



# EM Propagation Modeling and System Performance Assessment by SPAWARSYSCEN San Diego

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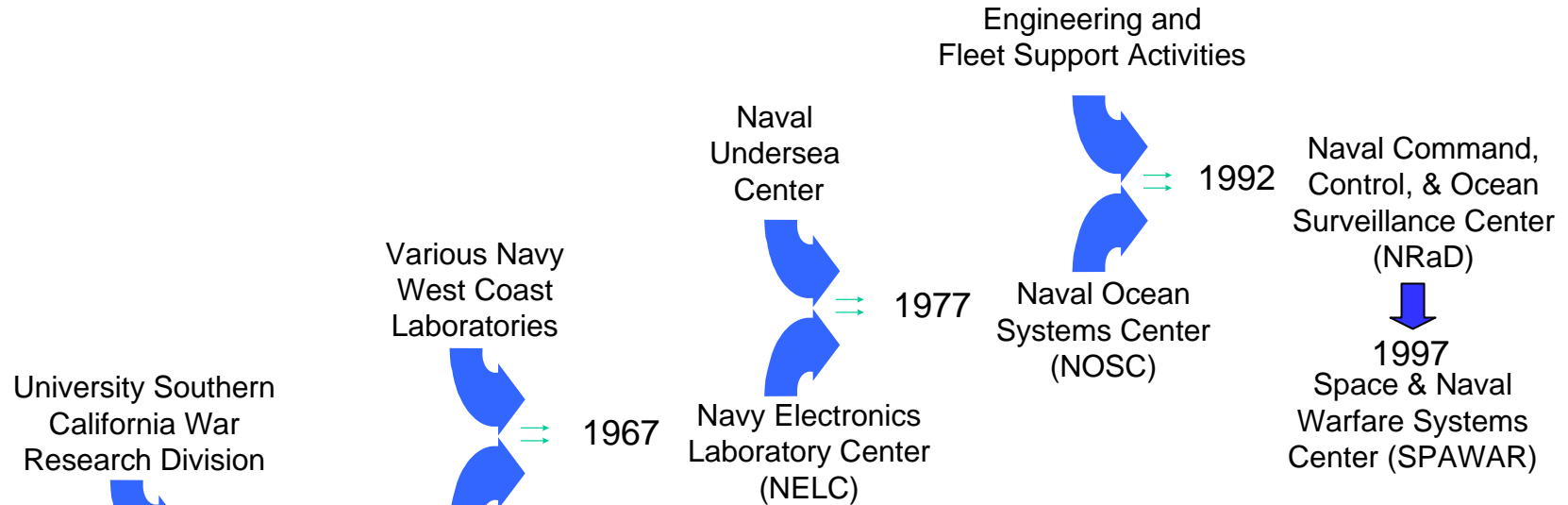
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# Presentation Agenda

- Who we are and what we do
- Advanced Refractive Effects Prediction System (AREPS)
  - Overview
  - Projects
  - EM system database
  - Terrain
  - Environmental input methods
- Summary

# Organizational History



While command may have changed,  
EM propagation research has been  
continuous over 60 years



# SSC San Diego 2858

## Atmospheric Propagation Branch

### Core Capabilities

1. EM/EO propagation modeling of environmental effects on radiated frequencies from MF (100 kHz) to infrared (300 THz)
  - a. Maritime
  - b. Terrain
  - c. Surface, airborne, satellite platforms
  - d. Spatially varying atmosphere and terrain
  - e. Interference/jamming with anomalous propagation
  - f. Ocean surface and terrain clutter
2. Analysis of atmospheric, ionospheric, and surface parameters
  - a. Temporal and spatial behavior
  - b. Joint probabilities
  - c. Statistical characterization of refractivity
  - d. Aerosol, molecular, and turbulence models for long-path propagation assessment.
3. Radar, communications, and weapons performance assessment
  - a. Probability of detection
  - b. Probability of communications
  - c. Spectrum management
  - d. Climatological propagation studies
4. Surveillance systems and Strike Warfare
  - a. Infrared Search and Track system—marine atmospheric modeling suite
  - b. Models and simulation for target detection and tracking
  - c. Small boat wake detection
5. Combat Systems tie-in:
  - a. Radar
  - b. Communications
  - c. High energy laser weapons system performance modeling for ship self-defense
6. Mission planning tie-in:
  - a. AREPS (Advanced Refractive Effects Prediction System)
  - b. TAWS (Target Acquisition Weather Software)
  - c. JMPS (Joint Mission Planning System)
  - d. JTRS (Joint Tactical Radio System)
  - e. NITES II (Naval Integrated Tactical Environmental Subsystem- II)
  - f. Composable FORCENet



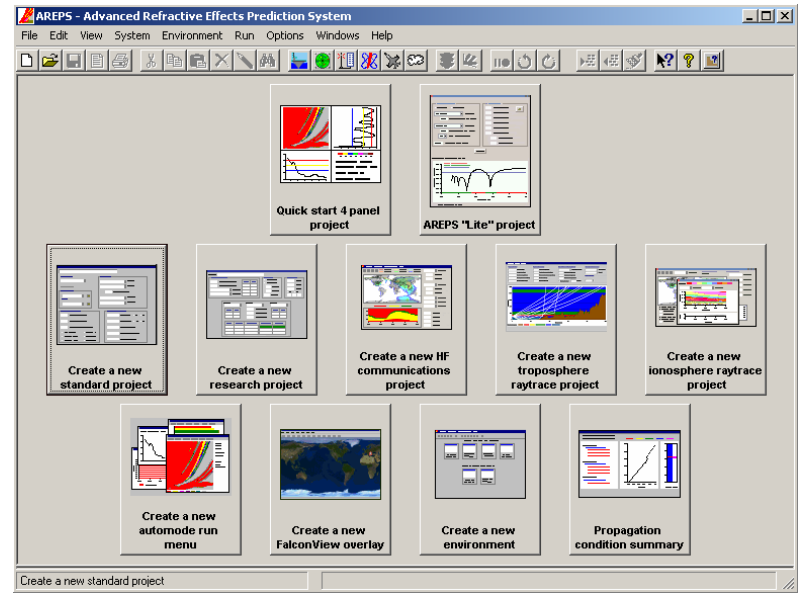


# Advanced Refractive Effects Prediction System

Provide an operational and research capability to compute and display EM system propagation effects over water, across coastlines, and over varying terrain, including range-dependent refractive effects, for land-based, sea-based, and airborne systems.

## Current operational uses

- Airborne & surface-based radar probability of detection
- ESM vulnerability
- LF to EHF communications assessment
- Strike & electronic countermeasures assessment
- Early warning aircraft stationing
- HF ground and sky-wave assessment\*





# AREPS (RFPAS) – The Application

GUI – model input/output processing ↔ Propagation models (RFPL)

## Atmosphere

- Modified refractivity \*
- Gaseous absorption \*
- Rain attenuation \*
- Solar activity - sunspot, planetary K, solar flux

## Surface – ocean & land

- Terrain heights \*
- Dielectrics \*
- Roughness \*

## Climatology

- Ducting
- Sea-surface
- ITU surface refractivity
- Ionosphere IRI & PIM

## EM systems

- Frequency
- Antenna patterns
- Etc.

## Post-processing

- HF ground wave & sky wave – combined full field

## Propagation model options

- APM mode
- Data output
- Troposcatter
- Clutter

## Displays

APM Includes HF ground wave

HF sky wave field strength

Modified Damboldt

Ionosphere ray trace

Troposphere ray trace

F-factor

ESPM<sup>2</sup>

NTIA - LF / MF

VOACAP

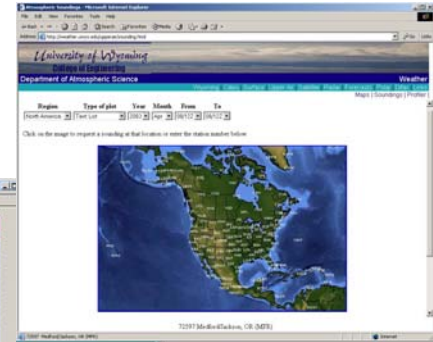
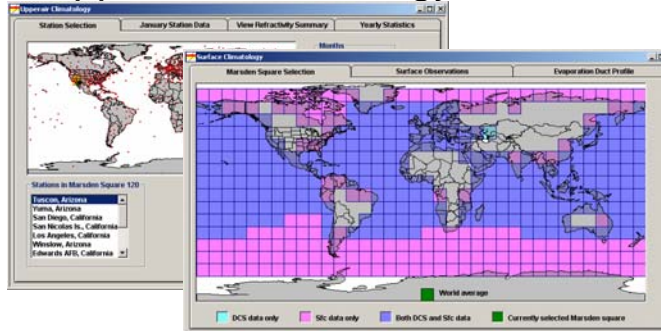
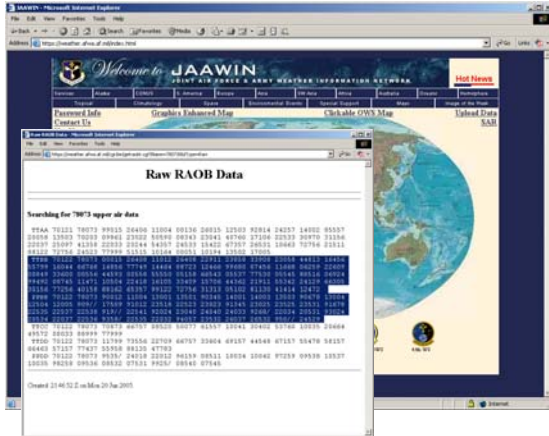


# Numerous Environment Data Sources

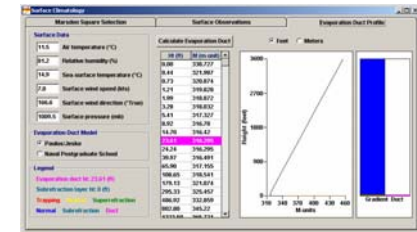
# Public Homepages

## JAAWIN

## Built-in Surface and Upper-air Climatology



## Real-time local observations



## Defense Threat Reduction Agency Weather Server

## CAAPS

## DoD Homepages

## Metcast

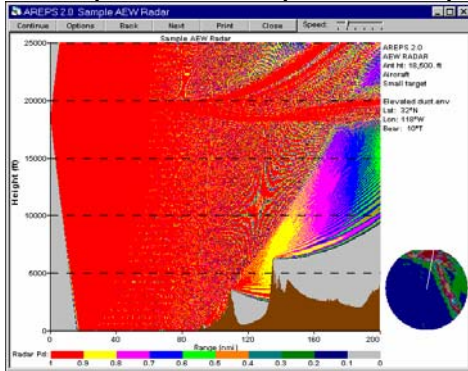
2/28/2007



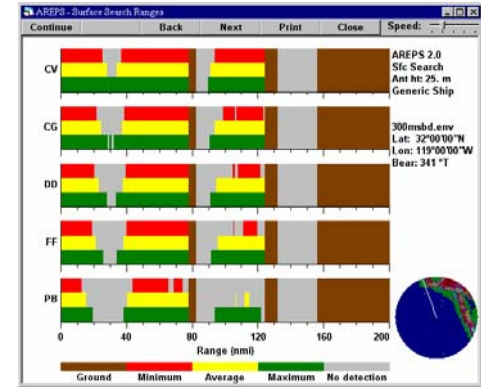
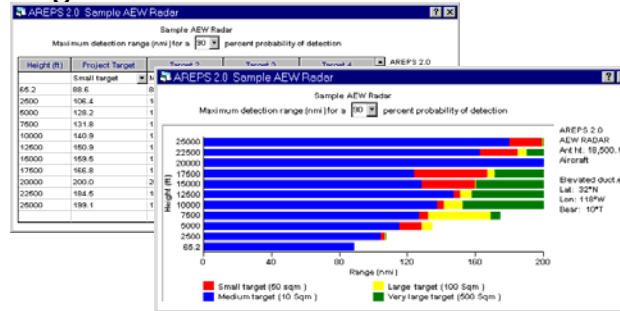
# Numerous Decision Aids

# Surface-search radars

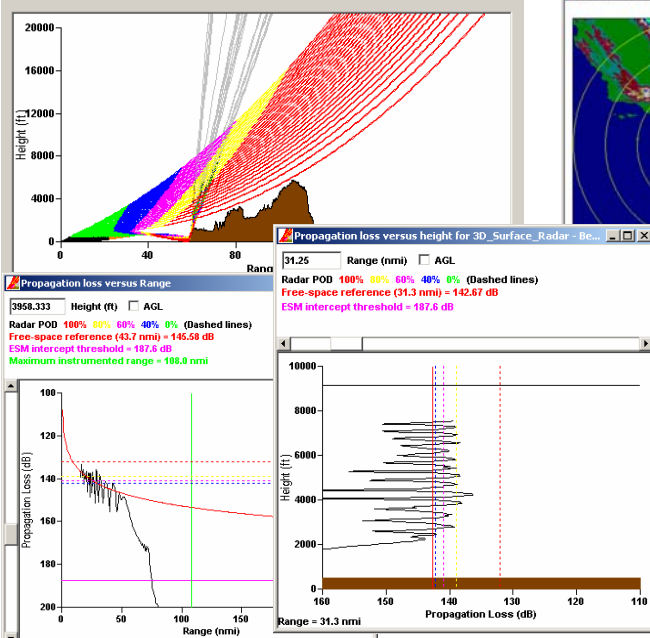
## Height vs. Range coverage



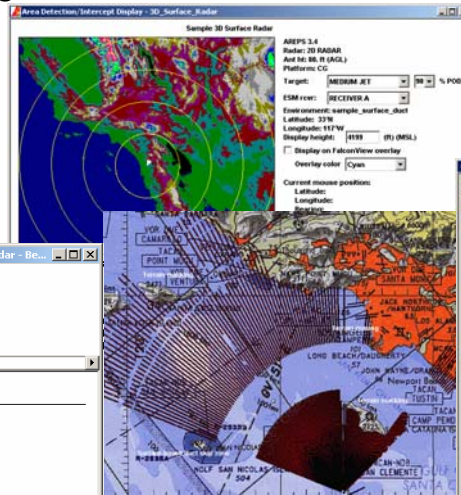
## Maximum detection/intercept range tables



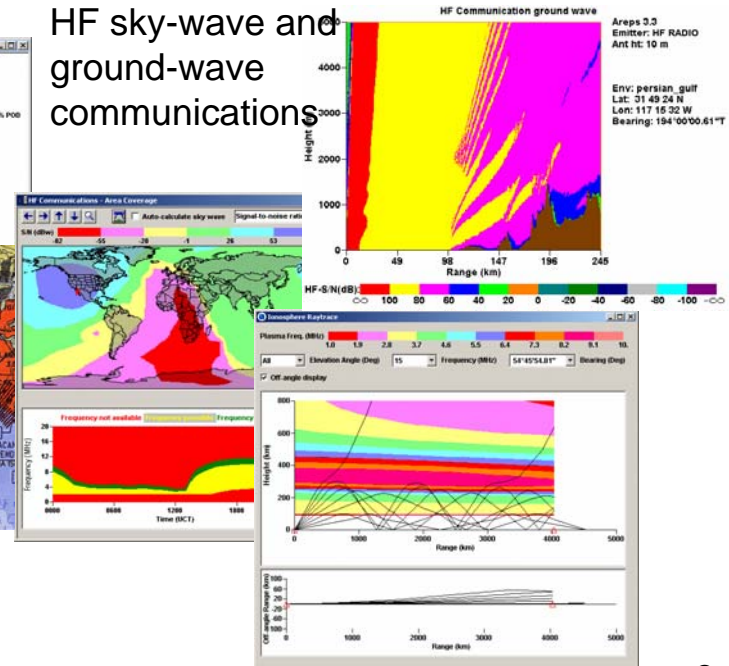
## Height-finder radar altitude errors



## Area displays



## HF sky-wave and ground-wave communications



## Constant height and range displays

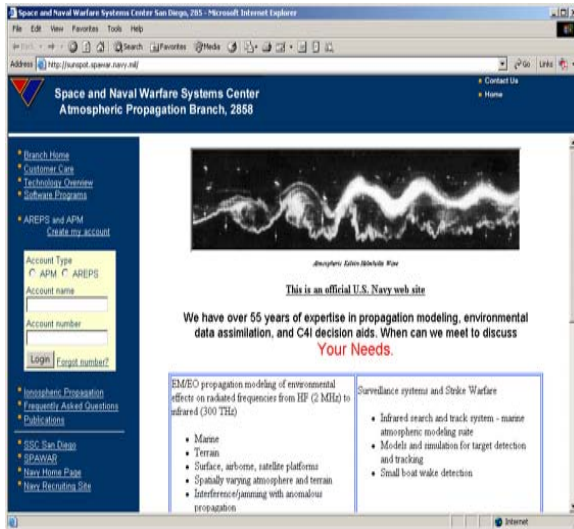
## HF ionosphere raytrace





# AREPS Help Opportunities

Internet: <http://sunspot.spawar.navy.mil>



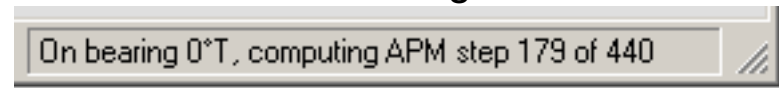
Tool tip



Status bar



Message bar



AREPS on-line help

Step-by-step help

**How do I create and run a standard project?**

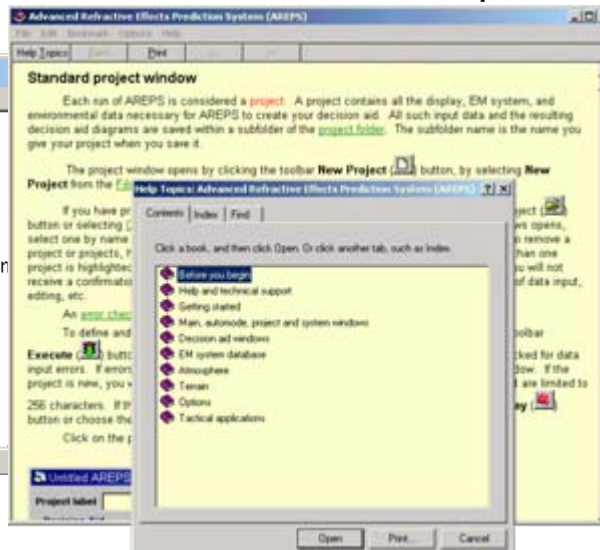
Step 1: Select a decision aid by clicking on one of the option buttons.

Step 2: From the platform dropdown menu, select a platform.

Step 3: Depending upon your decision aid, from the dropdown menu select a radar or transmitter. If necessary, adjust the antenna height and reference level.

Step 4: Depending upon your decision aid, from the dropdown menus, select a target or ESM receiver.

Step 5: From the atmosphere dropdown menu, select an atmosphere description. You may use the "Find an environment"



Context sensitive help

**Project Geographic Area**

**32N Latitude (Deg)**

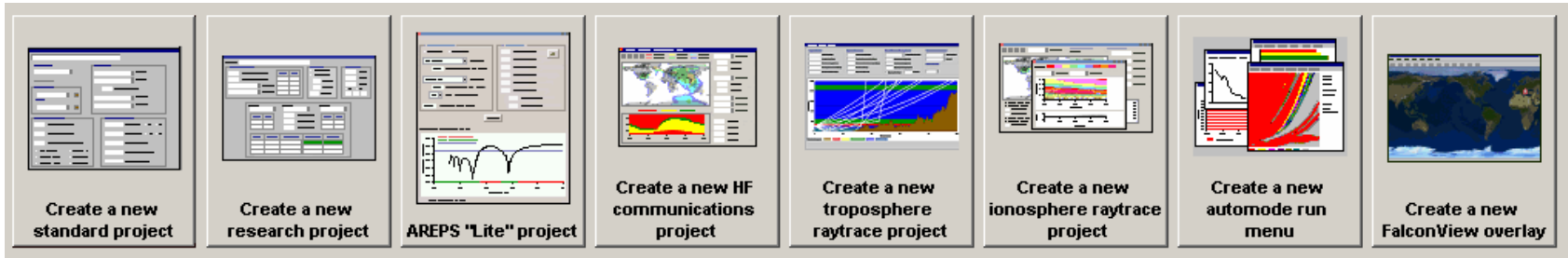
This latitude is used to extract terrain data from the DTED CD-ROMs.

The value may be entered in degrees, minutes, and seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the **Enter** key or leave the input box, the field will change to 36°30". You may also enter a decimal value for both the minutes and the seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32°46'36".

When entering latitude, you must also specify a quadrant. This may be N for north or S for south. Refer to the detailed help for a discussion of the quadrant options.



## AREPS Projects



- Standard
- Research
- AREPS "Lite"
- HF communications
- Troposphere ray trace
- Ionosphere ray trace
- Automode
- FalconView
- Broadcast (FY07)



# Standard project

- Asses radar, communication, and ESM systems upon platform for frequencies  $\geq 30$  MHz
- Range an bearing dependent atmospheric conditions.
- Terrain from DTED, SRTM, or custom file.
- Surface (ocean and terrain) clutter; troposcatter; gaseous absorption.
- Numerous data display and output options

**Untitled AREPS Project**

Project label:  Classification: **None**

**Decision Aid**

- Radar detection only
- ESM vulnerability only
- Both Radar and ESM vulnerability
- Communications (> 30 MHz)
- Surface search range table

**Environment Specification**

Atmosphere: **<Standard>**  
 Terrain: **<None>**  
 Wind: **<Read from atmosphere file>**

Include surface clutter

**Graphic Display**

Minimum height (ft): **0.**  
 Maximum height (ft): **15000.**  
 Maximum range (nmi): **150.**

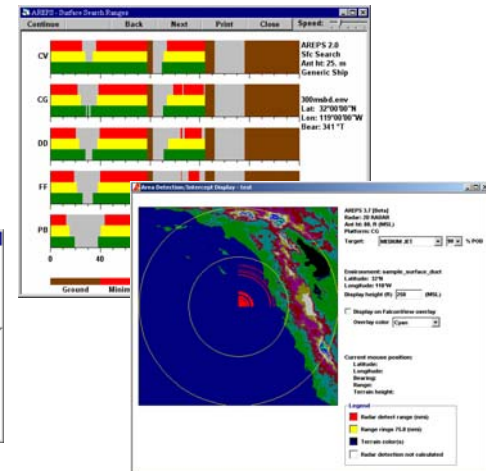
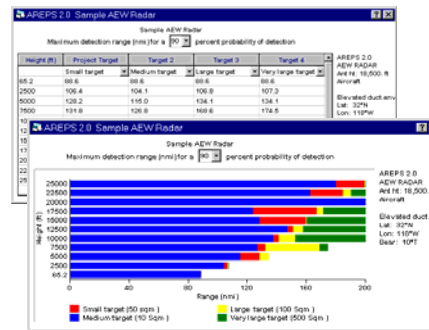
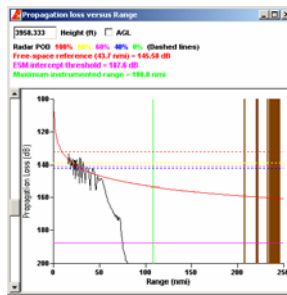
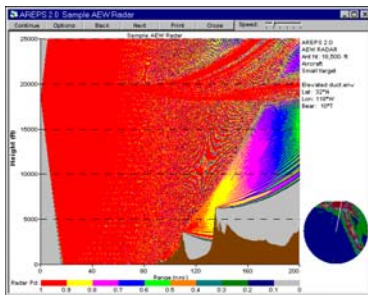
**System Specification**

**Auto-populate**

Platform/Site  
 Radar  
 Antenna height (ft) AGL: **20.**  
 Update antenna values on platform  
 Target  
 Receiver

**Project Geographic Area**

Latitude (Deg): **0°N**  
 Longitude (Deg): **0°E**  
 First bearing (°True): **0°**  
 Bearing increment (Deg): **1°**  
 Number of bearings: **1**



# Research project

Untitled AREPS Research Project

Project label

**EM system parameters**

Frequency (MHz)

3. Vertical beam width (Deg)

0. Antenna elevation angle (Deg)

12. Antenna height (ft) AGL

Horizontal  Polarization

Omni  Antenna type

**Antenna Pattern**

Pattern angle (Deg)	Pattern factor (Normalized)

**APM parameters**

Include troposcatter

PE only

Maximum PE angle (Deg)

1. Range multiplier

440 Number of range output points

380 Number of height output points

**Display options**

0. Minimum height (ft)

20000. Maximum height (ft)

100. Maximum range (nmi)

Propagation  loss  factor

110. Minimum loss (dB)

5. Loss increment (dB)

10. Number of increments

**Environmental inputs or files**

**Atmosphere**  <Standard>

**Terrain**  <None>

**Wind**  <None>

Height (m)	Refract (m-unit)	Layer	32N	Latitude (Deg)	Range (nmi)	Speed (kts)
0	350	Normal	117W	Longitude (Deg)	0	
1000	468		0°	First bearing (°True)		
			10°	Bearing increment (Deg)		
			1	Number of bearings		

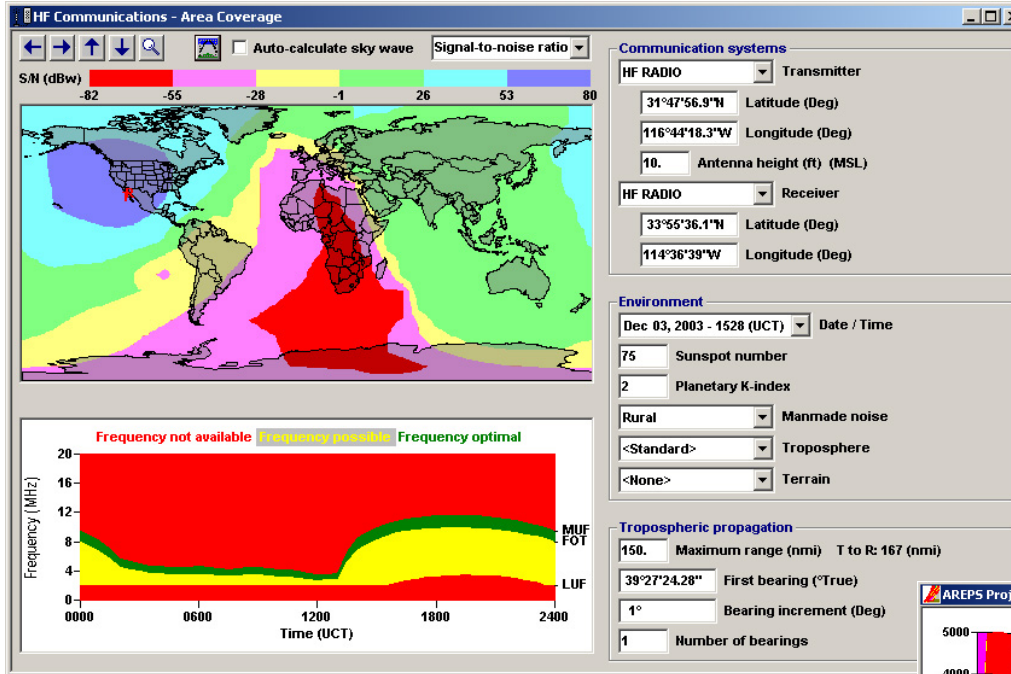
Range (nmi)	Height (ft)	Surface Type	Conductivity (S/m)	Permittivity	Scatter Effectiveness (dB)
0		Sea water	Compute	Compute	

- Used to exercise propagation model without need of EM database.
- No specific system performance thresholding
- Reads environment from a file created with the environment program or from data entered into tabular form.
- Reads terrain from DTED, a custom file, or data entered into tabular form.
- Reads wind from a custom file or data entered into tabular form.

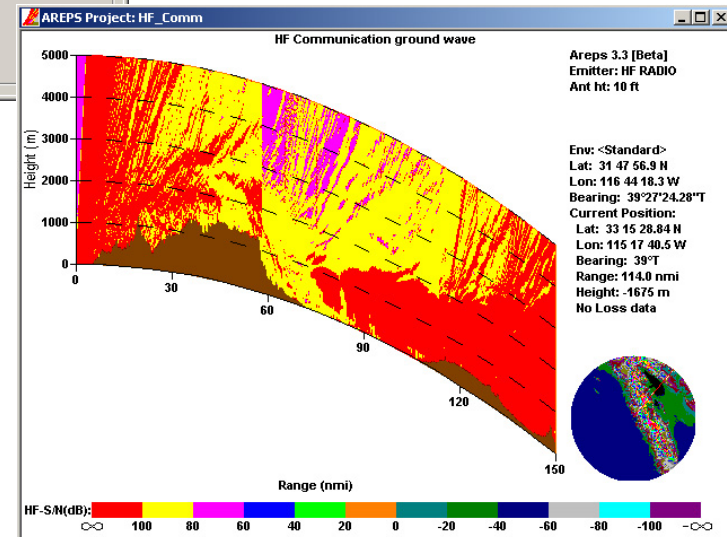


# HF communications project

- Used to assess HF sky-wave in both area and point-to-point display (currently uses SSC SD HF field-strength and noise models)
- Used to assess HF combined sky-wave and ground-wave
- Propagation loss, electric field, signal-to-noise, received power, terrain masking.
- Adding area and point-to-point VOACAP modeling - FY07

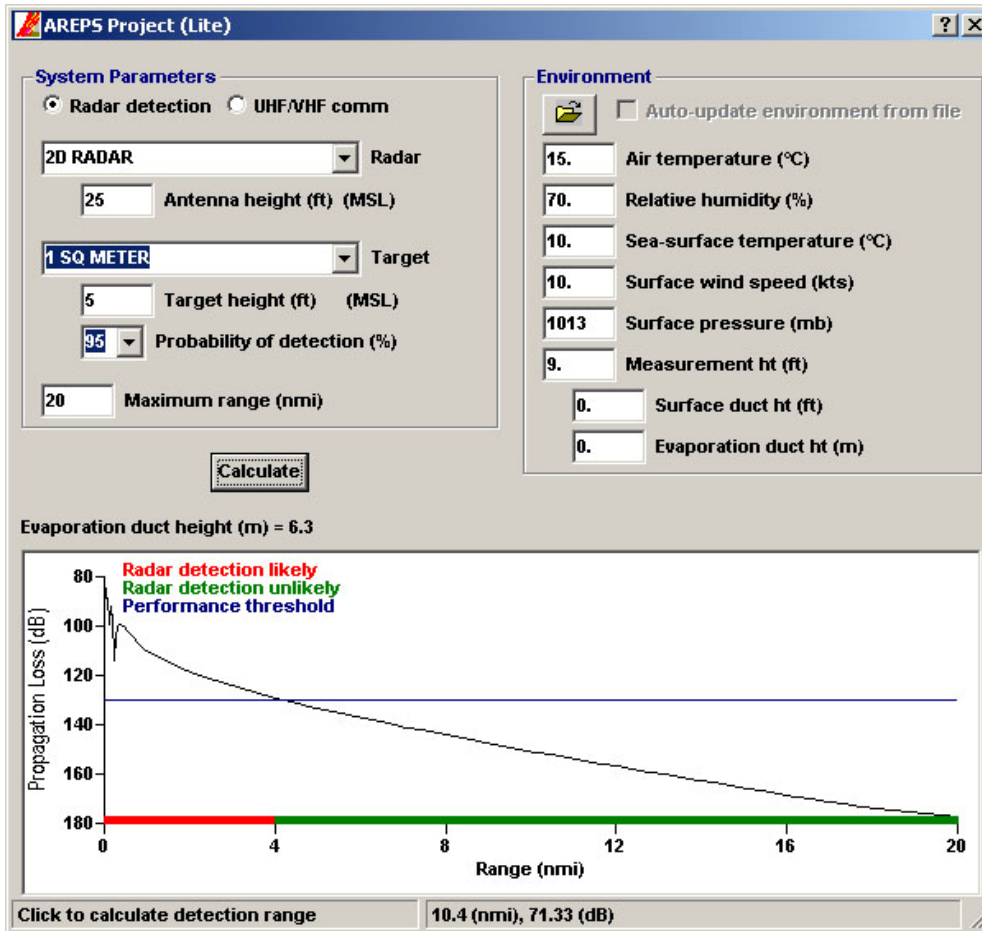


- Reads environment from a file created with the environment program and ionospheric data obtained via AREPS homepage or keyboard entry.
- Reads terrain from DTED or a custom file.



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## “Lite” project



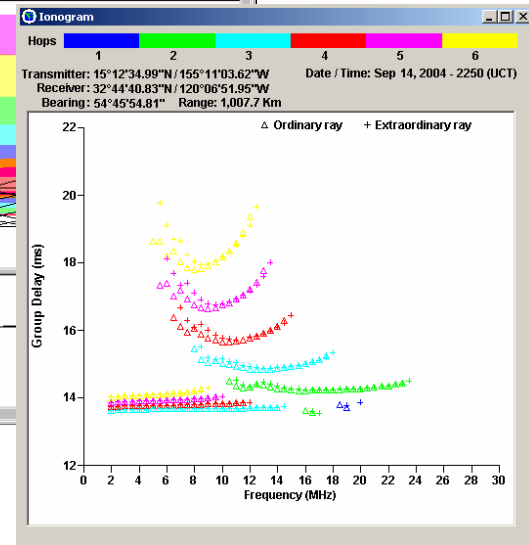
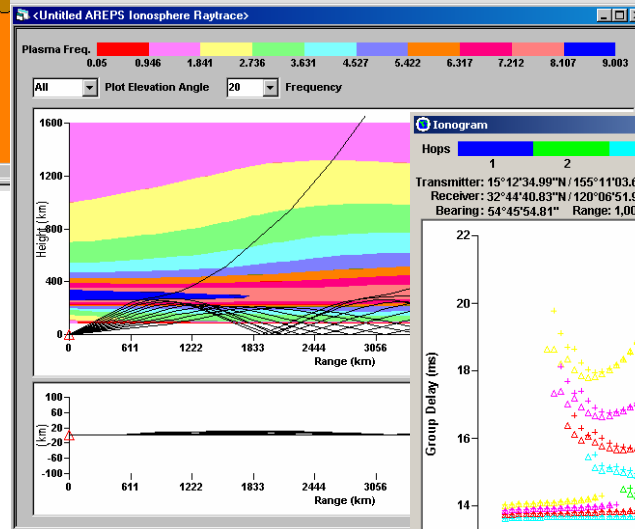
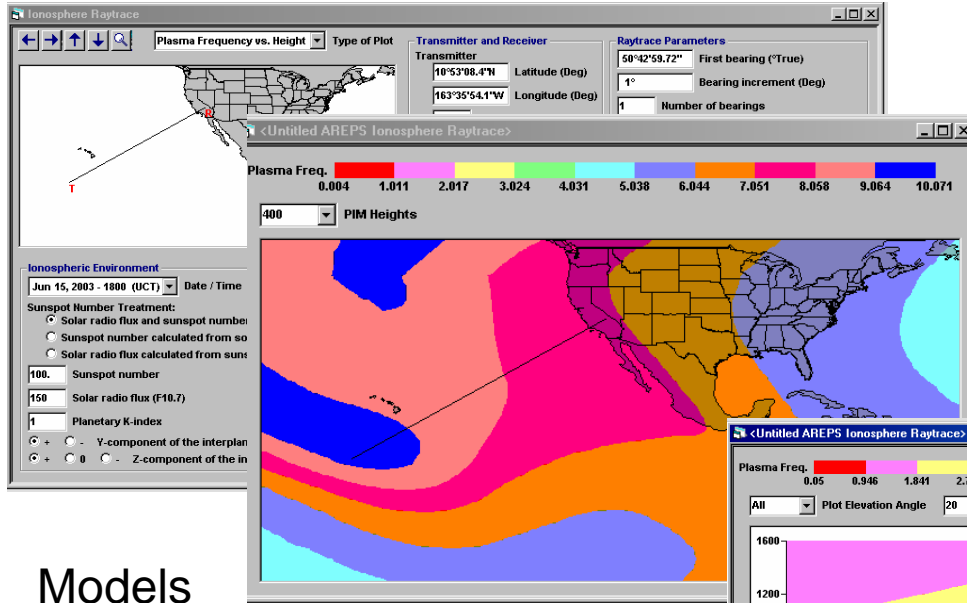
- Uses F-factor propagation model (no terrain)
- Surface-based ducting
- Evaporation ducting from surface observations
- Surface observations via files from meteorological sensors





# HF ionosphere ray trace project

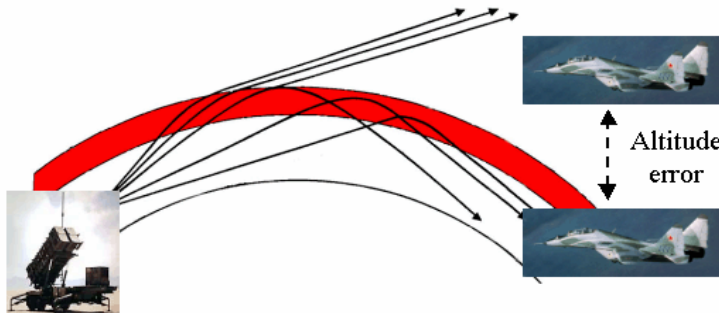
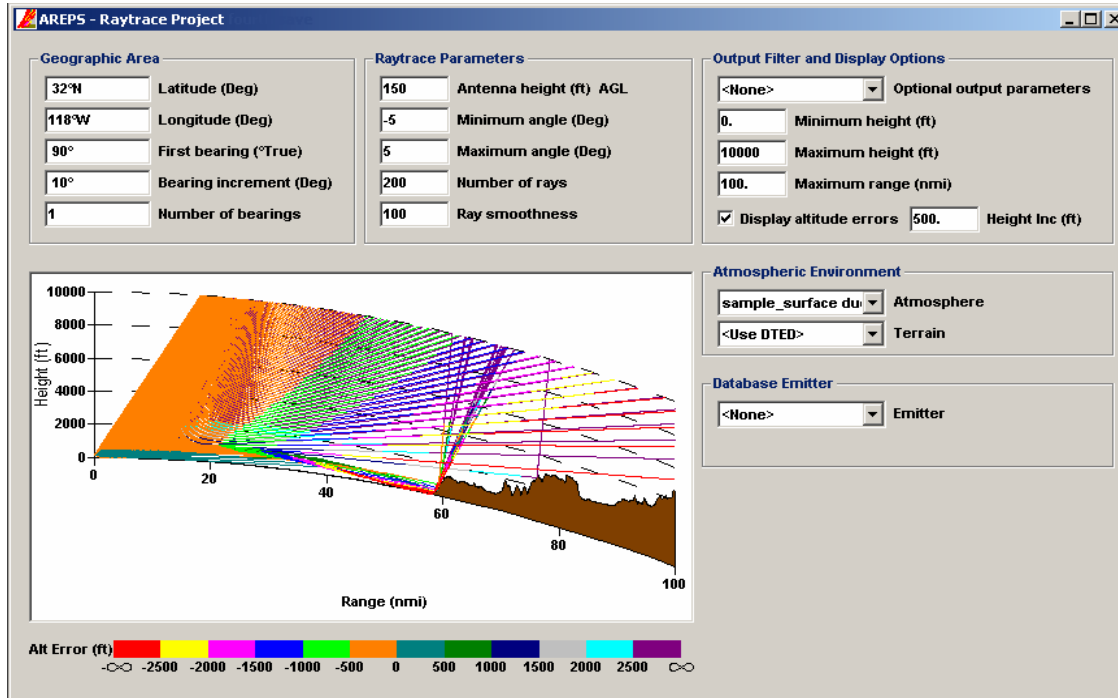
- Multiple azimuths, elevations, and frequencies
- Ray display - elevation and azimuth
- Plasma frequency contours in vertical and horizontal planes
- Contours of F2 and E region critical parameters
- Frequency homing
- Ionogram



## Models

- Jones-Stephenson 3-D ionosphere with geo-magnetic field
- Parameterized Ionosphere Model (PIM 1.7) and International Reference Ionosphere (IRI)
- Future - Real-time observations

# Troposphere ray trace project



- Snell's law small angle approximation modified for range and bearing dependent environment and terrain.

- Uses emitter from EM database or data entered into window

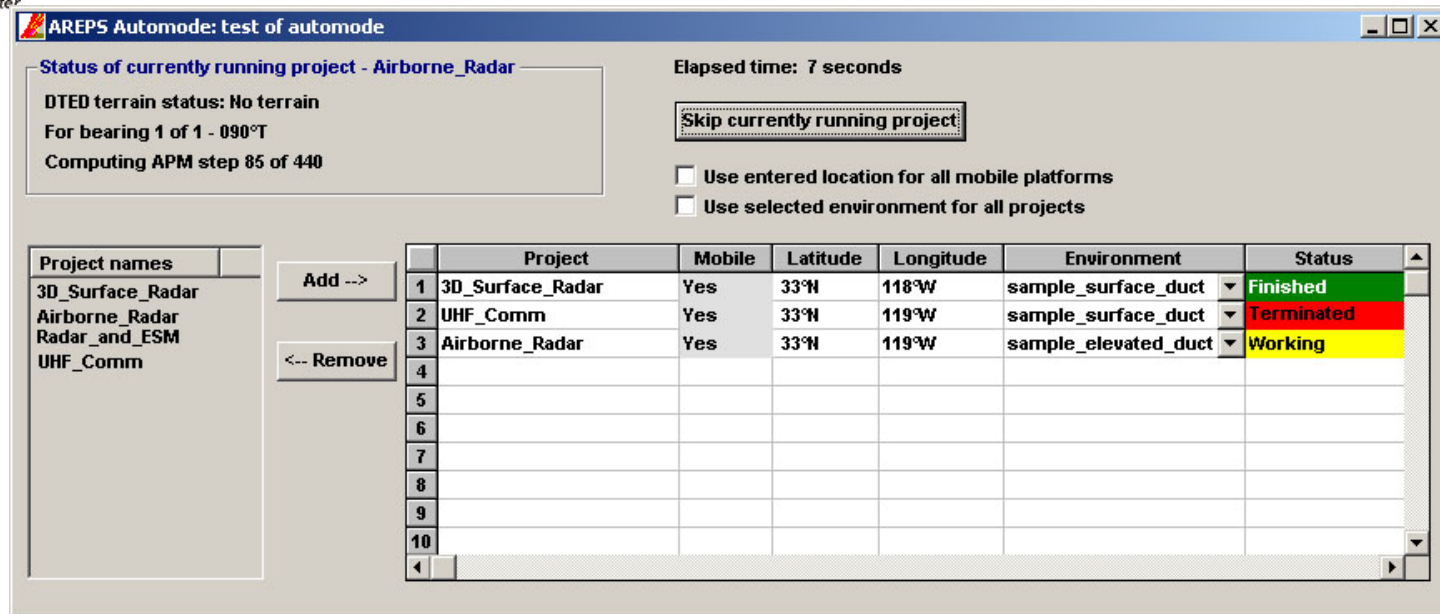
- Altitude error display with variable height increments.

- Reads environment from a file created with the environment program.

- Reads terrain from DTED or a custom file.

- Optional internal data output - angles, ranges, heights, times, etc

# Automode project



**AREPS Automode: test of automode**

Status of currently running project - Airborne\_Radar

DTED terrain status: No terrain  
For bearing 1 of 1 - 090°T  
Computing APM step 85 of 440

Elapsed time: 7 seconds

**Skip currently running project**

Use entered location for all mobile platforms  
 Use selected environment for all projects

Project names	Project	Mobile	Latitude	Longitude	Environment	Status
3D_Surface_Radar	1 3D_Surface_Radar	Yes	33°N	118°W	sample_surface_duct	Finished
Airborne_Radar	2 UHF_Comm	Yes	33°N	119°W	sample_surface_duct	Terminated
Radar_and_ESM	3 Airborne_Radar	Yes	33°N	119°W	sample_elevated_duct	Working
UHF_Comm	4					
	5					
	6					
	7					
	8					
	9					
	10					

- Used to assess radar, communication, and ESM systems upon platforms in a batch operation.
- Reads environment from a file created with the environment program.
- Reads terrain from DTED or custom file.



# FalconView project

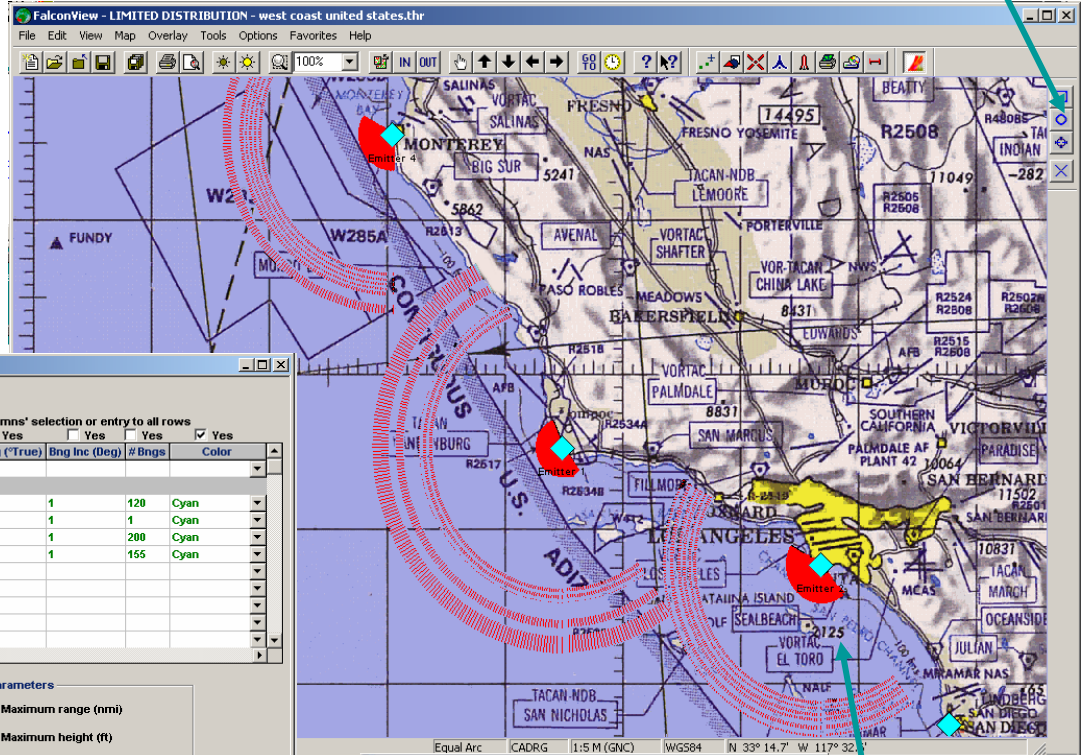
## FalconView display

AREPS toolbar



Requires FalconView program be installed.

Multiple emitters



Areps Project FalconView

System Legend  
 Radar in database    Radar not in database    Not Accessible by AREPS    Error

Apply columns' selection or entry to all rows										
Platform	Radar	Lat (Deg)	Lon (Deg)	Ant Ht (ft) AGL	Target	1st Bng (°True)	Bng Inc (Deg)	#Bngs	Color	
<input checked="" type="checkbox"/>	Coastal Surve	36°33'01.8"N	121°56'23.6"W	80	Small boat	180	1	120	Cyan	
<input checked="" type="checkbox"/>	Coastal Surve	34°31'20.1"N	120°29'53.7"W	40	Small boat	300	1	1	Cyan	
<input checked="" type="checkbox"/>	Coastal Surve	32°43'50.3"N	117°13'01.2"W	60	Small boat	120	1	200	Cyan	
<input checked="" type="checkbox"/>	Coastal Surve	33°45'54.2"N	118°18'17.5"W	100	Small boat	145	1	155	Cyan	

Environment

Use AREPS environment file  
 sample\_surface du    AREPS environment files

Use COAMPS environment file  
 Browse for a COAMPS environment file

COAMPS forecast times

-Use DTED-    Terrain

0.    Sea-surface wind speed (kts)

Electronic Order of Battle

Browse for an EOB file

Display emitters on FalconView map  
 Show emitter names

Display Parameters

100.    Maximum range (nmi)

20000.    Maximum height (ft)

50    Elevation (ft) (MSL)

95    Probability of detection (%)

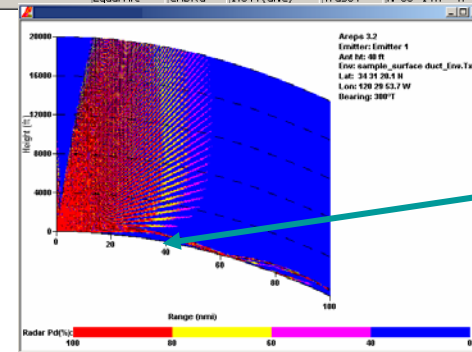
[4] Emitter 1 (34°31'    Coverage display  
 Save files

DTED terrain

Range & bearing environment data

Import various Electronic Order of Battle files

All normal AREPS displays



Surface-based duct skip-zone



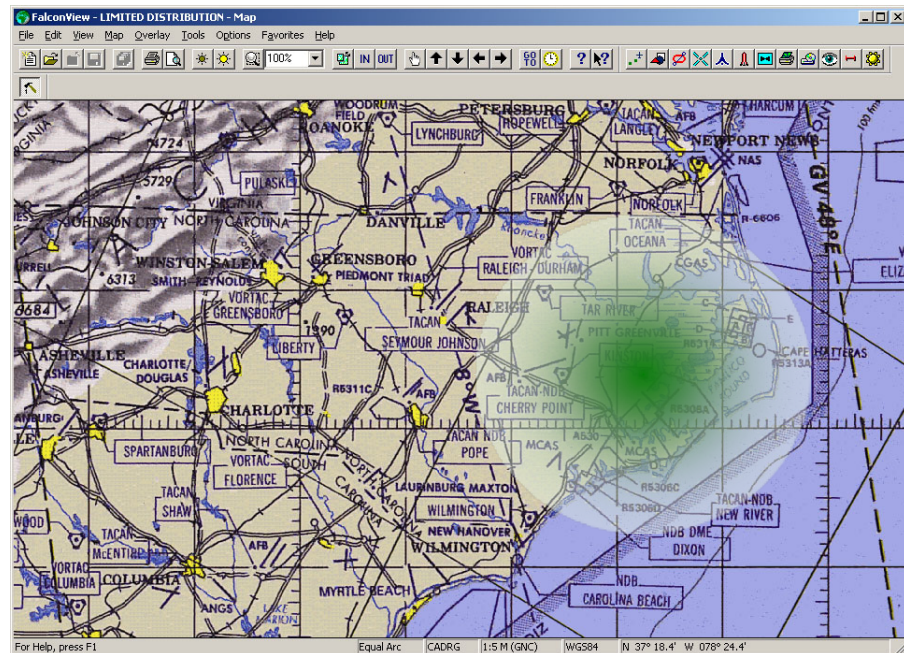
## Broadcast project (FY07 effort)

- NTIA/ITS LF/MF model
- Terrain from DTED, SRTM, or user created (either external to AREPS or using AREPS terrain editor).
- Surface dielectrics from built-in ITU climatology
- FalconView background display

FY07 effort addresses two questions

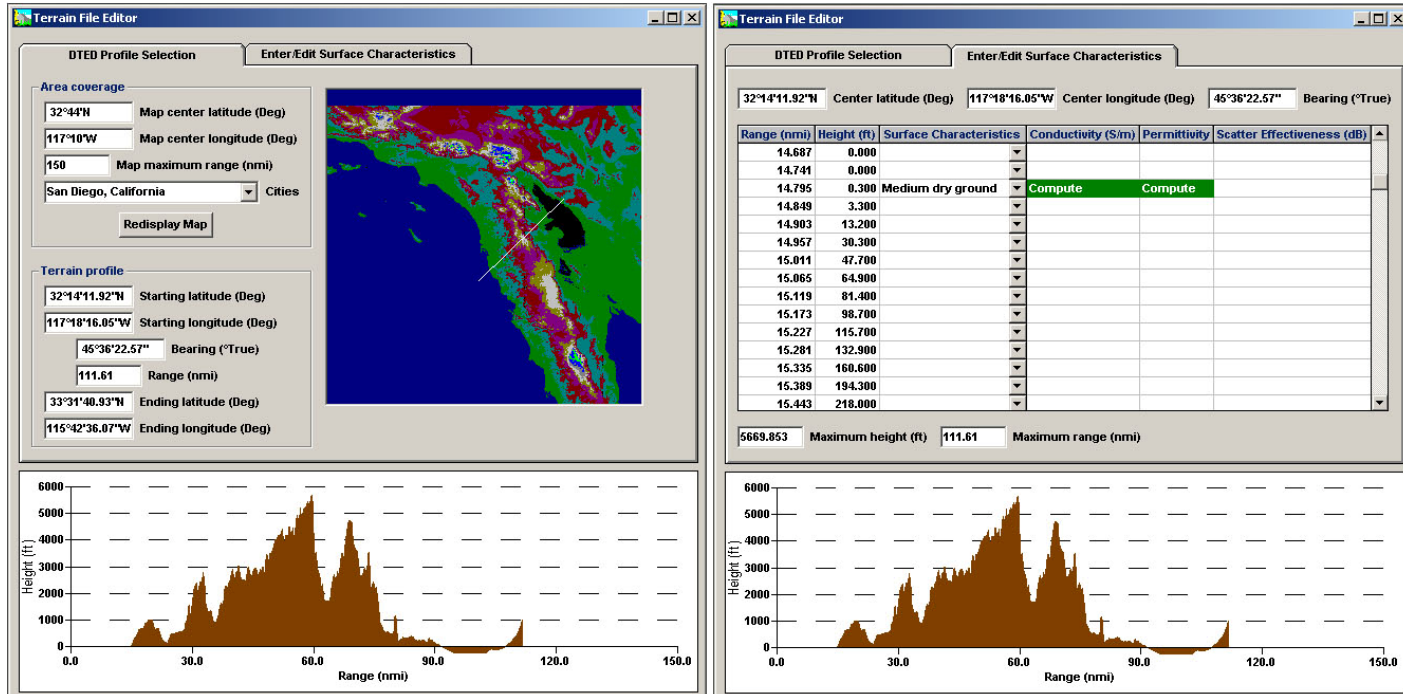
1. Given my transmitter location, what is my area coverage?
2. Given a target audience location, where may I locate my transmitter?

(picture is conceptual)





# Custom Terrain Editor



- Automatic DTED and SRTM, ASCII text file, or keyboard data entry
- Pre-defined surface characteristics or user defined conductivity, permittivity, and scatter effectiveness.
- Selectable “city” drop-down menu for ease of initial location
- FY07 – ITU database for surface dielectrics



# AREPS EM System Database

Radar editor

The Radar Editor interface includes several sections:

- Classification:** Radio buttons for NONE, Level 1, Level 2, and Level 3.
- Radar Calculations/Type:** Radio buttons for Simple pulsed radar, Integrated - Incoherent, Integrated - Coherent, and CW or other radar.
- Optional information:** Text input fields for Latitude (Deg), Longitude (Deg), and Antenna height (ft) (AGL). Includes a dropdown for Function and a dropdown for Associated weapon.
- Vertical Antenna Pattern:** A table with columns for Pattern angle (Deg) and Pattern factor (dbi).
- Antenna type:** A dropdown menu set to 'Omni'.
- Antenna type configuration:** Radio buttons for Horizontal and Vertical polarization, and checkboxes for Hits per scan, Antenna gain (dbi), Antenna scan rate (rpm), Horizontal beam width (Deg), Vertical beam width (Deg), and Antenna elevation angle (Deg).
- Other parameters:** Checkboxes for Your identification label, Frequency (MHz), Peak power (kW), Pulse length (µs), Compressed pulse length (µs), Receiver noise figure (dB), Assumed system loss (dB), Maximum instrumented range (nmi), Pulse rate (Hz), Free-space range (1 sqm target) (nmi), and Probability of false alarm (set to 1.0E-04).

ESM receiver editor

The ESM Receiver Editor interface includes:

- Classification:** Radio buttons for NONE, Level 1, Level 2, and Level 3.
- Polarization:** Radio buttons for Horizontal, Vertical, and Circular.
- Frequency and Sensitivity:** A table with columns for Band Lower Frequency (MHz), Band Upper Frequency (MHz), and Band sensitivity (dbm).

Target editor

The Target Editor interface includes:

- Classification:** Radio buttons for NONE, Level 1, Level 2, and Level 3.
- Target type:** Radio buttons for Aircraft, Missile (selected), Ship, Truck, and Other.
- Missile description:** A checkbox for Cruise velocity (kts) and a table for Flight profile with columns for Range (nmi) and Height (ft).
- Swirling case:** Radio buttons for Steady and Fluctuating.
- Target Parameters Table:**

Freq (MHz)	RCS (sqm)	Polarization	Elev Ang (Deg)	Azm Ang (°True)
		<input checked="" type="radio"/> Hor <input type="radio"/> Ver <input type="radio"/> Cir		
		<input checked="" type="radio"/> Hor <input type="radio"/> Ver <input type="radio"/> Cir		
		<input checked="" type="radio"/> Hor <input type="radio"/> Ver <input type="radio"/> Cir		
		<input checked="" type="radio"/> Hor <input type="radio"/> Ver <input type="radio"/> Cir		
		<input checked="" type="radio"/> Hor <input type="radio"/> Ver <input type="radio"/> Cir		
		<input checked="" type="radio"/> Hor <input type="radio"/> Ver <input type="radio"/> Cir		

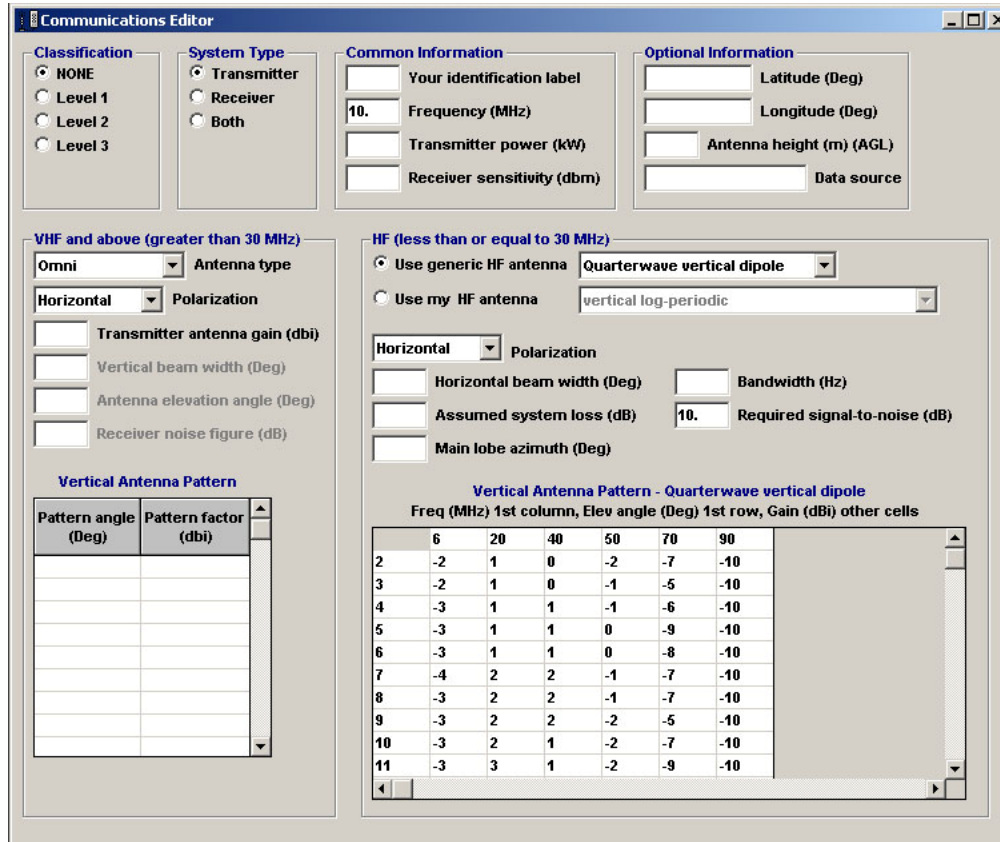
The Platform Editor interface includes:

- Classification:** Radio buttons for NONE, Level 1, Level 2, and Level 3.
- Platform Type:** Radio buttons for Ship, Missile, Aircraft, Other, Tower, Unknown, and Truck.
- Location And Association:** A checkbox for 'This platform is mobile', text input fields for Latitude (Deg) and Longitude (Deg), and a dropdown for Country (set to United States).
- Antenna Height Reference:** Radio buttons for Sea level and Local ground.
- Emitter Library:** A list of emitters including 2D RADAR, 3D RADAR, and AEW RADAR.
- Platform's Emitter Suite:** A table showing emitter details.
 

Emitter name	Antenna Ht (ft)
2D RADAR	32
- Buttons:** 'Add -->' and '<-- Remove' buttons.

# AREPS EM System Database

## Communication editor



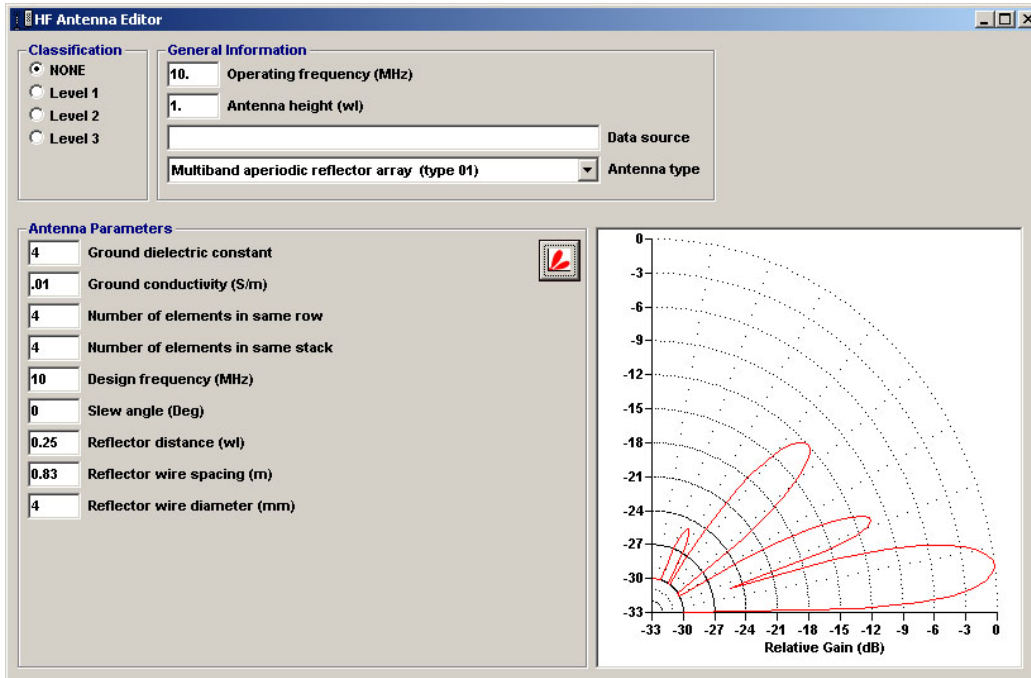
The screenshot shows the 'Communications Editor' window with the following sections:

- Classification:** Radio buttons for NONE, Level 1, Level 2, and Level 3.
- System Type:** Radio buttons for Transmitter, Receiver, and Both.
- Common Information:**
  - Your identification label: [ ]
  - Frequency (MHz): 10.
  - Transmitter power (kW): [ ]
  - Receiver sensitivity (dbm): [ ]
- Optional Information:**
  - Latitude (Deg): [ ]
  - Longitude (Deg): [ ]
  - Antenna height (m) (AGL): [ ]
  - Data source: [ ]
- VHF and above (greater than 30 MHz):**
  - Antenna type: Omni
  - Polarization: Horizontal
  - Transmitter antenna gain (dbi): [ ]
  - Vertical beam width (Deg): [ ]
  - Antenna elevation angle (Deg): [ ]
  - Receiver noise figure (dB): [ ]
- Vertical Antenna Pattern:** A table with columns for Pattern angle (Deg) and Pattern factor (dbi).
- HF (less than or equal to 30 MHz):**
  - Use generic HF antenna: Quarterwave vertical dipole
  - Use my HF antenna: vertical log-periodic
  - Polarization: Horizontal
  - Horizontal beam width (Deg): [ ]
  - Bandwidth (Hz): [ ]
  - Assumed system loss (dB): [ ]
  - Required signal-to-noise (dB): 10.
  - Main lobe azimuth (Deg): [ ]
- Vertical Antenna Pattern - Quarterwave vertical dipole:** A table with columns for Freq (MHz), 1st column, Elev angle (Deg), 1st row, Gain (dBi), and other cells.

- Transmitter, receiver, or transceiver specification
- 11 built-in pre-defined HF antenna patterns, editable by operator
- FY07 - User defined antenna patterns using HFAnt and VOACAP

# AREPS EM System Database

## HF antenna editor (Currently under development)

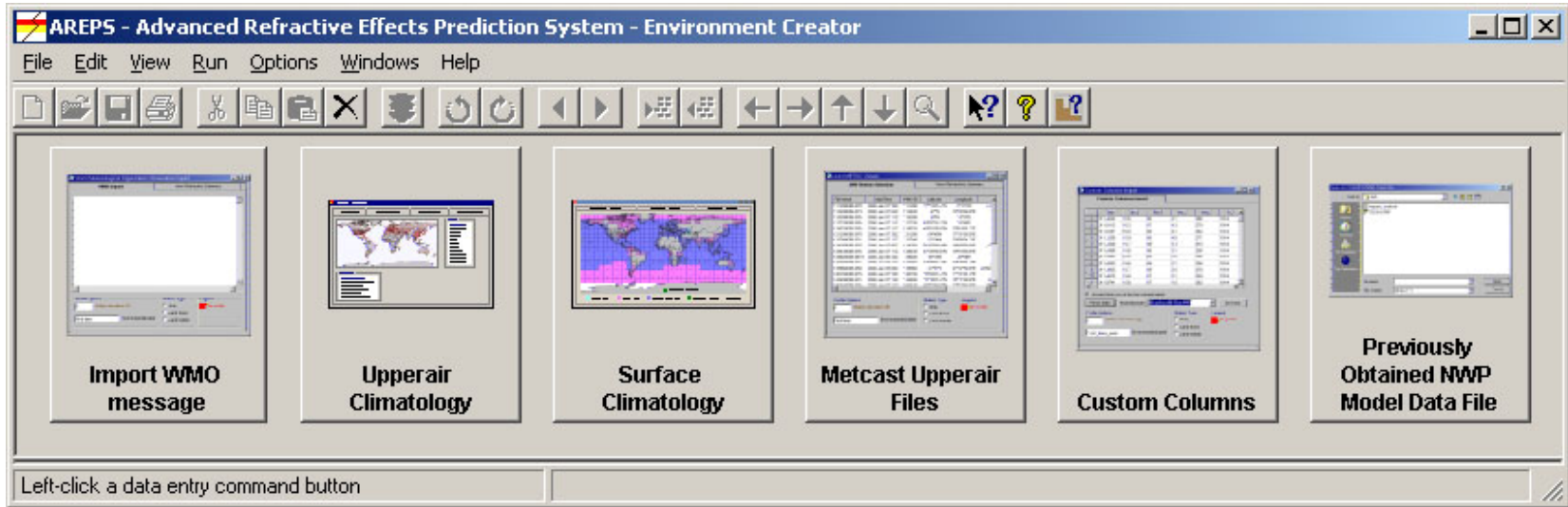


The screenshot shows the 'HF Antenna Editor' window. It is divided into several sections:

- Classification:** Radio buttons for 'NONE', 'Level 1', 'Level 2', and 'Level 3'. 'NONE' is selected.
- General Information:** Fields for 'Operating frequency (MHz)' (10), 'Antenna height (wl)' (1), 'Data source' (empty), and 'Antenna type' (Multiband aperiodic reflector array (type 01)).
- Antenna Parameters:** A list of parameters with input fields:
  - Ground dielectric constant: 4
  - Ground conductivity (S/m): .01
  - Number of elements in same row: 4
  - Number of elements in same stack: 4
  - Design frequency (MHz): 10
  - Slew angle (Deg): 0
  - Reflector distance (wl): 0.25
  - Reflector wire spacing (m): 0.83
  - Reflector wire diameter (mm): 4
- Antenna Pattern Plot:** A polar plot showing relative gain in dB. The x-axis is 'Relative Gain (dB)' from -33 to 0. The y-axis is from 0 to -33. A red curve shows the antenna's radiation pattern, peaking at 0 dB and extending to approximately -30 dB.

- AREPS implementation of NTIA/ITS HFANT (Greg Hand)
- Build-in Sample.00 to Sample.48 antennas
- Antenna pattern created from VOACAP method 13
- After initial implementation, will add drag/drop capability for any antenna file.
- Antenna saved in AREPS EM system database for assignment to user-defined HF radio.

# AREPS Environment Creation Program

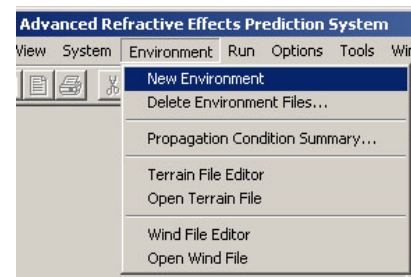
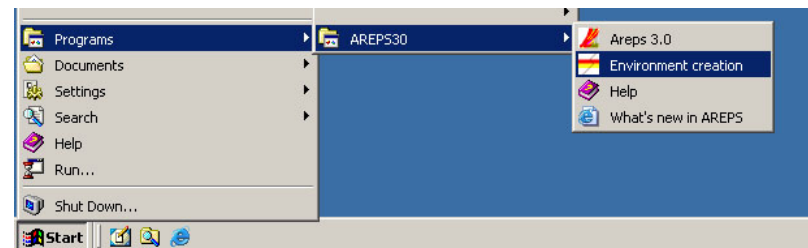


Starts from the:

Windows Start Menu

AREPS menu system

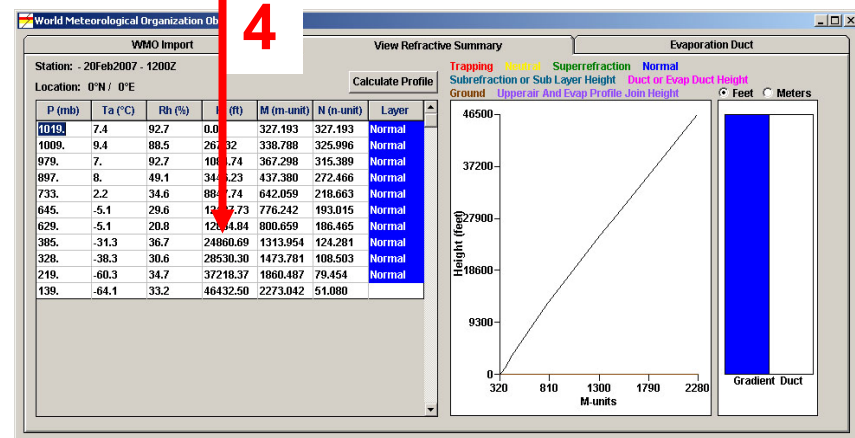
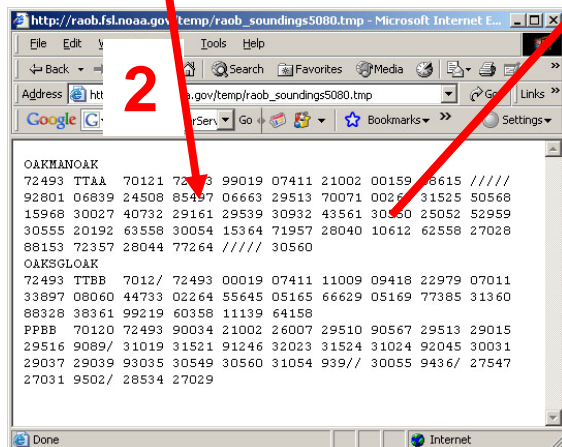
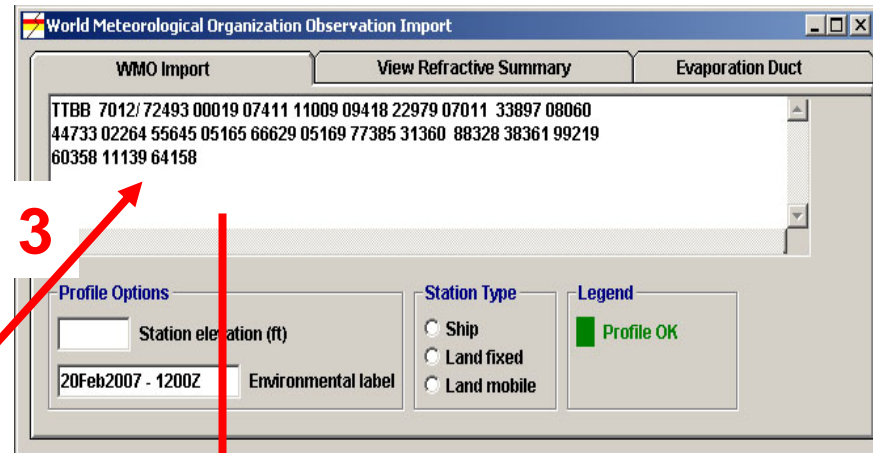
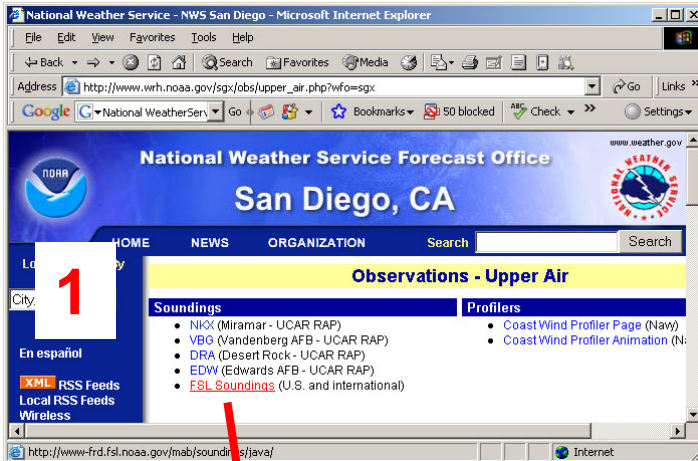
AREPS command button





# WMO Input Method

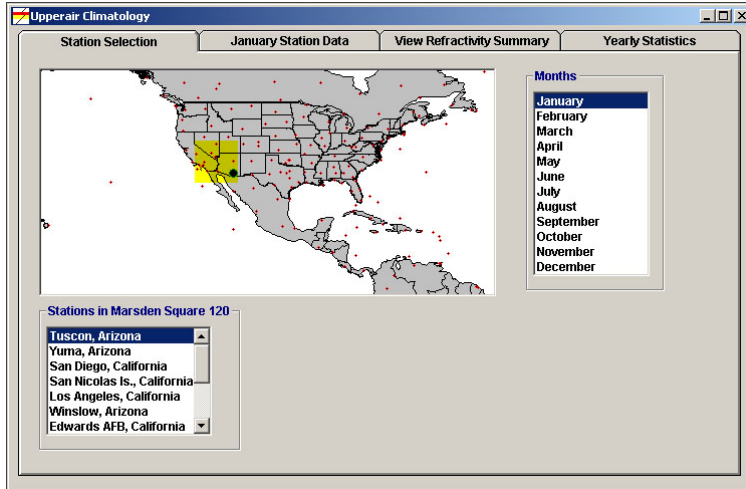
1. Browse to radiosonde sounding
2. Copy sounding to Windows clipboard.
3. Paste into AREPS
4. View and save environment



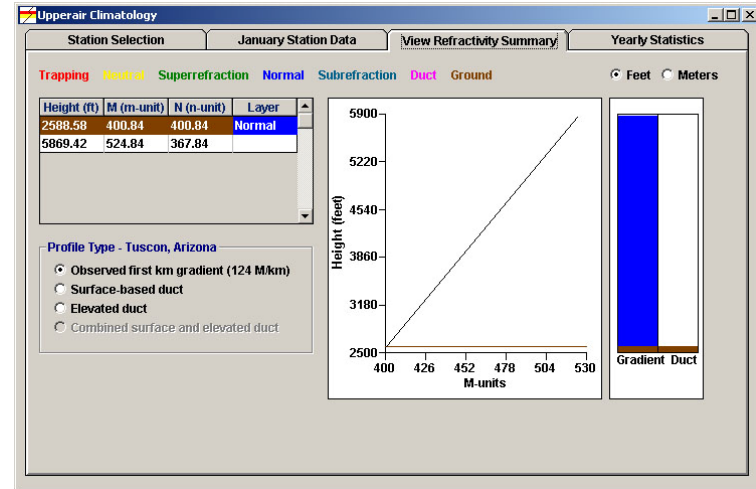


# Upper-air Climatology – 921 stations worldwide

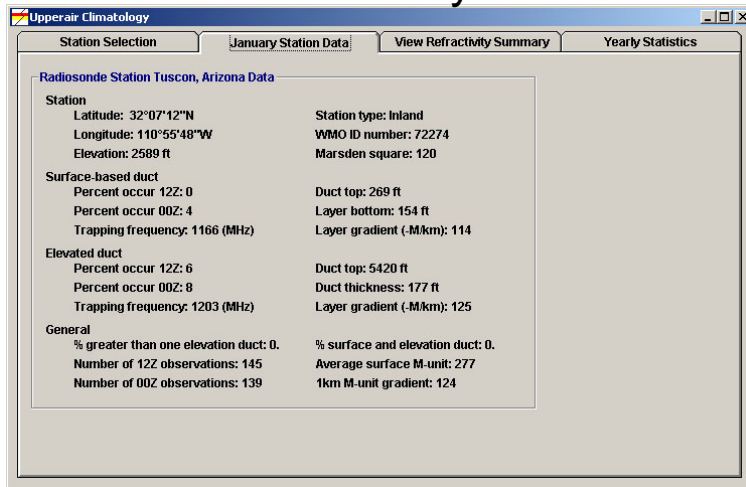
## 1. Select station and month



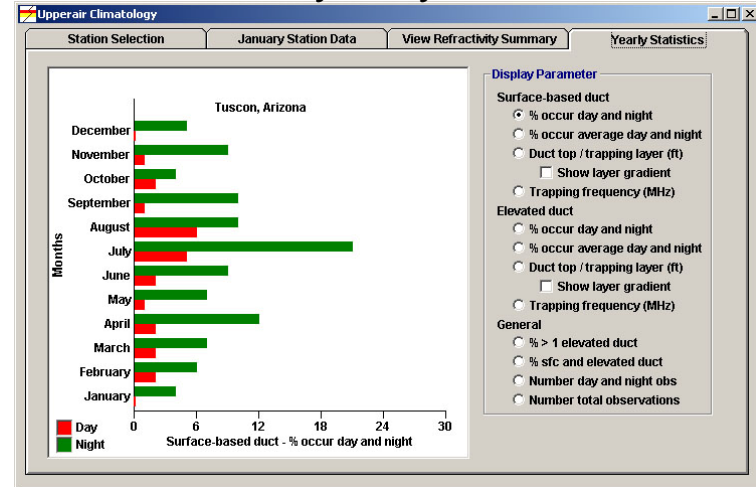
## View profiles



## View monthly statistics

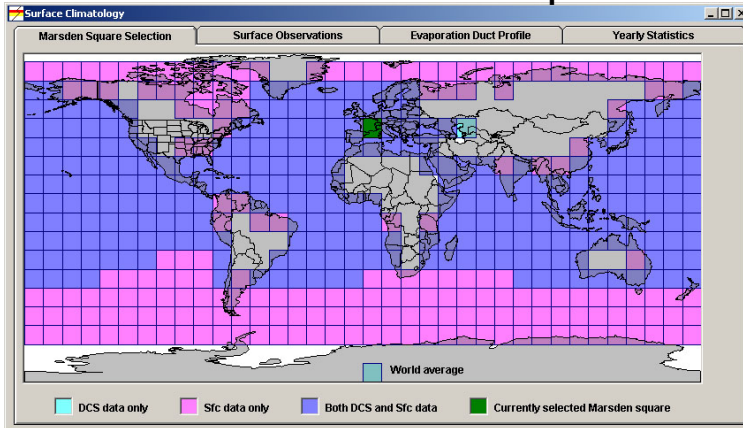


## View yearly statistics

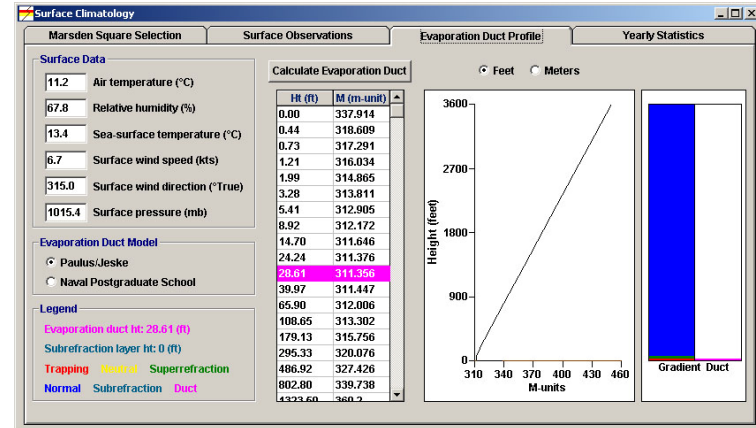


# Surface Climatology Method

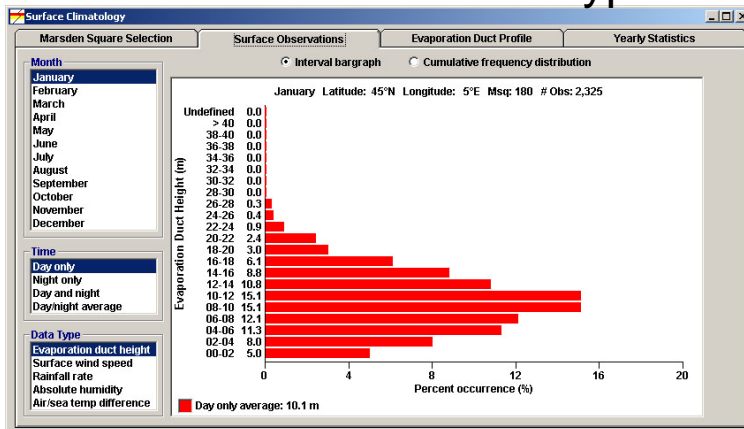
## 1. Select Marsden square



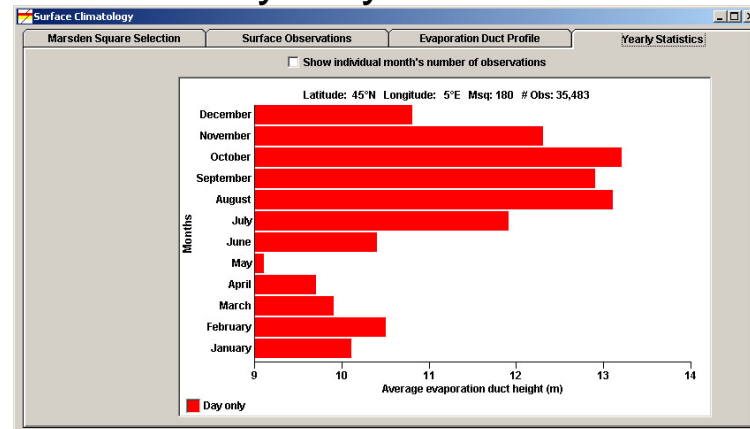
## View evaporation duct profile



## 2. Select month & data type



## View yearly statistics





# METCAST Import Method

METCAST is a request-reply subscription system for weather and oceanographic information over the Internet

Joint METOC Viewer

File Name	Date/Time	WMO ID	Latitude	Longitude	Station Name
722930072.20c	2007 Feb 20 12Z	722930	32°49'58.8"N	117°07'01.2"W	KSGX, SAN DIEGO RAOB
723550072.20b	2007 Feb 20 11Z	723550	34°39'N	98°24'W	KFSI, FORT SILL
723570072.20c	2007 Feb 20 12Z	723570	35°13'58.8"N	97°28'01.2"W	KOUN, NORMANWESTHEIMER
723630072.20c	2007 Feb 20 12Z	723630	35°13'58.8"N	101°42'W	KAMA, AMARILLO ARPT(AWOS)
723640072.20c	2007 Feb 20 12Z	723640	31°52'01.2"N	106°42'W	KEPZ, SANTA TERESA
723650072.20c	2007 Feb 20 12Z	723650	35°01'58.8"N	106°37'01.2"W	KABQ, ALBUQUERQUE INTL
723760072.20c	2007 Feb 20 12Z	723760	35°13'58.8"N	111°49'01.2"W	KFGZ, FLAGSTAFF RAOB
723870072.20c	2007 Feb 20 12Z	723870	36°37'01.2"N	116°01'01.2"W	KDRA, MERCURY/DESERT ROCK
723930072.20c	2007 Feb 20 12Z	723930	34°43'58.8"N	120°33'W	KVBG, VANDENBERG AFB
724510072.20c	2007 Feb 20 12Z	724510	37°46'01.2"N	99°58'01.2"W	KDDC, DODGE CITY
724690072.20c	2007 Feb 20 12Z	724690	39°46'01.2"N	104°52'01.2"W	KDNR, DENVER/STAPLETON
724760072.20c	2007 Feb 20 12Z	724760	39°07'01.2"N	108°31'01.2"W	KGJT, GRAND JUNCTION
724890072.20c	2007 Feb 20 12Z	724890	39°34'01.2"N	119°46'58.8"W	KREV, RENO WSFO RAOB
724930072.20c	2007 Feb 20 12Z	724930	37°45'N	122°13'01.2"W	KOAK, OAKLAND
725580072.20c	2007 Feb 20 12Z	725580	41°19'01.2"N	96°22'01.2"W	KOAX, OMAHA RAOB
725620072.20c	2007 Feb 20 12Z	725620	41°07'58.8"N	100°42'W	KLBF, NORTH PLATTE
725720072.20c	2007 Feb 20 12Z	725720	40°46'58.8"N	111°57'W	KSLC, SALT LAKE CITY INTL



Requires DoD Public Key Infrastructure (PKI) certificate and a Common Access Card

Joint METOC Viewer

Profile Options: 1612. Station elevation (m)

Station Type:  Ship,  Land fixed,  Land mobile

Station: KDNR, DENVER/STAPLETON - 2007 Feb 20 12Z

Location: 39°46'01.2"N / 104°52'01.2"W

P (mb)	Ta (°C)	Rh (%)	Ht (ft)	M (m-unit)	N (n-unit)	Layer
828.	-0.4	78.9	5288.71	512.091	259.007	Normal
815.	2.4	59.8	5705.99	523.857	250.805	Normal
802.	3.	47.7	6132.53	536.455	242.992	Normal
700.	-4.6	38.4	9693.73	674.673	210.793	Normal
679.	-6.6	44.8	10477.10	707.684	206.317	Normal
652.	-7.6	20.1	11514.56	745.080	194.067	Normal
605.	-11.4	6.3	13409.92	821.799	180.086	Normal
527.	-19.4	8.	16828.35	966.873	161.576	Normal
500.	-20.8	6.9	18107.10	1020.505	154.015	Normal
400.	-33.	23.3	23386.98	1248.699	129.548	Normal
336.	-43.4	41.	27323.06	1421.049	113.542	Normal
300.	-47.8	27.2	29800.87	1529.194	103.115	Normal
293.	-48.	23.9	30311.85	1551.297	100.766	Normal
260.	-54.4	42.	32860.09	1664.441	91.968	Normal
250.	-55.2	47.4	33682.93	1700.590	88.740	Normal
222.	-57.2	35.9	36159.02	1809.762	79.423	Normal
204.	-53.	22.2	37930.58	1886.650	71.535	Normal
200.	-53.8	19.2	38348.70	1905.484	70.361	Normal
182.	-57.4	13.5	40320.06	1994.473	65.013	Normal

Calculate Profile

Trapping Neutral Superrefraction Normal  
Subrefraction or Sub Layer Height Duct or Evap Duct Height  
Ground Upperair And Evap Profile Join Height

Height (feet) vs M-units graph showing a linear relationship. Gradient Duct is indicated.

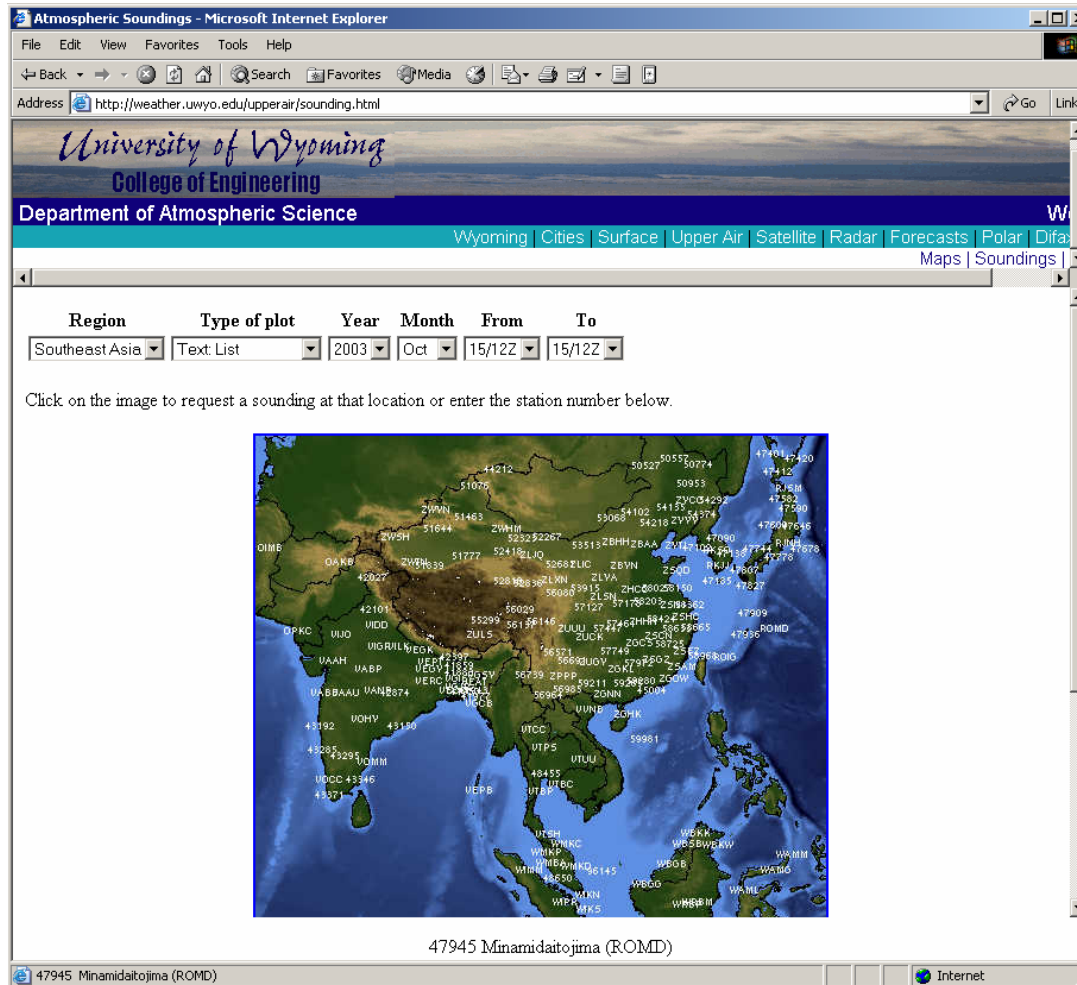
1. Schedule data delivery via METCAST
2. Select station from AREPS



# Custom Column Import Method

Used to import an upper-air observation where the data are arranged in columns

## Example using University of Wyoming



Atmospheric Soundings - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://weather.uwyo.edu/upperair/sounding.html>

University of Wyoming  
College of Engineering  
Department of Atmospheric Science

Wyoming | Cities | Surface | Upper Air | Satellite | Radar | Forecasts | Polar | Difa  
Maps | Soundings

Region: Southeast Asia | Type of plot: Text: List | Year: 2003 | Month: Oct | From: 15/122 | To: 15/122

Click on the image to request a sounding at that location or enter the station number below.

47945 Minamidaitojima (ROMD)

1. Locate your data source.  
<http://weather.uwyo.edu/upperair/sounding.html>
2. Select the desired world region, time, and text list for type of plot.
3. Click on desired observation station, for example 47158 RKJJ Kwangju Air Base

# Custom Column Import Method

## Continued example using University of Wyoming

http://weather.uwyo.edu/cgi-bin/sounding?region=seasia&TYPE=TEXT:LIST&YEAR=2003&MONTH=10&FROM=1 ...

File Edit View Favorites Tools Help

Address http://weather.uwyo.edu/cgi-bin/sounding?region=seasia&TYPE=TEXT%3ALIST&YEAR=2003&MONTH=10&FROM=1

### 47158 RKJJ Kwangju Ab Observations at 12Z 15 Oct 2003

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1016.0	13	13.0	7.0	67	6.22	40	1	284.9	302.4	285.9
1000.0	147	13.2	6.2	63	5.98	15	4	286.4	303.4	287.4
988.0	247	12.4	5.9	64	5.91	350	7	286.5	303.3	287.5
925.0	795	7.8	4.0	77	5.54	335	18	287.3	303.2	288.2
880.0	1203	4.4	2.1	85	5.09	317	23	287.9	302.6	288.8
875.0	1250	4.2	1.8	84	5.01	315	24	288.2	302.7	289.1
850.0	1485	3.4	0.4	81	4.66	310	25	289.7	303.3	290.5
802.0	1954	0.2	-8.8	51	2.46	310	30	291.1	298.6	291.6
741.0	2590	2.4	-18.6	20	1.20	310	36	300.2	304.1	300.4
734.0	2666	1.9	-19.4	19	1.13	310	37	300.5	304.2	300.7
700.0	3047	-0.3	-23.3	16	0.84	305	37	302.1	305.0	302.3
670.0	3397	-1.3	-34.3	6	0.31	302	36	304.8	305.9	304.9
624.0	3960	-4.3	-35.3	7	0.31	298	36	307.6	308.8	307.7
500.0	5660	-18.5	-47.5	6	0.11	285	33	310.4	310.8	310.4
490.0	5811	-19.7	-48.7	6	0.09	285	34	310.8	311.1	310.8
485.0	5886	-20.2	-49.2	6	0.09	285	34	311.1	311.4	311.1
469.0	6135	-21.7	-50.7	5	0.08	284	41	311.1	311.5	312.2
449.0	6457	-21.3	-53.3	4	0.06	283	50	311.1	311.8	316.6
408.0	7155	-26.3	-54.1	5	0.06	280	70	311.1	312.2	319.0
400.0	7300	-27.3	-54.3	6	0.06	280	72	311.1	312.7	319.4
392.0	7445	-28.5	-55.5	6	0.05	280	74	311.1	313.1	319.7
343.0	8395	-31.5	-57.5	6	0.05	283	84	311.1	313.3	328.1
318.0	8926	-35.5	-59.5	7	0.04	284	90	329.7	329.9	329.7
300.0	9330	-36.3	-60.3	7	0.04	285	94	334.1	334.3	334.1
299.0	9353	-36.4	-60.3	7	0.04	285	94	334.3	334.5	334.3
263.0	10242	-38.9	-61.9	7	0.04	281	116	343.1	343.2	343.1
250.0	10590	-41.3	-63.3	7	0.03	280	125	344.5	344.7	344.5
247.0	10671	-41.8	-63.7	8	0.03	280	126	344.9	345.1	344.9
217.0	11535	-47.5	-67.5	8	0.02	280	124	349.1	349.2	349.2
200.0	12070	-49.1	-68.1	9	0.02	280	122	354.9	354.9	354.9
177.0	12871	-50.7	-69.7	9	0.02	276	114	364.8	364.9	364.8
150.0	13930	-59.7	-75.7	11	0.01	270	104	367.0	367.1	367.0
149.0	13972	-60.1	-76.1	11	0.01	270	103	367.0	367.1	367.0
145.0	14567	-62.3	-78.3	12	0.01	265	81	367.0	367.1	367.0

Copies the selection to the Clipboard.

Internet

4. Clicking and dragging mouse, highlight desired data and select “Copy” from the right mouse click menu. It is only necessary to highlight the data to the height of your tactical application.

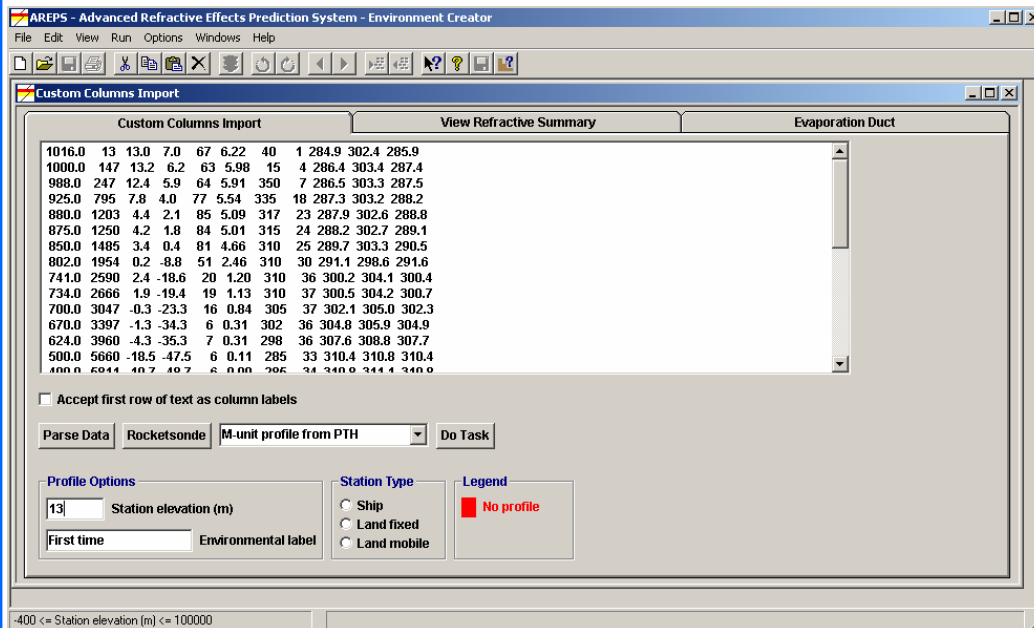
5. Note the column definitions. In this example, column 1 is pressure (hPa), column 3 is air temperature (°C), and column 5 is relative humidity (%).

6. Note the height of the first pressure level. In this example, it is 13 meters.



# Custom Column Import Method

## Continued example using University of Wyoming



7. Open the AREPS environment program and click on the Custom Column quick action button.

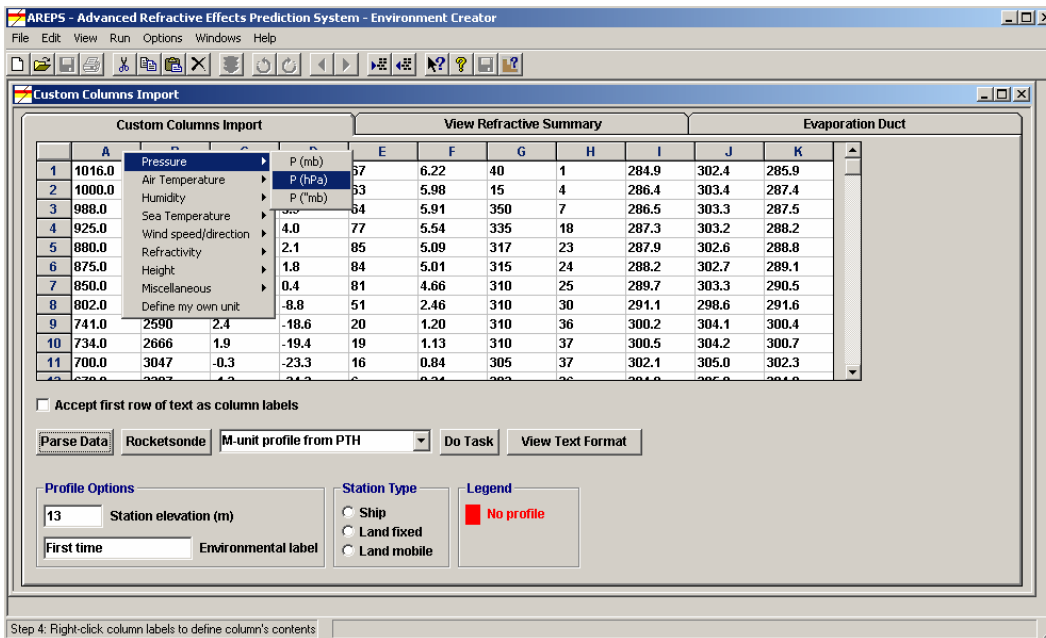
8. Click into the input box and “Paste” the contents of the clipboard using the Edit menu, the toolbar button, or the mouse right-click popup menu.

9. Enter the height of the first pressure level into the station elevation box. Make sure the units are correct. (Right click the station elevation label to change units)

10. Click the “Parse data” button.

# Custom Column Import Method

## Continued example using University of Wyoming



AREPS - Advanced Refractive Effects Prediction System - Environment Creator

Custom Columns Import

Custom Columns Import				View Refractive Summary				Evaporation Duct			
	A			E	F	G	H	I	J	K	
1	1016.0	Pressure	P (mb)	57	6.22	40	1	284.9	302.4	285.9	
2	1000.0	Air Temperature	P (hPa)	53	5.98	15	4	286.4	303.4	287.4	
3	988.0	Humidity	P (mb)	54	5.91	350	7	286.5	303.3	287.5	
4	925.0	Sea Temperature		4.0	77	5.54	335	18	287.3	303.2	288.2
5	880.0	Wind speed/direction		2.1	85	5.09	317	23	287.9	302.6	288.8
6	875.0	Refractivity		1.8	84	5.01	315	24	288.2	302.7	289.1
7	850.0	Height		0.4	81	4.66	310	25	289.7	303.3	290.5
8	802.0	Miscellaneous		-8.8	51	2.46	310	30	291.1	298.6	291.6
9	741.0	Define my own unit		2.4	20	1.20	310	36	300.2	304.1	300.4
10	734.0			1.9	19	1.13	310	37	300.5	304.2	300.7
11	700.0			-0.3	16	0.84	305	37	302.1	305.0	302.3

Accept first row of text as column labels

Parse Data Rocketsonde M-unit profile from PTH Do Task View Text Format

Profile Options: Station elevation (m) First time Environmental label

Station Type: Ship Land fixed Land mobile

Legend: No profile

Step 4: Right-click column labels to define column's contents

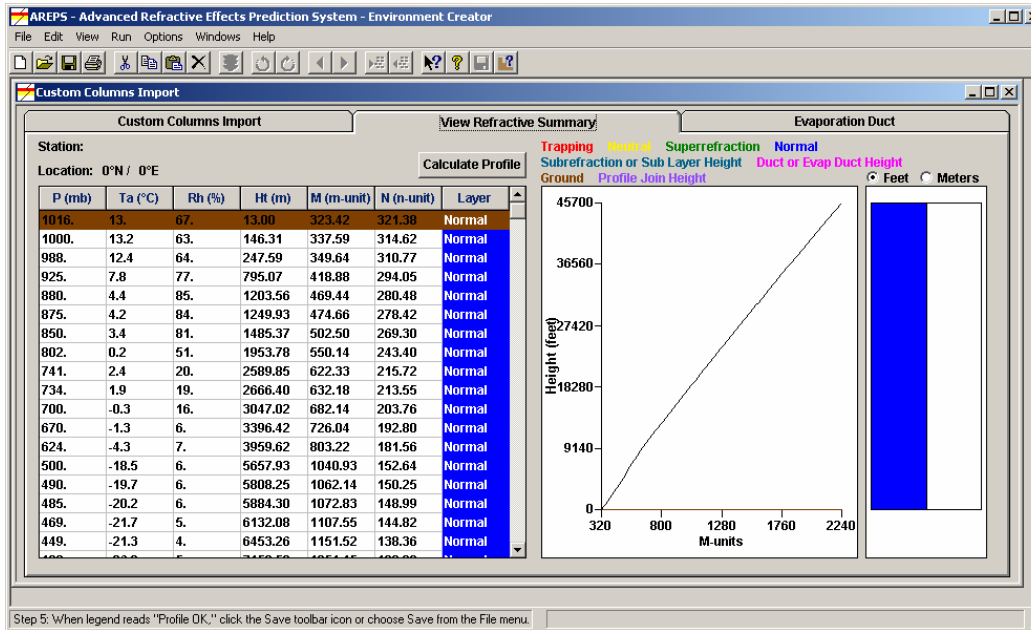
11. For each column of data recorded earlier, right-click on the column label and select the appropriate unit. For example, column 1 is pressure (hPa).

12. Insure the task defined is "M-unit profile from PTH."

13. Click the "Do Task" button.

# Custom Column Import Method

Continued example using University of Wyoming



14. You may click on the “View Refractive Summary” tab to see the resulting refractive profile.

15. Save the profile with any name you wish.

The profile will now be selectable from your project’s environment dropdown menu.



# Previously Obtained NWP Model Data File Method

<https://www.fnmoc.navy.mil/PUBLIC/index.html>



Requires DoD Public Key Infrastructure (PKI) certificate

Centralized Atmospheric Analysis and Prediction System (CAAPS)

Using COAMPS-OS™ On-Scene Numerical Weather Prediction for DoD Oceanographic Operations

NIPRNET 8-P Operations @ FNMOC Monterey, CA  
Version 1.2p6

**Message from the CAAPS System Administrator:**  
Requires Java 1.4.2 or higher installed on users desktop for application and data GUIs to function.  
-- Message updated Wed Mar 23 17:48:31 GMT 2005

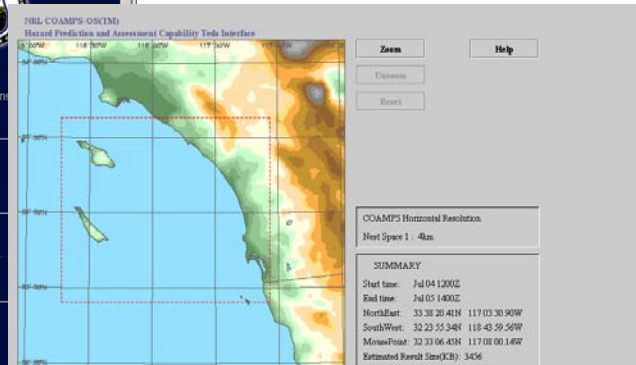
Daily COAMPS™ Forecasts

- ASW-
- NSW-

Applications: COAMPS-OS GUI, IPVS-CHARTS, Station Interface, VISSD

Data: AREPS, HPAC, Observations, VLSTrack

Services: Documentation, Parameter Descript, Remote Monitor



**MWP Data File Description**

Jul 28, 2005 - 0.00 UCT Time

**AREPS Project Geographic Area**

36°50'51.7"N Latitude

122°24'05.4"W Longitude

0° First bearing (°True)

45° Bearing increment (Deg)

8 Number of bearings

250. Maximum range (nmi)

7 Profiles per bearing

**Refractivity Summary**

Select project's geographic center

Show raw NWP model data

Edit raw NWP model data

Left click and drag to zoom in - Right click for options

If supported by data, append evaporation duct

**Legend**

Profile OK Data OK Data Missing

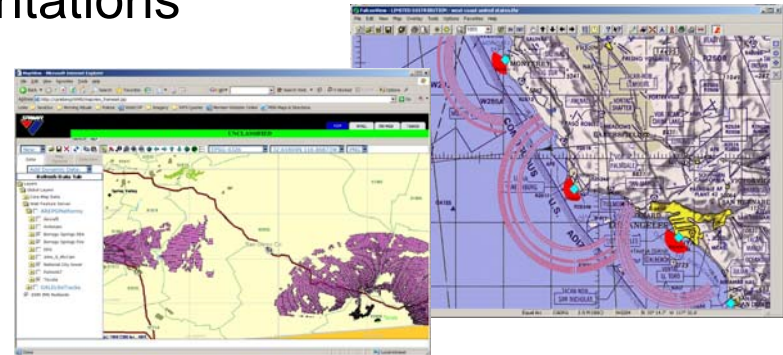
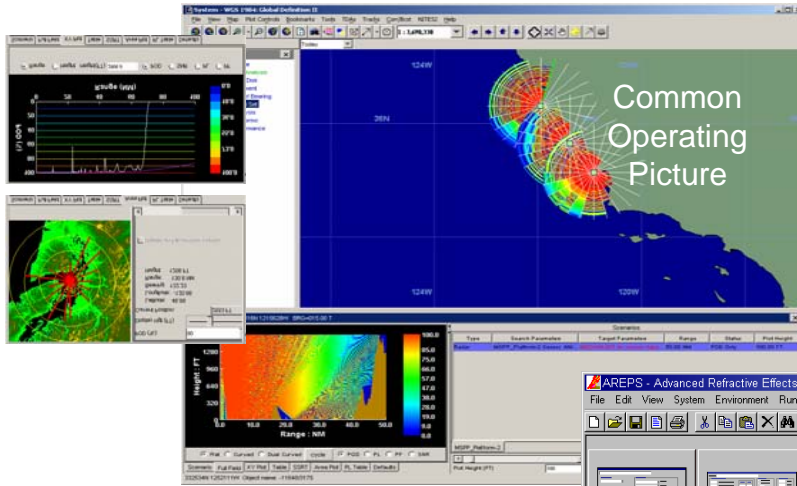


Data also available from Defense Threat Reduction Agency

# Various AREPS implementations

## FalconView

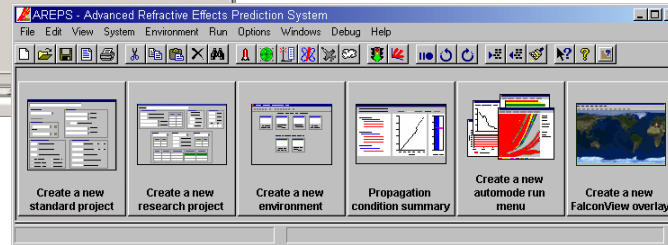
## GCCS-M / GCCS-J NITES



Homeland Defense

Coast Guard Multi-sensor Performance Prediction (MSPP)

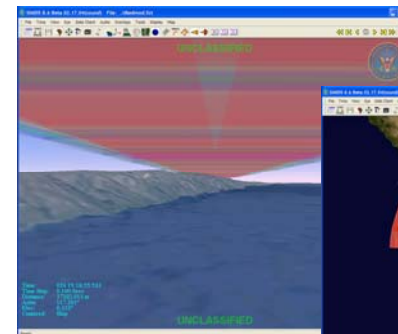
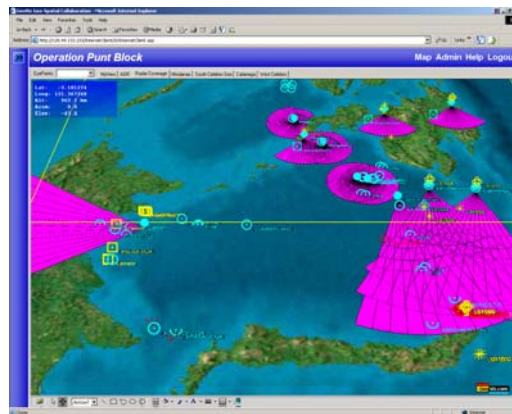
Personal -PC



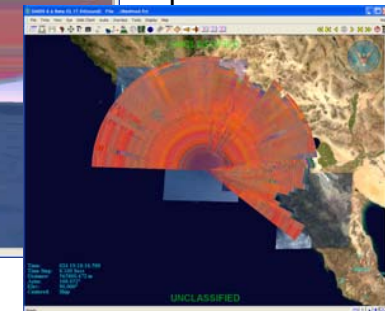
## Composable ForceNet (Current Installs)

- CTF-74
- CTF-72
- CTF-72.2
- USS Blue Ridge
- USS Ronald Regan
- USS Kitty Hawk

2/28/2007



Ship Air Defense Model







# Summary

1. SSC San Diego, Atmosphere Propagation Branch has over 60 years of expertise in propagation modeling, environmental data assimilation, and C4I decision aids.
2. APM is the only Navy accredited EM (100 MHz – 57 GHz) propagation model (N096/N61 accreditation Ser N962 / 3U561120 - Oct 03)
3. APM and AREPS are elements of the Defense Modeling and Simulation Office (DMSO) library
4. AREPS is a CNO approved application within the Department of the Navy Chief Information Officer DON Applications & Database Management System (DADMS)
5. AREPS is NMCI certified
6. AREPS is NATO approved, Military Committee Meteorological Group/WG - Battle Area Meteorological Systems and Support plus with Partners

When can we meet again to discuss

**your needs** in greater detail?

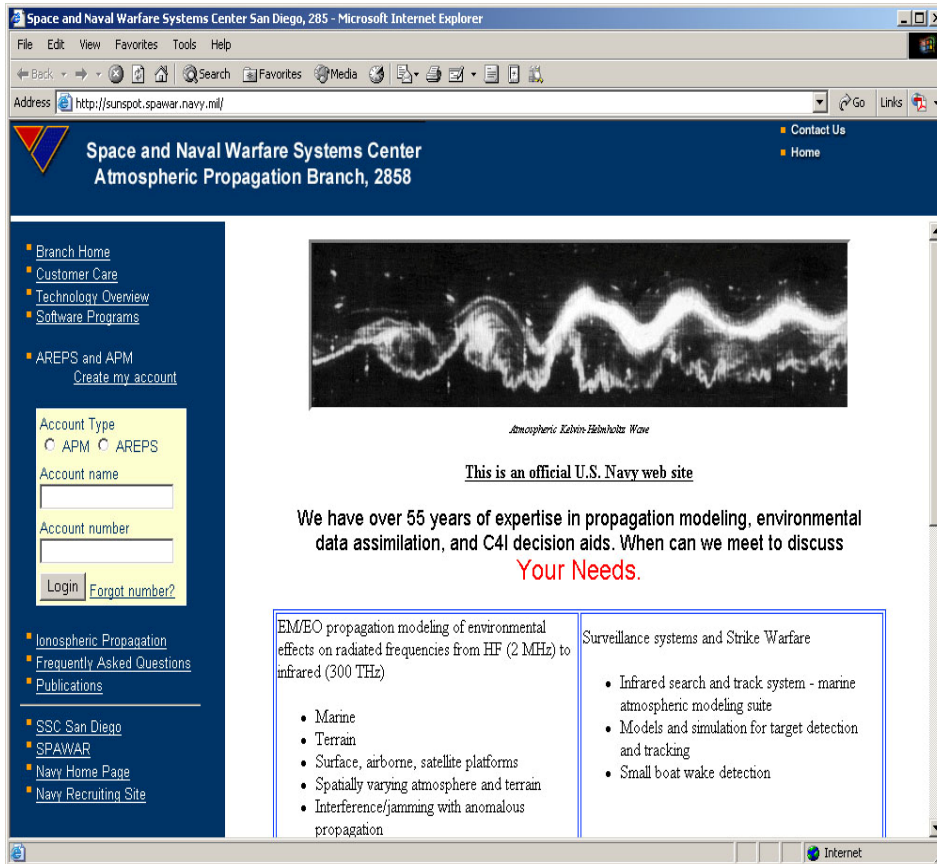


# How to Contact Us

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553-1423

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[areps@spawar.navy.smil.mil](mailto:areps@spawar.navy.smil.mil)

Public Internet - <http://sunspot.spawar.navy.mil>