Analysis of Environmental Impacts on Military Systems

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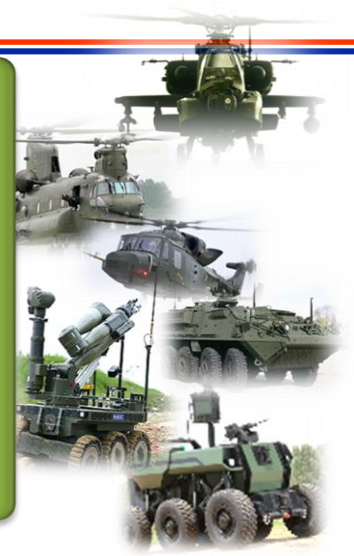
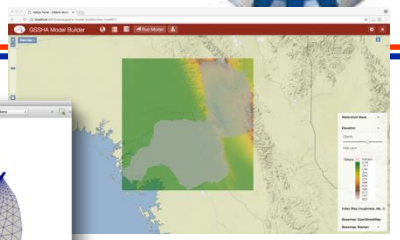
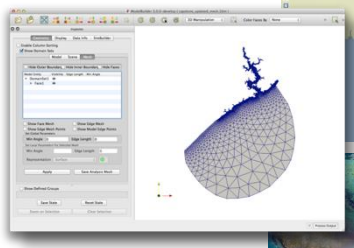
Environmental Simulation

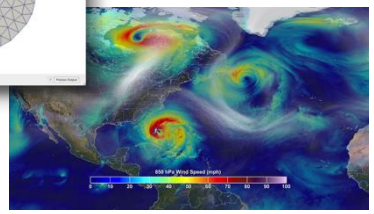
- Data Access/Archival
- Hi Fidelity Physics
- Tradespace Analytics
- Advance Computing Infrastructure

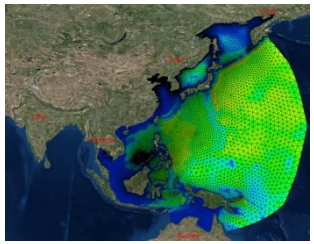
MILITARY SYSTEMS

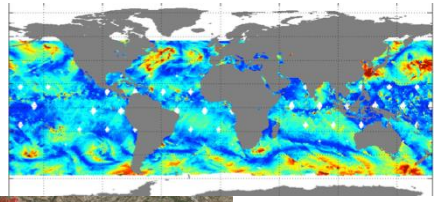


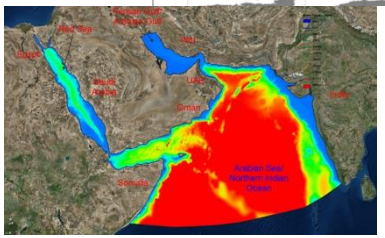




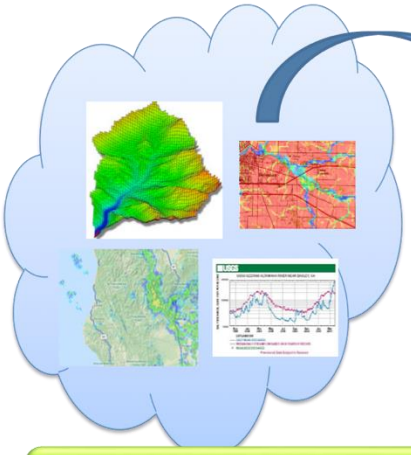


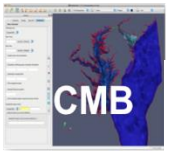


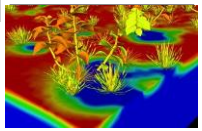


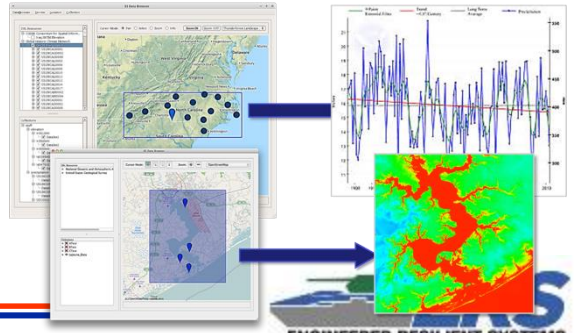


Met Office







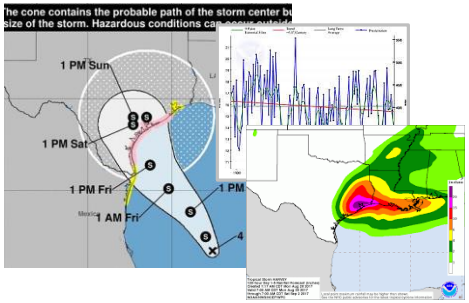


High Resolution Global Capability with Rapid Turn Around

Why

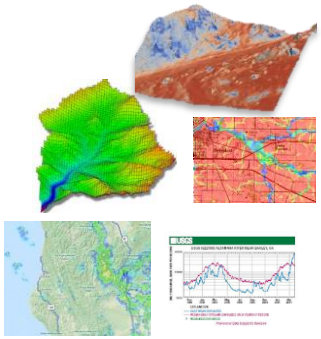
- **Gaps:**
  - DoD has an explosion of environmental data but access and retrieval is difficult
  - Demand within DoD for data has expanded but it is challenging to efficiently utilize
  - DoD lacks capability to produce high-fidelity, predictive, environmental physics for the entire globe to support 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

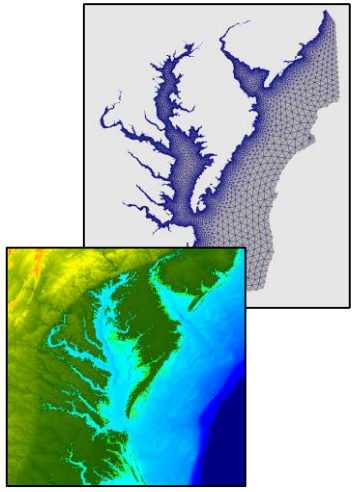


FORECAST SCENARIOS

Rapidly evaluate many forecast scenarios anywhere across the globe



ENVIRONMENTAL DATA



COMPUTATIONAL GEOMETRY

PHYSICS BASED SIMULATION ENGINES

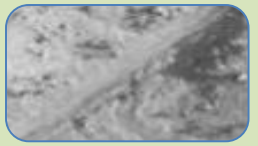
Temperatures

Soil Moisture

Inundation

Velocities & Depths

Use Cases



Sensors

Mobility

Fluid Structure Interaction

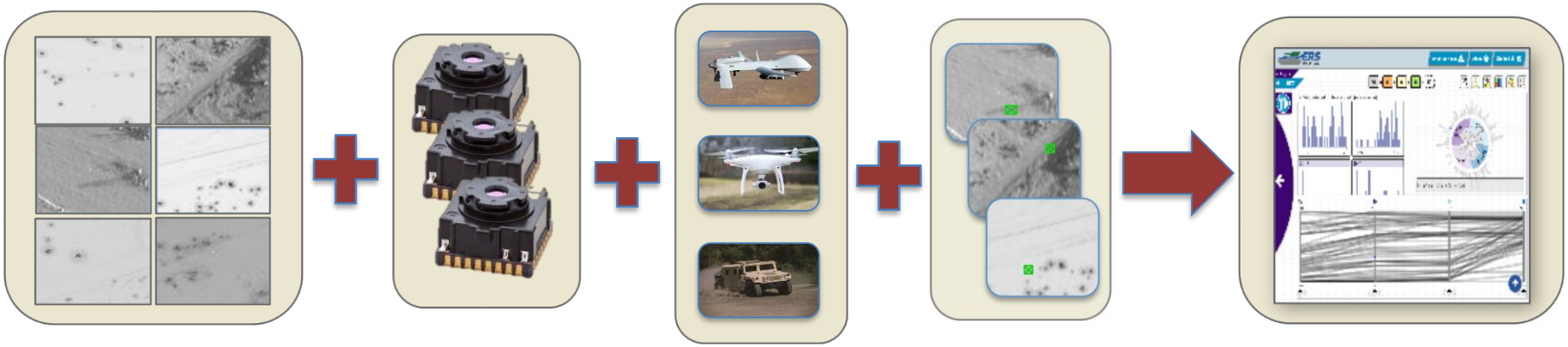
VIZUALIZATION & ANALYSIS

6 Months → Hours

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



VALIDATED ENVIRONMENTS | **SENSORS** | **PLATFORMS** | **TARGET RECOGNITION MODELS** | **TRADESPACE ANALYTICS**

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

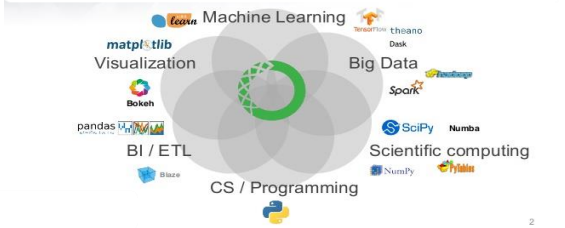
Can require excessive setup and programming and be complicated to deploy

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



ANACONDA ENTERPRISE

Rapid Application Development

python

ERS Quest

Stellar Science Galaxy

DASK

Stellar Science Galaxy

Spark

Scale

Workflow Automation

Enterprise Security
Secure Collaboration
Containerized Deployment

Frontends

jupyter

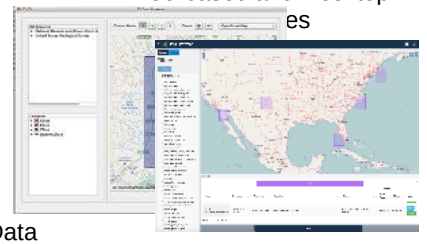
CMB

ERS Quest

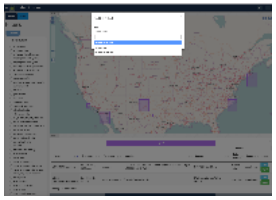
Search, download, and transform environmental data needed to set up high-fidelity, physics based models

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

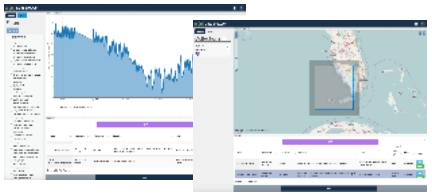
Web-based and Desktop

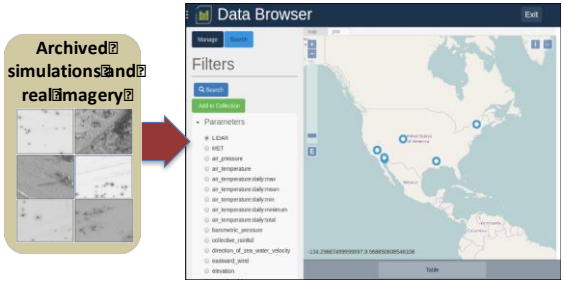


Transform Data



Visualize Time Series and Raster





Demo

ERS Quest

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

ERS NDIA
FUELING INNOVATION & COLLABORATION