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World of Earth Science | Advection

Earth's atmosphere is a dynamic sea of gases in constant motion and Earth's oceans contain currents that move water across the globe. Advection is a lateral or horizontal transfer of mass, heat, or other property. Accordingly, winds that blow across Earth's surface represent advectional movements of air. Advection also takes place in the ocean in the form of currents. Currently, geologists debate the presence and role of substantial advective processes in Earth's mantle.

Differential pressures and temperatures drive the mass movement of air seeking equilibrium (the lowest energy state). Advective winds move from areas of higher temperature toward areas of lower temperature. In contrast, convection, the vertical movement of mass or transfer of heat, manifests itself as air currents. Accordingly, winds are a result of advection, while air currents are a result of convection.

Although in a gaseous state, the atmosphere observes fluid-like dynamics. This is an important consideration when considering advection, because advection is usually more pronounced in the movement of fluids. For example, advection also takes place in the oceans where advection is broadened to include the lateral (horizontal) transfer of not only fluid mass and heat, but of other properties such and oxygen content and salinity.

In the atmosphere, advection is the sole process of lateral transfer of mass. In contrast, vertical transfer occurs via conduction, convection, and radiation. Just as ocean currents permit heat transfer from areas of warm water to an area of water with cooler temperatures, advective winds allow the transfer of both sensible heat and latent heat (a function of humidity).

Although advection processes are important heat equilibration mechanisms for both the atmosphere and the oceans, the speed and volume of mass transported differs greatly between the atmosphere and oceans. The magnitude of heat transference depends on heat flux (the rate of heat transport), and flux in turn relates the transfer of heat energy in terms of area and time. Both processes contribute approximately equally because wind currents are much faster (higher rate) than ocean currents but ocean currents move substantially denser masses of molecules.

Advection is also responsible for the formation of advection fog. Advection fog usually occurs when the atmosphere is very stable so that moist (humid) air near the surface does not mix vertically with an overlying layer of drier air. The advection fog forms as warm and moist air moves horizontally along the cooler surface and the air near the surface is cooled to its dew point.

See also Adiabatic heating; Atmospheric circulation; Atmospheric composition and structure; Atmospheric inversion layers; Atmospheric lapse rate; Atmospheric pressure; Convection (updrafts and downdrafts); Insolation and total solar irradiation; Wind chill; Wind shear