

USAF C-130 SFMR Data

1. General Description

This data set contains the Stepped Frequency Microwave Radiometer (SFMR) data from the United States Air Force (USAF) C-130 aircraft flights into the tropical systems of interest to the TCI field project. The primary parameters included are the surface wind speed and rain rate. The storms included are Erika and Joaquin from the 2015 Atlantic region, Marty and Patricia from the 2015 East Pacific region, and Matthew from the 2016 Atlantic region. These data are in NetCDF format and were collected from the NOAA HRD archives.

2. Flights into the TCI Storms

The flights into the tropical systems of interest to TCI are summarized in Table 1 (Erika), Table 2 (Marty), Table 3 (Joaquin), Table 4 (Patricia), and Table 5 (Matthew).

Table 1. Flights into Erika (2015 Atlantic)

Storm Name	Take-Off Date	Aircraft	Flight ID	Take Off Time (UTC)	Landing Time (UTC)	Flight Identifier
Erika	20150825	NOAA49	WA05A	1345	2043	20150825N1
		USAF301	0105A	1632	2322	20150825U1
		NOAA43	WB05A	1741	0022	20150825I1
	20150826	NOAA43	UC05A	0554	1246	20150826I1
		USAF301	0205A	0847	1506	20150826U1
		NASA DC8	1046	~1100		
		NASA AV6	WX05A	1400	1043	
		NOAA43	0305A	1706	2316	20150826I2
		USAF301	0405A	2120	0136	20150826U2
	20150827	NOAA43	0505A	0456	1146	20150827I1
		USAF303	0605A	1018	1812	20150827U1
		NASA DC8	1047	~1200		
		NOAA49	0705A	1728	0050	20150827N1
		USAF309	0805A	1938	0416	20150827U2
	20150828	NOAA43	0905A	0607	1304	20150828I1
		USAF303	1005A	0819	1816	20150828U1
		NOAA49	1105A	1726	0134	20150828N1
	20150829	USAF303	1205A	0922	1427	20150829U2
NASA AV6		WX05A	1100			

	20150830	NASA WB57	TCI-01	1445	1910	
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Table 2. Flights into Marty (2015 Eastern Pacific)

Storm Name	Take-Off Date	Aircraft	Flight ID	Take Off Time (UTC)	Landing Time (UTC)	Flight Identifier
Marty	20150927	NASA WB57	TCI-02	1805	2327	
	20150928	NASA WB57	TCI-03	1643	2209	
		USAF300	0117E	1437	1657	20150928U1

Table 3. Flights into Joaquin (2015 Atlantic)

Storm Name	Take-Off Date	Aircraft	Flight ID	Take Off Time (UTC)	Landing Time (UTC)	Flight Identifier
Joaquin	20150928	USAF307	0111A	1428	1947	20150928U2
	20150929	USAF300	0211A	1304	2204	20150929U1
		NOAA49	WA11A	1808	2344	20150929N1
	20150930	USAF300	0311A	0709	1307	20150930U1
		NOAA49	0411A	1730	0209	20150930N1
	20151001	USAF309	0511A	2004	0351	20150930U2
		NOAA49	0611A	0616	1435	20151001N1
		USAF301	0711A	0805	1752	20151001U1
		NOAA49	0811A	1736	0142	20151001N2
	20151002	USAF300	0911A	1929	0510	20151001U2
		NOAA49	1011A	0533	1311	20151002N1
		USAF306	1111A	0753	1734	20151002U1
		NASA WB57	TCI-04	1512	1922	
	20151003	USAF305	1211A	1931	0616	20151002U2
		USAF304	1311A	0848	1522	20151003U1
		NASAWB57	TCI-05	1503	2050	
	20151004	USAF303	1411A	2233	0703	20151003U2
		USAF305	1511A	0753	1610	20151004U1
		NASA WB57	TCI-06	1527	2110	
	20151005	USAF304	1611A	2016	0351	20151004U2
NASA WB57		TCI-07	1448	2037		

Table 4. Flights into Patricia (2015 Eastern Pacific)

Storm Name	Take-Off Date	Aircraft	Flight ID	Take Off Time (UTC)	Landing Time (UTC)	Flight Identifier
Patricia	20151020	NASA WB57	TCI-08	1800	2324	
		NOAA43	WXWXA	1751	2037	20151020I1
	20151021	NOAA43	0120E	1705	2248	20151021I1
		NASA WB57	TCI-09	1710	2227	
	20151022	NASA WB57	TCI-10	1558	2133	
		NOAA43	0220E	1648	2228	20151022I1
		USAF303	0320E	2223	0750	20151022U1
	20151023	NOAA43	0420E	1648	0121	20151023I1

	NASA WB57	TCI-11	1809	0020	
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Table 5. Flights into Matthew (2016 Atlantic)

Storm	Date	Aircraft	Flight ID	Take Off (UTC)	Landing (UTC)	Flight Identifier	
Matthew	20160927	USAF303	0114A	1527	2137	20160927U1	
	20160928	USAF303	0214A	0936	1526	20160928U1	
		USAF303	0314A	2146	0506	20160928U2	
	20160929	USAF303	0414A	1005	1735	20160929U1	
		NOAA43	WXWXA	1716	2116	20160929I1	
		NOAA49	0514A	1731	0116	20160929N1	
	20160930	USAF306	0614A	2218	0608	20160929U2	
		USAF306	0714A	0929	1449	20160930U1	
		NOAA43	WA14A	1507	2237	20160930I1	
		NOAA49	0814A	1745	0200	20160930N1	
	20161001	USAF303	0914A	2112	0222	20160930U2	
		NOAA43	WB14A	1502	2327	20161001I1	
		USAF306	1014A	0952	1342	20161001U1	
	20161002	NOAA49	1114A	1729	0156	20161001N1	
		USAF303	1314A	0843	1733	20161002U1	
		NOAA49	1414A	1718	0156	20161002N1	
	20161003	USAF303	1514A	2059	0619	20161002U2	
		USAF306	1614A	0914	1754	20161003U1	
		NOAA43	WXWXA	1443	1825	20161003I1	
		NOAA49	1714A	1712	0159	20161003N1	
	20161004	USAF306	1814A	2121	0511	20161003U2	
		USAF303	1914A	0926	1716	20161004U1	
		NOAA49	2014A	1740	0131	20161004N1	
	20161005	USAF303	2114A	2049	0559	20161004U2	
		NOAA49	2214A	0517	1349	20161005N1	
		USAF304	2314A	0832	1332	20161005U1	
		NOAA43	WC14A	0752	1332	20161005I1	
		NOAA49	2414A	1732	2051	20161005N2	
		NOAA43	WD14A	1813	0139	20161005I2	
	20161006	USAF309	2514A	2021	0531	20161005U2	
		NOAA43	2614A	0536	1327	20161006I1	
		USAF307	2714A	0502	1422	20161006U1	
		NOAA49	2914A	1721	0120	20161006N1	
	20161007	NOAA43	3014A	1752	0146	20161006I2	
		USAF307	3114A	0003	0854	20161007U1	
		NOAA49	3214A	0553	1344	20161007N1	
		USAF301	3314A	0906	1656	20161007U2	
		NOAA43	3414A	1752	0130	20161007I1	
	20161008	USAF307	3514A	1748	2348	20161007U3	
		USAF301	3614A	0310	1100	20161008U1	
		NOAA43	3714A	0555	1315	20161008I1	
		USAF302	3814A	1209	2100	20161008U2	
		NOAA43	3914A	1903	0042	20161008I2	
			USAF301	4014A	2104	0624	20161008U3

3. Data Format Description

These data files are now encoded in NetCDF format. Each file contains data from one flight. The files are named according to the convention:

AAAA_SFMRYYYYMMDD[AC].nc

AAAA is the aircraft agency **NOAA** for AOC aircraft or **AFRC** for Air Force.

"_SFMR" denotes a Stepped Frequency Microwave Radiometer file.

YYYYMMDD is the starting year, month, and day of the mission

[AC] is the aircraft ID (**H**=N42RF, **I**=N43RF, **U**=Air Force) followed by the sequential number of that flight for the day.

".nc" designates a NetCDF file
(examples: AFRC_SFMR20110823U1.nc NOAA_SFMR20140916H1.nc)

Information on NetCDF can be found at the UCAR/UNIDATA web site:

<https://www.unidata.ucar.edu/software/netcdf/>

Here is a listing of the parameters as recorded in the SFMR files

```
netcdf NOAA_SFMR20050828I1 {
dimensions:
    time = 34172 ;
variables:
    int DATE(time) ;
        DATE:units = "YYYYMMDD" ;
        DATE:valid_range = 0, 100000000 ;
        DATE:C_format = "%.8d" ;
        DATE:long_name = "Date" ;
    int TIME(time) ;
        TIME:units = "HHMMSS UTC" ;
        TIME:valid_range = 0, 235959 ;
        TIME:C_format = "%.6d" ;
        TIME:long_name = "Time" ;
    float LON(time) ;
        LON:units = "deg. E." ;
        LON:valid_range = -180.f, 180.f ;
        LON:C_format = "%8.3f" ;
        LON:long_name = "Longitude" ;
    float LAT(time) ;
        LAT:units = "deg. N." ;
        LAT:valid_range = -90.f, 90.f ;
        LAT:C_format = "%8.3f" ;
        LAT:long_name = "Latitude" ;
    float RALT(time) ;
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        RALT:units = "m" ;
        RALT:valid_range = 0.f, 9999.f ;
        RALT:C_format = "%9.1f" ;
        RALT:long_name = "Radar altitude" ;
float RANG(time) ;
        RANG:units = "deg." ;
        RANG:valid_range = -30.f, 30.f ;
        RANG:C_format = "%8.2f" ;
        RANG:long_name = "Roll angle" ;
float PANG(time) ;
        PANG:units = "deg." ;
        PANG:valid_range = -30.f, 30.f ;
        PANG:C_format = "%8.2f" ;
        PANG:long_name = "Pitch angle" ;
float ATEMP(time) ;
        ATEMP:units = "deg. Celsius" ;
        ATEMP:valid_range = -60.f, 60.f ;
        ATEMP:C_format = "%7.1f" ;
        ATEMP:long_name = "Air temperature" ;
float SST(time) ;
        SST:units = "deg. Celsius" ;
        SST:valid_range = 22.f, 36.f ;
        SST:C_format = "%7.2f" ;
        SST:long_name = "Sea-surface temperature" ;
float SALN(time) ;
        SALN:units = "g/kg" ;
        SALN:valid_range = 35.f, 37.f ;
        SALN:C_format = "%7.1f" ;
        SALN:long_name = "Salinity" ;
float SWS(time) ;
        SWS:units = "m/s" ;
        SWS:valid_range = 0.f, 999.f ;
        SWS:C_format = "%9.1f" ;
        SWS:missing_value = -999.9f ;
        SWS:long_name = "SFMR wind speed" ;
float SRR(time) ;
        SRR:units = "mm/hr" ;
        SRR:valid_range = 0.f, 999.f ;
        SRR:C_format = "%9.1f" ;
        SRR:missing_value = -999.9f ;
        SRR:long_name = "SFMR rain rate" ;
float FWS(time) ;
        FWS:units = "m/s" ;
        FWS:valid_range = 0.f, 999.f ;
        FWS:C_format = "%9.1f" ;
        FWS:long_name = "Flt. lvl. wind speed" ;
float FDIR(time) ;
        FDIR:units = "deg. meteor." ;
        FDIR:valid_range = 0.f, 360.f ;
        FDIR:C_format = "%9.1f" ;
        FDIR:long_name = "Flt. lvl. wind direction" ;
int FLAG(time) ;
        FLAG:units = "unitless" ;
        FLAG:valid_range = 0, 3 ;
        FLAG:C_format = "%.1d" ;
        FLAG:valid_data = 0 ;

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        FLAG:questionable_data = 1 ;
        FLAG:invalid_data = 2 ;
        FLAG:no_solution = 3 ;
        FLAG:long_name = "Validity flag" ;
int NGC(time) ;
    NGC:units = "channels" ;
    NGC:valid_range = 0, 6 ;
    NGC:C_format = "%.1d" ;
    NGC:long_name = "Number of channels" ;
float TB1(time) ;
    TB1:units = "Kelvin" ;
    TB1:valid_range = 0.f, 325.f ;
    TB1:C_format = "%7.1f" ;
    TB1:missing_value = -999.9f ;
    TB1:long_name = "Bright. Temp. (4.74 GHz)" ;
float TB2(time) ;
    TB2:units = "Kelvin" ;
    TB2:valid_range = 0.f, 325.f ;
    TB2:C_format = "%7.1f" ;
    TB2:missing_value = -999.9f ;
    TB2:long_name = "Bright. Temp. (5.31 GHz)" ;
float TB3(time) ;
    TB3:units = "Kelvin" ;
    TB3:valid_range = 0.f, 325.f ;
    TB3:C_format = "%7.1f" ;
    TB3:missing_value = -999.9f ;
    TB3:long_name = "Bright. Temp. (5.57 GHz)" ;
float TB4(time) ;
    TB4:units = "Kelvin" ;
    TB4:valid_range = 0.f, 325.f ;
    TB4:C_format = "%7.1f" ;
    TB4:missing_value = -999.9f ;
    TB4:long_name = "Bright. Temp. (6.02 GHz)" ;
float TB5(time) ;
    TB5:units = "Kelvin" ;
    TB5:valid_range = 0.f, 325.f ;
    TB5:C_format = "%7.1f" ;
    TB5:missing_value = -999.9f ;
    TB5:long_name = "Bright. Temp. (6.69 GHz)" ;
float TB6(time) ;
    TB6:units = "Kelvin" ;
    TB6:valid_range = 0.f, 325.f ;
    TB6:C_format = "%7.1f" ;
    TB6:missing_value = -999.9f ;
    TB6:long_name = "Bright. Temp. (7.09 GHz)" ;

// global attributes:
:Source = "NOAA/AOML/HRD/" ;
:Project = "SFMR hurricane surface winds" ;
:Update = "Reprocessed using 2015 operational algorithm" ;
:FlightDate = "2005/08/28" ;
:Aircraft = "NOAA43" ;
:TimeInterval = "16:08:51-01:54:10" ;
:StormName = "Katrina" ;

```

4. Data Remarks

These data were retrieved from the NOAA/HRD archives on 21 November 2017 which at that time was located here:

<ftp://ftp.aoml.noaa.gov/hrd/pub/data/sfmr/>

SFMR processing is documented in:

Klotz, B. W. and E. W. Uhlhorn, 2014: "Improved Stepped Frequency Microwave Radiometer Tropical Cyclone Surface Winds in Heavy Precipitation." *J. Atmos. Oceanic Technol.*, **31**, 2392-2408.

<https://doi.org/10.1175/JTECH-D-14-00028.1>

Uhlhorn, E.W., P.G. Black, J.F. Franklin, M. Goodberlet, J. Carswell, A.S. Goldstein, 2007: "Hurricane surface wind measurements from an operational Stepped-Frequency Microwave Radiometer." *Mon. Wea. Rev.*, **135**, 3070-3085. <https://doi.org/10.1175/MWR3454.1>