



The Development of an Acoustic Transmission Loss Data Base for the Joint Warfare System (JWARS) Using MIV

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**SEDRIS Technology Conference
January 6-9, 2004**



Joint Warfare System (JWARS)

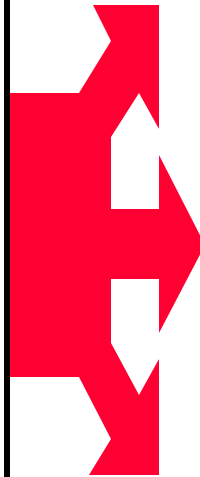
- **Campaign-level model of military operations developed by the Office of Secretary of Defense (OSD)**
- **Will support multi-billion dollar resource allocation decisions and critical operational planning**
- **Mission: To develop a state-of-the-art, constructive simulation that will:**
 - **Provide a multi-sided and balanced representation of joint theater warfare**
 - **Be able to assess current and future operational concepts**
 - **Use C4 and ISR as the foundation for how entities perceive and interact with one another**



JWARS Users and Applications

Users

- Joint Staff
- Services
- CINCs
- OSD
- Joint Task Forces
- Other DoD org's
- Industry

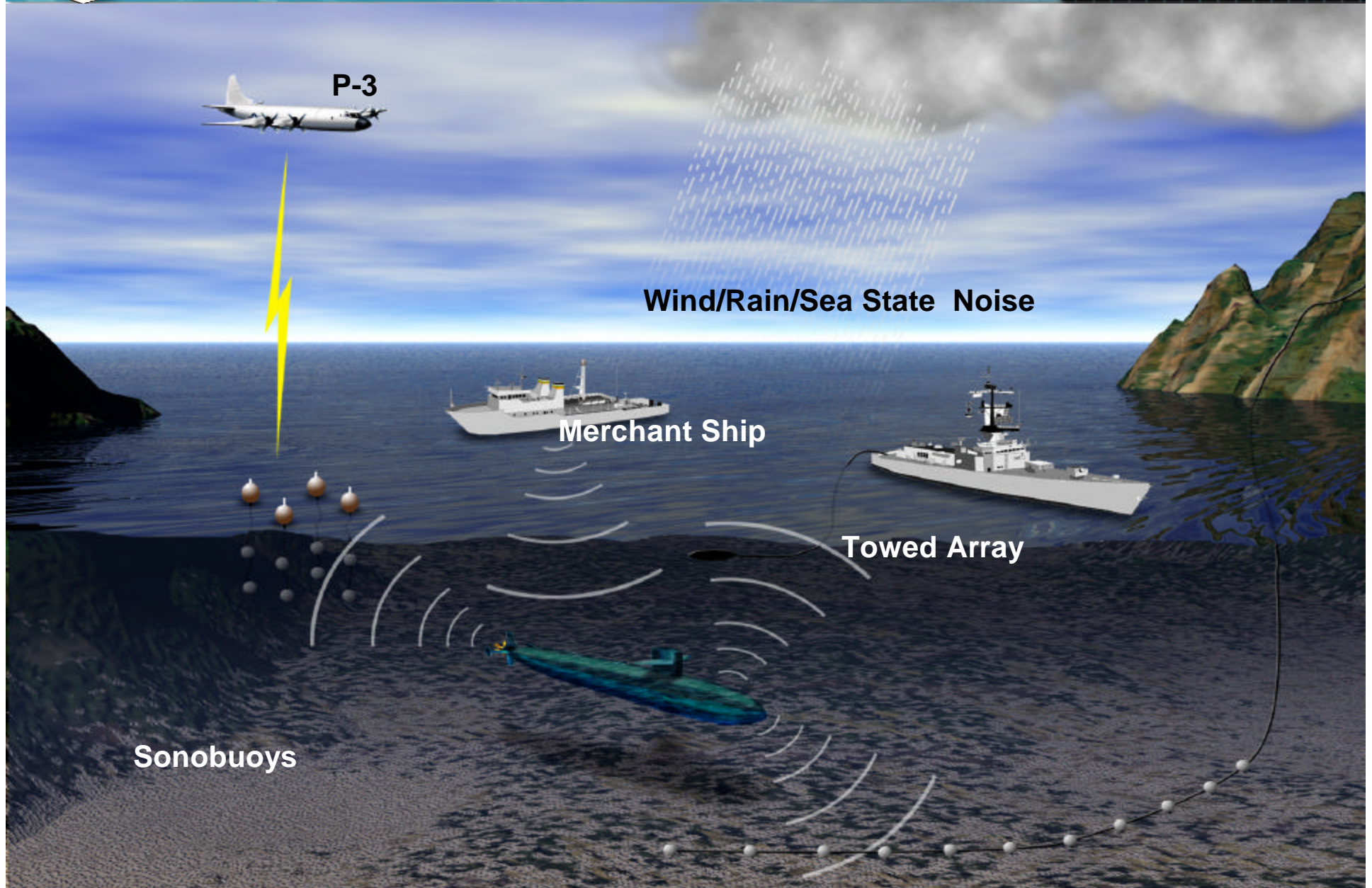


Applications

1. Force assessment
2. Planning and execution
 - Deliberate planning
 - Crisis action planning
3. System effectiveness and trade off analysis
4. Concept and doctrine development and assessment

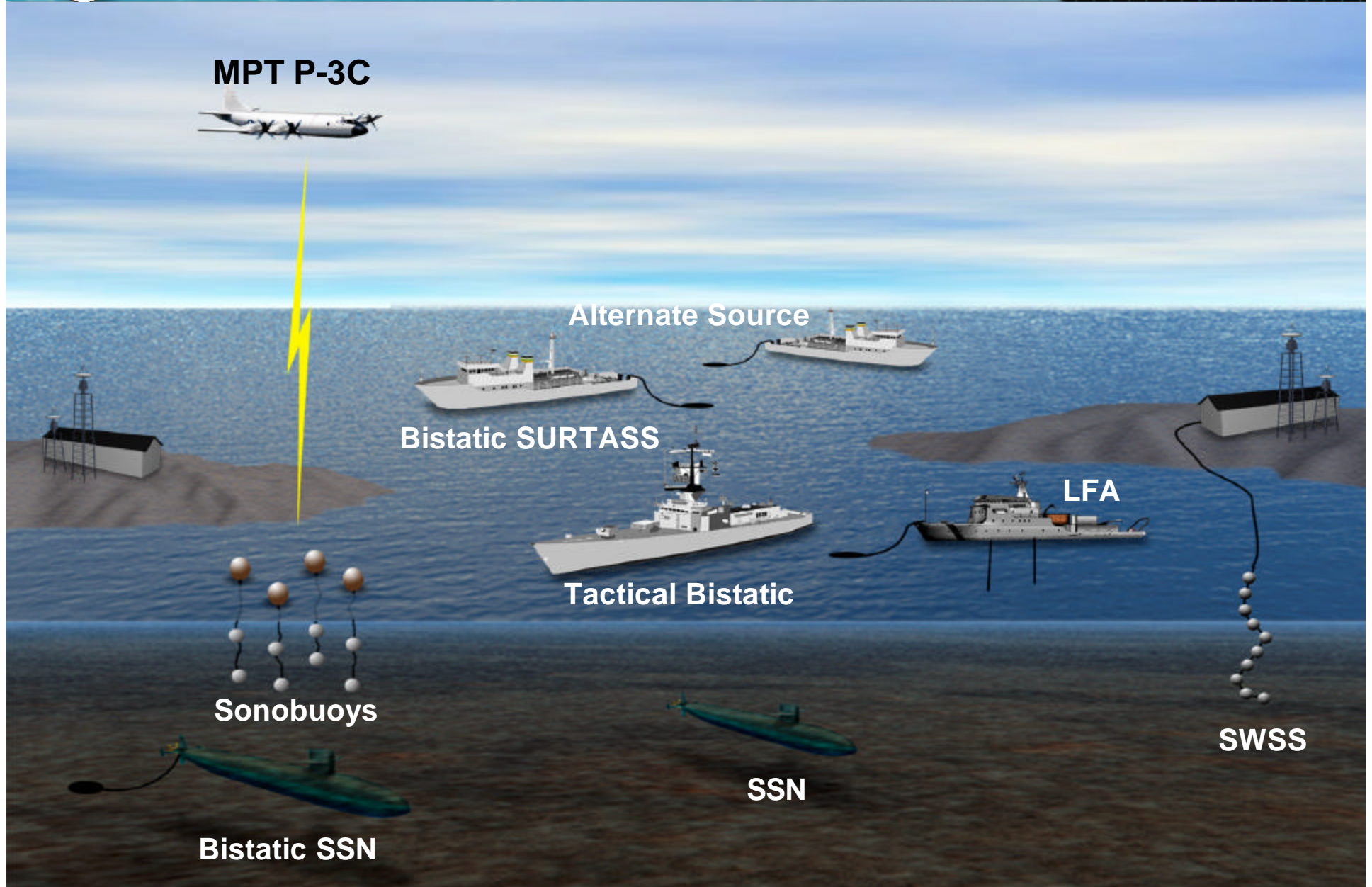


Passive SONAR Systems





Active SONAR Systems



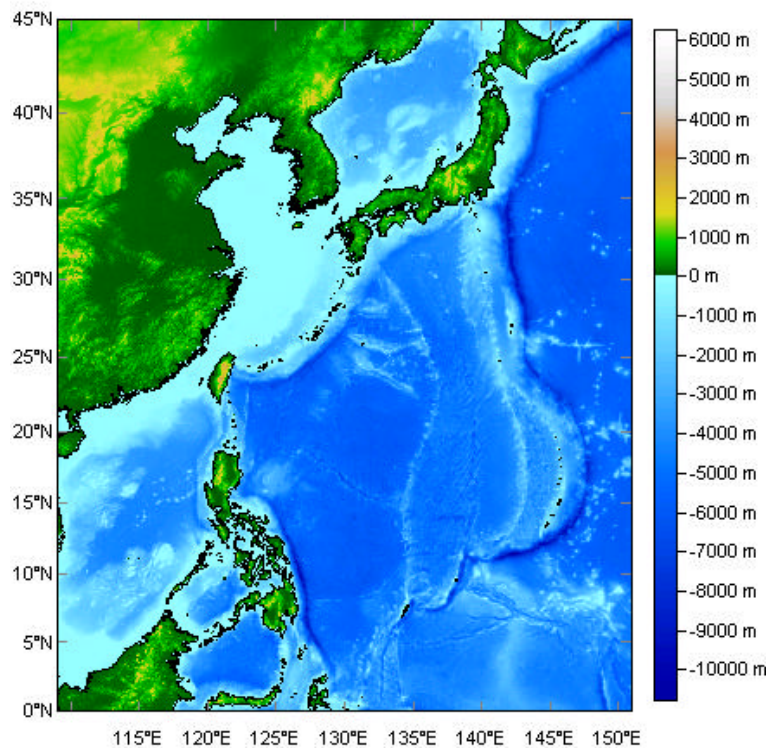


JWARS Ocean Acoustic Environment

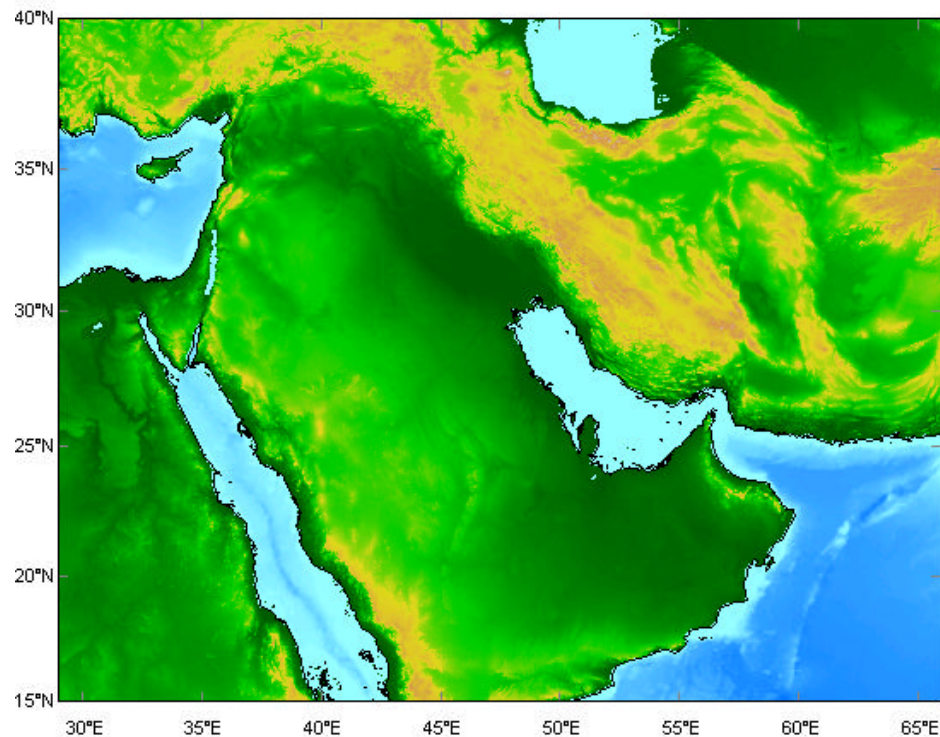
- Realistic simulation of environmental effects on anti-submarine warfare sensors is required
- Geographic and time varying response to the environment for January 1997 through June 1998.
- **M**odel-Response **I**nvestigation and **V**isualization (**MIV**) provides:
 - Complete but compact data base of transmission loss curves
 - Full range of propagation behavior
 - Littoral and deep ocean environments
- MIV process:
 - Automated and objective Geographic area provincing
 - Comprehensive physics-based model calculations
 - Cluster analysis of model calculations to develop complete but compact data base



JWARS Geographic Areas of Interest



East Asia



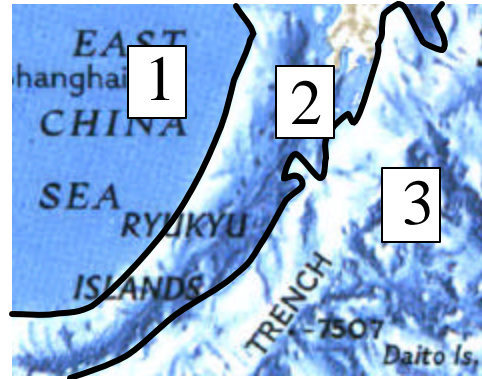
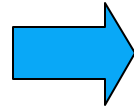
Southwest Asia



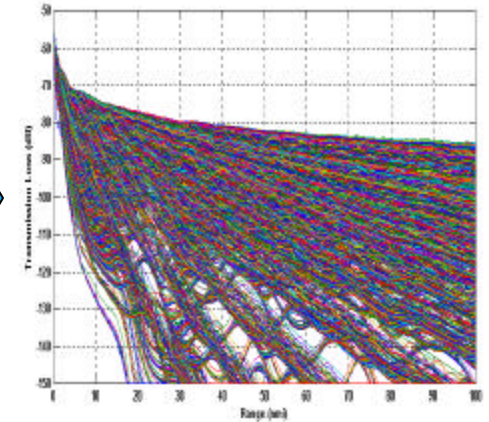
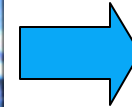
MIV Process



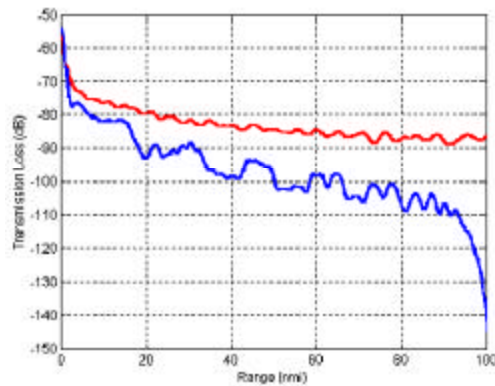
Environmental Analysis



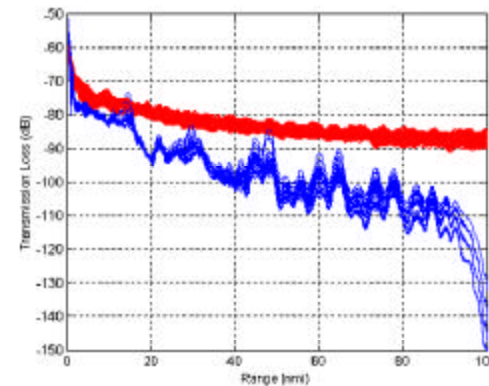
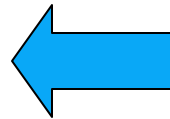
Feature Area Development



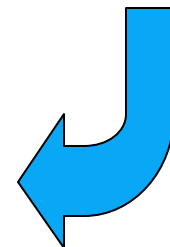
Propagation Model



**“Representative” Results
Provided to the Simulation**



**Cluster Analysis of
Propagation Model Results**

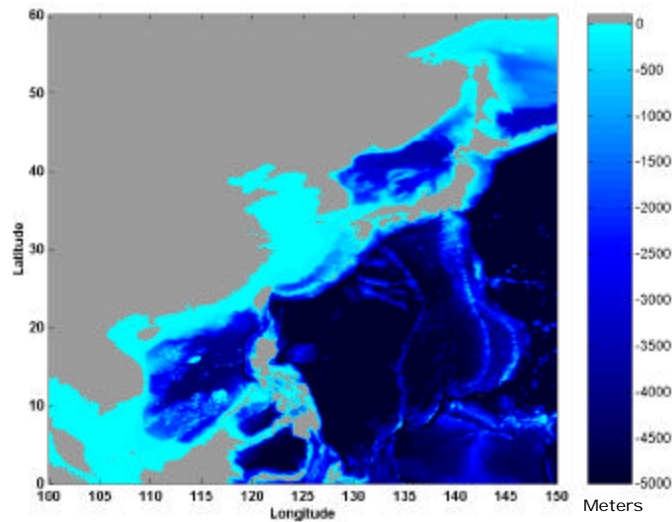




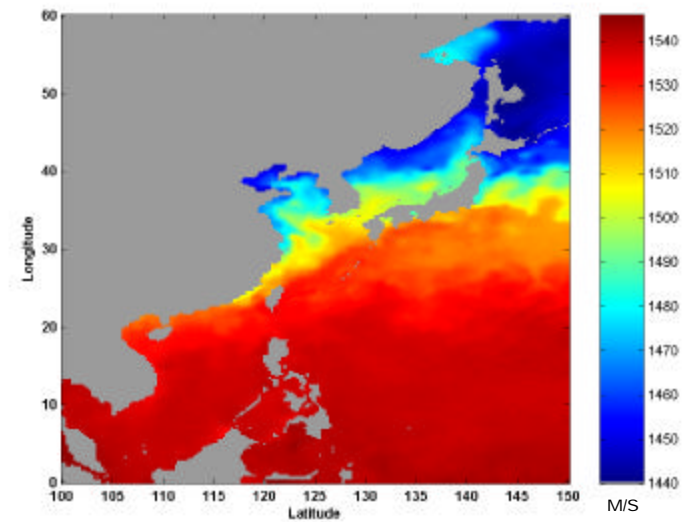
MIV Process: Environmental Analysis

- Analyze environmental features which most affect acoustic propagation
 - Bathymetry: DBDB-V
 - Bottom Loss: (Various Sources)
 - Sound Speed: MODAS

Bathymetry



MODAS Surface Sound Speed



12 Feb 1997



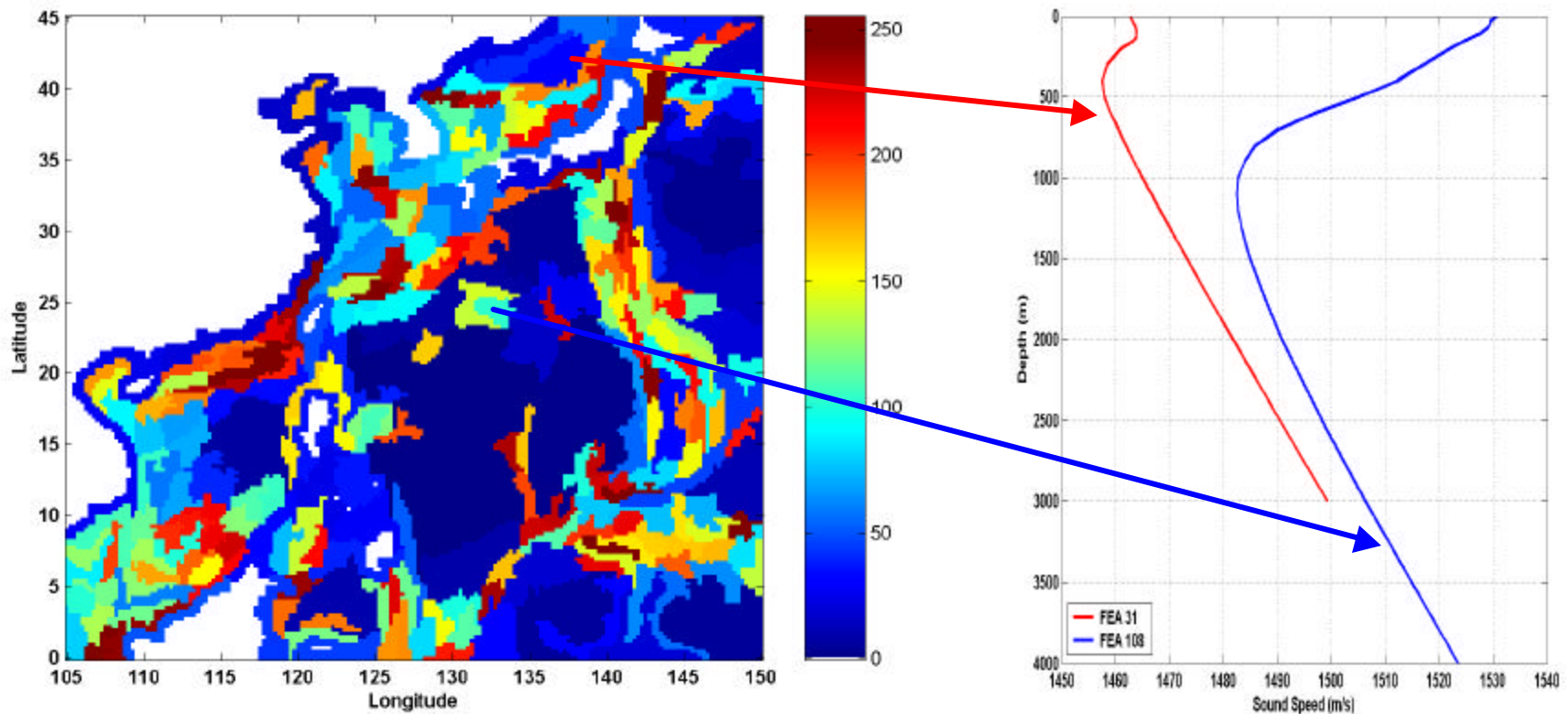
Sound Speed Profile Data MODAS

- **Modular Ocean Data Assimilation System (MODAS) provides 3D gridded sound speed fields for specified analyses times**
- **MODAS fields are calculated by optimal interpolation using:**
 - **Climatology**
 - ***In-situ* temperature profile data (XBT)**
 - **Remotely sensed sea surface temperature data (SST)**
 - **Remotely sensed sea surface height data (SSH)**
- **Results are 1/8 by 1/8 degree grids of temperature and salinity profiles**
- **MODAS data provided by Naval Research Lab/SSC (Dan Fox)**



MIV Process: Feature Area Calculation

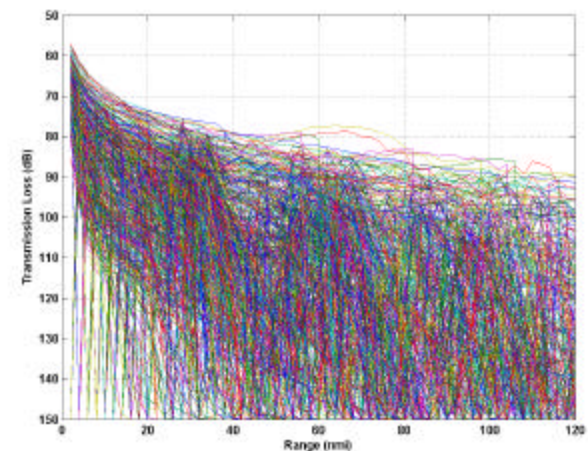
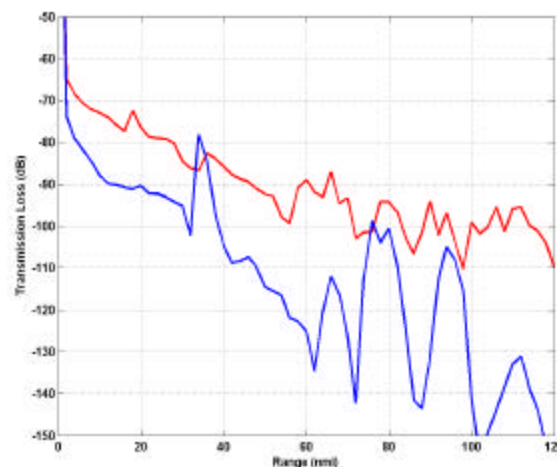
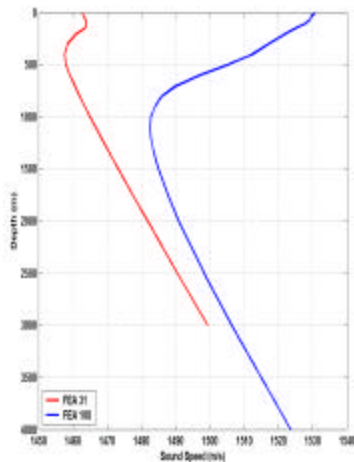
- Apply cluster analysis to environmental data to calculate feature areas





MIV Process: Propagation Model

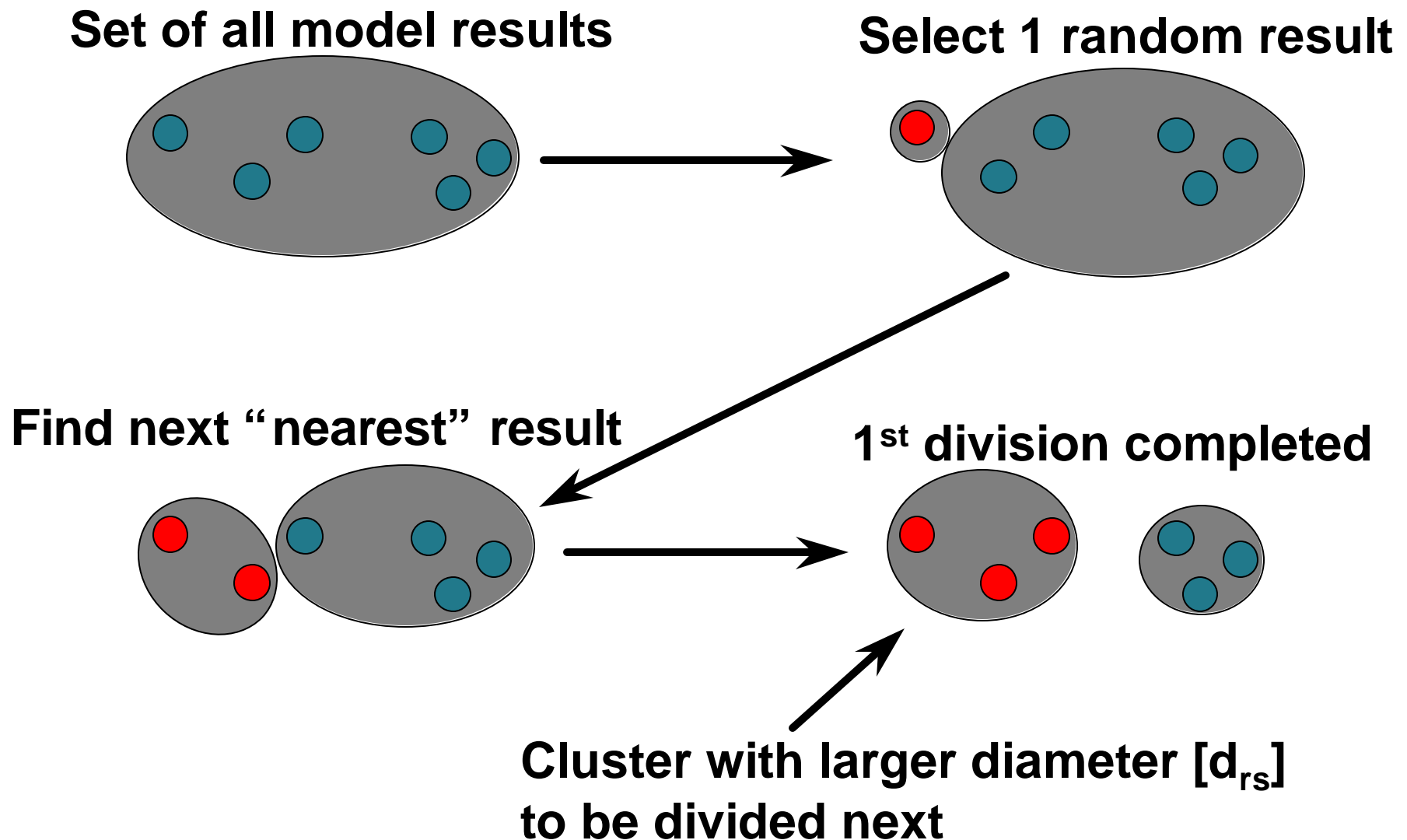
- Select representative tracks (acoustic trajectories)
- Run acoustic propagation model for representative tracks and large combination of frequencies, source depths, and receiver depths
- Apply cluster analysis to propagation model results
- Select representative model results



Environment → **Propagation Model** → **500 Representative Model Runs Provided To Simulation**
1-2 Million Model Runs

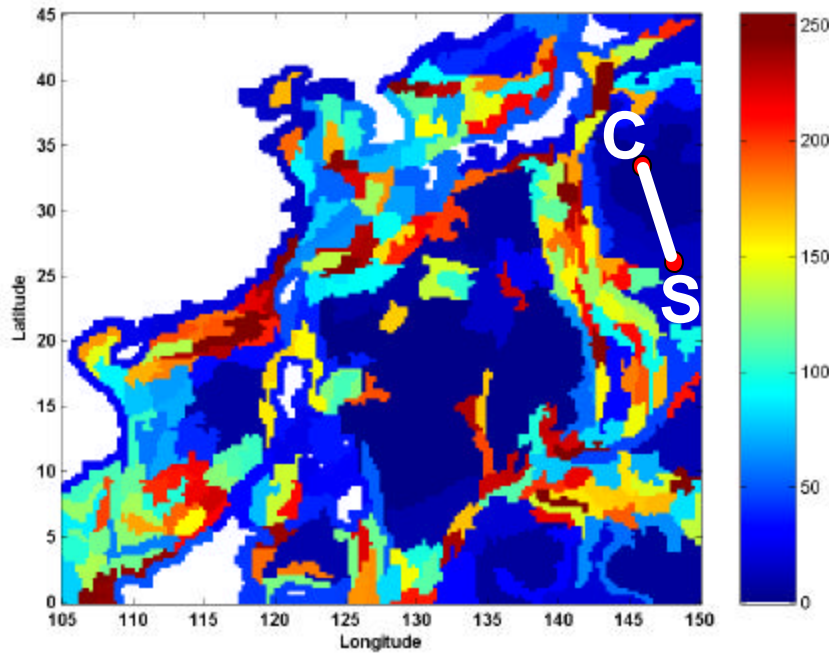


Divisive Clustering Process





MIV Process: Use in Simulation



Contact
Frequency
Latitude
Longitude
Depth
Sensor
Latitude
Longitude
Depth
Sensor to contact range

Transmission Loss Value
For Insertion into Simulation

Transmission Loss Library



Summary

- **Weekly transmission loss fields over an eighteen month period**
- **Wide range of frequencies and operating depths**
 - Frequency range: 20 to 5000 Hz
 - Operating depth range: 50 to 1500 feet
- **MIV provides a detailed and realistic representation of the ocean acoustic environment**
- **For JWARS, MIV has provided a time varying passive acoustic environment for East Asia and Southwest Asia**
- **APL is currently addressing MIV-based data to support active acoustic ASW for JWARS**
- **Future: possible application of MIV to other propagation domains such as radar and chemical/biological dispersion**