

*Warm western boundary currents such as the Gulf Stream play an important role in the climate system because they contribute to the meridional heat transport. The Gulf Stream is about 100 km wide, has a depth of 500 m and has a mean speed of  $1 \text{ ms}^{-1}$ .*

a. *Provide an estimate of the volume transport of the Gulf Stream (in Sv).*

The volume transport  $\Phi$  of the Gulf Stream can be estimated by

$$\Phi = UDL$$

where  $L$  is its width,  $D$  its depth and  $U$  its average speed. With the values above, we find  $\Phi = 10^5 \times 1 \times 500 = 50 \text{ Sv}$ .

*The meridional heat transport due to the Gulf Stream depends on the temperature difference between the warm water flowing northward and the cooler water flowing southward.*

b. *Provide an estimate of this temperature difference and of the meridional heat transport associated with the Gulf Stream.*

The meridional heat transport  $\Phi_H$  is given by

$$\Phi_H = \rho C_p U \Delta T D L$$

where  $\Delta T$  is the difference in the temperature between the northward flowing warm water and southward flowing slightly cooler water. When we take  $\Delta T = 5^\circ\text{C}$ , we find

$$\Phi_H = 10^3 \times 4.3 \times 10^3 \times 1 \times 5 \times 500 \times 10^5 = 1.1 \text{ PW}$$