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Global and regional entropy budgets of the Atmosphere

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The balance equations for the entropy in the atmosphere are presented and discussed. Using observed energy fluxes and the atmospheric temperatures, we present estimates of the various terms involved in the global mean entropy budget. The largest boundary fluxes of entropy are associated with the emission of longwave radiation. Fluxes of entropy associated with turbulent and molecular diffusions are found to be much smaller. On the planetary scale the mean outgoing flux of entropy at the top of the atmosphere is found to be about 24 times larger than the mean incoming flux of entropy associated with solar radiation. The rates of entropy production and destruction, by the various irreversible processes that occur in the atmosphere, are also computed. The largest sources of entropy for the atmosphere are, by far, the entropy production terms involved in the release of latent heat and the absorption of solar radiation, whereas the production of entropy associated with the absorption of longwave radiation is an order of magnitude smaller. The Entropy "destruction" is mainly accomplished through cooling by outgoing longwave radiation. The contributions of the sensible heat fluxes and friction are relatively small. A detailed zone-by-zone analysis has been performed on a seasonal basis. Therefore, regional contributions to the total entropy generation in the atmosphere are studied by considering 6 regions bounded by two latitudinal walls and a polar region poleward of 70^0 N. The entropy sources and sinks are not uniformly distributed. The rates of entropy generation by the various diabatic processes are higher in the equatorial region and part of the generated entropy is exported to higher latitudes. In general, they are stronger in the summer. An attempt has been made to depict a three dimensional distribution of the entropy sources and sinks of the two main processes. An explanation of the negantropy generation required to maintain the general circulation of the atmosphere is given, by showing that the heating and cooling of the atmosphere occurs mainly in selected and preferentially hotter and cooler regions, respectively. This tendency for some order generates the required negantropy.