

Intro to ODV

Chemical Oceanography Data visualization

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CHEM Oc | SPRING 2013

PREVIOUSLY IN CHEMICAL OCEANOGRAPHY...

Introduction

Density structure of the Atlantic Ocean

Differences are small!

<1 part in 1000 in the deep Atlantic

< part in 10000 below 2000m.

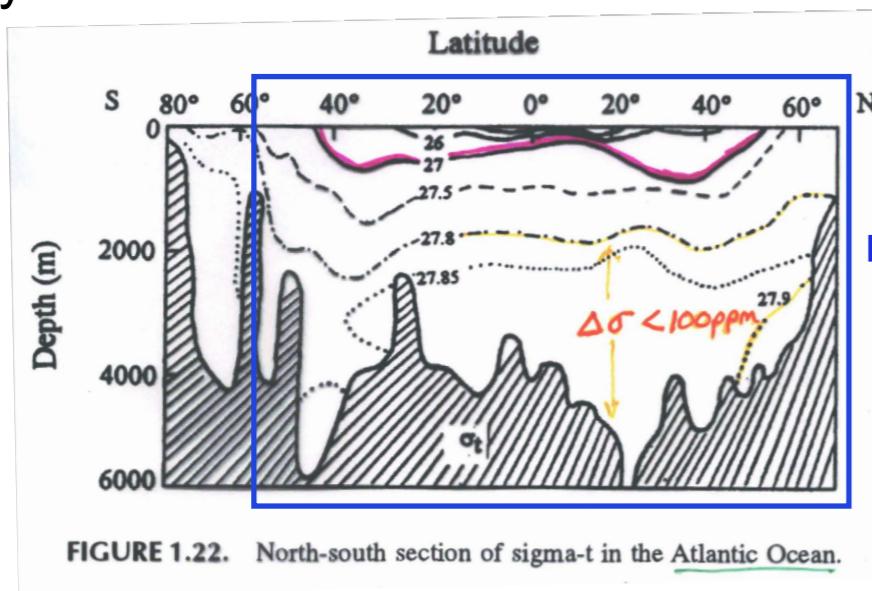
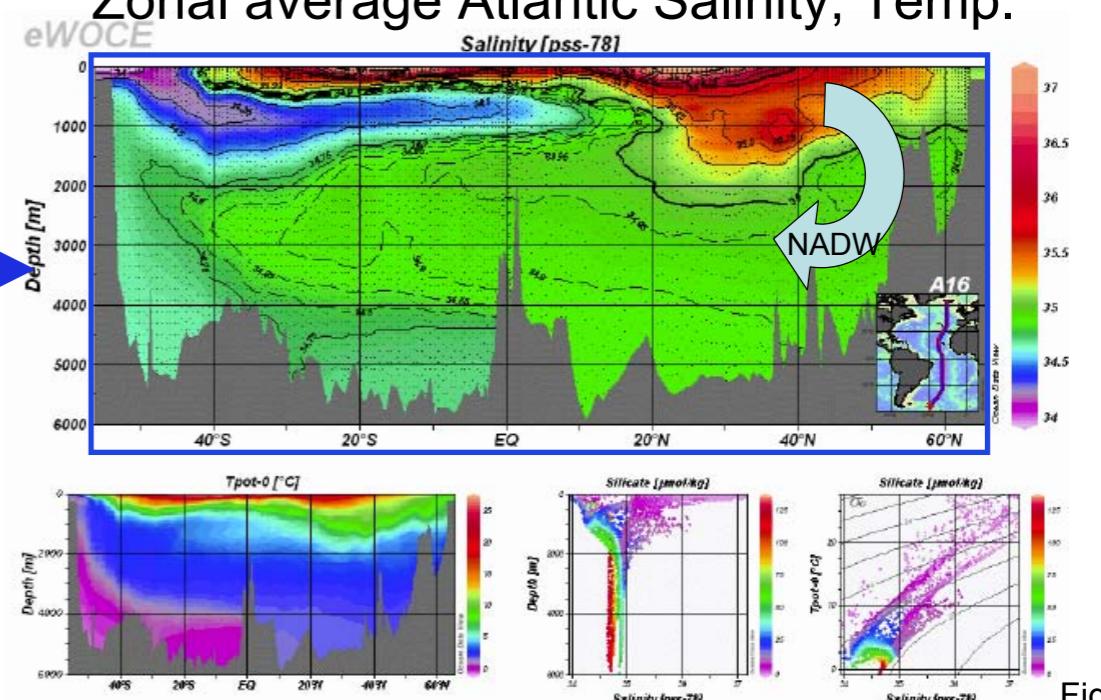


Fig S3 (Millero)

Small differences require accurate and precise measurements

Zonal average Atlantic Salinity, Temp.



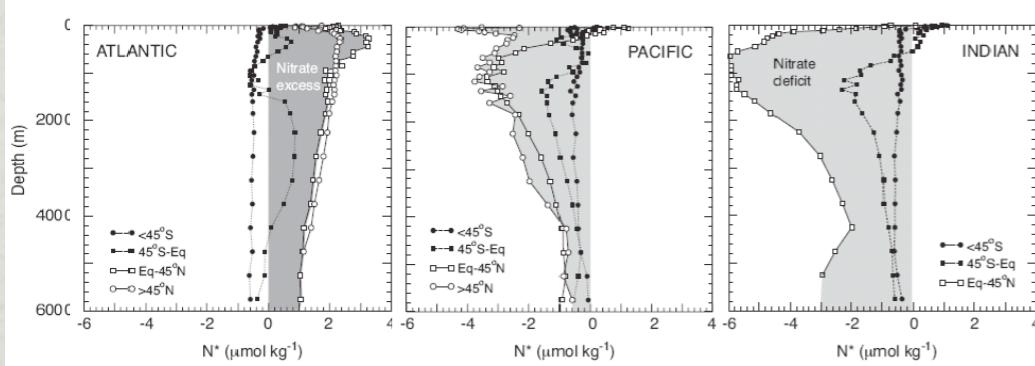
Salty N Atlantic surface water cools, becoming dense enough to sink to ~4000m. Densest waters (on bottom), formed around Antarctica, are less salty but much colder (lower left).

HAND DRAWN ----> ODV

PREVIOUSLY IN CHEMICAL OCEANOGRAPHY...

Introduction

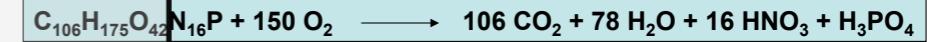
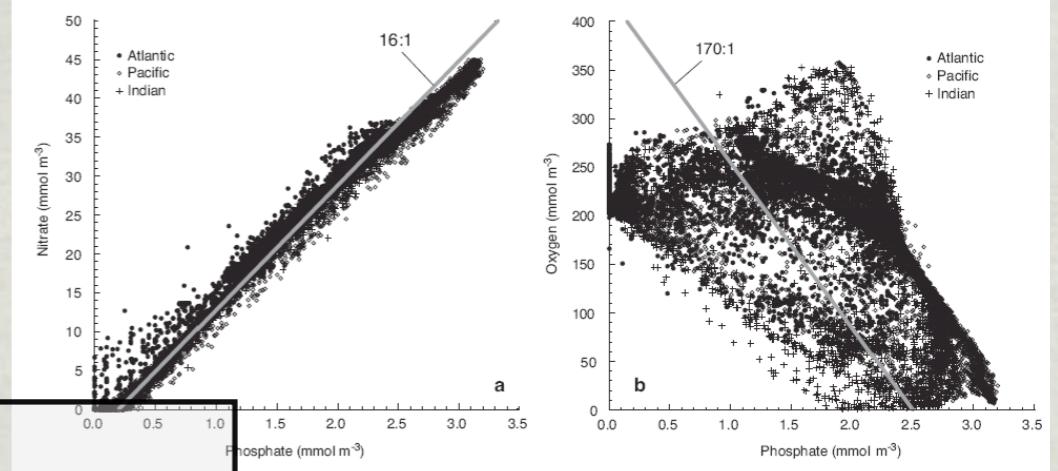
Horizontally averaged profiles of N^*



- Atlantic is a major source of nitrate via N_2 -fixation, and the Indian Ocean is a major sink relative to the other basins
- major areas of water column anoxia are in the Arabian Sea and eastern equatorial Pacific: areas of intense denitrification

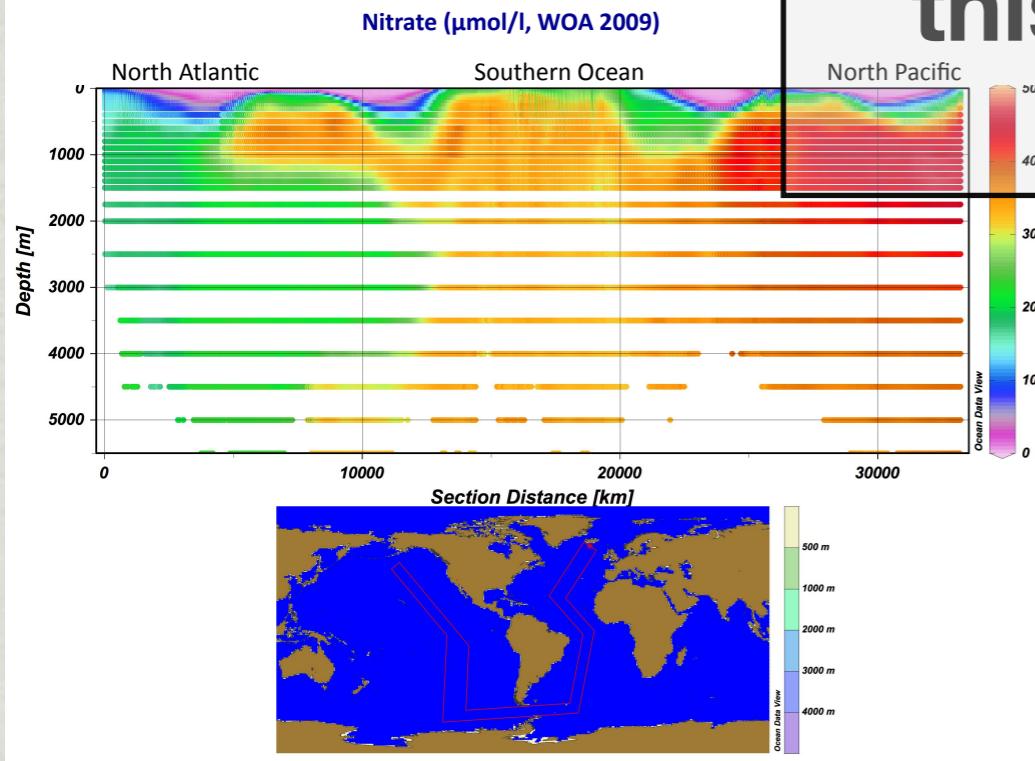
! this long held view of N_2 -fixation patterns has now been challenged by introducing P^+ !

Nitrate and phosphate concentrations from all depths



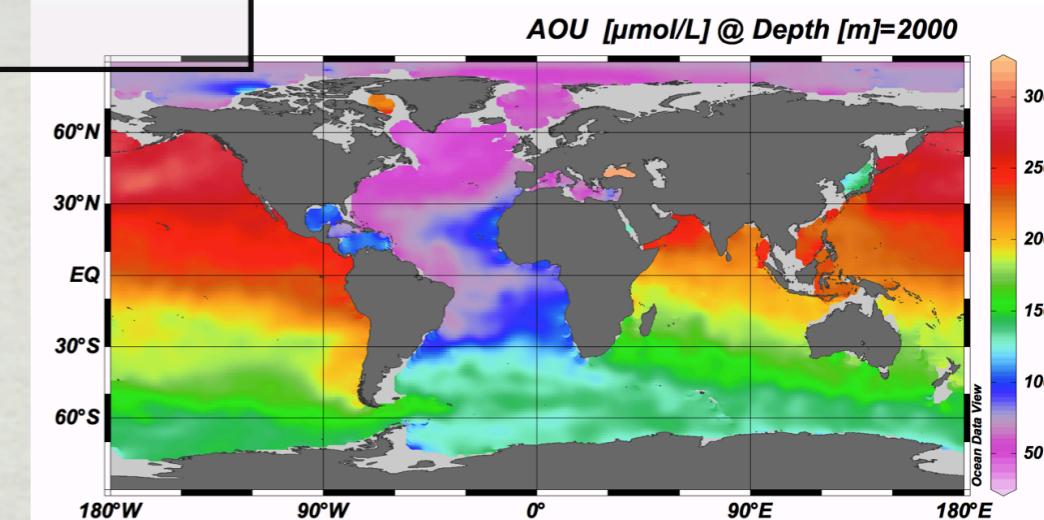
→ N/P suggests remineralization is similar to reverse of photosynthesis reaction
→ N/P cannot be explained by aerobic regeneration alone

They have graced
this stage before...



Apparent Oxygen Utilization in 2000m deep waters of the world oceans

Note that AOU should really be shown in $\mu\text{mol/kg}$ but I could not figure it out...



$$\text{AOU} = [\text{O}_2]^* - [\text{O}_2]_{\text{meas}}$$

1. Introduction

2. Data Visualization

3. Data Sets

4. Quick-start Guide

a. Start, Make, Modify

b. Plot types

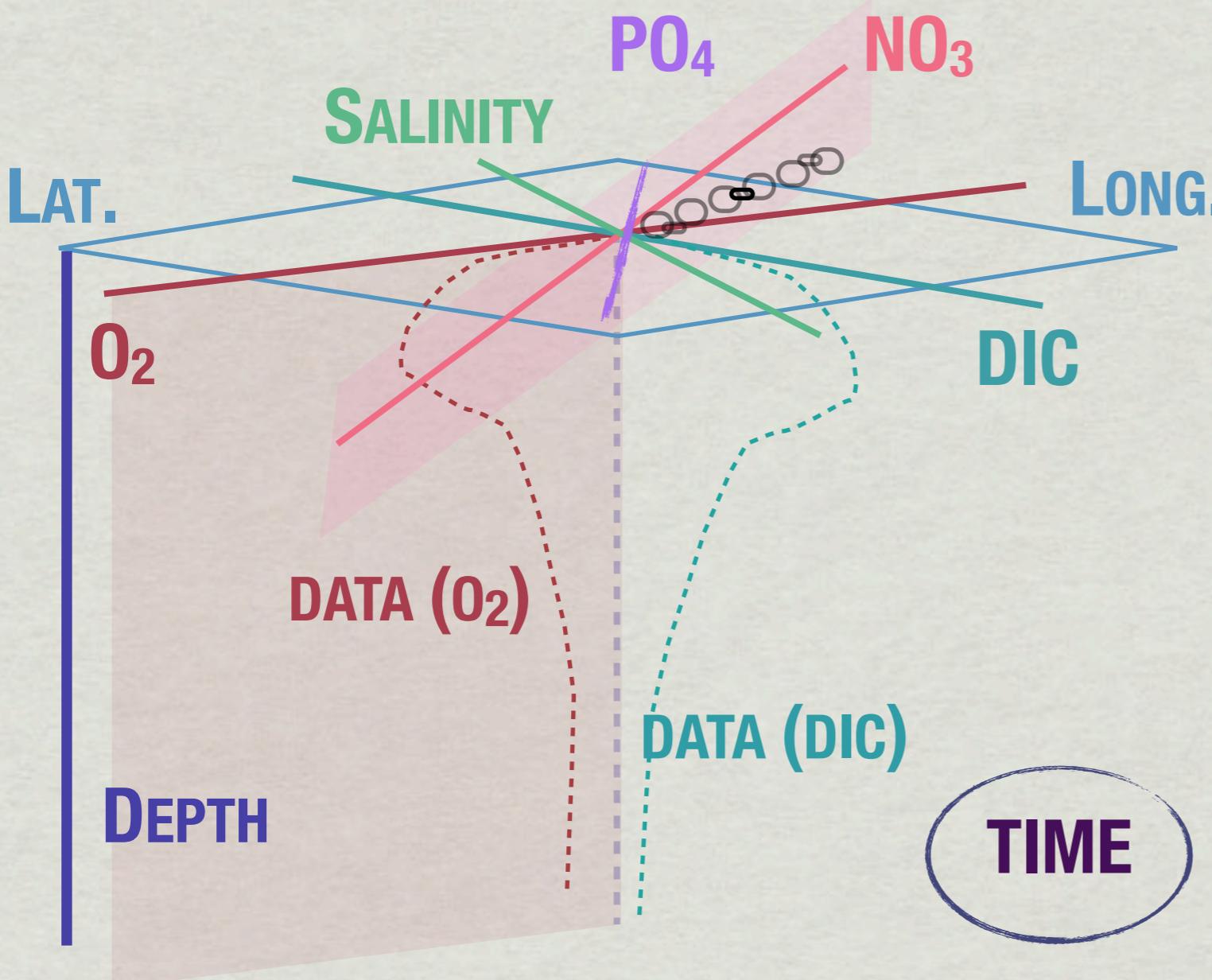
c. Load, Import, Export

(briefly, see Appendix slides for details)

5. Extra Features

STRUCTURE OF DATA

Data Visualization



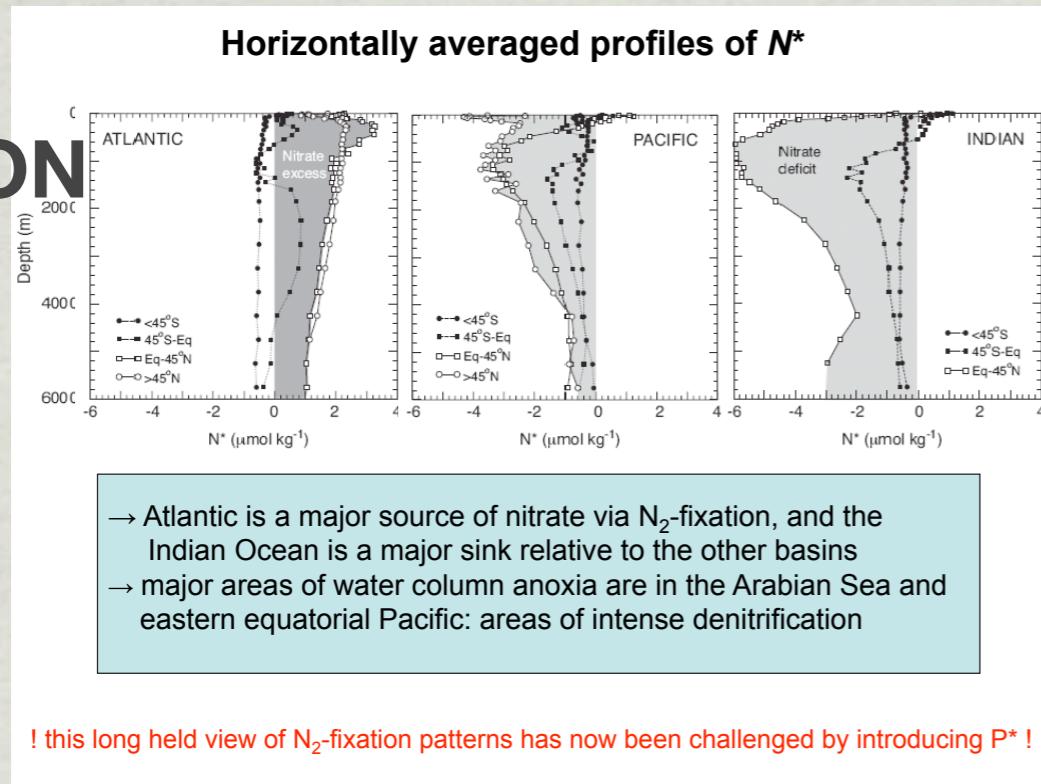
- ❖ ODV facilitates 3-D data visualization of large data sets
 - X axis, Y axis, color
- ❖ 5 plot types: each with a different approach to space/time metadata
 - latitude, longitude, depth, time

* Here we focus on spatial rather than time-series data. The intrigued ODV dabbler is encouraged to explore the BATS and HOT data outside of class!

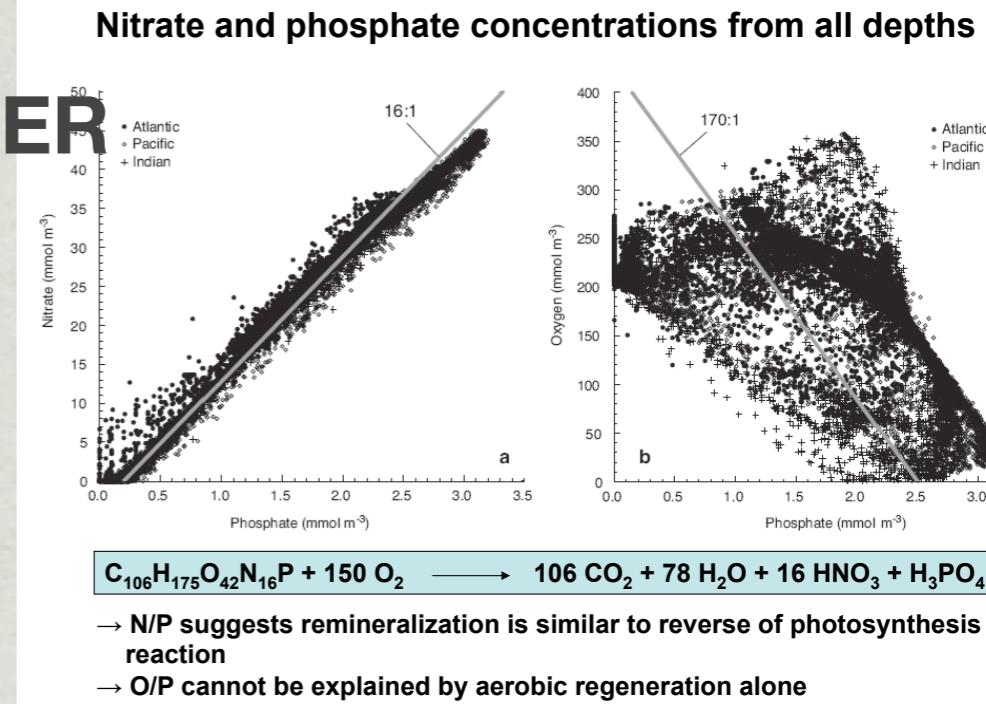
PLOT TYPE OVERVIEW

Data Visualization

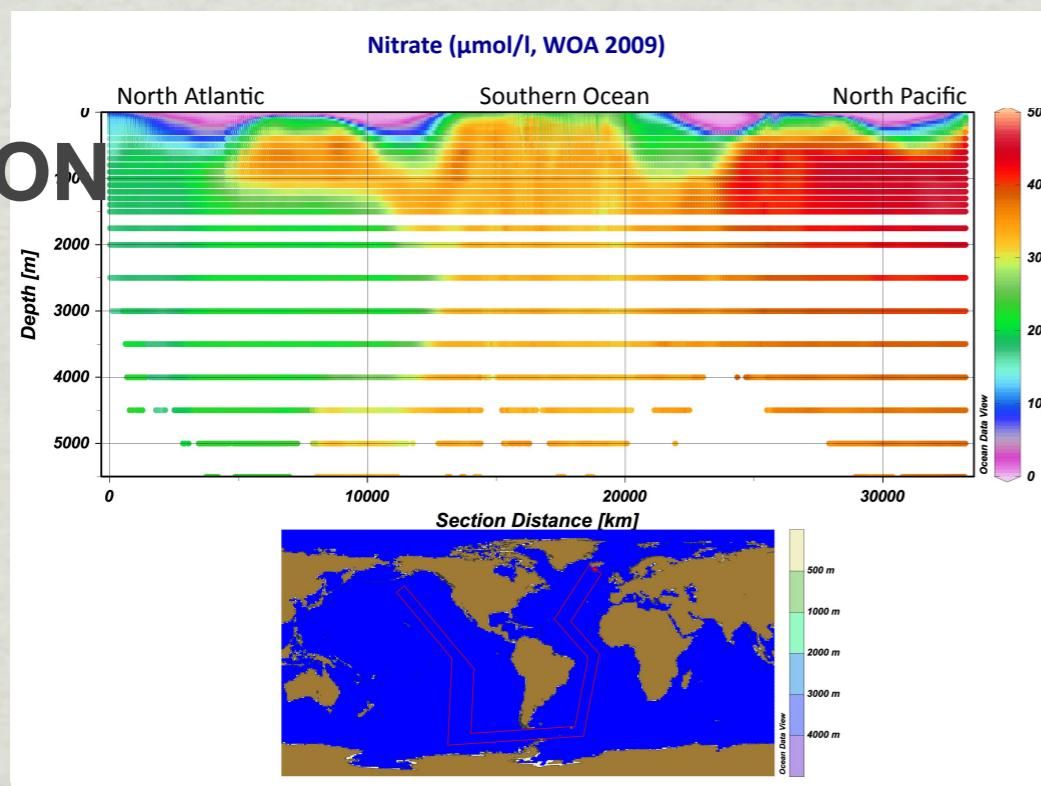
STATION



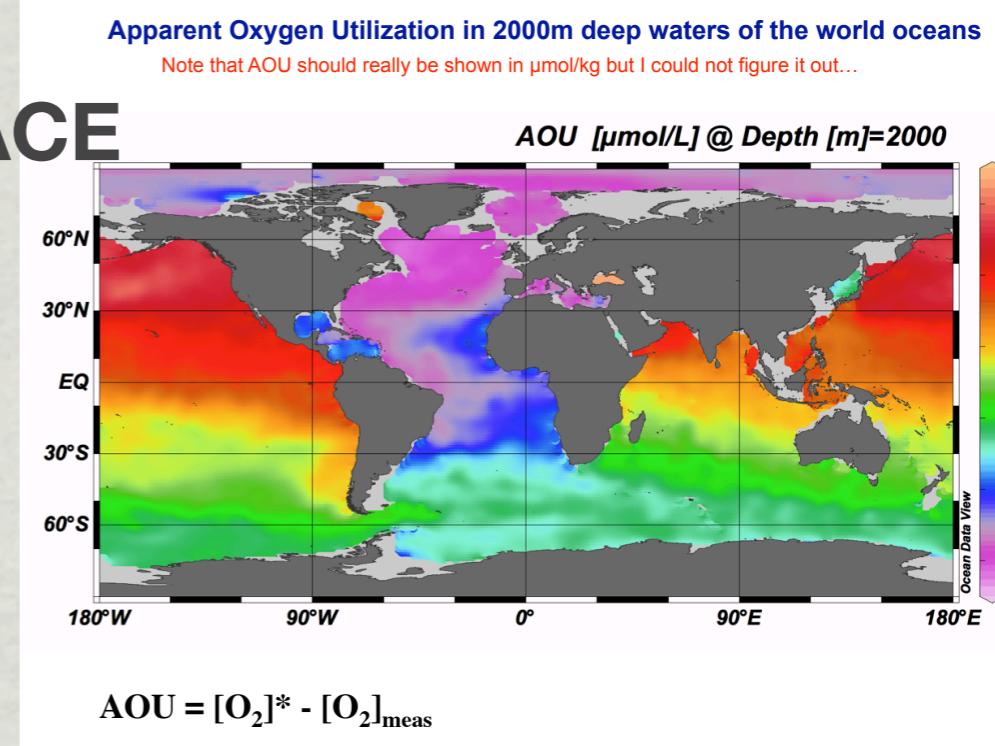
SCATTER



SECTION



SURFACE



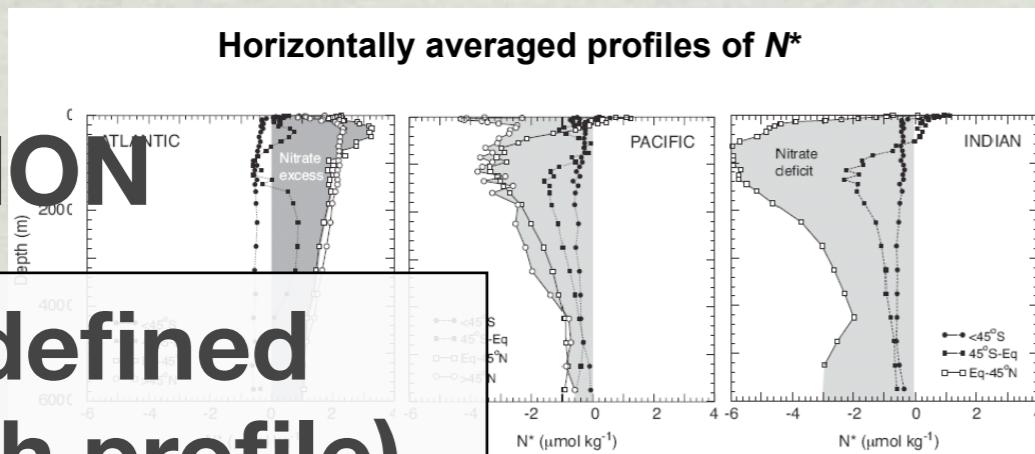
PLOT TYPE OVERVIEW

Data Visualization

STATION

Site defined (depth profile)

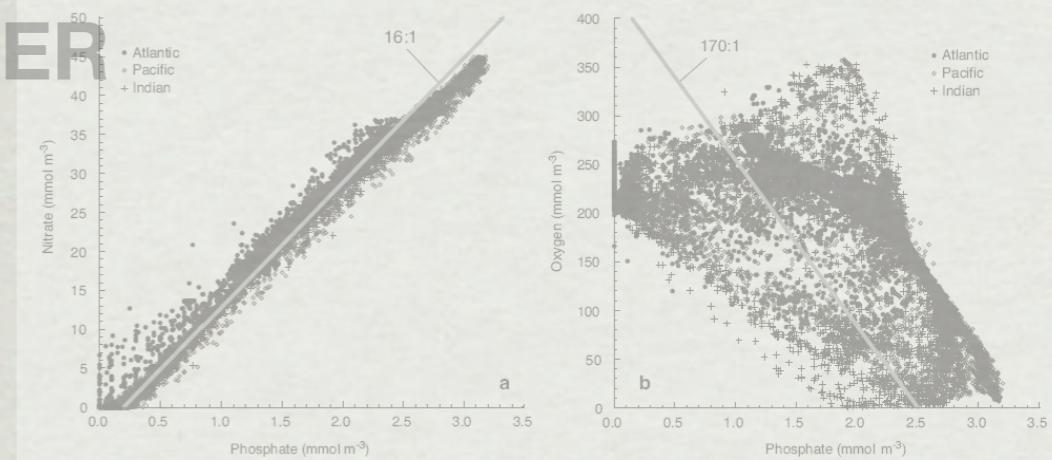
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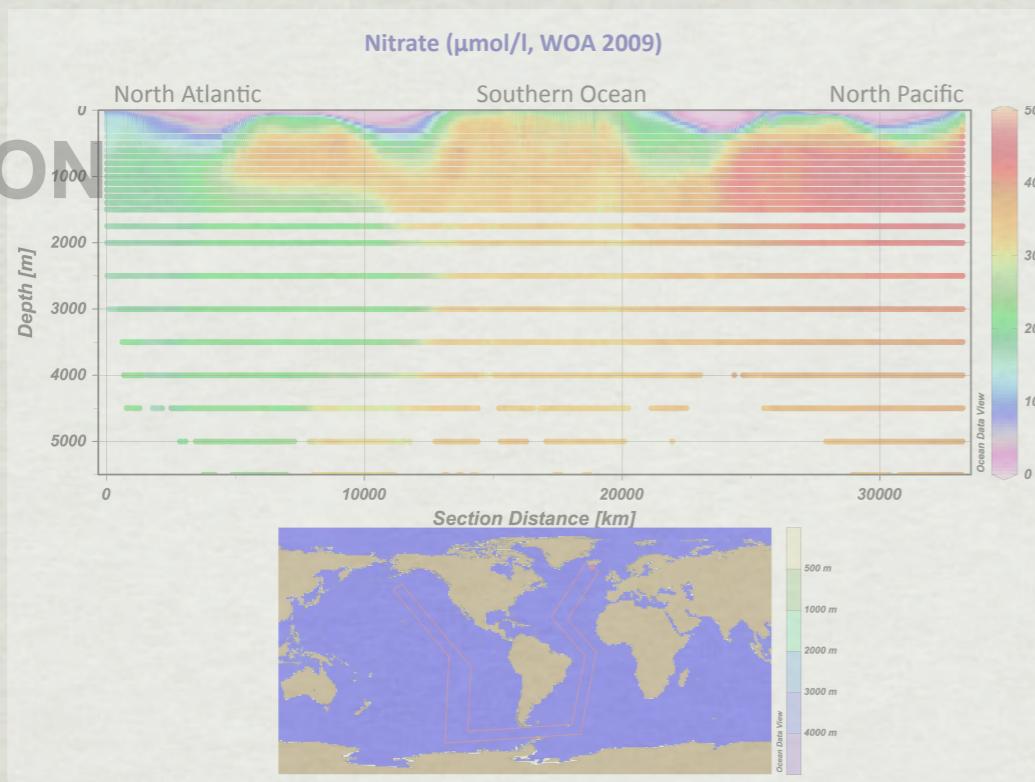
SCATTER

Nitrate and phosphate concentrations from all depths



→ N/P suggests remineralization is similar to reverse of photosynthesis reaction
→ O/P cannot be explained by aerobic regeneration alone

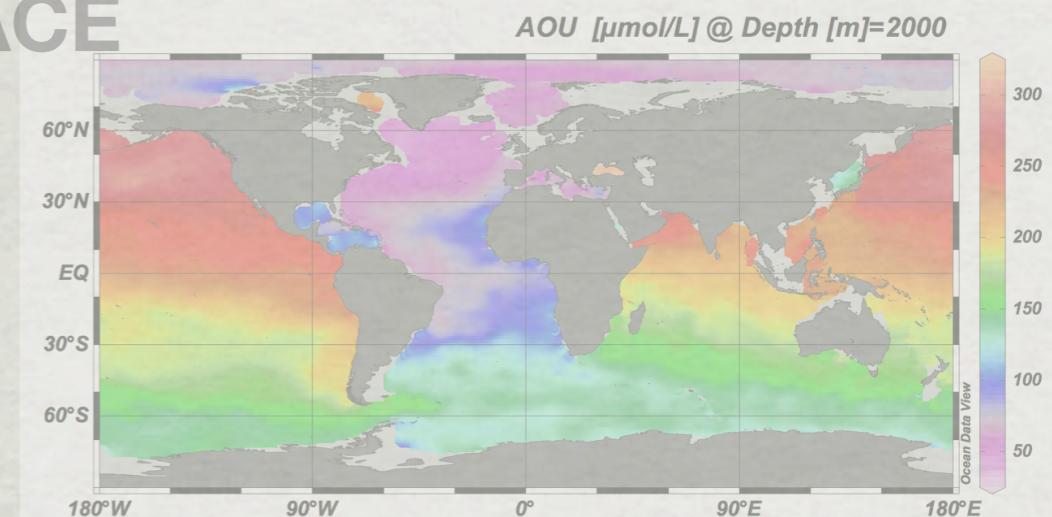
SECTION



SURFACE

Apparent Oxygen Utilization in 2000m deep waters of the world oceans

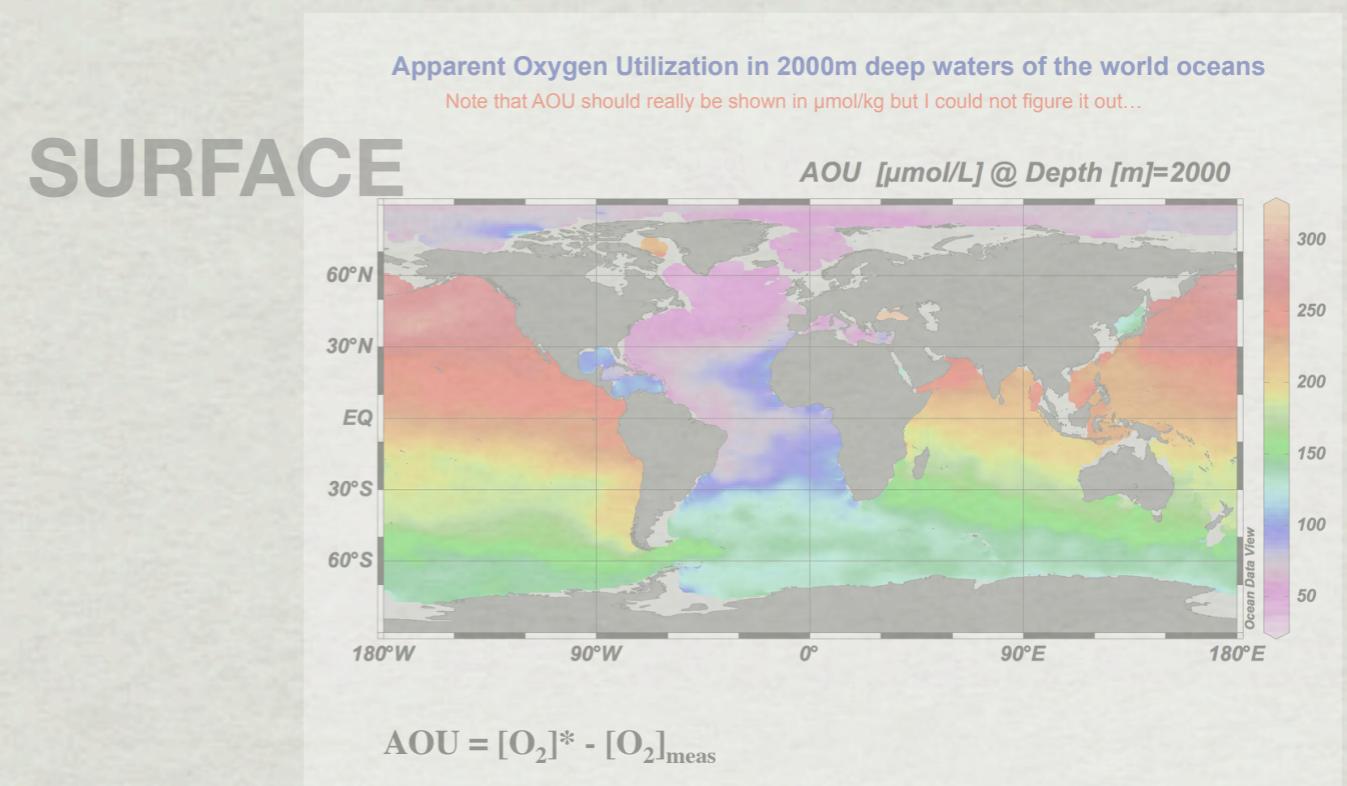
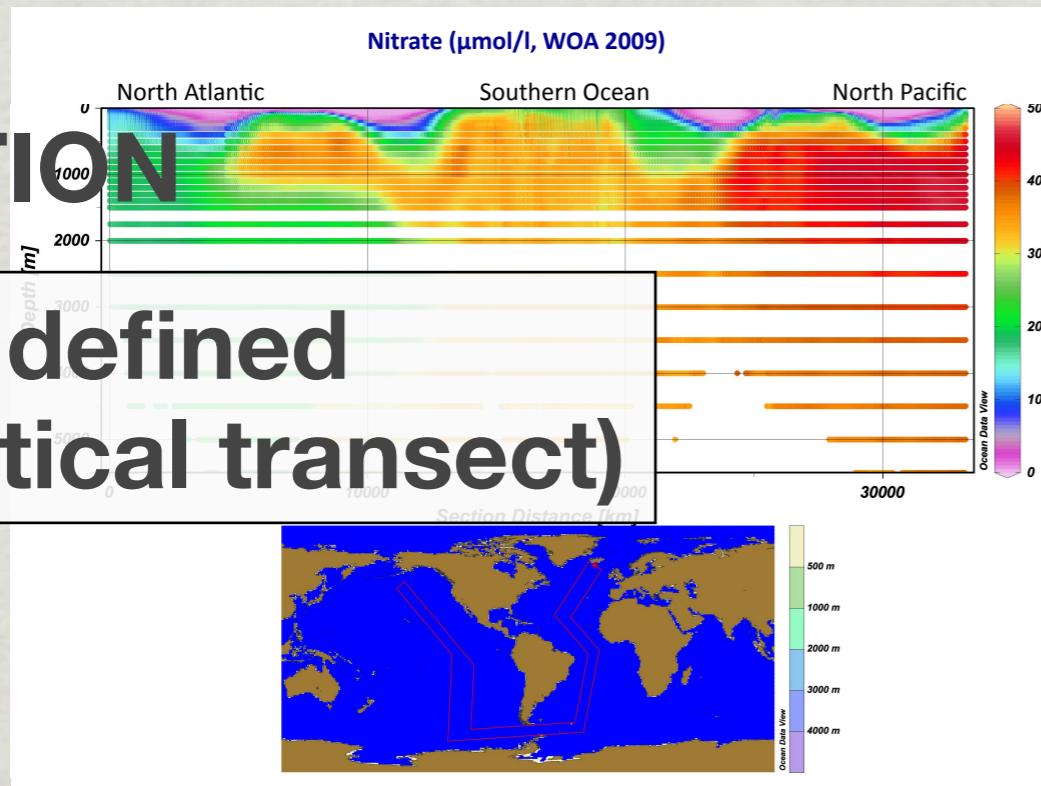
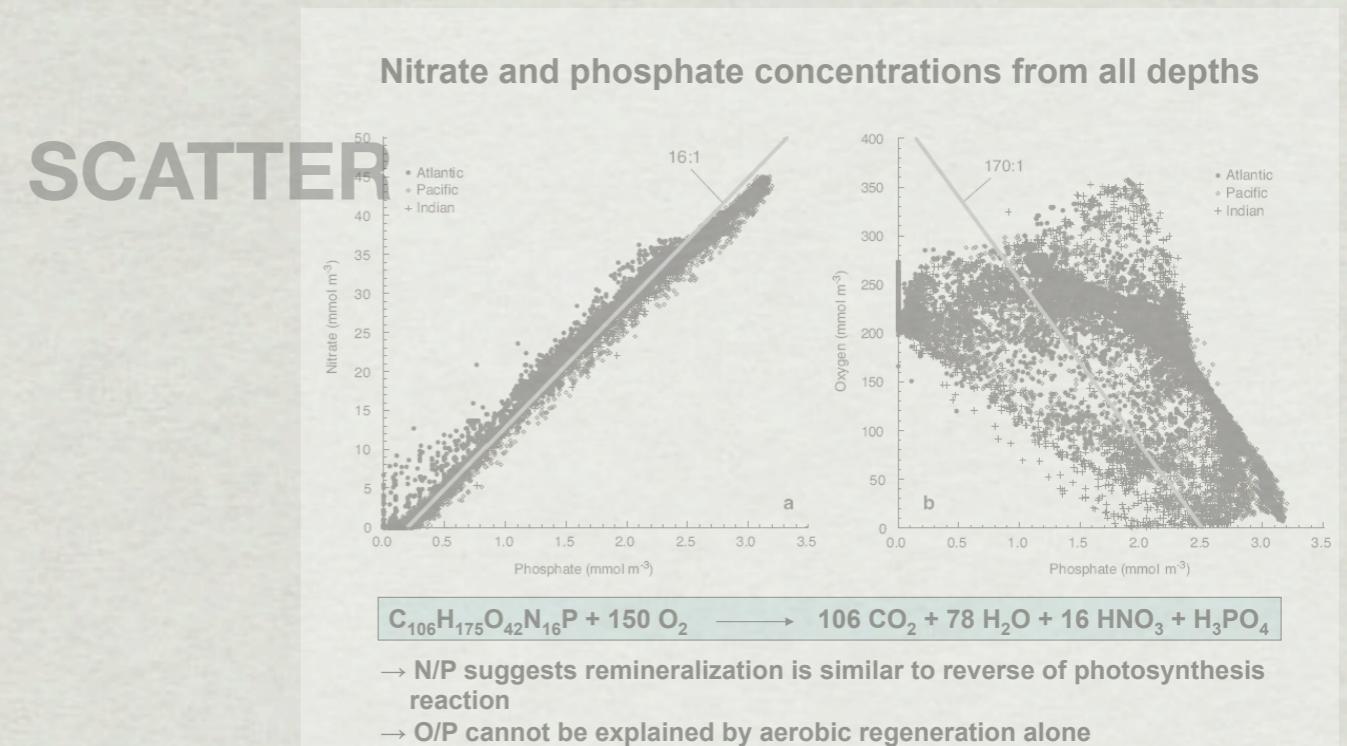
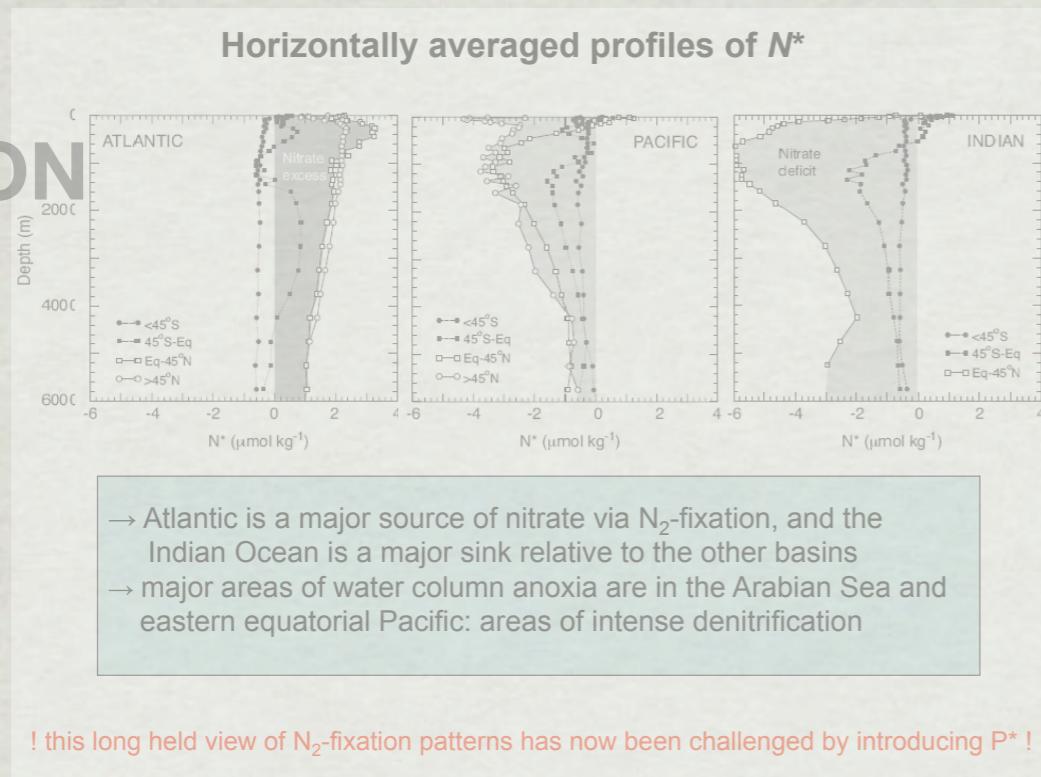
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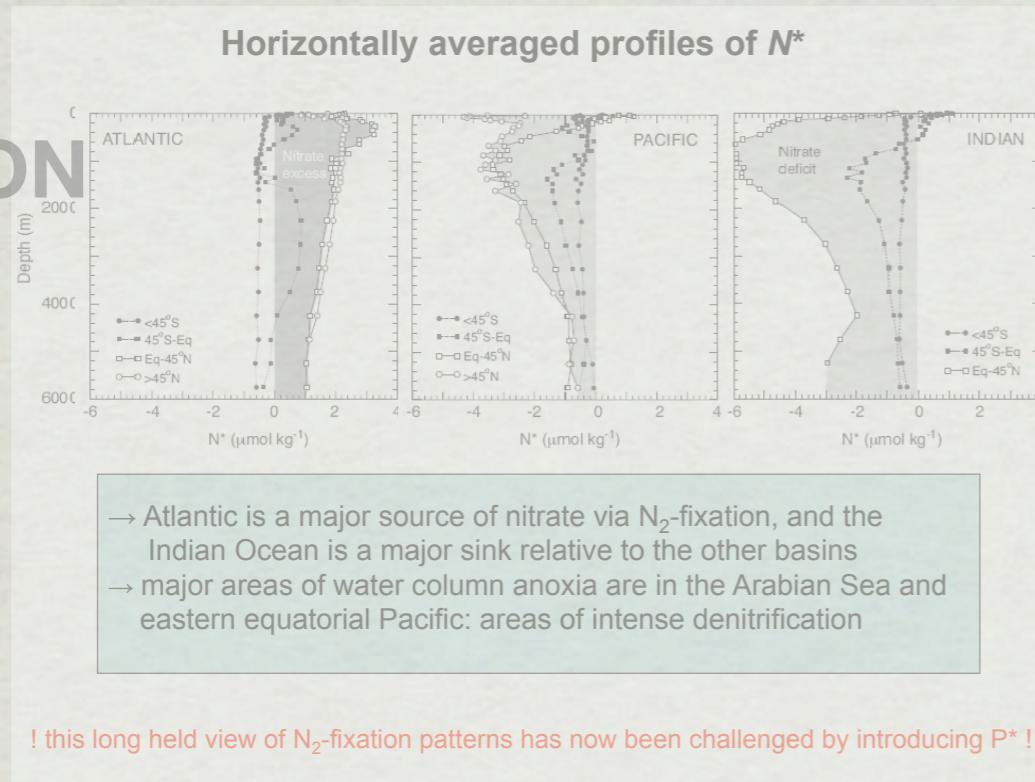
Data Visualization



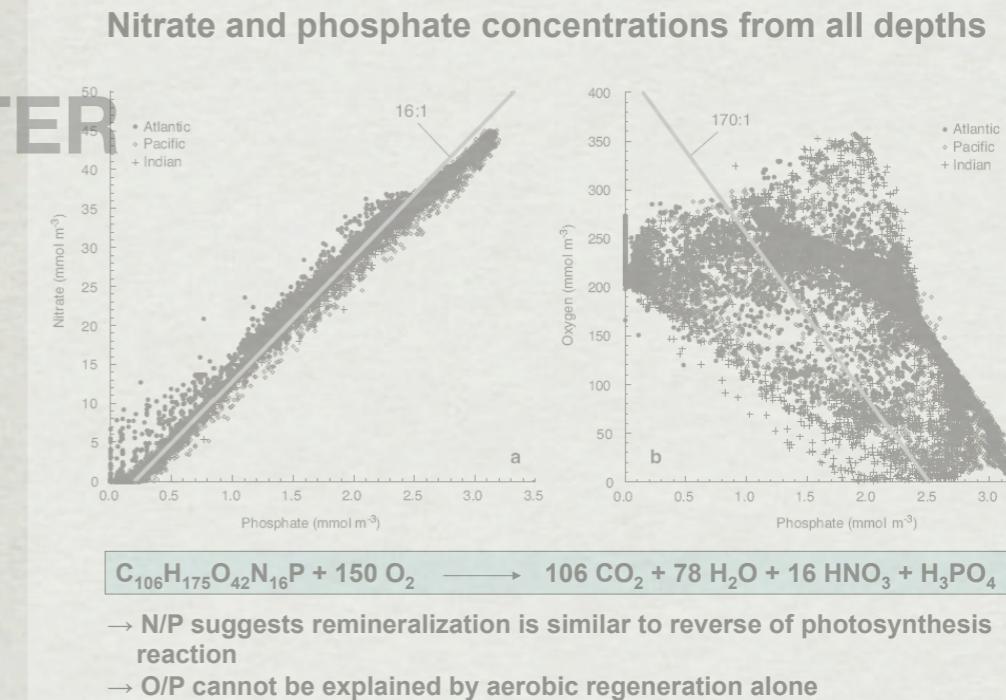
PLOT TYPE OVERVIEW

Data Visualization

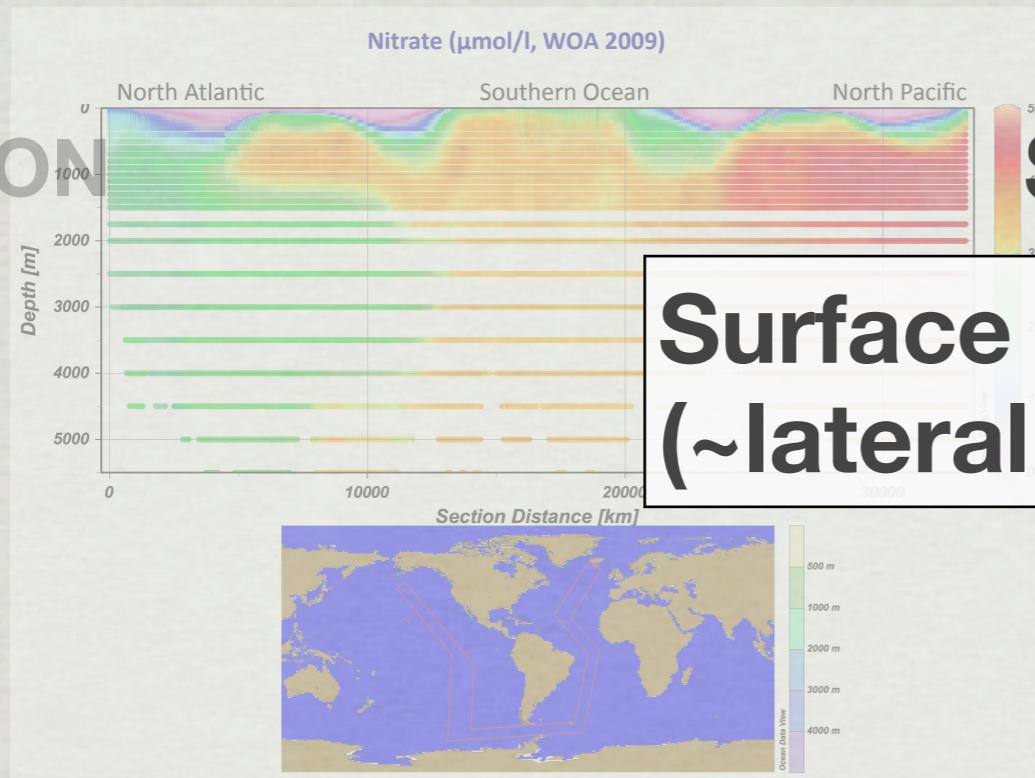
STATION



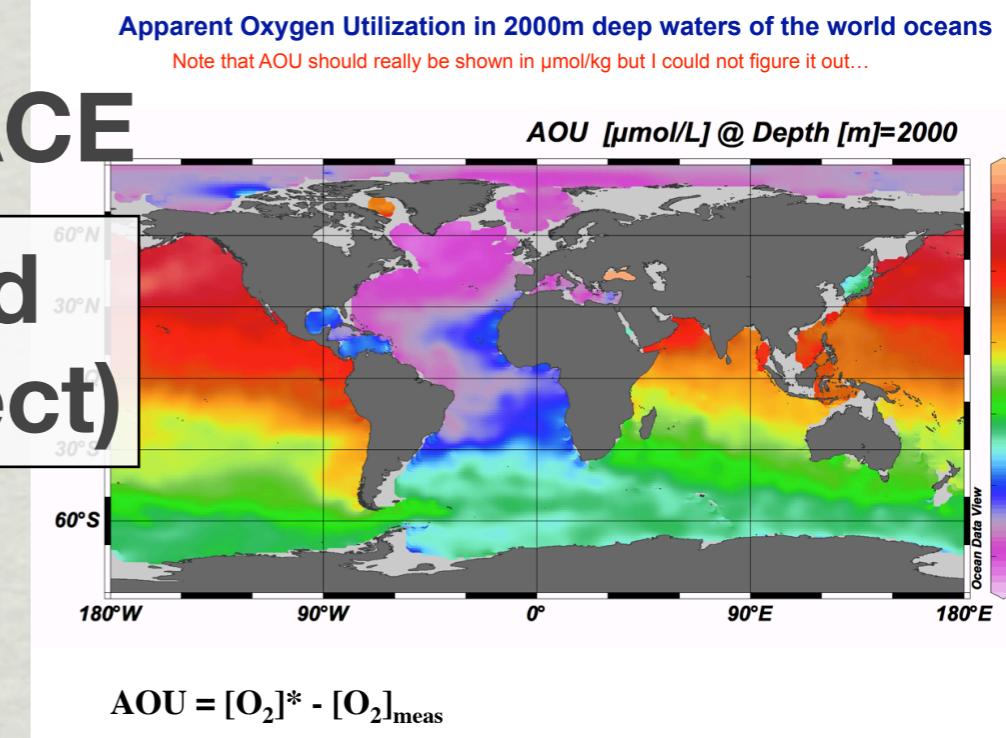
SCATTER



SECTION



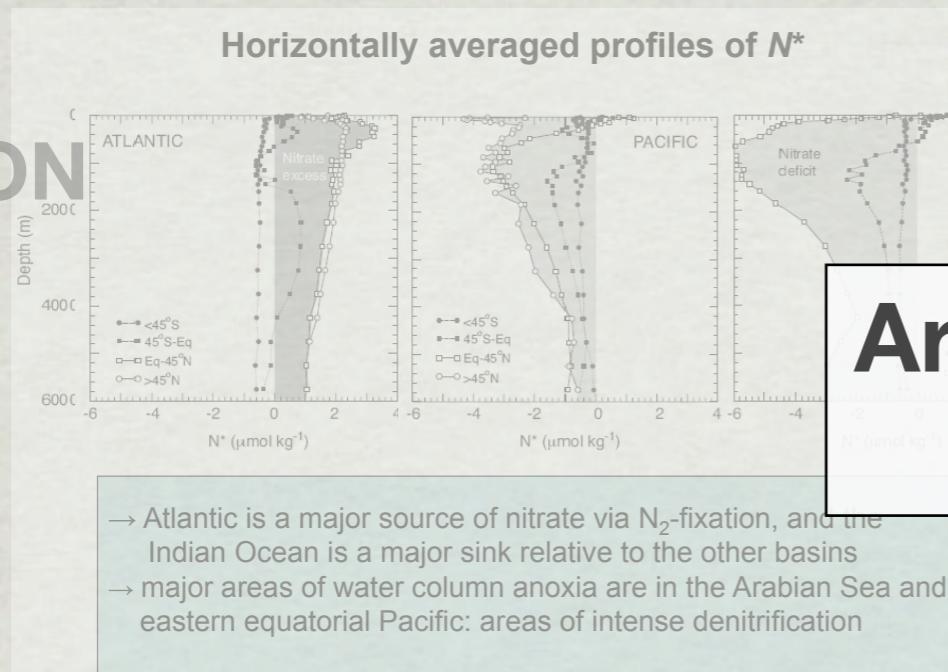
SURFACE



PLOT TYPE OVERVIEW

Data Visualization

STATION

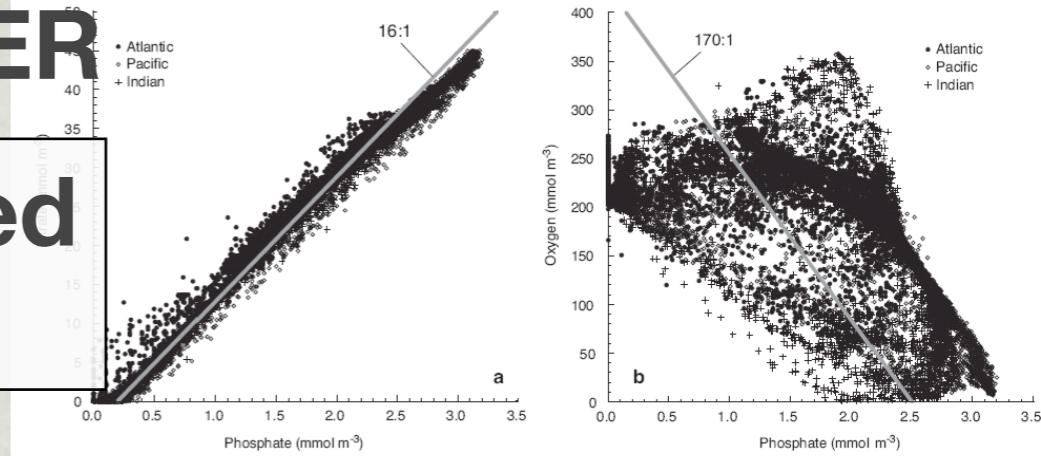


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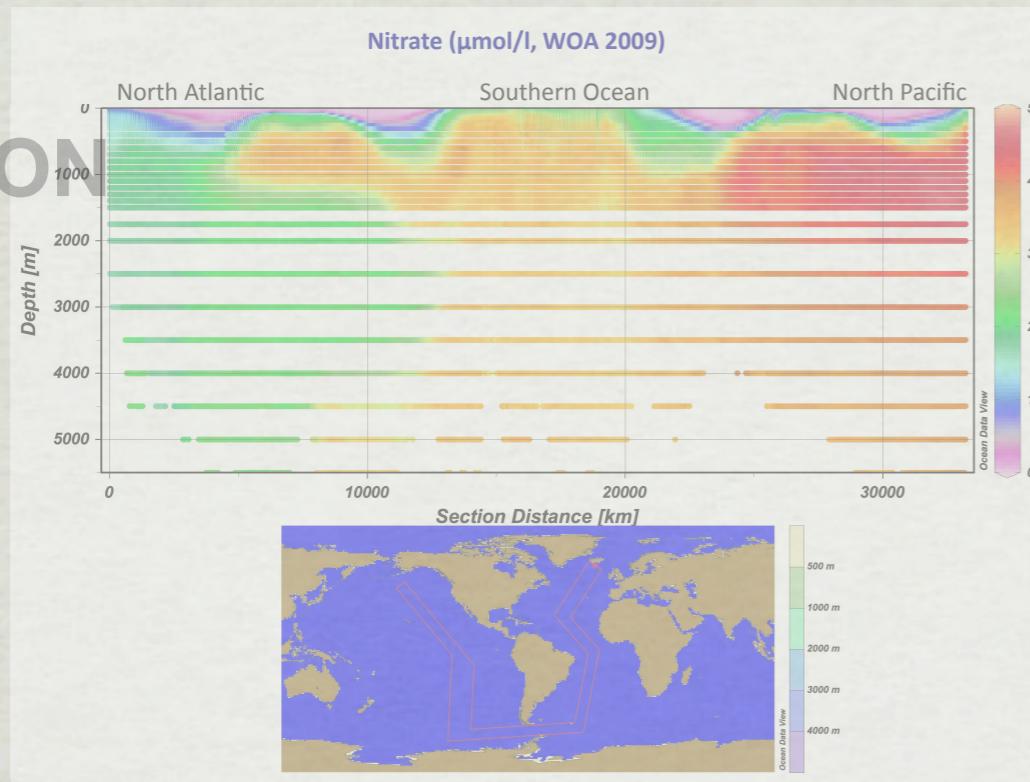
Area defined (volume)

Nitrate and phosphate concentrations from all depths



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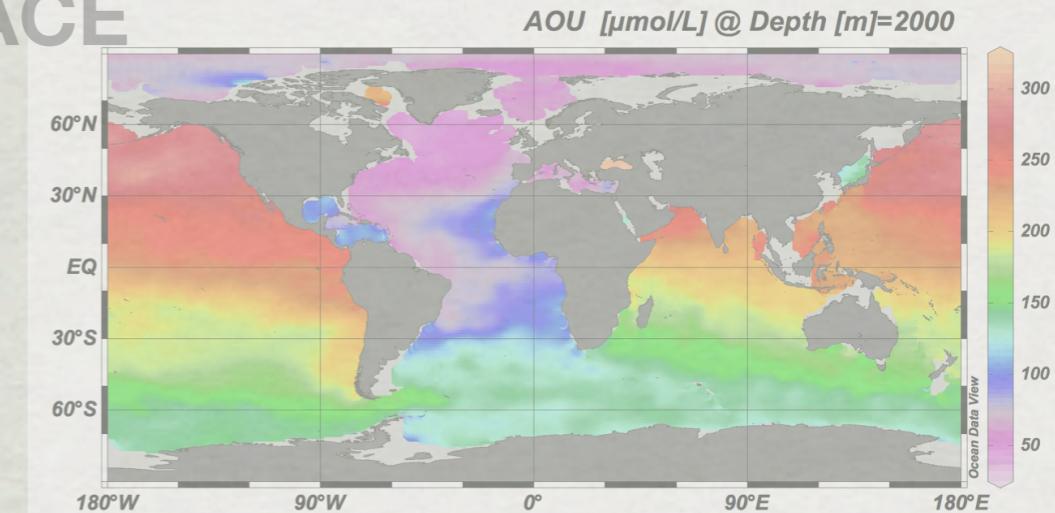
SECTION



SURFACE

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COMMONLY REFERENCED DATA

Data Sets

Spotted in lecture...

❖ *Chemical constituents:*

- World Ocean Atlas 2009: Monthly, seasonal, annual hydrographic data (U.S. NODC '09)
- LDEO pCO₂ Data: Global pCO₂ dataset > 6.4*10⁶ stations (1957-2011)

❖ *Hydrographic variables:*

- World Ocean Circulation Experiment (eWOCE): climatology state variables (1990-1997)

❖ *Time-series:*

- BATS Bottle Data: Bermuda Atlantic Time-Series Study Bottle Data

* Additional data sets in appendix slides

Name	Description
eWOCe	Electronic Atlas of WOCE Data
BATS Bottle Data	Bermuda Atlantic Time-Series Study Bottle Data
CARINA Bottle Data	Hydrographic, nutrient and intensity consistent data of carbon system parameters (CARINA Group, 2009)
Gorringe CORA-3 Dataset	Coraline CORA3 Database for Radiotracer - CORA3 (8.2 Mo temperature and salinity profiles 1990 - 2012)
Global Alkalinity & TCO2	GEOSECS Hydrographic and Tracer Data; 1972 - 1976
GEOSECS	Estimated alkalinity and total dissolved inorganic carbon (Goyet et al., 2008)
Global Transmissometer Database	Transmissometer and hydrographic data for the global ocean (W. D. Gardner, et al., 2003)
GLODAP Bottle Data	Hydrographic and carbon data for the global ocean (Key, R.M., et al., 2004)
GLODAP Gridded Data	Hydrographic and carbon climatology for the global ocean (Key, R.M., et al., 2004)
HOT Bottle Data	Hawaiian Ocean Time-series Bottle Data
LDEO pCO2 Data	Global pCO ₂ dataset containing more than 6.4 million stations (1957-2011)
Mediterranean	Hydrographic data for the Mediterranean and Black Sea (Medea Group, 2002)
Mixed Layer Depths	Monthly global mixed layer depths on 1°x1° grid (Moninger and Levitus, 1997)
Red & Mantyla	Global collection of historical hydrographic and nutrient data (Red & Mantyla)
PHC 3.0	Polar science center Hydrographic Climatology (PHC3.0; Steig et al., 2005)
SOCAT v1.5 ICO2 Data	Global ICO ₂ dataset containing 6.3 million surface water measurements (1960-2007)
Southern Ocean Atlas	Standard depth profiles and gridded version of the Hydrographic Atlas of the Southern Ocean (Olbers et al., 1990)
World Ocean Atlas 2001	Monthly, seasonal and annual hydrographic data from the U.S. NODC World Ocean Atlas 2001
World Ocean Atlas 2005	Monthly, seasonal and annual hydrographic data from the U.S. NODC World Ocean Atlas 2005
World Ocean Atlas 2009	Monthly, seasonal and annual hydrographic data from the U.S. NODC World Ocean Atlas 2009
WOCE Global Hydrographic Climatology	Global 0.5 x 0.5 degree gridded climatology of Gouretski and Kossmann (2004)

DATA PRODUCTS

Data Sets

ODV loads two types of data structures:

1. Optimized Data Products:

- large multi-dimensional arrays (.odv, .var, .nc, .cdf)
- web available via ODV (<http://odv.awi.de/en/data/>);
(ODV site acts as a directory for data products)

2. Character Separated Files:

- human sized spreadsheets; Excel etc. (.csv, .txt)
- web available via individual projects and repositories
(e.g. [GEOTRACES](#), [NCDC](#))

Download data set to ODV/data

Open data product: (1) start ODV; (2) File-->Open; (3) navigate to saved folder; (4) click through the nested folders until you arrive at the data file ; (5) click open

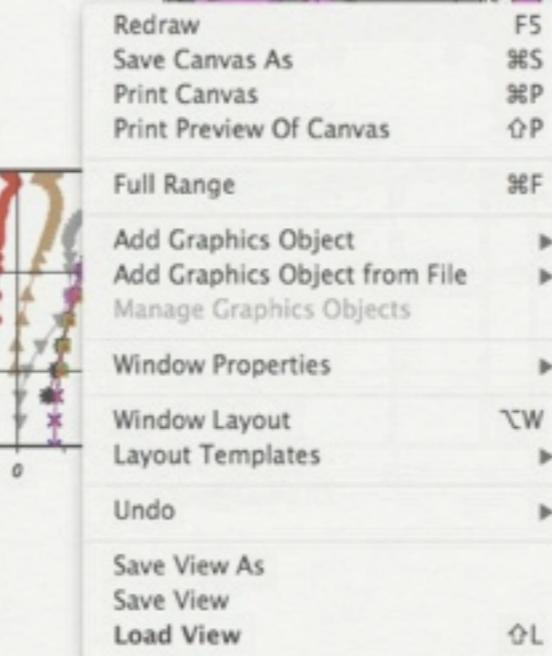
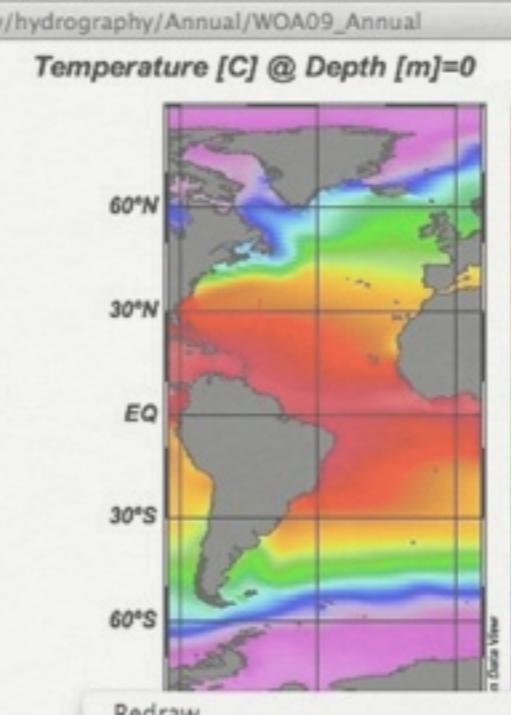
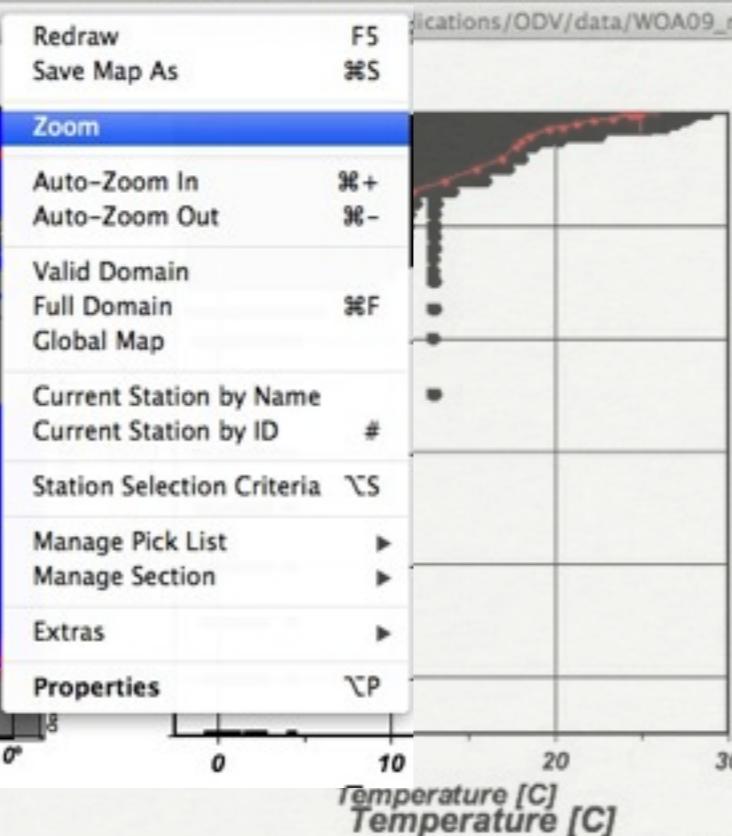
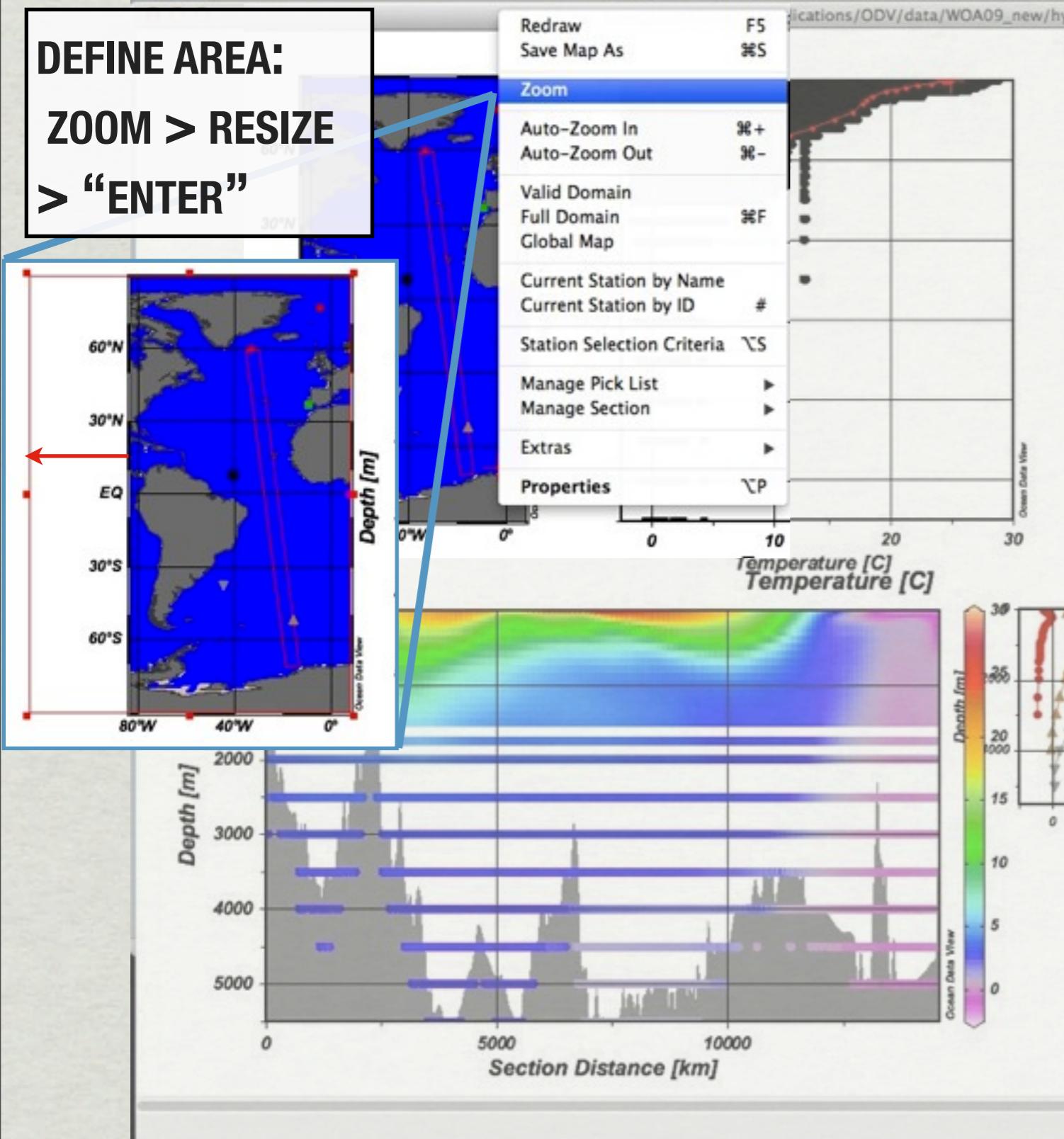
START, MAKE...

Quick-Start Guide

DEFINE AREA:

ZOOM > RESIZE

> “ENTER”



Station ID: 29617
Cruise WOA09_Annual
Station 29617 (B)
Posit... 56.5°W / 27.5°N
Date
Time

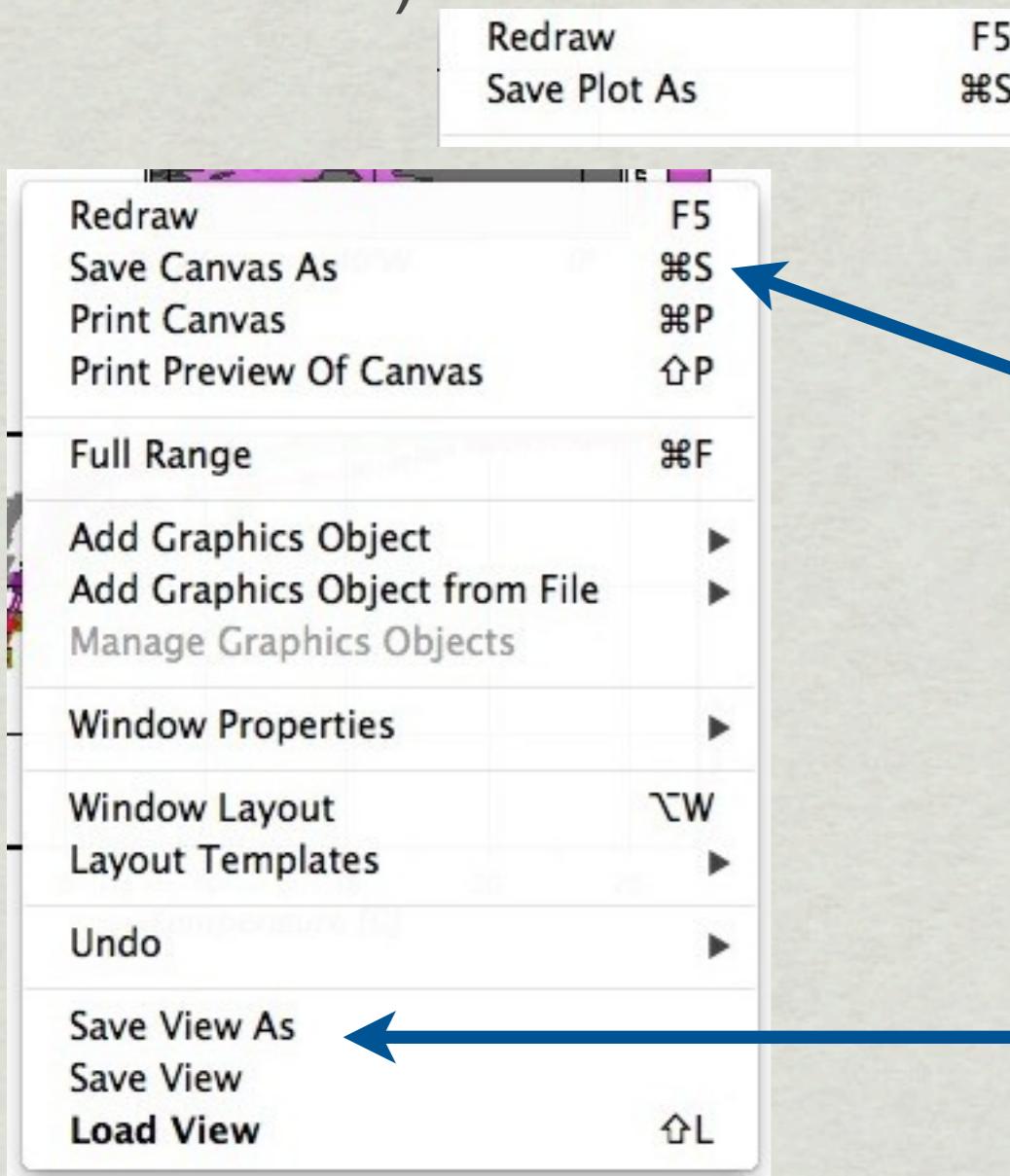
Full Screen Map	F8
1 STATION Window	
2 STATION Windows	
6 STATION Windows	F9
1 SCATTER Window	
2 SCATTER Windows	F10
6 SCATTER Windows	
1 SECTION Window	
2 SECTION Windows	
3 SECTION Windows	F11
5 SECTION Windows	
6 SECTION Windows	
1 SURFACE Window	F12
2 SURFACE Windows	
3 SURFACE Windows	
5 SURFACE Windows	
8 SURFACE Windows	
11 SURFACE Windows	
5 MIXED Windows	
From View File	

...SAVE.

Quick-Start Guide

SAVING

(early and often; ODV stability
is...variable)



- Static Panels:

- an *INDIVIDUAL panel* (.png, .gif, .jpg, .tif, .eps):
 - right click panel, select "save plot/map as"

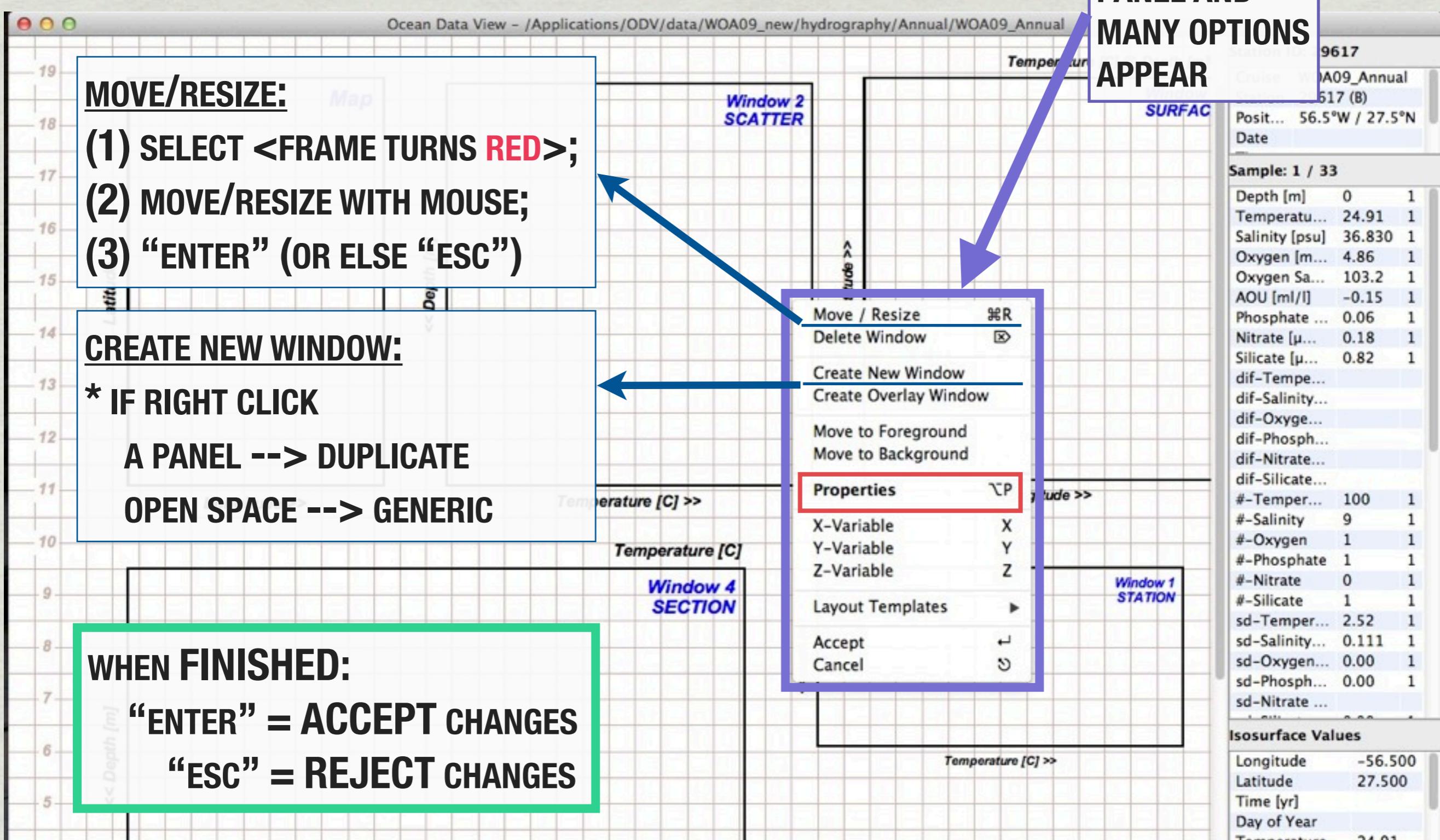
- *the SET of panels* (.png, .gif, .jpg, .tif, .eps):
 - right click open space, select "save canvas as"

- View Mode:

- *the SET of views for future work* (.xview):
 - right click open space, select "save view (as)"

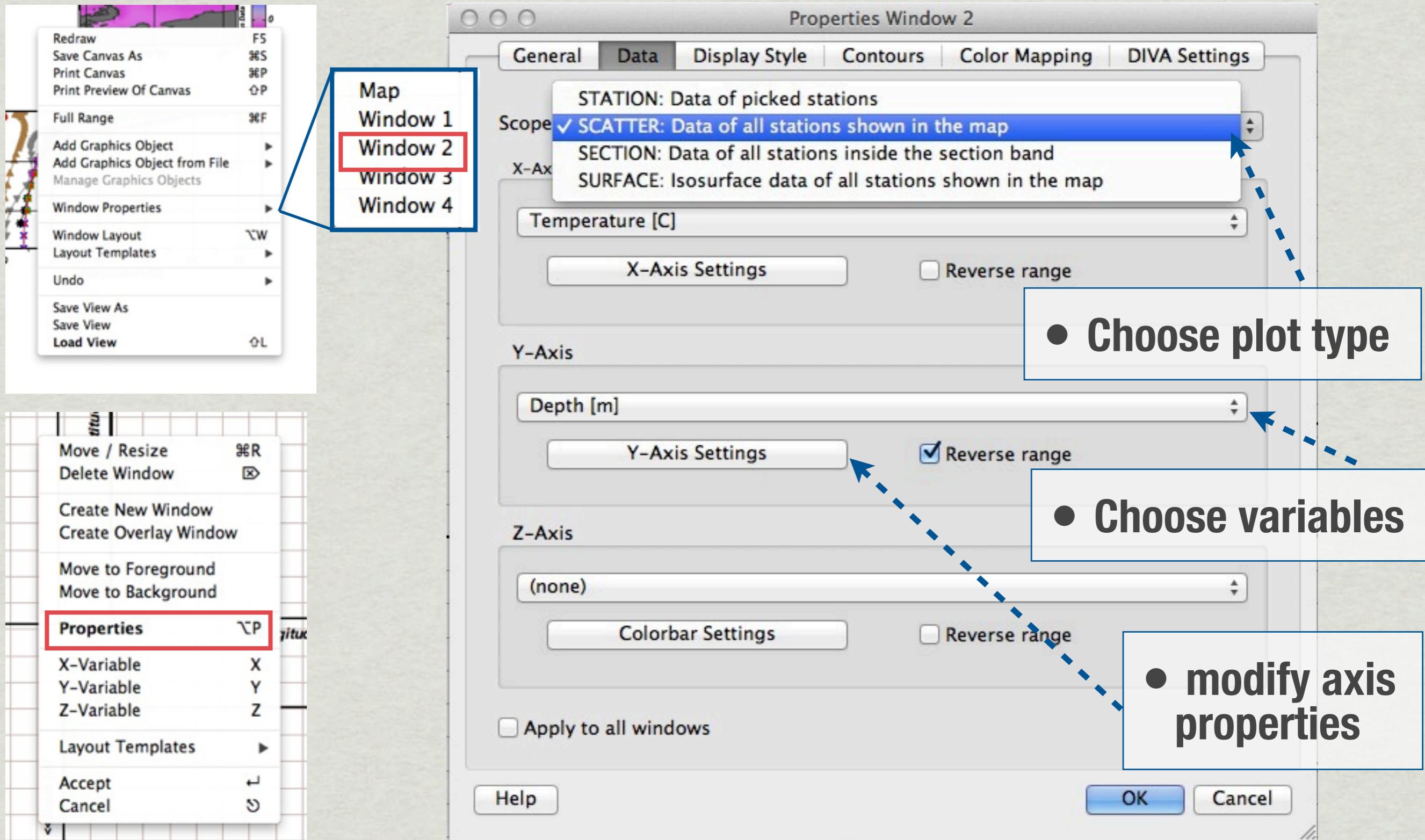
MODIFY

Quick-Start Guide



MODIFY

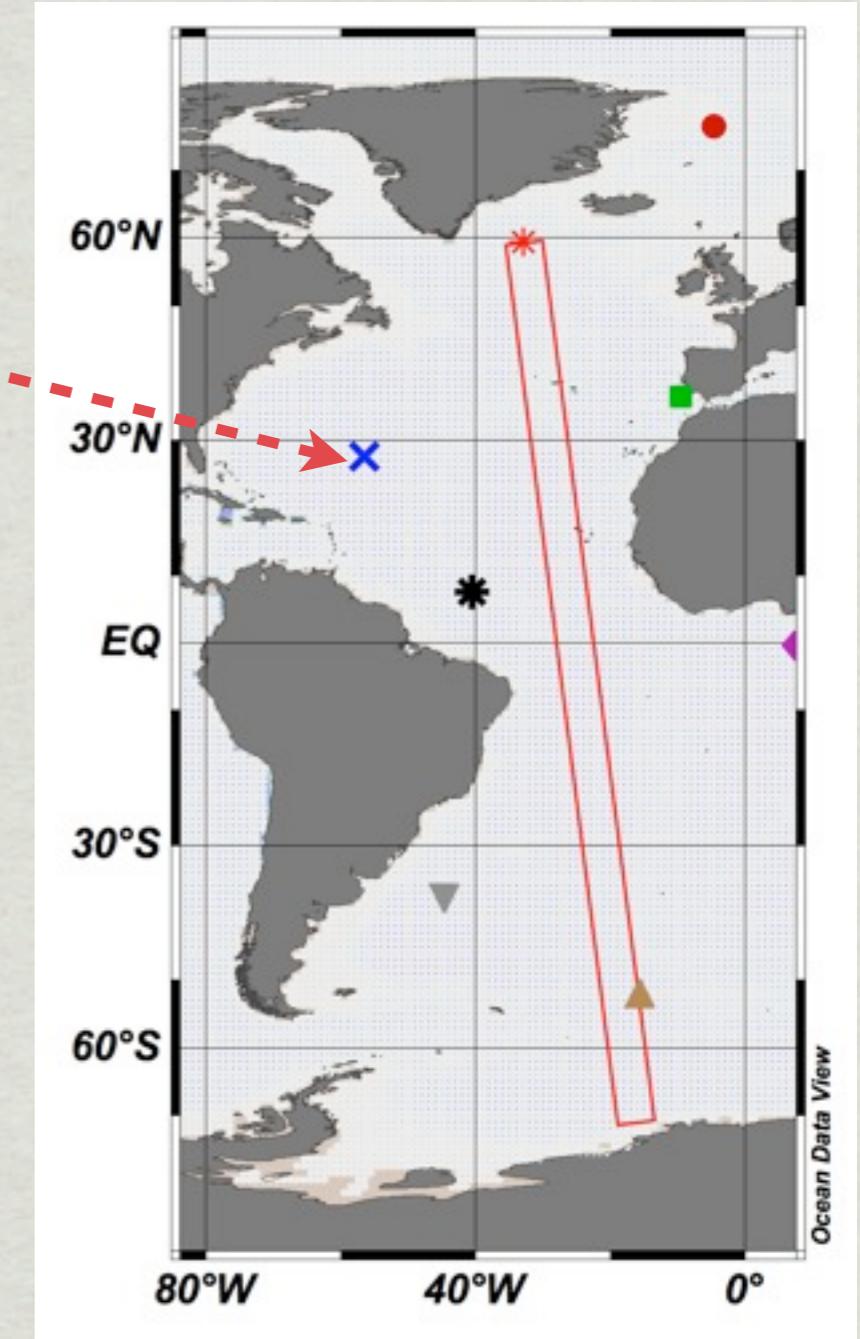
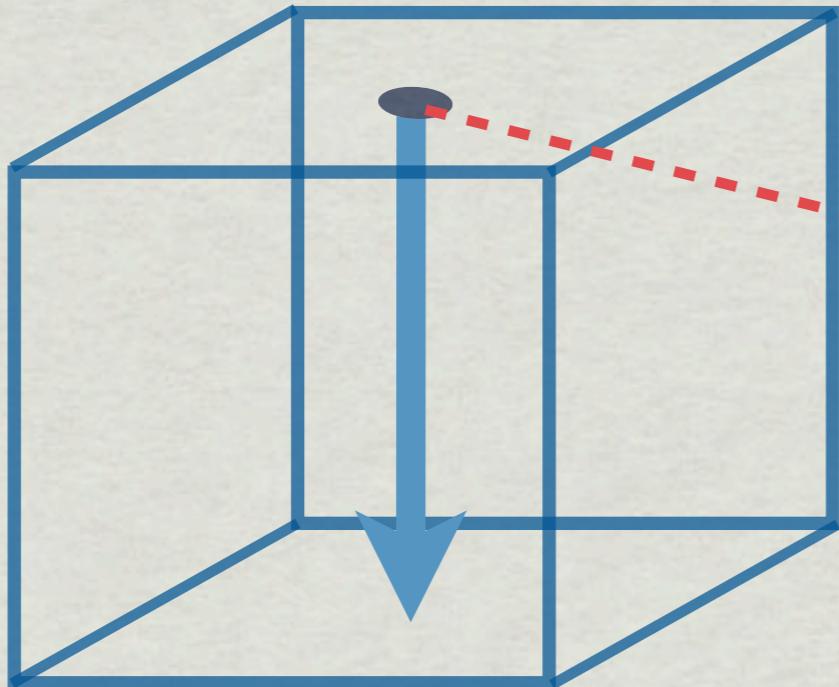
Quick-Start Guide



STATION PLOTS

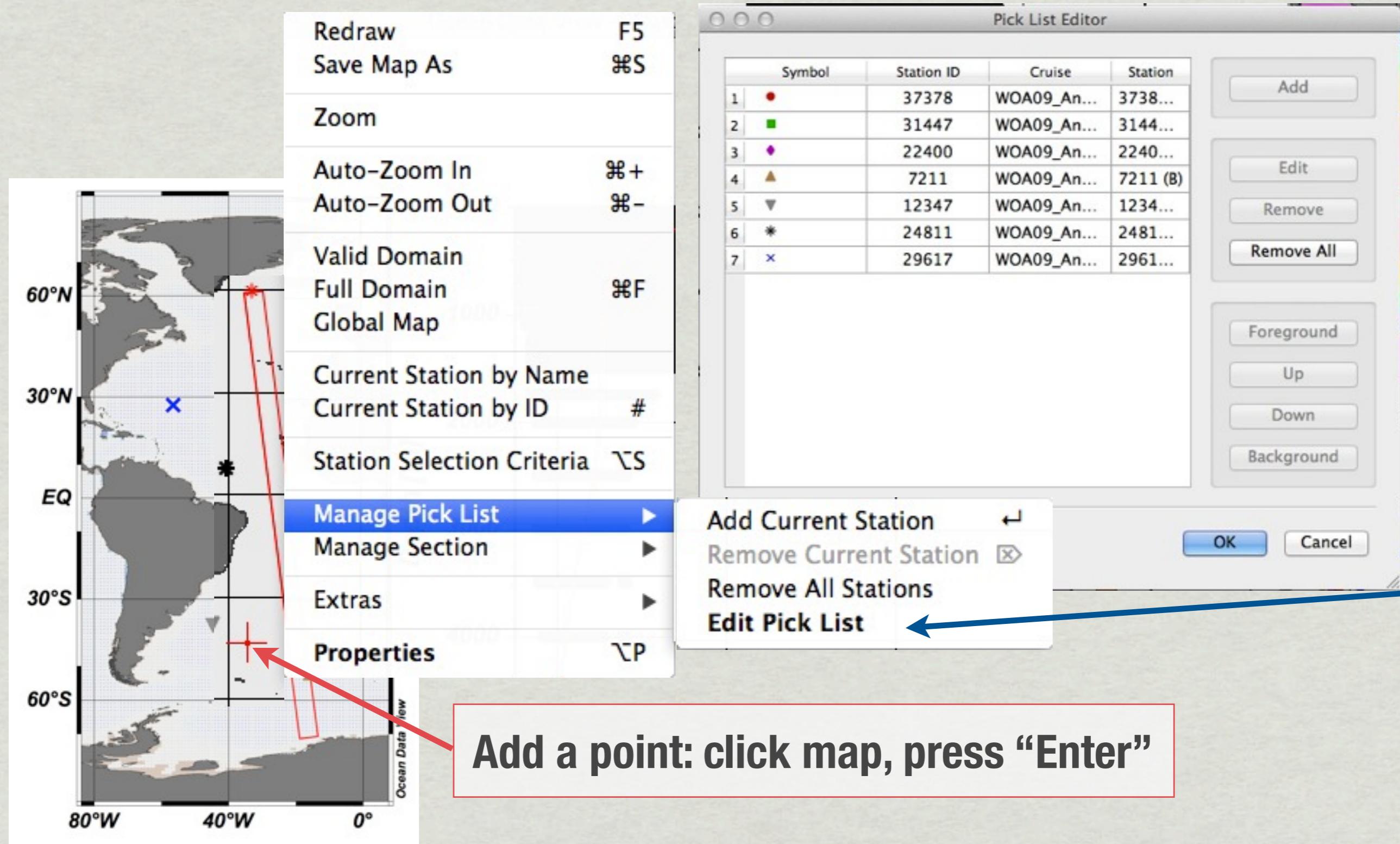
Data Visualization

- 1D
- (lat, long)= sitelD
- properties = {depth, measure. array}
- property/property trajectories



STATION PLOTS

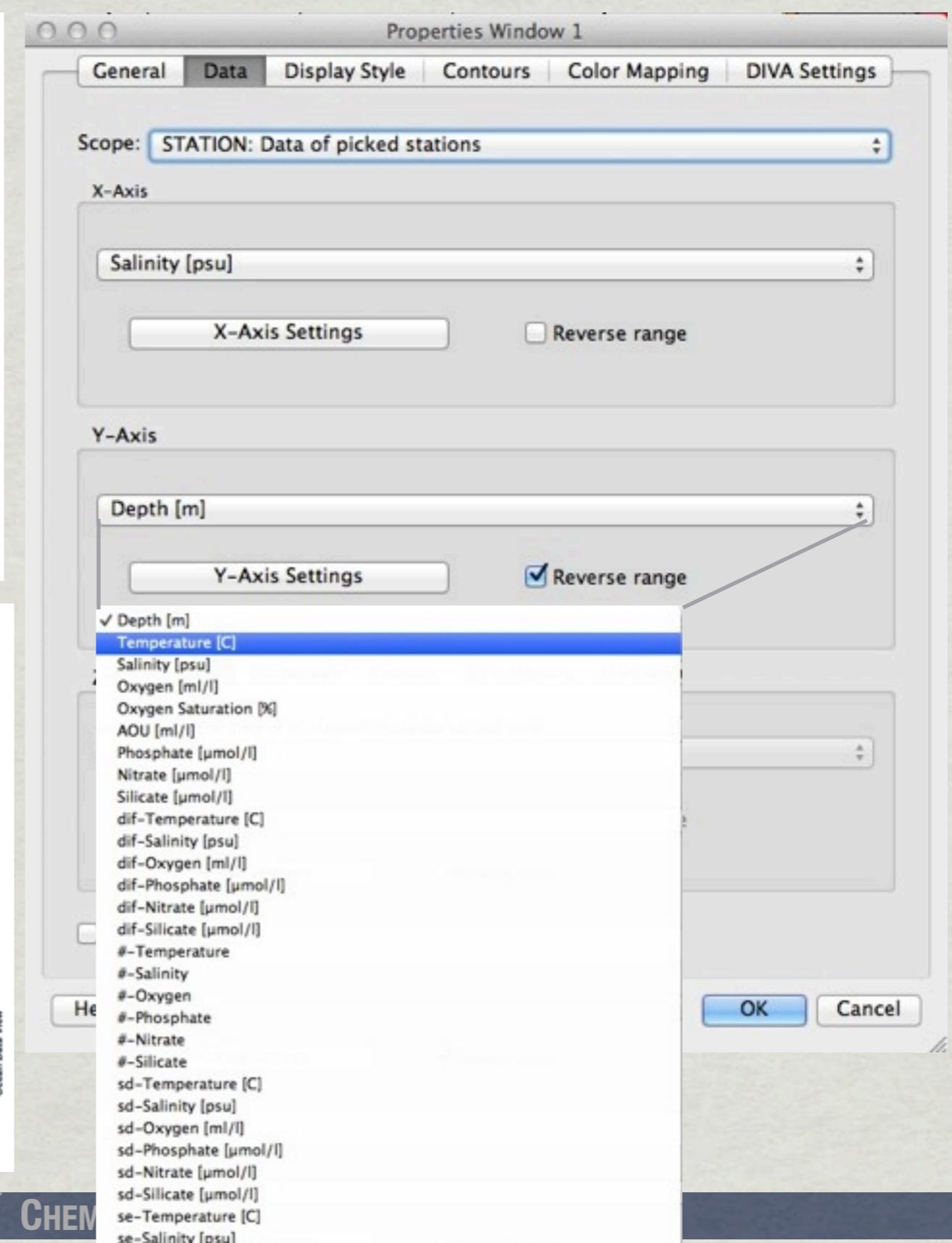
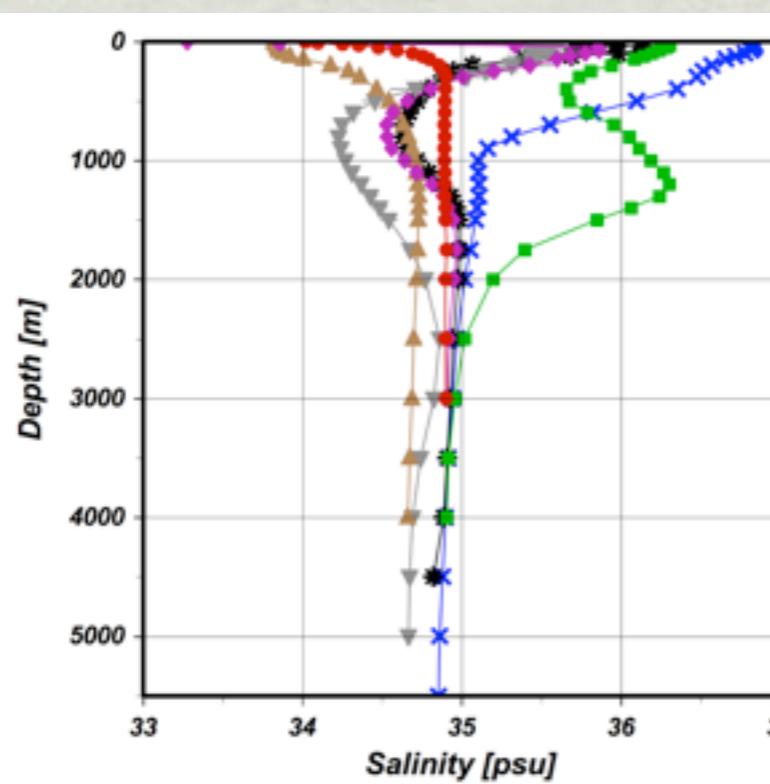
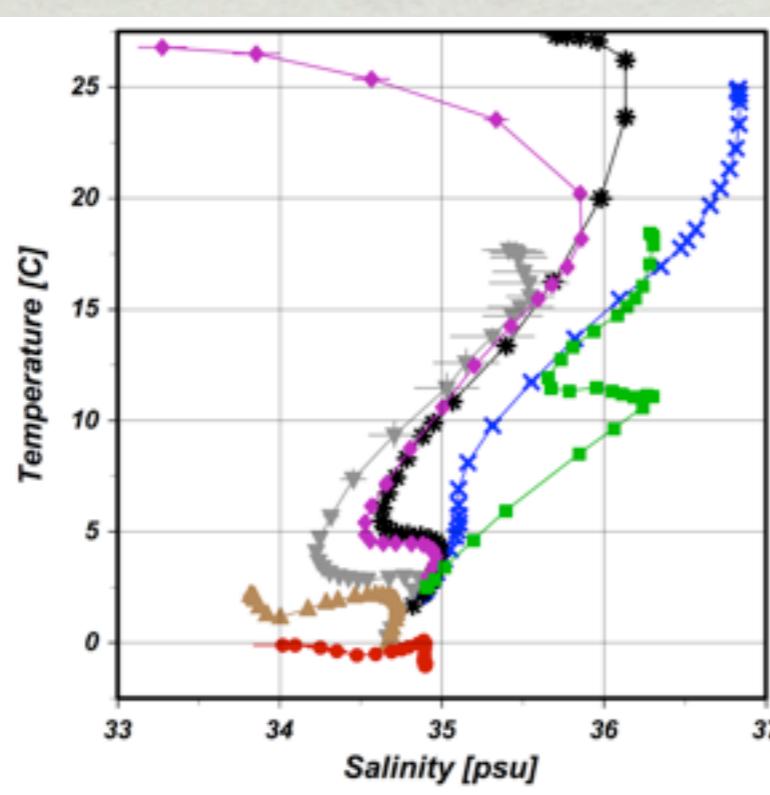
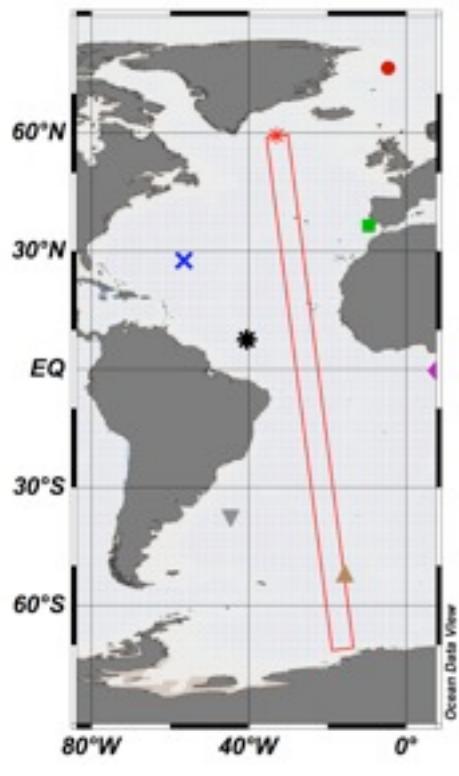
Data Visualization



Add a point: click map, press “Enter”

STATION PLOTS

Data Visualization

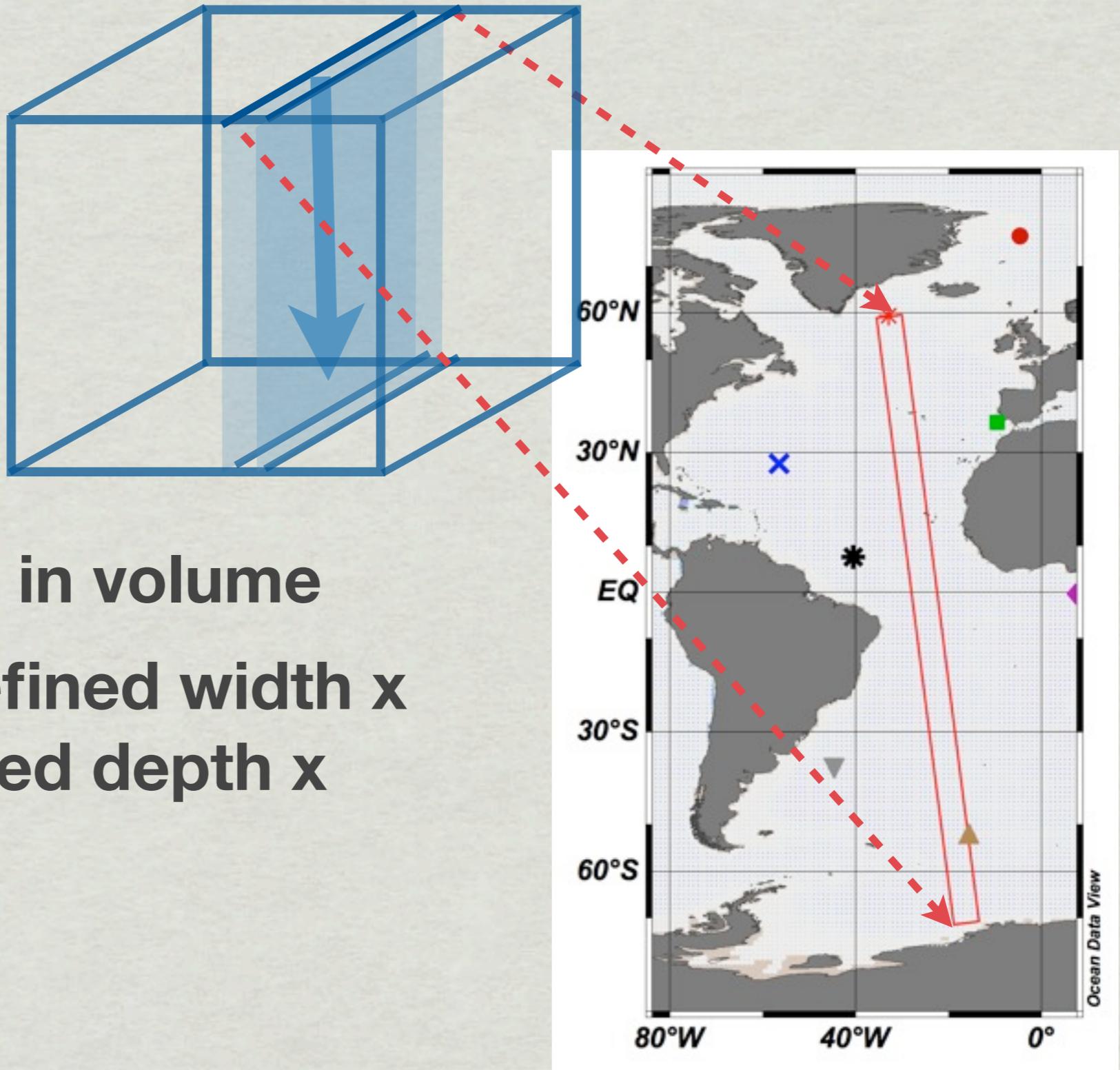


(X,Y, color)
= (property,
property,
stationID)

SECTION PLOTS

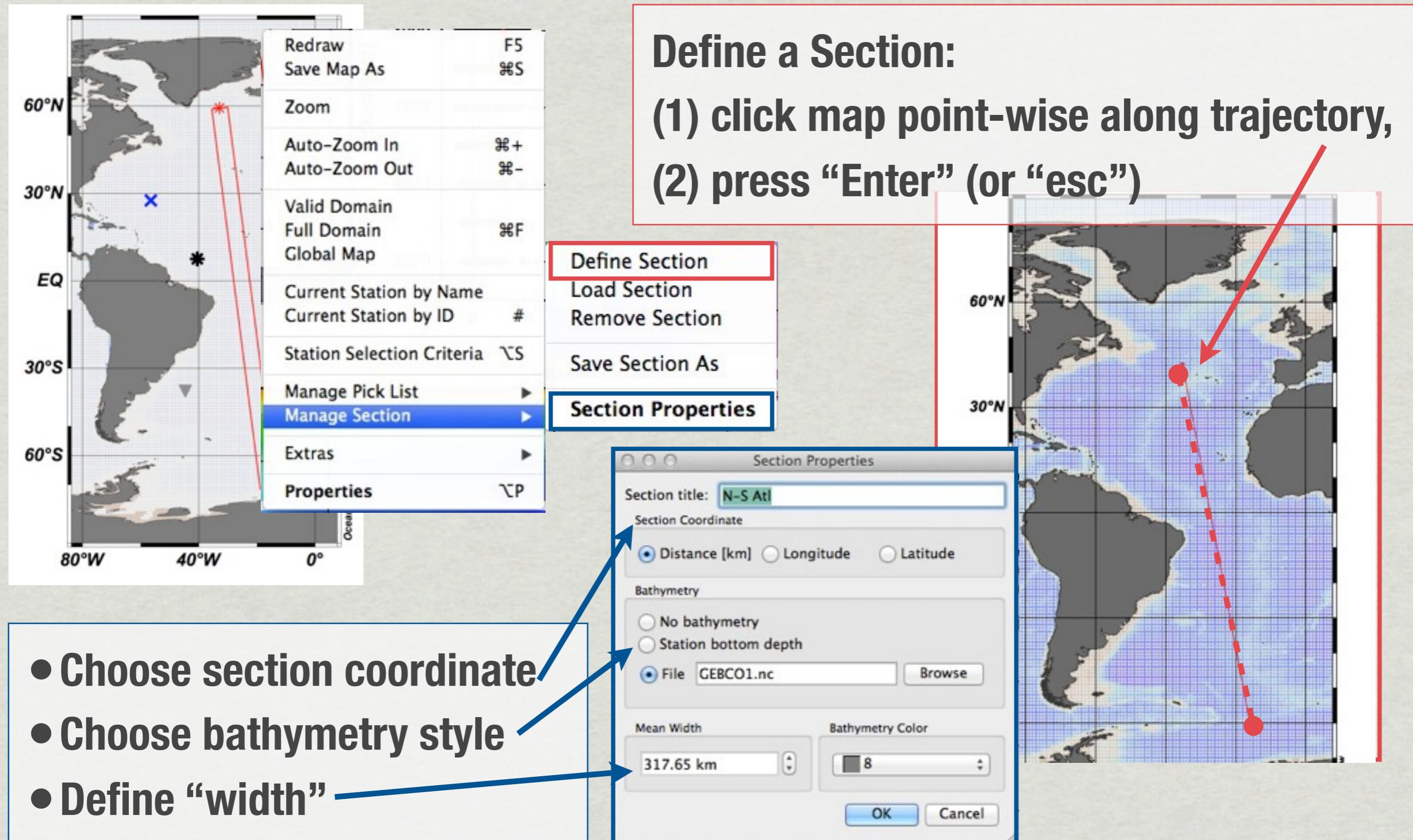
Data Visualization

- 2.5D
- (lat, long)-->
path with “width”
- section data = data in volume
→ **volume = user defined width x
bathymetry defined depth x
path length**



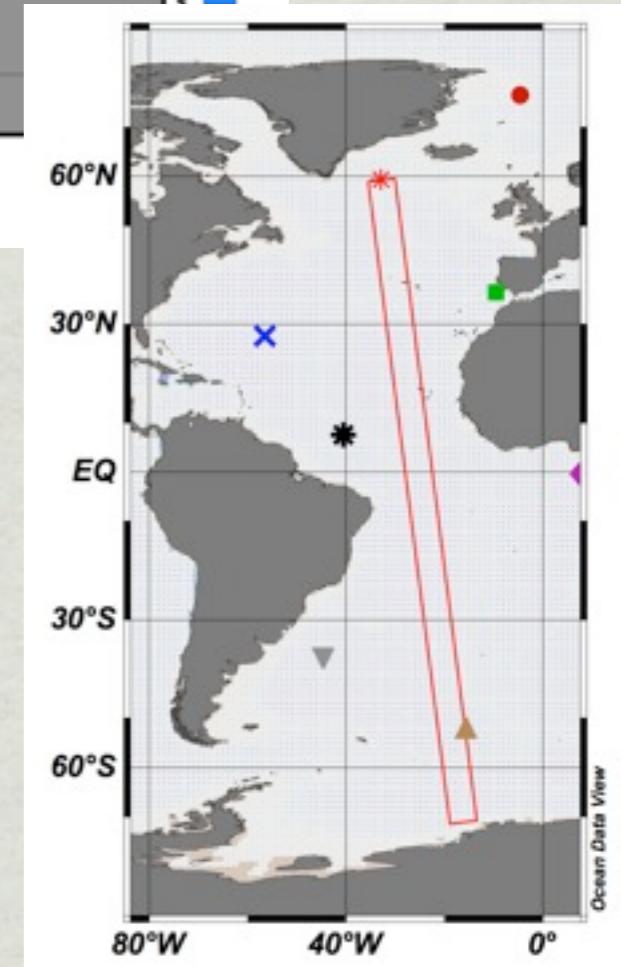
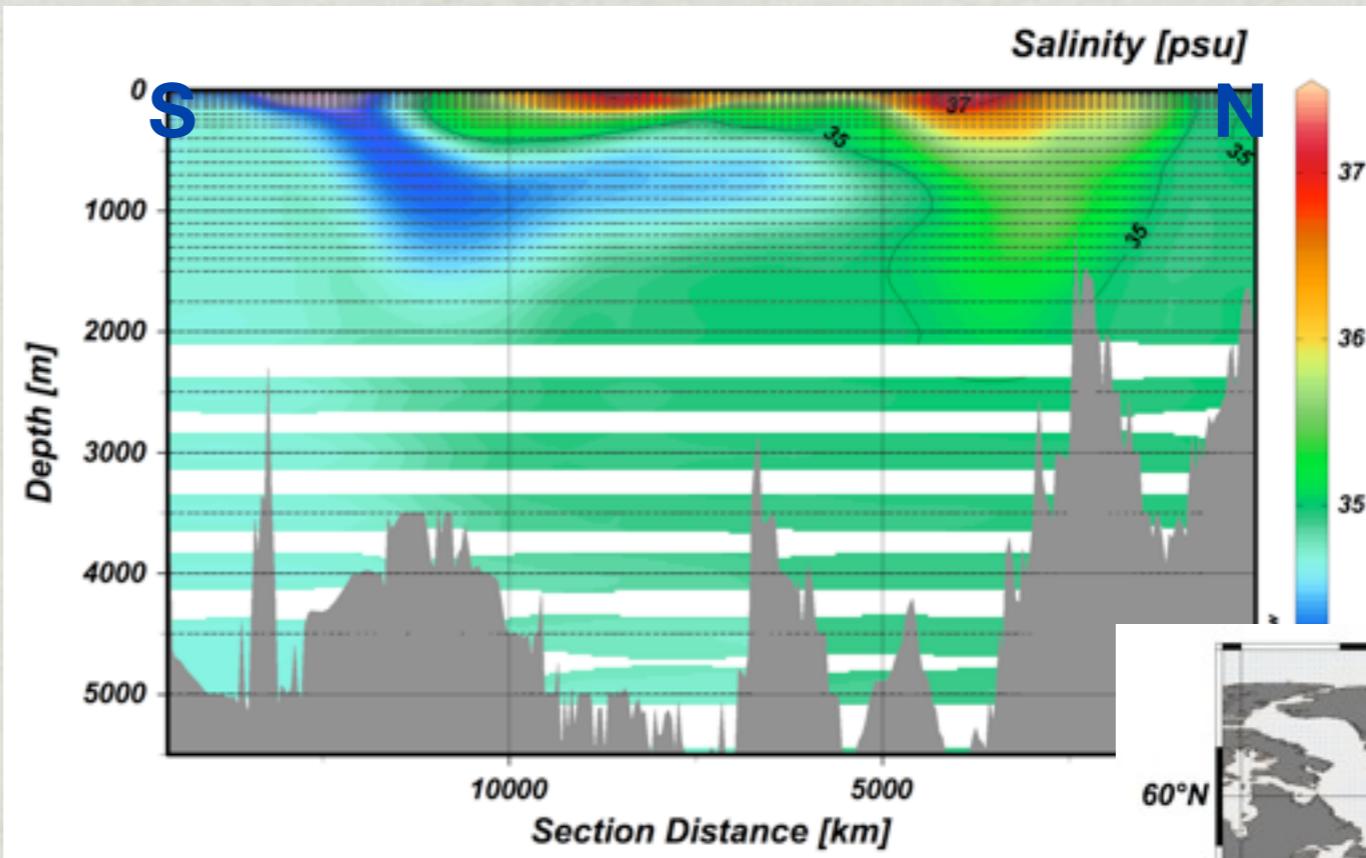
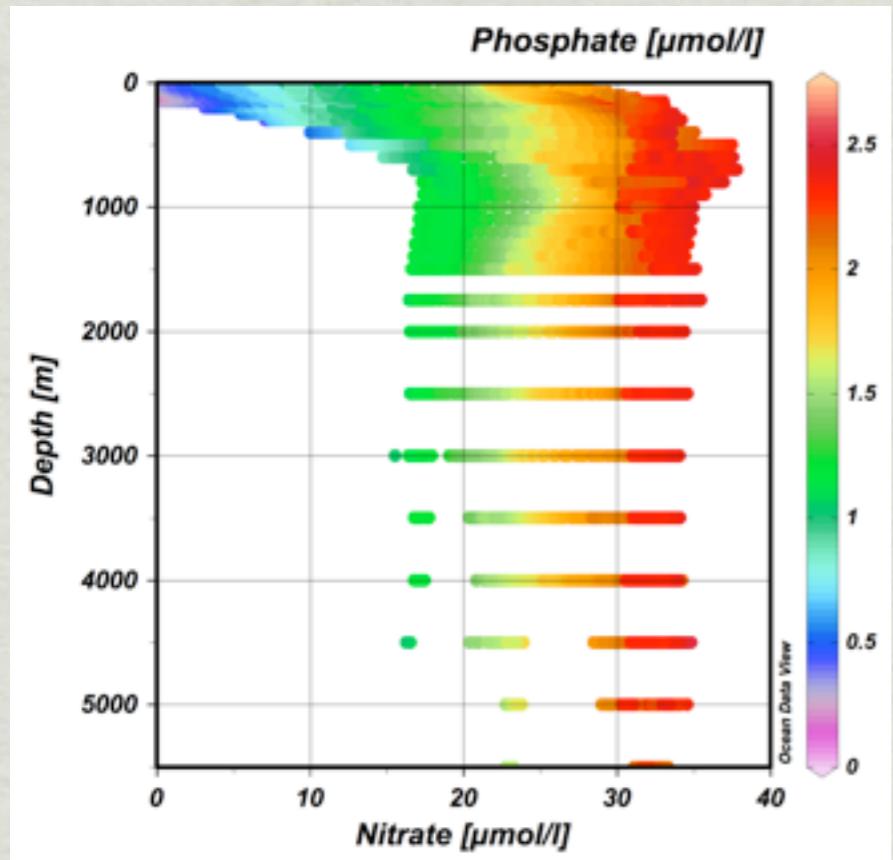
SECTION PLOTS

Data Visualization

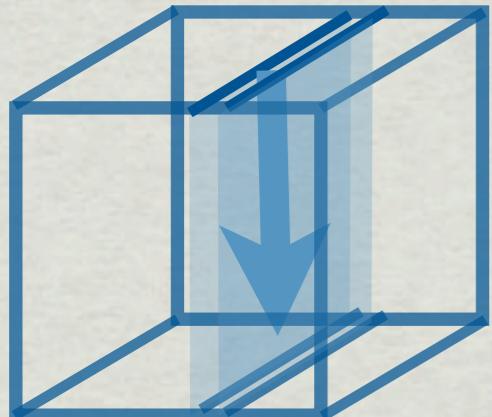


SECTION PLOTS

Data Visualization

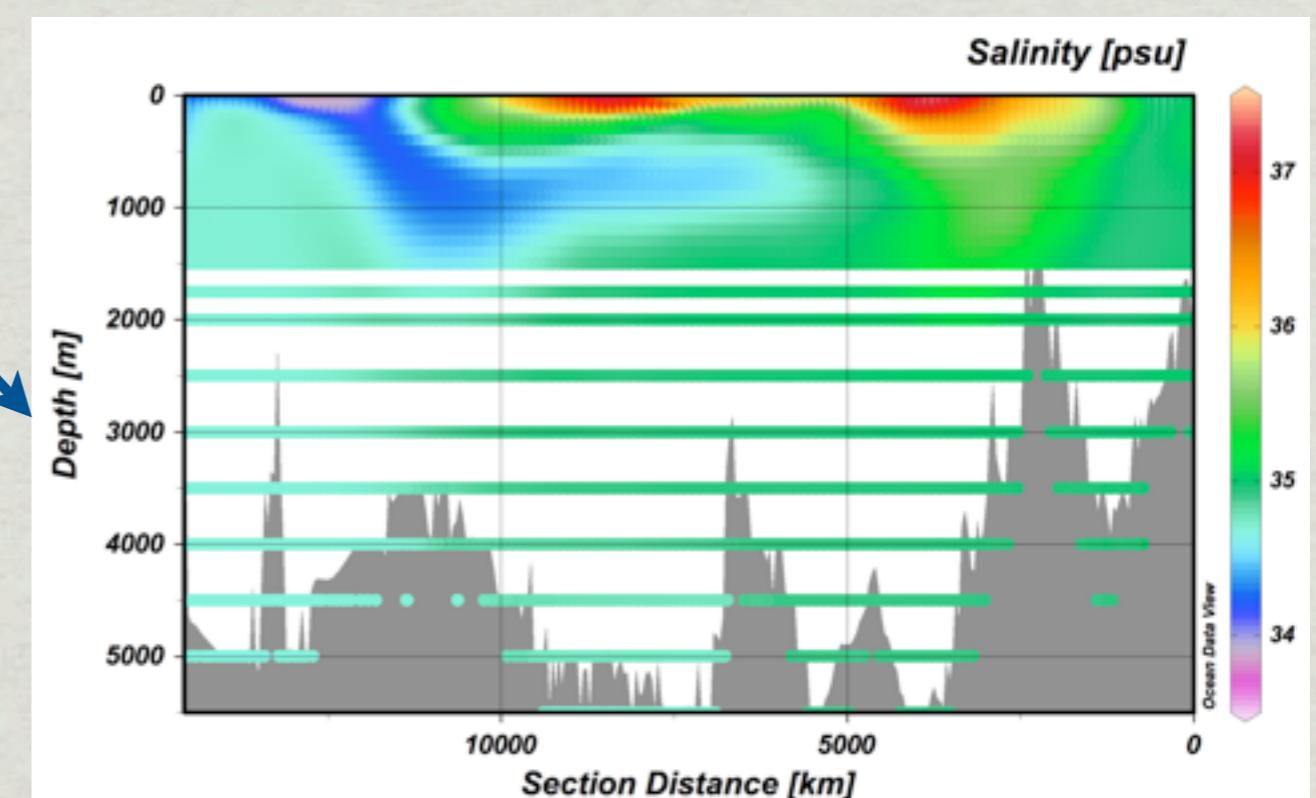
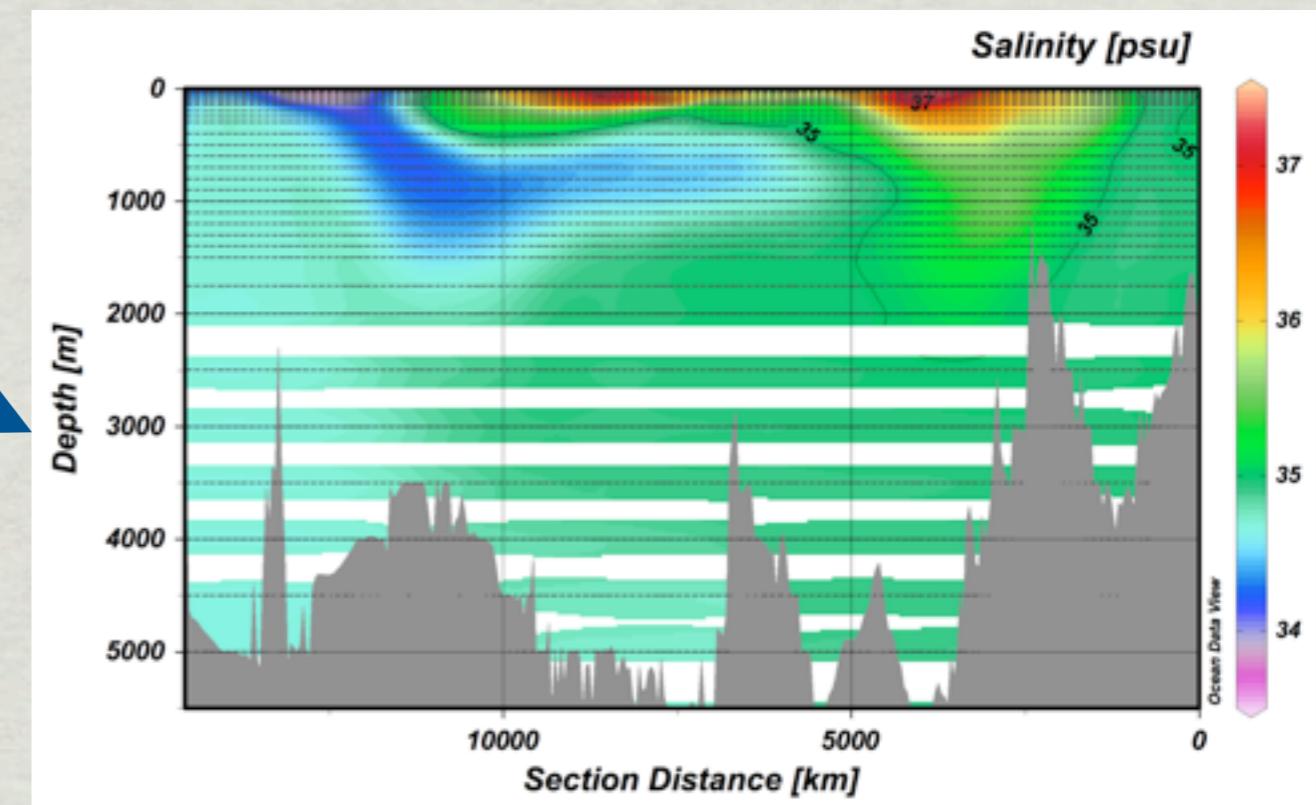
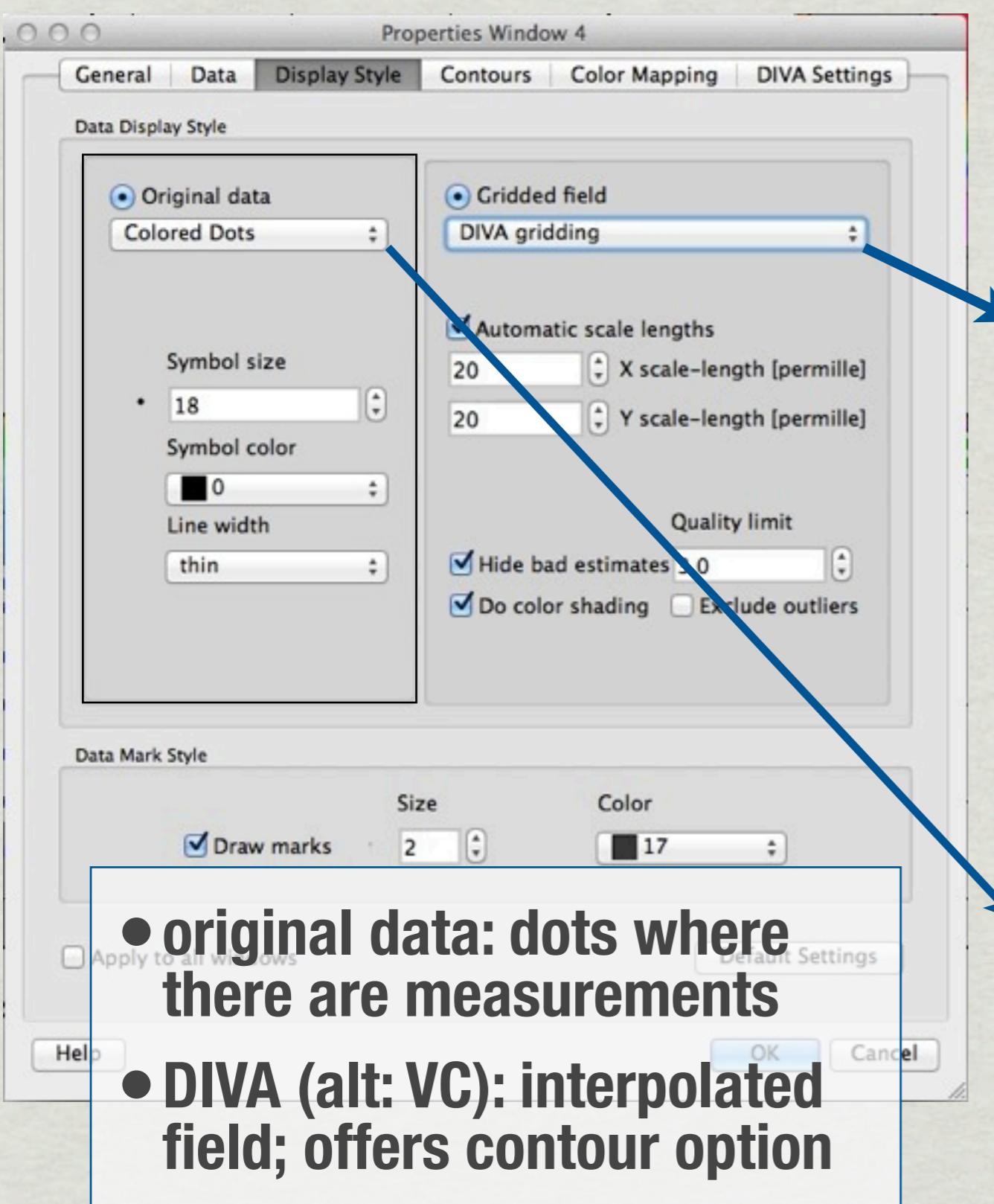


- property/property plots (X, Y, color) of all data in volume
- section distance/depth plots of width average of property



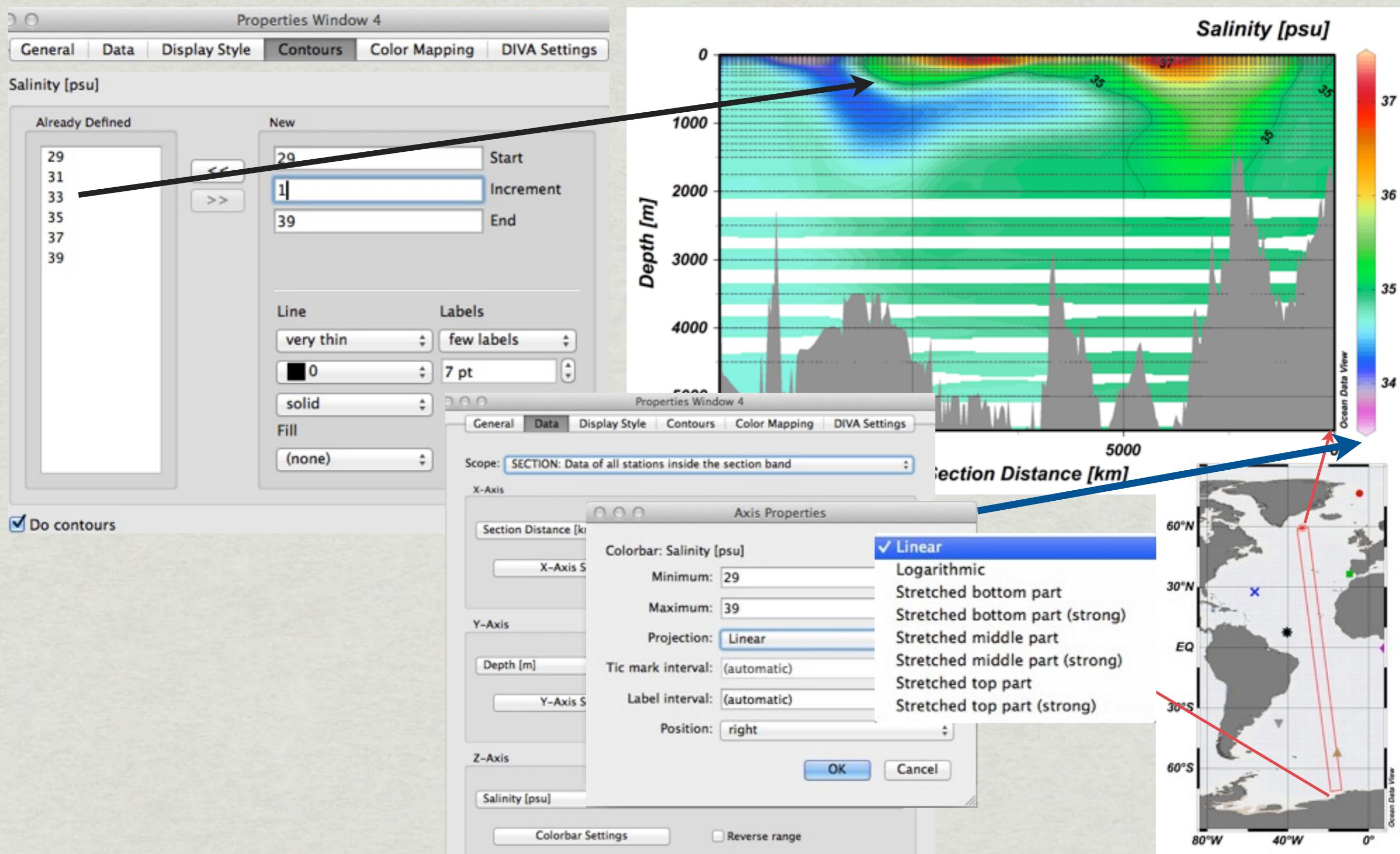
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Data Visualization



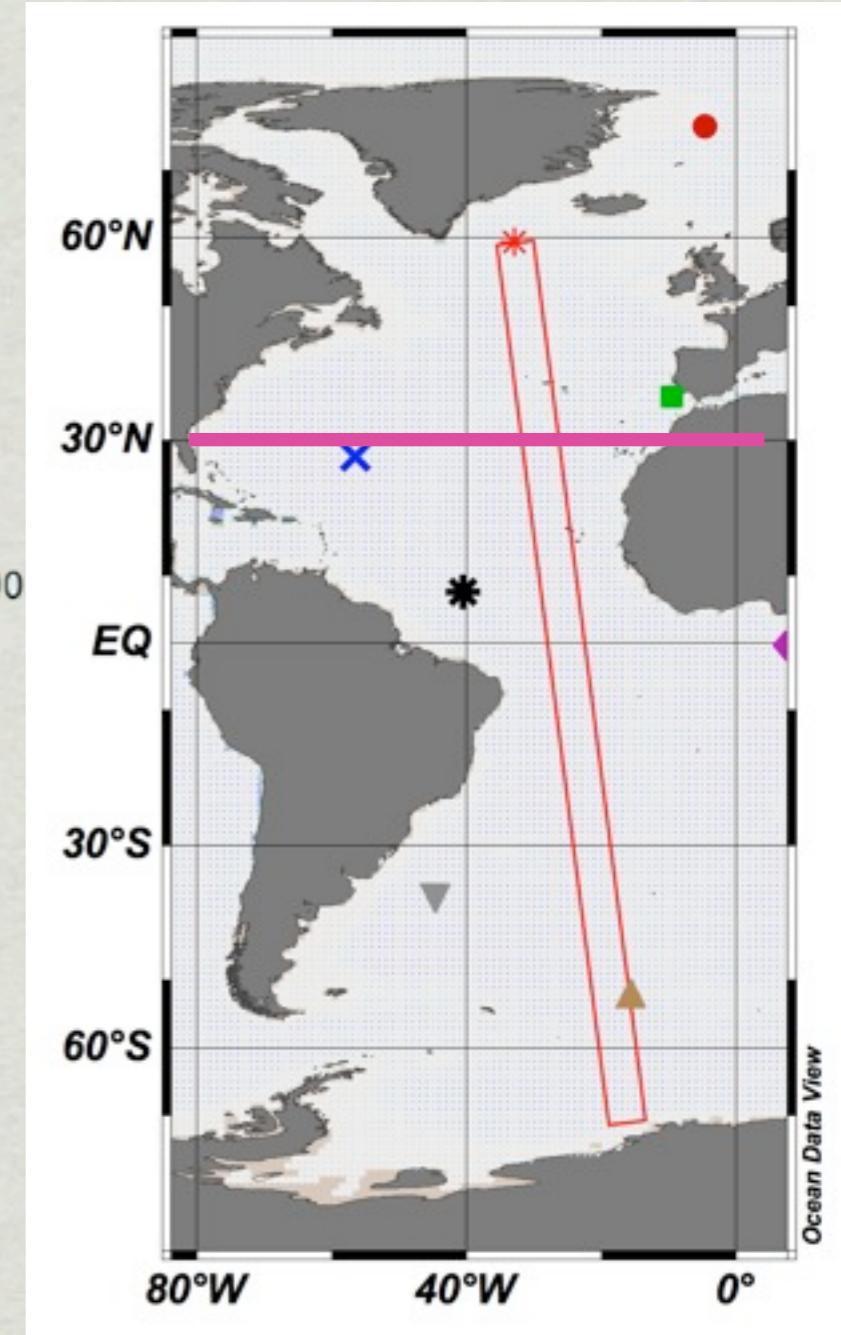
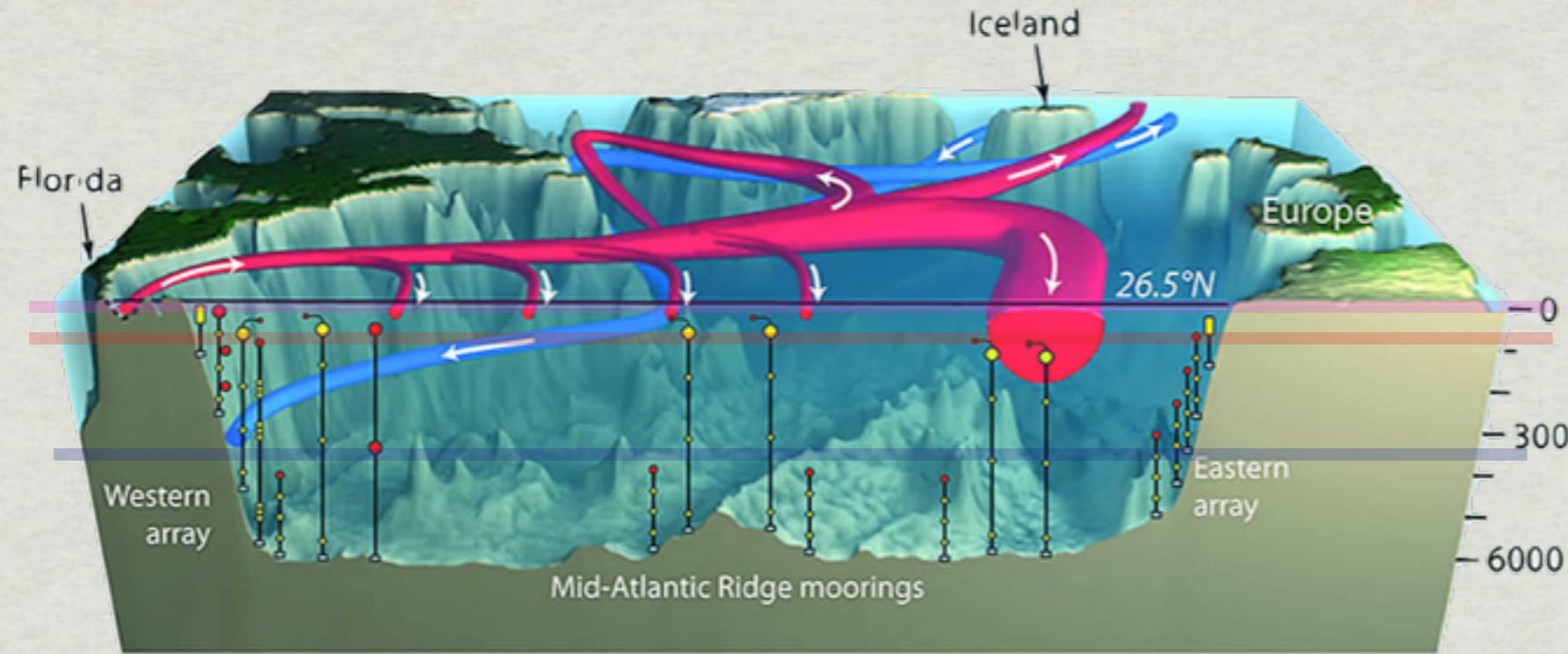
SECTION PLOTS

Data Visualization



SURFACE PLOTS

Data Visualization

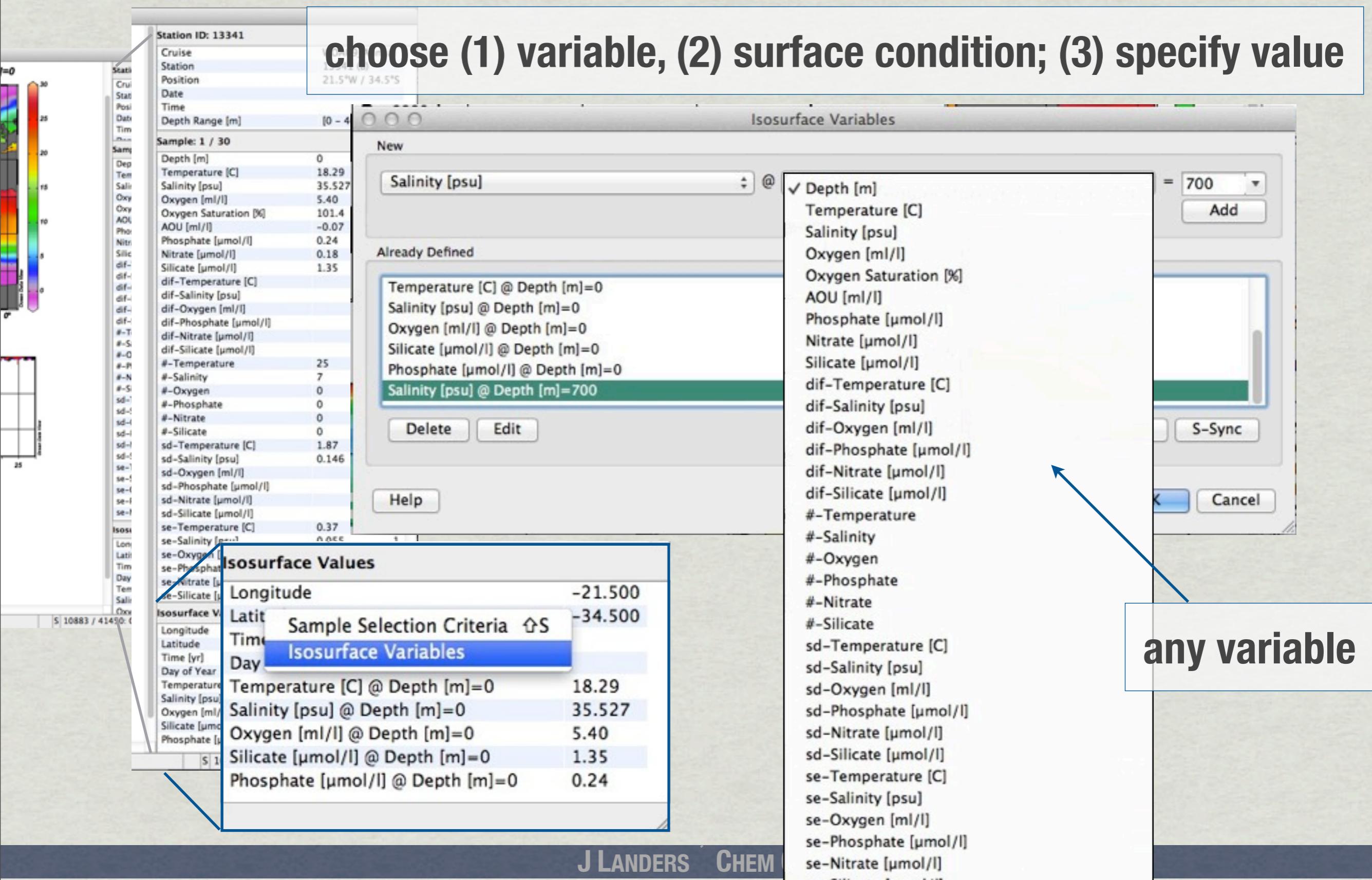


- 2D (lateral section)
- (lat x long)--> area
- depth defined by equal value surface
- SURFACE data = data lying in plane depth)

<HTTP://PLANETEARTH.NERC.AC.UK/FEATURES/STORY.ASPX?ID=80>

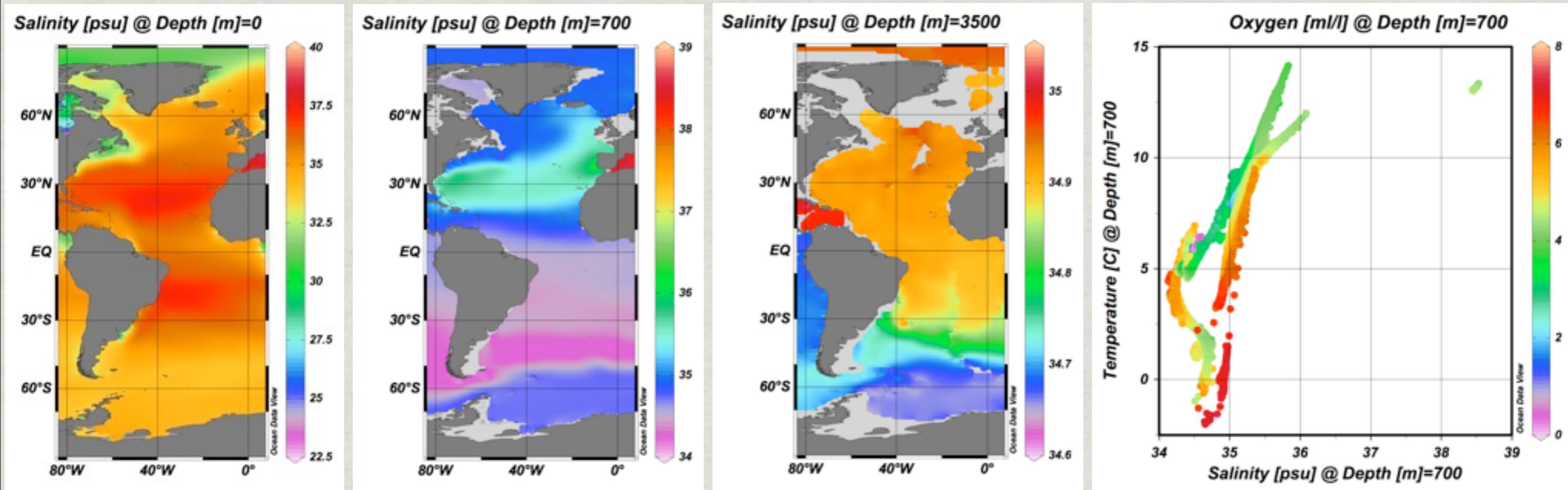
SURFACE PLOTS

Data Visualization

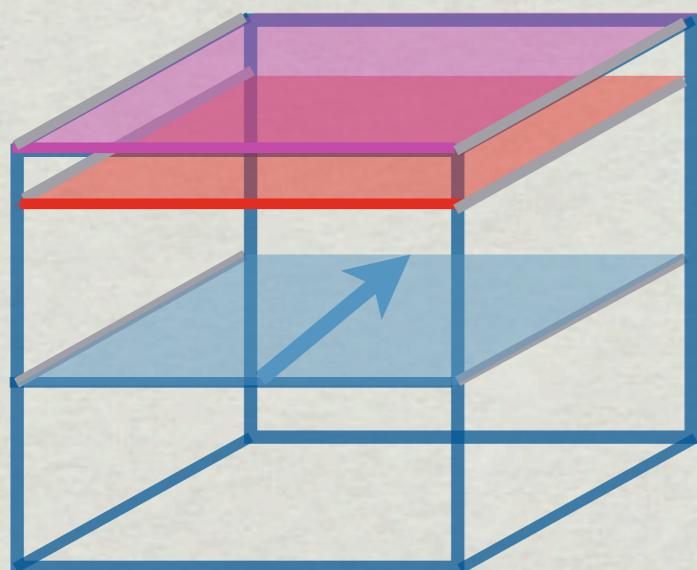


SURFACE PLOTS

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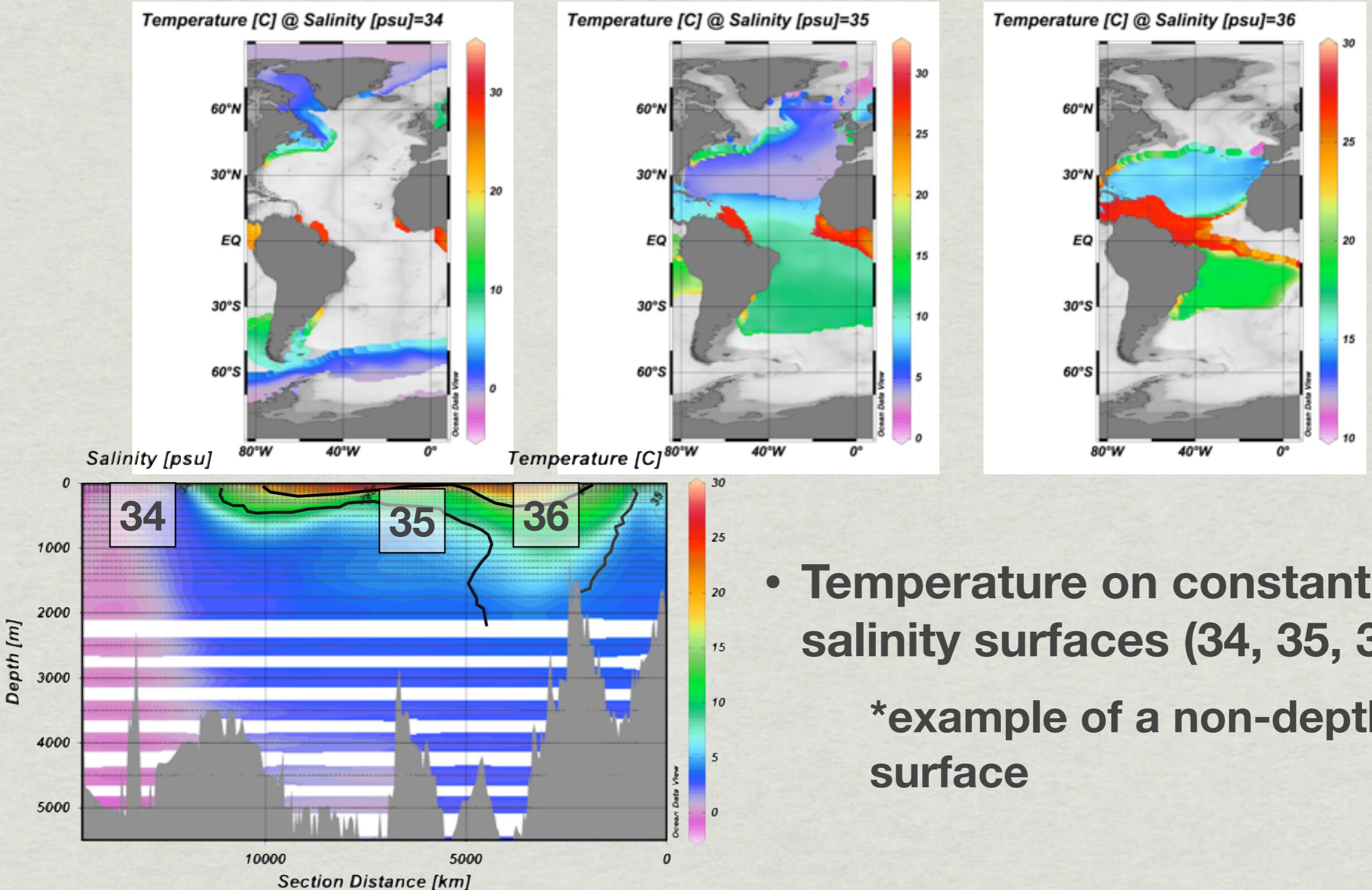


- property/property plots (X, Y, color) of data on a given surface
- plots are of data specifically available at that surface or interpolated based on “good coverage criteria”



SURFACE PLOTS

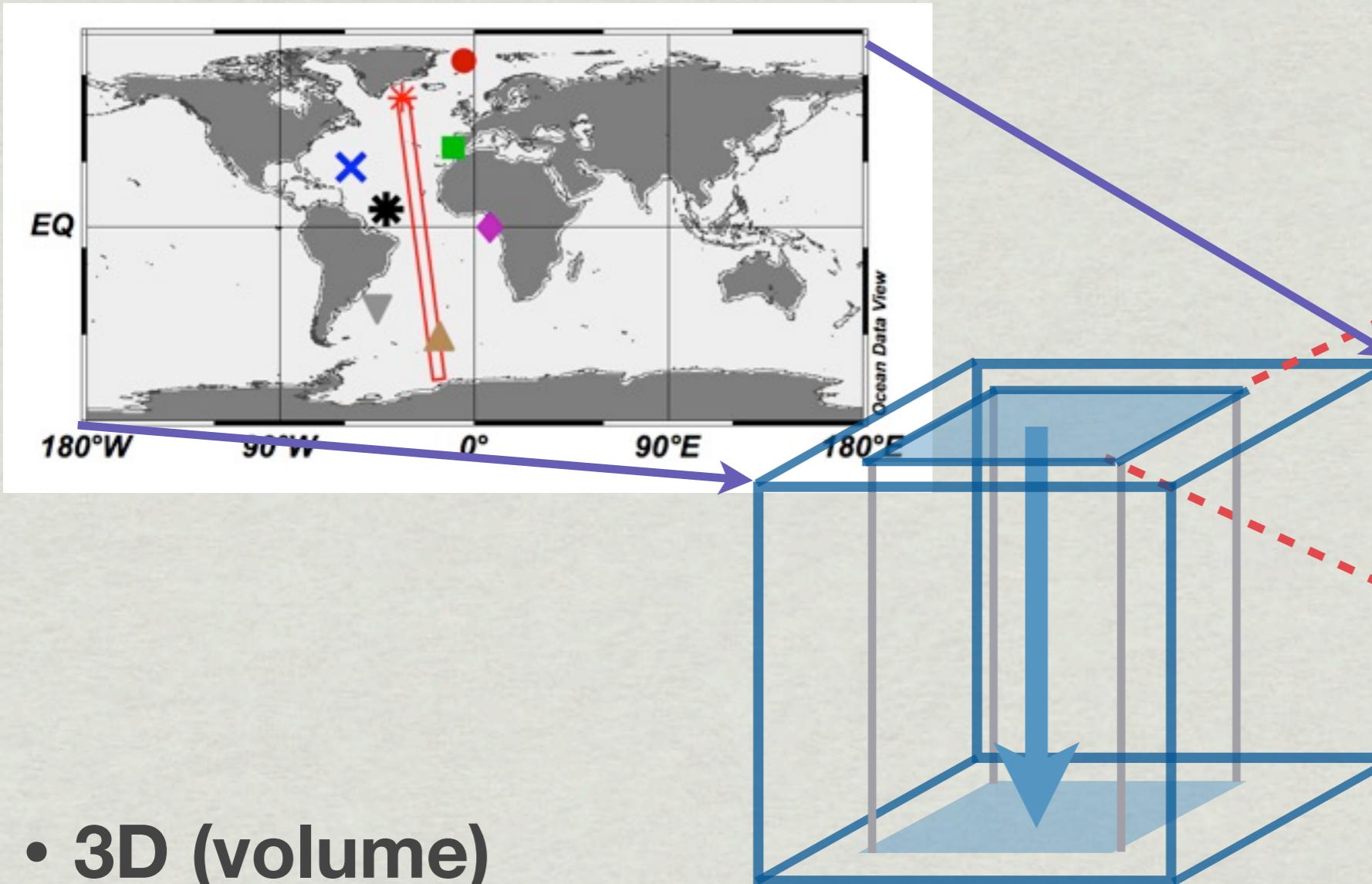
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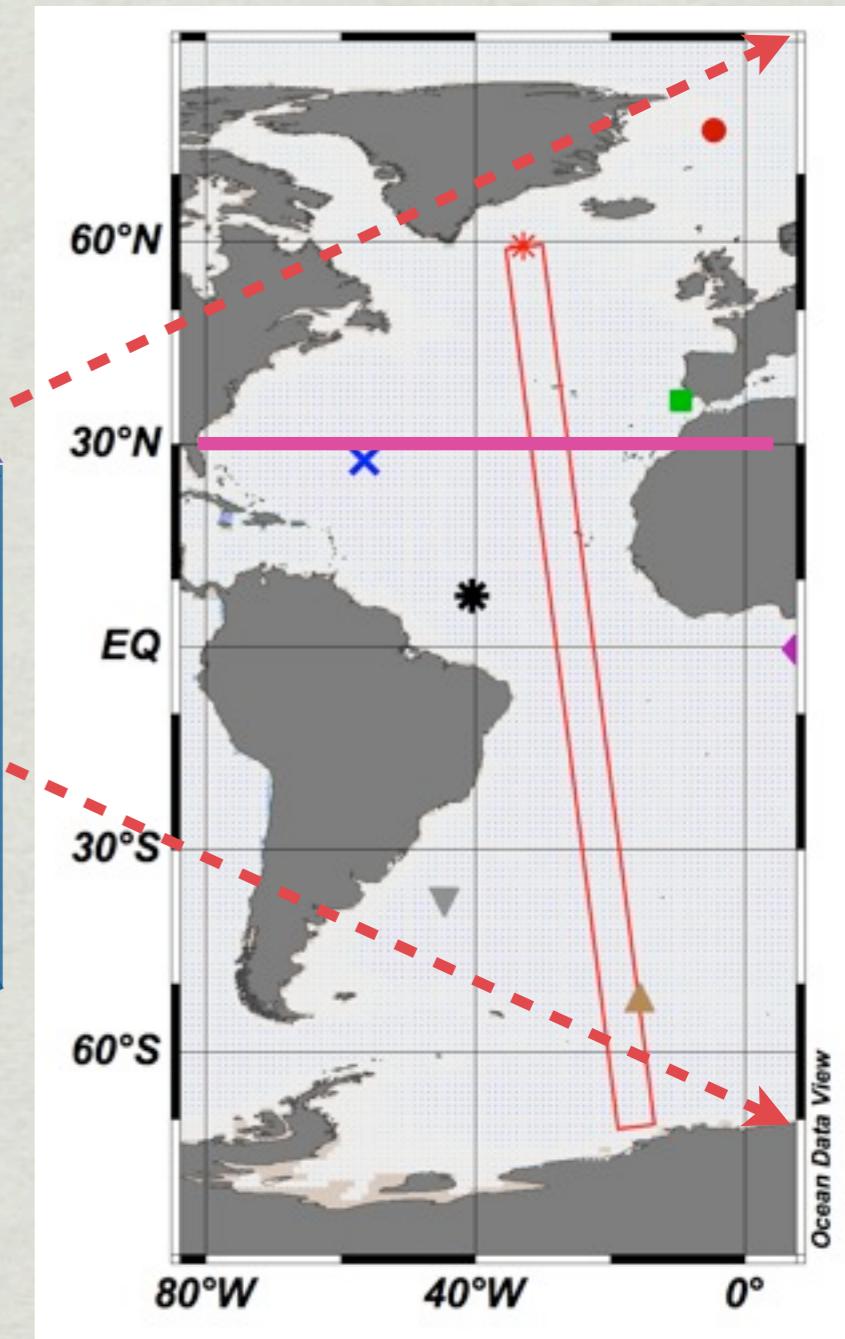
- Temperature on constant salinity surfaces (34, 35, 36)
- *example of a non-depth surface

SCATTER PLOTS

Data Visualization



- 3D (volume)
- (lat x long)--> defined area
- SCATTER data = data in volume of surface area integrated over ocean floor depth

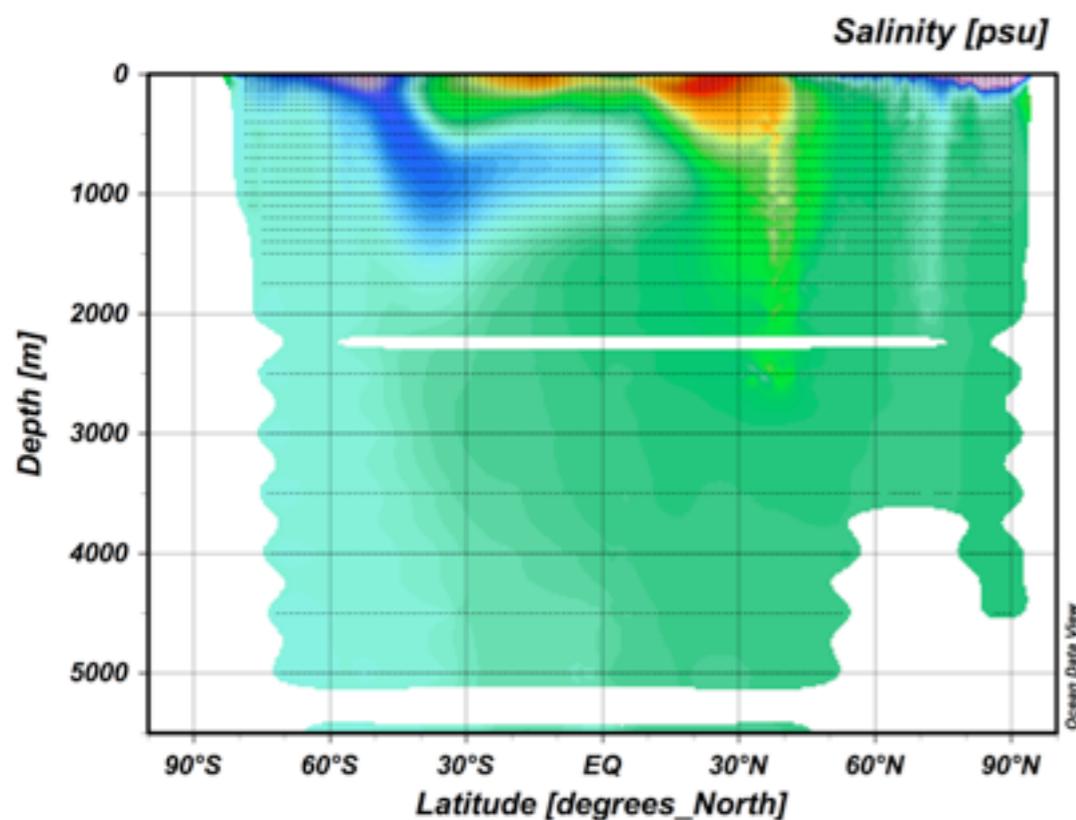


SCATTER PLOTS

Data Visualization

- Each data point (lat, long, depth, property) exists independently within the defined volume
 - ... *almost* possible to make all other plots by cleverly arranging phrasing a scatter plot

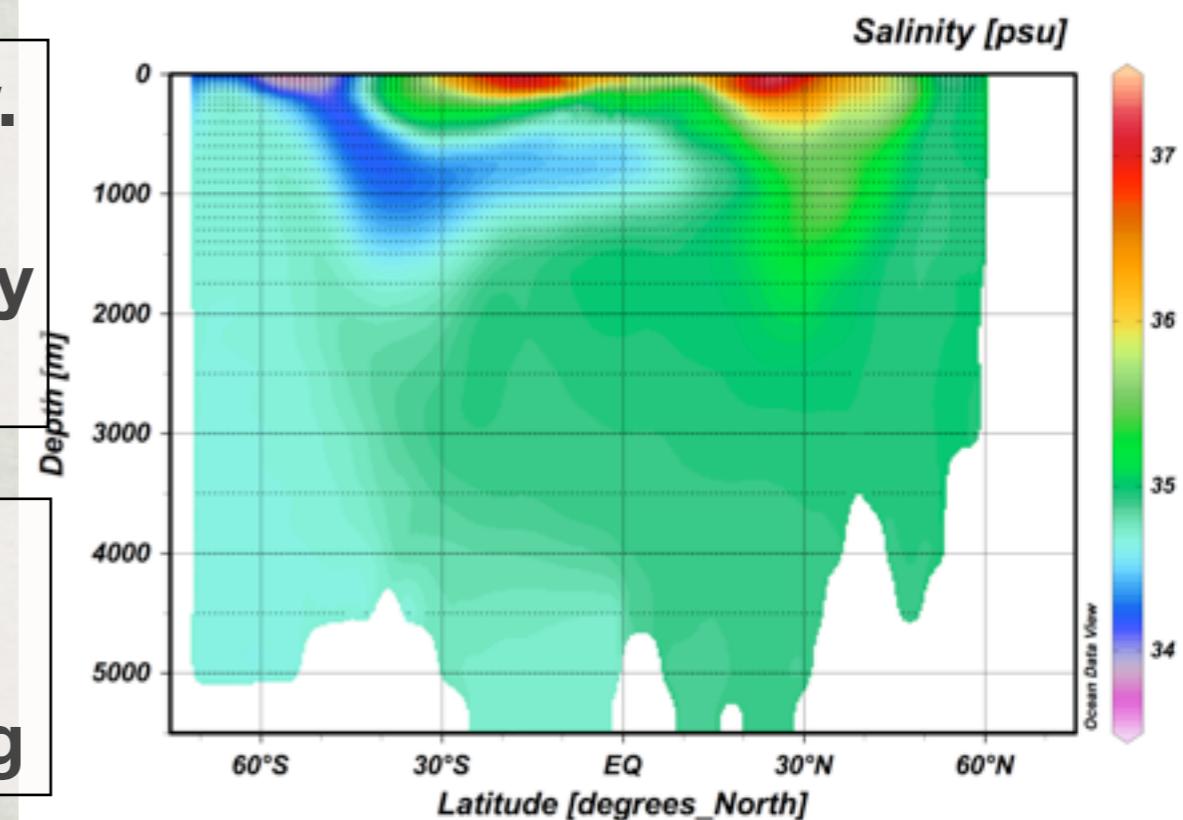
SCATTER



latitude v.
depth,
colored by
salinity

greater
zonal
averaging

SECTION

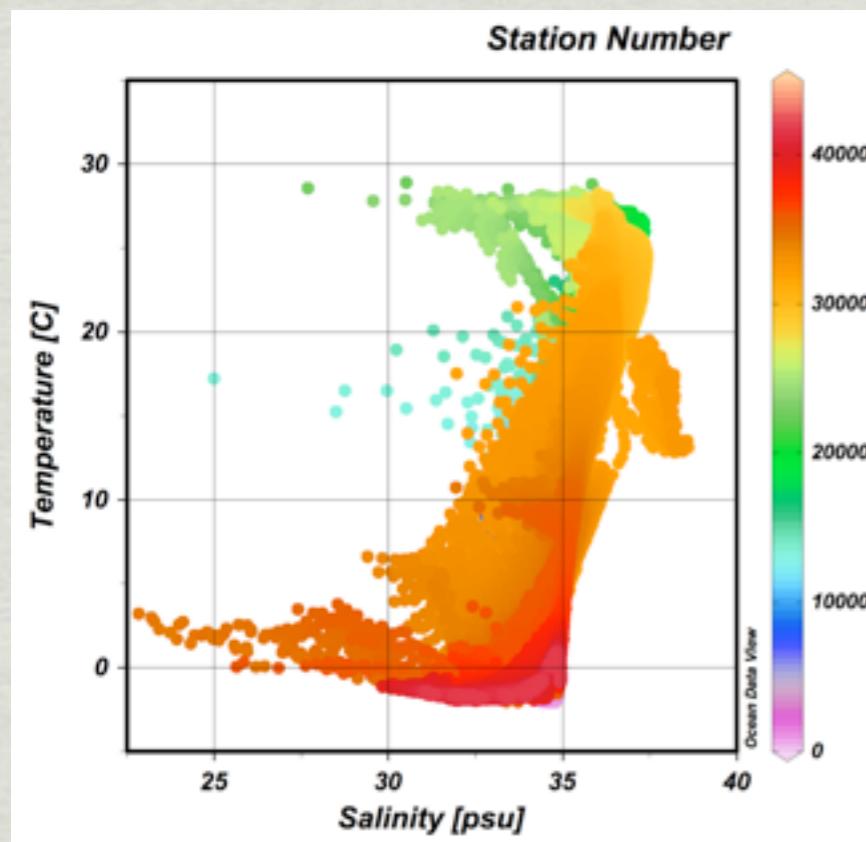


SCATTER PLOTS

Data Visualization

- Each data point (lat, long, depth, property) exists independently within the defined volume
 - ... *almost* possible to make all other plots by cleverly arranging phrasing a scatter plot

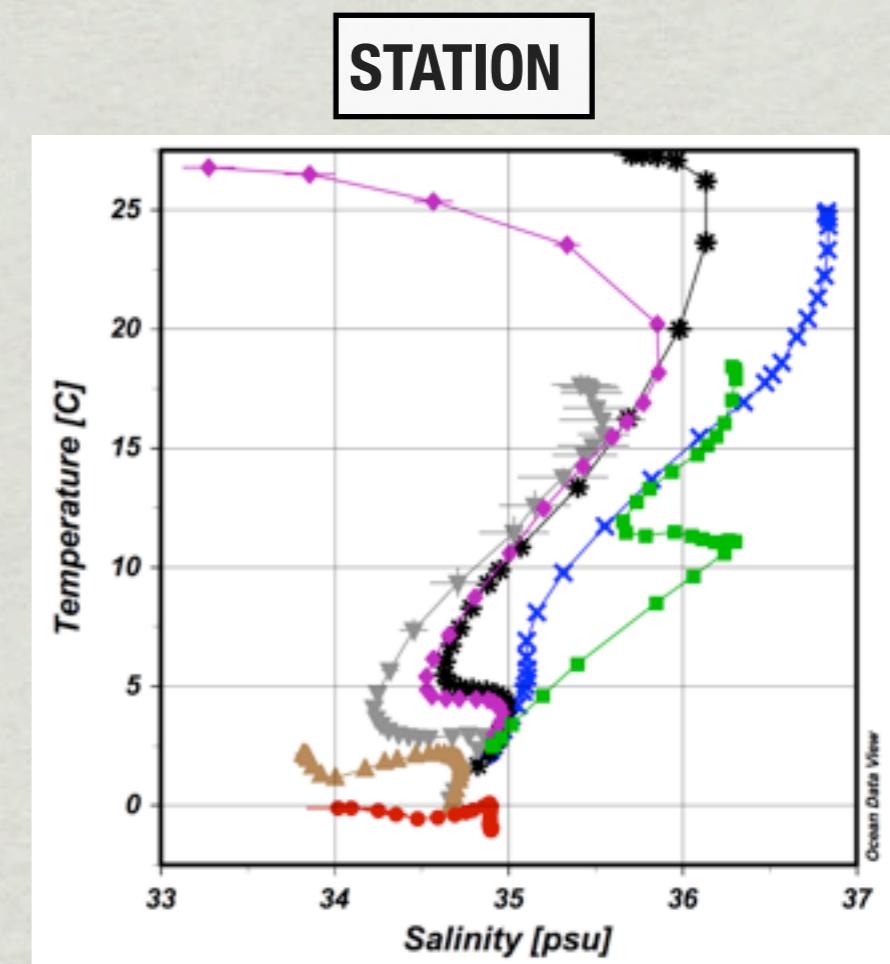
SCATTER



STATION

salinity v.
temperature,
colored by
SiteID

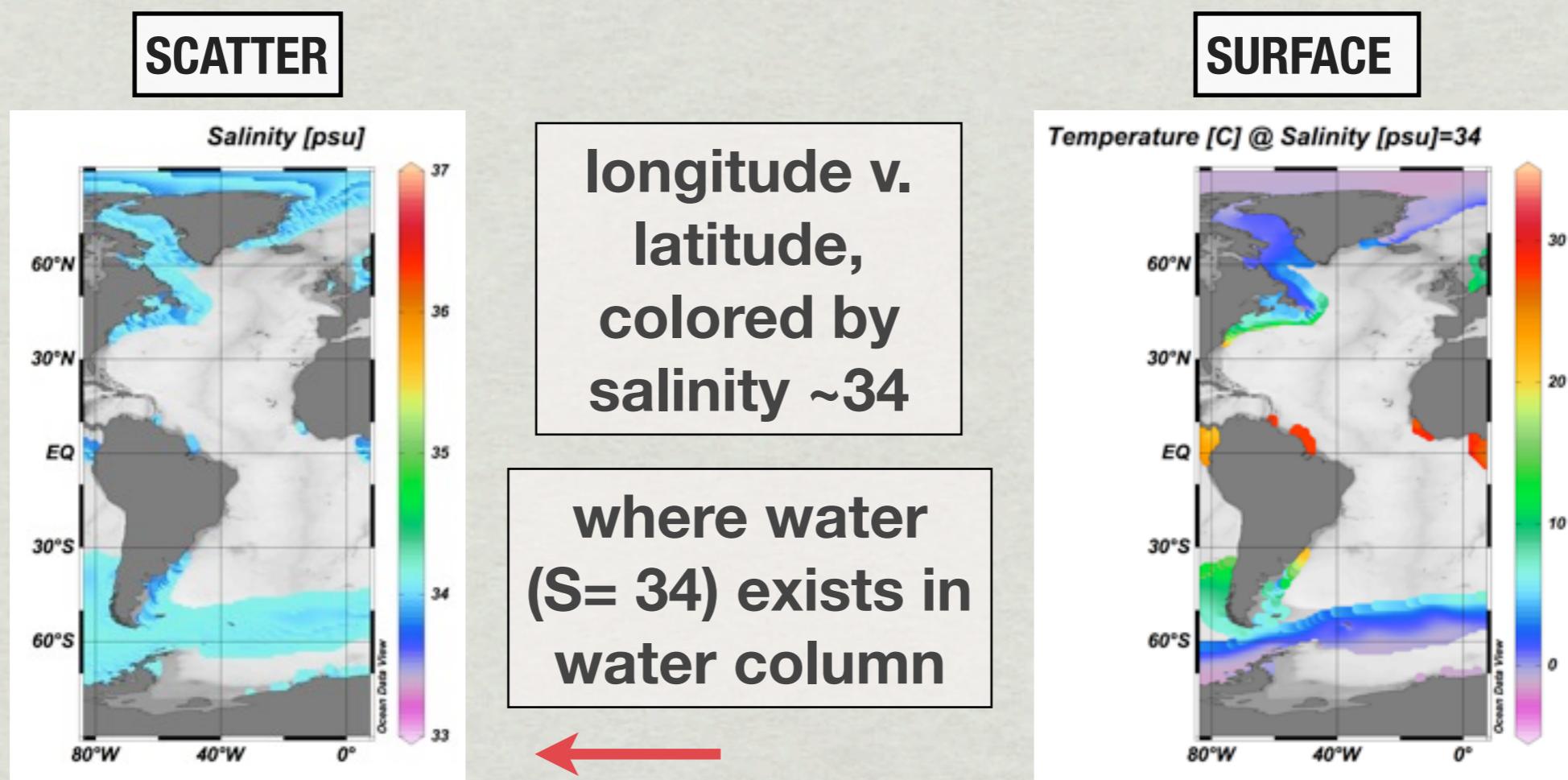
many more
SiteIDs...



SCATTER PLOTS

Data Visualization

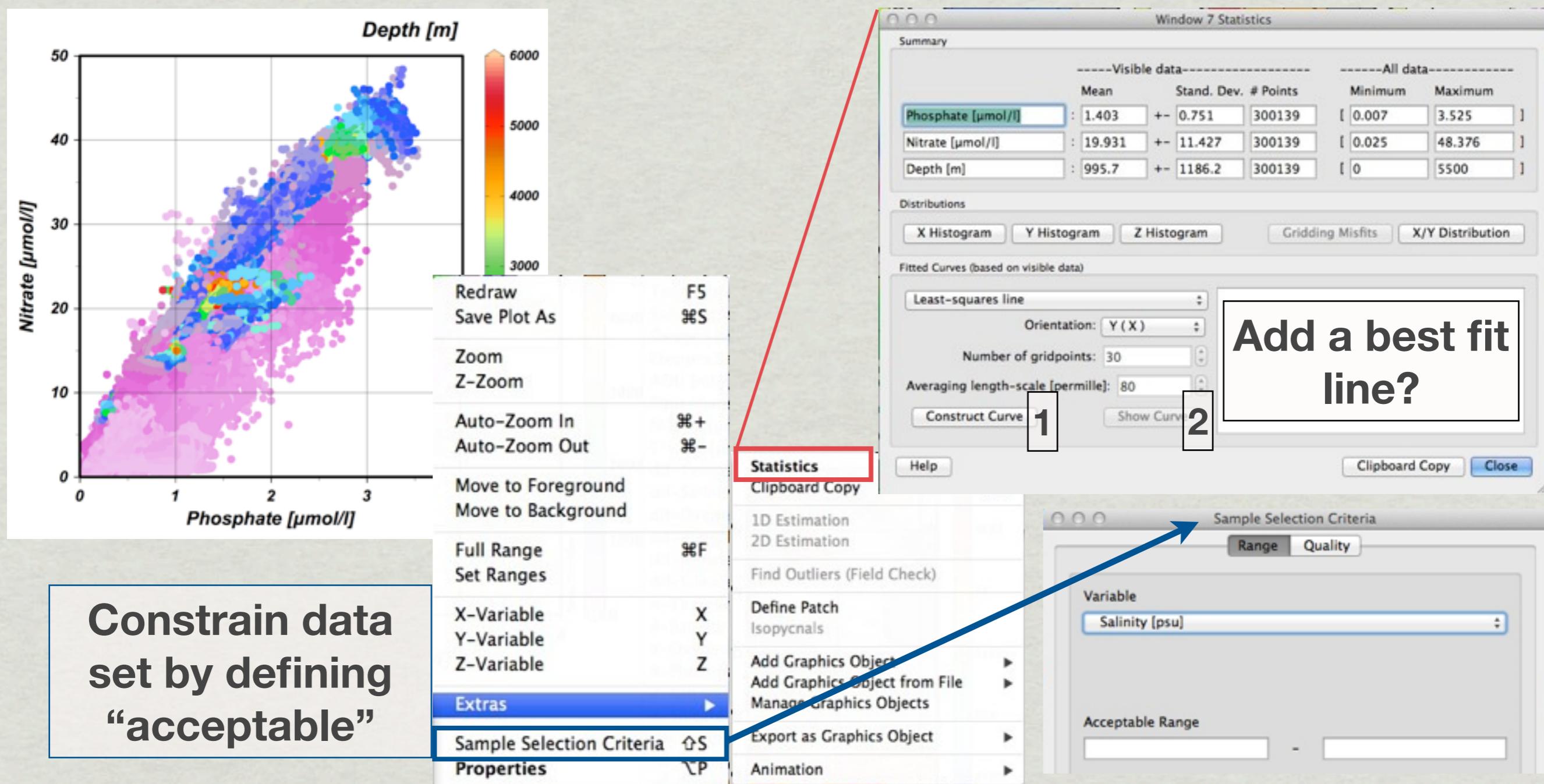
- Each data point (lat, long, depth, property) exists independently within the defined volume
 - ... *almost* possible to make all other plots by cleverly arranging phrasing a scatter plot



SCATTER PLOTS

Data Visualization

SCATTER plots: effective for comparing watermasses by property (other plots make better use of location data)



Constrain data set by defining “acceptable”

SUMMARY

Data Visualization

- **STATION**: data for a given property are sequential by depth
- **SECTION**: depth transects are sequential along a path
- **SURFACE**: data is structured in “sheet”
- **SCATTER**: data are related by watermass properties primarily, spatial/temporal meta-data secondarily

ADDITIONAL DATA

Reference

❖ Ocean

- CARINA Bottle Data: Hydrographic, nutrient and internally consistent data of carbon system parameters (CARINA Group, 2009)
- Coriolis CORA3: Coriolis Ocean Database for ReAnalysis - CORA3 (6.2 Mio temperature and salinity profiles; 1990 - 2012)
- GEOSECS: GEOSECS Hydrographic and Tracer Data; 1972 - 1978
- Global Alkalinity & TCO₂: Estimated alkalinity and total dissolved inorganic carbon (Goyet et al., 2000)
- Global Transmissometer Database: Transmissometer and hydrographic data for the global ocean (W. D. Gardner, et al., 2003)
- GLODAP Bottle Data: Hydrographic and carbon data for the global ocean (Key, R.M., et al., 2004)

ADDITIONAL DATA

Reference

❖ Ocean (cont.)

- GLODAP Gridded Data: Hydrographic and carbon climatology for the global ocean (Key, R.M., et al., 2004)
- MedatlasII: Hydrographic data for the Mediterranean and Black Sea (Medar Group, 2002)
- Mixed Layer Depths: Monthly global mixed layer depths on $1^\circ \times 1^\circ$ grid (Monterey and Levitus, 1997)
- Reid & Mantyla: Global collection of historical hydrographic and nutrient data (Reid & Mantyla)
- PHC 3.0: Polar science center Hydrographic Climatology (PHC3.0, Steele et al., 2005)
- SOCAT v1.5 fCO₂ Data: Global fCO₂ dataset containing 6.3 million surface water measurements (1968-2007).

ADDITIONAL DATA

Reference

❖ Ocean (cont.)

- Southern Ocean Atlas: Standard depth profiles and gridded version of the Hydrographic Atlas of the Southern Ocean (Olbers et al., 1992)
- World Ocean Atlas 2001: Monthly, seasonal and annual hydrographic data from the U.S. NODC World Ocean Atlas 2001
- World Ocean Atlas 2005: Monthly, seasonal and annual hydrographic data from the U.S. NODC World Ocean Atlas 2005
- WOCE Global Hydrographic Climatology: Global 0.5×0.5 degree gridded climatology of Gouretski and Koltermann (2004)

ADDITIONAL DATA

Reference

❖ Atmosphere (Radiosonde Data)

- RASO Koldewey: Koldewey Station, Svalbard (AWI)
- RASO Neumayer: Neumayer Station, Antarctica (AWI)
- RASO Polarstern: RV Polarstern (AWI)

❖ Miscellaneous

- River Discharge : River discharge data for 1018 stations worldwide (Vorosmarty, Fekete, and Tucker)