The 18th Workshop on high performance computing in meteorology

CMA HPC Update

Supporting meteorological service

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National Meteorological Information Centre
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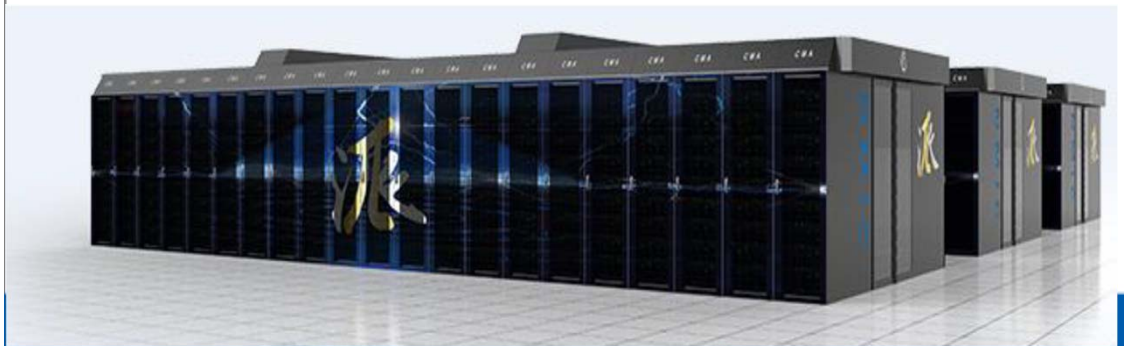

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Contents

- HPC Systems
- Model-Supportive Software Systems
- Conclusions

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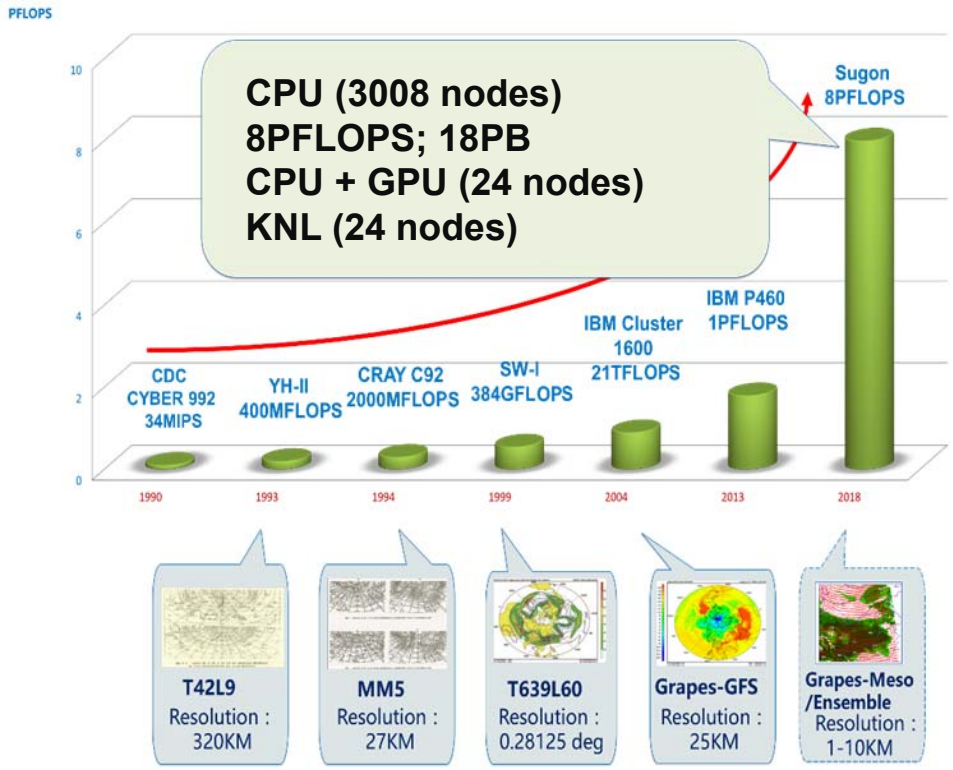
History



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IBM HPCS

Beijing : 1 PFLOPS

Shenyang : 75 **TFLOPS**

Shanghai : 50 **TFLOPS**

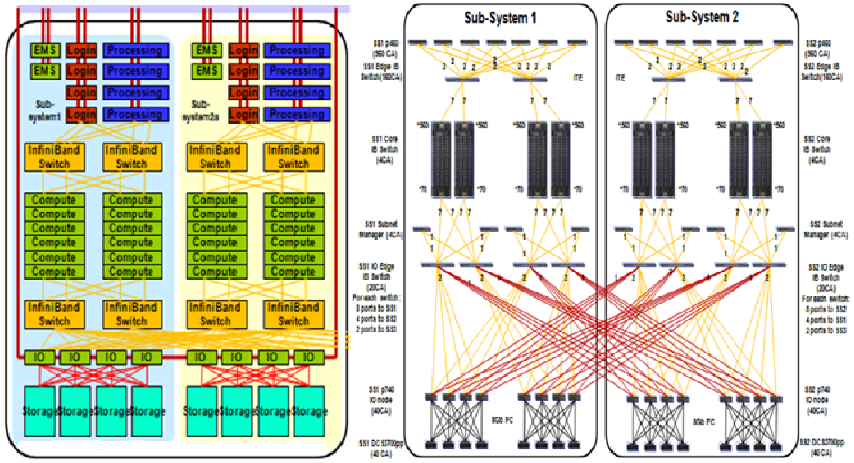
Wuhan : 75 **TFLOPS**

Guangzhou: 400 **TFLOPS**

Chengdu : 25 **TFLOPS**

Lanzhou : 25 **TFLOPS**

Urumqi : 25 **TFLOPS**



System	Installation Time	Peak Performance (TFLOPS)	Storage Capacity (TB)
IBM Flex System P460	2013	Production Subsystem: 527	2109.38
	2014	Research Subsystem: 527	2109.38

Resource utilization

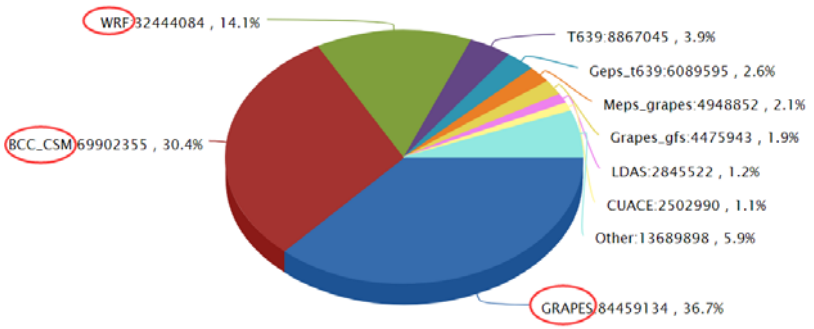
IBM HPCS accounts

- 578

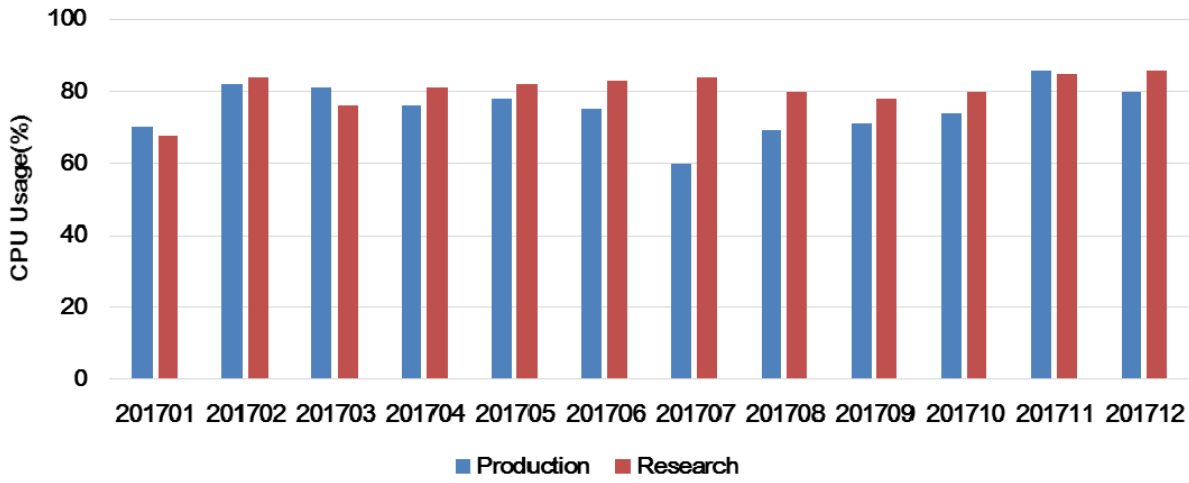
IBM HPCS utilization

- Maintain high both in system availability and CPU utilization, 70% to 80% on average peaking at 95%.

Computing resources statistics



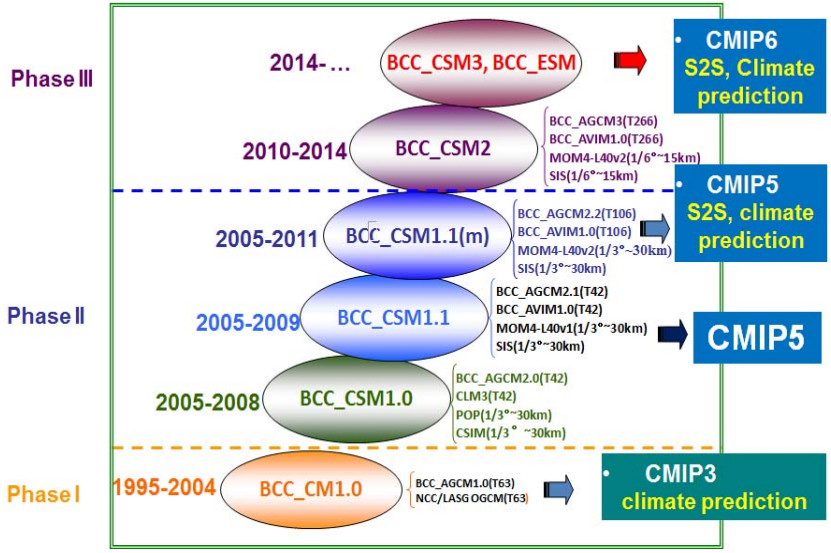
Average CPU utilization rate



GRAPES & BCC_CSM

- GRAPES = Global/Regional Assimilation PrEdiction System
- BCC_CSM = Beijing Climate Center Climate System Model

	GRAPES-GFS	GRAPES-MESO	GRAPES-TYM	GRAPES-MEPS
Forecast range	10d	3d	5d	3d
Domain	Global	East Asia	West Pacific	East Asia
H-resolution	0.25°	0.1°	0.12°	0.15°
V-resolution	60L 3hPa	50L 10hPa	50L 10hPa	50L 10hPa
Forecast time	00, 12 UTC 240 h	00, 12 UTC	00, 12 UTC	00, 12 UTC 15 members



Benchmark

- GRAPES-GLOBAL model (Parallel)
- GRAPES-MESO model (Parallel)
- GRAPES-4DVAR four-dimensional variational model (Parallel)
- BCC_CSM climate system model (Parallel)
- BCC_AGCM atmosphere model (Parallel)
- GRAPES-SVD singular vector analysis of regional ensemble forecast system (Serial)
- WRF model (Parallel)

- IOzone Benchmark
- IMB Benchmark
- Job scheduling
- Public domain meteorological software packages

PI-Sugon

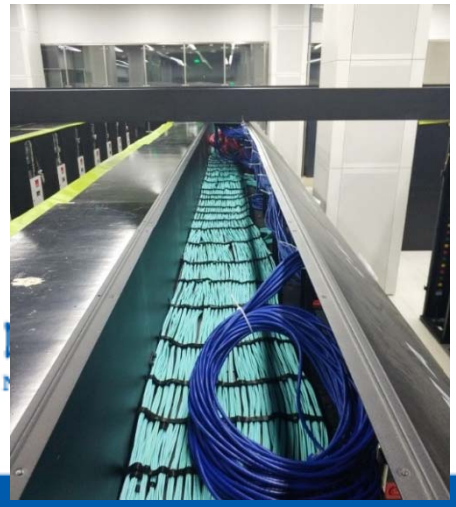
2017.9 2018.1 2018.6

1 Contract 2 Arrival 3 Installation 4 Power up 5 Service 6 Pre-Operation





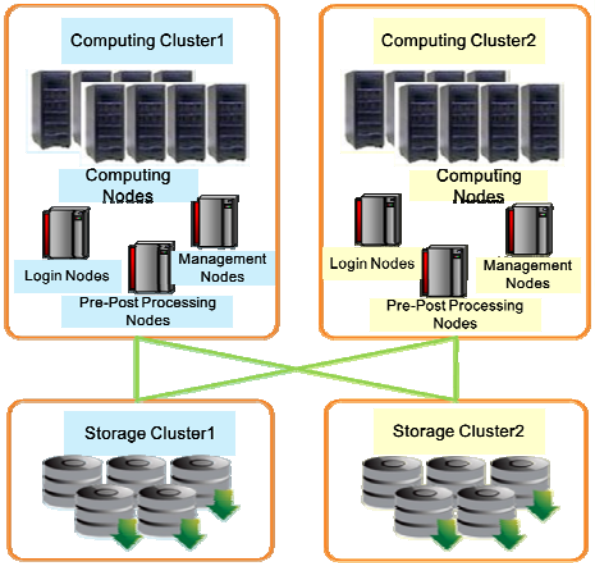


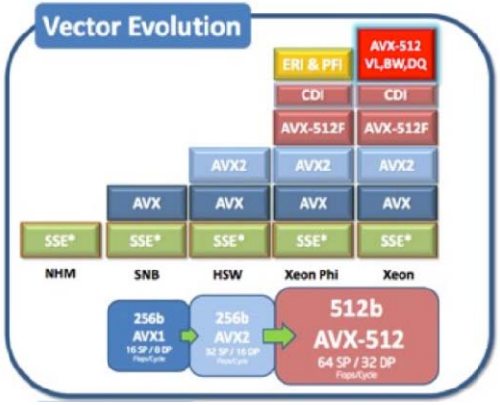


Architecture

Two subsystems: hot standby

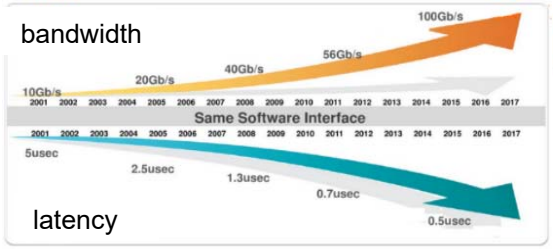
- Independent computing, shared storage
- General processor, for each system
  - Computing nodes: ~1500
  - Total CPU cores: ~50000
  - Intel Xeon Gold 6142 (16 Core, 2.6GHz)
- 8 PFLOPS peak performance
- 18 PB storage capacity
- 100Gb/s InfiniBand EDR network
- Parastor 300 parallel file system

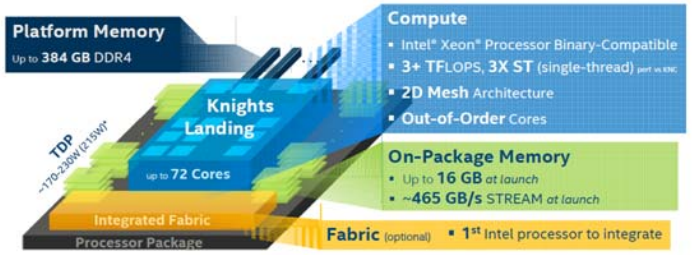




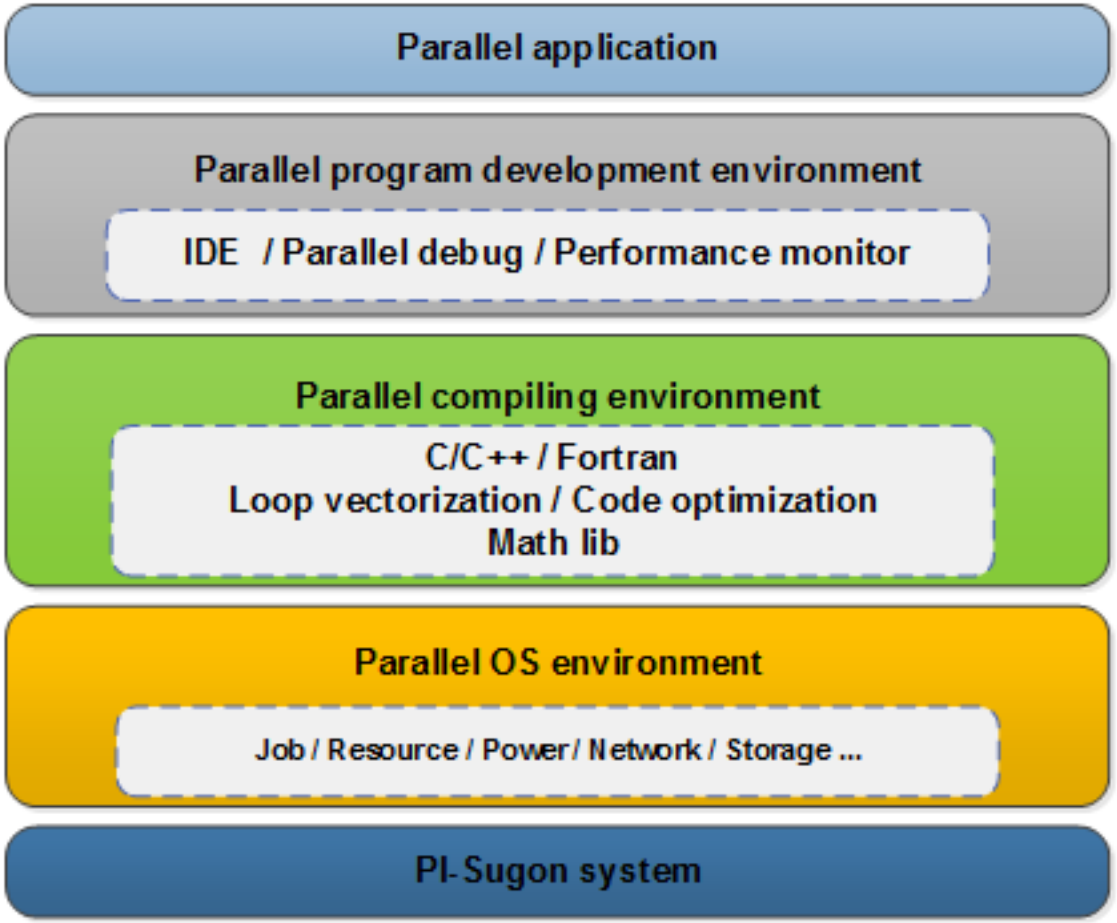
New technology test and development subsystem

- CPU + GPU (24 nodes)
- Intel KNL (24 nodes)





Software Stack



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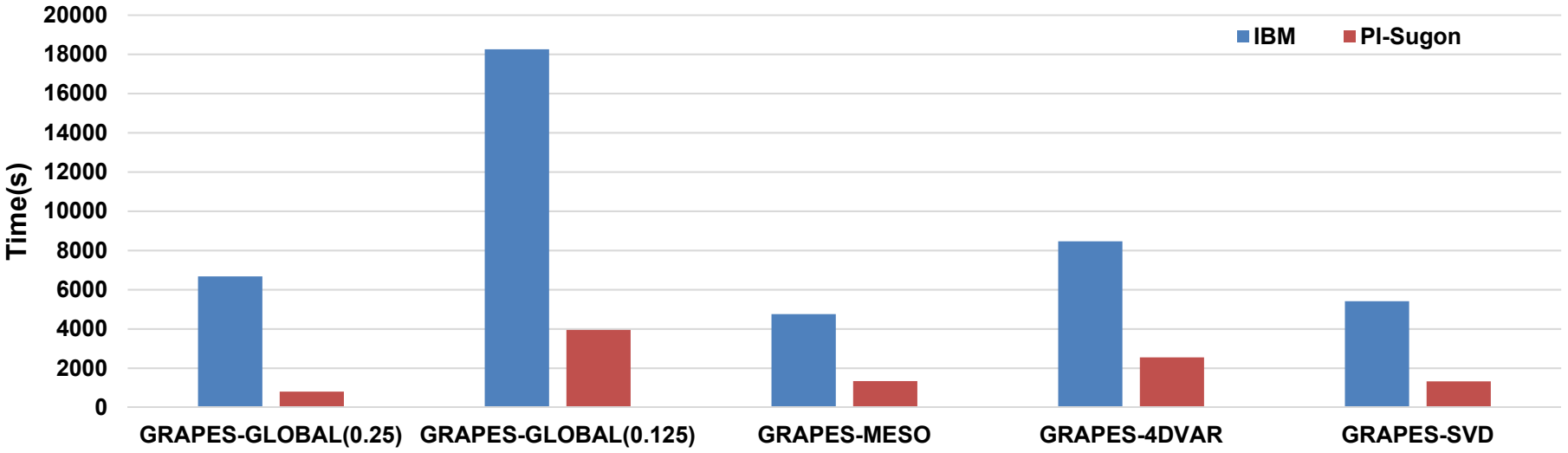
IBM & PI-Sugon

	IBM	PI-Sugon
Improvement		
Peak Performance	~1PFLOPS	~8PFLOPS
Storage Capacity	~4PB	~18PB
Inter-Connection	QDR 40Gb/s	EDR 100Gb/s
Difference		
OS	AIX 7.1.0.0	RedHat Enterprise 7.4

adios	ferret	grads	hdf5	ioapi	ncl_ncarg	nlopt	plapack	udunits
blas	fftw	grib_api	hdfeos	jasper	nco	openblas	plasma	wgrib
boost	geos	gsl	hdfeos5	lapack	ncview	parallel-netcdf	proj	wgrib2
esfm	GotoBlas2	hdf	hypre	libpng16	netcdf	petsc	scalapack	

GRAPES model suite



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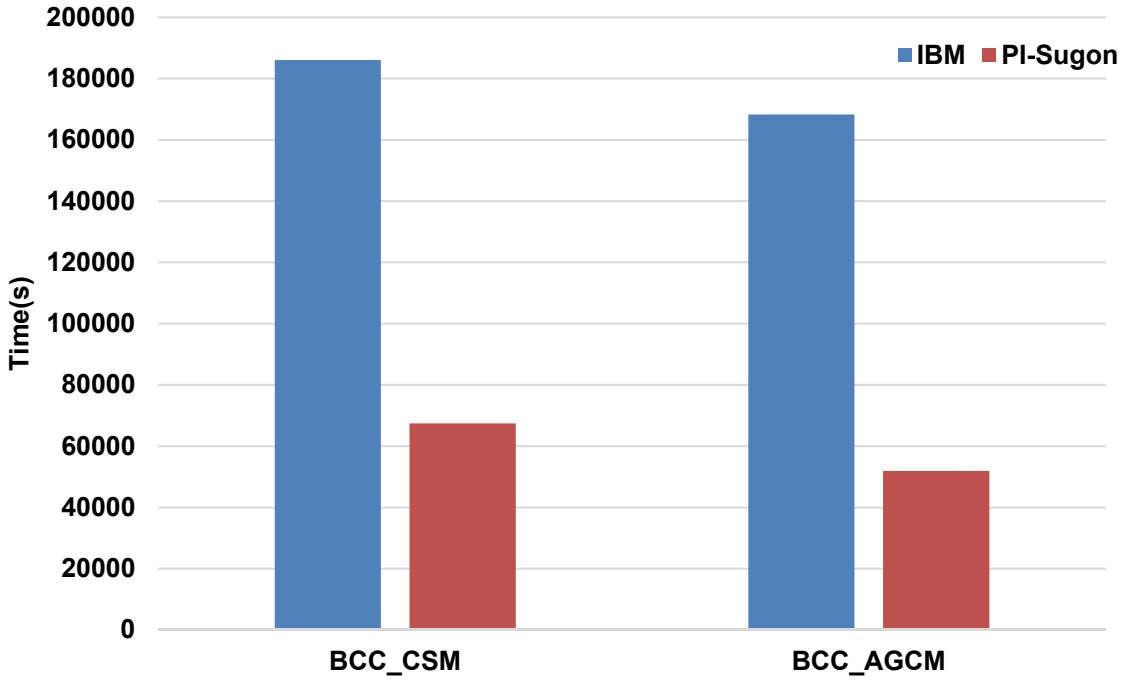
Climate models



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- **High performance computer management software**
  - Refined resource management system
  - Operational monitoring system
- **Numerical model supporting software**
  - Code management system
  - GRAPES Integrated Setting Experiment Tool(GISET)
  - GRAPES Interactive Data Analytics Tool (GIDAT)

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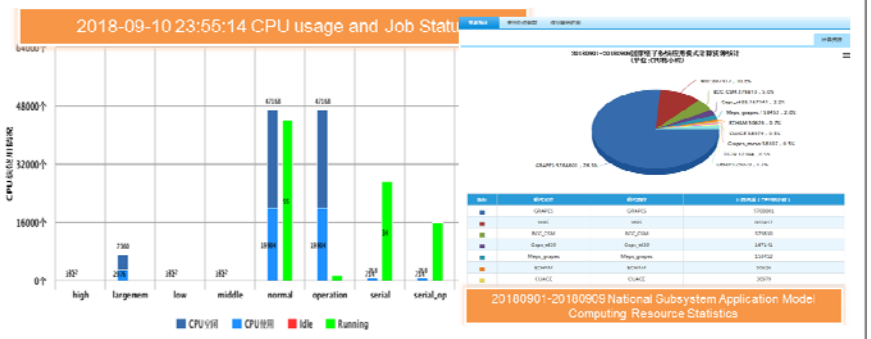
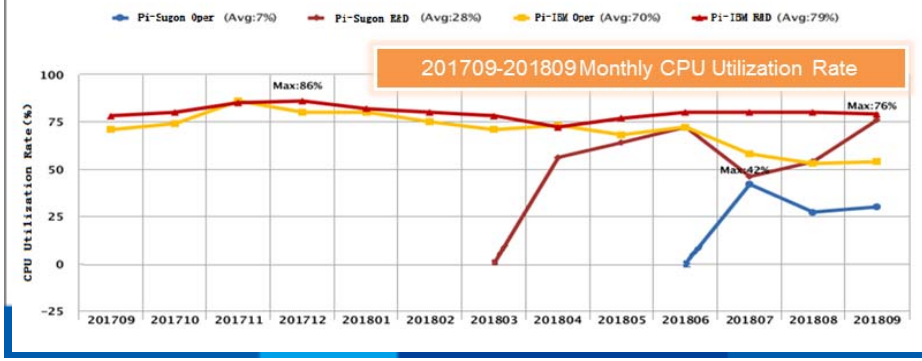
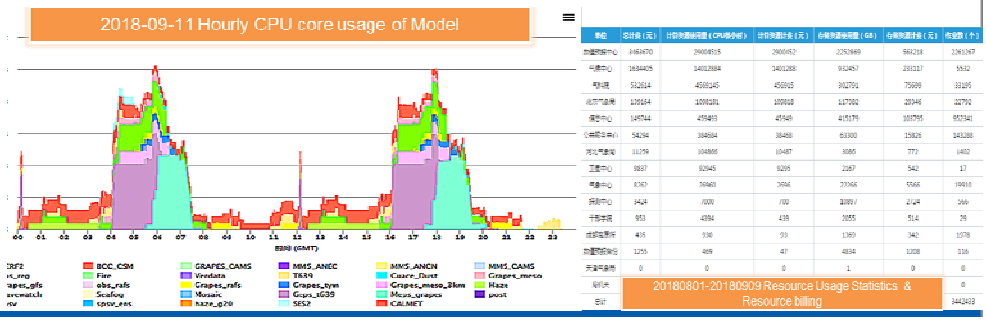
Refined resource management system

- Resource management of IBM & PI-Sugon systems
- Unified management of national and regional resources
- Real-time and historical statistical analysis of system resource usage and utilization
- Computing resource and storage resource usage accounting
- Model & job statistical analysis
- Planning: intelligent resource management
  - Resource data mining
  - Decision support analysis

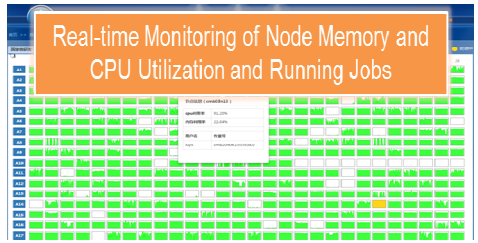


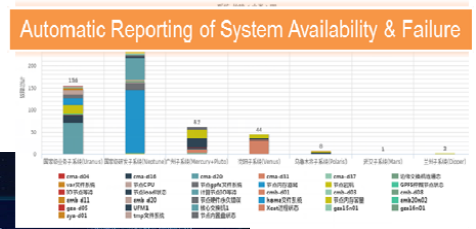


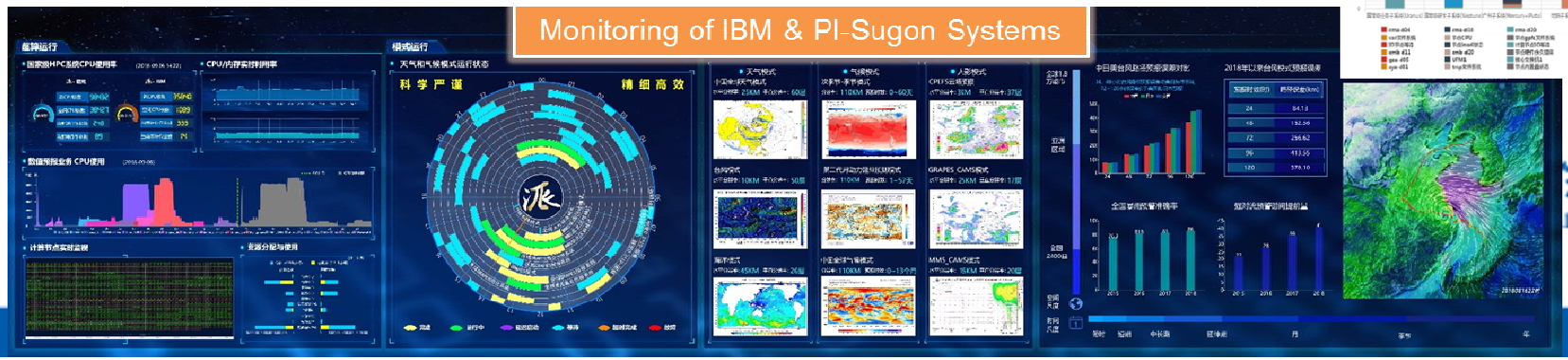


Operation monitoring system

- Monitoring of IBM & PI-Sugon systems and software，audio alarm
- Unified management of national and regional resources
- Real-time monitoring and historical statistical analysis of failure
- Automatic reporting of system availability & statistical analysis of failure
- Fault handling workflow & fault knowledge database
- Model job monitoring
- Real-time monitoring of memory, CPU utilization and jobs
- Planning: intelligent job management
  - Model application feature analysis and data mining
  - Decision support analysis







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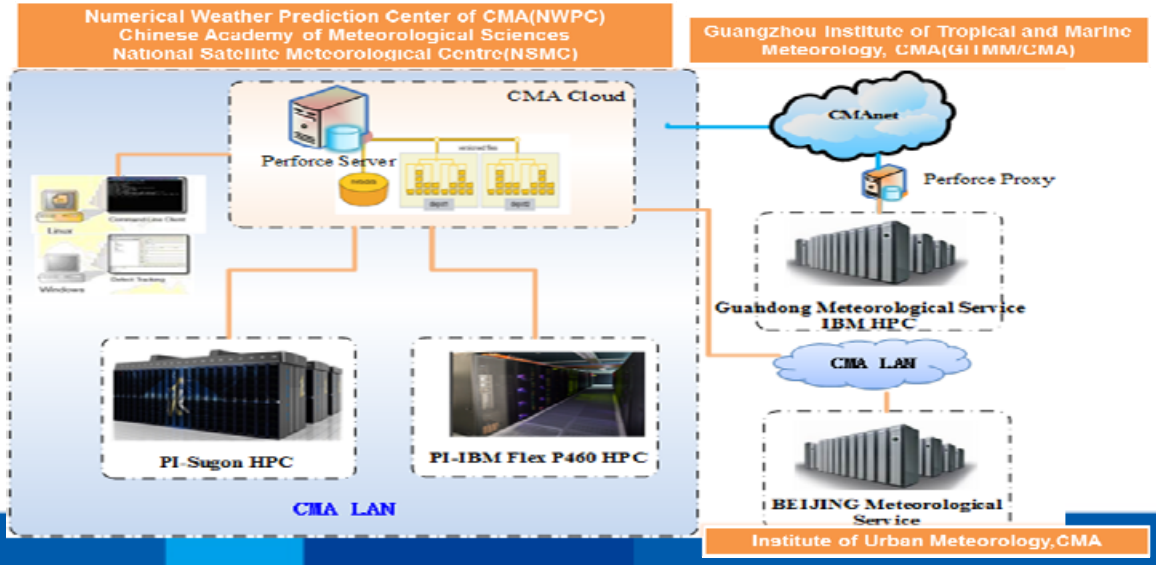
Code management system

- Code management system (since 2010)
  - Perforce application on IBM and PI-Sugon HPC
  - GRAPES-GFS,GRAPES-MESO,BCC_CSM code repository
  - National & regional distributed design for GRAPES-MESO collaboration
  - Code version control and integration control
  - Code updates 17,000+, code integration 1,000+, version release and bug fix 500+
- Planning: git-based code management



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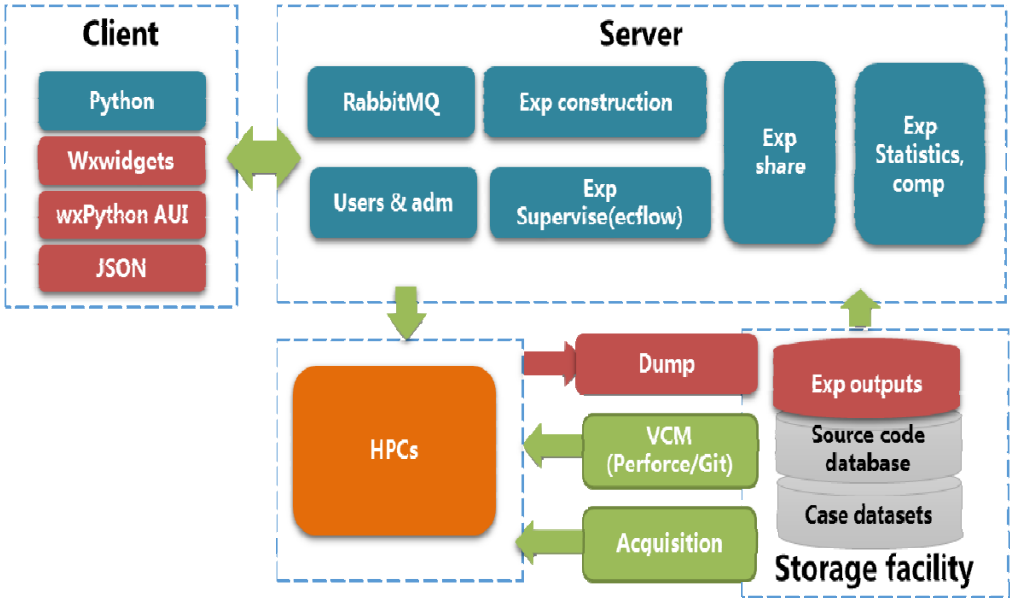
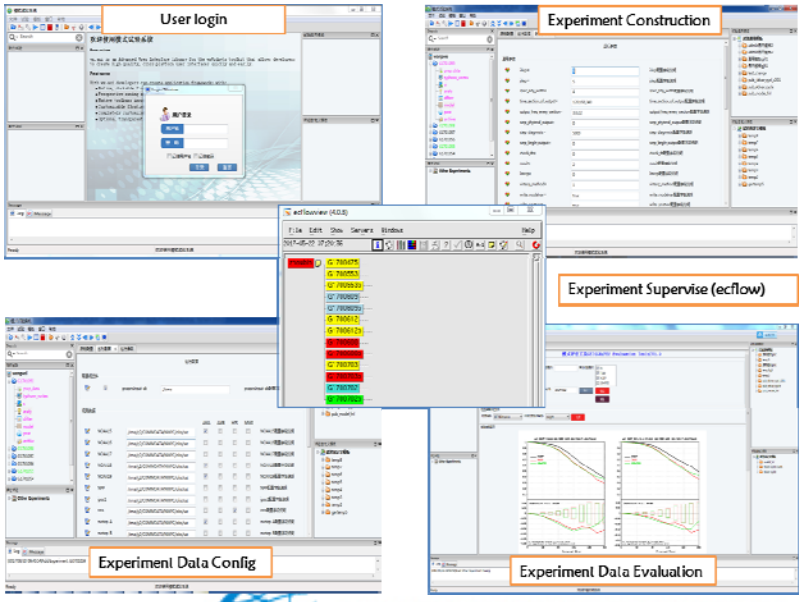
GRAPES Integrated Setting Experiment Tool(GISET)

- Experiment construction
- Experiment scheduling (ecFlow)
- Experiment sharing, statistics, compare
- Integrated code and experiment data management

- Design and implementation based on C/S mode
- Coded by python
- Back-end services run on servers





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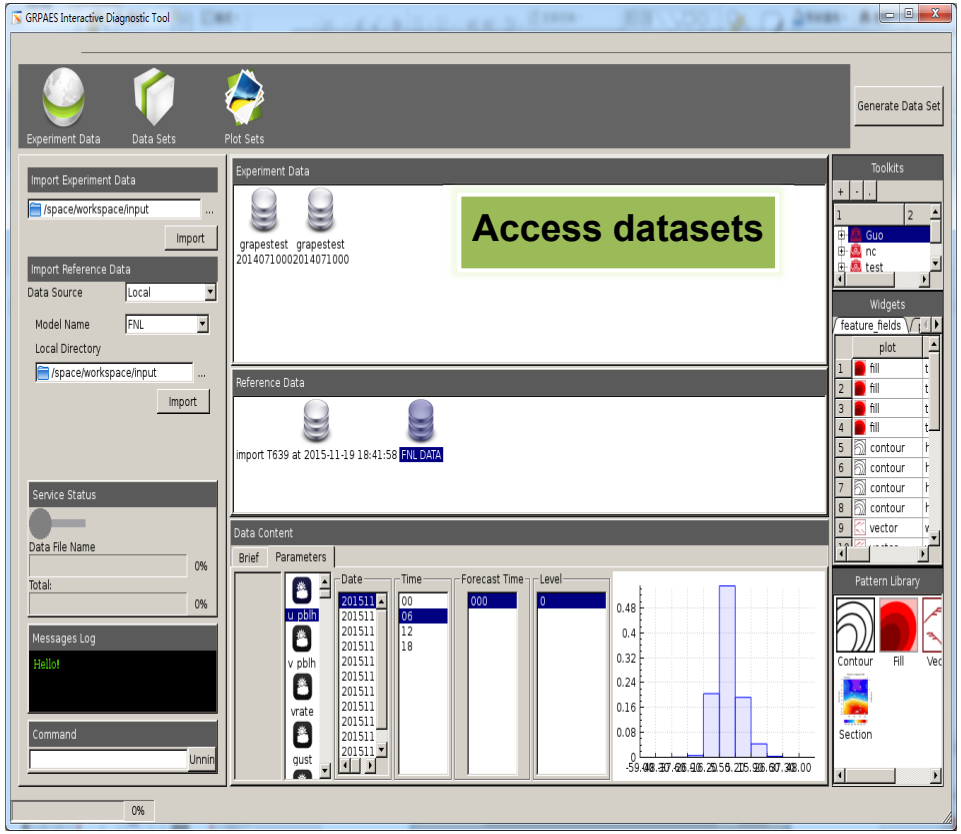
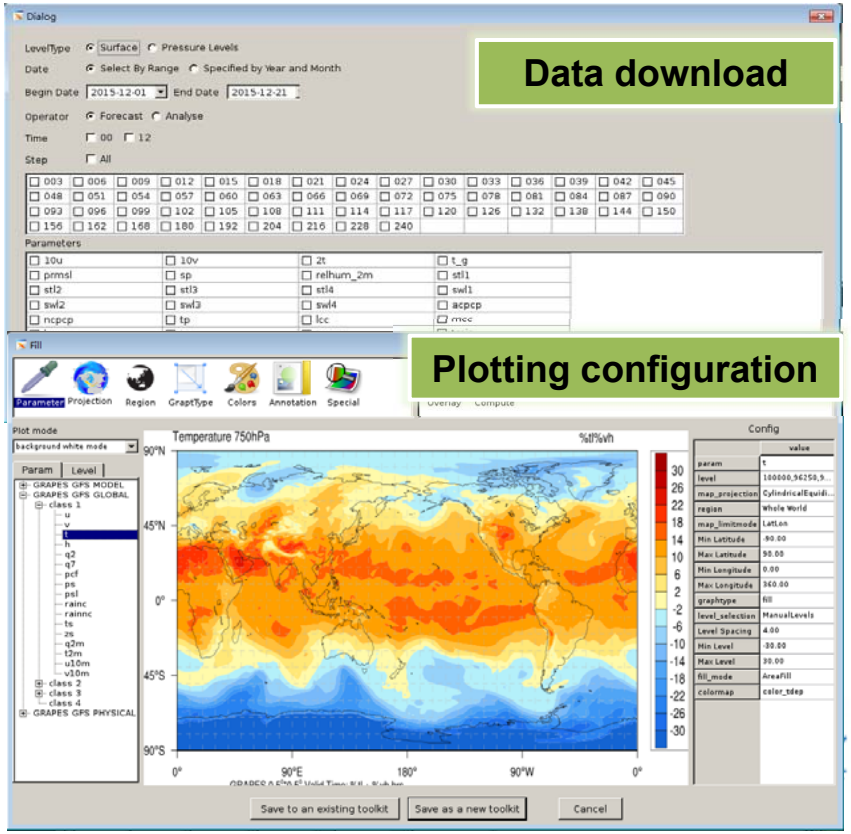
GRAPES Interactive Data Analytics Tool (GIDAT)

- On-line plotting of diagnostic data
- Interactive analytics function
- Access the datasets by data service API





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What have we achieved?

A new HPC solution has been deployed

- Architecture: CPU cluster; GPU cluster; Intel KNL cluster; network, environment, redundancy……
- Majority of migration work completed
- Testing novel architectures
- Collaboration: CMA members; vendors; universities

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Next steps

- Efficient and portable code
- Test new architectures and programming models
- Software support services

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Thank You for listening !

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