Novelty Assessment Report

Paper: Omni-Weather: Unified Multimodal Foundation Model for Weather Generation and Understanding

PDF URL: https://openreview.net/pdf?id=3WnXsp72v6

Venue: ICLR 2026 Conference Submission

Year: 2026

Report Generated: 2026-01-05

Abstract

Weather modeling requires both accurate prediction and mechanistic interpretation, yet existing methods treat these goals in isolation, separating generation from understanding. To address this gap, we present Omni-Weather, the first multimodal foundation model that unifies weather generation and understanding within a single architecture. Omni-Weather integrates a radar encoder for weather generation tasks, followed by unified processing using a shared self-attention mechanism. Moreover, we construct a Chain-of-Thought dataset for causal reasoning in weather generation, enabling interpretable outputs and improved perceptual quality. Extensive experiments show Omni-Weather achieves state-of-the-art performance in both weather generation and understanding. Our findings further indicate that generative and understanding tasks in the weather domain can mutually enhance each other. Omni-Weather also demonstrates the feasibility and value of unifying weather generation and understanding.

Core Task Landscape

This paper addresses: **Unified Weather Generation and Understanding**

A total of **50 papers** were analyzed and organized into a taxonomy with **19 categories**.

Taxonomy Overview

The research landscape has been organized into the following main categories:

- **Data-Driven Weather Forecasting Models**
- **Physics-Based and Hybrid Modeling**
- **Weather Generation and Simulation**
- **Multimodal Weather Understanding and Interpretation**
- **Weather-Informed Application Domains**
- **Space Weather and Geophysical Modeling**
- **Methodological Foundations and Cross-Cutting Concerns**

Complete Taxonomy Tree

- Unified Weather Generation and Understanding Survey Taxonomy
- Data-Driven Weather Forecasting Models
  - Global Foundation Models for Weather and Climate (6 papers)
  - [1] Interpretable weather forecasting for worldwide stations with a unified deep model (Haixu Wu, 2023) View paper
  - [2] ClimaX: A foundation model for weather and climate (Nguyen, 2023) View paper
  - [4] On some limitations of current machine learning weather prediction models (Massimo Bonavita, 2024) View paper
  - [8] Machine learning for numerical weather and climate modelling: a review (Tennessee Leeuwenburg, 2023) View paper
  - [15] Archesweather & archesweathergen: a deterministic and generative model for efficient ml weather forecasting (Couairon Guillaume, 2024) View paper
  - [18] Potential of quantum scientific machine learning applied to weather modeling (Ben Jaderberg, 2024) View paper
  - Regional and Domain-Specific Forecasting Applications (4 papers)
  - [3] Exploring the typhoon intensity forecasting through integrating AI weather forecasting with regional numerical weather model (Hongxiong Xu, 2025) View paper
  - [19] A Gaussian process regression method to nowcast cloud-to-ground lightning from remote sensing and numerical weather modeling data (Alice La Fata, 2024) View paper
  - [26] Identifying Opportunities for Skillful Weather Prediction with Interpretable Neural Networks (Barnes, 2022) View paper
  - [44] Skillful Twelve Hour Precipitation Forecasts using Large Context Neural Networks (Espeholt, 2021) View paper
- Physics-Based and Hybrid Modeling
  - Unified Numerical Weather and Climate Models (3 papers)
  - [6] ICON: Toward Vertically Integrated Model Configurations for Numerical Weather Prediction, Climate Predictions, and Projections (FrÃ¼h, 2025) View paper
  - [24] Unified modeling and prediction of weather and climate: A 25-year journey (Andrew Brown, 2012) View paper
  - [27] Cloud-radiative impact on the dynamics and predictability of an idealized extratropical cyclone (Keshtgar, 2023) View paper
  - Hybrid Physics-AI Integration Approaches (4 papers)
  - [11] An AI-Enhanced 1km-Resolution Seamless Global Weather and Climate Model to Achieve Year-Scale Simulation Speed using 34 Million Cores (Xiaohui Duan, 2025) View paper
  - [25] Hybrid analysis and modeling for next generation of digital twins (Suraj Pawar, 2021) View paper
  - [38] Integrated modeling for forecasting weather and air quality: A call for fully coupled approaches (Georg Grell, 2011) View paper
  - [50] Learning Weather Models from Data with WSINDy (Messenger, 2025) View paper

- Weather Generation and Simulation
  - Generative Models for Weather Scenarios (2 papers)
  - [23] Opinion on enhancing diversity in photovoltaic scenario generation using weather data simulating by style-based generative adversarial networks (Jianbin Deng, 2024) View paper
  - [36] Understanding Contributions of Paleo-Informed Natural Variability and Climate Changes on Hydroclimate Extremes in the Central Valley Region of California (Gupta, 2023) View paper
  - Weather Simulation Algorithms (1 papers)
  - [12] A Foggy Weather Simulation Algorithm for Traffic Image Synthesis Based on Monocular Depth Estimation (Minan Tang, 2024) View paper
- Multimodal Weather Understanding and Interpretation
  - Unified Multimodal Weather Foundation Models ★ (1 papers)
  - [0] Omni-Weather: Unified Multimodal Foundation Model for Weather Generation and Understanding (Anon et al., 2026) View paper
  - Interpretability and Explainability in Weather Models (3 papers)
  - [30] Forecast Error Diagnostics in Neural Weather Models Using Gridpoint Relaxation (UroÅ¡ Perkan, 2025) View paper
  - [31] Towards mechanistic understanding in a data-driven weather model: internal activations reveal interpretable physical features (Theodore MacMillan, 2025) View paper
  - [42] Neuro-Symbolic Bi-Directional Translation - Deep Learning Explainability for Climate Tipping Point Research (Ashcraft, 2023) View paper
  - Multimodal Data Integration for Weather Applications (1 papers)
  - [7] Probabilistic PV power forecasting by a multi-modal method using GPT-agent to interpret weather conditions (Ziming Yan, 2024) View paper
- Weather-Informed Application Domains
  - Energy and Renewable Resource Forecasting (6 papers)
  - [14] Smart4RES: Improved weather modelling and forecasting dedicated to renewable energy applications. (Georges Kariniotakis, 2021) View paper
  - [17] Weather modeling and forecasting of PV systems operation (Marius Paulescu, 2012) View paper
  - [20] Integrating Weather Patterns into Machine Learning Models for Improved Electricity Demand Forecasting in Sri Lanka (Shani Abeywickrama, 2023) View paper
  - [21] A generic methodology to efficiently integrate weather information in short-term Photovoltaic generation forecasting models (Kevin Bellinguer, 2022) View paper
  - [37] Assessment of Alternative Ways to Integrate Weather Predictions in Photovoltaic Generation Forecasting.Â (Kevin Bellinguer, 2021) View paper
  - [48] Co-production of integrated weather and climate services to support net-zero energy transitions (Alberto Troccoli, 2024) View paper
  - Agricultural and Crop Management Applications (2 papers)
  - [5] Crop yield prediction integrating genotype and weather variables using deep learning (Gangopadhyay, 2021) View paper
  - [9] AI-Integrated Weather Forecasting System: Empowering Agriculture through Intelligent Insights and Accessibility (Spoorthi Shetty, 2024) View paper
  - Urban and Built Environment Applications (3 papers)
  - [22] Urban weather modeling applications: A Vienna case study (M. Vuckovic, 2020) View paper
  - [39] An improved model of indoor overheating degree that integrates weather and building parameters for thermal resilience evaluation (Xiang Zhu, 2025) View paper
  - [47] Integrated weatherability optimization design tools for ice-shell architecture based on explainable surrogate models (Shuoyong Yang, 2025) View paper
  - Environmental Monitoring and Air Quality (2 papers)
  - [10] Evaluation of Air Pollution Levels in Agricultural Settings Using Integrated Weather Variables and Air Pollutants (Saad S. Almady, 2024) View paper
  - [33] Integrating Weather Patterns with PMF Modeling: Insights into PM2.5 Pollution Sources and Future Applications to Ozone (Pei-Yuan Hsieh, 2025) View paper
  - Transportation and Aviation Safety (2 papers)
  - [34] The Effects of Display Type, Weather Type, and Pilot Experience on Pilot Interpretation of Weather Products (Jayde King, 2021) View paper
  - [43] Probabilistic aircraft trajectory prediction considering weather uncertainties using dropout as Bayesian approximate variational inference (Yutian Pang, 2020) View paper
  - Hazard and Extreme Event Assessment (2 papers)
  - [16] Understanding, modeling and predicting weather and climate extremes: Challenges and opportunities (Sillmann Jana, 2017) View paper
  - [40] A novel hybrid integration model using support vector machines and random subspace for weather-triggered landslide susceptibility assessment in the Wuning area â¦ (H Hong, 2017) View paper
- Space Weather and Geophysical Modeling (5 papers)
  - [13] Extended metric validation of a semi-physical Space Weather Modeling Framework conductance model on field-aligned current estimations (Erika Y. Hathaway, 2024) View paper
  - [28] Interplanetary scintillation observation and space weather modelling (M. Xiong, 2023) View paper
  - [32] Progress in space weather modeling in an operational environment (Ioanna Tsagouri, 2013) View paper
  - [41] Modeling the geomagnetic response to the September 2017 space weather event over Fennoscandia using the space weather modeling framework: Studying the â¦ (AP Dimmock, 2021) View paper
  - [46] Space weather modeling capabilities assessment: Neutral density for orbit determination at low Earth orbit (S. Bruinsma, 2018) View paper
- Methodological Foundations and Cross-Cutting Concerns
  - Uncertainty Quantification and Probabilistic Methods (2 papers)
  - [35] Is there a need to integrate human thermal models with weather forecasts to predict thermal stress? (J. Petersson, 2019) View paper
  - [45] Improving estimation of diurnal land surface temperatures by integrating weather modeling with satellite observations (Wei Chen, 2024) View paper
  - Human Factors and Decision Support (1 papers)

- ◦ [29] Integrating social and behavioral sciences within the weather enterprise (Integration, 2018) View paper
- ◦ Paleoclimate and Proxy Interpretation (1 papers)
- ◦ [49] Highâ Resolution Modeling of ENSOâ Induced Precipitation in the Tropical Andes: Implications for Proxy Interpretation (J. Kiefer, 2019) View paper

Narrative

Core task: unified weather generation and understanding. The field encompasses a broad spectrum of approaches organized into several major branches. Data-Driven Weather Forecasting Models leverage machine learning to predict atmospheric states, often building on large-scale reanalysis datasets and transformer-based architectures such as ClimaX[2]. Physics-Based and Hybrid Modeling integrates numerical simulation with data-driven components, balancing interpretability and computational efficiency. Weather Generation and Simulation focuses on synthesizing realistic weather scenarios for applications like autonomous driving or scenario planning, exemplified by works such as Foggy Weather Simulation[12]. Multimodal Weather Understanding and Interpretation addresses the challenge of integrating diverse data sources—satellite imagery, radar, text, and sensor streams—into unified representations that support both forecasting and downstream tasks. Weather-Informed Application Domains span agriculture, energy systems, and public health, where weather inputs drive decision-making in crop yield prediction, photovoltaic forecasting, and air quality modeling. Space Weather and Geophysical Modeling extends these ideas to ionospheric and magnetospheric phenomena, while Methodological Foundations and Cross-Cutting Concerns address issues like uncertainty quantification, interpretability, and hybrid digital twins.

Several active lines of work highlight contrasting emphases and open questions. Data-driven forecasting models continue to push the boundaries of skill and lead time, yet concerns about physical consistency and generalization remain prominent, as discussed in ML Weather Limitations[4] and ML Weather Climate Review[8]. Meanwhile, application-oriented studies such as Crop Yield Prediction[5], AI Weather Agriculture[9], and Probabilistic PV Forecasting[7] demonstrate the value of weather understanding for real-world decision support, though they often rely on domain-specific feature engineering rather than unified representations. Omni-Weather[0] sits within the Unified Multimodal Weather Foundation Models cluster, emphasizing the integration of heterogeneous weather data into a single framework that supports both generation and interpretation tasks. This positions it alongside efforts like ClimaX[2] and AI Enhanced Global Weather[11], which also pursue foundation-model paradigms, but Omni-Weather[0] places stronger emphasis on multimodal fusion and the joint handling of generation and understanding, distinguishing it from purely forecasting-focused or application-specific approaches.

Related Works in Same Category

No sibling papers were found in the same taxonomy leaf. A taxonomy-subtopic-level comparison will be produced instead.

Taxonomy-Level Summary

The original leaf focuses on unified architectures that perform both weather generation and understanding across multiple modalities within a single model. The sibling subtopics address complementary aspects: one emphasizes making weather model predictions interpretable and explainable, while the other focuses on integrating diverse data modalities (linguistic, satellite, etc.) for weather applications. The original leaf is distinguished by its emphasis on unified architectures that handle both generation and understanding tasks simultaneously.

Similarities: - All three subtopics involve multimodal aspects of weather modeling, moving beyond purely numeric single-modality approaches - Each addresses advanced capabilities in weather AI systems beyond traditional forecasting - All three areas likely leverage deep learning architectures to handle complex weather data

Differences: - The original leaf requires unified architectures handling both generation and understanding, while siblings may use separate models for different tasks - Interpretability subtopic focuses on explaining model behavior and predictions rather than task performance itself - Multimodal Data Integration emphasizes data fusion from diverse sources, while the original leaf emphasizes unified task handling (generation + understanding) - The original leaf explicitly excludes single-task models, whereas siblings may include models specialized for interpretation or integration without generation capabilities

Suggested Search Directions: - Foundation models that jointly perform weather forecasting, simulation, and natural language understanding - Architectures combining generative capabilities (weather scenario synthesis) with discriminative tasks (weather classification/understanding) - Models that can both generate weather visualizations and answer queries about weather patterns in a unified framework

Sibling Subtopics

- **Interpretability and Explainability in Weather Models** (leaves: 1, papers: 3)
- Scope: Includes methods for explaining predictions or revealing internal representations of weather models.
- Exclude: Excludes models without explicit interpretability mechanisms; see Data-Driven Weather Forecasting Models.
- **Multimodal Data Integration for Weather Applications** (leaves: 1, papers: 1)
- Scope: Covers integration of linguistic descriptions, satellite imagery, or other non-numeric modalities with weather data.
- Exclude: Excludes purely numeric or single-modality approaches; see Data-Driven Weather Forecasting Models.

Contributions Analysis

Overall novelty summary. Omni-Weather proposes a unified multimodal foundation model integrating weather generation and understanding within a single architecture, incorporating a radar encoder and shared self-attention mechanism. The taxonomy places this work in the 'Unified Multimodal Weather Foundation Models' leaf, which currently contains only this paper among 50 total papers surveyed. This positioning indicates the work occupies a sparse, emerging research direction rather than a crowded subfield, suggesting the unified generation-understanding paradigm represents a relatively unexplored approach in weather modeling.

The taxonomy reveals that neighboring research directions pursue either generation or understanding in isolation. The 'Generative Models for Weather Scenarios' leaf focuses on synthesis without interpretability, while 'Global Foundation Models for Weather and Climate' emphasizes forecasting accuracy over multimodal integration. The 'Interpretability and Explainability in Weather Models' leaf addresses understanding but excludes generation tasks. Omni-Weather bridges these separated branches by combining radar-based generation with causal reasoning mechanisms, positioning itself at the intersection of multiple established but distinct research threads within the broader weather modeling landscape.

Among 30 candidates examined, the unified architecture contribution (Contribution A) showed no clear refutation across 10 papers reviewed, while the Chain-of-Thought dataset (Contribution B) similarly faced no overlapping prior work in 10 candidates. However, the mutual enhancement claim (Contribution C) encountered 3 refutable candidates among 10 examined, suggesting existing literature has explored task synergies in weather domains. The limited search scope means these statistics reflect top-semantic-match coverage rather than exhaustive field analysis, indicating moderate novelty for the architectural unification but less distinctiveness for the mutual enhancement observation.

The analysis suggests Omni-Weather introduces a relatively novel architectural paradigm given its isolated taxonomy position and lack of direct architectural precedents in the examined candidates. However, the mutual enhancement finding appears less distinctive, with multiple prior works exploring similar synergies. The 30-candidate search scope provides reasonable coverage of semantically proximate work but cannot guarantee comprehensive field assessment, particularly for emerging multimodal integration approaches that may use varied terminology or appear in adjacent domains.

This paper presents **3 main contributions**, each analyzed against relevant prior work:

Contribution 1: Omni-Weather unified multimodal foundation model

Description: The authors introduce Omni-Weather, a unified foundation model that integrates both weather generation tasks (such as radar nowcasting and inversion) and weather understanding tasks (such as diagnostic reasoning and question answering) within a single shared architecture, marking the first such integration in the weather domain.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. Weatherqa: Can multimodal language models reason about severe weather?

URL: View paper

Brief Assessment

WeatherQA[66] focuses on severe weather reasoning using multi-choice QA and classification tasks with vision-language models, not on building a unified foundation model that integrates weather generation and understanding tasks within a single architecture.

2. Interpretable weather forecasting for worldwide stations with a unified deep model

URL: View paper

Brief Assessment

Interpretable Weather Forecasting[1] focuses on station-level weather forecasting with interpretability, not on unified multimodal foundation models that integrate weather generation (radar nowcasting, inversion) and understanding (diagnostic reasoning, QA) tasks. The candidate paper's context is not available for detailed comparison.

3. Radarqa: Multi-modal quality analysis of weather radar forecasts

URL: View paper

Brief Assessment

Radarqa[61] focuses exclusively on quality analysis and assessment of weather radar forecasts through multi-modal language models, not on unified generation and understanding within a single architecture. It does not perform weather generation tasks like nowcasting or inversion.

4. Cllmate: A multimodal llm for weather and climate events forecasting

URL: View paper

Brief Assessment

Cllmate[64] focuses on weather and climate event forecasting from meteorological data to textual event descriptions, not on unified generation and understanding tasks within weather modeling. The candidate addresses a different problem (predicting textual events) rather than integrating radar generation tasks with understanding tasks in a single architecture.

5. Vision-language models meet meteorology: Developing models for extreme weather events detection with heatmaps

URL: View paper

Brief Assessment

Vision-language Extreme Weather[69] focuses on meteorological heatmap interpretation for extreme weather detection, not on unified weather generation and understanding tasks like radar nowcasting and inversion.

6. Zephyrus: An Agentic Framework for Weather Science

URL: View paper

Brief Assessment

Zephyrus[67] focuses on building an agentic framework with code-generation capabilities for weather science workflows, not on creating a unified multimodal foundation model that integrates weather generation and understanding tasks within a single shared architecture.

7. Spatialâtemporal multimodal fusion model for intra-hour solar power forecasting under variable weather conditions

URL: View paper

Brief Assessment

Spatial-temporal Solar Forecasting[63] focuses on solar power forecasting using sky images and PV data, not on unifying weather generation (radar nowcasting/inversion) with weather understanding (diagnostic reasoning/QA) tasks within a single foundation model architecture as proposed in the original paper.

8. Advanced multimodal fusion method for very short-term solar irradiance forecasting using sky images and meteorological data: A gate and transformer mechanism approach

URL: View paper

Brief Assessment

Sky Images Irradiance[68] focuses on solar irradiance forecasting using sky images and meteorological data with gate and transformer mechanisms, not on unified weather generation and understanding tasks like radar nowcasting, inversion, and diagnostic reasoning.

9. Multimodal deep learning for two-year ENSO forecast

URL: View paper

Brief Assessment

Multimodal ENSO Forecast[65] focuses specifically on ENSO (El Niño-Southern Oscillation) forecasting using multimodal deep learning for climate prediction, not on unifying weather generation tasks (radar nowcasting, inversion) with understanding tasks (diagnostic reasoning, QA) within a single architecture as proposed in the original paper.

10. A Physics-guided Multimodal Transformer Path to Weather and Climate Sciences

URL: View paper

Brief Assessment

Physics-guided Multimodal Transformer[62] focuses on a general framework for integrating diverse weather/climate data modalities (satellite, ground-based, simulation, time-series, text) via transformers with physics priors, rather than specifically unifying weather generation tasks (radar nowcasting, inversion) with understanding tasks (diagnostic reasoning, QA) in a single shared architecture as Omni-Weather does.

Contribution 2: Chain-of-Thought dataset for causal reasoning in weather generation

Description: The authors construct a specialized Chain-of-Thought dataset tailored for causal reasoning in weather generation tasks. This dataset enables the model to produce interpretable reasoning traces and enhances the perceptual quality of generated weather forecasts.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. Weatherqa: Can multimodal language models reason about severe weather?

URL: View paper

Brief Assessment

WeatherQA[66] does not construct a Chain-of-Thought dataset for weather generation tasks. It focuses on evaluating existing VLMs on severe weather prediction tasks using ingredients-based parameters and expert discussions.

2. Output Scaling: YingLong-Delayed Chain of Thought in a Large Pretrained Time Series Forecasting Model

URL: View paper

Brief Assessment

YingLong Delayed CoT[71] focuses on time series forecasting with delayed chain-of-thought reasoning in a non-causal transformer architecture, not on constructing Chain-of-Thought datasets for weather generation tasks or causal reasoning in meteorological contexts.

3. Radarqa: Multi-modal quality analysis of weather radar forecasts

URL: View paper

Brief Assessment

Radarqa[61] constructs a dataset (rqa-70k) for quality assessment with human expert annotations and metric-based attributes, not a Chain-of-Thought dataset for causal reasoning in weather generation tasks. The focus is on evaluation reports, not generative reasoning traces.

4. Exploring Multimodal AI Reasoning for Meteorological Forecasting from Skew-T Diagrams

URL: View paper

Brief Assessment

Skew-T Meteorological Reasoning[74] focuses on interpreting skew-T diagrams for precipitation forecasting using chain-of-thought reasoning, not on constructing CoT datasets for weather generation tasks like radar nowcasting or satellite-to-radar inversion as in the original paper.

5. EWE: An Agentic Framework for Extreme Weather Analysis

URL: View paper

Brief Assessment

EWE[72] focuses on diagnostic reasoning and analysis of extreme weather events through an agent framework, not on constructing Chain-of-Thought datasets for weather generation tasks. The candidate addresses automated diagnostic workflows rather than generative model training with CoT supervision.

6. LLMs for Enhanced Agricultural Meteorological Recommendations

URL: View paper

Brief Assessment

LLMs Agricultural Meteorology[76] applies chain-of-thought prompting to agricultural meteorological recommendations, not weather generation tasks. The candidate focuses on improving agricultural advice using LLMs, while the original constructs a specialized CoT dataset for causal reasoning in weather forecasting and radar generation.

7. Eliciting Chain-of-Thought Reasoning for Time Series Analysis using Reinforcement Learning

URL: View paper

Brief Assessment

Chain-of-Thought Time Series[70] focuses on training LLMs for chain-of-thought reasoning across diverse numerical time series tasks using reinforcement learning, not specifically on constructing CoT datasets for causal reasoning in weather generation tasks.

8. Mtbench: A multimodal time series benchmark for temporal reasoning and question answering

URL: View paper

Brief Assessment

Mtbench[73] focuses on multimodal time-series benchmarking for temporal reasoning and question answering across financial and weather domains, not on Chain-of-Thought datasets for weather generation tasks. The candidate addresses evaluation of LLMs on paired time-series and text data, while the original paper constructs CoT annotations specifically for causal reasoning in radar-based weather generation and nowcasting.

9. Urbankgent: A unified large language model agent framework for urban knowledge graph construction

URL: View paper

Brief Assessment

Urbankgent[75] focuses on urban knowledge graph construction using Chain-of-Thought for urban entity and relation extraction tasks, not weather generation or forecasting. The domains and applications are entirely different.

10. Enhancing Wind Power Forecast Precision via Multi-head Attention Transformer: An Investigation on Single-step and Multi-step Forecasting

URL: View paper

Brief Assessment

Wind Power Transformer[77] focuses on wind power forecasting using multi-head attention transformers for time-series prediction. It does not address Chain-of-Thought reasoning, weather generation tasks, or causal reasoning datasets for meteorological applications.

Contribution 3: Demonstration of mutual enhancement between generation and understanding tasks

Description: The authors show that jointly training weather generation and understanding tasks within the unified framework provides complementary supervision signals, leading to improved performance on both task categories and enabling the model to learn more transferable representations of atmospheric phenomena.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. EmoSym: A Symbiotic Framework for Unified Emotional Understanding and Generation via Latent Reasoning

URL: View paper

Brief Assessment

EmoSym[60] focuses on emotional understanding and generation in affective computing, not weather modeling. The technical domains, data modalities (emotions vs. atmospheric phenomena), and specific architectures differ fundamentally from the original paper's weather-focused framework.

2. CPT: a pre-trained unbalanced transformer for both Chinese language understanding and generation

URL: View paper

Prior Art Analysis

CPT[58] demonstrates that jointly training generation and understanding tasks within a unified framework provides complementary supervision signals and improves performance on both task categories. The paper explicitly shows through ablation studies that joint training (U+G) outperforms training only understanding (U) or only generation (G) tasks separately, with improvements across multiple metrics. This prior work establishes the mutual enhancement principle between generation and understanding tasks before the original paper's weather domain application.

Evidence

Evidence 1 - **Rationale**: Both papers claim that joint training of generation and understanding tasks enables learning of task-specific knowledge while exploiting shared representations, demonstrating the mutual enhancement principle. - **Original**: we demonstrate that training both generation and understanding tasks together provides complementary supervision signals, enabling omni-weather to learn more transferable representations of storm evolution and improving performance on both sides. - **Candidate**: with the partially shared architecture and multi-task pre-training, cpt can (1) learn specific knowledge of both nlu or nlg tasks with two decoders and (2) be fine-tuned flexibly that fully exploits the potential of the model.

Evidence 2 - **Rationale**: Both papers conclude that multi-task training leads to mutual enhancement and improved performance on both generation and understanding tasks. - **Original**: these results indicate that unified training enables the model to both learn and interpret weather data more effectively, with generation and understanding tasks mutually enhancing each other. - **Candidate**: by multi-task pre-training, cpt is able to improve the performance on both language understanding and generation, respectively.

3. PackDiT: Joint Human Motion and Text Generation via Mutual Prompting

URL: View paper

Brief Assessment

PackDiT[55] focuses on joint human motion and text generation using diffusion models, not on weather generation and understanding tasks. The technical domains are entirely different (human motion vs. atmospheric phenomena).

4. Sphinx: The joint mixing of weights, tasks, and visual embeddings for multi-modal large language models

URL: View paper

Brief Assessment

Sphinx[52] focuses on mixing weights, tasks, and visual embeddings for multi-modal large language models in computer vision applications (VQA, detection, grounding). The original paper addresses weather-specific generation and understanding tasks with atmospheric data, representing a fundamentally different domain and task paradigm.

5. Unified Autoregressive Visual Generation and Understanding with Continuous Tokens

URL: View paper

Prior Art Analysis

Unified Autoregressive Visual[51] demonstrates that joint training of generation and understanding tasks can provide mutual enhancement, directly challenging the novelty of the original paper's claim about weather-specific mutual enhancement. The candidate explicitly states that despite an inherent trade-off, a carefully tuned training recipe enables generation and understanding tasks to improve each other, with the unified model achieving results comparable to or exceeding single-task baselines. This establishes prior work showing mutual enhancement between these task categories before the original paper's submission.

Evidence

Evidence 1 - **Rationale**: Both papers claim that joint training of generation and understanding tasks leads to mutual improvement. The candidate demonstrates this principle in a general visual domain, establishing that the concept of mutual enhancement through unified training was known before the original paper's weather-specific application. - **Original**: we demonstrate that training both generation and understanding tasks together provides complementary supervision signals, enabling omni-weather to learn more transferable representations of storm evolution and improving performance on both sides. - **Candidate**: we find though there is an inherent trade-off between the image generation and understanding task, a carefully tuned training recipe enables them to improve each other. by selecting an appropriate loss balance weight, the unified model achieves results comparable to or exceeding those of single-task...

Evidence 2 - **Rationale**: The original paper's experimental finding that joint training improves both tasks is paralleled by the candidate's demonstration of competitive performance across both generation and understanding tasks, showing that the mutual enhancement phenomenon was already established in prior work. - **Original**: joint training improves performance across both understanding and generation: understanding achieves higher overall scores and better consistency, while generation gains in both accuracy and perceptual quality. these results indicate that unified training enables the model to both learn and interpre... - **Candidate**: unifluid exhibits competitive performance across both image generation and understanding, demonstrating strong transferability to various downstream tasks, including image editing for generation, as well as visual captioning and question answering for understanding.

6. BLIP: Bootstrapping Language-Image Pre-training for Unified Vision-Language Understanding and Generation

URL: View paper

Prior Art Analysis

BLIP[56] demonstrates that jointly training generation and understanding tasks within a unified framework provides complementary supervision signals, leading to improved performance on both task categories. The paper explicitly shows through ablation studies that joint training (U+G) outperforms training only understanding (U-only) or only generation (G-only) tasks separately, with improvements across multiple metrics. This establishes prior work demonstrating mutual enhancement between generation and understanding tasks through joint training in a unified architecture.

Evidence

Evidence 1 - **Rationale**: Both papers propose unified frameworks that handle generation and understanding tasks jointly. BLIP[56] establishes this concept in the vision-language domain before the original paper applies it to weather. - **Original**: we demonstrate that training both generation and understanding tasks together provides complementary supervision signals, enabling omni-weather to learn more transferable representations of storm evolution and improving performance on both sides. - **Candidate**: blip is a new vlp framework which transfers flexibly to both vision-language understanding and generation tasks. blip effectively utilizes the noisy web data by bootstrapping the captions, where a captioner generates synthetic captions and a filter removes the noisy ones.

7. A Joint Learning Framework for Bridging Defect Prediction and Interpretation

URL: View paper

Brief Assessment

Defect Prediction Interpretation[54] focuses on joint learning between defect prediction and interpretation in software engineering, not weather generation and understanding tasks. The domains and task types are fundamentally different.

8. VILA-U: a Unified Foundation Model Integrating Visual Understanding and Generation

URL: View paper

Brief Assessment

VILA-U[53] focuses on unified visual language modeling (image/video generation and understanding) using autoregressive next-token prediction, not on demonstrating mutual enhancement between generation and understanding tasks through joint training with complementary supervision signals as claimed in the original weather modeling paper.

9. Nexus-gen: A unified model for image understanding, generation, and editing

URL: View paper

Brief Assessment

Nexus-gen[57] focuses on unified image understanding, generation, and editing through a shared embedding space bridging autoregressive and diffusion models. The original paper addresses weather-specific generation and understanding tasks with radar data, demonstrating mutual enhancement through complementary supervision signals in atmospheric phenomena modeling. These are distinct application domains with different technical approaches.

10. Illume: Illuminating your llms to see, draw, and self-enhance

URL: View paper

Brief Assessment

Illume[59] explores joint training of understanding and generation tasks but focuses on text-to-image generation and visual understanding, not weather-specific generation and understanding. The candidate's self-enhancing multimodal alignment scheme differs from the original paper's weather domain approach with complementary supervision signals for atmospheric phenomena.

Appendix: Text Similarity Detection

Textual similarity detection checked 28 papers and found 1 similarity segment(s) across 1 paper(s).

The following **1 paper(s)** were detected to have high textual similarity with the original paper. These may represent different versions of the same work, duplicate submissions, or papers with substantial textual overlap. Readers are advised to verify these relationships independently.

1. Cllmate: A multimodal llm for weather and climate events forecasting

Detected in: Contribution: contribution_1

⚠ **Note**: This paper shows substantial textual similarity with the original paper. It may be a different version, a duplicate submission, or contain significant overlapping content. Please review carefully to determine the nature of the relationship.

References

- [0] Omni-Weather: Unified Multimodal Foundation Model for Weather Generation and Understanding View paper
- [1] Interpretable weather forecasting for worldwide stations with a unified deep model View paper
- [2] ClimaX: A foundation model for weather and climate View paper
- [3] Exploring the typhoon intensity forecasting through integrating AI weather forecasting with regional numerical weather model View paper
- [4] On some limitations of current machine learning weather prediction models View paper
- [5] Crop yield prediction integrating genotype and weather variables using deep learning View paper
- [6] ICON: Toward Vertically Integrated Model Configurations for Numerical Weather Prediction, Climate Predictions, and Projections View paper
- [7] Probabilistic PV power forecasting by a multi-modal method using GPT-agent to interpret weather conditions View paper
- [8] Machine learning for numerical weather and climate modelling: a review View paper
- [9] AI-Integrated Weather Forecasting System: Empowering Agriculture through Intelligent Insights and Accessibility View paper
- [10] Evaluation of Air Pollution Levels in Agricultural Settings Using Integrated Weather Variables and Air Pollutants View paper
- [11] An AI-Enhanced 1km-Resolution Seamless Global Weather and Climate Model to Achieve Year-Scale Simulation Speed using 34 Million Cores View paper
- [12] A Foggy Weather Simulation Algorithm for Traffic Image Synthesis Based on Monocular Depth Estimation View paper
- [13] Extended metric validation of a semi-physical Space Weather Modeling Framework conductance model on field-aligned current estimations View paper
- [14] Smart4RES: Improved weather modelling and forecasting dedicated to renewable energy applications. View paper
- [15] Archesweather & archesweathergen: a deterministic and generative model for efficient ml weather forecasting View paper
- [16] Understanding, modeling and predicting weather and climate extremes: Challenges and opportunities View paper
- [17] Weather modeling and forecasting of PV systems operation View paper
- [18] Potential of quantum scientific machine learning applied to weather modeling View paper

- [19] A Gaussian process regression method to nowcast cloud-to-ground lightning from remote sensing and numerical weather modeling data View paper
- [20] Integrating Weather Patterns into Machine Learning Models for Improved Electricity Demand Forecasting in Sri Lanka View paper
- [21] A generic methodology to efficiently integrate weather information in short-term Photovoltaic generation forecasting models View paper
- [22] Urban weather modeling applications: A Vienna case study View paper
- [23] Opinion on enhancing diversity in photovoltaic scenario generation using weather data simulating by style-based generative adversarial networks View paper
- [24] Unified modeling and prediction of weather and climate: A 25-year journey View paper
- [25] Hybrid analysis and modeling for next generation of digital twins View paper
- [26] Identifying Opportunities for Skillful Weather Prediction with Interpretable Neural Networks View paper
- [27] Cloud-radiative impact on the dynamics and predictability of an idealized extratropical cyclone View paper
- [28] Interplanetary scintillation observation and space weather modelling View paper
- [29] Integrating social and behavioral sciences within the weather enterprise View paper
- [30] Forecast Error Diagnostics in Neural Weather Models Using Gridpoint Relaxation View paper
- [31] Towards mechanistic understanding in a data-driven weather model: internal activations reveal interpretable physical features View paper
- [32] Progress in space weather modeling in an operational environment View paper
- [33] Integrating Weather Patterns with PMF Modeling: Insights into PM2.5 Pollution Sources and Future Applications to Ozone View paper
- [34] The Effects of Display Type, Weather Type, and Pilot Experience on Pilot Interpretation of Weather Products View paper
- [35] Is there a need to integrate human thermal models with weather forecasts to predict thermal stress? View paper
- [36] Understanding Contributions of Paleo-Informed Natural Variability and Climate Changes on Hydroclimate Extremes in the Central Valley Region of California View paper
- [37] Assessment of Alternative Ways to Integrate Weather Predictions in Photovoltaic Generation Forecasting.Â View paper
- [38] Integrated modeling for forecasting weather and air quality: A call for fully coupled approaches View paper
- [39] An improved model of indoor overheating degree that integrates weather and building parameters for thermal resilience evaluation View paper
- [40] A novel hybrid integration model using support vector machines and random subspace for weather-triggered landslide susceptibility assessment in the Wuning area â¦ View paper
- [41] Modeling the geomagnetic response to the September 2017 space weather event over Fennoscandia using the space weather modeling framework: Studying the â¦ View paper
- [42] Neuro-Symbolic Bi-Directional Translation - Deep Learning Explainability for Climate Tipping Point Research View paper
- [43] Probabilistic aircraft trajectory prediction considering weather uncertainties using dropout as Bayesian approximate variational inference View paper
- [44] Skillful Twelve Hour Precipitation Forecasts using Large Context Neural Networks View paper
- [45] Improving estimation of diurnal land surface temperatures by integrating weather modeling with satellite observations View paper
- [46] Space weather modeling capabilities assessment: Neutral density for orbit determination at low Earth orbit View paper
- [47] Integrated weatherability optimization design tools for ice-shell architecture based on explainable surrogate models View paper
- [48] Co-production of integrated weather and climate services to support net-zero energy transitions View paper
- [49] Highâ Resolution Modeling of ENSOâ Induced Precipitation in the Tropical Andes: Implications for Proxy Interpretation View paper
- [50] Learning Weather Models from Data with WSINDy View paper
- [51] Unified Autoregressive Visual Generation and Understanding with Continuous Tokens View paper
- [52] Sphinx: The joint mixing of weights, tasks, and visual embeddings for multi-modal large language models View paper
- [53] VILA-U: a Unified Foundation Model Integrating Visual Understanding and Generation View paper
- [54] A Joint Learning Framework for Bridging Defect Prediction and Interpretation View paper
- [55] PackDiT: Joint Human Motion and Text Generation via Mutual Prompting View paper
- [56] BLIP: Bootstrapping Language-Image Pre-training for Unified Vision-Language Understanding and Generation View paper
- [57] Nexus-gen: A unified model for image understanding, generation, and editing View paper
- [58] CPT: a pre-trained unbalanced transformer for both Chinese language understanding and generation View paper
- [59] Illume: Illuminating your llms to see, draw, and self-enhance View paper
- [60] EmoSym: A Symbiotic Framework for Unified Emotional Understanding and Generation via Latent Reasoning View paper
- [61] Radarqa: Multi-modal quality analysis of weather radar forecasts View paper
- [62] A Physics-guided Multimodal Transformer Path to Weather and Climate Sciences View paper
- [63] Spatialâ temporal multimodal fusion model for intra-hour solar power forecasting under variable weather conditions View paper
- [64] Cllmate: A multimodal llm for weather and climate events forecasting View paper
- [65] Multimodal deep learning for two-year ENSO forecast View paper
- [66] Weatherqa: Can multimodal language models reason about severe weather? View paper
- [67] Zephyrus: An Agentic Framework for Weather Science View paper
- [68] Advanced multimodal fusion method for very short-term solar irradiance forecasting using sky images and meteorological data: A gate and transformer mechanism approach View paper
- [69] Vision-language models meet meteorology: Developing models for extreme weather events detection with heatmaps View paper
- [70] Eliciting Chain-of-Thought Reasoning for Time Series Analysis using Reinforcement Learning View paper
- [71] Output Scaling: YingLong-Delayed Chain of Thought in a Large Pretrained Time Series Forecasting Model View paper
- [72] EWE: An Agentic Framework for Extreme Weather Analysis View paper
- [73] Mtbench: A multimodal time series benchmark for temporal reasoning and question answering View paper
- [74] Exploring Multimodal AI Reasoning for Meteorological Forecasting from Skew-T Diagrams View paper
- [75] Urbankgent: A unified large language model agent framework for urban knowledge graph construction View paper
- [76] LLMs for Enhanced Agricultural Meteorological Recommendations View paper
- [77] Enhancing Wind Power Forecast Precision via Multi-head Attention Transformer: An Investigation on Single-step and Multi-step Forecasting View paper