Title: OTREC Surface GPS-Met Network

Authors:

Yolande Serra, Lead PI
Cooperative Institute for Climate, Ocean and Ecosystem Studies, University of Washington, Seattle, WA
yserra@uw.edu, https://orcid.org/0000-0003-3542-1158

Co-authors:
Ana María Durán-Quesada, CIGEFI, Universidad de Costa Rica, San Jose, Costa Rica
David Gochis, Research Applications Laboratory, National Center for Atmospheric Research, Boulder, CO
David Adams, CCA, Universidad Nacional Autónoma de México, Mexico City, Mexico
Benjamin Lintner, Department of Environmental Sciences, Rutgers University, New Brunswick, NJ

Time of Interest: 2019/08/05 00:00:00 to 2019/10/09 23:55:00

Area of Interest: 9.25° to 10.70° N, 85.70° to 82.7° W, Costa Rica

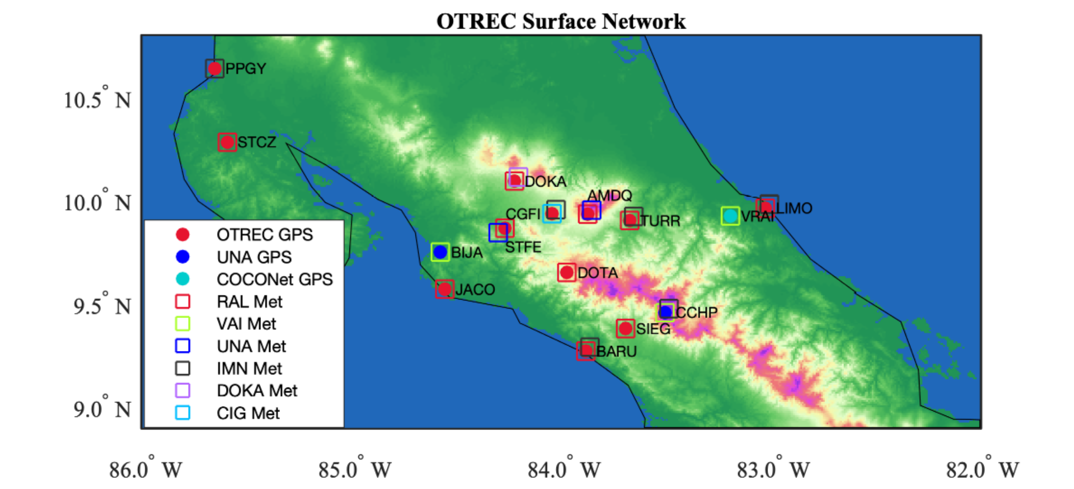
Data Frequency: 5-min

Data Types: Ascii (.asc)

General Data Description:

Met system: Meter Group, Inc. (RAL), Vaisala/RM Young/Hydrological Servies/Campbell Scientific (IMN), Davis Instruments (UNA and DOKA), Vaisala (COCONet, UNAM)
GPS: Trimble Net RS/Net R9

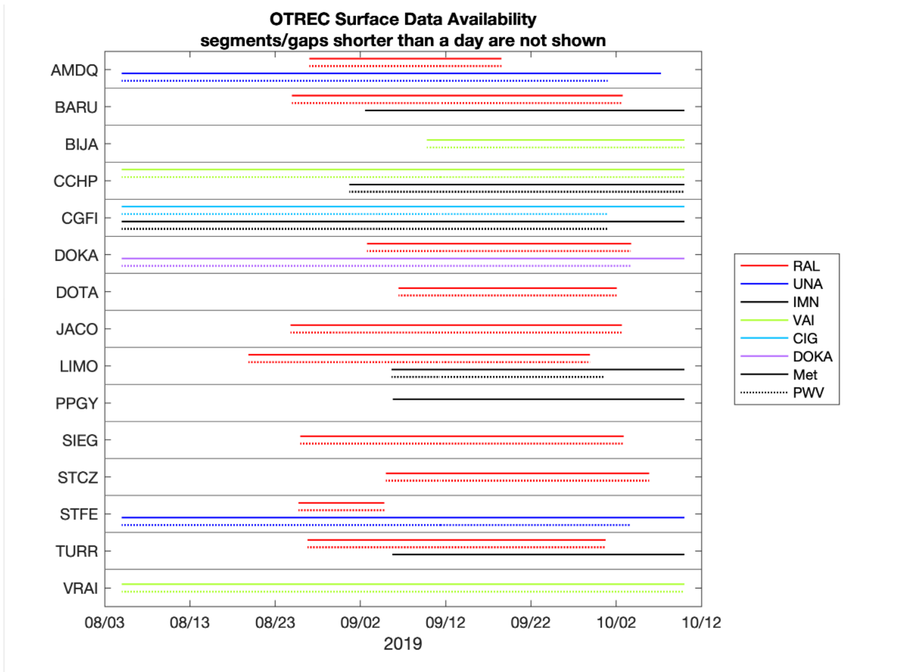
The surface network for OTREC was made possible through the help of several different organizations that provided both GPS receivers and surface meteorological stations. The core OTREC surface network included 10 GPS receivers obtained through the UNAVCO (Boulder, CO) instrument loan program, an ongoing program funded by the National Science Foundation, and 10 meteorological stations provided by NSF collaborator Dr. David Gochis from the National Center for Atmospheric Research Research Applications Laboratory (NCAR RAL). Through personal contacts we were also able to obtain three GPS receivers loaned to the project by Tim Melbourne of Central Washington University (CWU). Additional GPS sites include one GPS receiver with a meteorological package already operating in Costa Rica as part of COCONet (coconet.unavco.org), a second longtime GPS site maintained by Prof. Marino Protti of the Universidad Nacional de Costa Rica (UNA), and a new GPS-Met site established for OTREC by Prof. Protti. One GPS receiver was not installed due to technical issues resulting in a total of 15 GPS-Met sites operating in Costa Rica during OTREC (See station map below).



Meteorological stations for the additional five GPS sites, as well as duplicate meteorological stations at sites equipped with RAL instrumentation, were provided by the Costa Rican Instituto Meteorológico Nacional (IMN), the UNA, the Centro de Investigaciones Geofsicas (CIGEFI) at the Universidad de Costa Rica, and the Grupo Santa Eduviges coffee farm (DOKA). Two Vaisala (VAI) meteorological stations were also donated permanently to UNA by Prof. David Adams, an NSF collaborator on the project and faculty member at the Universidad Nacional Autónoma de México (UNAM) in Mexico City. These meteorological packages were used to convert the longterm GPS site at BIJA, as well as the new GPS installation on Mount Chirripó (CCHP) to permanent GPS-Met sites in Costa Rica maintained by Prof. Marino Protti.

Delays in the shipment of 10 NCAR RAL surface meteorological stations to OTREC resulted in shorter data records at many sites than the nominal OTREC campaign period. While additional meteorological stations were available at many sites, sub hourly data were not always available for the entire OTREC time period and generally not for the first part of August. As each site is unique regarding the data sampling frequency, a uniform 5-min data record from 2019/8/5 through 2019/10/9 is provided in each file with missing values used when no meteorological and/or GPS data were available.

QC: Quality control of the surface meteorological data consisted primarily of comparing parameters with overlapping observations from more than one data source. At DOKA, an error in the setup of the pressure sensor for the Doka Farm meteorological package identified following OTREC resulted in an offset of the surface pressure observations at this site. The RAL pressure sensor was used to bias correct (225 hPa) the Doka Farm surface pressure using the time period over which both instruments were available. The correlation of 0.99 between the RAL and Doka Farm sensors suggests that the offset was the only issue with the Doka Farm pressure measurements. A bias correction was also applied to the UNA surface pressure at AMDQ. When compared to the RAL surface pressure, this site indicated a small bias (7.6 hPa) but with high temporal correlation (0.97), suggesting a possible error in the original configuration of the sensor. The UNA pressure sensor near the STFE site was also corrected for a bias with respect to the RAL sensor (-99.6 hPa). No other corrections have been applied to the meteorological data.



Meteorological and GPS data at each site varied depending on date of installation and, in the case of IMN, dates for which 2-min or 5-min data files were saved. The figure does not show short periods of missing data or short periods of existing data. Solid lines indicate meteorological data availability; dotted lines indicate PWV data availability, which depended on availability of GPS, T and P variables. IMN packages at PPGY and TURR did not provide P.

Aside from the bias corrections in surface pressure applied to the Doka Farm values at DOKA and UNA values at AMDQ, these data are provided “as is”. Comparisons of the variables where more than one sensor was available nearby were overall reasonable. An exception are the nighttime RH data from the IMN sensor at BARU. While RAL RH values tended to remain below 90% at night, the BARU RH values always read 100% from roughly 6pm to 6am local time. IMN daytime values appear higher than RAL but not unreasonable. Use the RH from the IMN sensor at BARU with caution.

The data from the RAL met system at LIMO compares well with the IMN met system, which was newly installed at the beginning of OTREC. However, data from the RAL system are primarily available only during the day when the system could run on solar power because of a power supply failure early on in the project.

Interpolation: In order to obtain total precipitable water vapor at each site on a uniform time grid, meteorological measurements have been interpolated to 5-min for the nominal OTREC time period. GPS data were all sampled at 1-min. Surface meteorological data from RAL (AMDQ, BARU, DOKA, DOTA, JACO, SIEG, STCZ, STFE, TURR) are also available at 1-min (instantaneous). Other sources of meteorological data available to this project provided data at frequencies ranging from 2-min (IMN at CCHP, LIMO, PPGY and TURR), 5-min (CIG at CGFI; IMN at BARU; UNA at AMDQ and STFE; VAI at BIJA, CCHP, and VRAI), 30-min (DOKA at DOKA), and hourly (IMN at CGFI) (See Table below). Values of temperature, pressure and humidity greater than five standard deviations were set to missing. Missing data over periods of up to one hour were linearly interpolated at the native sampling frequency prior to interpolation to a 5-min time grid.

GPS PWV Processing: Total column precipitable water vapor (PWV) was calculated using the Jet Propulsion Laboratory (JPL) GipsyX software (https://gipsy-oasis.jpl.nasa.gov). The OTREC surface network provided the surface air temperature and pressure data used to estimate PWV from the zenith total delay (ZTD) measured by the surface GPS receivers. Both PWV and ZTD are provided in the surface data files.

Data Format: The surface network files are in space-delimited ascii format. The first two lines are headers providing the variable names and units. Variables are written in the following order:
Year, Month, Day, Hour, Minute, Pressure, Temperature, Relative Humidity, Dew Point Temperature, Rain Rate, Wind Speed, Wind Direction, Downward Solar Radiation, PWV, ZTD. Downward solar radiation is only available at a subset of OTREC surface sites, as not all surface meteorological stations included this sensor. Missing value: -9999.

OTREC Surface Network

Site ID	Latitude	Longitude	Elevation (m)	GPS Source	Met Source(s)
AMDQ	9.9341	-83.8739	2506	UNAVCO	RAL, UNA
BARU	9.2704	-83.8834	13	UNAVCO	IMN, RAL
BIJA	9.7499	-84.5771	545	UNA	VAI
CCHP	9.4567	-83.5048	3336	UNA	IMN, VAI
CGFI	9.9362	-84.0447	1224	UNAVCO	CIG, IMN
DOKA	10.0936	-84.2239	1257	UNAVCO	DOKA, RAL
DOTA	9.6505	-83.9723	1550	CWU	RAL
JACO	9.5698	-84.5549	9	UNAVCO	RAL
LIMO	9.9627	-83.0249	5	CWU	IMN
PPGY	10.6418	-85.6551	6	UNAVCO	IMN
SIEG	9.3797	-83.6914	766	UNAVCO	RAL
STCZ	10.2837	-85.5952	41	UNAVCO	RAL
STFE	9.8654	-84.2681	996	UNAVCO	RAL, UNA*
TURR	9.9031	-83.6731	613	CWU	IMN, RAL
VRAI	9.9248	-83.1906	427	COCONet	COCONet

OTREC Surface Meteorological Stations

Met Source ID	Institution	Met System	Sampling Frequency
CIG	Prof. Ana María Durán-Quesada, Center of Geophysical Investigations (CIGEFI), University of Costa Rica, San Jose, Costa Rica	Davis Instruments Vantage Pro 2 weather station	5-min
COCONet	Continuously Operating Caribbean GPS Observational Network (COCONet) funded by the National Science Foundation (coconet.unavco.org)	Vaisala WXT520 weather station	5-min
DOKA	Grupo Santa Eduviges, Doka Farm, Costa Rica	Davis Instruments Davis Vantage Pro 2 weather station	30-min
IMN	Martha Pereira Molina, Instituto Meteorológico Nacional (IMN), San Jose, Costa Rica	Vaisala Hmp155 T and RH sensor, Vaisala ptb330 P sensor, Gill WindSonic75 anemometer, Hydrological Services TB4 tipping bucket rain gauge**	2-min, 5-min (BARU), hourly (CGFI)
RAL	Dr. David Gochis, National Center for Atmospheric Research, Research Applications Laboratory (RAL), Boulder, Colorado	Meter VP4 T, RH, P sensor, Hydrological Services TB3/4 tipping bucket rain gauge	1-min (Met), 5-min (Rain)
UNA	Prof. Ricardo Sánchez-Murillo, Universidad Nacional de Costa Rica (UNA), San Jose, Costa Rica	Davis Instruments Davis Vantage Pro 2 weather station	5-min (AMDQ), 30-min (STFE*)
VAI	Prof. David Adams, Universidad Nacional Autónoma de México (UNAM), Mexico City, Mexico	Vaisala WXT520 weather station	5-min

*The UNA met station at STFE was located in Puriscal, 4.3 km to the southwest of the GPS site. **The IMN operational weather stations have various configurations that are upgraded as needed. This was the configuration at the Limon airport at the start of OTREC, which was also the newest IMN installation at this time.

For questions please contact the OTREC PI for the surface network Dr. Yolande Serra, yserra@uw.edu.

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Filename raw data: <siteid>_OTREC_GIPSYX_met<sourceid>.asc

Data Restrictions: None.

Digital Object Identifier (DOI): 10.26023/ATW3-HC63-ED00

GCMD Keywords:
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC TEMPERATURE>SURFACE TEMPERATURE>AIR TEMPERATURE
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC TEMPERATURE>SURFACE TEMPERATURE>DEW POINT TEMPERATURE
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC PRESSURE>SURFACE PRESSURE
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC WINDS>SURFACE WINDS>WIND SPEED
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC WINDS>SURFACE WINDS>WIND DIRECTION
EARTH SCIENCE>ATMOSPHERE>PRECIPITATION>PRECIPITATION RATE
EARTH SCIENCE>ATMOSPHERE>PRECIPITATION>TOTAL SURFACE PRECIPITATION RATE
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC WATER VAPOR>WATER VAPOR INDICATORS>HUMIDITY>RELATIVE HUMIDITY
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC WATER VAPOR>WATER VAPOR INDICATORS>TOTAL PRECIPITABLE WATER
EARTH SCIENCE>ATMOSPHERE>ATMOSPHERIC RADIATION>INCOMING SOLAR RADIATION