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We present a non-conforming method for the variational problem on a bounded domain involving the fractional Laplacian. We first derive an alternative integral representation of the bilinear form corresponding to the variational problem involving solutions of elliptic problems defined on  $\mathbb{R}^d$ . The numerical approximation of the action of the corresponding stiffness matrix consists of three stages: (i) Apply a SINC quadrature scheme to approximate the integral representation by a finite sum where each term involves the solution of an elliptic partial differential equation defined on  $\mathbb{R}^d$ ; (ii) Reduce each term to a truncated problem on a bounded domain; (iii) Use the finite element method to approximate the solution of the truncated problem. The consistency error analysis is discussed together with the numerical implementation of the entire algorithm. The results of computations illustrate the error behavior in terms of the mesh size restricted to the bounded domain, the domain truncation parameter and the quadrature spacing parameter. (Received September 12, 2016)