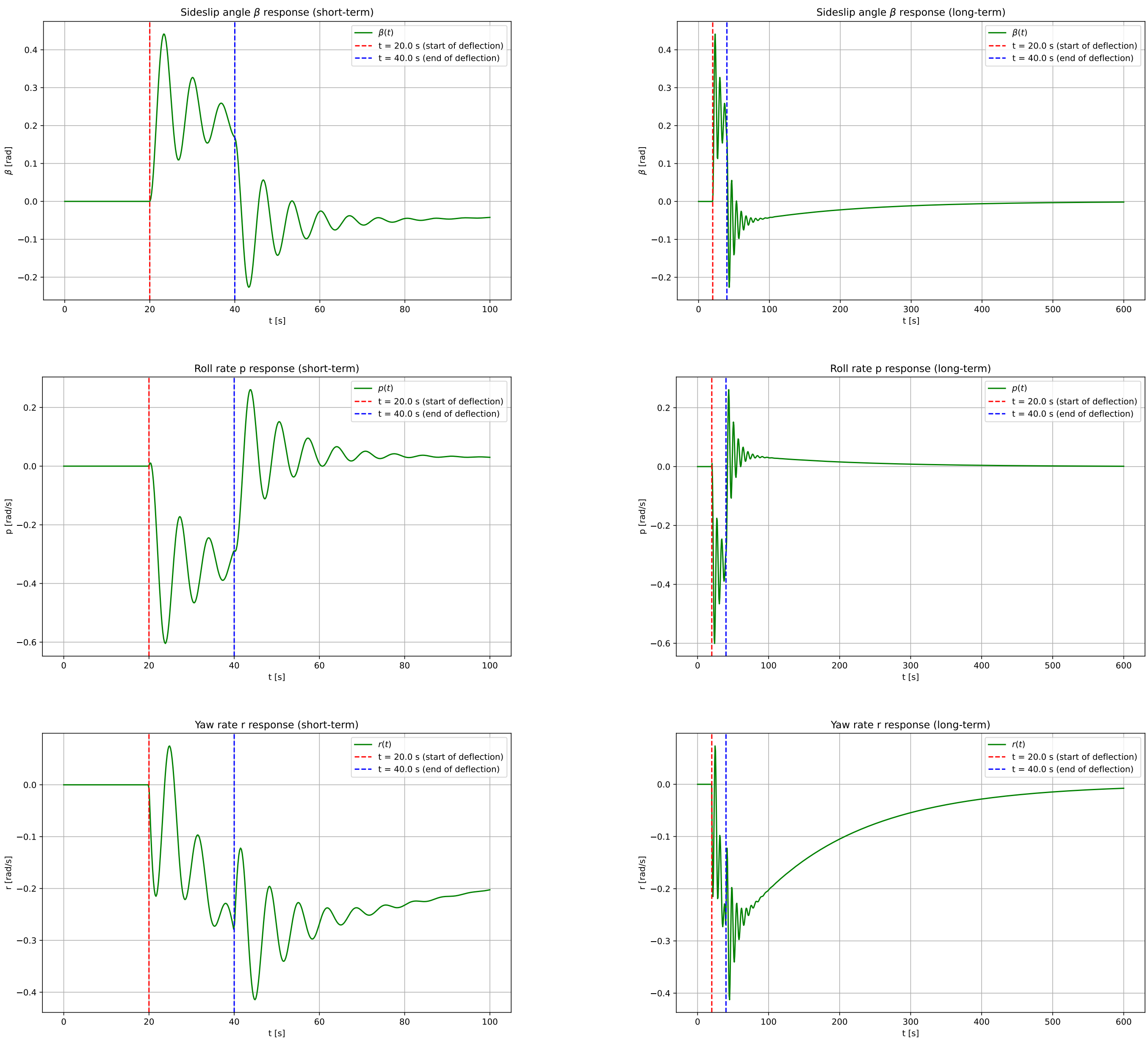
Lateral–directional response to rudder deflection



After 20 s, the pilot deflects the rudder by 0.175 rad and holds it for another 20 s. This generates a force on the tail to the right, causing the aircraft's nose to yaw left, resulting in a negative yaw rate, a positive sideslip angle, and a negative roll rate (since the right wing, moving faster, produces more lift and rises).
The variation of the sideslip angle β is characterized by oscillations due to the activation of the Dutch roll mode, which has a period of about 6.5 s. These oscillations gradually damp out until the rudder is returned to its neutral position, generating similar new oscillations. Over a longer time interval, β slowly returns to zero, following an exponential decay typical of the spiral mode, with a halving time of approximately 100 s.
The roll rate p and yaw rate r exhibit a behavior similar to that of β. After rudder actuation, both show initial oscillations due to the Dutch roll, which are rapidly damped. Subsequently, p quickly approaches zero, both because variations of p are intrinsically small in the spiral mode and because the rudder primarily produces a significant change in r. Indeed, rudder motion generates a dominant yawing moment, while the induced rolling moment is smaller. The yaw rate r follows a pattern similar to β, with initial oscillatory damping followed by an exponential convergence toward zero, characteristic of the spiral mode.