

# CLIMATE

AWS data from each of the seven ABRACOS sites are presented in 6 month blocks with a file name format as follows:

AB-C[sitecode].[year][A or B]

where the site codes are:

FD	Fazenda Dimona	Manaus
NS	Fazenda Nossa Senhora Aparecida	Ji-Parana
BS	Fazenda Boa Sorte	Maraba
RD	Reserva Ducke	Manaus
RJ	Reserva Jaru	Ji-Parana
RV	Reserva Vale do Rio Doce	Maraba
MS	Urban climate	Manaus

A and B correspond the first and second half of the year.

Each line of the files contains the following data

Site Code

Year

Day number

Time GMT

Incoming solar radiation (direct + diffuse) (W /m<sup>2</sup>)

Reflected solar radiation (W /m<sup>2</sup>)

Net all-wave radiation (W /m<sup>2</sup>)

Wet bulb temperature (Degrees C)

Air temperature (Degrees C)

Wind speed (m/s)

Wind direction (Degrees from North)

Soil heat flux	(W/m <sup>2</sup> )
Rainfall	(mm)

The data were written to the files using the FORTRAN format statement -

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FORMAT(1X,A2,1X,I4,1X,I3,1X,I4,1X,9(F9.2))
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Missing data are given the value -99.99.

## SITE DESCRIPTIONS

### *a. Reserva Ducke, Manaus*

Reserva Ducke (2 57'S, 59 57'W) is an area of protected primary forest, 25 km north-east of Manaus at 80 m above mean sea level. The experimental site was also the site of the Amazon Regional Micrometeorological Experiment in the early 1980s (see Shuttleworth et al. (1991) for a summary), but was re-established for ABRACOS in late 1990. The mean forest canopy is 35 m high, but some trees reach up to 40 m. The forest in Reserva Ducke, in common with the other two forest sites studied, is made up of a large variety of tree species. The tallest species in the area around the tower are *Piptadenia suaveolens* Miq., *Licania micrantha* Miq., *Bocoa viridiflora* (Ducke) Cowan, *Naucleopsis glabra* Spruce ex Baill and *Enterolobium schomburgkii* Benth. The site is surrounded by undisturbed forest for at least 5 km. An extensive description of the site is given by Shuttleworth et al. (1984) and Roberts et al. (1990). The automatic weather station is mounted at the top of a 45 m aluminium tower.

### *b. Fazenda Dimona, Manaus*

#### Pasture

Fazenda Dimona (2 19'S, 60 19'W) is a cattle ranch located about 100 km north of Manaus. The ranch is a 10 km square clearing at an altitude of 120 m above mean sea level. It was created in about 1975 by felling and burning an area of primary forest. The ground was planted with pasture grass (*Brachiaria decumbens* and *Brachiaria humidicola*) but 11% of the surface area is bare soil and many felled tree trunks still remain, covering 5% of the ground area (Wright et al. 1992). The pasture has been regularly burnt to destroy the vigorous regrowth of bushes. Since late 1992, however, this practice has ceased and the pasture is becoming rapidly overgrown. Instrumentation was installed at the site in September 1990. The automatic weather station is mounted at the surface. Descriptions of the site are given by McWilliam et al. (1993) and Wright et al. (1992) together with the results of biomass and micrometeorological measurements respectively.

#### Forest

Soil moisture access tubes were installed in primary forest close (900m) to the Pasture of Fazenda Dimona and the above site location details apply. See Hodnett et al. 1995.

***c. Reserva Vale do Rio Doce, Maraba***



This forest site (5 45'S, 49 10'W) was established in July 1991 in the forest reserve of the Companhia Vale do Rio Doce at 150 m above sea level 50 km to the south of Maraba. The forest reserve is 17,000 hectares in area and is to a large degree uncut, but is almost completely surrounded by cleared areas. The automatic weather station is mounted on top of a 52 m tower positioned to the east of a mature Brazil nut tree (*Bertholletia excelsa* HBK) with a height of 49 m, but the continuous forest canopy, consisting mainly of *Inga alba* (SW) Willd, *Pourouma guianensis* Aubl., *Guarea guidonia* (L.) Sleumer and *Sagotia brachysepaia* (Muell Arg.) R.Secco in the area surrounding the tower, is much lower, around 20 to 25 m. The abundance of the large Brazil nut trees is a characteristic feature of the

forests in the Maraba region and means that the structure of the canopy in this area differs considerably from that of the Reserva Ducke or Reserva Jaru sites. See Roberts et al (1996), Sa et al (1996) and Solamao (1991).

***d. Fazenda Boa Sorte, Maraba***

Fazenda Boa Sorte (5 10'S, 48 45'W) is a cattle ranch 50 km to the north-east of Maraba at 170 m above mean sea level and was deforested sometime before 1975. The site was established in July 1991 and is a large area of pasture covered predominantly with tropical grass (*Panicum maximum* Jacq.) and small patches of bare soil: a red-yellow sandy loam Latosol (Oxisol). The ranchland has numerous Babau palms which, because of their resistance to fire, commonly remain after forest clearance, and as such is typical of clearings in the Maraba region. See Roberts et al (1996), Sa et al (1996). The site differs from Fazenda Dimona in that the dead tree trunks and stumps were removed in the initial clearance. The automatic weather station is mounted at the top of a 6 m aluminium tower.

***e. Reserva Jaru, Ji-Parana***



Reserva Jaru (10 05'S, 61 55'W) is a forest reserve owned by the Brazilian Environmental Protection Agency (IBAMA) and is located about 80 km north of Ji-Parana at 120 m above



sea level. The 52 m forest tower was installed and instrumented in October 1991. The mean height of the forest canopy is 33 m. The tallest tree species in the area immediately surrounding the tower are *Cedrella odorata*, *Inga* sp., *Dioclea* cf *bicolor* Bth., *Strychnos amazonicus* Krukoff, *Protium polybotrium* and *Leonia glydicarpa* Ruiz, see McWilliam et al. (1996) and Roberts et al. (1996). The automatic weather station was mounted at the top of the tower.

***f. Fazenda Nossa Senhora da Aparecida, Ji-Parana***

This site (10 45'S, 62 22'W) was established in October 1991 on a cattle ranch 220 m above sea level about 50 km east-north-east of Ji-Parana . The site was deforested in about 1977 and is in the centre of an area of about 50 km in radius which has been largely cleared. The grass (*Brachiaria brizantha*) is clumpy and the original planting rows can still be clearly seen from above, see McWilliam et al. (1996) and Roberts et al. (1996). The area of bare soil was surveyed in April 1993 and found to form 12% of the surface area. The ranchland is similar in appearance to Fazenda Boa Sorte with several palms and, in contrast to Fazenda Dimona, with very few dead tree trunks. The pasture had been burnt in the month prior to equipment installation, but it was not burnt again during ABRACOS. The automatic weather station is mounted in a similar way to that at Fazenda Boa Sorte.

***g. Manaus City***



This urban weather station site was established in October 1990 close to the Instituto Nacional de Pesquisas da Amazonia (INPA) in Manaus (60 10'W, 3 6'S) to assess the effect of urbanisation on climate in Amazonia. The site is representative of the urban area of Manaus, but not in the centre of that area, see Maitelli and Wright (1996). The weather station was installed over an area of grass and so care should be taken with interpretation of data such as net radiation and reflected solar radiation. These parameters should not be assumed to be representative of the urban landscape as a whole. The weather station is mounted at the surface similarly to the Fazenda Dimona weather station.

For reasons of security and to avoid damage by livestock, the instruments at all the ranchland sites are located within wire fenced enclosures of about 10 m by 10 m. However, to ensure that the measurements are as representative as possible of the grazed areas, the grass within these enclosures is regularly monitored and cut when necessary to keep it of similar length to that outside the enclosures.

## INSTRUMENTATION

The instruments used to record these data are discussed by Bastable et al.(1993) but are also summarised below. The data were recorded as hourly averages, or in the case of rainfall an hourly total, by a Campbell Scientific CR10 logger.

### *Solar radiation.*

Kipp and Zonen (Delft, The Netherlands) CM-5 solarimeter recorded radiation of wavelengths 0.3 to 3 micrometers. A similar sensor but inverted was used to measure the reflected solar radiation. The error in these measurements is estimated to be about plus or minus 1 %.

### *Net radiation*

Net all-wave radiation measured by a single dome Q\*6 radiometer (Radiation Energy Balance Systems, Seattle, USA). A comparison was carried out between these instruments and the agreement between was found to be better than their probable calibration errors of about plus or minus 3%.

### *Wet bulb temperature and air temperature*

The wet bulb and air temperatures were measured using aspirated platinum resistance thermometers housed in an Institute of Hydrology design psychrometer screen. The thermometers were calibrated against a standard and are accurate to plus or minus 0.1 degree C.

### *Wind speed and direction*

Wind speed was measured by an DWR-201 anemometer and wind direction by a DWD-103 wind vane both manufactured by Didcot Instruments Ltd, Abingdon, UK. The anemometer has metal cups of robust design and a starting speed of 0.3 to 0.4 metres per second and a stalling speed of 0.2 metres per second.

### *Soil heat flux.*

The soil heat flux was measured with two model 610 soil heat flux plates (Thorntwaite, Elmer, New Jersey, USA), which were installed at a depth of 5 mm. The value recorded in the dataset is an average of the values from the two instruments.

## *Rainfall*

Rainfall was measured using a 0.2 mm resolution tipping bucket raingauge (Didcot Instrument Company, Abingdon UK). The instrument stood on a concrete slab at the surface. For the sites at which the weather station was mounted on a tower the raingauge was connected by a tube to a funnel mounted at the same height as the weather station.

Instrument heights Measurement	Site						
	RD	FD	MS	RV	BS	RJ	NS
Solar radiation	47.0	3.0	3.0	53.0	6.0	53.0	6.0
Reflected solar	44.0	1.2	1.2	51.3	3.9	51.0	3.9
Net Radiation	45.0	1.2	1.2	51.3	3.9	51.0	3.9
Wet bulb and air temperature	46.5	1.2	1.2	52.5	5.1	52.5	5.1
Wind speed and direction	46.5	2.0	2.0	52.5	5.4	52.5	5.4
Rainfall	45.0	0.3	0.3	52.0	6.0	52.0	6.0

## START AND END DATES OF DATA

N.B The AWSs were not dismantled in December 1993 (except for Manaus City), and measurement continued beyond this date. These subsequent data are managed by CPTEC/INPE at Cachoeira Paulista, SP, Brazil.

Site	Start date	End date
Reserva Ducke	31/12/90	31/12/93
Fazenda Dimona	1/10/90	31/12/93
Reserva Vale do Rio Doce	23/07/91	27/12/93
Fazenda Boa Sorte	9/07/91	28/12/93
Reserva Jaru	24/10/91	31/12/93
Fazenda Nossa Senhora	4/10/91	31/12/93
Manaus City	8/11/90	30/04/93

## MAJOR PERIODS OF MISSING DATA

Periods of more than 24 hours when data from all instruments is missing are listed.

Site	Year	Start day	Time	End day	Time	No. Hours
RD	1990	274	100	275	2100	44
RD	1992	97	1700	143	1500	1102
RD	1992	226	1300	234	1600	195
RD	1992	282	1500	283	2100	30
RD	1993	85	1400	92	1400	168
RD	1993	253	1300	266	1500	314
FD	1990	345	2100	353	1700	188
FD	1991	66	2200	72	2000	142
FD	1991	190	1400	193	2400	82
FD	1992	72	1300	79	1300	168
FD	1992	107	1300	114	1200	167
FD	1992	261	1300	275	800	331
FD	1992	289	1200	295	1400	146
FD	1993	119	1600	126	1400	166
FD	1993	140	2000	149	1200	208
RV	1991	182	100	204	1800	545
RV	1992	48	1400	166	1800	2836
RV	1992	168	1400	171	1900	77
RV	1992	209	1400	223	1300	335
RV	1992	274	1500	279	1600	121
RV	1992	289	1300	293	2000	103
RV	1993	39	1400	41	1600	50
RV	1993	81	1400	102	1700	507
RV	1993	193	1400	221	1300	671
RV	1993	242	1600	244	1200	44
RV	1993	361	1700	365	2400	104
BS	1991	182	100	190	2000	211
BS	1991	202	1400	211	1300	215
BS	1992	176	1400	245	2000	1662
BS	1992	273	1300	280	1600	171
BS	1992	291	1800	294	1700	71
BS	1993	82	800	89	1400	174

BS	1993	52	1300	169	1400	409
BS	1993	173	1400	195	900	523
BS	1993	202	800	208	1300	149
BS	1993	228	2300	230	1200	37
BS	1993	246	100	251	1000	129
BS	1993	264	1400	278	1800	340
BS	1993	362	1300	365	2400	84
RJ	1991	274	100	297	1500	566
RJ	1992	25	1300	36	1300	264
RJ	1992	36	1500	45	1300	214
RJ	1992	136	1400	142	2000	150
RJ	1993	364	2000	1	100	53
RJ	1993	86	2200	92	1400	136
NS	1991	274	100	277	1500	86
NS	1992	102	1800	104	500	35
NS	1992	104	1700	107	500	60
NS	1993	23	2000	26	2000	72
NS	1993	256	1400	262	1800	148
MS	1990	305	100	312	1200	179
MS	1991	301	1400	308	1300	167
MS	1992	219	1900	225	2000	145
MS	1992	290	1600	297	1400	166
MS	1992	350	1700	364	2000	339
MS	1993	106	1600	113	1600	168

Particular problems were experienced with the raingauges which lead to a poor record of rainfall at some of the sites. Periods of longer than 24 hours for which there is no rainfall record are listed.

Site	Year	Start day	Time	End day	Time	No. Hours
RD	1990	274	100	275	2100	44
RD	1992	97	1700	143	1500	1102

RD	1992	226	1300	234	1600	195
RD	1992	282	1500	283	2100	30
RD	1993	1	100	92	1400	2197
RD	1993	133	100	303	100	4080
FD	1990	274	100	279	100	120
FD	1990	344	2200	353	1700	211
FD	1991	54	100	180	100	3024
FD	1991	190	1400	193	2400	82
FD	1992	72	1300	79	1300	168
FD	1992	107	1300	114	1200	167
FD	1992	261	1300	275	800	331
FD	1992	289	1200	295	1400	146
FD	1993	17	100	134	100	2808
FD	1993	140	2000	149	1200	208
RV	1991	182	100	204	1800	545
RV	1992	48	1400	166	1800	2836
RV	1992	168	1400	171	1900	77
RV	1992	209	1400	223	1300	335
RV	1992	274	1500	279	1600	121
RV	1992	289	1300	293	2000	103
RV	1993	39	1400	41	1600	50
RV	1993	81	1400	102	1700	507
RV	1993	193	1400	221	1300	671
RV	1993	242	1600	244	1200	44
RV	1993	361	1700	365	2400	104
BS	1991	182	100	190	2000	211
BS	1991	202	1400	211	1300	215
BS	1992	176	1400	245	2000	1662
BS	1992	273	1300	280	1600	171
BS	1992	291	1800	294	1700	71
BS	1993	82	800	89	1400	174
BS	1993	152	1300	169	1400	409
BS	1993	173	1400	195	900	523

BS	1993	202	800	208	1300	149
BS	1993	228	2300	230	1200	37
BS	1993	246	100	251	1000	129
BS	1993	264	1400	278	1800	340
BS	1993	362	1300	365	2400	84
RJ	1991	274	100	297	1500	566
RJ	1992	25	1300	36	1300	264
RJ	1992	36	1500	45	1300	214
RJ	1992	136	1400	142	2000	150
RJ	1993	364	2000	1	100	53
RJ	1993	86	2200	92	1400	136
NS	1991	274	100	277	1500	86
NS	1992	102	1800	104	500	35
NS	1992	104	1600	107	500	61
NS	1993	23	2000	26	2000	72
NS	1993	256	1400	262	1800	148
MS	1990	305	100	312	1200	179
MS	1991	301	1400	308	1300	167
MS	1993	1	100	120	2400	11664

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