HOLODEC Data Description

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1.0 Data Set Overview

The Holographic Detector for Clouds (HOLODEC-II) was flown during the Cloud Systems Evolution in the Trades (CSET) project from June 1 to Aug 15, 2015. The HOLODEC-II determines the size, two-dimensional shape, and three-dimensional position of hydrometeors via digital in-line holography.

2.0 Instrument Description

More information on the HOLODEC instrument can be found here.

3.0 Data Collection and Processing

To create final HOLODEC particle timeseries and histogram data (counts and concentration), collected images are reconstructed and classification rules are applied. Then, using two separate Matlab scripts, particle by particle timeseries (PBP) , and per-hologram histogram (H2H), records are created and stored in PBP and H2H files, respectively.

4.0 Data Formats

4.1 Raw Data Format

Raw imagery collected by the HOLODEC are stored in .seq files. *(Describe .seq format here.)*

3.3 holograms/second/flight are collected. These files require extensive processing to extract particle sizes, shapes and locations, and to generate size distributions, and are therefore not generally useful to the community. Preliminary data are archived, internal only, for file tracking purposes.

4.2 PBP Data Format

Particle-by-particle data are generated using holographic reconstruction techniques. This creates a list of particles and their x,y, and z location in the hologram, diameter, etc. Data are approx. 1Gb per flight. This level of detail should not be available to the public.
Data files follow the BADC-CSV format, with a couple modifications.

- Metadata field names contain upper-case
- Dimensionless units are indicated with a #

PBP files have names like CSET-HOLODEC-PBP_GV_YYMMDD.HHMMSS-HHMMSS.csv

Here is an example header for a single HOLODEC flight:

Conventions,G,BADC-CSV,1
title,G,Particle size distributions per hologram from HOLODEC cloud probe
creator,G,Raymond Shaw,Michigan Technological University
creator_email,G,rashaw@mtu.edu
location,G,Sacramento, CA - Kona, HI
feature_type,G,histogram
observation_station,G,N677F - NSF GV
activity,G,CSET
project,G,CSET
source,G,Holosuite Version 2016

date_valid,G,2015-07-22
FlightNumber,G,RF08
last_revised_date,G,2017-06-12
history,G,2017-06-12 Preliminary data (automatic processing)
comments,G,Processing settings: numzs>=5; minsiz>=6e-6; asprat<=1.5; minPatchArea=4
comments,G,Classification settings: underthresh>= 0.04; dsqoverlz<= 10
comments,G,Probe powered down periodically for heat management.
comments,G,see 1Hz file for power on/off times.
comments,G,Bad holograms are not included.
coordinate_variable,Time,Time
long_name,Time,instantaneous time of measurement, seconds since 2015-07-22 00:00:00 +0000
standard_name,Time,time,seconds since 2015-07-22 00:00:00 +0000,CF
type,Time,float
long_name,xpos,X-position in image frame,meters
type,xpos,float
_FillValue,xpos,-9999.0000
long_name,ypos,Y-position in image frame,meters
type,ypos,float
_FillValue,ypos,-9999.0000
long_name,zpos,Z-position between arms,meters
type,zpos,float
_FillValue,zpos,-9999.0000
long_name,area,Area,microns^2
type,area,float
_FillValue,area,-9999.0000
long_name,diameter,Equivalent diameter,microns
type,diameter,float
_FillValue,diameter,-9999.0000
long_name,major_axis,Major axis,microns
type,major_axis,float
_FillValue,major_axis,-9999.0000
long_name,minor_axis,Minor axis,microns
type,minor_axis,float
_FillValue,minor_axis,-9999.0000
long_name,roundness,Round particle flag,#
type,roundness,float
_FillValue,roundness,-9999.0000
data

This is followed by data with each row representing a single particle. Times are given to microsecond accuracy, and there can be many particle having the same timestamp, indicating they all come from the same hologram. For example:

Time,xpos,ypos,zpos,area,diameter,major_axis,minor_axis,roundness
54480.074100, 0.000458, 0.003145, 0.049400, 78.854402, 10.020007, 12.701906, 9.140772, 1.389588
54480.074100, -0.000226, 0.001024, 0.077600, 61.331197, 8.836815, 12.666907, 9.580615, 1.322139
54480.074100, 0.002017, -0.002659, 0.080300, 61.331197, 8.836815, 11.140207, 8.074283, 1.379715
54480.373000, 0.000419, 0.001021, 0.027700, 61.331197, 8.836815, 9.580615, 8.963508, 1.068847

The header, as given above, complies with the BADC-CSV format. To confirm compliance of your files with the BADC-CSV format, use the BADC-CSV format checker: http://badc.nerc.ac.uk/cgi-bin/badccsv/badctextfileChecker-cgi.py

4.3 H2H ASCII Data Format

For each hologram, particle size distributions and concentrations are generated and made available in both ASCII and NetCDF format. ASCII H2H data are available at two frequencies: sample rate (3.3 samples/sec) and 1hz. Final NetCDF files, suitable for viewing with ncplot and ncpp, and for comparison with the data from other RAF particle probes, are available at 1Hz.

Per-hologram and and averaged 1hz histogram data files follow the BADC-CSV format, with a couple modifications.

- Metadata field names contain upper-case
- Dimensionless units are indicated with a #
- A single piece of metadata can apply to more than one parameter. In this case, the column reference will match multiple column headers in the line after the “data” line. This allows us to concisely handle histogram data within the BADC format. The asc2cdf code will combine all of these columns into a single netCDF variable with an extra dimension equal to the number of columns.

H2H files have names like CSET-HOLODEC-H2H_GV_YYMMDD.HHMMSS-HHMMSS.csv

Here is an example H2H header for a single HOLODEC flight:

Conventions,G,BADC-CSV,1
title,G,Particle size distributions per hologram from HOLODEC cloud probe
creator,G,Raymond Shaw,Michigan Technological University
creator_email,G,rashaw@mtu.edu
location,G,Sacramento, CA - Kona, HI
feature_type,G,histogram

observation_station,G,N677F - NSF GV
activity,G,CSET
project,G,CSET
source,G,Holosuite Version 2016
date_valid,G,2015-07-22
FlightNumber,G,RF08
last_revised_date,G,2017-06-09 14:49
history,G,2017-06-09 Preliminary data
comments,G,Processing settings: numzs>=5; minsiz>=6e-6; asprat<=1.5; minPatchArea=4
comments,G,Classification settings: underthresh>= 0.04; dsqoverlz<= 10
comments,G,Probe powered down periodically for heat management
comments,G,see 1Hz file for power on/off times.
comments,G,Bad holograms are not included.
coordinate_variable,Time,Time
long_name,Time,instantaneous time of measurement, seconds since 2015-07-22 00:00:00 +0000
standard_name,Time,time,seconds since 2015-07-22 00:00:00 +0000,CF
type,Time,float
long_name,QCflag_LWII,QC flag,#
type,QCflag_LWII,float
flag_values,QCflag_LWII,1,2
flag_meanings,QCflag_LWII,Preliminary (automatic processing),Final (manual processing)
long_name,THDCC_LWII,Total number concentration,#/cm3
type,THDCC_LWII,float
long_name,THDCA_LWII,Total number of particles,#
type,THDCA_LWII,float
long_name,CHDC_LWII,Number concentration per bin,#/cm3/um
SampleVolume,CHDC_LWII,13
SampleVolumeUnits,CHDC_LWII,cm3
type,CHDC_LWII,,float
CellSizes,CHDC_LWII,6.0,10.0,12.5,15.0,17.5,20.0,22.5,25.0,30.0,35.0,40.0,45.0,50.0,60.0,70.0,80.0,90.0,100.0,150.0,200.0,250.0,300.0,350.0,400.0,450.0,500.0,2000.0
CellSizeUnits,CHDC_LWII,micrometers
CellSizeNote,CHDC_LWII,cell_sizes are upper bin limits as diameter
long_name,AHDC,_LWIITotal number of particles per bin,#
type,AHDC_LWII,float
CellSizes,AHDC_LWII,6.0,10.0,12.5,15.0,17.5,20.0,22.5,25.0,30.0,35.0,40.0,45.0,50.0,60.0,70.0,80.0,90.0,100.0,150.0,200.0,250.0,300.0,350.0,400.0,450.0,500.0,2000.0
CellSizeUnits,AHDC_LWII,micrometers
CellSizeNote,AHDC_LWII,cell_sizes are upper bin limits as diameter
data

Data begin with column headings that match the reference indices given in the header:

Time,QCflag_LWII,THDCC_LWII,THDCA_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_
LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII
,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CH
DC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_LWII,CHDC_
LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,
AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHD
C_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_L
WII,AHDC_LWII,AHDC_LWII,AHDC_LWII,AHDC_LWII

54480.074100,1,0.461538,6,0.038462,0.030769,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,5,
1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
54480.373000,1,0.692308,9,0.038462,0.092308,0,0,0,0,0,0,0.015385,0,0,0,0,0,0,0,0,0,0,0,0,0,0
,0,0,0,5,3,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0

5.0 Data Remarks

Flights RF01 and RF06 are missing - no data was collected.

The HOLODEC collects data at 3.3 holograms per second. In order to create 1hz data, some seconds will contain 3 holograms and some will contain 4. This varying sample size will cause a statistical variation on the concentration of less-common (larger) particles between the 3- and 4-hologram seconds.

The sample volume per hologram is a constant 13 cm^3.

The current version of the data is preliminary. Please contact the data team before using this data in research.

6.0 References

BADC-CSV format checker:
http://badc.nerc.ac.uk/cgi-bin/badccsv/badctextfileChecker-cgi.py

BADC-CSV format description:
https://badc.nerc.ac.uk/help/formats/badc-csv

Holographic Detector for Clouds instrument description:
https://www.eol.ucar.edu/instruments/holographic-detector-clouds