

# **Evaluation of XBT network**

**OceanObs 99 recommendations**

**What has been accomplished ?**

**What has not been accomplished ?**

**Why were these transects selected ?: science objectives, operational objectives.**

**Role of these observations for meridional heat advection studies, surface current monitoring studies, heat storage, etc**

**XBT vs Argo observations**

**Fall rate equation**

**Issues that may need consideration.**

# **Evaluation of XBT network Issues**

**Should HD transects be re-evaluated ?**

**Should we try to start doing those transects that were recommended and were never implemented ?**

**Assess value of FR/LD transects (Do NCEP, Mercator, ...need them?)**

**Have one center only for data distribution ? GTSP status**

**Contact modeling community to identify regions where models are failing and investigate if this is because of problems with the models or because of lack of sufficient observations.**

**OceanObs99 vs CLIVAR panel recommendations.**

**Value of simultaneous XBT/TSG/pCO<sub>2</sub> observations**

**Refer to July 26, 2008 by GG, for an extensive list**

# **Ship Of Opportunity Program**

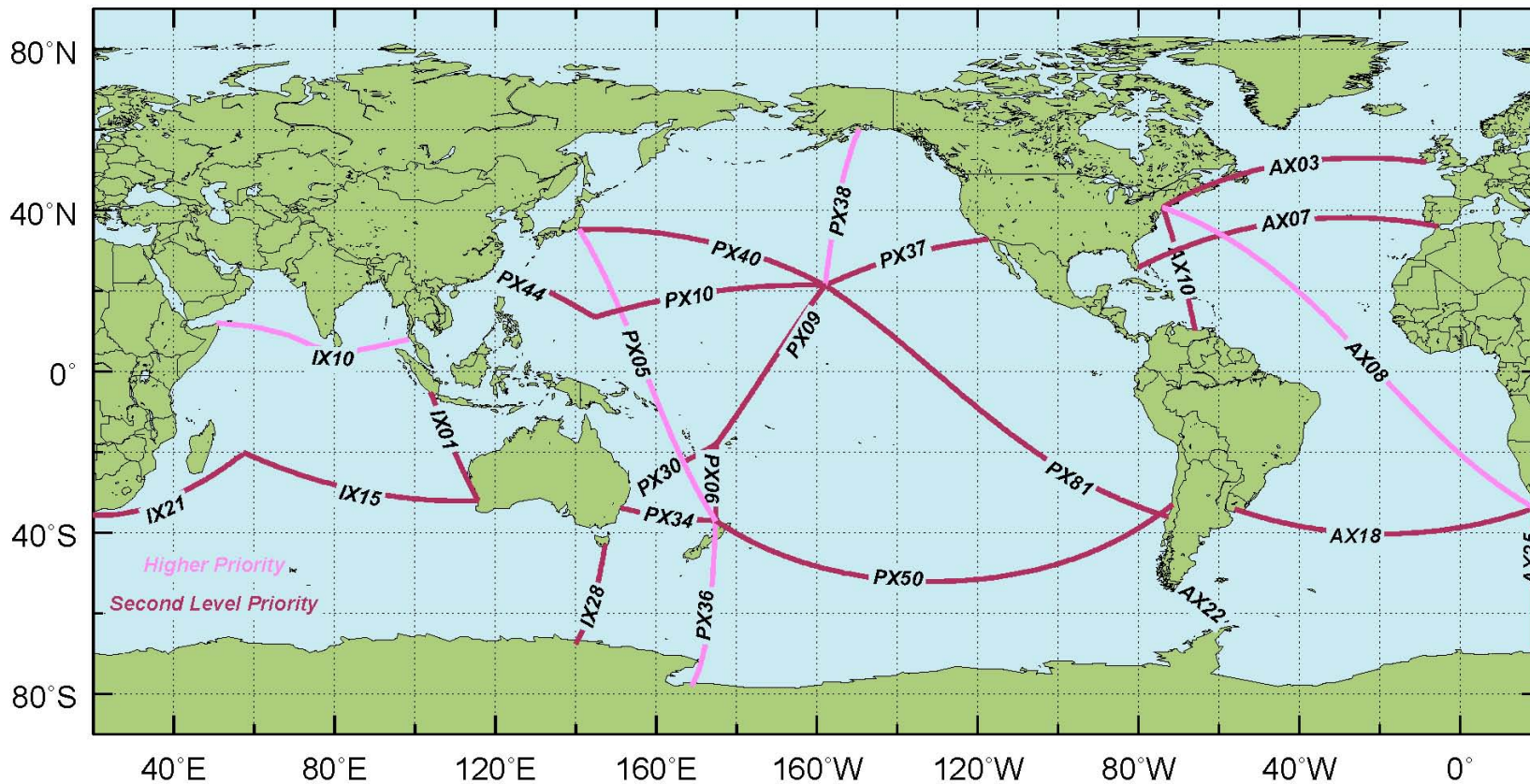
**XBTs:**

**XCTDs:**

**Continuous ocean observations: TSGs, pCO<sub>2</sub>, CPR, ADCP**

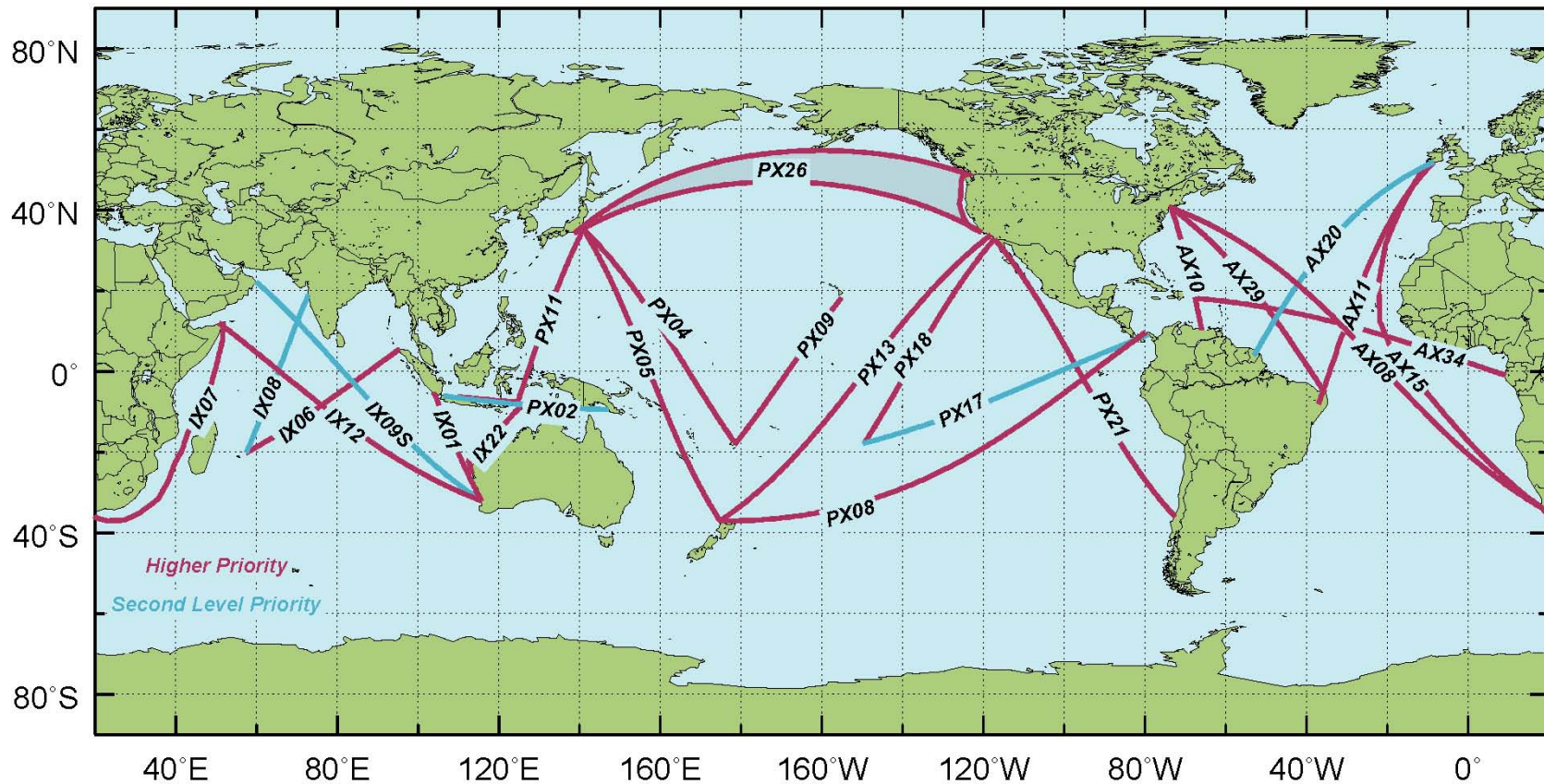
**Platform to deploy other instruments: Surface drifters, profiling floats.**

## High Density (HD) XBT Network, OceanObs99 Recommendations



MODE	Spacing	Frequency
Low Density (LD)	~ 250 km	12 times per year
Frequently Repeated (FR)	~ 150 km	18 times per year
High Density (HD)	~25 km	4 times per year

## Frequently Repeated (FR) XBT Network, OceanObs99 Recommendations



MODE	Spacing	Frequency
Low Density (LD)	~ 250 km	12 times per year
Frequently Repeated (FR)	~ 150 km	18 times per year
High Density (HD)	~25 km	4 times per year

# **What the different (CLIVAR) panels recommend**

**Atlantic Ocean**

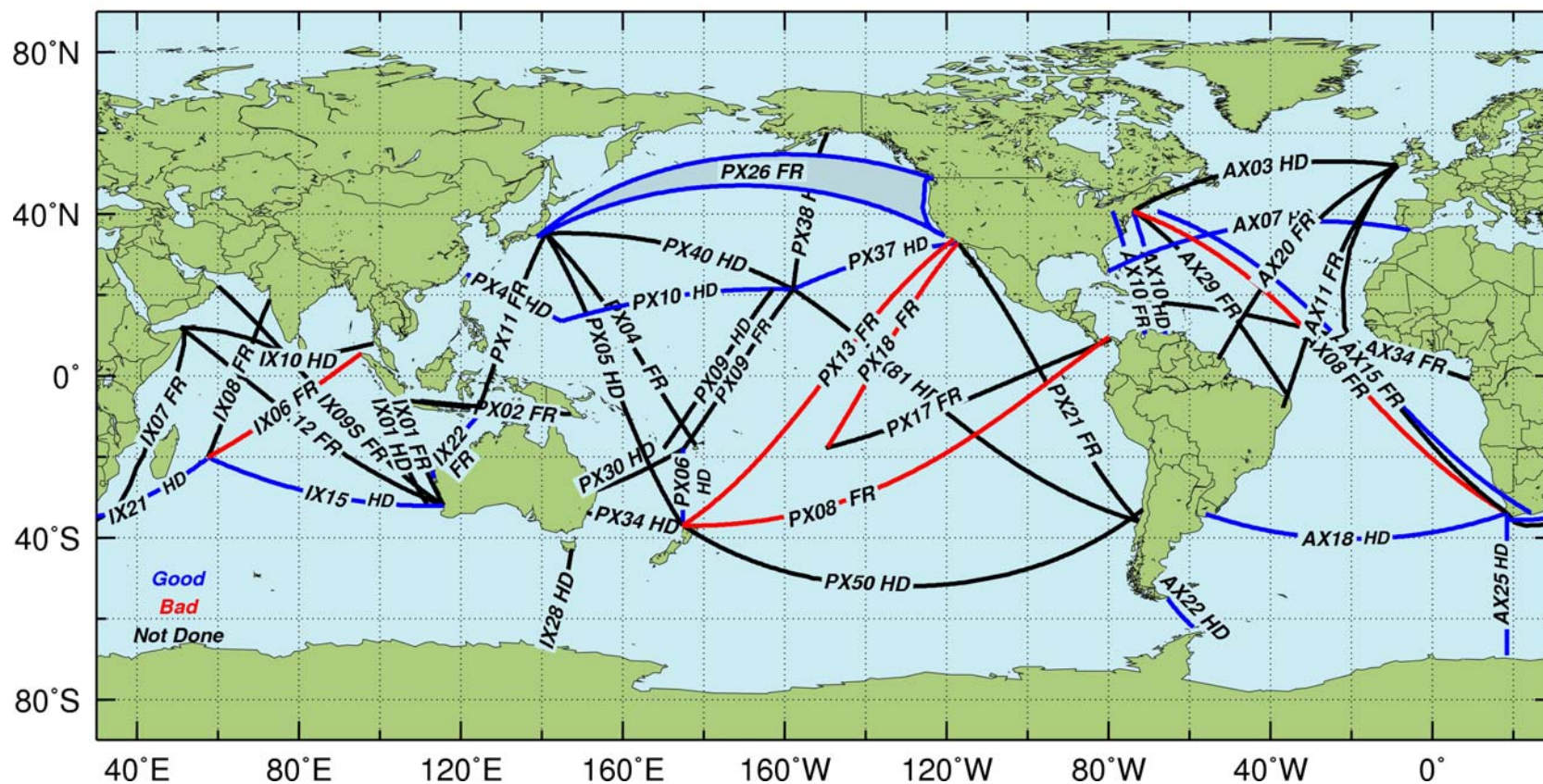
**Indian Ocean**

**Pacific Ocean**

**Southern Ocean**

# ALL (HD,LD,FR) GTS

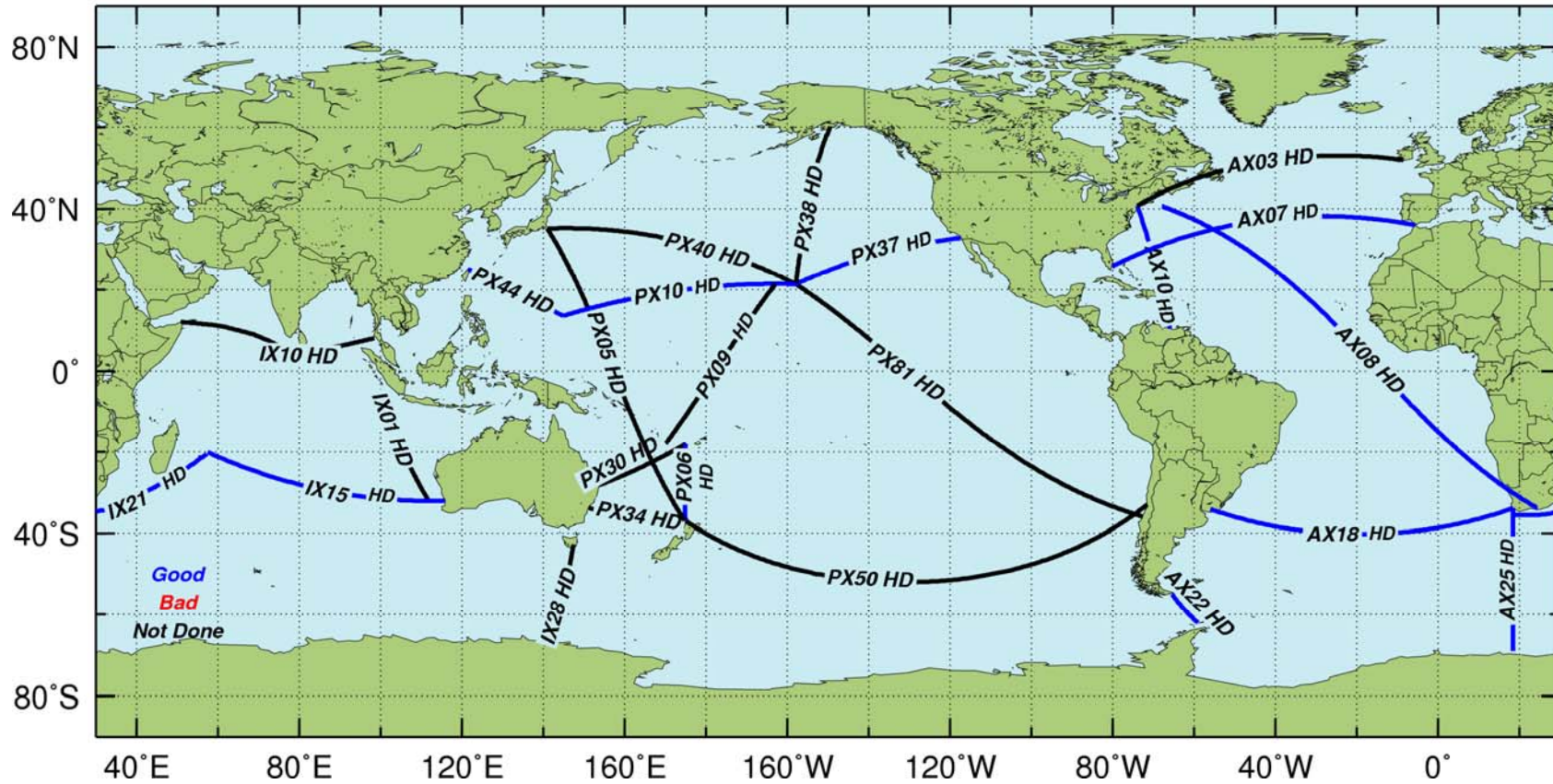
XBT Network OceanObs99 Recommended Line Status 2007



Good HD 3+ transects per year FR 16+ transects per year

# HD GTS

High Density (HD) XBT Network OceanObs99 Recommended Line Status 2007

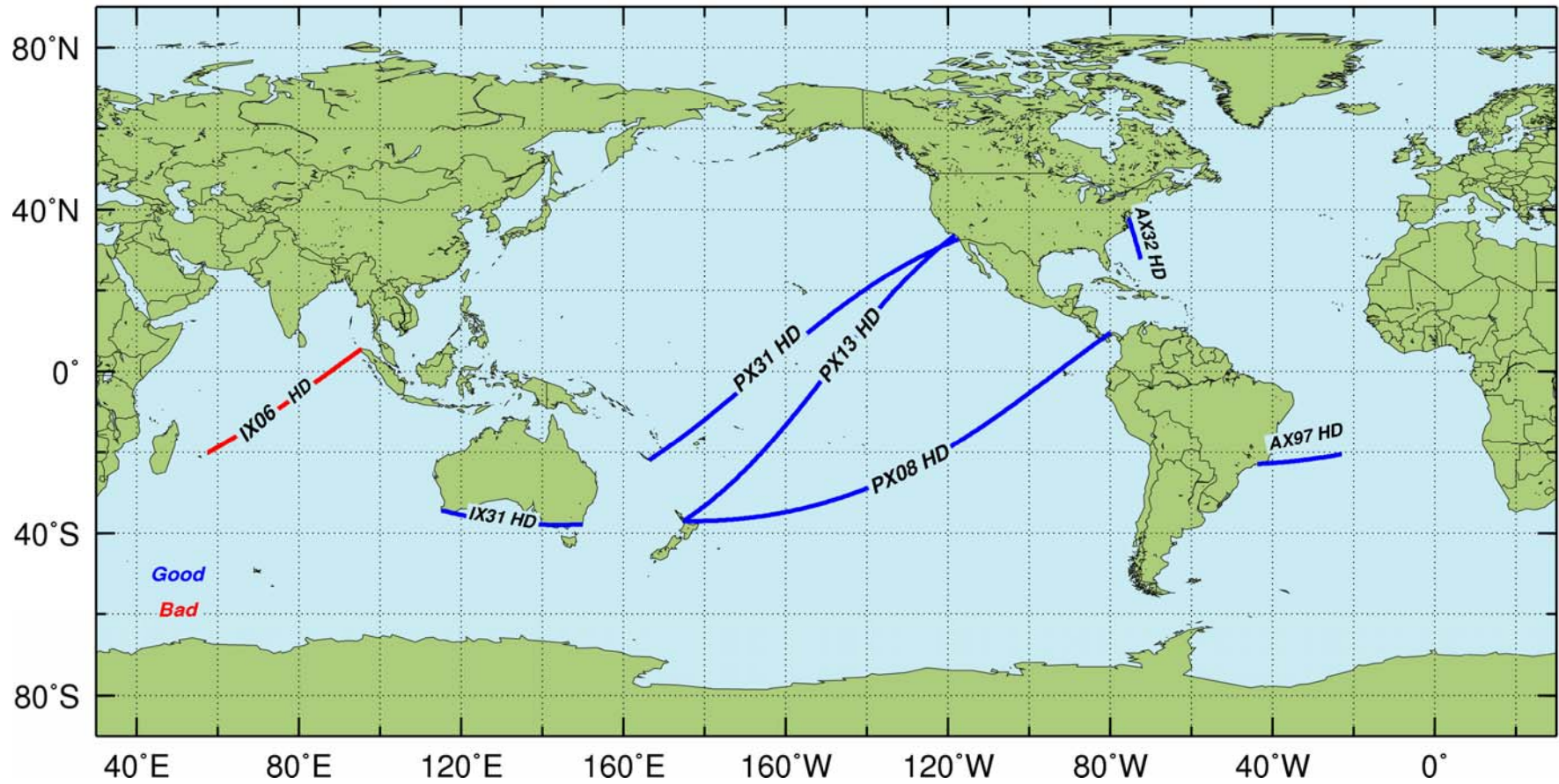


Good HD 3+ transects per year



# HD GTS

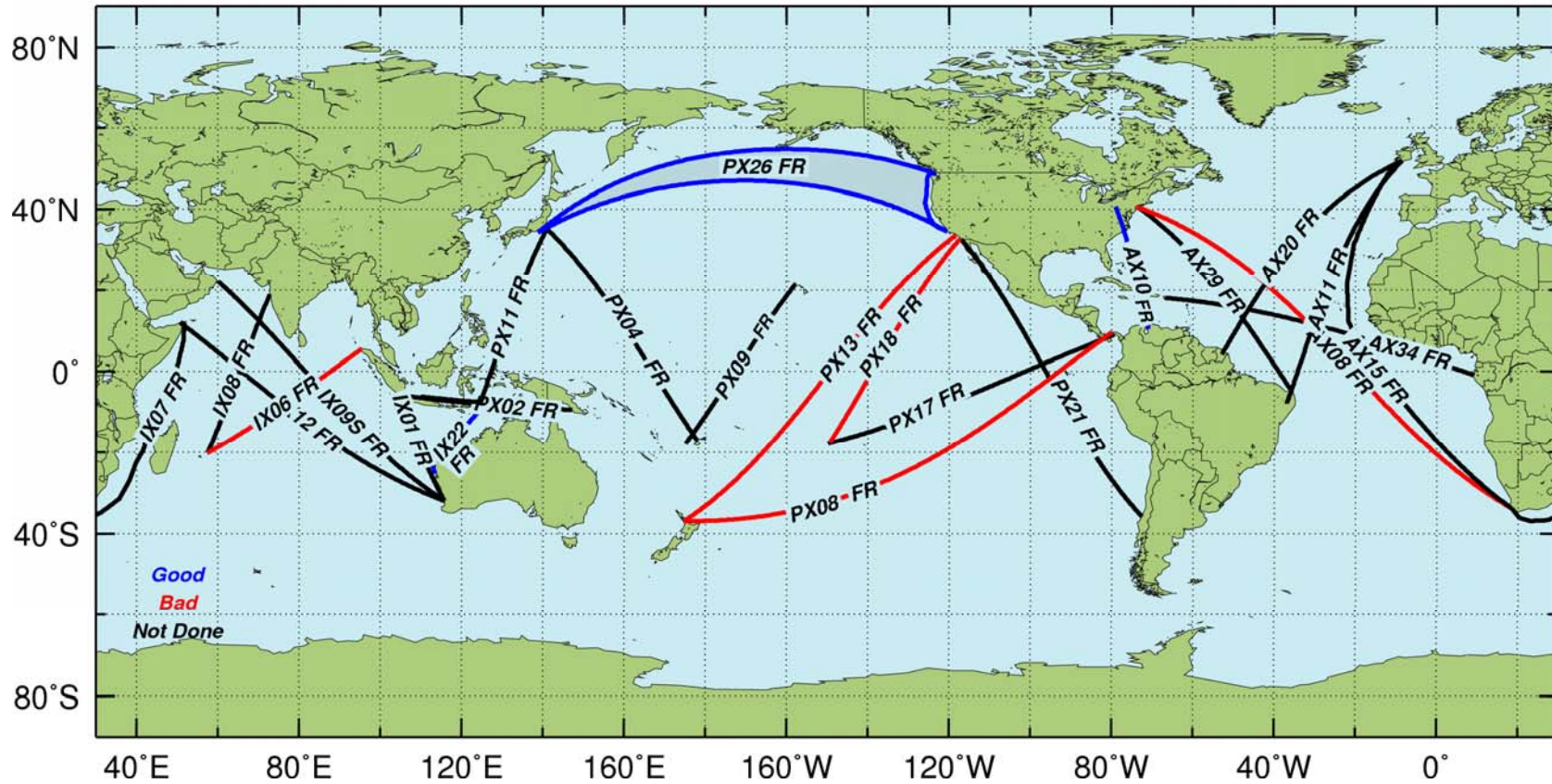
High Density (HD) XBT Network OceanObs99 Not Recommended Line Status 2007



**Good HD 3+ transects per year**

# FR+LD GTS

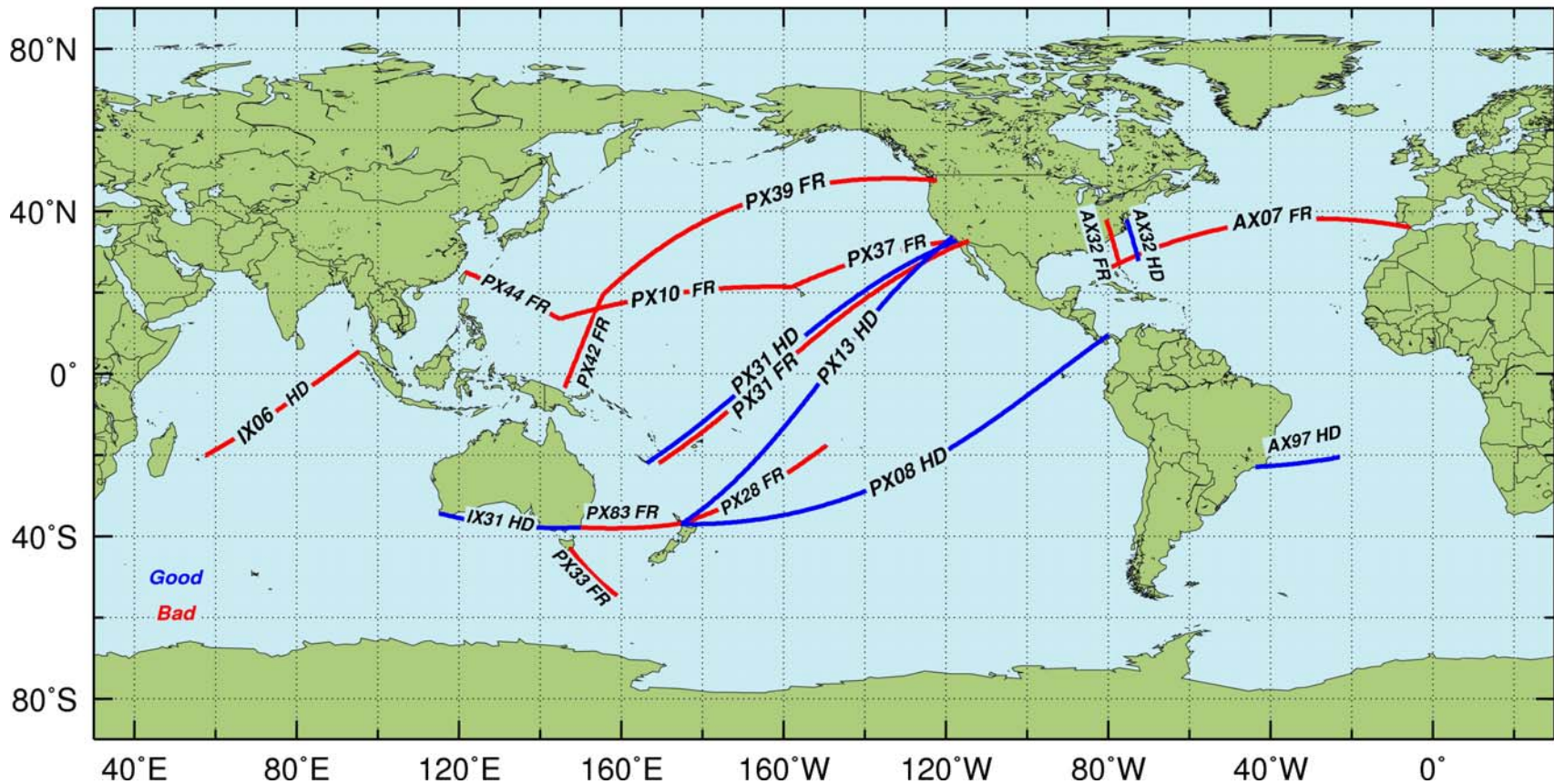
Frequently Repeated (FR) XBT Network OceanObs99 Recommended Line Status 2007



**Good HD 3+ transects per year FR 16+ transects per year**

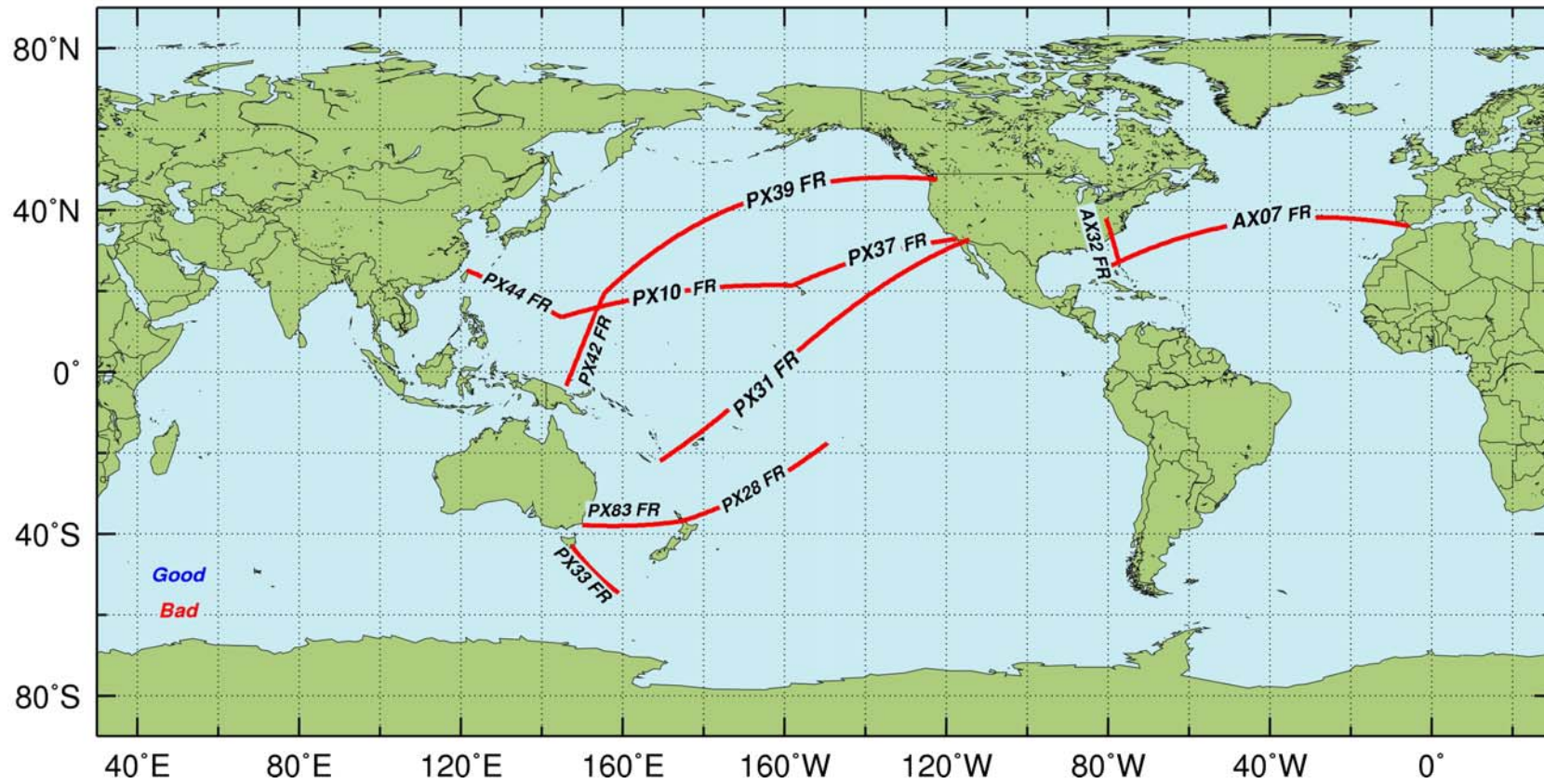
# HD+FR GTS

XBT Network OceanObs99 Not Recommended Line Status 2007



**Good HD 3+ transects per year FR 16+ transects per year**

# Frequently Repeated (FR) XBT Network OceanObs99 Not Recommended Line Status 2007



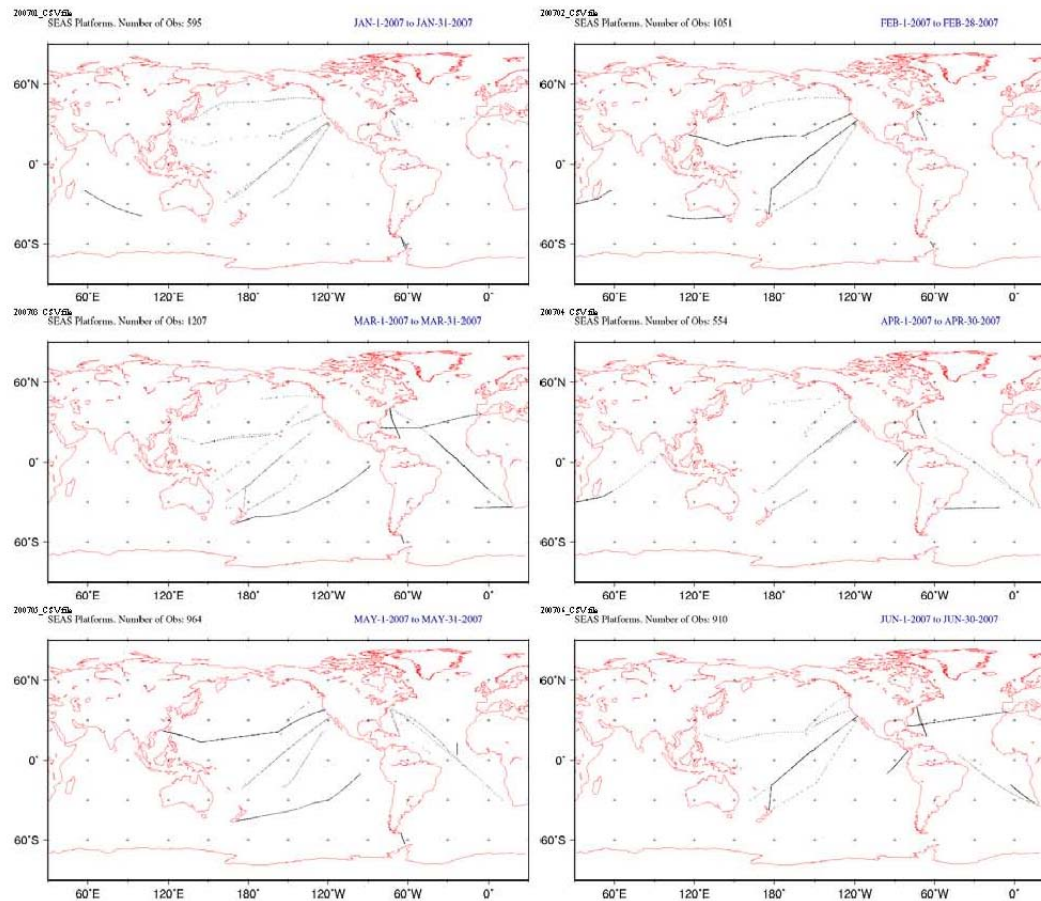
**Good FR 16+ transects per year**

GOOS OPERATIONS: SEAS TRANSMISSIONS

Report Date: DEC 2007

**GOOS Operations: XBT Program**

PDF file



**Not recommended but in GTS**

Good

Bad

**2006**

Line	Mode	Trxs	XBT	Status
AX04	FR	6	88	Bad
AX07	FR	6	71	Bad
AX32	FR	2	51	Bad
AX32	HD	3	6	Good
IX20	FR	1	1	Bad
IX20	HD	2	18	Bad
IX31	HD	4	275	Good
PX06	FR	4	54	Bad
PX08	HD	4	892	Good
PX10	FR	13	340	Bad
PX31	FR	10	500	Bad
PX31	HD	5	740	Good
PX37	FR	8	108	Bad
PX44	FR	12	138	Bad
PX83	FR	16	84	Good
			<b>3366</b>	

**2007**

Line	Mode	Trxs	XBT	Status
AX07	FR	5	103	Bad
AX17	HD	2	351	Bad
AX32	FR	6	25	Bad
AX32	HD	7	130	Good
IX06	HD	2	208	Bad
IX20	FR	1	1	Bad
IX31	HD	3	228	Good
PX08	HD	4	960	Good
PX10	FR	14	356	Bad
PX13	HD	4	275	Good
PX28	FR	6	116	Bad
PX31	FR	5	273	Bad
PX31	HD	3	592	Good
PX33	FR	1	6	Bad
PX37	FR	15	170	Bad
PX39	FR	8	102	Bad
PX42	FR	1	19	Bad
PX44	FR	12	125	Bad
PX83	FR	6	15	Bad
			<b>4055</b>	

**2008 Jan to Sept**

Line	Mode	Trxs	XBT	Status
AX07	FR	9	282	Bad
AX17	HD	1	171	Bad
AX32	FR	7	36	Bad
AX32	HD	8	150	Good
IX06	HD	3	348	Good
IX31	HD	3	216	Good
PX06	FR	3	202	Bad
PX08	HD	1	217	Bad
PX10	FR	12	339	Bad
PX28	FR	1	8	Bad
PX31	HD	3	608	Good
PX37	FR	11	144	Bad
PX44	FR	12	134	Bad
PX83	FR	2	2	Bad

*\*note: 2008 cruise schedule not yet completed*

**Recommended and in GTS**

Good  
Bad

**2006**

Line	Mode	Trxs	XBT	Status
AX07	HD	6	809	Good
AX08	HD	4	1024	Good
AX10	FR	49	332	Good
AX10	HD	4	291	Good
AX18	HD	4	687	Good
AX22	HD	10	440	Good
AX25	HD	2	334	Bad
AX29	FR	6	107	Bad
AX34	FR	1	36	Bad
IX15	HD	4	428	Good
IX21	HD	3	168	Good
PX06	HD	4	258	Good
PX08	FR	12	553	Bad
PX10	HD	4	487	Good
PX13	FR	17	987	Good
PX18	FR	4	117	Bad
PX26	FR	17	501	Good
PX37	HD	4	320	Good
PX44	HD	4	365	Good
PX50	HD	1	195	Bad
			8439	

**2007**

Line	Mode	Trxs	XBT	Status
AX07	HD	5	764	Good
AX08	FR	8	410	Bad
AX08	HD	4	1001	Good
AX10	FR	38	371	Good
AX10	HD	4	380	Good
AX18	HD	1	171	Bad
AX22	HD	8	379	Good
AX25	HD	1	125	Bad
IX06	FR	1	18	Bad
IX15	HD	3	407	Good
IX21	HD	4	359	Good
PX06	HD	3	204	Good
PX08	FR	4	162	Bad
PX10	HD	4	504	Good
PX13	FR	10	464	Bad
PX18	FR	6	170	Bad
PX26	FR	16	452	Good
PX37	HD	4	337	Good
PX44	HD	4	378	Good
			7056	

**2008 (Jan - Sep)**

Line	Mode	Trxs	XBT	Status
AX07	HD	2	387	Bad
AX08	FR	9	399	Bad
AX08	HD	3	821	Good
AX10	FR	9	125	Bad
AX10	HD	2	220	Bad
AX22	HD	7	264	Good
AX25	HD	1	193	Bad
IX15	HD	3	418	Good
IX21	HD	3	277	Good
PX08	FR	9	588	Bad
PX10	HD	4	484	Good
PX13	FR	11	488	Bad
PX26	FR	15	457	Bad
PX37	HD	3	329	Good
PX44	HD	4	347	Good
PX50	HD	1	263	Bad
			5797	

*\*note: 2008 cruise schedule not yet completed*

**Recommended but missing from GTS**

<b>2006</b>	
<b>Line</b>	<b>Recommended Mode</b>
AX03	HD
AX08	FR
AX11	FR
AX15	FR
AX20	FR
IX01	FR
IX01	HD
IX06	FR
IX07	FR
IX08	FR
IX09S	FR
IX10	HD
IX12	FR
IX22	FR
IX28	HD
PX02	FR
PX04	FR
PX05	FR
PX05	HD
PX09	FR
PX09	HD
PX11	FR
PX17	FR
PX21	FR
PX30	HD
PX34	HD
PX38	HD
PX40	HD
PX81	HD

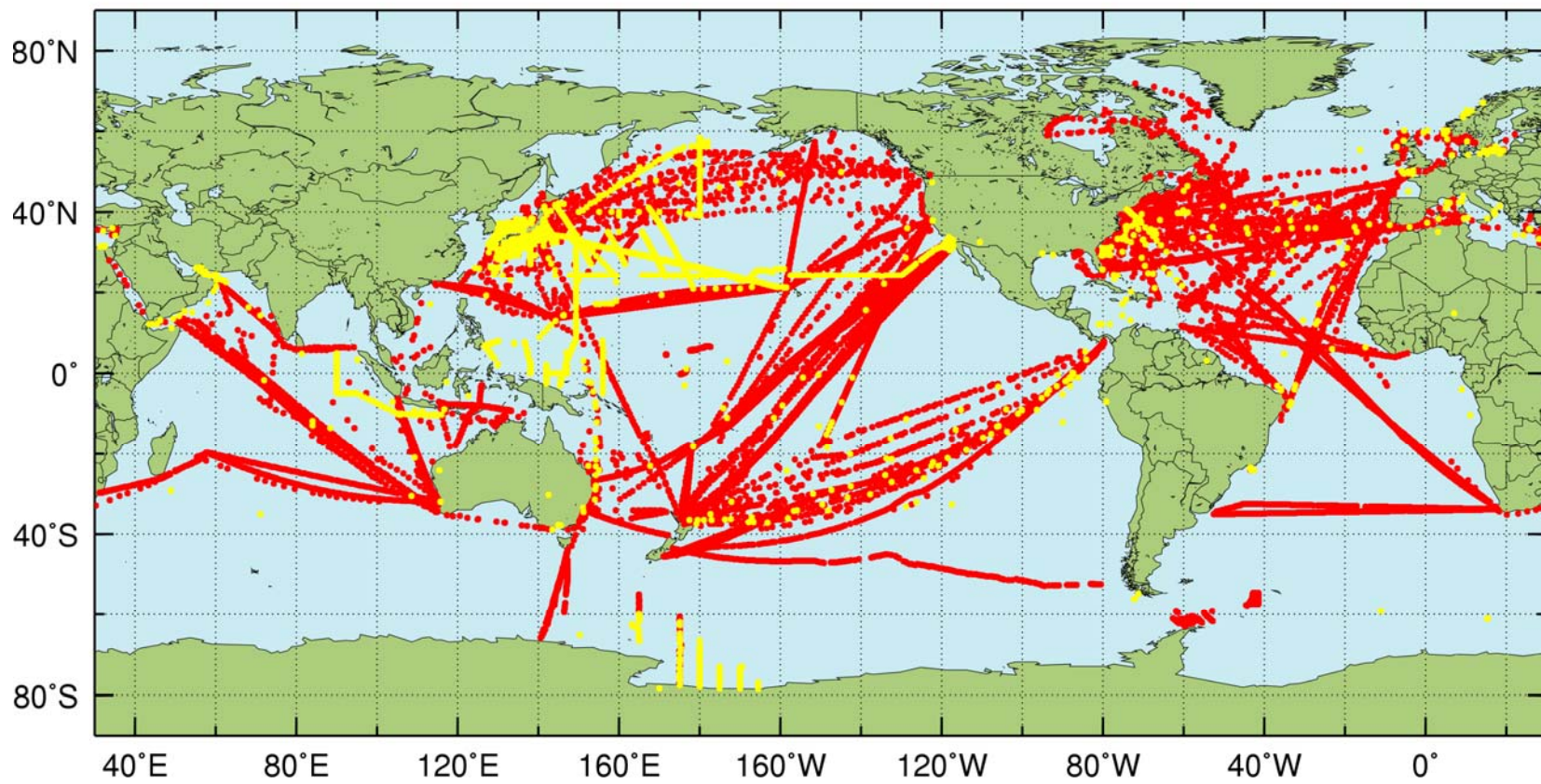
<b>2007</b>	
<b>Line</b>	<b>Recommended Mode</b>
AX03	HD
AX11	FR
AX15	FR
AX20	FR
AX29	FR
AX34	FR
IX01	FR
IX01	HD
IX07	FR
IX08	FR
IX09S	FR
IX10	HD
IX12	FR
IX22	FR
IX28	HD
PX02	FR
PX04	FR
PX05	FR
PX05	HD
PX09	FR
PX09	HD
PX11	FR
PX17	FR
PX21	FR
PX30	HD
PX34	HD
PX38	HD
PX40	HD
PX50	HD
PX81	HD

<b>2008(Jan-Sept)</b>	
<b>Line</b>	<b>Recommended Mode</b>
AX03	HD
AX11	FR
AX15	FR
AX18	HD
AX20	FR
AX29	FR
AX34	FR
IX01	FR
IX01	HD
IX06	FR
IX07	FR
IX08	FR
IX09S	FR
IX10	HD
IX12	FR
IX22	FR
IX28	HD
PX02	FR
PX04	FR
PX05	FR
PX05	HD
PX06	HD
PX09	FR
PX09	HD
PX11	FR
PX17	FR
PX18	FR
PX21	FR
PX30	HD
PX34	HD
PX38	HD
PX40	HD
PX81	HD



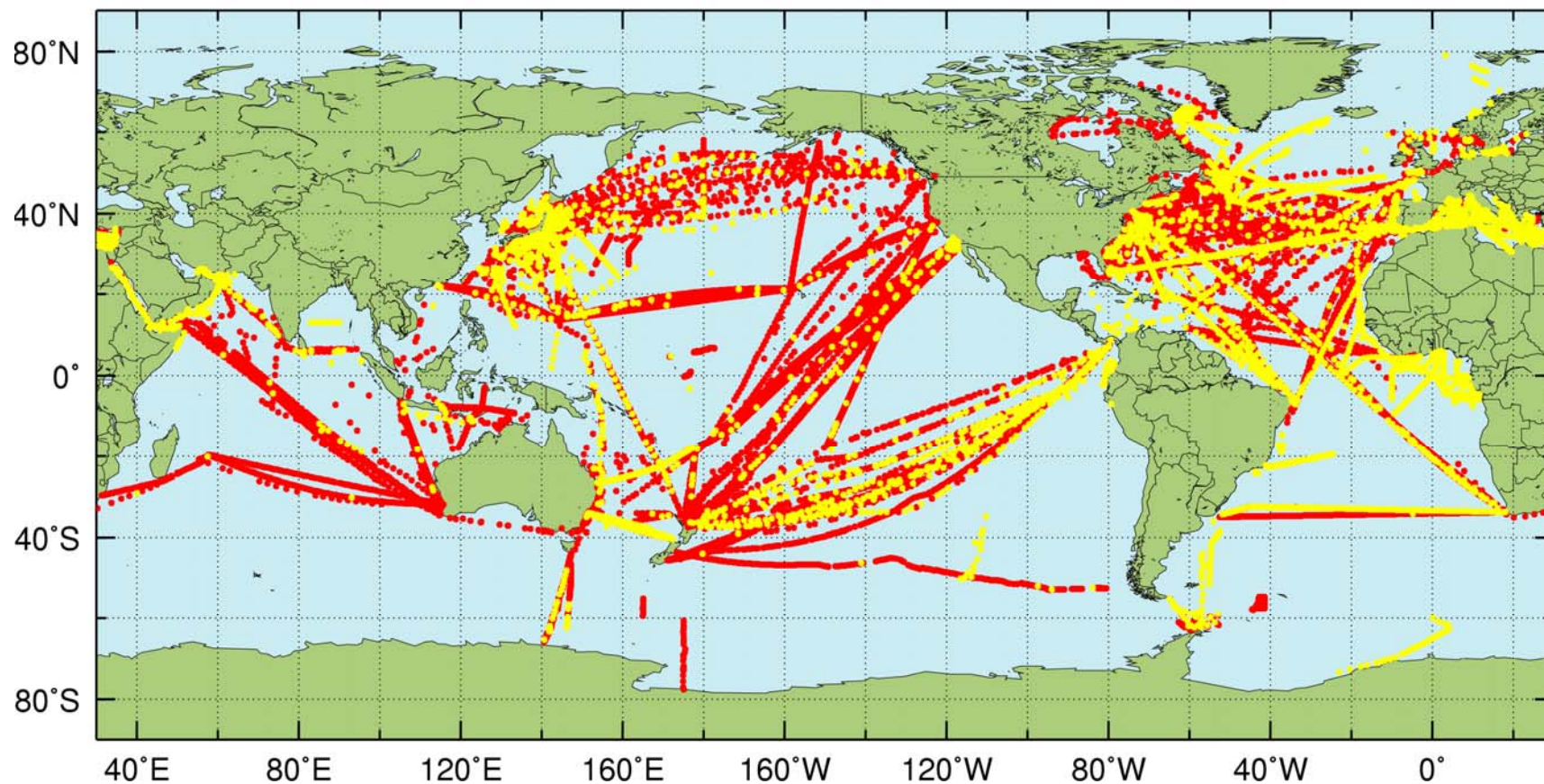
Y2005 GTSinWODB=17905

GTSnotinWODB=2499



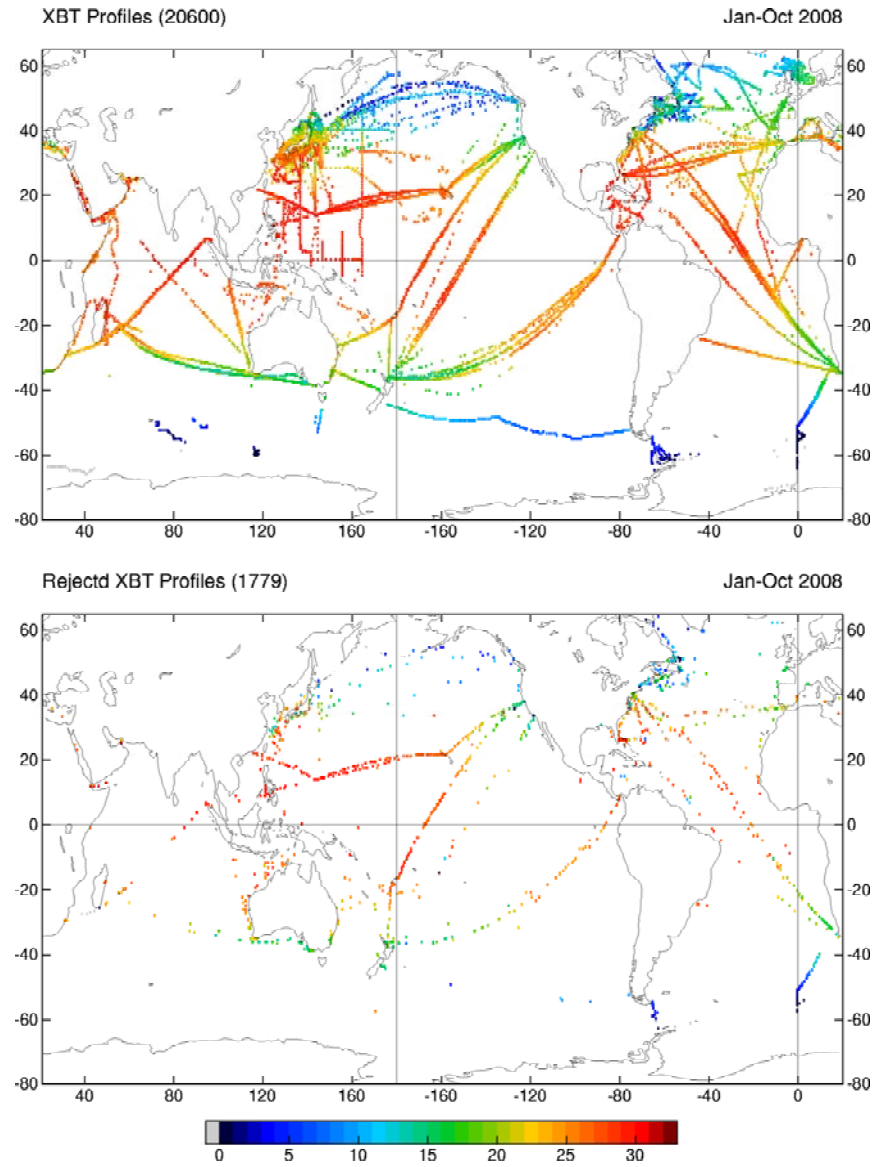
Y2005 WODBinGTS=17916

WODBnotinGTS=7281

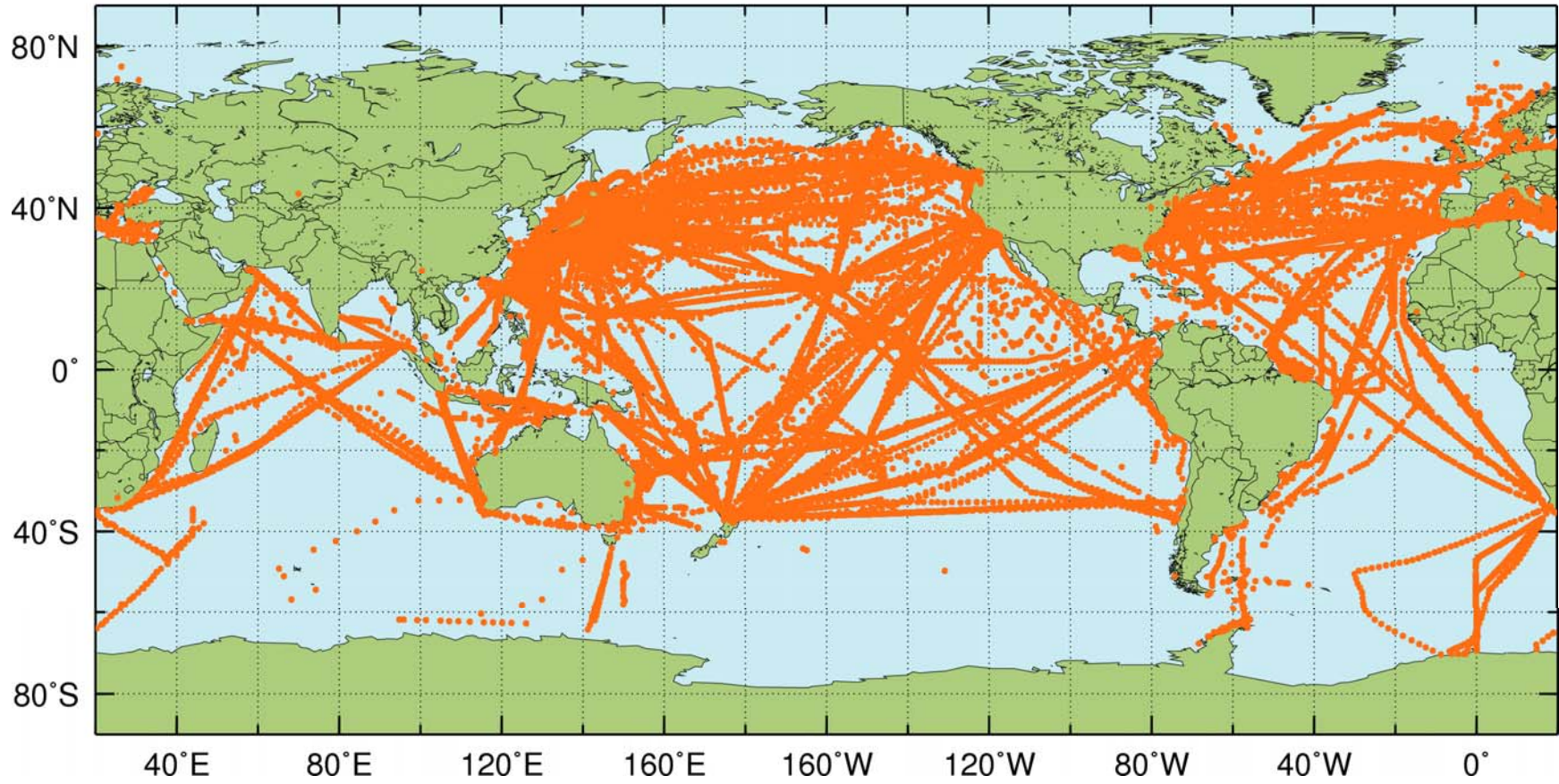


**We need to have centers push ALL data into GTS**

# NCEP XBT Rejections

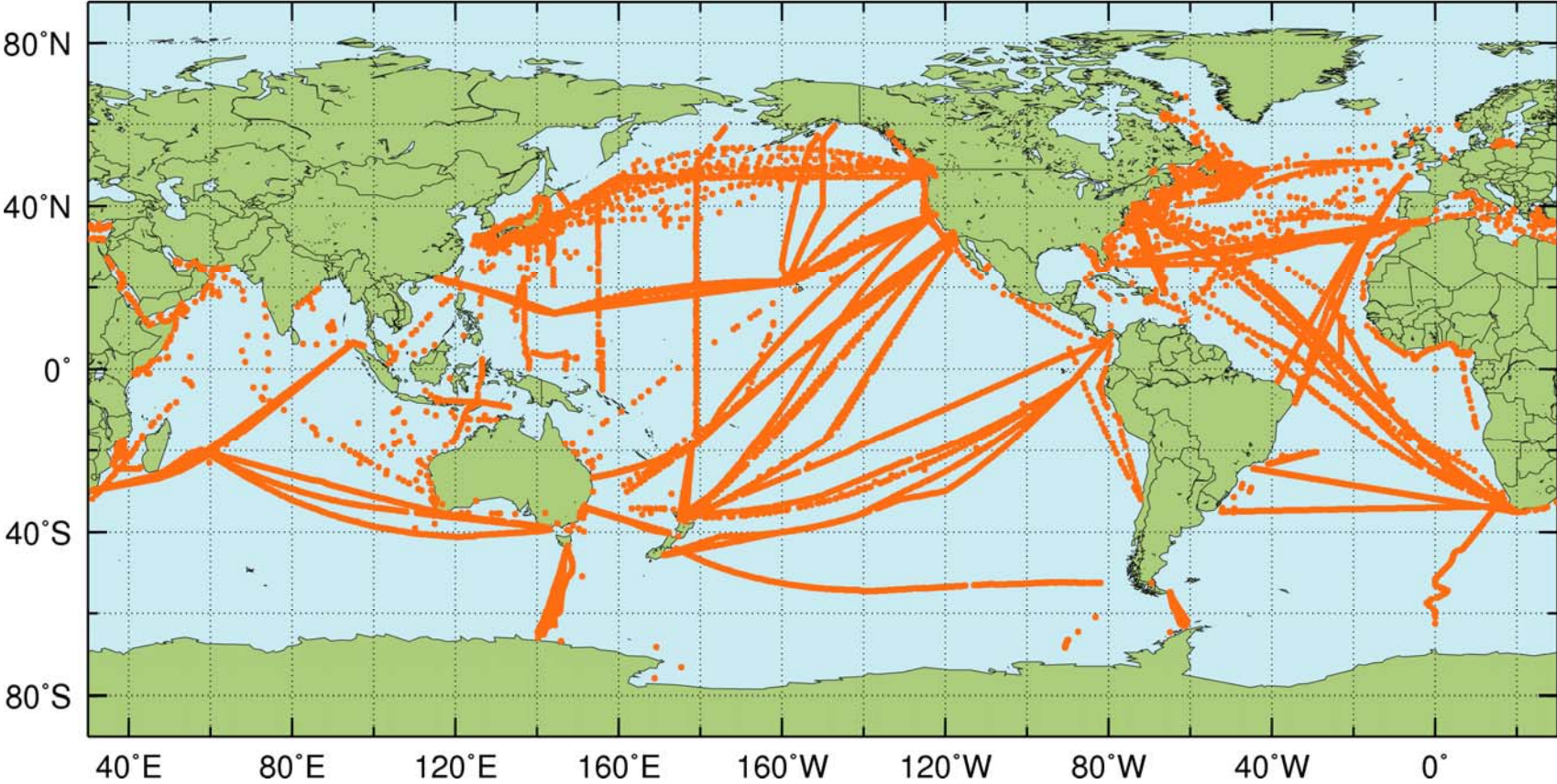


# 1999 XBT NODC Global Data



**N=46,423**

# 2007 XBT GTS Global Data



**N=17,179**

## Main contributors

### **USA/NOAA**

**AOML: HD in Atlantic and FR globally**

**SIO: HD in Pacific, Indian, Drake Passage**

**France: HD with AOML probes**

**Australia :HD, FR, with many AOML probes**

**India: HD, XCTD**

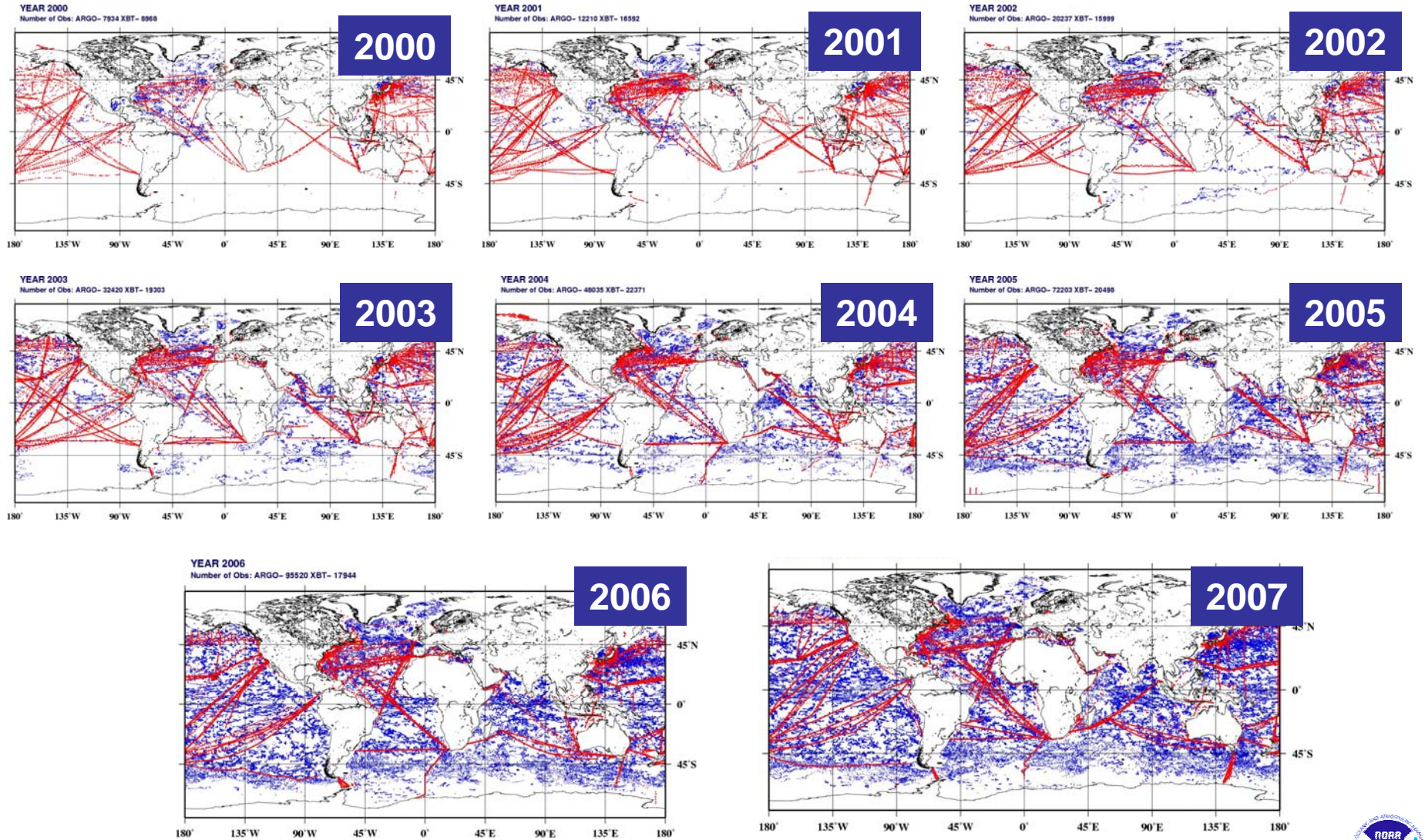
**Japan: ?**

**Brazil: HD with AOML probes, equipment**

**South Africa: HD with AOML probes, equipment**

**Noumea: ?, with AOML probes**

# Argo and XBT (GTS) observations

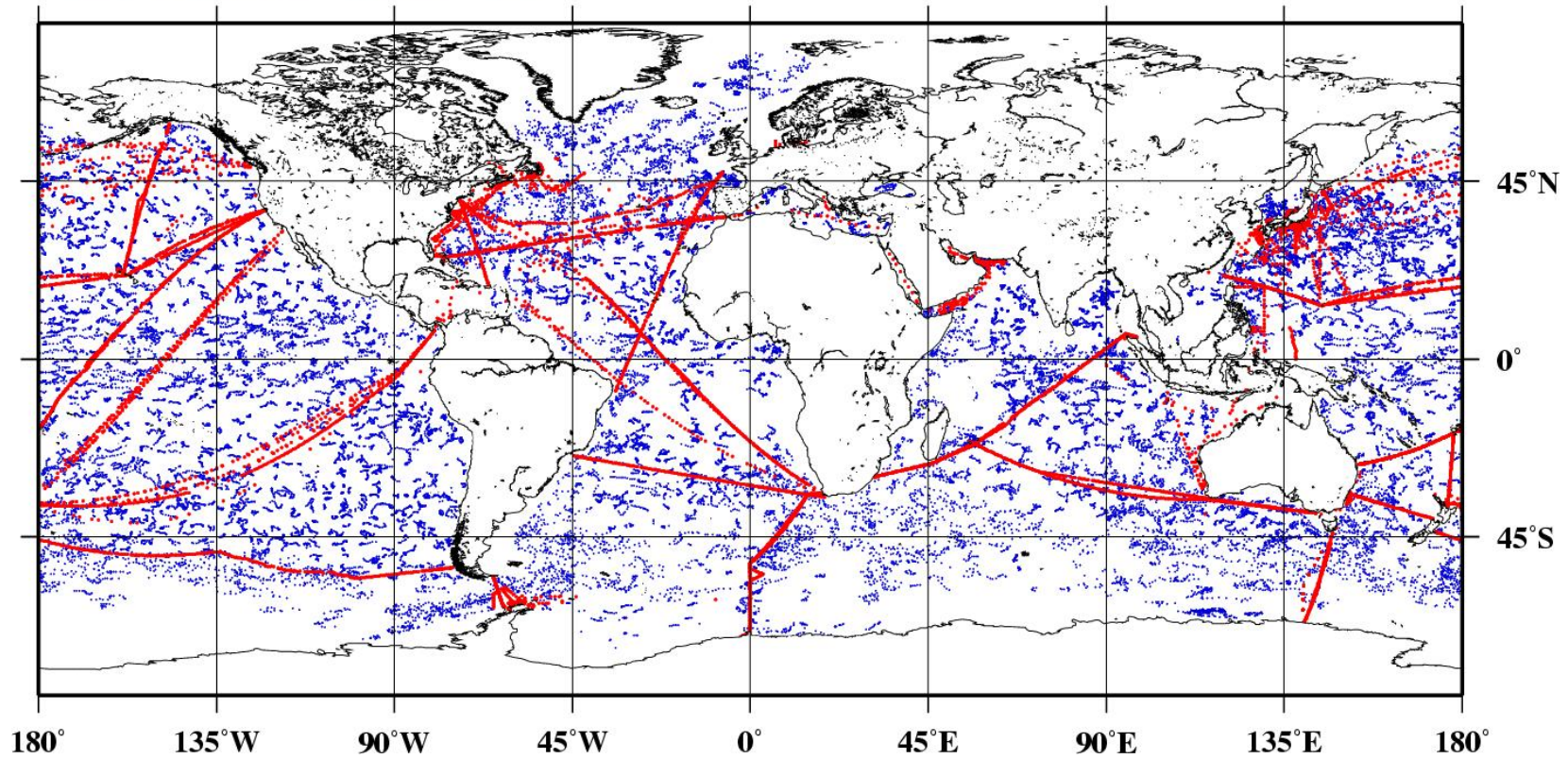


# Argo and XBT observations

YEAR 2008

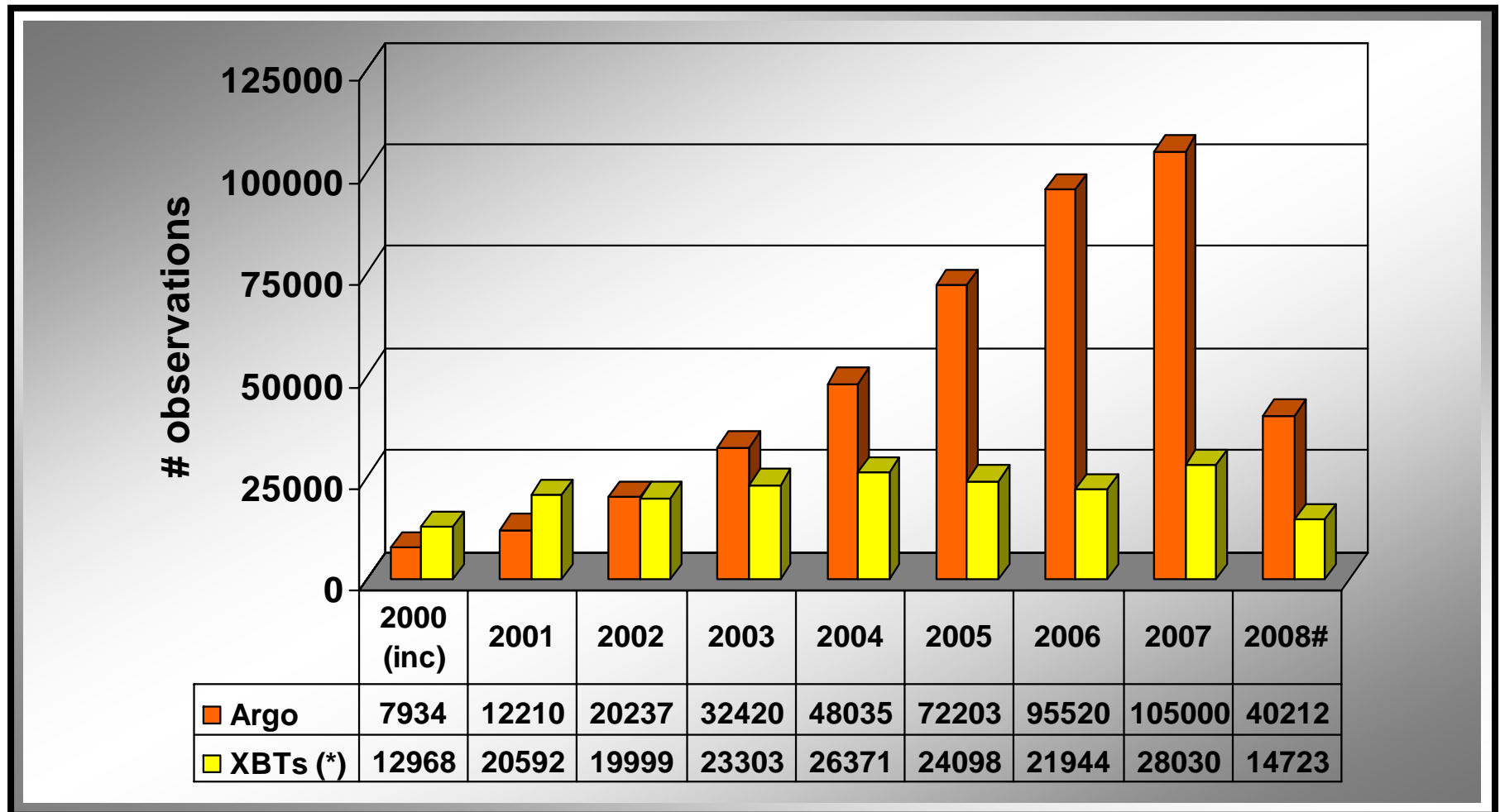
Number of Obs: ARGO- 40212 XBT- 10723

2008 (JAN-MAY)





# XBT and Argo observations in the GTS 2000-2007 (temporal distribution)



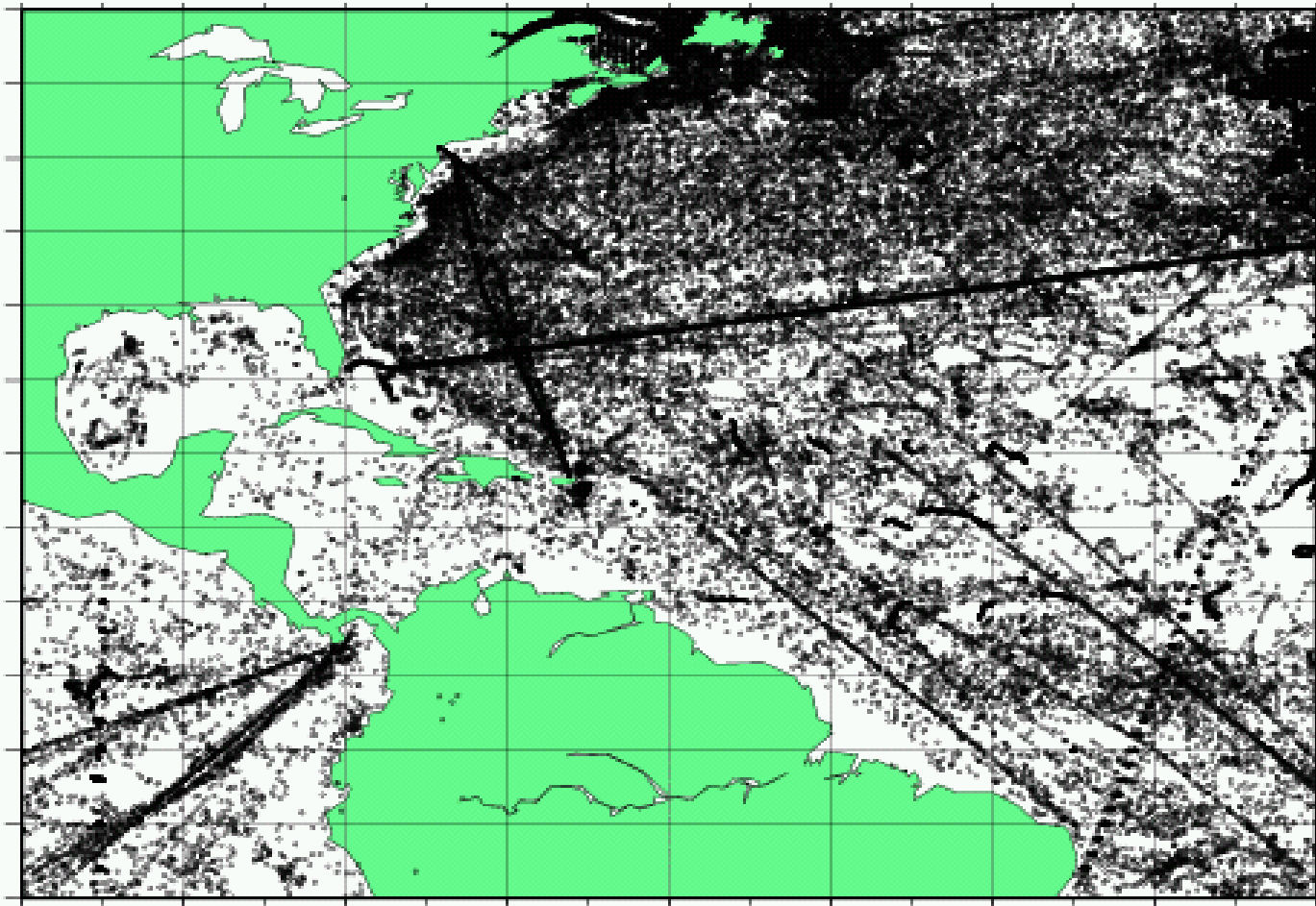
Inc= Year is incomplete

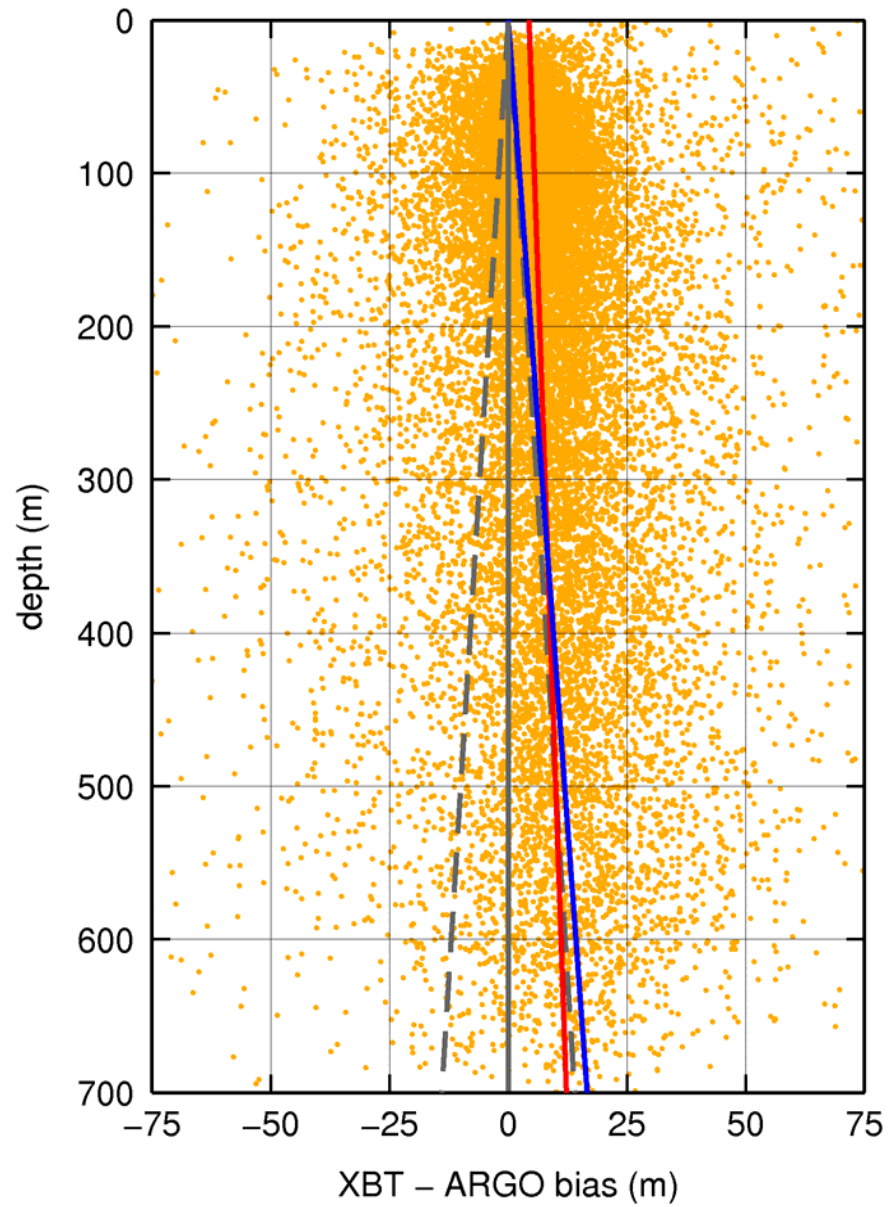
\* Includes additional estimated 4k XBTs per year that are not transmitted into the GTS

# Are data until May 20, 2008

# Undersampled regions

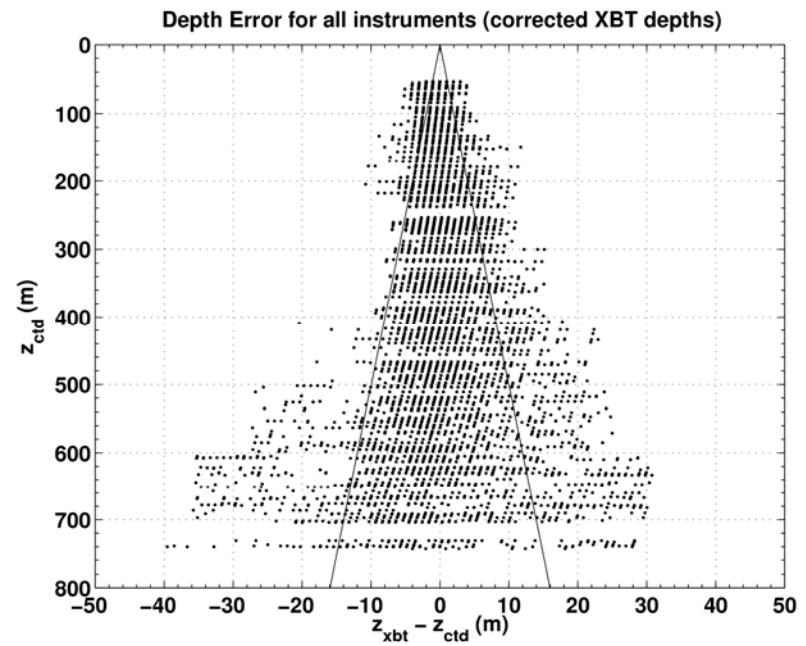
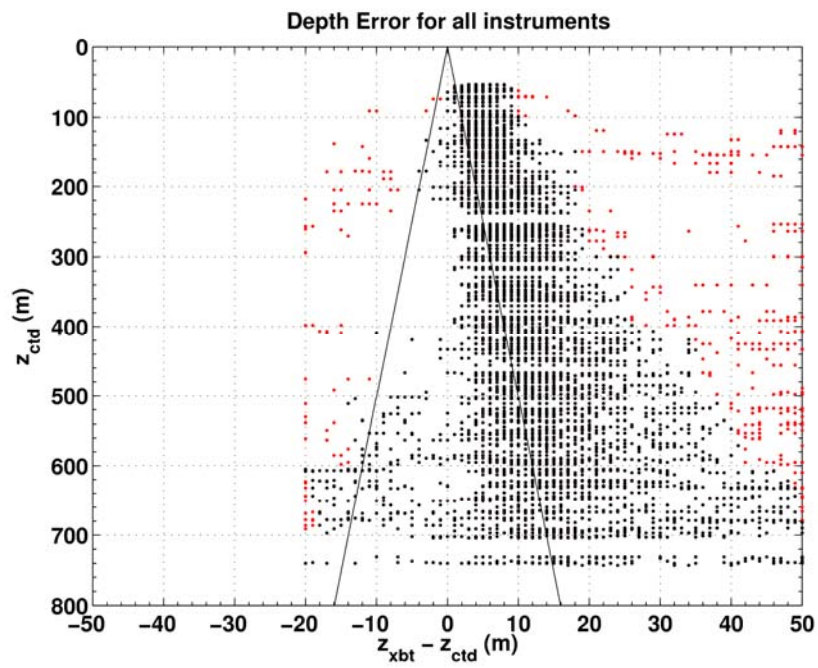
1999-2005 XBT obs in GTS





## Fall rate equation issues

# Fall rate equation issues



# XBTs since OceanObs 99

- Some recommended transects are not being implemented (HD PX50),
  - Some recommended transect that are being implemented were not recommended (FRX PX08, LD AX32-Oleander, HD AX98, LD/HD AX02),
  - There may be need to carry new transects (high latitude in NA),
  - There may be need to remove some transects,
  - Evaluate if some transects need to be sampled deeper than 800m,
  - Evaluate if some transects need to be sampled with XCTD instead of XBTs,
- 
- There may not acceptable/sufficient scientific justification for some of the XBT transects, in particular for FRX transects,
- 
- After 10 years of Argo, can we now evaluate if profiling float observation can reproduce XBT LD signals? May be it is too early to do this,
- 
- Are current ocean models adequate to carry an evaluation of the system ?

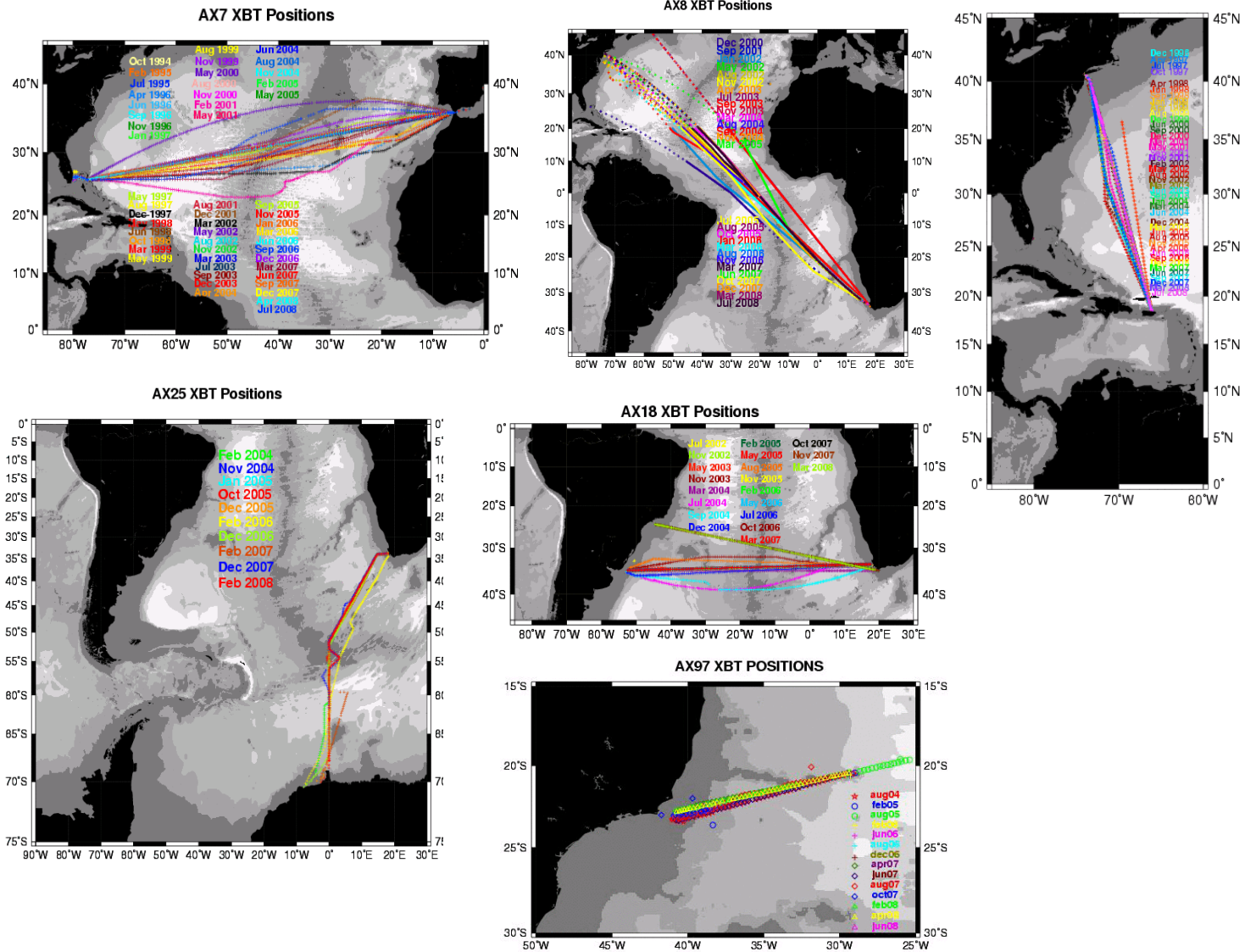


# XBTs since OceanObs 99

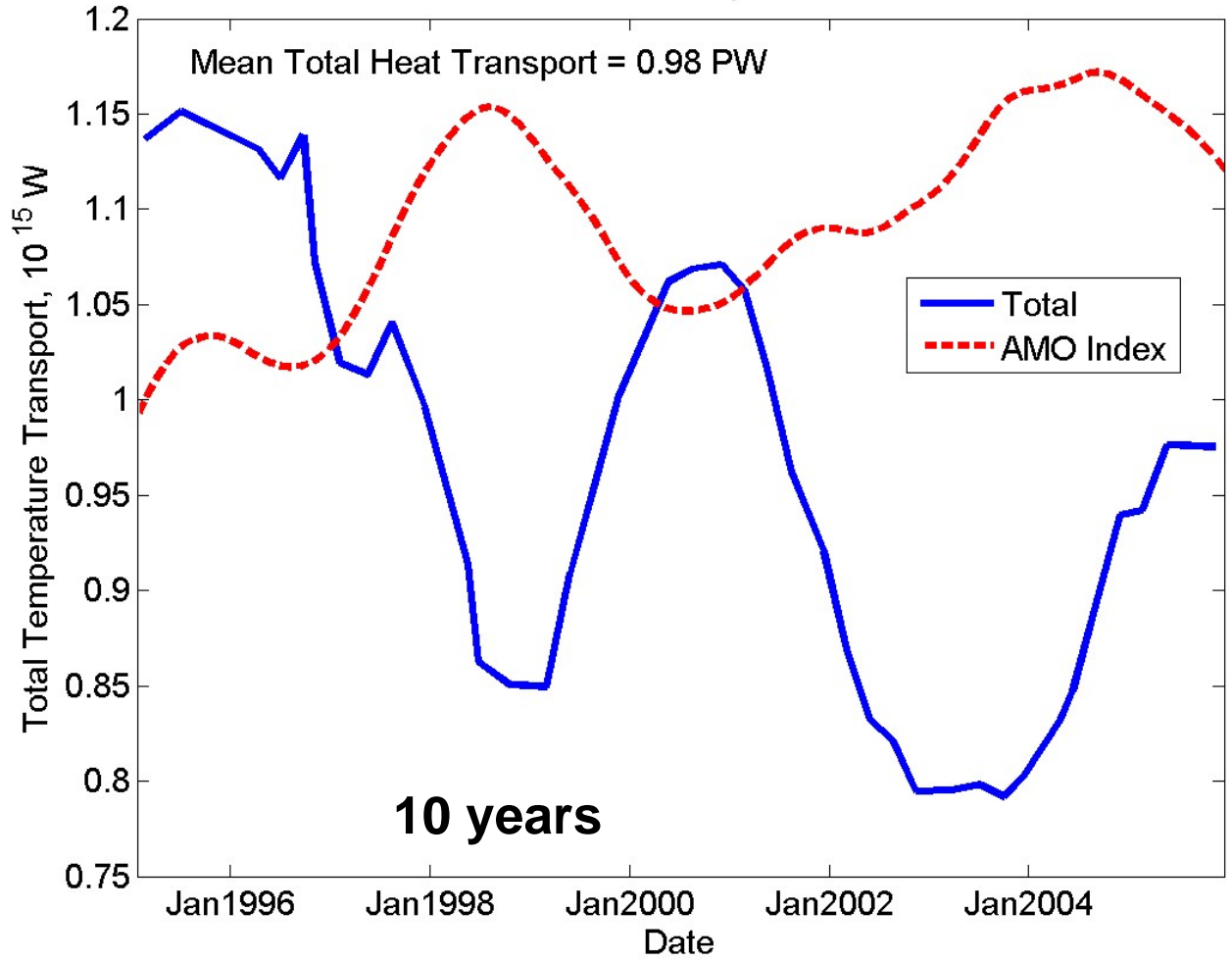
- Who is using the data ? (NCEP, US Navy's MODAS)
- What are the data used for ? (weather and climate model initialization, data analysis, ...)
- Real-time transmission issues (Not all the data are transmitted in real-time into the GTS),
- Is there a need for a re-evaluation of the observing system for upper ocean thermal studies ?
- Can Argo float provide adequate monitoring of the observing system for upper ocean heat storage ? If not, how can XBT and altimetry help ?
- Cost issues: ~\$80 per XBT (~\$35 when NOAA buys them) and \$15 per transmission using Inmarsat (~\$1.20 using Iridium, change is currently in test phase).



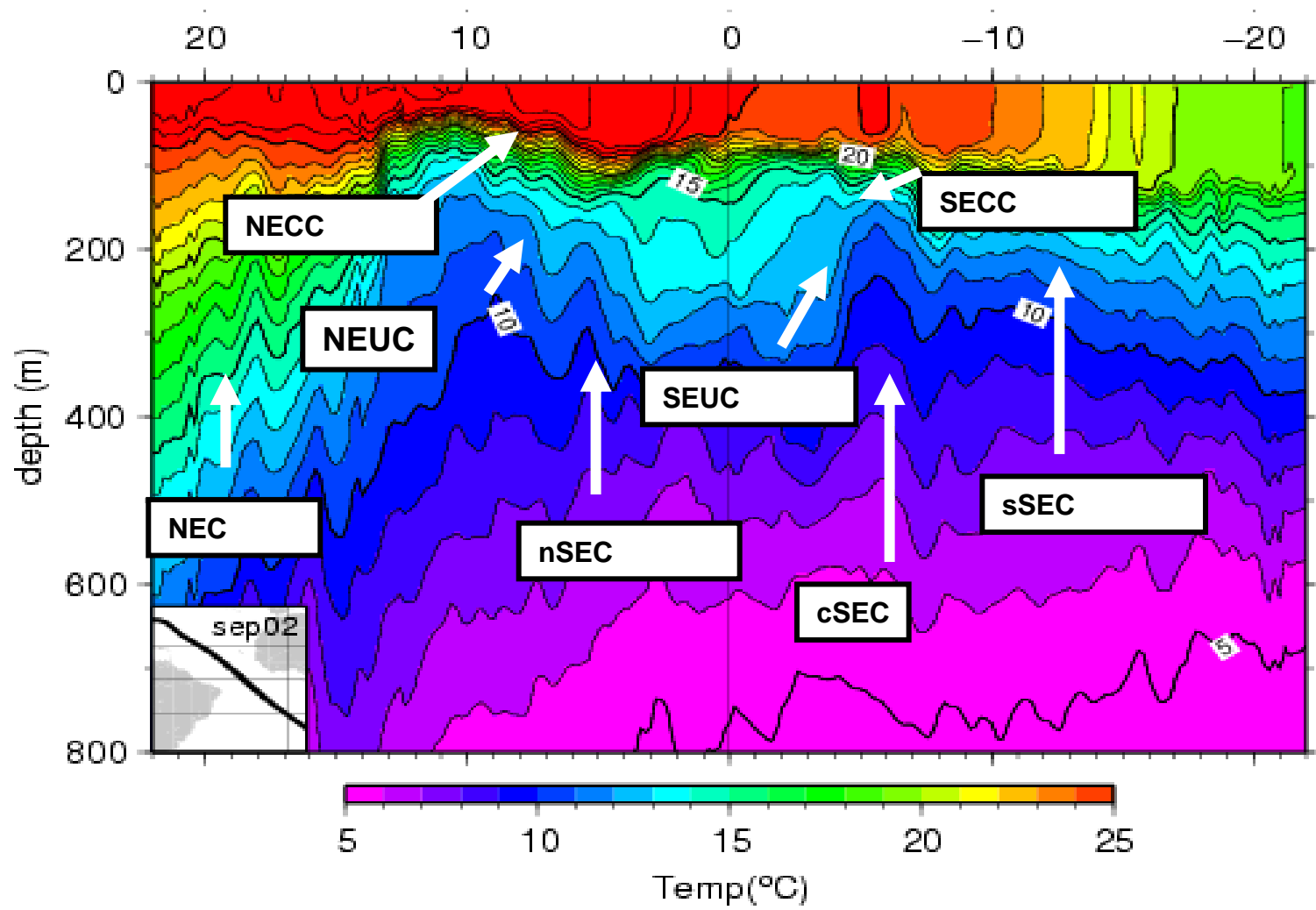
# NOAA/AOML HD data raw vs QC data distribution



### Northward Heat Transport Across AX7

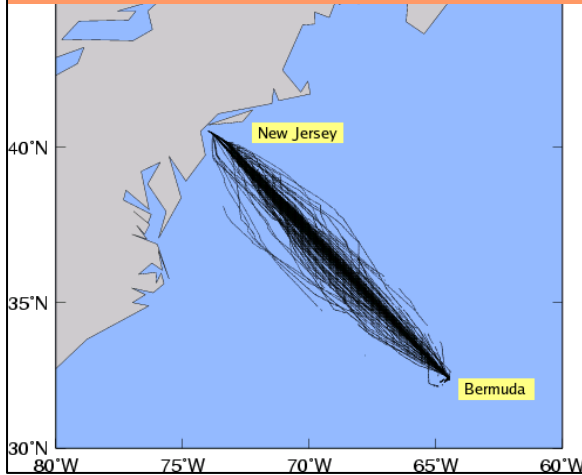




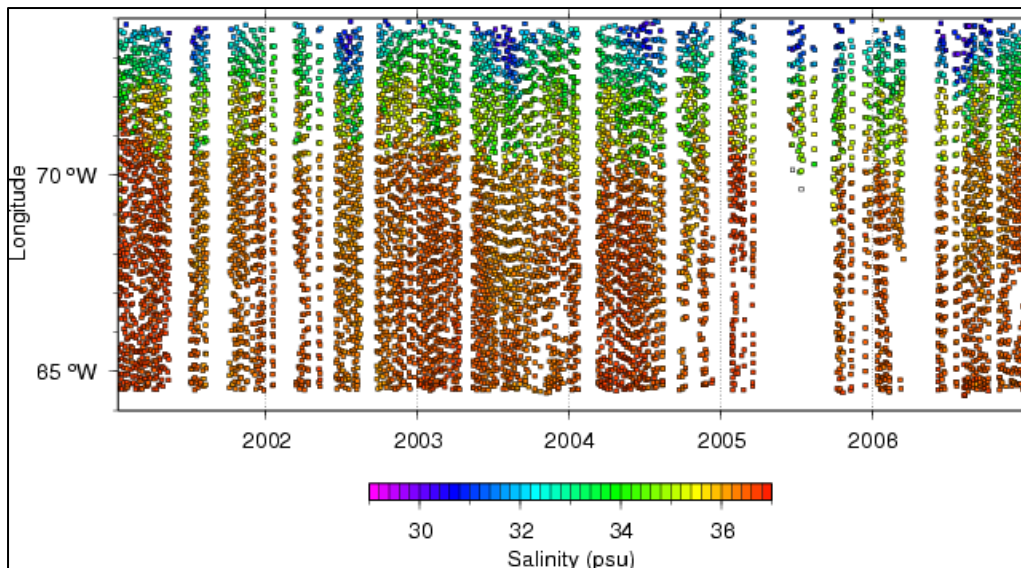


# The Oleander Project

This is not a recommended XBT transect

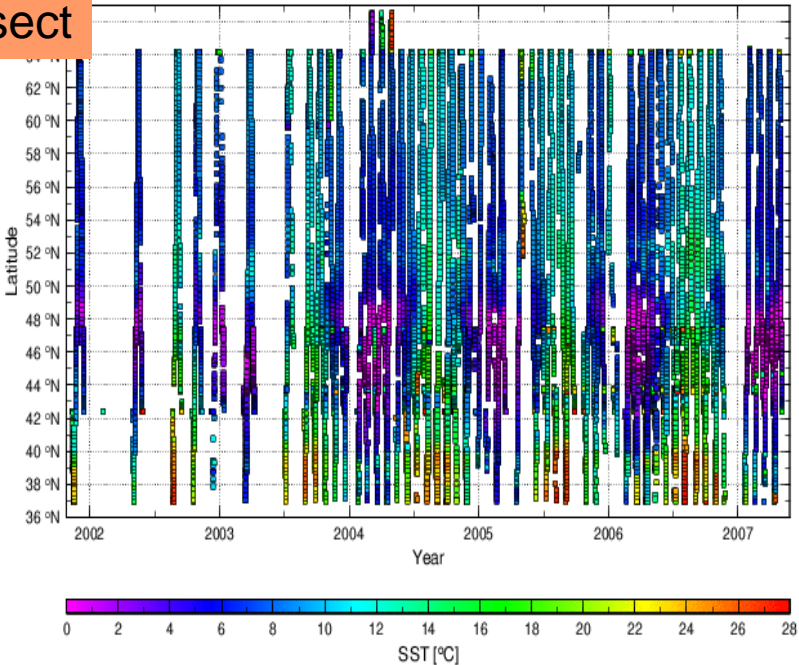


- TSG NOAA/AOML and NOAA/NEFSC 1991 to present: RT transmission, water sampling, 10 sec TSG sampling, 2 transects/week all year.
- XBTs NOAA/NEFSC and NOAA/AOML 1976 to present.
- ACDP NOAA contract with URI and SUNY LI mid 1990s to present.
- pCO<sub>2</sub> NOAA/AOML 2006 to present.
- CPR NEFSC 1975 to present.

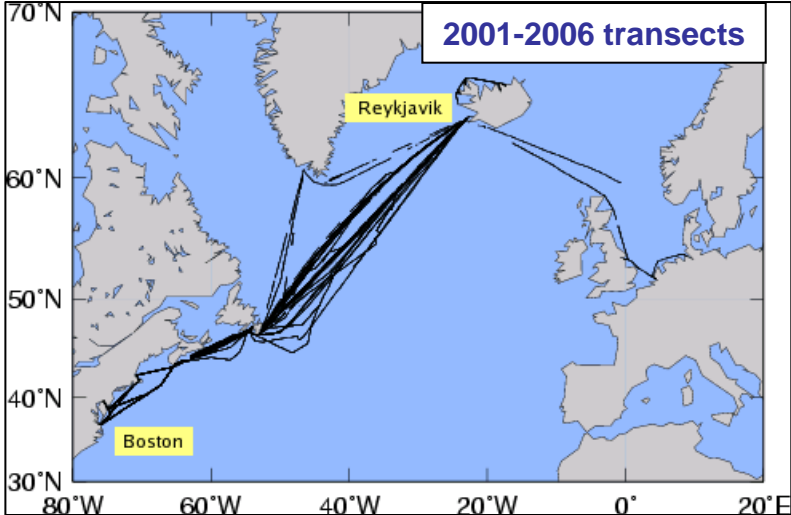


# NYC - Iceland

This is not a recommended XBT transect



NOAA / AOML / PHOD. Last update: Tue Nov 13 16:11:51 EST 2007



- + pCO2
- + water sampling
- + XBTs

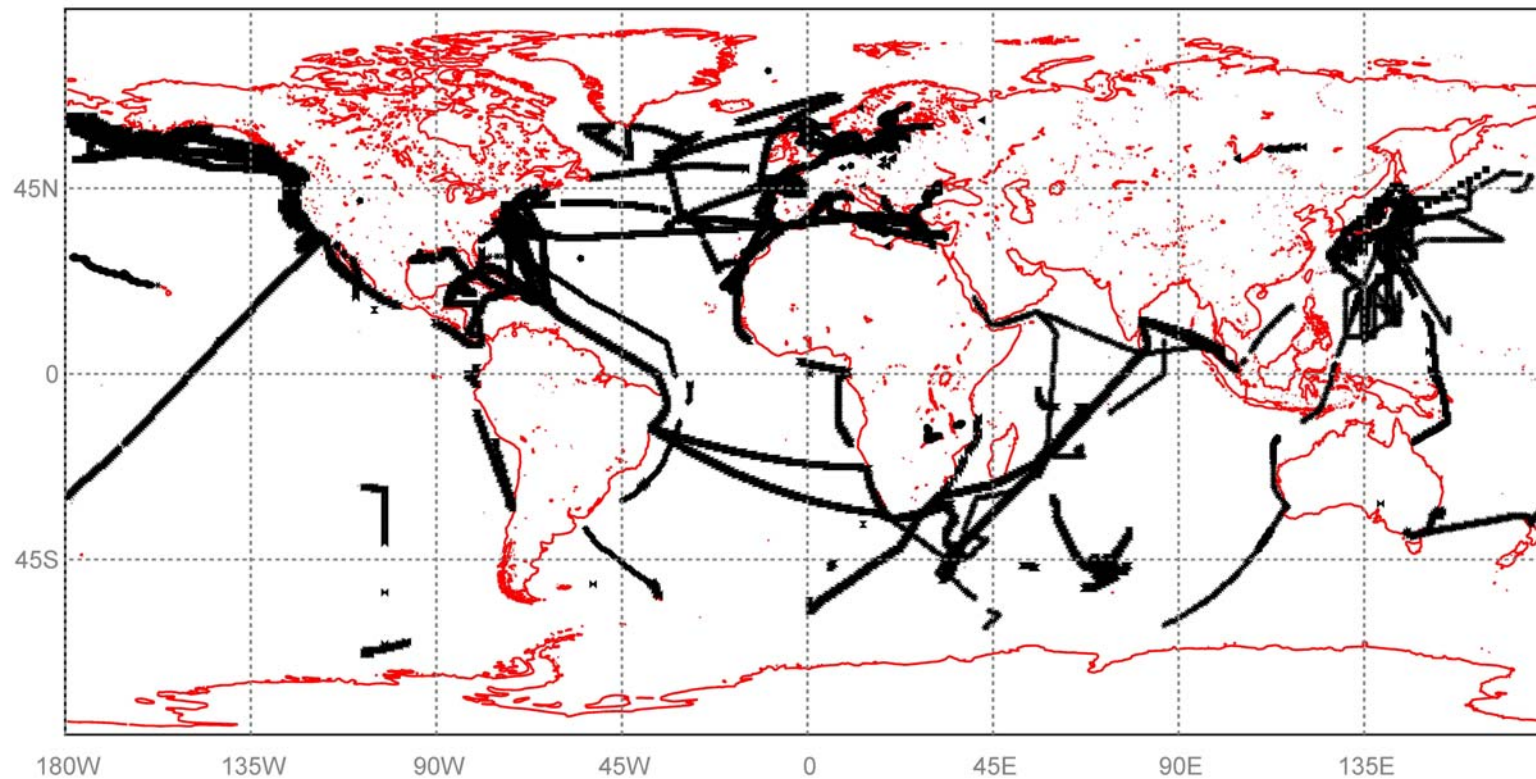
# TSG Observations

**Do we need recommended transects for TSGs as is done with XBTs ?**

*SEAS TRACKOB Database*

JAN-1-2007 to NOV-5-2008

All Platforms, Number of Obs: 444994



## TSGs in NOAA Fleet

Ship	Use	Main area of operation
Ronald Brown	O	Worldwide
Oscar Dyson	F	Gulf of Mexico, Pacific and Atlantic oceans
Miller Freeman	F	Pacific Ocean
Ka'imimoana	O - A	Tropical Pacific Ocean
Hi'ialakai	O - F	Pacific Ocean
Oscar E. Sette	F	Tropical Pacific
Nancy Foster	E-F	Atlantic Ocean
Gordon Gunter	F	Gulf of Mexico and Atlantic Ocean
Fairweather	NC	Gulf of Alaska
Mc. Arthur II	E-F	Pacific Ocean
Albatros IV	F	North Atlantic Ocean
Delaware II	F	North Atlantic Ocean
Oregon II	F	Gulf of Mexico, Atlantic
David Jordan	F	Off CA and OR coast



**Ships with pCO<sub>2</sub> systems**



**Ships transmitting in RT**

# **Issues of TSG Work**

**Should TSG operations be part of GOOS ?**

**Recommendations of transects by a panel (GOSUD ?)**

**Scientific justification**

**Monitoring the transects**

**Where to place transects to better serve future satellite missions**

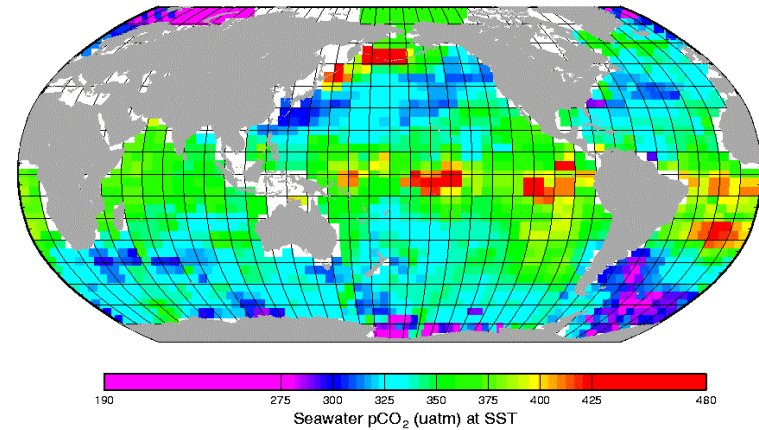
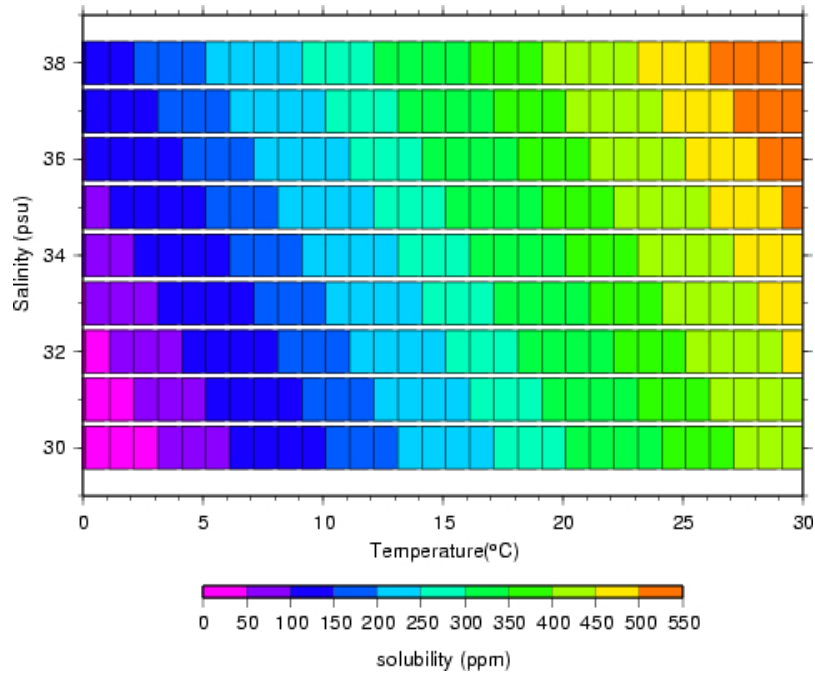
**Are these data being assimilated into forecast models ?**

**Real-time data transmission: GTS, CORIOLIS, ....., both ?**

**Identification of operational users: initialization of models...**

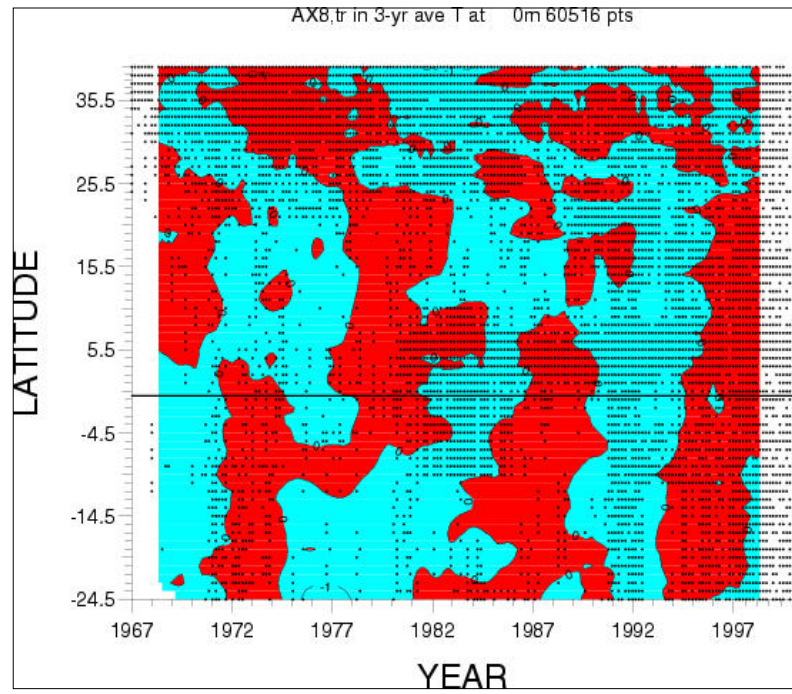
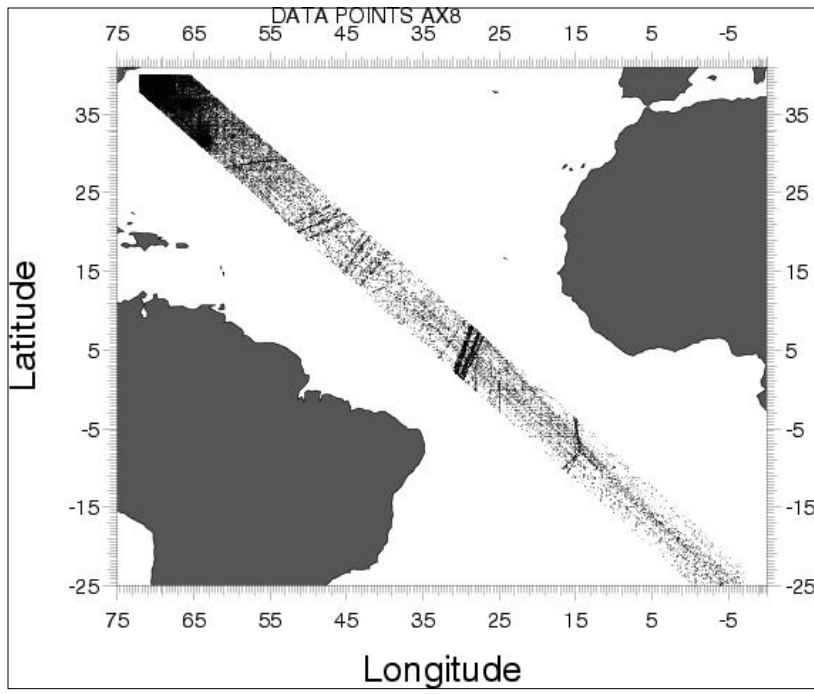
**Science use: El Nino studies, pCO<sub>2</sub> support, MLD studies, Satellite missions**

## ① pCO<sub>2</sub> in surface water



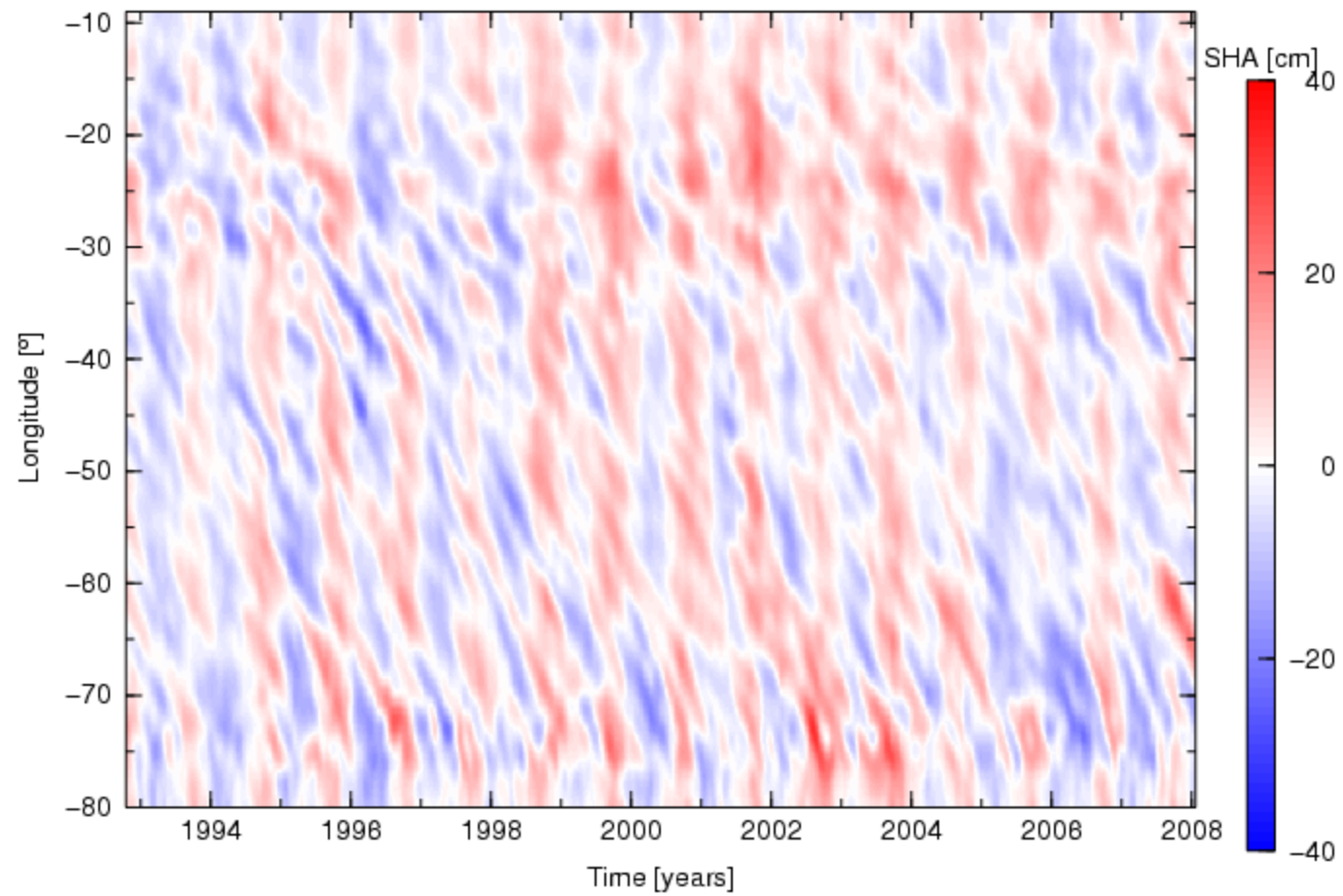
Courtesy R. Wanninkhof

**An objective of the pCO<sub>2</sub> project is to increase the number of samples to produce seasonal maps of CO<sub>2</sub> with initial focus on the North Atlantic and North Pacific Ocean.**  
**Blue=sinks**  
**Red=sources**

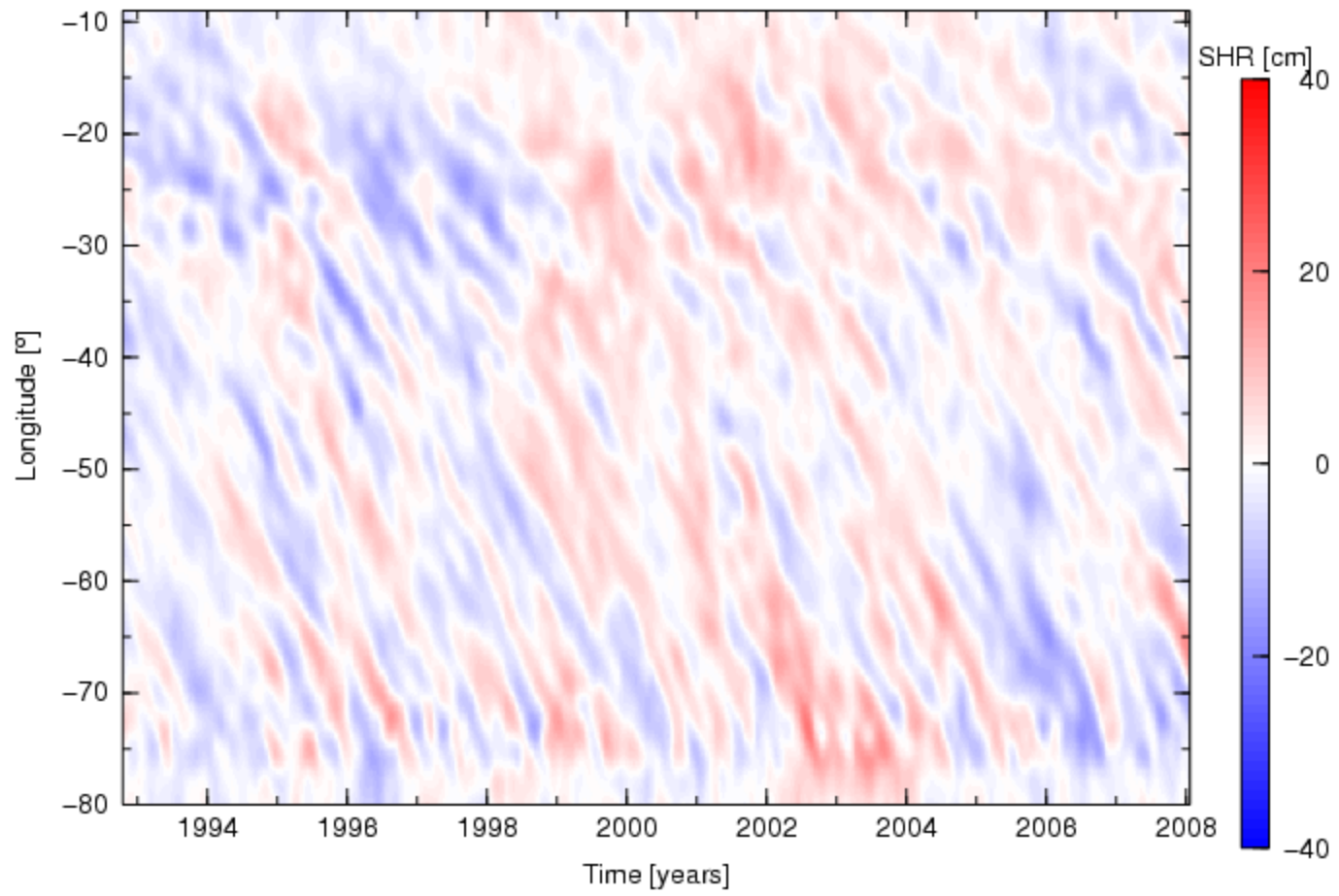




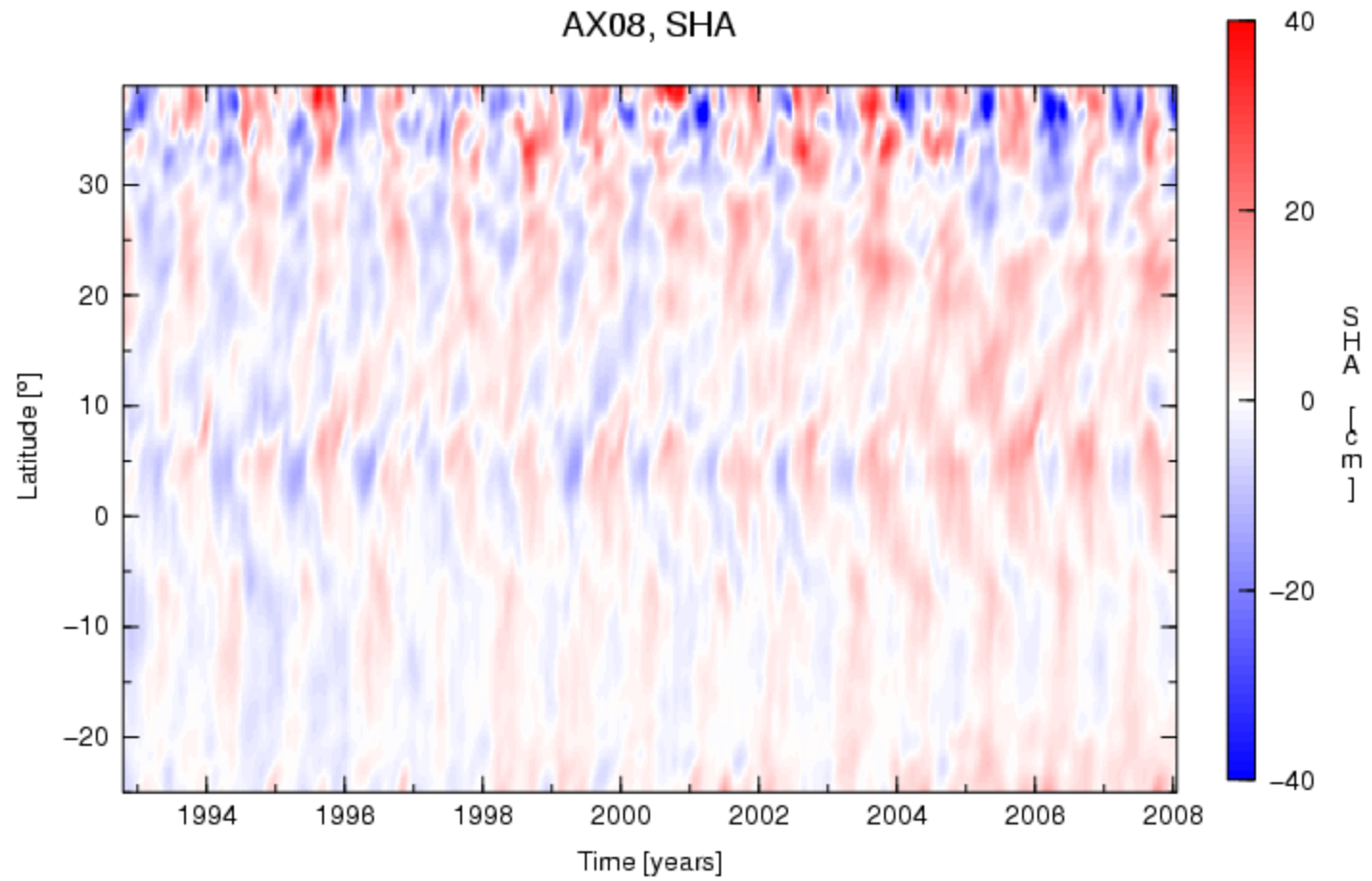
### AX07, SHA



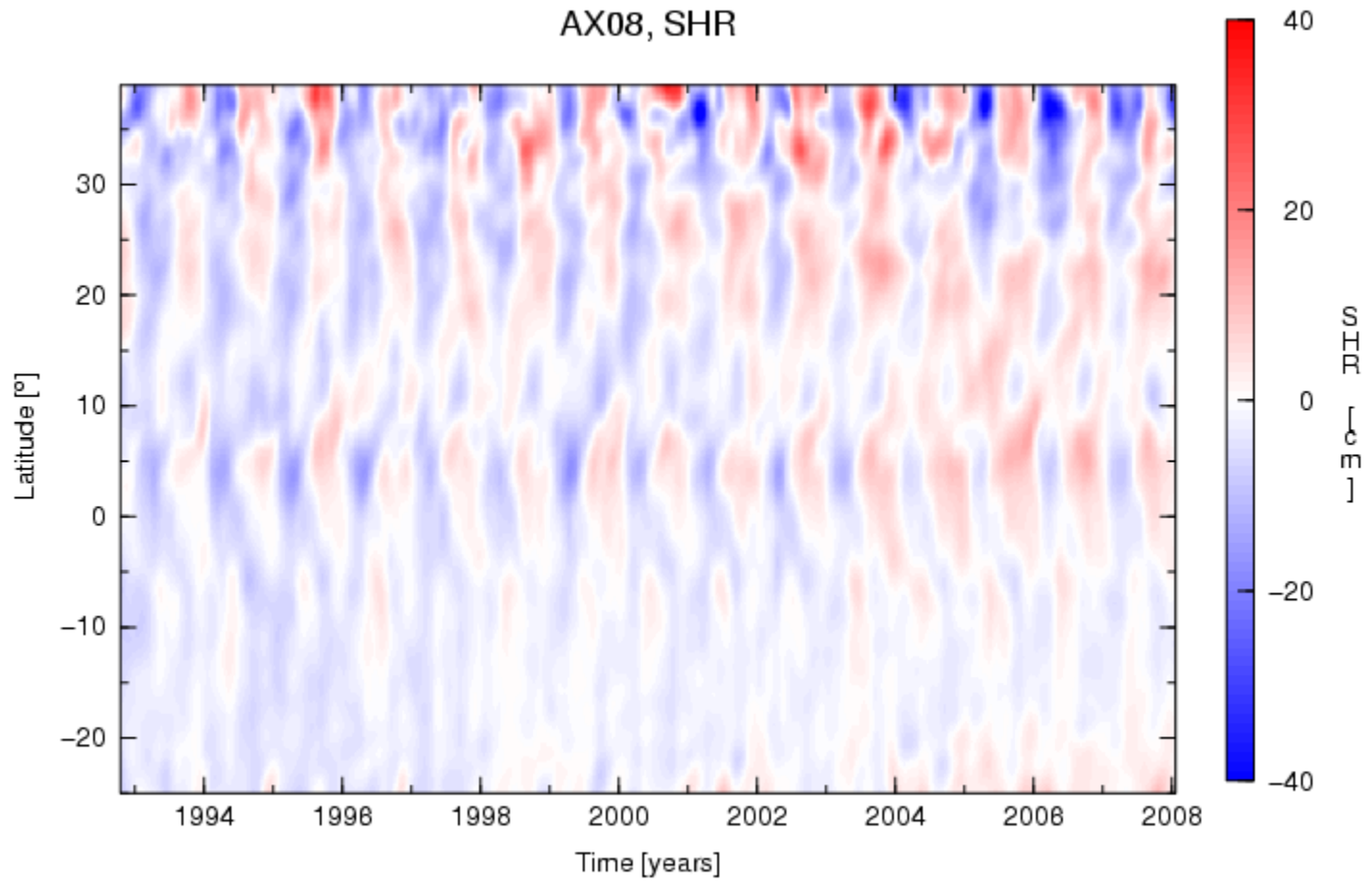
### AX07, SHR



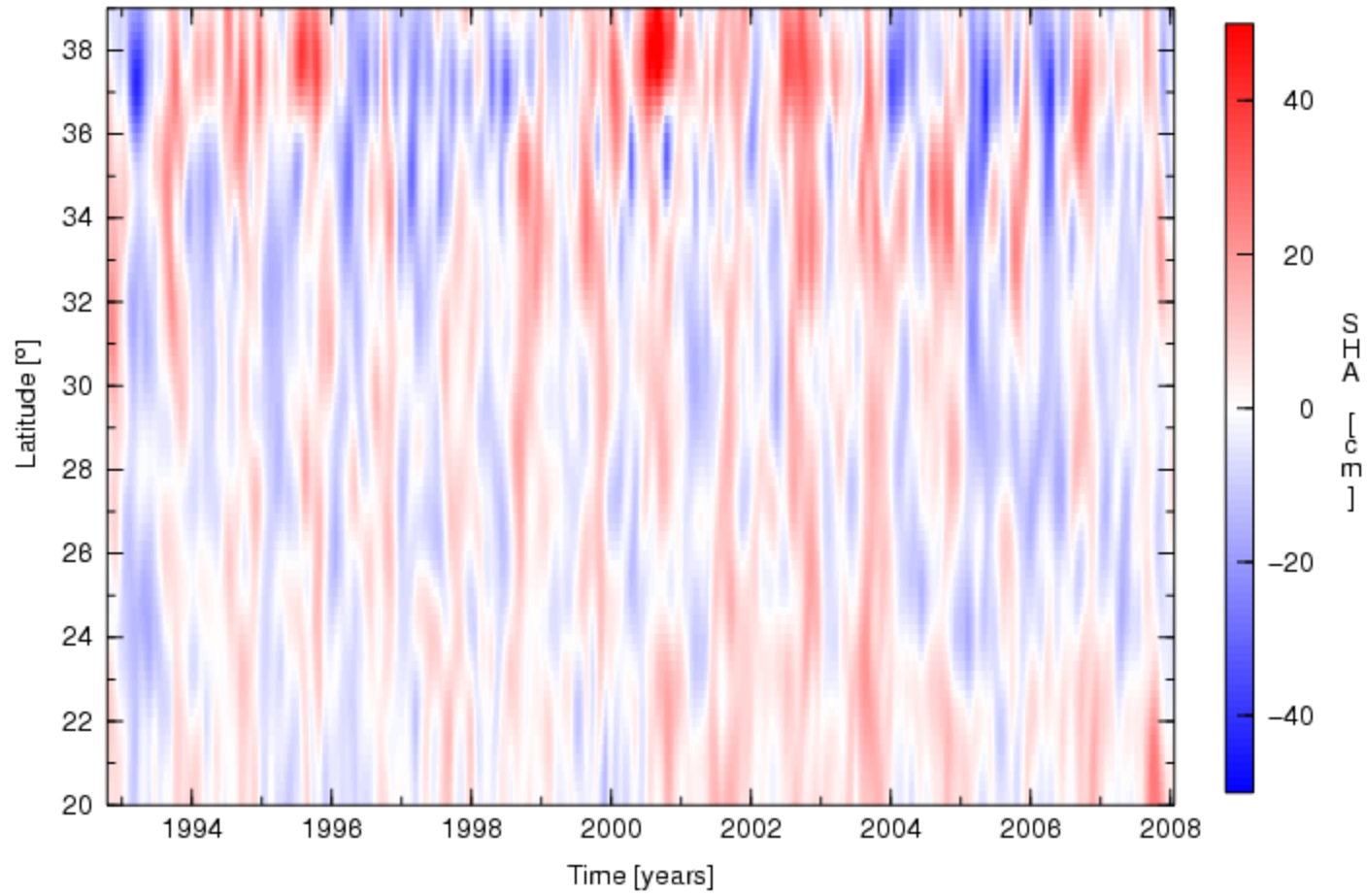
# AX08, SHA



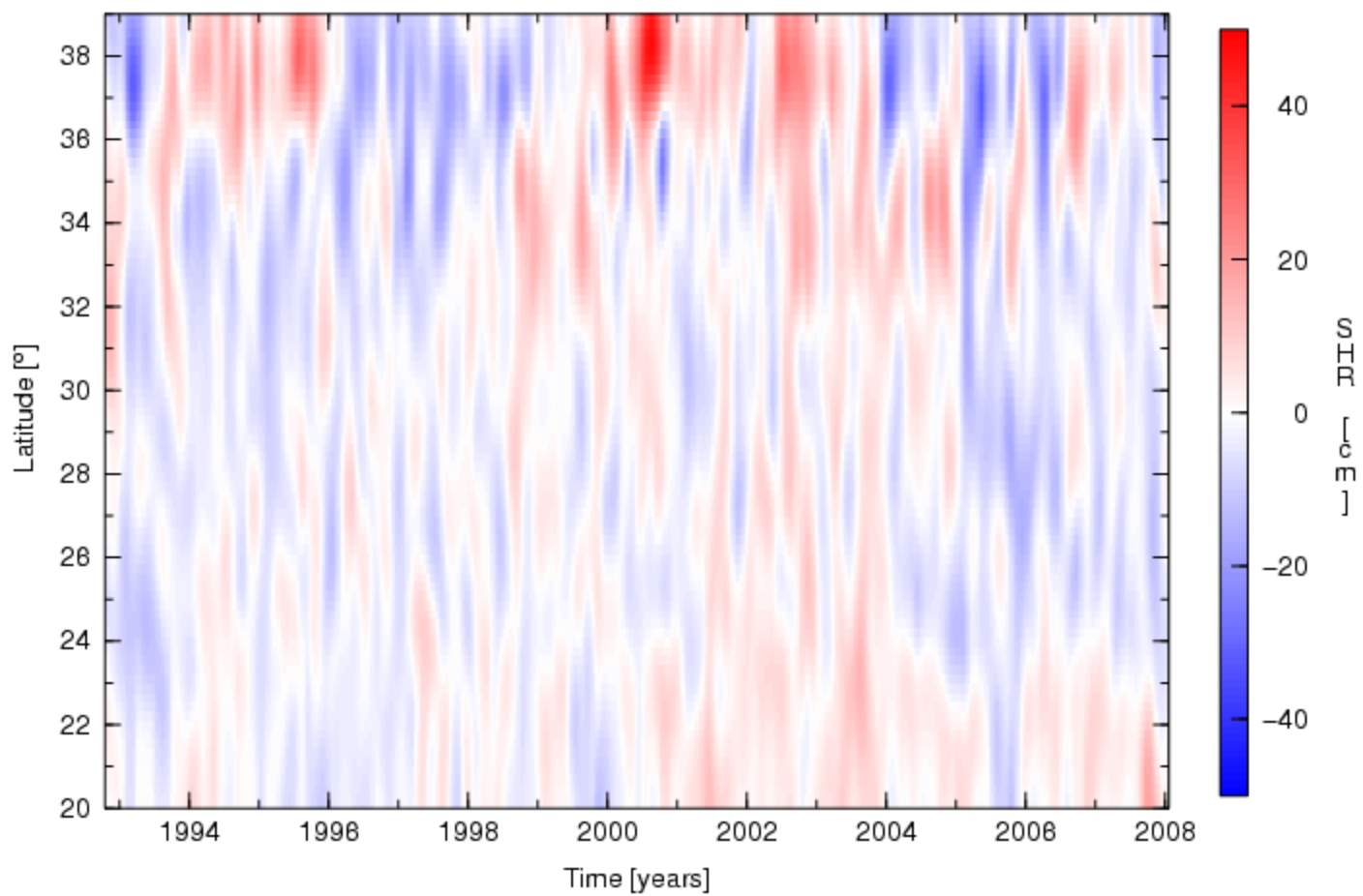
AX08, SHR



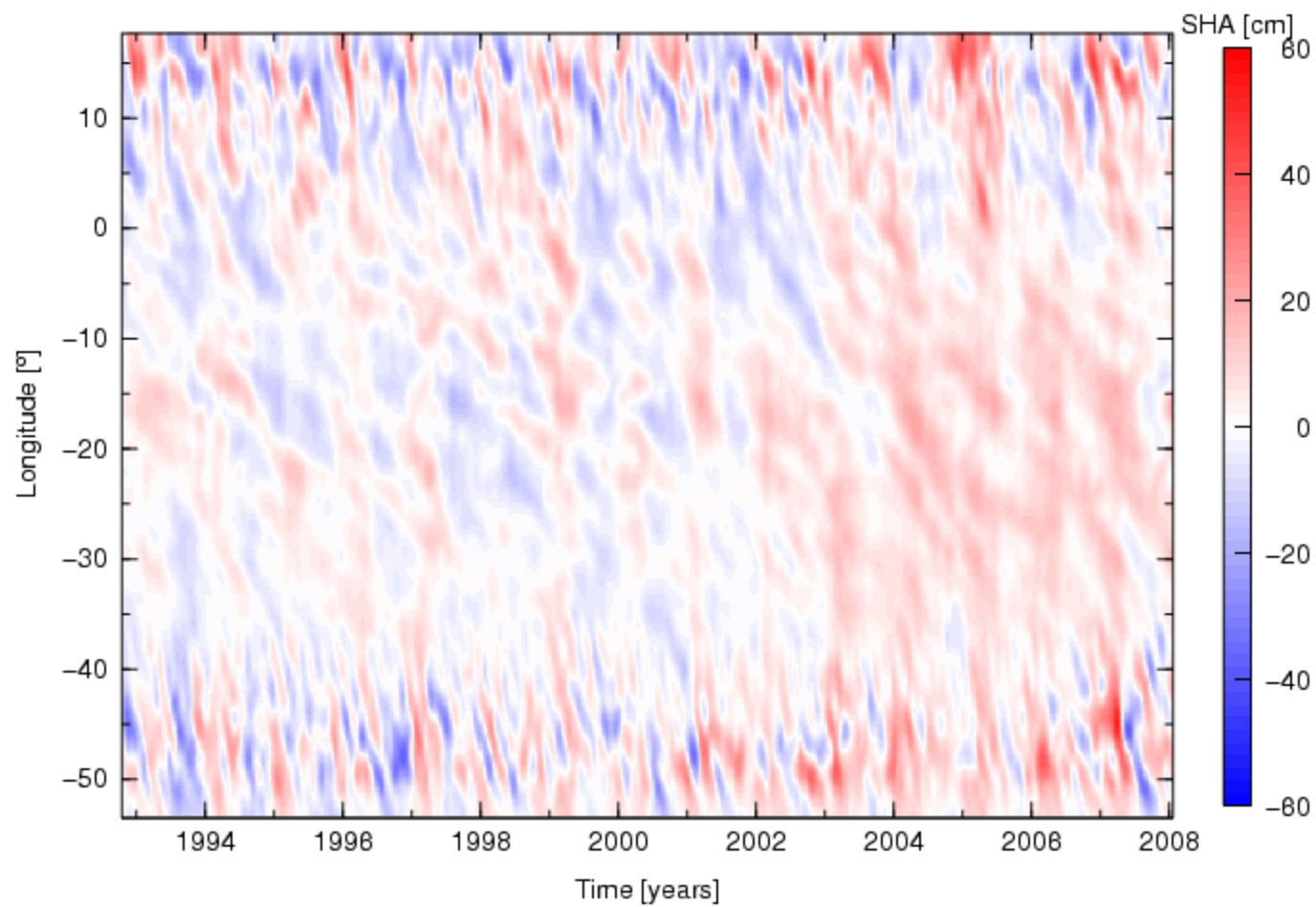
# AX10 SHA



### AX10 SHR



### AX18, SHA



### AX18, SHR

