Analysis of Environmental Impacts on Military Systems

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Dr. Dharhas Pothina
Associate Technical Director
US Army Engineer Research and Development Center
Environmental Simulation

- Data Access/Archival
- Hi Fidelity Physics
- Tradespace Analytics
- Advance Computing Infrastructure

High Resolution Global Capability with Rapid Turn Around
Why

• **Gaps:**
  – DoD has an explosion of environmental data but access and retrieval is difficult
  – Demand within DoD for data has expanded but it is challenging to efficiently utilize
  – DoD lacks capability to produce high-fidelity, predictive, environmental physics for the entire globe to support operations and acquisitions
  – Data sources within the DoD have a scale and parameter mismatch (weather, terrain, etc.) for many classes of problems (operational, in-depth analyses, …)

• **ERS Approach:**
  – Develop a modular HPC enabled framework to discover, simulate, and retrieve environmental data
  – Develop high-fidelity scene generation and environmental simulation tools
  – Demonstrate modeling of environmental scenes worldwide

• **Leverage:**
  – DoD, federal, international, geospatial data, and environmental-modeling frameworks
  – Army ERS program
  – Studies directed by Army MSCoE, NVESD, PEO IEW&S, and others
Motivating Example: Hurricane Flooding

Rapidly evaluate many forecast scenarios anywhere across the globe

Use Cases
- Sensors
- Mobility
- Fluid Structure Interaction

VIZUALIZATION & ANALYSIS

6 Months → Hours

Forecast Scenarios

Environmental Data

Computational Geometry

Physics Based Simulation Engines

6 Months → Hours

Temperatures
Soil Moisture
Inundation
Velocities & Depths

Use Cases
Motivating Example: Sensor Virtual Proving Ground Workflow

Analyze Environmental Impacts

- Access validated geotypical simulations and real imagery
- Bring in notional Sensor / Automatic Target Recognition (ATR) Models
- Mount on arbitrary platforms
- Test existing sensors for probability of detection (PD) and false alarm rates (FAR) in new or different environments

Evaluate thousands of sensor/platform/environment combinations with validated physics

Desired Capability
A New Approach

**Integrated Product**
Powerful but heavyweight and inflexible, making it **hard** to:
- Adapt to new tasks
- Make use of available computing hardware
- Automate repetitive steps like parameter sweeping
- Create novel visualizations
- Add support for data larger than previously expected

**Ad-Hoc Scientific Python**
- Flexible by design
- Glue components together to make a workflow
- Components can be substituted/modified at will
- Flexible support for scaling up and out (Numba, Dask)
- Simple visualization via web browsers for local or remote sessions
- Solutions for big data viewed in browsers (Datashader)
- Emerging support for deploying notebooks as apps, dashboards

Can require excessive setup and programming and be complicated to deploy
Designing for Resiliency

- Modular Python wrapped components
- Flexible workflows
- Front end agnostic
- Scale to multiple architectures
- Enhance existing open tools when possible
- Utilize existing enterprise capabilities when available
- Use standards when possible/feasible but value simplicity over compliance
Notional Architecture

Open Data Science Ecosystem

Enterprise Security
Secure Collaboration
Containerized Deployment

Rapid Application Development

ERS Quest

Workflow Automation

Scale

Frontends

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Distribution Statement
ERS Quest

Search, download, and transform environmental data needed to set up high-fidelity, physics-based models

- Extensible Plugin Architecture
- Python API
- Abstraction Layer
- Multiple Frontends
- Geospatial/Geotypical Search
- Data Catalog/Retrieval/Archival
- Data Transformation
Demo

ERS Quest

Bokeh
Datashader
HoloViews
Collaborators

Environmental Simulator Team:
Kevin Winters
Scott Christensen
Aaron Valorosa
Gaurav Savant

ERDC Collaborators:
Integrated Simulation Environment Phenomenology (ISEP) Program

Industry Collaborators:
Anaconda Incorporated
Kitware Incorporated
Aquaveo
Questions