2008 Western Pacific Geophysics Meeting
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mitigation of coral

HR: 08:45h
AN: OS51B-02
TI: Mitigation of Coral Bleaching on the Reef Front by Wave Mixing
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AB: Coral bleaching becomes particularly likely when the water becomes stratified, with warm water absorbing solar radiation and sitting in a stable fashion on top of underlying cooler water. The physical conditions that cause vertical mixing of the water column often mitigate coral bleaching. Generally these are thought to be: low current speeds (low turbulent kinetic energy); low wave heights (small degree of micro-breakers and non-linearities); low wind speeds (low stress and shears). In this work we evaluate the mixing along the exposed ‘weather edge' of a reef where even small-amplitude waves break and cause vertical mixing. Given that low wind speeds increase the likelihood of bleaching, the waves that might influence the reef-front are generally swell waves produced by the wind at a distant location. The combination of non-linearities in the waves and dispersion mean that the swell is the main contributor to vertical mixing at the reef-front. We adopt linear wave theory to bring the wave across the shelf to the reef front. Within about one wavelength of a steep reef front, the wave becomes non-linear and its surface elevation increases until it breaks. In this breaking zone, wave dynamics do not apply and the physics is best dealt with by momentum and energy considerations. Some of the energy is reflected as a propagating wave; some energy is carried over the reef-top into a lagoon or reef-flat as a momentum bore or a re-generated wave train; and some is converted to turbulence at the reef front. The energy that produces turbulent mixing at the reef front is compared with the potential energy of stratification, and it is found that even small-amplitude waves produce significant mixing. The partitioning of energy depends predominantly on wave height and sea water level. For most reefs, the elevation of the reef top is the level of the Lowest Astronomical Tide and this is used as the datum. The partition indices are presented as functions of Hs/D, where Hs is the significant wave height, and D is the water depth. Other parameters of water depth, wavelength, and width of the reeftop have smaller effects on the energy partition. The calculations show that for small Hs/D values (high tide) the mixing is high. As Hs/D increases towards low tide, more energy is spilled across the reef and less is spent on vertical mixing at the reef front. The application of this work to reef ecology is in identifying sections of a reef that are more

resilient to coral bleaching. The results here show that even the smallest of swell produces sufficient vertical mixing to remove stratification and mitigate coral bleaching along the exposed front of a reef. The side of the reef normally exposed to swell will also normally be the windward side where prevailing wind-driven currents are likely to be driven across the reef flat. This means that corals on the reef front are likely to be a prime source of larvae in any recovery process if the reef suffers coral loss by bleaching, crown of thorns or disease.

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