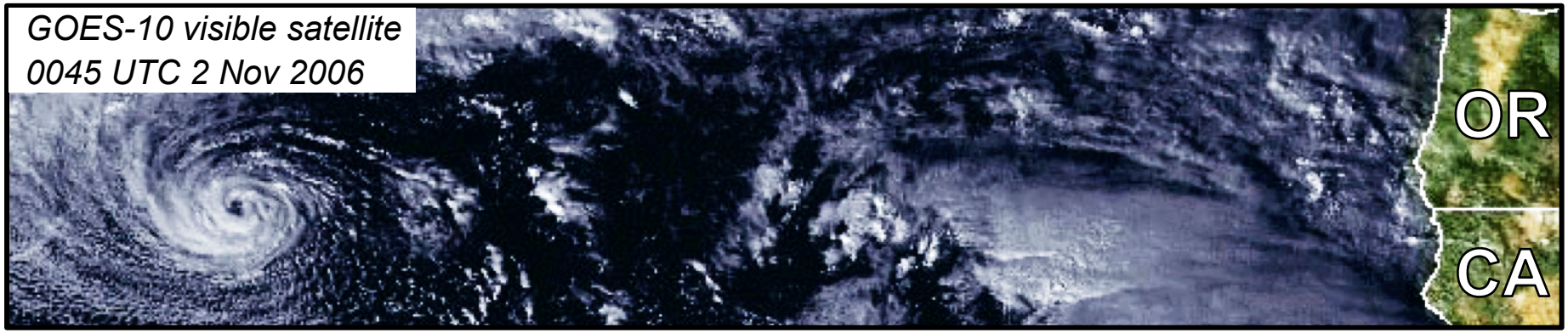
# Tropical Transition of an Unnamed, High-Latitude, Tropical Cyclone in the Eastern North Pacific

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# Background

- Tropical cyclones (TCs) are not exclusive to the tropics
- The majority of TCs forming poleward of 25°N (25°S) in the Northern (Southern) Hemisphere develop in the presence of an upper-tropospheric disturbance in a baroclinic environment (McTaggart-Cowan et al. 2013)

*Global Climatology of Baroclinically Induced Tropical Cyclogenesis (1948–2010)*

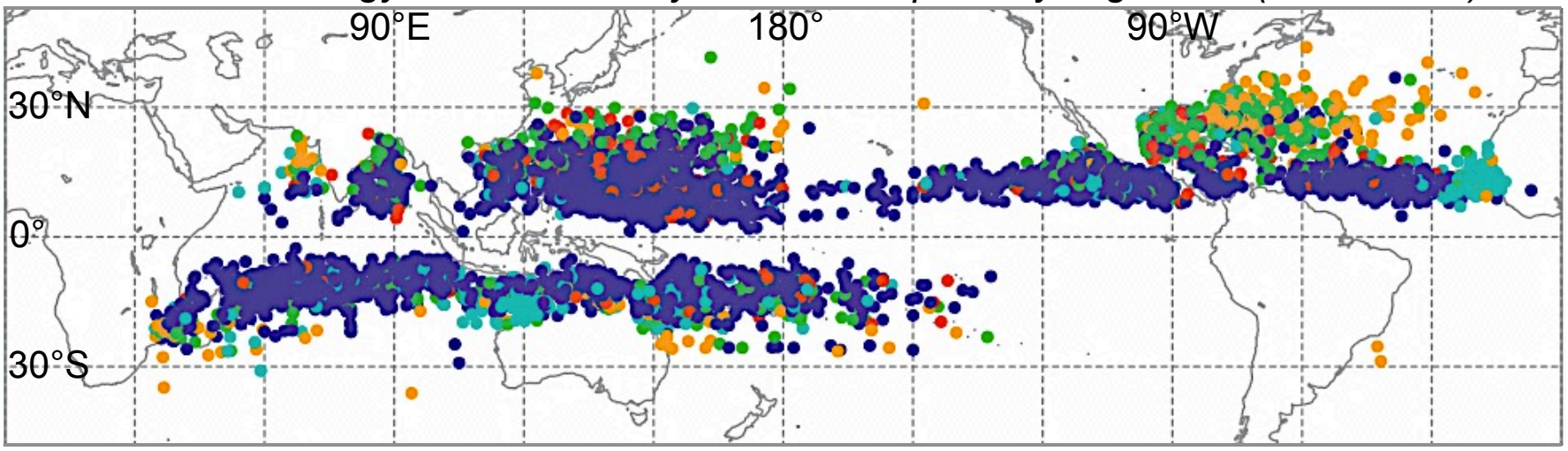



*Fig. 7 adapted from McTaggart-Cowan et al. (2013)*

# Tropical Transition

- TCs developing in the presence of an upper-tropospheric disturbance in a baroclinic environment typically form via the tropical transition (TT) process (Davis and Bosart 2003, 2004)

***Asymmetric, cold-core, extratropical cyclone (EC)***

⇩

***Axisymmetric, warm-core, TC***

**Initial Stages**

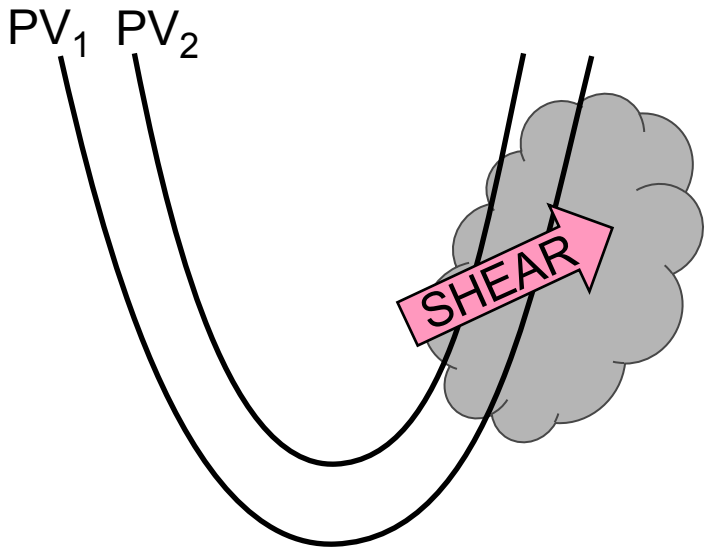



*Fig. 2 adapted from Davis and Bosart (2003)*

**Latter Stages**

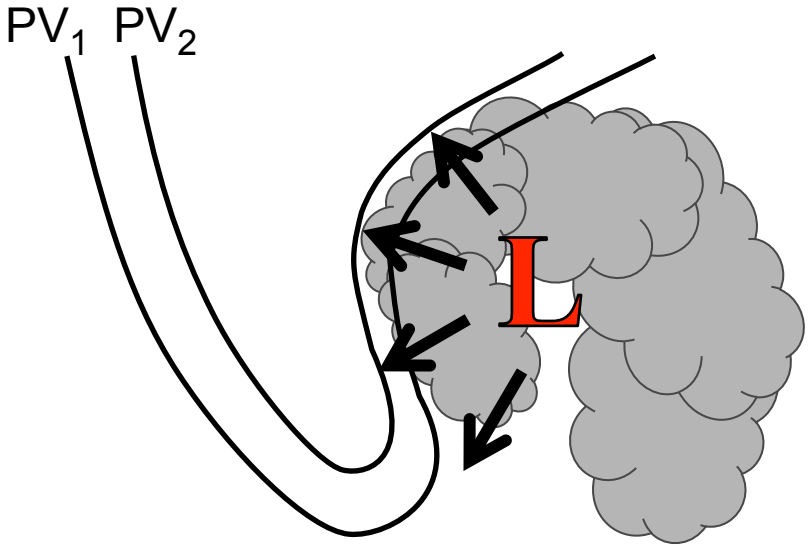
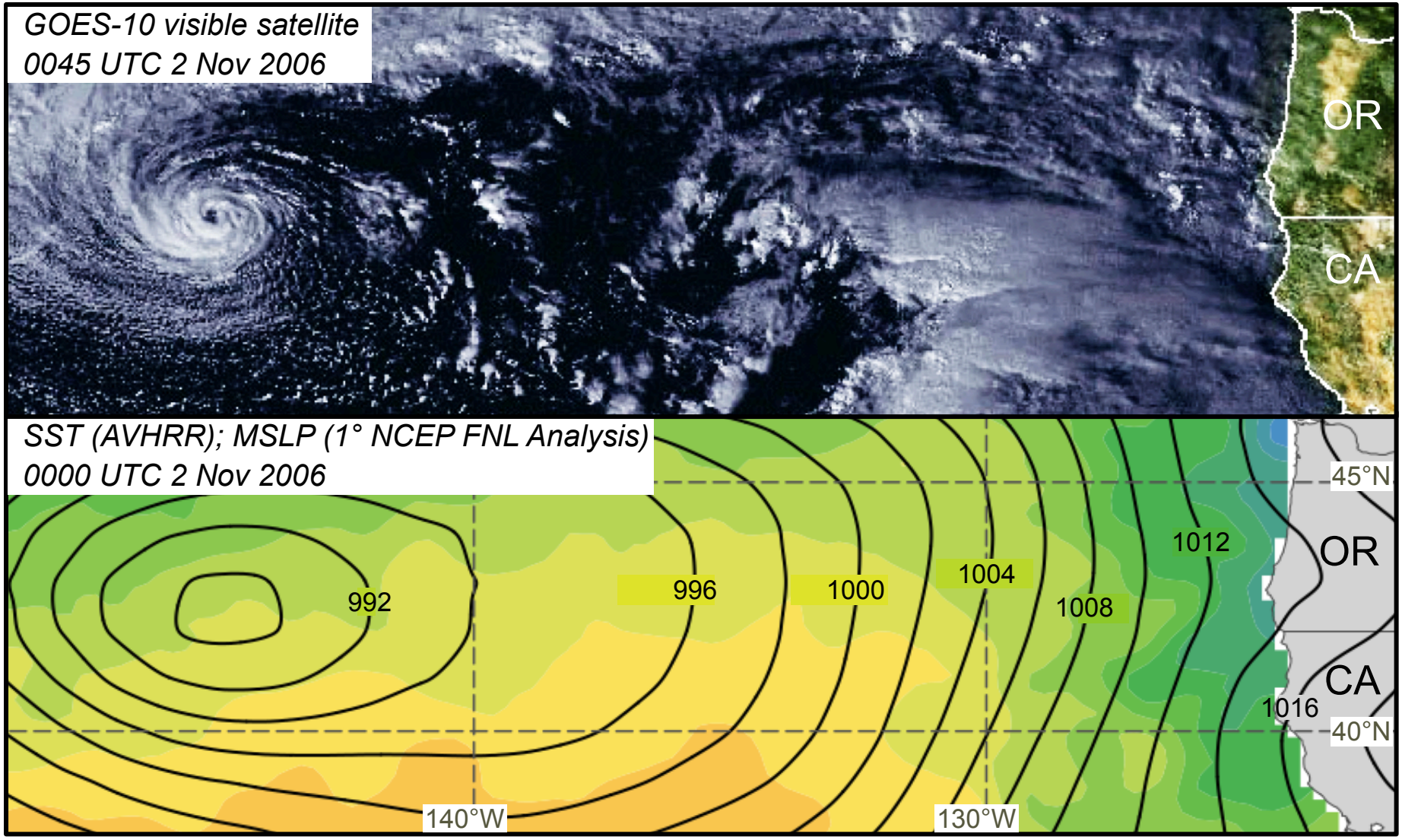



*Fig. 3 adapted from Davis and Bosart (2004)*

# Motivation


GOES-10 visible satellite
0045 UTC 2 Nov 2006
OR
CA
SST (AVHRR); MSLP (1° NCEP FNL Analysis)
0000 UTC 2 Nov 2006
992
996
1000
1004
1008
1012
1016
45°N
40°N
140°W
130°W
OR
CA
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
(°C)

# Outline

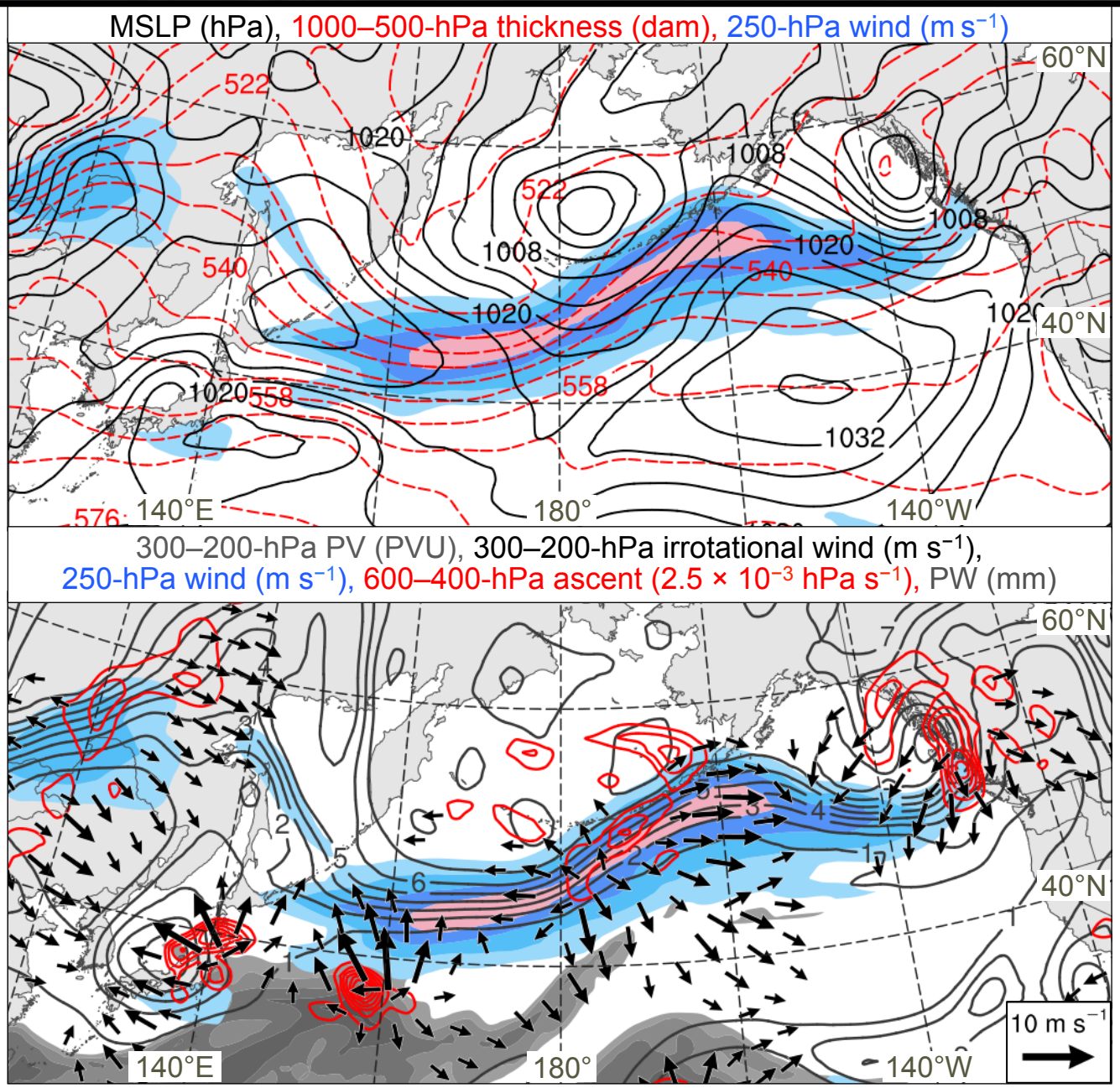
- Identify the upper- and lower-tropospheric features linked to the formation of the EC that transitions into the unnamed TC

- Provide a synoptic overview of the features and processes associated with the unnamed TC's TT

- Investigate the differences in TC structure and intensity that can arise from changing the complexity of the microphysical parameterization scheme used to simulate the TT process

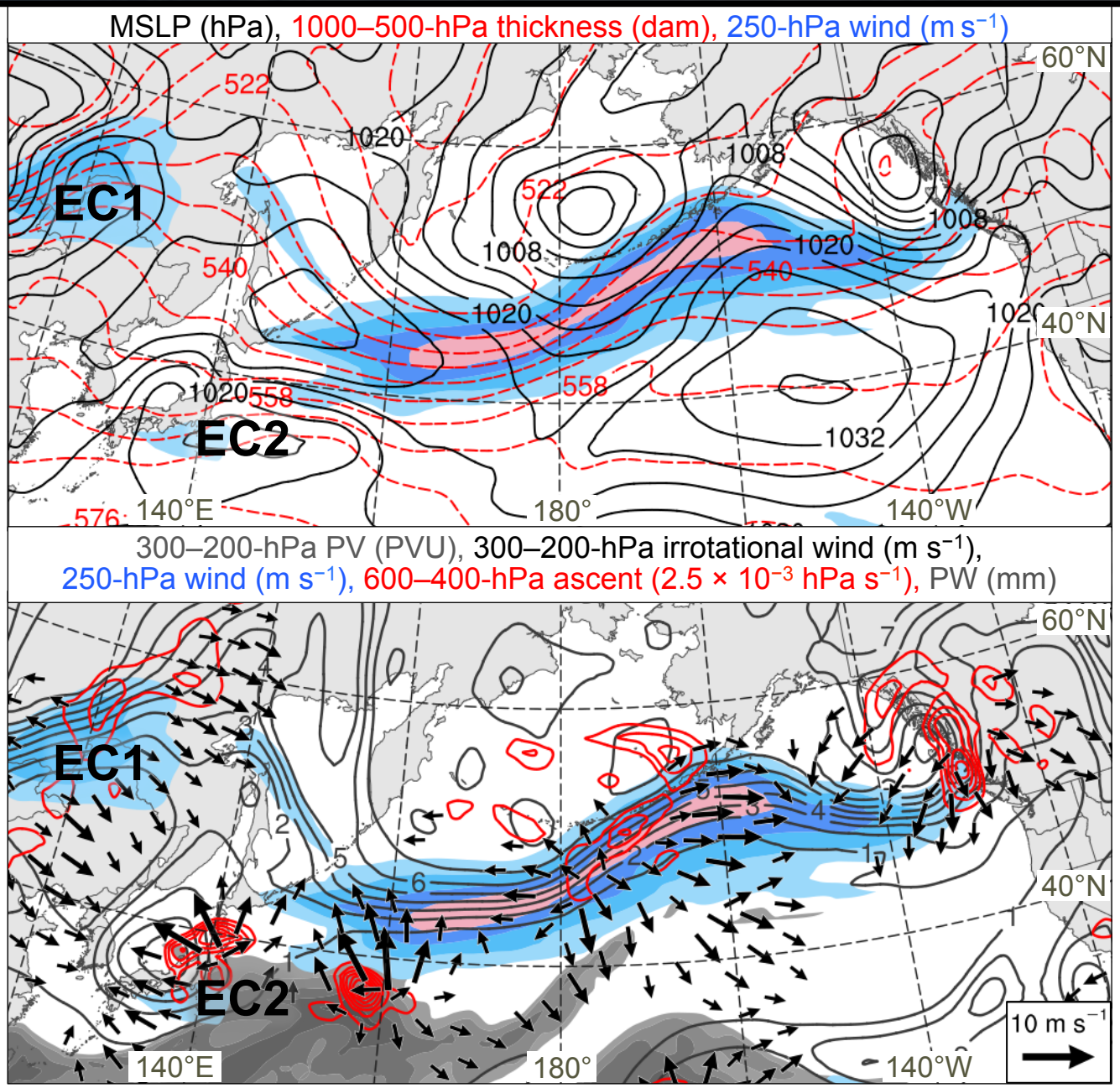
# Precursors to EC Formation

0000 UTC 24 Oct 2006



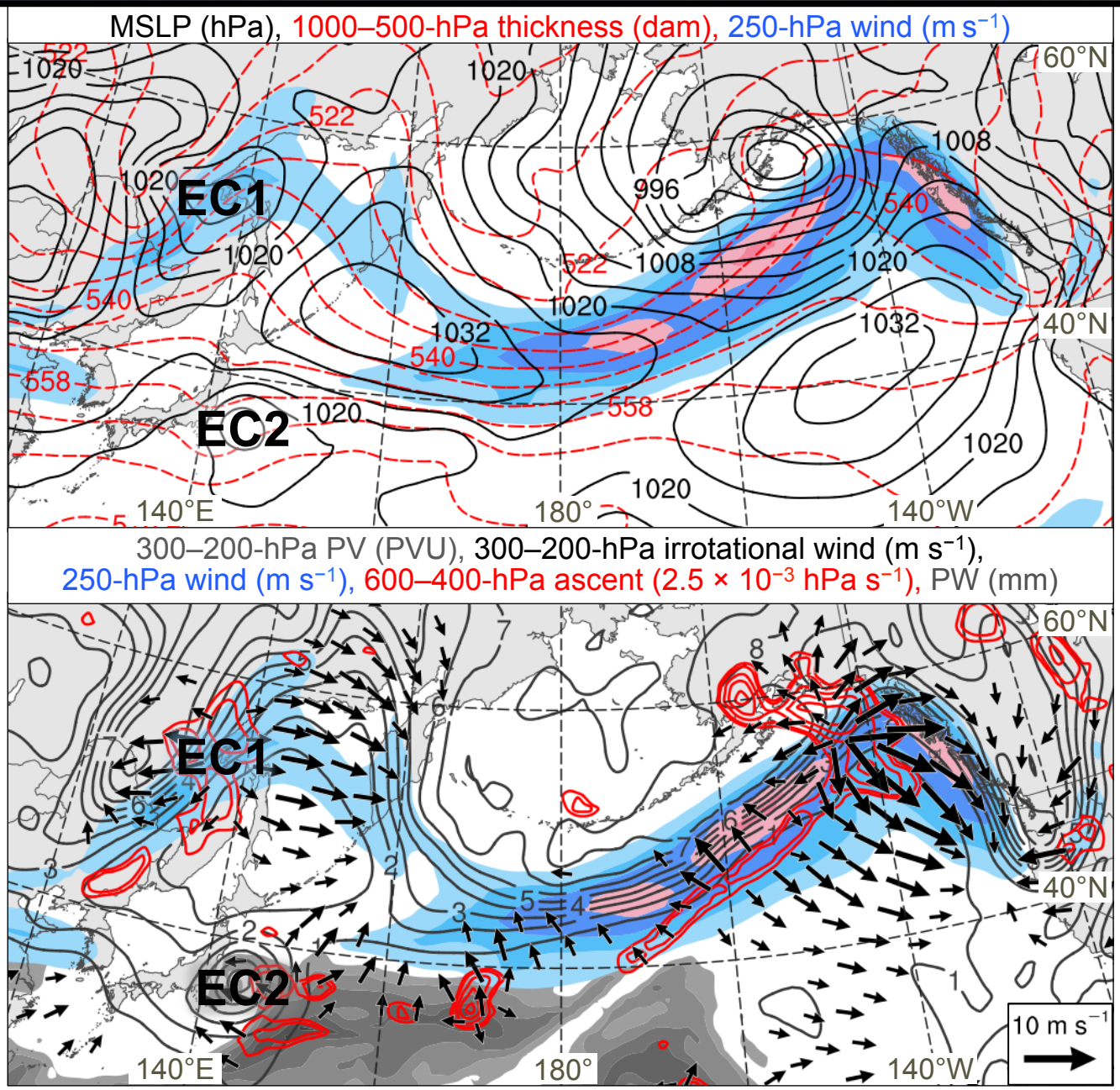
# Precursors to EC Formation

0000 UTC 24 Oct 2006



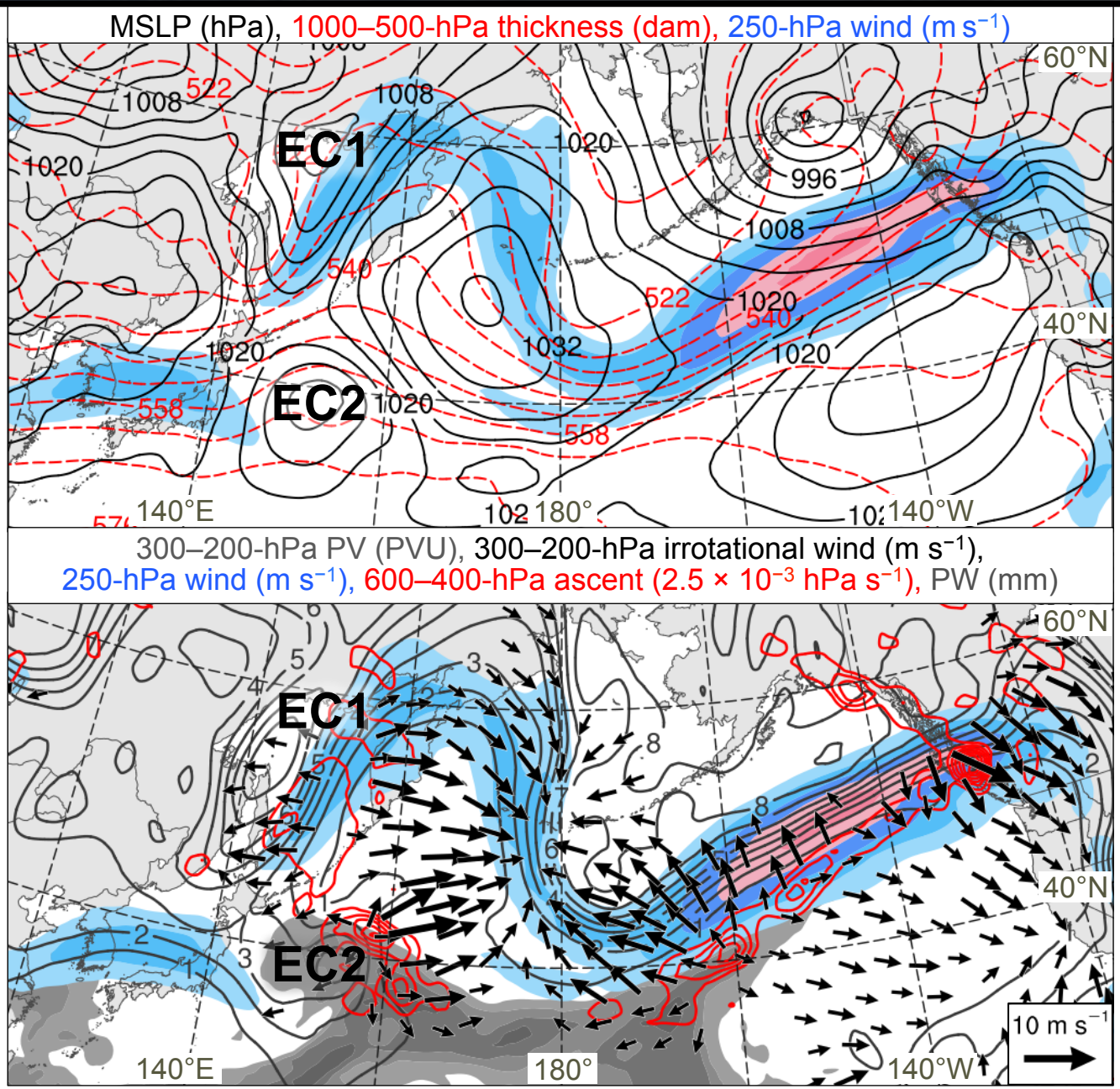
# Precursors to EC Formation

0000 UTC 25 Oct 2006



# Precursors to EC Formation

0000 UTC 26 Oct 2006



# Precursors to EC Formation

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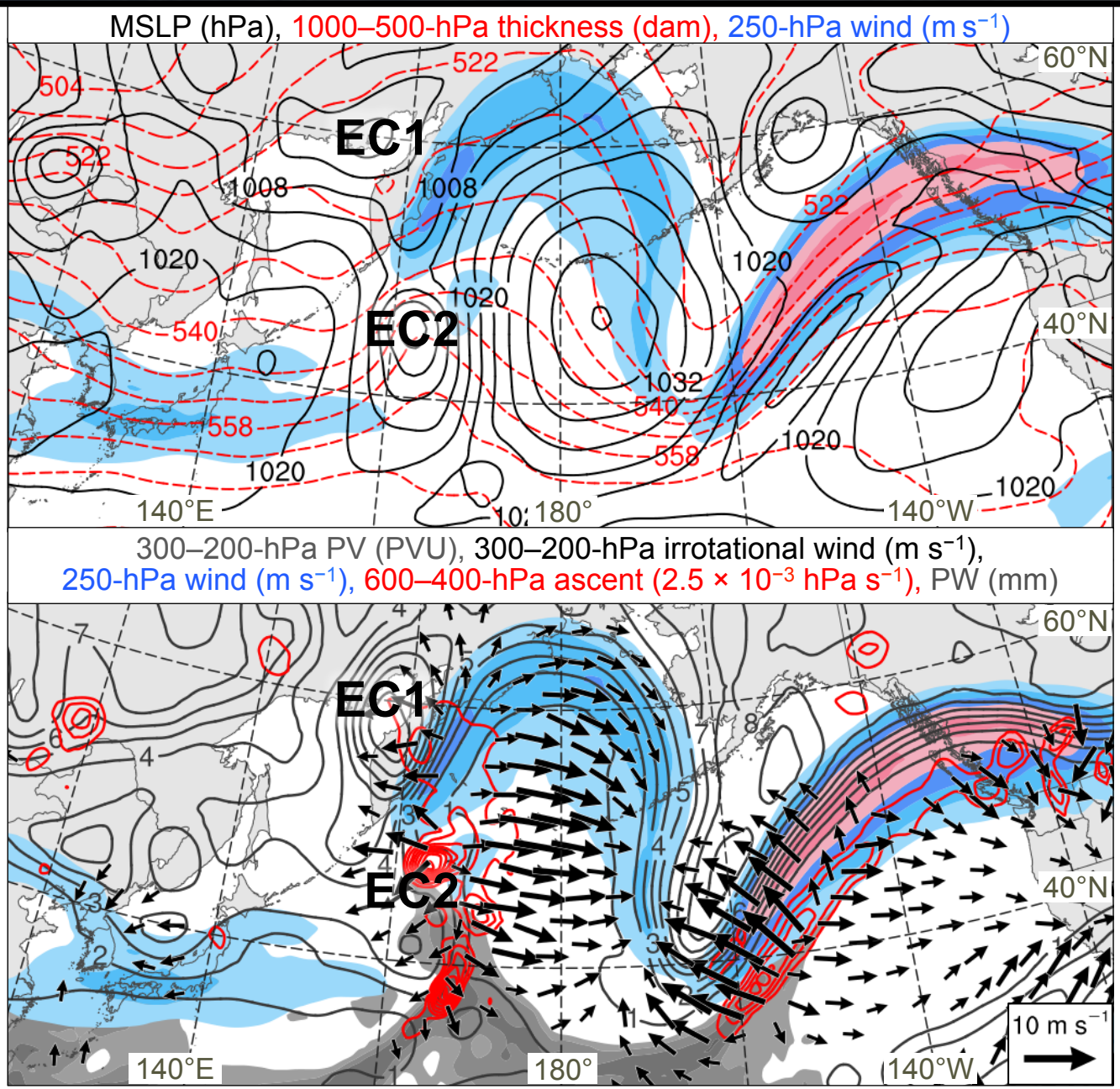
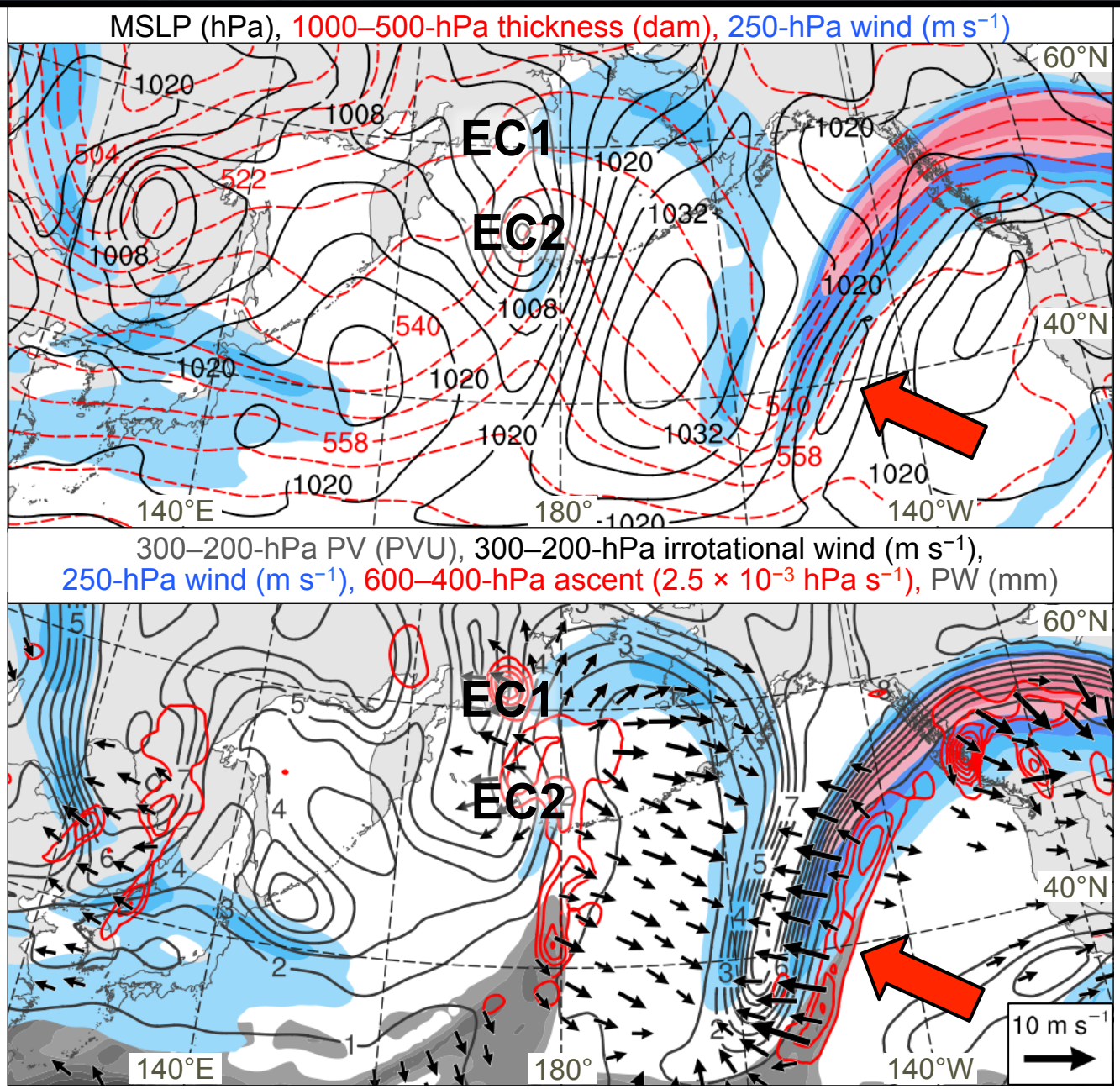


# Precursors to EC Formation

0000 UTC 28 Oct 2006



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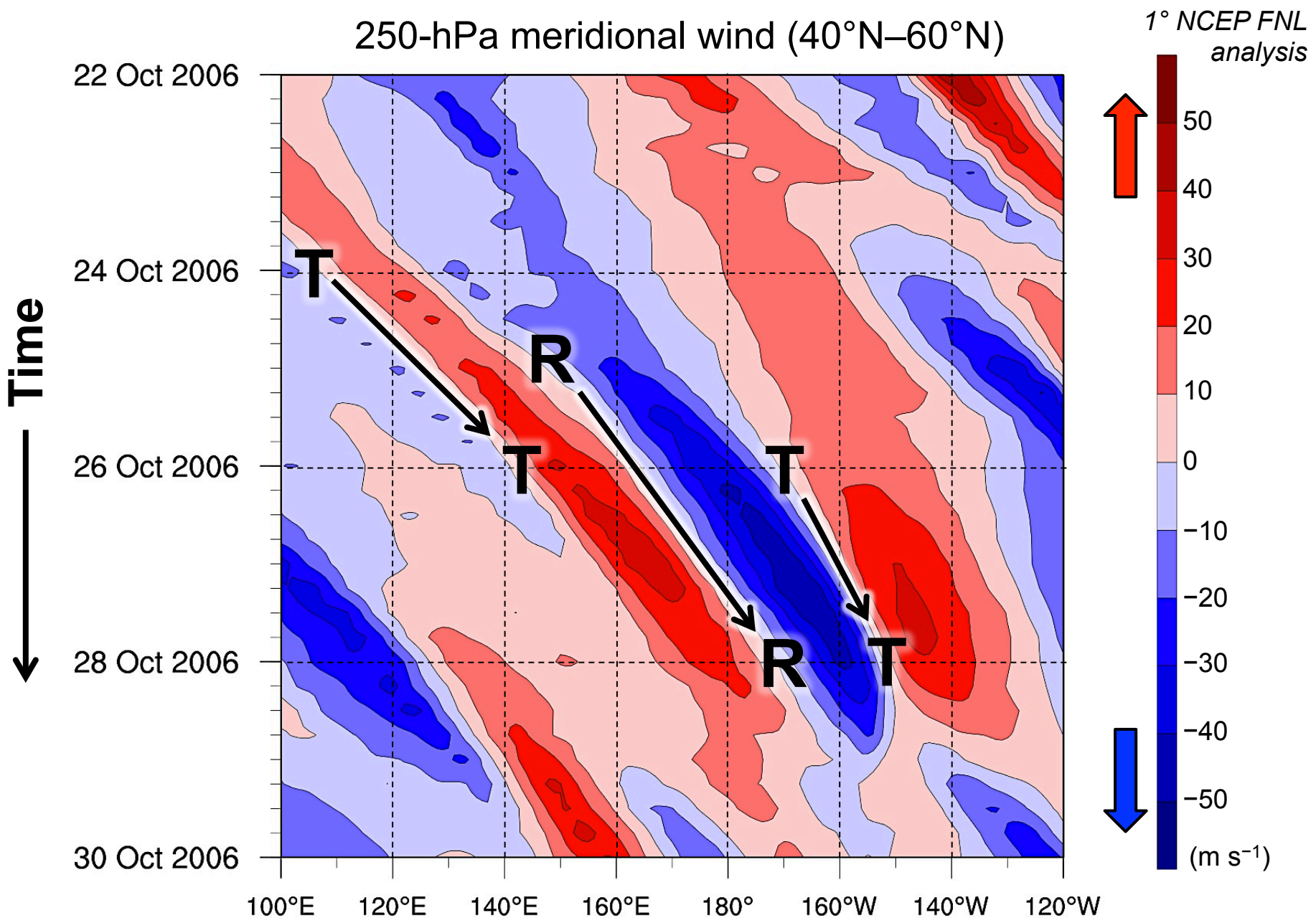

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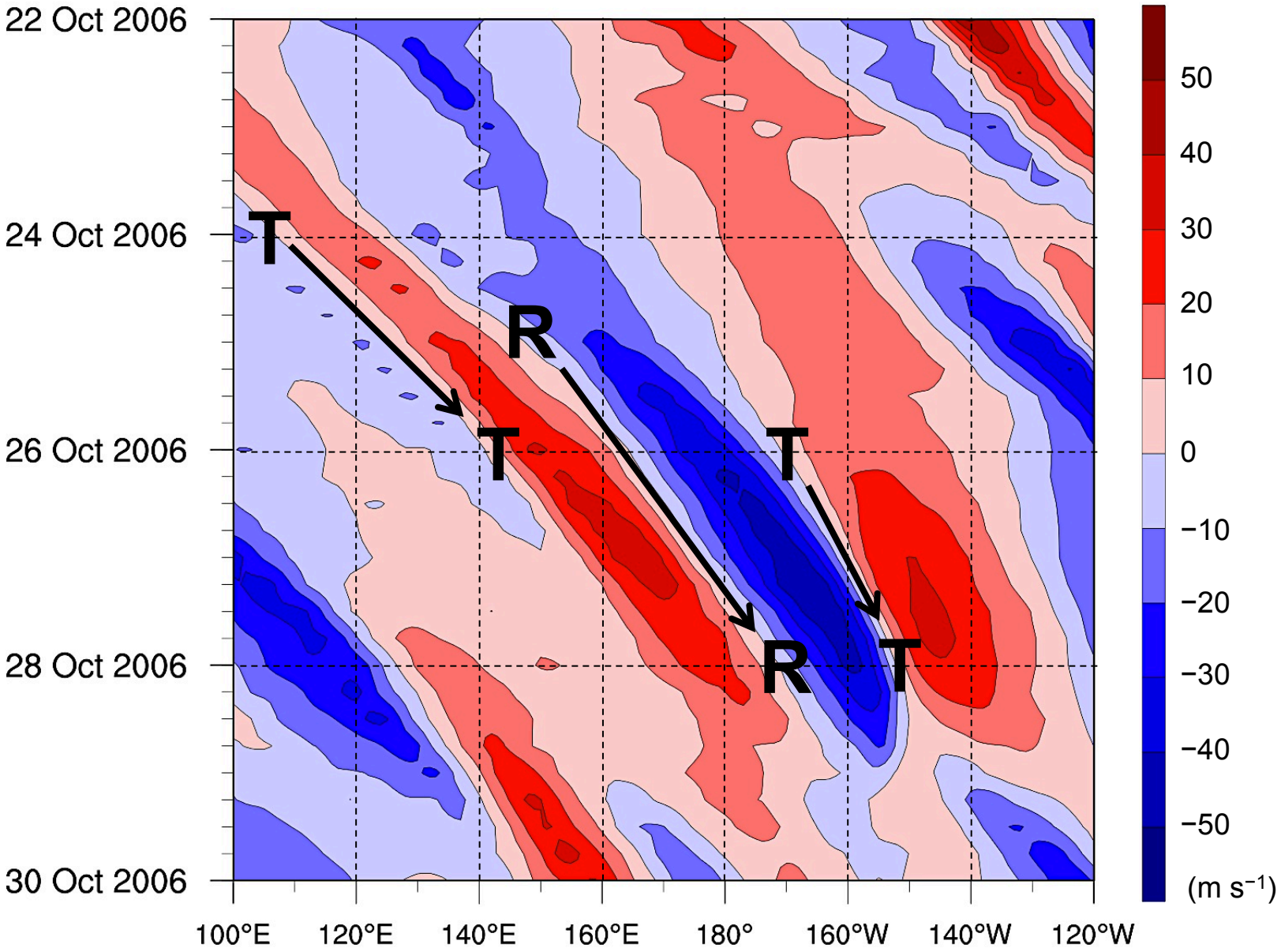
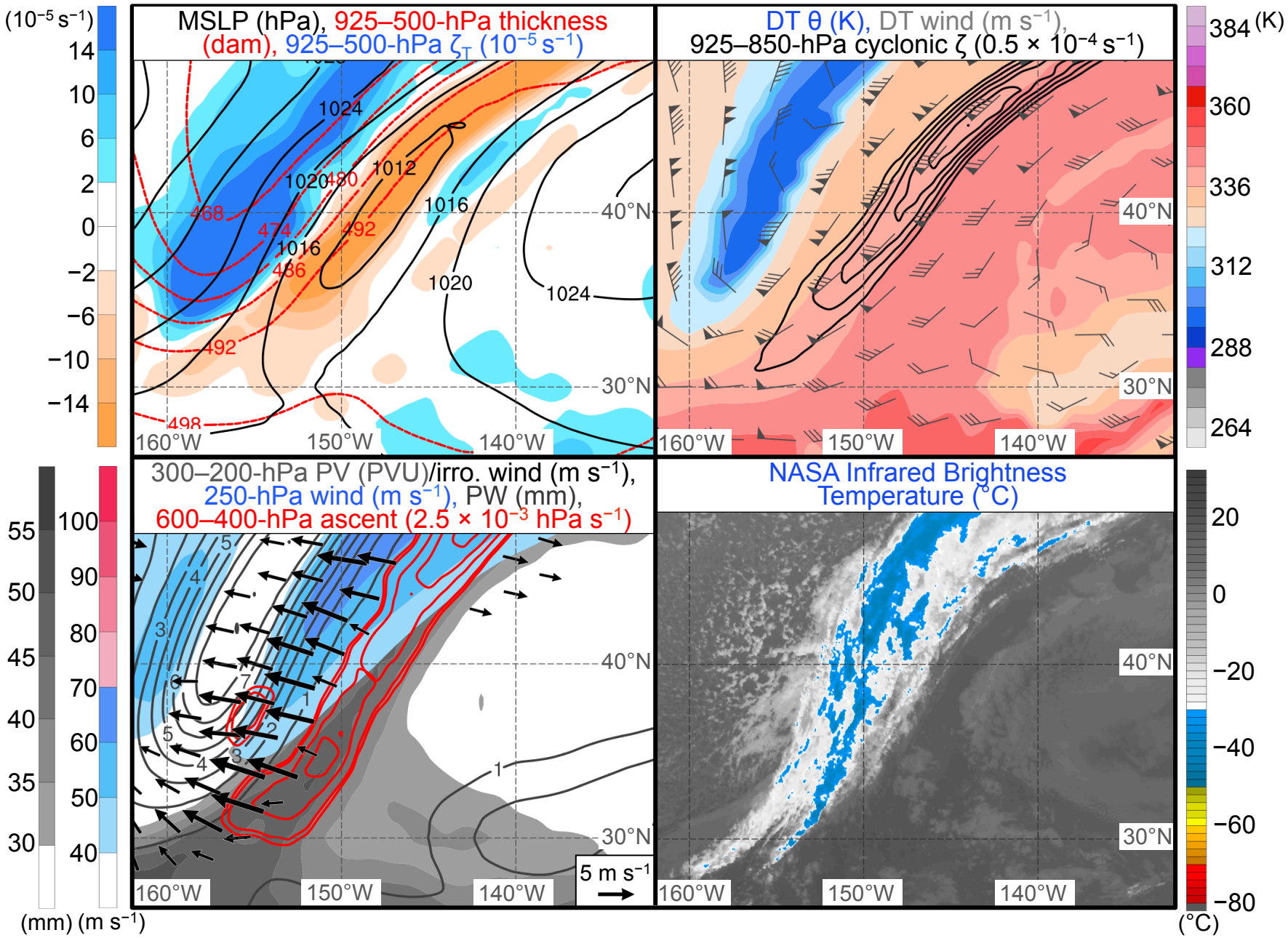


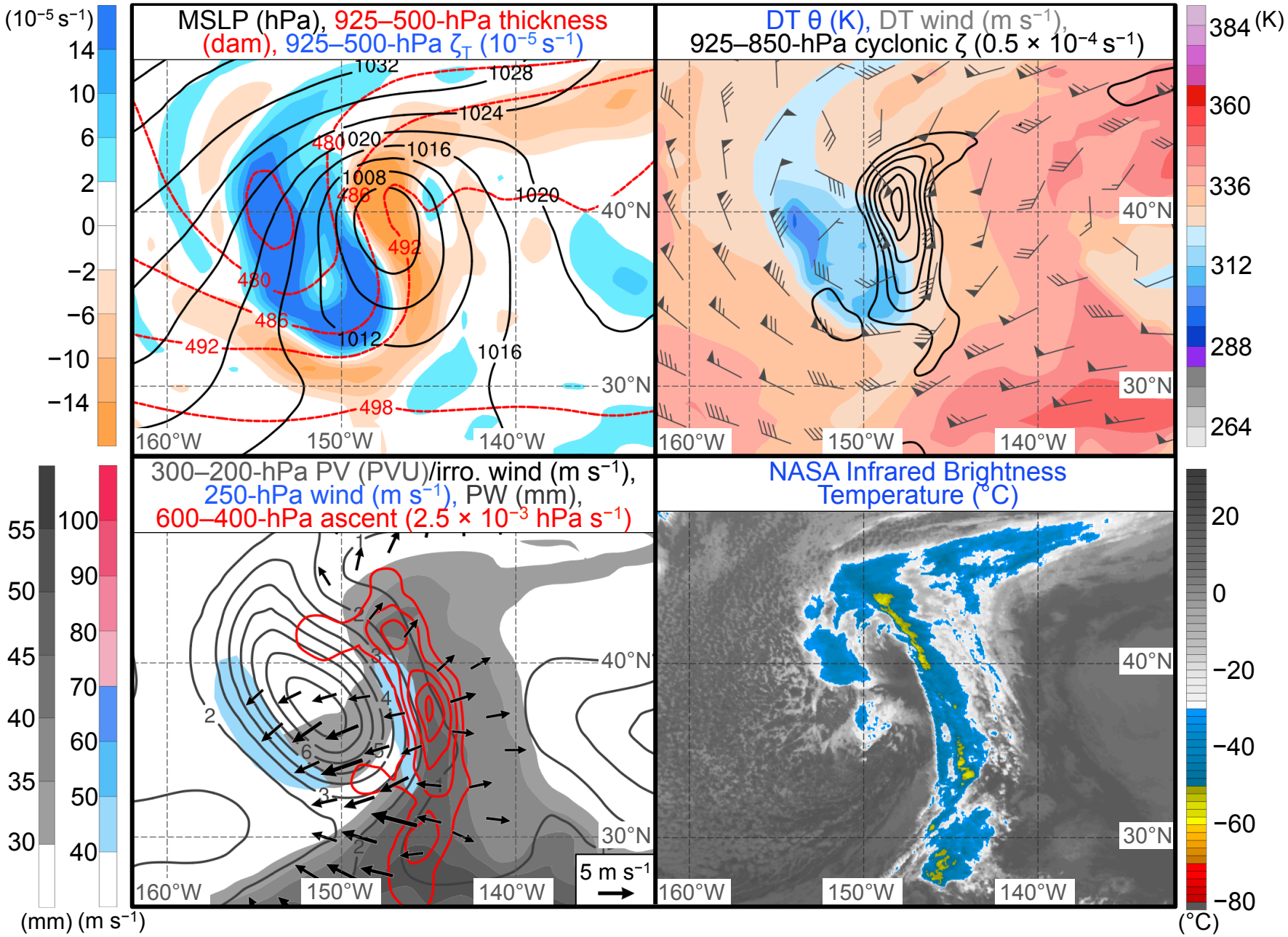
# Tropical Transition

0000 UTC 28 Oct 2006



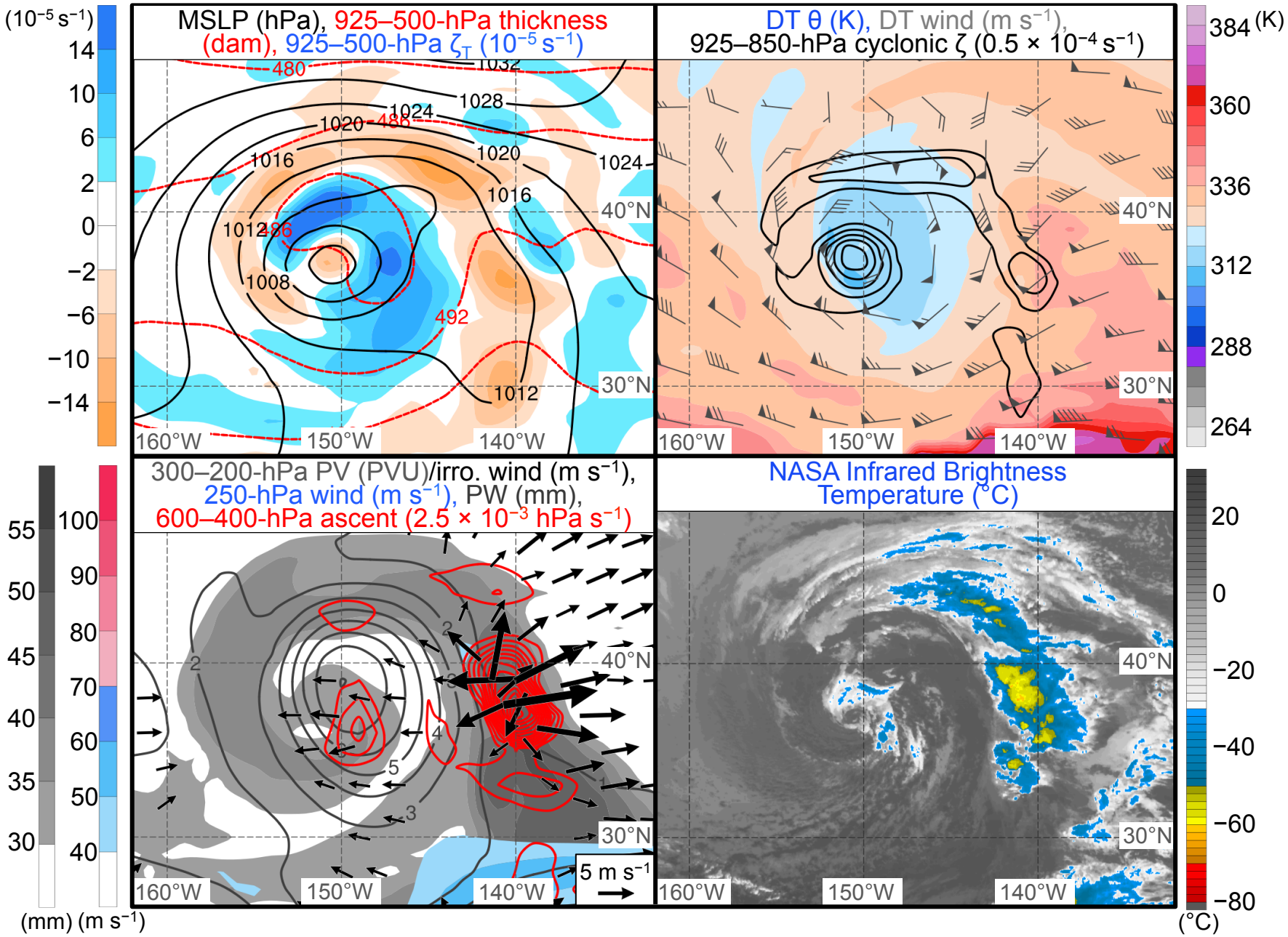
# Tropical Transition

0000 UTC 29 Oct 2006



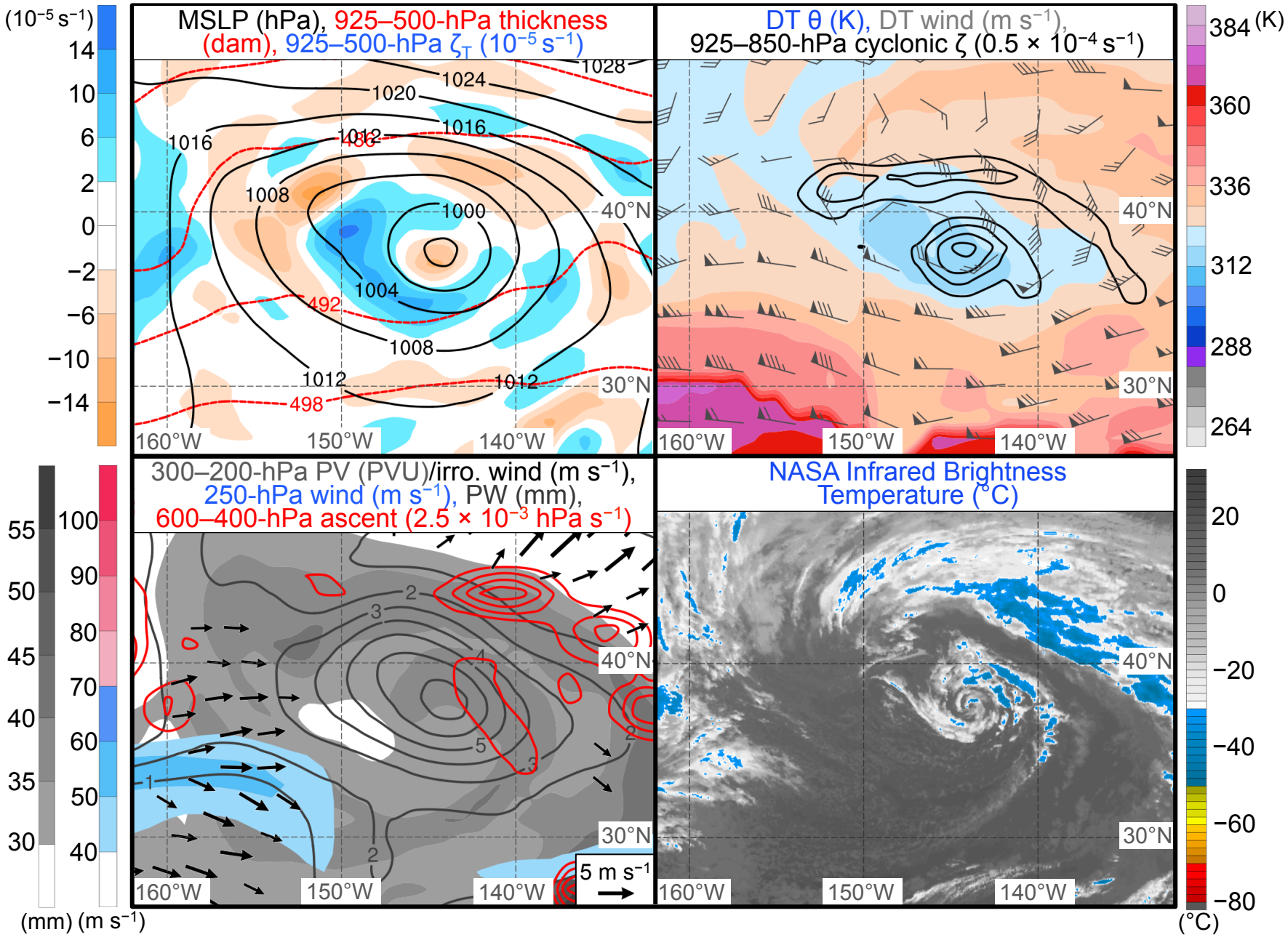
# Tropical Transition

0000 UTC 30 Oct 2006



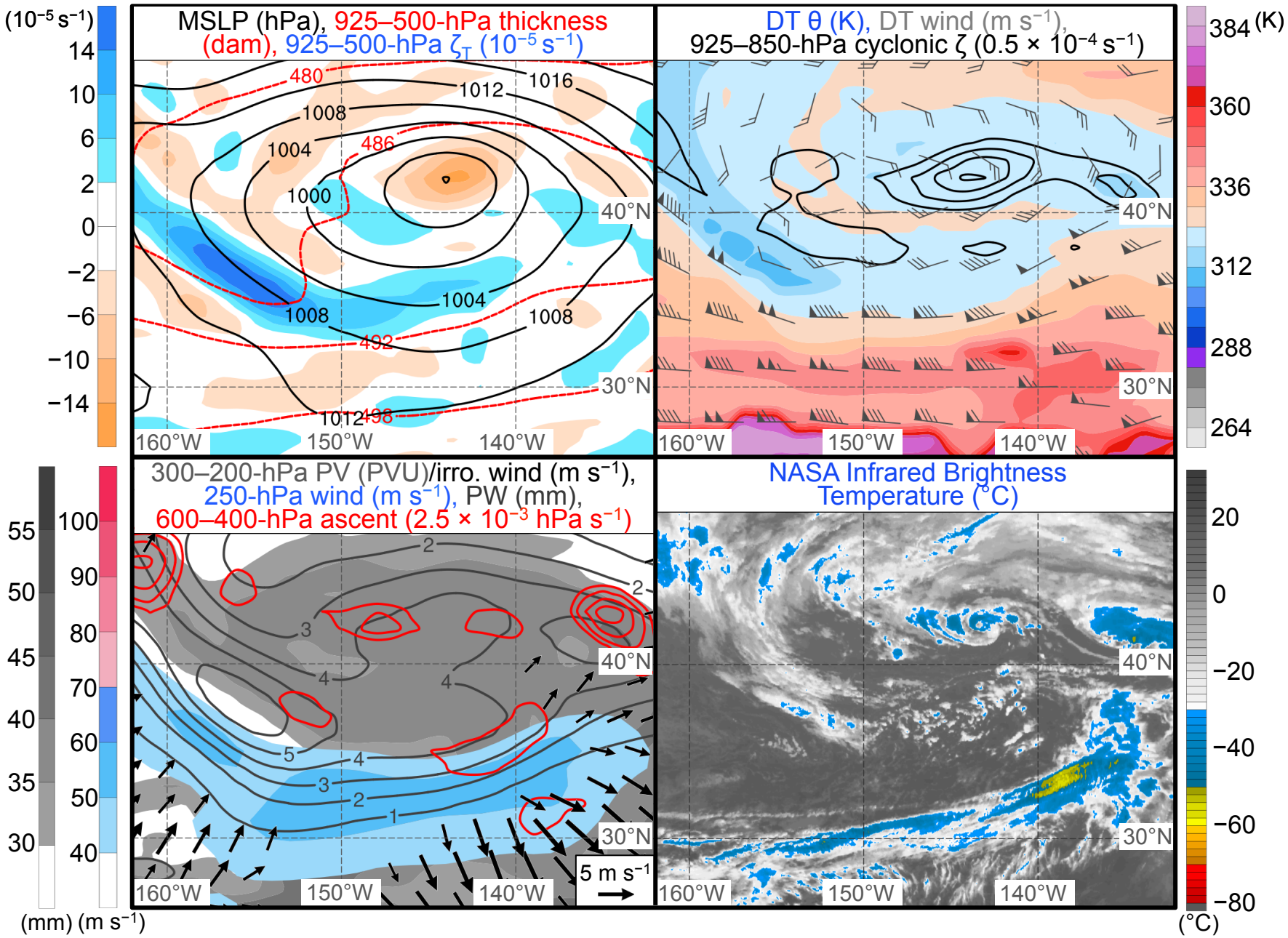
# Tropical Transition

0000 UTC 31 Oct 2006



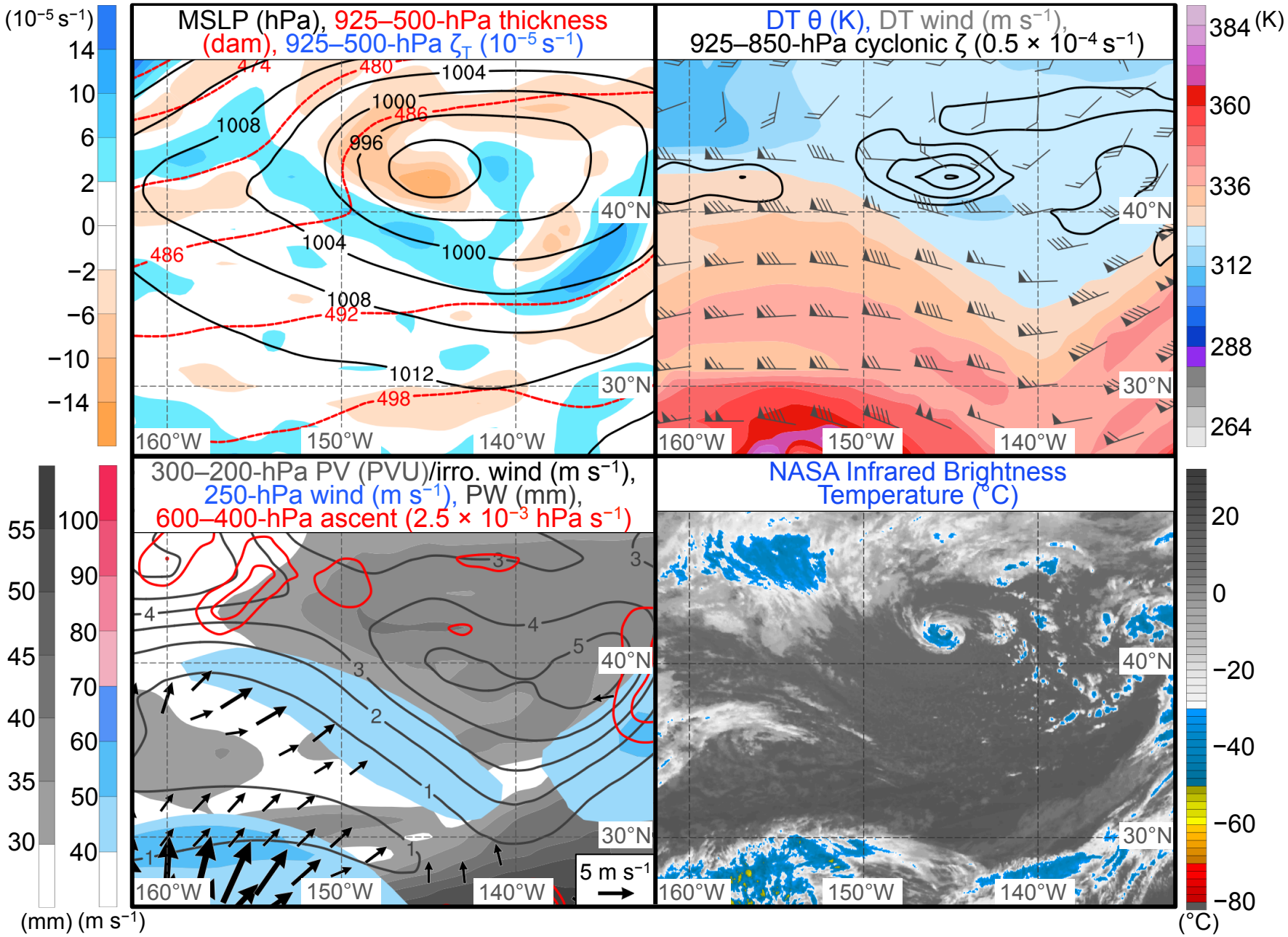
# Tropical Transition

0000 UTC 1 Nov 2006



# Tropical Transition

0000 UTC 2 Nov 2006



# Tropical Transition

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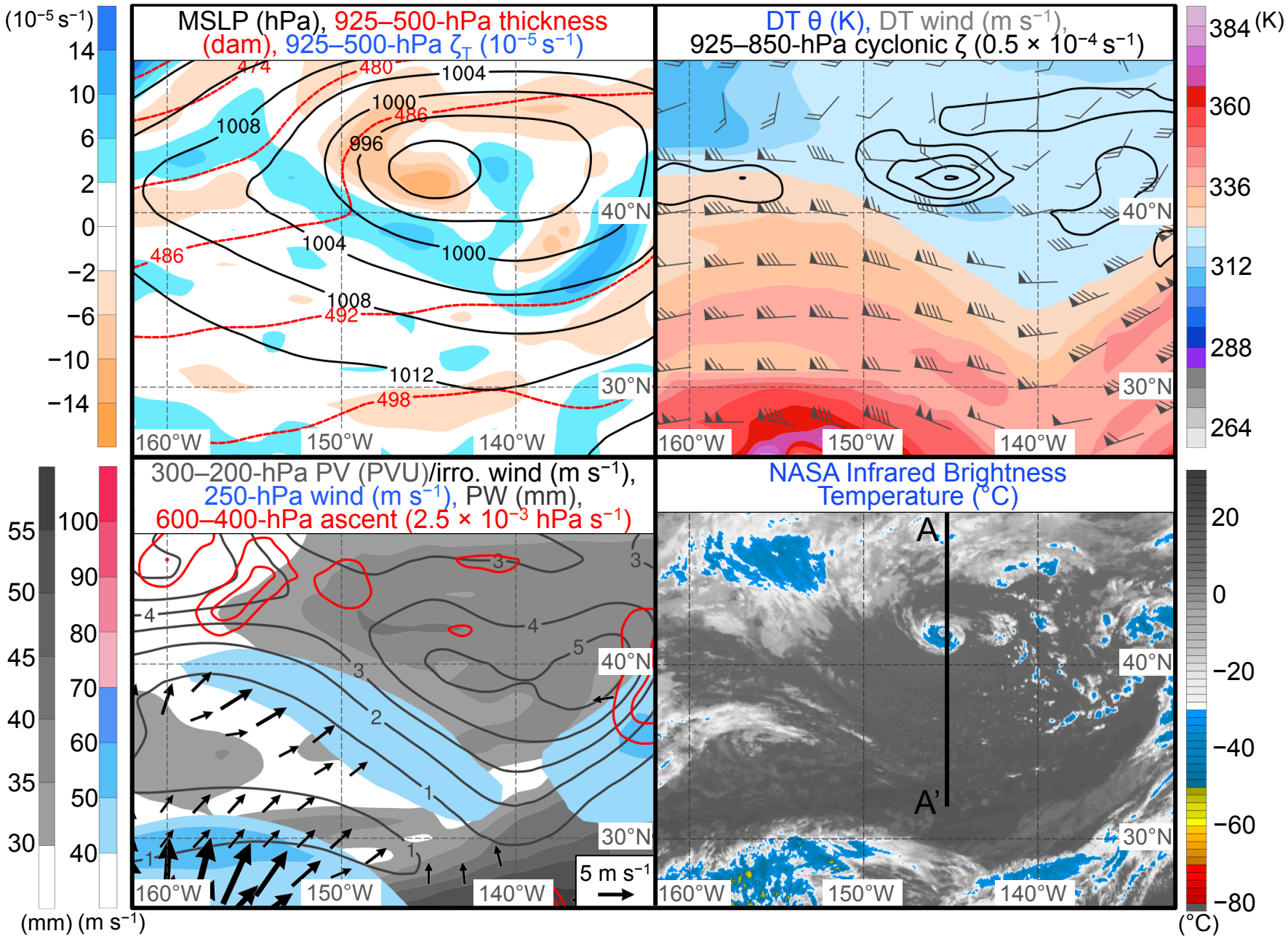

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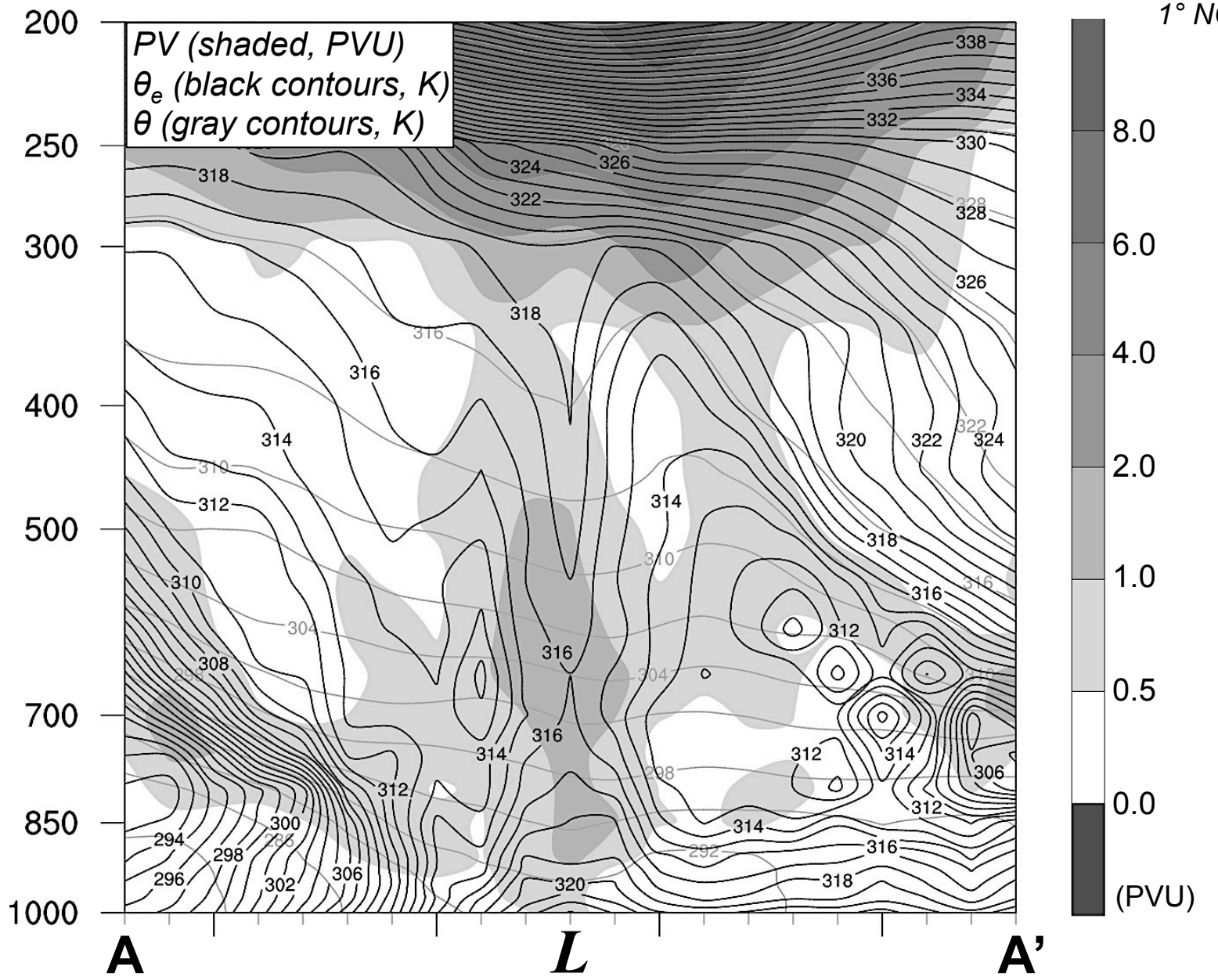
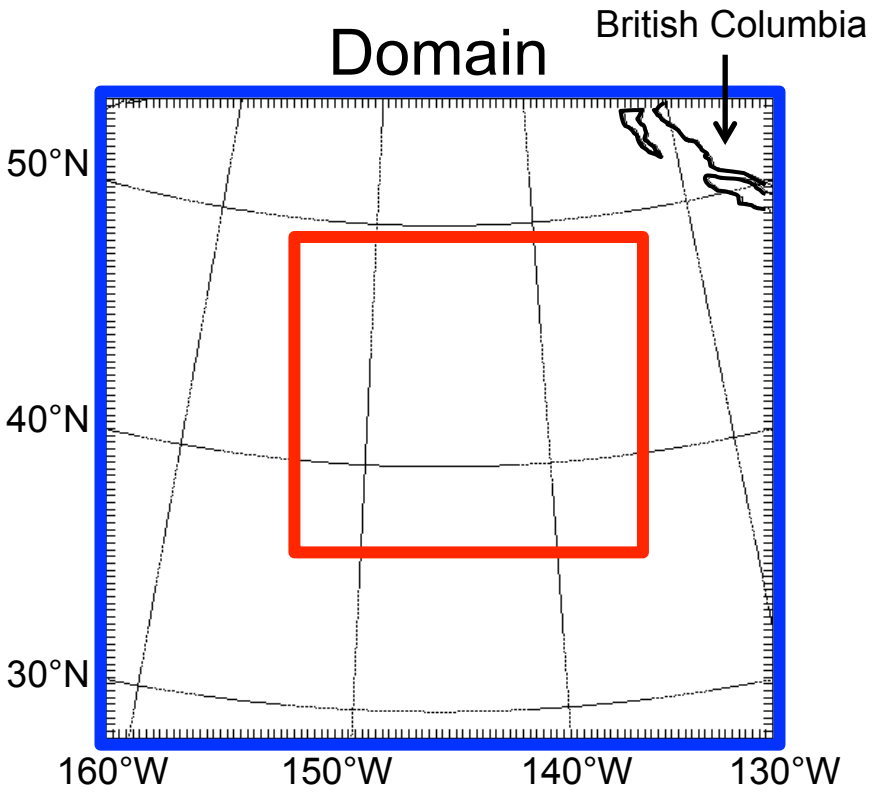


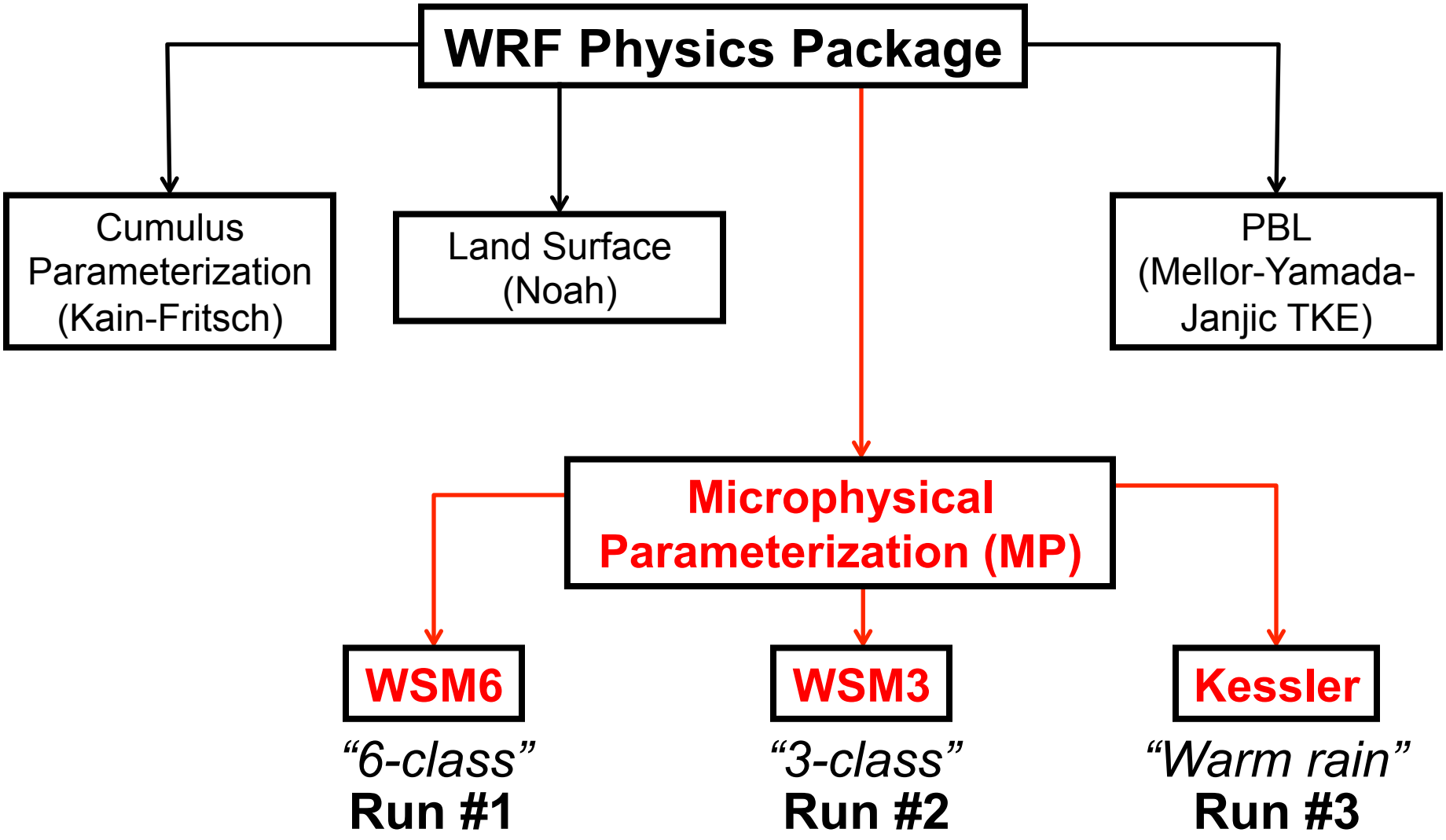
# Model Configuration

- **Weather Research and Forecasting** (WRF) V3.4
- Data: 1° NCEP FNL analysis
- Two-way nested grid
- Resolution { Outer = 30 km; Inner = 10 km }
- 35 vertical levels




- Start time: 0000 UTC 28 October 2006
  End time: 0000 UTC 2 November 2006

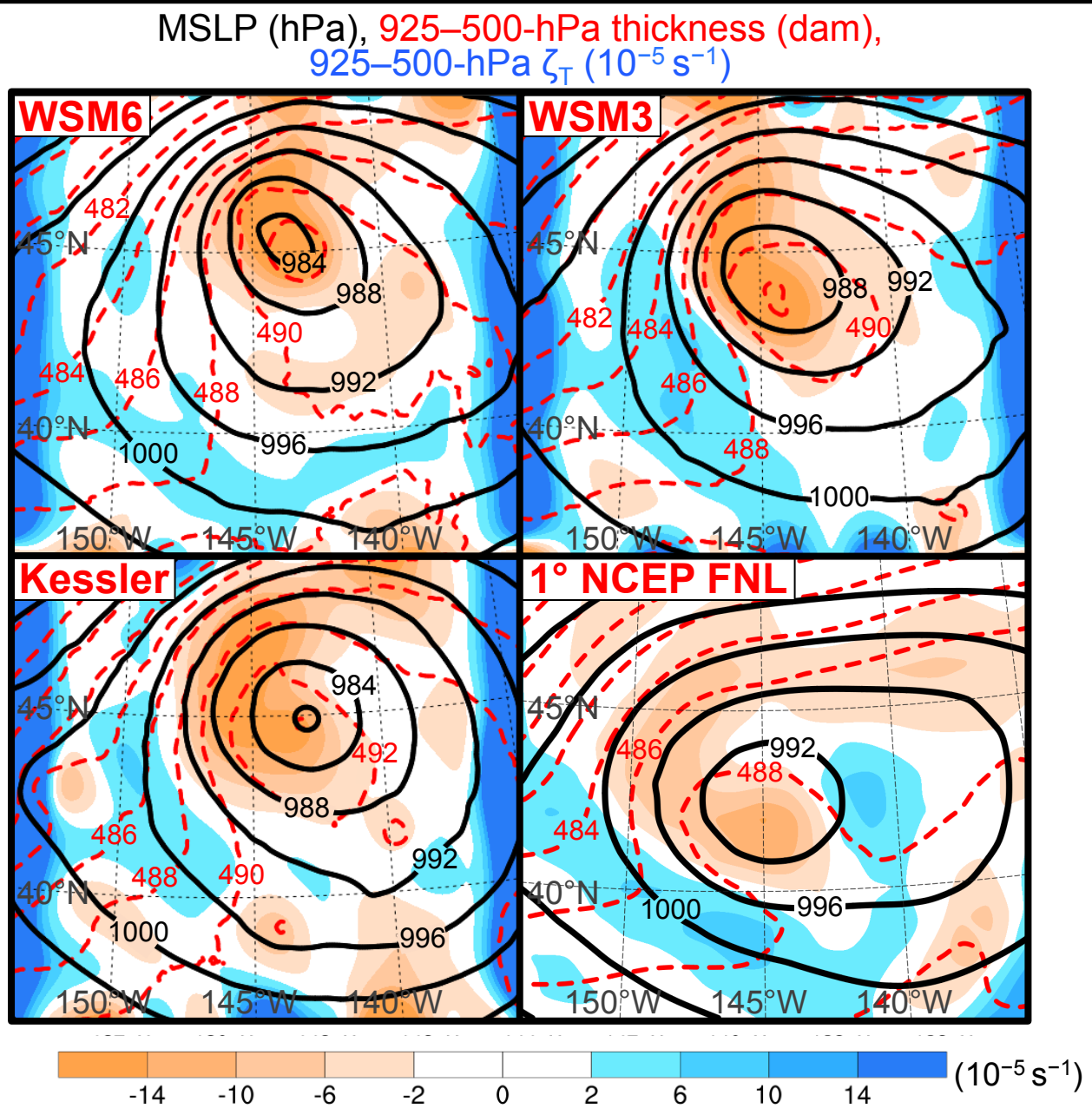
# Model Configuration



# Model Results

0000 UTC 2 Nov 2006

- **All three MP schemes** produce a warm-core cyclone
- **All three** warm-core cyclones have a central pressure lower than observed (1° NCEP FNL)
- **Kessler** results in the deepest cyclone (980 hPa)
- **WSM3** results in the smallest position error

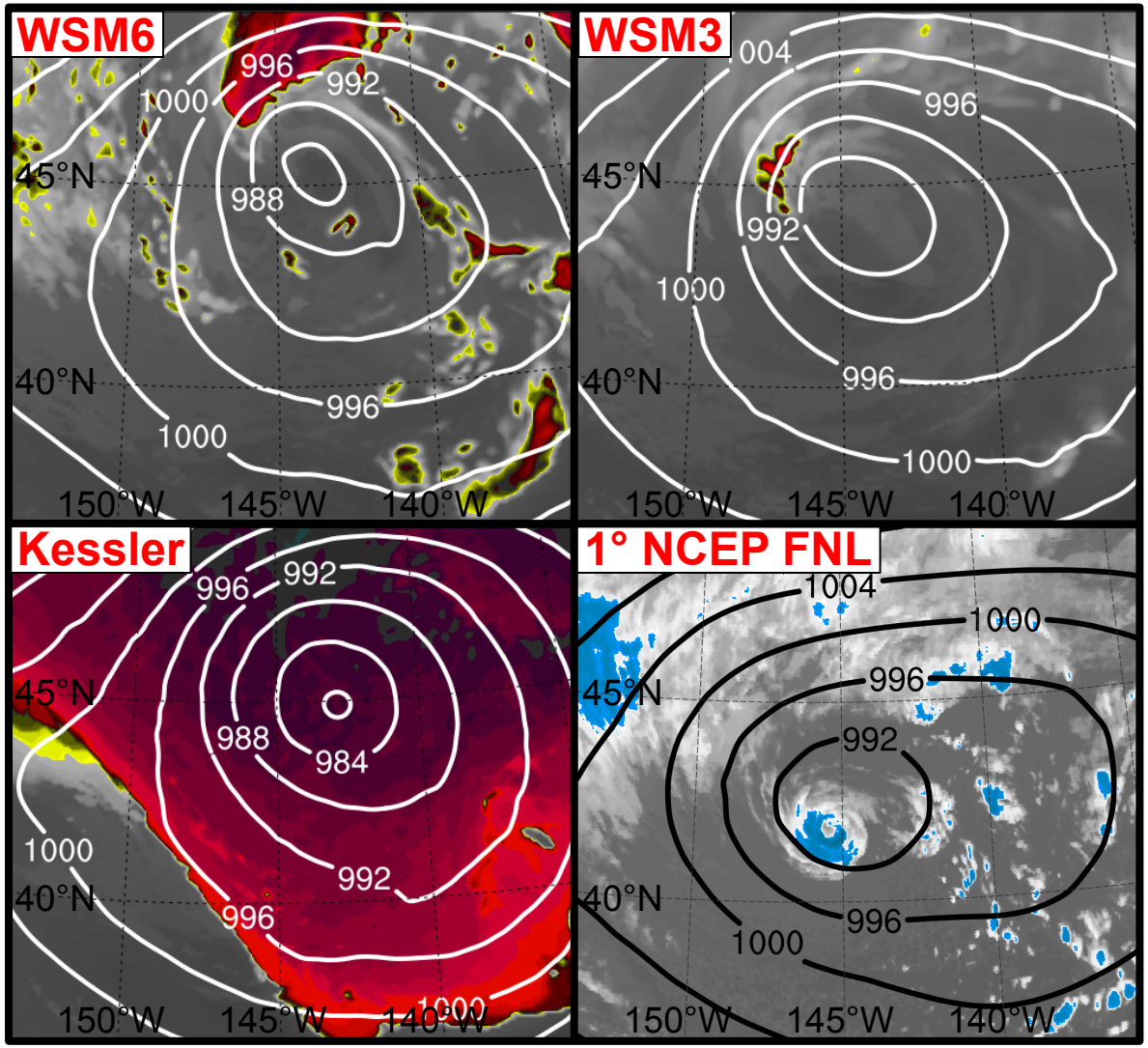


# Model Results

0000 UTC 2 Nov 2006

- **All three MP schemes** fail to capture deep convection near the cyclone center
- **WSM6** does the best job capturing high clouds to northwest and southeast of cyclone center
- **Kessler** lofts too much condensate into the upper troposphere, creating a giant anvil

MSLP (hPa), Outgoing Longwave Radiation (W $m^{-2}$), NASA Infrared Brightness Temperature (°C)



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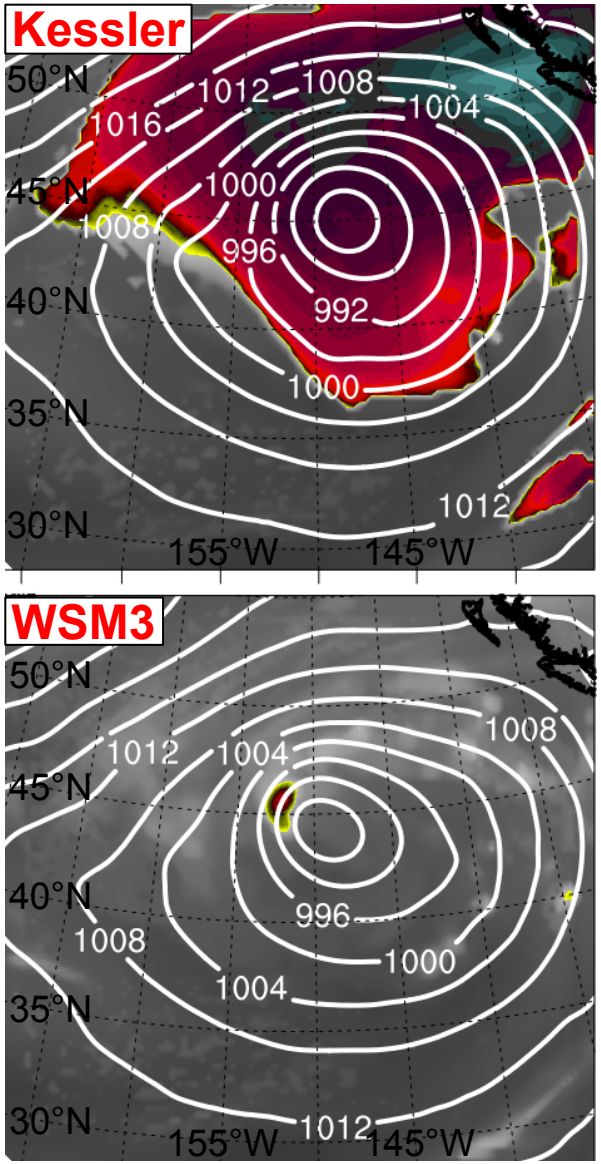
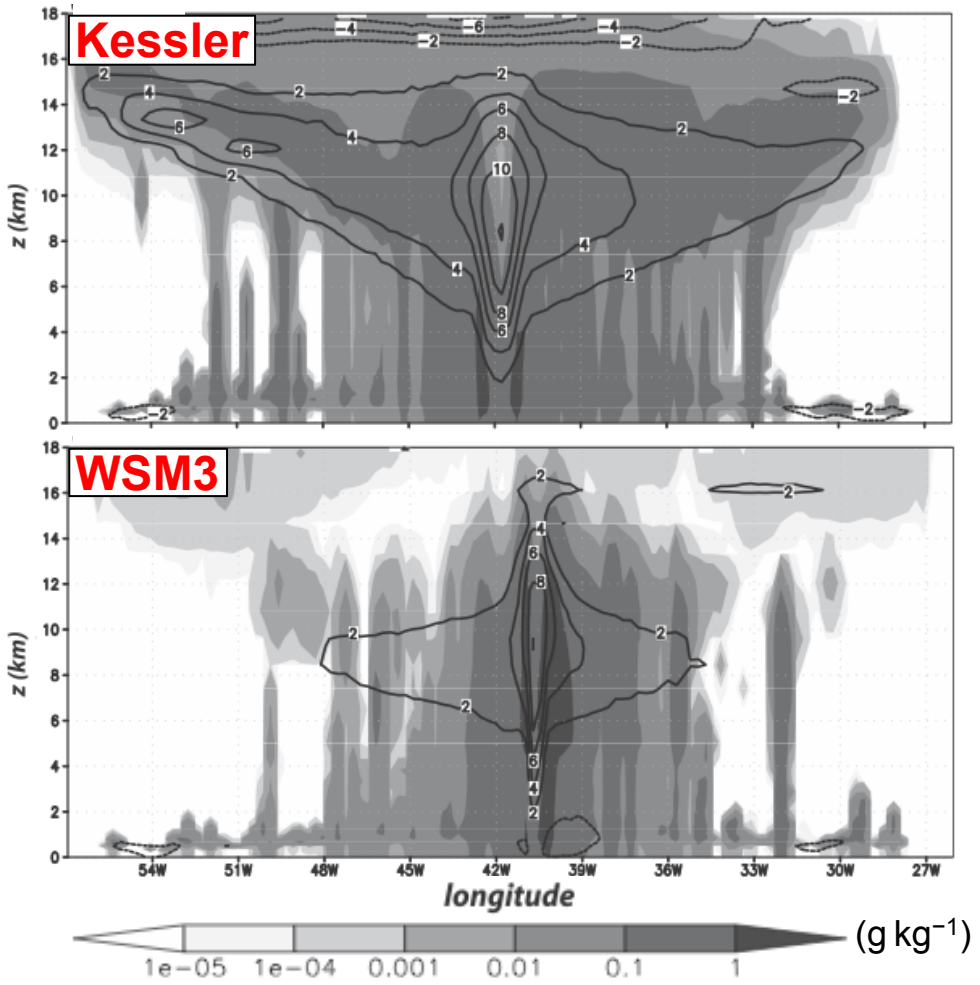
0000 UTC 2 Nov 2006




Vertical cross sections of condensate (g kg$^{-1}$; shaded) and virtual temperature perturbations from the initial state (K; contoured) [Fig. 7 adapted from Fovell et al. 2009]

# Conclusions (1/2)

- TT of an unnamed TC occurred at ~40°N in the eastern North Pacific between 28 October 2006 and 2 November 2006
- An EC, forming in association with a thinning upper-tropospheric trough, serves as the precursor disturbance to TT
- EC progresses through the life cycle of a marine extratropical frontal cyclone, developing a bent-back warm front
- Lower-tropospheric relative vorticity maximum separates from bent-back warm front, allowing cyclone to completely transition into axisymmetric, warm-core, TC

# Conclusions (2/2)

- TC structure was sensitive to the microphysical parameterization (MP) scheme used to model the TT process

- All three MP schemes produce a warm-core cyclone with a lower central pressure than observed in the 1° NCEP FNL

- **WSM6:** best representation of convection in OLR field

  **WSM3:** smallest position error, closest solution to 1° NCEP FNL

  **Kessler:** deepest cyclone, warmest core, horrible OLR field

- Kessler MP scheme lofts too much condensate into the upper troposphere, creating an anvil that encompasses the east Pacific

# Questions?

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- All three MP schemes produce a warm-core cyclone with a lower central pressure than observed in the 1° NCEP FNL

- **WSM6:** best representation of convection in OLR field

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