

# Research (Useful Tools)

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## The North Dakota Citation Research Aircraft Measurement Platform

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### Abstract

The North Dakota Citation Research Aircraft is a Cessna Citation II twin-engine fan-jet aircraft modified to be an atmospheric research platform that has been used on many field projects since the 1970s. The typical sampling speed of the modified Citation II is 160 knots indicated air speed (IAS), with sampling at altitudes up to 12.1 km (40,000 ft). The Citation Research Aircraft was operated by the University of North Dakota (UND) for many years but is now operated by Weather Modification International (WMI) of Fargo, North Dakota. WMI and UND together provide a unique test facility that is capable of deploying a wide range of instrumentation. WMI has the experience to install the custom instrumentation required for a specific field project and the expertise to conduct the most demanding aircraft sampling, including thunderstorm in-situ measurements. UND provides scientific know-how on obtaining measurements at the required accuracy and experience to ensure instruments are performing well. Robust, open-source software tested for over 15 years provides the ability to quickly process data to enable analysis to begin shortly after completion of an aircraft flight. Visualization software allows observations to be efficiently quality-assured, which enables timely creation of a final data set that can be analyzed to meet each project's scientific objectives. Past and

ice content of the clouds and precipitation. For turbulence and wind shear studies, measurements were made from a flow angle probe and inertial navigation system. When flights were made in convective environments, operations were closely coordinated with ground-based radar observations to ensure crew safety. Campaigns were flown in a number of different locations to determine geographic variations in conditions. The early field projects with the North Dakota Citation Research Aircraft were done in partnership with the Massachusetts Institute of Technology (MIT) Lincoln Laboratories and funded by the Federal Aviation Administration (FAA).

A second period of activity occurred from 1992 to 2005 when the North Dakota Citation Research Aircraft was used to provide measurements of icing conditions for the purpose of aircraft certification. The Code of Federal Regulations (CFR), 14 CFR 23.1419 and 14 CFR 25.1419, require that the effectiveness of ice protection systems and their components be tested "in measured natural atmospheric icing conditions". These measurements include the cloud parameters of liquid water content, drop size distribution, and temperature. Several aviation companies provided funding for projects, including a series of field projects to certify the Sikorsky S-92 helicopter for flights in known icing conditions.

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# Tool for Background Research

- Article Search
  - Google Scholar (<https://scholar.google.com/ncr>)
- Reference Manager
  - **Zotero** (Wrote 15 % of the Delene 2016 Paper)
- PDF Reader
  - **Foxit** (Highlight and Add Notes)
- Word Processor (**Article Guide**)
  - **Libreoffice** (Open Document Format, odt)
    - Paragraph Styles
    - Figures
      - Anchor as Character (Move with Text)
      - Cross Referencing Figure Number
    - Text Read Out Loud

# Tools: Setup and Learning

- Install (Personal Computers)
  - Zotero
  - Foxit
  - Libreoffice
  - Text Read Out Loud
- Accounts
  - Zotero
- Start using the Totals
  - Test One Article
    - Search – Google Scholar
    - Article into Zotero (Setup AMS style)
    - Paragraph in Document (Read it Out Loud)
    - Citation Entry

# Tools: Full Example

- Article using Zotero

- Delene, D., Hibert, K. Poellot, M., and Brackin N., The North Dakota Citation Research Aircraft Measurement Platform, SAE Technical Paper 2019-01-1990, 2019, doi: 10.4271/2019-01-1990.

