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The effect of cloud cover on the radiation-, energy- and carbon balance of a seasonally dry tropical forest in Brazil (Caatinga)

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The Caatinga is a seasonally dry tropical forest, which is the dominant vegetation type in the northeastern region of Brazil. Its many plant species have adapted to the semiarid climate through different biophysical and physiological traits and drought survival strategies. In recent years, this region has endured a number of prolonged droughts that have adversely affected this already severely water-limited region. Despite the relatively small amounts of rainfall (with annual rainfall ranging approximately between 100–800 mm/year), there is an almost perpetual occurrence of clouds due to the regional atmospheric circulation; broadly speaking cumulus or cumulonimbus in the rainy season, and mostly stratocumulus during the transition from wet to dry, and dry seasons. We studied the effect of cloud cover on the radiation balance, as well on the surface energy- and carbon balance of a pristine Caatinga area from 2011 to 2018.

This study used radiation and weather data obtained from a SONDA BSRN radiation station, as well from a flux tower installed in the study area; both were near the urban areaofPetrolina, Brazil. Furthermore, radio-sounding data collected nearby were employed to obtain column integrated atmospheric water vapour, to estimate atmospheric emissivity.

We derived cloudiness from a number of indirect methods (using shortwave- and longwave incoming radiation) at diurnal, seasonal and multi-year timescales. We also employed observed cloud cover data, including those from sky-cameras, for verification.

Estimates of clear-sky atmospheric emissivity were required to determine cloud cover. These were obtained from well-known equations (e.g., Brunt, Brutsaert and Prata) using tower air temperature and/or vapour pressure; calibration of the constants in these equations was required and their performance varied considerably. Occasionally, there were large differences between column integrated atmospheric water vapour and near-surface humidity; this had implications for estimates of atmospheric emissivity and hence of cloud cover.

Seasonal variations in turbidity varied by a factor of 2. Clear-sky conditions occurred for between 8-18% of the time, with the lowest percentage occurring for the wettest year (2011).

Despite its considerable effect on the radiation balance, the variation in cloud cover had a

relatively modest effect only on the energy- and carbon balance fluxes. This has implications for our understanding of the Caatinga vegetation functioning, as well as for the development and testing of land surface models for this ecosystem.

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