

**Quantitative Validations of Subsurface Temperatures  
from the Assimilative HYCOM and NCOM**

**By**

**BIROL KARA, JOE METZGER, ALAN WALLCRAFT,  
CHARLIE BARRON AND HARLEY HURLBURT**

**Naval Research Laboratory,  
Stennis Space Center, USA**

# Report Documentation Page

Form Approved  
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>APR 2007</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2007 to 00-00-2007</b>	
4. TITLE AND SUBTITLE <b>Quantitative Validations of Subsurface Temperatures from the Assimilative HYCOM and NCOM</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Naval Research Laboratory, Stennis Space Center, MS, 39529</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>11th HYCOM Consortium Meeting, Apr 24-26, 2007, Stennis Space Center, MS</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>17</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

## **INTRODUCTION**

- **Two global ocean models: HYCOM and NCOM**
  - **brief description of each model**
  - **assimilation procedures**
- **Daily subsurface temperatures and SST**
  - **validation against buoy temperatures in 2004**
  - **various statistical metrics and summary**

**We would like to answer the question,**

**which model performs better in simulating temperatures?**

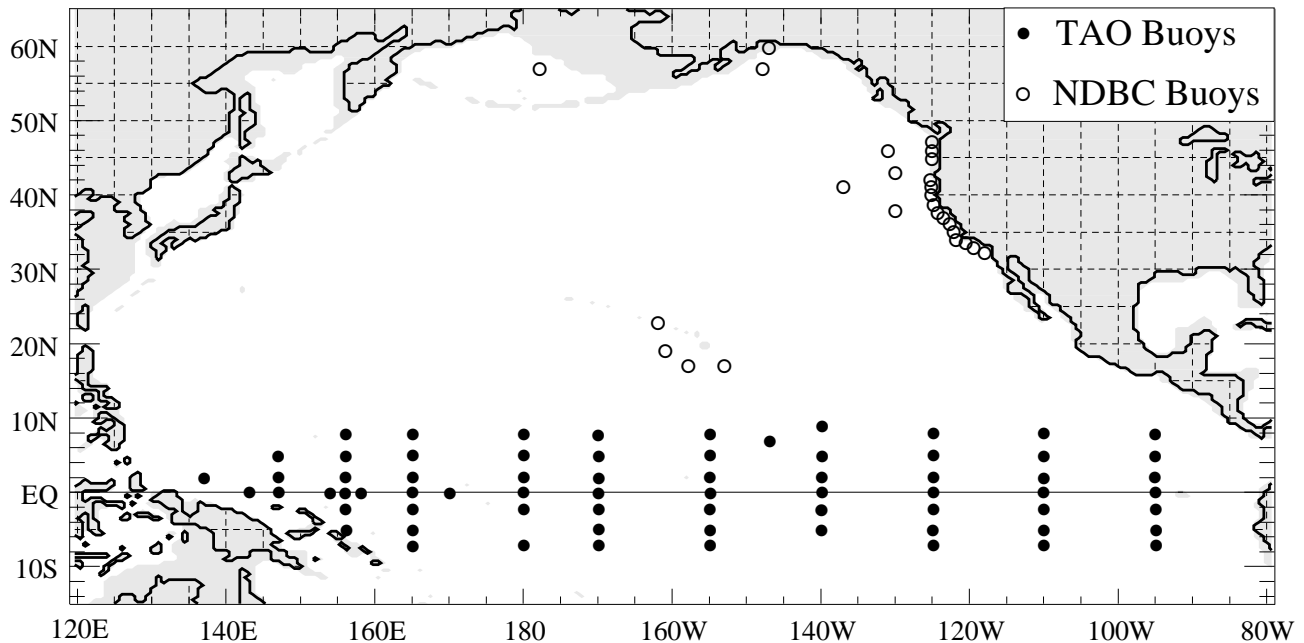
## AN OVERVIEW OF THE MODELS

	<b>NCOM</b>	<b>HYCOM</b>
<b>Grid resolution</b>	1/8°	1/12°
<b>Vertical layers</b>	40 level sigma-z	32 layer hybrid
<b>Initialization</b>	MODAS T/S	GDEM T/S
<b>Simulation</b>	Inter-annual	Inter-annual
<b>Mixed layer</b>	Mellor-Yamada	GISS
<b>Atm. forcing</b>	NOGAPS	NOGAPS
<b>River forcing</b>	NRL database	NRL database
<b>Turbidity</b>	Constant	SeaWiFS data
<b>Bulk formulae</b>	Sensible/latent heat	Sensible/latent heat
<b>Relaxation</b>	None except SSS	None except SSS

## MAJOR FEATURES OF THE ASSIMILATION

	<b>NCOM</b>	<b>HYCOM</b>
<b>Observation</b>	SST and SSH	SST, SSH, profiles
<b>Methodology</b>	Nudging to MODAS gridded 3D product	NCODA, MVOI Cooper–Haines (1996)
<b>Projection</b>	Synthetic T and S, 1/32° NLOM SSH 1/8° MODAS SST for profile calculation	Vertical projection, incremental updating of model variables
<b>Time interval</b>	daily assimilation	daily assimilation

# SUBSURFACE TEMPERATURES FROM BUOYS



- Tropical Atmosphere–Ocean (TAO) array
- Pilot Research Moored Array in the Tropical Atlantic (PI-RATA)
- Two sets of buoys: temperatures at different depths
  - I: east of 155°W
    - 1, 20, 40, 60, 80, 100, 120, 140, 180, 300, 500 meters
  - II: west of 155°W, including 155°W
    - 1, 25, 50, 75, 100, 125, 150, 200, 250, 300, 500 meters

**Note: NDBC buoys do NOT report subsurface temperatures**

## **MODEL-DATA COMPARISONS**

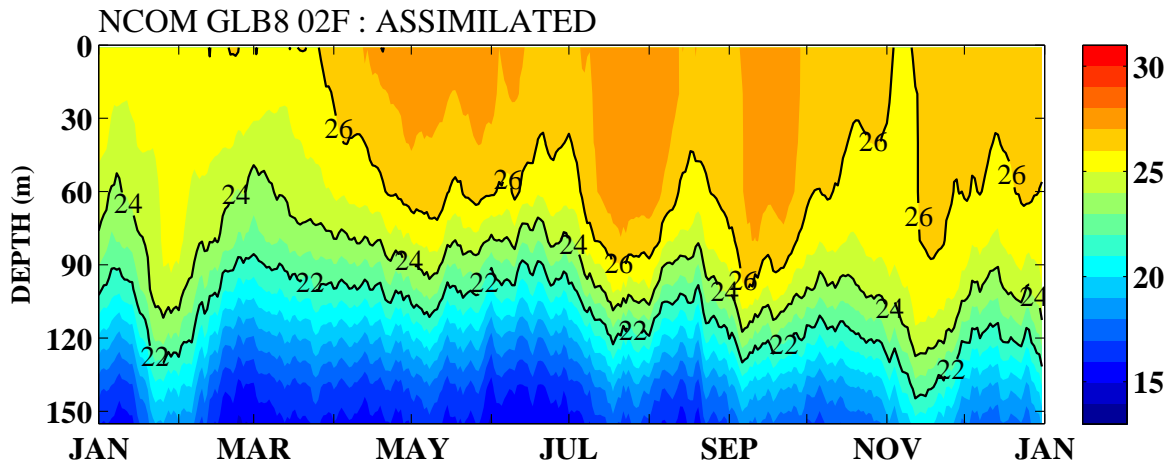
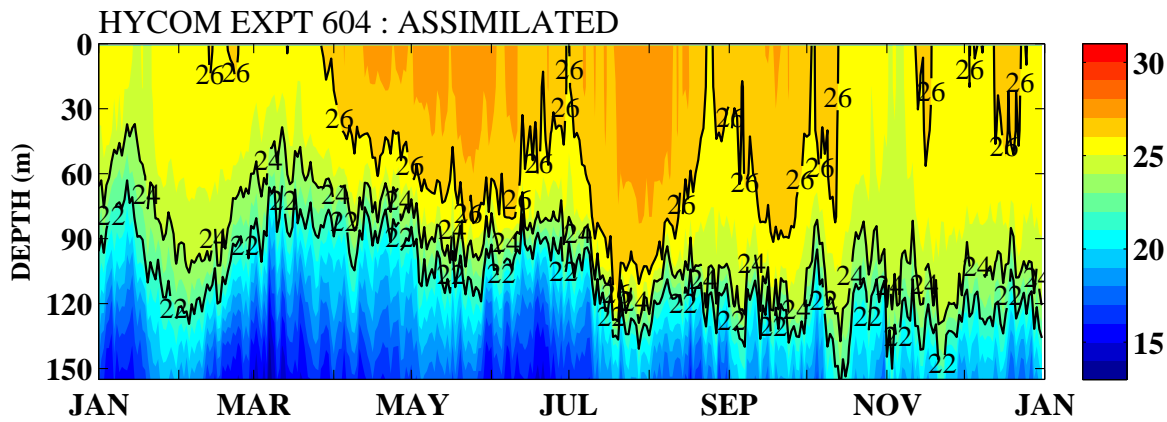
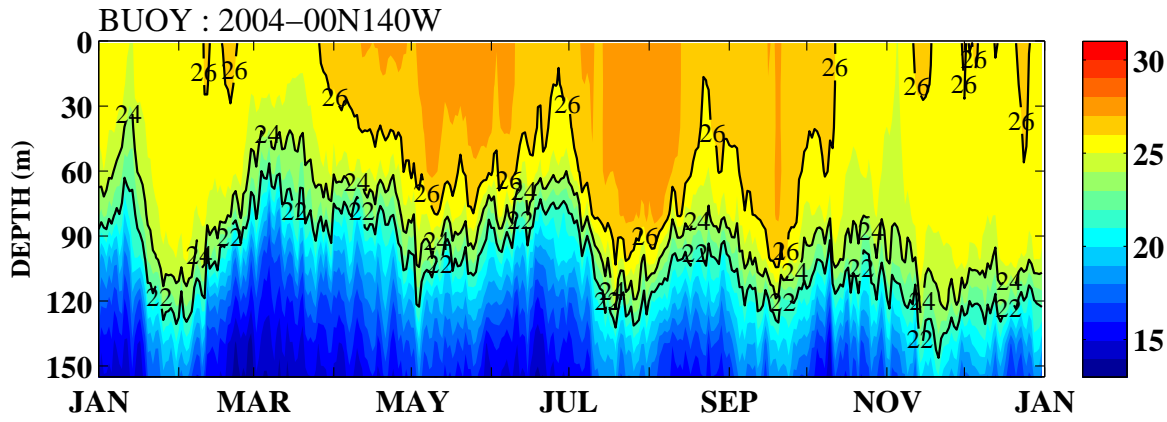
- **Validation procedure**

- o yearlong subsurface temperatures at each depth
- o buoys which have a nearly complete yearlong time series
- o temperature voids at buoys filled if  $< 1$  month
- o voids filled by linear interpolation

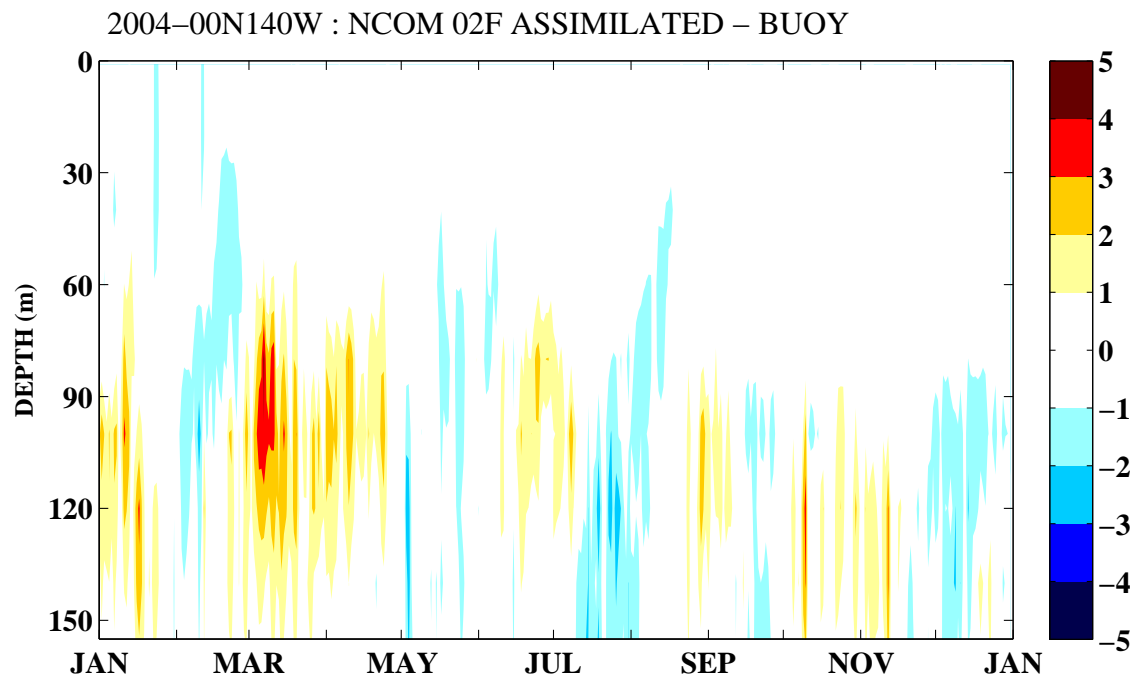
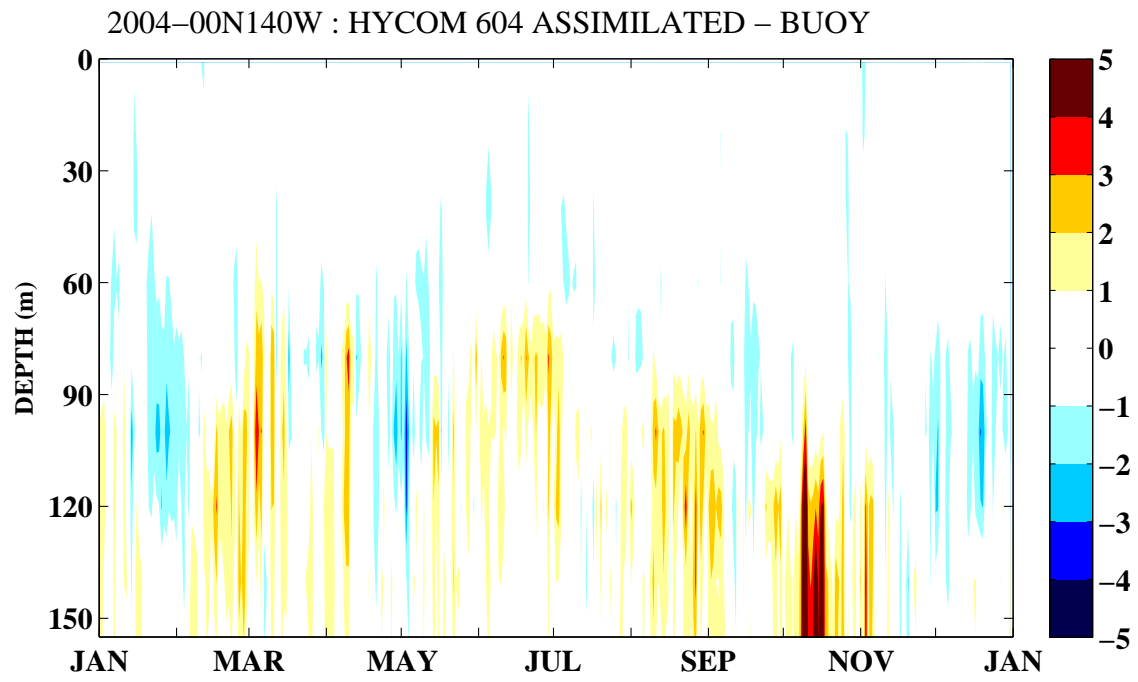
- **Validation Statistics**

- o calculate mean bias and RMS at each depth level
- o buoy vs NCOM and buoy vs HYCOM at each buoy
- o combining statistics using temperatures from all buoys

# SUBSURFACE TEMPERATURES AT (00°N, 140°W)



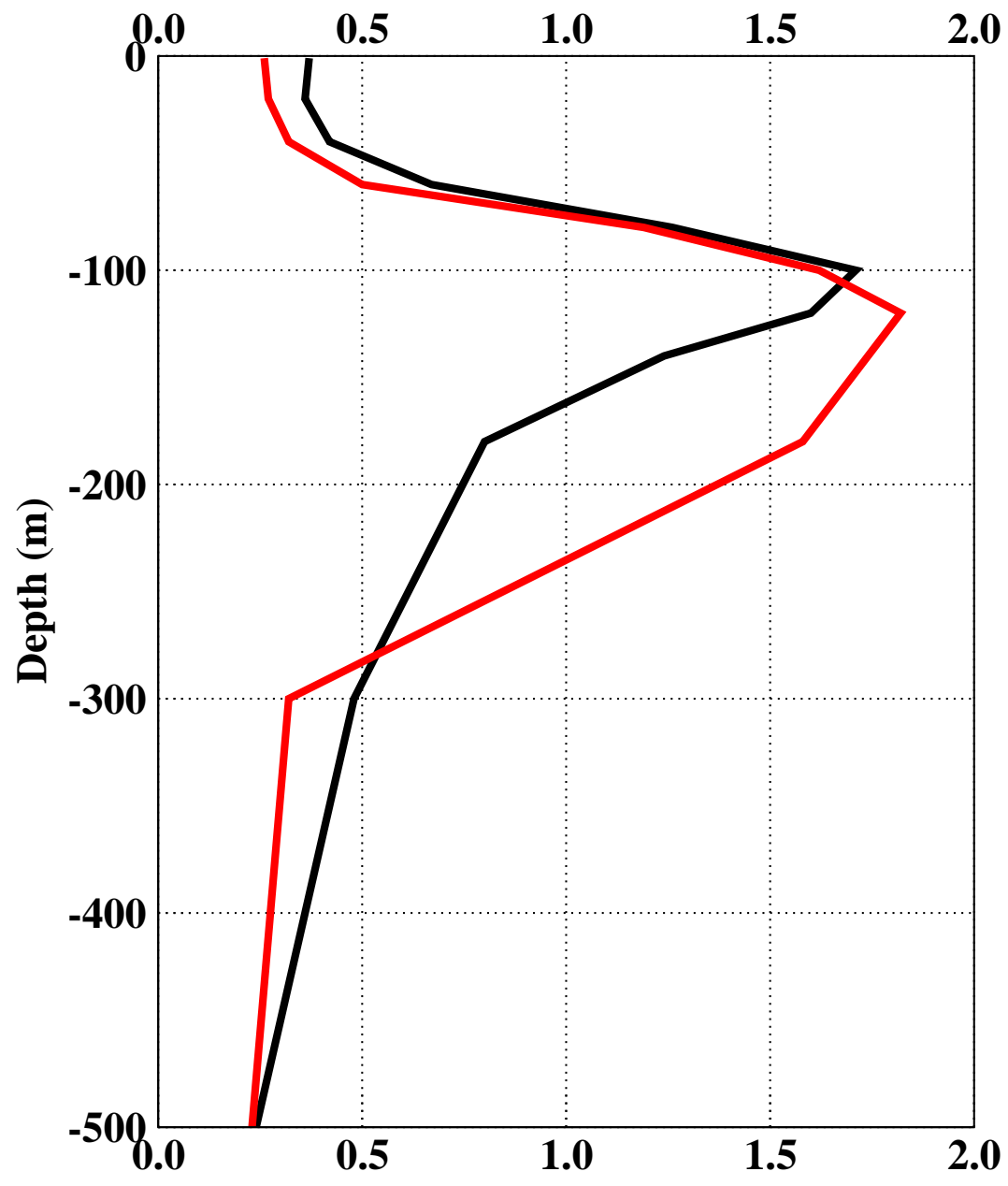
# TEMPERATURE DIFFERENCES AT (00°N, 140°W)



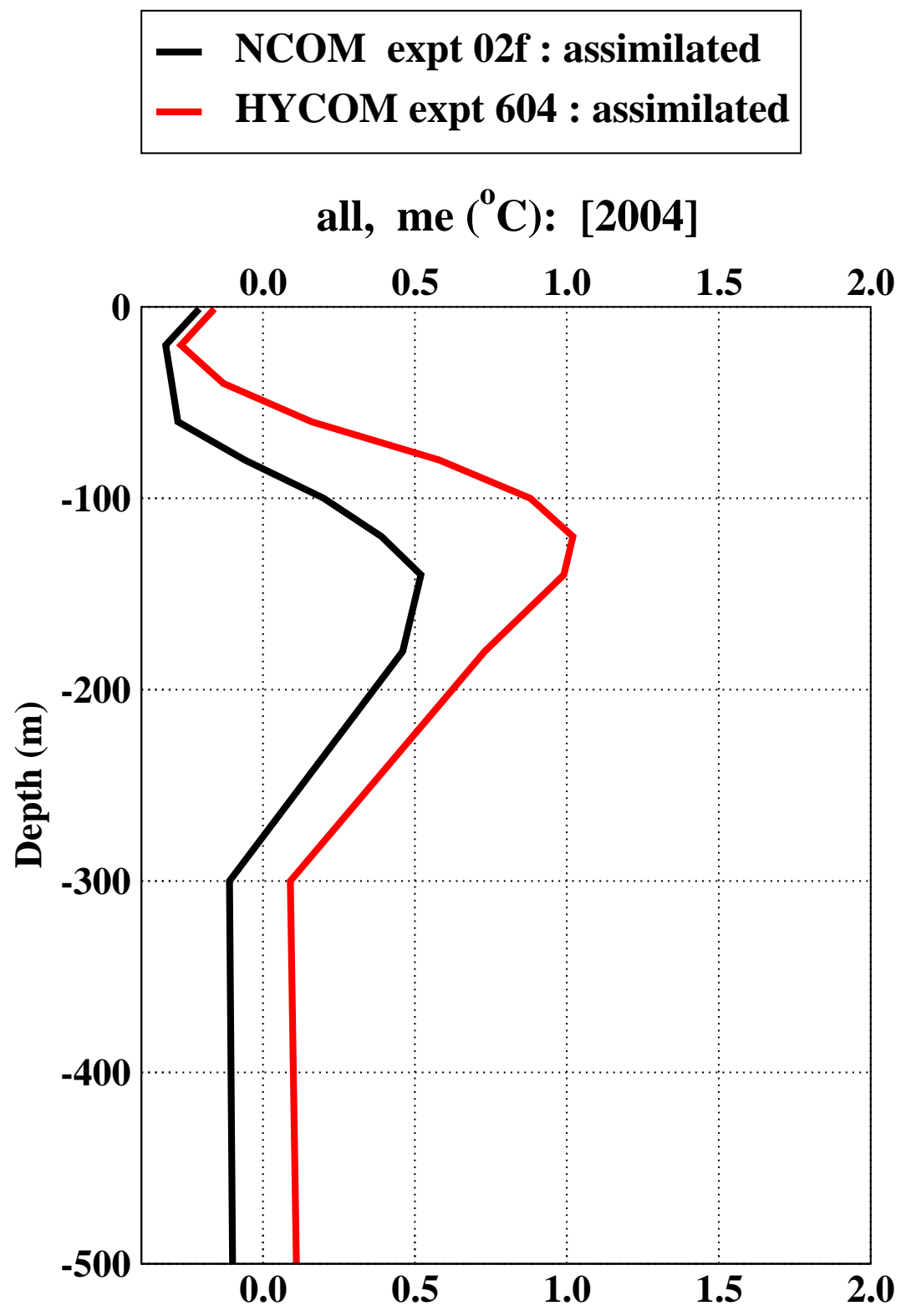
# RMS SST DIFFERENCE AT (00°N, 140°W)

- NCOM expt 02f : assimilated
- HYCOM expt 604 : assimilated

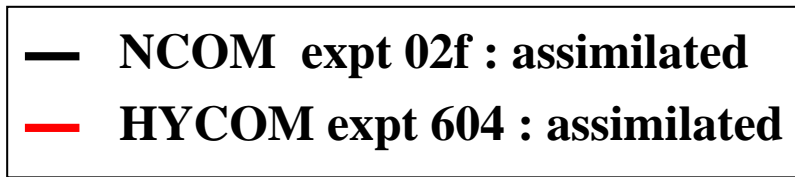
00n140w, rmse (°C): [2004]



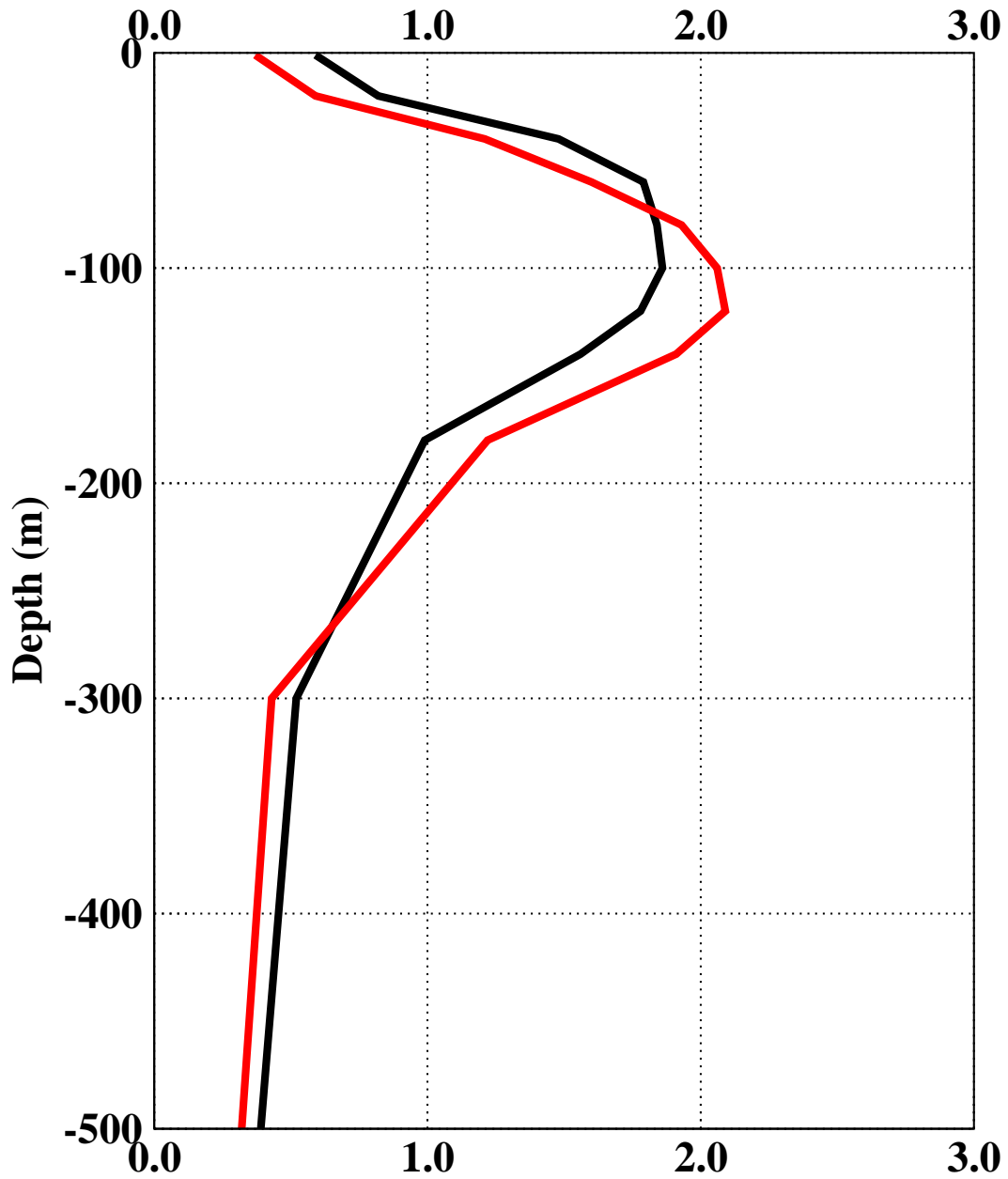
# SUMMARY STATISTICS FOR SET I BUOYS: BIAS



# SUMMARY STATISTICS FOR SET I BUOYS: RMS



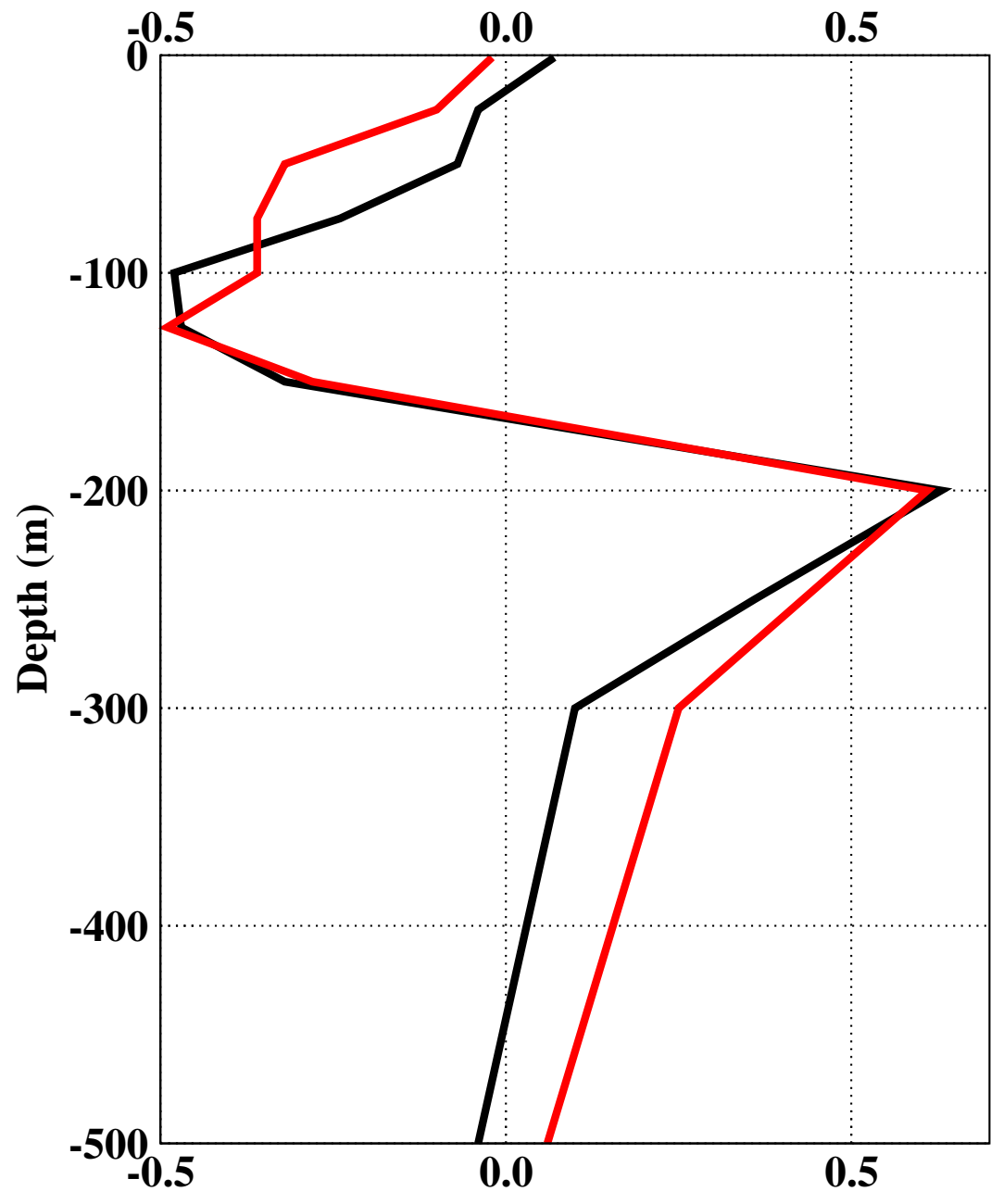
all, rmse ( $^{\circ}\text{C}$ ): [2004]



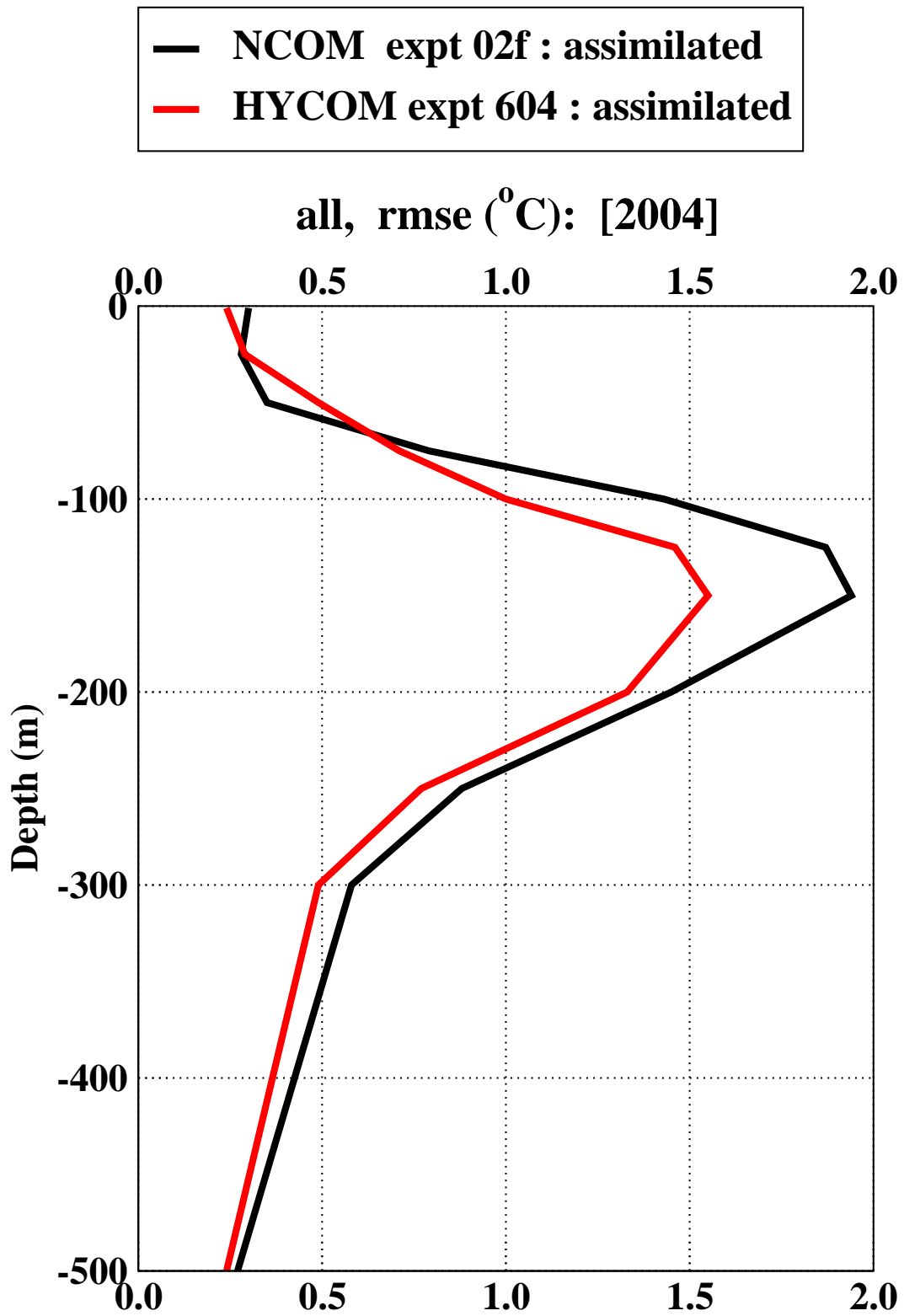
# SUMMARY STATISTICS FOR SET II BUOYS: ME

— NCOM expt 02f : assimilated  
— HYCOM expt 604 : assimilated

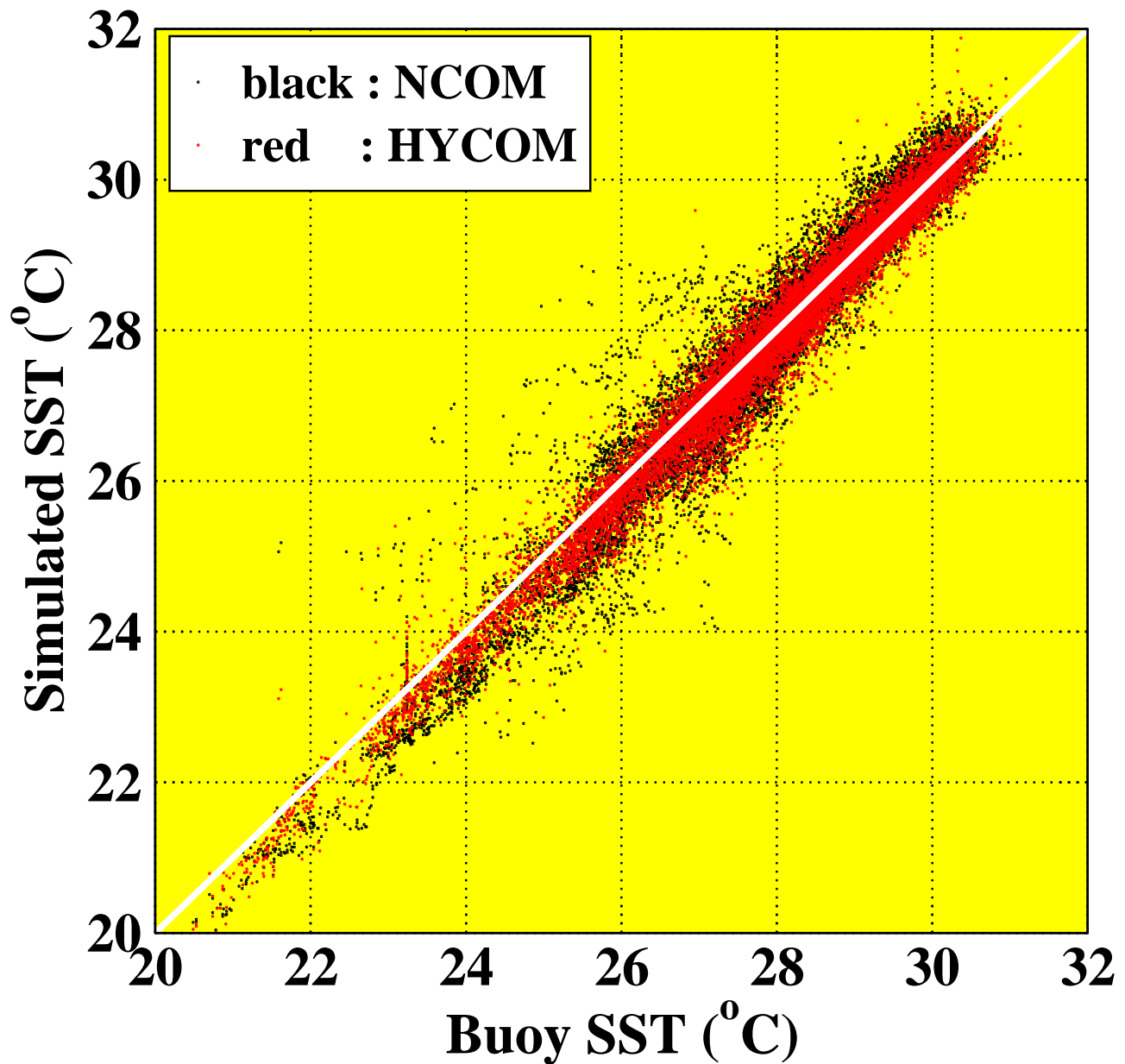
all, me ( $^{\circ}\text{C}$ ): [2004]



# SUMMARY STATISTICS FOR SET II BUOYS: RMS



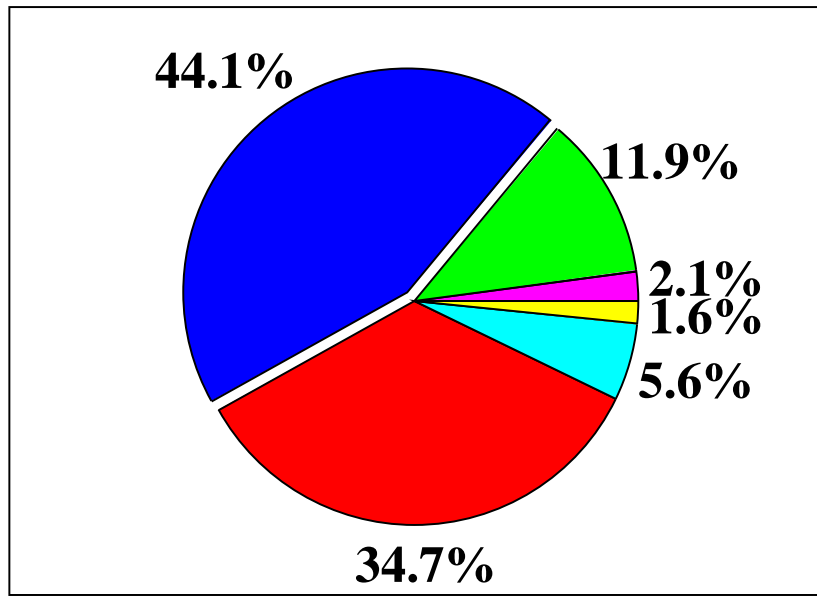
## SST VALIDATION : SET I and SET II BUOYS



- 17,202 daily SSTs from all TAO buoys
- Median SST bias:  $-0.1^{\circ}\text{C}$  for NCOM and HYCOM

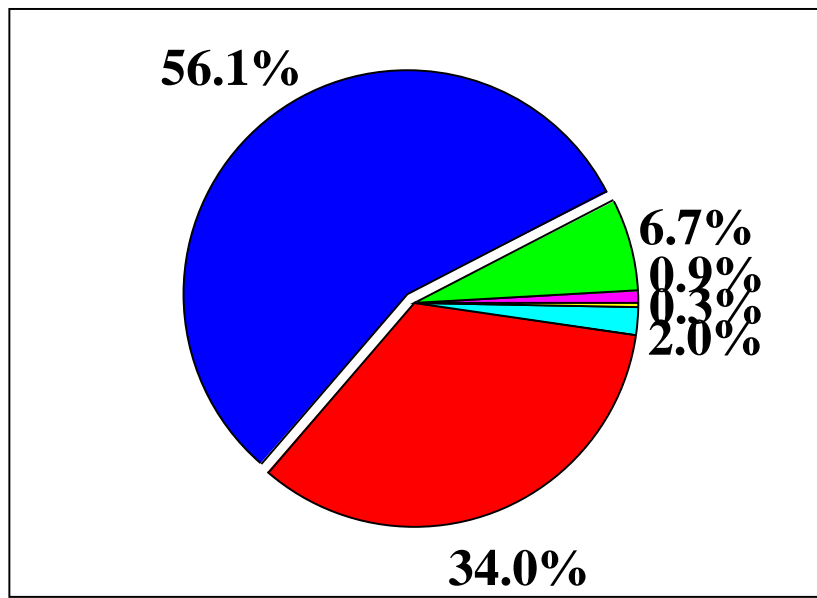
# SST ERROR INTERVALS FOR ALL BUOYS

**SST bias: NCOM vs TAO Buoys**



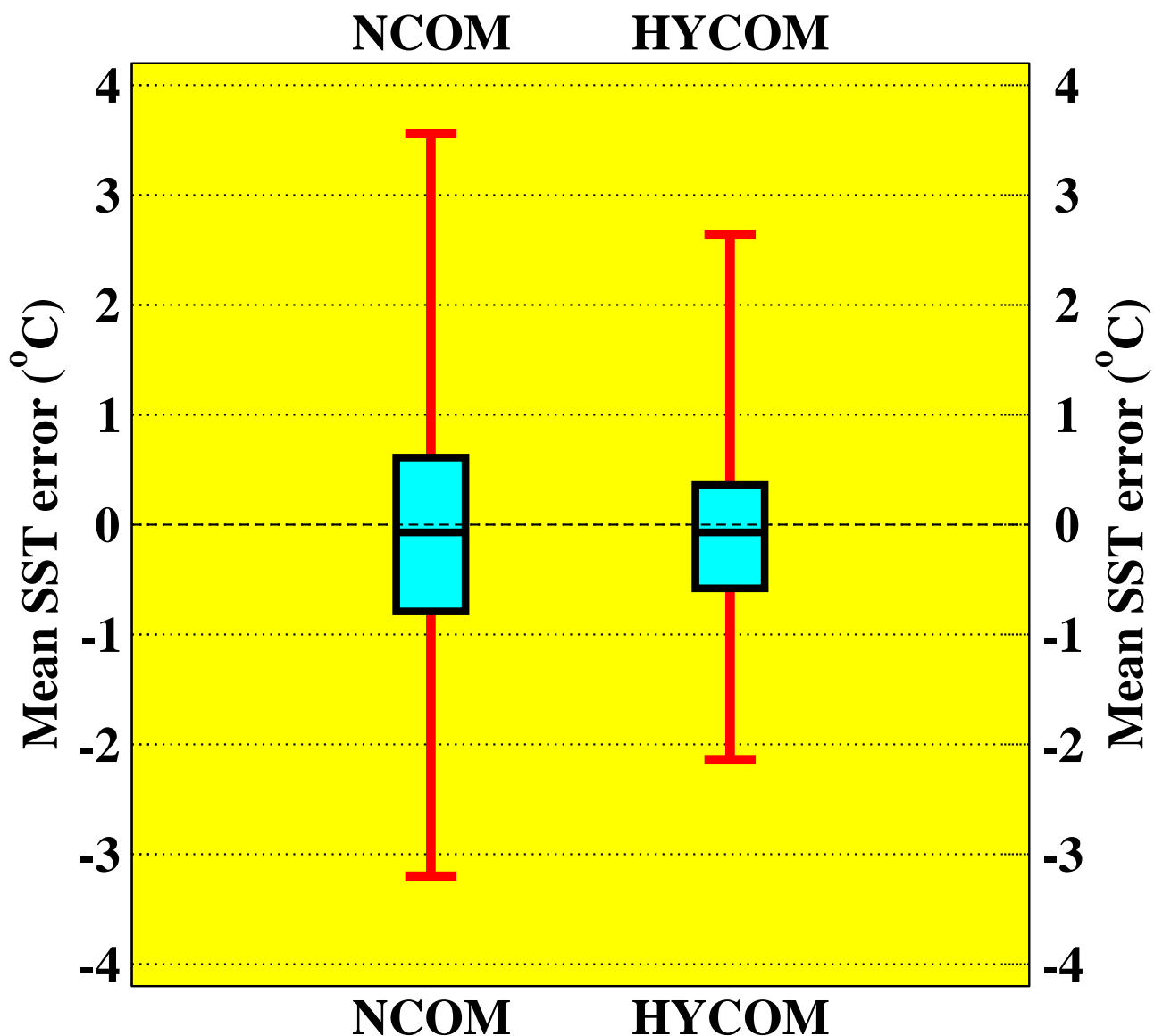
< -1.0°C  
-1.0°C to -0.5°C  
-0.5°C to 0.0°C  
0.0°C to 0.5°C  
0.5°C to 1.0°C  
> 1.0°C

**SST bias: HYCOM vs TAO buoys**



**Results are based on 17,202 daily SST values**

# PERCENTILES OF THE SST ERRORS



- **The ends of the whiskers:** Min and Max SST biases
- **The upper (lower) edge of the box:** 95th (5th) percentiles
- **The line in the box:** Median SST bias
- **Note:** SST biases from NCOM and HYCOM are NOT skewed.

## **SUMMARY AND CONCLUSIONS**

- **HYCOM and NCOM were evaluated in 2004:**
  - **Subsurface temperatures**
  - **SST**
- **Both models yield realistic results**