HARP2 Level-1 Data Processing Plan

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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 L1 data
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
Multi-Angle Observation

No sunglint

Sunglint peak

Multiple Angles
# HARP2 Level-1 Data Processing Flow

## HARP2 Level 1 data types

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>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.</td>
</tr>
<tr>
<td>1beta</td>
<td>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. <em>(L1beta data are not intent for public distribution.)</em></td>
</tr>
<tr>
<td>1B</td>
<td>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</td>
</tr>
<tr>
<td>1C</td>
<td>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.</td>
</tr>
</tbody>
</table>
HIPP processing flow for HARP/HARP2 (1)

Level 1A to level 1beta

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 ETOP01 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 = Hyper-angle Image Processing Pipeline
HIPP processing flow for HARP/HARP2 (2)

- 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

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

CCD1 (P0)
CCD2 (P45)
CCD3 (P90)
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

- root
  - Global Attributes
  - blue
  - green
  - red
  - nir

- green Attributes
- green Dimensions

- View01
  - Latitudes(x,y)
  - Longitudes(x,y)
  - I(x,y)
  - QFlag(x,y)
  - View01 Attrs
  - View01 Dims

- View02

- View10
Demonstration with a HARP CubeSat L1B file

Click here to view the demonstration of HARP CubeSat L1B file:
https://photos.app.goo.gl/Y3Beo3eWwmGoJAA96
HARP L1C Data Structure

Level 1C netCDF4

- **root**
  - **Global Attributes**
  - **Global Dimensions**
  - **Coordinates**
    - **Coord Attributes**
      - Latitudes(x,y)
      - Longitudes(x,y)
      - Altitudes(x,y)
      - LandMask(x,y)
  - **blue**
  - **green**
    - **green Attributes**
      - green views
      - I(x,y,views)
      - Q(x,y,views)
      - U(x,y,views)
      - QFlag(x,y,views)
  - **red**
  - **nir**
  - **Data variables**

Red Angle: +053.76
Green Angle: +054.49
Blue Angle: +051.92
Demonstration with a HARP CubeSat L1C file

Click here to view the demonstration of HARP CubeSat L1C file: https://photos.app.goo.gl/yA5Xqg8HxWT7kNSS6
Proxy HARP2 L1 datasets

- **AirHARP campaign data**
  - AirHARP/ACEPOL L1B: [https://www-air.larc.nasa.gov/missions/acepol](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)
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.
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