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JAXA Supercomputer System Annual Report April 2016 – March 2017

Security and Information Systems Department
Japan Aerospace Exploration Agency (JAXA)

November 2017

Introduction of the Full Version of this Report

This brochure is the excerpt of the Annual report.

The full version of the reports are available on the net at JSS2 public relations web site.

JSS2 public relations web site: https://www.jss.jaxa.jp/jss_ar2016_e/

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Corresponding QR codes are also presented to access the pages easily.

Using them to get access to the pages would be greatly appreciated.

Editors Team for "JAXA Supercomputer System Annual Report April 2016 - March 2017"
Supercomputer Division
Security and Information Systems Department

JAXA Supercomputer System Annual Report
April 2016 – March 2017

Contents

【Abstract】

Aviation

Space

Basic Research

Other

Aviation (Inter-University Reserch)

Space (Inter-University Reserch)

Basic Reserch (Inter-University Reserch)

Outline of the system

In addition to SORA-MA, JSS2 consists of advanced systems such as SORA-LM, a large-scale memory system, SORA-PP, a pre-post system, SORA-FS, a file system and J-SPACE an archiving system(Fig1). JSS2 is also designed for energy saving by adoption of a water-cooling system. JSS2 is composed of these well-developed systems and eco-friendly policy.

In April 2016, SORA-MA was updated to the peak performance 3.49 PFLOPS and the total memory size 100 TiB. Since then, JSS2 has been fully operational.

For utilization of the supercomputer from remote locations via the Internet, JAXA has developed and examined the high-speed transfer technology that is 30 times faster than the conventional system.

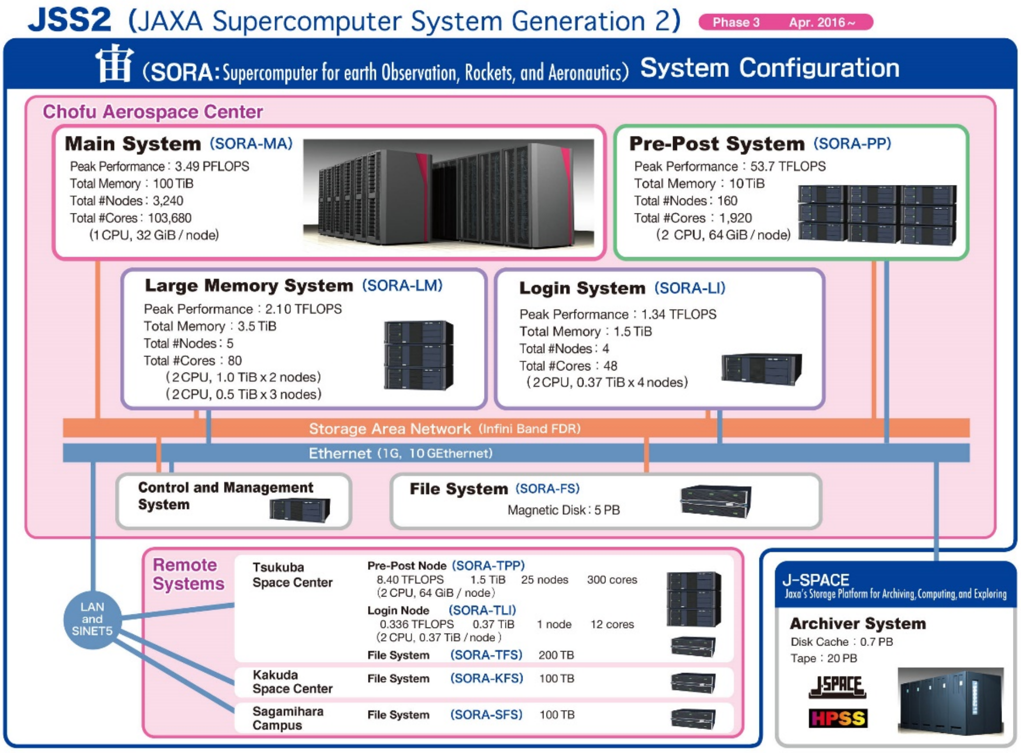


Fig1: JSS2 system configulation

Specification of JSS2 system is indicated in the Table 1-1.

Table 1-1: Main specification of JSS2 system (As of April first, 2016)

System name	Main System (SORA-MA)	Pre-Post System (SORA-PP)	Large Memory System (SORA-LM)	Tukuba Pre-Post System (SORA-TPP)
Model name	Fujitsu FX100	Fujitsu RX350 S8	Fujitsu RX350 S8	Fujitsu RX350 S8
Total #nodes	3,240	160	5	25
Peak performance	3.49PFLOPS	53.7TFLOPS	2.10TFLOPS	8.40TFLOPS
#cores/CPU	32	6	8	6
#CPUs/node	1	2	2	2
Memory size/node	32GB	64GB	1024/512GB	64GB

Numerical Study of Hypersonic Intake

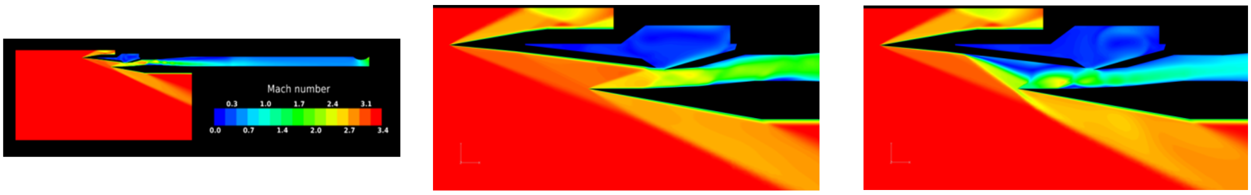
Report Number:R16E0105　　　　　　　　https://www.jss.jaxa.jp/ar/e2016/2112/

Inquires

Hidekazu Yoshida (gooden85@fuji.waseda.jp)

Abstract

JAXA develops the hypersonic turbojet engine which works at Mach 1 to 5. The intake of the hypersonic turbojet reduces air speed and compresses incoming air. We conducted the CFD analysis to understand these flow field that is not obvious in the experiment. We also aim to understand operating condition and develop higher efficiency hypersonic turbojet engine.



$h_{noz} = 11.1$　　　　$h_{noz} = 9.3$

Mach Number Contour(h_{th}=7.6)

Environment Conscious Aircraft Systems Research in Eco-wing Technology :Aerodynamic System Design Technology

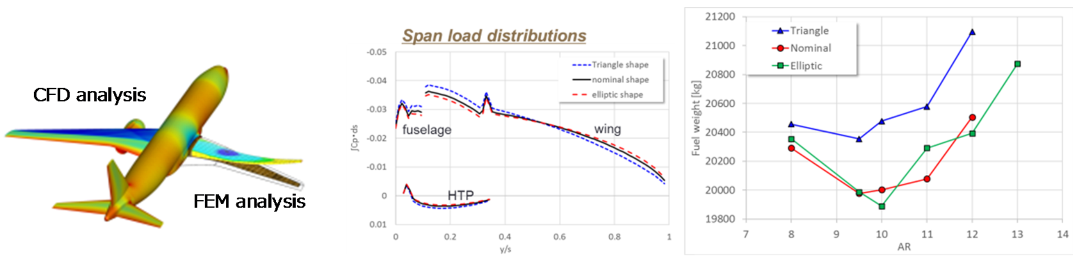
Report Number:R16E0001　　　　　　　　https://www.jss.jaxa.jp/ar/e2016/1912/

Inquires

Dongyoun Kwak (kwak.dongyoun@jaxa.jp)

Abstract

Innovative drag reduction technologies are investigated to reduce the fuel consumption for a conventional aircraft configuration. Aircraft noise prediction technologies and the conceptual design technologies are also developed for future aircraft which achieve low noise and high efficiency.



空力構造統合設計
Aero-structure coupled design

スパン方向の揚力分布
Spanwise load distributions

ARと揚力分布による燃料消費量
Fuel consumption on several wing AR and load distributions

Estimation of fuel consumption on three wings with different wing aspect ratio

Environment Conscious Aircraft Systems Research in Eco-wing Technology :Airframe-Engine Noise Reduction Technology

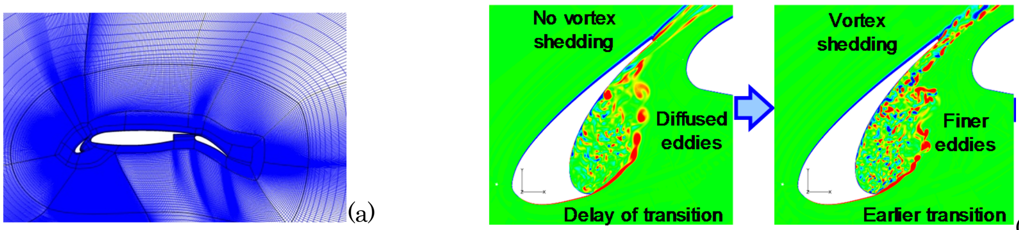
Report Number:R16E0002 https://www.jss.jaxa.jp/ar/e2016/1914/

Inquires

Dongyoun Kwak (kwak.dongyoun@jaxa.jp)

Abstract

Innovative drag reduction technologies are investigated to reduce the fuel consumption for a conventional aircraft configuration. Aircraft noise prediction technologies and the conceptual design technologies are also developed for future aircraft which achieve low noise and high efficiency.



3rd-order M-DDES 5th-order M-DDES

Comparison of the computational results using 3rd-order and 5th-order schemes.
(a) Computational grid, (b) Instantaneous spanwise vorticity contours around slat.

FINE: Flight Investigation of skiN-friction reducing Eco-coating

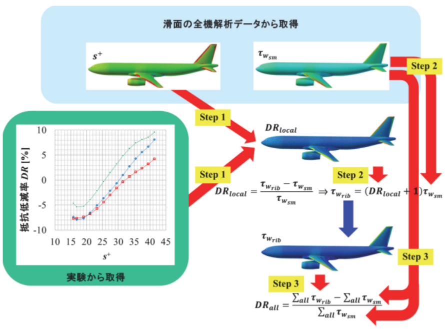
Report Number:R16E0003 https://www.jss.jaxa.jp/ar/e2016/1916/

Inquires

Mitsuru Kurita (kurita@chofu.jaxa.jp)

Abstract

FINE : Flight Investigation of skiN-friction reducing Eco-coating. The riblet reduces skinfriction on the surface of an airplane with turbulent boundary layer. An original technique for the riblet is developed in JAXA. In the FINE, the riblet is adopted on the fuselage of an experimental airplane Hisho in JAXA.



Estimation of drag-reducing performance of riblet applied to the whole body of an aircraft.

Computational Simulations for Aircraft Modification Design in the FQUROH Project

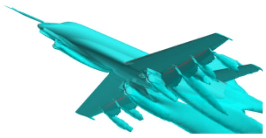
Report Number:R16E0027 https://www.jss.jaxa.jp/ar/e2016/1964/

Inquires

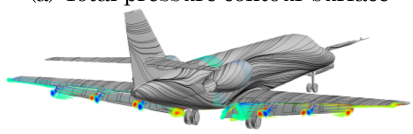
Yasushi Ito (ito.yasushi@jaxa.jp)

Abstract

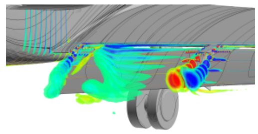
The FQUROH project aims at raising the technical maturity level of the noise reduction technology for high-lift devices and landing gear, which draws international attention to reduce noise in areas around airports, to a level applicable to future development of aircraft and related equipment. This contributes to reduction of aircraft noise in local communities around the airport and airline operating costs by reducing landing fee. One of the objectives of the FQUROH project is to verify the feasibility of practical noise reduction concepts and design methods based on advanced computational simulations through modification of aircraft.



(a) Total pressure contour surface



(b) Surface stream lines and *x* component of vorticity on cross-flow cross-sections around the flaps



(c) Enlarged view of b around the leeward inboard flap.

Hisho gear-down, 35° flap deflection angle configuration with flap and landing-gear low-noise devices for the flight test in 2017 (angle of attack of 0°, sideslip angle of 10°, wind speed of 175 kt)

Research on Airframe Noise Reduction Design in the FQUROH Project

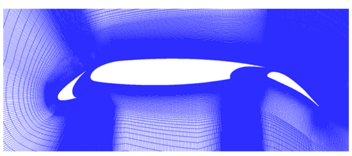
Report Number:R16E0028 https://www.jss.jaxa.jp/ar/e2016/1966/

Inquires

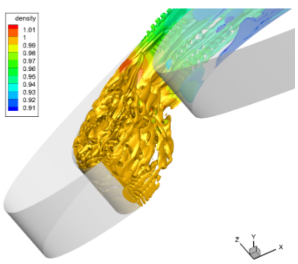
Yasushi Ito (ito.yasushi@jaxa.jp)

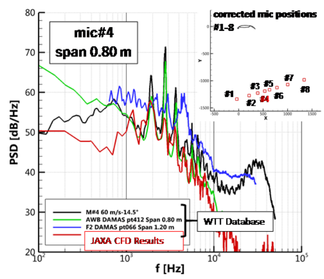
Abstract

This research is being carried out as part of the FQUROH project aimed at raising the technical maturity level of the noise reduction technology for high-lift devices and landing gear, which draws international attention to reduce noise in areas around airports, to a level applicable to future development of aircraft and related equipment. This contributes to reduction of aircraft noise in local communities around the airport and airline operating costs by reducing landing fee.



(a) Computational grid





(b) Example of computational results (Left: Iso-surface of streamwise vorticities colored by density; Right: Evaluation of far-field noise level)

Validation study of a CFD unsteady flow problem through a benchmarking problem on slat noise.

Cooperative Research on Landing Gear in the FQUROH Project

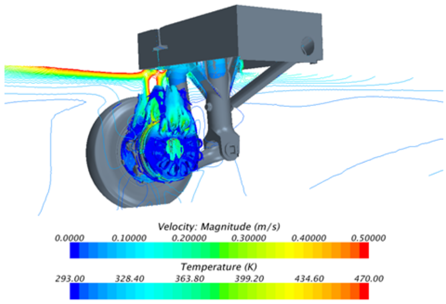
Report Number:R16E0030　　　　https://www.jss.jaxa.jp/ar/e2016/1970/

Inquires

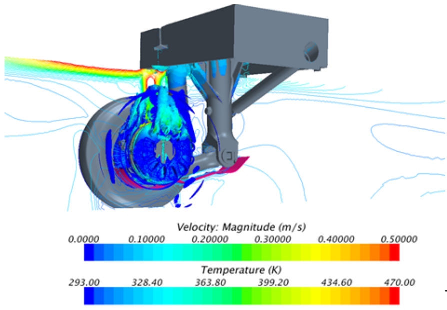
Yasushi Ito (ito.yasushi@jaxa.jp)

Abstract

This collaborative research with Sumitomo Precision Products is being carried out as part of the FQUROH project aimed at raising the technical maturity level of the noise reduction technology for landing gear, which draws international attention to reduce noise in areas around airports, to a level applicable to future development of aircraft and related equipment. This contributes to reduction of aircraft noise in local communities around the airport and airline operating costs by reducing landing fee.



a)



b)

Temperature distributions on a vorticity contour surface and flow velocity distributions on a cross-section across the tire in an early stage of cooling down the main landing gear of Hisho under a no-wind landing condition.

Cooperative Research on High Lift Devices in the FQUROH Project

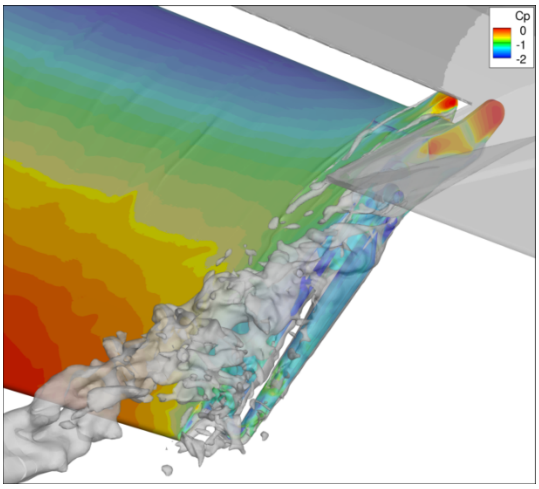
Report Number:R16E0029　　　　https://www.jss.jaxa.jp/ar/e2016/1968/

Inquires

Yasushi Ito (ito.yasushi@jaxa.jp)

Abstract

This collaborative research with Kawasaki Heavy Industries is being carried out as part of the FQUROH project aimed at raising the technical maturity level of the noise reduction technology for high-lift devices, which draws international attention to reduce noise in areas around airports, to a level applicable to future development of aircraft and related equipment. This contributes to reduction of aircraft noise in local communities around the airport and airline



Unsteady CFD analysis around outboard flap tip of Hisho

Aircraft gust alleviation technology

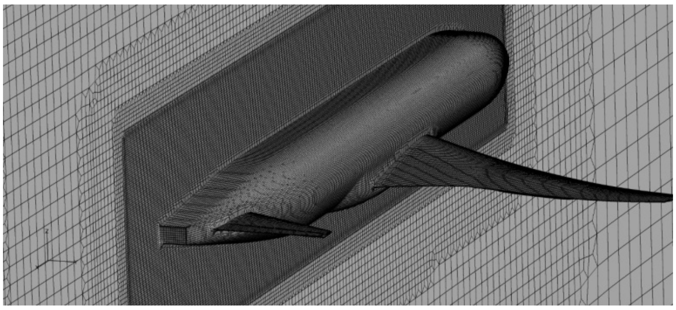
Report Number:R16E0031 https://www.jss.jaxa.jp/ar/e2016/1972/

Inquires

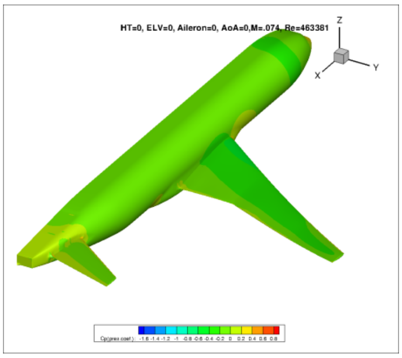
Kenichi Saitoh (ksaitoh@chofu.jaxa.jp)

Abstract

In the research and development of aircraft gust alleviation technology, we aim to reduce the accident in the cabin hit by clear air turbulence. To suppress such an aircraft motion, we are developing a control technology using LIDAR which detects the turbulence. Currently, we are verifying the theory by the wind tunnel test.



Grid for analysis



Sample of pressure distribution

Collaborative work for aerodynamic optimization

Report Number:R16E0036 https://www.jss.jaxa.jp/ar/e2016/1982/

Inquires

Shigeru Kuchiishi (kuchi-ishi.shigeru@jaxa.jp)

Abstract

A Multi-Objective Evolutionary Algorithm (MOEA) is employed as an aerodynamic optimization method and the optimization tool is aimed to enable the direct evolutionary computing to perform within a practical computational time by FaSTAR. In the present project, basic programs are developed and validated using JSS2. A series of programs are also supplied to the collaborative partners to set in their optimization tools and examine how much speed-up is realized by FaSTAR.

Studies on JetEngine Noise Reduction

Report Number:R16E0005 https://www.jss.jaxa.jp/ar/e2016/1920/

Inquires

Junichi Kazawa (kazawa.junichi@jaxa.jp)

Abstract

Noise generated from the jet engine is dominant to total aircraft noise level and it is very important to reduce this. In this project, demonstration of exhaust noise reduction by changing exhaust duct shape, and study of fan noise reduction technique by numerical analysis are carried out.

Numerical calculation of Green engine (study of ultrahigh-temperature low NOx emission combustor technology) filming-type airblast atomizing process

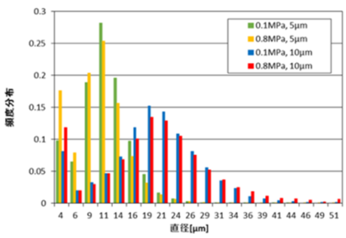
Report Number:R16E0101 https://www.jss.jaxa.jp/ar/e2016/2104/

Inquires

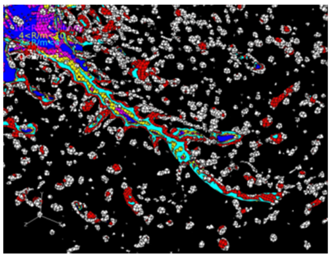
Kazuaki Katsuura (matsuura.kazuaki@jaxa.jp)

Abstract

Experimental study of planner filming-type airblast atomizer shows the clear effects of the ambient pressure and the vane angles on atomization characteristics. Since the atomization process occurs in the narrow region which is vicinity of the injection outlet, it is difficult to understand the atomization phenomena only by experiment. The objective of this work is to understand the atomization mechanism by numerical study which calculate the atomization field in the near region of the injection outlet.



Distribution of the particle diameter by the difference in pressure condition and mesh size)



Distribution of the curvature estimated on the surface which VOF function is 0.5

Study of Green engine (study of ultrahigh-temperature low NOx emission combustor technology) atomization process of a fuel spray nozzle in a practical geometry

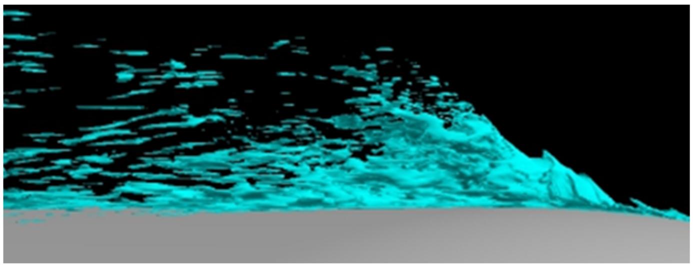
Report Number:R16E0006 https://www.jss.jaxa.jp/ar/e2016/1922/

Inquires

Kazuaki Matsuura (matsuura.kazuaki@jaxa.jp)

Abstract

Since the atomization process occurs in the narrow region which is vicinity of the injection outlet in a practical geometry fuel injector, it is difficult to understand the atomization phenomena only by experiment. The objective of this work is to understand the atomization mechanism by numerical study which calculated the atomization field in the near region of the injection outlet.



Atomization process of fuel spray nozzle in a practical geometry. Side view

Investigation of internal flow of aircraft combustor for Green Engine Project

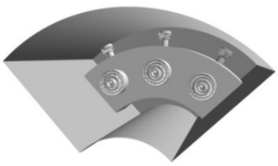
Report Number:R16E0004 https://www.jss.jaxa.jp/ar/e2016/1918/

Inquires

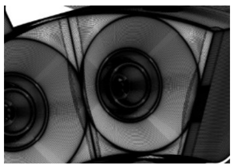
Mitsumasa Makida (makida@chofu.jaxa.jp)

Abstract

In the development process of aircraft combustors, air mass flow distribution between fuel nozzles, dilution and cooling air holes on the liner effects performances of combustors. So it is important to understand the internal flow and estimate the mass flow distribution. In this research, we conduct cold-flow simulations of internal flow inside the combustor which faithfully simulates the configuration of practical combustor. Then we aim to develop methods to analyze aerodynamic performance of combustors such as air mass flow distribution with high accuracy.

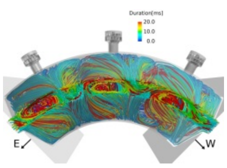


Total configuration viewed from inlet

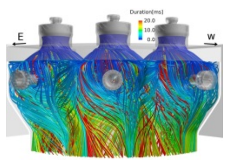


Calculation grids on downstream wall of fuel nozzles

Configuration and calculation grids of combustor



Viewed from combustor exit



Viewed from outside

Stream lines from fuel nozzles

Innovation for Design, Data-acquisition,Trouble-shoot and Certification in Aircraft Development: Aerodynamic Optimization

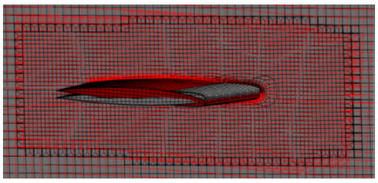
Report Number:R16E0033 https://www.jss.jaxa.jp/ar/e2016/1976/

Inquires

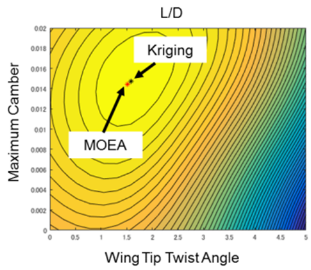
Shigeru Kuchiishi (kuchi-ishi.shigeru@jaxa.jp)

Abstract

A Multi-Objective Evolutionary Algorithm (MOEA) is employed as an aerodynamic optimization method and the optimization tool is aimed to enable the direct evolutionary computing to perform within a practical computational time by FaSTAR. In the present project, basic programs are developed and validated using JSS2.



ONERA M6 grid deformation



Comparison of Optimal Solutions

Innovation for Design, Data-acquisition,Trouble-shoot and Certification in Aircraft Development: Basic Techniques for Real Flight Prediction

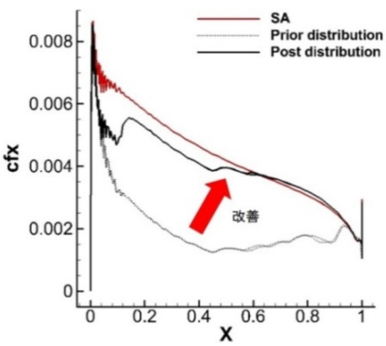
Report Number:R16E0034 https://www.jss.jaxa.jp/ar/e2016/1978/

Inquires

Kazuyuki Nakakita (nakakita@chofu.jaxa.jp)

Abstract

As a series of real flight prediction techniques, we try to develop a basic method which adjusts the parameters of the transition model in CFD analysis from the observed data using the data assimilation technique.



Overview of the pseudo satellite.

Conceptual Study of a High Speed Compound Helicopter for Innovative Air Transportation

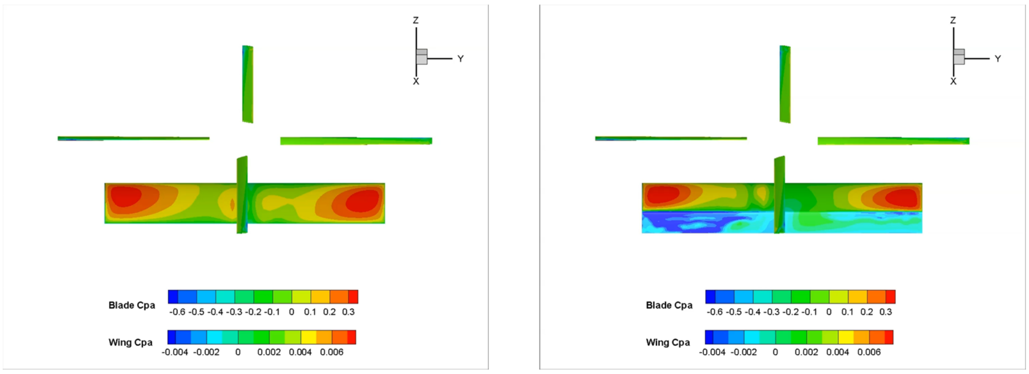
Report Number:R16E0037 https://www.jss.jaxa.jp/ar/e2016/1984/

Inquires

Yasutada Tanabe (tan@chofu.jaxa.jp)

Abstract

In Fiscal Year 2016, aerodynamic data of a conceptual model that has been flight tested are obtained and used to validate the CFD tool rFlow3D developed for rotorcraft. The aerodynamic interactions between a main rotor and a wing are simulated. Reduction of the downloading on the wing by a trailing edge flap is evaluated.



Wing surface pressure caused by Rotor/Wing Interaction [Left: no flap; Right: Flap 60 deg]

Analysis of the flight characteristic of Jet-FTB

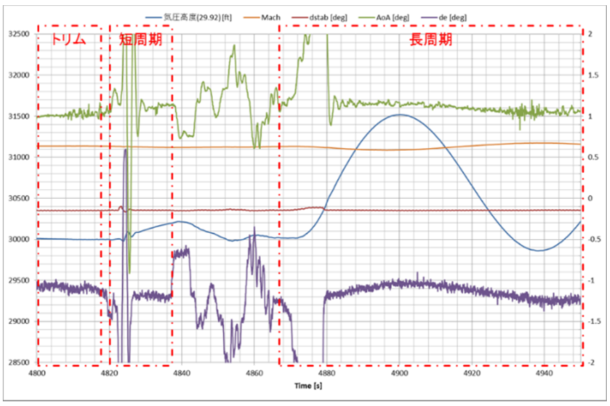
Report Number:R16E0010 https://www.jss.jaxa.jp/ar/e2016/1930/

Inquires

Takashi Ishida (ishida.takashi@jaxa.jp)

Abstract

In this research, we develop an aerodynamic data-base and extract an aerodynamic model from the data-base aimed for constructing a flight simulator through the analysis of the flight characteristics of Jet-FTB.



Results of flight test

Studies on real flight prediction

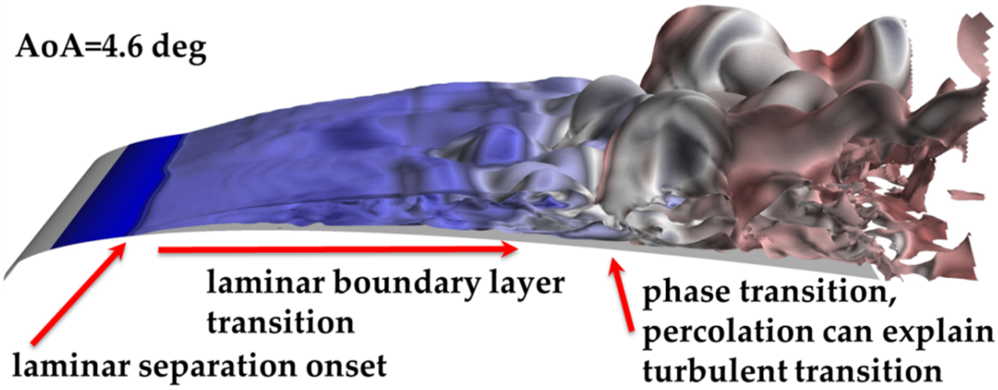
Report Number:R16E0038 https://www.jss.jaxa.jp/ar/e2016/1986/

Inquires

Kazuyuki Nakakita (nakakita@chofu.jaxa.jp)

Abstract

By applying the sophisticated data analysis techniques to unsteady CFD data, we develop a methodology to detecting the sign of unsteady aerodynamic phenomena including buffet.



DES result of NACA0012 buffet analysis (iso-surface of eddy viscosity)

Research on High Speed Propulsion Systems using Hydrogen Fuel

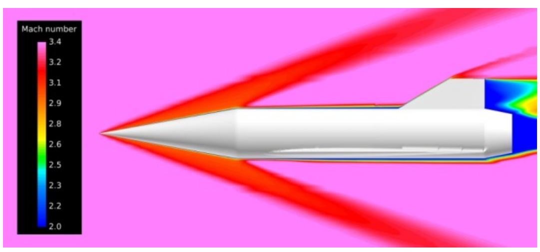
Report Number:R16E0022 https://www.jss.jaxa.jp/ar/e2016/1954/

Inquires

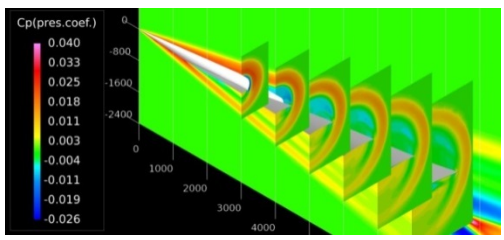
Hideyuki Taguchi (taguchi.hideyuki@jaxa.jp)

Abstract

Research and development to establish technologies for a Mach 5 class hypersonic passenger aircraft that can cross the Pacific Ocean in 2 hours is being conducted. Hypersonic passenger aircraft flying at Mach 5 will be exposed to higher temperature environments than supersonic aircraft flying at around Mach 2. Therefore, research and development of a new engine and a heat-resistant structure are necessary. With the main focus on research and development of hypersonic turbojet engine that can operate continuously from takeoff to Mach 5, our R&D in this field also include system analysis of hypersonic passenger aircraft, aerodynamic design, heat resistant design, and other important features.



High-Mach Integrated Control Experimental Aircraft, Mach number (Mach 3.4, AoA=0deg)



Hypersonic Cruise Experimental Aircraft, Mach number (Mach 5, AoA=0deg)

Research and development for system integration of silent supersonic airplane technologies

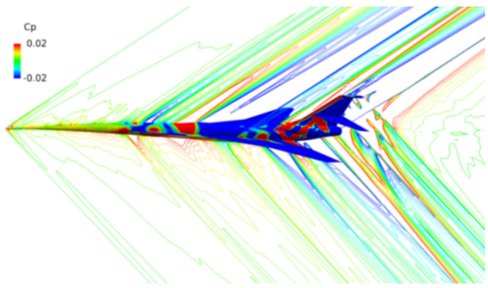
Report Number:R16E0007 https://www.jss.jaxa.jp/ar/e2016/1924/

Inquires

Yoshikazu Makino (makino@chofu.jaxa.jp)

Abstract

The system integration design technologies for achieving low sonic-boom, low aerodynamic drag, low landing and take-off noise, and light weight simultaneously are the key technologies for future supersonic airplanes. JAXA is promoting the R&D for these technologies based on our experiences of demonstrating the advanced low-drag and low-boom design concepts.



Cp distribution of low boom model

Basic research for system integration of silent supersonic airplane technologies

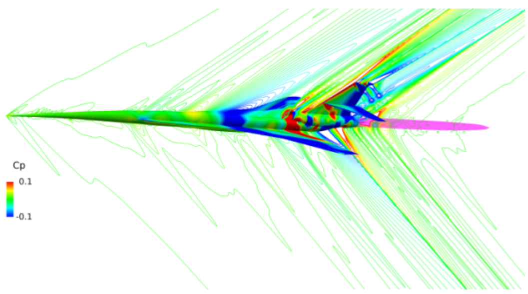
Report Number:R16E0100 https://www.jss.jaxa.jp/ar/e2016/2102/

Inquires

Yoshikazu Makino (makino@chofu.jaxa.jp)

Abstract

The system integration design technologies for achieving low sonic-boom, low aerodynamic drag,low landing and take-off noise, and light weight simultaneously are the key technologies for future supersonic airplanes. JAXA is promoting the R&D for these technologies based on our experiences of demonstrating the advanced low-drag and low-boom design concepts. The effects of the exhaust of a jet engine on the sonic-boom pressure signatures for NASA'ssupersonic low-boom demonstrator which is used as a test case in the 2nd international sonic-boom prediction workshop held in January, 2017 are estimated with JAXA's CFD tool.



Simulation of low-boom aircraft with jet plume effects.

Adbanced Numerical Simulation of Compressible Two-phase Flow of diesel atomization

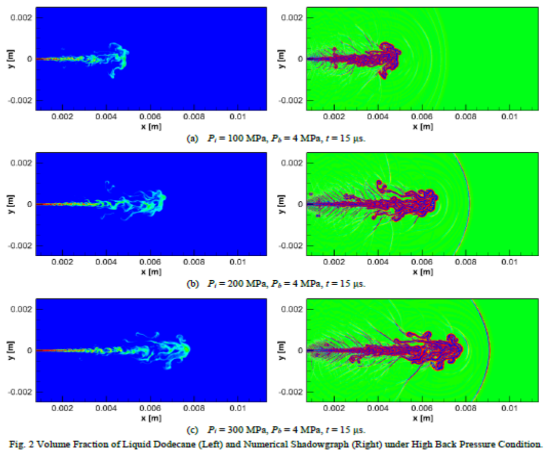
Report Number:R16E0066　　　　　　https://www.jss.jaxa.jp/ar/e2016/2040/

Inquires

Takuji Kurotaki (kurotaki@chofu.jaxa.jp)

Abstract

Atomization of fuel of aeronautical engines is focused in because of fuel consumption and environmental issues. Information from CFD results is very helpful for solutions of them. The research of numerical simulation of compressible muti fluid flow is conducted to apply for these problems.



Numerical results of high pressure atomizung jet by diffuse interface approach (Volume of fraction(left), shadowgraph(right), pressure of accumulator 100-300MPa)

Environment Conscious Aircraft Systems Research in Eco-wing Technology

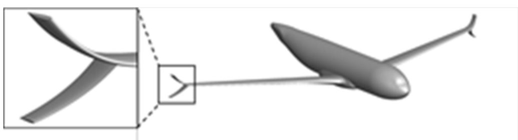
Report Number:R16E0107　　　　　　https://www.jss.jaxa.jp/ar/e2016/2116/

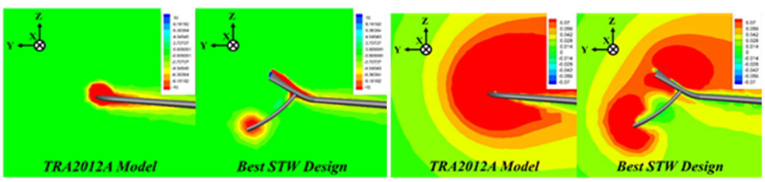
Inquires

Dongyoun Kwak (kwak.dongyoun@jaxa.jp)

Abstract

Innovative drag reduction technologies are investigated to reduce the fuel consumption for a conventional aircraft configuration. Aircraft noise prediction technologies and the conceptual design technologies are also developed for future aircraft which achieve low noise and high efficiency.





(top) TRA2012A wing-body configuration with STW, (left) Vorticity distributions of representative designs, (right) Induced drag source distributions of representative designs

Research on Active Control Technology for Dynamic Aeroelastic System

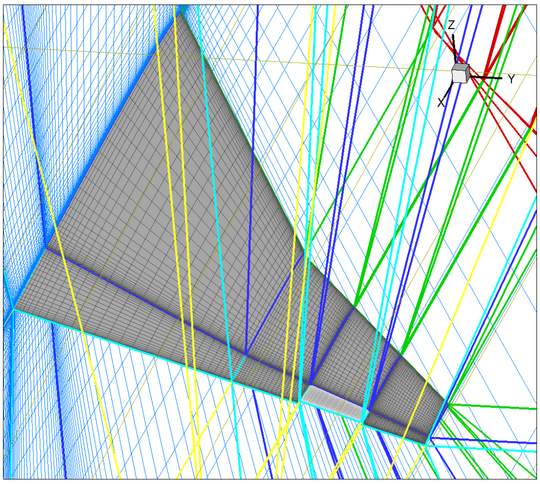
Report Number:R16E0012 https://www.jss.jaxa.jp/ar/e2016/1934/

Inquires

Kenichi Saitoh (ksaitoh@chofu.jaxa.jp)

Abstract

The flutter which is a destructive vibration phenomenon of aircraft occurs more easily around sonic speed than the other speed range. Meanwhile, it is known to be a limit cycle oscillation (LCO). To understand these properties, wind tunnel test is performed, and accuracy of the numerical analysis is improved to simulate these phenomena. Also the control technology for suppressing the LCO is developed.



Grid of the model with aileron

CFD Simulations of Agriculture Spraying from Multi-Rotor Drones

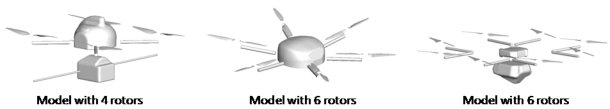
Report Number:R16E0069 https://www.jss.jaxa.jp/ar/e2016/2046/

Inquires

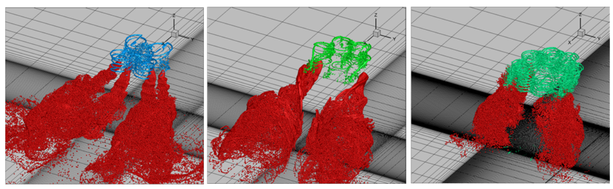
Yasutada Tanabe (tan@chofu.jaxa.jp)

Abstract

High fidelity CFD simulations for three types of multi-rotor drones used for agricultural spraying are performed. The sprayed particles are also dynamically simulated considering their gravity and air resistance. The rotating propellers and the major body and support arms are numerically modelled. The sprayed particle distributions on the monitoring heights are calculated and validated with the experimentally measurements. At some certain flight conditions, when the sprayed particles go out of the downwash of the rotors, the particles drafted in the air and can be carried away from the flight path. It is desirable to put the spray nozzle inside the rotor downwash to obtain ideal spraying effect.



Three multicopter models with different number of rotors



Sprayed particle patterns from three types of multicopters at flight speed of 15km/hr in calm air

Acoustic Vibration Simulation of Cavity Flow with Unstructured CFD Code

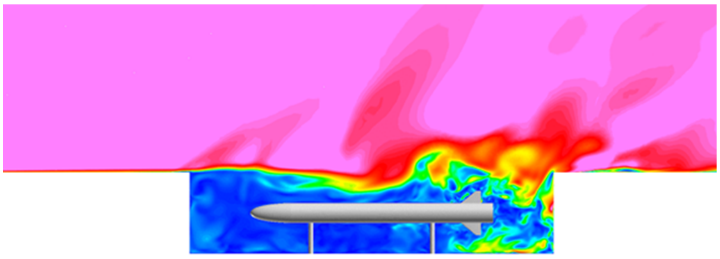
Report Number:R16E0017 https://www.jss.jaxa.jp/ar/e2016/1944/

Inquires

Atsushi Hashimoto (hashimoto.atsushi@jaxa.jp)

Abstract

We analyze the effect of payload in the cavity. We validate the computational result comparing with the experimental data.



Flow inside cavity

CFD analysis of wind turbine wake

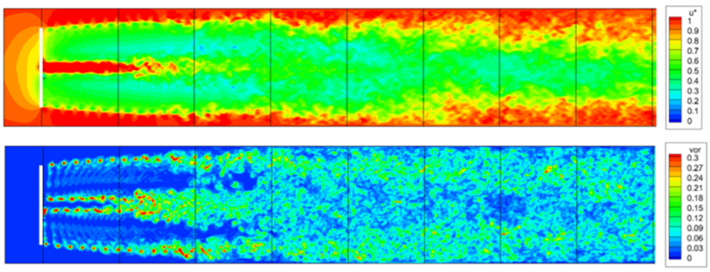
Report Number:R16E0104 https://www.jss.jaxa.jp/ar/e2016/2110/

Inquires

Yosuke Shinozaki (shinozaki.yosuke@ilab.eco.rcast.u-tokyo.ac.jp)

Abstract

In a wind farm, a distance between turbines is important from the point of view of energy recovery and turbulence intensity in a wake. And in recent years, the introduction of two-bladed wind turbines is investigated. The purpose of this study is to reveal the effect of blade number change on the wake from the wind turbines.



Visualization of wake (Upper: velocity of main stream direction, Lower: vorticity)

Unsteady Aerodynamics Simulation of Frontier Region

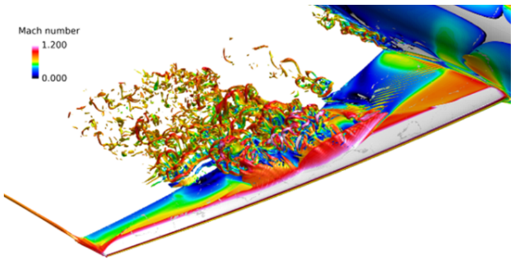
Report Number:R16E0013 https://www.jss.jaxa.jp/ar/e2016/1936/

Inquires

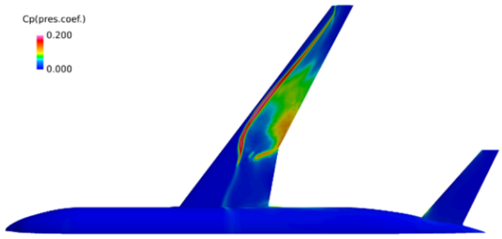
Atsushi Hashimoto (hashimoto.atsushi@jaxa.jp)

Abstract

The objective of this study is to realize CFD that can be used in the entire flight envelope by investigating precise CFD technologies that can be applied to unsteady phenomena, such as aerodynamic buffeting and flow separation.



Q Criteria



RMS of Surface Pressure

Air flow distribution control by a fluidic element

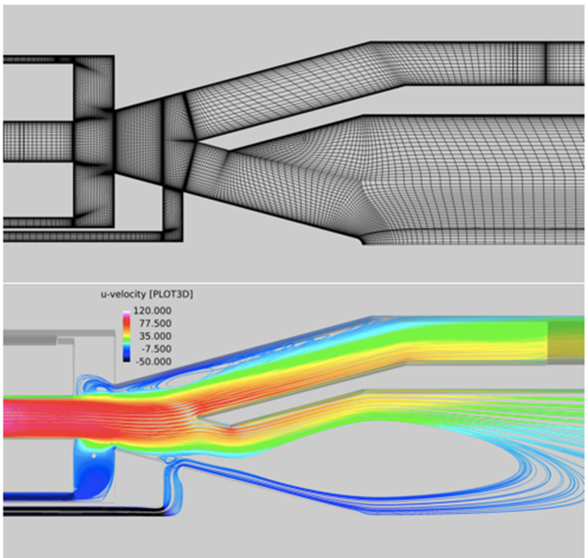
Report Number:R16E0109 https://www.jss.jaxa.jp/ar/e2016/2120/

Inquires

Seiji Yoshida (yoshida.seiji@jaxa.jp)

Abstract

Lean combustion is promising to reduce nitrogen oxide emission from jet-engines. To solve combustion instability, that is a problem of lean combustion, a pilot burner for ensuring stable combustion and a main burner for performing lean, low-NOx combustion are used. The purpose of this study is improvement of combustor performance by controlling air flow rate distribution between the pilot burner and the main burner using a fluidic element, which has no moving part.



Computational grid and flow field of the fluidic element

Study of numerical simulation for 3-dimensional buffet

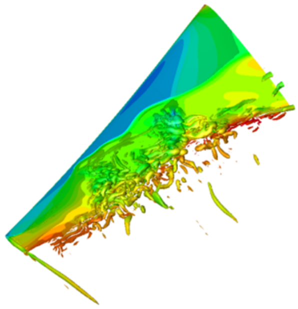
Report Number:R16E0111 https://www.jss.jaxa.jp/ar/e2016/2124/

Inquires

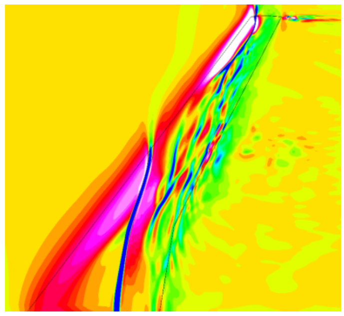
Yoshimi Kojima (y-kojima@st.go.tuat.ac.jp)

Abstract

Transonic buffet is self-induced oscillation of shock waves appeared on a suction side of a wing. In this project, we simulated the transonic buffet over a NASA-CRM which is similar the actual aircraft shape. The numerical results indicate that spectrum of shock oscillation over the 3D wing exhibits broadband and three-dimensionally oscillation. It is a remarkable feature compared with buffet over the 2D wing which have a narrow band oscillation uniform in the spanwise direction.



Structure of turbulent eddy of transonic buffet



Kutta wave generated at the trailing edge of the wing

aFJR light weight sound absorption liner technology development

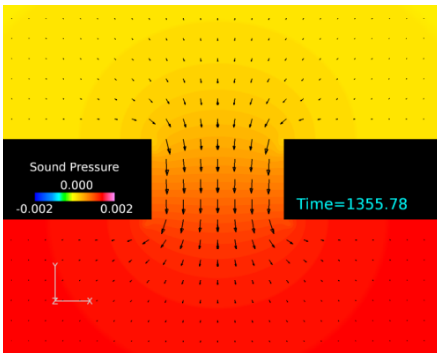
Report Number:R16E0024 https://www.jss.jaxa.jp/ar/e2016/1958/

Inquires

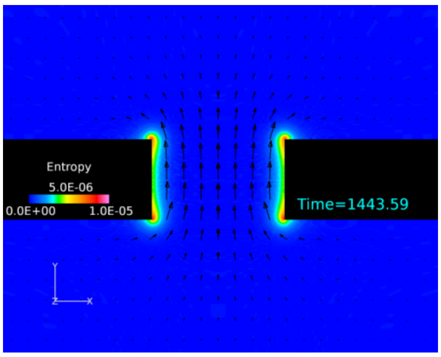
Shunji Enomoto (eno@chofu.jaxa.jp)

Abstract

The purpose of aFJR project is to advance research on jet engine component technologies so that Japanese manufacturers can join more effectively in international joint-development projects on next-generation jet engines. We reduce its weight without sacrificing sound-absorbing performance by changing the material to resin.



Sound pressure and velocity vector



1 Entropy and velocity vector

Numerical Analyses of LPT flutter

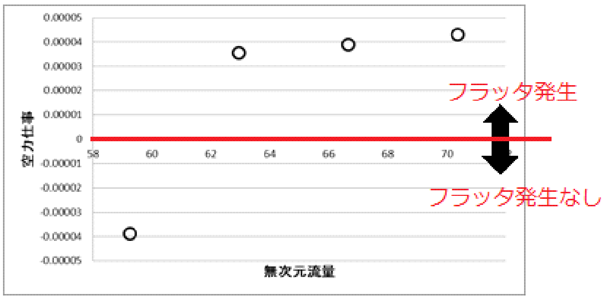
Report Number:R16E0025 https://www.jss.jaxa.jp/ar/e2016/1960/

Inquires

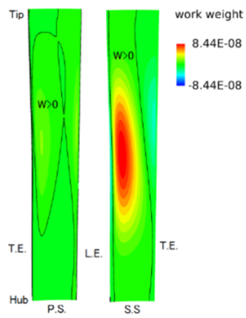
Junichi Kazawa (kazawa@chofu.jaxa.jp)

Abstract

The purpose of aFJR project is to advance research on jet engine component technologies so that Japanese manufacturers can join more effectively in international joint-development projects on next-generation jet engines. Regarding LPT flutter, we aim to develop LPT design technology by improving prediction accuracy.



Results of Flutter Prediction



Aerodynamic Work Distribution on Blade Surface

Low pressure turbine structural analysis

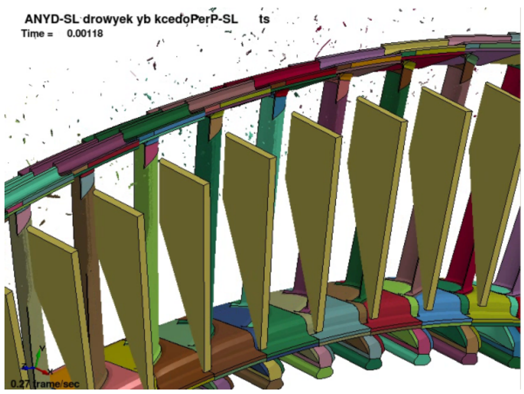
Report Number:R16E0026 https://www.jss.jaxa.jp/ar/e2016/1962/

Inquires

Masahiro Hojo (hojo.masahiro@jaxa.jp)

Abstract

The purpose of aFJR project is to advance research on jet engine component technologies so that Japanese manufacturers can join more effectively in international joint-development projects on next-generation jet engines. Application of a Ceramic Matrix Composite (CMC) to low pressure turbine blade material is conducted to reduce the engine weight in the aFJR project.



An analysis result of the cascades of CMC low pressure turbine blades.

aFJR high efficiency fan technology development

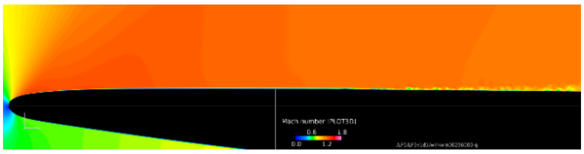
Report Number:R16E0023 https://www.jss.jaxa.jp/ar/e2016/1956/

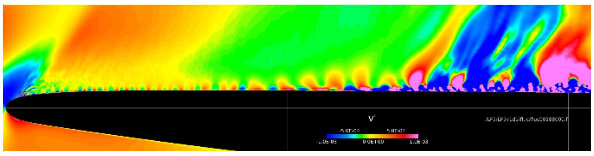
Inquires

Shunji Enomoto (eno@chofu.jaxa.jp)

Abstract

The purpose of aFJR project is to advance research on jet engine component technologies so that Japanese manufacturers can join more effectively in international joint-development projects on next-generation jet engines. To compensate for increasing fan diameter, we are developing lightweight fan blades that have higher aerodynamic efficiency by applying advanced simulation technology and composite materials evaluation technology.


Mach number


Velocity fluctuation component

Prediction of Transonic Buffet with URANS

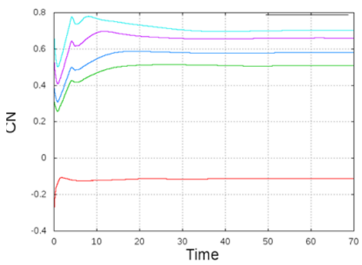
Report Number:R16E0019 https://www.jss.jaxa.jp/ar/e2016/1948/

Inquires

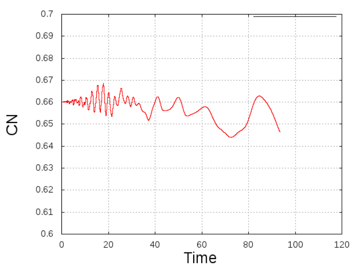
Atsushi Hashimoto (hashimoto.atsushi@jaxa.jp)

Abstract

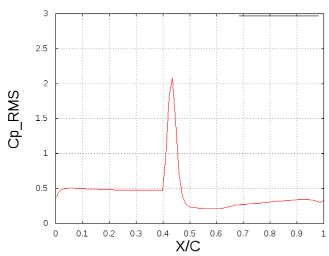
Transonic buffet is characterized by unsteady shock excursions. In the numerical prediction of transonic buffet boundary, URANS have used. This research, we introduced numerical perturbation method into FaSTAR to improve accuracy of the prediction. As a result, we found that this method could produce the transonic buffet more precisely.



CN Histly without perturbation



CN Histly with perturbation(4.65[deg])



Cp RMS at mid-span (4.65[deg])

Uncertainty quantification on satellite thermal design

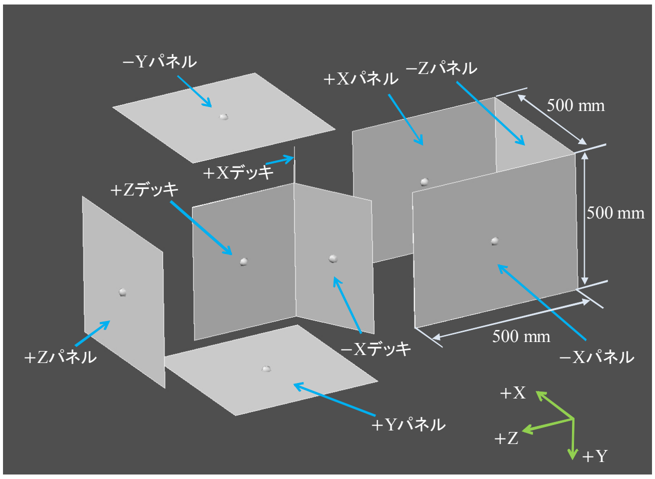
Report Number:R16E0086 https://www.jss.jaxa.jp/ar/e2016/2076/

Inquires

Hiroshi Kato (kato.hiroshi@jaxa.jp)

Abstract

In satellite thermal design, there are several design constraints to deal with the uncertainty of the satellite thermal environment. However, these constraints will be obstacles to improve the satellite thermal design process in the future. In this study, we aim to appropriately evaluate constraints on satellite thermal design by quantifying the uncertainty of satellite thermal environment.



Overview of the pseudo satellite.

Fundamental Studies of Methane RCS

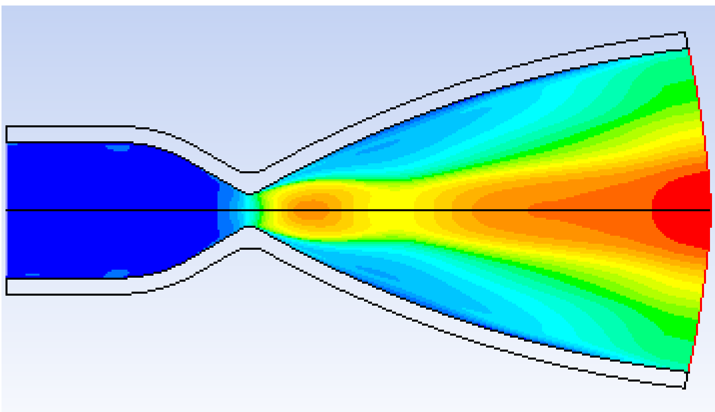
Report Number:R16E0087 https://www.jss.jaxa.jp/ar/e2016/2078/

Inquires

Daiki Terakado (terakado.daiki@jaxa.jp)

Abstract

The present RCS of hydrazine used for controling rockets has a weak point on its toxicity. The present project focuses on the non-toxic property of methane and develops safer RCS system for the future rockets.



A test computation of methane RCS

DSMC analysis of the rarefied gas flows

Report Number:R16E0083 https://www.jss.jaxa.jp/ar/e2016/2072/

Inquires

Yu Daimon (daimon.yu@jaxa.jp)

Abstract

To understand the rearfield gas flow phenomenon in high altitude and outer space, which is difficult to conduct ground test, and to predict the aerodynamic / thermal environment for reentry and the thermal load of gas plume from a thruster, we aim to develop a practical tool that can deal with actual shape and short analysis period.

Main thruster plume distribution at landing on the moon

Protection from Space Environment for Expanding Future Space Activities

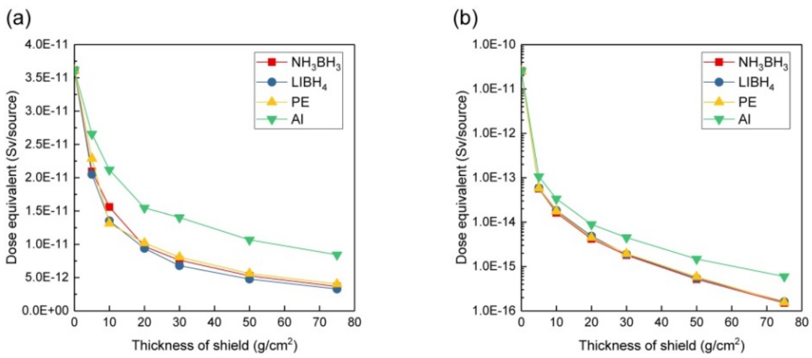
Report Number:R16E0080 https://www.jss.jaxa.jp/ar/e2016/2066/

Inquires

Aki Goto (goto.aki@jaxa.jp)

Abstract

Our goal is to obtain the technology and knowledge to protect spacecraft and astronauts from harsh space environment for expanding future space activities. Long-term-stay under safer environment is especially required in the future manned-mission. We, therefore, address the radiation shielding technology in terms of materials for supporting the safe and long-period manned space activity.



Dependence of dose equivalent in a water target on shielding thickness of hydrogen storage materials (NH_3BH_3, $LiBH_4$), PE, and Al)against GCR (a), and GCR+SEP (b).

Research and Development of Predicting Launch Vehicle Acoustics

Report Number:R16E0082 https://www.jss.jaxa.jp/ar/e2016/2070/

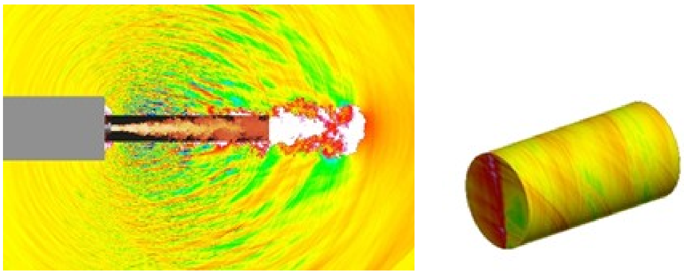
Inquires

Seiji Tsutsumi (tsutsumi.seiji@jaxa.jp)

Abstract

Prediction and reduction of the acoustic environment level caused by aeroacoustics of exhaust jet at lift-off and transonic buffet are required for the development of the next flagship launch vehicle (H3). Therefore, improve the acoustic analysis tool at the lift-off constructed up to the previous phase, and expand the range of application, predict the acoustic environment throughout the flight of the launcher / spacecraft, contribute to the design of low noise launch pad and silent launch vehicle.

CFD result, Density distribution



CAA result. pressure distribution

Greenhouse gases Observing SATellite (GOSAT) mission

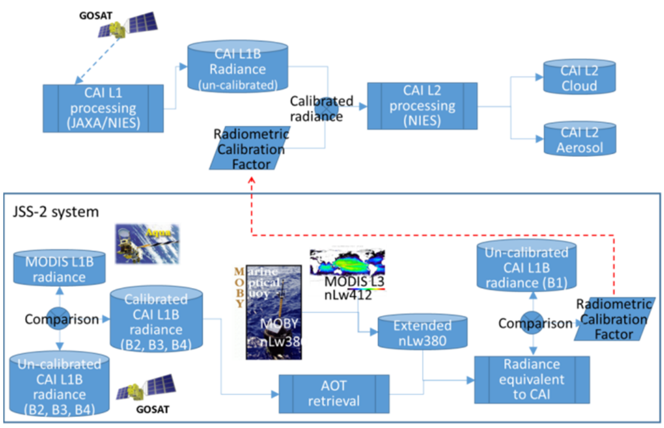
Report Number:R16E0096 https://www.jss.jaxa.jp/ar/e2016/2388/

Inquires

Yoko Ueda (ueda.yoko@jaxa.jp)

Abstract

GOSAT continues its observations beyond its 5-year mission, providing well-calibrated high spectral resolution data. The overall functions and performances are successful and no significant degradation of SNR and spectral resolution has been observed. Several anomalies were found onboard, but they have stabilized since. The Level 1 algorithms have been updated since launch in order to correct these anomalies.



GOSAT CAI processing flow (top) and radiometric calibration flow (bottom)

Small synthetic aperture radar satellite

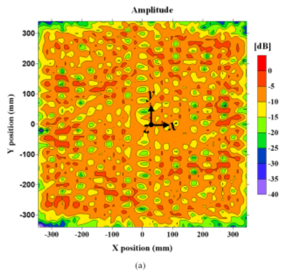
Report Number:R16E0068 https://www.jss.jaxa.jp/ar/e2016/2044/

Inquires

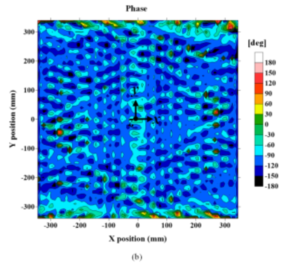
Hirobumi Saito (saito.hirobumi@jaxa.jp)

Abstract

We are goint to develop synthetic aperture radar system that can be onboard on a 100kg class satellite and to verify it on ground. Conventionally radar observations have required large or medium satellite with 500-1000kg mass. Our research and development may change earth observation drastically.



The simulated distribution of aperture amplitude at 9.65 GHz.



The simulated distribution of aperture : phase at 9.65 GHz

Utilization of JSS2 for AMSR-E L1 data processing

Report Number:R16E0093 https://www.jss.jaxa.jp/ar/e2016/2090/

Inquires

Kazuyoshi Nakamura (nakamura.kazuyoshi@jaxa.jp)

Abstract

We will provide AMSR-E product in the same format as AMSR2 which is succeeding sensor, and expedite the provision of products to users. And expedite the provision of products to users.

Utilization of JSS2 for AMSR-E higher level data processing

Report Number:R16E0094 https://www.jss.jaxa.jp/ar/e2016/2092/

Inquires

Kazuyoshi Nakamura (nakamura.kazuyoshi@jaxa.jp)

Abstract

We will reprocess and provide AMSR-E high level product and AMSR2 high level product with the same algorithm (including improved algorithms). And expedite the provision of products to users.

Study on development of satellite-based ocean data assimilation system

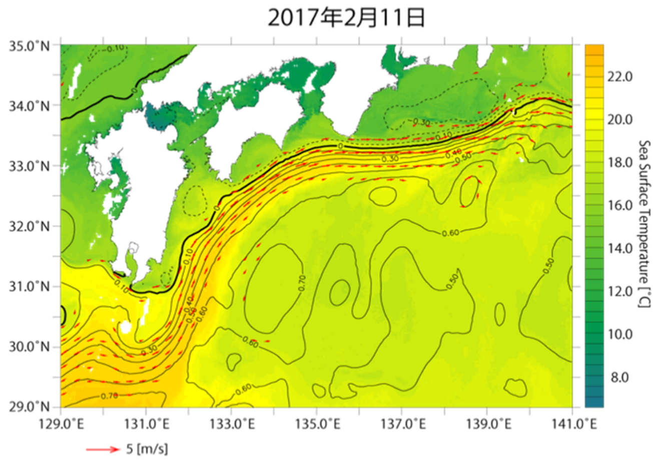
Report Number:R16E0098 https://www.jss.jaxa.jp/ar/e2016/2098/

Inquires

Misako Kachi (kachi.misako@jaxa.jp)

Abstract

We will distribute long-term data sets of ocean and sea ice, which are essential to climate change monitoring and prediction, by utilizing satellites. Ocean environmental data sets are also produced by combining satellite, in-situ and model. Those data sets will also contribute to operational applications, such as utilization in sea state monitoring at fishery experiment stations in each prefecture.



Example of output from satellite-based ocean data assimilation system at JSS2.

Launch Cost Reduction by Reusing Launch Vehicles

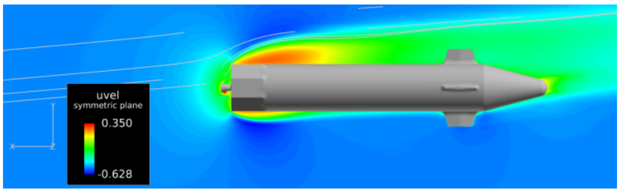
Report Number:R16E0076 https://www.jss.jaxa.jp/ar/e2016/2060/

Inquires

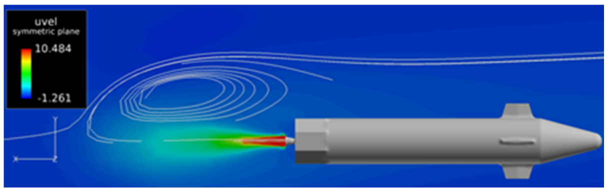
Yoshiki Takama (takama.yoshiki@jaxa.jp)

Abstract

This research conducts the study of key technologies applied to future reusable launch vehicles including long-life rocket engines, lightweight structures, landing guidance, and small experimental vehicles to validate the technologies.



Axial velocity distribution with the opposing jet off (M=0.5, AOA=175deg)



Axial velocity distribution with the opposing jet on (M=0.5, AOA=175deg)

Cloud Aerosol Radiation Application Research

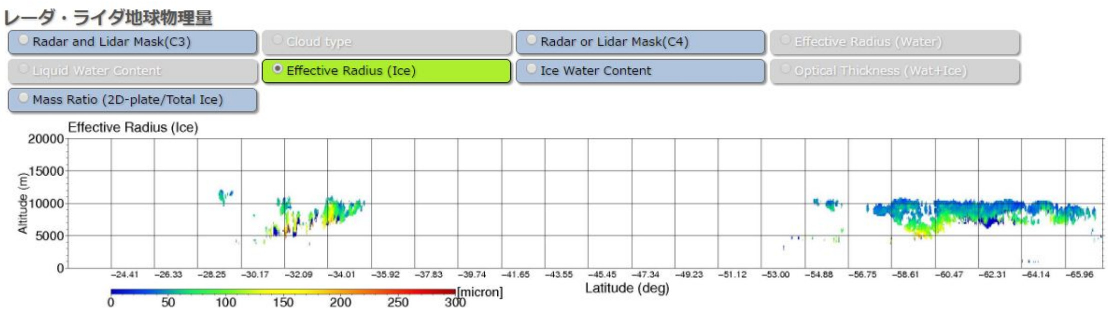
Report Number:R16E0095 https://www.jss.jaxa.jp/ar/e2016/2094/

Inquires

Maki Kikuchi (kikuchi.maki@jaxa.jp)

Abstract

Long-term process of cloud microphysics estimation from CloudSat satellite and CALIPSO satellite.



Effective radius of ice

Fundamental Research on High Speed Fluid Dynamics

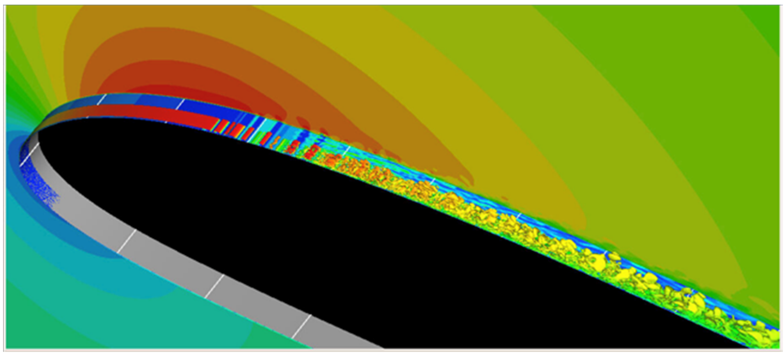
Report Number:R16E0114 https://www.jss.jaxa.jp/ar/e2016/2128/

Inquires

Akira Oyama (oyama2@flab.isas.jaxa.jp)

Abstract

Objective of this research is to conduct fundamental research on high-speed fluid dynamics required in the field of space engineering. In this fiscal year, we study wall-model for high Reynolds number flow computation and fluid control devices that may significantly reduce aerodynamic drag of space transportation systems.



Instantaneous flowfield of airfoil obtained by LES with wall-model.

Research on Space Propulsion Flow Dynamics

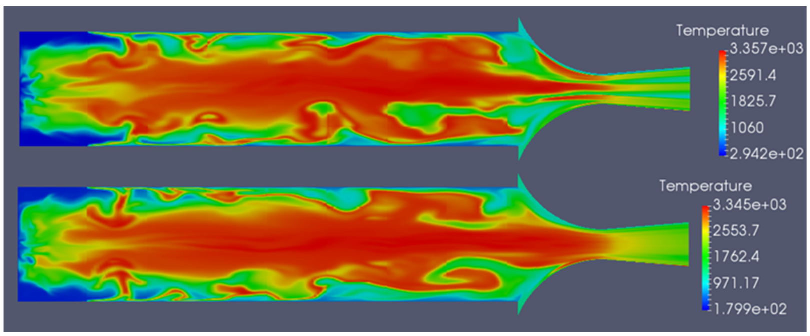
Report Number:R16E0113 https://www.jss.jaxa.jp/ar/e2016/2126/

Inquires

Mikiroh Motoe (motoe.mikiroh@jaxa.jp)

Abstract

It is natural and logical to require safe and economic space transportation for the realization of sustainably growing future space economy. However, the current space transportation system cannot be as safe as the current aircraft because the current rocket has essential explosive nature of the propellant. In order to realize non-explosive safe rocket, we suggest A-SOFT hybrid rocket and research on computer simulation of swirling turbulent combustion field in hybrid rocket engine for realization of this type of rocket.



Contour of temperature

Study on the reusable launch vehicle

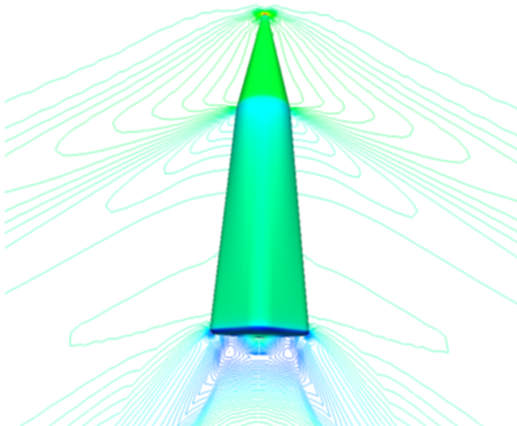
Report Number:R16E0072 https://www.jss.jaxa.jp/ar/e2016/2052/

Inquires

Takashi Ito (ito.takashi@jaxa.jp)

Abstract

The small reusable launch vehicle demonstrator will be developed by utilizing the JAXA's past advanced technologies such as reusable sounding rocket technical demonstration project and the component and system level studies related to future reusable systems. The demonstrations will be focused on life management technology on propulsion systems, fault tolerant system, vertical takeoff and landing system, and aerodynamically vehicle controlled system to obtain the competitive advantage from the other related projects. The new technologies obtained in these activities will be applied to the future flagship mission to develop the large launch vehicle systems.



Mach number (flow field) and pressure distributions (vehicle body)

Prediction of RCS Jet Interaction on Re-entry Capsule

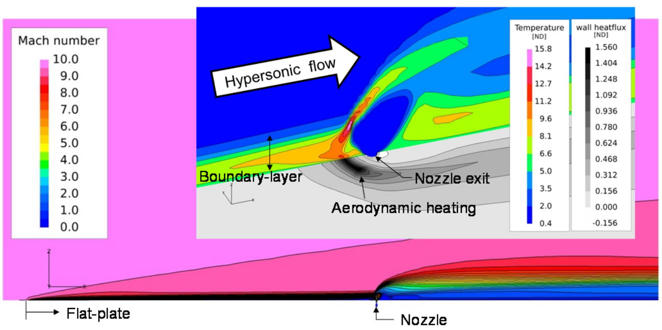
Report Number:R16E0009 https://www.jss.jaxa.jp/ar/e2016/1928/

Inquires

Hajime Miki (miki.hajime@jaxa.jp)

Abstract

JAXA progresses research and development on lifting re-entry capsule as a return procedure for manned space activity. In atmospheric re-entry, gas jets emitted from reaction control system (RCS) interact with external flow around a capsule aero-thermodynamically. In order to predict its influence on capsule's aerodynamic and aerodynamic heating, RCS jet interaction is examined in various flow conditions by using not only wind tunnel testing but also CFD analysis.



Aerodynamic heating caused by RCS jet interaction on a flat plate

Research and Development of Sample Return Capsule for future planetary exploration

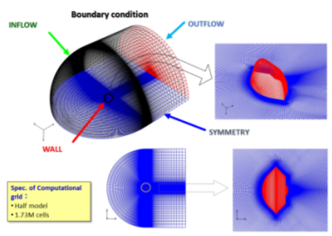
Report Number:R16E0118 https://www.jss.jaxa.jp/ar/e2016/2136/

Inquires

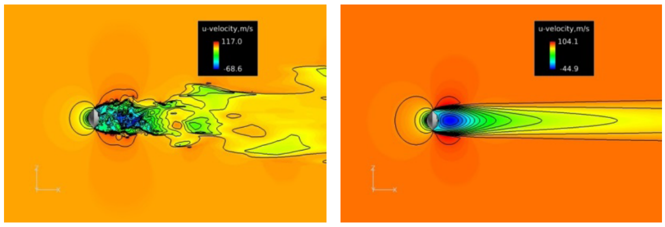
Kazuhiko Yamada (yamada.kazuhiko@jaxa.jp)

Abstract

"Hayabusa" is the first sample return mission from an asteroid in deep space and proved its value worldwide. The sample return mission will become one of important missions in future planetary exploration. A sample return capsule is indispensable technology to realize it. The objectives of this activity are to take over its heritage and to improve its technology in order to realize the flexible and attractive future sample return mission.



Computational grid



Comparison of velocity contours in wake region between BL model (Left) and SSTmodel(right)

Studies on space science topics via large-scale numerical simulations

Report Number:R16E0116 https://www.jss.jaxa.jp/ar/e2016/2132/

Inquires

Masaki Fujimoto (fujimoto.masaki@jaxa.jp)

Abstract

Magnetic reconnection, a process that explosively releases magnetic energy, is considered to be triggered when two oppositely directed field lines are strongly pushed against each other so that the distance between the two field lines become small. How small the distance has to be for magnetic reconnection to take-off? We show that the distance can be more than 30 times larger than what has been considered, implying that magnetic reconnection happens more easily that what one used to assume.

Analysis of landing site candidates required for system-level technical study

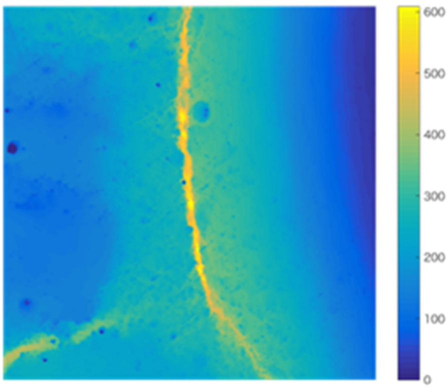
Report Number:R16E0063 https://www.jss.jaxa.jp/ar/e2016/2034/

Inquires

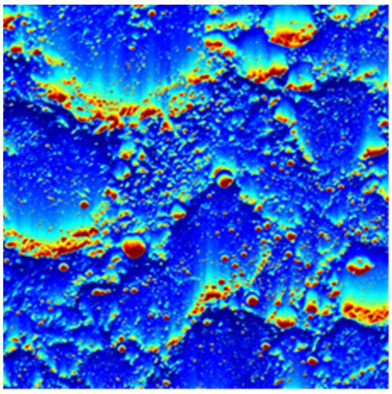
Takeshi Hoshino (hoshino.takeshi@jaxa.jp)

Abstract

The sunshine period and the communication visibility, which are criteria for selecting the landing site, are obtained by simulation and analysis. We will reflect these results in the system level study of the lunar lander.



Total sunshine days in two years in the rim of Whipple crater in the moon's Arctic Region



Horizon database of 300 km square around the Moon North Pole

Lifting body shape design considering real gas effect

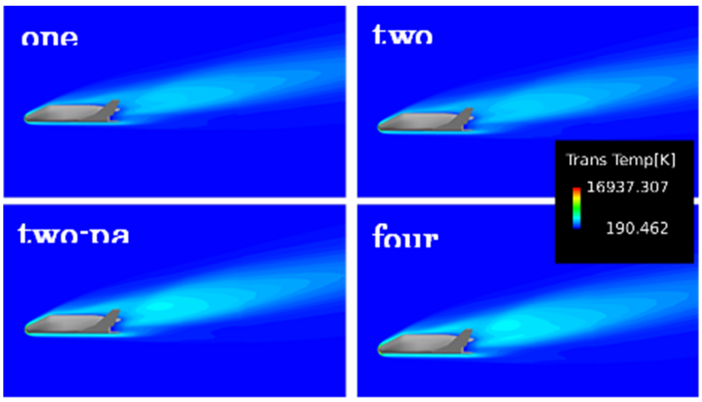
Report Number:R16E0110 https://www.jss.jaxa.jp/ar/e2016/2122/

Inquires

Keiichi Murakami (murakei@chofu.jaxa.jp)

Abstract

We investigate the influence of the real gas effect on aerodynamic performance and aerodynamic heating for the target lifting body.



Comparison of translational temperature distributions for 4 types of temperature model

Quantitative safety analysis technology by high-fidelity numerical simulation

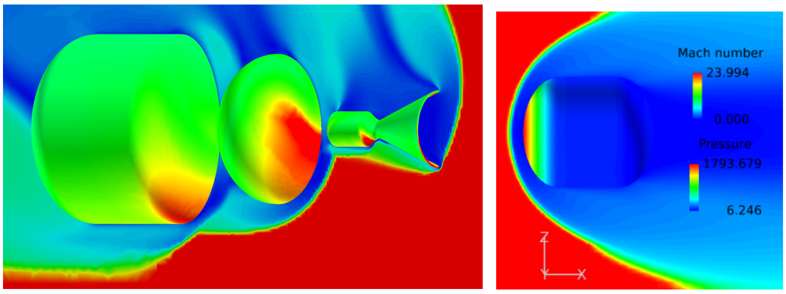
Report Number:R16E0085 https://www.jss.jaxa.jp/ar/e2016/2074/

Inquires

Keiichiro Fujimoto (fujimoto.keiichiro@jaxa.jp)

Abstract

In order to perform detailed destructive re-entry safety analysis and to obtain the validation data for the empirical models, the aerodynamic and heat flux analysis under the wide range of flow conditions based on the developed rapid turn-around CFD method is carried out. In addition, by using the developed tools, the aerodynamic and heat flux design analysis are conducted in order to support the research and development activities for the small re-entry capsule installed in HTV and the fly-back re-usable rocket.



Aerodynamic and heat-flux analysis for rocket upper stages and propellant tanks.

Research on the future transportation technology

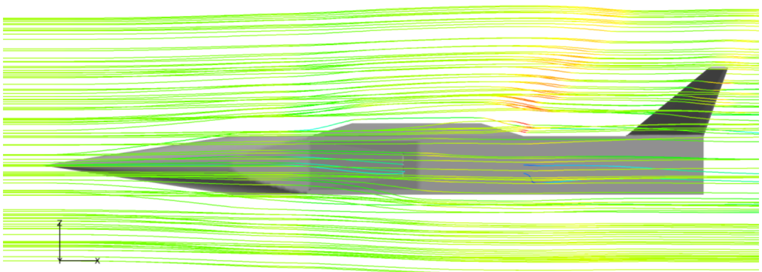
Report Number:R16E0074 https://www.jss.jaxa.jp/ar/e2016/2056/

Inquires

Susumu Hasegawa (hasegawa.susumu@jaxa.jp)

Abstract

The aerodynamic characteristics of the airframe and the engine of the spaceplane which integrates the them will be clarified. Taking into consideration of the movement of the center of gravity, the aerodynamic center and the change of the engine thrust under the various flight conditions from take-off to high speed, aerodynamic characteristics of the spaceplane were investigated numerically and experimentally.



Streamlines and Mach numbers around the splaceplane for the flight condition of Mach 1.3

Research for Future Transportation System (Research for Scramjet Engine Flow Path)

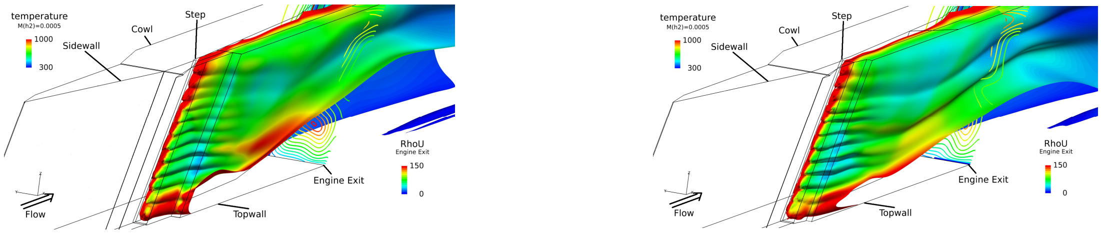
Report Number:R16E0075 https://www.jss.jaxa.jp/ar/e2016/2058/

Inquires

Shigeru Sato (ssato@kakuda.jaxa.jp)

Abstract

As a future hypersonic propulsion engine scramjet engine has been studied in many countries including USA and others, and the research is widely spread from basic researches to flight tests. In our country the scramjet engine research has been carried out since the former National Aeronautical Laboratory in flight condition of Mach 4, 6 and 8 by utilizing Ramjet Engine Test Facility (RJTF) which was completed in 1993, and a lot of knowledge about the engine has been obtained. The factor that bothers engine performance completion has been found, and Sato et al are researching the solution by using CFD in order to create engine design method.



a) 5/5-Height Strut configuration b) Boat-tail Strut configuration

Trial combustion calculations in the both configurations - fuel injection and temperature distribution on 0.05%H_2 plain.

Study of Space Transportation Technology (Integrated Design of Airframe and Engine)

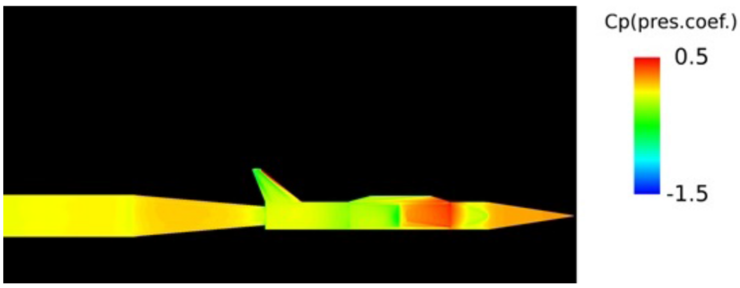
Report Number:R16E0073 https://www.jss.jaxa.jp/ar/e2016/2054/

Inquires

Susumu Hasegawa (hasegawa.susumu@jaxa.jp)

Abstract

Integrated design technology of Spaceplane and its engine for future space transportation is studied, and conceptual design technology will be established. Wind tunnel tests, CFD simulation and conceptual study for estimation of transportation ability are conducted. The spaceplanes have larger thrust and larger engines than the planes have. Therefore, aerodynamic characteristics of the spaceplanes interacts with the engine thrust and the engine integration. In the study, stability is a key issue, as well as the transportation ability and economical efficiency.



Distribution of pressure coefficient around the wind tunnel test model. Mach number is 1.1.

Study on Future Space Transportation System using Air-breathing Engines

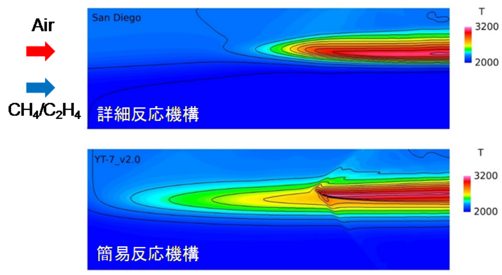
Report Number:R16E0079 https://www.jss.jaxa.jp/ar/e2016/2064/

Inquires

Masatoshi Kodera (kodera.masatoshi@jaxa.jp)

Abstract

In order to reduce the cost of space transportation systems significantly, reusable rockets are considered. However, in order to extend the structural lifetime, it is necessary to operate with relatively low engine power, leading to a decrease in launch capability. Therefore, a combined cycle of a rocket and an air-breathing engine, RBCC is promising to compensate the drawback. By using air in the atmosphere as an oxidizer, it becomes highly efficient, and it can be expected to maintain and improve the launch capability even if it is reused. In this project, we will research and develop key technology for practical application of the RBCC engine.



Comparison between CFD results with simple and detailed reaction mechanisms:
2D supersonic combustion shear flow

Numerical Analysis of aerodynamic characteristics on H3 launch vehicle

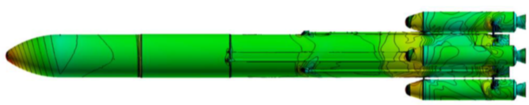
Report Number:R16E0089 https://www.jss.jaxa.jp/ar/e2016/2082/

Inquires

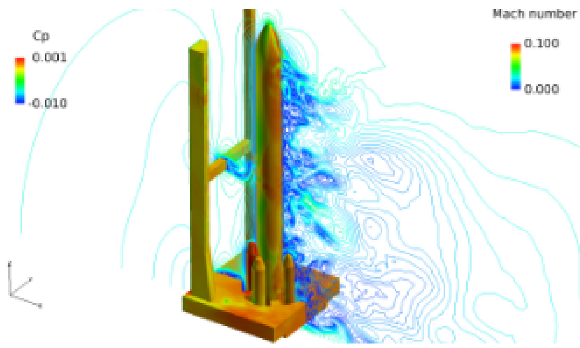
Hiroshi Ikaida (ikaida.hiroshi@jaxa.jp)

Abstract

From the viewpoint of international competitiveness, develop a new launch system with low cost and high performance.



Surface distribution of Cp
(Type H3 24L, M=1.3,α=5°, φ=0°)



Ground Wind Analysis
(Mach distribution, Type H3 24L, at launch pad)

Numerical Simulation of Propellant Management for Rockets and Spacecrafts

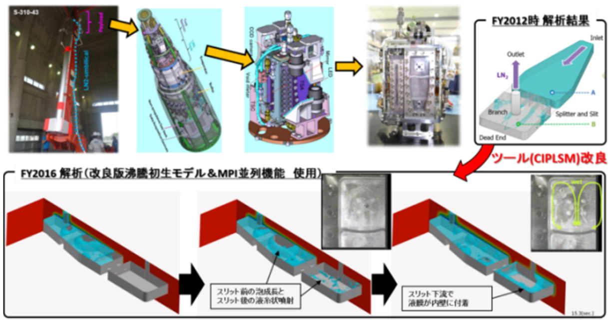
Report Number:R16E0084 https://www.jss.jaxa.jp/ar/e2016/2386/

Inquires

Yutaka Umemura (umemura.yutaka@jaxa.jp)

Abstract

In order to improve the payload capacity of spacecraft, it is necessary to optimally design the propellant amount on board under the uncertainty of cryogenic propellant evaporation and low gravity environment. This project has been conducting numerical simulation development for the cryogenic propellant thermal flow analysis. By understanding the internal heat flow of the propellant tank and the feed line, it is linked to the change of propellant system design and operation.



Comparison between experiment and simulation on the flowfield in the test section.

Numerical Plasma Simulation on Advanced Space Propulsion Systems

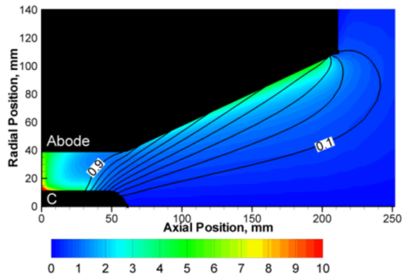
Report Number:R16E0115 https://www.jss.jaxa.jp/ar/e2016/2130/

Inquires

Ikkoh Funaki (funaki.ikkoh@jaxa.jp)

Abstract

A numerical design tool for spacecraft electric and advanced propulsion systems is ivevitably important for quick and robust design without depending only on experimental method. In this fiscal year, Magnetoplasmadynamic (MPD) arcjet, one of high-power spacecraft electric propulsion, was studied to make a test simulation with a discharge plasma model included. MAPS code we developed enabled a combined analysis of the Navier-Stokes equation and the Maxwell equation, and with this code not only thrust, dischage voltage, and its efficiency, but also heat flux toward the electrodes can be estimated in a self-consistent manner.



Discharge current path and Hall parameter distribution
in a self-field MPD thruster (Ar, 1.8g/s, 6kA)

Development of micro-satellite launch vehicle

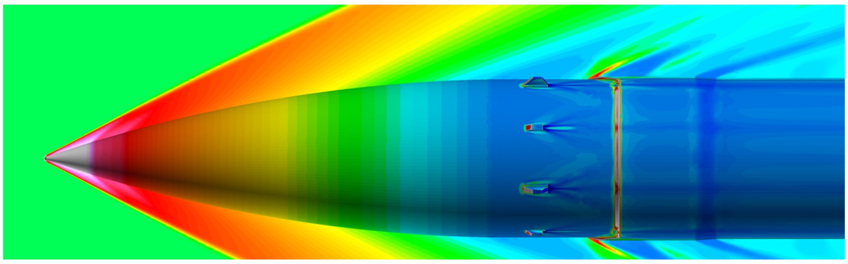
Report Number:R16E0120 https://www.jss.jaxa.jp/ar/e2016/2404/

Inquires

Takahiro Nakamura (nakamura.takahiro@jaxa.jp)

Abstract

The SS-520 No.4 has the performance to launch the 3 kg mass microsatellite "TRICOM-1" into the low earth orbit. This rocket launched at 15 January 2017 [JST] however satellite could not be into the orbit due to the rocket system anomaly. According to 1st stage flight results, the flight trajectory and impact point are as a planned. It was confirmed that setting of aerodynamic characteristics in orbit planning was appropriate. In addition, condition of aerodynamic heating was also appropriate from rocket telemetry data.



Heat flux distribution, M = 3.0, aoa = 0 deg

Internal flow, combustion and rotating machinery

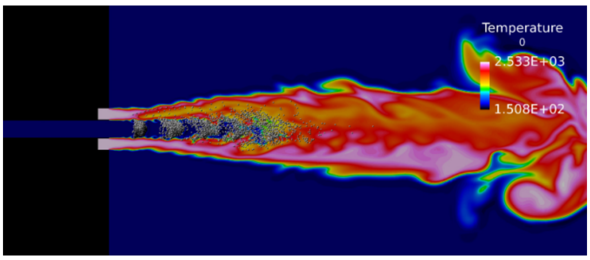
Report Number:R16E0081 https://www.jss.jaxa.jp/ar/e2016/2068/

Inquires

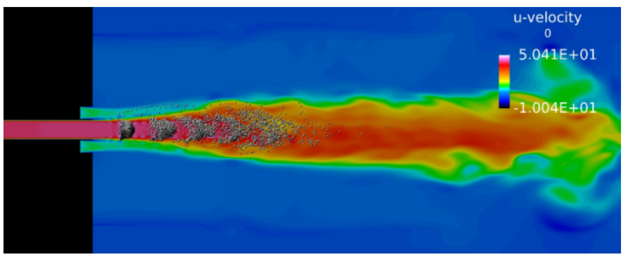
Taro Shimizu (shimizu.taro@jaxa.jp)

Abstract

To capture the unsteady phenomena in the liquid rocket engine, a combustion LES analysis is carried out, and this evaluation tool is validated by comparing with a sub-scale test. For thrusters, we build analysis code that can simulate spray combustion mode, first aim at prediction of steady state performance.



Temperature distribution



Axial velocity distribution

Research of Tropical Rainfall Measuring Mission (TRMM) / Precipitation Radar (PR)

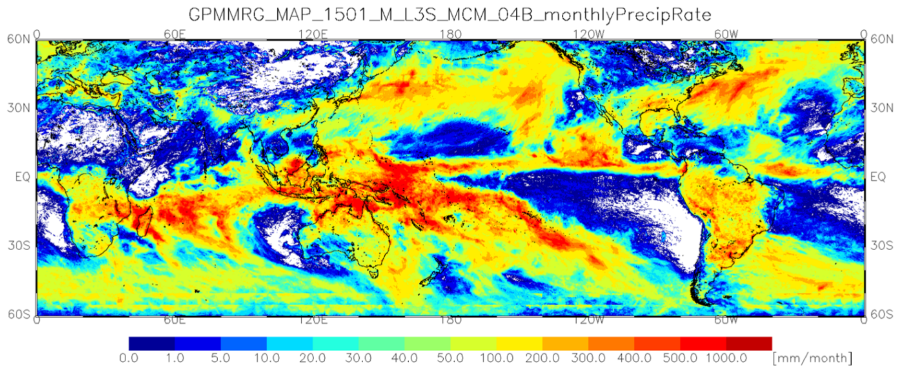
Report Number:R16E0092 https://www.jss.jaxa.jp/ar/e2016/2088/

Inquires

Takuji Kubota (kubota.takuji@jaxa.jp)

Abstract

We performed the experimentations for the version upgrade and production of the long-term dataset using the GSMaP algorithm (V4). We also performed the long-term experimentations of PR V8 (PU1, PU2) and DPR V5 (L2Ku, L2Ka, L2DPR), which leads to helpful algorithm evaluations and improvements.



Monthly precipitation using GSMaP

NLFFF calculation of the solar coronal magnetic field based on Hinode observations

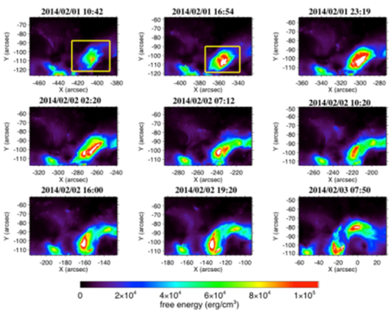
Report Number:R16E0117 https://www.jss.jaxa.jp/ar/e2016/2134/

Inquires

Toshifumi Shimizu (shimizu.toshifumi@jaxa.jp)

Abstract

Our study focuses on understanding of the mechanism responsible for the occurrence of the solar flares. We derive 3D magnetic field structure in the corona by performing a 3D magnetohydrodynamics simulation using vector magnetic field map acquired with the *Hinode* spacecraft. We investigate the relation between 3D magnetic field structure and the occurrence of solar flares.



The temporal evolution of the spatial distribution of magnetic free energy stored in an active region. The energy increase can be seen in the area specified by yellow rectangle

Research for Innovation of Rocket Propulsion Engine

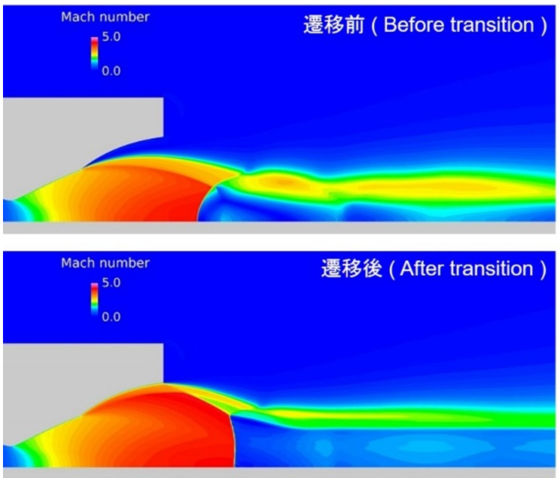
Report Number:R16E0078 https://www.jss.jaxa.jp/ar/e2016/2062/

Inquires

Masahiro Takahashi (takahashi.masahiro@jaxa.jp)

Abstract

We are trying to solve key technical issues commonly required for the development of the rocket engines used for the H3 rocket and those for future space transportation systems. This research activities will contribute to the realization of more reliable rocket engine than ever.



Mach number contours before and after the operation mode transition of the dual-bell nozzle

Research for data assimilation of satellite global rainfall map

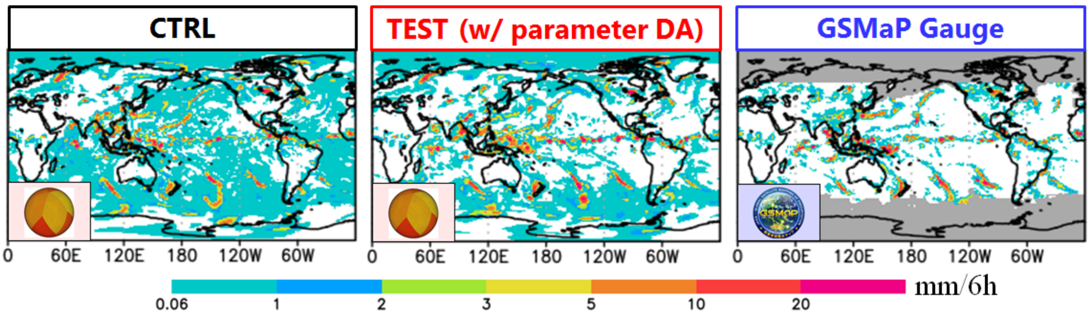
Report Number:R16E0091 https://www.jss.jaxa.jp/ar/e2016/2086/

Inquires

Takuji Kubota(kubota.takuji@jaxa.jp)

Abstract

This study aims to improve NWP model forecasts by an effective use of earth-observing satellite data through an advanced data assimilation method. In addition, we also aim to produce a new precipitation product through our global atmospheric data assimilation system.



Global precipitation patterns (mm $6h^{-1}$) for (left) control experiment, (center) parameter estimation experiment, and (right) GSMaP_Gauge observation. The gray color denotes missing data. Adopted from Kotsuki et al. (2017c, in preparation).

Greenhouse gases Observing SATellite-2 (GOSAT-2) Project

Report Number:R16E0099 https://www.jss.jaxa.jp/ar/e2016/2100/

Inquires

Tomoo Yamasaki (yamasaki.tomoo@jaxa.jp)

Abstract

As the successor to the "IBUKI" (GOSAT) mission, GOSAT-2 aims to obtain the greenhouse gases concentrations with higher levels of accuracy via even higher-performance onboard observation sensors. The project will serve to provide observation data to environmental administrations and contribute the international anti-global warming efforts.

Earth observation satellite data processing for GPM/DPR

Report Number:R16E0090 https://www.jss.jaxa.jp/ar/e2016/2084/

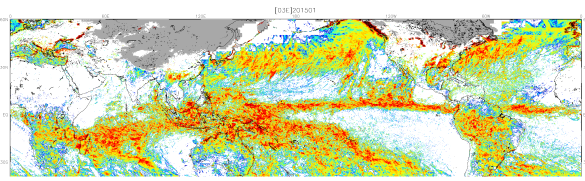
Inquires

Takahiro Minami (minami.takahiro@jaxa.jp)

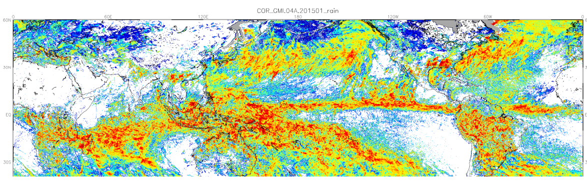
Abstract

In recent years, worldwide interest has been increasing about the necessity of grasping the global environmental change. To deal with such problems, various approaches using observation technology from space have been carried out by artificial satellites.

Global Precipitation Measurement (GPM) mission, as follow-on and expansion of the TRMM satellite, is an international mission to achieve highly accurate and frequent global rainfall observation. it is carried with multiple satellite, one primary satellite with Dual-frequency Precipitation Radar (DPR) jointly developed by JAXA and NICT, and with GPM Microwave Imager (GMI) developed by NASA, and another 8 constellate satellites with Microwave Imager.



Precipitation map in old version(2015/01)
(Snowfall on Eurasia continent ~ North American continent can not be detected in old version)



Precipitation map in latest version(2015/01)
(Snowfall can be detected in the latest version)

Design analysis for technology demonstration project of small capsule installed in HTV

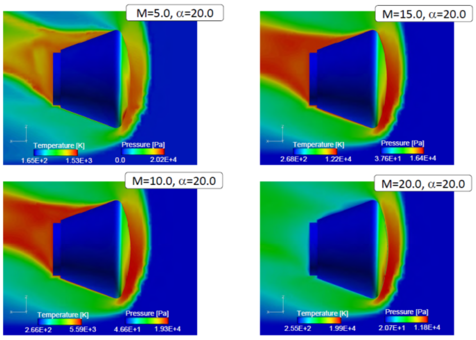
Report Number:R16E0121 https://www.jss.jaxa.jp/ar/e2016/2140/

Inquires

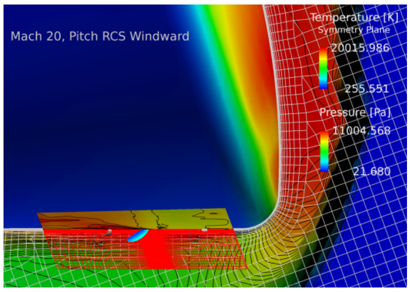
Keiichiro Fujimoto (fujimoto.keiichiro@jaxa.jp)

Abstract

Evaluation of the heat flux induced by the RCS jet and free-stream interaction is conducted. For each RCS thrustors, wide range of heat flux CFD analysis is conducted.



Hypersonic flow over the capsule for small re-entry capsule installed in HTV.



Heat-flux analysis induced by the RCS jet and free-stream interaction for small re-entry capsule installed in HTV.

SLIM project

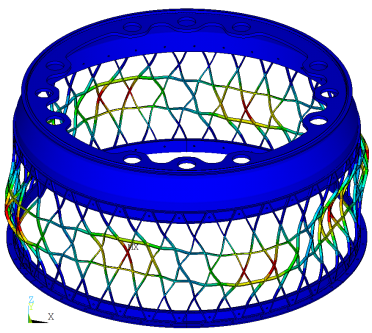
Report Number:R16E0119 https://www.jss.jaxa.jp/ar/e2016/2138/

Inquires

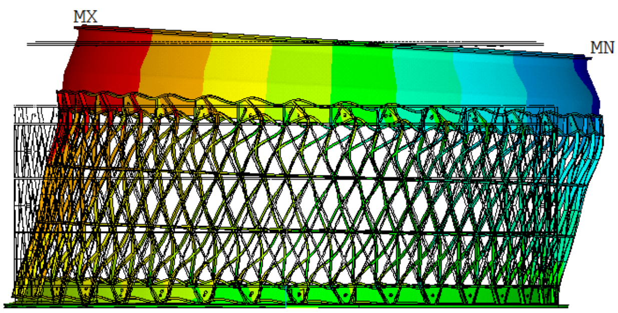
Miki Nishimoto (nishimoto.miki@jaxa.jp)

Abstract

By acquiring the technique of pinpoint landing to the place where you want to land and demonstrating it on the moon, it enables landing the planet that is more restrictive than the moon and sample return.



Buckling Mode



Shear Deformation

Research for maintenance and enhancement of aerospace technology

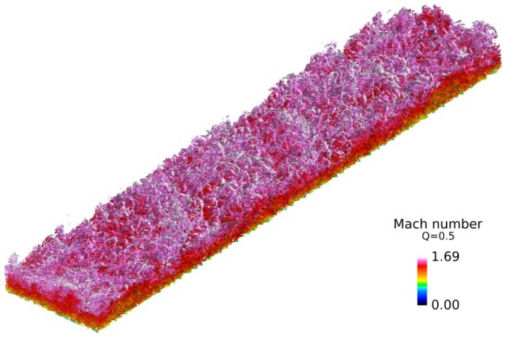
Report Number:R16E0077 https://www.jss.jaxa.jp/ar/e2016/2400/

Inquires

Takanori Haga (haga.takanori@jaxa.jp)

Abstract

Prediction accuracy of turbulent flows in high Reynolds number is important for aerospace fluid problems. The conventional RANS model is not sufficient for accurately predicting separation and reattachment of the boundary layer and its transition. On the other hand, the computational cost of LES which resolves to small scale vortices near the wall is prohibitively expensive. We focus on improving the prediction accuracy of high Reynolds number wall turbulence flow with feasible computational cost aiming for extending applicability of CFD as a design tool.



Iso-surface of the second invariant of velocity gradient tensor (colored by Mach number).

Research of coupled analysis of motion and aerodynamics

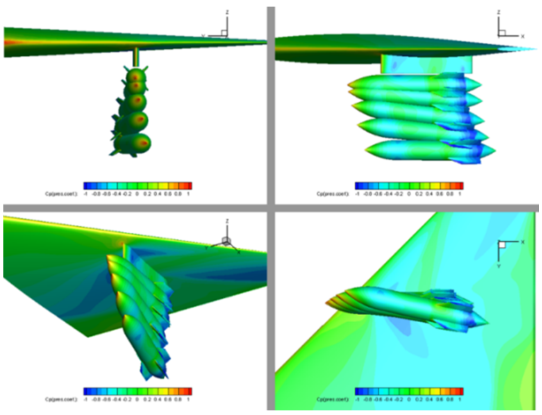
Report Number:R16E0035 https://www.jss.jaxa.jp/ar/e2016/1980/

Inquires

Takashi Ishida (ishida.takashi@jaxa.jp)

Abstract

In this research, we have extended FaSTAR-code to be able to handle coupled analysis of motion and aerodynamics and conducted a store-separation analysis for the validation.



Cp distribution, trajectories

Research on combustor simulation

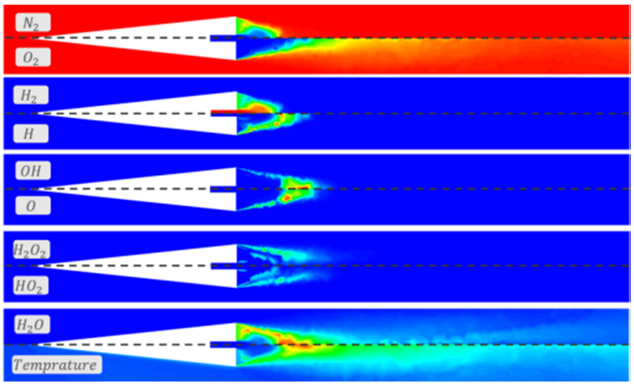
Report Number:R16E0112 https://www.jss.jaxa.jp/ar/e2016/2390/

Inquires

Rui Toyonaga (toyonaga.l.0121@ruri.waseda.jp)

Abstract

For the development of the air breathing engine combustor in space plane,we develop the chemical reaction flow calculation code using the Flamelet Approach. In order to evaluate this code in supersonic region, a verification is performed on the experimental data of the strut-injection supersonic combustion flow field designed by German Aerospace Center.



The chain reactions in the downstream of fuel injection strut.

Study on Acoustic Analysis Techniques to Improve Aerospace Interior Acoustic Environment

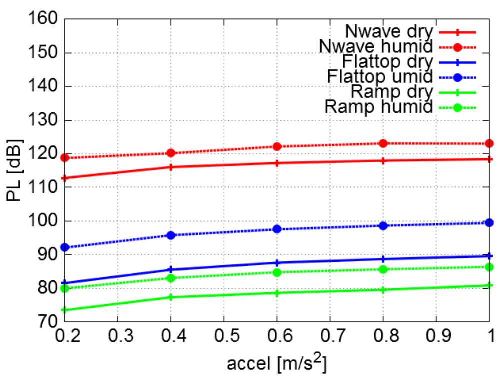
Report Number:R16E0014 https://www.jss.jaxa.jp/ar/e2016/1938/

Inquires

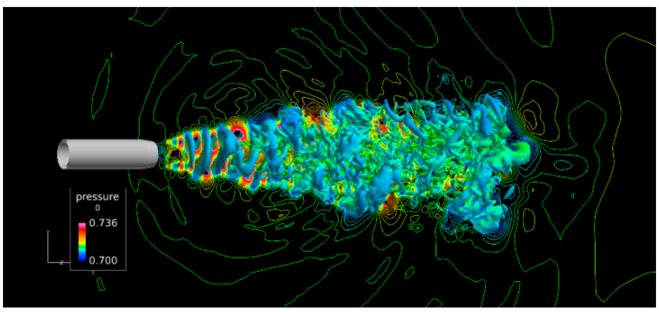
Takashi Takahashi (takahashi.takashi@jaxa.jp)

Abstract

We are concentrating on the wave-based method, which makes it possible to precisely analyze a wide range of acoustic vibrations up to mid-frequencies. We are also studying the numerical prediction approaches of sound sources and propagations for practical aerospace applications.



Variation of Perceived Level(PL) against acceleration for various input waveforms



Pressure distribution around a subsonic jet

Development of CFD technology to support design of aircraft combustor with real configuration

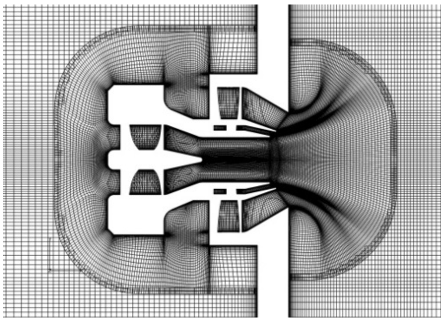
Report Number:R16E0021 https://www.jss.jaxa.jp/ar/e2016/1952/

Inquires

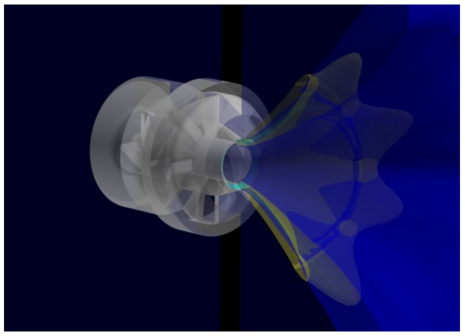
Mitsumasa Makida (makida@chofu.jaxa.jp)

Abstract

For the development of combustors with practically complicated configuration which consist of many parts, it is important to develop CFD technologies to conduct many parametric studies effectively by changing parameters for configurations. In this research, we utilize a multi-block structured grid solver, which conduct large scale cold-flow simulation inside combustors with real complicated configurations, as a base solver, and integrate various spray and combustion models, aiming to obtain design methods for development of aircraft combustors, which estimate dispersion of the fuel droplets, evaporation, and combustion processes.



Numerical grids (2D sectional)



Iso-surfaces of spray density
(yellow: 30 μ m, blue:100 μ m diameter)

Research and development of applied fundamental technology

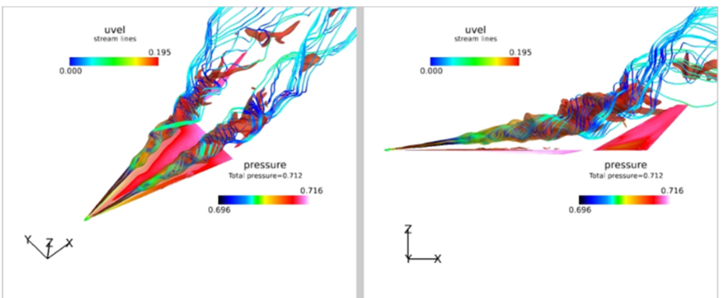
Report Number:R16E0032 https://www.jss.jaxa.jp/ar/e2016/1974/

Inquires

Takashi Ishida (ishida.takashi@jaxa.jp)

Abstract

In this research, we develop a common fundamental aerodynamic analysis tool by extending FaSTAR-code to be able to handle fluid-structure interaction problems aimed for establishing the technical basis which accelerate the development of civil airplanes.



Numerical results of fin buffet

High Resolution Analysis of Unsteady Aerodynamics for RLG with Fast Fluid Solver FaSTAR

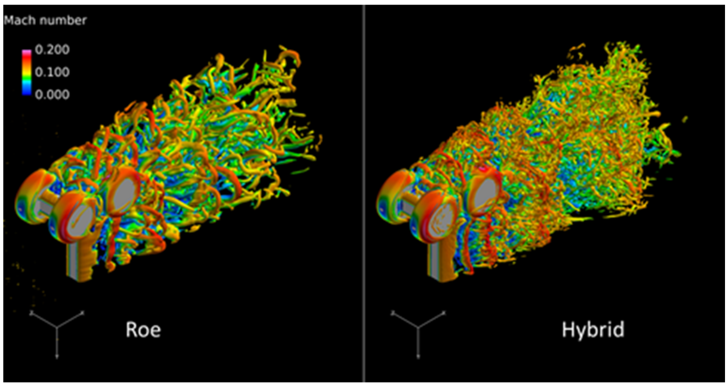
Report Number:R16E0103 https://www.jss.jaxa.jp/ar/e2016/2108/

Inquires

Keiichi Murakami (murakei@chofu.jaxa.jp)

Abstract

In order to obtain a low computation cost and stable high resolution solution for the aircraft Rudimentary Landing Gear (RLG), the CFD solver FaSTAR developed by JAXA is used as the central difference base, and in the place where the calculation is unstable, the numerical viscosity of the upwind difference To extend. As a result, the resolution in the high frequency region was improved.



Instantaneous visualization of Q

Research on the aircraft structures and advanced composite materials

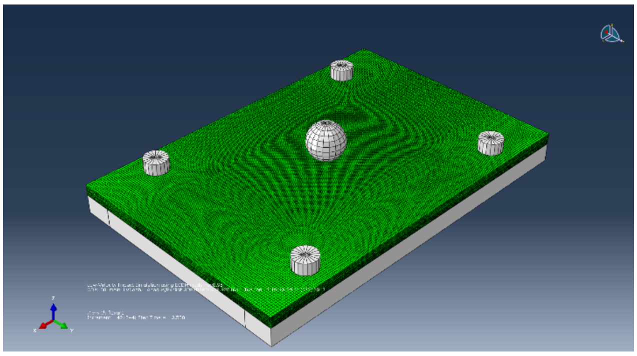
Report Number:R16E0011 https://www.jss.jaxa.jp/ar/e2016/1932/

Inquires

Akinori Yoshimura (yoshimura.akinori@jaxa.jp)

Abstract

Application of the composite materials will contribute to improving the performance of aircraft and spacecraft components. JAXA conducts researches for overcoming weaknesses of current composite materials, clarifying unknown aspects such as fracture mechanisms, improving performance and enabling application to design technology.



Model overview of the low-velocity impact simulation

Investigation on Fine-scale Scalar Mixing in High Reynolds Number Turbulent Jets

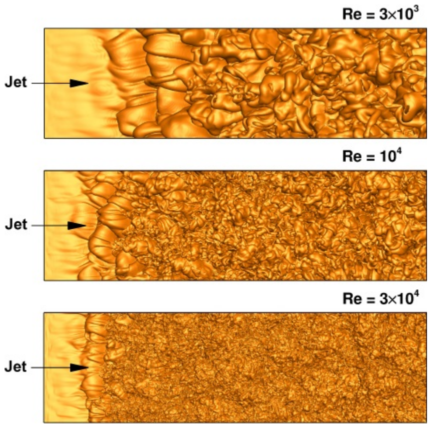
Report Number:R16E0065 https://www.jss.jaxa.jp/ar/e2016/2038/

Inquires

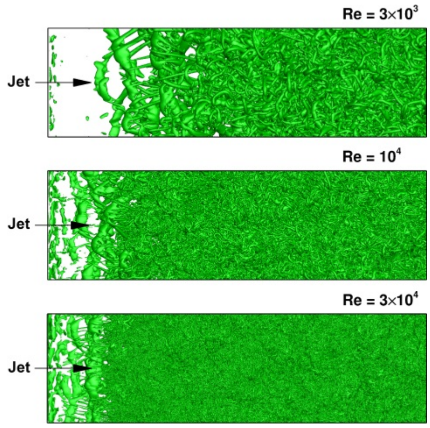
Shingo Matsuyama (smatsu@chofu.jaxa.jp)

Abstract

In this research, large scale direct numerical simulation of turbulent flow is performed on supercomputer to clarify the role of very small-scale turbulence in the mixing process of fuel and air. We try to clarify the role of fine-scale turbulence by analyzing the data obtained by simulations with varying the Reynolds number which is a parameter that governs the turbulence intensity.



Top view of iso-surfaces of scalar mass fraction for the DNS at Re = 3×10^3, 10^4 and 3×10^4.



Top view of iso-surfaces of positive Q criteria for the DNS at Re = 3×10^3, 10^4 and 3×10^4.

Study on Unstability of the re-entry capsule at Transonic Speed

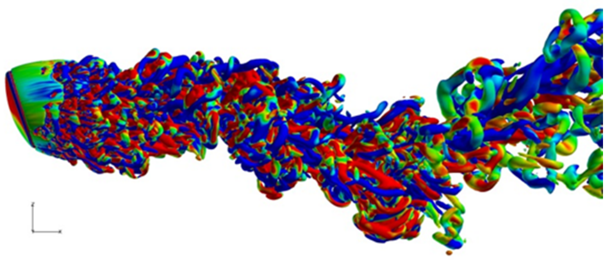
Report Number:R16E0106 https://www.jss.jaxa.jp/ar/e2016/2114/

Inquires

Yuya Ohmichi (ohmichi.yuya@jaxa.jp)

Abstract

In this study, coherent structures around a reentry capsule were investigated using the unsteady flow solver FaSTAR. The flow field around a reentry capsule is important because the dynamic instability occurs especially in subsonic cruise. We studied the dynamic instability by numerically simulating the unsteady flow fields around the reentry capsule.



Instantaneous flow field. Isosurfaces of the Q value, colored with freestream direction component of vorticity.

Development of 3D CFD core-software of automotive engine combustor

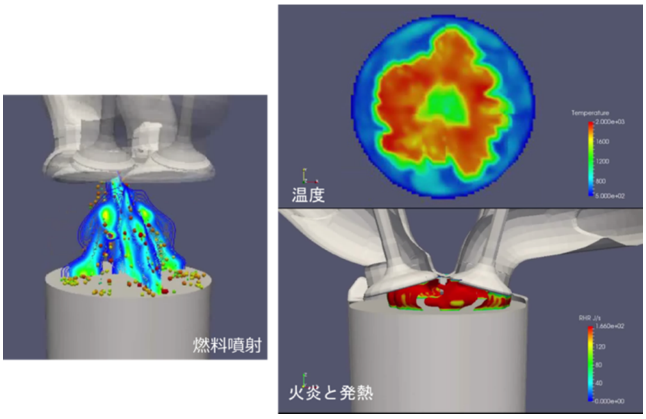
Report Number:R16E0020 https://www.jss.jaxa.jp/ar/e2016/1950/

Inquires

Yasuhiro Mizobuchi (mizo@chofu.jaxa.jp)

Abstract

Development of 3D fully compressible flow simulation software based on Cartesian grid + IB method that can easily deal with moving boundaries, and incorporate automotive engine related sub-models on it.



SI engine process simulation

Convergence Acceleration of High Reynolds number Transonic Flow with Hyperbolic Navier-Stokes Equations

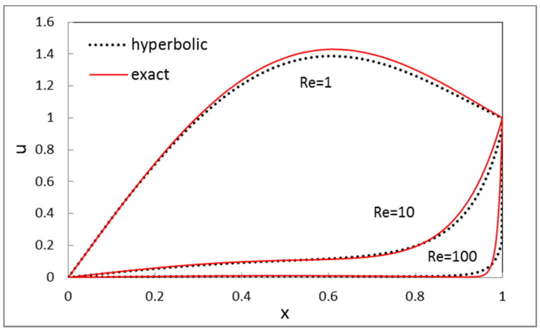
Report Number:R16E0064 https://www.jss.jaxa.jp/ar/e2016/2036/

Inquires

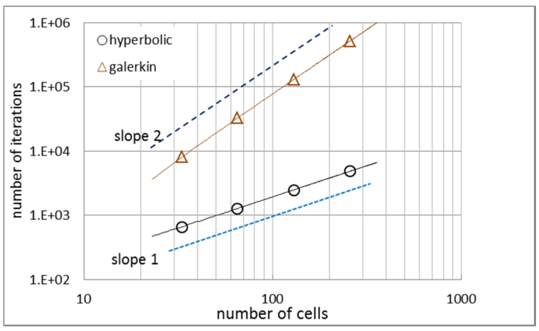
Atsushi Hashimoto (hashimoto.atsushi@jaxa.jp)

Abstract

We evaluate the hyperbolic equations for one and two dimensional advection-diffusion equations.



Numerical results



Number of iterations

Atmospheric Environmental Monitoring Simulation

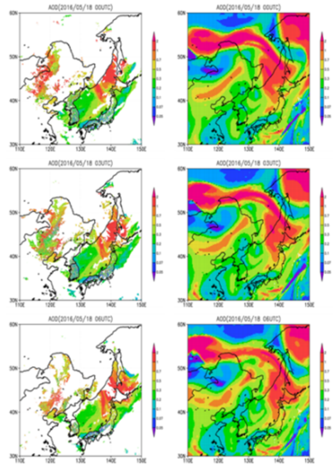
Report Number:R16E0097 https://www.jss.jaxa.jp/ar/e2016/2096/

Inquires

Maki Kikuchi (kikuchi.maki@jaxa.jp)

Abstract

This project is aimed at development of an integrated system of numerical modeling and satellite observation of air pollution for its reliable monitoring and prediction. For this purpose, seamless atmospheric modeling system is operated on JSS2 to conduct simulations of air pollution transport over East Asia. The results are also validated against satellite observations of aerosols.



Comparisons of aerosol optical depth (AOD) between Himawari-8 satellite observations (left) and NICAM-SPRINTARS simulations (right) for the case in May 18, 2016 at 00UTC, 03UTC and 06UTC (top to bottom).

Sparse model analysis of unsteady flows around a reenty capsule

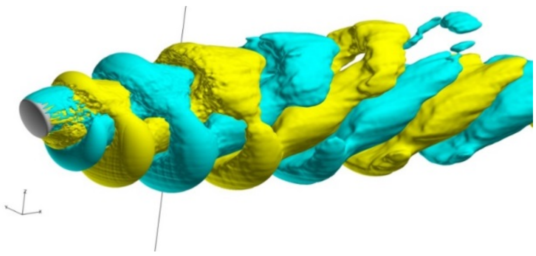
Report Number:R16E0070 https://www.jss.jaxa.jp/ar/e2016/2048/

Inquires

Yuya Ohmichi (ohmichi.yuya@jaxa.jp)

Abstract

Recently, data analysis methods for massive data sets are important because the massive data can be relatively easily obtained thanks to the development of the computers and numerical simulation techniques. In this study, we are developing such data analysis tools which extract patterns from a massive data obtained by unsteady fluid simulations.



An example of coherent structures in the wake of the reentry capsule.

Prediction of aerothermal environment around atmospheric entry vehicles with sophisticated numerical tools

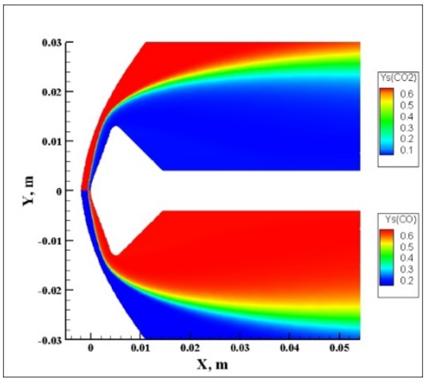
Report Number:R16E0008 https://www.jss.jaxa.jp/ar/e2016/1926/

Inquires

Toshiyuki Suzuki (suzuki.toshiyuki@jaxa.jp)

Abstract

In this study, we try to enhance the physical model for high temperature gas and numerical simulation method to accurately predict the heating and aerodynamic characteristics at the hypersonic atmospheric entry. We aim to realize high fidelity simulation tool by demonstrating the accuracy of the prediction by comparing experimental data and simulation results with newly proposed model and method.



Computation of the flowfield around a small scale capsule model. Mass fraction fields of CO_2 (upper) and CO (lower).

Research on numerical simulation of combustion phenomena

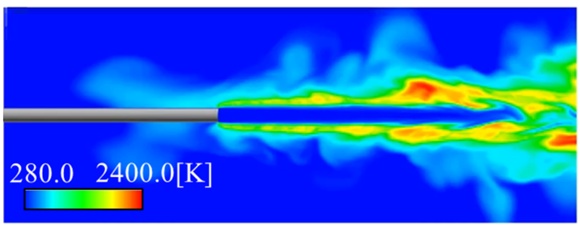
Report Number:R16E0102 https://www.jss.jaxa.jp/ar/e2016/2106/

Inquires

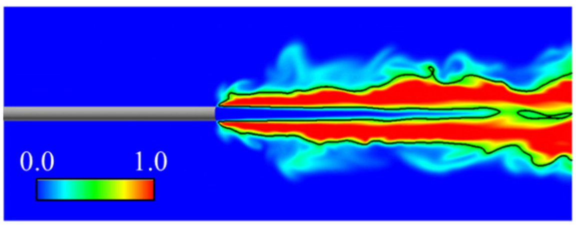
Himeko Yamamoto (himeko@toki.waseda.jp)

Abstract

For the development of a jet engine combustor with high environmental compatibility, we develop the combustion calculation code that can capture the complex combustion field and the pressure propagation with practical calculation cost. In addition, a verification calculation of this calculation code is conducted on the hydrogen jet lifted flame.



Temperature distribution
(no correction by scalar G)



Scalar G distribution
(correction by scalar G, solid line: G=0.5, turbulent combustion model: damkohler model, C=3.15, n=1.0)

Study on Simulation Technology to Realize Front Loading of Combustor Design Process

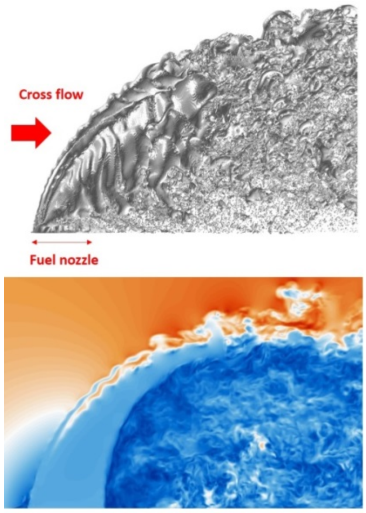
Report Number:R16E0015 https://www.jss.jaxa.jp/ar/e2016/1940/

Inquires

Yasuhiro Mizobuchi (mizo@chofu.jaxa.jp)

Abstract

We try to understand the physical nature of fuel jet atomization and separated turbulent boundary layer by detailed simulations, and then to create practical numerical models using the information.



Visualization of liquid phase surface and velocity distribution near the fuel nozzle

Reseach related to buffet simulation

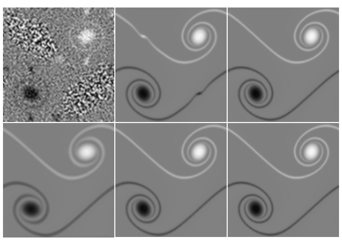
Report Number:R16E0108 https://www.jss.jaxa.jp/ar/e2016/2118/

Inquires

Takashi Ishida (ishida.takashi@jaxa.jp)

Abstract

The purpose of this study is to construct a fast unsteady CFD (Computational Fluid Dynamics) method with LBM (Lattice Boltzmann Method). Comparisons with SRT (Single-Relaxation Time) and CLBM (Cascaded-LBM) that are collision models are conducted in terms of the stability and the calculation time through the calculation of doubly periodic shear layer with a range of grid resolution. It is cleared that CLBM has the most stability with good accuracy in high Reynolds number regimes and the case of low resolution. However, compared to SRT, the calculation time of CLBM is 10 times longer. As a result of code tuning, the calculation time of CLBM is shortened by 85% compared with before tuning.



The vorticity field (Computational stability)
Columns: Collision models (SRT, CLBM), Rows: Division number of a side = 128, 256, 512

Incorporation of High Resolution Schemes into Flow Analysis Code "FaSTAR"

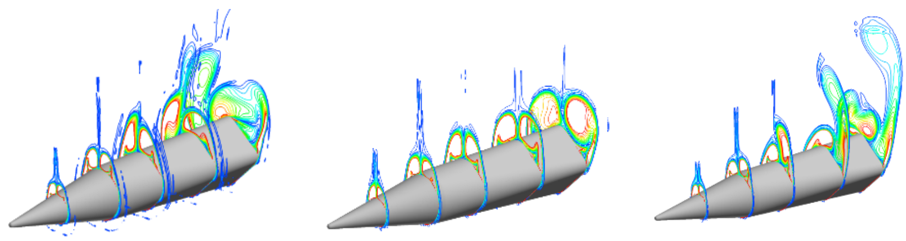
Report Number:R16E0018 https://www.jss.jaxa.jp/ar/e2016/1946/

Inquires

Keiichi Kitamura (kitamura@ynu.ac.jp)

Abstract

New, high resolution schemes "Post Limiter" and "HR-SLAU2"(numerical flux) have been incorporated into the numerical analysis code "FaSTAR." The enhanced "FaSTAR" actually attained higher resolution than the original version, and its normal operation on JSS2 was confirmed. We therefore expect its wider applications in many flow analyses.



(a) Baseline (b) Coarse (c) Coarse (Post Limiter)

Asymmetry Vortices around Slender Body produced by Post Limiter on Coarse Grid

Post-K Priority Issue 8D: Research and development of core technology to innovate aircraft design and operation

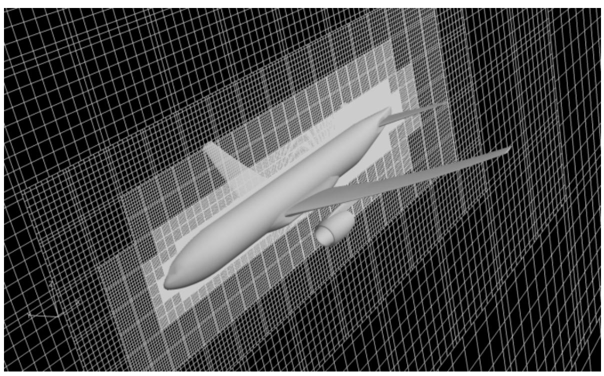
Report Number:R16E0067 https://www.jss.jaxa.jp/ar/e2016/2042/

Inquires

Ryoji Takaki (ryo@isas.jaxa.jp)

Abstract

We develop a high-speed/high-precision computational program using a quasi-first principle method, which can faithfully reproduce the actual flight environment to understand the true nature of fluid phenomena. Specifically, we develop a high-precision compressible flow solver with geometric wall models and LES (Large Eddy Simulation) wall models based on hierarchical, orthogonal and equally spaced structured grids.



Example of Hierarchical orthogonal and equally spaced structured grid around NASA CRM

SIP CFRP high fidelity modeling technology

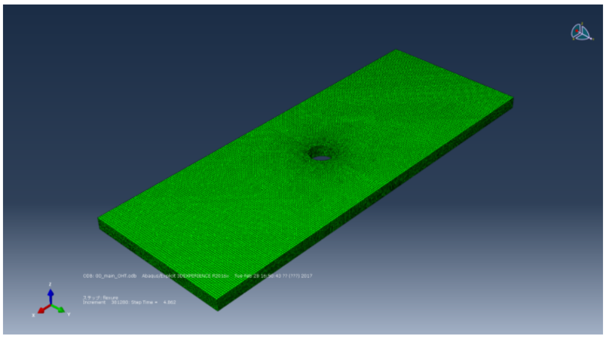
Report Number:R16E0071 https://www.jss.jaxa.jp/ar/e2016/2050/

Inquires

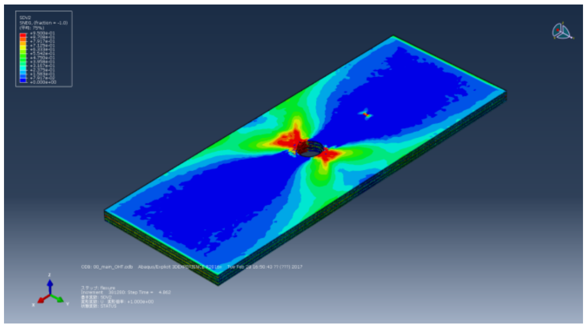
Akinori Yoshimura (yoshimura.akinori@jaxa.jp)

Abstract

JAXA contributes to the SIP (Cross-ministerial Strategic Innovation Promotion) program, which is governed by Cabinet Office, Government of Japan. JAXA takes charge high fidelity modeling of the polymer matrix composites for aircraft structure. The calculation for the modeling is performed in this topic.



Model overview of the low-velocity impact simulation



Predicted damage

Building a Simulation Hub

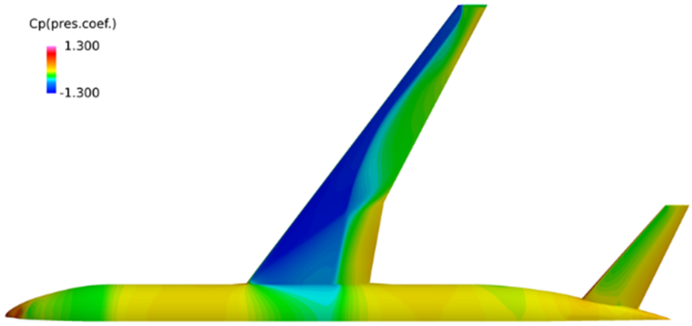
Report Number:R16E0016 https://www.jss.jaxa.jp/ar/e2016/1942/

Inquires

Atsushi Hashimoto (hashimoto.atsushi@jaxa.jp)

Abstract

We develop analysis tools, database for integrated simulation hub.



Example of numerical results

Supporting for JAXA Supercomputer Users in Kakuda Space Center

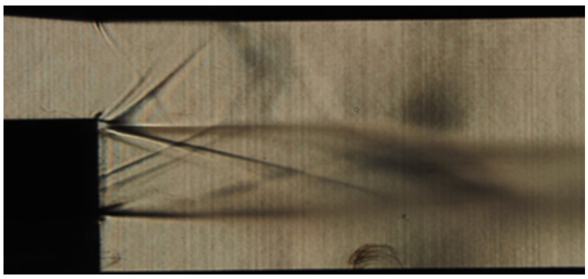
Report Number:R16E0088 https://www.jss.jaxa.jp/ar/e2016/2080/

Inquires

Shigeru Sato (ssato@kakuda.jaxa.jp)

Abstract

Kakuda Space Center is not only testing engines in ground facilities, but also simulating the engines. In order to maximize research and development products, technical engineers are working to maintain high performance visualizing terminals and software. Communication technology is also important for researchers in Kakuda Space Center that is located in long distance from Chofu JSS2. Kakuda Computer Center maintains hardware performance and technical skills to support researchers with increasing the quality levels on service requirement.



Schlieren photo — Rocket total pressure 20MPa

Simulation result of the experiment above

Study of high-fidelity numerical schemes for compressible turbulent flows

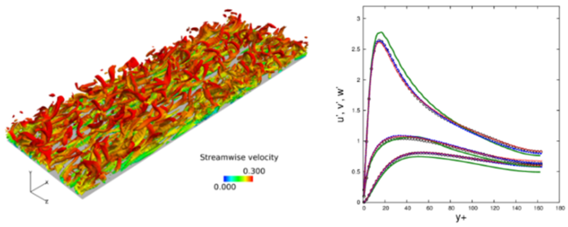
Report Number:R16E0041 https://www.jss.jaxa.jp/ar/e2016/1992/

Inquires

Soshi Kawai (kawai@cfd.mech.tohoku.ac.jp)

Abstract

Low-noise devices for reducing airframe noise of aircrafts have been studied and developed in many literature, but the details of interaction between each device are insufficiently investigated. This study develops discontinuous Galerkin (DG) based high-fidelity numerical schemes for compressible turbulent flows around aircrafts to enhance guidelines for designing next-generation low-noise aircrafts by clarifying the details of interaction between each low-noise device.



Iso-surfaces of Q criterion and performances of an iterative implicit time integration scheme obtained by the turbulent channel flow computation using high-order DG methods. The number of iterations is 10(green), 15(blue), and 20(red)

Feedback Control of Flow Separation Using DBD Plasma Actuator

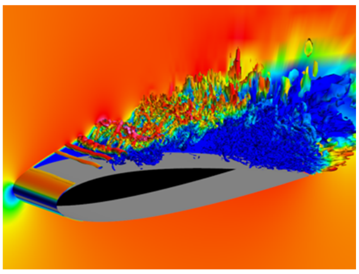
Report Number:R16E0060 https://www.jss.jaxa.jp/ar/e2016/2028/

Inquires

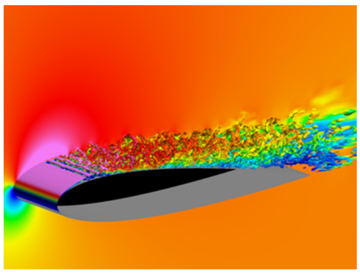
Kengo Asada (asada@rs.tus.ac.jp)

Abstract

The project develops flow control technic by using dielectric barrier discharge (DBD) plasma actuator to establish high efficient and robust vehicle systems such as rockets, aircrafts, and motor vehicles. We propose and demonstrate feedback control methods to adapt unsteady flows over the vehicles through a series of high-fidelity unsteady simulations.



(1) No Actuation



(2) Feed-back control

Iso-surfaces of Q criterion colored by chordwise velocity.

A Study on High-order Accurate Fluid Dynamic Simulations for Rotating Fluid Machinery

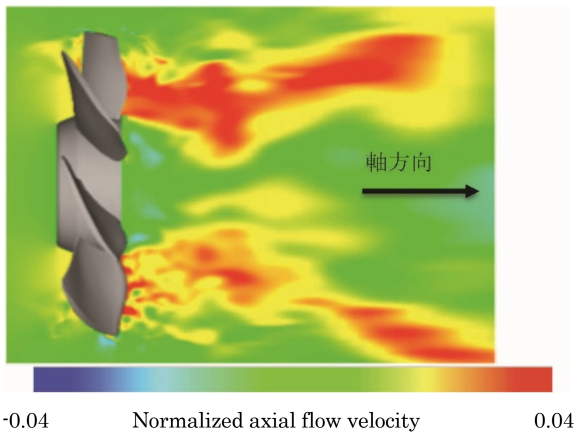
Report Number:R16E0058 https://www.jss.jaxa.jp/ar/e2016/2024/

Inquires

Hikaru Aono (aono@rs.tus.ac.jp)

Abstract

This project relates to the development of fluid analysis technology that can be applied to the design of rotating fluid element in turbo pump. In this fiscal year, large-eddy simulation analysis and its verification were carried out for a flow around a small axial flow fan with a low Reynolds number condition and available verification data. From the computed results, it was possible to demonstrate detailed unsteady fluid phenomena around the fan and quantitative evaluation of prediction accuracy. We are planning to proceed with verification using pumps and turbines in the near future.



Snapshot of instantaneous axial flow distributions around the small fan

Study on Aerodynamic Design for Mars Exploration Airplane

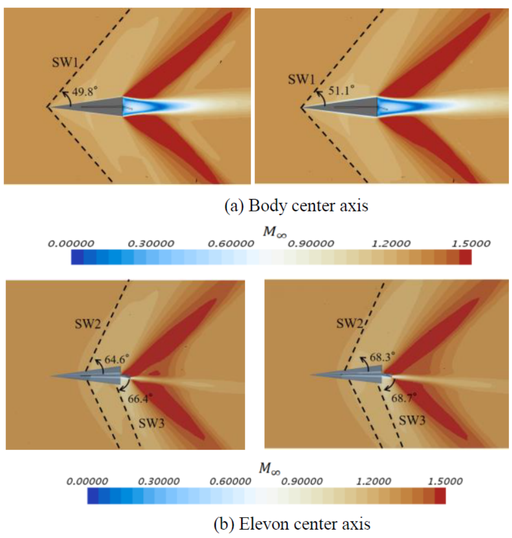
Report Number:R16E0052 https://www.jss.jaxa.jp/ar/e2016/2012/

Inquires

Seiichiro Morizawa (morizawa@mech.tottori-u.ac.jp)

Abstract

It is necessary to understand the flow field under low Reynold and high Mach numbers conditions when we conduct the aerodynamic design for Mars exploration airplane. However, there is few studies on the flow field. Thus, we conduct the fluid simulations under the condition and aim to obtain the information of aerodynamic design for the airplane.



Comparison in the Earth (left figure) and Mars (right figure) conditions

Numerical study of the convection structure in planetary atmospheres

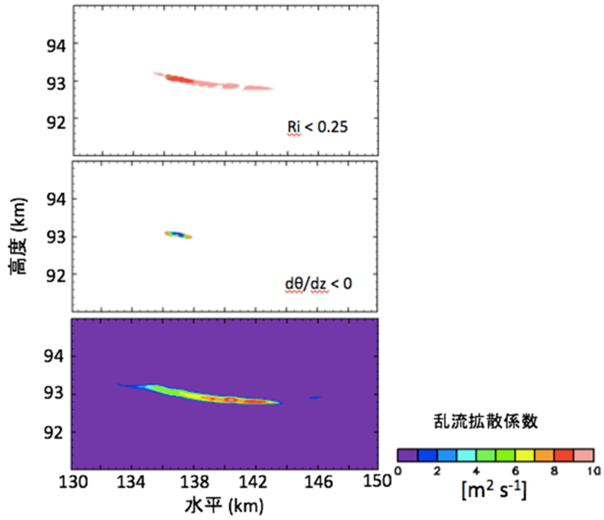
Report Number:R16E0048　　　　　　　https://www.jss.jaxa.jp/ar/e2016/2004/

Inquires

Ko-ichiro Sugiyama (sugiyama@gfd-dennou.org)

Abstract

Gravity waves influence the atmospheric motion due to the heat and momentum transports associated with their propagation and breaking. In order to investigate propagation and breaking of the gravity waves main source of which is convection, we perform numerical experiment using our cloud resolving model. Our results indicate that their breaking is caused by shear instability and convective instability.



The distribution of Richardson number (upper panel), atmospheric stability (middle panel), and turbulent diffusion coefficient (lower panel) in a region where gravity wave breaking occurs.

Influence of Fineness Ratio on Aerodynamic Characteristics of Fight Vehicles

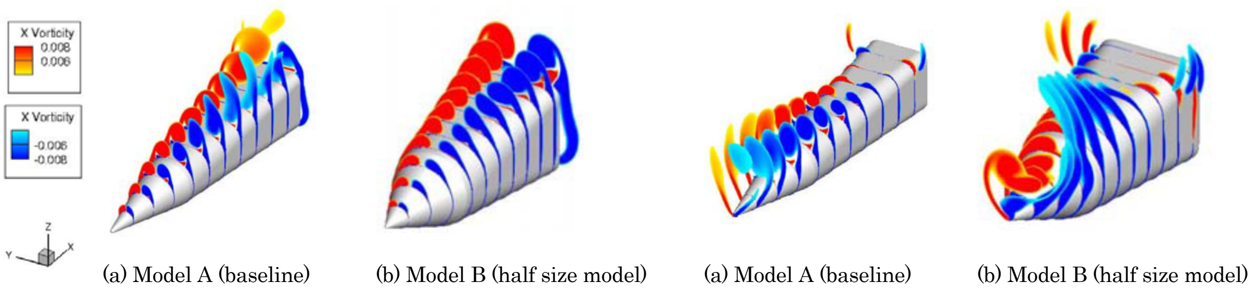
Report Number:R16E0055　　　　　　　https://www.jss.jaxa.jp/ar/e2016/2018/

Inquires

Ayano Inatomi (inatomi-ayano-ng@ynu.jp)

Abstract

In this study, we investigated details of flow field around the slender-bodied-vehicle numerically with configurations having different fineness ratios. Interestingly, the trend of 140 degrees of AOA is totally opposite to that observed at 50 degrees of AOA. It had been considered that the large nose bluntness and the small fineness ratio can reduce asymmetry and CY, however, this study showed that it is not true in the case over 90 degrees of AOA.



(a) Model A (baseline)　(b) Model B (half size model)　(a) Model A (baseline)　(b) Model B (half size model)

AOA = 50 [degrees]　　　　　AOA = 140 [degrees]

Development of a shock-capturing magnetohydrodynamic code, "OpenMHD"

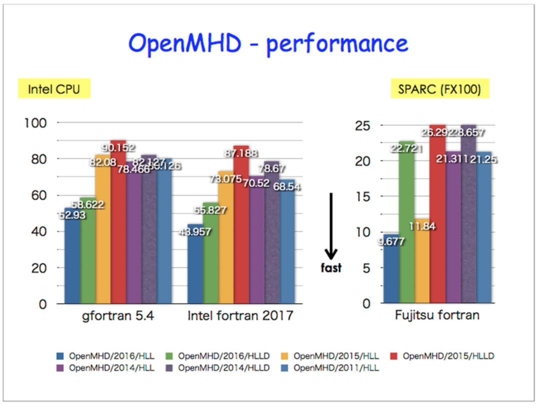
Report Number:R16E0040 https://www.jss.jaxa.jp/ar/e2016/1990/

Inquires

Seiji Zenitani (zenitani@rish.kyoto-u.ac.jp)

Abstract

We conduct scientifitc researches on basic processes in space plasma environments, by using numerical simulations. We also develop an open-source simulation code.



Benchmarks of the OpenMHD code

Origin of material substance, thermal history and magnetic field generation of Mercury

Report Number:R16E0043 https://www.jss.jaxa.jp/ar/e2016/2428/

Inquires

Youhei Sasaki (uwabami@math.kyoto-u.ac.jp)

Abstract

We will clarify the current internal state of Mercury and the evolution by numerical calculations of the internal structure and the intrinsic magnetic field generation and comparing with the data obtained from observations.

Radiative Magnetohydrodynamic Simulations of Solar Atmosphere

Report Number:R16E0059 https://www.jss.jaxa.jp/ar/e2016/2026/

Inquires

Haruhisa Iijima (h.iijima@isee.nagoya-u.ac.jp)

Abstract

"We investigate the validity of the reduction of the Alfven speed in the solar atmospheric model and implement the method to reduce the computational cost of the simulation. We carry out the full sunspot simulation with about 1/100th smaller computational cost."

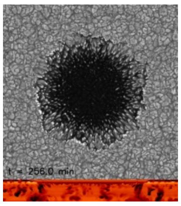


Fig.1
Radiative magnetohydrodynamic simulation of the sunspot. Emerging bolometric radiative intensity viewed from above (Top) and the vertical slice of the horizontal perturbation of the entropy (Bottom) is shown.

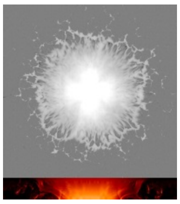


Fig.2
Same as Fig. 1 but showing the vertical magnetic field on the average height of the bolometric optical depth unity (Top) and the vertical slice of the amplitude of the magnetic field.

Large Scale N-body simulation of Planet Formation : Outward Migration of a Protoplanet within a Gas Disk

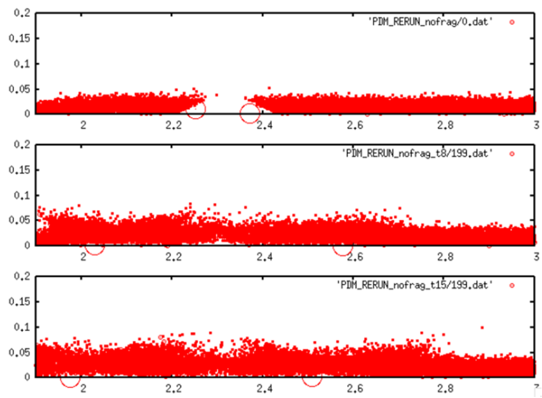
Report Number:R16E0053 https://www.jss.jaxa.jp/ar/e2016/2014/

Inquires

Masaki Fujimoto (fujimoto.masaki@jaxa.jp)

Abstract

Planets are thought to be formed from dust in protoplanetary disks. However, so far, we have not succeeded to reproduce even our Solar system. I am carrying out N-body simulation in order to clarify how the planetary system was formed.



semimajor axis(AU)

Snapshots of random velocity vs the semimajor axis. Top panel is the initial state, middle panel is t=240000 years and the bottom panel is 480000 years. The outer protoplanet once migrates outward, however, changes the direction afterwards due to type-I migration.

Large Scale N-body simulation of Planet Formation : Effect of Fragmentation of Planetesimals.

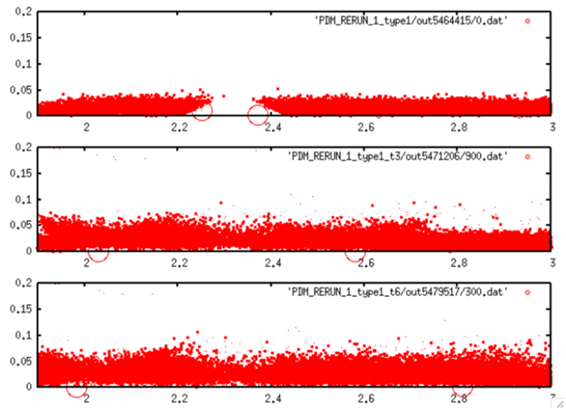
Report Number:R16E0061 https://www.jss.jaxa.jp/ar/e2016/2030/

Inquires

Masaki Fujimoto (fujimoto.masaki@jaxa.jp)

Abstract

Planets are thought to be formed from dust in protoplanetary disks. However, so far, we have not succeeded to reproduce even our Solar system. I am carrying out N-body simulation in order to clarify how the planetary system was formed.



semimajor axis(AU)

Snapshots of random velocity vs the semimajor axis. Top panel is the initial state, middle panel is t=320000 years and the bottom one is t=640000 years. The outer protoplanet continues moving outward.

Numerical Study of Unstable Mode and Turbulent Transition in Hypersonic Boundary Layer

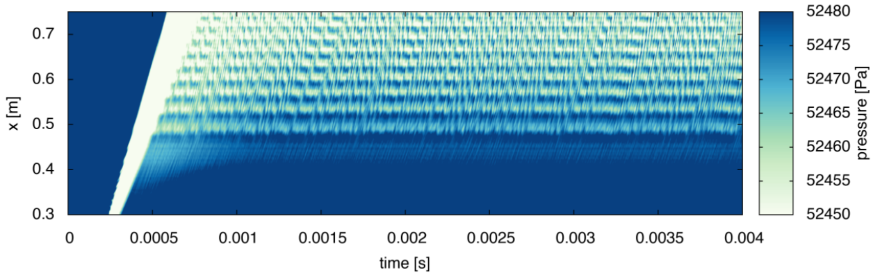
Report Number:R16E0049 https://www.jss.jaxa.jp/ar/e2016/2006/

Inquires

Naofumi Ohnishi (ohnishi@rhd.mech.tohoku.ac.jp)

Abstract

Unstable modes were obtained by conducting dynamic mode decomposition to field data calculated by numerical simulation of hypersonic flow around a sharp cone which was used in past experiment. The characteristic mode was extracted and had the similar structure to the second mode, which is considered as an unstable mode. Moreover, different frequencies were obtained between the modes in upstream and downstream, suggesting that a mode transfer may occur until a position at which the turbulent transition was observed in the experiment.



Wall pressure variation around a sharp cone.

Development and application of two-phase flow solver around moving objects

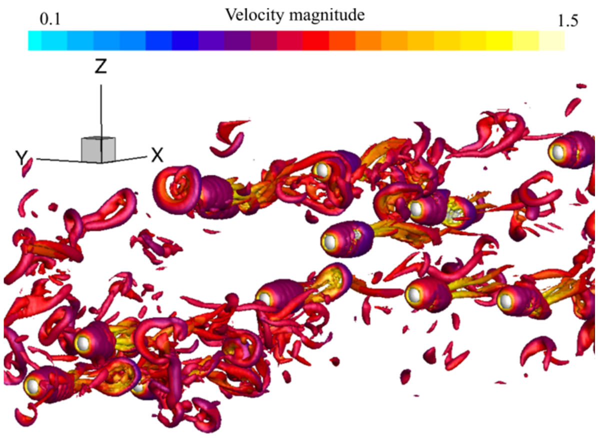
Report Number:R16E0044 https://www.jss.jaxa.jp/ar/e2016/1996/

Inquires

Shun Takahashi (takahasi@tokai-u.jp)

Abstract

Two-phase flows with moving objects are commonly used in practical engineering products. This study is subject to investigate the effect of the micro particles in the exhausted gas from the rocket engine to the strong pressure waves and the thermal conductance modification due to the water film around the menisci in the heat pipes. These multiphase flows that are important from the points of the industrial application and the academic interest must be solved by the large scaled simulation.



Vortex structure identified by the isosurface of second invariant value of the velocity gradient tensor around multiple particles.

Numerical Study of Breakdown and Shock Wave Structures for Improvement of Flight Performance in a Beamed-Energy Vehicle

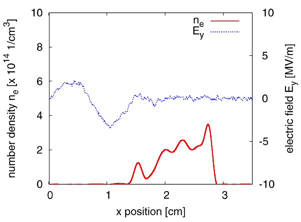
Report Number:R16E0051 https://www.jss.jaxa.jp/ar/e2016/2010/

Inquires

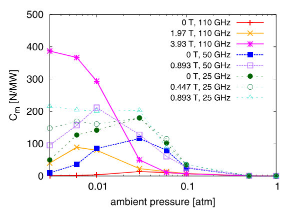
Masayuki Takahashi (mtakahashi@rhd.mech.tohoku.ac.jp)

Abstract

Plasma simulations with kinetic particle and fluid models were coupled with an electromagnetic field propagation to reproduce the breakdown structure in a beamed-energy propulsion system. The compressible fluid simulation was also conducted to reproduce the shock wave propagation around the vehicle. Thrust performance and flight stability of the vehicle were improved by applying an external magnetic field into the breakdown region.



Beam-induced breakdown reproduced by particle simulation.



Thrust performance improvement by an external magnetic field.

Computational Study on Aerodynamic Characteristics of Slender Body Configurations

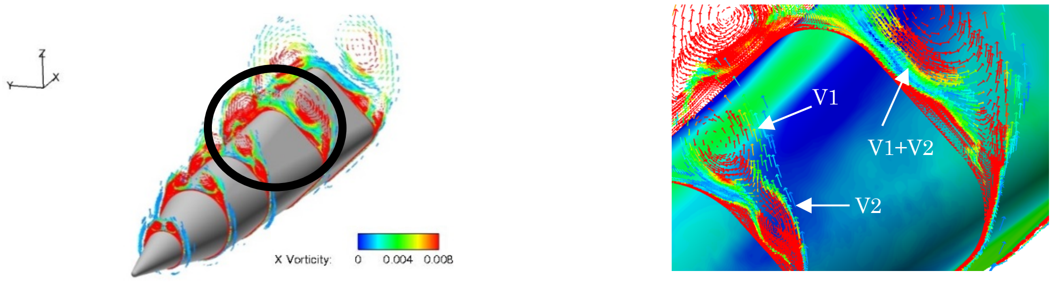
Report Number:R16E0046 https://www.jss.jaxa.jp/ar/e2016/2000/

Inquires

Takuya Aogaki (aogaki-takuya-rf@ynu.jp)

Abstract

We conducted numerical analysis on a slender body configuration which mimics a reusable rocket. In this study, we acquired detailed flowfields which have not been obtained from previous experiments and related them with aerodynamic characteristics. As a future work, by reference to our results, we will install aerodynamic devices and examine configurations to get better aerodynamic characteristics.



(a) 2D vectors colored with vorticity magnitude

(b) Close-up of (a) ($x/L = 0.50$ plane and $x/L \approx 0.75$ plane)

AOA=40 degrees

The Effect of Protuberant Devices on Aerodynamic Characteristics of Slender Body Vehicle

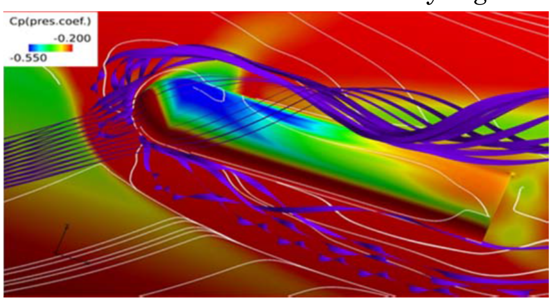
Report Number:R16E0054 https://www.jss.jaxa.jp/ar/e2016/2016/

Inquires

Toshiaki Harada (harada-toshiaki-vt@ynu.jp)

Abstract

It is important for rocket developments to quantitatively estimate the influence of protuberances in the flight vehicles which create asymmetry of flow around the vehicles and aerodynamic forces. Using fluid numerical computation, it is expected that we obtain a guideline for the protuberance choice in the future rocket development by conducting systematic and fundamental aerodynamic study on protuberance positions and sizes allowed to arbitrary flight vehicles.



The streamlines around protuberance
(protuberance position: center of gravity; angle of attack: 20 degrees)

Compressible effects in plasmoid-dominated magnetic reconnection

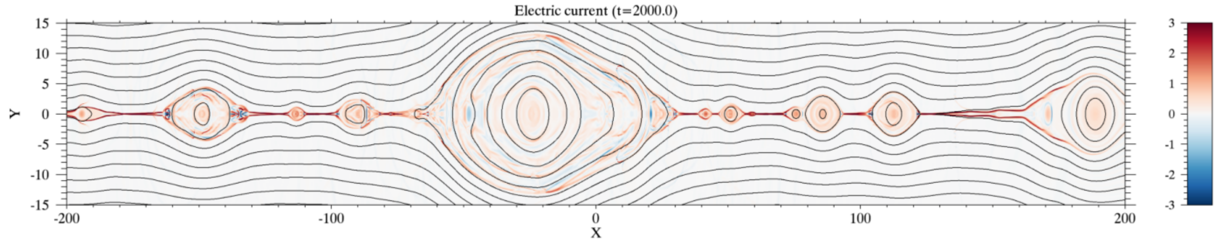
Report Number:R16E0062 https://www.jss.jaxa.jp/ar/e2016/2032/

Inquires

Seiji Zenitani (zenitani@rish.kyoto-u.ac.jp)

Abstract

We conduct scientifitc researches on basic processes in space plasma environments, by using numerical simulations. We also develop an open-source simulation code.



MHD simulation of large-scale magnetic reconnection
(In-plane magnetic field lines and the electric current density)

Numerical Study on Combustible Flow in Supersonic Flight Engines and Rocket Engines

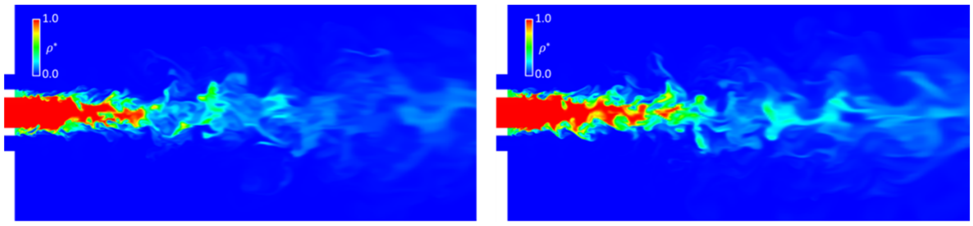
Report Number:R16E0039 https://www.jss.jaxa.jp/ar/e2016/1988/

Inquires

Nobuyuki Tsuboi (tsuboi@mech.kyutech.ac.jp)

Abstract

Reactive Fluid Dynamics Laboratory at Department of Mechanical and Control Engineering, Kyushu Institute of Technology has the following research keywords: (1)Numerical simulation(CFD) (2) Compressible and supersonic/hypersonic flow (3)Combustion flow (4)Liquid rocket engine, Detonation. We study these topics mainly by using numerical simulations and we also conduct some experiments. We collaborate on research activities with many domestic and international researchers..



(a)5 MPa (b)12 MPa

Instantaneous normalized density contours.

Construction of LES Model for High Mach-number-turbulent-multi-phase-flow model based on DNS

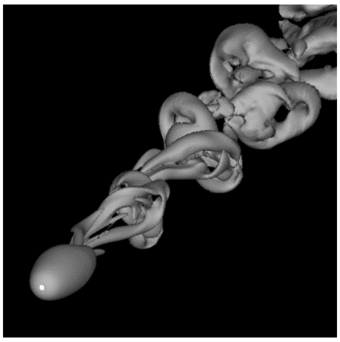
Report Number:R16E0045 https://www.jss.jaxa.jp/ar/e2016/1998/

Inquires

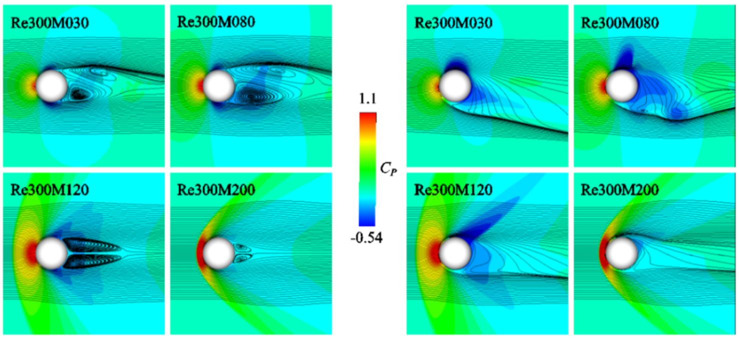
Kota Fukuda (fukuda@tokai-u.jp)

Abstract

In order to construct LES model for high Mach number multi-phase turbulent flow, direct numerical simulation (DNS) of high Mach number and low Reynolds number flow around a particle will be carried out and construction of its data base and examination of the flow phenomena will be conducted.



Vortex structure identified by the isosurface of second invariant value of the velocity gradient tensor.



Pressure coefficient distributions and stream lines around a rotating sphere.

Studies on nonlinear vortex dynamics in the later-stage of laminar-turbulent transition in compressible boundary layers

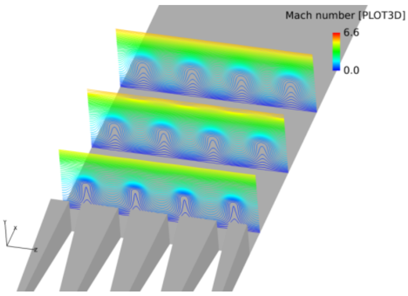
Report Number:R16E0047 https://www.jss.jaxa.jp/ar/e2016/2002/

Inquires

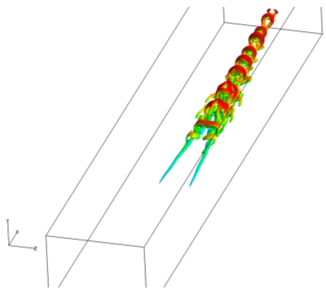
Kazuo Matsuura (matsuura.kazuo.mm@ehime-u.ac.jp)

Abstract

Boundary layer transition around a solid object is important in order to predict the condition for stable engine operation and the distribution of heat transfer when an airplane flies at the speed five times faster than the speed of sound. Vortex dynamics occurring inside the boundary layer is investigated using supercomputer. Also, mathematical techniques necessary for the investigation are also developed.



Vortex generation downstream of protuberance in a hypersonic boundary layer, M_∞=6.0



Secondary hairpin vortex generation in a transitional process

Direct Numerical Simulations of Developed Turbulence

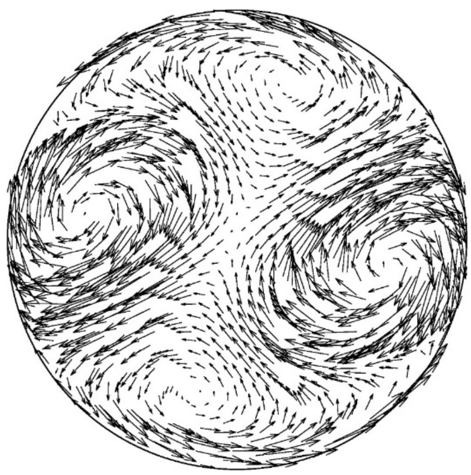
Report Number:R16E0042 https://www.jss.jaxa.jp/ar/e2016/1994/

Inquires

Susumu Goto (goto@me.es.osaka-u.ac.jp)

Abstract

Turbulence is ubiquitous. Interestingly, small-scale eddies in turbulence have universal properties, which are independent of the kind of turbulence. We aim at reviewing the physics of this universality and constructing new turbulence models which can be applied to many problems in aerospace engineering.



Large-scale vortices in turbulence sustained in a precessing sphere. Two pairs of anti-parallel vortices effectively create small-scale turbulent eddies.

Stabilization of high-order flux-reconstruction schemes with split forms

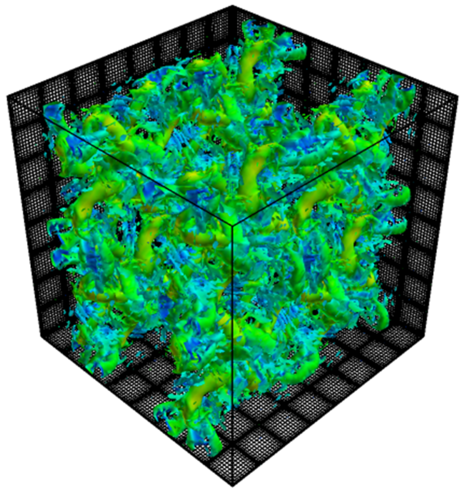
Report Number:R16E0056 https://www.jss.jaxa.jp/ar/e2016/2020/

Inquires

Yoshiaki Abe (y.abe@imperial.ac.uk)

Abstract

We have investigated a coupling of very-high-order flux-reconstruction scheme and kinetic energy preserving framework for simulating high-Reynolds-number flows around complex geometries using parallel computers. Several numerical experiments have been conducted for isotropic turbulence without excessive numerical dissipation.



Instantaneous isosurfaces of vorticity in Taylor-Green vortex using new split form of FR scheme with sixteenth-order accuracy

Numerical Analysis of Transformation of Shock Waves around a Forward-Facing Cavity

Report Number:R16E0057 https://www.jss.jaxa.jp/ar/e2016/2022/

Inquires

Toshiharu Mizukaki (mizukaki@keyaki.cc.u-tokai.ac.jp)

Abstract

Around the supersonic parachute for Mars probing, drastic transformation of shock-wave oscillation has been observed. In the worst case, the shock waves oscillation deforms the parachute to collapse. In this research, we try to revile the mechanism of transformation of the shock waves and develop the design methodology for oscillation-free parachute. At the first step of this research, simplified model of the supersonic parachute is investigated to compare to experimental result.

Numerical analysis of discharge process for clarification of body force characteristics in DBD plasma actuator

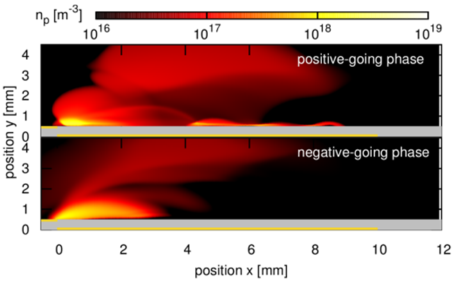
Report Number:R16E0050 https://www.jss.jaxa.jp/ar/e2016/2008/

Inquires

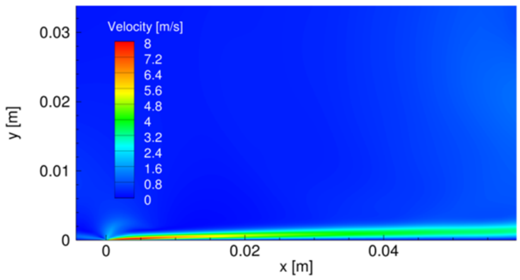
Naofumi Ohnishi (ohnishi@rhd.mech.tohoku.ac.jp)

Abstract

We conducted numerical simulations of the discharge process in the DBD plasma actuator to improve the induced flow velocity. Clarification of the discharge process is a key issue because the flow is induced by the electrohydrodynamic force caused by the discharge. The relationship between the voltage waveform and discharge regime was investigated. A wall jet is reproduced by using the discharge simulation results.



Positive ion number density with a triangle voltage waveform (13 kV, 10 kHz).



Time-averaged velocity of a wall jet induced by the DBD plasma actuator.

JAXA Special Publication JAXA-SP-17-003E

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