Changing Hydrologic Exchanges in a Warming World

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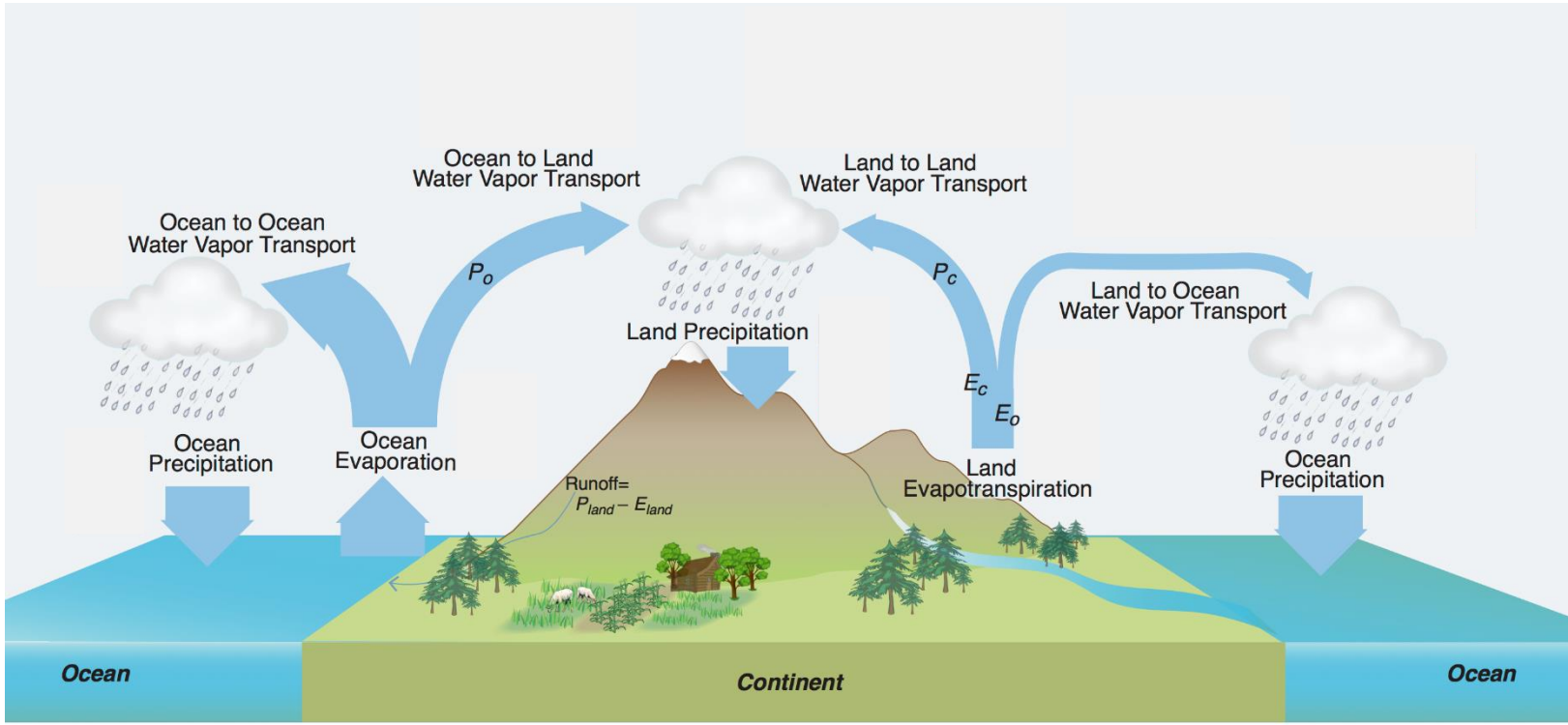
Presenting author during live chat: *Ruud van der Ent – TU Delft*

What is the magnitude of each of these terms in the global hydrological cycle?

How will they change in a warming world?

We can address these questions with water tracking algorithms

- e.g., WAM-2layers, van der Ent et al. (2010 WRR, 2014 ESD)
- GFDL's ESM2G (Dunne et al., 2012, 2013)

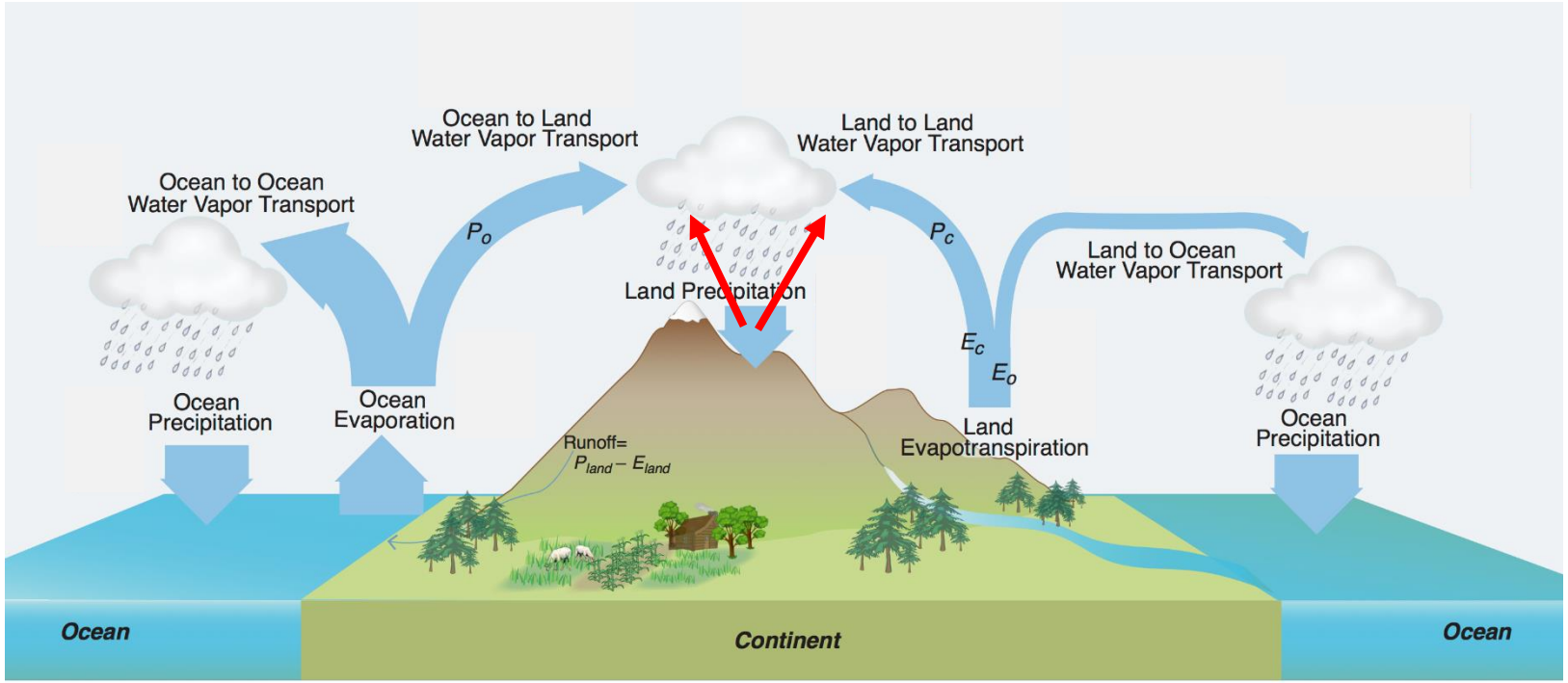


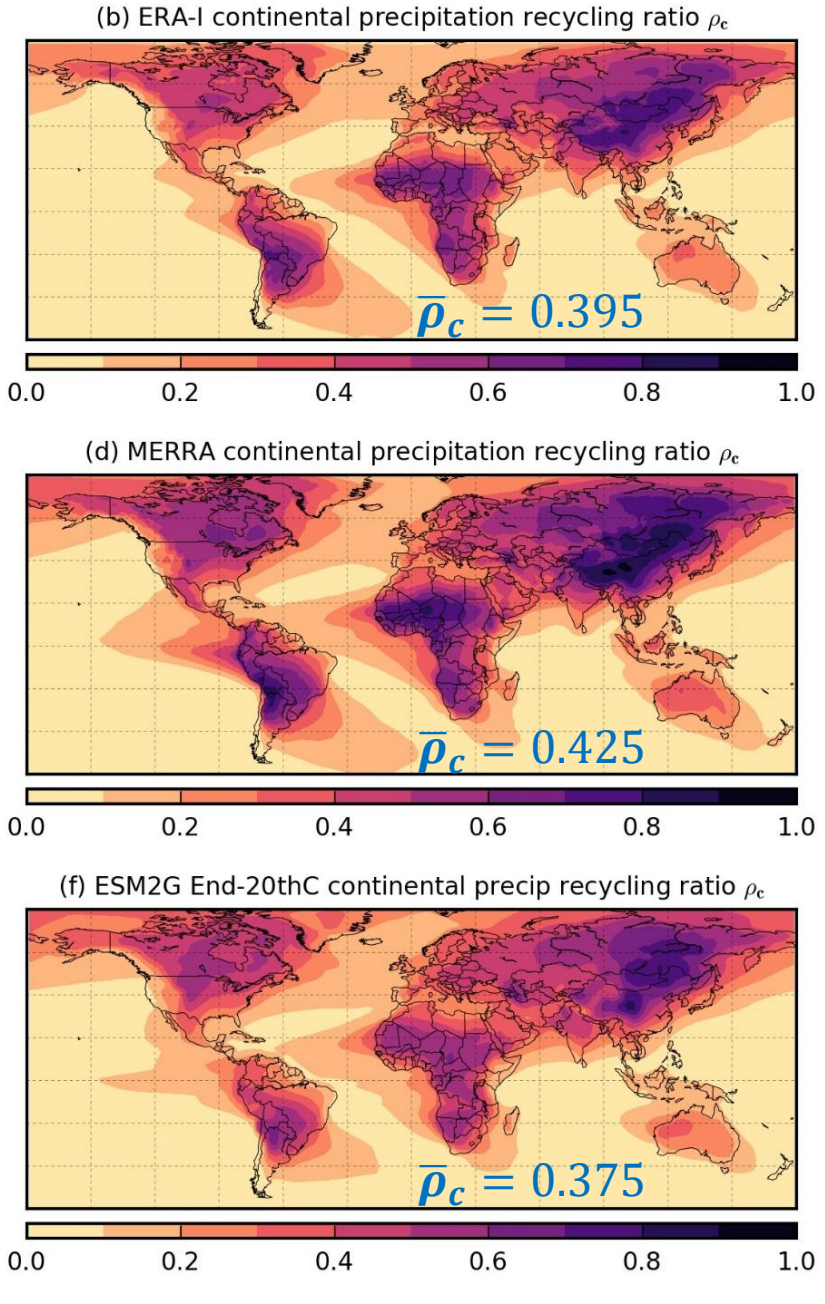
Findell, K. L., Keys, P. W., van der Ent, R. J., Lintner, B. R., Berg, A. and Krasting, J. P.: Rising Temperatures Increase Importance of Oceanic Evaporation as a Source for Continental Precipitation, Journal of Climate, 32(22), 7713–7726, dx.doi.org/10.1175/JCLI-D-19-0145.1, 2019.

Precipitation tracked backwards

- The continental precipitation recycling ratio, ρ_c,

$$\rho_c(t,x,y) = \frac{P_c(t,x,y)}{P_c(t,x,y) + P_o(t,x,y)} = \frac{P_c(t,x,y)}{P_{TOT}(t,x,y)}$$

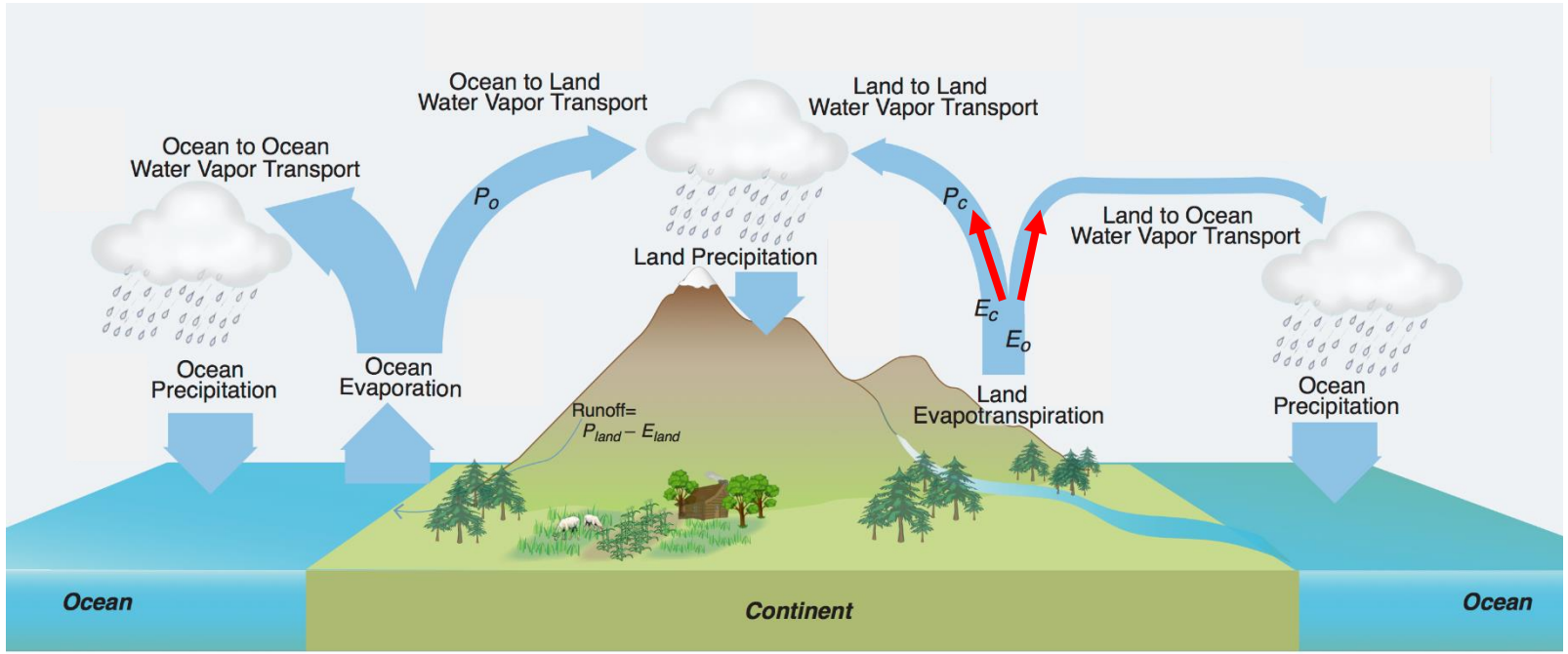


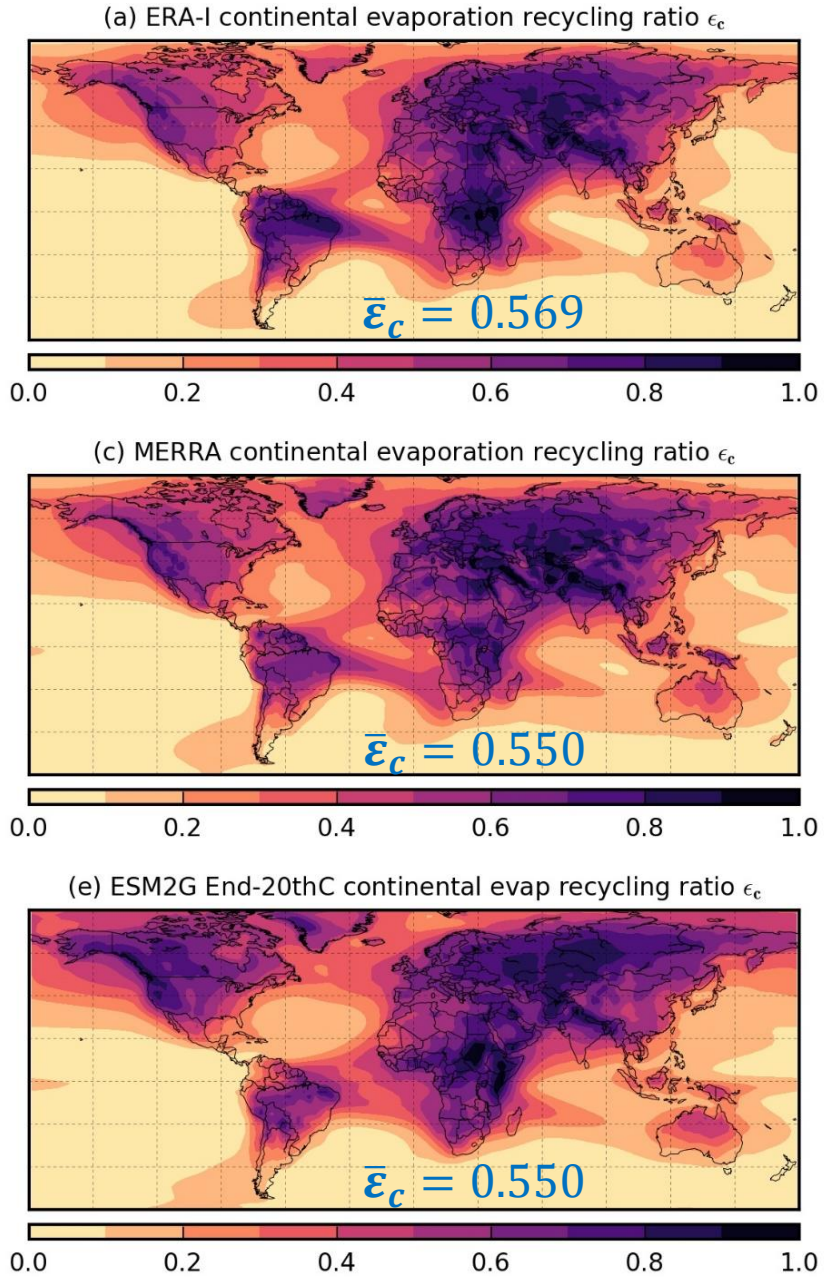


Evaporation tracked forwards

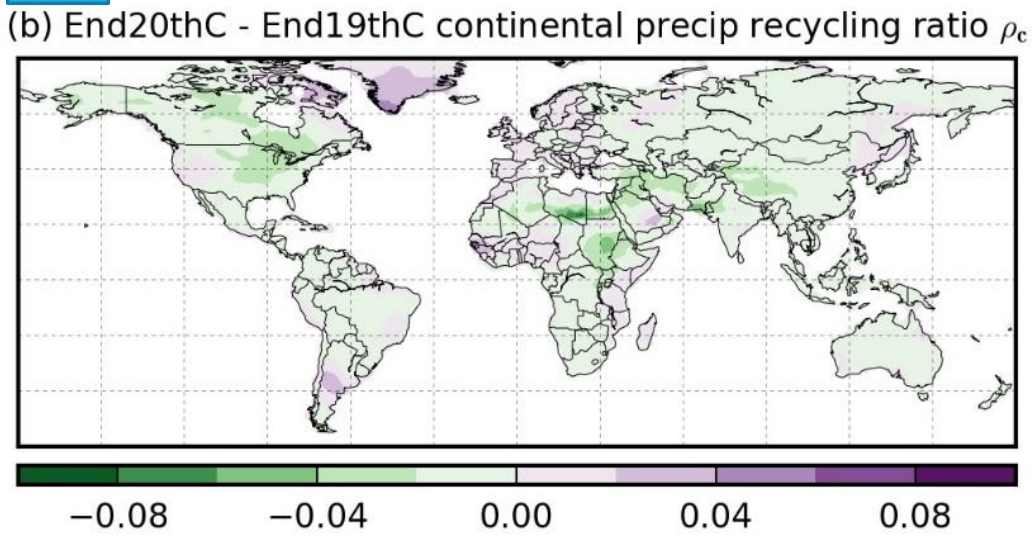
- The continental evaporation recycling ratio, ε_c,

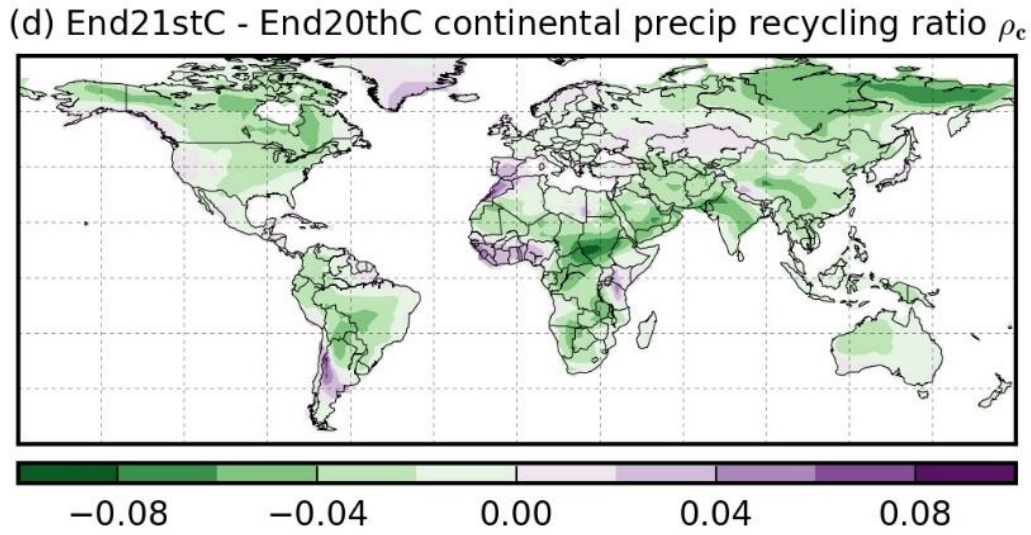
$$\varepsilon_c(t,x,y) = \frac{E_c(t,x,y)}{E_c(t,x,y) + E_o(t,x,y)} = \frac{E_c(t,x,y)}{E_{TOT}(t,x,y)}$$

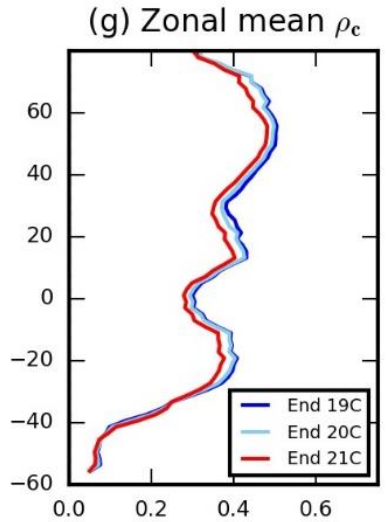


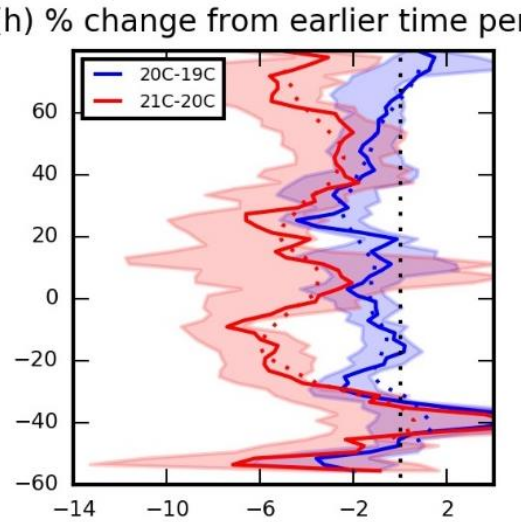


Continental moisture recycling decreases with warming









With a simple prototype model, we can show that as long as $\Delta E_{ocean} > \Delta E_{land}$ as $\Delta T\uparrow$, then continental moisture recycling ratios must go down.

Soil moisture limitation on land, then, means that ρ_c must decrease in a warming world.

Changes in Hydrologic Exchanges

ESM2G's near-global (60°S-80°N) values in 1000 km^3/yr

As global temperatures warm, both recycling ratios get smaller: the ocean imprint on continental hydrology gets bigger

Continental moisture recycling decreases by 2-3% with each degree of increase in global temperatures