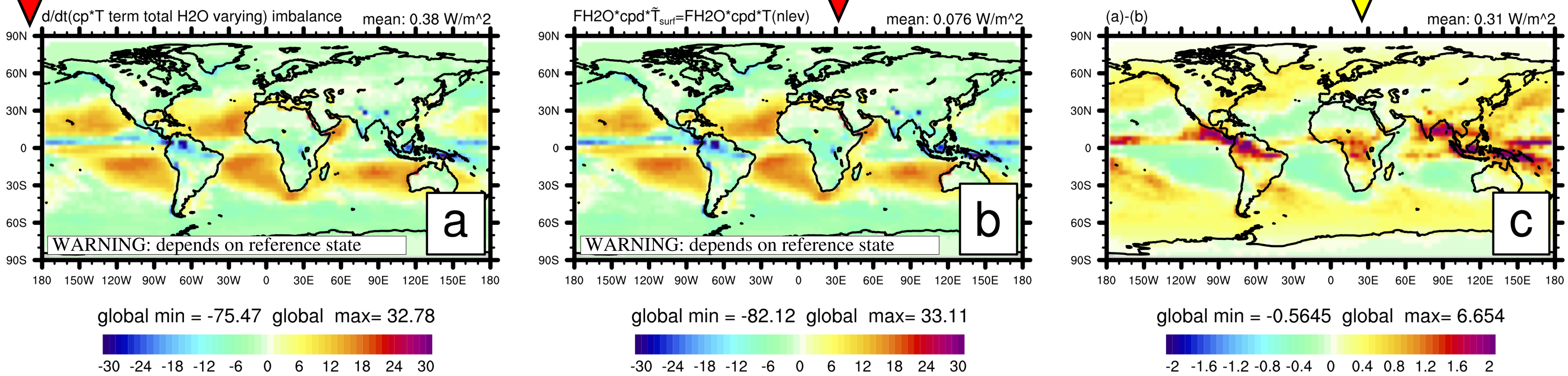
Modified (consistent) total energy equation assuming constant latent heats

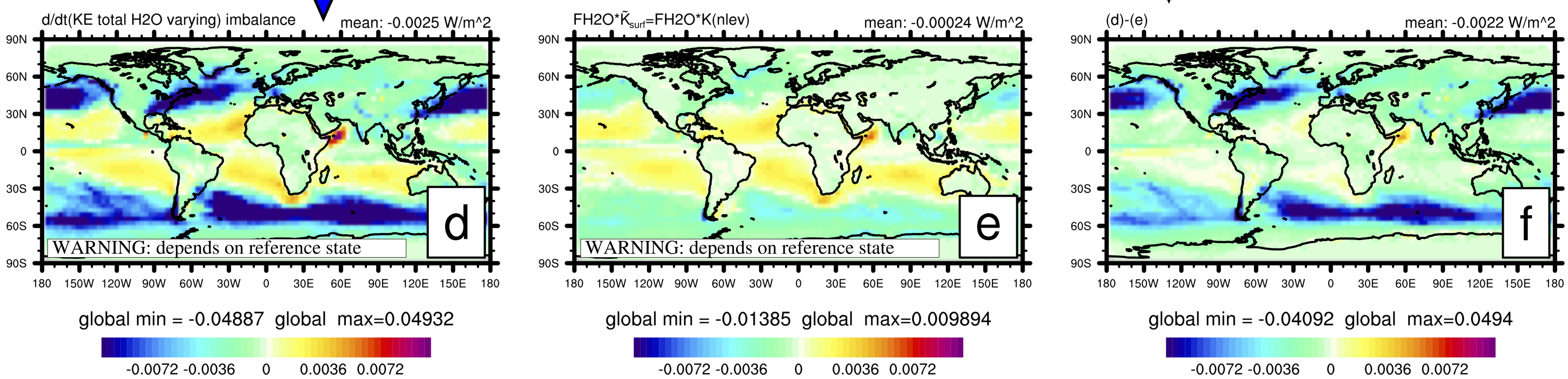
$$\frac{\partial}{\partial t}\int \overline{\rho}^{(d)}\left\{\left(1+\overline{m}^{(H_2O)}\right)\left[\underline{\overline{K}}+\underline{\overline{\Phi}_s}+\underline{c_p^{(d)}\left(\overline{T}-T_{00}\right)}\right]+\overline{m}^{(wv)}L_{s,00}+\overline{m}^{(liq)}L_{f,00}\right\}dz$$

$$-\underline{\Delta\widehat{\mathcal{I}}_{\partial m^{(H_2O)}/\partial t}}-\cancel{\Delta\mathcal{I}_{m_{tn}^{(H_2O)}}}=\overline{F}_{net}^{(H_2O)}\left[\underline{c_p^{(d)}\left(\widetilde{\overline{T}}_s-T_{00}\right)}+\underline{\widetilde{\overline{K}}_s}+\underline{\overline{\Phi}_s}\right]+\overline{F}_{net}^{(wv)}L_{s,00}+\overline{F}_{net}^{(liq)}L_{f,00}+\overline{F}_{net}^{(turb,rad)}$$

$$\underline{\int c_p^{(d)}\left(\overline{T}-T_{00}\right)\frac{\partial}{\partial t}\left[\overline{\rho}^{(d)}\widehat{\overline{m}}^{(H_2O)}\right]dz}-\underline{\overline{F}_{net}^{(H_2O)}c_p^{(d)}\left(\widetilde{\overline{T}}_s-T_{00}\right)}=\underline{\Delta\widehat{\mathcal{I}}^{(h)}_{\partial m^{(H_2O)}/\partial t}}$$



$$\underline{\int \overline{K}\frac{\partial}{\partial t}\left[\overline{\rho}^{(d)}\widehat{\overline{m}}^{(H_2O)}\right]dz}-\underline{\overline{F}_{net}^{(H_2O)}\widetilde{\overline{K}}_s}=\underline{\Delta\widehat{\mathcal{I}}^{(K)}_{\partial m^{(H_2O)}/\partial t}}$$



$$\underline{\int \overline{\Phi}_s\frac{\partial}{\partial t}\left[\overline{\rho}^{(d)}\widehat{\overline{m}}^{(H_2O)}\right]dz}-\underline{\overline{F}_{net}^{(H_2O)}\overline{\Phi}_s}=\underline{\Delta\widehat{\mathcal{I}}^{(\Phi)}_{\partial m^{(H_2O)}/\partial t}}$$