

Outline of the Earth Simulator Project

1. Mission and Basic Principles of the Earth Simulator

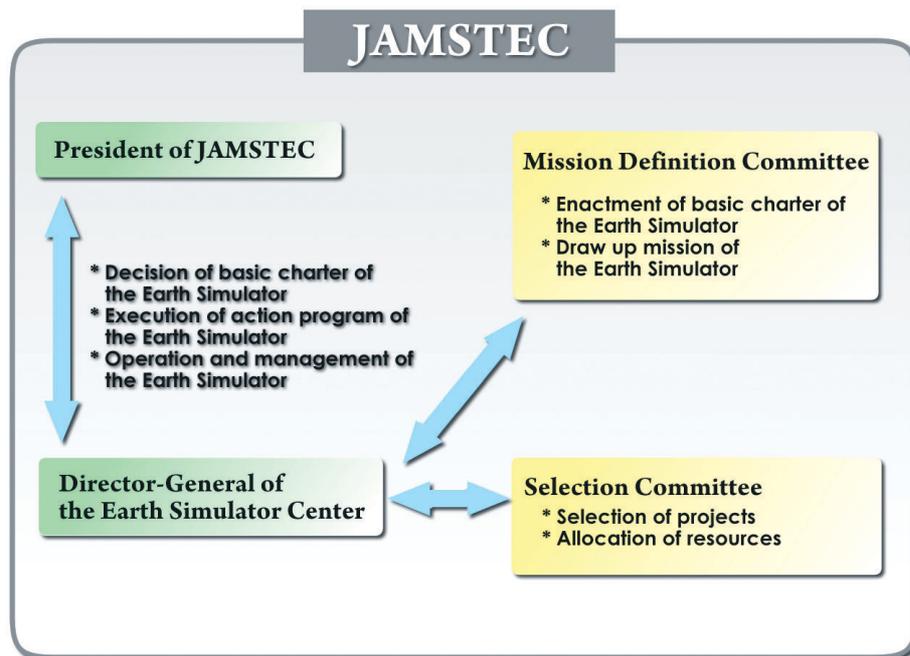
The Earth Simulator was developed for the following aims. The first aim is to ensure a bright future for human beings by accurately predicting variable global environment. The second is to contribute to the development of science and technology in the 21st century. Based on these aims, four principles are established for the projects of the Earth Simulator.

- 1) Each project should be open to researches in each research field and to the public, rather than it is confined within the limited research society.
- 2) In principle, the research achievements obtained by using the Earth Simulator should be promptly published and returned to the public.
- 3) The Mission Definition Committee will examine the 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

The Earth Simulator Project is managed under policy which is decided by the Mission Definition Committee and the Selection Committee. The Mission Definition Committee enacts the basic charter of the Earth Simulator and draws up its mission. Research projects using the Earth Simulator are selected by the Selection Committee every year.

Fig. 1 Managing System for the Earth Simulator Project



3. Earth Simulator Research Project

There are three fields of Earth Simulator Research Projects, as follows:

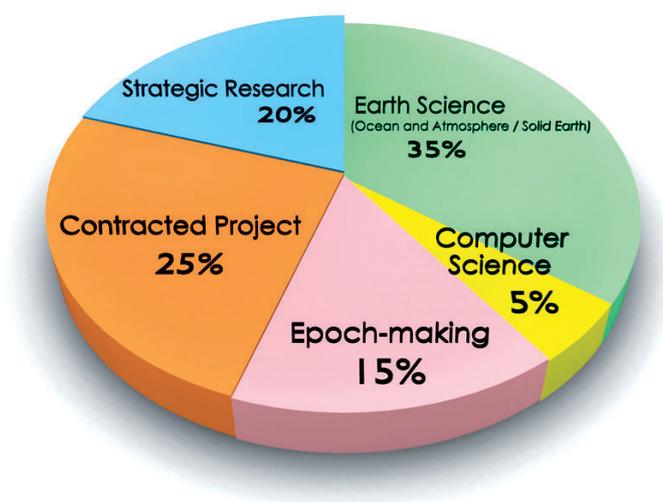
- Earth Science
- Computer Science
- Epoch-making Simulation

Allocation of the Earth Simulator resources is planned by the Mission Definition Committee each fiscal year. The allocation of resources for each research field in FY2006 was decided to be as shown in following graph (Fig. 2).

Public project recruitment for Earth Simulator Research Projects in FY2006 was held in February 2006, and 40 research projects were selected by the Selection Committee. The allocation of resources for each project was also decided by the Selection Committee.

International Collaboration Projects were carried out under the allocation of Strategic Research.

Fig. 2 The Allocation of Resources of the Earth Simulator in FY2006



Authorized Projects in FY2006

Earth Science (18 projects)

	Title	Project leader	Affiliation of project leader
1	Atmospheric Composition Change and its Climate Effect Studied by Chemical Transport Models	Hajime Akimoto	FRCGC, JAMSTEC
2	Understanding and Forecasting High-Impact Phenomena in the Atmosphere and Ocean	Wataru Ofuchi	ESC, JAMSTEC
3	Study on the Diagnostics and Projection of Ecosystem Change Associated with Global Change	Eitaro Wada	FRCGC, JAMSTEC
4	Multi-Scale Weather/Climate Simulations with Coupled Non-hydrostatic Ocean-Atmosphere GCM on the Earth Simulator	Keiko Takahashi	ESC, JAMSTEC
5	Study on the Mechanism of Climate and Ocean Variability and Their Predictability	Toshio Yamagata	FRCGC, JAMSTEC

6	Development of a Numerical Model of Urban Heat Island	Yasunobu Ashie	Building Research Institute
7	Development of a High-Resolution Coupled Atmosphere-Ocean-Land General Circulation Model for Climate System Studies	Tatsushi Tokioka	FRCGC, JAMSTEC
8	Northern North Atlantic Deep Water Formation Studied by an Eddy-Resolving Coupled Sea Ice-Ocean Circulation Model	Hiroyasu Hasumi	Center for Climate System Research, The University of Tokyo
9	Simulations of Atmospheric General Circulations of Earth-like Planets by AFES	Yoshiyuki Hayashi	Graduate School of Science, Hokkaido University
10	Global Elastic Response Simulation	Seiji Tsuboi	IFREE, JAMSTEC
11	Simulation Study on the Generation and Distortion Process of the Geomagnetic Field in Earth-like Conditions	Yozo Hamano	IFREE, JAMSTEC
12	Numerical Simulation of the Mantle Convection	Yoshio Fukao	IFREE, JAMSTEC
13	Predictive Simulation for Crustal Activity in and around Japan	Mitsuhiro Matsuura	Graduate School of Science, The University of Tokyo
14	Numerical Simulation of Seismic Wave Propagation and Strong Ground Motions in 3-D Heterogeneous Media	Takashi Furumura	Earthquake Research Institute, The University of Tokyo
15	Simulation of Earthquake Generation Process in a Complex System of Faults	Kazuro Hirahara	Graduate School of Science, Kyoto University
16	Development of Advanced Simulation Tools for Solid Earth Sciences	Akira Kageyama	ESC, JAMSTEC
17	Numerical Simulation of Physical Properties of Earth's Materials	Mitsuhiro Toriumi	Graduate School of Frontier Sciences, The University of Tokyo
18	Numerical Simulations of the Dynamics of Volcanic Phenomena	Takehiro Koyaguchi	Earthquake Research Institute, The University of Tokyo

Computer Science (2 projects)

	Title	Project leader	Affiliation of project leader
19	Development of Multi-Scale Coupled Simulation Algorithm	Kanya Kusano	ESC, JAMSTEC
20	Development of General Purpose Numerical Software Infrastructure for Large Scale Scientific Computing	Akira Nishida	21st Century Center of Excellence Program, Chuo University

Epoch-making Simulation (20 projects)

	Title	Project leader	Affiliation of project leader
21	Numerical Simulation of Rocket Engine Internal Flows	Nobuyuki Tsuboi	Japan Aerospace Exploration Agency
22	Large-Scale Simulation on the Properties of Carbon-Nanotube	Kazuo Minami	Research Organization for Information Science & Technology

23	Development of the Next-generation Computational Solid Mechanics Simulator for a Virtual Demonstration Test	Ryuji Shioya	Graduate School of Engineering, Kyushu University
24	Large-Scale Simulation for a Terahertz Resonance Superconductors Device	Masashi Tachiki	Research Organization for Information Science & Technology
25	Geospace Environment Simulator - Evaluation of Spacecraft Environment -	Yoshiharu Omura	Research Institute for Sustainable Humansphere, Kyoto University
26	Particle Modeling for Complex Multi-Phase System with Internal Structures using DEM	Hide Sakaguchi	IFREE, JAMSTEC
27	Cosmic Structure Formation and Dynamics	Ryoji Matsumoto	Faculty of Science, Chiba University
28	Direct Numerical Simulations of Fundamental Turbulent Flows with the Largest Grid Numbers in the World and its Application of Modeling for Engineering Turbulent Flows	Chuichi Arakawa	Interfaculty Initiative in Information Studies, Graduate School of Interdisciplinary Information Studies, The University of Tokyo
29	Large-Scale Softmaterial Simulation on Drug Delivery System	Atsushi Miyauchi	Research Organization for Information Science & Technology
30	Nano-Simulation of Electrode Reaction in Fuel Cells	Tamio Ikeshoji	Research Institute for Computational Sciences, National Institute of Advanced Industrial Science and Technology
31	Synergetic Simulation Study on Cross-Hierarchy Complex Physics in High-Temperature Plasmas	Tomohiko Watanabe	Theory and Data Analysis Division, National Institute for Fusion Science
32	Revolutionary Simulation Software for the 21st Century	Chisachi Kato	Institute of Industrial Science, The University of Tokyo
33	Study on Numerical Predictions of Complicated Thermal-Hydraulic Dynamics in Nuclear Reactors by Large-Scale Simulations	Kazuyuki Takase	Japan Atomic Energy Agency
34	Numerical Studies for Novel Superconducting Properties and Neutron Detector Applications by Superconductor Nano-fabrication Techniques	Masahiko Machida	Japan Atomic Energy Agency
35	Electronic and Atomistic Simulations on the Irradiation Induced Property Changes and Fracture in Materials	Hideo Kaburaki	Japan Atomic Energy Agency
36	First-Principles Molecular Dynamics Simulation of Oxide Layers for Radiation-Tolerant SiC Devices	Atsumi Miyashita	Japan Atomic Energy Agency
37	A Large-Scale Post-Genome Analysis using Self-Organizing Map for All Genome and Protein Sequences	Toshimichi Ikemura	Nagahama Institute of Bio-Science and Technology
38	Protein Folding Simulations from the First Principles	Yuko Okamoto	Graduate School of Science, Nagoya University
39	Analysis of the Function of a Large-Scale Supra-Biomolecule System by Molecular Dynamics Simulation	Atsushi Matsumoto	Japan Atomic Energy Agency

A light blue world map is visible in the background of the page, showing the continents and oceans.

40	Simulation of Damage of Wide Coastal Area due to the Huge Tsunami	Shigeo Takahashi	Port and Airport Research Institute
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JAMSTEC : Japan Agency for Marine-Earth Science and Technology

FRCGC : Frontier Research Center for Global Change

IFREE : Institute for Research on Earth Evolution

ESC : The Earth Simulator Center

4. International Collaboration Projects

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

Table 1 International Collaboration Projects in FY 2006

Scripps Institution of Oceanography, USA
Met Office Hadley Centre, UK
NCAS-Climate, University of Reading, UK
Italian Aerospace Research Center, Italy
Recherche en Prévision Numérique, Meteorological Service of Canada, Canada
National Energy Research Scientific Computing Center, USA
Computational Visualization Center, The University of Texas at Austin, USA
Centre National de la Recherche Scientifique, France
Institut Français de Recherche pour l'Exploitation de la Mer, France
Department of Geology and Geophysics, University of Minnesota, USA
International Arctic Research Center , University of Alaska Fairbanks, USA
National Applied Research Laboratories, Taiwan
Meraka Institute, South Africa
Institute of High Performance Computing, Singapore

5. Domestic Collaboration Projects

In addition to international collaboration projects, we also pursue research activities based on domestic collaboration, especially for industrial researches. We will continue to promote collaboration with them more strongly.

Table 2 Domestic Collaboration Projects in FY 2006

Automobile Simulation: Japan Automobile Manufacturers Association, Inc.
Aerodynamic Simulation: School of Engineering, Tohoku University, Japan Aerospace Exploration Agency, Mitsubishi Heavy Industries, Ltd.
Ink and Printing Simulation: The Intec Inc., Institute for Research on Earth Evolution, JAMSTEC
Simulation of building damage by earthquake: Osaka University
Simulation of urban climate change: Building Research Institute
Modeling and simulations of a coupled system of wind turbine generators with multi-scale simulator for the geoenvironment (MSSG): The University of Tokyo
Data assiilation based on ensemble Kalman filtering: Chiba Institute of Science, Japan Meteorological Agency

6. System Configuration of the Earth Simulator

The Earth Simulator is a highly parallel vector supercomputer system of the distributed-memory type, consisting 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 16 GB main memory system (MS), a remote access control unit (RCU), and an I/O processor. The peak performance of each AP is 8 Gflops. Thus, the ES as a whole consists of 5120 APs with 10 TB of main memory and theoretical performance of 40 Tflops.

Table 3 Specification of the Earth Simulator

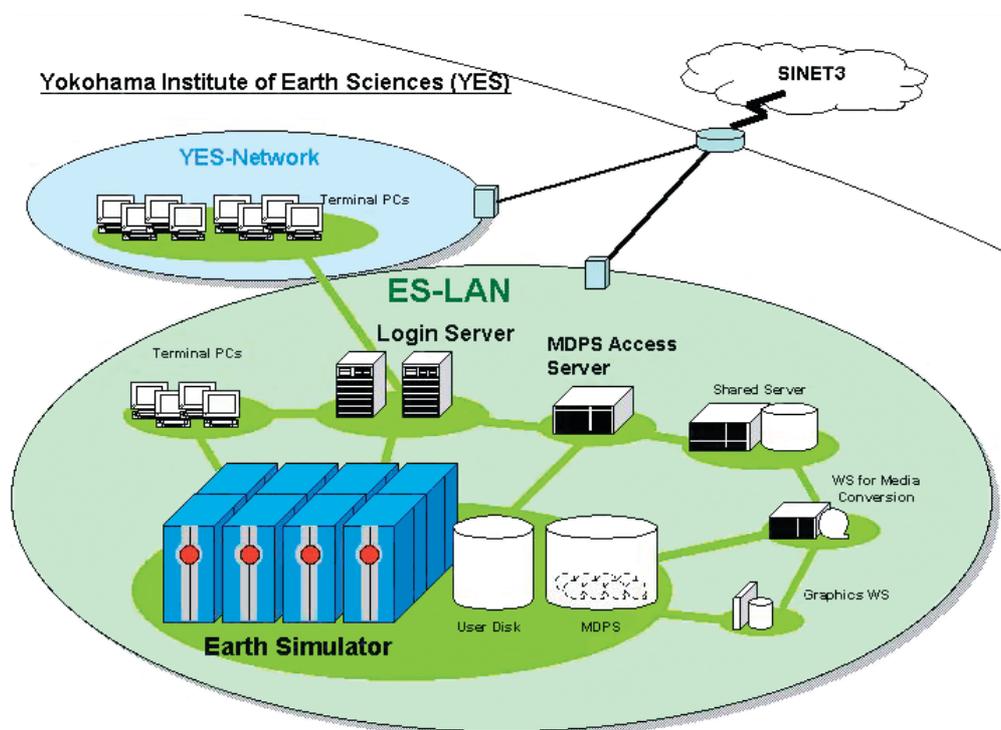
Peak performance/AP	8 Gflops	Total number of APs	5120
Peak performance/PN	64 Gflops	Total number of PNs	640
Shared memory/PN	16 GB	Total peak performance	40 Tflops
		Total main memory	10 TB

From October 2003, an 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, 250 TB disks, and a currently used 1.8 PB cartridge tapes library (CTL). The MDPS was adopted in order to improve manageability for data transmission performance and access.

In April 2007, the Earth Simulator Center/JAMSTEC was connected with the SINET3(*), which is expected to contribute to effective use of data obtained from the Earth Simulator.

(*) The SINET3 is an ultra-high-speed network operated by the National Institute of Informatics (NII).

Fig. 3 Network Composition around the Earth Simulator



7. History and Event Calendar

Year 2001

Apr. 1	The Earth Simulator Center established as part of Japan Marine Science and Technology Center.
Dec. 1	Prof. Tetsuya Sato became director of the Earth Simulator Center.
Dec. 7	1 st Advisory Committee

Year 2002

Jan. 28	2 nd Advisory Committee
Mar. 1	Operation of the Earth Simulator
Mar. 6	1 st Orientation of the Earth Simulator users
Mar. 11	2 nd Orientation of the Earth Simulator users
Mar. 15	Opening Ceremony at the Earth Simulator Center
Apr. 18	Earth Simulator achieved 35.61 Tflops using Linpack HPC, registered as No.1 in the Linpack report dated April 17, 2002. (Press release by JAMSTEC)
Jun. 5	1 st meeting of the Mission Definition Committee
Jun. 20	Earth Simulator certified as the world's fastest supercomputer, with performance of 35.86 Tflops, in the TOP500 list of June 2002.
Jun. 21-30	Public project recruitment of FY2002
Jul. 10	1 st Selection Committee
Jul. 16	Start of the authorized projects of FY2002
Sep. 28	1 st Earth Simulator Center Symposium at Pacifico Yokohama "Harmonious Relationship between the Earth and Mankind"
Oct 23	2 nd Mission Definition Committee
Nov. 1-30	Additional public project recruitment of FY2002
Nov. 20	Earth Simulator certified as the fastest supercomputer, in the TOP500 list of November 2002.
Nov. 21	Gordon Bell Awards at SC2002 in US; <ul style="list-style-type: none"> • "A 26.58 Tflops Global Atmospheric Simulation with the Spectral Transform Method on the Earth Simulator" (Award for Peak Performance) • "14.9 Tflops Three-dimensional Fluid Simulation for Fusion Science with HPF on the Earth Simulator" (Award for Language) • "16.4 Tflops Direct Numerical Simulation of Turbulence by a Fourier Spectral Method on the Earth Simulator" (Awards for special accomplishment)
Dec. 13	2 nd Selection Committee
Dec. 24	Start of the additional authorized projects of FY2002

Year 2003

Feb. 1-2	Annual Meeting for research projects in FY2002
Feb. 28	3 rd Advisory Committee
Mar. 5	3 rd Mission Definition Committee
Mar. 12-30	Public project recruitment of FY2003
Apr. 10	3 rd Selection Committee
Apr. 19	Open House of Yokohama Institute for Earth Sciences
Jun. 3	Won the 2003 Computerworld Honors 21 st - Century Achievement Awards in the Environment, Energy & Agriculture category

Jun. 19	2 nd Earth Simulator Center Symposium at NATIONAL MUSEUM OF EMERGING SCIENCE AND INNOVATION (TOKYO) "Harmonious Relationship between the Earth and Mankind~A message from another Earth"
Jun. 25	Earth Simulator certified as the fastest supercomputer, in the TOP500 list of June 2003.
Aug. 21	4 th Mission Definition Committee
Nov. 16	Earth Simulator certified as the fastest supercomputer, in the TOP500 list of November 2003.
Nov. 20	Won the Gordon Bell Award at SC2003 in U.S.; • "A 14.6 Billion Degrees of Freedom, 5 Teraflop/s, 2.5 Terabyte Earthquake Simulation on the Earth Simulator" (Award for Peak Performance)

Year 2004

Jan. 10-11	Annual Meeting for research projects in FY2003
Jan. 21	4 th Advisory Committee
Jan. 22	5 th Mission Definition Committee
Feb. 2-29	Public project recruitment of FY2004
Mar. 11	4 th Selection Committee
Mar. 19	Won the Tokyo Creation Award 2003
Apr. 1	Start of the authorized project of FY2004
Apr. 17	Open House of Yokohama Institute for Earth Sciences
May. 20	Won the IPSJ Industrial Achievement Award
Jun. 16	ESC made a contract with the Japan Automobile Manufacturers Association for collaborative research.
Jun. 23	Earth Simulator certified as the fastest supercomputer, in the TOP500 list of June 2004.
Sep. 15	1 st meeting of the reorganized Mission Definition Committee
Oct. 13	3 rd Earth Simulator Center Symposium at Iino Hall (Tokyo) "A Harmonious Relationship between the Earth and Mankind ~ the Earth is changing this way"
Oct. 25	ESC made a contract with the Institute of Economic Research of Hitotsubashi University for collaborative research.
Nov. 11	Won the Gordon Bell Award at SC2004 conference in U.S.; • "A 15.2 TFlops Simulation of Geodynamo on the Earth Simulator" (Award for Peak Performance)
Nov. 29	Mid-term Evaluating Committee starts evaluating the research activities associated with the Earth Simulator.

Year 2005

Jan. 7-8	Annual Meeting for research projects in FY2004
Jan. 13	2 nd Mission Definition Committee
Jan. 19	Initiation of international collaborative research with Hadley Centre for Climate Prediction and Research
Feb. 2-28	Public project recruitment of FY2005
Mar. 10	5 th Selection Committee
Mar. 25- Spt. 25	EXPO 2005 AICHI JAPAN was held in Aichi Prefecture and the visual contents associated with the Earth Simulator were displayed.
Apr. 1	Start of the authorized project of FY2005
Apr. 16	Open House of the Yokohama Institute for Earth Sciences
May. 16	"The Program for Strategic Use of Advanced Large Research Facilities" project recruitment of FY2005
Jun. 13	3 rd Mission Definition Committee

Jul. 1	Starting "The Remote Batch Job Entry for Earth Simulator", for all users using the Earth Simulator inside and outside the country
Jul. 8	Start of the authorized "The Program for Strategic Use of Advanced Large Research Facilities" projects of FY2005
Jul. 12-15	Prof. Tetsuya Sato, the Director-General of the Earth Simulator Center, received the second John Dawson Prize at ICNSP&APPTC joint international conference.
Jul. 14	4 th Earth Simulator Center Symposium at Chiyoda Uchi-Saiwai-cho Hall "Harmonious Relationship between the Earth and Mankind~ The front of simulation science"
Sep. 1	Won "Global 100 Eco-Tech Awards", in EXPO 2005 AICHI JAPAN
Sep. 22	4 th Mission Definition Committee
Oct. 1	Start of the authorized "Core Research for Evolutional Science and Technology" projects of FY2005
Nov. 2	Dr. Sumi's project of "The Kyosei Project" (supported by MEXT) won "Nikkei Global Environmental Technology Award"
Dec. 15- Jan. 31	"The Program for Strategic Use of Advanced Large Research Facilities" project recruitment of FY2006

Year 2006

Jan. 6-8	Annual Meeting for research projects in FY2005
Jan. 8	5 th Mission Definition Committee
Jan. 20- Feb. 20	Public project recruitment of FY2006
Feb. 2	Dr. Kageyama, a project leader of Solid Earth Science research field, received JSPS (Japan Society for the Promotion Science) prize.
Mar. 8	6 th Selection Committee
Apr. 1	Start of the authorized project of FY2006
Apr. 15	Open House of the Yokohama Institute for Earth Sciences
Sep. 1	Conclusion of Collaborative Research Agreement between the ESC and Institute of High Performance Computing (Singapore) - International Cooperation on the advancement of scientific research and technological development in ocean and earth, and engineering sciences -
Sep. 22	5 th Earth Simulator Center Symposium at the Center for the Advancement of Working Women "Harmonious Relationship between the Earth and Mankind~The front of simulation science"
Sep. 29	Conclusion of Collaborative Research Agreement between the ESC and Business Development Division, National Applied Research Laboratories (Taiwan) - International Cooperation on hydrology/ meteorology modeling and simulation -
Nov. 1	Conclusion of Collaborative Research Agreement between the ESC/JAMSTEC and Building Research Institute - Collaborative research on abnormal weather in urban area by using the Earth Simulator -
Nov. 15	Conclusion of Joint Research Agreement among the ESC/JAMSTEC, Chiba Institute of Science and Japan Meteorological Agency - To develop technology of data assimilation based on ensemble Kalman filtering using the Earth Simulator -
Dec. 1	Conclusion of Joint Research Agreement between the ESC/JAMSTEC and University of Tokyo - To develop performance evaluation technology of wind turbine generator using the Earth Simulator -

Year 2007

Jan. 26-27	Annual Meeting for research projects in FY2006
Jan. 28	6 th Mission Definition Committee
Feb. 1-28	Public project recruitment of FY2007
Feb. 1	Conclusion of Collaborative Research Agreement between the ESC and Meraka Institute - International cooperation on Simulation Study and Human Capital Development -
Mar. 1	Conclusion of Joint Research Agreement between the ESC/JAMSTEC and Osaka University - Cooperative Simulation Study of Building Damage caused by Earthquake -
Mar. 5	7 th Selection Committee