IN43C-3715: Near Real-time Review of Instrument Performance using the Airborne Data Processing and Analysis Software Package

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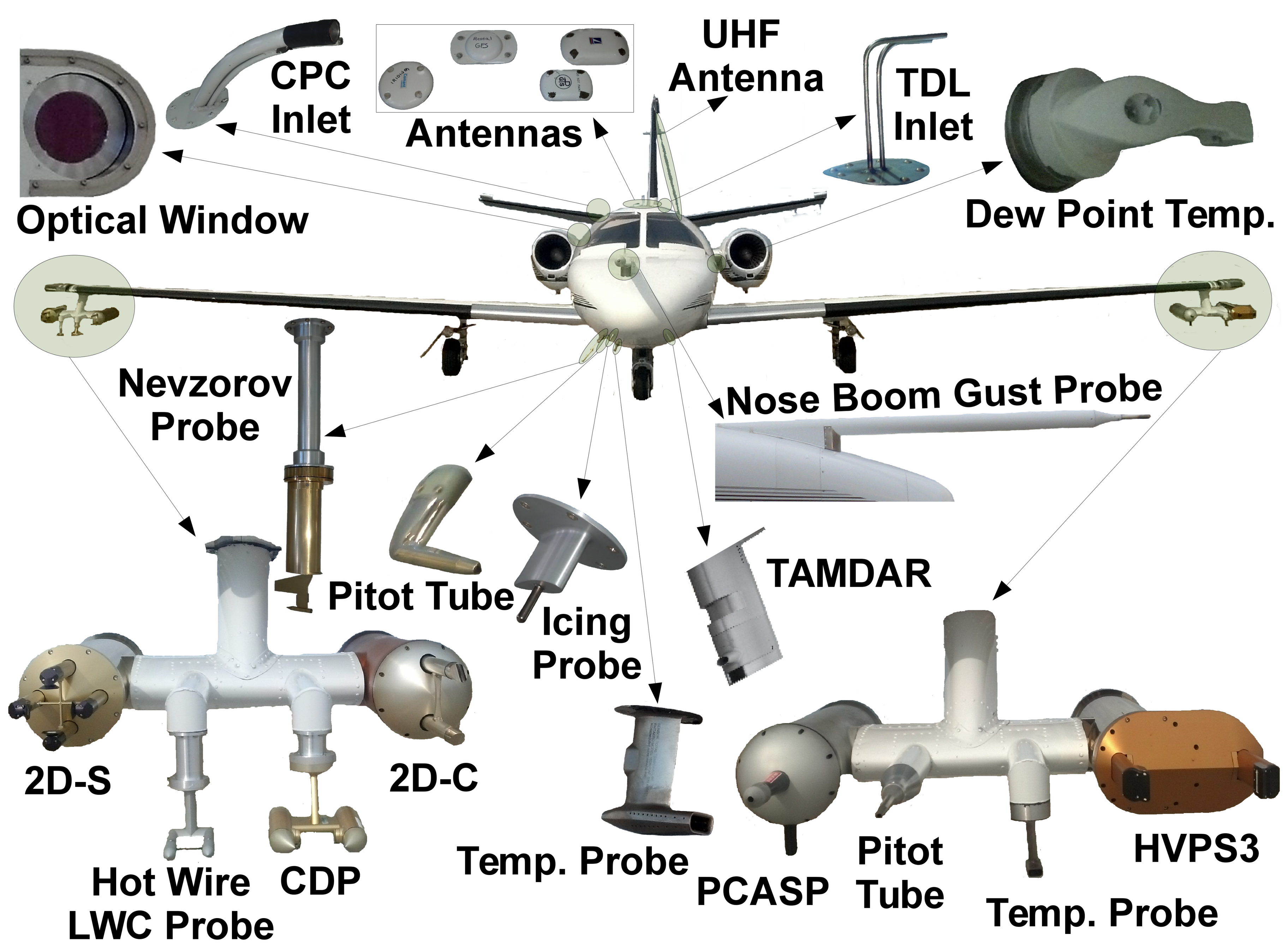
Introduction

Research aircraft for conducting atmospheric measurements carry an increasing array of equipment that each produce a huge amount of ancillary data on instrument performance. While on-board personnel constantly review tables and plots of instrument parameters during flight, there are an overwhelming number of items available. During an aircraft mission, the flight scientist monitors data from many instruments to ensure flight objectives are achieved, and a flight engineer is typically given the responsibility of monitoring the status of on-board instruments. While major issues such as not receiving data are quickly identified, subtle issues such as low but believable concentration measurements may go unnoticed. Therefore, it is critical to quickly review data after a flight to identify instrument performance issues and ensure high quality measurements were obtained. Additionally, ground data taken while conducting specific instrument performance checks needs to be quickly processed and analyzed.

Airborne Data Processing and Analysis

The Airborne Data Processing and Analysis (ADPAA) software package (Delene, 2011) automates post-processing of time series data including measurements for airborne probes. Utilizing scripts to process the measurements recorded by the on-board data acquisition systems enables generation of fully processed data files within an hour of flight completion. The ADPAA Cplot visualization program provides quick display of all derived parameters which enable timely review of instrument performance. The near real-time review of aircraft flight data enables instrument problems to be identified, investigated and fixed before conducting another flight. For example, near real time data review resulted in identification of unusually low measurements of cloud condensation nuclei which enabled timely investigation of the cause. As a result, a leak was found and fixed before the next flight. With the high cost of aircraft flights, it is critical to fix instrument problems in a timely matter.

University of North Dakota Cessna Citation II Research Aircraft External Equipment



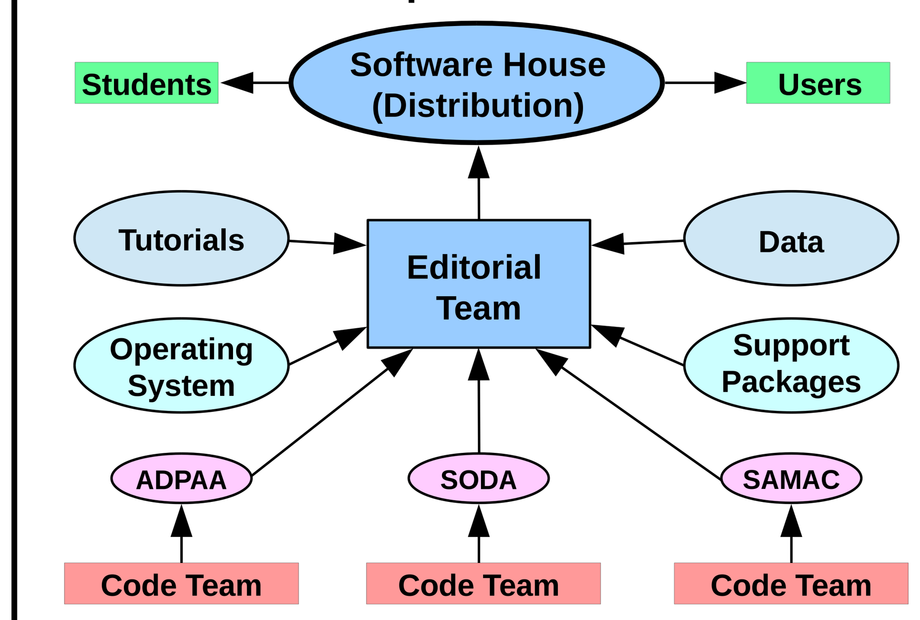
Fall 2014 Instrument Testing Field Project

UHF Antenna	Ultra high frequency (UHF) antenna for long range communications.
TDL Inlet	Gas inlet for the Tunable Diode Laser Hygrometer (TDL) instrument.
Dew Point Temp.	Chilled mirror sensor for measurement of dew point temperature.
Nose Gust Probe	Differential pressure sensors for measurements of 3-dimensional velocity relative to the atmosphere.
TAMDAR	The Tropospheric Airborne Meteorological Data Reporting (TAMDAR) Probe measures and down-links various meteorological parameters.
HVPS3	The High Volume Precipitation Spectrometer version 3 (HVPS3) measures precipitation from 150 µm to 1.9 cm with 128 size channels.
Temp. Probe	The Temperature (Temp.) Probes measure total temperature which is corrected for air speed to obtain ambient air temperature.
Pitot Tube	The Pitot Tubes measure the aircraft's air speed using pressure transducers.
PCASP	The Passive Cavity Spectrometer Probe (PCASP) measures aerosols from 0.1 to 3.0 µm in diameter with 15 size channels.
2D-C	The 2-dimensional cloud (2D-C) probe measures hydrometeors from 30 to 3000 µm in diameter.
CDP	The Cloud Droplet Probe (CDP) measures (30 channels) droplets from 3 to 50 µm in diameter at 8 Hz with particle-by-particle information.
Hot Wire Probe	The King Hot Wire Liquid Water Content (LWC) Probe measure cloud liquid water content
2D-S	The 2-dimensional stereo (2D-S) probe images hydrometeors using 128 diodes which are 10 µm in length.
Icing Probe	The Icing Probe detects supercooled liquid water that forms ice on aircraft surfaces.
Nevzorov Probe	The Nevzorov Probe uses hot wires to measure total cloud liquid and ice water content.
Optical Window	The normal windows have been replaced with specially designed optical glass windows for sampling with LIDAR based instruments.
CPC Inlet	The Condensation Particle Counter (CPC) measures aerosols larger than 10 nm in diameter using a forward facing 1.0 in diameter heated inlet.
Antennas	Several GPS and Iridium antennas provide time and position information, along with two-way satellite based communication.

Future Work: Community Software House

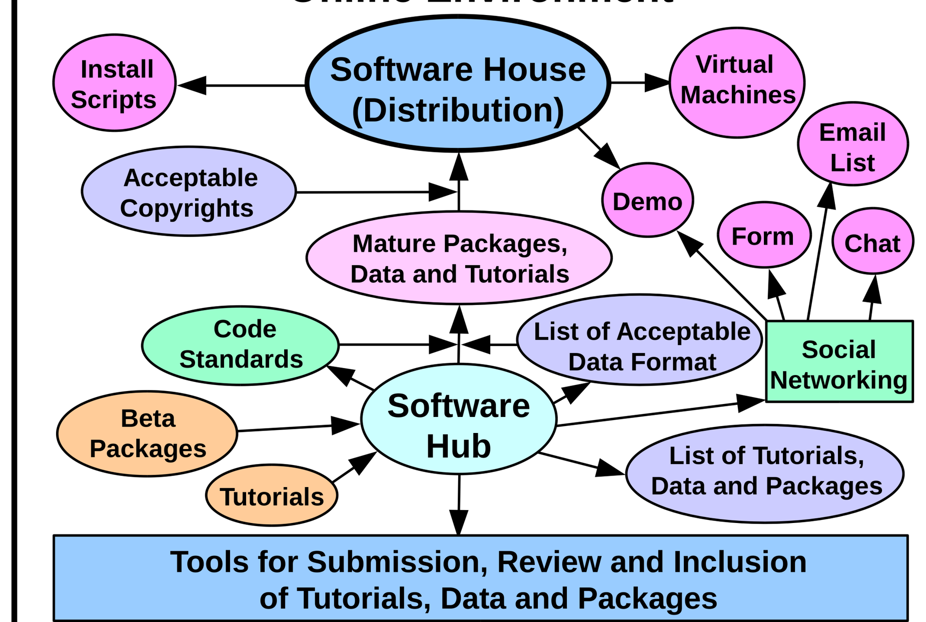
Several groups have developed and made available open source software similar to ADPAA but with different capabilities. However, scientists continue to spend significant amounts of time developing their own software instead of utilizing existing packages. To enable wide spread community adoption, existing scientific software needs to be distributed by an editorial team that works with developers to create mature packages, incorporate support software with an operating system, provide example data and develop tutorials which illustrate the usefulness and limitations of the software. The pulling together of materials would be done yearly to create a "Software House" that would be distributed to the scientific community.

Desktop Environment



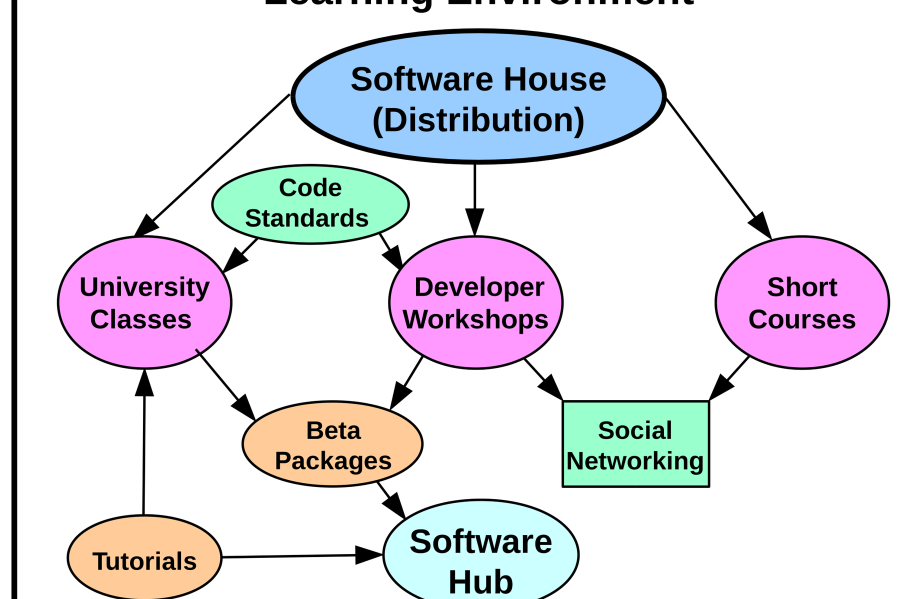
Schematic of the user's desktop computer work environment where squares denote people and ovals denote computer files. The editorial team ensures that the Software House includes all necessary support packages in addition to a full operating system. Code development teams create tutorials to illustrate how their software package improves on previous processing methods or software implementations. While editorial team members would likely be on code teams, the editorial team's function is not to write code but to determine which packages, and corresponding data and tutorials, to include in the yearly Software House distribution.

Online Environment



Schematic of the online environment that enables productive interaction between software users and developers while enabling effective management of the community "Software Hub". A web development team would create and maintain tools for people to submit tutorials, data and software. The editorial team would determine if software packages meet the established coding standards to allow inclusion in that year's Software House distribution. The Software Hub is not a static web site but a suite of tools designed to facilitate creation of the Software House and the social interaction of an engaged community.

Learning Environment



Representation of the learning environment that would result from creation of the Software House and Software Hub. Instructors use tutorials from the Software House but also create their own material which they submit to the Software Hub for possible inclusion in the next year's distribution. Code standards serve as guidelines for students working on coding assignments. Students use the Software House like they use a textbook. Data users and the wider scientific community learn how to work with the Software House during short courses. The social networking tools connect students, developers and users in an interactive, online community.

Reference: Delene, D. J., Airborne Data Processing and Analysis Software Package, Earth Science Informatics, 4(1), 29-44, 2011, URL: http://dx.doi.org/10.1007/s12145-010-0061-4, DOI: 10.1007/s12145-010-0061-4