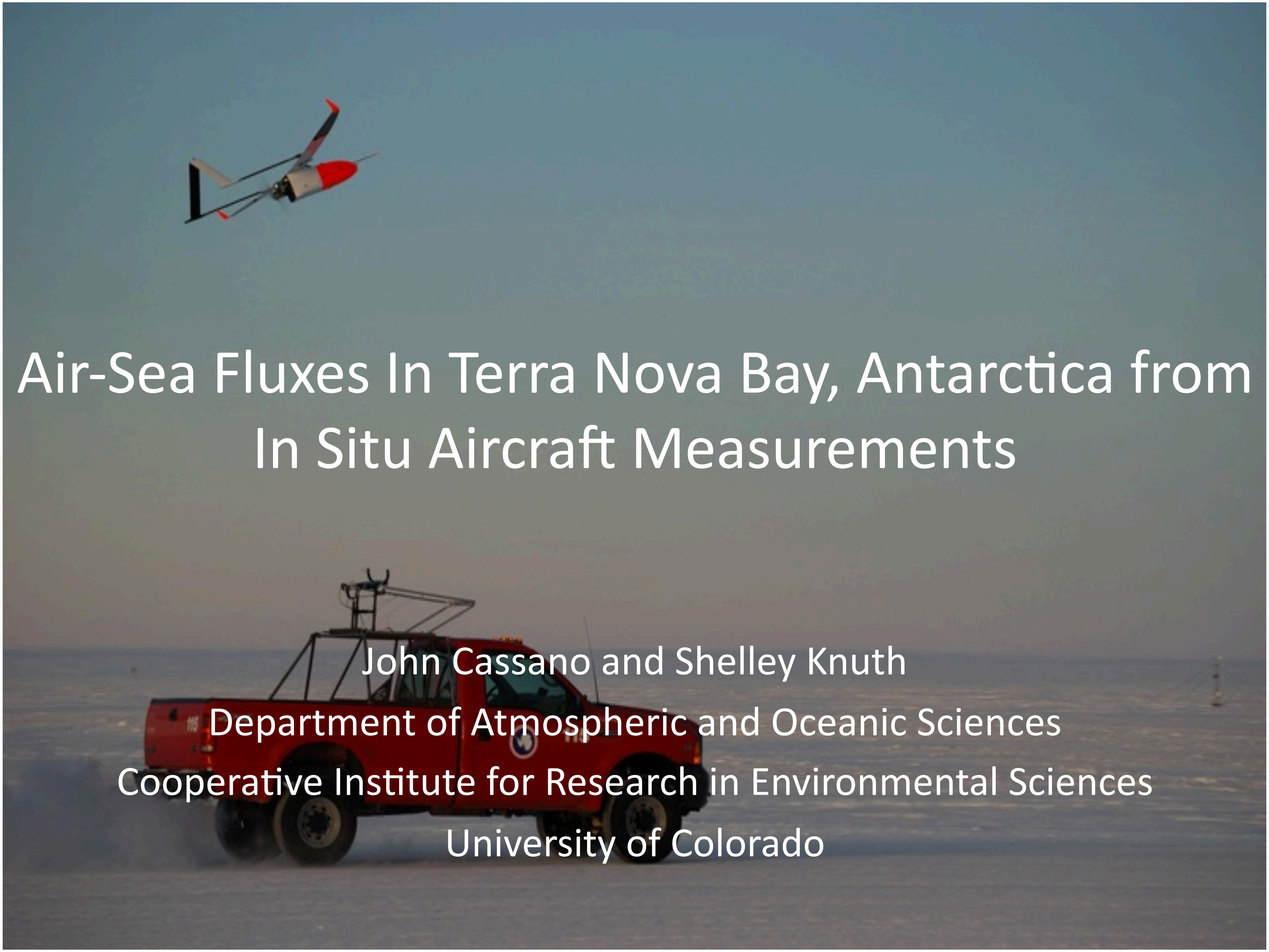

Air-Sea Fluxes In Terra Nova Bay, Antarctica from In Situ Aircraft Measurements

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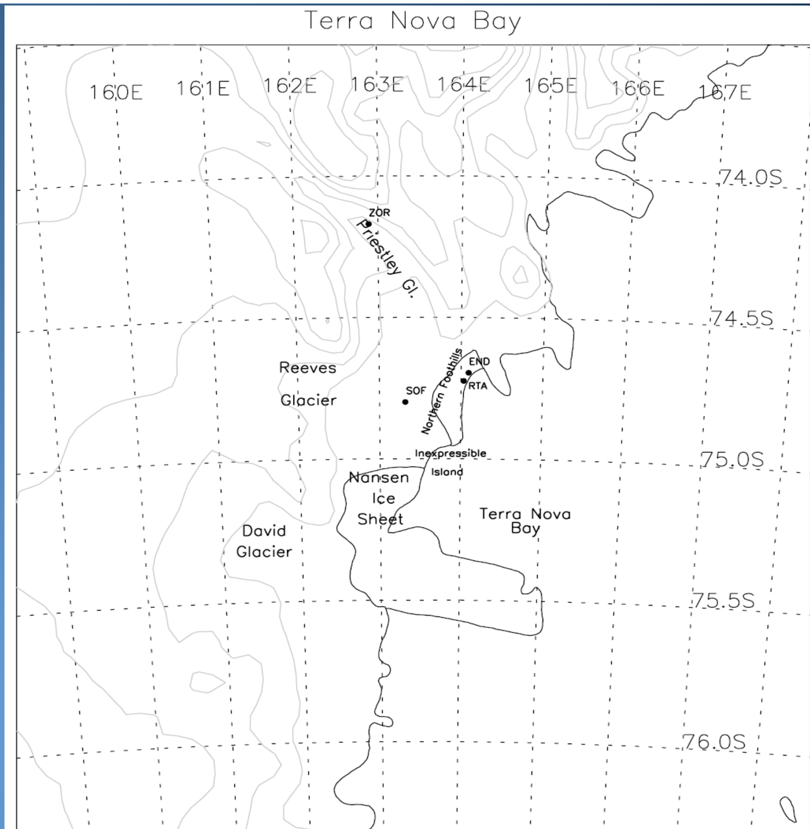
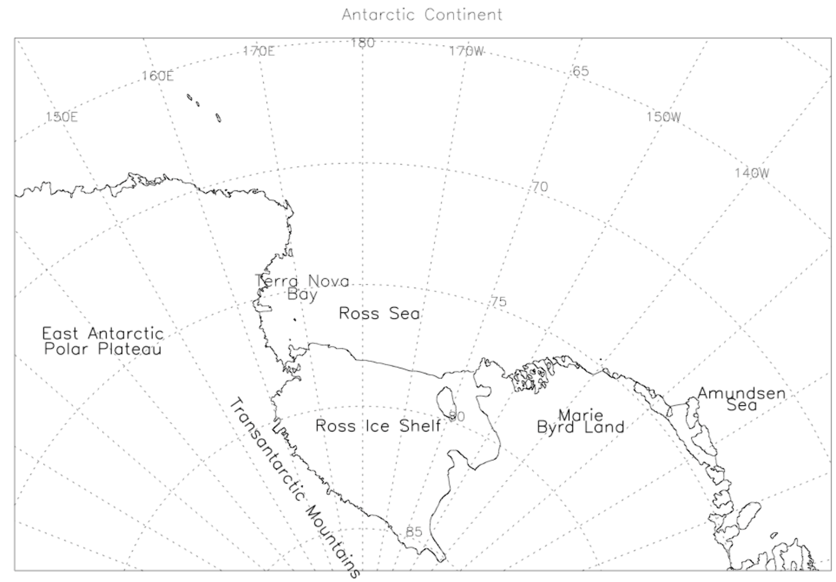
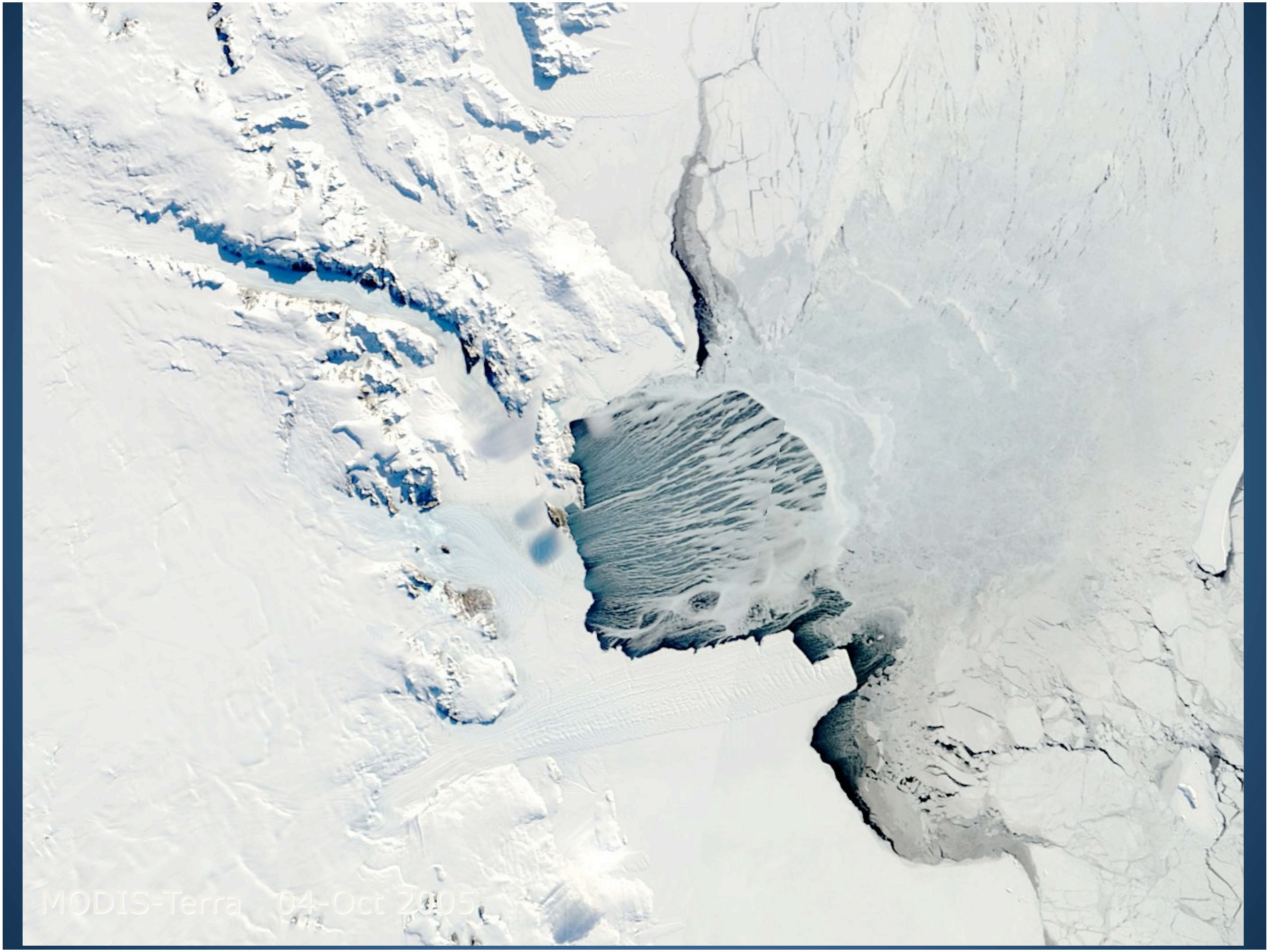
Department of Atmospheric and Oceanic Sciences
Cooperative Institute for Research in Environmental Sciences
University of Colorado

Project Overview

- Use Aerosonde UAVs to make meteorological measurements in the vicinity of Terra Nova Bay
- Why Terra Nova Bay?
  - Location of recurring polynya
  - Region of strong katabatic winds
  - Source region for Antarctic bottom water
- Prior to this project there were no in-situ atmospheric measurements of the wintertime atmosphere over the Terra Nova Bay polynya





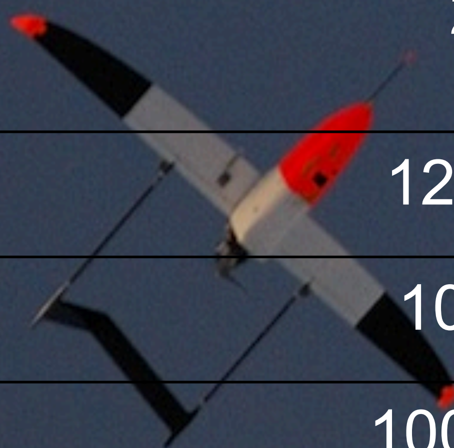

MODIS-Terra 04-Oct 2005

Science Questions

- How do changes in the atmospheric state alter the amount of heat and moisture removed from the ocean in the polynya?
  - What impact does this have on the development of Antarctic bottom water?
- How does the presence of the polynya modify the katabatic airstream as it passes over the polynya?

Aerosonde UAV

Wingspan	3 meters
Weight	15 kg
Payload Capacity	2-5 kg
Endurance	12-17+ hrs
Range	1000+ km
Altitude	100-6000 m



Communications via 900 MHz radio and Iridium

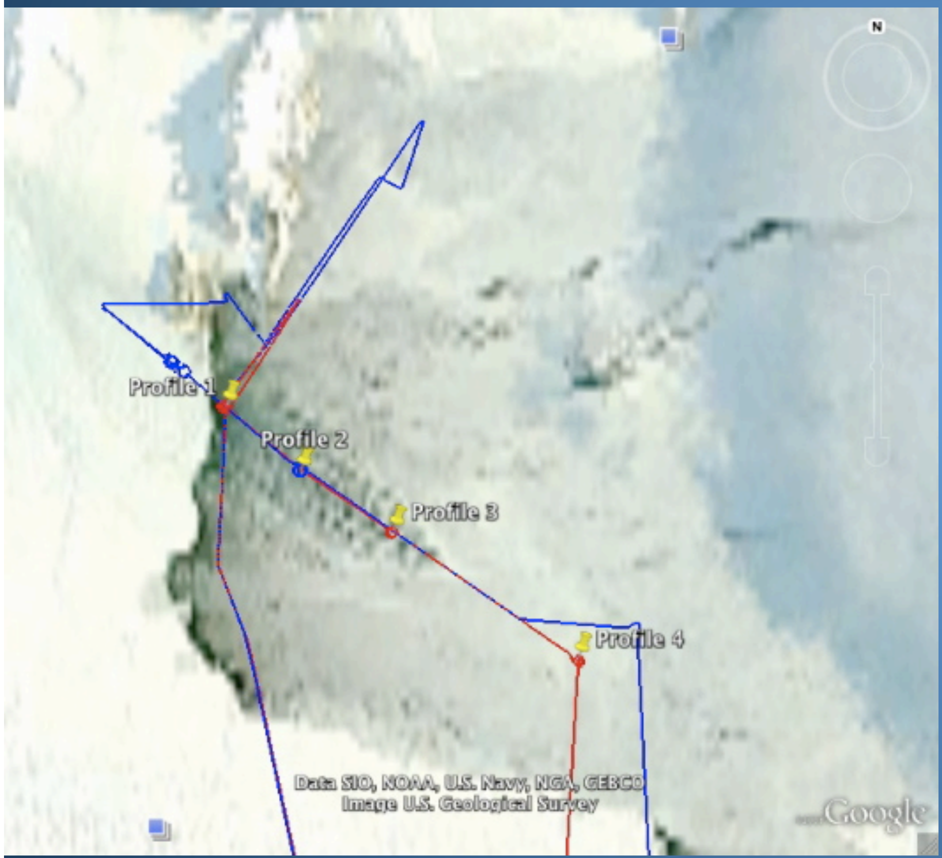
Flies in fully autonomous mode with user-controlled capability

Aerosonde Measurements

Wind Speed/Direction	Pitot with GPS
RH/Temp/Pressure	Standard Radiosonde Met Sensors
Ocean /Ice Skin Temperature	Infrared Thermometer
Ocean/Ice Visible Imagery	Still Digital Camera
Net Shortwave Radiation	Pyranometer
Net Longwave Radiation	Pyrgeometer
RH/T/P/wind profiles	Dropsondes
Altitude and Surface Waves	Laser Altimeter


7-27 Sept 2009
• 16 flights
– 8 science flights to TNB
• 11000 km (7000 miles)
• 130 flight hours
TL00115
115

Surface Fluxes From UAV Observations

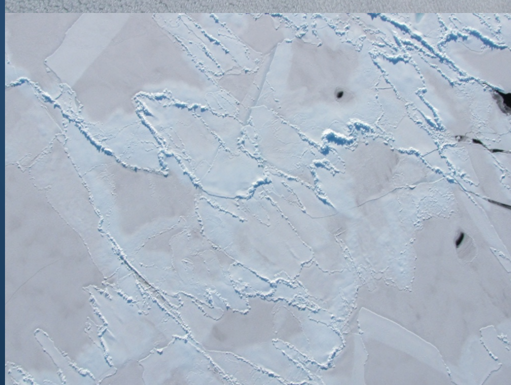


- 24 September 2009
- Determine modification of katabatic air stream as it passes over polynya
- Estimate heat, moisture, and momentum fluxes based on changes in downstream profiles
- Neglect changes below 100 m flight level
- Assume changes due to surface fluxes only

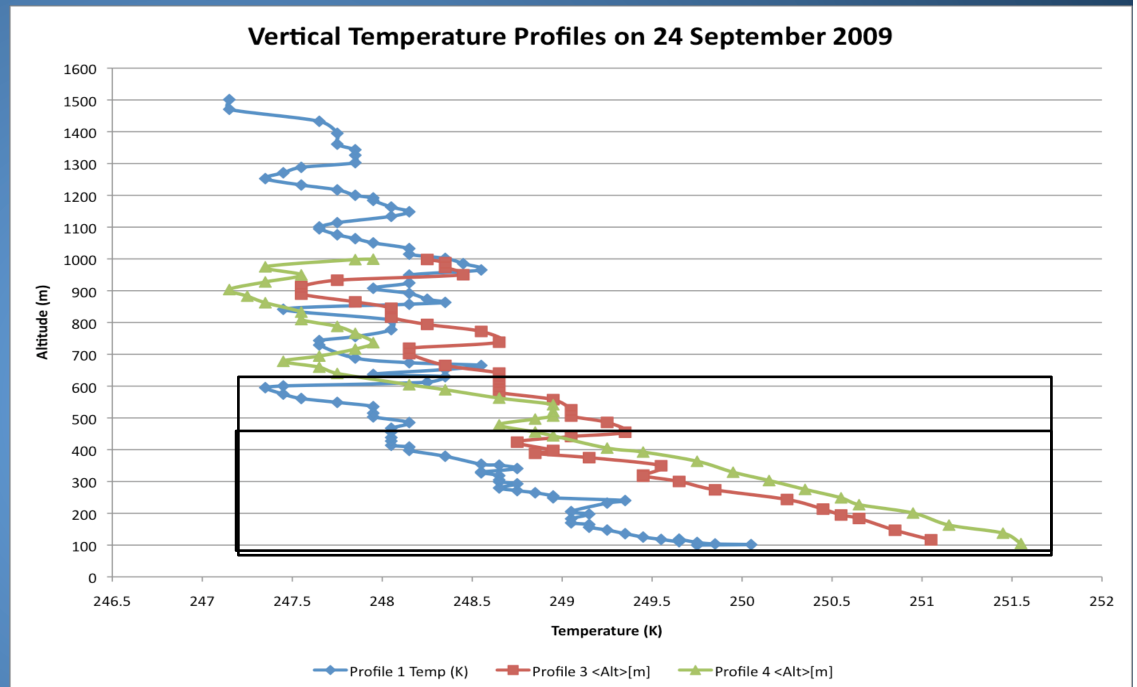
Temperature Profiles and Sensible Heat Fluxes

Profile 1

Profile 3



Profile 4



	24 September Sensible Heat Flux
Profile 1 to 3	608 W m^{-2}
Profile 3 to 4	122 W m^{-2}

Sensible Heat Fluxes for Three Flights

	18 September Sensible Heat Flux
Profile 1 to 2	515 W m^{-2}
Profile 3 to 4	514 W m^{-2}

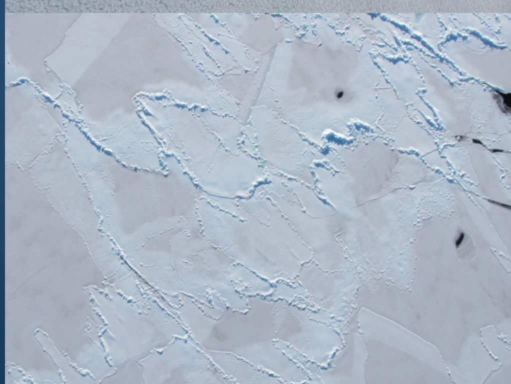
	24 September Sensible Heat Flux
Profile 1 to 3	608 W m^{-2}
Profile 3 to 4	122 W m^{-2}

	25 September Sensible Heat Flux
Profile 3 to 4	163 W m^{-2}
Profile 4 to 5	-45 W m^{-2}

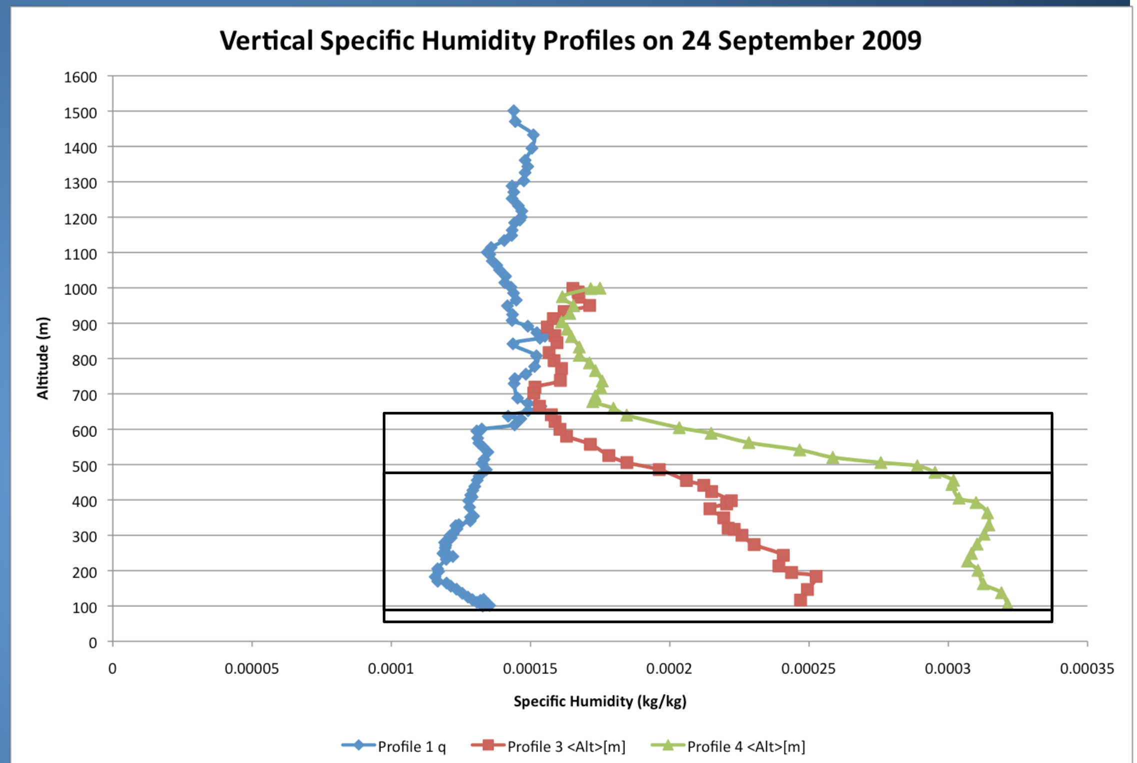
Specific Humidity Profiles and Latent Heat Fluxes

Profile 1

Profile 3



Profile 4



	24 September Latent Heat Flux
Profile 1 to 3	118 W m^{-2}
Profile 3 to 4	60 W m^{-2}

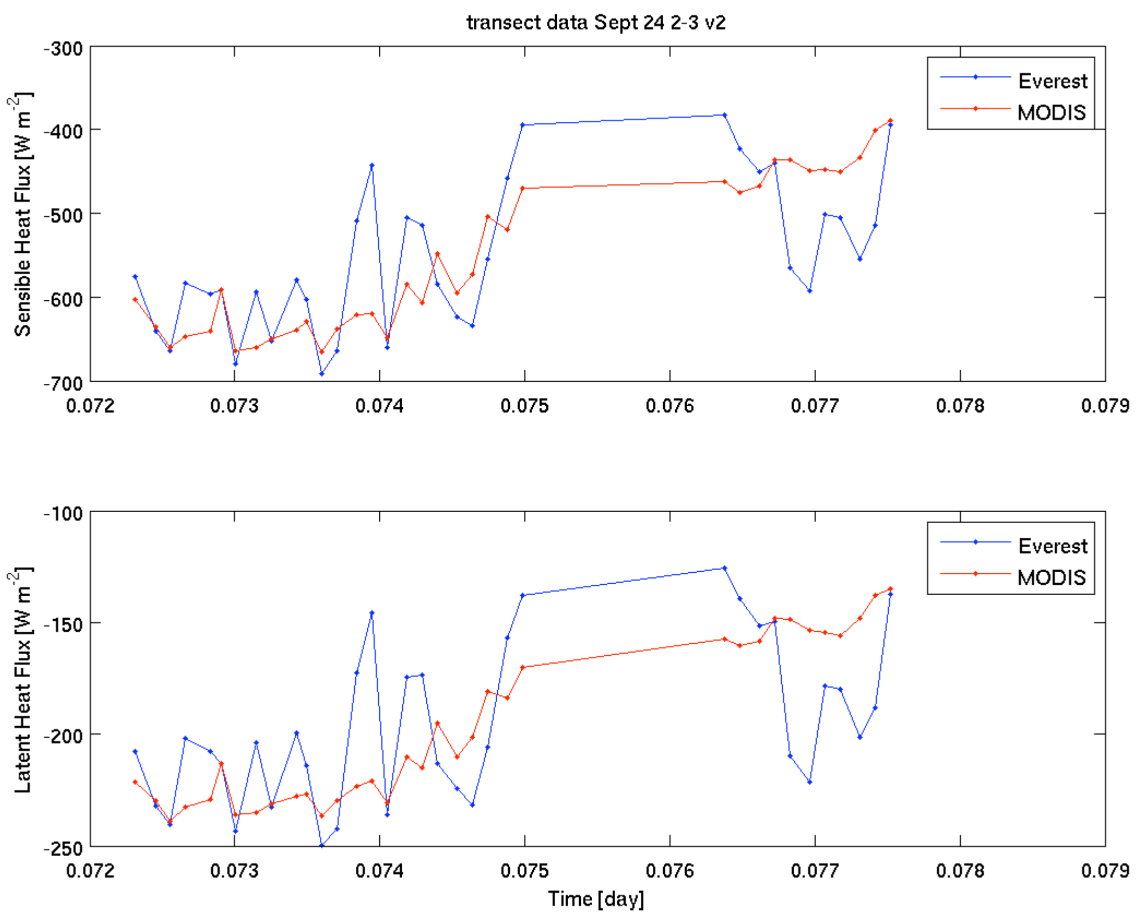
Latent Heat Fluxes for Three Flights

	18 September Latent Heat Flux
Profile 1 to 2	35 W m^{-2}
Profile 3 to 4	137 W m^{-2}

	24 September Latent Heat Flux
Profile 1 to 3	118 W m^{-2}
Profile 3 to 4	60 W m^{-2}

	25 September Latent Heat Flux
Profile 3 to 4	19 W m^{-2}
Profile 4 to 5	123 W m^{-2}

Bulk Flux Estimates: Profiles 1-3

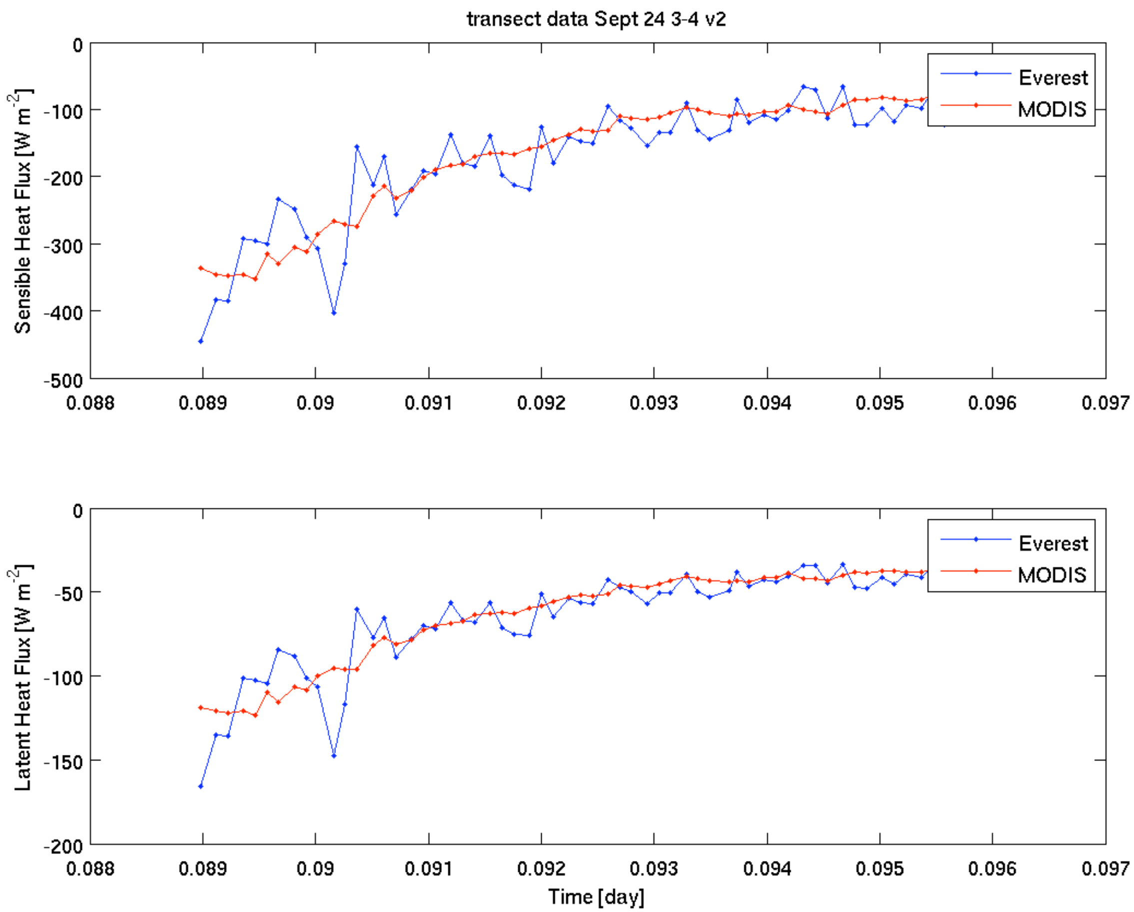


Profile Estimates

Sensible Heat Flux: 608 W m^{-2}

Latent Heat Flux: 118 W m^{-2}

Bulk Flux Estimates: Profiles 3-4



Profile Estimates

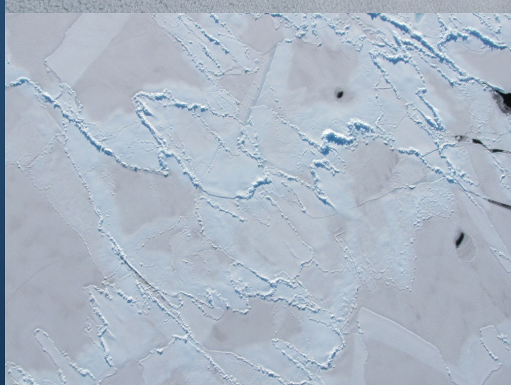
Sensible Heat Flux: 122 W m^{-2}

Latent Heat Flux: 60 W m^{-2}

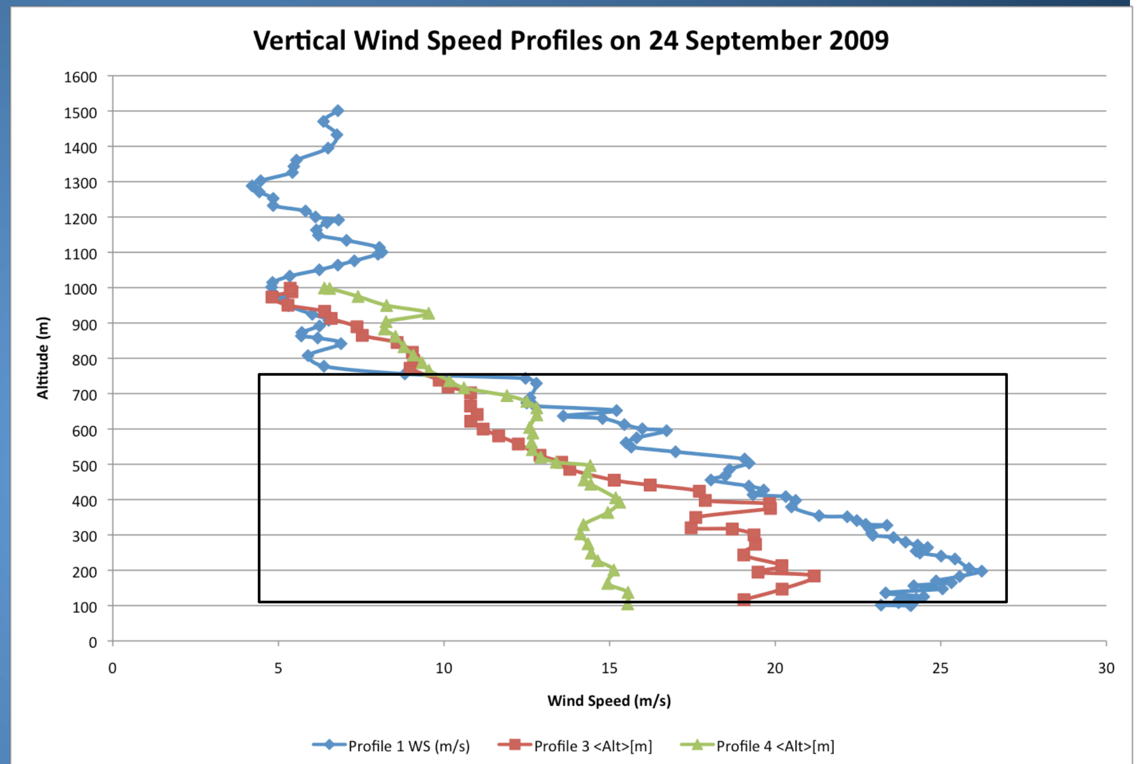
Wind Speed Profiles and Momentum Flux Divergence

Profile 1

Profile 3



Profile 4



	24 September Momentum Flux Div.
Profile 1 to 2	-3.51×10^{-3} m s^{-2}
Profile 3 to 4	-1.45×10^{-3} m s^{-2}

Momentum Flux Divergence for Three Flights

	18 September Momentum Flux
Profile 1 to 2	-5.24×10^{-3} m s^{-2}
Profile 3 to 4	-5.85×10^{-3} m s^{-2}

	24 September Momentum Flux
Profile 1 to 2	-3.51×10^{-3} m s^{-2}
Profile 3 to 4	-1.45×10^{-3} m s^{-2}

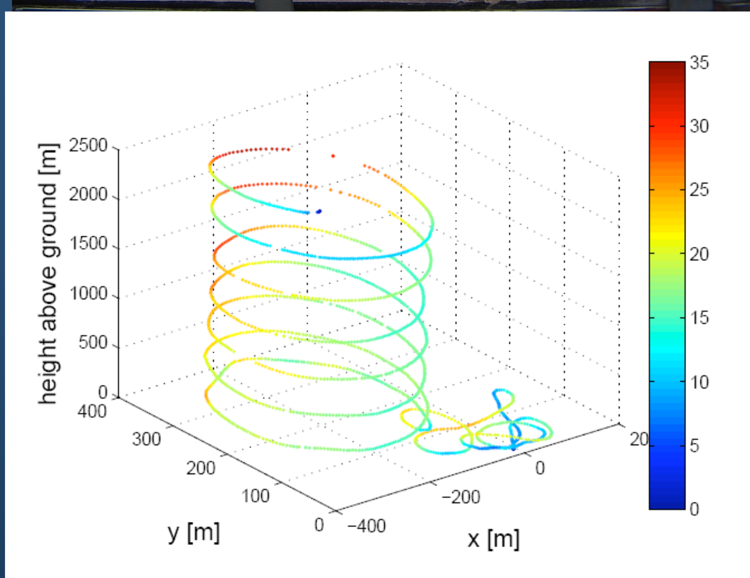
	25 September Momentum Flux
Profile 3 to 4	-4.40×10^{-3} m s^{-2}
Profile 4 to 5	-1.60×10^{-3} m s^{-2}

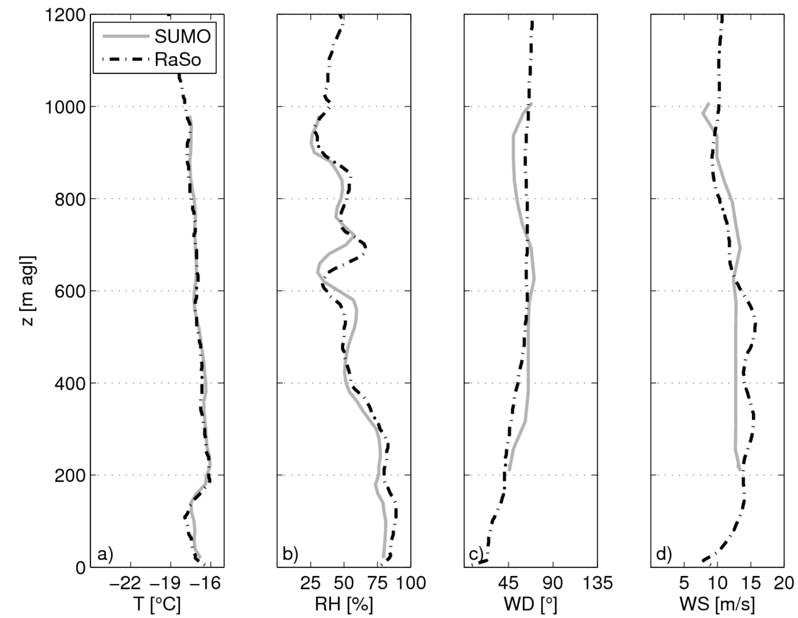
Summary and Future Work

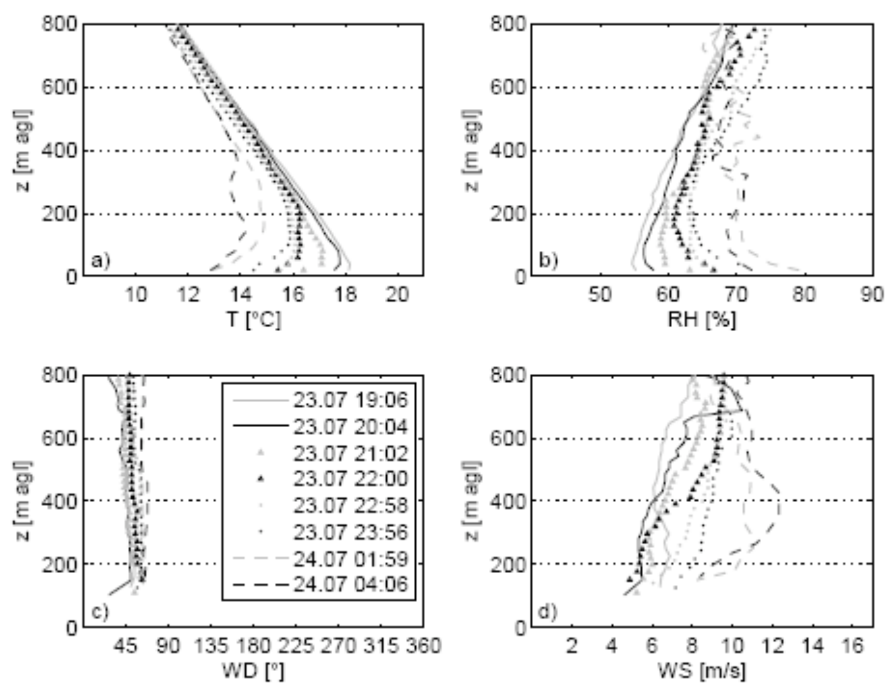
- First wintertime in-situ observations over Terra Nova Bay polynya
  - Calculate surface fluxes from observations
- Fluxes are reflective of varying surface conditions
  - Analyze variability between flights
  - More extensive comparison to other sources
- Repeat Aerosonde flights in September 2012
- SUMO UAVs for local process studies Jan-Feb 2011

Photo: Shelley Knuth

Small Unmanned Meteorological Observer (SUMO) UAV







http://www.gfi.uib.no/

SUMO operation