Control simulation experiment for a typhoon case with a global numerical weather prediction system

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Weather modification & Weather control

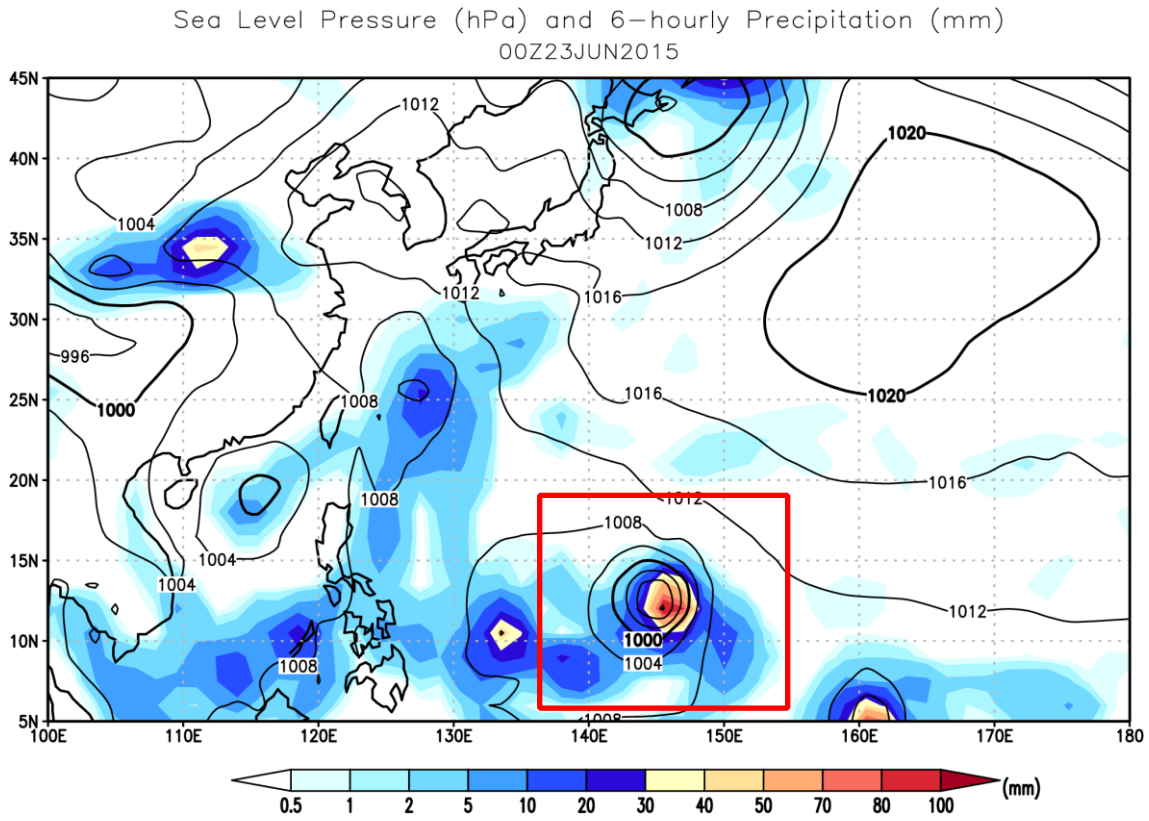
- **Weather Modification**
  - Based on physical process (e.g., Cloud seeding)

- **Weather Control**
  - Use the chaotic nature of the atmosphere to control in the desired direction
  - Determine control from ensemble forecast variability

Typhoon hits Kyushu

Computer simulations create the future

2015/6/23/00Z



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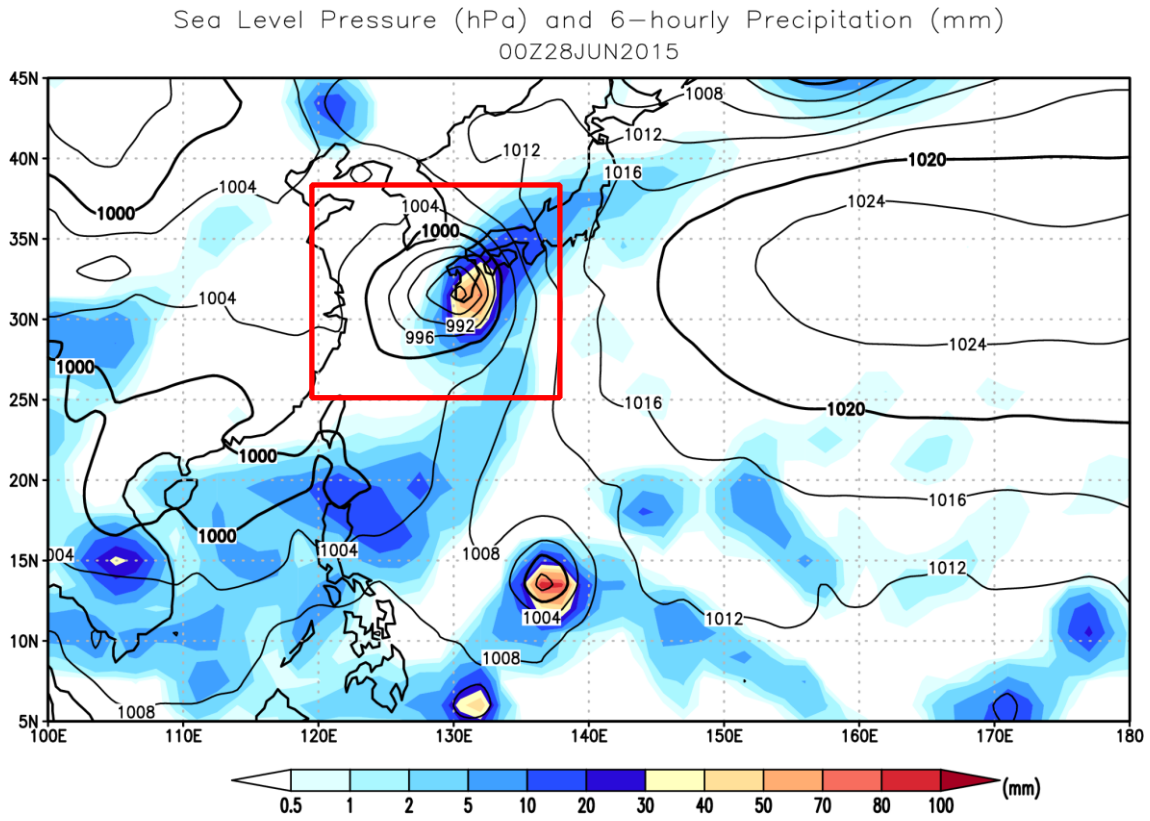
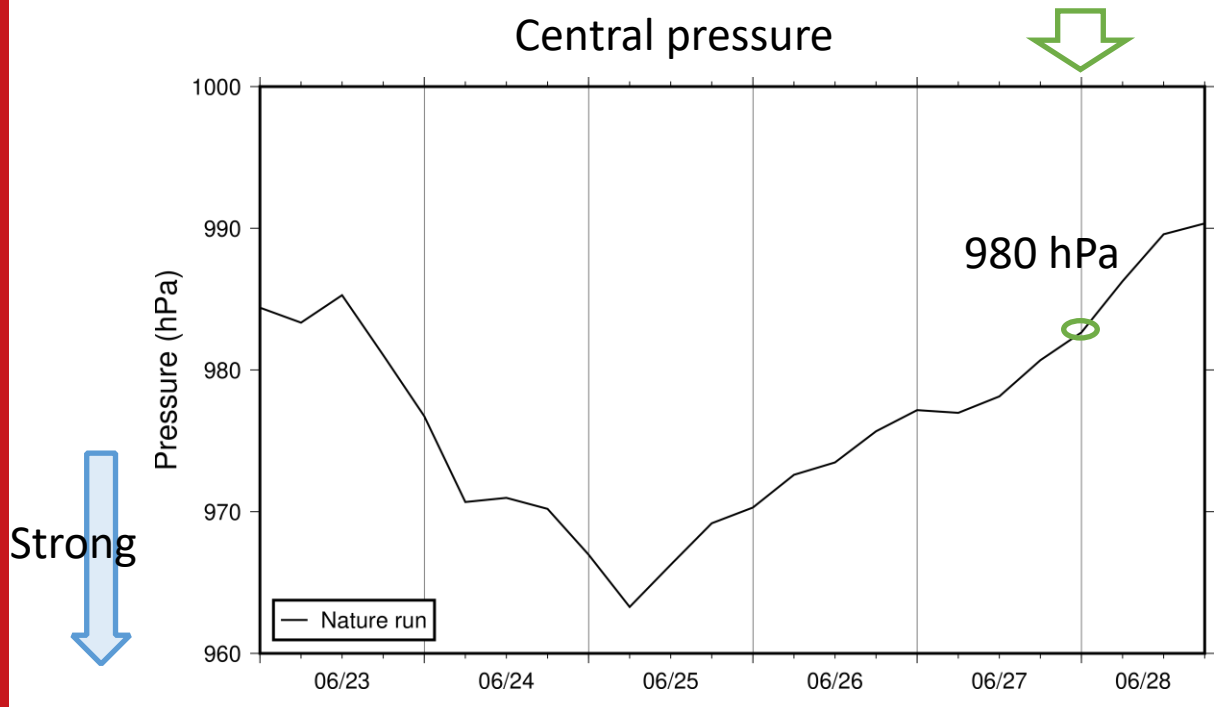
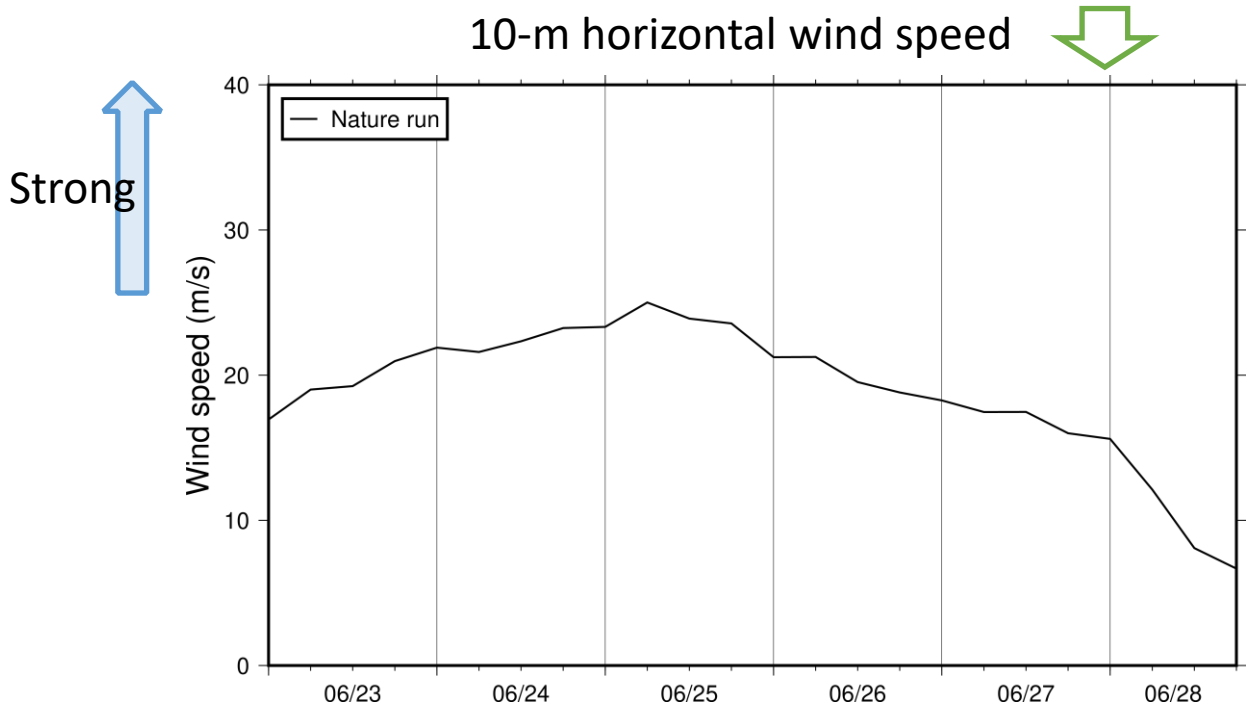


Central pressure & 10-m wind speed

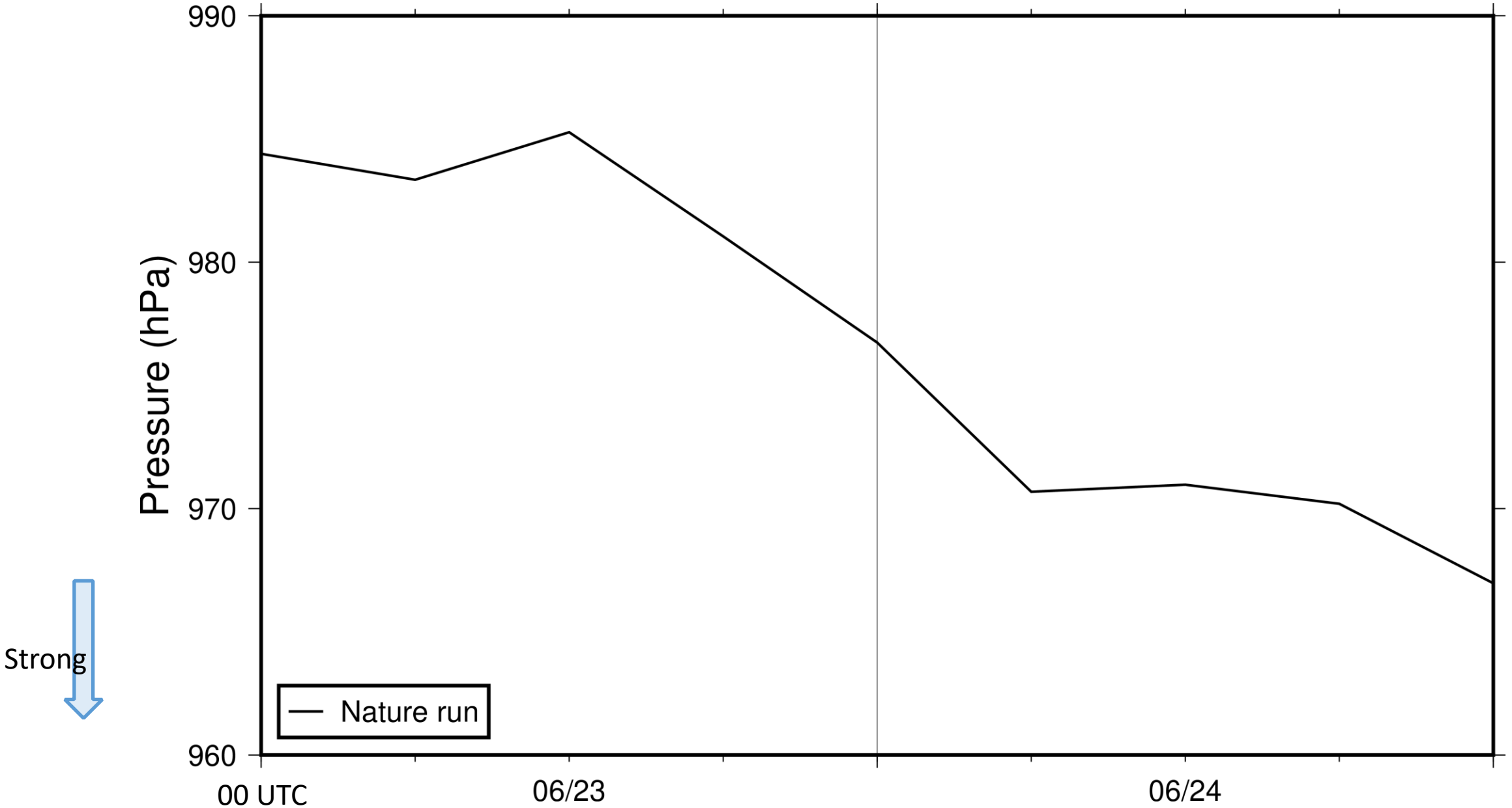




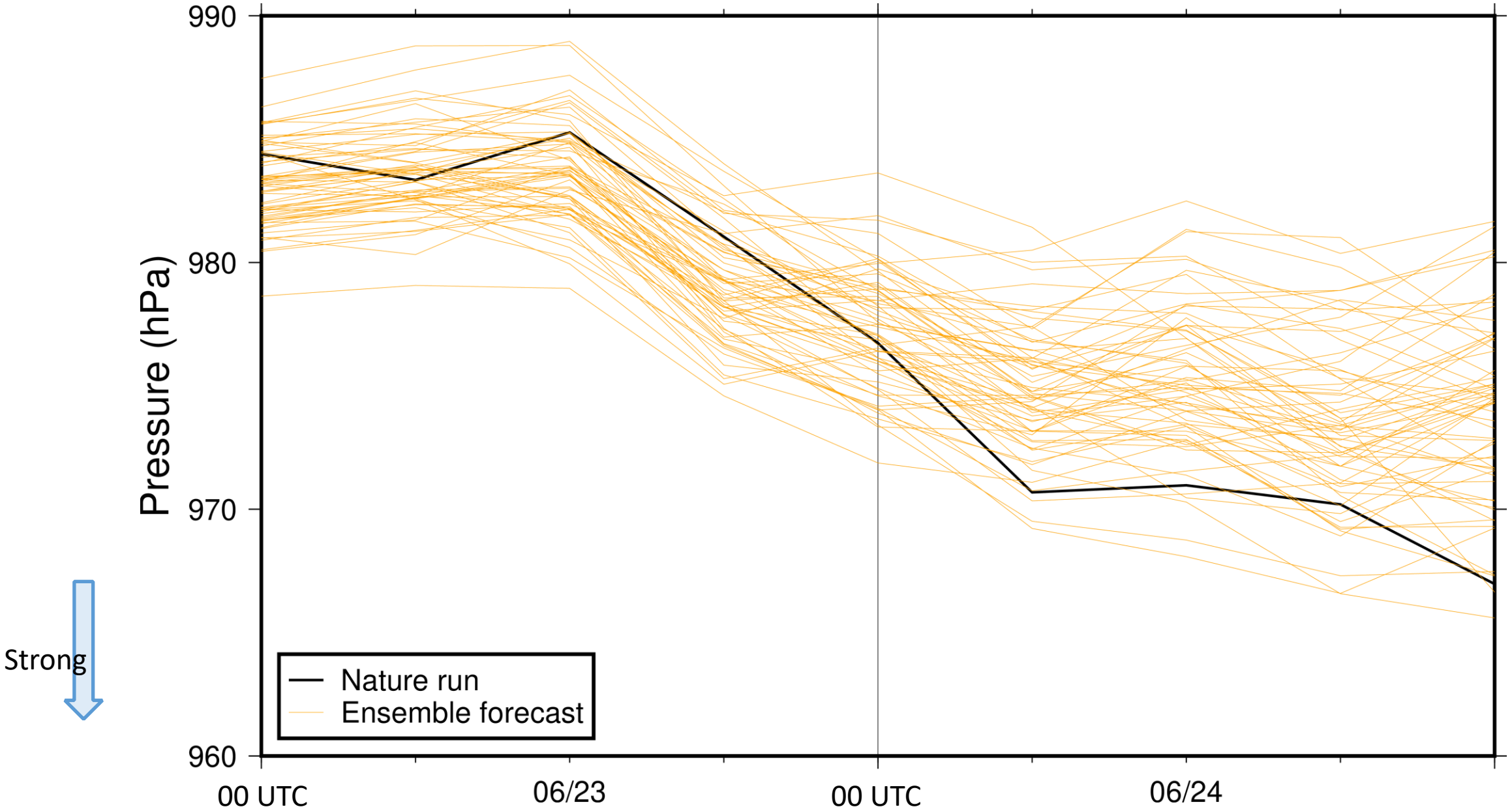
Experimental setting

NWP model	Nonhydrostatic ICosahedral Atmospheric Model (NICAM)
Data assimilation	Local Ensemble Transform Kalman Filter（LETKF）
Horizontal resolution	Glevel-6 (112 km)
Vertical resolution	38 layers (up to 40 km)
Ensemble size	64
Observations	Temperature, zonal wind, meridional wind, humidity, surface pressure
Covariance localization	Horizontal: 250 km Vertical: 0.4 ln$p$

How to control the typhoon in Control simulation experiment (CSE)



How to control the typhoon in CSE



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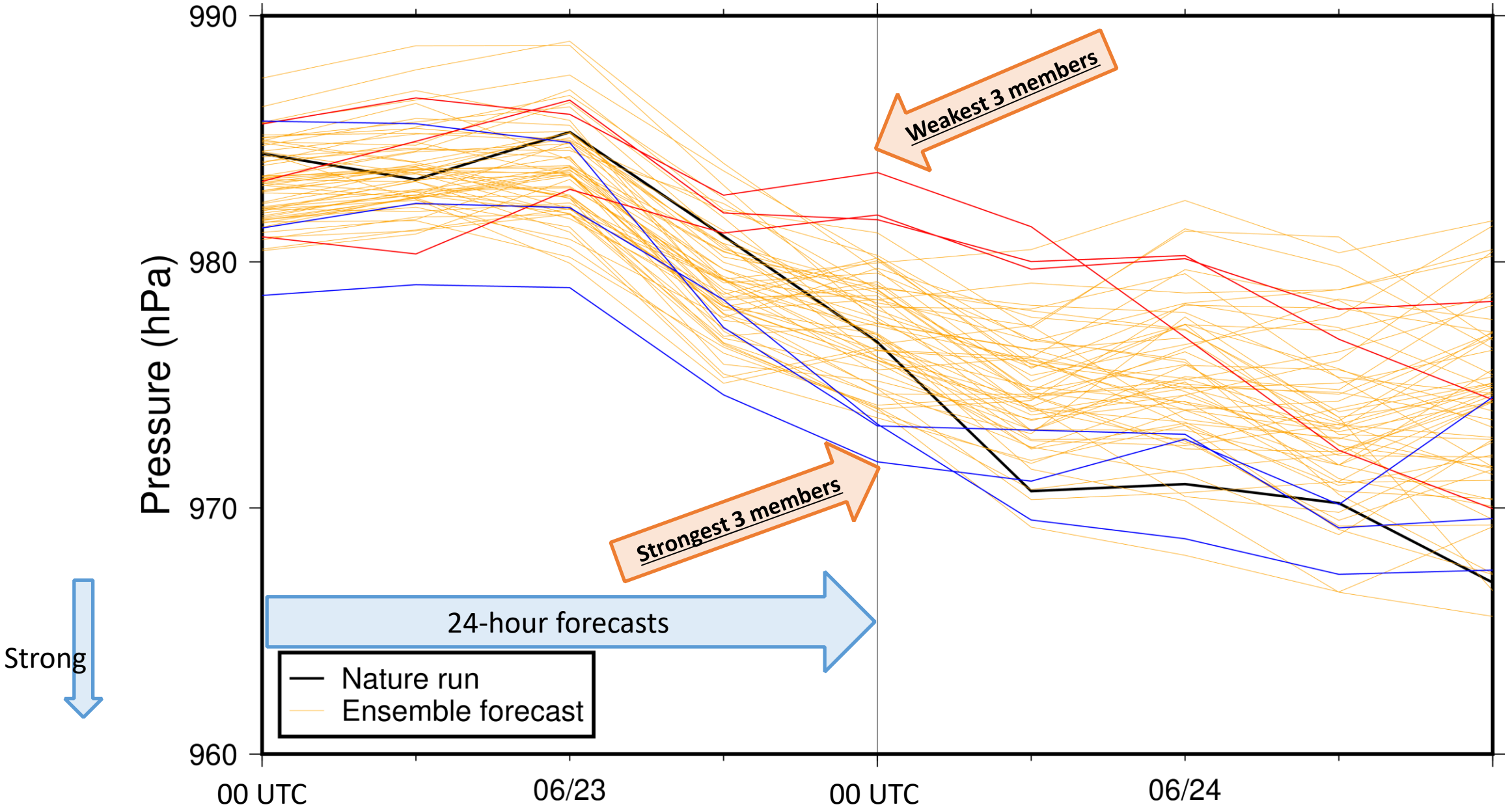

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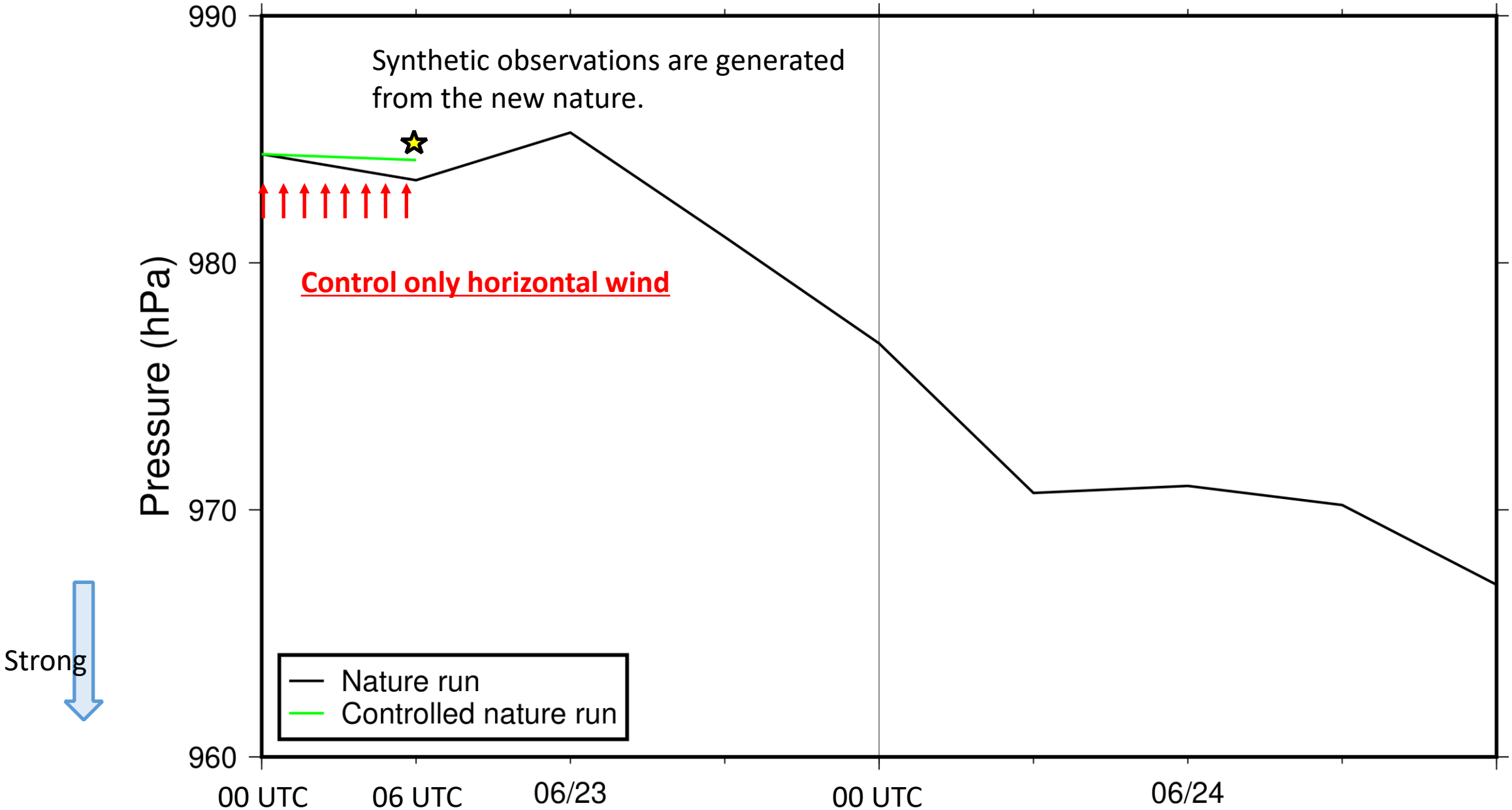

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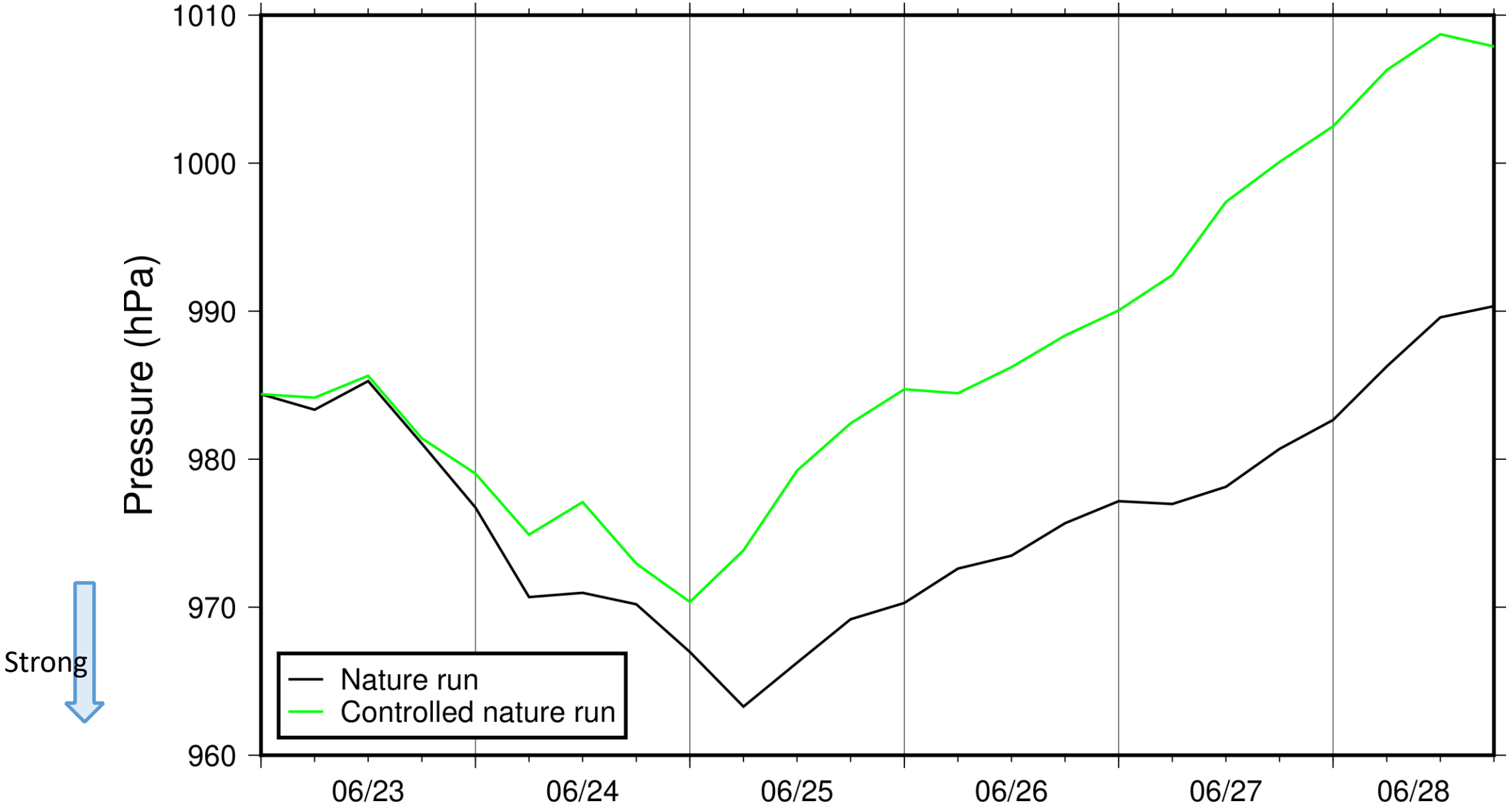
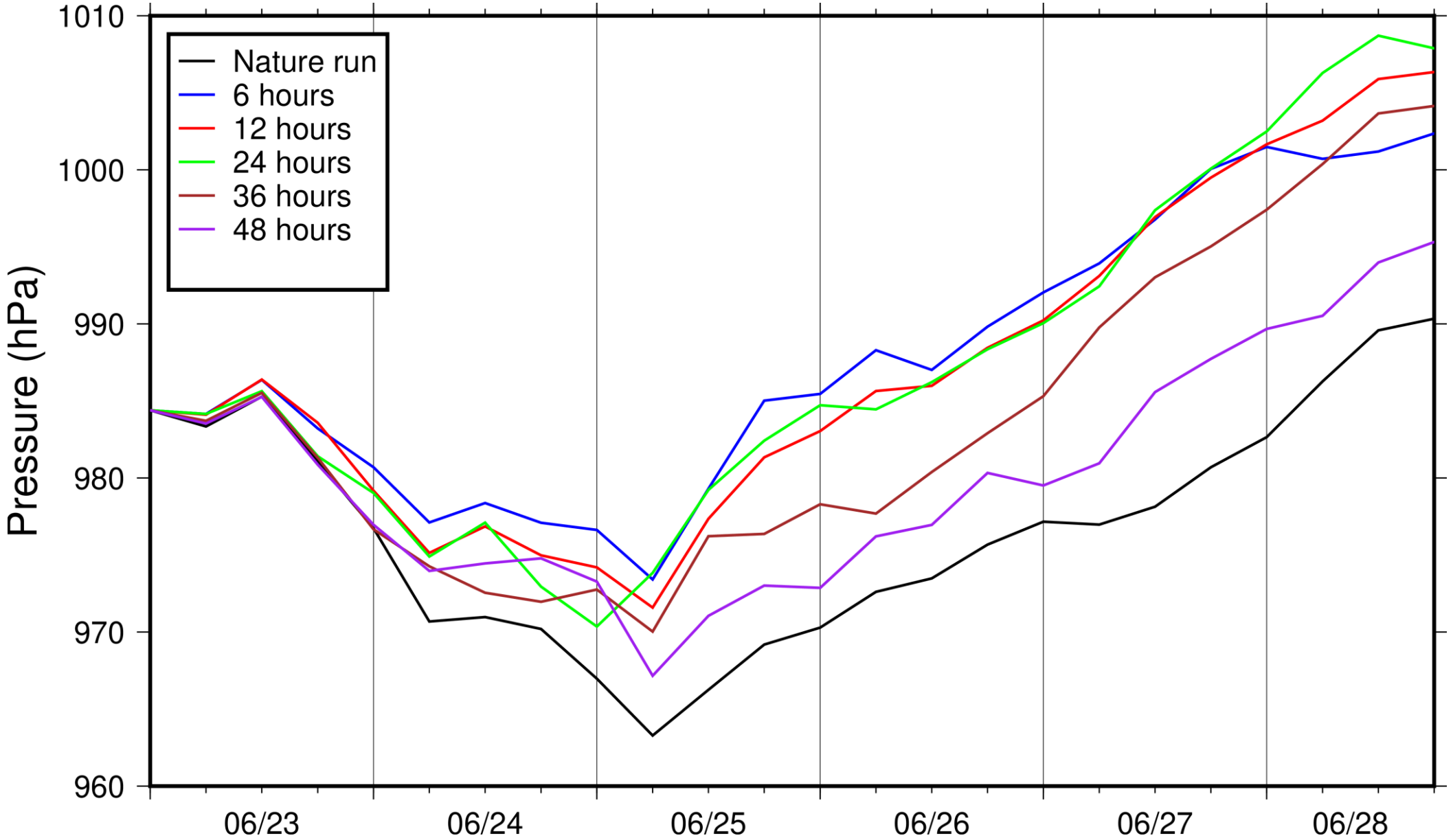
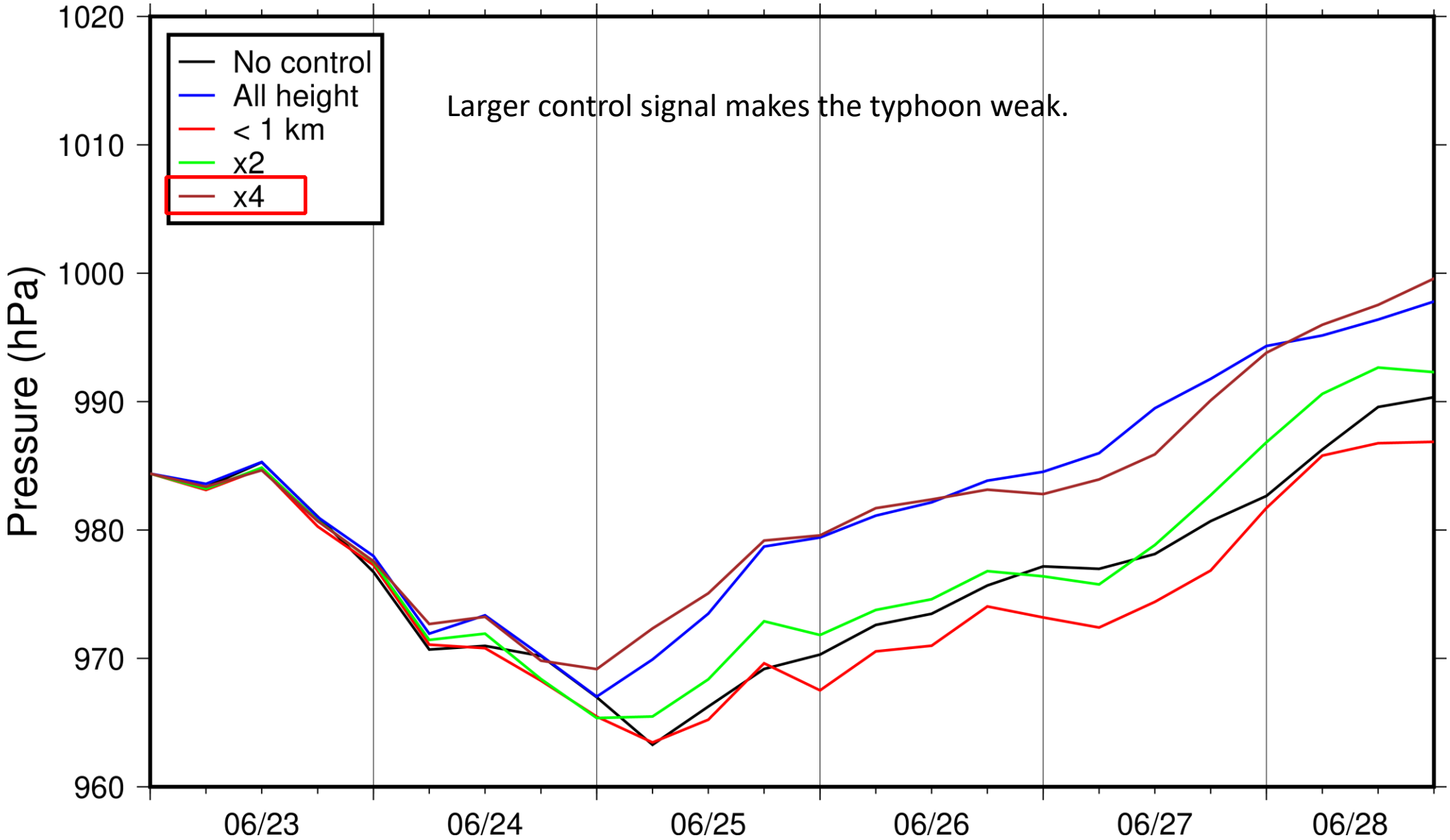


6-24 hours forecasts are optimal for this experiment

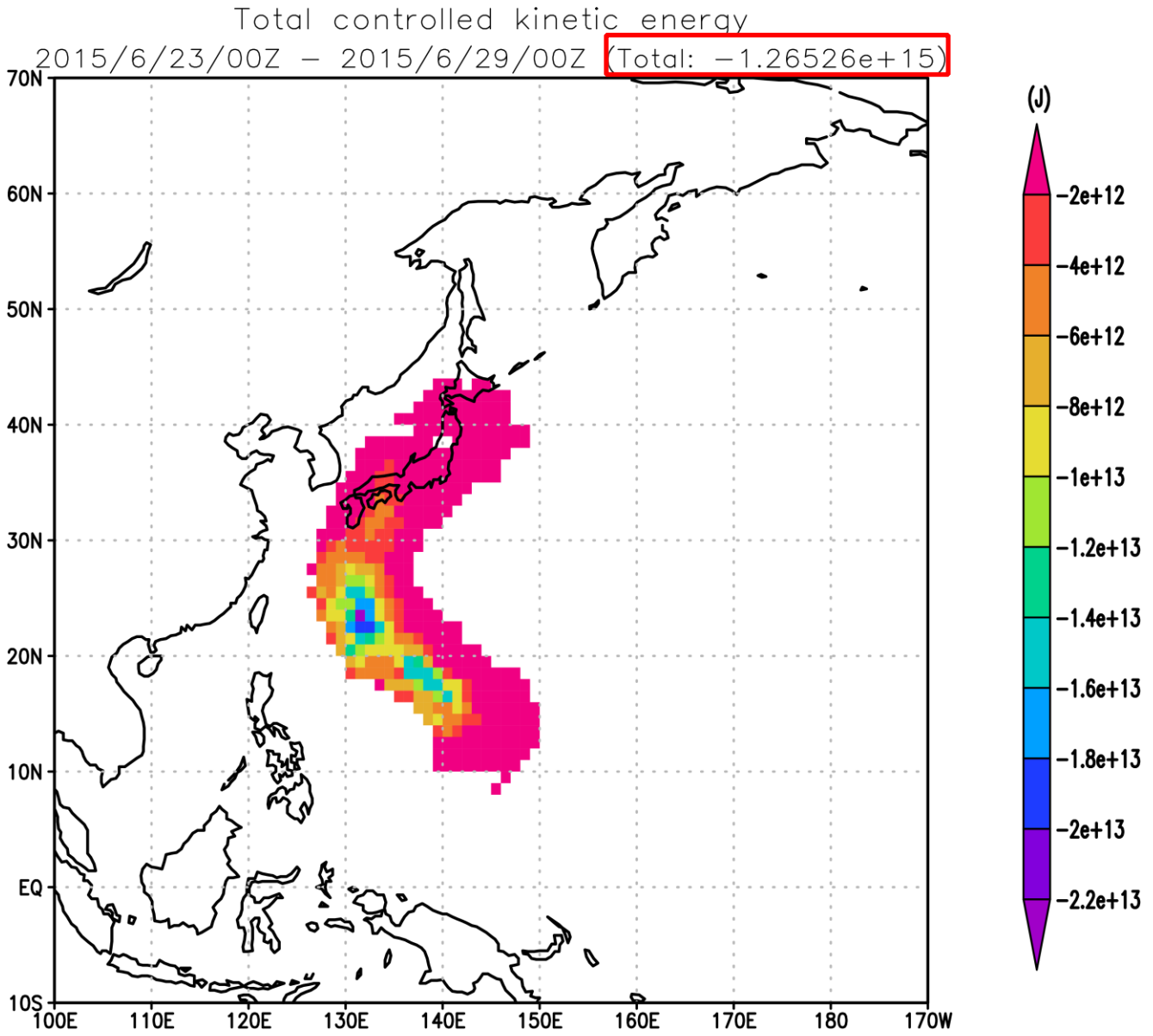


Strong

Smaller control area



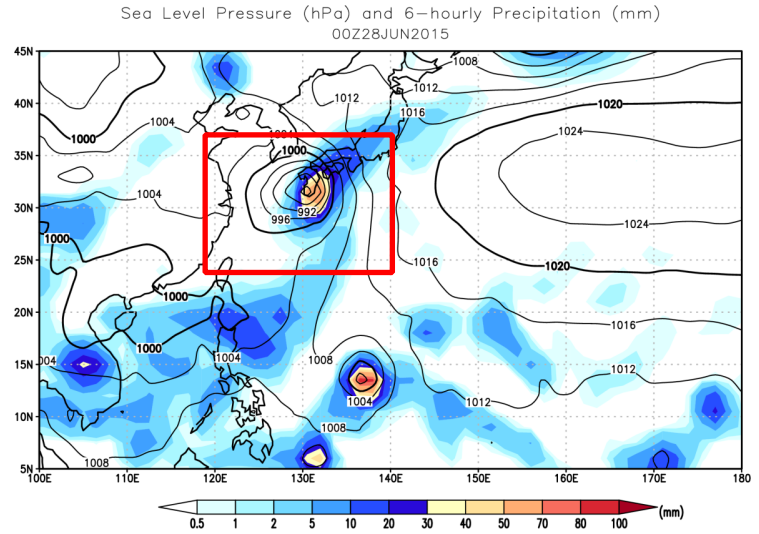
How much energy is reduced?



- Kinetic energy of typhoon: 10^{18} J
- Nuclear power plant (100M kW)
  5.0×10^{16} J (6 days)

Summary

- **Control simulation experiment for a typhoon case with a global numerical weather prediction system**
  - We successfully suppressed the typhoon in the nature run.
    - How long is effective to determine the control signal → 6～24 hours
    - What variable to be perturbed? → Horizontal winds



- **Next plan**
  - More realistic method to control
  - Consideration of the objective function of control