

INTRODUCTION TO SYSTEMS ENGINEERING FOR SEACOOS (OR THE GATEWAY TO THE LAND OF METRICS)

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OUTLINE

- BACKGROUND TO SYSTEMS ENGINEERING FOR SEACOOS
- SYSTEMS ENGINEERING THOUGHTS IN THE CONTEXT OF SEACOOS
- RECOMMENDED STEPS FOR SYSTEMS ENGINEERING IN SEACOOS

BACKGROUND

- SEACOOS EXTERNAL EVALUATION PANEL URGED ADOPTION OF A SYS. ENG. APPROACH TO GUIDE DEVELOPMENT OF SEACOOS THRU PRIORITIZATION AND COST/BENEFIT ANALYSES
- HISTORICALLY, SYS. ENG. IS LINKED TO INDUSTRIAL ENGINEERING, OPERATIONS RESEARCH, MANAGEMENT SCIENCE, CONTROL THEORY, ETC.
- THUS, IT IS A FORM OF QUANTITATIVE ANALYSIS (IN SOME CASES, HIGHLY MATHEMATICAL) TO GUIDE SYSTEM ASSESSMENT AND DECISION-MAKING RE: SYSTEM PERFORMANCE

THOUGHTS IN SEACOOOS

CONTEXT

- THE “SYSTEM” IS THE “OBSERVING SYSTEM” IN THE LARGE SENSE; I.E., THE “INFORMATION SYSTEM” COMPRISED OF THE COMBINED OBSERVING SYSTEM ELEMENTS (INCLUDING THE “NATIONAL BACKBONE”), MODELING SYSTEM ELEMENTS (INCLUDING NAVY & NOAA OPERATIONAL OCEAN PREDICTION SYSTEMS), AND INFORMATION MANAGEMENT SYSTEM ELEMENTS (INCLUDING NATIONAL STANDARDS), ALL OF WHICH CANNOT BE FULLY SETTLED UNTIL A NATIONAL “CONCEPT OF OPERATIONS” IS ESTABLISHED

- GEOGRAPHICALLY AND PHENOMENOLOGICALLY, THE SEACOOS “INFO SYS” ENCOMPASSES THE
 - SE COASTAL OCEAN (EEZ)
 - COASTAL OCEAN CIRCULATION SYSTEMS, INCLUDING THE ATMOSPHERIC MARINE BOUNDARY LAYER, WAVES, STORM SURGES, AND TIDES
 - COASTAL OCEAN ECOSYSTEMS, INCLUDING FISH
 - COASTAL OCEAN SEDIMENT TRANSPORT SYSTEMS
 - COASTAL OCEAN WATER QUALITY

- PERFORMANCE OF SEACOOS WILL BE JUDGED IN TERMS OF ITS ABILITY TO SUPPORT LEADING APPLICATION THEMES; E.G.,
 - MARITIME OPERATIONS (OIL SPILL RESPONSE, SEARCH & RESCUE, SAFE NAVIGATION, FORCES ON STRUCTURES, AQUACULTURE, ETC.)
 - SUSTAINABLE FISHERIES (ECOSYSTEM-BASED APPROACHES TO FISH MGMT., SYNOPTIC AND CLIMATIC ESTIMATES OF HABITAT CONDITIONS, WATER QUALITY, HABs, ETC.)
 - COASTAL HAZARDS (WINDS, WAVES, TIDES, SURGES, RIP CURRENTS, BEACH EROSION AND DEPOSITION, POLLUTION, ETC.)

EXAMPLE INFORMATION REQUIREMENTS FOR MARITIME OPERATIONS

- provide synoptic depictions of
 - mesoscale features (jets, eddies, and fronts) in the coastal ocean (i.e., EEZ)
 - seasonal and transient coastal upwelling/downwelling structures, including alongshore currents and counter/undercurrents
 - submesoscale features (surface tides, internal tides, small eddies and fronts)
 - surface wave properties
- provide estimates of particle trajectories and particle dispersion
- provide nowcasts, forecasts to the limit of highly accurate weather forecasts (ca. 72 hrs presently), and hindcasts for retrospective analyses.
- provide archival capability
- provide spatial domain coverage for a region or subregion or sub-subregion (TESTBED)
- provide “error bars”, as well as forecast skill scores and other metrics
- provide 4D fields as well as graphics

Products are required with the following resolution:

- Cross-shore ~ 1 km
- Alongshore ~ 3 km
- Vertical ~ 5 m in upper and lower 50 m, (H-100)/10 m for the interior
- Temporal ~ 1 hr (for output)

Products are required with the following accuracy and precision:

- T ~ 0.1 C
- S ~ 0.01 ‰
- Cross-shore velocity ~ 0.01 m/s
- Alongshore velocity ~ 0.1 m/s

EXAMPLE DESIGN GOALS, ATTRIBUTES FOR SEACOOS

- ESTABLISH ROBUSTNESS IN THE FACE OF HARSH MARINE ENVIRONMENT, STORM-DRIVEN POWER OUTAGES, PERSONNEL TURNOVERS, ETC.
 - REDUNDANCY IN COMPUTER OPERATIONS, SHORT-TERM DATA ARCHIVES, COMMUNICATION LINKS
 - EQUIPMENT AND PERSONNEL BACK-UPS

- DETERMINE RELIABILITY OF INFORMATION SYSTEM PRODUCTS
 - DOCUMENTED QA/QC PROCEDURES
 - DOCUMENTED GENERALIZED ERROR CHARACTERISTICS (E.G., “ERROR BARS”) ON OBSERVATIONAL AND MODEL PRODUCTS, PREFERABLY UPDATED SYNOPTICALLY
 - LEADS TO BUILD OUT STRATEGY

- CHARACTERIZE THE SYNOPTIC STATE OF THE SE COASTAL OCEAN
 - GULF STREAM SYSTEM (LOOP CURRENT, FLORIDA CURRENT AND THEIR MEOSOCAL MEANDERS, EDDIES, AND FRONTS)
 - MISSISSIPPI RIVER PLUME AND HIGH DISCHARGE EVENTS
 - HAB EVENTS
 - SEASONAL (AND SYNOPTIC EVENT) COASTAL UPWELLING/DOWNWELLING
 - PRIMARY PRODUCTIVITY SPACE-TIME PATTERNS
 - CIRCULATION AND PRIMARY PRODUCTIVITY ANOMALIES ASSOCIATED WITH TOPOGRAPHIC AND COASTLINE ANOMALIES
 - ISSUE AN ANNUAL SECO STATUS REPORT, POSSIBLY A DYNAMIC SYNOPTIC (“Ocean Weather”) REPORT

RECOMMENDED INITIAL SYSTEMS ENGINEERING STEPS

- START THE SYS. ENG. PROCESS BY FOCUSING ON THE MARITIME OPERATIONS (MO) APPLICATION THEME IN ONE OR MORE OF OUR TESTBEDS WHERE SEACOOS HAS A RELATIVE ABUNDANCE OF OBSERVATIONS AND CIRCULATION MODEL SUPPORT, AND WHERE MO APPLICATION INTEREST IS HIGH
- DETERMINE THE SPATIAL-TEMPORAL CORRELATION SCALES OF OBSERVED AND SIMULATED FIELDS
- DEVELOP “ERROR BARS”
- SIMULATE AND EVALUATE THE EXISTING OBSERVING SYSTEM AND HYPOTHETICAL VARIANTS ON IT
- CONDUCT Coastal Ocean Data Assimilation Experiment (CODAE) ACTIVITIES, WHICH MAY REQUIRE WORKING WITH THE “IMITATORS”