Pleiades and Electra Get Major Operating System Upgrade

- HECC staff upgraded the Pleiades and Electra compute nodes to SUSE Linux Enterprise Server 12, Service Pack 2 (SLES12 SP2), after significant user testing. This replaces SLES11, which was in use for six years with different service packs.
- SLES12 SP2 brings a much newer Linux kernel, version 4.4, which supports kernel updates without rebooting. HECC staff will evaluate this feature with the intent of utilizing it to further minimize downtime and improve security.
- Along with the SLES upgrade, HECC adopted a new software management policy that clarifies how user software requests will be satisfied and when software will be removed. This policy allows more software to be made available to users through third-party projects, such as the NetBSD Packages Collection (pkgsrc), requiring less effort by HECC staff.

**Mission Impact:** Operating system upgrades and new software management policies keep HECC at the forefront of system administration and productivity, providing NASA with an extensive and reliable software environment.

**POCs:** Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division, Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, CSRA, LLC
I/O Improvement Delivers 120x Checkpoint Speedup, Accelerates User Code

- HECC systems staff actively monitor the health of the shared Lustre filesystems. Recently, they identified a user’s Lattice Boltzmann Method (LBM) code as the cause of intermittent high loads on one of the Lustre filesystems.
- Experts from the Application Performance and Productivity group analyzed the I/O patterns of the LBM with their in-house mpiprof and licensed IOT tools, and found that the high loads were caused by all MPI ranks reading or writing to large, shared checkpoint files with a single stripe.
- By increasing the stripe count from 1 to 32, the checkpointing time dropped from 20 minutes to ~10 seconds for the 1036-rank production cases—a 120x speedup. In addition, the Lustre contention was greatly reduced improving performance for all users accessing that file system.
- The LBM code is used in support of ARMD’s High-Fidelity Modeling of Multi-Rotor Flows Project to perform pilot studies of rotational blade geometries.

Mission Impact: I/O performance improvements provided by HECC applications experts greatly reduce the time-to-solution of simulations and enables faster development work by scientists.

An unmanned aerial vehicle (UAV) known as SUI Endurance, with the T-Motor 15x5 propellers. NASA Ames researcher Patricia Ventura uses a Lattice Boltzmann Method code to study the performance of the propeller at different rotational velocities. HECC applications experts provided Ventura with two optional methods for improving code performance.

POC: Sherry Chang, sherry.chang@nasa.gov, (650) 604-1272, NASA Advanced Supercomputing (NAS) Division, CSRA LLC
HECC Network Engineers Work with JSC to Improve Data Transfer Rates Between Sites

- HECC network engineers detected suboptimal transfer speeds from the JSC AeroLab to the NAS facility across a 2x1-gigabit (Gb) Ethernet link. These links were later upgraded to a 1x10 Gb link with a software limit of 2 Gb.
- Before the upgrade, throughput for single- and multi-stream transfers averaged 125 Mbps, depending on the protocol used and the data transfer method.
- The network team worked with JSC engineers to tune TCP window sizes and network stack for AeroLab hosts and upgrade links, resulting in throughput speeds up to 1.5 Gb/s for the bbSCP transfer method and 1.2 Gbps for the rsync method—about a 10x performance improvement.
- By actively working with JSC engineers, the HECC team identified areas where we can improve the network and help the users understand the most effective way to use different file transfer tools.

**Mission Impact:** By taking responsibility for network problems end-to-end, HECC network engineers ensure that users are provided optimal network performance to efficiently move large amounts of scientific data into and out of the NAS facility.

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**POCs:** Chad Narvasa, chad.narvasa@nasa.gov, (650) 604-4852, Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, NASA Advanced Supercomputing Division, CSRA LLC

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This chart shows data transfer rates (throughput) and the number of parallel streams for a single transfer between Johnson Space Center and NASA Ames using the bbFTP utility. HECC engineers achieved end-to-end performance tuning by adjusting the TCP window size (represented by each line on the graph.) TCP window size is simply the amount of data in bytes that a sender is willing to send at any point in time.
myNAS Principal Investigator (PI) Edition Released to Beta Testers

• The HECC Tools team released a beta version of the myNAS PI website on June 28 to a selected group of test users. The site provides PIs with near-real-time information on jobs across all their GIDs. Job listings can be filtered by users, machines, queues, models, and other parameters. PIs can also view bar and pie charts that show detailed allocation and accounting information at a glance.

• The HECC Application Performance and Productivity team, and the Tools team collaborated to develop the myNAS website, which is hosted on the new portal.nas.nasa.gov server. PIs must authenticate using Launchpad, with either a NASA Smartcard or RSA token to access the site.

• The myNAS website currently utilizes:
  – Eight backend scripts to collect, store, and process job and accounting information from several sources.
  – Five backend API calls to send the data to the myNAS website front end.
  – Ten front-end scripts to display the information in a series of interactive tables and charts.

• After the production release of the PI edition, a version of the myNAS website is planned for individual users.

**Mission Impact:** The myNAS website now provides principal investigators with new tools to analyze and optimize their use of HECC resources.

- myNAS tables list currently running, waiting, held, and recently finished jobs from the user’s GID(s). This screenshot from the finished jobs table highlights jobs that failed, and provides additional information integrated from Lumber analysis.

**POC:** John Hardman, john.hardman@nasa.gov, (650) 604-0417, NASA Advanced Supercomputing Division, CSRA LLC
Tools Team Continues Development and Automation of HECC Tools and Websites

- The HECC Tools team develops and support applications, web tools, and databases that help to automate processes for our HECC team and users. Recent work includes:
  - Continued improvements to the HECC and HEC monthly accounting reports by automating the ongoing setup of the report files.
  - Released the Electra page for the myNAS application and beta release for the myNAS Principal Investigators (PI) version to provide PIs with near-real-time data on their project’s jobs.
  - Released the Remedy workflow for Downtime Processing that automatically notifies affected users about scheduled system downtime and creates outage records for the downtime.
  - Released the RSA Fob Replacement website that allows users to renew their expiring RSA fobs and choose a soft token or physical fob for replacement.
  - Added new features in the Remedy Purchase Request workflow to provide additional request statuses and improve the approval process.
- New projects under development: a Status website for user and staff communication during outages; Modular Supercomputer Facility (MSF) reporting; a Special Access website for requesting elevated privileges; and a Remedy workflow for travel request approval.

**Mission Impact:** HECC applications, web tools, and reports provide NASA users with enhanced accounting and request processes, along with visibility into the performance of their jobs.

**POC:** Mi Young Koo, mi.y.koo@nasa.gov, (650) 604-4528, NASA Supercomputing Division, CSRA LLC
NAS Facility Passes Safety Audit with Flying Colors

- A team from the NASA Ames Occupational Safety, Health, and Medical Services Division (Code QH) conducted a safety audit of all Code TN facilities on the Ames campus.
- The team lead, Ahleah Rohr-Daniel, remarked that she “looks forward to working with Code TN on safety audits because we take safety so seriously.” The audit included a comprehensive review of building N258 and all Code TN-managed areas of N233A.
- Some minor findings were noted during the audit (e.g., a daisy-chained heater), all of which were addressed within a week of the audit.
- The team identified two best practices during the audit:
  - Safety netting keeping items on shelves from falling out in the N258 shipping/receiving area.
  - Pallets of hardware labeled with pertinent information (such as POC, date of removal).
- Running a supercomputing facility involves many potentially hazardous elements, including high voltage, heavy equipment, and construction activities. By making it priority one, HECC continues to demonstrate our commitment to safety.

Mission Impact: Working in a supercomputing environment poses a great number of potential safety hazards. By continually training, documenting, and raising safety awareness with staff, HECC continues to provide a safe working environment to NASA’s most vital assets: its people.

POCs: Ana Grady-Hiser, ana.l.grady-hiser@nasa.gov, (650) 604-4607, NASA Advanced Supercomputing (NAS) Division; Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, NAS Division, CSRA LLC

One of the best practices identified by a safety audit of Code TN facilities: netting was installed to protect people from falling objects in the event of an earthquake.
HECC Successfully Completes Annual Equipment Inventory in 2017

Property custodians responsible for HECC/NAS property completed the 2017 Annual Equipment Inventory of more than 1,300 pieces of decaled equipment with a 99.93% scan rate, an improvement over last year. The audit was completed in early June, three months earlier than in 2016.

- One item was not located. To close out this item, a Property Survey Report (Form NF598) was completed to identify the asset as missing equipment and have it removed from the NASA property database.
- The Property staff’s active tracking and updating of the HECC/NAS data created an efficient and successful inventory. Ongoing tracking and management of equipment during FY17 included:
  - Tagged 171 new pieces of equipment.
  - Excessed 130 pieces of equipment.
  - Closed 442 tickets, most relating to equipment location and ownership updates.

Mission Impact: Accurate tracking of assets through their life cycle and removal of NASA data prior to system disposal ensures control of government equipment and prevents loss of NASA data.

POC: Judy Kohler, judy.j.kohler@nasa.gov, (650) 604-4303, NASA Advanced Supercomputing Division, CSRA LLC

During the annual equipment inventory, HECC property custodians account for all equipment associated with the NASA Advanced Supercomputing (NAS) facility, including all components of the Pleiades supercomputer.
Predictive Modeling for NASA Entry, Descent, and Landing Missions *

- Researchers in NASA’s Entry Systems Modeling (ESM) Project are developing modeling and simulation technologies for new entry, descent, and landing (EDL) concepts, helping to define mission concepts, quantify risk, ensure correct system operation, and analyze data from previous missions.
- Using the Pleiades supercomputer, the ESM team made several key impacts on EDL modeling and simulation in 2016, including:
  - Provided new data on shock layer radiation and updates to the Orion margin policy for Exploration Mission-1, saving significant thermal protection system mass.
  - Demonstrated that infrared radiation from CO₂ could account for the difference between flight data and predictions for the Mars Science Laboratory EDL instrument sensors, which measured the temperatures and atmospheric pressures during entry. Their data provided the justification needed to include a radiometer on the instrument aboard the Mars 2020 entry vehicle.
  - Produced a full, dynamic trajectory-based simulation of an entry body from hypersonic to subsonic flow; results were combined with detailed experimental data to enhance the credibility of CFD for use in analyzing and predicting capsule dynamic stability.

Mission Impact: Entry, descent, and landing modeling and simulation methods have supported NASA missions such as the Mars Science Laboratory, which successfully landed in 2012, and are helping engineers design the thermal protection system for the Orion spacecraft’s upcoming Exploration Mission-1.

* HECC provided supercomputing resources and services in support of this work.

POC: Michael Wright, michael.j.wright@nasa.gov, (650) 604-4210, NASA Ames Research Center

Desktop ballistic range: A visualization of the temperature around a free-flying model tested in the NASA Ames Ballistic Range. The model is allowed to rotate freely according to predicted aerodynamic moments. Observed and simulated flight dynamics are compared in order to validate the computational model. Joe Brock, NASA/Ames
Simulations Improve Understanding of Scramjet Physics, Advance Hypersonic Transportation *

• In scramjet engines, air compression results naturally from a complex system of multiple shock-turbulent boundary layer interactions (“shock train”), where external perturbations can delay ignition and decrease thrust.

• Researchers at the University of Michigan ran direct numerical simulations (DNS) on Pleiades to investigate the impact of static and dynamic inlet boundary layer variations over the shock train. Achievements included:
  - Identified—for the first time—a resonance frequency that could potentially lead to critical engine failure.
  - Used the shock train’s dynamic response to upstream perturbation in the simulation to identify the resonating frequencies that are of critical interest in designing a stable compressor.
  - Investigated a model hydrogen-fueled scramjet combustor coupled with an ab initio comprehensive hypersonic chemistry model, revealing how non-equilibrium thermodynamics is relevant to scramjet engines.

• These large-scale simulations, using computationally expensive numerical models, would not have been possible without the capability provided by HECC.

Mission Impact: Large-scale direct numerical simulations, enabled by the Pleiades supercomputer, are helping researchers improve their understanding of the underlying physics of scramjet engine components and contribute to further development of hypersonic transportation.

POC: Romain Fièvet, rfievet@umich.edu, Venkat Raman, ramanvr@umich.edu, University of Michigan

Video showing 3D views of a supersonic flame in a model hydrogen-fueled scramjet combustor. Romain Fièvet, University of Michigan

* HECC provided supercomputing resources and services in support of this work.
HECC Facility Hosts Several Visitors and Tours in June 2017

- HECC hosted 15 tour groups in June; guests learned about the agency-wide missions being supported by HECC assets, and some groups also viewed the D-Wave 2X quantum computer system. Visitors this month included:
  - Janet Kavandi, Director of Glenn Research Center, along with Deputy Director Marla E. Perez-Davis and Associate Director Janet Watkins.
  - Ludovico Vecchione, Director, Italian Aerospace Research Center.
  - Several visitors from the Naval Post Graduate School, Monterey, CA.
  - Craig Kundrot, Director of Space Life and Physical Sciences Division at NASA Headquarters; and other attendees of the Space Life Physical Sciences Quarterly Review from Jet Propulsion Laboratory, Marshall Space Flight Center, Glenn Research Center, Kennedy Space Center, and Headquarters also visited.
  - Josef Aschbacher, Director of the European Space Agency’s Earth Observation program.
  - 30 interns from the 2017 NASA Ames summer intern program.
  - 25 Howard University Computer Science juniors who are participating in a Google summer program.
  - His Excellency Professor Manuel Heitor, Portugal’s Minister of Science, Technology and Higher Education.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division
Papers

  - "A Comparative Study of Simulated and Measured Main Landing Gear Noise for Large Civil Transports," B. Köing, E. Fares, P. Ravetta, M. Khorrami. *
  - “On the Importance of Spatial Resolution for Flap Side Edge Noise Prediction,” R. Mineck, M. Khorrami. *
  - “Computations of Crossflow Instability in Hypersonic Boundary Layers,” M. Choudhari, F. Li, P. Paredes, L. Duan. *
  - “Stabilization of Hypersonic Boundary Layers by Linear and Nonlinear Optimal Perturbations,” P. Paredes, M. Choudhari, F. Li. *
  - “Identifying Dynamic Modes of Separated Flow Subject to ZNMF-based Control from Surface Pressure Measurements,” E. Deem, et al. *

* HECC provided supercomputing resources and services in support of this work
Papers (cont.)

- **AIAA Aviation Forum (cont.)**
  - "High Ice Water Concentrations in the 19 August 2015 Coastal Mesoconvective System,” F. Proctor, S. Harrah, G. Switzer, J. Strickland, P. Hunt. *
  - “Prediction of Turbulent Temperature Fluctuations in Hot Jets,” J. DeBonis. *
  https://arxiv.org/abs/1706.03784
  https://arxiv.org/abs/1706.04219

* HECC provided supercomputing resources and services in support of this work
Papers (cont.)

  https://arxiv.org/abs/1706.05383
  http://journals.ametsoc.org/doi/abs/10.1175/MWR-D-16-0389.1
  https://arxiv.org/abs/1706.07447
  https://arxiv.org/abs/1706.07514

* HECC provided supercomputing resources and services in support of this work
Papers (cont.)

  https://arxiv.org/abs/1706.08983

* HECC provided supercomputing resources and services in support of this work
Presentations

Presentations

• AIAA Aviation Forum (cont.)
Presentations

- **AIAA Aviation Forum (cont.)**
  - “CFD Vision 2030 and its Implementation,” M. Rogers, M. Malik.
News and Events

- **OU Astrophysicist Studies Earth-Size Planets**, *University of Oklahoma Research Press Release*, June 10, 2017—An astrophysics researcher from the University of Oklahoma has identified the possible compositions of the seven Earth-sized planets in the TRAPPIST-1 system. Simulations were performed using the Pleiades supercomputer.
  

  – **Scientists Identify the Possible Composition of Planets in the TRAPPIST-1 System**, *Tech Times*, June 11, 2017.
    

  

- **Mystery of Floppy Solar Jets is Solved at Last**, *Physics World*, June 23, 2017—Computer simulations done by researchers in the US and Norway, including work done on NASA's Pleiades supercomputer, suggest an interplay between neutral particles and plasma in the Sun's atmosphere that allow tangled magnetic fields to launch spicules.
  
News and Events (cont.)


• NASA Researchers Rock the World of Asteroid Simulation, NAS Feature Story, June 29, 2017—Assessing potential damage from an asteroid strike and planning mitigation strategies is now faster and more accurate thanks to simulations and risk models run on NASA supercomputers. https://www.nas.nasa.gov/publications/articles/feature_asteroid_simulations.html
HECC Utilization

June 2017

Pleiades: Share Limit, Job Drain, Dedtime Drain, Limits Exceeded, Unused Devel Queue, Insufficient CPUs, Held, Queue Not Schedulable, Not Schedulable, No Jobs, Dedicated, Down, Degraded, Boot, Free/Testing, Used

Endeavour: Share Limit, Job Drain, Dedtime Drain, Limits Exceeded, Unused Devel Queue, Insufficient CPUs, Held, Queue Not Schedulable, Not Schedulable, No Jobs, Dedicated, Down, Degraded, Boot, Free/Testing, Used

Merope: Share Limit, Job Drain, Dedtime Drain, Limits Exceeded, Unused Devel Queue, Insufficient CPUs, Held, Queue Not Schedulable, Not Schedulable, No Jobs, Dedicated, Down, Degraded, Boot, Free/Testing, Used

Electra: Share Limit, Job Drain, Dedtime Drain, Limits Exceeded, Unused Devel Queue, Insufficient CPUs, Held, Queue Not Schedulable, Not Schedulable, No Jobs, Dedicated, Down, Degraded, Boot, Free/Testing, Used

Production: Share Limit, Job Drain, Dedtime Drain, Limits Exceeded, Unused Devel Queue, Insufficient CPUs, Held, Queue Not Schedulable, Not Schedulable, No Jobs, Dedicated, Down, Degraded, Boot, Free/Testing, Used
HECC Utilization Normalized to 30-Day Month

Standard Billing Units

- NAS
- NLCS
- NESC
- SMD
- HEOMD
- ARMD

Alloc. to Orgs
HECC Utilization Normalized to 30-Day Month

- SMD
  - Standard Billing Units in Millions
  - Dates and corresponding values:
    1. Nehalem ½ racks retired from Merope
    2. Westmere ½ racks added to Merope
    3. 16 Westmere racks retired from Pleiades
    4. 10 Broadwell racks added to Pleiades
    5. 4 Broadwell racks added to Pleiades
    6. 14 (All) Westmere racks retired from Pleiades
    7. 14 Broadwell Racks added to Pleiades
    8. 16 Electra Broadwell Racks in Production, 20 Westmere 1/2 racks added to Merope

- ARMD
  - Standard Billing Units in Millions

- HEOMD, NESC
  - Standard Billing Units in Millions
  - Dates and corresponding values:
    1. 7 Nehalem ½ racks retired from Merope
    2. 7 Westmere ½ racks added to Merope
    3. 16 Westmere racks retired from Pleiades
    4. 10 Broadwell racks added to Pleiades
    5. 4 Broadwell racks added to Pleiades
    6. 14 (All) Westmere racks retired from Pleiades
    7. 14 Broadwell Racks added to Pleiades
    8. 16 Electra Broadwell Racks in Production, 20 Westmere 1/2 racks added to Merope
Tape Archive Status

![Graph showing tape archive status with data points for Tape Library Capacity, Tape Capacity, Total Tape Data, and Unique Tape Data. The x-axis represents the months from Jul-15 to Jun-17, and the y-axis represents Peta Bytes from 0 to 600. The graph indicates a significant increase in tape data capacity over time.]
Pleiades: SBUs Reported, Normalized to 30-Day Month
Pleiades: Devel Queue Utilization

![Graph showing Devel Queue Utilization from July 2016 to June 2017. The graph displays the utilization of standard billing units across different months. Each month is color-coded to represent different agencies: NAS, NLCS, NESC, SMD, HEOMD, and ARMD. The graph also shows the allocated Devel Queue.]
Pleiades: Monthly Utilization by Job Length

June 2017
Pleiades:
Monthly Utilization by Size and Mission

Standard Billing Units

NAS
NLCS
NESC
SMD
HEOMD
ARMD

Job Size (cores)

1 - 32
33 - 64
65 - 128
129 - 256
257 - 512
513 - 1024
1025 - 2048
2049 - 4096
4097 - 8192
8193 - 16384
16385 - 32768
32769 - 65536

June 2017
Pleiades:
Monthly Utilization by Size and Length

June 2017
Pleiades:
Average Time to Clear All Jobs

![Bar chart showing average time to clear all jobs for different months and years, with ARMD, HEOMD/NESC, and SMD categories. The x-axis represents months from July 16 to June 17, and the y-axis represents hours from 0 to 312. The chart illustrates the comparative performance of ARMD, HEOMD/NESC, and SMD across these periods.]
Pleiades: Average Expansion Factor

The chart shows the average expansion factor from July 2016 to June 2017, categorized by months and categorized by three distinct groups: ARMD, HEOMD, and SMD. The expansion factor is measured in increments of 1.00, ranging from 1.00 to 10.00. The data points are represented by bars corresponding to each month, with different colors for each group.
Electra:
SBUs Reported, Normalized to 30-Day Month
Electra:
Devel Queue Utilization
Electra: Monthly Utilization by Job Length

Job Run Time (hours) | Standard Billing Units
---|---
0 - 1 | <250,000
> 1 - 4 | <250,000
> 4 - 8 | <250,000
> 8 - 24 | >250,000
> 24 - 48 | >250,000
> 48 - 72 | >250,000
> 72 - 96 | >250,000
> 96 - 120 | >250,000
> 120 | >250,000

June 2017
Electra: Monthly Utilization by Size and Mission

June 2017

Job Size (cores)

Standard Billing Units

- NAS
- NLCS
- NESC
- SMD
- HEOMD
- ARMD

June 2017
Electra:
Monthly Utilization by Size and Length

Job Size (cores)

- 1 - 32
- 33 - 64
- 65 - 128
- 129 - 256
- 257 - 512
- 513 - 1024
- 1025 - 2048
- 2049 - 4096
- 4097 - 8192
- 8193 - 16384
- 16385 - 32768

Standard Billing Units

- > 120 hours
- > 96 - 120 hours
- > 72 - 96 hours
- > 48 - 72 hours
- > 24 - 48 hours
- > 8 - 24 hours
- > 4 - 8 hours
- > 1 - 4 hours
- 0 - 1 hours

June 2017
Electra: Average Time to Clear All Jobs

Hours

ARMD
HEOMD/NESC
SMD
Merope: SBUs Reported, Normalized to 30-Day Month
Merope: Monthly Utilization by Job Length

![Bar chart showing monthly utilization by job length for June 2017. The chart displays the number of standard billing units spent on jobs run for different time intervals. The intervals include 0 - 1, > 1 - 4, > 4 - 8, > 8 - 24, > 24 - 48, > 48 - 72, > 72 - 96, > 96 - 120, and > 120 hours. The highest utilization is seen in the 8 - 24 hours interval.]
Merope: Monthly Utilization by Size and Mission

June 2017
Merope:
Monthly Utilization by Size and Length

June 2017
Merope:
Average Time to Clear All Jobs

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</table>

Legend:
- Red: ARMD
- Green: HEOMD/NESC
- Blue: SMD
Merope: Average Expansion Factor

ARMD | HEOMD | SMD

- Jul-16
- Aug-16
- Sep-16
- Oct-16
- Nov-16
- Dec-16
- Jan-17
- Feb-17
- Mar-17
- Apr-17
- May-17
- Jun-17
Endeavour: SBUs Reported, Normalized to 30-Day Month
Endeavour: Monthly Utilization by Job Length

June 2017

- Standard Billing Units
- Job Run Time (hours)

- 0 - 1
- > 1 - 4
- > 4 - 8
- > 8 - 24
- > 24 - 48
- > 48 - 72
- > 72 - 96
- > 96 - 120
- > 120
Endeavour: Monthly Utilization by Size and Mission

June 2017
Endeavour: Monthly Utilization by Size and Length

June 2017
Endeavour:
Average Time to Clear All Jobs

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Legend:
- ARMD
- HEOMD/NESC
- SMD
Endeavour: Average Expansion Factor