

# The Extreme Cold Anomaly over Southeast Asia in February 2008: Roles of ISO and ENSO

C.-C. Hong<sup>1</sup>, Tim Li<sup>2</sup>

<sup>1</sup>University of Taipei, <sup>2</sup>University of Hawaii

Hong, C.-C. and T. Li, 2009: The Extreme Cold Anomaly over Southeast Asia in February 2008: Roles of ISO and ENSO, *J. Climate*, 22, 3786-3801.

# 2008年1月华南持续性冻雨事件



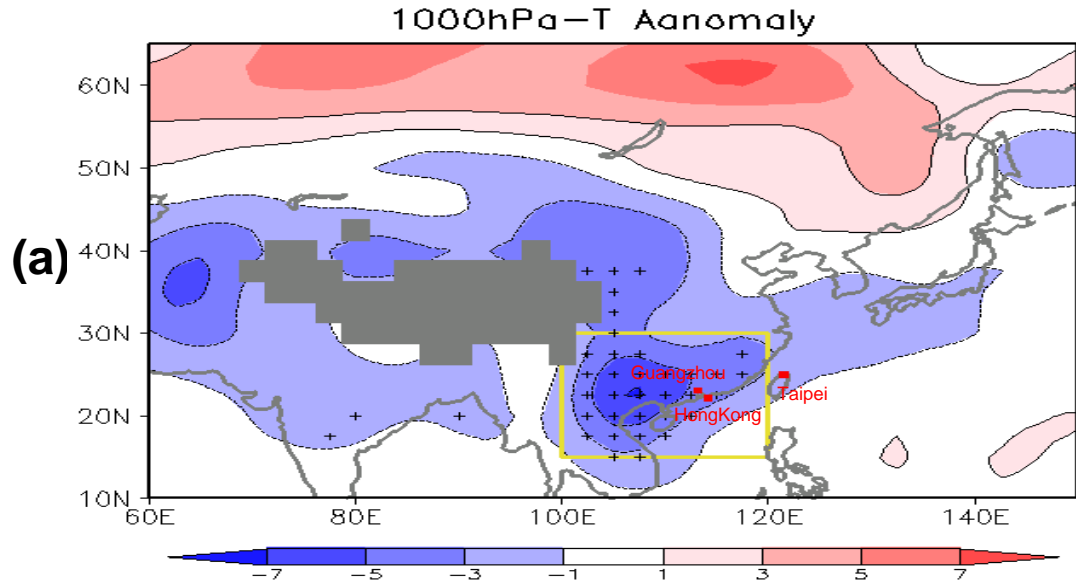
**影响区域：10省**

**经济损失：500亿元**

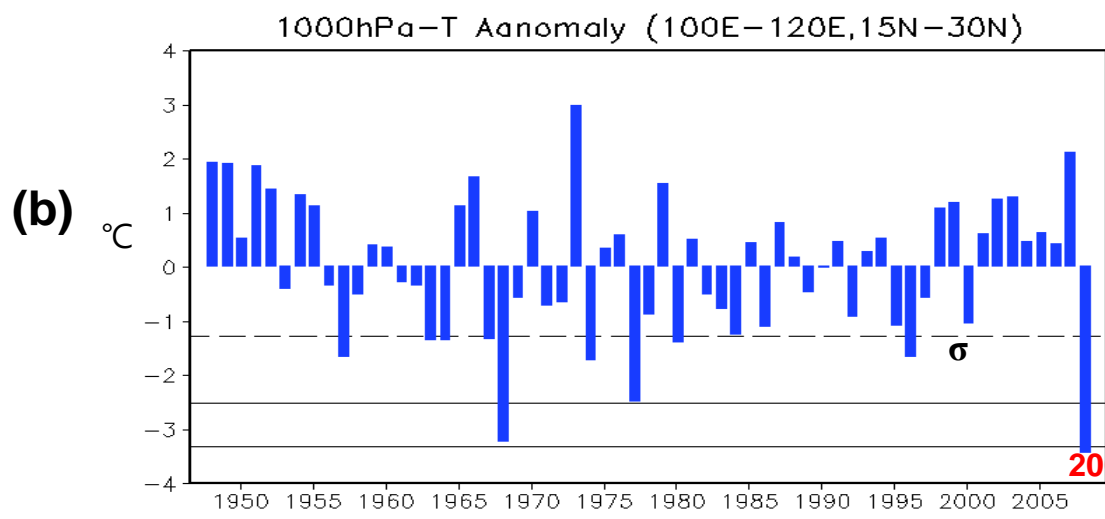
**2008年1月10-31日有2859 列  
火车延误，近600万 旅客滞留  
在火车站或困在火车里。**



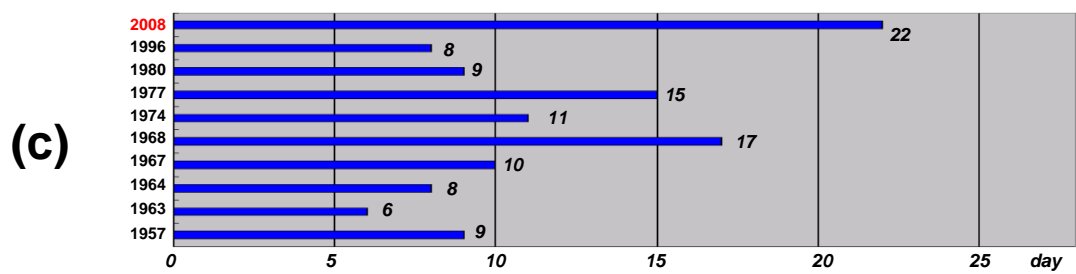
**有4次强降雪过程, 虽能准确  
预报单个过程, 但不能预测  
一个月内连续发生的4次过程.**



**Top:** Distributions of 1000hPa temperature anomaly over the Eurasia in **February 2008**. The areas marked by “+” indicate the temperature anomaly greater than a 95% confidence level.

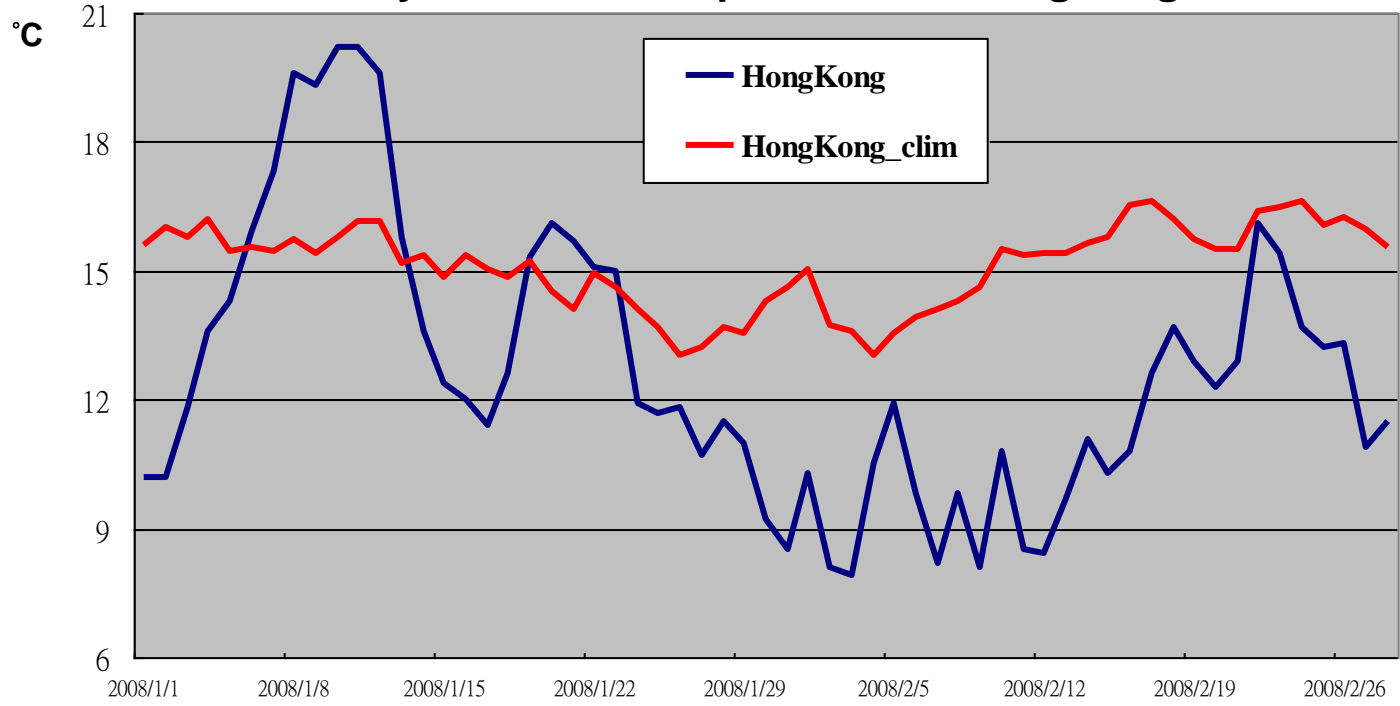


**Middle:** Interannual variation of the averaged (box in panel a) 1000hPa temperature anomaly in February from 1949-2008. The horizontal lines denote the threshold of the 95% and 99% confidence level respectively.



**Bottom:** Accumulated days of the daily 1000hPa temperature lower than  $-1\sigma$  from the February climatology. Only the years of the February mean temperature lower than  $-1\sigma$  are listed. The **2008** confidence level is determined based on a t-test and the extreme cold events listed in panel (c) are chosen as samples and the 95% confidence level is 2.3.

### Daily Minimum Temperature of HongKong



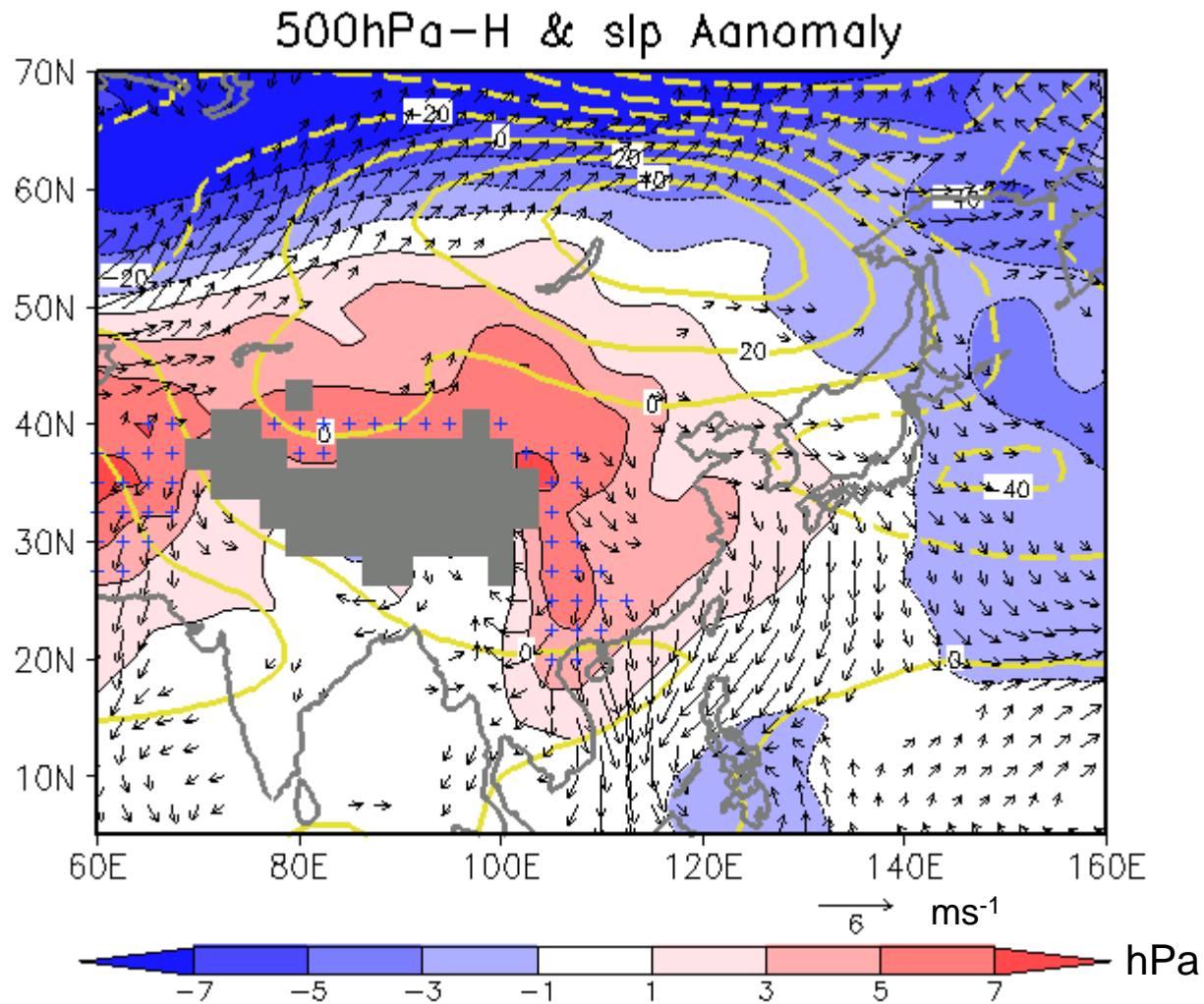


Figure 3. Same as in Fig. 1, but for the 500hPa height (contour), 1000hPa wind (vector), and the sea level pressure (SLP, shading) anomalies. The areas marked by “+” indicate the sea level pressure anomaly greater than a 95% confidence level. Only the anomalous wind speed great than  $1 \text{ m s}^{-1}$  is plotted. The contour interval is 20 m.

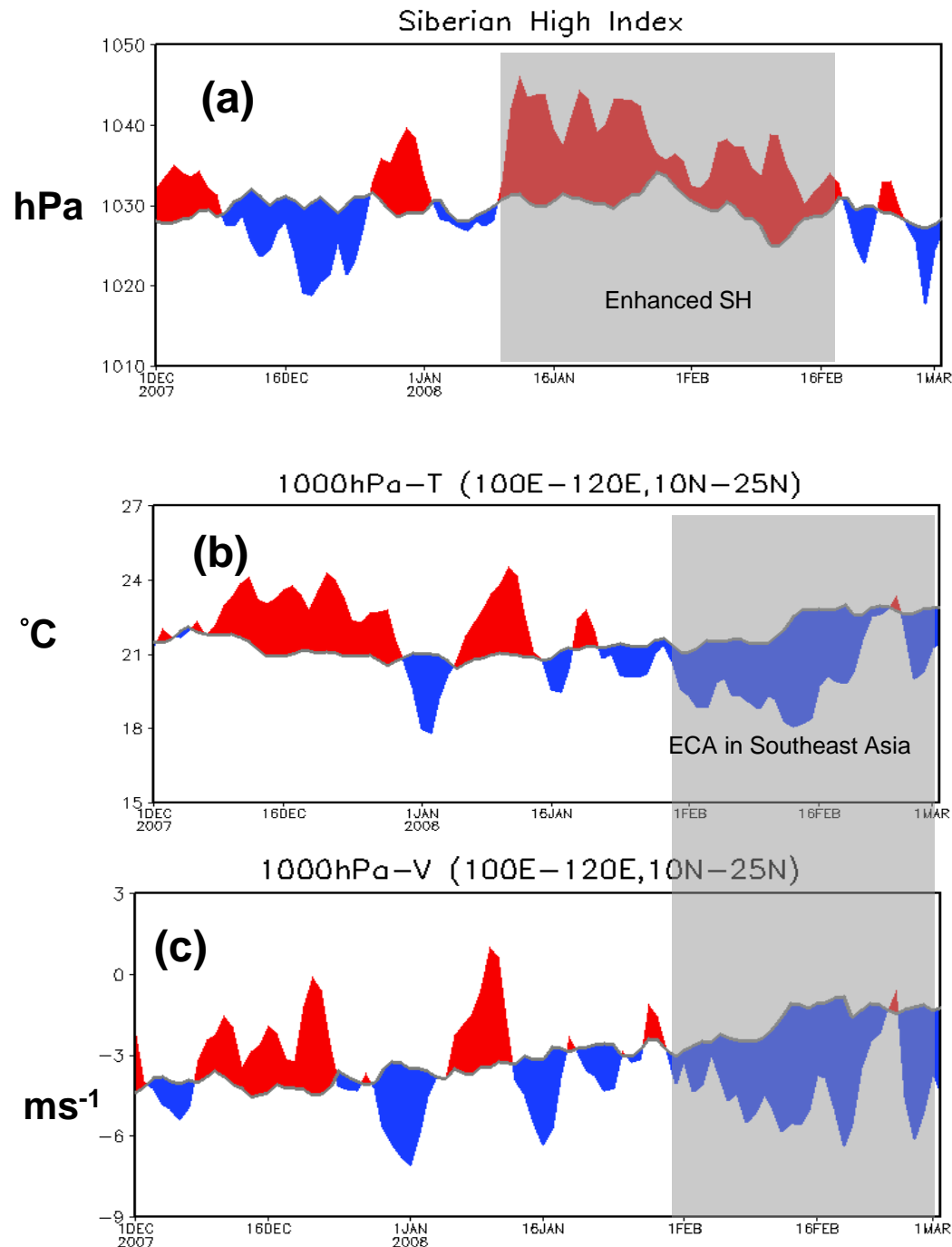
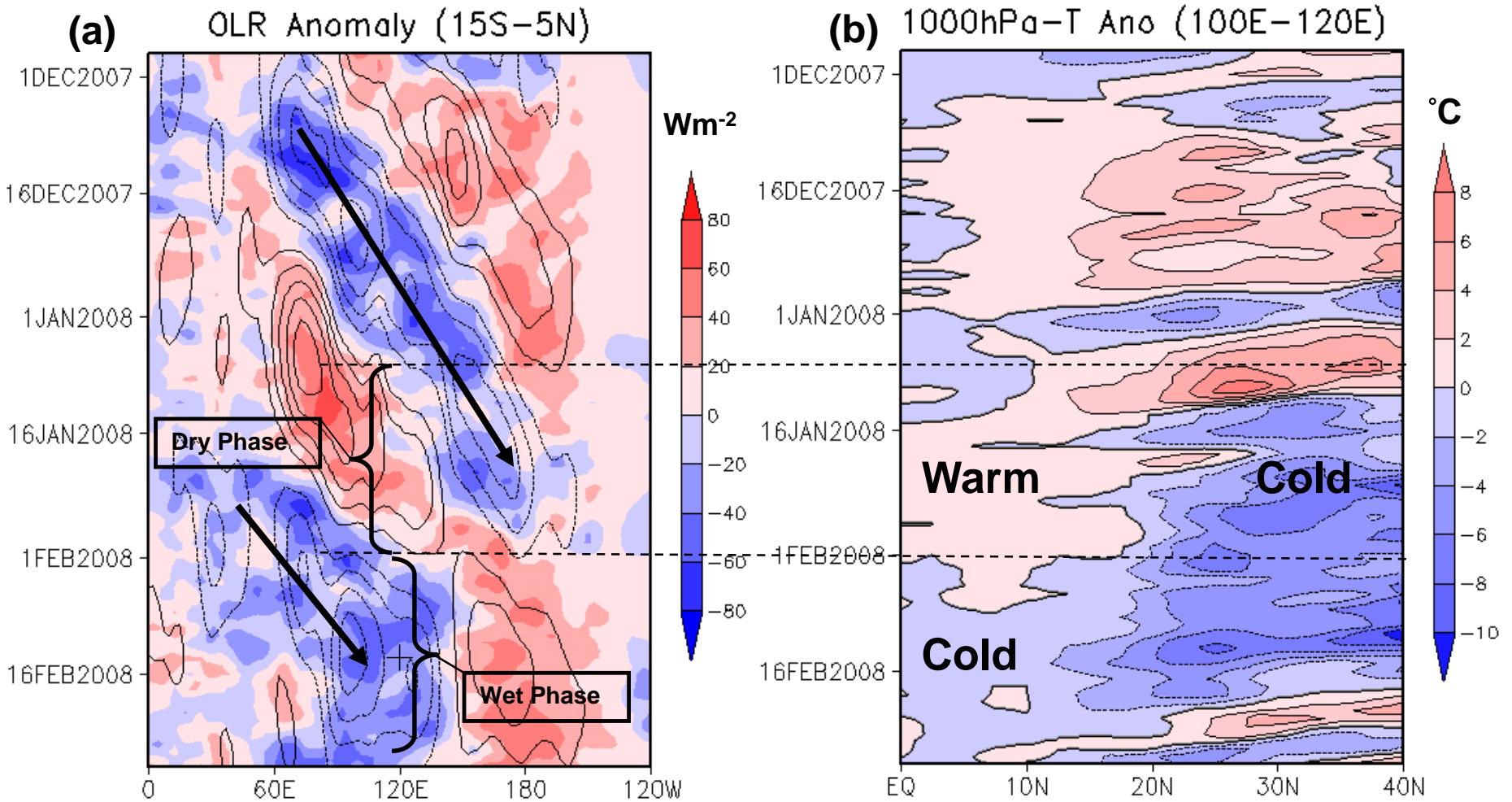
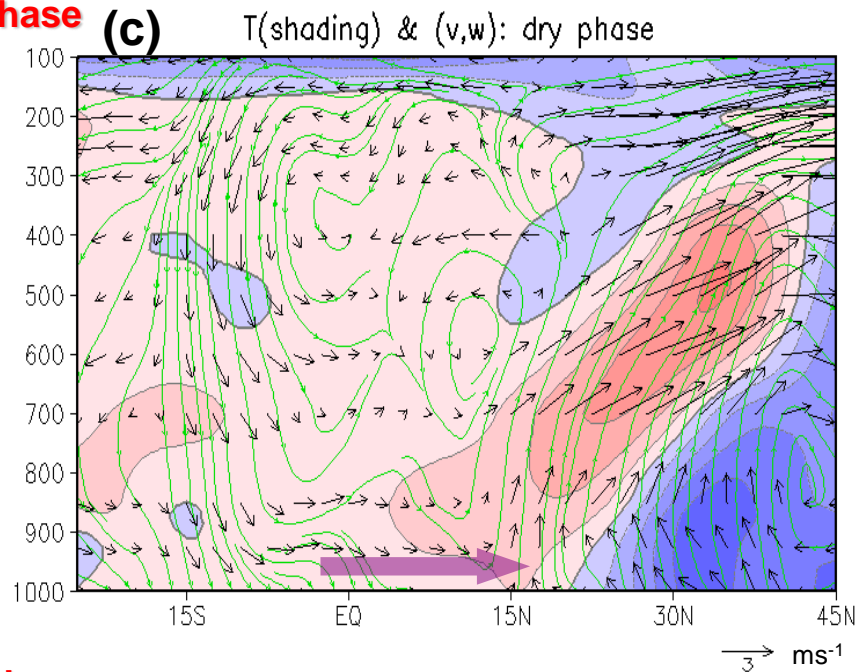
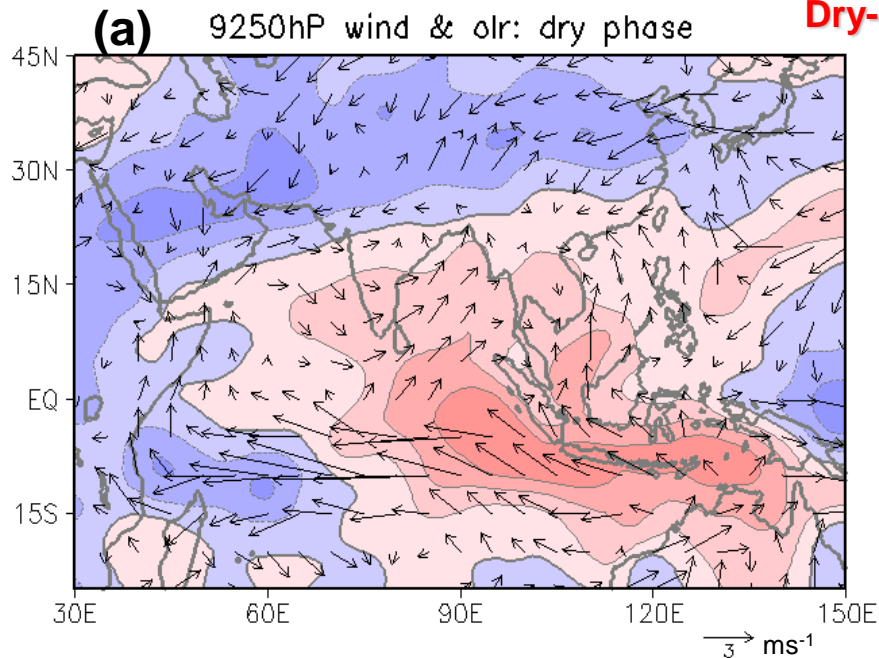


Figure 4. The time series of the SH index (a), the averaged 1000hPa temperature (b), and the averaged 1000hPa meridional wind (c). The dark (light) shading indicates above (below) the climatology. The SH index is defined as the averaged SLP over 80°-120°E, 40°-60°N, the temperature and northerly are averaged over 100°-120°E, 10°-25°N. The gray shading in (a) denotes the periods of the enhanced SH, and represents the ECA in (b) and (c). Here, for simplicity the same domain is used for the temperature and wind anomalies. From Fig. 1a and Fig. 3, it is noted that the maximum northerly anomaly is located slightly south of the maximum temperature anomaly.

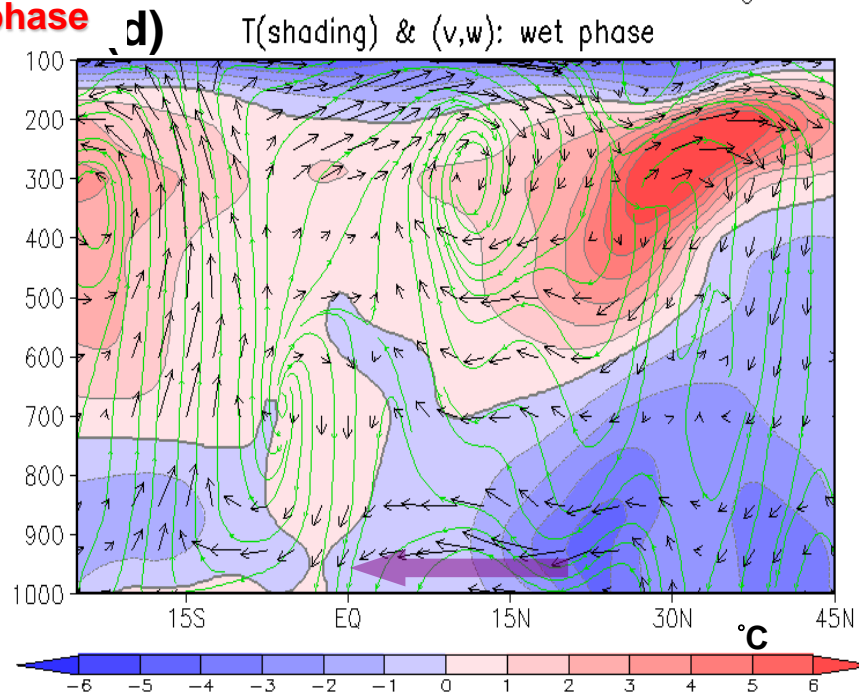
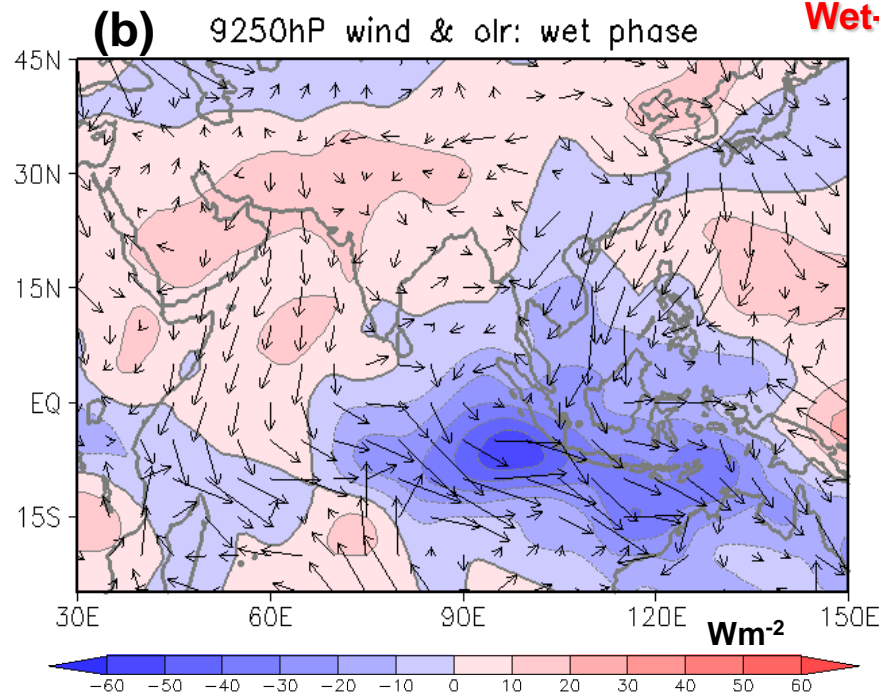


**Figure 5** (a) The Hovmöller diagram for the daily OLR anomaly averaged over  $15^{\circ}$ - $5^{\circ}$ S. The shading denotes the raw data and the contour represents the 20-70 days filtered anomalous OLR. The contour interval is  $20 W m^{-2}$ . Panel b is same as in panel a except for the unfiltered 1000hPa temperature anomaly averaged over  $110^{\circ}$ - $120^{\circ}$ E. The boxes in (a) and (b) indicate the periods of the occurrence of the extreme cold anomaly. The brackets in (a) denotes the periods of the negative OLR anomaly (wet phase) and positive OLR anomaly (dry phase) of Sumatra. The cold anomaly in dry phase is corresponding to the sever snow storm over central China happened in middle January to late January.

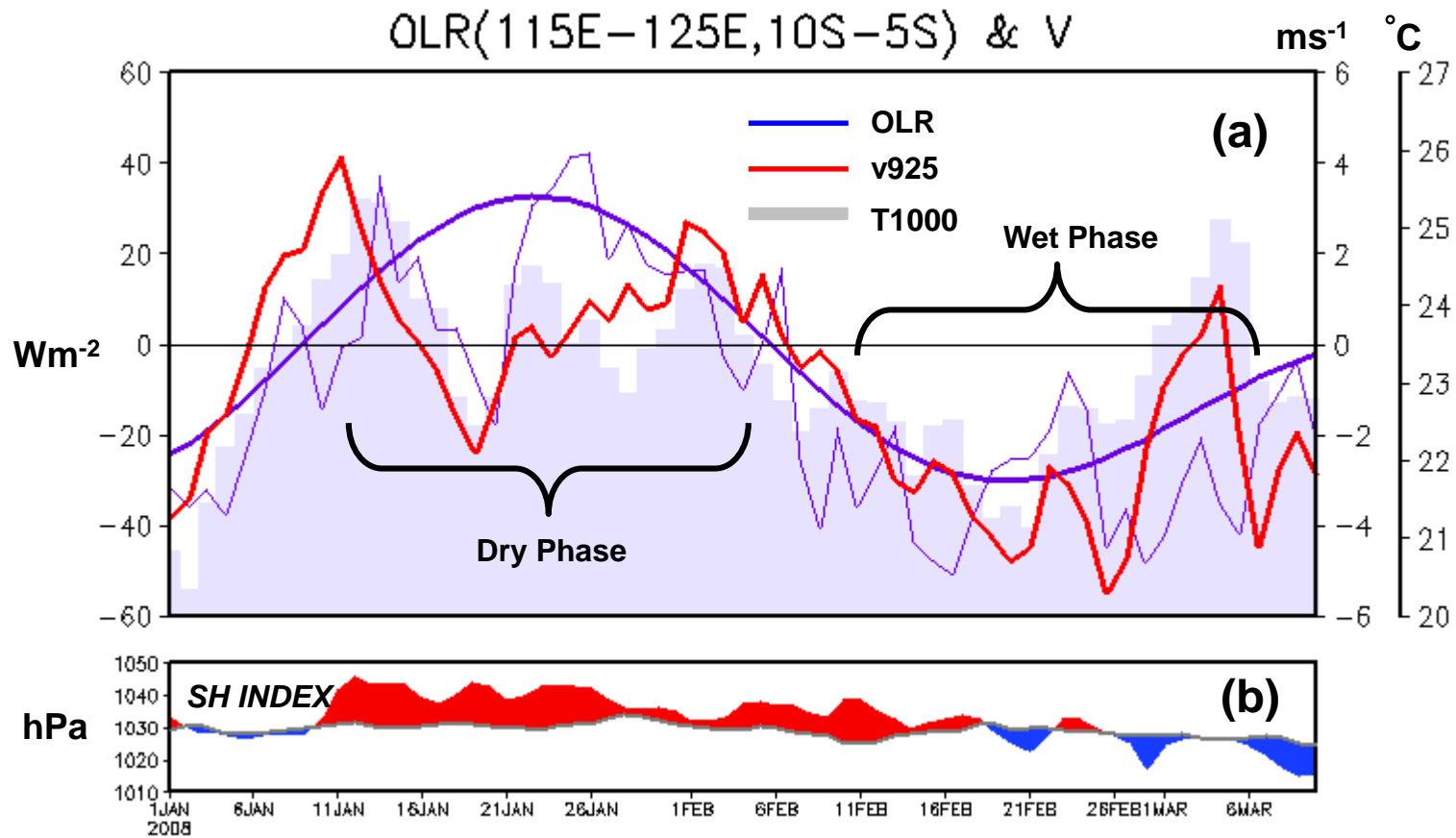
**Dry-phase**



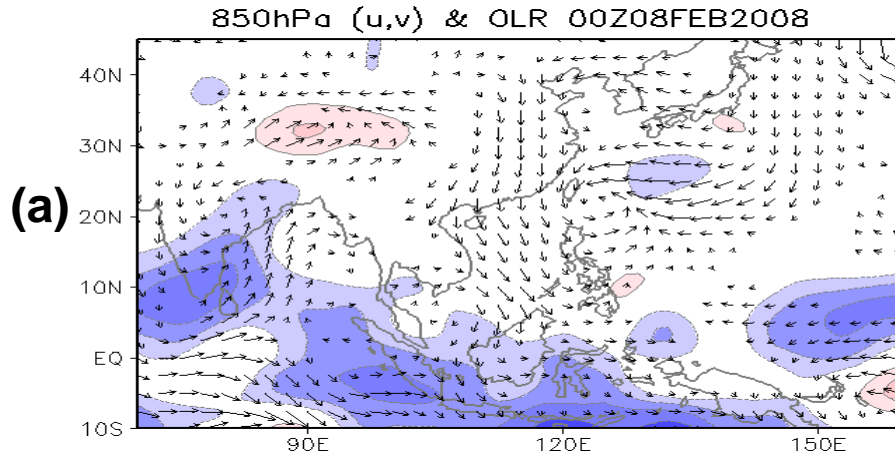
**Wet-phase**





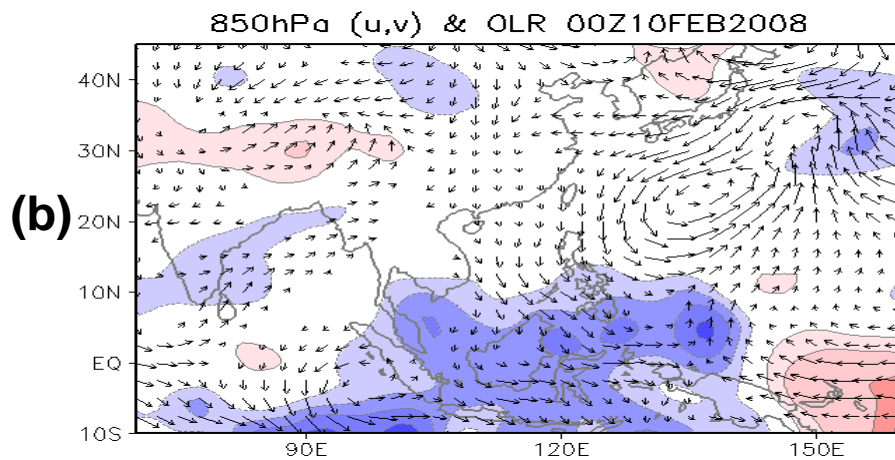


**Figure 7** (a) Time evolution of the area-averaged OLR anomaly over Sumatra (dashed line) and 925hPa meridional wind anomaly (gray line) and 1000hPa temperature anomaly (gray shading) over Southeast Asia (100°-120°E, 10°-25°N). The black line denotes the 20-70 days filtered OLR. The bottom panel (b) presents the time series of the SH index defined in Fig. 4.

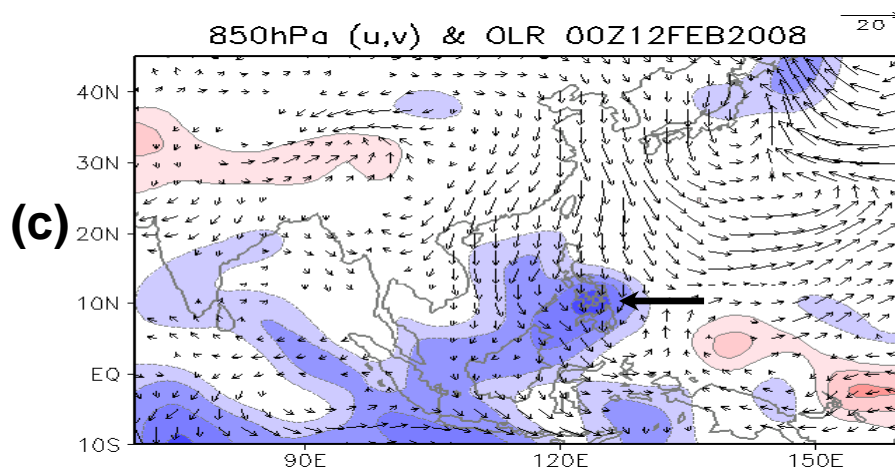


Day -4

**Figure 8** The spatial evolution of the OLR anomaly (shading) and 850hPa wind anomalies at Day -4, Day -2, and Day 0 corresponding to the formation of sub-convection (the arrow in panel c).

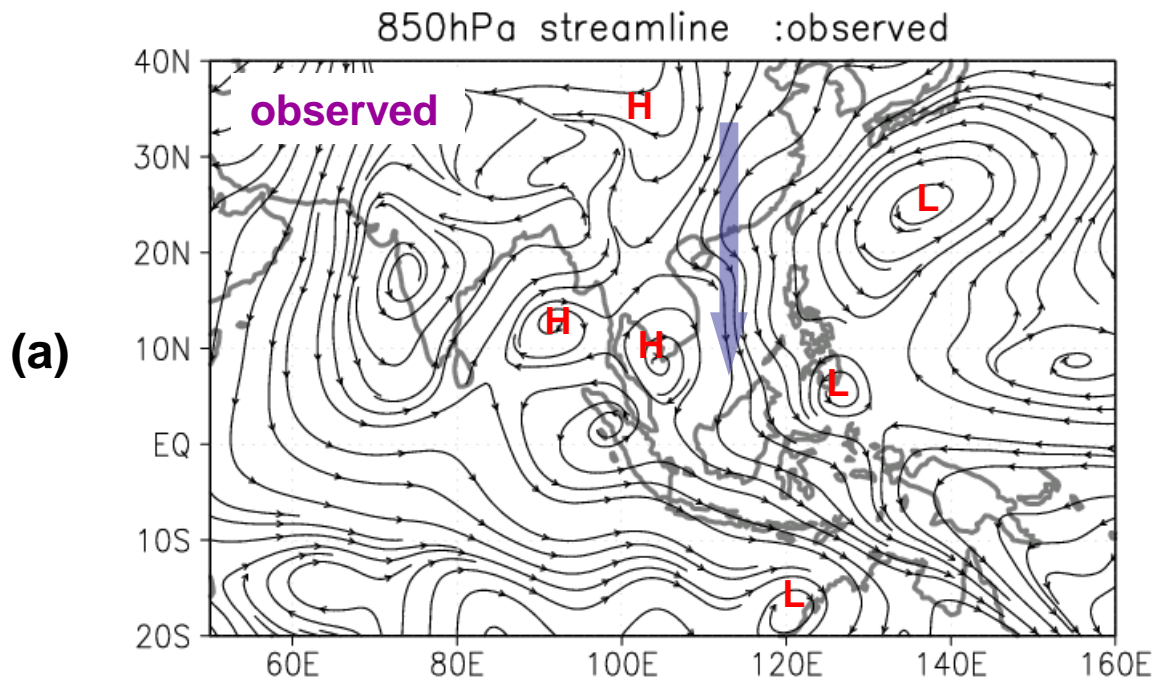


Day -2

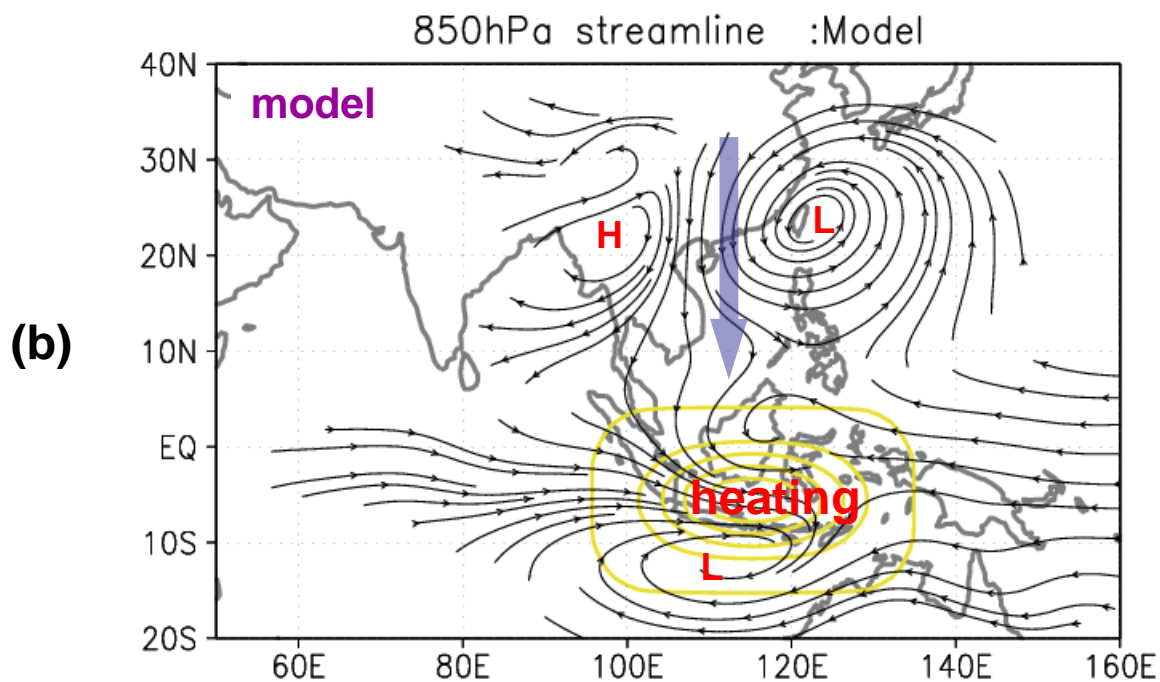


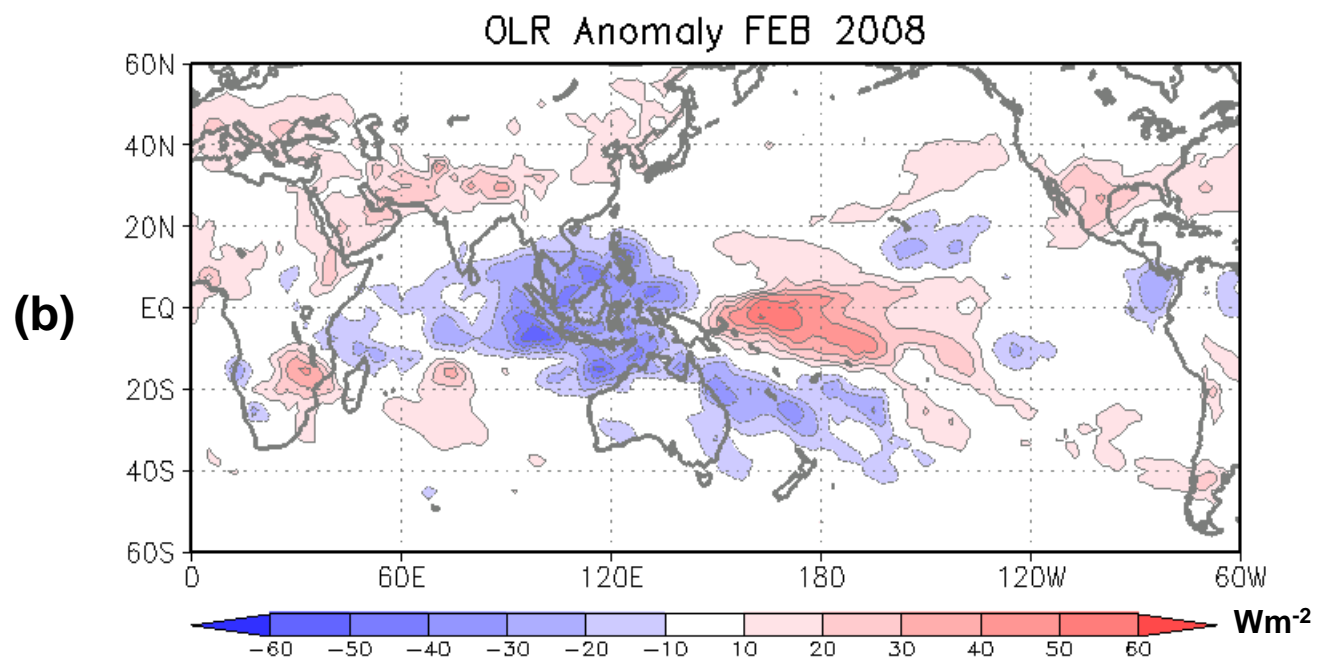
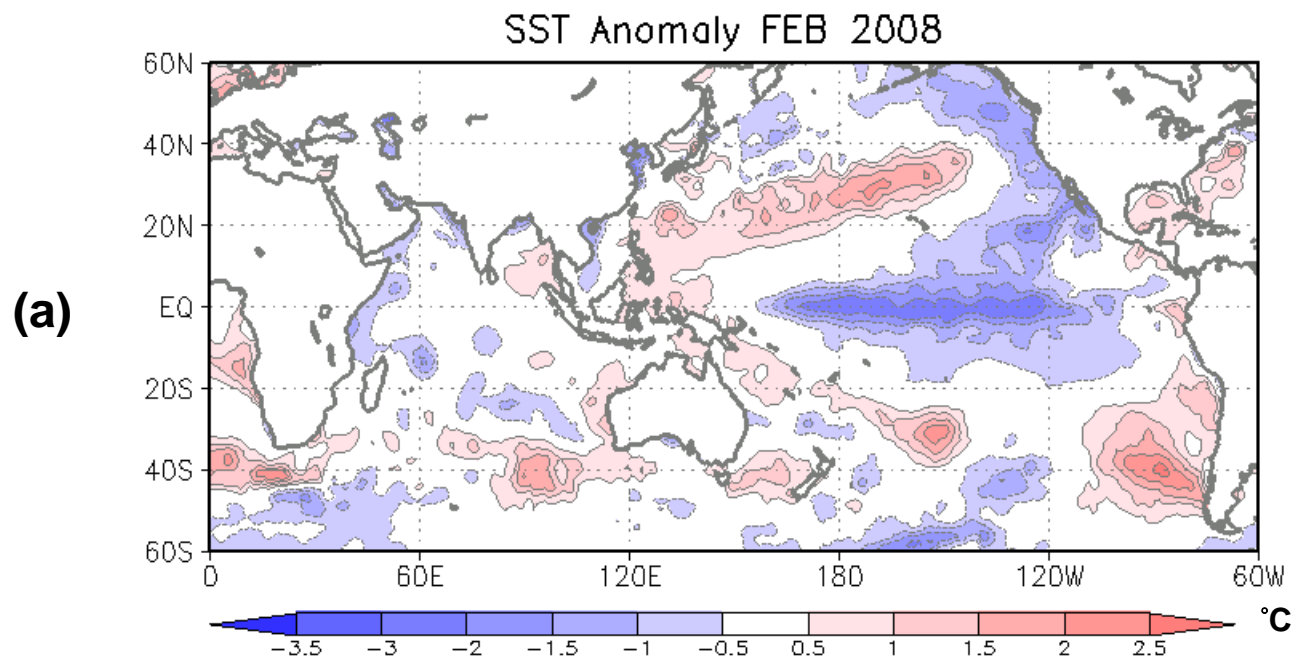
Day 0

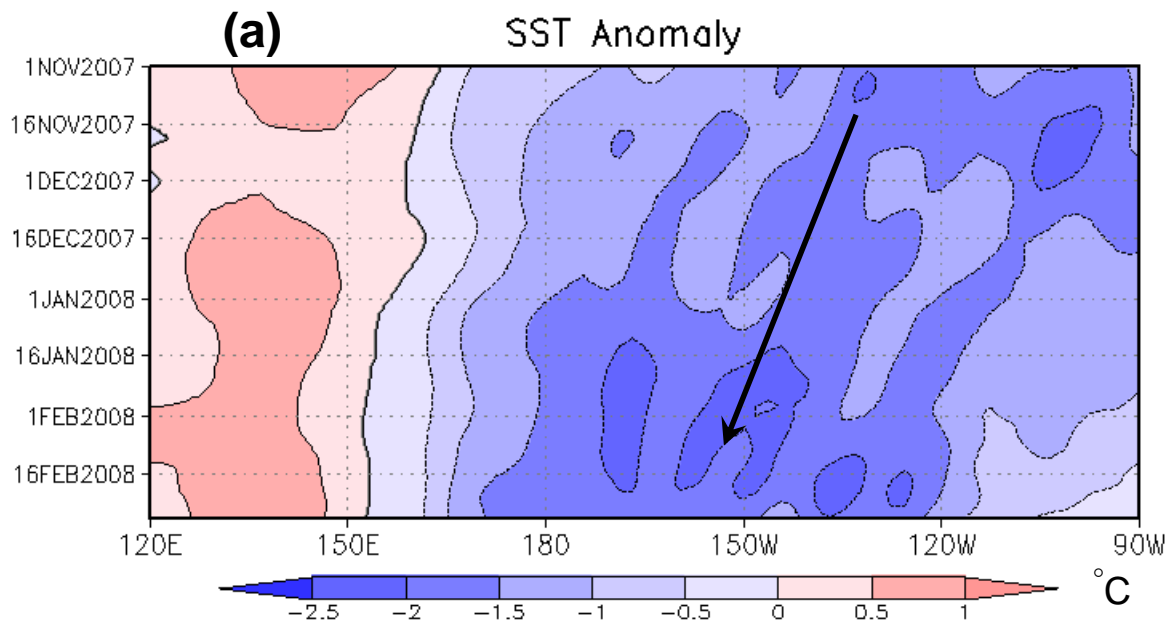
$Wm^{-2}$



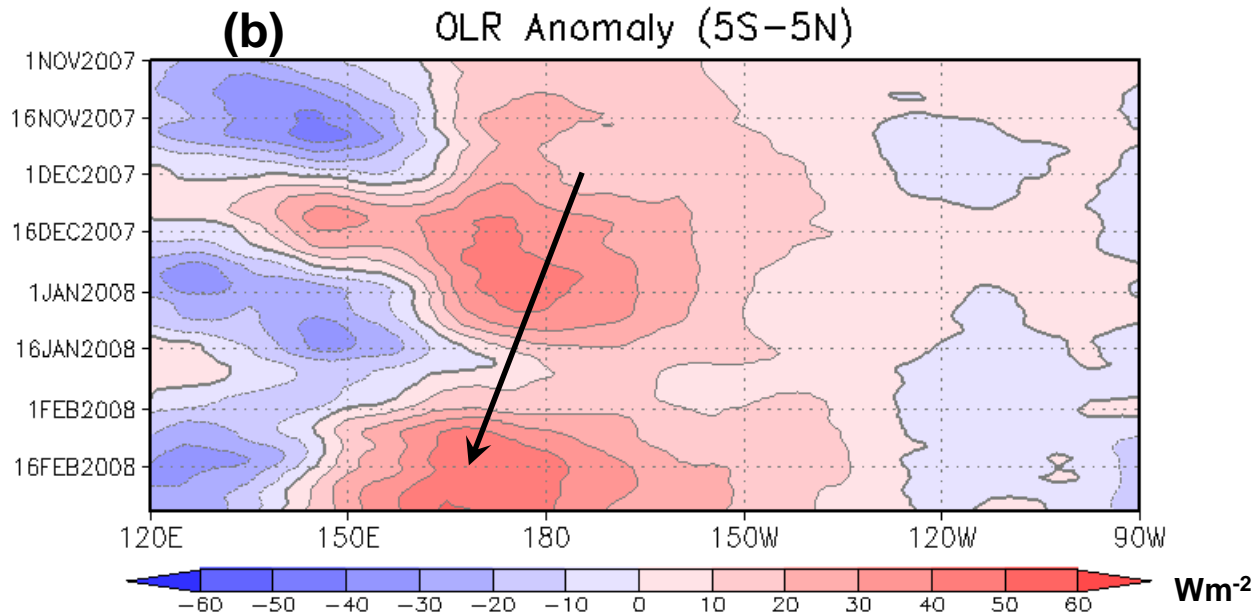
**Figure 10** (a) Distributions of the observed 850hPa streamline anomaly during the ISO wet phase (February 1-15). (b) Same as in (a) but for the steady response of the model to the elliptical heating (centered at 115°E, 5°S) marked by the gray contour. The thick gray arrows denote the northerly anomalies. The high/low pressure anomaly is marked by “H” / “L”.

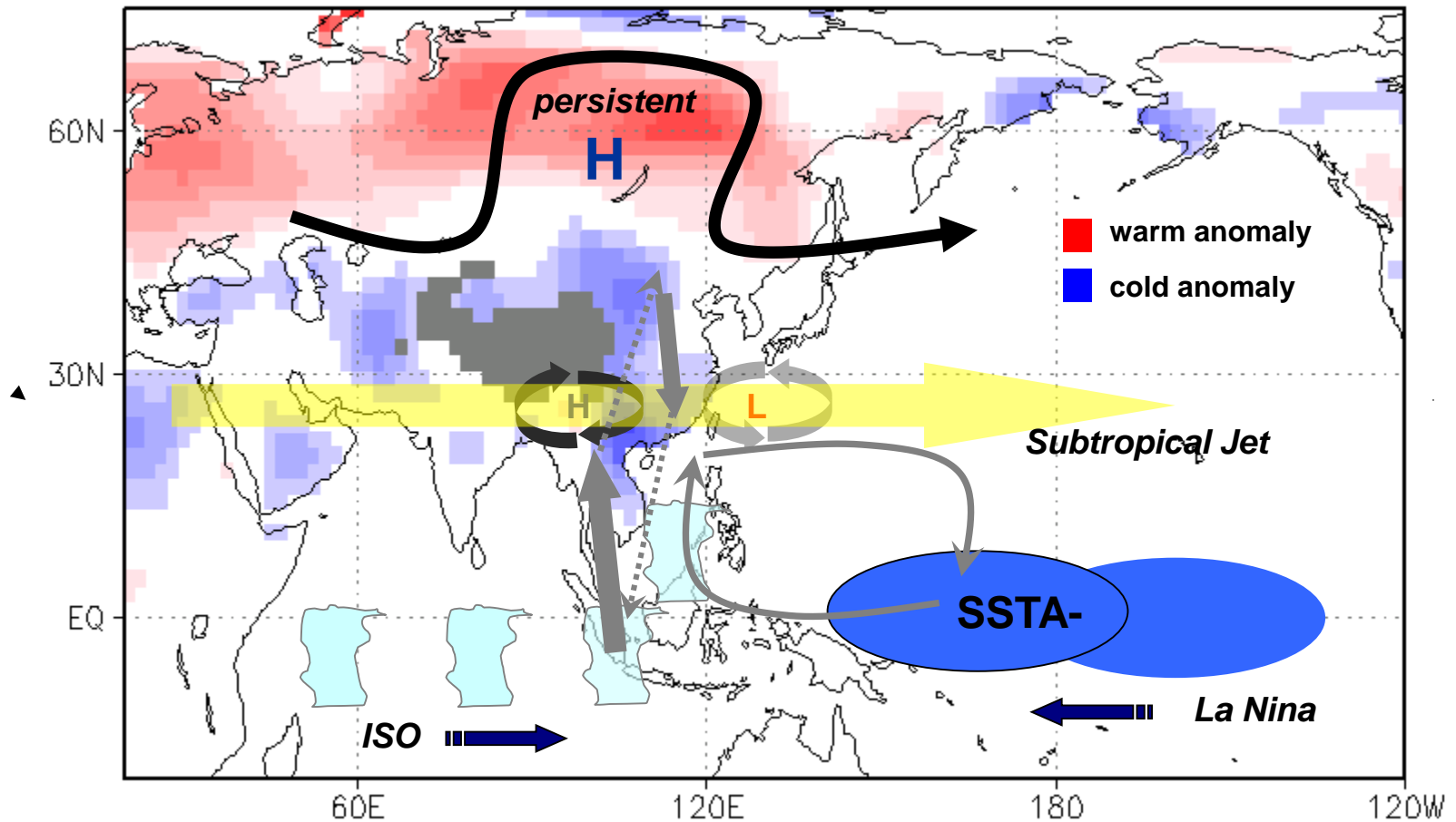






**Figure 11** Same as in Fig. 5, but for the 15-days running mean of SSTA (a), and the OLR anomaly (b). The SSTA and OLR are averaged over 5°S-5°N. The black arrows represent the westward propagation of SSTA and OLR anomaly.





**Figure 13** The schematic diagram to illustrate the physical processes to lead to ECA. The gray arrows represent the vertical overturning circulation.