The Hydrosphere State Mission

HYDROS (AF XOW 0301)

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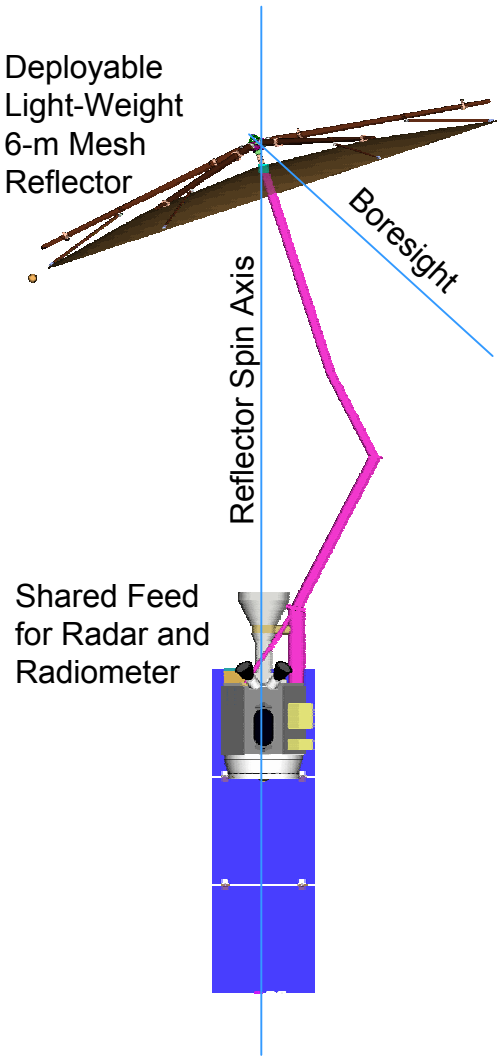

Concept

Objective:

Map Global Surface Soil Moisture and Soil Freeze/Thaw:

A Key EDR Measurement Across DoD

Air Force: Input Data to Fog, Visibility, and Weather Forecast Models
Army/Marines: Required Element of Terrain Trafficability Assessment
Navy: New Capability to Detect Ice Edge and Age

Description:

Provide Soil Moisture Information to a Depth and Spatial Resolution Which Cannot be Done With Other Sensors

Capability:

- Global Coverage With 2-3 Days Revisit
- Sensing Under Cloudy and Clear Conditions
- 3 km Radar and 40 km Radiometer Ground Resolution
- 5 cm Soil Penetration Under Most Vegetation

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Justification

MILITARY RELEVANCE	
AFSPC Weather Information Key EDR: *"The entire DoD lacks the ability to rapidly and accurately monitor on a global basis 6 key environmental parameters (…, soil moisture,…)"*	**JROC NPOESS IORD-II EDR:** *"Key Performance Parameter (KPP) 4.1.6.1.6 …Soil moisture measurements are needed to derive trafficability information useful for support of the deployment of amphibious and ground forces."*

	JROC Requirements		Current DMSP	Future NPOESS	HYDROS
	Threshold	Objective			
Sensing Depth	1 mm	80 cm	1mm (Bare Soil)	1mm (Bare Soil)	50 mm (Most Vegetation)
Spatial Resolution	1-4 km Clear 40-50 km Cloudy	2 km All Weather	25 km (SSM/I **19 GHz**)	1-3 km Clear (VIIRS) 40-50 km Cloudy (CMIS **6 GHz**)	Clear and Cloudy 3 km Radar **1.2 GHz** 40 km Radiom. **1.4 GHz**

Comparison to Alternatives:

Higher Frequency Microwave Sensors: Limited to Sensing the Surface Skin Moisture and Across Bare Soil Regions Only

HYDROS Low Frequency Measurements: Capable of Sensing Through Most Vegetation Cover and Soil Moisture to Greater Depth

Military Utility: An Example

Numerical Weather Prediction (NWP) Models Require Gridded Surface Layer (0-5 cm) Soil Moisture Data for Initialization of Forecasts

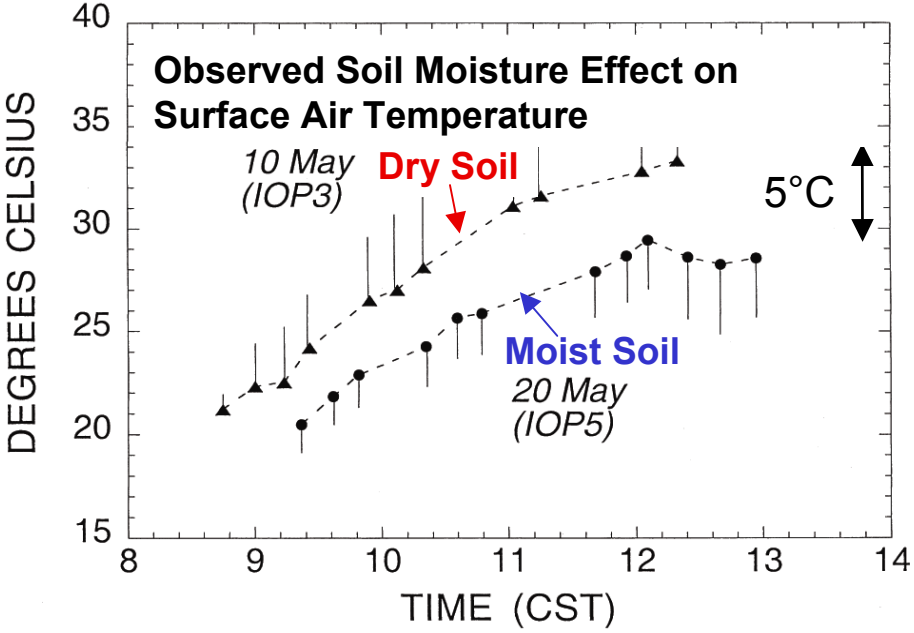
HYDROS Demonstrates Capability to Make All-Weather Measurements to Meet this Data Requirement

At Same Runway 5 °C Change in Air Temperature Results in 650 Feet Difference in Density Altitude

Less Density Altitude Means

- **Decreased Takeoff Distance**
- **Increased Rate of Climb**

~ Equivalent to 1 (Out of 5) Additional Pallet per Sortie on a C-130

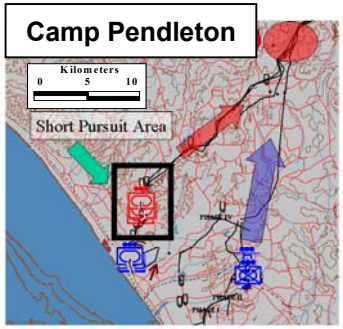


Measurements of daytime evolution of convective mixing – SE Kansas, *Bulletin of the American Meteorological Society*, 81(4), 2000.

Military Utility: An Example

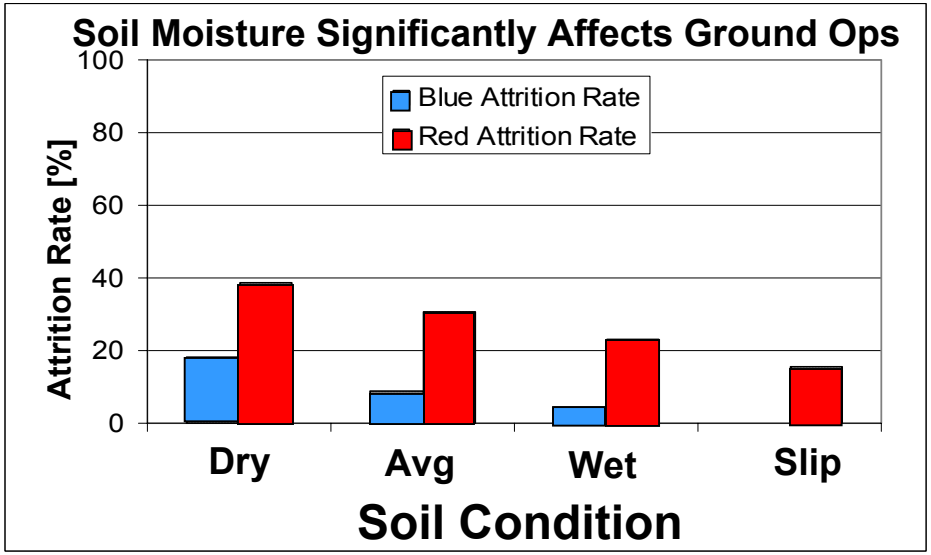
New Concepts of Ground Operations

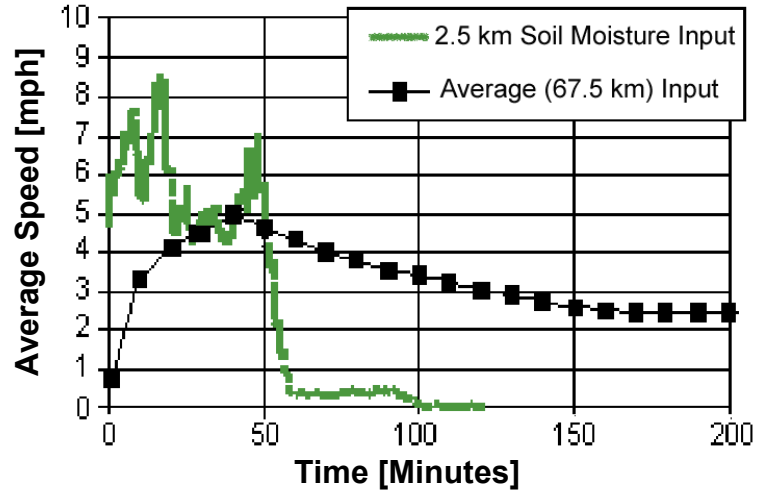
- **Fewer Forces**
  - **Increased Dispersion**
    - **Greater Mobility**



Joint Semi-Automated Forces (JSAF) Combat Model

Mason, G. L. et al. (2002), *Int. Society for Terrain Vehicle Systems*, Vicksburg.





Knowledge of Soil Moisture Variations at 2.5 km Resolution (vs. Average at 67.5 km) Resulted in Significant Differences in Speed of Vehicles and Tempo of Operations

HYDROS Demonstrates The Capability to Sense Soil Moisture to a Depth and at Spatial Resolution That Are Required for Trafficability Assessment

HYDROS

MIT JPL NASA Goddard Space Flight Center

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Summary of Data Application

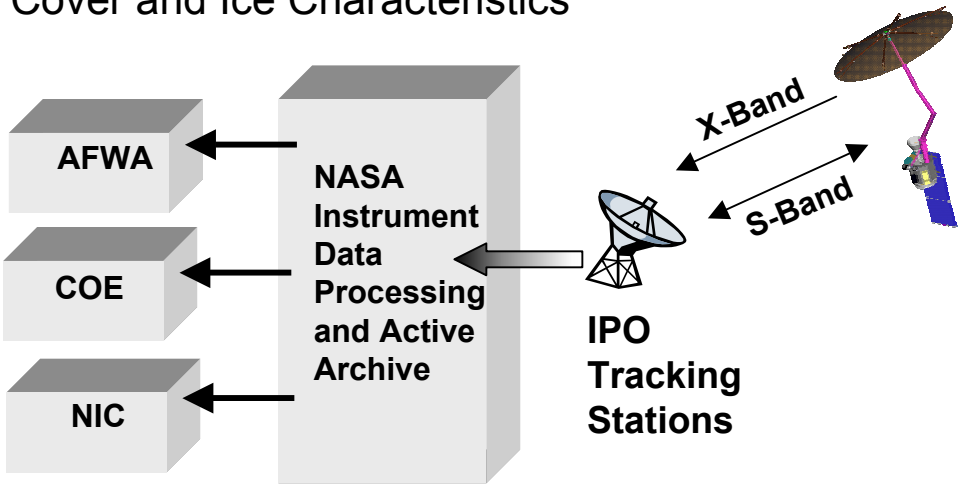
Air Force Weather Agency: Use Experiment Data to Initialize Numerical Weather Prediction Models (Forecast Low-Level Fog, Visibility, and Severe Weather)

Army Corps of Engineers/G-2 Army/Marine Corps: Use Experiment Data to Validate and Improve Tools to Evaluate Threat and Friendly Mobility

Naval Ice Center: Use Experiment Data for High-Resolution Mapping of Marine and Littoral Ice Cover and Ice Characteristics

Instrument and Processed Data Products will be Disseminated During Operations and Through Existing NASA and DoD Data Networks

Applicable Category of Experiment: Applied Research



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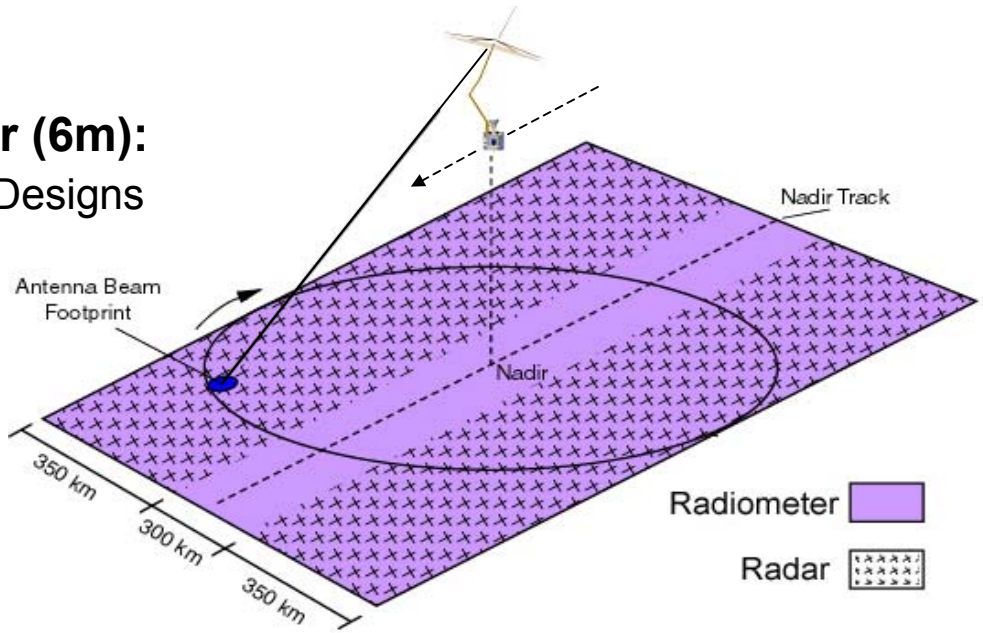
Experiment Design

Spacecraft: Same as Coriolis (STP's P98-2)
Provided by Spectrum Astro, Inc.

+

Light-Weight Mesh Deployable Reflector (6m):
Flown Northrop-Grumman & Harris Designs

= Low Risk



1.26 GHz Radar at 3 km (VV, HH, HV)
1.41 GHz Radiometer at 40 km (V, H, U)
at Constant 40° Incidence

Wide 1000 km Swath for Global Mapping and
Good Revisit (1-2 Day Polar; 2-3 Days Equatorial)

6 am Nodal Crossing