MPAS-O Update 2015

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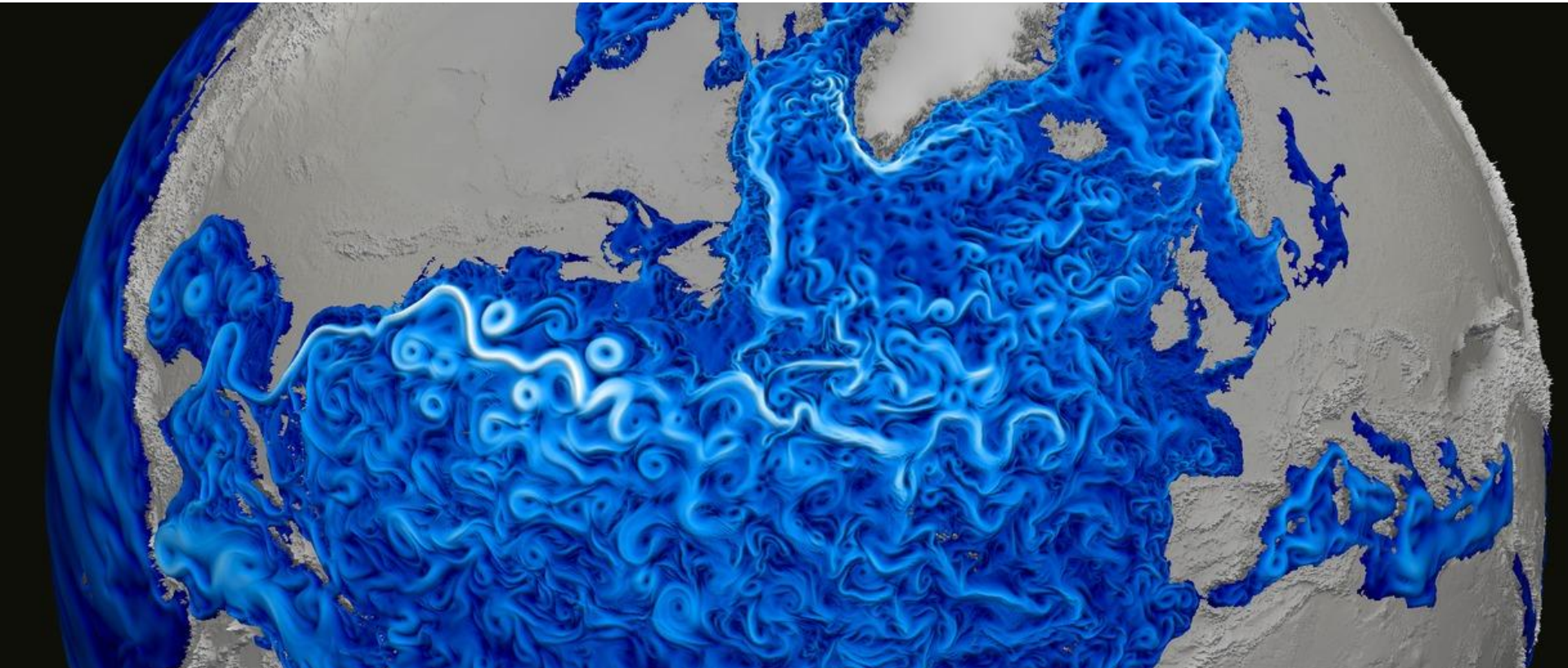
MPAS-Ocean, kinetic energy: 15km North Atlantic regional mesh, within 75km global.



Topics to discuss

- 2014 Accomplishments
  - Version 3 Release (November 2014) Included:
    - New Data Structures
    - I/O Streams*
    - GM
    - CVMix
    - Analysis members*
  - Paper (Vertical Coordinate, in Ocean Modelling)
- New Grids
- Coupled C-Compset runs
- Performance
- 3D Overflow

Release v3.0

v3.0 was released November 18th 2014.

This release brought with it some major framework modifications, and some ocean modifications, including:

- Completely new data structures (pools)
- An entirely new I/O configuration method (streams)
- The addition of some new ocean parameterizations (GM, CVMix)
- An ocean analysis run mode

Streams

One of the major additions in v3.0 was the inclusion of our new flexible run-time configurable I/O method.

All MPAS cores now support the ability to have multiple I/O streams. A stream is defined by:

- A unique name (identifier)
- A type (input, output, input;output, none)
- A frequency of input and output
- A frequency of new file creation
- A reference time defining when file breaks occur
- A list of fields to be “handled”
- If the stream is mutable or not

Streams

Stream attributes are:

- name -- Specifies the unique identifier for this stream
- type -- Specifies the “type” or “direction” of the stream
- reference_time -- Specifies an arbitrary time where a file break should occur
- filename_template -- Specifies a path and template for files this stream should refer to, can expand a filename using the following variables given a time stamp.
  - $Y -- Year
  - $M -- Month
  - $D -- Day of month
  - $d -- Day of year
  - $h -- Hour
  - $m -- Minute
  - $s -- Second
- filename_interval -- Specifies a time interval between file breaks
- precision -- Precision of the fields in the files
- clobber_mode -- Defines how to handle files that exist (when writing a stream)
- {input,output}_interval -- Defines the interval for how often a stream should be handled

Streams

The configuration occurs in a run-time specified XML file.

For example, an immutable restart stream might show up as:

```
<immutable_stream name="restart"
                  type="input;output"
                  filename_template="restarts/restart.$Y-$M-$D_$h.$m.$s.nc"
                  filename_interval="output_interval"
                  reference_time="0000-01-01_00:00:00"
                  clobber_mode="truncate"
                  input_interval="initial_only"
                  output_interval="0005_00:00:00"/>
```

Streams

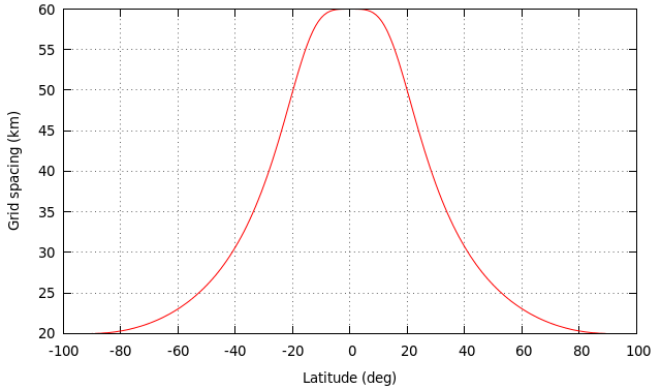
An example of a mutable stream is:

```
<stream name="output"
        type="output"
        filename_template="output/output.$Y-$M-$D_$h.$m.$s.nc"
        filename_interval="01-00-00_00:00:00"
        reference_time="0000-01-01_00:00:00"
        precision="double"
        clobber_mode="truncate"
        output_interval="0001_00:00:00">

    <stream name="mesh"/>
    <var_struct name="diagnostics"/>
    <var_array name="tracers"/>
    <var name="layerThickness"/>
    <var name="ssh"/>
    <var name="xtime"/>
    <var name="kineticEnergyCell"/>
</stream>
```

Grids

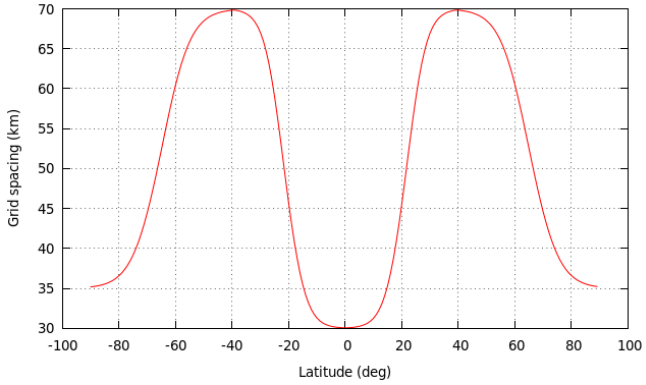
Rossby Radius Scaling Mesh



Target Mesh Resolutions:

- 5km to 15km
- 10km to 30km
- 20km to 60km

Eddy Closure Mesh

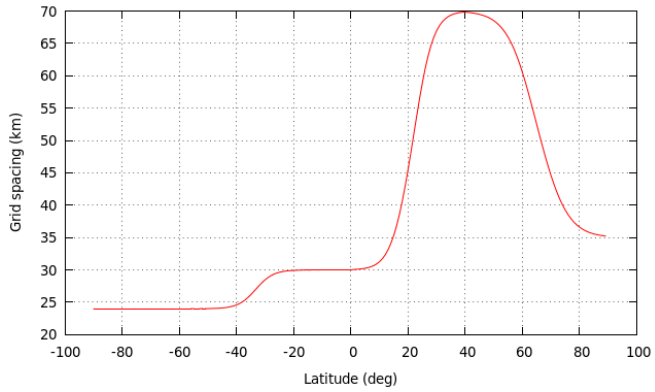


Target Mesh Resolutions:

- 30km to 70km
- 60km to 140km
- 120km to 280km

Grids

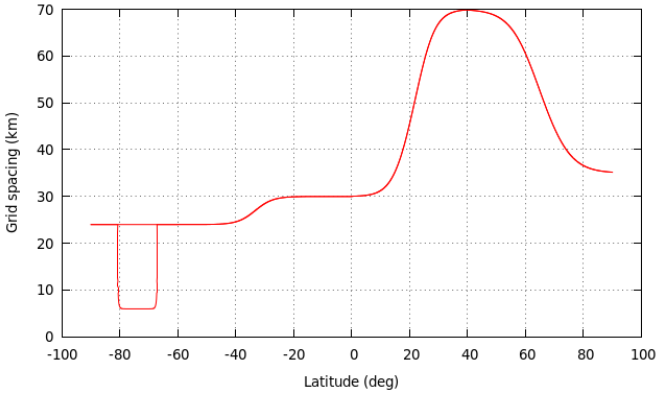
Southern Ocean Enhanced Mesh



Target Mesh Resolutions:

- 70km to 24km
- 70km to 12km
- 70km to 6km

Southern Ocean Enhanced Mesh With Embayments



Target Mesh Resolutions:

- 70km to 24km to 6km
- 70km to 12km to 3km
- 70km to 6km to 1.5km

CORE-Forced Simulations

CORE (Coordinated Ocean-ice Reference Experiments)

- Target mesh: Eddy Closure 60-30km
- Normal year forcing (CORE-I), compare to Griffies et al. (2009)
- Inter-annual forcing (CORE-II), compare to Danabasoglu et al. (2014)
- Forcing data sets provided within CESM, C-Comp set
- MPAS-Ocean is now coupled within ACME, with data sea-ice.
- Initial tests have run out for a decade
- Plan: conduct MPAS-O validation studies with CORE forcing this year

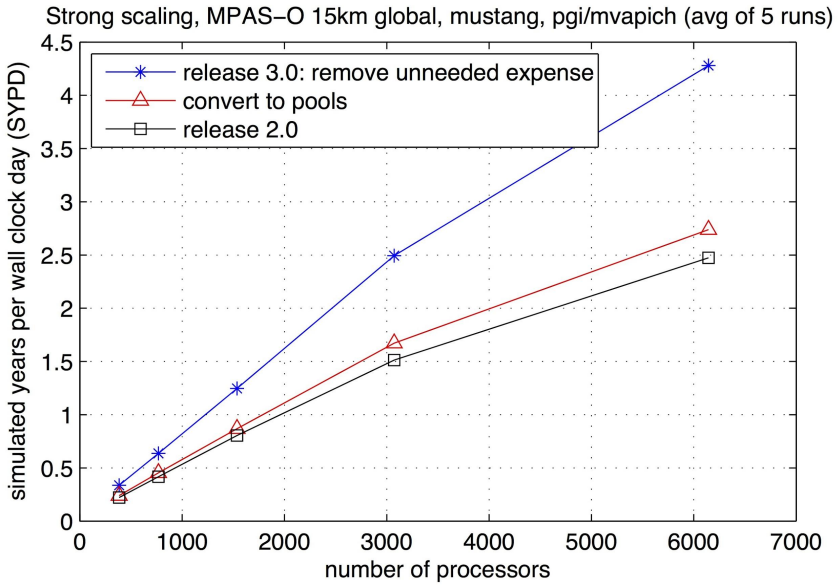
MPAS-Ocean Analysis Capabilities

Problem: Our ability to produce data is outstripping our ability to manipulate and analyze this data.

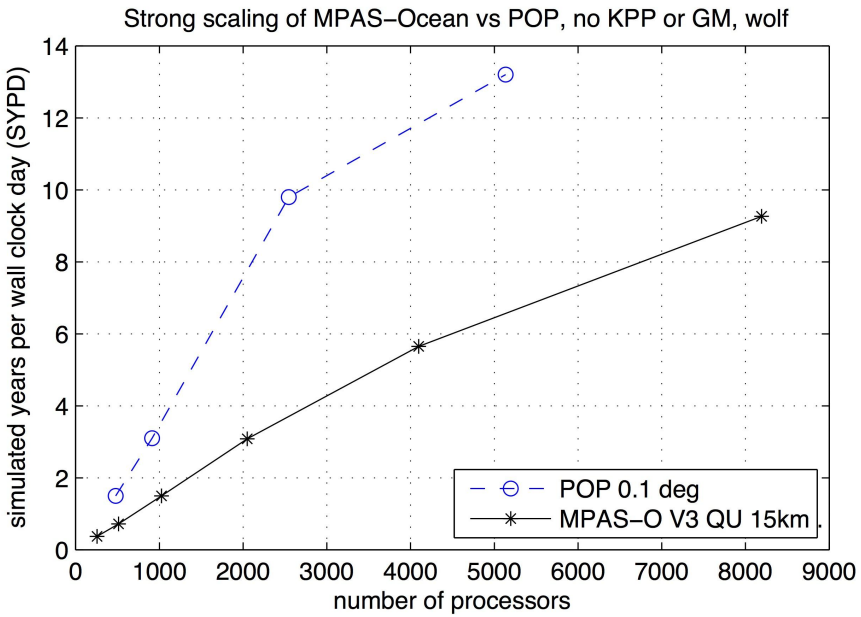
Solution: Analysis tools fully integrated into the model, that may be applied in-situ (*forward mode*) or post-processing (*analysis mode*).

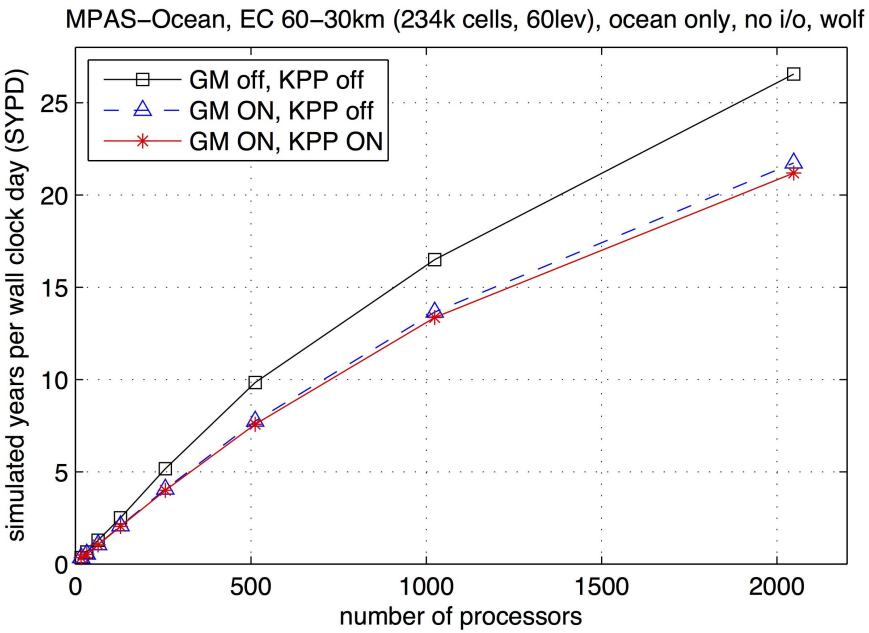
- Analysis members written within MPAS, using native variables, operators, decomposition, i/o.
- Analysis is fully parallelized, scales with code.
- Each analysis member is a separate module, begun from a template.
- Easy for MPAS users to contribute analysis tools back to released code through repository tools, using pull request and review.
- Once approved, new analysis members will be maintained and distributed with future releases.
- In MPAS Version 3. More analysis members will be developed this year.

Performance



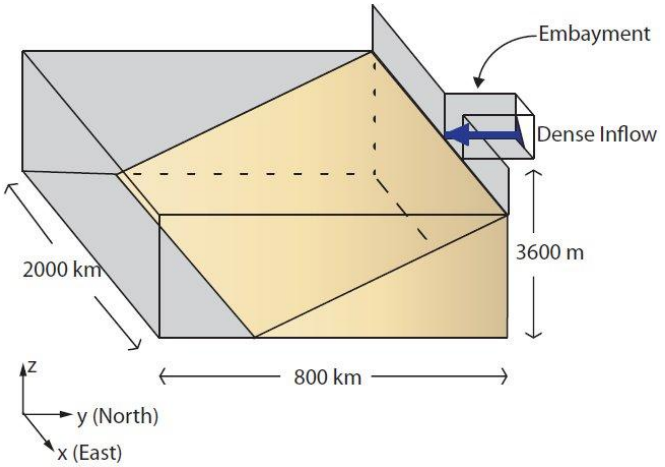
- MPAS-O version 2 to 3: doubling of speed
- MPAS-O 15km half as fast as POP 0.1 deg
- Evidence with SOMA test case that MPAS-Ocean quality is similar to POP at 2-4x the grid-cell size.
- GM adds 20%, KPP adds <3% in run time.
- MPAS-O scales well to thousands of processors

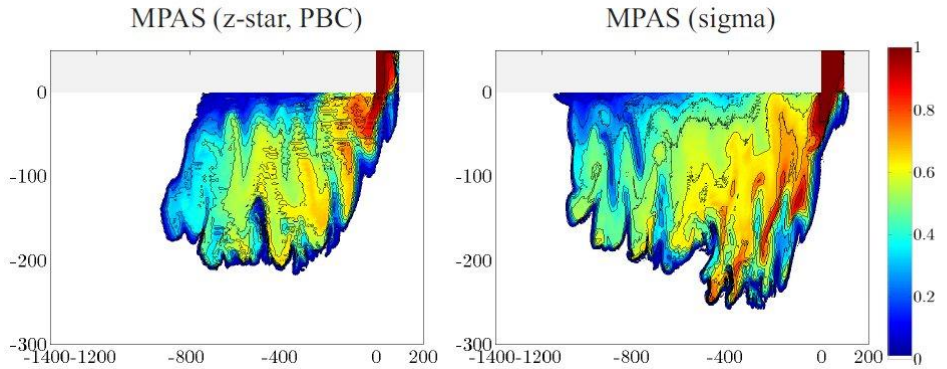


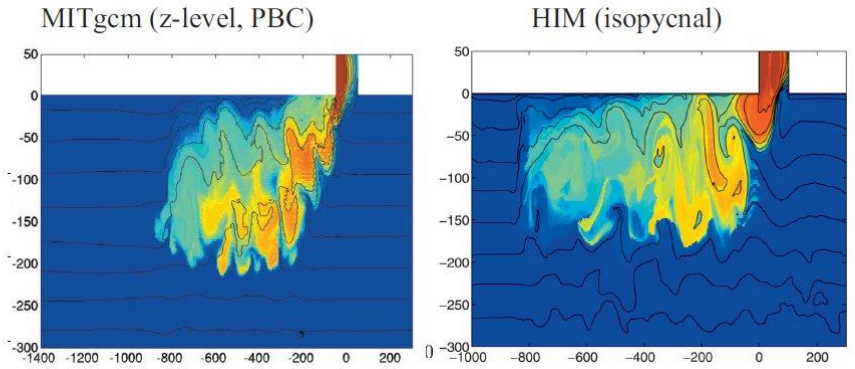


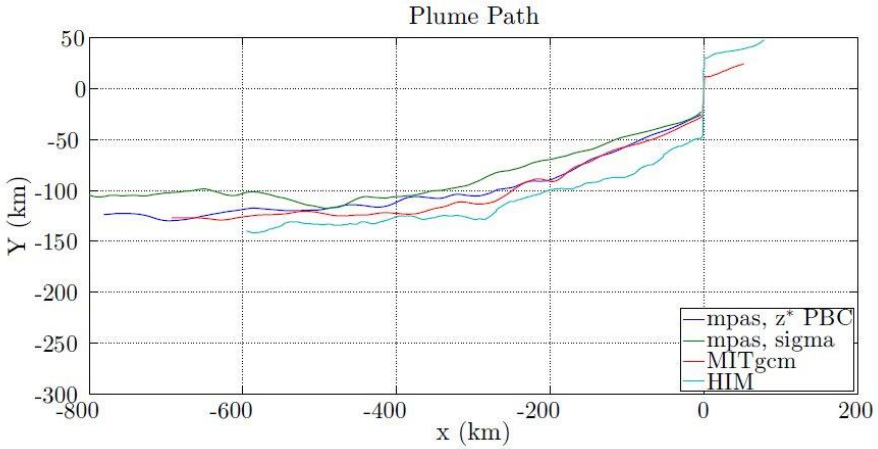
3D Overflow Simulations

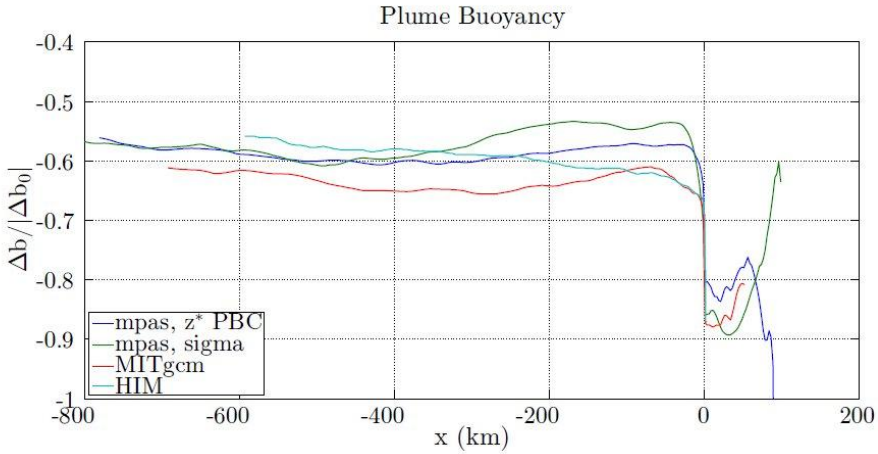
- With Shanon Reckinger and Scott Reckinger
- DOME configuration: Legg et al (2006, 2009)
- Study of vertical coordinate and resolution











The End

Thanks!

Any Questions?