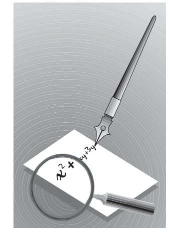
commentary and analysis



Comments on "Choice of South Asian Summer Monsoon Indices"

The choice of an appropriate index for the south Asian summer monsoon has been a subject of some controversy and received considerable attention in recent years (Webster and Yang; Goswami et al. 1999). Two major indices are the zonal wind shear index proposed by Webster and Yang (1992, hereafter referred to WYI) and the meridional shear index defined by Goswami et al. (1999, hereafter referred to as GKA; the index is hereafter referred to as MHI). In their recent article in the *Bulletin*, Wang and Fan (1999, hereafter referred to as WF) attempt to provide a dynamical basis for the discrepancies between different indices. Based on outgoing longwave radiation (OLR) data, they define summer monsoon activity in terms of a convection index, CI1, representing OLR anomalies over the center of convective activity around the northern Bay of Bengal. They try to identify centers of circulation variability that are closely associated with the variation of CI1. Based on such examinations, they show that WYI did not represent the first baroclinic response to CI1 correctly, as they averaged the shear over a region where the anomalies were not largest. They recommended the use of a new zonal wind shear index, MCI, a modified version of WYI in which anomalies are averaged over the region where the zonal wind shear response to CI1 is largest. They also take pains to point out that "the southerly shear [i.e., an index like MHI] should be used with caution because the meridional shears do not represent the first baroclinic mode simulated by convective heating" (p. 636 of their article). Here, we argue that WF are incorrect in making this statement and that no higher objectivity is involved in the choice of a zonal wind shear index over a meridional shear index.

We do not understand how WF arrived at the above-mentioned conclusion. In fact, the first baroclinic response to an off-equatorial heat source (Webster 1972; Gill 1980) would certainly have a meridional wind shear associated with it, which is clearly evident in the regression pattern of WF (their Fig. 4c). This basically was the point made by GKA in their paper. It is true that it may not apply as well to an equatorial heat source.

One criticism of the use of the meridional shear (or southerly shear as they call it) is the fact that the "climatological" mean meridional winds are not homogeneous over the region where MHI is defined (see Figs. 1c and 2c of WF). We agree with that. However, MHI is an index for interannual variations of the monsoon and one has to see whether the meridional shear "anomalies" are coherent over this region and not the climatological mean. The meridional shear anomalies are indeed coherent over this region (cf. Fig. 8a of GKA). This must be so, otherwise WF would not get coherent correlation between meridional wind shear and CI1 over this region (Fig. 4b of WF). The fact that MHI and CI1 are well correlated is duly noted by WF on p. 633. Therefore, we do not think that the criticism for using the meridional wind shear index is well founded.

Coming to the question of exercising caution, one has to exercise it in using any index, including the WY index. Wang and Fan show beautifully that the index originally defined by WY, although based on a sound concept, was incorrect in representing the Asian monsoon as they averaged it over a region where the anomalous response to monsoonal heating is neither uniform nor largest! Even now many researchers are blindly using the WY index as defined by WY to define the strength of the Indian monsoon. While WF show nicely why one should exercise caution even using the WY index, they fail to emphasize this point in the article and unduly stress caution for using the southerly shear index.

Finally, what WF recommend as the MCI1 index is nothing but a corrected WY index. The correlations presented in their Table 2 in no way establish that it is a superior index to MHI, as the correlations with AIRI are 0.68 and 0.64, respectively. The fact that MCI1 and MHl correlate significantly (0.51) indicate that they are two aspects of the same first baroclinic response of the atmosphere to an off-equatorial heat source (CI1). This further reinforces our claim that there is no basis for choosing the zonal wind shear index over the meridional shear index.

References

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Reply

Dr. Goswami's primary concern is the remarks we made on the "two major indices": the zonal wind shear index proposed by Webster and Yang (1992, hereafter WYI) and the meridional shear index defined by Goswami et al. (1999, hereafter the MHI). He concluded that "while WF (Wang and Fan 1999) show nicely why one would exercise caution even using the WY index, they failed to emphasize this point in the article and unduly stress caution for using the southerly shear index." I appreciate his concern but disagree with his comments on our assessment of the WYI and on our cautious remarks on the use of meridional shear indices. The purpose of this reply is to clarify some misunderstanding in these aspects and to highlight our major points regarding the appropriate choice of the south Asian summer monsoon indices.

1. Assessment of the WY index

How should we assess the WYI? Have we failed to emphasize the caution with use of the WYI?

To assess the value of any index, it is essential to first understand the meteorological meaning of the index. One of our major endeavors was to interpret the meaning of the WYI in terms of observed correlation between convection and circulation and based on our theoretical understanding of the tropical atmospheric response to imposed heating. We pointed out that the westerly shear associated with the Indian summer monsoon (ISM) convection is primarily confined to the west of 80°E (Fig. 4 of WF), while the westerly shear associated with the Philippine convection is mainly found east of 80°E (Fig. 6 of WF). Therefore, the WYI defined by the westerly shear from 40° to 110°E in longitude reflects the variability of the convection centers at both the Bay of Bengal (and India) and the vicinity of the Philippines. That also explains in part why the WYI has a relatively low correlation with AIRI (all Indian summer rainfall index). The WYI is, therefore, a measure of the combined convective variability in the two major convection regions in the Asian summer monsoon. It quantifies the variability of the entire tropical Asian monsoon without considering regional differences. The WYI is also adequately defined in the core region of the zonal wind shear (Fig. 1 of WF), thus reflecting well the variability of the large-scale Asian monsoon westerly shear. As long as one understands the meaning of the WYI, one can make good use of it. In this sense, use of WYI need not be cautious unless one decides to use WYI to measure *Indian monsoon rainfall variability,* which, I believe, was not the intention of the original authors.

However, we did point out the limitation of the WYI. We showed that the two convection centers are not significantly correlated in their interannual variations. Therefore, we recommend use of two indices to measure separately the variability of the ISM and the SEASM (southeast Asian summer monsoon). Lau et al. (2000) came up with essentially the same recommendation. This point is one of the primary conclusions of WF, stated in the abstract. Therefore, we did not fail to emphasize the limitation of the WYI.