README

IWGADTS Data Set from GoAmazon, Feb. 22nd to Mar. 23rd and Sep. 8th to Oct. 10th 2014

Created by Fan Mei for PNNL ARM Aerial Facility.

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1 Data source

The data were collected onboard the G1 aircraft, operated by the PNNL ARM Aerial Facility during the GoAmazon campaign.

Background: The Interagency Working Group for Airborne Data and Telemetry Systems (IWGADTS) is developing a suite of tools to promote standardization of instrument interface, data format and data processing. ARM Aerial Facility uses the IWGADTS "IWG1" format and the detailed information can be found at: http://www.eol.ucar.edu/iwgadts.

1.1 Location

Origin and termination of the data files is the aircraft's base. In this campaign, there are two intensive observation periods. The sampling location is near Manaus, AM, Brazil. The aircraft flight paths are primarily over the amazon basin along the downwind of Manaus.

1.2 Time period of collection

Flights were conducted in wet season and dry season. The first one is from February 22^{nd} to March 23^{rd} and the second one is from September 8^{th} to October 10^{th} .

1.3 General description:

Measurements from multiple instruments are consolidated into a single file. The data structure is described in the diagram below and the instrument origins and precision in a table.



1.4 Level a0

Level "a0" data consist of the output data from SEA M300 data acquisition.

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The file is only used in flight to disseminated information to instruments and provides visual display of aircraft location.

1.5 Level a1

1.5.1 Version1

Level a1 data consist of aircraft state and meteorological parameters from different instruments consolidated into one file.

The following data files are merged into the IWG1 level a1 file:

- Aimms20 output from yyyymmdds.aim.txt
- DSM outputs: yyyymmdds.dsm.txt
- TANS outputs: yyyymmdds.tans.txt
- Cabin outputs: yyyymmdds.cab.txt
- MET outputs: yyyymmdds.met.txt
- Dilutor outputs: yyyymmdds.dil.txt

Level a1 data is available in 2 formats:

- 1. ascii file under the name: "YYYYMMDDs.IWG1.a1.ver1.txt". The file is comma delimited. It contains 2 lines of headers: IWGADTS variable short name and corresponding units.
- 2. IWGATS formatted files under the name: "aaf.iwg1001s.g1.bbop.YYYYMMDDs.hhmmss.a1.txt". The name of the file reflects the version.

1.5.2 Version 2

This version is produced during the campaign to include dilution corrections and may also reproduce after campaign to include other corrections. (i.e.: instruments post-campaign calibrations.) The ascii file name will be "YYYYMMDDs.IWG1.a1.ver2.txt".

1.6 Level a2

Level a2 data set is the final version of IWG1 file. The name of the file reflects the version: "aaf.iwg1001s.g1.bbop.YYYYMMDDs.a2.txt"

1.7 IWG1 format

File naming conventions: Each file is named according to a convention beginning with the year, month, day (at the begin time of the flight), and a serial letter (with "a" being the first flight of the day, "b" being the second, etc.). The First line includes the number of header lines.

Subsequent lines (records) are strings have the following attributes

- Each data string is terminated by a carriage-return and line feed: \r\n

- Fields not supplied are assigned -9999

- Custom parameters are added at the end of each string: for this campaign, flags were developed to mark aircraft attitude, cloud penetration, and cloud types.

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Figure 1: IWG1 definitions: Aircraft reference frame versus inertial (earth surface) frame

1.8 Data description and instrument source:

Index	Variable Name	Units	Range or Frequency	From Instrument:	Accuracy	Description Definition
1	IWG1		1Hz			String identifier
2	Date / Time	UTC	YYYY-MM-DD hh:mm:ss	SEA M300 DAQ		Date and Time stamp in Iso8601 format. Synchronized daily with GPS external antenna or available zulu time.
3	Lat	Degrees	-90 to 90	Aimms-20 (DSM)	± 1 m (±1 m)	Platform latitude
4	Lon	Degrees	-180 to 179.99999	Aimms-20 (DSM)	± 1 m <i>(±1 m)</i>	Platform longitude
5	GPS_MSL_Alt	m	0 to 15 km	Calculated		Mean Sea Level altitude calculated from GPS altitude using the geoid model EGM96 worldwide 15-minute binary geoid height data from National Geospatial Intelligence Agency.
6	WGS_84_Alt	m	0 to 15 km	Aimms-20	±5 m	Altitude above the ellipsoid based on WSG-84.
7	Press_Alt	ft	0 to 11 km	Calculated		Calculated from US standard atmospheric tables.
8	Radar_Alt	ft	0 to 36,000 ft	Calculated		Calculated using GPS altitude and position with the Digital Terrain Elevation Data sets from NGA. Resolution of

Table 1: IWG1 format description

						terrain is 30 arc sec spacing.
9	Gnd_Spd	ms-1	0 to 150 ms ⁻¹	Calculated		Platform speed over the ground. Calculated from Aimms20 measurements.
10	True_Airspeed	ms ⁻¹	0 to 150 ms ⁻¹	Aimms-20		Platform airspeed through the air (TAS). Compensated for non-standard pressure and temperature.
11	Indicated_ Airspeed	ms ⁻¹	0 to 150 ms ⁻¹	Aimms-20		Calculated based on the TAS and static temperature measured by Aimms-20.
12	Mach_Number	Dimension -less	0 to 1	Calculated		Aircraft Mach number Ma = TAS/speed of sound
13	Vert_Velocity	ms ⁻¹		Aimms-20 (DSM)		Platform vertical velocity defined in the body frame. Positive is up.
14	True_Hdg	Degrees	0 to 359	Aimms-20 <i>(TANS)</i>	(0.3°)	Platform direction with respect to true north . Angle between aircraft longitudinal axis and true north. Defined in the body frame.
15	Track	Degrees	0 to 359	Calculated		Platform path angle from the True North. Defined in the earth reference frame. Calculated from Aimms20 measurements.
16	Drift angle	Degrees	-45 to 45	Calculated		The angle between the heading of aircraft and the track
17	Pitch	Degrees	-90 to 90	Aimms-20 (TANS)	(0.25°)	Angle between the aircraft longitudinal axis and the horizon. Defined in the body frame. Positive is nose up.
18	Roll	Degrees	-90 to 90	Aimms-20 (TANS)	(0.5°)	Angle between the aircraft vertical and lateral axis. Defined in the body frame. Positive is right wing down.
19	Side_Slip	Degrees	-90 to 90	Calculated		Derived from Aimms-20 differential pressures. Angle between the longitudinal axis and relative wind or flight path.
20	Angle_of_Attack	Degrees	-90 to 90	Calculated		Derived from Aimms-20 differential pressures. Angle between the aircraft longitudinal axis and relative wind or flight path.
21	Ambient_Temp	Celsius	-50 to 50 (-20 to 50)	G-1 Rosemount 102E (Aimms-20)	± 0.5C (± 0.1C)	Air temperature also called static temperature or OAT.
22	Dew_Point_Temp	Celsius	-75 to 50	G-1 General Eastern 1011-B	± 0.5C	Dew point temperature
23	Total_Temp	Celsius	-50 to 50 (-20 to 50)	G-1 Rosemount 102E (Aimms-20)	± 0.5C (± 0.1C)	Total temperature
24	Static_Press	mbar	400 to 1060	G-1	3mb	Static pressure

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			(0 to 1100)	Rosemount 1201F1 (Aimms-20)	(1mb)	
25	Dynamic_Press	mbar	0 to 140	Gust Probe (Aimms-20)	0.2mb	Dynamic pressure
26	Cabin_Press	mbar		G-1 Setra		Cabin pressure
27	Wind_Speed	ms ⁻¹		Aimms-20		Wind speed. Defined in the earth frame at altitude Zg.
28	Wind_Dir	Degrees	0 to 359	Aimms-20		Wind direction (from). Angle is with respect to True North in the earth frame at altitude Zg.
29	Vert_Wind_Spd	ms ⁻¹		Aimms-20		Vertical Wind speed in the earth frame at altitude Zg. Up is positive.
30	Solar_Zenith_Gnd	Degrees	0 to 90	Calculated		Calculated using Matlab script running equations derived from NREL technical report TP560-34302. Defined in the earth reference frame with respect to vertical.
31	Sun_Elev_AC	Degrees	0 to 90	Calculated		Calculated NREL/TP560-34302 Defined in the body frame.
32	Sun_Az_Gnd	Degrees	0 to 359	Calculated		Calculated NREL/TP560-34302 Defined in the earth reference frame with respect to True North.
33	Sun_Az_AC	Degrees	0 to 359	Calculated		Calculated NREL/TP560-34302 Defined in the body frame.
34	Flag_qc	Dimension less	Integer value 0 to 127	Binary flag		Quality check flag. When positive indicates secondary instrument was used or some data must be used with caution. See table below.
35	Flag_ac	Dimension less	- 4 to + 4	Integer flag		Maneuver flag (level, climb, etc) See table below.
36	Flag_Diluter	Dimension less	0 or 1	Integer flag		Inlet selection flag for Diluter 0 = Diluter off 1 = Diluter on
37	Flag_in_cloud	Dimension less	0 or 1	Integer flag		See table below 0 = Clear (no cloud) 1 = Large Particle detected 2 = Cloud
38	Flag_cloud_phase	Dimension less				0 = Clear (no cloud) 1 = Liquid cloud 2 = Mixed cloud 3 = Ice cloud
39	RH_water	Percent	0 to 100	Calculated		Calculation is based on Goff– Gratch (1946) equation
40	RH_ice	Percent	0 to 100	Calculated		Calculation is based on Goff- Gratch (1946) equation over ice
41	Theta	Celsius		Calculated		Calculated from ambient temperature and pressure.
42	Cabin_Temp	Celsius				Temperature sensor located

IWGADTS Data Set

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					on the first rack in G1. (Tcab1)
43	Q_Dilution	LPM	0 to 10	MFC	Zero air from bottle, controlled by MFC (10 LPM)
44	Q_bypass	LPM	0 to 5	MFC	Zero air from bottle, controlled by MFC (5 LPM)
45	D_ratio	Dimension less		Calculated dilution factor	Calculated from Q_total/(Q_total-Q_Dilution), Q_total sums up all the flows from 2 CPCs, FIMS, PSAP, PMex.
46	Leg_num	Dimension less	1-20	Integer	Calculated based on altitudes

1.9 Definition and diagrams

The figures below supplement the definitions of table 1.



Figure 2: Aircraft reference frame and angles definitions, top view



Figure 3: Aircraft reference frame and angles definitions, side view

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Figure 4: Aircraft reference frame and angles definitions, front view



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Figure 6: Sun angle definitions

The Maneuver flag is defined according to the following table:

Table 2: Maneuver flag definition

Flag		Conditions
+ 4	Climb right turn	
+ 3	Climb straight	
+ 2	Climb left turn	
+ 1	Level flight right turn	Roll angle > 4 $^{\circ}$
0	Straight and level flight	-0.15 < dP/dt < 0.15
- 1	Level flight left turn	Roll angle < - 4 °
- 2	Descent right turn	
- 3	Descent straight	
- 4	Descent left turn	

The variables (calibrated value or calculated) from Table4 have been through a first quality check. A quality flag is issued based on the choice of primary instrument for the variables and based on known issues with the primary parameters. The quality flag is a decimal between 0 and 16384 formed by a binary string. Use a function to translate the flag from decimal to binary string. The binary string has 14 bits, it covers the different instruments used and some calculated variables. For each of the binary index, zero means data from AIMMS-20, 1 means the data is from default instruments as described in the following table.

MSB index	Variable short name	IWG1 list index	Issue
1	Lat, Lon, WGS_84_Alt, Vert_Velocity	3, 4 6 13	Platform position and velocity from DSM (default instrument)
2	Radar_Alt	8	Calculated altitudes to be used with caution due to inaccuracy (precision is around 100m due to grid size of the DTED input files)
3	True_Airspeed	10	TAS flagged due to problem with AIMMS-20
4	True_Hdg, Pitch, Roll	14 17 18	Platform attitude from TANS (default instrument) or corrected with TANS offset due to known bias in pitch and roll of Aimms20 probe.
5	Side_Slip, Angle_of_Attack	19 20	Freestream direction to be used with caution due to sensor error or correction applied
6	Ambient_Temp, Total_Temp	21 23	Temperature from AIMMS-20 sensors or corrected due to known error
7	Dew_Point_Temp	22	Dew point temperature flagged due to problem with GE sensor
8	Static_Press	24	Static pressure from AIMMS-20 sensors instead of usual static source
9	Dynamic_Press	25	Dynamic Pressure to be used with Caution, problem with sensor
10	Cabin_Press	26	Known problem with cabin pressure sensor
11	Wind_Speed, Wind_Dir	27 28	AIMMS20 winds speed and direction to be used with caution
12	Vert_Wind_Spd	29	AIMMS20 Wind Vertical Velocity to be used with caution
13	Solar_Zenith_gnd, Sun_Az_Gnd	30 32	Solar angles to be used with caution
14	Sun_Elev_AC, Sun_Az_AC	31 33	Sun angles from the platform to be used with caution

Table 3: Quality check flag definition for level a1