Maximal growth rate of the ascending phase of a sunspot cycle for predicting its amplitude

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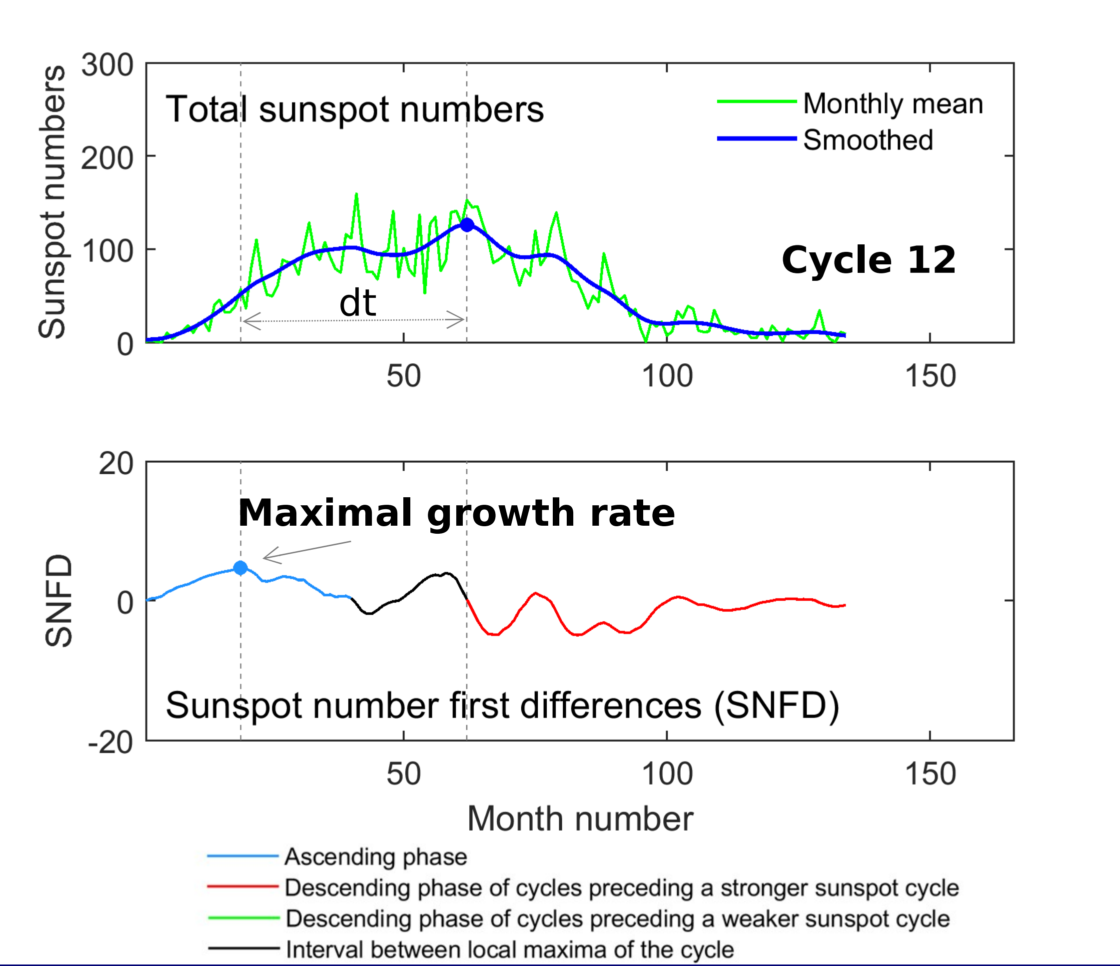
Total Sunspot Numbers

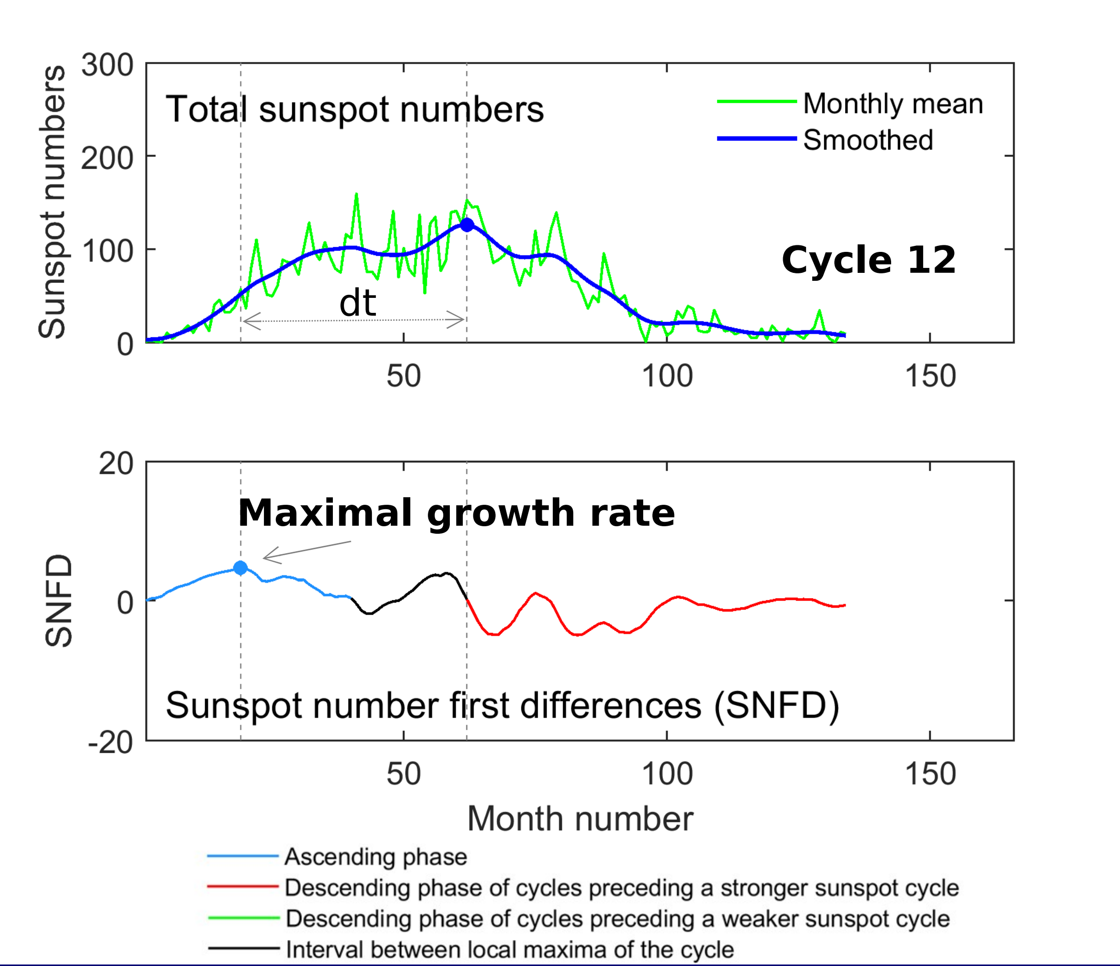
Maximal growth rate - precursor of the sunspot cycle amplitude



Podladchikova et al. (2022)

Total Sunspot Numbers

Maximal growth rate - precursor of the sunspot cycle amplitude



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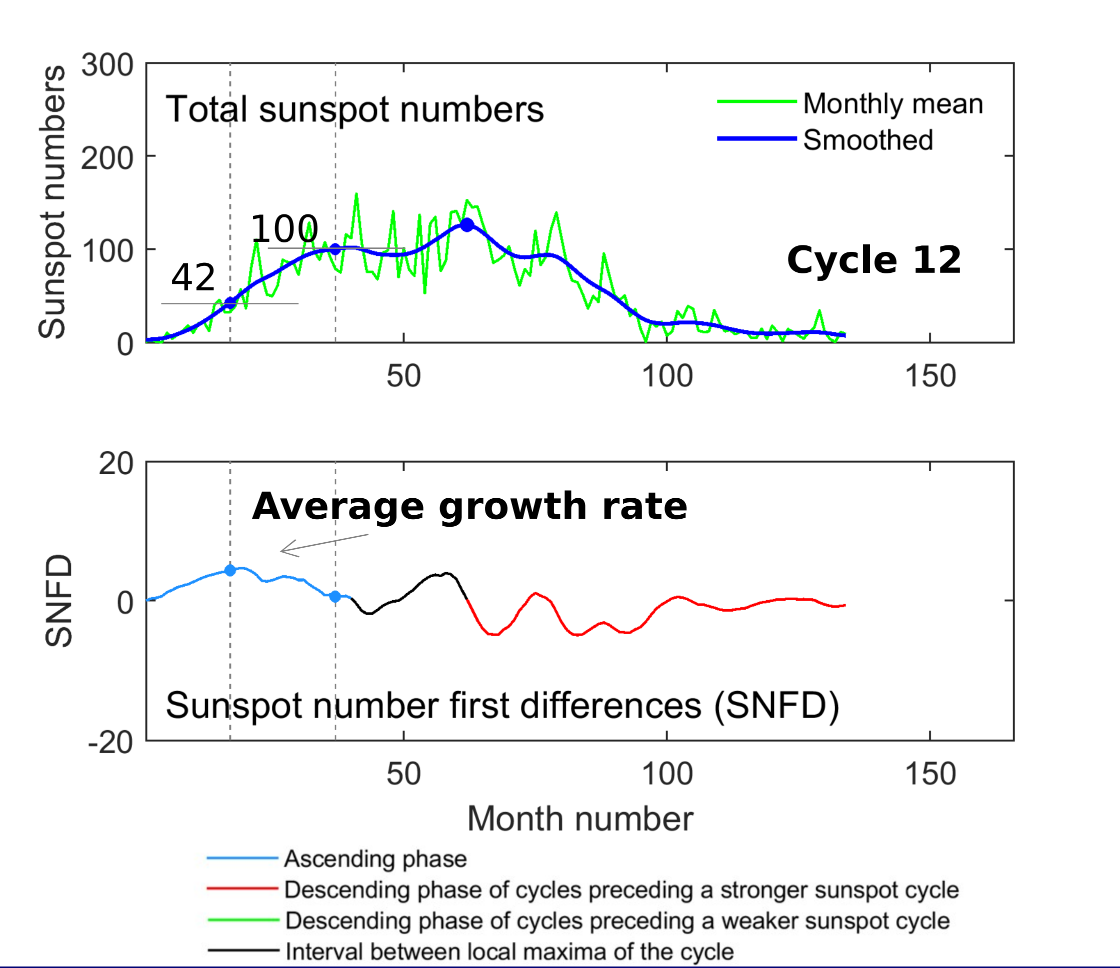
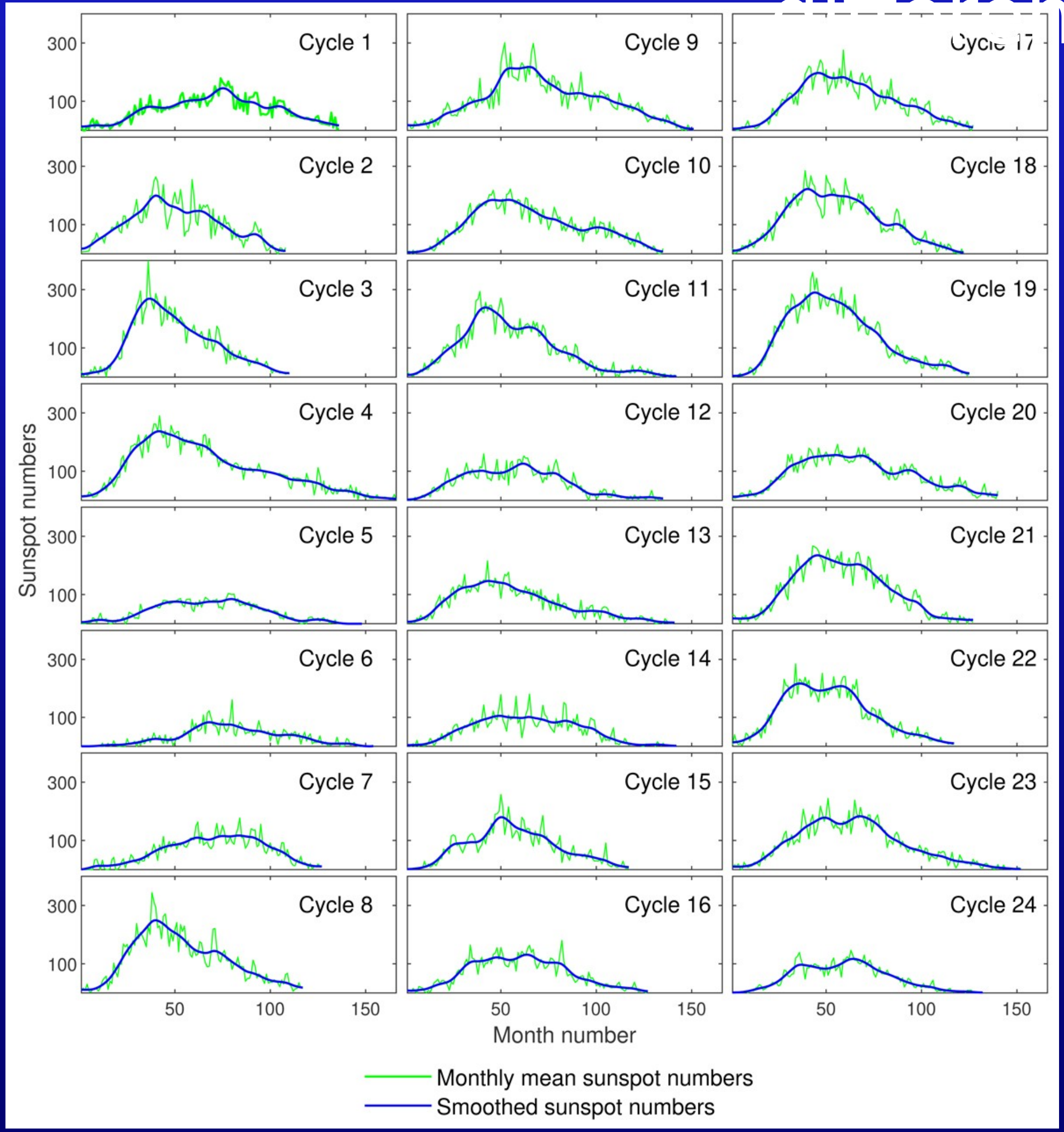
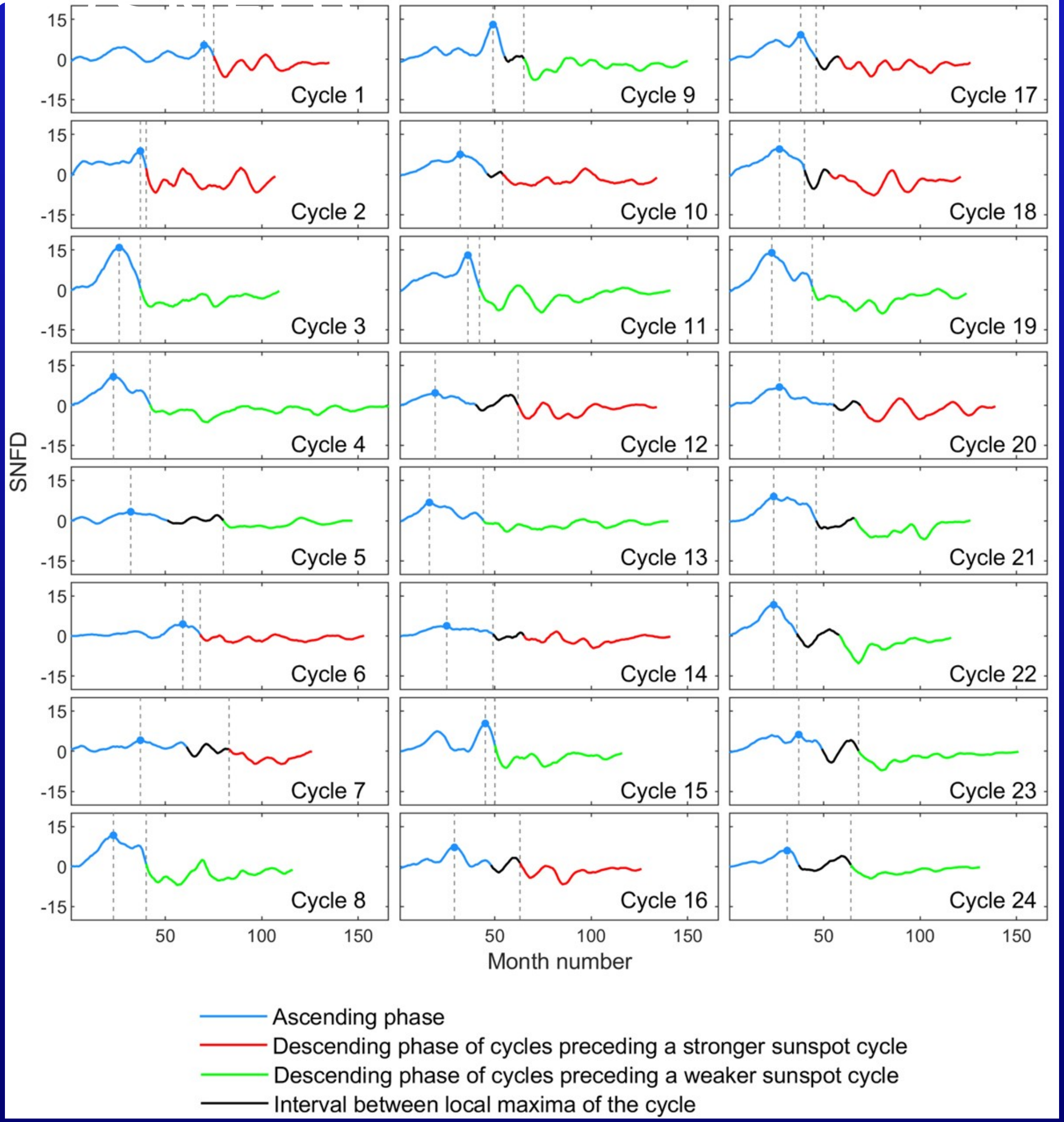


Cameron and Schüssler (2008)

Solar cycles 1-24 together with the sunspot number first differences (SNFD)



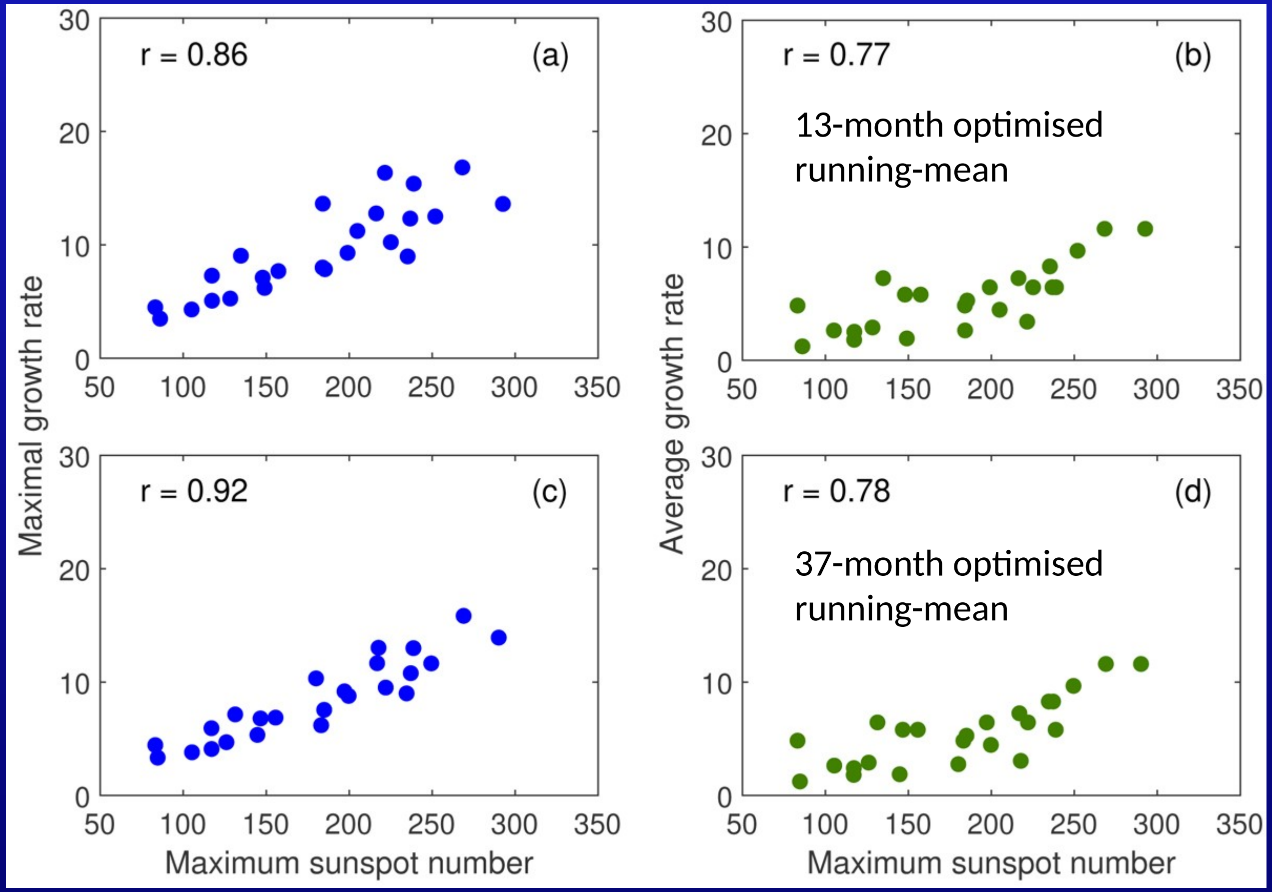


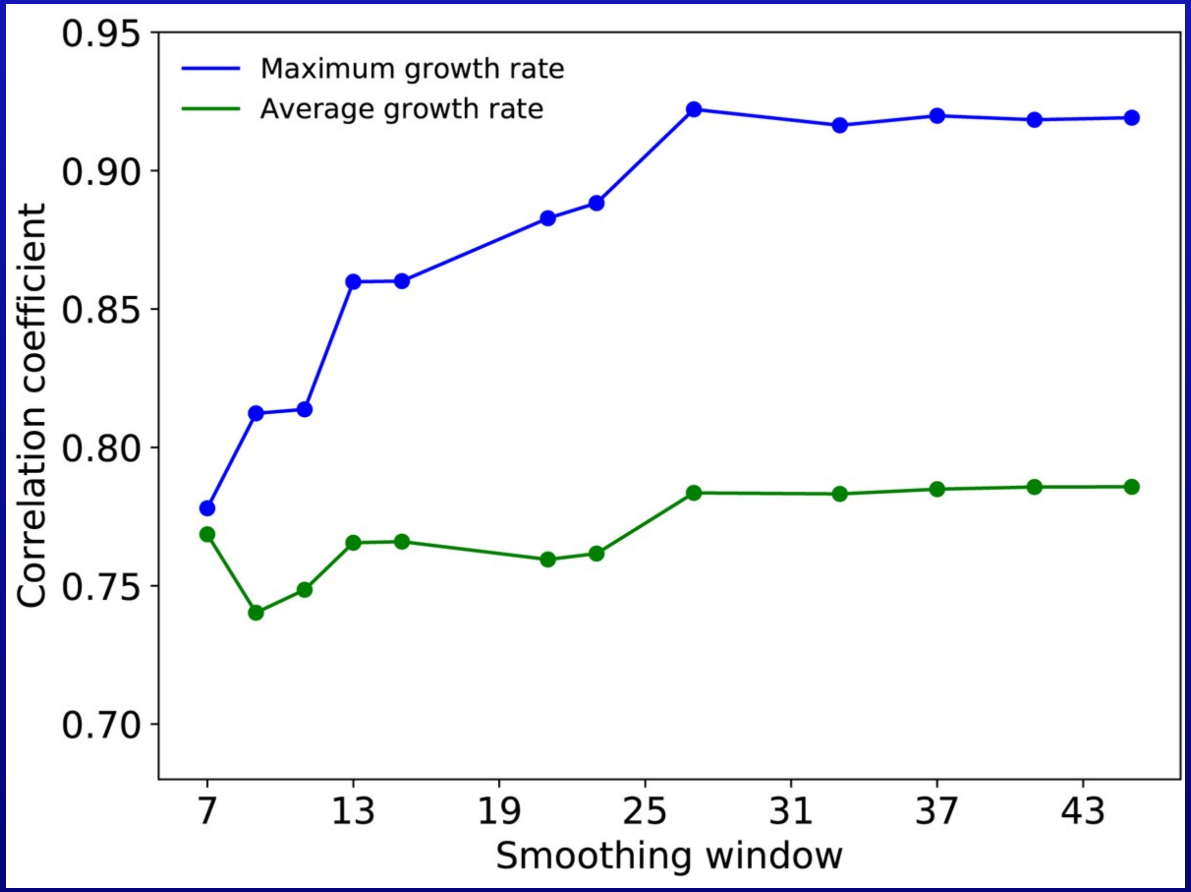
37-month optimized running-mean
Podladchikova et al. (2017)

Lead times: 2- 49 months
On average: 21 months

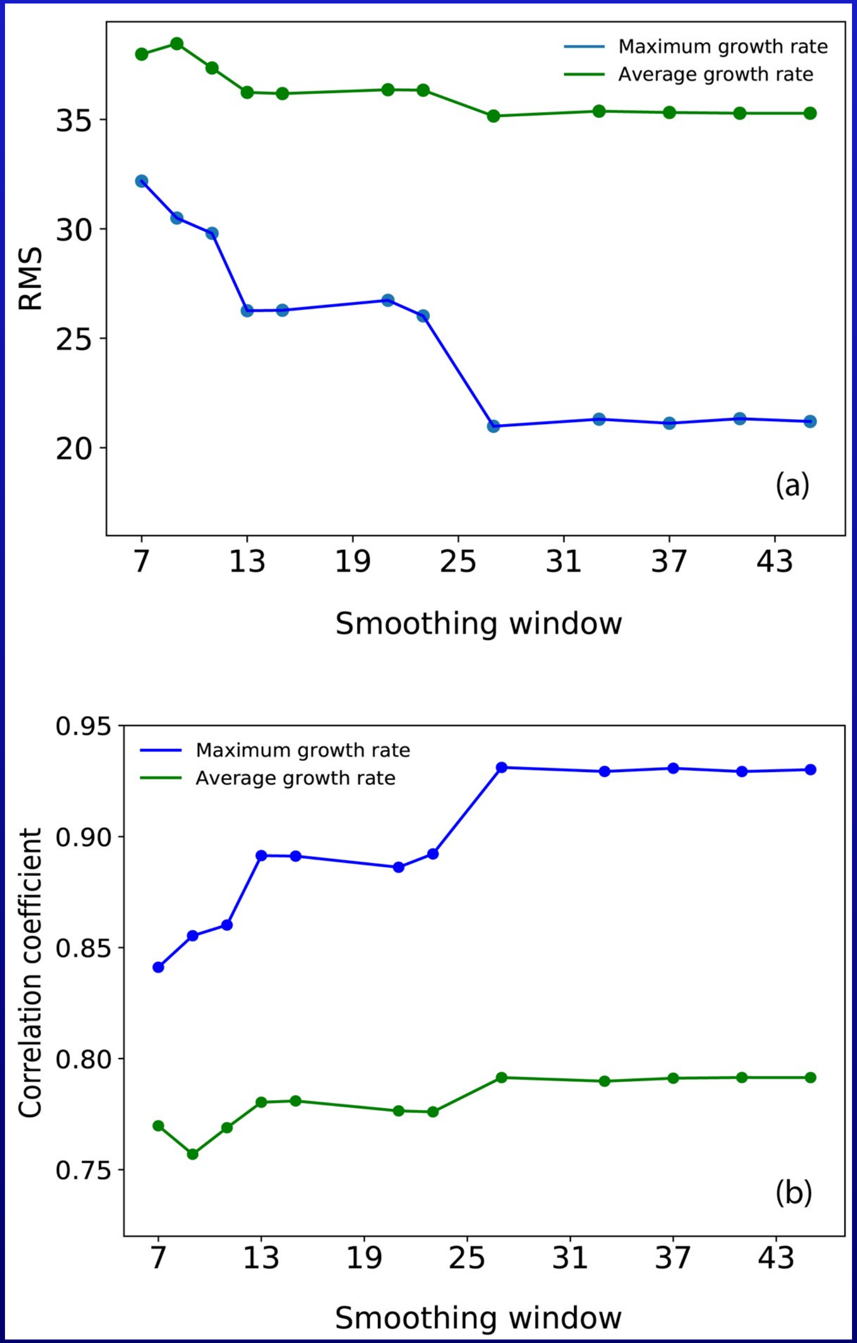
Total Sunspot Numbers

Growth rate indicators VS the amplitudes of solar cycles 1–24





Total Sunspot Numbers



Prediction performance of amplitudes of cycles

Third order linear regression

$$S^P = \beta_0 + \beta_1 I + \beta_2 I^2 + \beta_3 I^3$$

- value of the cycle amplitude
- value of the growth rate indicator (maximal or average)

Total Sunspot Numbers

Catalogue: Extended Hemispheric Sunspot Numbers 1874 - 2020

The Data Catalogue of Hemispheric Sunspot Numbers is available via SILSO https://www.sidc.be/silso/extheminum
And via Vizier: https://cdsarc.cds.unistra.fr/viz-bin/cat/J/A+A/652/A56

Sunspot Index and Long-term Solar Observations

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Extended hemispheric sunspot numbers

A catalogue consisting of Hemispheric Sunspot Numbers from 1874-2020

Reconstructed hemispheric sunspot numbers extending the base international hemispheric sunspot numbers before 1992. This series is based on hemispheric sunspot numbers from the Kanzelhöhe and Skalnate-Pleso Observatories back to 1945, and on total sunspot areas from the Greenwich photographic catalogue back to 1874.

Any use of this data set should include the citation of the original reference below.

Daily Hemispheric Sunspot Data (1874-05-01 to 2020-10-31)

- Daily Hemispheric Sunspot Data — TXT CSV INFO

Monthly Mean and Smoothed Hemispheric Data (1874-05 to 2020-10)

- Monthly Hemispheric Sunspot Data — TXT CSV INFO

Reference article:

Astrid M.Veronig, Shantanu Jain, Tatiana Podladchikova, Werner Pötzi, Frédéric Clette, 2021: Hemispheric Sunspot Numbers 1874-2020
Astronomy & Astrophysics, Vol. 652, A56, DOI 10.1051/0004-6361/202141195
https://www.aanda.org/articles/aa/full_html/2021/08/aa41195-21/aa41195-21.html

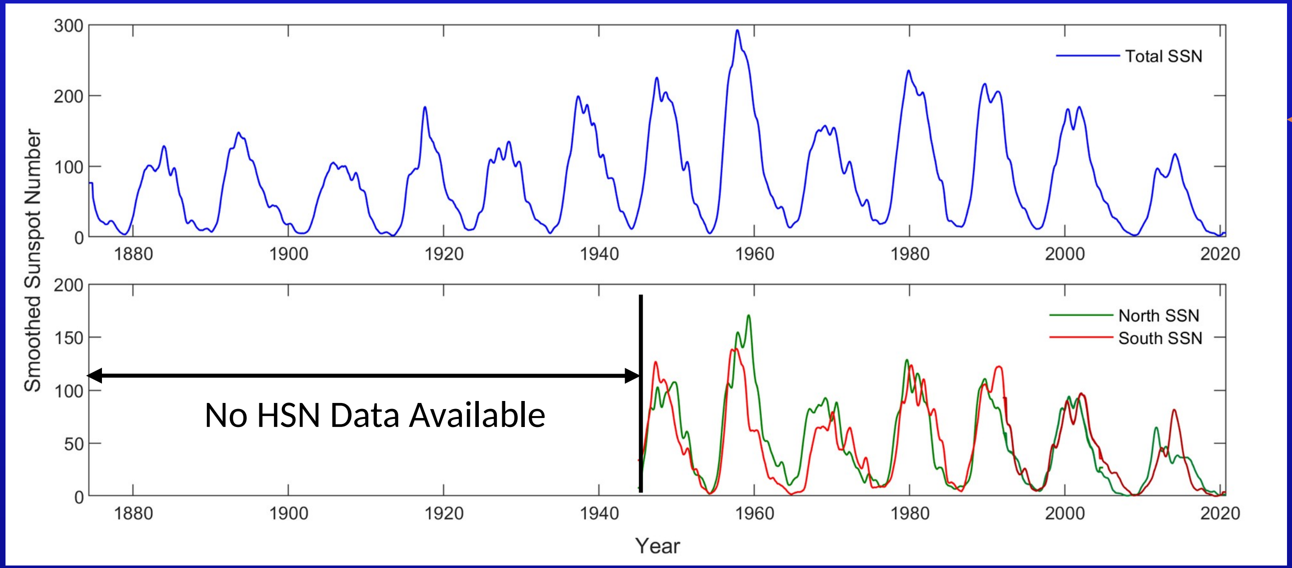
SILSO

Vizier

Hemispheric Sunspot Numbers

Reconstructing Hemispheric Sunspot Numbers

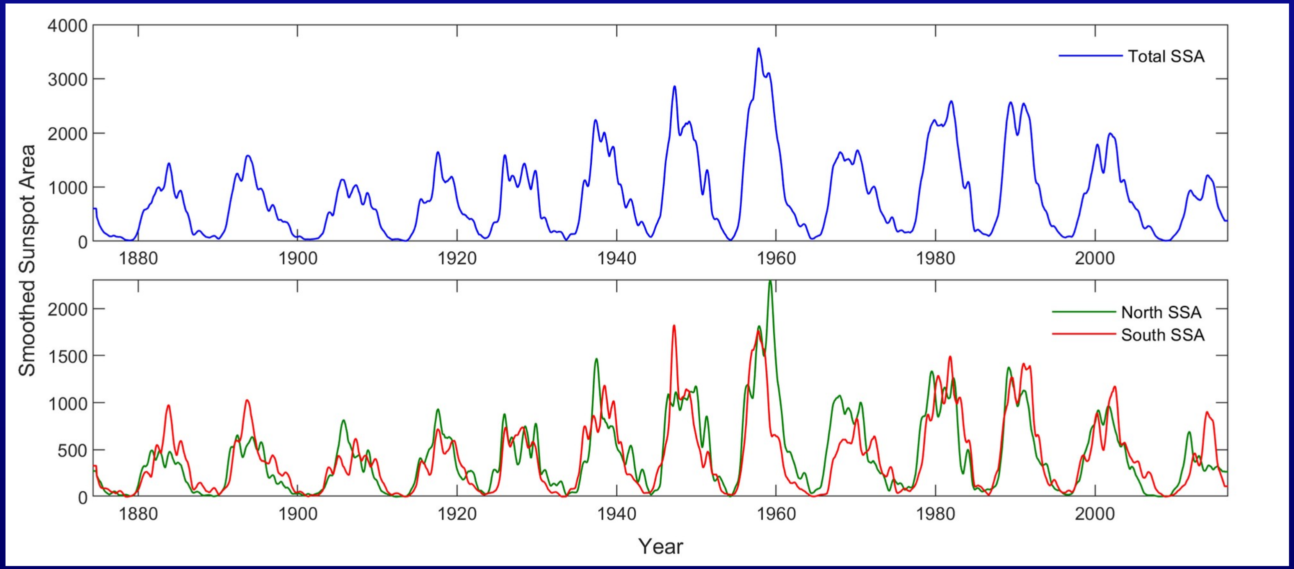
Hemispheric Sunspot Numbers



(Total) Sunspot Number ISN (V2.0, Clette et al. 2014)

Hemispheric SN:
1945-2004: Temmer et al. (2006) – not calibrated to ISN V2.0
1992-2020: SILSO World Data Centre (calibrated to ISN V2.0)

Sunspot Area
Total and Hemispheric
(Greenwich 1874-2016)



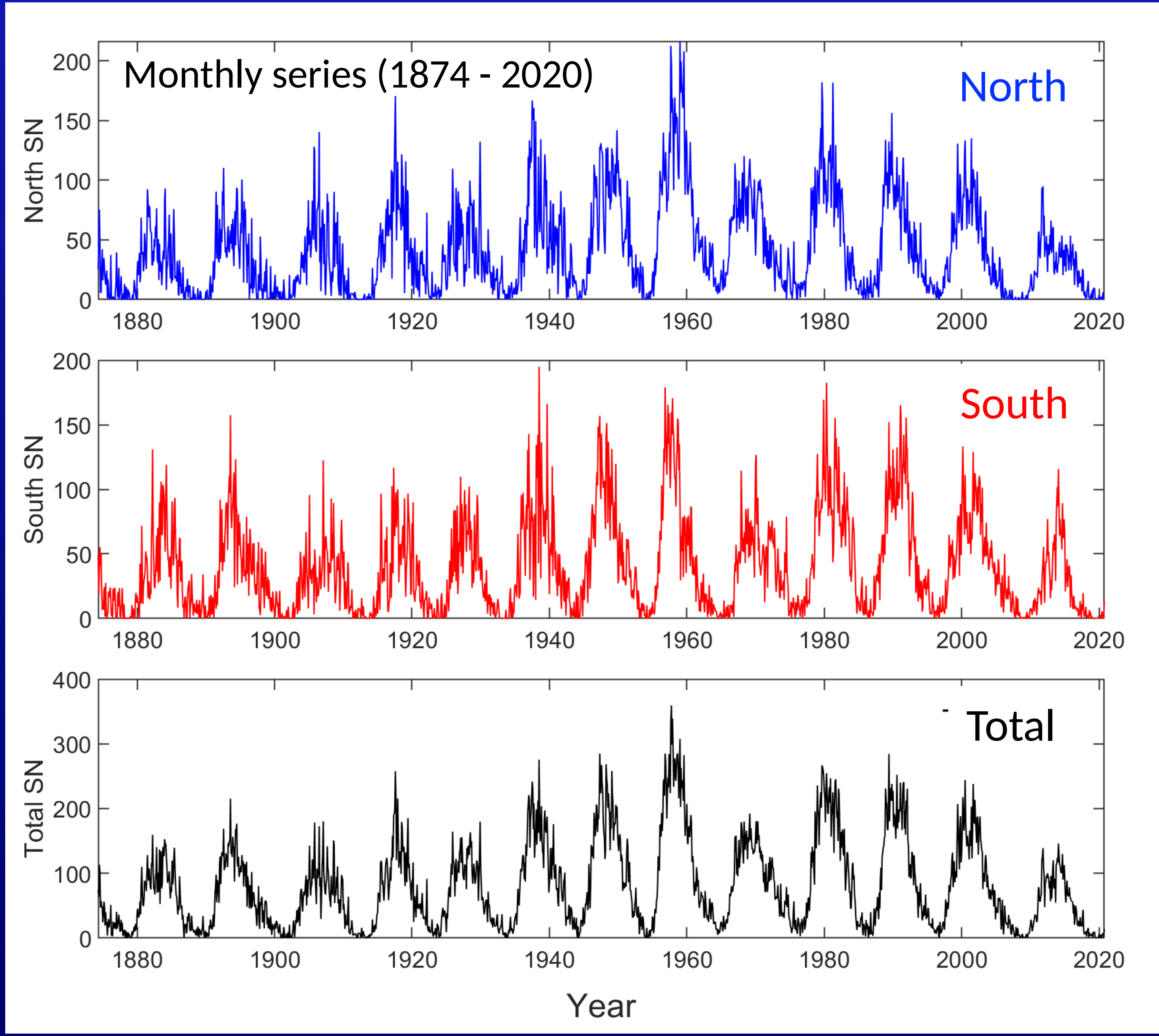
We use Hemispheric Sunspot Areas to reconstruct Hemispheric Sunspot Number:

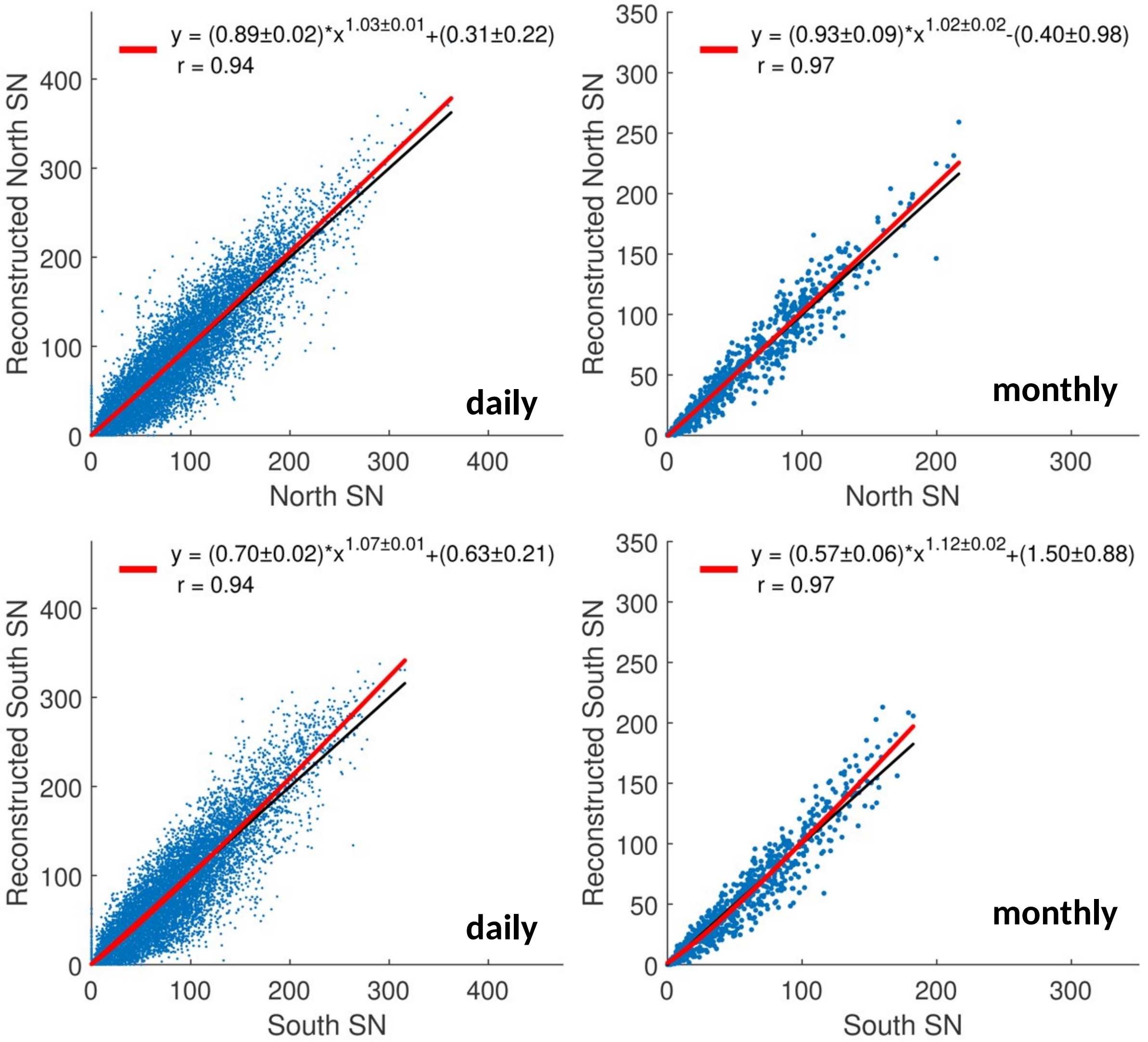
Calculate relative fraction of sunspot area and calibrate to Total Sunspot Number (ISN V2.0)

Hemispheric Sunspot Numbers 1874-2020

1874 - 1944: Reconstructed from Sunspot Areas
1945 - 1991: From Temmer et al. (2006), but recalibratd to ISN V2.0
1992 - : From World Data Centre SILSO

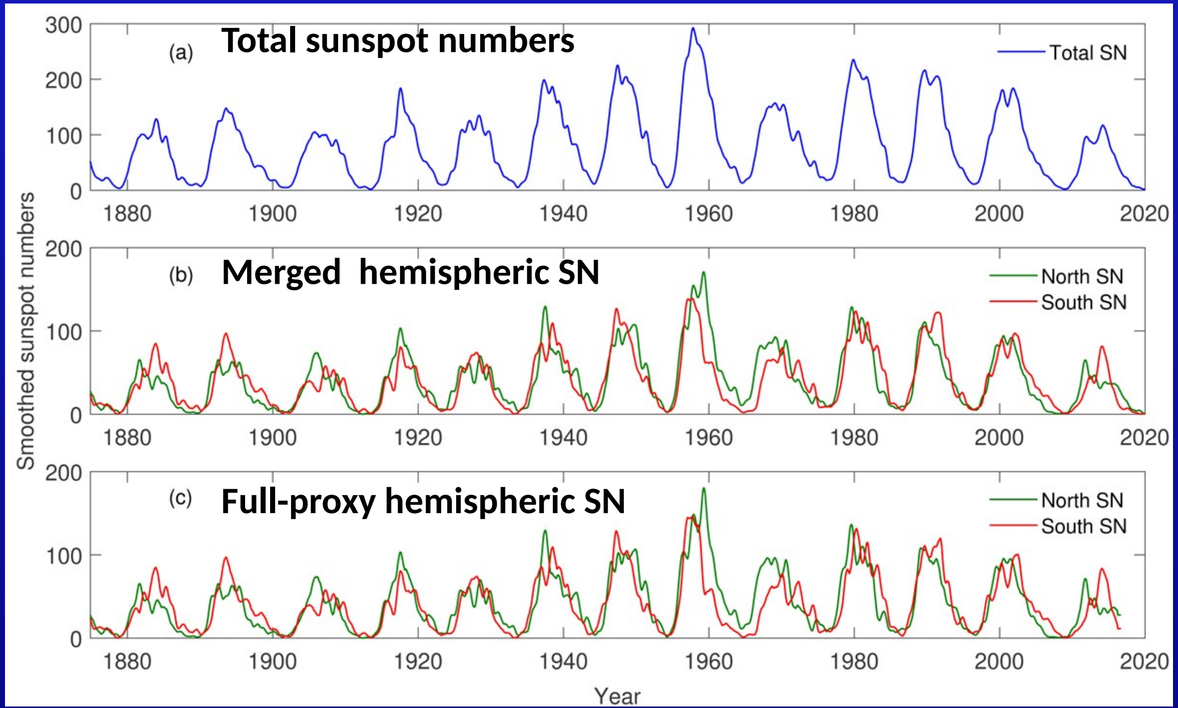
Reconstructed HSN compared to the existing HSN data for the common time period (1945 - 2016)
Veronig et al. (2021)

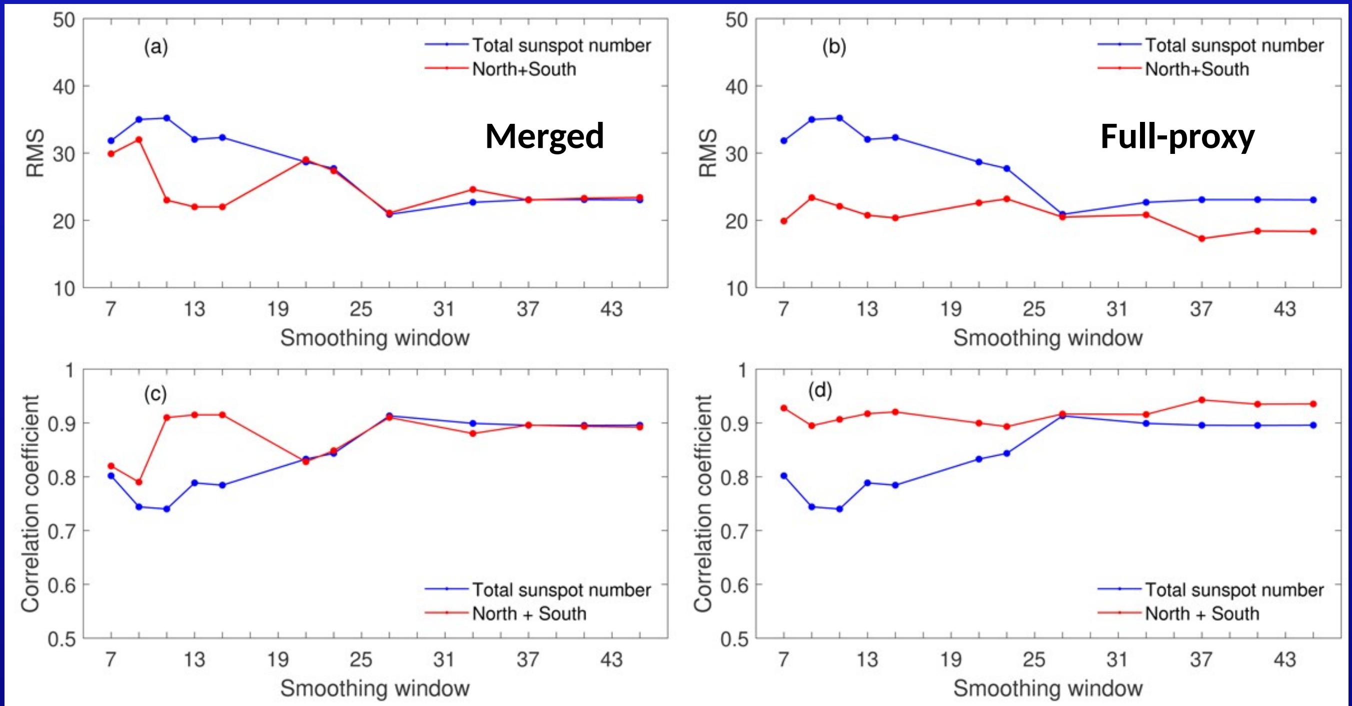




Hemispheric Sunspot Numbers

…iction performance of amplitudes of cycles 1–24 with the hemispheric sunspot numbers





Merged hemispheric SN: reconstructed from
1874 - 1944: Reconstructed from Sunspot Areas
1945 - 1991: From Temmer et al. (2006), but recalibratd to ISN V2.0
1992 - : From World Data Centre SILSO

Full-proxy hemispheric SN: reconstructed purely from sunspot areas over 1874–2016

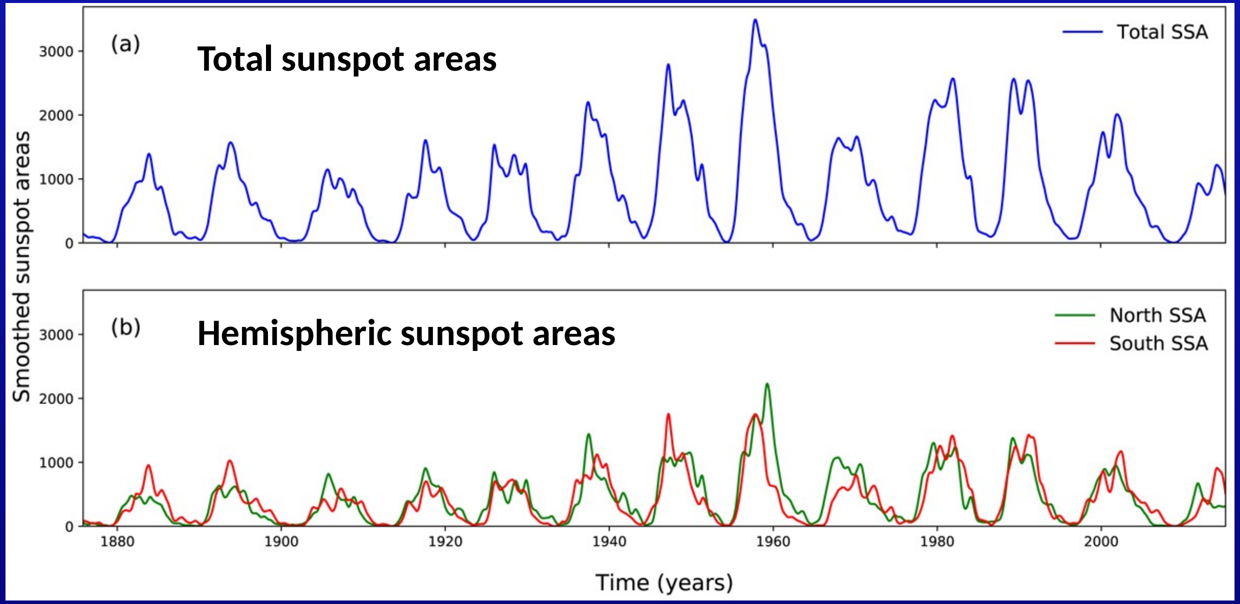
$$S^P = \beta_0 + \beta_1 I + \beta_2 I^2 + \beta_3 I^3$$

- value of the cycle amplitude

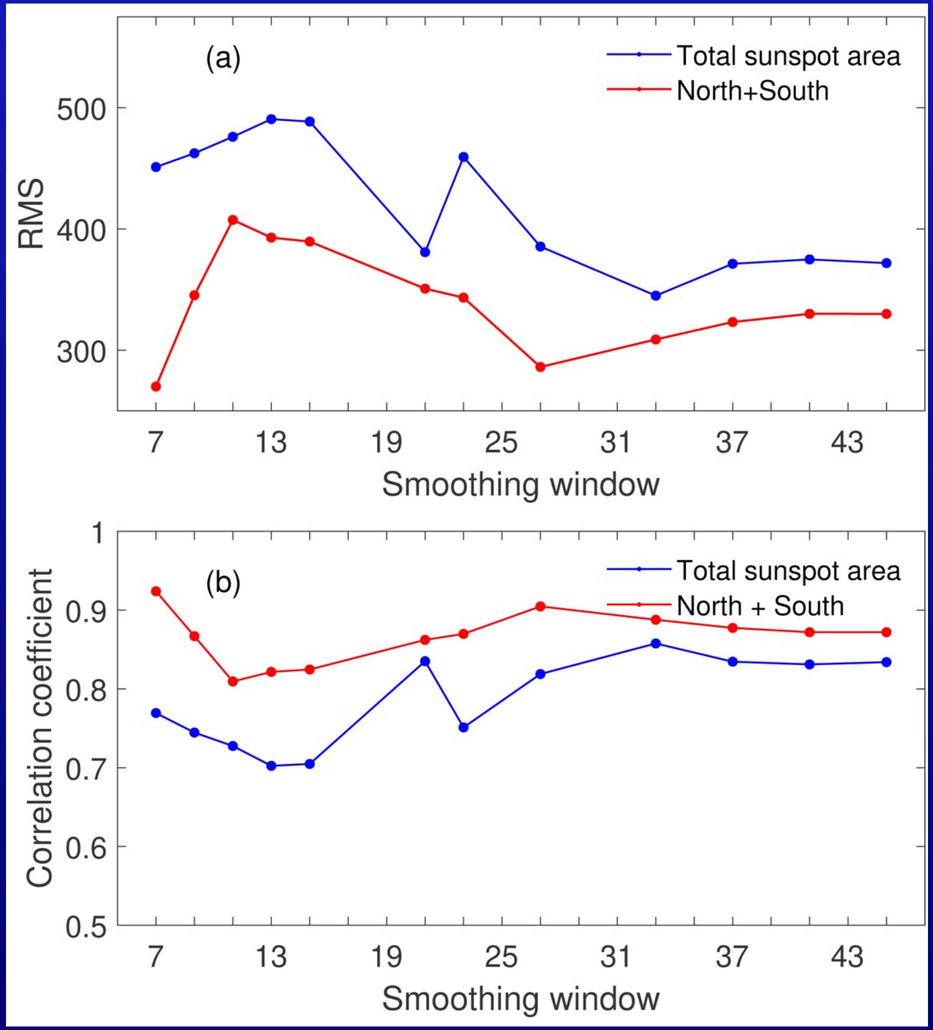
- sum of the maximal growth rate at North and South

Hemispheric
Sunspot Areas

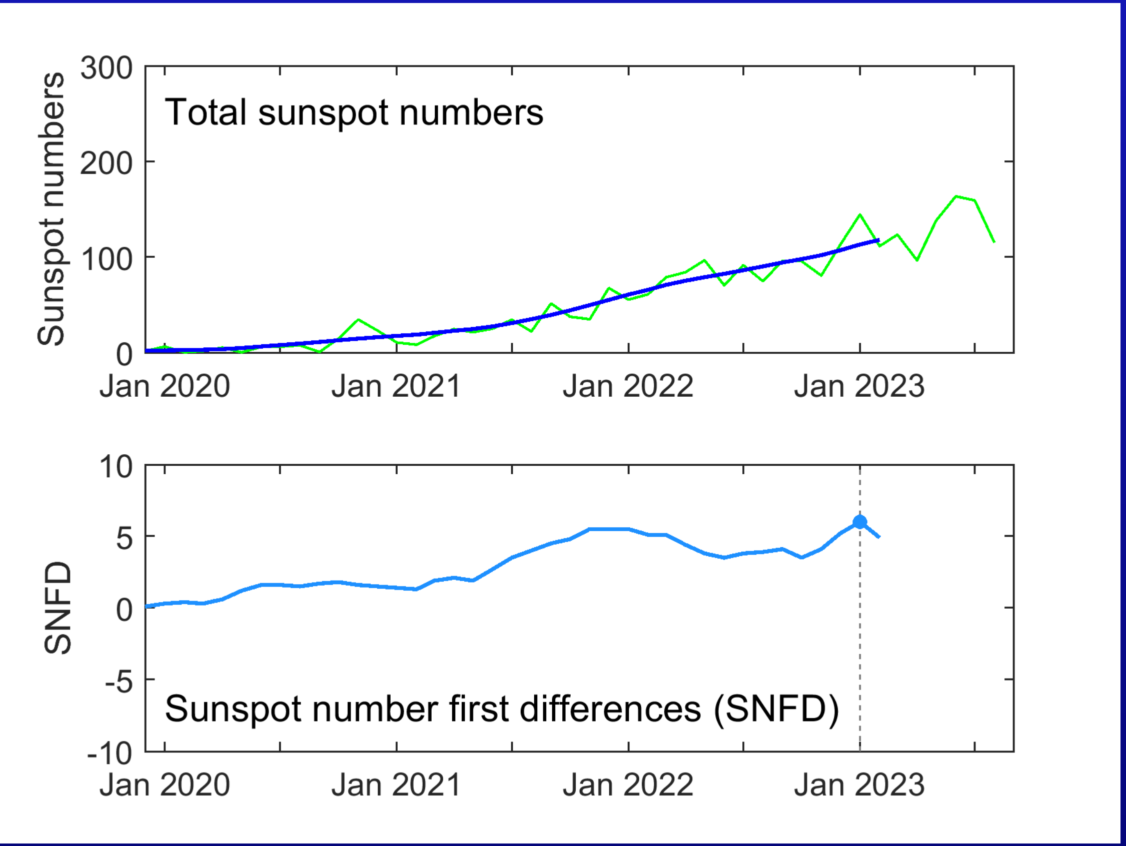
iction performance of amplitudes of cycles 1–24 with the hemispheric sunspot areas



37-month optimized running-mean



Prediction of the amplidudue of cycle 25 with the total sunspot numbers



Lower estimate: 126±26

Last available smoothed sunspot numer: February 20223

Other predictions in range from 90 to 139 (e.g.)

Kitiashvili 2016; Podladchikova et al. 2017;
Singh & Bhargawa 2017;
Bhowmik & Nandy 2018;
Labonville et al. 2019; Miao et al. 2020;
Burud et al. 2021; Kumar et al. 2021;
Brajša et al. 2022.

Prediction with a large amplitude of 233

McIntosh et al. (2020)

SUMMARY

1

Maximal growth rate of sunspot activity in the ascending phase of a solar cycle is a **better precursor** of a subsequent solar cycle amplitude than the **average growth rate.**

2

We developed and tested a prediction technique based on using **the maximal growth rate** as a precursor.

3

Finally, we demonstrated that **the hemispheric sunspot indices** derived separately for the two hemispheres **provide advantages** in predicting the solar cycle amplitudes compared to the sunspot indices describing the entire solar disc. This is a strong foundation for **supporting regular monitoring, recording, and predictions of solar activity based on hemispheric sunspot data,** which accounts for the different evolution of the two hemispheres over a solar cycle, which in general do not evolve in phase.

THANK YOU FOR YOUR ATTENTION!

See more details in Podladchikova et al. (2022)