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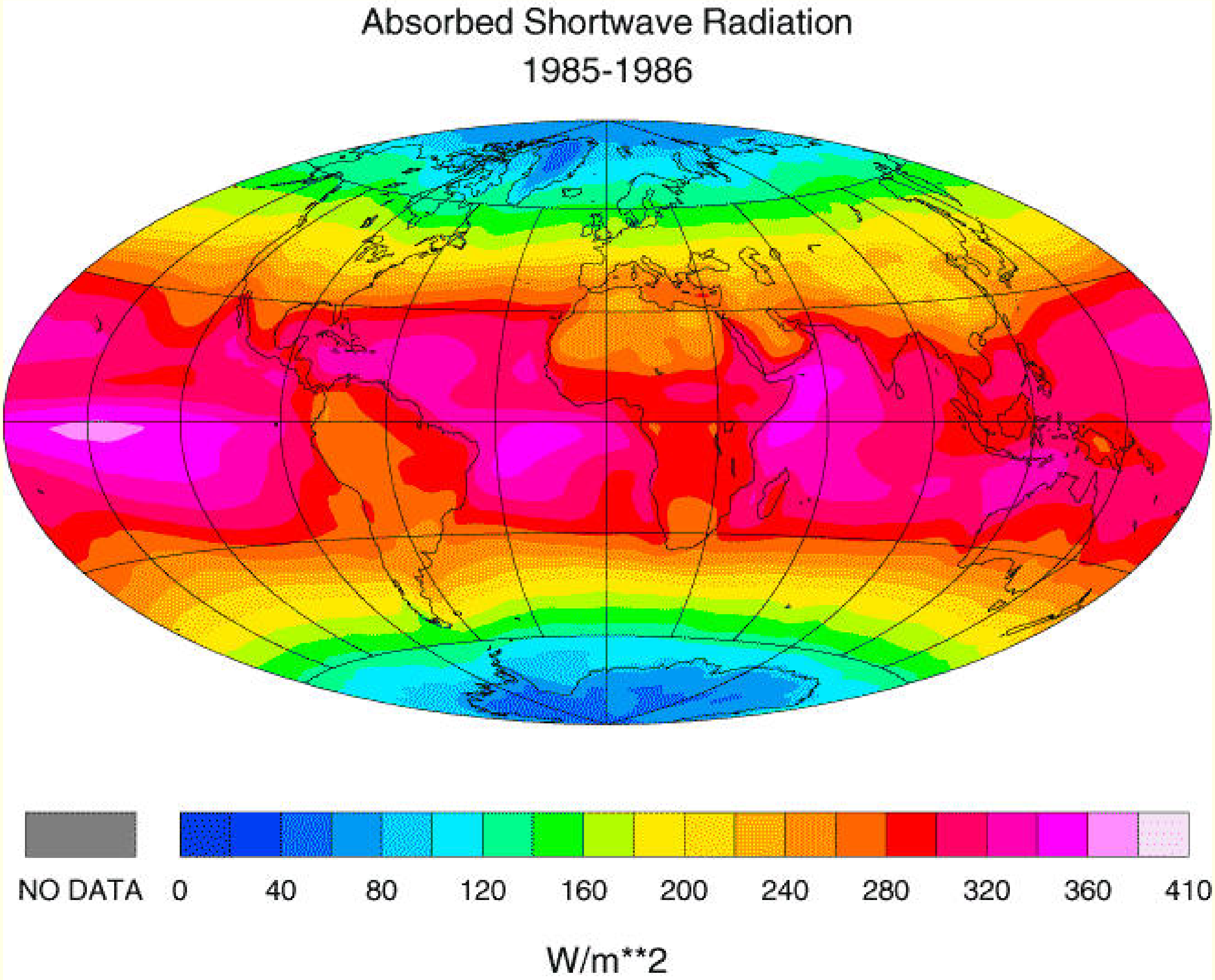
This takes into account the geographical variations in solar declination angle and local albedo.



Global distributions of the annual-mean absorbed shortwave radiation at the top of the atmosphere (ERBE data).

Incoming Shortwave Radiation

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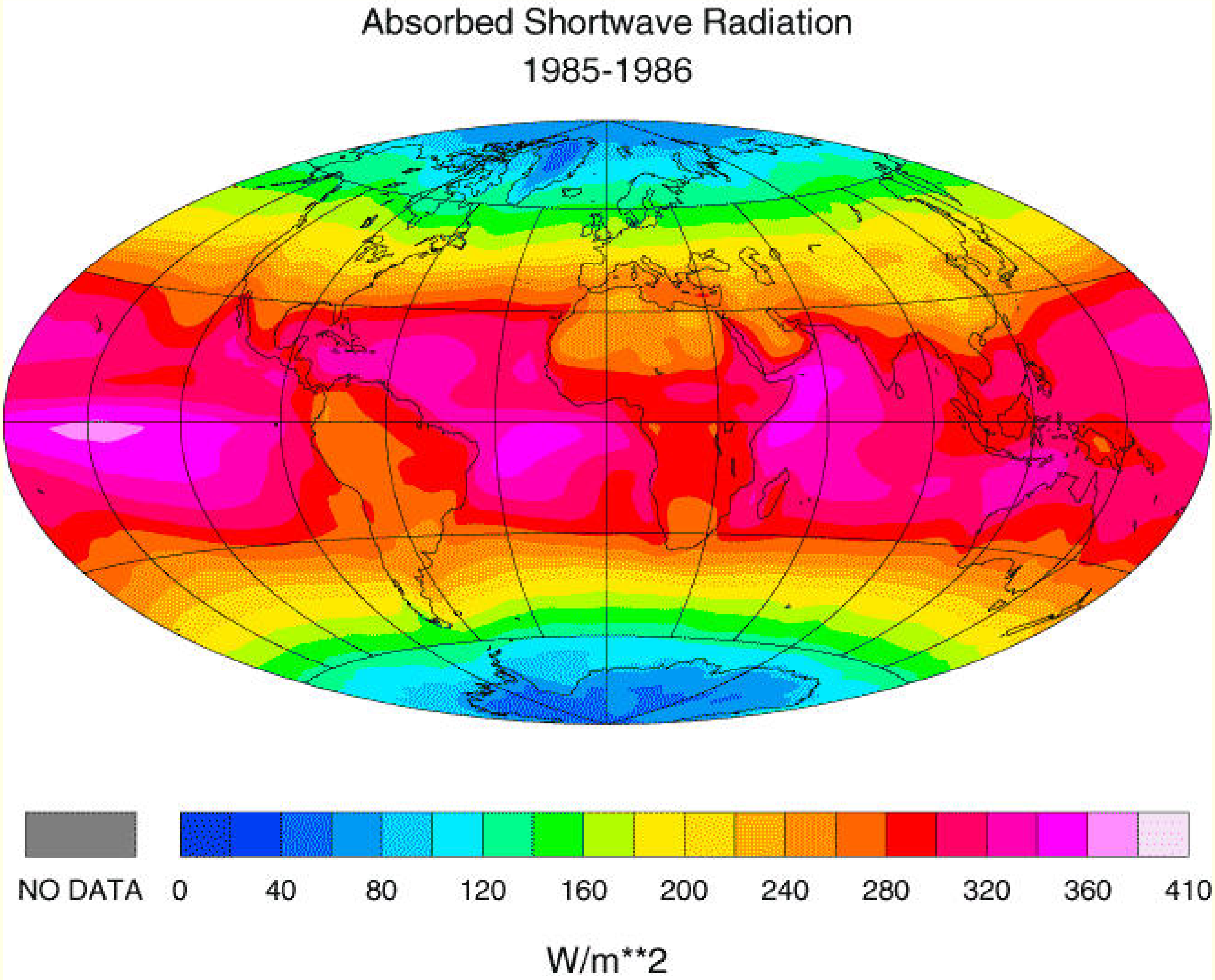
- **Here the winters are dark and the continuous summer daylight is offset by the high solar zenith angles, widespread cloudiness and the high albedo of ice covered surfaces.**



Global distributions of the annual-mean absorbed shortwave radiation at the top of the atmosphere (ERBE data).

Outgoing Longwave Radiation

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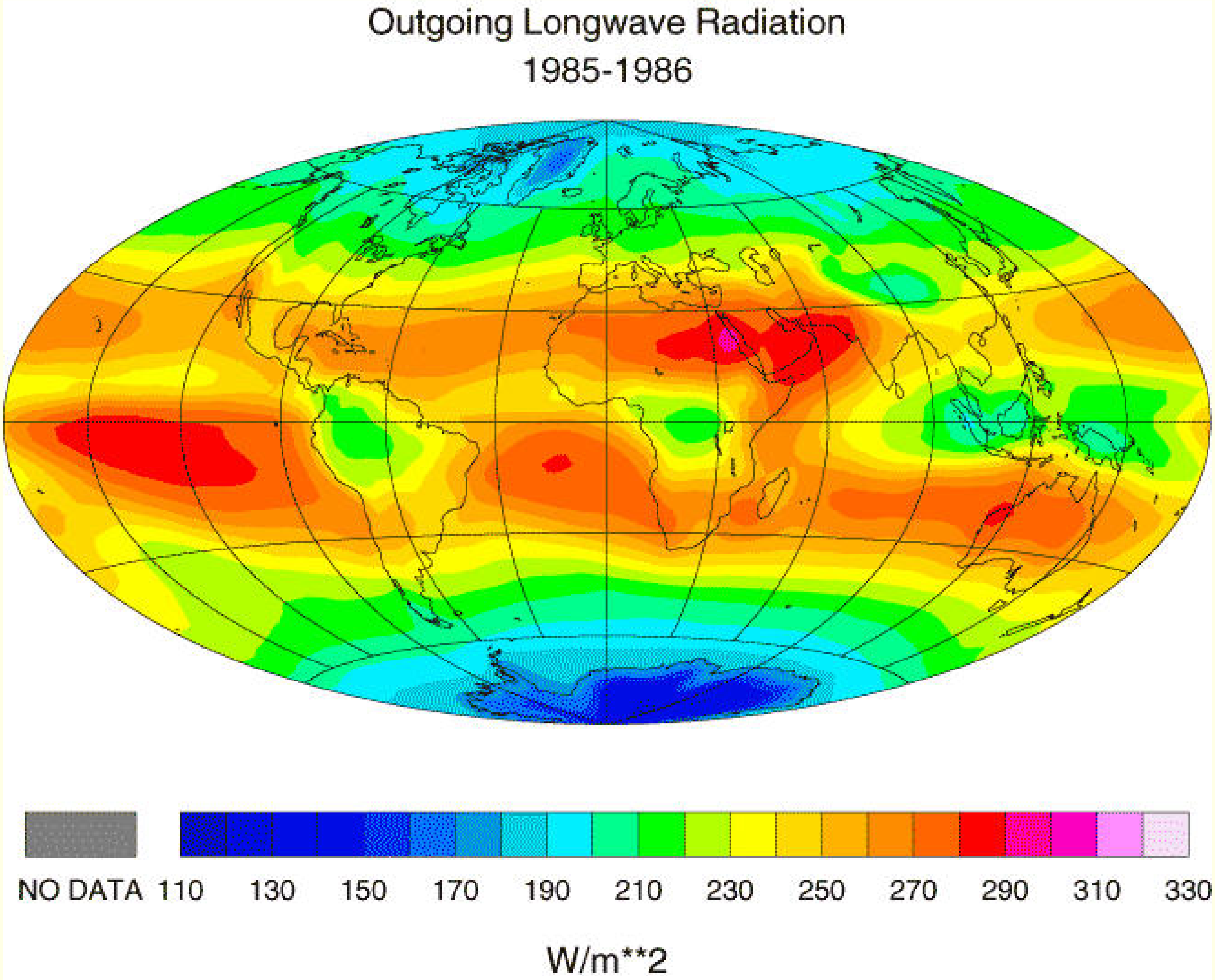
The corresponding distribution of outgoing longwave radiation (OLR) at the top of the atmosphere, is shown next.

It exhibits a gentler equator-to-pole gradient and more regional variability within the tropics.



Global distributions of the annual-mean outgoing longwave radiation at the top of the atmosphere (ERBE data).

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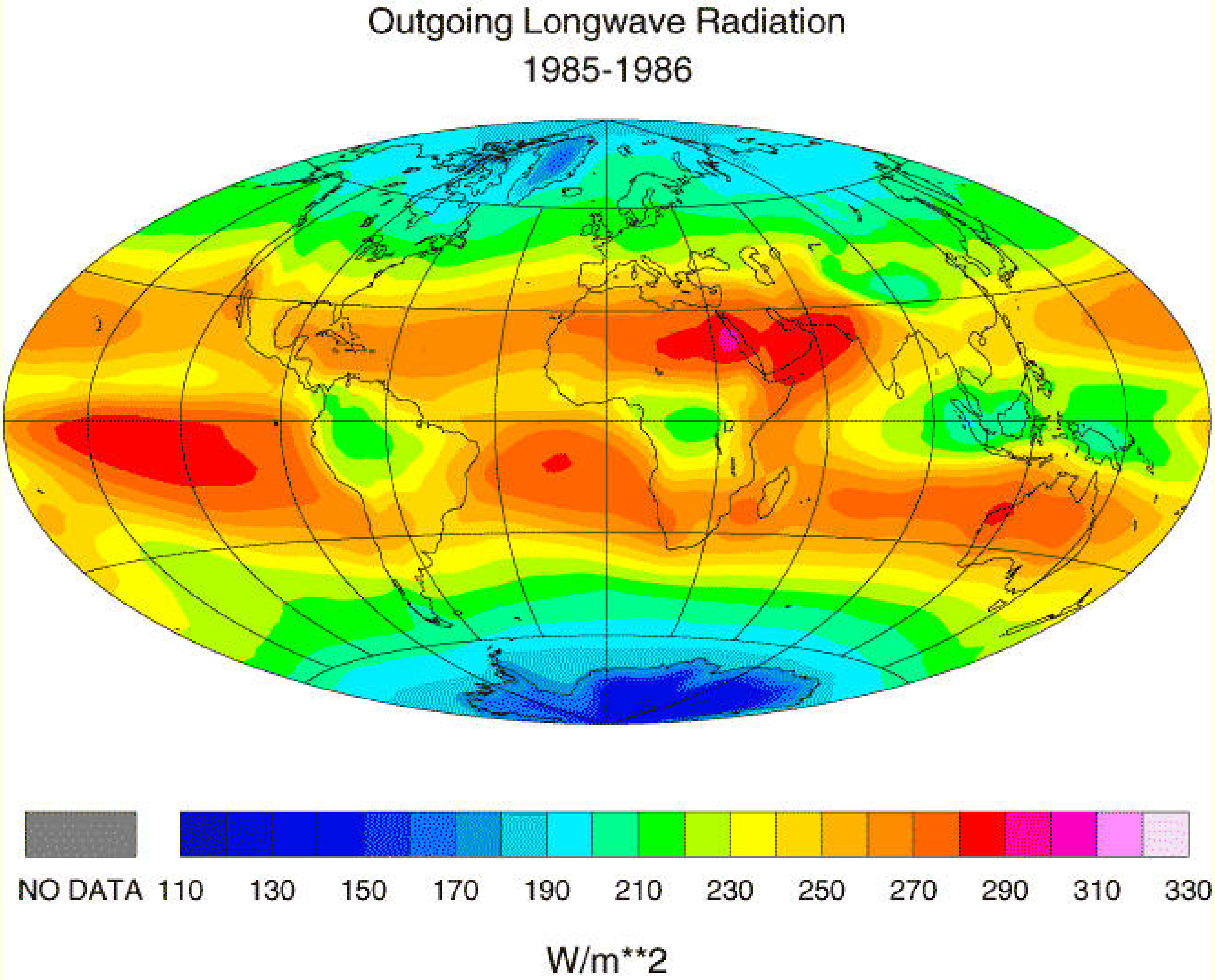
- **the intertropical convergence zone is also evident as a local OLR minimum.**
- **The areas with the highest annual mean OLR are the deserts and the equatorial dry zones over the tropical Pacific, where the atmosphere is relatively dry and cloud free.**



Global distributions of the annual-mean outgoing longwave radiation at the top of the atmosphere (ERBE data).

Net Radiation at TOA

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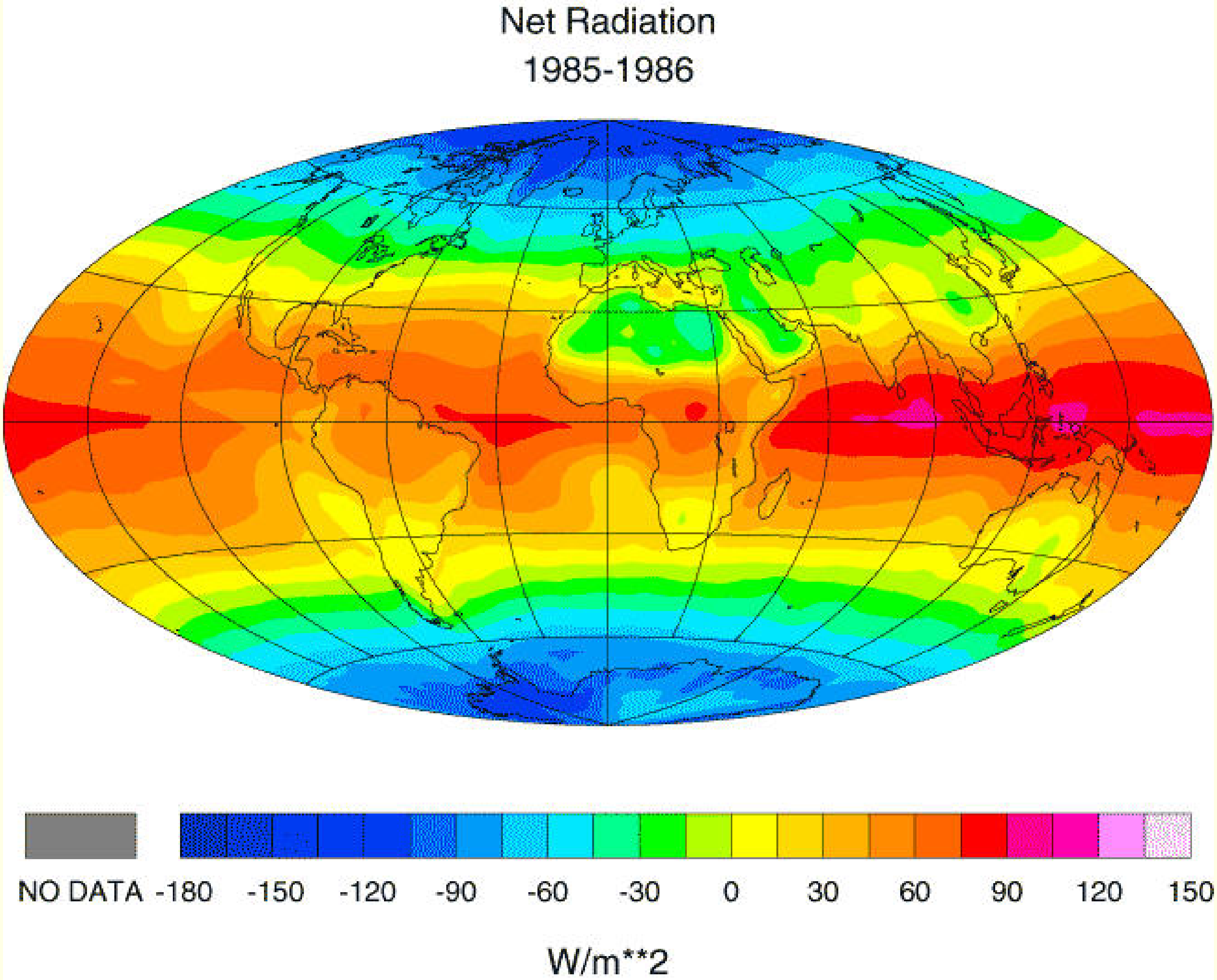
The *net* downward radiation at the top of the atmosphere (i.e., the imbalance between net solar and outgoing long-wave radiation at the top of the atmosphere) is obtained by taking the *difference* between the two distributions seen already.



Global distribution of the net imbalance between the annual-mean net incoming solar radiation and the outgoing longwave radiation. Positive values indicate a downward flux (ERBE data).

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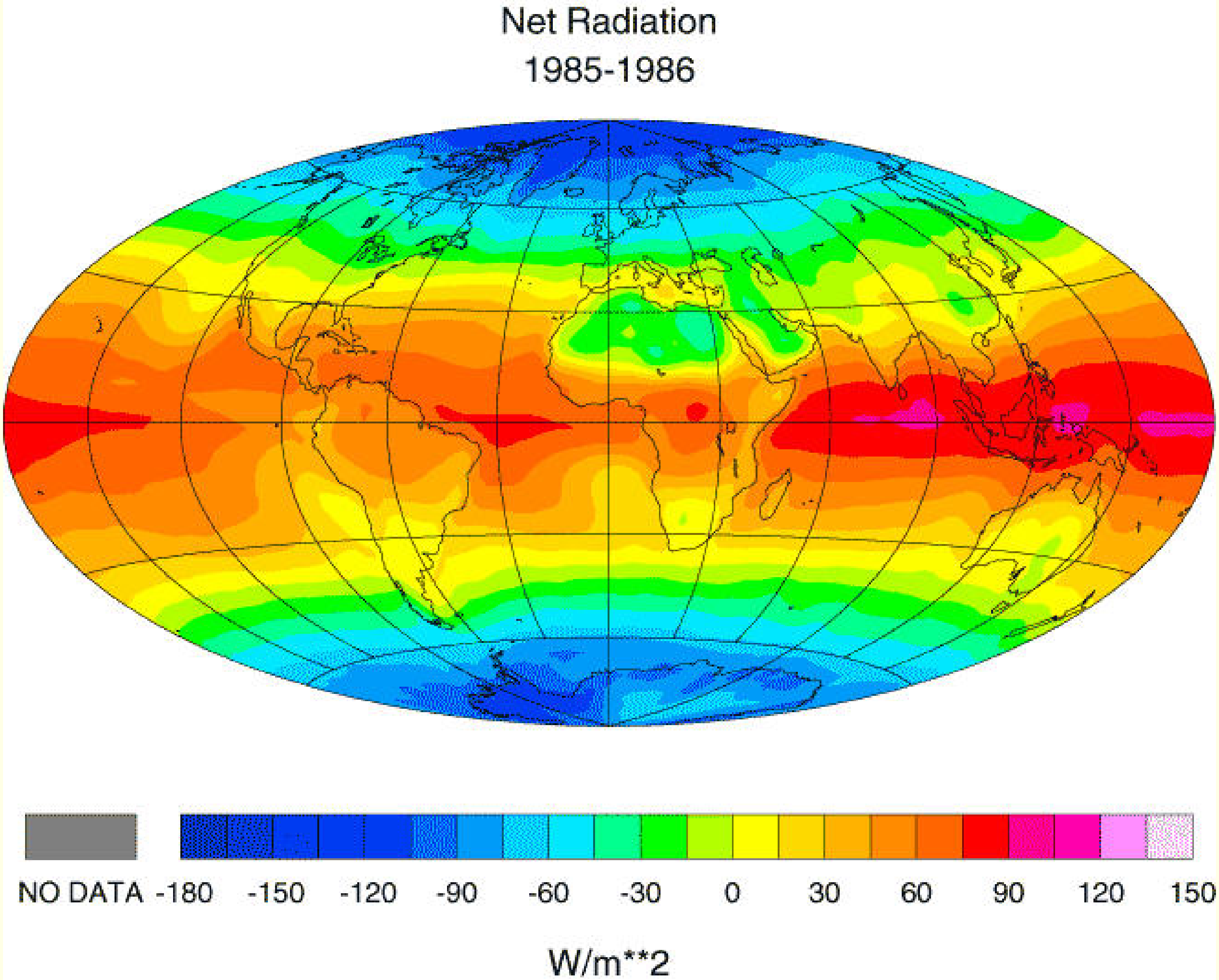
It is notable that over some of the world's hottest desert regions, the outgoing longwave radiation exceeds absorbed solar radiation. Radiation deficits prevail over these regions even during summer.



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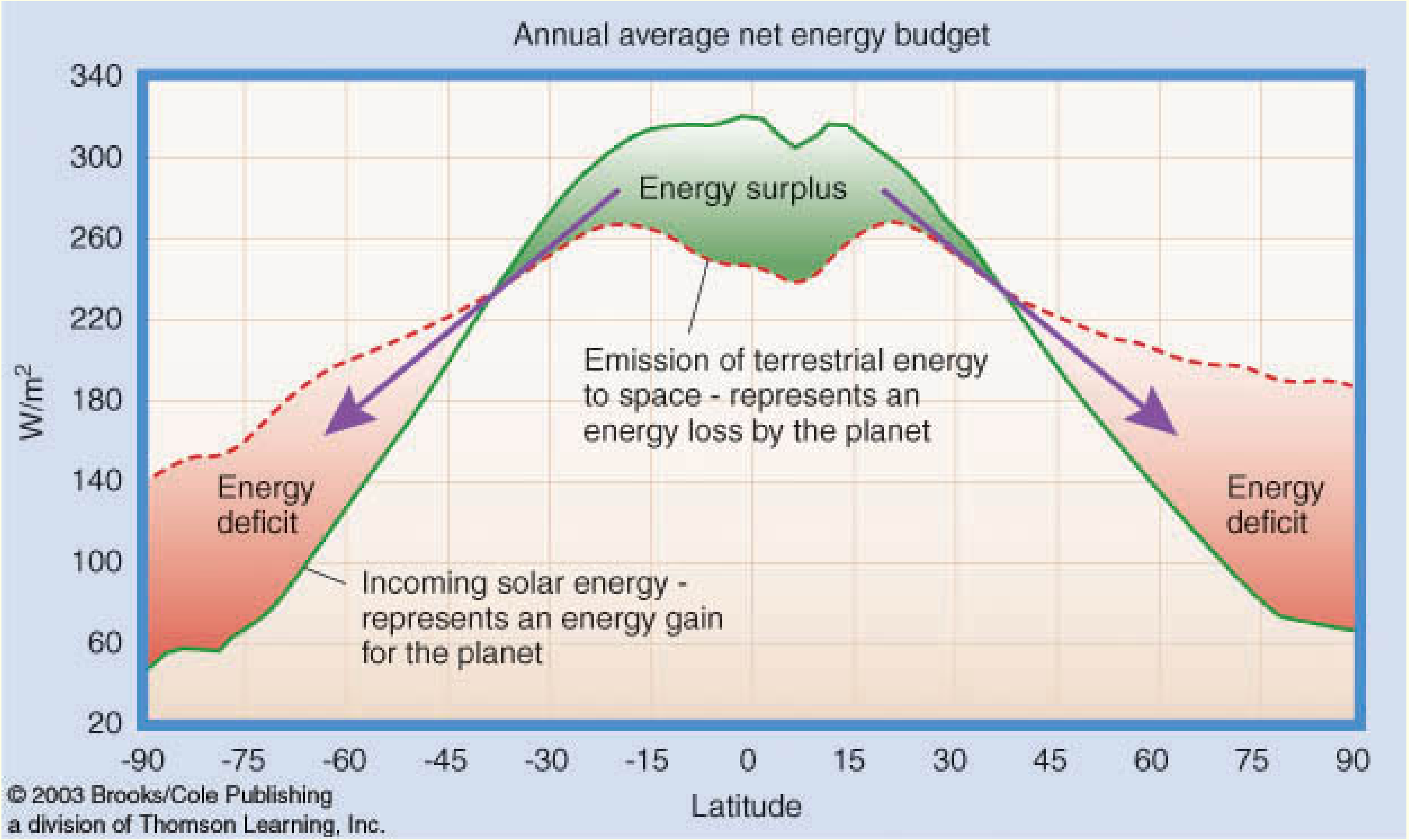

Zonally averaged radiation balance in the atmosphere.

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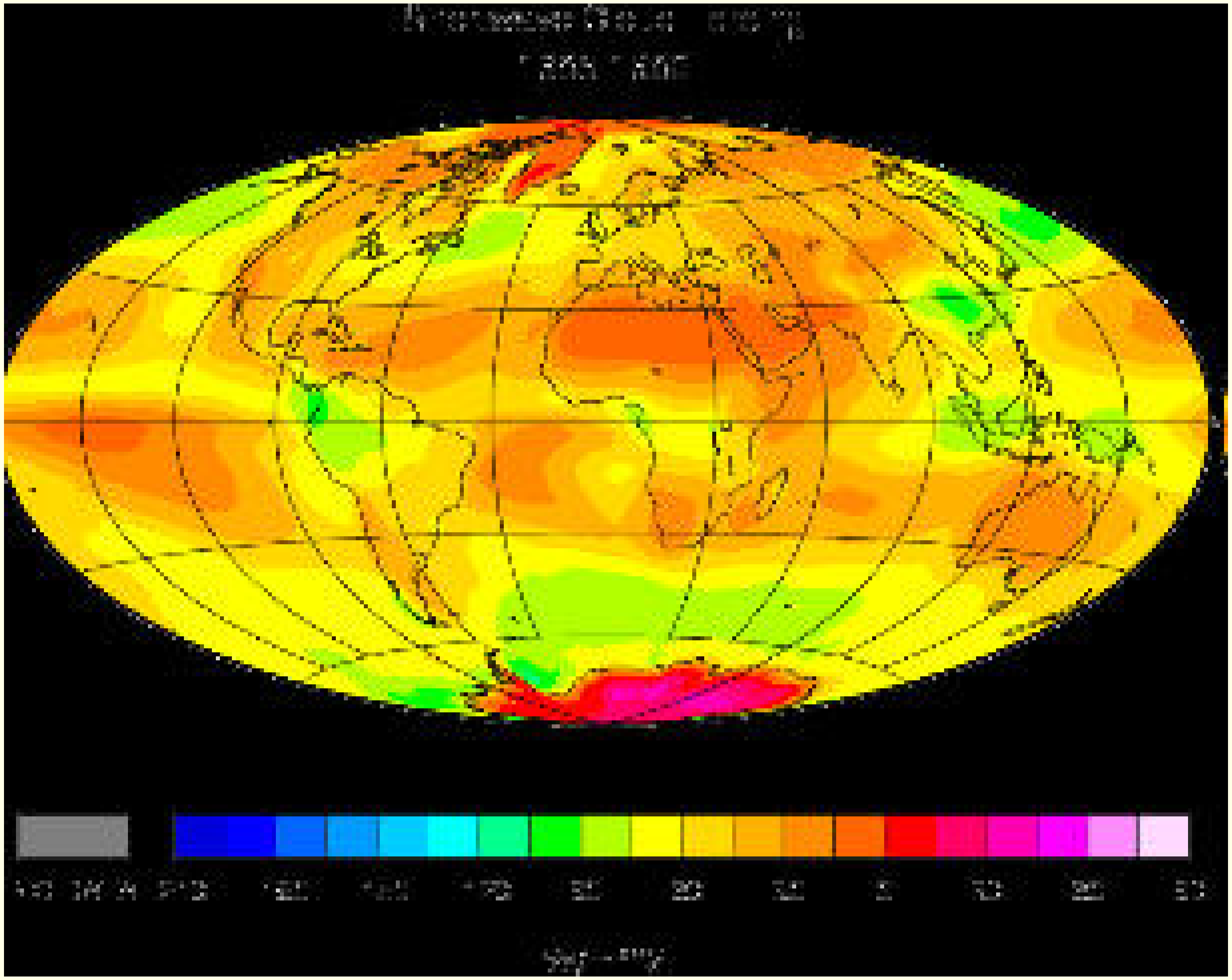
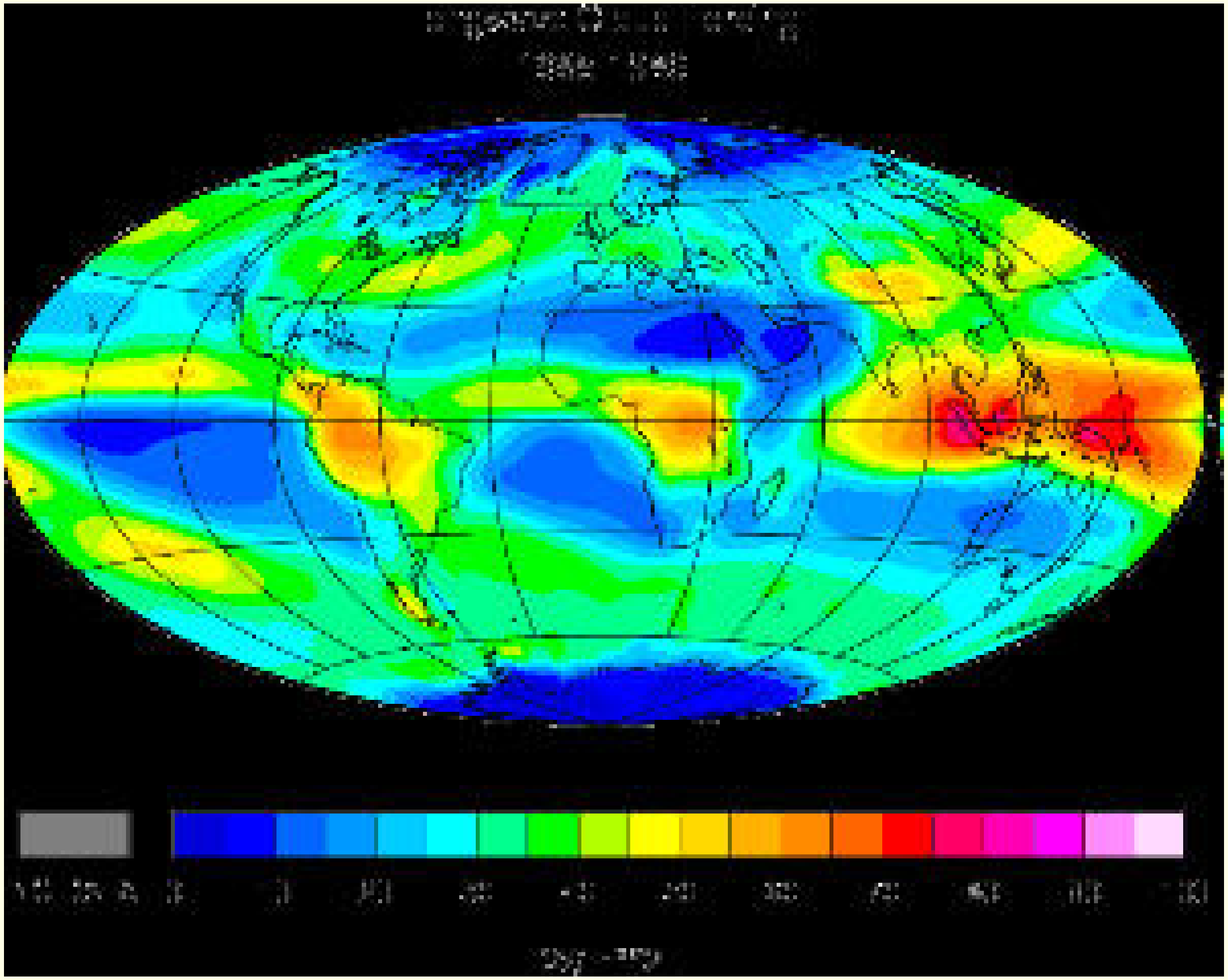
For example, the high albedo of the deep convective clouds over the tropical continents and the ITCZ reduces the incoming shortwave radiation in those regions, while the coldness of the tops of those clouds reduces the outgoing longwave radiation.



Global distribution of annual-mean cloud forcing of the radiative fluxes at the top of the atmosphere. Positive values indicate an enhanced flux due to the presence of clouds and vice versa. Based on data from the NASA Earth Radiation Budget Experiment.



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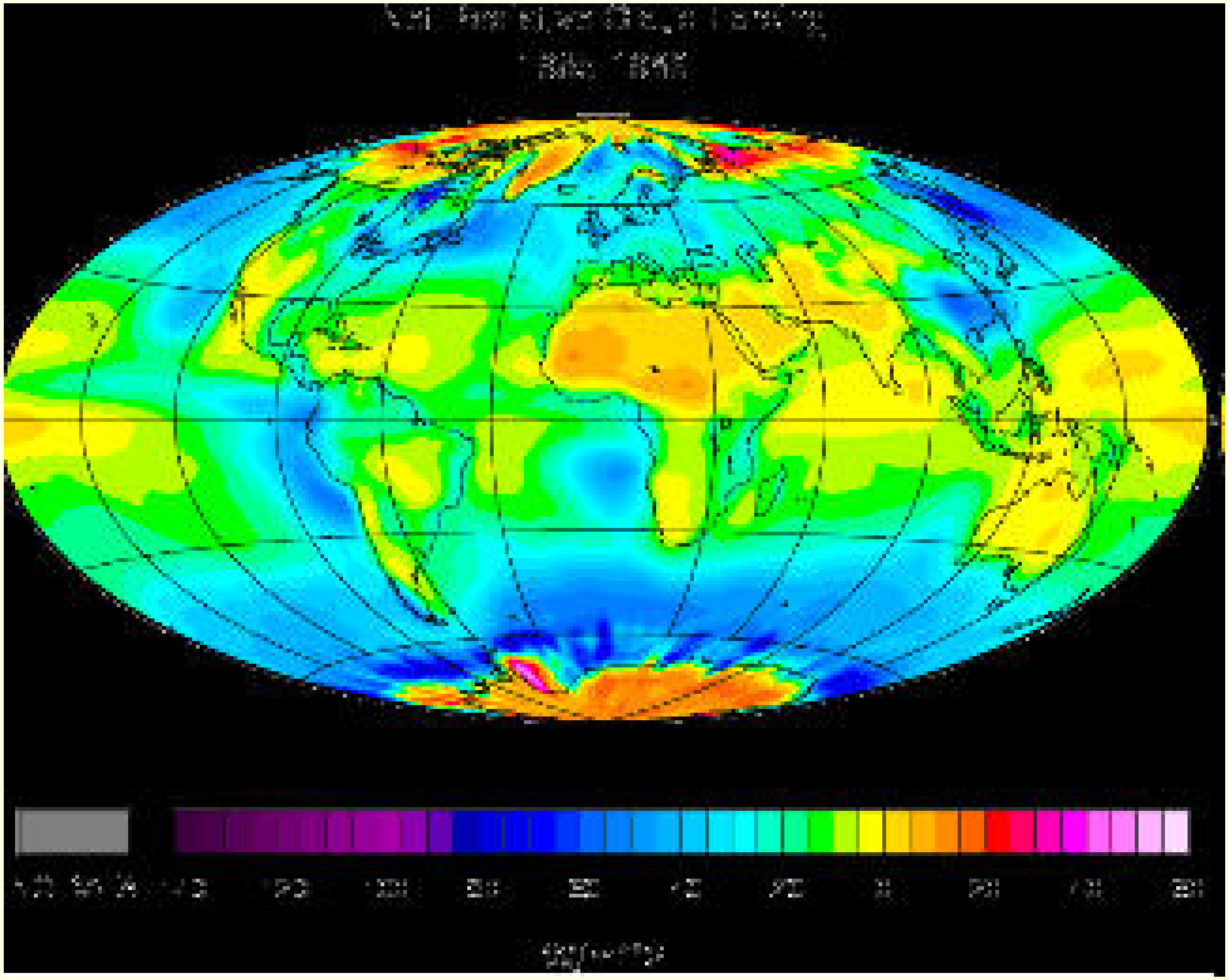
The largest negative values correspond to regions of persistent low cloud decks that are of sufficient optical thickness to reflect much of the incoming solar radiation back to space, but whose tops are low, and warm enough so that they emit almost as much longwave radiation as the underlying ocean surface.



Global distribution of annual mean net cloud forcing of the radiative fluxes at the top of the atmosphere. Positive values indicate an enhanced downward flux due to the presence of clouds and vice versa. Based on data from the NASA Earth Radiation Budget Experiment.

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The energy balance at the earth's surface is more complicated because conduction of latent and sensible heat across the earth's surface also play important roles.

Likewise, the distribution of temperature within the atmosphere is determined not by radiation alone but by the interplay between radiative transfer, turbulent convection, and large-scale motions.

End of §4.4