

Introduction to Digital Twin

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NOAA Hydrographic Services Review Panel

Public Meeting, September 27 - 29, 2023, Hotel Silver Spring, Silver Spring, MD

Introduction to Digital Twin

- 1 Digital Twin Defined
- 2 NOAA Services
- 3 Data Sciences and Future Directions
- 4 Q&A and Discussion

Agenda



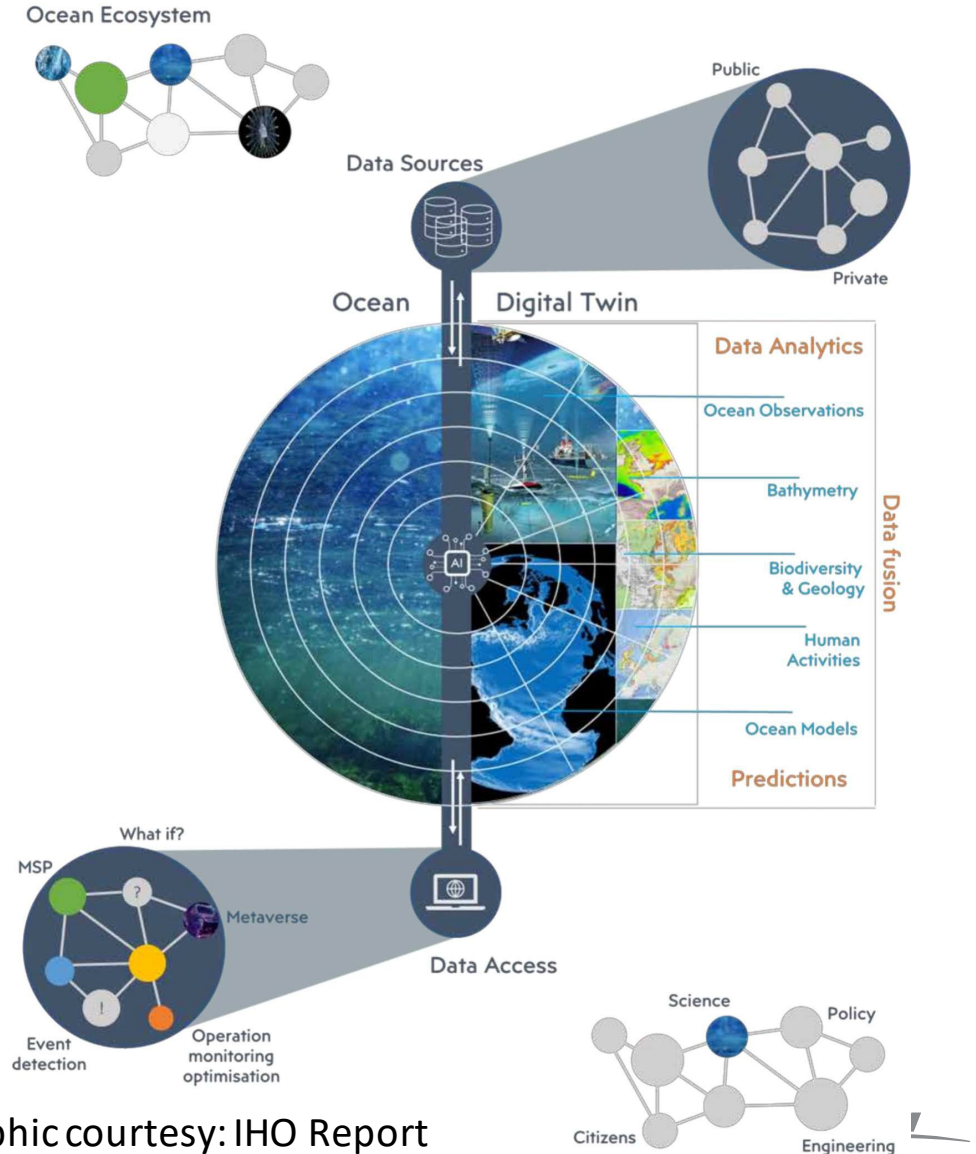
What is Digital Twin?

- Dynamic, up-to-date replica or representation of a physical object, asset, or system
- Complete collection of all data in a single place
- Evolves with the flow of real-time input from sensors and more
- **NOT** a static 3D model or simulation; **DOES** continue to evolve with added data and information
- Connection between digital and physical worlds enhances life cycles, informs decision-making, and supports predictive capabilities



How Digital Twin Relates to NOAA's Ocean and Coastal Monitoring and Mapping Activities

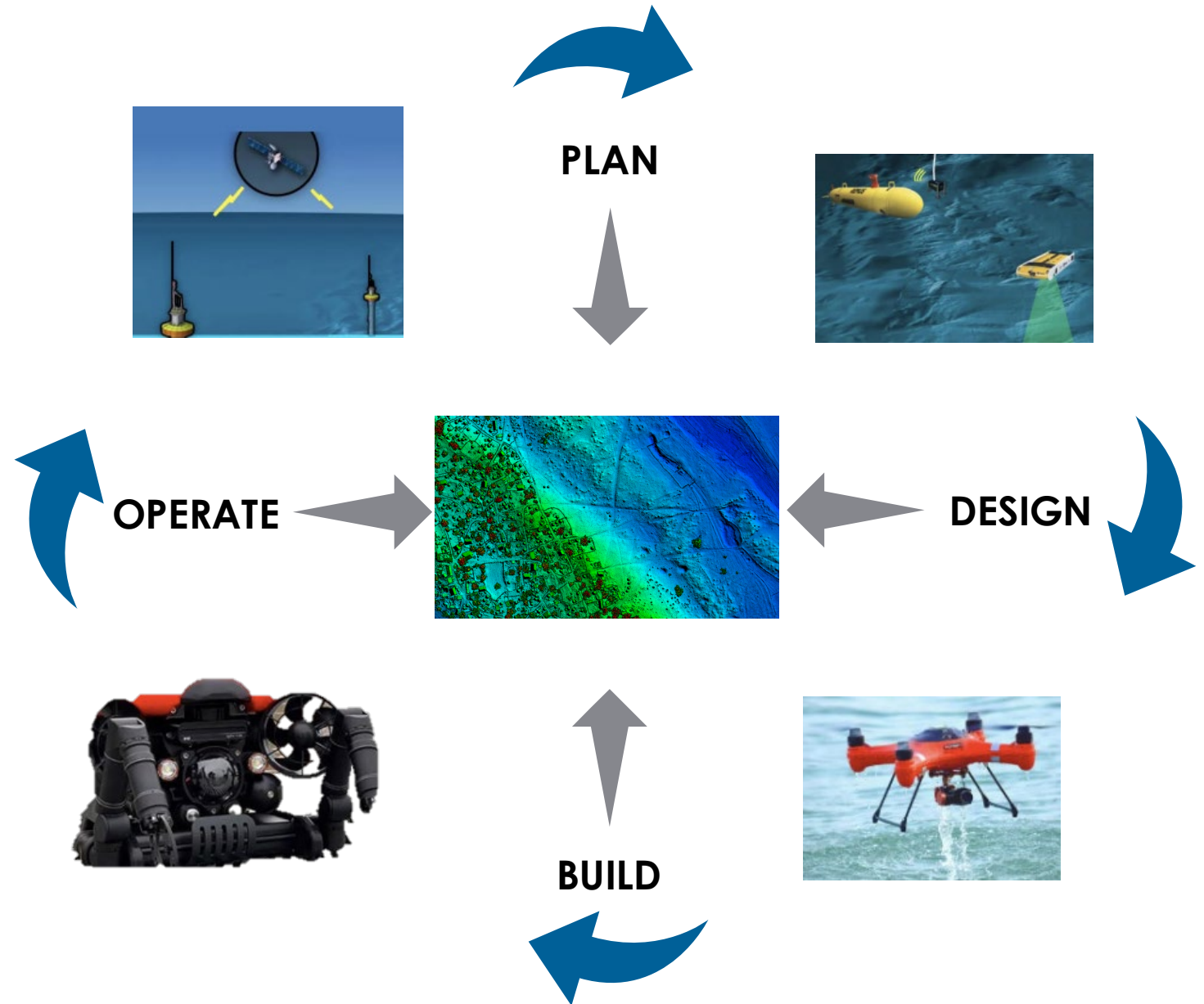
Digital twin of the ocean:
Virtual representation of the ocean with its physical, chemical, and biological properties, based on ocean observations and ocean models with the purpose of developing what-if scenarios for decision-making.



Graphic courtesy: IHO Report

How Digital Twin Benefits NOAA in Managing Assets

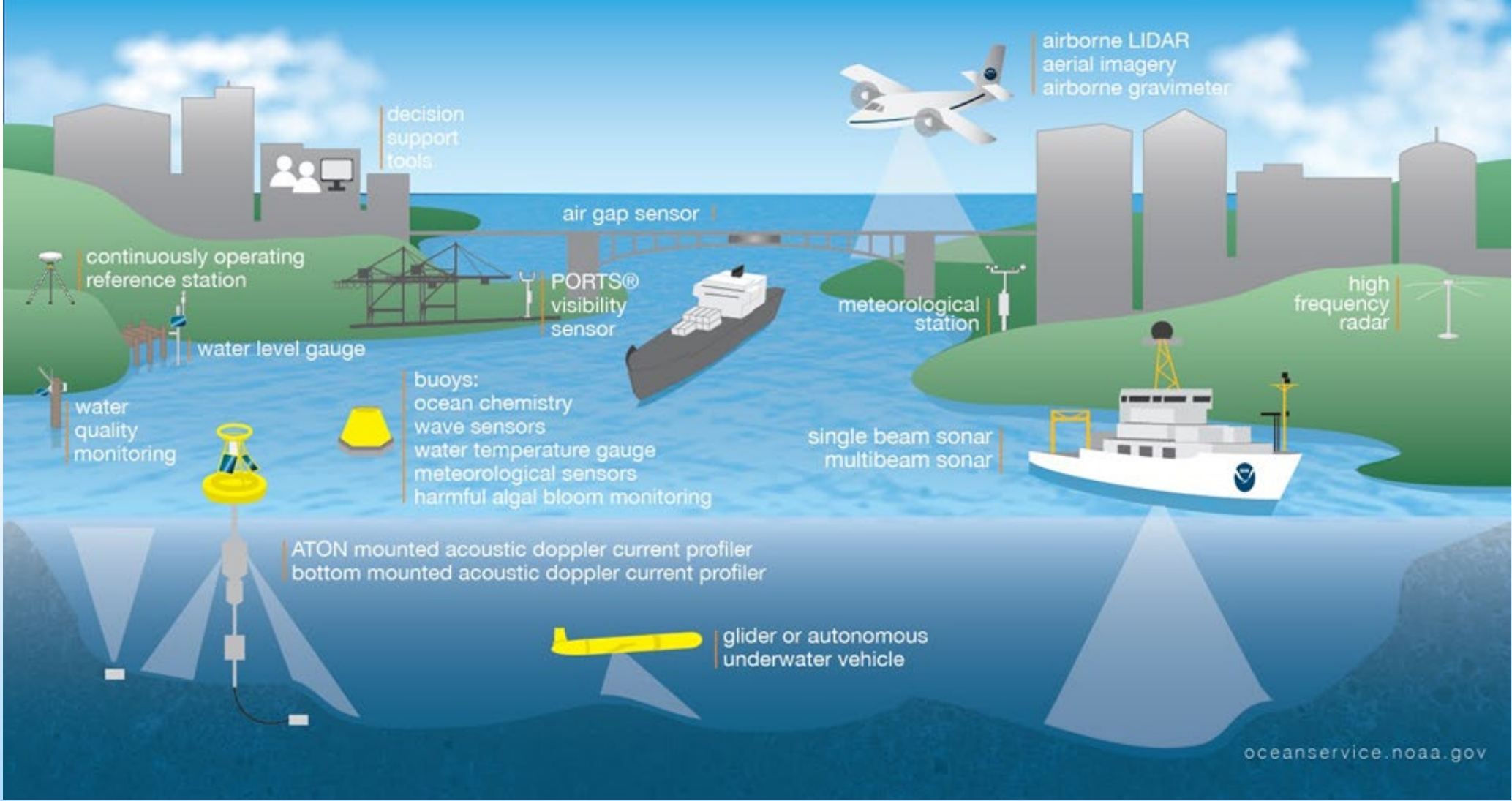
- ❖ Accelerates asset operational readiness
- ❖ Transforms asset life cycles with maintenance and performance data
- ❖ Lives in dynamic, easy-to-access and manage objects
- ❖ Prevents trapping of digital data in static files by transferring all data related to the entire asset life cycle (design to operation)
- ❖ Minimizes asset management challenges caused by analog, unclassified, and disconnected data



What do I know about NOAA services?

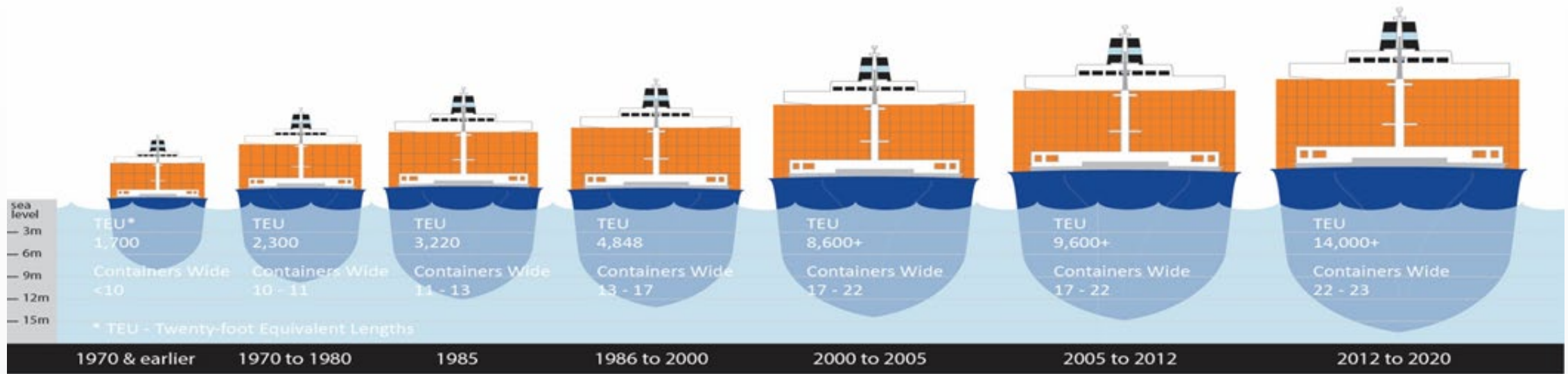
NOAA provides public and federal agencies with a tremendous amount of data and services.

Foundational Data



compliments of NOAA

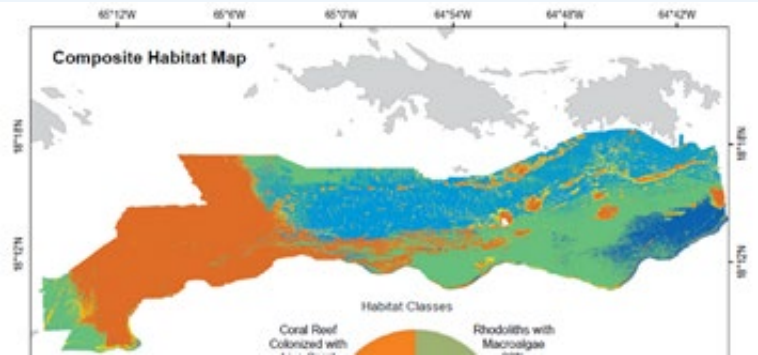
Supporting Maritime Commerce Now



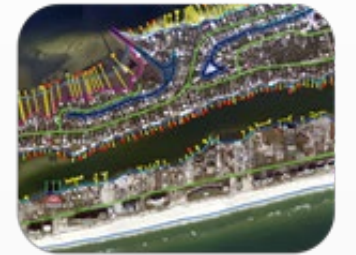
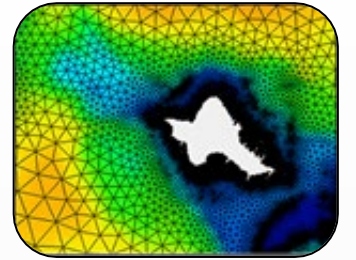
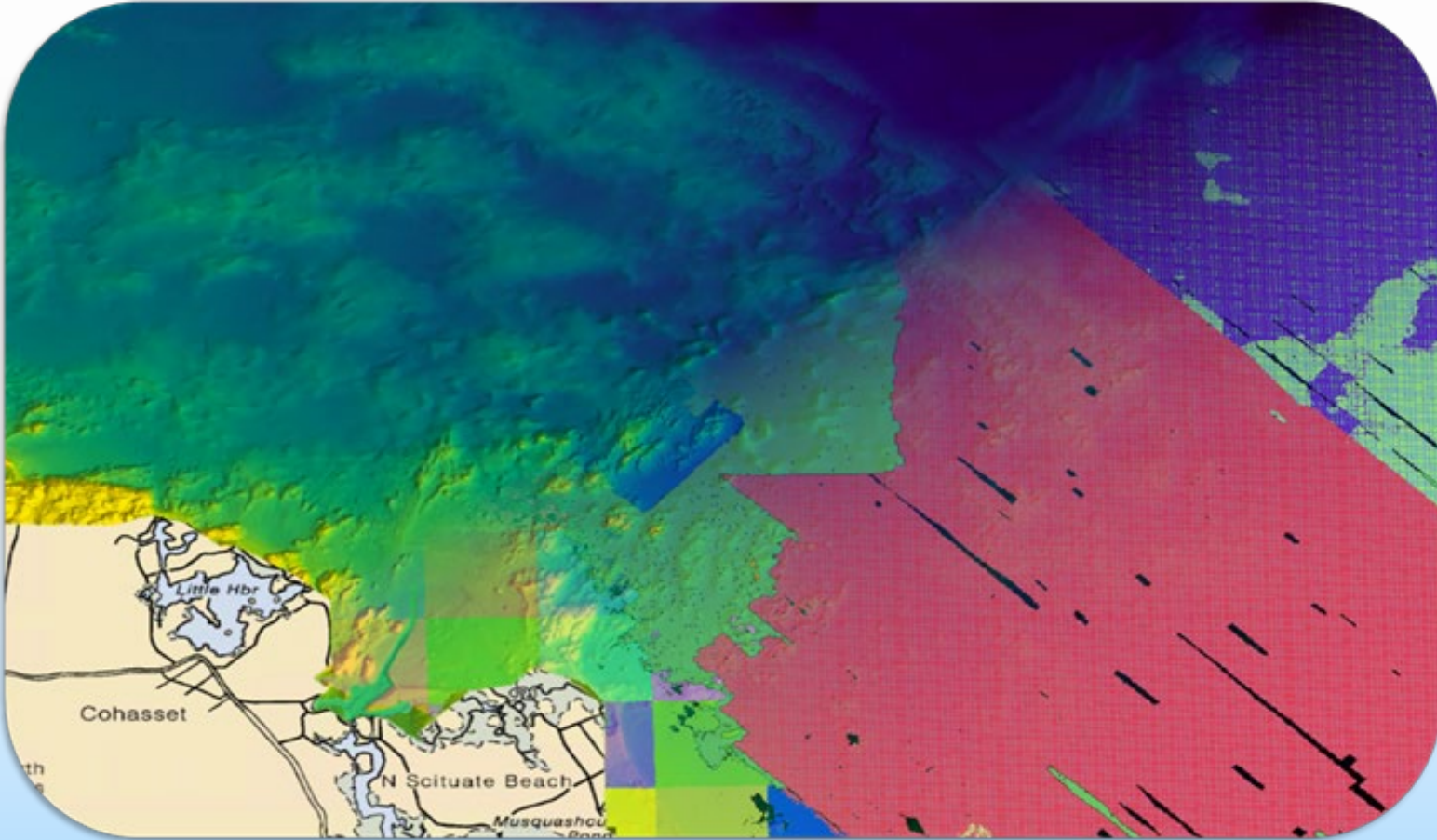
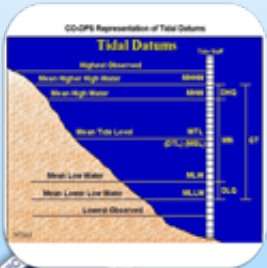
compliments of NOAA

National Ocean Service

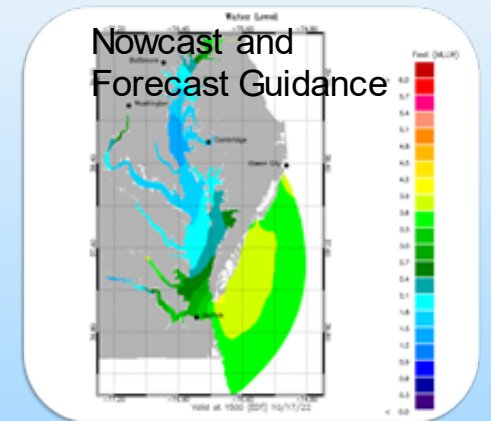
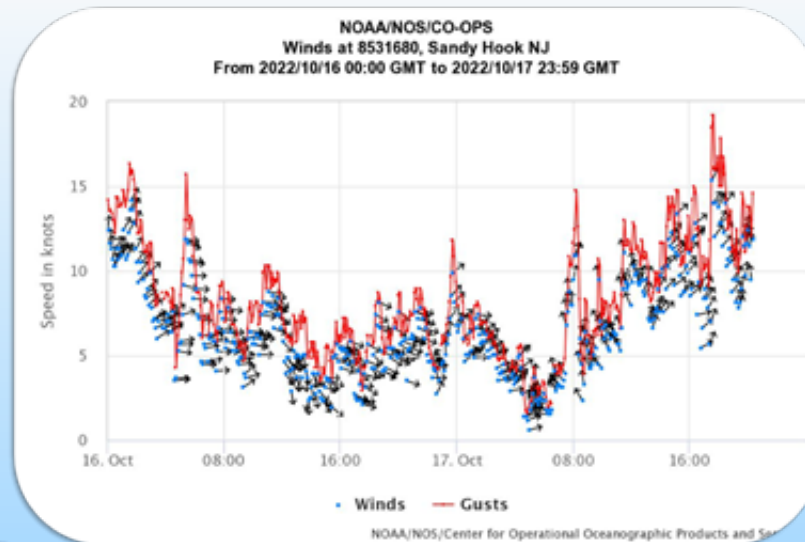
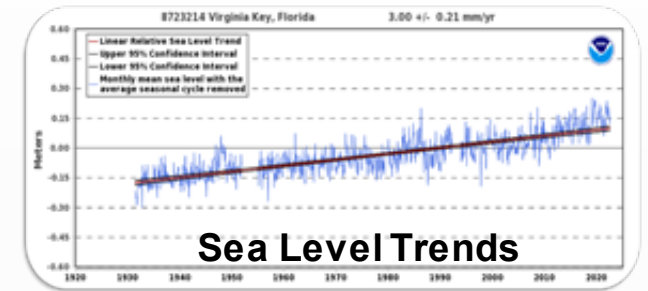
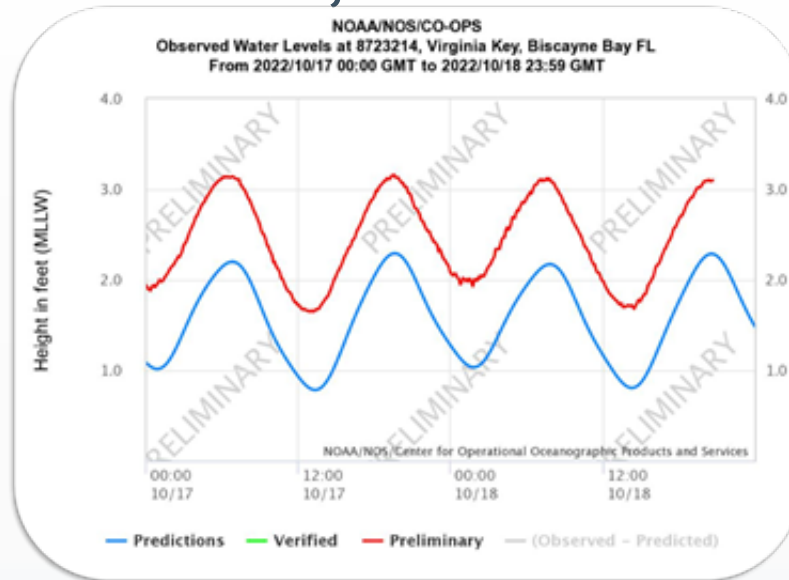
Non-Navigational Uses of Foundational Data



Mapping Data Streams and Uses

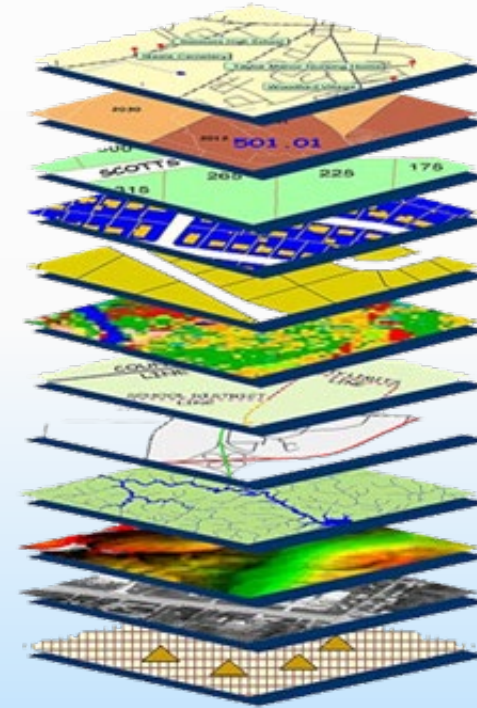
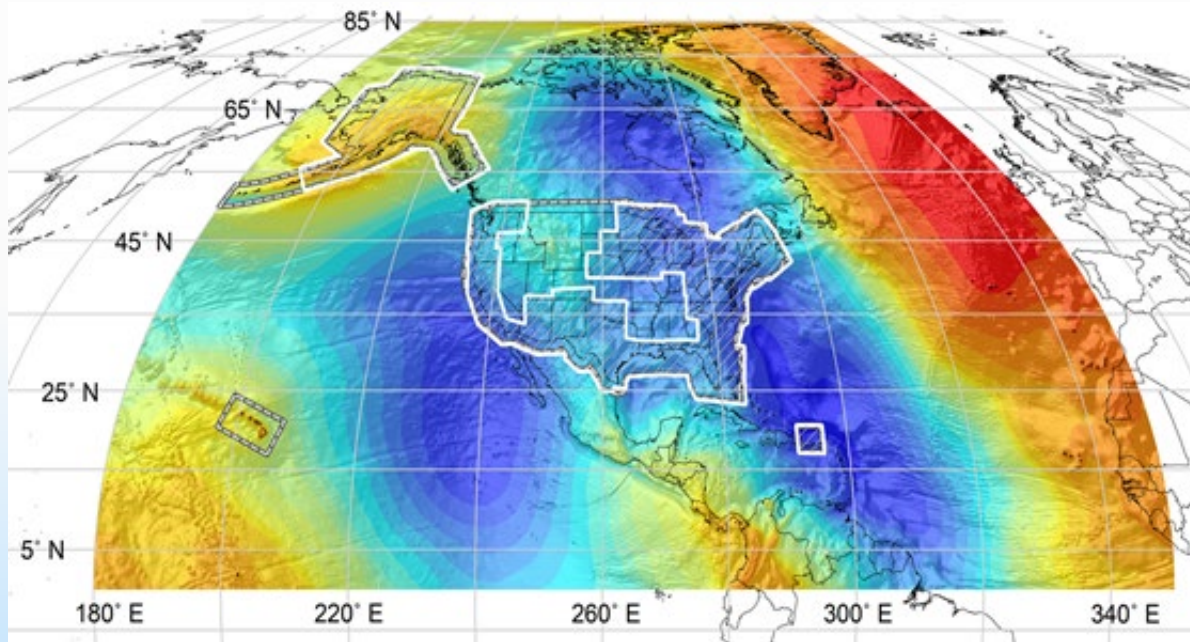


Water Levels, Currents, Ocean/Met Data and Uses



compliments of NOAA

Geodetic Data



Satellite Observations
Environmental Modeling
Obstructions in Air & Sea
Water Levels and Flow
Sea Surface Topography
Navigation
Habitat Mapping
Bathymetry
Land Elevations
Aerial Imagery
Geodetic Control

compliments of NOAA

Federal Agency Data Users and Uses



Government of Canada



National Ocean Service

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Massive data presents massive challenges

The past dictated...

- Technological challenges in processing, analyzing, and disseminating large amounts of data
- Lack of digital transformation readiness within NOAA stakeholders
- Clarity in understanding future directions for data and data sciences



Massive fleet of ships, aircraft, and facilities presents massive challenges

- Substantial resources and energy are spent on managing large assets using the conventional way. Today's conventional asset management is challenging as it is:
 - ❖ Based on analog, unclassified, and disconnected data and records
 - ❖ Slows asset operational readiness
 - ❖ Lose track of asset life cycles due lack of efficient tracking of maintenance and performance data



The Future is Now...

Global initiatives require holistic approach to data management characterized by:

- Data updated and served in real or near-real time through stable, easy-to-access interface
- Data based on AI-driven data science and analytics
- Trustworthy data interoperable with digital twin
- Accurate globe positioning using common datum and accuracy standards



Enabling Events and Technologies

- NGS modernization of Spatial Reference System Positions

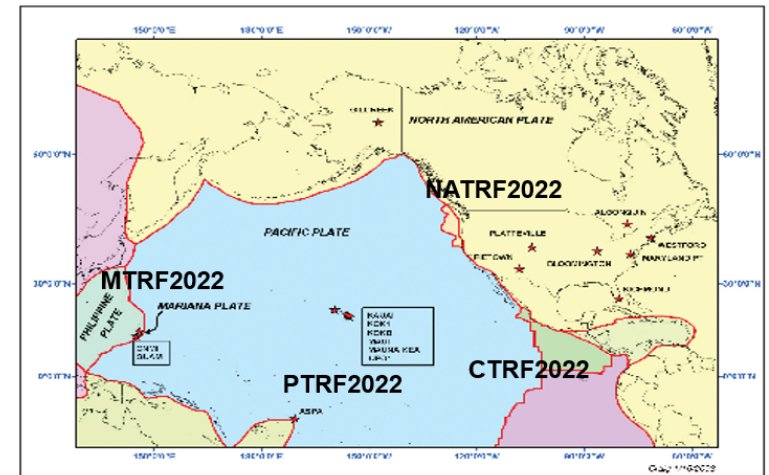
- Provides more accurate and consistent datum for CONUS, Alaska, Hawaii, and all territories.
- Regularly updated with Earth's crustal motion
- Increased accuracy and efficiency
- Consistent with GNSS (geocentric)
- Compatible with terrestrial methods (e.g., leveling)
- 4 new terrestrial reference frames
- 1 new geopotential (“vertical”) datum
- Semi-dynamic
 - All locations will have velocities (dynamic)
 - Can get coordinates for specific dates (semi)

- ASPRS second edition of positional accuracy standards

- Supports high accuracy of today’s data and NGS new datum

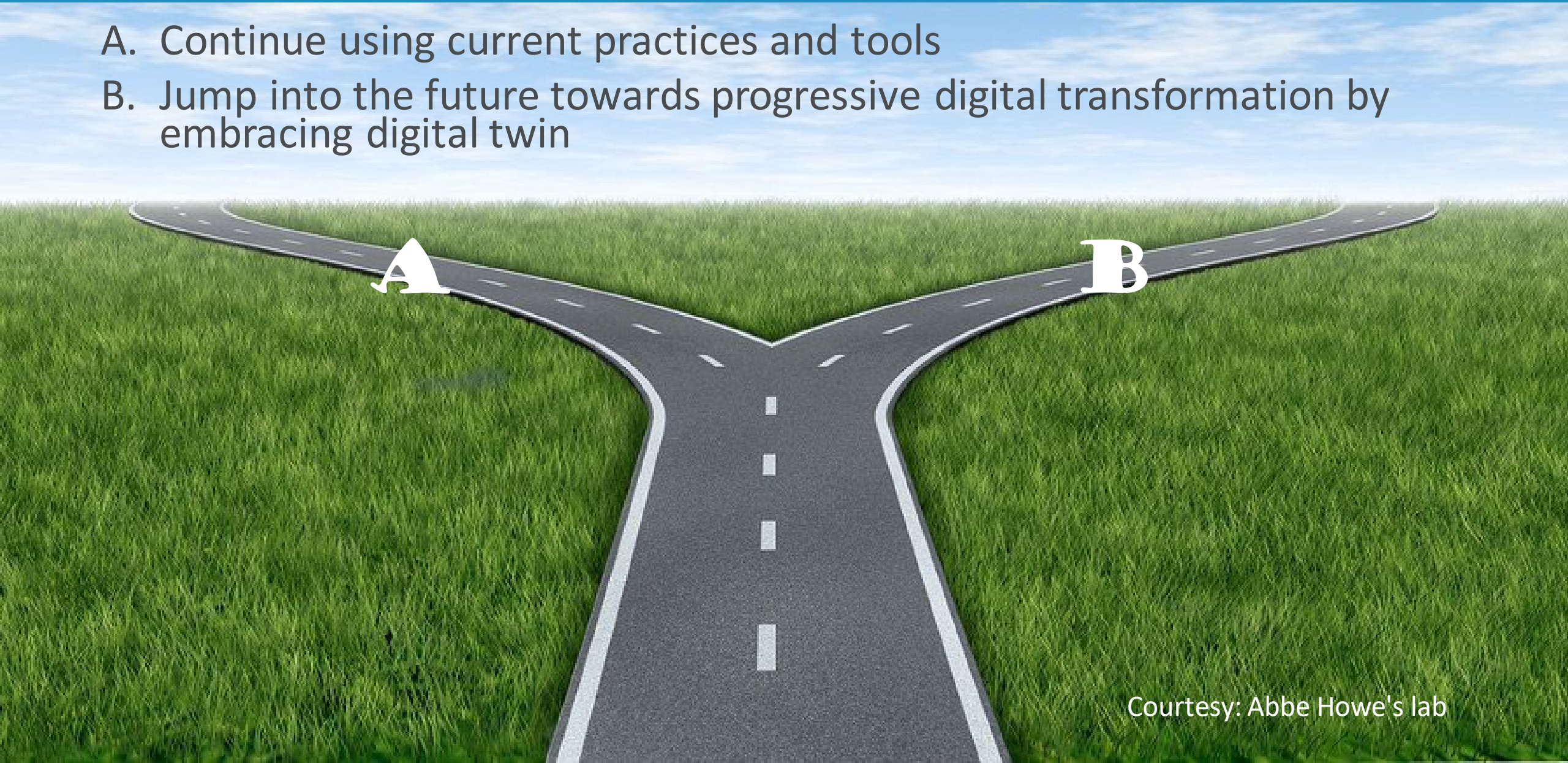
Digital twin offers the promise of building constantly updated data models including all NOAA data services.

Four Frames/Plates in 2022



Today's Crossroads

- A. Continue using current practices and tools
- B. Jump into the future towards progressive digital transformation by embracing digital twin



Courtesy: Abbe Howe's lab

What Does It Take?

Digital twin requires building on modern data construction practices

- Founded on AI-driven data science and analytics
- Ensured interoperability between data and digital twin



Graphic courtesy: IHO Report**

What Does It Take?

Ensure system endorses guiding principles (TRUS) to demonstrate trustworthiness of the data repositories



Transparency

Terms of use, time frames, additional features or services (e.g. sensitive data)



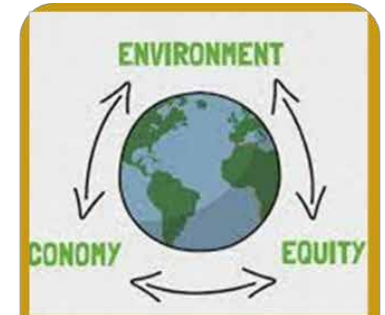
Responsibility

Adhering to community's metadata and curation standards, services (portals, download, processing), IP issues



User focus

Metadata scheme, data file formats, controlled vocabularies, ontologies, and other semantics, data metrics, community catalogues, future needs



Sustainability

Risk mitigation, business continuity, disaster recovery, funding, governance to assure FAIR

Graphic courtesy: IHO Report**

** IHO Report: Digital Twins of the Ocean can foster a sustainable blue economy in a protected marine environment



Thank You!

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