ENSO AND COUPLING OF ATMOSPHERIC TRANSPORTS OVER TROPICAL AND SUB-TROPICAL SOUTHERN AFRICA

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ABSTRACT

Influences of El Niño Southern Oscillation (ENSO) phases on atmospheric transport pathways, and coupling mechanisms between tropical and subtropical synoptic systems over southern Africa have been investigated employing forward trajectory analysis and conventional methods of synoptic analysis. Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) forward trajectory computations supported by an enhanced method of cluster analysis were used to characterize mean atmospheric transport modes over the sub-continent. Trajectories were calculated from two source points, Mongu, Zambia and Tshane, Botswana, representative of the tropical and subtropical sub-regions respectively. Three study years were selected, corresponding to three distinct phases of ENSO: 1991/1992 El Niño episode, 1996/1997 neutral ENSO episode and 1999/2000 La Niña episode. The National Center for Environmental Prediction (NCEP)/ National Center for Atmospheric Research (NCAR) Reanalysis model is employed to reproduce mean composite synoptic circulation fields over southern Africa for the three study periods. Summaries of the pathways and seasonal frequencies are given for the four prevalent mean transport pathways, identified by trajectory analysis, from each site and for each of the ENSO episodes. Particular attention is given to the airflows exiting toward the Indian Ocean, which have been described previously. In this work, a novel distinction is made between the *Indian Ocean fast* and the *Indian Ocean slow* exit pathways. The *Indian Ocean slow* corresponds to the conventional off-coast flow, such as observed during SAFARI'92. *The Indian Ocean fast* exit pathway is a newly described transport mode, resulting from strong coupling between the subtropical circulation systems and mid-latitude westerly flows. It is characterized by higher speeds while exiting off the south-east coast, and extends further into the temperate latitudes towards Australia. This transport mode couples to the tropical sub-region during the neutral ENSO episode, mainly from July through October. Thus, it provides conditions favourable for transport of tropical fire emissions towards the Indian Ocean, as was the case during SAFARI 2000, when the *River of Smoke* transport pattern was first described. The intermittent nature, dependent on ENSO phases, and associated low frequencies, may explain why it was observed in SAFARI 2000, but escaped observation and comment during previous studies, such as SAFARI'92.

Keywords: ENSO phases (El Niño, La Niña, neutral-ENSO), atmospheric transport, coupling mechanisms, biomass burning emissions, cluster trajectory analysis, tropical and subtropical southern Africa, SAFARI 2000, River of Smoke.