

$J(\mathbf{x})$	Cost function
$J_b(\mathbf{x})$	Background cost function
$J_o(\mathbf{x})$	Observation cost function
$\nabla J(\mathbf{x})$	Cost function gradient
$\ \nabla J(\mathbf{x})\ $	Cost function gradient norm
$\nabla^2 J(\mathbf{x})$	Cost function Hessian
$\mathbf{B}$	Background error covariance
$\mathbf{R}$	Observation error covariance
$M$	WRF-CO2 forward model
$\tilde{M}$	WRF-CO2 tangent linear model
$\tilde{M}^T$	WRF-CO2 adjoint model
$H$	Observation operator
$\tilde{H}$	Tangent linear observation operator
$\tilde{H}^T$	Adjoint observation operator
$\mathbf{k}_{\text{co2}}$	CO <sub>2</sub> emission scaling factor
$\mathbf{q}_{\text{co2}}$	CO <sub>2</sub> mixing ratio (dry air)
$g_{\mathbf{k}_{\text{co2}}}$	Tangent linear variable for CO <sub>2</sub> emission scaling factor
$a_{\mathbf{k}_{\text{co2}}}$	Adjoint variable for CO <sub>2</sub> emission scaling factor
$g_{\mathbf{q}_{\text{co2}}}$	Tangent linear variable for CO <sub>2</sub> mixing ratio (dry air)
$a_{\mathbf{q}_{\text{co2}}}$	Adjoint variable for CO <sub>2</sub> mixing ratio (dry air)
$\mathbf{x}^b$	Prior estimate of CO <sub>2</sub> emission scaling factor
$\mathbf{x}^n$	Analysis of CO <sub>2</sub> emission scaling factor
$\hat{\mathbf{x}}$	Analysis increment of CO <sub>2</sub> emission scaling factor
$y_k$	Observation at the $k$ th assimilation window
$\mathbf{d}_k$	Innovation vector at the $k$ th assimilation window

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