



**Pacific  
Northwest**  
NATIONAL LABORATORY

# ThermalTracker-3D

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U.S. DEPARTMENT OF  
**ENERGY** **BATTELLE**

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# Project Overview

## Purpose

- Provide site-specific information on seabird and bat activity.
  - Complement aerial and ship-based surveys
  - Record continuously, day and night, all weather
  - Data: time, species, flight height, flight direction, time in rotor-swept-zone, etc.

## Goals

- Reduce uncertainty during siting/permitting
- Improve accuracy of collision risk models with empirical data
  - Activity correlated with environmental conditions
  - Avoidance behavior



# BOEM Guidelines for Avian Surveys Offshore

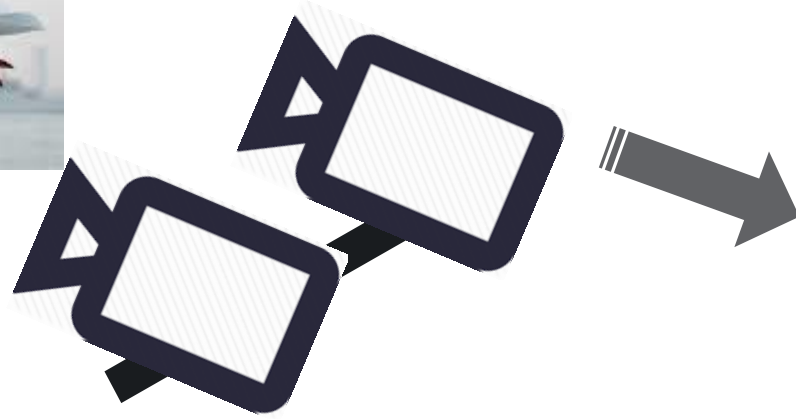
- **Identify and confirm which avian species are using the project site, and when** these species may be present where development is proposed;
- **Establish a pre-construction baseline** which may be used to assess whether detectable changes associated with proposed operations occurred in post-construction abundance and distribution of avian species;
- **Collect additional information aimed at reducing uncertainty** associated with baseline estimates and/or to inform the interpretation of survey results; and
- **Develop an approach to quantify any substantial changes** in the distribution and abundance of avian species associated with proposed operations.

[https://www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/Avian\\_Survey\\_Guidelines.pdf](https://www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/Avian_Survey_Guidelines.pdf)

# ThermalTracker-3D Operation



1. Thermal cameras record continuous video.



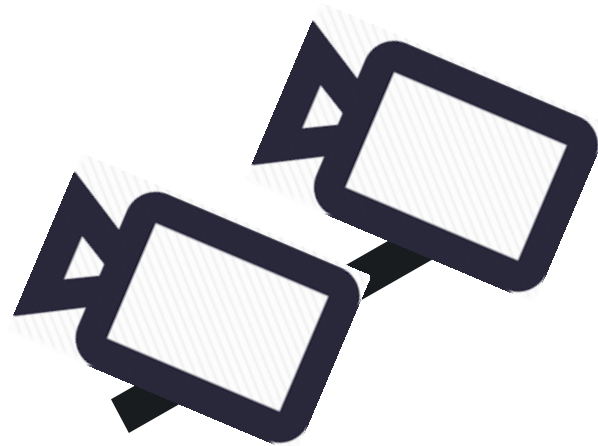
2. Software automatically extracts flight track data in real-time.



3. Flight track data is transmitted to shore-based server.

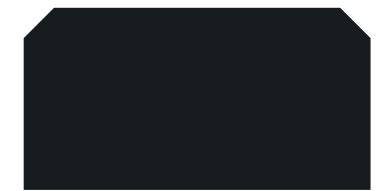
ID	Time	Direction	Speed	Min Height	Max Height	Avg Height	Species	Confidence
20200612-1	00:01.8	west	12.6	30	46	36	Gull	98
20200612-2	00:10.0	west	11.5	36	44	40	Gull	97
20200612-3	00:10.2	northwest	11.3	18	38	27	Tern	82
20200612-4	02:02.0	west	12.9	27	39	32	Gull	93
20200612-5	03:26.7	north	8.3	64	168	94	Albatross	98
20200612-6	03:35.9	northwest	12.6	29	43	29	Tern	79
20200612-7	03:42.4	northwest	10.5	39	53	41	Gull	84

# ThermalTracker-3D Basic Components

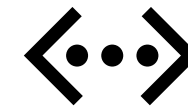


thermal camera x 2

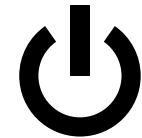
ThermalTracker-  
3D software



computer

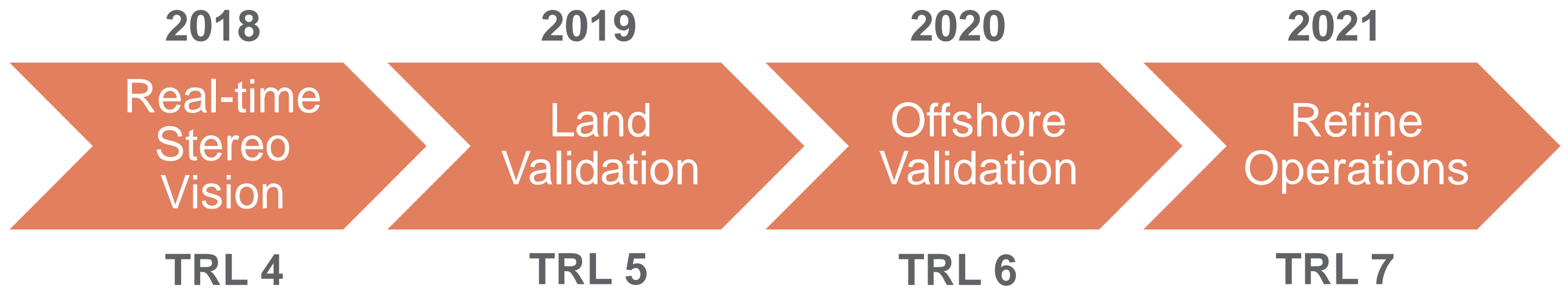


data link



power

# ThermalTracker-3D Development Timeline



# Land-based Validation

NREL's National Wind Technology Center

- Drone flights validated 3D tracking
- Evaluated camera positioning/orientation
- Endurance test

Variable weather conditions

FireFly Pro



# Land-based Prototype (\$25k)

FLIR A65



\$9k x 2



System 76 Oryx Pro

\$3.5k



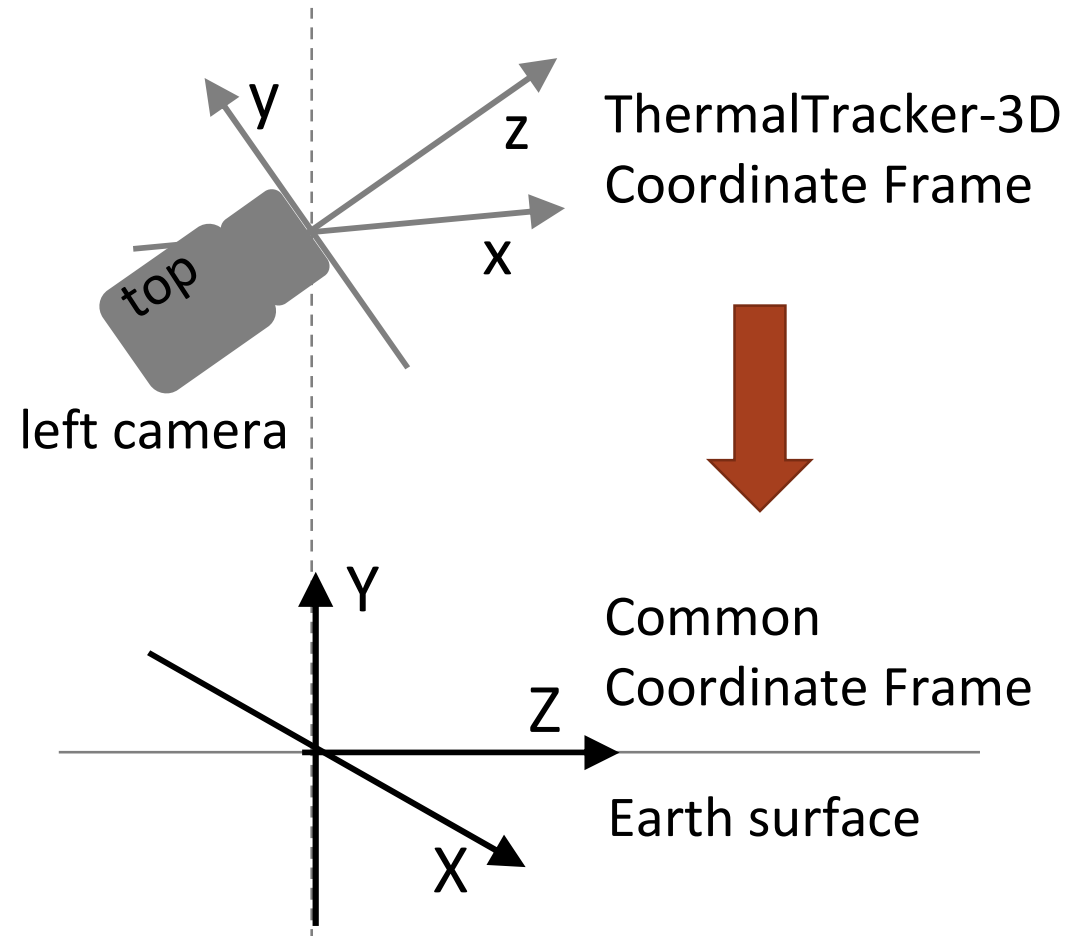
Netgear GS308P





# Results

- Positions were transformed to a common coordinate frame
- GPS data were interpolated to coincide with ThermalTracker estimates
- Manuscript submitted for publication



## Error\* Statistics

N = 18,801

Dimension	Percentile				
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
X	-7.3	-5.4	-2.1	2.2	6.1
Y	-0.3	1.0	3.2	4.3	6.8
Z	-17.2	-6.5	3.0	11.6	19.9

\*Error = ThermalTracker-3D – GPS (meters)

Distances ranged from 50 to 350 meters

## 2020 Plan: Offshore Validation

- ThermalTracker-3D will be integrated with a Wind Sentinel buoy
- 25 nautical miles offshore in Humboldt potential lease area
- 1-year deployment starting April 2020
- Observer visits spring, fall to survey

DOE Wind Sentinel Buoy

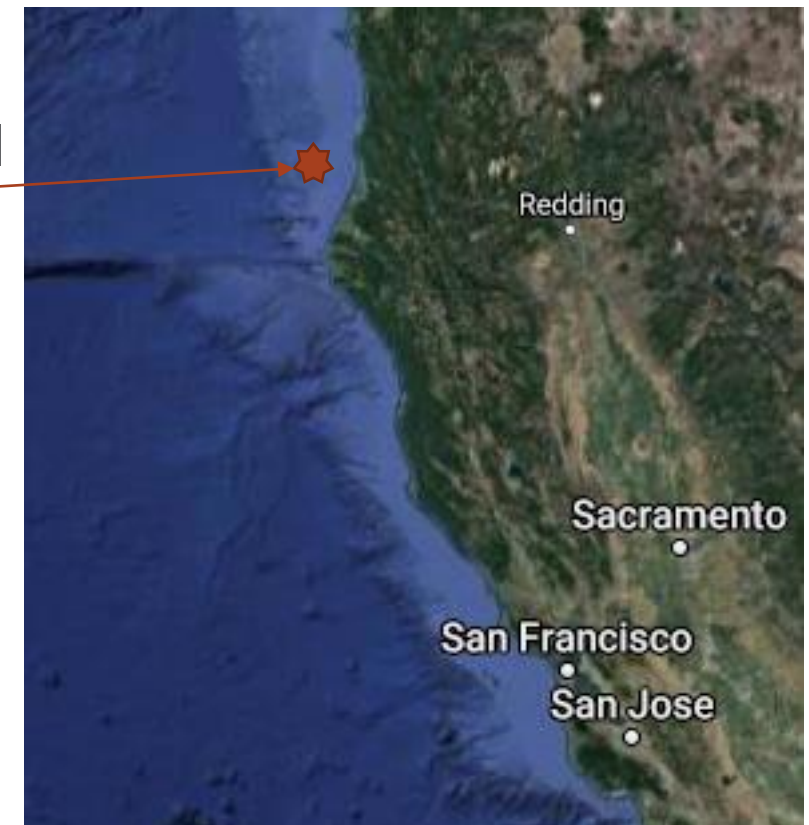


Wind Profiling Lidar  
wind speed, direction up  
to 200 m

Other instrumentation:

- surface wind
- temperature
- ADCP

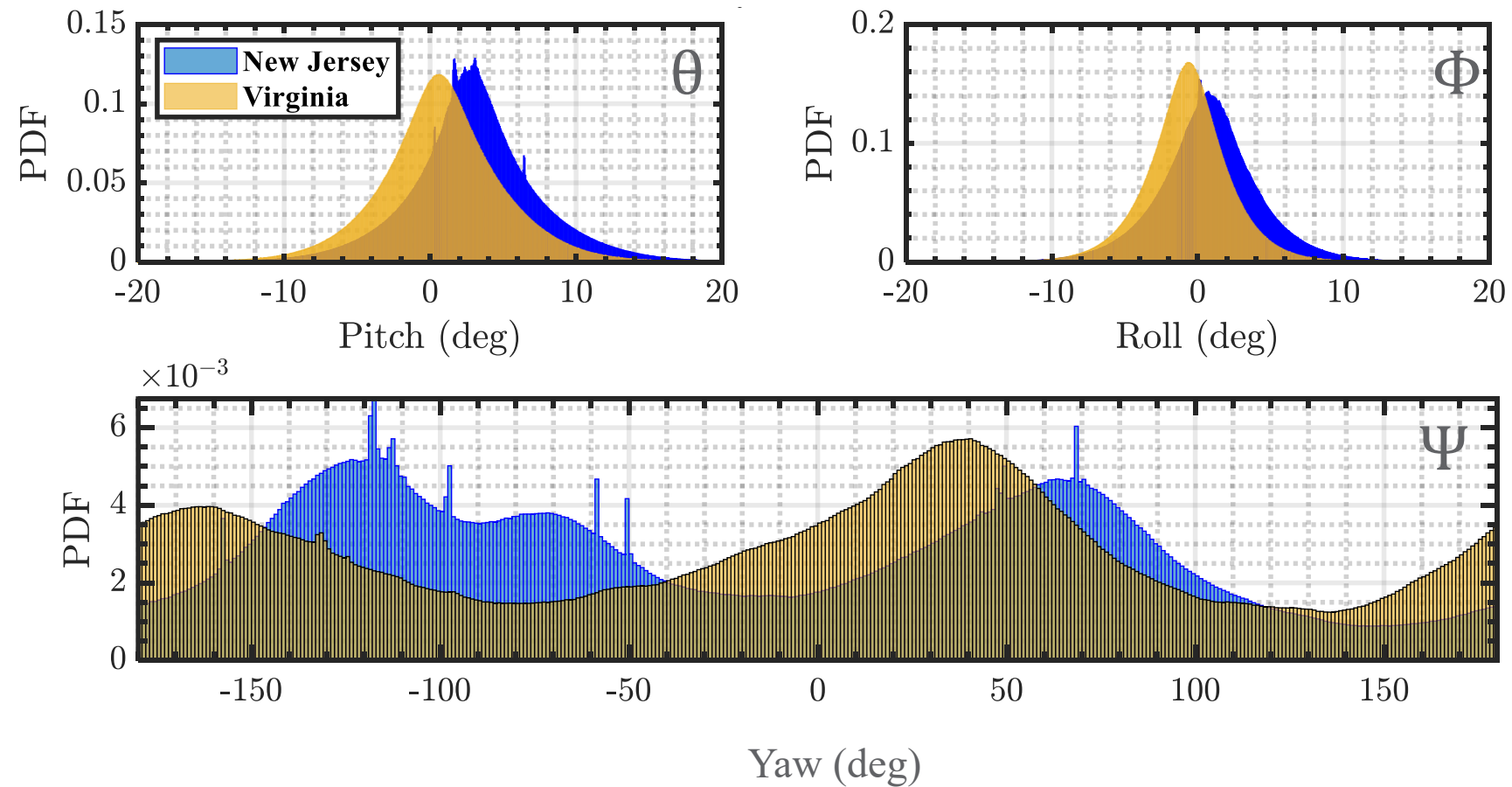
BOEM's Humboldt call  
area (approximate)



# Technical Challenges

- Platform motion

Motion Data from Atlantic Deployments



- Harsh environment



# Offshore Prototype (~\$65k)

IMU



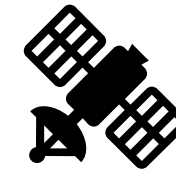
Flir A65 in stainless steel housing

GPS



Lucid Triton high-res camera

IMU



satellite link

ThermalTracker-3D software

- hardened for extended operation
- residual motion compensation



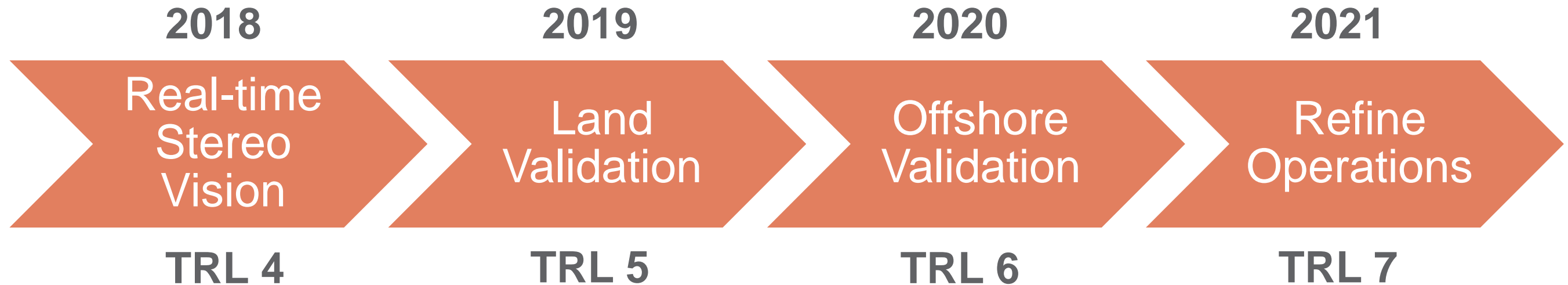
Perfect Horizon stabilization system



OnLogic Karbon 700

# ThermalTracker-3D Summary

- Purpose: Collect site-specific seabird (bat) flight activity.
- Use for baseline data collection during siting/permitting.
- Use for operational monitoring to quantify change.
- Reduce uncertainty, improve collision risk models.





# Thank You

## Acknowledgment

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