University of Saskatchewan

Visualization, Geometry & Algorithms Lab

ContourMove: Exploring Temporal Changes in Large Geo-spatial Data

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Abstract

We have developed an interactive system to visualize change in geo-spatial data. As a case study we used the weather research and forecasting (WRF) model output. ContourMove first extracts the change information as directional vectors directions from 9 months of soil moisture datasets. Then it visualizes the vectors over the contour map of the first day, i.e., the vectors depict the changes occurred over time. However, such a straightforward visualization would be cluttered and unreadable. ContourMove uses various computational techniques to filter and visualize important changes, and provides support for real-time user interactions.

Motivation

Half of the world's population and all of Canada are dependent upon water from cold regions where the landscape, ecosystems and the water environment is continuously threatened by global warming. To support informed decision making and risk-management, we need better data analytics methods that can improve our understanding of how various water related parameters are changing over time. Representation of multivariate data or showing multiple datasets in one image is a challenging task due to cognitive limitations, visual clutters, etc. [1]. Traditional methods such as Spaghetti plots [2] and color overlays [3] are not always suitable for revealing changes, especially when the change is subtle. This inspired our work on creating a visualization model that depicts the change of soil moisture data over-time.

Method

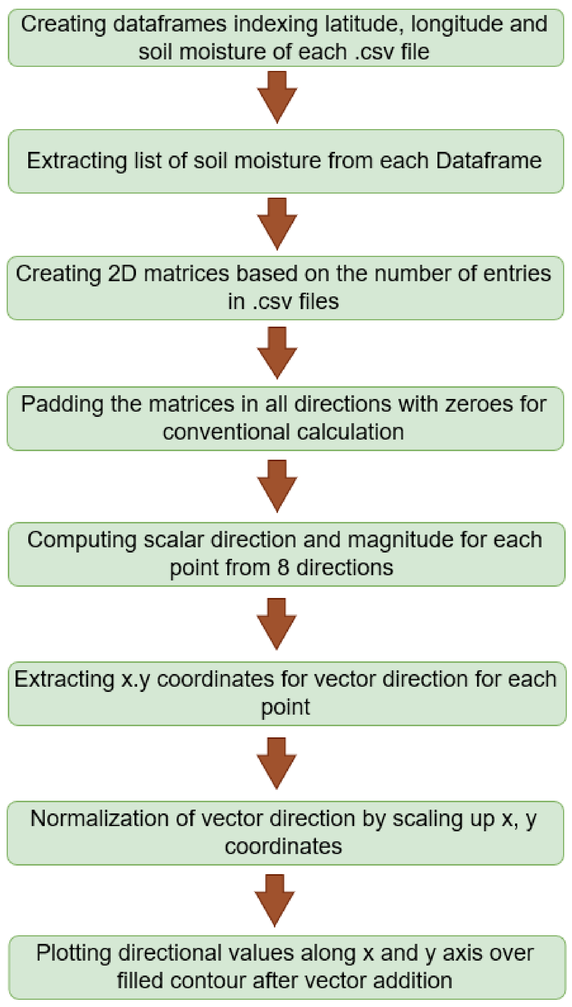
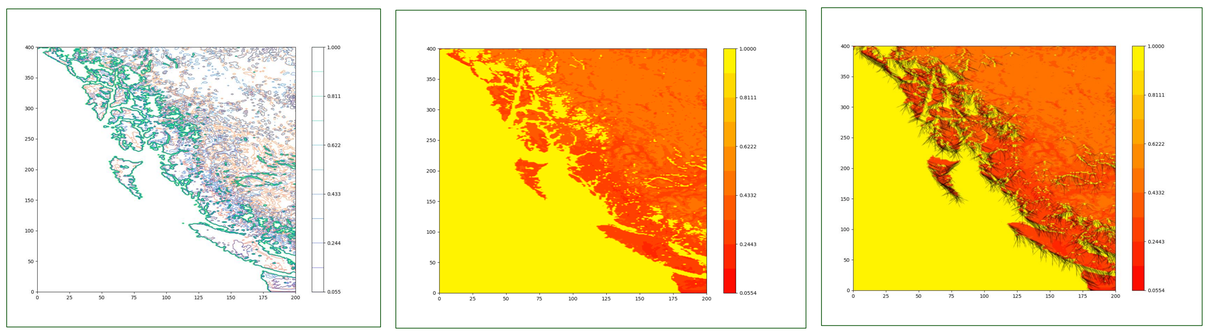


Figure 1: ContourMove Workflow

Results

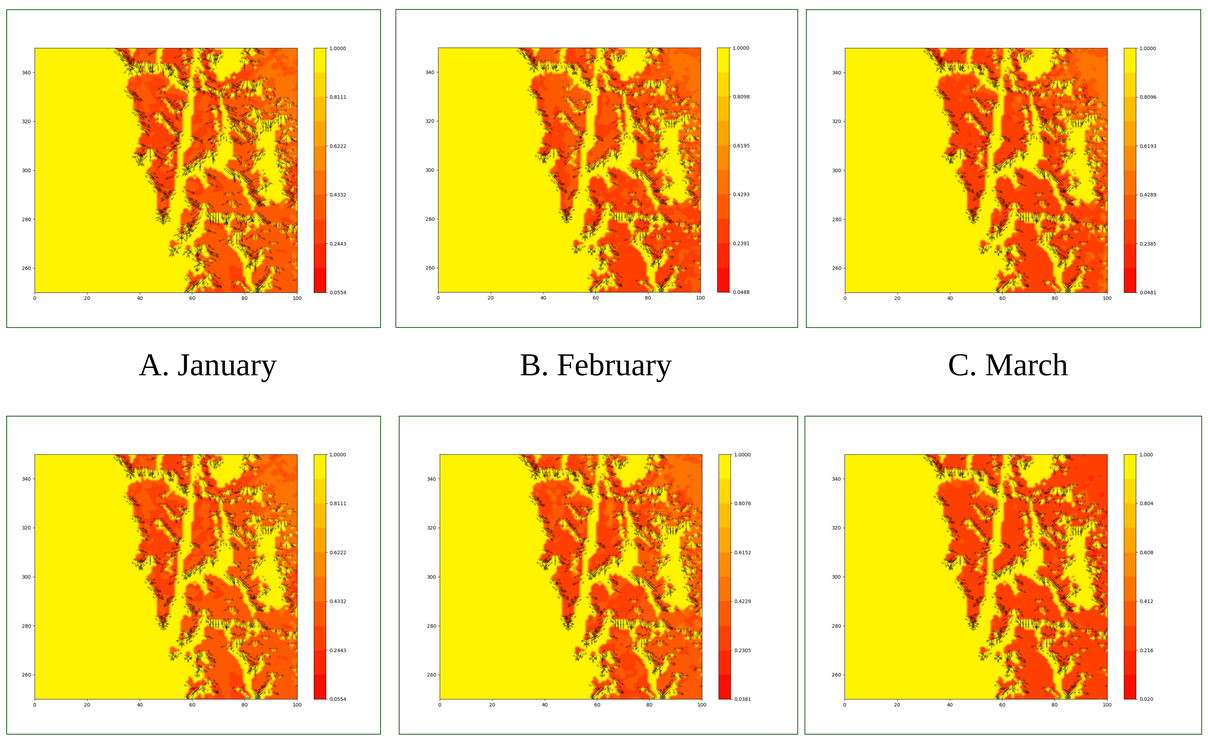
We used soil moisture data from January to September of 2015. We implemented Spaghetti plot, Color overlay and our proposed approach ContourMove for the same dataset of matrix size 639 X 699. The generated images for all the approaches are of the similar size. But for better visualization and comparison, here we have shown a 200 X 400 area of the West Coast of Canada.



A. Spaghetti Plot B. Color Overlay C. ContourMove

Figure 2: Comparison among Spaghetti Plot, Color Overlay and ContourMove

ContourMove illustrates the change of soil moisture data over as vectors. The following figure show the data in a monthly (change in 15 days) and tri-monthly basis (change in 3 months). Here we show a zoomed in view, where all the images, the colormap is 'autumn', magnitude threshold is 0.79 and direction is 'downwards'.



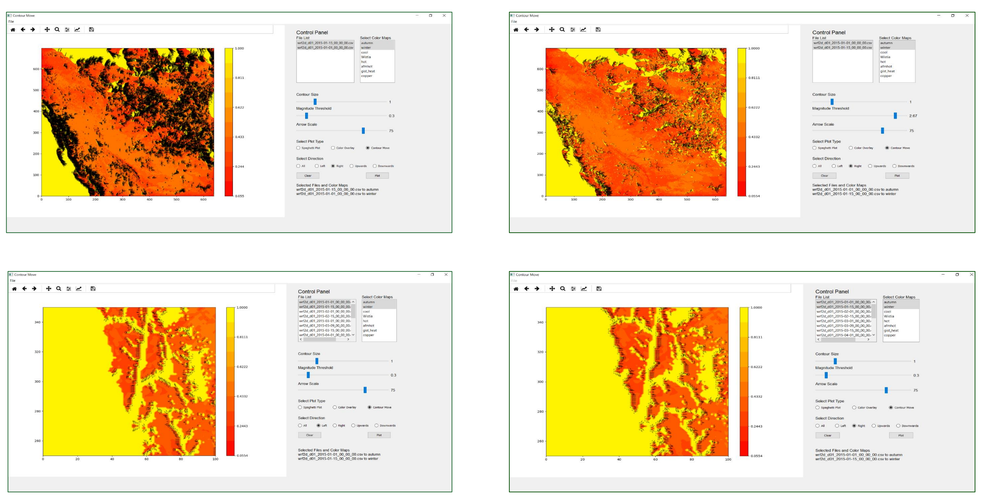
A. January B. February C. March

D. January – March E. April – June F. July - September

Figure 3: Change of Soil Moisture in monthly basis: A. January B. February C. March and tri-monthly basis: D. January – March E. April – June F. July - September

User Interactions

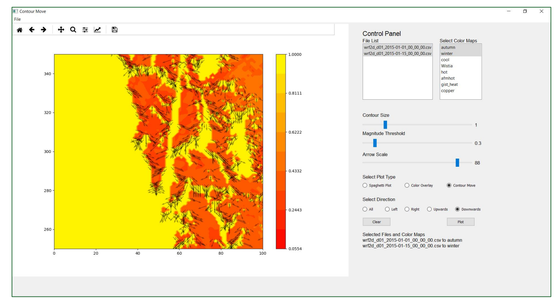
ContourMove provides various widgets for modifying and understanding features of the visualized data. The features for user interactions are: modifying contour size for spaghetti plot, changing magnitude threshold , filtering direction, and scaling vector lengths.



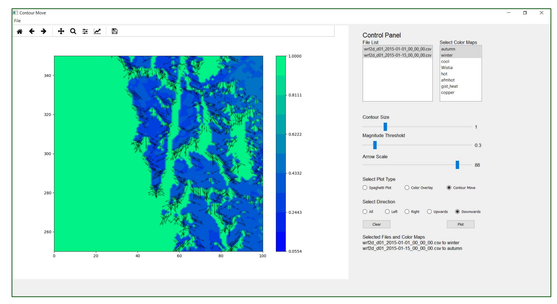
A. Changing Magnitude Threshold

B. Selecting Vector Direction

Figure 4: User Interactions for ContourMove



A. Changing Arrow Scale from 75 (default) to 88



B. Changing Colormap from 'autumn' to 'winter'

Figure 5: Changing Arrow Scale and Colormap

Discussion

As shown on Figure 2, spaghetti plot and color overlay suffer from visual clutter in illustrating change in soil-moisture in a specified duration of time. ContourMove solves this problem by computing the resultant direction of all the vectors computed from the daily soil moisture data for the given time range. Consequently, a diagram will be plotted comprising a filled contour diagram of the first dataset and overlaid with the aggregated vectors.

Directions for Future Work

The outputs generated by ContourMove indicates that the result is promising. However, there are a number of avenue for future research. First, the output may still be cluttered since the visualization does not consider the zoom level while rendering the vectors. Thus for a zigzag location, the directions are hard to interpret. We plan to make the rendering adaptive to the zoom level. We also envision working with domain experts to auto summarize the computed changes, such that the system can guide the users to the interesting locations to explore.

References

[1] C. Ma, T. Luciani, A. Terebus, J. Liang, G. E. Marai, "PRODIGEN: visualizing the probability landscape of stochastic gene regulatory networks in state and time space", *BMC bioinformatics*, vol. 18, no. 2, pp. 24 – 37, 2017.

[2] B. Swihart, B. Caffo, B. D. James, M. Strand, B. S. Schwartz and N. M. Punjabi, "Lasagna plots: A saucy alternative to Spaghetti plots", *Epidemiology*, vol. 21, no. 5, pp. 621 - 625, 2010.

[3] P. Rheingans, "Dynamic color mapping of bivariate qualitative data", in *IEEE Visualization Conference*, 1997, pp. 159–166.

Acknowledgement

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