

INDEPENDENT LEARNING



Flow regime evolution of westbound typhoons around the Taiwanese waters and its experimental modeling.

50104 黃玉涵

Outline



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Reflection and reasoning

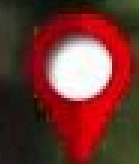
The background image shows the interior of the Hagia Sophia in Istanbul. It features a series of tall, fluted columns supporting a complex system of pendentive arches. The architecture is illuminated with warm, golden light, highlighting the intricate details of the masonry and the rhythmic pattern of the columns and arches. The perspective is looking down a central aisle, creating a sense of depth and grandeur.

Learning motivation

颱風逐漸
逼近台灣
提醒 做好
防颱準備

雨彈狂炸高雄

CN 中視新聞 HD



國道岡山

高雄

民眾

很可怕 真的很可怕

CN 中視新聞

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Summarize the regional rainfall distribution in Taiwan caused by various westward-moving typhoon tracks

learning motivation

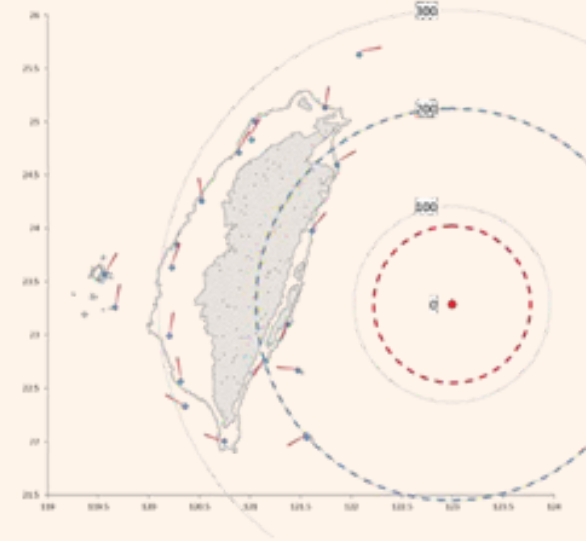
Typhoon

One common weather disaster in Taiwan is typhoons. The strong winds and heavy rain they bring often have a big impact on the island.



Flow regime evolution of westbound typhoons around the Taiwanese waters and its experimental modeling.

Wind field analysis



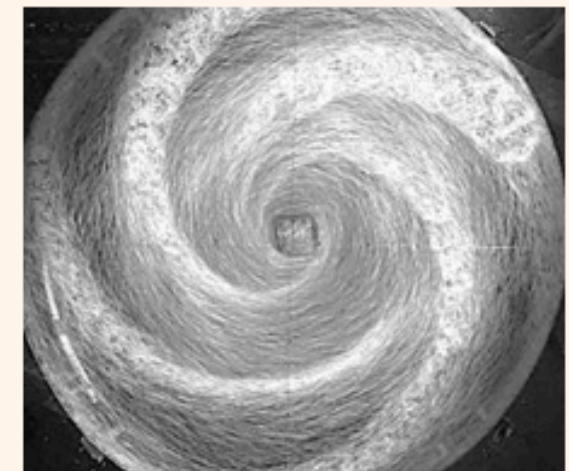
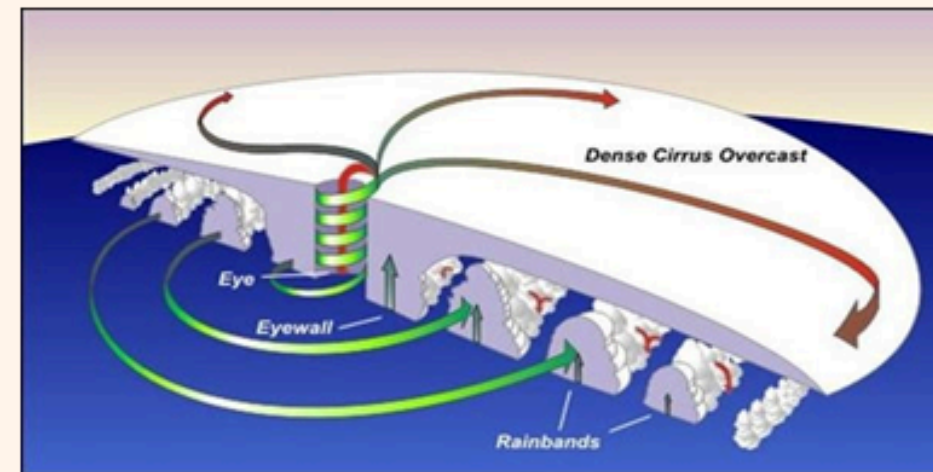
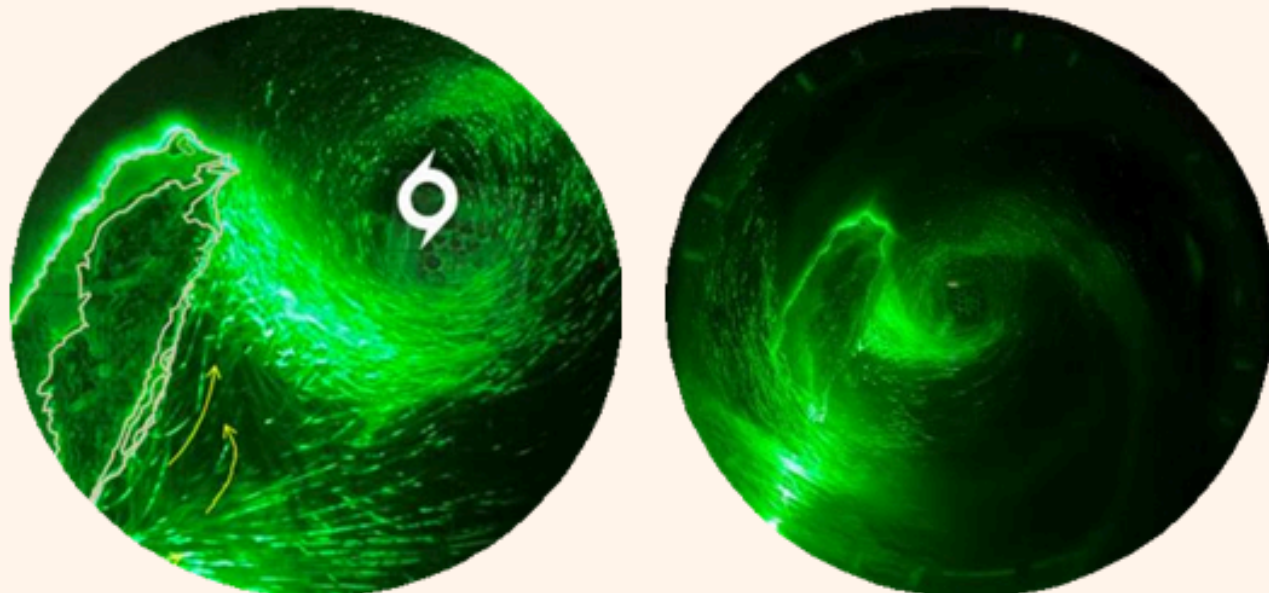
Define the flow regime

List cases and find out the location of the typhoon


Discuss the relationship between typhoon paths and flow regime evolution

Compare the differences between the model and the real typhoons

Airflow field model development



Simulate various flow regime changes

The background image shows the interior of a large, ornate dome, likely from a mosque. The ceiling is covered in intricate Islamic geometric and floral patterns in shades of gold, red, and blue. A large central medallion (shamsa) with Arabic calligraphy is prominent. The architecture features ribbed vaulting and smaller circular medallions scattered across the surface.

Implementation Process

METHOD

Select target typhoons for analysis and collect their warning bulletins. Confirm the basic parameters of each typhoon

- 首頁
 - Catalog
 - 日累積雨量
 - 時累積雨量
 - 地面氣溫
 - CWB天氣圖
 - JMA天氣圖
 - 區域探空圖
 - 月-日雨量
 - 月-14時雷達
 - 月-14時溫度
 - 熱帶氣旋
 - 測站氣候
 - 天氣圖練習
 - 魔幻天空
-
- 中央氣象署
 - 現在天氣
 - 雷達圖
 - 衛星雲圖
 - 日雨量圖
 - 時雨量圖
 - 閃電圖
 - 溫度圖
 - 天氣圖
 - 天氣概況
 - 雨量資料
 - 降雨預報
 - 氣象署測站資訊

中央氣象局日累積雨量圖(TST) 資料說明

Y20

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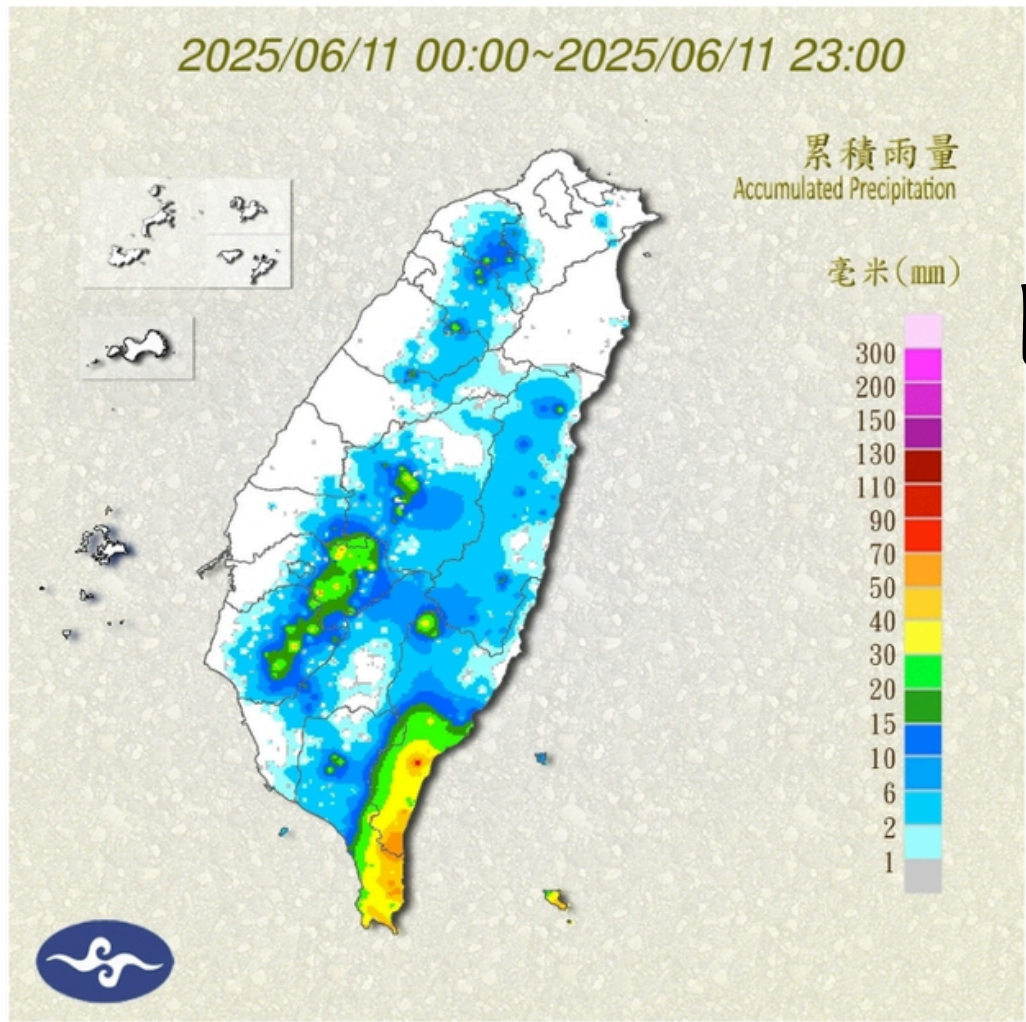
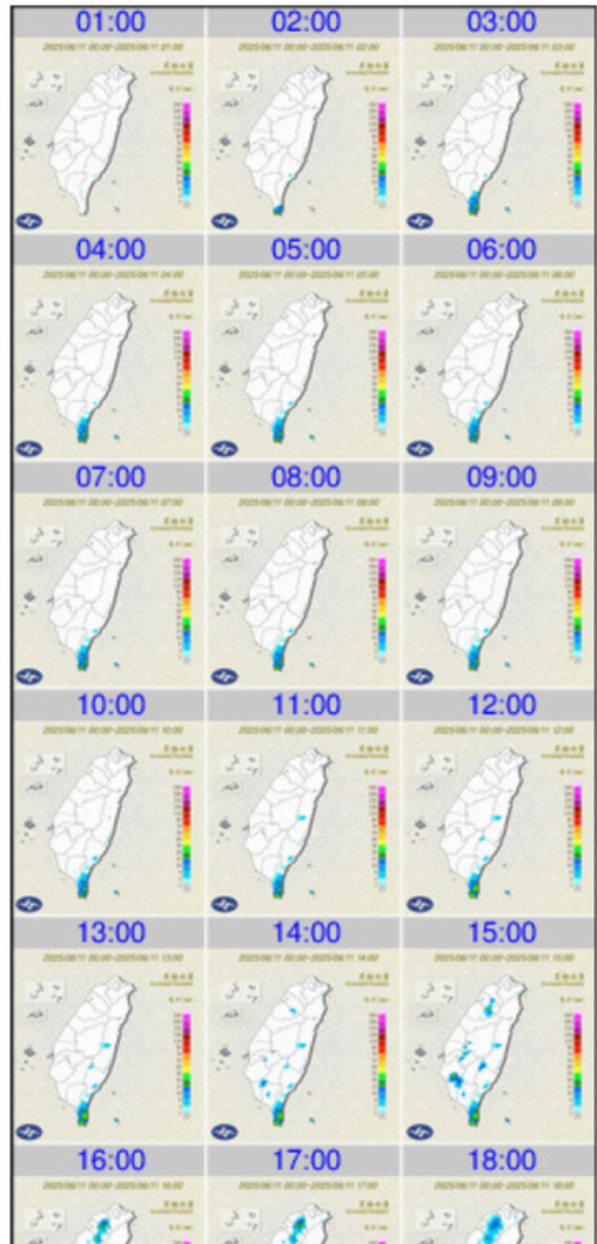
2025

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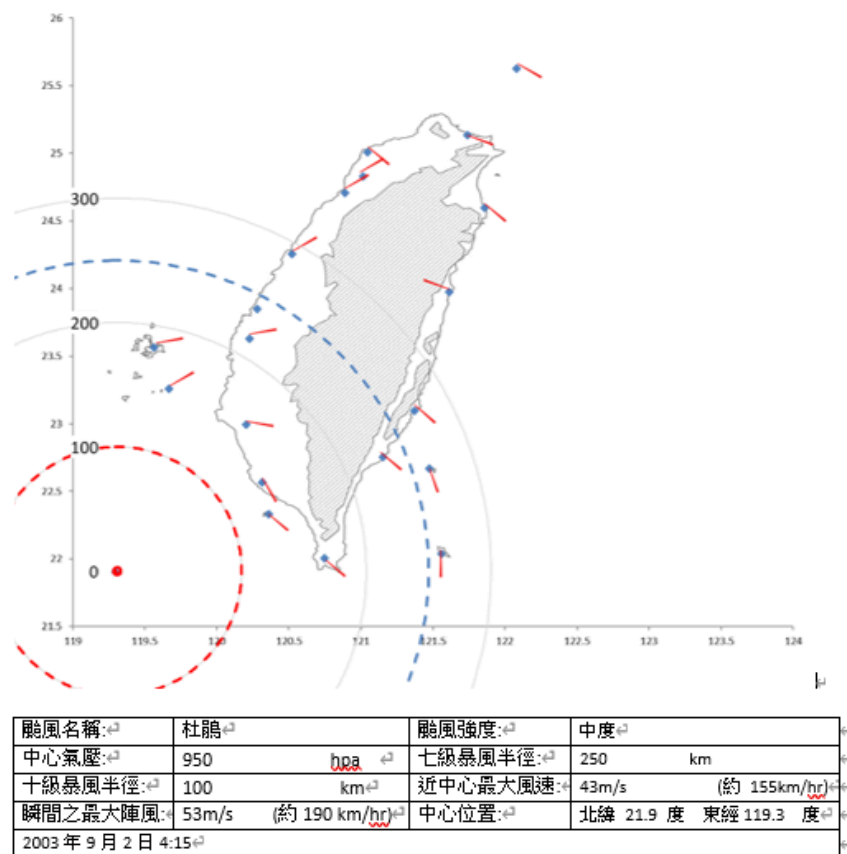
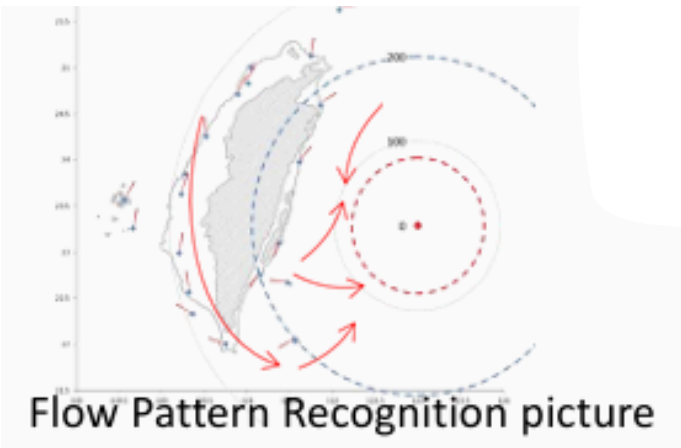
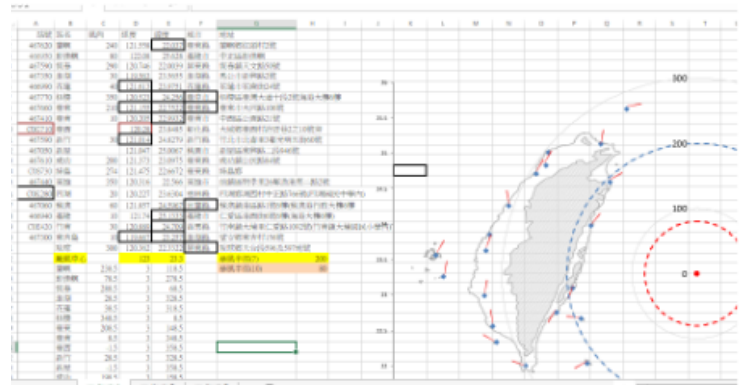
2025-06

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06/10 2025-06-11 中央氣象署日雨量 06/12 2230← 2025/06/11 2300 rainda2 日累積雨量 →2330

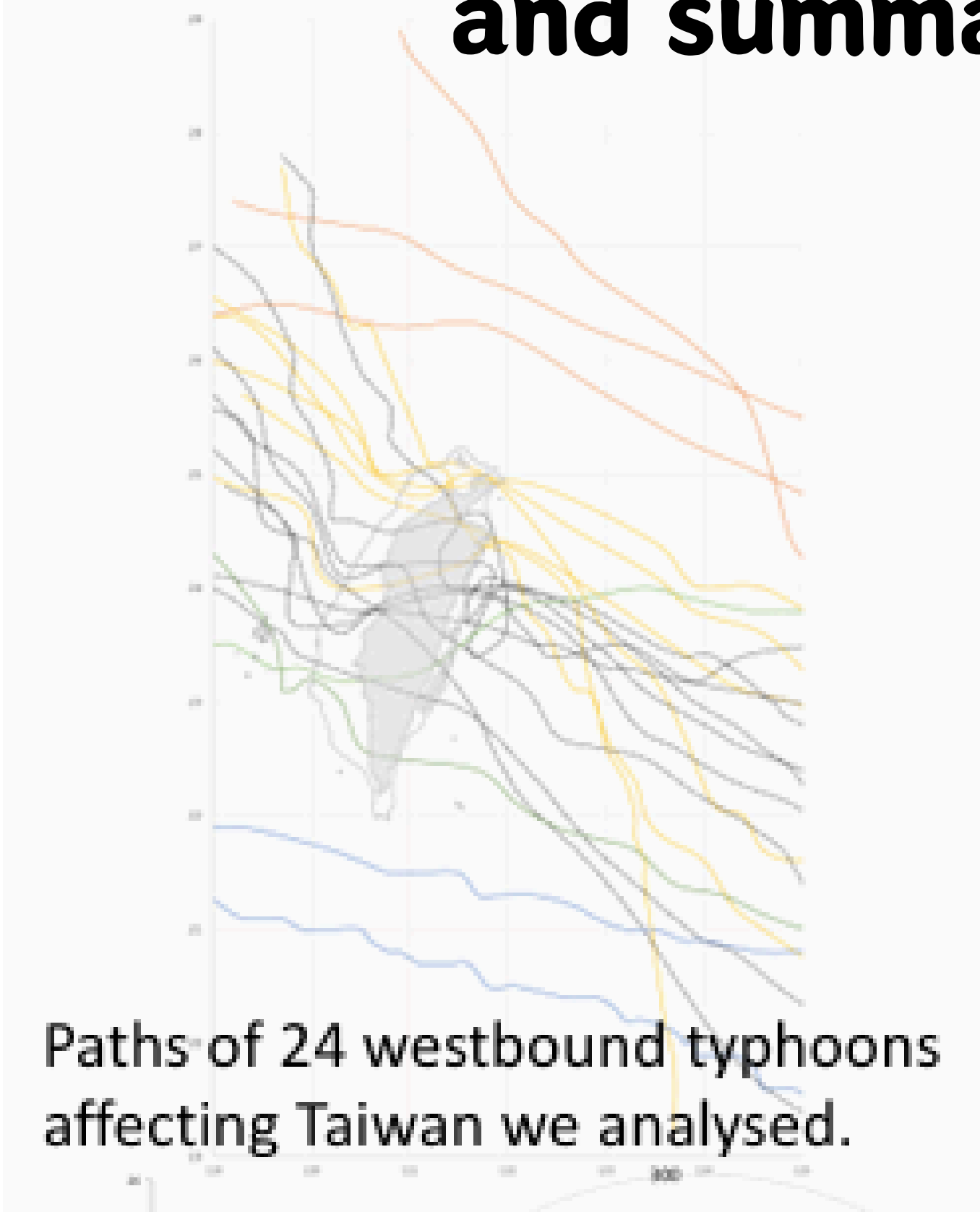


2230← 2025/06/11 2300 rainda2 日累積雨量 →2330

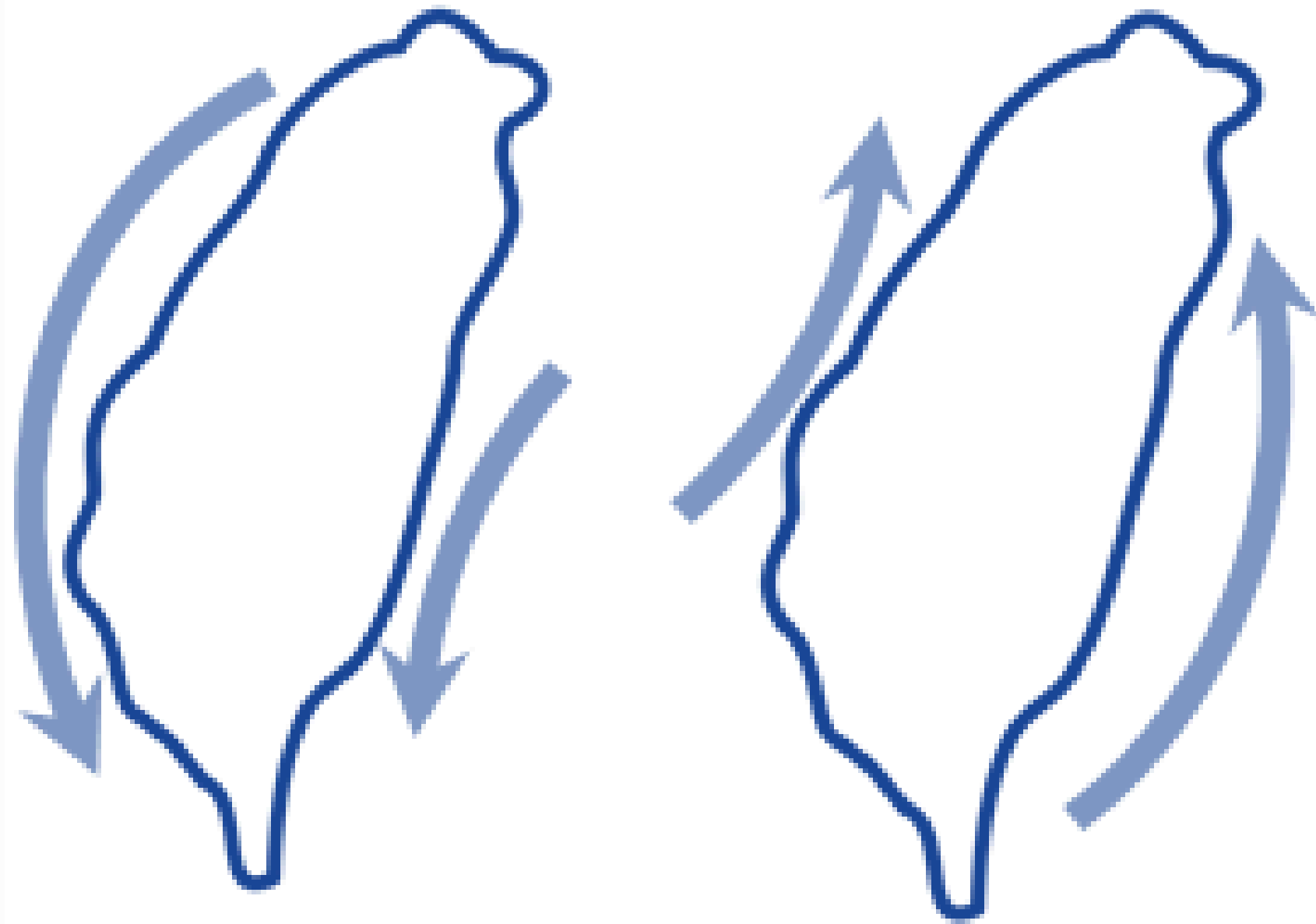


颱風名稱: 杜鵑	中心氣壓: 950 hpa	七級暴風半徑: 250 km	中度
十級暴風半徑: 100 km	近中心最大風速: 43m/s (約 155km/hr)	瞬間之最大陣風: 53m/s (約 190 km/hr)	中心位置: 北緯 21.9 度 東經 119.3 度
2003 年 9 月 2 日 4:15			

Classify each typhoon by its movement regime and summarize the trend of its path.

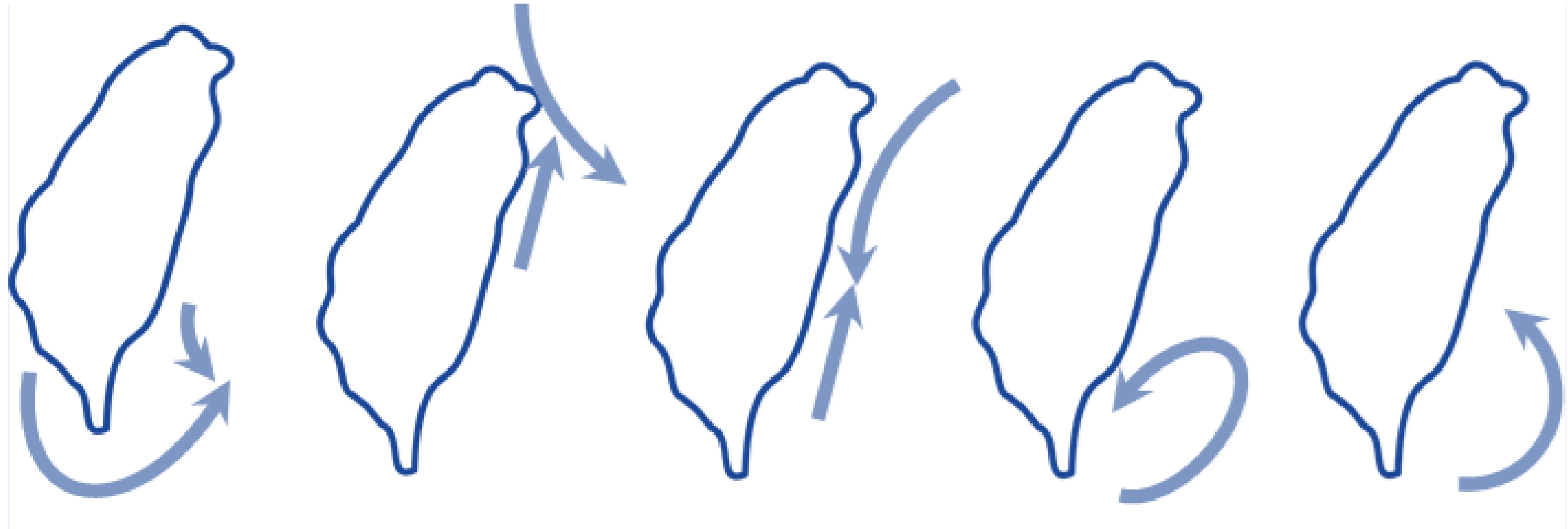


Parallel flow regime		East side wake flow regime				
Landing flow regime		Passing over mountain flow regime		Blocked flow regime		



PARALLEL FLOW REGIME

A small angle of
airflow entry
with the
mountain



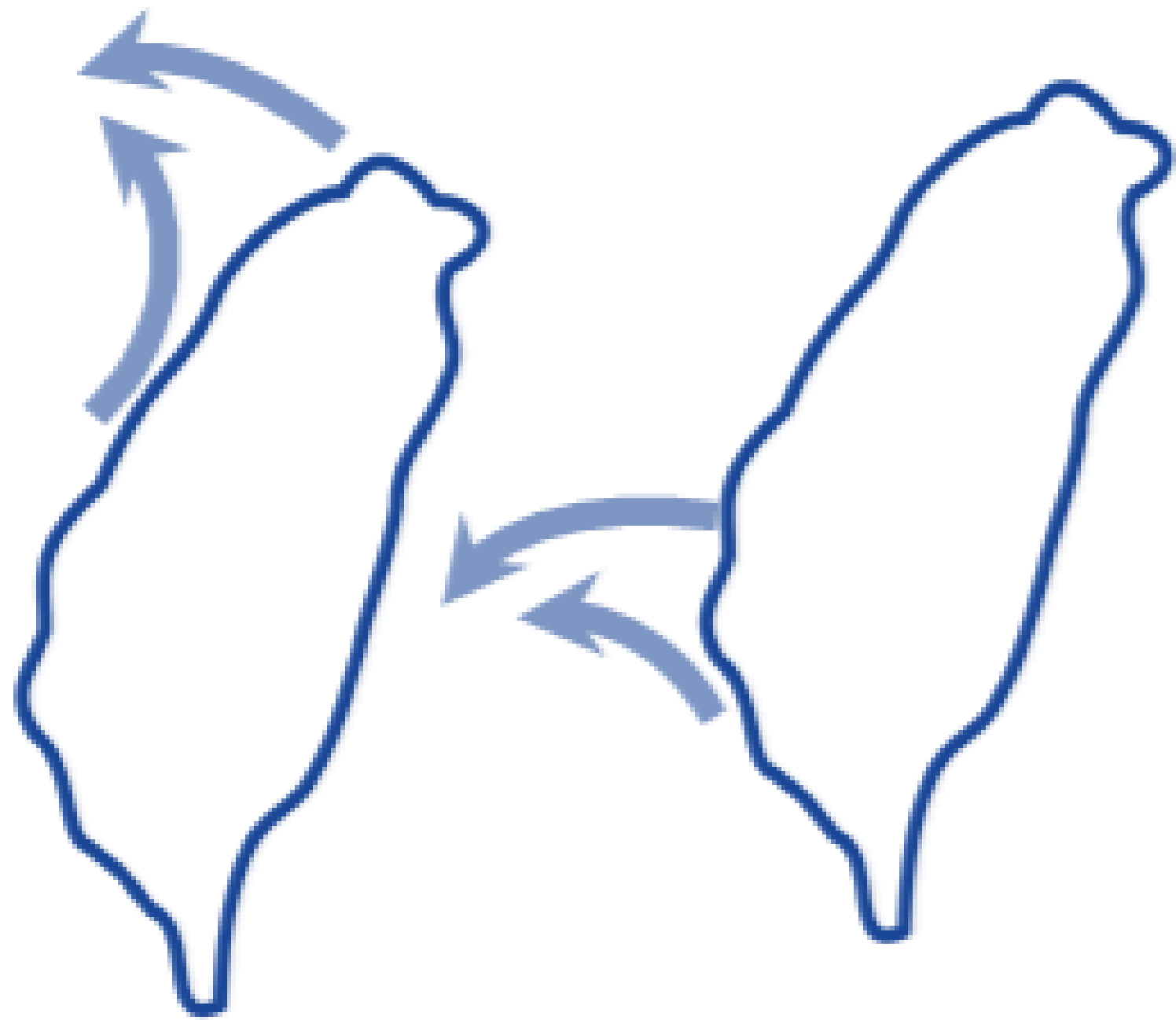
EAST SIDE WAKE FLOW REGIME

A wake or convergence tends to form on its eastern side and may lead to the formation of lee cyclogenesis or recurrent flow



LANDING FLOW REGIME

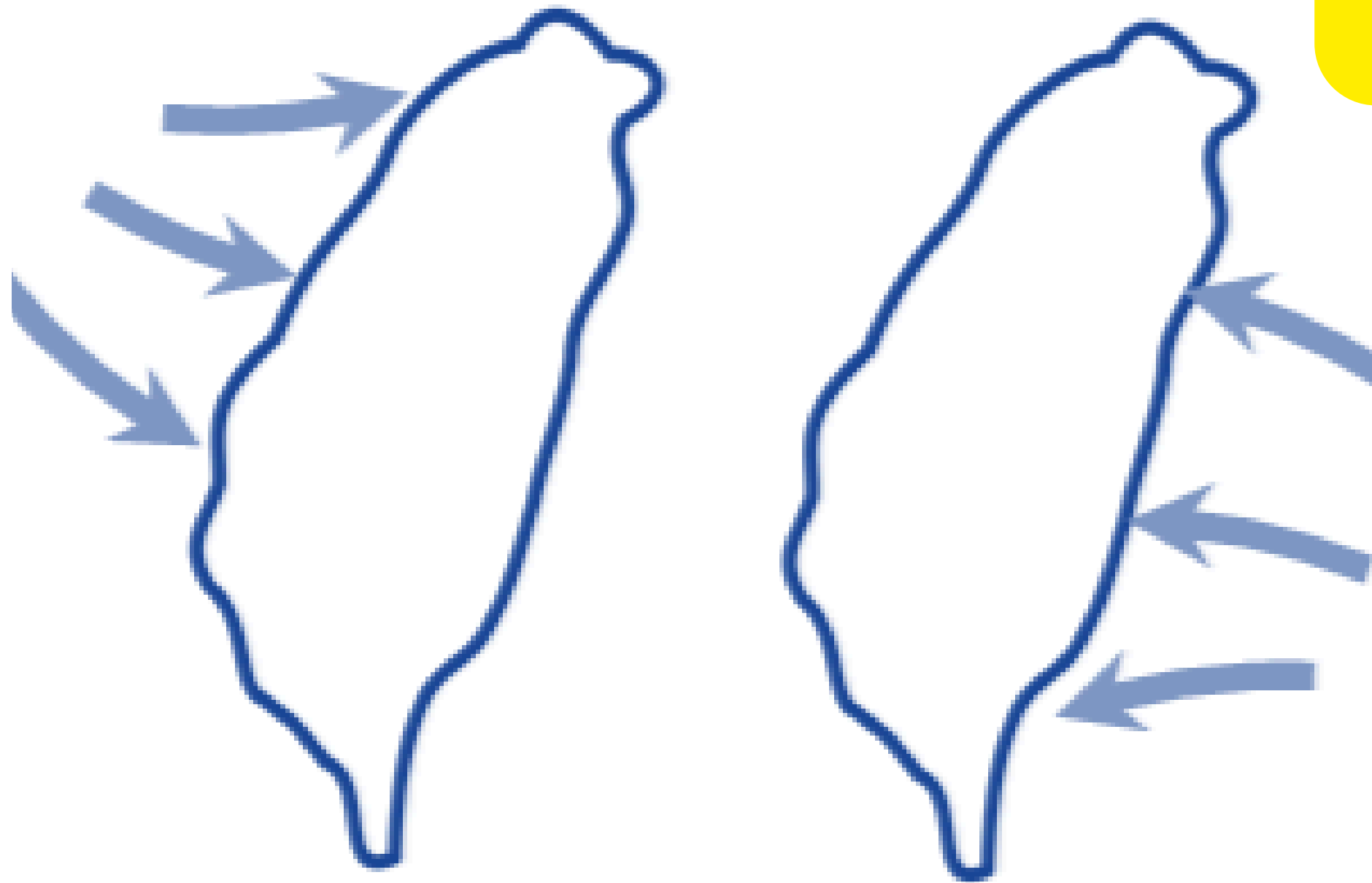
When the typhoon center is over land or close to land, the airflow either goes around Taiwan or has enough energy to climb mountains



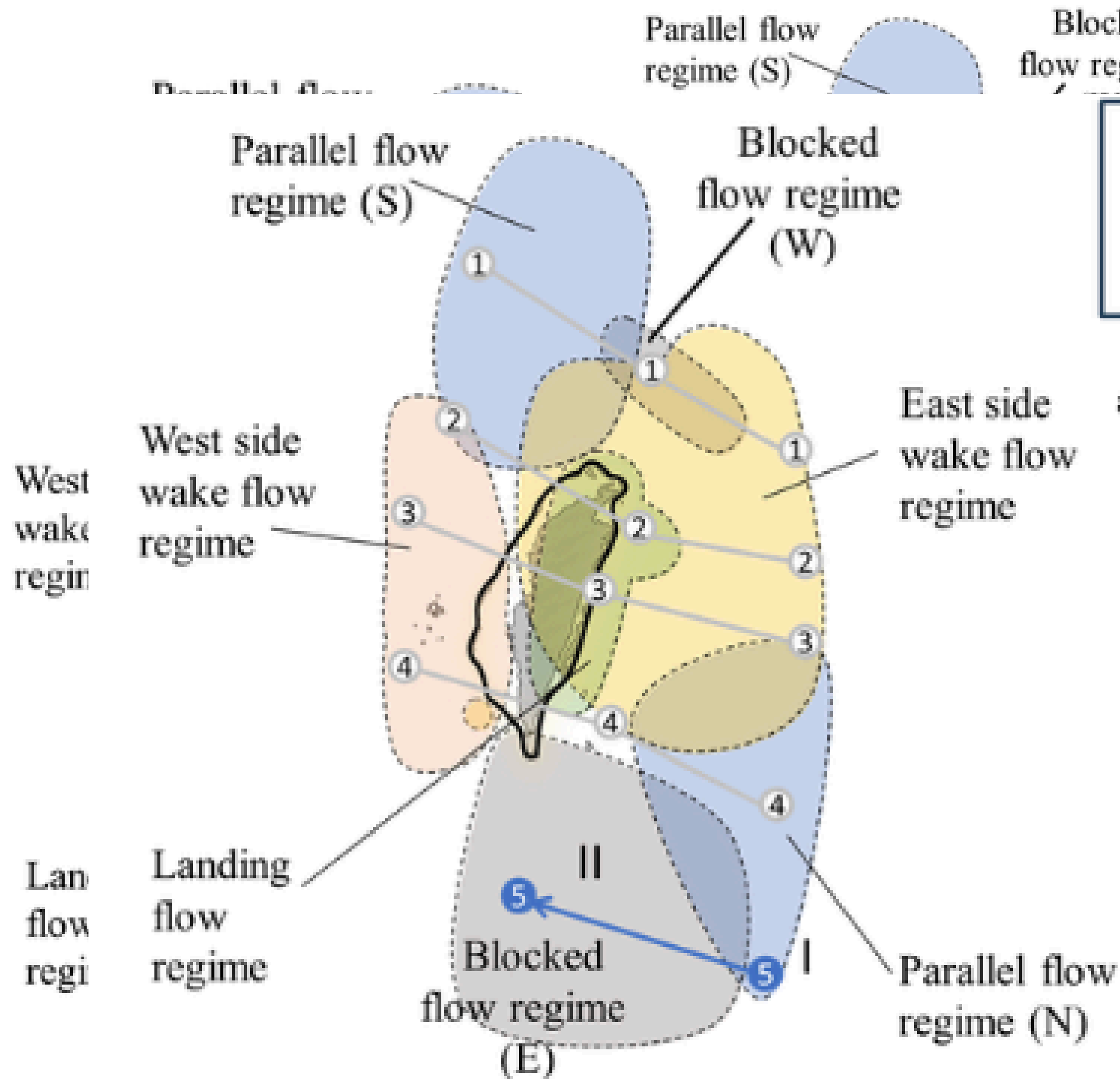
PASSING OVER MOUNTAIN FLOW REGIME

Wake or LC may
occur on the
western side

BLOCKED FLOW REGIME



The airflow
experiences a
stagnant on the
windward side



Blocked flow regime

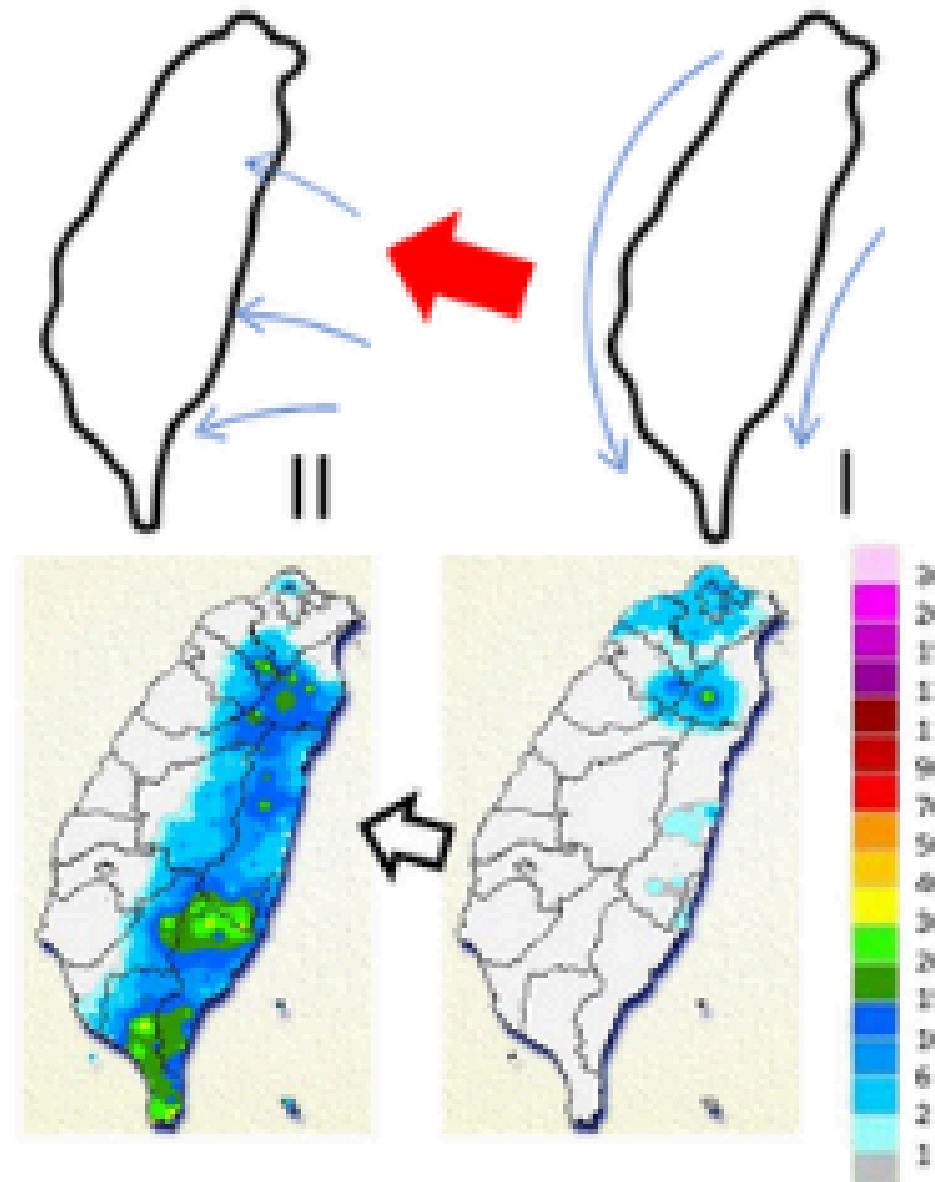
Path three

East side wake flow regime

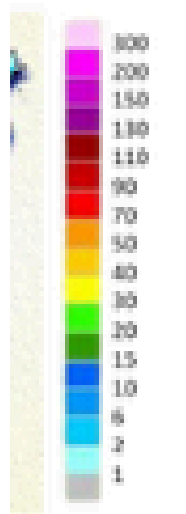
Path five

Parallel flow regime(N)
→ Blocked flow regime(E)

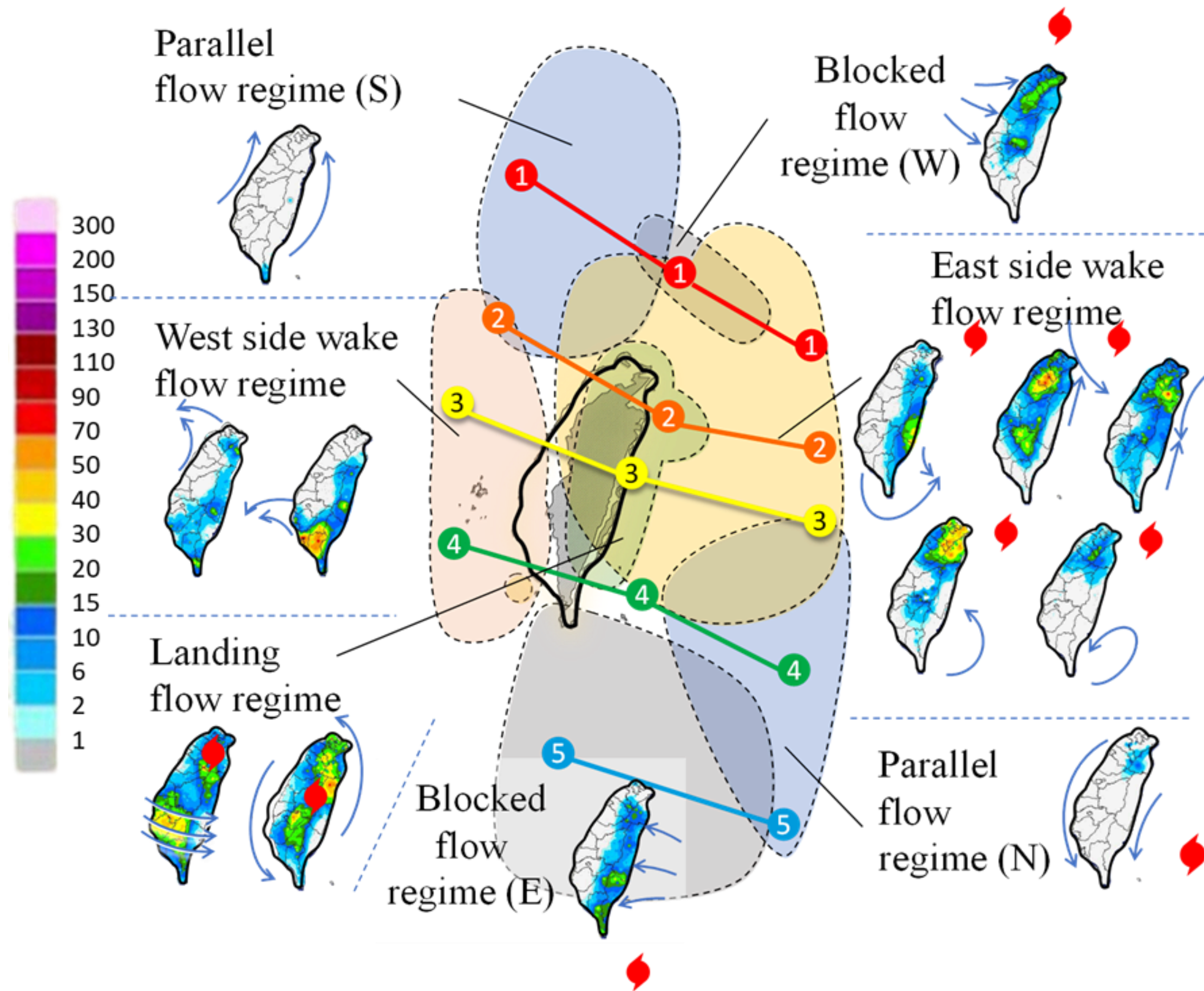
Possible flow regimes evolution and rainfall distribution along the typhoon track



track



0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300



- **Path one:**

East side wake flow regime →
Blocked flow regime (W)
→ Parallel flow regime (S)

- **Path two:**

East side wake flow regime →
Landing flow regime → West side
wake flow regime or Parallel flow

- **Path three:**

East side wake flow regime →
Landing flow regime → West side
wake flow regime

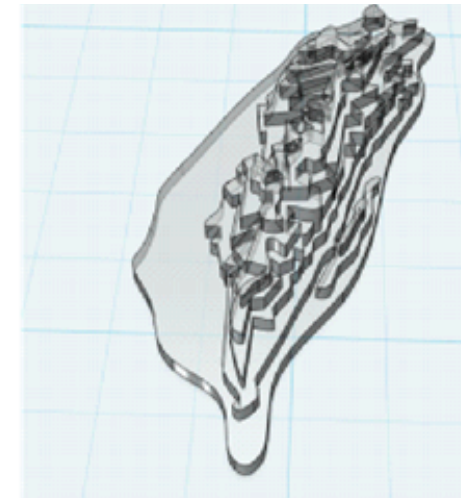
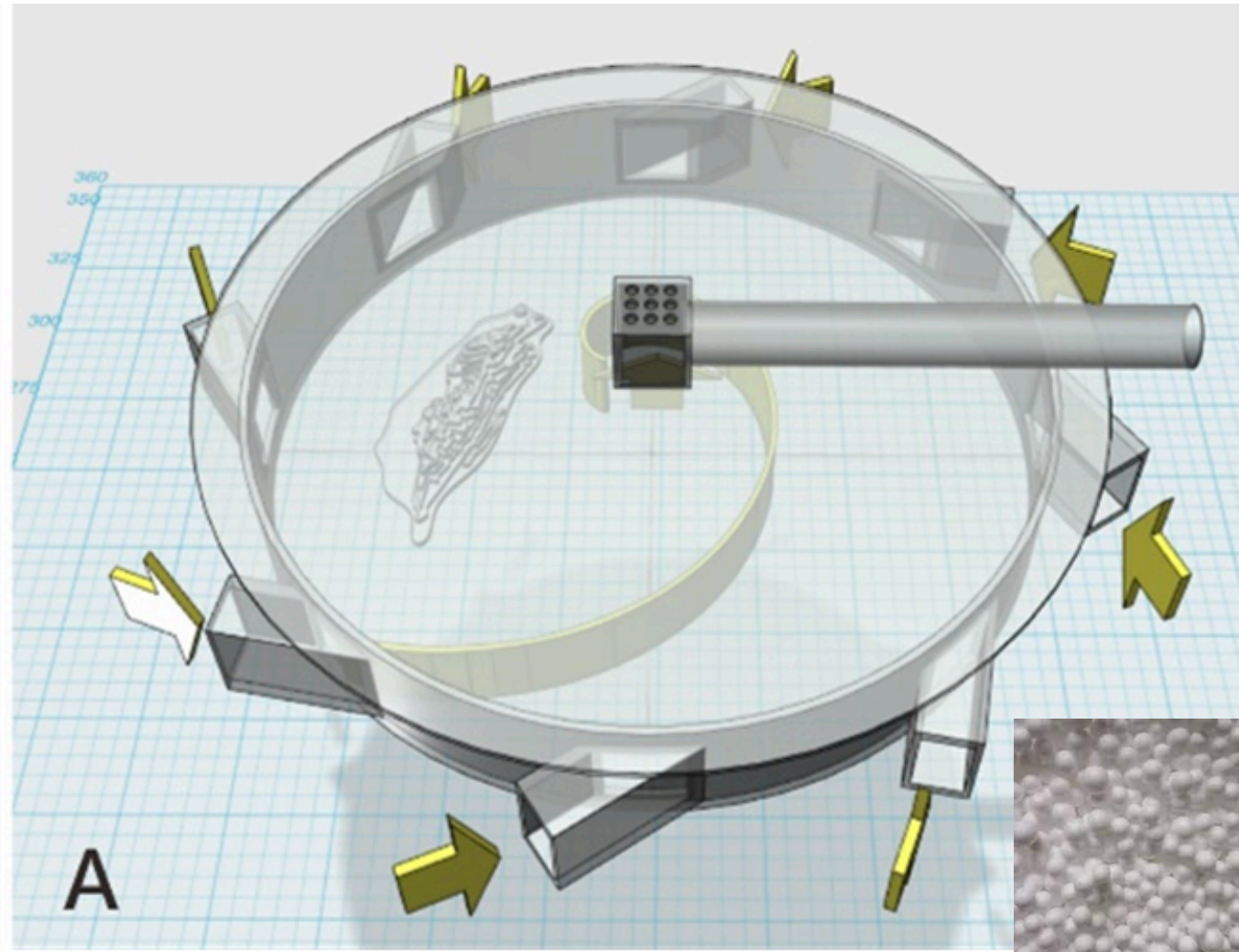
- **Path four:**

Parallel flow regime (N) → Landing
flow regime → West side wake
flow regime

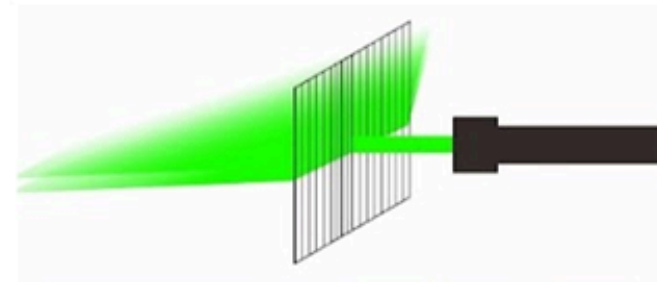
- **Path five:**

Parallel flow regime (N)
→ Blocked flow regime (E)

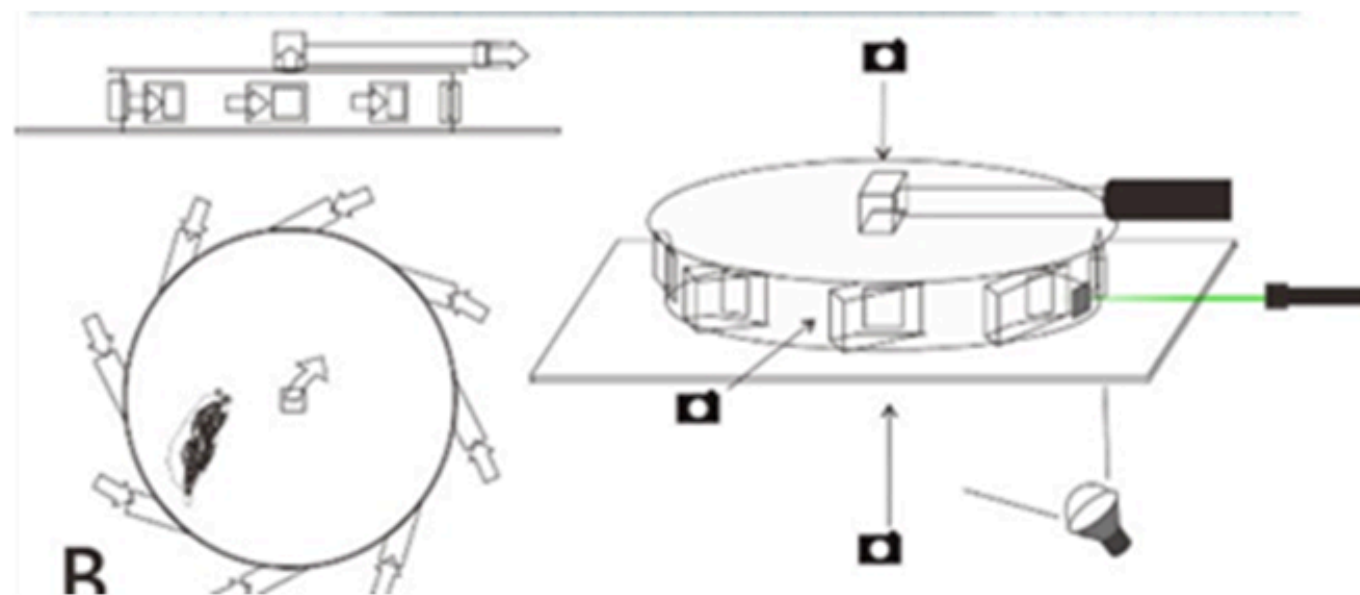
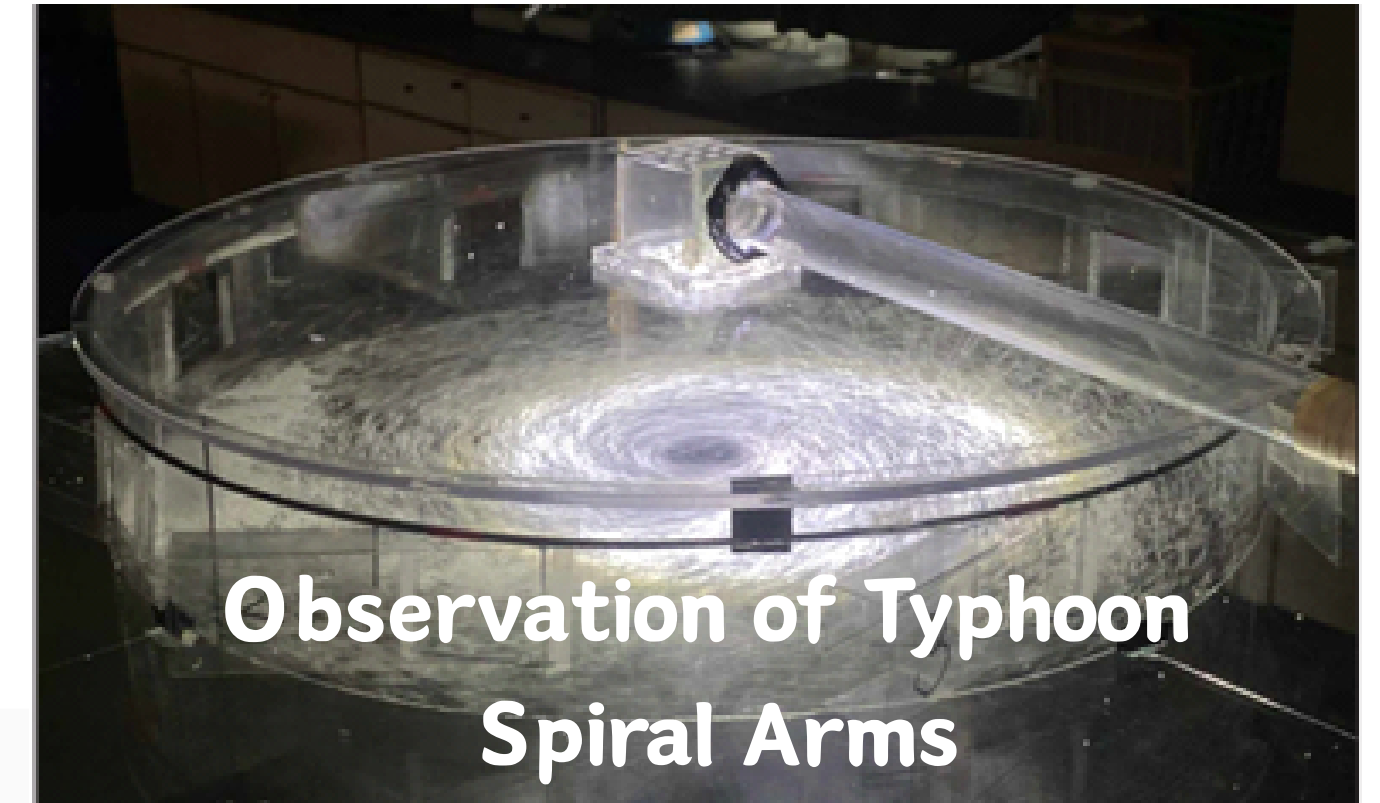
Methods



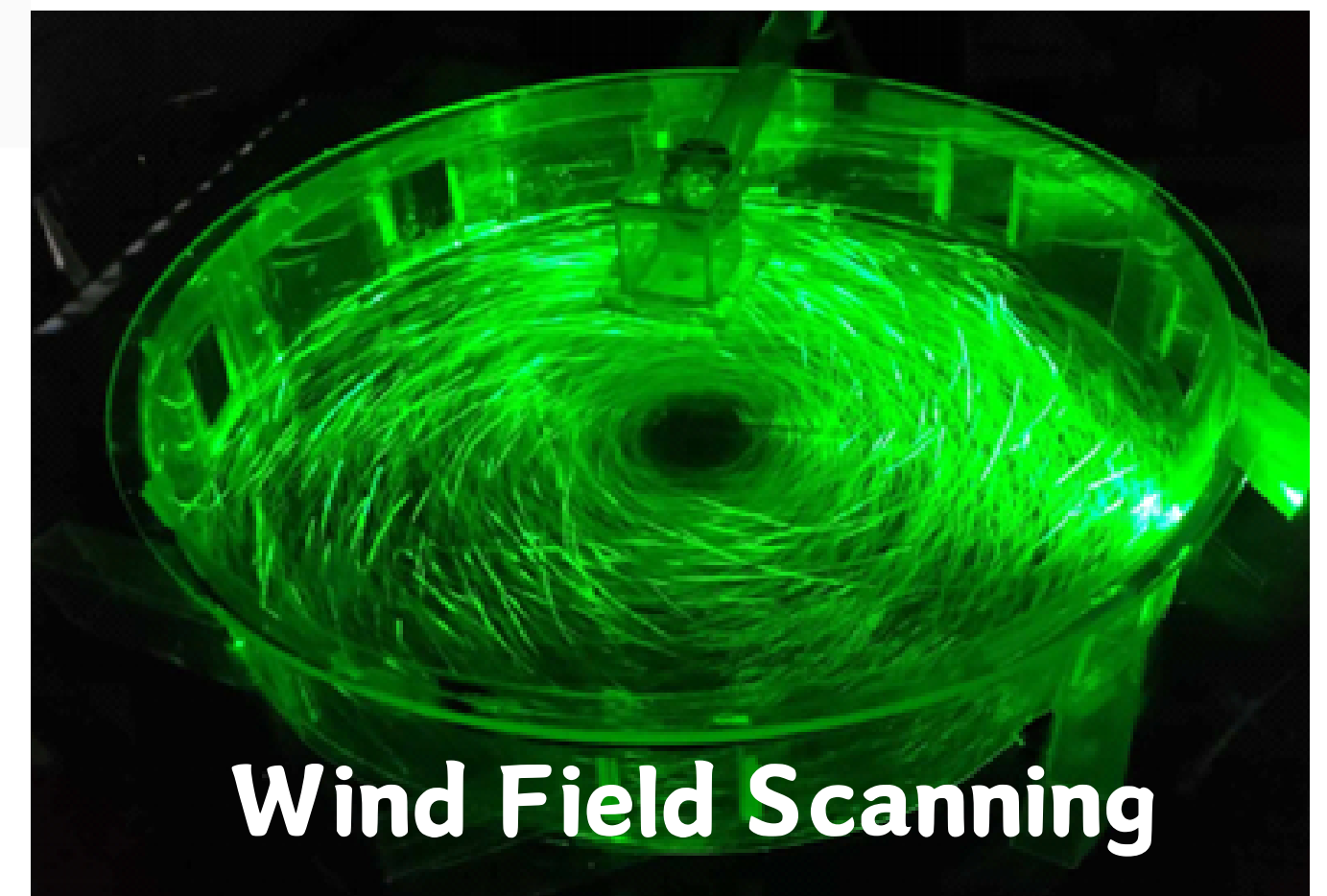
Creation of Taiwan's
Terrain Obstacle



Layered scanning
by laser



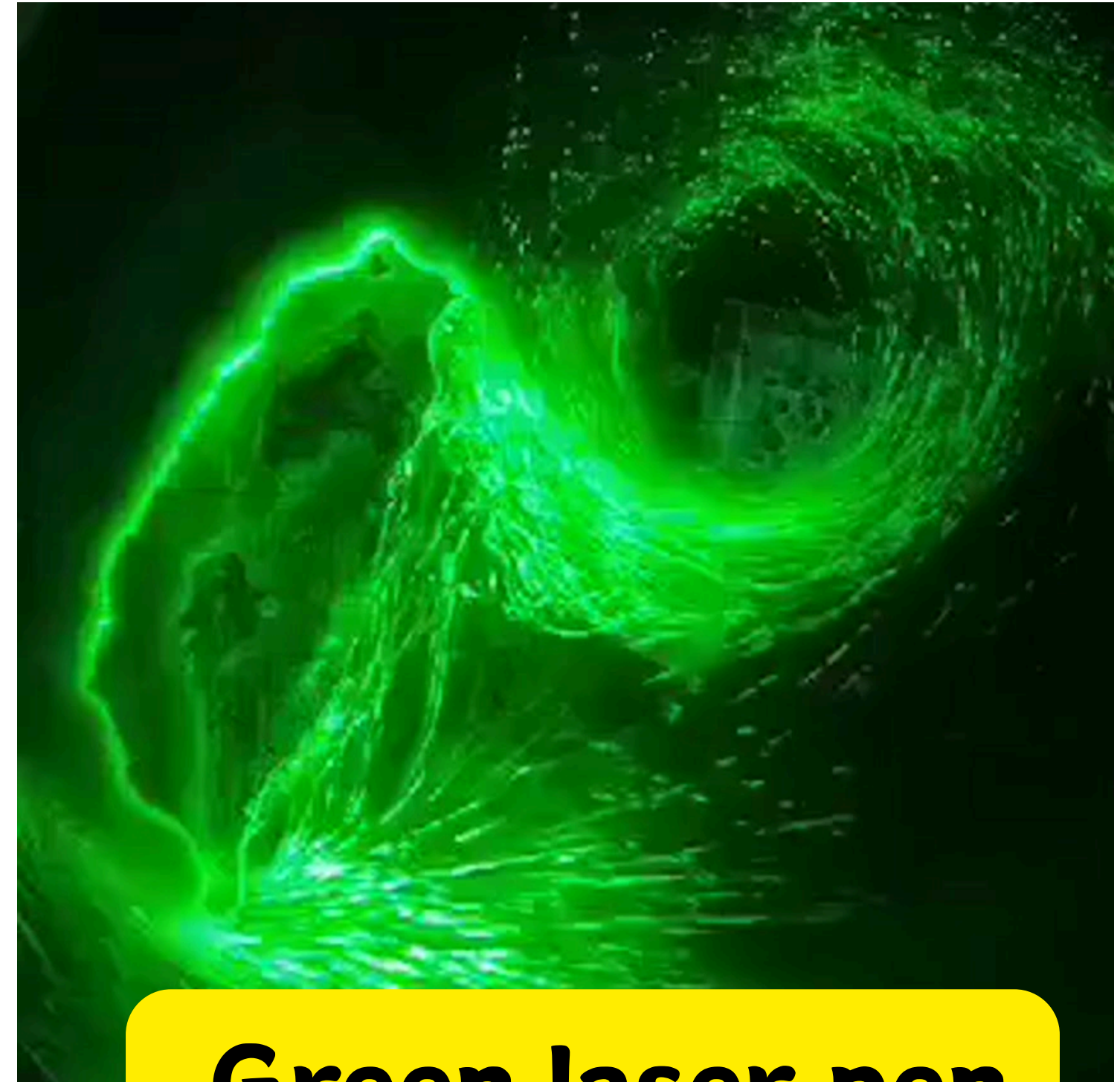
3D picture of Airflow Field





White light

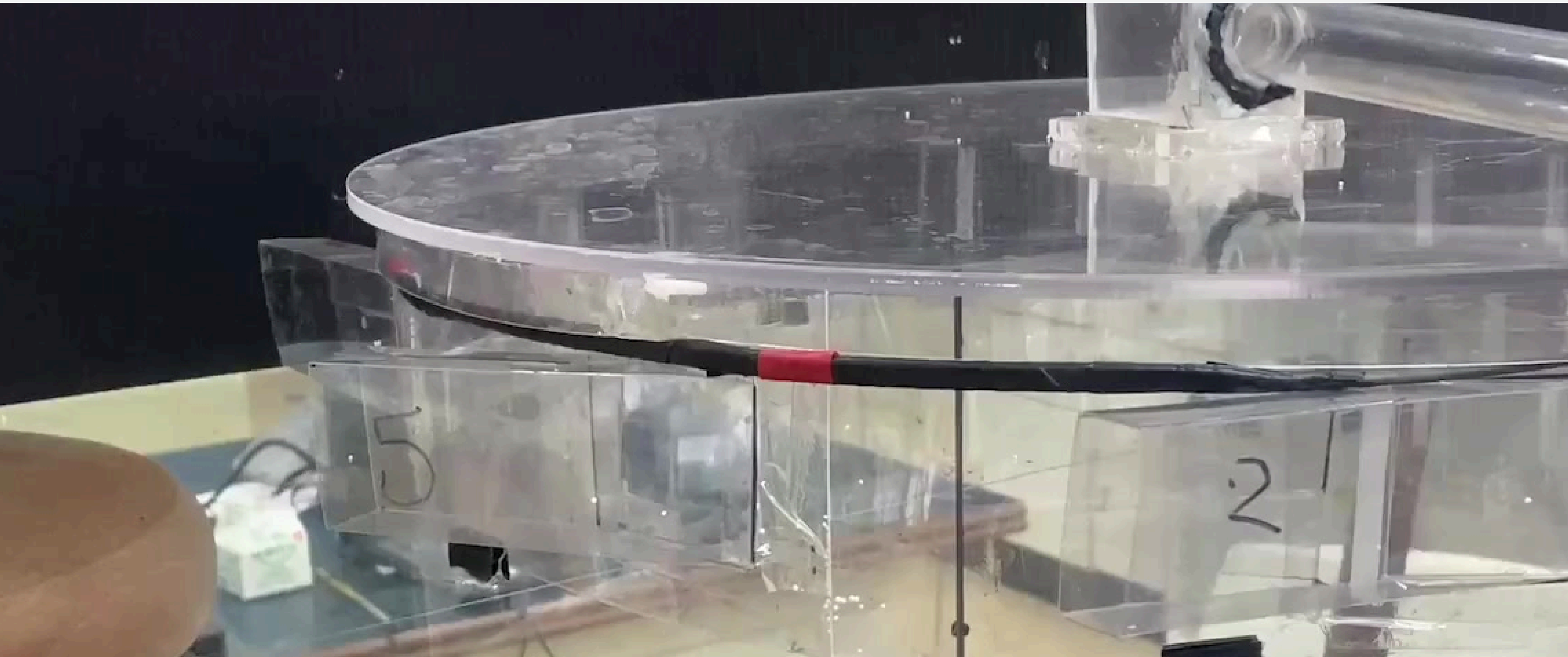
**Observe the accumulation
pattern of styrofoam**

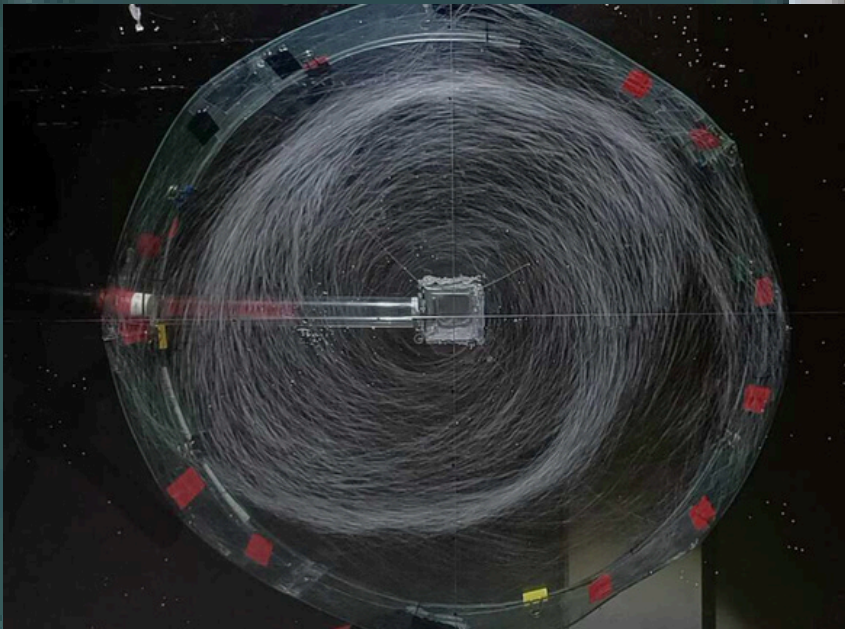
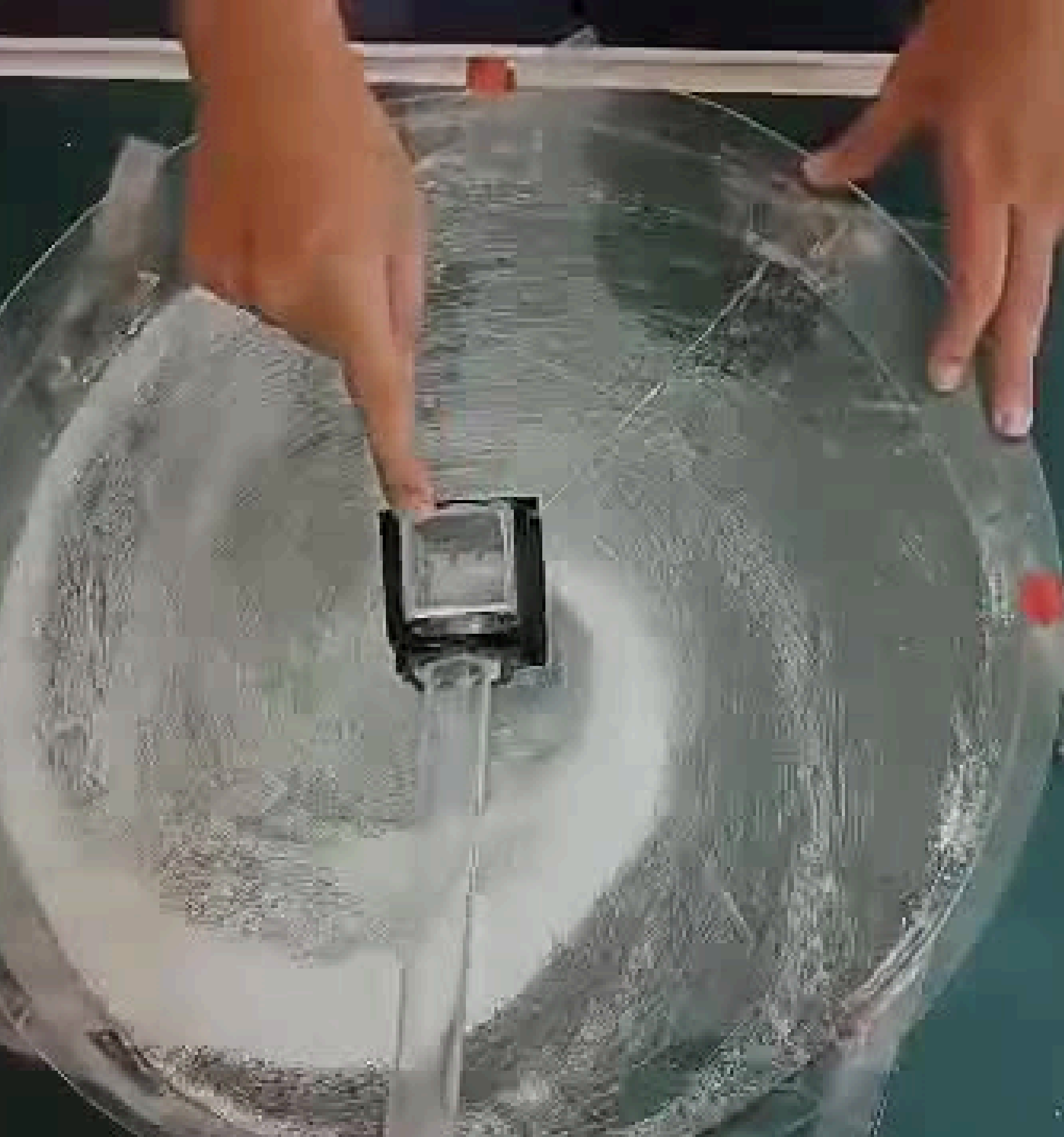
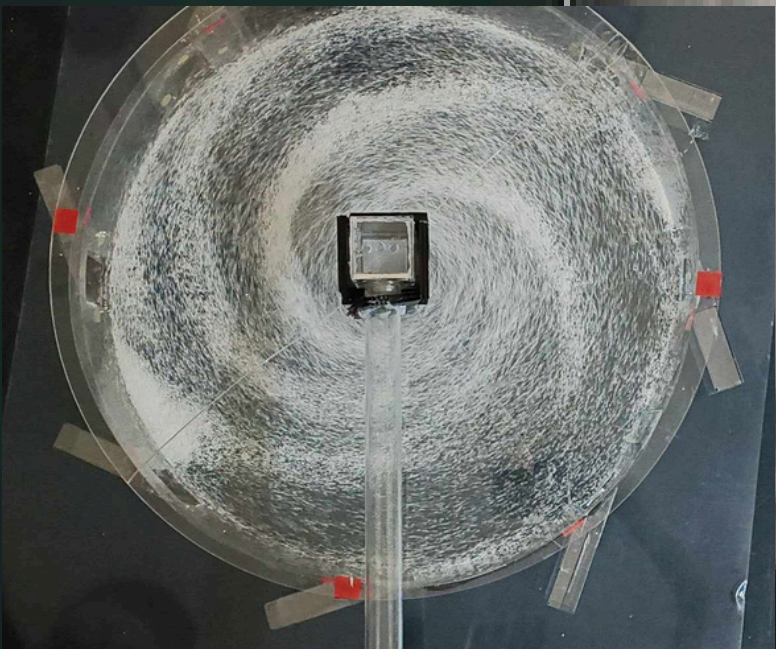
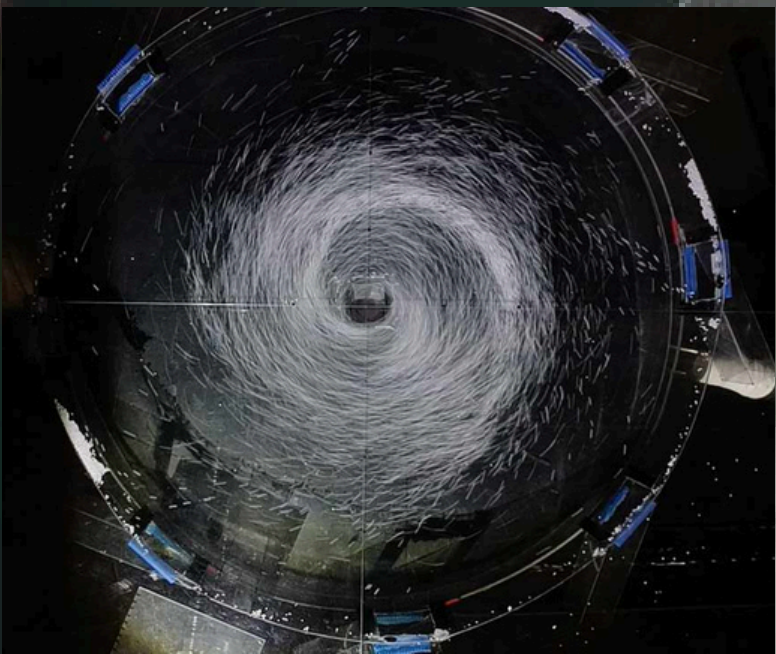


Green laser pen

**Observe the movement
path of styrofoam**

Device operation

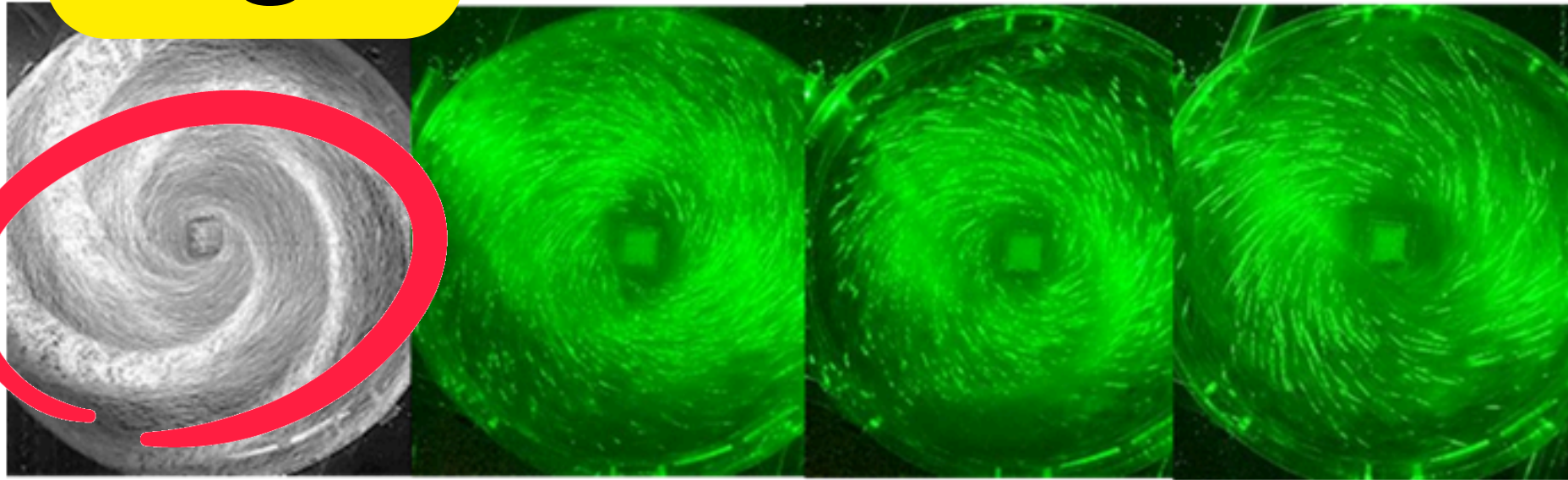




Control Variables

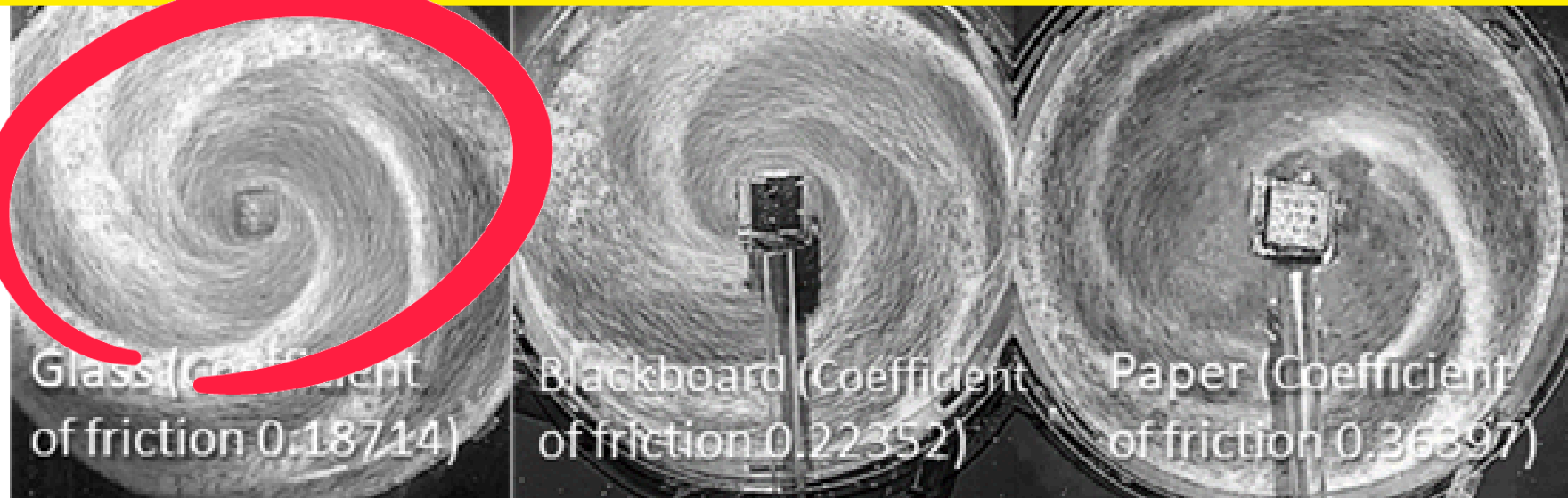
high

Wind field scanning



0.5cm high 1cm high 1.5cm high 2cm high

The friction of the underlying material

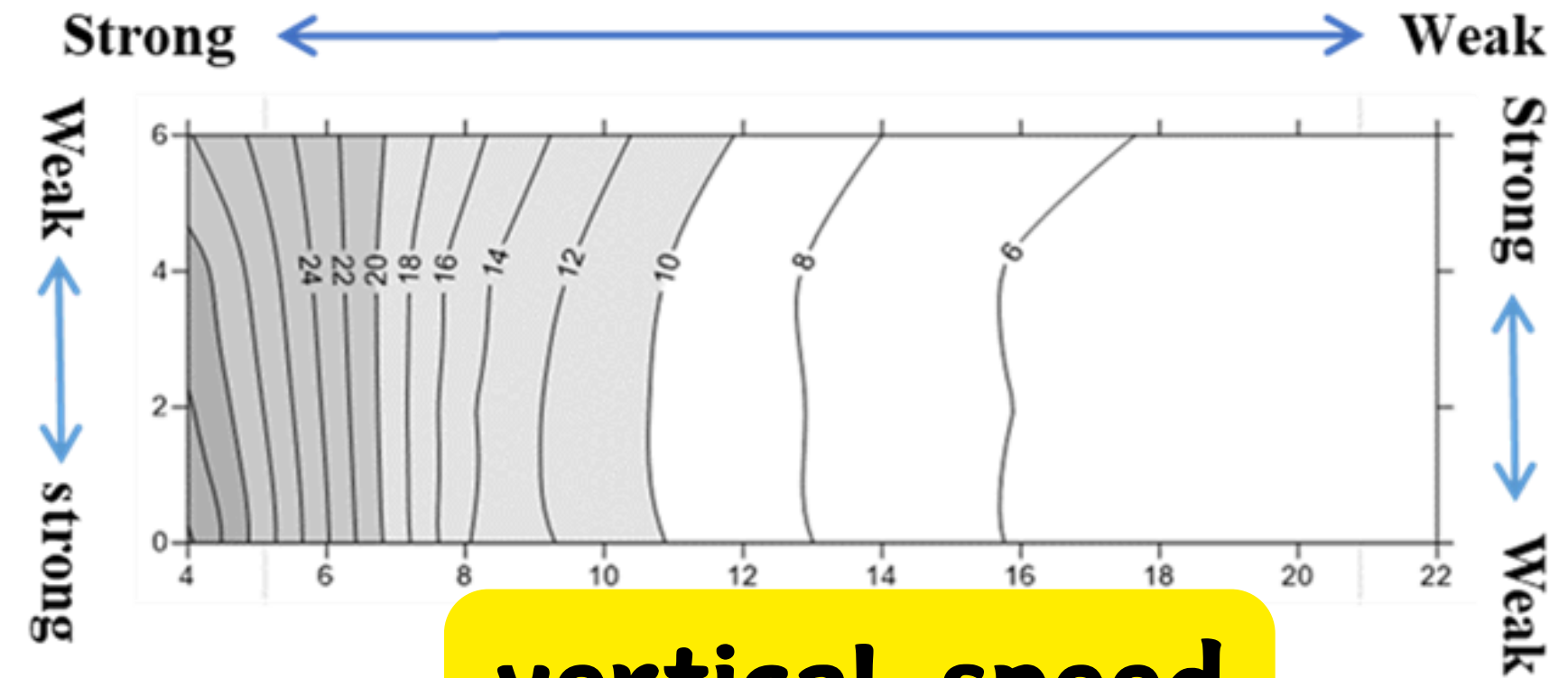


Glass (Coefficient of friction 0.18714)

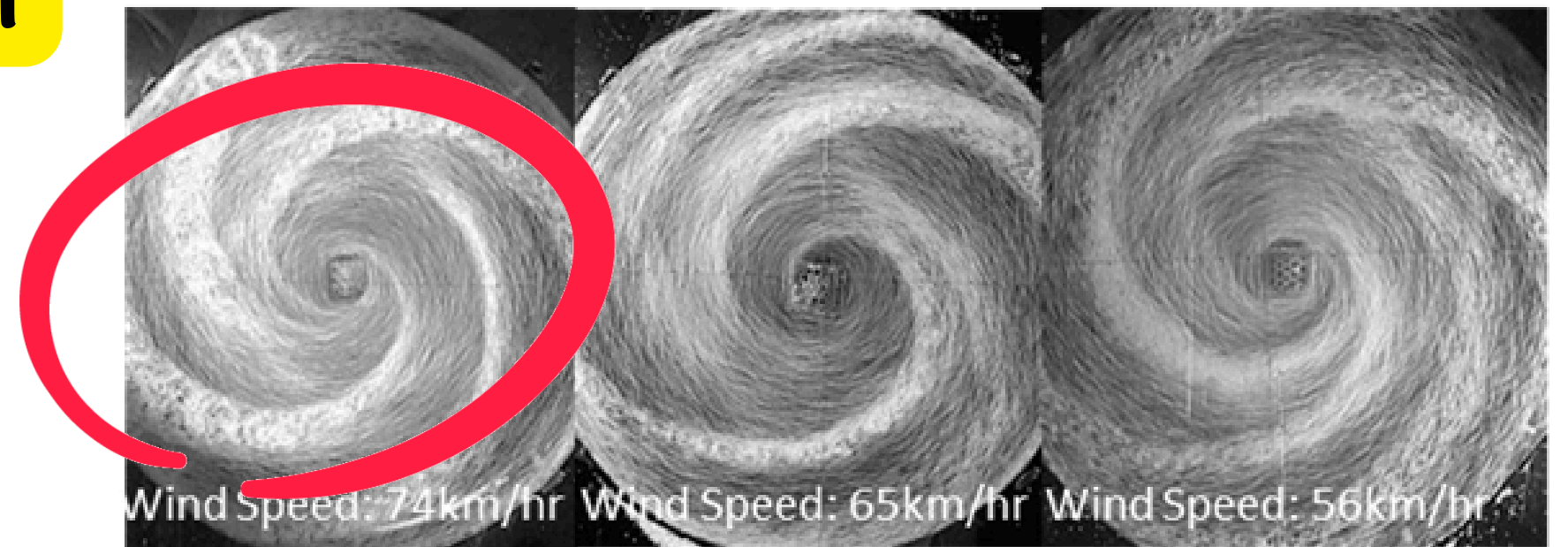
Blackboard (Coefficient of friction 0.22352)

Paper (Coefficient of friction 0.36397)

The exploration of the impact of surface friction on the spiral arms.



vertical speed



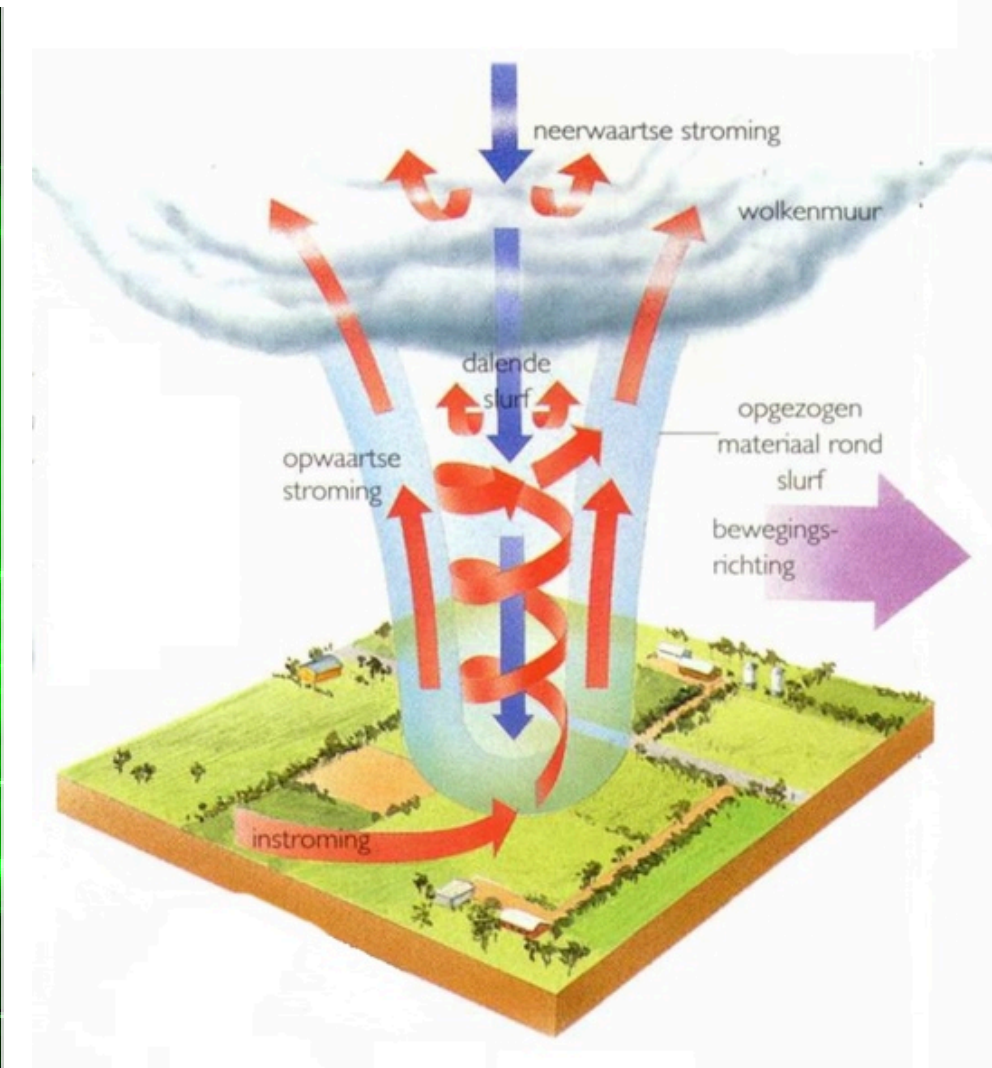
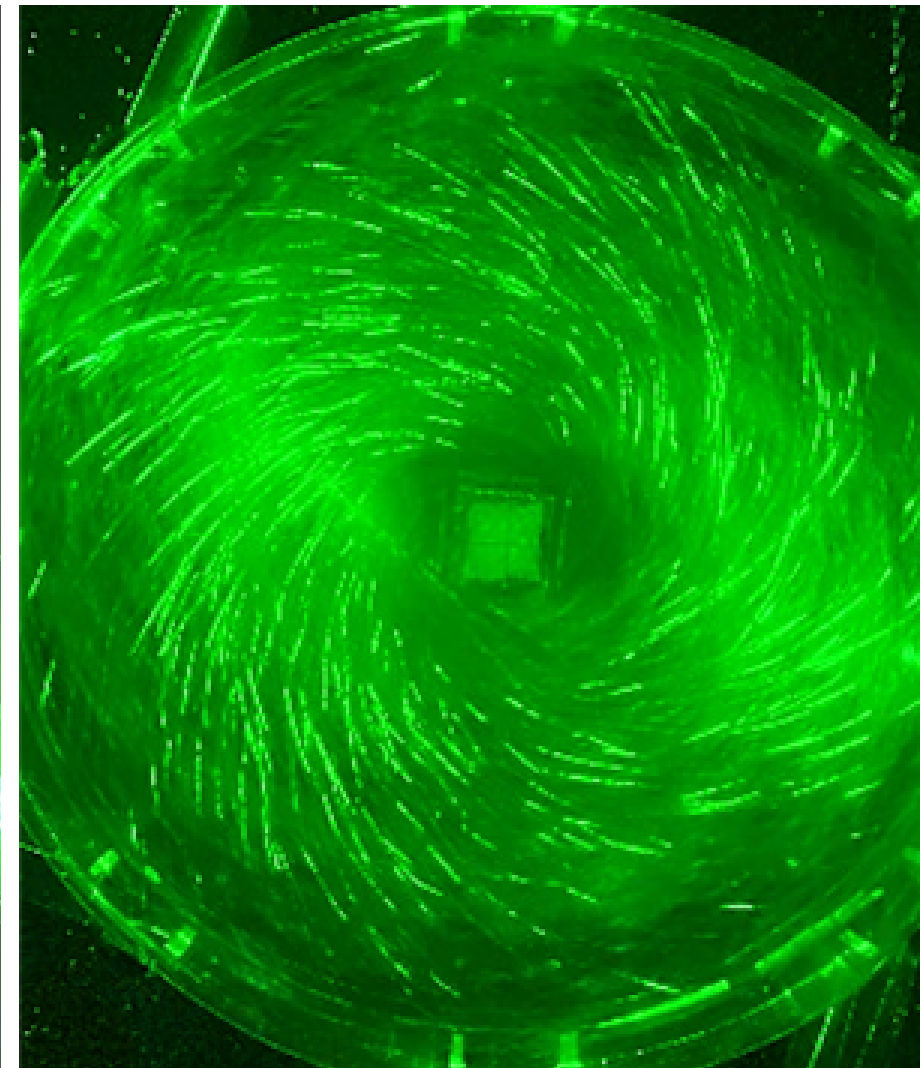
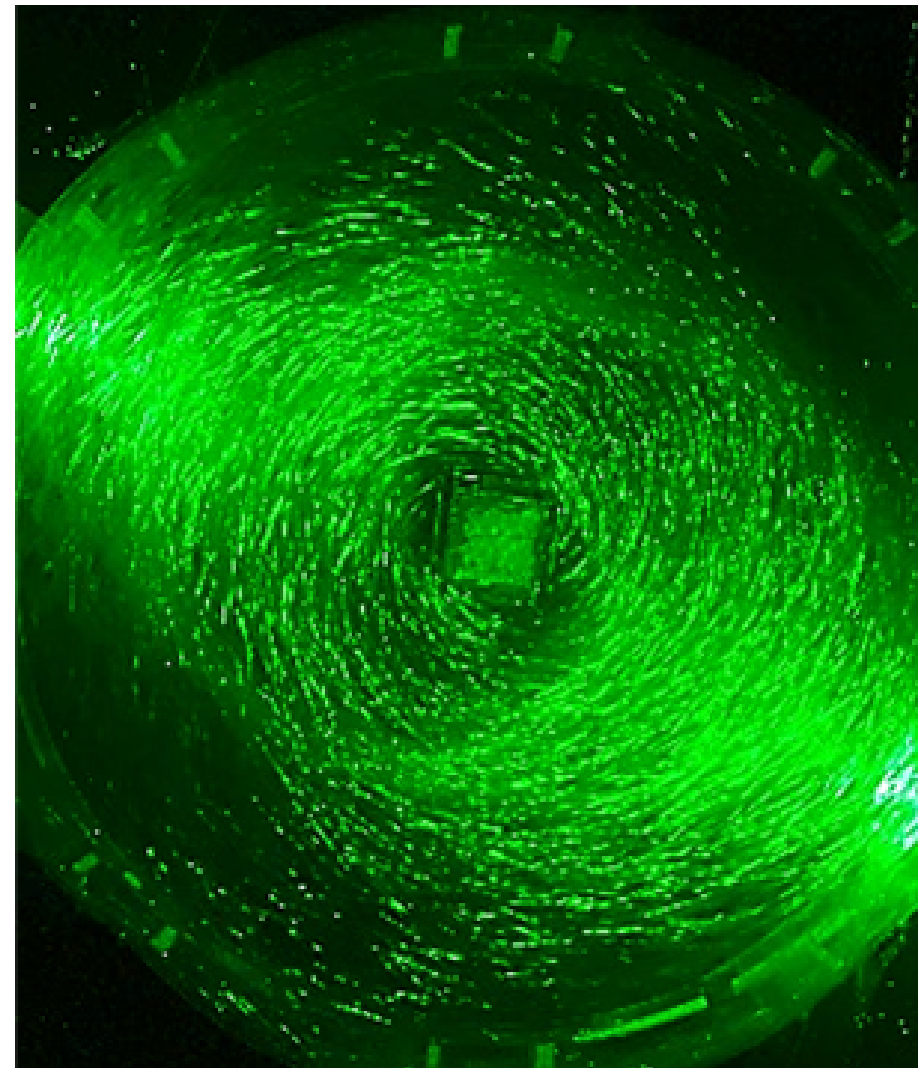
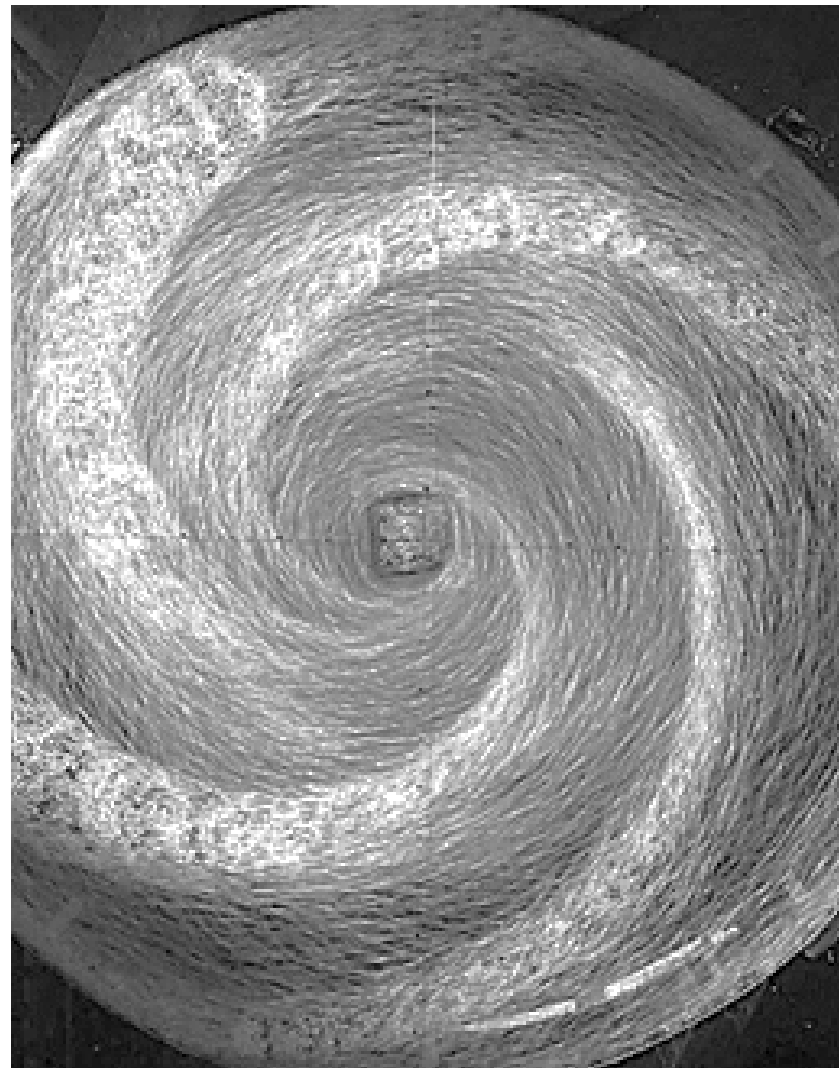
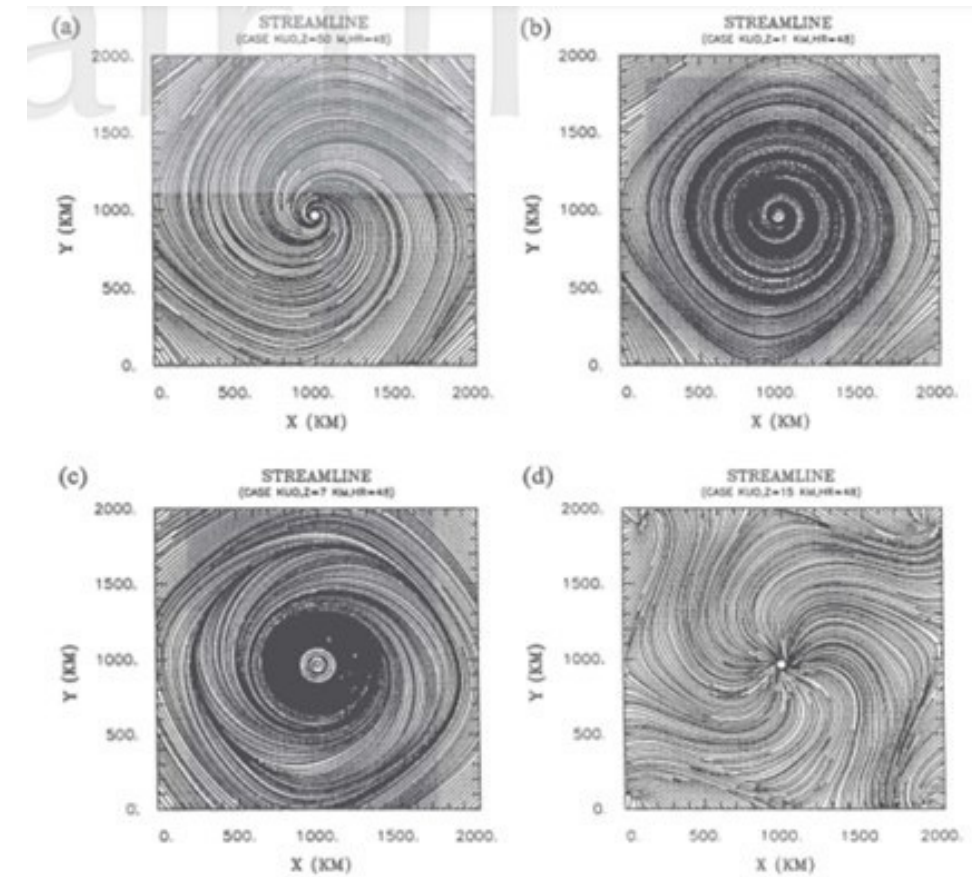
Wind Speed: 74km/hr Wind Speed: 65km/hr Wind Speed: 56km/hr

The influence of wind speed on the spiral arms.

wind speed

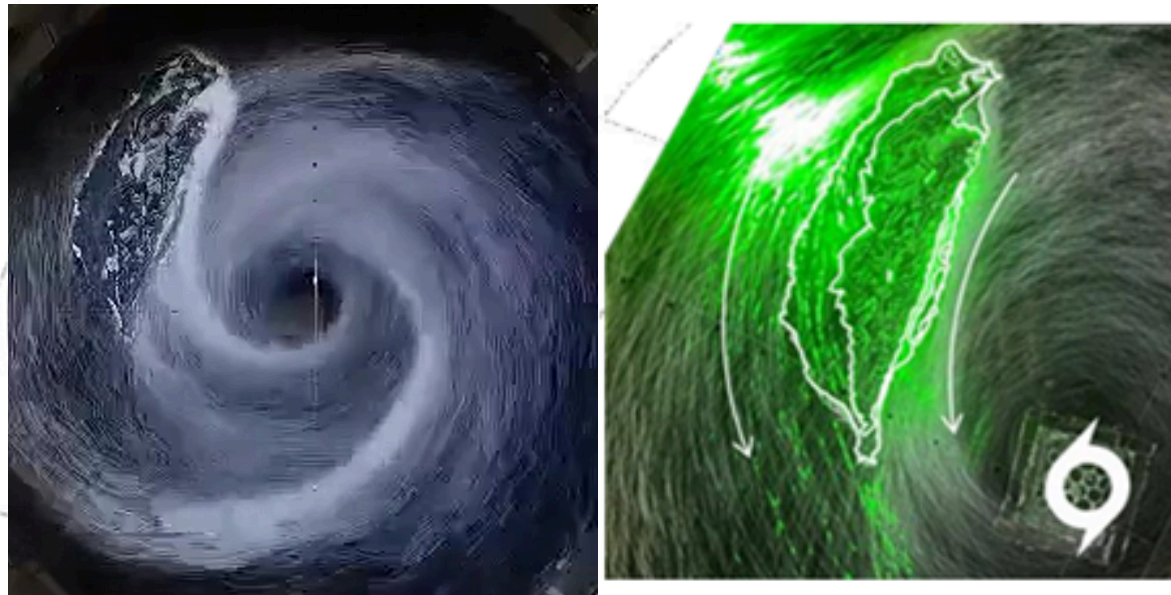
Compare the experiment results with a real typhoon

The results show a structure similar to the vertical layers of a typhoon.

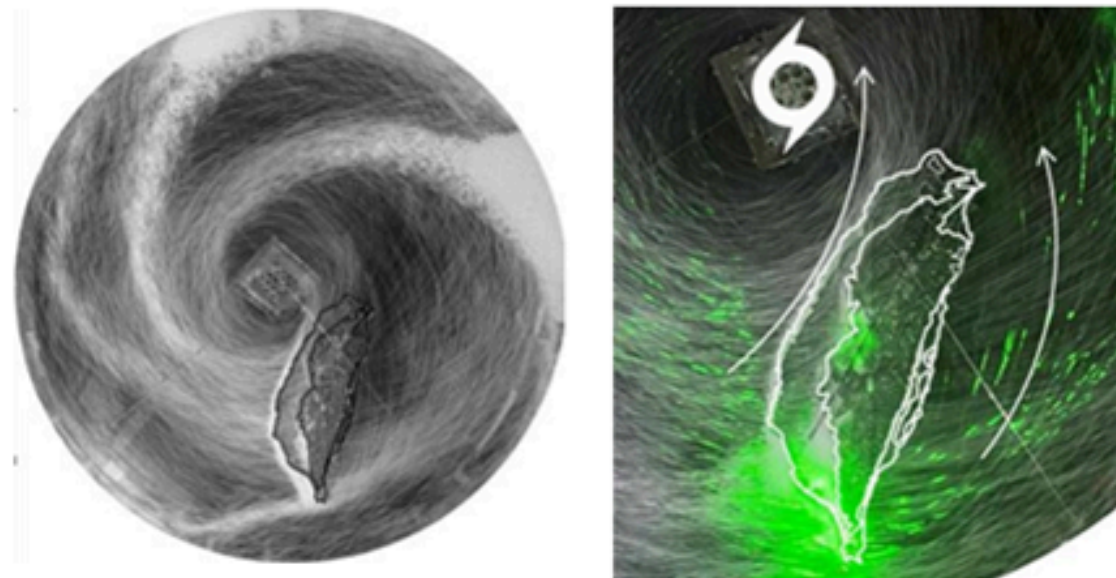


Simulation results

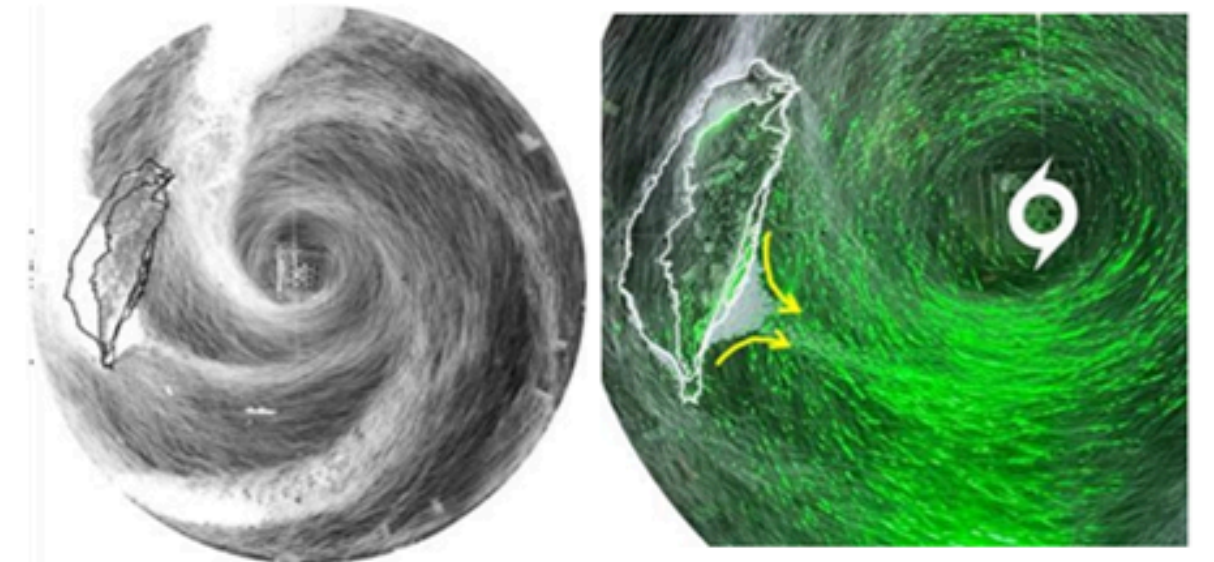
Parallel flow regime (N)
Northerly Winds



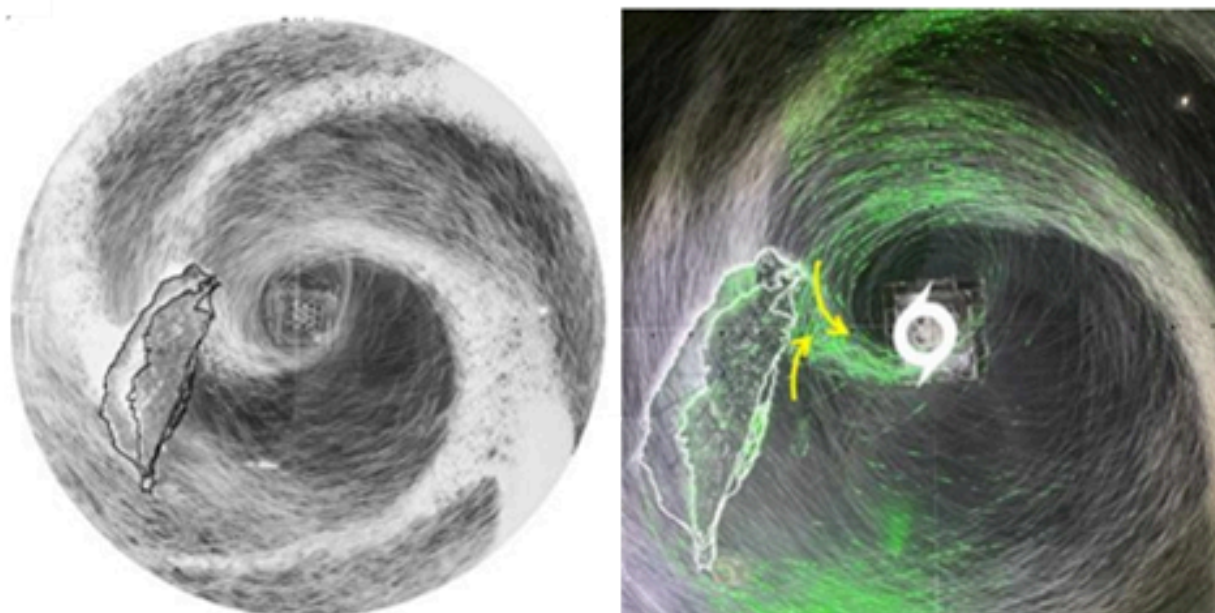
Parallel flow regime (S)
Southerly Winds



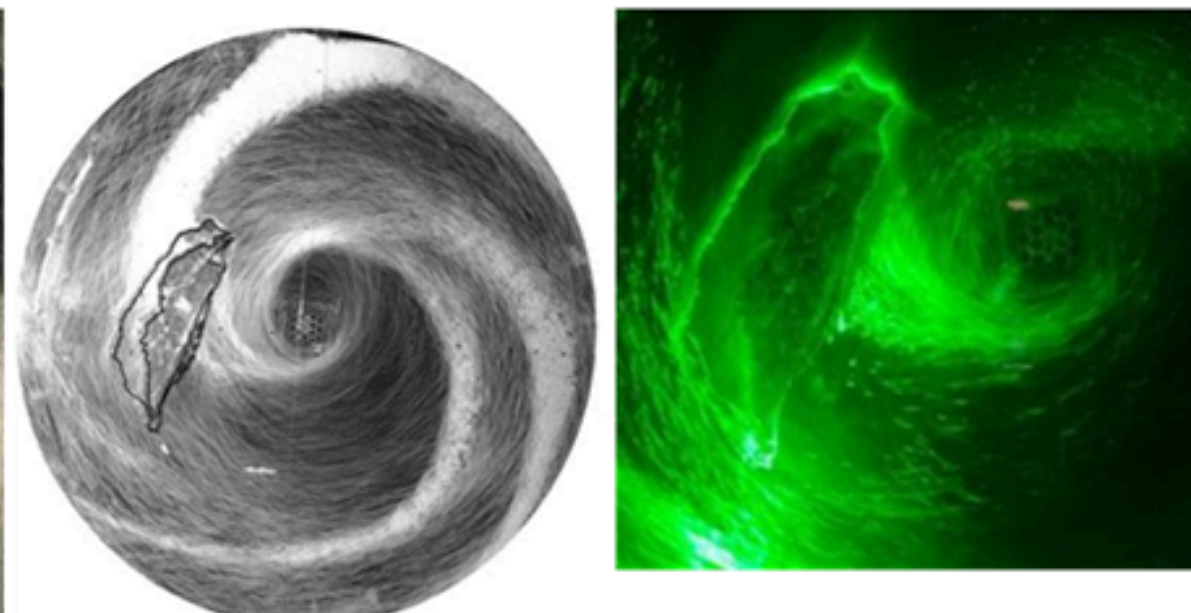
East side wake flow regime
Southeastern Wake



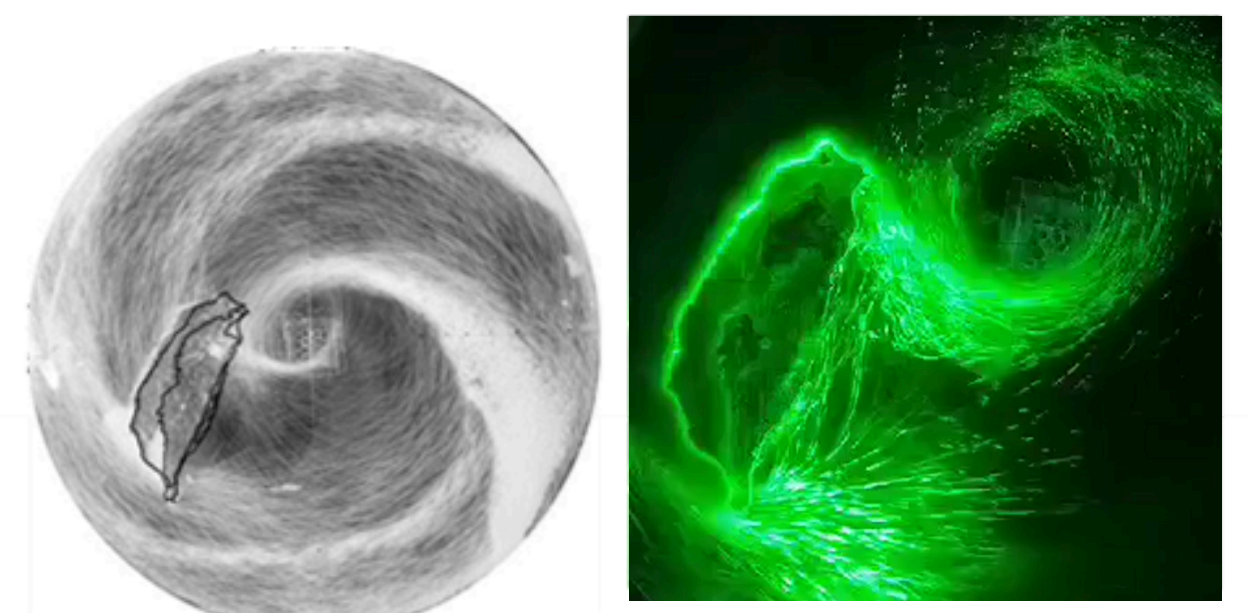
East side wake flow regime
Northeastern Convergence



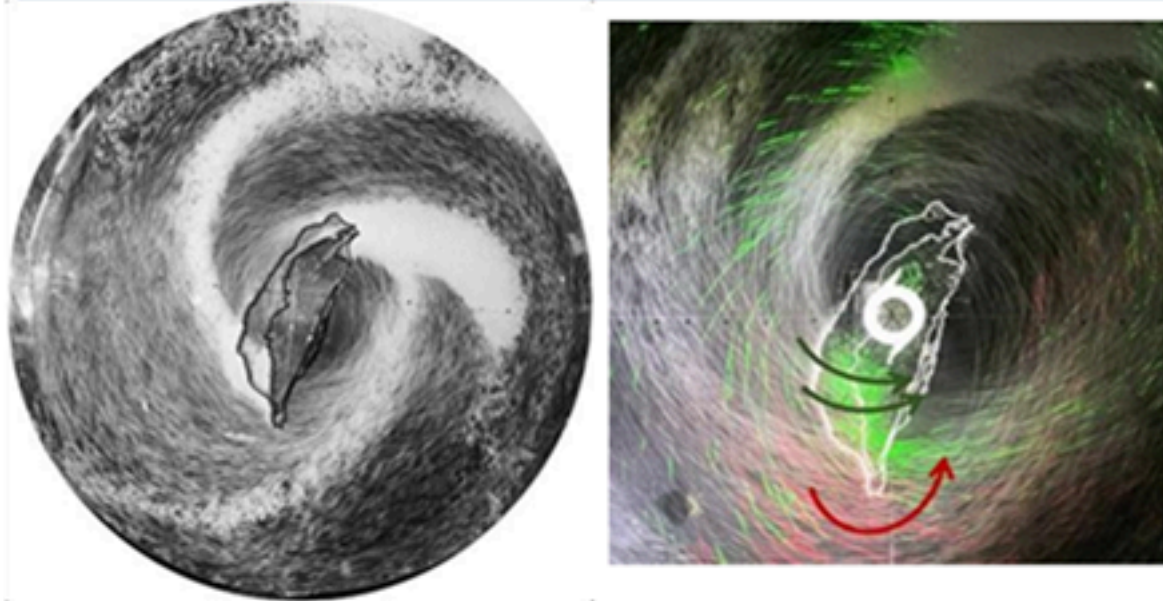
East side wake flow regime
Eastern Convergence



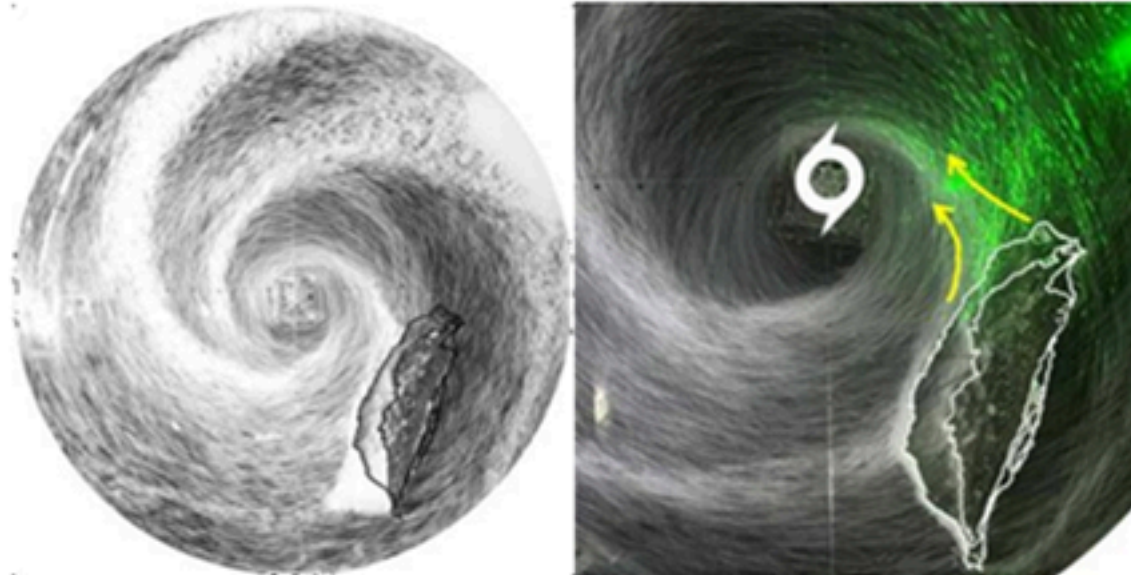
East side wake flow regime
Southeastern Recurrent Flow



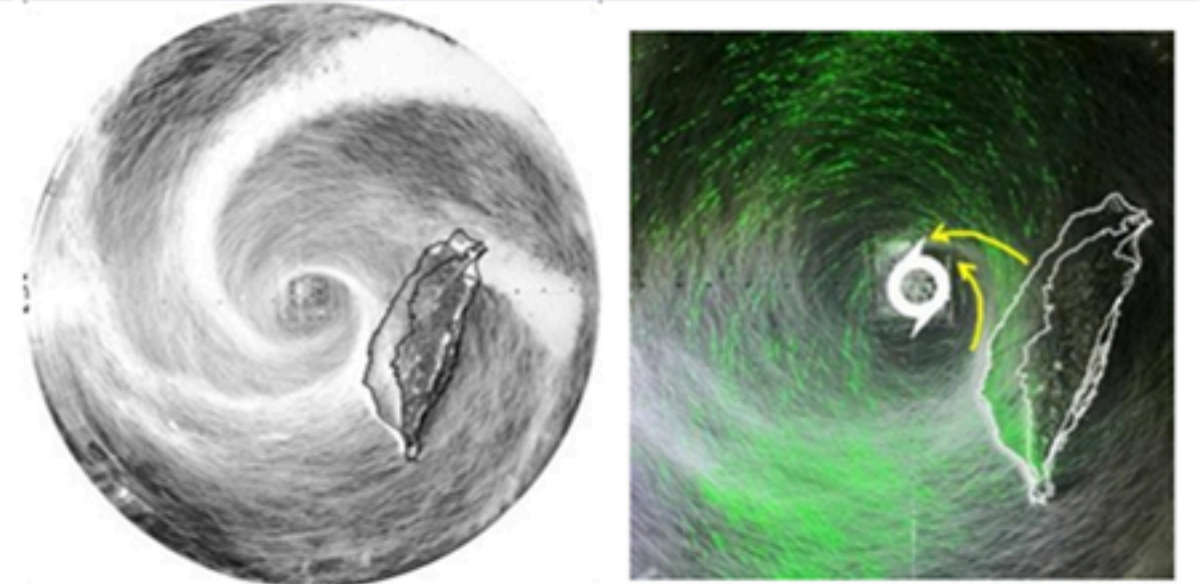
Landing flow regime
Southern Climbing Flow
Circulation Around Taiwan



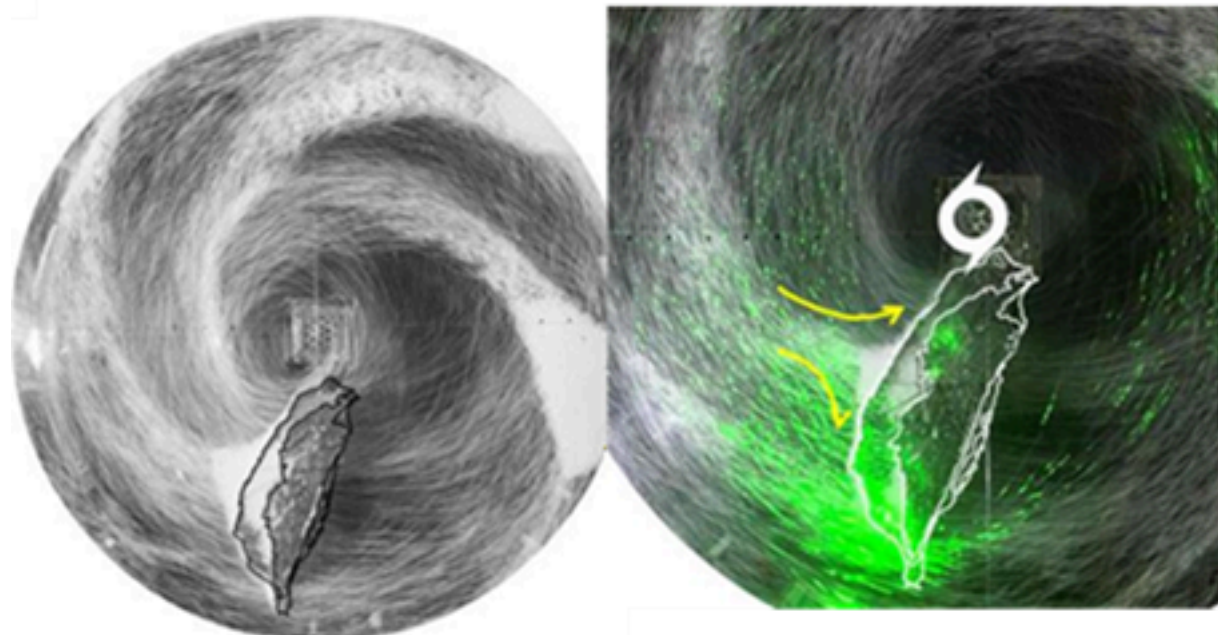
West side wake flow regime
Northwest Side Wake



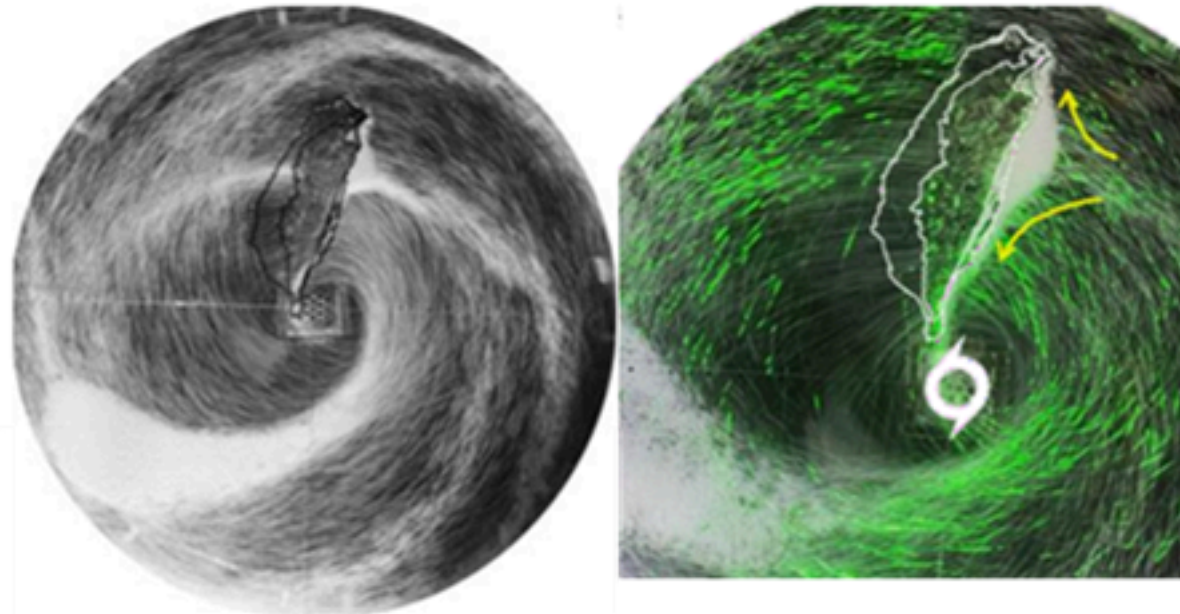
West side wake flow regime
West side wake



Blocked flow regime
West Side Stagnation



Blocked flow regime
East Side Stagnation



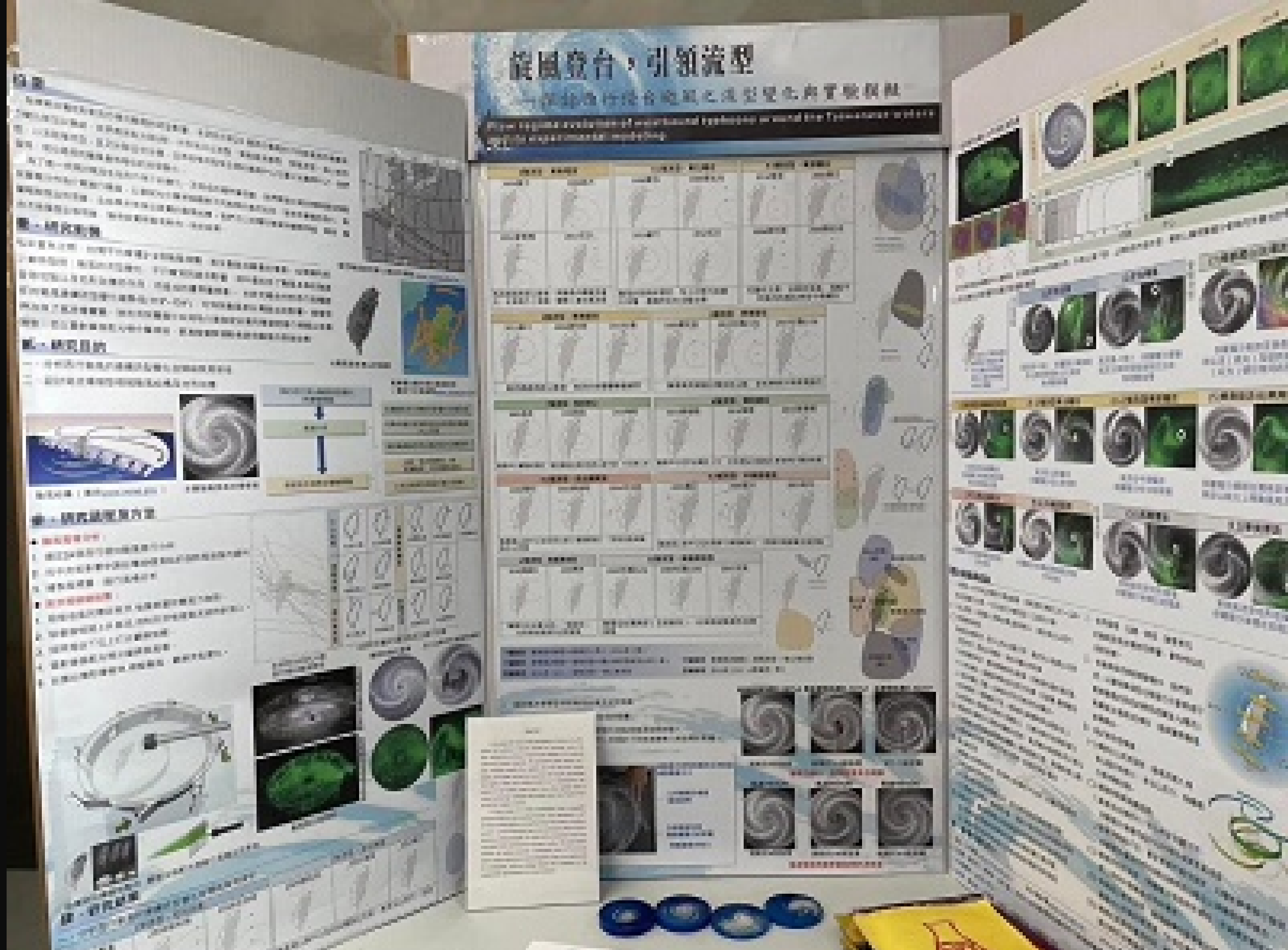
**Limitations of
@this study**

**Unable to simulate
Leeward cyclones**

PERFORMANCE RESULTS



2024
TISF



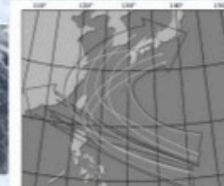
SIMULATION EXPERIMENTS ON THE FLOW REGIME EVOLUTION OF WESTWARD TYPHOONS NEAR TAIWAN

ABSTRACT

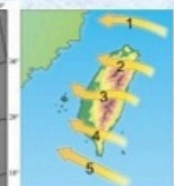
Generally speaking, Taiwan is hit by 3 to 4 typhoons on average every year. Being a mountainous island, these typhoons have caused great damage. At the same time, Taiwan's topography also has a considerable impact on the movement and structure of the typhoons. By analyzing the trends in the continuous flow regime of westbound typhoons along various paths, it is found that typhoons on similar paths exhibit similar flow pattern changes. Additionally, the study develops an airflow field model to simulate typhoon structures using Styrofoam and layered scanning with lasers to observe airflow directions at different heights. Taiwan-shaped obstacles are used for various flow pattern simulations.



Satellite Cloud Image of East Asia (from NASA)



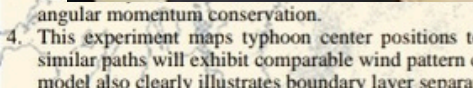
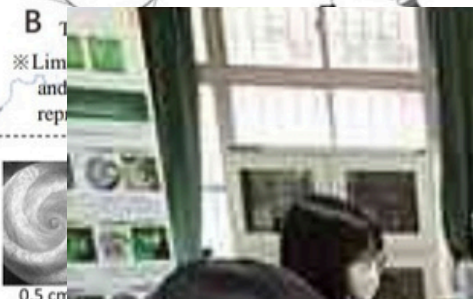
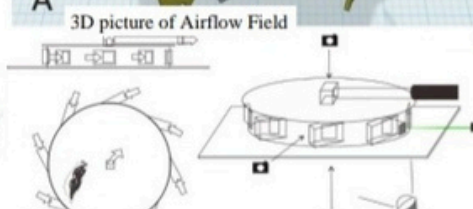
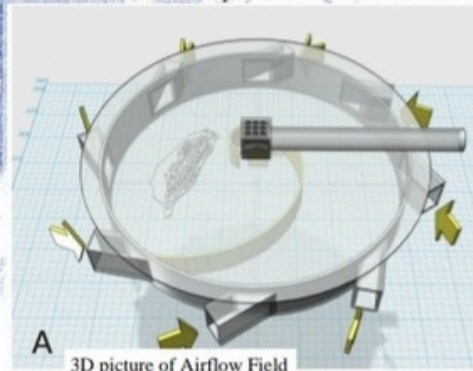
Typhoon Path Map in East Asia (from CWA website)



Selection of Westward Paths (1-5) for analysis

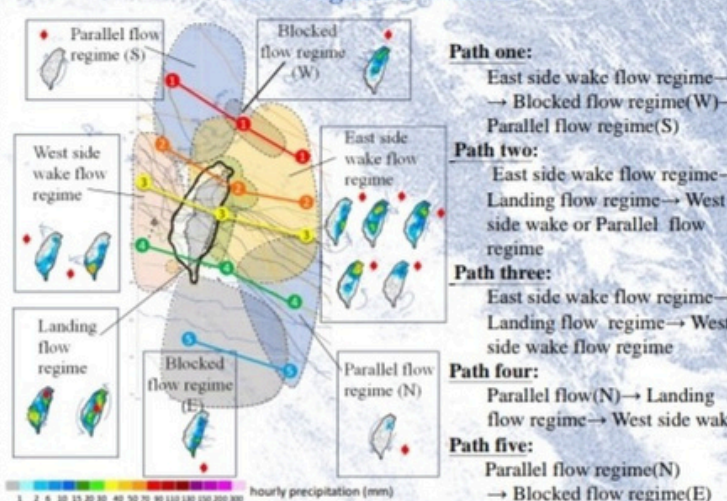
METHODS

- Wind Field Analysis: After drawing the wind field maps, we categorize and code similar flow regimes into 5 main types and 13 subtypes.
- To delve deeper into airflow modifications under topographic influences and the corresponding boundary layer phenomena, a self-developed airflow field device and Styrofoam were used for simulation purposes.



RESULTS

Flow regime evolution



Airflow field simulation

Placing Taiwan's terrain models in analyzed regions

Parallel flow regime (N)	Parallel flow regime (S)	East side wake flow regime
Northerly Winds	Southerly Winds	Southeastern Wake



- This experiment maps typhoon center positions to predict that typhoons with similar paths will exhibit comparable wind pattern changes in specific areas. The model also clearly illustrates boundary layer separation in fluid dynamics.
- NASA Earth Observatory <https://worldview.earthdata.nasa.gov/>
- Willoughby, H. E. 1995. Mature structure and evolution. Chapter 2, Global Perspectives on Tropical Cyclones.



FAIR PROCESS

SCIENCE IS...



Reflection and reasoning



REFLECTION AND REASONING

THIS INDEPENDENT LEARNING JOURNEY HELPED ME EXPLORE MY INTERESTS MORE DEEPLY. I LEARNED TO USE TIME WISELY AND STAY BALANCED, EVEN WHEN THINGS WERE DIFFICULT. ALTHOUGH I FACED CHALLENGES AND DOUBTS, I REALIZED THAT WITH PERSISTENCE AND CONFIDENCE, I CAN KEEP GROWING AND BECOME STRONGER.



DINLEDİĞİNİZ İÇİN
TEŞEKKÜR EDERİM

(是土耳其語謝謝大家的意思啦)

