ABSTRACTS

organized by last name

Forum Math-for-Industry 2017

October 23 - 26
UH Mānoa, Hawai`i

UNIVERSITY of HAWAI'I MĀNOA

KYUSHU UNIVERSITY

FORUM "MATH FOR INDUSTRY 2017"
Responding to the Challenges of Climate Change: Exploiting, Harnessing and Enhancing the Opportunities of Clean Energy
East-West Center, University of Hawaii
HAWAII IMIN INTERNATIONAL CONFERENCE CENTER AT JEFFERSON HALL

October 23, 2017 **Monday** **Keoni Auditorium**		October 24, 2017 **Tuesday** **Keoni Auditorium**	
9:15-9:45	UH-Manoa President D. Lassner Vice President Kyushu University M. Wakayama	9:50-10:20	**Yichao Zhu** Multiscale Modelling of Materials: From Microstructures to Macro-Behaviour *Department of Engineering Mechanics, Dalian University of Technology, China*
9:45- 10:15	**Sam ʻOhukaniʻōhiʻa Gon III** Lessons from a thousand years of island sustainability *Senior Scientist/Cultural Advisor* *The Nature Conservancy of Hawaiʻi*		
10:20-10:50	**Mark Glick** The Science of Energy Transformation – An Introduction to the 2017 Clean Energy & Climate Change Conference *Hawaii Natural Energy Institute and Former State Energy Office Director, Hawaii*	10:30-11:20 *Plenary talk*	**Petros Sofronis** Mathematical Challenges in Linking the Micro- with Macro-Scale Behavior of Materials in the Presence of Hydrogen *Director of I2CNER* *Kyushu University*
11:00-11:50 Plenary Talk	**Michael Celia** Modeling Geological Storage of Carbon Dioxide with a Focus on Model Complexity and Practical Simulations *Theodora Shelton Pitney Professor of Environmental Studies, Professor of Civil and Environmental Engineering, Princeton*	11:30-12:00	**Jeff Mikulina** Accelerating Hawaii toward 100% clean energy *Blue Planet Foundation*
12:00-12:50 Plenary Talk	**Seita Emori** Future projections and risk studies of climate change *Head of the Center for Global Environmental Research(Climate Risk Assessment Section*	12:10-12:40	**Dinh Hoa Nguyen** A novel optimization model for integrating carbon constraint with demand response and real-time pricing *II2CNER & IMI, Kyushu University*
LUNCH		LUNCH	
2:00-2:50 Plenary Talk	**Kamal Oudrhiri** Gravity science as an effective tool for monitoring Earth's freshwater resources *NASA Radio Science Group Manager* *Deputy Project Manager for the Cold Atom Laboratory mission*	1:30-2:20 Plenary Talk	**Yuji Ohya** Introduction of highly efficient multi-lens wind turbine and wind-solar tower based on new concepts *Research Institute for Applied Mechanics, Kyushu University*
3:00-3:30	**Esther Widiasih** Climate change: a complex reality viewed from a simple math lens *Mathematics, UH West Oahu*	2:30-3:20 Plenary Talk	**Alejandro Jofré** Optimization and game theory in Energy markets *Director of the Center for Mathematical Modeling Chile*
3:30-4:00	COFFEE BREAK		COFFEE BREAK
4:00-4:30	**Tony Jakeman** Identifiability and uncertainty of hydrological models for predicting climate change impacts on water resources *National Centre for Groundwater Research and Training* *The Australian National University*	3:30-5:30	POSTER Session

FORUM “MATH FOR INDUSTRY 2017”

Responding to the Challenges of Climate Change: Exploiting, Harnessing and Enhancing the Opportunities of Clean Energy

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	October 25, 2017 Wednesday Keoni Auditorium		**October 26, 2017 Thursday Keoni Auditorium**
9:30-10:20 Plenary Talk	**Jason Leigh** Painting the Big Picture for Environmental Decision Making and Communication *Laboratory for Advanced Visualization & Applications UH Manoa*	9:30-10:20 Plenary Talk	**Camilo Mora** We Punch Nature and It Will Punch Us Back: Human Impacts on Biodiversity and Their Feedback on People *Department of Geography, University of Hawaii*
10:30-11:20 Plenary talk	**David Wood** Helical Vortices: from the mathematics to wind turbine performance analysis *Schulich Professor of Renewable Energy University of Calgary*	10:30-11:20 Plenary Talk	**Rosalind Archer** Mathematical Tools to Support Geothermal Energy Production Mercury Chair in Geothermal Reservoir Engineering Department of Engineering Science University of Auckland, NZ
11:30-12:00	**John Jakeman** Quantifying uncertainty in sea-level change due to ice-sheet evolution in Greenland *Sandia National Laboratories - Center for Computing Research*	11:30-12:00	**Kaname Matsue** Mathematical treatment of flame dynamics toward foundation of combustion IMI & I2CNER, Kyushu University
12:00-12:30	**Ryan Perroy** Mapping and modeling three-dimensional coastal change on Hawai‘i Island under rising sea level conditions *Geography and environmental Sciences, UH Hilo*	12:00-12:30	**Christina Karamperidou** The interacting time scales of tropical Pacific climate: modeling challenges and impacts” *Department of Atmospheric Sciences UH Manoa*
	LUNCH		LUNCH
	EXCURSION NORTH SHORE	1:30-2:20 Plenary Talk	**Juliet Newson** Renewable Energy Education in Iceland *Director of the energy lab Iceland*
		2:30-3:20 Plenary Talk	**Steven Businger** The Impact of Global Warming on Recent Hurricanes *Department of Atmospheric Sciences UH Manoa*
		3:30-3:45	Closing address **Yasuhide Fukumoto**

Rosalind Archer
Mercury Chair in Geothermal Reservoir Engineering
Department of Engineering Science
University of Auckland
Auckland, New Zealand

Thu Oct. 26 10.30a

Title Mathematical Tools to Support Geothermal Energy Production

Abstract Geothermal energy is a clean energy source that generates 16% of New Zealand's electricity. Geothermal fluids are produced from deep within the earth from reservoirs that cost millions of dollars to drill. Those wells are almost a needle in a haystack when compared to the overall volume of the systems. How do we infer 3D reservoir structures? How do we model heat and mass transfer, and the associated multiphase flow, through complex fault and fracture networks? What are the best computational tools to handle the flow physics at appropriate scales? How can well placements and production plans be optimised? What mathematical tools are required to address flow problems which may have millions of degrees of freedom?

This talk will introduce a range of mathematical tools which are used to tackle these questions. The toolbox involved includes finite volume, finite element, and boundary element methods, lattice Boltzmann methods, analytical approaches for partial differential equations, geostatistical techniques, proxy/emulation methods, inverse modelling and nonlinear optimization methods.

Steven Businger
Department of Meteorology
University of Hawai`i at Manōa

Thu Oct. 26 2.30p

Title Improving Arctic Weather and Ice Extent Prediction

Abstract The ability to accurately predict Arctic storms and sea-ice extent are of growing strategic importance to the Navy in a warming climate. Recent observations of sea ice extent and Arctic cyclogenesis have lent support to the hypothesis that year-to-year variations in sea ice are driven to a great extent by a relatively small number of intense storms. For a variety of reasons, Arctic cyclones are very poorly predicted over the Arctic even by the most skillful NWP models. The inability to predict this forcing is a predictability barrier that must be overcome if intra- and inter-seasonal predictions of sea ice are to become a reality. The overarching objective of this proposal is to improve the Navy's ability to simulate and predict Arctic cyclones through improved satellite data assimilation, which also aims to shed light on the basic processes governing the development and evolution of Arctic cyclones, and their influence on coupled air-sea-ice processes. Significant gains in the performance of medium range NWP models in recent years have been attributed to assimilation of satellite radiance observations. However, because of the computational overhead, the radiance assimilation schemes employed by leading NWP centers do not currently exploit the full information content available from advanced hyperspectral sensors.

Recently the equivalence between assimilating the full set of radiances and assimilating retrieved thermodynamic profiles has been demonstrated and the conditions needed for the equivalence have been clearly prescribed (Migliorini 2012). For this project, we have selected two hyperspectral instruments (CrIS and IASI) flown on four polar orbiting sun-synchronous satellites (Suomi-NPP, JPSS1, METOP A and B). Since the orbital period of these satellites is slightly greater than 100 minutes, the Arctic Region is covered by a total of 64 overpasses per day. Moreover, spatial coverage includes a considerable degree of overlap between consecutive orbits. The strengths of this proposed strategy are:

- High temporal frequency of observations obtained from four polar orbiting satellites
- Improvement of satellite observations over sea ice and in cloudy conditions to supplement the high density observations under clear sky conditions
- Excellent timeliness of observations by use of Direct Broadcast stations
- Availability of an efficient Inversion System capable of producing soundings from different high spectral resolution IR instruments (CrIS and IASI)
- Three groups, UH, EUMETSAT, and ECMWF, have conducted early practical tests of optimal assimilation of scaled retrieval (soundings) derived from hyperspectral IR instruments, demonstrating the validity of the mathematical transformation proposed by Rodgers (2000) and Migliorini (2012).

Seita Emori
Climate Risk Assessment Section
Center for Global Environmental Research
Tsukuba, Ibaraki, Japan Mon Oct. 23 12noon

Title Future Projections and Risk Studies of Climate Change

Abstract Over the past 150 years, global average temperature has increased around 1 degree C. The main causes are very likely to be increased human-induced greenhouse gases (GHGs) in the atmosphere. With the rise of global temperature, various risks have been posed against human society and ecosystem; the sea level rise, the ice sheet melt, extreme weather such as heat waves and heavy rains growing both in frequency and scale.

At the end of 2015, the 21st session of the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change(UNFCCC) was held in Paris and adopted the 'Paris Agreement on Climate Change' which set path to keep global temperature rise well below 2 degrees C and to make efforts to limit the temperature increase even further to 1.5 degrees C above pre-industrial levels. It was also agreed to cut global CO_2 emissions to almost net-zero by the end of this century to achieve the goal. The energy-related CO_2 being the main part of GHGs, the agreement represents a determination by global community to realize a society which ends dependence on fossil fuels (decarbonized society) within this century.
Will it be possible to realize such goals? Why do we need to aim 1.5 degrees C or 2 degrees C? In this talk, I will overview the scientific analyses about present situations and future projections of climate change as well as its risks. Then I would like to discuss what choices humankind should make to challenge the decarbonization. Finally, I will mention the role that math for industry is expected to play in this transformation of our society.

Mark B. Glick
Specialist on Energy Policy & Innovation
Hawaii Natural Energy Institute
University of Hawaii at Mānoa Mon Oct 23 10.20a

Title The Science of Energy Transformation – An Introduction to the 2017 Clean Energy & Climate Change Conference

Abstract While the United States has yet to sign onto any binding international treaty to curb greenhouse gases, it has nonetheless voluntarily reduced more carbon dioxide emissions than any other nation and has been on a pace to meet an Obama administration pledge to reduce CO2 emissions by 17% from 2005 levels by 2020. However, President Trump's decision to rescind America's participation in the Paris Accord has called into question America's commitment to carbon reduction efforts and clean energy investments. The vast majority of national and international dialogue has been critical of Executive Branch decisions and appointments, notwithstanding the US Congress's persistent opposition to consider any potential American obligation to curb CO2 emissions. In the current environment, Congress and the Executive Branch present a united front in efforts to dismantle the Obama Administration's Clean Power Plan, roll-back efficiency standards and expand oil and coal use.

As a result, states and nonprofit organizations are coalescing to fill the void at the federal level for addressing climate change with the energy sector as ground zero in efforts to reduce carbon intensive energy sources. Renewable energy and energy efficiency measures are at the heart of energy transition strategies to reduce carbon emissions and Hawaii's energy policy agenda, the Hawaii Clean Energy Initiative, has emerged as the most ambitious energy transition in the United States. When the governor signed Act 97 into law in 2015, Hawaii strengthened its interim 2020 RPS to 30% and became the first state to establish a 100% RPS.

The RPS approach has been pursued by twenty-nine states plus the District of Columbia and five states have set targets at or above 50% (California, Hawaii, New York, Oregon, and Vermont). While acknowledging differences in market size, regulatory structure, and current electricity supply mix with other states, Hawaii's early experience with high renewable targets may offer lessons that are broadly applicable throughout the U.S., the Asia-Pacific region, and elsewhere in the world.

The Asia-Pacific region is a prime candidate for progressive strategies to reduce carbon intensity in the energy sector as one of the fastest growing economic regions in the world. With a rapidly rising energy demand driven by economic and demographic expansion, the region's primary energy requirement is projected to triple between 2005 and 2030, an increase by an average annual growth rate of 4% and substantially higher than the world's average growth rate of 1.8% in primary energy consumption through 2030. As the region´s economies are steadily expanding, rising energy demand presents challenges to the environment, energy security and sustainable development. Cost-effective, reliable, and secure supplies of energy and water are

Mark B. Glick
Specialist on Energy Policy & Innovation
Hawaii Natural Energy Institute
University of Hawai`i at Manōa Mon Oct. 23 10.20a

(cont'd) essential factors in assuring a stable, secure, prosperous, competitive, resilient and integrated economic region.

Energy transitions focused on renewable energy and energy efficiency measures are gaining popularity as proven and highly efficient ways to achieve climate mitigation. While each political jurisdiction may have its own reasons to pursue energy transformation based its own unique circumstances: geopolitical, demographic, and economic, such policies will result in significant reduction of a region's carbon footprint nonetheless.

Renewable energy has grown steadily in the Asia-Pacific region and is anticipated to contribute to more substantial growth as the region diversifies its energy mix from fossil fueled energy resources. With declining costs and increasing performance for small hydro installations, solar photovoltaics (PV) and wind turbines, and advances in electricity storage and control systems, micro-grid systems could become an important vehicle to support the development of renewables-based grids to improve energy security, power quality and reliability, as well as to avoid power blackouts due to natural disasters (e.g., hurricanes) or even deliberate attacks.

Analysis of energy utilization in the early stages of grid integration of renewables in the Asia- Pacific region is critical to effective long term infrastructure planning and development. This analysis may be instructive on cost-effective ways of enhancing energy security and utilization, improving the environment and promoting competitiveness. Such analysis may inform potential measures to reduce energy consumption without reducing productivity. Given the threats of natural disasters such as hurricanes, winter storms, heat waves, floods and the impacts of climate change, it is critical to identify and address common challenges, lessons learned and best practices to improve the resiliency of energy infrastructure in off-grid areas.

Efforts to share information and best practices, such as the Clean Energy and Climate Change conference, can help reveal how energy transitions can be replicated throughout the world by creating a clear policy framework to drive investments in a new energy ecosystem. Deployment of energy infrastructure requires business systems integration, technological innovation, and stakeholder alliances that are crucial to making change. This is true whether it be for greater energy security and self-sufficiency, carbon reduction, or the desire to move towards an ultimate technological solution in which conservation, efficiency and renewable energy can entirely meet daily, weekly and annual energy requirements of the entire energy ecosystem. In our changing world, energy transformation is a triple bottom line means to carbon reduction and creating a safer and more secure network of critical energy infrastructure systems and services.

Tony Jakeman
National Centre for Groundwater Research and Training
Australian National University Mon Oct. 23 4p

Title Identifiability and uncertainty issues around modeling the impacts of climate change on hydrology

Abstract The presentation will begin with a basic introduction to the types of impacts of climate change on water resources, a basic approach to assessing them using dynamic water balance models, and the main challenges involved. It will include some results of assessing water availability in major irrigation areas of Australia under various climate scenarios.

Identifiability is a key consideration in managing and reducing uncertainty in model predictions. The second part of the presentation will focus on identifiability issues of models in general and a fourfold classification of methods to assess identifiability. The methods will be illustrated for models used for predicting dynamic water balances in the face of climate variations.

J.D. Jakeman
Computer Science Research Institute
Sandia National Laboratory Wed Oct 25 11.30a

Title: Towards probabilistic predictions of future sea-level

Abstract: Polar ice sheets present the largest potential for future sea-level change (approximately 65 m of sea-level equivalent). Confidence in sea-level projections requires accurate simulations of ice sheet evolution using next-generation ice sheet and earth system models as well as analysis of the effect of system uncertainties on predictions. In this talk we present an overview of the ProSPect project, funded by the U.S. Department of Energy's Scientific Discovery through Advanced Computing (SciDAC) program, which been tasked with addressing the challenges of high-fidelity deterministic modeling and uncertainty analysis of ice-sheet evolution models. Focus will be given to research aimed at understanding and limiting the impact of uncertain ice-sheet initial conditions on future sea-level predictions. The approach presented employs Bayesian inference to condition initial estimates of uncertainty on observational data and employs techniques designed to overcome the challenges associated with large number of uncertain parameters and the computational expense of high-fidelity simulation.

Alexandre Jofre
Center for Mathematical Modeling
Universidad de Chile Tue Oct. 24 1.30p

Title: Optimization and game theory in Energy markets.
Abstract: In this talk we introduce a stochastic optimization/game-theory model to describe an energy market working on a network (transmission), including renewal energy suppliers, distributed generators and demand nodes. We characterize Nash equilibria and pricing rules in this stochastic setting as well as some stability properties and market power behaviors.

Jason Leigh
Laboratory for Advanced Visualization and Applications
University of Hawai`i at Mānoa Wed Oct. 25 9.30a

Title: Painting the Big Picture for Environmental Decision Making and Communication.
Abstract: CyberCANOEs (or Cyber-enabled Collaboration Analysis Navigation and Observation Environments) are networked, interactive, ultra-high-resolution display environments that have been growing in popularity in Hawaii as a means to understand complex data to make decisions with greater creativity, speed, accuracy, comprehensiveness and confidence. This presentation introduces the CyberCANOEs in the context of use cases such as: the visualization and analysis of data for flood disaster management in Japan; the visualization of Hawaii's renewable energy portfolios and its implications on land use; decision support for land use through predicting water resource recharge rates in Hawaii; and informing the public on the impact of climate change on coral health.

Kaname Matsue
IMI & I2CNER
Kyushu University Tue Oct 26 11.30a

Title Mathematical treatment of flame dynamics toward foundation of combustion
Abstract See next page.

Mathematical treatment of flame dynamics toward foundation of combustion

Kaname Matsue*, †

Combustion is the oldest technology for energy generations in human's history. Even if the variety of energy resource is expanded, combustion process still plays an important role in basic power generations. There are several types of combustions depending on the state of materials; vapor, liquid or solid. Our concern here is combustion among *gaseous* compounds. Dynamics involving flames is dominated by fundamental conservation laws such as (i) mass (equation of continuity), (ii) momentum, (iii) energy, as well as (iv) *conservation of chemical species* and (v) *equation of state*. The problem thus contains not only fluid mechanics, thermal and statistical physics but also chemical kinetics, which make us difficult to solve rigorously. Although there are plenty of numerical studies for understanding combustion process, all these studies have limitation to *universal* fundamental understandings of the process. On the other hand, mathematical studies provide us with the comprehensive and universal understandings of combustion, which have been developed for more than five decades. In my talk, a mathematical treatment of flame dynamics described below for understanding the fundamental essence is developed.

One of mathematical treatments of flame dynamics begins with Darrieus (1938) and Landau (1944). They treat the flame front *as the surface describing discontinuity of density and temperature of (gaseous) compounds* between burned and unburned states. Although the real flame possess the (chemical) reaction zone of compounds with nontrivial width, the reaction zone can be considered very thin compared with the fluid length scale. The problem is then reduced to the Navier-Stokes-type equation with (Rankine-Hugoniot type) jump condition across the flame front. It turns out that the flame front with the simplest geometry, namely the *planar flame front*, is unstable under perturbations, which is well-known as *Darrieus-Landau instability* of flame fronts and well describes the hydrodynamic property of flame fronts.

After a couple of decades, Sivashinsky (e.g., [5]) has developed a fundamental equation describing the behavior of (premixed) planar flame fronts based on treatments by Darrieus and Landau, which is now known as the *Michelson-Sivashinsky equation* written as

$$\phi_\tau + \frac{1}{2}\phi_x^2 - \alpha\phi_{xx} - \frac{1}{2}I(\phi) = 0, \quad (\tau, x) \in (0,\infty)\times(0,1), \tag{0.1}$$

$$I(\phi) := \frac{1}{2\pi}\int_{\mathbb{R}^2} |k|\phi(\xi,\tau)e^{ik(x-\xi)}d\xi dk \quad \text{(corresponding to the Hilbert transform of } \phi_x\text{)},$$

where α is a parameter proportional to length scale and the property of compounds called the *Markstein number*. The unknown function ϕ expresses the displacement of perturbation from the planar flame front. The fundamental mathematics such as bifurcation theory shows that the trivial solution $\phi \equiv 0$ is unstable for $\alpha \geq 4\pi$ and there stable nontrivial solutions called *pole solutions* (e.g., [6]) bifurcate from the trivial solution. The nontrivial pole solutions describe the *wrinkle* of flame fronts in terms of cusp-like structure, and its sharpness depends on α; namely the property of compounds. However, there is also a mathematical theory that a certain type of pole solutions (called *coalescent pole solutions*) are asymptotically stable ([7, 8]), which indicates that (0.1) can

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never describe secondary wrinkles like cellular structure. In other words, the Michelson-Sivashinsky equation itself cannot describe *turbulent combustion*. Recently there are several mathematical and physical studies of turbulent combustion based on Michelson-Sivashinsky equation with noise term (e.g., [2]).

Here I also mention several factors for deriving Michelson-Sivashinsky-type equation or general hydrodynamic model (e.g., [4]) of flame dynamics. Equation (0.1) is derived by Euler-type equation with jump condition across the flame front and the equation of flame speed. Geometric studies (e.g., [3, 9]) have shown that the flame speed depends on *flame stretch* given by

$$\mathbb{K} = \frac{1}{A}\frac{dA}{dt}, \quad A = A(t): \text{ the surface area of flame front.}$$

Flame stretch is shown to depend mainly on two kinds; one is the *curvature* κ *of flame fronts*, and the other is *flow strain* K_s. The dependence indicates that expression of flame dynamics is necessary to get information of *geometry of flame fronts* as well as *underlying flow field*.

The other factor I want to mention is *Markstein number* $\mathcal{L}$ determining α in (0.1). The number $\mathcal{L}$ determines the property of compounds, such as *Lewis number* determined by the ratio of thermo-diffusivity and molecular diffusivity of deficit reactant and *stoichometry* of compounds measuring rich or lean ratio of fuels relative to the air. The dependence on variable transport coefficients such as temperature is reported with good agreements of experimental measurements [1]. The parameter α in (0.1) can be thus considered to include all such information in principle.

References

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Jeff Mikulina
Blue Planet Foundation Tue Oct. 24 11.30a

Title: Hawaii's Journey to 100%

Abstract: Energy is the lifeblood of Hawaii's economy and way of living. But our current energy system is at odds with a healthy economy and livable climate. Responding to this challenge, Hawaii has become the first state in the nation—and one of the only places on Earth—to commit to 100% renewable energy. Blue Planet Foundation has been at the forefront of the policy changes and community engagement driving Hawaii's transition to clean energy. Jeff's presentation will explore some of the key aspects of our changing energy landscape, particularly distributed renewable energy, energy storage ,disruptive technologies, and opportunities for rapid decarbonization. He will also share examples of tools we can use to help us all "be the change we wish to see in the world."

Camilo Mora
Department of Geography,
University of Hawai`i at Mānoa Thu Oct. 26 9.30a

Title We Punch Nature and It Will Punch Us Back: Human Impacts on Biodiversity and Their Feedback on People

Abstract Human impacts on biodiversity are leading to extinction that largely exceeds natural background rates. This is impairing the capacity of ecosystems to deliver basic goods and services to humanity; and in turn, it is undermining efforts to improve human welfare, especially for the nearly one billion people that go hungry every day. In this presentation, I describe global scale analyses into the impacts of climate change on marine and terrestrial ecosystems and how they are making a large fraction of the world's human population vulnerable to losing important sources of revenue, food and jobs. I will also present the results of a simple energetic model that suggest that even if human consumption is reduced, we will still be in an ecological deficit and that only scenarios that include natality reductions do quickly balance our ecological footprint on Earth. For our generation will be the decision between a crowded planet or a better world.

Juliet Newson and R. Morgan Greene
Iceland School of Energy, Reykjavik University
Menntavegi 1, 101 Reykjavik, Iceland

Title Renewable Energy Education in Iceland

Abstract Iceland is the perfect environment for energy education. In around 70 years, Iceland has used the energy resources available to transform the country from the least developed nation in Europe, to a wealthy, environmentally conscious, modern society where electricity is generated from 100% renewable resources, (24% geothermal and 76% hydro). Ninety percent of space heating is from the direct use of geothermal heat. Large scale energy-intensive industries have been encouraged to move manufacturing to Iceland, thereby providing a market for Iceland's abundant energy. This energy industry landscape has led to multiple cutting edge research projects being based in Iceland, including the Iceland Deep Drilling Project (IDDP) and the CarbFix CCS project.

Iceland has two main energy education programmes; the Iceland School of Energy at Reykjavik University, and the United Nations University Geothermal Training Programme.
The Iceland School of Energy (ISE)is a graduate school within Reykjavik University, Iceland. The Iceland School of Energy has graduated 102 students since 2011, of which 80% are international. ISE students follow their interests in sustainable energy related topics in science, engineering, and management to gain a Master and/or Doctoral qualification. Students at the Iceland School of Energy get many opportunities to visit field sites, interact with energy professionals, and work on ‚real world' energy related topics. At least one internship is included in the second semester. Many internships are with local energy companies, some of these lead directly into a thesis topic.

The United Nations University Geothermal Training Programme (UNU-GTP) provides geothermal training for students from developing countries. Around twenty students per year receive scholarships from the Government of Iceland Ministry of Foreign Affairs as part of Iceland's foreign aid funding. The backbone of the course is a six-month geothermal training programme which is in itself not a degree programme, but Reykjavik University and the University of Iceland recognize the course as being worth 25% of a Master degree. Up to a maximum of five high achieving students per year from the six-month course are further supported by the UNU to do a Master degree in a geothermal topic, and one per year is supported to enrol in a geothermal-related PhD.

Ryan Perroy
Geography and Environmental Science
University of Hawaii - Hilo Wed Oct 25 11.30a

Title: Mapping and modeling three-dimensional coastal change on Hawaiʻi Island under rising sea level conditions.

Abstract: Accelerated shoreline erosion and inundation associated with sea-level rise (SLR) present an existential challenge for low-lying coastal communities worldwide. Accurately predicting and modeling future impacts to existing and planned infrastructure in coastal areas requires detailed knowledge of the environment, including high resolution topographic datasets. In close coordination with the County of Hawaiʻi Planning Office, we are working to quantify historic and present-day coastal change rates for three selected priority areas on Hawaii Island representing a diversity of geomorphic settings: sea cliffs, subsiding coastal lava fields, and calcareous beaches. New imagery and three-dimensional point clouds collected from small unmanned aerial systems (sUAS) and total station surveys, together with reconstructions of past geomorphic surfaces based on photogrammetric processing of historic aerial photographs and lidar coastal surveys, allow us to capture past and current shoreline change rates. These data are then merged with SLR projections and other geospatial layers to estimate future impacts to coastal communities and natural and cultural resources. Our final results will shared with local stakeholders and integrated into County of Hawaiʻi shoreline setback regulations.

Yuji Ohya+1, Koichi Watanabe+2 , and Takanori Uchida+1
+1 Research Institute for Applied Mechanics,
Kyushu University, Kasuga, Japan
+2 Kyushu University Platform of Inter/Transdisciplinary
Energy Research, Fukuoka, Japan Tue Oct. 24 1.30p

Title Highly efficient multi-lens wind turbine, offshore floating energy farm and wind-solar tower based on new concepts

Abstract (see next page)

Highly efficient multi-lens wind turbine, offshore floating energy farm and wind-solar tower based on new concepts

Yuji Ohya[+1], Koichi Watanabe[+2], and Takanori Uchida[+1]

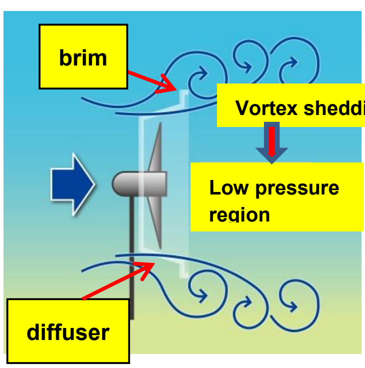
[+1] Research Institute for Applied Mechanics, Kyushu University, Kasuga, Japan

[+2] Kyushu University Platform of Inter/Transdisciplinary Energy Research, Fukuoka, Japan

1. Multi Rotor System with Wind Lens Turbine

The wind turbine industry has seen innovations leading to growing size of turbines of currently over 140 meters in diameter. However, as pointed out by some recent studies, scaling of blades has its limitations and therefore advantages of multi-rotor system (MRS) concepts have been suggested by Jamison [2011, "Innovation in Wind Turbine Design", Wiley Publication]. A diffuser-augmented wind turbine (DAWT) has been developed to increase the rotor performance of a conventional wind turbine in our laboratory (called Wind-Lens Turbine, WLT, see Fig.1). Recently, we have been investigating the power output performance of WLTs in a multi-rotor system. We placed two or three WLTs closely in an array perpendicular to the approaching flow and measured each power output and drag simultaneously. In parallel with wind tunnel experiments, we are doing numerical analyses of Computational Fluid Dynamics (CFD) of MRS with WLTs using an actuator-disc method.

In wind tunnel experiments, we show that a MRS using WLTs has an influence on each other's power output. At a certain separation gap, the total power output of a MRS with WLTs exceeded the sum of the stand-alone WLTs by over 10%. In the case of three WLTs in side by side arrangement (Fig.2), the largest increase in ΔC_p, up to 14%, is achieved for the gap ratios at around s/D = 0.2 to 0.4 (Fig.2). Here, s is the distance between the adjacent brims. D is the diameter of brimmed diffuser. The flows around MRS with WLTs and its aerodynamics are complicated due to gap flow behaviour and wake interference. Figure 3 shows a prototype of a 10kW Multi-Lens Wind Turbine system (M-WLT) using three 3kW wind-lens turbines in the field.



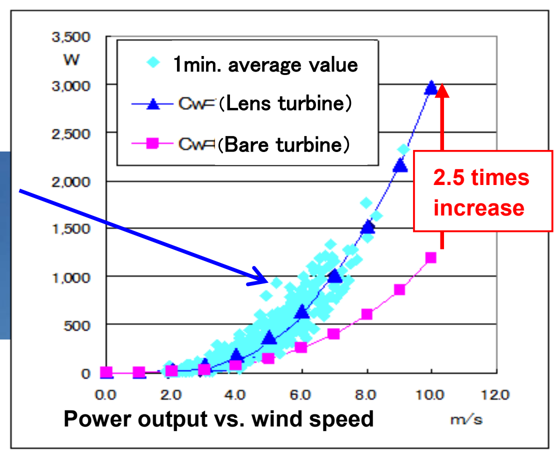


Fig.1 Mechanism of wind-lens turbine and power output performance in a field test

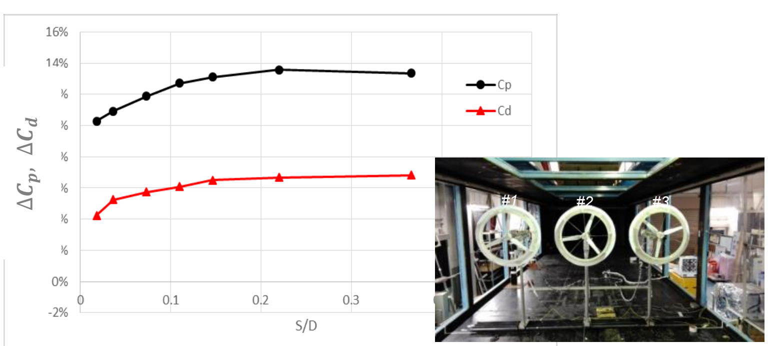


Fig.2. Increases in power output and drag of three WLTs in side-by-side arrangement compared to the sum of three stand-alone WLTs

Fig.3. 10kW multi wind-lens turbine using three 3kW wind-lens turbines at Kitakyushu city, 2017 March

2. Field Verification Test of Wind-Power Generation Potential in Nearshore Area Using a Moored Floating Platform

The offshore turbine system was installed on a floating platform moored in Hakata Bay, offshore of Fukuoka, Japan, shown in Fig.4. An identical turbine system was also installed at the adjacent waterfront. Wind flow tends to be more stable and the average tudy focused on the wind condition of a nearshore area to clarify the advantages of nearshore wind farming. Field verification test was done by directly comparing wind data obtained from the identical wind turbine systems installed at an offshore location and the adjacent waterfront over the same extended period. The corresponding power output of these turbines was also compared. The data set exhibits 23% larger annual average wind speed at the offshore location and smaller turbulent intensity, resulting doubled annual power production.

Fig.4. 18m wide concrete platform of offshore hybrid floating energy farm by Kyushu Univ. at Hakata-bay, Japan

3. A Wind Solar Tower (WST) Harnessing Sunshine and Wind Energies Simultaneously

In 1989, a pilot plant of a solar chimney was erected in Manzanares, Spain, to evaluate the feasibility of the solar tower as a new source of renewable energies. Since then, the solar tower was discussed in the press and academic research, but no commercial plant succeeded the development. A reason for this could be very low efficiency, i.e., very low power output compared with other renewable energy production systems. However, a solar tower that can generate electricity in a simple structure, and enables easy and less costly maintenance, has considerable advantages. A solar tower consists mainly of three components. The collector area is a glass roof, above ground with increasing height towards the center. Attached to the center of the collector is a vertical tower inside which a wind turbine is mounted at the lower entry into the tower. When solar radiation heats the ground through the glass roof, the uprising warm air is guided to the center into the tower, as seen in Fig.5.

To improve the efficiency in power production for a solar chimney, we focused on the shape of the tower and modified it from a conventional cylindrical type to a diffuser-type tower. This modification is considered to combine two mechanisms. Firstly, the mechanism to "Generate Wind" which becomes effective when solar thermal energy is available, and secondly the mechanism to "Converge Wind" which becomes effective when wind passes the top end of the diffuser even when solar thermal energy is not available (Fig.6). For new power generation system using both of wind and solar energies, we named "Wind Solar Tower (WST)". By combining these two independent concepts which complement one and another, a profitable energy availability power generation system is expected, that is capable of a larger power generation compared to the original solar tower prototype and much larger capacity factor.

Based on the two kinds of laboratory experiments, we are now making a field experiment using a prototype of WST with 10m tower height (Fig. 7). We have elucidated that the thermal updraft speed is proportional to the root of tower height and temperature difference between the collector inside and the ambient aloft. In the present research, we propose a new renewable energy device that can harness both sunshine and wind energies. It is now showing a high potentiality, reaching 50 times in power output compared to the Manzanares. Furthermore, almost similar amount of power output by wind aloft over the tower is expected depending on wind condition of the site.

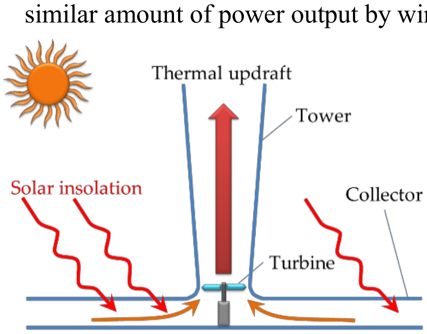


Fig.5. A solar chimney with a diffuser type tower, "Generate wind"

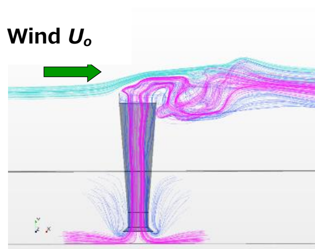


Fig.6. The upper wind draws lower air through a wind-solar tower, "Converge wind"

Fig.7. A wind solar tower for field experiment, tower 10m high, collector 15m^2, at RIAM, Kyushu University

P. Sofronis
International Institute for Carbon-Neutral Energy Research
Kyushu University
University of Illinois at Urbana-Champaign Tue Oct. 24 10.30

Title Mathematical Challenges in Linking the Micro- with Macro-Scale Behavior of Materials in the Presence of Hydrogen

Abstract The Mission of the International Institute for Carbon-Neutral Energy Research (I^2CNER) is to contribute to the creation of a sustainable and environmentally-friendly society by conducting fundamental research for the advancement of low carbon emission and cost effective energy systems. I^2CNER's approach to creating an energy vision for Japan with targeted CO_2 emission reductions is presented based on an array of technologies holding promise for the future.

One of the I^2CNER's goals is to develop and validate a lifetime prediction methodology for failure of materials used for hydrogen containment components, a technology that is essential for the realization of the hydrogen economy. This requires thorough understanding of the deformation and fracture mechanisms at the atom- and micro-scale along with an approach to link these mechanisms with the macroscopically observed failure at the macroscale. In particular, recent experimental studies demonstrate that the hydrogen by accelerating the development of the deformed microstructure establishes the local conditions that determine the fracture mechanism and fracture path at the macroscale. In this presentation, we will first describe the mechanics and physics of the hydrogen effect on materials and will continue on with an outline of the current state-of-the-art efforts on modeling and simulation. We will finish by discussing the mathematical challenges associated with the establishment of the link between behavior at the microscale and macroscale toward the development of models for hydrogen-induced fracture with predictive capabilities.

Esther Widiasih
Division of Mathematics and Science
University of Hawai`i - West O`ahu Mon Oct. 23 3.30p

Title: Climate change: a complex reality viewed from a simple math lens.
Abstract: Undoubtedly, Earth's climate is a complex system, and today it is going through some major changes. Can one understand climate change through the lens of simple math? In this talk, I will introduce the Budyko zonal energy balance model of the climate. The focus will be on the interactions of major climate eg. incoming solar radiation, outgoing longwave radiation, positive ice albedo feedback, and atmospheric greenhouse gases. Familiar dynamical systems concepts such as invariant manifold, tipping points and hysteresis arise naturally in the analysis of this model, lending a hand to the idea of climate change.

David Wood
Schulich Professor of Renewable Energy
University of Calgary Wed Oct. 25 9.30a

Title: Helical Vortices: from the mathematics to wind turbine performance analysis
Abstract: The rotating blades of propellers and wind turbines produce trailing helical vortices which can have a profound effect on machine performance. In addition, doubly-infinite straight vortices, vortex rings, and helices are the only vortex shapes that can exist without deformation. The talk will discuss the role of helical vortices in wind turbine performance analysis and describe ongoing work to improve aerodynamic models using recent advances in helical vortex theory. In addition, some of the fascinating history of vortex theory will be reviewed. Kelvin analyzed vortex rings in the 1860s, but, surprisingly, the corresponding analysis for helices was not completed till the end of the 20th century. The invariance of certain vortex shapes led Kelvin and others to briefly consider them as models for atoms but this apparently did not inspire them study to helical vortices in any detail. The talk will describe the fundamental contributions of Kawada (1935, 1939), Hardin (1982), Kuibin & Okulov (1998) and others to solving the velocity field for helical vortices and the recent work by the author, Okulov, and others to incorporate these results in “blade element-momentum” theory of wind turbines and propellers. Trailing helical vortices must be considered when accounting for the finite number of blades: the simplest form of the theory is for an infinite number of blades but most real wind turbines have only three. The talk will show that the usual form of correction, Prandtl’s “tip loss factor”, can be inaccurate compared to the new formulation. Current and future extensions of the work will be discussed.

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Dalian University of Technology

Tue Oct. 24 9.50a

Title Multiscale Modelling of Materials: From Microstructures to Macro Behavior

Abstract Nowadays, one perspective mean for the discovery of advanced materials is the effectual control of their underlying microstructures. In this talk, some examples on modelling materials microstructures for the prediction of their long-time macroscopic behaviour are presented. The talk starts with the continuum modelling of dislocations, which are believed to be the main carrier of the plastic deformation of crystalline materials. It will be shown that the mathematically well-established homogenisation approach has to be modified so as to effectively summarise the collective behaviour of a large number of discrete dislocations. Then the idea of modifying traditional homogenisation approaches is generalised to predict materials macroscopic properties based on their microstructures in nuclear industry and surface science.