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EarthNet2021: Self-supervised impact predictions of extreme weather.

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Climate changes globally, yet its impacts strongly vary between different locations in the same region. Today, numerical weather models are able to forecast weather patterns on a scale of several kilometers. However, the extreme weather impacts materialize at a finer scale, interacting with highly local factors such as topography, soil or vegetation type. The relationship between driving variables and Earth's surface at such local scales remains unresolved by current physical models and is partly unknown; hence, it is a source of considerable uncertainty. Most current efforts to predict the local impacts of extreme weather rely on weather downscaling as an intermediary step. However, weather impacts at high resolution are observed and analyzed on satellite imagery. Thus, we can bypass the weather downscaling step by directly forecasting satellite imagery. This is inherently similar to video prediction, a computer vision task that has been tackled with machine learning models. Here we introduce EarthNet2021, a machine learning challenge to forecast the spatio-temporal evolution of the Earth's terrestrial surface. The task can be summarized as translating coarse weather projections into high-resolution Earth surface imagery encompassing localized climate impacts. EarthNet2021 is a carefully prepared dataset containing target spatio-temporal Sentinel-2 imagery at 20 m resolution, matching with high resolution topography and mesoscale (1.28 km) weather variables. Comparing multiple Earth surface forecasts is not trivial. Thus, we design the EarthNetScore, a novel ranking criterion for Earth surface models. EarthNet2021 comes with multiple test tracks for evaluation of model validity and robustness as well as model applicability to extreme events and the complete annual vegetation cycle. In addition to forecasting directly observable weather impacts through satellite-derived vegetation indices, capable Earth surface models will enable downstream applications such as crop yield prediction, forest health assessments, coastline management or biodiversity monitoring.