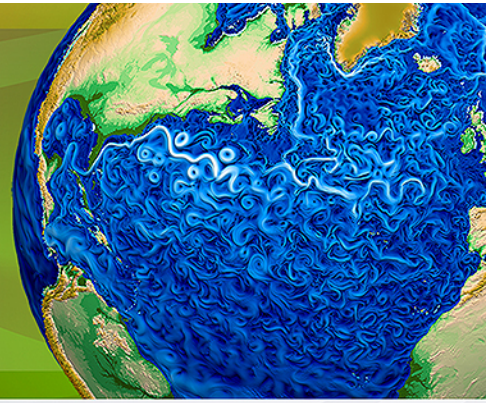
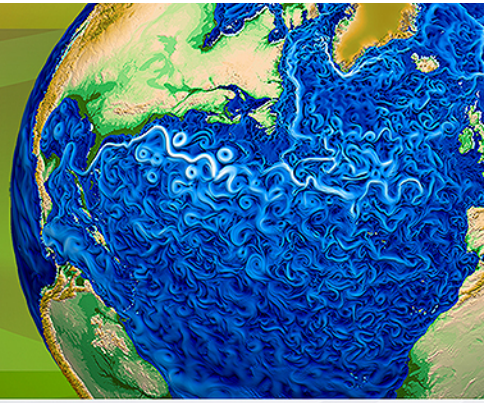


Guardians of the ACME
and
Only YOU Can Prevent Performance Fires

Phil Jones
On behalf of the Performance Team

ACME All-Hands
June 2017

ACME
Accelerated Climate Modeling for Energy



Guardians of the ACME

U.S. DEPARTMENT OF ENERGY

I am groot

- I am groot
  - I am groot
  - I am groot
- I am groot
  - I am groot
    - I am groot

Performance Group Roles

- Hero role: v1 support
  - POCs, SEs, Coupled Group
  - Fixing bugs
  - PE Layouts, PIO config
- Performance optimization
  - Evaluating and enhancing performance
  - Focus on current sims, current machines
- Preparing for Transition
  - Preventing future disasters
  - Early access
  - Identifying changes needed
  - Prototyping new ideas

- Performance Team
  - Az, Noel, Jayesh, Pat, Phil, Ben, Min
  - ECP/CAAR: Matt N., Sarat, Erich

Hero Contributions

- Machine Specific (POCs)
  - Changes in environment
    - Modules, compilers, etc.
    - Batch systems
  - Sporadic slowdowns Edison
- PE Layouts (next slide)
- Bugs
  - I/O Stack: pio, pnetcdf, netcdf
  - CIME
  - Thread irreproducibility
  - Misc.
- Infrastructure review
- Improved testing coverage
  - Integrators, developers, machines

Biggest weapons/knob

- PE layouts
- See: Benchmark Results and Optimal Layout in Perf Confluence

A_WCYCL2000 ne120_oRRS15 Titan 7448 —

SYPD:	1.41	**Charged CPUHours/SY**	3.9M	**Nodes:**	7448

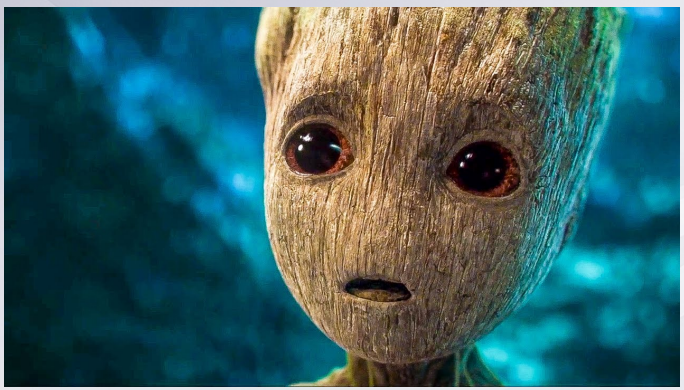
- Caveats:
  - Out-of-box results, YMMV
  - Little/no I/O, YMMV
  - Sometimes outdated
- Default PE layouts
- If you see something, say something
  - Try some tweaks, add your results

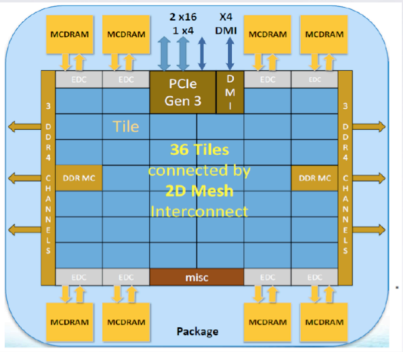
Internal Changes

- Nested threading in atm
- Threading in sea-ice
- CLUBB optimizations
- Atmospheric physics load balancing
- Improvements to initialization
  - Communication algorithms

Preparing for Next Generation

- Nested threading, improved threading, affinity
- GPU acceleration
  - superparameterization
- Vectorization
- Integrated projects
  - ECP
  - CAAR, NESAP
  - CMDV
  - SciDAC
- Significant code refactoring
- All above likely to be 2x-3x range.
- Need algorithm changes, new ideas





KNL: 68 cores, 272 threads, Vector units, high-bandwidth memory

GPU: SIMD cores, separate memory

ARM????

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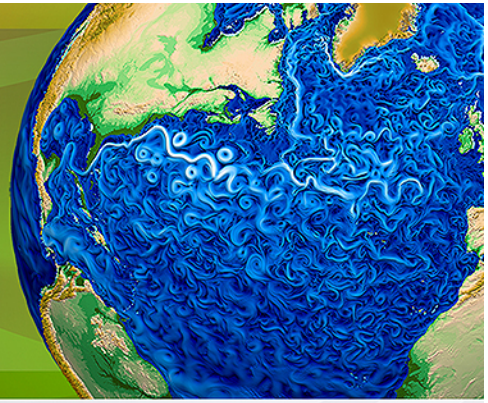

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Triage

- Extreme
  - Preventing high-priority sims
  - Type 1 Incident Response, multi-agency, aircraft, etc.
- Very High
  - Blocking of other sims (esp. high resolution), Substantial reduction in high-priority sim
  - Type 2 Incident Response
- High
  - Significant performance hit
  - Hot Shot team
- Moderate
  - Known issue
  - Workaround (containment)
- Low
  - No immediate threat, let burn

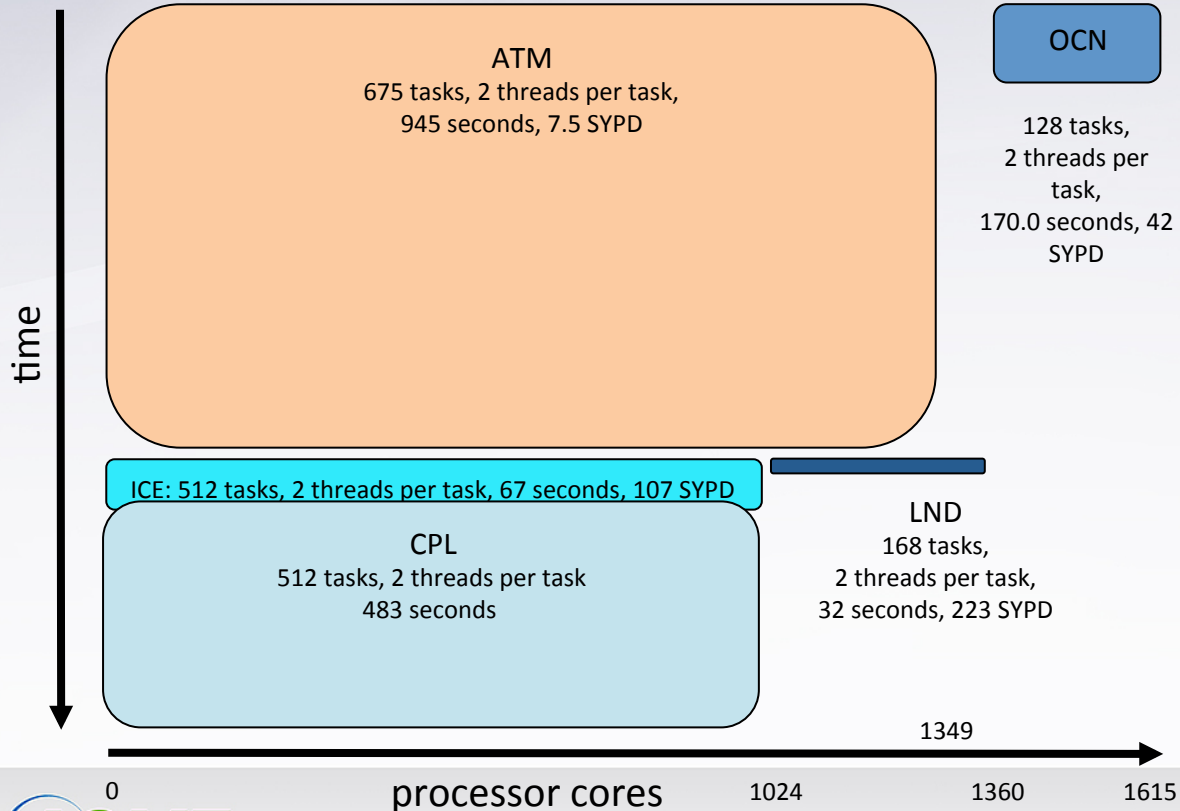
At a minimum

- Look at timing info:

```
 Init Time   :      36.677 seconds
 Run Time    :    1117.133 seconds       37.238 seconds/day
…
    TOT Run Time:    1117.133 seconds       37.238 seconds/mday
6.36 myears/wday
    LND Run Time:      31.850 seconds        1.062 seconds/mday
222.96 myears/wday
    ROF Run Time:       1.150 seconds        0.038 seconds/mday
6175.10 myears/wday
    ICE Run Time:      66.940 seconds        2.231 seconds/mday
106.09 myears/wday
    ATM Run Time:     945.307 seconds       31.510 seconds/mday
7.51 myears/wday
    OCN Run Time:     170.009 seconds        5.667 seconds/mday
41.77 myears/wday
    GLC Run Time:       0.000 seconds        0.000 seconds/mday
0.00 myears/wday
    WAV Run Time:       0.000 seconds        0.000 seconds/mday
0.00 myears/wday
    CPL Run Time:     482.530 seconds       16.084 seconds/mday
14.72 myears/wday
    CPL COMM Time:   1068.084 seconds       35.603 seconds/mday
6.65 myears/wday
```

At a minimum

- Adjust PE layout
- Rules of thumb – see Confluence:
  - How to Create PE Layout in Atm How-to
- But…always exceptions, Edisonian



Climate Exceptionalism

- Climate Lags Others
  - Failing readiness
  - Can’t use GPU or KNL, but at least we scale poorly

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  - Where performance comes from
  - Pros and Cons of abstractions

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- Back in the Day…
  - Where performance comes from
  - Pros and Cons of abstractions
- Everyone must think
  - Performance is MY responsibility


THE
ACME
We are SPARTA! (SuperParameterized ACME
Refactored for Tomorrow's Architectures)