

## CREATING THE LONG-TERM T-28 INSTRUMENTED RESEARCH AIRCRAFT DATA ARCHIVE

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### 1. INTRODUCTION

The T-28 armored research aircraft was developed beginning in 1968 with a grant from the National Science Foundation (NSF) to the South Dakota School of Mines and Technology (SDSMT). The modification of the stock military trainer was done under the direction of Paul MacCready with much of the engineering work performed by Robin Williamson. Once it went into service it was operated by the Institute of Atmospheric Sciences (IAS) at the SDSMT. From 1970 through 2003 it participated in regional, national and international convective storm research projects.

Initially it was supported on a project-by-project basis. It was a key platform for *in situ* observations of convective storm microphysics in the National Hail Research Experiment (NHRE), from 1972-1976. Following NHRE, projects tended to be conducted a year or two at a time. Beginning in 1986 it was operated as a national facility under a Cooperative Agreement between SDSMT and the National Science Foundation (NSF) and continued to support field programs by providing unique *in situ* observations in regions of convective storms that could not be safely penetrated using any other platform.

For its first two decades in service to the atmospheric science community the T-28 participated in projects investigating convective storm processes with an emphasis on studies of how hail develops. The aircraft was instrumented with a suite of state-of-the-art instrumentation for microphysical measurements. It was capable of accurate measurements of all species of hydrometeors, spanning the size range from a few micrometers to several centimeters. On a typical mission the aircraft penetrated storms containing strong updrafts, moderate to severe turbulence, nearly adiabatic concentrations of supercooled liquid water, and possibly hail up to 5 cm in diameter. In addition to using the observations to understand precipitation evolution in these storms, radar scientists were able to use the observations to learn to interpret polarimetric radar observations or rain, snow, graupel, and hail.

Beginning in 1989 instrumentation was added to support atmospheric electrical observations. These electrical observations were an important component of several large field programs.

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### 2. DEVELOPMENT OF THE ARCHIVE

During 34 years of operation the aircraft was a participant in more than two dozen major national and international convective storm field projects, and in addition was involved in many smaller more focused studies. As technology improved, instrumentation and data acquisition and processing also improved. Although changes in data acquisition and storage technology have resulted in loss of the original digitally recorded data from the magnetic tape era, digital data from the early 1990's through 2003 are still retained at the IAS. To organize and make easily available these unique and extensive *in situ* data from convective storms, the SDSMT and the National Center for Atmospheric Research's (NCAR) Earth Observing Laboratory (EOL) collaborated to create a comprehensive archive of these data (also including supporting datasets such as project radar data). The archive is available through a web site located at EOL. <http://www.eol.ucar.edu/projects/t28/>.

### 3. COMPONENTS OF THE ARCHIVE

An image of the home page of the T-28 archive is shown in Figure 1. Links from this page lead to a history and extensive documentation of the T-28 aircraft, descriptions of T-28 instrumentation, a list of projects in which the T-28 participated, photographs, access to publications ranging from internal reports to peer-reviewed publications (many older paper documents have been digitized), related relevant links, and access to the original digital data through the CODIAC data archive system. These digital data have been packaged into modern netcdf-formatted files compatible with a wide range of current data analysis software, including software available from EOL and many commercial packages as well. Along with the aircraft data, supporting radar data either from research project radars, or WSR-88D radars covering the project region, are also available from the archive web site.

Visualization tools are built into the website so a user can view data online and determine which flights and flight segments contain observations of interest. They allow on-line generation of custom plots of altitude, temperature, vertical winds, electric fields, and other parameters of interest over a specified time period during a flight. A portion of a plot generated with this package is shown in Figure 2. Netcdf-format data files can be downloaded for more detailed analysis. Image data files and software applications can be downloaded to display the types and concentrations of cloud and precipitation particles.

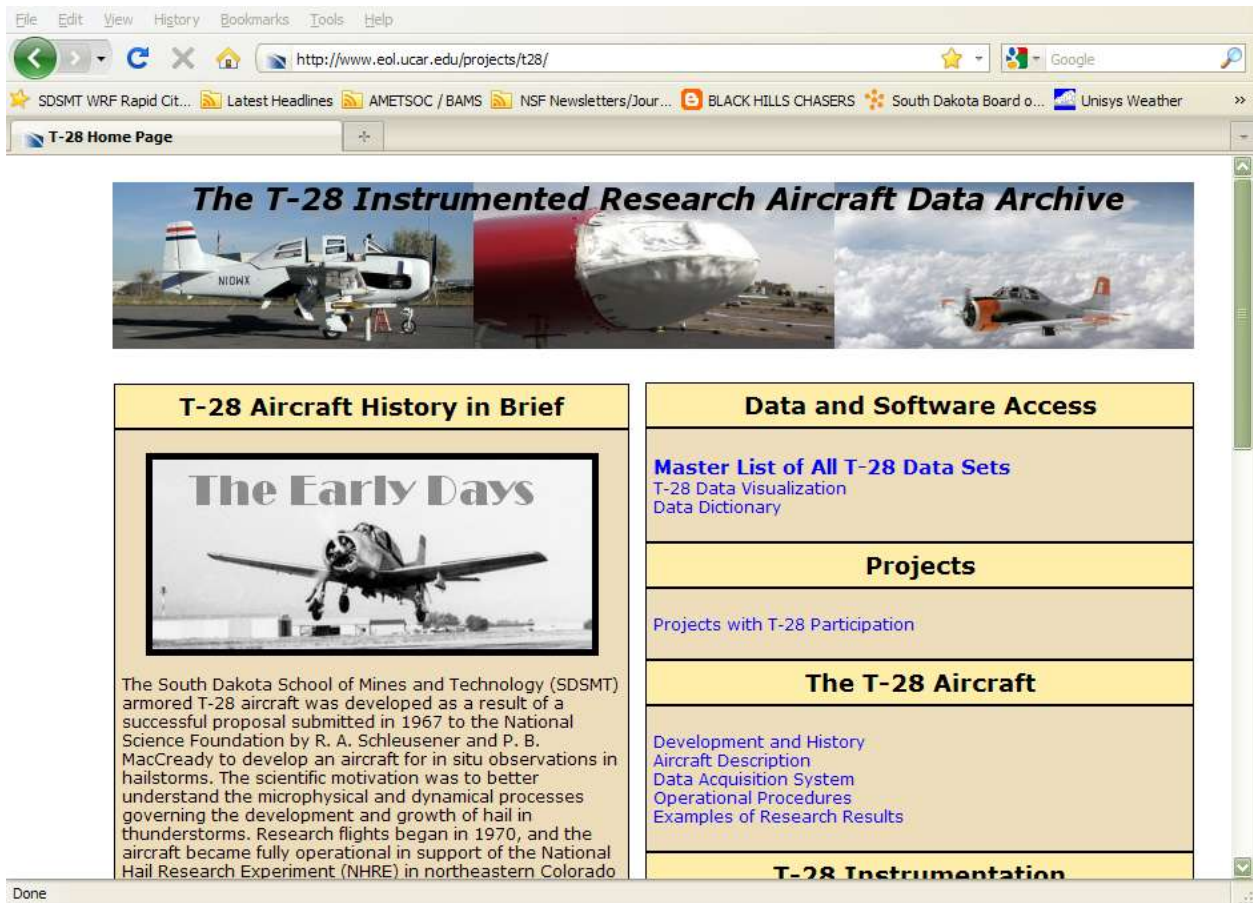


Figure 1 – An image of the homepage for the T-28 instrumented research aircraft data archive.

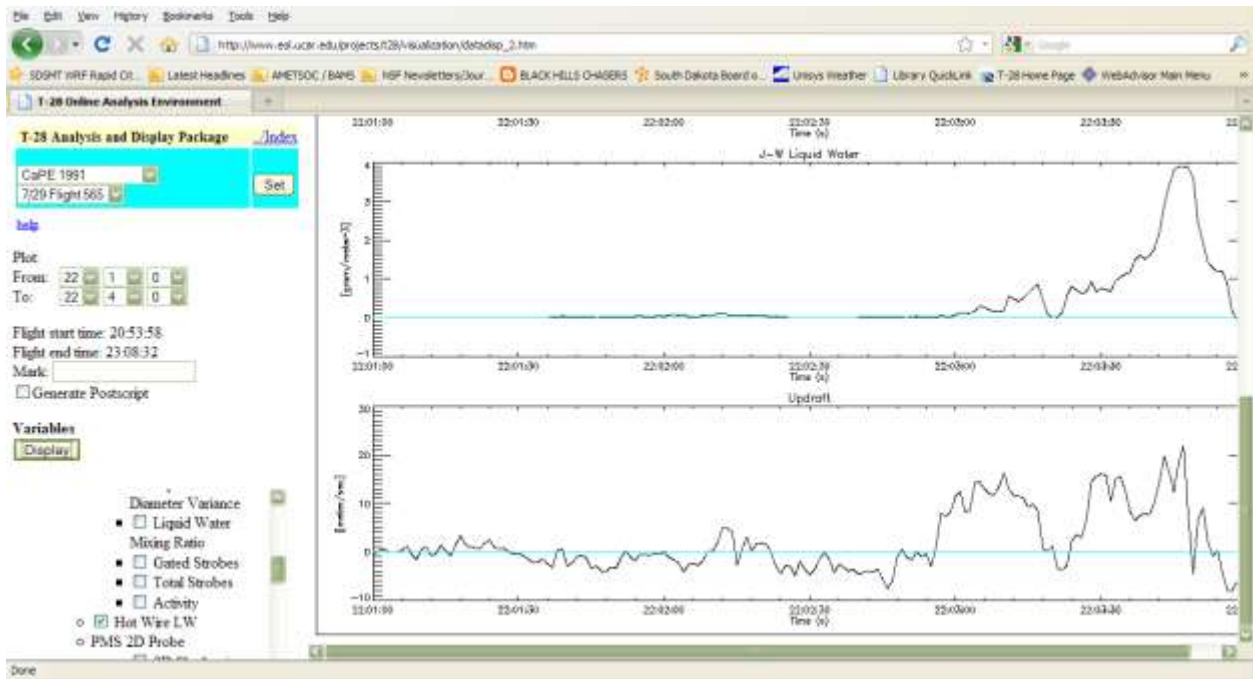


Figure 2: An example plot of cloud liquid water concentration and updraft speed from a pass through a Florida thunderstorm.

#### 4. USE OF THE ARCHIVE

The data are for the most part obtained with custom-built or limited-production instrumentation. Documentation available at the web site helps the non-specialist to become more informed about the instrumentation and interpretation of data from it. However, many of the data can be understood and interpreted qualitatively by someone with a general meteorological background.

We designed the site to make it accessible to users with a range of backgrounds from upper division undergraduate students in atmospheric and cloud physics classes to researchers with interest in detailed meteorological, microphysical and electrical observations in convective storms. Our goal is to support continued use of the data for both research and education. Data are included in the archive from projects ranging in meteorological regime from Florida to the central and northern Great Plains. The data will be useful in storm microphysical climatological studies analogous to the supercooled water climatologies of Pobanz *et al.*, 1993; Sand *et al.*; 1984; and Jeck 2008, which were built on many years worth of airborne *in situ* observations. Some T-28 observations are part of project storm microphysical climatologies already published, such as Musil and Smith, 1989; Blackmore *et al.*, 1989; and Stith *et al.*, 2006. The archive will support the preparation of additional more extensive climatologies, with the possibility of looking in more detail at regional variation in the relationship between storm microphysics and electrification.

For students, the archive will be a source of easily accessible original observations in convective storms that can be used to learn about basic storm processes. Instructors may find the observations useful in the context of class or homework exercises in which students learn about interpretation of real data as well as something about how clouds work.

#### 5. SUMMARY

A data archive containing unique *in situ* observations of convective storm meteorological, microphysical, and electrical characteristics has been assembled. The archive contains digital field project data from projects spanning the years 1991 - 2003, and a range of meteorological regimes. Supporting field data, primarily project radar data, also are contained in the archive. Finally, an

extensive collection of literature ranging from project reports to published analyses is available to provide background on the archived data and a window into highlights from projects for which digital data no longer are available.

#### 6. ACKNOWLEDGEMENTS

The aircraft was operated through much of its years of service with support from the NSF. Stable funding through a cooperative agreement since 1986 is responsible for the survival of the digital data and its documentation that is the core of the archive. In addition, field project support for some years also was provided by the National Oceanic and Atmospheric Administration and the Federal Aviation Administration. The NSF funded the development of this data archive. All of this support is most gratefully acknowledged. Matthew Beals originally developed the web-based software for displaying custom-selected data.

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