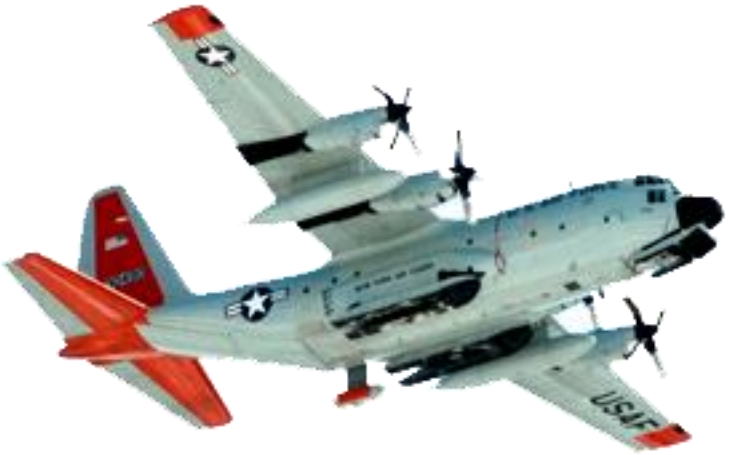


Technical Specification | v1.4

Icepod Technical Specifications

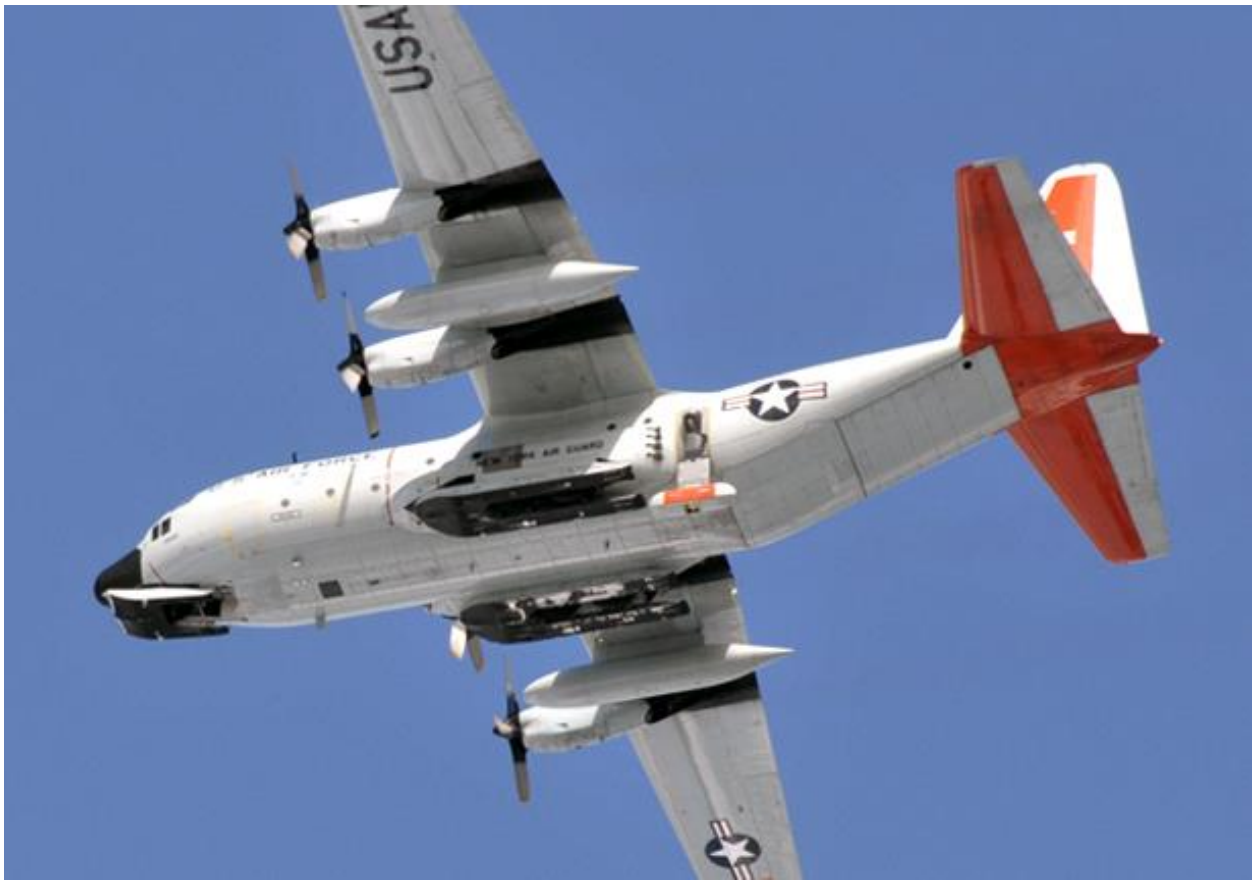
Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

Icepod Specification Document

Table of Contents

Icepod Specification Document

1. Introduction:



Icepod operating on a New York Air National Guard LC-130

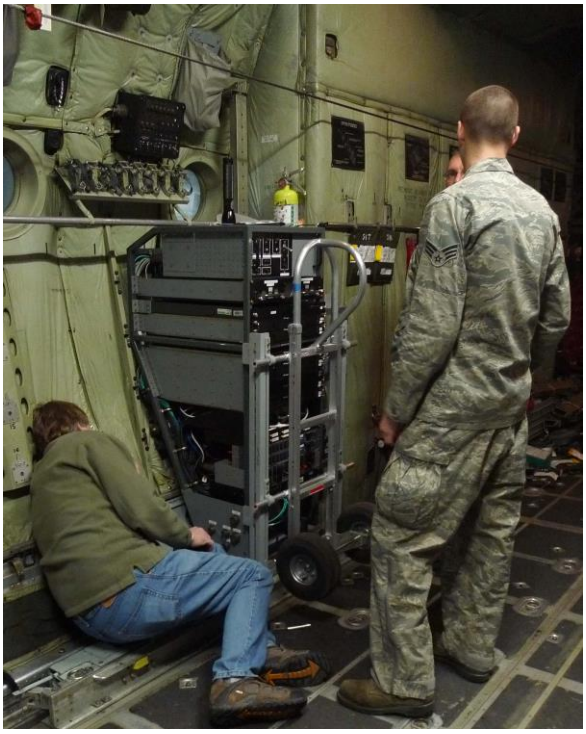
Icepod is a modular data collection and acquisition system designed to carry multiple airborne sensors on a C-130 Hercules Aircraft without special-to-type modifications to the airframe. It can be operated by a single, moderately technical person and can be installed and removed from an aircraft in less than a day. The Icepod system consists of the following main components:

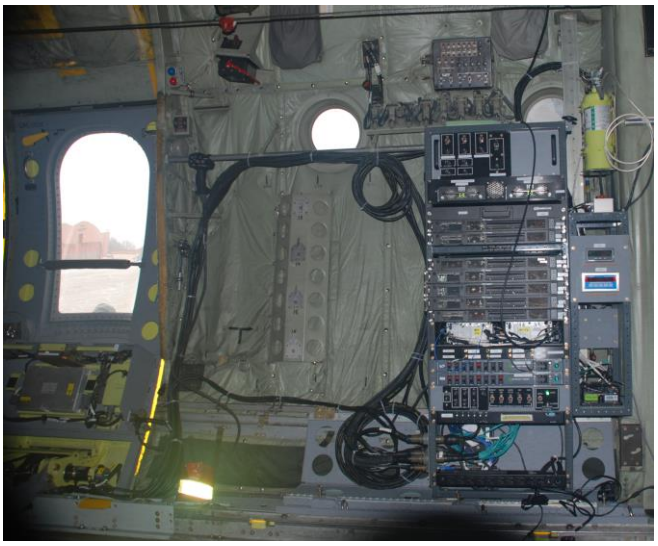
Outside:

1. Door Plug
2. SABIR Arm
3. Sensor Pod and Sensors

Inside:

4. Avionics Rack (Data Acquisition)
5. Power Rack (UPS and power supply conditioning)





Avionics Rack being installed forward of the port side rear troop door

The baseline configuration is set up for high-resolution, fine-scale temporal monitoring of ice-sheets, their margins and adjacent ocean processes. Other configurations may include atmospheric process monitoring, measurement of bathymetry in difficult to access locations, temperate climate processes, canopy definition and 'Search and Rescue' to name but a few.

2. Platform Specification

a. Hercules LC-130.

Cruise Altitude:	20,000ft to 28,000ft MSL
Cruise Speed:	270 knots (true airspeed)
Survey Elevation with Icepod:	Typically 3000 ft AGL +/- 3%
Survey Speed:	Typically 170 knots (indicated ground speed)
Duration:	Up to 10h
Track Reoccupation:	Typically +/- 100m

b. Icepod.

Weight: Door Plug: 120lb

SABIR Arm: 350lb

Unladen weight of the pod= 154lb

Maximum allowed weight of the Icepod including sensors = 425lb [limitation is currently set by certification. Increase in allowable weight to 600lb expected in 2014].

Volume: The Icepod includes:

Three bays with dimensions of 18" x 24" x 24"

Two Nose Cones with dimensions 20" high by 24" diameter

Vibration: Vibration isolation mounts available. Otherwise Mil Standard 810 G [Procedure details on request]

Temperature: Heat Dissipation via Cold-wall

Heating: Localized pad heaters available

Pressure: Unpressurised

Sensor Mounting Points: Sensors are mounted to brackets or vertical plates attached to the 'StrongBack' located in the roof of the pod and/or floor of the pod.

Power: Icepod system power is derived from the Aircraft Missile Support AC Bus and the Iron Lung DC Bus. It is isolated from the aircraft supply via a double conversion UPS with additional EMI Filtering. Hold-up time for the UPS is approximately 5 minutes on full load and is used to tolerate brownouts and power dropouts at ground/aircraft power handover.

From Aircraft Supply:

3 Phase, 115VAC, 400Hz from the Missile Support Bus to the Icepod UPS. Maximum power demand = 2800W. Typical operational power demand = 900W.

115VAC, 400Hz Phase A from the Missile Support Bus to the Icepod SABIR Arm Drive system. Max operating power = 250W.

+28Vdc from the Iron Lung Bus to the Icepod UPS. Max power demand = 1000W. Typical operational power demand = 400W.

+28Vdc from the Iron Lung Bus to the Icepod dc Heater system. Max operating power = 700W.

UPS Output 1: Single Phase 60Hz 115Vac to the Icepod Avionics rack

UPS Output 2: +28Vdc to the Icepod sensors

Icepod Sensor Power Supplies:

+28Vdc, 1KW

+/-15Vdc, 100W

+5Vdc, 50W

Others on request.

3. Sensor Specifications

All sensor specifications, unless otherwise stated, are given for the platform flying at the survey elevation of 3000ft AGL and survey speed of 170 knots (indicated ground-speed).

a. Lidar

Line scanner providing fully linear, unidirectional and parallel scan lines.

Data Products:	Geo-referenced point-cloud incorporating Range, Reflectivity, Amplitude.
Spot Size on the ground:	20 cm (at 3000 ft AGL)
Range accuracy:	25 mm
Point Density:	1.2 pixels/square meter
Swath width:	1154m (at 1000m AGL & 60˚ FOV).
Power Supply:	+18 to 32Vdc, 65W
Weight:	13 kg
Calibration:	Coefficients defined on install into pod prior to shipping

b. Depth Sounding Radar

Pulsed chirp depth sounding radar providing ice depth, sub-surface water distribution, internal structure.

Data Products:	Geo-referenced compressed radar-grams, bed picks.
Power Output:	> 1200 W
Center Frequency:	188 MHz
Bandwidth:	60 MHz

Chirp Length:	1 uS, 10uS
Depth Resolution:	< 2 meters
Along-track Resolution:	0.6 meters (No external stacking)
Maximum Depth Penetration:	> 3.5 km Northern Hemisphere (Cold Ice) >5 km Southern Hemisphere (Cold ice)
Power Supply:	+18 to 32Vdc, 120W
Weight:	100lb
Calibration:	Antenna beam pattern measured in-situ on pod. Transmit power (before antennas) measured at installation into pod prior to shipping.

c. Visible Wave Camera

High-resolution visible wave color camera providing high quality imagery for photogrammetry and feature recognition.

Data Products:	Geo-referenced images
Part Number:	IMPERX Bobcat IGV-B6620C-KFO
Image Size:	6600 pixels by 4400 pixels or 29M Pixels
Lens:	Typically Zeiss Distagon T, f/2, 50mm
Point size on the ground:	20cm
Point Density:	25 pixels/square meter
Swath width:	1.2km
Frame rate:	1 fps
Image Overlap:	90%
Power Supply:	+10 to 15Vdc, 18W max
Weight [body & lens]:	2lb

d. Thermal Infra-Red Camera

High Performance thermal Infra-red, closed cycle Sterling Engine cooled camera providing high quality thermal imagery.

Data Products:	Geo-referenced surface thermal structure with <20mK NEDT and high dynamic range
Part Number:	Sofradir IRE640L
Spectral Band:	7.7 – 9.5um
Dynamic Range:	14-bit
Image Size:	640 pixels by 512 pixels or 0.33M Pixels
Lens:	50mm equivalent Germanium
Point size on the ground:	78cm
Point Density:	1.28 pixels/square meter
Swath width:	400m
Frame rate:	>100 fps
Image Overlap:	60%
Uniformity Correction:	Four on-board selectable tables
Power Supply:	+10 to 15Vdc, 18W max
Weight [body & lens]:	9lb

e. Infrared Radiation Pyrometer

The Pyrometer records sky temperature which is subtracted from the IR Camera data in post-processing to give absolute temperature of thermal imagery.

Data Products:	Timestamped 1Hz measurement of sky temperature
Part Number:	Heitronics KT15-IIP
Temperature Range:	-100C to +200C
Spectral Band:	Narrowband 9.6um to 11.5um
Temperature Resolution:	0.65 C
Image Size:	Single Point
Sample rate:	1 Hz

Response Time:: 1 s

Power Supply: +22 to 30Vdc, 4W max

Weight [body & lens]: 1.1lb

f. GNSS

High resolution platform position and orientation. The GNSS system consists of a Novatel Span SE L1/L2 GPS Receiver and Litton based LN200 IMU mounted within the Pod. The IMU is hard mounted to the LIDAR inside the Optics bay. A Leica GNSS Receiver mounted in the Avionics rack inside the aircraft records data from a GNSS Antenna mounted on the cockpit emergency escape hatch.

Data Products: Aircraft Position < 10cm, Pitch, Roll, Yaw

Part Number: Novatel SPAN SE, Litton LN200

Spectral Band: L1/L2

Sample Rate: 10Hz

Power Supply: +22 to 30Vdc, 20W max

Weight [GNSS & IMU]: 7lb

g. Shallow Ice Sounding Radar

High Frequency FMCW radar that can record near-surface processes, Firn depth, Snow-pack depth, Sea-ice depth.

Data Products: Geo-referenced compressed radargrams.

Power Output: < 1 W

Center Frequency: 2 GHz

Bandwidth: 600 MHz

Chirp Length: 1 ms

Depth Resolution: 0.25 meters

Along-track Resolution: Nominally 4 meters

Maximum Depth Penetration: Approximately 350 meters

Power Supply: +18 to 32Vdc, 50W

Weight: 20 lb

Calibration: Antenna beam pattern measured in-situ on pod. Transmit power measured at installation into pod prior to shipping.

4. Additional/future Sensors

a. Magnetometer

A Cesium-3 Total Field Magnetometer will be deployed and tested with the Icepod during the spring of 2014.

Scintrex CS-3 cesium vapor magnetometer/Billingsley TFM100G2 magnetometer.

Data products Magnetic anomaly (nT)

Precision 0.1 nT

Sample rate 100 Hz

Weight 1.8 kg

b. Gravimeter

A rack-mounted BGM-3 type Gravimeter will be tested with the Icepod system in the fall of 2014.

BGM3/L&R S-80

Data products Free air gravity anomaly (mGal)/Bouguer gravity anomaly (with lidar/radar)

Accuracy ~2 mGal

Along-track resolution 14 km (assuming 170 s filter)

Sample rate 1 Hz

c. CTD Sounders

An AXCTD deployment system integrated into the Icepod Door Plug will be tested in the summer of 2014. One of its uses will be to measure conductivity, temperature and depth profiles close to the calving fronts of marine terminating glaciers.

d. Atmospheric Sensors

A carbon dioxide sensor will be integrated into the nose cone of the pod in the summer of 2014 to test quality of airflow below the aircraft.

5. Data Acquisition System Specification

a. General

The Data Acquisition System consists of rugged, data acquisition computers, one for each sensor and a Master Controller or User Interface computer. The sensor computer OS can be either Linux or Windows allowing for specific manufacturer requirements. Configuration commands and data are passed between sensor computer and sensor via GigEthernet and can be converted to USB or Serial commands locally inside the pod if required. The Master Controller connects to each sensor computer via a network switch passing on User commands and taking, formatting and displaying real-time sensor data. The sensor data is time-stamped during data collection and is stored on removable solid-state hard-drives which can be removed at the end of a flight for archiving and post-processing purposes.

b. Display

The display shows real-time sensor current data file name, file size, instrument status, and processed images where possible converted on-the-fly from the sample data.

c. Special to type software

We can also write data acquisition software for clients, or co-code with clients, or integrate client software.