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2007

## A modeling study of flows in the Strait of Hormuz

Chu, Peter C.; Clem, T.

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Chu, P.C., and T. Clem, A modeling study of flows in the Strait of Hormuz. Twenty Sixth International Union of Geodesy and Geophysics, Perugia, Italy, 2-13 July 2007.  
<https://hdl.handle.net/10945/42373>

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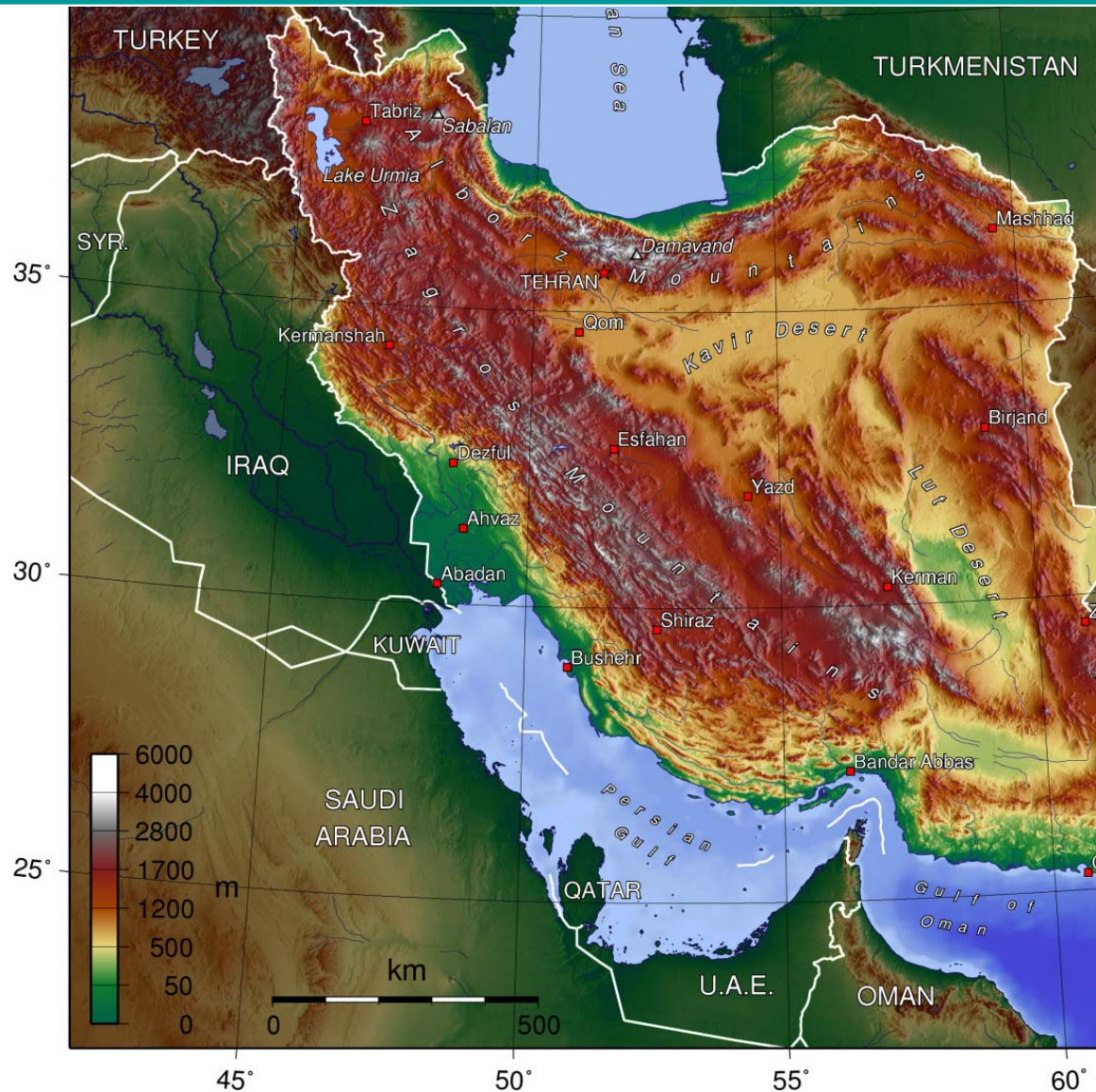
# A Modeling Study on Flows in the Strait of Hormuz (SOH)

Peter C Chu & Travis Clem  
Naval Postgraduate School  
Monterey, CA 93943, USA

IUGG 2007: PS005 Flows and Waves in Straits. July 5-6, Perugia, Italy

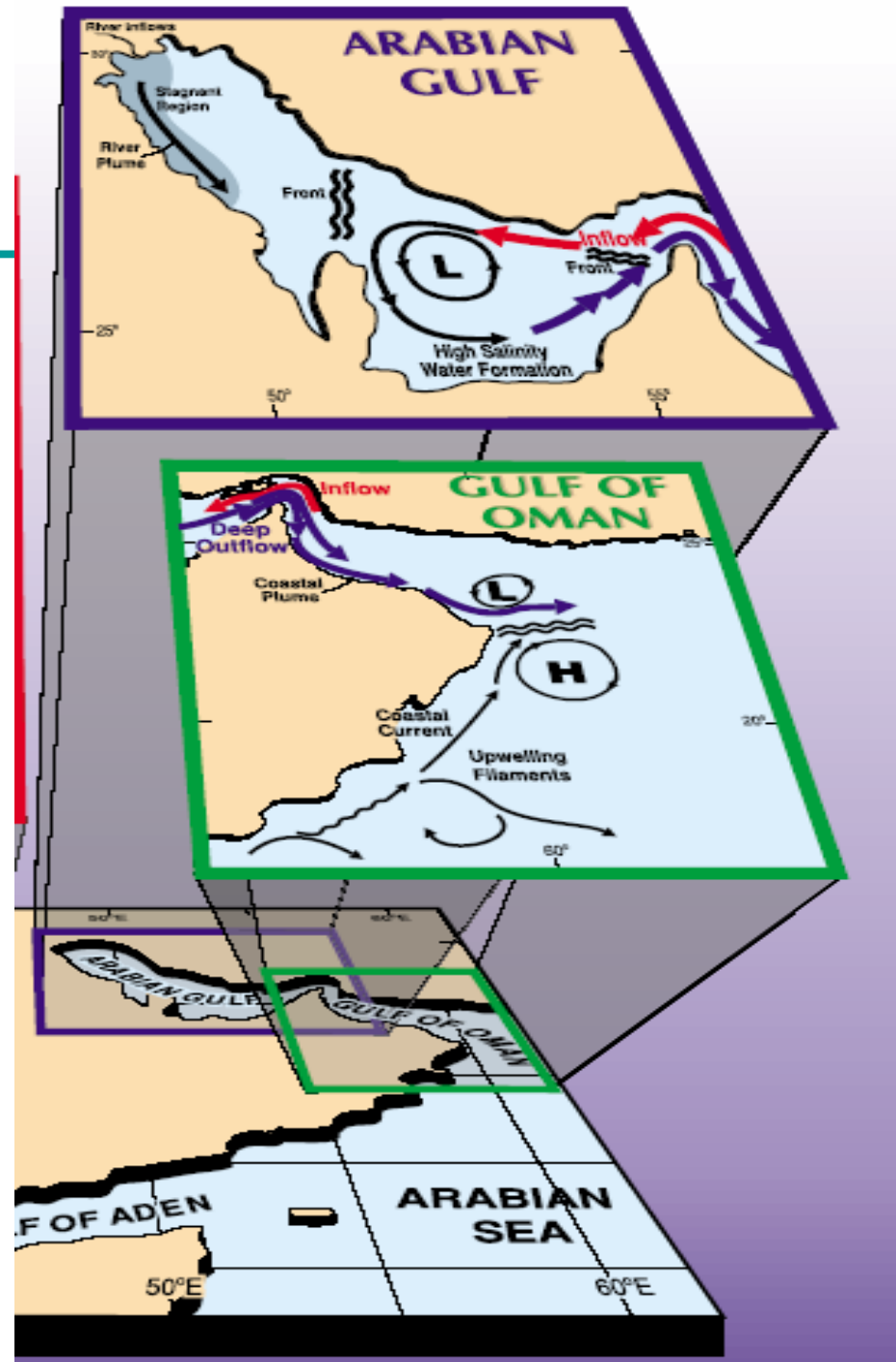


# Geography





# Current Systems in Arabian Gulf and Gulf of Oman

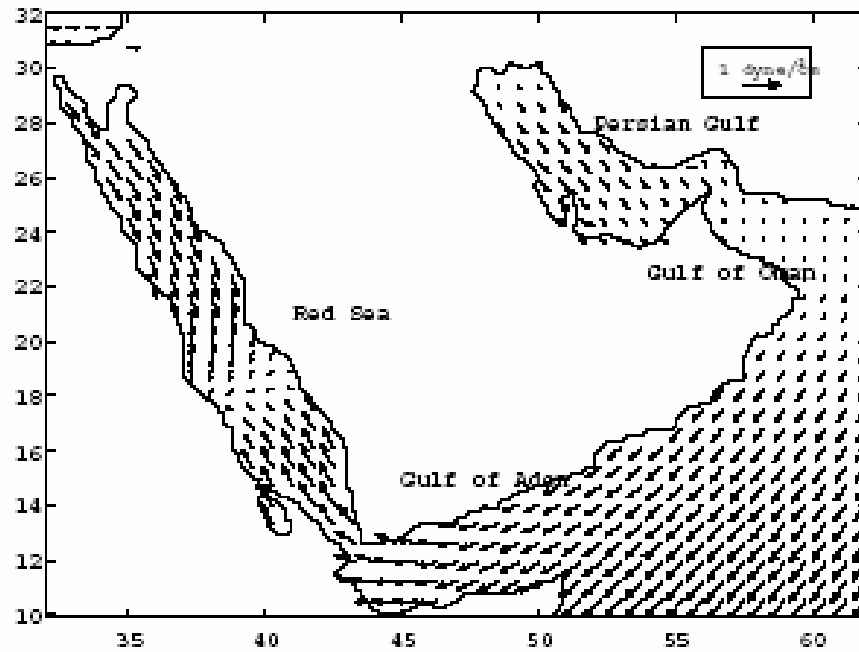




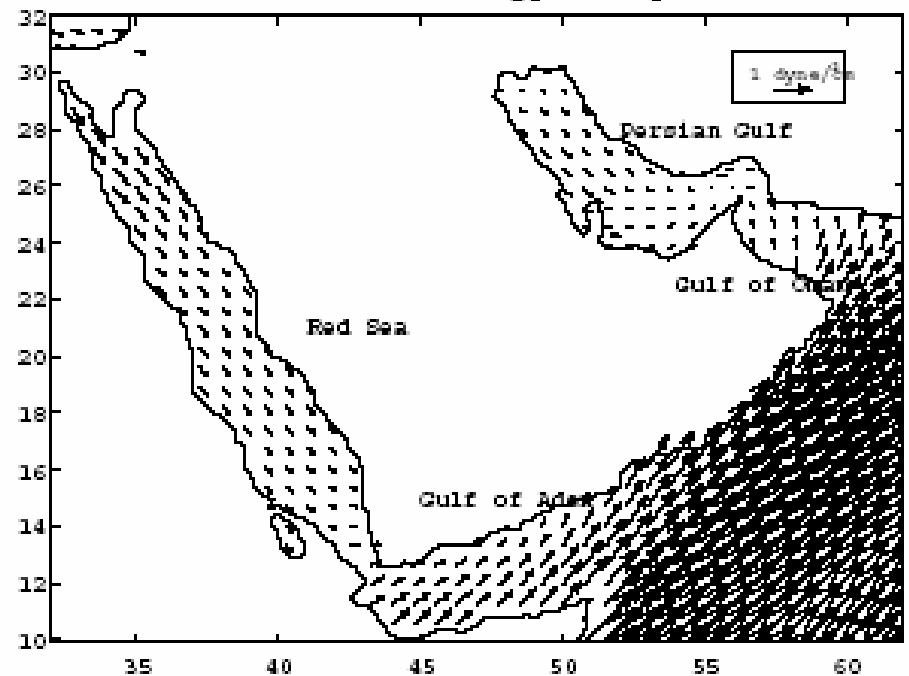
# Climatological Winds



COADS Climatology: January Wind-Stress



COADS Climatology: July Wind-Stress





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What are current systems in  
the Strait of Hormuz?



# Model Components



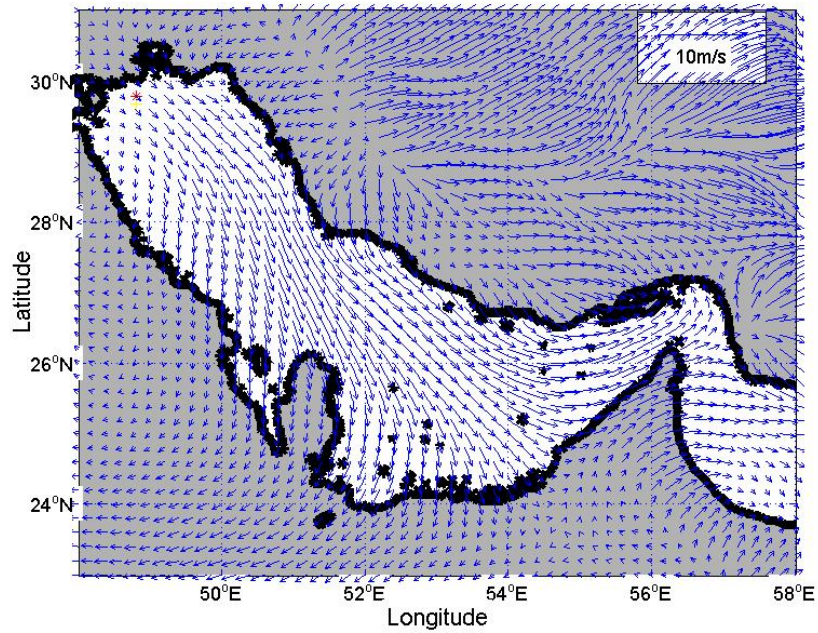
- Atmosphere:
  - Coupled Ocean/Atmosphere Mesoscale Prediction (COAMPS) → Non-Hydrostatic
  - 27 km inner nest within 81 km nest
- Ocean
  - Shallow Water Analysis and Forecast System (SWAFS) → Princeton Ocean Model (POM)
  - 2 km resolution
- Model Integration Period (Six Months)  
00UTC 01 Feb – 18UTC 31 Jul, 2006



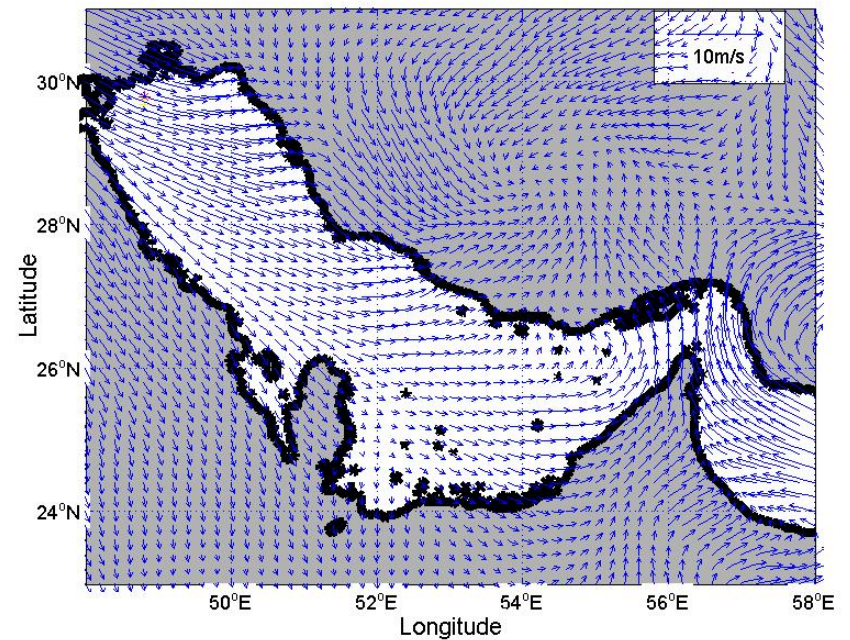
# Seasonal Variation of Winds



Mean Wind Vectors for FEB



Mean Wind Vectors for JUL



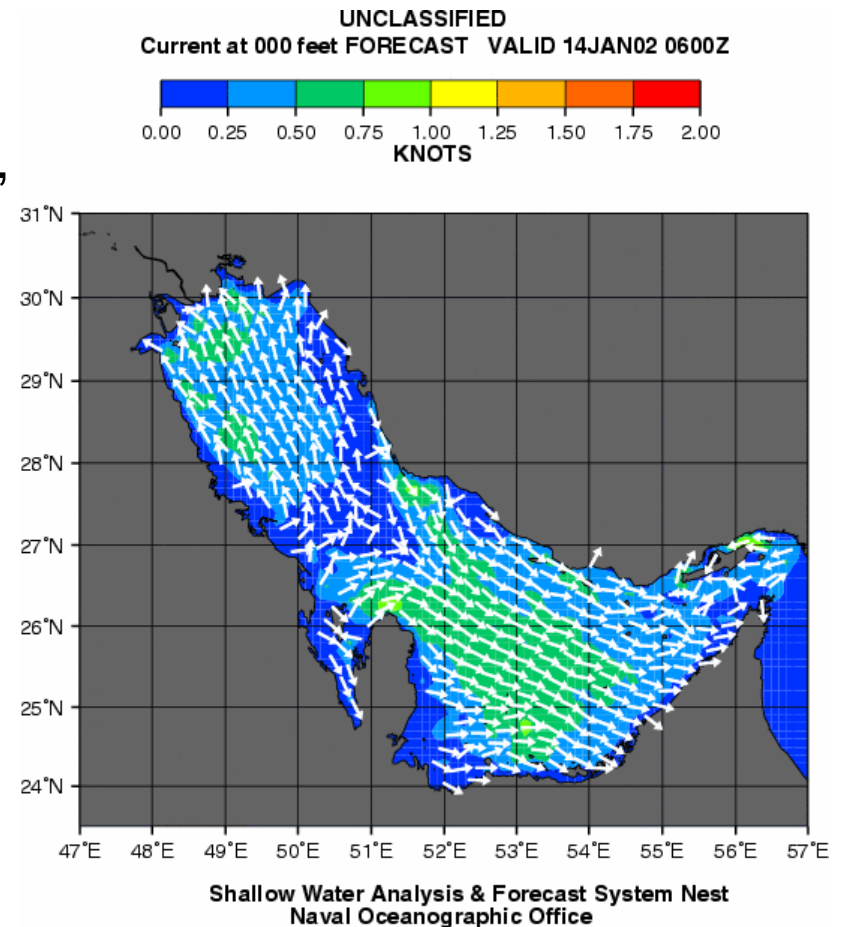




# SWAFS

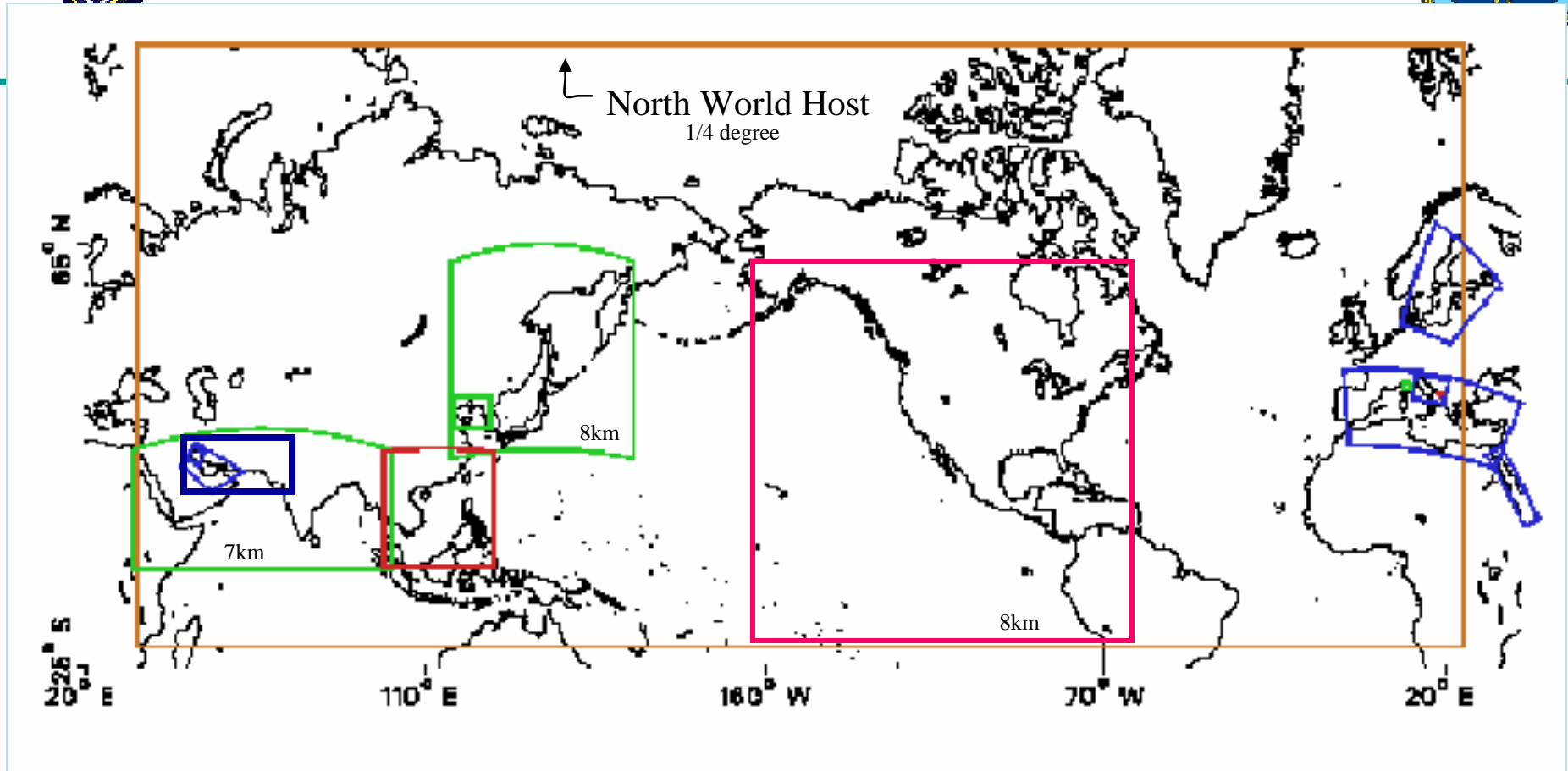





- Based on Princeton Ocean Model
- Multiple nested domains, 120 processors, passing lateral boundary conditions
- Assimilates satellite (SSTs, SSHs), in situ (XBTs, CTDs, float CTD)
- Assimilates elevations from global tide model in deep water
- Selectively assimilates elevations from coastal tide stations
- Provides 3-D currents, tides, and T,S





# SWAFS Computational Domains



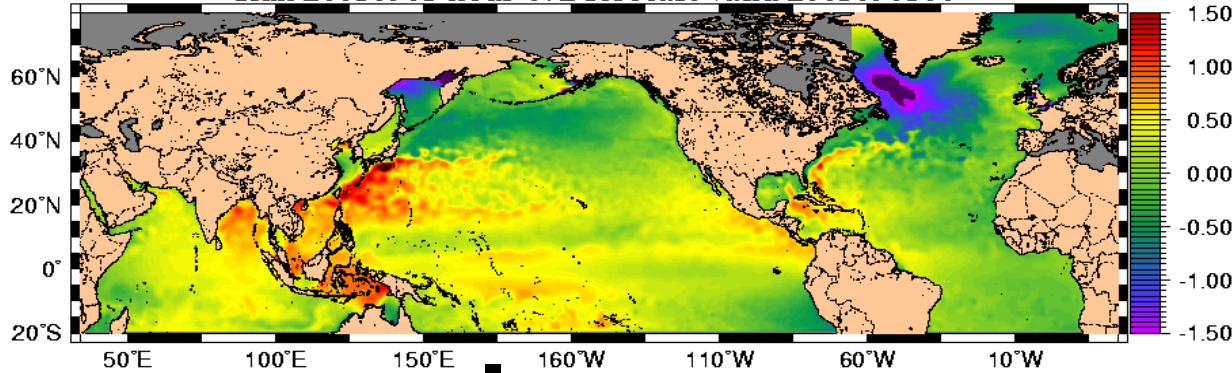
-  **Operational:** 95% chance model is adequate to provide product for a specific request
-  **Pre-Operational:** 70% chance model is adequate to provide product for a specific request
-  **Developmental:** 20% chance model is adequate to provide product for a specific request



# SWAFS Nesting (MPI)



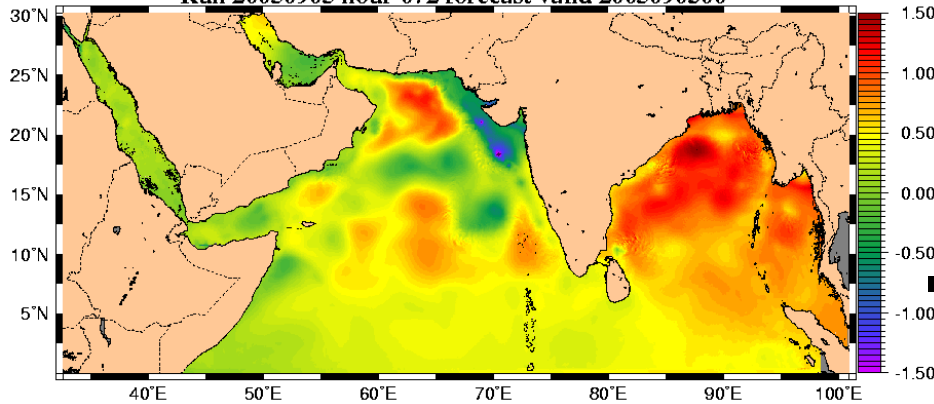
SWAFS surface height (m)  
Run 20030903 hour 072 forecast valid 2003090500



North World  
(1/4 degree)  
96 processors



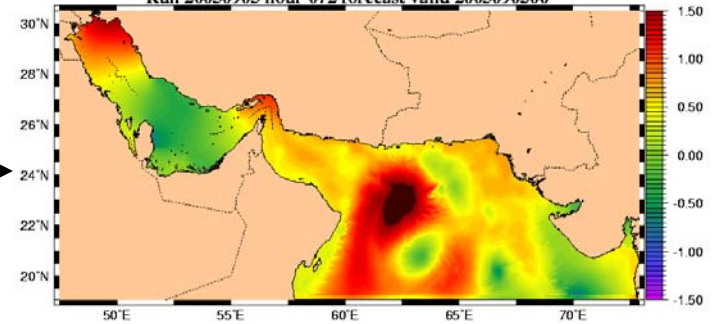
SWAFS surface height (m)  
Run 20030903 hour 072 forecast valid 2003090500



Indian Ocean Nest (7 km)  
120 processors



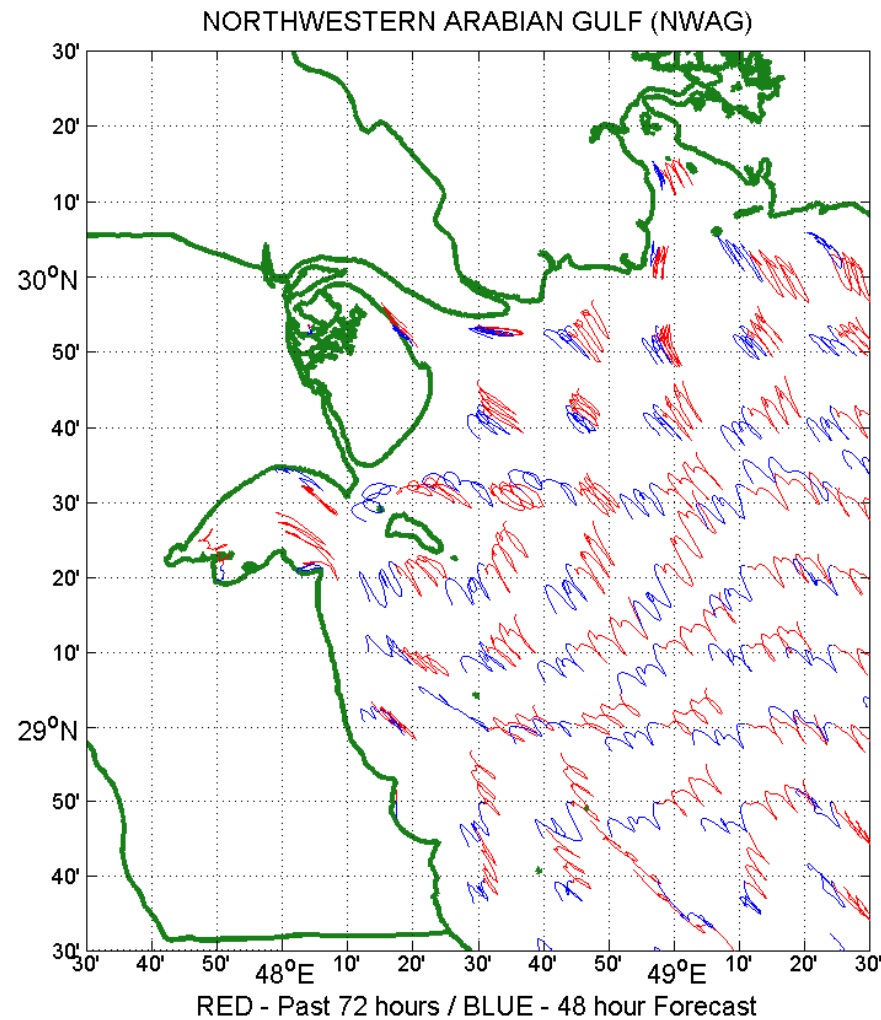
SWAFS surface height (m)  
Run 20030903 hour 072 forecast valid 2003090500



North Arabian Sea Nest (2km)  
120 processors



# SWAFS - 5-day trajectories

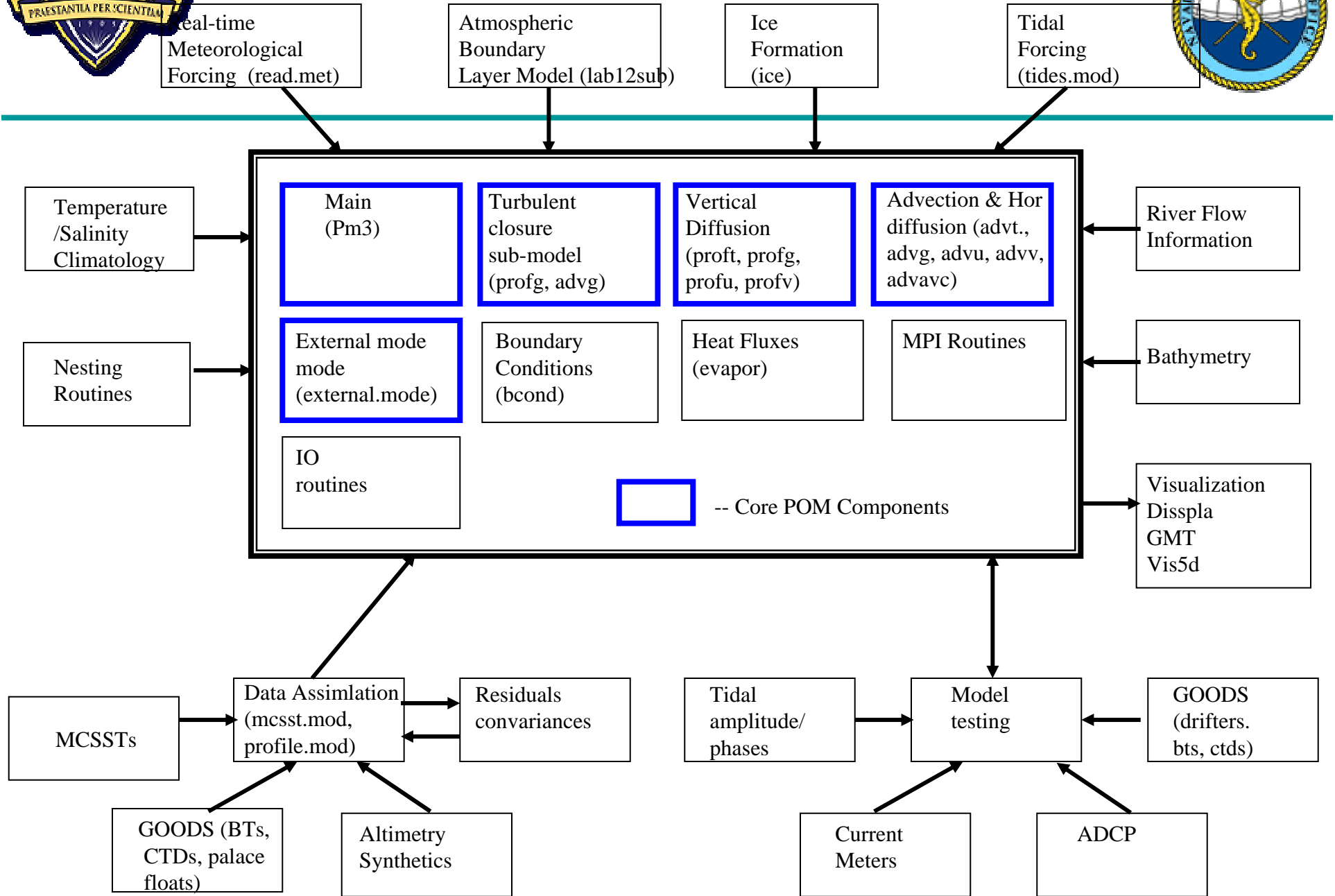


Blue: 2 day forecast

Red: 3 day hindcast

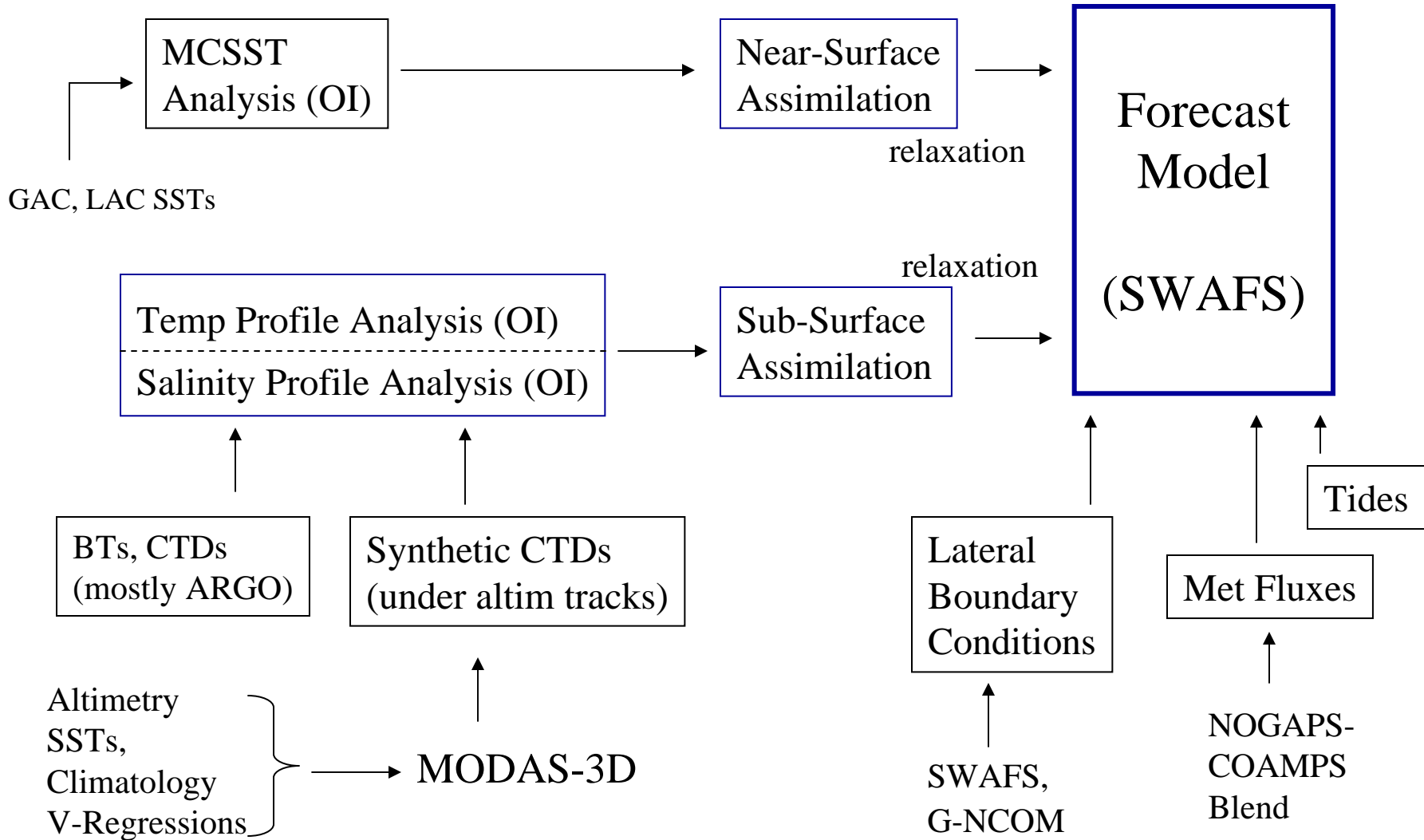


# SWAFS



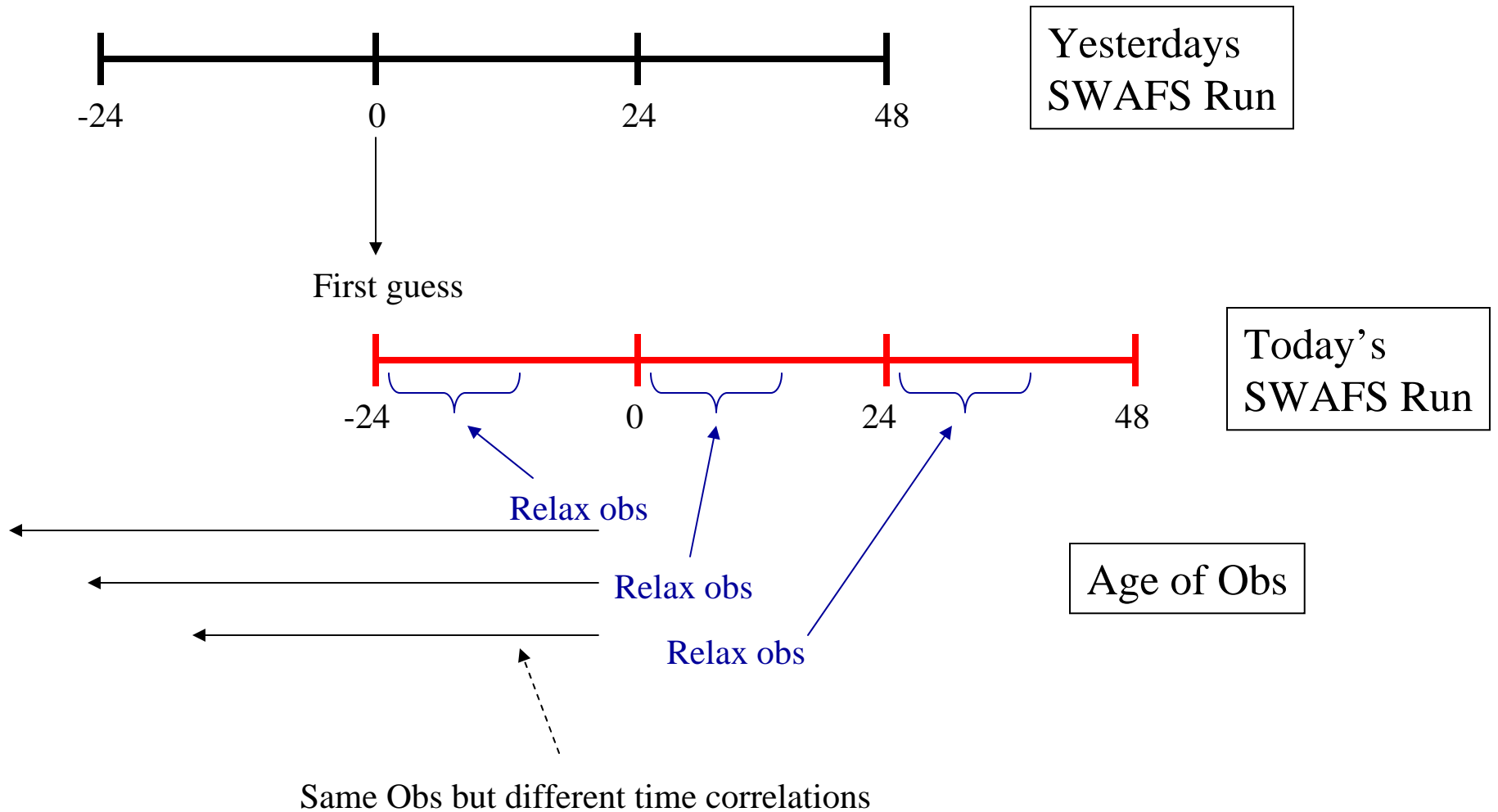


# Data Assimilation for SWAFS Circulation Model





# SWAFS Assimilation of Observed and Synthetic T,S Profiles for 3 day run

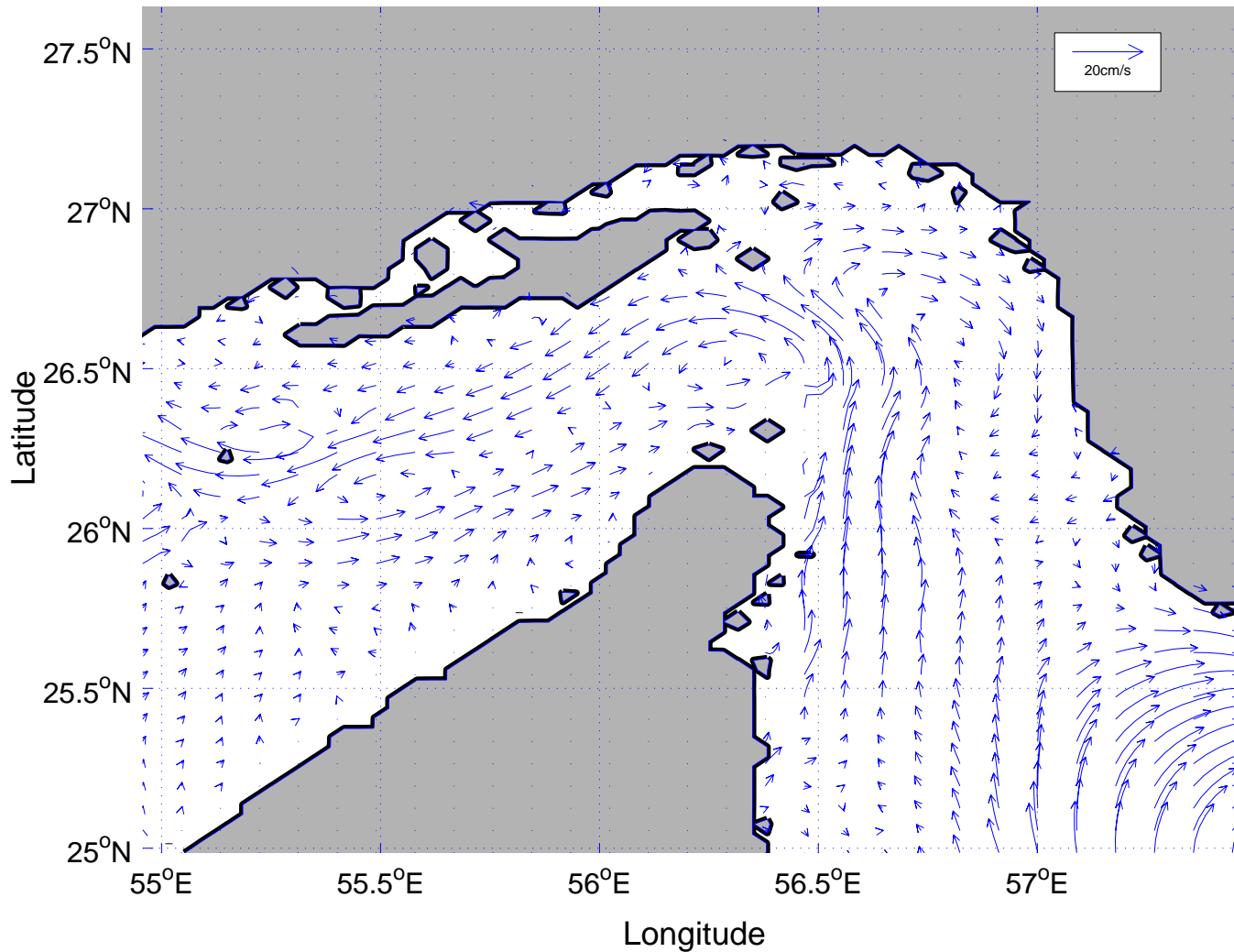




# Mean Currents (Feb-Jul, 2006) Multi-Eddy Structure



Mean Flow in SOH Feb-Jul 2006



→ Vector Scale

20 cm/s





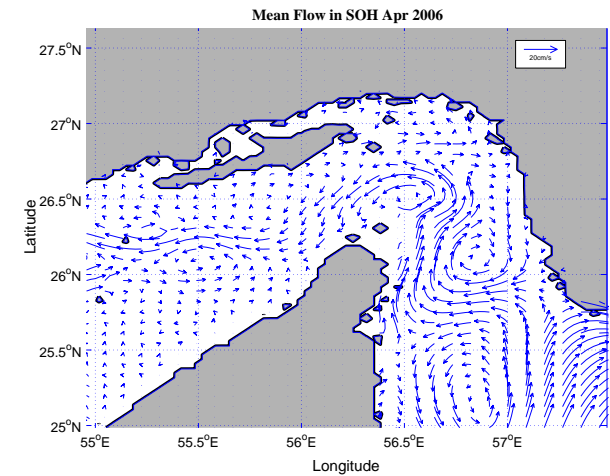
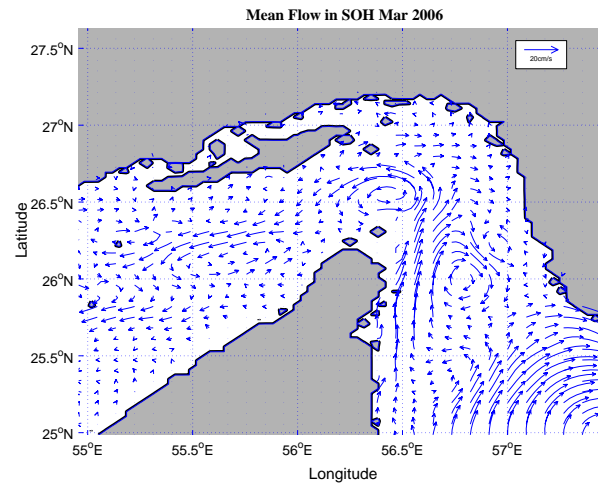
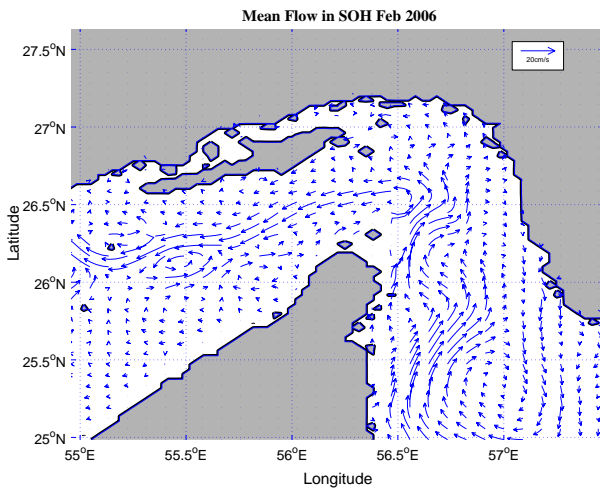
# Monthly Mean Currents (Vector Scale $\rightarrow$ 20 cm/s)



Feb

Mar

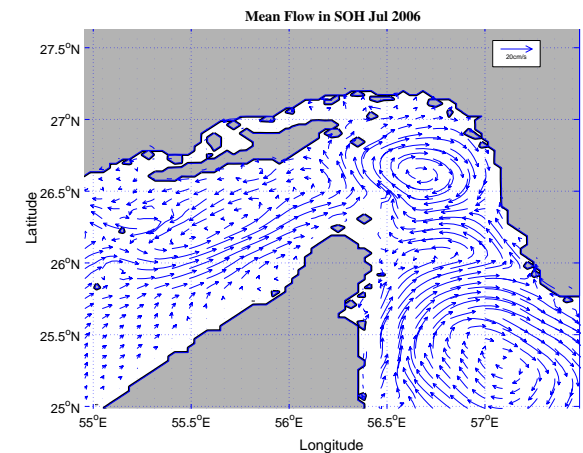
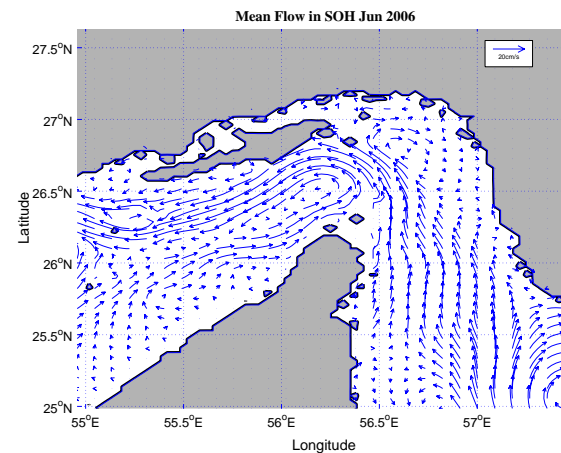
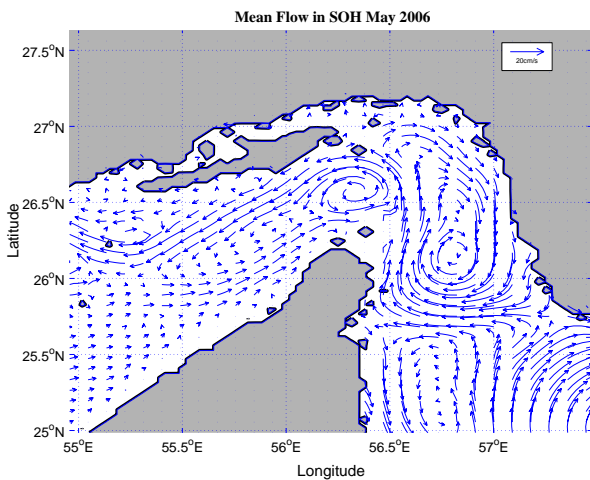
Apr



May

Jun

Jul





# Complex EOF Variance

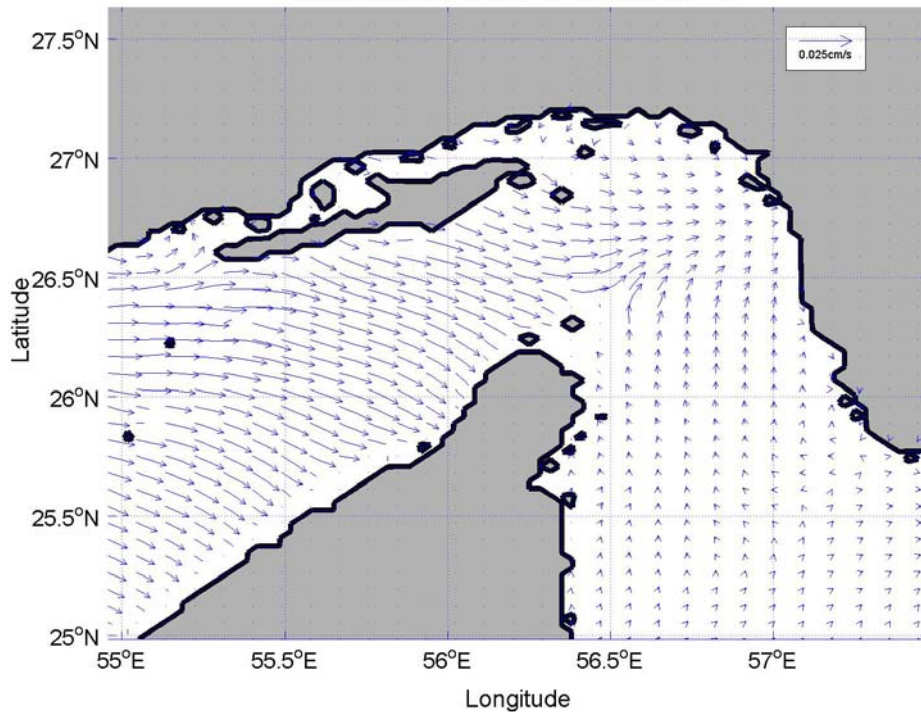
<b>EOF</b>	<b>Percentage of Variance</b>	<b>Cumulative Percentage of Variance</b>
<b>1</b>	<b>36.11%</b>	<b>36.11%</b>
<b>2</b>	<b>18.08%</b>	<b>54.19%</b>
<b>3</b>	<b>10.56%</b>	<b>64.75%</b>
<b>4</b>	<b>6.70%</b>	<b>71.45%</b>



# EOF-1



Current(1st Mode) in SOH Feb-Jul 2006

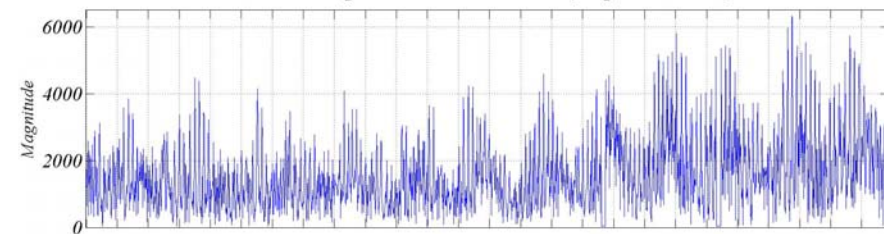


→ Vector Scale: 0.025 cm/s

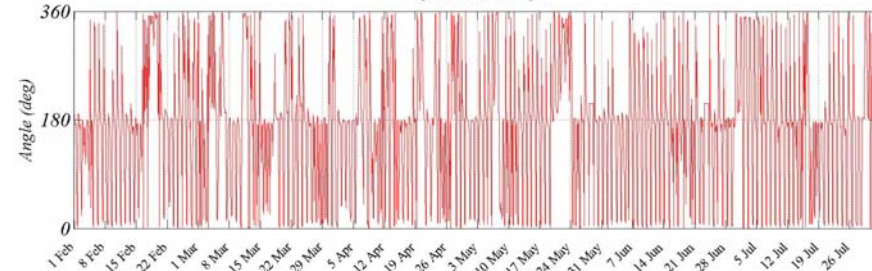
→ Maximum tidal current speed  
~ 1.5 m/s

EOF -1 is primarily tidal influence and includes semidiurnal, diurnal, as well as spring/neap tidal constituents.

SWAFS Magnitude/Theta Time Series: (Magnitude Mode1)

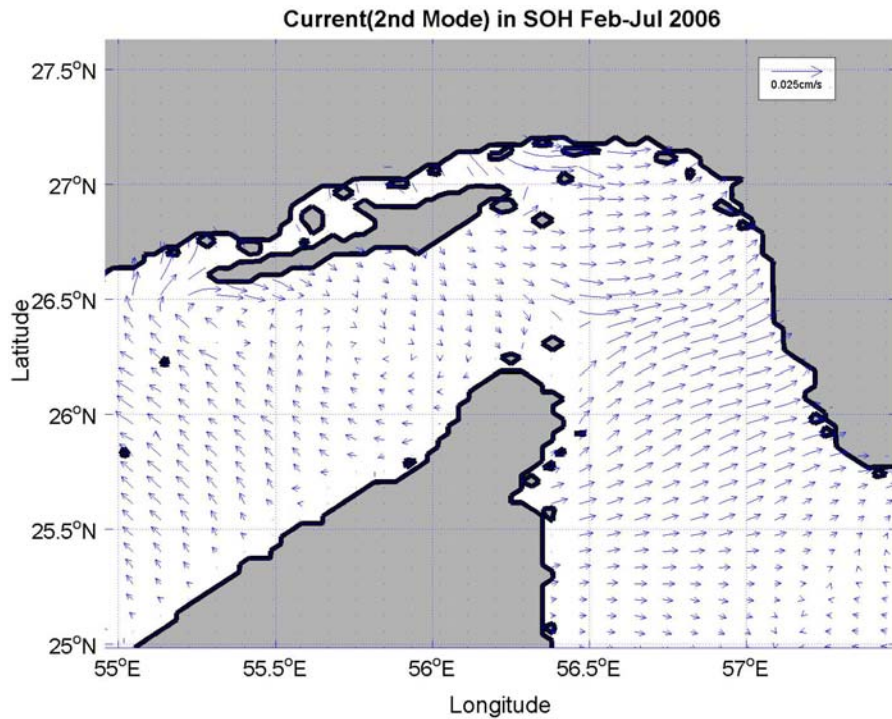


(Theta Mode 1)

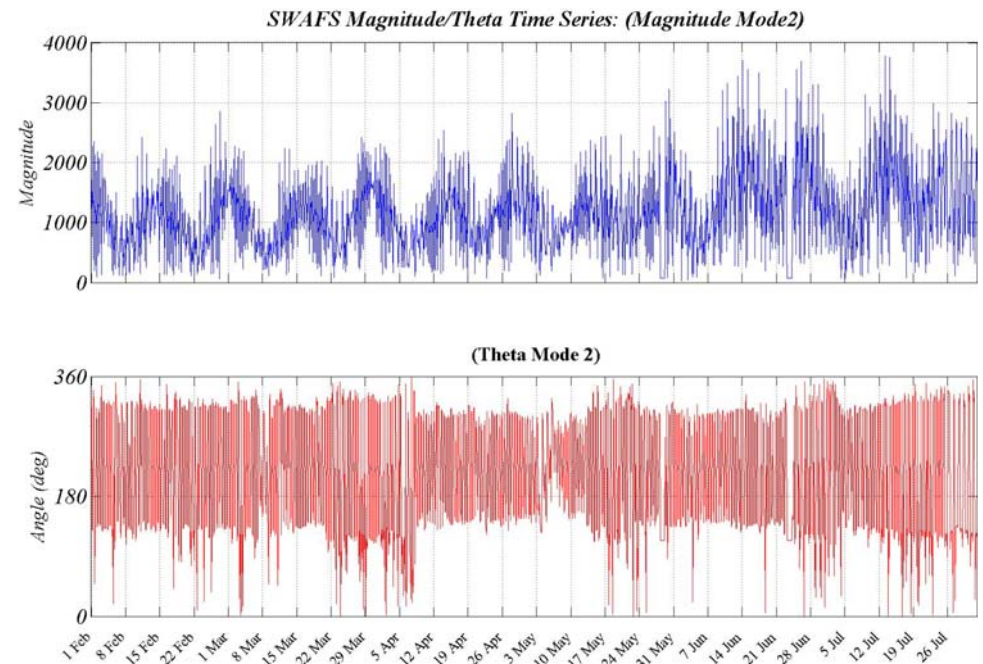




# EOF-2

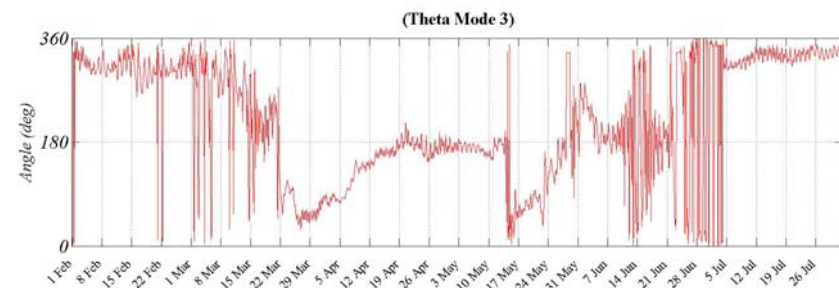
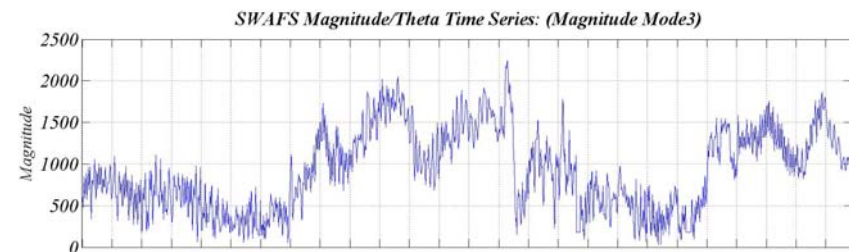
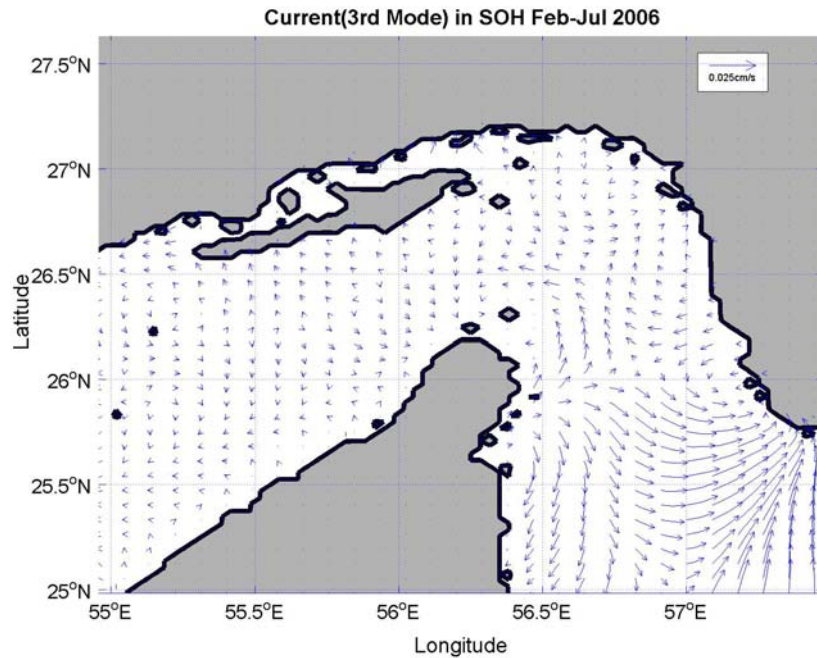


EOF -2 is mostly diurnal and spring/neap influenced but does have some semidiurnal influence.





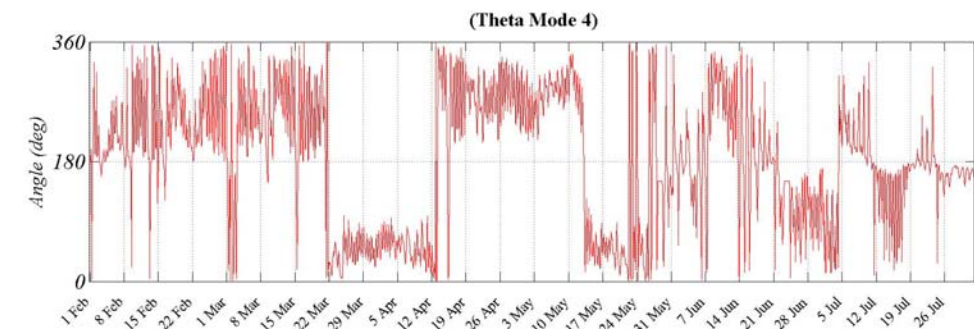
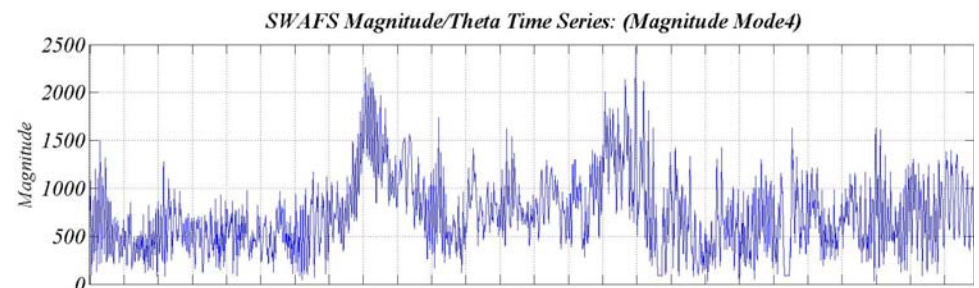
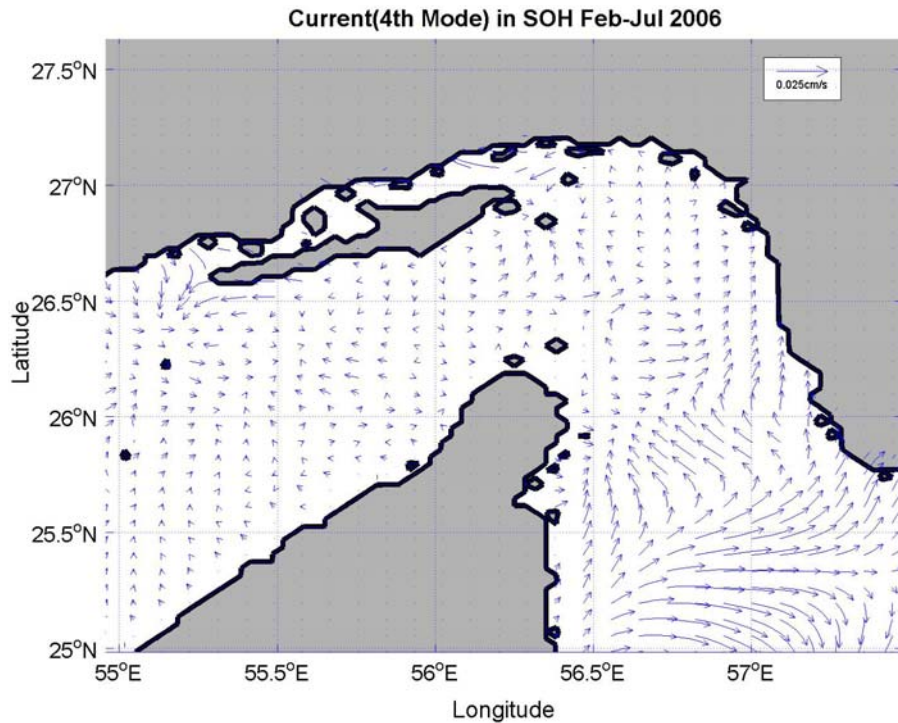
# EOF-3



EOF -3 is affected by the semidiurnal tidal cycle as well as the effects of the eddy from the GOO.



# EOF-4



EOF-4 is also affected by the semidiurnal tidal cycle and is related to the onset and retreat of the GOO eddy.



# Conclusions



- Multi-eddy structure exists in the Trait of Hormuz.
- Tidal currents dominate the Strait of Hormuz.
- This model is coupled to a chemical spill model