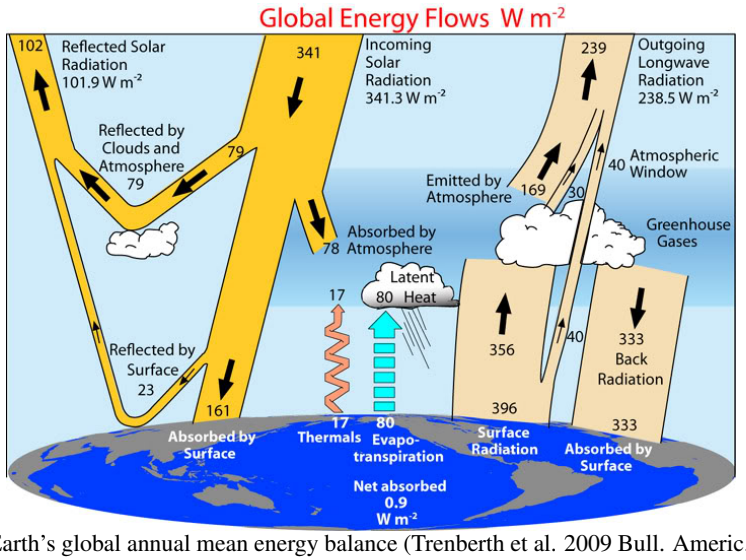
Radiative forcing, climate change and the global water cycle

Supervisors: Richard P. Allan and Keith P. Shine

Radiative forcings (for example due to carbon dioxide or changes in the sun) introduce an imbalance between the amount of sunlight absorbed by the planet and thermal emission back to space (Fig. 1). This imbalance drives climate change, the magnitude of which is determined by feedbacks (for example relating to water vapour, ice and cloud).



An estimate of Earth's global annual mean energy balance (Trenberth et al. 2009 Bull. Americ. Meteorol. Soc, http://journals.ametsoc.org/doi/abs/10.1175/2008BAMS2634.1.)

It is well known that a warming climate will lead to slow yet substantial changes in the global water cycle, one of the aspects of climate change that is particularly important in determining impacts on societies. However, recent research[1] has uncovered an additional direct influence of radiative forcing upon changes in precipitation brought about by the atmospheric energy balance between net radiative cooling and latent heating (or precipitation, P) illustrated in Fig. 1.

Specifically, changes in P may be decomposed as:

$$\Delta P \sim k\Delta T + G, \tag{1}$$

where k determines the slow responses in P to surface temperature, T, and G relates to the direct impact of radiative forcing agents upon ΔP.

The aim of this project is to quantify, using simple radiative-convective simulations and more complex models, the hydrological forcing for each of the main radiative forcing agents. These results will then be utilized in attributing past changes in precipitation, using observations, and to interpret the range of future projections in the global water cycle made by the latest generation of coupled climate models.

Student profile:

This project would be suitable for students with a degree in mathematics, physics or a closely related physical or environmental science. A motivation for understanding the fundamental workings of the climate system will be of benefit. The student will gain valuable experience in running numerical simulations and in dealing with large observational datasets and climate model outputs.

[1] see review by O'Gorman et al. (2012) Surv. Geophys: dx.doi.org/10.1007/s10712-011-9159-6