NOS S-111/S-104 Encoding Update

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5th Tides, Water Level and Currents Working Group (TWCWG5)

Remote VTC

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In memory of Kurt Hess

NOAA PRECISION NAVIGATION PROGRAM

International Hydrographic Organization

Objective

In support of NOAA's Precision Navigation Program, increase utility of NOS Operational Forecast Systems (OFS) for mariners by encoding & disseminating Hydrodynamic Model Guidance in IHO standardized S-100 Formats

Overview

- The Office of Coast Survey (OCS), Coast Survey Development Lab (CSDL) has developed a prototype processing and dissemination service for prototype S-111 HDF5 files made available via AWS S3 bucket for testing by commercial manufactures of Electronic Chart Display and Information Systems (ECDIS), portable pilot units (PPU), and electronic charting systems (ECS)

- The Precision Navigation Processing and Dissemination System is deployed using cloud infrastructure, open source software and NOS's suite of open source python packages developed to encode and deliver standardized, water current forecasts for use in navigation systems according to IHO S-100/S-111 HDF5 standards

- A Precision Navigation Data Gateway map viewer has been developed to discover, visualize and download S-100 datasets as they become available

NOAA/NOS/OCS/CSDL ENCODING UPDATES

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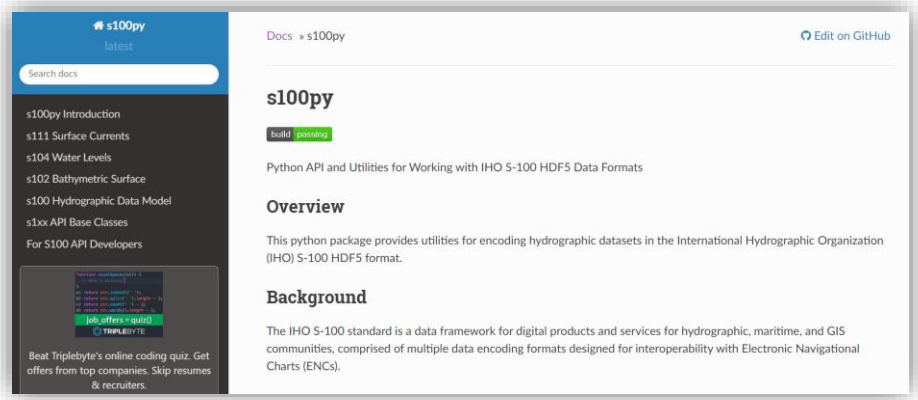
Released s100py v1.0.0-rc.1 on February 11, 2021, this replaces s100py v0.5.1

- This is a major release candidate, which includes a new API that encapsulates the data specifications to allow introspection with Python
- Support for s102 (bathymetry) and s104 (water levels) has been added
- A consistent API for S100 data structures was added and is used to encode S102, S104, and S111
- Convenience utility functions are available to convert data into S102/S104/S111 so detailed knowledge of the S100 specifications and APIs is not required in most cases
- The previous S111 library has been migrated to this general S100 API and therefore any code written against the previous s100py library will no longer work
- thyme python package is no longer a required dependency



https://s100py.readthedocs.io/en/latest/

https://github.com/noaa-ocs-s100/s100py

NOAA/NOS/OCS/CSDL ENCODING UPDATES

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- CSDL has built a Precision Navigation Processing and Dissemination System for prototype S-111 operations using AWS cloud infrastructure and open source software

- Migrated production of S-111 files for 5 NOS OFS regions to AWS cloud infrastructure, added 10 additional NOS OFS regions, and Dockerize python framework for easier deployment in the cloud

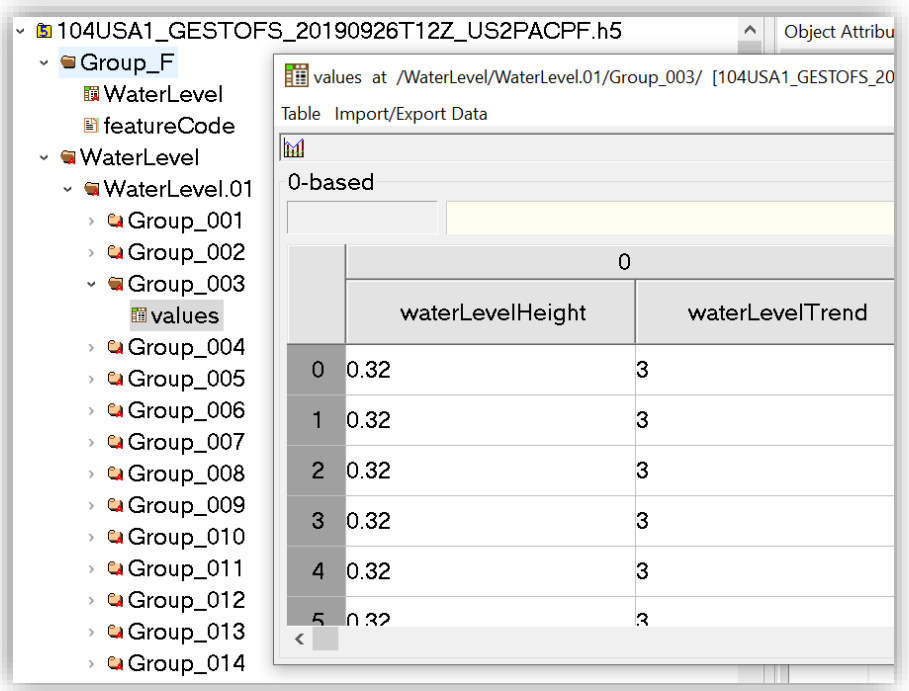
- Migrated s100py metadata database and NOAA REST API to AWS cloud infrastructure to automatically generate S-111 Exchange Catalogues for each OFS forecast cycle and disseminate via S3 bucket for discoverability

- Produced sample S-104 files using forecast guidance of water levels from NOAA's Global Extratropical Surge and Tide Operational Forecast System (G-ESTOFS)

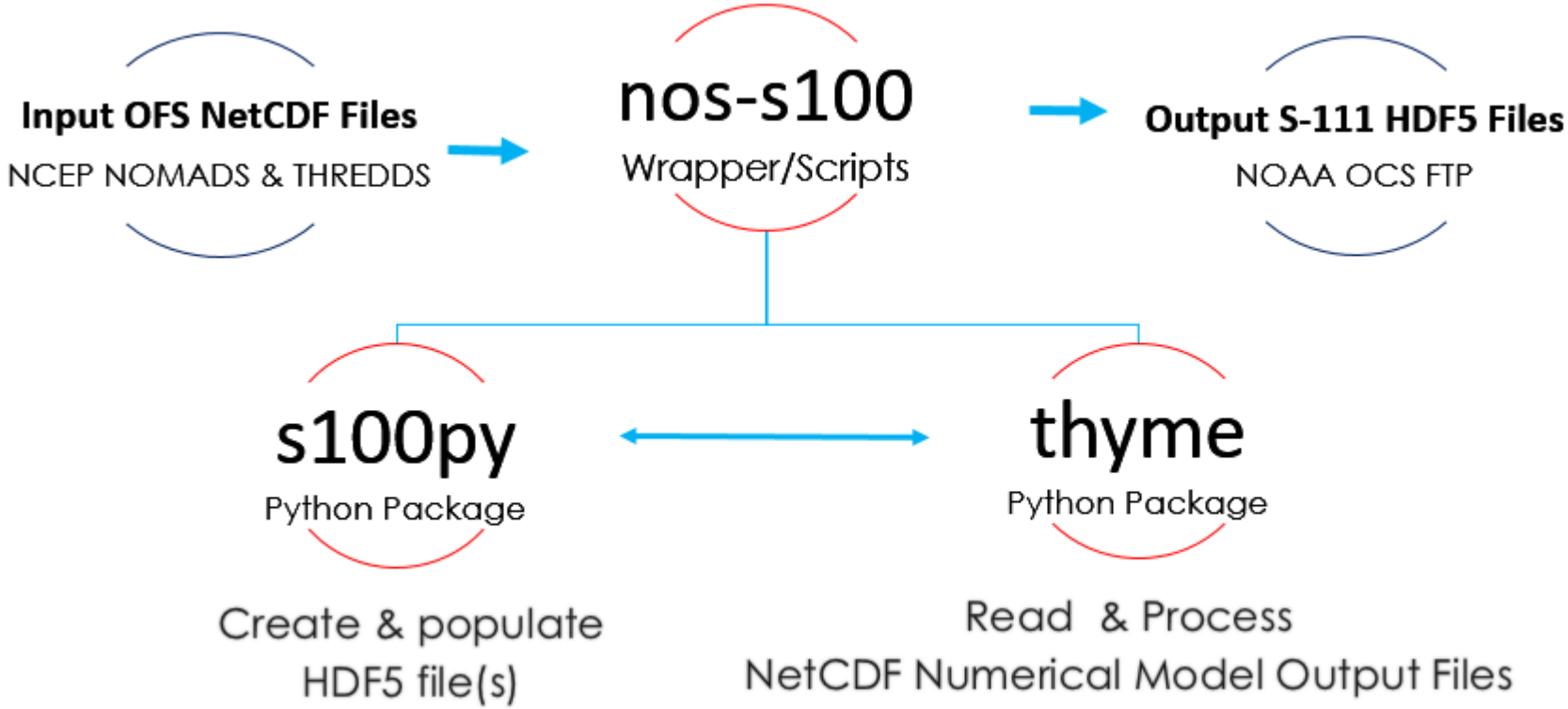
- Sample S-104 files were produced for reschemed ENC Band 2 cells located in Palau, Marianas, Guam, and American Samoa Pacific Islands

- Sample S-104 files match S-104 Product Specification v0.0.7 - Proposed Configurations and water level heights are relative to a global Mean Sea Level defined by the EGM2008 geoid

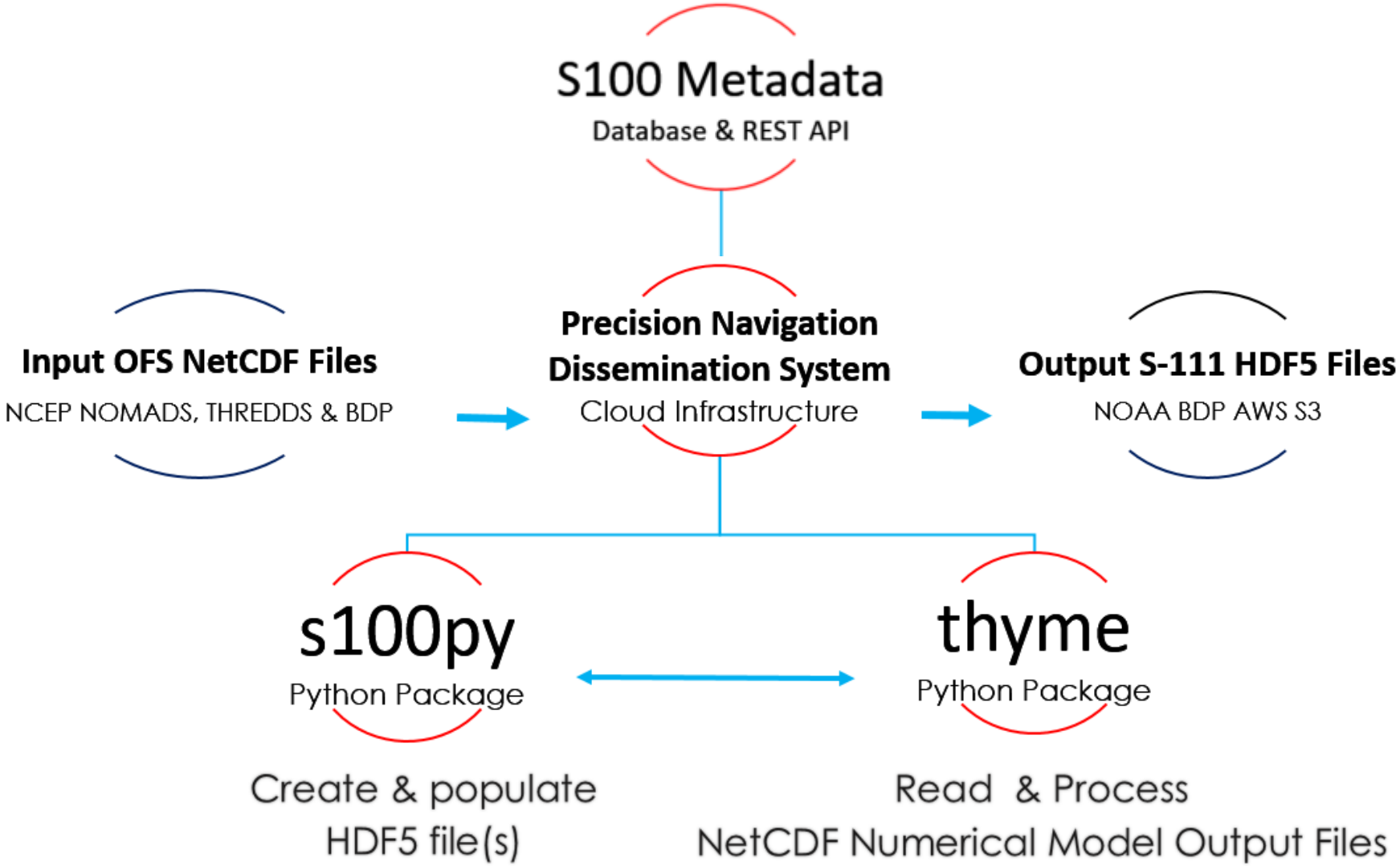
Sample S-104 file



PREVIOUS
S-111 ENCODING OPERATIONS



CURRENT S-111 ENCODING OPERATIONS



Precision Navigation & nowCOAST Cloud-Based Data Processing, Ingest, and Dissemination

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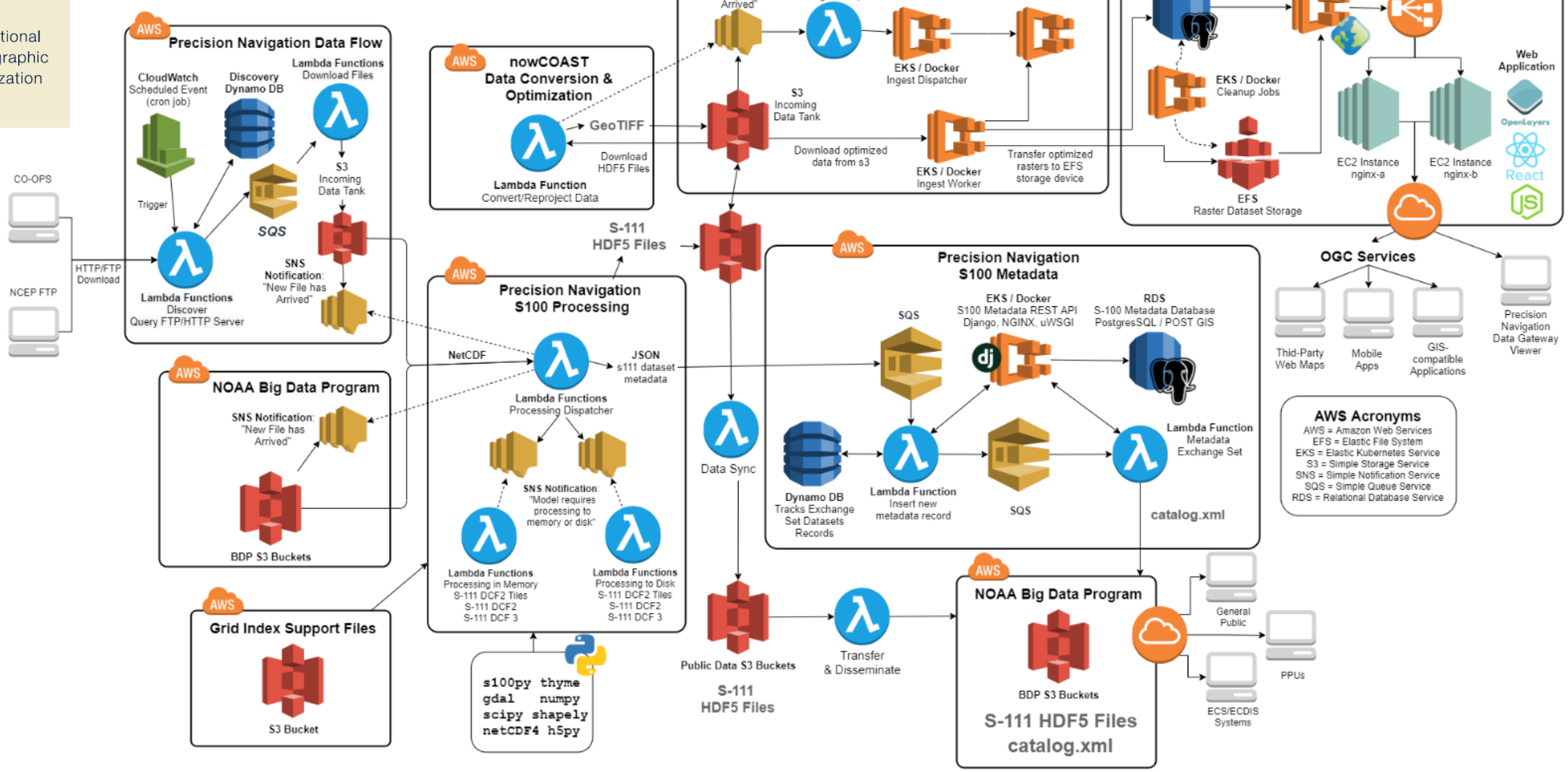

Terraform

PRECISION NAVIGATION SYSTEM S100 METADATA

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- Provides S-111 Exchange Catalog Metadata containing:
  - When new data is released
  - Where the data is stored
  - Where the data is geographically located
  - What type of data it is
  - Who produced the data

POST
Agency Static Values

POST
s111 Dataset

POST
Create Exchange Set

POST
s111 Datasets to Exchange Set

GET
Validate and Export Exchange Set XML

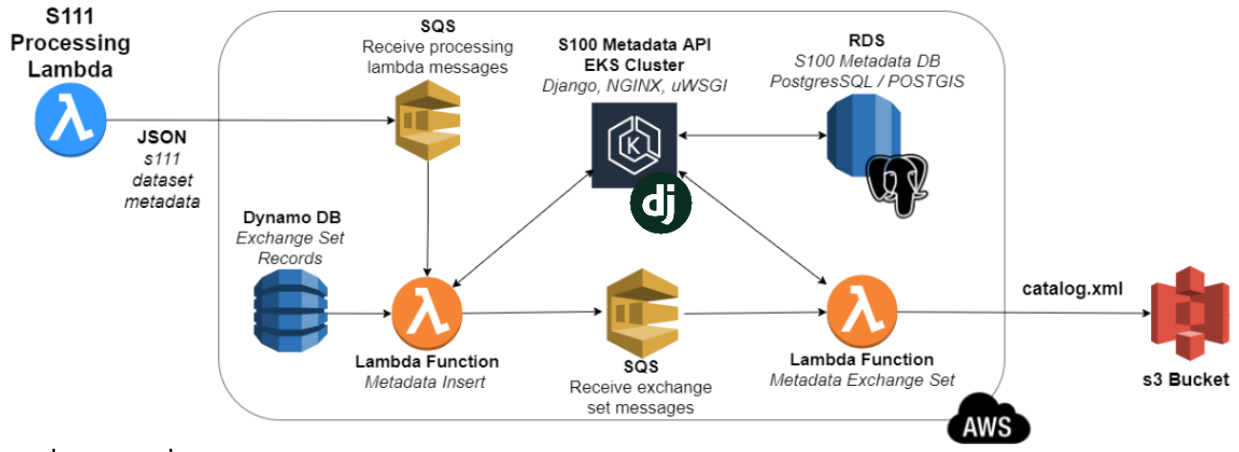
- S100 relational database tables developed by Raphael Malyankar and modeled after S-100 Edition 4.0.0 metadata

- NOAA REST API developed by IIC Technologies Inc based on NOAA requirements and built using Django

- Initialized and migrated to AWS by Precision Navigation Team using docker container that houses Django NOAA REST API, NGINX, uWSGI and works with external PostgreSQL (AWS RDS) S100 Metadata DB

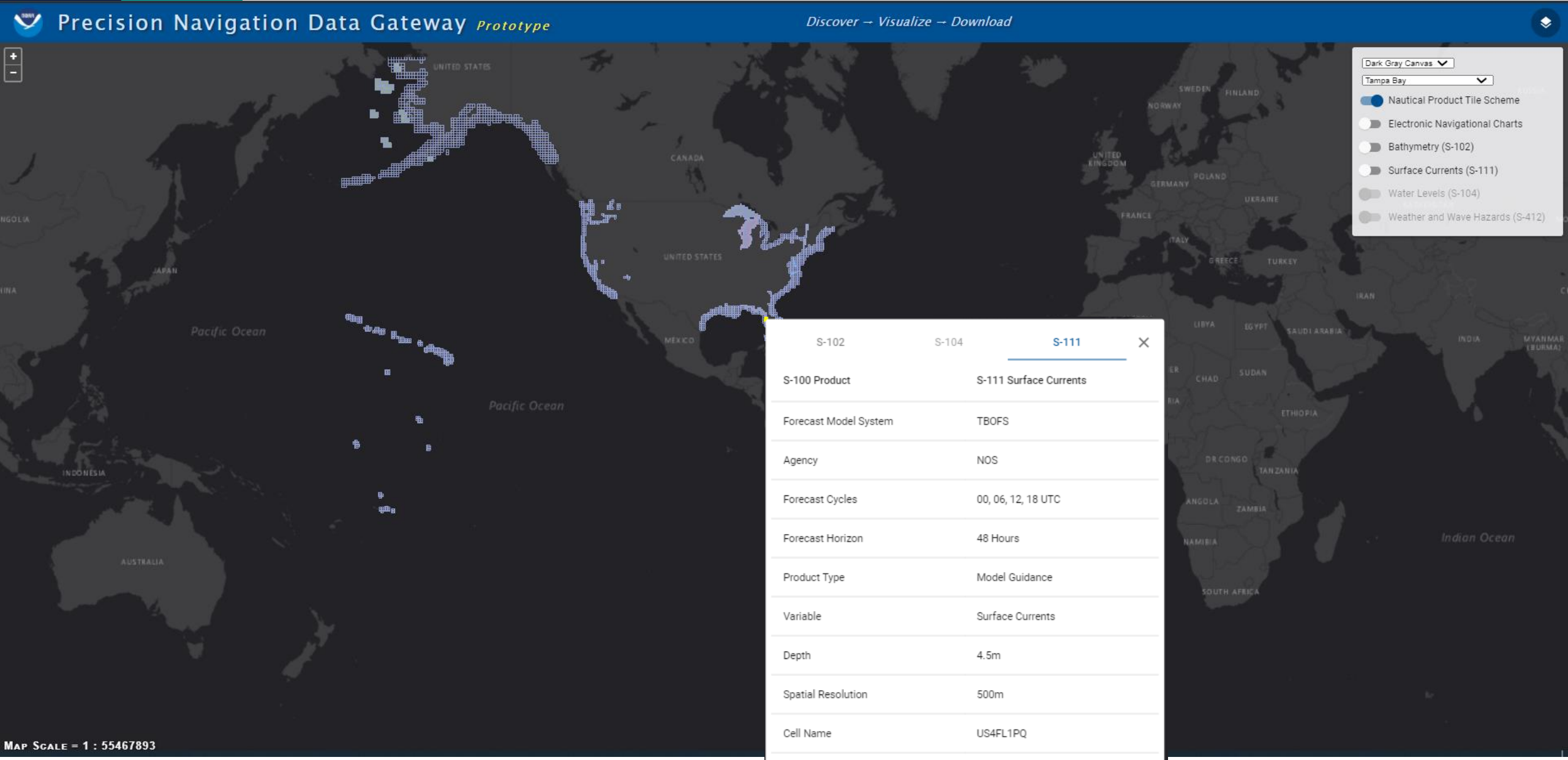
- Additional S-100 products have been added and include S101, S102, and S104, metadata will be generated as additional products become available

Precision Navigation S100 Metadata



Example S-111 Exchange Set Endpoints

POST	/exchangeSets/111	Adds S-111 exchange set record
PUT	/exchangeSets/111{exchangeSetId}	Updates specific S-111 exchange set record
GET	/exchangeSets	Retrieves all exchange set record IDs
GET	/exchangeSets/?Identifier=	Retrieves exchange set record matching specified identifier
GET	/exchangeSets/?ProductType=	Retrieves exchange set records matching specified product type
GET	/exchangeSets/{exchangeSetId}/export	Validates and exports specific exchange set record as XML
POST	/exchangeSets/{exchangeSetId}/datasets	Adds dataset associations to specific exchange set record
PUT	/exchangeSets/{exchangeSetId}/datasets	Updates dataset associations for specific exchange set record
GET	/exchangeSets/{exchangeSetId}/datasets	Retrieves dataset associations for specific exchange set record
DELETE	/exchangeSets/{exchangeSetId}/datasets	Deletes dataset associations from specific exchange set record



https://beta.marinenavigation.noaa.gov/gateway/

DISCOVER

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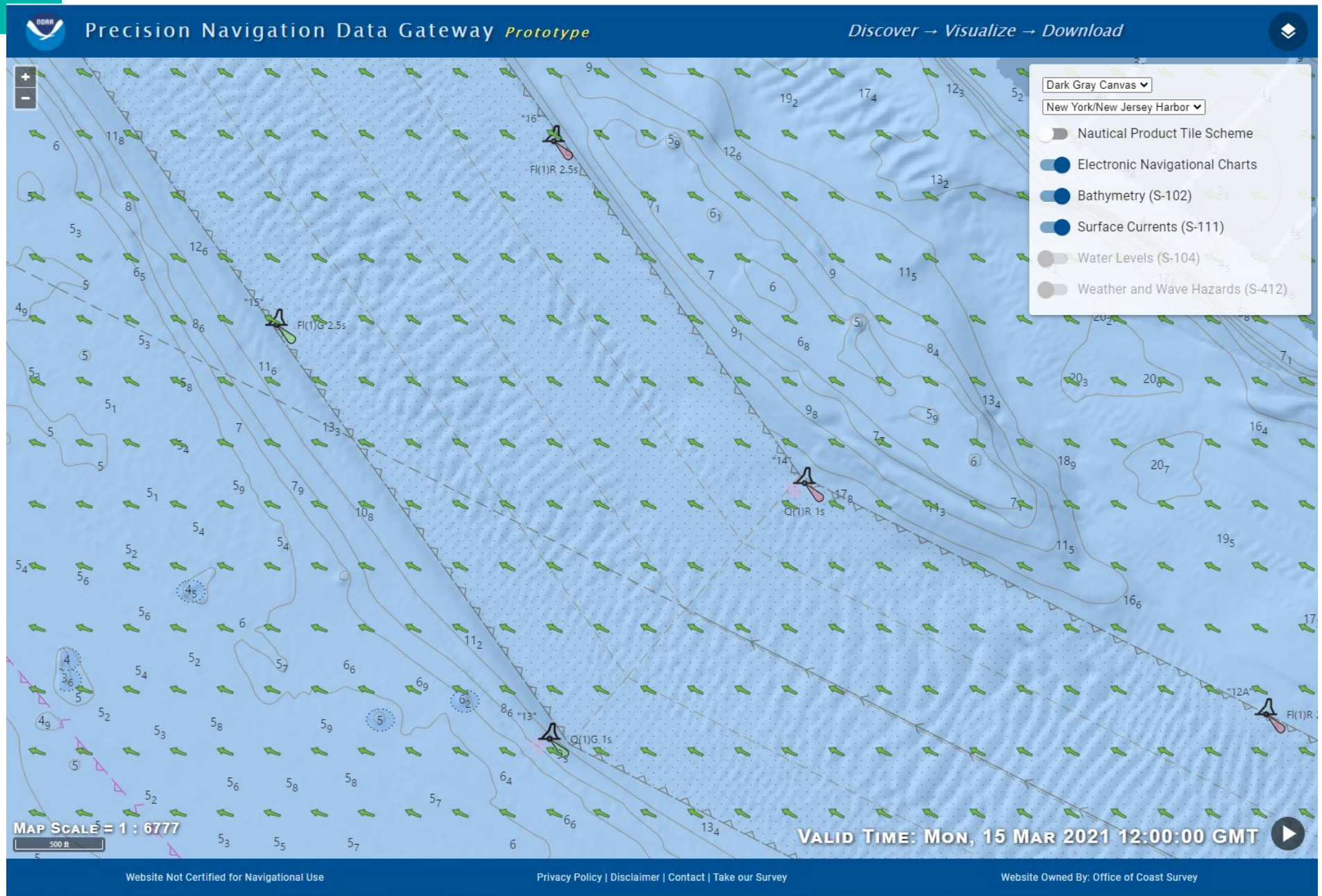
VISUALIZE

https://beta.marinenavigation.noaa.gov/gateway/



ACCESSING NOAA S-111 DATA ON AWS

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- Access to the datasets is being provided on Amazon Web Services (AWS) via Simple Storage Service (S3). Files can be downloaded via the native AWS S3 API using tools such as the AWS CLI or AWS SDK libraries such as the Python boto3 package.

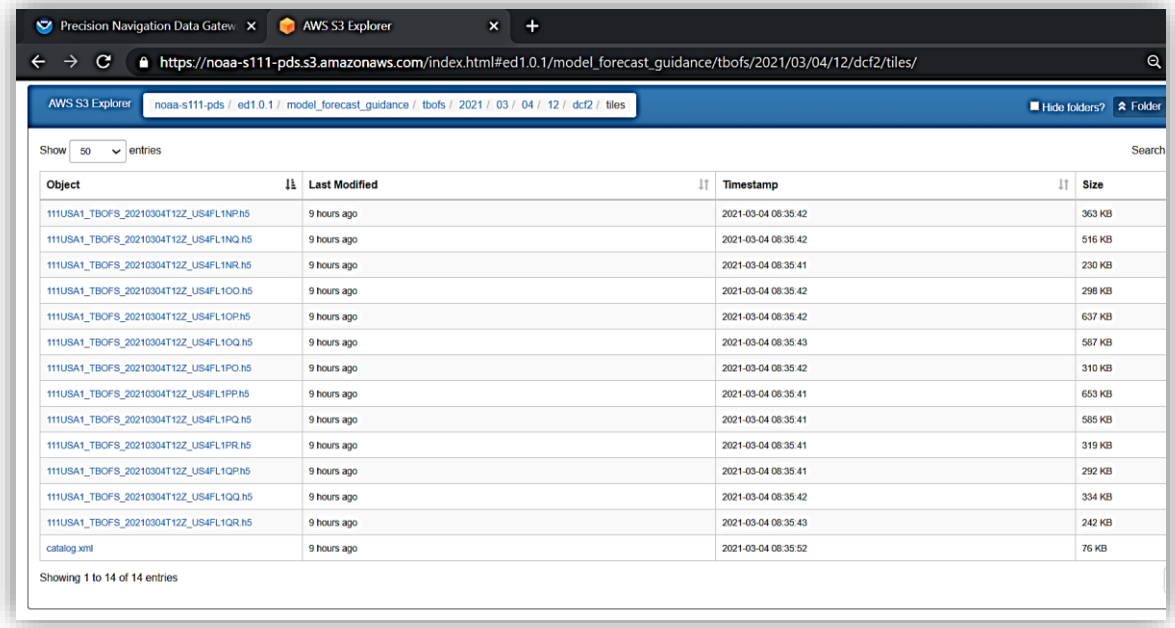
- AWS S3 also provides direct HTTP access to the files, so datasets can be downloaded using any HTTP client such as a web browser. The Amazon Resource Name (ARN) for the S3 Bucket is: arn:aws:s3:::noaa-s111-pds

- Additionally, an AWS Simple Notification Service (SNS) Topic has also been created to provide automated notifications when new files are added to the S3 Bucket. Users who operate their own infrastructure on AWS can integrate directly with this SNS Topic to trigger automated workflows using AWS Lambda or other services.

- The Amazon Resource Name (ARN) for the SNS Topic is: arn:aws:sns:us-east-1:123901341784:NewS111Object

- To make discovering and accessing the data easier, a simple AWS bucket explorer web app is also provided which allows you to navigate through the object key structure and download files using a web browser.

https://noaa-s111-pds.s3.amazonaws.com/README.html



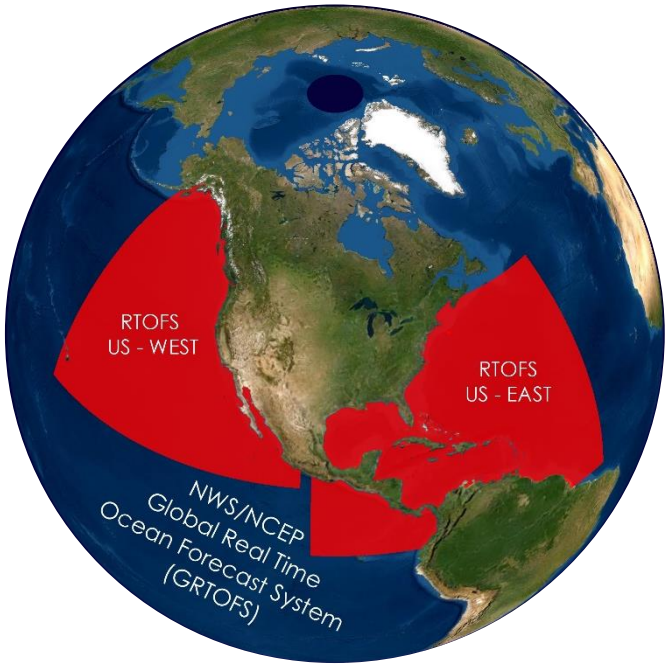
https://noaa-s111-pds.s3.amazonaws.com/index.html#ed1.0.1/model_forecast_guidance/

DOWNLOAD

PRECISION NAVIGATION S-111 DISSEMINATION

Automatically generating prototype S-111 HDF5 Type 2 tiles and exchange catalogs, Type 2 regional, and Type 3 regional files compliant with S-111 Edition 1.0.1 & S-100 Edition 4.0.0 for the following NOAA operational forecast systems :

Region	Horizontal Resolution	S-111 Tiles Per Exchange Set	Exchange Set Per Day	ENC Band
CBOFS	500 m	62	4	4
DBOFS	500 m	26	4	4
NYOFS	300 m	5	4	4
TBOFS	500 m	13	4	4
LEOFS	500 m	37	4	4
LOOFS	500 m	23	4	4
LSOFS	500 m	103	4	4
LMHOFS	500 m	154	4	4
NEGOFS	500 m	150	4	4
NWGOFS	500 m	19	4	4
NGOFS	1000 m	50	4	4
SFBOFS	300 m	15	4	4
GOMOFS	700 m	84	4	4
RTOFS – US EAST	8.5 km	32	1	2
ROTFS- US WEST	8.5 km	27	1	2



CHALLENGES IN WORKING WITH NOS OFS OUTPUTS

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- NOS ocean forecast system metadata is not standardized by framework, region, or model version, CF Metadata attributes mitigate some of the issues, but not all, thyme python module is developed to specifically for U.S. NOS operational forecast systems
- Presently, the BAND4 S-111/HDF5 tiles are only generated at one spatial resolution for each OFS (e.g. 500 m for XXOFS) which does not match native model grid resolution and is not sufficient for nearshore navigation
- NOS ocean models do not contain spatial indexing and require horizontal and vertical interpolation
- Initial regular grid masking solutions are not ideal for global grids and time varying masks (e.g. wetting and drying)
- Water Level predictions from saltwater OFSs are typically referenced to “Model Sea Level” rather than Local Mean Sea Level (LMSL) or chart datum (e.g. MLLW or LAT) and thus require vertical transformation
- NOS OFS model output can contain different units , dimensionality, fill values, vertical/horizontal coordinate systems, and variable naming conventions
- Water level, bathymetry, temperature, salinity, u/v, etc. may not be located at same grid points, implications on horizontal/vertical transformations, interpolation, and rotation
- Output files often contain variables not applicable to most users and a collection of all native output files for full forecast run can be huge (> 4GB for some models)

NEXT STEPS

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- Refactor and optimize thyme python package
- Upgrade to latest S100 Metadata API release and add to GitHub
- Add utilities for S-104/S-111 DCF 1, 4, 7, 8 in S100 API
- Develop S-104 test files from NOS OFS forecast guidance using new S100 API
- Improve surface current map services , use u/v instead of speed/direction
- Need S100 test bed with interoperability and portrayal and feature catalogs to test S-111 datasets feasibility
- Need data quality checks and data structure validation

Required Product Specification component	**Level 1** v1.0.0	**Level 2** v1-2.0.0	**Level 3** >v2.0.0	**Level 4** >v2.0.0	**Level 5** >v2.0.0
Main Document (Defines the relevant parts of S-100 that are required for the Product Specification)	X	X	X	X	X
A Default Encoding	X	X	X	X	X
S-100 Compliant Feature Catalogue	X (draft)	X (updated)	X (final, from IHO GI Registry)	X	X
Data Classification and Encoding Guide	X (draft)	X	X (final)	X	X
S-100 Compliant Portrayal Catalogue NOTE: Not every Specification will need a Portrayal Catalogue – this should be determined as part of the development process and stakeholder feedback.		X	X	X	X
Data Quality Checks		X	X	X	X
Test Data Sets		X	X	X	X
Data Validation (and test datasets)		*X*	*X*	*X*	*X*
Exchange Catalogue		X	X	X	X
Encryption / Digital Signatures			X	X	X
Interoperability			*x** (draft)	X* (tested)	X*
Alerts and Indications				X*	X*
Operational data					X

(X* = ECDIS only)

Acknowledgements

- Precision Navigation Team
  - Jason Greenlaw, Adam Gibbons, Stephen Gilbert, John Kelley
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- NOAA/NOS nowCOAST Project
  - https://nowcoast.noaa.gov

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