MERSEA IP
WP 5
"Integrated System Design and Assessment"

Internal Metrics for the MERSEA Global Ocean: Specifications for Implementation

Planning Workshop
CSIRO Hobart, Australia
17-18 March 2007

Participants

- F. Hernandez – MERCATOR
- M. Kamachi - MOVE
- J. Cummings - HYCOM
- P. Oke, G. Brassington, A Schiller – BLUELink
- C. Maes - IRD

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METRICS for the Global Ocean: Overview

Objective is to perform overall assessments of the fully integrated systems and identify quality and drawbacks of the systems for the world ocean.

Both MERSEA and GODAE projects must agree that this validation is to be shared by all contributors, following mainly two aspects:

1.« **the philosophy** »: a set of basic principles to assess the quality of MERSEA products/GODAE systems through a collaborative partnership.

2.« **the methodology** »: a set of tools for computing diagnostics, and a set of standards to refer to, for assessing the products quality. Both tools and standard have to be *share-able*, and *usable* among the different MERSEA/GODAE members and systems. Both tools and standards should be subject to upgrades and improvements.

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Validation « philosophy »

- Basic principles: defined for ocean hindcast and forecast (Le Provost 2002, MERSEA Strand 1):
  - **Consistency**: verifying that the system outputs are consistent with the current knowledge of the ocean circulation and climatologies
  - **Quality** (or **accuracy** of the **hindcast**) quantifying the differences between the system “best results” (analysis) and the sea truth, as estimated from observations, preferably using independent observations (not assimilated).
  - **Performance** (or **accuracy** of the **forecast**): quantifying the short term forecast capacity of each system, i.e. Answering the questions “do we perform better than persistency? better than climatology?…
- A complementary principal, to verify the interest of the customer (Pinardi and Tonani, 2005, MFS):
  - **Benefit**: end-user assessment of which quality level has to be reached before the product is useful for an application

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Validation « methodology »: classes of metrics

- Class 1, 2, and 3 metrics allow the **consistency** and **quality** of each system to be deduced
- The **performance** of each system is addressed using Class 4 metrics
- The **benefit** is assessed using all classes of metrics, but new « user-oriented » metrics may need to be defined to fully address this principle
- Class 1 to 3 metrics are provided on a real-time basis through OPeNDAP servers using a standardized NetCDF format
- The metrics have to be implemented in the same way for the different systems (fully standardized output fields and diagnostics)
- Class 4 metrics remain to be properly defined.

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Class 1 METRICS: General Overview of the System Dynamics

Comparison of 2D model fields interpolated to the GODAE grid

- zonal and meridional wind stress, total heat flux, freshwater flux
- barotropic stream function
- mixed layer depth – defined by change in T of 1°C and change in density of 0.05 kg/m^3
- sea surface height
- mean dynamic topography

Comparison of 3D model fields interpolated to the GODAE grid

- potential temperature
- salinity
- u,v velocity components

Class 1 metrics provide instantaneous estimates of the ocean from the different GODAE systems for direct inter-comparison

Types of outputs need to be defined: hindcast/best estimate, analysis, forecast

Gridding (horizontal and vertical) and regional divisions need to be defined

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Class 1 METRICS: Standard Vertical Levels per Ocean Basin

NORTH ATLANTIC	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
EQUATORIAL ATLANTIC	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
SOUTH ATLANTIC	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
NORTH PACIFIC	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
EQUATORIAL PACIFIC	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
SOUTH PACIFIC	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
INDIAN OCEAN	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
MEDITERRANEAN SEA	0	30	50	100	200	500	1000	2000				
SOUTHERN OCEAN	0	30	50	100	200	400	700	1000	1500	2000	2500	3000
ARCTIC OCEAN	0	30	50	100	200	400	700	1000	1500	2000	2500	3000

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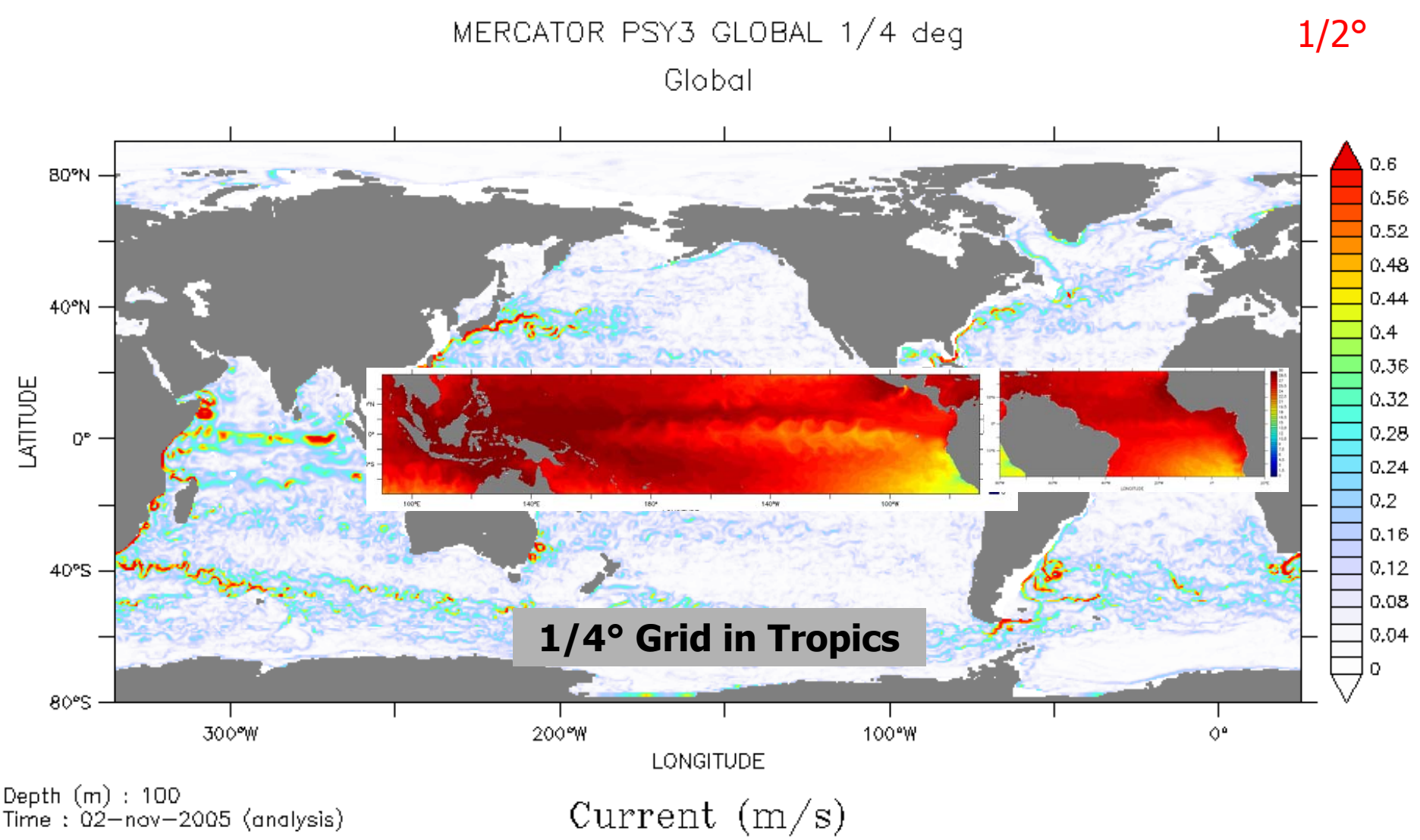
Class 1 METRICS: How Do We Define the GODAE Grid?



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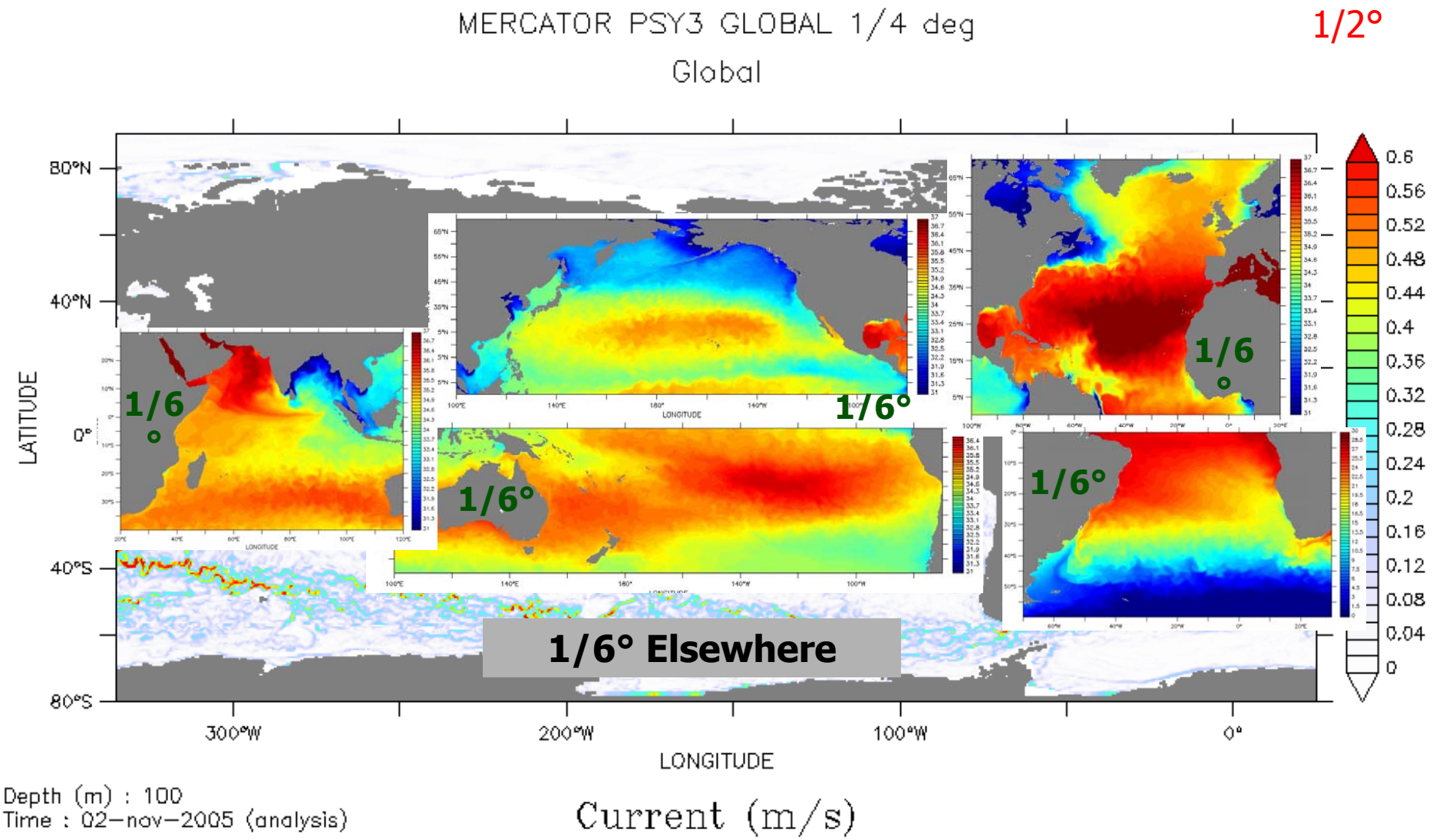
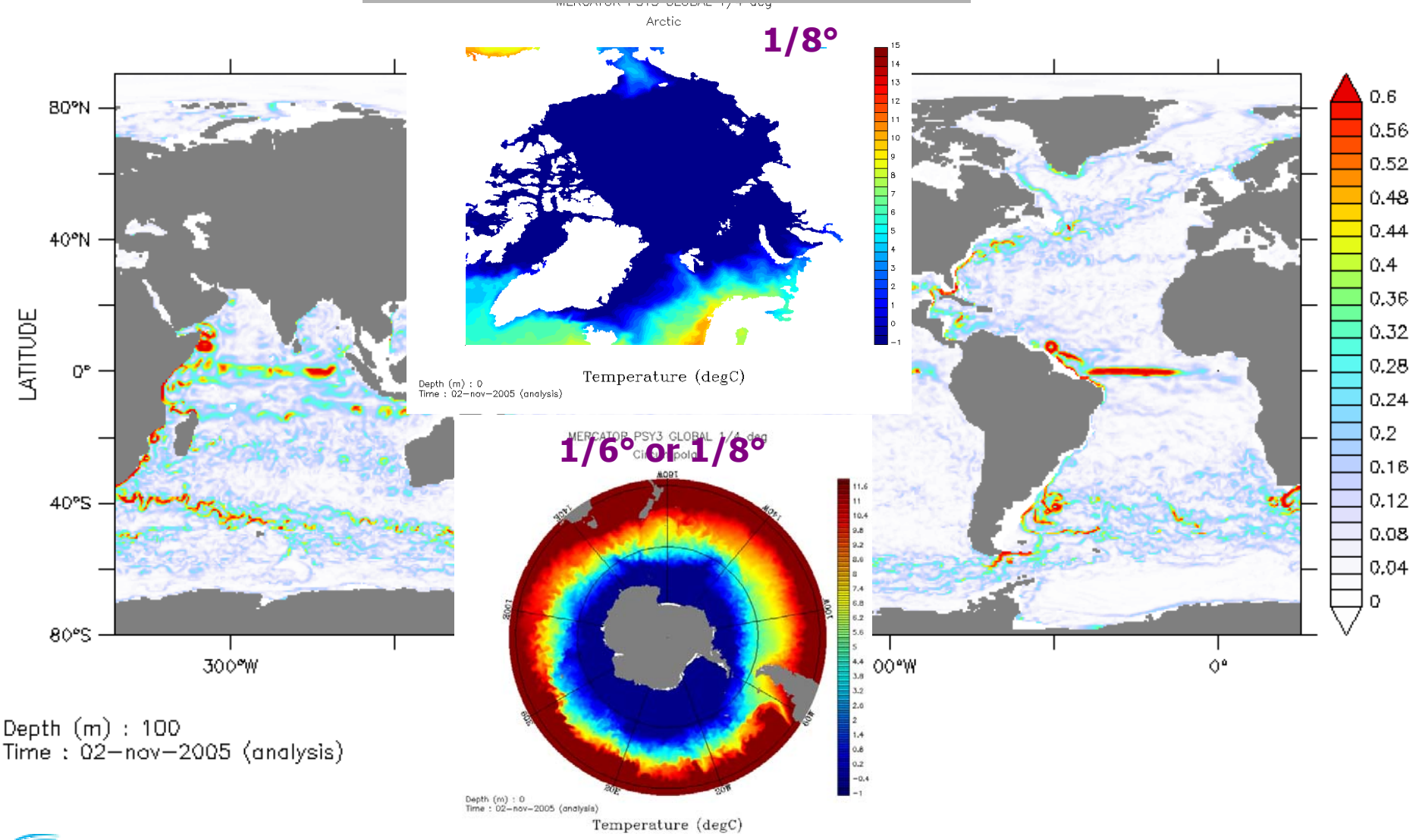

MERCATOR PSY3 GLOBAL 1/4 deg
Global
1/2°
80°N
40°N
0°
40°S
80°S
LATITUDE
300°W
200°W
100°W
0°
LONGITUDE
1/6°
1/6°
1/6°
1/6°
1/6° Elsewhere
0.6
0.56
0.52
0.48
0.44
0.4
0.36
0.32
0.28
0.24
0.2
0.16
0.12
0.08
0.04
0
Depth (m) : 100
Time : 02-nov-2005 (analysis)
Current (m/s)

1/6 ° or 1/8° in Polar Regions

1/2°



Class 2 METRICS: High Resolution for Monitoring Ocean Dynamics

Designed as virtual moorings or sections in the model domain

- mooring locations are provided (match *in situ* moorings)
- section locations are computed every 10 km (15 km in Arctic)
- section and mooring model outputs are « best estimate » daily means

Variables to consider

- potential temperature
- salinity
- velocity

Class 2 metrics provide direct comparison of model outputs with *in-situ* observations

Sections follow WOCE and CLIVAR repeat sections, but new definitions are being proposed – there must be some hope of the section being observed for it to be included

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Class 3 METRICS: Derived Physical Quantities

Derived physical quantities computed using model variables

- cannot be derived from class 1 or class 2 information
- need to be computed in line, during the model run, on the native grid, every model time step
- represent integrated quantities on the model grid

Variables to consider

- volume transports
- overturning stream function (function of latitude and depth or temperature or density)
- meridional heat transport

Class 3 mterics are designed to check physical apsects of the model behavior

Sections and/or locations for Class 3 diagnostics will incorporate Class 2 definitons

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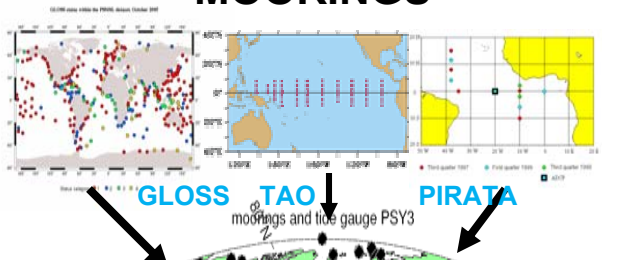
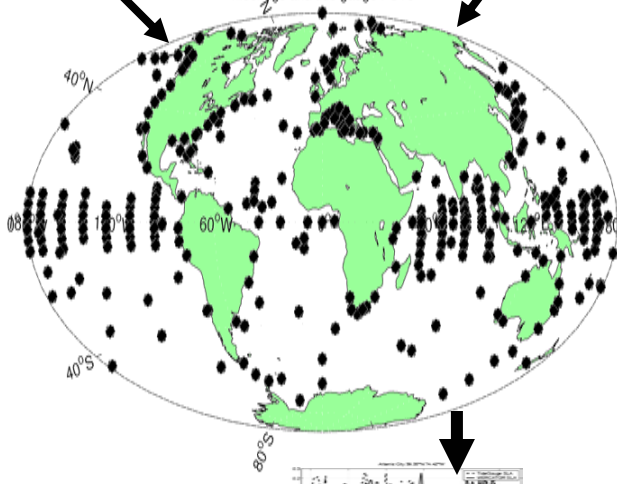
Class 2 and 3 METRICS: Moorings, XBT Lines and Repeat Sections

MOORINGS

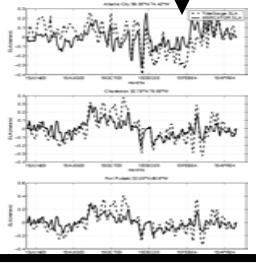


GLOSS TAO PIRATA

moorings and tide gauge PSY3

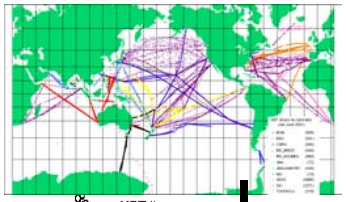


Model/Tide gauge SLA time series comparison

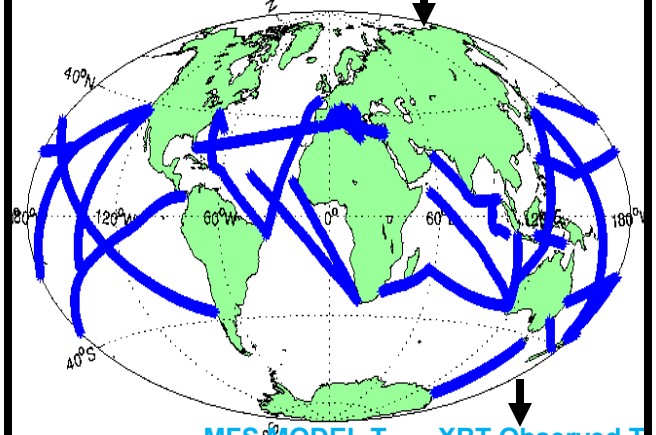


XBT lines

SOOP



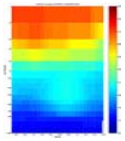
XBT lines

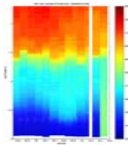


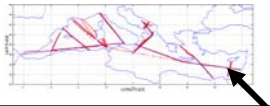
MFS MODEL T

XBT Observed T

MODEL/OBS comparison



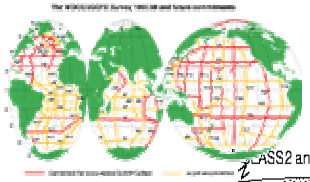


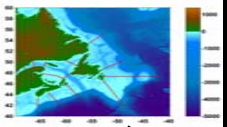


SECTIONS and TRANSPORT

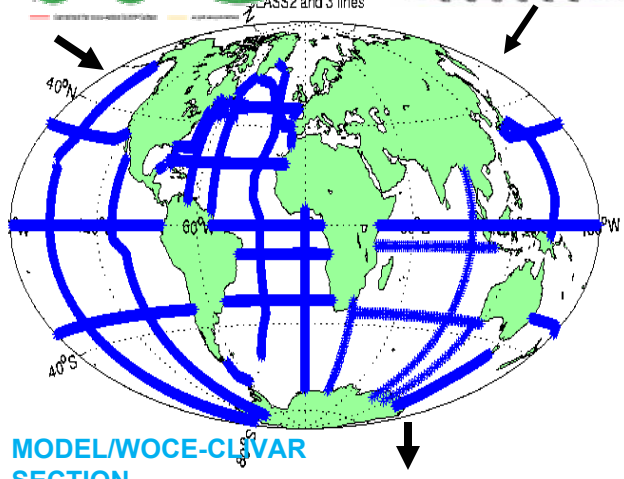
WOCE CLIVAR

CANADIAN SECTIONS

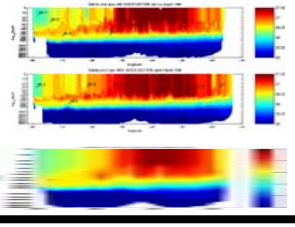




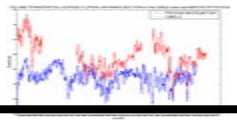
CLASS2 and 3 lines



MODEL/WOCE-CLIVAR SECTION



VOLUME TRANSPORT across FLORIDA Strait : MODEL/CABLE Comparison



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Class 2 and 3 METRICS: Standard Vertical Levels

NORTH ATLANTIC	EQ ATLANTIC	SOUTH ATLANTIC	NORTH PACIFIC	EQ PACIFIC	SOUTH PACIFIC	INDIAN OCN	MED SEA	SOUTHERN OCN	ARCTIC
0	0	0	0	0	0	0	0	0	0
10	10	10	10	10	10	10	5	10	10
20	20	20	20	20	20	20	10	20	20
30	30	30	30	30	30	30	20	30	30
50	50	50	50	50	50	50	30	50	50
75	75	75	75	75	75	75	50	75	75
100	100	100	100	100	100	100	75	100	100
125	125	125	125	125	125	125	100	125	125
150	150	150	150	150	150	150	125	150	150
200	200	200	200	200	200	200	150	200	200
250	250	250	250	250	250	250	200	250	250
300	300	300	300	300	300	300	250	300	300
400	400	400	400	400	400	400	300	400	400
500	500	500	500	500	500	500	400	500	500
600	600	600	600	600	600	600	500	600	600
700	700	700	700	700	700	700	600	700	700
800	800	800	800	800	800	800	800	800	800
900	900	900	900	900	900	900	1000	900	900
1000	1000	1000	1000	1000	1000	1000	1200	1000	1000
1100	1100	1100	1100	1100	1100	1100	1500	1100	1100
1200	1200	1200	1200	1200	1200	1200	2000	1200	1200
1300	1300	1300	1300	1300	1300	1300	2500	1300	1300
1400	1400	1400	1400	1400	1400	1400	3000	1400	1400
1500	1500	1500	1500	1500	1500	1500	3500	1500	1500

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Class 2 and 3 METRICS: Standard Vertical Levels (continued)

NORTH ATLANTIC	EQ ATLANTIC	SOUTH ATLANTIC	NORTH PACIFIC	EQ PACIFIC	SOUTH PACIFIC	INDIAN OCN	MED SEA	SOUTHERN OCN	ARCTIC
1750	1750	1750	1750	1750	1750	1750	4000	1750	1750
2000	2000	2000	2000	2000	2000	2000		2000	2000
2500	2500	2500	2500	2500	2500	2500		2500	2500
3000	3000	3000	3000	3000	3000	3000		3000	3000
3500	3500	3500	3500	3500	3500	3500		3500	3500
4000	4000	4000	4000	4000	4000	4000		4000	4000
4500	4500	4500	4500	4500	4500	4500		4500	4500
5000	5000	5000	5000	5000	5000	5000		5000	5000
5500	5500	5500	5500	5500	5500	5500		5500	5500

Total Number of Vertical Levels = 33

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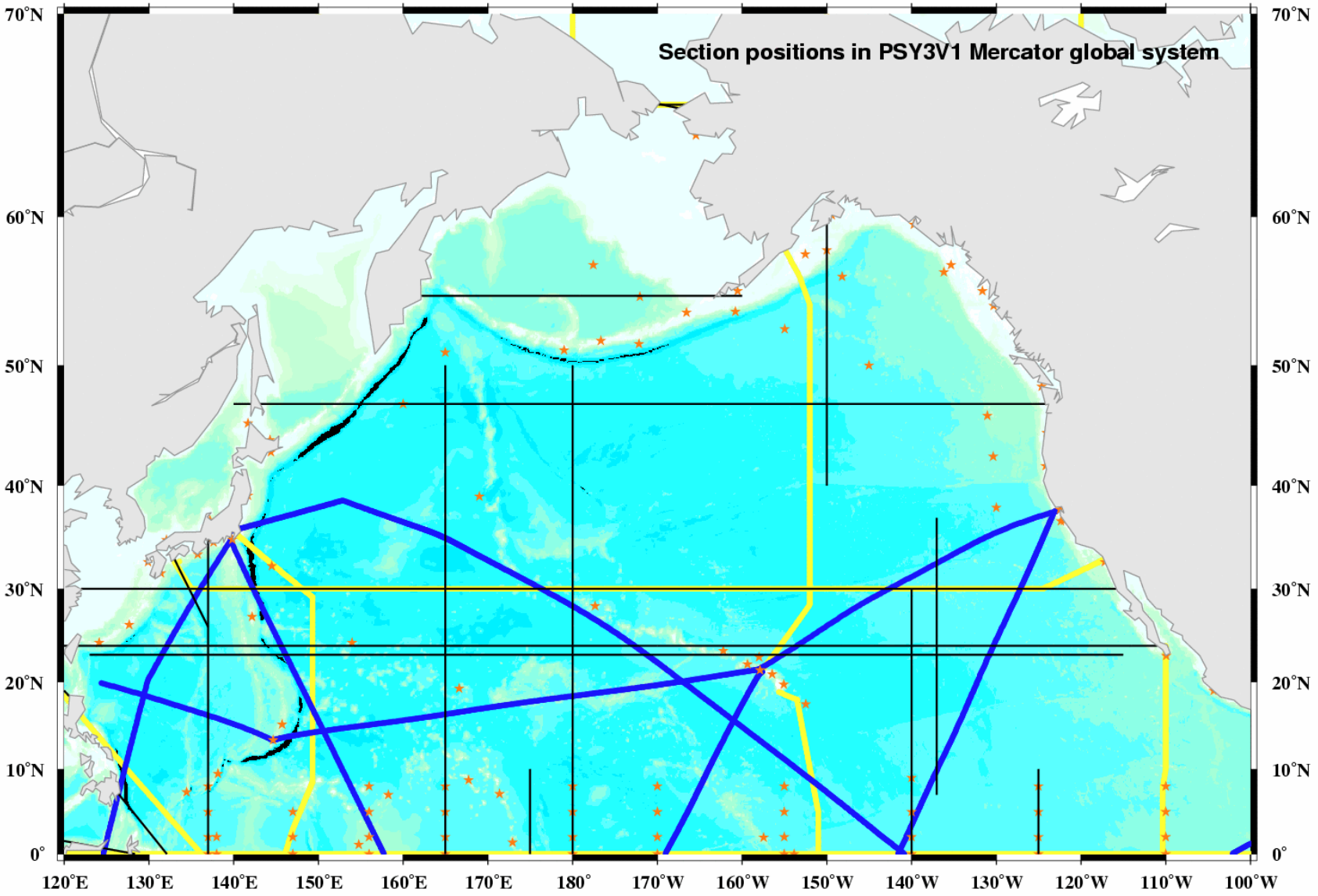
Class 2 and 3 METRICS: New Proposed Definitions for the Pacific



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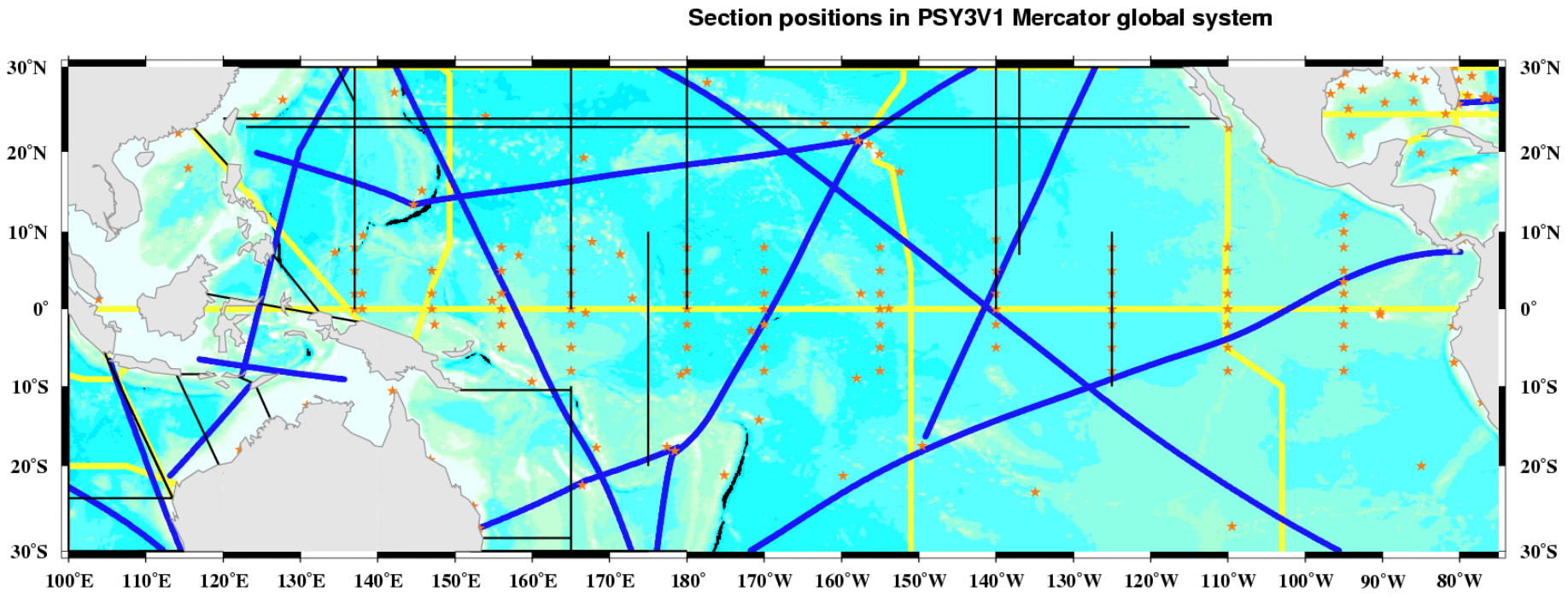

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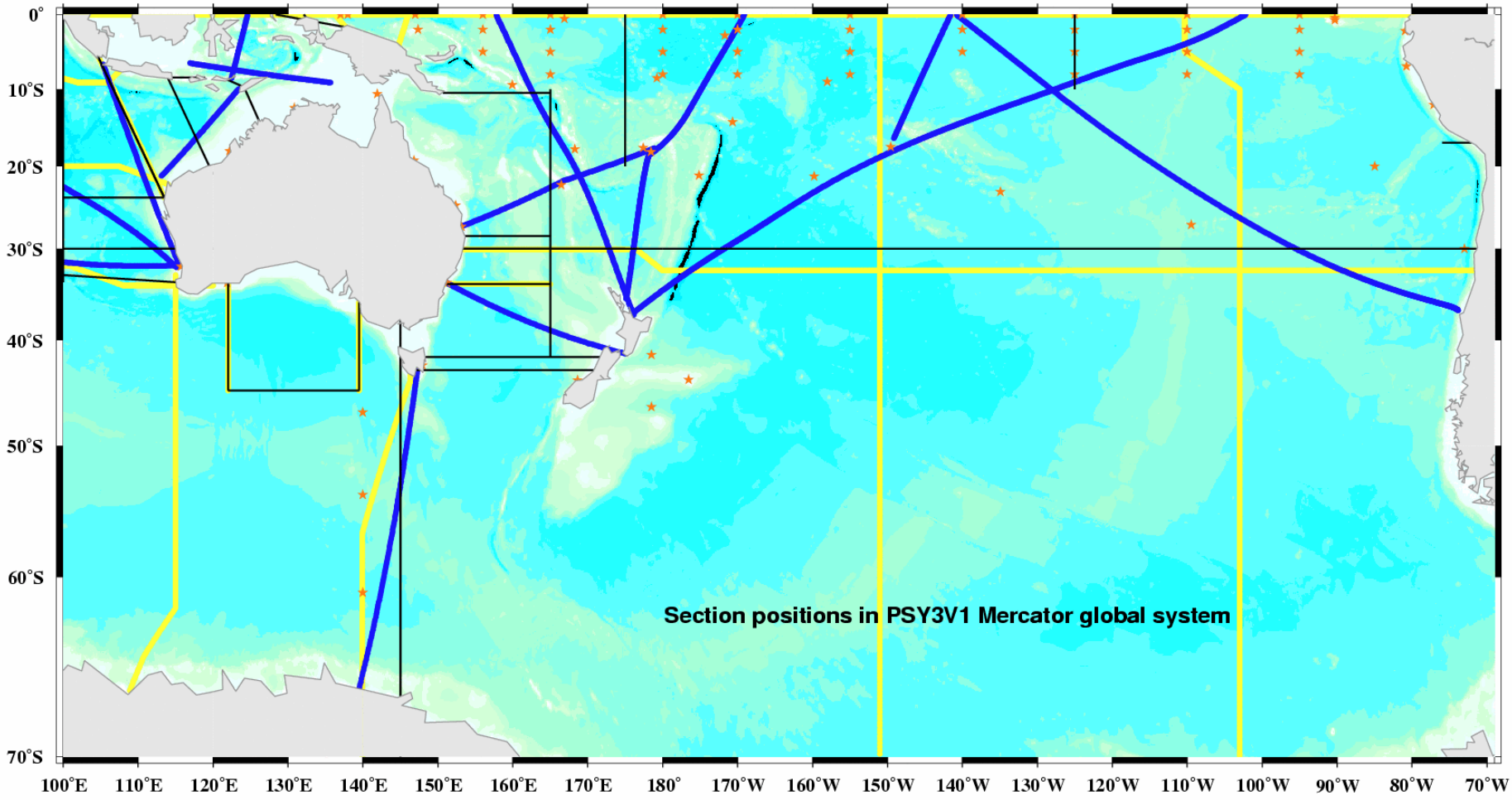

Class 4 METRICS: Performance of the Forecasting System

Measures the skill of the forecasting system

- describes the ocean and its forecasting skill at same time
- sets of observations are chosen (independent from those used in the assimilation) and compared to model fields
- model fields must be describing the same situtaion (i.e., forecast for day of observation from model forecast runs into the past)
- climatology and persistence forecast field comparisons are to be included

Variables to consider

- all analysis variables (varies with system)

Data to consider

- any set of data can be used, as far as equivalent information can be computed from the model variables

Definition of Class 4 metrics comparison domains (lat/lon boxes) not fully achieved yet.

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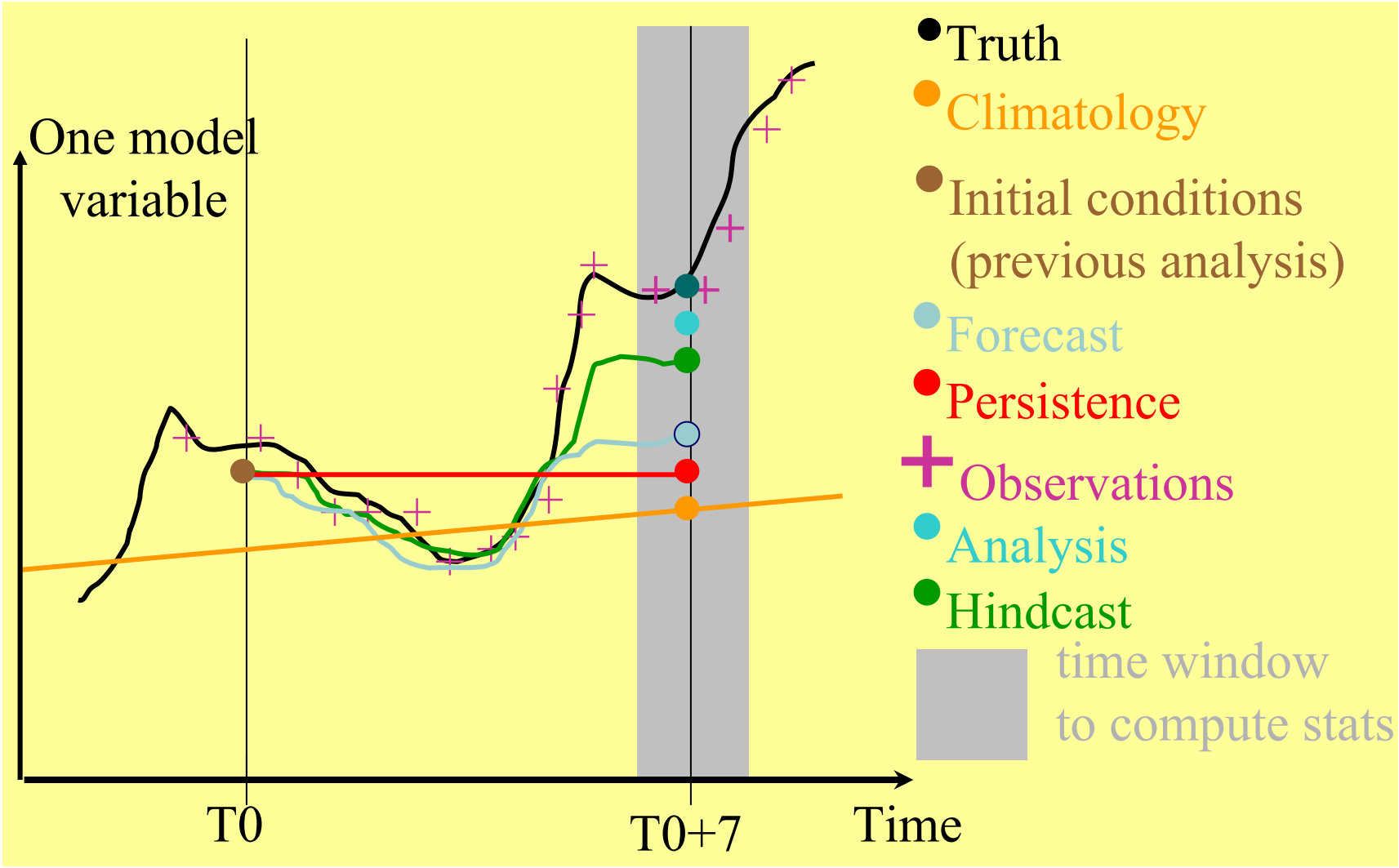
Class 4 METRICS: Concept



Class 4 METRICS: Definitions

Best estimates	May be calculated in delayed mode by the system
Best real time estimate	For some systems, can be the analysis
Best 3-day forecast	All systems can provide the 3-day forecast, the last forecast from DMI can be considered as the three day forecast
Best 6-day forecast	All systems but the DMI can provide a 6-day forecast.
Persistence at 3 days	Based on the corresponding best real time estimate
Persistence at 6 days	Based on the corresponding best real time estimate
First guess	Independent from the observation it is being compared
Climatology	Levitus, MEDAtlas (GDEM V3.0?)

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Class 4 METRICS: Implementation

- Implementation of T/S observation based Class 4 metrics
  - Coriolis provides daily files of quality controlled T/S observations
  - every forecasting center computes their “model-to-obs” dataset using the Coriolis observations

- Computation and binning of Class 4 statistics
  - statistics (box averaging…) not yet defined
  - per dedicated **geographical boxes** or in **regular boxes**?
  - per **vertical layers** (0-100m, 100-500m, 500-5000m?)

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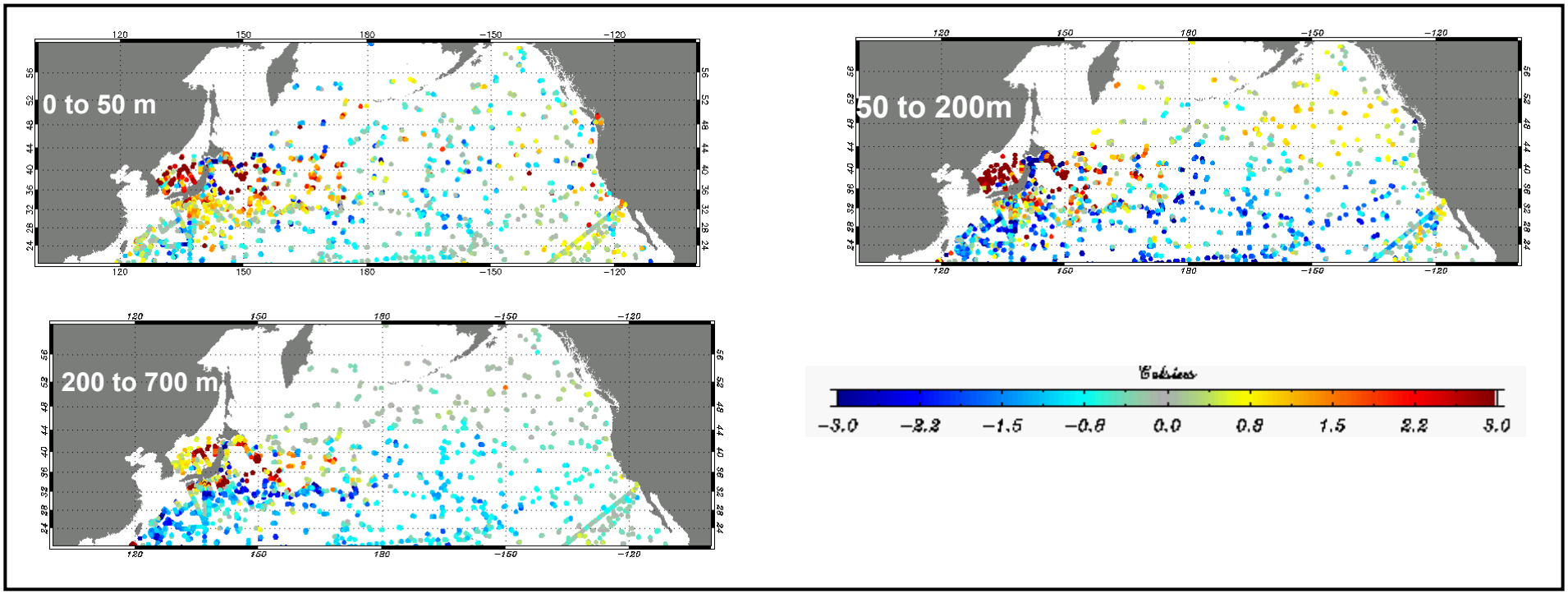
Class 4 METRICS: Presentation of Temperature Comparisons



Coriolis database for the North Pacific October 2006

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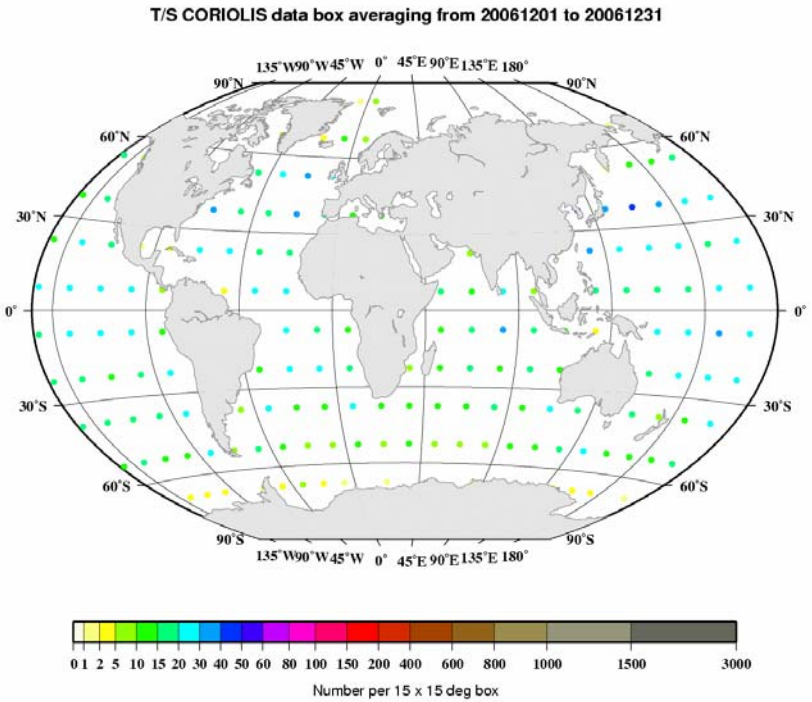
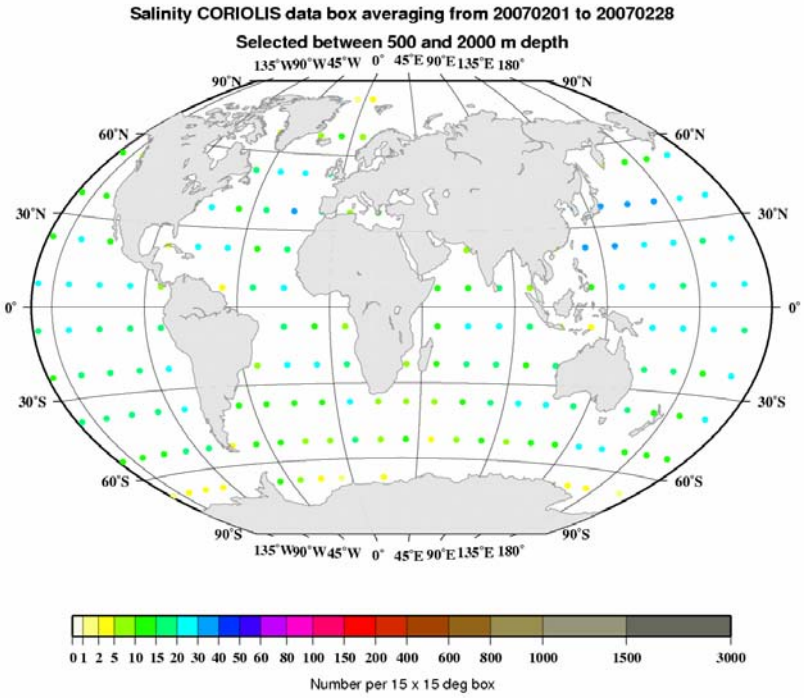
Class 4 METRICS: Binning of Observations

Testing different boxes:

- Global ocean: 15°x15°, 1 month, one data/file
- Dedicated boxes also for:
  - Baltic, NEA, Arctic, MED



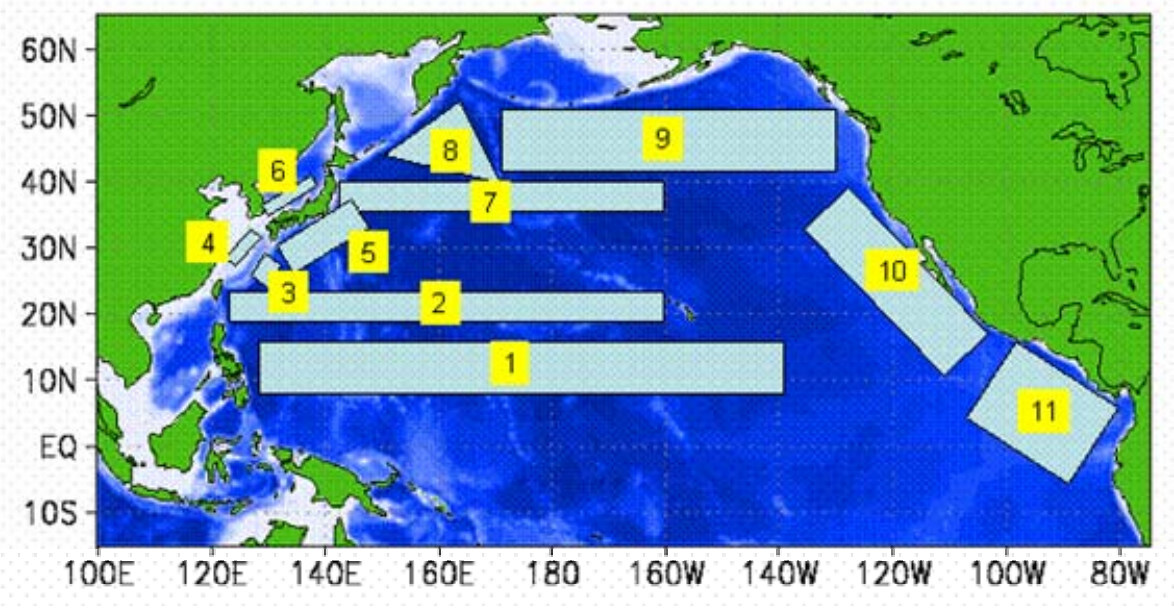
December 2006
All Vertical Levels



February 2007
500-2000 m Depth

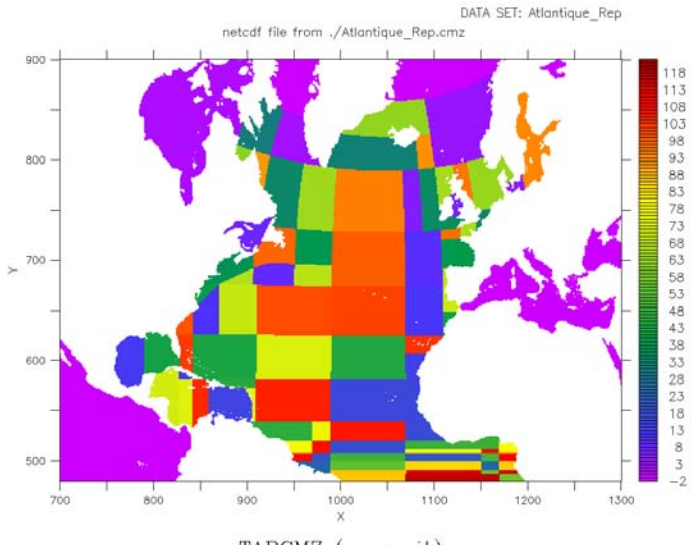
Class 4 METRICS: Binning of Observations

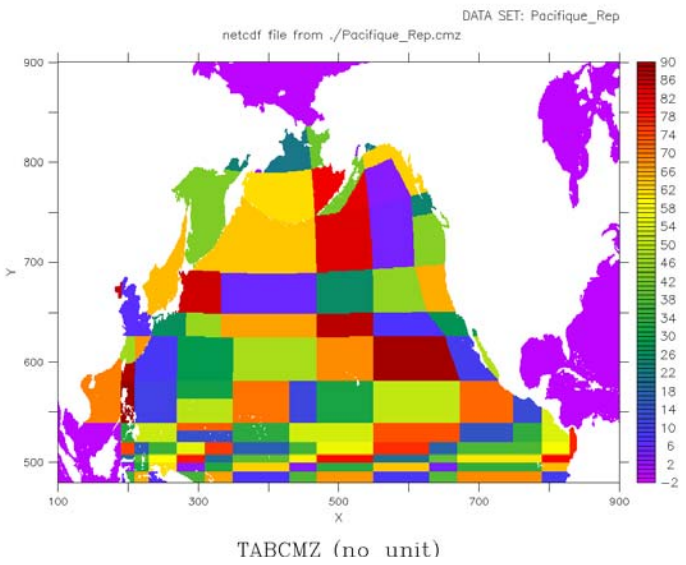
Bin averaging within dynamical regimes?

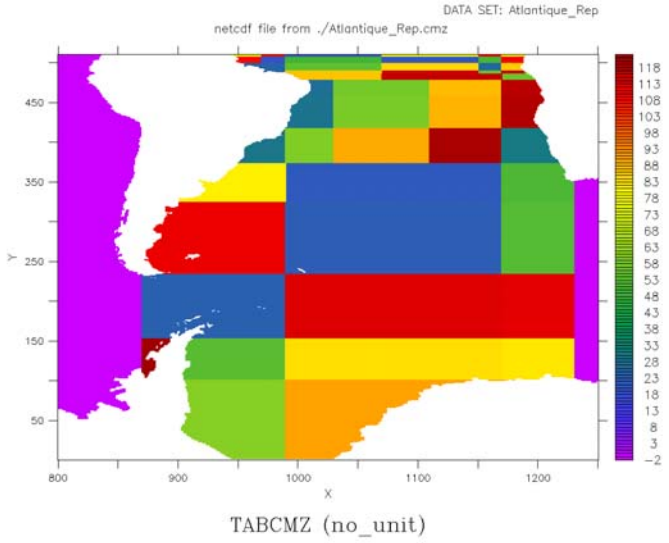


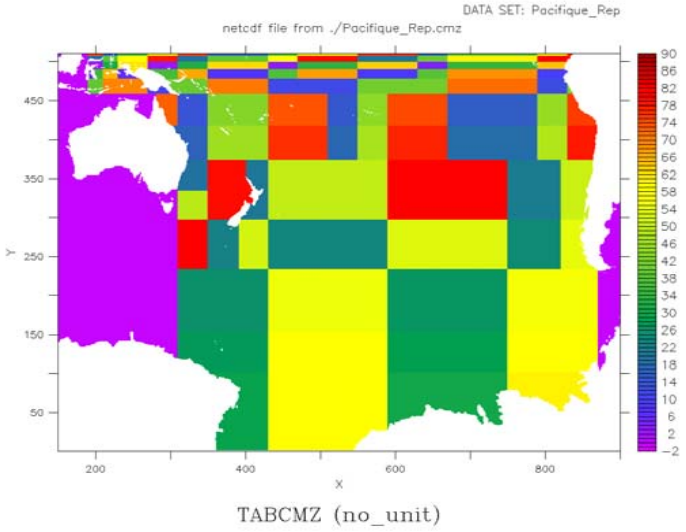
Class 4 METRICS: Binning of Observations

More ways of binning within dynamical regimes









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Summary: Way Forward and HYCOM Consortium

- Global metrics plan follows Le Provost (et al.) from first GODAE Symposium
- Builds upon existing basin-scale metrics defined for GODAE
  - North Atlantic (F. Hernandez), Equatorial Pacific (M. Reinecker),
  - Global Reanalysis (T. Lee), North Pacific (Kamachi et al.)
  - Australia/Indian Ocean (Oke and Brassington)
- Goal is to complete global metrics definitions in time for next IGST meeting (Aug)
- HYCOM and Mercator only global GODAE systems
- Metrics implementation timed to coincide with Mercator going global with multivariate assimilation (0.25 deg resolution - in demo mode now, metrics evaluation Spring, 2008)
- MOVE (Japan) and BLUELink (Australia) will participate where they can
- How much should HYCOM consortium participate?
  - tremendous amount of work being proposed; impact on model run-times?
  - leverage on-going validation efforts for transition to NAVO
- Many issues with current status of Class 4 metrics – need to address

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END

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