Ongoing Projects

- Wave groups and ship motion: Grant-in-aid for Scientific Research A FY2016-2018
  - Tanizawa, Houtani (NMRI); Watanabe
  - Stereo imaging at Hiratsuka tower; tank experiment in NMRI actual sea model basin
  - Data assimilation and buoy measurement
- Wave-ice Interaction: MEXT Arcs project FY2015-2019
  - Nose, Kodaira, Inoue, Sato (NMRI); Yamaguchi; Chabchoub
  - Wave modeling of summer Arctic Sea
  - Stereo-imaging of ice and wave
- Waves under typhoon, bomb cyclone, gust: Kakenhi A FY2016-2020
  - Kawamura (Kyushu U.) , Kita
  - Atmospheric-Wave coupled simulation under severe wind condition
  - Gustiness at southern ocean (SOFS-6)

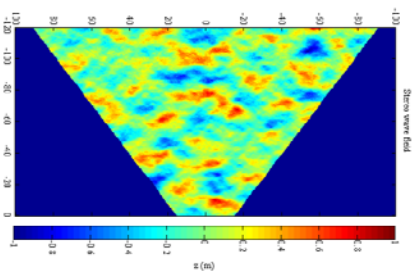
Ongoing Projects

- Wave groups and ship motion: Grant-in-aid for Scientific Research A 2016-2018
  - Tanizawa, Houtani (NMRI); Fujimoto, Watanabe, Davies; Benetazzo, Daniel
  - Stereo imaging at Hiratsuka tower; tank experiment in NMRI actual sea model basin
  - Ship-borne Stereo camera system (related to Arcs)

Stereo Imaging at the Hiratsuka Tower
—Different Sea states
—Detection & Classification of wave groups (2D)

Marine Accident Analysis System
—Wave field from directional spectrum
Data Assimilation: Wave field from stereo image

Detection of wave group



HOSM-wave generation
—reproduce wave group

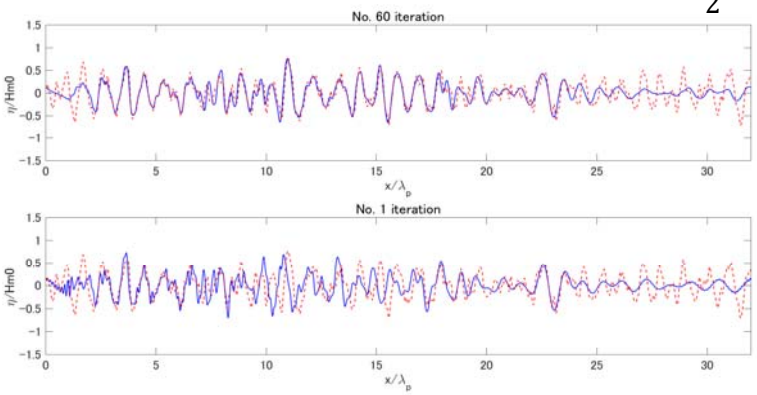
Ship model test
—elastic model
—bending, torsion

Output:
Wave group database
Wave group mechanism
Ship response in wave group

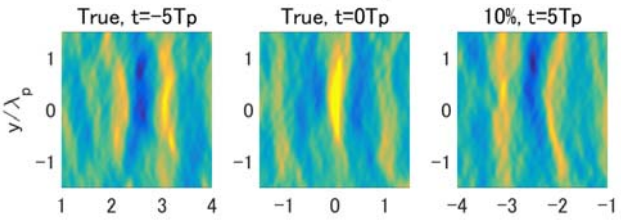
Data assimilation (a4DVAR)

Fujimoto 2018, Ph.D. UTokyo

$$J(\boldsymbol{x}_0) = \frac{1}{2}(H(\boldsymbol{x}_0) - \boldsymbol{y})^{\mathrm{T}}\mathbf{R}^{-1}(H(\boldsymbol{x}_0) - \boldsymbol{y}) + \frac{\alpha}{2}\boldsymbol{x}_0^{\mathrm{T}}\mathbf{B}'^{-1}\boldsymbol{x}_0.$$

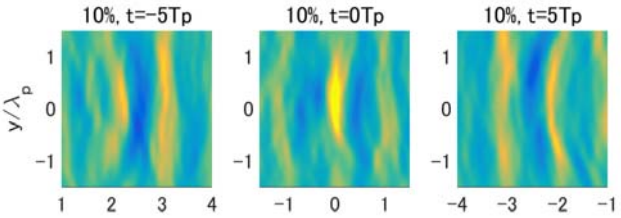


1D case
Reconstructing spatial wave profile from a time series



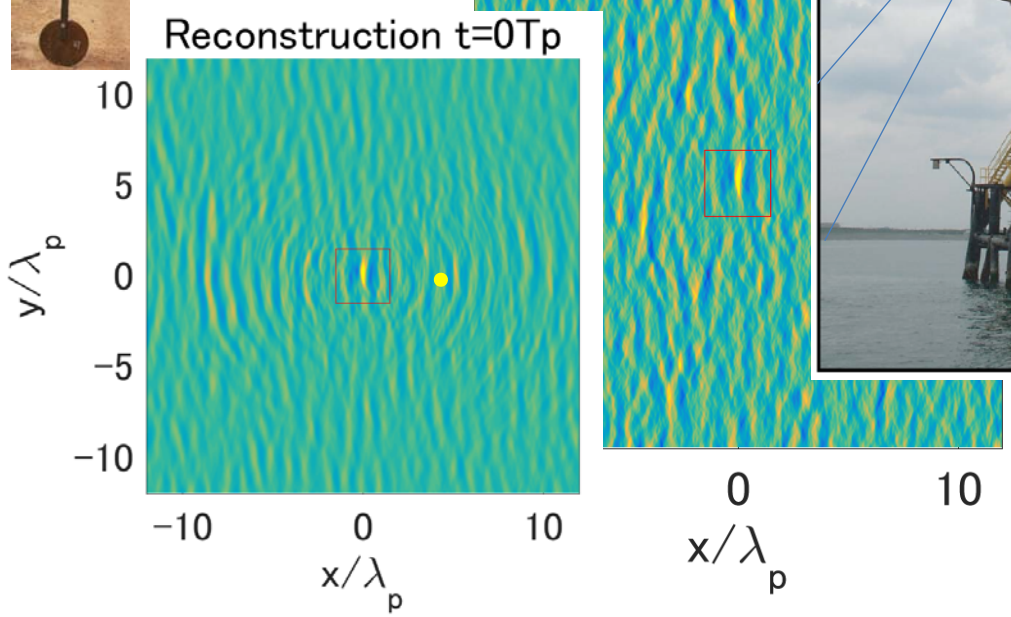
True state

Example of a 2D reconstruction, mimicking assimilation of stereo image 2D wave field.

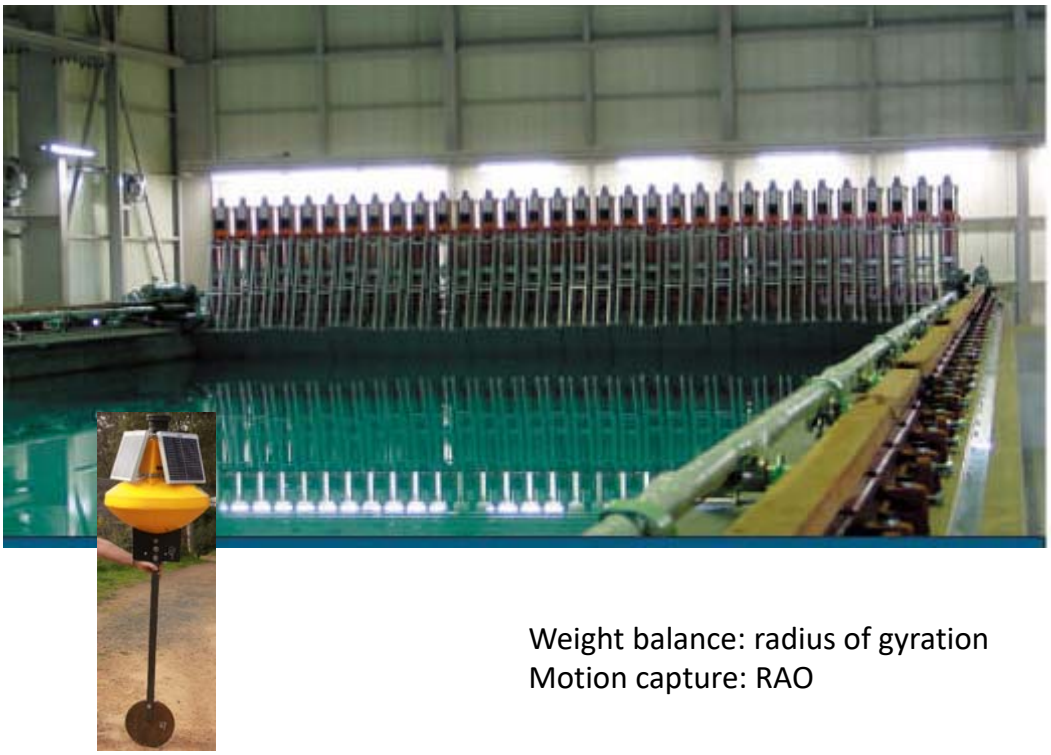


Reconstructed state

Hiratsuka tower experiment



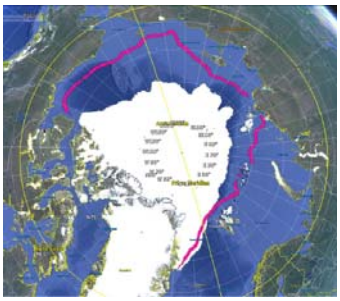
Tank experiment



Weight balance: radius of gyration
Motion capture: RAO

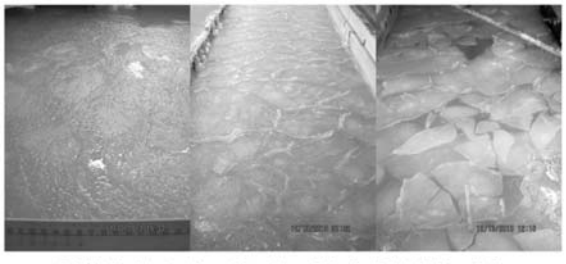
Ongoing Projects

- Wave-ice Interaction: MEXT Arcs project FY2015-2019
  - Inoue, Sato (NIPR); Nose, Kodaira, TBD, Yamaguchi; Chabchoub
  - Wave modeling of summer Arctic Sea



Northern Ship route

Dynamics of waves in ice covered sea



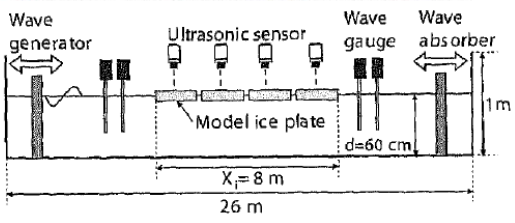
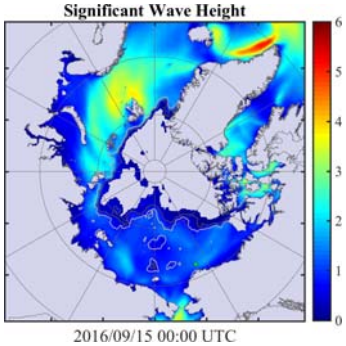
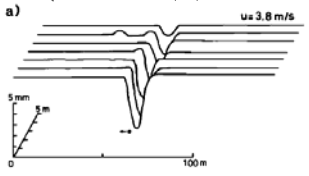


Fig. 3. The wave tank and experimental equipment.

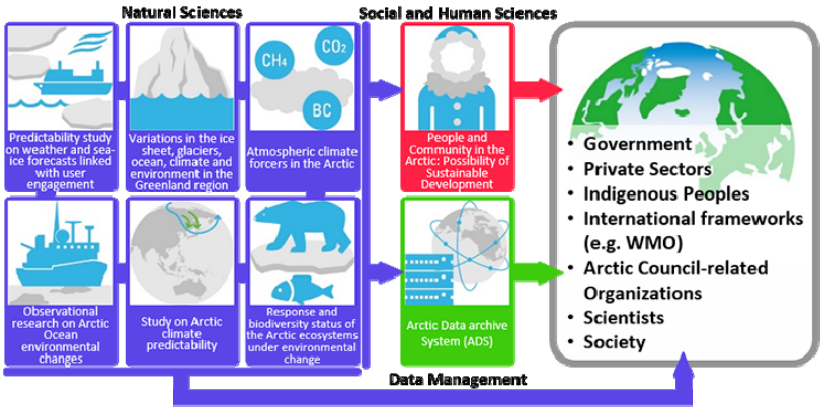
Modeling and validation



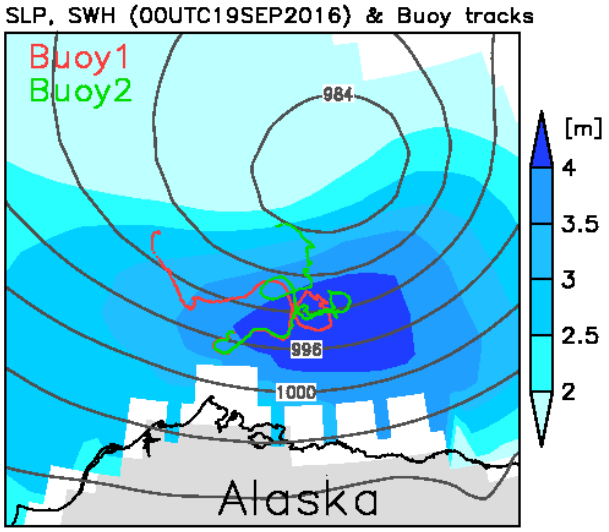


Arcs: Arctic Challenge for Sustainability 2015-2020

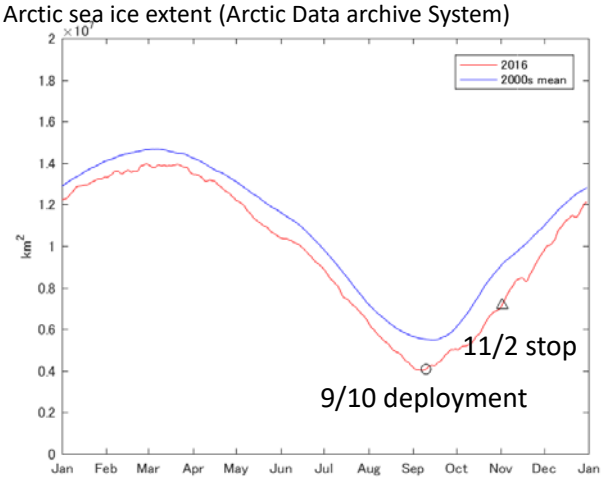
- Theme1: Predictability study on weather and sea-ice forecasts linked with user engagement
- Theme2: Variations in the ice sheet, glaciers, ocean and environment in the Greenland region
- Theme3: Atmospheric climate forcers in the Arctic
- Theme4: Observational research on Arctic Ocean environmental changes
- Theme5: Study on Arctic climate predictability
- Theme6: Response and biodiversity status of the Arctic ecosystems under environmental change
- Theme7: People and Community in the Arctic: Possibility of Sustainable Development
- Theme8: Arctic Data archive System (ADS)



Wave Observation Sep.10 – Nov.2 2016



Arctic sea ice extent (Arctic Data archive System)



First long-term wave observation by the Japanese project

Observational data available at ADS
https://ads.nipr.ac.jp/dataset/A20180306-001

SCIENTIFIC REPORTS

OPEN

3月14日

Correlated Increase of High Ocean Waves and Winds in the Ice-Free Waters of the Arctic Ocean

Received: 3 November 2017
Accepted: 23 February 2018
Published online: 14 March 2018

Takuji Waseda[1], Adrean Webb[1,2], Kazutoshi Sato[1,3], Jun Inoue[2], Alison Kohout[3], Bill Penrose[4] & Scott Penrose[4]

3月15日日刊工業新聞

夏の北極海、波の高さや風速上昇　東大・極地研が調査

ツイート　シェア 0　LINEで送る

(2018/3/15 05:00)

北極航路の利用が進む（イメージ＝ブルームバーグ）

東京大学と国立極地研究所の研究グループは、夏季の北極海で海氷の減少に伴って、波の高さや風速が長期的に上昇しているとする調査結果をまとめた。北極海で波浪観測を実施し、波高の長期変化を分析した。今回の知見は、北極航路での船舶の安全航行に向けた波浪推定などに役立てられる。

夏季の北極海は、この数十年で海氷が急減し、海氷のない「開放水面」が拡大。これにより北極航路の利用が進む。一方で、航行の支障となる波浪の増大が指摘されていた。

研究グループは２０１６年９―１１月に、漂流型波浪観測ブイ２基で、日本初の北極海での波浪観測を実施。この観測データと、ヨーロッパ中期予報センターが持つ過去３８年間の波浪再解析データを比較し、精度を確認。その上で、この波浪再解析データを使い、北極航路で使われる海域における８―１０月の波高の最大値を解析した。

その結果、３８年間で波高は上昇傾向にあり、１０月の波高最大値の期待値は、２・３メートルから３・１メートルに増大していた。また、同海域の最大風速の期待値は、毎秒１２メートルから同１４・２メートルに上昇した。

一般に、開放水面が拡大すると、風が吹く距離が長くなり、波高が高くなる。これに加え、今回の研究で、強風が氷上ではなく開放水面で吹く確率が高まることで波高が高くなることが分かった。

北極海上の波浪の推定精度を高めるには、さまざまな海上気象、海氷の面積、厚さ条件での波浪データが必要で、研究グループは結氷期の１１月にも波浪観測を予定する。

(2018/3/15 05:00)

3月16日環境ビジネスオンライン

北極海、氷が減って波が高くなる　東大院・極地研究所などが発表

2018年3月16日掲載　印刷　記事を保存　いいね！ 1　ツイート

観測に使用したブイ

東京大学大学院と国立極地研究所の研究グループは3月14日、北極海波浪観測により、夏季北極海における海氷面積は減少し、開放水面では強風が吹く確率が増大するため、船舶が遭遇しうる最大波高と最大風速が長期的に上昇していると発表した。

この観測は、2016年9月から11月に行ったもの。観測結果により、北極航路の利用に伴う船舶の安全性に資する重要な知見を得ることができたという。

開放水面拡大、波高も38年間上昇

今回の観測により、海氷の融解が激しい8月、海氷面積が最も小さい9月、結氷が開始する10月の3期間について、北極航路（北東航路）として利用されているラプテフ海、東シベリア海、チュクチ海、ボーフォート海の海氷のない開放水面における有義波高（海洋波浪の波高のひとつ）最大値の期待値は、過去38年間にわたり上昇傾向にあることが確認された。

なお、最大値の期待値とは、任意のデータセットにおける最大値が平均的にはどの程度となるかの見込み値。

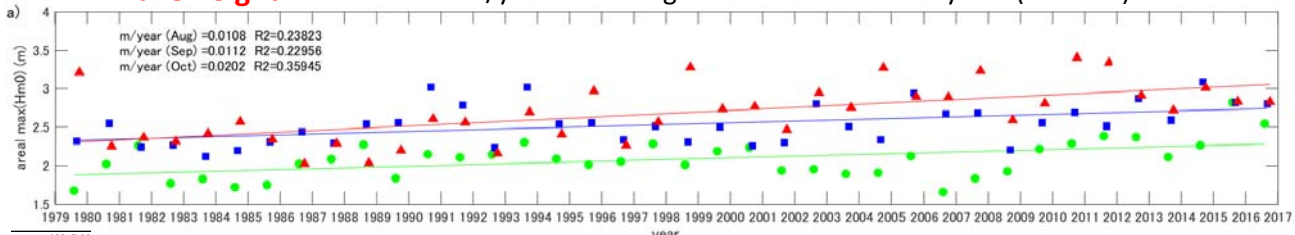
開放水面での最大風速増大により強い関連

この上昇傾向は開放水面の増大とも関連するが、開放水面における最大風速の増大に、より強い関連があることも明らかになった。具体的には、波高が増大するのは、強風が氷の上ではなく開放水面で吹く確率が高くなるために起こることがわかった。

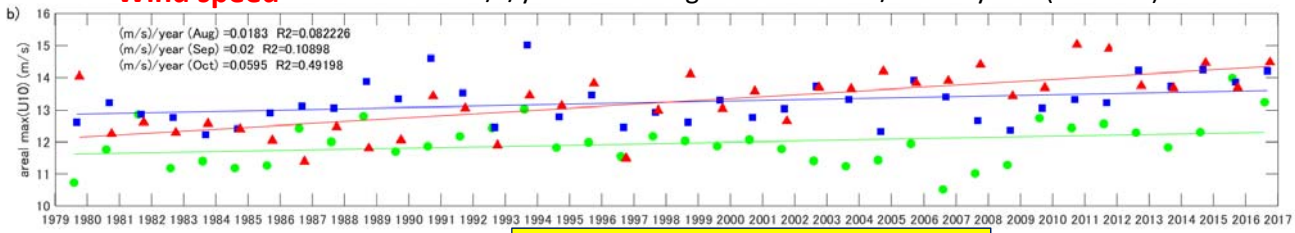
Trends of the ERA-interim maximum wave & wind in Laptev to Beaufort Sea

There is a clear increasing trend for both wave and wind, rate is largest in October

$\overline{H_s^{max}}$ **Wave height**　1 to 2 cm/year increasing trend → 0.76 m in 38 years (October)

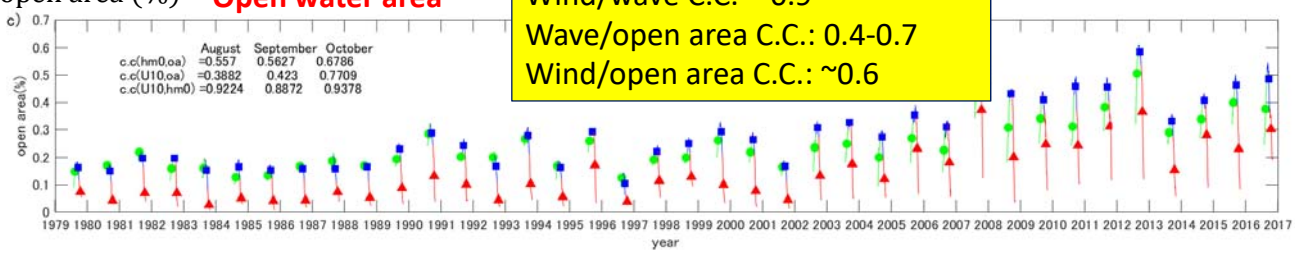


$\overline{U_{10}^{max}}$ **Wind speed**　2 to 6 cm/s/year increasing trend → 2.3 m/s in 38 years (October)



open area (%)　**Open water area**

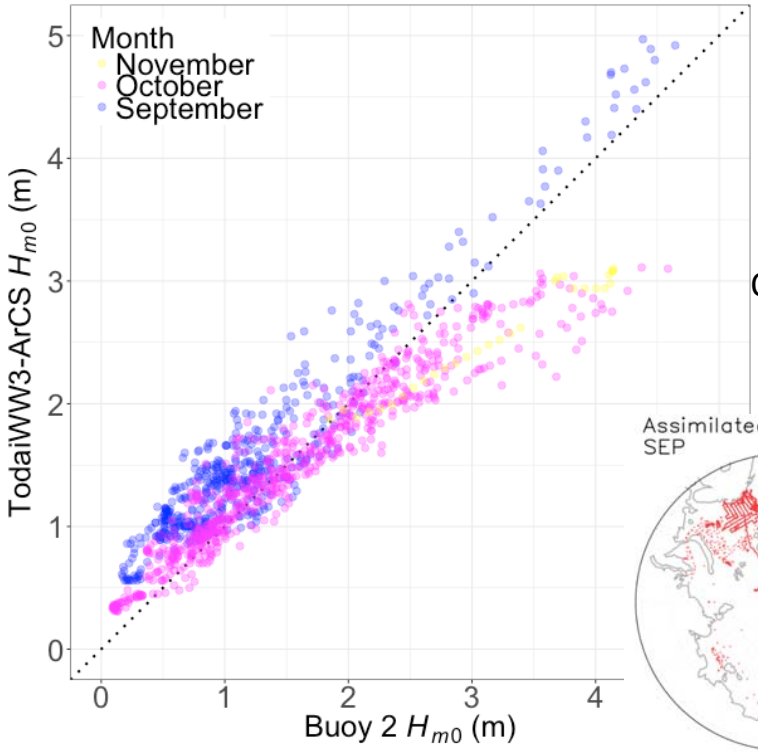
Wind/wave C.C. ~0.9
Wave/open area C.C.: 0.4-0.7
Wind/open area C.C.: ~0.6



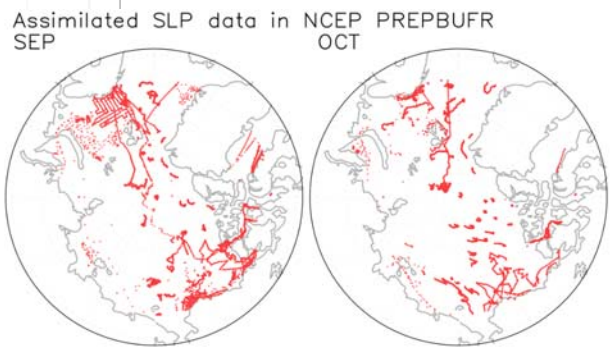
The clue: September vs. October

TodaiWW3-ArCS

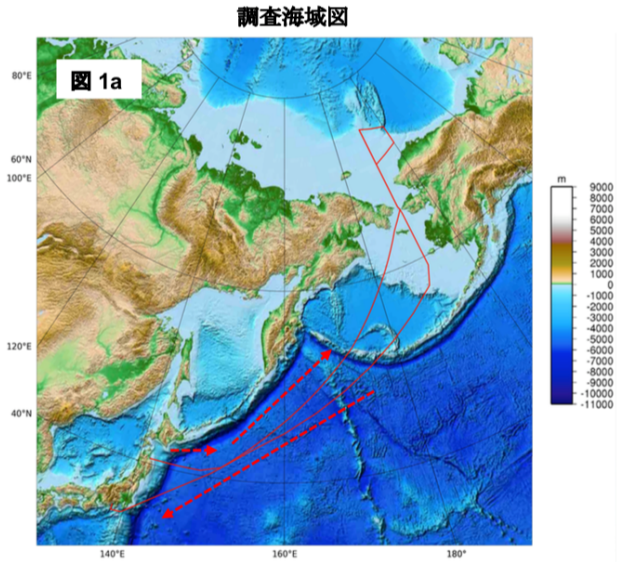
September: good correlation



October: model overestimates



2018 Oct. Mirai Cruise



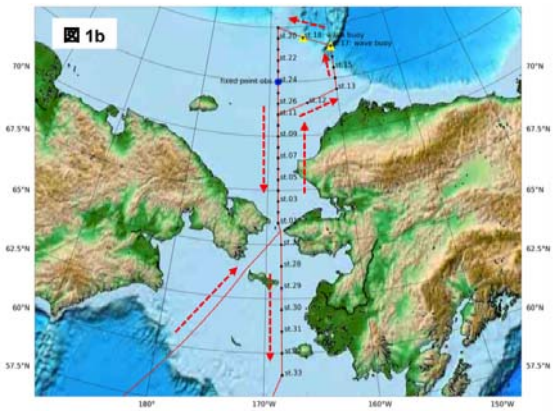
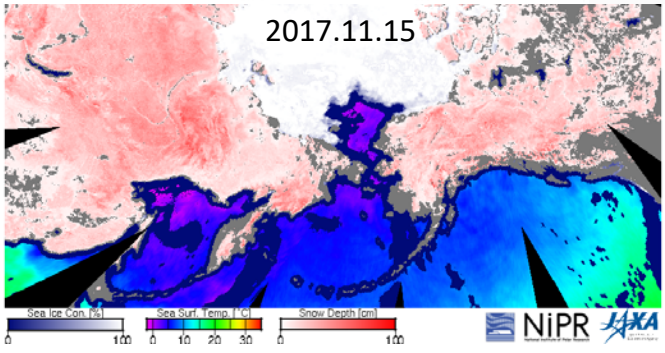


図 1. (a) 調査海域図。赤線は八戸港 - 北極海 - 清水港間の航路で、航走観測を行う。(b) 北極観測域（北部ベーリング海・チャクチ海）の拡大図。調査海域は米国 EEZ と領海を含む。黒点は CTD/LADCP/採水観測点、青点は定点（6 時間間隔の CTD/LADCP/採水観測）、黄色の三角は波浪ブイ投入予定地点を表す。観測測線（航路）、及び観測点は気象・海氷等の状況により変更される可能性がある。



Tank Experiment : elastic plate

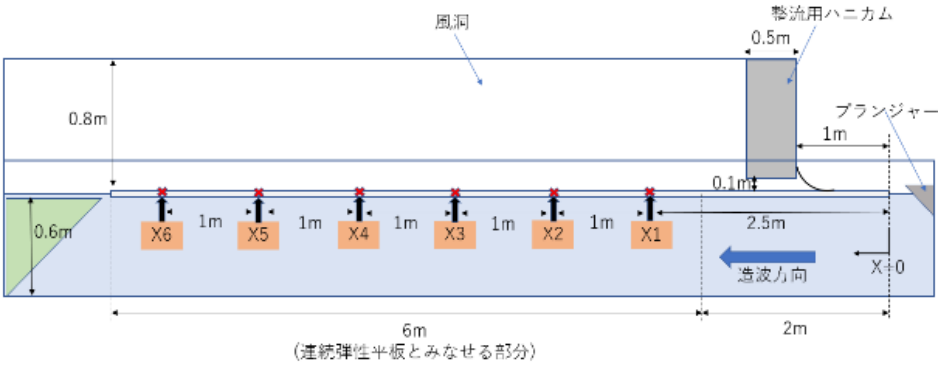
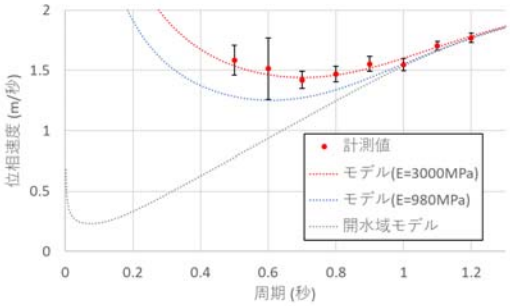


図 41. 計測点 X1～X6

図 28. 風洞内の様子（造波機側に向かって撮影）

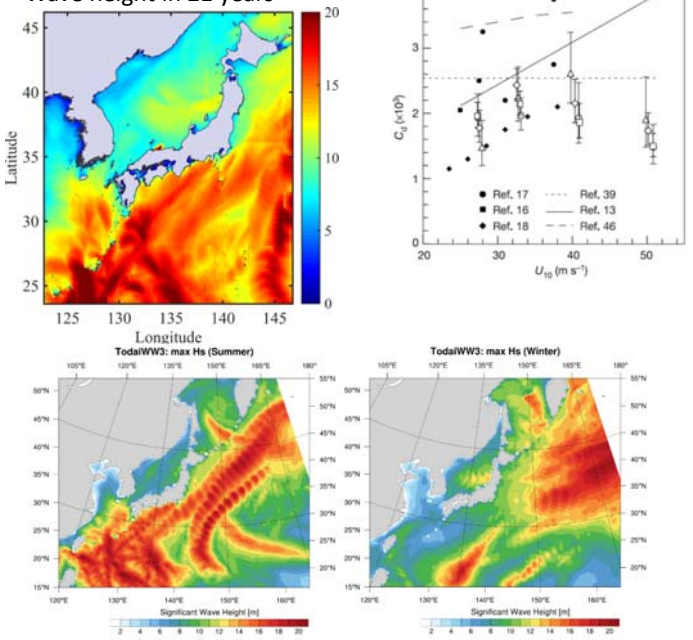


Undergraduate project
Nagashima 2018, UTokyo

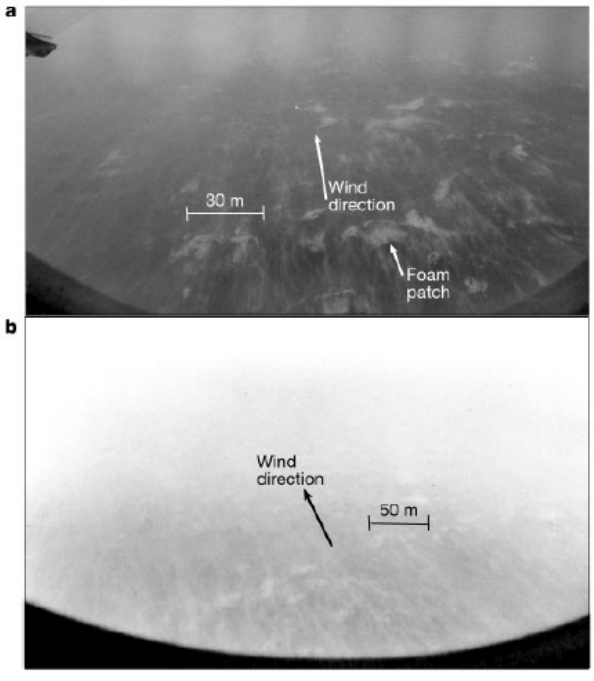
Ongoing Projects

- Waves under typhoon, bomb cyclone, gust: Kakenhi A 2016-2018
  - Kawamura (Kyushu U.) , Kita
  - Atmospheric-Wave coupled simulation under severe wind condition
  - Gustiness at southern ocean (SOFS-6)

Maximum significant
Wave height in 21 years

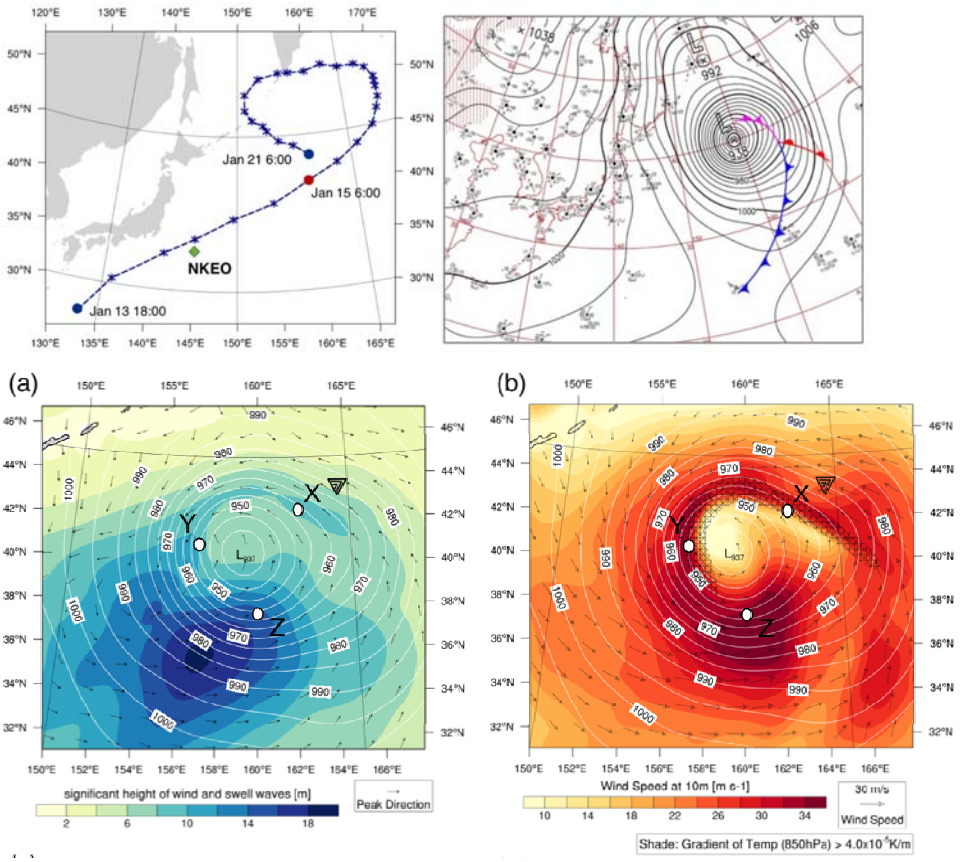


Powell et al. 2007 Nature



Waves under bomb cyclone

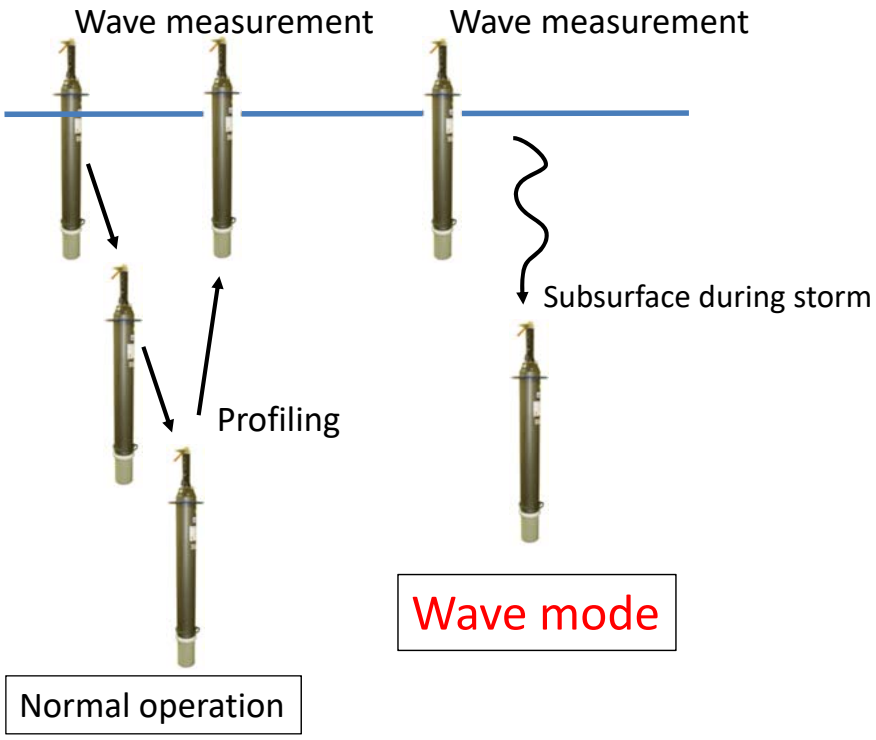
Kita et al. 2018 submitted ODYN



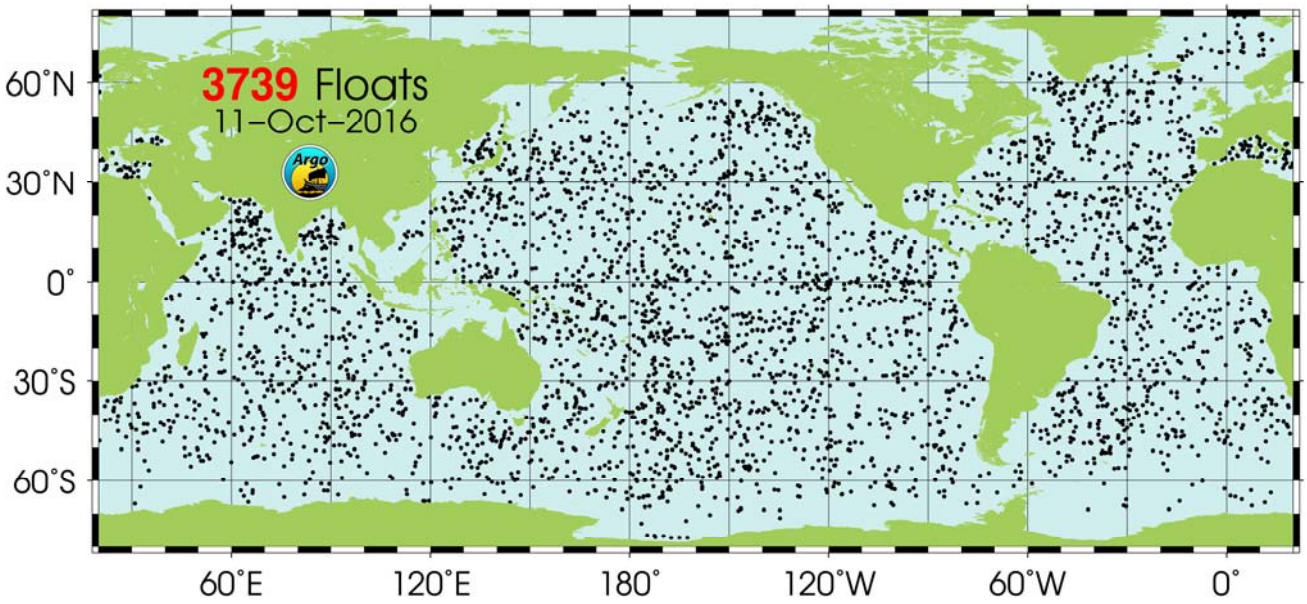
Wave Argo

- Development of wave buoy for global in-situ measurement, Grant-in-aid for Scientific Research Challenging Exploratory Research 2017-2018
  - Development of Wave Argo
  - In-situ wave buoy for severe sea condition (e.g. deployment from an airplane)

Measuring waves under water with a neutrally buoyant buoy



P.A.S. Consultants



Wave measurement by Argo buoy :
Simultaneous measurement by 1/10 of the Argo buoy

What is ***PIEREI***?

Mission To accelerate technology commercialization to increase security, safety, and economic opportunities in Hawaii and the Asia-Pacific region. Its focus is on renewable energy; natural disaster management; agriculture; and ocean, educational and dual-use technology. *(from PICHTR's Website)*

Mission of *PIEREI* in PICHTR

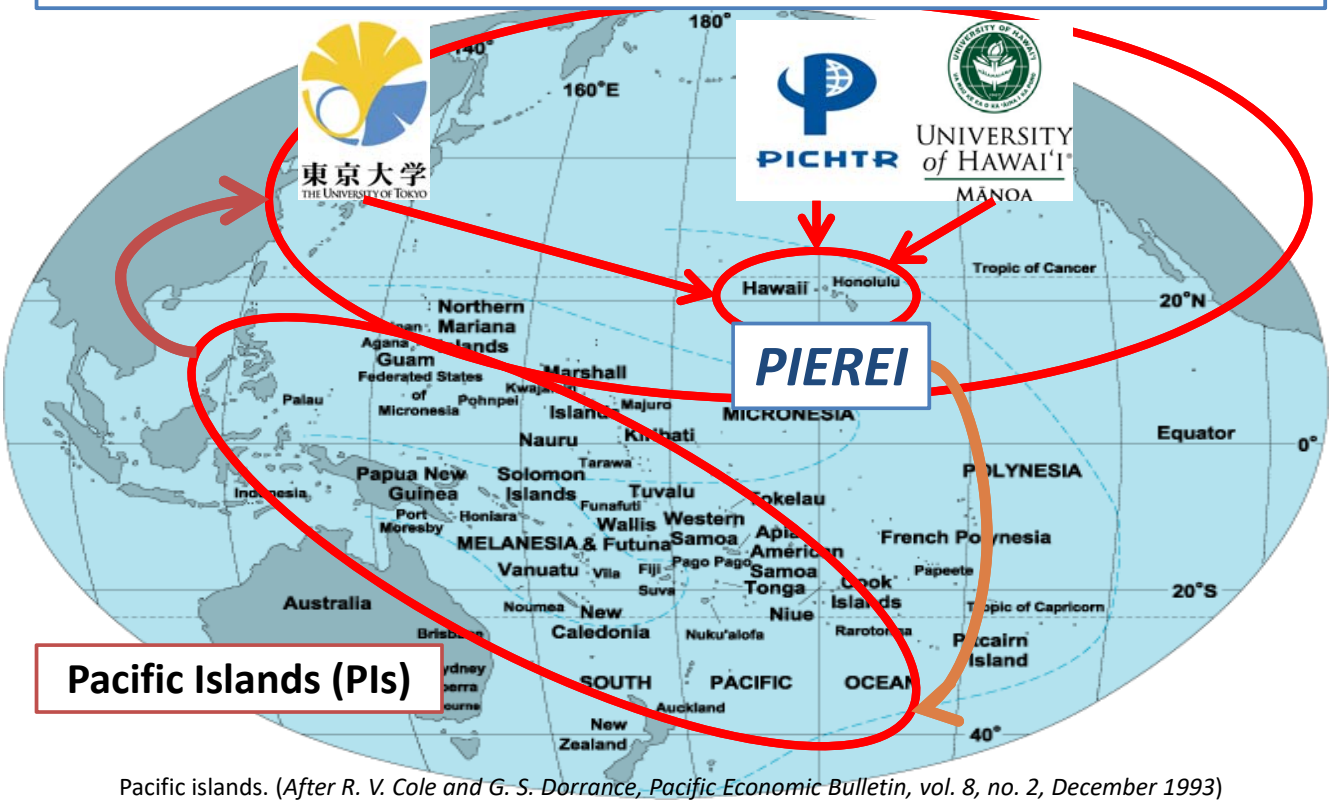
To commercialize Ocean Technology in Hawaii and the Asia-Pacific region.
BRIDGE between and among academia and industries of Japan and Hawaii.
DEVELOP & DEMONSTRATE innovative ocean technologies of the future.
DEPLOY environmentally-friendly technologies in the Pacific Islands.

KEY PLAYERS

Collaboration of the two leading universities of USA and Japan in Ocean Science & Technology will accelerate moves toward a sustainable future in *All Asia-Pacific Islands.*

VISION OF *PIEREI*

Protect the islands, the islands protect our future T2
---collaboration of Japan and Hawaii in World's Leading Ocean Technology R&D.



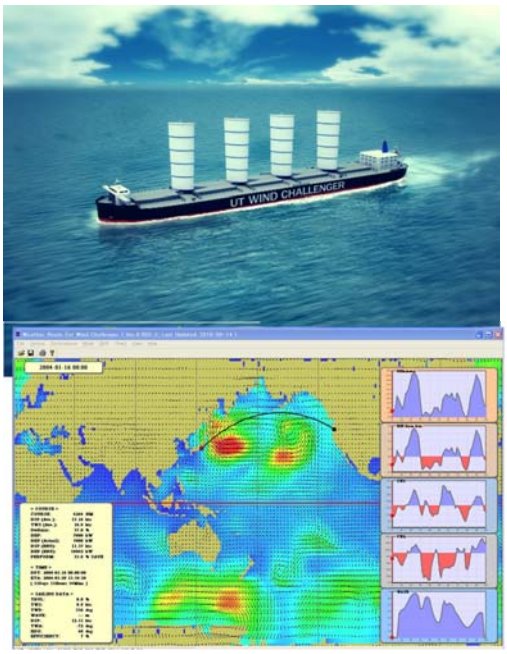
Pacific islands. (*After R. V. Cole and G. S. Dorrance, Pacific Economic Bulletin, vol. 8, no. 2, December 1993*)

T2 they は曖昧な印象
もとにもどします
Takuji, 2012/11/30

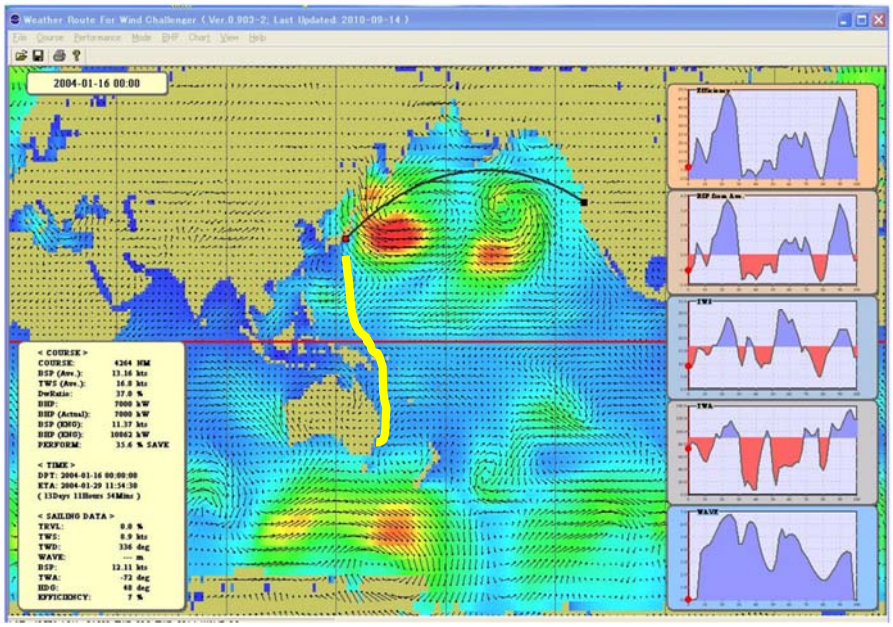
APDRC Data Servers (UH) for the Pacific Isl.

The APDRC provides web services that host the Pacific Islands Global Ocean Observing System (PI-GOOS) and Climate Observing System (PI-GCOS) web pages

- Wind Challenger Project: JIP 2018-2020
  - Ouchi, Davies, Kita
  - Hybrid cargo ship with rigid telescopic sail
  - Routing simulation with wind/wave forecasting
  - Second stat to construct of the first ship (MOL and Oshima Shipping)



Planned service: 2020 (confidential)



Bulk Carrier (XXX tons)

Research: validation of observed wind
Optimum routing algorithm
Commercialization

"Wind Hunter" the Hydrogen Generator

Dr. K. Ouchi / Univ. of Tokyo

L pp	220.0 m
B ext	40.0 m
D	19.5 m
d	9.5 m
DW	15,200 ton
Sail Area total	25,600 m^2
Engine aux.	5,000 kW
Vs (at Abeam Wind 15m/s)	24.0 Kt
Water Turbine	2 x 8.3mϕ
Power Output	31,500 kW
H2 Production	168,000 Nm^2/d
MCH Production	247 ton/d
Ship Type	Catamaran Fore Bridge

Ouchi 2017

Renewable Energy Projects (Wave)

- Coastal Wave Energy Converter: Ministry of Environment/MSE 2016-2018
  - Nakano (MSE); Sasmal
  - Coastal wave modeling to estimate energy potential, survival condition, extreme values, Energy Forecast
  - Improvement of the mode
    - Reflection
    - Diffraction

Renewable Energy Projects (Wave)

- Coastal Wave Energy Converter: Ministry of Environment/MES-Akiken 2016-2018
  - Miyajima (Akiken); Nakano (MES); Sasmal, Webb
  - Coastal wave modeling to estimate energy potential, survival condition, extreme values, Forecast

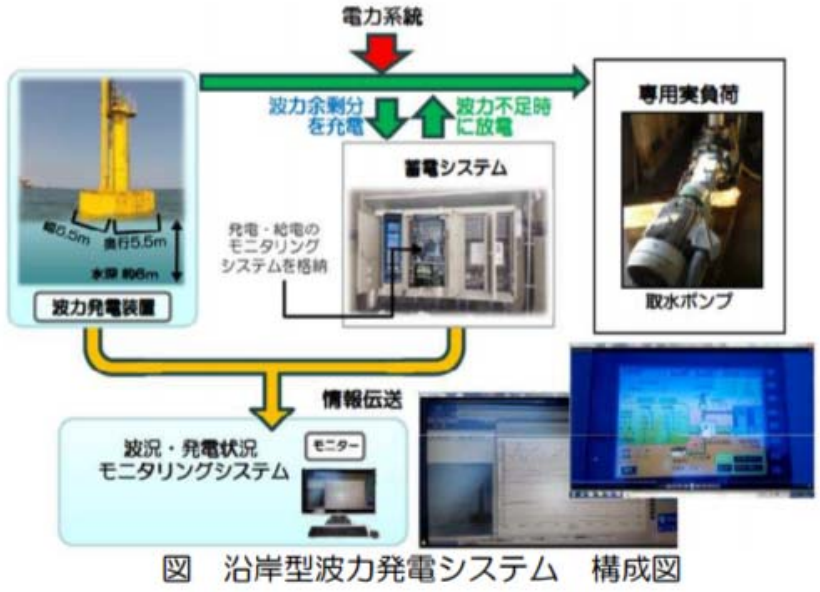
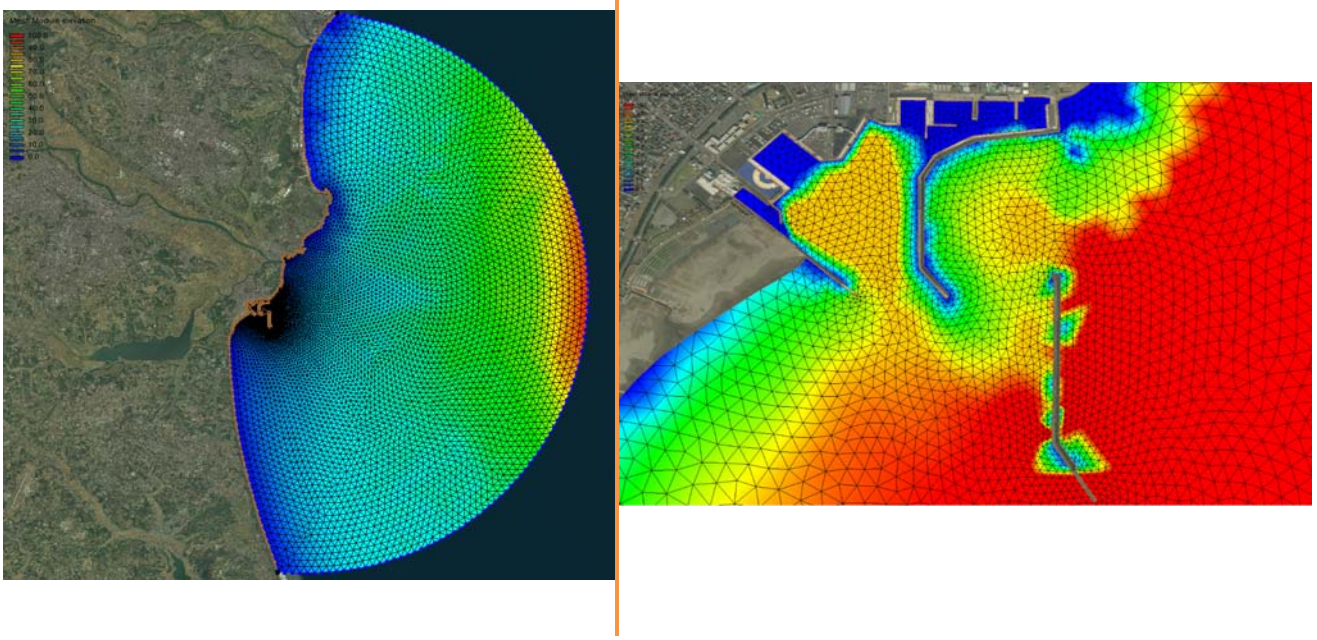


図　沿岸型波力発電システム　構成図

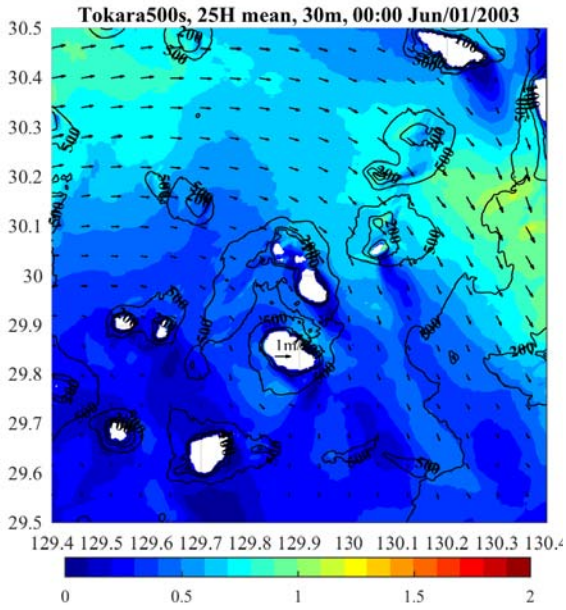
Unstructured mesh

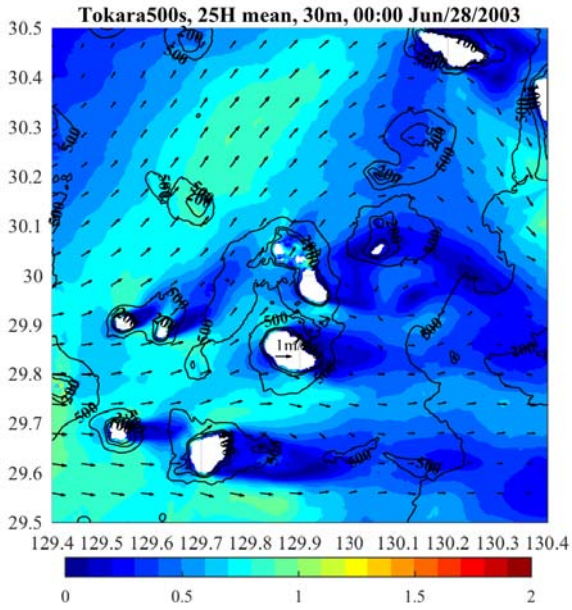


http://157.82.253.148/OARAI/Oarai_forecast.html

Renewable Energy Project (Current)

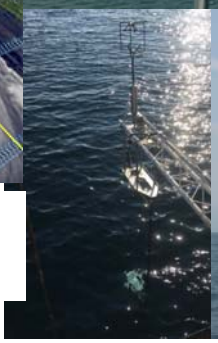
- Ocean Current Turbine testing: NEDO 2018-
  - Kodaira, Takagi, Imamura
  - Ocean current turbine test at the Kuchinoshima Island
  - Kuroshio current axis prediction and downscaling
  - Satellite data analysis

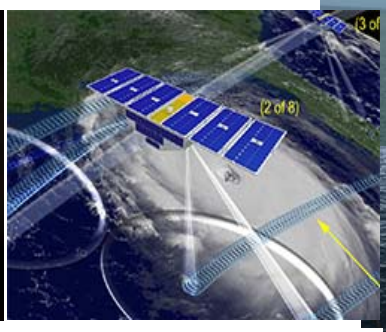




Hiratsuka-tower related

- GNSS-R observation of ocean: MEXT 2014-2016 (ended) continued as collaborative work
  - Ichikawa (Kyushu U.), Tamura (PARI)
  - Providing sea truth; wave, wind, current
  - Stereo imaging (Kaken-hi)
- High-frequency wave observation: Kaken-hi B 2016-2018
  - Tamura (PARI)



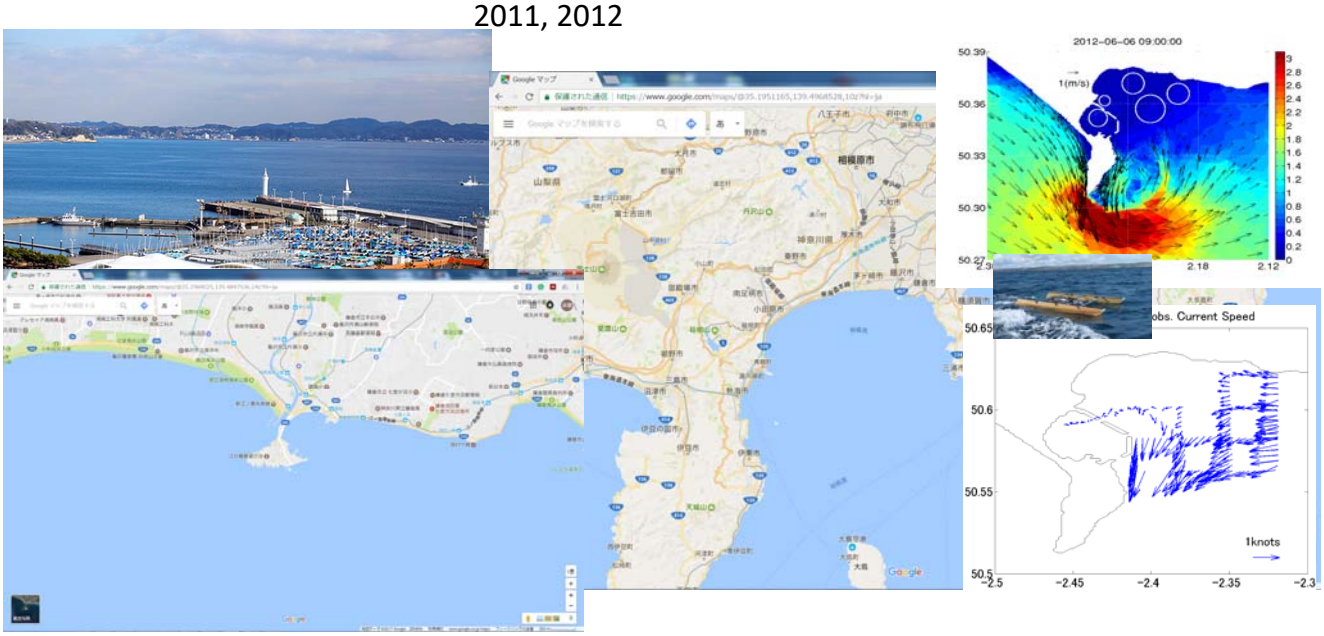


図－3　CYGNSS衛星（左）と軌道上の概念図（右）
（ミシガン大学HP、NASA　HPによる。）

Hiratsuka-tower related

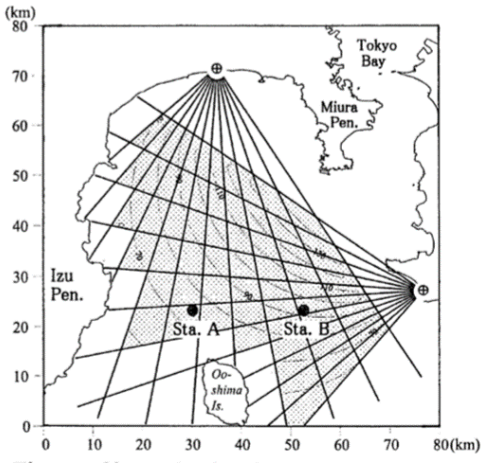
- 2020 Tokyo Olympic
  - Wave, current and wind forecast of the Sagami bay
  - Sailing race

2008 Beijing (Qingdao) POM modeling and observation
2012 London (Weymouth) FVCOM modeling and ADCP, EM-current meter observation
2011, 2012

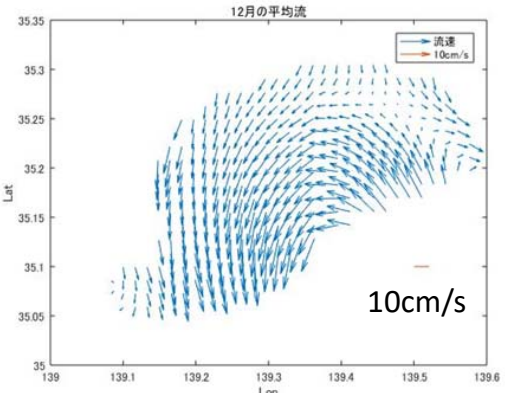


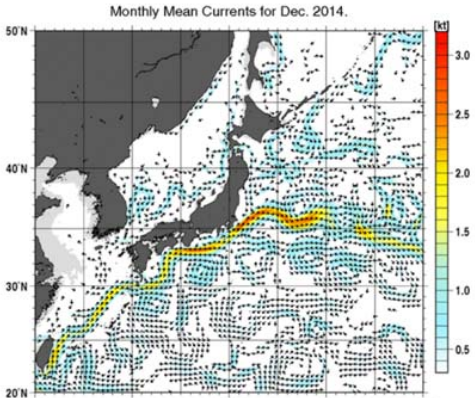
東京オリンピック：ナクラ17

Sagami-bay HF Radar



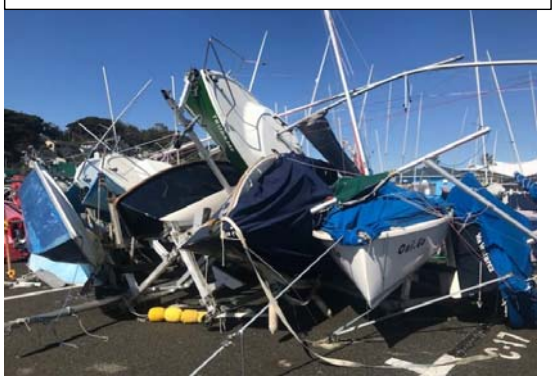
Kobayashi 2018
Undergrad. Thesis



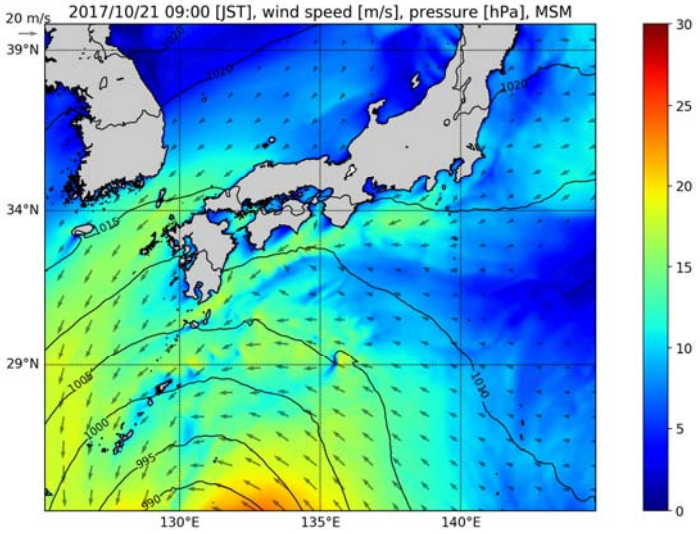


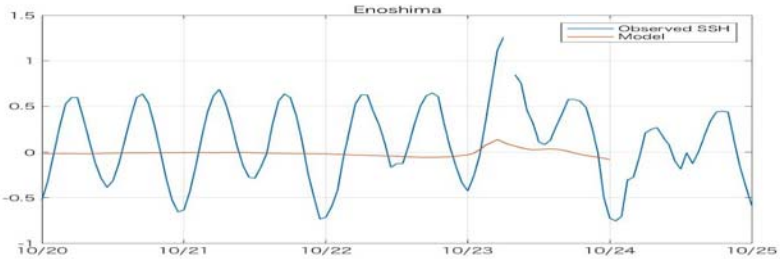
Storm Surge: Enoshima

高潮の被害（SAILFAST ブログより転載）



http://www.sailfast.jp/blog/?p=12399





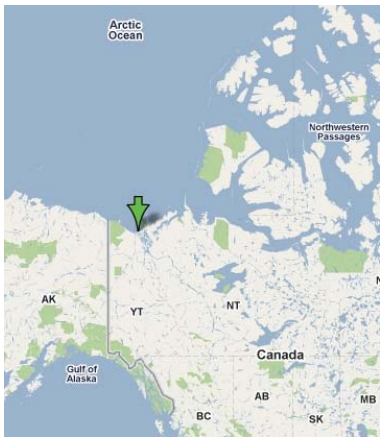
Student project

Storm surge in the Arctic Ocen

- As the open water area emerges, coastal region will be exposed to direct impact of the waves and currents
- Coastal erosion, storm surge may impact the coastal region
- Affects the economic development of the Arctic coasts

Mackenzie River delta（1999）

Credit: Trevor Lantz, University of Victoria



Others

- Mega-Tsunami Project 2014-2017, Ocean Alliance
  - Hibiya, Rheem, Tajima, Niwa, Hirobe, Tatehata
  - Tsunami detection by air-borne radar
  - High-resolution tsunami modeling and inversion
  - Tsunami hazard forecast for early evacuation