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Visualizing the Inter-Area Modes of the Western Interconnection

Background

This poster presents a visualization technique for incorporating eigenvector estimates with geospatial data to create inter-area mode shape maps. For each point of measurement, the method specifies the radius, color, and angular orientation of a circular map marker. These characteristics are determined by the elements of the right eigenvector corresponding to the mode of interest. The markers are then overlaid on a map of the system to create a physically intuitive visualization of the mode shape. This technique serves as a valuable tool for differentiating oscillatory modes that have similar frequencies but different shapes.

Reference Angle Selection

We solve the following optimization problem to determine the reference angle:

$$\underset{\bar{\theta}_i \in \Theta_i}{\text{minimize}} \sum_{l \in \mathcal{L}} |v_{il}|^2 |\sin(\theta_{il} - \bar{\theta}_i)|,$$

where the feasible set is $\Theta_i = \{\theta_{i1}, \dots, \theta_{in}\}$.

Marker Scaling

The area of each marker is proportional to the normalized oscillation amplitude:

$$\pi r(\tilde{v}_{il})^2 = \kappa |\tilde{v}_{il}| \Rightarrow r(\tilde{v}_{il}) = \sqrt{\kappa |\tilde{v}_{il}| / \pi}\,.$$

This serves to make markers at locations with smaller amplitudes easier to discern on the map.

Comparison

Fig. 1 shows the shapes of the dominant modes of the interconnection, North-South A and B, generated using our method. The polar (compass) plots for the same data set are shown in Fig. 2. The geospatial information promotes physical intuition about the modes.

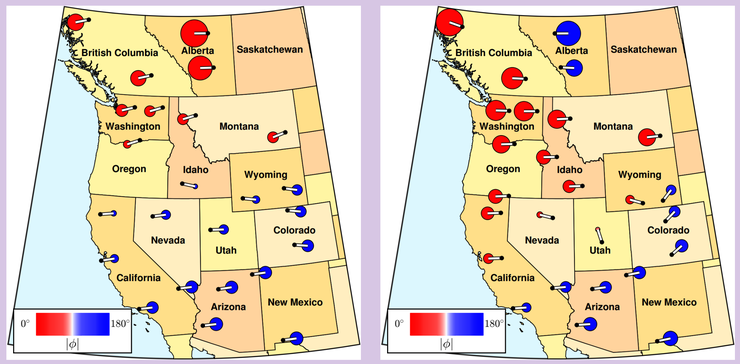

Fig. 1. Mode shape maps for NS-A (left) and B (right).

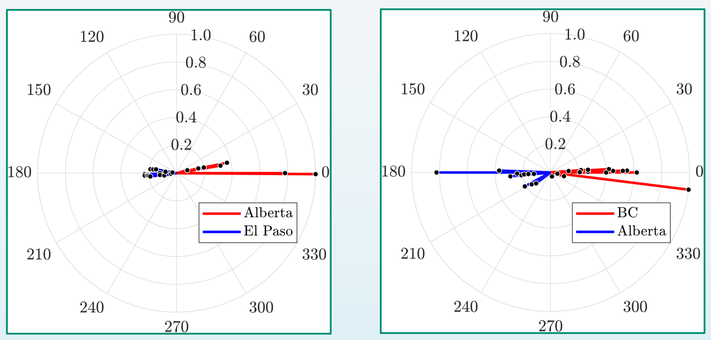

Fig. 2. Compass plots for NS-A (left) and B (right).

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