Texas A&M University (TAMU) Radiosonde Metadata
TAMU TRACER 2022

PIs
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1.0 Data set overview

To support research activities during **TAMU TRacking Aerosol Convection interactions ExpeRiment (TRACER)** 2022 field campaign, students, research staff, and faculty from the TAMU Department of Atmospheric Sciences operated a mobile radiosonde system around the Houston metropolitan region in Texas. Over the course of the field campaign from 1 June 2022 – 30 September 2022, a total of 29 Intensive Observation Periods (IOPs) were conducted with the scientific objective to sample the air mass heterogeneity across the sea/bay-breeze front. This data set includes a total of 58 radiosondes from the 29 IOPs.

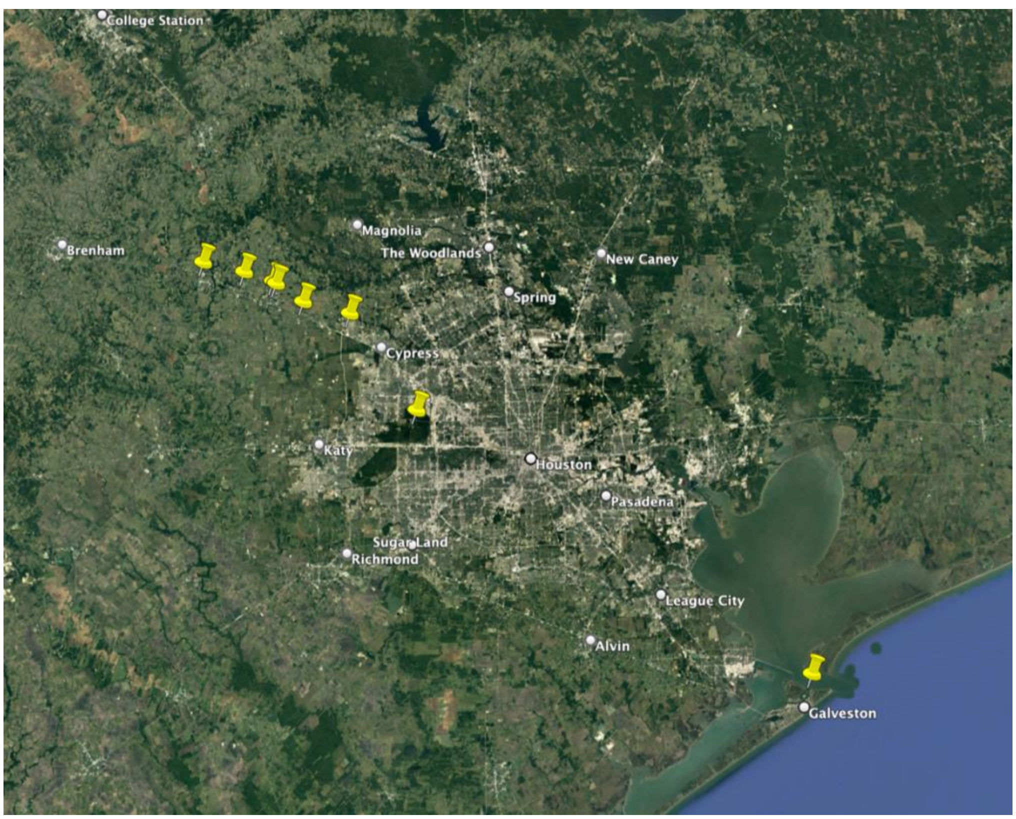

Figure 1. Location of mobile radiosonde sites during TAMU TRACER 2022.

2.0 Instrument description

Consistent with the past field campaigns, TAMU used iMet-4 radiosondes. Sonde data were copied via two ground stations (iMet 3050A, and iMet 3150) for redundancy. The files included in this data set were copied from the ground station with the highest signal quality and more complete sounding data points. The launch train consisted of 150-g balloons with an attached parachute and dereeler, inflated with helium to attain a target vertical ascent rate of 300 m/min. Manufacturer provided calibration, accuracy, and resolution of measured variables is provided in Table 1.

3.0 Data collection and processing

The **TAMU TRACER** is a research program that aims to better understand how thermodynamic and kinematic profiles, as well as aerosols, influence storm dynamics and microphysical processes in continental convective clouds. The presence of significant horizontal heterogeneity in the thermodynamic and kinematic environments due to the prevalence of sea/bay breeze boundaries and outflow from prior convection around Houston made it an ideal testbed to perform this research. The TAMU mobile radiosonde team sampled these airmass heterogeneities by strategically choosing deployment sites in a different airmass than the Atmospheric Radiation Measurement (ARM) fixed sites in La Porte and Guy, Texas. On days when the sea/bay breeze boundary was pushing inland, the TAMU TRACER team would usually sample the airmass on the maritime side of the sea-breeze front (SBF) at a coastal site in Galveston, TX in the early afternoon (1730 - 1900 UTC) and then move inland ahead of the SBF to sample the airmass on the continental side during late afternoon (2030 – 2230). These soundings were launched simultaneously with radiosondes at both the AMF1 and ANC sites on a subset of their rapid sounding operations/radar cell tracking days during the May-September 2022 IOP period. Any deviations from the standard strategy were necessitated by external factors such as widespread convective coverage requiring an earlier launch or mixing of SBF with convective outflow resulting in faster moving boundaries mandating the selection of a site and launching radiosondes from the same site before and after the sea-breeze crossed the site. If the conditions were favorable for obtaining a suitable inflow sounding, a third radiosonde was also launched for a few IOPs (see Table 2). More information on ARM TRACER is available at the ARM website: https://www.arm.gov/research/campaigns/amf2021tracer and information on TAMU TRACER is available at https://www.arm.gov/research/campaigns/osc2022tracer-tamu. A detailed breakdown of the date, launch time, and location of each deployment for all IOPs is provided in Table 2.

Sondes were typically released 20-40 minutes prior to their “valid” time. Surface observations of wind direction, wind speed, temperature, dewpoint temperature, wet bulb temperature, and pressure were taken at launch time using a surface weather station at the launch site and compared with the radiosonde measurements. If pre-launch radiosonde thermodynamic surface observations agreed with the surface weather station observations, the radiosonde-measured values were used as the surface observation.

Surface weather station wind measurements (obtained via sonic anemometer) were always used for the surface wind observation.

Launches were all initialized, collected, and processed with iMet-OS-II software with no additional quality control performed. Post-processed data were saved to two different types of text files before uploading and archival:

(i) Files with a constant time interval of 5 s (containing all variables including instantaneous lat/lon), and
(ii) Files with a constant time interval of 1 s converted to SPC/SHARPpy format.

These files contain the instantaneous values of atmospheric variables every 5 and 1 s, respectively, during the balloon ascent stage.

4.0 Data format

The sounding data files are provided in two separate directories corresponding to the two types of text files generated from the iMet-OS-II software. The naming convention for each of the TAMU TRACER **1 s sounding text files** is:

TAMU_TRACER_YYYYMMDD_HHmm_lonW_latN_SHARPPY.txt For instance, the file: TAMU_TRACER_20220729_1725_94.78W_29.33N_SHARPPY.txt is for the sounding valid at 1800 UTC (released at 1725 UTC) on 29 July 2022. Text files are formatted in SPC/SHARPpy format with the following header and footer information:

%TITLE%
MOBI YYMMDD/HHmm
LEVEL HGHT TEMP DWPT WDIR WSPD

%RAW%

Sounding data are arranged in six-column CSV format with a variable number of rows in descending pressure (ascending height) order: (1) Pressure [hPa], (2) Height above MSL [m], (3) Temperature [°C], (4) Dewpoint Temperature [°C], (5) Wind Direction [deg], (6) Wind Speed [kts].

%END%

The naming convention for each of the TAMU TRACER **5 s sounding text files** is:

TAMU_TRACER_YYYYMMDD_HHmm_lonW_latN_TSPOTINT.txt For instance, the file: TAMU_TRACER_20220729_1725_94.78W_29.33N_TSPOTINT.txt is for the sounding valid at 1800 UTC (released at 1725 UTC) on 29 July 2022. Text files are formatted with the following header and footer information:

```
SPOT TIME VALUES FOR SOUNDING "TRACER_05_1"
=========================================

Station Name          : MOBILE
.     WMO Number      : /////
.     ICAO Number     : TAMU
.     Mobile Call Sign : /////
.     Latitude        : <station latitude in decimal degrees>°N
.     Longitude       : <station longitude in decimal degrees>°W
.     Altitude (MSL)  : <station altitude>m

Sonde   Type          : iMet-4
.     Serial Number   : <sonde serial number>

Surface Pressure      : <sfc pres>hPa
.     Temperature     : <sfc temp>°C
.     Humidity        : <sfc rh>%
.     Wind Speed      : <sfc wspd>kts
.     Wind Direction  : <sfc wdir>°
.     Cloud Code      : /////

Launched (UTC)        : M/DD/YYYY H:MM:SS PM

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FltTime     Press     Temp     RelHum     WSpeed     WDirn
GPM_AGL     Alt_AGL     Alt_MSL     Long/E     Lat/N     North     East
VTemp     DP     Dens     VP     WNorth     WEast     GrndRng
Mix_Rat     GPM_MSL     UTC_Date     UTC_Time     FltTime     FltTime
Frost_Point
        s     hPa     °C     %     m/s     °     m     m
m                    km     km     °C     °C     g/m³     hPa
m/s     m/s     km     g/kg     m          hr:min:s     hr:min:s
min s     °C
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```

Sounding data are arranged in 27-column TSV format with a variable number of rows in descending pressure (ascending height) order: (1) Flight Time [s], (2) Pressure [hPa], (3) Temperature [°C], (4) Relative Humidity [%], (5) Wind Speed [m/s], (6) Wind Direction [deg], (7) Geopotential height AGL [m], (8) Altitude AGL [m], (9) Altitude MSL [m], (10) Longitude [°E], (11) Latitude [°N], (12) Distance of sonde from release location (North) [km], (13) Distance of sonde from release location (East) [km], (14) Virtual Temperature [°C], (15) Dewpoint Temperature [°C], (16) Air Density [g/km^3], (17) Vapor Pressure [hPa], (18) Northerly Wind Speed [m/s], (19) Easterly Wind Speed [m/s], (20) Ground Range [km], (21) Mixing Ratio [g/kg], (22) Geopotential height MSL [m], (23) UTC Date [M/DD/YYYY], (24) UTC Time [H:MM:SS], (25) Flight Time Since Launch [HH:MM:SS], (26) Flight Time [MM SS], (27) Frostpoint Temperature [°C]

5.0 Data remarks

Most soundings were terminated once the radiosonde ascended above the 100-mb pressure level, though several soundings were terminated early due to signal loss, lightning disruption, or balloon burst. We also maintain a local archive of raw data files and handwritten notes/details regarding each sounding with exact launch times, specific hardware for the launch, etc., which can be provided upon request. For specific questions, please contact Milind Sharma (milindsharma@tamu.edu), C. Nowotarski (cjnowotarski@tamu.edu), or A. Rapp (arapp@tamu.edu).

6.0 References

See http://www.intermetsystems.com for full descriptions of hardware and software referenced herein.

7.0 Acknowledgments

These data were collected for ARM Field Campaign AFC07055 and supported by DOE ASR grant DE-SC0021047. Special thanks to Erik Nielsen, Montana Etten-Bohm, and TAMU undergraduate and graduate students for assisting with TAMU TRACER data collection.

Table 1 – Manufacturer provided specifications for iMet-4/iMet-4C radiosondes (courtesy International Met Systems)

MEASUREMENTS	
Measurement cycle	1 Hz
TEMPERATURE SENSORS	Glass Bead
Manufacturer	Shibaura
Measurement range	+60°C to -90°C
Resolution	0.01°C
Response time: still air/ 5 ms^{-1} (1000 hPa)	2 / < 1 sec
Repeatability in Calibration	0.2 C
Combined Uncertainty/Reproducibility [1]	
> 100 hPa	0.5 C / 0.3 C
< 100 hPa	1.0 C / 0.75 C
Night flight	0.3 C / 0.3 C
Solar correction	≤ 1.2 C
HUMIDITY SENSOR	Capacitive Polymer
Manufacturer	IST
Measurement range	0-100 % RH
Resolution	0.1%
Response time	
@ 25C	0.6 seconds
@ 5C	5.2 seconds
@ -10C	11 seconds
@ -40C	61 seconds
Repeatability in Calibration	5 %
Uncertainty/Reproducibility [1]	
> 0 C	5% / 3%
-40 to 0 C	5% / 5%
PRESSURE [2]	Sensor
Manufacturer	Measurement Specialties
Measurement range	1200 hPa - 10 hPa
Resolution	0.01 hPa
Response time	0.5 milliseconds
Uncertainty/Reproducibility [1]	
Whole range	2.0 / 1.5 hPa
1200 - 400 hPa	1.0 / 0.75 hPa
400 hPa - 10 hPa	2.0 / 1.5 hPa
PRESSURE	GPS derived
Measurement range	SFC to 3 hPa
Resolution	0.1 hPa
Uncertainty/Reproducibility [1]	
1080 - 400 hPa	2.0 / 1.5 hPa
400 hPa - 3 hPa	0.5 / 0.25 hPa

GEOPOTENTIAL HEIGHT	Pressure derived
Measurement range	SFC to 40 km
Resolution	0.1 m
Combined Uncertainty/Reproducibility [1]	
1080 - 400 hPa	15 m / 10 m
400 - 10 hPa	200 m / 150 m
GEOPOTENTIAL HEIGHT	GPS derived
Measurement range	SFC to 40 km
Resolution	0.1 m
Combined Uncertainty/Reproducibility [1]	
1080 - 400 hPa	30 m / 15 m
400 - 3 hPa	60 m / 20 m
WIND SPEED AND DIRECTION	
Resolution	0.1 m/s / 1 degree
Speed	
Combined Uncertainty/Reproducibility [1]	0.5 / 0.25 m/s
Direction	
Combined Uncertainty/Reproducibility [1]	1 degree

TELEMETRY	
Transmission type	Synthesized
Maximum Range	> 250 km
Frequency stability	± 3 kHz
Deviation, peak to peak	6 kHz
Output Power	~ 30 – 200 mW
Modulation	AFSK
Data Rate	1200 Baud
Transmission Frequencies	7 Pre-programmed Channels
Custom Frequencies	Available
GPS RECEIVER	
Manufacturer / Type	U-Blox CAM-M8
Cold Start Time	< 60 seconds (typical)

OPERATIONAL DATA	
Battery	Lithium
Operating time	> 135 minutes
Weight	120 grams
Dimensions	Body (LWH): 139x67x31
	With boom (LWH): 235x67x31
Calibration Stability	2 years

** Subject to ground station, balloon size and atmospheric conditions*
[1] All uncertainties expressed at a 95% confidence level
[2] Primary atmospheric pressure derived by GPS altitude
[3] GECOS Reference Upper-Air Network
Specifications subject to change without notice
Document 202084-12

InterMet
International Met Systems
Grand Rapids, MI USA
www.intermetsystems.com

Table 2 – Summary of TAMU TRACER IOPs specifying date, IOP number, launch time and location of the launch site.

IOP #/Date	Launch time and deployment site 1	Launch time and deployment site 2	Launch time and deployment site 3
IOP 1 (2 June 2022)	2028 UTC Waller, TX	2330 UTC Waller, TX	No deployment
IOP 2 (21 June 2022)	1857 UTC Waller, TX	2159 UTC Waller, TX	No deployment
IOP 3 (22 June 2022)	2041 UTC Waller, TX	No deployment	No deployment
IOP 4 (26 June 2022)	1857 UTC Galveston, TX	2324 UTC Waller, TX	No deployment
IOP 5 (29 June 2022)	1725 UTC Waller, TX	2029 UTC Waller, TX	No deployment
IOP 6 (6 July 2022)	1854 UTC Waller, TX	2149 UTC Waller, TX	No deployment
IOP 7 (11 July 2022)	1901 UTC Galveston, TX	2327 UTC Waller, TX	No deployment
IOP 8 (12 July 2022)	2136 UTC Waller, TX	2327 UTC Waller, TX	No deployment
IOP 9 (13 July 2022)	1730 UTC Galveston, TX	2204 UTC Waller, TX	No deployment
IOP 10 (27 July 2022)	1732 UTC Galveston, TX	2123 UTC Waller, TX	No deployment
IOP 11 (28 July 2022)	1725 UTC Galveston, TX	2132 UTC Waller, TX	No deployment
IOP 12 (29 July 2022)	1725 UTC Galveston, TX	2109 UTC Waller, TX	No deployment
IOP 13 (30 July 2022)	1724 UTC Galveston, TX	2100 UTC Cypress, TX	No deployment
IOP 14 (7 August 2022)	1721 UTC Galveston, TX	2127 UTC Hempstead, TX	No deployment
IOP 15 (8 August 2022)	1724 UTC Galveston, TX	2131 UTC Hempstead, TX	No deployment
IOP 16 (9 August 2022)	1726 UTC Galveston, TX	2139 UTC Hempstead, TX	No deployment
IOP 17 (10 August 2022)	1719 UTC Houston, TX	2031 UTC Houston, TX	2242 UTC Houston, TX
IOP 18 (21 August 2022)	1728 UTC Waller, TX	1857 UTC Waller, TX	No deployment
IOP 19 (22 August 2022)	1740 UTC Hockley, TX	No deployment	No deployment
IOP 20 (26 August 2022)	1726 UTC Galveston, TX	2134 UTC Prairie View, TX	No deployment
IOP 21 (27 August 2022)	1724 UTC Hempstead, TX	1906 UTC Hempstead, TX	2039 UTC Hempstead, TX
IOP 22 (28 August 2022)	1728 UTC Galveston, TX	2119 UTC Hempstead, TX	No deployment
IOP 23 (31 August 2022)	1729 UTC Galveston, TX	No deployment	No deployment

IOP 24 (6 September 2022)	1730 UTC Hockley, TX	1904 UTC Hockley, TX	No deployment
IOP 25 (7 September 2022)	1729 UTC Hockley, TX	1900 UTC Hockley, TX	2029 UTC Hockley, TX
IOP 26 (17 September 2022)	1718 UTC Galveston, TX	2059 UTC Hockley, TX	No deployment
IOP 27 (18 September 2022)	1726 UTC Galveston, TX	2126 UTC Hockley, TX	No deployment
IOP 28 (19 September 2022)	1659 UTC Galveston, TX	2059 UTC Hempstead, TX	No deployment
IOP 29 (25 September 2022)	1730 UTC Galveston, TX	2200 UTC Hockley, TX	No deployment