

Update on APL-UW Airborne Remote Sensing: Mountain Snow and Coastal Processes



Chris Chickadel
(and Gordon Farquharson)

Air-sea Interaction and Remote Sensing Department
Applied Physics Laboratory



Compact Airborne System for Imaging the Environment (CASIE): Specifications

Synthetic Aperture Radar

- Along-track and cross-track interferometric
- L- and C-band
- 3 km imaging area

Thermal Infrared Cameras

- Dual uncooled thermal cameras
- 640 × 480 pixel resolution
- 25° and 40° fields-of-view
- External temperature reference

Lidar

- 690 nm wavelength ('eye safe')
- 3000 Hz sampling
- 6.4 cm resolution
- 1000 m range

Also have fixed visible wavelength cameras, a gimballed camera system, and radiometers.

Compact Airborne System for Imaging the Environment (CASIE): Applications

Synthetic Aperture Radar

- Ocean currents
- River flow
- Ocean waves
- Ocean fronts
- Internal waves
- Topographic mapping

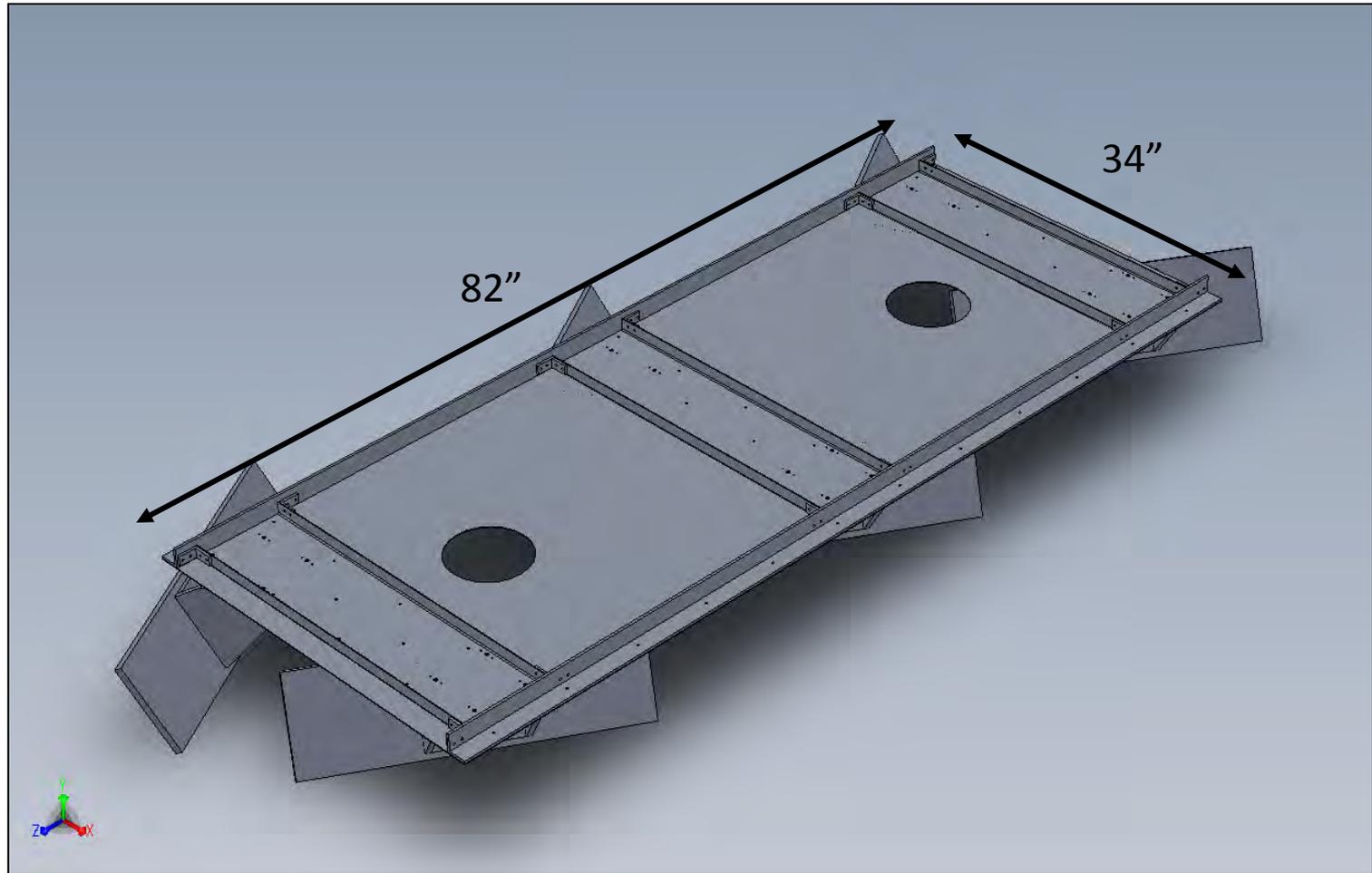
Thermal Infrared Cameras

- River temperature
- Water body mapping
- Ocean waves
- Ocean fronts
- Internal waves

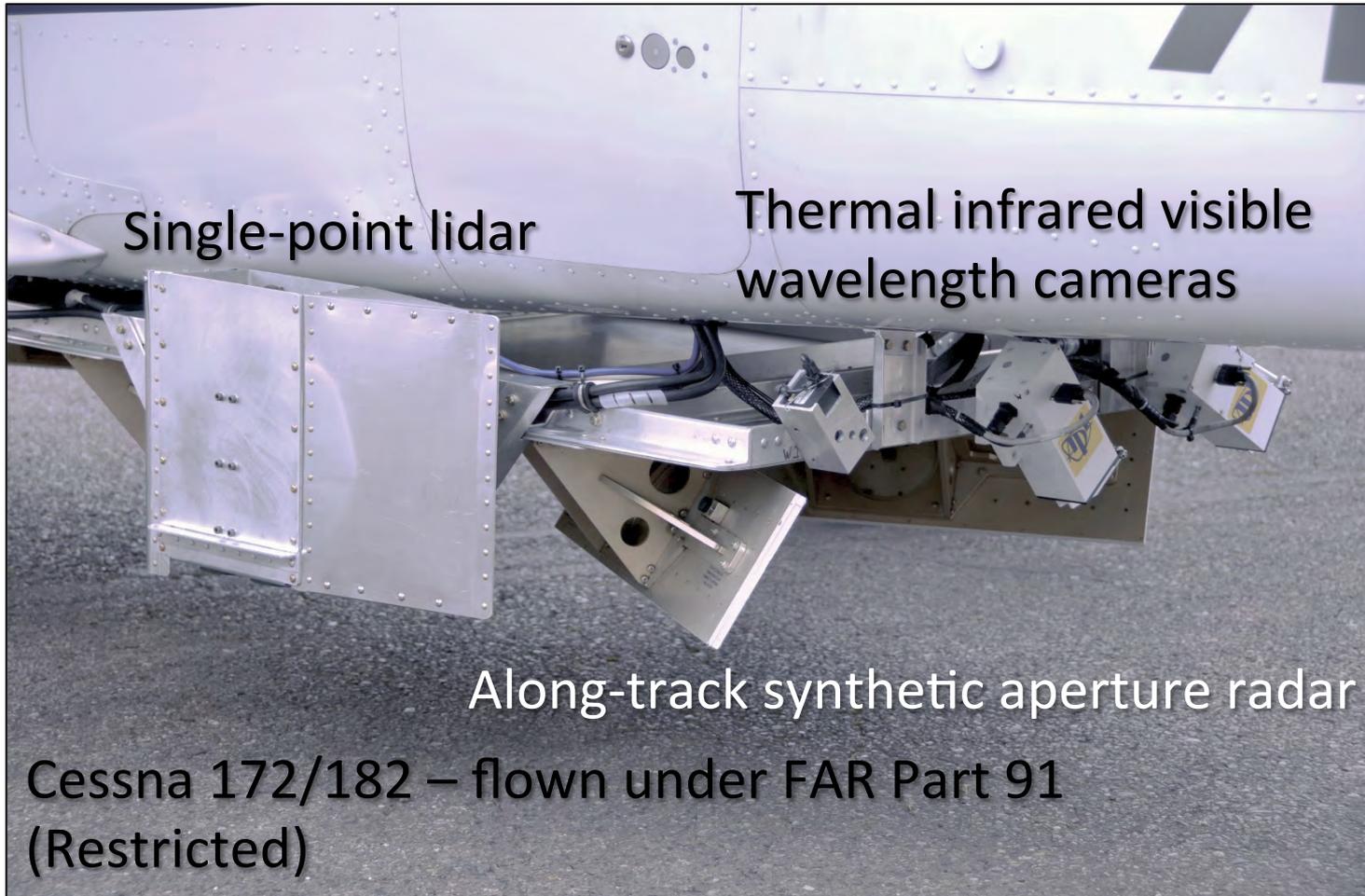
Lidar

- Ocean wave height
- Topographic mapping

Radar Antenna Mount (RAM)

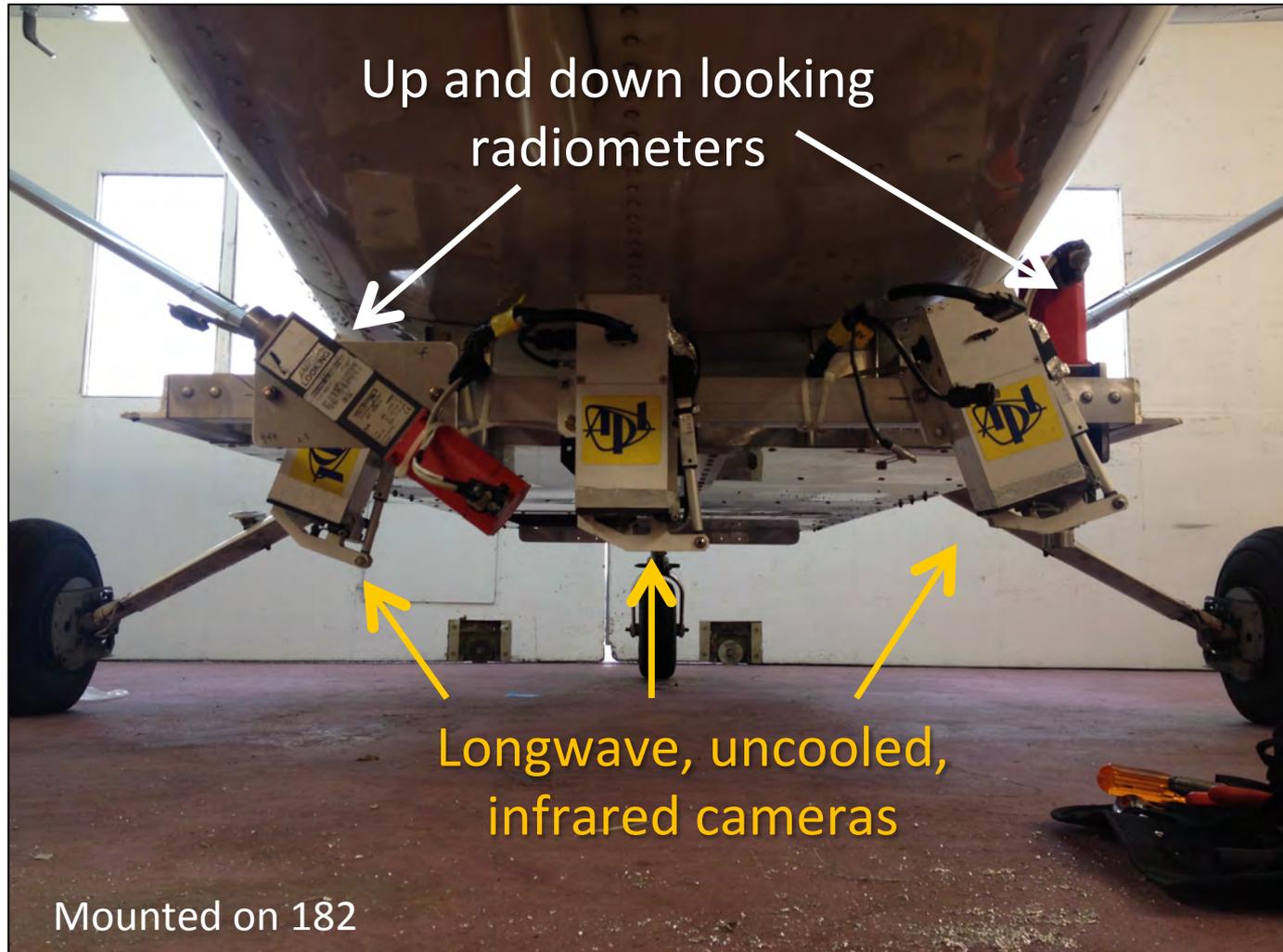


Compact Airborne System for Imaging the Environment (CASIE) - RAM



Owned and operated by Regal Air, WA

CASIE – Camera Only Platform (COP)



CASIE – Camera Only Platform (COP)



Mounted on 182

Dual-Beam ATI SAR



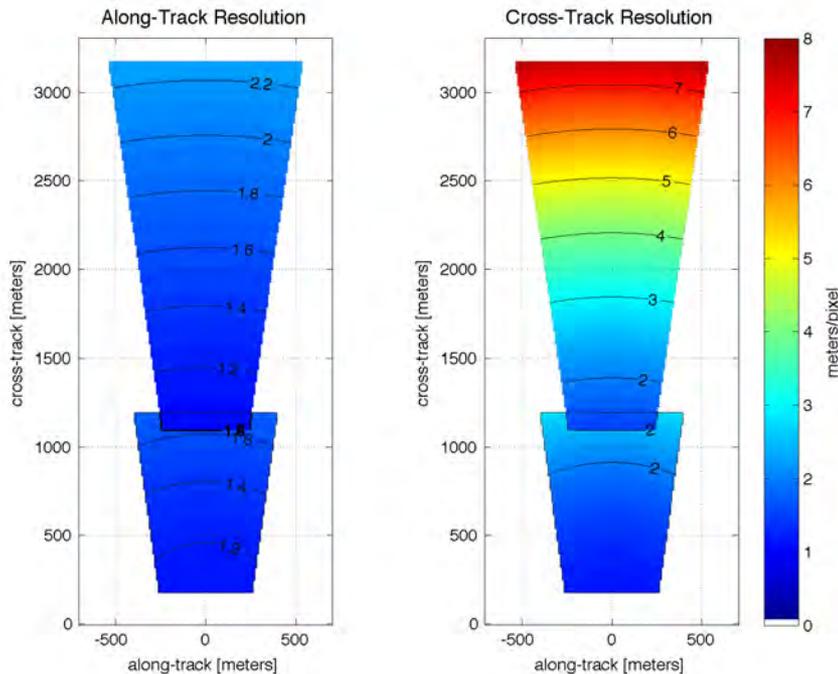
Antenna beams squinted
fore and aft of the
cross-track direction

Antenna beam
footprints and
radar swath

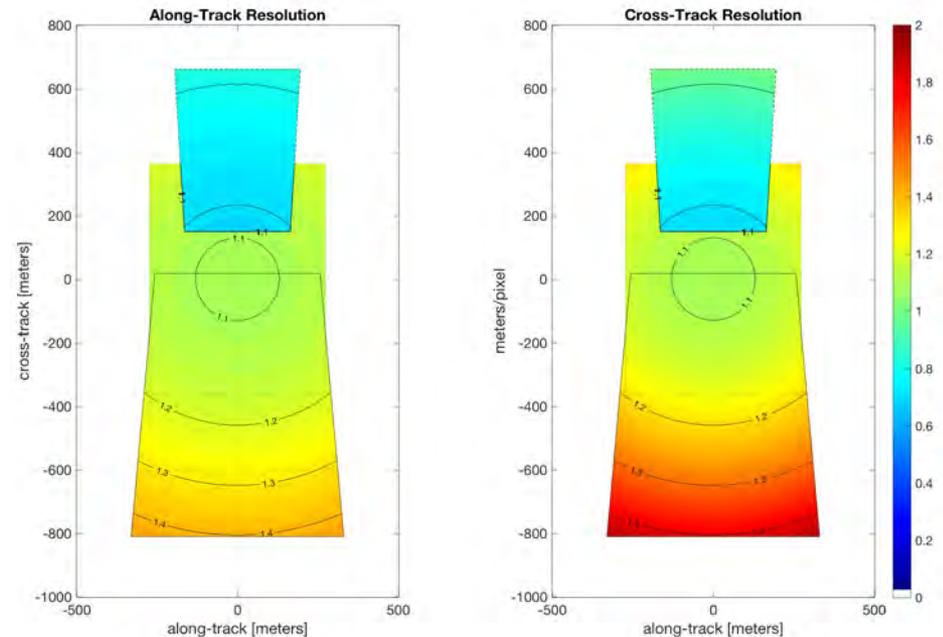
- Two C-band dual-channel transceivers built by Artemis Inc., an inertial navigation system, and six antennas
- Typically fly 3000 ft AGL, 90 knots
- Single-pass swath is ~3 km
- SAR data processed with GPUs

Thermal imaging cameras

Oblique view resolution



Nadir view resolution



← Plane flight direction

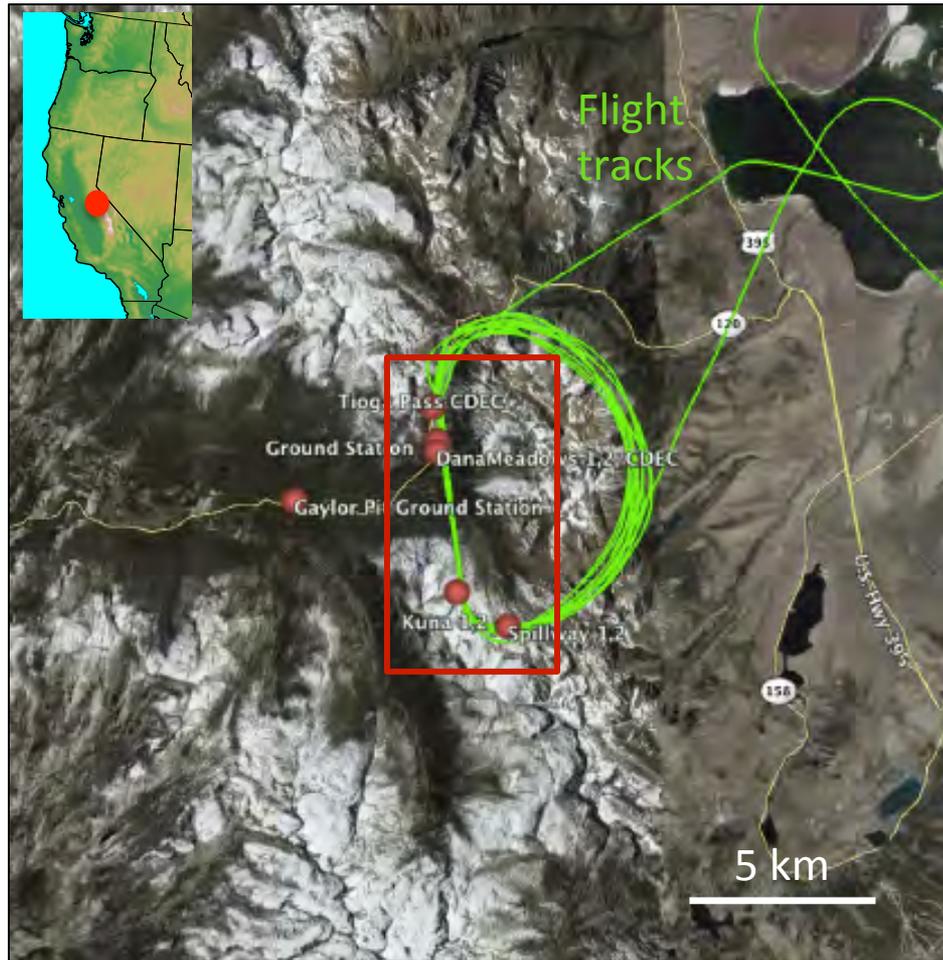
- Two longwave IR (8-12 micron) uncool cameras
- Single-pass swath is ~3 km
- Georectified w/ IMU and GPS data

Past and Present Projects

Year	Project	Location	Science Hours	Agency
2012	RIVET	NC	50	ONR
2012	CMOP	OR	20	NSF
2012	SWASH	WA / ID	30	DARPA
2013	AirSWOT	CA	20	APL/UW
2013	RIVET II	OR	80	ONR
2013	CMOP	OR	20	NSF
2014	Oso Landslide	WA	6	APL/UW
2014	DopplerScatt	WA	6	NASA/JPL
2014	Snow Temperature	CA	20	NASA
2015	Inner Shelf	CA	20	ONR
2016	Small Boat Detection	WA	20	NATO
2016	DopplerScatt	CA	30	NASA/JPL
2016	Multi-freq. ATI SAR	WA	20	ONR
2016	Snow Temperature	CA	25	NASA
2017	Inner Shelf	CA	80	ONR



Mountain Snow Temperature: Feb 2016, Yosemite NP



- Characterize diurnal snow surface temperature variability
- Model validation
- Address satellite tree/snow mixed pixel issues

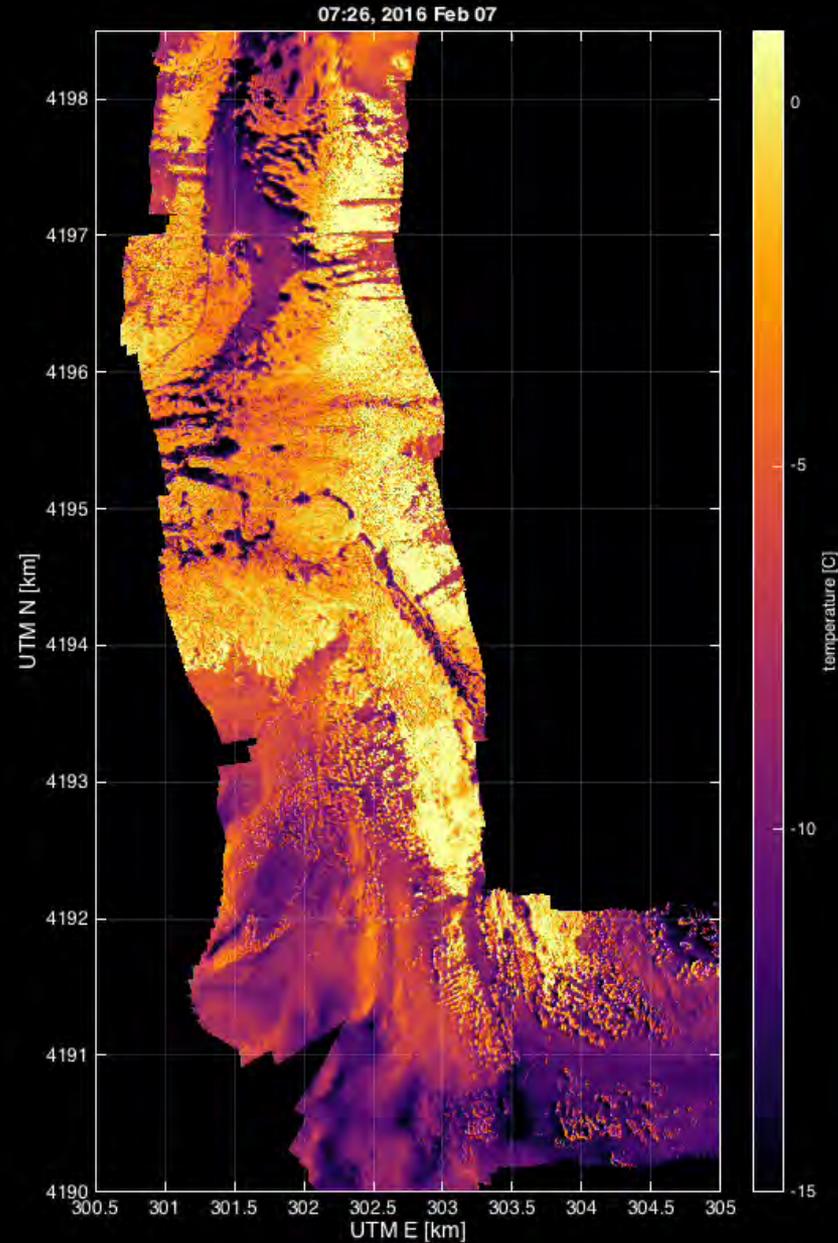
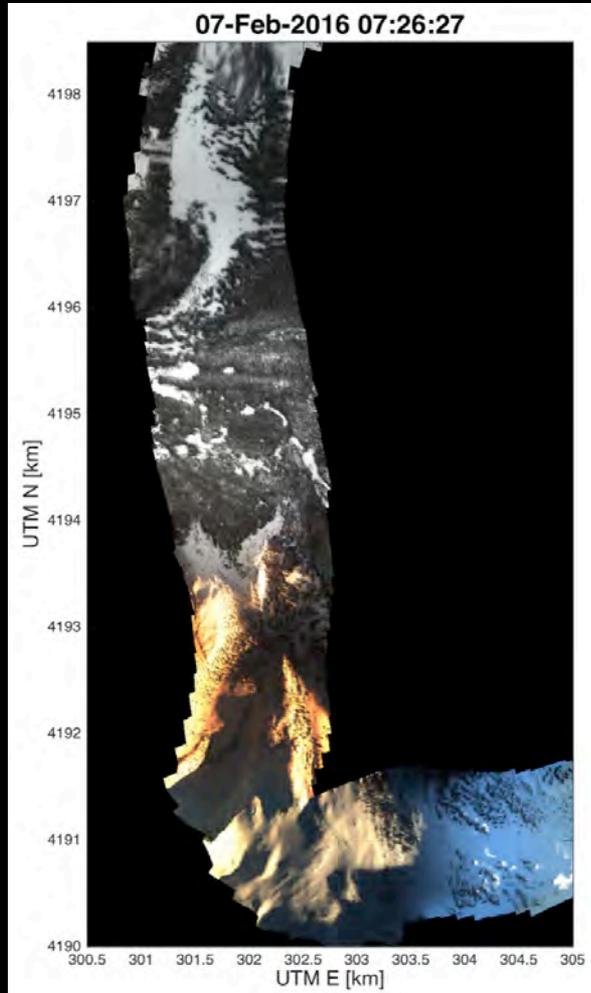
PI: Jessica Lundquist (Mt. Hyd. Lab. – UW CEE)



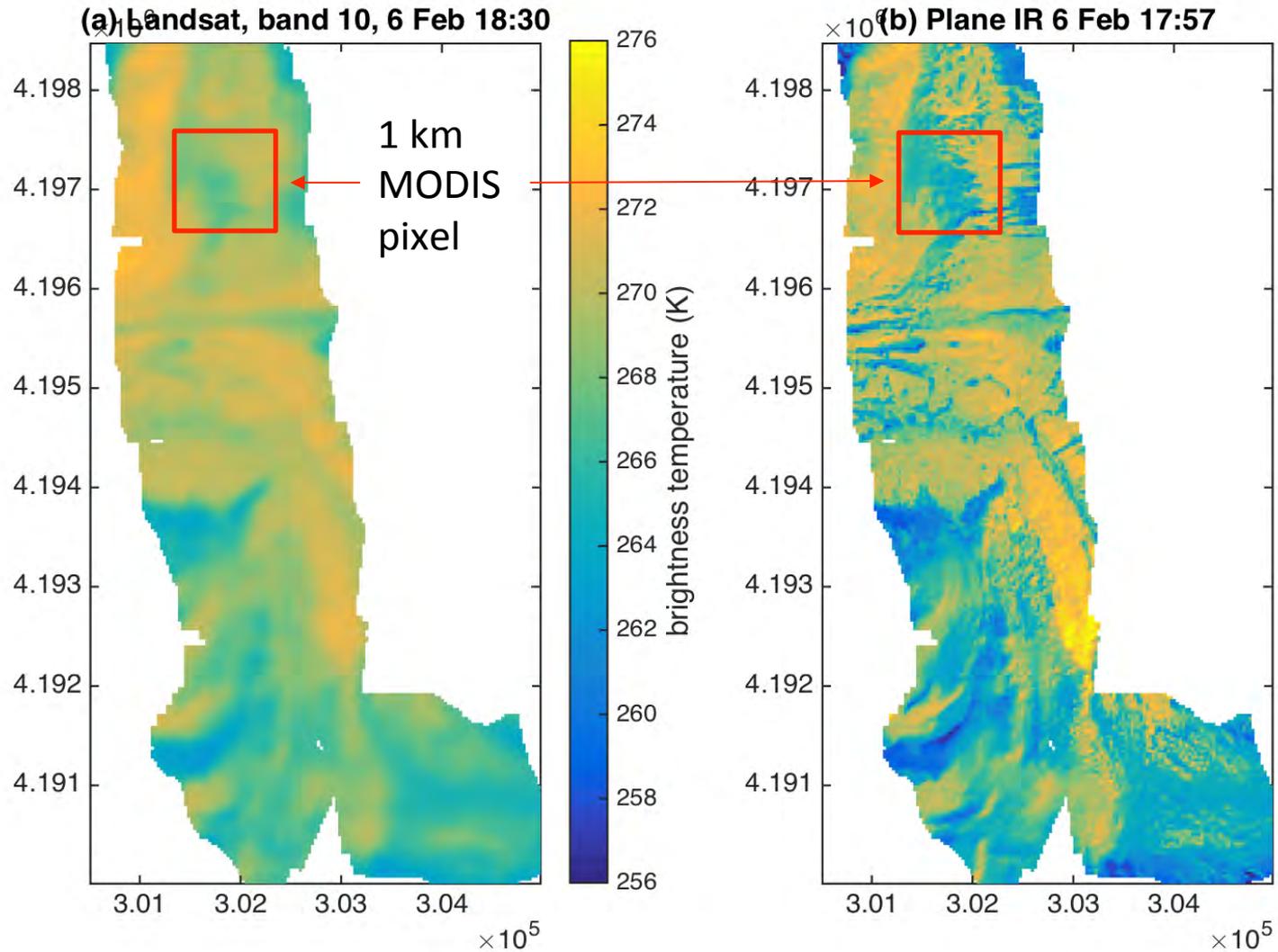
Sunrise in IR

IR

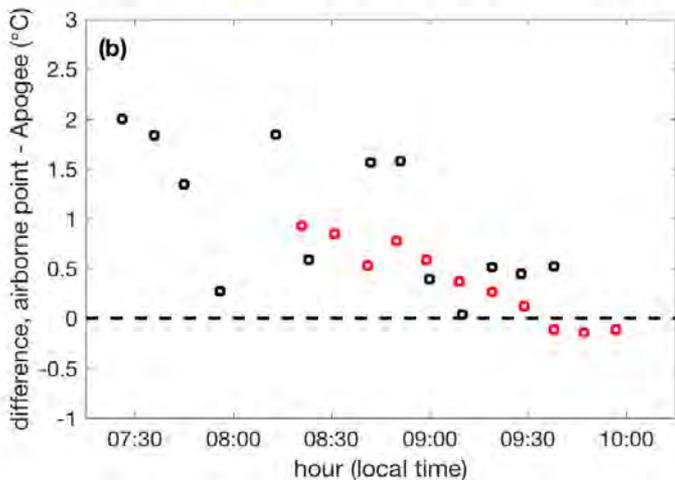
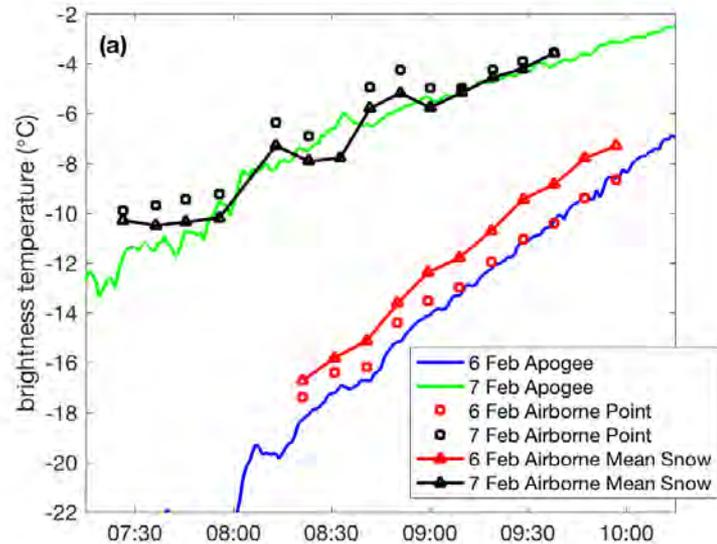
Visible



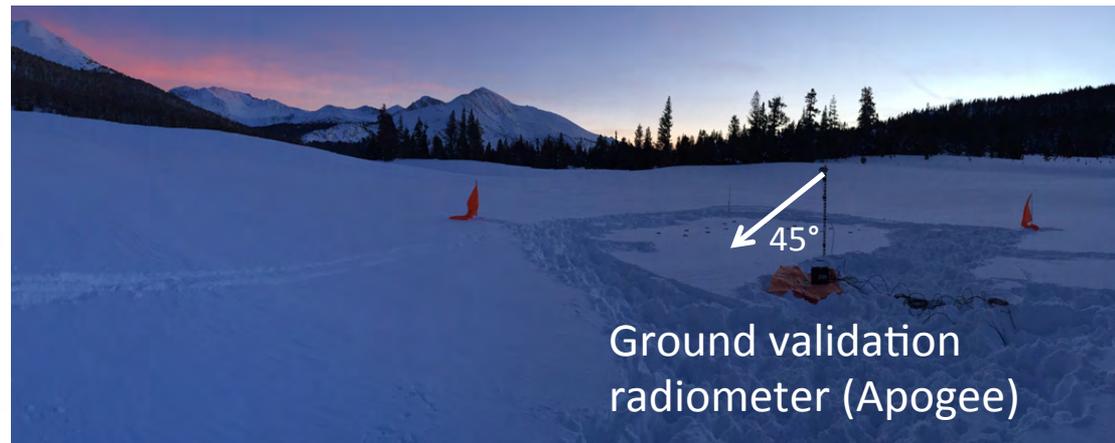
T_B Correspondence between airplane and Landsat 8



T_B Correspondence between airplane and ground



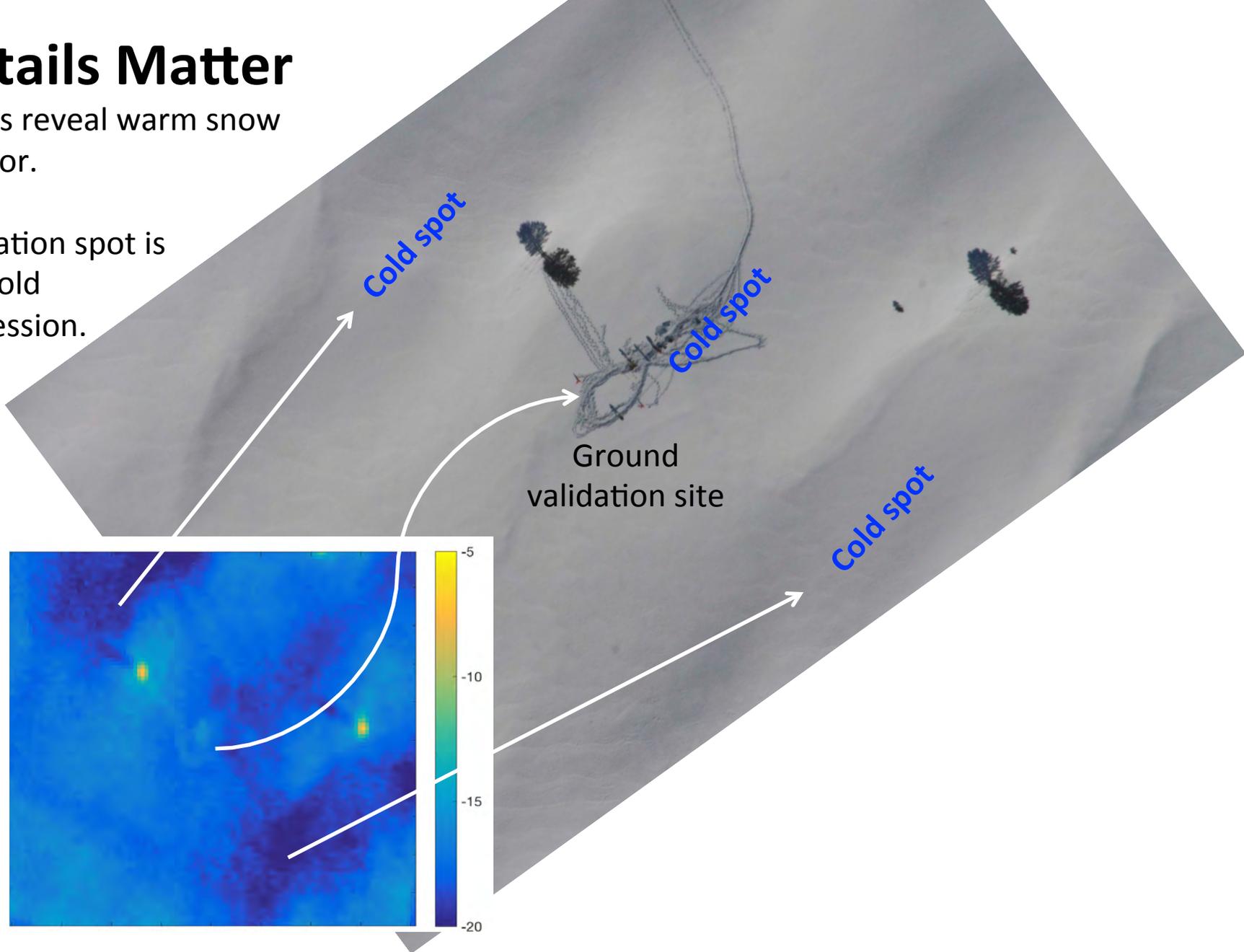
- On 6 Feb (cold air pool), ground matches well with nearby point but is consistently 1.5 C colder than meadow average
- On 7 Feb (windy), ground matches well with airborne meadow average
- Point measurements agree better later in the day
- Later identified warm bias in the ground radiometer



Details Matter

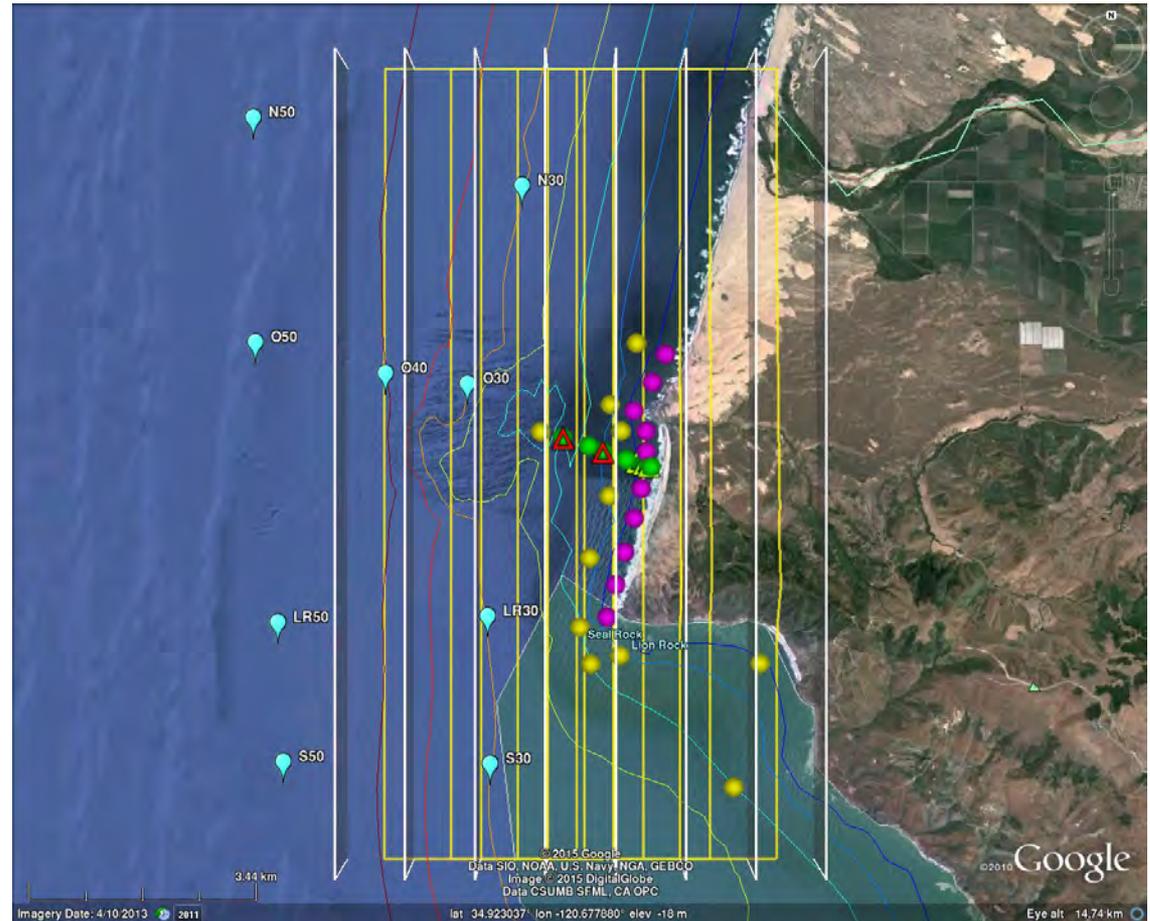
Tracks reveal warm snow interior.

Validation spot is in a cold depression.

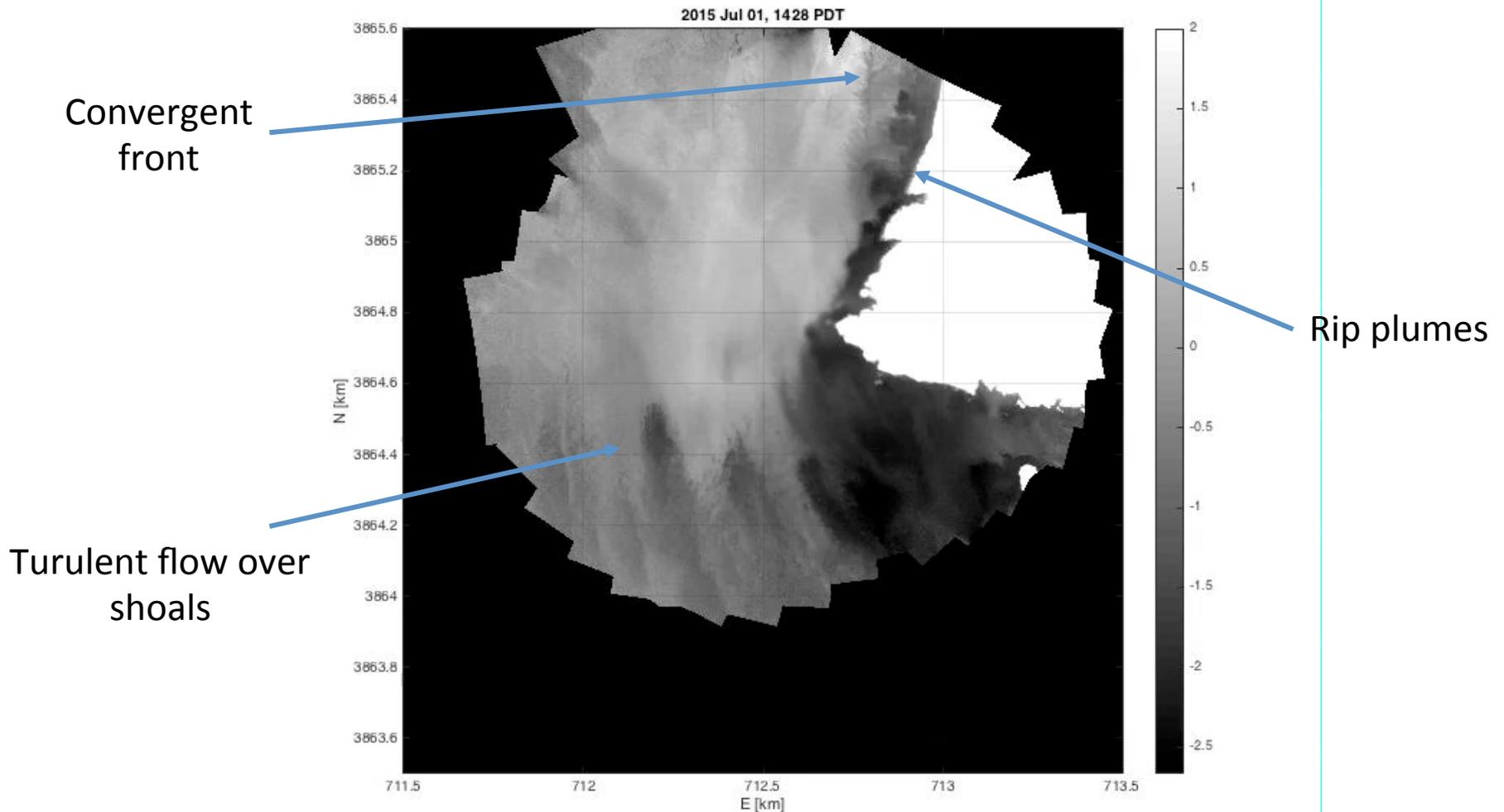


Inner Shelf DRI – 2015 pilot, 2017 main exp.

- Improved understanding of surf zone-shelf transition
- predictive understanding of remotely sensed ocean surface in the inner shelf

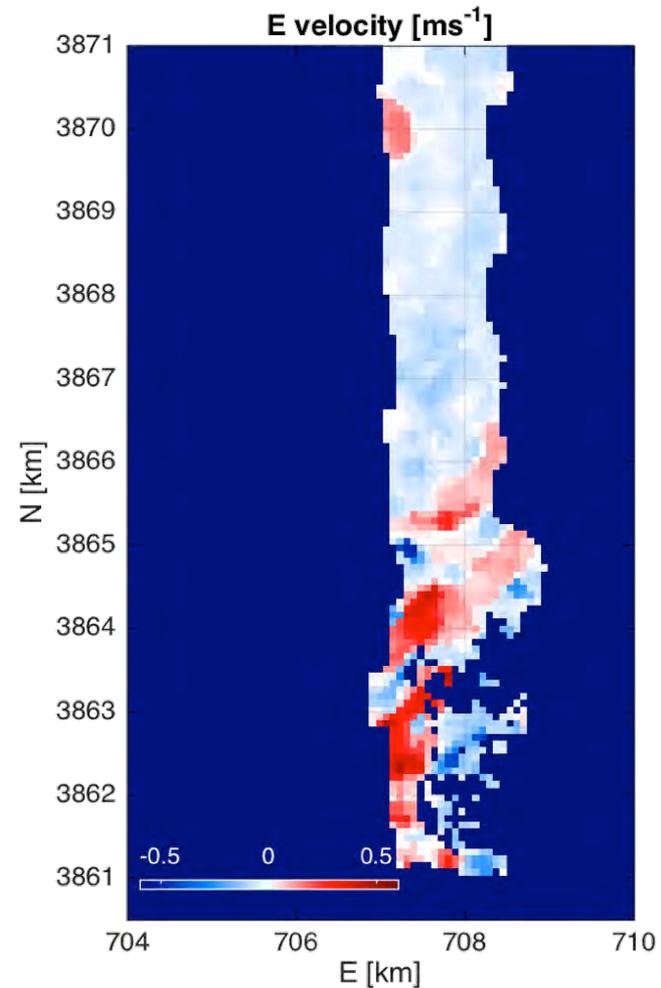
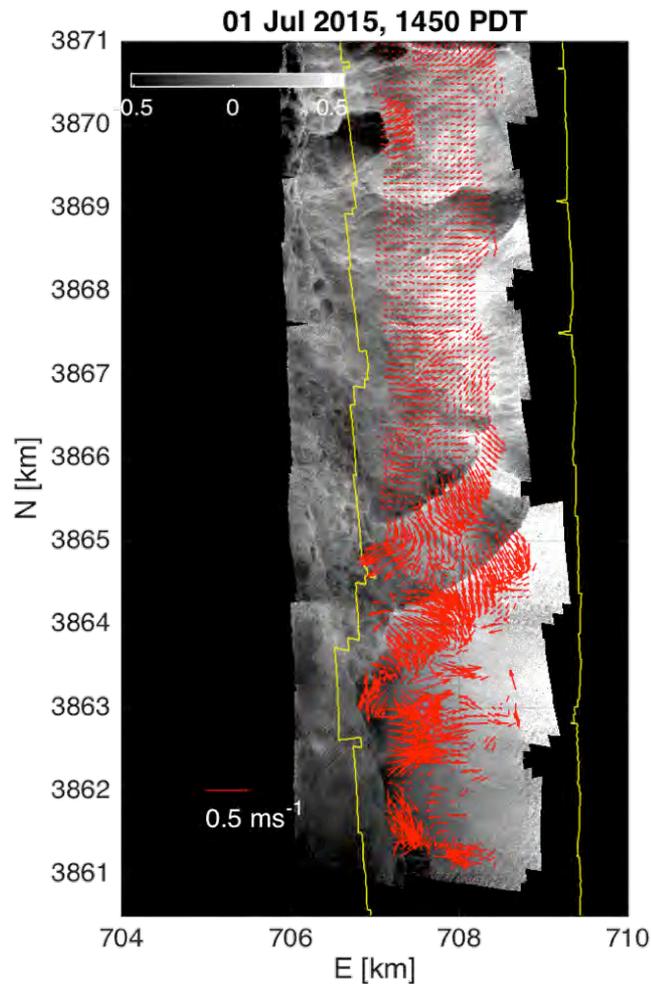


Repeat sampling – Point Sal orbit

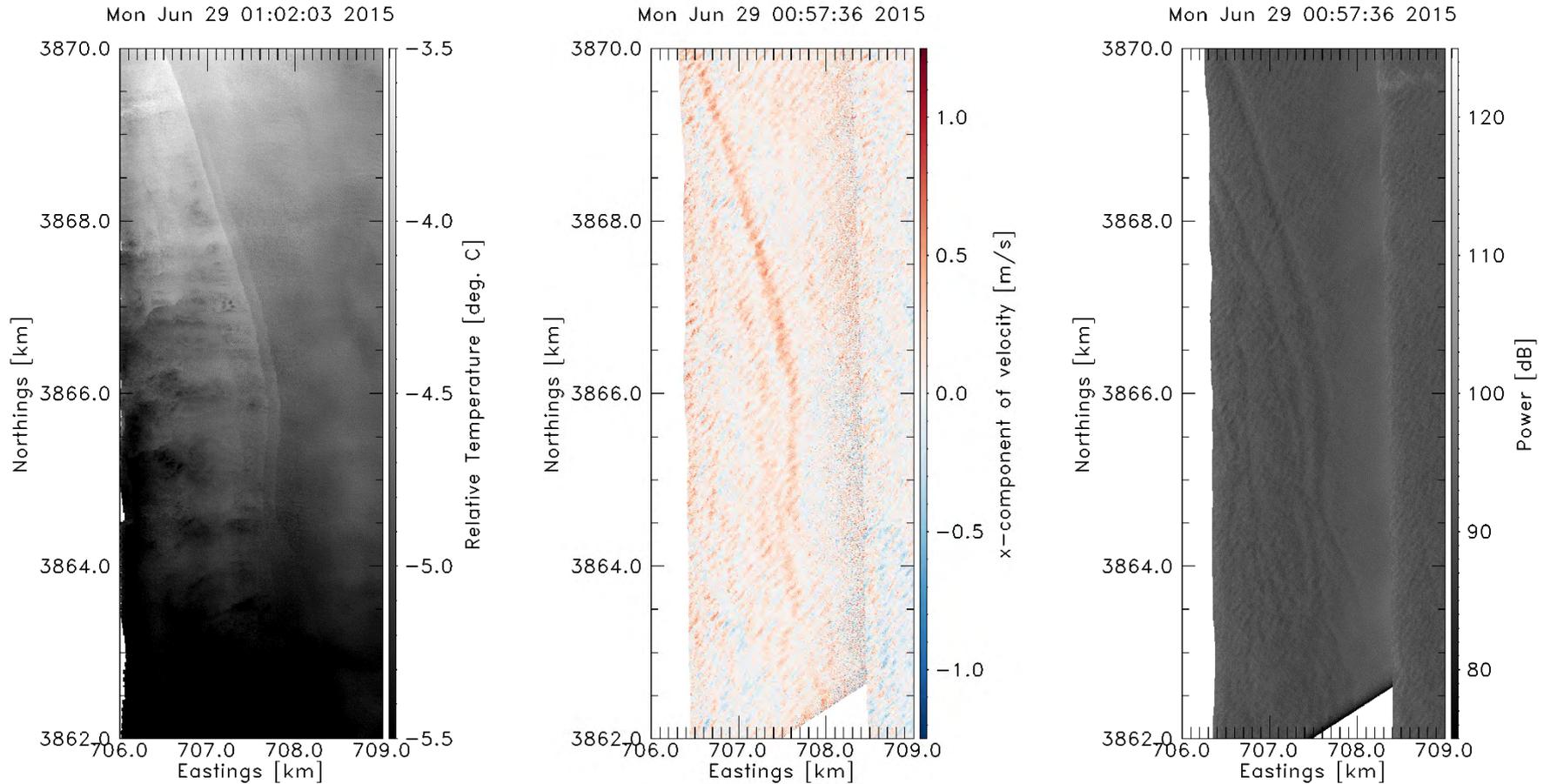


Internal waves – Infrared

2 frame
PIV

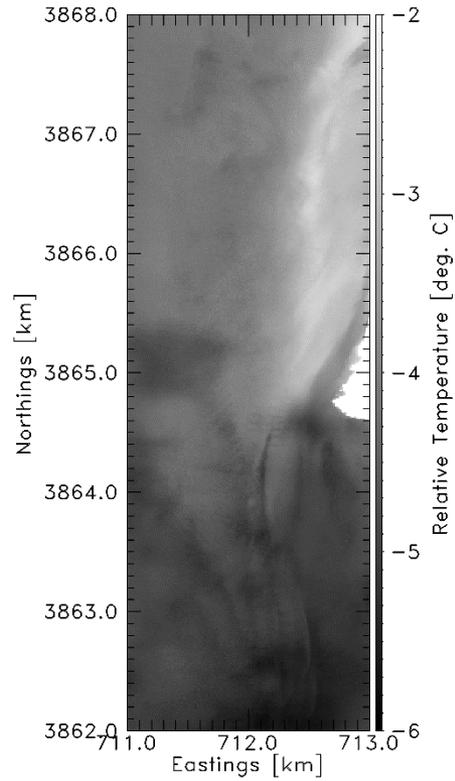


Internal Waves - SAR

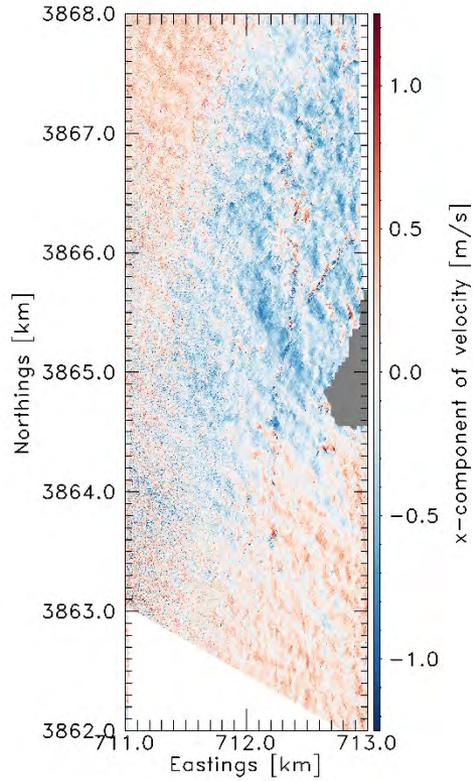


Slicks - SAR

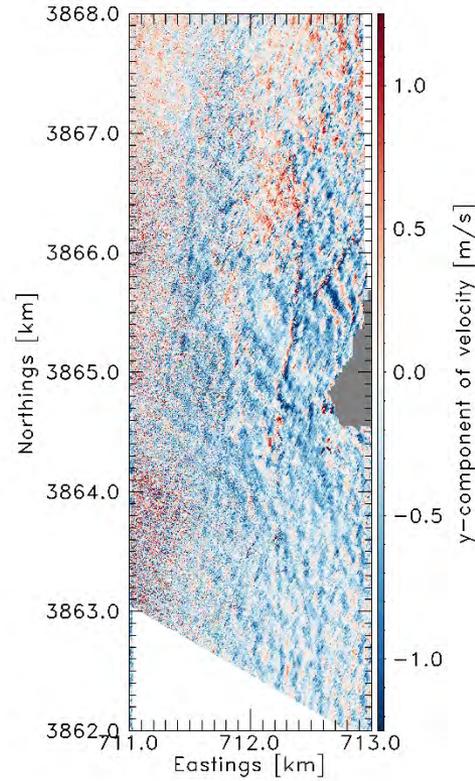
Mon Jun 29 01:02:03 2015



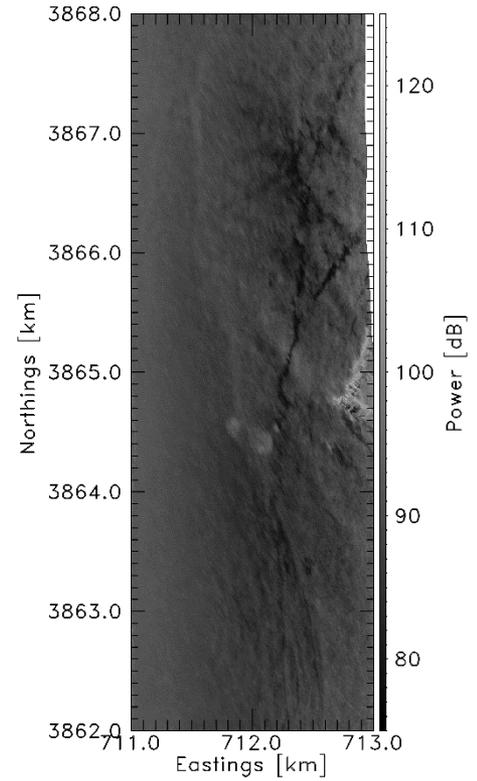
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Mon Jun 29 00:57:36 2015



Mon Jun 29 00:57:36 2015



Continued Work

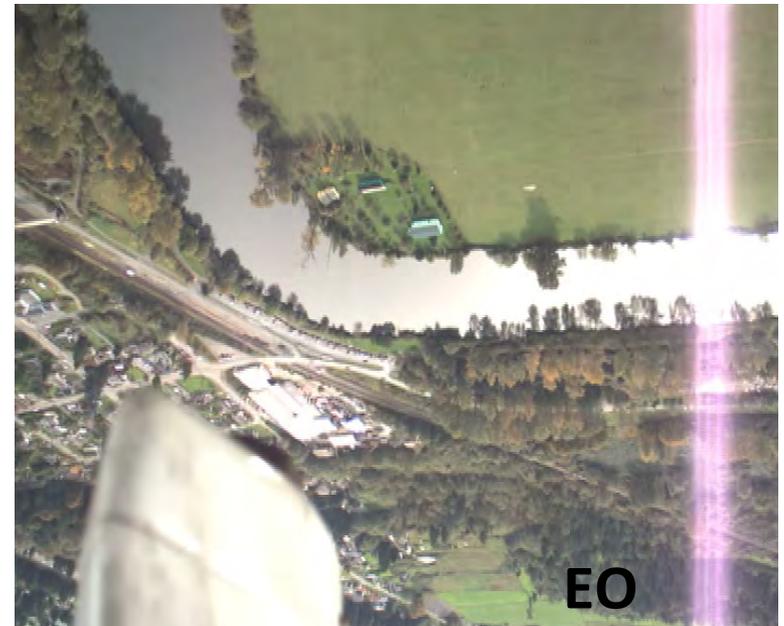
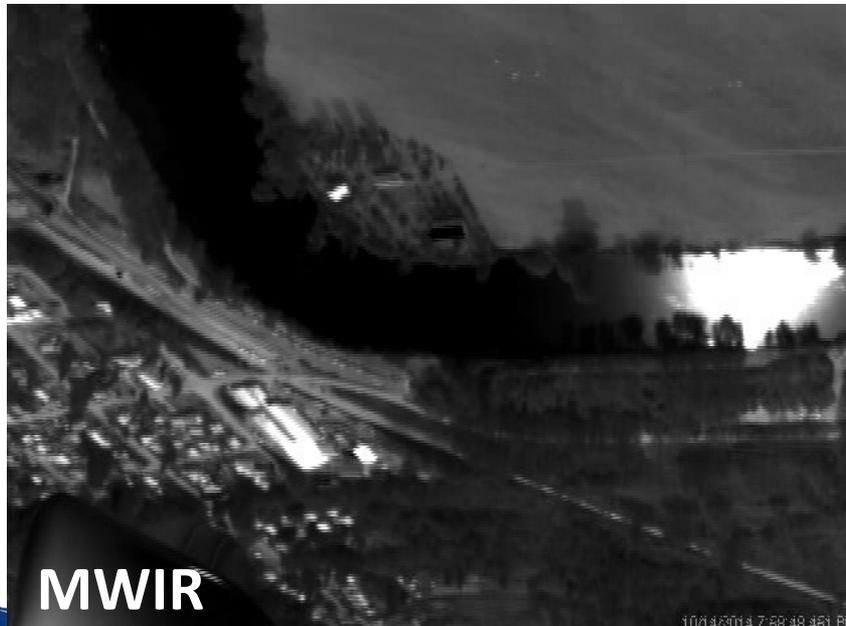
- Inner Shelf field experiment in September/October this year
- Continued work on 2017 snow temperature measurements Yosemite and N. of Lake Tahoe, UAS comparisons
- Continue to improve surface current estimation by using a more detailed microwave scattering model to correct for wave contribution to the mean Doppler shift
- Work underway to calibrate the ATI SAR to estimate radar cross section to apply scatterometry techniques to estimate near surface wind speed and direction (project with JPL)

APL-UW mid-wave IR / EO imaging gimbal DURIP

First flight test, 14 October 2014 – Snohomish River WA

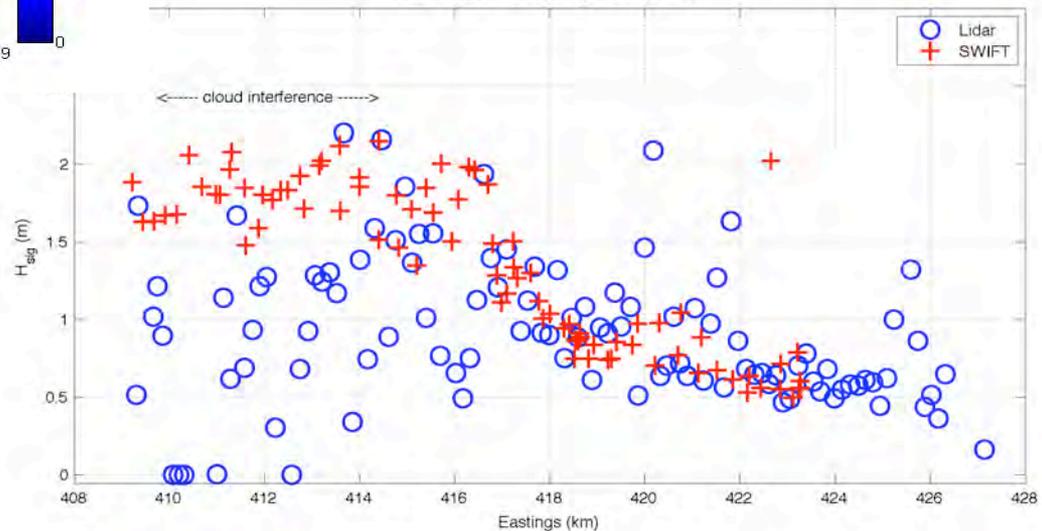
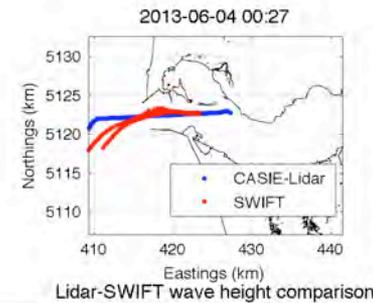
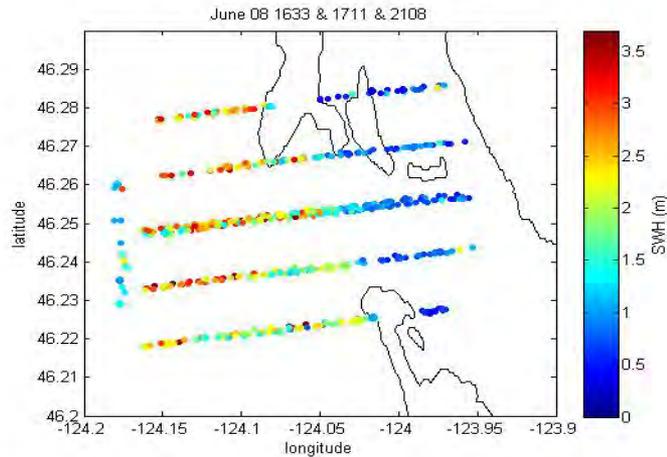


- 9" camera ball, 11lbs
- Full digital (16 bit) image, 10 Hz
- MWIR – 640x512 pixels, 35° fov
- EO – 2448x2048 pixels, 35° fov
- 2-axis stabilization
- Geo-pointing capability
(example movies below)



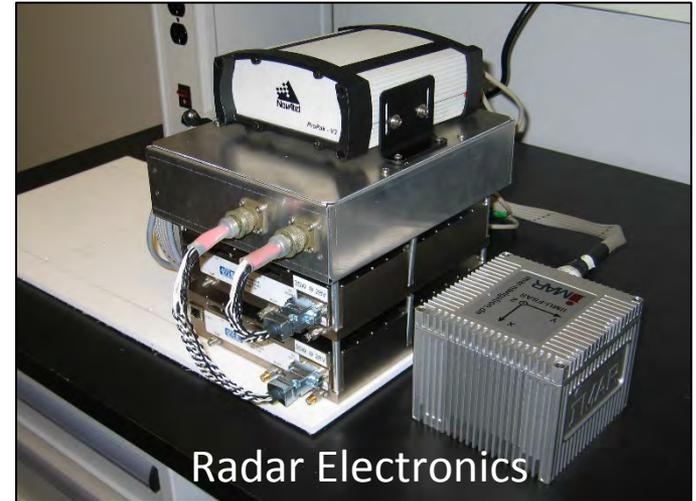
Ocean Waves

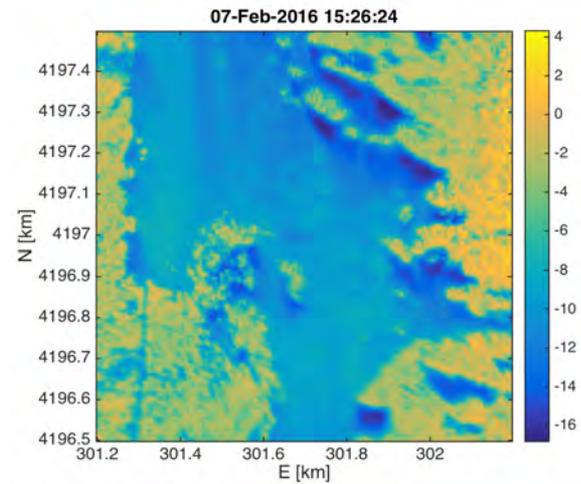
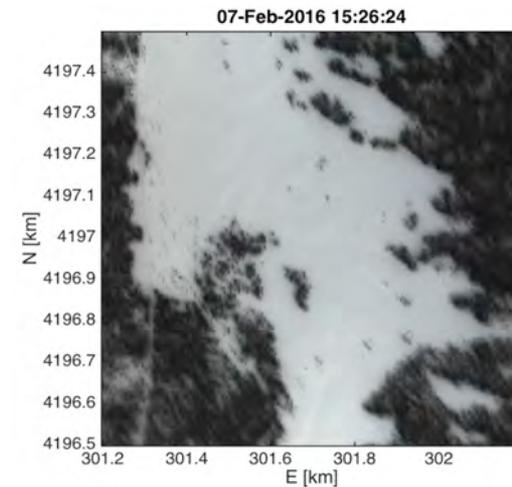
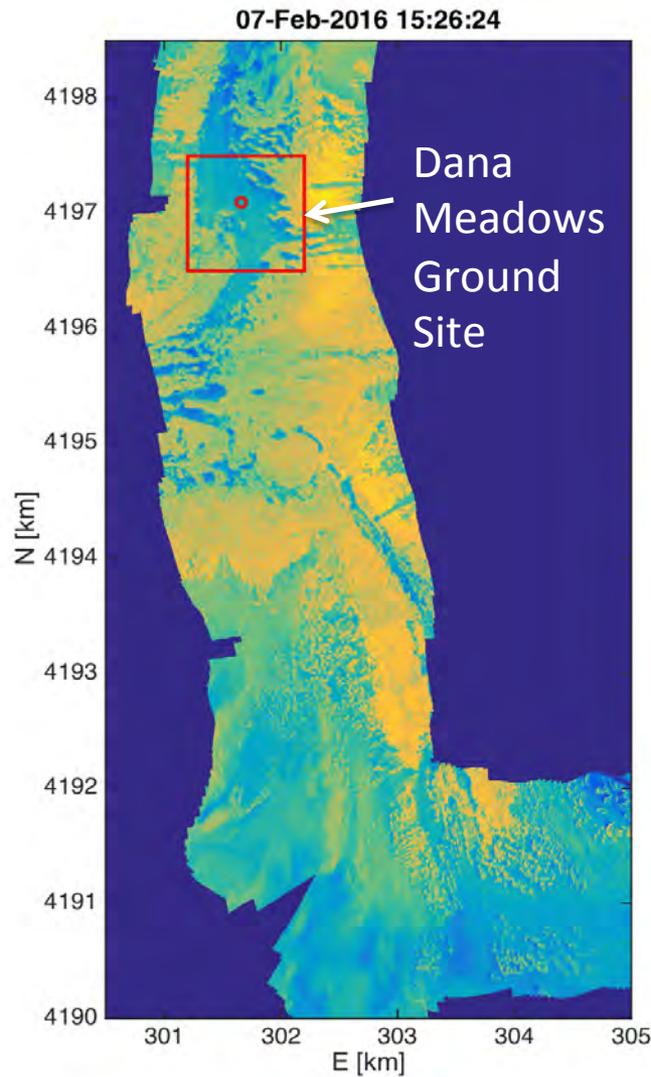
Lidar wave height map of the mouth of the Columbia River



ATI SAR

- The system consists of two C-band dual-channel transceivers built by Artemis Inc., an inertial navigation system, and six antennas
- The radar electronics are mounted in the baggage area of the Cessna 172/182
- Typically fly at around 3000 ft AGL, 90 knots
- Single-pass swath is around 3 km
- SAR data processed with GPUs





Showing 1 km x 1 km box (~ MODIS pixel size)