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Effective boundary layer temperature from atmospheric water vapour emission

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Measurements of the atmospheric boundary layer (ABL) temperature are obtained from concurrent measurements of two pyrgeometers: One standard pyrgeometer sensitive to the 3 μm to 50 μm wavelength range and one modified pyrgeometer sensitive only in the atmospheric window, e.g. from 8 μm to 14 μm. By combining the two measurements we retrieve the effective temperature of the saturated atmospheric water vapor from the radiation emitted by the atmosphere in the wavelength range 3 μm to 8 μm and 14 μm to 50 μm for four sites in Switzerland, Davos, Payerne, Locarno-Monti and Jungfraujoch. The radiation in this wavelength range is emitted from the layers of the atmosphere closest to the Earth's surface which form the ABL. The temperature derived from these measurements can be considered as an effective temperature of the saturated atmospheric water vapor, which depends directly on the profiles of humidity and temperature. We show that this effective saturated water vapor temperature is a powerful indicator for the state of the ABL when it is compared to the synoptic temperature measured at the surface. The ABL temperature measurements obtained from the pyrgeometers were validated at the BSRN site of Payerne using air temperature measurements obtained from a meteorological tower at 10 m and 30 m. The measurements show clearly the stable inversion layer during the night and the break-up of the ABL during daylight due to solar heating. The measurements at Jungfraujoch do not show any systematic diurnal variation of the atmospheric temperature relative to synoptic temperature which is due to the absence of a stable boundary layer at Jungfraujoch. This is consistent with observations that the Jungfraujoch at 3580 m.a.s.l. is located in the free troposphere. Our observations of the ABL temperature using infrared radiation emission of saturated water vapour are a crucial parameter for the parametrization of atmospheric longwave radiation models and can be used to improve cloud cover algorithms using longwave radiation measurements from standard pyrgeometers.