

Outlook for the 2003/04 East Asia Winter Monsoon

JOHNNY C L CHAN AND MAN-CHI WU

Laboratory for Atmospheric Research

Dept. of Physics & Mat. Sci., City University of Hong Kong, Hong Kong, China

Email: Johnny.chan@cityu.edu.hk

1. Introduction

A recent research (Wu 2003, hereafter W) suggests that some links can be found among the East Asia summer monsoon (EASM), the East Asia winter monsoon (EAWM) and ENSO (El Niño/Southern Oscillation). Therefore, under certain situations, it is possible to estimate the EAWM conditions based on what happened in the previous EASM and the ENSO conditions.

In this paper, an attempt is made to give an outlook of the winter conditions over China in 2003/04 based on the 2003 EASM and ENSO conditions. In particular, it will be argued that although the sea-surface temperature anomalies (SSTA) in the equatorial Pacific suggest neutral ENSO conditions, the atmospheric flow behaves very close to that associated with a La Niña (LN) event. If this argument is valid, the EAWM conditions should follow that of a winter following an LN onset.

2. Classification of EAWM

The definition in Lu and Chan (1999) is used to classify the strength of the EAWM. They defined a Unified Monsoon Index (UMI) as the 1000-hPa meridional wind averaged within the box (7.5-20°N, 107.5-120°E). After standardization, the following classification of EAWM is used, where the values of UMI are averaged between December and February:

Strong winter monsoon (SWM): $UMI < -0.5$

Weak winter monsoon (WWM): $UMI > 0.5$

Neutral: $-0.5 \leq UMI \leq 0.5$

3. Relationship between EAWM and ENSO

Since it is well recognized that 2002 was an El Niño (EN) year, the relationship between EAWM and EN is first discussed. W found that of the 12 WWM years from 1958-2000, 7 (65/66, 68/69, 72/73, 82/83, 91/92, 94/95, 97/98) occurred during the mature phase of an EN event, and 2002/03 was no exception. The 4 winters in italics were followed by the occurrence of an LN event. W also showed that of the 12 SWM years, 5 (70/71, 73/74,

83/84, 88/89, 95/96) were preceded by an LN onset.

These results therefore suggest that the winter during the mature phase of an EN event is likely to be weak. If this event then transitions into an LN event, the following winter is likely to be strong. A “biennial alternation” would therefore occur (Fig. 1). However, because an LN event usually lasts for more than one year, this cannot be considered to be a cycle that repeats itself.

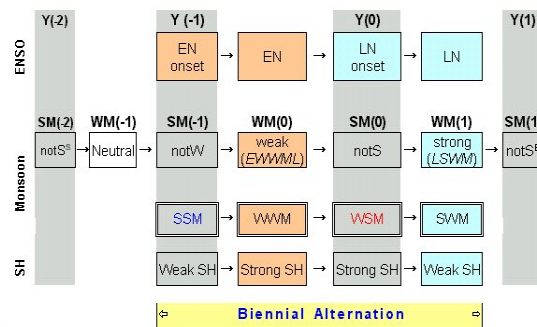


Fig. 1. Possible biennial alternation when an LN event occurs in year 0 [Y(0)] after an EN event in the previous year [Y(-1)]. “notW” (“notS”) refers to a “not weak” (“not strong”) EASM, which can be interpreted as a strong (weak) summer monsoon, or SSM (WSM). SH denotes the subtropical high.

Associated with this biennial alternation are the variations in the strength of the monsoon, changing from a strong EASM (SSM) to a WWM, then a weak EASM (WSM) and finally a SWM. W explained such changes through changes in the strength of the subtropical high (SH). A weak SH in the summer allows stronger southwesterlies to penetrate into East Asia and thus an SSM. However, as the EN event develops to its mature phase, an anticyclonic anomaly forms over the Philippine Sea (Wang et al. 2000) and thus the winter SH is enhanced. This strengthened SH “prevents” the cold surges to extend very far south and hence the winter is weak (and hence a WWM). This strong SH persists through the summer, which not only reduces the strength of the EASM (and hence a WSM) but also allows the development of an LN event. As the LN event matures, positive sea-surface temperature anomalies (SSTA)

develop over the western Pacific and a cyclonic anomaly forms over the Philippine Sea (Wang et al. 2000) and hence the winter SH is weaker, and thus a strong EAWM.

4. ENSO conditions in 2003

Till the end of October 2003, it is accepted that as far as the SSTA is concerned, 2003 is considered as a post-EN year with no development of an LN event. This can be seen from the SSTA time series (Fig. 2). However, note that negative SSTA did exist in May and early June in the Nino3.4 area, and persist till early October in the Nino1+2 region. In other words, while a “no-LN event” signal appears in the Nino3.4 region, the SST had been cooler than normal in the eastern equatorial Pacific throughout most of 2003.

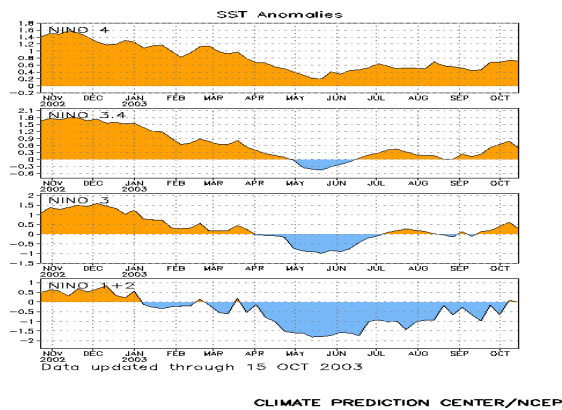


Fig. 2. SSTA time series in various Nino regions (from US Climate Prediction Center).

An explanation has been proposed for this “aborted” LN event from the 850-hPa zonal wind variations (Fig. 3). While easterly anomalies are seen throughout much of the western and central equatorial Pacific, a strong westerly wind burst occurring from April to May 2003 apparently “killed” the development of an LN event and hence the SSTA could not remain negative in the Nino3.4 region (Fig. 2).

5. An LN-like atmosphere in 2003

Although the SSTA distribution in 2003 does not resemble that of an LN event, the atmospheric flow did behave very much like previous LN events, as can be seen from the following analyses.

a. 850-hPa zonal winds

As can be seen from Fig. 3, the 850-hPa zonal wind anomalies in the equatorial Pacific were mostly negative throughout 2003, resembling the situation in an LN onset year.

Indeed, the 850-hPa zonal winds in the central equatorial Pacific had been strongly easterly compared with the long-term mean (Fig. 4a) and is ranked the first 1/3 among the strongest easterly cases in the past 50 years (Fig. 4b). Note also from Fig. 4b that most of the EN (LN) events rank the weakest (strongest) easterly so that 2003 should be one of the LN events.

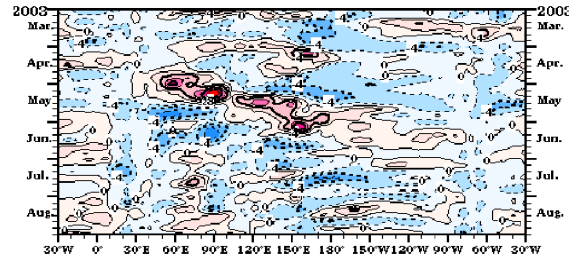


Fig. 3. Time-longitude cross-section of the 850-hPa zonal wind anomalies averaged between 5°S and 5°N from March 2003. Contour interval: 2 m s⁻¹. Solid and dashed contours indicate positive and negative anomalies, with shading indicating > 4 m s⁻¹.

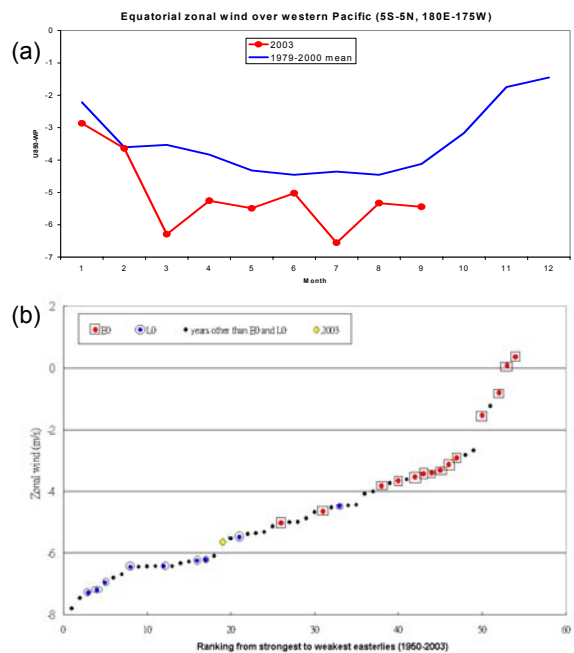


Fig. 4. 850-hPa zonal winds in the central equatorial Pacific averaged between 5°S and 5°N, and dateline and 175°W. (a) monthly variations compared with long-term mean, (b) ranking among the last 54 years (strongest being the lowest rank).

b. Rainfall over China

The summer rainfall pattern in China in 2003 was very much like that of a weak EASM,

with a very strong SH and the heaviest rainfall in the region between the Yangtze and Yellow River basins (Fig. 5). This pattern matches the biennial alternation in Fig. 1.

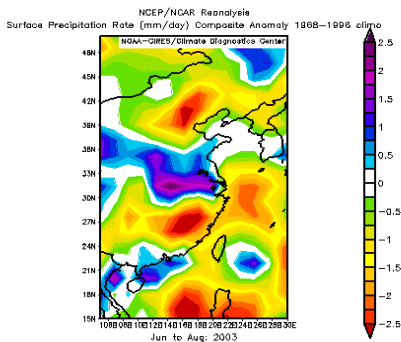


Fig. 5. Precipitation rate anomalies averaged between June, July and August (JJA) 2003.

The claim of a strong SH can be seen from the ranking of the JJA subtropical high in the last 54 years (Fig. 6). The strength of the SH in 2003 ranked among the highest.

Thus, all the evidence suggests that the atmospheric flow conditions in 2003 resembled those of an LN event.

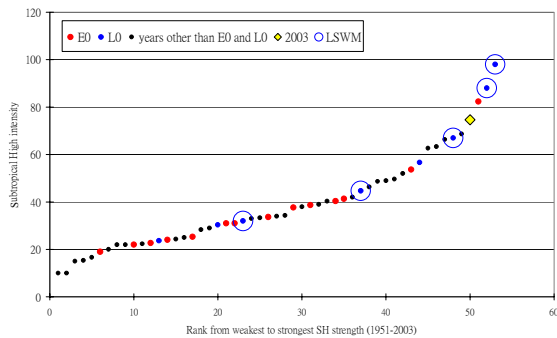


Fig. 6. Ranking of the strength of the JJA 500-hPa SH between 1951 and 2003. LSWM refers to cases of SWM during the mature phase of an LN event.

6. Outlook for the 2003/04 winter

The summer atmospheric flow conditions in 2003 were strong low-level easterlies in the western and central equatorial Pacific and a strong SH. What kind of winter conditions can be expected with such precursor signals?

A correlation between the JJA 850-hPa zonal winds in the central equatorial Pacific and the strength of the subsequent EAWM and of the SH shows that when these winds are strongly easterly, the subsequent EAWM is strong (Fig. 7a) and the SH weak (Fig. 7b). The magnitude of these winds in 2003

suggests that the coming EAWM is likely to be strong and the SH weak.

To conclude, it appears that even though the SSTA in the equatorial Pacific in 2003 does not possess an LN-like pattern, the atmospheric flow conditions in the summer of 2003 resembled those occurring during an LN onset year. Therefore, *the winter monsoon of 2003/04 over China is likely to be strong.*

References

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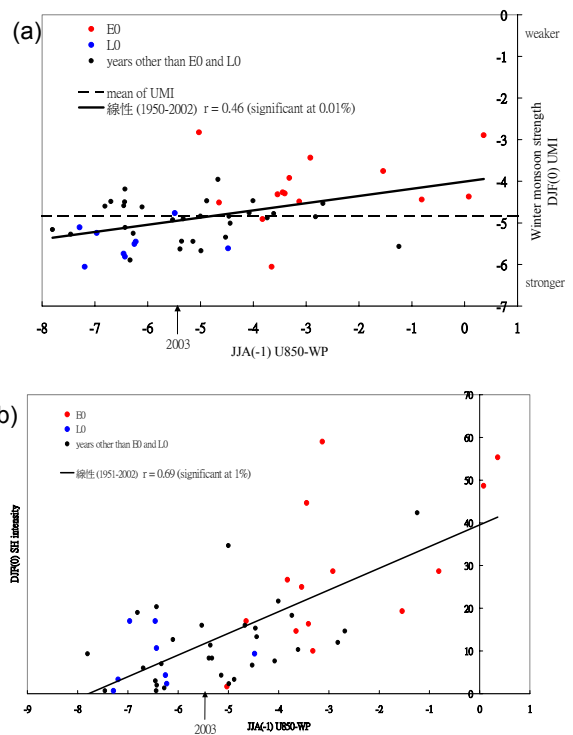


Fig. 7. Relationship between the JJA 850-hPa zonal winds and the subsequent DJF (a) strength of the EAWM as measured by the magnitude of the UMI, and (b) strength of the SH.