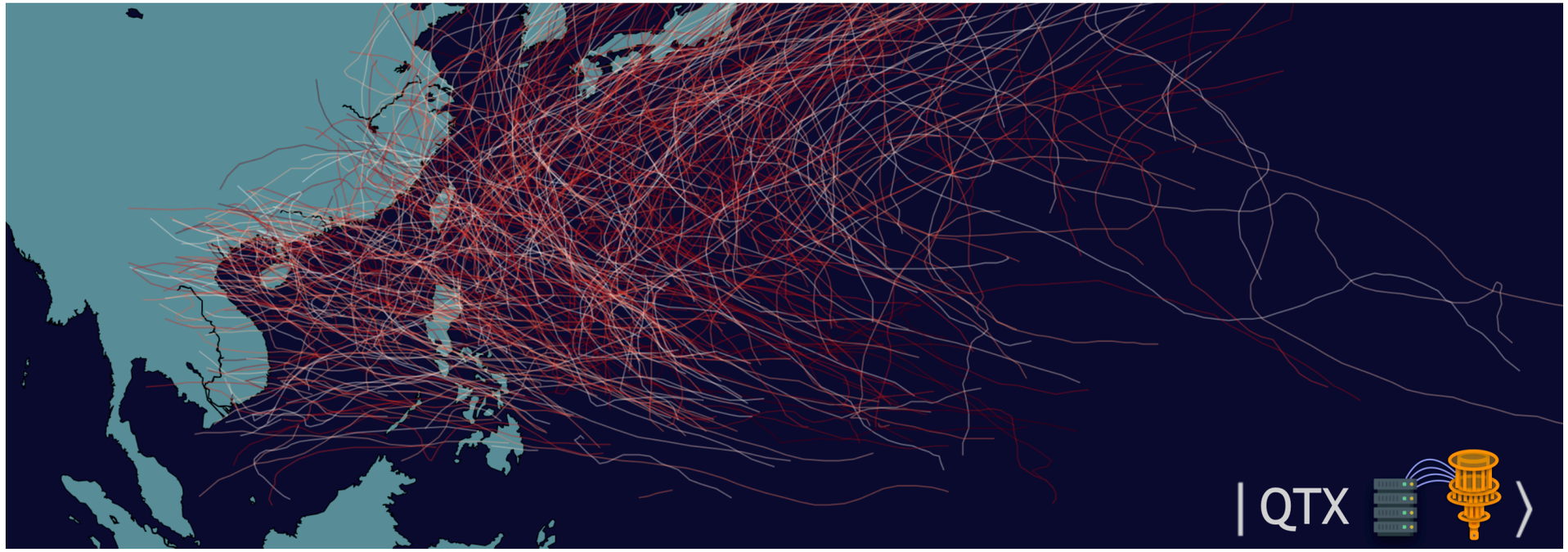
Pasqal

The Blaise Pascal Quantum Challenge



Quantum-Enhanced Parameter Efficient Learning for Typhoon Trajectory Forecasting Using Neutral Atom Quantum Computing

Team QTX

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Introduction and Problem Statement

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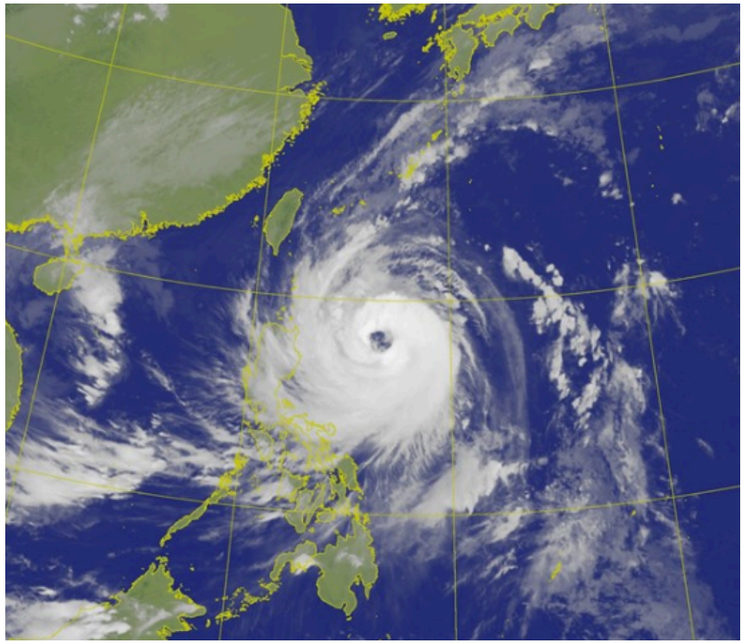

Satellite image: Central Weather Administration

The challenge

- Typhoons are among the most devastating natural disasters, causing **severe human, economic, and infrastructure losses** worldwide.

2009 Morakot typhoon in TW. Source: ctwant

2001 Nari typhoon in TW. Source: ctwant

Can we predict the typhoon trajectory precisely?

Yes. However, traditional deep learning models for typhoon prediction require **a lot of trainable parameters** and **high computational costs**, making them **energy-intensive** and maybe **inaccessible to many regions.**

🌍 **SDG 13: Climate Action**

Solution Overview

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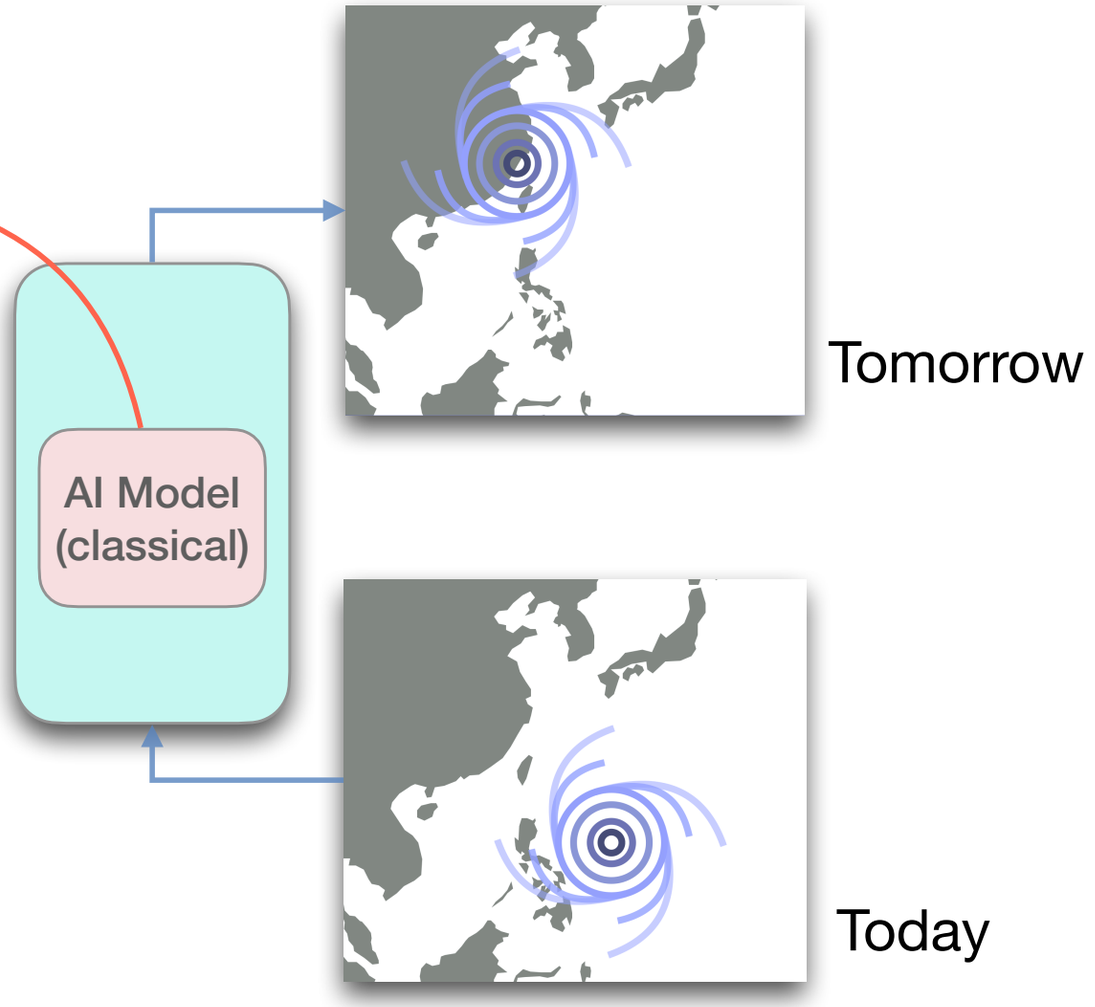
Train this ***Classical*** model efficiently by ***Quantum*** method



- Training result is a classical model
  → Can be deployed on classical computer
- Data encoding issue for quantum circuit is eliminated
- This is the first work to apply Quantum AI to the complex task of typhoon trajectory prediction.
- Quantum Parameter Adaptation (QPA) method (originally for LLM) to be published at ICLR 2025

ICLR
International Conference On Learning Representations

Technical Feasibility and Quantum Computing Contribution

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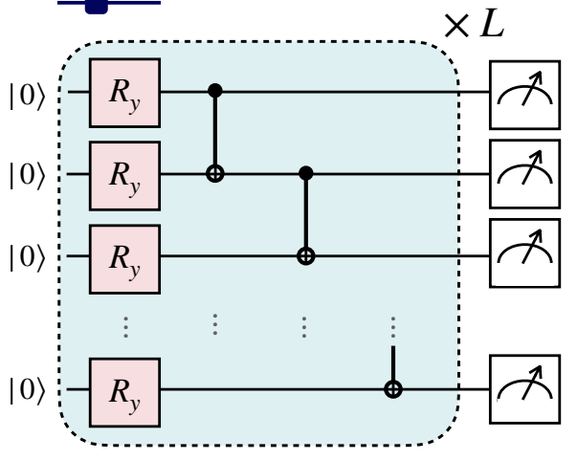
Use the power of Hilbert space to represent classical parameters with fewer quantum parameters.

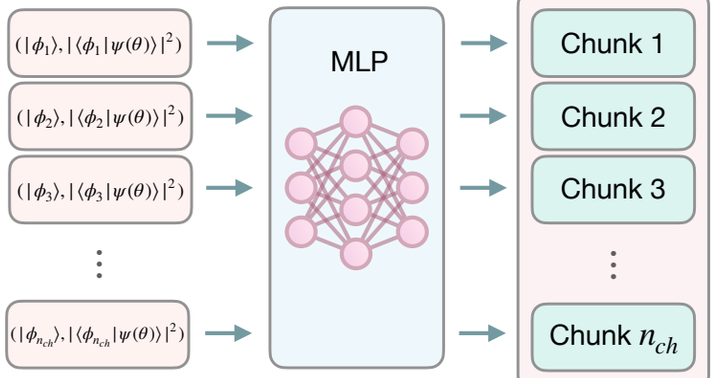
QADENCE



QNN

with $N = \lceil \log_2 n_{ch} \rceil$ qubits

QNN generated context vector



Mapping Model

Generate chunked parameters

Parameter Efficient Learning Parameters

LoRA

Original trainable parameters M

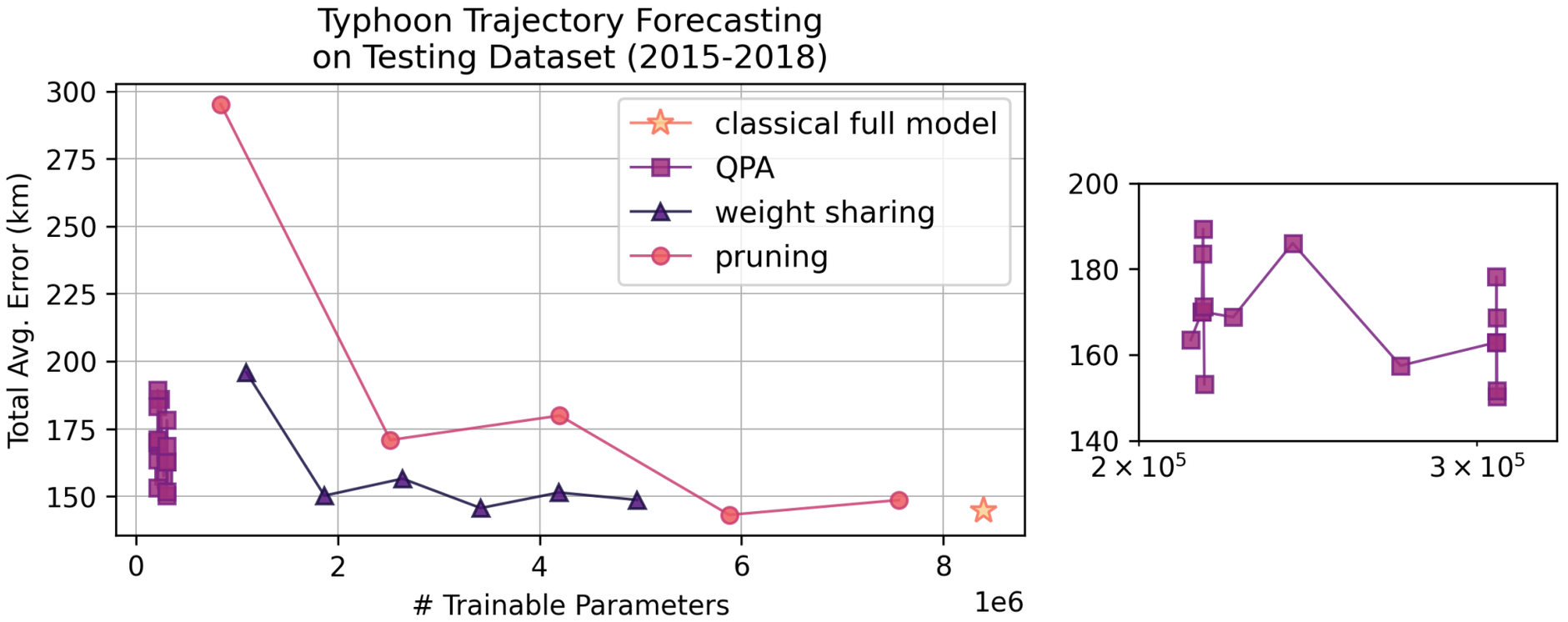
AI Model (classical)

Fewer trainable parameters ~ polylog(M)

Technical Feasibility and Quantum Computing Contribution

Pasqal

Use the power of Hilbert space to represent classical parameters with fewer quantum parameters.



- **only 2.57% of the original parameters with comparable performance.**

Sustainability Impact & Scalability

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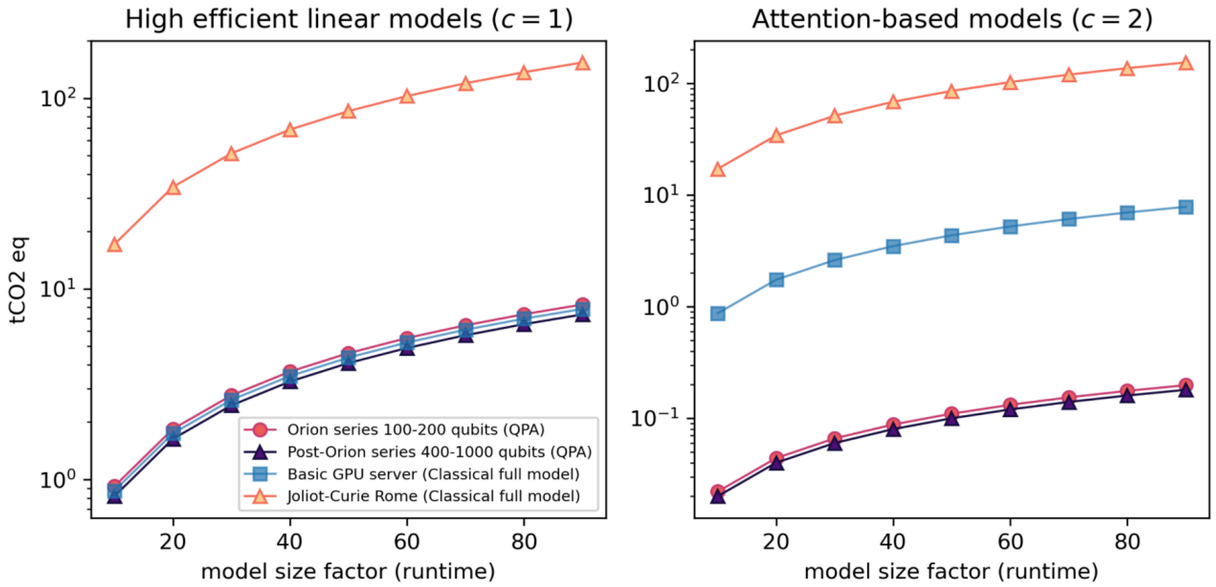
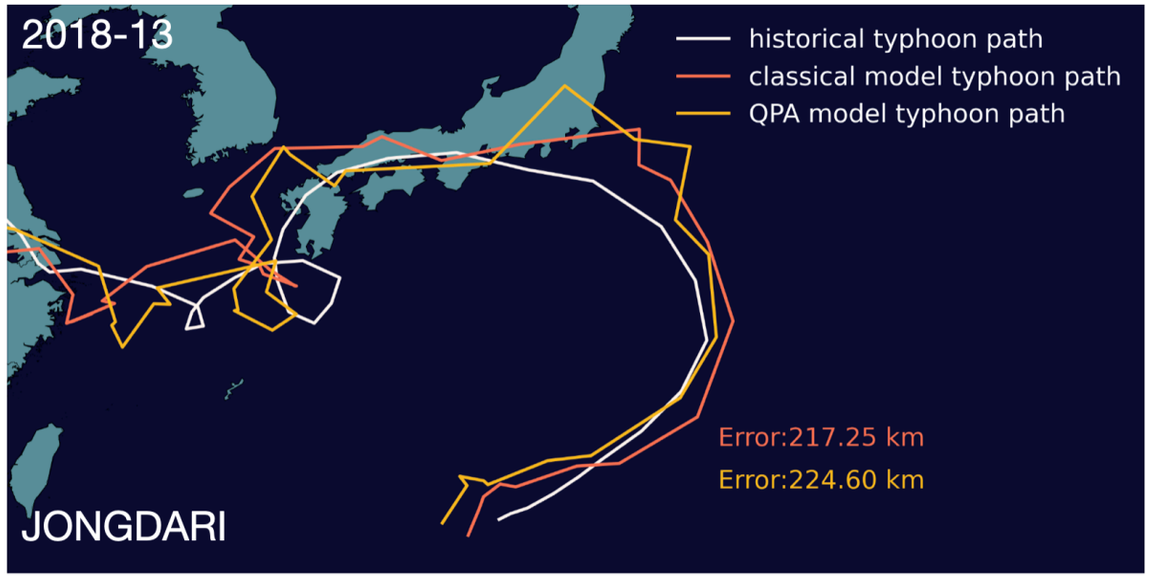
Lower CO2 emission with quantum computing

Comparable performance: live-saving potential





- Uses only ~10 qubits now… with strong potential for scalability!

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Quantum-Enhanced Efficient Learning for Typhoon Trajectory Forecasting

- Pushing the limits of Quantum AI for complex, life-saving tasks—enhancing efficiency, deployability, and social good.

The next steps

- Optimize usage with digital-analog neutral atom quantum computing.
- Typhoons are just one of many natural disasters— we will continue pushing the limits to tackle other complex climate challenges.