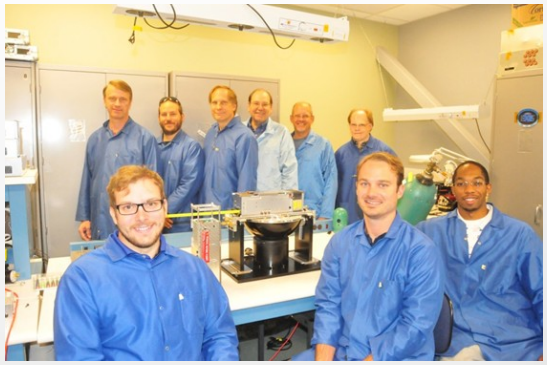
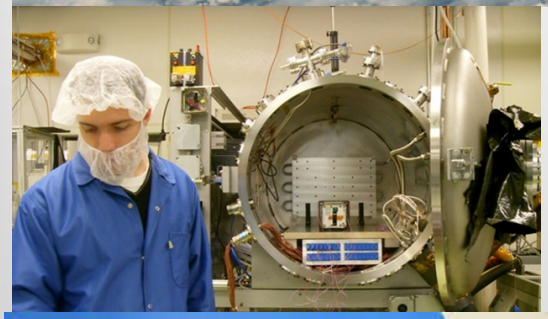
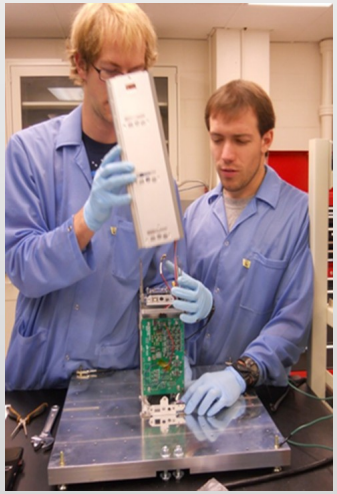
Air Deployed Microbouys (ADMB) and Self-Deployed Surface Sondes (SDSS): Tools for Conducting Polar Research

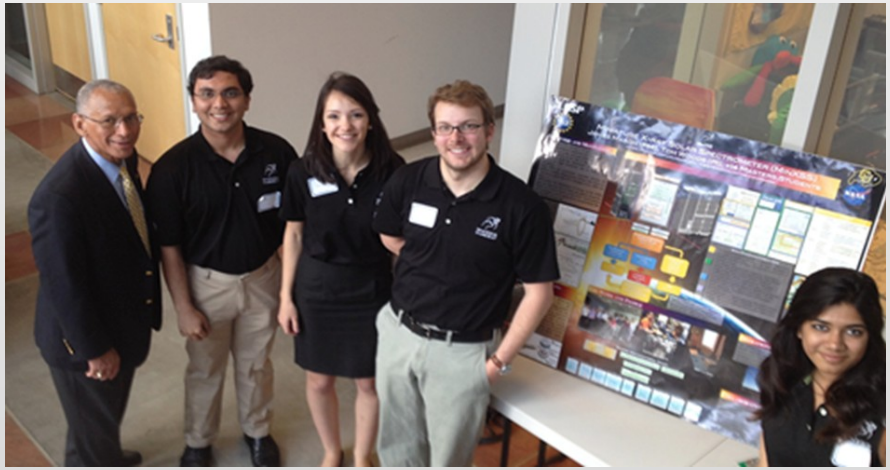
S.E. Palo, D.A. Lawrence, A. Bradley,
G. LoDolce and D. Weibel
Department of Aerospace Engineering Sciences
Research and Engineering Center in Unmanned Vehicles
University of Colorado Boulder

CubeSats as an analogy for polar hardware

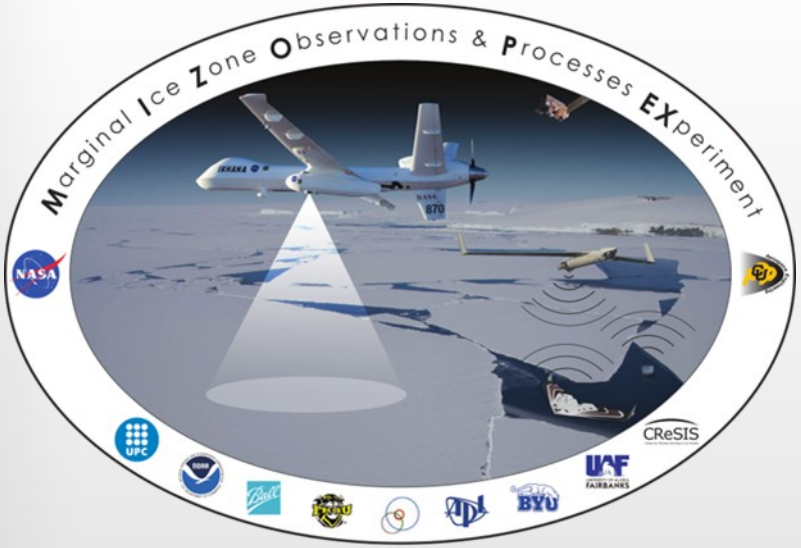


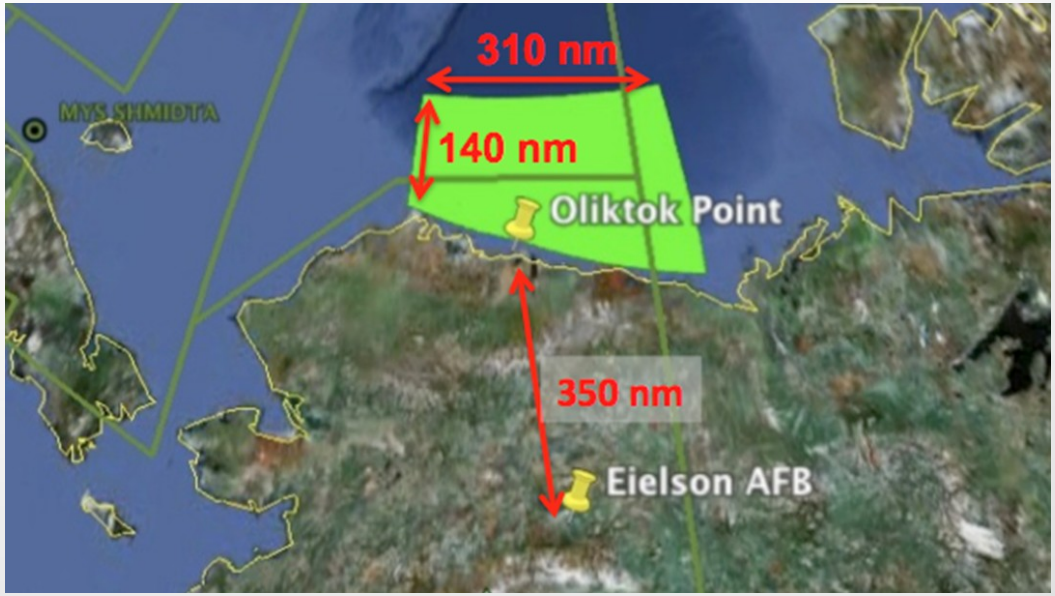






MIZOPEX





- Marginal Ice Zone Observations & Process Experiment
- NASA supported deployment summer 2013
- Based from Oliktok point Alaska

UAS Highlights at CU

RECUV created, 2003

SensorFlock, 2004
Datahawk

CoCoNUE, 2009
NexSTAR

NSF-KHI, 2011
Jicarmarca, Peru
Datahawk

MIZOPEX 2013
Datahawk

METMAP, 2014
4 UAS at once

NREL NWTC, 2014
Datahawk and Skywalke

CUAS formed, 2012

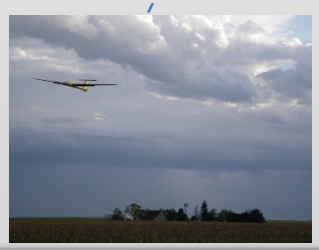
2000 2005 2010 2015

CAMEX-4, 2001
Aerosonde

AUGNet, 2004
Ares

NOAA UAV
Demo Project,
2005
Altair

Antarctica, 2012
SUMO



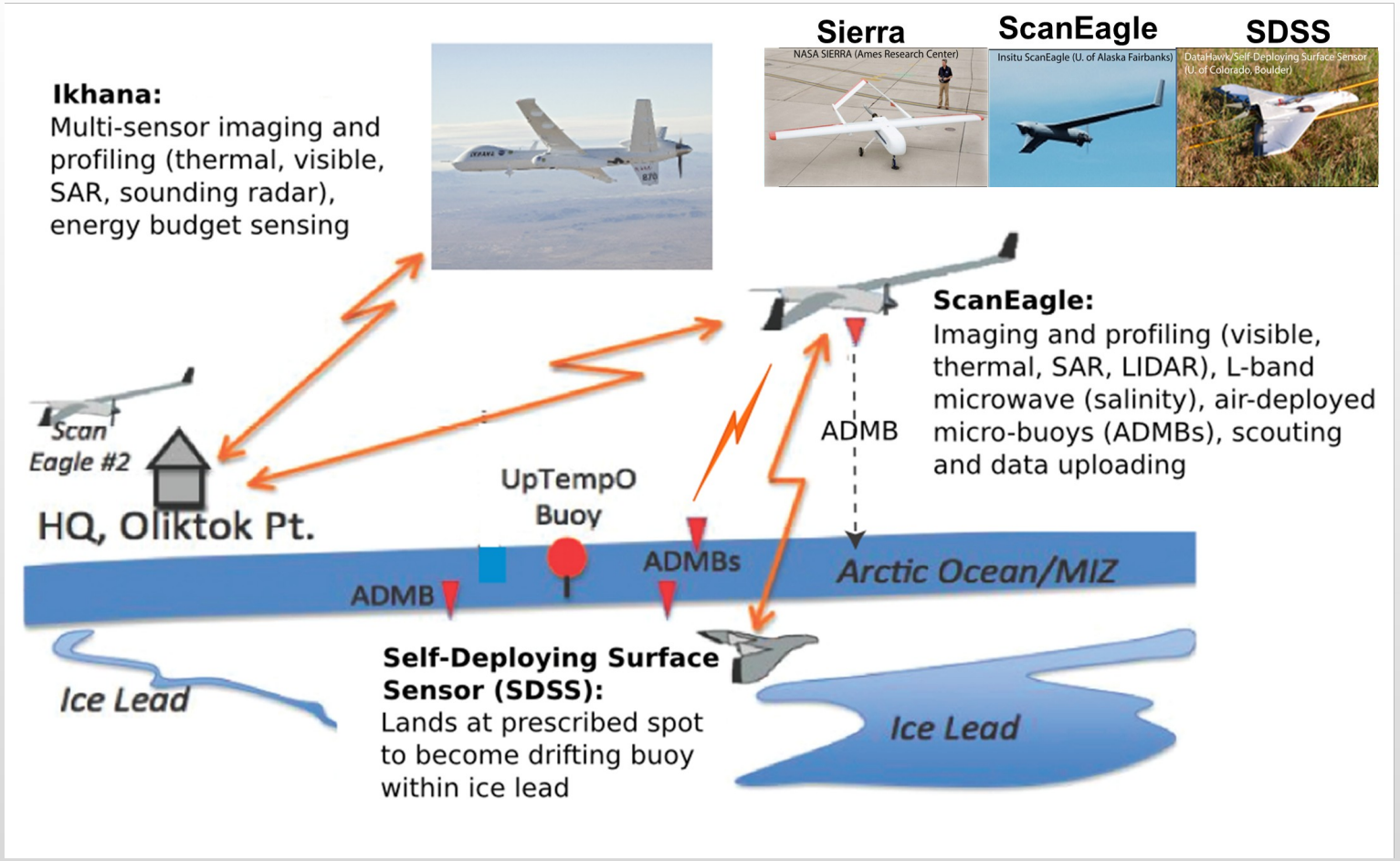
VORTEX2, 2010
Tempest

COA for
multiple
aircraft, 2013
Skywalker and

ERASMUS, 2015
Datahawk 2.0

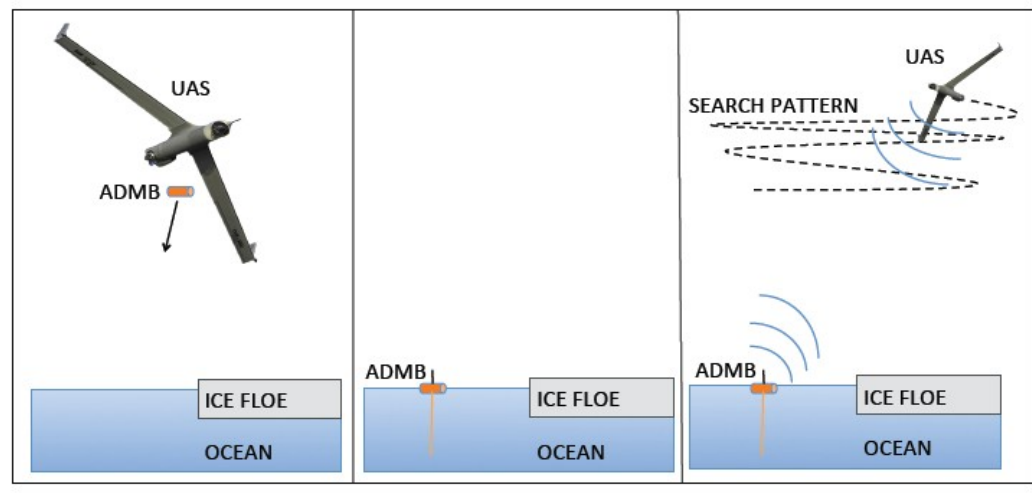
Marginal Ice Zone (MIZ)

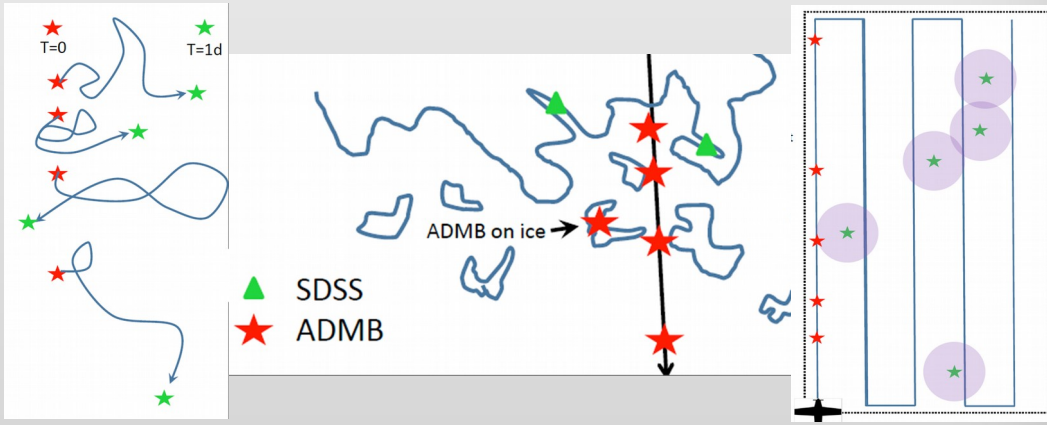
MIZOPEX CONOPS



Scan Eagle CONOPS

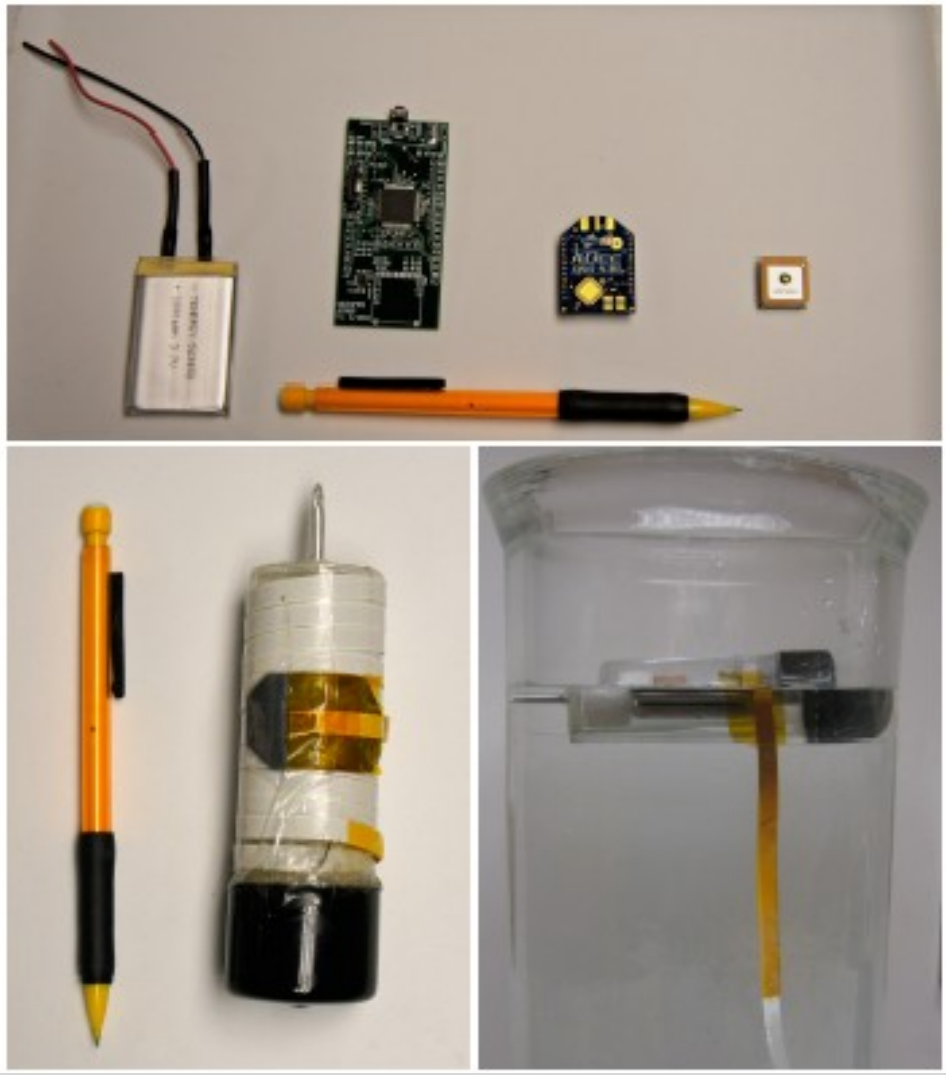
- Load deployer with 4 ADMB
- Drop ADMB at specified GPS location
- Loiter and collect initial data during startup
- Return after 48 hours to retrieve data





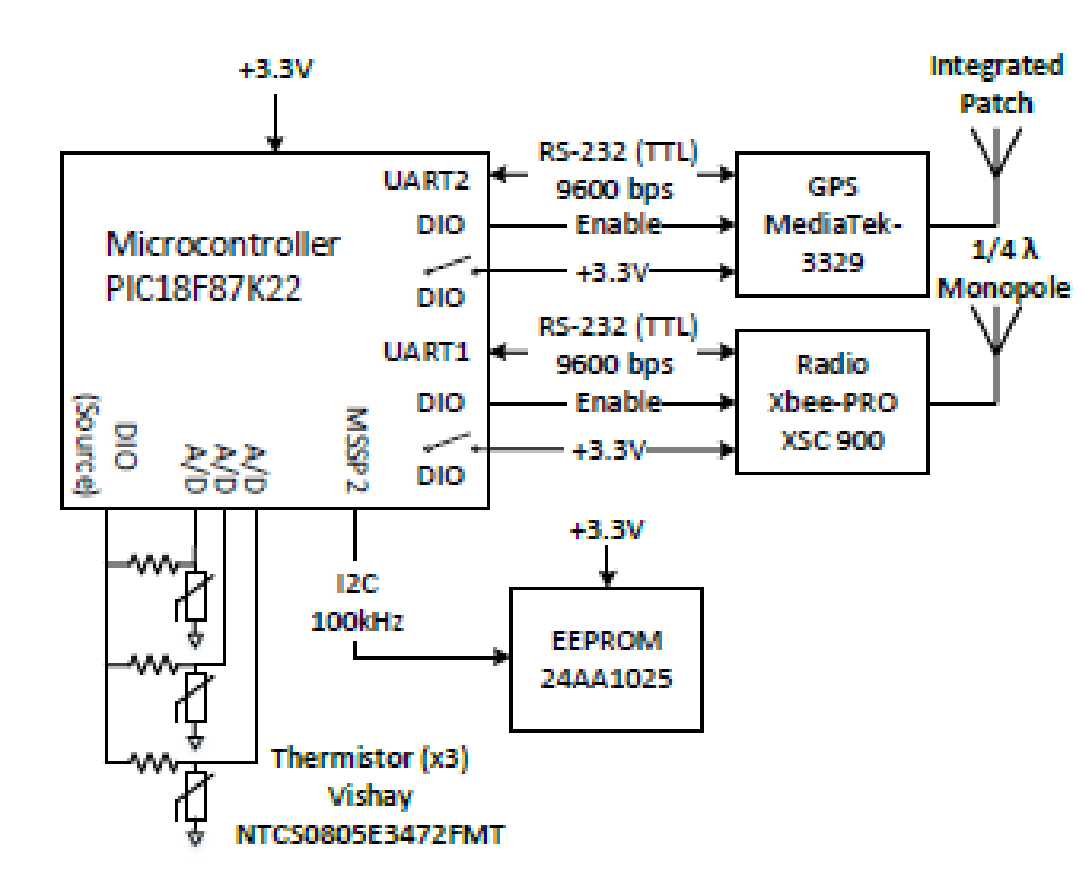
ADMB

- TOP
  - Li-poly battery
  - ADMB board
  - Xbee radio
  - GPS
- Bottom left
  - Integrated ADMB
- Bottom right
  - Deployed ADMB



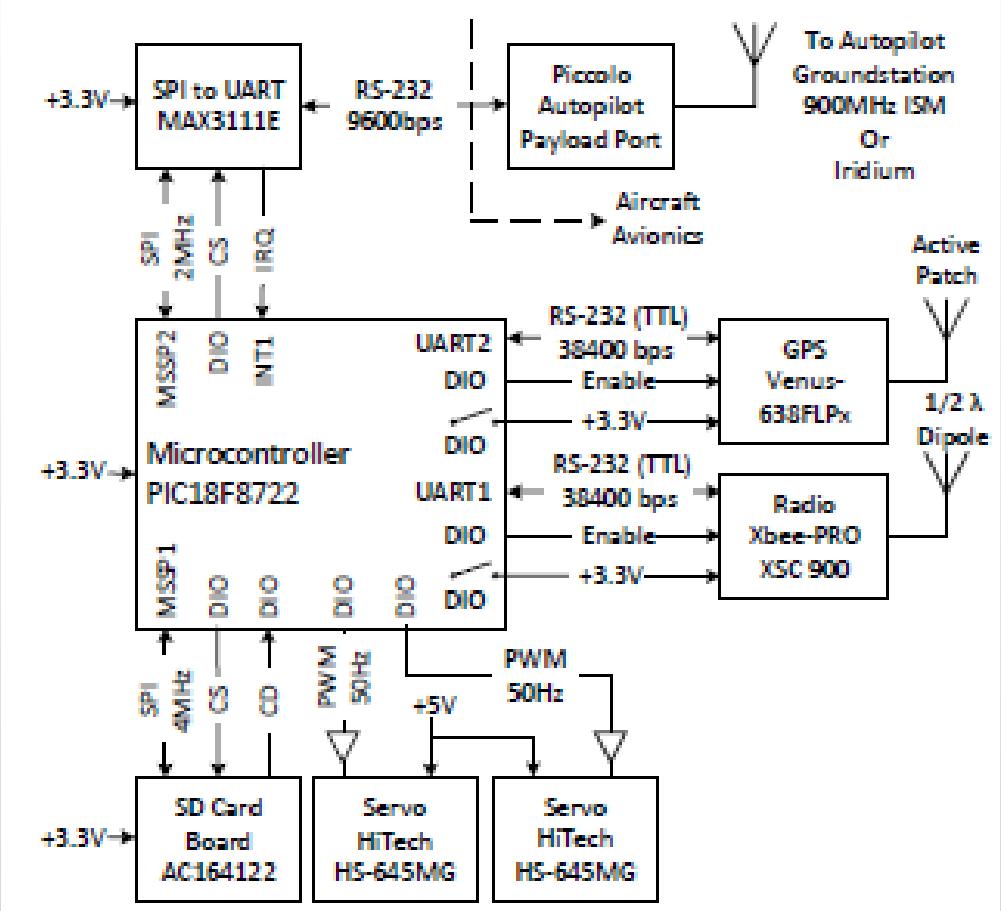
ADMB Block Diagram

- 8 bit low power microcontroller, PIC 18F87K22
- Integrated MediaTek GPS
- Xbee-PRO 915MHz radio
- EEPROM
- NTC Thermistor

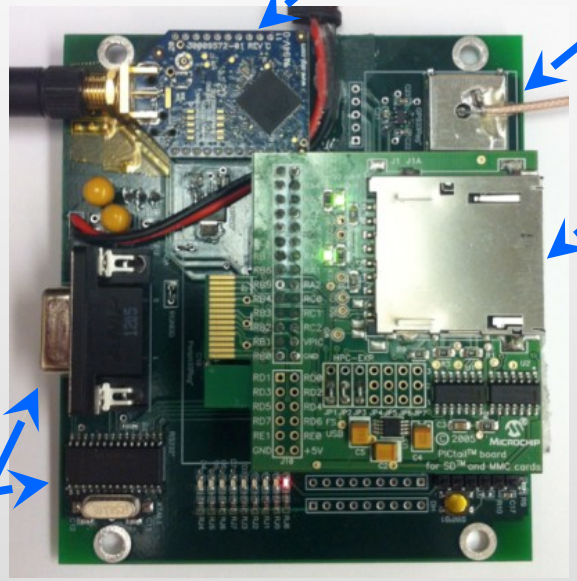


Receiver Block Diagram

- 8 bit low power microcontroller, PIC 18F87K22
- Integrated Venus GPS
- Xbee-PRO 915MHz radio
- SD Card
- PWM servo control
- Autopilot interface

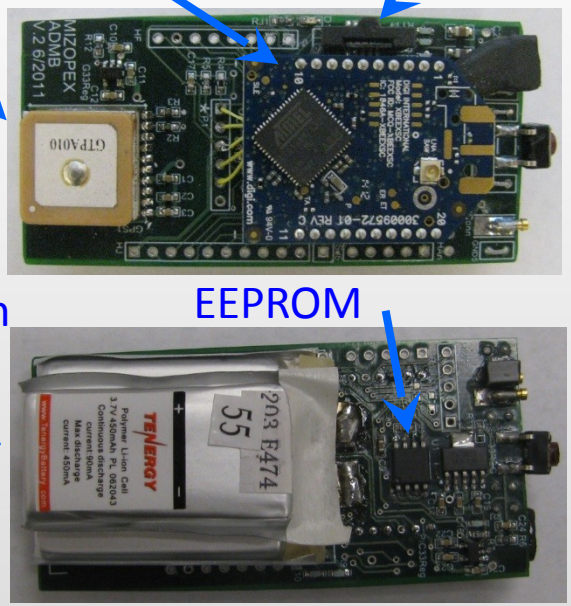


ADMB Electronics



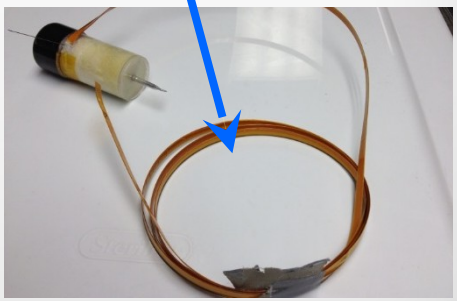
Not shown: PIC18 µC and servos

Receiver



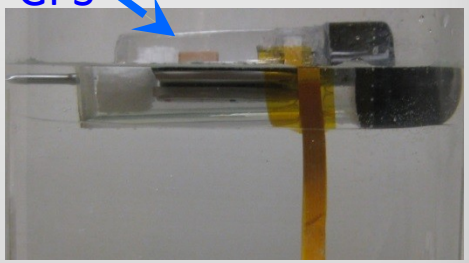
Not shown: PIC18 µC

Buoy

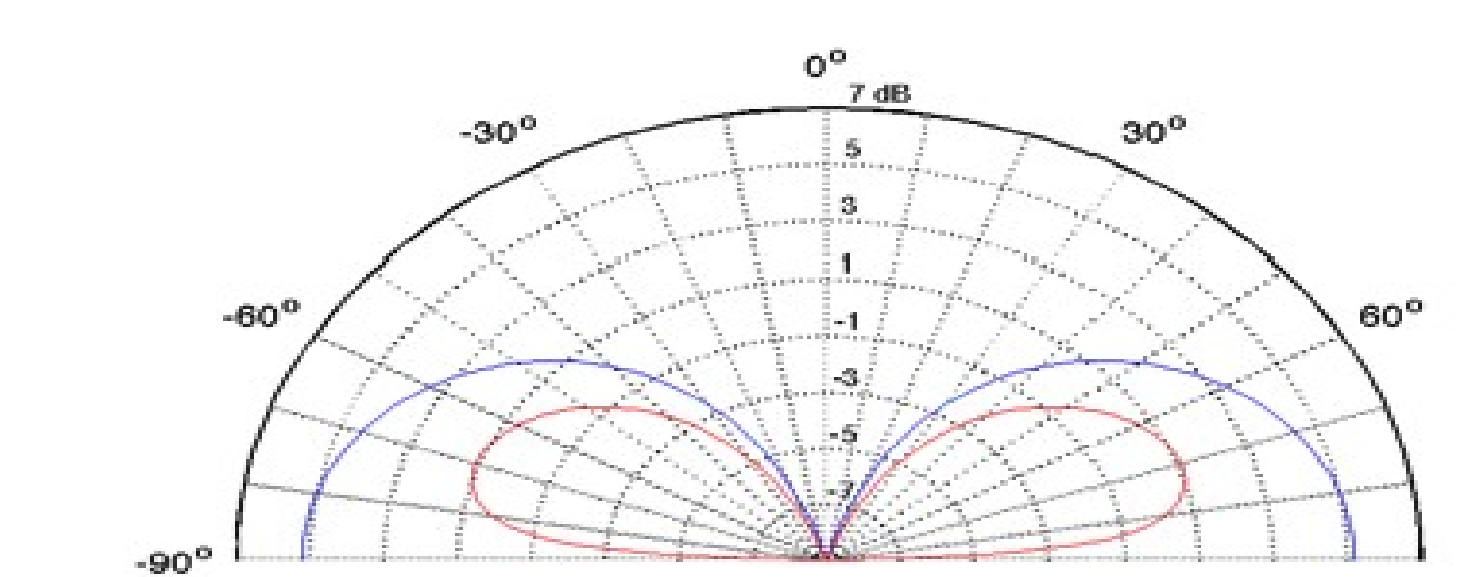


Dimensions: 11x3.5 cm

Mass: 80 g

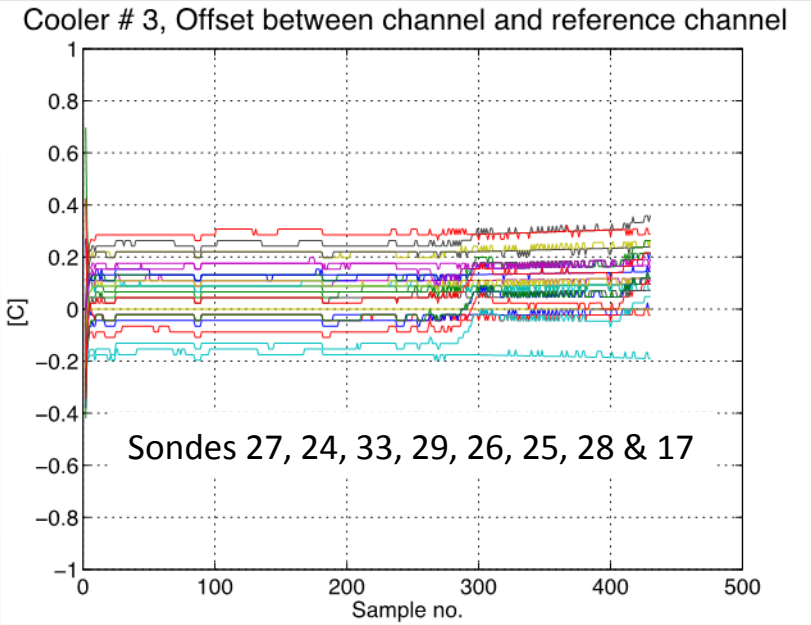


Monopole Antenna Pattern

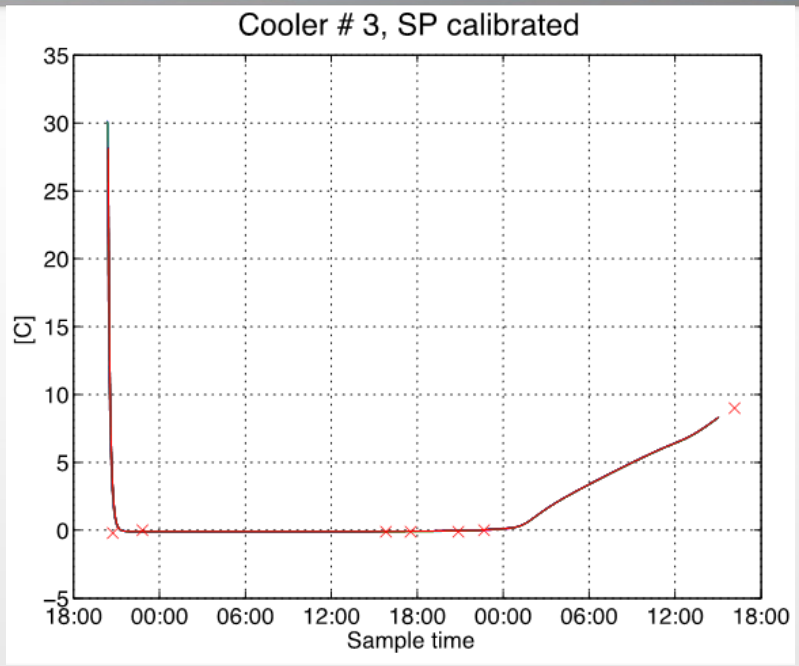


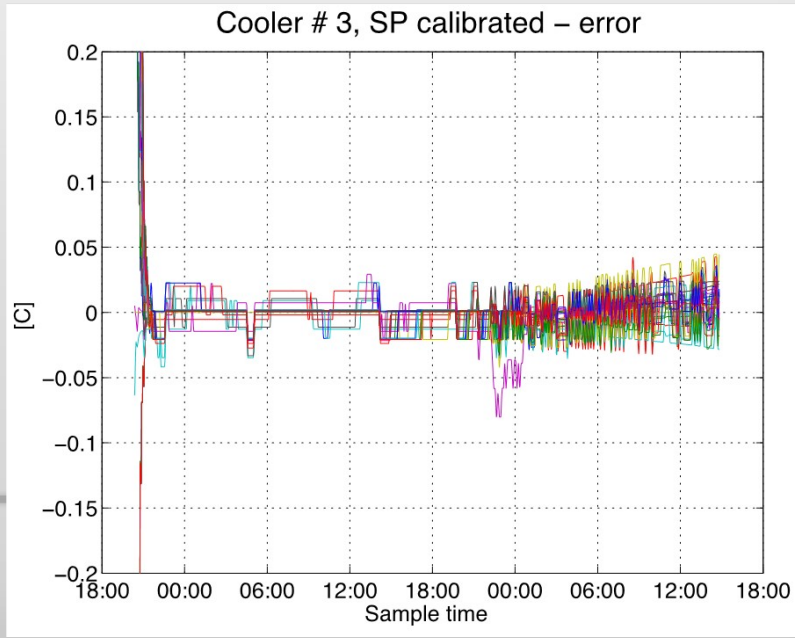
- Infinite perfect ground plane – blue
- Salt water ground plane - red

ADMB Calibration

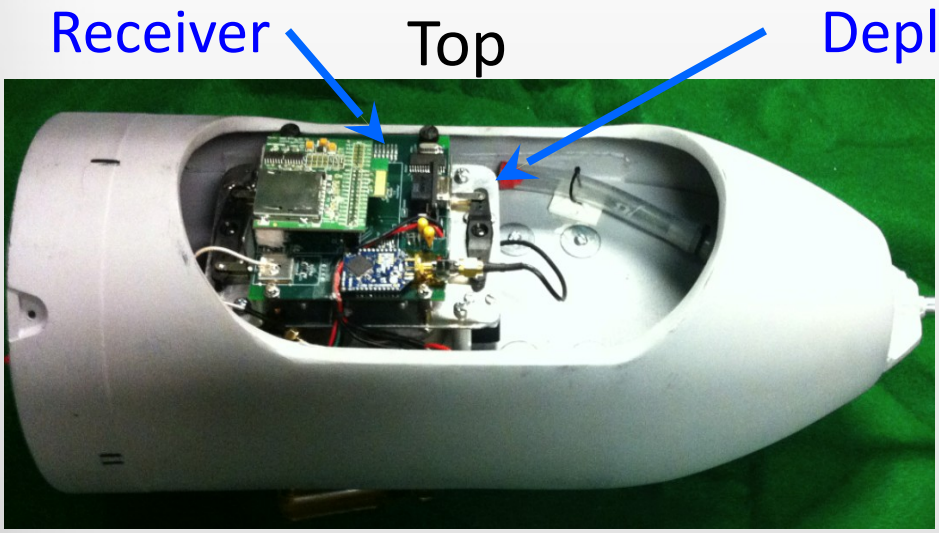


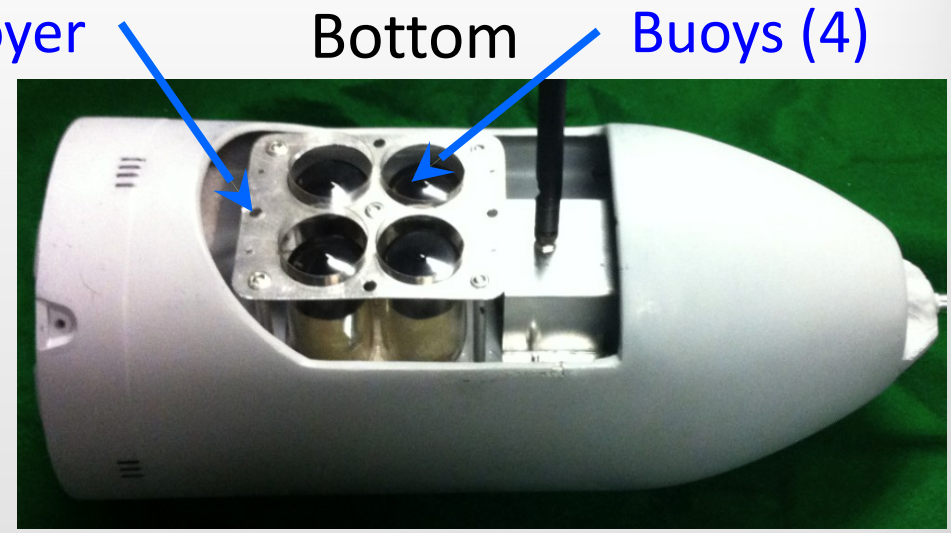
Single point calibration was conducted in ice filled cooler over 2 days with reference sensor





Integrated Scan Eagle Payload Bay



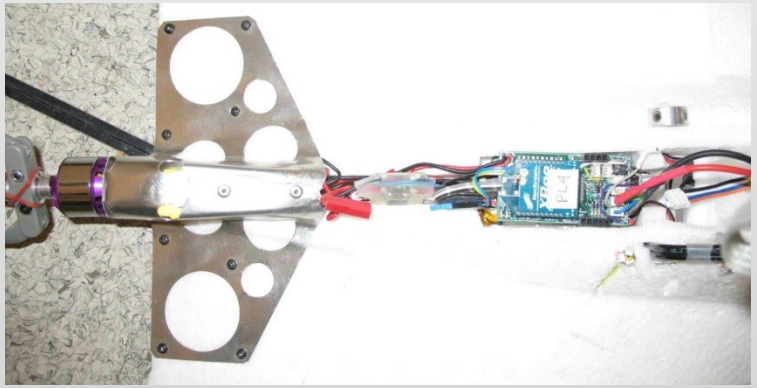


Receiver and Deployer in a ScanEagle Payload Bay

Scan Eagle Preparations

DataHawk

- Low cost UAV
- 700g mass
- 100g payload
- Autopilot
- One way range of 40km
- 10m RMS targeting circle
- Can be vectored inflight

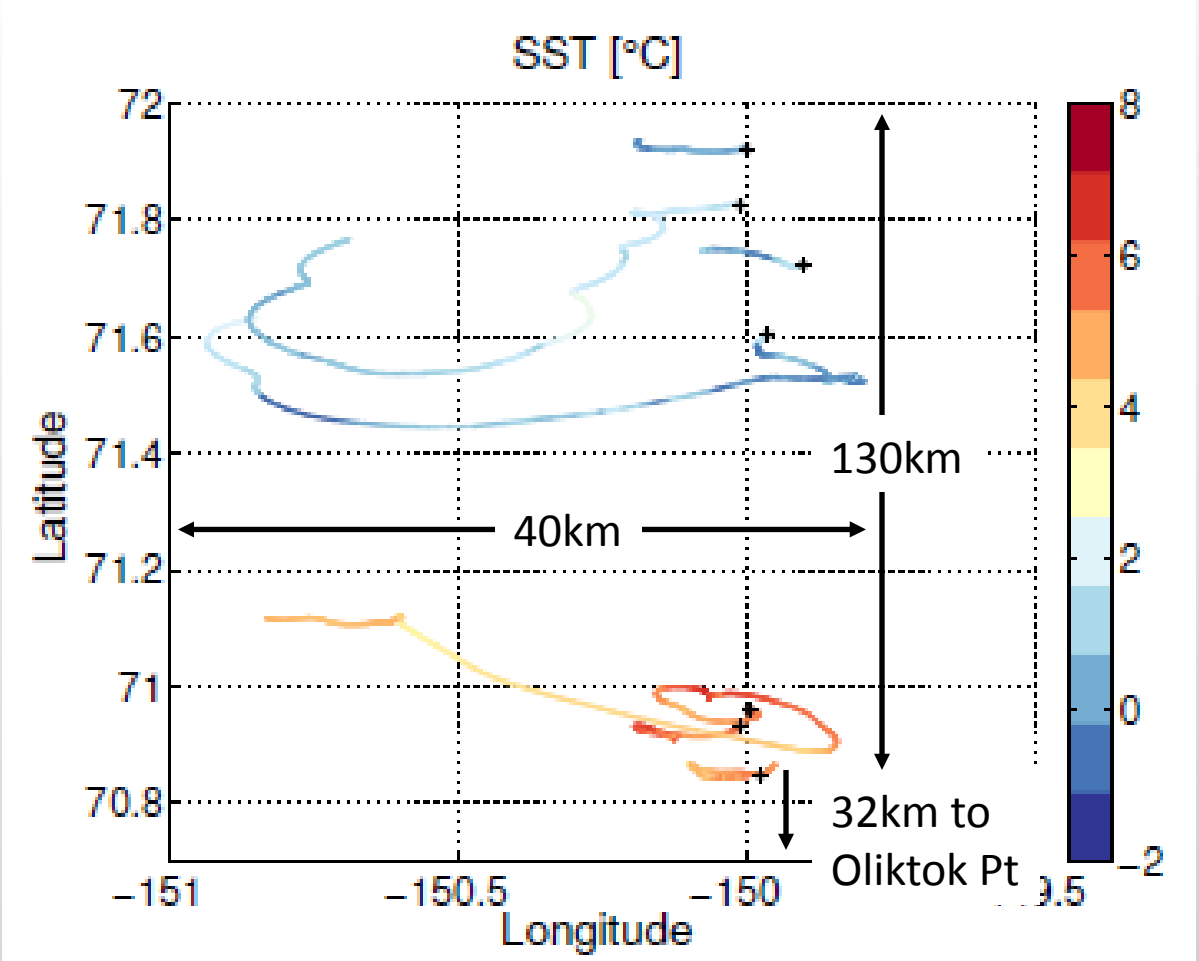


Data Hawk Flying

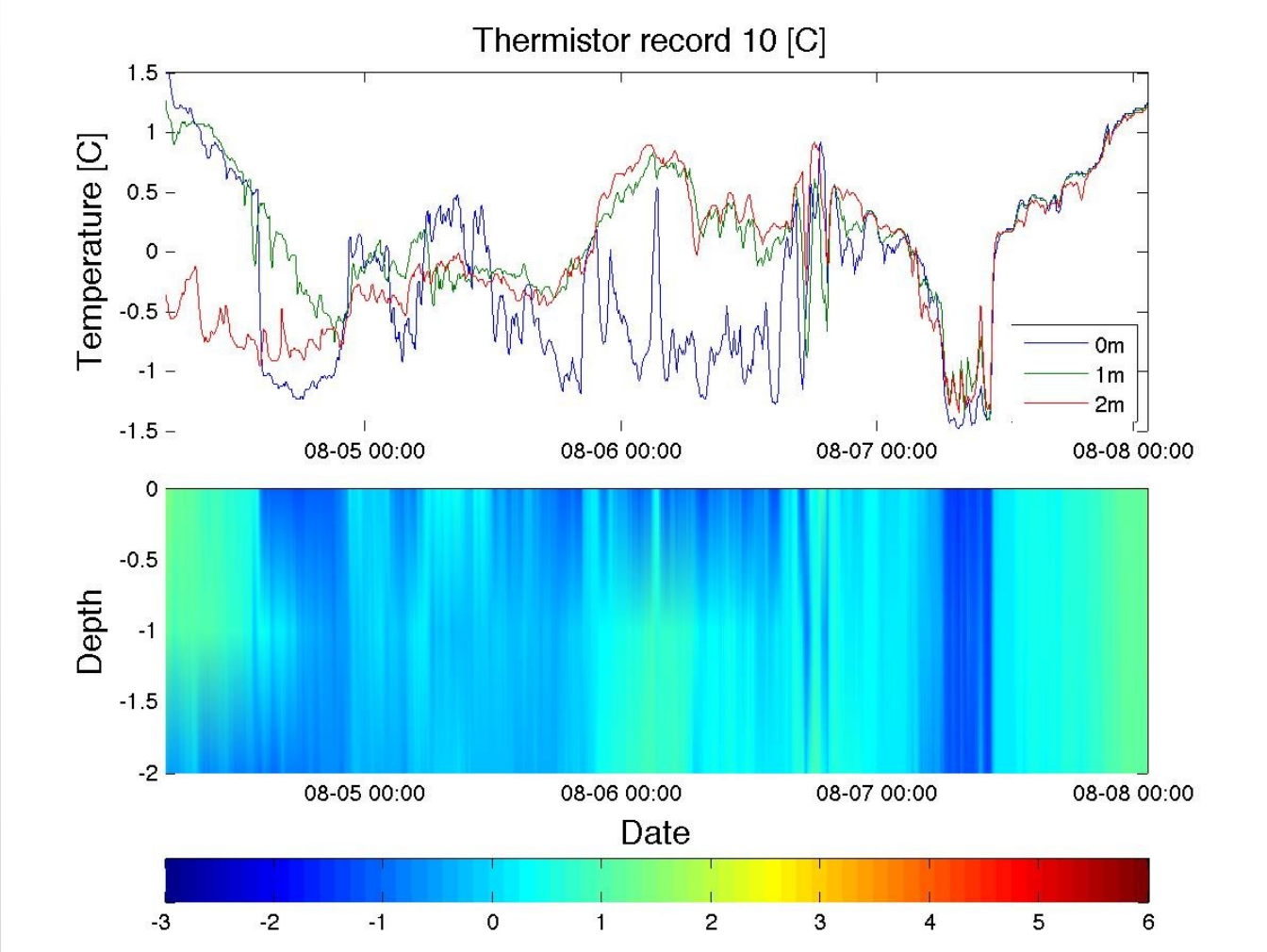
ADMB Deployment

ADMD surface temp and position

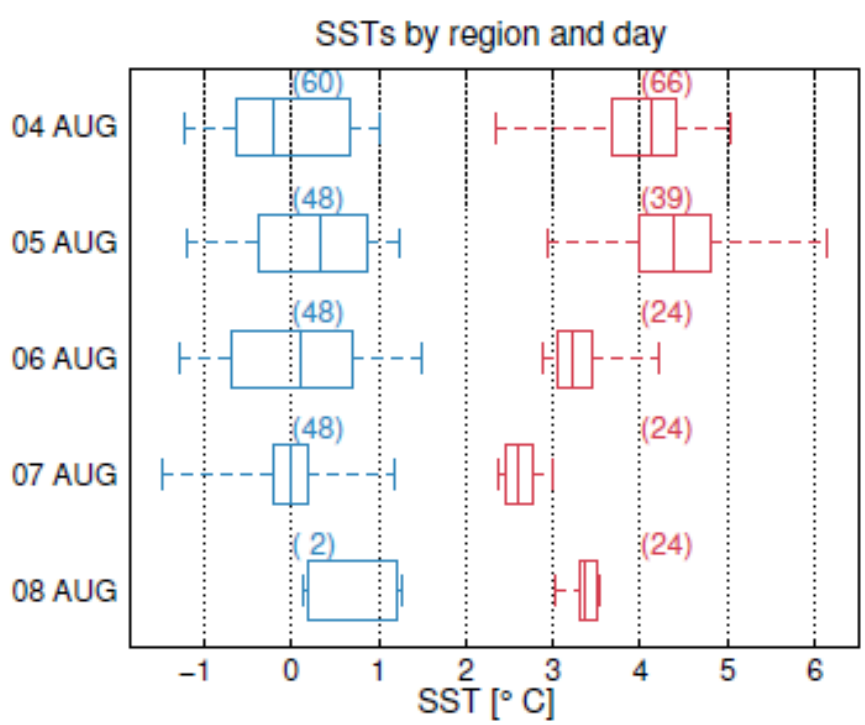
- 7 sondes deployed
- Two Scan Eagle Sorties
- South deployment in open water
- North deployment in the MIZ

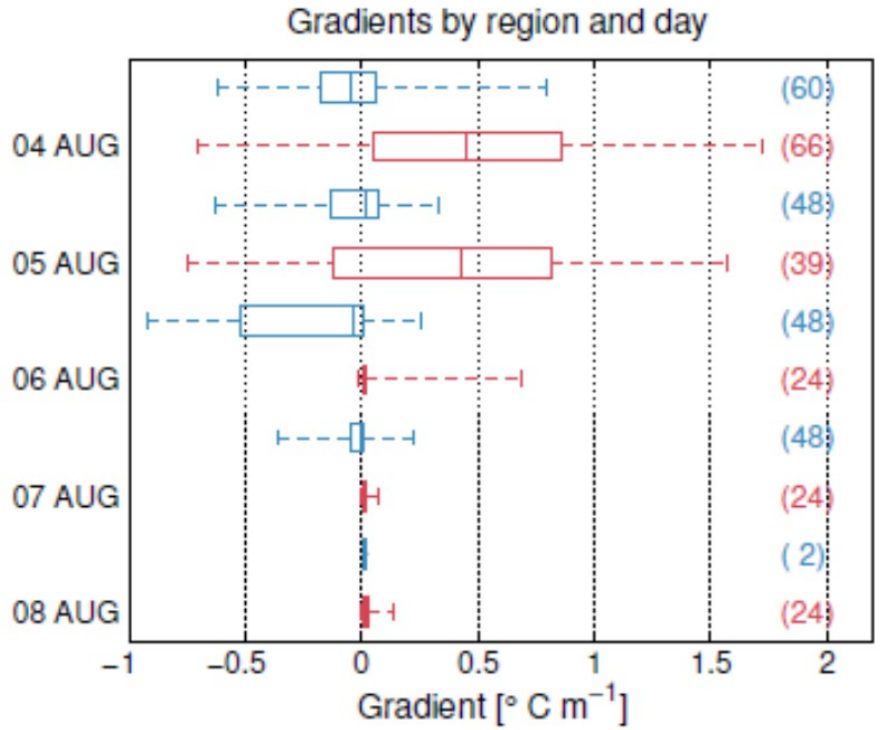


ADMB Results



Science analysis

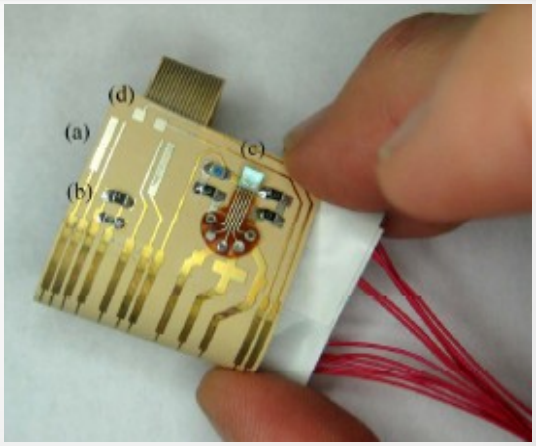




- Blue results are from northern buoys and red results are from southern buoys

Future Directions

- Expanding ADMB capabilities
  - Iridium SBD modem
  - Accelerometers to measure wave action
  - Conductivity sensor to measure salinity
- Modified Deployer
  - Scalable canister to hold more sondes
- Proposed Terra Nova Bay Polynya campaign
  - Integrate into Aerosonde UAV
  - Increased temperature resolution 0.01 to .005 RMS



Miniature CTD from Broadbent et al., 2010

Summary

- Low cost, campaign duration, UAV deployable sondes have been developed, tested and are available.
- ADMB paper in press

  Bradley, A., S. Palo, G. LoDolce, D. Weibel, and D. Lawrence, 2015: Air Deployed Micro Buoy measurement of temperatures in the marginal ice zone upper ocean during the MIZOPEX campaign. J. Atmos. Oceanic Technol. doi:10.1175/JTECHD- 14-00209.1, in press.