Analysis-ready Data from Aircraft Measurements using Open Source Software



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Scientific Programming: Problems and Solutions

- Scientists write programs because they understand the problem to be solved; however, they are judged/rewarded for writing papers, not producing data sets or software.
- Software used to collect, process and analyze measurements is almost never evaluated.
 - Sometimes by supervises or co-workers
 - No independent source code review.



- Mistakes in software result in wrong scientific conclusions!
 - Black Box / White Box Testing
- Science Article Outdated → <u>Computational Notebook</u> (See James Somers Article in The Atlantic)

Airborne Data Processing and Analysis (ADPAA) Software Package: <u>Overview</u>

- Automates data processing of aircraft research instruments that is documented using concept of <u>computational notebooks</u>.
- Fully incorporates the concept of missing value codes.
- Utilizes standard ASCII files, with meta data headers.
- Utilizes the concept of <u>data processing levels</u>.
- Produces a science summary file that can be visualized using the ADPAA cplot2 program.
- Tools for quality control and quality assurance of data. 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.

Airborne Data Processing and Analysis (ADPAA) Software Package: <u>Technical</u>

- Independent, Open, and Freely Available
- GNU/GPL v3 Licensed
- Started in 2007, Version 3350 20 April 2018
- 212,812 Lines of Code, 1305 files (from cloc) IDL (142,529), Bash (17,946), Perl (11,349), csh (11,318), C (10,391), Python (7,597), FORTRAN 77 (3,291), etc.
- Subversion (SVN) Code Management
- Feature Requests, Bug Tracker, and Wiki

https://sourceforge.net/projects/adpaa/

delene@ice:/nas/und/NorthDakota/2014/Aircraft/CitationII_N555DS/I	
[delene@ice 20140306_174537]\$ process_all_ophir	
Processing the 14_03_06_17_45_37.sea file	Done
Creating 14_03_06_17_45_37.applanix.1Hz	Done
Creating 14_03_06_17_45_37.analog.1Hz	Done
Processing the 14_03_06_17_45_37.analog.??? file	Done
Processing the 14_03_06_17_45_37.2dc file	Done
Processing the 14_03_06_17_45_37.serial.GPS.raw	Done
Creating 14_03_06_17_45_37.physical.clean	Done
Creating 14_03_06_17_45_37.physical.filtered	Done
Creating the 14_03_06_1/_45_37.physical.10Hz file	Done
Creating the 14_03_06_17_45_37.physical.1Hz file	Done
Processing the 14_03_06_17_45_37.physical.? file	Done
Creating 14_03_06_1/_45_37.basicP101.1Hz	Done
Creating 14_03_06_17_45_37.basicP1T2.1Hz	Done
Creating 14_03_06_1/_45_37.basicP211.1Hz	Done
Creating 14_03_06_17_45_37.basicP212.1Hz	Done
Creating 14_03_06_17_45_37.basic.10HZ	Done
Creating 14_03_06_1/_45_37.basic.1HZ	Done
Processing the 14_03_06_17_45_37.counts.pcasp.raw	Done
Creating 14_03_06_1/_45_37.Dasic.8HZ	Done
Processing the 14_03_06_17_45_37.counts.cop.raw	Done
Creating 14_03_06_1/_45_37.king.raw	Done
Crossing the 14_05_05_17_45_37.applantx.rdw	Done
Creating 14_05_06_17_45_37. digtes. dpptdlifx. 182	Done
Creating 14_03_06_17_45_37.ktng.1nz	Done
Creating 14_05_06_17_45_37.conc.cup.inz	Done
Creating 14_05_06_17_45_37.egg.1aw	Done
Creating 14_03_06_17_45_37 nevue raw file	Done
Creating 14_03_06_17_45_37 nevwe.14w Tite	Done
Creating 14_03_06_17_45_37_serial GPS_10ser	Done
Creating 14_03_06_17_45_37_BEAL winds 1Hz	Done
Creating 14_03_06_17_45_37_550nm scat raw	Done
Creating 14 03 06 17 45 37 conc stn pcasp raw	Done
Creating 14 03 06 17 45 37 onb file	Done
Creating 14 03 06 17 45 37 air file	Done
Using 14 03 06 17 45 37 2dc to create 2DC images	Done
[delene@ice_20140306_1745371\$	Done
1	

Data File Formats Supported

- Processing of any *.sea File (Science Engineering Associates (SEA) Data Acquisition System)
 - Conversion scripts support data recorded on instruments.
- Main Data Format
 - Gzipped NASA/UND (1001) ASCII
- Output Data Format
 - NASA/UND ASCII 1001 Format
 - 2013 ICARTT NASA Format (ict)
 - NetCDF
 - KML (Google Earth)
- Data File Import Routines
 - IDL, Python, Matlab, Scilab, Igor
- Conversion Routines
 - Too many to list.



Availability and Copyright

- SourceForge Repository (SVN)
 - Current version 3,350
 - 3 Admins
 - 10 Active Developers
 - 8 Inactive Developers
- Download
 - svn checkout



- svn://svn.code.sf.net/p/adpaa/code/trunk adpaa-code
- GNU/GPL v3 Licensed
 - Have to remain open, even when forked.

Data Processing

- Data Quality Control
 - Calibration Checks
 - Data Missing Values Codes
 - Levels of Data Processing
 - Raw Recorded Data
 - Engineering to Physical Units
 - Single Instrument Data Files
 - Combined Instrument Data File
- Data Quality Assurance
 - Scientific Data Review
 - Scripts Search for Unrealistic Values



Implementation of ADPAA Software Package

- Able to process all WMI aircraft data over the past ten years.
- Able to process all UND data since 2000, including recent ORACLES field project on the NASA P3 aircraft.
- Recently implemented for the Korean Meteorological Administration (KMA) and Shanxi, China aircraft by tailoring the package to provide fully automatic and userfriendly processing.



Integration of SODA2 (System for OAP Data Analysis version 2)

- SODA2 integration automated optical array probe (OAP) processing.
 - Images from OAPs are easily created by ADPAA, but most scientists want bulk microphysical information.
 - SODA2 provides microphysical information such as size spectra, area ratios, and aspect ratios by using advanced image processing methods.
- While it takes a highly trained eye to do quality assurance on data after processing, SODA2 allows groups with limited processing resources to conduct industry leading research with products that are highly time-consuming to create or otherwise cost-prohibitive.

Particle Size Distribution



Summary and Conclusions

- A Linux operating system is required which some researchers are not very experienced using; however, remote network access allows software and instrument support.
- Few users have experience processing data from the variety of instruments on today's research aircraft, so providing support is an important component to a successful research platform.
- The ADPAA/SODA2 software package allows for streamlined data processing.
- Training is straightforward and the progression toward doing science with a research aircraft moves forward more quickly.
- Allows the documentation of work flow using computational notebooks.

Questions and Discussion

<u>References:</u>

- ADPAA Web Site https://sourceforge.net/projects/adpaa/
- ADPAA Wiki http://adpaa.sourceforge.net/wiki/index.php/Main_Page
- Software Web Site http://aerosol.atmos.und.edu/ADPAA/index.html
- 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.
- Somers, James. "The Scientific Paper Is Obsolete." The Atlantic, April 5, 2018. https://www.theatlantic.com/science/archive/2018/04/the-scientific-paper-is-obsolete/556676/.



Getting Involved: ADPAA, ADTAE, and CoPAS

- Users
 - Read Earth Science Informatics ADPAA Software Articles.
 - Create accounts and request Wiki access.
 - Submit documentation and tutorials.
- Developers
 - Read the programming guide.
 - Submit code to Administrator for review.
- Administrators
 - Be a long time active developer.
 - Vote of current Administrators.

