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Numerical Study of Balearic Meteotsunami Generation and Propagation under Synthetic Gravity Wave Forcing

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A high resolution nested ocean modelling system forced by synthetic atmospheric gravity waves is used to investigate meteotsunami generation, amplification and propagation properties over the Mallorca-Menorca shelf (Balearic Islands, Western Mediterranean Sea). We determine how meteotsunami amplitude outside and inside of the Balearic port of Ciutadella depends on forcing gravity wave direction, speed and trajectory. Contributions of Mallorca shelves and Menorca Channel are quantified for different gravity wave forcing angles and speeds. Results indicate that the Channel is the key build-up region and that Northern and Southern Mallorca shelves do not significantly contribute to the amplitude of substantial harbour oscillations in Ciutadella. This fact seriously reduces early-warning alert times in cases of locally generated pressure perturbations. Tracking meteotsunami propagation paths in the Menorca Channel for several forcing velocities, we show that the Channel bathymetry serves as a focusing lens for meteotsunami waves whose paths are constrained by the forcing direction. Faster meteotsunamis are shown to propagate over deeper ocean regions, as required by the Proudman resonance. Meteotsunami speed under sub- and supercritical forcing is estimated and a first order estimate of its magnitude is derived. Meteotsunamis generated by the supercritical gravity waves are found to propagate with a velocity which is equal to an arithmetic mean of the gravity wave speed and local ocean barotropic wave speed.