RICO Aircraft: C-130 Cloud Droplet Spectrum Fast-FSSP

1. Authors

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2. Data overview

The Fast-FSSP (FFSSP) was mounted on the left pod just below the SSP-100. Available time sections for each flight are listed in Table 1.

Table 1: Overview of Fast-FSSP data for RICO

Fltno	Time section		Range (micron)	Comment
	start	end		
RF01				Data not available
RF02				Data not available
RF03				Data not available
RF04				Instrument not on board
RF05	15:00:00 18:27:05	17:00:00 21:52:45	2.2 - 47.8 2.2 - 47.8	No data between 17:00:00 and 18:27:05 (power switched off)
RF06	16:24:00	19:51:45	2.2 - 47.8	Flight complete
RF07	15:00:00	21:20:00	2.2 - 47.8	Flight complete
RF08	12:15:00	18:50:00	2.2 - 47.8	Flight complete
RF09	13:30:00	16:45:00	2.2 - 47.8	Flight complete
RF10				Instrument not on board
RF11	15:00:00	20:10:00	3.2 - 48.0	Flight complete
RF12	16:30:00	21:30:00	3.2 - 48.0	Flight complete
RF13	14:20:00	20:13:00	3.2 - 48.0	Flight complete
RF14	15:45:00	22:25:00	12.3 - 49.1	Very high size threshold
RF15	16:35:00 18:46:06	17:55:00 21:30:00	6.3 - 47.7 6.7 - 47.7	Below CB legs are noisy and have been removed.
RF16				Data not available
RF17				Instrument not on board
RF18				Data not recorded
RF19	10:17:00 11:37:00 13:06:00	10:27:00 11:38:10 14:41:14	3.1 - 38.8 3.1 - 38.8 3.1 - 38.8	First and last cloud legs are missing

3. Instrument description

The FFSSP is a modified version of the FSSP-100 with electronics that record for each detection individually, the pulse amplitude (255 size classes), pulse duration and inter-arrival time from the previous detection with a resolution of 1/16 μs and a flag for the position of the particle with respect to the depth of field (DOF) (Brenguier et al. 1998). Comparisons with measurements from FSSP-100 and LWC devices such as PVM or CSIRO hot wire probe, can be found in Burnet et Brenguier (2001).

The diameter range depends on the electronics setting of the probe. It is indicated for each flight in Table 1.

4. Data collection and processing

Data recorded asynchronously for each detection, allow us to rebuild the complete time series of counts. Standard processing at 1 or 10 Hz provides mean sample values of microphysical parameters such as cloud droplet number concentration, liquid water content, mean volume diameter, etc... The spectrum is represented by its 5% percentiles so that each of the 19 bins has the same statistical representativeness. Complete droplet size distribution over the 255 size classes could however be provided on request.

Calibration:

The preliminary processing has been done by using the glass beads calibrations realized after each probe cleaning, as listed in the Table 2. The glass beads spectra allow us to derive the Mie curve corresponding to the current configuration of the probe. This Mie curve is then fitted by a 5 degree polynomial curve. The 5 corresponding coefficients are indicated in the header of the each file.

Sample volume:

Computation of the droplet number concentration requires the knowledge of the DOF section to calculate the sampled volume. The DOF section depends on the electronics setting of the probe. It is measured by passing a 25 micron hole through the laser beam. A constant value has been used for each flight. They are listed in the Table 2 and are indicated in each file header as well.

Table 2: FFSSP glass beads calibration and DOF for RICO

Fltno	Calibration		DOF
	Date	ID	(mm^2)
RF05 to RF09	11 Dec 04	ca0003	0.1030
RF11 to RF13	07 Jan 05	ca0005	0.1170
RF14	13 Jan 05	ca0007	0.1100
RF15	15 Jan 05	ca0008	0.1100
RF19	19 Jan 05	ca0010	0.1000

5.0 Data format

a. File Naming Convention

There is one ASCII data file for each time section listed in the Table 1. The name of the ASCII data file gives the flight number, the time at the beginning of the section and the sampling rate. For example FFSSP_RF06_162400.0R0001 means that the section from flight RF06, starts at 16:24:00 (UTC) and that the sampling rate is 1 Hz.

When there are several time sections for one flight (RF05, 15 and 19), the ASCII data files are regrouped in a tar file FFSSP_Fltno.tar, where Fltno is the flight number.

b. File format

Format of R files: synchronous sampling.

The header provides information about processing and calibration coefficients:

```
# File created on: 16  8  5  at: 12  3 40  by: rdnew_LX
# startime= 8615000  duration=12465000  delay=    1900 (ms)
# filtering level= 4    modetype=1
# Time drift corrected
# DTV=  0
# DOF sampling section=  0.1030 (mm2)
# Calibration Coeff(5)=
#  0.17517E+01  0.47286E+00 -0.31565E-02  0.13004E-04 -0.20074E-07
```

The following lines are the data in the following order from var (1) to var (45), all integers.

var(1) : elapsed time (ms) since the beginning of the section (for example, with a 1 Hz processing, var(1) is incremented by 1000 for each sample).
var(2) : FFSSP record and bloc at the end of the sample
var(3) : control on the bloc duration
var(4) : control of synchronization

SOME DATA FROM THE BASIC ACQUISITION SYSTEM
var(5) : True air speed*1000 (m s^{-1}) from TASX[1]
var(6) : Altitude*1000 (m) from GCALTC[1]
var(7) : Pressure*1000 (mbar) from PSXC[1]
var(8) : Temperature*1000 (C) from ATX[1]
var(9) : Water vapor mixing ratio*1000 (g m^{-3}) from RHOLA[1] (RF05 to RF13) and RHOLA1[1] (RF14 to RF19)
var(10): Vertical velocity*1000 (m s^{-1}) from WIC[1]
var(11): PVM LWC*1000 (used for synchronization) from XGLWC[1]
var(12): Air density*1000 (kg m^{-3})

FFSSP DATA
var(13): Total droplet rate (s^{-1})
var(14): Mean pulse duration over all detections (digit)
var(15): Droplet rate in DOF (s^{-1})
var(16): Mean pulse duration for DOF detections (digit)
var(17): Coincidence correction*1000
var(18): Droplet concentration (cm^{-3})
var(19): Integral diameter*1000 (micron cm^{-3})
var(20): LWC*1000 (g m^{-3})
var(21): Reflectivity*1000 (dBz)
var(22): Mean diameter*1000 (micron)
var(23): Mean volume diameter*1000 (micron)
var(24): Effective Diameter*1000 (micron)
var(25): Main mode in the diameter distribution*1000 (micron)
var(26): Second mode in the diameter distribution*1000 (micron)
var(27): 5% percentile*1000 (micron)
.....
var(45): 95% percentile*1000 (micron)

[1] parameter name of the netcdf RAF file.

6. Data quality

Glass beads and/or lycopodium has been used to check the probe calibration before and after each flight, as much as possible. The analysis have shown that the salt deposition on the probe optics leads to an underestimation of the droplet size which can be significant (see the presentation from the June 2005 RICO data meeting on the JOSS RICO web site, http://www.joss.ucar.edu/rico/).
The self-calibration technique based on the Mie bumps (Brenguier et al., 1998) would be use to detect and eventually correct this loss of sensibility of the probe.

Preliminary comparison with the other microphysical probes have also shown that the FFSSP probably underestimates the droplet number concentration of the smaller droplets (MVD < 12 micron). Variation of the DOF section is likely to be responsible to this underestimation. Laboratory study would be conducted soon to investigate this dependence of the DOF section with the droplet size. A second processing would be done with a variable DOF section if necessary.

The droplet number concentration of the clouds sampled during this project is very low, with typical 1 Hz values around 50 cm^{-3}. Data processing with a higher sampling frequency to increase the spatial resolution will then seriously decrease the statistical representativeness of the results. An alternative would be to use the optimal estimator of Pawlowska et al. (1997).

7. References

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