

Perception Testing at the Sandia National Laboratories' Fog Chamber: Data Publication and Data Documentation

George E. Gorospe¹, Nicholas B. Cramer¹, Keerthana Kannan³, Daniel Hart², Corey A. Ippolito¹, Kelley E. Hashemi¹

¹NASA Ames Research Center, Moffett Field, California, USA

²NASA Langley Research Center, Hampton, Virginia, USA

³KBR LLC, NASA Ames Research Center, Moffett Field, California, USA

December 2021

Abstract:

In the summer of 2021, a novel perception testbed, built and tested at NASA Ames Research Center in Moffett Field, CA, was deployed to the Fog Chamber at Sandia National Laboratories in Albuquerque, NM. This testbed featured a visible spectrum camera, a longwave infrared camera, and a light detection and ranging (LIDAR) instrument. During this deployment and test campaign, the testbed was integrated with the fog test chamber for the evaluation of sensor capabilities in visually degraded environments with a variety of target features. The data which resulted from over 30 individual tests consists of images and LIDAR point cloud data sets. These experiment data, and associated documentation are here included in a compiled set for publication. Data documentation includes visualization of the data collected and charts detailing the environmental conditions during the experiment. Also included is a test matrix detailing the experiment sequence and test variables. The test team and developers hope that this data can be of use to the community interested in understanding the limitations of such sensors in visually degraded environments.



1 Experiment Setup and Equipment Specifications

1.1 Perception Testbed Hardware

A novel testbed, featuring a visible spectrum camera, a longwave infrared camera, and a lidar was built and transported to the Fog Chamber at Sandia National Laboratories for fog chamber testing. The perception testbed features the following equipment:

- FLIR BlackFly - Visible Range Camera
- FLIR Boson – Long wave infrared thermal camera
- AEye Intelligent LIDAR

1.2 Environment Monitoring Equipment

During fog experiments, the following equipment was used for characterization of the fog and light scattering resulting from the fog:

- Malvern Spraytec instrument with inhalation cell accessory - produces a measurement of fog particle sizes, this information is useful in understanding light scattering.
- Transmissometer – used in measuring the Meteorological Optical Range (MOR) a light emitting diode and camera are used under a static distance to measure the optical effects of the fog.

2 Useful References

The following documents may be useful in understanding the scope and context of the experiments.

Shish, Kimberlee H., et al. "Survey of Capabilities and Gaps in External Perception Sensors for Autonomous Urban Air Mobility Applications." AIAA Scitech 2021 Forum. 2021.

Redman, Brian J., et al. "Measuring resolution degradation of long-wavelength infrared imagery in fog." Optical Engineering 58.5 (2019): 051806.

Wright, Jeremy B., et al. "Optical characterization of the Sandia fog facility." Degraded Environments: Sensing, Processing, and Display 2017. Vol. 10197. International Society for Optics and Photonics, 2017.

Exp_Name	Description	Lights	Target	Distance (m)	Target Temp
cal01	Calibration for BlackFly	T	USAF-1951	N/A	37 C
cal02	Calibration for Lidar	T	USAF-1951	N/A	37 C
baseline01	Full sensor suite	T	USAF-1951	6.5532	37 C
baseline02	Full sensor suite	T	USAF-1951	6.5532	37 C
baseline03	Full sensor suite	F	USAF-1951	6.5532	37 C
baseline04	Full sensor suite	F	USAF-1951	6.5532	37 C
fog00	Preview - Full sensor suite	T	USAF-1951	6.5532	37 C
fog01	Full sensor suite	T	USAF-1951	6.5532	37 C
fog02	Full sensor suite	F	USAF-1951	6.5532	37 C
fog03	Full sensor suite	F	USAF-1951	6.5532	60 C
fog04	Full sensor suite	T	USAF-1951	6.5532	60 C
cal03	Calibration (FOV adjustment)	T	USAF-1951	41.148	60 C
fog05	Preview - Full sensor suite	T	USAF-1951	41.148	60 C
fog06	Full sensor suite	F	USAF-1951	41.148	60 C
End of Testing Day 1, Tuesday May 11th, 2021					
baseline05	Full sensor suite	T	USAF-1951	41.148	N/A
fog07	LIDAR Only	T	USAF-1951	41.148	37 C
fog08	Full sensor suite	T	USAF-1951	41.148	37 C
fog09	Full sensor suite	F	USAF-1951	41.148	37 C
cal04	Full sensor suite	T	USAF-1951	17.6276	N/A
fog10	Full sensor suite	T	USAF-1951	17.6276	37 C
fog11	Full sensor suite	F	USAF-1951	17.6276	37 C
fog12	Full sensor suite	T	USAF-1951	17.6276	60 C
fog13	No LIDAR Data	T	USAF-1951	17.6276	60 C
fog14	Blackbody temp. is likely 60 C.	T	USAF-1951	17.6276	N/A
pao01	One human in chamber	T	Human	N/A	N/A
Configuration Change: Boson camera focus set to infinity					
fog15	Full sensor suite	T	USAF-1951	45.6692	37 C
End of Testing Day 2, Wednesday May 12th, 2021					
baseline07	Full sensor suite	T	USAF-1951	45.6692	20 C
baseline08	Full sensor suite	T	USAF-1951	45.6692	60 C
fog16	Full sensor suite	T	USAF-1951	45.6692	60 C
Configuration Change: Switch to UAV target on a tripod w/ motors running					
baseline09	UAV Target	T	UAV-Oncoming	18.2372	N/A
fog17	UAV Target	T	UAV-Oncoming	18.2372	N/A
pao02	Target	T	USAF-1951	N/A	N/A
fog18	UAV Target	F	UAV-Oncoming	18.2372	N/A
End of Testing Day 3, Thursday May 13th, 2021					
baseline10	Cancel test, problem w/ motors	T	UAV-Oncoming	45.6692	N/A
fog19	UAV Target	T	UAV-Oncoming	45.6692	N/A
fog20	UAV Target	F	UAV-Oncoming	45.6692	N/A
baseline11	UAV Target	T	UAV-Oncoming	45.6692	N/A
baseline12	UAV Target	F	UAV-Oncoming	45.6692	N/A
baseline13	UAV Target	T	UAV-Hover	45.6692	N/A

baseline14	UAV Target	F	UAV-Hover	45.6692	N/A
fog21	UAV Target	F	UAV-Hover	45.6692	N/A
fog22	UAV Target	T	UAV-Hover	45.6692	N/A
fog23	No visible spectrum data	T	USAF-1951	17.6276	37 C
fog24	Full sensor suite	T	USAF-1951	17.6276	37 C



Perception Testbed Fog Chamber Data Documentation

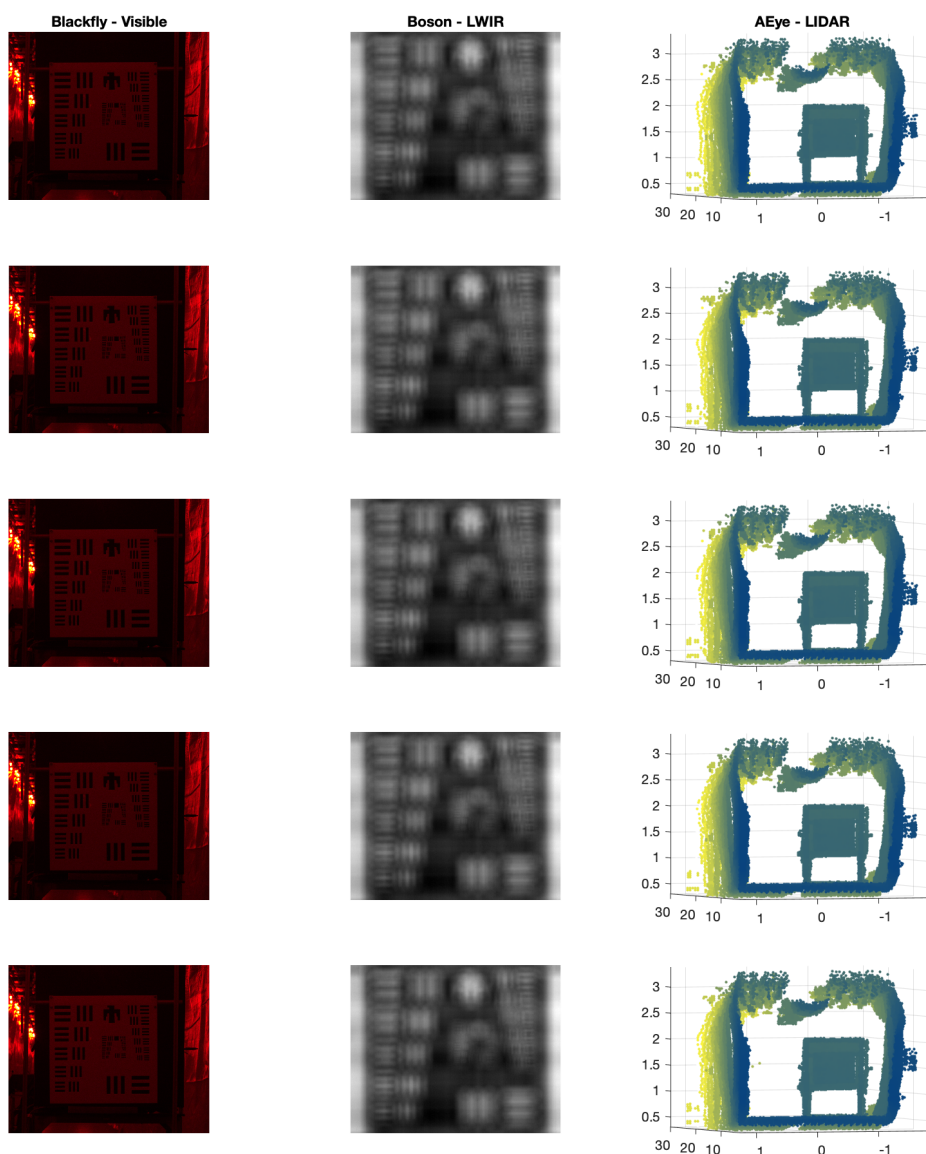
November 1, 2021

Experiment Name: baseline01
Start Time: 11-May-2021 10:47:27.331
Duration: 00:00:46.688
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 37 C
Environment Notes: No fog present during baseline tests.
 No environmental data available.

File Information:
Visible Spectrum: 422 Images
Longwave Infrared: 468 Images
LIDAR: 49 Data & Images

1 Data Snapshot: baseline01

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

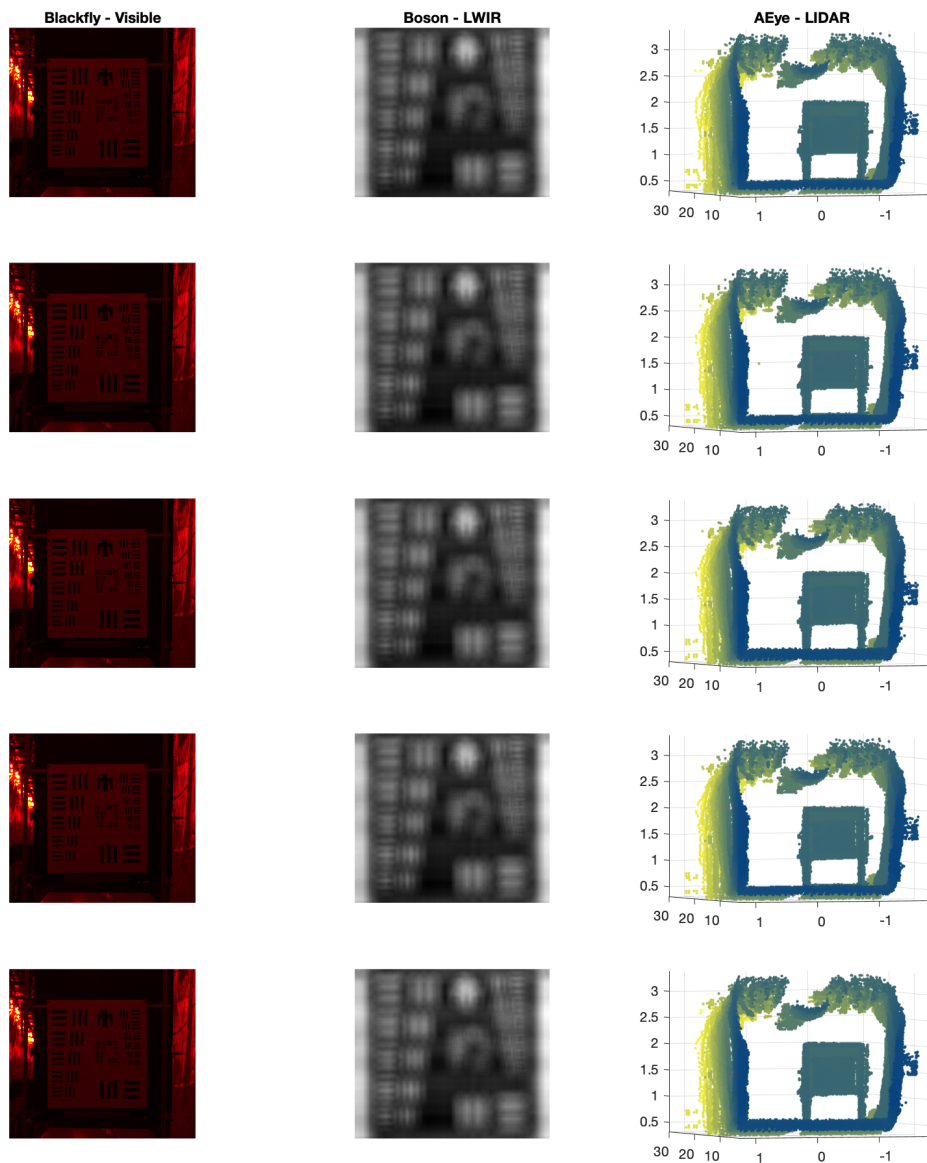
November 1, 2021

Experiment Name: baseline02
Start Time: 11-May-2021 10:50:04.854
Duration: 00:01:11.301
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 37 C
Environment Notes: No fog present during baseline tests.
No environmental data available.

File Information:
Visible Spectrum: 647 Images
Longwave Infrared: 714 Images
LIDAR: 72 Data & Images

1 Data Snapshot: baseline02

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

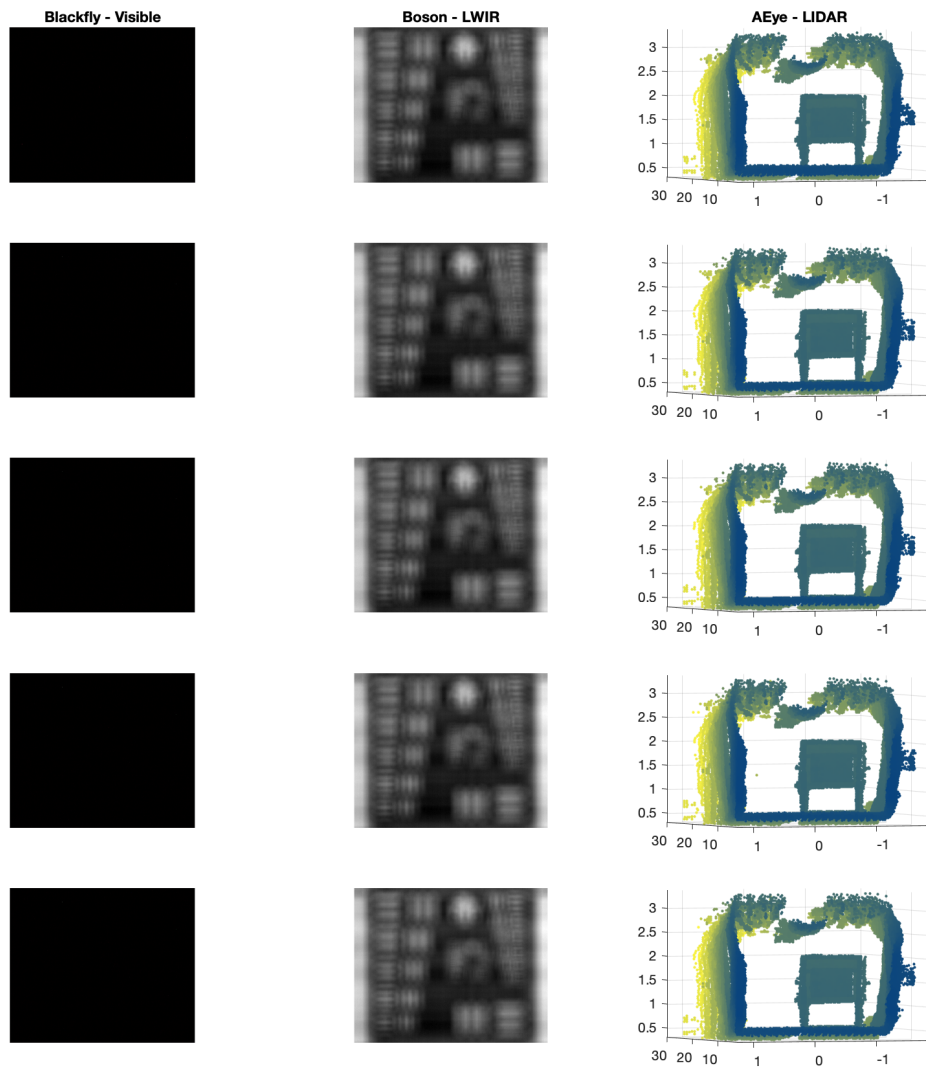
November 1, 2021

Experiment Name: baseline03
Start Time: 11-May-2021 10:54:57.179
Duration: 00:01:09.518
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 37 C
Environment Notes: No fog present during baseline tests.
No environmental data available.

File Information:
Visible Spectrum: 624 Images
Longwave Infrared: 696 Images
LIDAR: 78 Data & Images

1 Data Snapshot: baseline03

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

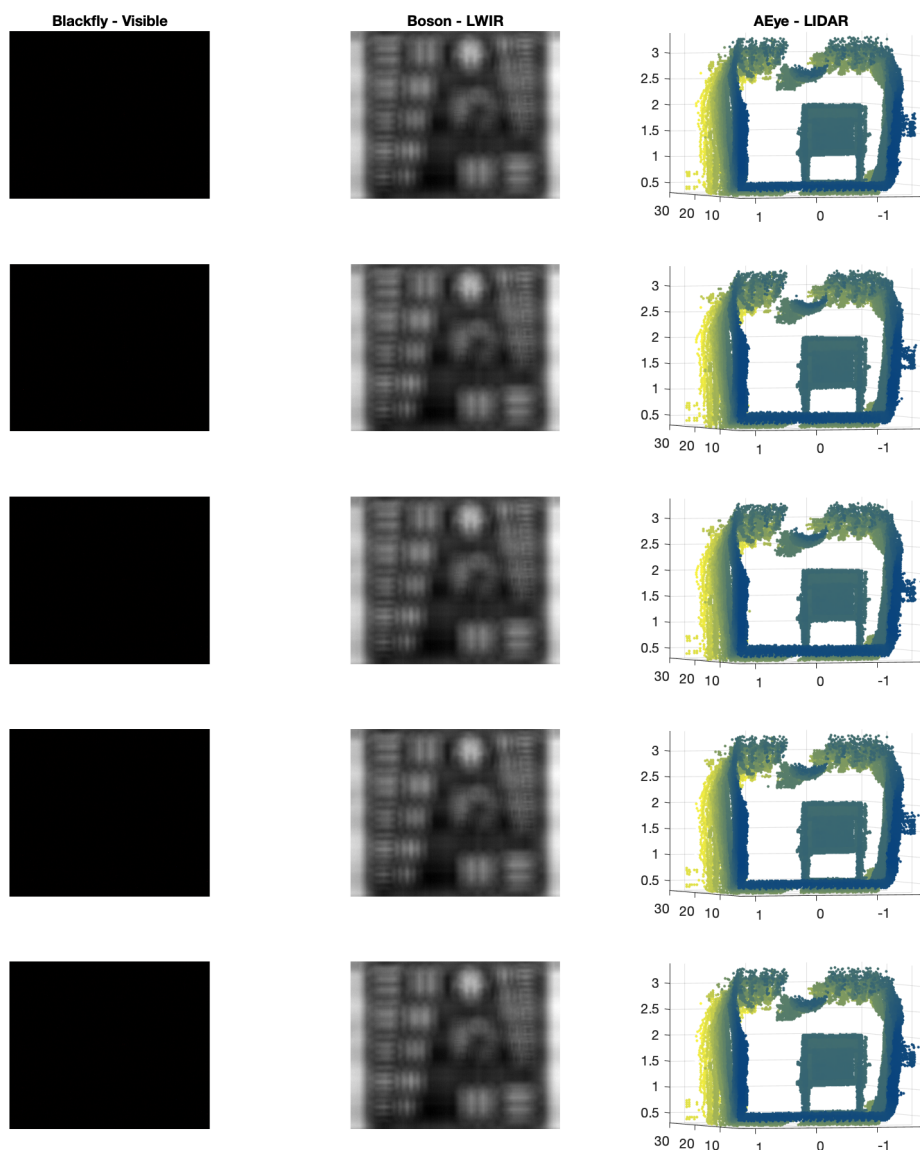
November 1, 2021

Experiment Name: baseline04
Start Time: 11-May-2021 10:57:44.260
Duration: 00:00:50.842
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 37 C
Environment Notes: No fog present during baseline tests.
No environmental data available.

File Information:
Visible Spectrum: 467 Images
Longwave Infrared: 509 Images
LIDAR: 60 Data & Images

1 Data Snapshot: baseline04

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

November 1, 2021

Experiment Name: baseline07

Start Time: 13-May-2021 08:24:20.328

Duration: 00:01:56.093

Target: USAF-1951

Target Distance: 45.6692 meters

Target Temperature: 20 C

Environment Notes: No fog present during baseline tests.

No environmental data available.

File Information:

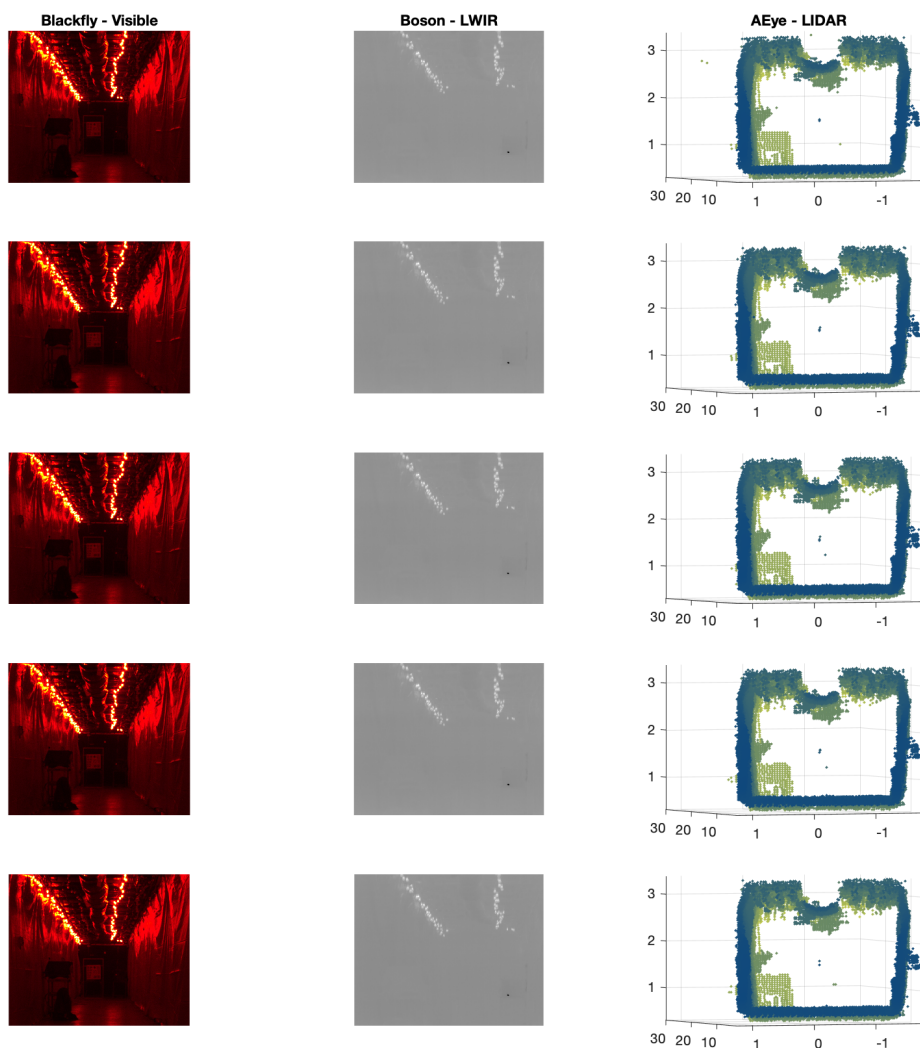
Visible Spectrum: 1065 Images

Longwave Infrared: 1162 Images

LIDAR: 147 Data & Images

1 Data Snapshot: baseline07

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

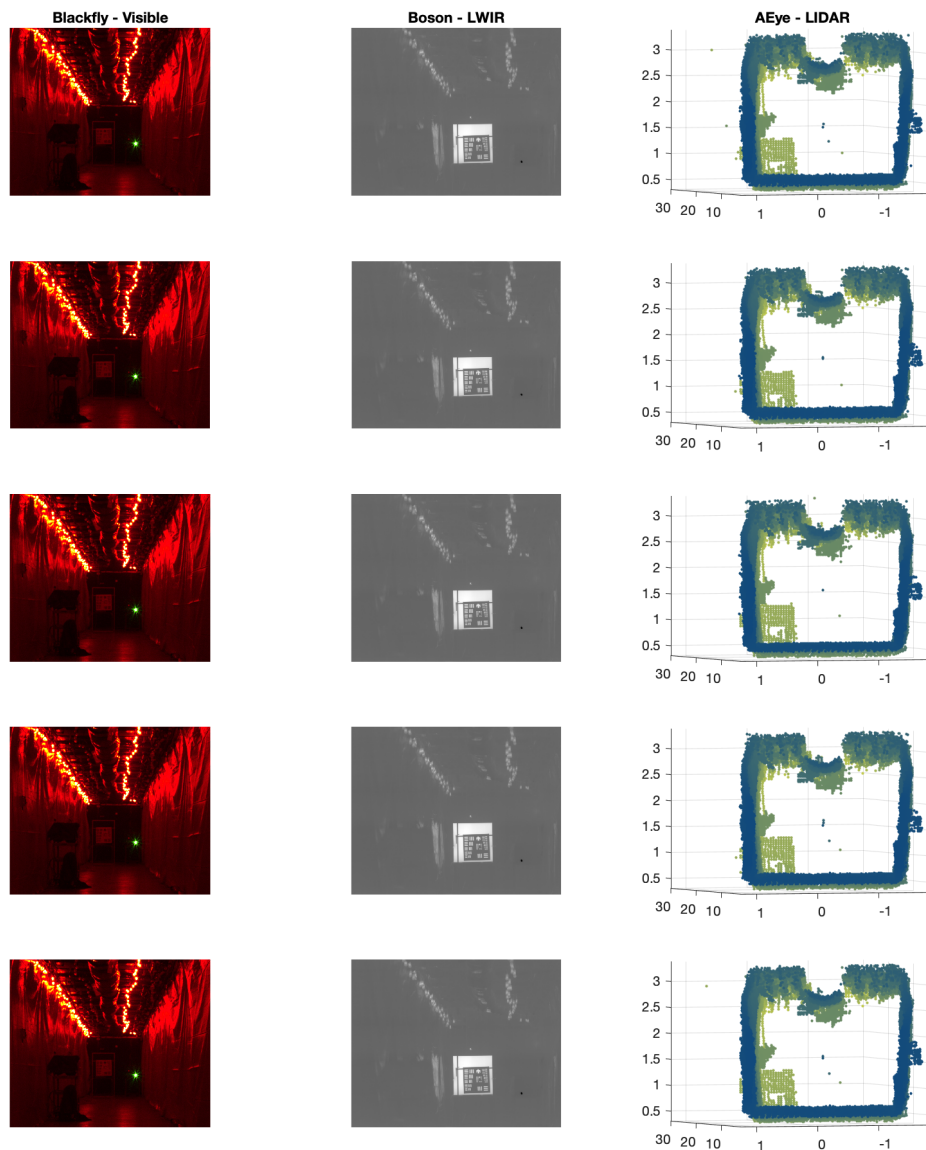
November 1, 2021

Experiment Name: baseline08
Start Time: 13-May-2021 08:37:41.334
Duration: 00:01:35.475
Target: USAF-1951
Target Distance: 45.6692 meters
Target Temperature: 60 C
Environment Notes: No fog present during baseline tests.
No environmental data available.

File Information:
Visible Spectrum: 952 Images
Longwave Infrared: 956 Images
LIDAR: 118 Data & Images

1 Data Snapshot: baseline08

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

November 1, 2021

Experiment Name: baseline09

Start Time: 13-May-2021 12:19:52.473

Duration: 00:01:41.971

Target: UAV-Oncoming

Target Distance: 45.6692 meters

Target Temperature: N/A

Environment Notes: No fog present during baseline tests.

No environmental data available.

File Information:

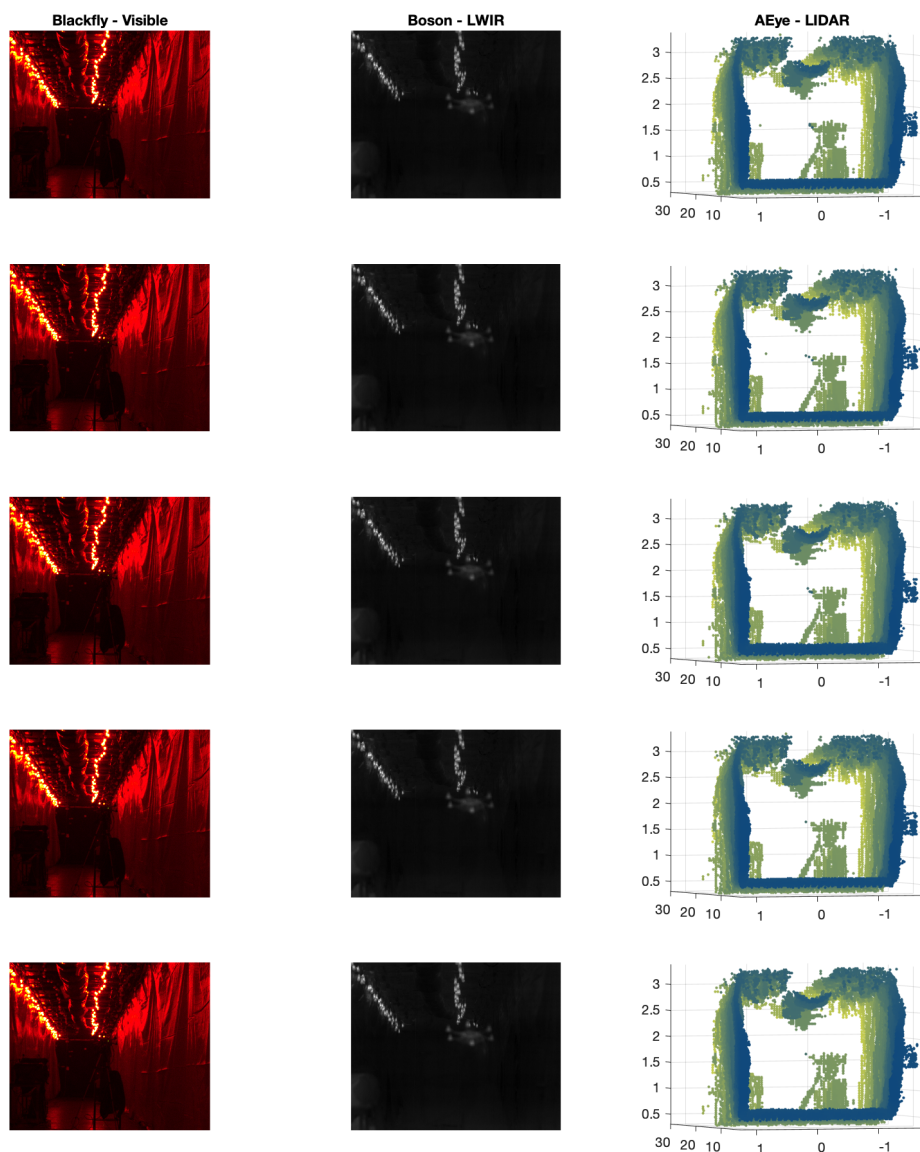
Visible Spectrum: 1016 Images

Longwave Infrared: 1021 Images

LIDAR: 121 Data & Images

1 Data Snapshot: baseline09

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

November 1, 2021

Experiment Name: baseline11

Start Time: 14-May-2021 11:39:53.795

Duration: 00:01:34.604

Target: UAV-Oncoming

Target Distance: 45.6692 meters

Target Temperature: N/A

Environment Notes: No fog present during baseline tests.

No environmental data available.

File Information:

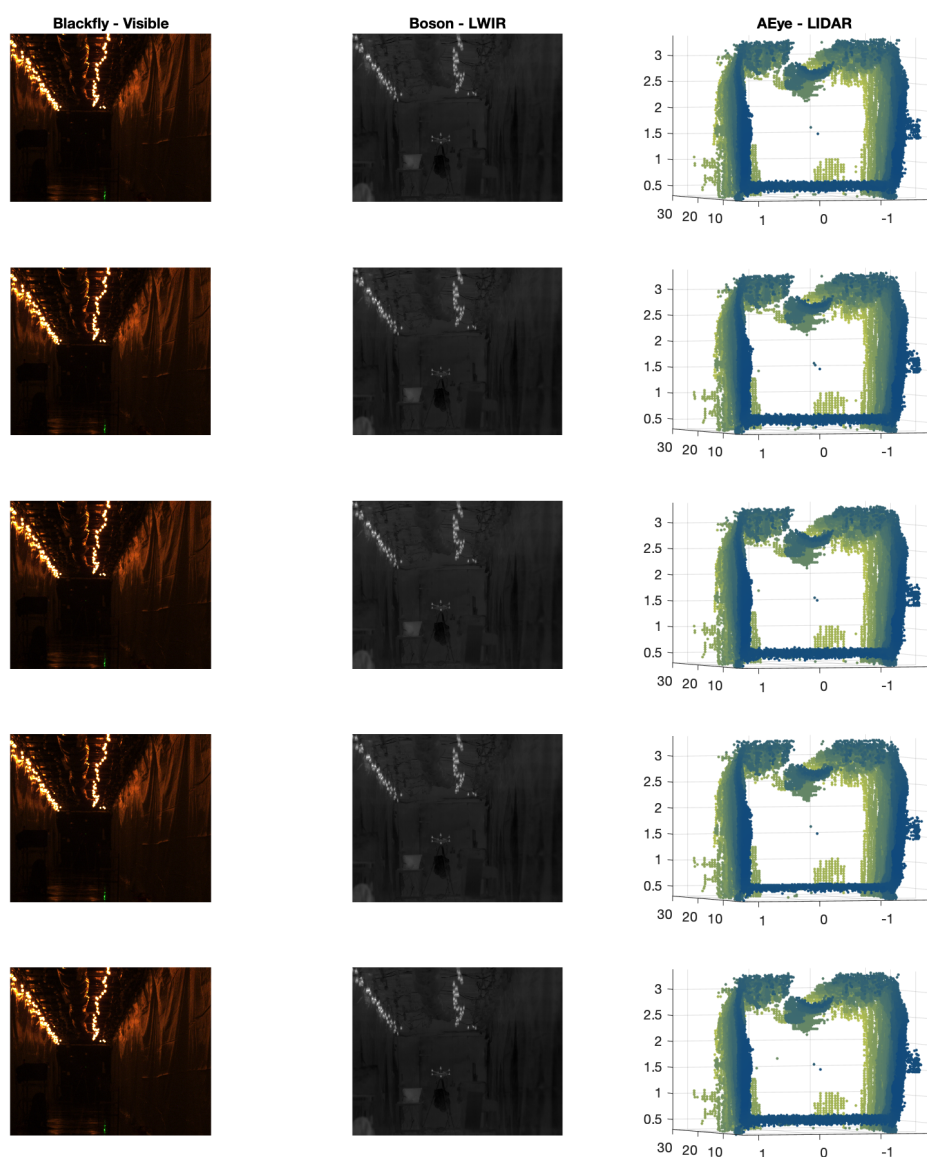
Visible Spectrum: 861 Images

Longwave Infrared: 947 Images

LIDAR: 120 Data & Images

1 Data Snapshot: baseline11

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

November 1, 2021

Experiment Name: baseline12

Start Time: 14-May-2021 11:51:06.320

Duration: 00:02:03.375

Target: UAV-Oncoming

Target Distance: 45.6692 meters

Target Temperature: N/A

Environment Notes: No fog present during baseline tests.

No environmental data available.

File Information:

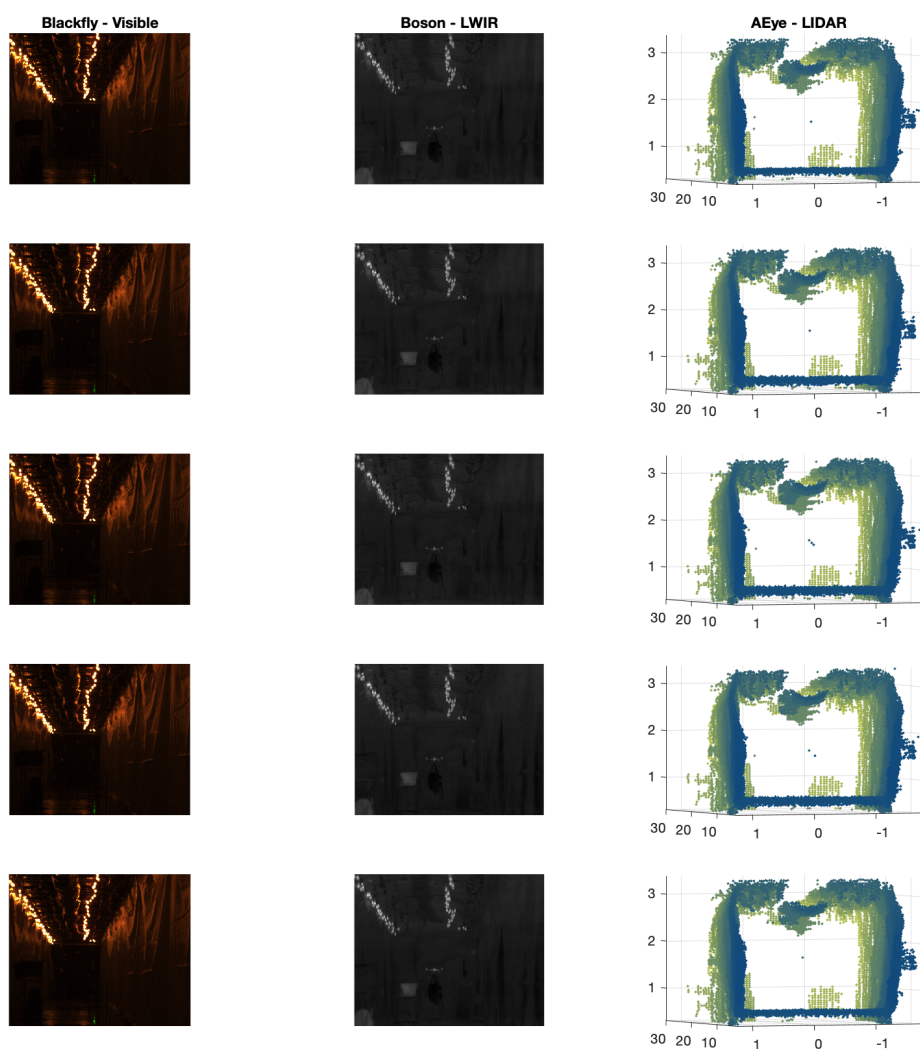
Visible Spectrum: 1123 Images

Longwave Infrared: 1235 Images

LIDAR: 209 Data & Images

1 Data Snapshot: baseline12

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

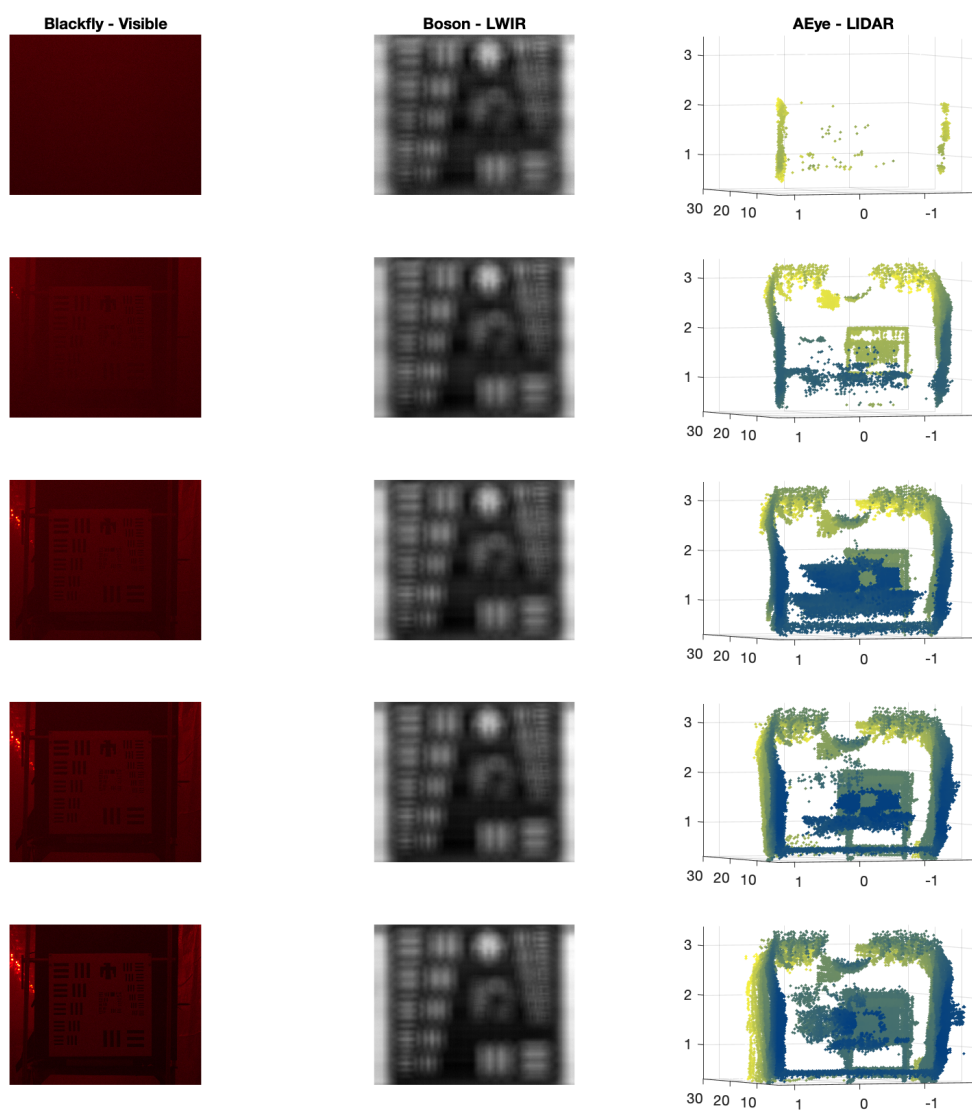
November 1, 2021

Experiment Name: fog01
Start Time: 11-May-2021 11:55:16.294
Duration: 00:25:03.796
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 13533 Images
Longwave Infrared: 15039 Images
LIDAR: 1975 Data & Images

1 Data Snapshot: fog01

The following images describe the variation in data during the experiment.



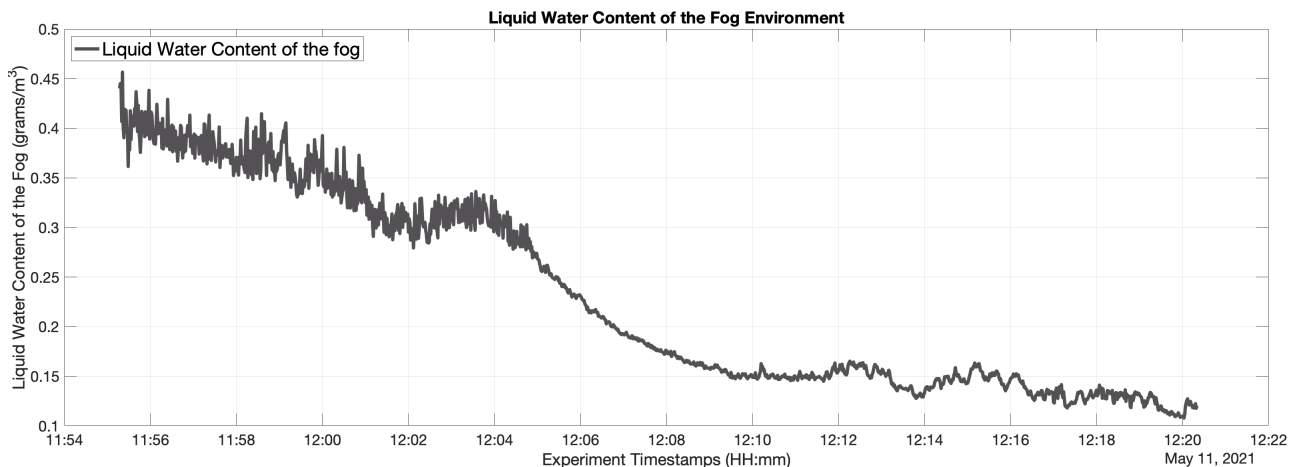
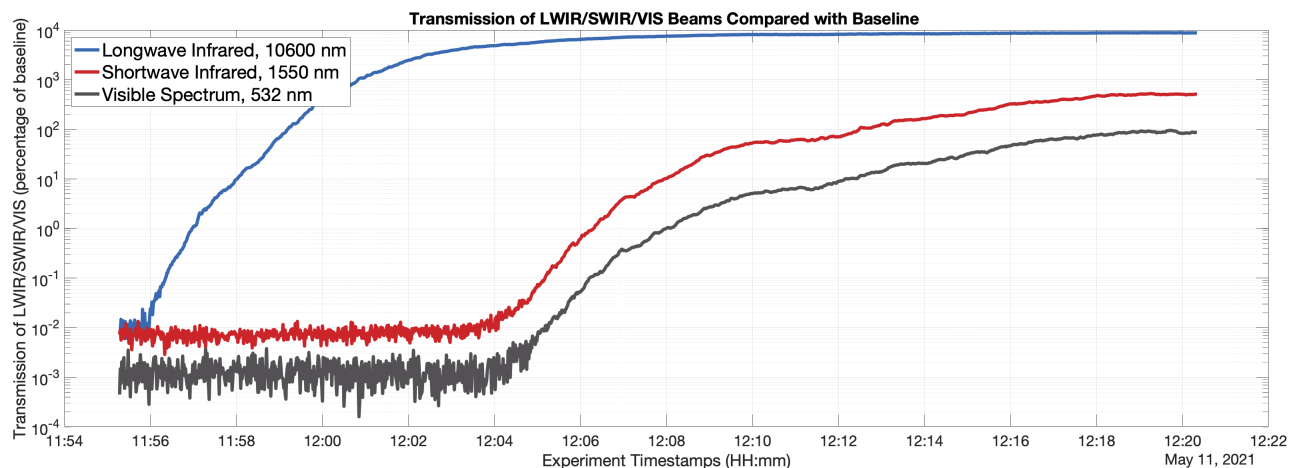
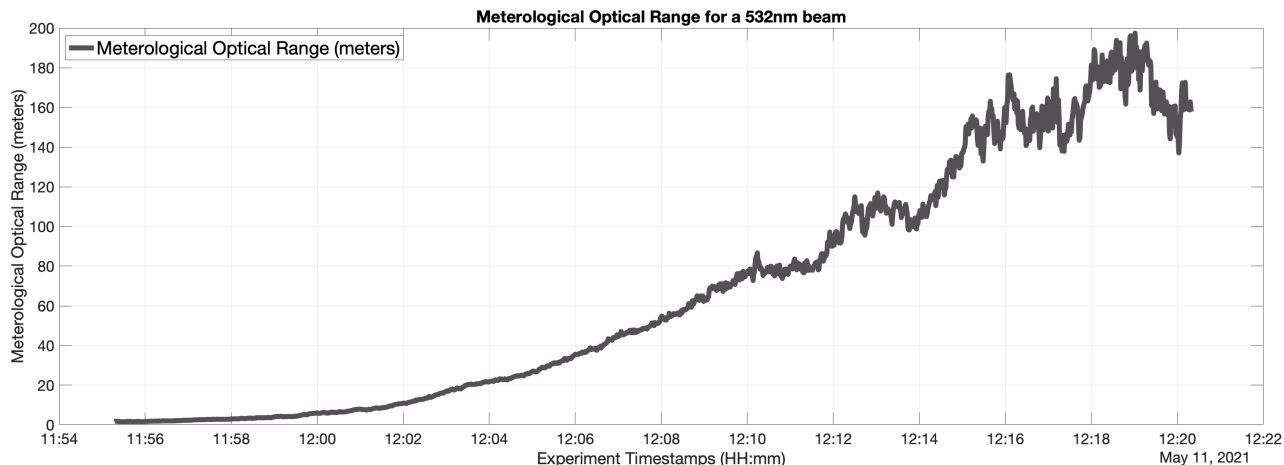


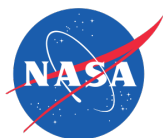
Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog01

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

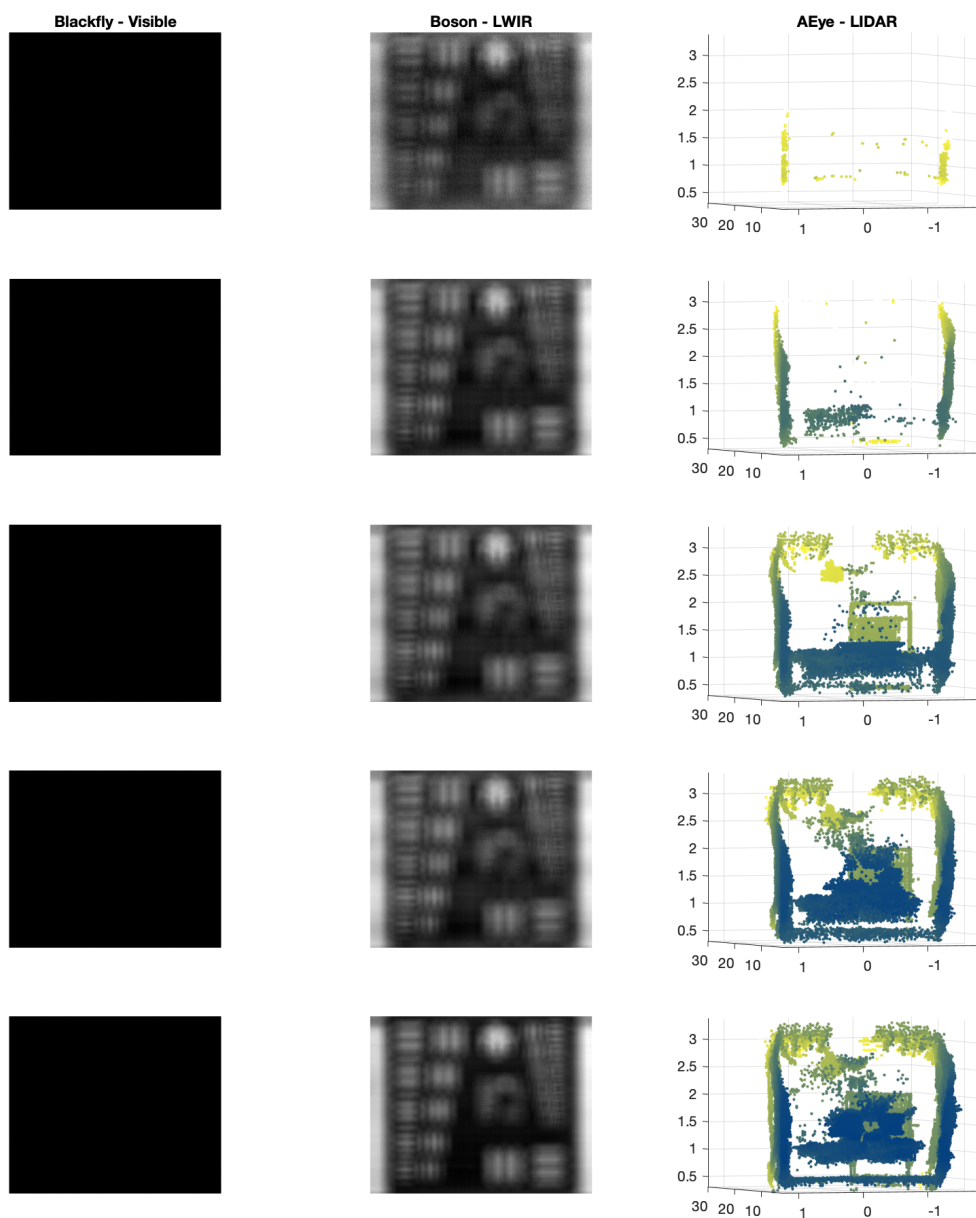
November 1, 2021

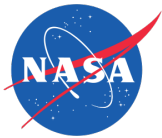
Experiment Name: fog02
Start Time: 11-May-2021 12:29:03.237
Duration: 00:13:58.549
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 7557 Images
Longwave Infrared: 8384 Images
LIDAR: 1085 Data & Images

1 Data Snapshot: fog02

The following images describe the variation in data during the experiment.



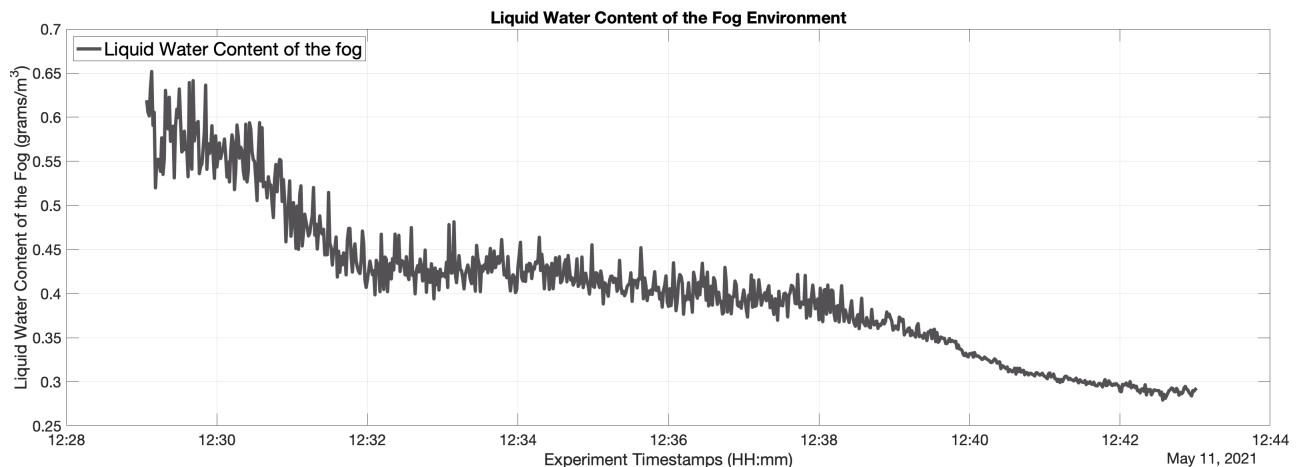
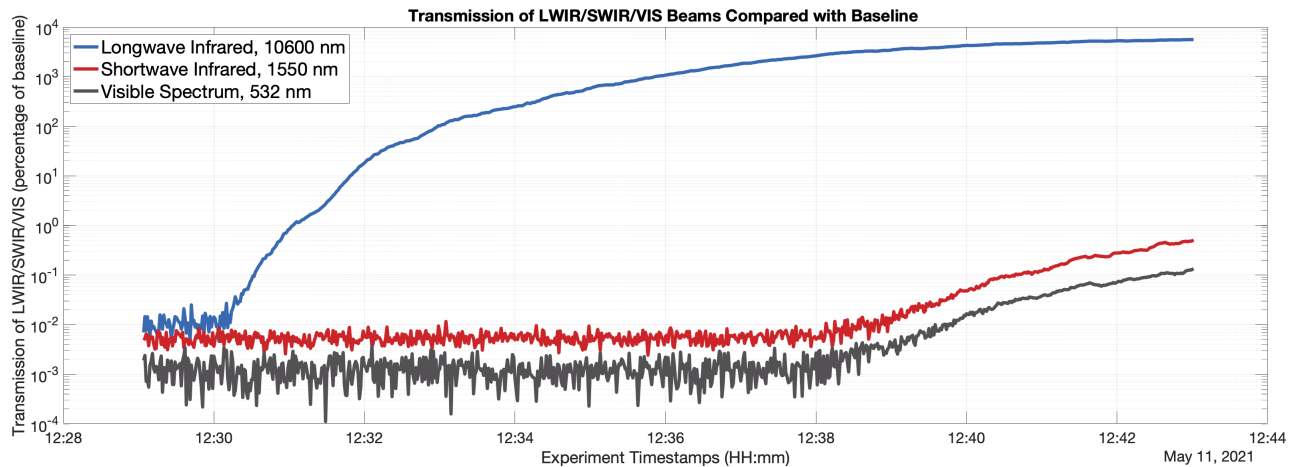
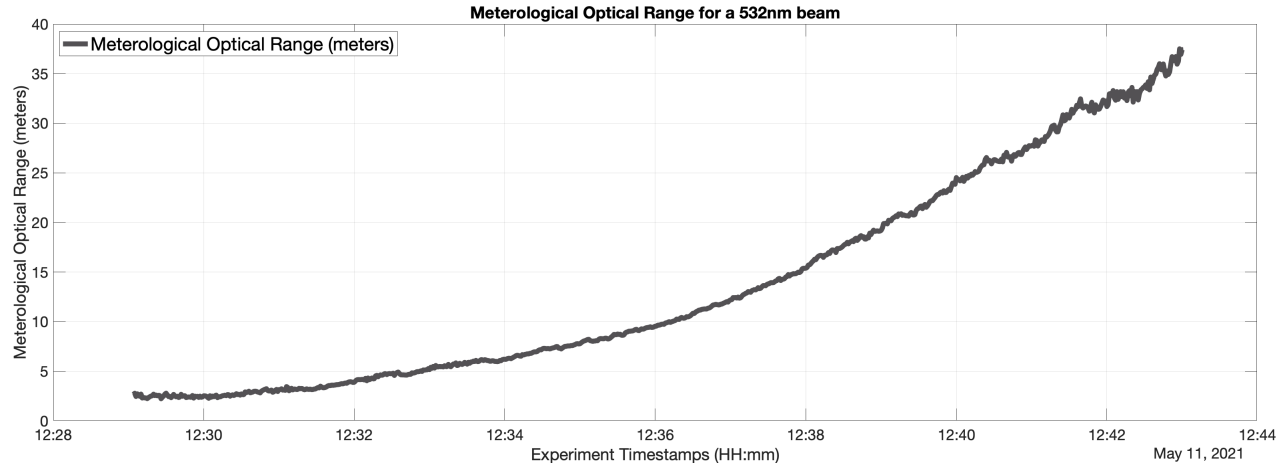


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog02

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

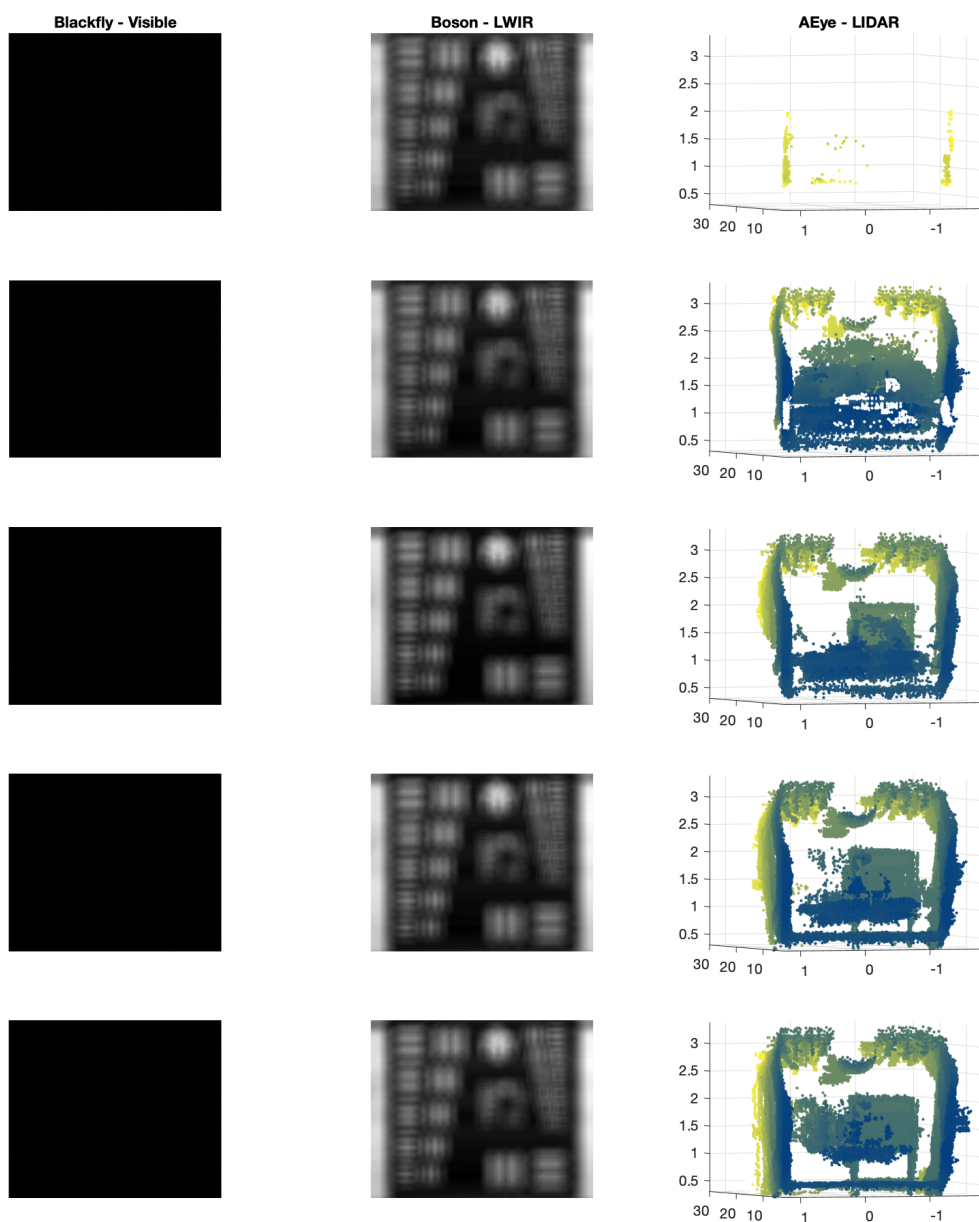
November 1, 2021

Experiment Name: fog03
Start Time: 11-May-2021 12:55:33.234
Duration: 00:15:49.901
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 60 C
Environment Notes: None.

File Information:
Visible Spectrum: 8547 Images
Longwave Infrared: 9500 Images
LIDAR: 1237 Data & Images

1 Data Snapshot: fog03

The following images describe the variation in data during the experiment.



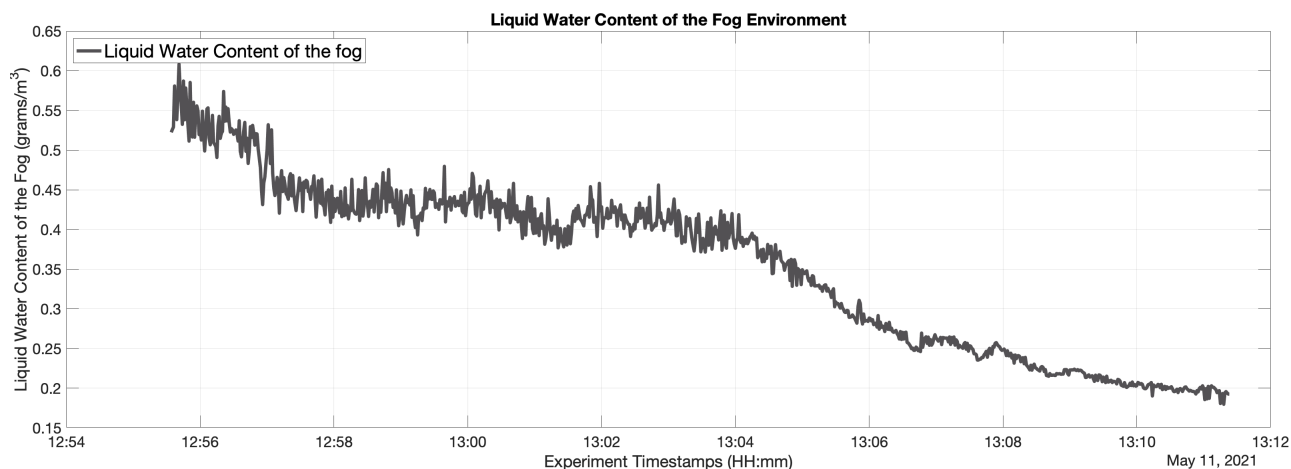
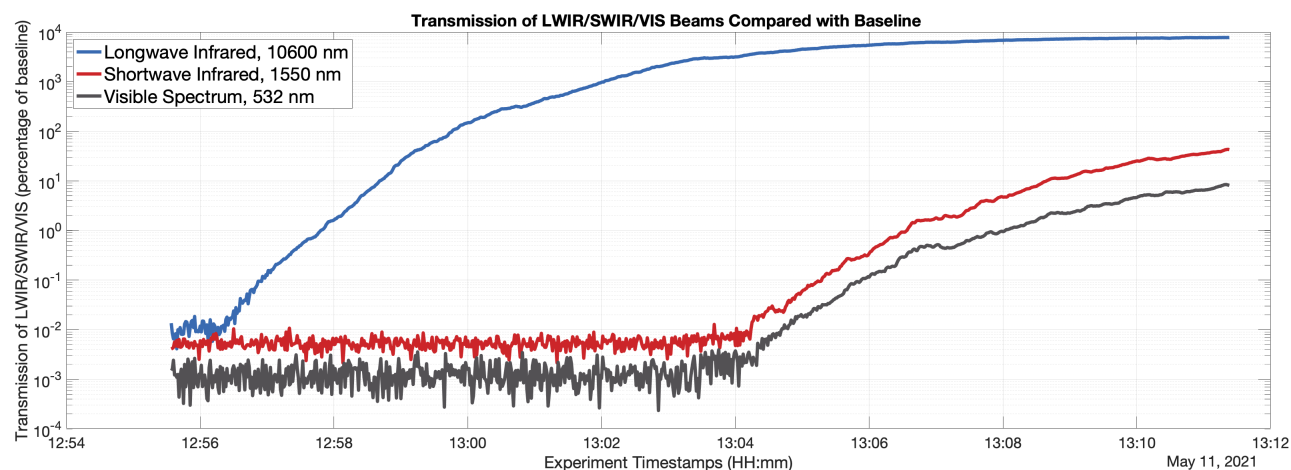
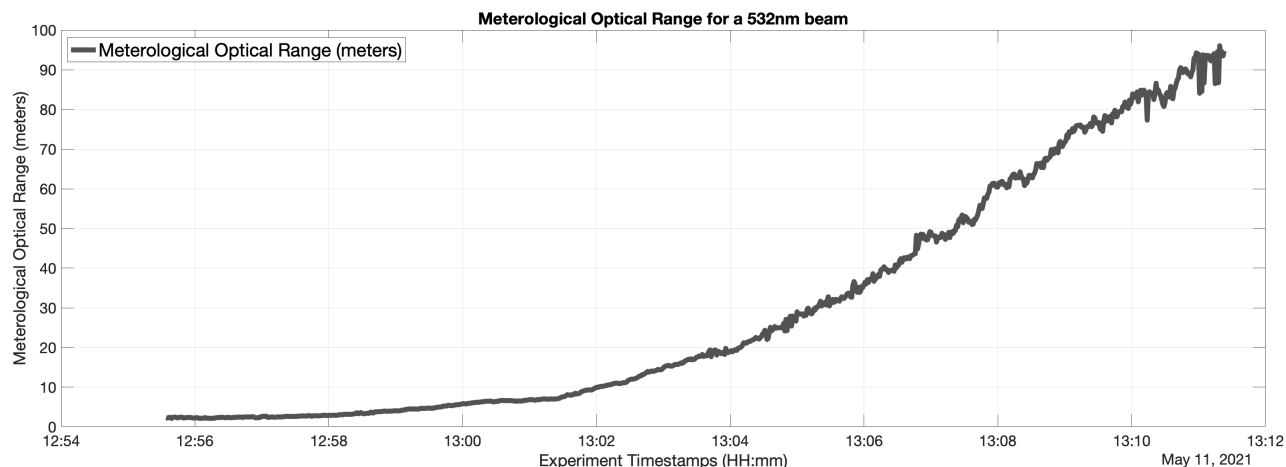


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog03

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

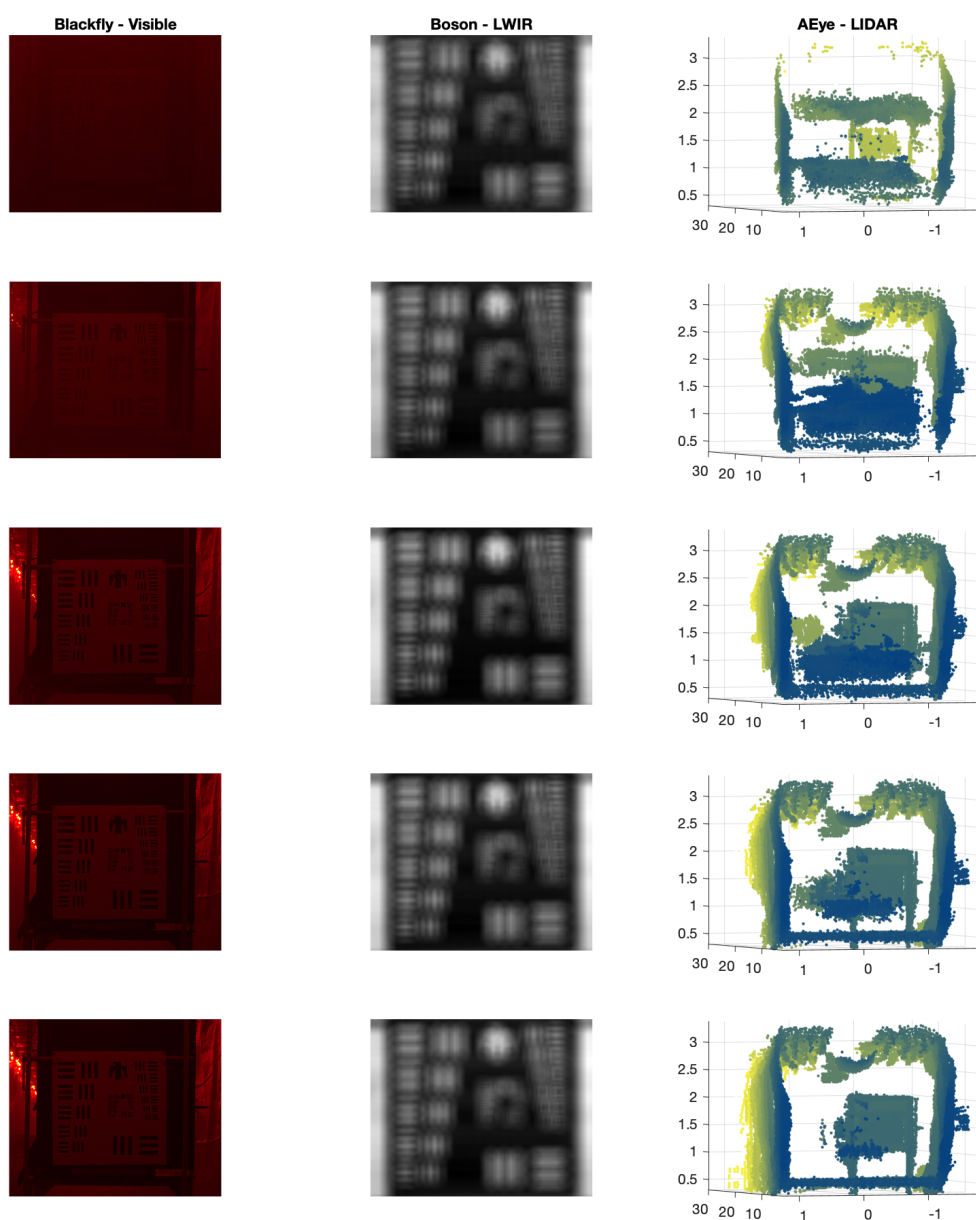
November 1, 2021

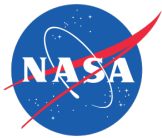
Experiment Name: fog04
Start Time: 11-May-2021 13:25:57.371
Duration: 00:16:03.175
Target: USAF-1951
Target Distance: 6.5532 meters
Target Temperature: 60 C
Environment Notes: None.

File Information:
Visible Spectrum: 8676 Images
Longwave Infrared: 9633 Images
LIDAR: 1253 Data & Images

1 Data Snapshot: fog04

The following images describe the variation in data during the experiment.



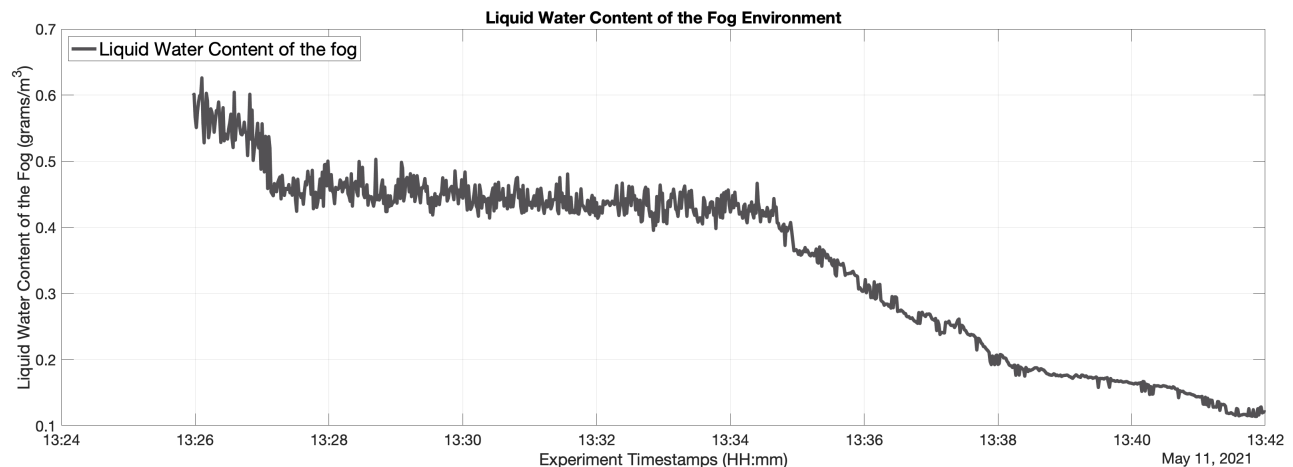
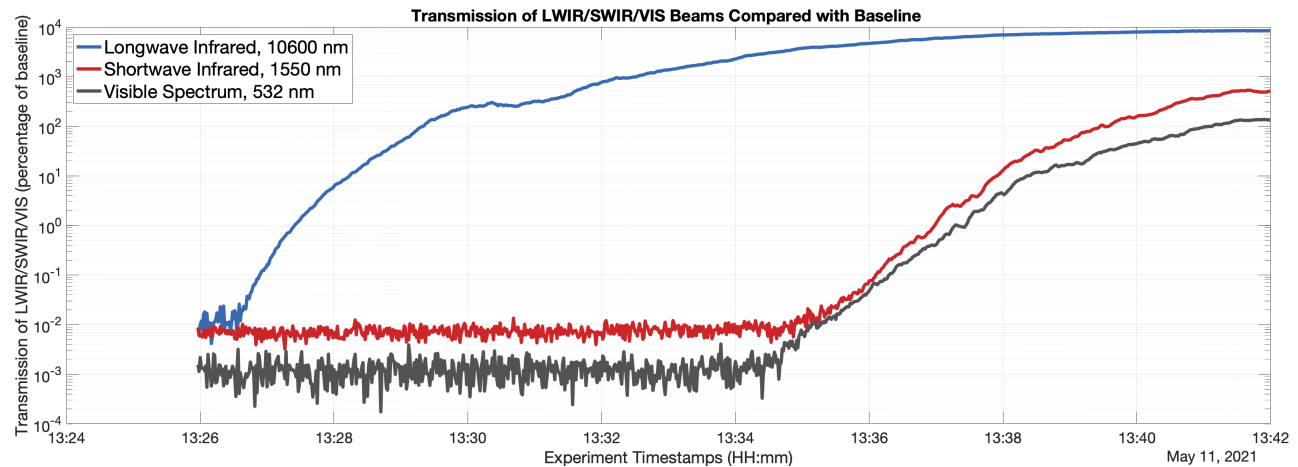
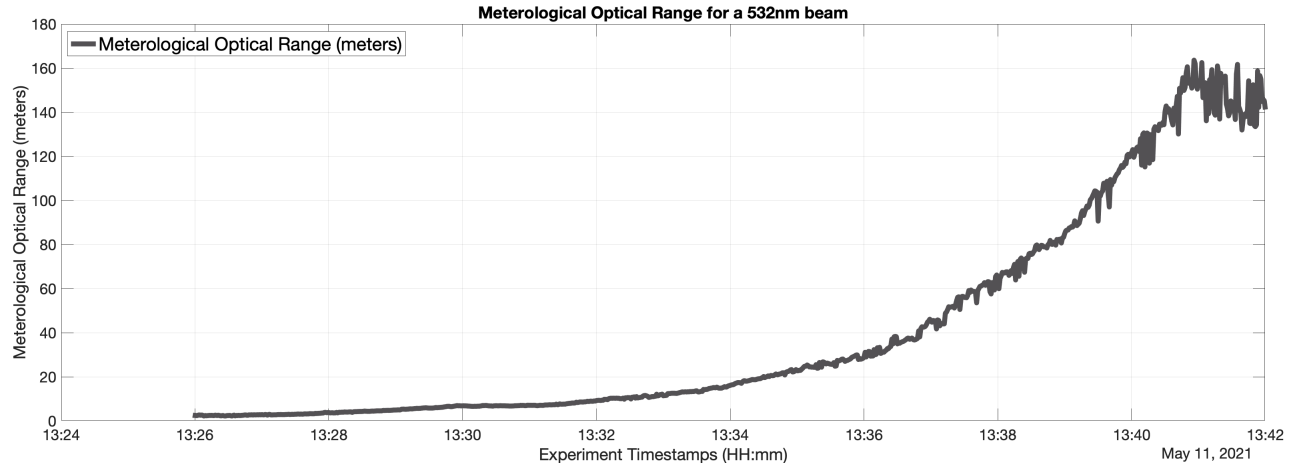


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog04

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

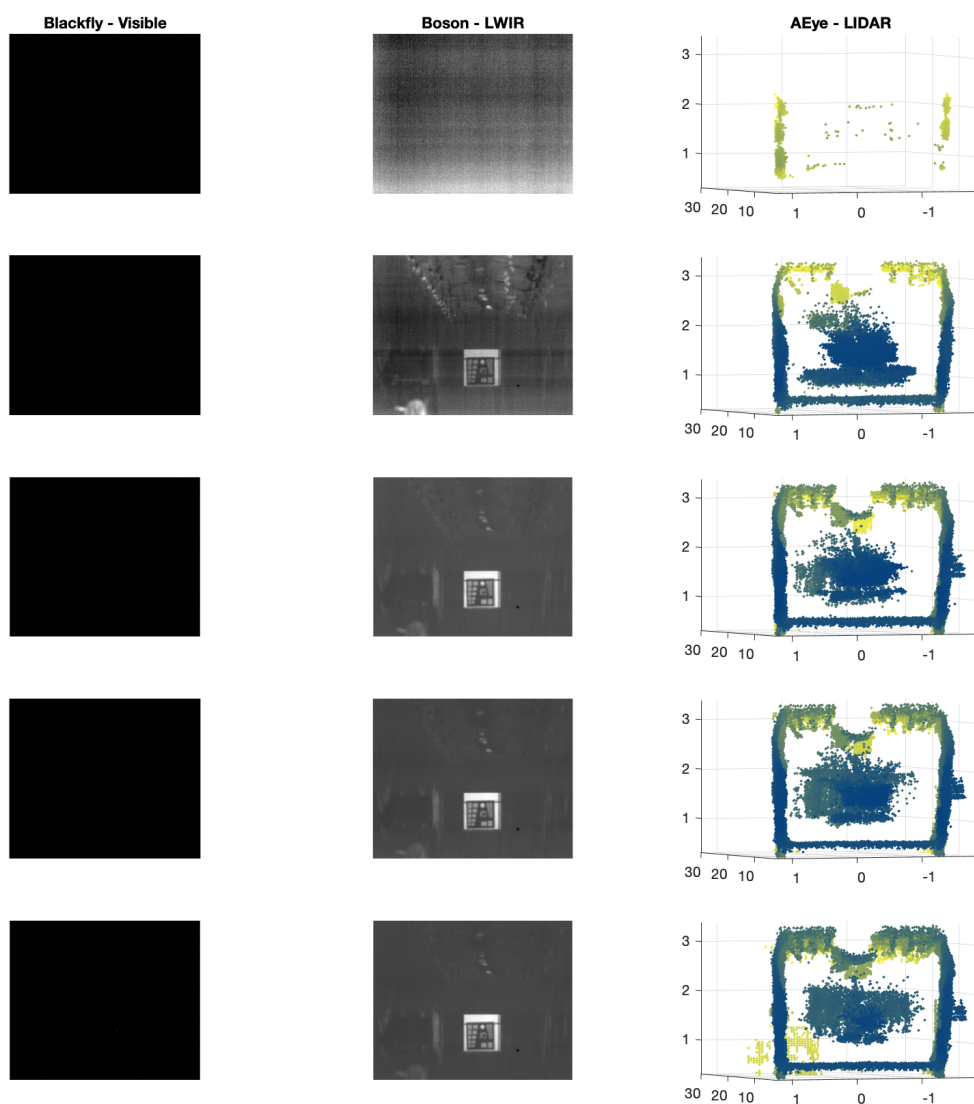
November 1, 2021

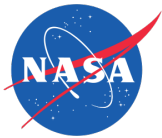
Experiment Name: fog06
Start Time: 11-May-2021 15:20:23.586
Duration: 01:13:27.429
Target: USAF-1951
Target Distance: 41.148 meters
Target Temperature: 60 C
Environment Notes: None.

File Information:
Visible Spectrum: 39844 Images
Longwave Infrared: 44074 Images
LIDAR: 5767 Data & Images

1 Data Snapshot: fog06

The following images describe the variation in data during the experiment.



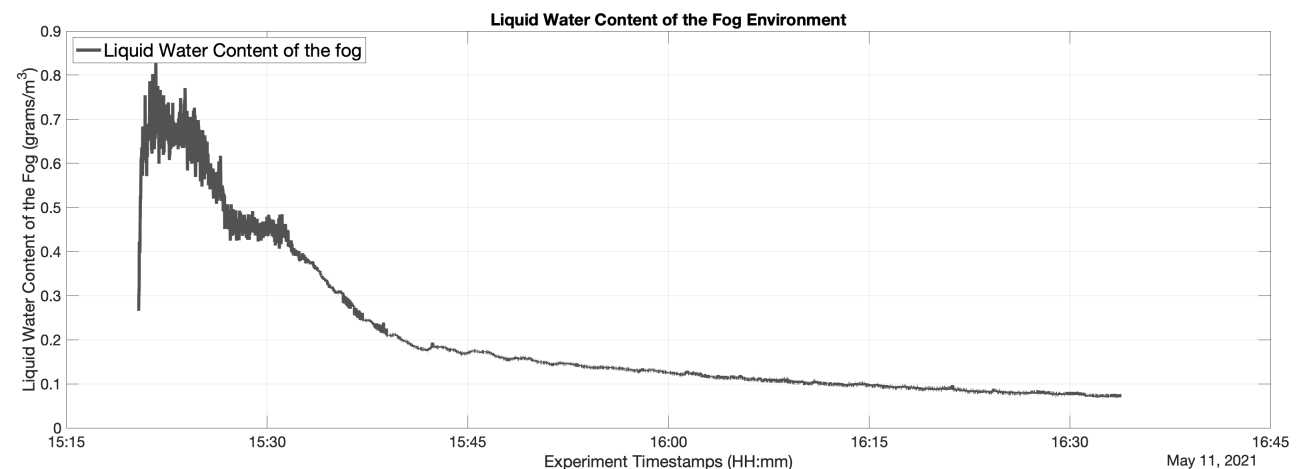
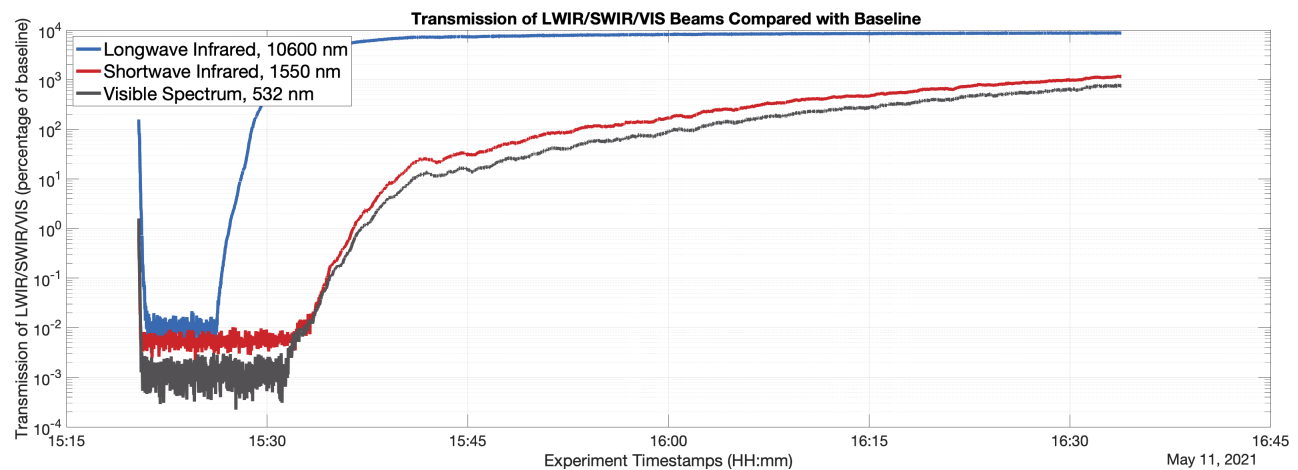
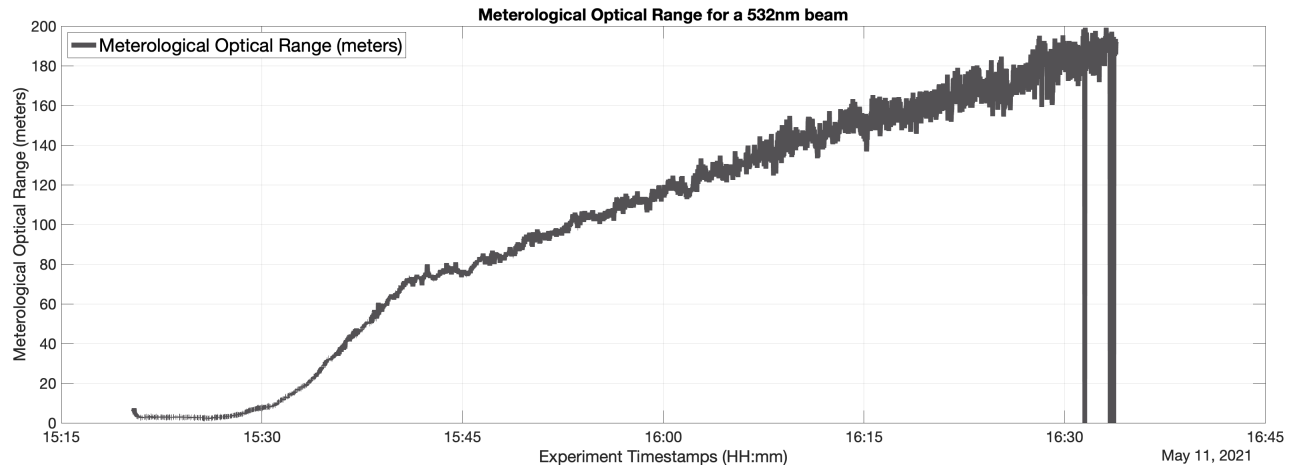


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog06

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

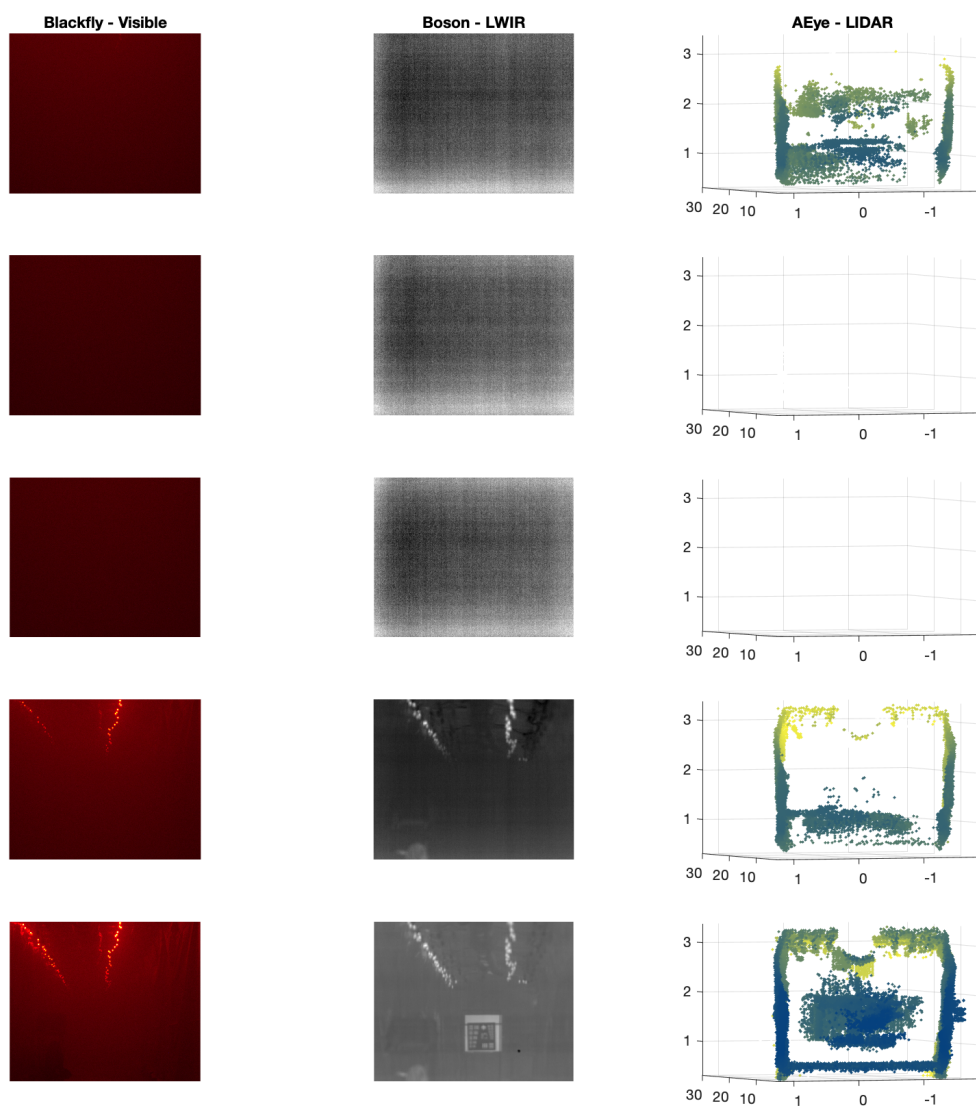
November 1, 2021

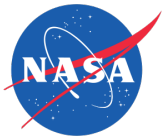
Experiment Name: fog08
Start Time: 12-May-2021 10:13:30.999
Duration: 00:35:53.752
Target: USAF-1951
Target Distance: 41.148 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 20060 Images
Longwave Infrared: 21536 Images
LIDAR: 2817 Data & Images

1 Data Snapshot: fog08

The following images describe the variation in data during the experiment.



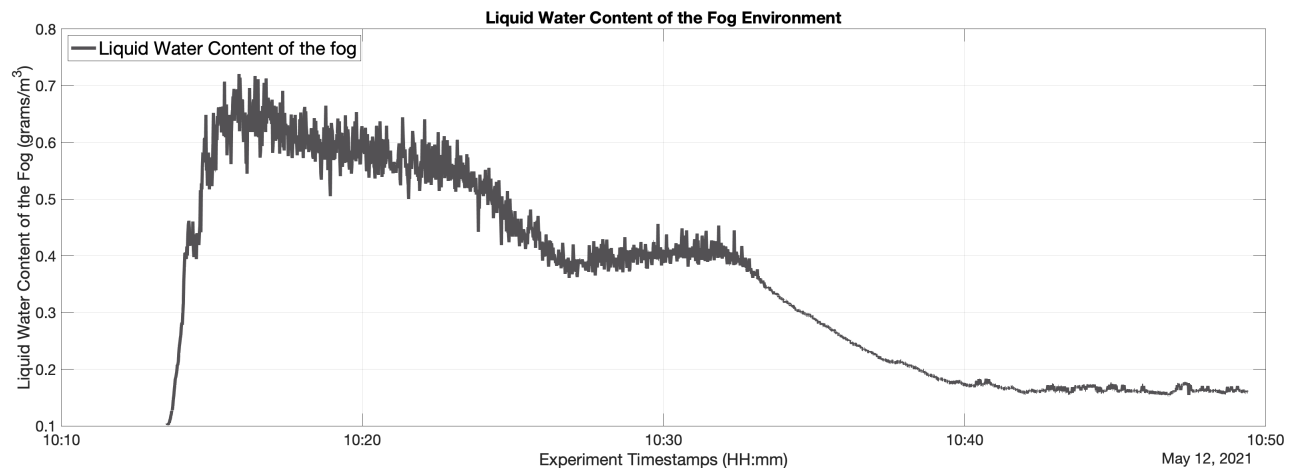
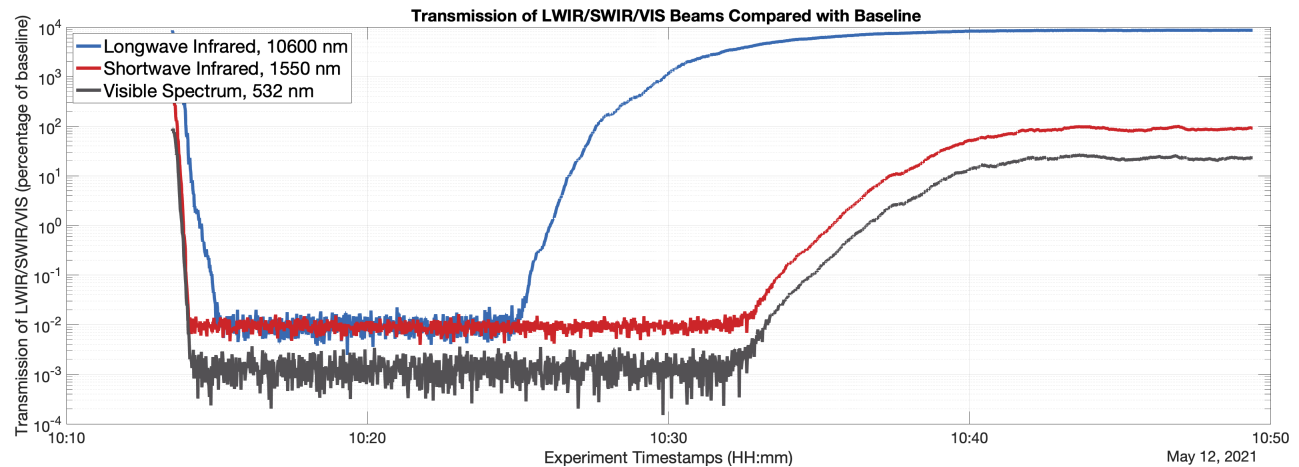
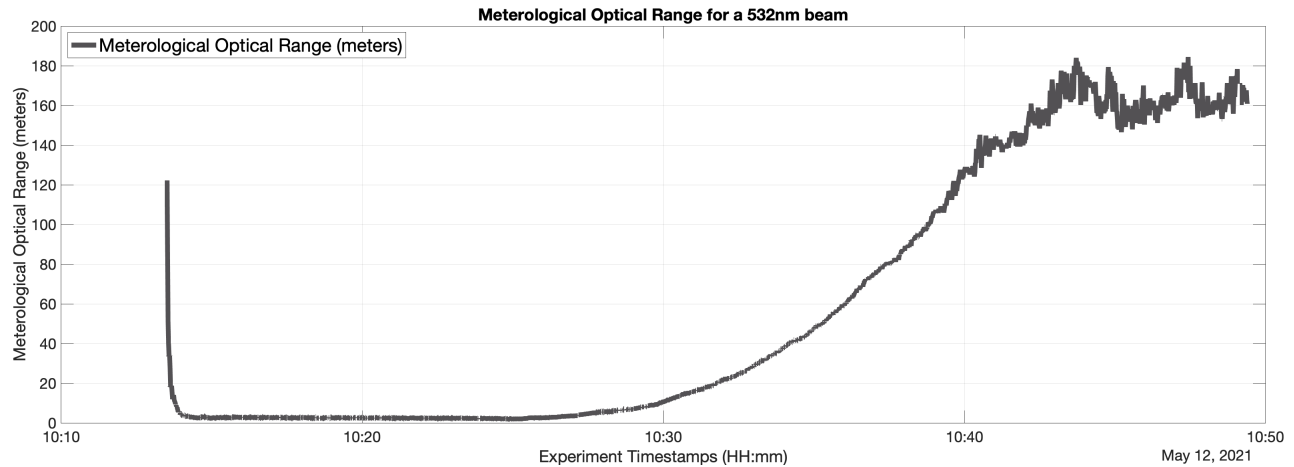


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog08

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

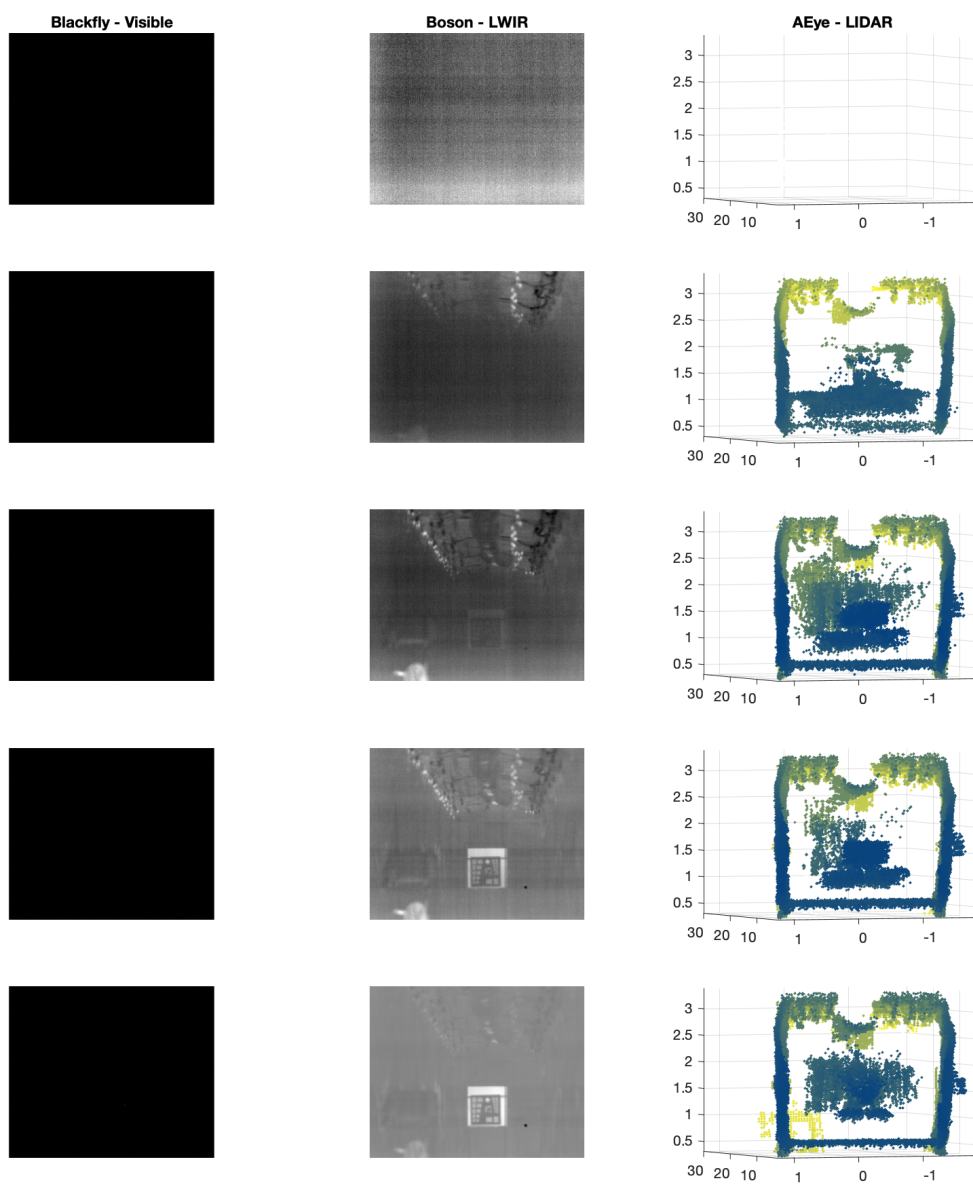
November 1, 2021

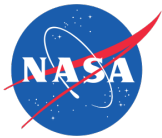
Experiment Name: fog09
Start Time: 12-May-2021 10:55:00.017
Duration: 00:26:17.360
Target: USAF-1951
Target Distance: 41.148 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 14289 Images
Longwave Infrared: 15772 Images
LIDAR: 2063 Data & Images

1 Data Snapshot: fog09

The following images describe the variation in data during the experiment.



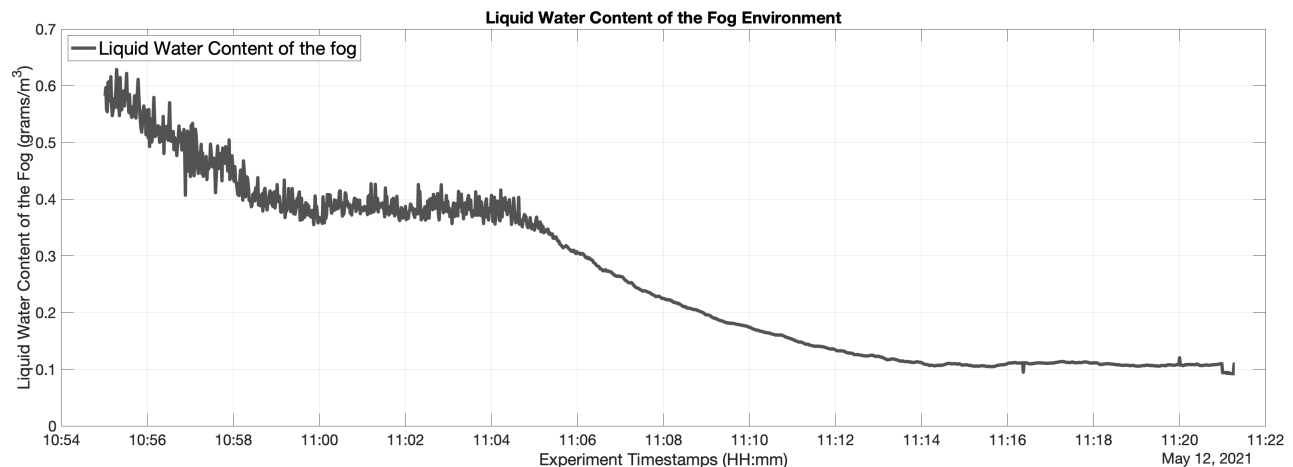
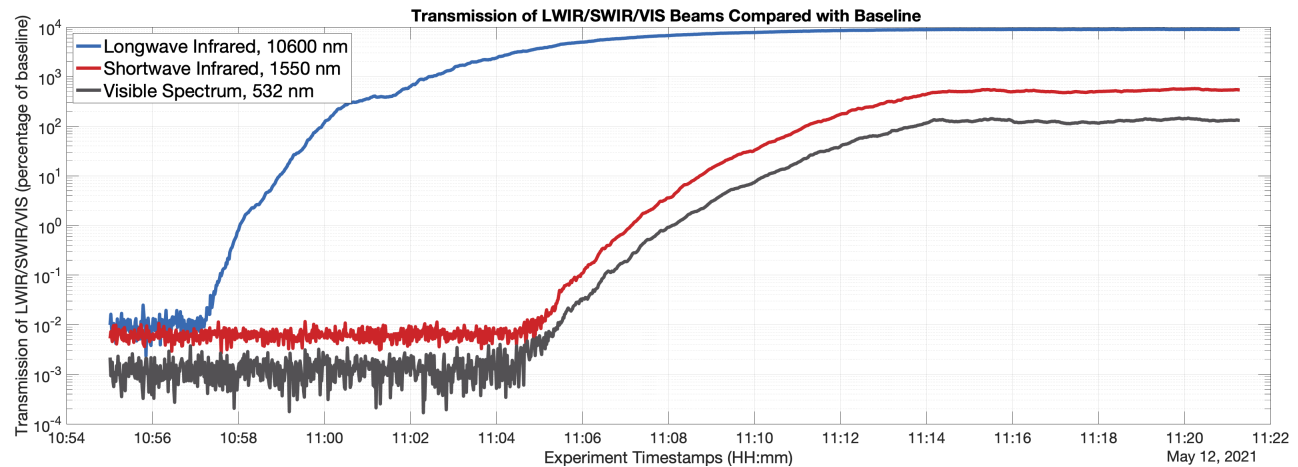
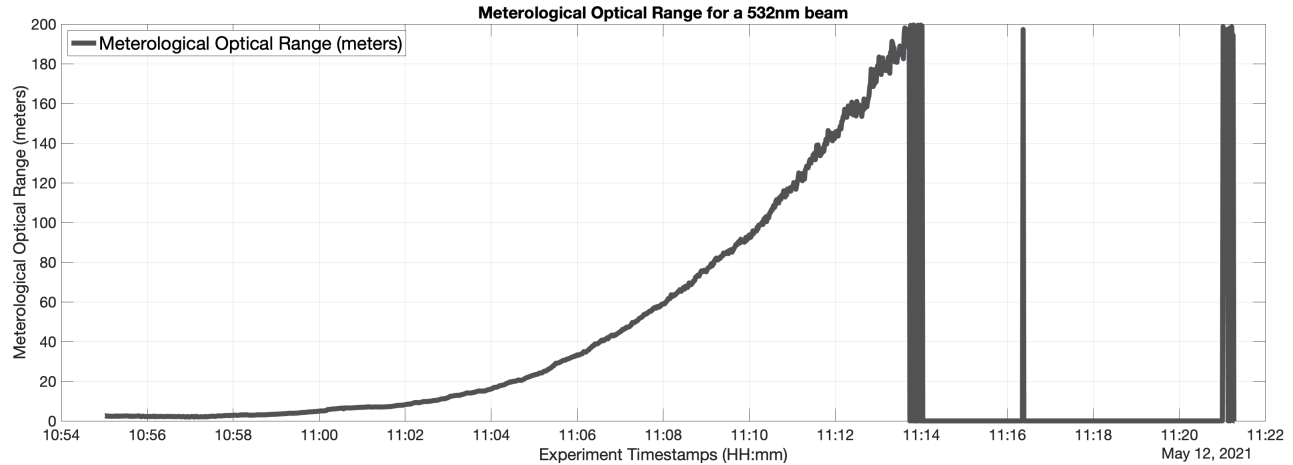


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog09

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

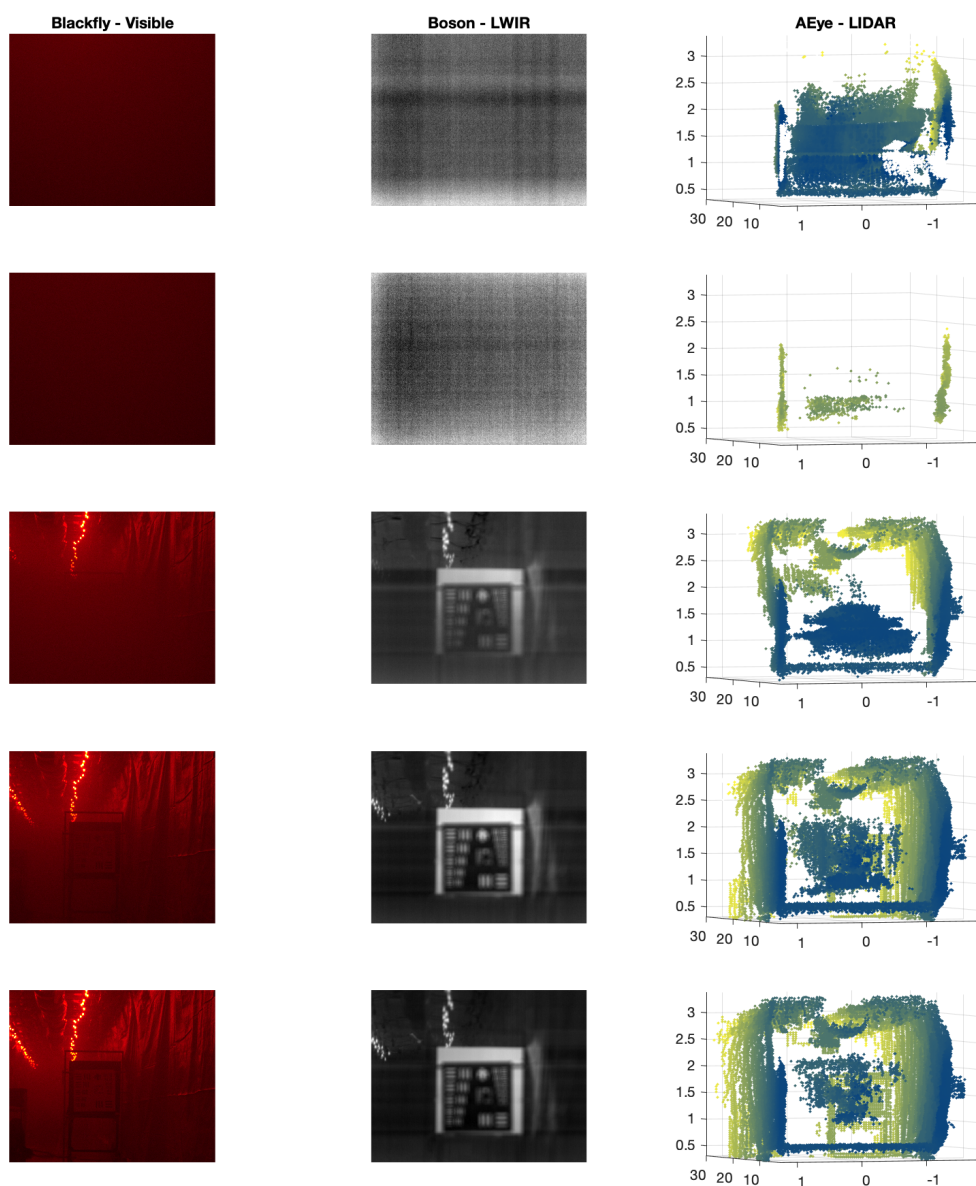
November 1, 2021

Experiment Name: fog10
Start Time: 12-May-2021 11:44:39.227
Duration: 00:28:41.182
Target: USAF-1951
Target Distance: 17.6276 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 15695 Images
Longwave Infrared: 17213 Images
LIDAR: 2247 Data & Images

1 Data Snapshot: fog10

The following images describe the variation in data during the experiment.



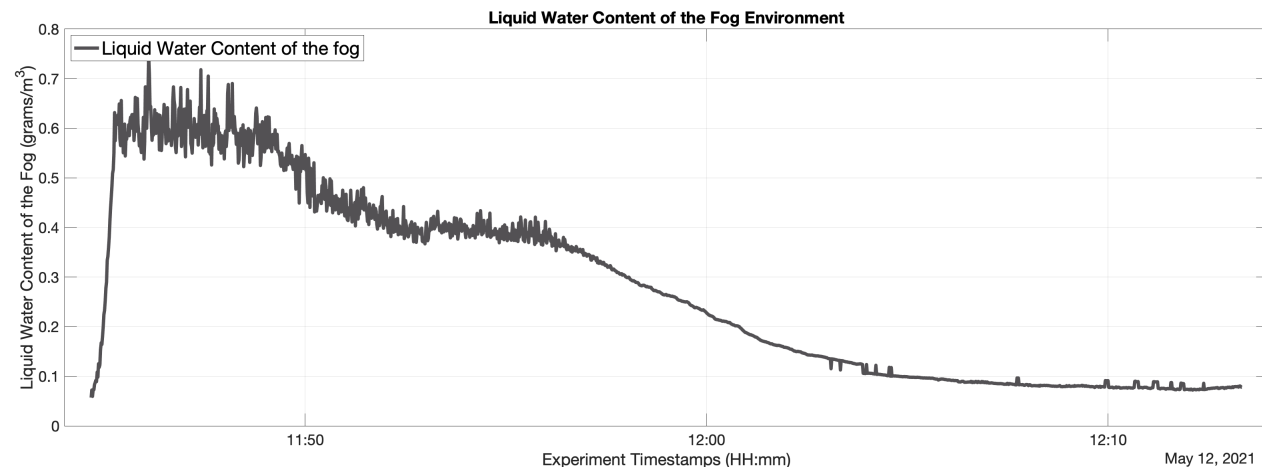
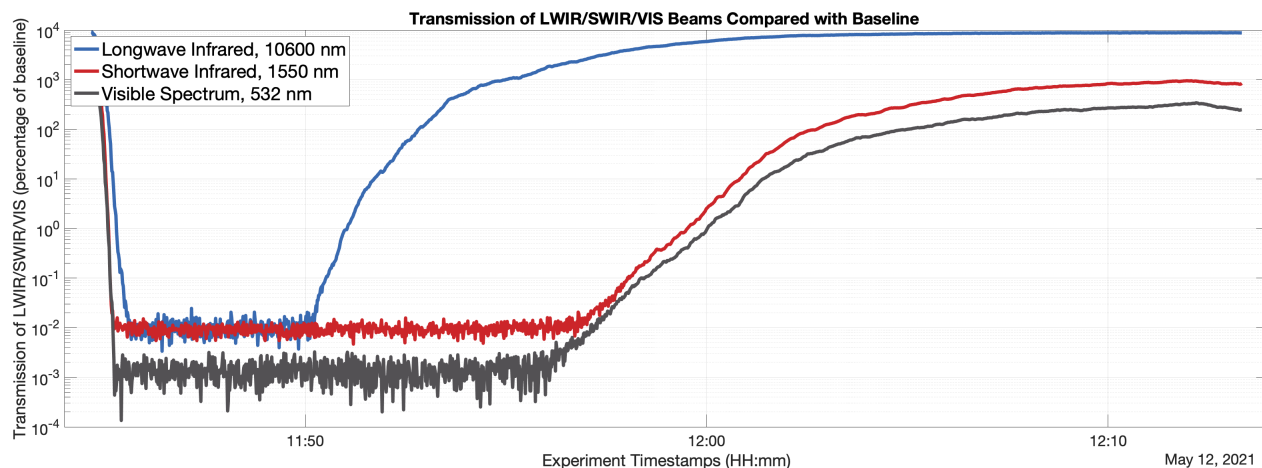
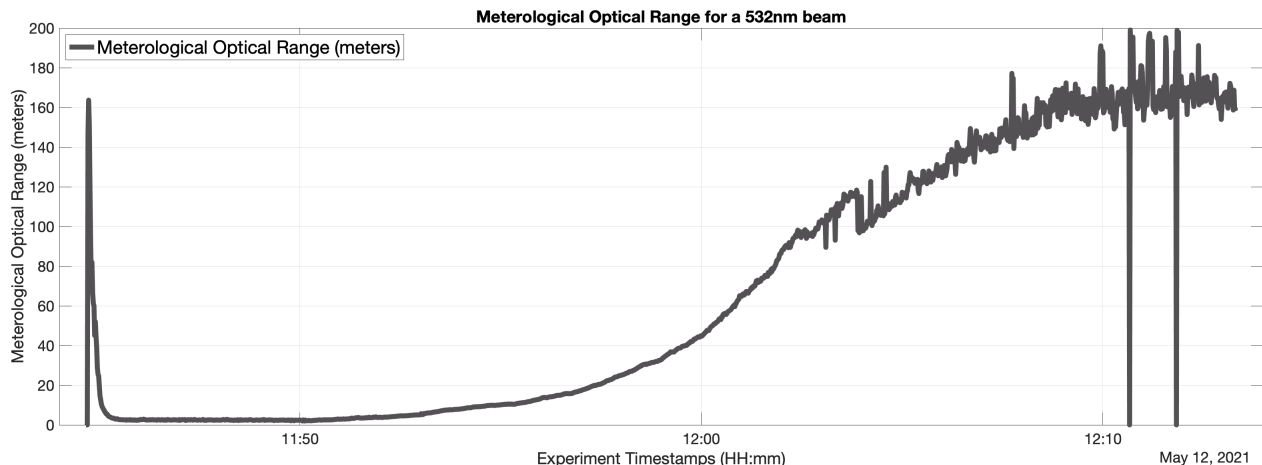


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog10

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

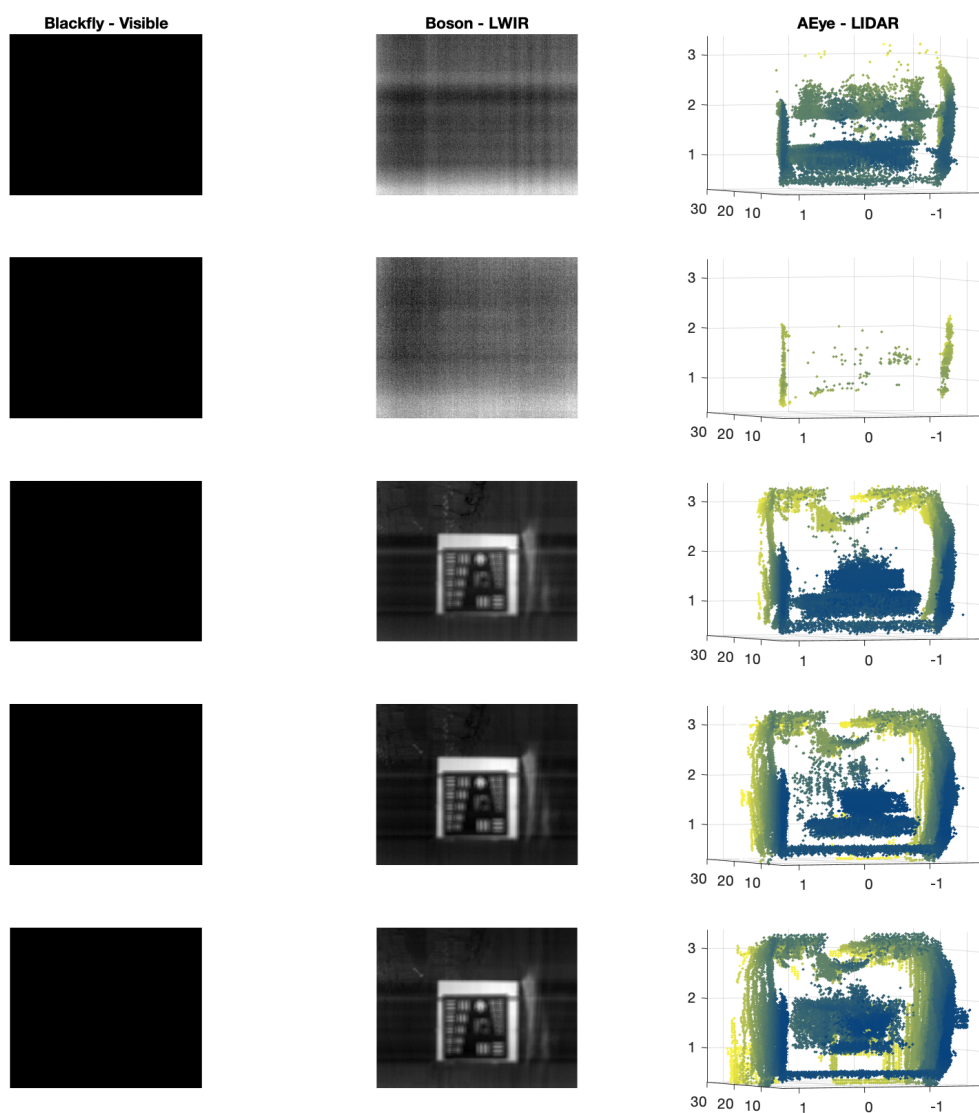
November 1, 2021

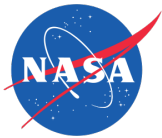
Experiment Name: fog11
Start Time: 12-May-2021 12:20:25.111
Duration: 00:35:42.372
Target: USAF-1951
Target Distance: 17.6276 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 20453 Images
Longwave Infrared: 21423 Images
LIDAR: 2798 Data & Images

1 Data Snapshot: fog11

The following images describe the variation in data during the experiment.



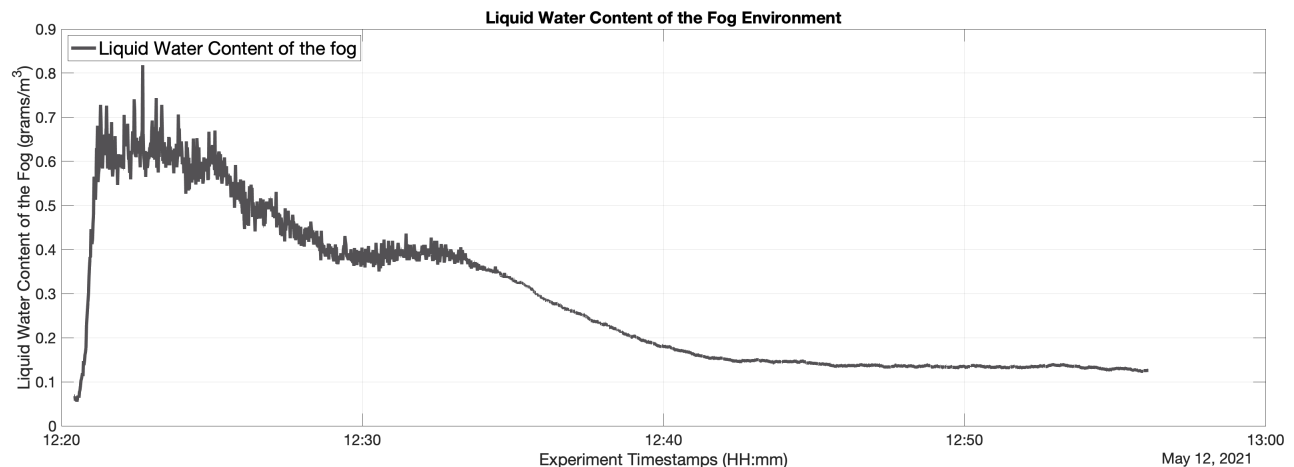
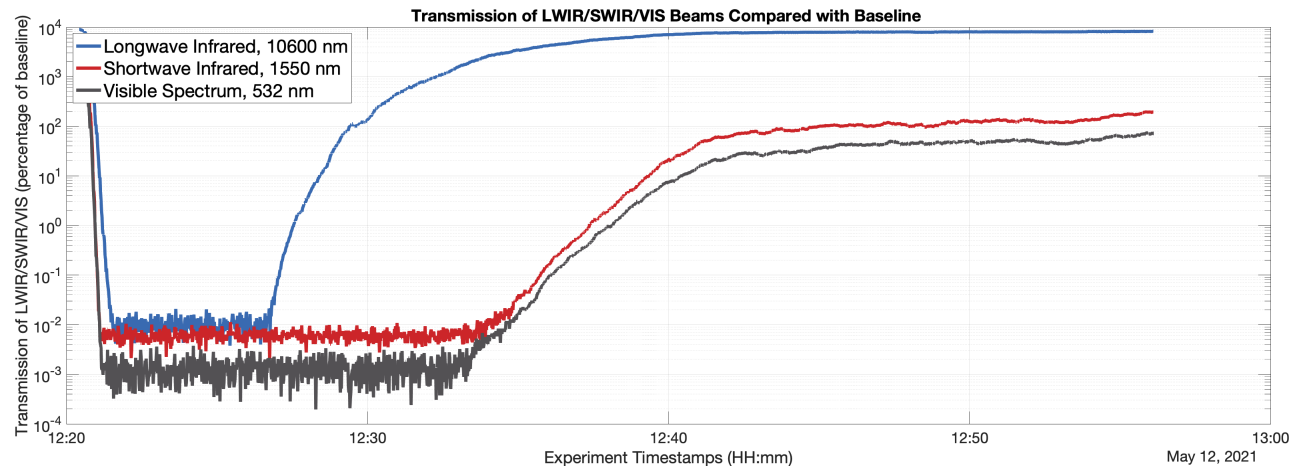
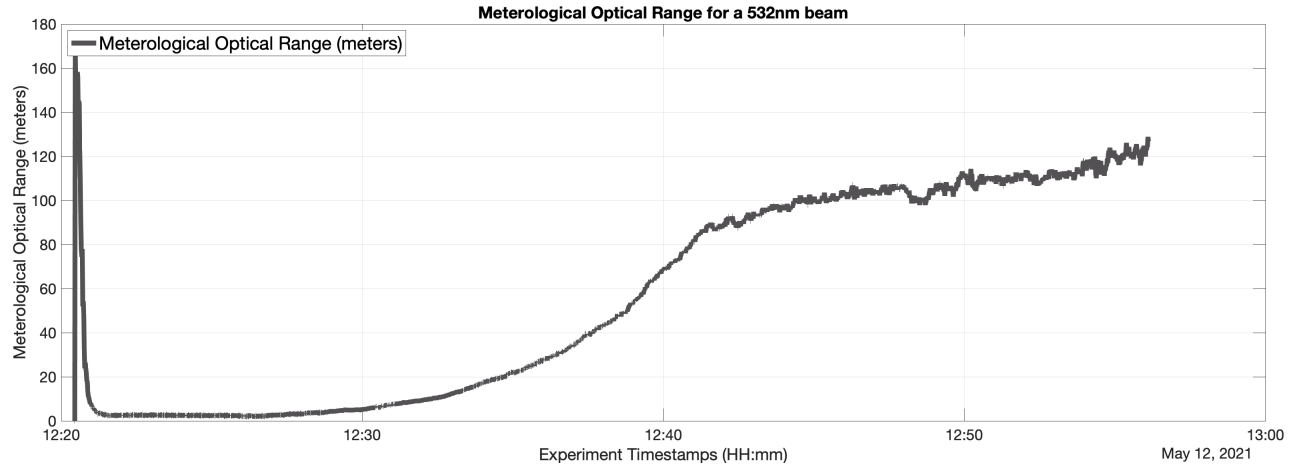


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog11

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

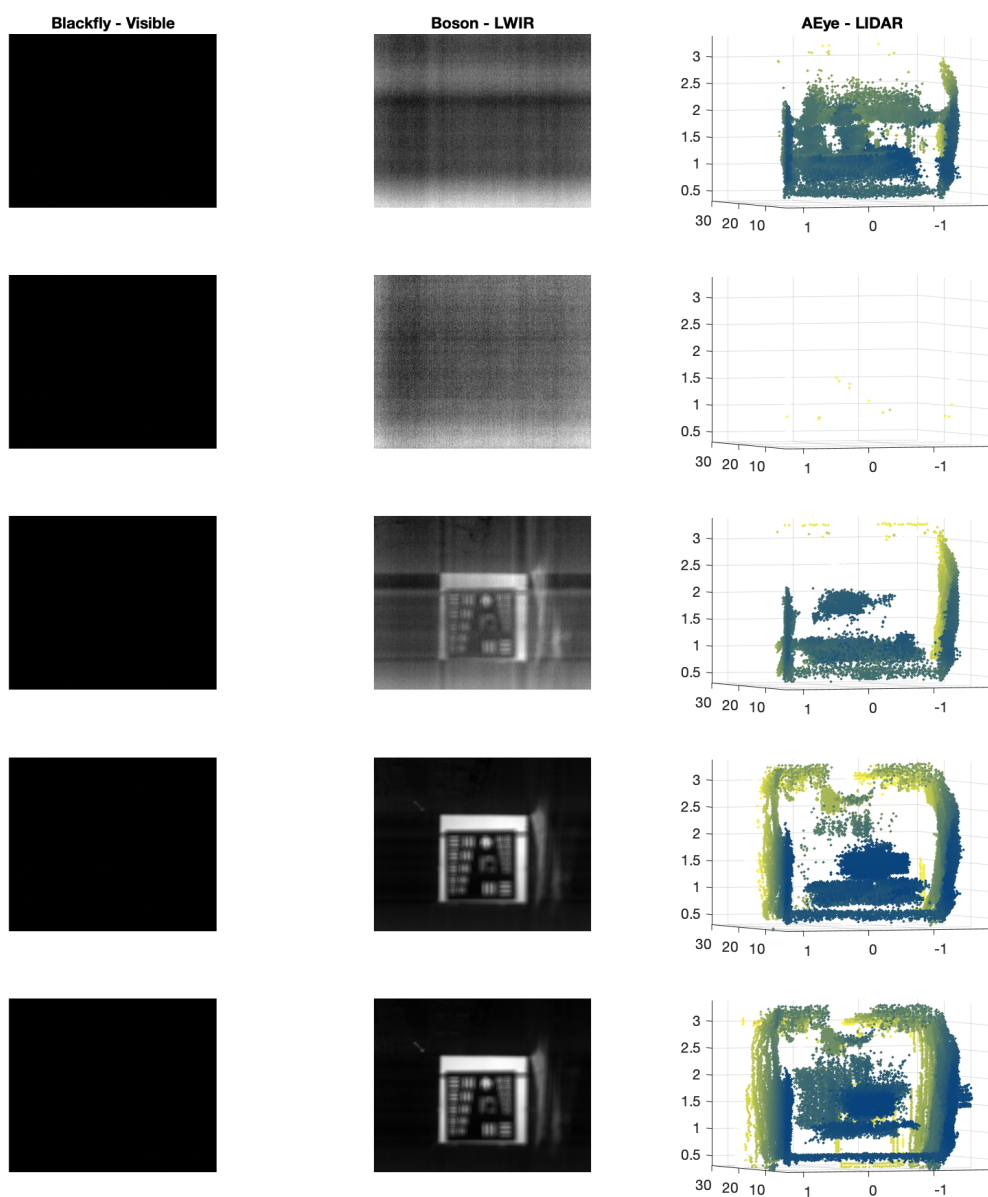
November 1, 2021

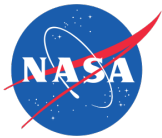
Experiment Name: fog12
Start Time: 12-May-2021 13:01:09.953
Duration: 00:27:36.052
Target: USAF-1951
Target Distance: 17.6276 meters
Target Temperature: 60 C
Environment Notes: None.

File Information:
Visible Spectrum: 14941 Images
Longwave Infrared: 16561 Images
LIDAR: 2172 Data & Images

1 Data Snapshot: fog12

The following images describe the variation in data during the experiment.



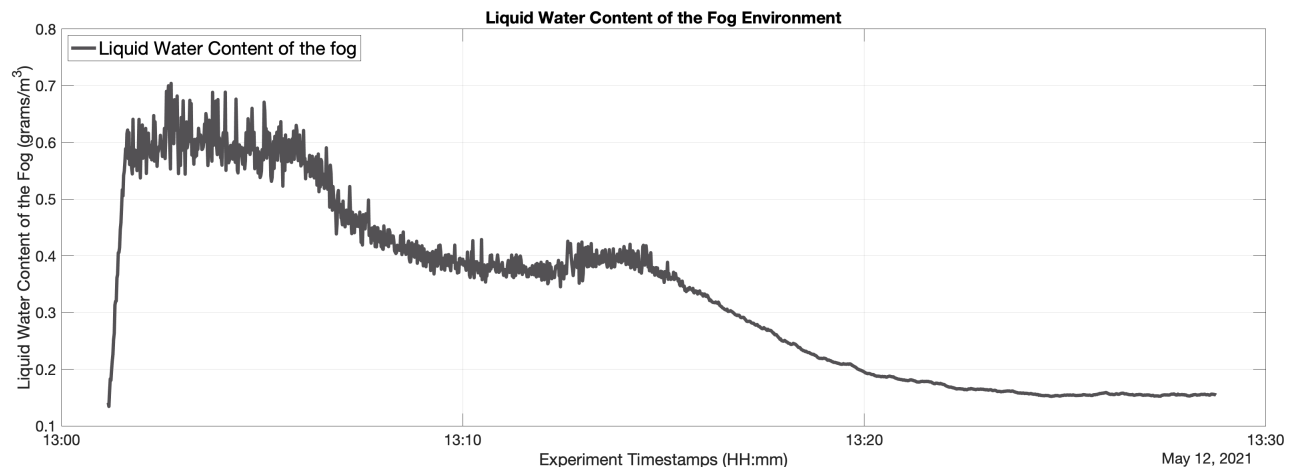
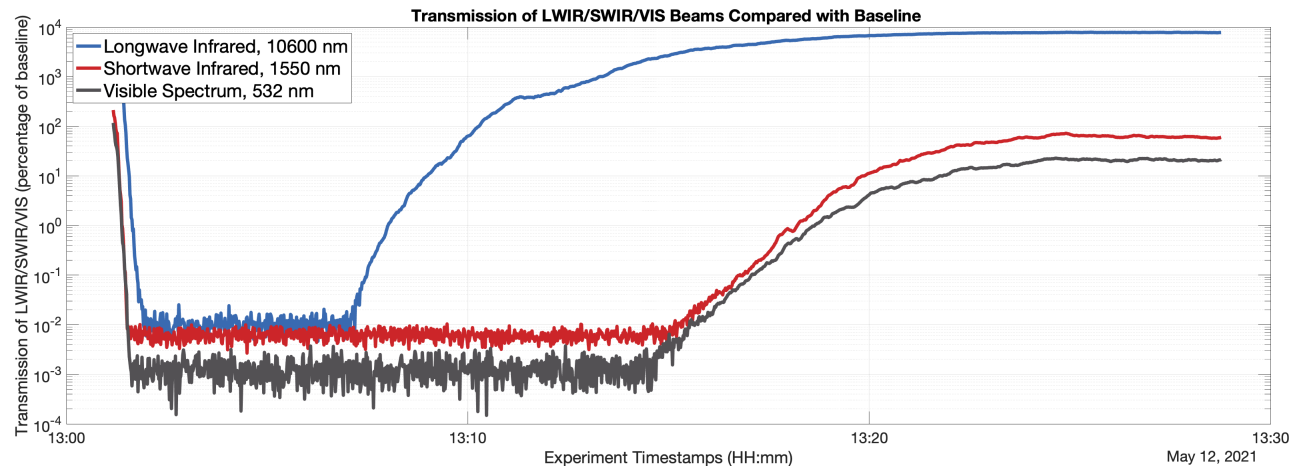
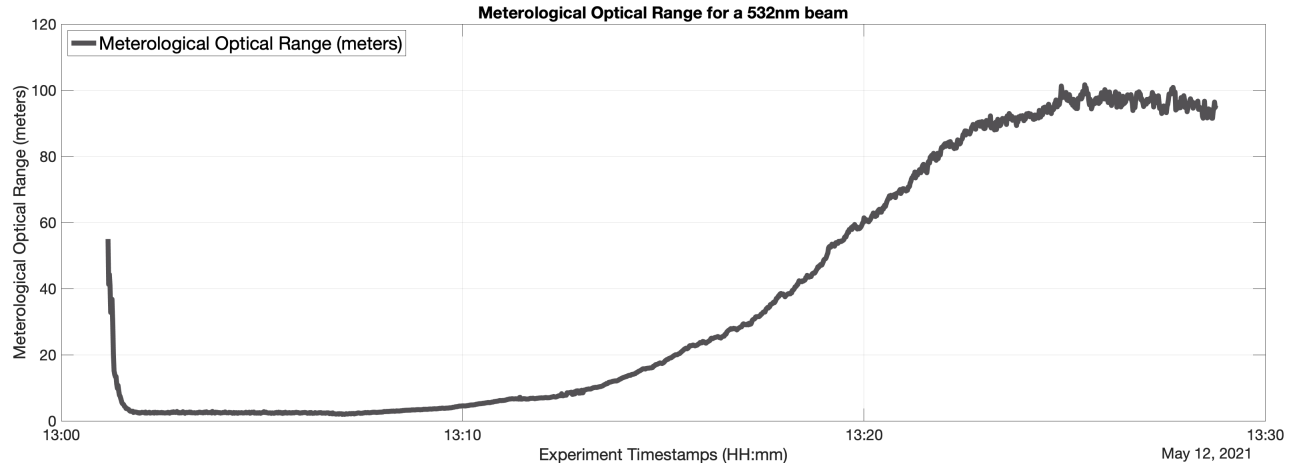


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog12

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

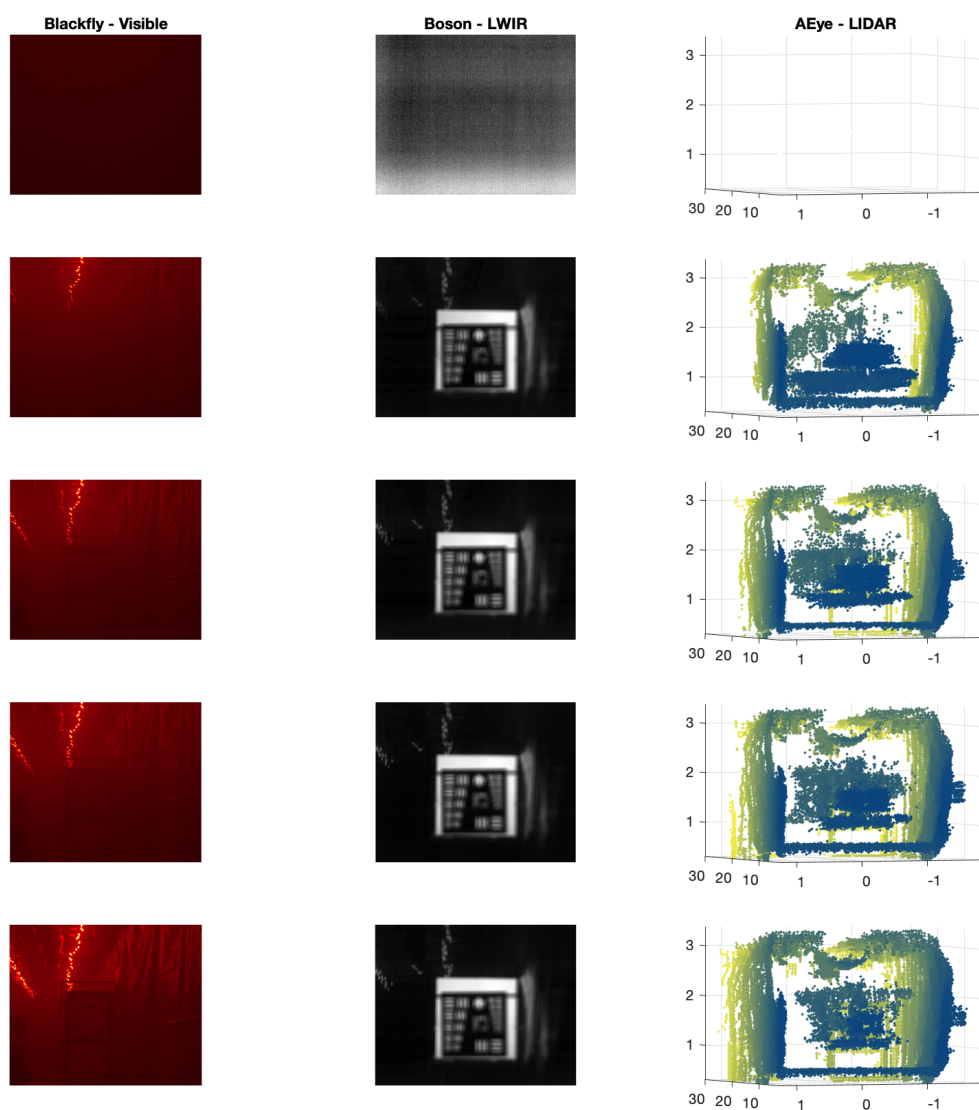
November 1, 2021

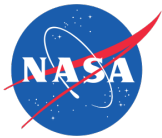
Experiment Name: fog14
Start Time: 12-May-2021 14:01:13.036
Duration: 00:58:41.298
Target: USAF-1951
Target Distance: 17.6276 meters
Target Temperature: N/A
Environment Notes: None.

File Information:
Visible Spectrum: 32035 Images
Longwave Infrared: 35212 Images
LIDAR: 4604 Data & Images

1 Data Snapshot: fog14

The following images describe the variation in data during the experiment.



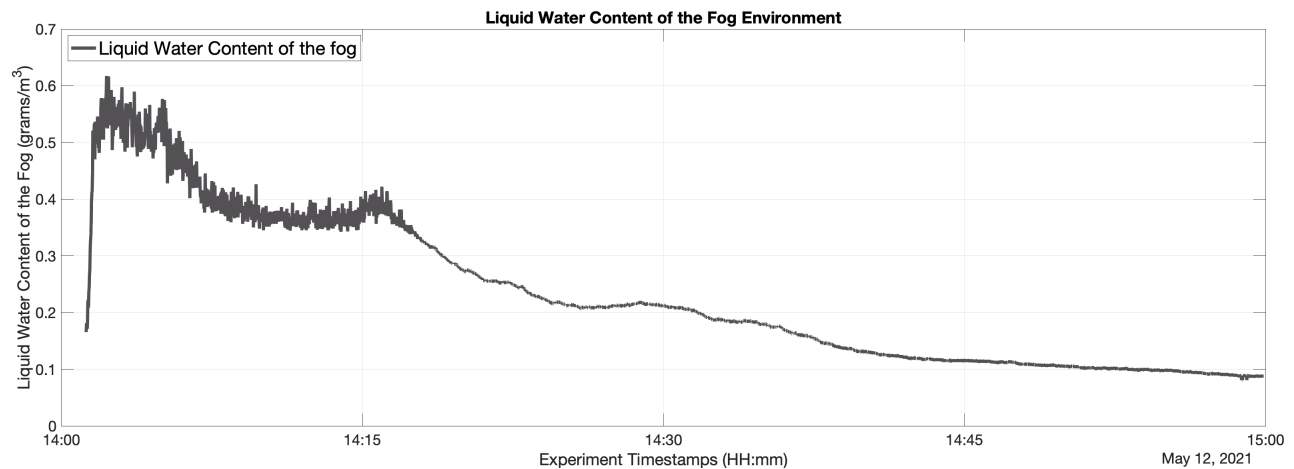
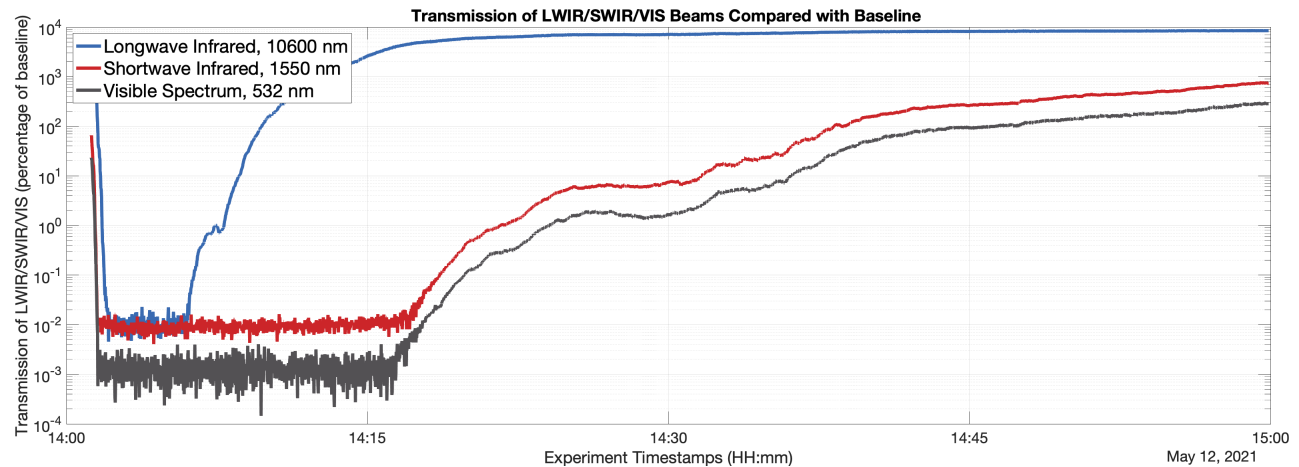
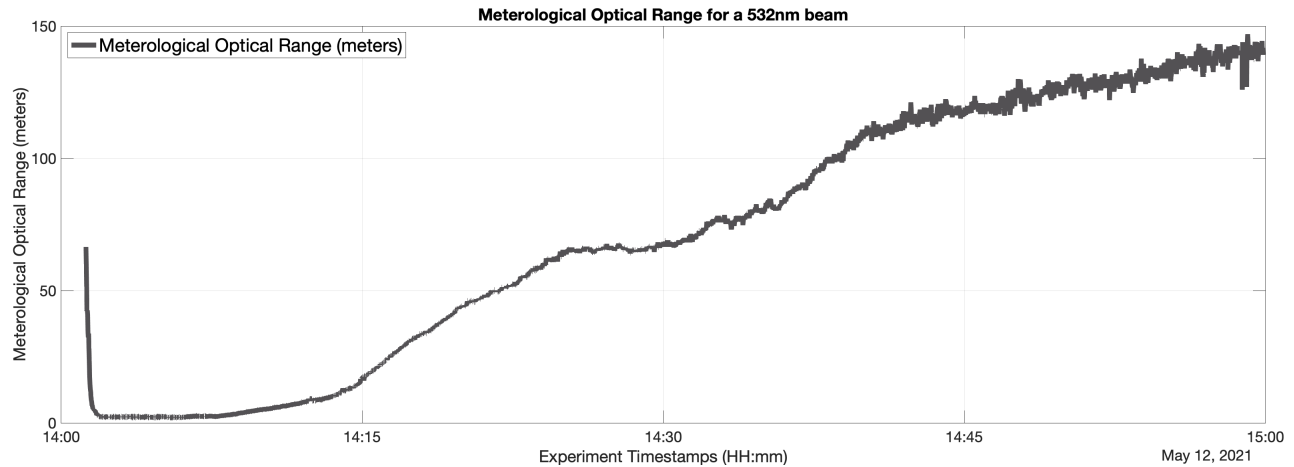


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog14

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

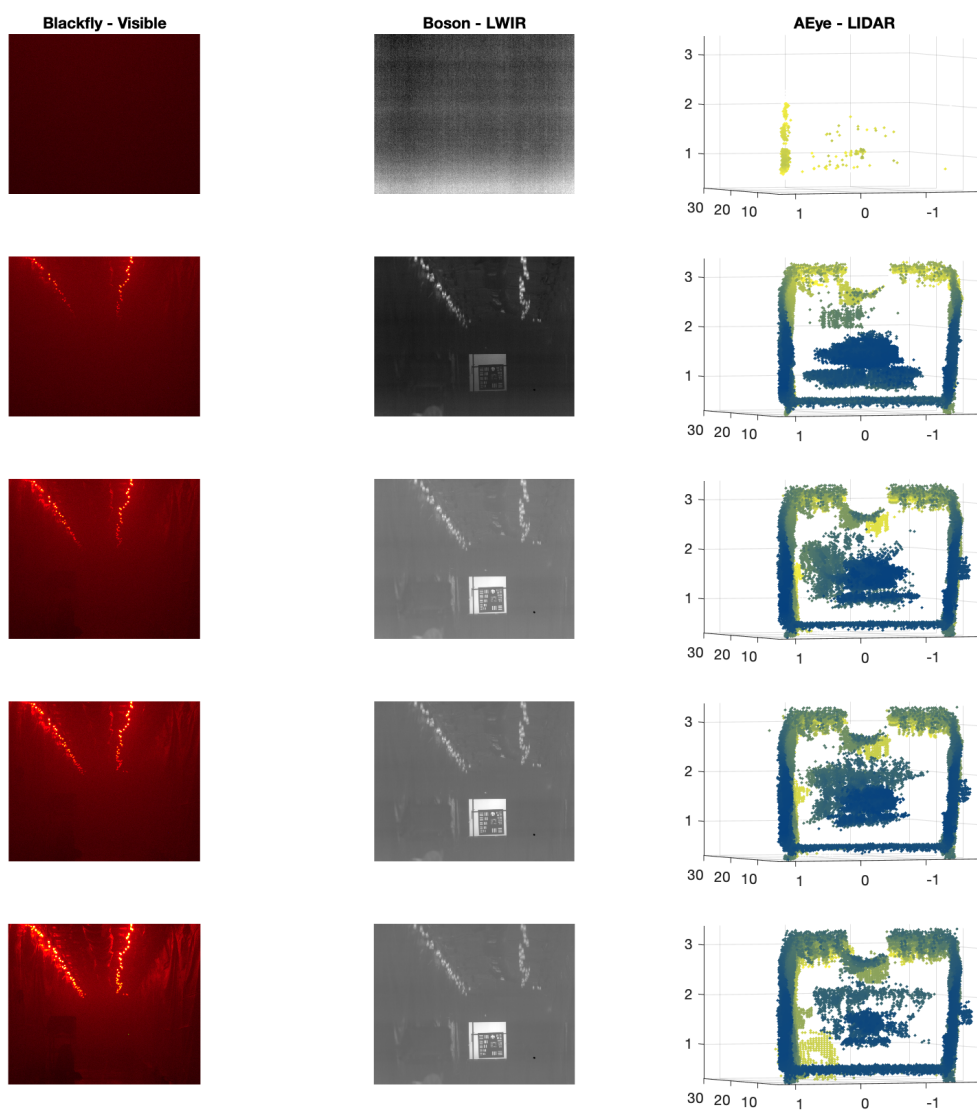
November 1, 2021

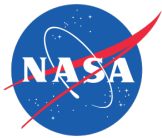
Experiment Name: fog15
Start Time: 12-May-2021 16:08:11.260
Duration: 01:22:05.925
Target: USAF-1951
Target Distance: 45.66 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 45034 Images
Longwave Infrared: 49259 Images
LIDAR: 6440 Data & Images

1 Data Snapshot: fog15

The following images describe the variation in data during the experiment.



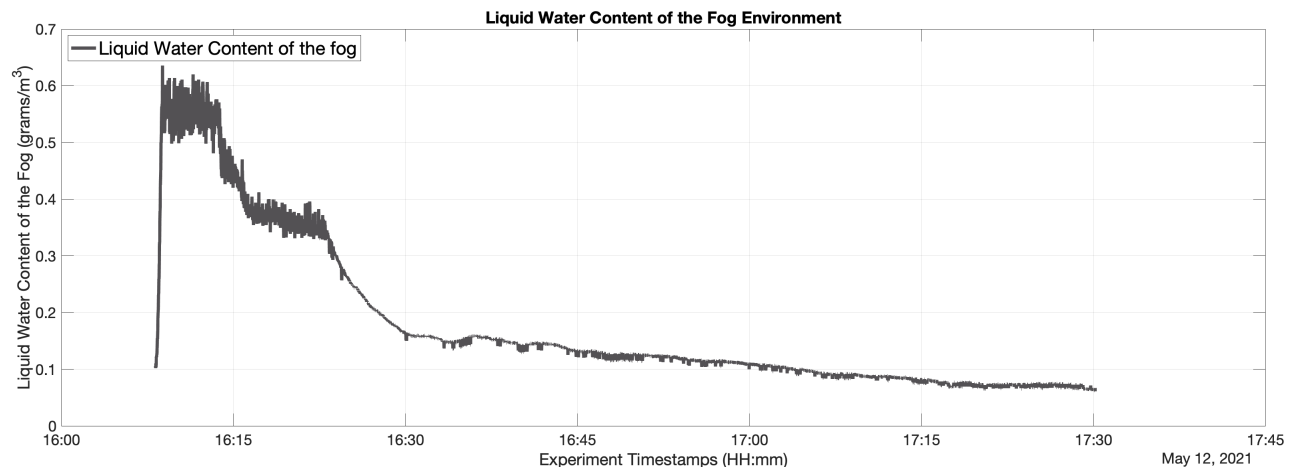
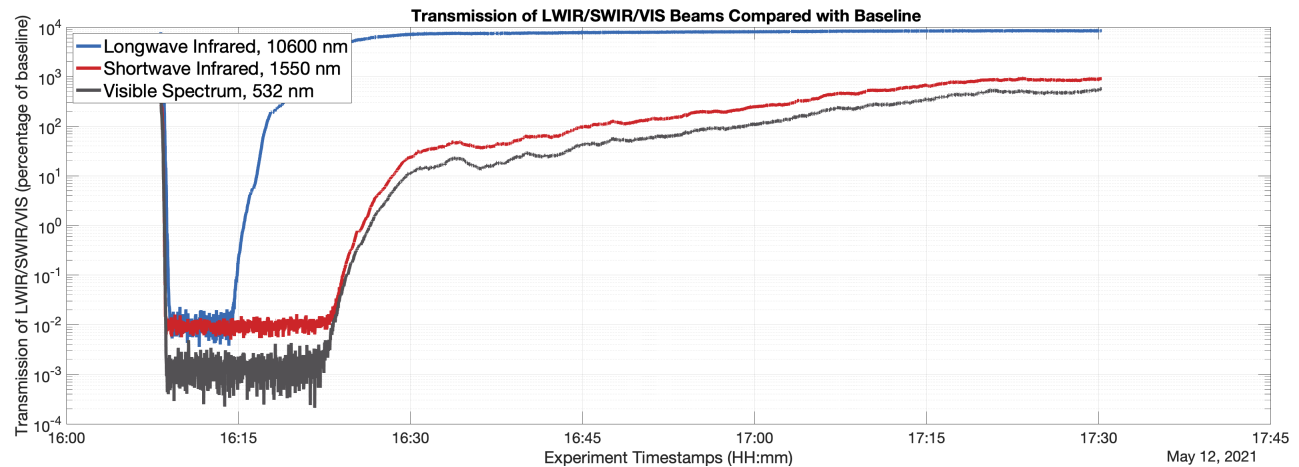
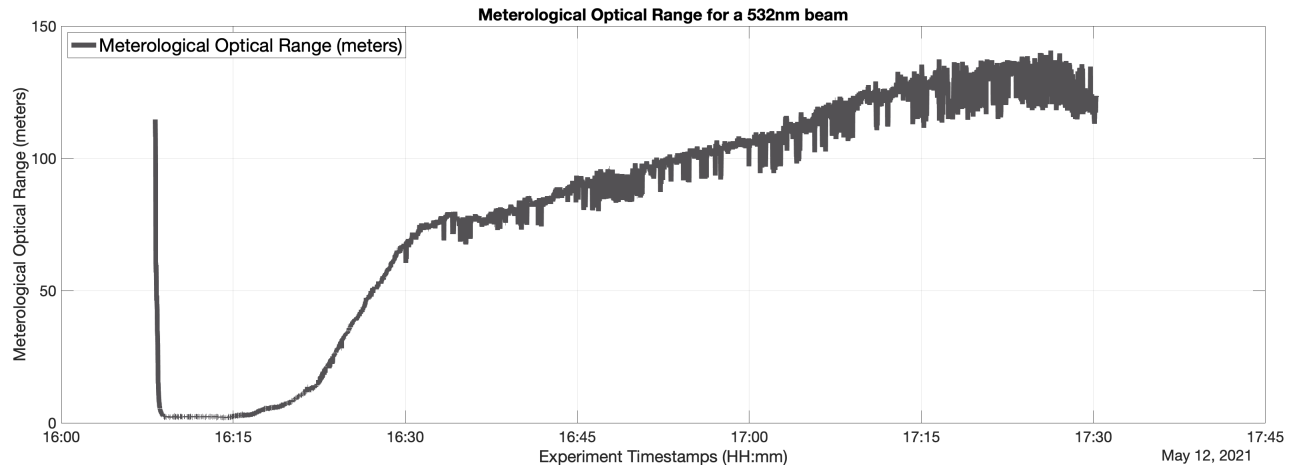


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog15

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

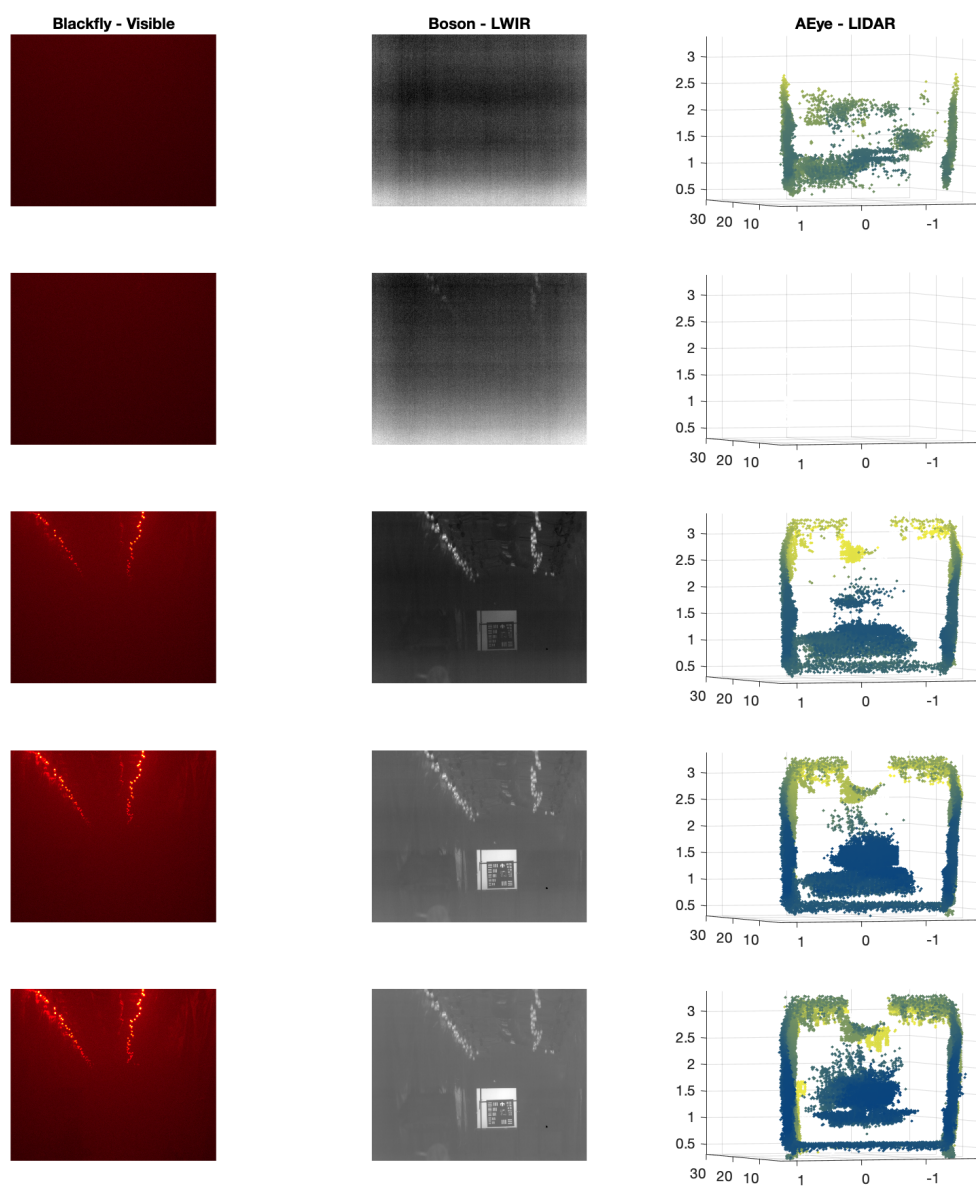
November 1, 2021

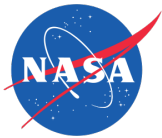
Experiment Name: fog16
Start Time: 13-May-2021 09:28:39.918
Duration: 00:41:40.255
Target: USAF-1951
Target Distance: 45.6692 meters
Target Temperature: 60 C
Environment Notes: None.

File Information:
Visible Spectrum: 22847 Images
Longwave Infrared: 25004 Images
LIDAR: 3271 Data & Images

1 Data Snapshot: fog16

The following images describe the variation in data during the experiment.



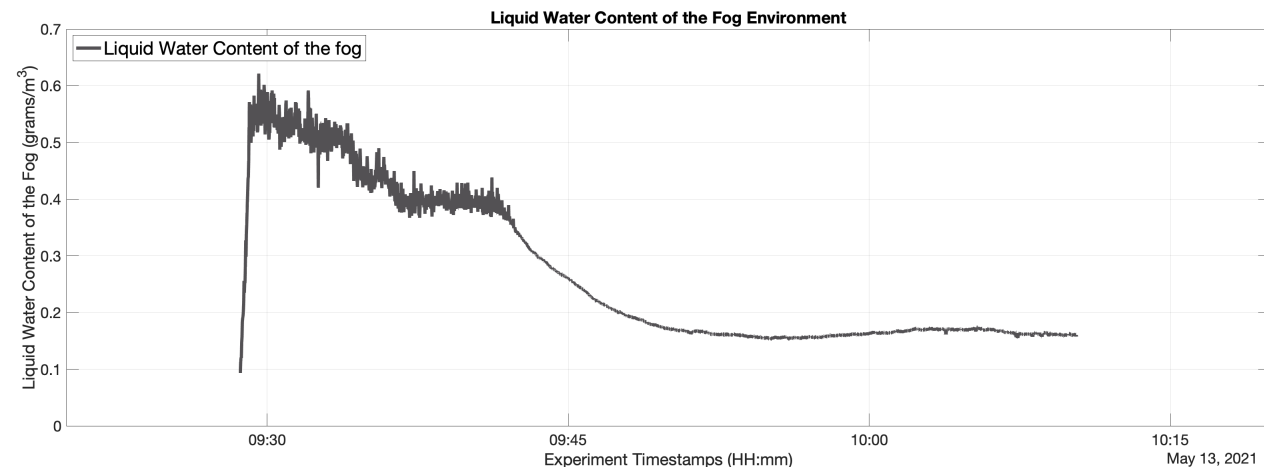
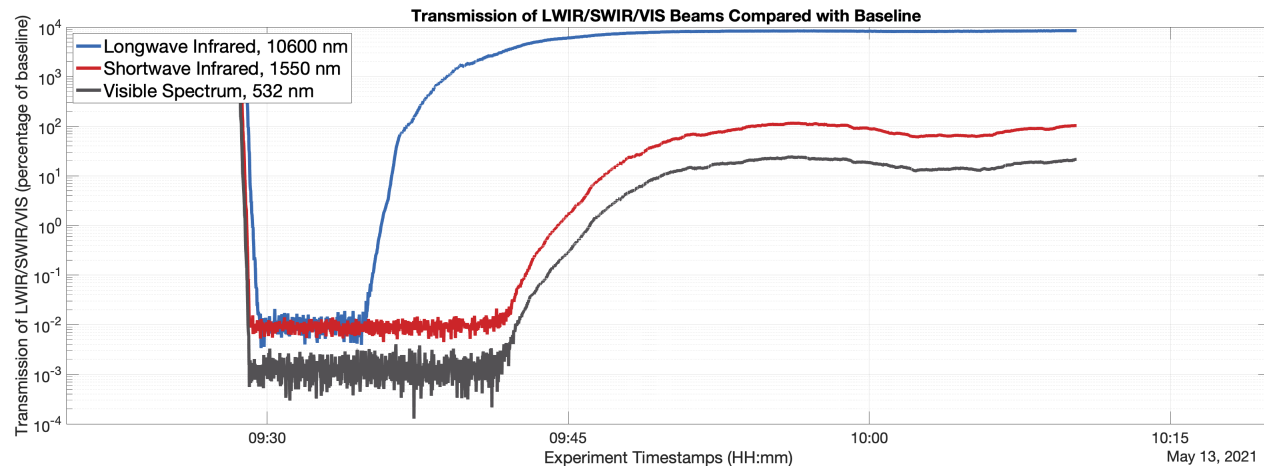
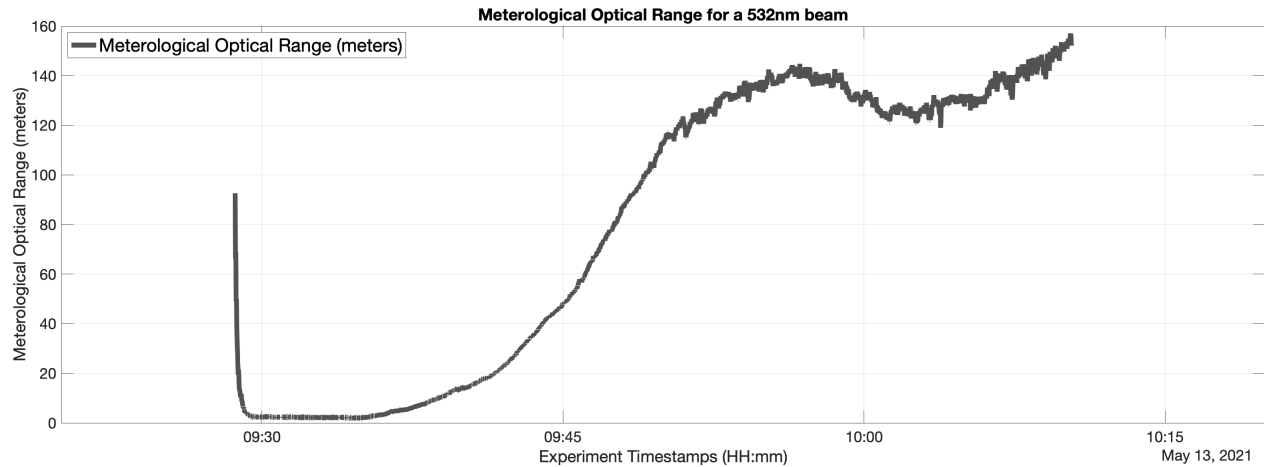


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog16

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

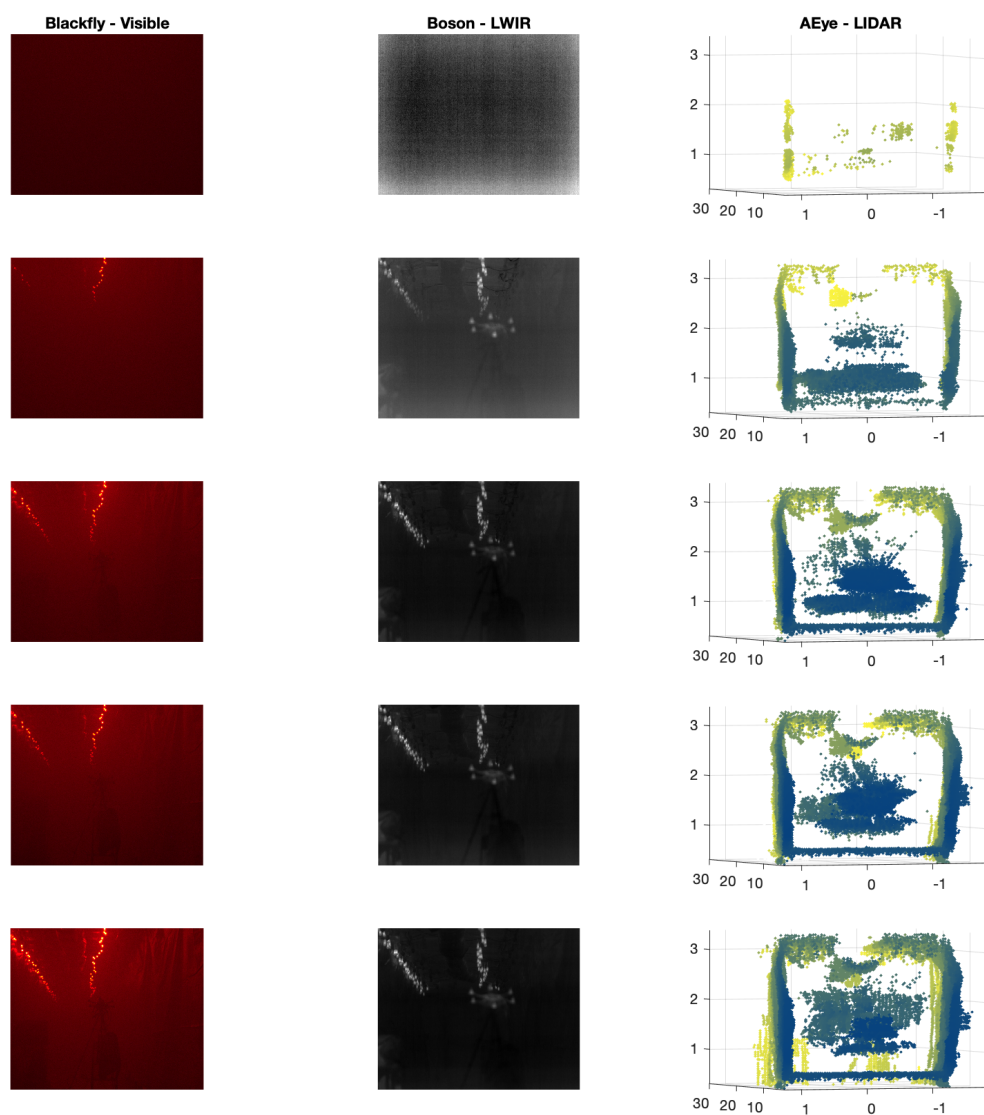
November 1, 2021

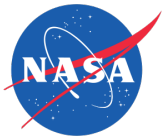
Experiment Name: fog17
Start Time: 13-May-2021 12:45:34.338
Duration: 01:02:59.197
Target: UAV-Oncoming
Target Distance: 18.23 meters
Target Temperature: N/A
Environment Notes: None.

File Information:
Visible Spectrum: 34384 Images
Longwave Infrared: 37793 Images
LIDAR: 4941 Data & Images

1 Data Snapshot: fog17

The following images describe the variation in data during the experiment.



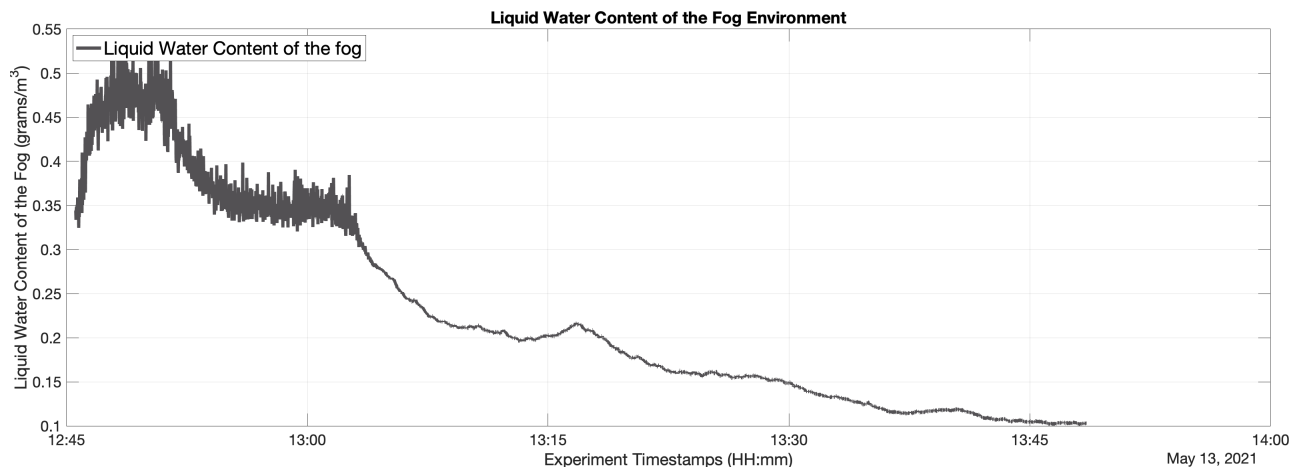
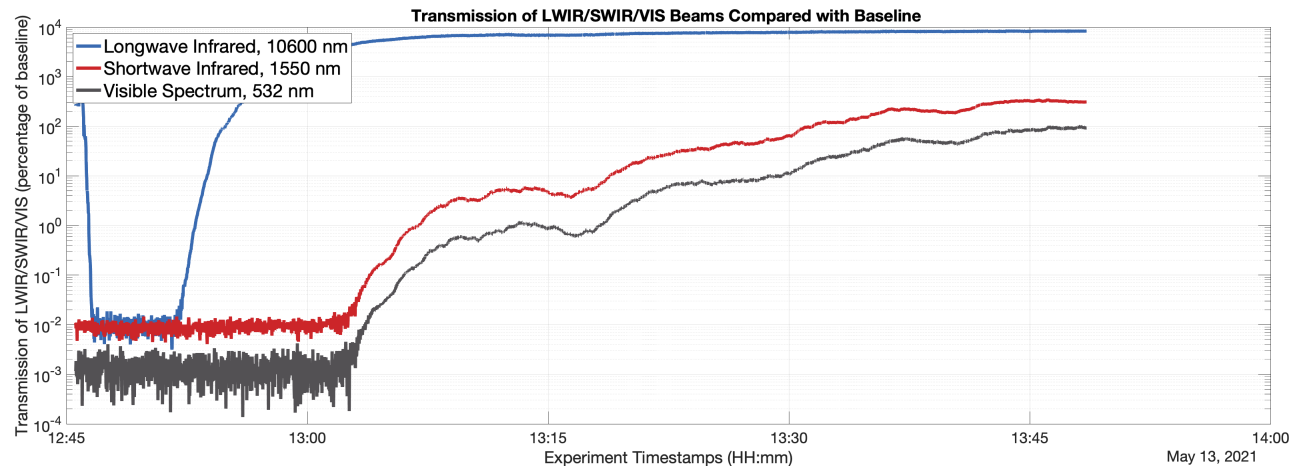
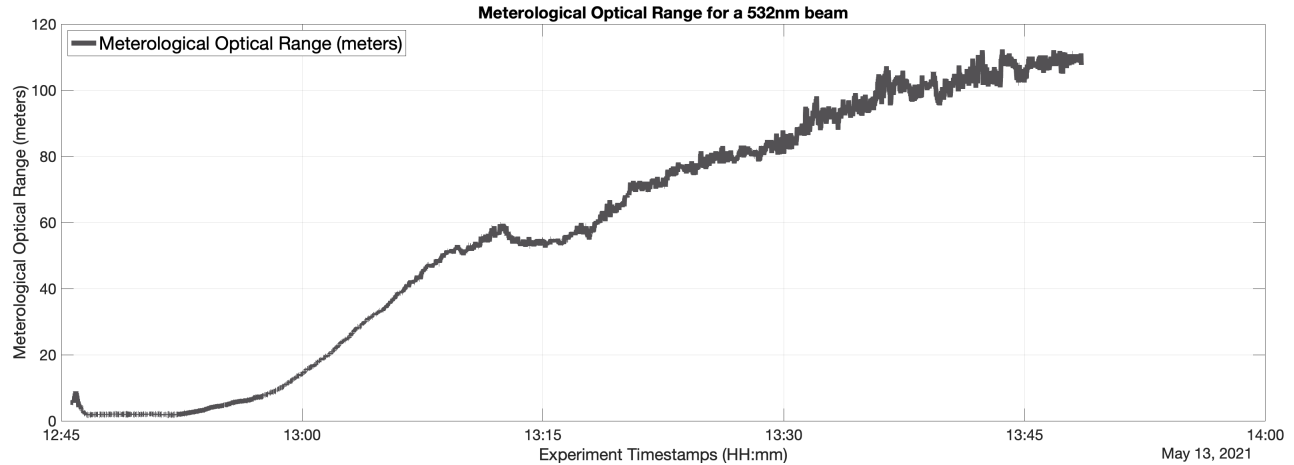


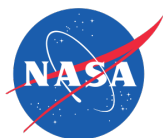
Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog17

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

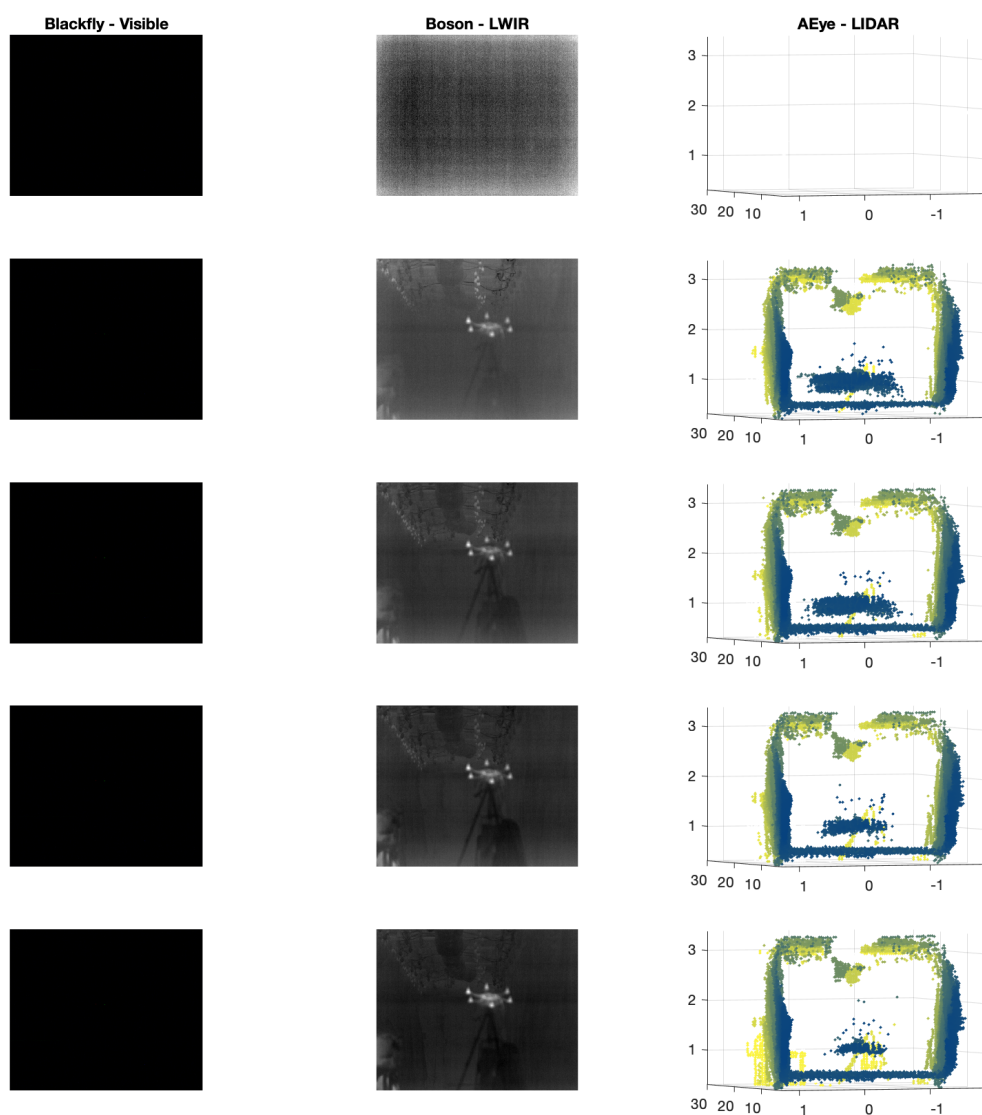
November 1, 2021

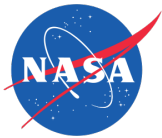
Experiment Name: fog18
Start Time: 13-May-2021 15:41:42.650
Duration: 00:48:00.116
Target: UAV-Oncoming
Target Distance: 18.2372 meters
Target Temperature: N/A
Environment Notes: None.

File Information:
Visible Spectrum: 25992 Images
Longwave Infrared: 28800 Images
LIDAR: 2789 Data & Images

1 Data Snapshot: fog18

The following images describe the variation in data during the experiment.



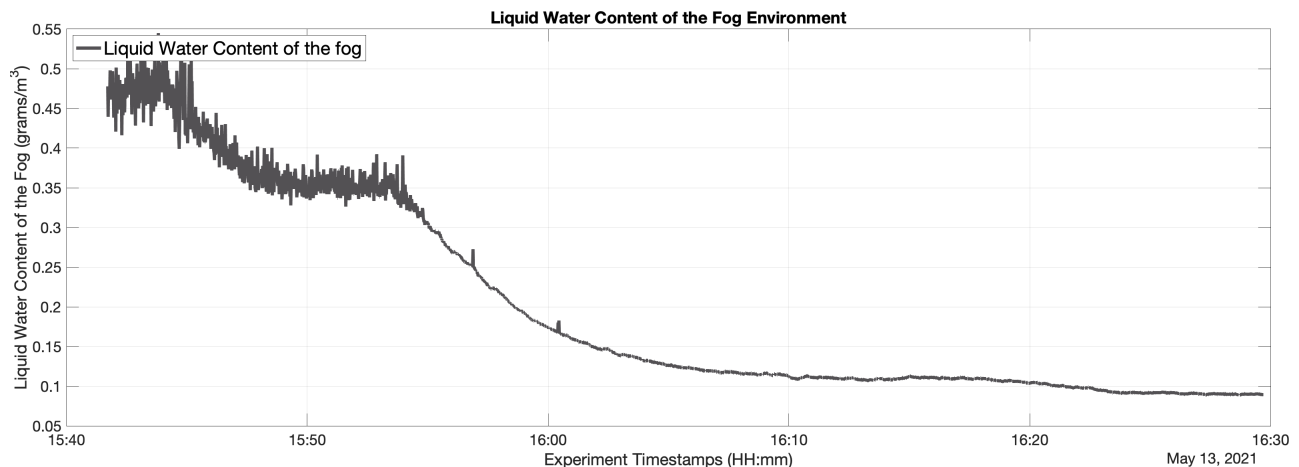
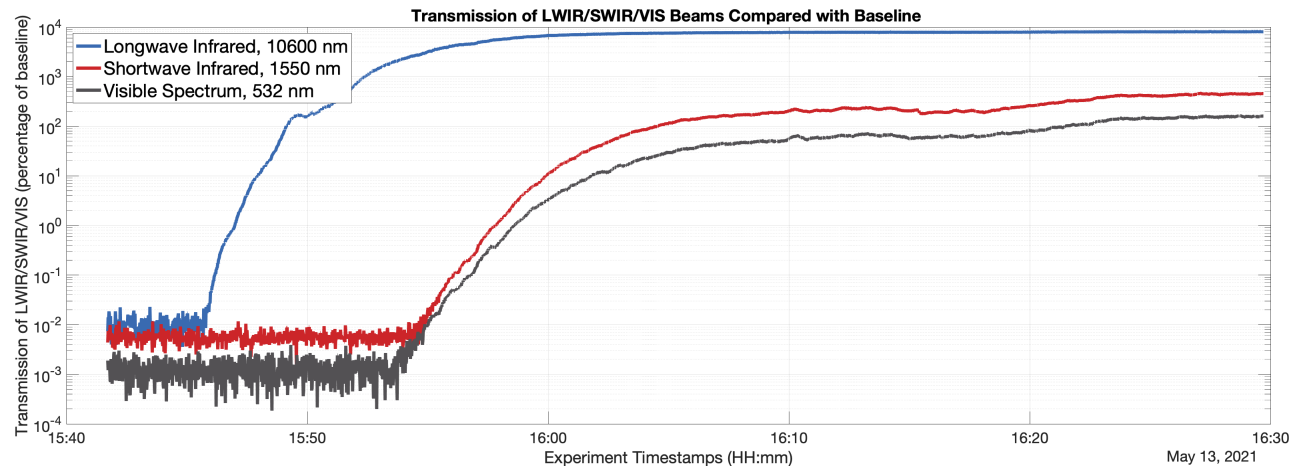
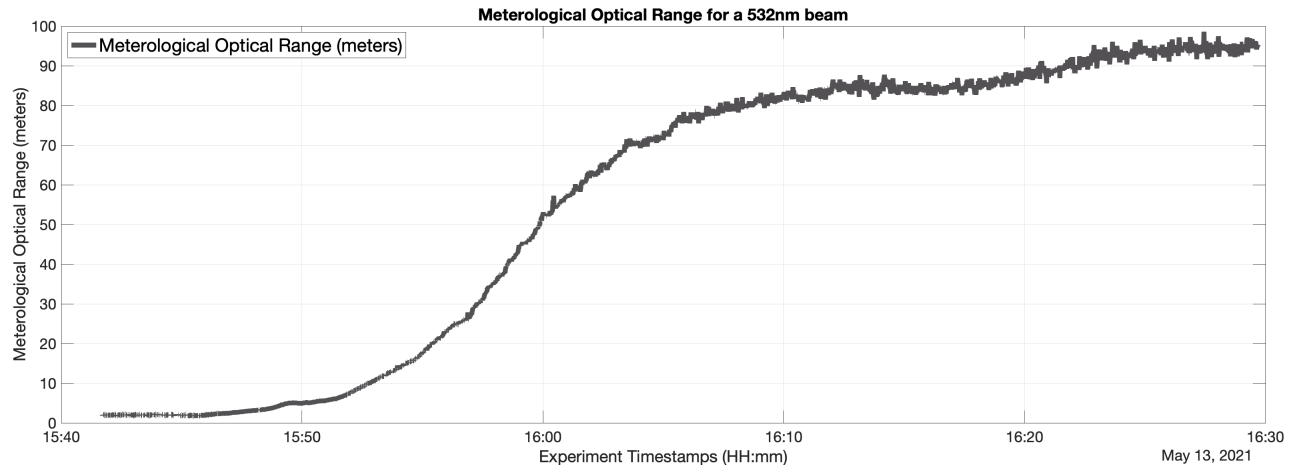


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog18

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

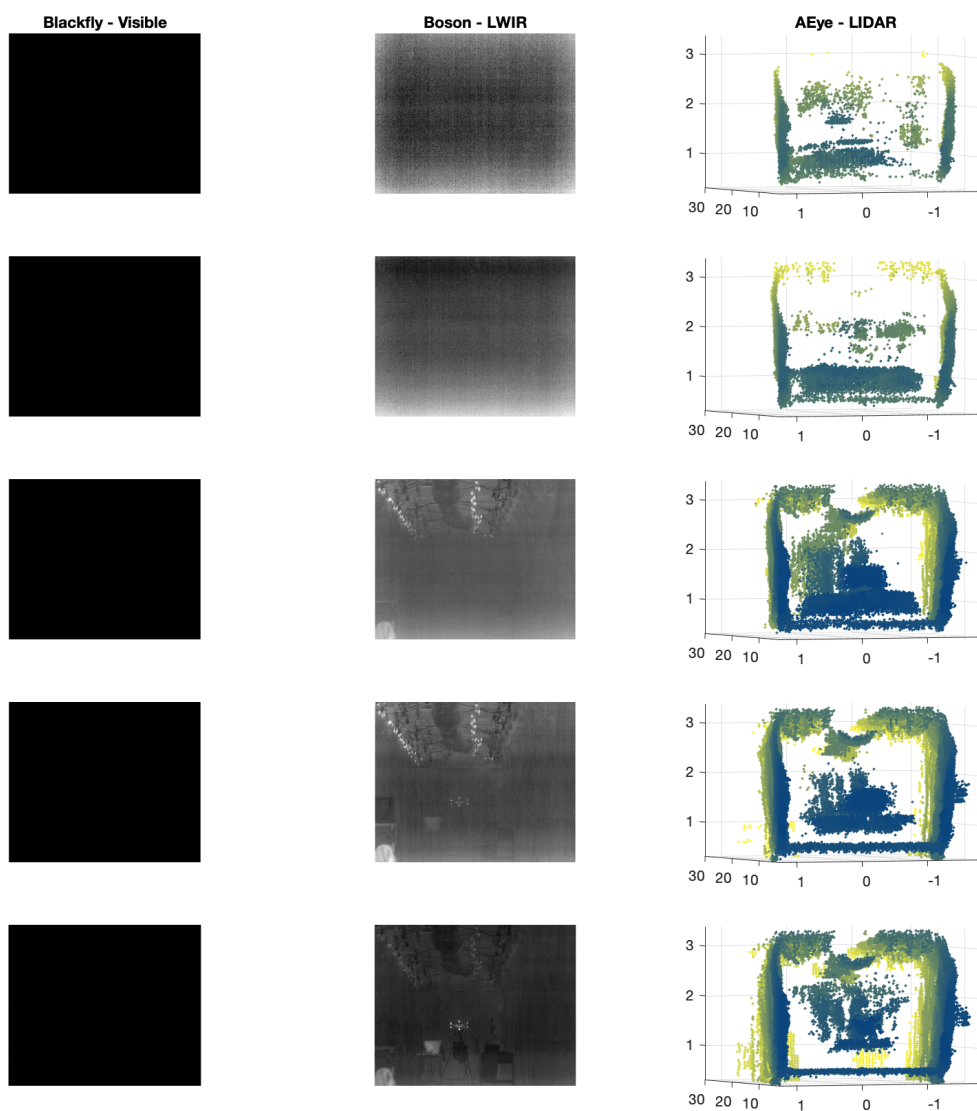
November 1, 2021

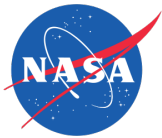
Experiment Name: fog20
Start Time: 14-May-2021 10:50:28.216
Duration: 00:31:18.961
Target: UAV-Oncoming
Target Distance: 45.6692 meters
Target Temperature: N/A
Environment Notes: None.

File Information:
Visible Spectrum: 17271 Images
Longwave Infrared: 18791 Images
LIDAR: 2452 Data & Images

1 Data Snapshot: fog20

The following images describe the variation in data during the experiment.



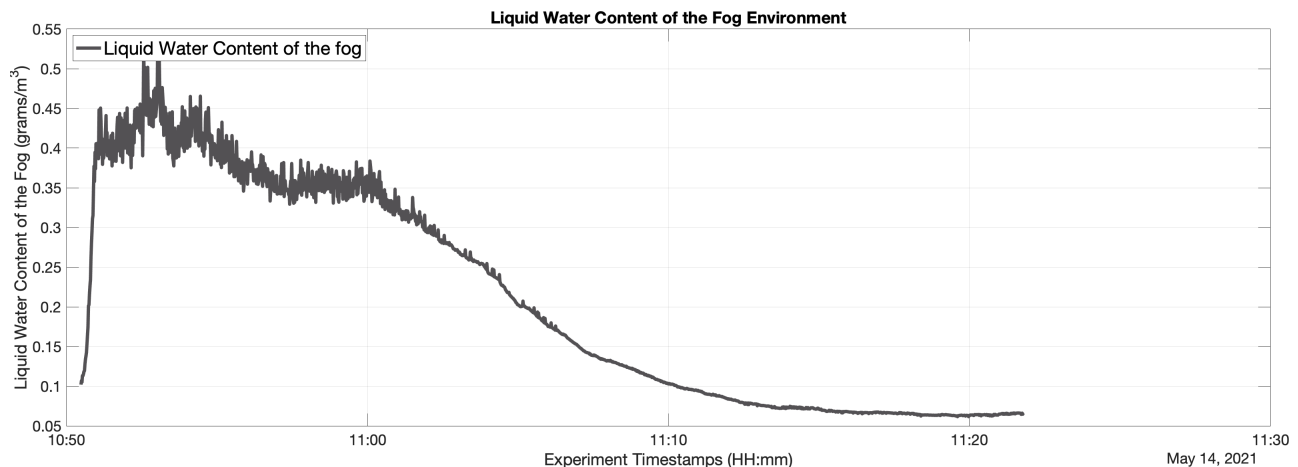
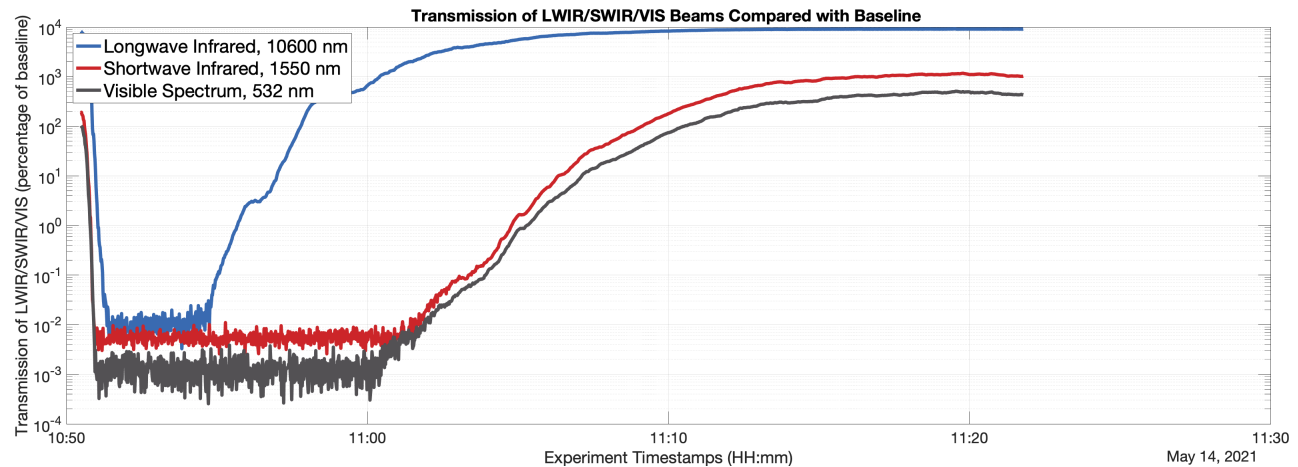
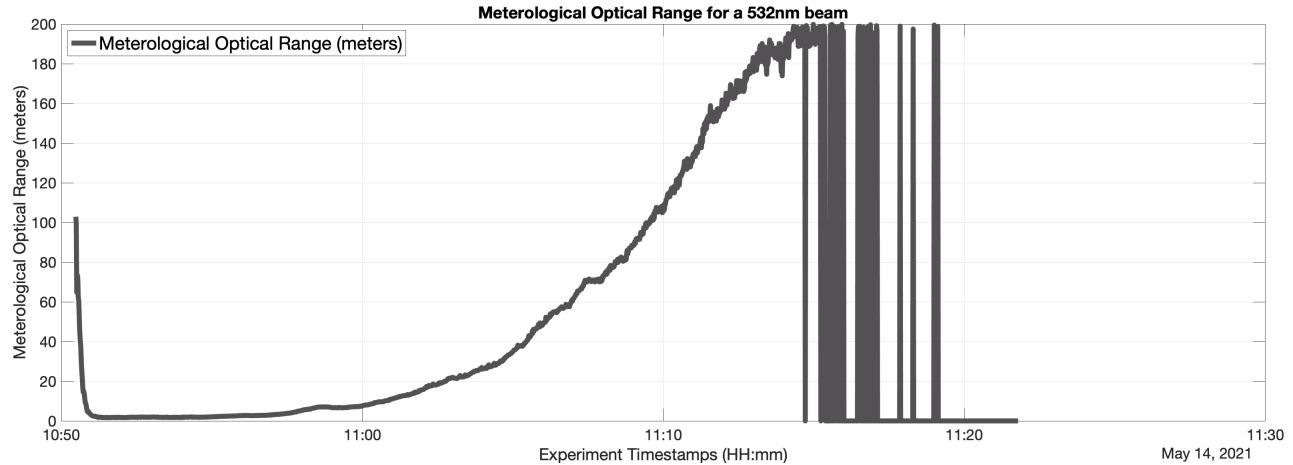


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog20

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

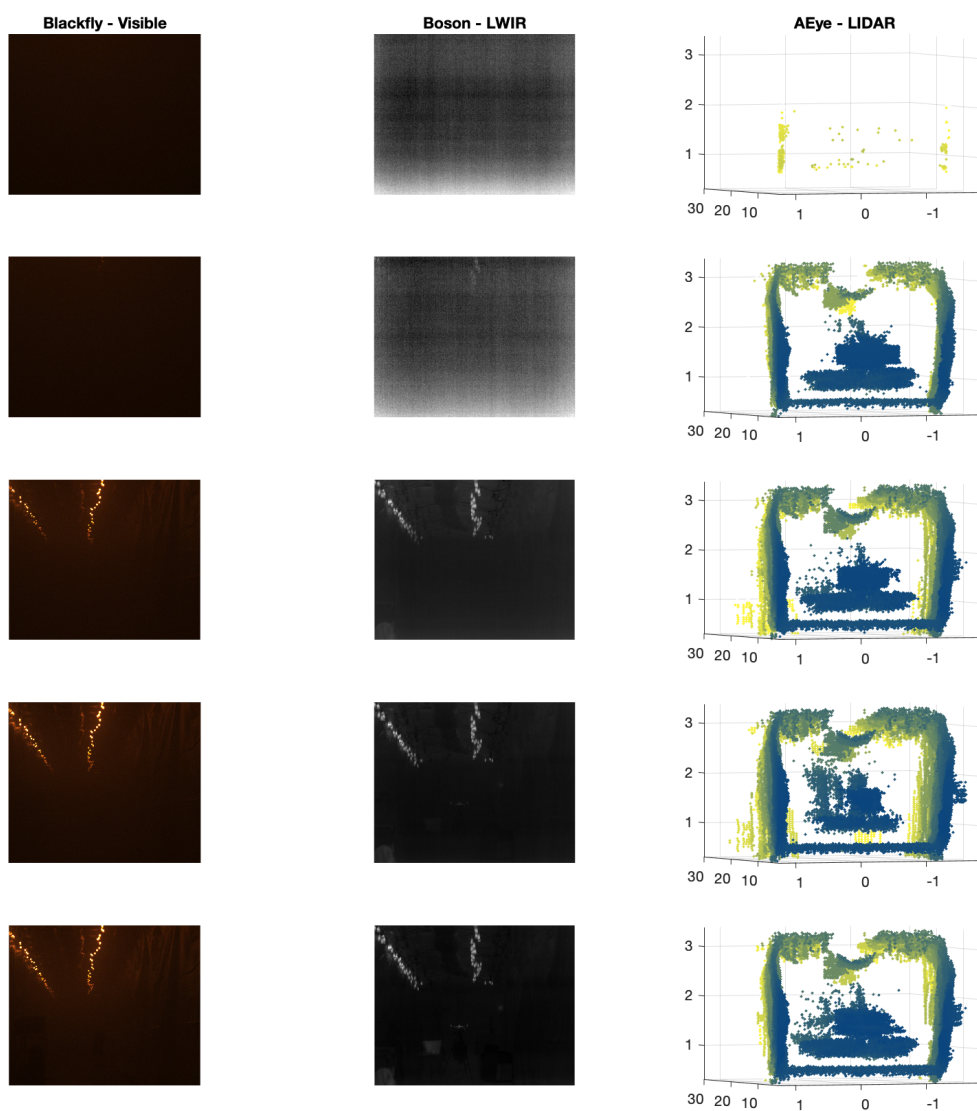
November 1, 2021

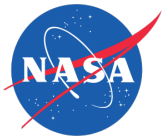
Experiment Name: fog22
Start Time: 14-May-2021 13:25:03.432
Duration: 00:31:05.889
Target: UAV-Hover
Target Distance: 45.6692 meters
Target Temperature: N/A
Environment Notes: None.

File Information:
Visible Spectrum: 16943 Images
Longwave Infrared: 18660 Images
LIDAR: 5548 Data & Images

1 Data Snapshot: fog22

The following images describe the variation in data during the experiment.



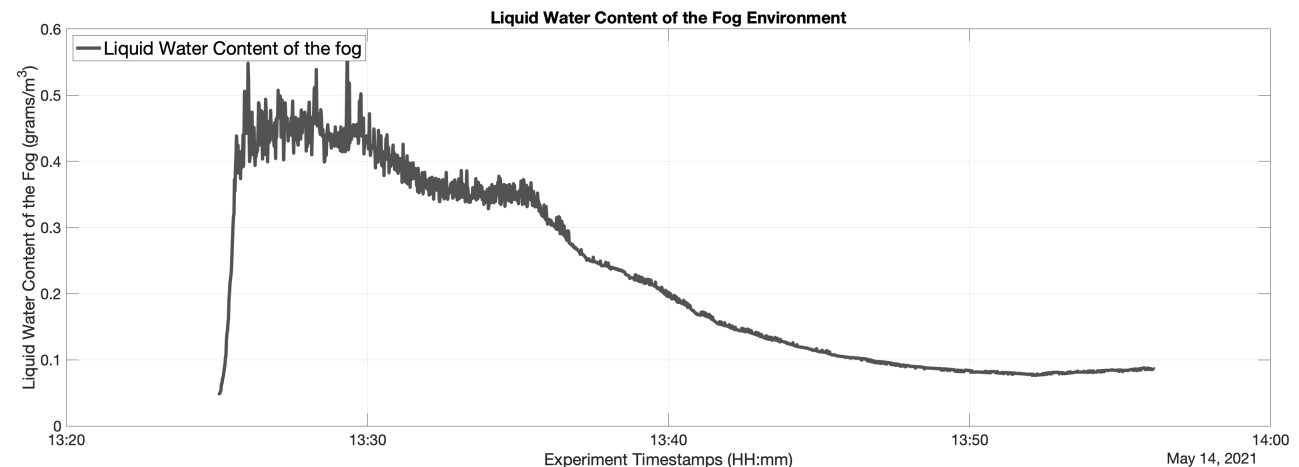
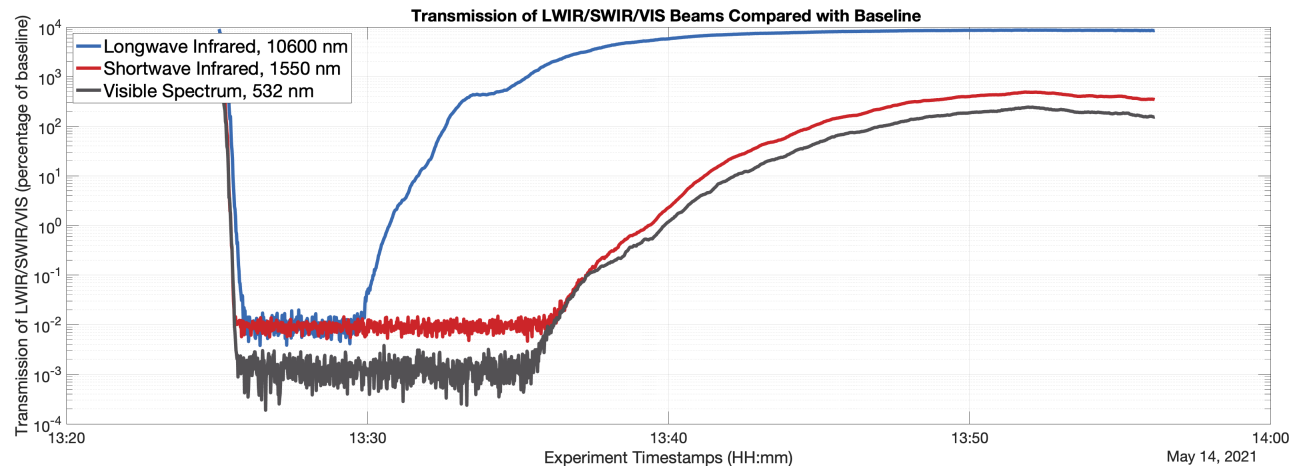
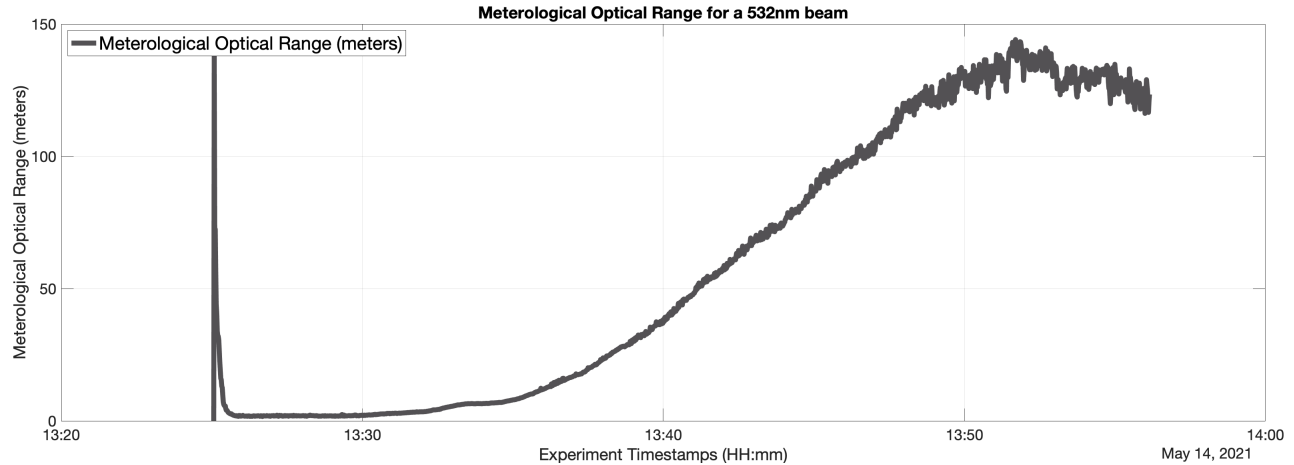


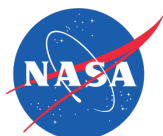
Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog22

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

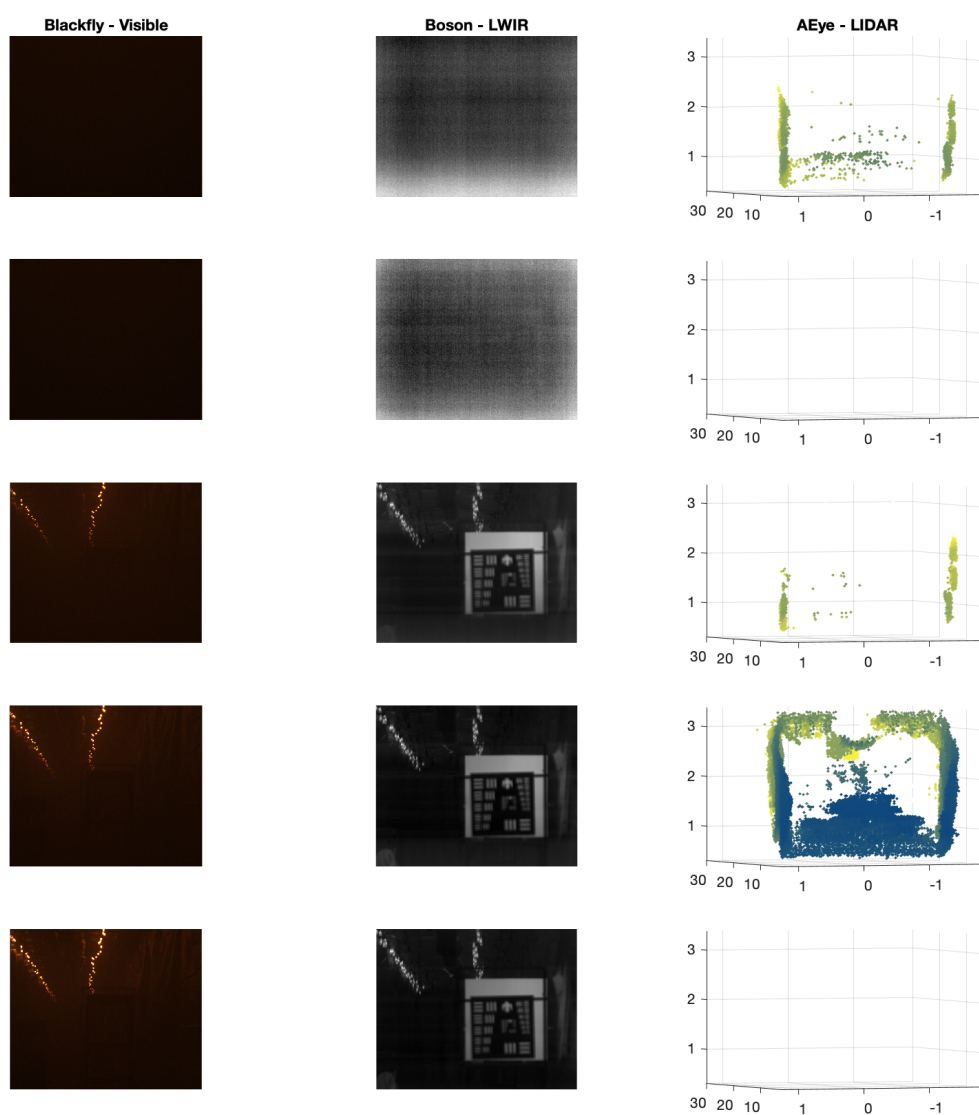
November 1, 2021

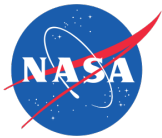
Experiment Name: fog24
Start Time: 14-May-2021 14:33:54.354
Duration: 00:56:35.916
Target: USAF-1951
Target Distance: 17.6276 meters
Target Temperature: 37 C
Environment Notes: None.

File Information:
Visible Spectrum: 30925 Images
Longwave Infrared: 33958 Images
LIDAR: 3243 Data & Images

1 Data Snapshot: fog24

The following images describe the variation in data during the experiment.



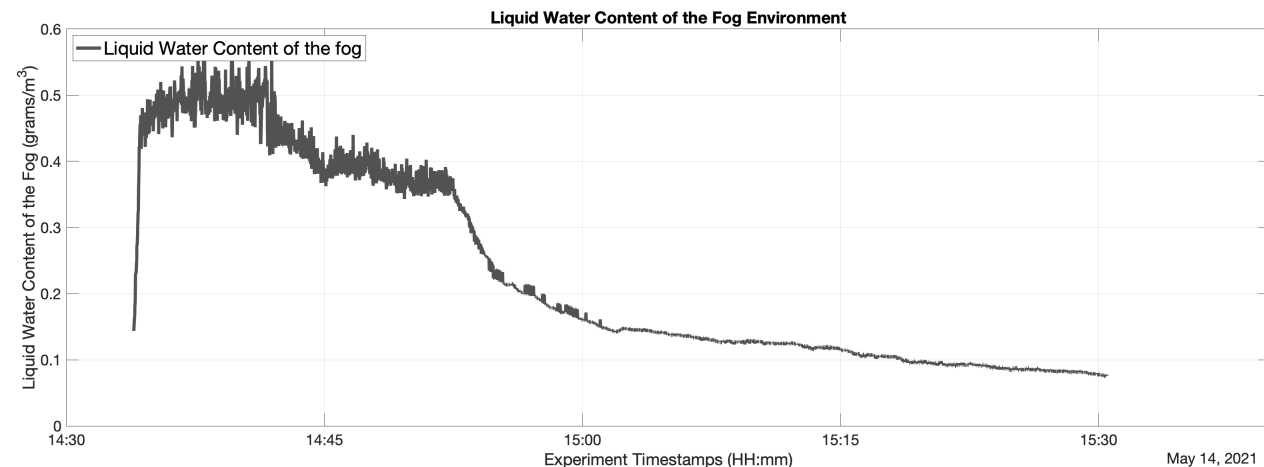
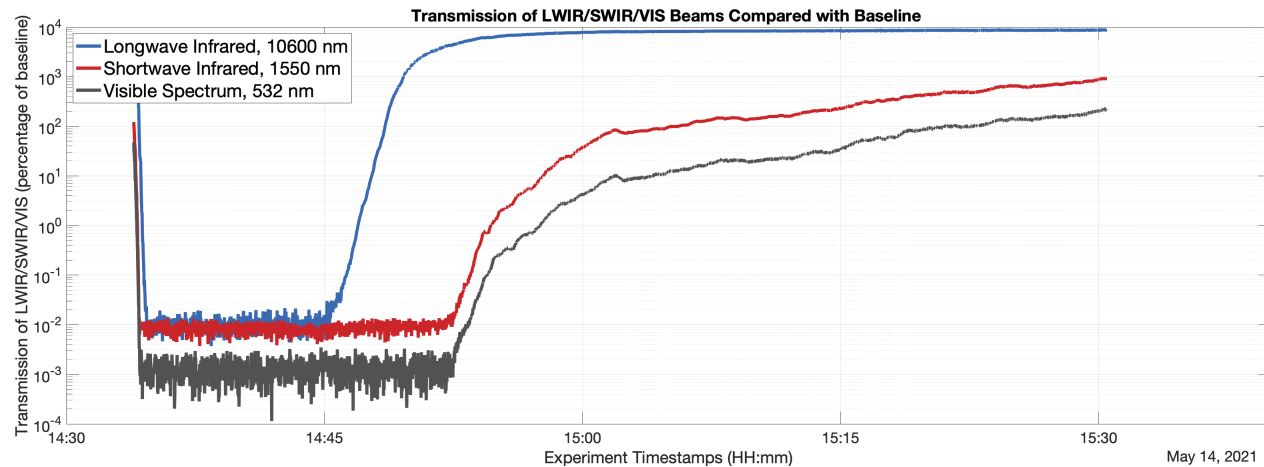
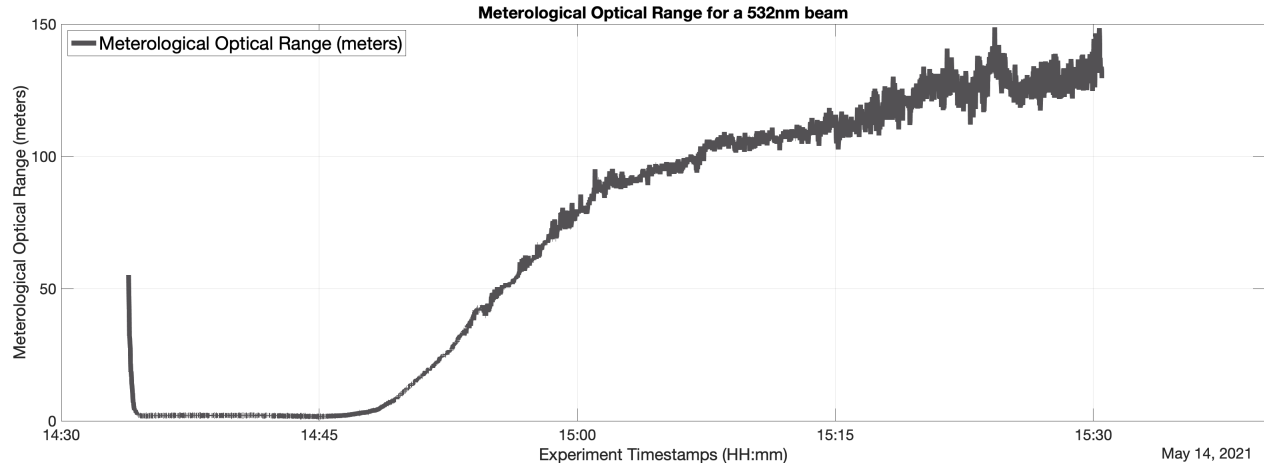


Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: fog24

The following graphs show the variation in the environment during the experiment.





Perception Testbed Fog Chamber Data Documentation

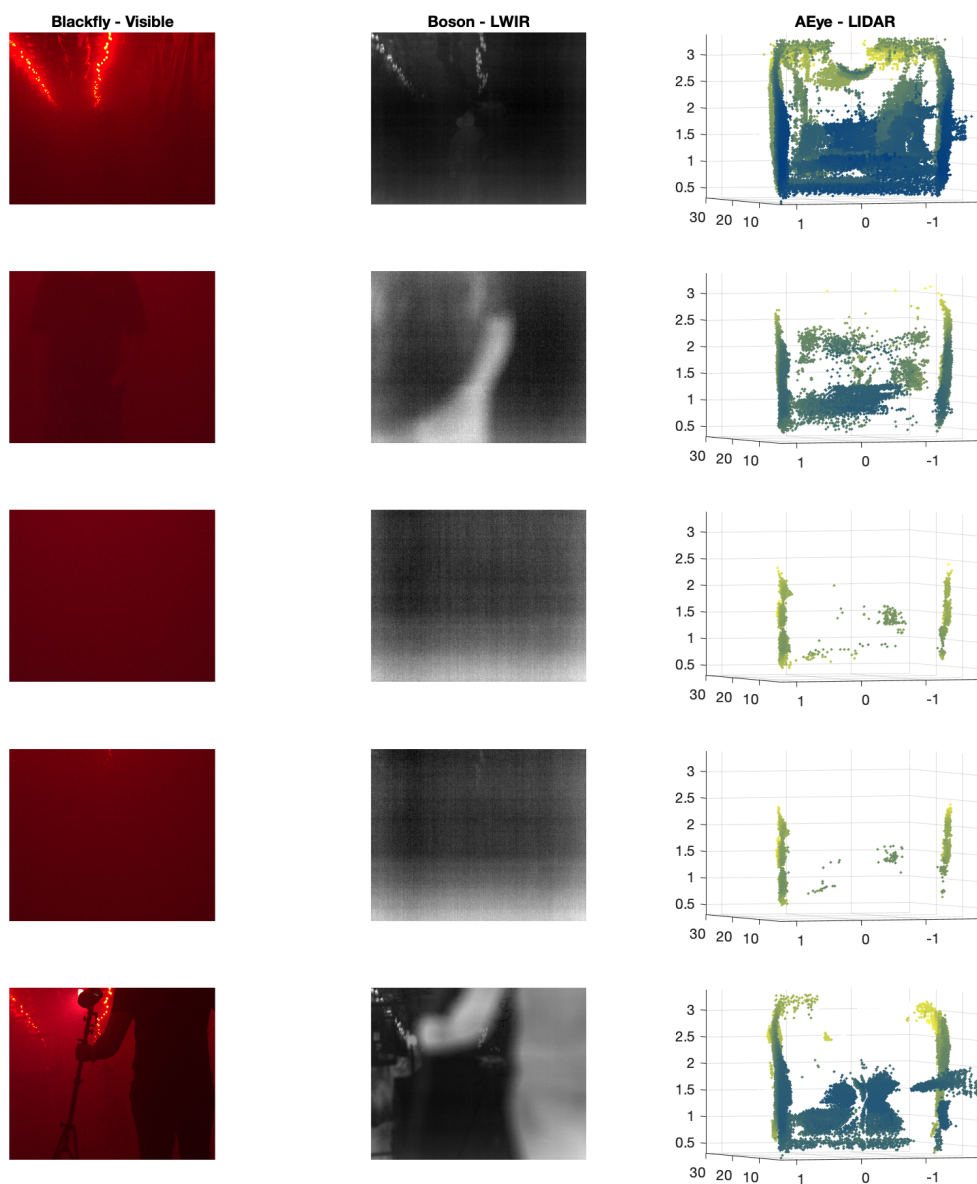
November 1, 2021

Experiment Name: pao02
Start Time: 13-May-2021 15:07:32.073
Duration: 00:09:31.249
Target: USAF-1951
Target Distance: 50 meters
Target Temperature: N/A
Environment Notes: None.

File Information:
Visible Spectrum: 5218 Images
Longwave Infrared: 5712 Images
LIDAR: 742 Data & Images

1 Data Snapshot: pao02

The following images describe the variation in data during the experiment.





Perception Testbed Fog Chamber Data Documentation

November 1, 2021

2 Experiment Environment: pao02

The following graphs show the variation in the environment during the experiment.

