IMPLEMENTATION OF A LIVE ACCESS SERVER FOR THE MANAGEMENT OF WAVE ENERGY DATA IN THE EASTERN MEDITERRANEAN

Stavros Stylianou[1], George Zodiatis[1], George Galanis[1,2], Andreas Nikoaidis[1]

Oceanography Centre, University of Cyprus[1]
Department of Physics, University of Athens[2]

IMDIS 2013
International Conference on Marine Data and Information Systems – Lucca (Italia), September 23-25, 2013

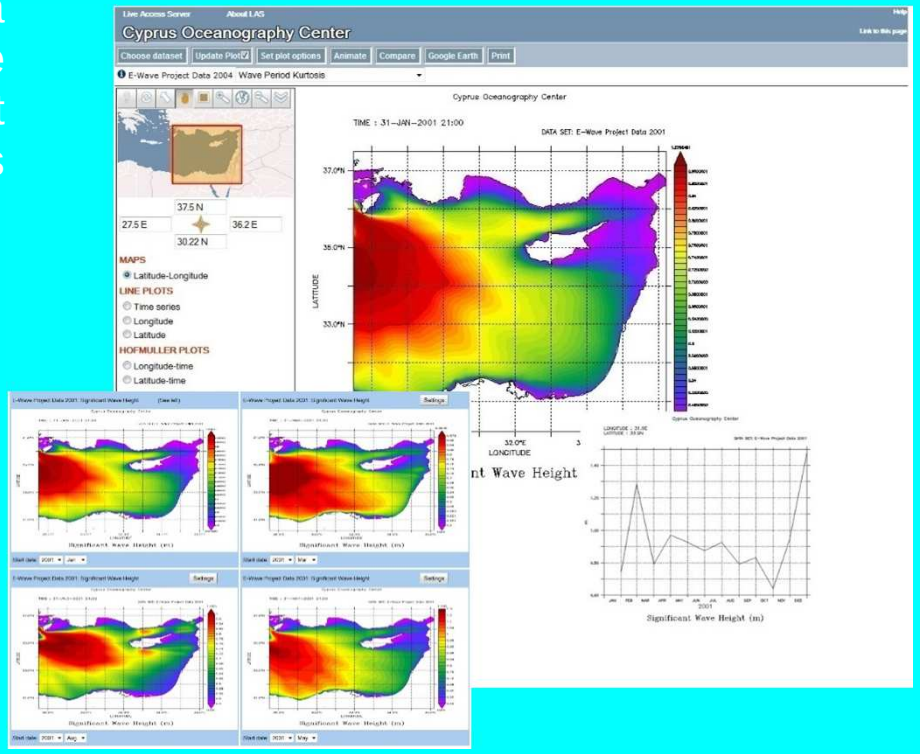
University of Cyprus

Outlines

- The Live Access Server (LAS)
  - What is LAS ?
  - Architecture
  - User perspective
  - Data provider perspective
- Wave Energy Potential in the Eastern Mediterranean
  - The E-WAVE Project
  - Preparing Data for LAS
- Deployment of LAS
  - System description
  - Visualizing Wave Energy Potential
- Conclusions

The Live Access Server (LAS)

- Live Access Server (LAS) is a highly configurable web server designed to provide flexible access to geo-referenced scientific data.
- It can present distributed data sets as a unified virtual data base through the use of OpenDap networking. The default visualization application used by LAS is Ferret.
- The LAS server has been developed at NOAA/Oceanic and Atmospheric Research's (OAR) Pacific Marine Environmental Laboratory (PMEL).
- A complete system must include the Ferret environment, Thredds Data Server (TDS), Apache web server and Tomcat.

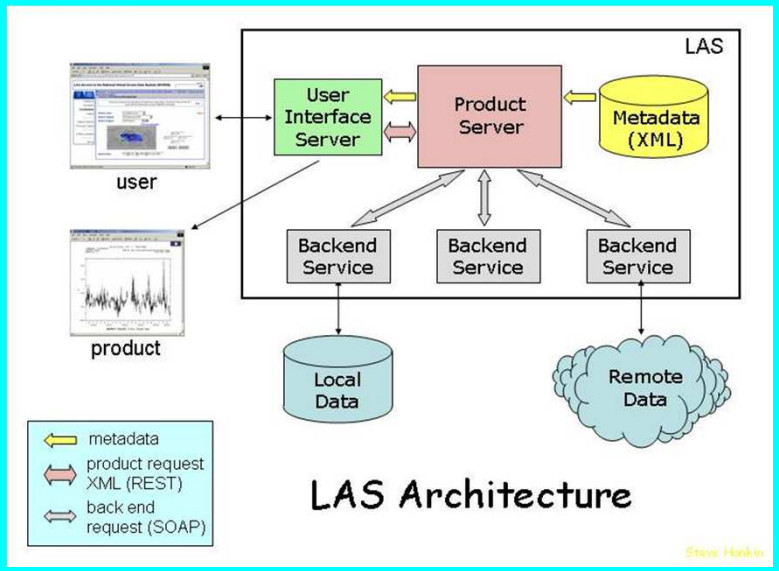


University of Cyprus

The Live Access Server (LAS)

LAS main components :

- The Product Server takes the user request through the UI server and farms out the work necessary to build the product to one or more backend services (e.g. Ferret) .
- The User Interface Server (UI) provides to the user the graphical interface with menus and data selection tools based on LAS configuration.
- The Backend Services that create the necessary product.

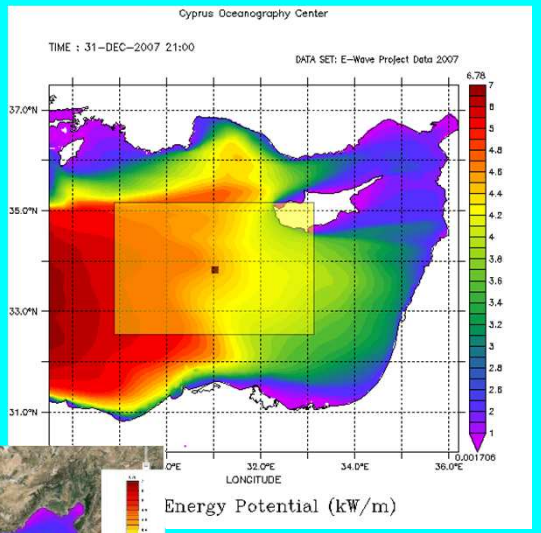


http://ferret.pmel.noaa.gov/LAS/documentation/introduction/the-las-architecture/

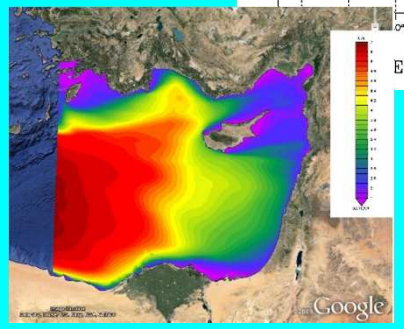
The Live Access Server (LAS)

LAS provides a single online interface where research users can :

- Visualize data with on-the-fly graphics
- Request custom subsets
- Access to metadata and documentation
- Compare variables
- Export and visualize data in Google Earth®
- Create animations
- Download data (NetCDF, ASCII, CSV)



Sub-set Selection



Visualizing in Google Earth

The Live Access Server (LAS)

LAS enables the data provider to:

- Distribute multiple types of data in a single interface
- Create thematic data servers from distributed data sources
- Offer derived products on the fly
- Fast delivery of products
- Provide access to gridded and in-situ datasets
- Customizable interfaces

Wave Energy Potential in the Eastern Mediterranean

The E-WAVE project (2011-2013)

The development of an integrated, high resolution system for monitoring the wave energy potential of the Eastern Mediterranean Levantine Basin and of the Cyprus EEZ, coupled with the Cyprus Coastal Ocean Forecasting System (CYCOFOS).

The project results include:

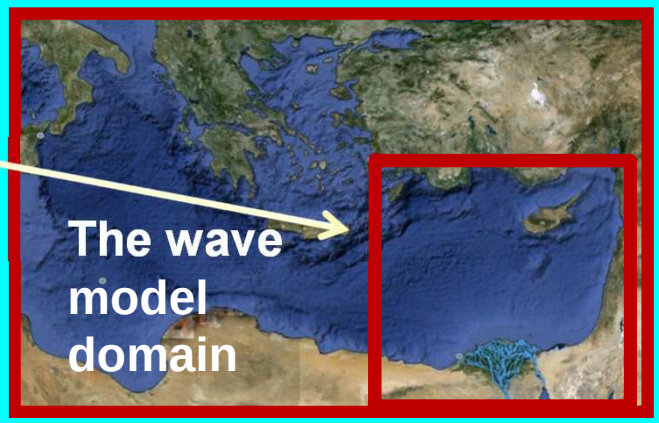
- A high resolution digital climatological atlas from 2001-2010, containing detailed maps for the coastal and offshore areas of the Eastern Mediterranean Levantine Basin with all the relevant sea wave characteristics, as well the temporal and spatial distribution of the wave energy potential.
- Prediction and quantification of wave energy for operational forecasts, a tool of significant value for grid energy designers and regulators.

http://www.oceanography.ucy.ac.cy/ewave/

Wave Energy Potential in the Eastern Mediterranean

- The latest version of the 3rd generation wave model WAM (ECMWF parallel version) is used.
- For the project the wave model domain cover the whole east Med region in order to capture all the swell information that could reach the Levantine Basin, the latter used to estimate the wave energy potential.

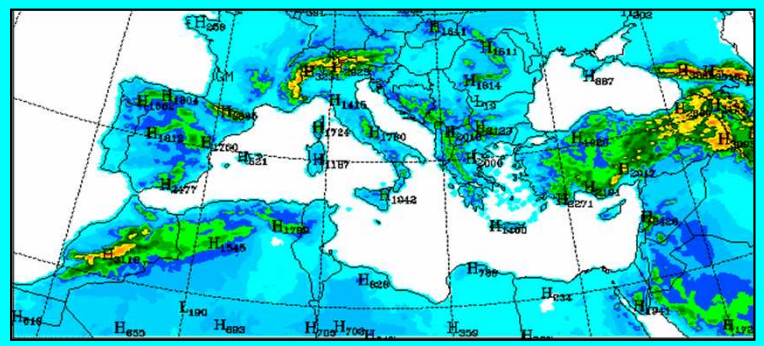
Wave model Characteristics	WAM ECMWF CY33R1
Model's domain	East Mediterranean Sea (30N – 41N, 15E – 37E)
Wave Energy Potential study area	Levantine Basin
Horizontal Resolution	1/60 x 1/60 degrees
Frequencies	25 (range 0.0417-0.54764 Hz, spaced logarithmically)
Directions	24 (equally spaced)
Time step	45 sec



Wave Energy Potential in the Eastern Mediterranean

- The non-hydrostatic modelling system SKIRON was used for simulating the necessary wind fields
- SKIRON has been developed by the E-Wave partner from the University of Athens based on the Eta/NCEP model
- The model is one of the main modelling systems of the Hellenic National Meteorological Service. Moreover, SKIRON supports with surface boundaries conditions the sub-regional and coastal Mediterranean operational oceanographic forecasting systems-MONGOOS (former MOON).
- Its a full physics non-hydrostatic model with sophisticated convective, turbulence and surface energy budget scheme
- Horizontal Resolution 1 x 1 nm
- 45 vertical levels up to 50hPa
- Nested with NCEP, produce hourly winds

Skiron domain



Preparing Wave Energy Potential for LAS

- Wave Energy data from the model :
  - Delivered in ASCII format.
  - For a period of 10 years (2001 - 2010)
  - With a 3 hourly and monthly avverages.
  - Files for each year are about 15Gb.

- Implementation of statistical analysis (descriptive statistical calculations, including Pearson's kurtosis and skewness).
- Wave energy potential calculations.
- Data were reformed in NetCDF format.

Deployment of LAS

- LAS server is build on an Intel i7 CPU 965 @ 3.20GHz Linux server with 8GB of RAM
- The system includes :
  1. The LAS server.
  2. Ferret environment for the visualization of the datasets.
  3. The THREDDS Data Server (TDS), serving the data.
  4. Apache Web Server
  5. and Tomcat.

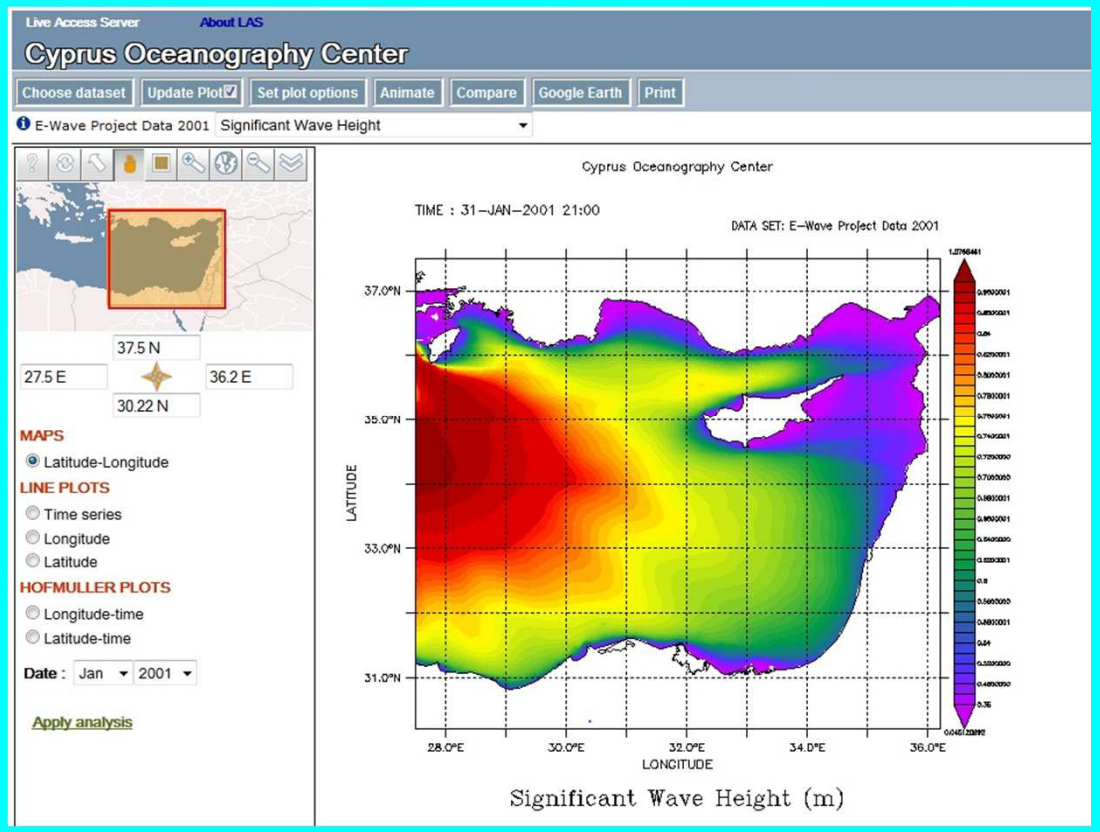
When LAS starts, automatically builds the necessary Ferret journal files that will allow TDS to serve the data from our LAS via OPeNDAP (remote data access protocol). The TDS server has been configured for the location of the Wave Energy NetCDF data and temporary files. The data that shared using LAS made available from data sources which can be read via the NetCDF API and are further organized into a THREDDS catalog.

University of Cyprus

Visualizing Wave Energy Potential in the Levantine

- Dataset Selection
- Compare Maps/Plots
- Animations
- Visualize in Google Earth

- Selection based on Latitude and Longitude
- Hovmoller Plots
- Line Plots
- Date Selection
- Apply Analysis (average, minimum, maximum, sum, variance)

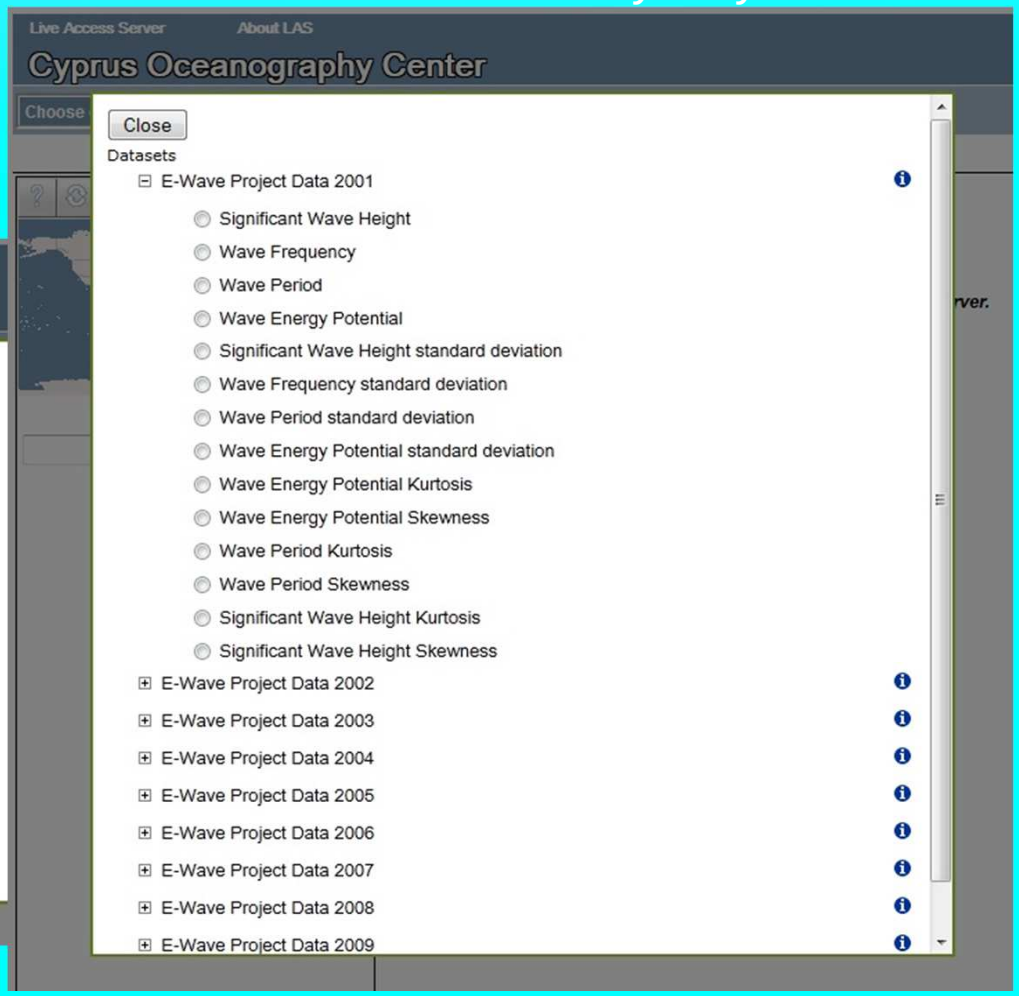


http://www.oceanography.ucy.ac.cy/las

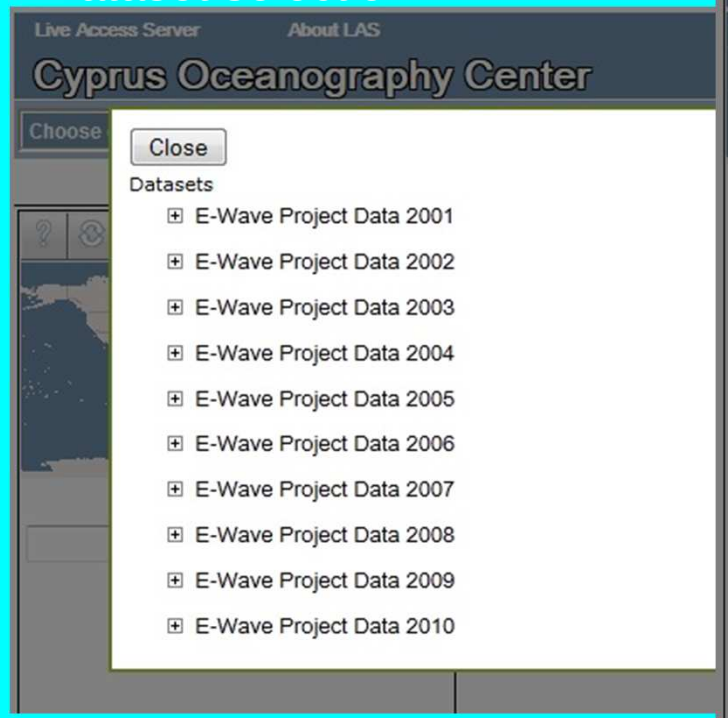
University of Cyprus

Visualizing Wave Energy Potential

Variables in yearly datasets



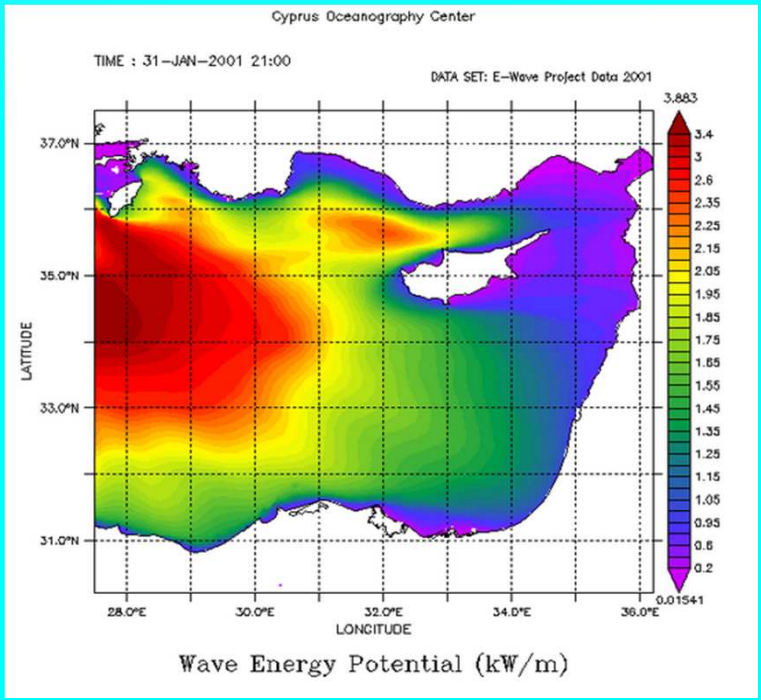
Dataset selection



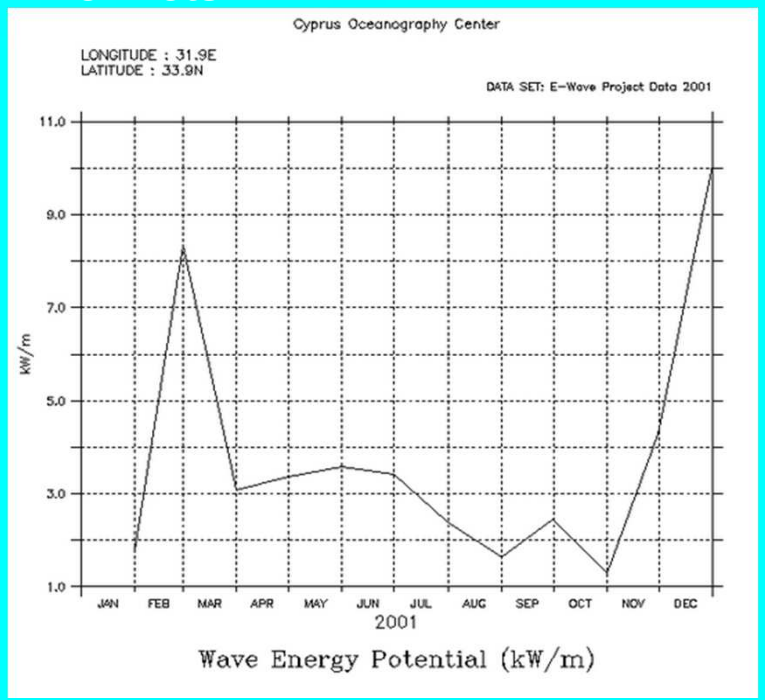
University of Cyprus

Visualizing Wave Energy Potential

Maps



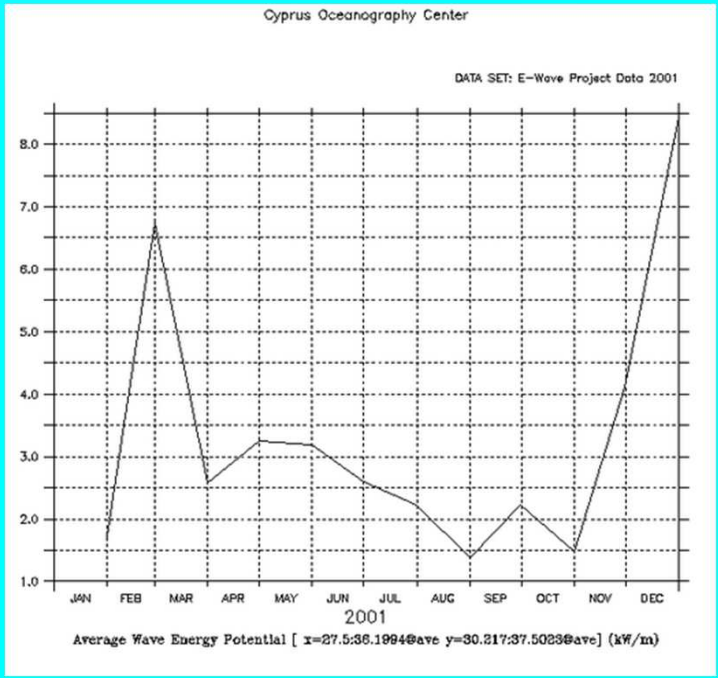
Line Plots



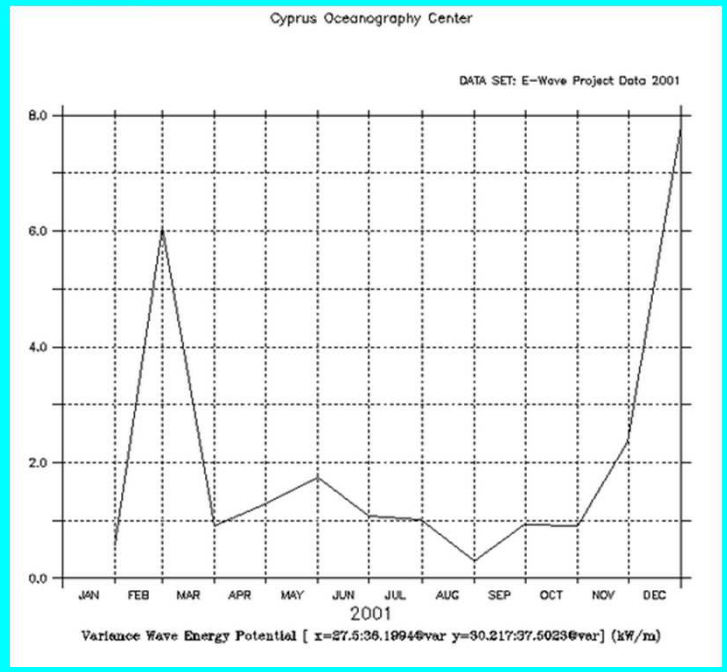
University of Cyprus

Visualizing Wave Energy Potential

on-line analysis

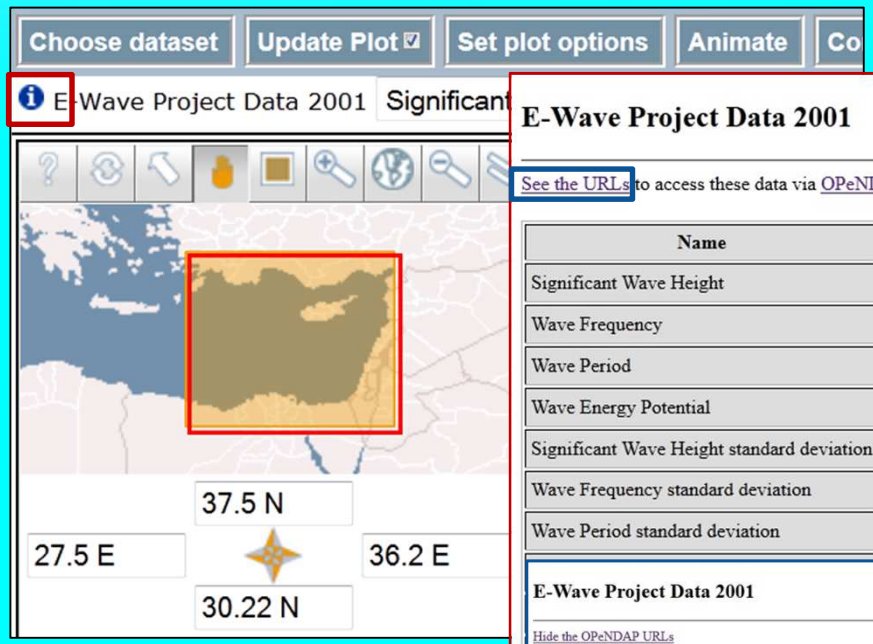


Average Wave Energy Potential (kW/m) for year 2001



Variance Wave Energy Potential (kW/m) for year 2001

Visualizing Wave Energy Potential



Variables Information Page

E-Wave Project Data 2001

See the URLs to access these data via OPeNDAP

Name	x - Range	y - Range	t - Range	Units
Significant Wave Height	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	m
Wave Frequency	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	Hz
Wave Period	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	s
Wave Energy Potential	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	kW/m
Significant Wave Height standard deviation	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	m
Wave Frequency standard deviation	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	Hz
Wave Period standard deviation	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	s
			-31 00:00:00	kW/m
			-31 00:00:00	1
			-31 00:00:00	1
			-31 00:00:00	1
			-31 00:00:00	1
			-31 00:00:00	1
			-31 00:00:00	1

E-Wave Project Data 2001

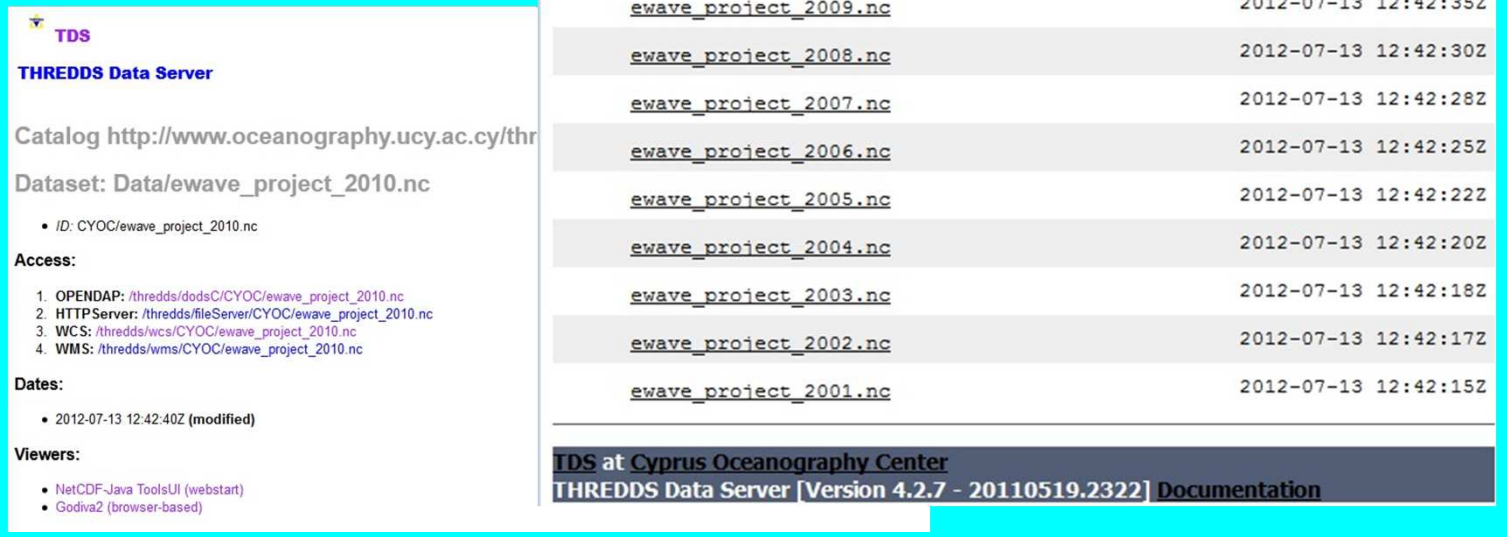
Hide the OPeNDAP URLs

Name	The URL to access these data via OPeNDAP			
	x - Range	y - Range	t - Range	Units
Significant Wave Height	LAS F-TDS URL: http://194.42.21.85/thredds/dodsC/las/id-ff2984b7b4/data_ewave_project_2001.nc.jnl			
	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	m
Wave Frequency	LAS F-TDS URL: http://194.42.21.85/thredds/dodsC/las/id-ff2984b7b4/data_ewave_project_2001.nc.jnl			
	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	Hz
Wave Period	LAS F-TDS URL: http://194.42.21.85/thredds/dodsC/las/id-ff2984b7b4/data_ewave_project_2001.nc.jnl			
	27.5 : 36.2	30.217 : 37.5	2001-01-31 00:00:00 : 2001-12-31 00:00:00	s

University of Cyprus

Visualizing Wave Energy Potential

Distributing Wave Data through THREDDS Data Server.



TDS

THREDDS Data Server

Catalog http://www.oceanography.ucy.ac.cy/thr

Dataset: Data/ewave_project_2010.nc

- *ID:* CYOC/ewave_project_2010.nc

Access:

1. **OPENDAP:** /thredds/dodsC/CYOC/ewave_project_2010.nc
2. **HTTPServer:** /thredds/fileServer/CYOC/ewave_project_2010.nc
3. **WCS:** /thredds/wcs/CYOC/ewave_project_2010.nc
4. **WMS:** /thredds/wms/CYOC/ewave_project_2010.nc

Dates:

- 2012-07-13 12:42:40Z **(modified)**

Viewers:

- NetCDF-Java ToolsUI (webstart)
- Godiva2 (browser-based)

Catalog http://www.oceanography.ucy.ac.cy/thredds/catalog/CYOC/catalog.html

Dataset	Size	Last Modified
Data		--
ewave_project_2010.nc		2012-07-13 12:42:40Z
ewave_project_2009.nc		2012-07-13 12:42:35Z
ewave_project_2008.nc		2012-07-13 12:42:30Z
ewave_project_2007.nc		2012-07-13 12:42:28Z
ewave_project_2006.nc		2012-07-13 12:42:25Z
ewave_project_2005.nc		2012-07-13 12:42:22Z
ewave_project_2004.nc		2012-07-13 12:42:20Z
ewave_project_2003.nc		2012-07-13 12:42:18Z
ewave_project_2002.nc		2012-07-13 12:42:17Z
ewave_project_2001.nc		2012-07-13 12:42:15Z

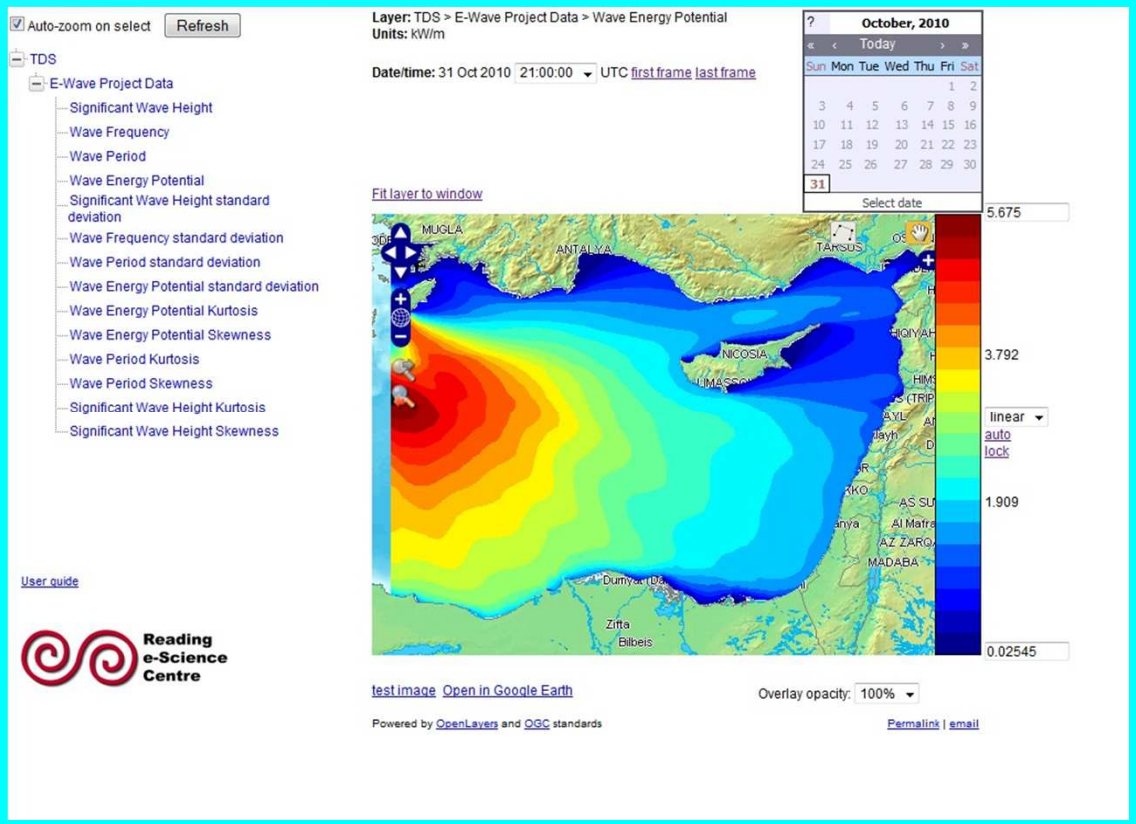
TDS at Cyprus Oceanography Center
THREDDS Data Server [Version 4.2.7 - 20110519.2322] Documentation

University of Cyprus

Visualizing Wave Energy Data

Visualizing data through GODIVA2

A dynamic website that provides visual access to distributed environmental data.



University of Cyprus

Conclusions

Through the Live Access Server the Cyprus Oceanography Centre provides access to the E-wave project database. This database includes information and statistical analysis regarding the energy potential and climatological characteristics of sea waves (such as Significant Wave Height, Wave Frequency, Wave Period, Wave Energy Potential, etc.) for a period of ten years, from 2001 and 2010 in the Eastern Mediterranean.

Users can access freely wave energy potential data individually per month or aggregated over time. The use of the time series function in OC-LAS provides a continuous set of data covering each year. The use of the OC-LAS server enables those interested in the potential of wave energy and the climatology of the waves to quickly visualize, collect subsets and derived products on the fly regarding wave energy data in the Eastern Mediterranean, Levantine Basin.

University of Cyprus

Thank you.