We study generalized special cycles on Hermitian locally symmetric spaces $\Gamma \backslash D$ associated to the groups $G = U(p,q)$, $\text{Sp}(2n, \mathbb{R})$ and $O^\ast(2n)$. These cycles are algebraic and covered by symmetric spaces associated to subgroups of $G$ which are of the same type. Using the oscillator representation and the thesis of Greg Anderson ([?]), we show that Poincaré duals of these generalized special cycles can be viewed as Fourier coefficients of a theta series. This gives new cases of theta lifts from the cohomology of Hermitian locally symmetric manifolds associated to $G$ to vector-valued automorphic forms associated to the groups $G' = U(m, m)$, $O(m, m)$ or $\text{Sp}(m, m)$ which are members of a dual pair with $G$ in the sense of Howe. This partially generalizes the work of Kudla and Millson on the special cycles on Hermitian locally symmetric spaces associated to the unitary groups. (Received July 05, 2019)