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**CARBON-AWARE ONLINE CONTROL OF GEO-DISTRIBUTED**

**CLOUD SERVICES**

**ABSTRACT**

Recently, datacenter carbon emission has become an emerging concern for the cloud service providers. Previous works are limited on cutting down the power consumption of datacenters to defuse such a concern. In this paper, we show how the spatial and temporal variabilities of the electricity carbon footprint can be fully exploited to further green the cloud running on top of geographically distributed datacenters. Specifically, we first verify that electricity cost minimization conflicts with carbon emission minimization, based on an empirical study of several representative geo-distributed cloud services. We then jointly consider the electricity cost, service level agreement (SLA) requirement, and emission reduction budget. To navigate such a three-way tradeoff, we take advantage of Lyapunov optimization techniques to design and analyze a carbon-aware control framework, which makes online decisions on geographical load balancing, capacity right-sizing, and server speed scaling. Results from rigorous mathematical analysis and real-world trace-driven evaluation demonstrate the effectiveness of our framework in reducing both electricity cost and carbon emission.