

# **HYCOM and GODAE in Relation to Navy Ocean Prediction**

**An Overview Presented by**

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# NRL Effort Related to HYCOM

## Modeling

Harley Hurlburt  
Birol Kara  
Joe Metzger

Jay Shriver  
Alan Wallcraft  
Xiabiao Xu (Postdoc at USM)

## Data Assimilation

Jim Cummings  
Ole Martin Smedstad (PSI)

## Regional Modeling and HYCOM Boundary Conditions for Regional/Coastal Models, Including COAMPS

<i>Nested Model</i>		<i>Nested Model</i>	
Pat Hogan	<i>HYCOM</i>	John Kindle	<i>NCOM or HYCOM</i>
Luis Zamudio (FSU)	<i>HYCOM</i>	Sergio Derada	<i>NCOM or HYCOM</i>
Prasad Thoppil (Postdoc at USM)	<i>HYCOM</i>	Stephanie Anderson	<i>NCOM or HYCOM</i>
Kyung-Hoon Hyun (Postdoc at USM)	-	Julie Pullen (NRLMRY)	<i>COAMPS</i>
Cheryl Ann Blain	<i>finite element</i>	Paul May (CSC in MRY)	<i>COAMPS</i>

# **Collaborative Effort on HYCOM for Ocean Prediction**

**Coordinated 6.1-6.4 effort with university, NOAA and international collaboration**

- **6.1 Global Remote Littoral Forcing via Deep Water Pathways**
- **6.1 Indonesian Throughflow**
- **6.1 ONR Philippine Straits DRI**
- **Navy/NOAA/Univ./Internat. HYCOM NOPP GODAE**
  - **development of a next generation global ocean prediction system, including boundary conditions for multiple coastal models and COAMPS**
- **Participating in multinational Global Ocean Data Assimilation Experiment (GODAE)**
- **6.4 Large-Scale Prediction and Ocean Data Assimilation**
  - **For transition to NAVOCEANO**
- **6.1 SEED ARI, 6.2 CO-NESTS and NOPP CODAE**
  - **boundary conditions for a variety of coastal models**
- **DoD HPC challenge and non-challenge computer time**
  - **Largest Navy user of DoD HPC**

# U.S. Navy Present and Planned Global Ocean Prediction Systems

Global Product	Mid-Lat Resolution	Vert. Coord.	Inputs	Run By	Actual or Target Date
1/16° NLOM	7 km	Layered	SSH, SST, hydro, FNMOC NOGAPS Atmospheric Forcing	NAVO	OP 9/01-3/06
1/8° NCOM <sup>1</sup>	15 km	$\sigma/z$		NAVO	OP 2/06
1/32° NLOM <sup>2</sup>	3.5 km	Layered		NAVO	OP 3/06
1/12° HYCOM <sup>3,5</sup>	7 km	$\rho/\sigma/z$		NAVO	2007
1/25° HYCOM	3.5 km	$\rho/\sigma/z$		NAVO	2011
Near Real-time demonstration					
1/12° Atl. HYCOM <sup>4,5</sup>	7 km	$\rho/\sigma/z$		NRL	2002

OP = operational

<sup>1</sup> High vertical resolution for mixed layer prediction. Assimilates SSH from NLOM via T and S synthetic profiles. Web page [http://www.ocean.nrlssc.navy.mil/global\\_ncom](http://www.ocean.nrlssc.navy.mil/global_ncom)

<sup>2</sup> Web page [http://www.ocean.nrlssc.navy.mil/global\\_nlom](http://www.ocean.nrlssc.navy.mil/global_nlom)

<sup>3</sup> Running in real time at NAVO.

<sup>4</sup> Under the National Ocean Partnership Program (NOPP), 1/12° Atlantic HYCOM demo is running in near real-time. Includes the Mediterranean Sea.

<sup>5</sup> Results at <http://www.hycom.org> (100Tb LAS server at FSU)

## Nesting Strategy for Ocean Prediction

Global	→	Regional	→	Littoral	→	Nearshore
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### Near-term: present-FY04 in R&D, FY04-FY08 operational, including transition

1/8° NCOM	→	NCOM or SWAFS	→	NCOM or SWAFS	→	ADCIRC
15-16 km mid-lat resolution	→	4 - 8 km, larger regions	→	< 1 to 2 km res	→	< 2 km resolution finite element

### Mid-term: FY04 - FY08 in R&D, FY07 – FY12 operational, including transition

1/12° HYCOM	→	HYCOM	→	*NCOM or HYCOM	→	ADCIRC
7 km mid-lat resolution	→	2 - 4 km, smaller regions	→	.5-1.5 km res	→	< 1.5 km res

### Long-term: FY07-FY12 in R&D, FY11 and beyond operational, including transition

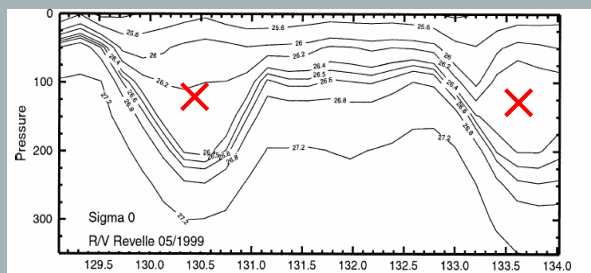
*1/25° HYCOM	→	Regional generally not needed	→	*NCOM or HYCOM	→	ADCIRC
3 - 4 km mid-lat resolution	→	Not used	→	≤ 1km res	→	≤ 1 km res

\*Hogan and Kindle CO-NESTS project will provide research results needed to make the appropriate choice. An alternative model such as ROMS may also be considered.

\*1/25° HYCOM gives useful littoral resolution globally

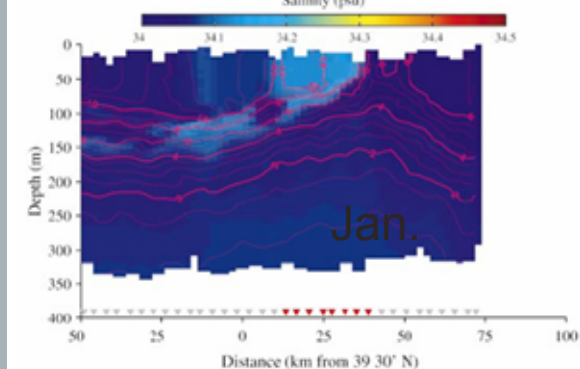


# HYCOM Helps Explain the Formation of Intra-Thermocline Eddies (ITEs) in the Japan/East Sea



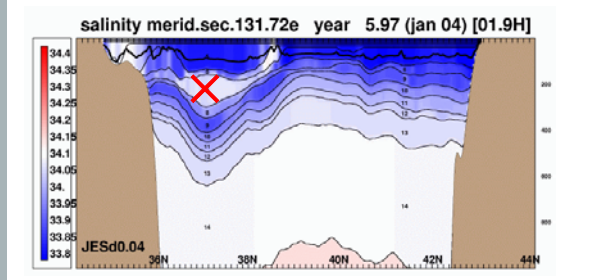
## Observed ITE

May 1999 Observed density cross-section from Gordon et al. (2002, JPO) along 37.75°N



## Observed frontal subduction

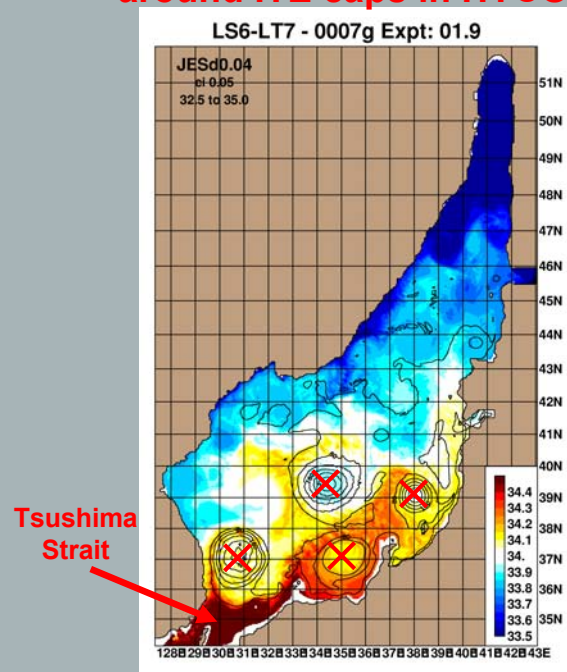
Jan 2000 Observed cross-section of temperature (contours) and salinity (color) along 134.4°E. From Gordon et al., 2002, JPO



## Simulated frontal subduction into an ITE

January HYCOM cross-section along 131.7°E. Salinity on model layers, isopycnal with z-levels near the surface

## Plumes of salinity wrap around ITE caps in HYCOM



July HYCOM layer 6 salinity (color) superimposed on layer 7 thickness contours

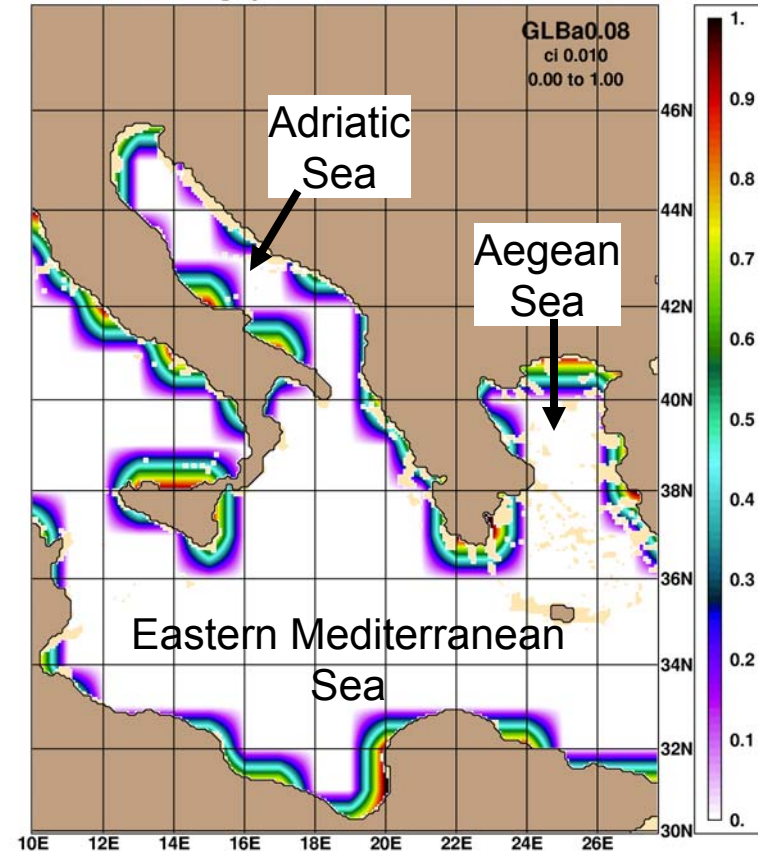
ITEs marked by X

From Hogan and Hurlburt (2006, Oceanography) ONR JES DRI follow-up

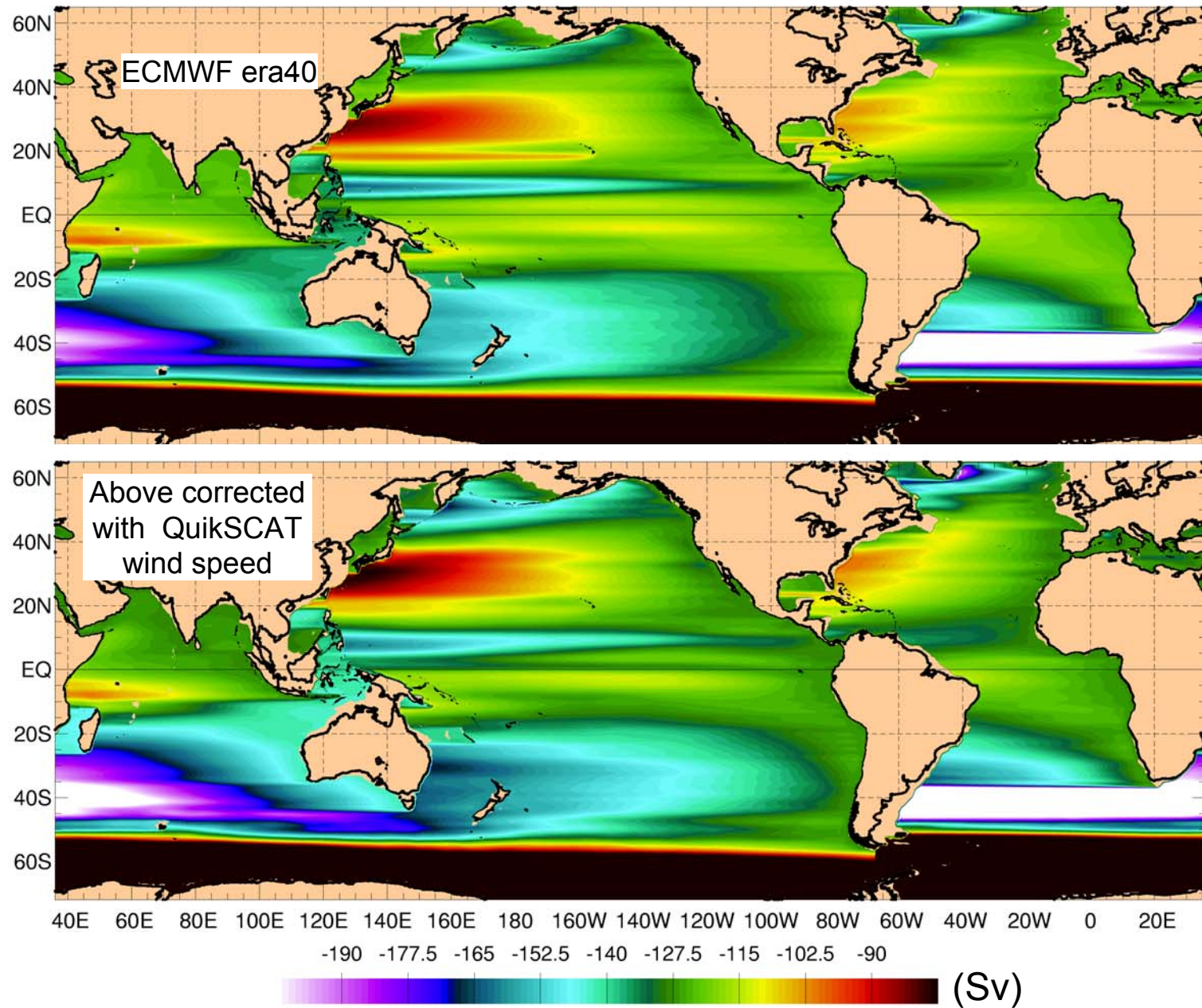
# Ongoing Work on Atmospheric Forcing

- New schemes for shortwave radiation penetration with turbidity
  - Kara et al. (2005, JPO), Lee et al. (2005, JGR-O)
- Creeping Sea Fill (Kara et al., 2007, JPO)
  - For removal of land contamination of sea grid points from any scalar atmospheric forcing field
  - Or filling data gaps, e.g. near land
- Satellite-based corrections to short and longwave radiation, wind speed, and precipitation monthly mean climatologies
  - Approach can be used for any sub-daily inter-annual or real-time atmospheric forcing product of choice, e.g. NOGAPS
  - Short and long wave radiation corrected using ISCCP climatology
  - Wind speed corrected using scatterometer or SSM/I climatology
    - Product wind direction retained
  - Precipitation is corrected using GPCP climatology

NOGAPS Land/Sea Mask over the Eastern Mediterranean Sea Region

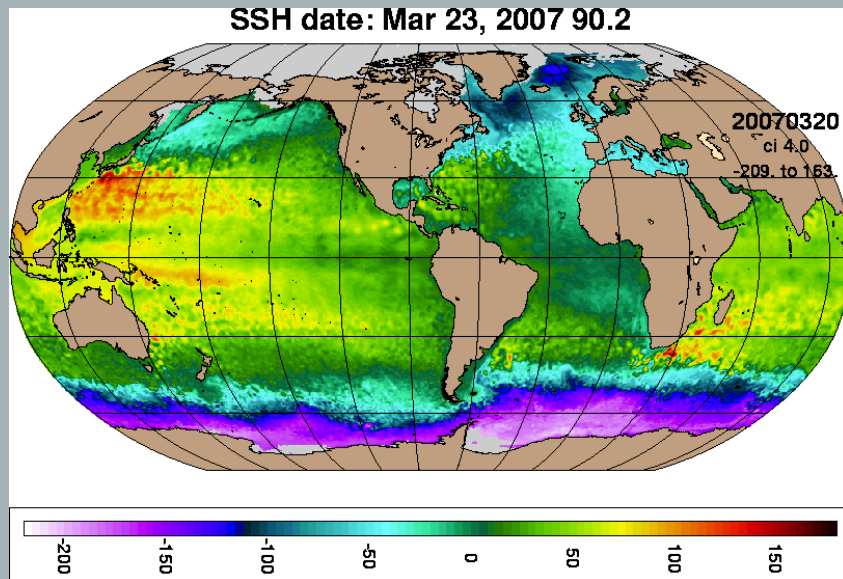


# 1/16° Global Linear Sverdrup Flow Circulation



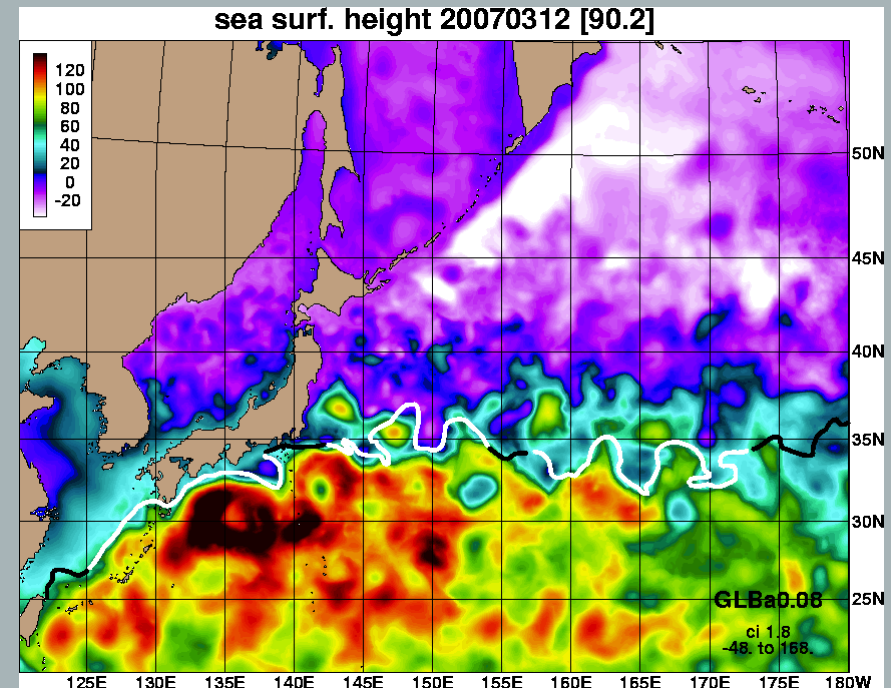


# Results from Real-Time .08° Global HYCOM with NCODA Data Assimilation



**Global SSH on 23 Mar 2007**

Gray areas are ice covered

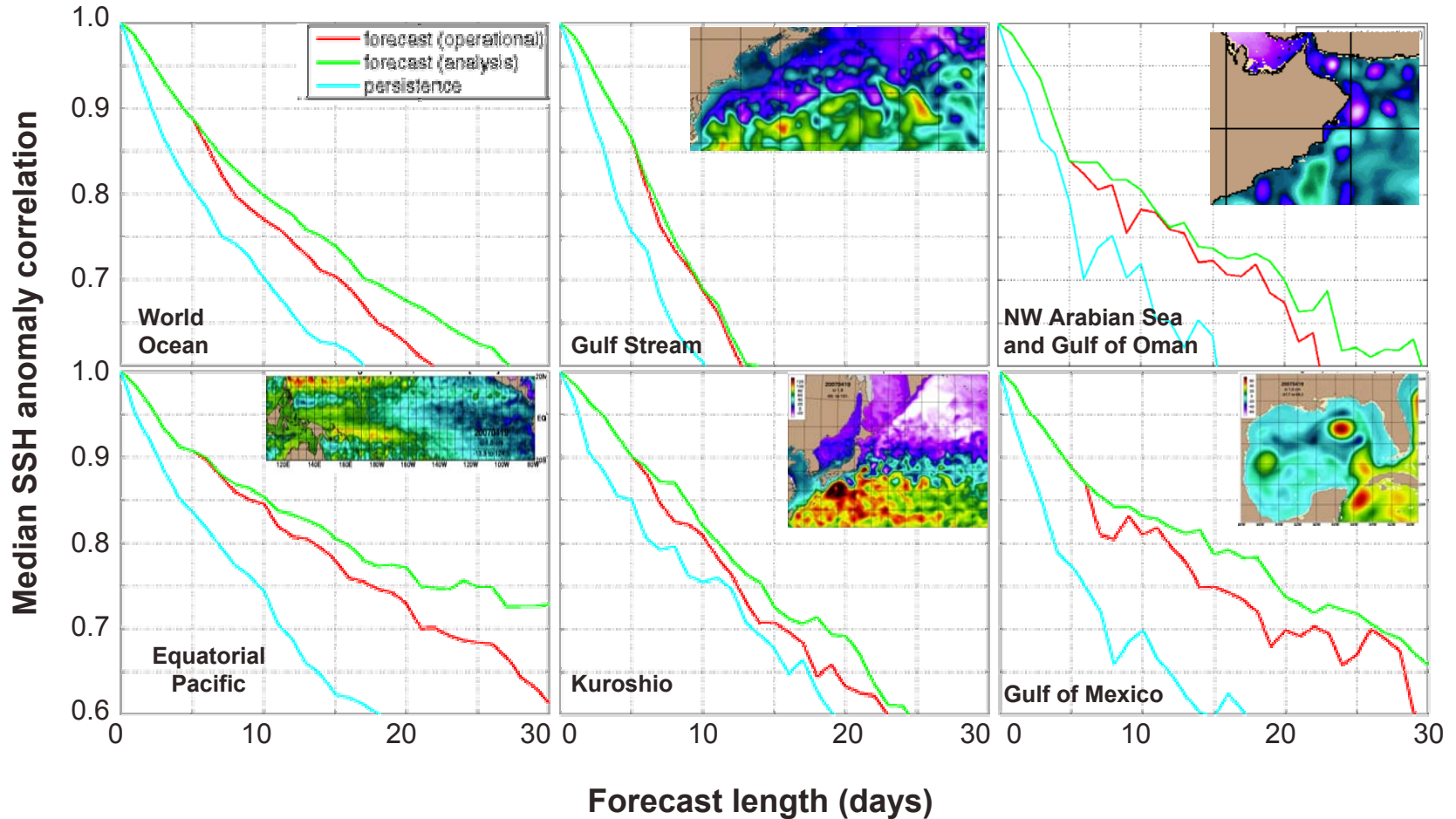


**NW Pacific SSH zoom on 12 Mar 2006**

NAVOCEANO operational analysis of the Kuroshio front based on satellite AVHRR imagery is overlaid

— black segments are based on imagery > 4 days old

# Forecast Verification Statistics from .08° Global HYCOM



4 Forecasts included in statistics