Recent advances in nonlinear dynamical systems theory have provided means for unveiling the skeletal structure around which material is organized in the flow of a fluid. This skeleton is composed of especial material surfaces which are widely known as Lagrangian Coherent Structures or LCS. The LCS guide the bulk of the material, serving as natural targets for forecasting and controlling its evolution. Furthermore, some of these LCS can sustain persistent, strongly attracting cores. Persistent strong attraction toward an LCS requires persistent strong stretching along the LCS. As a result, identification of an ‘LCS core’ provides a predictive capability because it indicates a developing transport event that is likely too strong to be halted by short-term future perturbations to the flow. In this talk, I review the elements of the recently developed ‘LCS-core analysis’ and describe results from applying this novel technique to forecasting oil and drifting buoy evolution in the ocean, and ash dispersion in the atmosphere.