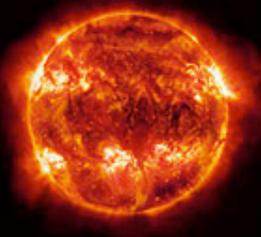


# A Comparison Between Magnetic Charge Topology and Local Correlation Tracking of Solar Active Regions



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August 2010

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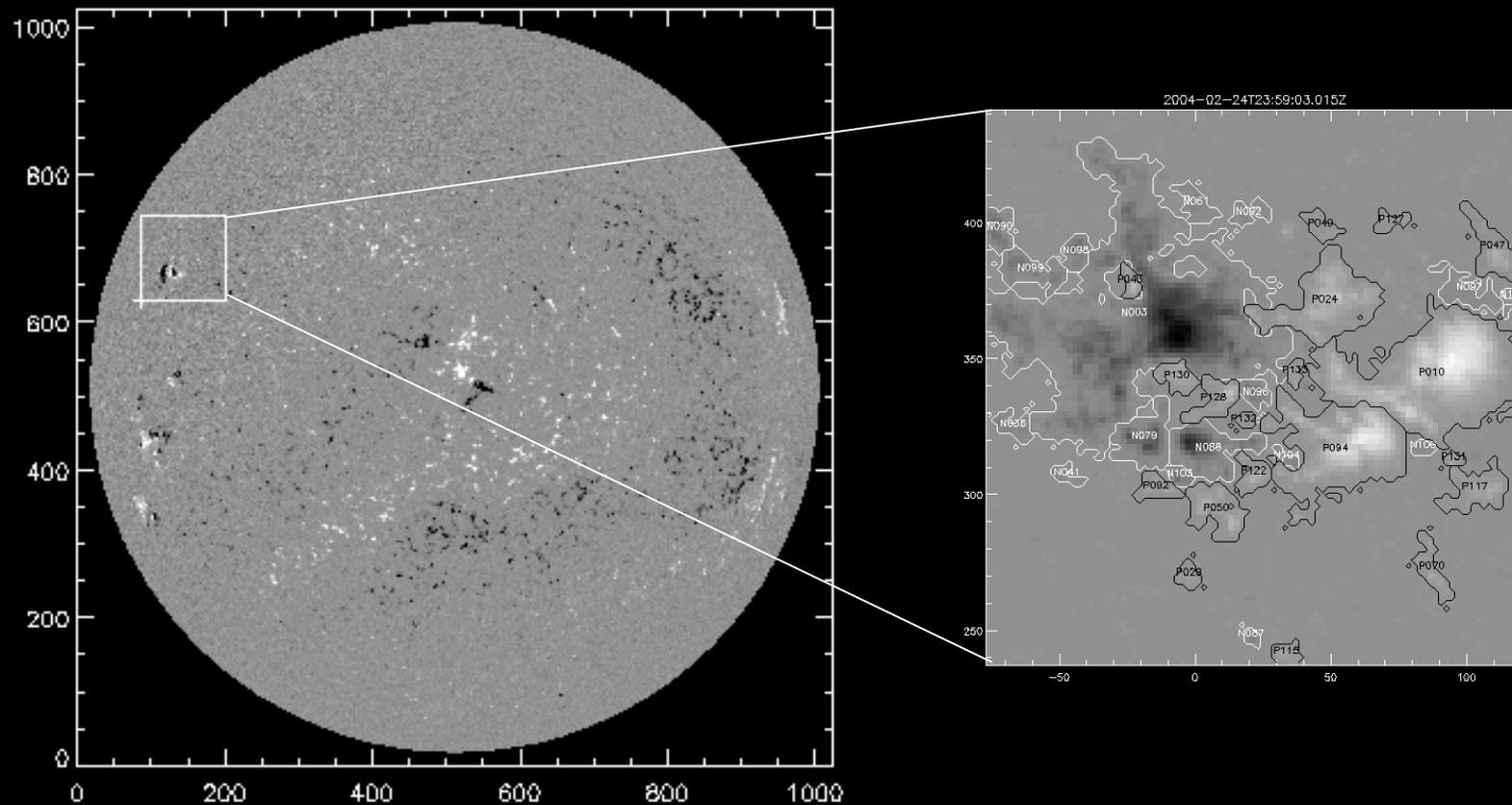


# Presentation Overview

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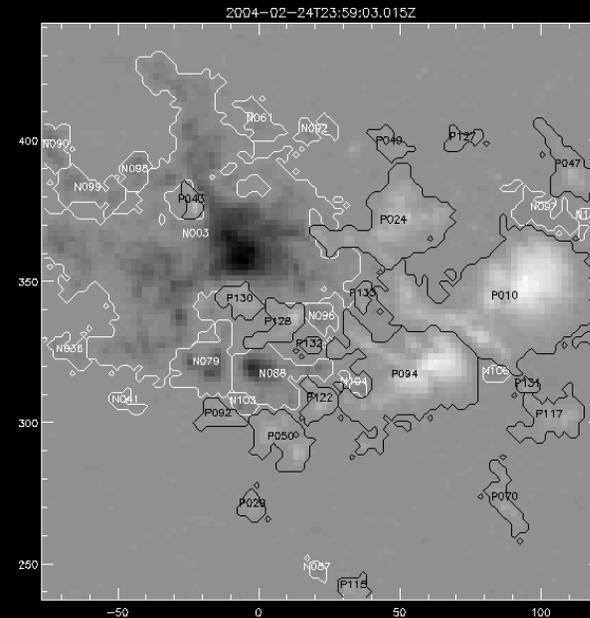
- Introduction to solar magnetic fields
- Developing an approach to partitioning and tracking active regions
- Current methods for tracking active region movement
- Comparing methodologies
- Conclusions and impacts of this research

# Magnetograms depict line of sight solar magnetic fields

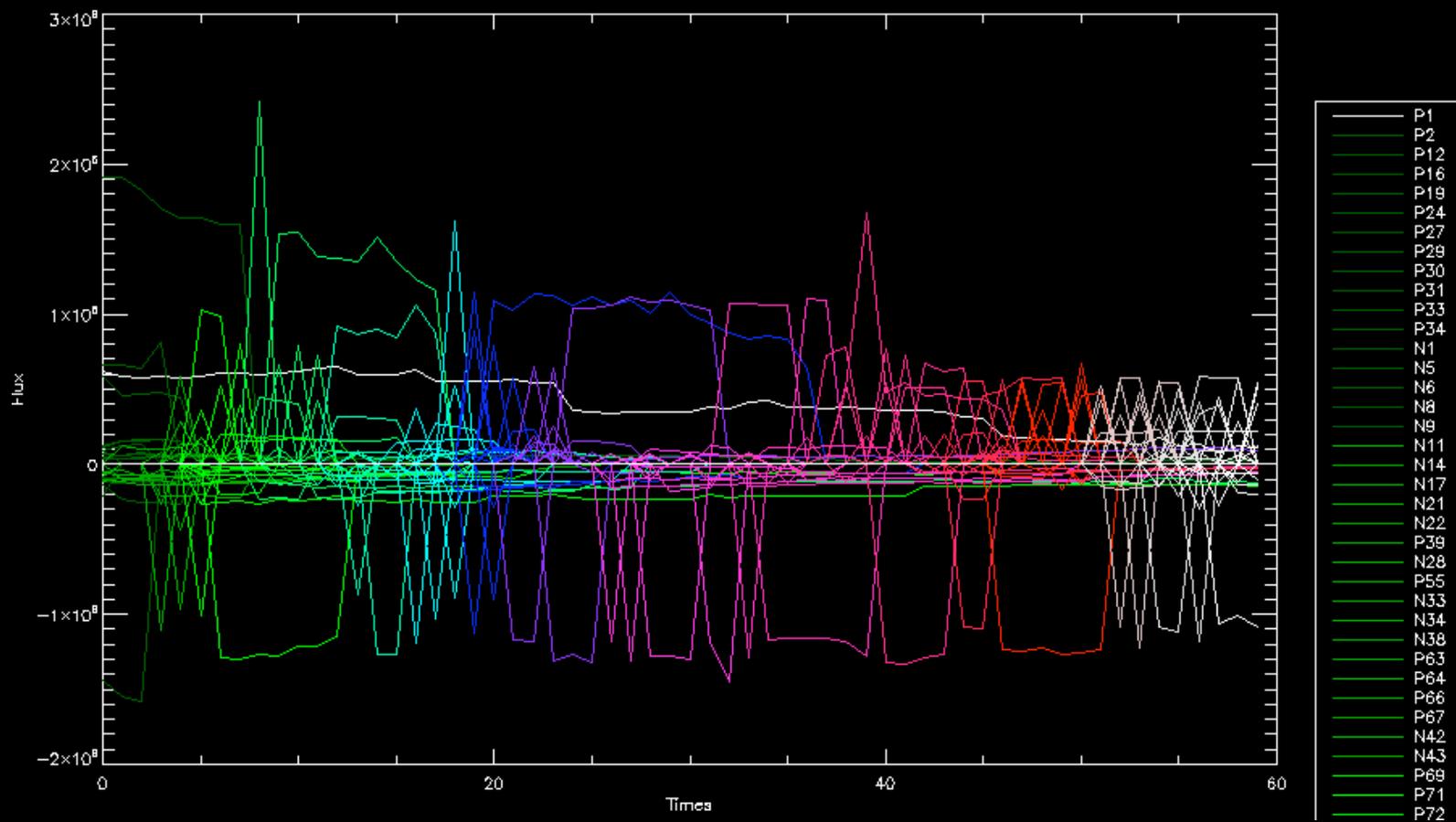


# Magnetograms depict line of sight solar magnetic fields

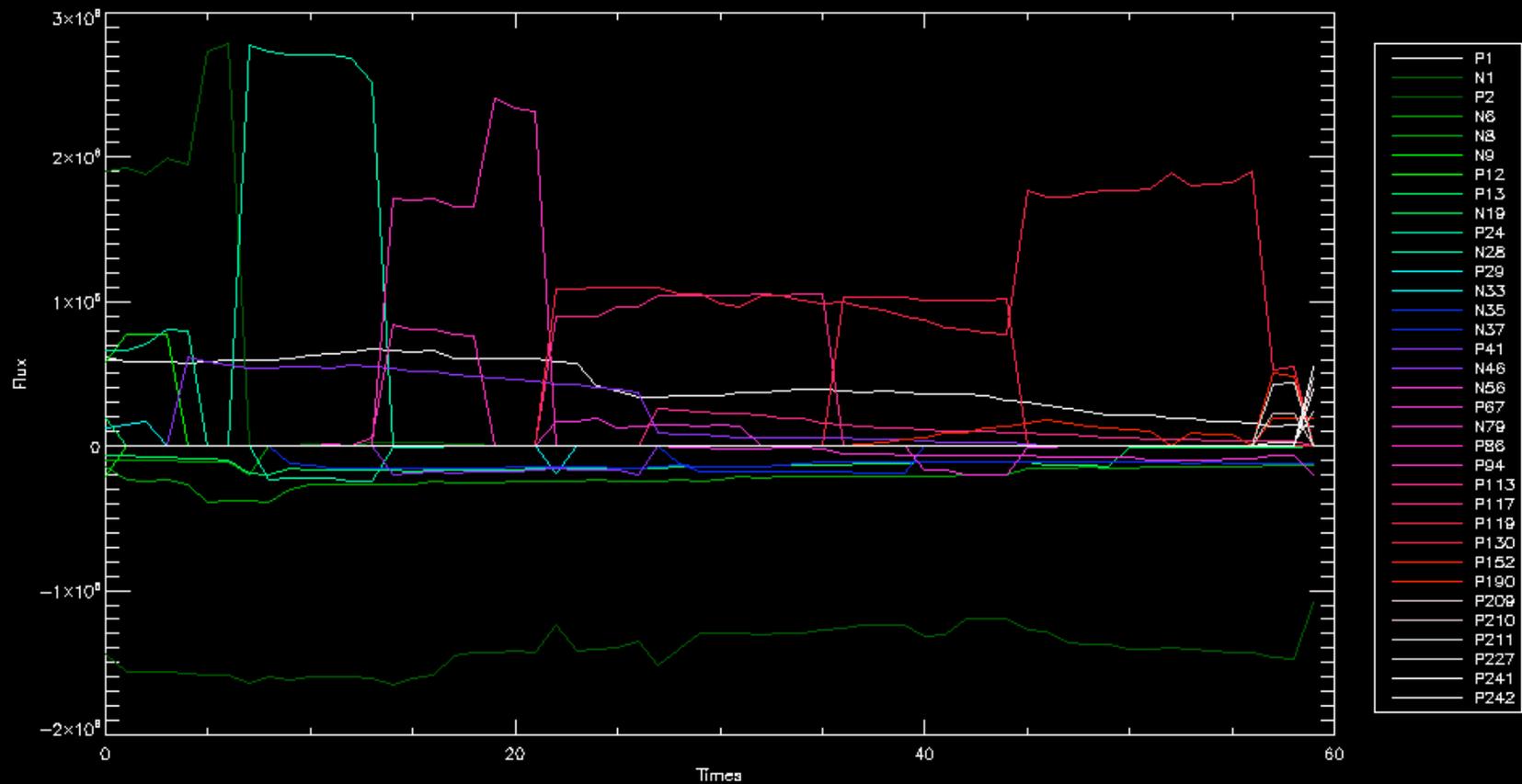
- MDI images were taken at 96 minute intervals
- To track active regions, a mask is created that partitions subregions of flux
- Potential problems:
  - Over several days, regions tend to disappear and reappear from time to time
  - Labels switch seemingly arbitrarily



# A reliable algorithm for pole consistency was developed

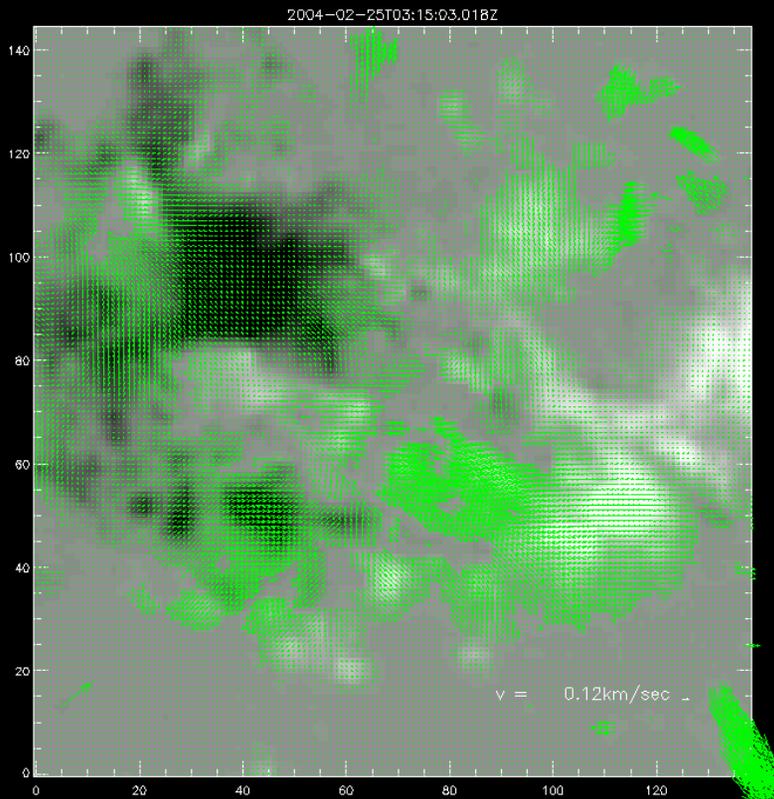


# A reliable algorithm for pole consistency was developed





# Local Correlation Tracking (LCT) is the current method for tracking regions



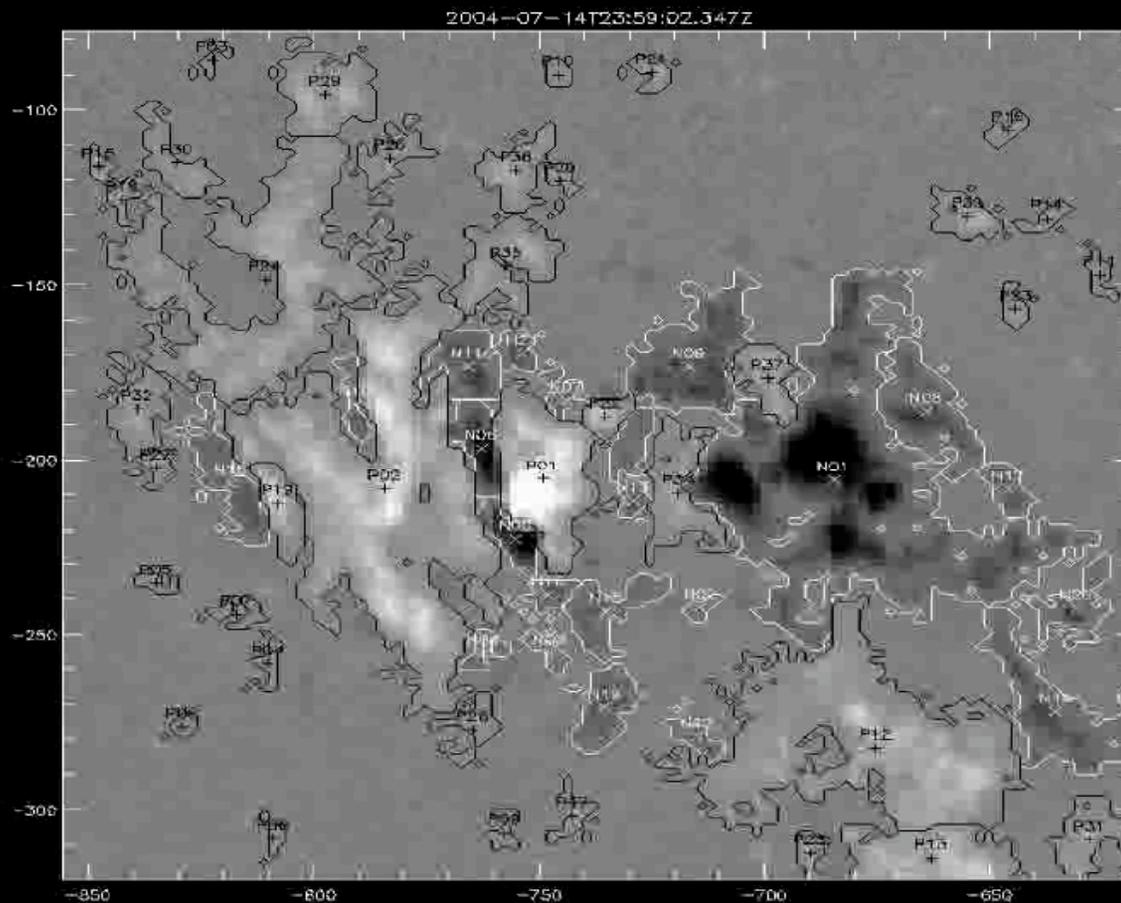
- LCT tracks movement of individual pixels of magnetograms to determine velocities
- Potential problems:
  - Underestimation of areas of stronger flux
  - Overemphasis on weaker flux regions

# Creating the mask currently relies on LCT

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- Mask regions have commonly been generated starting with the final LCT velocity fields and advecting back to the initial mask
- Using this mask to analyze the effectiveness of LCT begs the question since the mask was found using LCT to begin with
- Our method for creating the mask depends entirely on tessellation algorithms instead of LCT, allowing for both analysis of LCT and our method

# Magnetic Charge Topology (MCT) tracks source movement

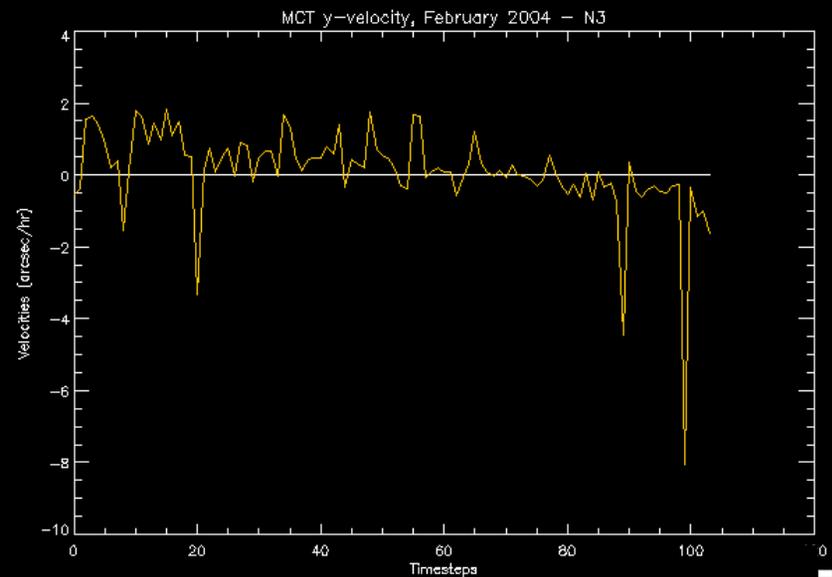
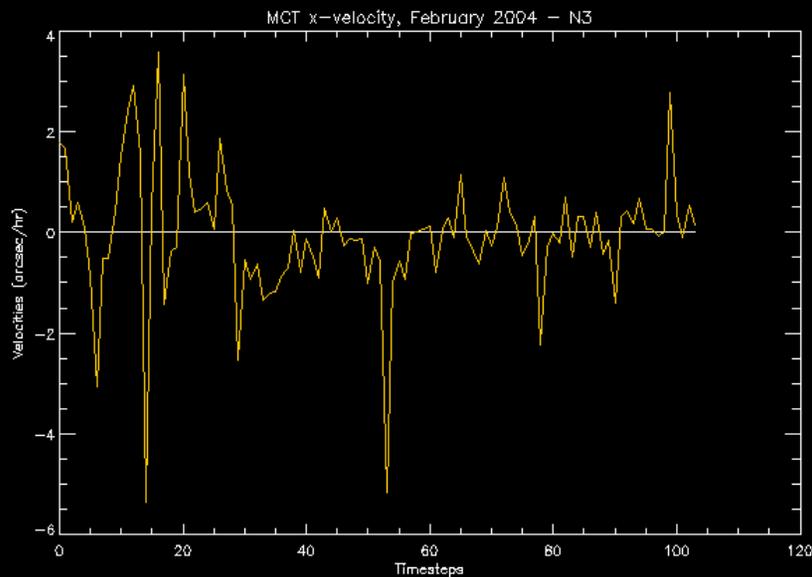


- MCT is used to approximate the flux regions as flux-weighted centroids
- The mask is generated from these sources

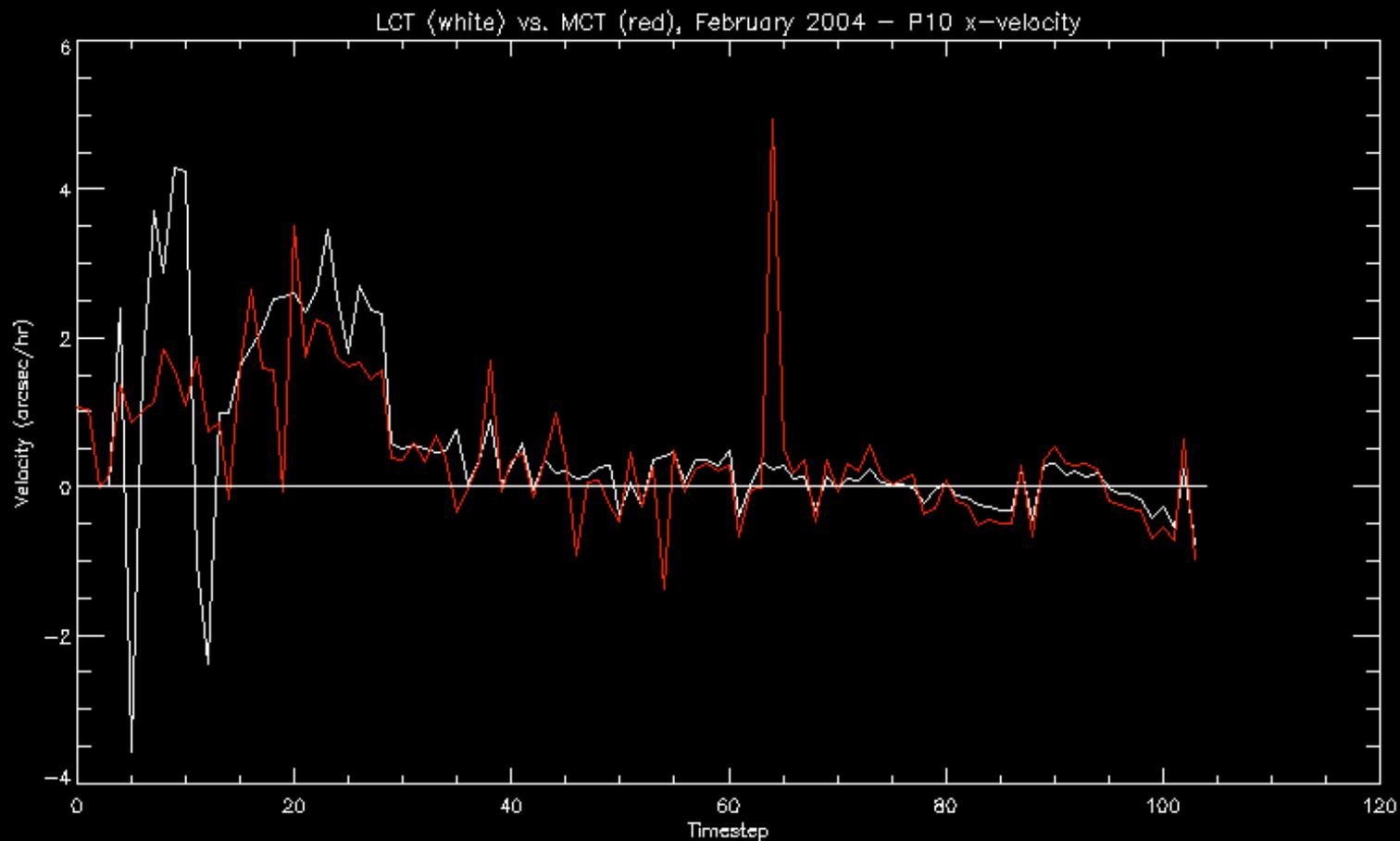
# Velocities can be determined by tracking pole movement

- Centroid velocities:

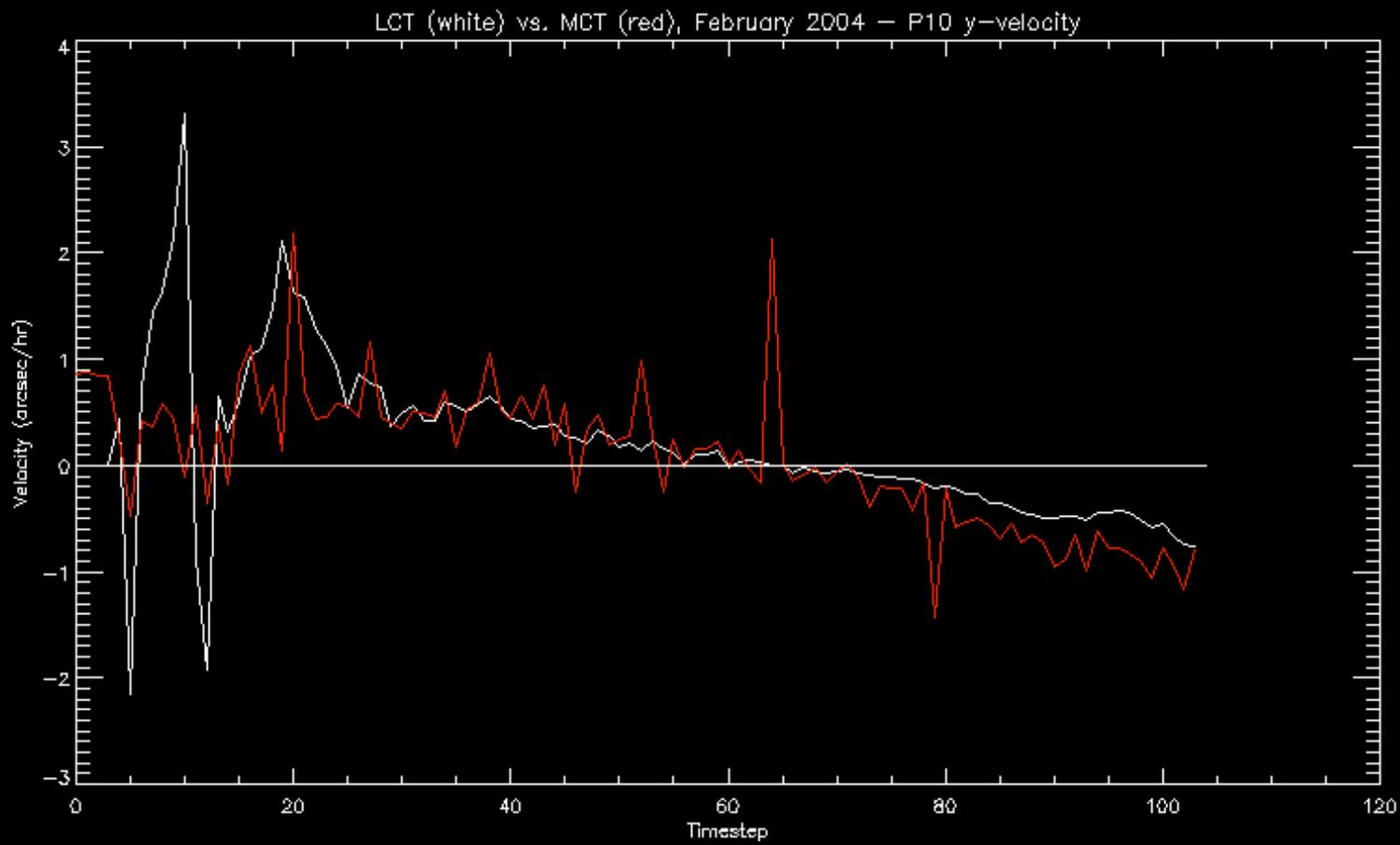
$$[x(i+1) - x(i)] / [\text{time}(i+1) - \text{time}(i)]$$



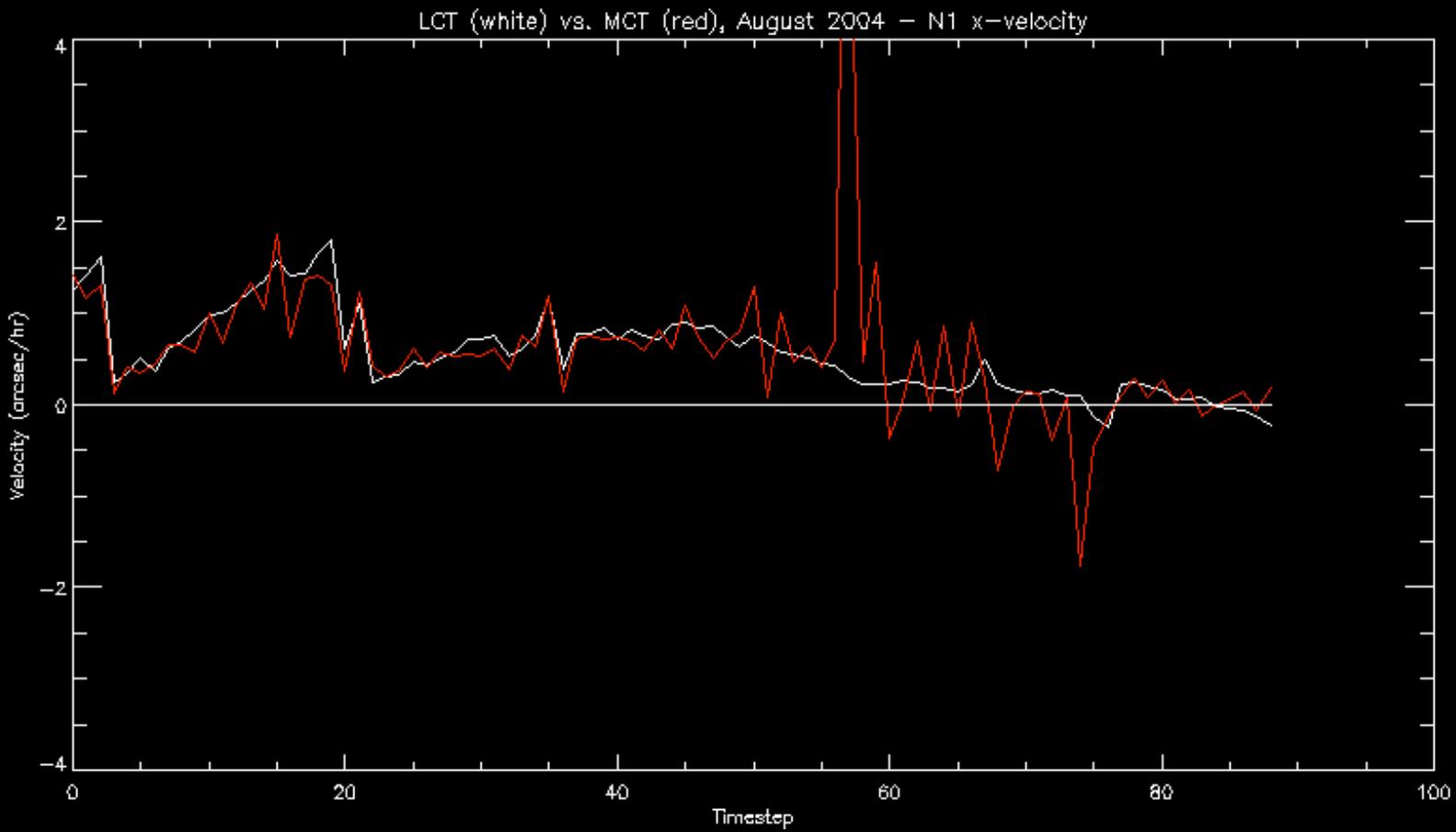
# Comparison between MCT and LCT showed a high degree of correlation



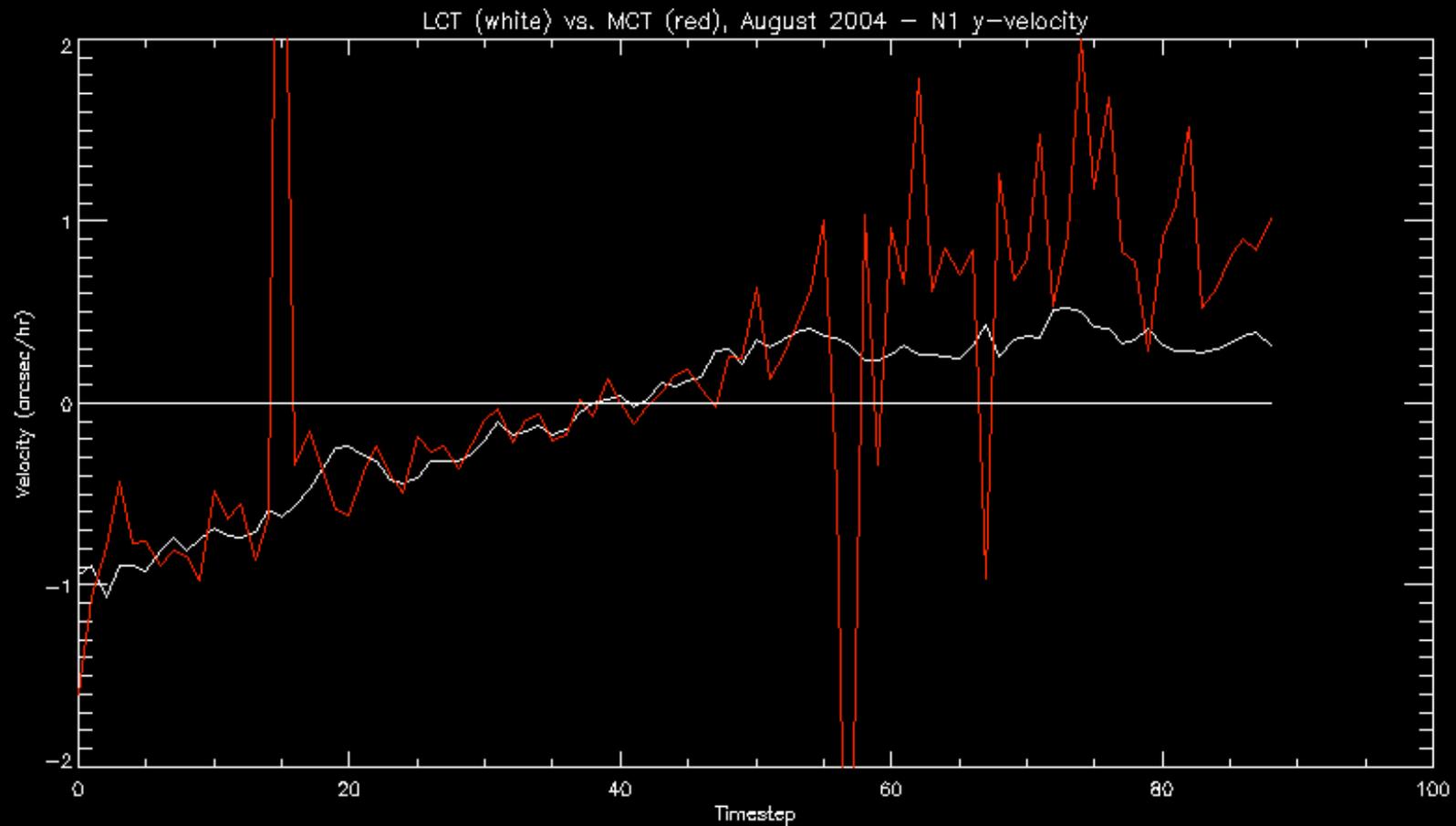
# Comparison between MCT and LCT showed a high degree of correlation



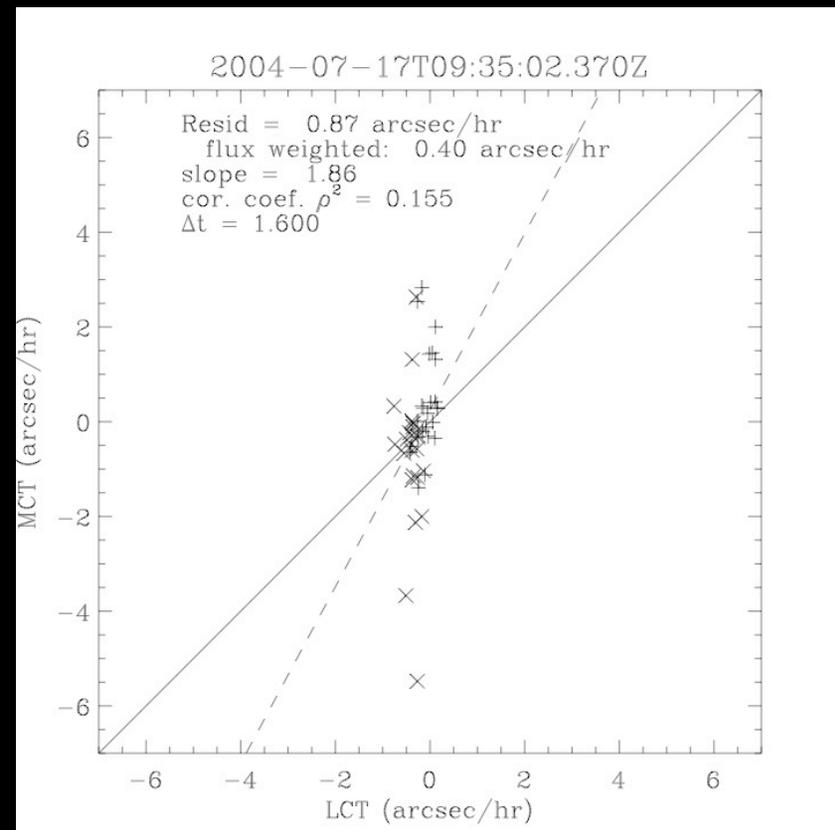
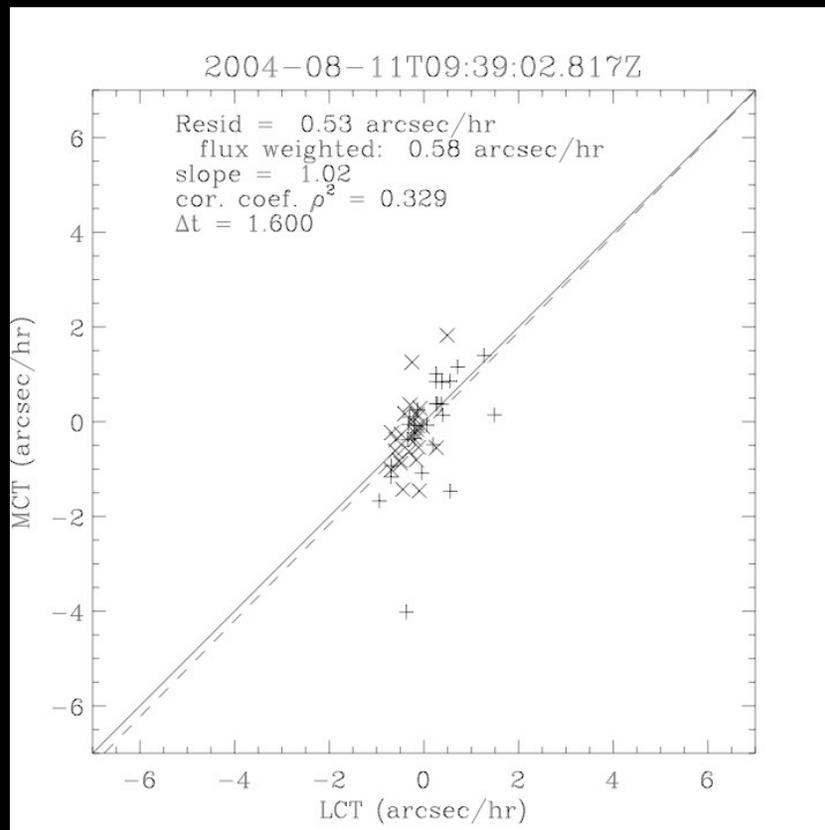
# Comparison between MCT and LCT showed a high degree of correlation



# Comparison between MCT and LCT showed a high degree of correlation



# Further analysis confirms this agreement between the two methods



# Conclusions/Impacts

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- Finding a repeatable algorithm to create masks not using LCT is feasible and effective
- Comparison of LCT and MCT allows for confirmation of the validity of both methods
- Where MCT does not match LCT, there is a reasonable explanation for it
- Tracking movement of active regions comes into play in energy storage and helicity calculations

# Thank you!

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- Acknowledgments:
  - Lucas Tarr
  - Dana Longcope
  - NSF
  - The entire solar physics group here at MSU
  - My cohorts here this summer