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Predicting Forest Damage in Europe: A Subseasonal-to-Seasonal Forecasting Approach for Hydro-meteorological Drivers

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Extreme meteorological events such as frost, heat, and drought can induce significant damage to vegetation and ecosystems. In particular, heat and drought events are projected to become more frequent in a changing climate. On the subseasonal-to-seasonal (S2S) forecasting timescale, skillful forecasts of hydro-meteorological hazards combined with targeted actions can prevent various vegetation damage and large-scale impacts (e.g. agriculture and food security, wildfire risk management, forest management, biodiversity and flora protection,etc.).

We here focus on forest damage in Europe, defined as negative anomalies of the normalized difference vegetation index (NDVI). Compound drought and heat wave events are known to trigger low NDVI events in summer. A dry summer combined with warm and moist conditions during the previous winter can also have a negative impact. However, to our knowledge, there exists no comprehensive study of hydro-meteorological drivers triggering forest damage in Europe. Hence, the goal of our study is a) finding the optimal variables to predict summer forest damage in Europe, and b) assessing the S2S forecast skill of these variables. We develop an automated procedure to systematically identify hydro-meteorological conditions leading to forest damage, up to 18 months prior to occurrence. We train a model using AVHRR remote sensing observation of NDVI for the impact data, and ERA5 and ERA5-Land reanalysis datasets for the explicative variables. These variables include temperature, precipitation, dew point temperature, surface latent heat flux, soil moisture, and soil temperature. To bridge the research gap between the S2S forecasts of hydrometeorological variables and vegetation damage, we assess the forecast skill of variables from the S2S hindcast database of ECMWF identified as responsible for low NDVI events. The idea is to determine to what extent S2S models can predict conditions triggering forest damage, by identifying the sources of predictability or potential need for improvement.