mild wind momentum input, then mixed deep at night, in a repeating process.

In contrast, the SW Monsoon's surface layer exhibited little diurnal variation during the first half of the monsoon, in either temperature or mixed layer depth. Strong inertial pulsing in the velocity shear associated with the base of the mixed layer and the near-neutral and later positive buoyancy flux suggest that the primary local mechanism driving the deepening and cooling of the surface layer during the SW Monsoon are wind-driven shear instabilities and entrainment. The gradient Richardson number is near-critical throughout the mixed layer, and often critical at the mixed layer base in concert with the observed elevated shear, confirming that shear-driven entrainment is an important process. This conclusion is different than one that might have been drawn from older climatologies, namely that strong latent heat fluxes forced convectively driven entrainment and deepening of the mixed layer during the SW Monsoon (for example Hastenrath and Lamb, 1979; Oberhuber, 1988).

While the Intermonsoon mixed layer seems to be primarily surface-driven, there is evidence of other processes at play during both monsoon seasons. The strongest velocities during each monsoon were not directly wind-driven, but associated with mesoscale features. Strong changes in the subsurface and, in the case of the SW Monsoon, surface temperature structure were concurrent with the strongest velocities in the record. The salinity record also exhibited a high degree of variability, some of which was inconsistent with surface evaporative forcing.

The one-dimensional heat and salt balances demonstrate that the balance during the latter half of the NE Monsoon and the two Intermonsoons was primarily one-dimensional; in other words, the upper-ocean processes were primarily surface-driven. But during the beginning of the NE Monsoon and to varying degrees during the SW Monsoon, there were deviations from this balance, which appear to be associated with mesoscale variability.

Altimetric observations show mesoscale features consistent with the moored velocity records, as discussed here and by Dickey et al. (1998). Mesoscale variability appears to be ubiquitous in the Arabian Sea. Flagg and Kim (1998) reported mesoscale current variability throughout the Arabian Basin along the US JGOFS cruise lines in ADCP observations, and Kim et al. (2001) in further analysis of that data together with altimetric data found that the eddy variability dominates currents in the Arabian Sea. Lee et al. (2000) reported strong mesoscale variability in physical as well as biological variables measured in SeaSoar cruises along the JGOFS southern line. During the SW Monsoon both remotely sensed SST (Brink et al., 1998) and the SeaSoar observations (Lee et al., 2000) show filaments of cool, recently upwelled water extending far off the Omani coast, which appear in altimetry to have reached the site of the moored array. On the basin-scale, models of the Indian Ocean and Arabian Sea (McCreary et al., 1993) and the climatological studies (Düing and Leetmaa, 1980; Rao et al., 1989) also have emphasized the importance of upwelling and horizontal advection in setting the thermohaline structure.

The physics of the mixed layer entrainment during each monsoon season, as well as the mesoscale effects observed at the mooring site, have been found to be important in understanding the high levels and variability in the primary productivity in the Arabian Sea. Elevated levels of surface chlorophyll and primary productivity were associated with mixed layer deepening and entrainment during the two monsoon seasons, as well as with the non-local eddy variability observed in both seasons (Dickey et al., 1998). Diel periodicity was observed in bio-optical variables, with the greatest amplitudes occurring when the mixed layer was relatively shallow (during the Intermonsoons) as discussed by Kinkade et al. (2000). Experiments with coupled biological–physical models show that the convective entrainment during the NE Monsoon, and in particular the large diurnal cycle in mixed layer depth, are crucial in replicating observed productivity rates (Wiggert et al., 2000) and bloom endurance (McCreary et al., 2001).

In summary, year-long observations of the upper-ocean in the north central Arabian Sea show strong variability associated with the