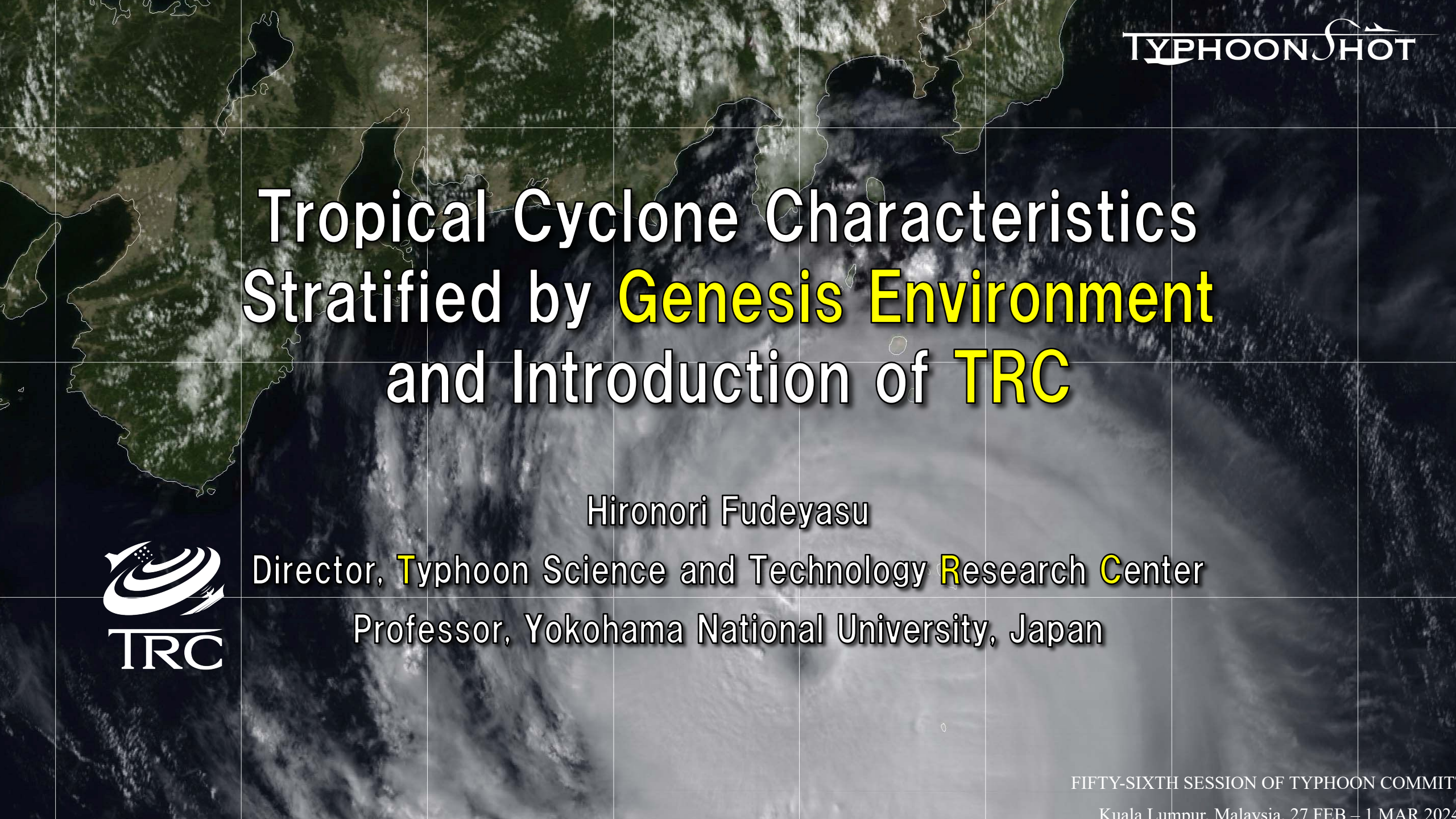


Tropical Cyclone Characteristics Stratified by Genesis Environment and Introduction of TRC

Hironori Fudeyasu

Director, Typhoon Science and Technology Research Center

Professor, Yokohama National University, Japan

FIFTY-SIXTH SESSION OF TYPHOON COMMIT

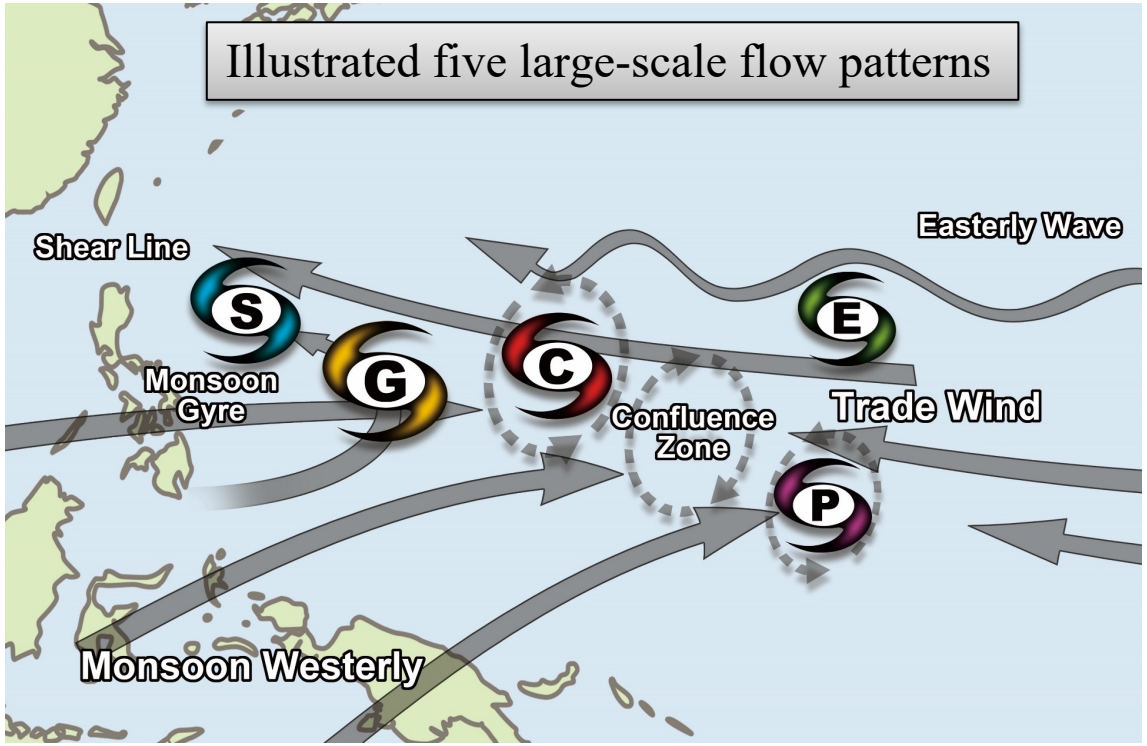
Kuala Lumpur, Malaysia, 27 FEB – 1 MAR 2024

Purpose: Do environmental patterns influence on typhoon characteristics?

Large-scale environmental conditions favorable for cyclogenesis

- High SST exceed 26℃ and supportive largescale flow patterns (Gray 1968, 1998).
- Large-scale flow patterns in the lower troposphere over the WNP were classified by Ritchie & Holland (1999)

1. Monsoon shear line (S-pattern)
2. Monsoon gyre (G-pattern)
3. Easterly wave (E-pattern)
4. Confluence region (C-pattern)
5. Rossby wave energy dispersion from a preexisting typhoon (P-pattern)



Fudeyasu & Yoshida (2018)

Working hypothesis

Differences in large-scale flow patterns contributing to cyclogenesis could be considered key to the characteristics of resulting typhoons.

Study objective

To statistically investigate the characteristics of typhoons stratified by five large-scale flow patterns.

Methodology: Typhoon Genesis Score (TGS) to objectively detect the five flow patterns

Yoshida & Ishikawa (2013), Fudeyasu et al. (2023)

Typhoon Genesis Score TGS

Yoshida & Ishikawa (2013)

Fundamental equations of TGS

Type S $$SCR_{SL} = \frac{\left(\frac{\partial u}{\partial y}\right)_{ave} exp(\mathrm{A_{SL}\ dist})}{Max[scr_{SL}]}$$

Type C $$SCR_{CR} = \frac{\left(\frac{\partial u}{\partial x}\right)_{ave} exp(\mathrm{A_{CR}\ dist})}{Max[scr_{CR}]}$$

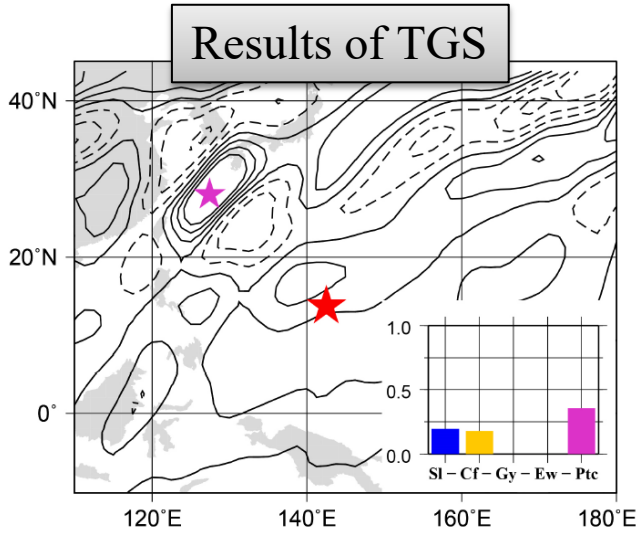
Type E $$SCR_{EW} = \frac{\left(\frac{\partial v}{\partial x}\right)_{ave} exp(\mathrm{A_{EW}\ dist})}{Max[scr_{EW}]}$$

Type G $$SCR_{GY} = \frac{exp(-M) \times (\zeta - \zeta_{std})}{Max[scr_{GY}]}$$

Type P $$SCR_{PTC} = \frac{C_{wv1}^2}{Max[scr_{PTC}]}$$

Analyzing environmental wind data at the time of typhoon genesis to produce five scores for each typhoon.

Results of TGS



TCG	SL	CR	GY	EW	PTC
D19960	**0.314**	0.000	0.004	0.311	0.000
D19960	**0.384**	0.000	0.146	0.092	0.000
D199603	0.232	0.000	0.000	**0.239**	0.000

Yoshida & Ishikawa (2013)

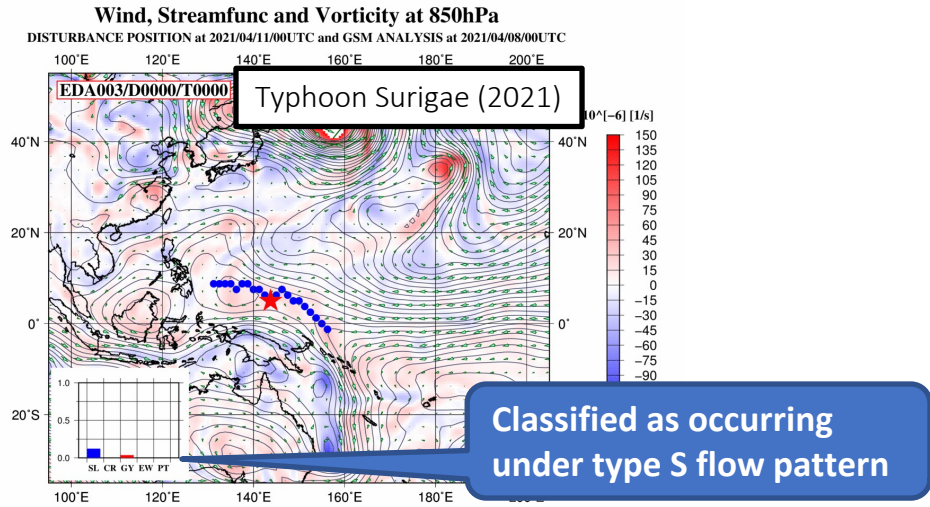
The pattern with highest score is identified as the genesis flow pattern

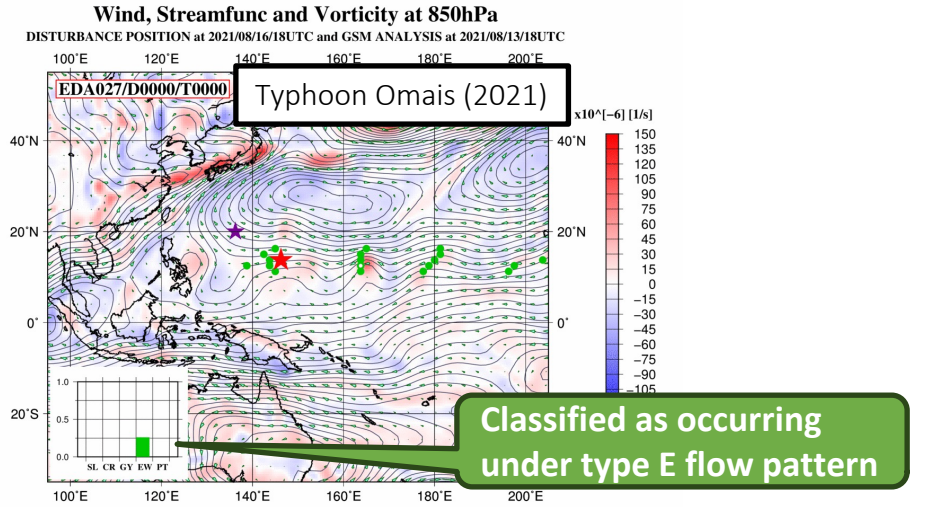
Classified over 800 genesis cases into five flow patterns and statistically analyzed their characteristics.

JMA-TGS

TGS implemented by the Japan Meteorological Agency

Fudeyasu et al. (2023)





Results: Relationship between the five flow patterns and typhoon characteristics

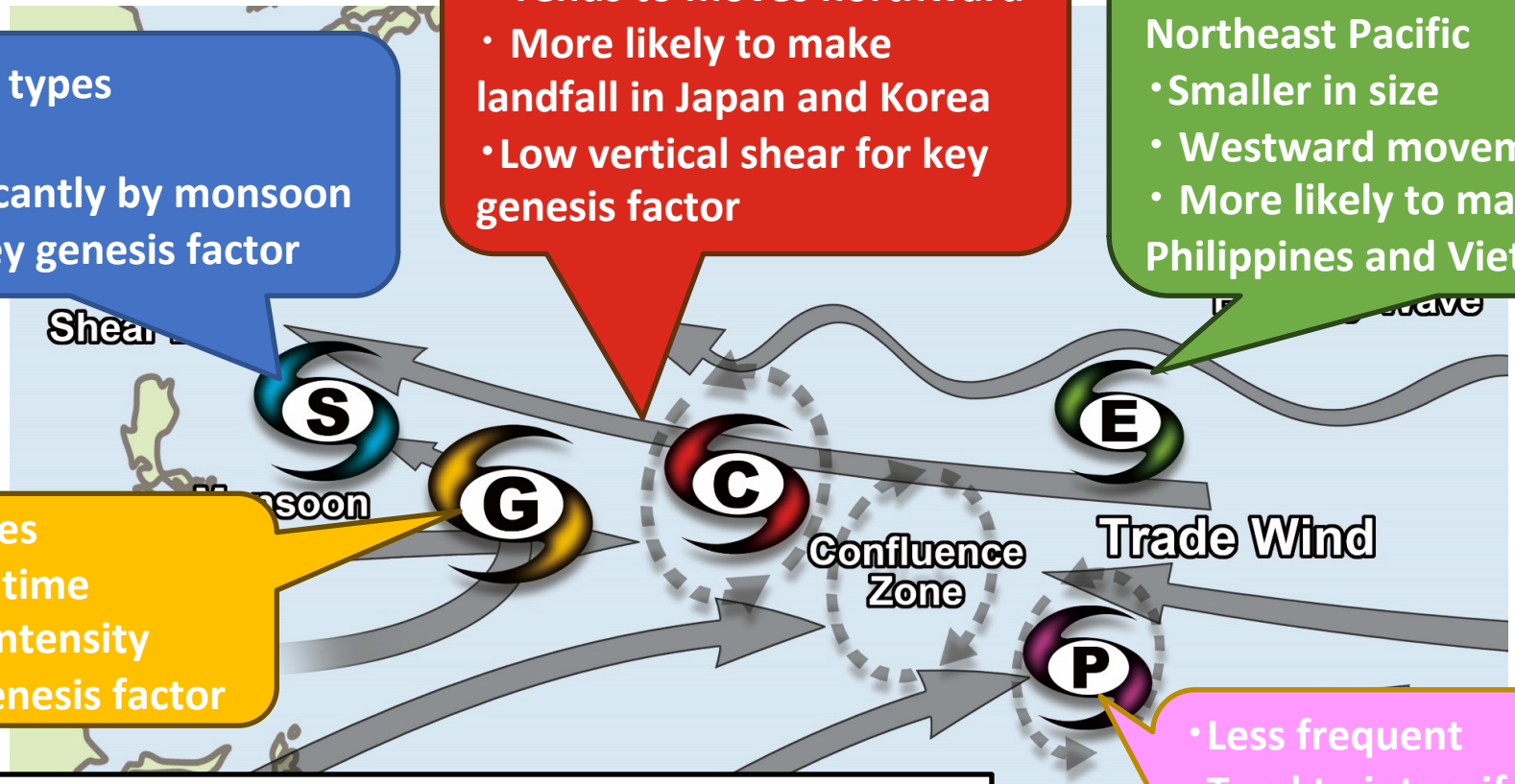
Fudeyasu & Yoshida (2018, 2020), Fudeyasu et al. (2019, 2020, 2023), Yoshida & Fudeyasu (2020)

Summary

- Monsoon-related types
- Most frequent
- Influenced significantly by monsoon
- High TCHP as a key genesis factor

- Tends to moves northward
- More likely to make landfall in Japan and Korea
- Low vertical shear for key genesis factor

- Environmental conditions in the Northeast Pacific
- Smaller in size
- Westward movement
- More likely to make landfall in the Philippines and Vietnam



- Monsoon-related types
- Larger size at genesis time
- Generally weaker in intensity
- High TCHP as a key genesis factor

- Less frequent
- Tend to intensify
- More likely to make landfall in the Philippines

Detecting such genesis environments at the genesis time can be very important in reducing typhoon damage. Understanding the likely landfall countries of typhoons stratified by genesis environments and early forecasting by TGS can be invaluable to each country.

What is the mission of the TRC?

TRC: The first research organization in Japan dedicated to typhoon research

Opening Ceremony on October 1, 2021 at YNU

Typhoon power generation
Innovation
Typhoon control
Career development

Typhoon Science and Technology Research Center
The Institute for Multidisciplinary Sciences
Yokohama National University

TRC Consortium

日本気象協会 MS&AD INSURANCE GROUP FUJITSU Kawasaki IHI
TOKIO MARINE D. OBAYASHI JGC 東京海上研究所
GLOBAL DX GuyCarpenter KDC KANSAI DESIGN COMPANY, LTD. 関西設計株式会社 SOTETSU
SoftBank MS&AD MS&ADインターリスク総研

Interdisciplinary research institutions

JAXA TOHOKU UNIVERSITY NEDO Keio University JAMSTEC HOKKAIDO UNIVERSITY FOUNDED 1876
KYOTO UNIVERSITY FOUNDED 1897 気象研究所 NIED NII CHIBA UNIVERSITY PARI

Joint research with companies

FUJITSU NTT
MS&AD INSURANCE GROUP weather map MS&AD MS&ADインターリスク総研

Mission 1 The TRC aims to minimize typhoon damages, especially **eliminating the loss of life**, through various typhoon research and technological development.

Mission 2 The TRC is focusing on utilization of the typhoon energy. By effectively utilizing the wind power of typhoons, we are trying to develop and promote **sustainable energy resources**. This is exactly about transforming typhoons to **positives**.

Overview of TRC Labs & Researchers

By sharing each other's expertise, we enhance our understanding of typhoons and work towards realizing our missions.

Director：Prof. Hironori Fudeyasu

Vice Directors： Prof. Kazuyoshi Tsuboki・Prof Masaki Satoh, Prof. Nobuhito Mori, As. Prof. Taiga Mitsuyuki

Total of 66 members from 10 universities, 7 research Institutes, 6 companies, 2 overseas organizations

Support team
Reader: Masayoshi Okumura

Typhoon Observation Research Lab
Leader：
Nagoya U./YNU
Porf. Tsuboki Kazuhisa

Typhoon Prediction Research Lab
Leader：Tolyo U. Prof. Msaki Satoh

Typhoon Power Generation System Development Lab
Leader：YNU Assoc. Prof. Taiga Mitsuyuki

Social Implementation Promotion Lab
Leader：YNU Prof. Seiji Manabe

Regional disaster prevention Lab
Leader：YNU Prof. Hironori Fudeyasu

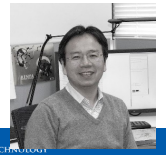
Typhoon data science Lab.
Leader：YNU Assoc. Prof. Ryuji Yoshida

International Advisor

Prof. Kerry A. Emanuel(MIT)
Prof. Yuqing Wang(UH)
Prof. Chun-Chieh Wu(NTU)

Meteorology

●Nagoya U
●U Ryukyus
●JAMSTEC
●Hokkaido U
●JAXA
★KHI



○YNU
●U Tokyo
●Kyoto U
●Tohoku U
●MRI
●U Ryukyus
●JAMSTEC
●Keio U
●CMA
●UCAR
★TMRI

Naval architecture Electronics engineering

○YNU
●JAMSTEC
●NEDO
●Hokkaido U

Economics Law Psychology

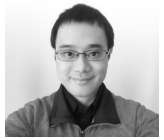
○YNU
★Deloitte Tohmatsu
★TMRI
★KHI

Education

○YNU
●Kyoto U
●Chiba U
●NIED
●MPAT
★Aioi Nissay Dowa
★TMRI
★MS&AD

Statistics

○YNU
●JAMSTEC
●NII
★Fujitsu Lab



Collaboration between the TRC and the Japan Meteorological Agency (JMA)

On November 1, 2023

Yokohama National University, home to the TRC, established a comprehensive agreement on cooperation and collaboration in typhoon-related research and development with the JMA.

This collaboration is centered around utilizing typhoon research for disaster prevention activities and human resource development. Notably, this is the first time that the JMA's main office has partnered with a university in such a collaboration.

国土交通省 気象庁 Japan Meteorological Agency

Nov. 1. 2023

The Mainichi Shimbun 2023/11/17

毎日新聞

大学倶楽部・横浜国立大

気象庁と「台風研究等に係る包括的連携・協力に関する協定

横浜国立大

2023/11/17 16:00（最終更新 11/17 16:00） 578文字

横浜国立大学の梅原学長（左）と気象庁の大林長官（右）

台風科学技術研究センターを有する横浜国立大学と気象庁は11月1日、「台風研究等に係る包括的連携・協力に関する協定」を締結した。

近年、毎年のように台風による大きな被害が発生しており、今後も地球温暖化の進行と共に、猛烈な台風の割合が増えると予測されている。そのため、台風に関する知見をさらに高め、予測精度を向上させようと協定の締結に至った。

President of YNU I. Umehara (left) and Director-General of the JMA O. Obayashi (right)

The First International Workshop of the TRC (IWTRC)

TRC organized the IWTRC at Yokohama National University on November 8-9, 2023.

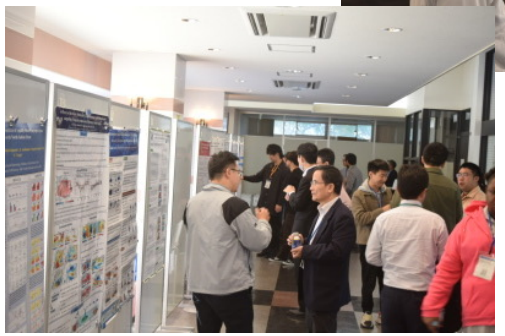
Objectives of the IWTRC

1. To share the latest developments and challenges in typhoon research.
2. To encourage students and young researchers.
3. To introduce TRC globally and explore international collaborations.



Keynote lectures provided by TRC International advisors








Workshop participation with great success

Total participants:125

International Attendees: 42 from 12 countries

International Students: 14

(TRC subsidized the travel costs of 6 students)

Highlights: Engaging discussions, valuable networking, successful presentations.

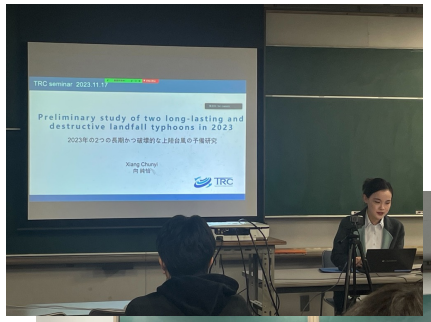
We plan to have 2nd IWTRC this year, so I hope you can join us.

The Story of Dr. Chunyi Xiang from China Meteorological Administration (CMA)

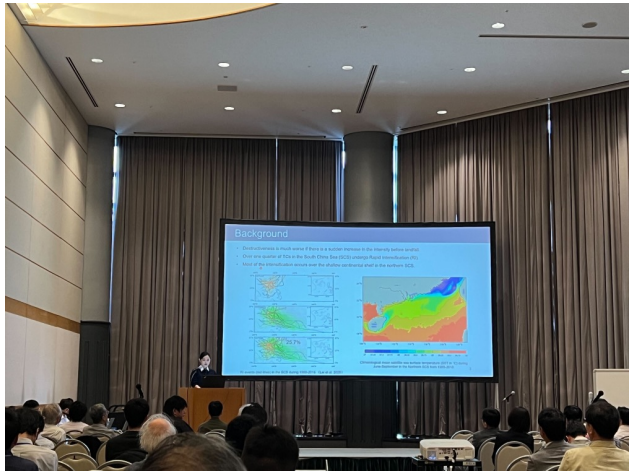
Dr. Xiang spent a full year in Japan, researching typhoons as a member of TRC

IMS Visiting Associate Professor

Dr. Xiang continues her association with TRC, keeping her connection with TRC.



Farewell party with YNU students



Dr. Xiang presented her research at Japanese conferences and discussed with the Japanese researchers.

Xiang's research was accepted by the Scientific Online Letters on the Atmosphere, Jan. 2024.

SOLA, 2024, Vol. 20, 55−61, doi:10.2151/sola.2024-008

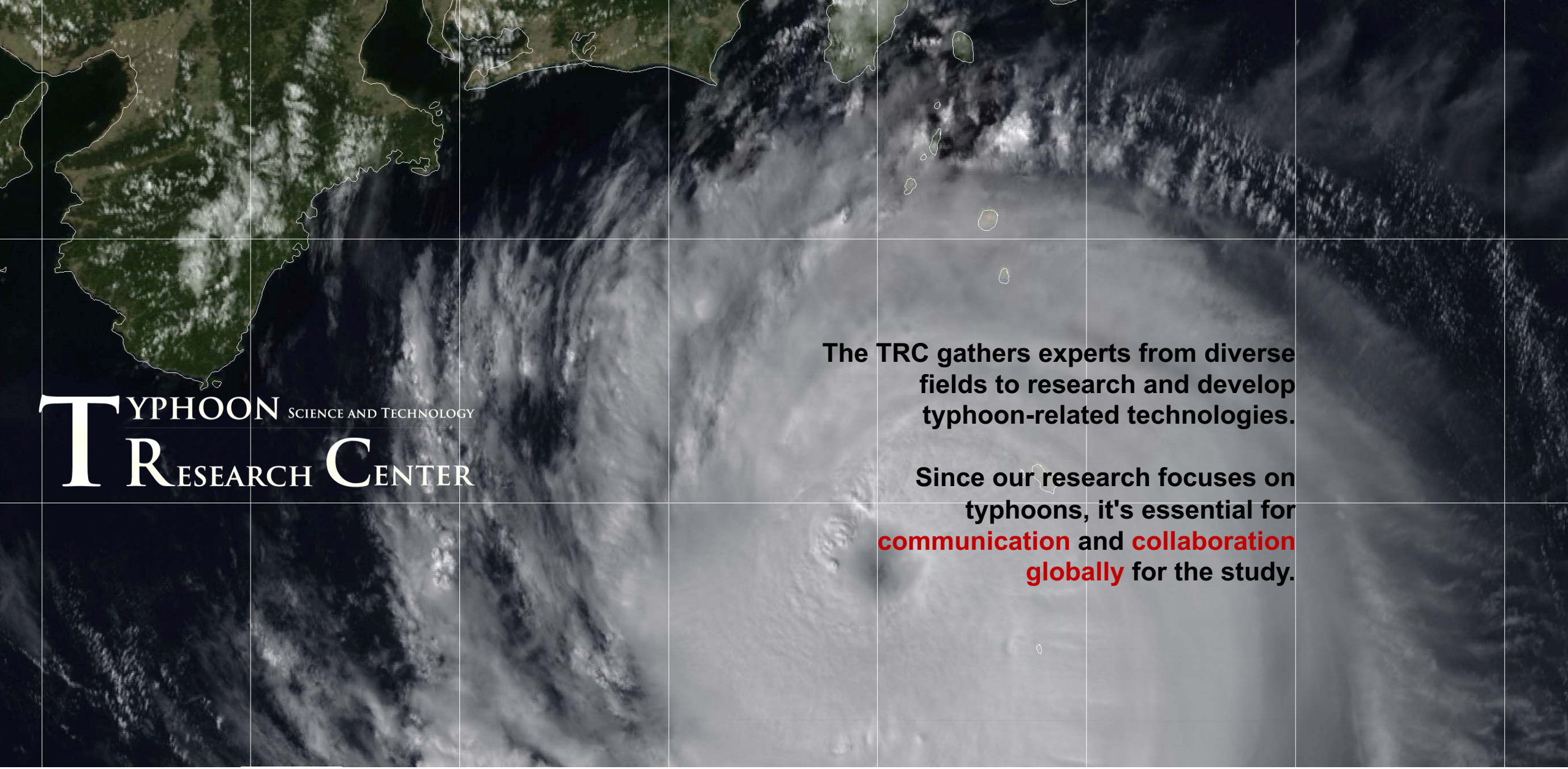
Shallow Coastal Water Responses During the Near Landfall Intensification of Tropical Cyclones in the South China Sea

Chunyi Xiang[1, 2], Hironori Fudeyasu[2, 3], Udai Shimada[2, 4], and Ryuji Yoshida[2, 5]

[1]*National Meteorological Center, Beijing, China*
[2]*Typhoon Science and Technology Research Center, Yokohama National University, Yokohama, Japan*
[3]*Graduate School of Education, Yokohama National University, Yokohama, Japan*
[4]*Meteorological Research Institute, Tsukuba, Japan*
[5]*Graduate School of Environment and Information Sciences, Yokohama National University, Yokohama, Japan*

(Manuscript received 5 October 2023, accepted 9 January 2024)

Abstract Shallow coastal seawater response during the passage of near-landfall intensification (NLI) tropical cyclones (TCs) and non-NLI TCs was examined using oceanic and atmospheric reanalysis data and observations. The sea surface temperature ahead of the NLI-TC track is maintained or even increases when NL
The magnitude of the wind stress, which play an important role in the NLI process, is rela
on the right side of the tracks. Coastal mixed layer warming can be explained by Ekman t
stress due to surface wind forcing. The successive deepening of the coastal ocean bound
warming in the subsurface seawater temperature by an average of 0.3°C, could maintain
degree. This shallow coastal water response could partly explain the NLI progress in th
indicating the importance of coastal ocean dynamics and air-sea interactions.



TYPHOON SCIENCE AND TECHNOLOGY RESEARCH CENTER

The TRC gathers experts from diverse fields to research and develop typhoon-related technologies.

Since our research focuses on typhoons, it's essential for communication and collaboration globally for the study.

Thank you!

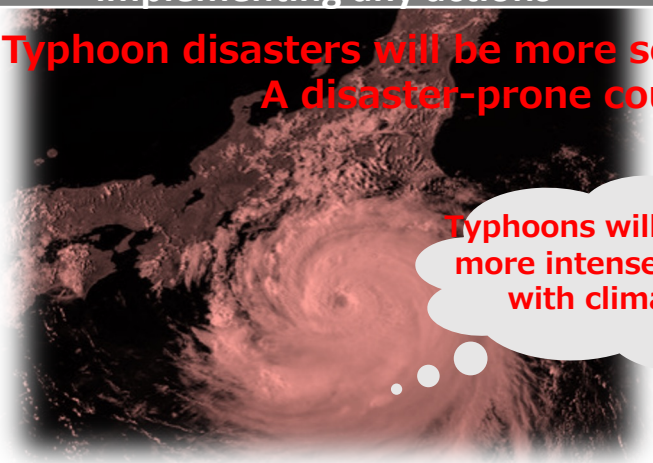
the preliminary slides

Changing Typhoons from "Threats" to "Blessings"

If we continue in this direction without implementing any actions

2050

Typhoon disasters will be more severe.
A disaster-prone country Japan

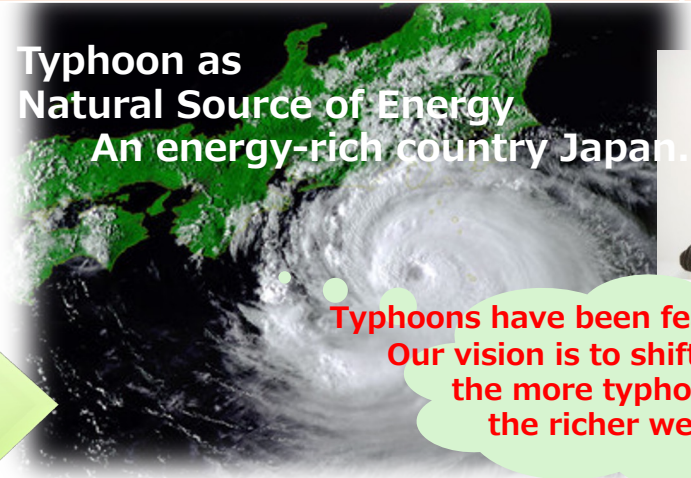


Typhoons will become even more intense in the future with climate change

Present

A populated area faces extensive damage.

The future realized the Typhoonshot project



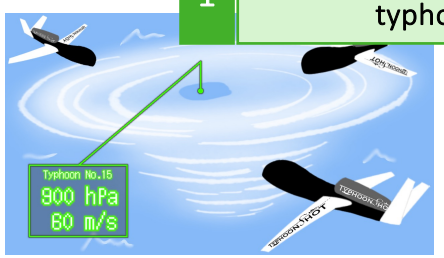
Typhoons have been feared and unwanted.
Our vision is to shift this paradigm:
the more typhoons we get,
the richer we become.

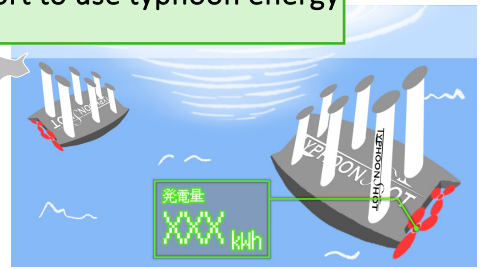
TYPHOON SHOT project

Subjects

1 Effort to artificially control typhoons

2 Effort to use typhoon energy





minus →Zero→Plus

National Project “Moonshot Goal 8”

MOONSHOT RESEARCH & DEVELOPMENT PROGRAM (2022—) JST

Realization of a society safe from the threat of extreme winds and rains by controlling and modifying the weather by 2050.

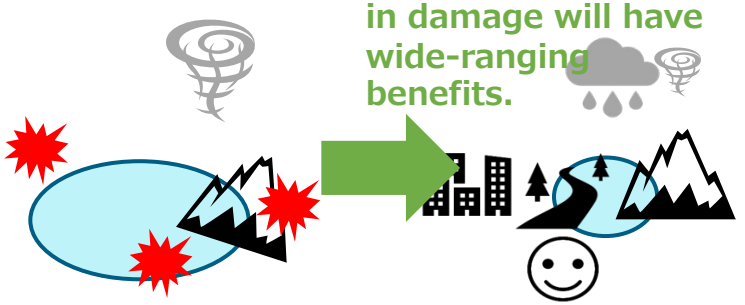
The goal of the TRC: Typhoon Control Research

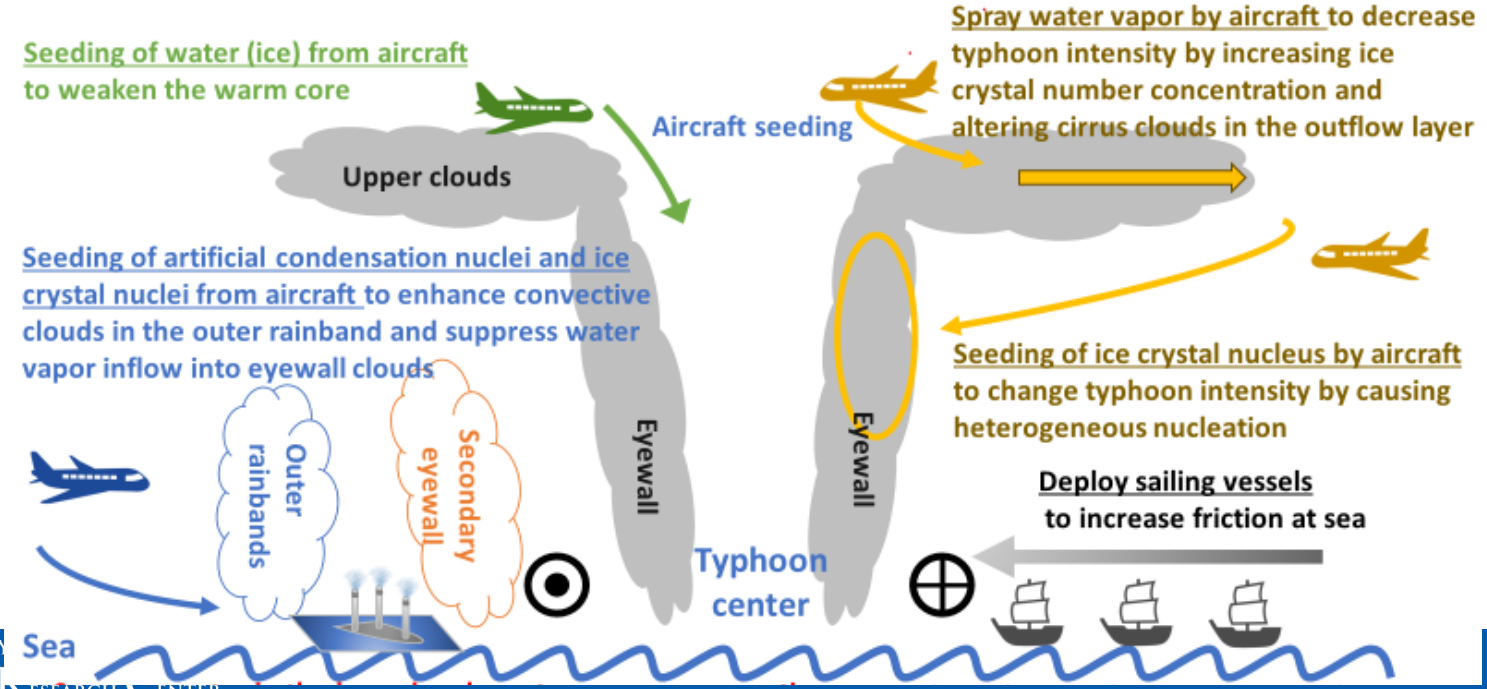
Typhoon Control: Reducing Intensity using human intervention, not truly controlling the typhoon.

This project aims to develop principles and fundamental techniques to artificially reduce the intensity of typhoons using numerical simulations. We work to reduce the intensity of strong typhoons to a level that can be managed by our current infrastructure. We do not aim to completely eliminate typhoons.

Change the timing, range and intensity of typhoons and extreme rains.

Resulting reduction in damage will have wide-ranging benefits.





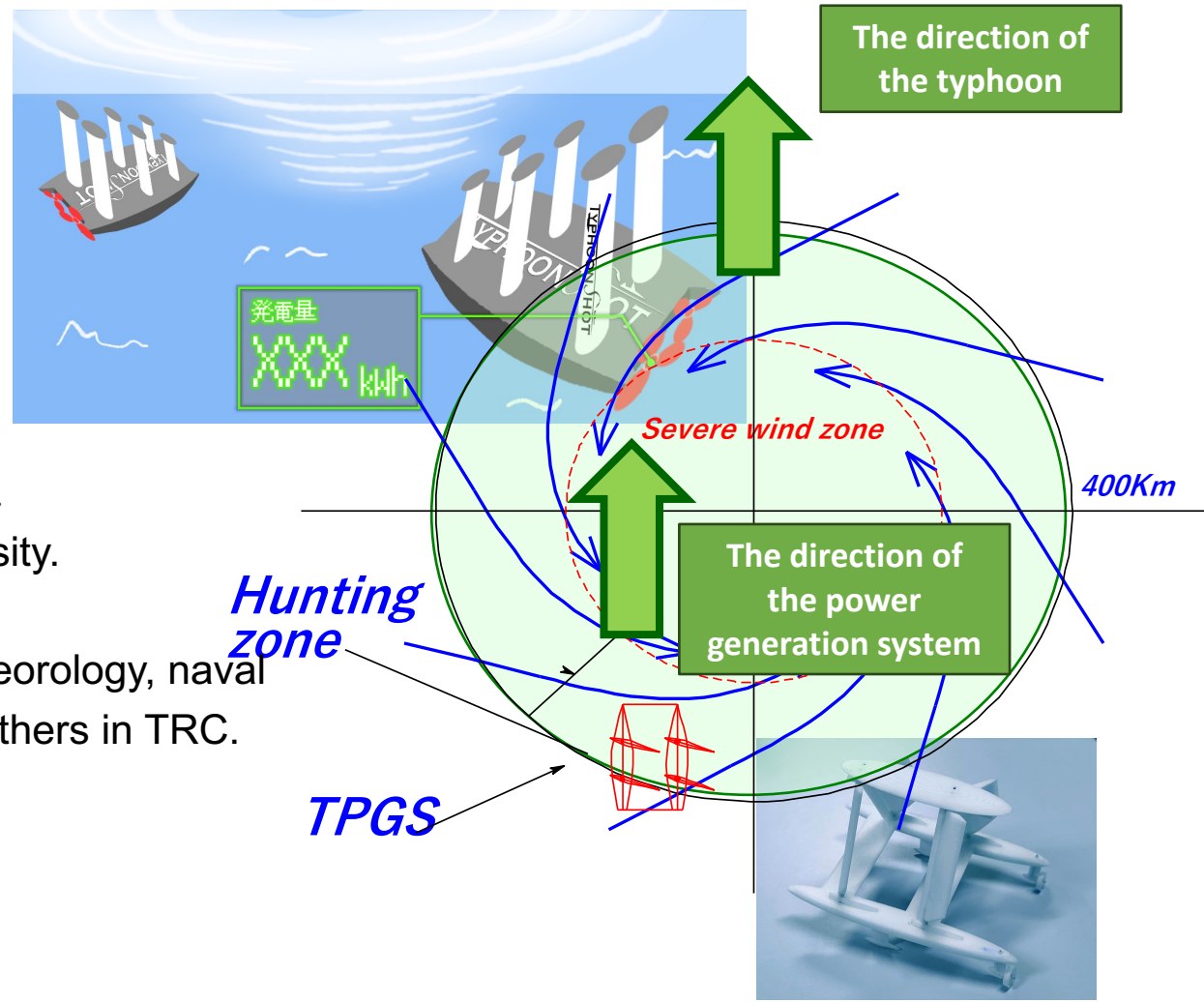
The TRC has been selected as a project manager team in the national project "Moonshot goal 8."

Development of Typhoon Power Generation Ships TPGS

An unmanned sailboat that taps into the powerful winds of typhoons for electricity generation.

Concept of TPGS

- TPGS is designed to be positioned behind the typhoon, capturing the wind using sails and sails along with the typhoon for extended periods.
- TPGS generates power by rotating screws underwater.
- TPGS stores this power on the boat, and then brings this stored power back to the coast.
- TPGS is unmanned, making it safer for operation in rough oceans.
- Another benefit is that it might help in reducing the typhoon intensity.
- We can expect a reasonably large amount of power generation.
- This project is a collaborative effort of experts in the fields of meteorology, naval architecture and ocean engineering, electrical engineering, and others in TRC.



Estimated Power Generation by TPGS

Per TPGS for Power generation capacity: **0.138 [GW]**

Annual power generation**: 3.31×108 [kWh]**

Given conditions: Power generation by twin turbines with a propeller diameter of 28m /The speed of the power generation system when following the typhoon is assumed to be 9m/s / The power generation efficiency of the turbine is assumed to be 0.30 / 20 typhoons occur near Japan annually, and that the power generation system can follow each typhoon for 5 days

Collaborative Research between Companies and TRC

The TRC has formed **collaborative research partnerships** with **big private companies**.

1. **NTT Space Environment and Energy Laboratories**
   Research into methods of typhoon forecasting using ocean-atmosphere observation data over maritime areas,
2. **Fujitsu - Yokohama National University Research Laboratory**
   Meteorological studies about typhoon using AI and HPC technologies.
3. **Mitsui Sumitomo Insurance Co., Inter Risk Research & Consulting, WEATHERMAP.inc**
   Developing Virtual Disaster Training Scenarios for Meteorological Warnings, Alerts, Typhoon Damage Estimation, and Local Government Disaster Preparedness.

1. NTT Space Environment and Energy Lab.

NTT

予測精度向上へ
台風研究タッグ
NTTと横国大

NTT（東京都千代田区）と横浜国立大学は台風の進路や強さを予測する共同研究を実施している。NTTが観測したデータを、横国大の台風予測モデルに組み込み、精度向上を目指す。

NTTは将来的な提供サービス充実のため、海洋にさまざまな観測装置を設置。台風の強度に直結する台風真下の気圧や風速、台風のエネルギー源となる水蒸気量や海水温を観測し、提供するリアルタイムデータの充実を目指している。横国大は2021年10月に全国で唯一の台風専門研究機関「台風科学技術研究センター（TRC）」を設立し、最先端の台風予測技術を有しているという。

共同研究は22年10月から始まり、3月まで続く。両者は「さまざまな業界、機関との協業により、海洋気象情報の超広域でのリアルタイム観測を実現し、台風に対する環境・社会活動の未来予測を高度化し、恵みに変えていく」としている。【富島麻実】

共同研究契約を締結したＮＴＴ宇宙環境エネルギー研究所前田裕二研究所長（左から２番目）と横浜国立大学梅原出学長（同３番目）ら＝ＮＴＴ提供

2. Fujitsu-YNU Research Lab.

FUJITSU
富士通株式会社

富士通-横浜国大 台風リサーチ・ラボ共同研究講座
（富士通-横浜国大リサーチ・ラボ）

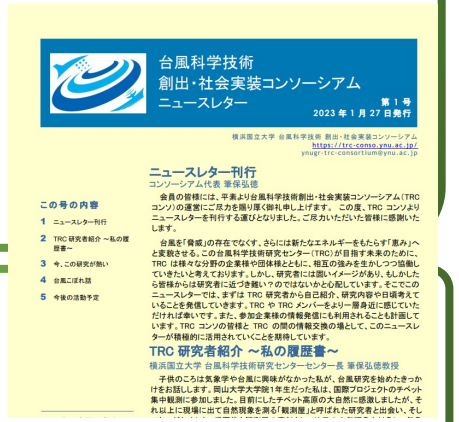
3. MS&AD, InterRisk Research Institute, WEATHERMAP

MS&AD INSURANCE GROUP
weather map
MS&AD
MS&ADインターリスク総研

Each of these companies brings a unique set of expertise, combining their strengths with TRC to carry out research and address the current challenges in typhoon disaster prevention. Together, they are providing innovative ideas and solutions to address these issues.

TRC Consortium

Through collaboration with numerous private companies and academia-government partnerships, the TRC consortium engages in activities to create and implement products and services utilizing typhoon science and technology.


台風科学技術
創出・社会実装コンソーシアム
ニュースレター
第１号
2023 年 1 月 27 日発行

横浜国立大学 台風科学技術 創出・社会実装コンソーシアム
https://trc-conso.ynu.ac.jp/
ynugr-trc-consortium@ynu.ac.jp

この号の内容
1 ニュースレター刊行
2 TRC 研究者紹介 ～私の履歴書～
3 今、この研究が熱い
4 台風こぼれ話
5 今後の活動予定

ニュースレター刊行
コンソーシアム代表 筆保弘徳

会員の皆様には、平素より台風科学技術創出・社会実装コンソーシアム（TRC コンソ）の運営にご尽力を賜り厚く御礼申し上げます。この度、TRC コンソよりニュースレターを刊行する運びとなりました。ご尽力いただいた皆様に感謝いたします。

台風を「脅威」の存在でなくす、さらには新たなエネルギーをもたらす「恵み」へと変換させる、この台風科学技術研究センター（TRC）が目指す未来のために、TRC は様々な分野の企業様や団体様とともに、相互の強みを生かしつつ協働していきたいと考えております。しかし、研究者には固いイメージがあり、もしかたら皆様からは研究者に近づき難い？のではないかとも心配しています。そこでこのニュースレターでは、まずは TRC 研究者から自己紹介、研究内容や日頃考えていることを発信していきます。TRC や TRC メンバーをより一層身近に感じていただければ幸いです。また、参加企業様の情報発信にも利用されることも計画しています。TRC コンソの皆様と TRC の間の情報交換の場として、このニュースレターが積極的に活用されていくことを期待しています。

TRC 研究者紹介 ～私の履歴書～
横浜国立大学 台風科学技術研究センターセンター長 筆保弘徳教授

子供のころは気象学や台風に興味がなかった私が、台風研究を始めたきっかけをお話しします。岡山大学大学院1年生だった私は、国際プロジェクトのテペット集中観測に参加しました。目前にしたテペット高原の大自然に感激しましたが、それ以上に現場に出て自然現象を測る「観測屋」と呼ばれた研究者と出会い、そし

Newsletter distribution

Started in February 2022 (monthly)

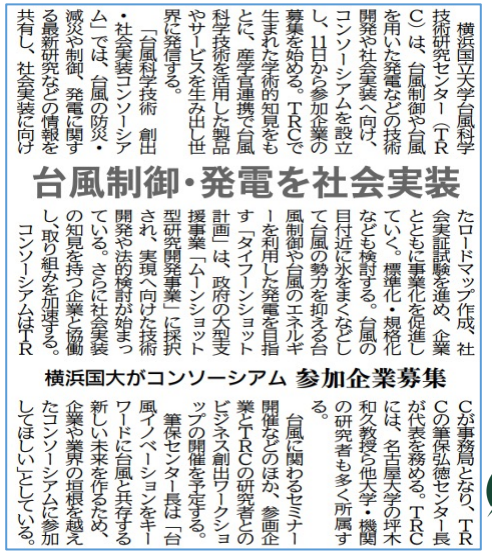
Study sessions

Des. 16. 2022

We can have discussions not just with researchers, but also with TRC members from various backgrounds.

Former Director-General of the JMA (center) is now a member of TRC.

The Nikkan Kogyo Shimbun 2023/2/11


横浜国立大学台風科学技術研究センター（TRC）は、台風制御や台風を用いた発電などの技術開発や社会実装へ向け、コンソーシアムを設立し、11日から参加企業の募集を始める。TRCで生まれた学術的知見をもとに、産学官連携で台風科学技術を活用した製品やサービスを生み出し世界に発信する。

「台風科学技術 創出・社会実装コンソーシアム」では、台風の防災・減災や制御、発電に関する最新研究などの情報を共有し、社会実装に向けたロードマップ作成、社会実証試験を進め、企業とともに事業化を促進していく。標準化・規格化なども検討する。台風の目付近に氷をまくなどして台風の勢力を抑える台風制御や台風のエネルギーを利用した発電を目指す「タイフーンショット計画」は、政府の大型支援事業「ムーンショット型研究開発事業」に採択され、実現へ向けた技術開発や法的検討が始まっている。さらに社会実装の知見を持つ企業と協働し、取り組みを加速する。

台風制御・発電を社会実装

横浜国大がコンソーシアム 参加企業募集

コンソーシアムはTRCが事務局となり、TRCの筆保弘徳センター長が代表を務める。TRCには、名古屋大学の坪木和久教授ら他大学・機関の研究者も多く所属する。

台風に関するセミナー開催などのほか、参画企業とTRCの研究者とのビジネス創出ワークショップの開催を予定する。

筆保センター長は「台風イノベーションをキーワードに台風と共存する新しい未来を作るため、企業や業界の垣根を越えたコンソーシアムに参加してほしい」としている。

Established in Nov. 2022

16 companies

are participating as of Sep. 2023

MS&AD INSURANCE GROUP
Kawasaki
FUJITSU
TOKIO MARINE
D.
OBAYASHI
GLOBAL DX
GuyCarpenter
KDC KANSAI DESIGN COMPANY, LTD. 関西設計株式会社
IHI
日本気象協会
東京海上研究所
JGC
SOTETSU
MS&AD
SoftBank
MS&ADインターリスク総研

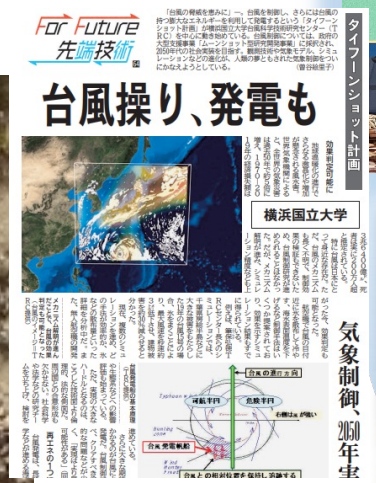
TRC Outreach: Media Coverage and TV Appearances

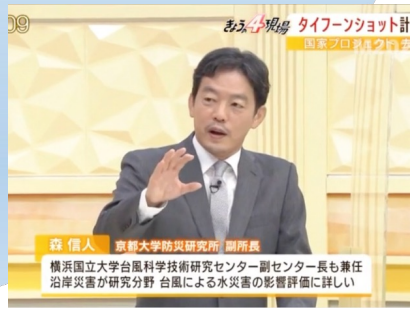
TRC has established a specialized outreach team and are actively engaging in outreach efforts.

Within 2022 and 2023

35 TV and radio programs

57 newspaper articles **9** magazines





The societal interest in TRC is high, resulting in a significant number of media interviews and appearance requests. Coverage through media provides us with invaluable opportunities to communicate with the general public.

TRC Outreach: Lectures, Symposium and Communication

Public Lectures

TRC Typhoon Academy
~The most useful typhoon lesson in the world~

Jun to Nov 2022 and Jun to Sep 2023 held monthly, total participation of 1,600 individuals.

Every month, different TRC members take turns to teach in open spaces, allowing us to spread our knowledge and expertise.

Symposium

National disaster prevention event
BOSAI KOKUTAI 2023

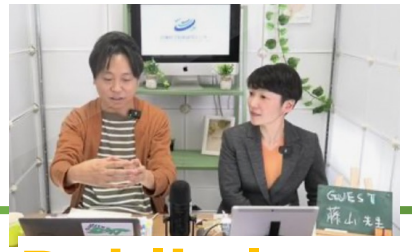
We received a special message for TRC from the former Prime Minister.

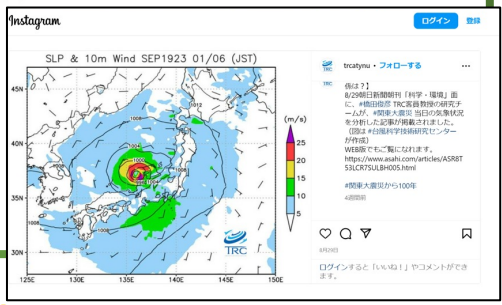
Participation in Bousai Kokutai, the largest, with over 16,000 attendees
TRC held a symposium and set up a booth there.

Communication via SNS

X(Twitter, approx.2300 followers)

Our outreach that we are initiating is not just physical. We're also active on social media platforms, where we share our initiatives and updates.





Public lesson

More than 20 public lessons held in the first year and a half since opening

Lecture for 120 first-year students at YNU.

We're hosting numerous events for school children to ensure they have the knowledge for a safer future.