?
?
$$\partial_t U + \nabla \cdot \vec{F}^c - \nabla \cdot \vec{F}^v = Q in \Omega, t > 0, \tag{1}$$
U
$\vec{F}^c$
$\vec{F}^v$
Q
ρ
ρu_1
ρu_2
ρu_3
$\rho c_P T$
$\vec{F}^c_i =$
ρu_i
$\rho u_i u_1 +$
$P\delta_{i1}$
$\rho u_i u_2 +$
$P\delta_{i2}$
$\rho u_i u_3 +$
$P\delta_{i3}$
$\rho u_i c_P T, \vec{F}^v_i =$
τ_{i1}
τ_{i2}
τ_{i3}
$\kappa \nabla T.$
??
$\vec{v} =$
(u_1, u_2, u_3)
ρ
P
$\tau_{ij} =$
$\mu_{tot}\big(\partial_j v_i +$
$\partial_i v_j -$
$\frac{2}{3}\delta_{ij}\nabla \cdot$
$\vec{v}\big)$
μ_{tot}
μ_{dyn}
μ_{tur}
μ_{tur}
c_P
T
κ
??
$\rho =$
p_0/RT
R
p_0
?
$V =$
$\{p, \vec{v}, T\}$
Γ
$\Gamma =$
$\frac{1}{\beta^2} 000 \rho_T$
$\frac{u}{\beta^2} \rho 00 \rho_T$
$\frac{v}{\beta^2} 0 \rho 0 \rho_T$
$\frac{w}{\beta^2} 00 \rho \rho_T$
$\frac{c_P T}{\beta^2} 000 \rho c_p +$
$\rho_T c_P T$
$\Gamma \partial_t V + \nabla \cdot \vec{F}^c - \nabla \cdot \vec{F}^v = Q in \Omega, t > 0.$
(2)
??
??
??
??
Ω

$$\int_\Omega \Gamma \frac{\partial V}{\partial t} d\Omega + \int_\Omega \nabla (\vec{F}^c - \vec{F}^v) d\Omega = \int_\Omega Q d\Omega,$$
(3)
$$\int_\Omega \Gamma \frac{\partial V}{\partial t} d\Omega = -R(V).$$
(4)
$R(V) =$
$\sum (F^c -$
$F^v) \Delta S +$
$Q|\Omega|$
F^c
F^v
ΔS
$|\Omega|$
f
i
j
F^c
$$F^c_{ij} = \left(\frac{\vec{F}^c_i + \vec{F}^c_j}{2} \right) . \vec{n}_{ij} - \frac{1}{2} \Gamma P |\Lambda_\Gamma| P^{-1} (V_i - V_j).$$
(5)
$\vec{}$