



DoD Modeling & Simulation Executive Agent Air and Space Natural Environment



Integrated Representation of the Natural Environment

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Motivation



- In many cases, a simulation's fidelity depends on interaction with the environment
 - Aircraft tactics based on clouds and visibility
 - Naval tactics based on acoustic performance
 - Troop movement rate determined by ground wetness
- Environment must be realistic and consistent
 - Should see ground get wet if it rains
 - Should see ocean response to high winds





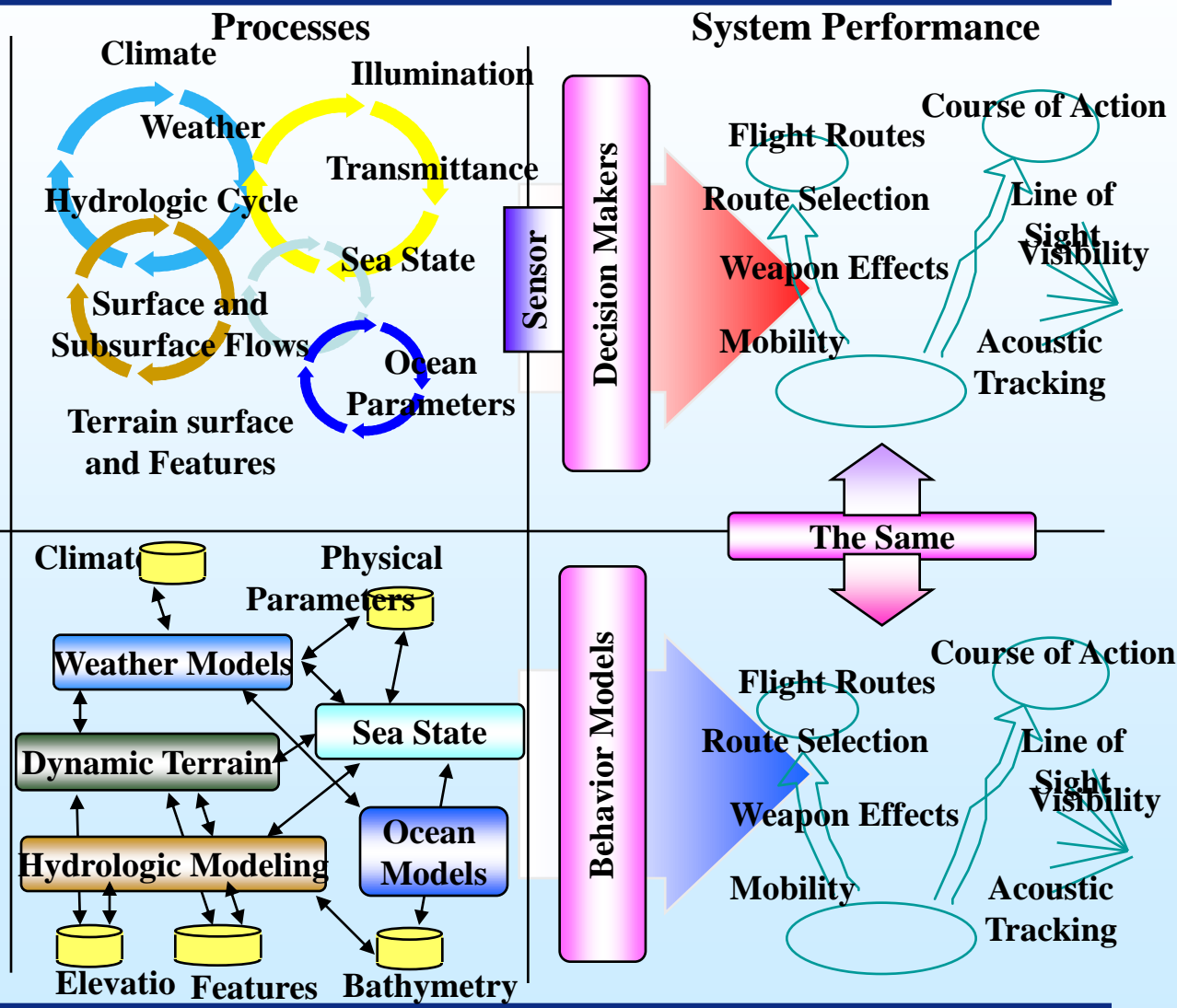
Integrated Natural Environment



Natural



Synthetic



n



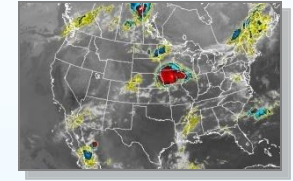
Environment Representation for M&S

- **Real vs. Realistic Data** - The complexity of today's simulations and training events *demand* physically consistent environment representations however...

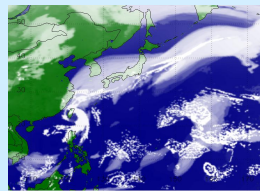
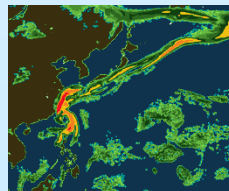
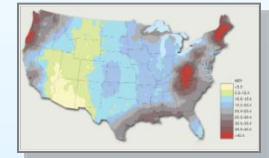
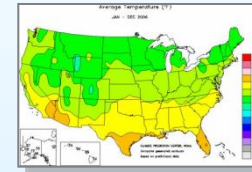
- Live forecast data is not the answer
 - No control over the conditions at game time
- Climatology data is not the answer
 - Can't run physics based models against "average"
- Historical Re-analysis provides the right mix
 - Build the underlying "ground-truth" representation to the best of your abilities
 - Control the conditions by selecting the right scenario
 - Derive all other products
 - Bounded by realism (if it never happened ...)



Temperature



Current Satellite



All weather parameters match customer objectives



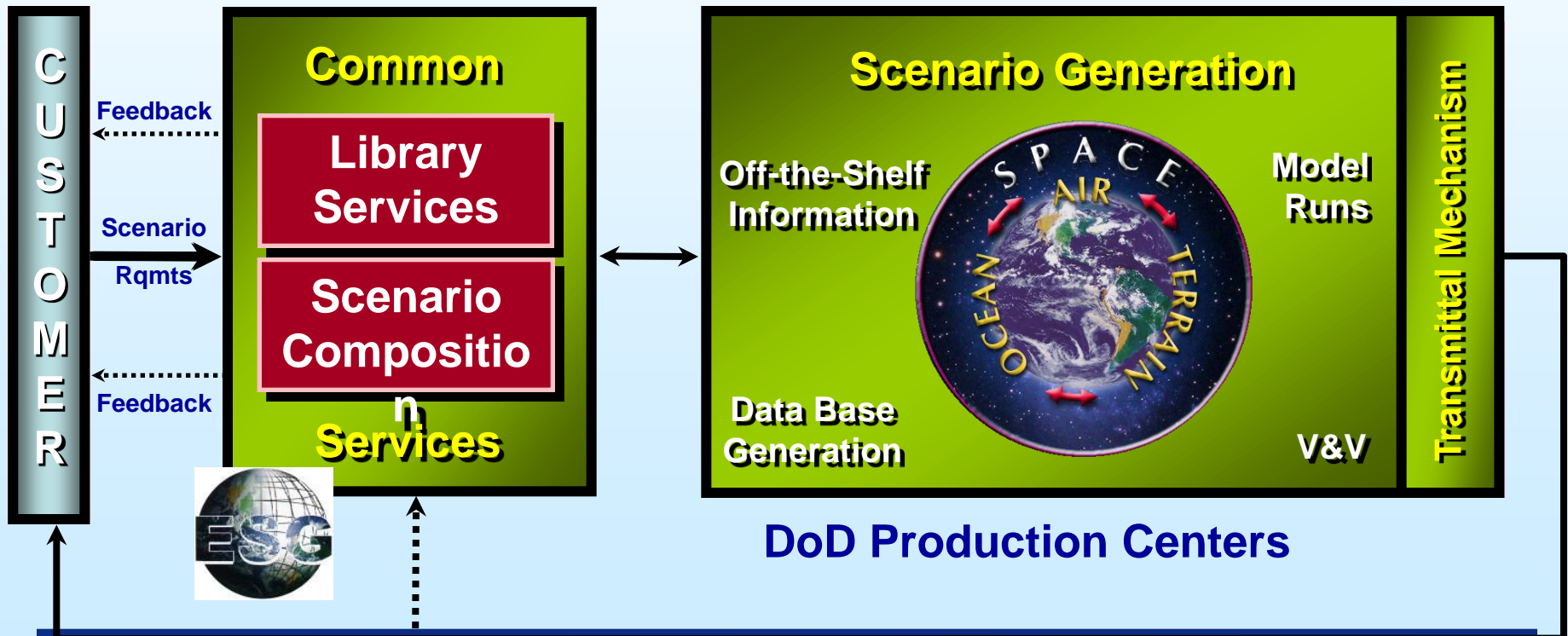
INEARP: A Process Model for Environment Support M&S



Integrated Natural Environment Authoritative Representation Process (INEARP)

The Challenge

Create a physically consistent, cross-domain authoritative “ground truth” environmental representation that meets user requirements





ASNE Technology Overview



- **Environmental Scenario Generator (ESG)**
 - Identifies historical scenarios that provide relevant conditions
 - Provides the Integrated Environment Representation
 - Common Open Services for Integrated Natural Environment (COSINE)

 - **Space Environment Impact System (SEIS)**
 - NGDC Developed Space domain overlay to ESG / EDCSS

 - **Environmental Data Cube Support System (EDCSS)**
 - Provides consistent views of the Environment Representation to the C4I, Control Group, and Simulation domains
 - Efficient runtime distribution and inject of data and effects
-

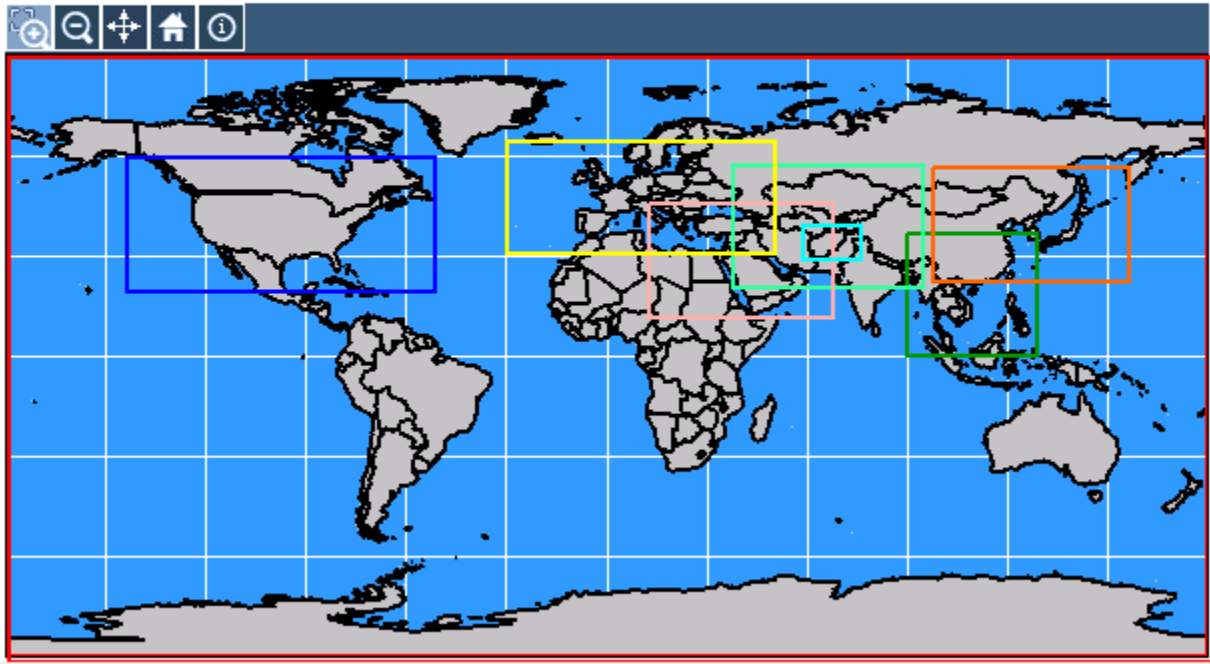


Environmental Scenario Generator



- **Scenario Search Mechanism**
 - Rapidly searches historical archives
 - Fuzzy-Logic Classification
 - Weapon System Impacts
 - Interactive Data Analysis

- **Produce Realistic Data Sets**
 - High-Quality data and models
 - Recreate historic scenarios
 - Customized post-processing
 - Standard/Custom formats



- WorldGrid
- Countries
- States/Provinces
- Cities
- Rivers
- Lakes

Atmosphere Resources

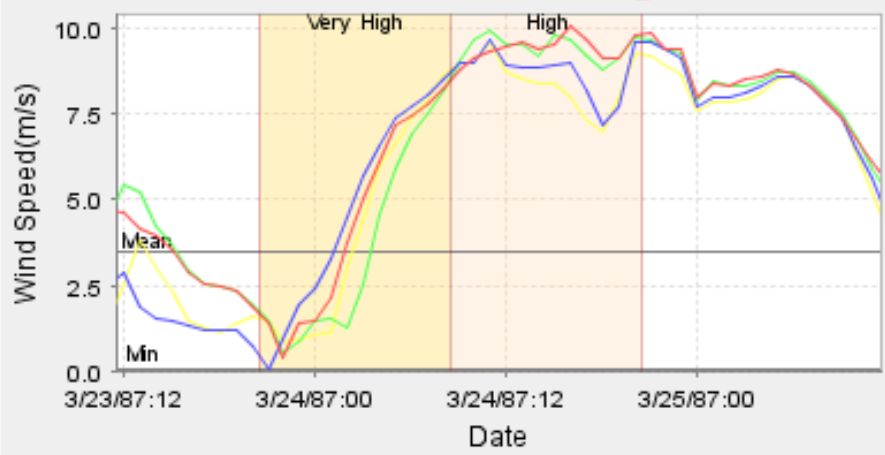
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<input type="radio"/>	■ ACMES CASIA	<input checked="" type="checkbox"/>	10/01/1986 - 09/30/1996	1 hour	40 km
<input type="radio"/>	■ ACMES IRAQ	<input checked="" type="checkbox"/>	10/01/1986 - 09/30/1996	1 hour	40 km
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<input type="radio"/>	■ ACMES Conus3	<input checked="" type="checkbox"/>	10/01/1986 - 09/30/1996	1 hour	40 km
<input type="radio"/>	■ ACMES CASIAB	<input checked="" type="checkbox"/>	10/01/1986 - 09/30/1996	1 hour	10 km

Space Resources

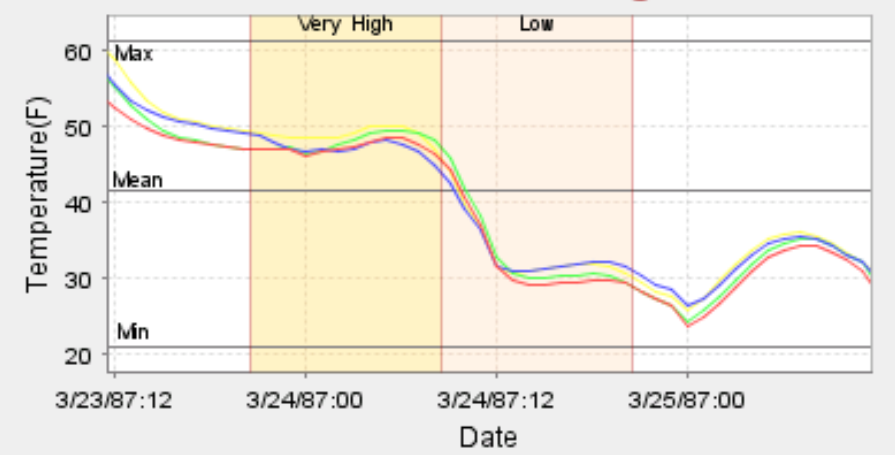
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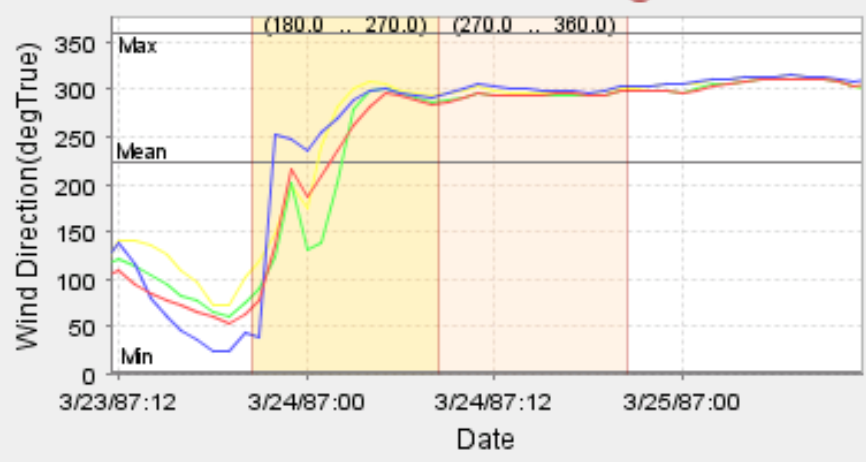
Wind Speed@Surface of Ground



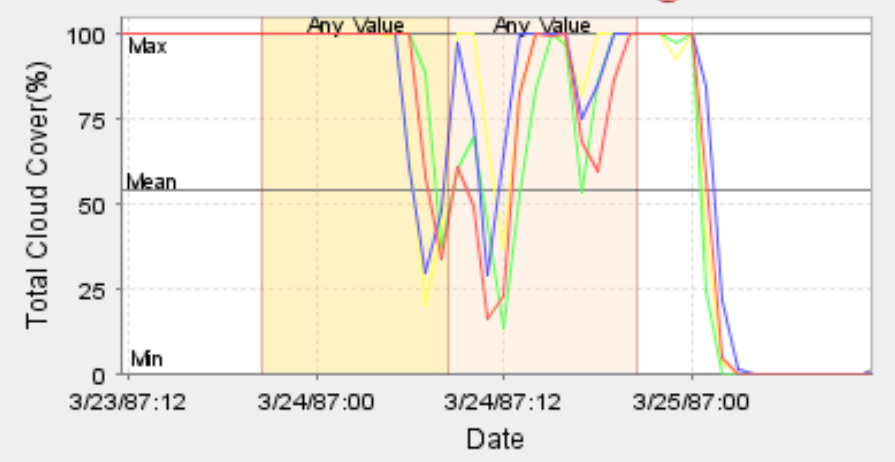
Temperature@Surface of Ground/S



Wind Direction@Surface of Ground



Total Cloud Cover@Surface of Ground





ESG and SEDRIS



- **ESG offers delivery of gridded (2D) data in SEDRIS V4.1.1**
 - **Content limited to that supported by EDCS**
 - **Current capability developed specifically for FCS support**
- **ESG utilizes SEDRIS technology components**
 - **EDCS for terminology definitions and mappings**
 - **Write API for the generation of V3.x STF**
 - **Grb2stf conversion tool for generation of V4.x STF**
- **Additional SEDRIS technology could have been used in ESG/COSINE for internal processing**
 - **SEDRIS offered no Java bindings at time of development**
 - **ESG metadata could have been based on SEDRIS DRM if XML schema elements defined**
 - **ESG internal terminology maintained neutral of any one standard**

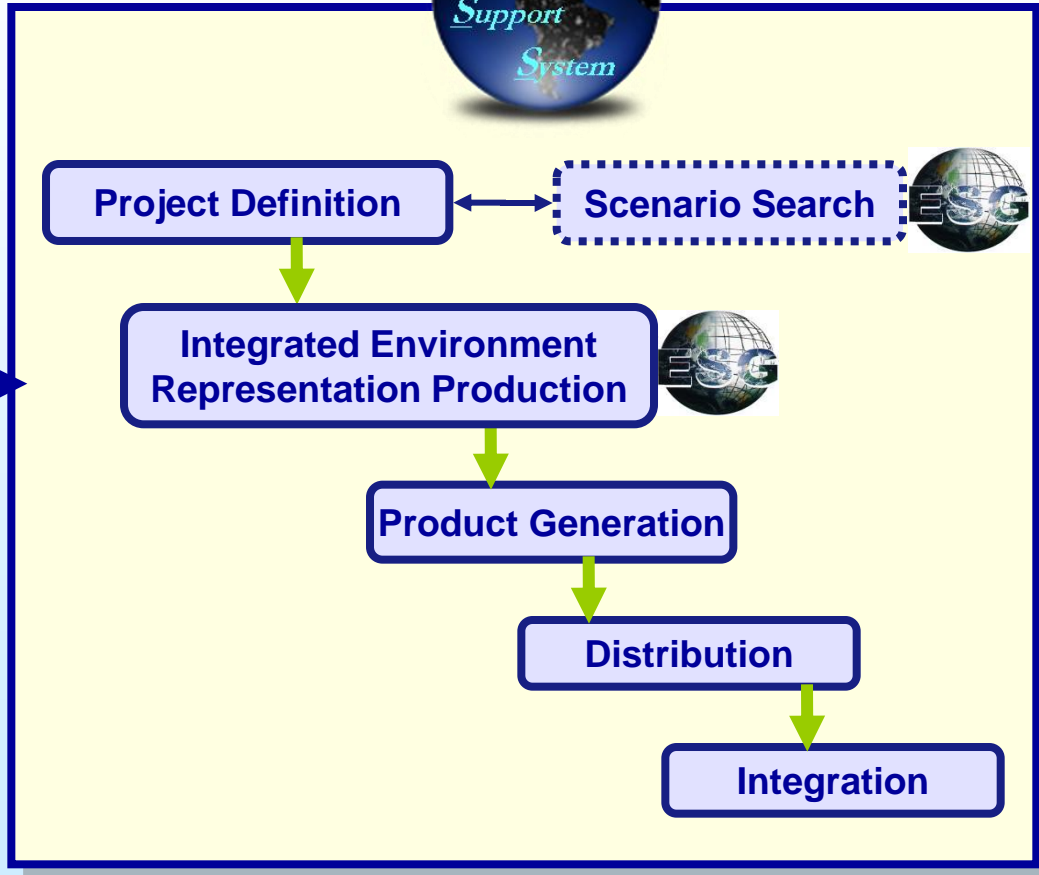
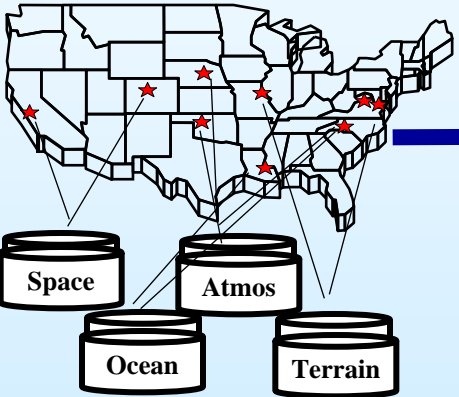


Environmental Data Cube Support System (EDCSS)



National Repositories

- DoD Ops/R&D Centers
- NOAA Data Centers
- Other Domain CoE



Simulation



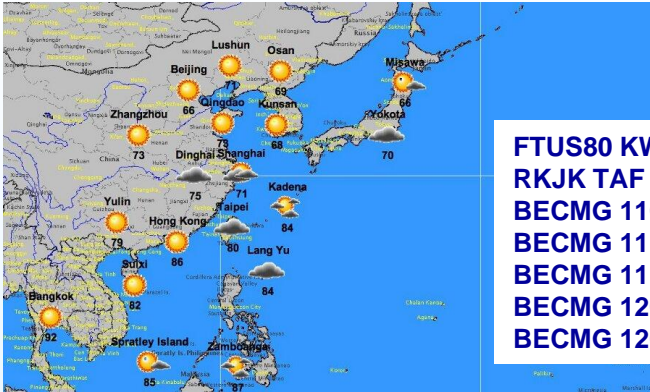
White Cell or Analyst



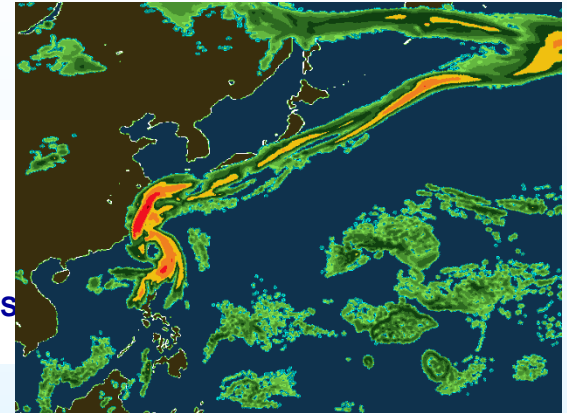
COP (C4ISR)



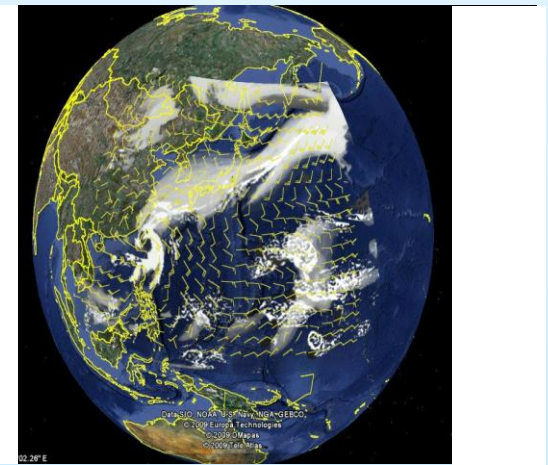
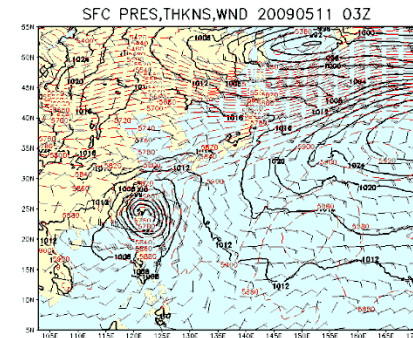
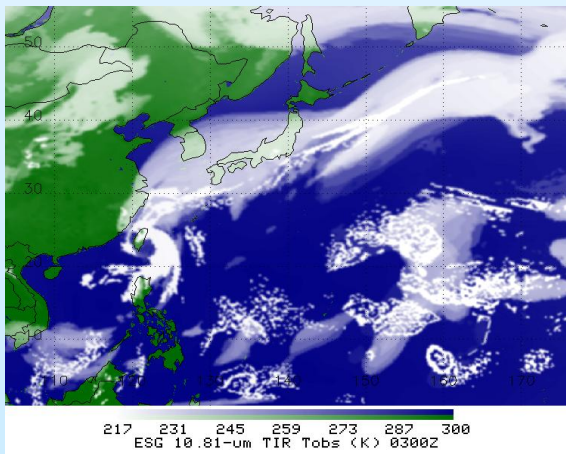
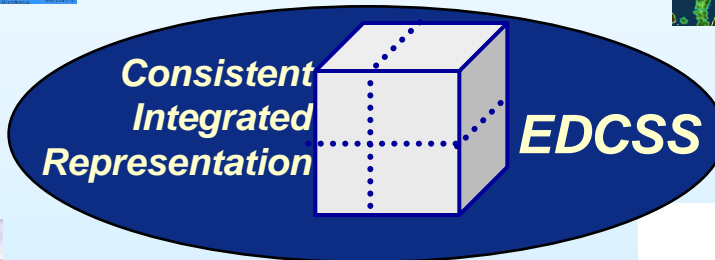
EDCSS Correlated Products



FTUS80 KWBC 110300
RKJK TAF 110303 04006KT 9999 SKC QNH3005INS
BECMG 1107/1109 35007KT 9999 SKC QNH2988INS
BECMG 1113/1115 09010KT 9999 SKC QNH2991INS
BECMG 1119/1121 04009KT 9999 SKC QNH2986INS
BECMG 1201/1203 03011G25KT 9999 SCT270 QNH2969INS
BECMG 1207/1209 33017G37KT 9999 SKC QNH2967INS



METAR RCMQ 110300Z 31016KT
10SM BKN140 30/25 Q0970





Communities of Interest

Environmental Representation Integration Projects

Acquisition

Analysis

Planning

Testing

Training

Experimentation

Common and Cross-Cutting M&S Tools

Common and Cross-Cutting M&S Data

Common and Cross-Cutting M&S Services

ASNE



ASNE Goals: Interoperability, Reuse, Efficiency



LPD-17

Probability of Raid Annihilation (PRA)



- **Integrated air/ocean data set for use in Radar simulation**
 - **Delivered test data set containing atmospheric parameters and sea heights**
 - **Created data for Mediterranean Sea play boxes**
 - **Provided NRL Stennis with 10 year archive of ACMES data used to create 10 year wave model archive that can be used ISO of future LPD 17 efforts and others**





Army Special Operations Training and Rehearsal System (ASTARS)



- H-60 Helo simulator
- Used ESG to find scenario for Ft Campbell KY
 - Produced and delivered high resolution (5 km) data set based on ACMES data
 - Produced higher resolution data set for entire CONUS (reuse)
 - ASTARS PM selected ESG as the data provider of choice for the initial training data sets





OSD/Service Programs Leveraging Environmental Data



LEAD	FLAGSHIP COMMUNITY PROGRAMS	Integration Level		
		<u>Started</u>	<u>Partial</u>	<u>Fully</u>
Army	Future Combat Systems (FCS)	X		
Army	One Semi-Autated Forces (ONESAF)	X		
Army	Army SOF Aviation Training and Rehearsal System (ASTARS)	X		
Navy	Joint Semi-Automated Forces (JSAF)		X	
Navy	Integrated Warfare Systems (IWS) Testbed		X	
Air Force	Air Force Modeling and Simulation Training Toolkit (AFMSTT)		X	
Air Force	Talon SHU	X		
Air Force	Storm		X	
Air Force	Thunder		X	
Air Force	Distributed Mission Operations (DMO)	X		
Joint	Joint Expeditionary Force Experiment (JEFX)			X
Joint	Joint Strike Fighter	X		
Joint	Joint Rapid Scenario Generation (JRSG)	X		
Joint	Joint Training Data Services (JTDS)	X		
Joint National Training Capability	Joint Live-Virtual Constructive (JLVC) Federation		X	
PACOM	Terminal Fury			X
EUCOM	Austere Challenge		X	
JFCOM	Joint Conflict and Tactical Simulation (JCATS)		X	
JFCOM	Joint Analysis System			X
Multi-National Experiment	Urban Resolve 2015		X	
JTF Mission Rehearsal	Unified Endeavor/Horn of Africa MRX		X	
Analysis	Unified Engagement		X	
FAA/NASA	Next Generation [aircraft] Messaging System (NexGEN)	X		
Defense Threat Reduction Agency	Hazard Prediction and Assessment Capability (HPAC)			X
National Reconnaissance Office	National Warfare System (NWARS)	X		



Benefits and Impacts



- **Benefits of continued investment in environmental representation:**
 - The use of interoperable environmental representations and their effects will increase within the DoD
 - DoD will have the capability to produce scalable, deployable environmental scenarios;
 - DoD will have the ability to integrate EDCSS capabilities into other DoD and Inter-Governmental agencies
 - DoD will have the ability to provide access to environmental M&S capabilities in support of emerging requirements for various DoD systems.
- **Negative impacts if no longer available:**
 - All of the benefits noted above are lost



Summary



- **Realistic M&S requires high-fidelity, consistent, and relevant multi-domain environment representations**
- **The INEARP provides the roadmap. ESG and EDCSS are two key enabling technologies**
 - **National data and modeling assets provide the content**
- **The ASNE MSEA is working with the Ocean and Terrain MSEA's to realize the full INEARP vision**