# Naval Oceanography Overview

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***Executive Director***
***Naval Meteorology and Oceanography - East***
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***UNCLASSIFIED***

# Chain of Command

**Chief of Naval Operations**

**Commander, U.S. Fleet Forces Command**

**COMNAVMETOCCOM (CNMOC) Stennis Space Center, MS**

*RDML Dave Titley*

**Fleet Numerical Meteorology And Oceanography Center (FNMOC) Monterey, CA**

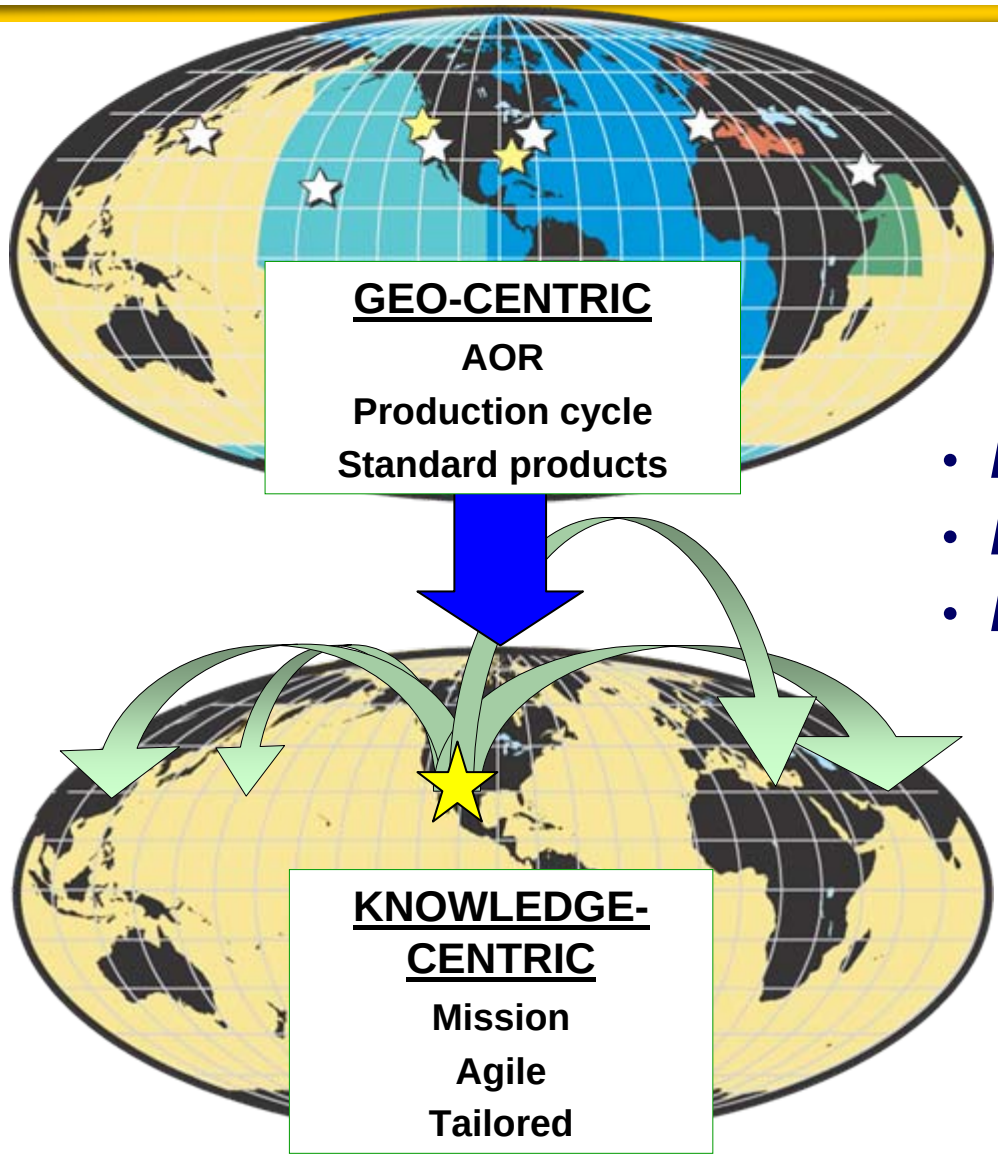
**Naval Oceanographic Office (NAVOCEANO) Stennis Space Center, MS**

**Naval Oceanography Operations Command (NOOC) Stennis Space Center, MS**

**Naval Meteorology and Professional Development Center (NMOPDC) Gulfport, MS**

**U.S. Naval Observatory (NAVOBSY) Washington, DC**

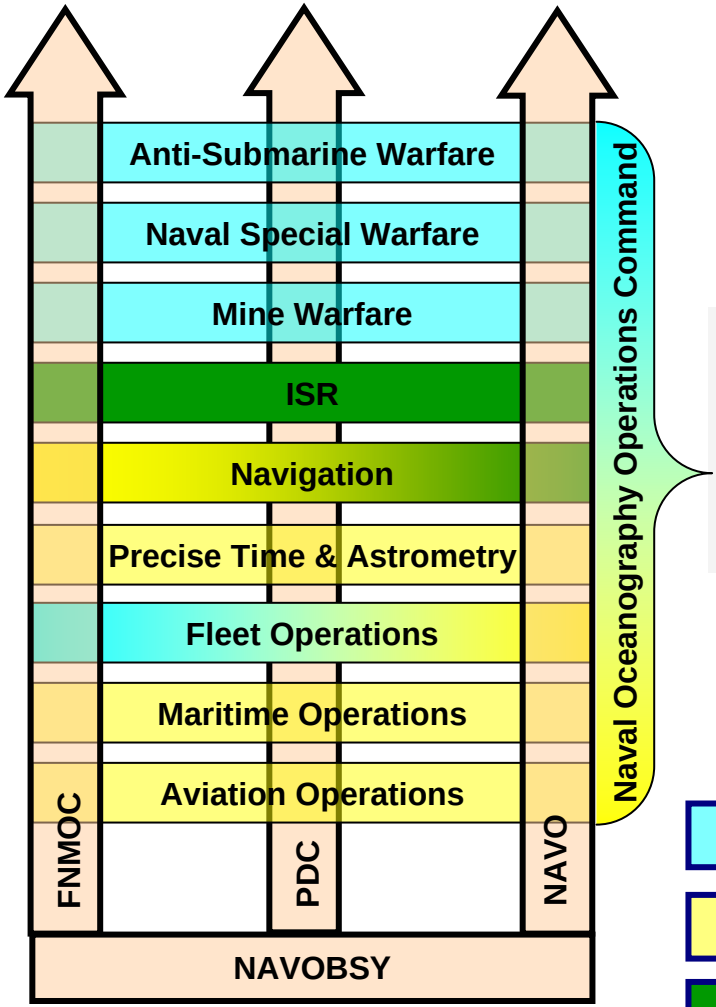
# Knowledge-Centric Operational Concept




- *Responsive to War Fighter*
- *Robust reach-back capability*
- *Rapid Global Deployment*

# Naval Oceanography

## WARFIGHTING FOCUSED




***Naval Oceanography***

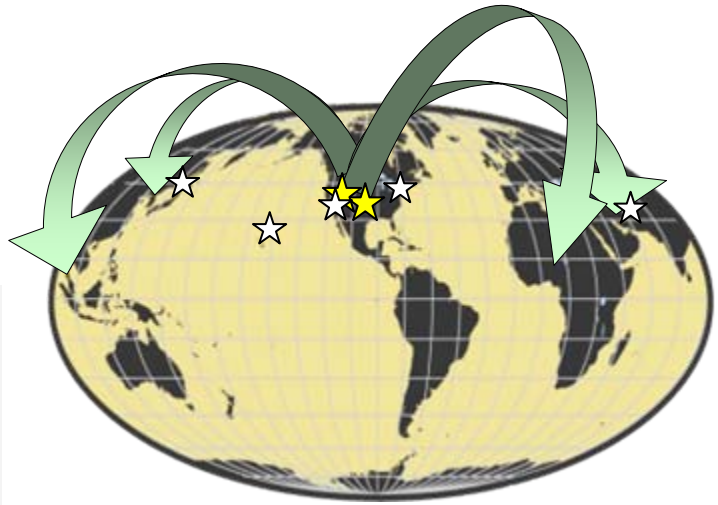
- *7 ships*
- *1,200 military*
- *1,300 civilians*

Warfighting

Safety

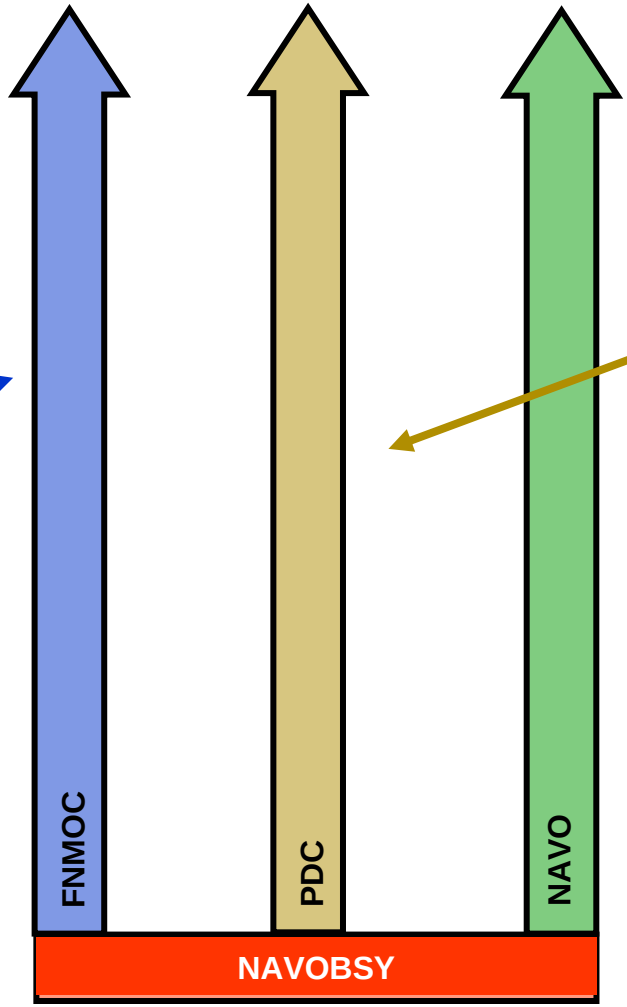
Shaping

## KNOWLEDGE-CENTRIC



- *Teamwork*
- *Technical Excellence*
- *Clear Communications*
- *Manage Risk*
- *Measure Results*
- *Continuous Improvement*

# The Foundation




***Fleet Numerical Meteorology and Oceanography Center***

***Center of Meteorology Excellence***

***Monterey, CA***

***U.S. Naval Observatory***

***The Nation's Precise Time & Astrometry***

***Washington, DC***

***Professional Development Command***

***Training***

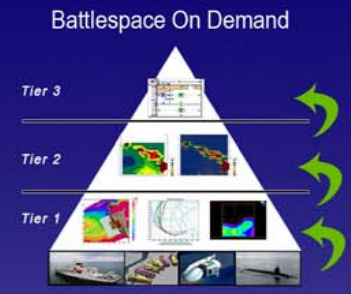
***Stennis Space Center, MS***

***Naval Oceanography Office***

***Center of Oceanography Excellence***

***Stennis Space Center, MS***

# NAVAL OCEANOGRAPHY PROGRAM OV-1




DoD Networks

DIA
NRO
NGA
ONI
DHS
USMC
AFWA
HPCMO

NAVAL OCEANOGRAPHY

USNO
NAVO
FNMOC
PDC
NOOC

NAVAL METEOROLOGY AND OCEANOGRAPHY COMMAND

ASW
AVN
NSW
MAR
MIW
ISR
PTA
FLT
NAV

NOAA
NASA
NATO
Ocean Observing
International
Inter-agency
Academia

Other Networks


COST TO DELIVER NAVY ENTITLEMENT

$6B/yr Leverage

$350M/yr Operating Budget

TYCOM

Sponsor

Provider

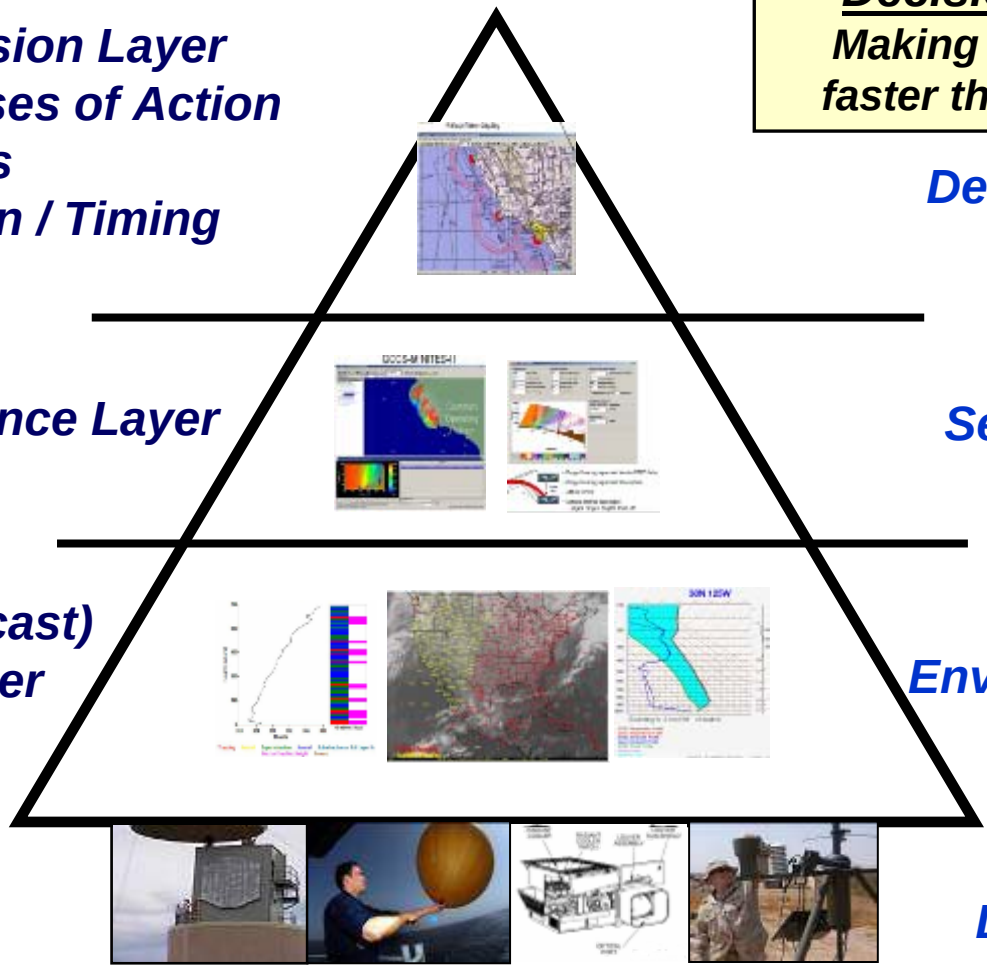
# Battlespace On Demand

**Decision Superiority**
***Making better decisions faster than the adversary***

***Tier 3 – the Decision Layer***
- ***Options / Courses of Action***
- ***Search Patterns***
- ***Asset Allocation / Timing***
- ***Quantify Risk***

***Tier 2 – Performance Layer***

***Tier 1 – the (forecast) Environment Layer***



***Decision***

***Sensor***

***Environment***

***Data***

***Initial and Boundary Conditions***

# U.S. Naval Observatory

## Precise Time

Ensemble of 90 Atomic clocks

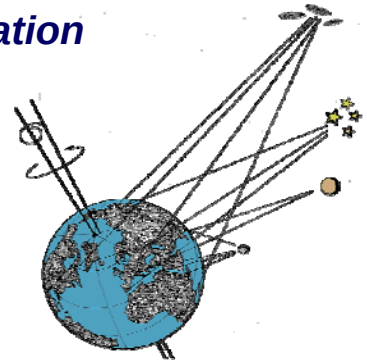
**Master Clock**

Most accurate time in the world

- **Voice (± 0.1s)** — *Personal Timekeeping*
- **Modem (± 1ms)** — *Internal System clocks*
- **Internet (± 1ms)** — *SIPR/NIPR Network Timing Protocol (NTP)*
- **GPS (± 10 ns)** — *Navigation, Precision Location*
- **2-Way Satellite Time Transfer (± 1 ns)** — *ISR, Communications*

## Earth Orientation Parameters

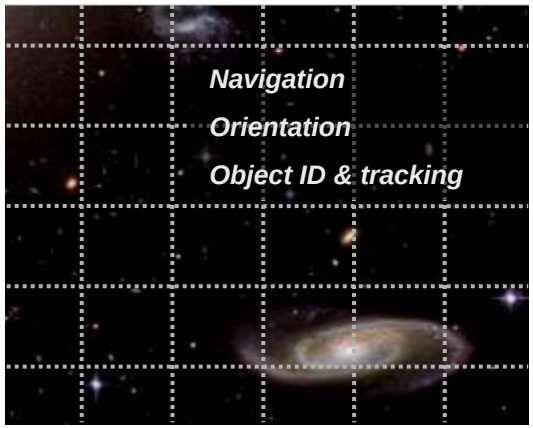
- ★ ***Departures from "pure" rotation***
- ★ ***Synchs the earth and its orbiting space platforms***
- ★ ***GPS Error = 2 meters w/in 1 week & 400 meters at 6 months w/o EOP***



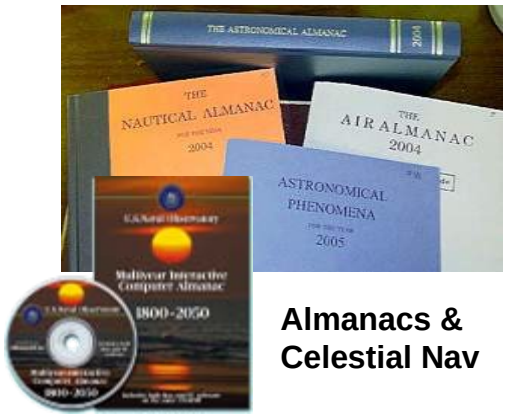
USNO

## Astrometry – star positions & motions






## Astronomical Applications

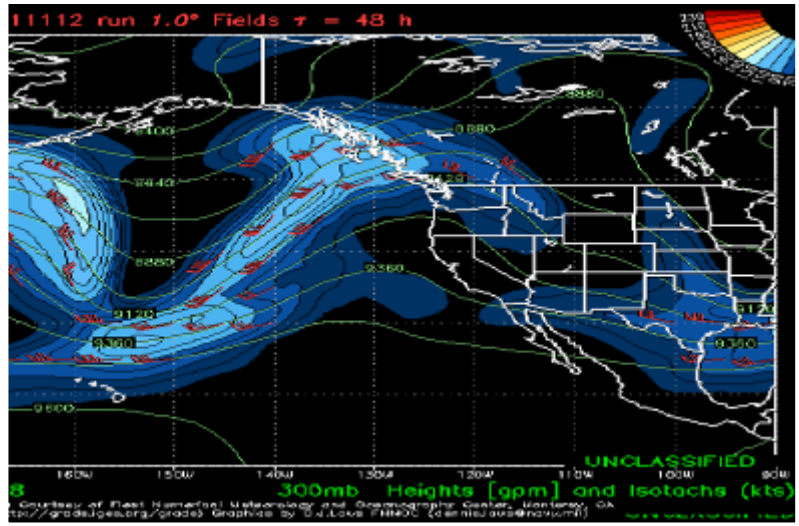



**Almanacs & Celestial Nav**

**Solar/Lunar Illumination**

# Fleet Numerical Meteorology and Oceanography Center

- *DoD's only global numerical weather prediction capability*
- *24x7 Operational Reachback Center (serves as CNMOC's operational watch)*
- *Collocated with Naval Research Laboratory and Naval Postgraduate School*

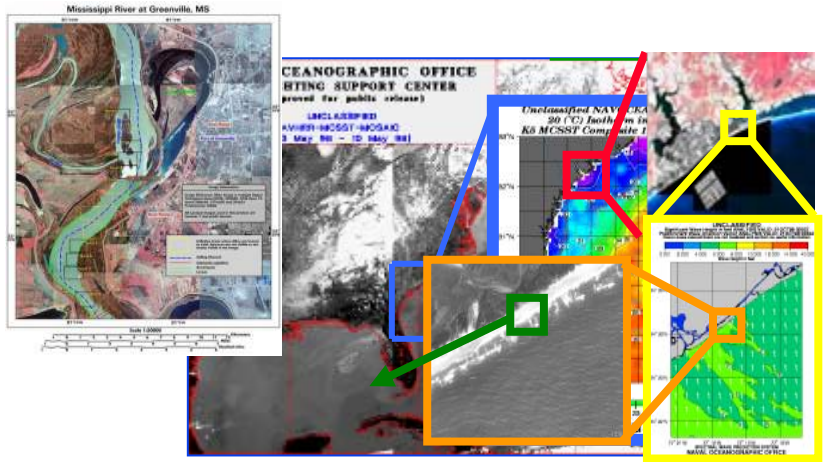



# Naval Oceanographic Office

## Collection Assets

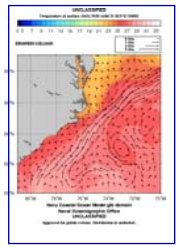
- Military Survey Ships
- Fleet Survey Team
- Airborne LIDAR
- UAVs
- Tethered Vehicles

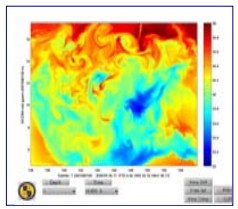
## Annotated Imagery

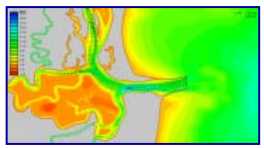



## Ocean Circulation Modeling

Global → Regional → Local

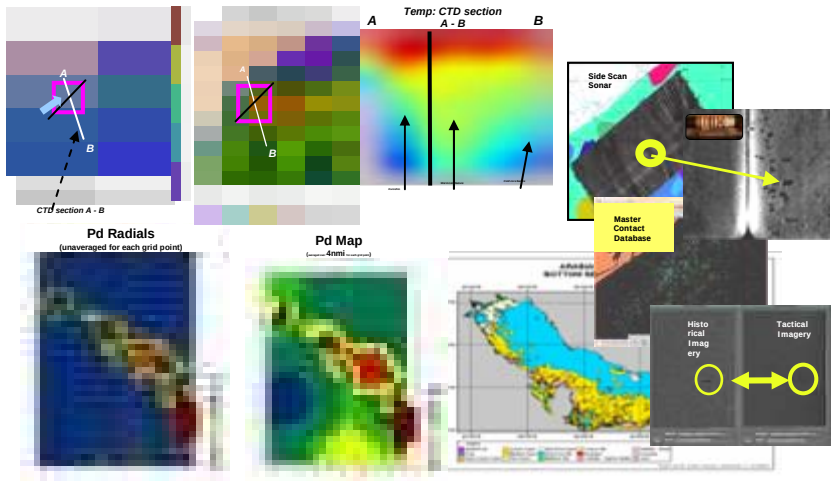






- Navy Layered Ocean Model
- Global Navy Coastal Ocean Model (NCOM)
- - Shallow Water Analysis & Forecast System
- - East Asian Seas NCOM
- - Relocatable-NCOM

## Tactical Products



# Naval Oceanography Operations Command

## Operational arm of the Naval Oceanography Program

- Provides an asymmetric advantage by exploiting current/future state of the environment.
- 24/7 reachback to production centers
- Small embedded military footprint forward


- **Five Warfighting-focused Directorates:**
  - ASW, NSW, MIW, FLT OPS, and ISR
- **Four Warfighting-enabling Directorates:**
  - NAV, PTA, AVN, and MAR
- **Integrated civilian / military team leveraging expertise and experience**

# Warfighter Support

- *Fleet Operations*
  - Direct support to CSG and ARG commanders, and Joint and contingency operations worldwide
- *Maritime Operations*
  - Routine ship weather forecasts
  - Joint Typhoon Warning Center
- *Aviation Operations*
  - Flight Route Weather Briefings via internet-based Flight Weather Briefer
- *Navigation/ISR*
  - Multi-purpose Survey Ships
  - Fleet Survey Team

# Warfighter Support

- *Anti-Submarine Warfare*
  - High-Performance Computing
  - Advanced Sensing Technology
  - Comprehensive Data Collection
- *Navy Special Warfare*
  - Comprehensive suite of tools supports all NSW mission areas
- *Mine Warfare*
  - Assist commanders with planning, tactics, post-exercise assessment

# Resource Sponsors & Acquisition Agents

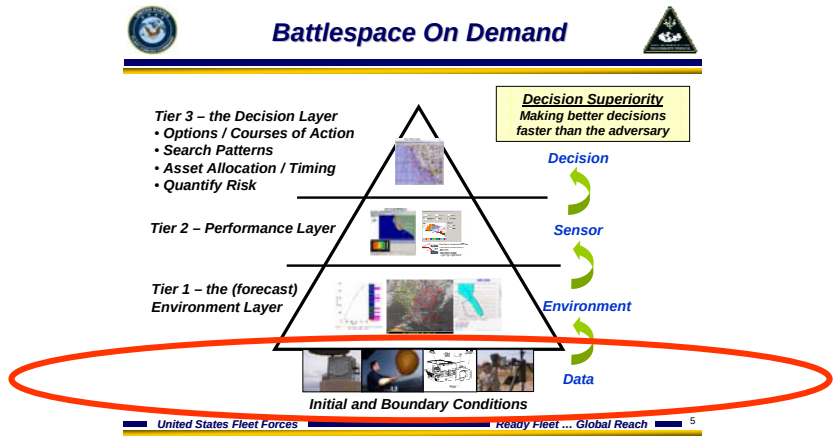
- **Resource Sponsors**
  - OPNAV N84 — Future Readiness
  - OPNAV N43 — Current Readiness
  - ONAV N87 — Undersea Systems
  - OPNAV N85 — Mine Warfare Systems
  - OPNAV N1 — Manpower
  - OPNAV N2 — Naval Intelligence
  - OPNAV N42 — Fleet Readiness

- **Acquisition Agents**
  - PEO(C4I) — METOC Systems
  - PEO(IWS) — USW-DSS
  - PEO(EIS) — Navy Enterprise Networks
  - PEO(Space) — METOC Space Systems

# *Future Challenges*

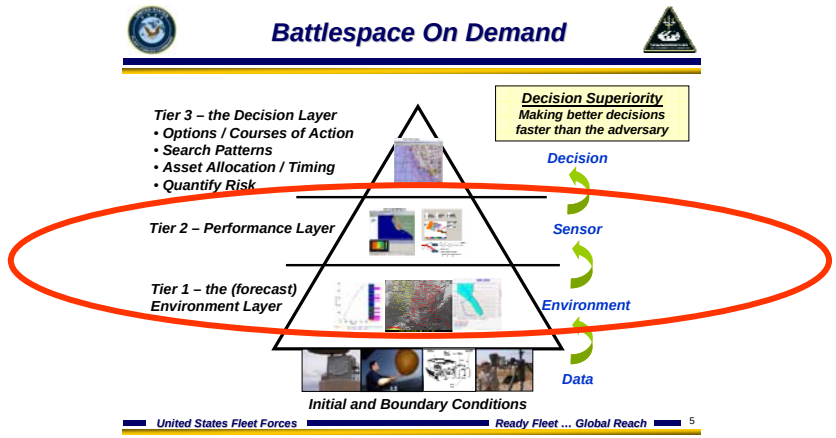
# Data

- *Exploiting "through the sensor" technology*
- *Acquiring data in denied environments*
  - *Remote sensing*
  - *Unmanned systems*
- *Continual improvement*
  - *Precision*
  - *Data processing*
  - *Improved communications*
- *Multi-mission Ships – next generation Survey Ship*
  - *Sensing/surveillance*



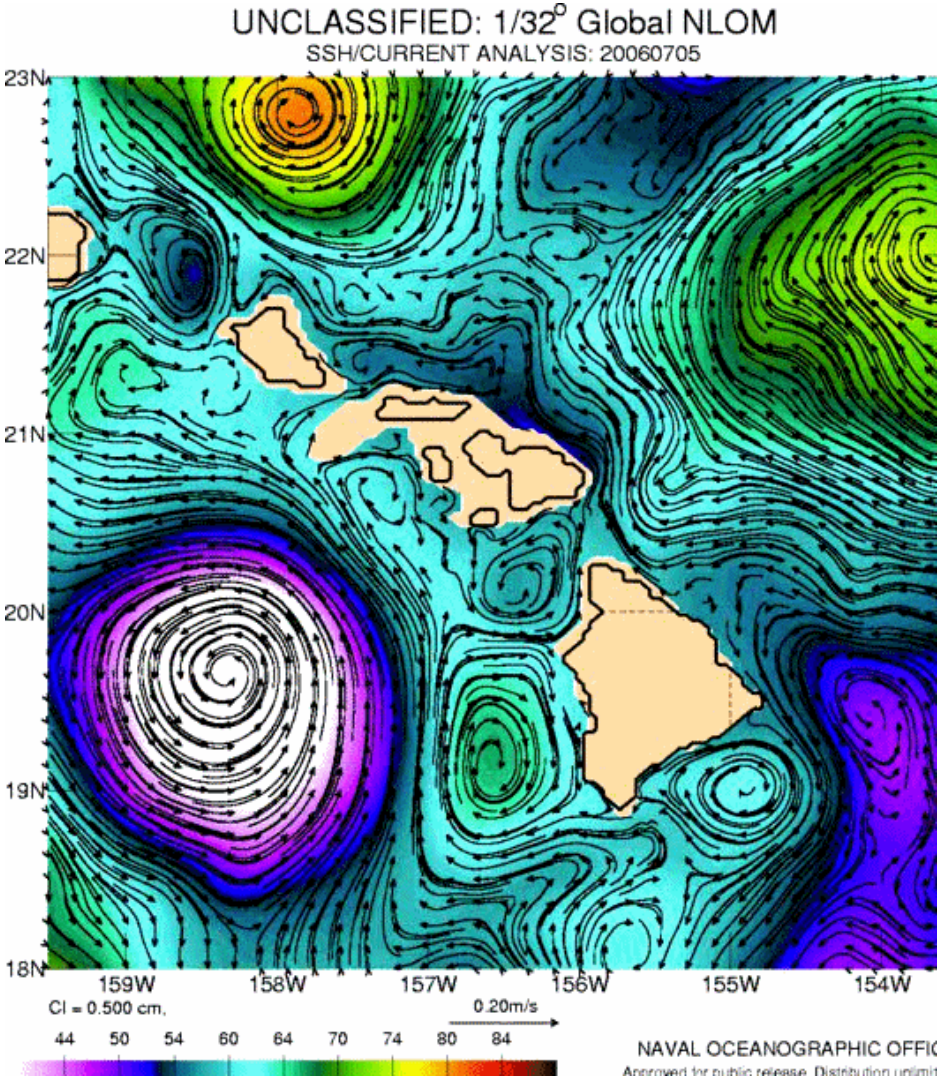
# Environments/Performance

- ***Modeling***
  - ***Ensembles***
  - ***Optimal resolution***
  - ***Quantifying risk***
  - ***Reducing uncertainty***

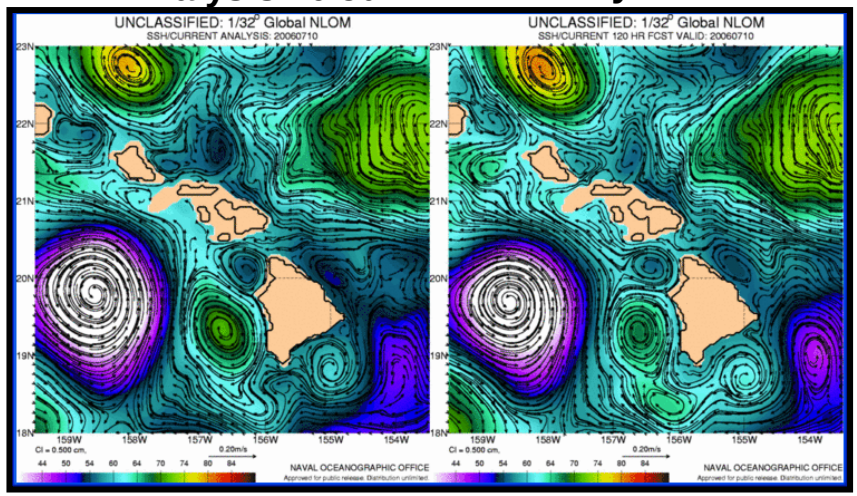



- ***Automation***
  - ***Reduce manpower required to operate complex systems***
- ***Numerical performance Surfaces***
  - ***Sonar systems for ASW***
  - ***Ship routing***

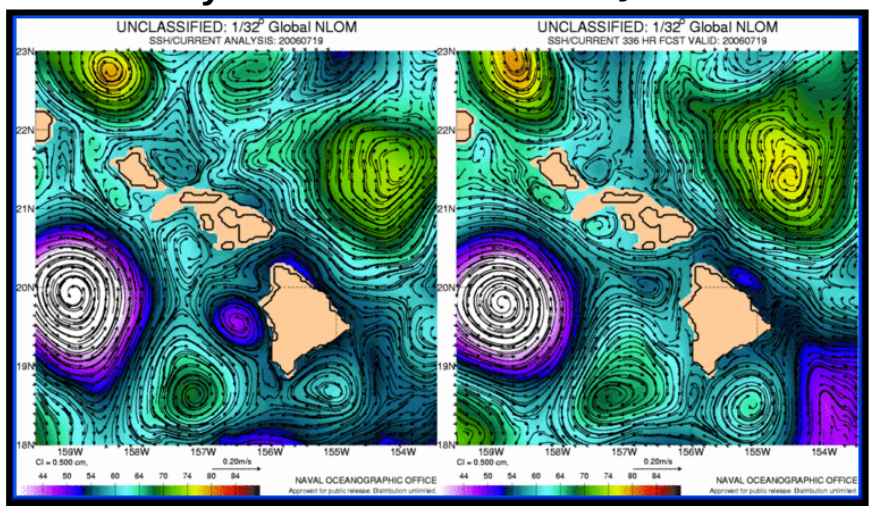
# The Dynamic Ocean at Operational Scales
## Thinking in "forecast space"




**Analysis 10 Jul** **5 Day Forecast**



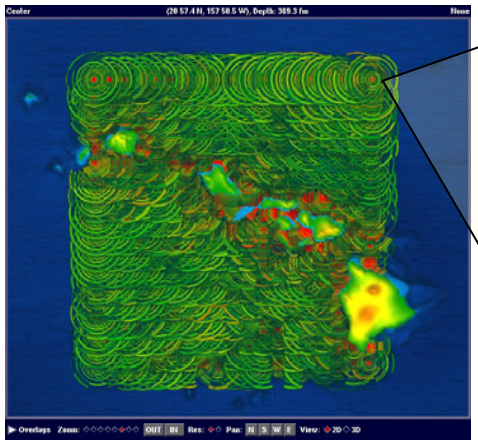

**Analysis 19 Jul** **14 Day Forecast**

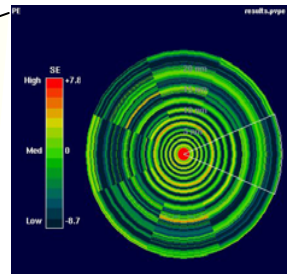


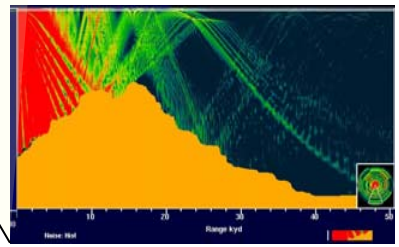
# Building a Performance Surface

## SNR* generated by STDA for gridded OPArea

(*SNR calculated by removing RD from SE)

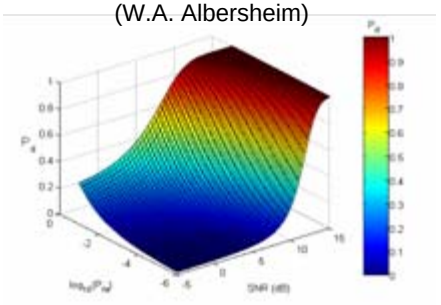


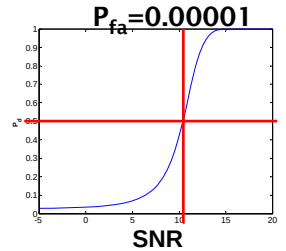



## SNR transform to Pd

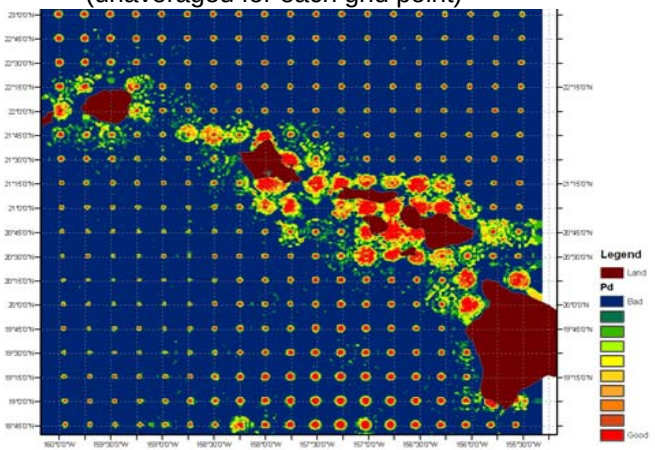
(W.A. Albersheim)





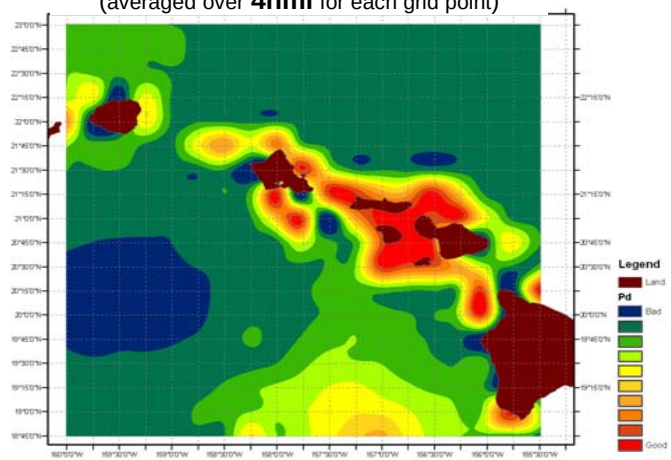

## Pd Radials

(unaveraged for each grid point)



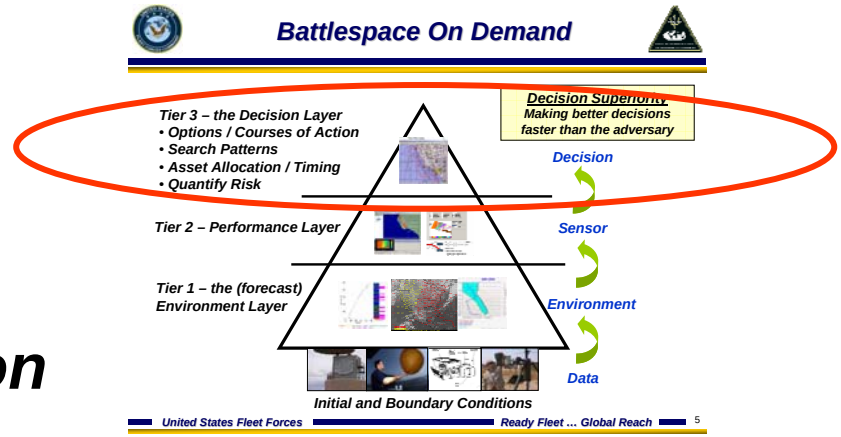

## Pd Map

(averaged over **4nmi** for each grid point)



# Decision Support

- **Goal: automated**
  - Primarily human support
  - Complex information fusion
- **Improved Decision Aids**
  - Higher accuracy
- **Integrated planning systems**
  - GIS enabled



# Broad Issues

- ***Enhanced resource protection***
  - ***Severe event protection/avoidance***
- ***Major role in energy conservation***
  - ***Long range forecasting***
  - ***Ship Routing***
- ***Synthetic Training Support***
- ***Climate Change/Arctic***
  - ***Anticipating impact on operations***
  - ***Uncharted arctic region***
- ***Joint/interagency partnerships***