

# Dependence of Atmospheric Meridional Heat Transports in Aqua Planets on Solar Constant

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The runaway greenhouse state is an important concept for understanding the variety of climates of the terrestrial planets. The previous studies using one-dimensional radiative-convective equilibrium model shows that there are an upper limit of outgoing longwave radiation (OLR) emitted from the top of atmosphere on planet with ocean (Nakajima *et al.*, 1992). The atmosphere, which takes incoming solar radiation greater than the upper limit of OLR, is in a runaway greenhouse state.

Ishiwatari *et al.* (2002) uses three-dimensional spherical gray atmosphere model to show that upper limit of OLR appears. They also shows that the meridional distribution of OLR and temperature is flattened as the increasing of solar flux. This is because that latent heat flux is increased under increased solar constant.

In this study, three-dimensional spherical non-gray atmospheric model, DCPAM, is used in order to calculate more Earth-like atmosphere. We perform five experiments, which has different solar constant,  $S = 1366, 1500, 1600, 1800, 2000 \text{ W/m}^2$ , and integration times are 41, 11, 11, 11, 21 years respectively. Energy flux for each solar constant is shown in Fig 1. Energy transport which is sum of latent energy transport and dry static energy transport increases as solar constant is increased. Latent energy transport increases as solar constant is increased up to  $S = 1800 \text{ W/m}^2$ . Dry static energy transport has maximum in  $S = 1500 \text{ W/m}^2$  but increasing solar constant over  $S = 1600 \text{ W/m}^2$  cause decrease dry static energy flux. Latent energy transport is dominant in total energy transport.

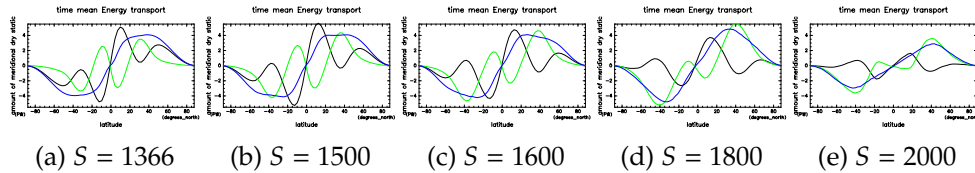


Figure 1: Meridional distributions of heat transports for all experiments. Blue lines are total transports, green lines are latent energy transports, and black lines are dry static energy transports. Horizontal axis is latitude [deg] and vertical axis is amount of energy flux [PW].