Averaging active regions: Is it a viable concept?

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Solar active regions (ARs) are fundamental manifestations of magnetic activity, yet their diversity complicates efforts to extract general evolutionary patterns. We test whether ensemble averaging can provide such insight by constructing an "average" bipolar AR from observations of the Helioseismic and Magnetic Imager and Atmospheric Imaging Assembly on board SDO. The selected ARs were normalized in space and time to ensure comparable polarity orientation, emergence conditions, and disk position before computing ensemble averages of magnetograms, Dopplergrams, and multi-wavelength intensity maps. The average AR reproduces the canonical picture known from individual case studies: flux emergence, peak activity, and decay, with the leading polarity retaining coherence longer than the trailing one. Flow maps show diverging outflows preceding clear magnetic signatures, and coronal diagnostics reveal enhanced heating above the AR. These agreements validate ensemble averaging as a robust method. We show convincingly that bipolar ARs are scale-invariant: after linear spatial and temporal normalization, their evolution follows the same pattern irrespective of size. Thus, ensemble averaging not only confirms known features of AR development but also demonstrates that their evolution can be universally described once appropriately scaled. We believe this methodology opens a new window into AR research.