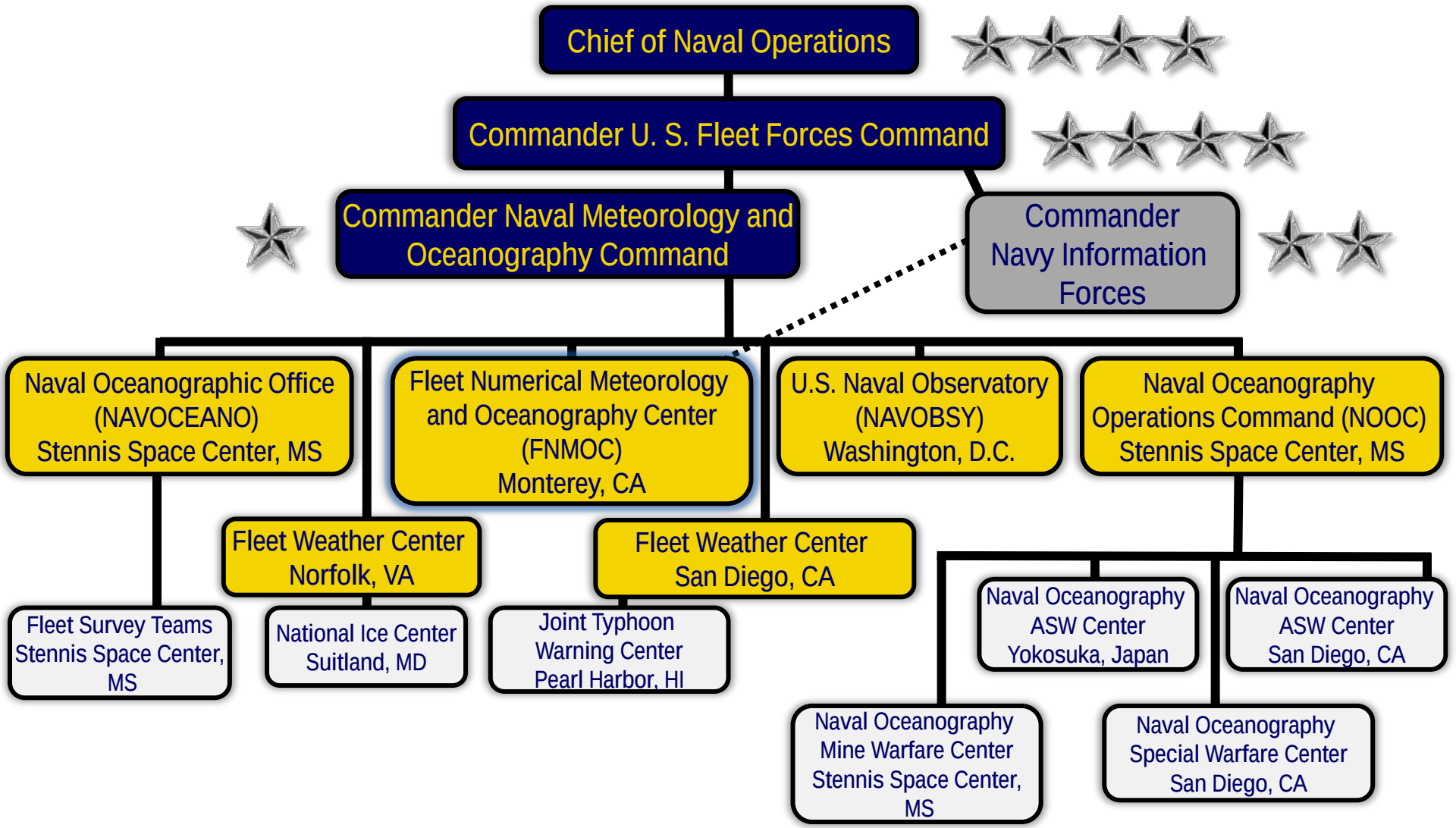
COPC
May 2017

Captain Russ Smith
Commanding Officer

Mr. Bill Kerr
Technical Director

Commander Sean Robinson
Executive Officer

METOC Enterprise



Predictive Battlespace Weapon System

Mission

FNMOC drives warfighting effectiveness and fleet safety of Naval, Joint and Coalition forces by operating and disseminating assured global and regional numerical environmental prediction and applied decision-making services

Vision

DoD's Premier Numerical Modeling Center - Lead for Physical Battlespace Awareness and Operational Advantage

Functions

- **FNMOC employs Assured C2 to deliver Physical Battlespace Awareness and directly support Integrated Fires. Products include: operational climatology support, custom high resolution weather prediction areas, weapon system inputs proven to improve performance and accuracy, specific ocean state data, go/no-go decision tools, tactical decision aids (TDAs), optimum path flight plans, and a variety of other mission-critical METOC data, products, and services.**
- **Serve as DISA Node for 12 DoD organizations on central California coast**
- **Strategic deterrence support**

Tasks

- **Operate a High Performance Computing Center (HPCC) with capabilities at every classification level**
- **Climatology support to Naval, Intelligence Community, and DoD Operations and Exercises at all classification levels**
- **Transition to Unified Modeling and follow-on deployment of Earth System Prediction Capability (ESPC)**
- **Collaborate with NAVO, NRL, NCEP, NESDIS, and 557th Weather Wing**

Team FNMOC Today

- Diverse team of highly-educated, technically proficient and warfighting-experienced Sailors, Civilians and Contractors.
  - 16 Officers
    - METOC, IP, SWO, Intel
    - 33% MS Degree
    - 90% Warfare qualified
  - 119 Civilian & 23 Contractors:
    - Predominantly Physical Science and Computer Science
    - 7% PhD, 23% MS Degree, 34% BS Degree
    - 42% eligible to retire within 5 years
      - Broad and deep experience in the mission and the science
      - Succession challenges
  - 71% manned

Warfighting Support Division

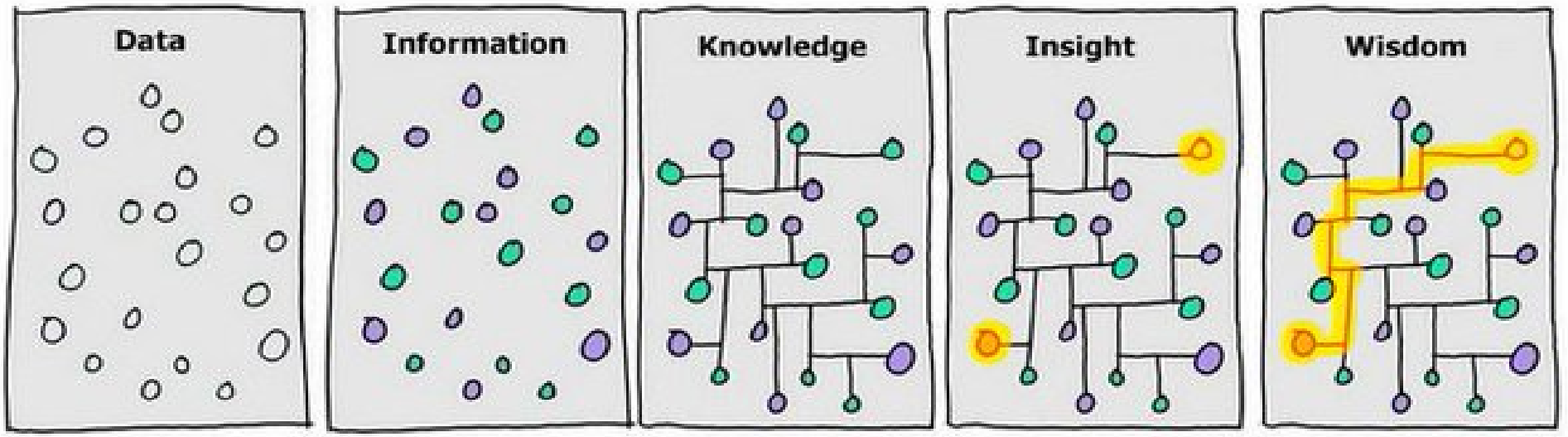
- A COCOM-focused operational reach back center for Joint Physical Battlespace Awareness and Mission Effectiveness
- Proactive coordination of tailored HPC/NWP production and Climate Support (ACAF and Climate Portal) to COCOM operations, exercises and contingency operations
- Engage COCOM and Fleet METOC officers, IC METOC, FWCs, RBCs (NOMWC and NOAC), and other traditional METOC partners
- Lead cross-functional teams with ONR / NRL and NPS to integrate/OPTEST leading edge technology and potential transition programs (i.e. NEXRAD/HWDDC REA, AAP)
- Bridging advances in science to warfighter operational advantage
  - Executive Summaries for upgrades/changes in capability
  - Expanding T&T and V&V capability
  - Proactive Customer Engagement early exercise/operations cycle
  - Coordination to advance the request and capability delivered


FLEET NUMERICAL METEOROLOGY AND OCEANOGRAPHY CENTER
MONTEREY, CA


DEPARTMENT OF THE NAVY
UNITED STATES OF AMERICA


DEPARTMENT OF THE AIR FORCE
UNITED STATES OF AMERICA
MCMXLVII


NATIONAL WEATHER SERVICE


Data
Information
Knowledge
Insight
Wisdom

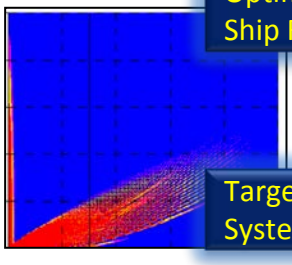
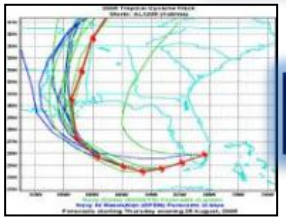
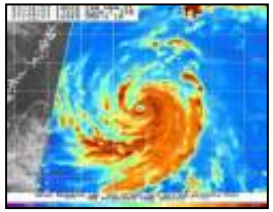
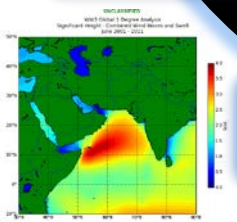
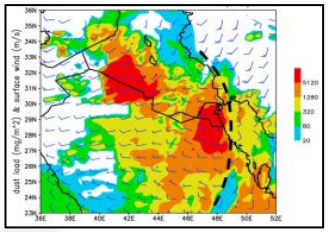
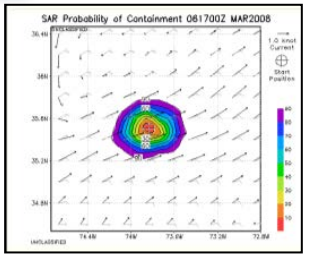
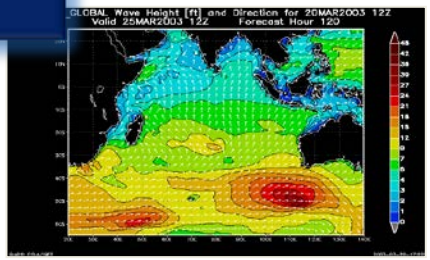
FNMOC Tomorrow: Unified Modeling

- Align 31 NAVOCEANO billets and 14 FNMOC billets to create FNMOC Modeling and Forecasting Department (N5)
- Establish the science team that will implement coupled models and ESPC
  - Includes global deterministic and ensemble modeling and small-scale deterministic and ensemble modeling of atmosphere, ocean, waves, ice, aerosols, tropical cyclones, and other dependent models
- Some riverine and hydrographic modeling remains with NAVOCEANO
- Ocean data acquisition, pre-processing and QC remains with NAVOCEANO

COPC Implications of Unified Modeling

- Some data exchanges currently coordinated with NAVOCEANO will be coordinated with FNMOC
- Modeling support to COPC partners will be coordinated with FNMOC
- Model transitions (upgrades) will be more complex and possibly take longer

FNMOC Operational Capabilities

Ocean Acoustic Forecasting

Aircraft Routing OPARS

Automated High Seas / Wind Warnings

Visibility/Dust Forecasts

Optimum Track Ship Route - WEAX

Electro-Optical Forecasts

Target Weapon Systems

Search and Rescue

Ice Forecasts

CEEMS

Tropical Cyclone Forecasts

Long-Range Planning

Operational Climatology

Ballistic Wind Computations

TCPED: Dissemination, Tasking, Collection, Processing, Exploitation & Analysis

NAVGEM Global Modeling

COAMPS Regional Modeling

NIPRNET – JWICS – SIPRNET

UNCLASSIFIED / FOUO

Current Models Overview

- **NAVGEM 1.4**– NAVal Global Environment Model; (T425L60) ~ 31 km, 60 vertical levels; Semi-Lagrangian dynamic core model. ***At the center of FNMOC production***.
- **COAMPS v5.2** – Coupled Ocean/Atmosphere Mesoscale Prediction System; high resolution model for quick response to warfighter support requests(< 1 day); multi-nested to less than 1 km; 60 vertical levels. Special support for tropical cyclones, dust, EM and acoustic propagation. Driven by NAVGEM. Run at all classification levels ***At the center of FNMOC production. 65/45/18***
- **WW3 v4.18** – WaveWatch III; ocean wave model; global (~35KM) and regional (5KM) implementations. Driven by NAVGEM and COAMPS. Model bias can be "tuned".
- **COAMPS - TC** – COAMPS centered on JTWC official forecast.
- **WW3 TC-OFCL** – WW3 forced by JTWC official forecast (as inserted into NAVGEM)
- **NAVGEM Ensemble 1.4** – Global 21-member, 16-day forecast, to T359 (33km)L60; supports 20-member global WW3 ensemble. Uses customized ensemble transform method to match member perturbations to model error. With the NCEP and CMC global ensembles, forms the National Unified Operational Prediction Capability (NUOPC) 60 member multi-model ensemble.
- **NAAPS** – Navy Atmospheric Aerosol Prediction System; the only operational global aerosol model. Atmospheric optical properties output feeds Target Acquisition Weapons Software (TAWS). Driven by NAVGEM.
- **AAP** – Atmospheric Acoustic Propagation; is a system for predicting the probability that a human ear will detect a helicopter in theater. System is a part of COAMPS-OS, atmospheric forecast from COAMPS.

Global NAVGEM

- Recent Events
  - v1.4 implemented operationally 12 Oct 2016
    - Hybrid Data Assimilation (DA)
    - MPI / IO
    - Ozone assimilation [Ozone Mapping & Profiling Suite (OMPS) & Solar Backscatter Ultraviolet Version 2 (SBUV/2)]
  - v1.4.1 Implemented 1 Mar 2017
    - Revised stochastic kinetic energy backscatter (SKEB) initialization procedure for NAVEFS
    - T359L60 NAVEFS
- Plans
  - v1.4.2 [3QFY17]
    - Data Assimilation (DA) upgrades
  - v2.0 [4QFY17]
    - T681L80 (~19 km grid spacing; 0.01 HPa model top ~80 km)

Regional COAMPS

- Recent Events
  - COAMPS v5.4 delivered to FNMOC for initial testing and evaluation [Jan 2017]
    - Updates associated with v5.4
      - ESMF/NUOPC v7 compatible (coupled modeling restructuring)
      - Use the TC new atmospheric PBL parameterizations for non-TC runs
- Plans
  - OpEval for high-resolution COAMPS grids (5.0/1.7/0.56 km grid spacing) [Ongoing]
    - Phase I - Proof of concept (Norfolk, VA)
    - Phase II – Extension to other areas
  - Aircraft Icing Potential [4QFY17]
    - Forecast for Icing Potential (probability of occurrence)
      - Maximum potential within a column
      - Maximum potential within 2,000 ft. layers (surface – 30,000 ft.)
    - Requirement for Triton Program
  - COAMPS v5.5 [3QFY18]
    - Atmospheric 4DVar
    - Improved coupling: NCOM v4.3

COAMPS-OS

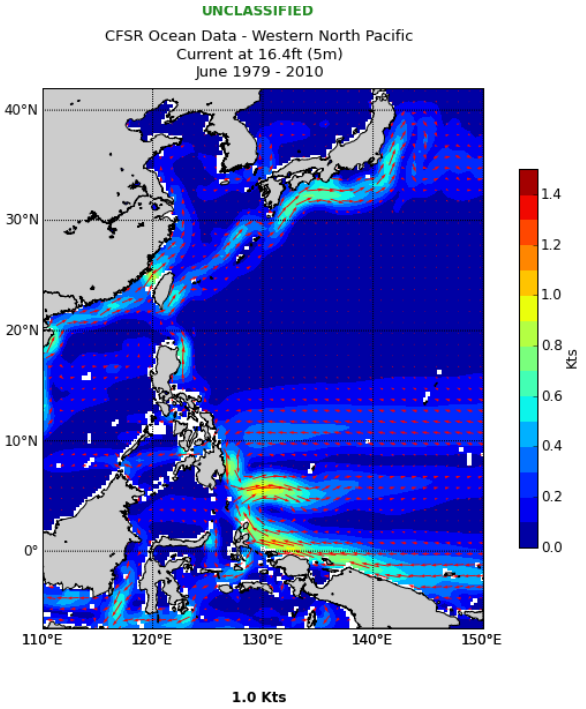
- Recent Events
  - Operational implementation of COAMPS-OS v2.7 [Feb 2017]
    - Ship following moving nests with Rapid Environmental Assessment (REA)/Hazardous Weather Detection and Display Capability (HWDDC)
    - Support for COAMPS v5.6 aerosol upgrade
    - Support for 4DVar data assimilation
- Plans
  - COAMPS-OS v2.7.1 [3QFY17]
    - Option to use WW3 curvilinear grids
    - Support for shipboard SPY-1/TEP radar data processing and quality control
    - Support for COAMPS v5.7 new atmospheric physics upgrades
  - COAMPS-OS v2.7.2 [4QFY17]
    - EM verification vs rawinsondes
    - Split system for MRY and DSRC processing

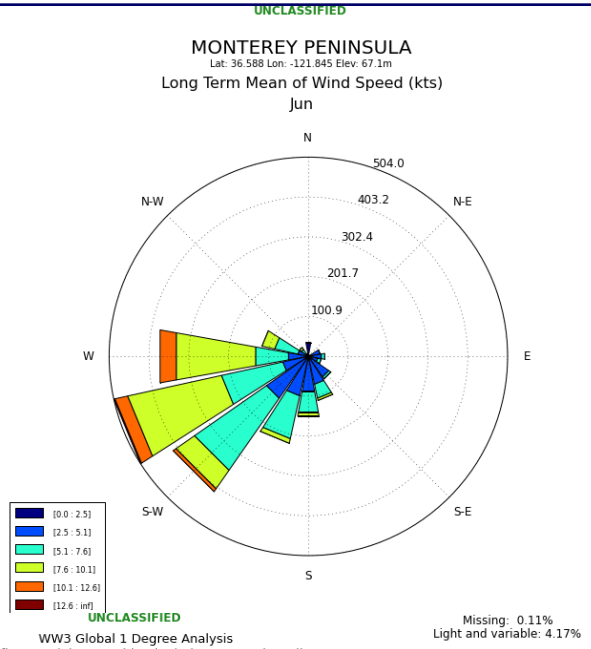
Navy Ensemble Forecast System

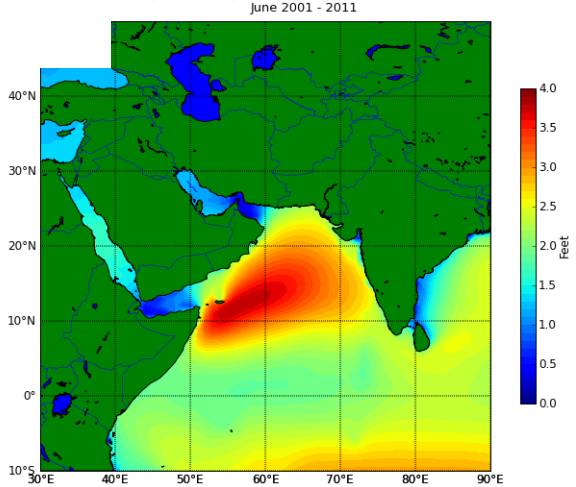
- Recent Events
  - NAVEFS v1.4.1 (T359L60, ~37 km) Operational implementation [Mar 2017]
    - Flexible-domain, 2-layer ensemble transform to better fit analysis perturbations to error constraints
    - Enhanced efficiency for ensemble transform, including a reduced-Gaussian-grid capability
    - Stochastic forcing (SKEB) reformulation
- Plans
  - Extend deterministic run to 240 hours and produce 0.25-degree grids; both to support NMME
  - Produce 0.5-degree grids for exchange with NCEP and CMC
  - NAVEFS v1.4.1+ (T359L60) [4QFY17]
    - Simple SST diurnal cycle model
    - SST analysis perturbation capability

Operational Climatology

- Archives/Updates ocean surface (i.e. wind and swell waves) and atmospheric numerical model fields
- Maintains the Advanced Climate Analysis and Forecasting (ACAF) system
- All classification levels
- S2S outlooks
  - El Nino/La Nina
  - Arctic
- Forensic Analysis
- New Trends and Tendencies (TnT) support

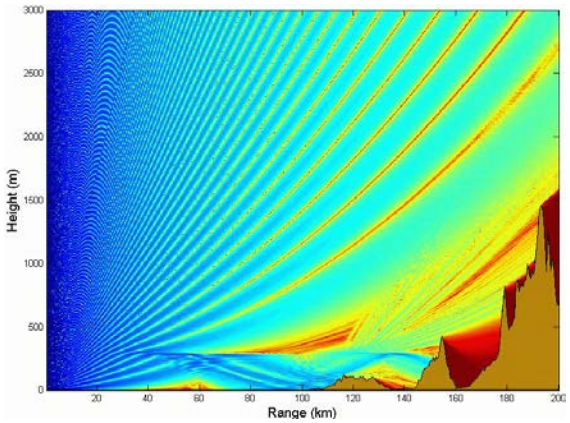






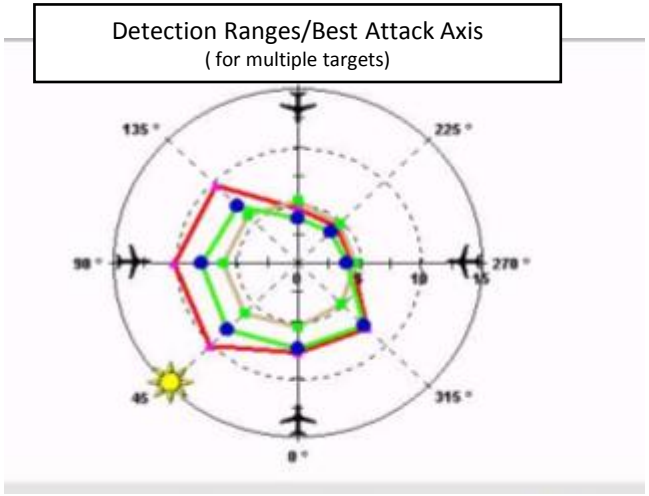
Tactical Decision Aids

Advanced Refractive Effects Prediction System (AREPS)



- FWC's provide RBC

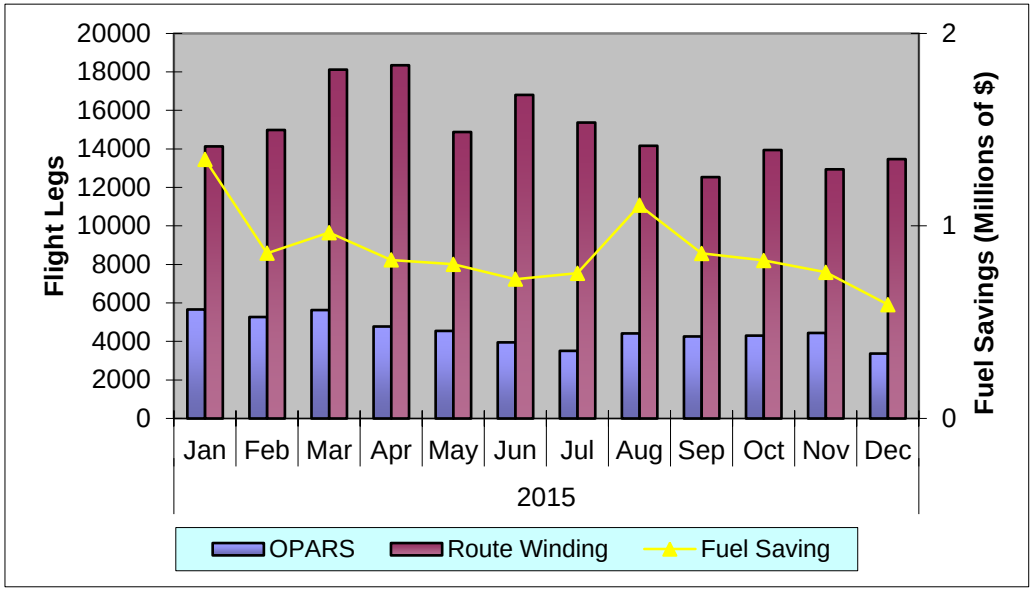
Target Acquisition Weapons Software (TAWS)



Optimum Path Aircraft Routing System (OPARS)

Estimated Fuel Cost Avoidance for 2015: **$10,405,825**

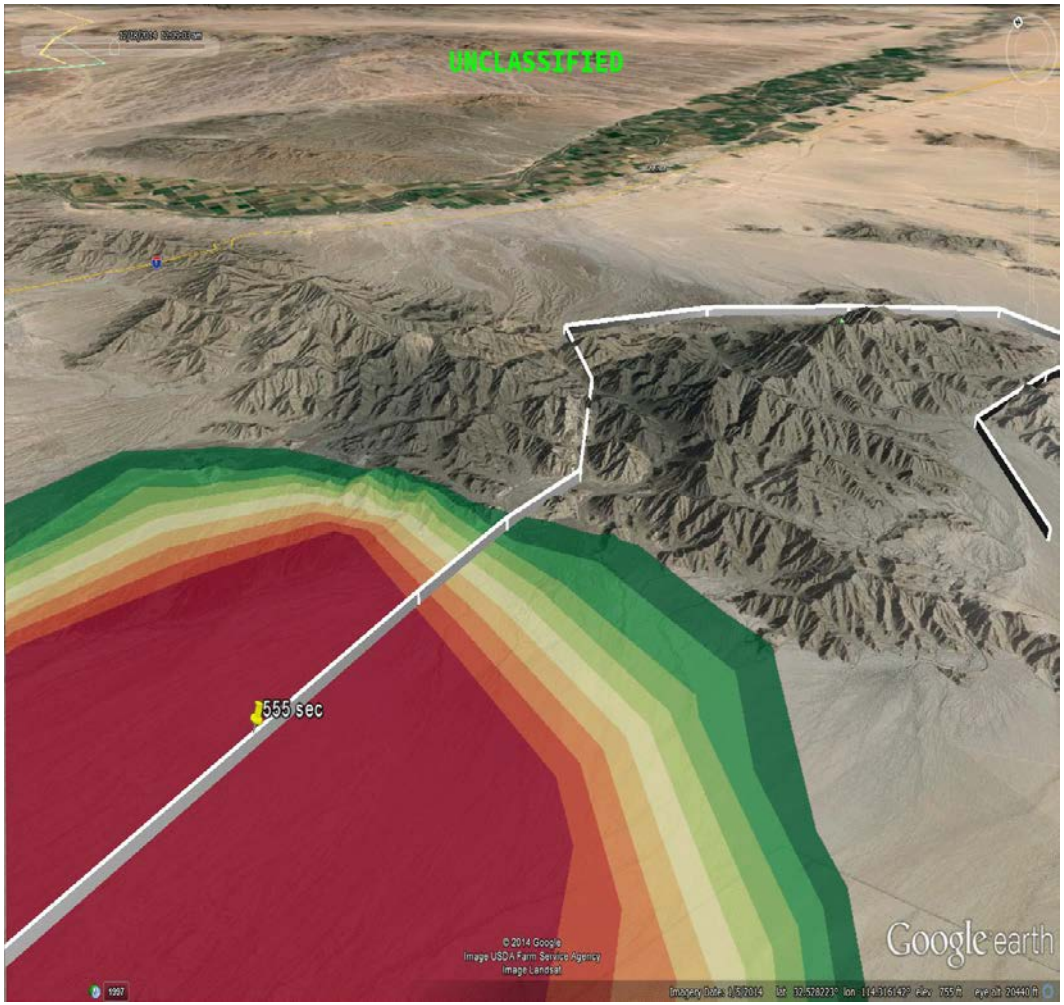
(Based on customer supplied cost avoidance percentage and Navy contract price of fuel per gallon)



Warfighters supported	6,160
** By Command/Unit/Squadron/Individual*	
Number of aircraft types supported	91
** Top 5 aircraft types: UC35, C12, P3C, KC130J, C130*	
Total OPARS flight legs requested	54,183
Total PFPS flight requests	179,727

Atmospheric Acoustic Propagation

- Initial OPTEST and OPEVAL completed
- Additional airframes in hand
  - AH-1Z Viper
  - Predator UAV
  - XH-60 variants
- Operational 1QFY18
- Future:
  - Additional airframes
  - Multi-platform capability
  - Optimum path routing
  - Threat avoidance routing



Green = 10-40% detection, Red = 90-100%

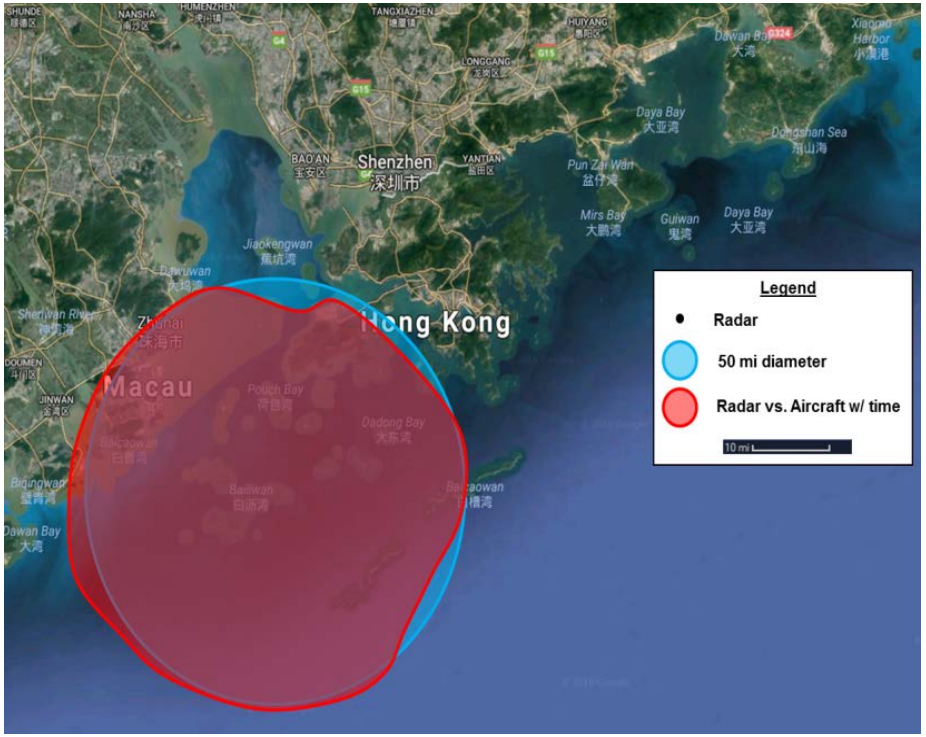
Ongoing Exchanges w/ COPC Partners

- **To NCEP**
  - Global ensemble to NOMADS for NUOPC
  - NAVGEM for verification
  - WW3 ensemble
  - Tropical Aids to NHC
- **To 557th WW**
  - NAVGEM for legacy applications
  - Global WW3 for visualization w/in AF-Webs
  - NAAPS aerosol products
  - DMSP UPP radiances, WINDSAT xDRs
- **To NESDIS**
  - DMSP & WINDSAT microwave xDRs
  - JPSS Program NAVGEM & NAAPS NWP fields for IDPS processing
- **To NAVO**
  - DMSP & WINDSAT microwave xDRs
  - NAVGEM/COAMPS NWP fields
  - NAVDAS-AR DA input fields for DSRC NAVGEM processing
- **From NCEP**
  - GFS for verification, MetCast & WxMap
  - Global ensemble from NOMADS for NUOPC
  - WW3 ensemble
- **From 557th WW**
  - CDFS-II for NUOPC cloud verification (in development)
  - Mark IVB, DMSP, foreign geostationary, S-NPP xDRs via NESDIS
  - LIS/LSM Land Surface fields (snow, soil moisture/temps, vegetative index)
  - NEXRAD (assimilated into COAMPS)
  - JMPLAT (station information)
  - Predator UAV
- **From NESDIS**
  - NOAA & foreign polar/geostationary data of all shapes & sizes via DAPEGATEWAY server and PDA
- **From NAVO**
  - SSTs, Altimetry SSH/SWH
  - HYCOM NWP fields
  - Miscellaneous Conventional Oceanographic OBS

Environmental Prediction Support to EMW

Era of USN multi-domain superiority (real or perceived) is challenged

- **Near Peer Competitors:** bring increased challenges
- **Operational Advantage:** significant gains from exploiting the environment
  - Sometimes slim, but Razor's Edge Advantages worth "clawing back" with relatively little investment
- **EMW modeling drives:**
  - Improved detection, tracking, targeting
  - Support counter-ISR maneuver (Air, Surface, Space, EMW domains)
  - Ionospheric modeling (OTHR)



$\sum$ Razor's Edge Advantage = Decisive Operational Advantage

Vision & Takeaways

Vision

DoD's Premier Numerical Modeling Center - Lead for Physical Battlespace Awareness and Operational Advantage

Takeaways

FNMOC is the foundation for fleet safety

Every ‘forecast’ for ships, submarines, aircraft and special forces start with FNMOC environmental prediction & production services

FNMOC provides the foundation for Physical Battlespace Awareness and provides direct support to Integrated Fires

Cybersecure assimilation, production and delivery enabling assured C2
Only center that models the Global and Regional Atmosphere to DoD CS Standards
Provides climatological support to Joint and Naval Operations

Questions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