

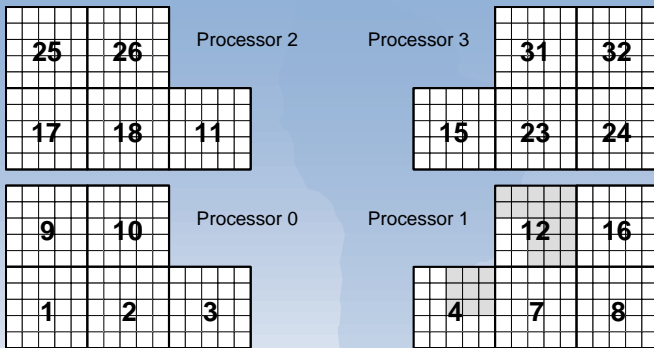
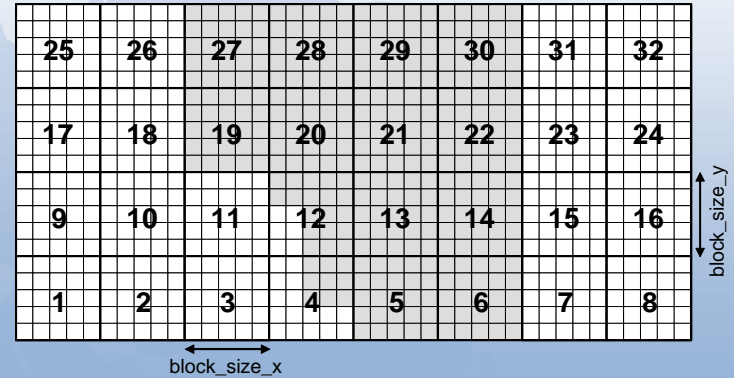
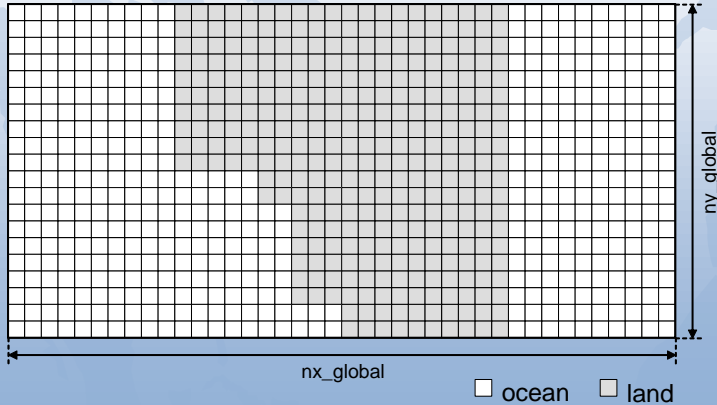
# POP2, POP3, HYPOP

Phil Jones

# Infrastructure Errors and Deficiencies (IEDs) and the Surge



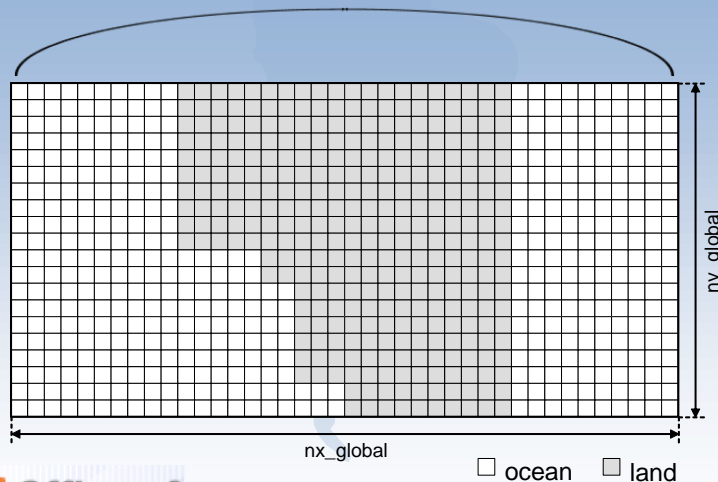
# POP Infrastructure



Load balancing  
Land point elim.  
Cache blocking  
Hybrid parallel

- Problem with E-W, N-S optimization
- Do corners separately
- Bundle messages
- More friendly to unstructured grids

# Tripole Changes



- Communicated with all domains across top
  - Padding
  - Now only few nbr blocks
- $2N^2$  search on initialization
  - Now  $2N$
  - Save some nbr info
- Better Armor
  - Vetting the vetters
- Performance

# Benchmarks for Withdrawal

- Surge for merge
- Incremental Remap advection
- New error handling
  - More component friendly
- New naming conventions
- Better encapsulation
  - Argument lists
  - Get/Put functions
- Better build
- Public subversion repo
- Trac for bug/feature tracking

# Hybridization of POP (HYPOP)

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Beth Wingate

# Three Way Cross Hybrid

- Hybrid Momentum/Tracer
  - Eulerian momentum
  - Lagrangian Tracer
- Hybrid Tracer grid
  - ALE, Isopycnal/Eulerian target
- Bred from POP
- High performance
  - High torque for acceleration



Zeedonk

# Hybrid Eulerian/Lagrangian

- Eulerian Z a “natural” momentum vertical coord
  - Pressure gradient
  - Boundary conditions simpler
  - Long evolutionary history: Re-use much of POP code, including barotropic splitting
- Lagrangian more “natural” for tracers and continuity
  - Eliminate undesirable mixing traits
  - Eliminates much complexity (e.g. G-M)
  - Advection easier to implement (2-d incremental remap) and must be monotone



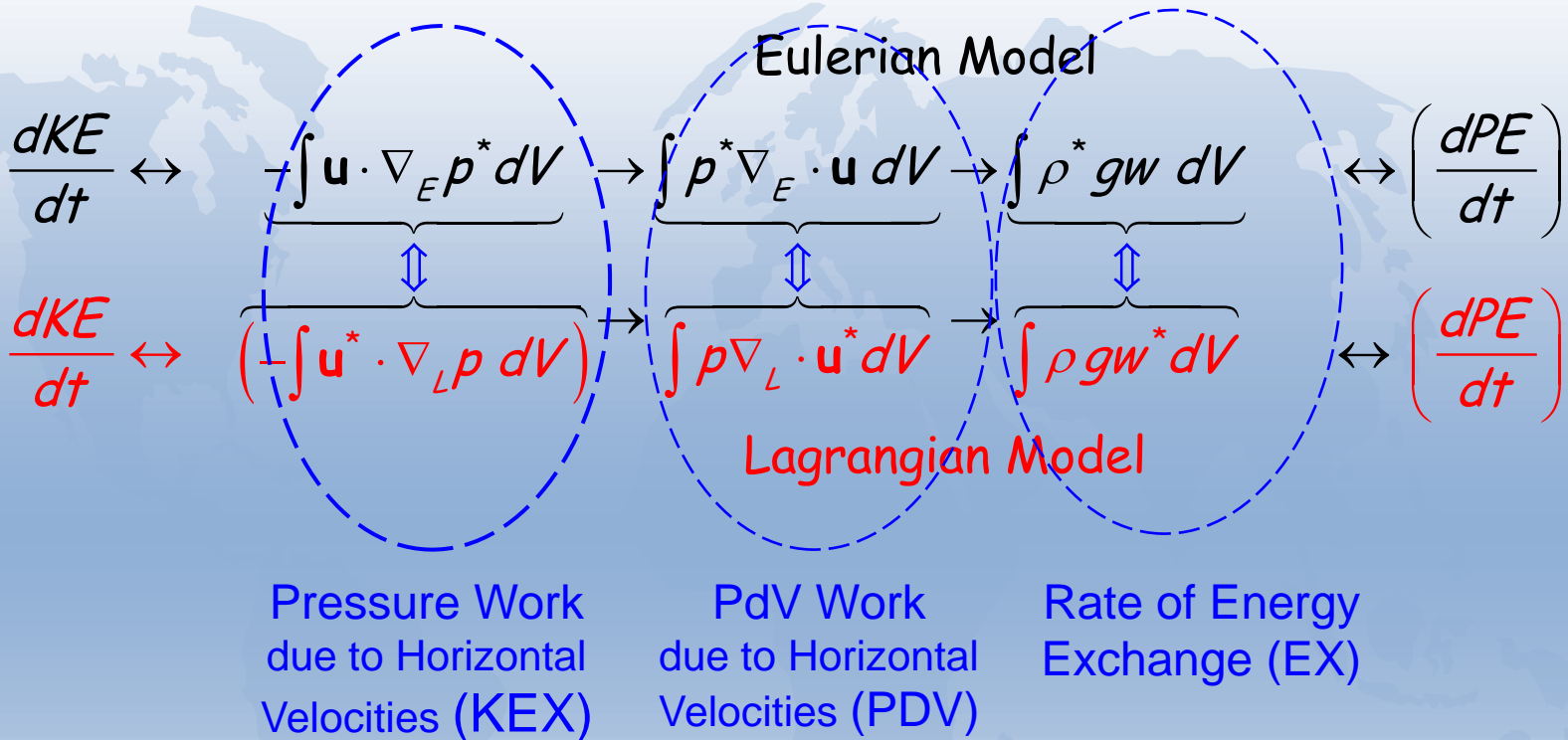
# Hybrid operation

$$\frac{\partial h}{\partial \tilde{t}} + \tilde{\nabla} \cdot (h\mathbf{u}^*) = 0, \quad \frac{\partial h\Theta}{\partial \tilde{t}} + \tilde{\nabla} \cdot (h\mathbf{u}^*)\Theta = 0, \quad \frac{\partial hS}{\partial \tilde{t}} + \tilde{\nabla} \cdot (h\mathbf{u}^*)S = 0$$

$$\rho_0 \left( \frac{\partial \mathbf{u}}{\partial t} + \nabla_3 \cdot \mathbf{u}_3 \mathbf{u} + f\mathbf{k} \times \mathbf{u} \right) = -\nabla p^* + \mathbf{F}_u$$

- Grafting p,u into pure lines
  - Momentum uses interpolated pressure from Lagrangian grid
  - Tracers use interpolated velocity from Eulerian grid

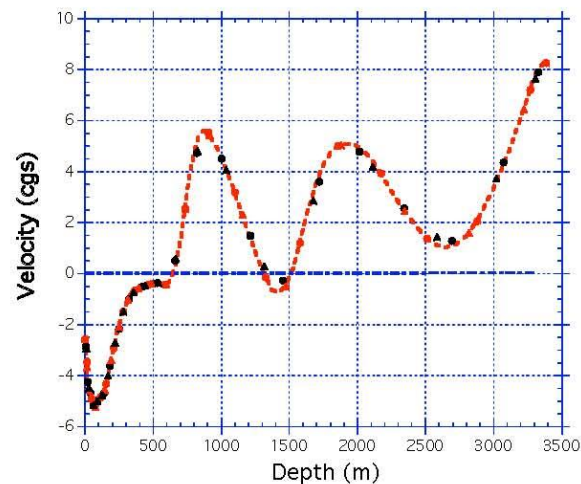
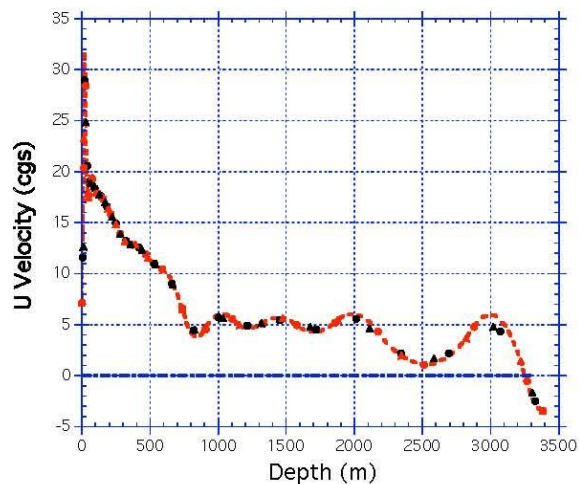
# Energetic Consistency



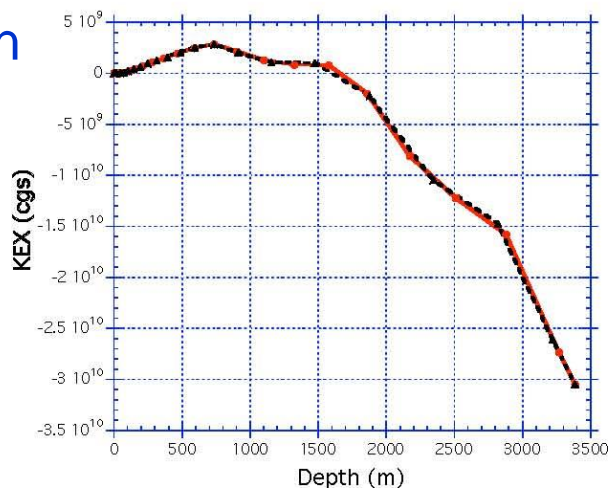
Ideally:  $EX_E = -KEX_E = PDV_E = PDV_L = -KEX_L = EX_L$

- Interpolate pressure and get velocity interpolation
  - Pressure from hydrostatic relation
  - Quad. Splines, max smoothness for interface  $u$
  - Constrained least-squares for Lag. Mean  $u^*$

# Results



Triangles are  
interpolated velocities on  
Lagrangian grid  
Circles are Eulerian  
velocities



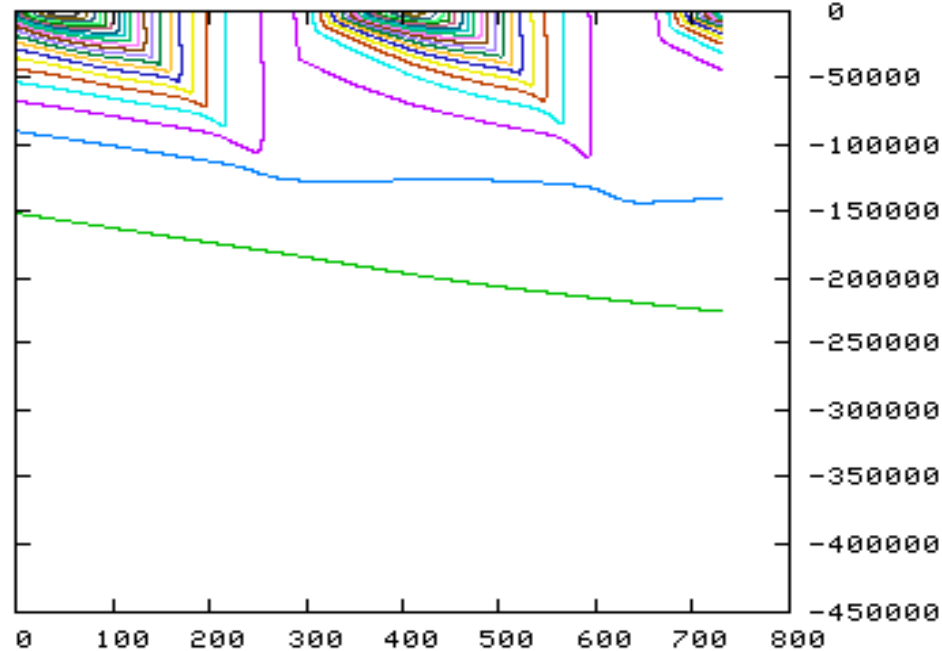
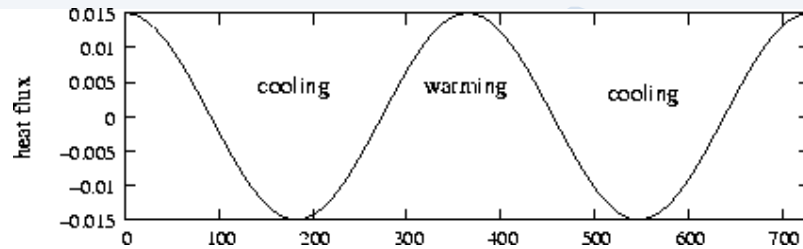
Column (6,20)

# Hybrid Arbitrary Lagrangian-Eulerian (ALE)

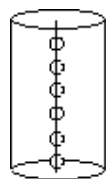
- Solution advanced on Lagrangian grid
- Periodic regridding to desired target
- Goals for target
  - Resolve mixed layer (Eulerian)
  - Resolve, better represent mixing deep ocean (Lag)
- Factors
  - Number of levels/layers
  - Choice of targets
  - T,S profile
  - Minimize arbitrary regridding

Smooth grid spacings

# Vertical coordinate unit test



- 1.037300
- 1.037250
- 1.037200
- 1.037150
- 1.037100
- 1.037050
- 1.037000
- 1.036950
- 1.036900
- 1.036850
- 1.036800
- 1.036750
- 1.036700
- 1.036650
- 1.036600
- 1.036550
- 1.036500
- 1.036450
- 1.036400
- 1.036350
- 1.036300



$t=0$

apply  
surface  
heat flux

use kpp to compute  
vertical diffusivity

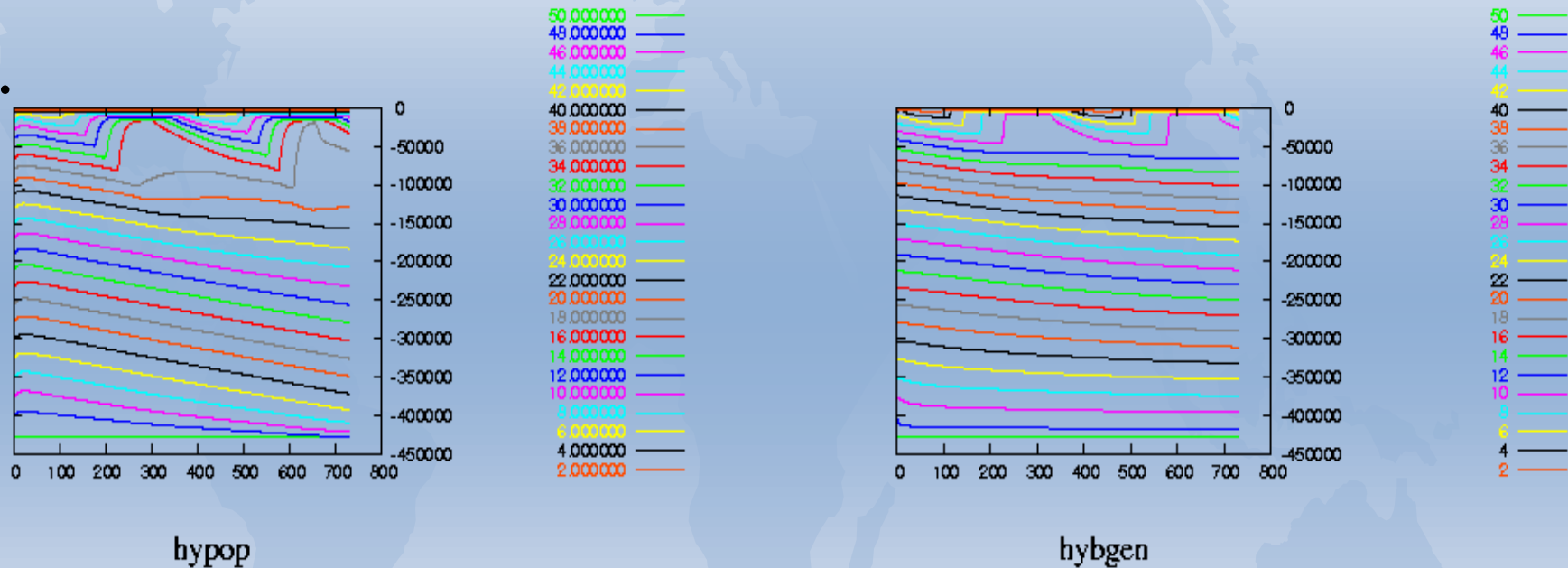
solve one-dimensional  
diffusion equation  
for tracers

regrid  
remap



# Minimum Layer Thickness

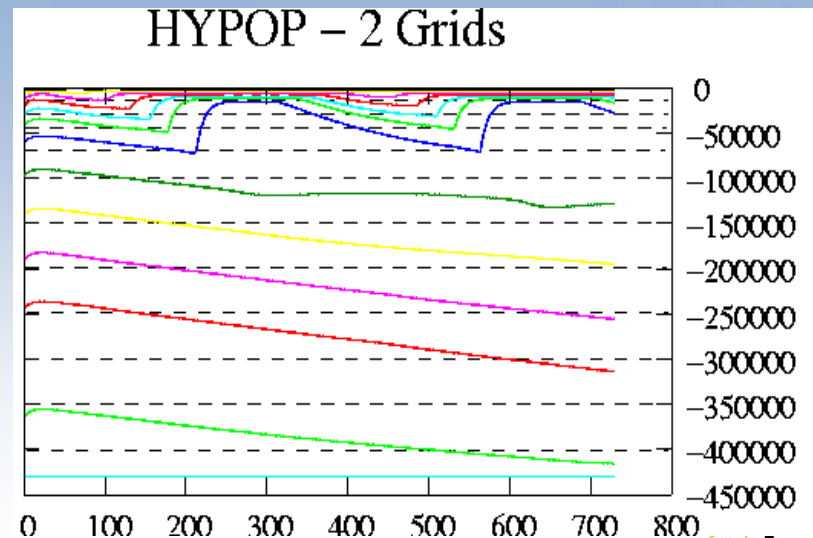
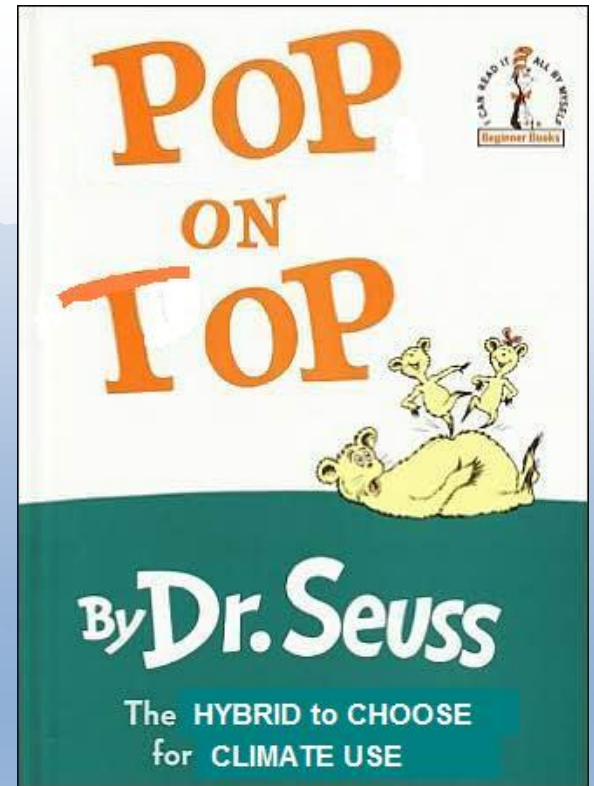
Figure 4 – sharp target distribution  
Coordinate surfaces plotted in z coordinates



Differences related to relaxation  
Large variation in thickness causes problems w/ KPP  
Less physical

# POP on Top

- Use POP-like variable grid near sfc
  - Use momentum grid
- Stay Lagrangian deep
- Make transition at physical depth
  - MLD, thermocline, pycnocline
  - Better resolution at transition



# Current Status

- HYPOP working in pure POP mode
  - 2 identical Eulerian grids
- HYPOP working with 2 different Eulerian grids
- Currently testing full ALE in POP mode (always remapping back to Eulerian)
- Experiment with other possible vertical grids
- Evaluating new 2 time level schemes to replace leap frog
- Evolutionary development

Eliminate sterile hybrids