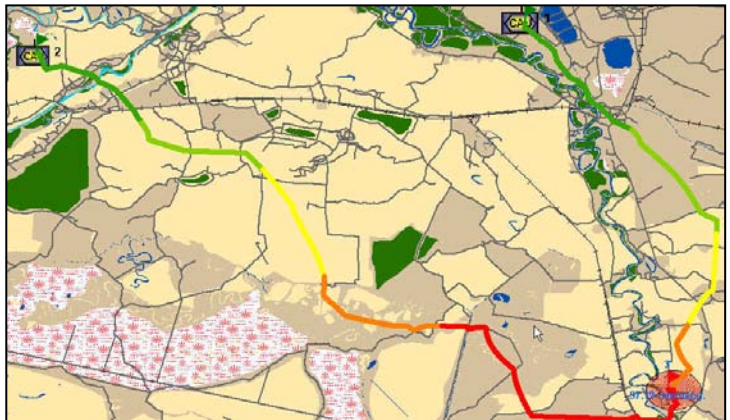



Better Mission Planning Through Terrain and Weather Integration

Susan Frankenstein & John Eylander
ERDC-CRREL, Hanover, NH

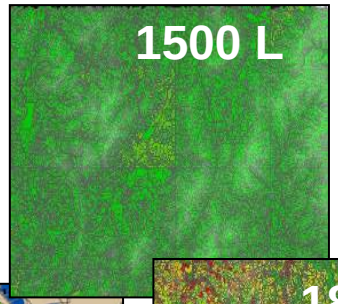

Outline

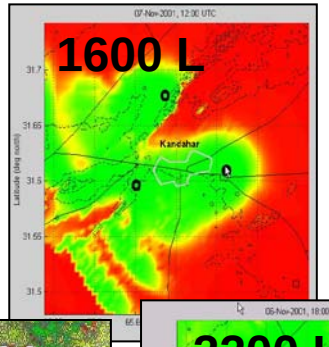
1. **Impetus**
2. Terrain Model details
   - Inputs/Outputs, Physics
3. Dynamic Terrain Products
   - Mobility Route Planners – Ground & Air
   - Sensor Performance Asset Planners
4. Conclusions
   - Hand-offs

Our Goal is *to truly integrate the dynamic effects of terrain and weather to account for environmental impacts on ground and air platforms as well as sensors such that …*

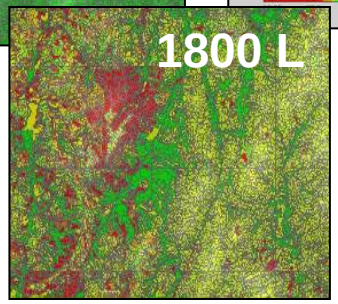
1) *Commanders can better compare courses of actions during the military decision making process (MDMP)*
2) *Environmental effects on platforms and sensors are integrated into battle command decisions.*
3) *Commanders understand the weather's impact on ISR (Intelligence, Surveillance and Reconnaissance) missions.*

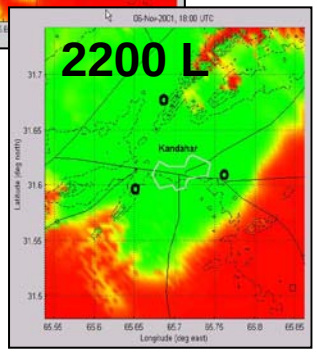








Outline

1. Impetus
2. **Terrain Model details**
   - **FASST – Fast All-season Soil STrength**
   - **Inputs/Outputs, Physics**
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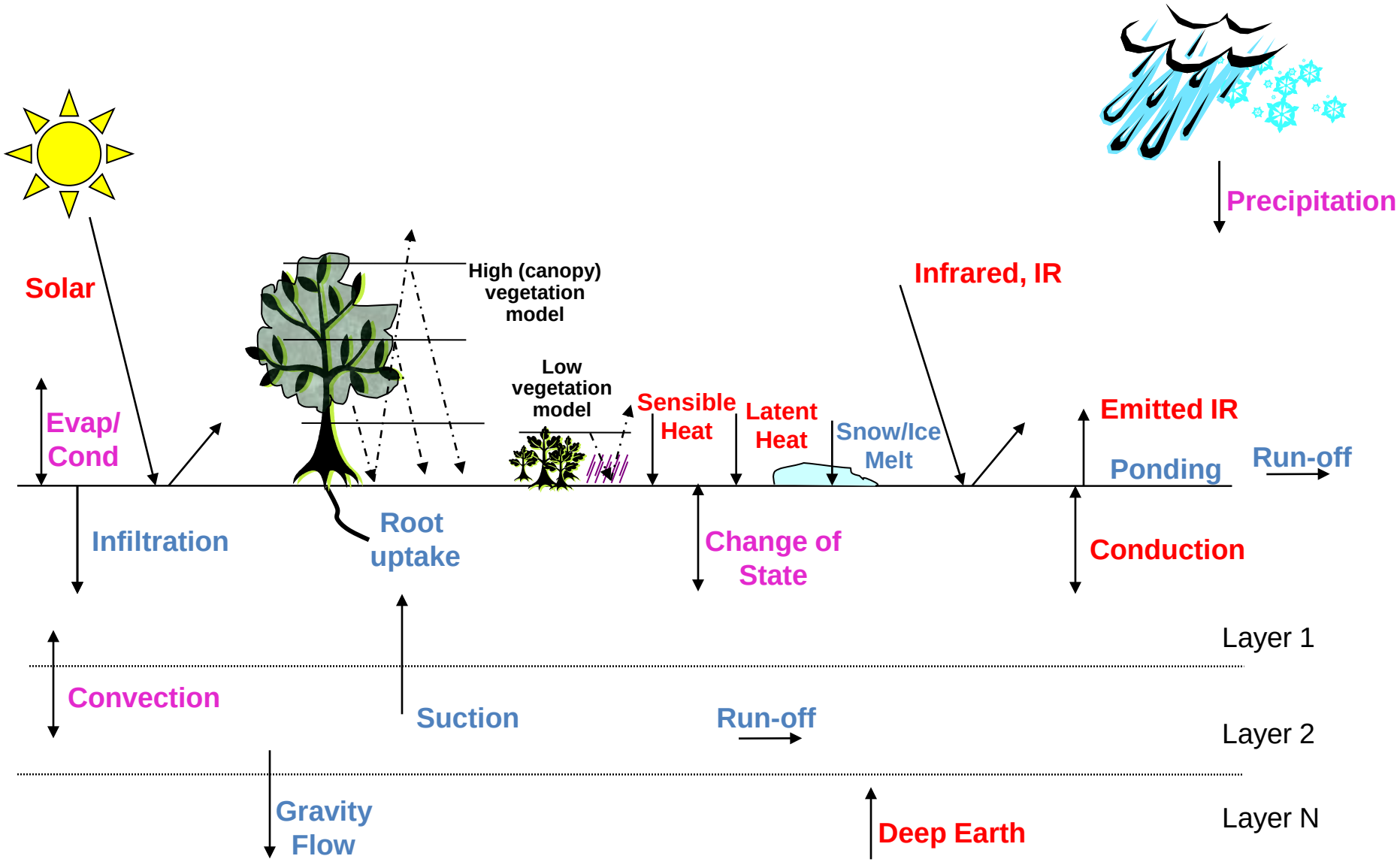
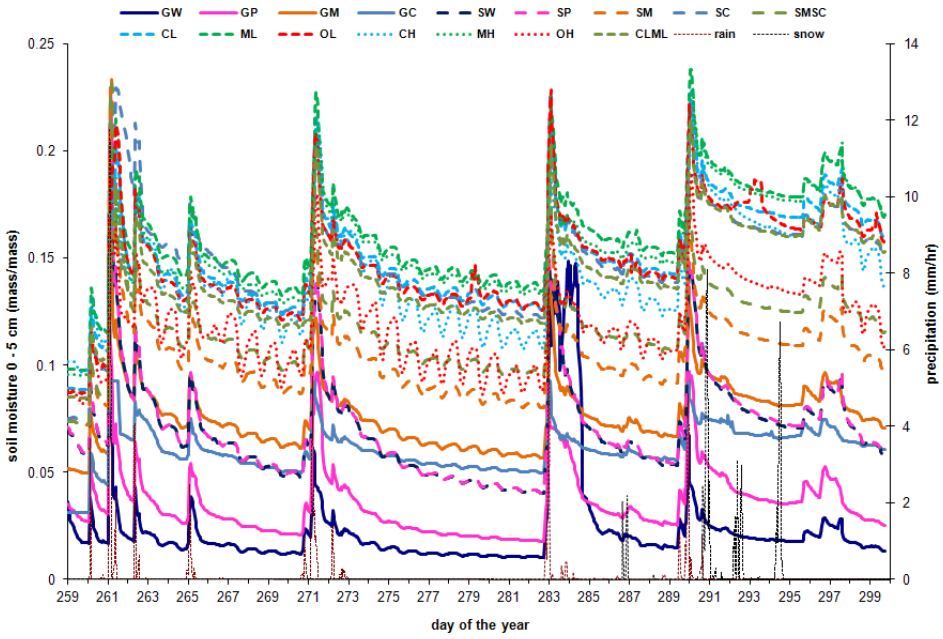
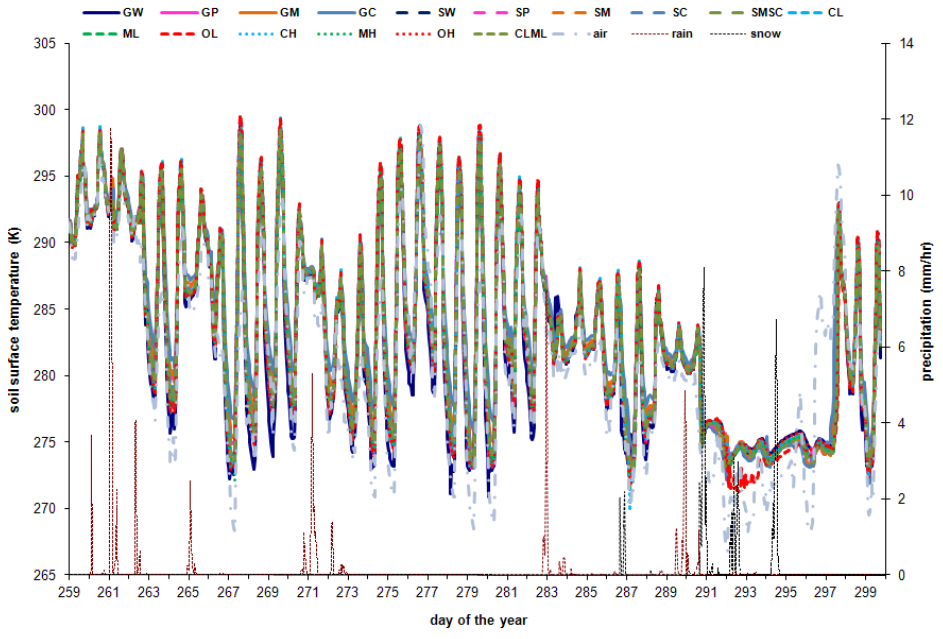
FASST Water & Energy Balance

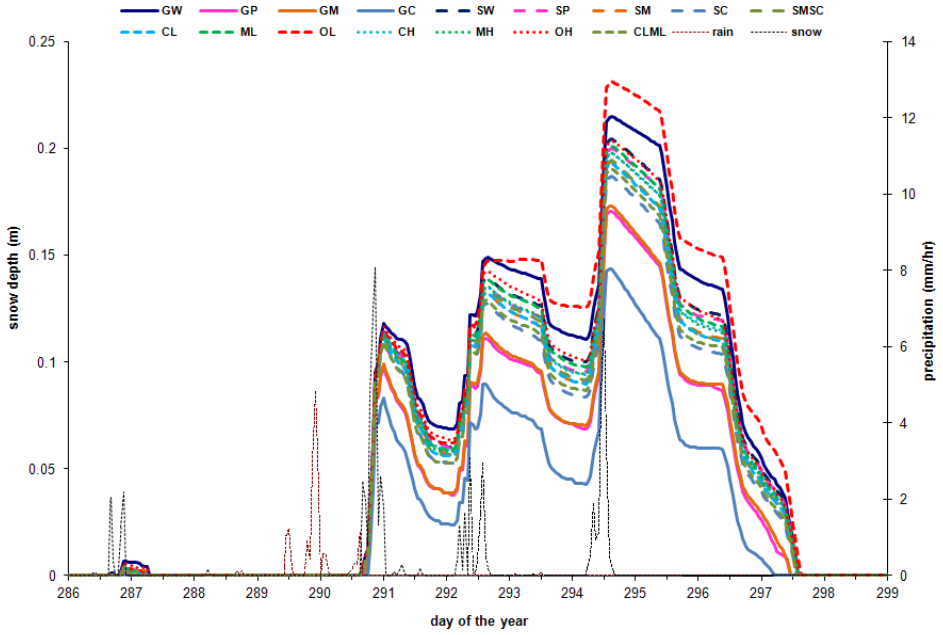


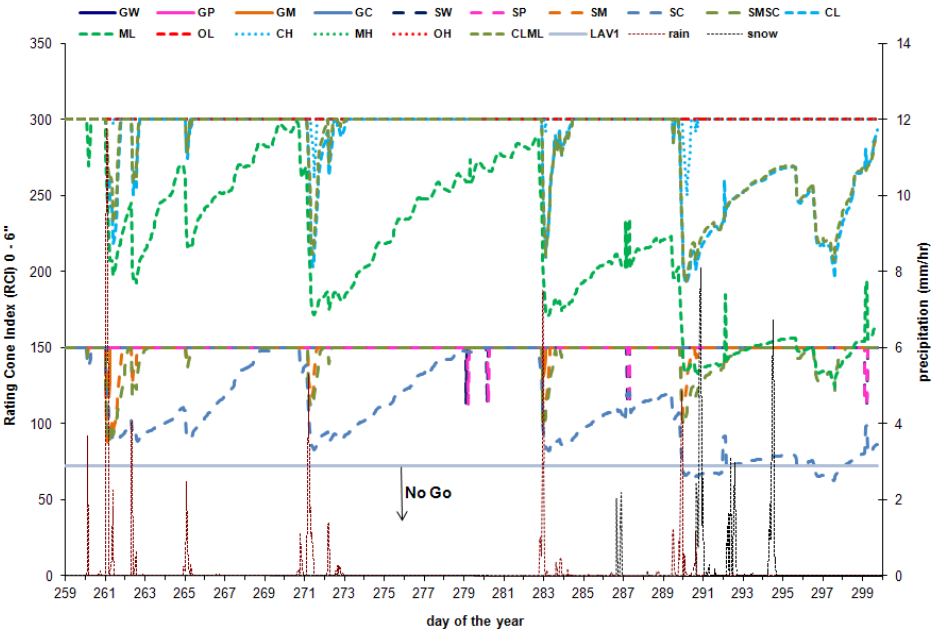
FASST Inputs/Outputs:

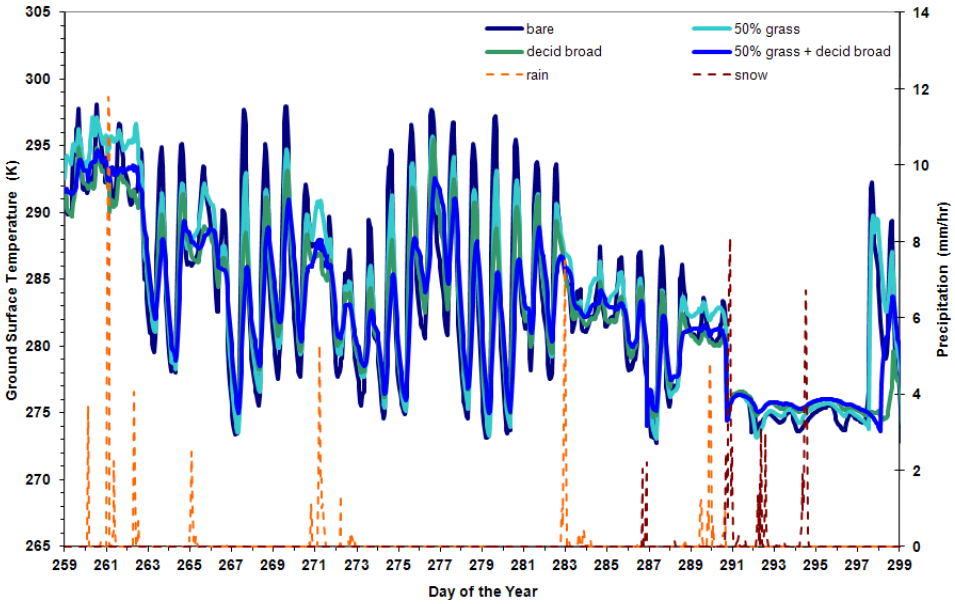
- **Inputs**
  - Meteorological Data (Dynamic)
    - WRF (AFWA), Observations
  - Soil Data (Static)
    - Number of Layers, Layer Thickness & Type, Material Properties
    - Initial Moisture & Temperature Profile; Snow Depth/Density
  - Vegetation Data (Static)
    - Type – High and Low; Density, Height
  - Site Specifics (Static)
    - Latitude, Longitude, Elevation, Slope, Aspect, Ground water level
    - Time offset from GMT
- **Outputs**
  - Soil Temperature; Moisture, Ice and Vapor Content
  - Freeze/Thaw Depths; Surface State (Frozen/Thawed)
  - Snow Depth; Snow Density; Surface Ice Thickness
  - Vegetation Temperatures
  - Surface Energy Fluxes
  - Soil Strength (0-6”, 6-12” RCI, CBR); Slippery Factor (W/D/S/I)

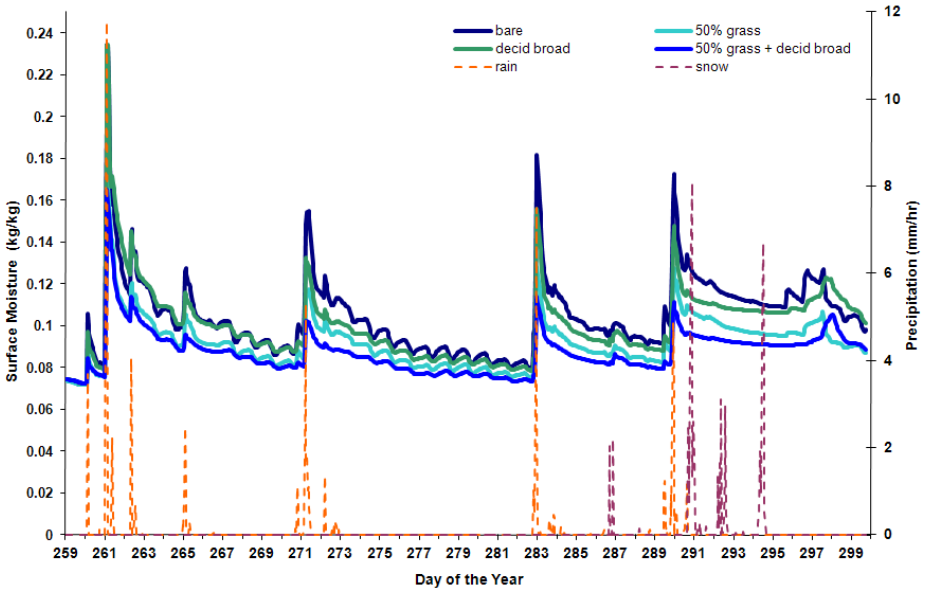

GW GP GM GC SW SP SM SC SMSC
CL ML OL CH MH OH CLML rain snow
soil moisture 0 - 5 cm (mass/mass)
precipitation (mm/hr)
day of the year

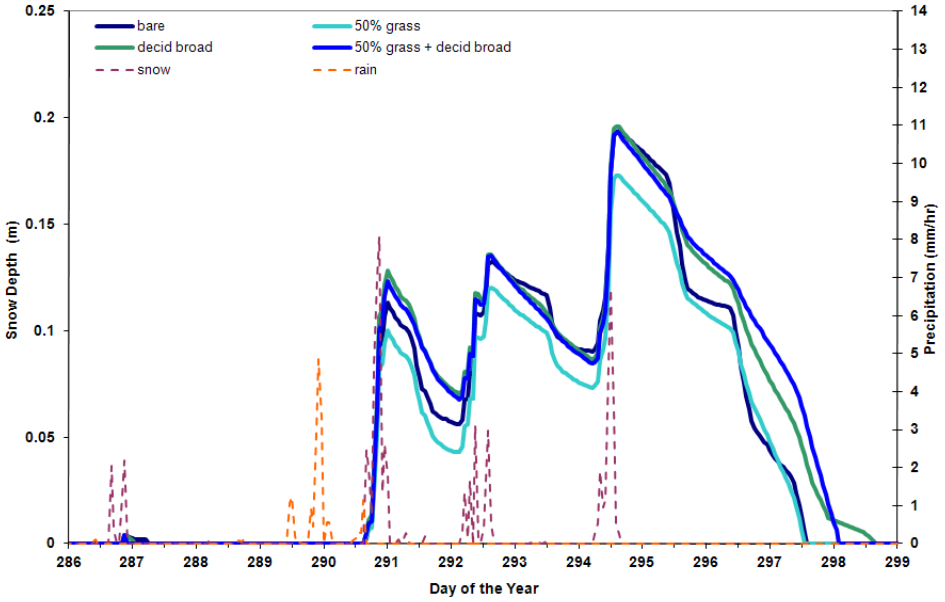

GW GP GM GC SW SP SM SC SMSC CL
ML OL CH MH OH CLML air rain snow
soil surface temperature (K)
precipitation (mm/hr)
day of the year

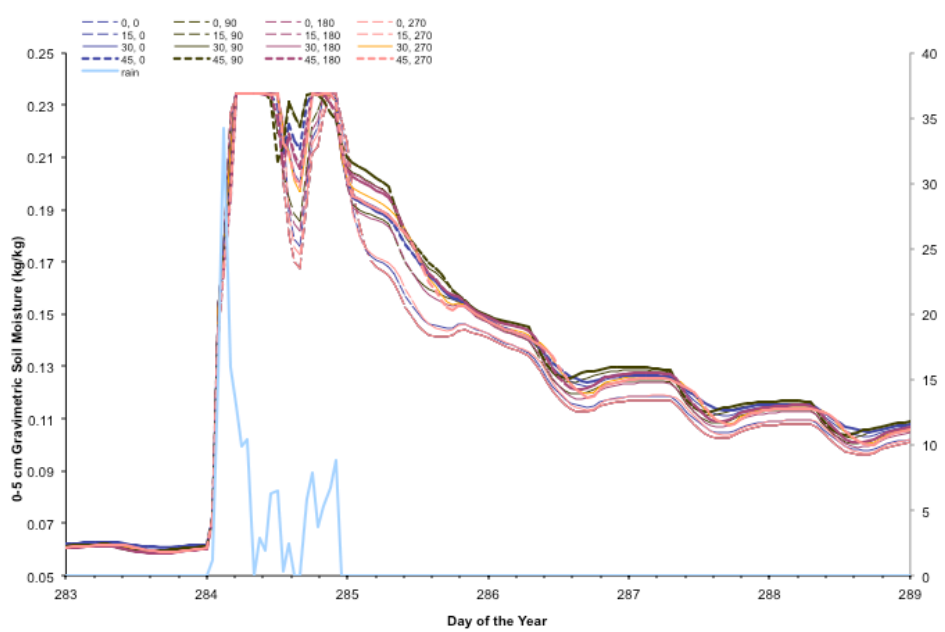

GW GP GM GC SW SP SM SC SMSC
CL ML OL CH MH OH CLML rain snow
snow depth (m)
precipitation (mm/hr)
day of the year

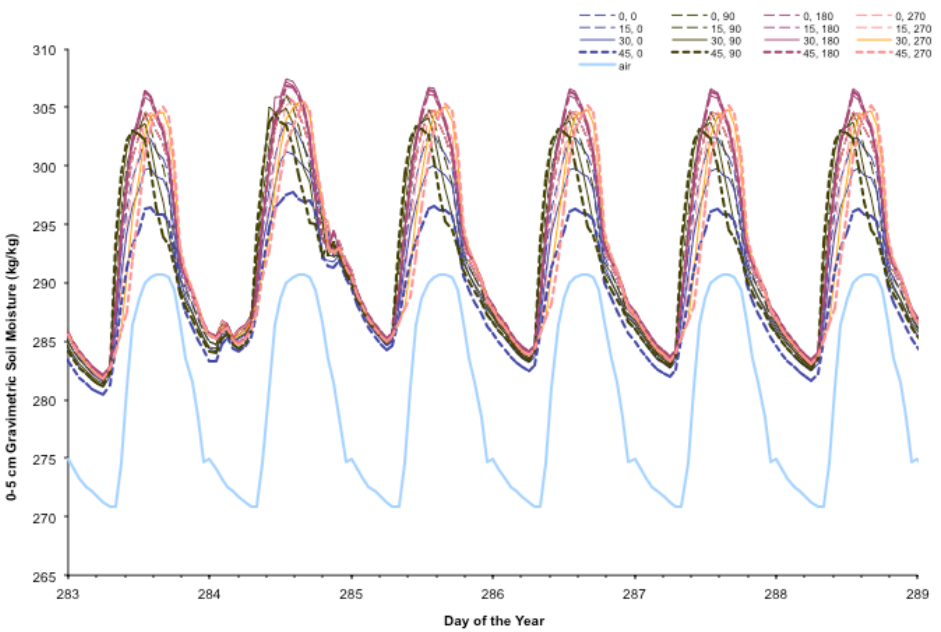

GW GP GM GC SW SP SM SC SMSC CL
ML OL CH MH OH CLML LAV1 rain snow
Rating Cone Index (RCI) 0 - 6"
No Go
precipitation (mm/hr)
day of the year


bare
50% grass
decid broad
50% grass + decid broad
rain
snow
Ground Surface Temperature (K)
Precipitation (mm/hr)
Day of the Year

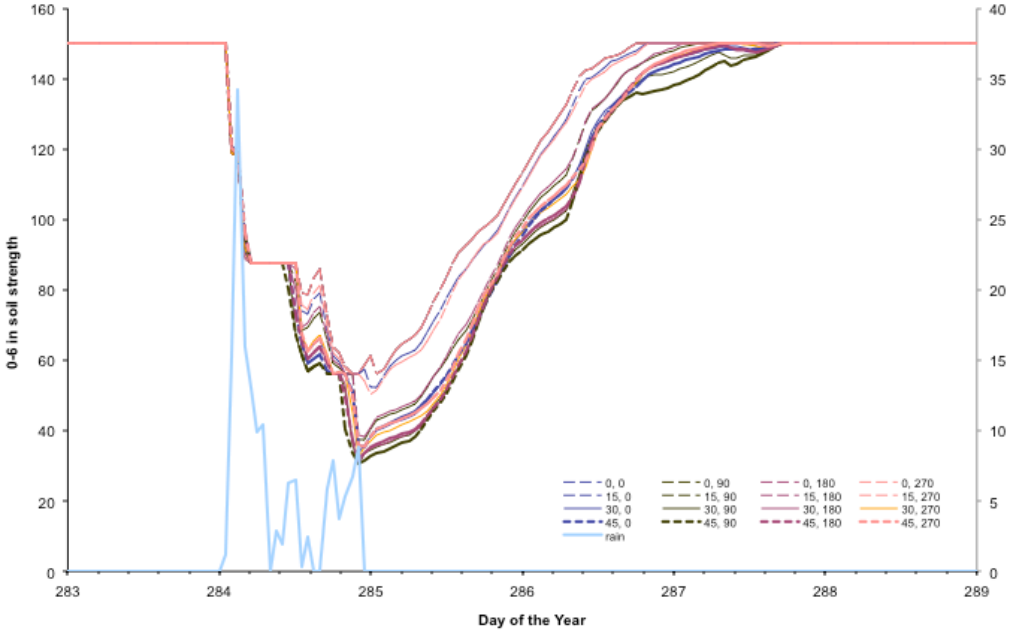

bare
50% grass
decid broad
50% grass + decid broad
rain
snow
Surface Moisture (kg/kg)
Precipitation (mm/hr)
Day of the Year

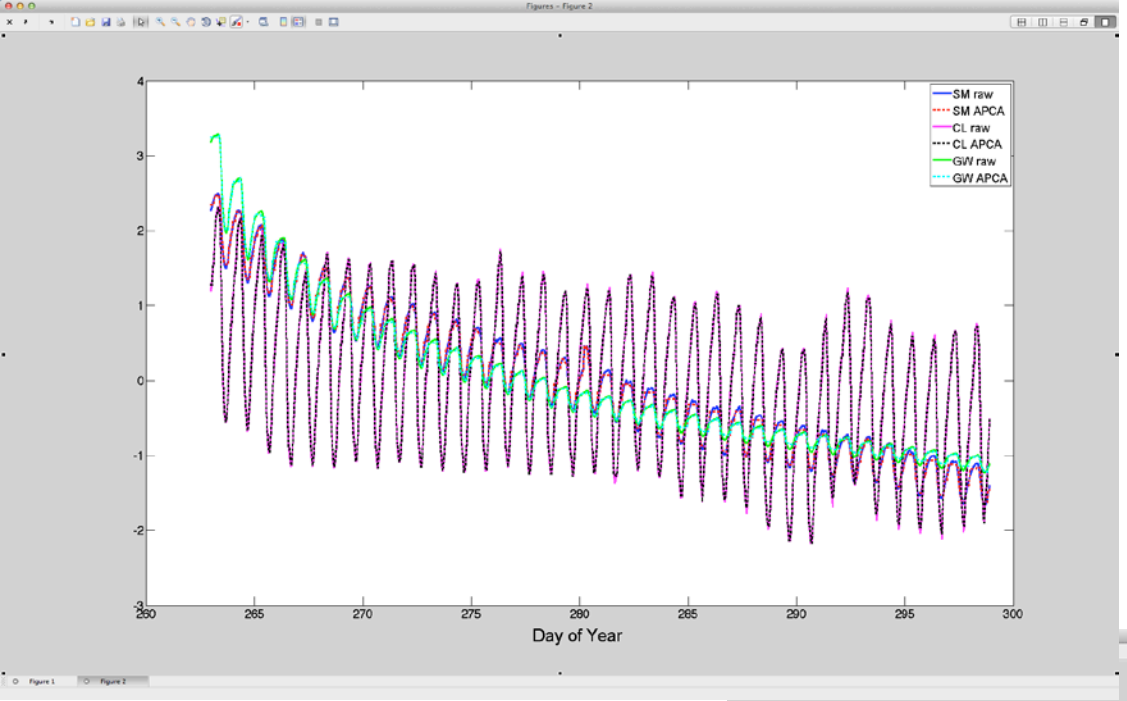

bare
50% grass
decid broad
50% grass + decid broad
snow
rain
Snow Depth (m)
Precipitation (mm/hr)
Day of the Year





Slope effects



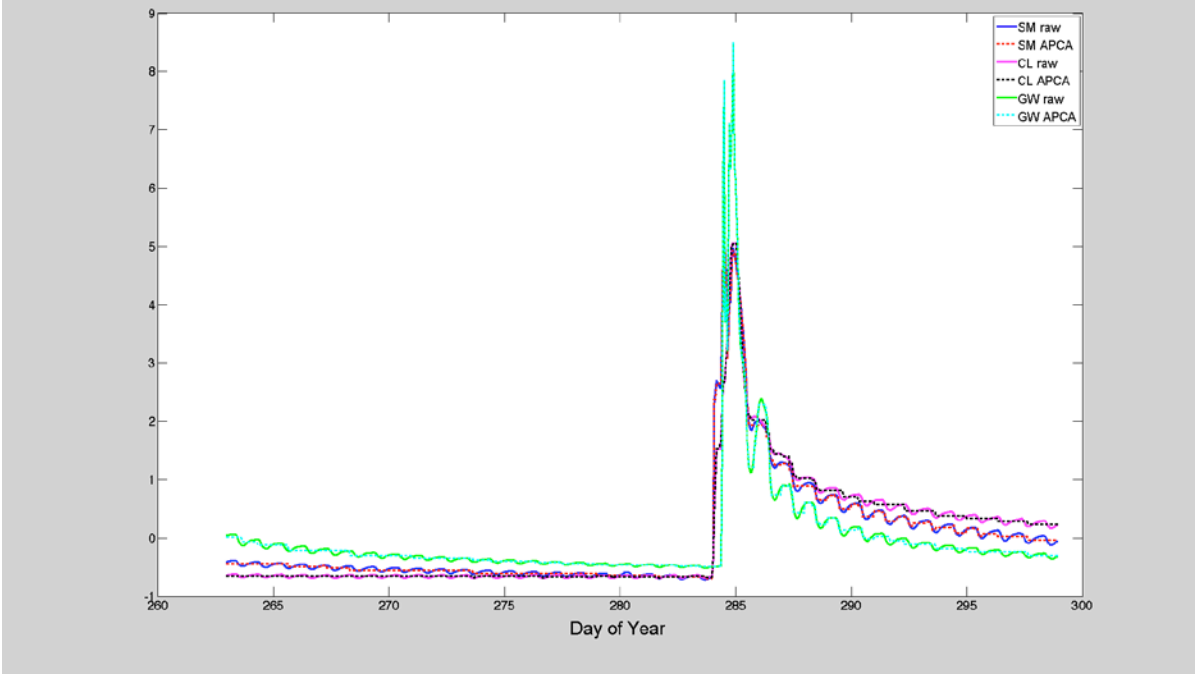


Adaptive Piecewise Constant Approximation (APCA)

- based on Haar discreet wavelet transforms
- variable segment lengths

SM: n = 241
CL: n = 585
GW: n = 163

SM: n = 66
CL: n = 50
GW: n = 66



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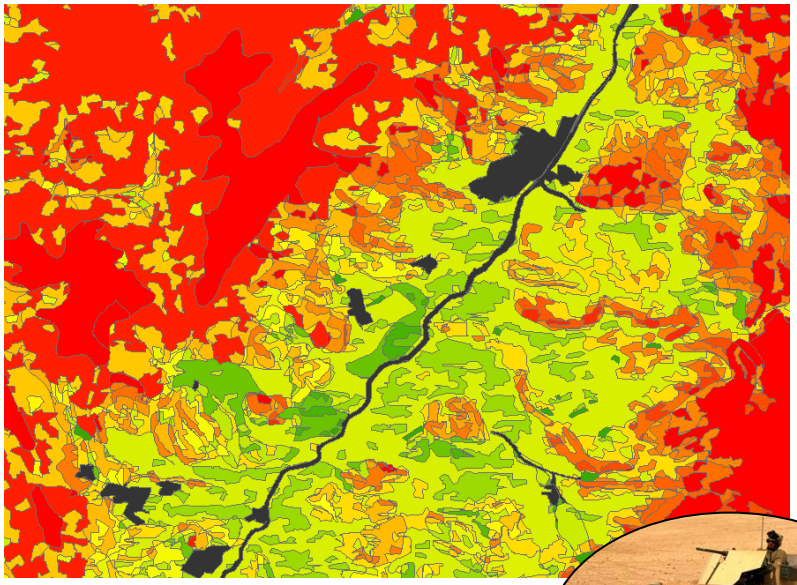
Cross Country and On Road Mobility

Both Provide mobility scores using terrain information and the ERDC mobility tool StndMob (NRMM)

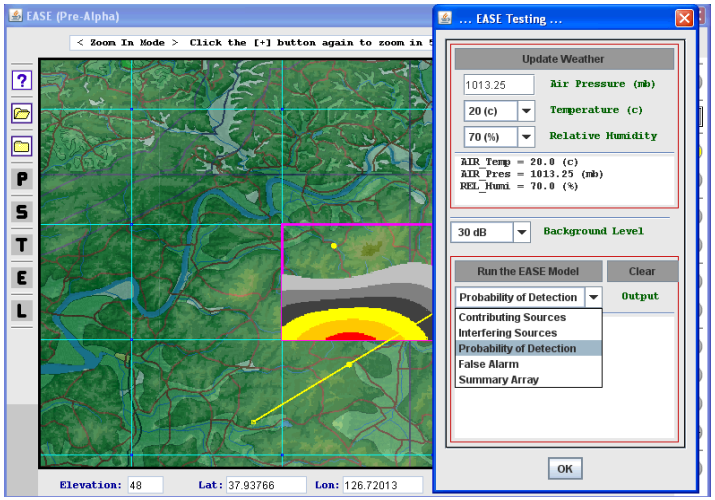


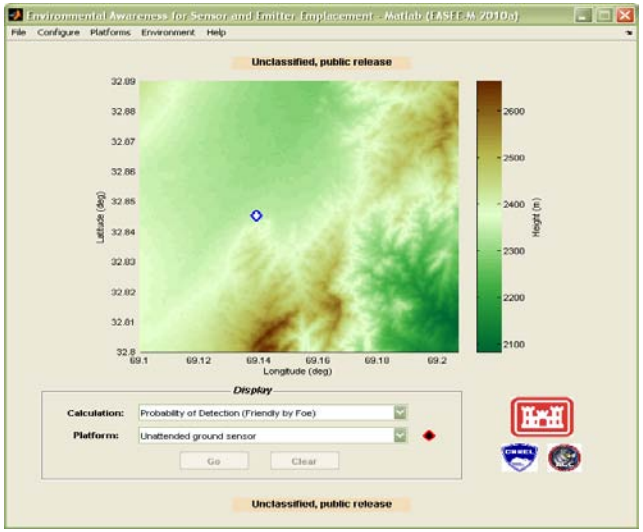
Scores depend on FASST soil strength predictions, visibility, snow and icing as well as “road” curvature and grade.

Environmental Awareness for Sensor and Emitter Employment (EASEE)

EASEE is a software framework for integrating signal generation, propagation, and processing models with the terrain and weather information needed to drive them.

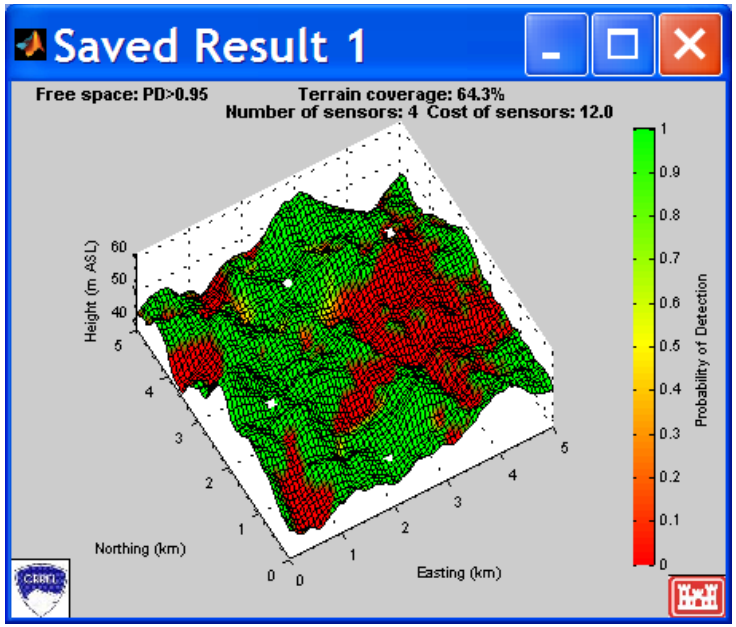
- **Flexible, object-oriented, reusable design** (coded in Java)
- **Is portable to many software and system environments** (C/JMTK, OpenMap, Google Earth, etc.)
- **Entirely *probabilistically* based**

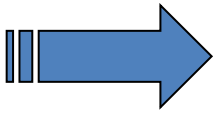


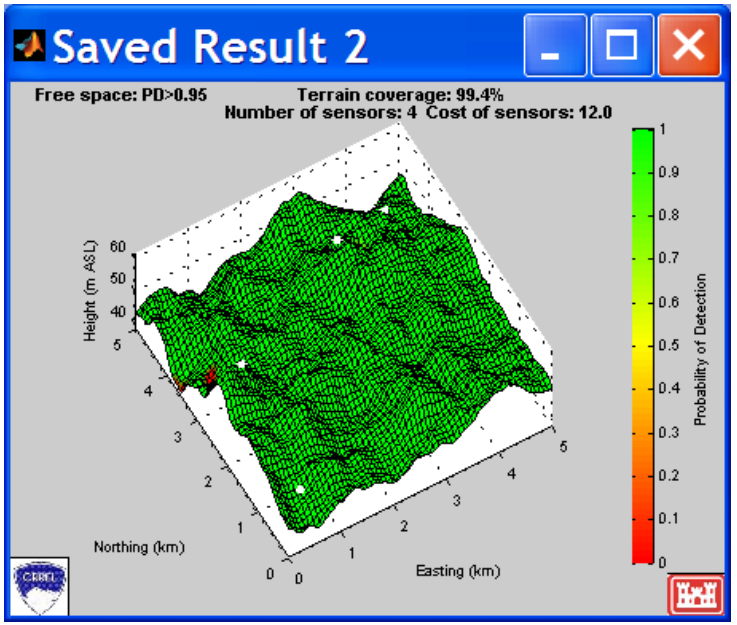


- **Facilitates many signal modalities** (e.g., acoustic, seismic, EO/IR, radar, RF, chemical/biological)
- **Goal is to provide a "standard" framework for defense mission planning applications involving signals and sensors**

Optimal Sensor Placement Tool (OSPTool)







manually placed:

- **1 line-of-site**
- **2 acoustic**
- **1 seismic**

64.3% of the terrain Covered

Relocated sensors with optimal placement algorithm

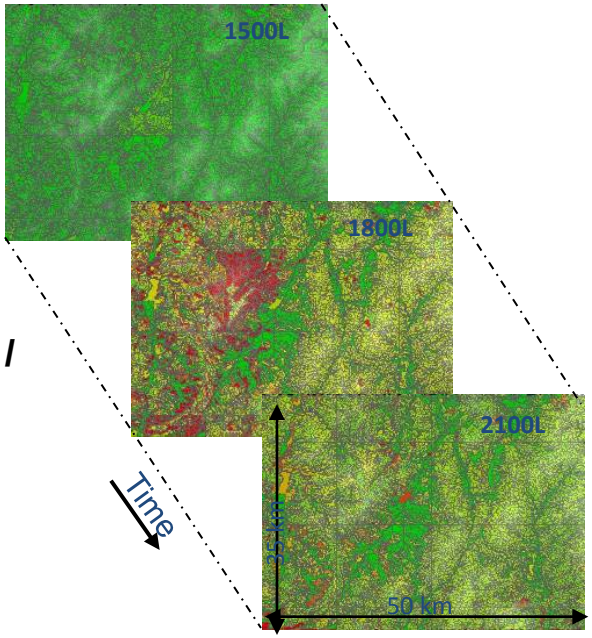
99.4% of the terrain Covered

Infrared Sensor Performance tied to UAS Flight Planning

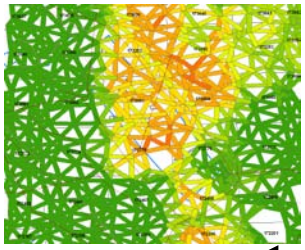
After attribution, the Unmanned Air Network contains spatial, temporal and scenario cases sufficient to finding IR sensor performance impacts along an entire UAS operation path.

Output in the form of:

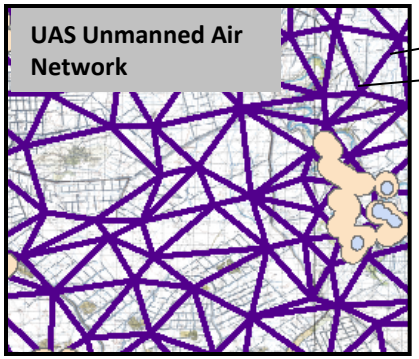
(1) scenario dependent sensor performance maps / data

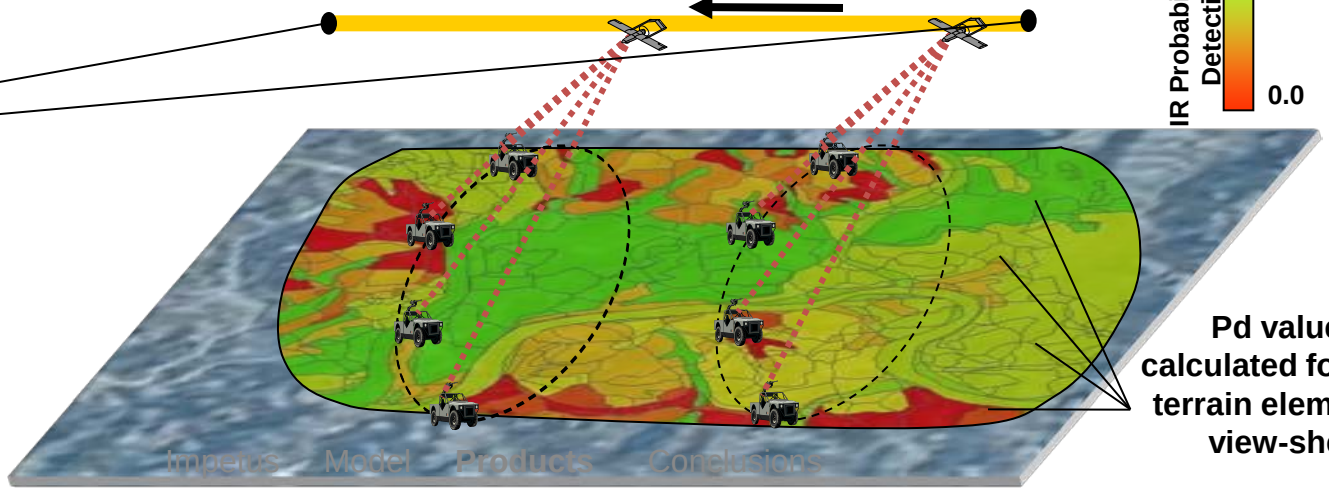


(3) UAF dynamic maneuver net



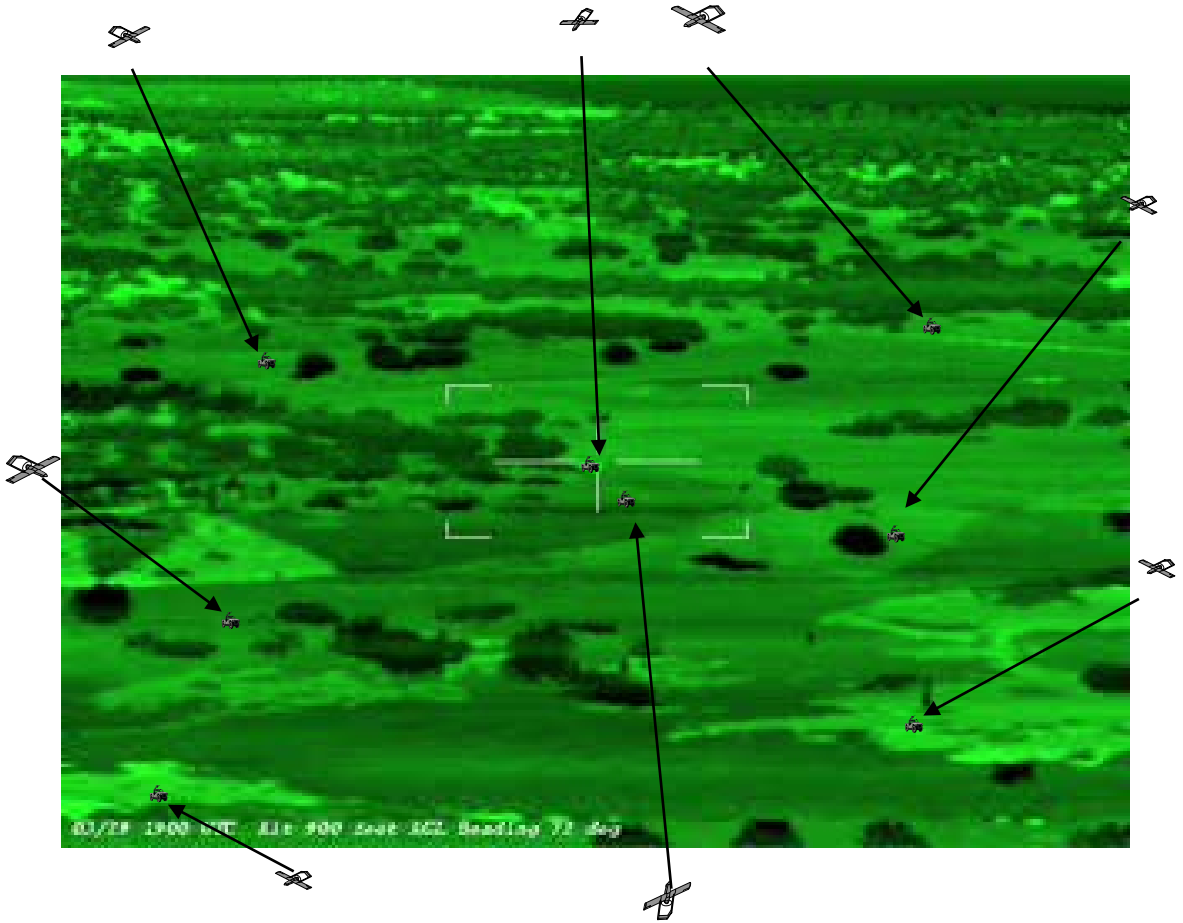
(2) Unmanned Air Network attribution





Pd values calculated for each terrain element in view-shed

TAWS8.x



- Includes IRTSS (IR Target Scene Simulation) pre-flight simulator capability
- Ingests weather via JMPS (Joint Mission Planning Segment – Air Force, Navy) using JMBL
- Displays in Google Earth, FalconView
- Weather getter for GMDB (Gridded Met Database) from DCGS-A

Conclusions

ERDC has developed a wide range of products that incorporate the dynamic state of the terrain into operations and intelligence tools enabling better planning and asset management.

- **Come to us – We can help!**