## Setup ADPAA via CoPAS

- Website to Download or Clone CoPAS:
  - https://github.com/daviddelene/CoPAS.git
- Clone Repository:
  - git clone
  - https://github.com/daviddelene/CoPAS.git
- Setup Aircraft Software:
  - mkdir ~/CoPAS\_Packages
  - cd ~/CoPAS\_Packages
  - ~/CoPAS/CoPAS.py
- Setup ADPAA on Linux:
  - ~/CoPAS\_Packages/ADPAA/bin/adpaa\_setup
- Setup Data Set:
  - cp -r

~/CoPAS\_Packages/ADTAE/TestData/FlightData/ 20150728\_153107 ~/20150728\_153107-SandBox OR

 Download the data to your \$HOME directory from http://192.168.123.40/20150728\_153107-SandBox



# 2D-C and 2D-S Data



#### EUFAR/ICCP/IUGG/IAMAS Expert Workshop on Processing of Cloud Particle Measurements

#### 7-9 July 2017 Oberpfaffenhofen, Germany

# Introduction: 2D-C



- Two-Dimensional Cloud Probe (2D-C)
- Optical Array Probe with One Laser
- 30  $\mu m$  resolution between 15  $\mu m$  and 3000  $\mu m$  in diameter.
- 1 Hz Data
- SODA code processes images.
- ADPAA's cplot2 plotting program can plot data or create images.

# Introduction: 2D-S



- Two-dimensional Stereographic Probe (2D-S)
- Optical array probe with two lasers, one vertically-oriented and one horizontallyoriented.
- 10  $\mu m$  resolution between 10  $\mu m$  and 2000  $\mu m$  in diameter.
- 1 Hz Data
- SODA code processes images, ADPAA wrapper code automates data processing.
- ADPAA's cplot2 plotting program displays data.

### **Creating Image Files**

- Navigate to directory where aircraft data is located (cd ~/20150728\_153107-SandBox).
- Execute script to process all images.
  - create\_all\_images
  - Calls all programs to create png image files.
    - plot2dc (ADPAA, for 2D-C images)
    - plotcip (ADPAA, for CIP and PIP images)
    - stripgifs (SODA, for 2D-S and HVPS images)
  - Only creates images if image directory is not present.

#### Visualizing Data: Graphical User Interface

- cplot2 ADPAA's data visualization program
  - Pure IDL code.
  - Plots multiple data on a single x- and y-axis.
  - Plots particle spectra, histograms, and boxplots.
  - Gives full control over axes ranges, colors, and text.
  - Filters data based on user-specified values.
  - Fits data to linear and non-linear regression lines.
  - Calculates and plots ratios between two parameters in same file.

#### Example: Open File in Cplot2 1) cd ~/20150728\_153107-SandBox/2DS\_Data 2) cplot2 15\_07\_28\_15\_31\_07.2DS\_V.conc.1Hz



#### Viewing Image Files

- Use your favorite photo viewing program that opens .png image files.
  - Examples include Eye of MATE, gThumb, ImageMagick, etc.
- This tutorial uses the Eye of MATE image viewer.
  - The command eom opens up the image viewer.
  - The command

eom ~/20150728\_153107-SandBox/2DC\_ImagesWithBars/15\_07\_28\_16\_23\_00.3320 .34409.00\_86.62.2dc\_image.png opens up the top image on the next slide.

## 2D-C Images



15\_07\_28\_16\_23\_00.3320.34409.00\_86.62.2dc\_image.png).

## 2D-C: Date of Flight

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8006(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

Date of the flight

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

### 2D-C: Start Time

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

#### Starting time of the first particle or timing bar in top row

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s

07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

### 2D-C: End Time

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s .7031(16:23:00) =58980TAS=86.6 m/s /28/ 58980.8906(16:2/3:00) End=58981.0312(16:23:01) Ending time of the first particle or timing bar in top row 07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 1 . . . 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) TAS=86.6 m/s Delta=0.140625 S 1 a 🖉 🗿 🖓 🖉

## 2D-C: Delta Time

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

#### Change in time (End minus Start) between first and last particle (or timing bar) in top row

1 × 1

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s

07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s

07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s

07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

### 2D-C: True Air Speed

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s 07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

#### True Air Speed (TAS) of the aircraft at the first particle (or timing bar)

07/28/15 Start=58980.3320(16:23:00) End=58980.5039(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.5312(16:23:00) End=58980.7031(16:23:00) Delta=0.171875 s TAS=86.6 m/s 07/28/15 Start=58980.7305(16:23:00) End=58980.8594(16:23:00) Delta=0.128906 s TAS=86.6 m/s

07/28/15 Start=58980.8906(16:23:00) End=58981.0312(16:23:01) Delta=0.140625 s TAS=86.6 m/s

### 2D-S Images

07282015 162300.78 Buffer width = 1280 microns. Project: UND-North Probe: 2DS Resolution: 10.0000 microns



Segment of an image produced by SODA image processing (whole image found at ~/20150728\_153107-SandBox/2DS\_Images/ 07282015\_162300.78\_2DS\_H.png).

### 2D-S Images

07282015 162300.78 Buffer width = 1280 microns. Project: UND-North Probe: 2DS Resolution: 10.0000 microns

07282015 162300.78 Buffer width = 1280 microns. Project: UND-North Probe: 2DS Resolution: 10.0000 microns



#### 2D-S Images: Date of Image



### 2D-S Images: Start Time



#### 2D-S Images: Project and Probe

07282015 162300.78 Buffer width = 1280 microns. Project: UND-North Probe: 2DS Resolution: 10.0000 microns

07282015 162300.78 Buffer width = 1280 microns. Project: UND-North Probe: 2DS> Resolution: 10.0000 microns



### 2D-S Images: Resolution



07282015 162300.78 Buffer width = 1280 microns. Project: UND-North Probe: 2DS Resolution: 10.0000 microns





### 2D-S Images: Buffer Width



## Data Comparison

Compare data from the 2D-C and 2D-S probes around the time of the images shown previously (16:22:55 [58,975 sfm] UTC to 16:23:05 [58,985 sfm] UTC on July 28<sup>th</sup>, 2015)

– 2D-C data is found in the directory

~/20150728\_153107-SandBox/PostProcessing

– 2D-S data is found in the directory

~/20150728\_153107-SandBox/2DS\_Data

- Use spectra where each data point represents a bin of particle data to show similarities between probes.
- Use line plots of concentration and mean diameter to show differences between probes.

#### Data Comparison: Making Spectra Plots

- Open 2D-S concentration file using cplot2:
  - cplot2 ~/20150728\_153107-SandBox/2DS\_Data/15\_07\_28\_15\_31\_07.2DS\_V.conc.1Hz
- Set time interval (Control > Time Interval) and plot the particle concentration spectrum (Plot > Spectrum).
- Set line weight/type and symbol type/size (Edit > Plot), set axes limits and properties (Edit > Axis), set axes and plot titles (Edit > Text), set spectrum type (Edit > Options > Spectrum Mode), and re-plot for changes to take effect (Plot > Spectrum).
- Change color of line by selecting an overlay color (Edit > Overlay) and re-plotting spectrum (Plot > Overlay Spectrum).
- Plot 2D-C spectrum on same axes by opening 2D-C concentration file (File > Open), changing color of overlay (Edit > Overlay), and overlaying 2D-C spectrum (*in original window:* Plot > Overlay Spectrum).

#### Data Comparison: Making Time-Series Plots

- Open 2D-S concentration file using cplot2:
  - cplot2 ~/20150728\_153107-SandBox/2DS\_Data/15\_07\_28\_15\_31\_07.2DS\_V.conc.1Hz
- Set time interval (Control > Time Interval), click to select 'Time [seconds]' in the X Axis column, scroll to click and select 'Nt2DSV\_all [#/m^3]' in the Y Axis column, and plot the graph (Plot > XY Graph).
  - 'Nt2DSV\_all' is the normalized 2D-S vertical channel concentration for all bin sizes.
- Set line weight/type and symbol type/size (Edit > Plot), set axes limits and properties (Edit > Axis), set axes and plot titles (Edit > Text), and re-plot for changes to take effect (Plot > XY Graph).
- To highlight inset on graph (see Concentration Comparison slides), set time interval accordingly (Control > Time Interval), set color of overlay (Edit > Overlay), and overlay color on desired section (Plot > Overlay).

#### Data Comparison: Un-normalized Spectra

ADPAA/SODA: Particle Concentration Spectrum 2015-07-28 162255-162305 UTC



#### Data Comparison: Spectra Normalized by



#### Data Comparison: Spectra Normalized by log (size interval)



#### **Concentration Comparison: All Channels**



 Red highlight shows data from 16:22:55 UTC to 16:23:05 UTC on July 28, 2015

#### **Diameter Comparison: All Channels**



 Red highlight shows data from 16:22:55 UTC to 16:23:05 UTC on July 28<sup>th</sup>, 2015

#### Diameter Comparison: Channels Greater than 105 um in Diameter



 Red highlight shows data from 16:22:55 UTC to 16:23:05 UTC on July 28<sup>th</sup>, 2015

#### Diameter Comparison: Channels Greater than 105 um in Diameter



 Red highlight shows data from 16:22:55 UTC to 16:23:05 UTC on July 28<sup>th</sup>, 2015

## Conclusions

- The two probes agree reasonably well during on July 28<sup>th</sup> for the period 16:22:55 [58,975 sfm] UTC to 16:23:05 [58,985 sfm] UTC .
  - Spectra have same general shape and local minima/maxima are within equal size ranges.



