ESCAP/WMO
Typhoon Committee

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TYPHOON COMMITTEE

# Newsletter

Special Edition - 2nd Semester 2021

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

WORLD METEOROLOGICAL ORGANIZATION

# 16th Online Integrated Workshop

The ESCAP/WMO Typhoon Committee (TC) at its 53rd Online Session decided to convene the 16th Integrated Workshop (16th IWS) in 2021 in ESCAP facility in Bangkok, Thailand. Due to the still ongoing COVID-19 pandemic and the complication arising from mutant strain cases around the world, it was recommended that the 16th IWS would be conducted virtually, from 2-3 December 2021, following the consultation with the Advisory Working Group (AWG) and approval from the TC Chairs, it was decided to adopt “Strengthening Impact-based Forecasting for Improving the Capacity of Typhoon-related Disaster Risk Reduction” as the main theme for the 16th IWS.

Once 16IWS is virtually held, this newsletter edition with focus on the technical presentations made during the online workshop.

On the left, 16IWS group photo and working groups parallel meeting photos

## 1. Tropical Cyclone Probabilistic Forecast Products Project" - Dr Hui YU, Shanghai Typhoon Institute/ CMA; Member of Working Group on Tropical Meteorology Research/WMO Research Board, China

WORLD METEOROLOGICAL ORGANIZATION

WWRP WORLD WEATHER RESEARCH PROGRAMME

# WMO Tropical Cyclone-Probabilistic Forecast Products (TC-PFP) Pilot Project

Hui YU
Shanghai Typhoon Institute/CMA, WGTMR member

**Project Team:**
**Chair:** Jason Dunion, University of Miami/CIMAS – NOAA/AOML/HRD, WGTMR member
**Members:** Raghavendra Ashrit (NCMRWF India), Chris Davis (NCAR), Estelle De Coning (WMO), Anne-Claire Fontan (WMO), Helen Greatrex (Penn State Univ), John Methven (Univ of Reading), Helen Titley (UK Met Office), Munehiko Yamaguchi (WMO), Hui Yu (Shanghai Typhoon Institute, CMA), Zhuo Wang (Univ of Illinois)



## TC-PFP Pilot Project - Motivation

**9th International Workshop on Tropical Cyclones (IWTC-9), Honolulu, HI. Dec 2018.**

IWTC: a part of the WMO major quadrennial symposia & workshops

- To bring forecasters and researchers together to summarize TC-related activities (operational forecasts, research outcomes, etc) during the four years between two adjacent events and make recommendations for future challenges.


## TC-PFP Pilot Project - Motivation

- IWTC-9 recommendations (a total of 35):
  - 19. Consider working toward **replacing static cones** of uncertainty **with dynamic types**, which can be **ensemble-based** or **hybrid statistical** and **dynamical techniques**.
  - 20. Include **social science aspects** and **knowledge of ensemble and uncertainty** as (mandatory/desirable) components of **basic meteorological training** under WMO.
  - 21. **Encourage access to forecast data** (deterministic and ensemble; global/regional) and international data sets, particularly **TIGGE**, to **facilitate** research and operational **use of ensemble forecasts**.
  - 35. Encourage the opportunity for major interdisciplinary research activity in the Asian Region aimed at improving the information available to typhoon forecasters and providing the research needed to **enhance** the **communication** and **utility of typhoon warnings**. This should be a **pilot project for the seamless Global Data Processing and Forecasting System** ...

*Explore the use of dynamic cones of uncertainty that incorporate model ensemble information and integrate social science & basic meteorological training*

# TC-PFP Pilot Project – Overview

**What is the Goal of the TC-PFP Project?**

- To coordinate across RSMCs and other forecast & NWP centers to identify best practice guidance for probabilistic tropical cyclone forecasts.

**Where does the TC-PFP Project fit within WMO?**

- Under the umbrella of the Typhoon Landfall Forecast Demonstration Project (TLFDP), led by the WWRP Working Group on Tropical Meteorology Research (WGTMR)
- A pilot project of WMO Seamless Global Data-processing and Forecasting System (S/GDPFS)

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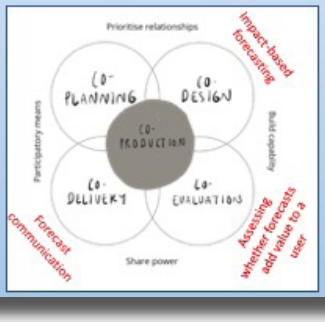
# TC-PFP Pilot Project – Overview

- This effort will be implemented in 3 phases, with an initial focus on Phase 1:
  - **Phase 1:** Work with forecast centers to identify best practices of a value-cycle approach to probabilistic forecasts of **TC formation and position**.
  - **Phase 2:** Work with forecast centers to identify best practices of a value-cycle approach to probabilistic forecasts of **TC intensity and structure**.
  - **Phase: 3:** Work with forecast centers to identify best practices of a value-cycle approach to probabilistic forecasts of **TC-related rainfall and storm surge**.

- Value cycle approach
  - Users are not "end users" but rather valuable partners in co-designing product information that is useful for a variety of situations.
  - Collaborating with WMO's Societal & Economic Research Applications (SERA) group

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# TC-PFP Pilot Project – Status

*Phase 1: Tropical Cyclone Formation and Position*

## Project Accomplishments

1) **Identify RSMCs and forecast centers** that might be interested in this effort (Jan-Feb 2021)
2) Reach out to RSMCs and forecast centers to **learn more about their current efforts & future plans** to produce probabilistic forecasts, their customers, **their various forecast challenges**, and to **gauge their interest** in this project (Feb-May 2021)
3) **Plan a WMO-sponsored workshop** that focusses on identifying best practice guidance for probabilistic forecasts of TC formation and position and invite interested forecast and NWP centers to participate (a 3-day virtual workshop was held on June 15, 17-18, 2021)

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# 2021 TC-PFP Workshop (15, 17-18 Jun 2021)

**Workshop Goal:**

- Coordinate across RSMCs and other centers to identify best practice guidance for probabilistic forecasts of TC formation and position…help us identify what directions we want to go with this effort.

**Workshop Format (keynote presentations >> breakout groups >> plenary discussions)**

- Day-1: Tue 15 June, 1230-1430 UTC
  - Topic: Current & planned probabilistic forecast products
  - Invited presentation by Andrew Burton (BoM Australia) and Jonathan Vigh (NCAR)
- Day-2: Thu 17 June, 1230-1430 UTC
  - Topic: Understanding & communicating probabilistic forecasts
  - Invited presentation by Helen Greatrex (Penn State Univ) and Mark DeMaria (CIRA/Colorado State Univ)
- Day-3: Fri 18 June, 1230-1430 UTC
  - Topic: Resources for producing probabilistic forecasts
  - Invited presentation by Helen Titley (UK Met Office), Fernando Prates (ECMWF), and Ryan Torn (Univ at Albany-SUNY)

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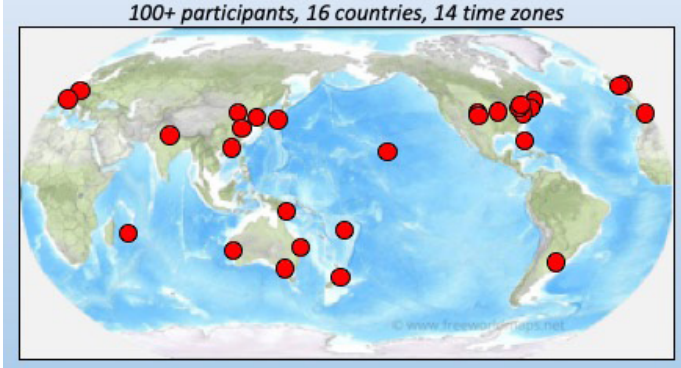
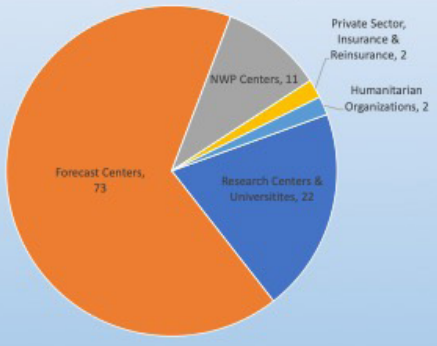
# 2021 TC-PFP 3-day Workshop: 15, 17-18 June 2021

2021 TC-PFP Workshop Participants

*100+ participants, 16 countries, 14 time zones*



TC-PFP Workshop Participants

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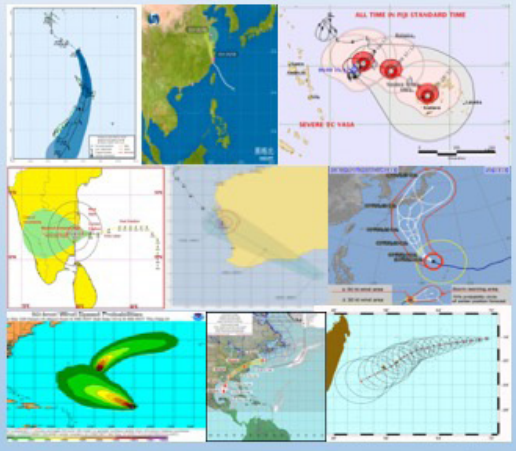
# Sample of Current Operational TC Track Forecast Products

(Extracted from the presentation by Andrew Burton and Jonathan Vigh on 15 June, 2021)

- Most centers use cones/circles to express forecast uncertainty
- The size of the cones/circles is determined in several different ways.
  - Subjective assessment - New Zealand MetService
  - Static cones based on past performance – HKO, CMA, RSMC Nadi, RSMC New Delhi, JTWC
  - Climatological cones with subjective modification – CHC
  - Objective statistical ensemble approach – RSMC Miami
  - Dynamical approach – RSMC Tokyo
  - Hybrid statistical-dynamical approach – RSMC La Reunion, BOM



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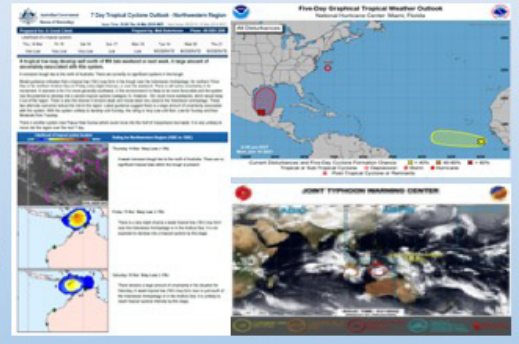
## Thoughts About Operational TC Genesis Forecast Products

(Extracted from the presentation by Andrew Burton and Jonathan Vigh on 15 June, 2021)

- Formation is a scientifically tougher problem than track
  - Requires disturbance/pre-disturbance tracking
- Cumulative vs. time-based approaches
- Graphical products seem to be key to public understanding
- Machine-readable formats recommended for verification



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## Possible future directions - Physical Science

(based on break-out group discussion notes)

- **Outreach, training and communication of verification to users** will lead to better understanding of probabilistic products.
- Currently, operational forecast products are mainly based on graphics, but **the combination of graphics and text** may be one way to provide users with more appropriate information about various situations, including bifurcation, and to promote the use of ensemble forecasts at operations.
- One approach to promote the use of ensembles may start from **recognizing the value of information of certainty** rather than information of uncertainty (need an incentive to use ensembles).
- In considering best practices, research and development on **calibration** (when ECMWF model is upgraded, TC tracks are generated for Reforecast (20years) 11mem. To be released in future), **weighting, best combinations**, etc. are needed (efforts such as the Lead Center to validate tropical cyclone ensemble forecasts are one solution).

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## Possible future directions - Social Science

(based on break-out group discussion notes)

- **Co-design of products** between the provider and user builds a common understanding of needs, capabilities and limitations. Engagement of social scientists with product design at NHC, Argentina Weather Service is a good example.
- **Various approaches to learn users' needs**: Pre- and post-season meeting/workshop with users, use of social media and AI/ML technologies, post-storm survey and assessment by social scientists.
- While limited resource, **a community-wide approach** with participation of the stakeholders from the public and private sectors, as well as academia and civil society is desirable.

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## Possible future directions - Resources

(based on break-out group discussion notes)

- **Build/improve a database where users can retrieve necessary data in a stable and timeliness manner (could be a cross-cutting effort with Global Data-Processing and Forecasting System: GDPFS).**
- **Data format and preparing necessary software (decoder/encoder) are also very important so that the data can be used by a large number of people, including operational centers, researchers, academia, private sectors etc.**
- **Augmentation of data (e.g., wind radii, genesis) is necessary for successful implementation of the project and promote R2O transfer (WWRP/TIGGE panel takes a lead).**

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## *What's next for TC-PFP*

1. A post workshop survey was sent to workshop participants (October 2021)
   - Collect comments & suggestions re: the format, break-out groups, etc.
   - Understand what worked well and identify areas for improvement
2. A writing team will develop the best practice guidance
   - Guidance based on the workshop discussions and the post-workshop survey
     - *Participants were contacted in early Nov to gauge their interest in joining a writing team*
3. Guiding a WMO-funded project to address scientific work related to TC-PFP
   - Project goal: quantify, in a few pertinent model ensemble systems, the impact of different TC tracking methods (i.e., trackers) on forecasts of storm track & intensity
   - PI: John Methven, University of Reading, UK
4. A project summary will be presented at IWTC-10 in Dec 2022
   - A session will be scheduled on TC-PFP at IWTC-10
   - By IWTC-10, TC-PFP will transit from Phase 1 to Phase 2 (TC **intensity & structure**)

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## *Thank You*


The WMO WWRP TC-PFP project highlighted in the October 2021 issue of WMO's *MeteoWorld*: https://public.wmo.int/en/resources/MeteoWorld#tophome

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**2. "Enhancing the capacity of TC members in impact based forecasting for resilience to typhoon" – Mr. Sung Eun Kim, Economic Affairs Officer, Disaster Risk Reduction Section/IDD, United Nations ESCAP**

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# Enhancing the Capacity for Impact-based-Forecasting for Resilience

## Asia Pacific Disaster Resilience Network (APDRN)

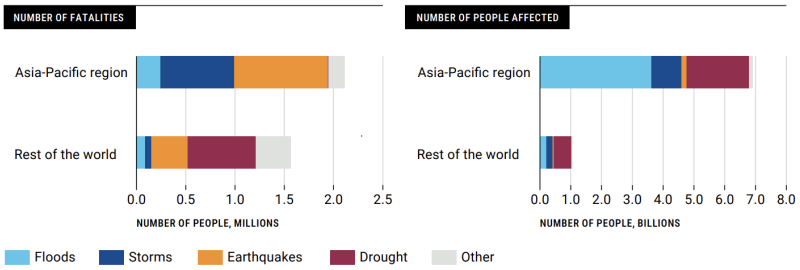
**SungEun KIM**
**Economic Affairs Officer, UN-ESCAP**

**2 December 2021, 16th Integrated Workshop of ESCAP/WMO Typhoon Committee**

**Climate-related hazards have greatly affected countries in the Asia-Pacific region.**

Since 1970, around **half of Asia-Pacific fatalities** and **most of the affected** from natural disasters were from tropical cyclones/floods/droughts.


**Number of fatalities and people affected in the Asia-Pacific region and the rest of the world, 1970-2020**




Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

*ESCAP (2021) Asia-Pacific Disaster Report 2021*

## Number of fatalities has reduced, but number of people affected has not.

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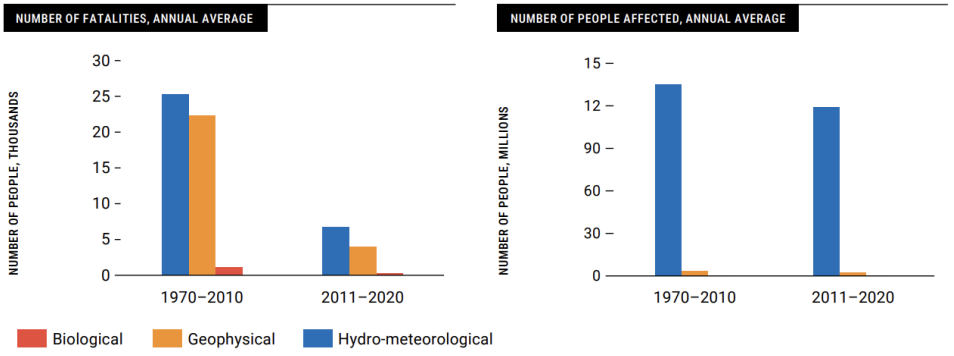
**Number of fatalities and people affected in the Asia-Pacific region, 1970-2020**




Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

*ESCAP (2021) Asia-Pacific Disaster Report 2021*

## Intensity of tropical cyclones in the Western North Pacific…

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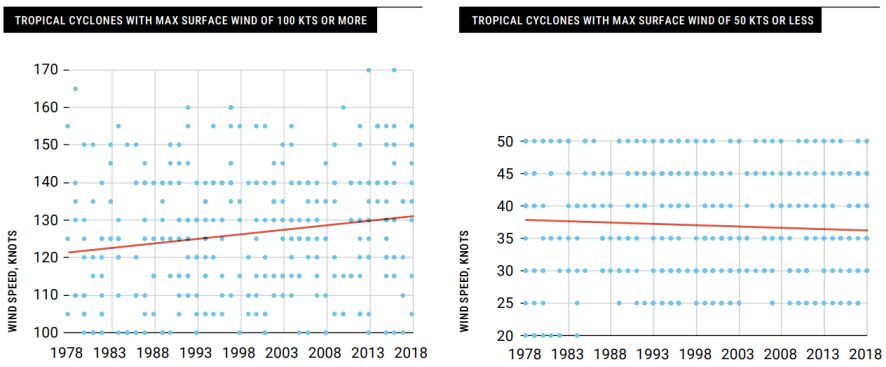
The strongest cyclones, which have a maximum surface wind speed of 100 knots or more, seem to have been getting stronger.

**Wind speeds of tropical cyclones in the Western North Pacific, 1978-2018**




Source: Data from Joint Typhoon Warning Center (JTWC), Annual Tropical Cyclone Reports.

*ESCAP (2021) Asia-Pacific Disaster Report 2021*

## Climate-related hazards converging with COVID-19

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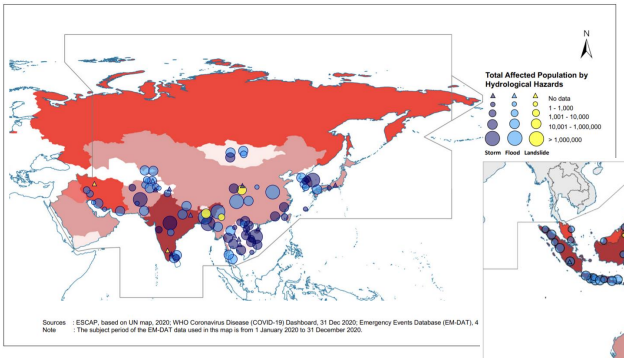
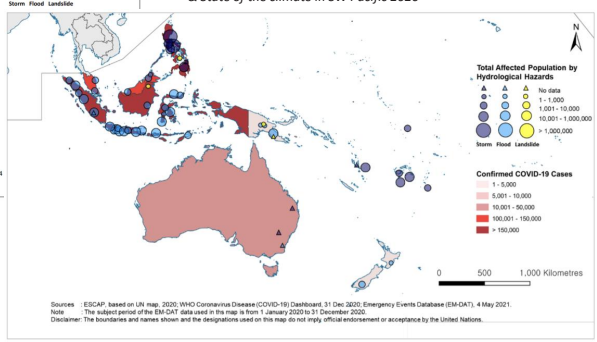



**Impact-based forecasting** can provide valuable information for policymakers, stakeholders and the public to address these risks.

Countries have faced **cascading risks** from the pandemic & other hazards.

*WMO (2021) State of the climate in Asia 2020 & State of the climate in SW Pacific 2020*



## ESCAP mandates

**2015** **ESCAP Resolution 71/12 Strengthening Regional Cooperation Mechanism for the Implementation of the SFDRR 2015-2030 in Asia and the Pacific**

- *To guide actions… **to strengthen** disaster risk modelling, assessment, mapping, monitoring and **multi-hazard early warning systems…**, **particularly those related to hydrometeorological issues**, by deepening existing regional cooperation mechanisms…*

**2017** **ESCAP Resolution 73/7 Enhancing regional cooperation for the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030 in Asia and the Pacific**

- *Continue to support and facilitate **multi-hazard early warning systems**, **impact-based forecasting** and disaster risk assessment to strengthen regional cooperation mechanisms;*

**2021** ***7th Session of ESCAP Committee on Disaster Risk Reduction*** *& 3rd ESCAP Disaster Resilience Week*

- Thematic expert meeting **on the implementation of the health aspects of the Sendai Framework** for Disaster Risk Reduction – **recognized impact-based forecasting as an important measure**
- *Committee recommended … to promote multi-hazard early warning systems, including through **impact-based forecasting approach for the detection of hazards with reasonable lead time**…*

## Impact-based forecasting

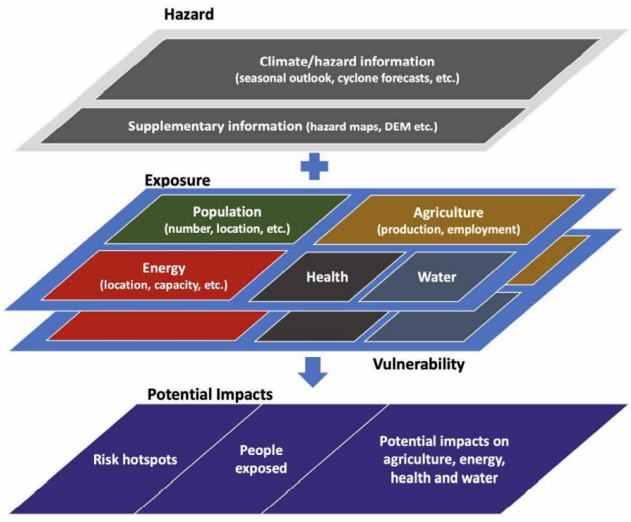
- A structured approach for **combining hazard, exposure and vulnerability data** to **identify risk** and support decision-making
- Moving from broadcasting ***what the weather will be*** to ***what the weather will do***
- Synthesizing weather information with exposure and vulnerability information to **identify the range of risks faced over an area**
- Impact-based forecasting, in different timescale, can help decisions of relevant stakeholders.


*Source: ESCAP(2018) Asia-Pacific Disaster Report 2017*

## ESCAP approach for Impact-based Forecasting

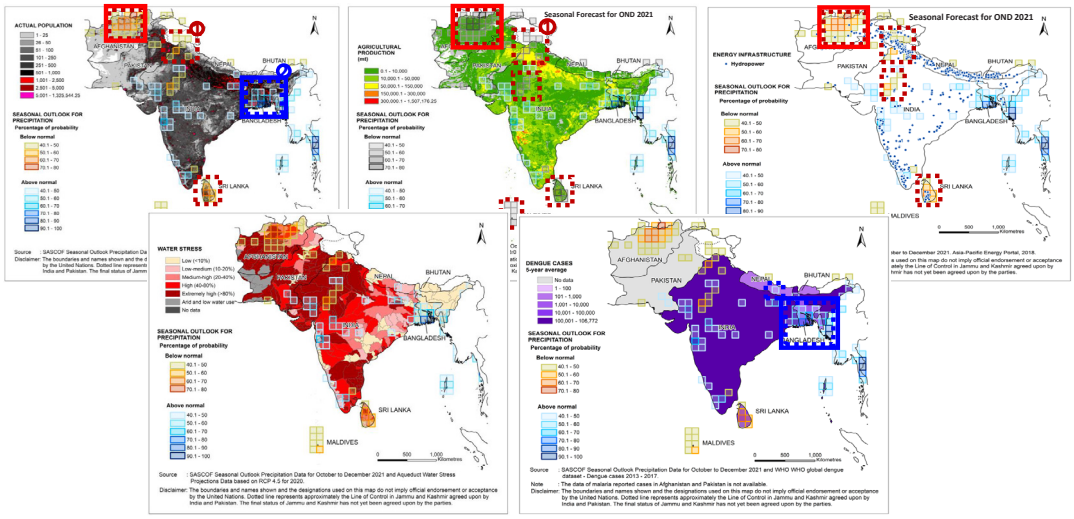
**Global Framework for Climate Services of WMO**
(https://gfcs.wmo.int/)

**Priority areas**
- Agriculture and food security
- Disaster risk reduction
- Energy
- Health
- Water



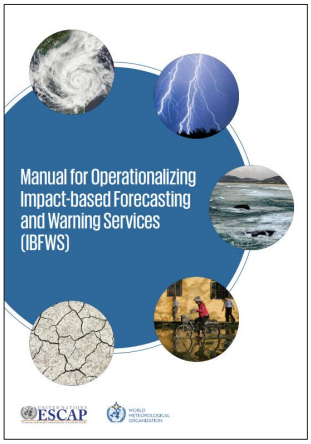

Source: ESCAP (2021) Overview of the work of secretariat and the UN system at the regional level. ESCAP/CDR/2021/INF/1

## Demonstrative cases of impact-based forecasting for various sectors




## Asia-Pacific Disaster Resilience Network (APDRN) products

### Training Manual and Working papers on IBF





**Available at** https://www.unescap.org/kp?f%5B0%5D=kp_category_facet%3A329

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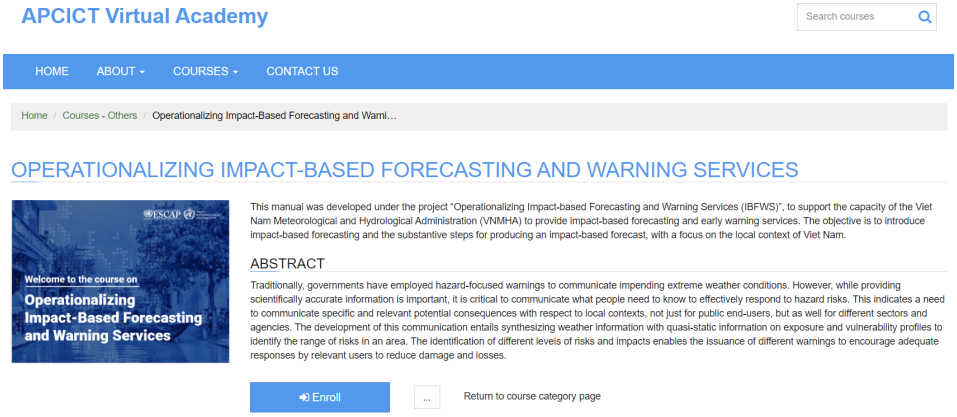
## E-learning course for IBFWS




***https://e-learning.unapcict.org/courses/detail?id=55***

## Bridging the science policy gap for informed action

RISK AND RESILIENCE PORTAL
An Initiative of the Asia Pacific Disaster Resilience Network


***https://rrp.unescap.org/***

# Thank you

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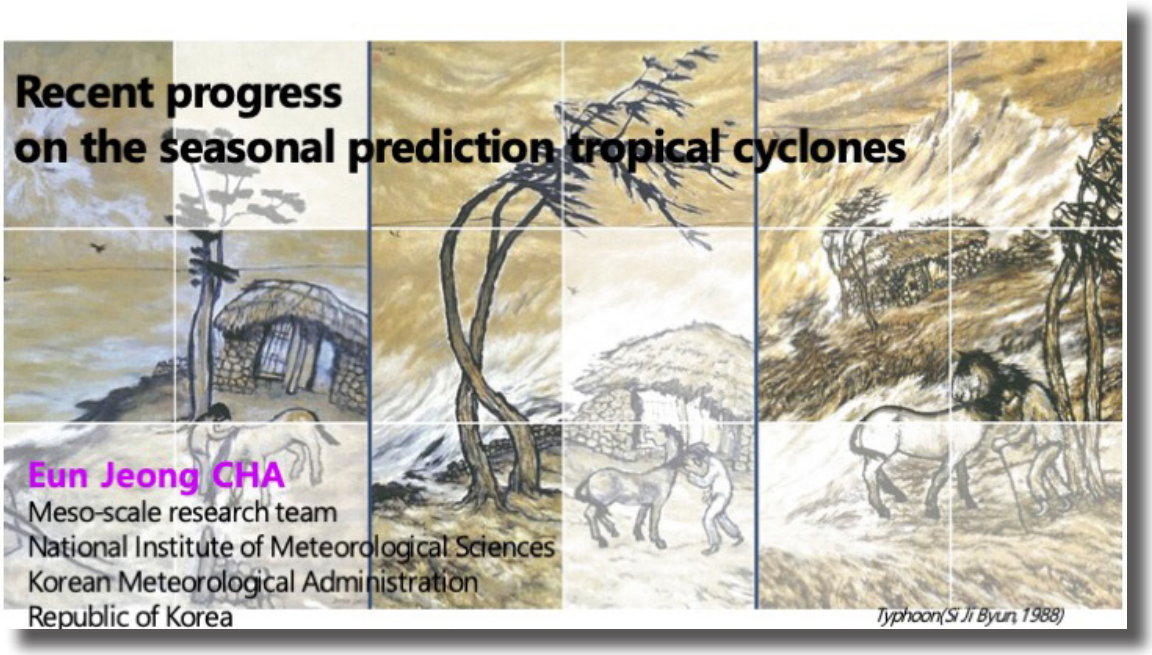
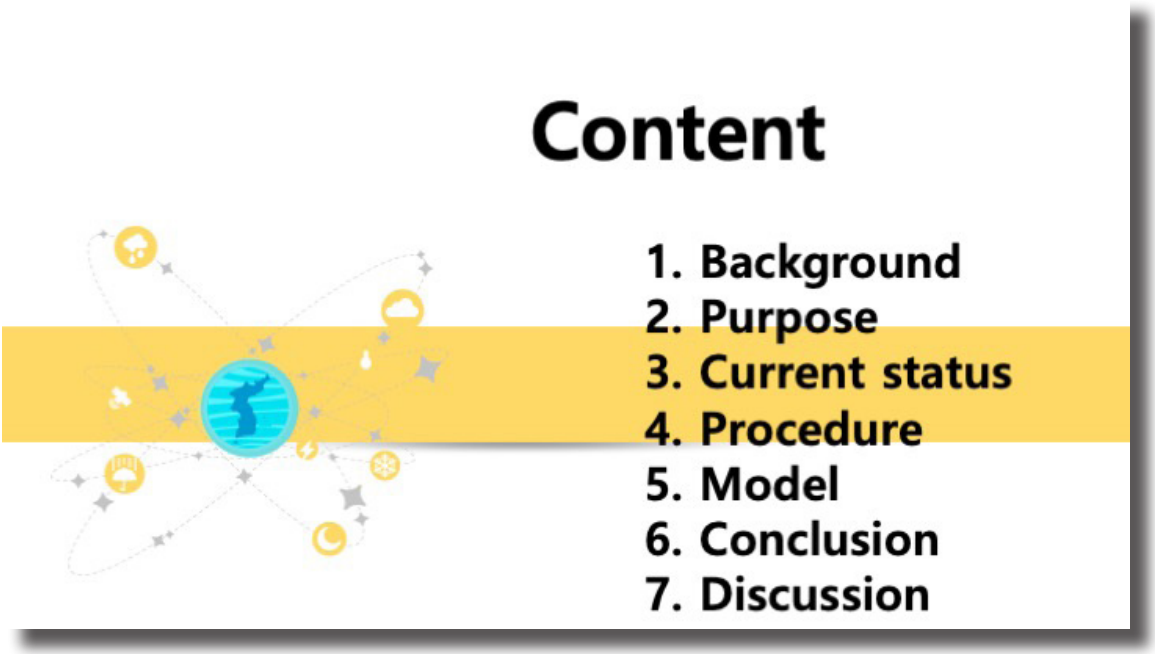
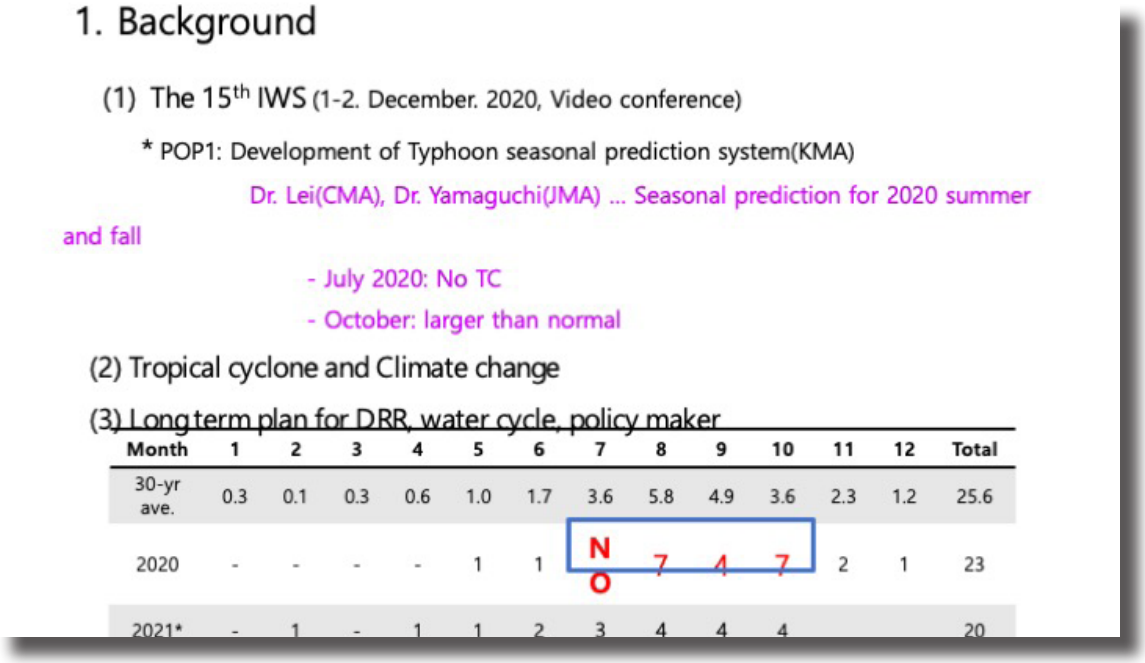
**3. "Recent progress and validation on the official seasonal tropical cyclones prediction of KMA" – Dr. Eun Jeong CHA, Head, Research Team of Meso-Scale, National Institute of Meteorological Sciences, Korea Meteorological Administration, Republic of Korea**



## 2. Purpose

- Review the current status of the seasonal TC predictions
- Suggestion for new research topics

## 3. Current status

(Klotzbach et al. 2019, TCRR)
Seasonal tropical cyclone forecasting

(1) Statistical model
(2) Statistical-Dynamical model(hybrid model)
(3) Dynamical model

| Forecast Agency | TC Basins Predicted | Metrics Forecast | Techniques Used | Forecast Website |
|---|---|---|---|---|
| Colorado State University | North Atlantic | Basinwide activity; Continental US and Caribbean landfall probability | Statistical, Statistical-Dynamical | http://tropical.colostate.edu |
| National Oceanic and Atmospheric Administration | North Atlantic, Eastern North Pacific | Basinwide activity | Statistical, Statistical-Dynamical, Dynamical | https://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml |
| Tropical Storm Risk | North Atlantic, Western North Pacific | Basinwide activity; Continental US landfalling activity; Caribbean Lesser Antilles landfalling activity | Statistical | https://tropicalstormrisk.com |
| UK Met Office | North Atlantic, Eastern North Pacific, Western North Pacific, South Indian, Australia, South Pacific | Basinwide activity<br>Global map for increased/decreased risk of tropical cyclone tracks | Dynamical | https://www.metoffice.gov.uk/weather/tropical-cyclone/ |
| Australian Bureau of Meteorology/University of Melbourne | Australia, South Pacific | Australian region and sub-region activity; South Pacific Region and sub-region activity | Statistical | Australia: http://www.bom.gov.au/climate/cyclones/australia/archive.shtml<br>South Pacific: http://www.bom.gov.au/climate/cyclones/south-pacific/archive.shtml |
| City University of Hong Kong | Western North Pacific | Basinwide activity; Landfall numbers for 3 sections of East Asian coast | Dynamical | http://weather.cityu.edu.hk/tc_forecast/forecast.htm |
| Hong Kong Observatory | Western North Pacific | Annual number of tropical cyclones within 500 km of Hong Kong | Statistical, Statistical-Dynamical, Dynamical | https://www.hko.gov.hk/wxinfo/seasonal/seasonal.htm |
| European Centre for Medium-Range Weather Forecasts | North Atlantic, Eastern North Pacific, Western North Pacific, South Indian, Australia, South Pacific | Basinwide activity<br>Global map of increased/decreased risk of tropical storm strike probability | Dynamical | https://www.ecmwf.int/en/forecasts/charts<br>Only available to member countries and commercial users. |
| Geophysical Fluid Dynamics Laboratory | North Atlantic, Eastern North Pacific, Western North Pacific | Basinwide major hurricane activity; Continental US landfalling activity; East Asian landfalling activity | Statistical-Dynamical, Dynamical | Only available internally to forecasters at NOAA |
| Japan Meteorological Agency | Western North Pacific | Basinwide activity and sub-region activity | Dynamical | Only available internally to forecasters at the Japan Meteorological Agency |
| Shanghai Typhoon Institute of China Meteorological Administration | Western North Pacific | Basinwide activity; Number of TCs making landfall in China and affecting subregions | Statistical, Statistical-Dynamical, Dynamical | Only available internally to forecasters at the China Meteorological Administration |
| National Typhoon Center/Korea Meteorological Administration | Western North Pacific | Basinwide activity (number, intensity, track); Annual number of tropical cyclones affecting the Korean peninsula | Statistical, Statistical-Dynamical, Dynamical | Only available to the fourteen member countries under the ESCAP/WMO Typhoon Committee's biennial operating plan. |

## Main Mechanism of the TC seasonal prediction

1. Neville Nicholls (1979, 1984, 1985) initiated seasonal TC forecasts at the Australian Bureau of Meteorology for the Australian region, and William Gray (1984a, b) started seasonal TC forecasts at Colorado State University for the Atlantic Basin.
2. Chan et al. (1998, 2001) expanded seasonal predictions to the WNP. These researchers developed statistical models based on the **relationships between TC activity and factors such as sea surface temperature (SST) and monsoons.**
3. Vitart et al. (1997) and Vitart and Stockdale (2001) introduced a hybrid statistical–dynamical forecast that uses model-predicted SSTs for seasonal Atlantic TC predictions.
4. Many operational organizations currently use statistical–dynamical models for seasonal TC forecasts.

## 4. Procedure

1. Analyzing the current characteristics of atmospheric and oceanic variables related to TC activity, such as SST, monsoons, convection, Madden–Julian Oscillation (MJO), and circulation of the Pacific High and the Tibetan High.

2. Finding years with climatological characteristics similar to those of the current year based on step (i), such as El Niño/La Niña years and strong/weak monsoon activity.

3. Examining the results of four models: a statistical model, a dynamical model, and statistical–dynamical models Ⅰ and Ⅱ.

4. Comparing the forecasts of other organizations, such as the European Center for Medium -Range Weather Forecasts, Tropical Storm Risk, Hong Kong University, and the International Research Institute for Climate and Society.

5. Preparing a seasonal forecast draft, discussing it at a joint climate–TC expert meeting, and making the final decisions.

6. Releasing the seasonal TC forecast in the third week of May for summer and in the third week of August for fall

7. Evaluating the forecast after the TC season to better understand the discrepancies between the forecasts and observations and improve future predictions.

## 5. Model

| | Statistical | Statistical-dynamical model (I) | Dynamical model | Statistical-dynamical model (II) |
|---|---|---|---|---|
| Developer/References (year) | KMA/Kwon et al. (2007) | KMA/Kim et al., (2012a), Ho et al., (2013) | KMA/KMA (2014) | KMA/Yang et al. (2018) |
| Predictors (Sources) | NCEP reanalysis data (SLP, 500-hPa gpm, 850-hPa T, 850-hPa W, SST) *May- Dec. June-August, July-September August-October September-November for WNP TC frequency *June-August, July-September August-October September-November for KP-influence TC frequency | NCEP CFSv2 dynamic seasonal forecast data (200-hPa W, vertical wind shear, 850-hPa vorticity, SST) | GloSea5 seasonal forecast data (SLP, 10-m W, 300-hPa W, 850-hPa W, 300-hPa T, 500-hPa T, 700-hPa T, 850-hPa vorticity) | GloSea5 seasonal forecast data (SST, SOI) |
| Characteristics | Multiple linear regression model based on ensemble model | NCEP CFSv2 + Track pattern-based model | GloSea5 | GloSea5 + Multiple linear regression model |
| Products | WNP TC frequency, KP-influence TC frequency | WNP TC frequency, Probability of track density | WNP TC frequency, Probability of track density | WNP TC Frequency |

## Validation

(1) Method: Error rate, Tercile probability test, Categorical forecast(Heidke skill)

(2) Period: 2014-2020

(JJA: June-July-August / SON: September-October-November)

### *(1) Error rate(JJA)*

Table 2. Error rates for the number of TCs occurred during summer (JJA) and fall (SON) from 2014~2020. The unit is %. A '-' indicates that no prediction data is available. The underlined numbers indicate the negative error rates. The bold numbers indicate the smallest error rate among the four models for the year

| Season | Year | Observation | Official Prediction | | Model | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Statistical | | Statistical -Dynamical (I) | | Dynamical | | Statistical -Dynamical (II) | |
| | | | Pre. | error rate | Pre. | error rate | Pre. | error rate | Pre. | error rate | Pre. | error rate |
| Summer (JJA) | 2014 | 8 | 10~12 | 25~50 | 12 | 50 | 18 | 125 | 10 | **25** | - | - |
| | 2015 | 9 | 11~14 | 22~55 | 12 | 33.3 | 11.6 | **28.9** | 13.8 | 53.3 | - | - |
| | 2016 | 11 | 7~10 | -(36~9) | 9 | -18.2 | 10.1 | **-8.2** | 7 | -36.4 | - | - |
| | 2017 | 14 | 8~13 | -(42~7) | 10 | -28.6 | 13.1 | **-6.4** | 11.2 | -20 | 8.3 | -40.7 |
| | 2018 | 18 | 9~12 | -(50~33) | 12.2 | -32.2 | 12.2 | -32.2 | 15 | **-16.7** | 9.6 | -46.7 |
| | 2019 | 10 | 11~13 | 10~30 | 11.2 | 12 | 13.6 | 36 | 13.4 | 34 | 10.6 | **6** |
| | 2020 | 9 | 9~11 | 0~22 | 9.2 | **2** | 9.2 | **2** | 14.8 | 64 | 7.1 | -21.1 |

Table 2. Error rates for the number of TCs occurred during summer (JJA) and fall (SON) from 2014~2020. The unit is %. A '-' indicates that no prediction data is available. The underlined numbers indicate the negative error rates. The bold numbers indicate the smallest error rate among the four models for the year

| Season | Year | Observation | Official Prediction | | Model | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Statistical | | Statistical -Dynamical (I) | | Dynamical | | Statistical -Dynamical (II) | |
| | | | Pre. | error rate | Pre. | error rate | Pre. | error rate | Pre. | error rate | Pre. | error rate |
| Fall (SON) | 2014 | 8 | 10~12 | 25~50 | 10.2 | **27.5** | - | - | 11.4 | 42.5 | - | - |
| | 2015 | 10 | 8~12 | 20 | 8.2 | -18 | 13.8 | 38 | 8.8 | **-12** | - | - |
| | 2016 | 14 | 8~12 | -(43~14) | 8 | -42.9 | 13.4 | -4.3 | 14.2 | **1.4** | 8.6 | -38.6 |
| | 2017 | 10 | 9~12 | -10~+20 | 10 | **0** | 13.9 | 39 | 15.4 | 54 | 8.7 | -13 |
| | 2018 | 8 | 9~12 | 13~50 | 10.8 | 35 | 12.5 | 56.3 | 17 | 112.5 | 9.2 | **15** |
| | 2019 | 16 | 9~12 | -(44~25) | 9.9 | -38.1 | 15.2 | **-5** | 13.3 | 16.8 | 8 | -50 |
| | 2020 | 12 | 11~13 | -8~+8 | 10.2 | -21.5 | 13.2 | **1.5** | 14.8 | 13.8 | 6.9 | -46.9 |

### *(2) Tercile probability test(JJA)*

Table 3. Validation results of tercile probability test in summer (JJA) and fall (SON) from 2014~2020. Blank denotes 'Near Normal (NN)'. A '-' indicates that no prediction data is available.

| Season | Year | Observation | | Official Prediction | | Model | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Statistical | | Statistical-dynamical (I) | | Dynamical | |
| Summer (JJA) | 2014 | 8 | BN | 11 | | 12 | | | | 10 | |
| | 2015 | 9 | | 12.5 | | 12 | | 11.6 | | 13.8 | |
| | 2016 | 11 | | 8.5 | | 9 | | 10.1 | | 7 | BN |
| | 2017 | 14 | AN | 10.5 | | 10 | | 13.1 | AN | 11.2 | |
| | 2018 | 18 | AN | 10.5 | | 12.2 | | 12.2 | | 15 | AN |
| | 2019 | 10 | | 12 | | 11.2 | | 13.6 | AN | 10 | |
| | 2020 | 9 | | 10 | | 9.2 | | 9.2 | | 14.8 | AN |

Table 3. Validation results of tercile probability test in summer (JJA) and fall (SON) from 2014~2020. Blank denotes 'Near Normal (NN)'. A '-' indicates that no prediction data is available.

| Season | Year | Observation | | Official Prediction | | Model | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Statistical | | Statistical-dynamical (I) | | Dynamical | |
| Fall (SON) | 2014 | 8 | BN | 11 | | 10.2 | | - | - | 11.4 | |
| | 2015 | 10 | | 10 | | 8.2 | | 13.8 | AN | 8.8 | |
| | 2016 | 14 | AN | 10 | | 8 | BN | 13.4 | AN | 14.2 | AN |
| | 2017 | 10 | | 10.5 | | 10 | | 13.9 | AN | 15.4 | AN |
| | 2018 | 8 | | 10.5 | | 10.8 | | 12.5 | AN | 17 | AN |
| | 2019 | 16 | AN | 11.5 | | 9.9 | | 15.2 | AN | 13.3 | AN |
| | 2020 | 12 | | 12 | | 10.2 | | 13.2 | AN | 14.8 | AN |

***(3) Evaluation of categorical forecasts***

Table 4. The contingency table for tercile probability (AN, NN, BN) comparing observation (Obs) and prediction (Pre). Bold and red values denote correct predictions.

| Pre / Obs | AN | NN | BN | Total |
|---|---|---|---|---|
| AN | **A** | B | C | D |
| NN | E | **F** | G | H |
| BN | I | J | **K** | L |
| Total | M | N | O | **P** |

$$Hit\ Rate = \frac{A+F+K}{P}$$

$$False\ Alarm\ Rate = \frac{(E+I)+(B+J)+(C+G)}{(P-D)+(P-H)+(P-L)}$$

$$Heidke\ Skill\ Score = \frac{(A+F+K)-Climatology}{P-Climatology}$$

Table 5. Verification of seasonal WNP TC predictions in summer (JJA) and fall (SON) from 2014~2020 using various skill score methods. The bold numbers indicate the best of all results for the year.

| Season | Methods | Official prediction | Statistical | Statistical-dynamical (I) | Dynamical |
|---|---|---|---|---|---|
| Summer (JJA) | HR | 0.43 | 0.57 | 0.57 | 0.71 |
| | FAR | 0.29 | 0.21 | 0.21 | 0.14 |
| | HR | -2.54 | -2.4 | -2.4 | -2.14 |
| Fall (SON) | HR | 0.57 | 0.43 | 0.50 | 0.29 |
| | FAR | 0.21 | 0.29 | 0.25 | 0.36 |
| | HSS | 0.32 | 0.09 | 0.21 | -0.14 |

## 6. Conclusion

1. In this study, we described the seasonal WNP TC prediction system of the KMA and evaluated the prediction results for the period 2014–2020. The official forecasts of the KMA are determined based on a combination of climatological data analysis, multiple model results, and expert opinions.
2. The seasonal prediction models use various atmospheric and oceanic variables related to TC activity, such as SST, monsoon, convective activity, and ENSO.
3. The official forecasts are issued in May for summer and in August for fall every year and are available on its website under the POP of the Typhoon Committee.
4. The evaluation showed that the prediction results were diverse, with no dominant trends or consistent results, making it difficult to identify the best model.
5. We also found that all official predictions for JJA over the evaluation period were Near Normal, indicating that all forecasts were within the range of the climatological mean values.
6. Some models also showed biased Neal Normal or Above Normal predictions. Especially for JJA, the HSSs showed that the official and the models' forecasts were not skillful.

## 7. Discussion

1. The statistical model should be updated using smarter predictors of WNP TC frequency trained on larger datasets that include recent data.

2. Ensemble averaging methods of the statistical model that can smooth the number of predicted TCs, reduce variability, and ultimately produce unskillful forecasts should be avoided.

3. Research into the atmospheric/oceanic environments and climate indices that affect TC activity in the WNP should continue.

4. The changes in TC activity due to climate change related to global warming should be investigated.

5. Statistical models should be established by subdividing the predictands to consider intra-basin differences in the relationships between WNP TCs and environmental variables.

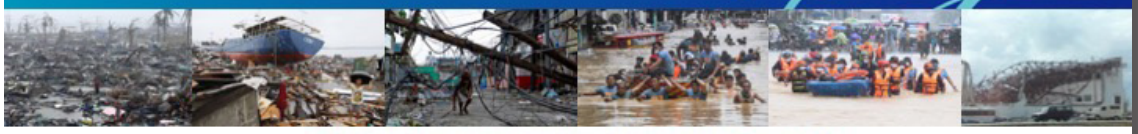
6. Case studies should be enhanced to accumulate experience of extreme events, such as ENSO years and the highest TC frequency years.

7. New technologies, such as artificial intelligence, should be introduced.

Department of Science and Technology (DOST)
Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

# Impact-Based Forecasting (IBF) in the Philippines:

## A Forecast Paradigm



ESCAP/WMO Typhoon Committee 16th Integrated Workshop, 02-03 December 2021

**LORENZO A. MORON**
Senior Weather Specialist
DOST-PAGASA

*.... towards informed, risk-free and resilient community!*

WMO Met Office

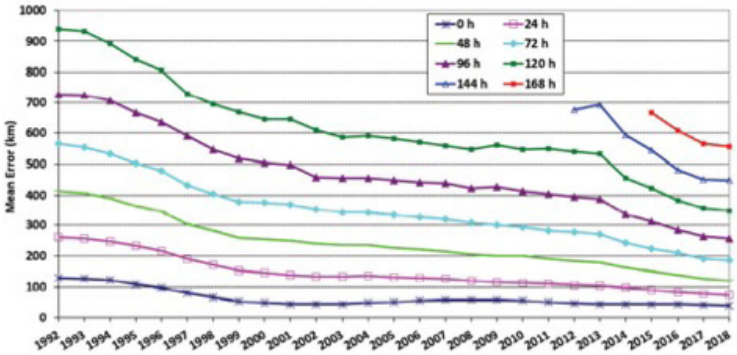
## What's inside?

- Introduction
- Highlights of IBF Development: The 6Ps
- Pilot Testing
- Benefits
- Challenges
- Way Forward

## Question: Why do good forecast result in a poor response?

**Although weather forecasting has significantly improved over time....**

Northern Hemisphere 5-year running mean
Tropical Cyclone Forecast Positional Errors



## For example…

Typhoon *Haiyan* (Phillippines)

- Although **ACCURATE** warnings were issued by PAGASA….
- Although the potentials for ***heavy rainfall***, ***severe wind*** and ***storm surges*** were explicitly stated and the regions to be most likely be affected….

But **WHAT HAPPENED???**

- 6,201 dead, 28,626 injured and 1,785 missing.
- More than sixteen million affected and more than US$827 million estimated for the damage of infrastructure and agriculture (NDRRMC 2014).

Were the **WARNINGS enough???**

Or the **IMPACTS** was not properly considered and/or was underestimated, and the response was inadequate…??

- Had there been *better knowledge of the risks*, particularly of the **storm surge**, it is likely that more extensive evacuations from exposed areas could have taken place sooner. *(Not enough knowledge of storm surge impacts)*

---

It is no longer enough to provide a ***good weather forecast or warning*** – people are now ***demanding information about what to do*** to ensure their safety and protect their property…

**WMO(2015)**

WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services

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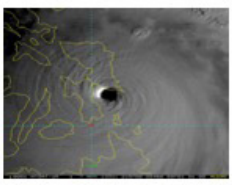
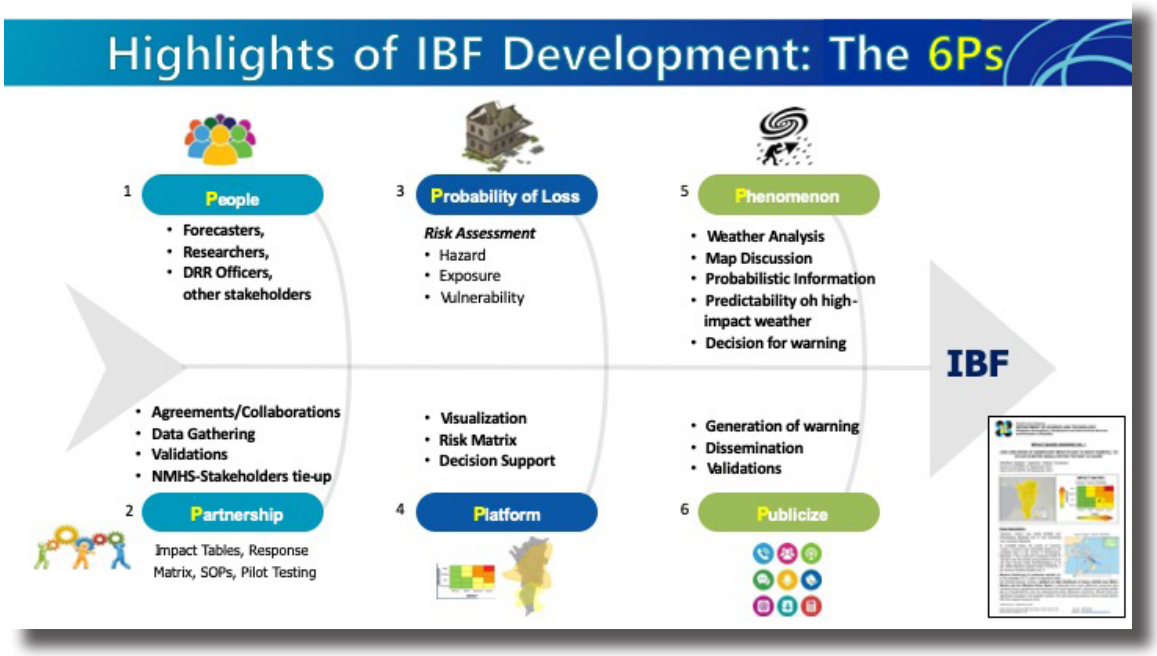
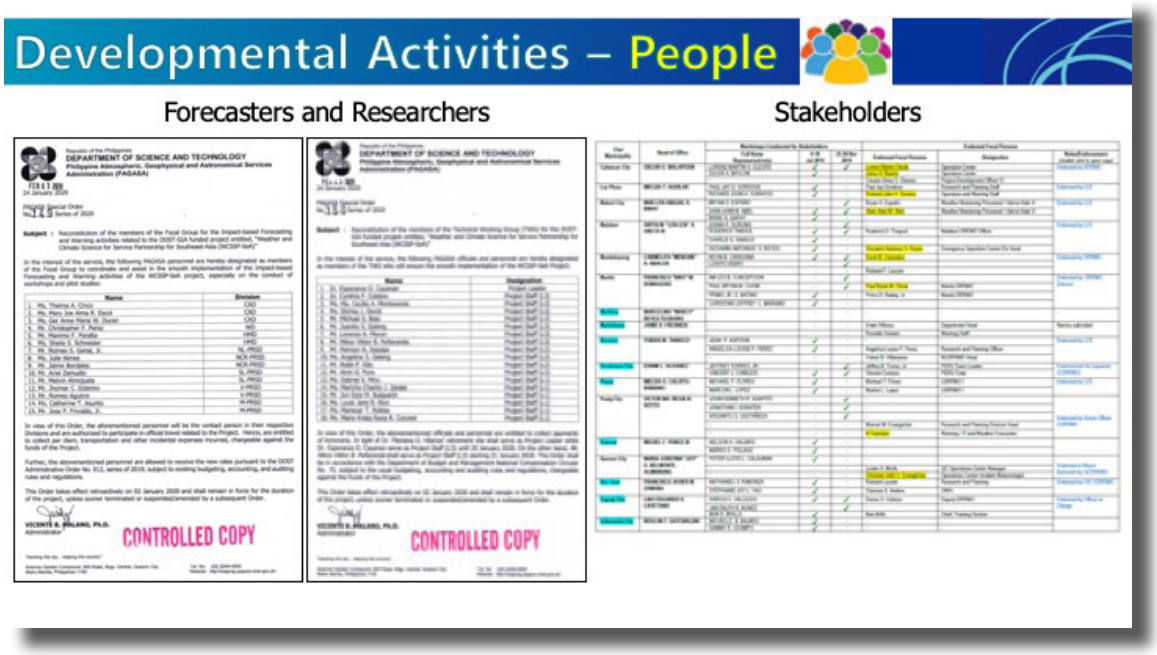
## IMPACT-BASED FORECASTING AND EWS MODEL

Transforming from "What the Weather will Be" to "What the Weather Will Do"

| Weather and climate extremes | Weather translation to hazards | Impact Estimation | Early actions and early response |
|---|---|---|---|
| Weather analyses & forecast data | Extraction of relevant information to predict hazards | Placing into situational context | Mitigation & Financing |
|  |  |  |  |
| Tropical cyclone track, size, & intensity | Storm surge, flooding, rain-induced landslide | Affected areas, population & infrastructure, disruption of services, damage due to wind & flood | Pre-emptive evacuation, early harvesting, house strengthening, release of emergency funds, cash transfer |


Highlights of IBF Development: The 6Ps
1 People
• Forecasters,
• Researchers,
• DRR Officers, other stakeholders
2 Partnership
• Agreements/Collaborations
• Data Gathering
• Validations
• NMHS-Stakeholders tie-up
Impact Tables, Response Matrix, SOPs, Pilot Testing
3 Probability of Loss
Risk Assessment
• Hazard
• Exposure
• Vulnerability
4 Platform
• Visualization
• Risk Matrix
• Decision Support
5 Phenomenon
• Weather Analysis
• Map Discussion
• Probabilistic Information
• Predictability oh high-impact weather
• Decision for warning
6 Publicize
• Generation of warning
• Dissemination
• Validations
IBF


Developmental Activities – People
Forecasters and Researchers
Stakeholders
DEPARTMENT OF SCIENCE AND TECHNOLOGY
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Developmental Activities - Partnership
Workshops and Consultative Meetings
Meeting with MMDRRMC
Meeting with MMDA
Meeting with PAGASA IBF TWG

## Developmental Activities - Partnership

- Creation of PAGASA Focal Group
- Development of a Prototype IBF System (PAGASA, 19-21 March 2018)
- Development of IBF System with the Focal Group (PAGASA, 19-20 Feb. 2019)
- Development of IBF System-Metro Manila (Q.C., 09-10 Jul 2019)
- Development of IBF System-Metro Manila (Q.C., 09-10 Jul 2019)

## Developmental Activities - Partnership


## Developmental Activities - Partnership

Impact Table: **Severe Wind**

| SECTOR | Minimal/ Very Low | Minor/ Low | Significant/ Medium | Severe/High |
|---|---|---|---|---|
| EDUCATION | No damage<br>Business as usual | Classes interrupted per local government discretion<br>Business as usual | Classes interrupted per local government discretion | Classes interrupted per flooding or state of calamity<br>Classes interrupted until recovery |
| POWER | No damage, business as usual<br>No damage | Power interruption for few hours<br>Power interruptions are experienced in few areas<br>Old electrical post are tilted or downed | Power interruption for few days<br>Some areas are experiencing power black out<br>Several electrical posts/signs/billboards are blown/downed<br>Interruption of power services for few hours to few days | Power interruption for few day to weeks<br>Prolonged power blackout<br>Potentially all electrical posts/signs/billboards are blown/downed<br>Prolonged interruption of power services for several days |
| STRUCTURES (Light) | No damage<br>No damage to houses/ structures made from light materials | Partial damage to houses/ structures made of light material<br>No damage<br>Slight damage to houses/ structures made from light materials | Significant damage to houses/ structures made of light material<br>(Minimal) cracks in glass windows<br>Some portions of roof are removed<br>Partial damage to houses/structures made from Light materials | Heavy damages to houses/ structures made of light materials<br>Major cracks in glass windows<br>Major or total removal of roof<br>Total damage to houses/structures made from Light materials |
| STRUCTURES (Heavy) | Minimal to no damage | Few detached materials are being observed | Some roof and wall are removed | Roof and wall totally removed |
| OTHER STRUCTURES (Billboards, etc.) | No damage | No damage | Slanted or swaying billboards | Slanted or toppled down billboard |
| COMMUNICATION | No damage | Interruption of communication services for few hours<br>Limited internet access<br>Temporary interruption communication services | Interruption of communication for hours to leading to days<br>Communication facilities moderately affected<br>Interruption of communication services for several days. | Interruption of communication services for few day leading to weeks<br>Communication facilities are totally damaged<br>Prolonged interruption of communication services for several days. |
| TRANSPORTATION | No damage | Stranded passengers<br>Interruption of transportation such | Stranded passengers due to limited transportation<br>Increase in precautionary | Transportation is interrupted in all sectors<br>Uprooted trees may block |

| SECTOR | Minimal/ Very Low | Minor/ Low | Significant/ Medium | Severe/High |
|---|---|---|---|---|
| | | as delayed or cancelled flights and routes | measures to be conducted by the government<br>Uprooted trees may block major thoroughfares<br>Small and light vehicles may experience loss of control<br>Not passable to light and medium vehicles for several hours. | Major thoroughfares<br>Toppled small and light vehicles and damaged vehicles due to flying and falling of debris<br>Not passable to light and medium vehicles for several hours. |
| MARITIME | Normal | Small sea crafts such as fishing boats and vessels sailing interrupted | All sea crafts and vessels sailing slightly interrupted | All types of sea crafts and vessels sailing cease to operate |
| COASTAL | Coastal communities No threat | Coastal communities Life threatening | Sea water intrusion during high tide, this will cause minimal urban and coastal flooding<br>Coastal communities Significant threat to life and fish industry | Sea water intrusion during high tide, this will cause widespread urban and coastal flooding<br>Coastal communities Potential death |
| EMERGENCY | Normal | Emergency services available | Limited emergency services available | Emergency services not available |
| ENGROACHMENT (Trees) | No damage | Toppling of trees | Some uprooted trees and broken branches | Large trees uprooted |
| BASIC SERVICES | Business as usual | Slight delay of the delivery of goods and services | Disrupted delivery of commodities<br>Limited access to basic services due to limited transportation<br>Some basic government services interrupted (e.g. administrative services.<br>Delayed delivery of goods and services | Prolonged basic government services interruption (e.g. administrative services)<br>Limited to no access to basic services due to prolonged interruption of transportation<br>Interruption of the delivery of goods and services |
| CIVIL SERVICE/ PRIVATE SECTOR | Business as usual | | Classes interrupted per local government discretion<br>Disrupted delivery of commodities<br>Disruption of outdoor activities | Prolonged disruption of delivery of commodities<br>Prolonged disruption of outdoor/economic/tourism activities |
| LIFE | No injuries | No injuries due to flying debris | Several injuries due to flying debris, few casualties<br>Several injuries few deaths due to flying debris | Life threatening injuries/ increased number of casualties<br>Potential large number of people are injured/died |
| DISASTER POLICY | | Normal | Increase in activity of disaster response personnel | Major increase in activity of disaster response personnel |

Impact Table: **Heavy Rainfall**

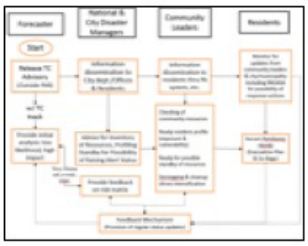
| SECTOR | Minimal/ Very Low | Minor/ Low | Significant/ Medium | Severe/High |
|---|---|---|---|---|
| TRANSPORTATION | Possible all types<br>Reported/ attended Commuters<br>Roads possible to all type of vehicle. | Possible medium vehicles Flood >10-30mm<br>Reported/ attended commuters<br>Roads possible to all type of vehicle. | Possible heavy and boats Flood >10-30mm<br>Reported/ attended commuters<br>Roads not possible to light vehicles, Delay of delivery of goods and services | Not possible all types of vehicle.<br>Reported/ attended commuters<br>Roads not possible to all types of vehicle.<br>Serious interruption of delivery of basic services |
| FLOOD LEVEL (No-Pumping Station) | Water Level: Clear Deep in Low Lying Areas | Water Level: Clear Deep in Low Lying Areas | Water Level: Mixed Deep in Low Lying Areas | Water Level: up to 2 Feet in Low Lying Areas |
| RESIDENTIAL | No impacts on residential areas | Minor impacts on residential areas made of light materials and properties | Major impacts on residential areas made of light materials and properties | Major damages on residential areas made of light materials and properties |
| DISASTER POLICY | Normal<br>No effect | Slight increase in commitment or work of OPR staff | Significant increase in commitment or work of OPR staff | Major increase in commitment or work of OPR staff |
| BUSINESS | Normal<br>Continuous operations of commercial/ manufacturing companies | Normal<br>Continuous operations of commercial/ manufacturing companies | Some businesses cease to operate<br>Some commercial/ manufacturing companies cease to operate | All businesses cease to operate<br>Most commercial/ manufacturing companies cease to operate |
| ECONOMIC | No effect | Slight damage on livestock | Partial damage on livestock | All crop lost (case: commodity) |
| AIRPORTS/ SEAPARE | Normal operation of sea ports and airports | Delayed in schedules of sea ports and airports | Selected flights delayed for short period of time | Delayed flights for longer period of time |
| ELECTRICITY | No effect<br>No interruption | Temporary power interruption (15-30 minutes)<br>No interruption<br>Possible Power Interruption | Temporary power interruption (12-24 hours)<br>Power interruption | Damaged power lines (1 day onwards)<br>Power Outage |
| WATER SUPPLY | No interruption<br>Possible contamination | No interruption<br>Possible contamination | Possible interruption<br>Possible contamination | Interruption<br>Possible contamination |
| HEALTH | Non-life threatening illnesses<br>Possible Communicable Diseases | Water-borne disease possible<br>Possible Communicable Diseases | Reported of communicable diseases, water-borne disease incidences<br>Possible Communicable Diseases | Widespread of communicable diseases, water-borne disease incidences<br>Widespread water-borne Diseases or illnesses |
| LIVESTOCK/ AGRICULTURE/ FISHERIES | No damage to livestock and agriculture<br>No impact on fish capture/ports | Possible minor damage to livestock and agriculture<br>No significant impact on fish capture/ports | Medium to moderate damage to livestock and agriculture<br>Some fish capture/ports are damaged | High to severe damage to livestock and agriculture<br>Most of the fish capture/ports are damaged |
| INFRASTRUCTURE | No damage to infrastructure<br>Bridges - none | Possible damage to infrastructure<br>Bridges - none | Possible Catastrophic damage to infrastructure<br>Bridges – possible damage not passable | Damage to infrastructure<br>Bridges – possible damage not passable |
| COMMUNICATIONS | No interruption | No interruption | Possible interruption | Interruption |
| CASUALTIES | Possible injured | Possible injured | Possible injured/ Casualties | Casualties |

## Developmental Activities - Partnership

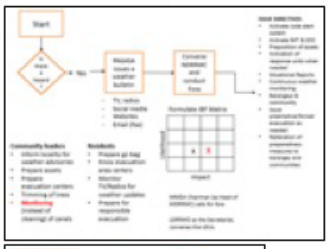
**Standard Operating Procedures**

5-day lead

4-day lead



3-day lead



2-day lead

1-day lead

## Developmental Activities - Partnership

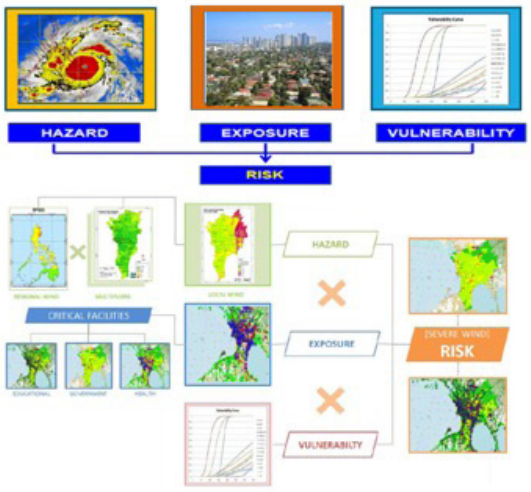
### Building Partnerships and Collaboration

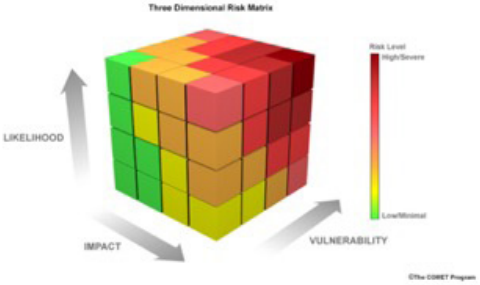

- Partners should work hand-in-hand towards ***effective***, ***sustained*** and ***successful*** IBF operation: **PAGASA** needs to work in partnership with **other government agencies and stakeholders** (emergency response, mapping agencies, transport, public, etc..)
- **Data sharing** among different agencies and departments vital (demographic, GIS and mapping, economic etc..)

**We need TEAMWORK in order to build and run the system!**

## Developmental Activities–Probability of Loss

**RISK ASSESSMENT**




**Risk = Likelihood x Impacts x Vulnerability**

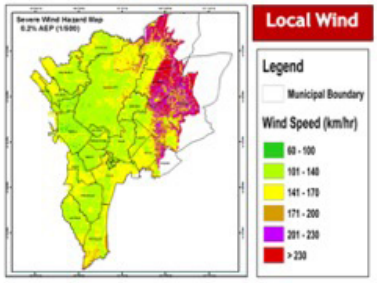
**Risk** is the product of the likelihood of an event occurring, the impacts if the event occurs and the vulnerability of the area or populations.

## Developmental Activities–Probability of Loss

### HAZARD MAPS

Regional Wind Hazard Maps in various Return Periods

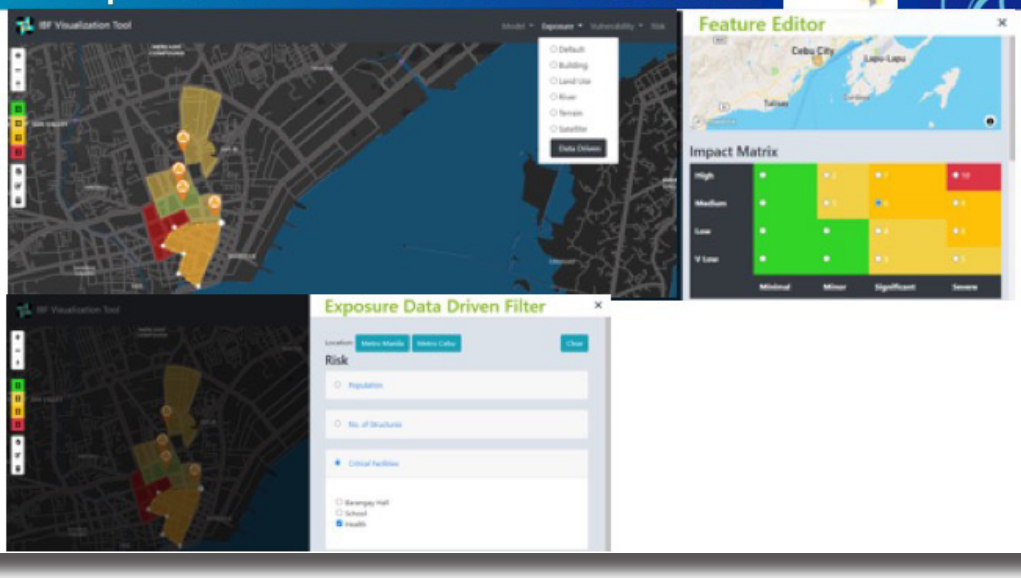
Local Wind Hazard Maps in Various Return Periods




20-, 50-, 100-, 200- and 500-yr RPs

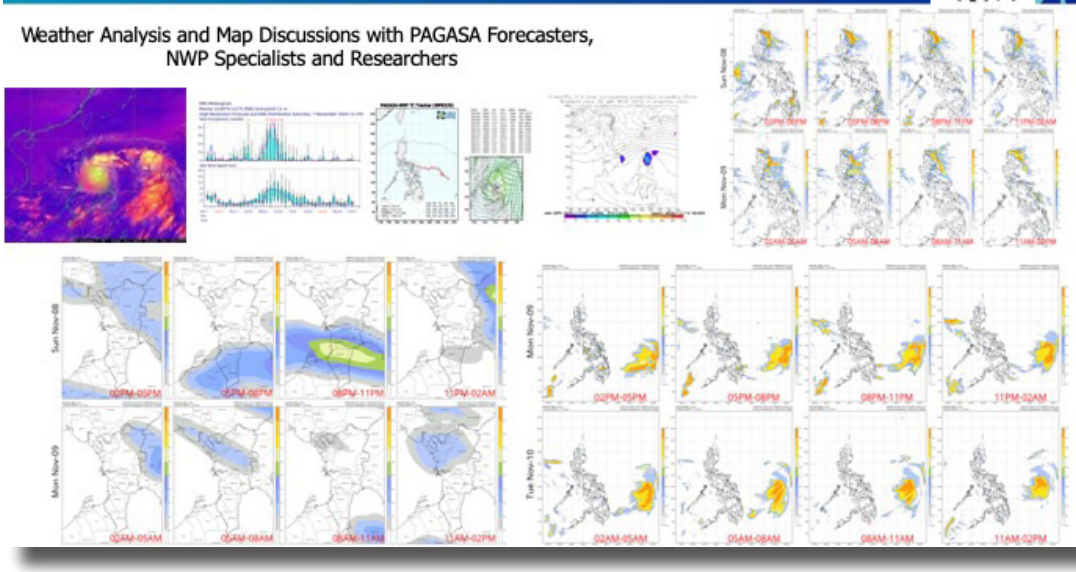
- The **probabilistic regional and local wind hazard maps** will tell us which areas of the community are exposed to severe wind hazards.

## Developmental Activities – Platform

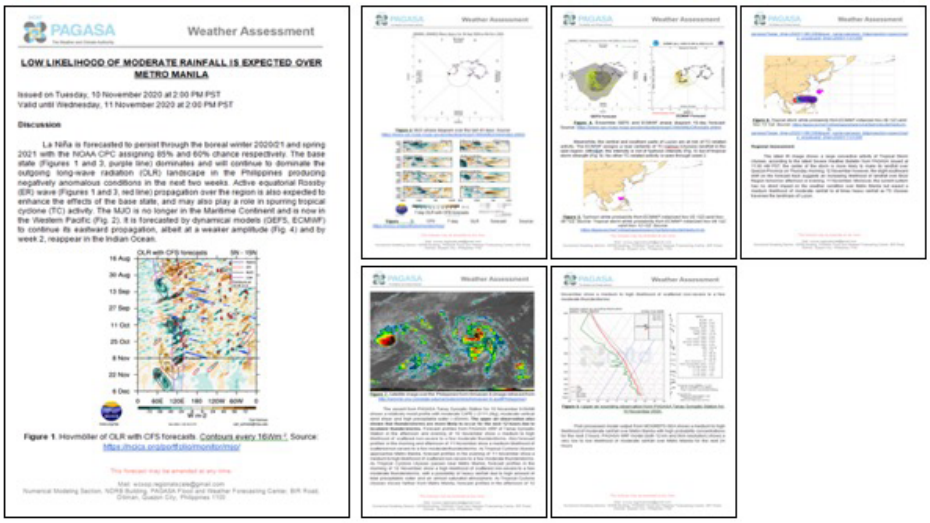



## Developmental Activities – Phenomenon

Weather Analysis and Map Discussions with PAGASA Forecasters, NWP Specialists and Researchers



# Developmental Activities – Phenomenon


PAGASA Weather Assessment

LOW LIKELIHOOD OF MODERATE RAINFALL IS EXPECTED OVER METRO MANILA

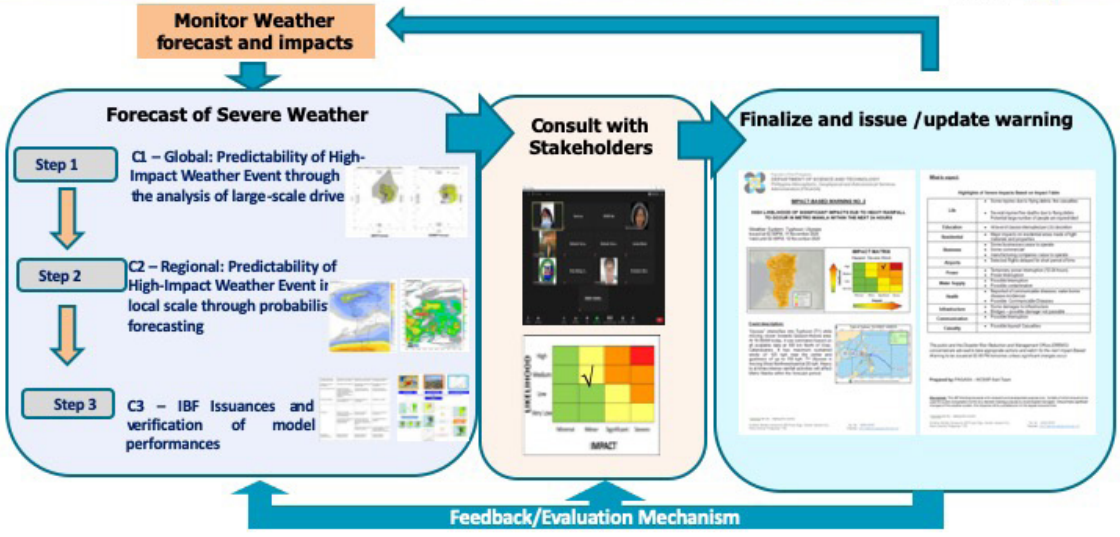
Issued on Tuesday, 10 November 2020 at 2:00 PM PST
Valid until Wednesday, 11 November 2020 at 2:00 PM PST

Discussion

La Niña is forecasted to persist through the boreal winter 2020/21 and spring 2021 with the NOAA CPC assigning 85% and 60% chance respectively. The base state (Figures 1 and 3, purple line) dominates and will continue to dominate the outgoing long-wave radiation (OLR) landscape in the Philippines producing negatively anomalous conditions in the next two weeks. Active equatorial Rossby (ER) wave (Figures 1 and 3, red line) propagation over the region is also expected to enhance the effects of the base state, and may also play a role in spurring tropical cyclone (TC) activity. The MJO is no longer in the Maritime Continent and is now in the Western Pacific (Fig. 2). It is forecasted by dynamical models (GEFS, ECMWF) to continue its eastward propagation, albeit at a weaker amplitude (Fig. 4) and by week 2, reappear in the Indian Ocean.

Figure 1. Hovmöller of OLR with CFS forecasts. Contours every 16W/m². Source: https://moca.org/portfoliomonitoring/

# Developmental Activities – Phenomenon




# Developmental Activities – Publicize

| | |
|---|---|
| GREEN | NO SEVERE WEATHER EXPECTED |
| YELLOW | **BE AWARE.** There is a moderate risk of severe or a low risk of extreme weather occurring. *Remain alert and ensure you access the latest weather forecast.* |
| AMBER | **BE PREPARED.** There is a high risk of severe or a moderate risk of extreme weather occurring. *Remain vigilant and ensure you access the latest weather forecast. Take precautions where possible.* |
| RED | **TAKE ACTION.** There is a high risk of an extreme weather event occurring. *Remain extra vigilant and ensure you access the latest weather forecast. Follow orders and any advice given by authorities under all circumstances and be prepared for extraordinary measures.* |

## Developmental Activities – Publicize

| RESPONSE MATRIX: RAINFALL (Suggested) | | | |
|---|---|---|---|
| **Very Low – No Action** | **Low – Be Aware** | **Medium – Be Prepared** | **High – Take Action** |
| The NMHS will continue to monitor for any changing weather conditions | • Be aware of flooding and stay out of flood waters.<br>• Evaluate inventory of emergency supplies (food, water, medical supplies); restock supplies as needed.<br>• Monitor roads and properties for localized flooding and possible traffic and public transportation disruptions. | • Be aware of flooding and stay out of flood waters.<br>• Check emergency supplies , purchase additional supplies if needed, fill gas tanks, etc.<br>• Be prepared for localized flooding of roads and properties in low lying areas and land slippages that could block roads.<br>• Prepare possible delays or cancellation of public transportation services. | • Stay out of flood waters and prepare to use emergency supplies.<br>• Avoid walking or driving through moving waters and seek safer/higher ground.<br>• Don't drive and stay off roads in flood prone areas.<br>• Plan to shelter in place in non-flood areas. |

## PILOT TESTING: How we do it?

**Stage 1** — Establishing Linkages & Team Organization

- ✓Communication with IBF Partners in Cebu (PDRRMO, MDRRMOs, etc) and other critical partners
- ✓ Communication with Regional Forecasters
- ✓ Creation of Group Chat for easy interaction
- ✓ Roles and Responsibilities of Focal Persons

**Stage 2** — Risk Analysis & IBF Forecast and Warning

- ✓Risk Map of Cebu
- ✓ Probabilistic Forecasting
- ✓ Drafted Impact Tables
- ✓Analysis of Risk Matrix
- ✓IBF Visualization & Platform
- ✓ IBF Warning Flow
- ✓Warning Dissemination Protocol

**Stage 3** — Identifying Challenges, Benefits & Way Forward

- ✓Issues arising from the pilot testing
- ✓Benefits derived
- ✓Feedback mechanisms
- ✓Preparation of Assessment Report
- ✓Conduct more case studies/ Pilot Testing
- ✓ Continuous refinement of impact tables, SOPs, etc.

## PILOT TESTING: How do we evaluate?

**Severe Wind**

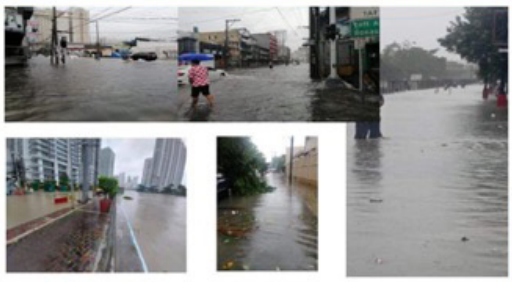


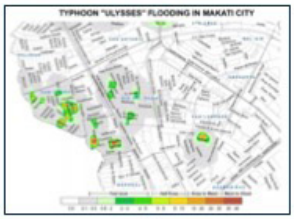

**Heavy Rainfall**

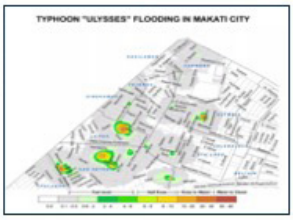


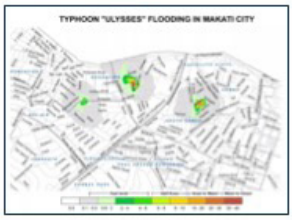
## PILOT TESTING: How do we evaluate?

Flooding in Makati City






## PILOT TESTING: How do we evaluate?

Flooding in Marikina City




## BENEFITS OF IBF

REPUBLIC OF THE PHILIPPINES
City of Makati

IBF: The benefit of the IBF in Makati City Disaster Risk Reduction and Management Office (DRRM)

- Improved early action and preparedness planning down to the Barangay levels.
- Improved collaboration and communication of Makati City Local Government Unit (Makati LGU) to DOST-PAGASA which established strong ties in protecting lives and properties within the city premises.
- Improvement in decision making of the local disaster management officials during severe weather threats.
- Strengthened of the City Early Warning System (EWS).

## BENEFITS OF IBF

REPUBLIC OF THE PHILIPPINES
City of Makati

### IBF Benefit: SAMPLE CASE FOR TY ULYSSES {VAMC0}

Typhoon ULYSSES (VAMCO) nearing landfall on November 11, 2020.

Established early and continuous information exchange between Makati City IBF focal person and PAGASA IBF Team.

IBF Issuance for Severe Wind and Heavy Rain

Activation of the city alert status two days before the expected landfall of the typhoon in order for the city to prepare for the "worst case scenario".


Local Severe Weather Bulletin with specified impacts issued for Makati City based on PAGASA SWB.

City Early Response

## BENEFITS OF IBF

REPUBLIC OF THE PHILIPPINES
City of Makati

### IBF Benefit: SAMPLE CASE FOR STS AMBO

- Makati local advisories with impact during the passage of Typhoon "AMBO"

MAKATI WEATHER UPDATED
FOR: TYPHOON "AMBO"
14 MAY 2020
ISSUED AT: 11:40 AM

ACCORDING TO PAGASA "AMBO" MAINTAINS ITS STRENGTH AS IT ENDANGERS THE EASTERN SAMAR-NORTHERN SAMAR AREA.

At 10:00 AM today, the center of Typhoon "AMBO" was estimated based on all available data at 589 km East Southeast of Makati City (12.2 °N, 125.9 °E)

IMPACTS TO MAKATI CITY :
-During Heavy Rains-
*Flooding over low lying/flood prone areas
*Disruption of outdoor Activities
*Poor visibility and Slippery roads

-During gusty winds-
*light to moderate damage over light build structures
*Branches of trees, billboards and some electrical outpost will likely to be toppled down.

All are advised to continue monitoring for updates from PAGASA and Makati DRRM.

OBSERVED

RESULT

NOTE:

- UPROOTED TREE ALONG BUENDIA INFRONT OF MAPUA AND EASTERN TELECOM BRGY. BEL-AIR

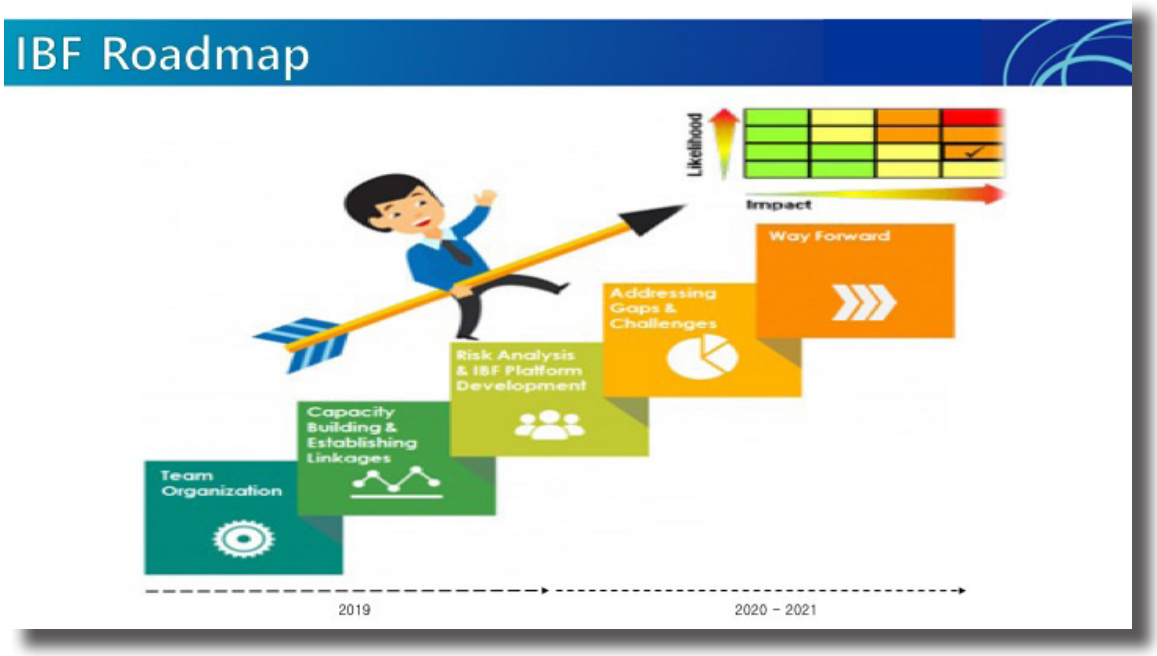
- FALLEN BRANCH OF TREE AT UNIT 615 GROUND FLOOR BUILDING 6 GUADALUPE BLISS BRGY. CEMBO

BANTAY BAYAN REPORTS

Localized Advisories sent to Email, SMS alerts and other messaging platform.

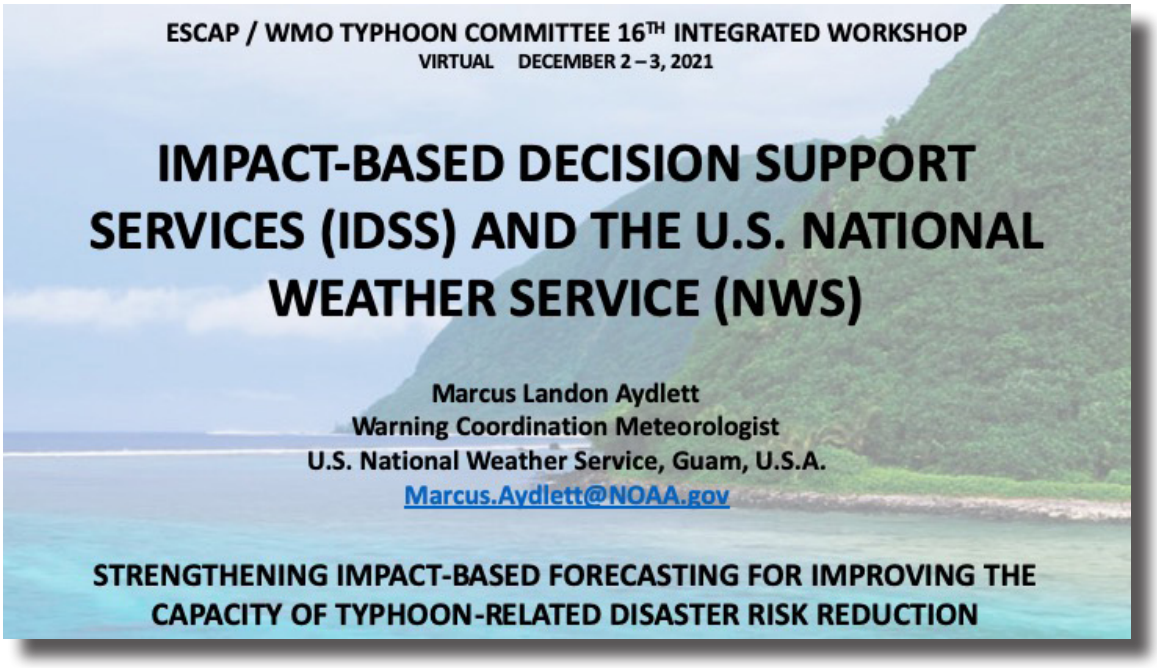
## WAY FORWARD

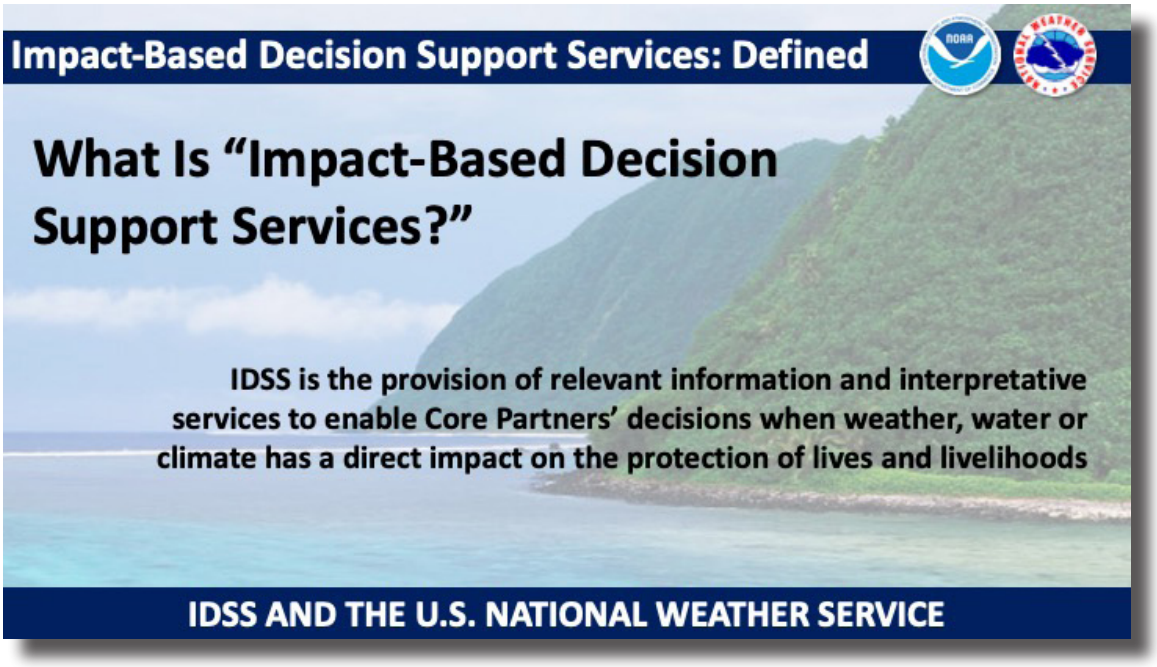
- Refinement of Impact Tables, SOPs, etc.
- Conduct more case studies
- Establishment of legal agreements between PAGASA and Stakeholders
- Improvement of IBF Visualization Platform
- More capacity buildings on IBF
- Establishment of Impact Data Library
- Development of IBF Guidebook


IBF Roadmap
Likelihood
Impact
Way Forward
Addressing Gaps & Challenges
Risk Analysis & IBF Platform Development
Capacity Building & Establishing Linkages
Team Organization
2019
2020 – 2021


Thank You!

**5. "Impact Based Decision Support Services (IDSS) and the U.S. National Weather Service (NWS)" – Mr. Marcus (Landon) AYDLETT, Warning Coordination Meteorologist of the Weather Forecast Office in Guam, USA**



## Importance of IDSS within the NWS

# NWS Mission Statement

**Provide weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy**

The NWS Mission Statement was updated in October 2021 for the addition of "impact-based decision support services."

**IDSS AND THE U.S. NATIONAL WEATHER SERVICE**

## Importance of IDSS within the NWS

**Dr. Louis Uccellini, Director, U.S. National Weather Service**
**On recognizing IDSS in the NWS Mission Statement:**

**"IDSS is now as much a part of our mission as forecasts and warnings, and reflects the realization that IDSS is actually an essential element for realizing the second half of the existing mission statement related to the protection of life and property."**

**"By updating our mission, we acknowledge that to keep Americans safe and to enhance the economy, *we must look beyond the forecast to transform the way people receive, understand, and act on information*."**

**IDSS AND THE U.S. NATIONAL WEATHER SERVICE**

## Why IDSS? A Vision for a Weather-Ready Nation

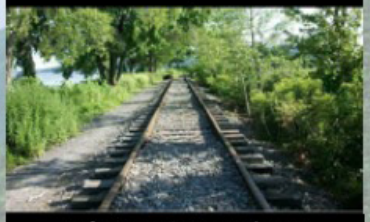
### Mission for Today

Provide weather, water, and seasonal data, forecasts, warnings **and Impact-Based Decision Support Services** for the protection of life and property and the enhancement of the national economy

### Vision for Tomorrow

A **Weather-Ready Nation** where society is prepared for and responds to weather and water events; where communities are "Ready, Responsive and Resilient"

**What People Want**

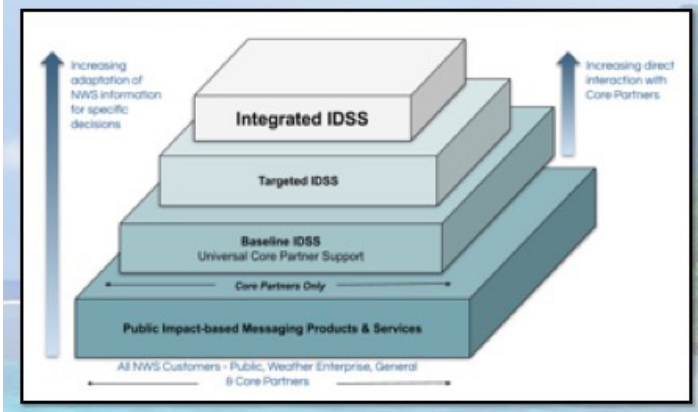


**What We Communicate**

**IDSS AND THE U.S. NATIONAL WEATHER SERVICE**

## IDSS Strategy within the NWS

### Continuum of Impact-based Messaging Services



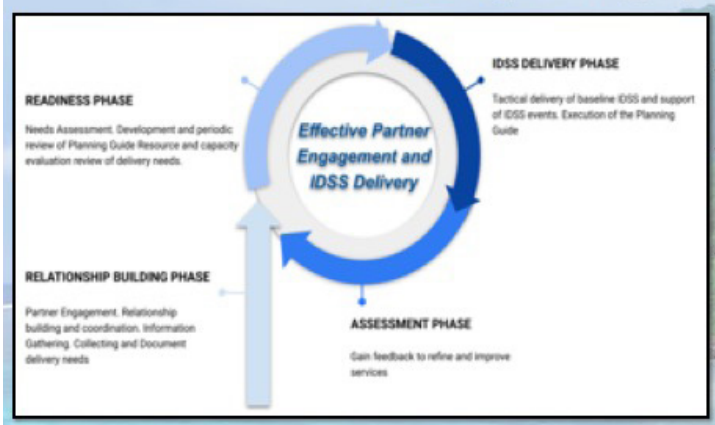

**Tiers of Products and Services**

- **Public IDSS Messaging**: The starting point of IDSS
- **Baseline IDSS**: Services common to all core partners
- **Targeted IDSS**: Services focused on a specific or group of core partners
- **Integrated IDSS**: Dedicated support to core partner(s)

IDSS AND THE U.S. NATIONAL WEATHER SERVICE

## IDSS Strategy within the NWS

### IDSS Operating Cycle



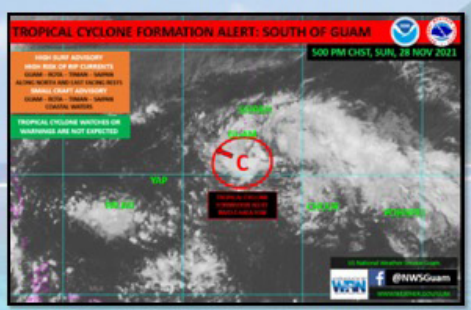

**4 Phases of the Operating Cycle**

- Relationship Building
  - Coordination with core partners on needs
- Readiness
  - NWS Office planning activities to meet partner needs and ensuring staff readiness (training and exercises)
- Delivery
  - Activities for the tactical delivery of IDSS based on planning and partner needs
- Assessment
  - Gathering feedback to refine and improve services to partners

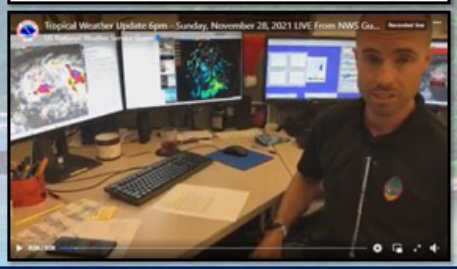
IDSS AND THE U.S. NATIONAL WEATHER SERVICE

## Operational IDSS: Social Media

- Text is plain language
- Easy to read/understand
- Tells the reader what they want to know
- Use of info-graphic
- When to expect new information
- Where to go for more information





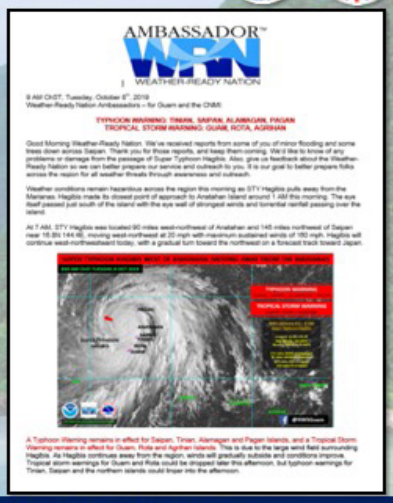


IDSS AND THE U.S. NATIONAL WEATHER SERVICE

## Operational IDSS: Weather-Ready Nation Emails

- When facing a weather threat, people want to know **what** that threat is, **what** it means to them, and **when**.
- This tangible item of the WRN is designed to do that.
- In the absence of Wireless Emergency Alerts (WEAs) in the region, this product is sent direct to the user.

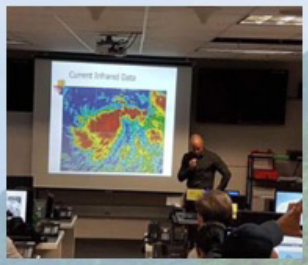
- Text is plain language
- Easy to read/understand
- Tells the reader what they want to know
- Use of info-graphic
- When to expect new information
- Where to go for more information
- Provides a point of contact at the NWS (for better or for worse)

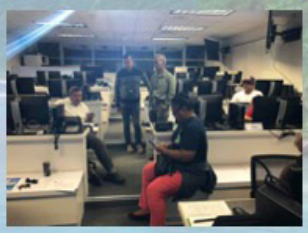

AMBASSADOR WRN
WEATHER-READY NATION

TYPHOON WARNING: TINIAN, SAIPAN, ALAMAGAN, PAGAN
TROPICAL STORM WARNING: GUAM, ROTA, AGRIHAN

IDSS AND THE U.S. NATIONAL WEATHER SERVICE

## Operational IDSS: Heavy Weather Briefs





**TYPHOON MANGKHUT**
**HEAVY WEATHER BRIEF**

**Guam Homeland Security/ Office of Civil Defense**
**September 2018**


IDSS AND THE U.S. NATIONAL WEATHER SERVICE

## Assessing IDSS in the NWS

### IDSS Surveys for Core Partners

**Two surveys were created to examine: Accessibility, Consistency, Comprehension, Decision-Making, Timeliness, Service Quality and Trust**

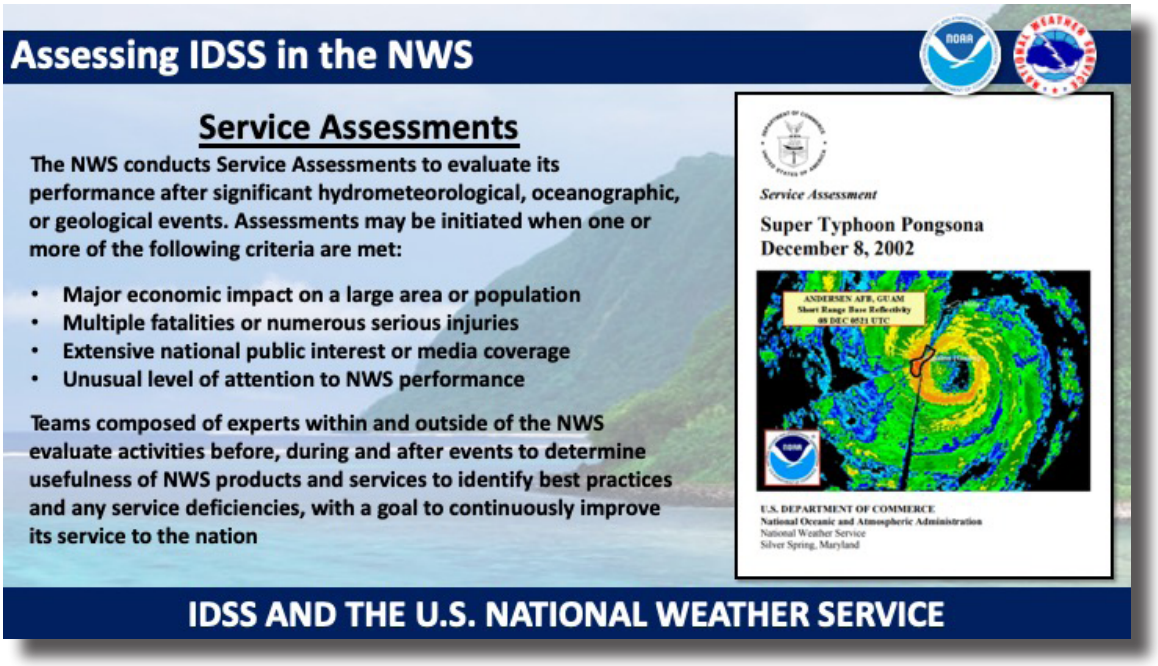
### Episodic Surveys

**Assesses event-driven IDSS; the provision of information and interpretive services to support an event or incident where weather, water or climate has a direct impact on the protection of lives/livelihoods**

### Annual (Routine) Surveys

**Serves as an end-of-year assessment of IDSS that occurred throughout the year. Survey includes joint training, Integrated Warning Team interactions, pre-event/scenario planning, forecasts and planning, table-top exercises and daily coordination regarding high value decisions**

IDSS AND THE U.S. NATIONAL WEATHER SERVICE


Assessing IDSS in the NWS
Service Assessments
The NWS conducts Service Assessments to evaluate its performance after significant hydrometeorological, oceanographic, or geological events. Assessments may be initiated when one or more of the following criteria are met:
• Major economic impact on a large area or population
• Multiple fatalities or numerous serious injuries
• Extensive national public interest or media coverage
• Unusual level of attention to NWS performance
Teams composed of experts within and outside of the NWS evaluate activities before, during and after events to determine usefulness of NWS products and services to identify best practices and any service deficiencies, with a goal to continuously improve its service to the nation
Service Assessment
Super Typhoon Pongsona
December 8, 2002
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Silver Spring, Maryland
IDSS AND THE U.S. NATIONAL WEATHER SERVICE

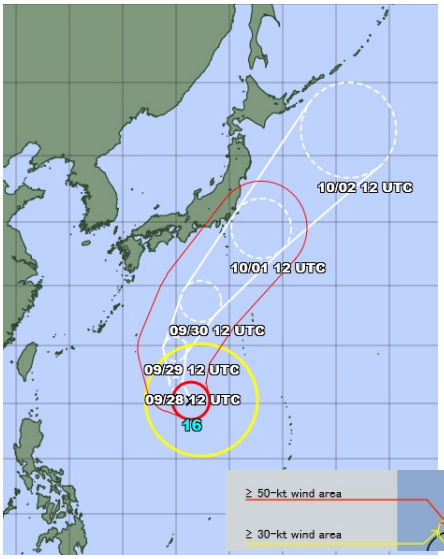

ESCAP / WMO TYPHOON COMMITTEE 16TH INTEGRATED WORKSHOP
VIRTUAL DECEMBER 2 – 3, 2021
FOR MORE INFORMATION ON TOPICS DISCUSSED IN THIS PRESENTATION:
Marcus Landon Aydlett
Warning Coordination Meteorologist
US National Weather Service, Guam
Marcus.Aydlett@NOAA.gov
3232
National Weather Service
THANK YOU!
STRENGTHENING IMPACT-BASED FORECASTING FOR IMPROVING THE CAPACITY OF TYPHOON-RELATED DISASTER RISK REDUCTION

# Impact-based Forecasting Connected to Typhoon-related Disaster Risk Reduction

16th Integrated Workshop
ESCAP/WMO Typhoon Committee
2-3 December 2021

## Effective Information Related to Tropical Cyclones

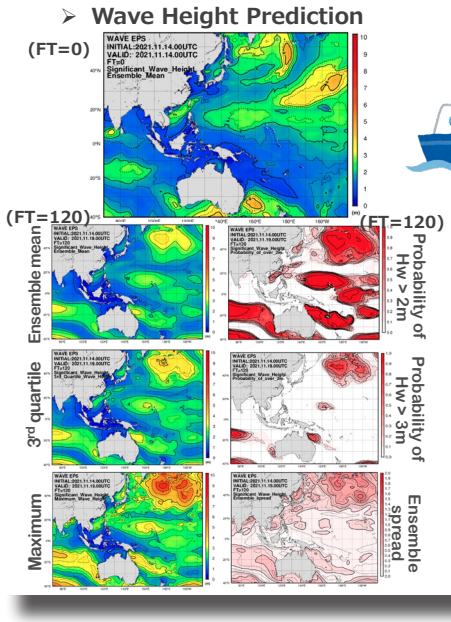
*We will introduce various ways to prepare for an upcoming hazard based on impact-based forecasts provided by JMA, focusing on the lifetime of a tropical cyclone.*

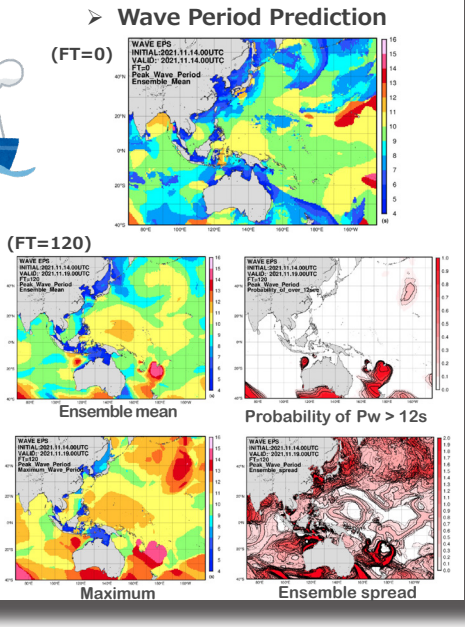



Japan Meteorological Agency 2

## Probabilistic forecast maps

*For marine navigation safety*



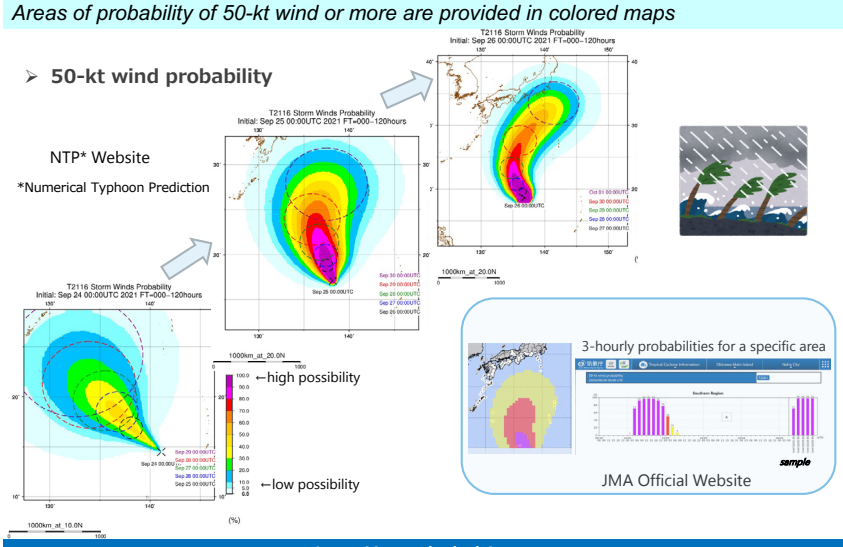
## 50-kt wind probability products

*Areas of probability of 50-kt wind or more are provided in colored maps*

➢ **50-kt wind probability**

NTP* Website

*Numerical Typhoon Prediction






## Probability of Warning-class Phenomenon

*Probability information for the risk of severe weather phenomena that may have significant impacts to the area are given up to 5 days ahead.*

From today to tomorrow

From day after tomorrow to five days ahead

| Southern ○○ Prefecture | Probability of warning issuance | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Target day/time | 3 Sun | 4 Mon | | | | 5 Tue | 6 Wed | 7 Thu | 8 Fri |
| | 18-24 | 0-6 | 6-12 | 12-18 | 18-24 | | | | |
| Heavy rain | [Mid] | | – | | | – | – | [Mid] | – |
| Storm(Gale) | – | | [High] | | | – | [Mid] | [High] | – |
| High waves | – | | [High] | | | – | [Mid] | [High] | – |

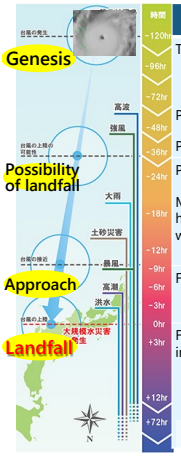
Before six o'clock in the evening –
Provide probability of warning issuance tonight, or early the next morning, to avoid evacuation in the middle of the night

Provide probability of warning issuance up to five days ahead to support the preparation needed for DRR stakeholders



## Timeline for DRR stakeholders – when, who and what

**Actions to be taken by the government, other organizations and residents**



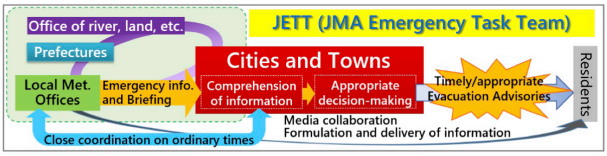

| | Government | | Traffic services | Municipalities | Residents |
|---|---|---|---|---|---|
| | TC forecast | Disaster response headquarters is established. | Traffic service suspension is announced in advance. | Wide-area evacuation system is checked and announced. | "My Timeline" |
| | Press conference | | | | |
| | Press conference | | | | |
| | Press conference | Liaison officers are dispatched. | Procedures of service suspension is checked and officially announced. | Wide-area evacuees are guided and accepted. | Wide-area evacuation starts. |
| | Meteorological/ hydrological warning | Impose operations such as dam pre-discharge | | Support delayed evacuees. | |
| | Flood danger info. | Liaison officers are dispatched to avoid further damage | Service disruption | Evacuation supporters also evacuate. | Wide-area evacuation completed |
| | Flood occurrence info. | Liaison officers are dispatched to support early recovery | | Request of support | |

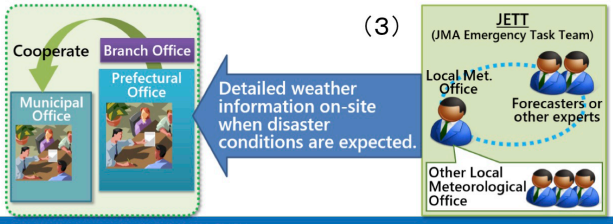
**Effective for promoting self-, mutual- and public-help.**

## Actions – various approaches to support municipalities and the public

JMA takes all possible actions to support municipalities and encourage the public towards early evacuation
(1)Press conferences
(2)Briefing to municipalities
(3)Delivering "JETT" as needed


(2)Various kinds of information (graphs, charts, etc.) are used during briefing

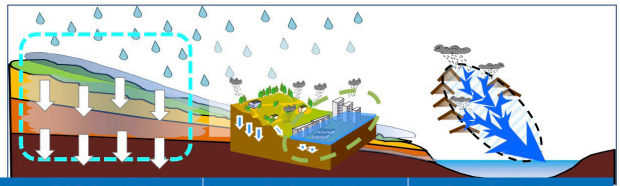



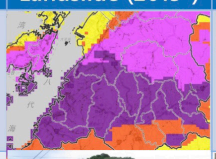
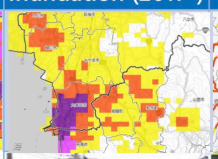
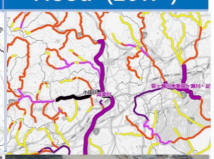
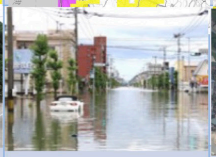

*Japan Meteorological Agency* 7

## Real-time Risk Map

*To initiatively check your current situation of risk possibility*

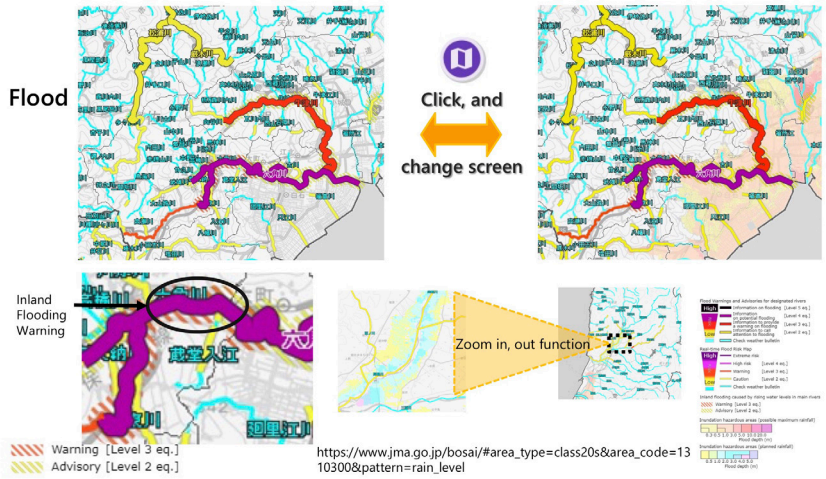
- Five risk levels colored from light blue to purple
- Determining risk-level by "Index"; ex. Soil water index – the water amount accumulated in the soil considered together with the rainfall amount in target areas



| | Landslide (2015-) | Inundation (2017-) | Flood (2017-) |
|---|---|---|---|
| Risk Map |  |  |  |
| Related Disaster |  |  |  |
| Resolution/Update Interval/ Lead time/Index used for warning criteria | 1 km/10 min/2 hours/ soil water index | 1 km/10 min/1 hour/ surface water index | 1 km/10 min/3 hours/ runoff index |

## Real-time Risk Map

*Continuous effort in progress to improve usability of Risk Maps*



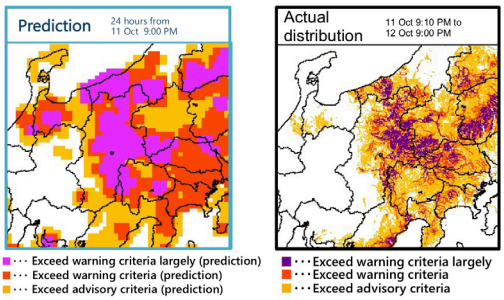



## Real-time Risk Map – Further Improvement

Longer forecast

- To call for caution against heavy rain at an earlier stage, JMA has developed a Maximum Risk Map with a longer lead time (approximately one day).
- Considering the uncertainty with longer forecasts, for the time being, the product will be used only during press conferences for tropical cyclones that may cause phenomena which largely exceeds the warning criteria.

Comparison between the prediction of the maximum risk of flood 24 hours in advance (left) and the actual Maximum Risk Map (right) [Typhoon Hagibis in 2019]






## 7. "Application Progress of FY Satellite in Tropical Cyclone Intelligence Detection and Intensity Estimation" – Mr. QIAN Qifeng, Typhoon and Marine Weather Forecast Center, NMC, CMA, China

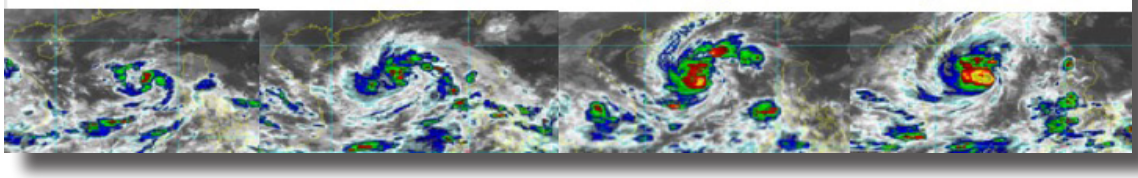
中央气象台 NATIONAL METEOROLOGICAL CENTRE

# Application Progress of FY Satellite in Tropical Cyclone Intelligence Detection and Intensity Estimation

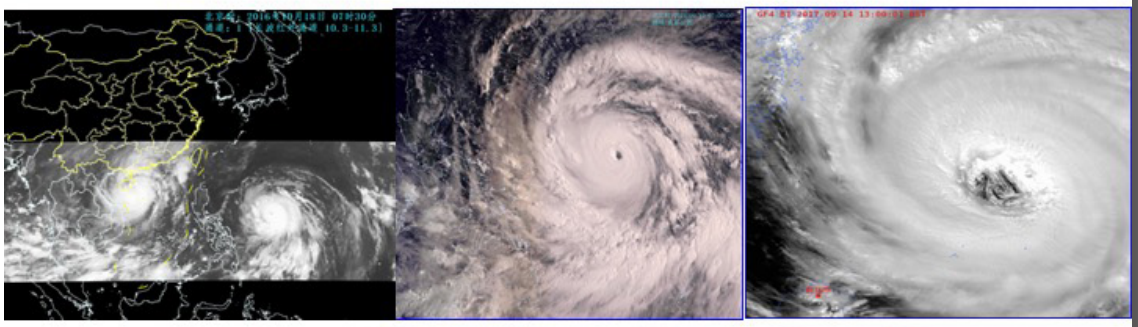
QIAN Qifeng

National Meteorology Center of CMA

ESCAP/WMO TYPHOON COMMITTEE 16th Integrated Workshop 2021-12



## FY- 2/4 Satellites Observation and Rapid Scanning



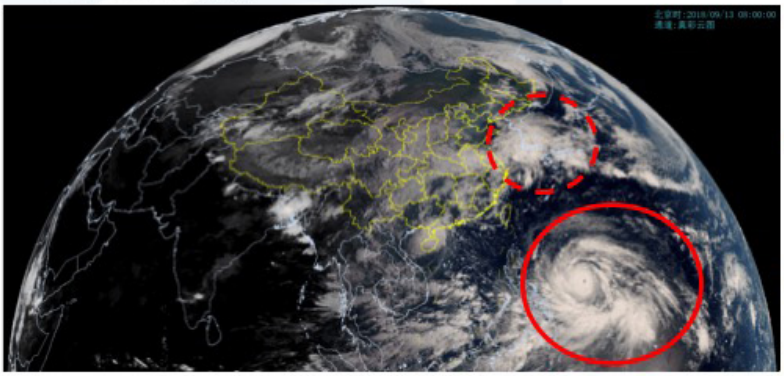
Product frequency: **1h** → **30min** → **15min** → **6min** → **5min** → **<5min**

- Improvement of TC analysis accuracy, especially for weak storms
- Improvement of understanding of TC structure and structure change
- Improvement of operation efficiency

## Brief introductions : Background

中央气象台

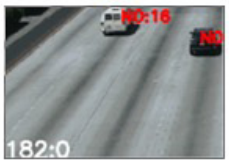
- FY-4A 5min regional

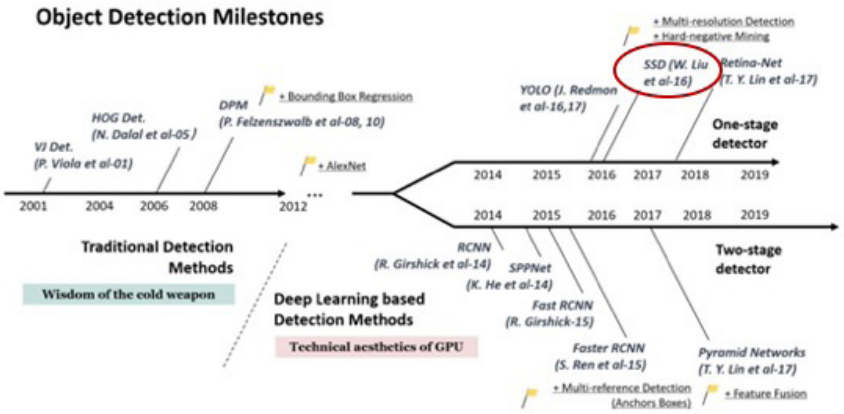


Distinguish tropical cyclone from other weather systems

# Way to solve

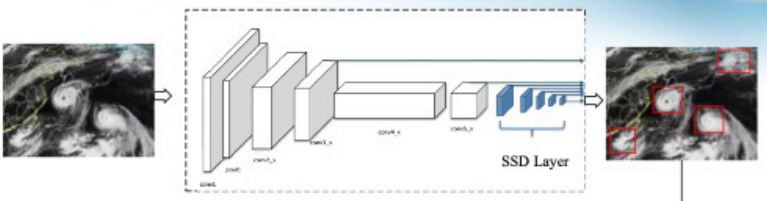
**Object Detection is a common problem of Computer Vision（CV）**
**Widely used in traffic, wise city, public security areas.**

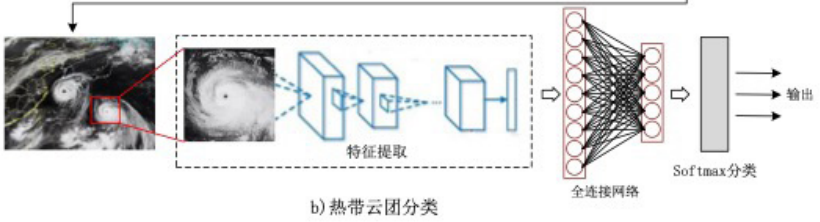

# Improved SSD model

Step 1:




a) 热带云团定位

Step 2:




b) 热带云团分类

**Intelligent Technique of TC Vortex Detection**

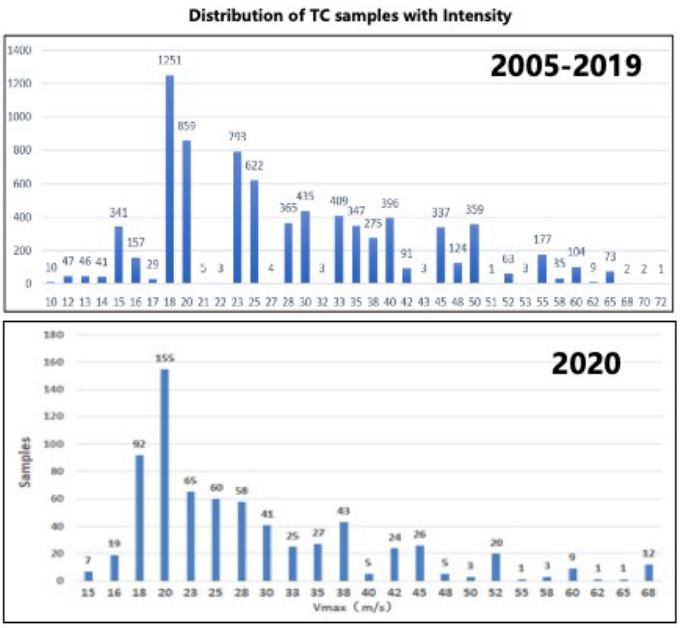
# DATA

**Training SET**

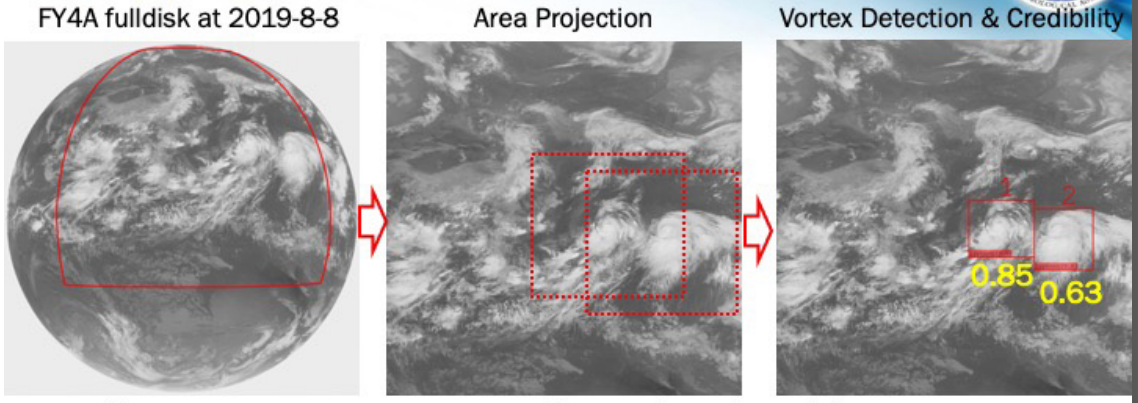
- **H8**
  - 2005-2018
    - 4872 Images
    - 5306 TCs
- **FY4A**
  - 2017-2019
    - 1417 Images
    - 1965 TCs

**Test SET**

- **FY4A**
  - 2020
    - 611 Images
    - 702 TCs

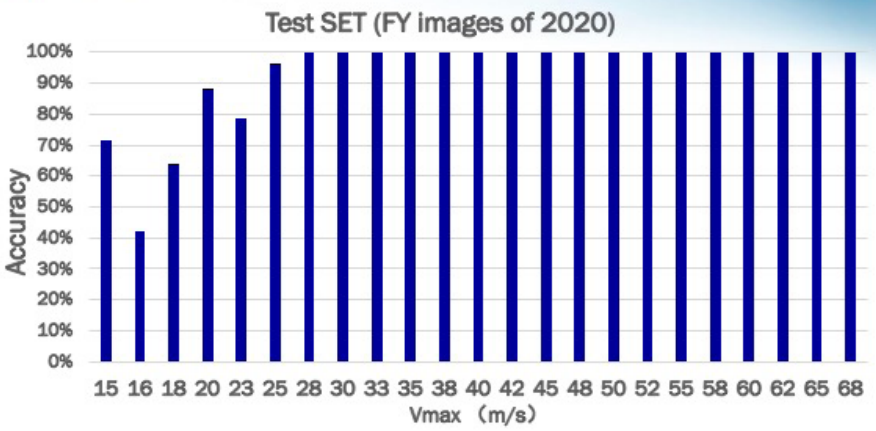


## Main Process



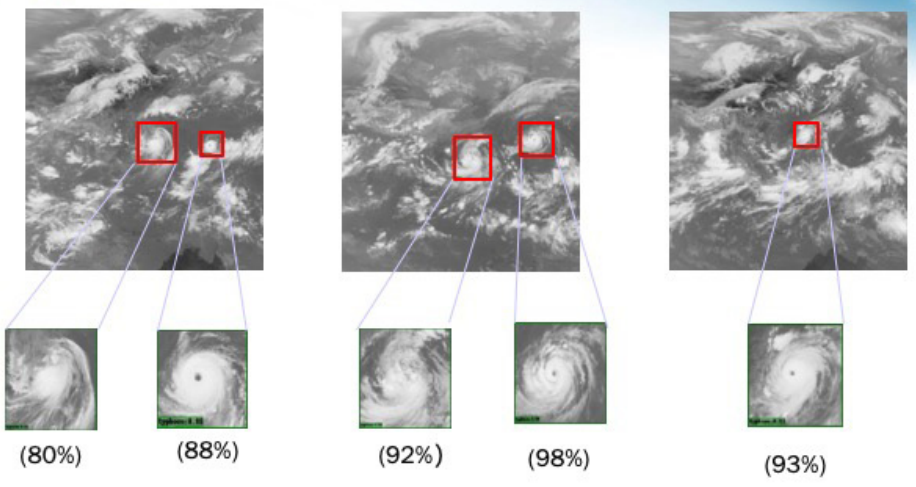

- ✓ Select a fixed region from fulldisk （ 70-160°E, 20°S-70°N）
- ✓ Scan this area, use SSD find the possible vortex with lower confidence level
- ✓ Scan each vortex, use higher confidence level in SSD and give its credibility

## Evaluation result

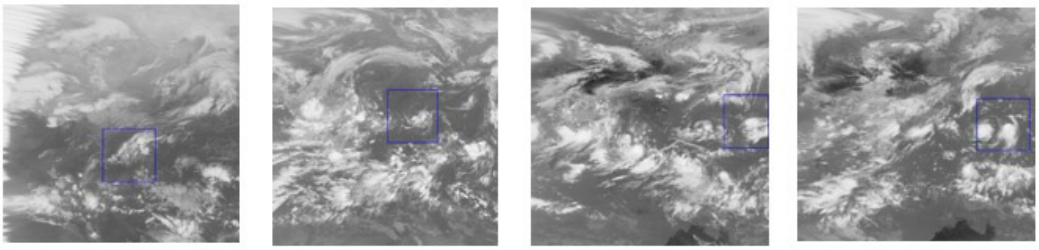



- ✓ Totally 702 TC samples, the average accuracy is 88.6%, 622 seccess , 80 failure
- ✓ TCs below STS(25m/s) is 40-90%, for TCs of STS level or above are more than 95%

## Some cases



## Shortages



Shape is not clear (Vmax:18m/s)

Shape is not clear (Vmax:17m/s)

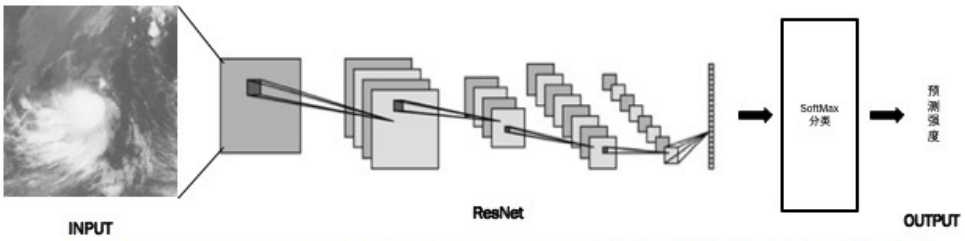
Near to the boundary (Vmax:28m/s)

Two TC very close maybe miss one

## Estimate the intensity

Typhoon intensity estimation technology based on deep learning

Aim: Input typhoon cloud picture → Output intensity value

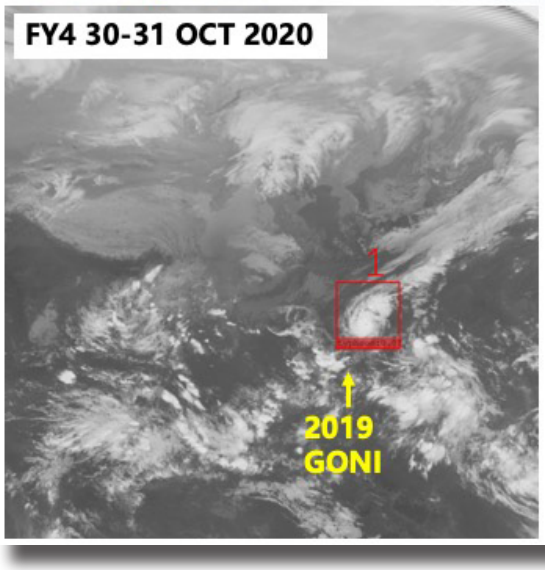


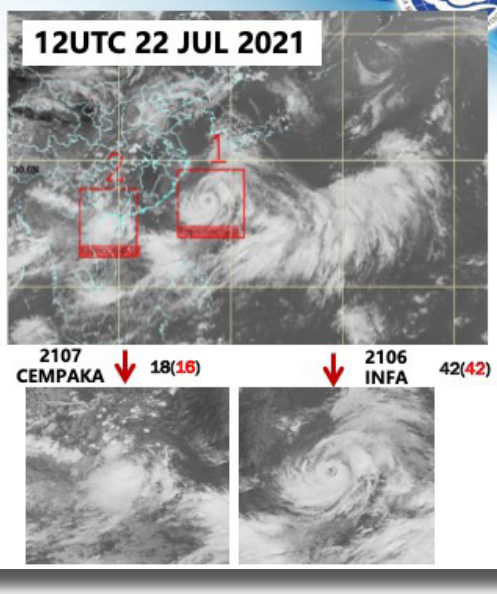

Features of typhoon-related information are extracted from satellite cloud

CNN deep learning models （RESNET-50）

TC intensity and probability value are given.

## Real time Case



## Conclusion

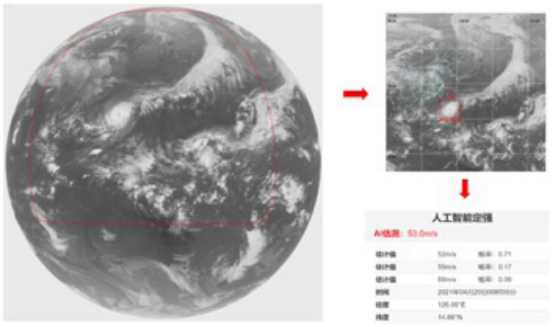


Fig. Intelligence Detection and Intensity Estimation System

- This is a tentative work, we use the target detection method in the field of artificial intelligence to detect the tropical cyclone vortex in the satellite image, ant determine its intensity afterwards. So that it is possible to tracking TC automatically, with FY high frequency observation.
- Strong typhoons have good structure and higher recognition accuracy, up to more than 95%, but they are easy to be missed for typhoons with weak or loose cloud structure.
- The results of detection and Intensity estimation can be combined with NWP data, and used as a reference to forecasters

## Thanks a lot for your attention!

The ESCAP/WMO Typhoon Committee Newsletter
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