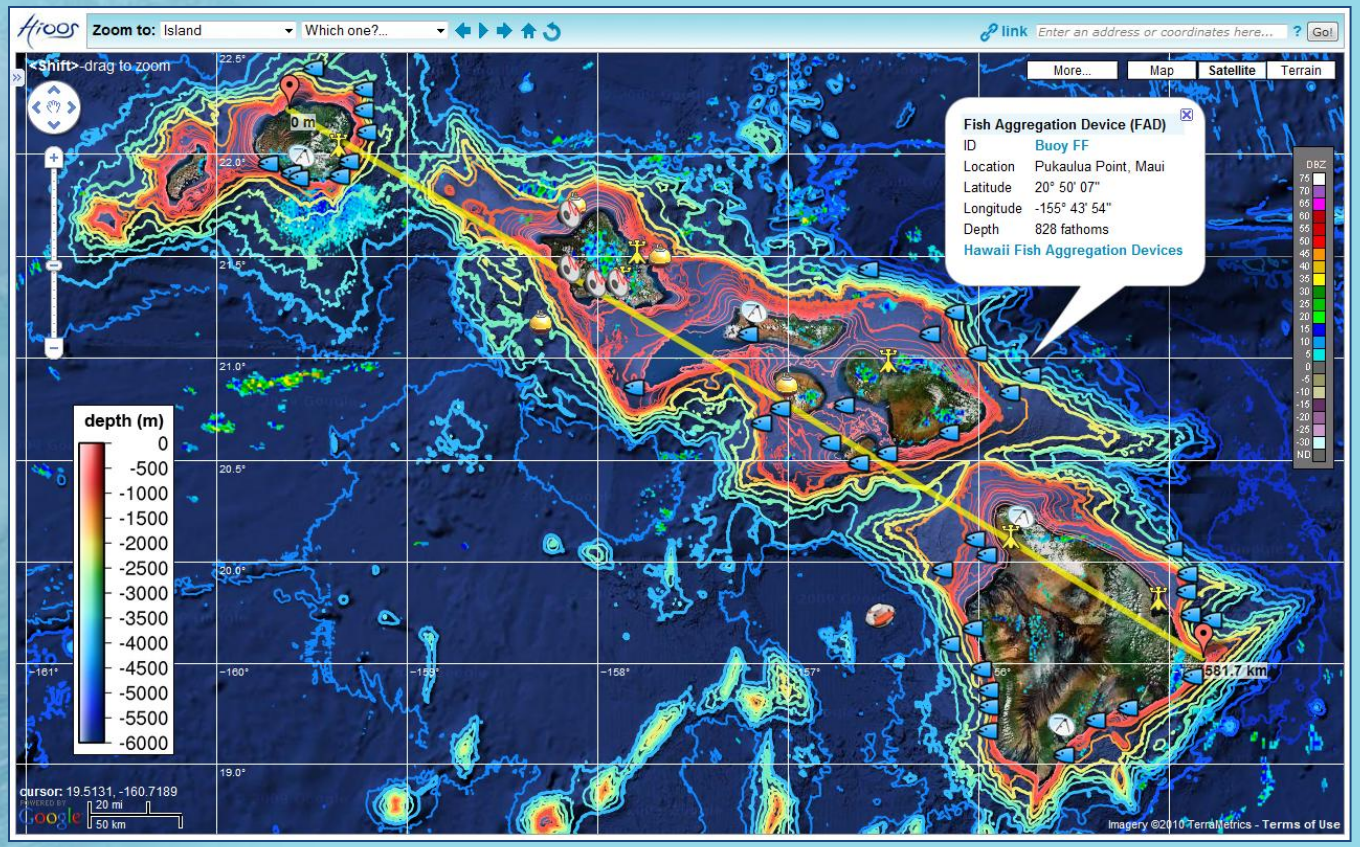
HiOOS Data Management and Communications (DMAC)



John Maurer
Data System Administrator
Hawaii Ocean Observing System (HiOOS.org)
School of Ocean and Earth Science and Technology (SOEST)
University of Hawai'i at Mānoa

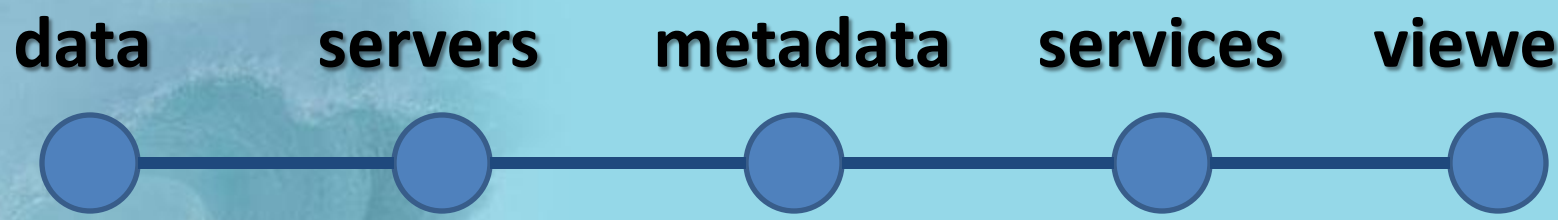
August 2010

john.maurer@hawaii.edu

i ka nānā no a ike • by observing we learn

HiOOS • Hawai'i Ocean Observing System

IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA



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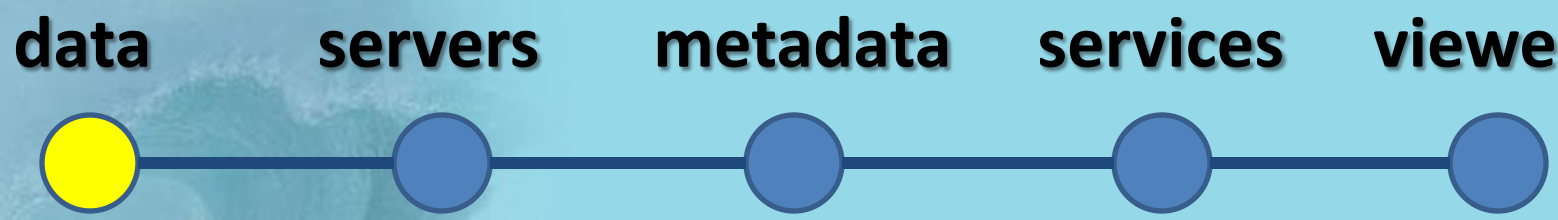

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data servers metadata services viewers

NetCDF: Network Common Data Form

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data servers metadata services viewers

NetCDF: Network Common Data Form

time series:

- nearshore sensors

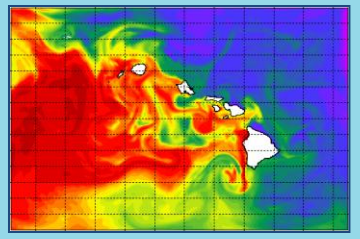
- water quality buoys

- tide gauges

- gliders

- high frequency radios

- forecast models



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data → servers → metadata → services → viewers

NetCDF: Network Common Data Form

time series:

- nearshore sensors
- water quality buoys
- tide gauges
- gliders
- high frequency radios
- forecast models
  - ocean circulation
  - ocean waves
  - atmosphere

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data → servers → metadata → services → viewers

NetCDF: Network Common Data Form

time series:

- nearshore sensors
- water quality buoys
- tide gauges
- gliders
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- forecast models

- **ROMS:** Regional Ocean Modeling System → ocean circulation
- **SWAN:** Simulating WAves Nearshore
- **NWW3:** NOAA/NCEP WaveWatch III → ocean waves
- **WRF:** Weather Research and Forecasting
- **GFS:** NOAA/NCEP Global Forecast System → atmosphere

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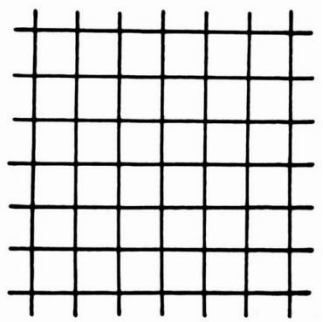
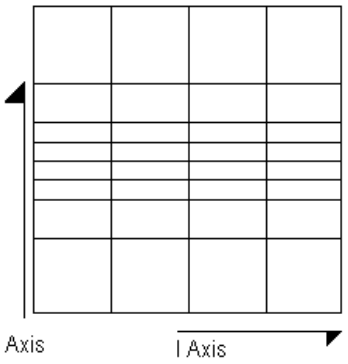
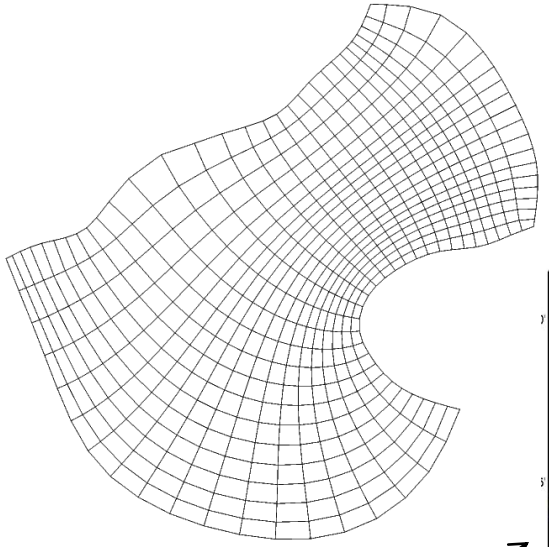
Structured grids:

Regular grids:

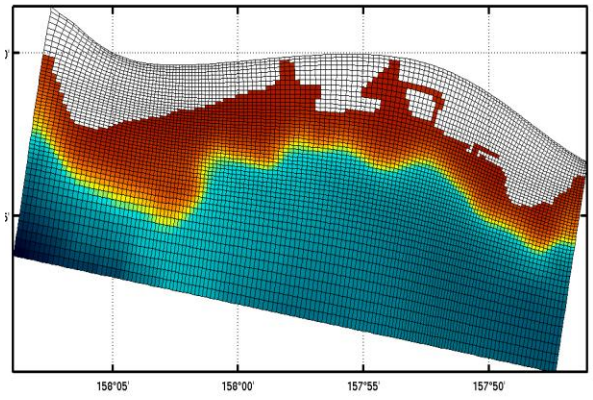




Cartesian grid **Rectilinear grid**

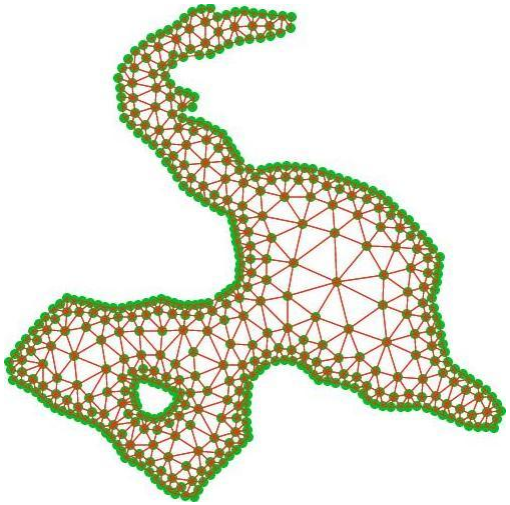


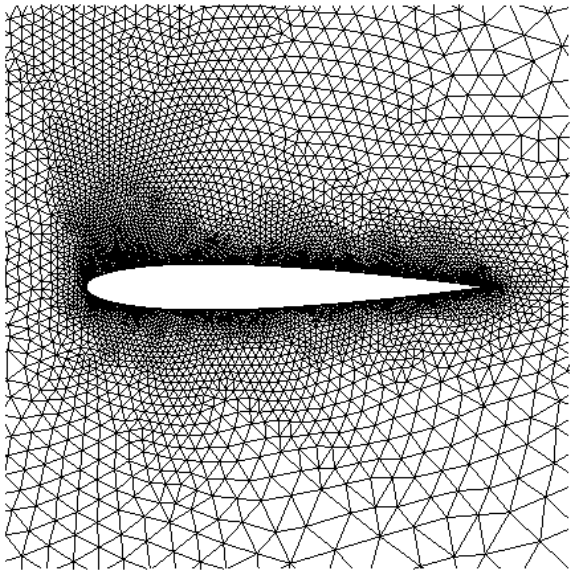
Irregular grids: Curvilinear grid

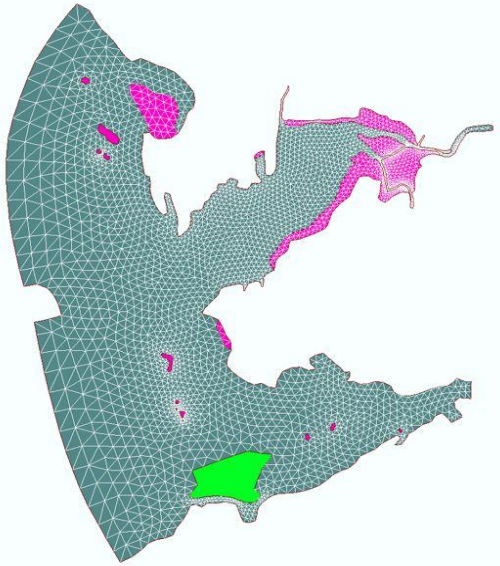


ROMS hiomsg

Unstructured grids:





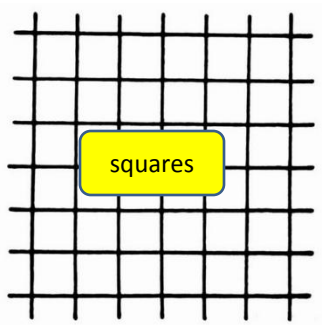


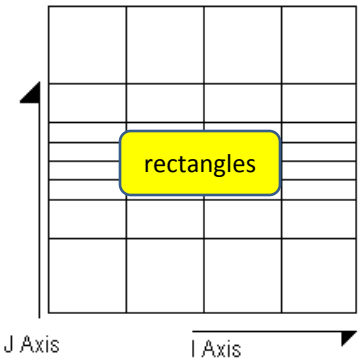
Structured grids:

i & j are integer array indices ("index space")
x & y are floating point lat/lon coordinates ("coordinate space")

map to

Regular grids:

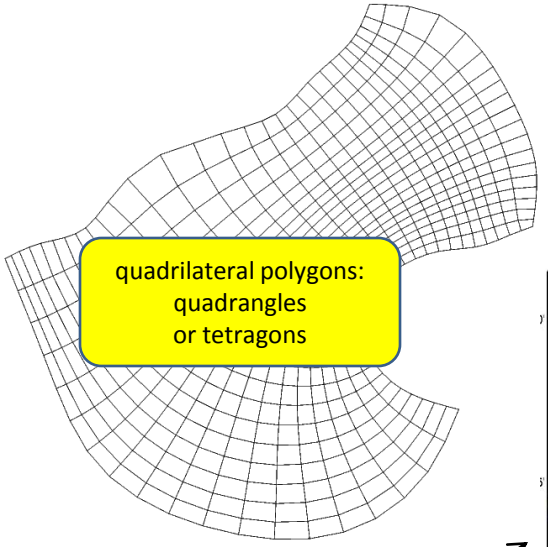




Cartesian grid **Rectilinear grid**

x = i
y = j
linear, unvarying

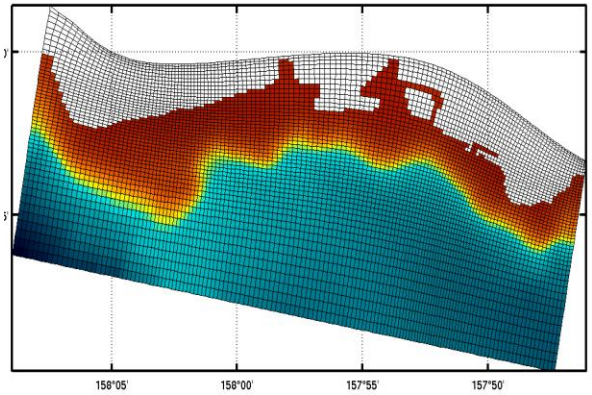
x = i * transform function
y = j * transform function
linear, but varying in *one* dimension



linear, but varying in *two* dimensions

Irregular grids: Curvilinear grid

x = (i * transform) + (j * transform)
y = (i * transform) + (j * transform)

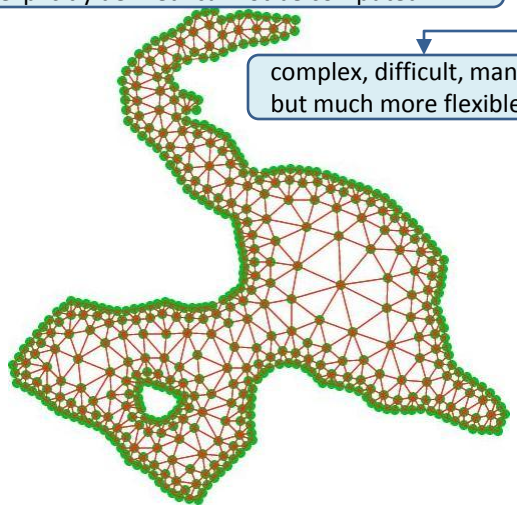


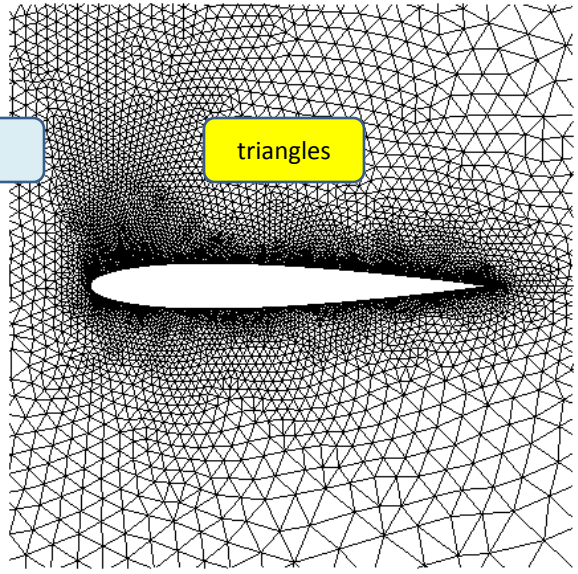
ROMS hiomsg

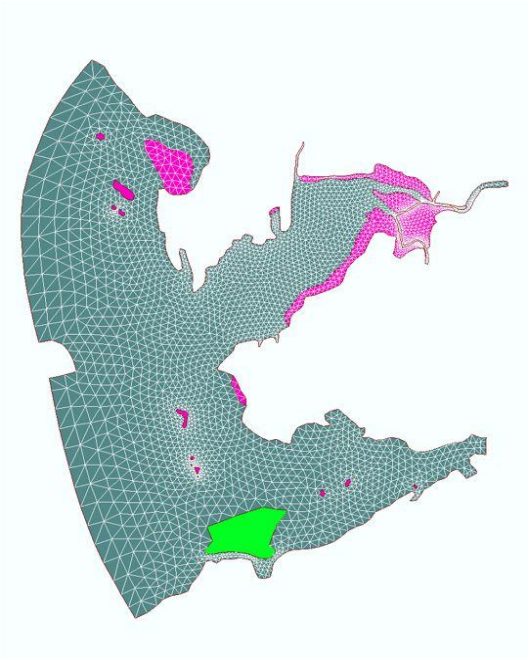
Unstructured grids:

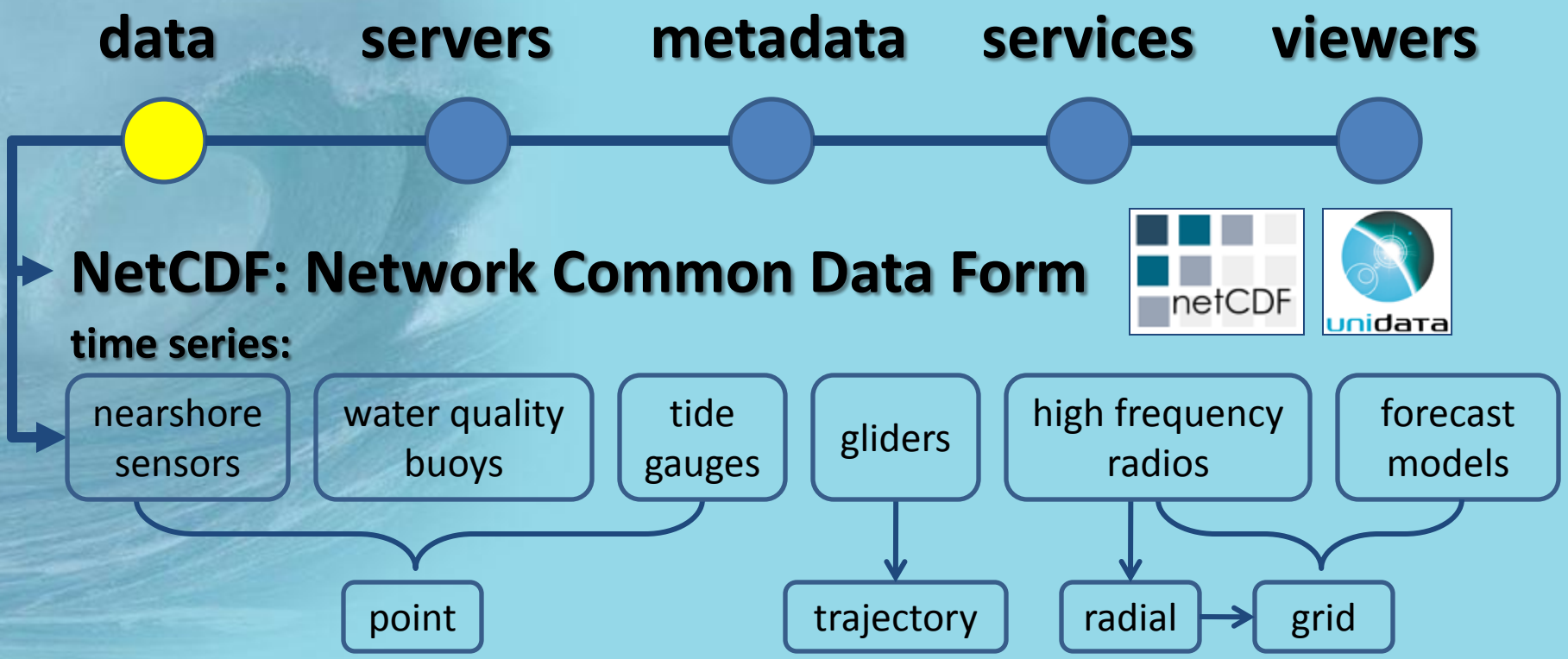
connection between points must be explicitly defined: cannot be computed

complex, difficult, manual, but much more flexible









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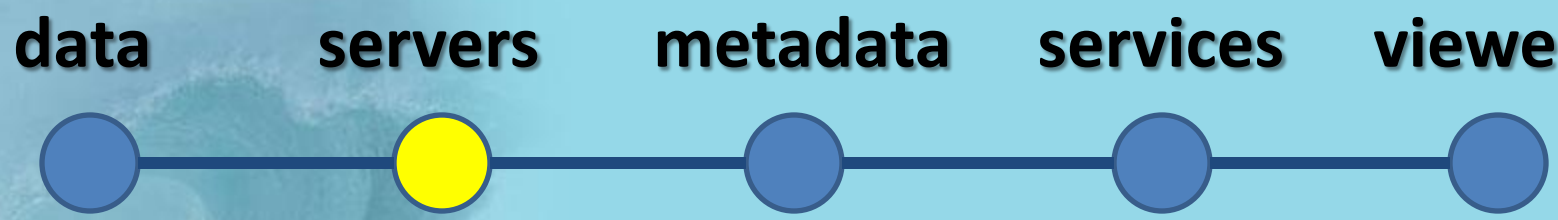

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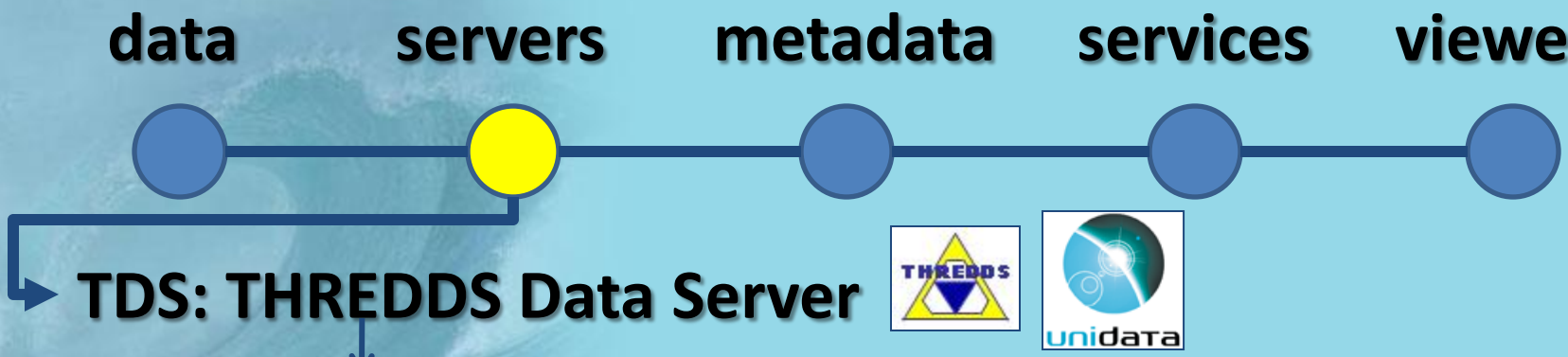

TDS: THREDDS Data Server

Thematic Realtime Environmental Distributed Data Services

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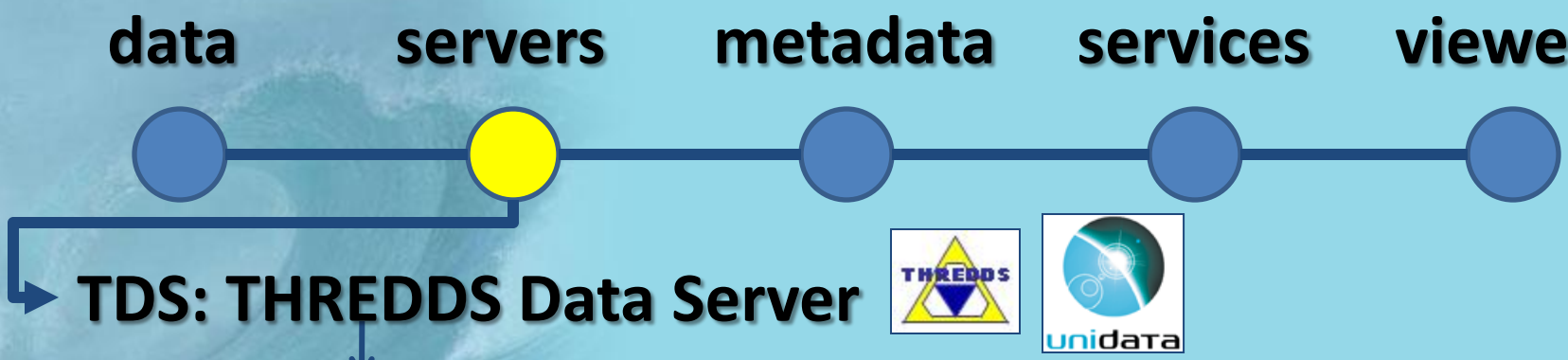

TDS: THREDDS Data Server

Thematic Realtime Environmental Distributed Data Services

- data catalog: organize and present your NetCDF data in one place
- virtual aggregations: more than a simple file server
- modifications to data/metadata via NetCDF Markup Language (NcML)

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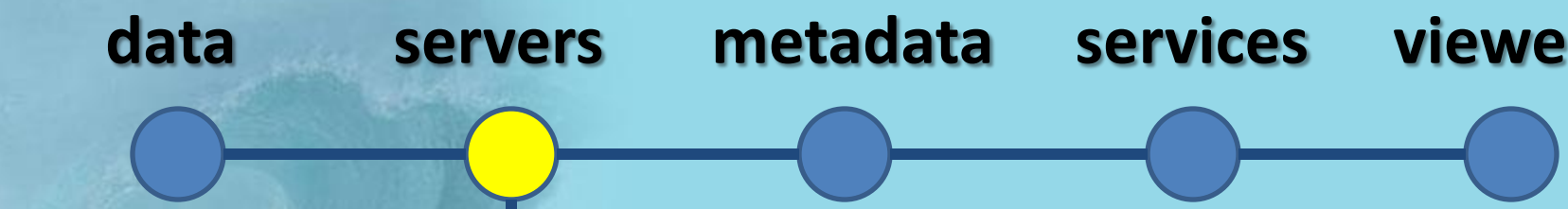

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Dapper

- used for DChart and ERDDAP viewers
- specifically for NetCDF point data

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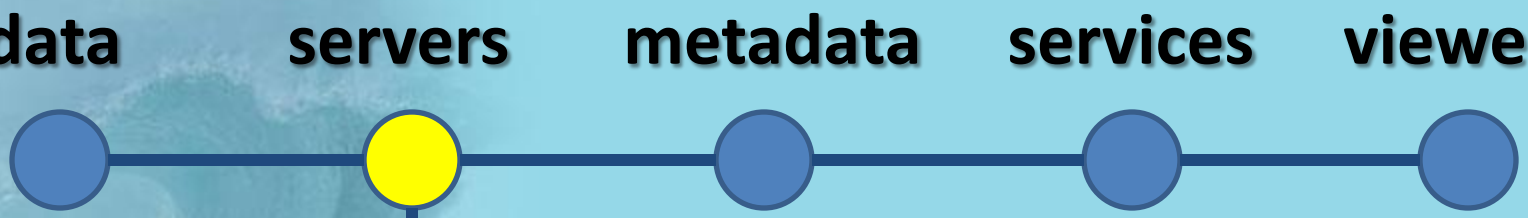

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OOS Tethys

Ocean Observing System + (Greek sea goddess)

- Sensor Observation Service (SOS)
- specifically for NetCDF point data

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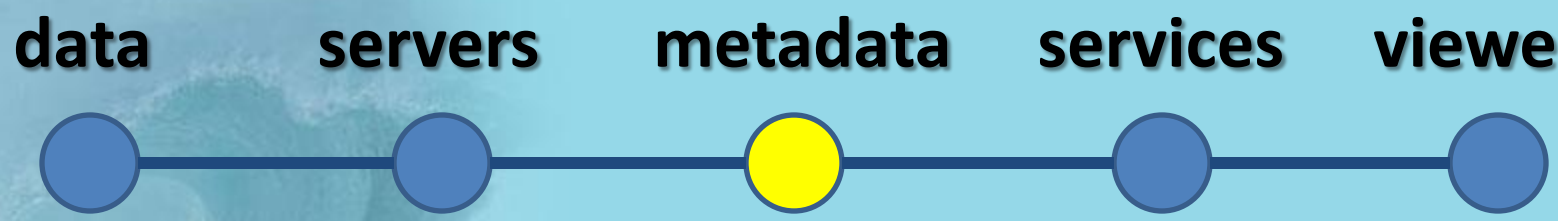

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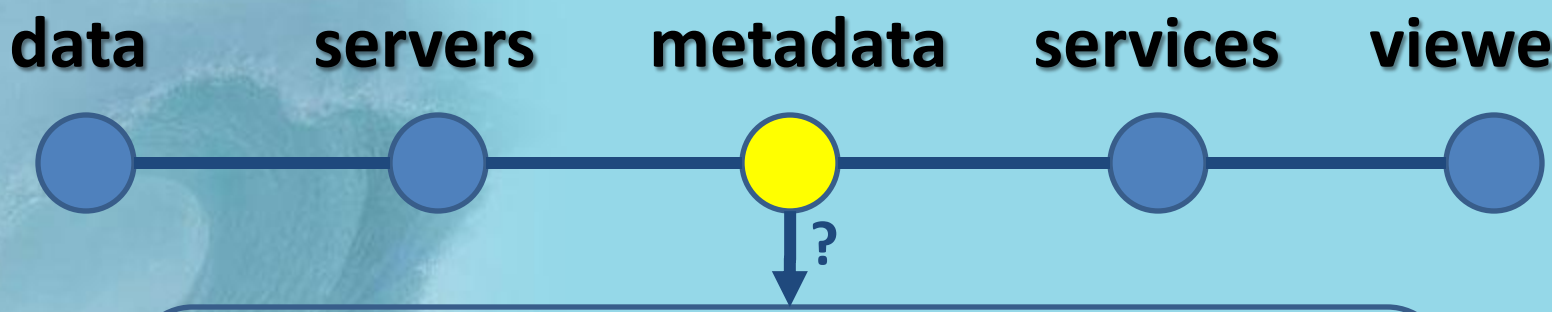

- descriptive information: who, what, when, where, why, how
- standardized vocabularies
- machine-readable format (XML)
- enable community-wide search and discovery

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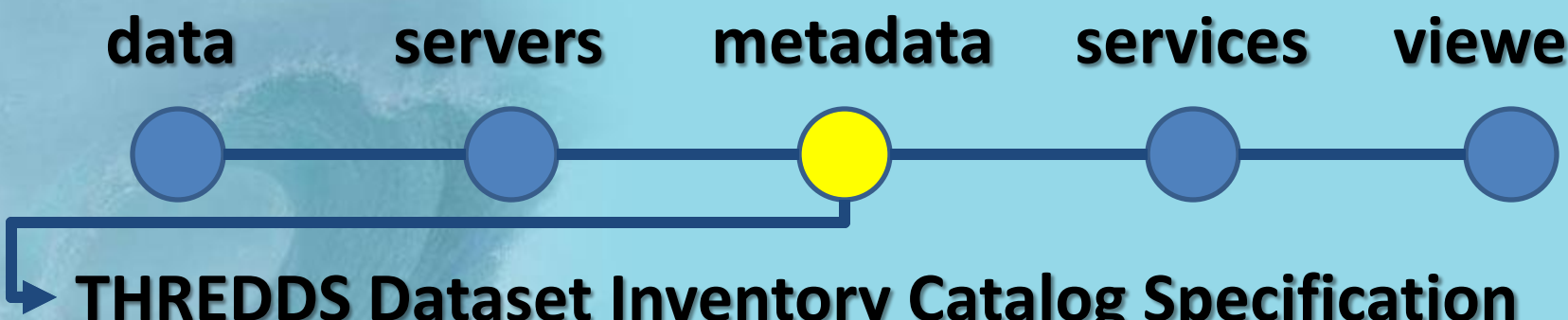

THREDDS Dataset Inventory Catalog Specification

- presents metadata on TDS catalog page

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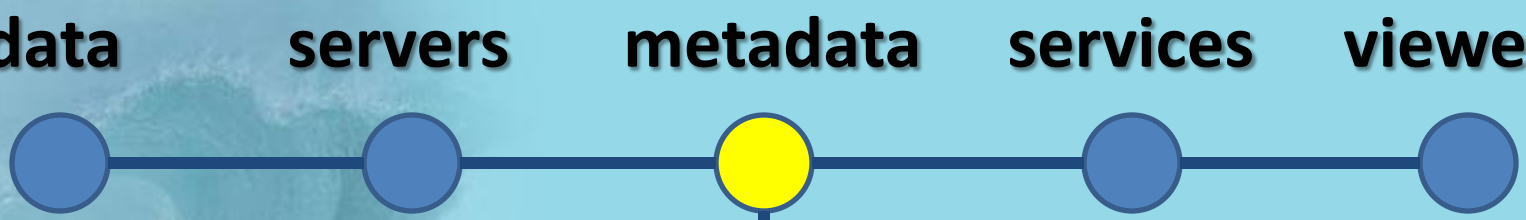
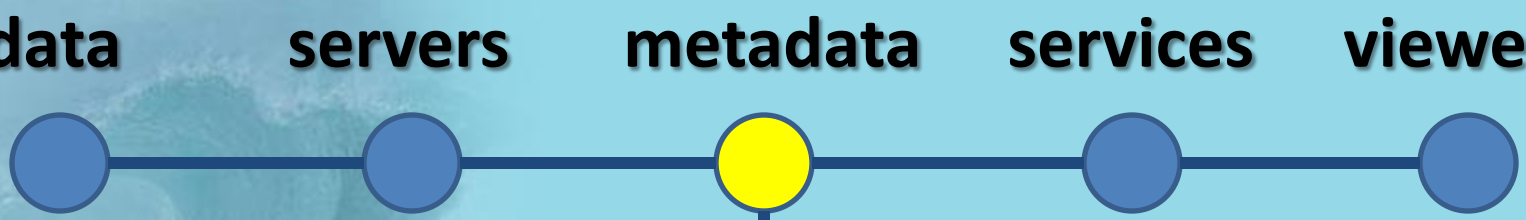


THREDDS Dataset Inventory Catalog Specification

- presents metadata on TDS catalog page

CF: NetCDF Climate and Forecast Metadata Convention

- global attributes + standard variable names + standard data organization + etc.



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NetCDF Attribute Convention for Dataset Discovery

- global attribute fields

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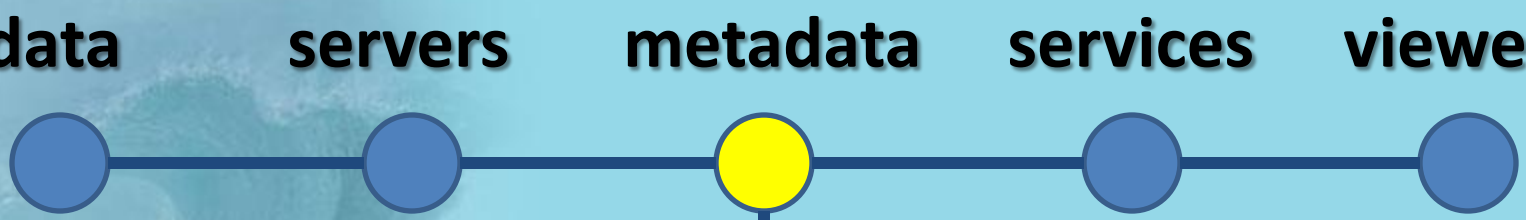

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NetCDF Attribute Convention for Dataset Discovery

- global attribute fields

ISO 19115-2: Geographic Information – Metadata

- international standard; will be auto-generated from the above standards

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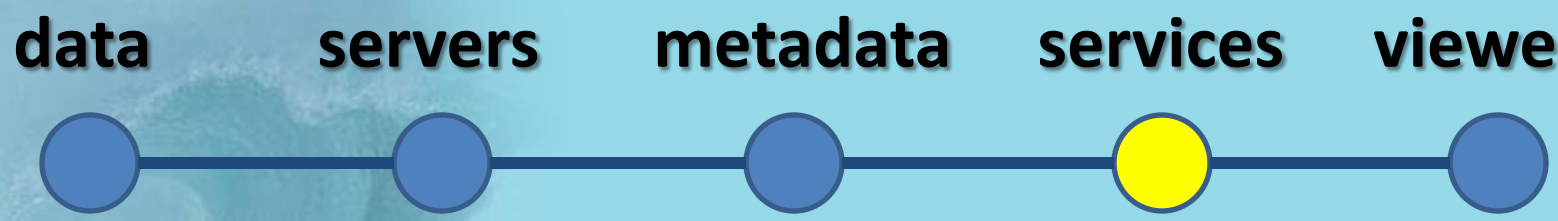

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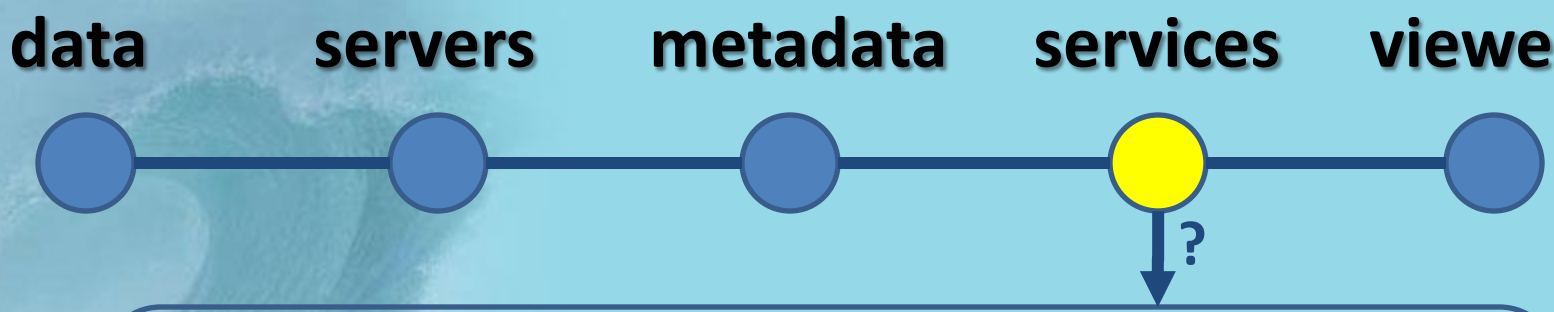

- standard protocols for accessing data over HTTP
- data accessed via URL; customize result via parameter values:
  REST = Representational State Transfer
- import data directly into user's software client (Matlab, ArcGIS, etc.)
- enable community-wide data interoperability

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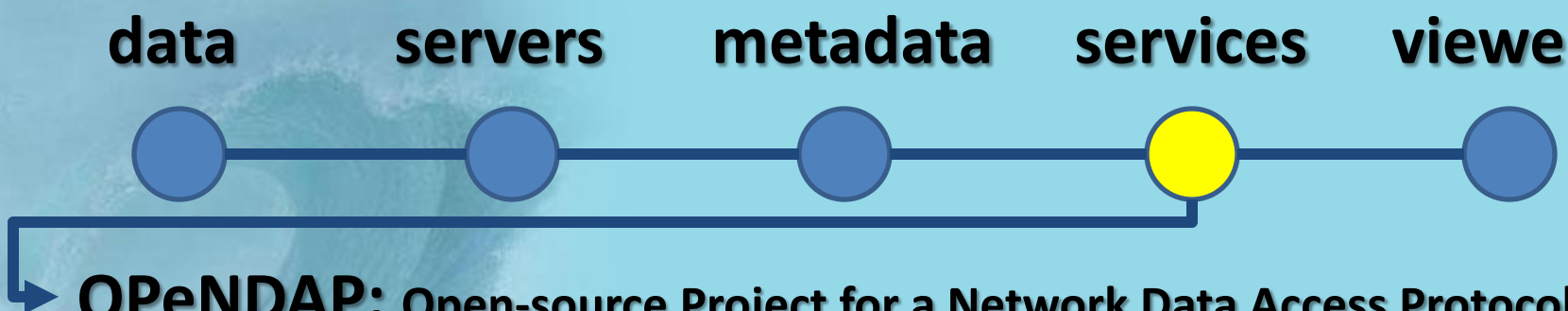

OPeNDAP: Open-source Project for a Network Data Access Protocol

- subset data via index ranges (e.g. [start:stride:stop], [0:5:50]); get ASCII or binary

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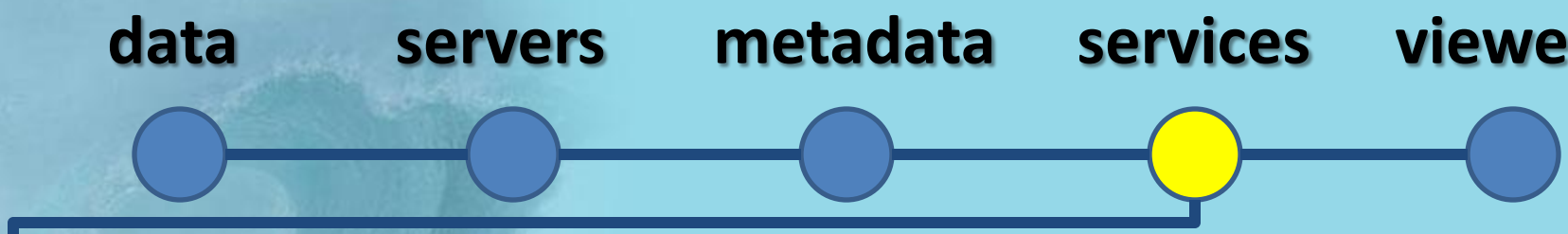

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NetCDF Subset Service

- subset gridded data via lat/lon, time, and/or depth; get ASCII, XML, or NetCDF

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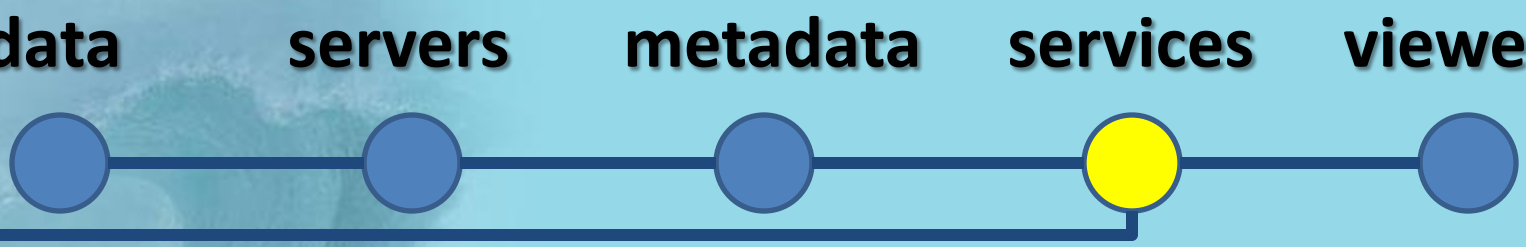

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WMS: Web Map Service

- for gridded data, get image (JPG, PNG, GIF, KMZ); specify projection, space, time, etc.

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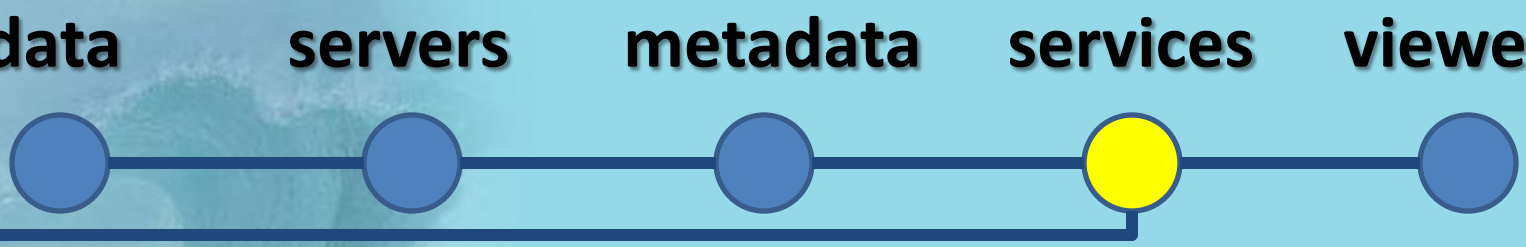

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WCS: Web Coverage Service

- for gridded data, get GeoTIFF; specify projection, space, time, resolution, etc.

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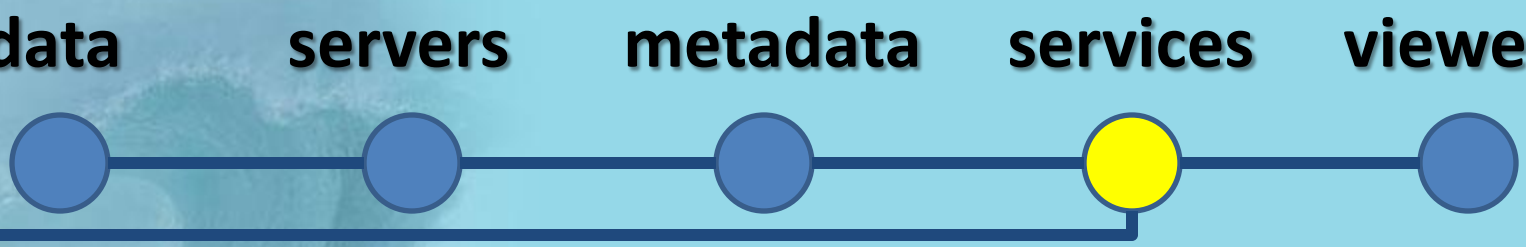

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- for gridded data, get GeoTIFF; specify projection, space, time, resolution, etc.

SOS: Sensor Observation Service

- for point data, get XML (O&M); specify space, time, etc.

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data servers metadata services viewers

OPeNDAP: Open-source Project for a Network Data Access Protocol

NetCDF Subset Service

WMS: Web Map Service

WCS: Web Coverage Service

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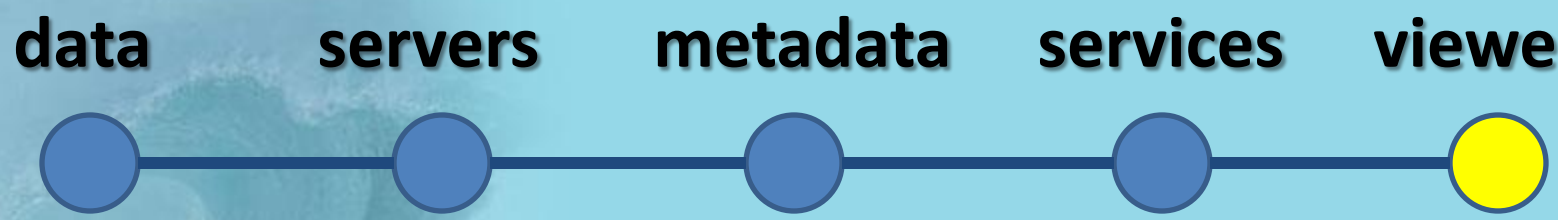

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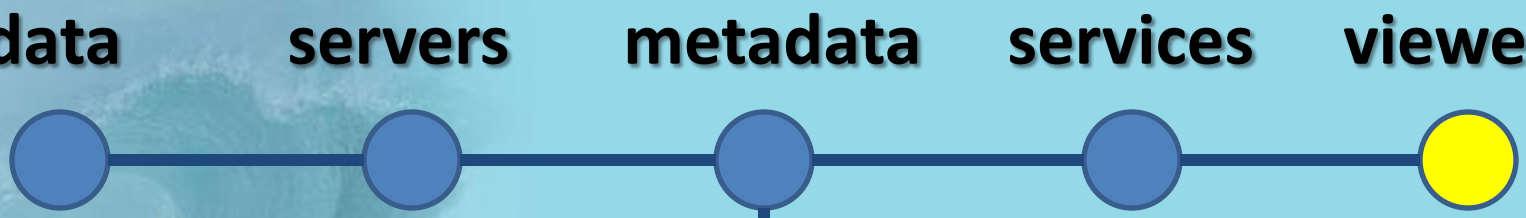

LAS: Live Access Server

- view gridded data: produce maps and plots; animate, compare, Google Earth, download

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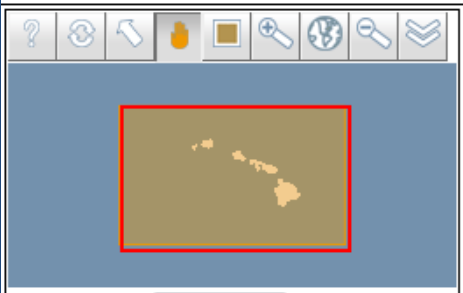
Hawaii Ocean Observing System (HiOOS)



23.98 N
163.83 W 152.52 W
17.02 N

MAPS
- (•) Latitude-Longitude

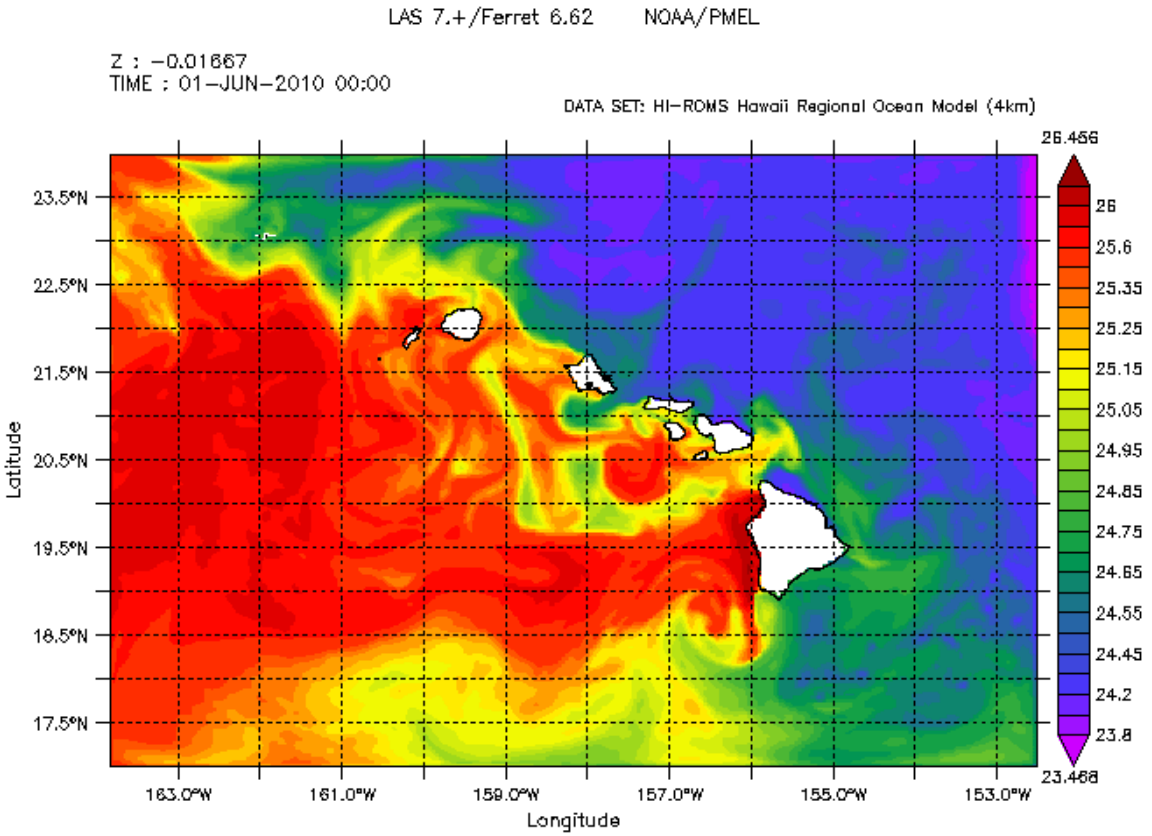
LINE PLOTS
- ( ) Time series
- ( ) Depth
- ( ) Longitude
- ( ) Latitude

VERTICAL SECTION PLOTS
- ( ) Longitude-depth
- ( ) Latitude-depth

HOFMULLER PLOTS
- ( ) Longitude-time
- ( ) Latitude-time
- ( ) Depth-time

Date : Jun 01 2010 00:00

Depth (sigma coordinate) : -0.0167



potential temperature (Celsius) Native Curvilinear Plot

Difference Mode

Z (sigma coordinate): -0.0167

Select Axis to Vary in Panels

Start date/Time: 2010 Jun 01 00:00

Auto Set Color Fill Levels for Gallery

Image zoom: Auto

Gallery Settings

Apply

Data Set | Plot Options

23.98 N

163.83 W | 152.52 W

17.02 N

Maps

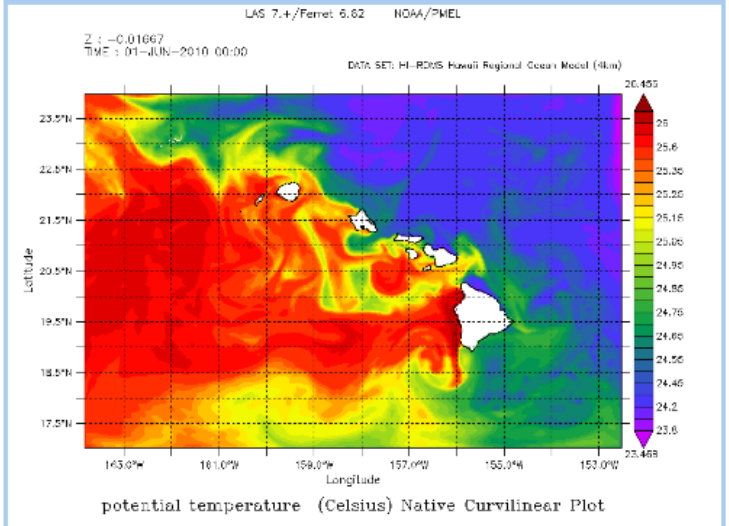
Latitude-Longitude

Line Plots

Vertical Section Plots

Hofmuller Plots

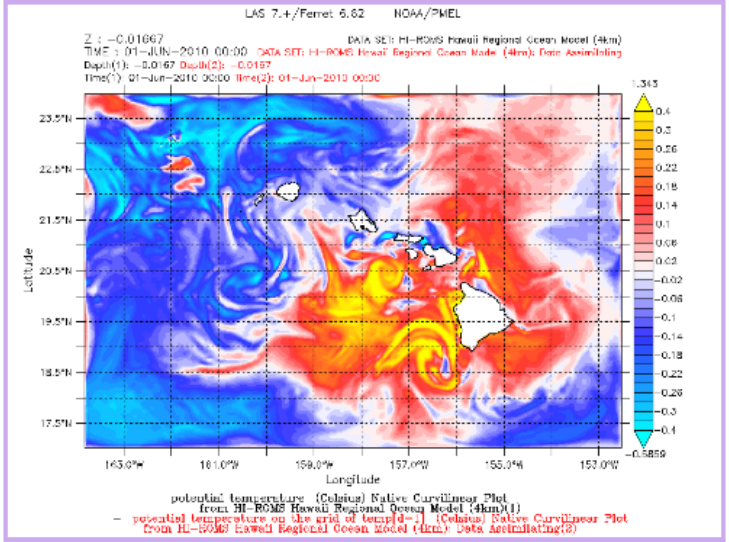
HI-ROMS Hawaii Regional Ocean Model (4km): potential temperature (See left)



Start date/Time: 2010 Jun 01 00:00

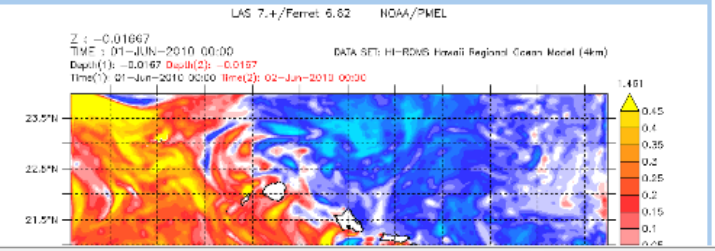
HI-ROMS Hawaii Regional Ocean Model (4km): Data Assimilating: potential temperature

Settings | Revert

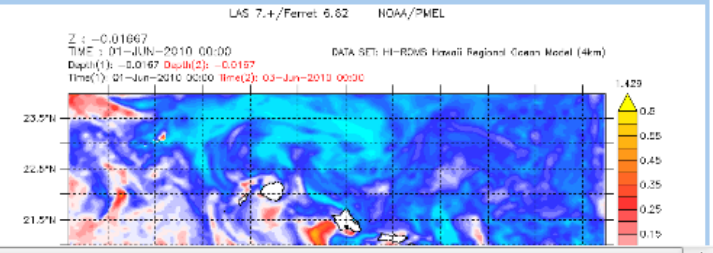


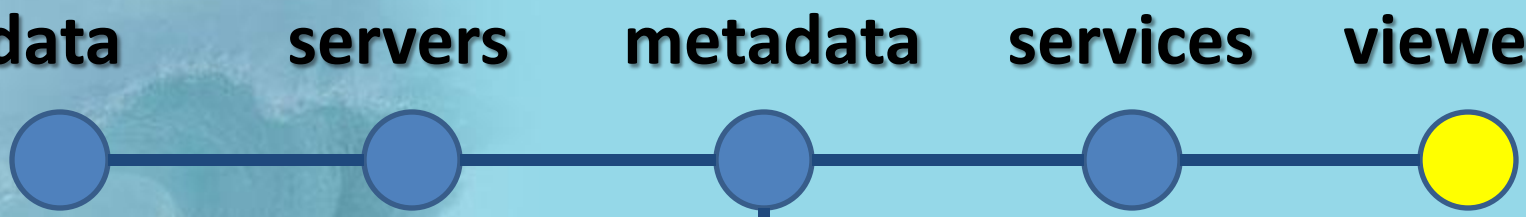
Start date/Time: 2010 Jun 01 00:00 Z (sigma coordinate): -0.0167

HI-ROMS Hawaii Regional Ocean Model (4km): potential temperature Settings



HI-ROMS Hawaii Regional Ocean Model (4km): potential temperature Settings





LAS: Live Access Server

- view gridded data: produce maps and plots; animate, compare, Google Earth, download

DChart: Dapper Chart

- view point or gridded data: dynamic plots or maps; download; Google Maps/Earth

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HiOOS DChart

Data discovery for the **Hawaii Ocean Observing System (HiOOS)**

Plot Selected | Link to this page

Center map at location:

Click to select one station or drag to select multiple stations | Help | Hide map

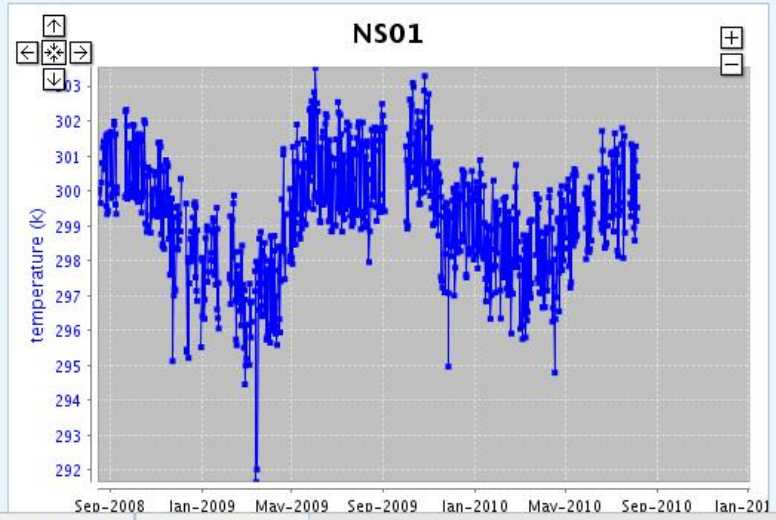
Server request timed out

Datasets (Search)

Category	Dataset
ARGO	Argo profiling floats
Nearshore Sensors	Aggregate
Nearshore Sensors	NS01
Nearshore Sensors	NS02
Nearshore Sensors	NS03
Nearshore Sensors	NS04
Tide Gauges	daily data
Tide Gauges	hourly data
Tide Gauges	monthly data
Water Quality Buoy	WQB AW

Variables (Search)

- chlorophyll
- conductivity
- salinity
- temperature
- turbidity



Plot type

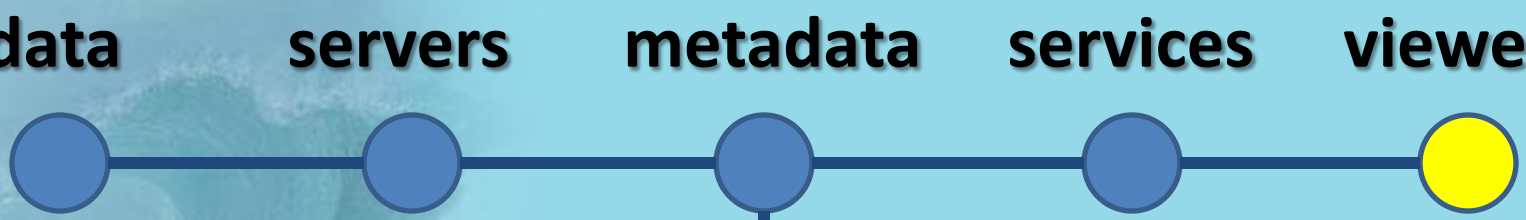
- Time series plot
- Time series bar plot
- Property/Property plot
- Export data
- Export to Google Earth
- Export to Google Maps

Station filter

Lon	-157.85	-157.84
Lat	21.28	21.29
Z	-1.01	-0.99
Time	15 Aug 2008 00:00:00	02 Jan 2011 00:00:00

Reset | Apply

Plot selected | Link to this page



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- view point or gridded data: dynamic plots or maps; download; Google Maps/Earth

ERDDAP: Environmental Research Division's Data Access Program

- view/download gridded data or download point data; get table; embed elsewhere

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ERDDAP Easier access to scientific data — Brought to you by NOAA NMFS SFSC ERD

ERDDAP > griddap > Make a Graph

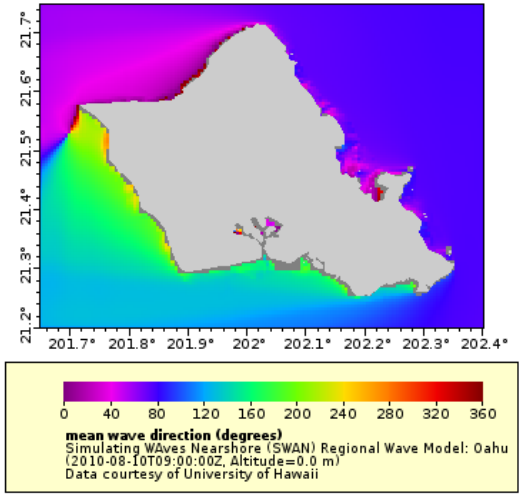
Dataset Title: **Simulating WAves Nearshore (SWAN) Regional Wave Model: Oahu**
Dataset ID: SWAN_Oahu_Best RSS
Institution: University of Hawaii
Information: Summary | Variables | Background | Data Access Form

Graph Type: surface
X Axis: longitude
Y Axis: latitude
Color: mdir

Dimension Ranges	Start	Stop
time (UTC)	specify just 1 value →	2010-08-10T09:00:00Z
altitude (m)	specify just 1 value →	0.0
latitude (degrees_north)	21.2	21.75
longitude (degrees_east)	201.65	202.4

Graph Settings
Color Bar: Continuity: Scale:
Min: Max: N Sections:
Draw the land mask: over the data

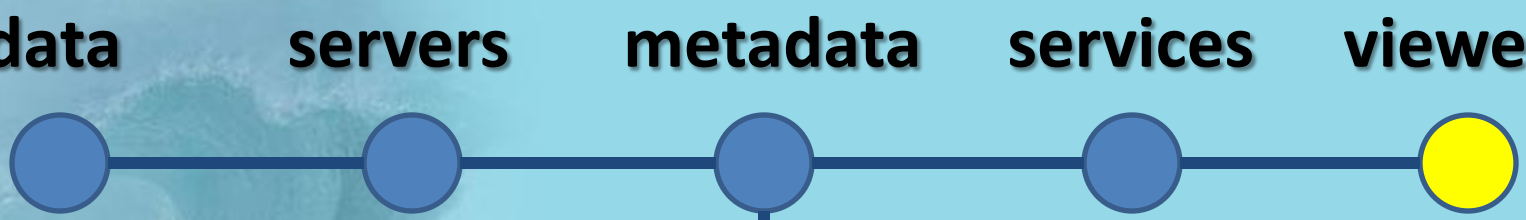
Redraw the Graph
Then set the File Type: .htmlTable and Download the Data or an Image
or view the URL: http://oos.soest.hawaii.edu/erddap/griddap/SWAN_Oahu_E



Things You Can Do With Your Graphs

- Web page authors can embed a graph of the latest data in a web page using HTML <img> tags.
- Anyone can use Slide Sorter to build a personal web page that displays graphs of the latest data, each in its own, draggable slide.
- Anyone can use or make Google Gadgets to display images with the latest data on their iGoogle home page.

The Dataset Attribute Structure (.das) for this Dataset



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Google Maps API and Google Earth

- HiOOS Data Viewer: one application for viewing all our data, plus others (in progress)

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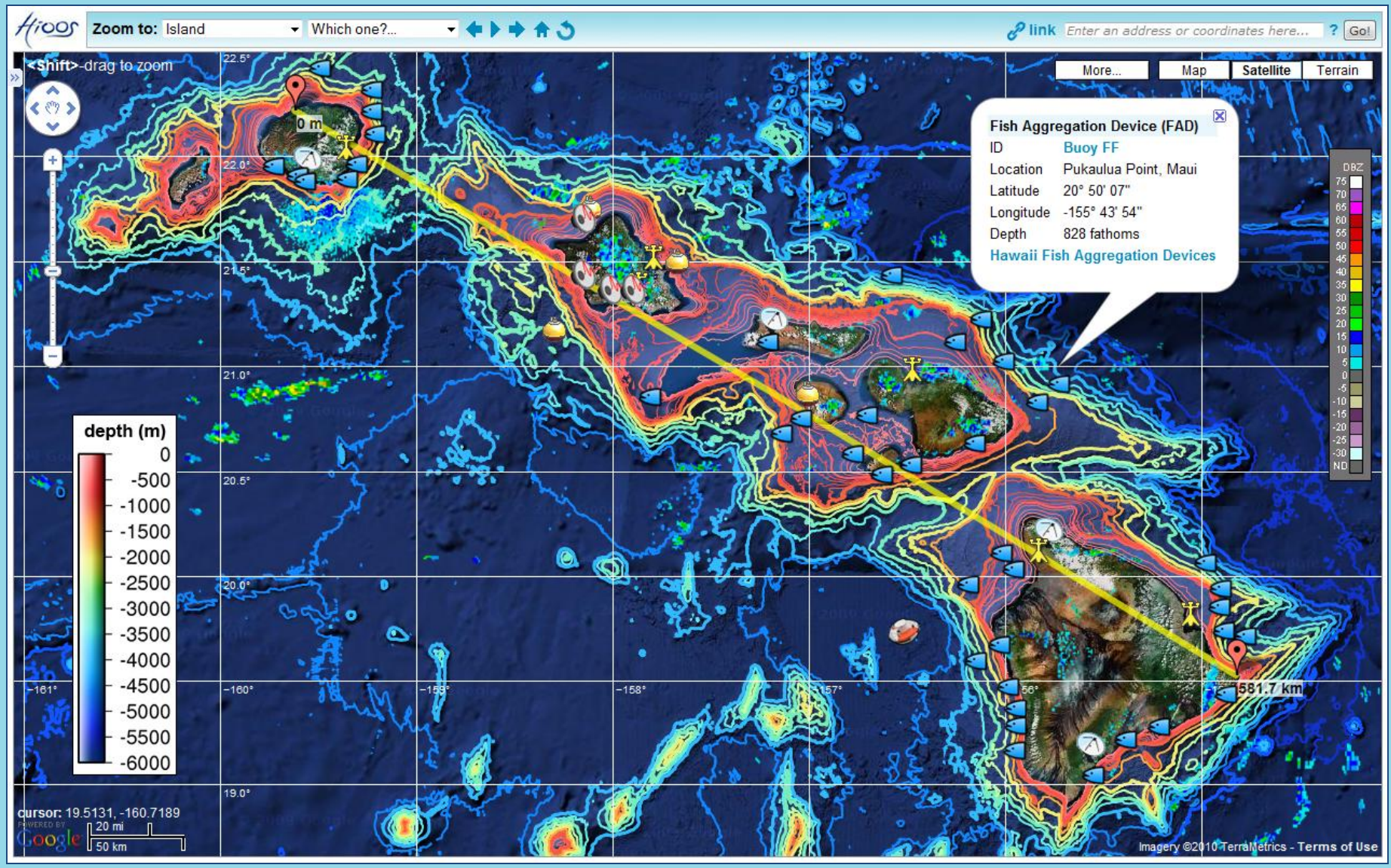
Zoom to: Island
Which one?...
link
Enter an address or coordinates here...
Go!
<Shift>-drag to zoom
More...
Map
Satellite
Terrain
0 m
Fish Aggregation Device (FAD)
ID Buoy FF
Location Pukaulua Point, Maui
Latitude 20° 50' 07"
Longitude -155° 43' 54"
Depth 828 fathoms
Hawaii Fish Aggregation Devices
DBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
ND
depth (m)
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
-5500
-6000
22.5°
22.0°
21.5°
21.0°
20.5°
20.0°
19.0°
-161°
-160°
-159°
-158°
-157°
581.7 km
cursor: 19.5131, -160.7189
20 mi
50 km
Imagery ©2010 TerraMetrics - Terms of Use

future directions

- Google Maps API Version 3
- add HFR and models to HiOOS Data Viewer *(+ lots others…)*
- add data plots to info pop-ups in HiOOS Data Viewer
- next LAS version will allow vector plots
- explore ncWMS and Godiva2
- webapp to monitor system health: data + servers + services
- finish adding metadata in TDS
- mobile devices?

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? or !

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School of Ocean and Earth Science and Technology (SOEST)
University of Hawai'i at Mānoa

Forecast Model Run Collection (FMRC)

1. **run time** = start of the model run (i.e. when it was kicked off) (a.k.a. **analysis time** or **generating time**)
2. **forecast time** = the time series that the model produces; can be a forecast, nowcast, or hindcast (a.k.a. **valid time**)
3. **forecast offset** or **forecast hour** = difference between run time and forecast time

---

2D Time Coordinates:

The forecast times vary for each run time, so an FMRC by definition has 2D time coordinates:

String **runtime(run=8)**;
:long_name = "Run time for model";
:standard_name = "forecast_reference_time";
:_CoordinateAxisType = "RunTime"; data: "2006-09-05T12:00:00Z", "2006-09-06T12:00:00Z", "2006-09-07T12:00:00Z", "2006-09-08T12:00:00Z", "2006-09-09T12:00:00Z", "2006-09-10T12:00:00Z", "2006-09-11T12:00:00Z", "2006-09-12T12:00:00Z"

runtime derived by TDS from filename in fmrc **scan** element

double **time(run=8, time=16)**;
:units = "hours since 2006-09-05T12:00:00Z";
:long_name = "forecast (valid) time";
:standard_name = "time";
:_CoordinateAxisType = "Time"; data: {90.0, 96.0, 102.0, 108.0, 114.0, 120.0, 126.0, 132.0, 138.0, 144.0, 150.0, 156.0, 162.0, 168.0, 174.0, 180.0}, {114.0, 120.0, 126.0, 132.0, 138.0, 144.0, 150.0, 156.0, 162.0, 168.0, 174.0, 180.0, 186.0, 192.0, 198.0, 204.0}, {138.0, 144.0, 150.0, 156.0, 162.0, 168.0, 174.0, 180.0, 186.0, 192.0, 198.0, 204.0, 210.0, 216.0, 222.0, 228.0}, {162.0, 168.0, 174.0, 180.0, 186.0, 192.0, 198.0, 204.0, 210.0, 216.0, 222.0, 228.0, 234.0, 240.0, 246.0, 252.0}, {186.0, 192.0, 198.0, 204.0, 210.0, 216.0, 222.0, 228.0, 234.0, 240.0, 246.0, 252.0, 258.0, 264.0, 270.0, 276.0}, {210.0, 216.0, 222.0, 228.0, 234.0, 240.0, 246.0, 252.0, 258.0, 264.0, 270.0, 276.0, 282.0, 288.0, 294.0, 300.0}, {234.0, 240.0, 246.0, 252.0, 258.0, 264.0, 270.0, 276.0, 282.0, 288.0, 294.0, 300.0, 306.0, 312.0, 318.0, 324.0}, {258.0, 264.0, 270.0, 276.0, 282.0, 288.0, 294.0, 300.0, 306.0, 312.0, 318.0, 324.0, 330.0, 336.0, 342.0, 348.0}

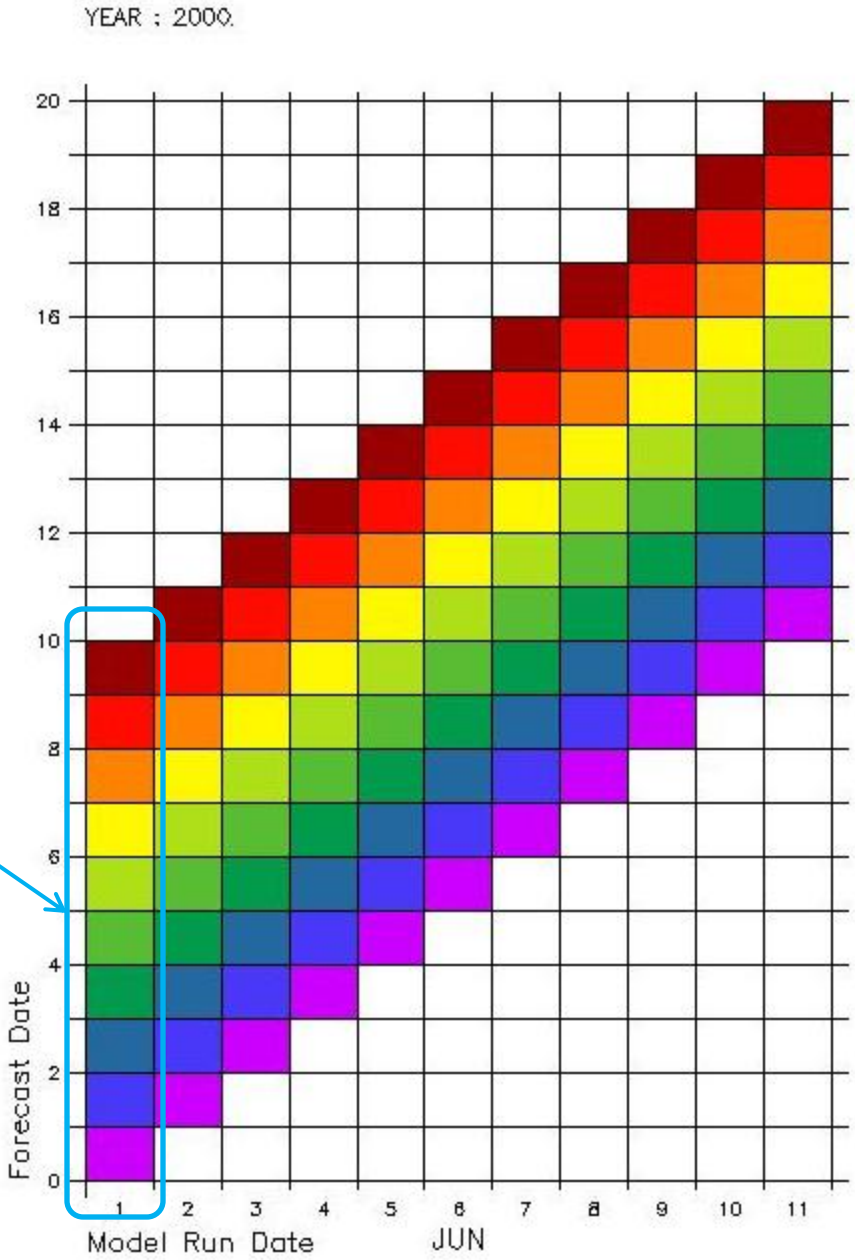
Each data variable will have both run time and forecast time dimensions: e.g. float temp(run,time,depth,lat,lon);

1D Time Coordinates:

TDS can be used to create different views/slices of an FMRC on a single time axis:

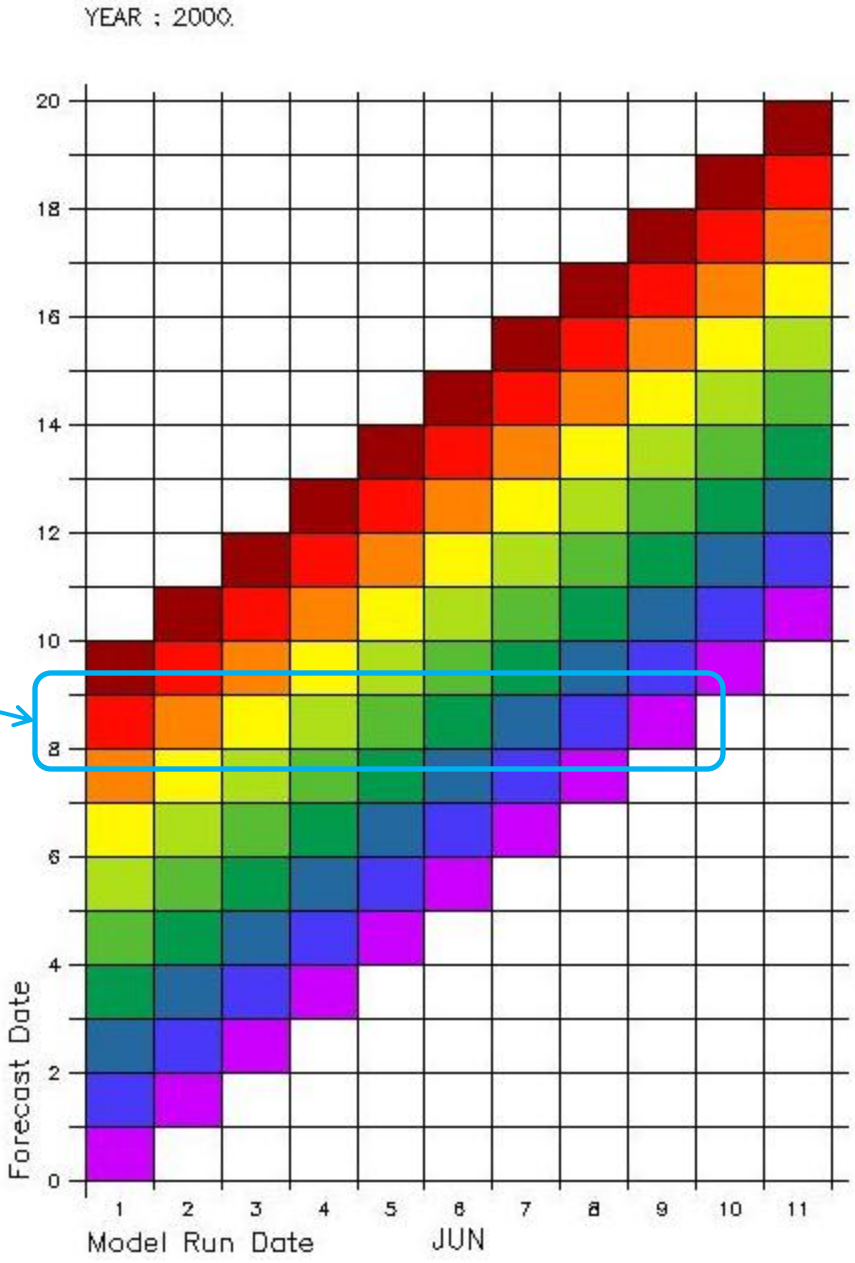
1. run time:
   - **Forecast Model Run** = the time series (forecast times) for a particular model run (run time)
2. forecast time:
   - **Best Time Series** = the time series (forecast times) constructed from the most recent model run available
   - **Constant Forecast Date** = data with the same forecast time across different model runs (run times)
3. forecast offset or forecast hour:
   - **Constant Forecast Offset** = data for the same forecast offset or forecast hour (e.g. 0 hour, +6 hour, etc.) across different model runs

1D Time Coordinates:



Forecast Model Run = time series (forecast times) for a particular model run (runtime)

1D Time Coordinates:

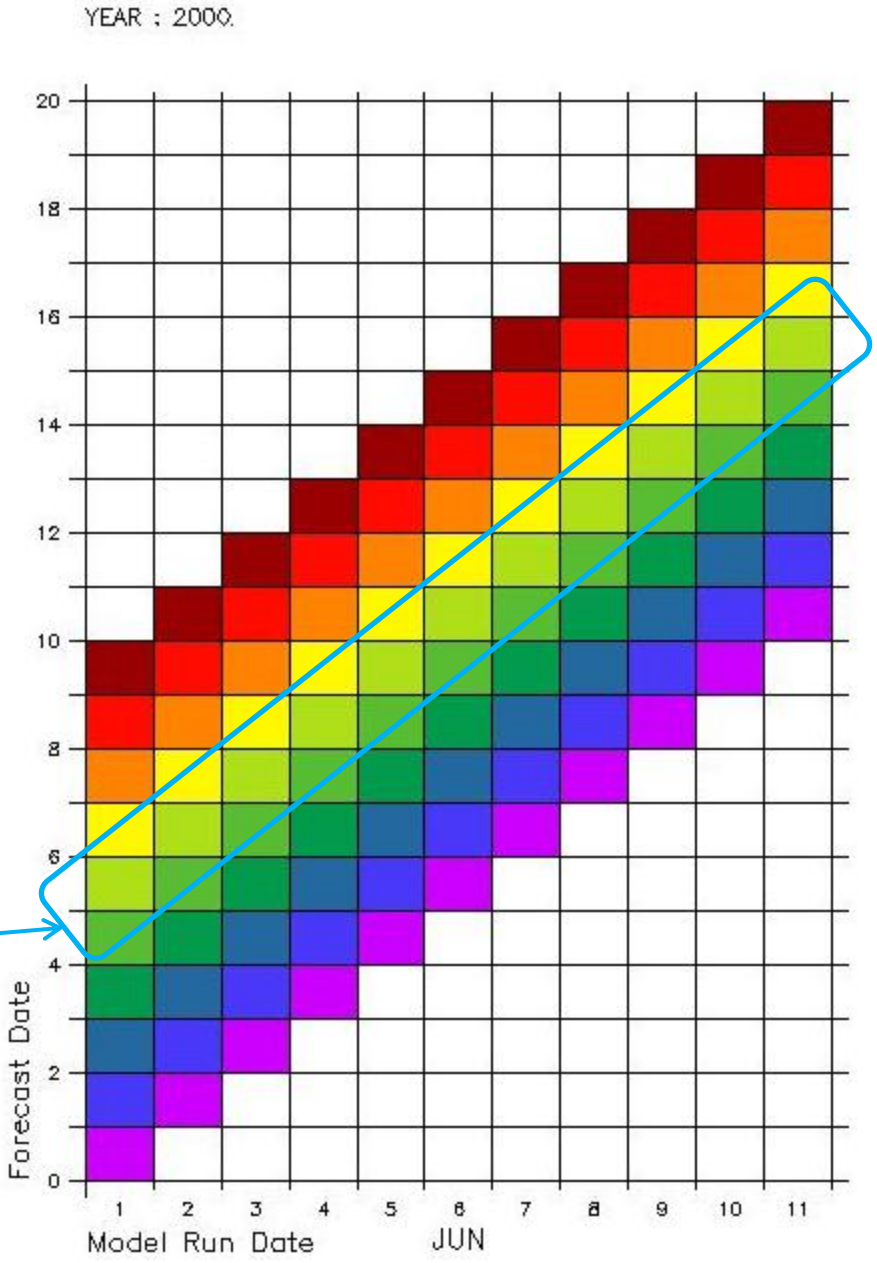


Constant Forecast Date = data with same forecast time across different model runs

NOTE: final timestamp = nowcast (runtime = forecast time)

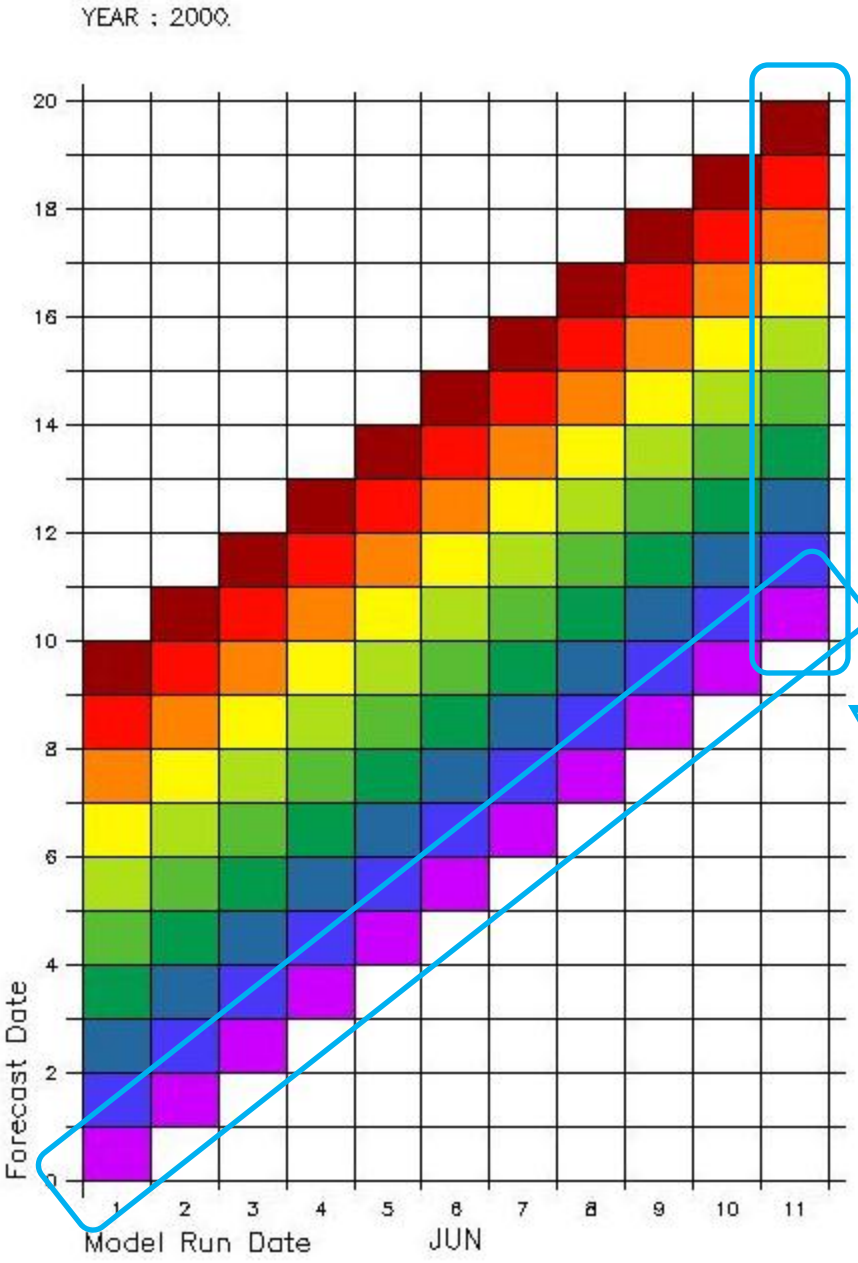
NOTE: successively shorter forecasts

1D Time Coordinates:



Constant Forecast Offset = data for same forecast offset (e.g. +1 day, +6 hours, etc.) across different model runs

1D Time Coordinates:



Best Time Series =
time series from most recent model run available = all nowcasts (+0 offset) + latest model forecasts (right column)