Research study improves solar radiation forecasting models by 30%

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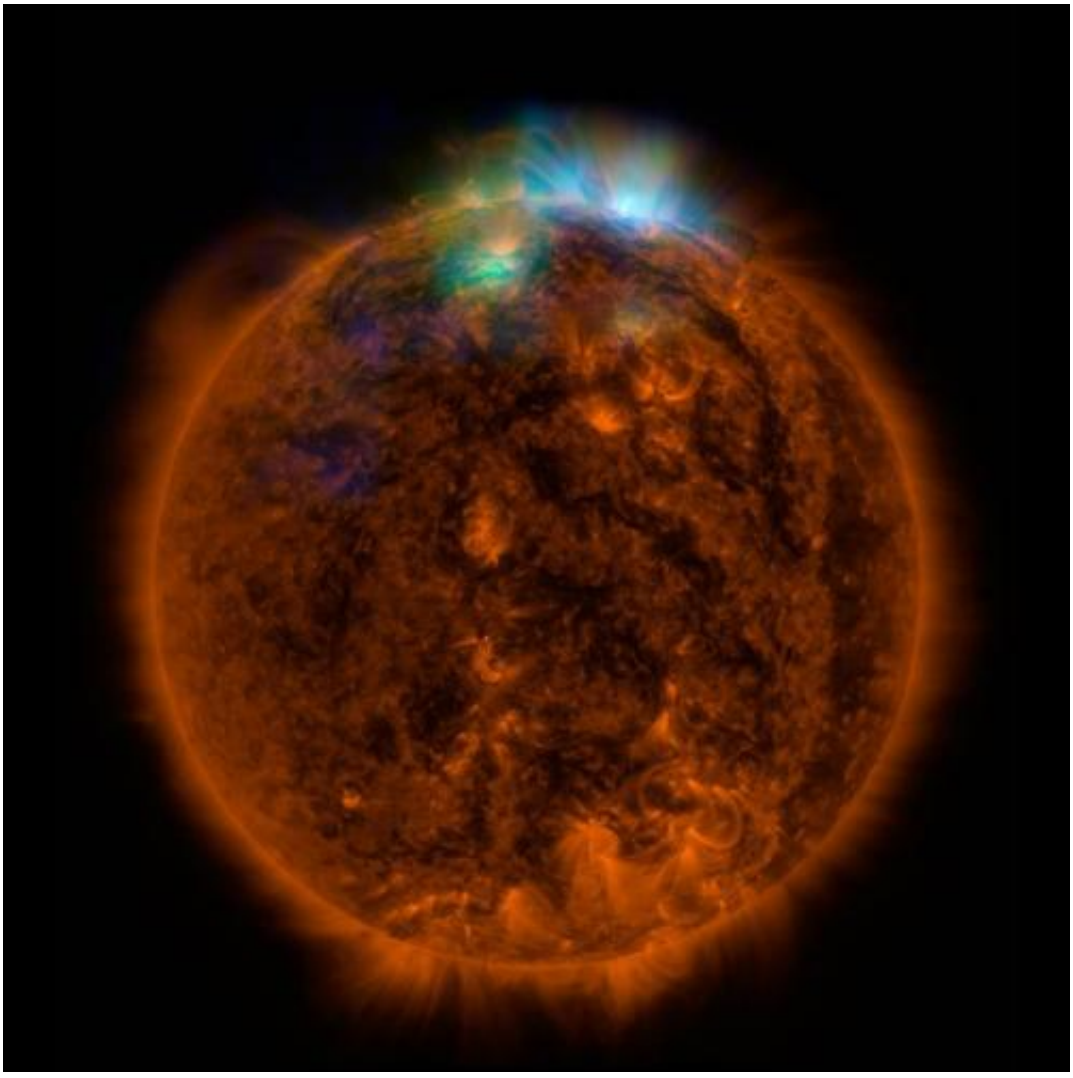

X-rays stream off the sun in this image showing observations from by NASA's Nuclear Spectroscopic Telescope Array, or NuSTAR, overlaid on a picture taken by NASA's Solar Dynamics Observatory (SDO). Credit: NASA

Researchers at Universidad Carlos III de Madrid (UC3M) and the Universidad de Jaen (UJA) have published a study reporting an optimal blending of solar radiation forecasting models with which they are able to reduce error in short-term forecasts (6 hours) by 25% and 30%.

The research project has focused on improving short-term solar radiation forecasting for the Iberian Peninsula, on a minute scale, an hour scale and a day scale. Specifically, five types of models were analyzed: based on cloud chambers, measurements, satellite images, weather predictions, and a hybrid of the last two. For this purpose, the researchers selected four meteorological stations as representative areas for the assessment located in Seville, Lisbon, Madrid and Jaen.

For two years, both research groups have divided their work into two parts. On one hand, the Evolutionary Computation and Neural Networks (EVANNAI) Group at UC3M has focused on applying artificial intelligence techniques to select the best model or combination of models for each meteorological situation, location and time horizon, as well as obtaining prediction intervals to estimate uncertainty in the forecasts. On the other hand, the Atmosphere and Solar Radiation Modeling (MATRAS) Group at UJA has focused on design and improvement of different solar radiation forecasting methods, for which they have used different methodologies such as cloud chambers, satellite images and meteorological models.

The most striking result obtained in this research is that the optimal modeling combination lowers the forecast error by around 30% with respect to the best models in each time horizon. "This is the first time that five independent models have been compared, and thanks to artificial intelligence and mathematical processing, we have been able to reduce the margin of error in each forecast horizon, which represents an economic savings because it reduces the cost of solar energy integration," explained project coordinator David Pozo, full professor of

applied physics at UJA.

"The use of artificial intelligence and specifically machine learning techniques enable the forecasts of different models to be automatically and efficiently integrated, with the model itself providing the best forecast for each time horizon. Furthermore, the use of evolutionary optimization techniques allows quantifying uncertainty for each of the forecasts. Incorporation of these new techniques into the context of renewable energies has led to important improvements with respect to the initial techniques," explained Inés M. Galván and Ricardo Aler, associate professors in the Computer Science and Engineering Department.

The researchers have determined the moment of the time horizon during which each model is more reliable, as occurs, for example, with the use of satellite images during the first two or three hours or the use of the numerical weather prediction model after the fourth or fifth hour. And among others things, it has also concluded that forecasting near coastal areas is more difficult even within the margin of an hour.

Part of this study has been published in two articles in the scientific journal *Solar Energy*, and another part is in the review process for other journals.

More information: Francisco J. Rodríguez-Benítez et al. A short-term solar radiation forecasting system for the Iberian Peninsula. Part 1: Models description and performance assessment, *Solar Energy* (2019). DOI: 10.1016/j.solener.2019.11.028

Javier Huertas-Tato et al. A short-term solar radiation forecasting system for the Iberian Peninsula. Part 2: Model blending approaches based on machine learning, *Solar Energy* (2019). DOI: 10.1016/j.solener.2019.11.091

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