

Small Drones for Science:
Preserving Space for Research and Innovation
in an Age of Airspace Commercialization

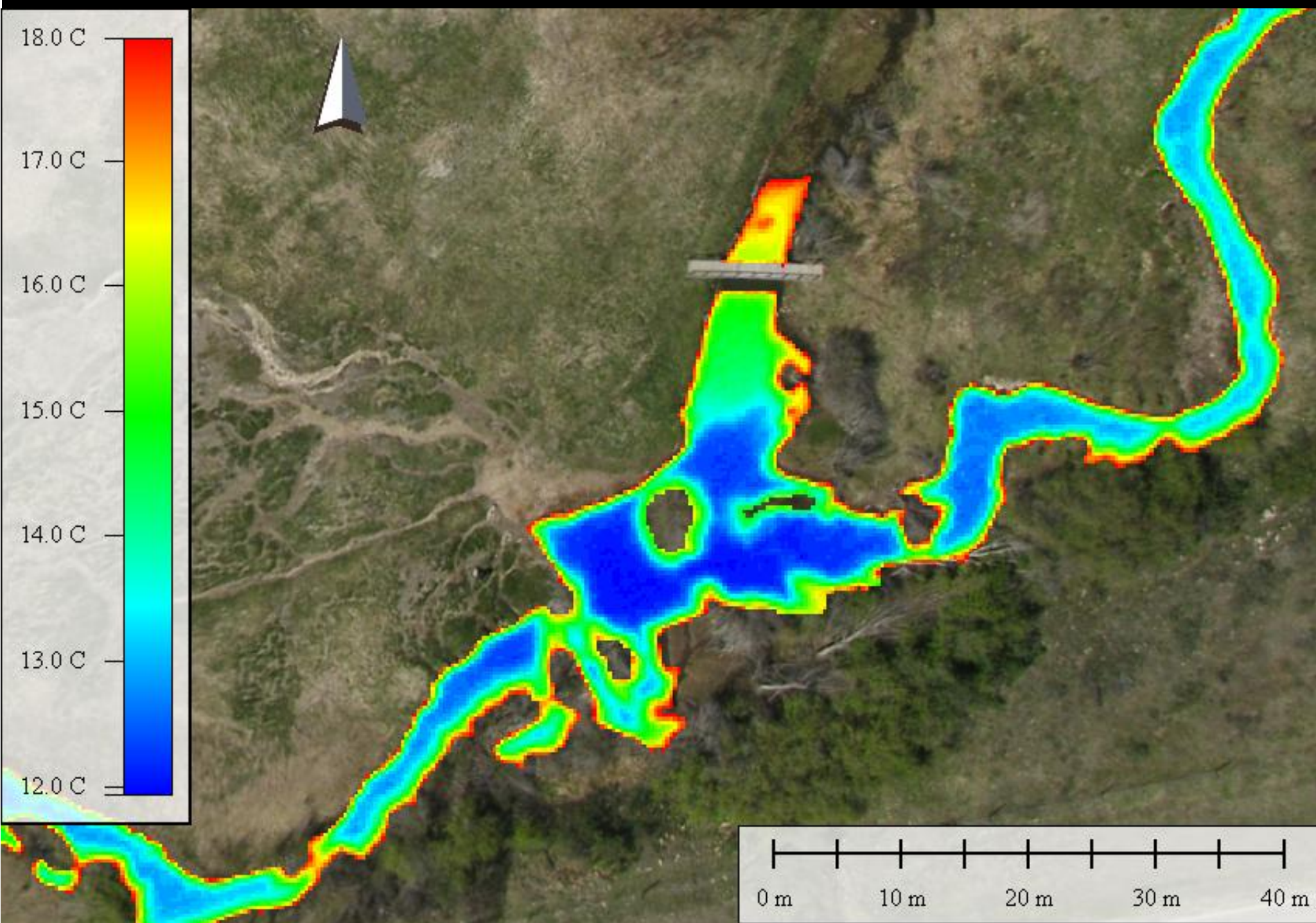
Paul B. Voss

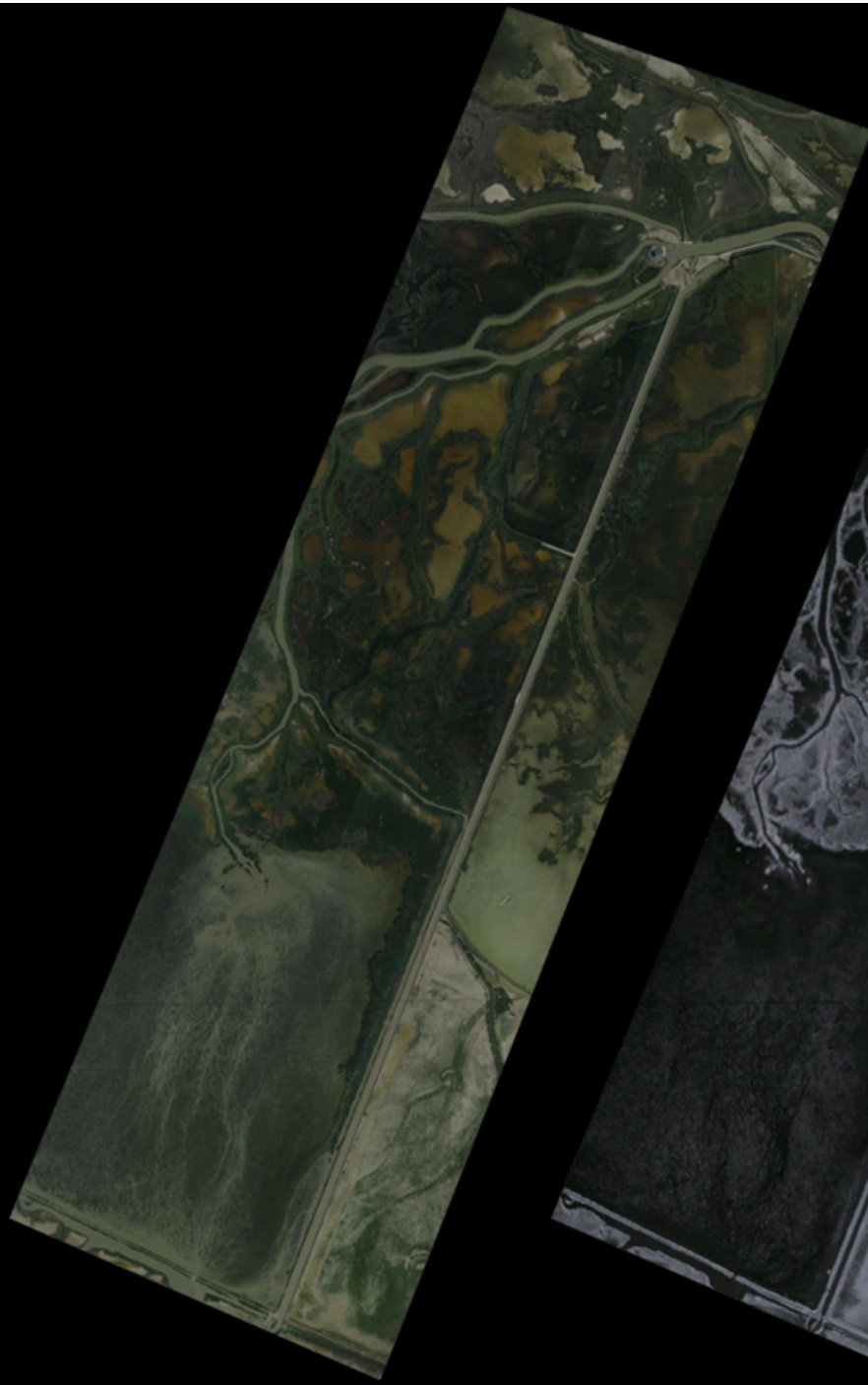
Picker Engineering Program
Smith College

Organization of Biological Field Stations Annual Meeting
September 23, 2014

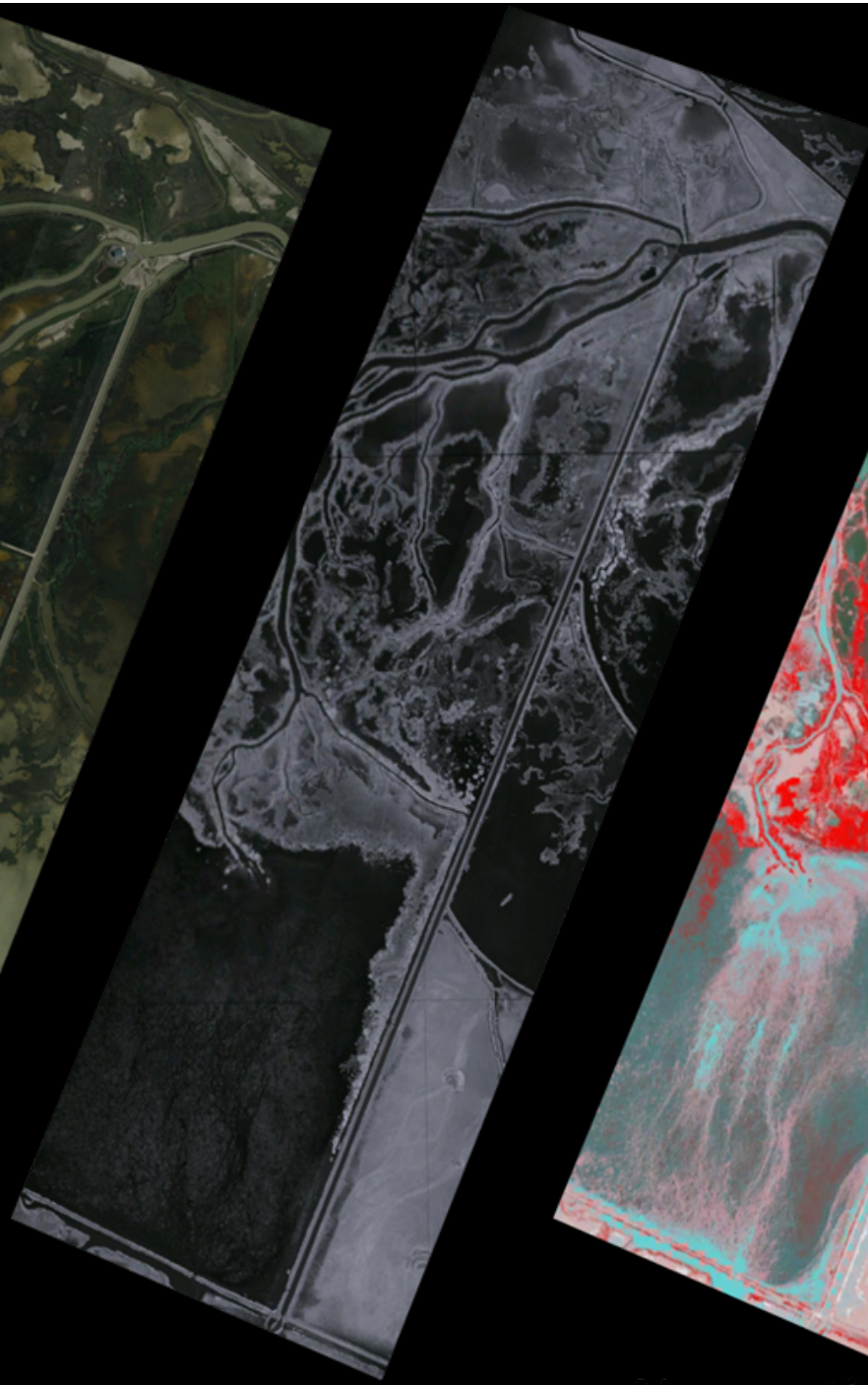


Walt and Bill Good and their R/C model—the Guff (circa 1939).

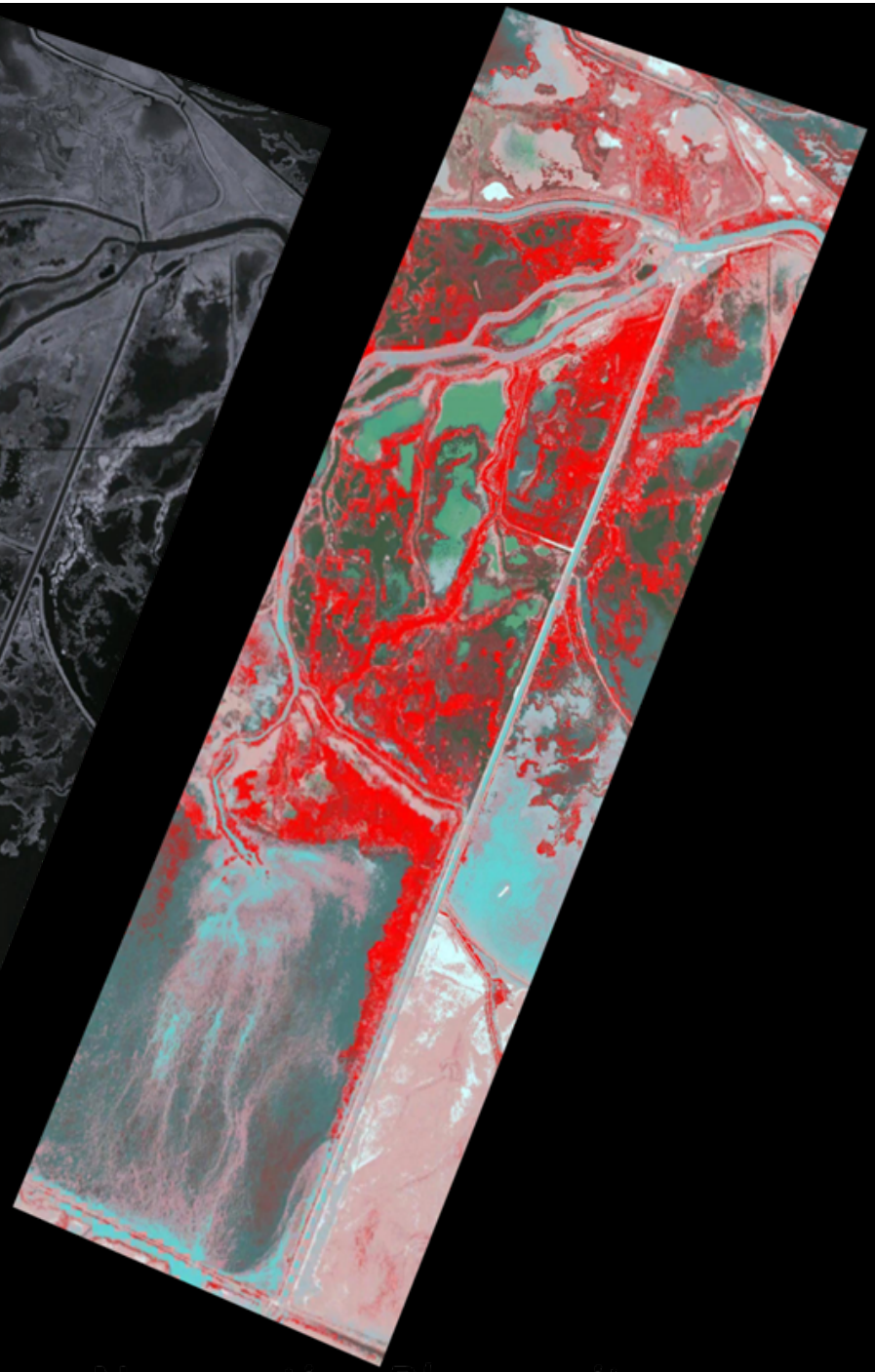




RGB
RGB



NIR
NIR



Non-native *Phragmites*
Phragmites australis (red) (red)



Jarrold Hodgson & Rohan Clarke
Monash University
www.researchecology.com.au

Seabird monitoring on remote islands in north-western Australia using a 3DRobotics multicopter flown 75 m above the surface without disturbing the birds.



Professional Aerial Mapping

Collects aerial photography of 1-10 sq km in a single flight at down to 5 cm precision.

The eBee has a flight time of up to 45 minutes allowing to cover areas of up to 10 sq km in a single flight. With its 16 MP camera it can shoot aerial imagery at down to 3 cm/pixel resolution. The images can then be used to create maps and elevation models with a precision of 5 cm.



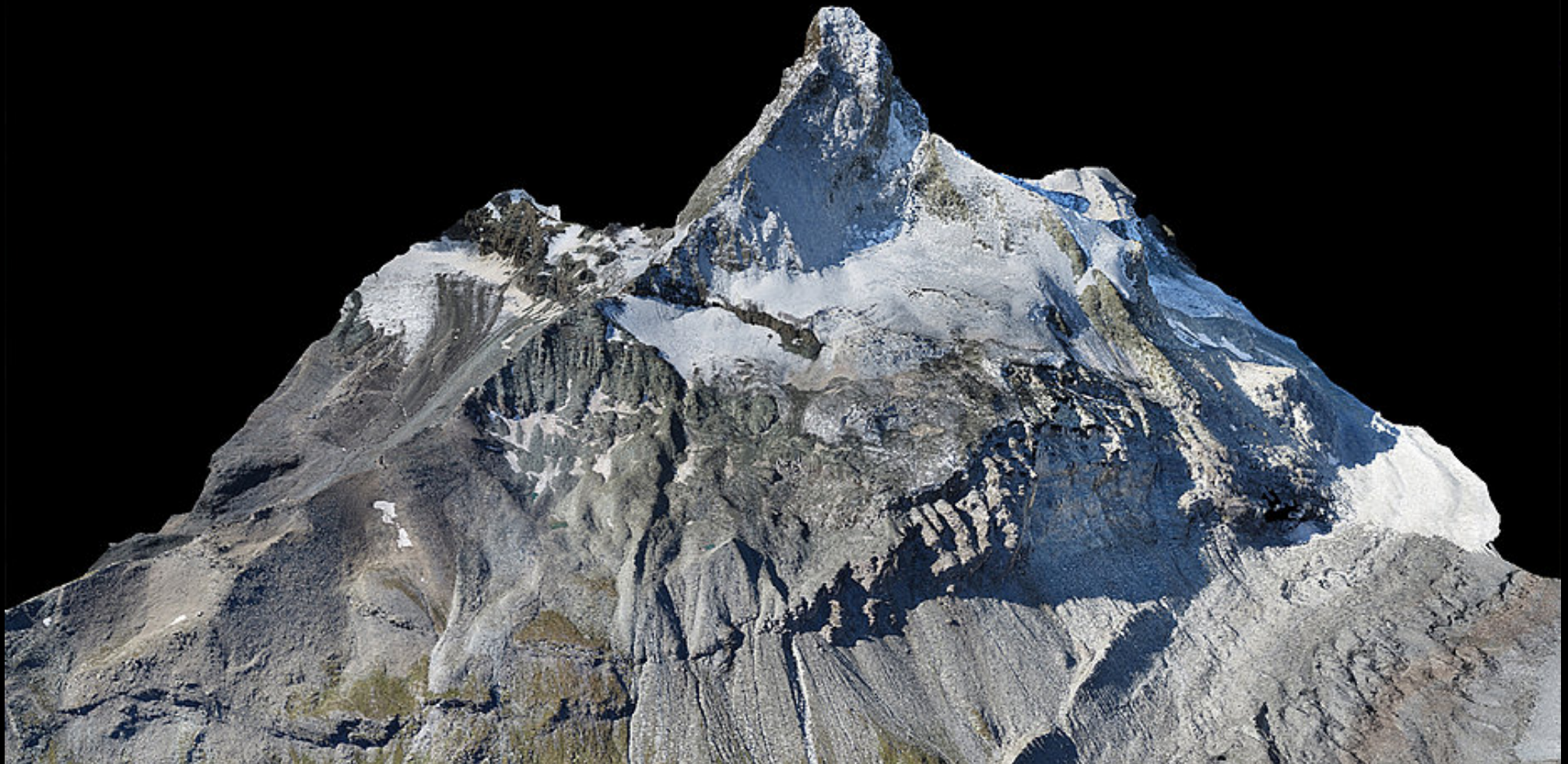
Size: 2800 hectares

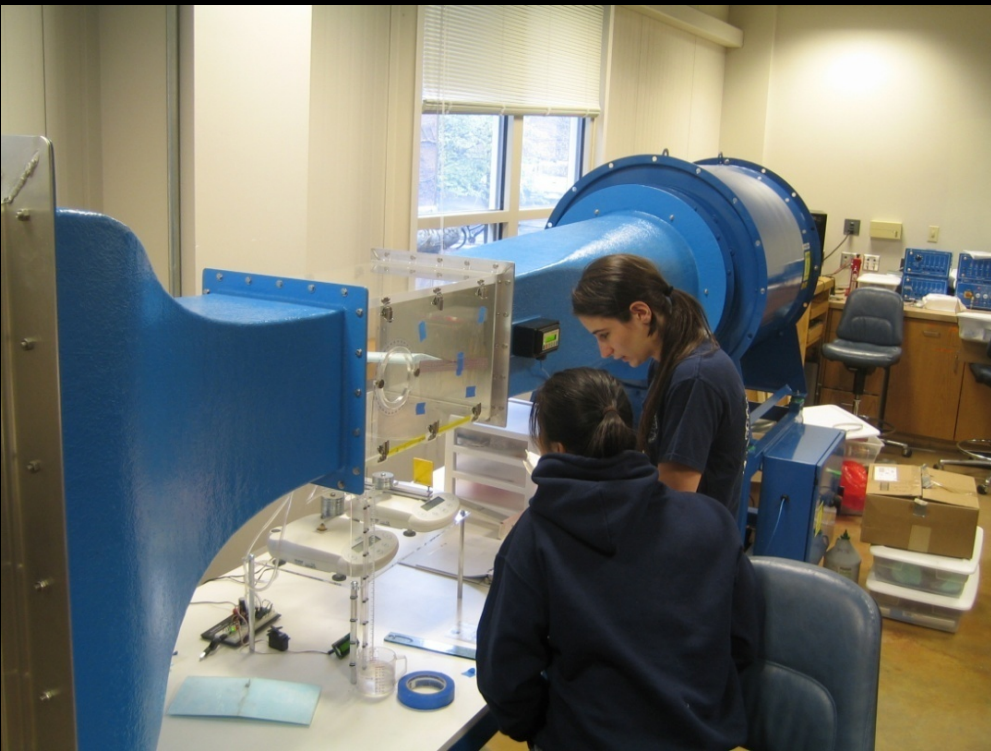
Number of flights: 11 flights

Number of pictures: 2188 pictures

Total distance flown: 263.6km

Precision: Average precision of 20cm

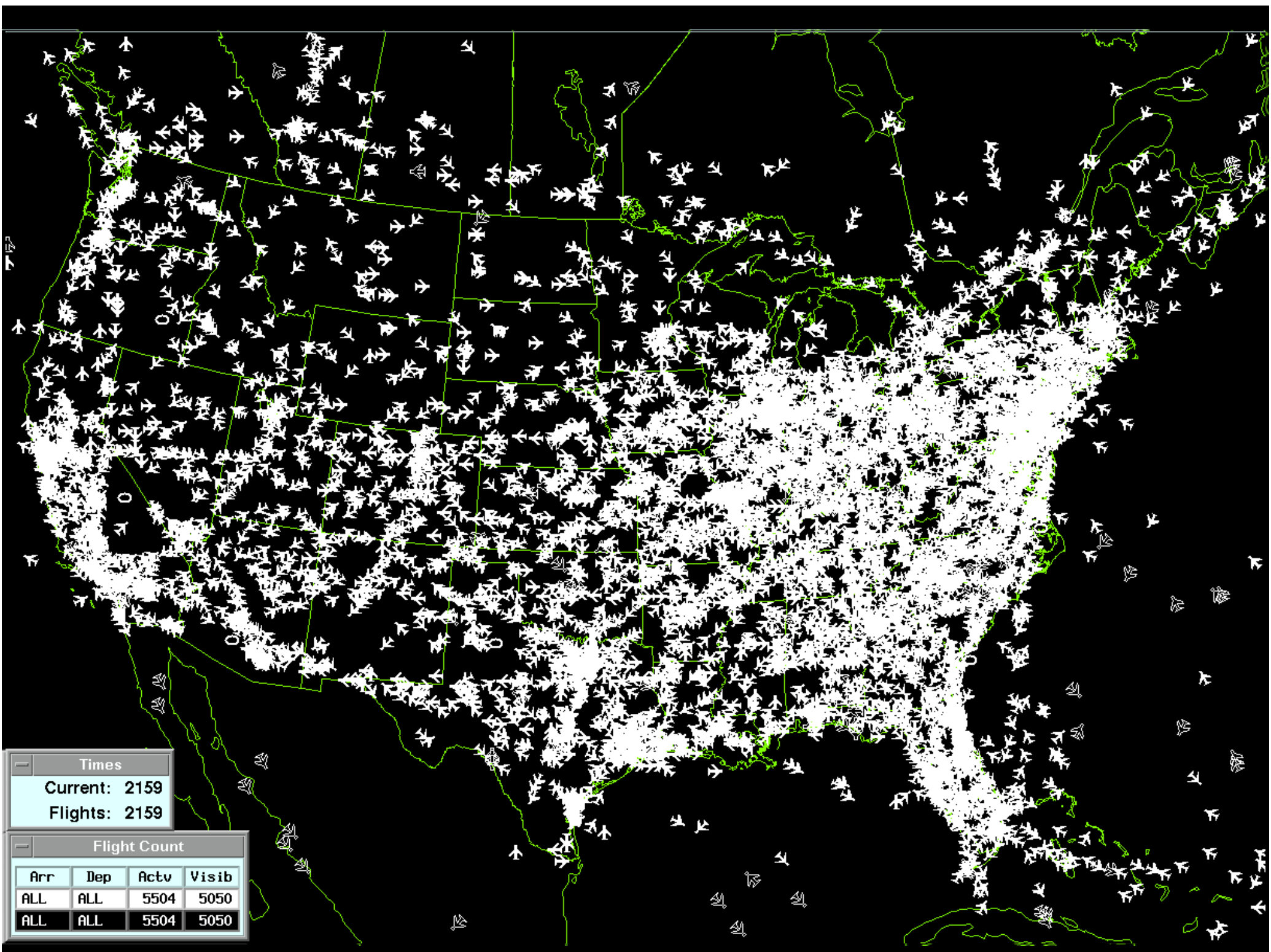












Times
Current: 2159
Flights: 2159

Flight Count

Arr	Dep	Actv	Visib
ALL	ALL	5504	5050
ALL	ALL	5504	5050



Human Power™

ENTER SEARCH TERM





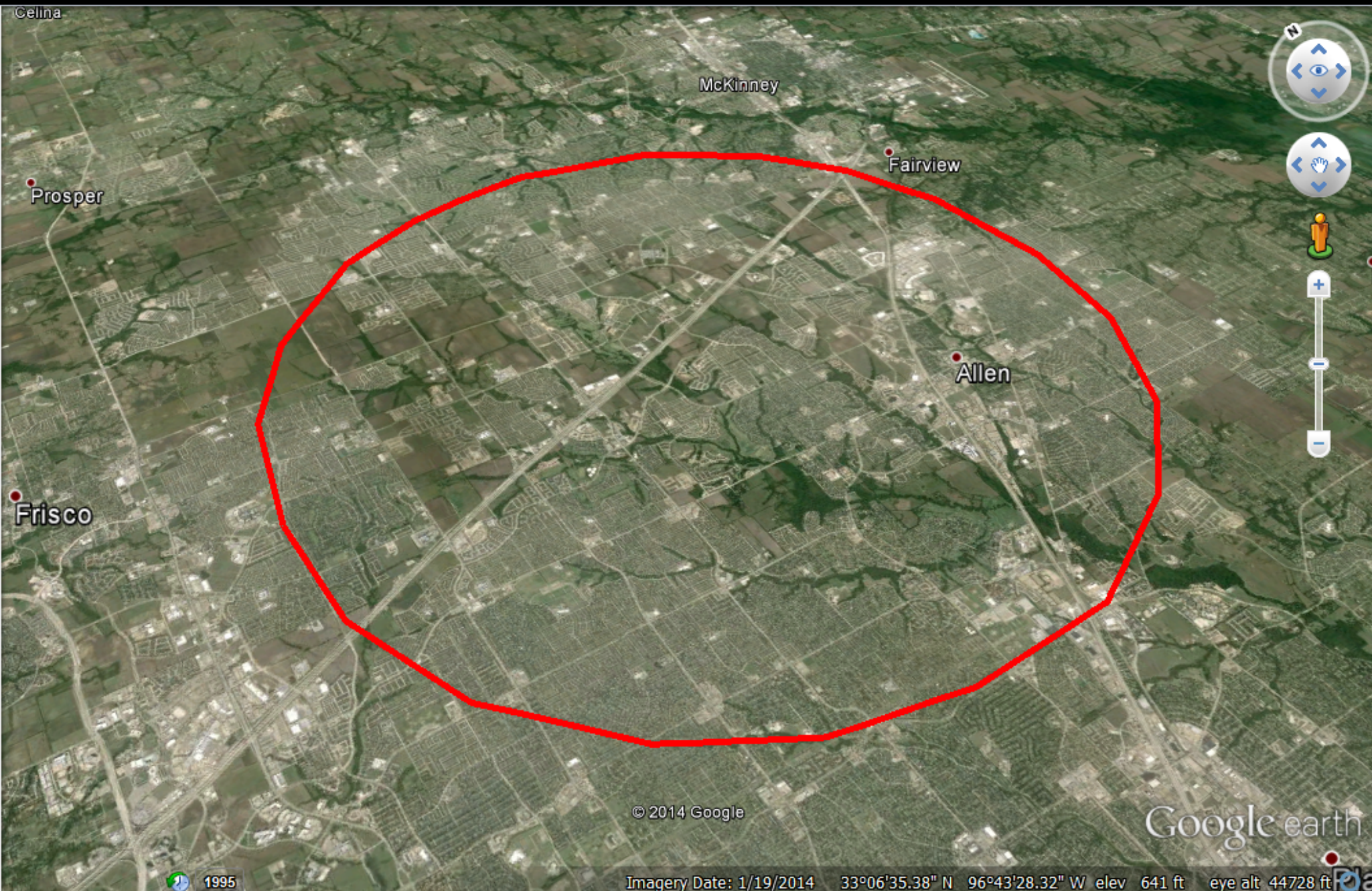
Caption ▲

Photo: Paul Taggart/Bloomberg News

AeroVironment's Nano Hummingbird







Celina

McKinney

Fairview

Prosper

Allen

Frisco

© 2014 Google

Google earth

1995

Imagery Date: 1/19/2014 33°06'35.38" N 96°43'28.32" W elev 641 ft eye alt 44728 ft

UAS ARC MEMBER ORGANIZATIONS

- General Atomics
- MITRE
- GE
- New Mexico State University *
- Raytheon
- National Business Aviation Association (NBAA)
- Northrop Grumman
- Insitu/Boeing
- Rockwell-Collins
- Honeywell
- PBFA
- DHS CBP
- ALPA
- AOPA
- AUVSI
- NASA
- AeroVironment
- Lockheed Martin

NOTICE

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

N 8900.227

National Policy

Effective Date:
7/30/13

Cancellation Date:
7/30/14

SUBJ: Unmanned Aircraft Systems (UAS) Operational Approval

11 – AIRWORTHINESS

(a) (2) Examples of acceptable policy/criteria include, but are not limited to:

- Department of Defense (DOD) Handbook, MIL-HDBK 516B, Airworthiness Certification Criteria;
- Air Force Policy Directive (AFPD) 62-6, USAF Aircraft Airworthiness Certification;
- Army Regulations (AR) 70-62, Airworthiness Qualification of Aircraft Systems; or
- Naval Air Systems Command Instruction, NAVAIRINST 13034.1 series, Flight Clearance Policy for Air Vehicles and Aircraft Systems.



U.S. Department
of Transportation
**Federal Aviation
Administration**

MAY 16 2013

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Reed Timmer
Tornado Videos.net/TVNWeather
4060 Nicole Pl
Norman OK 73072

Dear Mr. Timmer,

Our office recently became aware of your web site, www.tornadovideos.net advertising the use of a quadcopter or Unmanned Aircraft System (UAS) for the civil and commercial purposes of selling videos and conducting tornado research.

The Federal Aviation Administration (FAA) has the requirement for the regulation and safe operation of the National Airspace System which covers all navigable airspace in the US. Private land owners do not have any jurisdiction over the airspace above their property and cannot prohibit or allow aviation operations over their land. Unmanned Aircraft are unable to comply with Title 14,

Copyrighted Material



STUART BANNER

WHO OWNS THE SKY?

THE STRUGGLE TO CONTROL AIRSPACE

FROM THE WRIGHT BROTHERS ON

Copyrighted Material

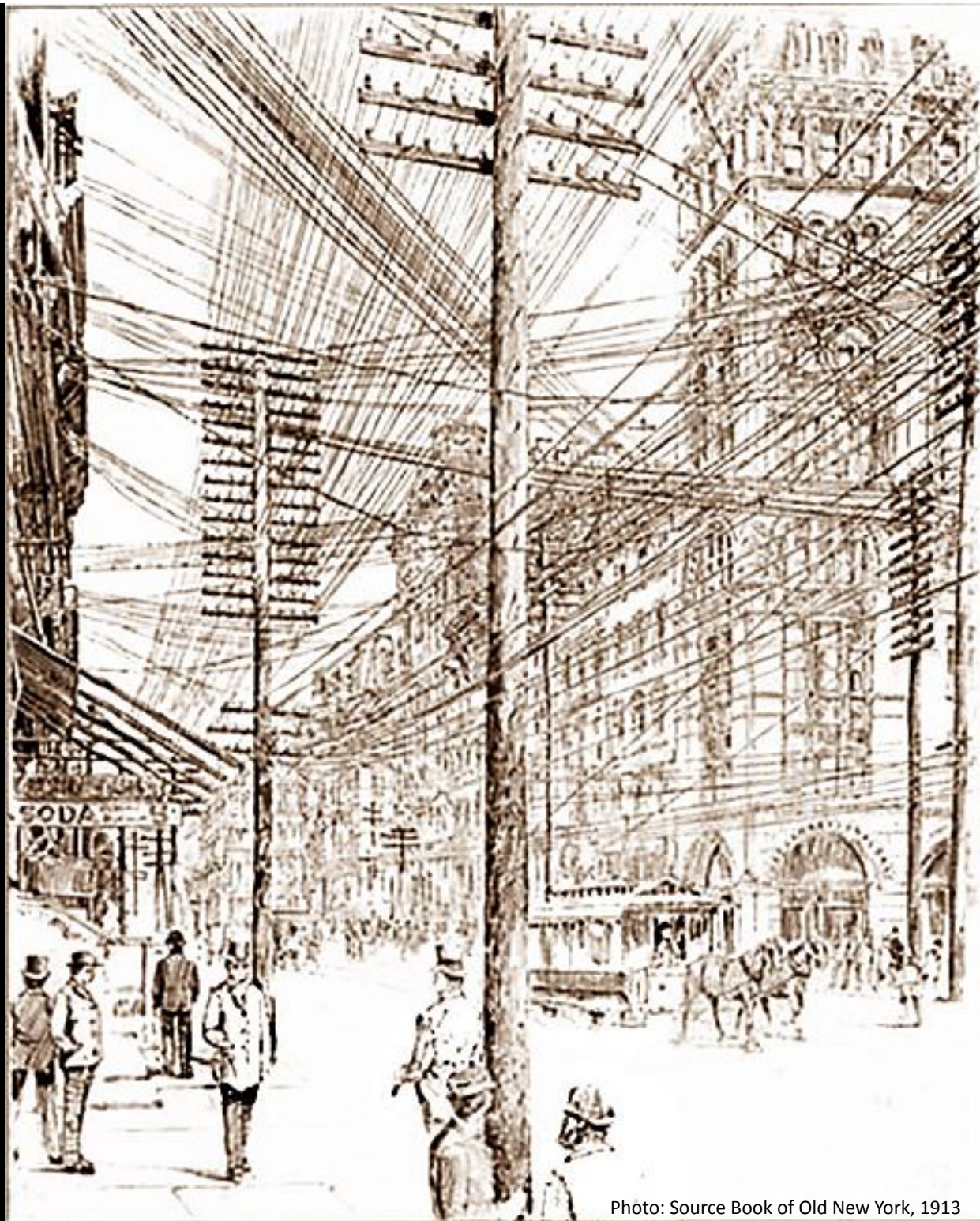


Photo: Source Book of Old New York, 1913

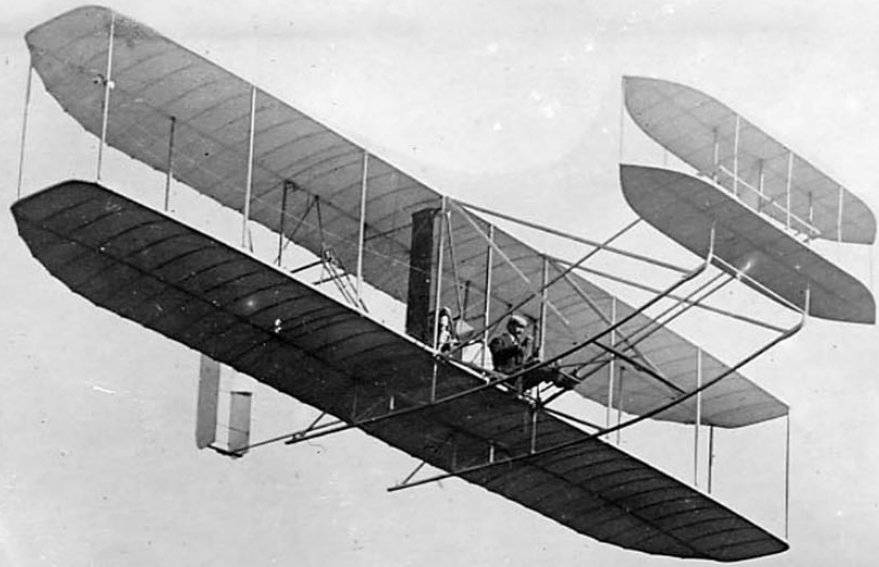


Photo: U.S. Air Force

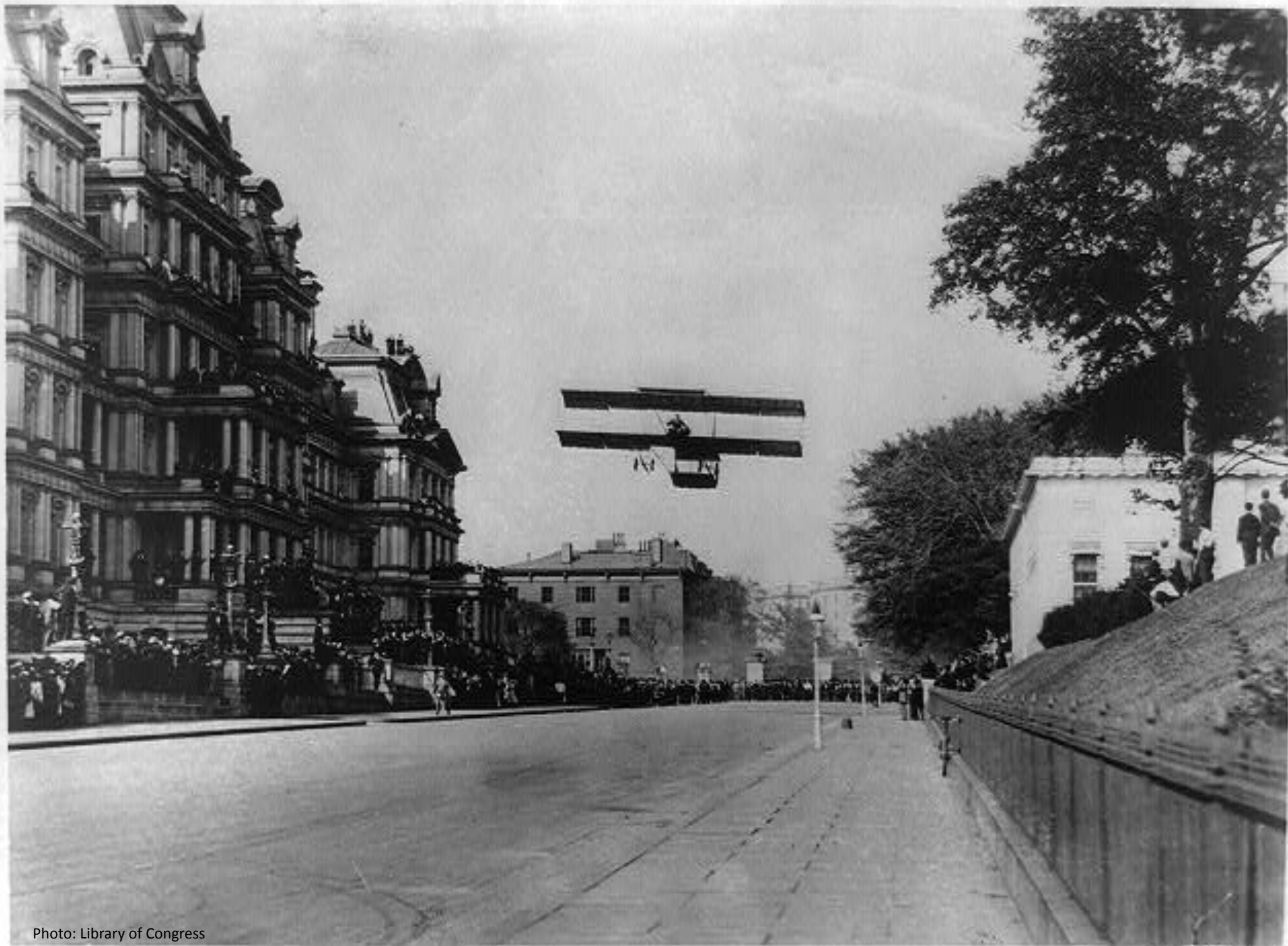


Photo: Library of Congress



Photo: National Photo Company



Photo: old-picture.com

<p>"Emergency landing field."</p> <p>"Air navigation facility."</p> <p>"Civil airway."</p> <p>"Airman."</p>	<p>and which provides facilities for shelter, supply, and repair of aircraft; or a place used regularly for receiving or discharging passengers or cargo by air.</p> <p>(h) The term "emergency landing field" means any locality, either of water or land, which is adapted for the landing and taking off of aircraft, is located along an airway, and is intermediate to airports connected by the airway, but which is not equipped with facilities for shelter, supply, and repair of aircraft and is not used regularly for the receipt or discharge of passengers or cargo by air.</p> <p>(i) The term "air navigation facility" includes any airport, emergency landing field, light or other signal structure, radio directional finding facility, radio or other electrical communication facility, and any other structure or facility, used as an aid to air navigation.</p> <p>(j) The term "civil airway" means a route in the navigable airspace designated by the Secretary of Commerce as a route suitable for interstate or foreign air commerce.</p> <p>(k) The term "airman" means any individual (including the person in command and any pilot, mechanic, or member of the crew) who engages in the navigation of aircraft while under way, and any</p>
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SEC. 10. NAVIGABLE AIRSPACE.—As used in this Act, the term "navigable airspace" means airspace above the minimum safe altitudes of flight prescribed by the Secretary of Commerce under section 3, and such navigable airspace shall be subject to a public right of freedom of interstate and foreign air navigation in conformity with the requirements of this Act.

<p>To navigate without a certificate, etc.</p> <p>Serving as airman without certificate, etc.</p> <p>To navigate not in conformity with air traffic rules.</p> <p>Penalty for violating designated regulations.</p> <p>Stat., p. 572.</p> <p>Prohibition, etc., allowed.</p> <p>Lien against the aircraft.</p> <p>Proceedings to collect penalty.</p>	<p>or in violation of the terms of any such certificate.</p> <p>(4) To serve as an airman in connection with any aircraft registered as an aircraft of the United States, or any foreign aircraft, without an airman certificate or in violation of the terms of any such certificate.</p> <p>(5) To navigate any aircraft otherwise than in conformity with the air traffic rules.</p> <p>(b) Any person who (1) violates any provision of subdivision (a) of this section or any entry or clearance regulation made under section 7, or (2) any customs or public health regulation made under such section, or (3) any immigration regulation made under such section, shall be subject to a civil penalty of \$200 which may be remitted or mitigated by the Secretary of Commerce, the Secretary of the Treasury, or the Secretary of Labor, respectively, in accordance with such proceedings as the Secretary shall by regulation prescribe.</p> <p>In case the violation is by the owner or person in command of the aircraft, the penalty shall be a lien against the aircraft. Any civil penalty imposed under this section may be collected by proceedings in personam against the person subject to the penalty and/or in case the penalty is a lien, by proceedings in rem against the aircraft. Such proceedings shall conform as nearly as may be to civil</p>
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Navigable Airspace

Minimum Safe Altitude





Photo: anyjazz65 on Flickr.com

United States v. Causby

328 U.S. 256 (1946)

“We have said that **the airspace is a public highway**. Yet it is obvious that if the landowner is to have full enjoyment of the land, [the landowner] must have exclusive control of the immediate reaches of the enveloping atmosphere. Otherwise buildings could not be erected, trees could not be planted, and even fences could not be run. The principle is recognized when the law gives a remedy in case overhanging structures are erected on adjoining land. The landowner owns at least as much of the space above the ground as he can occupy or use in connection with the land. The fact that he does not occupy it in a physical sense-by the erection of buildings and the like-is not material. As we have said, the flight of airplanes, which skim the surface but do not touch it, is as much an appropriation of the use of the land as a more conventional entry upon it.”

City of Northampton

MASSACHUSETTS

In City Council, June 27, 2013

Upon the recommendation of Councilor William H. Dwight, Councilor Jesse M. Adams, Councilor Maureen T. Carney, and Councilor Paul D. Spector

RESOLUTION ON DRONE AIRCRAFT

WHEREAS, such an expansion of navigable airspace is contrary to the aviation statutes in Title 49 of the United States Code^x, which have been in force, largely unchanged, since President Coolidge first signed them into law in 1926; and

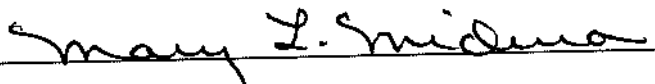
BE IT FURTHER RESOLVED, that the City of Northampton affirms that within the city limits, landowners subject to state laws and local ordinances have exclusive control of the immediate reaches of the airspace and that no drone aircraft shall have the “public right of transit” through this private property; and

Approved: David J. Narkewicz, Mayor

Rules suspended, passed two readings and enrolled.

I hereby certify that the above Order passed the Northampton City Council on July 11, 2013.

David J. Narkewicz, Mayor approved the Order on July 12, 2013

Attest: , Clerk of Council

Academic Safety Code for SAOs on Institutional Property

For the purposes of this code, Small Airborne Objects (SAOs) are understood to include any small balloon, kite, rocket, projectile, model aircraft, drone, unmanned aircraft, flying toy, or similar contrivance used below the federal navigable airspace for conventional manned aircraft. Any SAO used on institutional property:

- shall not be operated in a manner that creates a hazard to other persons or their property;**
- shall not exceed 400 feet altitude, or exceed the height of nearby obstacles when used in the vicinity of any airport, except as allowed by the Federal Aviation Administration;**
- shall not enter any other property below 400 feet altitude, nor create a nuisance on, nor survey any other property without permission from the affected landowner;**
- shall display the operator's contact information if it is capable of sustained flight;**
- shall give way to, and not interfere with, any manned aircraft;**
- shall comply with institution-specific *SAO Safety Guidelines* developed by a designated institutional authority in accordance with community-based safety programming.**

