A reproducible Total Solar Irradiance estimation process using a Recurrent Neural Network

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ABSTRACT:

The Sun have a constant action on Earth, interfering in different ways on life in planet. The physical, chemical and biological processes that occur on Earth are directly influenced by the variation of solar irradiance, which is a function of the activity in the Sun's different atmospheric layers and their rapid variation. Studying this relationship may require the availability of a large amount of collected data, without significant gaps that could be caused from many kind of issues. In this work, we present a Recurrent Neural Network, Keras GRU, as an option for estimating the Total Solar Irradiance (TSI) and the Spectral Solar Irradiance (SSI) variability. Solar images collected on different wave components were preprocessed and used as the input parameters, and TSI and SSI data collected by instruments onboard of SORCE were used as reference of the results we deserved to reach. Beyond that approach, we opted for developing a reproducible procedure, for which we chose a free programming language, in attempt to offer the same kind of results, with same accuracy, for future studies which would like to replay the procedure. In this expectation, reproducible notebooks will be generated with the intention of providing transparency in the data analysis process, and allowing the process and the results to be validated, modified and optimized by those who would like to do it. This approach aims to obtain a good accuracy in estimating the TSI and SSI, allowing its reconstruction in gap scales and also the forecast of their values six hours ahead.

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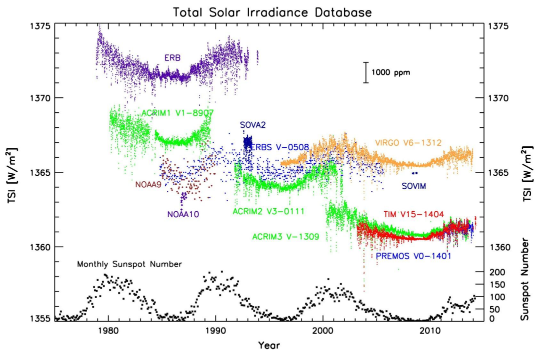
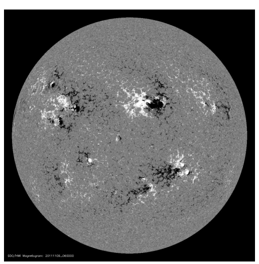
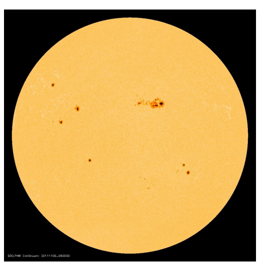
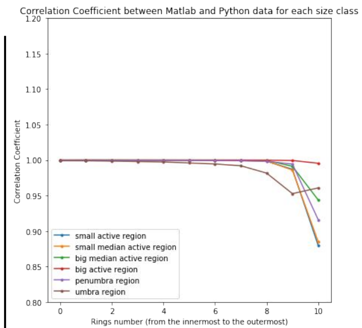
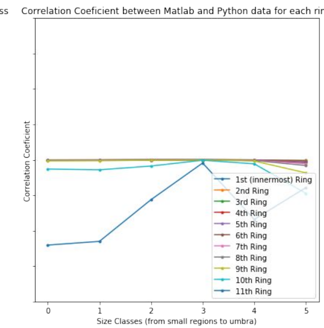




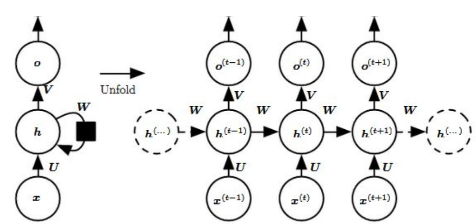


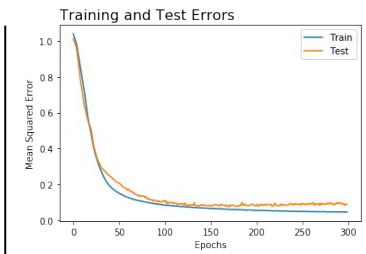
Workflow based on Vieira, L. E. A., de Wit, T. D., Kretzschmar, M.: Short-term forecast of the total and spectral solar irradiance.preprint arXiv:1111.5308 (2011).





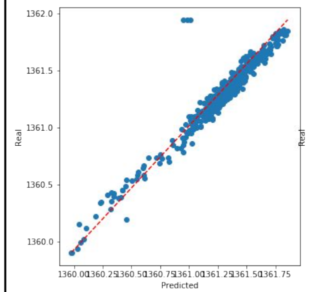
The uncorrelated columns were discarded, lasting 10 rings and 4 classes of region type

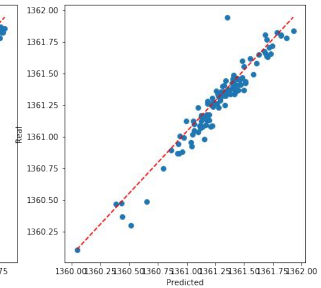




Keras GRU:

Hidden units: 1
Batch size: 5
Input samples: 587
Input parameters: 40
Time step: 1
Prediction: 6 hours





>90% Accuracy

Reproducible codes are available at:
https://github.com/amitamk/egu2020