

The HARP family of Hyper-Angular Imaging Polarimeters and its applications from Aircraft and Space

J. Vanderlei Martins, Brent McBride, Anin Puthukkudy, Xiaoguang (Richard) Xu, Noah Sienkiewicz, Henrique M. J. Barbosa, Roberto Fernandez-Borda, Lorraine Remer, Oleg Dubovik, Pavel Litvinov

2nd APOLO Conference – Lille, France - 11/03-08/2019

HARP: Hyper-Angular Polarization

Wide FOV front lens followed by HARP Prism with Polarization Separation

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- +/- 114 deg along track
- 94 deg cross track



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Multiple Angles

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WUMBC The HARP Polarimeter Family

Air HARP HARP CubeSat





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- Frequent Ground calibration
- ~40m resolution
- Potential for HARP2 Cal/Val

Launched to ISS Nov 2nd 2019 Deployment Jan 2020

- 4 km resolution
- Limited data set: 1 snapshot/day
- No calibrator onboard/only vicarious



Launch: 2022-23

- Improved SNR
- Better calibration features
- ~3 km resolution
- Global coverage in 2 days



Hi-resolution concept

- Extended Wavelength range
- Improved SNR
- Full calibration features
- ~0.5km resolution

Image: Ward of the second s

- Global coverage in 2 days
- Synergy with Ocean color and SPEXOne polarimeters



HARP CubeSat

HARP launched Nov. 2nd 2019

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WUMBC CubeSats require deployment from ISS



HARP deployment planned for late Jan/2020

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Example of other Cubesats being deployed from ISS

HARP Polarization Accuracy

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Comparison with RSP





BC Comparisons with SPEX and MSPI



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Data Processing Algorithms

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Level 1 HARP Image Processing Pipeline

- UMBC HIPP algorithm for HARP2
 - Produce Level 1beta NetCDF files based on raw data
 - Generates levels 1B and 1C images from level 1beta
 - 1A raw data frames
 - 1beta intermediate data processing file (not for distribution)
 - 1B gridded/calibrated/geolocated/topographically corrected images, viewing and solar geometry (all angles)
 - 1C common gridded data set between all PACE payloads
- Archived data include levels 1A, 1B and 1C.

Importance of Topography for

Geolocation



Actual (Lat, Lon) as compared with Nadir view

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Importance of Topography for

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Geolocation





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Implementation by Noah Sienkiewicz



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- Aerosol
 - GRASP algorithm is being used for the retrieval of aerosol load and microphysical properties
 - Successful retrievals from preliminary level 1 data sets
 - Currently running on reprocessed level 1 including topographical correction
- Surface properties
 - Sub-product from GRASP Aerosol Retrievals
- Cloud
 - Parametric retrievals of cloud effective radius and variance at the pixel level

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AirHARP Aerosol retrievals from ACEPOL

2017-11-09T19:30:55-RGB-Nadir



More Details later on Anin Puthukkudy's presentation tomorrow (paper in preparation)

AirHARP cloud retrievals

AMTD 2019

Spatial distribution of cloud droplet size properties from Airborne Hyper-Angular Rainbow Polarimeter (AirHARP) measurements

Brent A. McBride^{1,2,3}, J. Vanderlei Martins^{1,2,3}, Henrique M.J. Barbosa⁴, William Birmingham^{2,3}, and Lorraine A. Remer^{2,3}



More on Brent Mcbride's Poster

AMTD 2019

Spatial distribution of cloud droplet size properties from Airborne Hyper-Angular **Rainbow Polarimeter (AirHARP) measurements**

Brent A. McBride^{1,2,3}, J. Vanderlei Martins^{1,2,3}, Henrique M.J. Barbosa⁴, William Birmingham^{2,3}, and Lorraine A. Remer^{2,3}



More on Brent Mcbride's Poster

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WIMBC AirHARP BRDF and BPDF Retrievals

DOLP (440,550,670)





0° Reflectance





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More on Richard's Xu Poster

Oral: Wed 11:00– 11:15 - Anin Puthukkudy

Retrieval of aerosol properties from Airborne Hyper-Angular Rainbow Polarimeter (AirHARP) observations during the 2017 ACEPOL campaign

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Posters: Thu 14:00-15:40:

• Section 5 - Xiaoguang Xu, et al.

Angular distribution of **total and polarimetric land surface reflectance** measured by AirHARP

• Section 7 - Brent A. McBride et al.

Spatial distribution of **liquid water cloud droplet** size properties retrieved from Airborne Hyper-Angular Rainbow Polarimeter (AirHARP) observations • HARP CubeSat launched to ISS 11/2/19 – release for indepent data collection: late January 2020.

Summarv

- HARP2 development is going very well
- First version of the HIPP level 1 processing system has been applied to AirHARP data and is currently under testing by the PACE SDS group at Goddard
- GRASP has been successfully applied to AirHARP level 2 Aerosol processing paper in preparation (Anin Puthukkudy)
- Cloud retrievals have been successfully performed with AirHARP data and are currently under review on AMTD paper (McBride et al. 2019)
- BRDF/BPDF Surface studies are underway with AirHARP data (Richard Xu).