Comments on "A Study of the Southern Oscillation and Walker Circulation Phenomenon"[1]

JAMES C. SADLER

Department of Meteorology, University of Hawaii, Honolulu 96822

20 April 1979 and 14 November 1979

I enjoyed the literature summary of the Southern Oscillation and Walker Circulation by Julian and Chervin (1978, hereafter referred to as JC) and their additional observational studies which support the previously documented fact that ocean thermal anomalies and atmospheric anomalies are consistently and significantly related in the Pacific basin. However, after a diligent search through the figures of the latter portion of the paper, I am unable to agree with their conclusion that the numerical model "simulation of the phenomenon was successful."

I compare the simulations with well-documented observations over the areas of good data coverage which they referenced plus additional observations, some of which were available to them.

The disagreement begins with and is highlighted by the *surface pressure anomaly* simulation (JC, Fig. 8) over the tropical central Pacific. Only the anomaly south of the equator extending east from the dateline passes their significance test yet, surprisingly, is not even discussed. This simulated *positive* anomaly of near 4 mb is in contradiction to the observations of a *negative* anomaly of 1–2 mb in this region (Bjerknes, 1969). This simulation error of 6 mb amounts to three times the annual variation of mean monthly pressures in this region of slight pressure gradients where an anomaly of 1–2 mb is sufficient to reverse the direction of the mean low-level circulation. The other large simulated anomaly of *positive* 6 mb at 110°W, 35°S is near Easter Island where the largest *negative* anomaly is observed (see JC, Fig. 1).

The poor pressure simulation obviously results, as JC state, in a poor low-level circulation simulation. The simulated *easterly* anomaly (JC, Fig. 9) in the near-equatorial central Pacific contrasts to an observed *westerly* anomaly (Brooks and Braby, 1921; Bjerknes, 1969; Ichiye and Petersen, 1963).

The simulations of both the high- and low-level circulations (Figs. 9 and 11) can be evaluated with data at the four stations JC selected for the composite sketch of Fig. 5. Only two of the eight winds were simulated with the proper sign.

Continuing with the chain of events at low levels, the poor circulation simulation leads to an erroneous positioning of the area of deep cloud and rainfall anomaly. These are more directly related to the altered low-level divergence patterns rather than to the increased convective instability over the warm anomaly, as the models simulate [see also Rowntree (1972)]. Warm anomalies do not equate to warm waters. In a warm anomaly in the equatorial eastern

[1] Contribution No. 79-1 of the Department of Meteorology, University of Hawaii.

0027-0644/80/060825-04$05.00

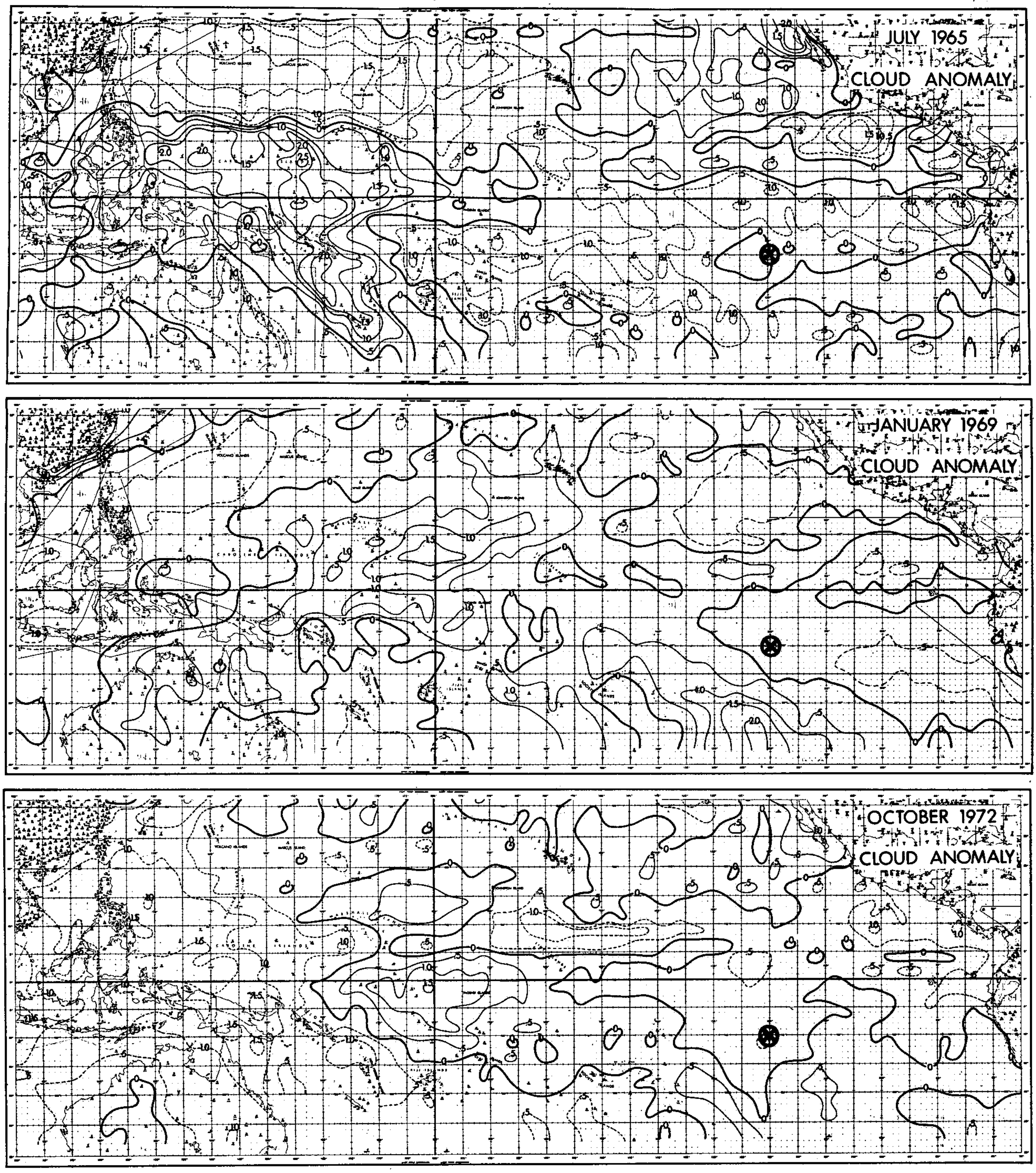

FIG. 1. Satellite observed cloudiness anomalies from the 9-year mean (in oktas) for the positive SST anomaly months of July 1965, January 1969 and October 1972. Thin solid lines are positive. The crossed circle at 10°S, 120°W marks the center position of the large positive cloud anomaly simulated by Julian and Chervin.

Pacific the water remains colder than on either side; areas far removed from the anomaly may have greater convective instability primed for release by only small changes in the low-level divergence. It is doubtful that numerical models, even the anticipated ocean-atmosphere coupled ones, will ever correctly simulate this deep tropic event where small pressure anomalies below the sensitivity threshold of the models may accompany drastic changes in the divergence pattern and ultimately in the amount and

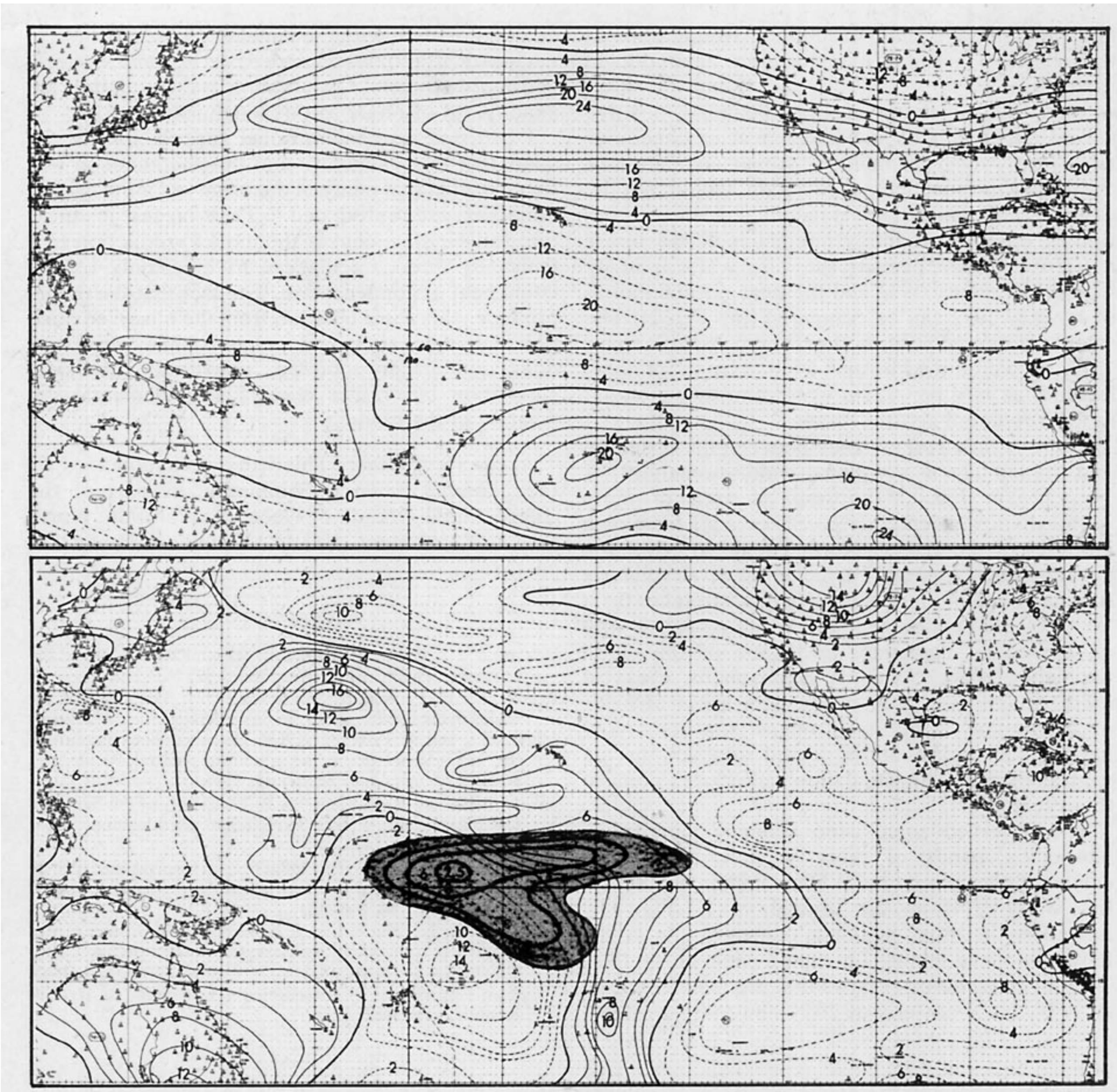

FIG. 2. The differences in the observed 200 mb winds for January 1973 minus January 1972. Top: *zonal component*. More easterly/westerly flows during January 1973 are shown by thin dashed lines/solid lines. The isopleth interval is 4 m s^{-1}. Bottom: *meridional component*. More northerly/southerly flows during January 1973 are shown by thin dashed lines/solid lines. The isopleth interval is 2 m s^{-1}. The satellite-observed positive cloudiness differences exceeding 1 okta (January 1973 minus January 1972) are shown on the bottom map within the shading. The isopleth interval is 0.5 okta.

position of anomalous rainfall and latent heat release. As JC discuss, the model simulation does place the maximum *positive* cloud anomaly westward of the positive SST anomaly; however, it is still far removed from the observed position, and in a region of predominant *negative* anomalies where no large positive anomaly has ever been observed by satellites (Sadler *et al.*, 1976).

Monthly satellite cloudiness anomalies are available for three of the five warm ocean periods selected by JC (Fig. 6) for their Fig. 5 composite. Anomalies for a month within each of the three periods are shown in my Fig. 1 for July 1965, January 1969 and October 1972. The observed anomaly patterns differ, but common to all is a large positive anomaly in the equatorial central Pacific and predominantly negative anomalies over the eastern Pacific at the location of their simulated positive anomaly which is noted on Fig. 1 by circled crosses. The positions of the positive anomaly as observed and simulated are some 6000 km apart and none of the observed patterns resemble the simulation in their Fig. 15.

Since the positions of the maximum positive anomalies of rainfall and latent heat of condensation were wrongly simulated, proper simulation of the upper tropospheric circulation would not be expected. Although there is insufficient documentation of observed monthly anomalies at the upper level for extensive periods, the warm water anomaly month of January 1973 and the near normal month of January 1972 can be compared (my Fig. 2). The satellite observed positive cloud anomaly for January 1973, shown on the bottom of Fig. 2 by stippling, is located, as in other warm water anomaly months, in the equatorial central Pacific.

There is little resemblance between the observed and the simulated meridional wind anomaly of JC Fig. 12. In Fig. 2 (bottom) an area of more northerly flow oriented NW–SE extends from high latitudes of the central North Pacific to cover the entire tropical eastern Pacific to 30°S. A similarly oriented band of more southerly flow stretches from the equatorial region near 140°W across Japan with an embedded maximum northwest of the cloud anomaly. In the Southern Hemisphere, areas of more southerly flow alternate with areas of more northerly flow with the strongest northerly flow located just south of the cloud anomaly in the central Pacific. The simulation reproduces none of these features.

The observed zonal wind anomaly patterns of alternating bands of more westerly and more easterly flow are oriented WNW–ESE in Fig. 2 (top) but WSW–ENE in the simulation (JC Fig. 11); however, the most significant difference is in the latitudes of the bands. I compare them along 180°. The observed cores of flows that are more westerly at 34°N, more easterly at 10°N and more westerly at 18°S compare with the simulated cores located at the identical latitudes of more easterly, more westerly and more easterly. Observation and simulation are exactly out of phase at this longitude.

I can find no observational support for the JC statement that "simulation of the phenomenon was successful in that many of the observed atmospheric variations are reproduced." Their biggest justification for the statement is the model production of a thermally direct circulation driven mainly by the latent heat of condensation. The fact that the model produces this some 6000 km from the observed position and where such an anomaly is never observed, does not, in my opinion, constitute successful simulation but rather reveals a fundamental deficiency in the model.

Acknowledgments. This work was supported by the National Science Foundation as part of the International Decade of Ocean Exploration, North Pacific Experiment (NORPAX) under Grant OCE 74-13737.

REFERENCES

Bjerknes, J., 1969: Atmospheric teleconnections from the equatorial Pacific. *Mon. Wea. Rev.*, **97**, 163–172.

Brooks, C. E. P., and H. W. Braby, 1921: The clash of the trades in the Pacific. *Quart. J. Roy. Meteor. Soc.*, **47**, 1–13.

Ichiye, T., and J. Petersen, 1963: The anomalous rainfall of the 1957–58 winter in the equatorial central Pacific arid area. *J. Meteor. Soc. Japan*, **41**, 172–182.

Julian, P. R., and R. M. Chervin, 1978: A study of the Southern Oscillation and Walker Circulation phenomenon. *Mon. Wea. Rev.*, **106**, 1433–1451.

Rowntree, P. R., 1972: The influence of tropical east Pacific Ocean temperature on the atmosphere. *Quart. J. Roy. Meteor. Soc.*, **98**, 290–321.

Sadler, J. C., L. Oda and B. J. Kilonsky, 1976: Pacific Ocean cloudiness from satellite observations. Meteorology Dept., University of Hawaii, UHMET 76-01, 137 pp. [Available from Department of Meteorology, University of Hawaii, Honolulu, HI 96822.]