Graphene and other two-dimensional van der Waals materials provide a fertile ground for studying quantum Hall states. In Bernal or rhombohedral stacking multilayer graphene, the Landau levels exhibit sophisticated structures that can be manipulated using magnetic and electric fields. An intricate interplay of single-particle orbitals and many-body interactions result in a plethora of quantum Hall states in multilayer graphene. In some cases, multiple Landau levels are very close in energy and strong mixing between them plays an important role. We show that non-Abelian fractional quantum Hall states of the Moore-Read type can be realized and the precise nature of a state depends on the details of Landau level mixing. The chiral graviton spectral function can serve as a convenient bulk probe of these non-Abelian states. We have also investigated the evolution of integer quantum Hall states under Landau level mixing and the associated chiral gravitons. It is possible to drive phase transitions between quantum Hall states by tuning the spacings between Landau levels.