WRF Software

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Mesoscale and Microscale Meteorology

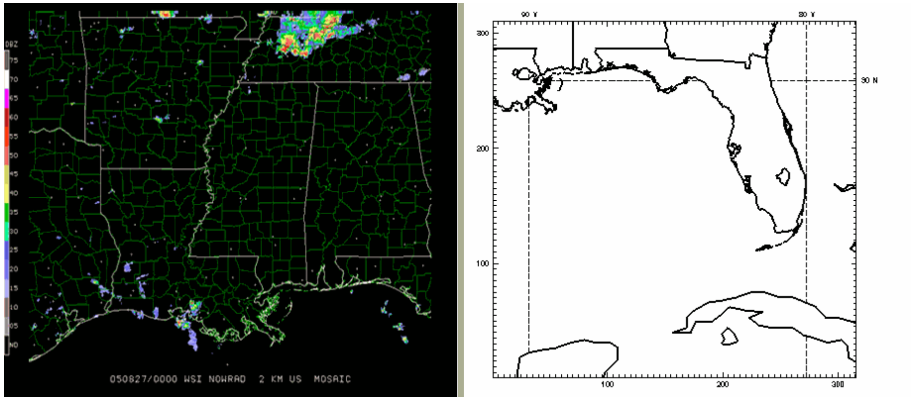
National Center for Atmospheric Research

- Outline
  - Overview
  - New developments
  - Petascale computing

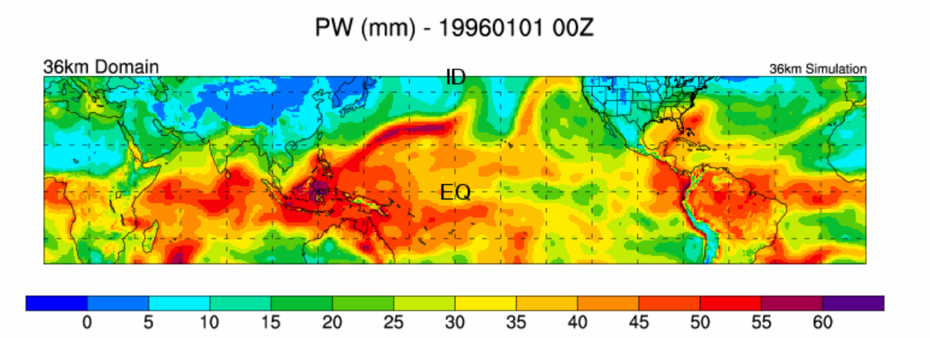
WRF Users Workshop -- June 19, 2006

WRF Software Overview

- Characteristics, Features, & Capabilities
  - Flexible, extensible to range of WRF applications
  - Movable, feature following nested grids
  - Coupling to other models
  - Parallel, efficient on range of computers in WRF community



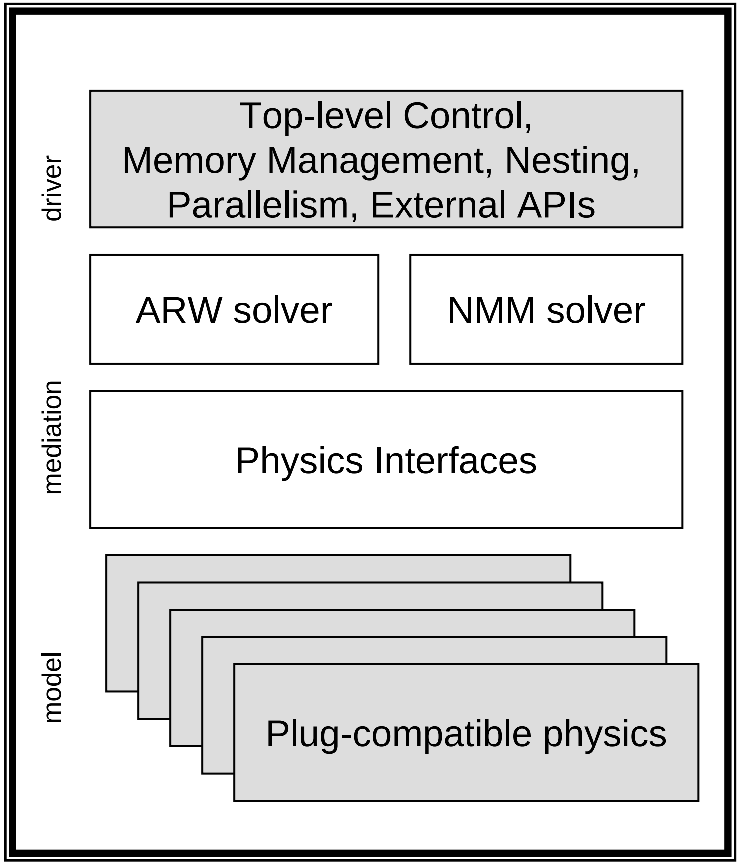
4km Hurricane Katrina Moving Nest (right) with Composite radar (left)



Precipitable H^2O, Year 2 of Nested Regional Climate Model

WRF Software Overview

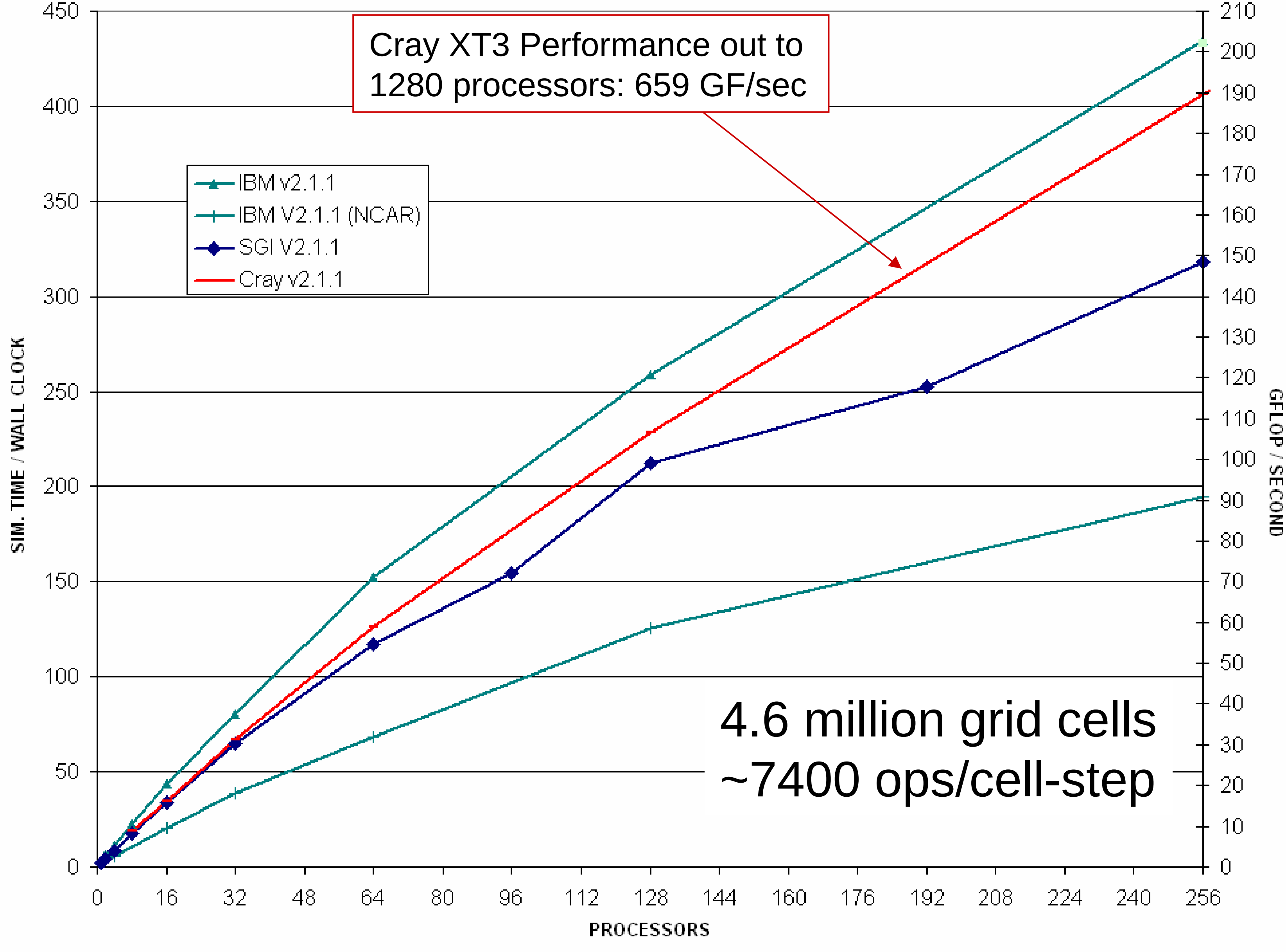
- Implementation of WRF Architecture
  - Hierarchical organization
  - Multiple dynamical cores
  - Plug compatible physics
  - Abstract interfaces (APIs) to external packages
  - Registry for managing model state
  - Portable/efficient for range of computers in community



WRF SW Enhancements (next release)

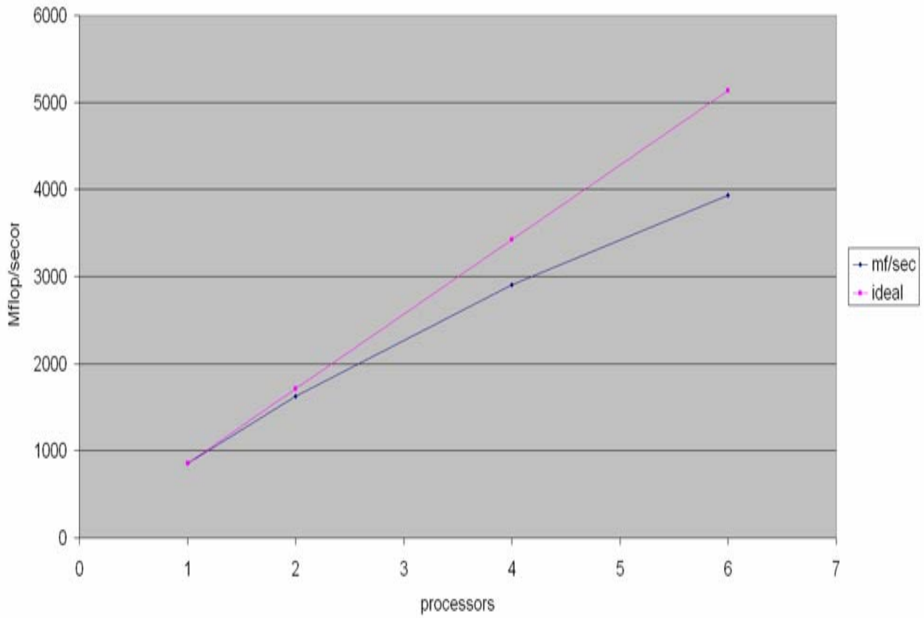
- NMM Nesting (Gopalakrishnan, Dusan)
- WRF-Chem (Grell, Peckham, Gustafson, many others)
- GRIB 1 and GRIB 2 input and output (Hutchinson, WSI)
- New SI program (Gill, Wang, Duda)
- ESMF coupling (Henderson)
- Porting and Performance (HPCMO & IBM, SGI, Cray)

Performance (v2.1.1)



Under Development

- Windows port (Microsoft, AMD, PGI)
- WRF VAR parallelization and code unification (NCAR, AFWA, KMA)
- Parallel NetCDF (Argonne NL)
- Nested Regional Climate Model (MMM, CGD)
- Global WRF (CalTech, Cornell)
- WRF-Hycom coupling (NRL, U. Miami)
- LEAD integration (U. Oklahoma, NCSA)



WRF Performance on Windows 2003 with SUA
Dual AMD-Opteron 2.6 GHz (single core)
GigE Interconnect. Portland Group compiler
Benchmark case: 12km CONUS

Petascale Computing

- NSF, DARPA, DOE moving forward on plans to build systems capable of 10^{15} sustained floating point operations per second by 2010
- Major shift in high-performance computing
  - Reaching terascale has been the result of faster processors
  - Scaling to petascale means using orders of magnitude more processors efficiently
- Will WRF be able to exploit these systems?

IBM Blue Gene Performance

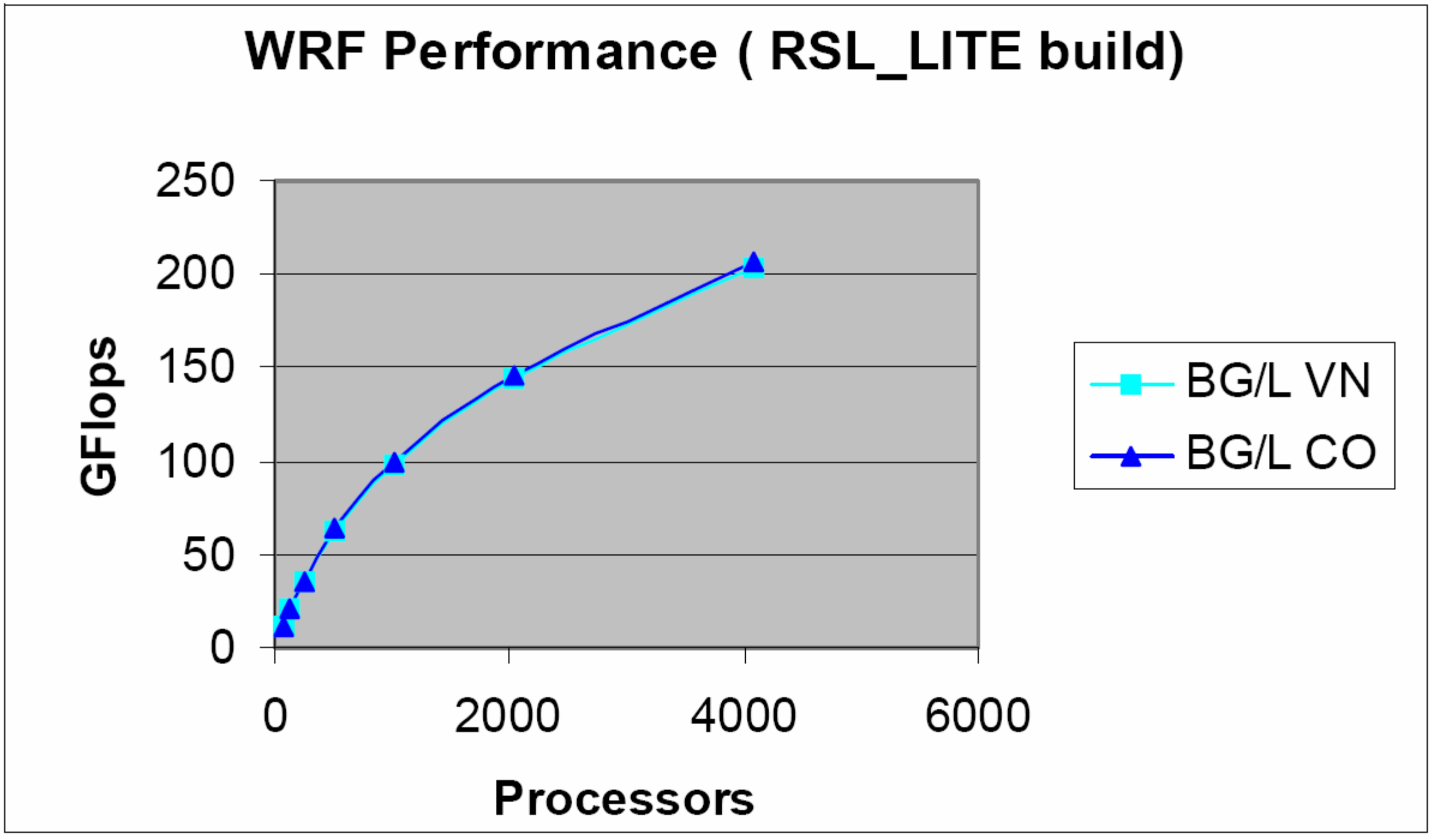


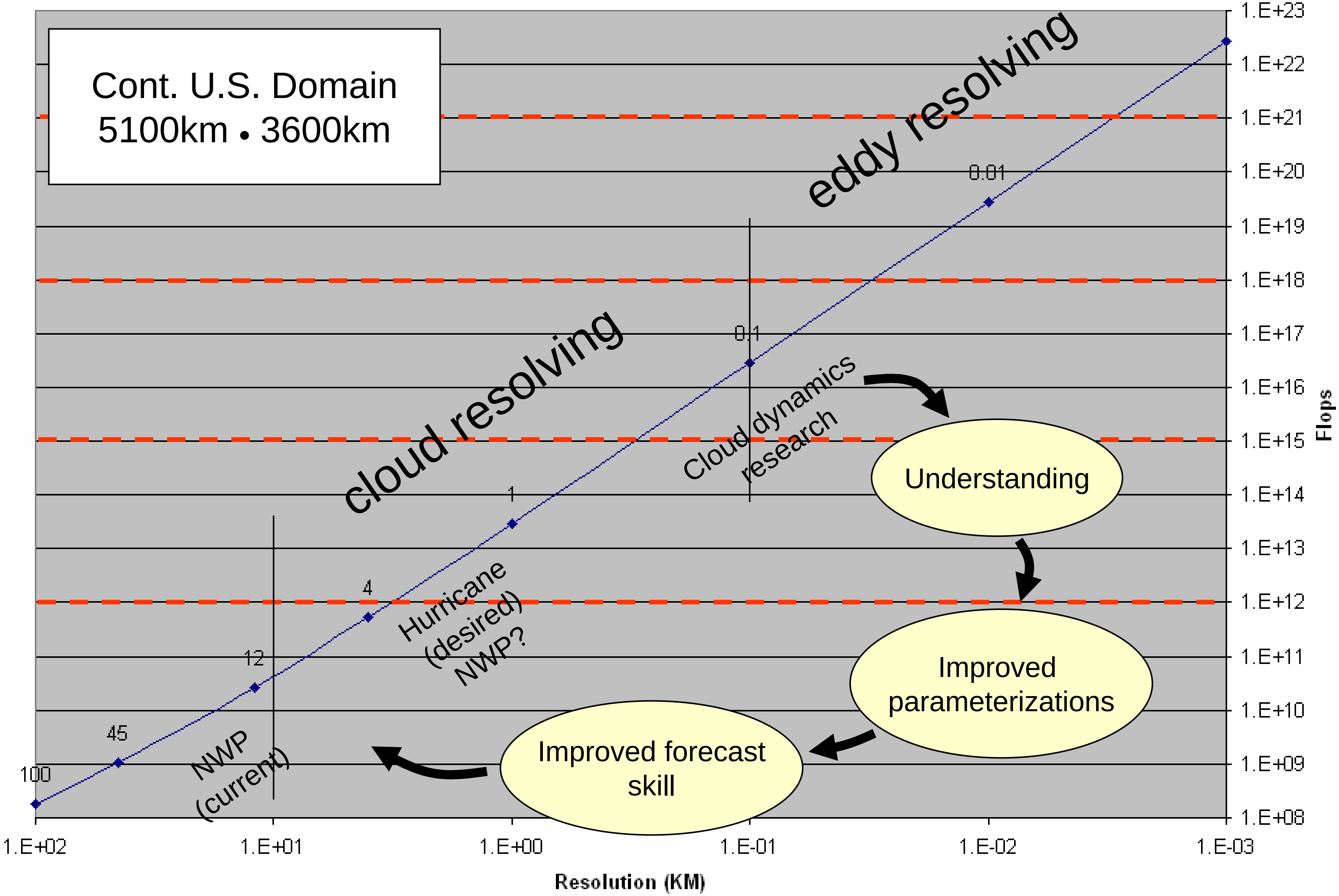
Figure 8-37 WRF performance (RSL_LITE build)

Thanks: Sheeba Prakash
From: Unfolding the IBM @server Blue Gene Solution
ibm.com/redbooks,

Weather as a Petascale Application

- The only dimension of the weather problem that scales to larger numbers of processors is resolution
  - Improving initial conditions is a data assimilation problem – expensive but doesn't necessarily scale to Petaflops
  - Ensemble techniques are also costly but scale trivially with capacity (don't need capability computing)
  - Better physics will cost more but until we parallelize in the vertical dimension, this argues for faster processors, not more of them
- Weather is a petascale application only to the extent that higher resolution can be usefully employed
- Cloud-resolving ($\Delta h \sim O(100\ m)$) simulations are needed to understand cloud dynamics and to improve parameterizations for forecasting

Cost as a function of resolution



WRF as a Petascale Application

- Impact for developers?
  - What changes need to be made in WRF
  - Will those changes be compatible with other supported architectures
  - How will we maintain both? Resources?
- Impact for users?
  - Who has petascale applications of WRF?
  - Access to petascale systems? (the Hubble effect)
  - What about everyone else?

Summary

- WRF modeling system implemented on WRF Software Framework
- Support for range of applications, platforms in community, now and into Petascale era
- Documentation and other information
  - http://www.mmm.ucar.edu/wrf/WG2/software_v2
  - wrfhelp@ucar.edu