Measured signal

$N_{measure}$

Stage 1: Temperature retrieval

Initialize four free parameters

$\theta_1^{(0)} = (I_{RB}^{(0)}, I_{Mie}^{(0)}, v^{(0)}, T^{(0)})$

I_{RB}, I_{Mie}, v, and T all vary

Forward spectral model

$$N_{fit,1}^{(k)}(\nu) = [I_{RB}^{(k)} S_{RB}(\nu - \Delta\nu_D^{(k)}, T^{(k)}) + I_{Mie}^{(k)} S_{Mie}(\nu - \Delta\nu_D^{(k)})] \otimes F(\nu) \otimes S_{laser}(\nu)$$

Residual calculation

$r_1^{(k)} = N_{measure} - N_{fit,1}^{(k)}$

Nonlinear least-squares optimization

$\min_{\theta_1} \Sigma_i [r_{1,i}]^2$

Update all four parameters

$I_{RB}^{(k+1)}$, $I_{Mie}^{(k+1)}$, $v^{(k+1)}$, $T^{(k+1)}$

$k \leftarrow k + 1$

Temperature convergence criterion satisfied?

No

Yes

Output retrieved temperature

$T_{retrieved}$

Fix T = $T_{retrieved}$

Stage 2: Wind retrieval

Initialize three free parameters

$\theta_2^{(0)} = (I_{RB}^{(0)}, I_{Mie}^{(0)}, v^{(0)})$

$T = T_{retrieved}$ throughout Stage 2

Forward spectral model

$$N_{fit,2}^{(j)}(\nu) = [I_{RB}^{(j)} S_{RB}(\nu - \Delta\nu_D^{(j)}, T_{retrieved}) + I_{Mie}^{(j)} S_{Mie}(\nu - \Delta\nu_D^{(j)})] \otimes F(\nu) \otimes S_{laser}(\nu)$$

Residual calculation

$r_2^{(j)} = N_{measure} - N_{fit,2}^{(j)}$

Nonlinear least-squares optimization

$\min_{\theta_2} \Sigma_i [r_{2,i}]^2$

Update three parameters

$I_{RB}^{(j+1)}$, $I_{Mie}^{(j+1)}$, $v^{(j+1)}$

$j \leftarrow j + 1$, $T = T_{retrieved}$

Wind velocity convergence criterion satisfied?

No

Yes

Output retrieved wind velocity

$v_{retrieved}$

Final output

$T_{retrieved}$, $v_{retrieved}$