The energy density per unit volume of the atmosphere is the sum of **internal**, **potential**, and **kinetic** energies: $\rho(C_v T + gz + v^2/2)$.

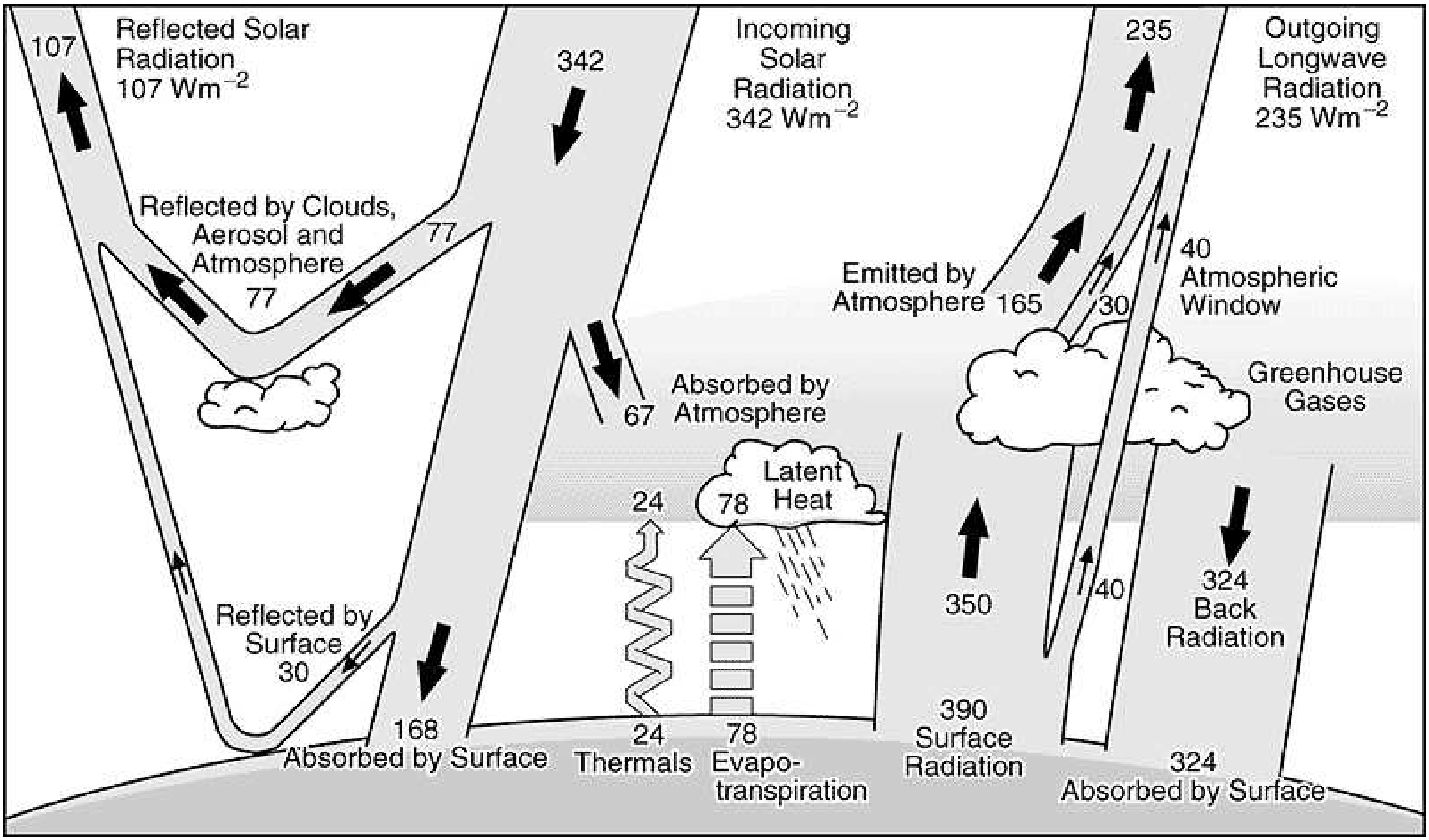
Internal and potential energies are closely coupled. When air in a hydrostatic atmosphere is heated, it expands, doing work against the local pressure, and converting some of the heat into potential energy. Raising the temperature of a parcel by δT requires $C_v \delta T$ of internal energy and $R\delta T$ of work. The sum $(C_v + R)\delta T \equiv C_p \delta T$ is called the **enthalpy**.

The quantity which is conserved by a parcel moving in a hydrostatic atmosphere is the **dry static energy**. It includes the enthalpy rather than the internal energy. The energy flux is the product of the dry static energy and the velocity vector: $\rho(C_p T + gz + \frac{1}{2}v^2)\vec{v}$.

The conservation law for atmospheric energy density says that the rate of change of energy in a volume plus the flux out of the volume equals the diabatic heating rate Q

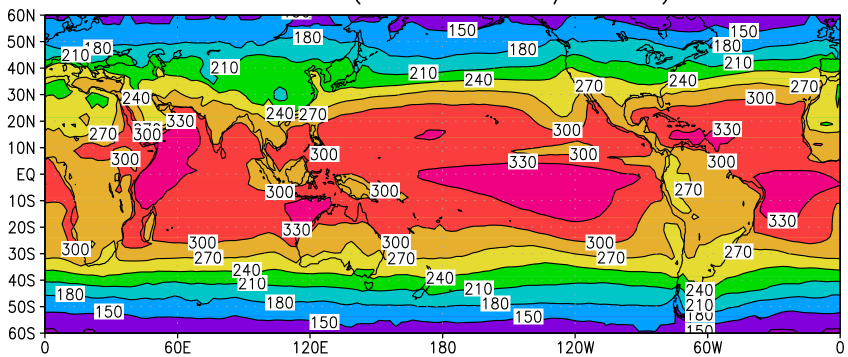
$$\frac{\partial}{\partial t}\{\rho(C_v T + gz + \frac{1}{2}v^2)\} + \nabla \cdot \{\rho(C_p T + gz + \frac{1}{2}v^2)\vec{v}\} = \rho Q$$

Energy budget of the Earth and conversion of heat in different forms. The greenhouse effect of the atmosphere is due to its particular radiative properties: almost transparent for solar radiation, but almost opaque for the infrared terrestre radiation.

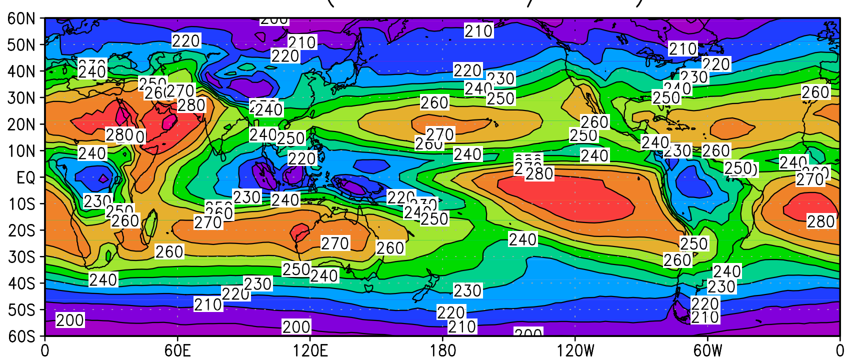


Radiative budget at the top of the atmosphere

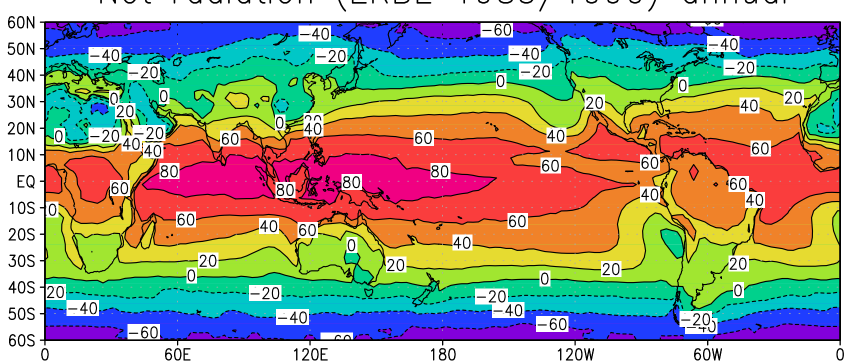
Solar radiation (ERBE 1985/1990) annual



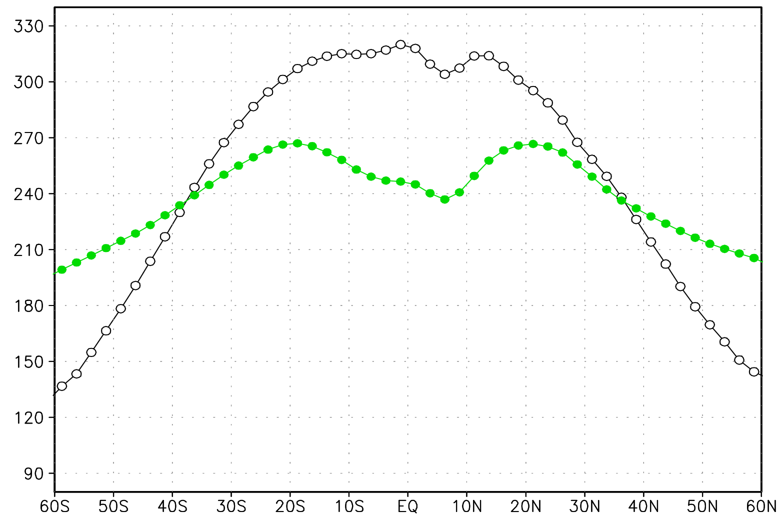
IR radiation (ERBE 1985/1990) annual



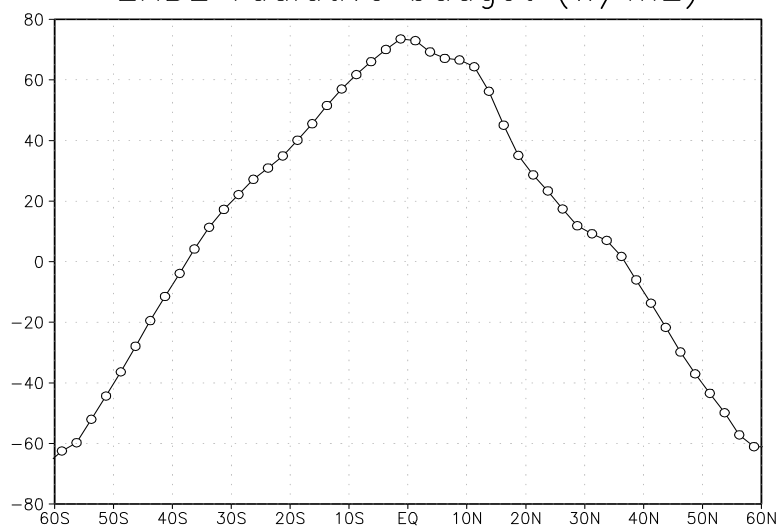
Net radiation (ERBE 1985/1990) annual



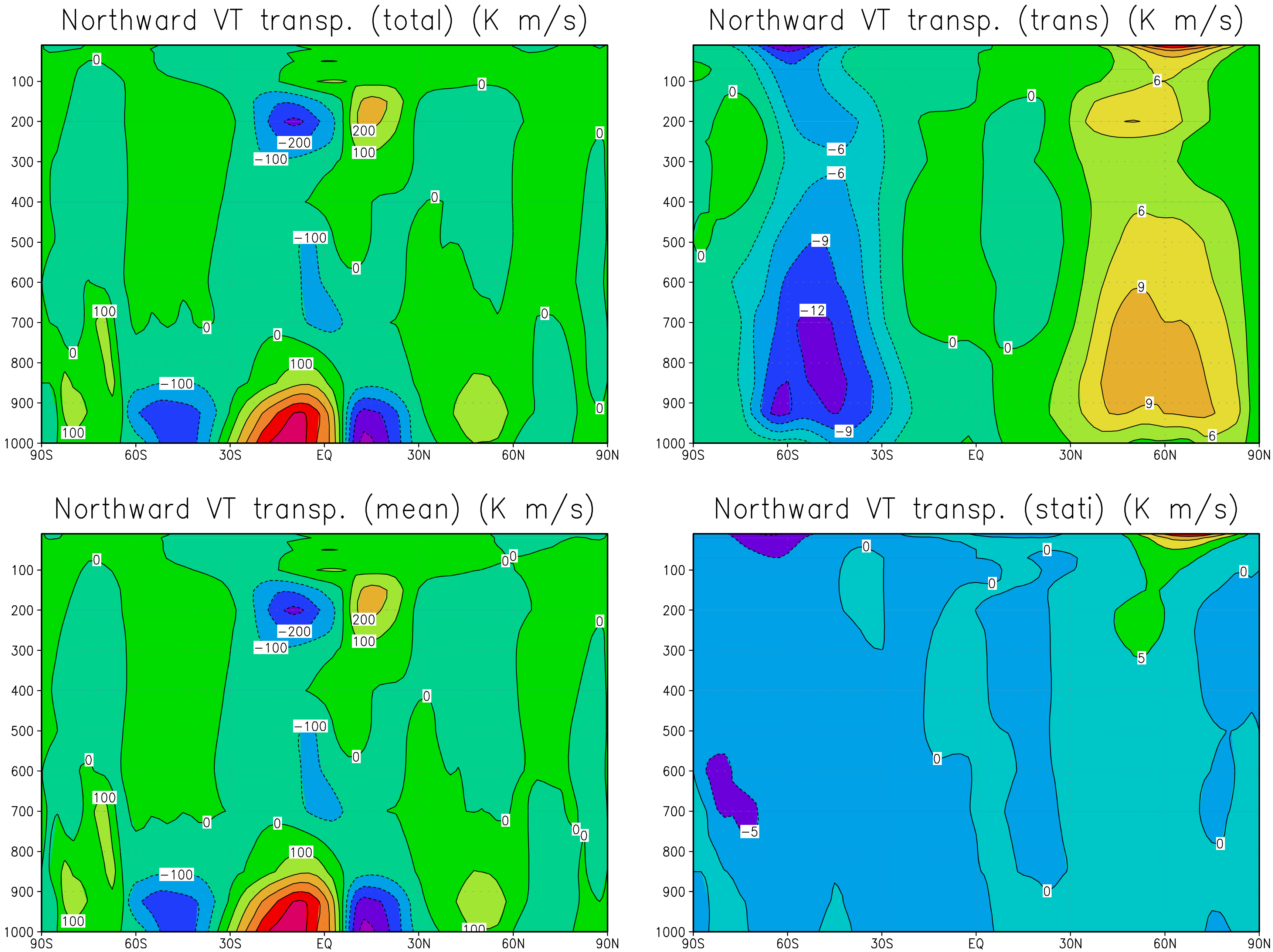
ERBE radiative budget (W/m2)



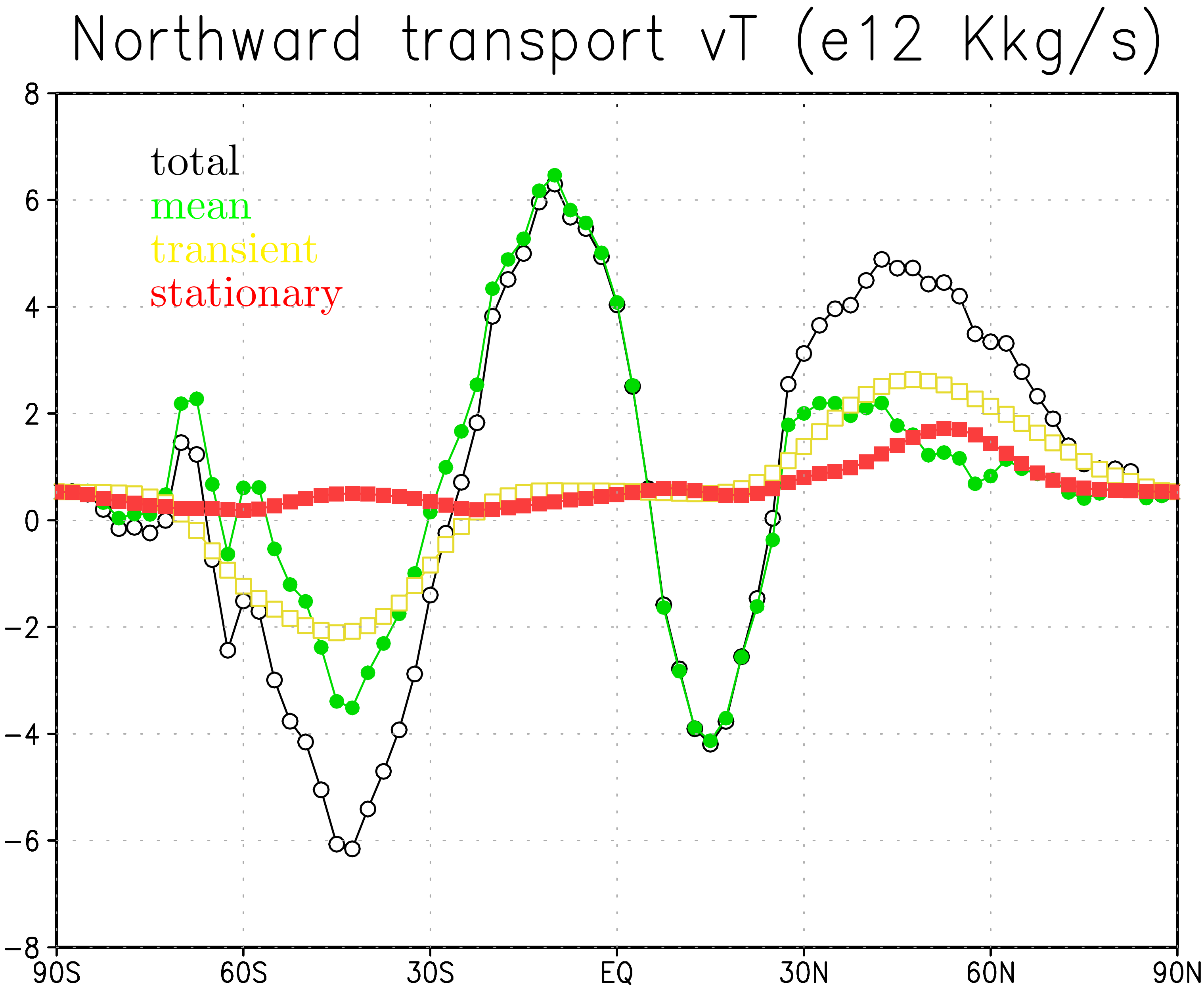
ERBE radiative budget (W/m2)



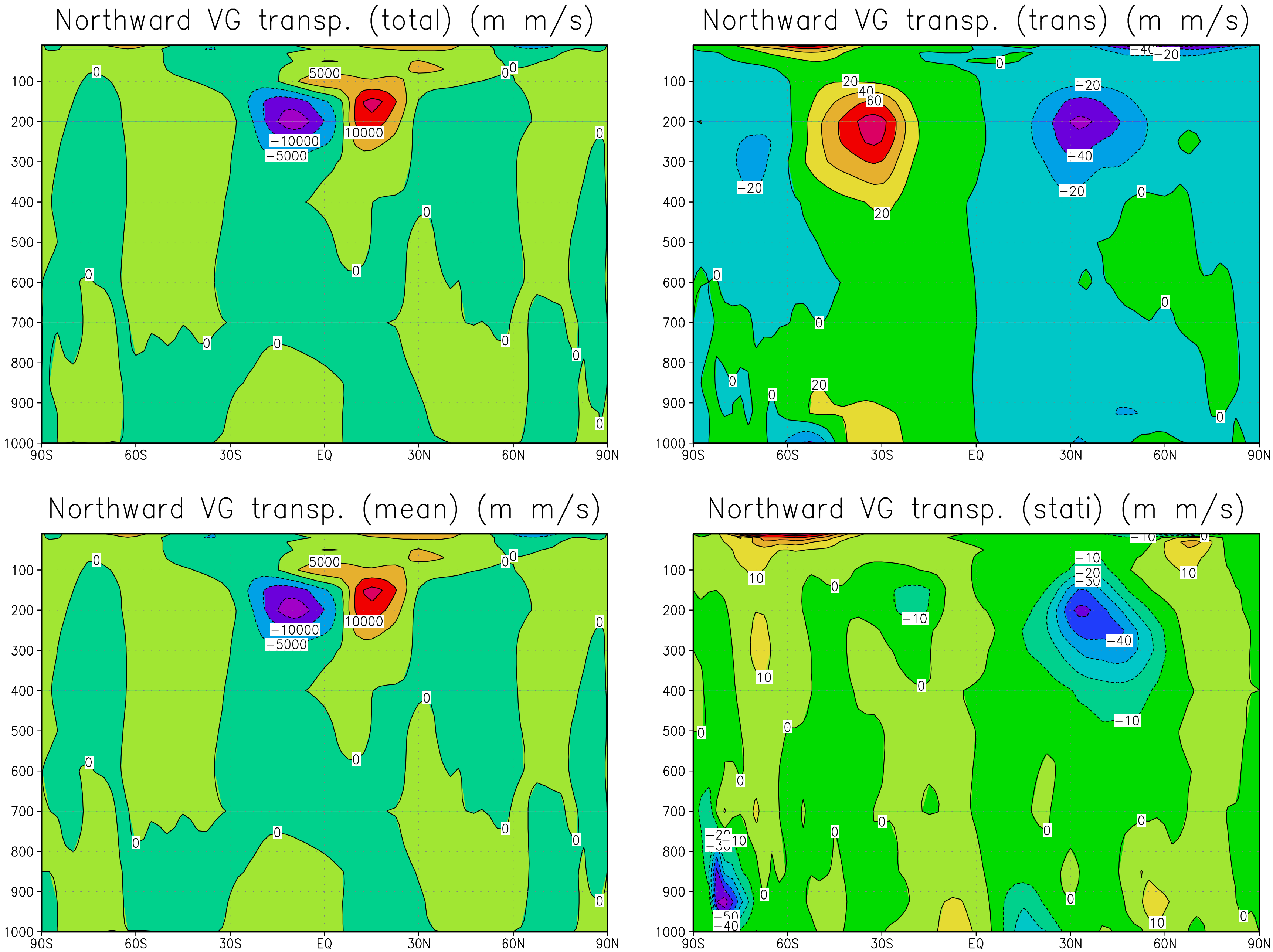
Zonally and annually averaged of vT



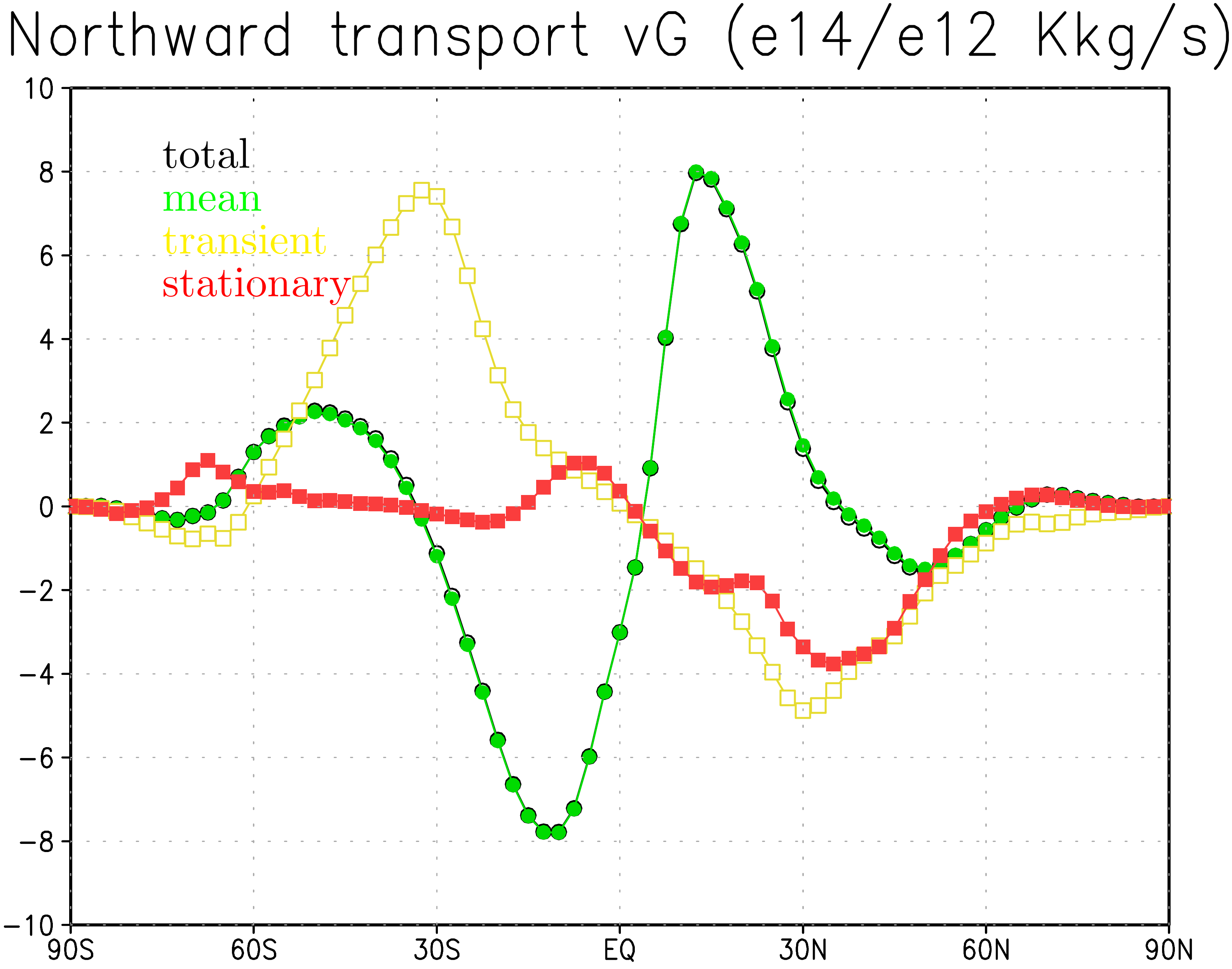
Vertical integration of vT, annual average



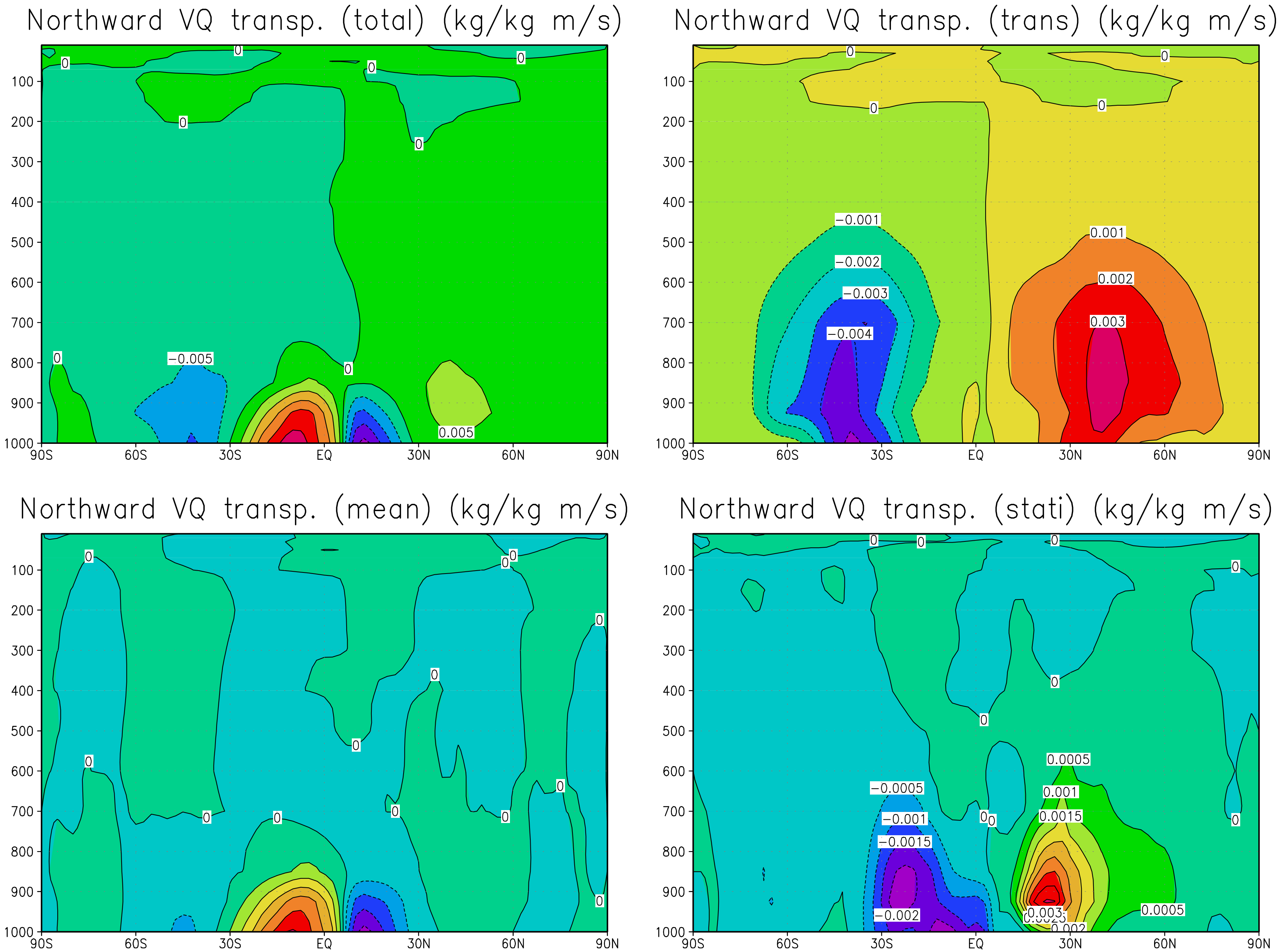
Zonally and annually averaged of vZ



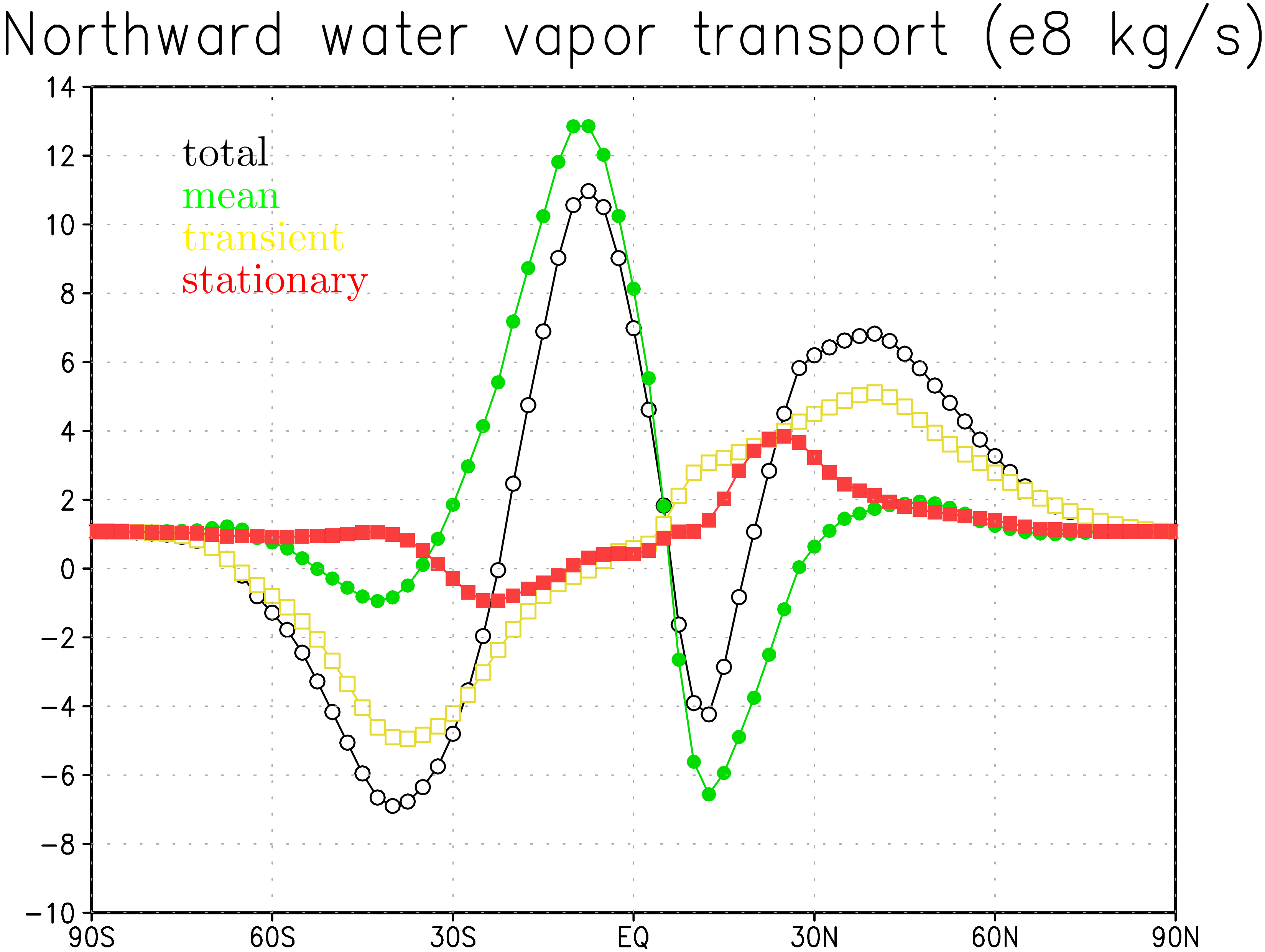
Vertical integration of vZ, annual average



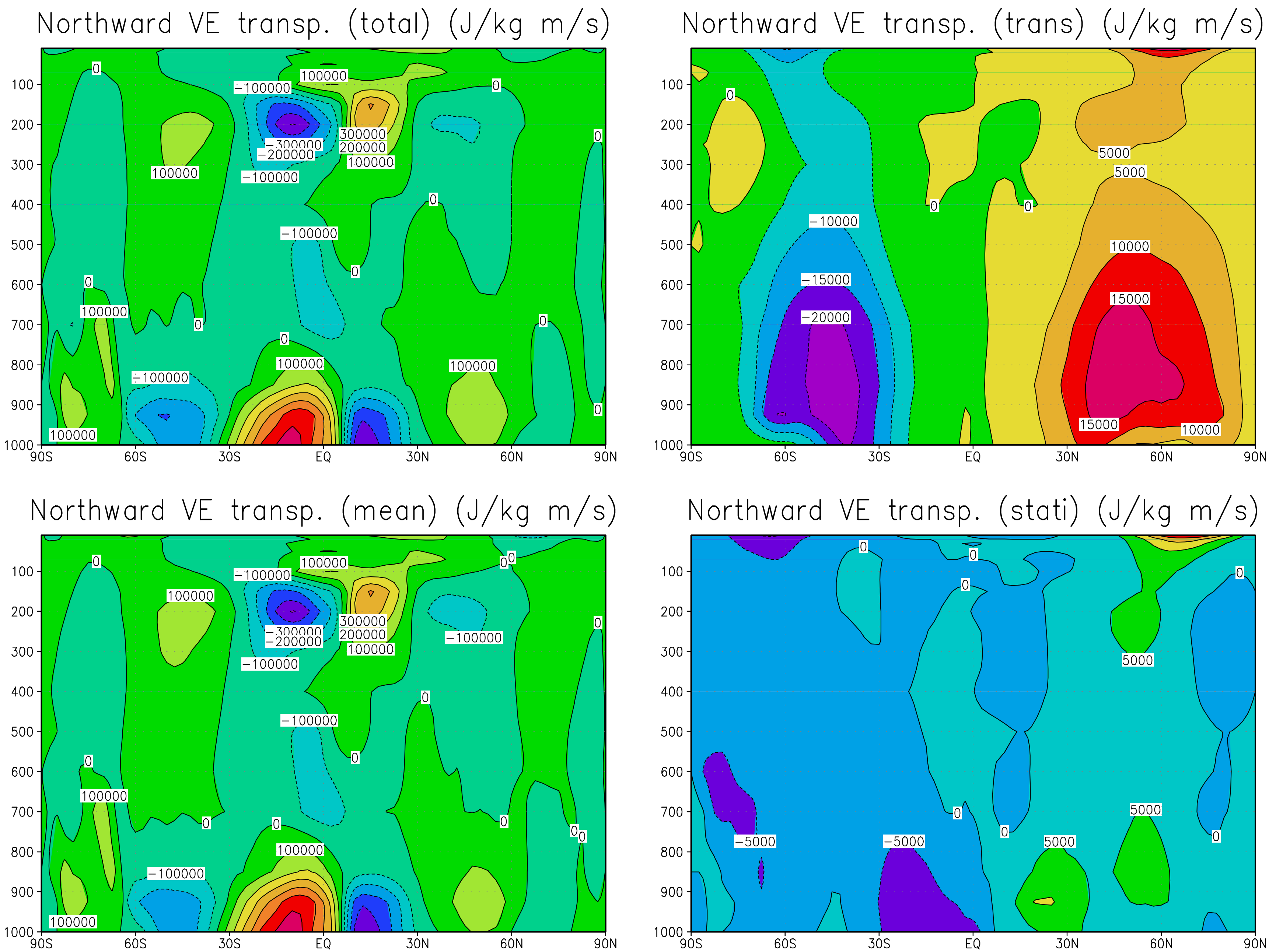
Zonally and annually averaged of vq



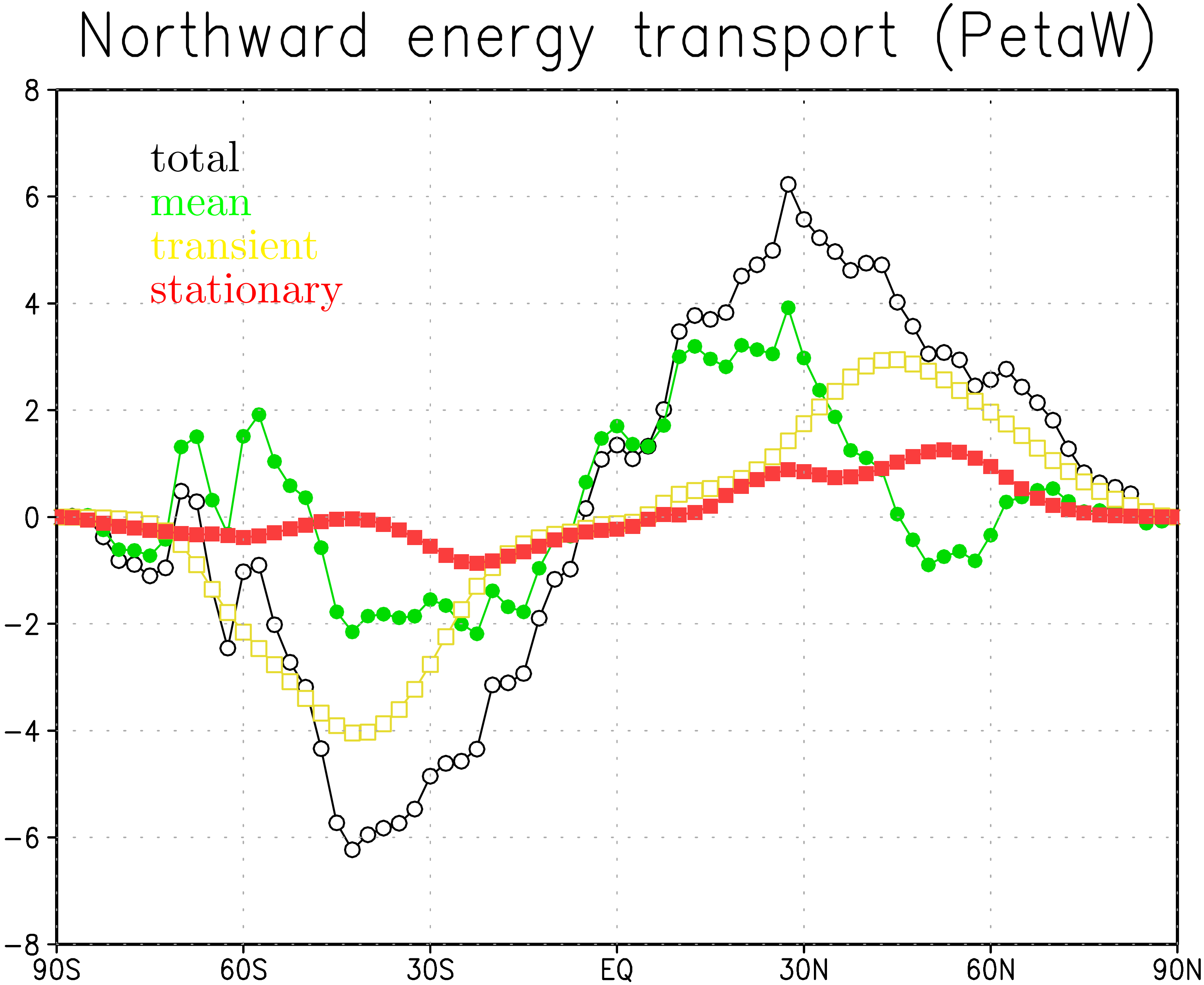
Vertical integration of vq, annual average



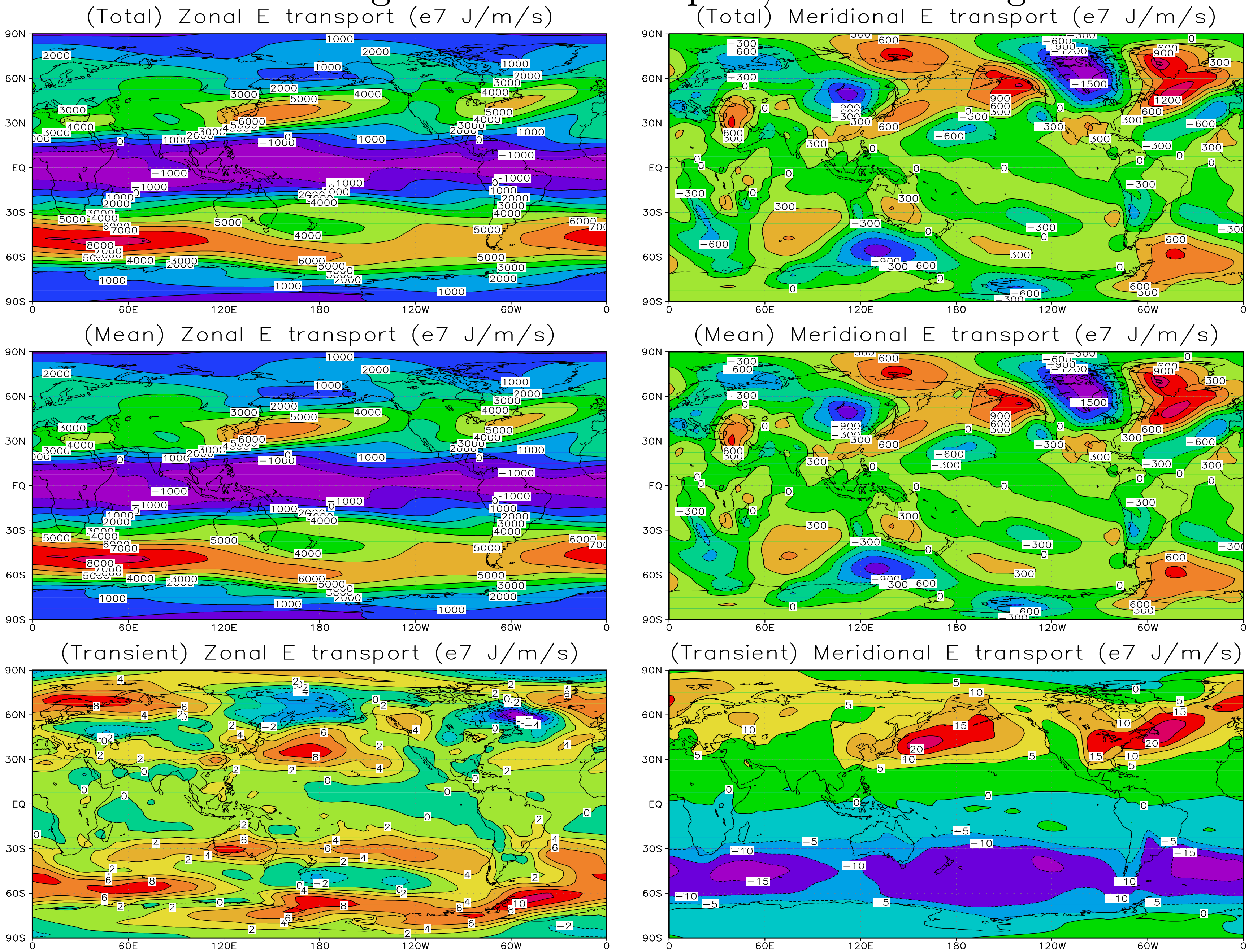
Zonally and annually averaged of vE



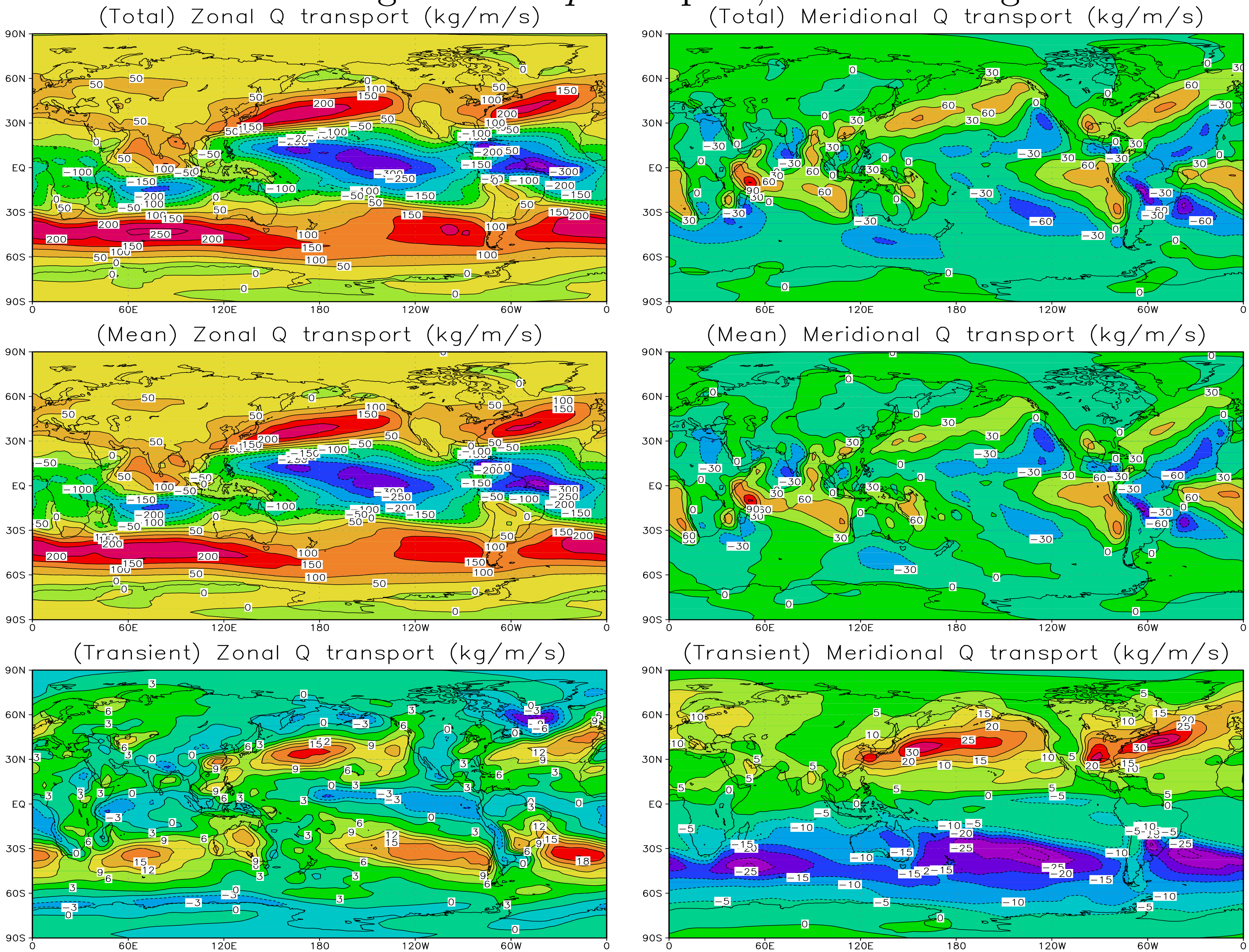
Vertical integration of vE, annual average



Vertical integration of E transport, annual average



Vertical integration of q transport, annual average



Divergence of E transport and q transport, annual average