Data assimilation for continuous global assessment of severe conditions over terrestrial surfaces

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This study investigates the capability of LDAS-Monde global offline land data assimilation system to monitor and forecast the impact of extreme events such as heatwaves and droughts on the Land Surface Variables (LSVs). LDAS-Monde is driven by ERA-5 atmospheric forcing from ECMWF and is able to ingest information from satellite-derived surface soil moisture (SSM) and leaf area index (LAI) observations to constrain the interactions between soil–biosphere–atmosphere (ISBA, Interactions between Soil, Biosphere and Atmosphere) land surface model (LSM) coupled with the CNRM (Centre National de Recherches Météorologiques) version of the Total Runoff Integrating Pathways (ISBA-CTRIP) continental hydrological system. SSM and LAI observations are assimilated using a simplified extended Kalman filter (SEKF), which uses finite differences from perturbed simulations to generate flow dependence between the observations and the model control variables.

A global 2010-2018, 0.25°x0.25º spatial resolution, a reanalysis of the LSVs is first evaluated thanks to global estimates of SSM, LAI (both from CGLS), evapotranspiration (from the GLEAM project), Gross Primary Production (GPP from the FLUXCOM project), Sun Induced Fluorescence (SIF from GOME2 satellite) as well as several in situ measurements dataset of soil moisture, river discharge, and flux measurements (fluxnet2015). This 9-yr global reanalysis is then used to provide a climatology for estimating anomalies of the land surface conditions. Significant anomalies are used to decide on where to focus for a more detailed monitoring and forecasting activity using LDAS-Monde. 19 regions across the globe known for being potential hot spots for droughts and heat waves were investigated for 2018. Two of them, presenting particularly large negative anomalies of SSM and LAI in 2018 were further analysed, namely Western Europe and the Murray-Darling river basin in southeastern Australia. Over these areas, LDAS-Monde was operated forced by ECMWF IFS high resolution atmospheric analysis leading to a 0.1°x0.1° reanalysis of the LSVs. It complements the coarse resolution LDAS-Monde operated using ERA5. ECMWF IFS forecast capacity with a 10 day lead time initialised by LDAS-Monde analysis for the year 2018 is also presented. It highlights LDAS-Monde capacity to monitor the land surface conditions at a global scale and to trigger on demand higher spatial resolution monitoring and forecasting activities for a region of interest.