AIRBORNE MICROWAVE AND INFRARED REMOTE SENSING

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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)

Single-point lidar
Thermal infrared visible wavelength cameras
Along-track synthetic aperture radar

Cessna 172 – flown under FAR Part 91 (Restricted)
Owned and operated by Regal Air, WA
### Past and Present Projects

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<th>Project</th>
<th>Location</th>
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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
• Typically fly at around 3000 ft AGL, 90 knots
• Single-pass swath is around 3 km
• SAR data processed with GPUs
Dual-Beam ATI SAR

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

Antenna beam footprints and radar swath
Mouth of the Columbia River
ATI SAR Interferograms

2013-06-03 13:55 – 14:02 PDT (20:55 – 21:02 UTC)
Max ebb: 13:55 PDT (20:55 UTC, 2.2 knots)
MCR Ebb Flow
MCR Ebb Flow
MCR Ebb Flow

Tue Jun 4 23:40:48 2013

x-component of velocity [m/s]
MCR Ebb Flow

Wed Jun  5 00:32:00 2013

Northing [km]

Eastings [km]

x-component of velocity [m/s]
Data collected from 14:42 to 15:12 PDT on June 4, 2013 (max. ebb flow around 14:50 PDT)

The SWIFT drifter velocities were measured between 12:42 and 16:42 PDT
Cathlamet Bay
Cathlamet Bay
Mouth of the Columbia River – Internal Hydraulic Jump

Surface currents in the mouth of the Columbia River

6 m × 6 m resolution
Vorticity

SAR vorticity (s⁻¹)

Surface jets

N (km)

E (km)
New River Inlet
Comparison with SWIFT Drifter Measurements

Radar

Radar and SWIFT
Bathymetric Retrieval

![Graph showing bathymetric retrieval results for different data sets: Prior, SAR only, Radar only, All data, and True.](image)
Other Instruments / Applications
Ocean Waves

Lidar wave height map of the mouth of the Columbia River
Ground Water Seepage

Hood Canal near Belfair, WA
Oso Landslide Extent

New river channel well established 9 days after the slide

Water inundated areas distinctly imaged in infrared imagery
Terrestrial Mapping: Oso Landslide Topography

SAR-derived Topography

Oso landslide topography measured with interferometric SAR
Snow Temperature

Snow coverage. Snow is around 0° C.

Snoqualmie Summit, WA
River Temperature

Skagit River, WA thermal characterization

Thermal map

Cold Skagit River

Mixing zone

Warm Sauk River
Algal Blooms

Visual Image

Bloom Concentration

M. rubra bloom mat in the south channel of the Columbia River
**Current Work**

- Small ship detection project in July at the MCR
- Dual-frequency (L- and C-band) ATI SAR experiment in Fall to test the idea of estimating the Bragg-wave phase velocity contribution to the mean Doppler shift
- Inner Shelf field experiment in September/October next year
- 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)
Summary

- Flexible platform for airborne remote sensing
- Limited to inland and coastal areas