1. Introduction

The interest in space weather has never been greater, with society becoming ever more reliant upon technology and infrastructure which are potentially at risk. Geomagnetic storms are potentially damaging to power grids, communication systems and oil and gas operations.

2. Data

- Samples times over ~15 years of geomagnetic and solar wind data
- Storms rarely important
- Balance dataset: otherwise storms look nice
- Features selected like
  - Training set: same scaling applied to other sets
  - Some algorithms require \( x_1 \neq x_2 \)
  - Use Principal Component Analysis to decompose

4. Results

- Initial dataset with 205 samples (small set)
  - Some models much better at identifying storms than others
  - Large range in rms values and percentage of predictions which are close to the true value
- We then increased the total dataset size to 1000 samples (large set) and tested the best performing models
  - Again range of rms values
  - All the machine learning models outperform the ARIMA model in terms of rms, HitRate and skill (HSS)
- Positive results: worth pursuing for production system

3. Techniques

Machine Learning

- A branch of statistics
- We use regression algorithms here
- Capped out as for matrix inversion (little like finding best fit line with 2D data)
- Many algorithms (see [2] for an excellent introduction), some are like linear regression e.g.

ARIMA

- Auto-regressive moving average
- A linear regression over a windowed average of \( a \)
- Only input is \( a \) timeline
- Currently operational: used here as a baseline quality comparison

5. Summary and Future Work

- Scoping study results positive
- Value in predictions
- Proceed to operational system
- Here we only predict 1 hour interval into future
- Some models easily configures to predict multiple intervals
- Others need new train, validate, test cycles
- Classification not regression
  - e.g. G1, ..., G5
- More useful aid to human forecaster
- Potentially easier computation
- Up-weight storm categories: balance dataset
- More features per sample
  - Models converge with few training samples (see fig.): models powerful enough
  - Data mine human forecasts, coronagraph data...
- Science potential in ‘white box’ models: which features give useful info?

References


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