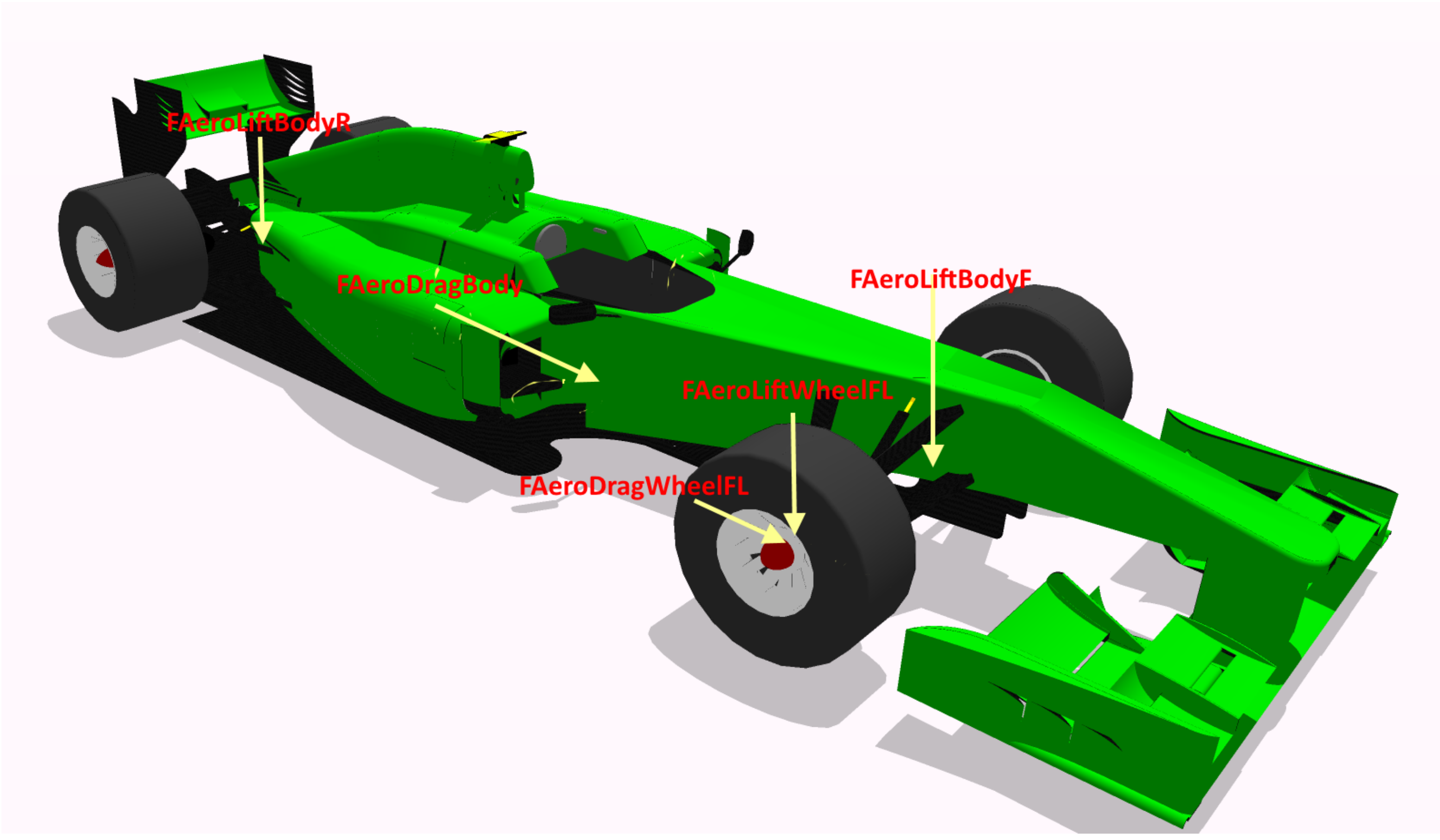
Aerodynamics

The aerodynamic model attempts to capture the key features of the influence of aerodynamics on the car. The outputs of the aerodynamics model are the following:

1. A front body aerodynamic load applied at the user specified front ride height measurement point.
2. A rear body aerodynamic load applied at the user specified rear ride height measurement point.
3. A body drag force applied along the aero force application plane, at the centre line.
4. A wheel lift force applied at the wheel centre of each wheel.
5. A wheel drag force applied at the wheel centre of each wheel.



Each of these forces is computed using the following formula:

$$F_{\mathrm{aero}} = \frac{1}{2}\rho v_{\mathrm{car}}^2 C_{\mathrm{aero}} A_{\mathrm{ref}}$$

In which ρ is the air density, v_{car} the longitudinal velocity of the car, and A_{ref} the reference area of the car (typically $1.5m^2$). Finally C_{aero} is the all-important aerodynamic coefficient. These coefficients vary significantly as a function of car attitude, and it is the computation of these to which most effort is devoted in the aero model. The coordinate system in which aero forces are calculated can be specified in aeroForceApplication, with the option to choose between ground plane and z=0 plane. Note that if z=0 plane is selected, then for a raked car, downforce will contibuite very slightly to drag and vice versa.

Polynomial Map

Polynomial maps are a very popular means of parameterising an aeromap. While many more complex models may be implemented, polynomial maps are very frequently used as some part of the aerodynamic model. However, the form of the polynomial maps can vary a great deal between teams. It is not Canopy's intention or wish to implement every possible form of polynomial map for every customer, so we provide the means for users to configure their own aeromaps to their own specification.

A polynomial aeromap is of the form:

$$\begin{aligned}\mathrm{AeroCoefficient} = &\mathrm{PolynomialTerm}_1 \times \mathrm{PolynomialCoefficient}_1 + \\ &\mathrm{PolynomialTerm}_2 \times \mathrm{PolynomialCoefficient}_2 + \\ &\ldots \\ &\mathrm{PolynomialTerm}_n \times \mathrm{PolynomialCoefficient}_n + \end{aligned}$$

In each case the *PolynomialCoefficient* is a single number, and the *PolynomialTerm* is generated by multiplying together any combination of the *aerodynamic degrees of freedom*. This is quite abstract so consider the following example. Imagine we know that our rear aerodynamic coefficient has the following characteristics:

1. A quadratic dependence on rear ride height.
2. A linear loss of lift coefficient with increasing car roll angle.
3. A cross term between front ride height and rear ride height.
4. A constant term