Outline of the Earth Simulator Project

1. Mission and Basic Principles of the Earth Simulator

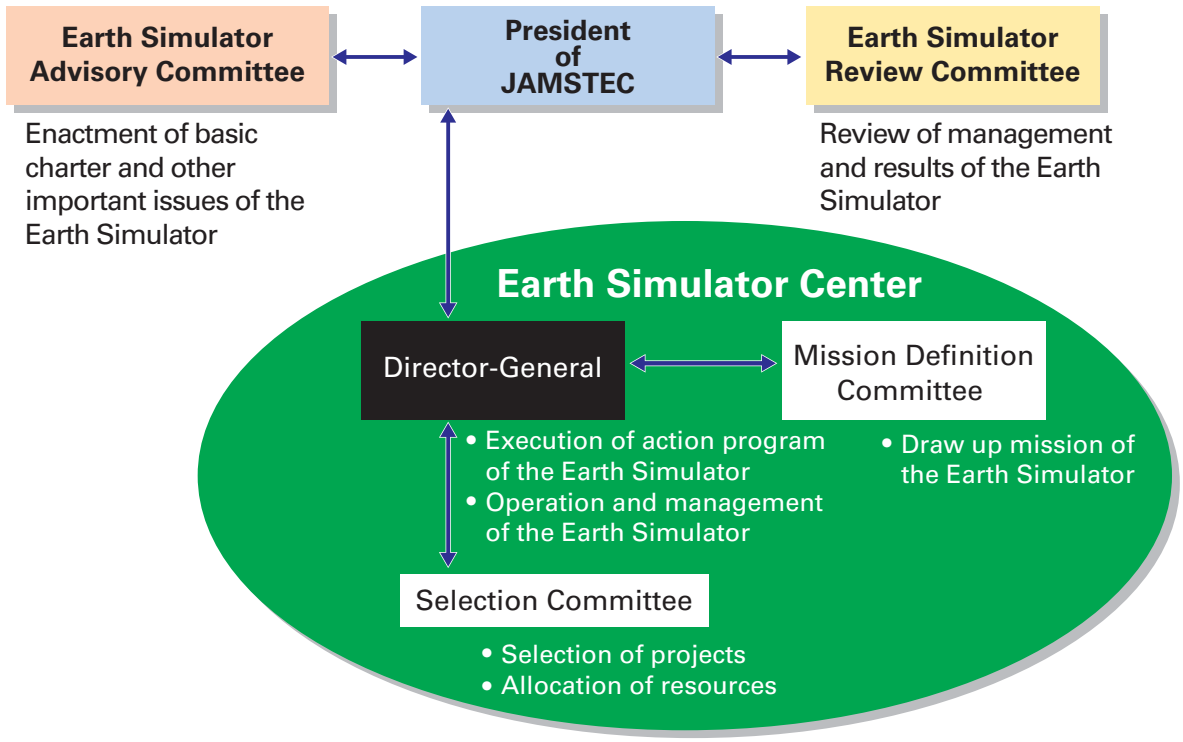
The Earth Simulator was developed for two aims and objectives. The first ensures a bright future for human kind by predicting variable global environment accurately, and the second contributes for the development of science and technology in the 21st century. Basing these purposes, four principles as follows are established to the projects of the Earth Simulator.

1) Each project should be open to researchers in the same field and to public, not to be confined within limited of researchers.
2) In principle, the research achievements by the Earth Simulator should be swiftly published and delivered to the public.
3) The Mission Definition Committee will examine research achievements and encourage effective operations.
4) Each project should be carried out for peaceful purposes only.

2. Managing System for the Earth Simulator Project

There were four important committees which work for the Earth Simulator management in FY2003.

Managing System for Projects in FY2003



In FY2004, the Earth Simulator Advisory Committee has disbanded, and as a result, the role and authority of the Earth Simulator Advisory Committee was transferred to the Mission Definition Committee.

3. Earth Simulator Research Project

Public project recruitment for the Earth Simulator Research Projects in FY2003 was held in February 2003 and **34 research projects** were accepted out of 53 proposals.

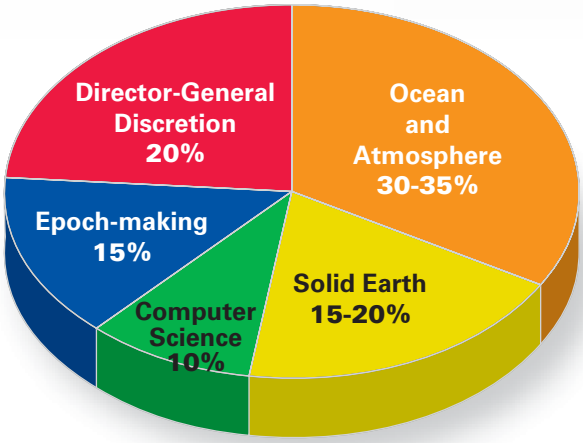
There are four fields of the Earth Simulator Research Projects as follows:

- Atmospheric and Oceanic Simulation
- Solid Earth Simulation
- Computer Science
- Epoch-making Simulation

The allocation of resources of the Earth Simulator is planned by Mission Definition Committee each fiscal year. The allocation of resources for each research fields in FY2003 was decided as following circle graph.

International Collaboration Projects were carried out under the allocation of Director-General Discretion.

The allocation of resources of the Earth Simulator in FY2003



Authorized Projects in FY2003

Atmospheric & Oceanic Simulation (12 projects)

Title	Name	Affiliation
Development of super high-resolution atmospheric and oceanic general circulation models on quasi-uniform grids	Yukio Tanaka	FRSGC, JAMSTEC
Atmospheric Composition Change and Its Climate Impact Studied by global and Regional Chemical Transport Models	Hajime Akimoto	FRSGC, JAMSTEC
Development of High-resolution Cloud-resolving Regional Model and its Application to Research on Mesoscale Meteorology	Fujio Kimura	FRSGC, JAMSTEC
Process Studies and Seasonal Prediction Experiment using Coupled General Circulation Model	Toshio Yamagata	FRSGC, JAMSTEC
Future Climate Change Projection using a High-Resolution Coupled Ocean-Atmosphere Climate Model	Akimasa Sumi	Center for Climate System Research, The University of Tokyo

Development of high-resolution atmosphere-ocean coupled model and global warming prediction	Kouki Maruyama	Central Research Institute of Electric Power Industry
Research on development of global climate model with remarkably high resolution and climate model with cloud resolution	Takashi Aoki	Japanese Meteorological Research Institute
Research Development of 4-dimensional data assimilation system using a coupled climate model and construction of reanalysis datasets for initialization	Toshiyuki Awaji	FRSGC, JAMSTEC
Development of Integrated Earth System Model for Global Change Prediction	Taro Matsuno	FRSGC, JAMSTEC
Parameterization of turbulent diffusivity in the deep ocean	Toshiyuki Hibiya	Graduate School of Science, The University of Tokyo
Mechanism and predictability of atmospheric and oceanic variations induced by interactions between large-scale field and meso-scale phenomena(AFES CFES OFES)	Wataru Ofuchi	ESC, JAMSTEC
Development of holistic simulation codes on non-hydrostatic atmosphere-ocean coupled system	Keiko Takahashi	ESC, JAMSTEC

Solid Earth Simulation (9 projects)

Title	Name	Affiliation
Global elastic response simulation	Seiji Tsuboi	IFREE, JAMSTEC
Simulation study on the generation and distortion process of the geomagnetic field in Earth-like conditions	Yozo Hamano	IFREE, JAMSTEC / Graduate School of Science, The University of Tokyo
Numerical simulation of the mantle convection	Yoshio Fukao	IFREE, JAMSTEC
Predictive Simulation for Crustal Activity in and around Japan	Mitsuhiro Matsuura	Graduate School of Science, The University of Tokyo
Numerical simulation of seismic wave propagation and strong ground motions in 3-D heterogeneous media	Takashi Furumura	Earthquake Research Institute, The University of Tokyo
Simulation of Earthquake Generation Process in a Complex System of Faults	Kazuro Hirahara	Graduate School of Environmental Studies, Nagoya University
Development of Solid Earth Simulation Platform	Hiroshi Okuda	Research into Artifacts, Center for Engineering, The University of Tokyo
Simulator experiments of physical properties of earth's materials	Mitsuhiro Toriumi	Graduate School of Frontier Science, The University of Tokyo
Dynamics of Core-Mantle Coupled System	Akira Kageyama	ESC, JAMSTEC

Computer Science (2 projects)

Title	Name	Affiliation
Designing and implementation of parallel numerical computing library for multi-node environment of the earth simulator	Kenichi Itakura	ESC, JAMSTEC
Performance Evaluation of Large-scale Parallel Simulation Codes and Designing New Language Features on the HPF(High Performance Fortran) Data-Parallel Programming Environment	Yasuo Okabe	Academic Center for Computing and Media Studies, Kyoto University

Epoch-making Simulation (11 projects)

Title	Name	Affiliation
Numerical Simulation of Rocket Engine Internal Flows	Hiroshi Miyajima	Japan Aerospace Exploration Agency
Large-scale simulation on the properties of carbon-nanotube	Kazuo Minami	Research Organization for Information Science & Technology
Development of the next-generation computational solid mechanics simulator for a virtual demonstration test	Ryuji Shioya	Graduate School of Engineering, Kyushu University
Study of the Standard Model of Elementary Particles on the Lattice with the Earth Simulator	Akira Ukawa	Center for Computational Physics and Institute of Physics, University of Tsukuba
Large-scale simulation for a Tera Hz resonance superconductorsdevice	Masashi Tachiki	National Institute for Material Science
Geospace Environment Simulator	Yoshiharu Omura	Radio Science Center for Space and Atmosphere, Kyoto University
Particle modeling for complex multi-phase system with internal structures using DEM	Hide Sakaguchi	IFREE, JAMSTEC
Development of Transferable Materials Information and Knowledge Base for Computational Materials Science	Shuhei Ohnishi	CAMP (Collaborative Activities for Materials Science Programs) Group
Cosmic Structure Formation and Dynamics	Ryoji Matsumoto	Faculty of Science, Chiba University
Bio-Simulation	Nobuhiro Go	Forum on the Bio-Simulation
Large scale simulation on the atomic research*	Hiroshi Okuda	Atomic Energy Society of Japan

***Sub-theme under the "Large scale simulation on the atomic research"**

Title	Name	Affiliation
Large-Scale Numerical Simulations of Complicated Thermal-Hydraulic Behavior in Nuclear Reactors Using Direct Analysis Methods	Kazuyuki Takase	JAERI
First Principles Molecular Dynamics Simulation of Solution	Masaru Hirata	JAERI
Direct Numerical Simulations of Fundamental Turbulent Flows with the Largest Grid Numbers in the World and its Application of Modelling for Engineering Turbulent Flows	Chuichi Arakawa	CCSE, JAERI
Research on structure formation of plasmas dominated by hierarchical dynamics	Yasuaki Kishimoto	JAERI
Large-scale parallel fluid simulations for spallation type mercury target adopted in the project of high-intensity proton accelerator.	Chuichi Arakawa	CCSE, JAERI
Studies for Novel Superconducting properties and Neutron Detector Applications by Superconductor Nano-fabrication Techniques	Masahiko Machida	CCSE, JAERI
Electronic and atomistic simulations on the irradiation induced property changes and fracture in materials	Hideo Kaburaki	CCSE, JAERI
Large-Scale Simulation of Groundwater Flow and Radioactive Nuclide Transportation	Hiroshi Okuda	Research into Artifacts, Center for Engineering, The University of Tokyo
First-principles molecular dynamics simulation of oxide layers for radiation-tolerant SiC devices	Atumi Miyashita	JAERI

JAMSTEC : Japan Marine Science & Technology Center
FRSGC : Frontier Research System for Global Change
IFREE : Institute for Frontier Research on Earth Evolution
JAERI : Japan Atomic Energy Research Institute
CCSE : Center for Promotion of Computation Science and Engineering
ESC : The Earth Simulator Center

4. International Collaboration Projects

We place a special emphasis on elevating a world-wide power of simulation science and technology. As one way of achieving this task, we are doing our best to promote an international collaboration based on the institution-to-institution agreement.

International Collaboration Projects as of March 2004

SIO - Scripps Institution of Oceanography, USA
HCCPR - Hadley Centre for Climate Prediction and Research / The Met Office, UK
CGAM - Centre for Global Atmospheric Modelling / NERC Centres for Atmospheric Science, UK
CIRA - Italian Aerospace Research Center, Italy
RPN/MSC - Numerical Prediction Research Division, Environment Canada Meteorological service of Canada, Canada
NERSC - National Energy Research Scientific Computing Center, USA
CCV/ICES/UT - Center for Computational Visualization, Department of Computer Sciences and Institute for Computational Engineering and Sciences, The University of Texas, USA
CNRS - French National Centre for Scientific Research, France
IFREMER - French Research Institute for Exploitation of the Sea, France

5. System Configuration of the Earth Simulator

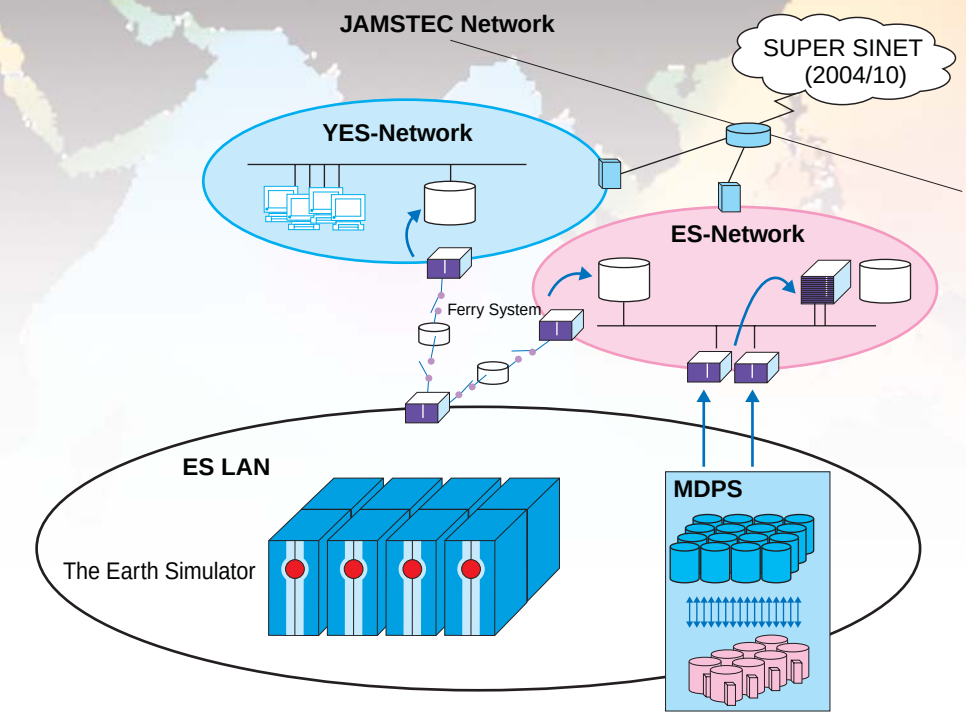
The Earth Simulator is a highly parallel vector supercomputer system of the distributed-memory type, and consisted of 640 processor nodes (PNs) connected by 640x640 single-stage crossbar switches. Each PN is a system with a shared memory, consisting of 8 vector-type arithmetic processors (APs), a 16GB main memory system (MS), a remote access control unit (RCU), and an I/O processor. The peak performance of each AP is 8Gflops. The ES as a whole thus consists of 5120 APs with 10 TB of main memory and the theoretical performance of 40Tflops.

Specification of the Earth Simulator

Peak performance/AP	8Gflops	Total number of APs	5120
Peak performance/PN	64Gflops	Total number of PNs	640
Shared memory/PN	16GB	Total peak performance	40Tflops
		Total main memory	10TB

From October 2003, MDPS (Mass Data Processing System) was installed as a new data storage system, which renews the archive system. It consists of four file service processors, 250TB disks, and a currently used 1.5 PB cartridge tapes library (CTL). MDPS was adopted aiming to improve manageability for a data transmission performance and access.

Network around the Earth Simulator

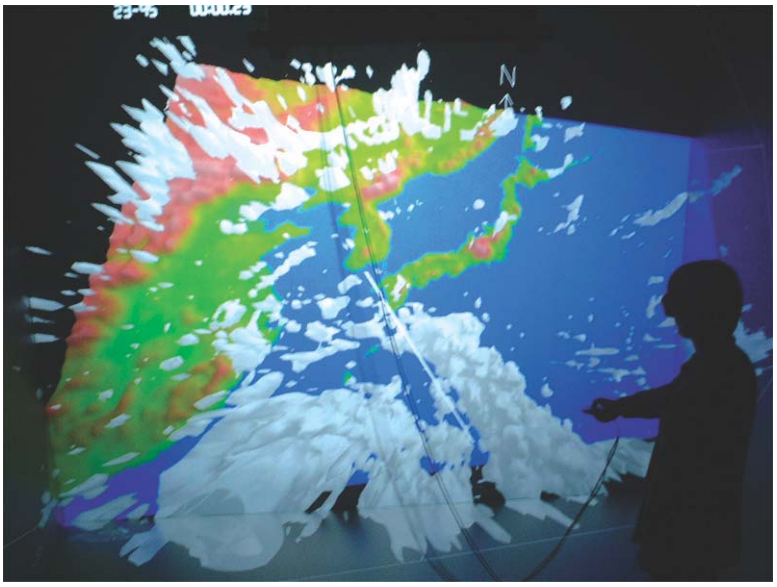


YES：Yokohama Institute for Earth Sciences

6. Visualization

In 2003, we introduced the Earth Simulation Virtual Reality System, BRAVE(Booth for Resolving Aspects of Virtual Earth), which is a visualization environment that the images on each of four big screens (3m x 3m)of right and left, front, and floor side can be projected deeply from different angles and observes inside can view as three-dimension images.

BRAVE



7. History and Event Calendar

Year 2002

Mar 6	1st Orientation for users
Mar 11	2nd Orientation for users
Mar 15	Opening Ceremony at the Earth Simulator Center
May 3	35.86 Tflops at Linpack test
Jun 5	1st Mission Definition Committee
Jun 20	TOP500 Award at Heidelberg
Jun 21-30	Public project recruitment of FY2002
Jul 10	1st Selection Committee
Jul 16	Start of the Authorized project
Sep 28	1st Earth Simulator Center Symposium "Harmonious Relationship between the Earth and Mankind"
Oct 23	2nd Mission Definition Committee
Nov 1-30	Additional Public project recruitment of FY2002
Nov 22	Gordon Bell Award at SC2002 in US; ・The Gordon Bell Award for Peak Performance ・The Gordon Bell Award for Language (special category) ・Three additional papers earned Gordon Bell Awards for special accomplishment
Dec 13	2nd Selection Committee
Dec 24	Start of the additional authorized project

Year 2003

Feb 1 & 2	Annual Meeting of the Earth Simulator projects in FY2002
Feb 28	3rd Advisory Committee
Mar 5	3rd Mission Definition Committee
Mar 12-30	Public project recruitment of FY2003
Apr 10	3rd Selection Committee
Apr 19	Open House of Yokohama Institute for Earth Sciences
Jun 3	2003 Computerworld Honors 21st-Century Achievement Awards in the Environment, Energy & Agriculture category
Jun 19	2nd Earth Simulator Center Symposium "A message from another Earth"
Aug 21	4th Mission Definition Committee
Nov 21	Gordon Bell Award at SC2003 in US; ・The Gordon Bell Award for Peak Performance

Year 2004

Jan 10-11	Annual Meeting of the Earth Simulator projects in FY2003
Jan 21	4th Advisory Committee
Jan 22	5th Mission Definition Committee
Feb 2-29	Public project recruitment of FY2004
Mar 11	4th Selection Committee
Mar 19	Tokyo Creation Award 2003