HARP2 Level-1 Data Processing Plan

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Acknowledgement: Bryan Franz, Meng Gao, Fred Patt, Sean Bailey, and Joel Gales

UMBC EARTH AND SPACE INSTITUTE

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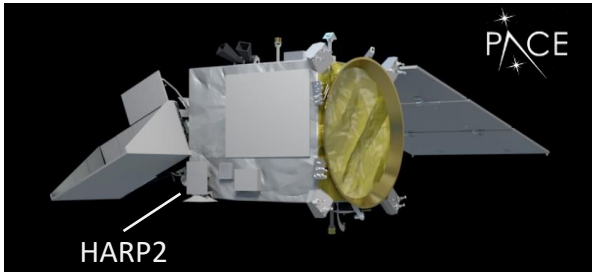
Outline

- HARP2 instrumentation and technology
- HARP2 level-1 data categories
- Hyper-angle Image Processing Pipeline (HIPP)
- Demonstration of HARP L1A/B/C data structure
- HARP2 proxy data
  - HARP CubeSat data products
  - AirHARP field data products
  - Planned synthetic PACE/HARP2 L1data

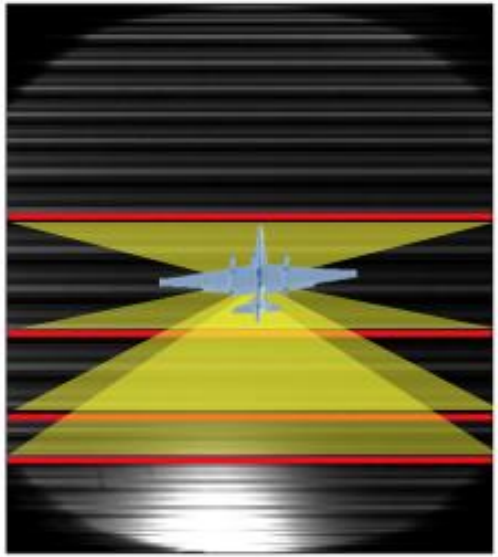
The HARP2 instrument

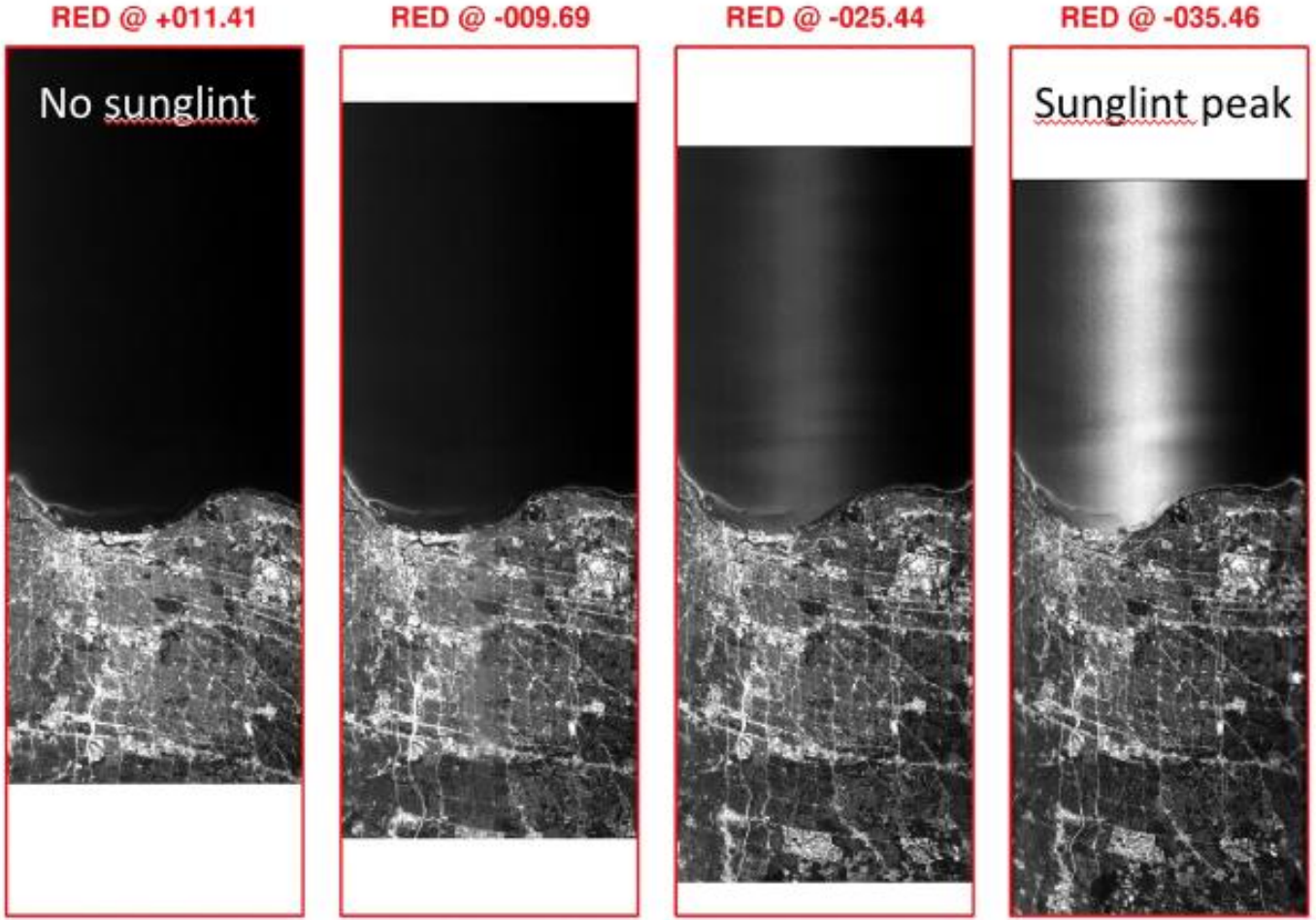
- Three 2048 x 2048 CCD detectors with polarization angles of 0°, 45°, and 90°
- 4 spectral bands (FWHM): 441 (15), 549 (12), 669 (16), 873 (43) nm
- Cross track FOV: 94°, spans a 1555 km swath with ~3 km binned resolution at nadir, 2-day global coverage
- Along-track FOV: 114°, splitting into 60 along-track view angles for the 669 nm band, 10 angles for each of the other 3 bands
- Onboard lunar and solar calibrations
- Polarization accuracy: DoLP < 0.01



AIR HARP

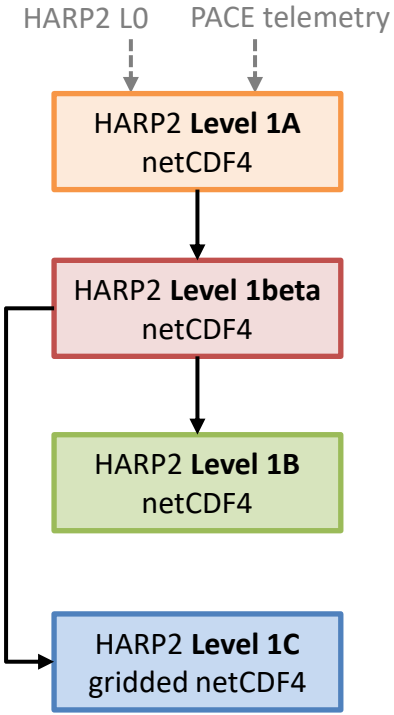
Multi-Angle Observation





Multiple Angles

HARP2 Level-1 Data Processing Flow

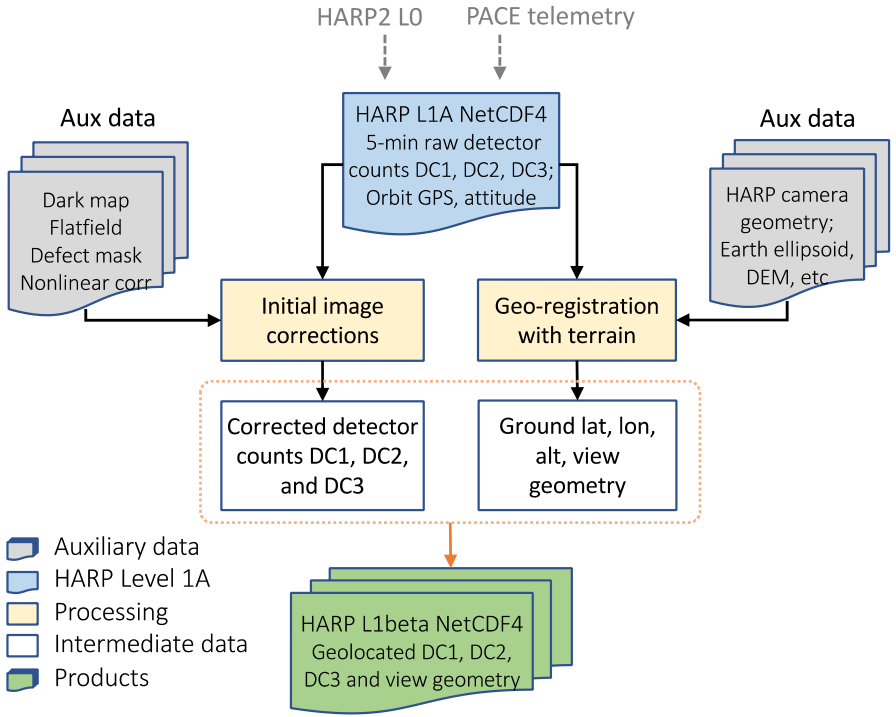


HARP2 Level 1 data types

1A	5-min reconstructed, unprocessed instrument data (digital counts from three detectors) at full resolution, time-referenced, and annotated with the spacecraft ephemeris and attitude data.
1beta	Geo-located, topographically corrected instrument data at full resolution in the detector frame. Radiance data remain in digital count units but with initial corrections applied. (L1beta data are not intent for public distribution.)
1B	Geo-registered, radio-polarimetrically calibrated data (i.e., Stokes-vector parameters I, Q, U) in radiance units for individual HARP2 view angles (pushbroom images) at native spatial resolution. 5-min granule
1C	Co-located and co-registered radiance data for all HARP2 observation angles at a given fixed geographical grid. 5-min granule based on nadir view.

HIPP processing flow for HARP/HARP2 (1)

Level 1A to level 1beta



HIPP = Hyper-angle Image Processing Pipeline

Geolocation: Images are projected to ground altitude for each of three CCDs:

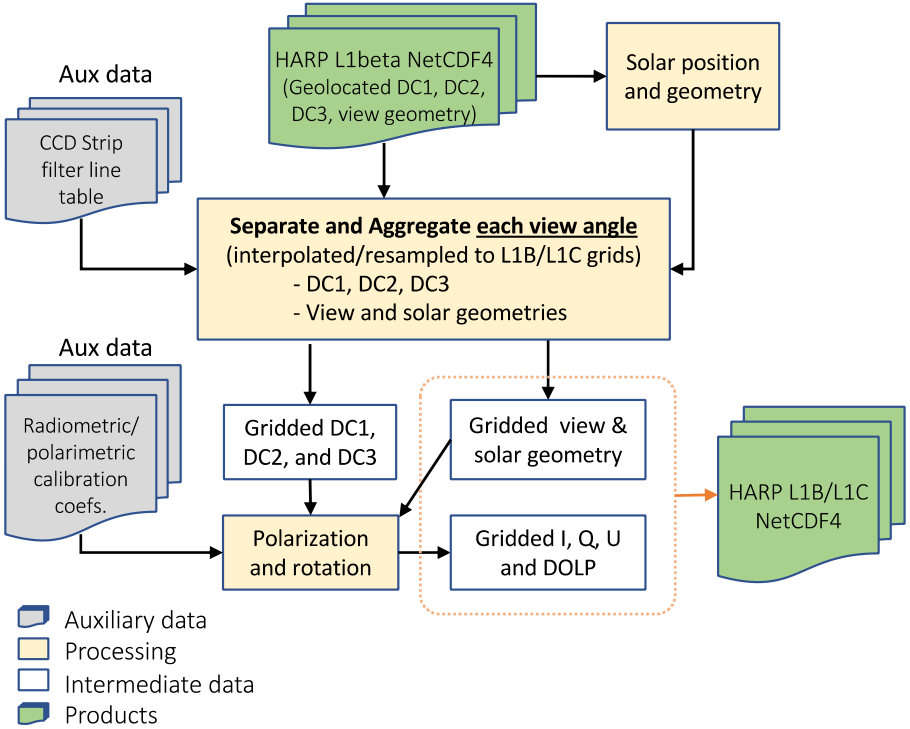
- ZEMAX CCD camera geometries calibrated with real captures
- Various coordinate transformations
- WGS84 ellipsoid + 1-arc-min ETOPO1 DEM
- Iterative terrain correction

Initial CCD image corrections:

- Dark current: temperature dependent
- Defect mask for hot/defect pixels
- Non-linear CCD response correction
- Flat fielding and CCD fringe corrections

HIPP processing flow for HARP/HARP2 (2)

Level 1beta to level 1B and 1C

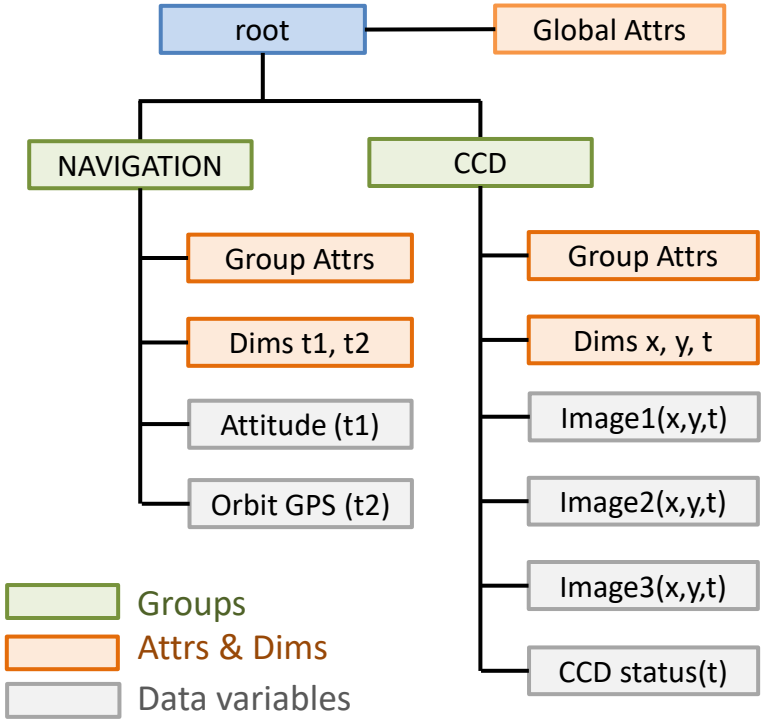


- Extract lines of each filter strip (view angle) and stitch them together to form pushbroom images for each CCD
- Collocate pushbrooms for the 3 CCDs
  - L1B: register to a reference CCD
  - L1C: Pre-determined L1C grids
- Convert resampled/gridded DCs to radiances for pushbrooms of each view angle and rotated to view meridional plane

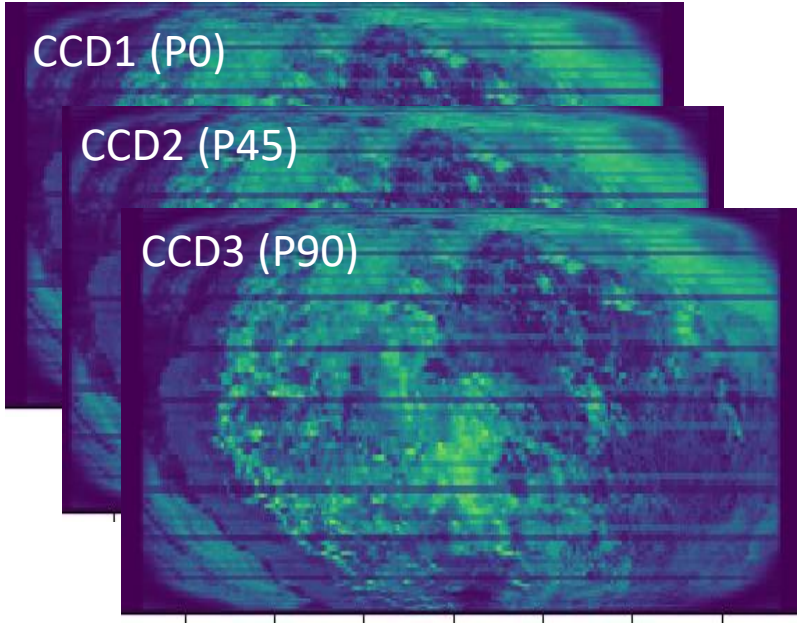
$$\begin{bmatrix} I \\ Q \\ U \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix}^{-1} \begin{bmatrix} DC1 \\ DC2 \\ DC3 \end{bmatrix}$$

HARP L1A Data Structure

Level 1A netCDF4

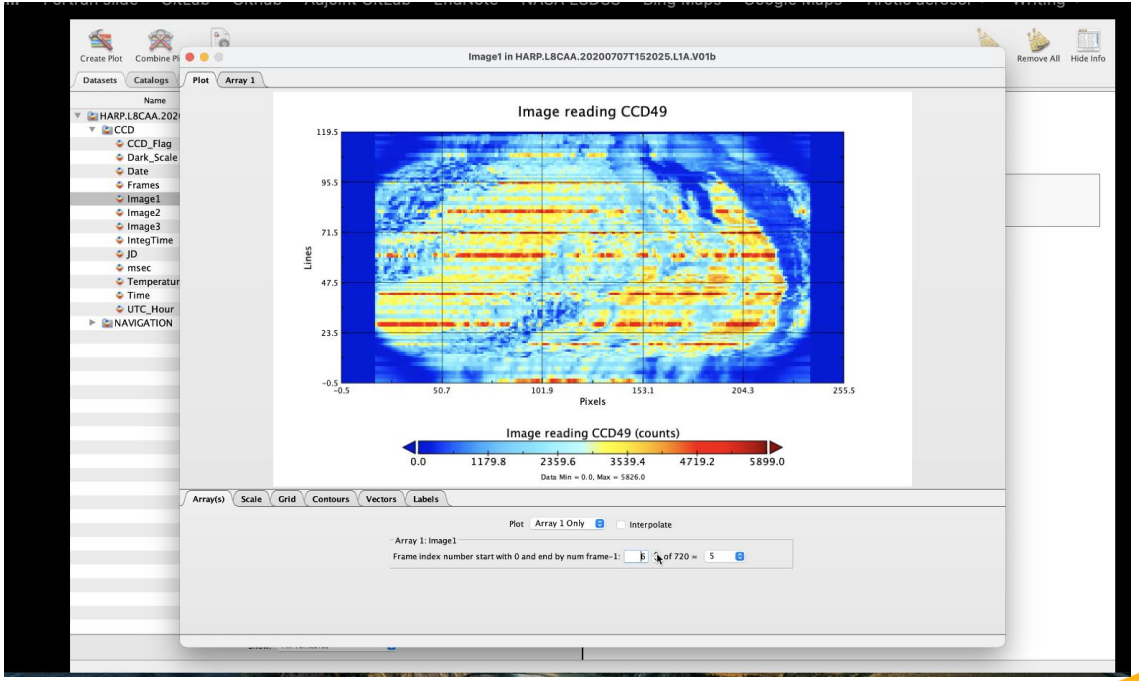


Movie of HARP L1A images acquired on 05/03/2020



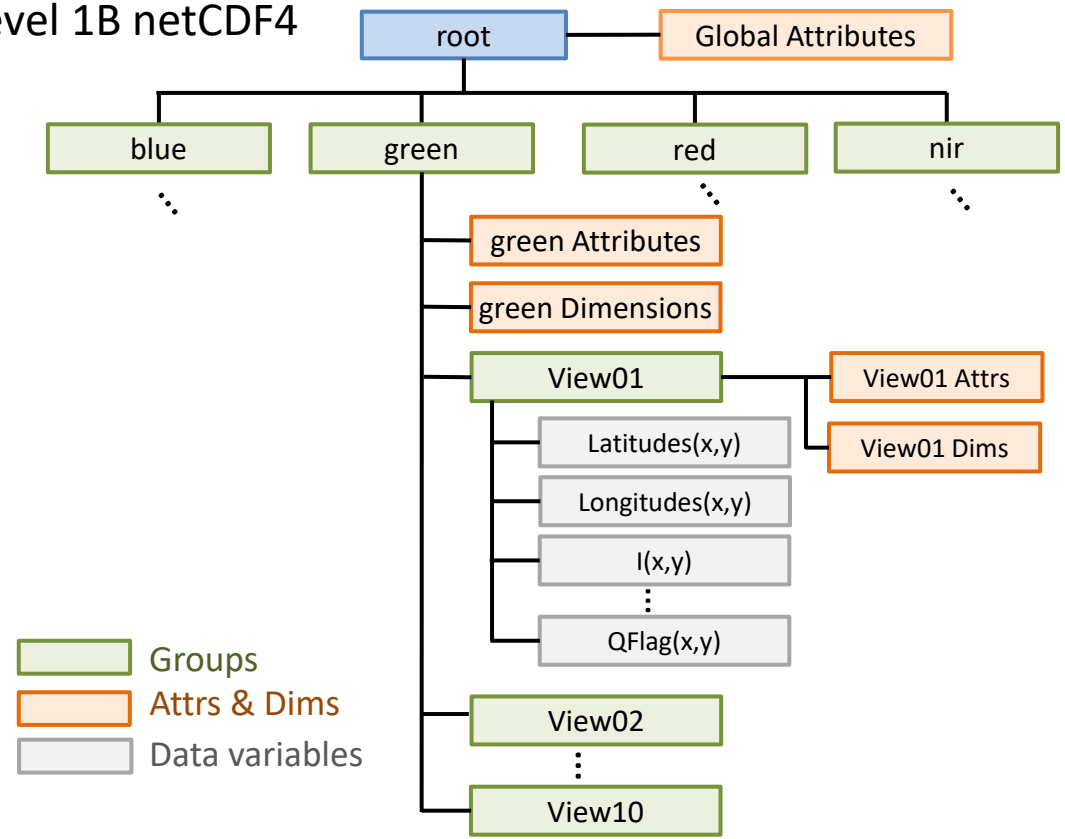
Demonstration with a HARP CubeSat L1A file

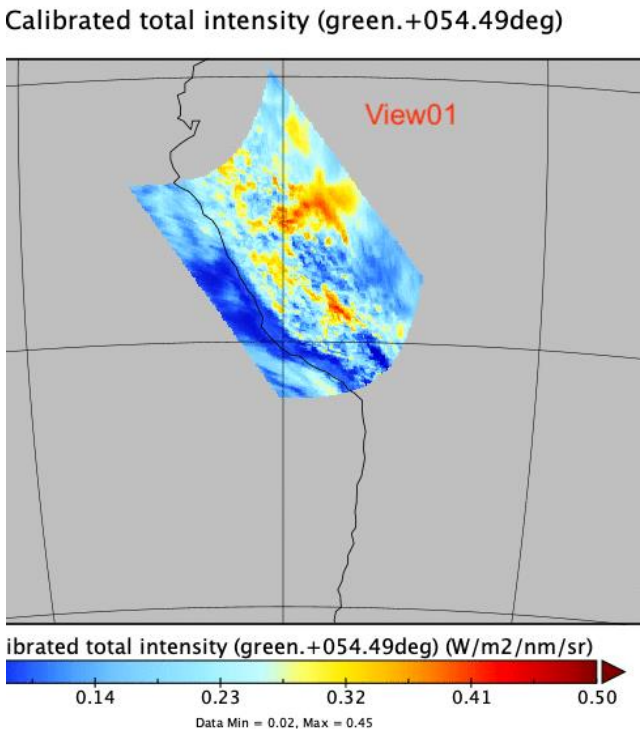
Click here to view the demonstration of HARP CubeSat L1A file:
https://photos.app.goo.gl/cM9BQozpztPs7tYy5



HARP L1B Data Structure

Level 1B netCDF4





Demonstration with a HARP CubeSat L1B file

Click here to view the demonstration of HARP CubeSat L1B file:
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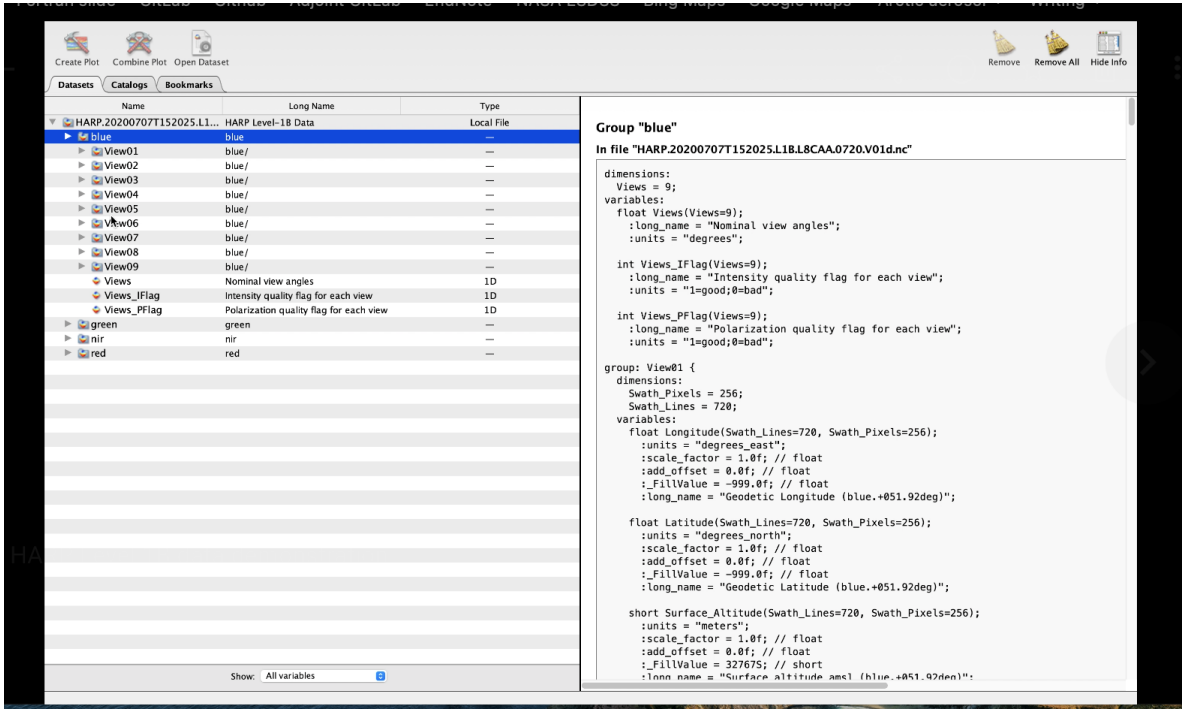
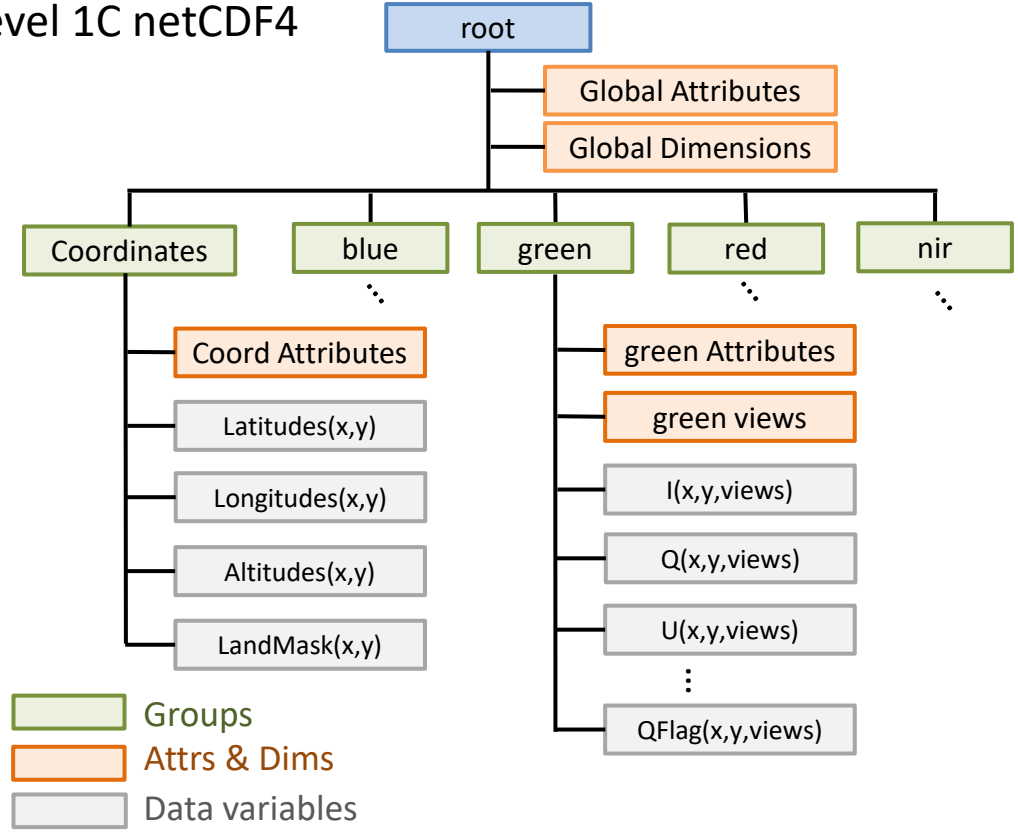
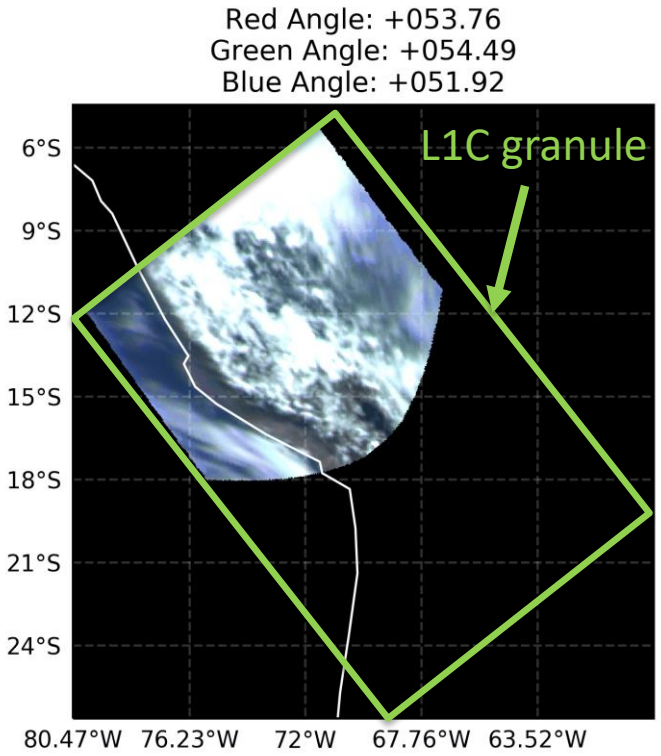


HARP L1C Data Structure

Level 1C netCDF4





Demonstration with a HARP CubeSat L1C file

Click here to view the demonstration of HARP CubeSat L1C file:
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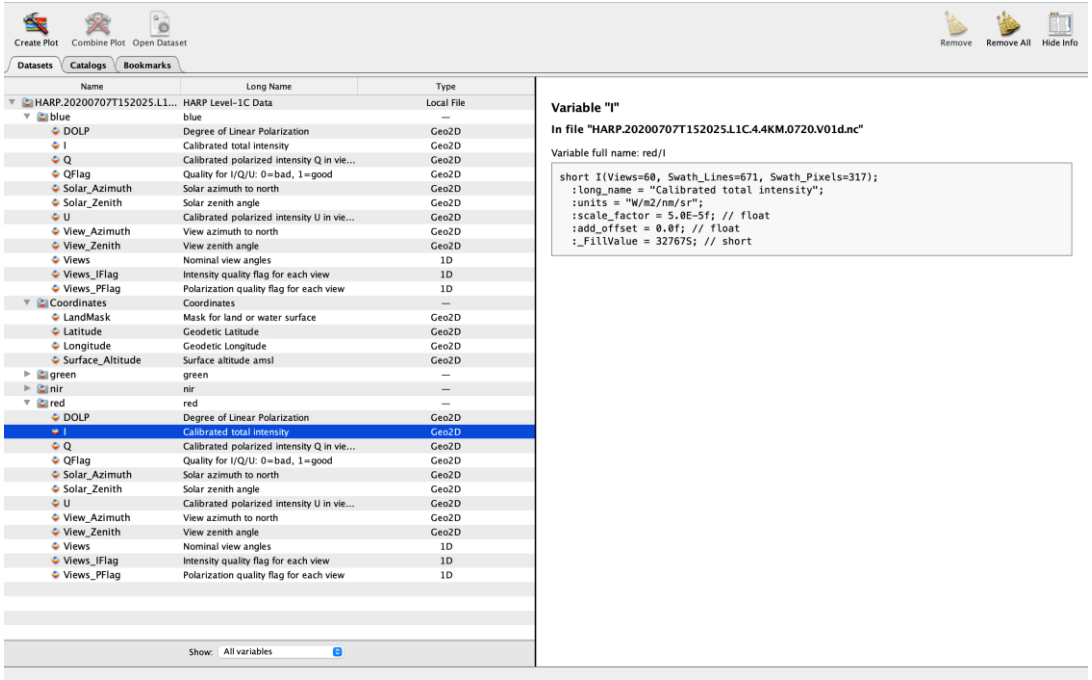
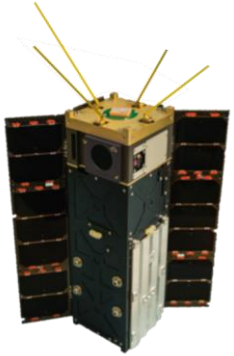


Proxy HARP2 L1 datasets

- AirHARP campaign data
  - AirHARP/ACEPOL L1B: https://www-air.larc.nasa.gov/missions/acepol

- HARP CubeSat
  - Deployed from ISS in 2020-02-19
  - Data collection since May 2020
  - Targeted captures

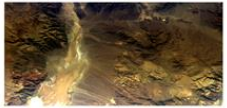


- Synthetic HARP2 L1B/L1C Data (under development)

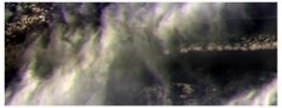
AirHARP's Image Gallery for ACEPOL 2017

Oct 19th

ISS Rosamond Track WPT 4, 17:24Z



USC SeaPrism/Huntington Beach WPT 7, 17:57Z



Oct 23rd

Rosamond WPT 4, 18:07Z

Ocean PP WPT 20, 20:10Z

Ocean WPT 23, 20:49Z

Catalina WPT 26, 21:30Z

CalTech WPT 29, 21:53Z

Oct 25th

Rosamond Dry Lake WPT 5, 17:28Z

Rosamond Dry Lake WPT 14, 18:55Z

Rosamond Dry Lake WPT 8, 17:57Z

Rosamond Dry Lake WPT 17, 19:28Z

Rosamond Dry Lake WPT 11, 18:26Z

Bakersfield WPT 20, 19:55Z

Fresno WPT 23, 20:21Z

USC SeaPrism/Huntington Beach WPT 29, 21:04Z

Oct 26th

Fresno WPT 5, 18:55Z

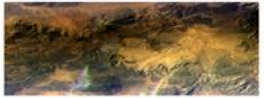
Salton Sea WPT 17, 19:57Z

Bakersfield WPT 8, 19:15Z

Arizona Border WPT 20, 20:13Z

Caltech WPT 11, 19:37Z (LAC)

CALIPSO Track WPT 23, 20:42Z



CALIPSO Track WPT 24, 21:00Z

Central Valley WPT 27, 21:24Z

Oct 27th

Kaibab WPT 4, 17:57Z

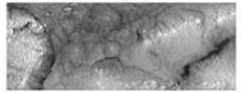
Kaibab WPT 7, 18:16Z

Railroad Valley WPT 10, 18:58Z

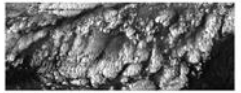
Las Vegas WPT 13, 19:22Z

Nov 1st

Ocean PP WPT 4, 17:24Z (LAC)

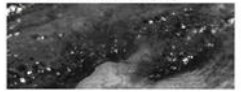


USC SeaPrism WPT 7, 17:56Z (LAC)



Discretionary Track WPT 19, 19:14Z

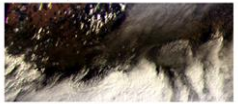
West-East Transit WPT 9, 18:25Z (LAC)



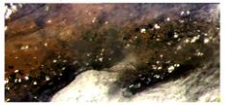
Las Vegas WPT 25, 20:015Z (LAC)

Nov 3rd

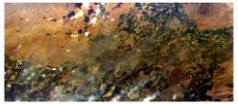
Modesto WPT 4, 19:56Z



Fresno WPT 10, 20:39Z



Bakersfield WPT 7, 21:07Z

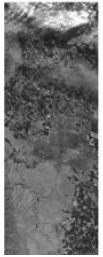


Nov 7th

Caltech WPT 4, 18:09Z

USC SeaPrism/Long Beach WPT 7, 18:34Z

Bakersfield WPT 10, 19:04Z

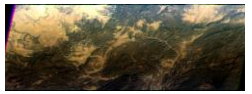


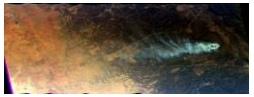
Fresno WPT 13, 19:36Z

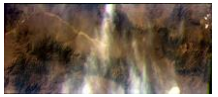
Modesto WPT 16, 20:03Z

Ocean WPT 20, 20:30Z

Nov 9th

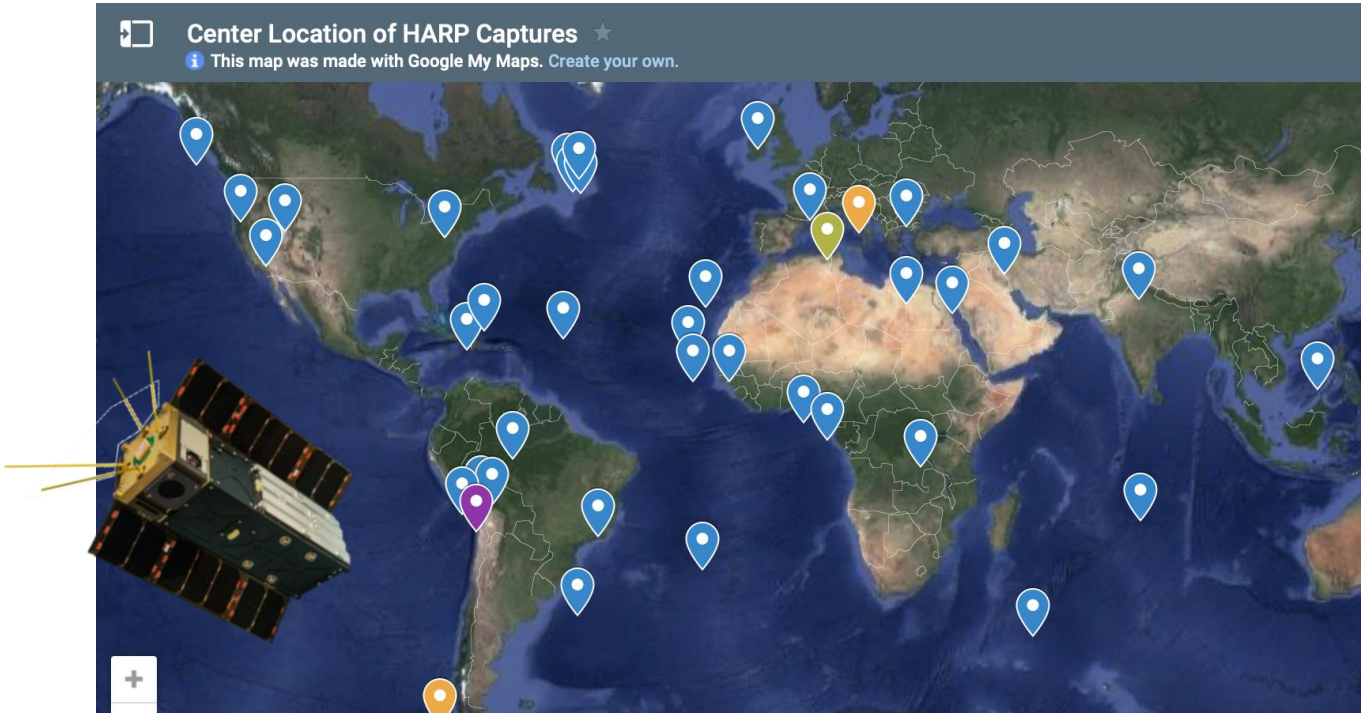






HARP2 Proxy data 1: HARP CubeSat Data Collection

Preliminary quicklook for all science captures are available at https://sites.google.com/umbc.edu/harp/harp-quicklooks



Over 40 successful science captures focusing on clouds, aerosol (dust, smoke), ocean and land surfaces, and vicarious calibrations

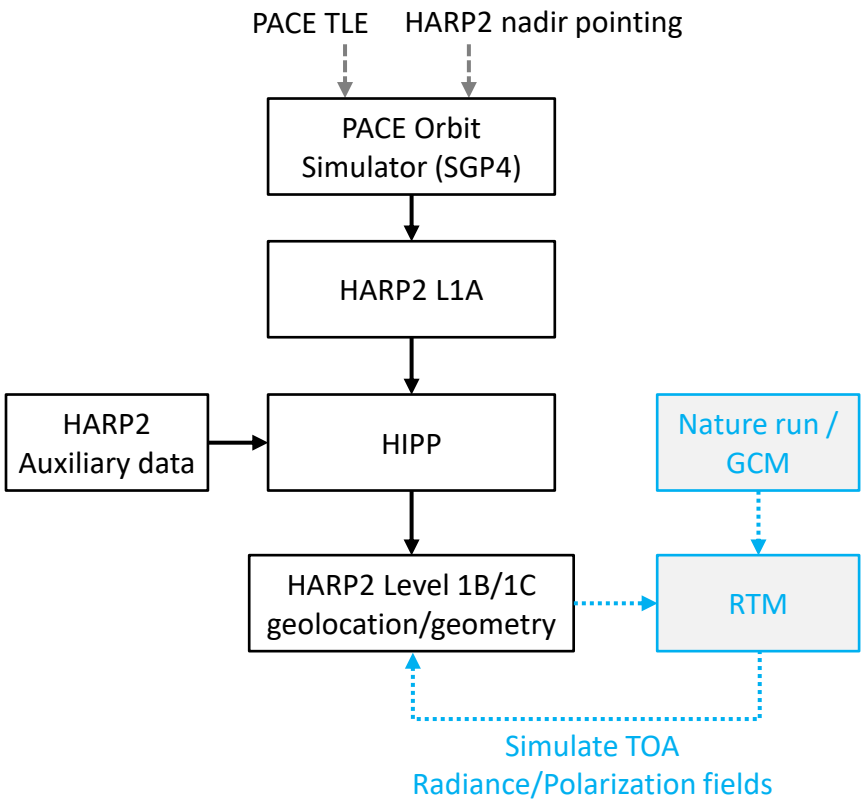
Most of them were collected in May-Sep 2020

Recent captures have begun after a 6-month ground station maintenance

Synthetic HARP2 L1B/L1C Data

Why HARP2 synthetic data?

- Evaluate HARP2 onboard binning schemes that are much more complicated than those of HARP CubeSat
- Help implementation of HARP2 L1 operational processing
- Provide a PACE/HARP2 synthetic test data to the L2 community



Summary

We have introduced

- HARP2 Level 1 data categories
- Hyper-angle Image Processing Pipeline
- L1A, L1B, and L1C HARP2 data format with demonstration
- Available and upcoming HARP2 proxy data

Thank you for your time and attention!
Questions? Shoot me an email at xxu@umbc.edu