From Visualization to Visual Analytics for Environmental Science

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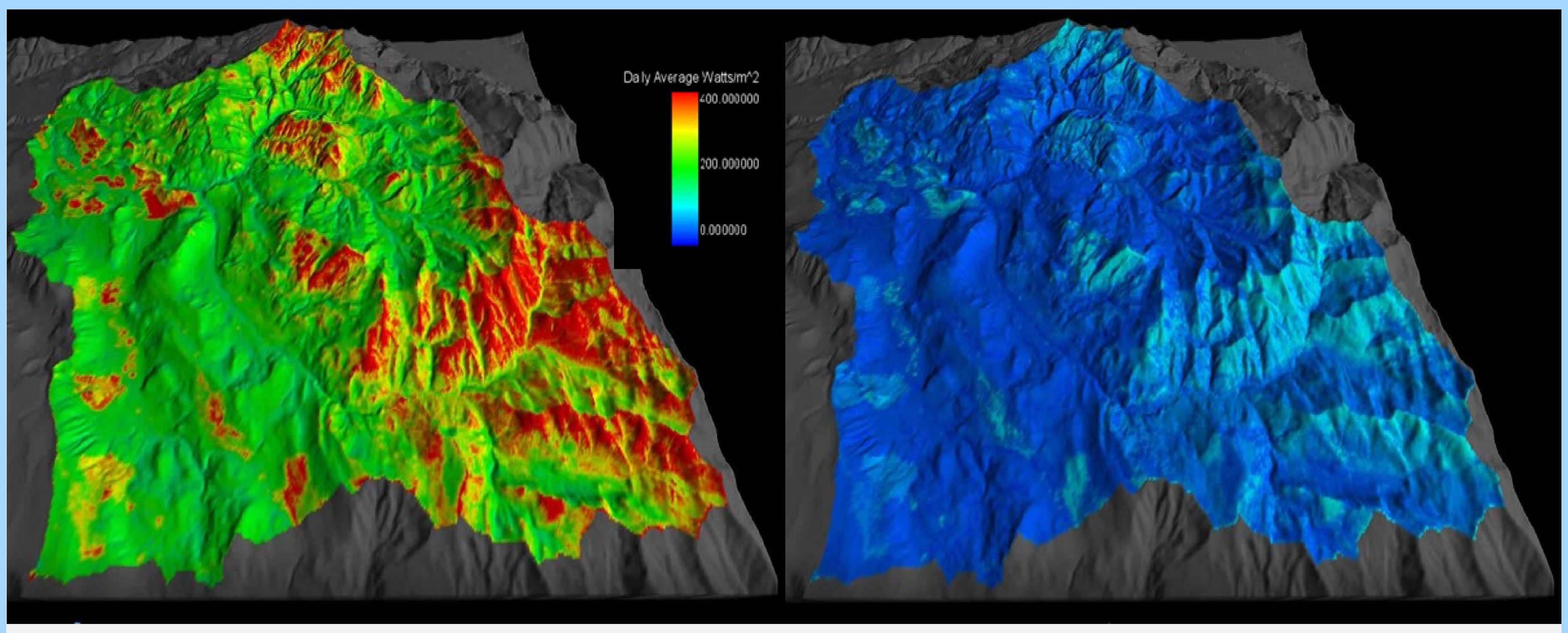
Software and code – ***github.com/VISTAS-IVES/pyvistas***

Find out more at ***blogs.evergreen.edu/vistas***

The ***Visualization for Terrestrial and Aquatic Systems*** (***VISTAS***) is a tool that assists environmental scientists exploring and refining ecological datasets by transforming them into interactive 3D terrains. Users can visualize data in a variety of formats, create fly-through animations and export annotated video and still-frame snapshots of their data. Collaborators report that VISTAS is significantly easier to use and faster than other software that perform the same functions, fast-tracking the testing and hypothesis cycle.

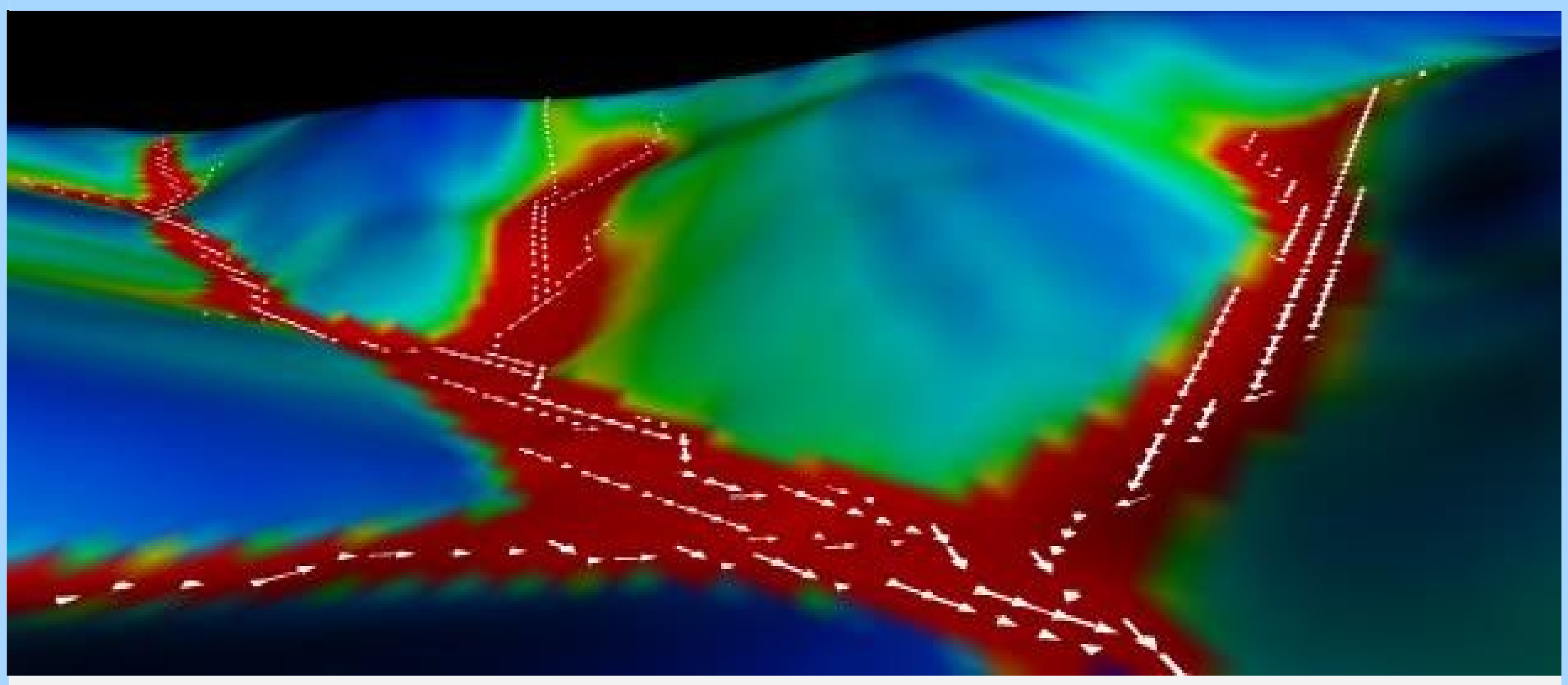
Our current focus is the development of innovative visual analytics techniques that further the environmental scientist's ability to understand their data from both the qualitative and quantitative level. Such techniques could include data visualizations derived from hot-spot analysis, clustering classifications and results derived from a calculation based on a value identified at a geo-located point or neighborhood. VISTAS is a desktop application implemented in Python using open-source scientific libraries.

Visualizing Daily Solar Irradiance



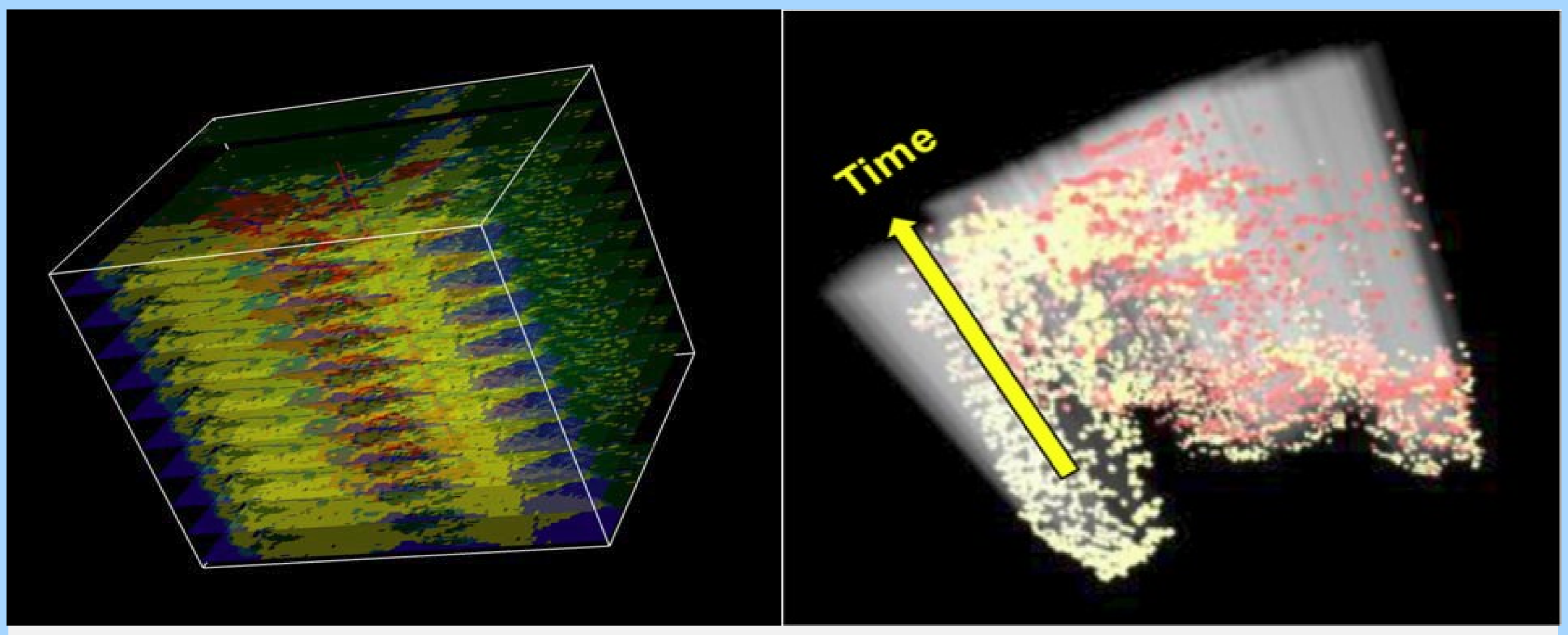
VISTAS users need to connect observed qualitative patterns within VISTAS to the underlying ecological relationships present in the source data. Jonathan Halama (Oregon State University) uses VISTAS to rapidly visualize and fine-tune *Penumbra*, a spatial shade-irradiance model, to associate landscape incident solar radiation with environmental impacts on terrestrial health and resilience. The interactive features of VISTAS enables Halama to see changes over time on local and regional scales, identifying patterns for further analysis.

Major Watershed Flows



Environmental scientists need help determining quantitative relationships by cross-comparing related spatial input data and performing analysis within VISTAS. We plan to integrate a workflow that provides the needed analysis by integrating user-defined area statistics and 2D data processing routines that feed into a resulting 2D or 3D visualization. This allows for rapid, iterative testing and fine tuning, capturing a real-time 3D visual analytics workflow . A candidate for this workflow is watershed flows. Flow direction and accumulation are encoded into a vector field that is filtered based on a lower accumulation bound, resulting in a water flow network draped across a VISTAS terrain. Fine tuning the lower bound was necessary to obtain the location of the major flows through the watershed, revealing the primary flow network.

Ecological Tipping Points



Collaboration with environmental scientists has shown there is a need to understand what where and when ecological tipping points occur within spatiotemporal datasets. To show these within time and space, Bailey and VISTAS developers have prototyped visualizations of spatiotemporal data within a single image frame as a **time-extrusion**, where each 2D time step is arranged vertically (left) and analyzed to identify points where a threshold was met (right). We plan to incorporate an analytics workflow that identifies patterns in ecological datasets by adding the following capabilities: easy selection of data dimensions to view them simultaneously, use of parallel coordinates to visualize correlations in data, and time extrusions to create at-a-glance views of data over time.

Image Segmentation with Machine Learning

Manually deciphering images of the physical environment is time-consuming and error prone. Drake, Orr and other team members used deep convolutional neural networks (DCNNs) to train a network that identifies cloud pixels in photos taken by the Total Sky Imager system. The trained network is capable of classifying 91.9% of pixels correctly, and an ensemble of several networks increases this to 94.6%. Our goal is to apply lessons learned to other spatiotemporal data to determine landscape classifications within image-based, remote sensing datasets, which could be used in tandem with time-extrusions to pinpoint ecological tipping points within space and time.

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