A Rapidly Relocatable Prediction System: Operational Implementation and Validation

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NRL-7320

MODAS-NRLPOM

- Provide short-term (2-day) forecast
- User-friendly interface
- Relocatable from deep to shallow, from open sea to inlets
- Portability (toward PC)
- Primary clients: NAVO and Navy operational units

Operational vs Research Mode

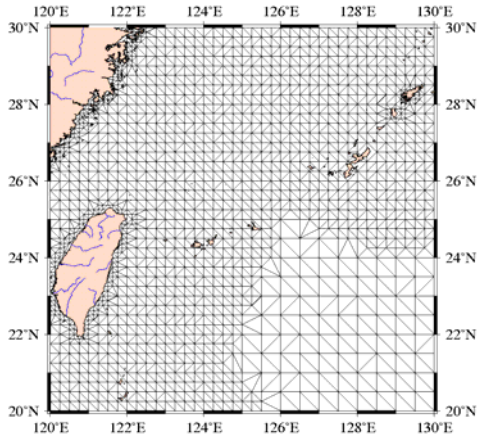
Operational: find the optimal configuration for *good* solutions *everywhere*.

Research: find *the* configuration for *the best* solution for a *given* problem.

MODULAR OCEAN DATA ASSIMILATION SYSTEM

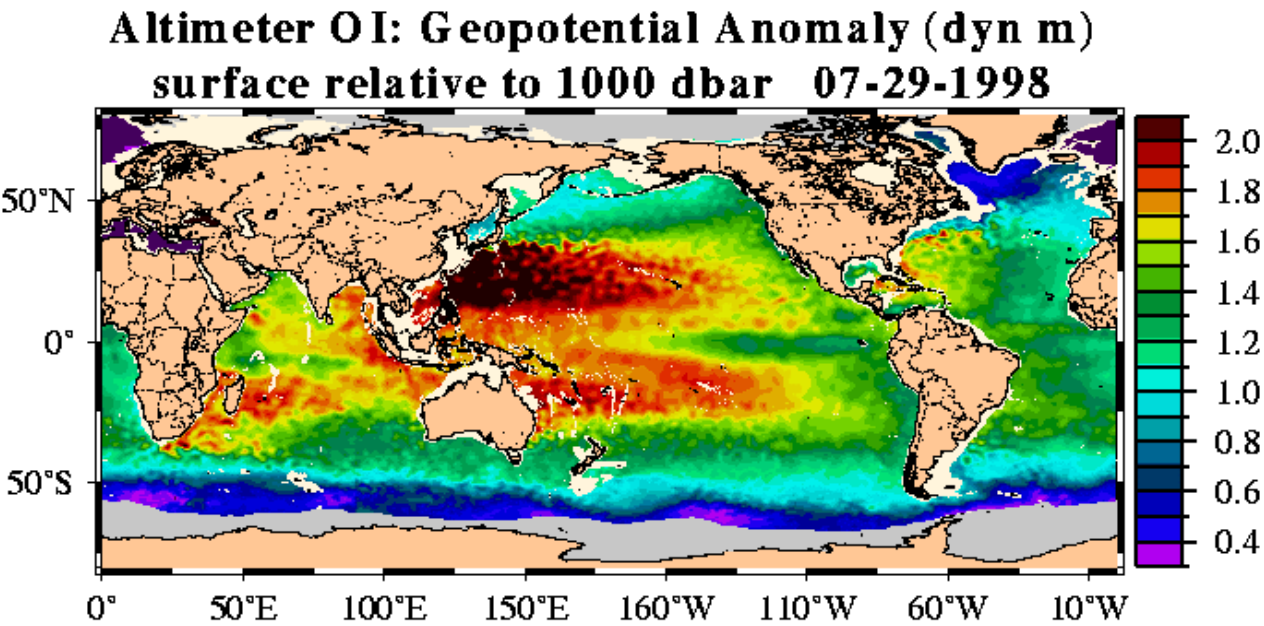
A Static and dynamic climatology for production of 3-D nowcast temperature and salinity fields.

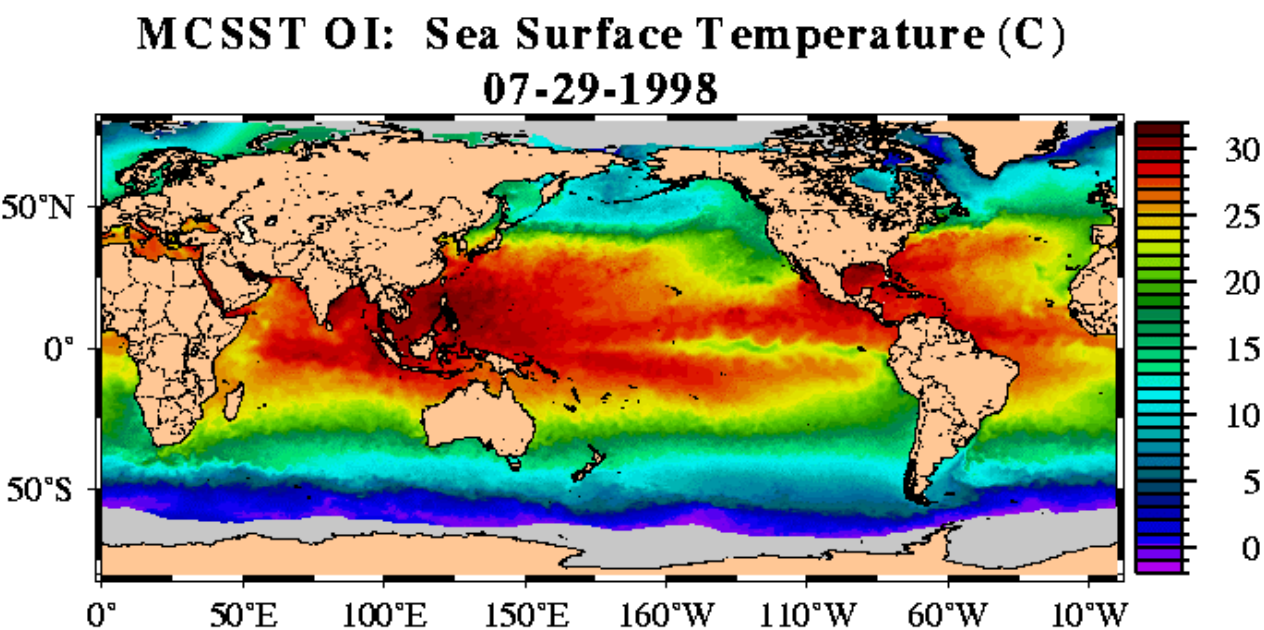
•The ***static climatology*** represents historical average, stored on an irregular mesh, varying from 1 to 1/8 degree in resolution to permit high resolution analyses in shallow water regions



•The ***dynamic climatology*** assimilates multiple data type with heavy reliance on remotely sensing data for area coverage

Global MODAS Analyses





MODAS 2.0:

Altimeter and AVHRR MCSST produce global fields of gridded dynamic height and sea surface temperature

System implementation is being upgraded to include MVOI that takes into account the spatial and temporal auto- and cross-covariance of the dynamic height and temperature fields. This allows data to be incorporated in a manner consistent with observed variations over the climatological record.

MODAS

- MODAS is successful in deep/open sea
  - altimetry and SST are ‘reliable’
  - high correlation between surface and subsurface features
  - data are available on spatial/temporal scales order of the dominant features
- Shallow and semi-enclosed sea are more challenging.
- Difference between average (minimum distance/ error) and most probable solution.

NRLPOM

(***POM's engine with a new body)***

Portability

- C-preprocessor (double/single precision)
- allocated memory
- makefiles with compiler option
- toward PC rather HPC

User-Friendly Interface

- Parameters and Flags in Namelist files

NRLPOM Cont'd

Physical Accuracy

- Initialization
  - cold/warm/diagnostic
  - restart from previous runs
- Boundary Conditions (always in progress !)
  - radiation+relaxation (no conservative)
  - coupling with other models
- Tides (forcing from Grenoble model)
  - SSE at the boundary and/or geopotential

Real time models

- Rapid configuration (< 6hrs).
  - Default data sets:
  - Bathymetry (dbdv5), winds (NOGAPS)
  - MODAS climatology
- Default configuration
- MODAS- NRLPOM executed with copies of the same executable
  - different namelist files

Forecast methodology

- MODAS nowcast as IC and BC for NRLPOM
  - Barotropic field at the BC may be estimated by other models
- NRLPOM forced by the best available forecasted winds (Several initialization procedures)
- MODAS field nudged during hindcast only.

  NO assimilation during the forecast
- Plots of output often posted on web pages.
- no smoothing filtering on model outputs
- data shown as retrieved from data server.

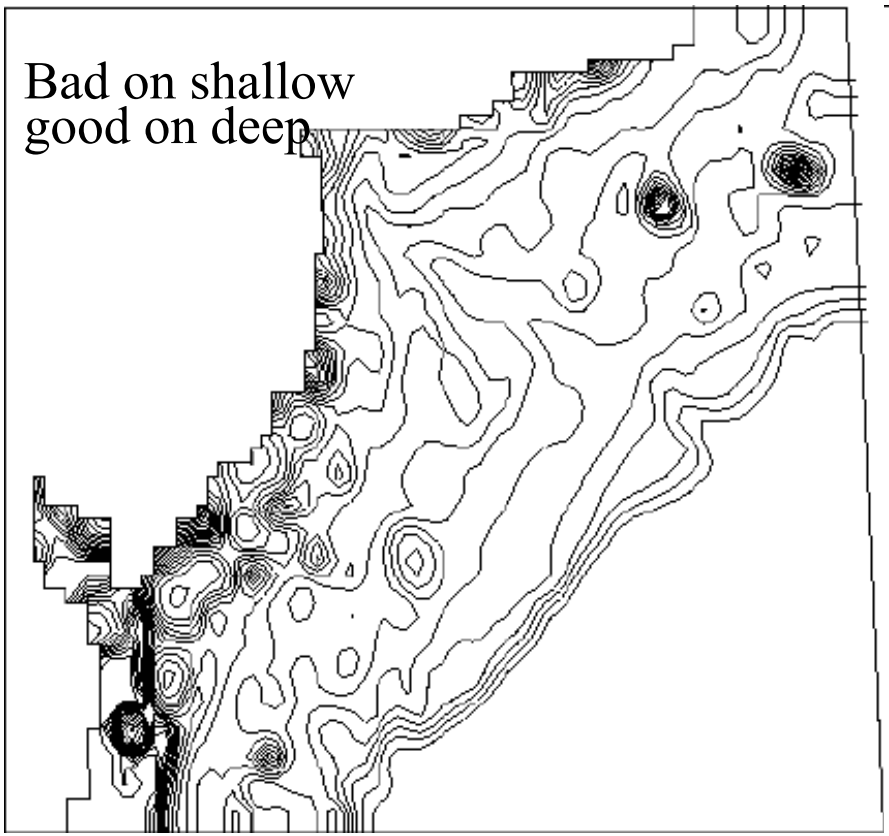
Potential problems

Most of the instabilities/inaccuracies are from a 'poor' model configuration.

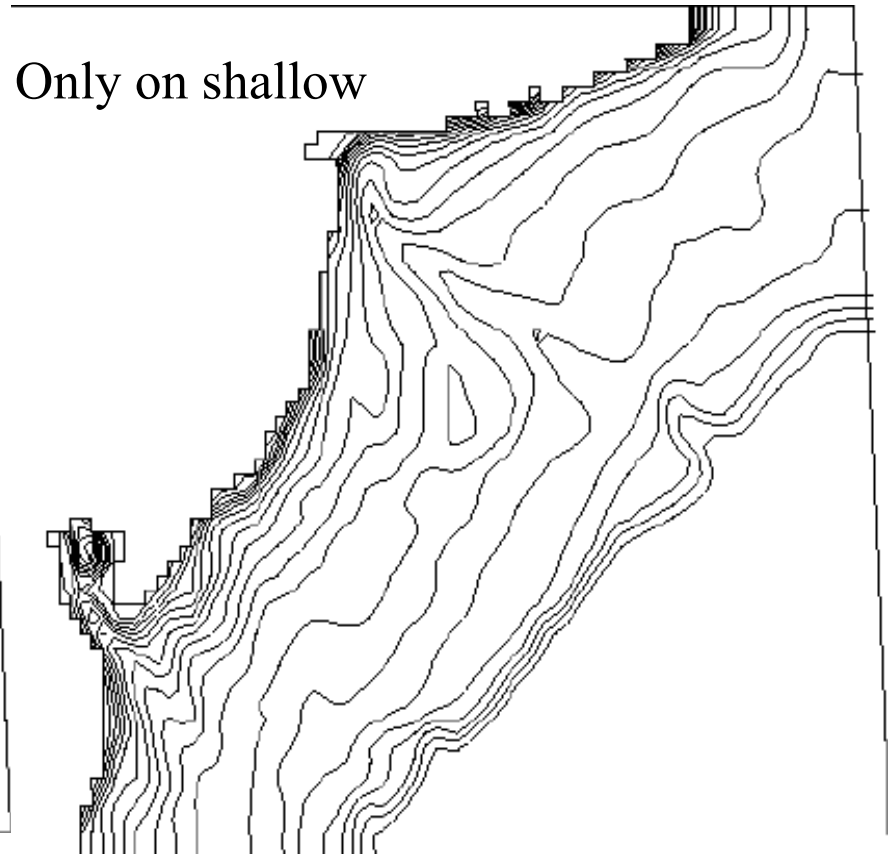
- Bathymetry and domain configurations
- Wind datafiles
- Forcing at the boundary
  - From data
  - From models

Bathymetry @ Leo15

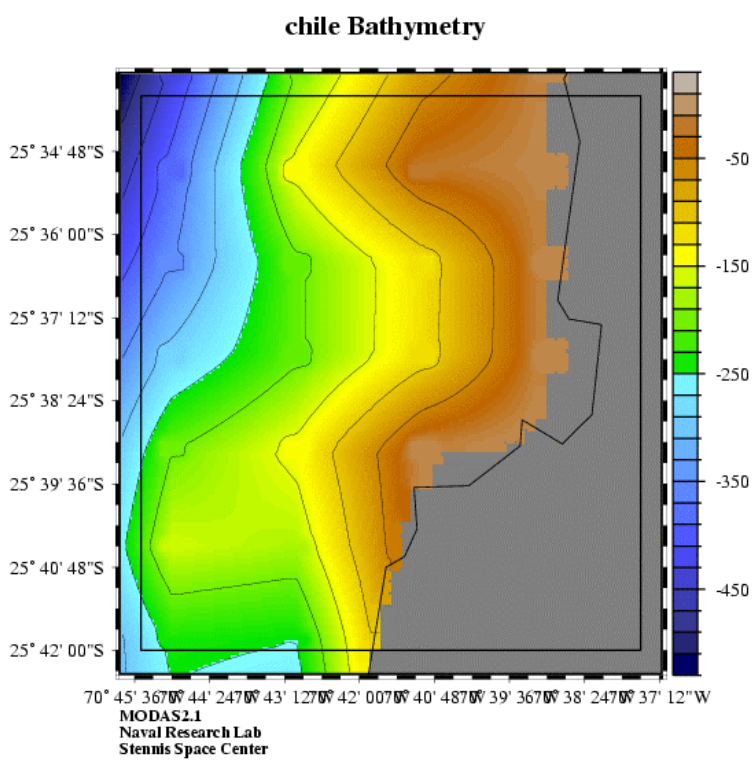
Sandwell

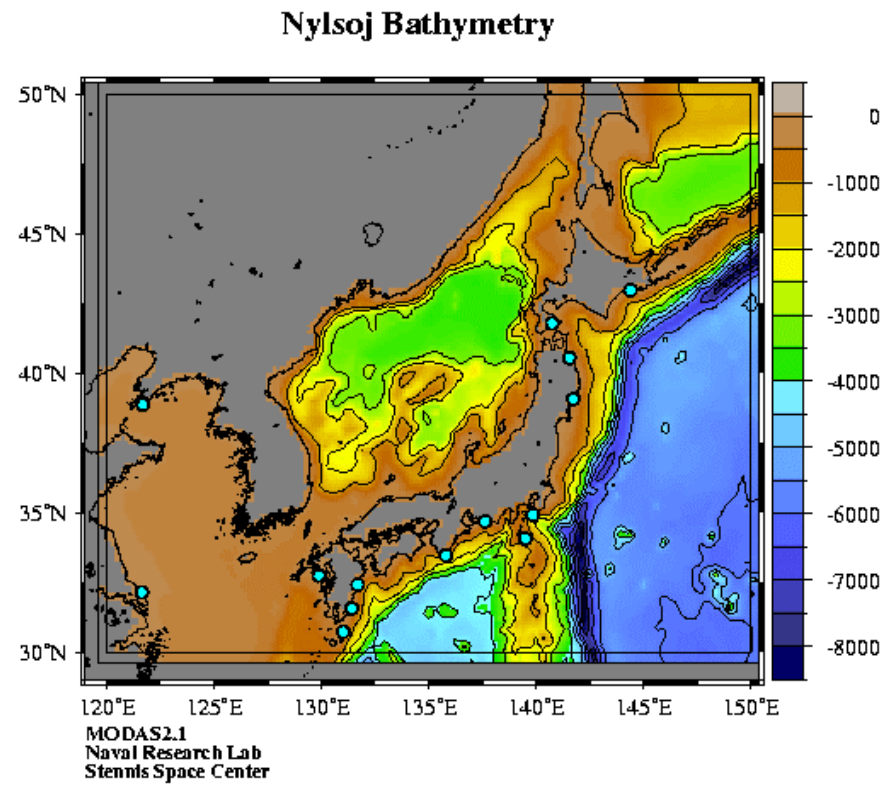


Rutgers



Potential problems

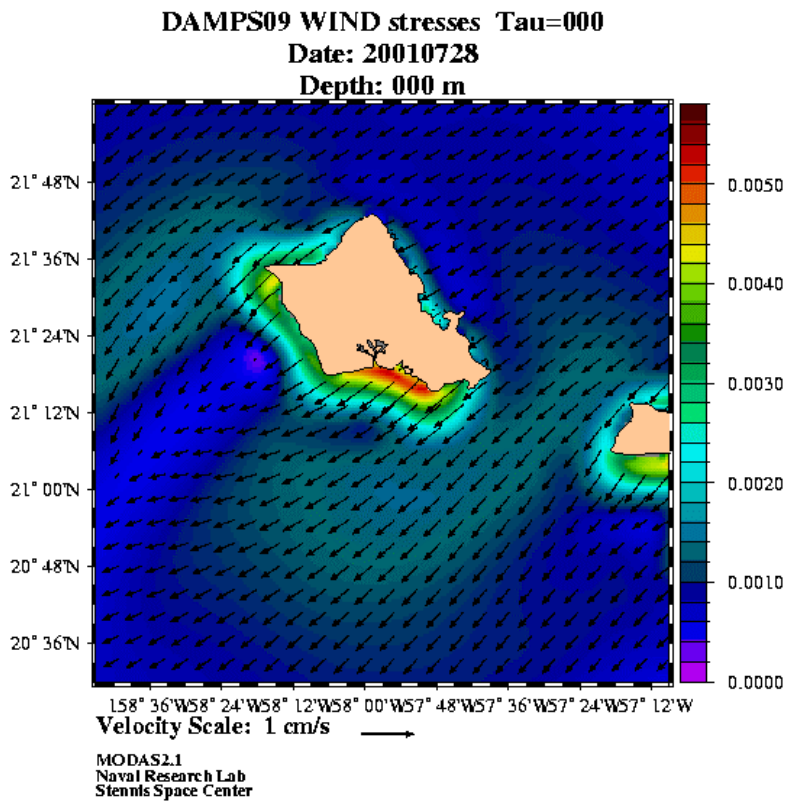




Bad coastlines

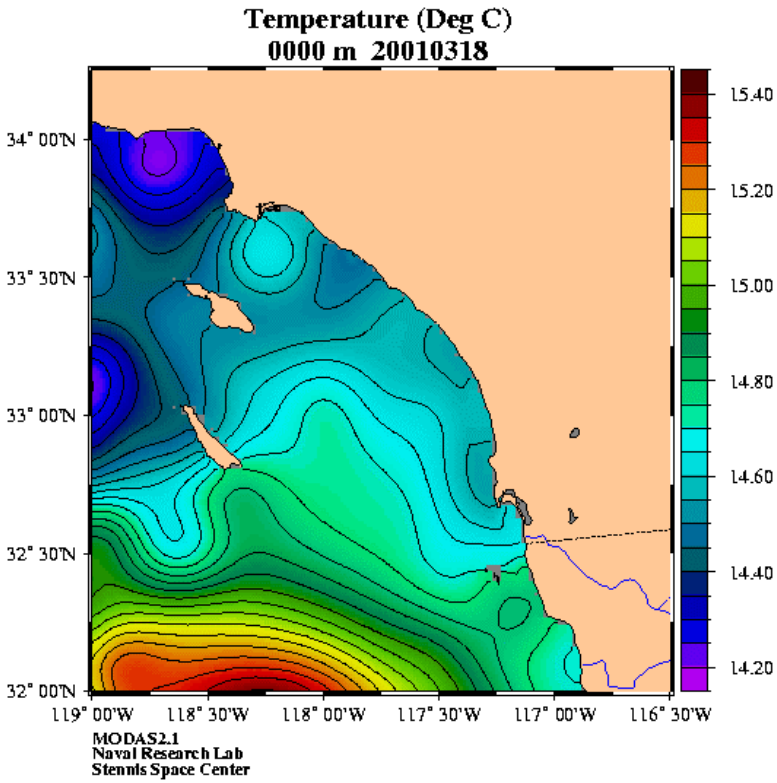
Wrong open boundaries

Potential Problems

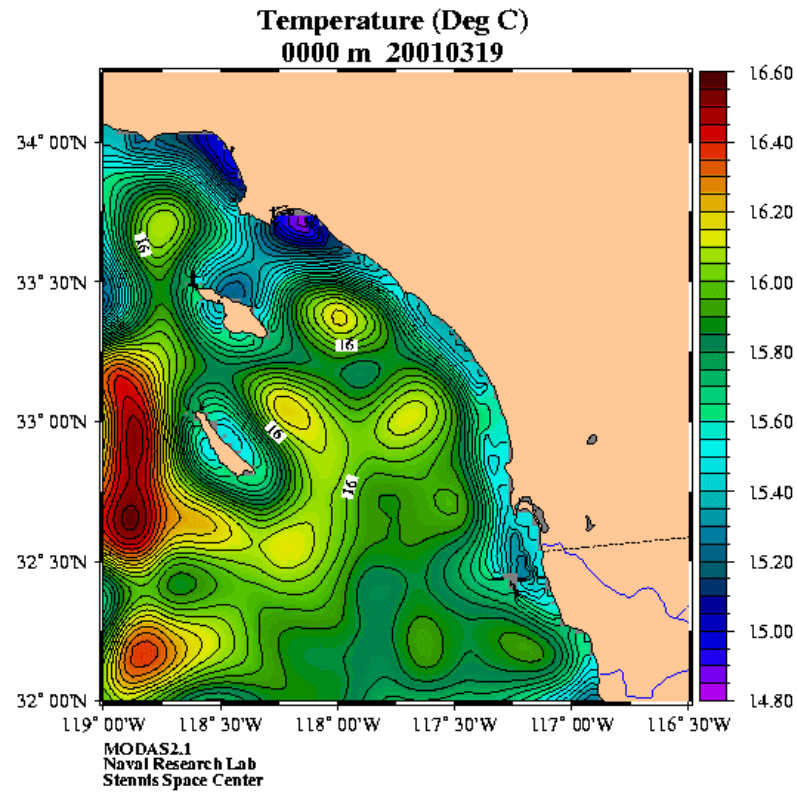


Averaging procedure at land-sea point for wind stresses on the operational grids

Cloud coverage



Clear day

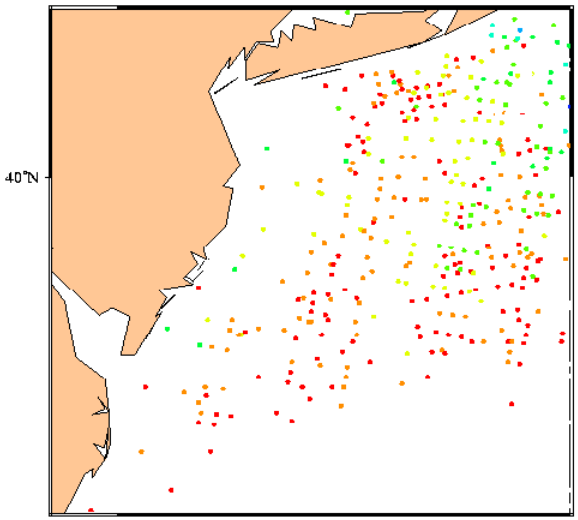


Static Clim.

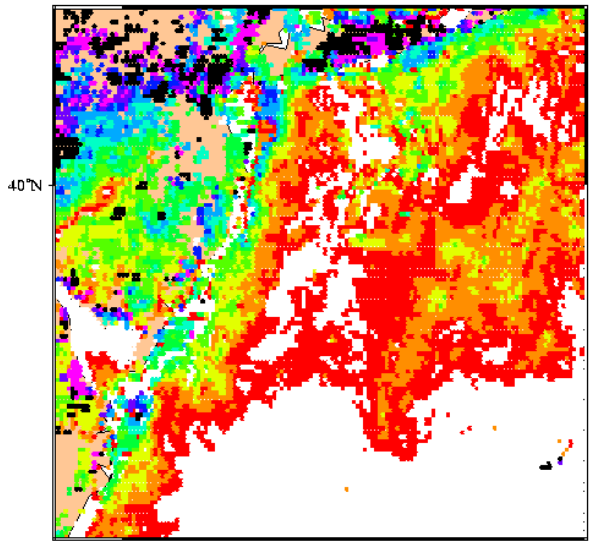
Dynamic Clim.

MCSST Data Files

July 18, 2000



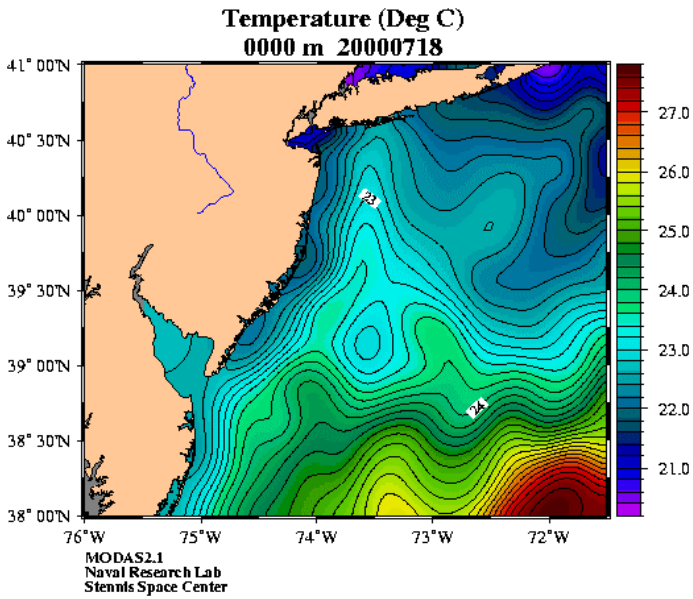
NAVO Global @ 9 km



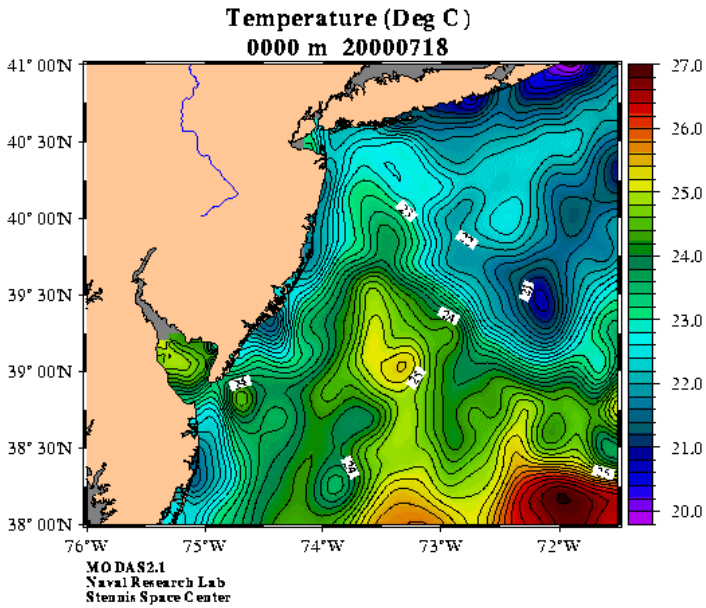
Rutgers University @ 2km

•NAVO has recently released a 2km Global MCSSTdata set

MODAS SST analysis



From NAVO



From Rutgers

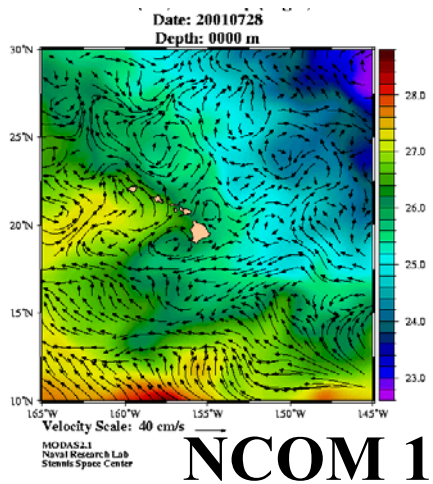
Potential Problem: Open Boundary Conditions

- Radiation-like OBC requires some reference boundary values.
- Baroclinic component: geostrophy
- Barotropic values are missing:
  - No dynamic height in h<200m
  - No altimetry in coastal/shallow water

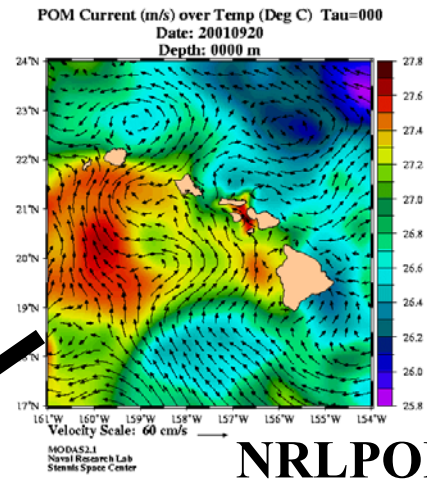
1-way coupling

- Only the barotropic field is necessary from other models
- easy to implement
- wide range of forcing models
  - σ/z/../ coordinates

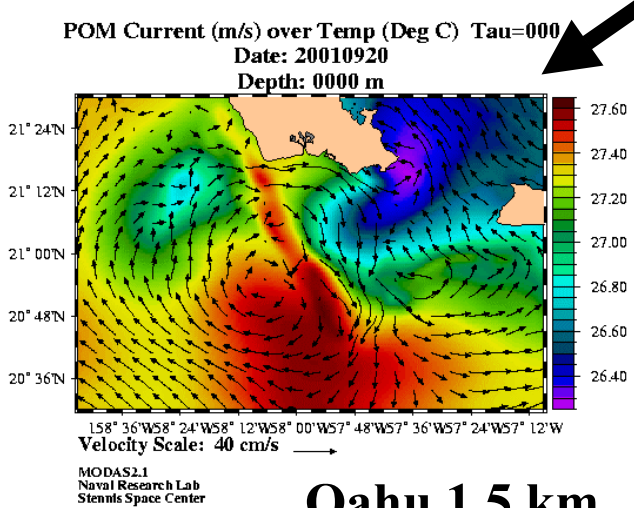
Coupling/nesting



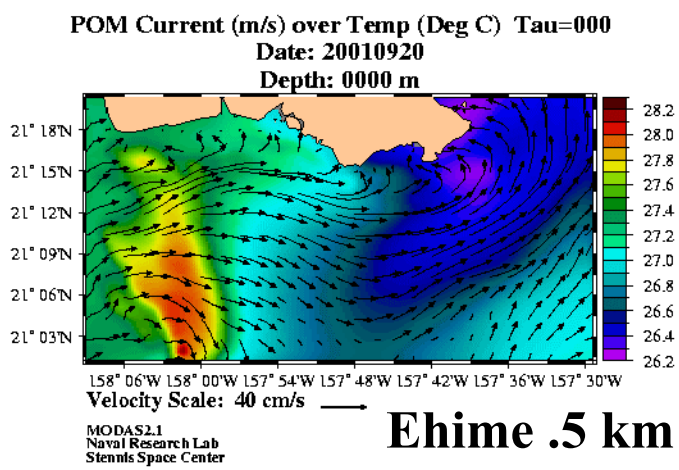
NCOM 1/4º



NRLPOM 7km



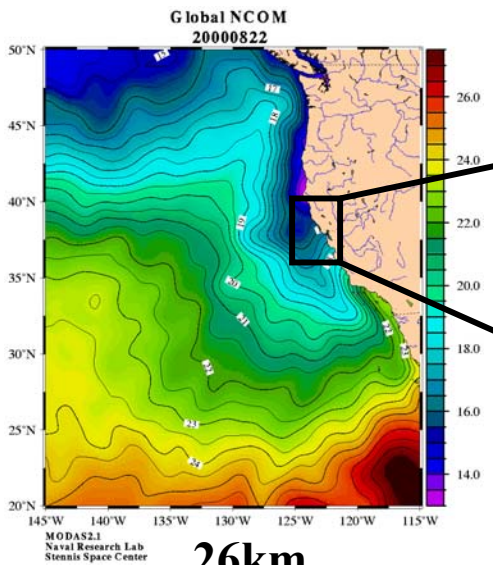
Oahu 1.5 km



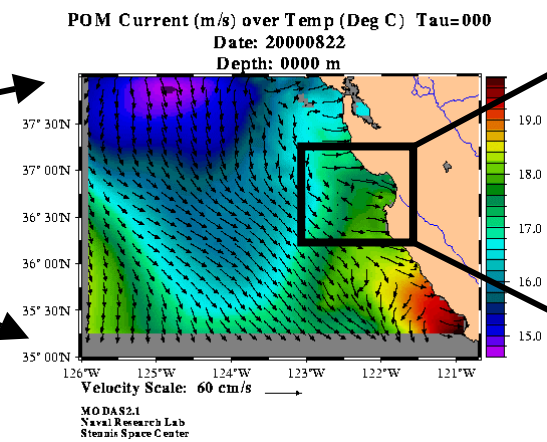
Ehime .5 km

Tide

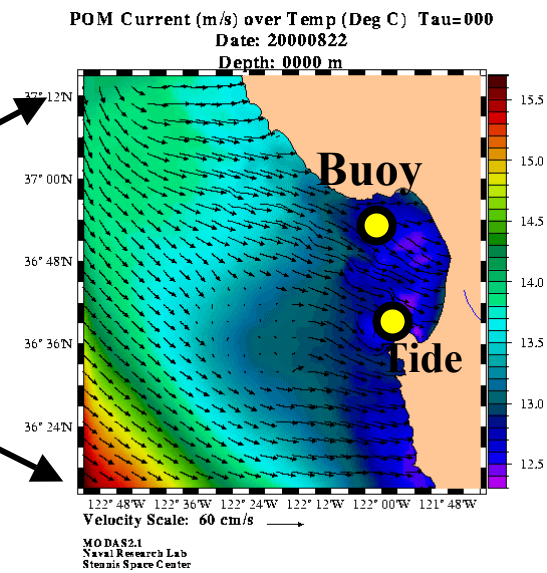
MODAS-NRLPOM @ Monterrey Bay



26km



6km



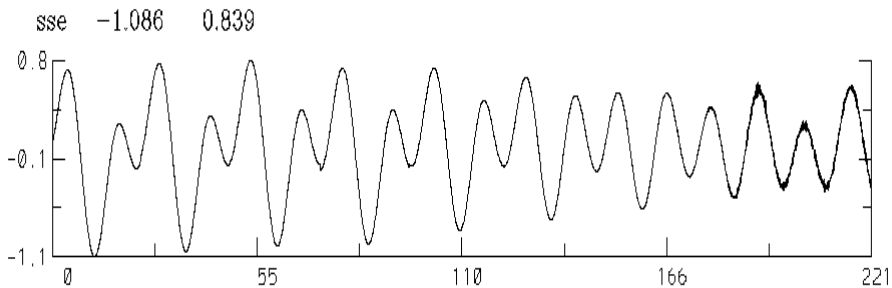
1.5km

NCOM provides BC for the regional model (no tides) that provides BC to the coastal model (with tides)

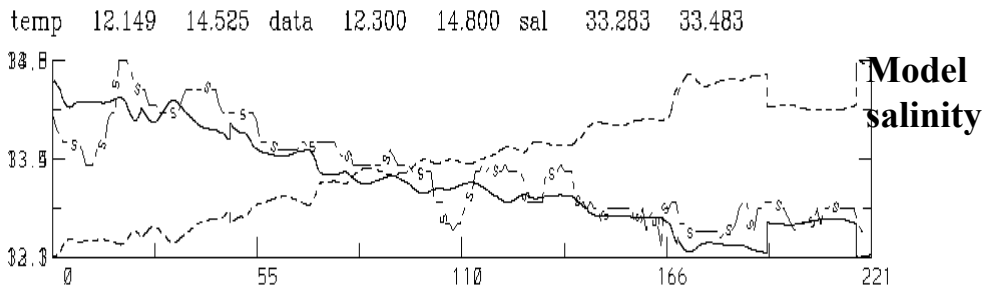
MODAS-NRLPOM @ Monterrey Bay

1-day forecasting sequence

Tides



SST



Coupling/Nesting

- **MODAS-NCOM** is under development. One model from global to relocatable.
- Nesting with the same model is operationally efficient (the code and system are easy to maintain) but restrictive.
- The coupling procedure has been designed for application to a wide range of model formulations
- 1 requirement: the parent model be without tide (to separate tidal and barotropic flow)

EVALUATION

PROBLEMS:

- There are already few data for MODAS analysis, virtually none for model-data comparison.
- Comparison must be done in in real-time to calibrate the system before the next forecast cycle.

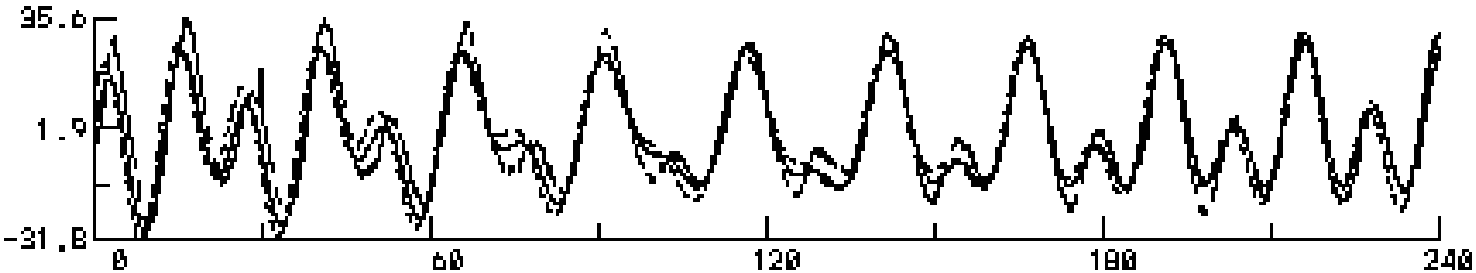
Main data sets for the comparison

- Tide gauges from NOAA (US coast)
- Bouys from NOAA NBCD

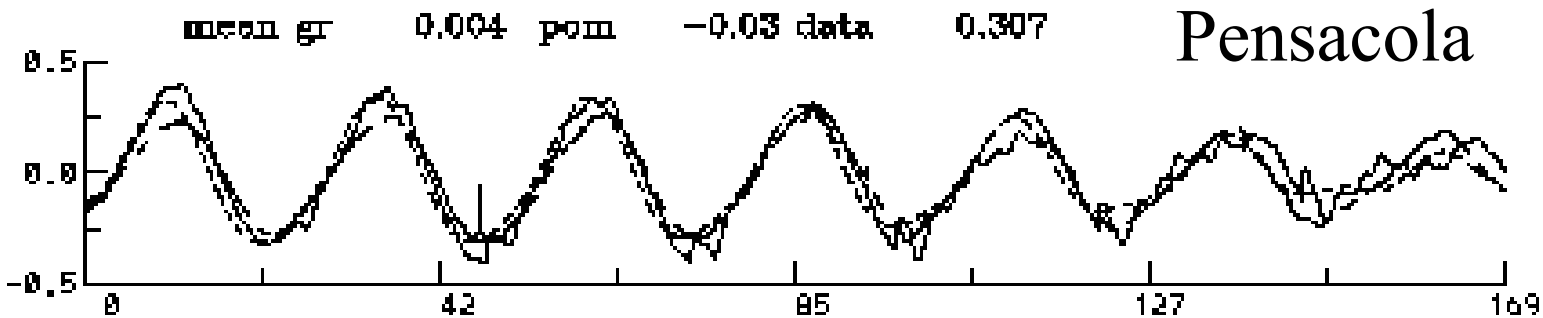
Grazie NOAA!!!

Tides (model data comparison)

Pearl Harbor

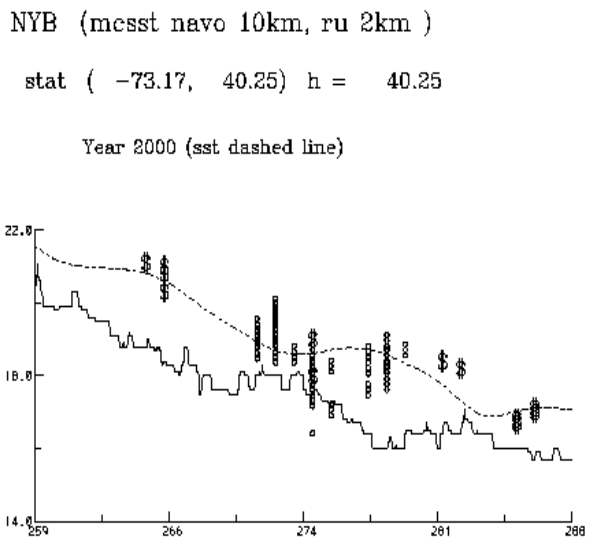


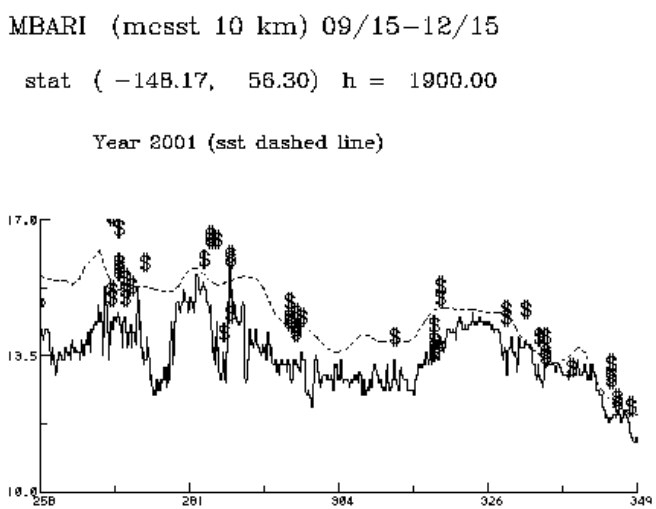
Pensacola



EVALUATION

- Products are as good as the ingested ‘data’





Data-Data comparison

- Mismatch between the ***skin*** temperature measured by satellites and the ***bulk*** (***SST*** for the modelers) temperature beneath
- Mismatch appears more severe in
  - cooling seasons
  - shallow/coastal areas

Comparison @ NYB

	Buoy	**MODAS-2d**	**NCOM**
Mean	18.59	19.31	19.60
Minimum	16.50	17.23	17.30
Maximum	21.20	21.72	21.77
St. Dev.	1.74	1.77	1.68

	Buoy/ MODAS2D	**Buoy/ NCOM**	**MODAS2/ NCOM**
Mean error	-0.72	-1.01	-0.29
Max. error	-1.52	-2.18	-1.29
Correlation	0.98	0.97	0.98
St. Dev.	0.36	0.44	0.36

CONCLUSIONS

- MODAS-NRLPOM a rapidly-relocatable, user-friendly real-time prediction system with a comprehensive physics.
- Difficulty of managing potential problems during the configuration (Gui interface)
- Difficulty of model evaluation to correct model calibration during real-time exercises