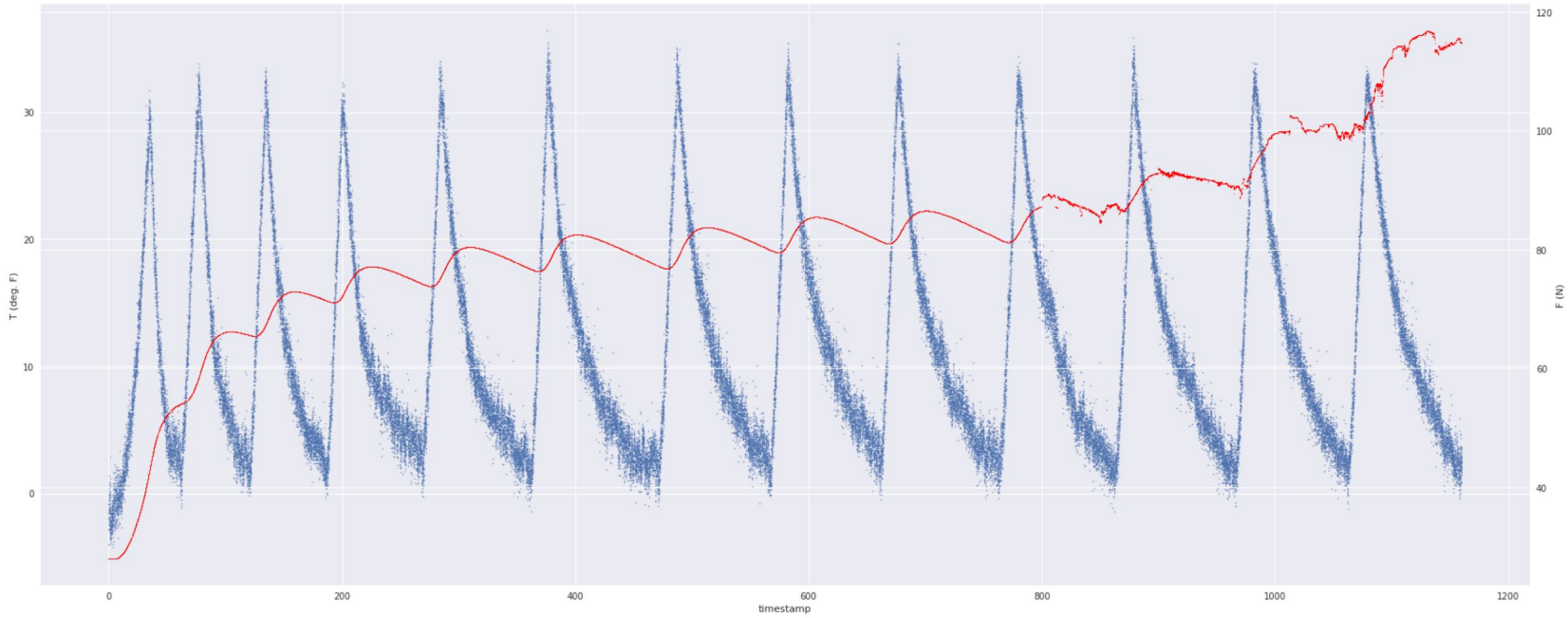
1. **Temperature** tracks **force** with positive trend.
   (goal: clean data, feature engineer & remove trend)

In **red:** temperature (deg. F)
In **blue**: force (N)

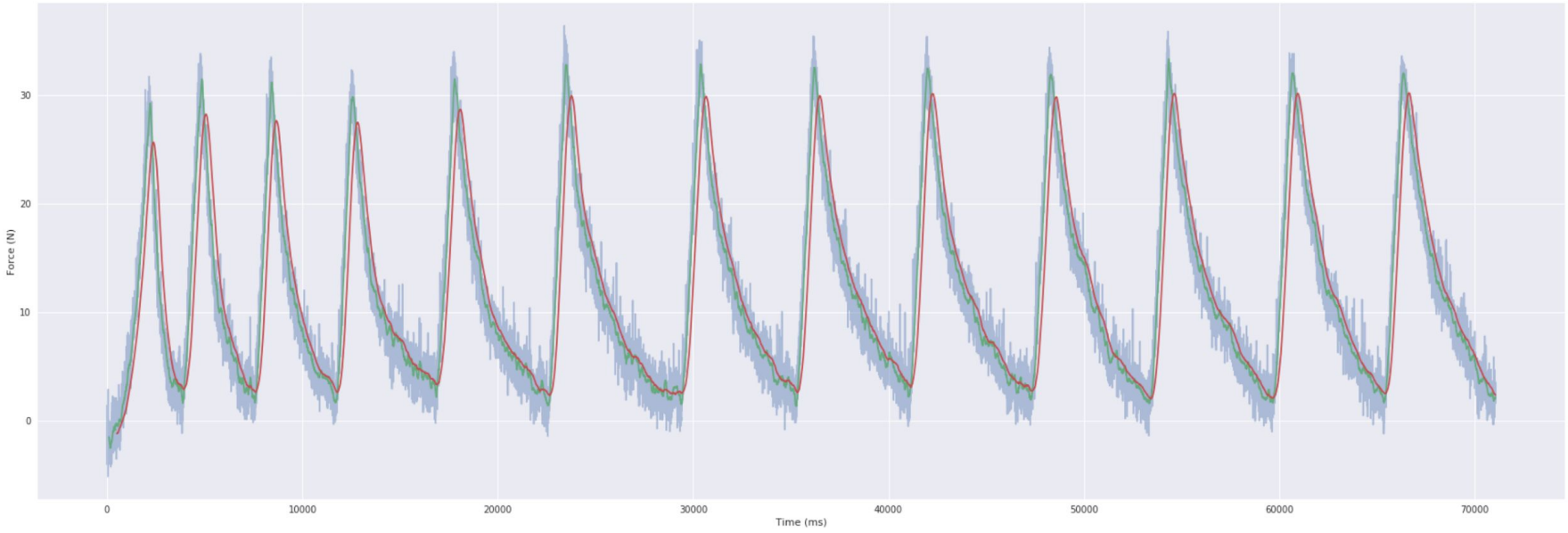
Below: **12** full cycles (discard first)



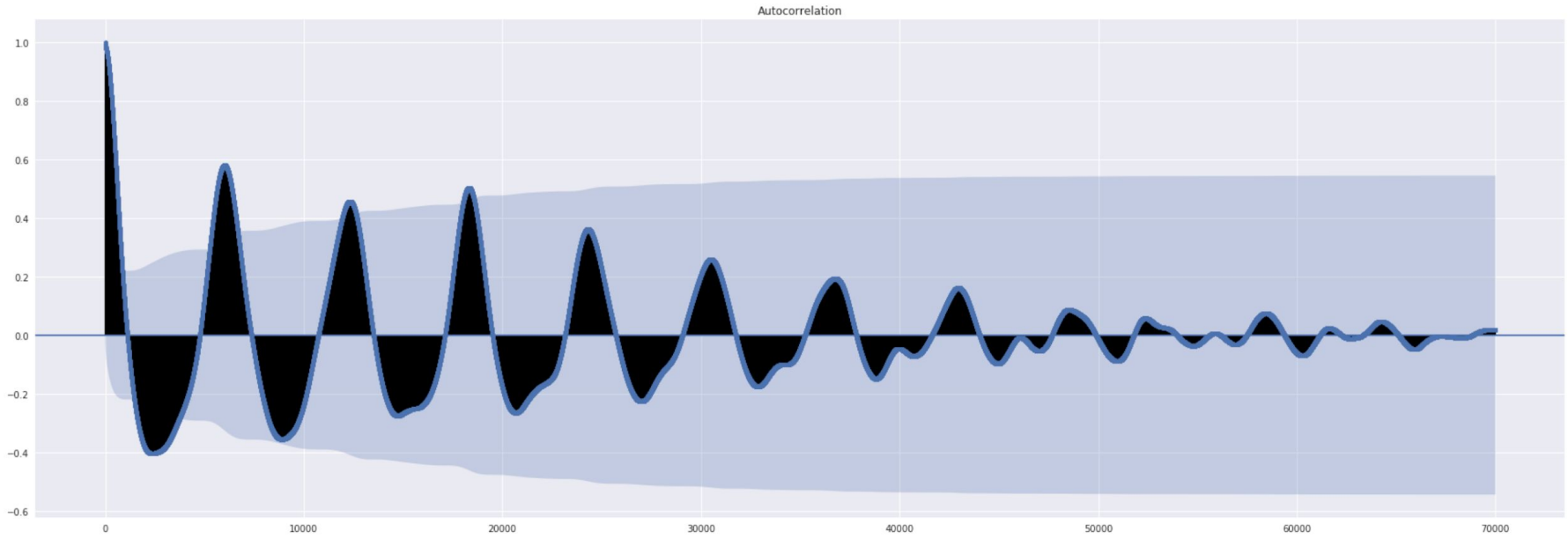
2. Simple moving average (window=**100**, **500**) sufficiently smooths noise, especially near minima

In **blue**: force (N), ground truth (raw data) - **noisiest**
In **green:** 100-point moving average - **less noisy**
In **red:** 500-point moving average - **smooth, lags behind signal ~100ms**

Below: **12** full cycles (discard first)



3. Autocorrelation on force (N) shows strong positive correlation with last 2-3 cycles, disappearing with greater lag



4. Out-of-the-box ARMA (autoregression + moving average) model fits raw data well...

In **green:** force, raw data (N)
In **blue**: ARMA fit on training data

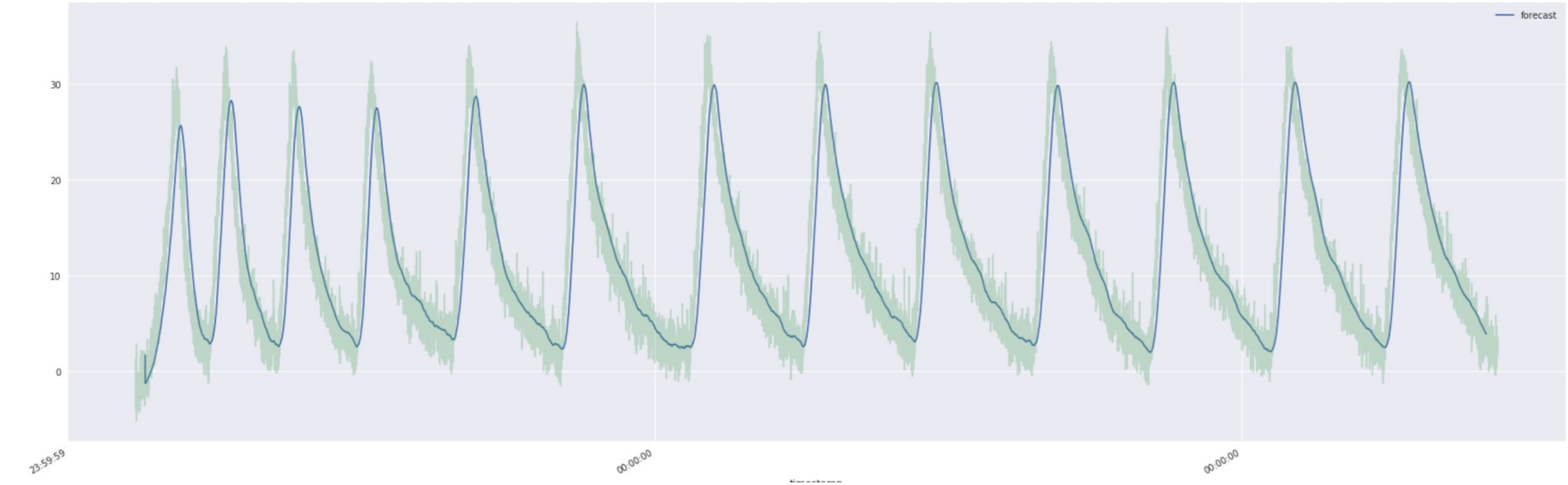
RMSE = 28.45
MAE = 23.45

```
In [375]: rmse(pred.f, Xf.f)

Out[375]: 28.448979096177236

In [378]: mae(pred.f, Xf.f)

Out[378]: 23.452899800206044
```



5. ...but the same ARMA model fails on test split (attempting to predict last 3 cycles).

In **green:** force, raw data (N)
In **blue**: ARMA prediction on test data