



## POWERWULF CLUSTERS: WEATHER MODELING

### CASE STUDY

WEATHER MODELING AT ROCKY MOUNTAIN CENTER (RMC) WITH PSSC LABS POWERWULF CLUSTERS.

"PSSC Labs understands the importance of my work. Their ability to deliver a complete turn-key solution allows me to focus on my work and not managing a cluster."

- KARL ZELLER, PH.D. USDA FS RMRS

#### CHALLENGE

- RMC required a compute intensive HPC Cluster to run MM5.
- RMC required a turn-key solution with easy to use management capabilities and support.
- RMC did not have funding for an ongoing support contract.

#### SOLUTION

- RMC selected PSSC Labs to design a custom configured PowerWulf Cluster
- PSSC Labs installed CBeST (Complete Beowulf Software Toolkit)
- PSSC Labs included FREE technical support for all hardware / software components.

#### IMPACT

- RMC runs MM5 and BlueSky models daily.
- Rocky Mountain Center has a trusted cluster vendor that provides reliable hardware, turnkey software and free technical support.



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### CASE STUDY CONTINUED

#### ORGANIZATIONAL PROFILE

The RMRS Rocky Mountain Center (RMC) is one of the five regional members of the US FS Fire Consortia for Advanced Modeling of Meteorology and Smoke (FCAMMS). FCAMMS is supported by Forest Service Research under the National Fire Plan and NOAA. The RMC Team is engaged in a continuous development and deployment of science-based computer applications for real-time delivery of high-resolution fire-weather intelligence and smoke dispersion forecasts over the Western USA. The vision of RMC is to provide comprehensive weather support to wildland fire operations, prescribed burns, and air resource management.

RMC delivers real-time spatially explicit hourly information about current and future values of weather elements such as air temperature, relative humidity, precipitation, cloud cover, wind speed and wind direction, as well as several fire indices (i.e. Ventilation, Haines, Fosberg, and Ketch-Byrum). Weather forecasts and analysis are performed over a large domain covering the entire Western USA at 12-km spatial resolution. Forecasts extend up to 72 hours into the future. Web products are produced for the main domain and numerous nested sub-domains (windows) covering territorial units managed by the Eastern Great Basin Area Coordination Center (EGBACC), the Rocky Mountain Area Coordination Center (RMACC), and the Southwest Area Coordination Center (SWACC) as well as individual states.

For selected areas, RMC delivers mass-balanced wind fields scaled down to 90-m resolution to support detailed air quality assessments and fire behavior models such as FARSITE. RMC currently produces wind field downscaling for Colorado Front Range, Northern Arizona, and Southern California. In addition, RMC provides real-time smoke dispersion forecasts for the entire Western USA using the BlueSky Modeling System. RMC plans to expand their list of operational products to include maps of crucial indices from the National Fire Danger Rating System (NFDRS). The information products created by RMC are delivered to consortium members and the general public via the World Wide Web in the form of interactive 2-D maps, point observations & point forecasts, and actual 3-D data fields.

RMC conducts a comprehensive real-time forecast verification using point observations from hundreds of METAR stations and observed data fields from LAPS analysis. All verification products are updated daily.



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### CASE STUDY CONTINUED

Analysis of observed (past) weather are performed using the Local Analysis and Prediction System (LAPS) supported by the NOAA Forecast Systems Laboratory in Boulder, CO. Weather forecasts are generated by the latest version of the MM5 Community Model jointly developed by the Pennsylvania State University (PSU) and the National Center for Atmospheric Research (NCAR). MM5 is a limited-area, non hydrostatic, terrain-following sigma-coordinate model designed to simulate 3-D mesoscale atmospheric circulation.

LAPS assimilates thousands of meteorological observations every hour from land surface and the upper air (including data from satellite and Doppler radar stations) as well as large-scale model output, and interpolates them to a continuous 3-D grid of certain resolution. Data interpolation employs statistical methods as well as algorithms based on laws of atmospheric physics. The analysis produces a consistent mass-balanced 3-D data fields of cloud cover, temperature, water vapor, wind speed and wind direction. These fields are passed to the MM5 model that performs temporal integration and produces the weather forecast. We use MM5 version 3.6.3. with Reisner mixed phase microphysics (Reisner2) including graupel, the MRF PBL scheme, no cumulus parameterization option.

The MM5 model is run twice per day for the entire Western portion of USA using 12-km grid spacing. Model initialization times are 11:00 and 23:00 MST. The interpolated fields of observed data generated by LAPS provide initial conditions to the MM5 model. Boundary conditions are extracted from the NCEP Eta model. The LAPS analysis offer a unique model initialization for all domains by specifying mass-balanced 3-D fields of actual cloud cover and precipitable water content during the first hour of simulation. Known as a Hot Start, this method eliminates the need for model spin-up to achieve diabatic initialization, and allows the production of a reliable forecast from the commence of model simulation.

MM5 & BlueSky are executed on a 96-Intel Xeon CPU Parallel Super-computer running RedHat Fedora Linux Operating System. Forecasts of smoke dispersion are produced by the BlueSky Modeling System through a collaboration with the Northwest Regional Modeling Consortium. BlueSky requires forecast meteorological fields for input that are provided by the RMC MM5 model runs. (1)

### CHALLENGE

As a government organization with a limited budget, Rocky Mountain Center was looking for a cluster vendor with a reliable product, easy to use management tools and great support. They wanted a company with an expertise in designing, building, and supporting high performance computing clusters. They also had a limited budget to meet these requirements and could not set aside funding for ongoing support contracts.



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### CASE STUDY CONTINUED

#### SOLUTION

Rocky Mountain Center found the right match when they discovered PSSC Labs. PSSC Labs PowerWulf Clusters are custom configured to meet the performance specifications and budget of its customers. The knowledgeable sales team helped configured a PowerWulf Cluster solution that not only met their demanding specifications but also met their budget. PSSC Labs configured a PowerWulf Cluster for Rocky Mountain Center in 2003. Once delivered, PSSC Labs Cluster Technicians provided unlimited support for the hardware and software provided. The combination of hardware, software and support was just what Rocky Mountain Center was looking for.

PSSC Labs installed CBeST, Complete Beowulf Software Toolkit. CBeST is a compilation of open source utilities optimized and customized for your specific cluster and application. CBeST allows you to easily manage, monitor, maintain, and upgrade your cluster; allowing you to focus on your work not managing your cluster. Most importantly CBeST comes with FREE unlimited lifetime technical support.

#### IMPACT

The custom configured PowerWulf Cluster from PSSC Labs has enabled RMC to provide detailed forecasts and fire simulations. This solution not only met their demanding technical specifications but was provided at a very competitive price.

The technical support provided by PSSC Labs allows RMC to focus on their work, not managing a cluster. PSSC Labs FREE technical support allows RMC to pick up the phone and speak directly to the Cluster Technician who installed their custom CBeST installation. This high level of support combined with a highly optimized PowerWulf Cluster led RMC to confidently invest in a second PowerWulf Cluster.

PSSC Labs delivered two more PowerWulf Clusters in 2004 and added additional slave nodes in 2005. PSSC Labs has delivered over 200 high performance processors to RMC. The reliable hardware, turnkey software and great support allowed RMC to invest confidently in more nodes from PSSC Labs. PSSC Labs PowerWulf Clusters help RMC research and manage smoke and fire in the Western United States.



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### CASE STUDY CONTINUED

#### ABOUT PSSC LABS

PSSC Labs is not just another computer company. Our commitment to customer satisfaction, careful attention to detail and focus on high performance computing differentiates us from the pack. PSSC Labs line of PowerWulf Clusters, PowerServe Servers, PowerStation Workstations and RAIDStation Storage systems are custom configured for each end user's needs and budget. If you are tired of dealing with computer companies that promise the world but leave you stranded then you are ready to experience the PSSC Labs difference. Everyday more people are discovering why PSSC Labs is the right choice. PSSC Labs is based in Lake Forest, CA. [www.pssclabs.com](http://www.pssclabs.com)

(1) Information provided by <http://www.fs.fed.us/rmc/>