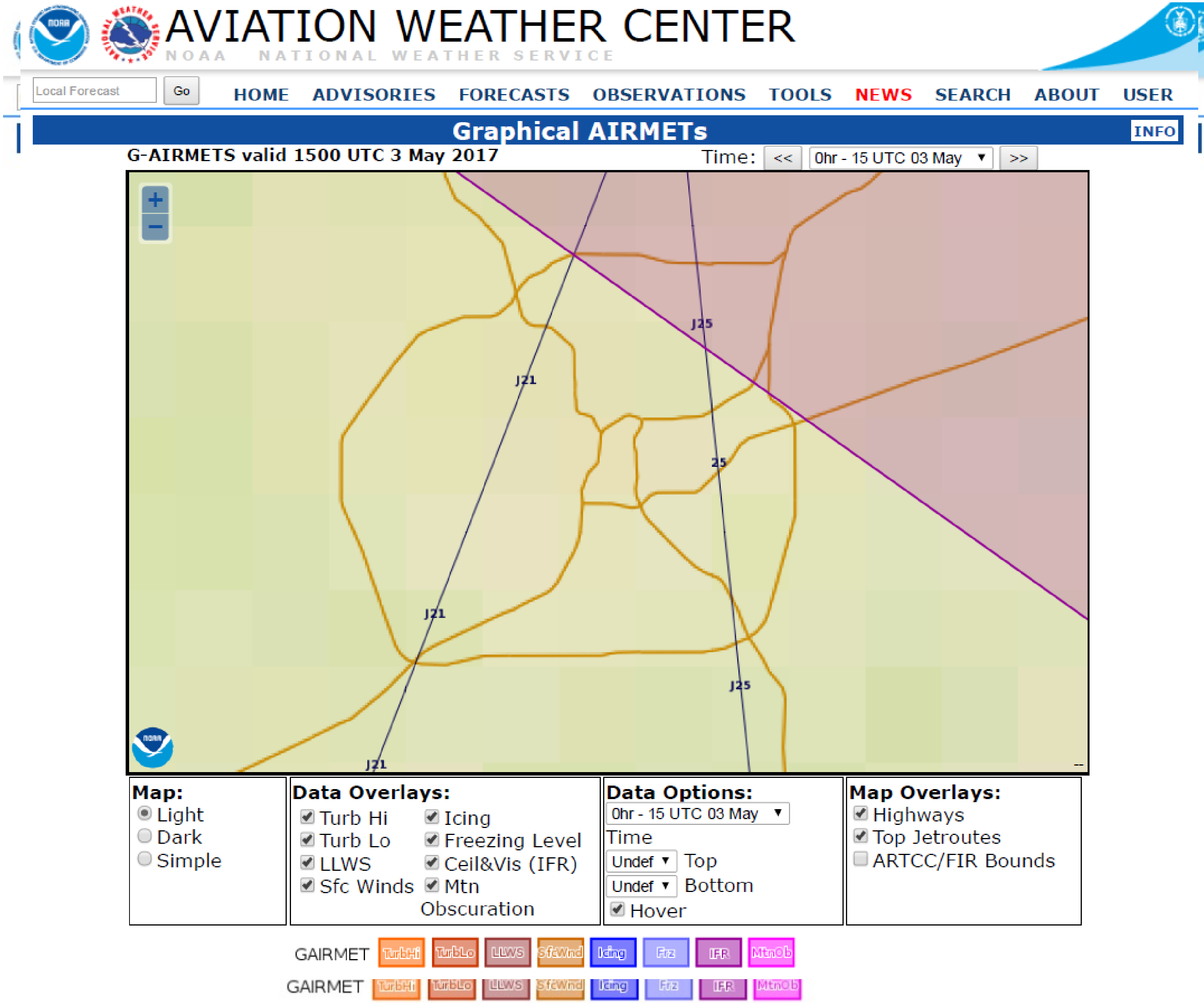
AVIATION WEATHER CENTER
NOAA NATIONAL WEATHER SERVICE
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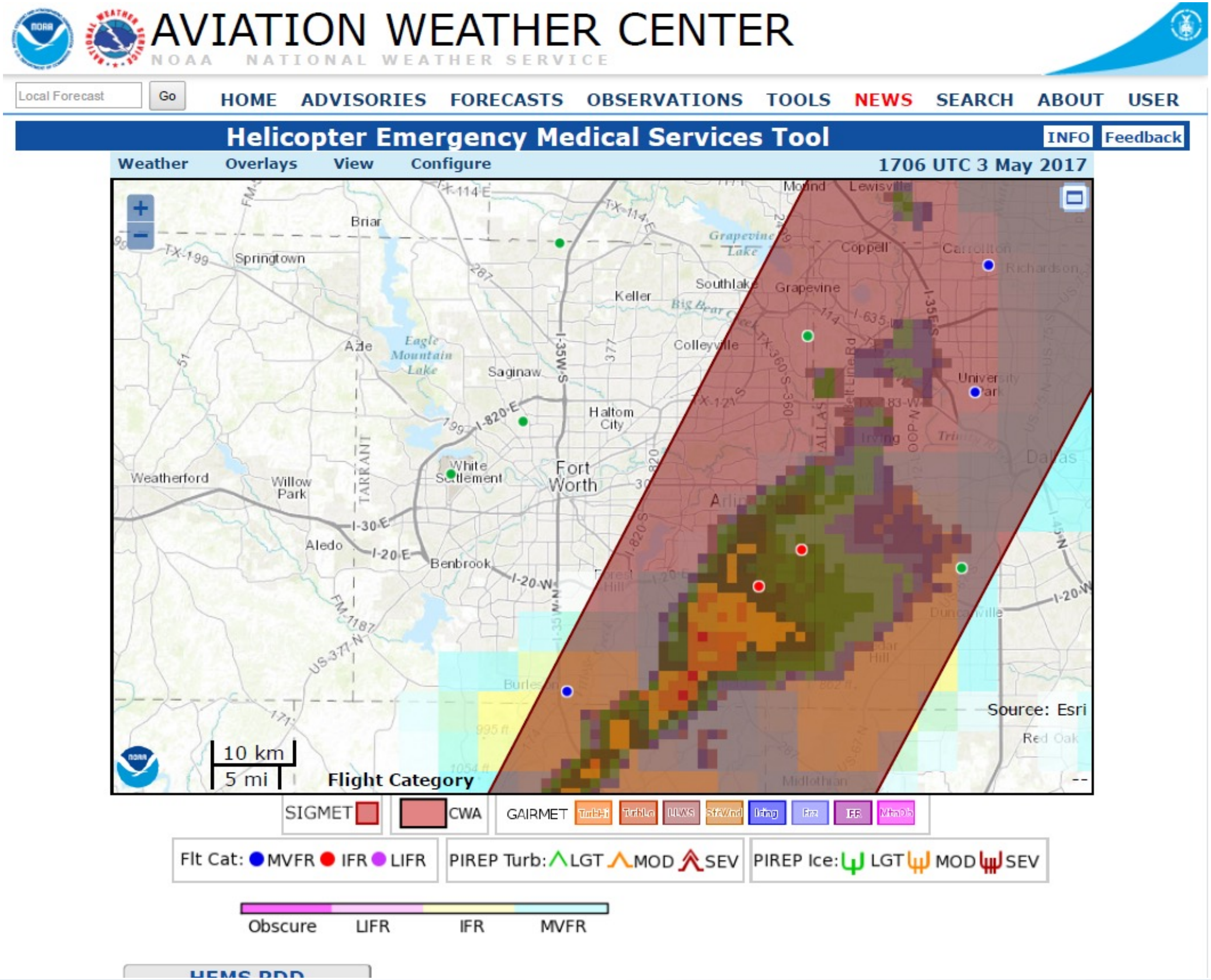

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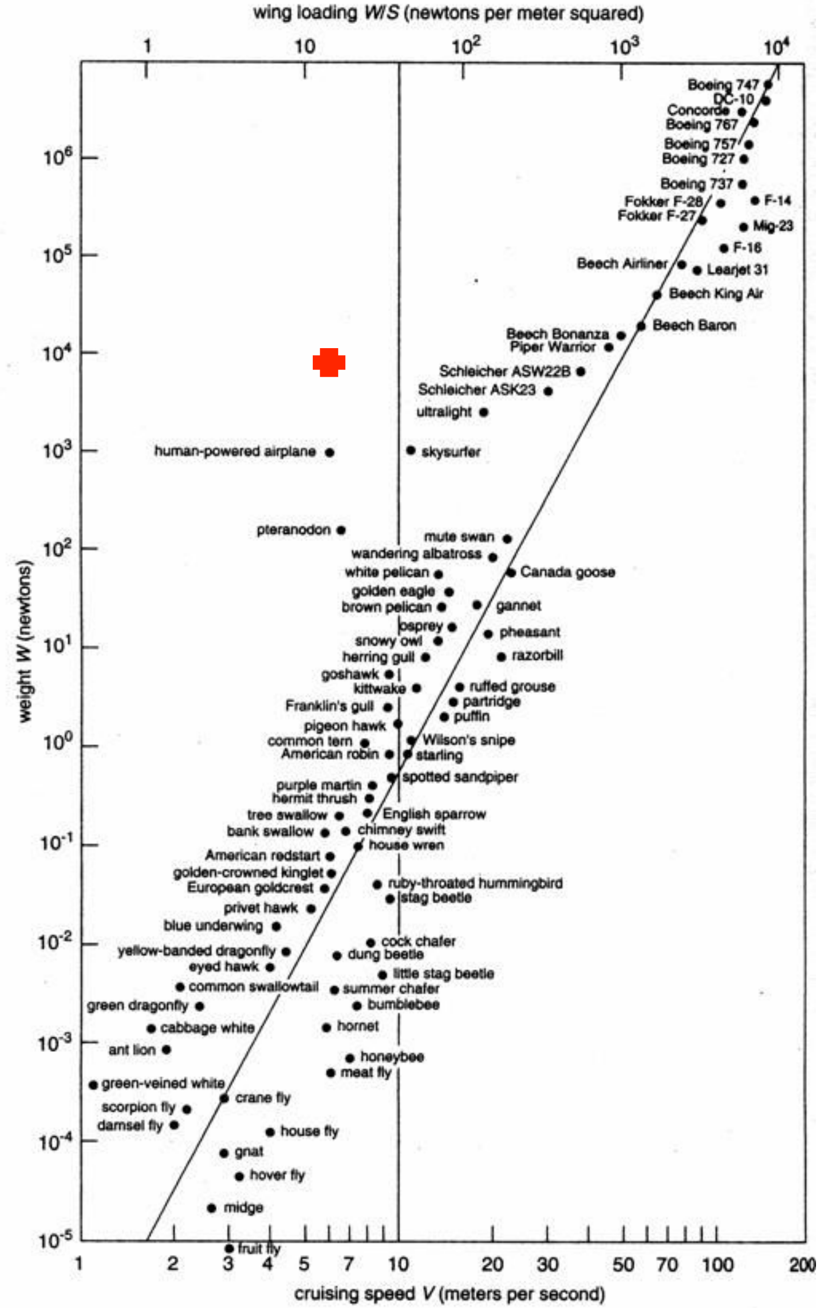
"Takeaways"

- UAS "stick to the air"
- So, we need to know more about how the air moves
- With much more granularity
- In both time and space



Questions?