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Ensemble regression exigent analysis applied to a case of Florida citrus damage

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We describe a new method to analyze exigent meteorological conditions via singular vector, Mahalanobis-scaling, and ensemble regression methodologies. This technique should prove useful for the assessment of risk to life and property in future extreme weather scenarios. Basically given a forecast ensemble and a loss metric we ask what is the worst case scenario consistent with the uncertainty of the initial conditions. As a specific proof of concept we apply ensemble regression exigent analysis (EREA) to the damage to the citrus industry in Florida during the overnight of 10 to 11 January 2010.

In general, EREA determines the magnitude and spatial distribution of a user-defined worst-case "exigent" meteorological condition or damage metric with a user-specified relative likelihood of occurrence with respect to the ensemble distribution. EREA proceeds by applying the singular value decomposition (SVD) to a Mahalanobis-normed ensemble regression (ER) operator that maps ensemble perturbations of the analysis-time state vector to an ensemble of the user-defined exigent condition. The SVD gives the ensemble state perturbation at the analysis-time that maps to the leading eigenvector of the damage ensemble, the ensemble vector of the greatest magnitude. In order to prescribe a relative likelihood of occurrence to the exigent perturbation, the magnitude of the analysis state perturbation is scaled so that its Mahalanobis distance from the ensemble mean corresponds to that of the probability ellipsoid enclosing the user-specified percentage of ensemble members.

For the Florida citrus case, EREA is applied to an operational 50-member ECMWF ensemble of the T2m, zonal and meridional winds, geopotential height, and temperature at four tropospheric pressure levels to determine the worst-case damage to citrus trees in Florida on 11 January 2010 due to cold temperatures, given that the analysis-time state vector perturbation is at the 90th quantile of the ensemble distribution. The 300 hPa geopotential height-portion of the analysis-time exigent perturbation depicts a significantly strong and deepened trough with respect to the ensemble mean. This perturbation is consistent with physical expectations, given that a deepened trough would enhance northerly cold air advection toward Florida 24 hours later.