**High-altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)**

***Summary***

The High-altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) is a dual-frequency (Ku- and Ka-band, similar to the Global Precipitation Mission (GPM) Dual-frequency Precipitation Radar (DPR) frequencies), and dual-beam (30 & 40 degree incidence angle) Doppler radar system. It was developed under the support of the NASA Instrument Incubator Program (IIP) and flew for the first time on the NASA Global Hawk during Genesis and Rapid Intensification Processes (GRIP) in 2010 with a downward-looking conical scan antenna.

During MC3E, HIWRAP was modified with a new dual-frequency nadir pointing antenna designed for the ER-2. For each radar frequency (Ku- or Ka-band), one of three pulse sequences were used: (2, 20), (2, 20, 2) , or (20, 2) . Each of the pulses had a slightly different center frequency so that they could be separated by the digital receiver. The 20 chirp pulse is the main return of interest. The first short pulse is used to obtain returns near the radar in the “blind” zone of the chirp pulse. The second short pulse is used to obtain returns near the surface since strong surface returns contaminated the near surface rain signal through the pulse compression range side lobes in the chirp channel. The reflectivity from the chirp channel has about 8 to 9 dB higher sensitivity than that of short pulses. Because of surface clutter in the chirp channel range side lobes, we have replaced the reflectivity from the chirp channel with that from the second short pulse beyond 16.425 km range from the radar. This works well for most of the situations except in regions where the sensitivity from the short pulse is below the minimum detectable reflectivity and the chirp return is detectable.

***Instrument Description***

Table 1. HIWRAP MC3E System Specifications

|  |  |  |
| --- | --- | --- |
| Parameters | Specifications | |
|  | Ku-band | Ka-band |
| RF Frequency (GHz) | Chirp mode: 13.915  Pulse mode: 13.904 | Chirp mode: 33.733  Pulse mode: 33.716 |
| Transmitter Peak Power (W) | 25 | 8 |
| Antenna Gain (dB) | 34.8 | 42.0 |
| Antenna 3 dB Beamwidth AZ (o) | 3.07 | 1.23 |
| Antenna 3 dB Beamwidth EL (o) | 2.96 | 1.19 |
| PRF (Hz) | 4516/3859 | 4516/3589 |
| RF Pulse Width (μs) | Chirp mode: 20  Pulse mode: 2 | Chirp mode: 20  Pulse mode: 2 |
| Receiver Bandwidth (MHz) | 2 | 2 |
| Doppler Range (m/s) | +/- 97 | +/-40 |
| Minimum Detectable Reflectivity (dBZ) (@10 km, 0.5s ave) | Chirp mode: -0.5  Pulse mode: 9.5 | Chirp mode: -10.6  Pulse mode: -2.9 |

***Data Release History***

1. ***12-30-2011: 5/20/2011 reflectivity***

***File Naming Convention and Data Format***

* The data files are in NetCDF (Network Common Data Form), and are named as the example below:

mc3e\_hiwrap\_yymmdd\_hhmmss\_hhmmss.nc

yymmdd\_hhmmss\_hhmmss – indicate the GPS (note that GPS time is ahead of UTC by 15 sec) start and end time of the data (year, month, day and hours, minutes, seconds)

* There are multiple files for each flight. The vertical resolution is 75 meters and horizontal resolution is about 0.1 km.
* Measurements included within the data files are Merged pulse and chirp radar reflectivity profiles at 13.9 and 33.7 GHz.
* Other information associated with data positions is also included. These data can be read with most any NetCDF reader, thus no sample read software is provided by the data producer. More information about NetCDF may be found at

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

* An example of metadata is given at the end of this document.

***Data Policy***

The HIWRAP data collection was funded by the GPM Ground Validation for the the PMM Science Team algorithm development and validation. Access to HIWRAP data is not restricted. However, we do ask that data users respect the experiment PIs and others with rights to the data. Acknowledgement or an offer of co-authorship on any publications, presentation, etc., should be made to the PI and his/her team if images and/or data are used (even if they are freely accessed).

***Contact Information***

Users are welcome to address questions and provide feedback to

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**Appendix I Example of metadata**

netcdf mc3e\_hiwrap\_20110520\_135617-140741 {

dimensions:

timed = 1186 ;

range = 239 ;

variables:

short year ;

year:long\_name = "Year the data was collected" ;

float wlku ;

wlku:long\_name = "Wavelength length of Ku radar" ;

wlku:units = "m" ;

float wlka ;

wlka:long\_name = "Wavelength length of Ka radar" ;

wlka:units = "m" ;

float gatesp ;

gatesp:long\_name = "radar range gate" ;

gatesp:units = "m" ;

float missing ;

missing:long\_name = "missing value" ;

missing:units = " " ;

float timed(timed) ;

timed:long\_name = "GPS time" ;

timed:units = "hour" ;

float gspeed(timed) ;

gspeed:long\_name = "Ground speed of aircraft" ;

gspeed:units = "m/s" ;

float range(range) ;

range:long\_name = "range from radar" ;

range:units = "m" ;

float lat(timed) ;

lat:long\_name = "GPS aircraft latitude, minus sign= South" ;

lat:units = "degree" ;

float lon(timed) ;

lon:long\_name = "GPS aircraft longitude, minus sign=West" ;

lon:units = "degree" ;

float roll(timed) ;

roll:long\_name = "aircraft roll angle" ;

roll:units = "degree" ;

float pitch(timed) ;

pitch:long\_name = "aircraft pitch angle" ;

pitch:units = "degree" ;

float altitude(timed) ;

altitude:long\_name = "aircraft altitude" ;

altitude:units = "meter" ;

float head(timed) ;

head:long\_name = "aircraft heading" ;

head:units = "deg" ;

float zku(timed, range) ;

zku:long\_name = "Ku band Radar Reflectivity" ;

zku:units = "dBZ" ;

float zka(timed, range) ;

zka:long\_name = "Ka band Radar Reflectivity" ;

zka:units = "dBZ" ;

float zka(timed, range) ;

zka:long\_name = "Ka band Radar Reflectivity" ;

zka:units = "dBZ" ;

// global attributes:

:title = "ER2 HIWRAP Data, NASA Goddard Space Flight Center" ;

:filename = "/karldata4/tian/MC3E/hiwrap/netcdf/0520/mc3e\_hiwrap\_2011

0520\_135617-140741.nc" ;

:experiment = "NASA MC3E" ;

:source = "created from ER2 HIWRAP binary file, Version 0.0" ;

:comments = "Contact: lin.tian-1@nasa.gov" ;