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# Meteotsunami generation from numerically modeled idealized convection

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Meteotsunamis are atmospherically generated shallow water waves in the tsunami frequency band. Proudman resonance is the most frequently observed amplification mechanism for meteotsunamis, occurring when atmospheric forcing speed (U) is the same as the shallow water wave speed ($\sqrt{gH}$). A linear increase in wave height with distance is often inferred from Proudman resonance. Observations and numerical ocean models have confirmed that convective systems produce meteotsunamis through Proudman resonance. This study investigates meteotsunami amplification mechanisms with the ocean model Telemac, forced by convection simulated in the Weather Research and Forecasting atmospheric model (WRF).

In WRF convection was initialized with a thermal bubble released at 1.5 km above ground level, on a 600 × 60 × 20 km domain. Vertical shear was produced by zonal wind linearly increasing from 0–25 $\mathrm{ms}^{-1}$ between 0–5 km above ground level. Convection was produced moving from west to east, with maximum surface pressure anomalies of 2–3 hPa between 300–350 km. The anomaly increased from 1–3 hPa between 200–350 km, and then weakened to 1 hPa between 350–600 km. WRF surface pressure outputs were passed to Telemac as a forcing over a constant depth domain, where $\sqrt{gH} = 22\ \mathrm{ms}^{-1}$. Averaging the sea level disturbance in the cross-propagation direction shows a final wave height of 0.55 m, and both super-linear and sub-linear amplification of the wave as it propagated.

First analysis indicates that both variable U and time-varying pressure contributed to non-linear wave growth. One dimensional cross-correlation indicates that the atmospheric disturbance was very poorly coupled ($U > 25\ \mathrm{ms}^{-1}$) prior to 200 km, suppressing initial wave growth. However, there was very strong coupling between 220–280 km ($U \approx 22\ \mathrm{ms}^{-1}$), which should have resulted in linear wave growth. After 280 km the coupling remained strong ($U \approx 23\ \mathrm{ms}^{-1}$), which should have produced slightly sub-linear wave growth. However, time-varying pressure may have contributed to non-linear wave growth. One-dimensional analytical solutions suggest that strengthening surface pressure anomalies may explain super-linear growth between 200–350 km, and that weakening surface pressure anomalies may have further contributed to sub-linear growth between 350–600 km. Importantly, this study shows that wave growth may be super-linear for a forcing which is increasing in amplitude and moving at Proudman resonant speeds, such as a strengthening surface pressure anomaly in a moving convective system.