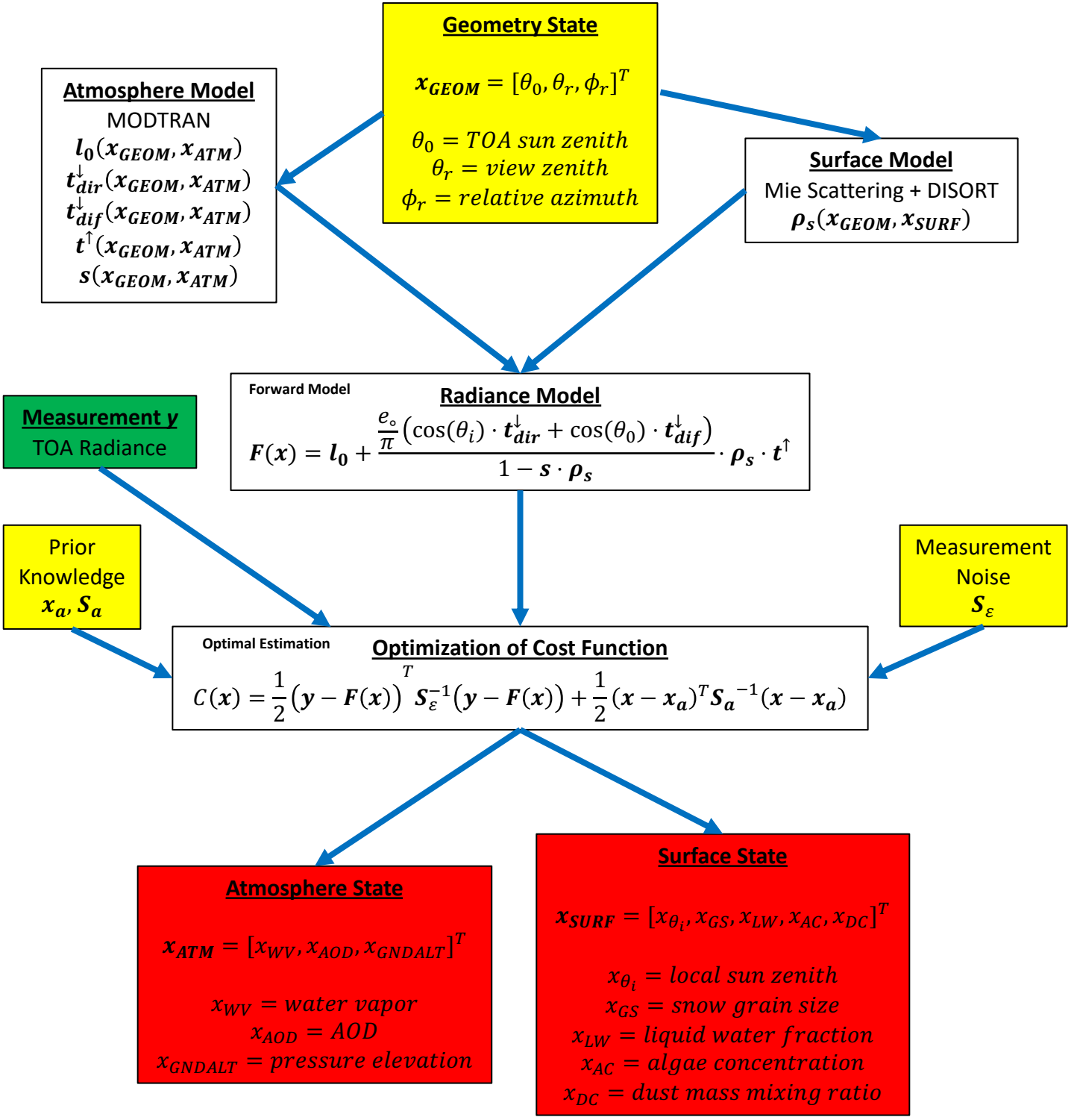
Geometry State
$x_{GEOM} = [\theta_0, \theta_r, \phi_r]^T$
$\theta_0 = TOA\ sun\ zenith$
$\theta_r = view\ zenith$
$\phi_r = relative\ azimuth$
Atmosphere Model
MODTRAN
$l_0(x_{GEOM}, x_{ATM})$
$t^{\downarrow}_{dir}(x_{GEOM}, x_{ATM})$
$t^{\downarrow}_{dif}(x_{GEOM}, x_{ATM})$
$t^{\uparrow}(x_{GEOM}, x_{ATM})$
$s(x_{GEOM}, x_{ATM})$
Surface Model
Mie Scattering + DISORT
$\rho_s(x_{GEOM}, x_{SURF})$
Forward Model
Radiance Model
$F(x) = l_0 + \frac{\frac{e_\circ}{\pi}(\cos(\theta_i) \cdot t^{\downarrow}_{dir} + \cos(\theta_0) \cdot t^{\downarrow}_{dif})}{1 - s \cdot \rho_s} \cdot \rho_s \cdot t^{\uparrow}$
Measurement y
TOA Radiance
Prior Knowledge
x_a, S_a
Measurement Noise
S_ε
Optimal Estimation
Optimization of Cost Function
$C(x) = \frac{1}{2}(y - F(x))^T S_\varepsilon^{-1}(y - F(x)) + \frac{1}{2}(x - x_a)^T S_a^{-1}(x - x_a)$
Atmosphere State
$x_{ATM} = [x_{WV}, x_{AOD}, x_{GNDALT}]^T$
$x_{WV} = water\ vapor$
$x_{AOD} = AOD$
$x_{GNDALT} = pressure\ elevation$
Surface State
$x_{SURF} = [x_{\theta_i}, x_{GS}, x_{LW}, x_{AC}, x_{DC}]^T$
$x_{\theta_i} = local\ sun\ zenith$
$x_{GS} = snow\ grain\ size$
$x_{LW} = liquid\ water\ fraction$
$x_{AC} = algae\ concentration$
$x_{DC} = dust\ mass\ mixing\ ratio$