Artificial Intelligence Techniques Applied to Automating Meteor Validation and Trajectory Quality Control to Direct the Search for Long Period Comets

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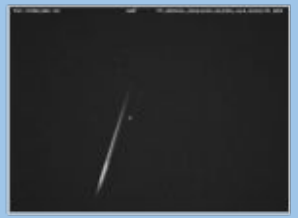
Project Accomplishments

- **Machine Learning Applications**
  - *Confirmation of Meteor Tracks*
  - *Identification of Streams*
- **Constrained Aggregation and Trajectory**
- **Interactive Visualization Tools**
  - *3D Radiants*
  - *Stream Orbits*
- **Detecting Long Period Comets**

Image Based Confirmation of Meteors with CNN

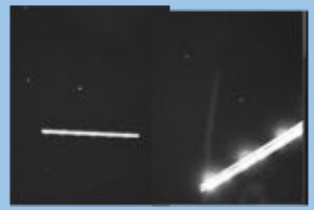
Training Data
True Meteors



Convolutional Neural Network

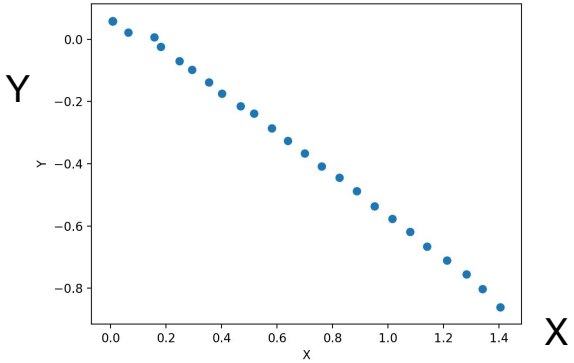
YES or NO

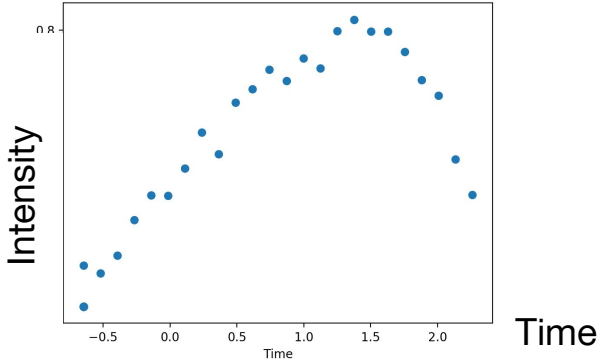
Training Data
False Alarms



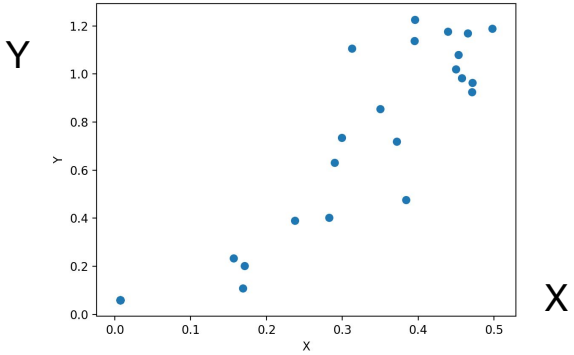
Tracklet Based Confirmation of Meteors with RF / LSTM

Meteor





Non-Meteor



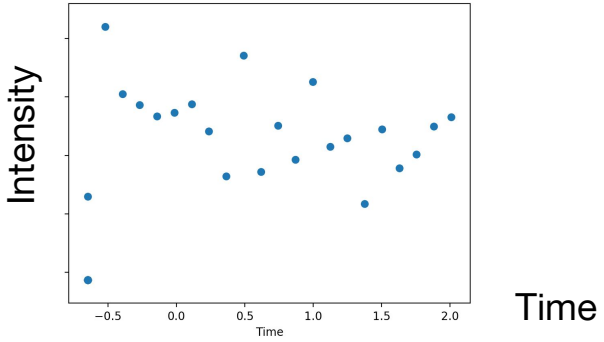
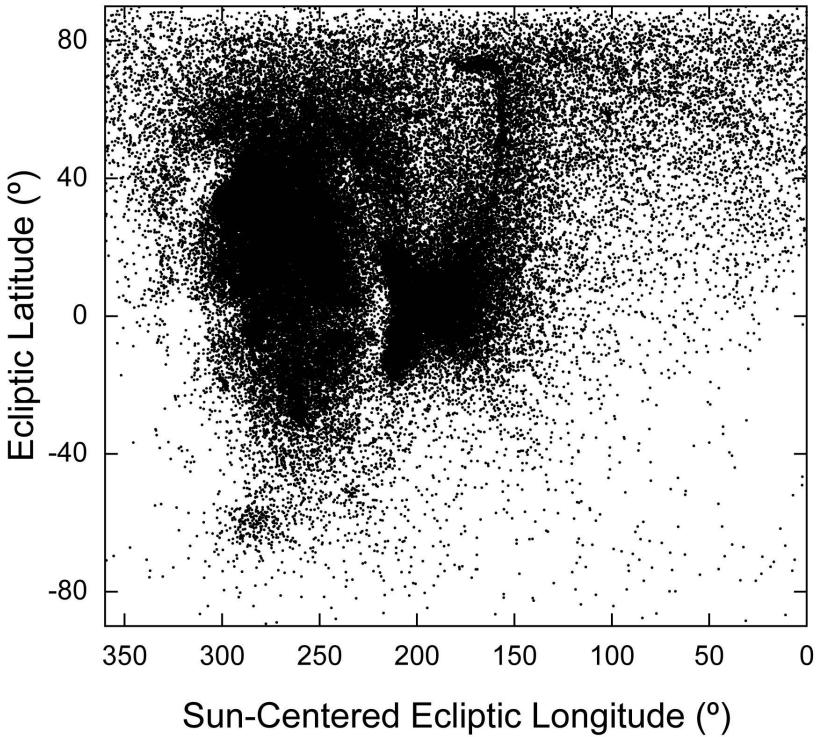


Image versus Tracklet Comparison

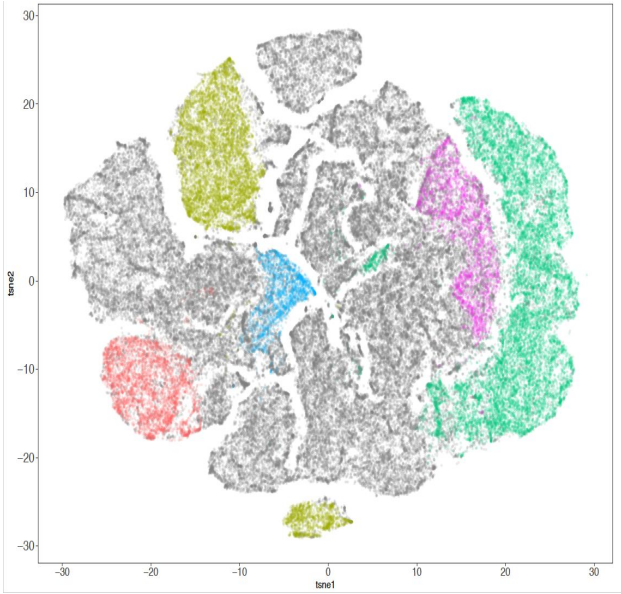
Input Based on:	Method	% that were false alarms	Recall = % of known meteors	Figure of Merit
Images	Convolutional Neural Network	11.7	**90.3**	89.5
Tracklets	Random Forest	**10.0**	80.6	84.9
	Long-Short Term Memory	**10.0**	89.1	**89.6**

Cluster Identification by Hand vs. Automated

Solar Longitude = 90⁰ - 135⁰ (June - July)

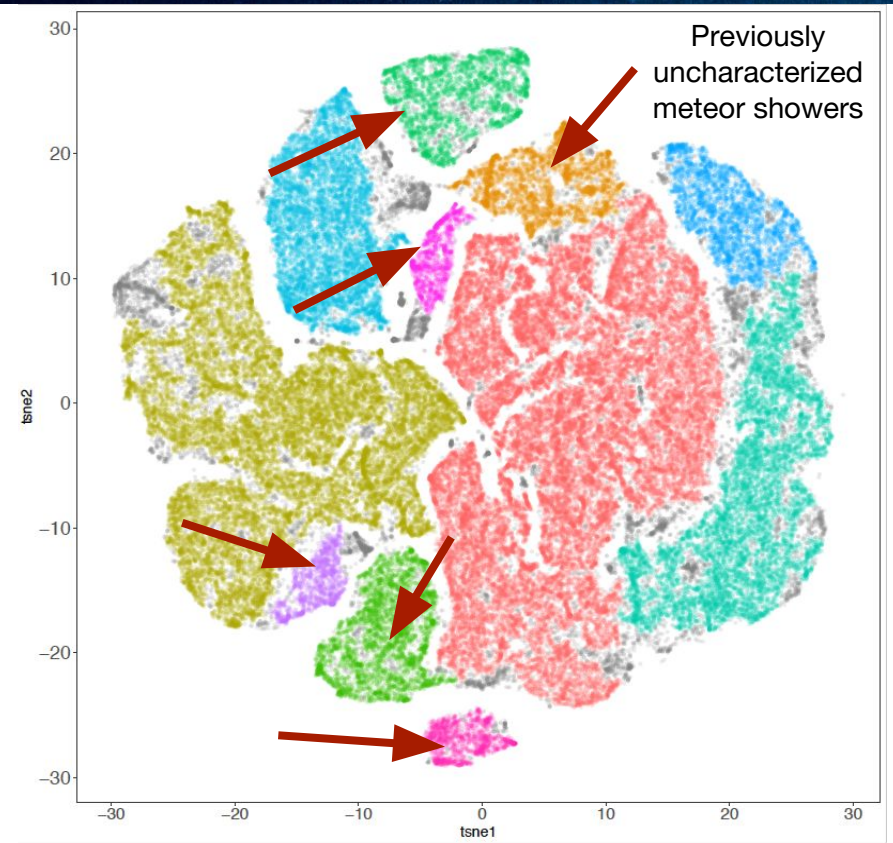


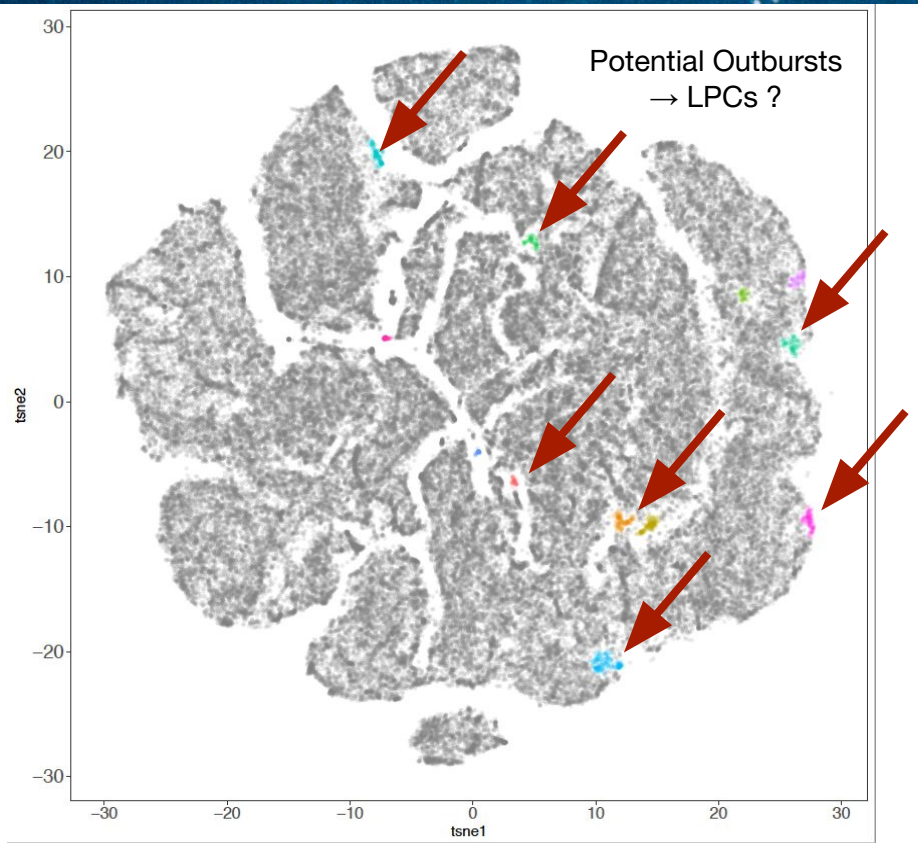
Multi-Dimensional Scaling using t-SNE



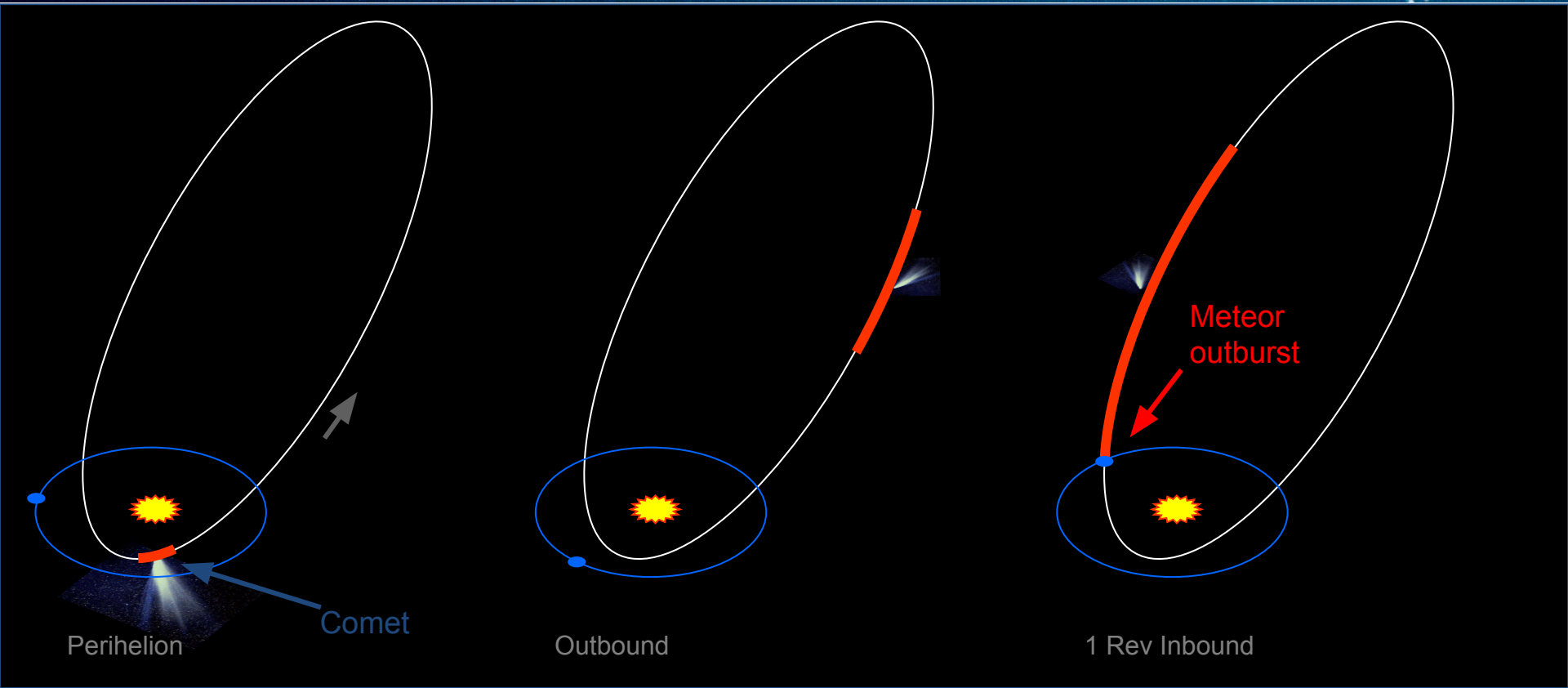
IAU Showers Identified

Stream ID via Unsupervised Machine Learning





Outbursts to Direct the Search for Long Period Comets



CAMS Interactive Visualization

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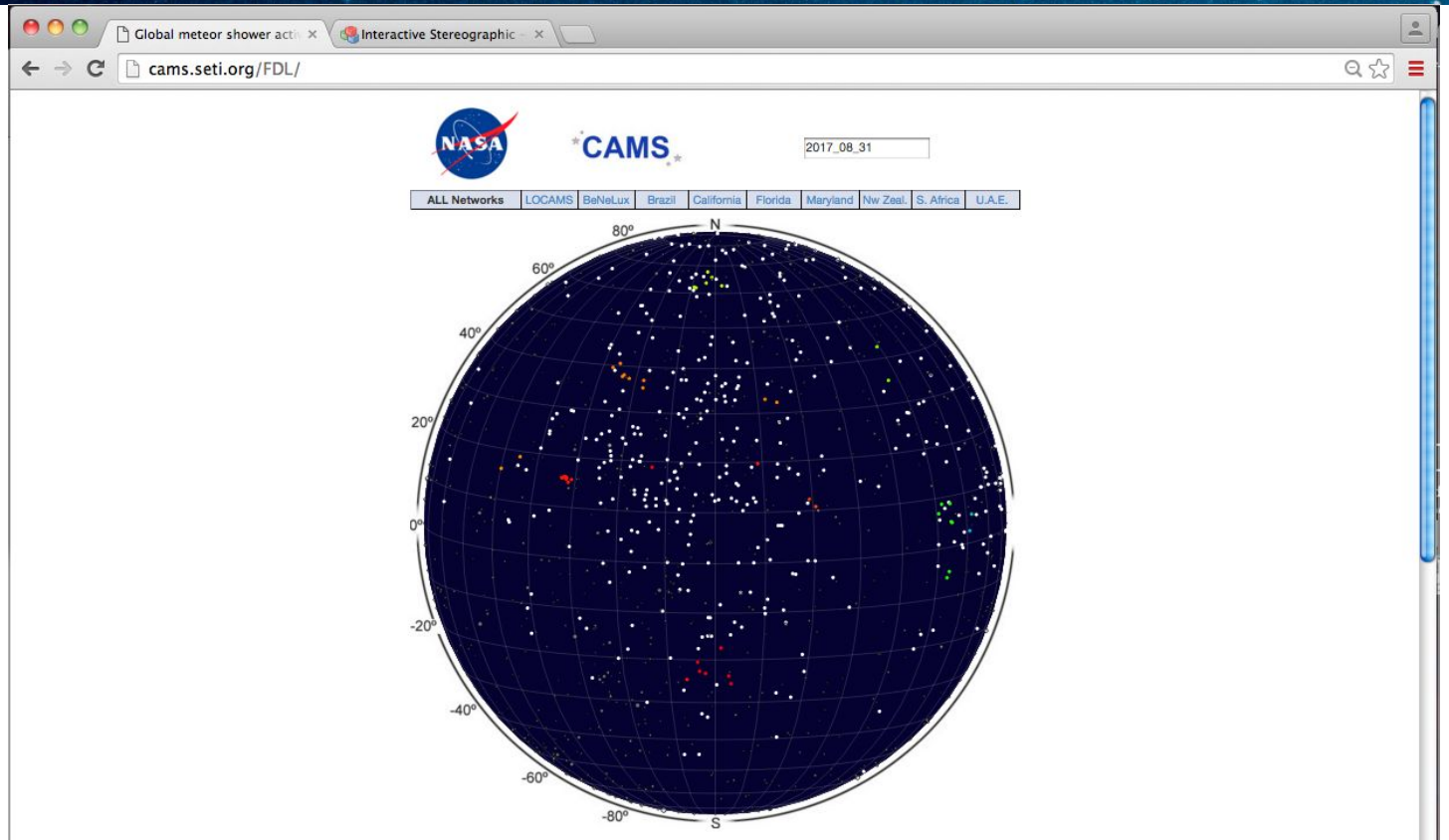
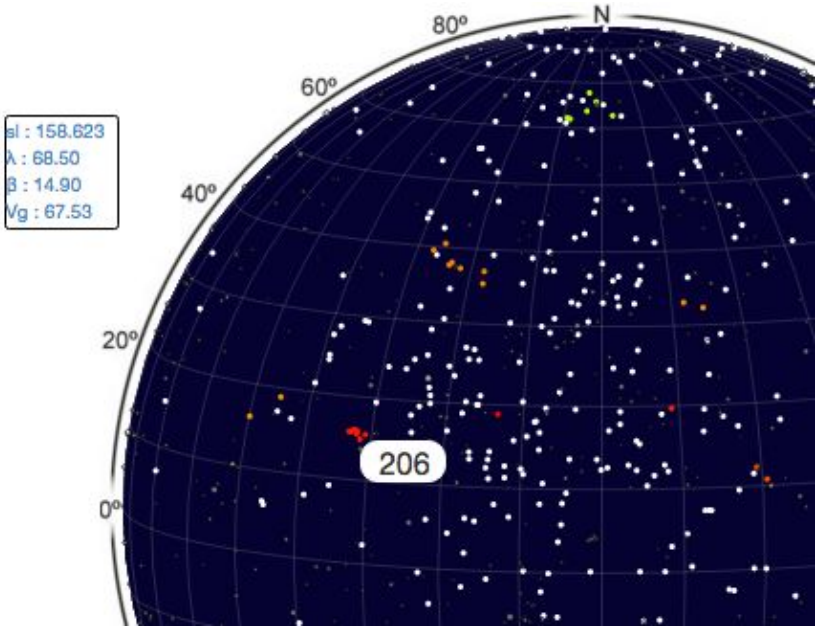


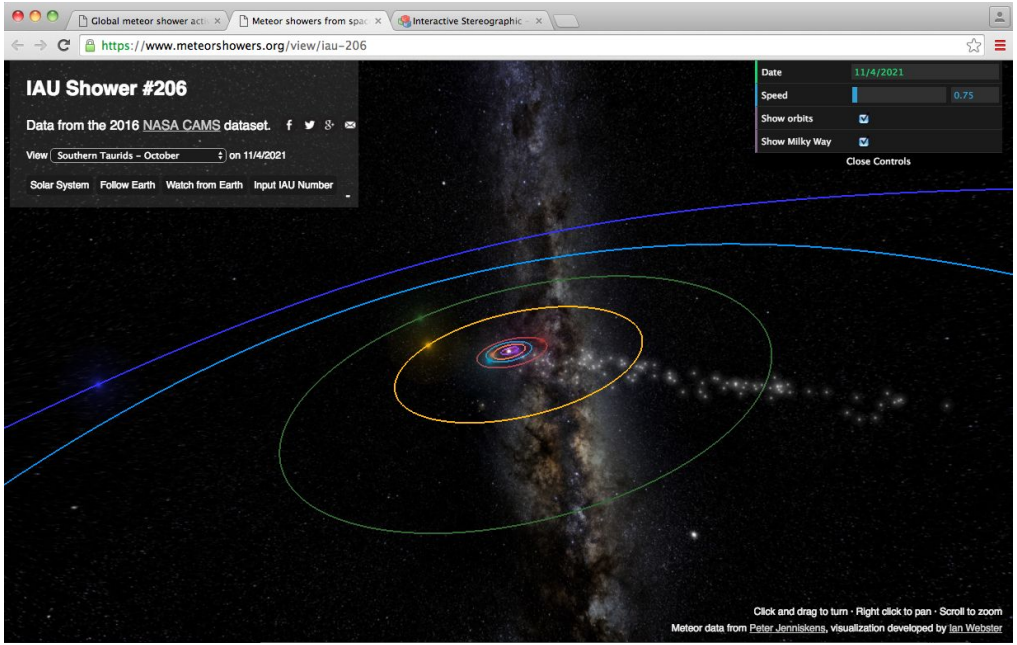
CAMS Stream Discovery Tools

CAMS Radiant Display Tool



http://cams.seti.org/FDL/

CAMS Planetarium Visualization Tool



http://www.meteorshowers.org/

Mission Statement

Provide more warning time for long period comet impacts by applying machine learning to meteor shower observations, whose trajectories enable dedicated searches along predicted orbits.

But that needs: long term and global monitoring!