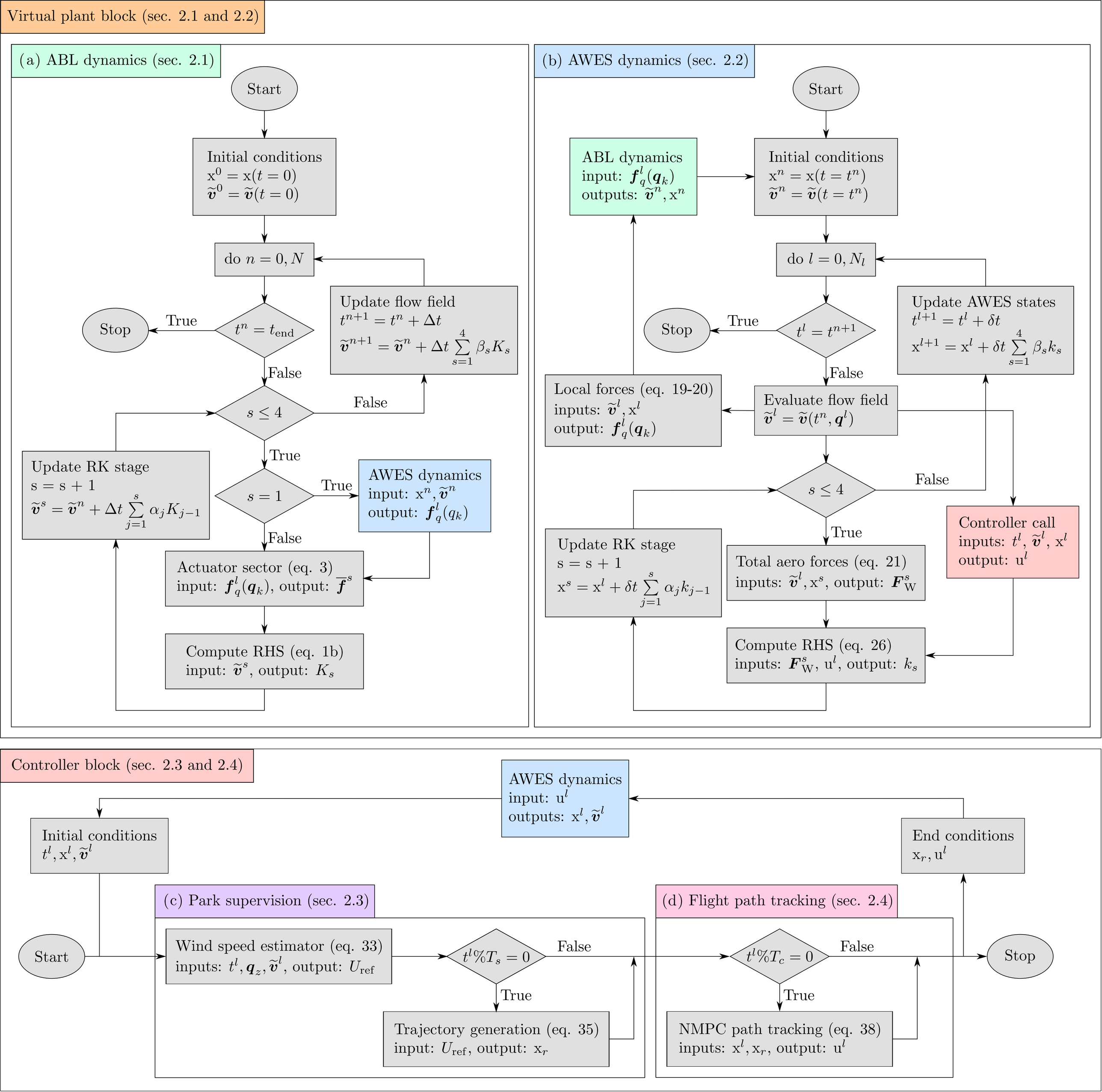
Virtual plant block (sec. 2.1 and 2.2)
(a) ABL dynamics (sec. 2.1)
Start
Initial conditions
$x^0 = x(t=0)$
$\widetilde{\boldsymbol{v}}^0 = \widetilde{\boldsymbol{v}}(t=0)$
do $n = 0, N$
$t^n = t_{end}$
True
Stop
False
Update flow field
$t^{n+1} = t^n + \Delta t$
$\widetilde{\boldsymbol{v}}^{n+1} = \widetilde{\boldsymbol{v}}^n + \Delta t \sum_{s=1}^{4} \beta_s K_s$
$s \leq 4$
False
True
Update RK stage
$s = s + 1$
$\widetilde{\boldsymbol{v}}^s = \widetilde{\boldsymbol{v}}^n + \Delta t \sum_{j=1}^{s} \alpha_j K_{j-1}$
$s = 1$
True
AWES dynamics
input: $x^n, \widetilde{\boldsymbol{v}}^n$
output: $\boldsymbol{f}_q^l(q_k)$
False
Actuator sector (eq. 3)
input: $\boldsymbol{f}_q^l(\boldsymbol{q}_k)$, output: $\overline{\boldsymbol{f}}^s$
Compute RHS (eq. 1b)
input: $\widetilde{\boldsymbol{v}}^s$, output: K_s
(b) AWES dynamics (sec. 2.2)
Start
ABL dynamics
input: $\boldsymbol{f}_q^l(\boldsymbol{q}_k)$
outputs: $\widetilde{\boldsymbol{v}}^n, x^n$
Initial conditions
$x^n = x(t = t^n)$
$\widetilde{\boldsymbol{v}}^n = \widetilde{\boldsymbol{v}}(t = t^n)$
do $l = 0, N_l$
$t^l = t^{n+1}$
True
Stop
False
Update AWES states
$t^{l+1} = t^l + \delta t$
$x^{l+1} = x^l + \delta t \sum_{s=1}^{4} \beta_s k_s$
Local forces (eq. 19-20)
inputs: $\widetilde{\boldsymbol{v}}^l, x^l$
output: $\boldsymbol{f}_q^l(\boldsymbol{q}_k)$
Evaluate flow field
$\widetilde{\boldsymbol{v}}^l = \widetilde{\boldsymbol{v}}(t^n, \boldsymbol{q}^l)$
$s \leq 4$
False
True
Update RK stage
$s = s + 1$
$x^s = x^l + \delta t \sum_{j=1}^{s} \alpha_j k_{j-1}$
Total aero forces (eq. 21)
inputs: $\widetilde{\boldsymbol{v}}^l, x^s$, output: $\boldsymbol{F}_W^s$
Controller call
inputs: t^l, $\widetilde{\boldsymbol{v}}^l$, x^l
output: u^l
Compute RHS (eq. 26)
inputs: $\boldsymbol{F}_W^s$, u^l, output: k_s
Controller block (sec. 2.3 and 2.4)
AWES dynamics
input: u^l
outputs: $x^l, \widetilde{\boldsymbol{v}}^l$
Initial conditions
$t^l, x^l, \widetilde{\boldsymbol{v}}^l$
End conditions
x_r, u^l
(c) Park supervision (sec. 2.3)
(d) Flight path tracking (sec. 2.4)
Start
Wind speed estimator (eq. 33)
inputs: $t^l, \boldsymbol{q}_z, \widetilde{\boldsymbol{v}}^l$, output: U_{ref}
$t^l \% T_s = 0$
False
True
Trajectory generation (eq. 35)
input: U_{ref}, output: x_r
$t^l \% T_c = 0$
False
True
NMPC path tracking (eq. 38)
inputs: x^l, x_r, output: u^l
Stop