中層環流對熱帶氣旋形成影響之探討
—以桔梗颱風（2013）為例
A Study of the Influence of Mid-level Circulation on TC Formation: Toraji (2013)

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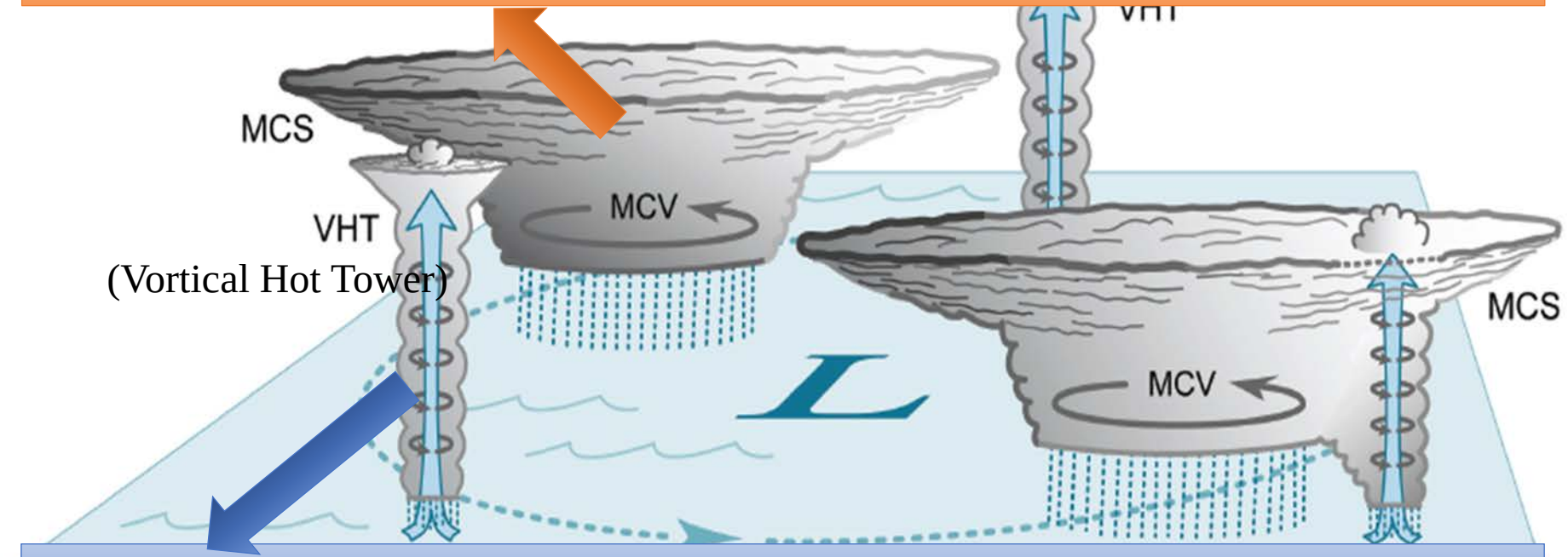
Outline

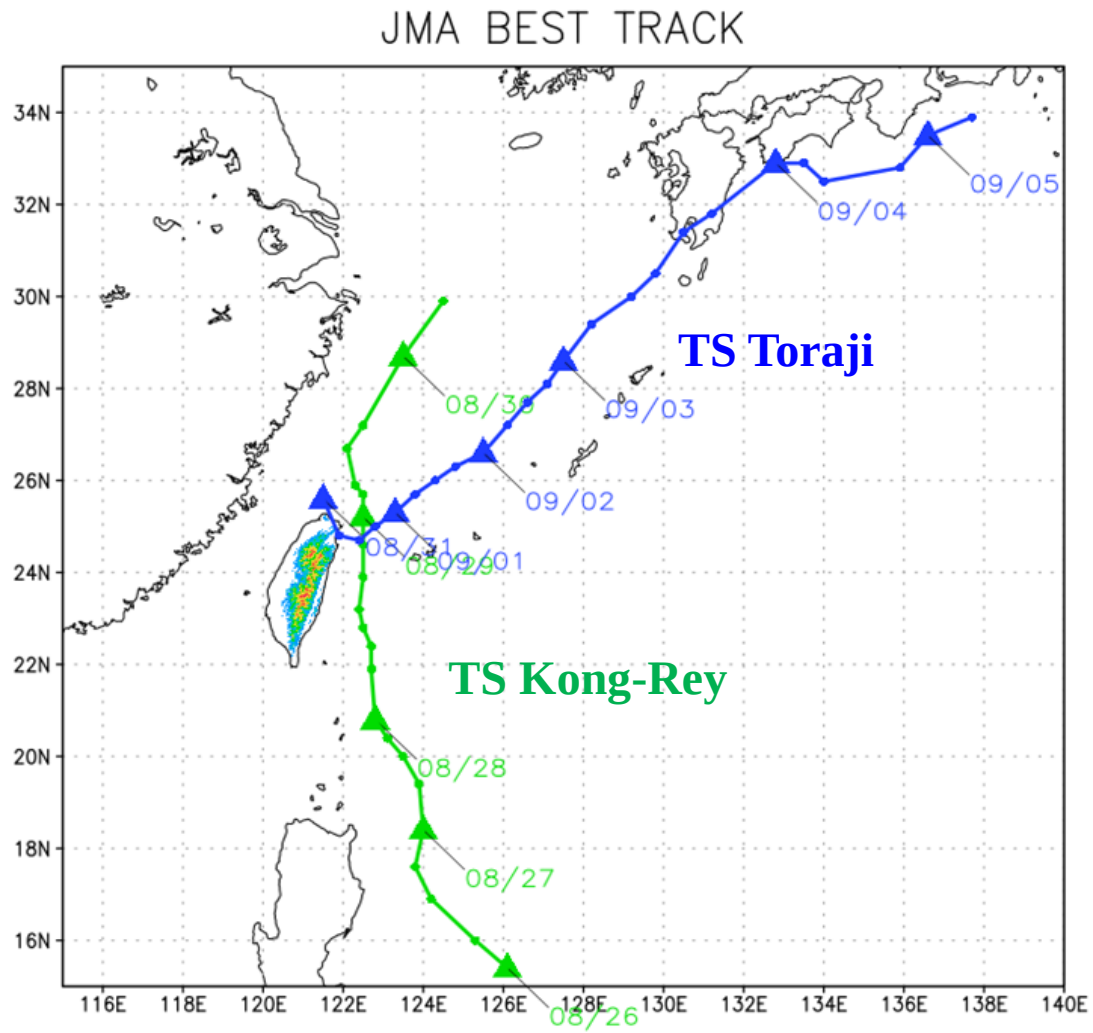
- Introduction
- Method
  - Piecewise PV Inversion (PPVI)
  - Sensitivity Experiments
- Result
- Summary

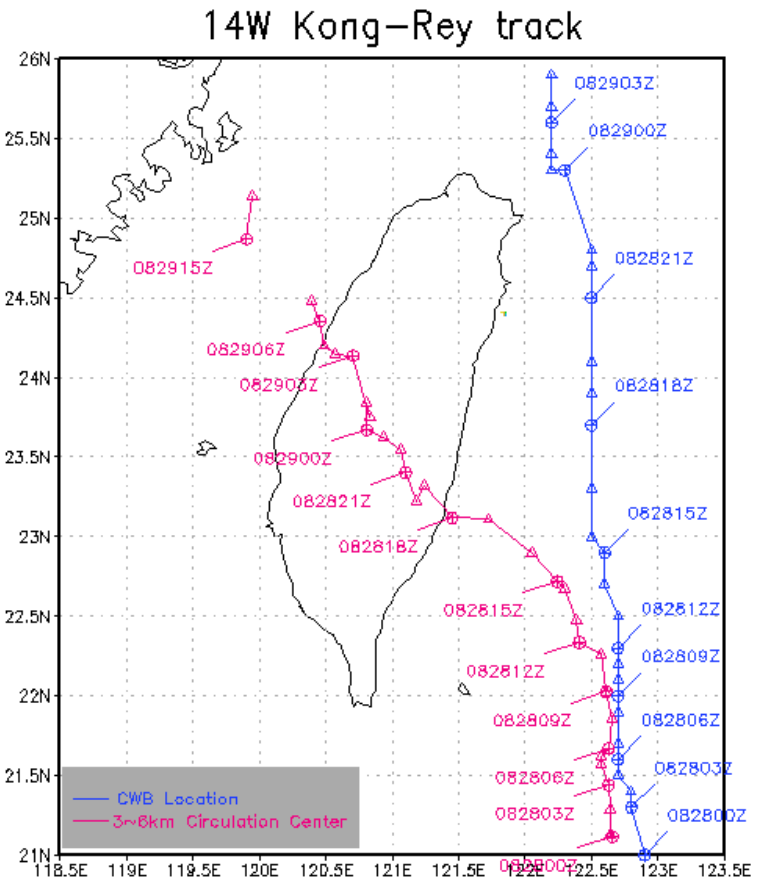
➢ A conceptual model of VHTs and MCV for TC formation. (Houze et al., 2009)

TOP-DOWN MERGER THEORY
(Ritchie and Holland, 1997；Simpson et al., 1997 ; Bister and Emanuel, 1997)



BOTTOM-UP THEORY
(Hendricks et al., 2004；Montgomery et al., 2006)



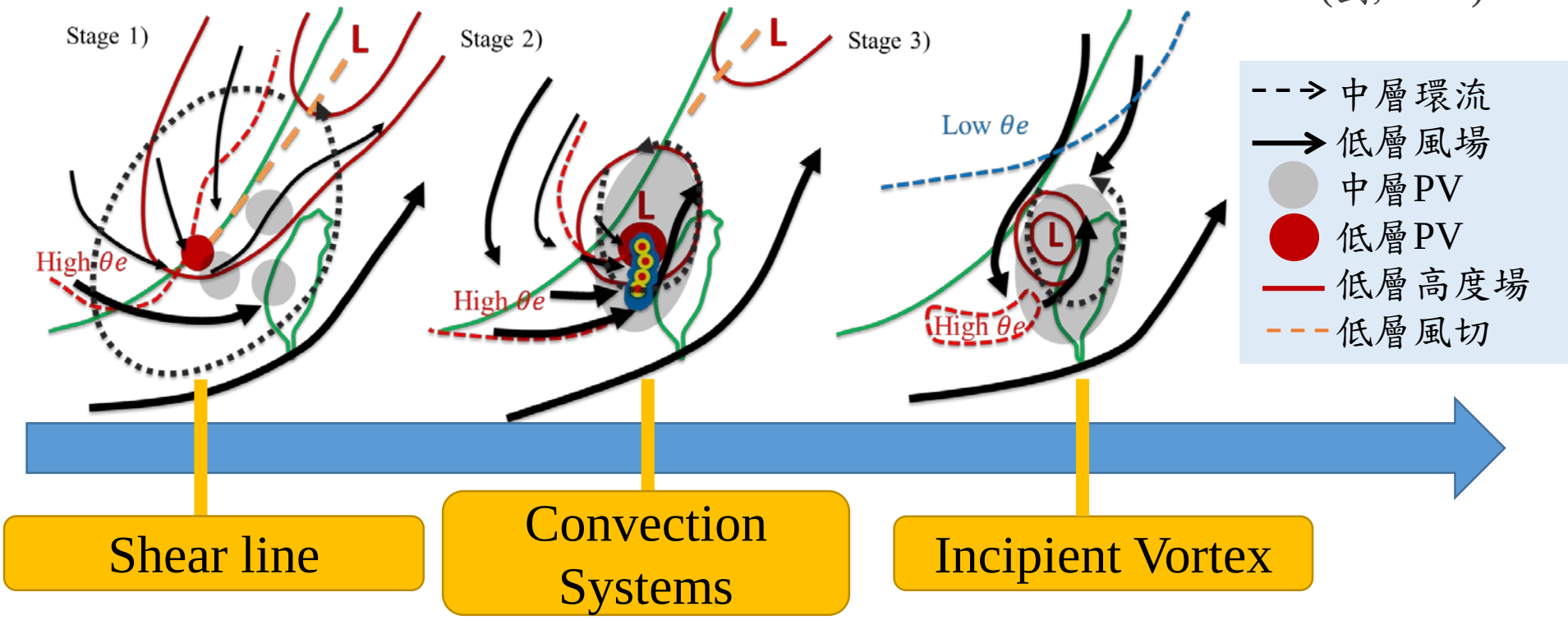


In 2013…

Location of the circulation center (by dudo-wind)

➢Formation of incipient vortex at Taiwan Strait

(劉, 2016)



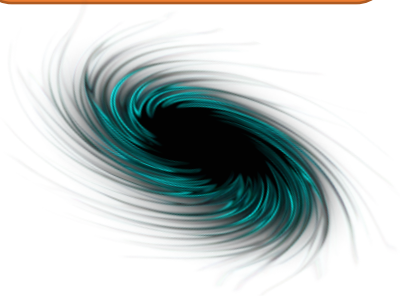
What role does the mid-level circulation play?

✓ Aggregates PV anomalies generated by convections.

✓ *Might* create a favorable environment for the formation of Toraji's incipient vortex.

➢ The question is…

Mid-level Vortex



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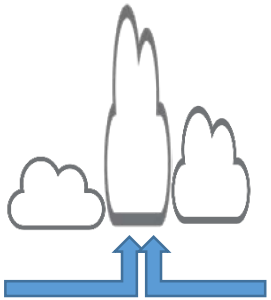
Convection



Tropical Cyclone

(Hendricks et al., 2004)
(Montgomery et al., 2006)
(Houze et al., 2009)

Objectives

Study the influence of the mid-level circulation on the formation of Toraji

Piecewise PV Inversion (PPVI)

(Davis et al., 1991)

u, v, Φ field

by different factors

- ✓ **Diagnose the contribution of each level to low level**
- ✓ **Find the most contribution layers**

ECMWF ERA-Interim Reanalysis Data

WRF

Control Run CTRL

(劉, 2016)

Remove mid-level vortex

Experiments:
RMPV0.1, RMPV0.2, …, RMPV1.5

- ✓ **Test the sensitivity**
- ✓ **Discuss the role of the mid-level vortex**

●**Model Setting:** WRF Modeling (劉, 2016)

✓Initial fields:

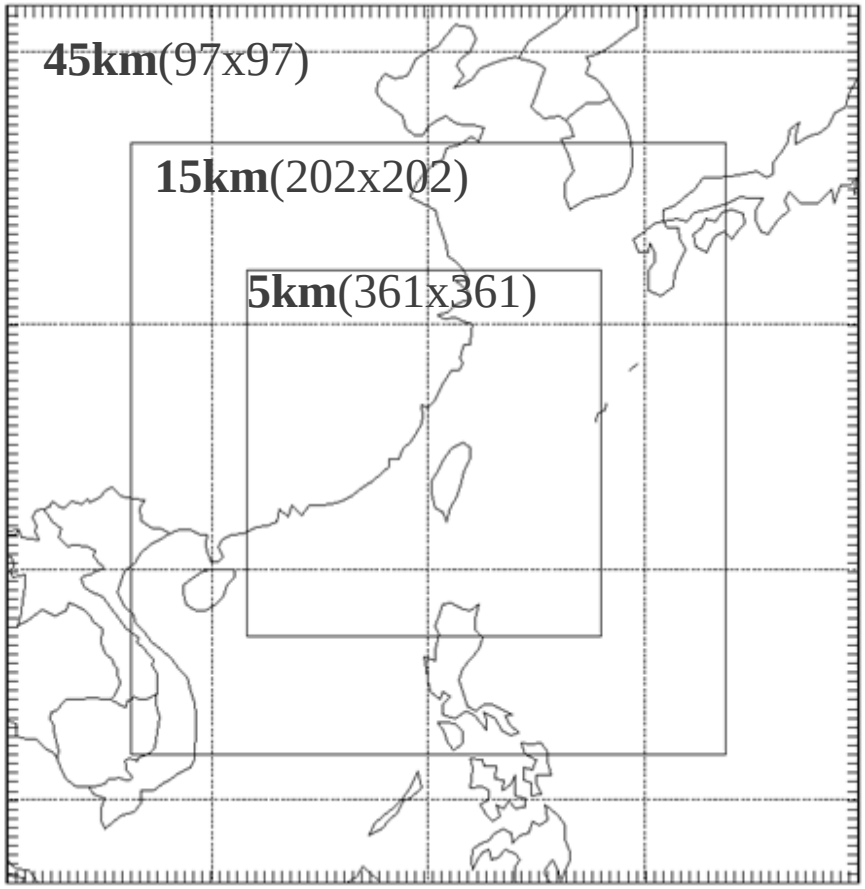
- ➢EC ERA-interim reanalysis data.
- ➢0.25˚X 0.25˚, 6 hrs, 37 levels

✓Starting at 2013-08-29_06Z.

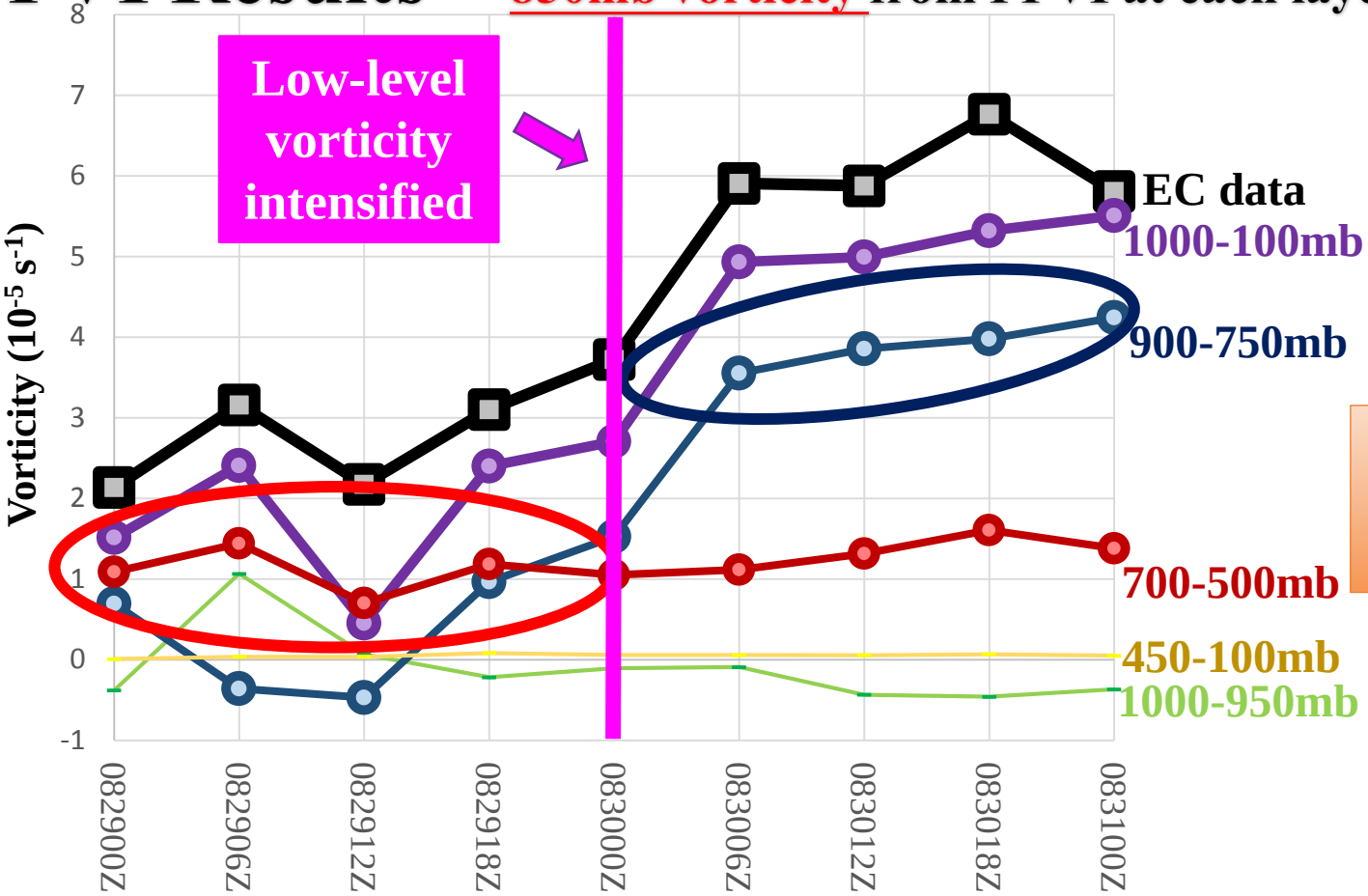
- ➢**60h before TC formation**

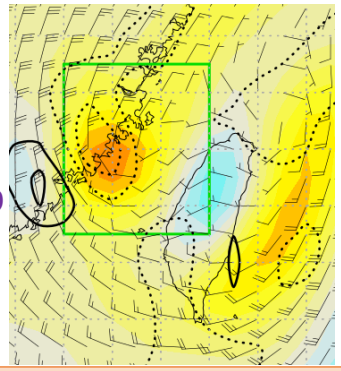
✓Parameterization schemes

- ➢Grell 3D ensemble cumulus scheme
- ➢Goddard GCE microphysics scheme
- ➢YSU boundary layer scheme
- ➢RRTM radiation scheme



- **PPVI Results：850mb vorticity from PPVI at each layer (ordinate)**





Over Area:
118 ˚E~121 ˚E
23.5 ˚N~26.5 ˚N

The mid-level PV anomaly has the most contribution to 850mb positive vorticity

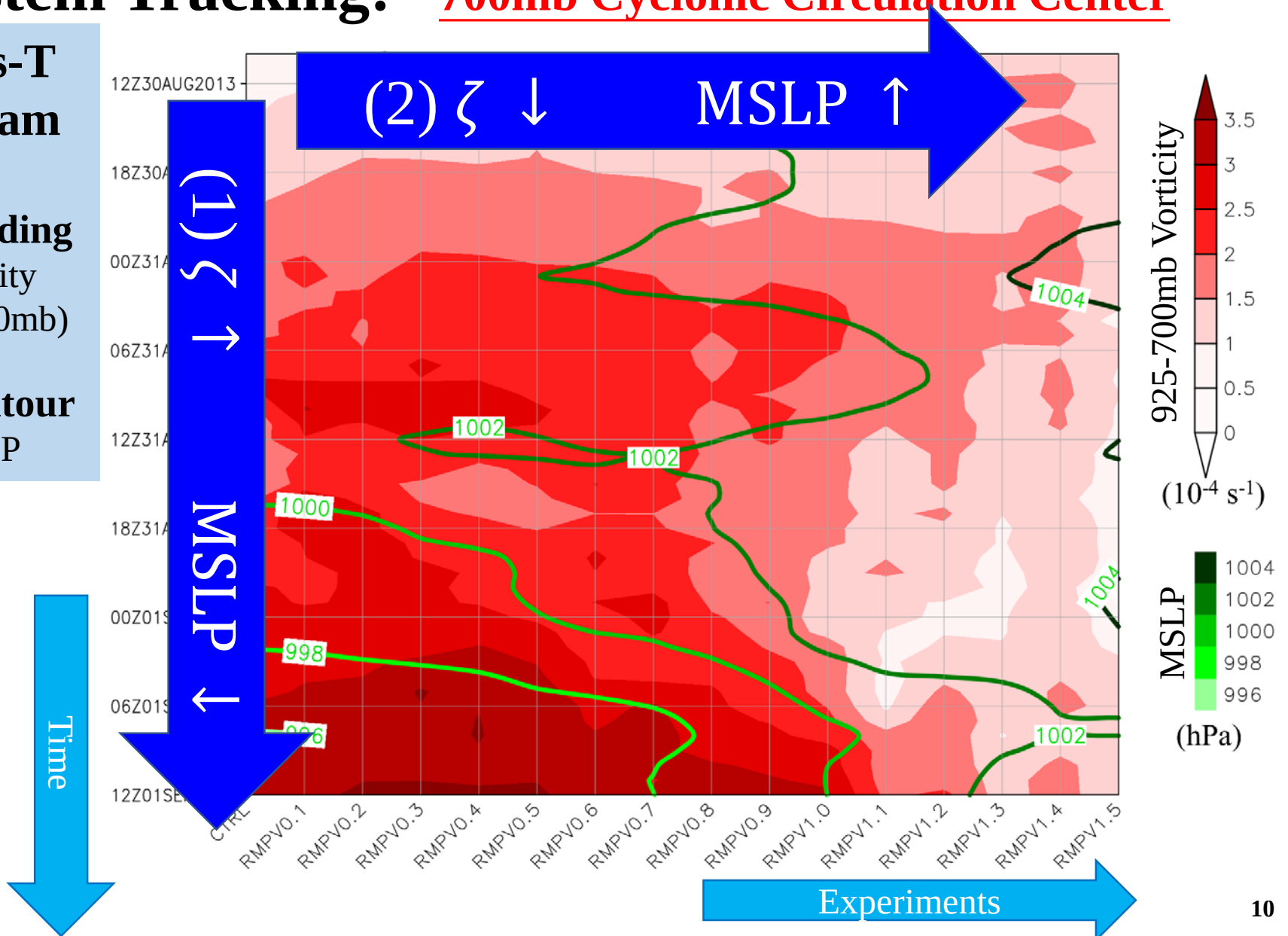
The low level PV anomaly has the most contribution to 850mb positive vorticity

➢System Tracking: 700mb Cyclonic Circulation Center

EXPs-T diagram

(1) Shading
Vorticity
(925-700mb)

(2) Contour
MSLP

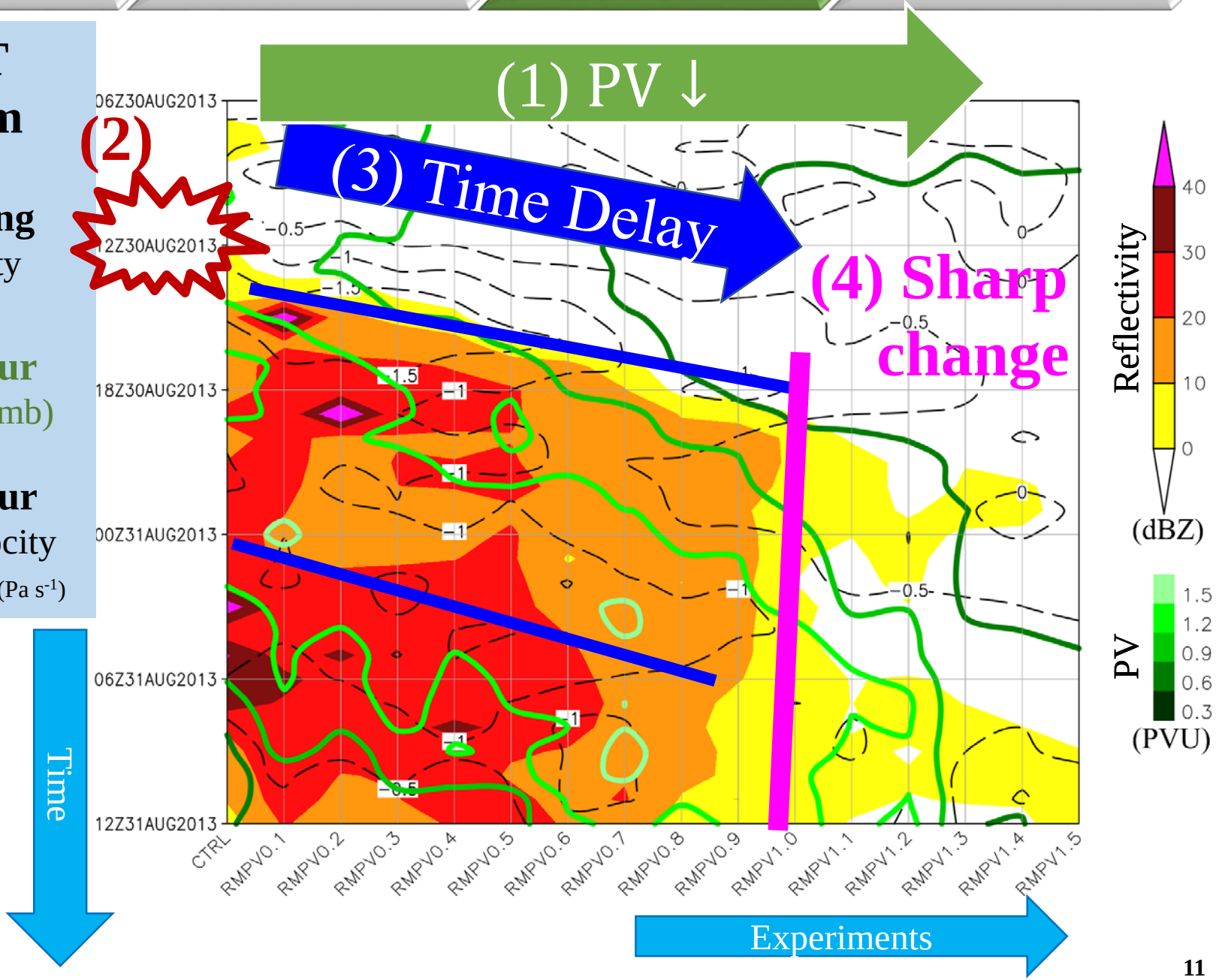


EXP-T diagram

(1) Shading
Reflectivity

(2) Contour
PV(700-500mb)

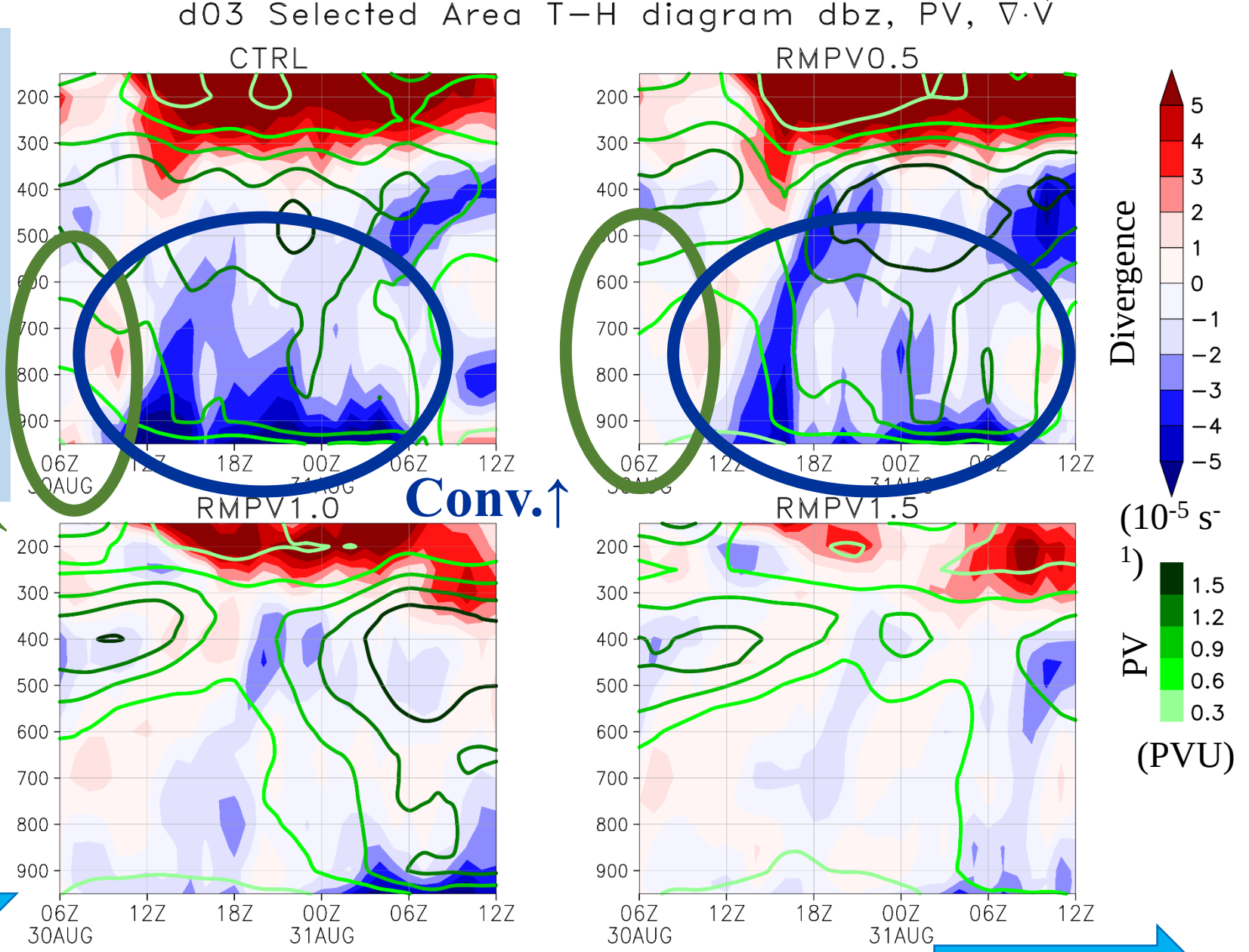
(3) Contour
Vertical Velocity
(400-600mb)(Pa s^{-1})



T-H diagram

(1) Shading
Divergence

(2) Contour
PV



EXP-H diagram

083010Z

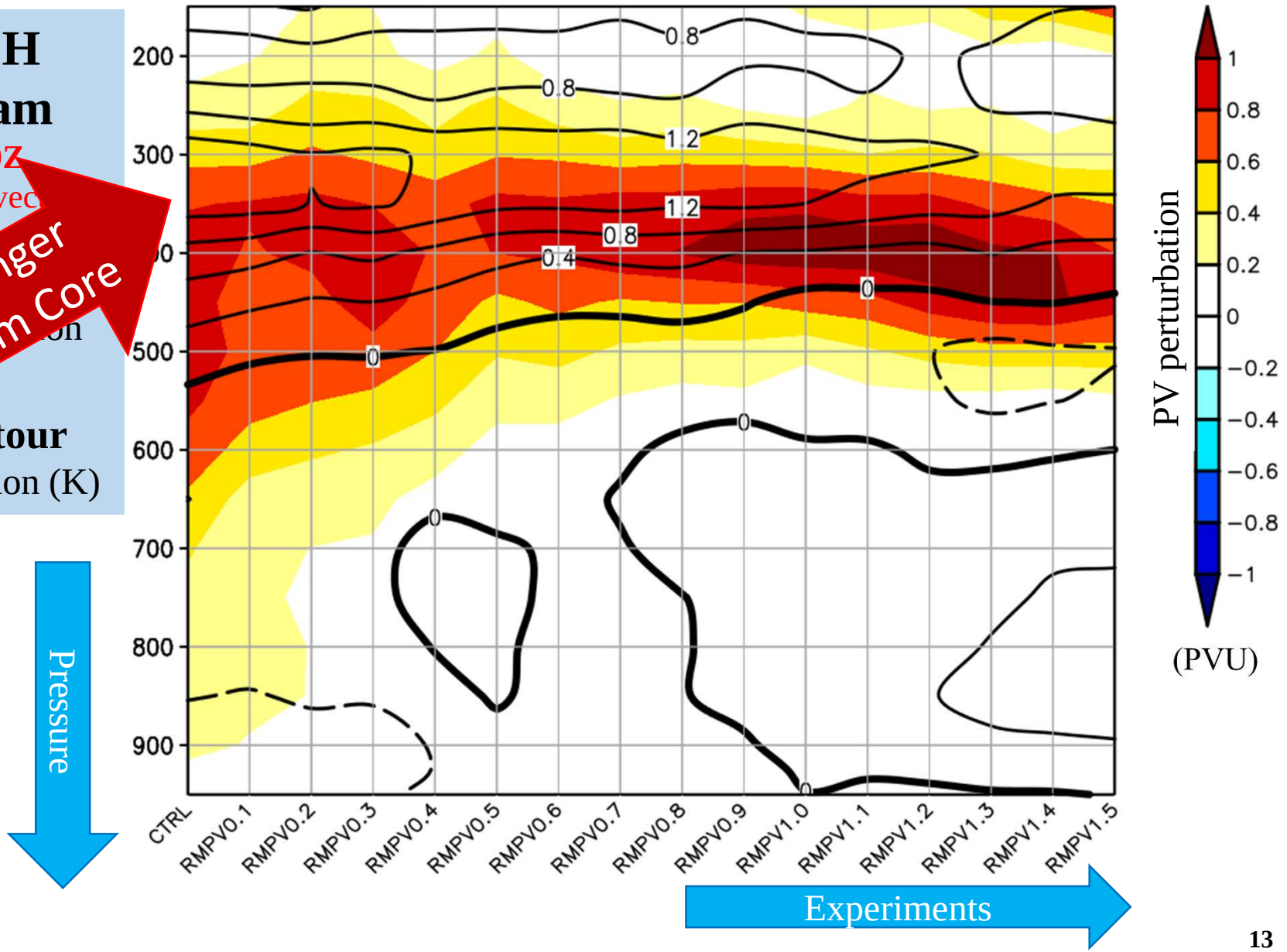
(Before Convec

(1) P on

Stronger Warm Core

(2) Contour

θ perturbation (K)



EXP-H diagram

083010Z

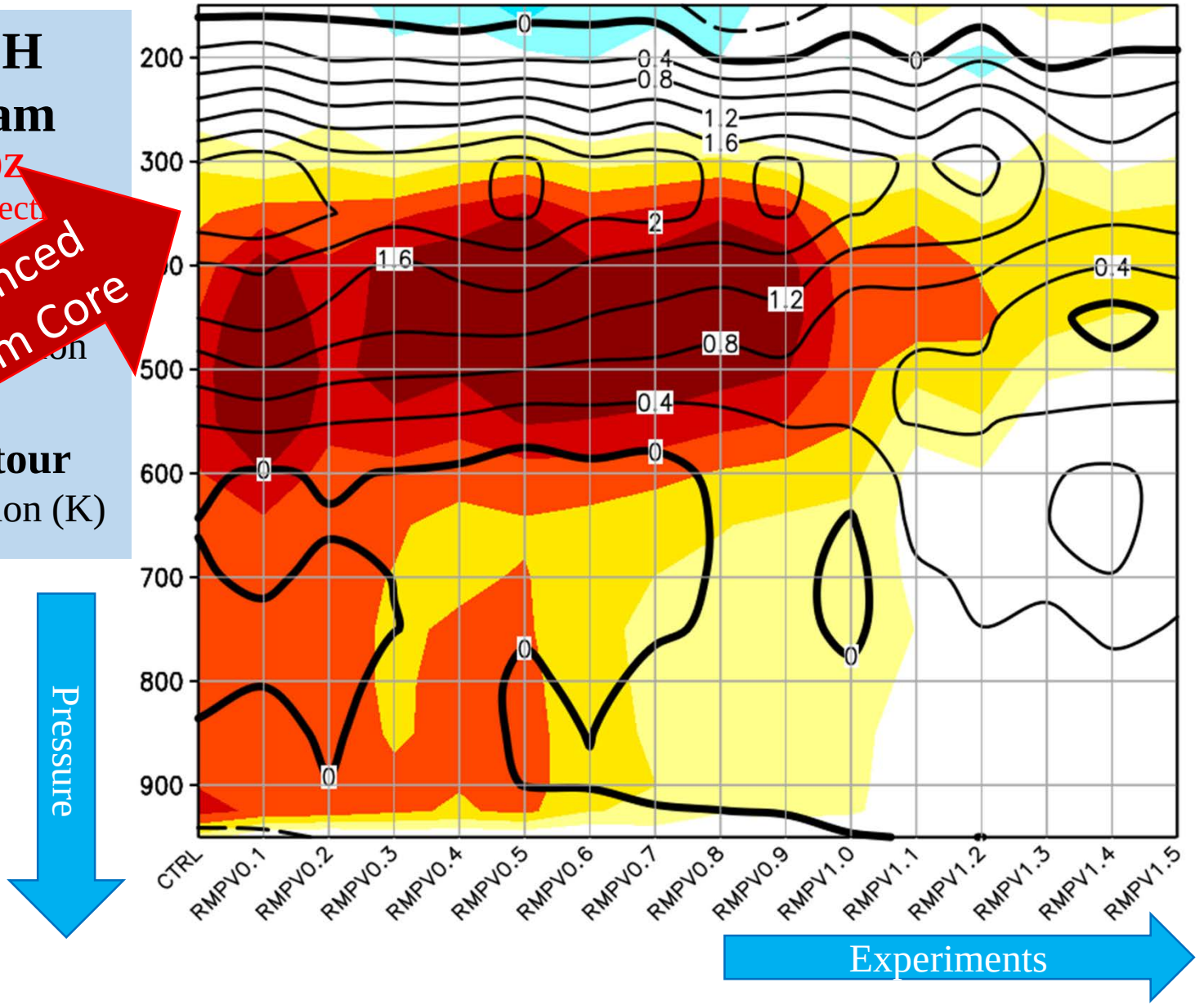
(After Convect

(1) P on

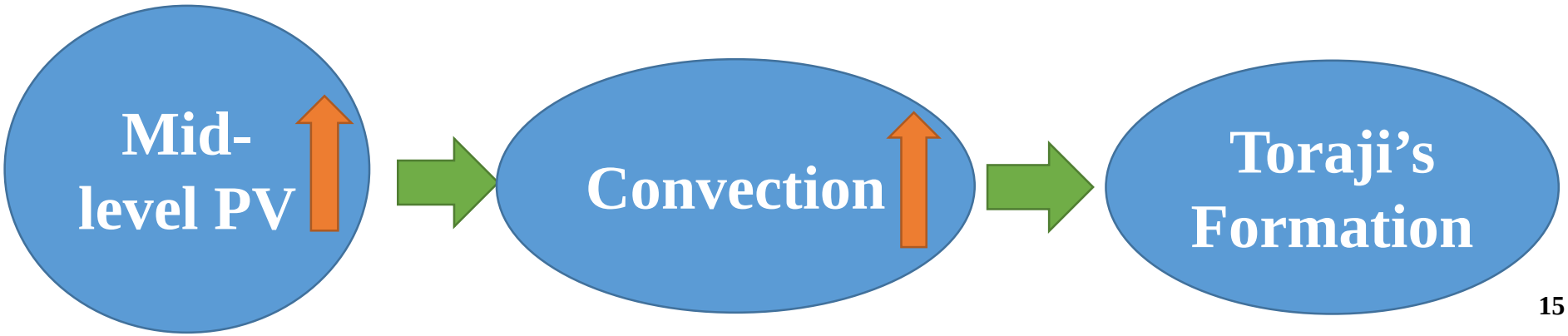
Enhanced Warm Core

(2) Contour

θ perturbation (K)



- ✓**PPVI:**
  - ➢**Mid-level PV anomaly has the most positive contribution to the low-level cyclonic circulation before low level vorticity intensified.**
- ✓**Sensitivity Experiments:**
  - ➢**The mid-level cyclonic circulation creates a favorable environment for convections and leads to Toraji's formation.**



✓Summary of Sensitivity Experiments