1 Radiative cooling

In PS2 you considered the climate on a body without an atmosphere (the moon) and observed that one of the things the atmosphere does is to reduce the rate of nighttime cooling, so that the Earth’s nightside does not cool as strongly as does the nightside of the moon, which radiates directly to space. However, nighttime radiative cooling on Earth can still be significant. Before the invention of refrigeration, the ancient Persians (in modern-day Iran) used radiative cooling to make ice in the desert in the night-time, even when air temperatures remained above freezing. Imagine that you insulate a pan or trough of water from heat exchange with the ground, and consider the limit of no heat exchange with the air molecules of the atmosphere above the pan. Then the only means for the water to lose energy is through radiation, and it will in fact lose energy if its emission (rate of energy loss in W/m$^2$) is greater than the rate it receives energy.

![Figure 1.1: Persian “yakhchal”, from referenced website.](http://misfitsarchitecture.com/tag/persian-ice-houses/)

There is a bit of information on Persian ice manufacturing available, including this page [http://misfitsarchitecture.com/tag/persian-ice-houses/].
presence of water troughs makes it clear that the Persians were making ice locally, even though air temperatures are generally above freezing throughout the year. The article begins: “By 400BC, Persians had developed a system for making ice in winter and storing it throughout the summer and in a hot desert climate, in buildings they called yakhchal.”

Consider that assertion in light of the modeling results of the posted reading. (You need not actually read the article; you could just look at Figure 5, which is repeated below.) Do these results support the assertion that the Persians could make ice by radiative cooling in the winter but not in the summer?

Figure 1.2: from Pavlakis et al, Atmos. Chem. Phys. 4, 127-142, 2004.