Spidersonde: A Novel Approach to Tropical Cyclone Reconnaissance via Biomimicry of Spiders' Ballooning

Kim, Minjun (School: Cheongshim International Academy)
Kim, Eunjae (School: Cheongshim International Academy)
Lee, Hyunbin (School: Cheongshim International Academy)

Spidersonde is a revolutionary ground launch sonde system that implements spider's ballooning mechanics to collect meteorological in-situ data critical in accurately forecasting Tropical Cyclones' (TCs') path. Traditionally, sondes attached to parachutes to slow the free-fall for more accurate readings, called Dropsondes, are most prominently used. Dropsondes, because of their parachutes, require an aircraft deployment over TCs, which deters deployment in higher-category TCs with stronger wind speeds and basins other than the Atlantic Ocean because of substantial operating costs. To confront these issues, Spidersonde utilizes a similar mechanic to a spider's ballooning, a process in which it spreads numerous threads to create drag, similar to a parachute. This nimble and fluid design enables Spidersondes to be launched from the ground, reducing cost and making deployment in higher-category TCs possible. To demonstrate the feasibility of this concept, several working prototypes were tested to determine the aerodynamics of Spidersonde's threads and their performance in creating drag compared to Parachutes. We conducted wind tunnel and tensile tests to compare the drag efficiency of Spidersonde threads with traditional parachutes and to determine optimal thread length, number, material, and thickness for TC conditions. Results indicate that Spidersondes match or exceed the performance of parachutes in capturing in-situ data across TC categories, with a cost reduction factor exceeding 200 times.