Harvard Ocean Prediction System (HOPS) Technical Overview

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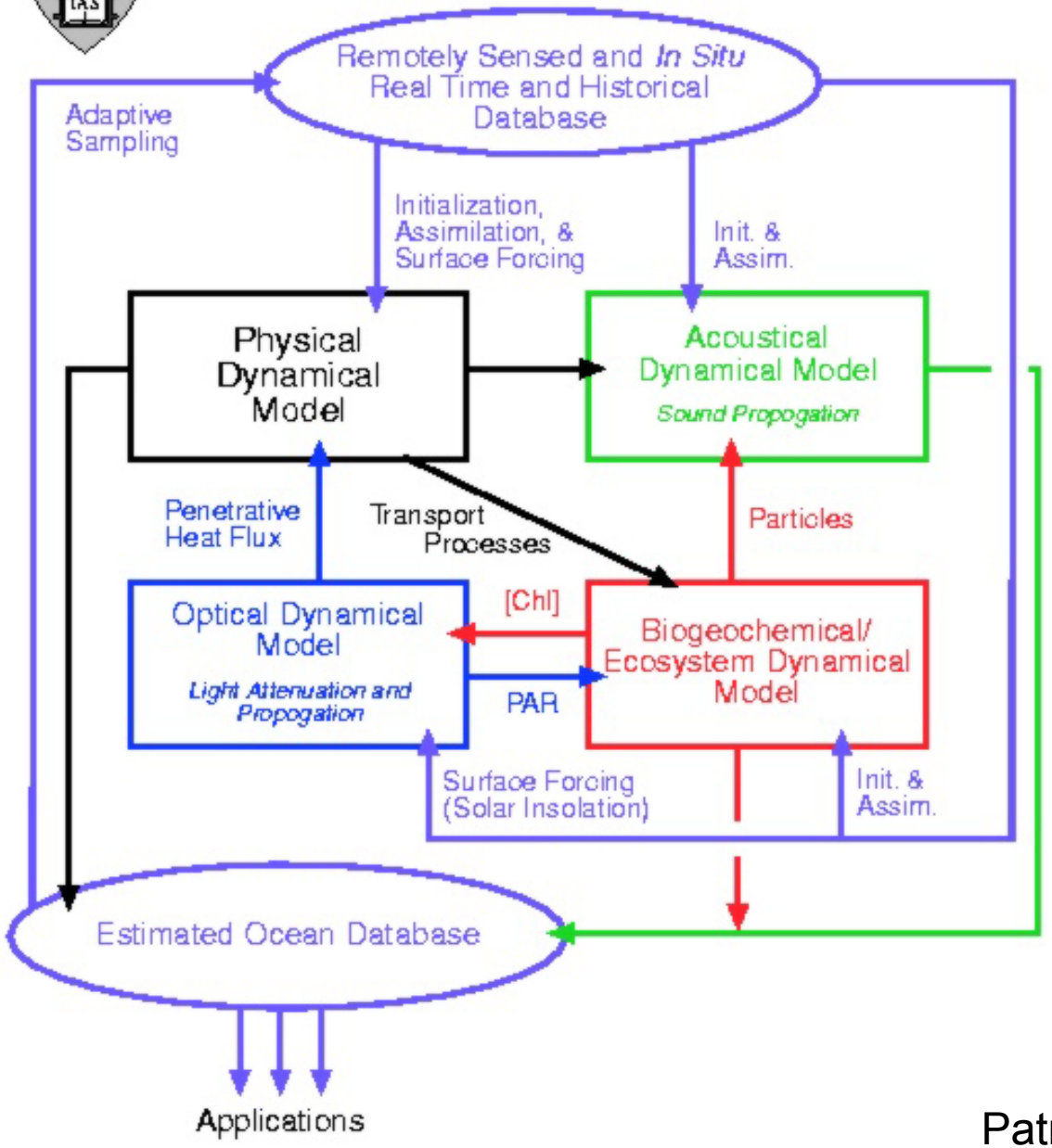
HARVARD OCEAN PREDICTION SYSTEM - HOPS



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HOPS Modules

- **Core**
  - Domain Set-Up
    - Domain Definition
    - Topography Conditioning
  - Data Manipulation
    - Conversion
    - Quality Control
  - Data Preparation
    - Mapping (Objective Analysis)
    - Preparation for Model Ingestion
  - Dynamical Model
    - Primitive Equation
      - Terrain Following Coordinates
      - Data Assimilation (OI)
      - Biological Models
      - 2-way Nesting
      - External Forcing (atmospheric, tidal, river)
- **Additional**
  - Error Sub-Space Statistical Estimation (ESSE) Data Assimilation
  - Multi-Scale Energy and Vorticity Analysis (MS-EVA)
- **Up and Coming**
  - Free Surface

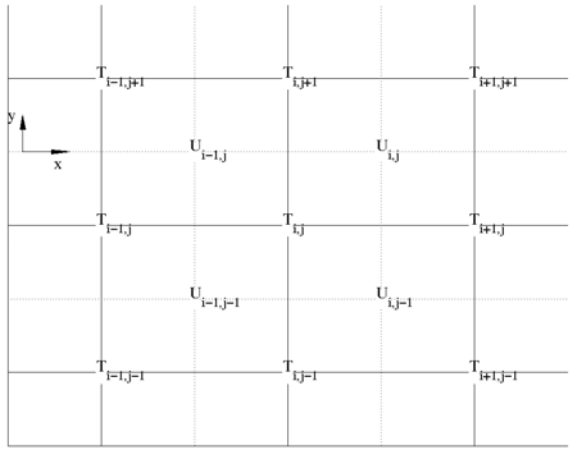
HOPS PE Model

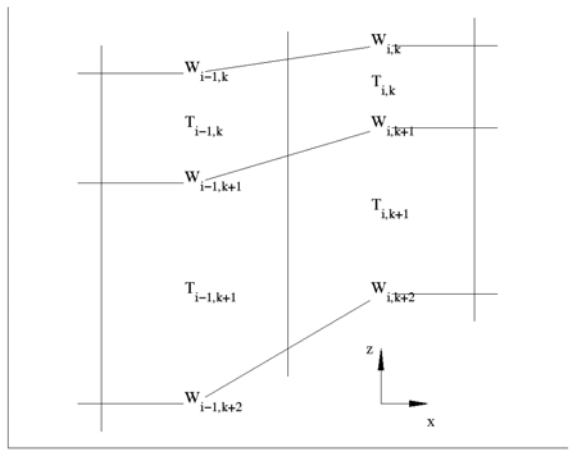
Based on GFDL Bryan & Cox

- Arakawa B-Grid
  - o 2nd order finite difference
- Leap Frog Time Stepping

Additions

- Open Boundary Conditions
- Shapiro Filter Subgrid Scale Parameterization
- Terrain Following Coordinates
  - o σ, hybrid, 2-σ
  - o robust pressure gradient algorithm
- OI Assimilation
- 2-way Nesting
- External Forcing (atmospheric, tidal, river)
- Coupled Biological Models





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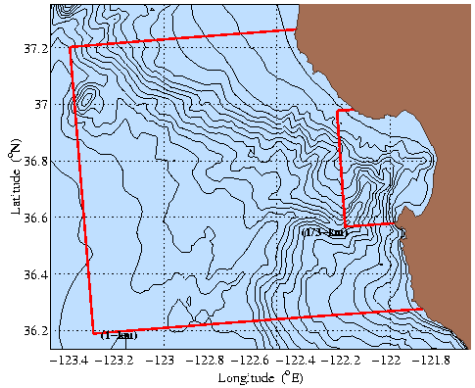
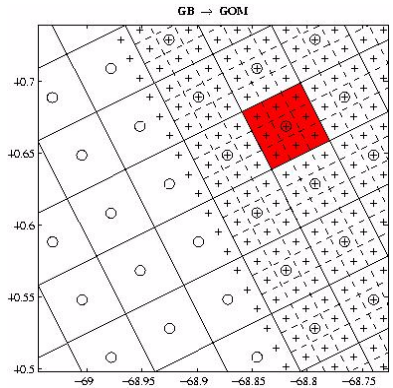
2-Way Nesting

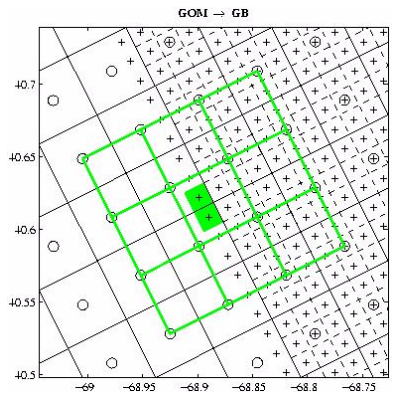
- **At each time step, independent estimates are made in each domain.**
- **Nesting algorithm "aligns" the estimates at each time step.**

- **Fine grid data is averaged to update coarse grid estimates.**
  - Collocation simplifies navigation between coarse nodes and supporting fine grid nodes.
  - 3:1 ratio for scale matching

- **Coarse grid data is interpolated onto fine grid boundaries**
  - Bi-Cubic interpolation. Compromise between:
    - Smoothness across coarse grid boundaries
    - "Footprint" of the interpolation







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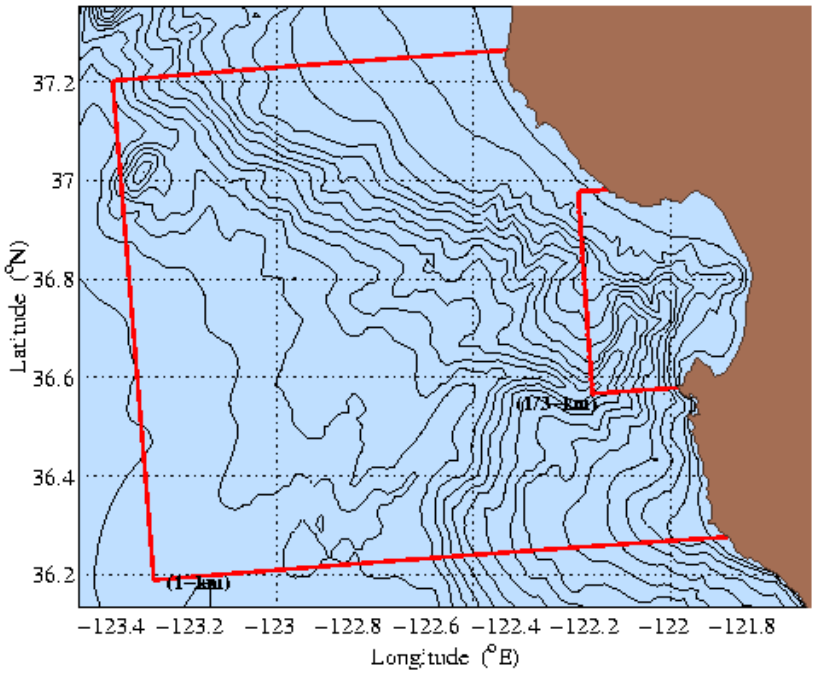
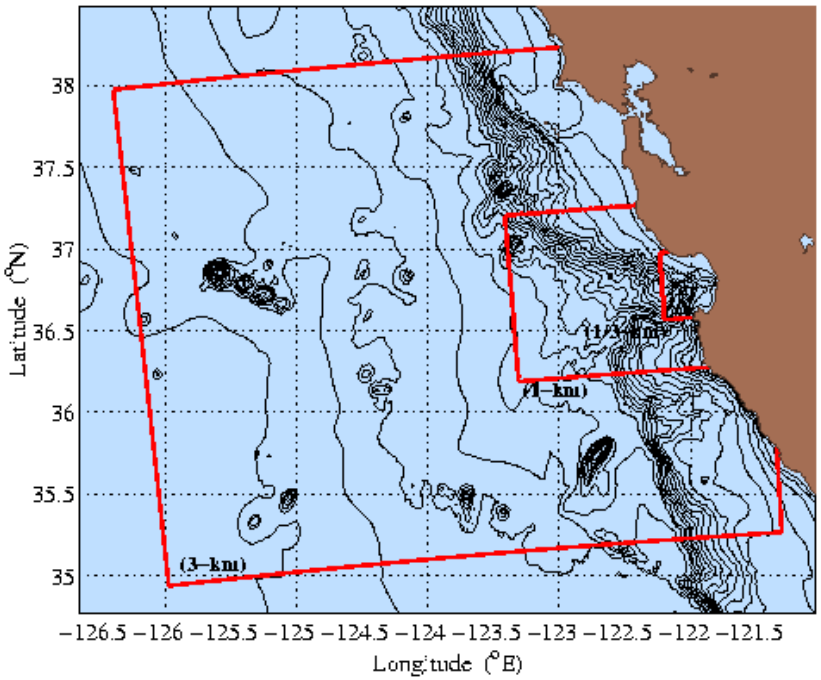
Focus Domains



Support Domains



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Issues

- **Set Up**
  - Domain Set-Up
    - Baseline Topography
  - Process Selection
    - California Current Influence
    - Rivers
    - Tides
- **OSSE**
  - Domain Set-Up
    - Domain Definitions
      - Extents
      - Resolutions
      - Vertical Distributions
    - Topography Conditioning
  - Model Tuning
    - Parameters
    - Assimilation Methodology