WAVE CLIMATOLOGY SUMMARY PRODUCTS FROM 32-YEAR WAVE HINDCAST MODEL DATA

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Agenda

- Purpose
- NREL Wave Hindcast Model Data
- Data Preparation
- Summary GIS Data Products
- Data Access

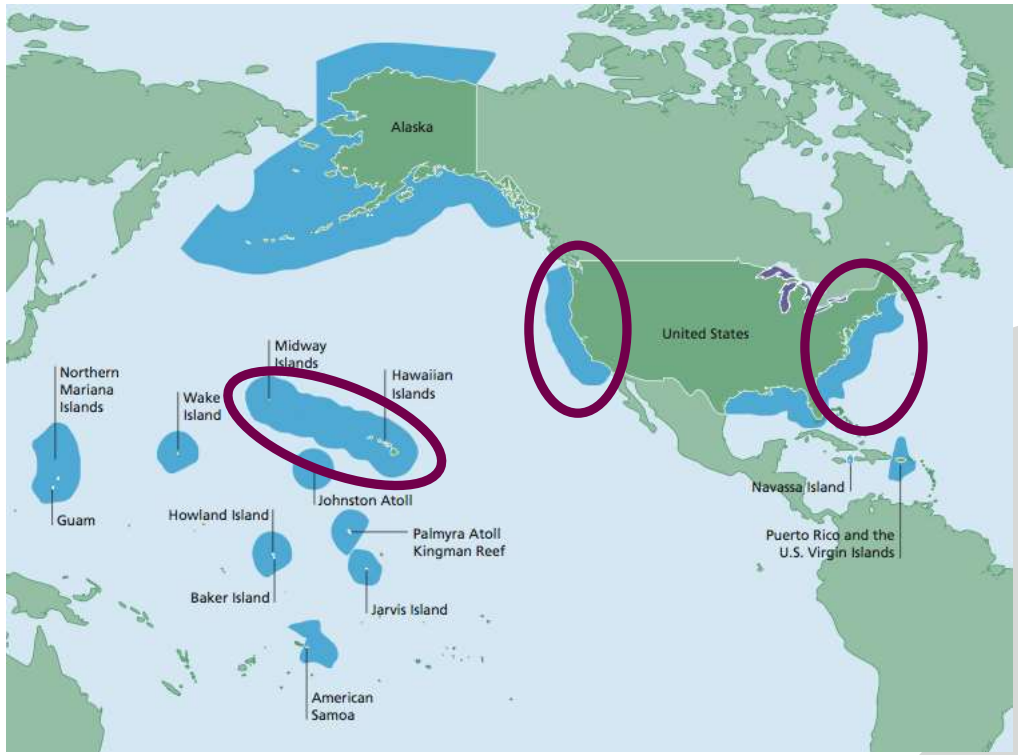
Purpose

- Marine Spatial Planning and Marine Operations Support
  - Oil & Gas
  - Renewables
  - Aquaculture / Blue Economy
  - Coastal Resilience
- Needs:
  - Wave characteristics: Wave height, Direction, Period, etc.
  - Covering a long-term history
  - High-level summaries to support siting
- Helps support:
  - Site suitability assessments
  - Operations planning
  - Design

Source: Aquaculture Magazine (aquaculturemag.com)

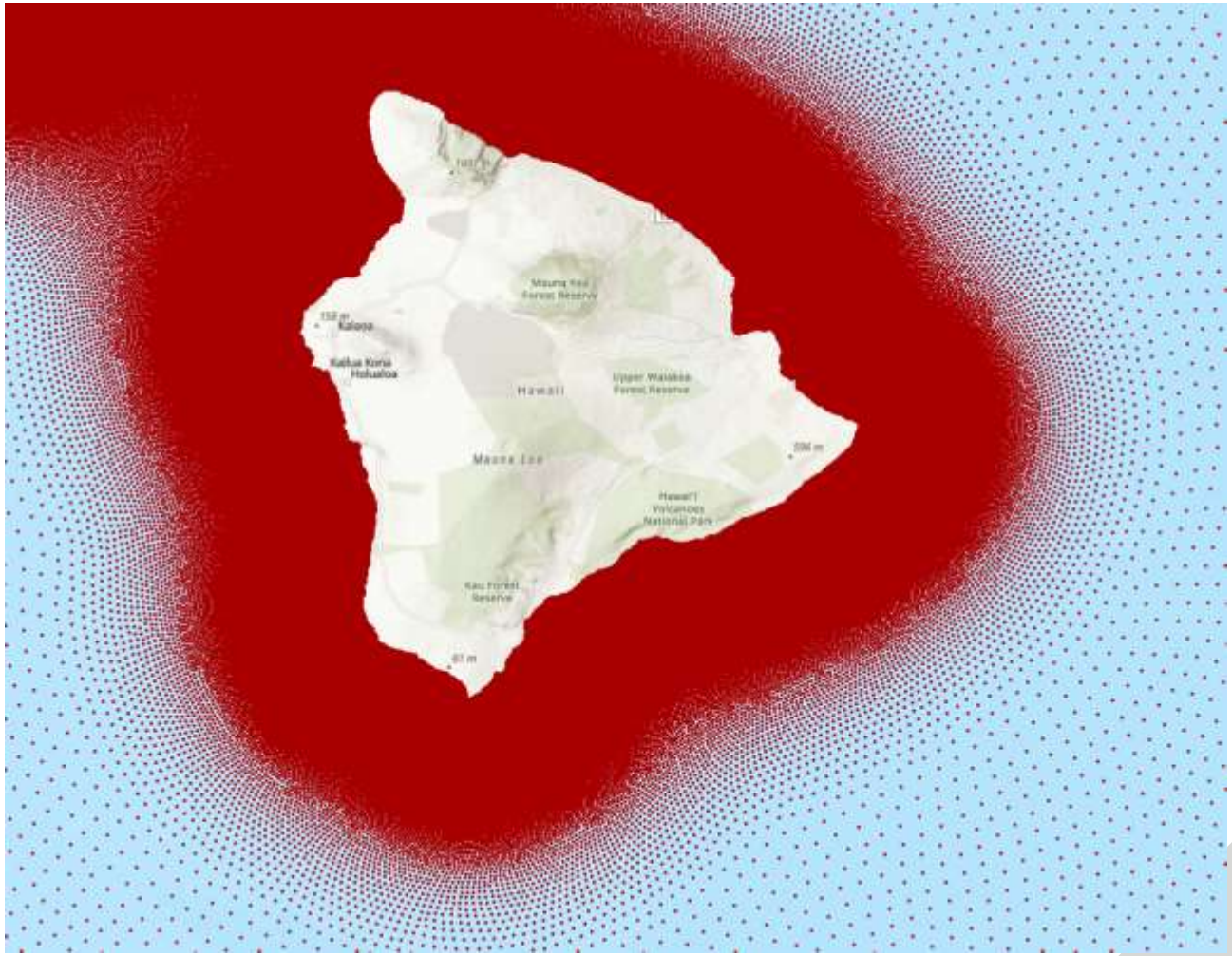
High Resolution Ocean Surface Wave Hindcast

- U.S. Department of Energy – National Renewable Energy Laboratory (NREL)
  - Covers 32-year period from 1979 to 2010
  - WaveWatch III & SWAN Models
- Primary purposes:
  1. Improve understanding of U.S. wave energy resource
  2. Provide critical information for wave energy project development
  3. Historical record of wave statistics at any U.S. site
- Highest resolution publicly available long-term wave hindcast dataset
- Plan to eventually cover entire US EEZ when complete
- Current data processed:
  - Pacific (HI), West Coast, Atlantic



Wave Hindcast Data

- Multi-scale, unstructured-grid
  - 200 to 5,000 meters
  - 700K – 2.6M points
- 3-hour time interval
- 10 wave variables available
- Hierarchical Data Format 5 (HDF5) format
- Stored on AWS S3 bucket:
  - Each annual file 82 – 308 GB
  - For download or read access through a Developer API



Data Preparation – Access, Filtering, and Summarization

- Python-based Developer API
  - Access data directly from AWS S3
  - Request Parameters: time period, time interval, geography, variables
  - Rate limitations
- Data requested in smaller batches
- Used only 5 of wave variables

Request every 8th Time Step (Daily)

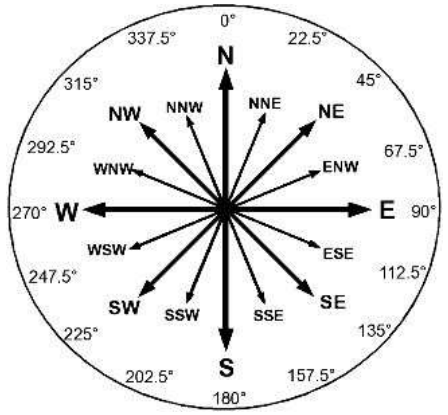
Average Daily Values for the Month and Year

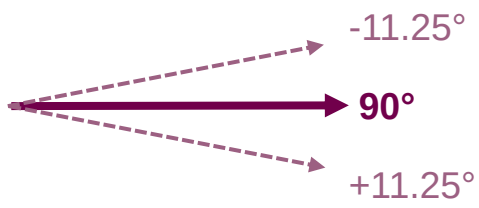
Average values for all 32 years – overall and by month

- **Mean Wave Direction**
- **Significant Wave Height**
- **Mean Absolute Period**
- **Peak Period**
- **Maximum Energy Direction**
- Mean Zero Crossing Period
- Energy Period
- Directionality Coefficient
- Omni-Directional Wave Power
- Spectral Width

Data Preparation – “Averaging” of Direction Variables

- Unable to average without true vector info
- Converted directions into 16 - 22.5° bins





Request every 8th Time Step (Daily)

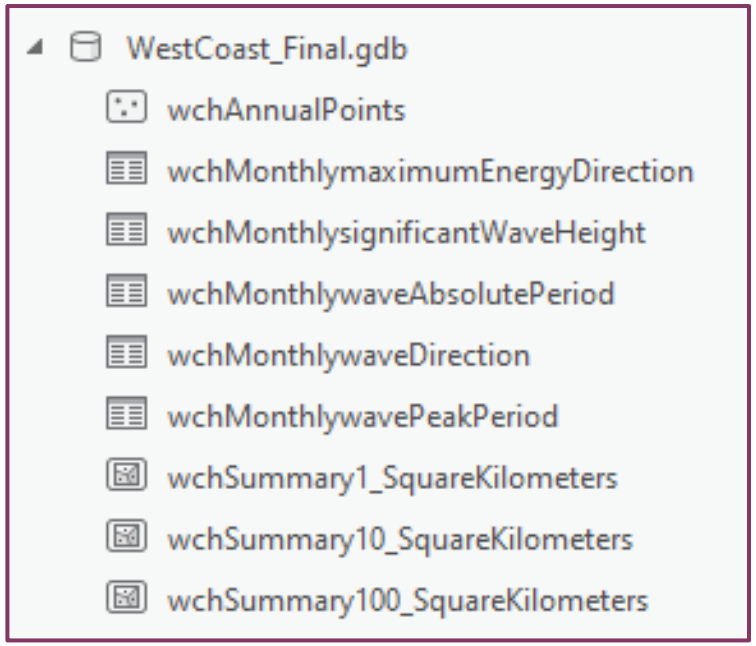
Tally the Frequency of each direction bin by year and month

Total the Frequencies over the 32-years overall and by month

Identify the most frequent (mode) direction for each time period

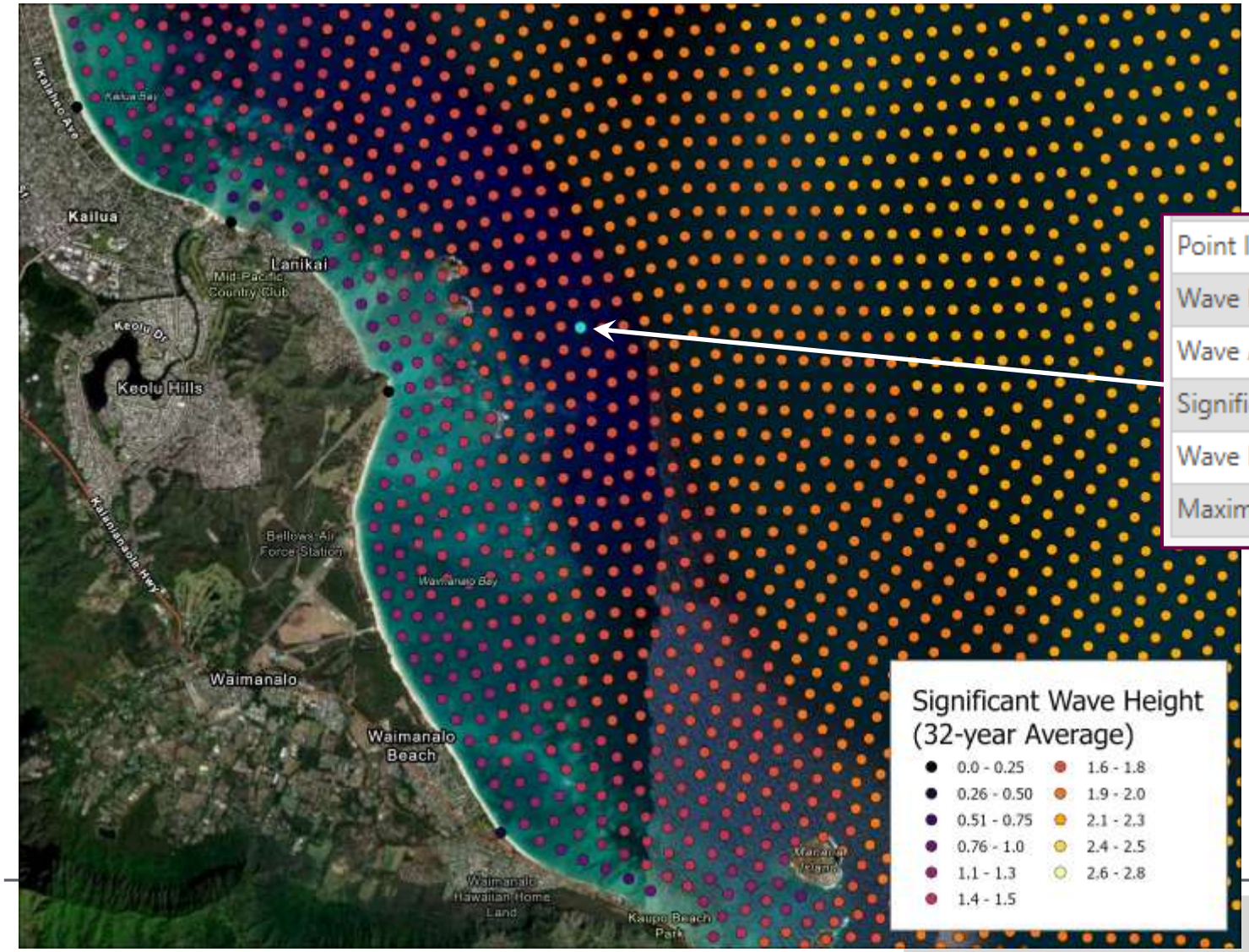
Summary GIS Data Products – Overview

- One Geodatabase per Region:
  1. Hind cast model points
     - Contains overall 32-year average, all 5 variables
  2. Tables of monthly statistics
     - Monthly average, all 5 variables (one table each)
     - Link to hindcast model points
  3. Summary Grids
     - 3 resolutions
     - Contains overall 32-year average, 3 primary variables (only)



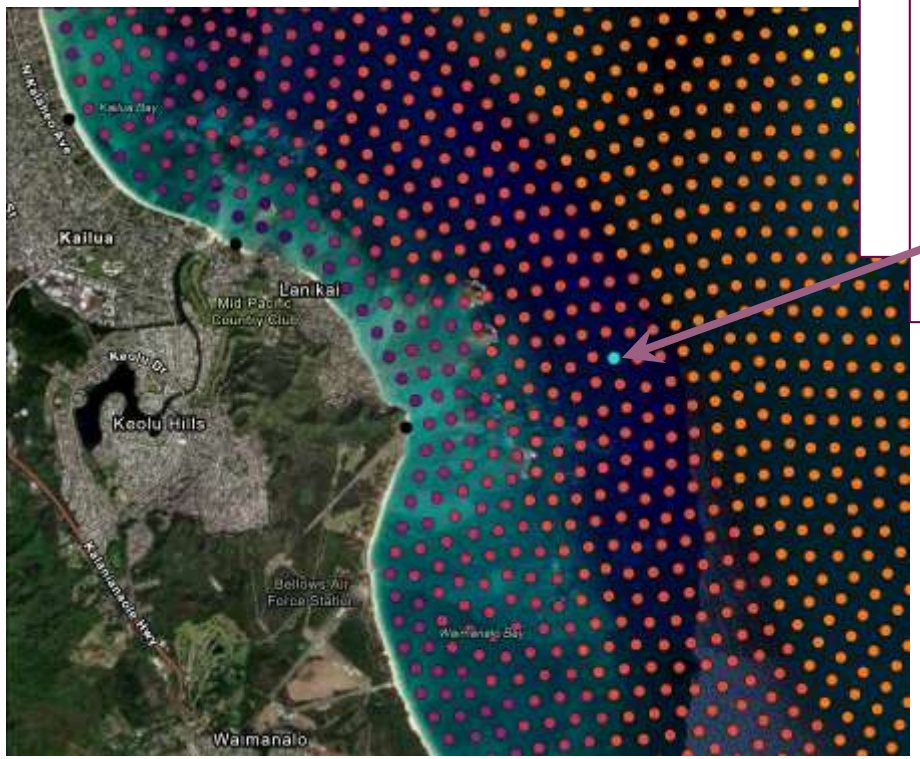
- Designed for flexibility:
  - Most commonly used summaries prepared
  - Intermediate data to generate other types of summaries

Summary GIS Data Products – Hind Cast Model Points



Point ID	637190
Wave Direction Annual Mode	67.5
Wave Absolute Period Annual Mean	6.13
Significant Wave Height Annual Mean	1.65
Wave Peak Period Annual Mean	8.65
Maximum Energy Direction Annual Mode	202.5

Summary GIS Data Products – Monthly Statistics Tables



Monthly Mean Wave Direction

Monthly Maximum Energy Direction

Monthly Mean Absolute Period

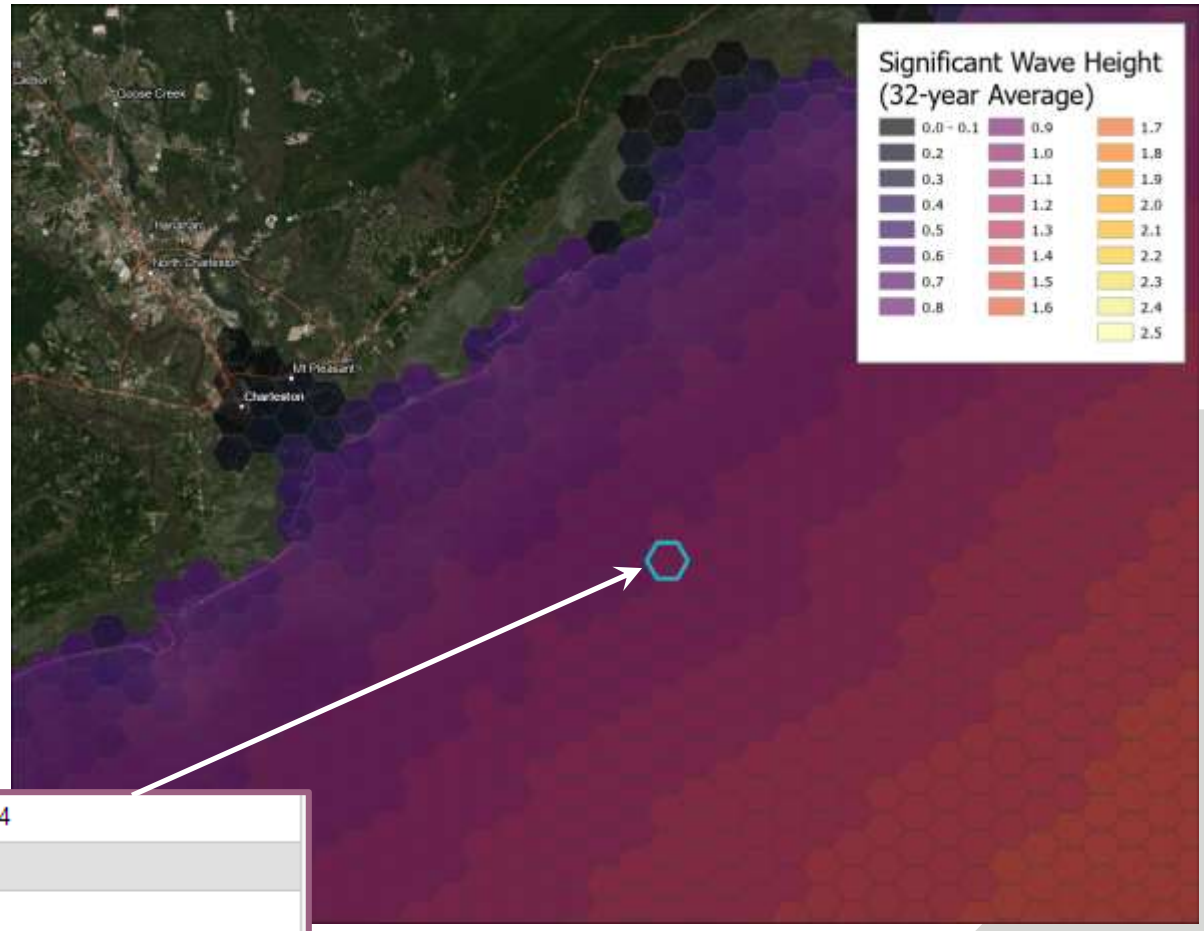
Monthly Peak Period

Monthly Mean Significant Wave Height

Point ID	Wave Peak Period Monthly Mean Jan	Wave Peak Period Monthly Mean Feb	Wave Peak Period Monthly Mean Mar	Wave Peak Period Monthly Mean Apr
0	12.73	12.76	11.89	10.39
1	12.73	12.79	11.89	10.38
2	12.72	12.78	11.89	10.38
3	12.74	12.79	11.89	10.37
4	12.75	12.79	11.9	10.37
5	12.75	12.79	11.9	10.37
6	12.75	12.79	11.89	10.36
7	12.75	12.79	11.89	10.35
8	12.75	12.79	11.9	10.35
9	12.74	12.78	11.9	10.35
10	12.74	12.76	11.9	10.35
11	12.75	12.75	11.91	10.34

Summary GIS Data Products – Summary Grids

- 3 Hexagon Grid Resolutions:
  - 100, 10, 1 km^2 cells
  - Designed for display at different scale ranges
- 3 wave variables summarized
  - Mean Absolute Period
  - Significant Wave Height
  - Wave Direction
- Summarizes hindcast points within each cell
- Overall, 32-year averages only



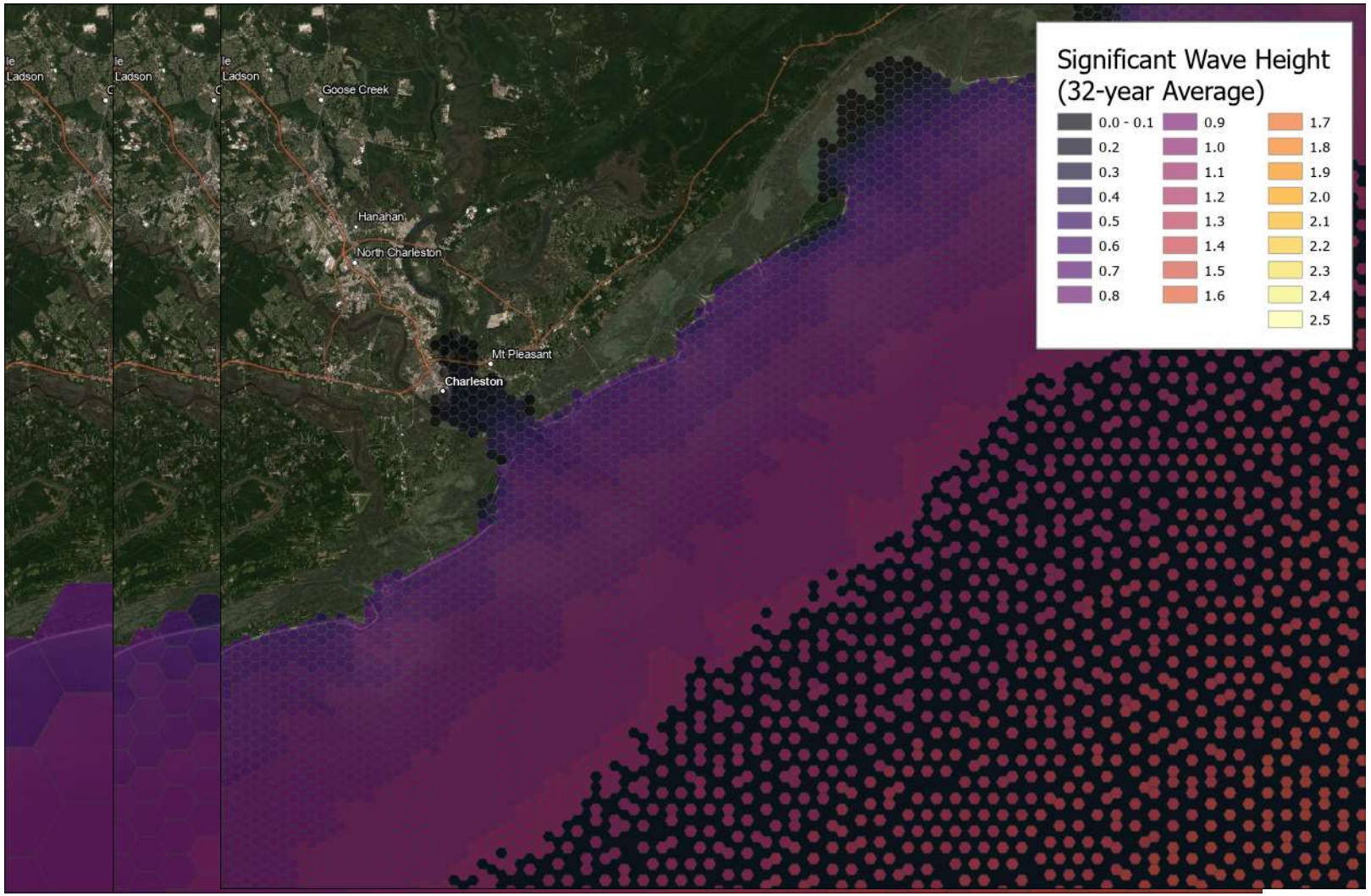
Hexagon grid cell ID	BX-514
Wave Direction Annual Mode	112.5
Wave Absolute Period Annual Mean	5.77
Significant Wave Height Annual Mean	1.01

Summary GIS Data Products – Summary Grids

100 km^2 cells

10 km^2 cells

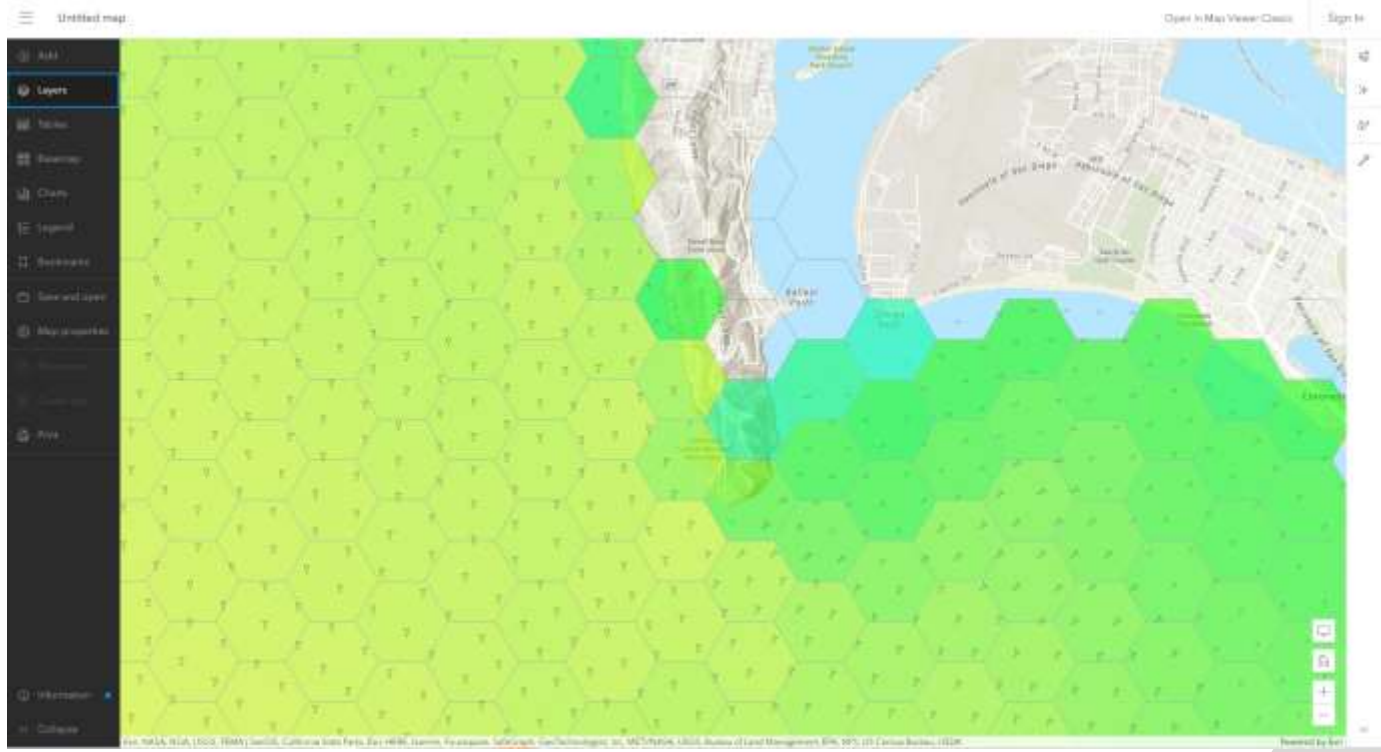
1 km^2 cells



Data Access

- MarineCadastre.gov
  - Tile Cache Map Services
  - One per region
  - Displays significant wave height data
  - Hind cast points also show direction
  - Scale-dependent display

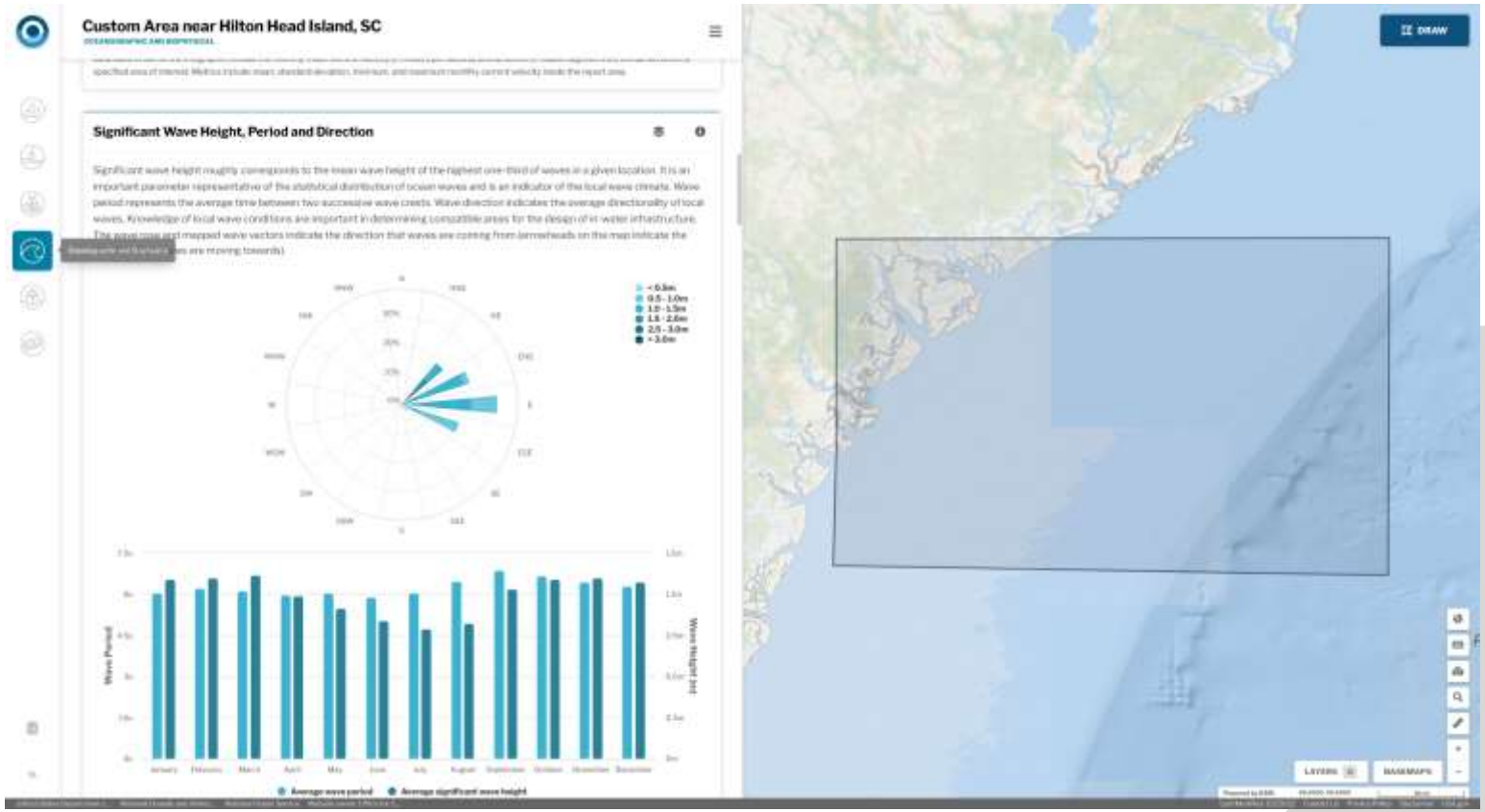
- https://coast.noaa.gov/arcgis/rest/services/MarineCadastre/
  - AtlanticSignificantWaveHeight
  - HawaiiSignificantWaveHeight
  - PacificSignificantWaveHeight



Future Data Access

- NOAA Ocean Reports
  - To replace coarser data currently used
  - Summarize wave variables within defined extent
  - Monthly averages
  - Distribution of direction

- https://marinecadastre.gov/oceanreports



Thank You!

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