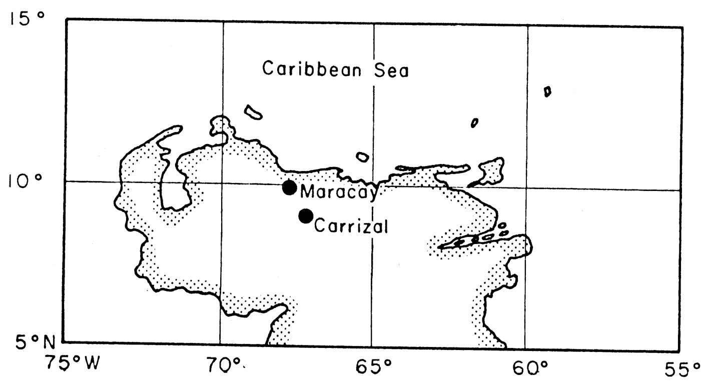
VIMHEX-1972 RAWINSONDE DATA: (May 22 - September 6, 1972)
Tropospheric 25 mb Wind and Thermodynamic Data
330 high quality rawinsondes: surface to 150hPa
[also 10mb BL lag-corrected thermodynamics, surface to 700hPa]

Alan K. Betts
akbetts@aol.com
http://alanbetts.com/research
Atmospheric Research, 58 Hendee Lane, Pittsford, VT 05763.

[This documentation revised April 1, 2000; edited Feb 2, 2102]
[Data originally processed September 1975 at the
Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado 80523]

1. INTRODUCTION

The 1972 Venezuelan International Meteorological and Hydrological Experiment (VIMHEX-1972) was conducted in north-central Venezuela. A weather radar and GMD-1 rawinsonde system were located within a raingauge network at Carrizal, Venezuela (9°22.8'N, 66°55.0'W, Elevation 194m). Fig. 1 shows the location in Venezuela.



The period of the experiment was the rainy season (May 22 - September 6, 1972), although this summer was the driest on record at Carrizal. The climate of the region is a dry savannah type. The terrain is relatively flat with the coastal mountains to the north at a distance of about 70 km. The objectives of the experiment were to study tropical convection over land, its structure and parameterization, and surface hydrological effects; as well as the interaction with the synoptic scale fields. This rawinsonde data was taken primarily to define the local structure of the atmosphere near mesoscale convective systems, as well as to provide a time cross-section for synoptic analyses.

The principal investigators were Dr. H. Riehl and Dr. A. K. Betts (meteorology) and Dr. E. Richardson and Dr. M. A. Stevens (hydrology). It was a cooperative project with the Meteorological Service of the Venezuelan Air Force. The National Center for Atmospheric Research provided the field management, some of the technical personnel and research support - in particular, research flights by the Queen-Air and Sabreliner aircraft of the NCAR Flight Facility. A catalog of the rainfall and radar echo data and some statistics is available (Betts and Stevens, 1974), and there were a series of publications dealing with boundary layer processes and mesoscale convection in the tropics (see reference list).

This is a brief description of the upper air data collected and the data reduction methods. The set of 330 sondes gives thermodynamic and wind data at 25 mb levels from the surface to 150 mb (or sounding termination if lower). This data was derived by interpolation of data at one minute intervals for the first 30 minutes of ascent and then two minute intervals.

2. LAUNCH PROCEDURES

The sonde used was the VIZ-1290 series weather bureau sonde. A calibration box (designed and built by W. R. Green at CSU) was used to calibrate sondes in the field. About half the sondes were calibrated just before launch, the other half were precalibrated one or two days previously and stored in airtight polythene bags until launch. This ensured a ready supply of precalibrated sondes which could be launched in rapid sequence as a convective system passed. The calibration of a sample of these precalibrated sondes was checked before launch (Betts, 1974) and no significant drift in calibration could be found. Balloons were inflated to a constant lift which gave a mean rise rate of slightly less than 5 m $s^{-1.}$ Ascents were terminated at about 130 mb to provide winds to 150 mb. This is below the tropical tropopause (about 110 mb), but typically a little above the parcel equilibrium height of air from the sub-cloud layer. More frequent soundings were chosen, rather than soundings reaching the tropopause. Surface thermodynamic data was taken with an aspirated psychrometer in the shade. The surface wind comes from the first 1-2 min of the balloon tracking, which at times of strong surface directional shear can lead to missing data, because of the limitations of the GMD-1 tracking system. The launch site was on an unused airfield and the surface parameters may not be strictly representative of the surrounding scrub grassland.

A sounding was launched daily at 1000 local time (GMT - 4 hours). Other soundings were launched as needed, but not in general at routine times. The data contains a few sequences of soundings on dry days at two hour intervals and a second afternoon or evening sounding on most days. However, most soundings were launched in sequence after precipitating convection developed in the area scanned by radar, with range roughly 150km. Information from the radar and rainfall network are contained in Betts and Stevens (1974), and should be consulted.

The first few soundings were launched in pairs, 0400, 0500, and 0900, 1000 (local time) to about 400mb, in order to investigate any spurious “diurnal variation” in the radiosonde mixing ratio. [This had been a major problem in earlier field programs such as BOMEX, and the VIZ-1290 sonde had been redesigned to reduce the thermal heating and lag of the hygristor]. No significant variation in mixing ratio was found from before to after sunrise (Riehl and Betts, 1972), so we concluded the redesign was successful.

3. 25 MB RESOLUTION DATA REDUCTION

3.1 Processing

The temperature, humidity and reference frequency data were recorded on a strip-chart recorder. Values at one minute intervals (to 30 minutes) and two minute intervals after 30 minutes [because of the very limited computational capability of the on-site PDP-8S computer] were read from the chart and converted to temperature and humidity (using a calibration slide-rule) and pressure (using the baroswitch calibration chart with each sonde). This reduction was done in the field by the rawinsonde crew and monitored by the field scientist. A separate chart-recorder punched the azimuth and elevation angles of the GMD-1 tracking unit at one minute intervals. After 30 minutes, only the two minute values were used. The data were punched on computer cards. From this raw data, minute or two minute values of the mixing ratio, hydrostatic height, x and y balloon positions, u and v wind components, vertical velocity of the balloon and various potential temperatures were computed. The winds are two-minute averages for the first 30 minutes and four-minute averages after that time. The thermodynamic parameters are point values corresponding to the frequencies read from the chart. This data was interpolated to 25 mb intervals from 975 mb to 150 mb.

3.2 Editing

The data was edited by manual inspection of the processed output. Some methods used were:

a) The balloon perturbation vertical velocity shows up errors in the pressure (usually caused by miscounting contact switches).
b) A uniform decrease in temperature, mixing ratio and a uniform increase in potential temperature were looked for.
c) Large wind fluctuations were checked - usually caused by errors in reading balloon azimuth or elevation.
d) Many punching errors were located by averaging of soundings where wild values became obvious.

Corrected data was re-punched and the sounding reprocessed. A few errors may remain in the data, but the data may be considered as research quality (rather than operational quality).

3.3 Corrections.

No corrections were applied to the data for thermistor or hygristor lag. The thermistor lag is believed to be small (few seconds), which would give the data a warm bias of only one or two tenths of a degree. Brousaides and Morrissey, (1974) suggested that the hygristor thermal lag of the 1290 series sonde was in the range (15-20 seconds) below 700 mb. However, Betts et al. (1974) estimated rather smaller values (~7 seconds) from a small number (14) of ascents into the base of a cloud during the experiment, suggesting that in a well-mixed sub-cloud layer, the dry mixing ratio bias in these data is <0.5g Kg^{-1} (see also Betts (1976b).

A second set of data - lag-corrected (see Betts 1976b) thermodynamic data only for the same soundings at 10 mb intervals for the low levels, typically surface to 700 mb, is available [VIMHEX72-10mbSonde-lagcorrected.TXT].
This data was interpolated from contact level readings of pressure, temperature and humidity. It shows the low level thermodynamic structure in greater detail, but has no wind data.

3.4 Surface data

There is also an hourly surface dataset, digitized from a recording hydrothermograph and barograph [VIMHEX72-SURF.TXT]**,** discussed in Betts (1998)

4. REFERENCES (available at http://alanbetts.com/research along with datasets)

Riehl, H., and A. K. Betts, 1972: Humidity Observations with the 1972 U.S. Radiosonde Instrument. *Bull. Amer. Meteor. Soc.*, **53**, pp. 887-888
Betts, A. K., 1973: Precalibration of the VIZ-NWS Radiosonde. *Bull. Amer. Meteor. Soc.*, **54**, pp. 222-223.
Betts, A. K., 1973: A Composite Mesoscale Cumulonimbus Budget. *J. Atmos. Sci.*, **30**, pp. 597-610.

Betts, A. K., F. J. Dugan and R. W. Grover, 1974: Residual Errors of the VIZ Radiosonde Hygristor as Deduced from Observations of Subcloud Layer Structure. *Bull. Amer. Meteor. Soc.*, **55**, pp. 1123-1125.

Betts, A. K., 1974: Thermodynamic Classification of Tropical Convective Soundings. *Mon. Wea. Rev.*, **102**, pp.760-764.

Betts A. K. and M. A. Stevens, 1974: Rainfall and Radar echo statistics: VIMHEX-1972. Research Report, Dept. of Atmospheric Science, Colorado Stat Univ., Fort Collins, CO 80523, 151pp.

Betts, A. K., R. W. Grover and M. W. Moncrieff, 1976: Structure and Motion for Tropical Squall Lines over Venezuela. *Q.J. Roy. Meteor. Soc.*, **102**, pp. 394-404.

Betts, A. K., 1976a: The Thermodynamic Transformation of the Tropical Subcloud Layer by Precipitation and Downdrafts. *J. Atmos. Sci*., **33**, pp. 1008-1020.

Betts, A. K., 1976b: Modelling Subcloud Layer Structure and Interaction with Shallow Cumulus Layer. *J. Atmos. Sci.*, **33**, pp. 2363-2382.

Brousaides F. J. and J. F. Morrissey, 1974: Residual temperature induced humidity errors in the National Weather Service radiosonde. Final Report, Meteorological Laboratory, Project ILIR, AFCRL, Bedford, Massachusetts 01730, 39pp.

Miller, M. J., and A. K. Betts, 1977: Travelling Convective Storms over Venezuela. *Mon. Wea. Rev.*, **105**, pp. 833-848.

Betts, A. K., 1998: Surface diurnal cycle over Venezuela. Meteorol. Atmos. Phys., 67, 213-216. (Herbert Riehl Memorial Vol.). http://alanbetts.com/research/paper/surface-diurnal-cycle-over-venezuela/#abstract

5. DATA FIELD FORMAT

VIMHEX1972.DAT 816725 bytes comma delimited

Sonde#
Date [mo/day/year-1900]
LocalTime [GMT-4 hours]
pressure [mb]
temperature [deg C]
mixingratio [g/kg]
winddirection [degrees from true North]
windspeed [m/s]

Pressure (p), temperature (T) and relative humidity (RH) are measured. Mixing ratio (r) was calculated, using

Teton's formula for saturation vapor pressure es = 6.11*10^(7.5*T/(T+237.3))
Vapor pressure from e = (RH/100)*es
Mixing ratio from r = 622*e/(p-e)

The hydrostatic height (calculated from pressure and virtual temperature) and the GMD-1 tracking angles every one minute (every 2 min after 30min) were used to compute the balloon position. The time rate of change of position gives the vector wind.

VimhexDoc.pdf [This document file], revised Feb 2 2012