Statistical analysis of the NMA's CPOS system in Northern Norway

Michael Bitney

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This report describes the master project of Michael Bitney supervised by Lasse Clausen at the University of Oslo, Knut Stanley Jacobsen from the Norwegian Mapping Authority (NMA) and Anna Follestad at the University of Oslo. Here we will be looking into GNSS-disturbances in the NMAs CPOS-system. The CPOS-system is influenced by space weather and is vulnerable to ionospheric disturbances observed during e.g. geo-magnetic storms and substorms. Here Michael Bitney will be investigating statistical data from the CPOS and the goal is to look into what causes the disturbances of the CPOS.

1 Description

The CPOS-system is a network Real-Time Kinematic (RTK) positioning service provided by the NMA (Kartverket), that is used by numerous industries. Disturbance can cause problems for numerous operations. Here we want to investigate these noise levels and try to develop a baseline to this noise in order to understand how it varies, what are its causes and if one can predict these noise levels. Michael Bitney (master student) will look into seasonal and daily variation in order to see how the noise behaves. We have an interest in this to see if one can try to either improve the system or better predict the different levels of noises.

1.1 Techniques

Since we are looking at new parts of CPOS-data, we are not aware of what we can find underneath the data, so different method will be utilized based on what we find. The first thing we will consider is to look at averages from the daily data and calculate variations. Although we are unsure of what the data will show, we know that the disturbances is influenced by space weather and we will therefore look into variations in e.g. keograms and convection maps to try to see how these correlate with the disturbances.

Michael Bitney (master student) has an additional idea to look into recurrent neural networks, in order to predict certain patterns in the noise, but might not be pursued.

1.2 What should be investigated?

We will look into the CPOS-system data for a year and look at the daily inaccuracies and look for patterns in this. In order to try to explain the variation we will look into keogram data, convection maps and many other global data to see what effects the noise levels. There is particular interest into investigating the northern Norway in the night, as we see more ionospheric disturbances there as opposed to more southern latitudes.

2 Work Plan

Fall2019

- Take 3 courses:

  Fys-Stk-4155: Applied data analysis and machine learning

  Fys-4640: Space weather and satellite navigation systems

  Fys-4150: Computational Physics

- Writing project description
- Learn about CPOS system and study a few case studies

Spring2020

- Take 2 courses at Svalbard:

  AGF-304 Radar Diagnostics of Space Plasma (15 ECTS)

  AGF-301 The Upper Polar Atmosphere (15 ECTS)

- look at the CPOS data from the NMA

  Study machine learning in Space Weather

Fall2020

- August

  Literary studies

- September-October

  process data

  plot data

  start to interpret data

- November -December

  investigate which method can be used to explain the data

  start writing rapport

Spring2021

- January - February

  If time permits: Start making a recurrent neural network with the data

  Continue writing thesis

- March - April

  Write thesis

  Correct thesis and take input from supervisor

- May

  Complete writing thesis

  Send in thesis

  Prepare presentation

3 Supervision suggestions

Lasse Clausen and Anna Follestad suggests meetings every two weeks from fall semester 2020. In case of unavailability, E-mail is suggested instead. Any meeting before Fall 2020 will be through E-mail. Knut Stanley Jacobsen suggests visits to UiO when needed, which will be most likely at the beginning of fall 2020. Michael Bitney will also sometimes visit Kartverket to visit people working on the same project. Otherwise mail will be used as general contact.

4 Signatures

Lasse Clausen:

main supervisor

Knut Stanley Jacobsen :

co-supervisor

Anna Kristine Fæhn Follestad :

co-supervisor

Michael S. Bitney:

master student

References

[1] Jay Johnson Wing Simon and Enrico Camporeale. Machine learning techniques for space weather. 2008.

[2] A. Fæhn Follestad, L. B. N. Clausen, E. G. Thomas, Y. Jin, and A. Coster. Polar cap patch prediction in the expanding contracting polar cap paradigm. *Space Weather*, n/a(n/a).

[3] Jacobsen, Knut Stanley and Schäfer, Sebastian. Observed effects of a geomagnetic storm on an rtk positioning network at high latitudes. *J. Space Weather Space Clim.*, 2:A13, 2012.

[4] Alessandro P. Cerruti, Paul M. Kintner Jr., Dale E. Gary, Anthony J. Mannucci, Robert F. Meyer, Patricia Doherty, and Anthea J. Coster. Effect of intense december 2006 solar radio bursts on gps receivers. *Space Weather*, 6(10), 2008.