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

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Project Team:
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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):
  o 19. Consider working toward replacing static cones of uncertainty with dynamic types, which can be ensemble-based or hybrid statistical and dynamical techniques.

  o 20. Include social science aspects and knowledge of ensemble and uncertainty as (mandatory/desirable) components of basic meteorological training under WMO.

  o 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.

  o 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)
TC-PFP Pilot Project – Overview

• This effort will be implemented in 3 phases, with an initial focus on Phase 1:
  o **Phase 1:** Work with forecast centers to identify best practices of a value-cycle approach to probabilistic forecasts of **TC formation and position**.
  o **Phase 2:** Work with forecast centers to identify best practices of a value-cycle approach to probabilistic forecasts of **TC intensity and structure**.
  o **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
  o Users are not “end users” but rather valuable partners in co-designing product information that is useful for a variety of situations.
  o Collaborating with WMO’s Societal & Economic Research Applications (SERA) group
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)
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
  o Topic: Current & planned probabilistic forecast products
  o Invited presentation by Andrew Burton (BoM Australia) and Jonathan Vigh (NCAR)

• Day-2: Thu 17 June, 1230-1430 UTC
  o Topic: Understanding & communicating probabilistic forecasts
  o Invited presentation by Helen Greatrex (Penn State Univ) and Mark DeMaria (CIRA/Colorado State Univ)

• Day-3: Fri 18 June, 1230-1430 UTC
  o Topic: Resources for producing probabilistic forecasts
  o Invited presentation by Helen Ttitley (UK Met Office), Fernando Prates (ECMWF), and Ryan Torn (Univ at Albany-SUNY)
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

- Forecast Centers, 73
- Research Centers & Universities, 22
- NWP Centers, 11
- Private Sector, Insurance & Reinsurance, 2
- Humanitarian Organizations, 2

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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.
  o Subjective assessment - New Zealand MetService
  o Static cones based on past performance – HKO, CMA, RSMC Nadi, RSMC New Delhi, JTWC
  o Climatological cones with subjective modification – CHC
  o Objective statistical ensemble approach – RSMC Miami
  o Dynamical approach – RSMC Tokyo
  o Hybrid statistical-dynamical approach – RSMC La Reunion, BOM
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
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 (20 years) 11 mem. 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).
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.
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).
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)
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