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TRAINING ON FORECAST INTERPRETATION AND VERIFICATION

23-27 September 2024 | Noida, India

TRAINING OUTCOME REPORT

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BACKGROUND

The South Asian Hydromet Forum (SAHF) plays a vital role in strengthening regional collaboration on meteorological and hydrological services, especially given the vulnerability of South Asia (SA) to climate-related weather events. Established to address shared forecasting challenges, SAHF supports the enhancement of meteorological capacity and fosters a cooperative approach to early warning and disaster preparedness. In a region frequently impacted by extreme weather, from monsoon-induced flooding to droughts and cyclones, it is recognized that accurate forecasts are critical for ensuring public safety, economic stability, and disaster resilience. SAHF brings together national meteorological and hydrological services from across South Asia, facilitating shared solutions, technological advancement, and capacity-building efforts to improve forecast reliability and relevance.

In line with SAHF's overarching objectives, the recent Training On Forecast Interpretation And Verification, 23-27 September 2024 (hybrid format) was organized in collaboration with NCMRWF, India to enhance technical forecasting capabilities across NMHSs in South Asia. . This training targeted operational forecasters responsible for delivering critical weather forecasts, emphasizing skills that directly impact the quality and accuracy of predictions. By providing participants with advanced tools and methodologies, SAHF aims to strengthen early warning systems that support preparedness and response efforts in the face of severe weather. The training also provided a platform for discussing forecasting challenges unique to each participating country, promoting regional knowledge exchange and innovative problem-solving.

RATIONALE FOR THE TRAINING

As climate change intensifies, the need for accurate, timely, and reliable hydrometeorological services, especially in South Asia. Weather events are becoming more frequent and severe, demanding that the National Hydrology and Meteorological Services (NMHSs) adopt more sophisticated and robust forecasting approaches. While many NMHSs have developed foundational forecasting skills, there remains a need for more advanced expertise in areas such as probabilistic forecasting, model verification, and impact-based forecasting (IBF). These advanced techniques not only improve the precision of weather models but also ensure that the forecasts are actionable and relevant to various sectors such as agriculture, aviation, and disaster management.

The Training On Forecast Interpretation And Verification was developed in response to these needs, aiming to close specific knowledge and skill gaps within the NMHSs in the region. Participants were equipped with practical skills to enhance forecast accuracy and relevance, which are essential for minimizing the adverse impacts of extreme weather events on lives and livelihoods. Additionally, the training responded to the need for collaboration and information-sharing among the NMHSs. Recognizing that regional cooperation can enhance the effectiveness of forecasting efforts, SAHF structured the

training to facilitate peer learning, with participants exchanging insights and strategies based on their unique national challenges.

TRAINING OBJECTIVES

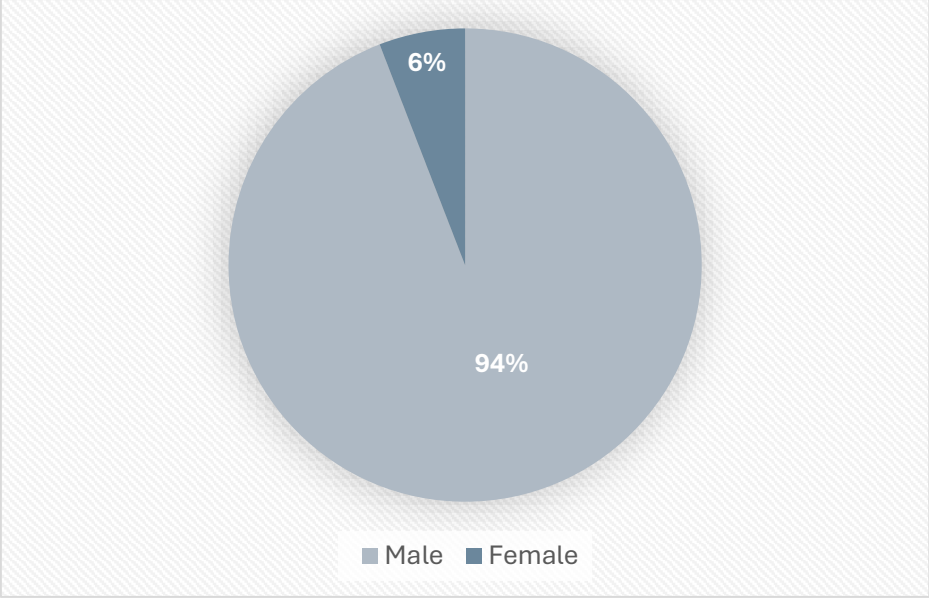
- To strengthen participants' ability to evaluate, interpret, and integrate multi-model, multi-scale NWP products for improved service delivery, enabling them to communicate actionable weather insights and anticipated impacts effectively to user-sector agencies.
- To enhance participants' skills in applying verification techniques to NWP products, thereby improving forecast accuracy, reliability, and user confidence in forecast services.
- To develop participants' capacity to utilize real-time satellite data for the monitoring, detection, and tracking of severe weather phenomena across South Asia, supporting timely and informed decision-making.

PARTICIPANTS

The training included 17 professionals from various National Meteorological and Hydrological Services (NMHSs) across South Asia. The gender distribution was predominantly male, with 16 male participants and 1 female participant. The attendees represented hydrometeorological institutions from SAHF member countries, including departments from Afghanistan, Bhutan, India, Maldives, Nepal, and Pakistan. Their roles varied from meteorologists and scientists to heads of forecasting departments, showcasing a range of responsibilities and expertise levels.

In terms of age, most participants were within the 25–40 age group (10 participants), followed by those in the 41–60 age range (6 participants), and one participant under 25. This blend of both seasoned professionals and younger participants introduced a diversity of perspectives, which enriched discussions and learning exchanges throughout the training.

This demographic composition fostered a dynamic learning environment, supporting the exchange of both established expertise and fresh ideas. The presence of experts alongside emerging professionals contributed to a rich and varied educational experience, effectively catering to the broad spectrum of experience and knowledge within the group.



1. Gender distribution among study participants

Knowledge and Skills Baseline

The pre-training assessment highlighted a varied baseline of knowledge and skills among participants, revealing strengths in foundational forecasting areas and potential gaps in more advanced techniques. Many participants rated their understanding of core concepts, like NWP products (extended range), coupled models, and basic forecast interpretation, as moderate to good. However, more specialized areas, including model evaluation tools (METs), statistical post-processing, and satellite data utilization, received lower ratings from several respondents. This suggested an opportunity for the training to focus on building a stronger grasp of these advanced areas, which are essential for producing accurate and actionable forecasts in complex weather conditions. Similarly, knowledge of verification techniques, particularly for deterministic and ensemble forecast products, showed moderate proficiency overall, but some participants expressed limited familiarity. Addressing these gaps could significantly enhance the group's ability to validate forecasts accurately and consistently.

Attitudes and Training Expectations

Expectations for the training were centred on practical skill-building and the application of theoretical knowledge to real-world scenarios. Participants were keen on learning techniques for interpreting and verifying NWP products, especially in areas with a direct impact on regional weather patterns and extreme events like heatwaves, cyclones, and heavy rainfall. This focus on severe weather reflects the group's intent to improve both the accuracy and reliability of forecasts to better serve their respective countries. Furthermore, many participants expressed an interest in developing proficiency with modern forecasting tools and platforms, particularly those related to satellite imagery, probabilistic verification, and statistical post-processing, aiming to leverage these resources for more nuanced and precise forecasting outputs.

Beyond technical skills, participants showed a strong desire to enhance their abilities in decision support and risk management, hoping to translate new forecasting knowledge into real-time support during critical weather situations. They viewed the training as an opportunity not only to refine their forecast outputs but also to enhance public safety through timely and accurate information. This multifaceted set of expectations highlights a need for a balanced training approach that combines hands-on practical training with theoretical insights, empowering participants to return to their roles equipped with a broad spectrum of skills to improve forecasting practices and decision-making in their home institutions.

HIGHLIGHTS

Session 1: Overview of NCMRWF Activities

Resource Person: Dr. Ashish Routray, Scientist-F, NCMRWF
Type of Methodology Used: Presentation

Summary of Session:
In this session, an overview of the National Centre for Medium Range Weather Forecasting (NCMRWF) was provided, highlighting its mission and operational services for various users. The presentation discussed the high-performance computing (HPC) resources utilized to enhance forecasting capabilities and introduced the NCMRWF Unified Model (NCUM) as part of its assimilation forecast system. Key topics included operational NWP models, data assimilation techniques for the GFS-based NWP model, and the significant impact of observational data on model performance over the past 25 years. Additionally, the session covered the intercomparison of forecasts with other NWP centers, the diverse range of users benefiting from the services, and key international partnerships, including collaborations with regional initiatives. The presentation concluded with insights into the development of coupled models, including the Coupled Global NWP System and the Coupled NWP System, emphasizing their role in advancing weather forecasting.

Output:

- Enhanced understanding of NCMRWF's mission, operational models, and data assimilation processes.
- Recognition of the impact of observations on forecast accuracy and improvements over time.
- Identification of key partnerships and user engagement strategies**.**

Issues/Concerns Raised and Resolutions:

- Quality control remains a significant concern in the forecasting process. Participants emphasized the need for targeted quality control measures tailored

specifically to the characteristics of individual forecasting models and the observational data used.
Resolution: To address this concern, it was suggested to focus on specific models and the observations associated with them. Implementing tailored quality control measures for each model will enhance accuracy and reliability in forecasting outcomes.

Session 2: Seamless Modelling System

Moderator: Dr. Saji Mohandas, Scientist-G, NCMRWF
Type of Methodology Used: Presentation

Summary of Session:

This session provided an in-depth overview of the seamless modeling system utilized for weather forecasting across various time ranges, including short, medium, extended, and long-range forecasts. A key focus was the seamless prediction paradigm, which promotes synergy between weather and climate prediction communities within a unified framework. The session highlighted the NCMRWF Unified Model (NCUM), discussing its Assimilated Forecast System and the capabilities of the model, which provides 7-day forecasts. The Kerala floods of 2018 served as a practical example illustrating the model's application.

Further discussions covered the development of a lighting scheme, and ongoing advancements related to boundary conditions (vertical and lateral) and urban modeling that accounts for anthropogenic urban heat fluxes. The exploration of chemical and cloud interactions included the I-FLOWS initiative, chem/cloud aerosol interactions, and specific applications such as DM-Chem and the Met Office Reading Urban Surface Exchange Scheme (MORUSES). Case studies, including the Amarnath Yatra model and the Manali floods, showcased the real-world applications of the NCUM.

The session also addressed uncertainties in NWP models, focusing on initial condition uncertainty, model dynamics, and the chaotic nature of weather forecasting. Discussions on the ensemble prediction system (EPS) included current research and development activities related to the NCUM global model and its EPS-based drought outlooks. Finally, the session presented a case study on the Wayanad cloud burst, emphasizing the future directions for modeling and data assimilation to enhance the accuracy and reliability of forecasts.

The discussion session highlighted key concerns and potential improvements in forecasting accuracy. Participants addressed the integration and accuracy of the lightning scheme within the National Centre for Medium Range Weather Forecasting Unified Model (NCUM), with particular attention to its reliability and fit within the larger model framework. Ground data assimilation was another focal point, as participants examined the need for standardized formats and configurations to enhance data consistency and

model performance. Additionally, the challenges of accurately forecasting fog events were discussed, emphasizing the need for refined model algorithms and better observational data integration to improve prediction of fog—a phenomenon crucial for public safety and transportation efficiency.

Output:

- Enhanced understanding of the Seamless Modelling System, integrating short, medium, and long-range weather forecasting.
- Insight into NCUM and its capabilities, including real-world applications demonstrated through case studies like the Kerala floods.
- Recognition of the importance of addressing uncertainties in NWP models to improve forecast reliability.
- Awareness of advancements in urban modeling and the integration of anthropogenic factors to enhance the accuracy of forecasts in urban settings.
- Understanding the role of the EPS in improving drought forecasting and ongoing research efforts in this area.

Session 3: Introduction to Coupled Models

Resource Person: Dr. Imran Ali, Scientist-D, NCMRWF
Type of Methodology Used: Presentation

Summary:
The session provided a comprehensive overview of the prediction of weather and climate through numerical modeling. Key topics included the Earth's climate system and the role of Earth System Models (ESMs) in improving predictive capabilities. The impact of coupling in models was emphasized, illustrated by experiments comparing coupled and uncoupled models, specifically highlighting the HadGem3 AO-based NCMRWF Global Coupled Model. The discussion covered significant issues related to the Indian Ocean, such as seasonal variations, the Indian Ocean Dipole (IOD), and intra-seasonal variability. Participants learned about the capabilities of the NCMRWF Global Coupled Model, which operates at a resolution of 60 km, and how it enhances extended range predictions. The session concluded with insights into regional coupled models and the status of coupled modeling initiatives at NCMRWF, supported by High-Performance Computing (HPC) resources.
Output:

- Enhanced understanding of the role of coupled models in weather and climate prediction.
- Insights into the Earth's climate system and the significance of ESMs.
- Recognition of the impact of model coupling on prediction accuracy, demonstrated through comparative experiments.

- Awareness of the NCMRWF Global Coupled Model's capabilities, including its application to seasonal variations and intra-seasonal variability in the Indian Ocean.
- Understanding the advancements in regional coupled modeling and the status of NCMRWF's coupled modeling initiatives supported by HPC.

Session 4: NWP Products (Extended Range) and Accessibility

Resource Person: Dr. Ankur Gupta, Scientist D, NCMRWF
Type of Methodology Used: Presentation

Summary of Session:

The session provided an in-depth introduction to the forecasting products offered by NCMRWF, focusing on their accessibility and practical applications. Participants were guided through the NCMRWF website. Participants were also introduced to key tools for analysing various parameters, including precipitation anomalies, 850 hPa geopotential height, and minimum and maximum temperature forecasts. The session highlighted the significance of the NCMRWF seasonal forecasting system, which employs categorical probabilistic forecasting methods for both seasonal temperature and precipitation predictions, including innovative techniques such as Prediction of Land and Urban Meteorology Events (PLUME) probabilistic forecasting.

Additionally, the discussion addressed the multi-range nature of weather and climate predictions, emphasizing the importance of understanding seasonal and sub-seasonal climate indices. The El Niño-Southern Oscillation (ENSO) was presented as a critical coupled phenomenon influencing seasonal forecasts, with verification plots illustrating the model's performance in predicting such phenomena.

Output:

- Familiarity with the seasonal forecasting system and its categorical probabilistic forecasts for temperature and precipitation.
- Recognition of the multi-range nature of weather and climate forecasts, including sub-seasonal climate indices.
- Insight into the importance of ENSO as a coupled phenomenon in seasonal forecasting, supported by verification plots.

Session 5: Extreme in Short, Medium, Sub Seasonal and Seasonal Scales |Linux Environment

Resource Persons: Dr. Anitha Gera, Scientist - F, Dr. Navin Chandra, Project Scientist- II, Dr. Sukhwinder Kaur, Project Scientist- II, Mr. Bibhuti Sharan Keshav, Project Scientist- II, NCMRWF
Type of Methodology Used: Presentation and Hands On Session

Summary of Session:

The session began with a comprehensive definition of extreme weather events, discussing global trends and the impact of climate change. It explored different types of extreme weather phenomena, particularly focusing on rainfall and heatwaves. Participants learned about the Categorical Verification Scores and the Symmetric Extremal Dependent Index (SEDI), alongside the Extreme Forecast Index (EFI) and the heat index utilized in operational forecasts. The NCMRWF's drought monitoring system was also highlighted, showcasing how extreme weather events are analyzed using sub-seasonal to seasonal (S2S) forecasting. Real-world examples, such as the rainfall extremes leading to flooding in Pakistan, illustrated the operational seasonal forecast capabilities and the significance of monitoring indices like the IOD.

The second part of the session provided a hands-on introduction to the Linux environment, focusing on supercomputing at NCMRWF. Participants learned about the configuration and advantages of using Linux for parallel computing, including how to access computing clusters and utilize basic commands for data transfer and storage. The session also introduced the Portable Batch System (PBS) for job control, allowing participants to understand HPC capabilities and how to manage computational tasks effectively. Discussions included practical applications of .pbs and .sbs scripts, reinforcing the importance of Linux in high-performance computing and weather forecasting.

Output:

- Enhanced understanding of extreme weather definitions, types, and global trends, particularly in the context of changing climate conditions.
- Insights into specific extreme weather indices such as SEDI, EFI, and their applications in operational forecasting.
- Knowledge of the operational seasonal forecasting process and real-world examples of extreme weather events.
- Hands-on experience with Linux , including basic commands, data transfer, and job control using PBS.

Session 6: Interpretation and Visualization of NWP Products

Resource Person: Dr. Anumeha Dube, Scientist-E, NCMRWF
Type of Methodology Used: Presentation

Summary of Session:

The session provided an in-depth look into the NCMRWF's NWP products and their operational use in forecasting. The presentation covered various deterministic models, including the NCUM (Global and Regional), and NCMRWF Ensemble Prediction System, (NEPS), explaining their configurations, resolutions, and forecast applications. Key products such as wind patterns, temperature changes, rainfall predictions, and Skew-T diagrams were discussed, with an emphasis on interpreting model outputs for weather analysis.

The session also examined the challenges of forecasting extreme events like heavy rainfall, extreme wind, and temperature deviations, highlighting how NWP models use climatological thresholds (like the 95th percentile) to predict these anomalies. The importance of indices such as Convective Available Potential Energy (CAPE), K Index, and convective parameters in severe weather prediction was explained. The session provided valuable insights into model performance, showcasing real-world case studies on how forecasts can sometimes differ from observations due to model limitations.

Output:

- Enhanced understanding of NWP models (NCUM, NEPS) and their operational use in weather forecasting.
- Insights into interpreting extreme weather predictions, including the use of climatology to identify unusual weather patterns.
- Familiarity with specific weather forecasting tools and indices like CAPE and the K Index.

Session 7: Statistical Pre and Post Processing Techniques

Moderators: Dr. Kondapalli Niranjan Kumar, Scientist – E, NCMRWF
Type of Methodology Used: Presentation

Summary of Session

The session focused on the role of statistical pre and post-processing techniques in improving NWP systems. It began with an overview of how forecast errors occur, addressing both systematic and probabilistic model errors. Participants were introduced to statistical methods for post-processing model outputs, particularly focusing on systematic error removal. Key concepts covered included Model Output Statistics (MOS) and Perfect Prognosis (PP), highlighting the differences between the two.

The discussion extended to statistical downscaling techniques, explaining the distinction between bias correction and downscaling. Various scaling methods, such as variance correction and quantile mapping, were discussed, with a particular focus on parametric quantile mapping to adjust model outputs for improved accuracy. Special patterns in forecasts were also touched upon, and the session concluded with an explanation of Kalman filters and their application in post-processing to refine forecasts.

Output:

- Understanding of forecast errors in NWP systems and techniques for error correction using statistical post-processing.
- Knowledge of key statistical methods such as MOS, Perfect Prognosis, and their applications in refining model outputs.
- Clear distinction between bias correction and downscaling techniques for improving model forecast accuracy.
- Familiarity with advanced statistical tools like variance correction, quantile mapping, and Kalman filters for systematic error removal.

Session 8: Forecast Verification

Resource Person: Dr. Nirajan Kumar
Type of Methodology Used: Presentation

Summary of Session:
The session focused on the principles and methods of forecast verification, particularly within the framework of seamless modeling systems at NCMRWF. It introduced the strategies used for verifying different types of forecast models, including continuous variables (such as mean values) and categorical events (binary outcomes). Participants learned about various verification scores applied to the NCUM global model, including categorical verification scores that assess the accuracy of specific forecast events. A detailed explanation was provided on feature-based verification, which evaluates forecasts in terms of the scale and spatial distribution of atmospheric features. The session also discussed upon process-oriented diagnostics and verification, offering insights into how models are evaluated based on physical processes. Spatial spectra analysis was highlighted as a key tool for verifying atmospheric features at different scales. The group discussed the datasets used for wavelength analysis, which helps in evaluating the performance of forecast models over different spatial and temporal scales.

Outputs:

- Understanding of different verification strategies for both continuous and categorical forecast variables.
- Familiarity with feature-based verification and its importance in assessing forecast accuracy on various spatial scales.
- Insight into process-oriented diagnostics for verifying model performance against physical processes.

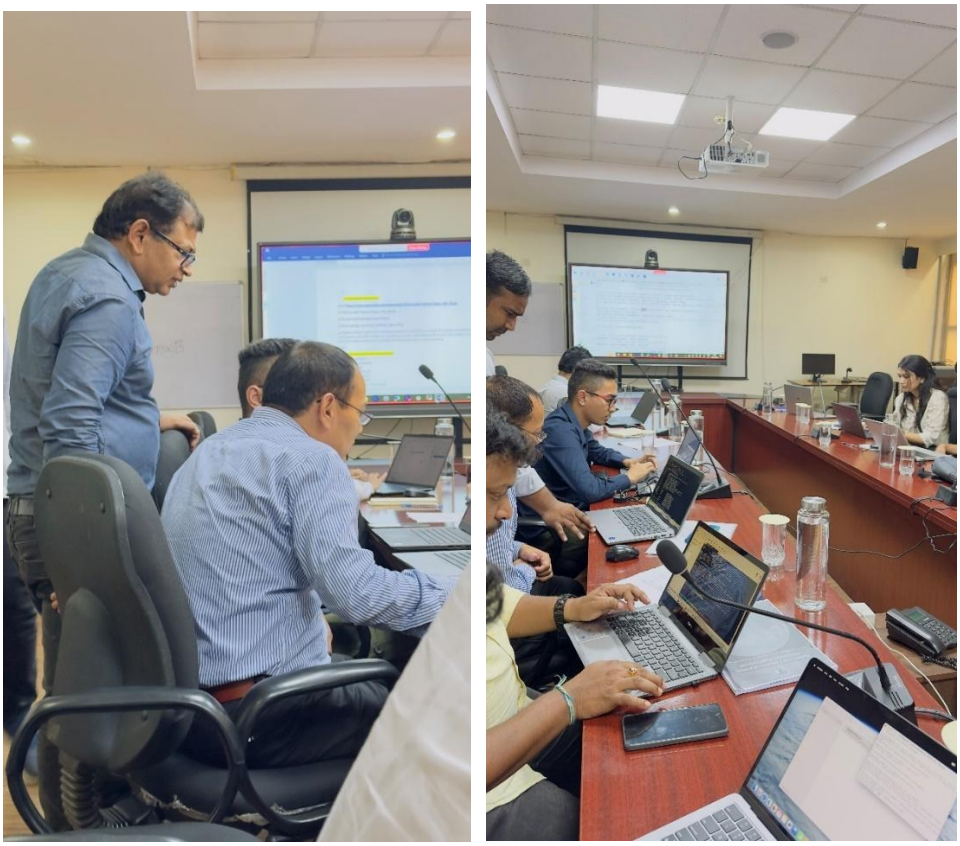
- Knowledge of the role of spatial spectra in the verification of atmospheric features across different wavelengths.

Session 9: Basics of Forecast Verification-Significance of Testing and Group Exercise

Resource Person: Dr. Sukhwinder Kaur, Project Scientist- I, Mr. Harvir Singh, Project Scientist- III, Mr. Gauri Shanker, Project Scientist- II, NCMRWF
Type of Methodology Used: Hands on and Group Exercise

Summary of Session:
This hands-on session introduced participants to the basics of forecast verification using the R programming environment. The session covered the process of installing the R environment and generating necessary data for forecast verification. Participants worked on data computation tasks, such as extracting relevant data, calculating biases, and plotting results. A focus was placed on understanding how to generate graphs that visualize biases and errors in forecasts.

Key computational tools and methods introduced included the Root Mean Square Error (RMSE) for evaluating forecast accuracy and handling station data. Participants also gained practical experience working with NetCDF files, which are commonly used for storing large, multidimensional scientific data sets. Through group exercises, participants collaboratively applied these concepts to real-world datasets.



2. Participants and experts during the hands on session

Outputs:

- Practical experience in setting up and working within the R environment for forecast verification.
- Hands-on skills in data extraction, bias computation, and plotting bias for forecast analysis.
- Understanding of RMSE as a key metric for evaluating forecast performance.
- Familiarity with handling and analysing NetCDF files for station data and forecast verification.

Session 10: Advanced Forecast Verification- Contiguous Rain Area (CRA)

Resource Person: Dr. Greeshma M Mohan, Project Scientist, NCMRWF
Type of Methodology Used: Presentation and Demonstration

Summary of Session:
The session provided an in-depth exploration of CRA verification, a technique used to address the shortcomings of traditional forecast verification methods. Traditional methods, while useful, often fail to account for spatial displacement errors and the structural characteristics of forecasted phenomena like precipitation. The CRA method helps overcome these limitations by comparing forecasted and observed spatial patterns. Participants were introduced to CraR, a software package developed by NCMRWF to implement CRA verification. The methodology behind CRA was explained, with a focus on error decomposition, which breaks down forecast errors into three components: location error, volume error, and pattern error. This allows a more nuanced understanding of where forecast models deviate from actual observations.

The session also featured a real-case discussion, where participants reviewed a case study illustrating the practical application of CRA in forecast verification. The demonstration of the CraR package walked through its features, showcasing how it can be used to apply CRA methodology to actual forecast data. A hands-on segment followed, where participants worked with the software to analyze real data.
Outputs:

- Understanding of the drawbacks of traditional forecast verification methods and how CRA addresses them.
- Knowledge of the CRA methodology and its components: location, volume, and pattern errors.
- Practical exposure to the CraR package developed by NCMRWF, and its application in real case forecast verification.
- Hands-on experience with advanced forecast verification techniques using CRA to improve spatial and structural accuracy.

Session 11: Model Evaluation Tools (MET; MODE)

Resource Person: Mr. Harvir Singh
Type of Methodology Used: Presentation and Demonstration

Summary of Session:

This session introduced participants to the Model Evaluation Tools (MET), specifically focusing on MET Plus and the MODE (Method for Object-Based Diagnostic Evaluation) module. The session began with an overview of MET Plus, a suite of tools designed for forecast evaluation, followed by an explanation of how MET tools are categorized based on their functionalities and applications. The concept of spatial verification was emphasized, which goes beyond point-based verification methods by evaluating forecasts spatially, particularly in cases of rainfall, temperature, and other weather events. The discussion covered the importance of object-based verification, a methodology that identifies and compares spatial objects (such as areas of rainfall or high temperatures) in forecast and observation data. This method provides a more detailed assessment of forecast performance, especially when dealing with complex weather systems. Participants were walked through the object-based verification methodology, including a step-by-step flow chart for performing the verification process, from identifying forecast objects to comparing them with observations. The session concluded with case studies that illustrated how object-based verification is used in real-world applications, such as verifying maximum temperature (Tmax) forecasts.

Outputs:

- Understanding of MET Plus tools and their categorization for model evaluation and verification.
- Knowledge of spatial and object-based verification methods and why they provide a more detailed analysis than traditional point-based methods.
- Familiarity with the workflow for object-based verification, from data extraction to performance analysis.
- Application of object-based verification techniques in case studies, particularly for Tmax forecasting.

Session 12: MET Used for Tropical Cyclone Verification

Resource Persons: Dr. Mohan S Thota, Scientist E, Mr. Sushant Kumar, Project Scientist-III; Dr. Abhijit Sarkar Scientist-F; Dr. Harvir Singh, NCMRWF
Type of Methodology Used: Presentation and Hands on

Summary of Session:

In Session 12, an informative discussion was held on the verification of tropical cyclone (TC) forecasts, emphasizing the significance of utilizing Model Evaluation Tools (MET) for this purpose. The session began with an examination of trends and distribution patterns

of rapid intensification (RI) cyclones, highlighting their relevance for effective forecasting. Participants were introduced to the NCUM (NCMRWF Unified Model) and its specific configurations, as well as the operational use of TC trackers at the NCMRWF, which is adapted from methodologies used by the United Kingdom Met Office (UKMO).

The lecture covered the verification methodologies available within MET, including TC pairs, TC statistics, and TC landers, providing insights into how these tools facilitate the evaluation of cyclone forecasts. A hands-on demonstration allowed participants to engage directly with MET TC tools, focusing on practical applications such as analysing basic track errors, setting model parameters, and scripting. This interactive segment reinforced the concepts discussed and enhanced participants' understanding of how to effectively utilize these tools in real-world scenarios.

The session concluded with a discussion on current and future cyclone activity in the North Indian Ocean (NIO), examining grid and point statistics that inform forecasting practices. By the end of the session, participants gained a comprehensive understanding of the significance of TC verification in enhancing forecast accuracy and public safety, as well as familiarity with MET tools tailored for tropical cyclone evaluation.

Outputs:

- Enhanced understanding of the significance of TC verification in improving forecast accuracy and ensuring public safety.
- Familiarity with MET tools designed specifically for tropical cyclone evaluation and their functionalities.
- Knowledge of various verification methodologies, including spatial and object-based verification approaches.
- Insights gained from case studies that demonstrate the application of MET in real-world tropical cyclone scenarios.
- Awareness of key performance metrics that are crucial for evaluating the effectiveness of tropical cyclone forecasts.

Session 13: Familiarization Of Ensemble Products

Resource Person: Dr. Ashu Mamgain, Scientist C, NCMRWF
Type of Methodology Used: Presentation

Summary of Session:

In Lecture 11, the focus was on the interpretation and verification of probabilistic forecasts, led by a presentation that delved into the fundamentals of probabilistic forecasting and its significance in weather prediction. The session began with an exploration of the sources of error in NWP and the associated uncertainties that affect forecast reliability. Key terminologies related to ensemble forecasting were introduced, along with a discussion on the components of ensemble forecasts, including perturbation techniques and the salient features of the NCMRWF Global Ensemble Prediction System

(NEPS-G). Participants learned about various ensemble products, such as spaghetti plots, ensemble mean and spread, and plume diagrams, which help visualize and quantify forecast uncertainty.

The interpretation of probabilistic forecasts was illustrated through case studies, including recent tropical cyclone events and examples of extreme temperature interpretations. The session also included a discussion on transformation matrices, initial condition selection for ensemble forecasts, model preference, and the challenges associated with ensemble prediction. By the end of the lecture, participants gained a comprehensive understanding of the principles underlying probabilistic forecasting, familiarized themselves with ensemble forecasting methodologies, and recognized the importance of effective interpretation techniques in real-world forecasting scenarios.

The discussion segment of the lecture addressed several critical topics related to probabilistic forecasting and ensemble prediction. One key area of focus was the use of transformation matrices, which help to elucidate the relationships between different forecast outputs and improve the understanding of forecast variability. The importance of selecting appropriate initial conditions for ensemble forecasts was also emphasized, as the accuracy of these conditions directly influences forecast outcomes. Participants explored the concept of model preference, weighing the strengths and weaknesses of various models in the context of specific forecasting situations. Additionally, the discussion highlighted the challenges associated with ensemble prediction, including issues related to model performance, the interpretation of ensemble outputs, and the need for continuous improvement in ensemble forecasting techniques.

Output

- Enhanced understanding of the principles and applications of probabilistic forecasting.
- Familiarity with ensemble forecasting methodologies and their relevance in assessing forecast uncertainty.
- Knowledge of interpretation techniques for probabilistic forecasts, supported by real-world case studies.
- Awareness of the challenges and considerations involved in ensemble prediction and model selection.

Session 14: Interpretation And Verification Of Probalistic Forecasts

Resource Person: Dr. Anumeha Dube
Type of Methodology Used: Presentation

Summary of Session:

In session 14, the focus was on understanding and applying verification techniques for probabilistic and deterministic forecasts, with an emphasis on what makes a forecast reliable and why verification is essential. The session began with an introduction to the

basics of forecast verification, discussing the purpose and value of this process in enhancing forecast accuracy and reliability. Participants learned about key verification metrics, such as the Brier score, which evaluates the accuracy of probabilistic forecasts, and reliability plots, which assess how well forecast probabilities match observed outcomes. A practical exercise on creating reliability diagrams allowed participants to deepen their understanding of this concept, while discussions on ROC plots and economic value diagrams demonstrated additional ways to evaluate forecast performance.

The session also introduced the continuous ranked probabilistic score (CRPS), a metric used to measure the accuracy of continuous probabilistic forecasts, and explained how these scores can guide improvements in forecast quality. During the discussion, the economic value diagram was further explored, focusing on its relevance for specific user sectors. Participants considered how ensemble forecast products are tailored to meet the unique requirements of various sectors, underscoring the role of probabilistic forecasting in practical, real-world applications.

Output

- Understanding of the fundamentals of forecast verification and its importance in improving forecast reliability.
- Knowledge of key verification metrics, including the Brier score, reliability plots, ROC plots, economic value diagrams, and CRPS.
- Familiarity with techniques for interpreting and constructing reliability diagrams to assess forecast accuracy.
- Insights into the application of probabilistic forecast verification in user sectors, emphasizing the relevance of ensemble products for sector-specific needs.

Session 15: Deterministic And Ensemble Lighting Forecast

Resource Person: Dr. Kiran Prasad Siripurapu, Project Scientist- III; Dr. Kumarjit Saha, Project Scientist, NCMRWF
Type of Methodology Used: Hands on

Summary of Session:

This session provided participants with hands-on training in both deterministic and ensemble lightning forecasting. The session began with an introduction to deterministic and probabilistic scoring methods, which are essential for evaluating forecast accuracy. Participants learned about the basics of lightning formation, including the physical processes that lead to lightning and the associated hazards. Key verification metrics were covered, such as the equitable threat score and the fractional skill score, both of which are useful for assessing the accuracy of lightning forecasts. The concept of the "double penalty effect" was also discussed, highlighting challenges in forecast evaluation when predicting high-impact events like lightning.

Participants were guided through the practical steps of creating an environment for running forecasting models, accessing necessary packages, and setting up tools for real-time forecasting and verification.

Output

- Familiarity with methods to evaluate forecast accuracy in lightning prediction.
- Insight into the conditions that lead to lightning events and the associated risks.
- Experience with metrics like equitable threat score and fractional skill score for assessing lightning forecasts.
- Hands-on experience in initiating forecasting environments, setting up necessary packages, and preparing tools for lightning forecast evaluation.

Session 16: Verification of Probalistic Forecast

Resource Person: Dr. Prabodha Kumar Pradhan - Project Scientist-III; Mr. Gauri, NCMRWF
Type of Methodology Used: Presentation and Hands on

Summary of Session:
This session focused on the verification methods used to assess the accuracy of probabilistic forecasts. The lecture component introduced participants to important verification metrics, including bias, root mean square error (RMSE), forecast spread, the Brier score, and the area under the ROC curve. Each metric was explained in terms of its role in evaluating different aspects of forecast quality, from bias assessment to reliability and accuracy of probabilistic predictions.

During the hands-on segment, participants practiced calculating RMSE and forecast spread, gaining practical experience in applying these metrics to real-world probabilistic forecast data.

Output

- Knowledge of essential metrics for probabilistic forecast verification, including bias, RMSE, spread, Brier score, and area under the ROC curve.
- Practical experience in calculating RMSE and spread, strengthening participants' ability to assess forecast accuracy.
- Familiarity with using verification metrics to evaluate forecast performance and reliability.

Session 17: Special Products And Observations-Satellite Data Utilization For Monitoring , Detection And Movement Of Severe Weather Phenomena Over South Asia

Resource Person: Dr. Srinivas, Scientist E, NCMRWF
Type of Methodology Used: Presentation

Summary of Session:

This session provided an overview of the use of satellite data in monitoring and forecasting severe weather events in South Asia. It began with an introduction to remote sensing fundamentals, covering satellite characteristics and the role of real-time NWP in severe weather monitoring. The evolution of observing systems and the critical role of satellite data in sourcing, assimilation, and analysis at the NCMRWF were discussed, with a particular focus on data from Indian satellites. Specific applications included rainfall monitoring, flood forecasting, and the use of the Dvorak technique for estimating cyclone intensity. The session also highlighted available satellite product resources and their applications in severe weather forecasting. The discussion concluded with insights into the use of satellite data for assessing wind speed.

Output

- Gained knowledge of how satellite data supports real-time NWP for severe weather monitoring.
- Insight into the contributions of Indian satellites in rainfall and flood monitoring.
- Understanding of Dvorak Technique method for estimating cyclone intensity from satellite imagery.
- Familiarity with resources and tools for accessing satellite-based observations relevant to severe weather forecasting.
- Learned about the application of satellite data for evaluating wind speed in severe weather contexts.

Session 18: High Resolution Rapid Refresh (RRR) NWP Products

Resource Person: Dr. Hari Prasad, Scientist E, NCMRWF
Type of Methodology Used: Lecture

Summary of Session:

This session focused on the High Resolution Rapid Refresh (RRR) numerical weather prediction (NWP) products and their applications in forecasting. Participants were introduced to the source code and access points for RRR products, as well as test cases that demonstrated RRR applications in forecasting rainfall and cyclone events. The discussion covered key aspects such as ensemble product usage, resolution requirements, and data sourcing. Additionally, the session provided insights into accessing state-specific data, lightning prediction products, and the integration of tools like WARF (Weather Research and Forecasting), GIS, and WRF (Weather Research and Forecasting) for comprehensive weather analysis.

Outputs:

- Gained knowledge of the source code, access points, and setup for using RRR NWP products.

- Insight into the application of RRR in rainfall and cyclone forecasting through real-world test cases.
- Understanding of the role of ensemble products, data resolution, and sourcing in high-resolution weather forecasting.
- Awareness of data resources available for localized forecasts, including lightning prediction.
- Knowledge of using WARF, GIS, and WRF tools to enhance weather prediction and analysis.

3. Participants and experts during the visit to the HPC facility at NCMRWF (newly launched Arunika HPC system)

KNOWLEDGE, SKILLS, AND ABILITIES (KSA) FINDINGS

The KSA findings post-training indicate a significant enhancement in the participants' knowledge, skills, and abilities related to forecasting and verification techniques. Many participants reported a marked improvement in their understanding of advanced verification methods, particularly in interpreting and applying NWP products. They noted that the training provided them with a clearer framework for assessing the reliability and

accuracy of forecasts, which is crucial for enhancing the quality of meteorological services provided by their respective agencies.

In terms of skills, there was a noticeable increase in participants' confidence in utilizing advanced forecasting tools and techniques. Participants highlighted their improved proficiency in applying statistical verification methods to evaluate forecast accuracy. This skill set enables them to analyze discrepancies between predicted and observed weather patterns, leading to more accurate forecasting. Participants expressed a strong desire for more extensive hands-on sessions, suggesting that practical training enhances their learning experience and aids in the retention of complex concepts. Participants highlighted that additional group activities could further foster collaboration among forecasters.

Regarding abilities, the training equipped participants with improved analytical skills and a deeper understanding of how to collaborate effectively within teams. They acknowledged the importance of sharing insights and strategies with colleagues to bolster collective forecasting efforts. Participants reported intentions to explore innovative ideas and approaches, including integrating new verification techniques into their routine practices. The training encouraged them to engage in ongoing professional development, with several expressing interest in forming mentorship connections to support their growth in meteorological practices.

Moreover, the feedback highlighted specific areas where participants gained practical knowledge, such as the application of extreme weather forecasting techniques and the integration of real-world case studies into their work. Many participants recommended the establishment of a training portal to provide access to reference materials and contacts for ongoing support. Overall, the KSA findings underscore the training's positive impact on participants' professional development and their commitment to advancing their capabilities in forecasting and collaboration within their organizations.

4: Participants' overall ratings of the training's alignment and structure

Learning:

- Participants reported a deeper understanding of advanced model verification techniques and the interpretation of NWP products. This included practical applications for assessing forecast reliability, particularly in extreme weather events, and utilizing statistics to minimize discrepancies between observed and predicted values.
- The training significantly improved participants' confidence in disseminating weather information. Many expressed a commitment to explore new methodologies and integrate the training concepts into their daily work practices, reflecting a proactive approach to ongoing professional development.
- Feedback emphasized the need for more hands-on sessions, suggesting that practical training enhances engagement and understanding of complex concepts. Participants also valued the collaborative environment fostered during the training, which encouraged the sharing of experiences and strategies for effective forecasting among diverse regional participants.
- Participants highlighted the effectiveness of using real-world case studies during training, which helped contextualize theoretical knowledge and improved their forecasting practices. Suggestions were made to include specific case studies related to severe weather impacts, especially for aviation forecasting.
- Many participants requested the establishment of a training portal for easy access to reference materials, training presentations, and ongoing support from resource persons. This would facilitate continuous learning and allow for refreshers on key topics discussed during the training

Training Gaps:

- Participants noted that the duration of the training was not sufficient to cover all aspects of verification in depth, suggesting that longer sessions are necessary for comprehensive learning.
- There was a consensus that more practical, hands-on sessions are needed to enhance understanding and application of advanced verification techniques, enabling participants to gain real-world experience.
- Some participants suggested that better pre-training preparations, such as providing relevant materials or guidance links beforehand, could improve readiness and understanding of training content.
- There was a call for regular training sessions to address ongoing learning needs and to keep participants updated on advancements in forecasting technologies and methodologies.
- Participants expressed a desire for the inclusion of more relevant case studies during training to facilitate practical understanding of the concepts taught.
- Suggestions were made to improve opportunities for collaboration and knowledge sharing among participants from different countries, which could enrich the learning experience.

FEEDBACK

- Participants expressed that the training significantly enhanced their forecasting skills and improved their confidence in applying new techniques and methodologies in their daily work.
- The theoretical components of the training were well-received, with participants appreciating the depth of knowledge shared. However, many also highlighted the need for more practical sessions to solidify their understanding and application of the concepts learned.
- There was a call for increased hands-on practice, with participants suggesting that practical assignments and group activities would enhance engagement and learning outcomes.
- Participants recommended organizing similar training workshops regularly to keep pace with advancements in meteorological forecasting and to provide ongoing opportunities for skill development.
- While the content was highly regarded, some participants pointed out logistical challenges, such as delays in travel and visa documentation, which impacted their experience.
- Participants requested that training materials, presentations, and reference documents be made available post-training to aid in refreshers and knowledge sharing among colleagues.
- Participants recognized the importance of fostering collaboration among attendees from various countries and suggested that future training could benefit from enhanced networking opportunities.

RECOMMENDATIONS

Delivery:

- Extend the training duration to allow for comprehensive coverage of all topics, including ample time for practical sessions and hands-on activities.
- Incorporate more hands-on training exercises and group activities to ensure participants can apply theoretical knowledge in real-world scenarios effectively.
- Address logistical issues by ensuring timely arrangements for travel and visa documentation, allowing participants to focus on learning rather than administrative challenges.
- Create structured networking sessions that enable participants to share experiences and collaborate on future projects, enhancing the overall training experience.

Usefulness:

- Provide detailed training materials that participants can reference post-training, ensuring ongoing learning and application of skills.
- Include case studies and examples relevant to participants' contexts, which will help bridge the gap between theory and practical application.

- Utilize the SAHF Knowledge Hub (SKHub) to provide access to resources, training materials, and contact information for trainers and experts to facilitate ongoing support.

Next Steps (based on the feedback session held after the training):

- Provide additional training on interpreting specific forecast products tailored to local and regional needs, such as seasonal, extreme event, and probabilistic forecasts.
- Support participants in developing their own digital models to strengthen in-country forecasting capabilities, with a focus on products that address high-impact weather events.
- Conduct targeted workshops on generating and applying IBF products, particularly for sectors with high vulnerability, like agriculture and disaster management.
- Include hands-on sessions in data assimilation techniques to enhance model accuracy and reliability, allowing forecasters to integrate real-time data effectively into their predictions.
- Provide advanced training on aviation sector forecasting, addressing the specific needs for high-precision, real-time forecasts crucial for safety and navigation.
- Include practical sessions in advanced scripting (e.g., Python or R) for custom forecast generation, automated data handling, and model output analysis to improve efficiency and skills in data processing.
- Increase exposure to advanced verification techniques such as CRA and MODE to improve forecast accuracy and validation.
- Utilise SKHub as a resource portal with accessible materials, including contact information for trainers, relevant datasets, documentation on forecast verification, and post-training support to ensure sustained learning.

ANNEX 1: TRAINING NOTE AND AGENDA

TRAINING ON FORECAST INTERPRETATION AND VERIFICATION

Co-organized by RIMES and NCMRWF, India
Venue: Noida, Uttar Pradesh, India, 23-27 September 2024

CONCEPT NOTE

Background

The South Asia Hydromet Forum (SAHF) aims to enhance forecasting and operational service delivery by National Meteorological and Hydrological Services (NMHSs) in South Asia. Financially and technically supported by the World Bank, RIMES has conducted extensive consultations with NMHSs through the SAHF thematic Working Groups (WGs), which are represented by the NMHSs of SAHF member states. One crucial need identified is the capacity enhancement of the NMHSs in the interpretation and verification of numerical weather prediction (NWP) products, to improve their operational weather forecasting and support multi-hazard impact-based forecasting (MHEWS) for various user sectors.

In collaboration with the National Centre for Medium Range Weather Forecasting (NCMRWF), India, the CARE-SAHF, RIMES has scheduled a training on NWP forecast interpretation and verification from 23-27 September 2024 at NCMRWF Headquarters, Noida, Uttar Pradesh, India.

The training is intended to enhance participants' ability to examine, assess, and utilize Numerical Weather Prediction (NWP) products, and to provide the required skills for operational forecasters to implement verification of these products. The training has the following objectives:

- To enhance participants' ability to examine, assess, and interpret multi-model and multi-scale NWP products for effective service delivery through quantifying actionable information and to communicate with the user sector agencies with anticipated impacts.
- To improve participants' ability to implement verification of NWP products to enhance the skill and reliability of forecast products.
- Use of real-time satellite data for monitoring, detection and movement of severe weather phenomena over South Asia (SA)

Expected Outcome of the Training

The expected outcomes of the training are:

- Improve access and capability of operational forecasts to examine and interpret NWP products relevant to the South Asia region and their respective countries.

- Develop forecasters' skills to implement verification of NWP products, making them more relevant for their respective countries.

TRAINING AGENDA

Days	Programme
Day 1	**Opening session** - *Welcome Remarks* - *Purpose and goals of the training* - *Introduction of participants and instructors*
	TECHNICAL SESSIONS **Session I:** A) Overview of NCMRWF activities B) Seamless Modelling systems at NCMRWF **Session II:** **C) Familiarization of NWP products (accessibility)** • *Medium Range and Extended Range Forecast products* • *Understanding drivers for extremes at short, medium, sub-seasonal and seasonal scales* • *Introduction to coupled models*
Day 2	**Session III: Basics of Forecast Verification** • *Overview of statistical interpretations* • *Overview of forecast verifications* • *General framework for forecast verifications* • *Basic statistical concepts and definitions* **Session IV: Basics of Forecast Verification - Hands-on** • *Significance of testing* • *Group Exercise: Calculating basic statistics* • *Statistical Models- Regression* • *Group Exercise- Under the use and interpretation of regression models*
Day 3	**Session V: Advance Forecast Verification** • *Spatial verification methods* • *Model Evaluation Tools (package)* • *Exercise: Verifications of deterministic forecasts*

	• *Exercise: Forecasts verification for common events- cyclones, heavy rainfall and heatwaves (include NWP and satellite data & images*
Day 4	**Session VI: Forecast Verification of Probabilistic Forecasts** • *Interpretation and verification for probabilistic forecasts* • *Exercise: Verifications of probabilistic forecasts* • *Group Exercise (Case Study): Use and interpretation of NWP products for forecasting and monitoring extreme events*
Day 5	**Session VII: Special products and observations** • *Satellite Data Utilization for monitoring, detection and movement of severe weather phenomena over South Asia* • *High-resolution rapid refresh NWP products and relevance in the prediction and monitoring of extremes in the region and national level* **Session VIII: Feedback / Doubt clarification / Interaction**

ANNEX 2: PARTICIPANTS LIST

S No.	Name	Designation	Organization	Gender
1.	Ahmed Muslim	Meteorologist	Maldives Meteorological Service (MMS)	Male
2.	Ahmed Nazeer	Assistant Meteorologist	Maldives Meteorological Service (MMS)	Male
3.	Ananda Kumar Das	Scientist F	India Meteorological Department (IMD)	Male
4.	Esmatullah Mohammadi	Member of the General Management of satellite	AMD	Male
5.	Ghulam Sakhi Alizadah	Weather Forecaster	AMD	Male
6.	Mohamed Shahudh	Meteorologist	Maldives Meteorological Service (MMS)	Male
7.	Mohammad Jawed Moradi	Member of Satellite management	AMD	Male
8.	Mr. Fawad Auobui	Head of Forecast Division	AMD	Male
9.	Mr. Muhammad Farooq	Deputy Director	NWFC, Islamabad	Male
10.	Mr. Rana Muhammad Atif	Deputy Director	Met. Office, Lahore	Male
11.	Mujeeb Ullah Hakimiar		AMD	Male
12.	Rahmatullah. Munib	Member of Aviation Meteorology	AMD	Male
13.	Ranjit Tamang	Sr. Meteorology/Hydrology Technician/Weather Forecaster	National Center for Hydrology and Meteorology (NCHM)	Male
14.	Saroj Acharya	Meteorology/Hydrology Officer	National Center for Hydrology and Meteorology (NCHM)	Male
15.	Saroj Pudasainee	Meteorologist	Department of Hydrology and Meteorology	Male
16.	Sayed Taher Atlas	Forecaster	AMD	Male
17.	Yojana Bastakoti	Meteorologist	Department of Hydrology and Meteorology	Female

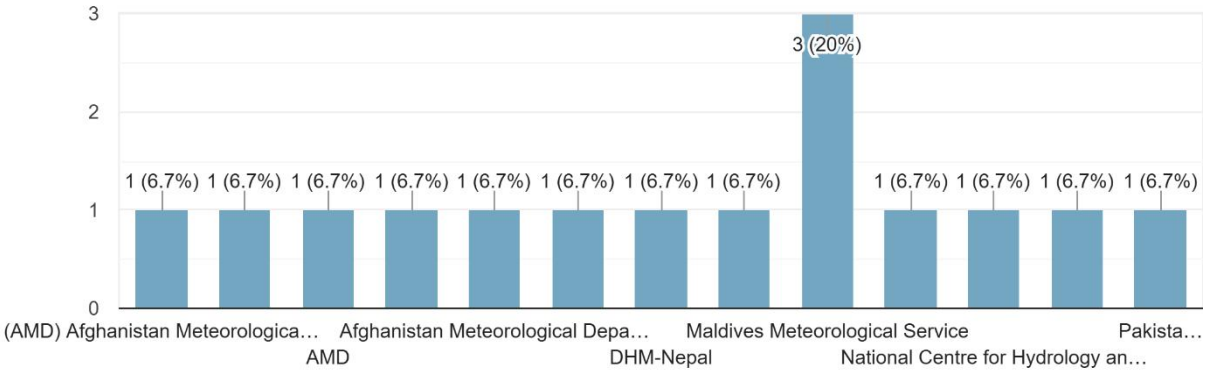
ANNEX 3: TRAINING ASSESSMENT

PRE TRAINING ASSESSMENT

RESPONDENT INFORMATION

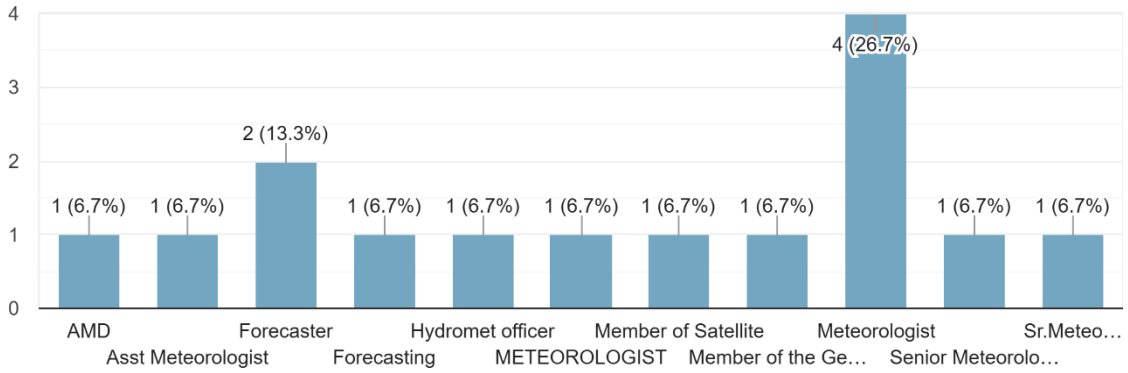
Institution:

15 responses



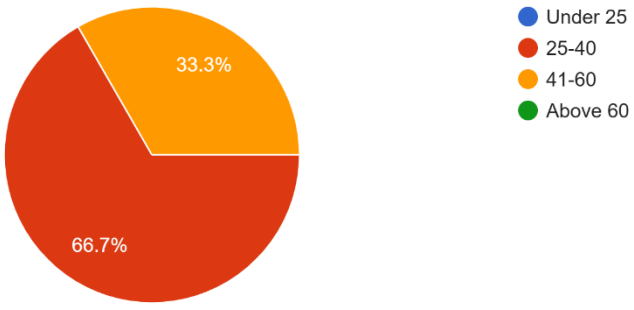
Designation in Institution:

15 responses



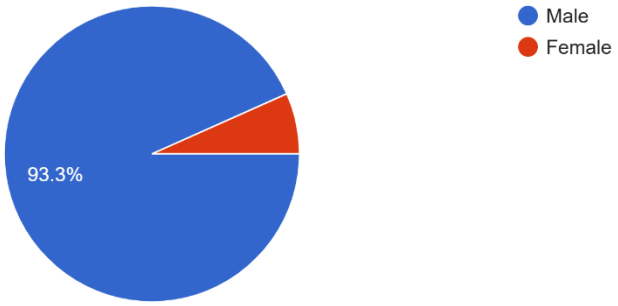
Age Group:

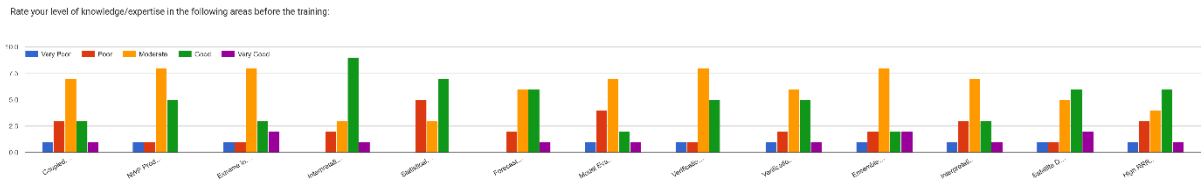
15 responses



Gender:

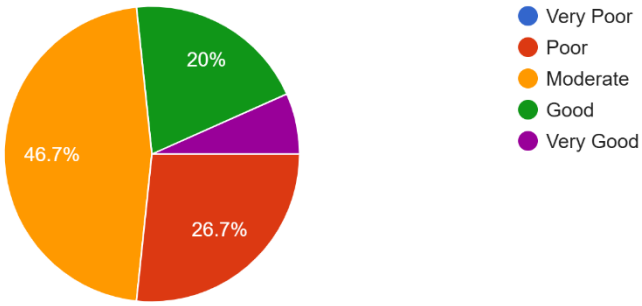
15 responses





Rate your level of experience in integrating climate change considerations into your professional work.

15 responses



How can this training help you in your work?

(Please describe your expectations and what you hope to gain from this training.)

15 responses

- Over all it will help me to improve my Weather Forecast based on model out puts, specifically for our region .
- I hope to learn new, updated concepts and skills from the training.
- Learning about techniques used for extreme precipitation events predictions
- Help verify performance of currently used nwp products in operational forecast.

- learn how to verify the accuracy of current model products we are using which will improve our forecast
- This training can equip me with a deeper understanding of meteorological concepts, enabling me to provide more accurate, informative, and contextually relevant information related to weather and NWP models. This training also provides me the concepts of bias correction for the improvement of weather forecasting.
- Methods and technique for conducting verification. Familiarization with NCMRWF.

Can work to clarify our prediction

What are your expectations from this training?

(Please share any specific topics or skills you are interested in learning more about.)

15 responses

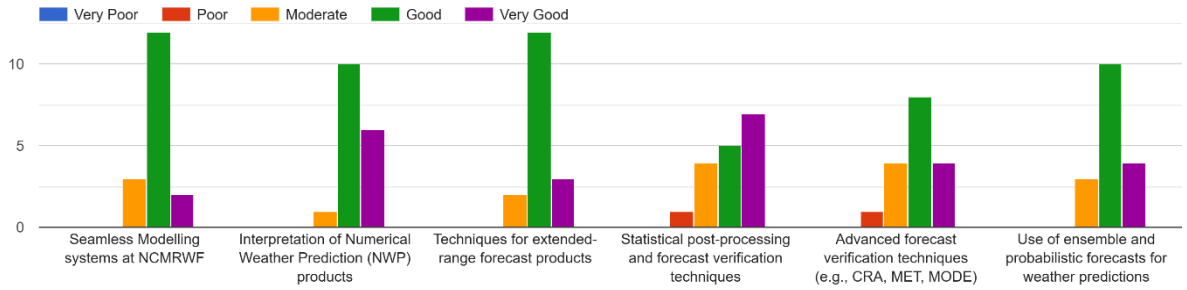
- TAF validations for Aviation services, Impact based Sever weather Forecast specifically Heat Wave commencement, Torrential rainfall e.t.c
- I hope to receive thorough training that will enable me to effectively validate our forecasts.
- Numerical weather prediction model used for sub seasonal to seasonal forecasts
- Learn methods and algorithms used to verify model products.
- Learn different tools and techniques used for weather model interpretation and verification
- I expect this training to provide me with a comprehensive understanding of forecast interpretation and verification techniques. I hope to learn how to effectively analyze and evaluate different types of forecasts, identify potential errors, and communicate forecast information accurately and effectively. Additionally, I am eager to explore how these skills can be applied in various real-world contexts, such as decision-making and risk management.
- Verification of NWP products

POST TRAINING ASSESSMENT

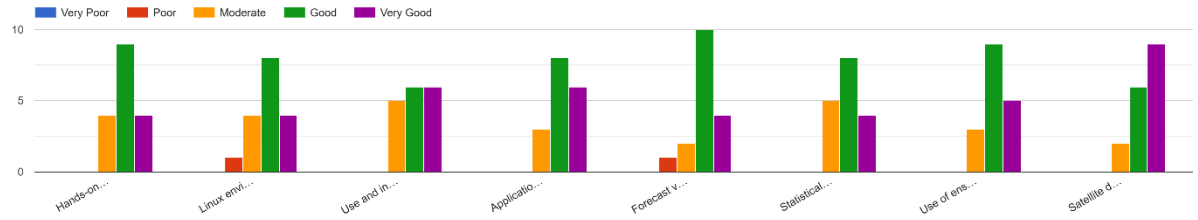
Knowledge, Skills and Attitude (KAP)

Training Alignment and Structure

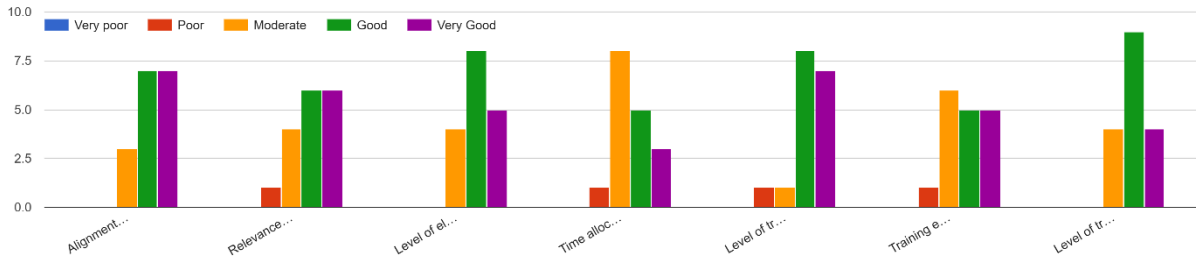
Rate your level of knowledge/expertise in the following areas after the training:



Rate your level of knowledge/expertise in the following areas after the training:

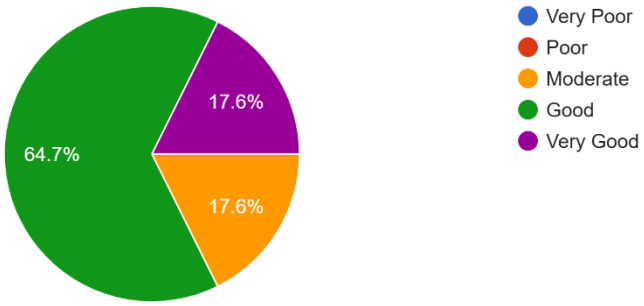


Grade the specific parts of the training with regard to your satisfaction level:



Rate your likelihood of integrating climate change considerations into your professional work after the training.

17 responses



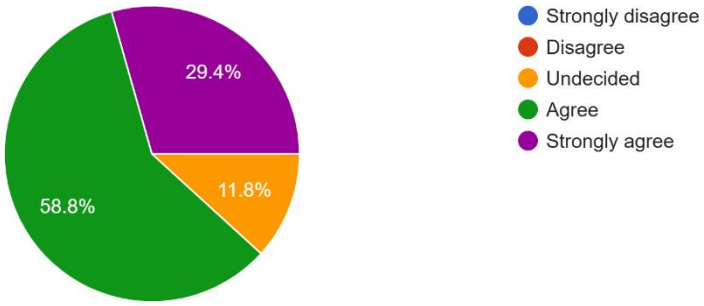
Among your expectations from this training, which ones were not met?

17 responses

- This training was very useful for my career and for my work experience
- The trainee need to bring a few event/case data (including few sets of observations) of their region. So that a small project by each trainer or a group of tainees might have been carried out at the last day with the techniques they learned in the training.
- Exceptions were well achieved
- One of my expectations that wasn't met is the limited hands-on sessions provided. Additionally, I expected more assignments to actively engage participants, which was lacking.
- If program settings documents along with theoretical documents and PPT were provided would be very helpful
- The objective of the training was to interprete and verify the NWP products which were explained more than expectations.
- More time for practical session

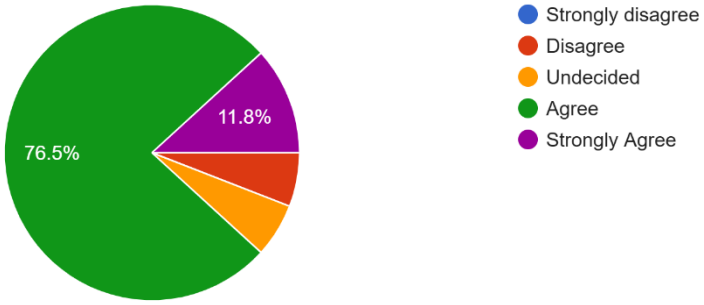
The training was designed based on the needs of the target beneficiaries.

17 responses



The training followed an inclusive and participatory approach to engage stakeholders to ensure relevance to local needs and ownership

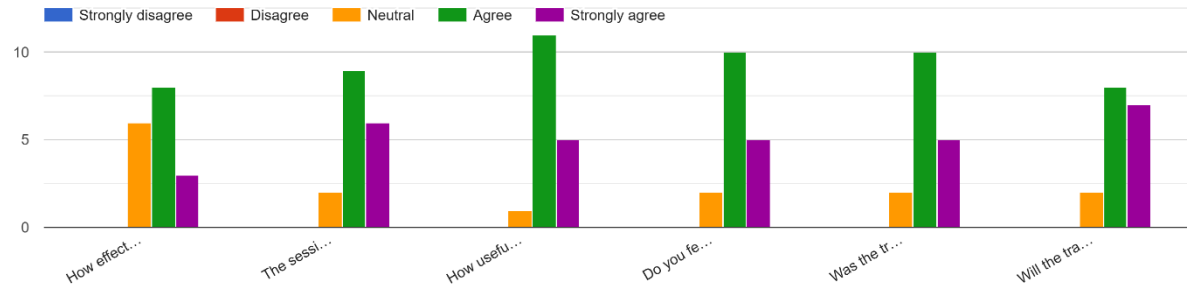
17 responses



Comments17 responses

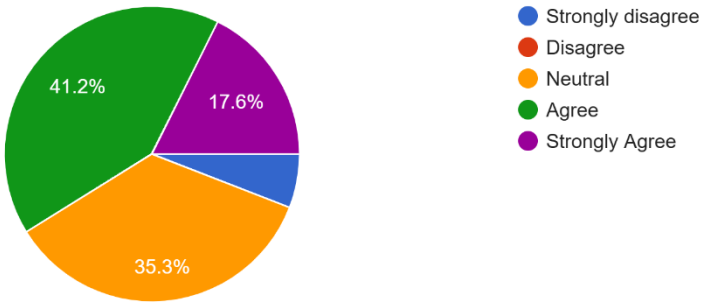
- Sometimes the connection had problem other was very good
- We can carry out refresher training course after a time gap on the same topic. Sector specific NWP guidance and product generation and interpretation for various sectors may be carried out. Use of NWP models in the next step of EWS to generate Impact based forecast and warning may also become another future topic for training.
- Overall good
- The training provided valuable insights into forecast interpretation and verification. The content was well-structured, and the trainers were knowledgeable, making the concepts easy to understand. The discussions were engaging and helped clarify key ideas effectively.
- Training was very good, but since I am new for program on Linux I would need set program on my PC including guidance to install required software such R
- The training was really fruitful to me, I learned a lot about NWP products interpretation and prediction.

Coherence



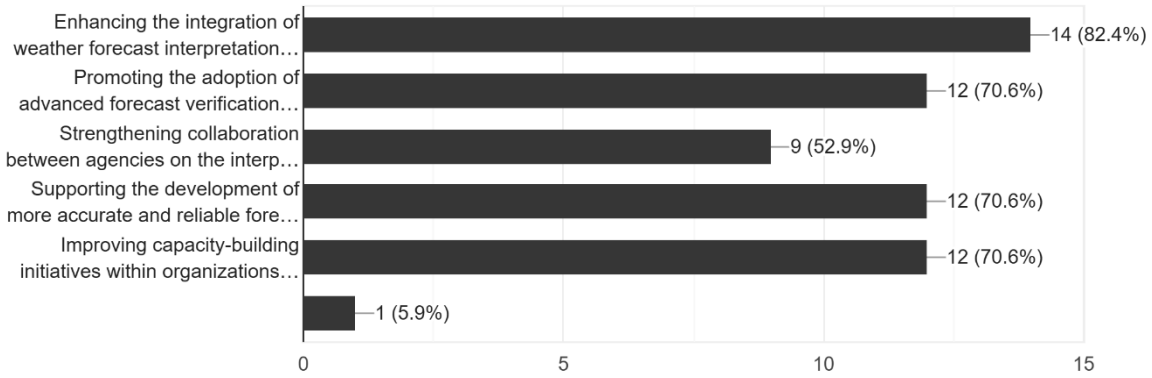
The group exercises on statistical models and forecast verification were effective in identifying practical applications.

17 responses



Please specify how the training is complementing/contributing to other programs, projects, and activities related to forecasting and weather information application in operational plans and decisions

17 responses



Comments

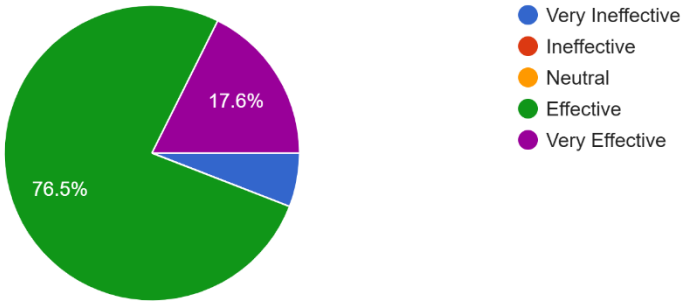
7 responses

I want the same opportunity for AMD and forecasters. And if it's possible to attend in person from AMD
Post-training regular interaction between various agencies need to be established and maintained.
Training content was very relevant and organized well
More time allocation for practical session would be good
Trying to improve.
Training helps in the accuracy and effectiveness of forecasts and thus prevents dangerous natural accidents
no comment

Effectiveness

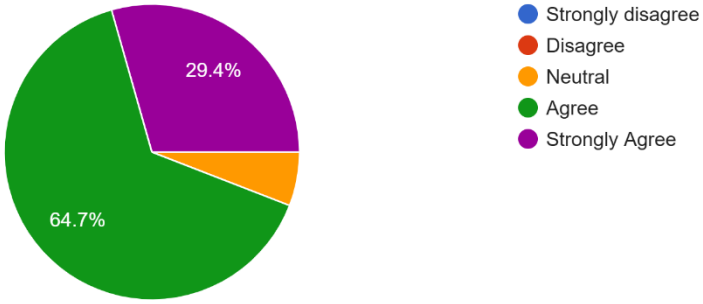
How effective was the workshop in improving your skills in forecast interpretation/verification techniques?

17 responses



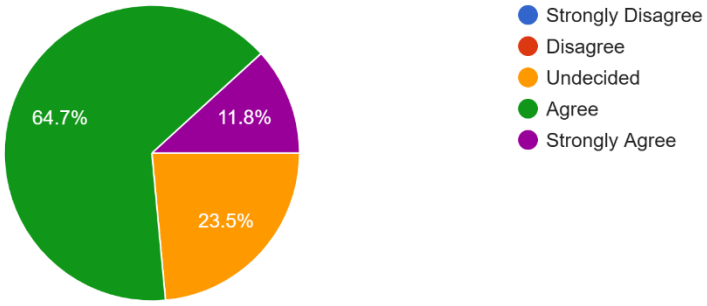
The workshop provided practical strategies for enhancing forecasting accuracy and preparedness for extreme events.

17 responses



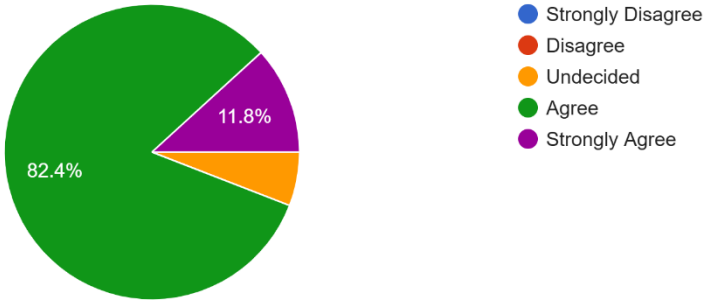
The training will positively influence policy-making, planning, financing and decision-making processes within your department regarding climate change adaptation and climate risk management.

17 responses



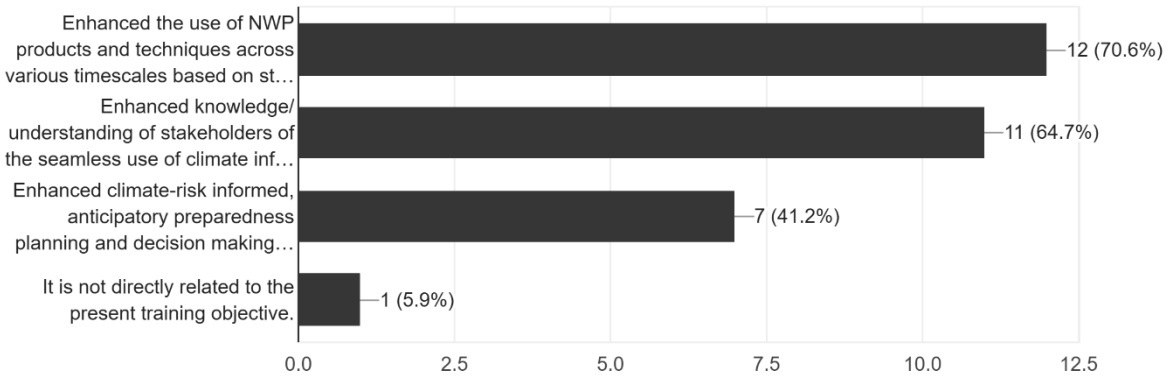
You are likely to incorporate the knowledge and skills learned from the training to your current or future projects related to climate-informed designs, standards, policies and planning.

17 responses



Please identify how the training would be effective in addressing gaps in climate information application in plans and decisions:

17 responses



Comments

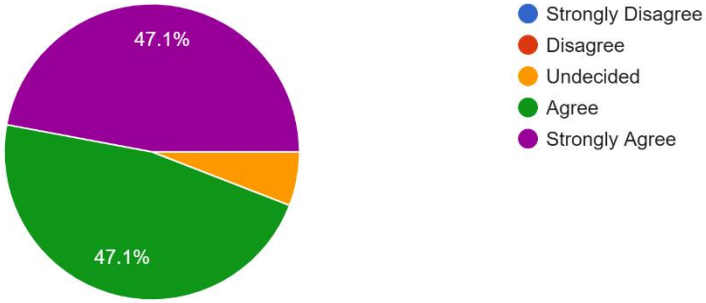
5 responses

- It was very useful
- A few recommendations taken in the feedback session of the training programme need to be considered by the SAHF, RIMES
- With verifications techniques models can be more trusted in decision making
- The knowledge we gained during the training will greatly help us.
- Teaching about short-term and long-term predictions.

Impact

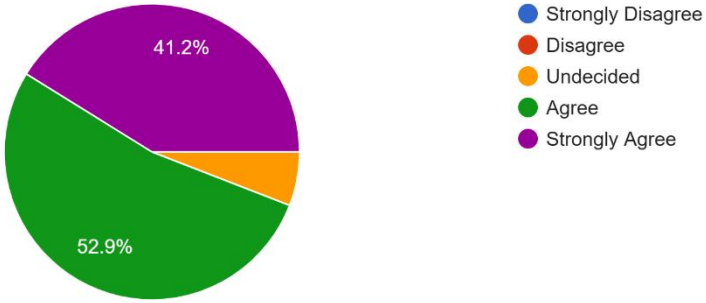
You will apply the knowledge and skills learned in your daily forecasting activities.

17 responses

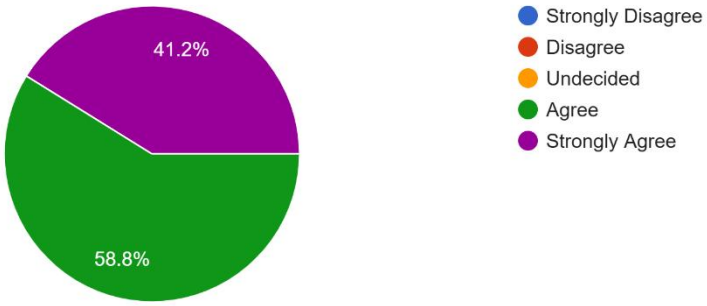


The workshop will influence your approach to forecasting and disseminating weather information.

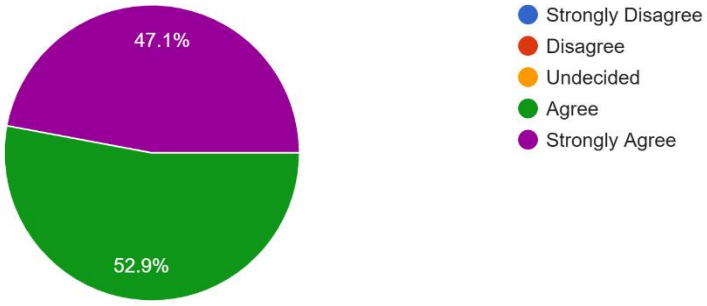
17 responses



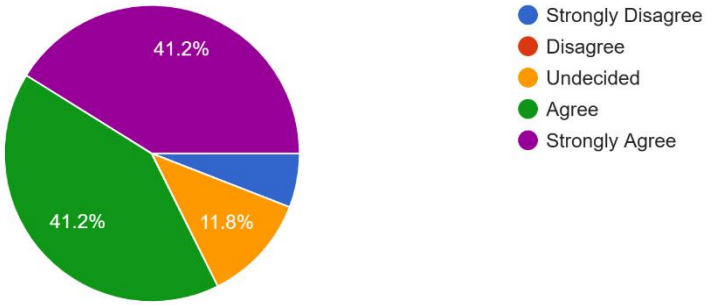
You are likely to recommend the workshop to your colleagues and other professionals in the field.
17 responses



You are likely to use the training outcomes in your work.
17 responses



The training changed your mindset/ perspective on how you would do your work differently.
17 responses



Comments 8 responses

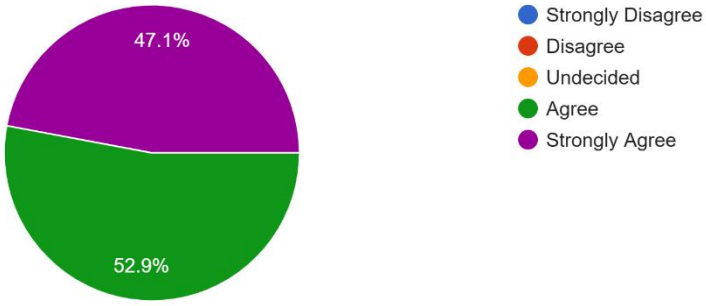
- Yes, it was so useful for forecasting and forecasters
- None
- The training strongly changes my mindset about perspectives of how I have to work differently.
- No comment

- The training workshops was very relevance and useful to us to verify the reliability of the forecast.
- It is very useful; we use it for daily work.
- The training significantly enhanced my forecasting skills and will positively impact my daily work. I feel more confident in disseminating weather information and am likely to recommend this workshop to my colleagues. It has changed my perspective on effective forecasting practices.

Sustainability

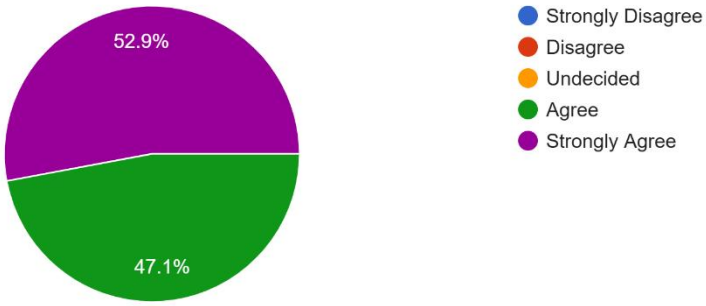
The training you received has inspired you to explore new ideas and approaches.

17 responses



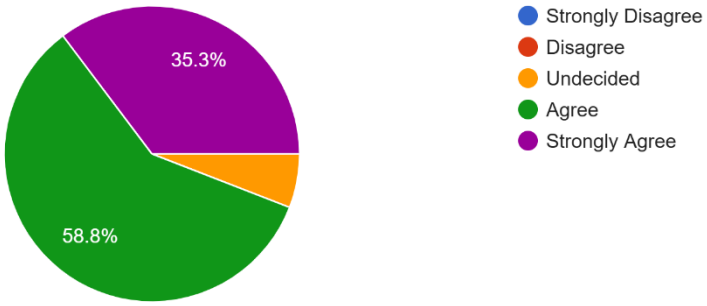
You will share the course material and learnings among your colleagues.

17 responses



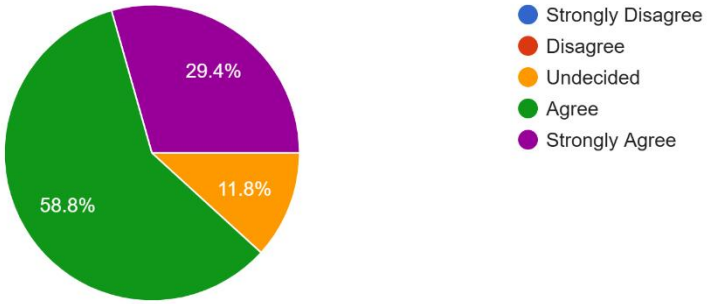
The workshop has encouraged ongoing learning and professional development in forecasting.

17 responses



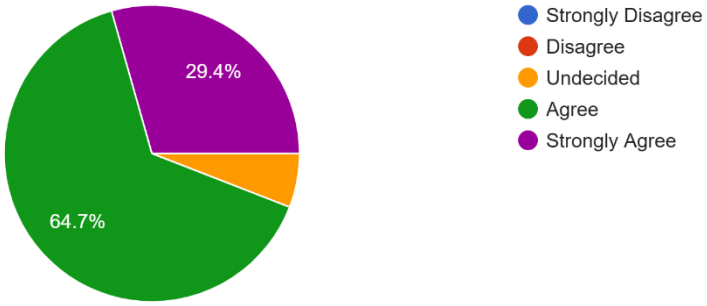
The training is likely to improve your collaboration with other colleagues/units in your agency

17 responses



You recommend integrating the learnings of the training into your internal documents.

17 responses



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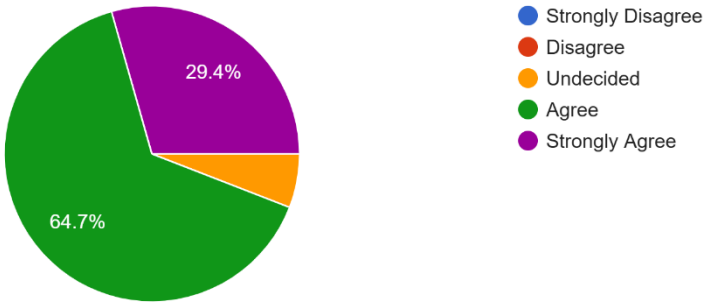
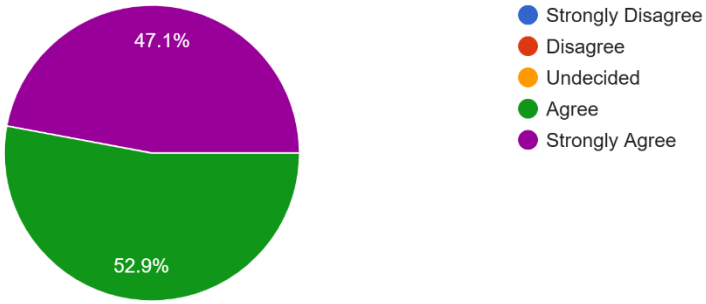
17 responses



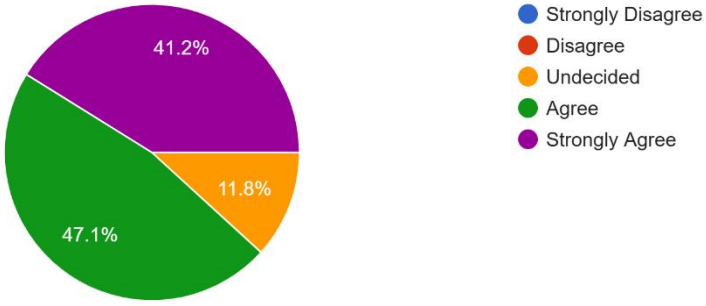
You would like to see similar workshops organized regularly to keep up with advancements in forecasting technologies.

17 responses



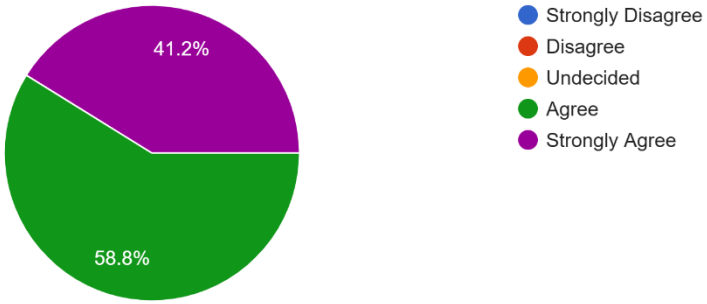
You recommend this training to the other related governmental organizations

17 responses



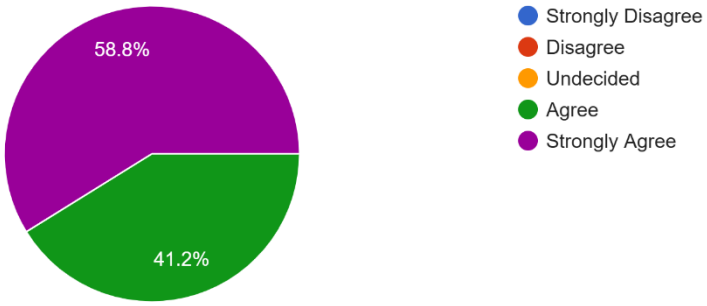
You recommend making this training a regular part of your organization's capacity building initiatives to reach a wider audience.

17 responses



You recommend integrating the learnings of the training into your internal documents.

17 responses



Comments5 responses

- We request to the organizer of this training to share the presentations via email for us and also in some models Afghanistan was not add we want as a member of rimes to add Afghanistan in plat form.
- Hope training materials are made available soon, for future refreshments and to share with colleagues
- Theoretical part was excellent in my level, but I think I still need more knowledge even to start practical part. for which I recommend establishing long term guidance link and provide the detail material
- No comments
- Such useful training workshops may be conducted periodically.

Lessons Learnt and Recommendations

What went well? What areas need improvement?

17 responses

- Time duration was not sufficient to cover all aspects of verification with a good allocation of time for hands on. If possible, number of trainees may be increased and group activities in the training may be planned.
- Training content and resource persons were great, organization could improve a little (travel and visa documents were too late to apply for proper visa)
- More hands-on sessions and assignments would enhance practical learning and participant engagement.
- Theory was very good, but PPT or detail topic document is needed
- All the areas were really awesome.
- Practical session was good. However more time needed
- Over all the training program was scheduled and designed very perfectly only my suggestion in the future was that it would be good if the training handouts are provided.
- All were good.
- Update models to weather forecast.
- use of nwp products for extreme events was interesting however, its verification process needs improvements.
- Verification of weather forecast through NWP in accordance with the actual situation was a good idea for improvement of NWP. Severe Weather Forecast Techniques related to Aviation may also be included.
- The training effectively covered essential forecasting techniques and provided valuable insights into advanced verification methods. The trainers were knowledgeable and engaged, facilitating a productive learning environment. More hands-on practice sessions would enhance understanding. Additionally, providing more resources for further study and allowing more time for discussions would improve the overall experience.
- Areas that have not seen these training
- more practical sessions
- Yes
- Forecasting

What insights/opportunities have you gained from this training?

17 responses

- Using of the weekly weather forecast
- The advantages and need of New ways of verifications was the key point.
- Have learned more advanced model verification techniques
- From this training, I gained a deeper understanding of forecast interpretation techniques and verification methods. I also see opportunities to apply these concepts to improve the accuracy of my work and to collaborate more effectively with colleagues in weather analysis.
- modelling techniques, and different way to verify models
- I have gained a lot of knowledge about NWP products interpretation and verification.

- Verification techniques
- The insights opportunities i have gain from this training was all the scientist and Doctors are very knowledgeable/professional in their fields and found that they are very experts in their fields.
- improve in meteorology, especially in forecasting.
- Many opportunities such us usage of new models...
- improved skill in weather forecasting
- Application of statistics to minimize the difference between observed value and estimated/predicted value in NWP
- I gained a deeper understanding of advanced forecasting techniques and statistical verification methods. This training has also opened up opportunities for collaboration with peers in the field and improved my confidence in using numerical weather prediction tools for better decision-making.
- sometimes yes
- As I am very new to NWP model verification I learn lot from experts.
- Our knowledge improved by this course
- i learn new things from the training

What recommendations can be made for enhancing subsequent trainings?

17 responses

- In person attending of Afghanistan forecasters in training s
- A bit longer period for training and relevant case studies within the training may be considered for hands-on which may be selected before the training.
- May be training portal with reference materials and resource persons contacts cam be beneficial.
- For enhancing subsequent trainings, I recommend incorporating more hands-on sessions to provide practical experience, along with more assignments to actively engage participants. Additionally, including real-world case studies could help in better understanding the application of the concepts.
- in short i would say Identify weak areas and set the goal to achieve with timeline. Start from basic after providing document and guidance link such as remote mentor
- This type of training should organize time to time because I only not learn about the training,