# Long Term Temporal and Periodic Variation of Flare Index: Comparison with International Sunspot Number Time Series

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## DATA AND METHODS

Hα flare index (FI) data are taken from Bogazici University Kandilli Observatory as daily values. Then monthly average values calculated.

The ISSN data are taken from the WDC-SILSO, Royal Observatory of Belgium, Brussels, as a monthly mean values. Here we used the second version ISSN data.

The FI data cover almost five solar cycles (cycle 20 to 24). Therefore the same interval sunspot number data are used for the analysis

The temporal variations of hemispheric and full disc FI data sets compared with the international sunspot numbers.

Cross correlation analyses were applied to hemispheric and full disc FI and the ISSN data sets.

Periodic variations of hemispheric and full disc data were obtained by using the Morlet wavelet and MTM period analysis methods.

Coherency of periodicities are obtained by applying the wavelet coherence analysis method.

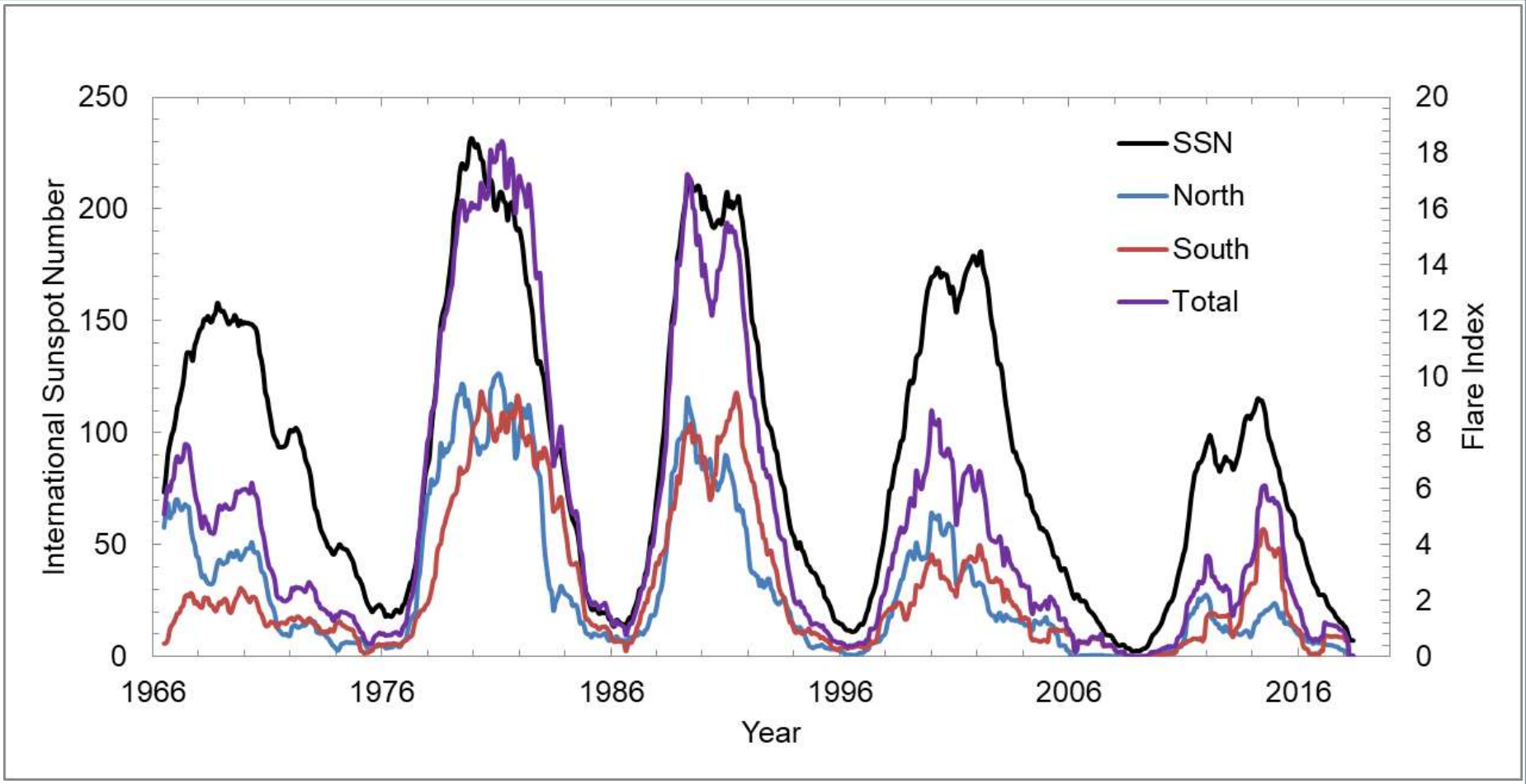


Figure 1. Temporal variations of the hemispheric and total flare index and the ISSN.

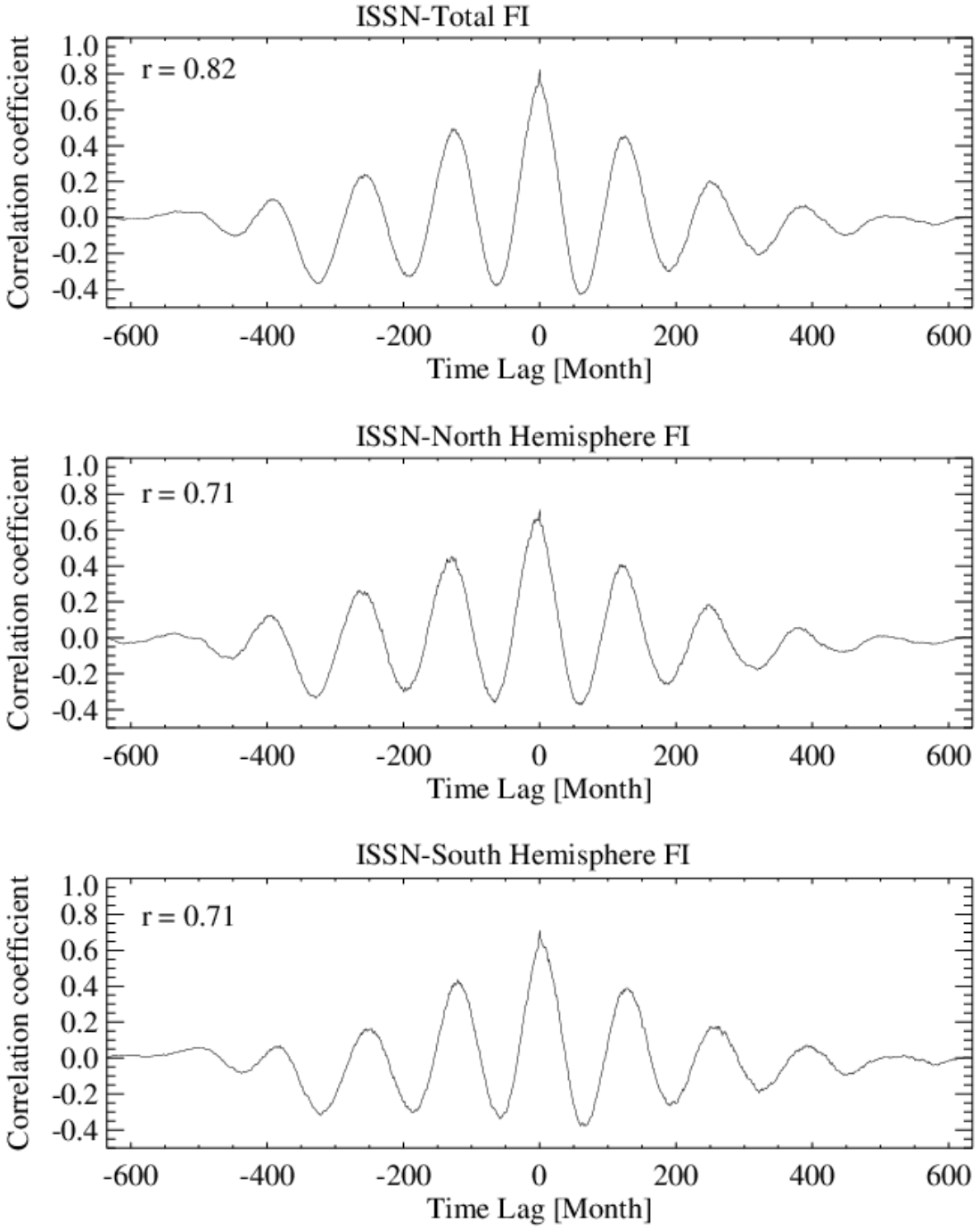


Figure 2. Cross correlation analysis results between the ISSN and hemispheric and full disc solar FI during the investigated time period (1966-2018).

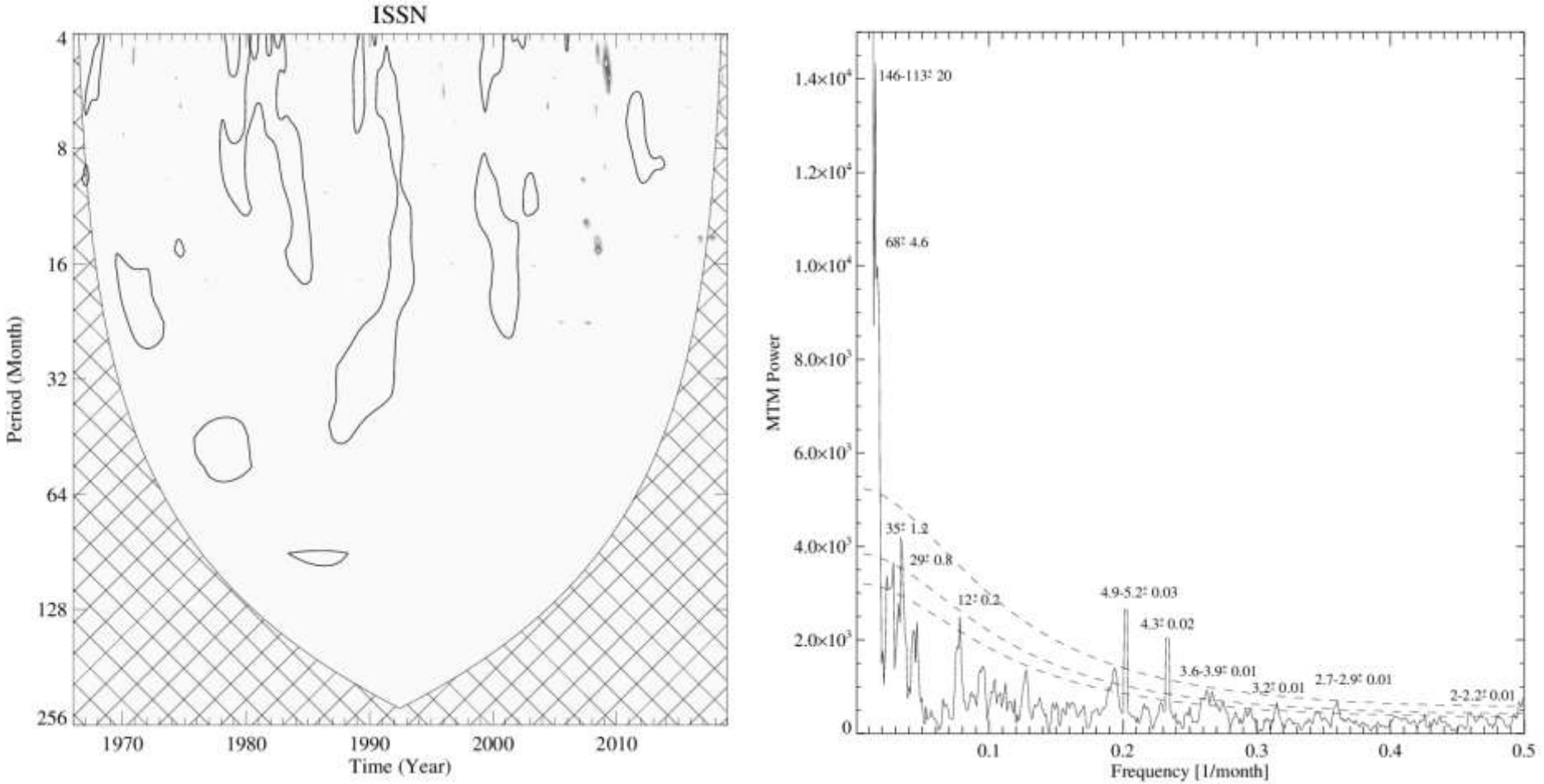


Figure 3. Wavelet (left panel) and MTM (right panel) period analysis results for the ISSN data during the investigated time period (1966-2018).

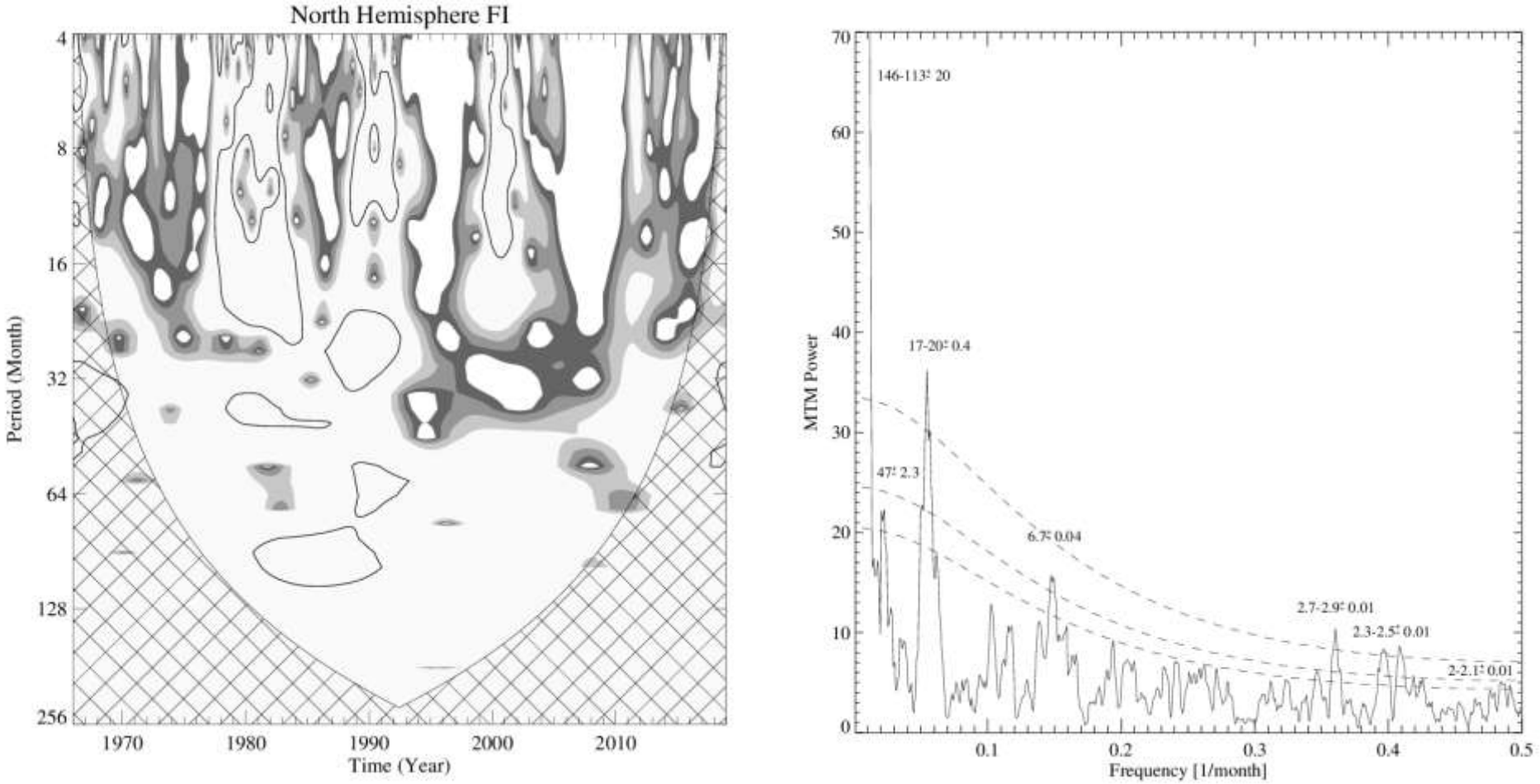


Figure 4. Wavelet (left panel) and MTM (right panel) period analysis results for the North hemisphere FI data during the investigated time period (1966-2018).

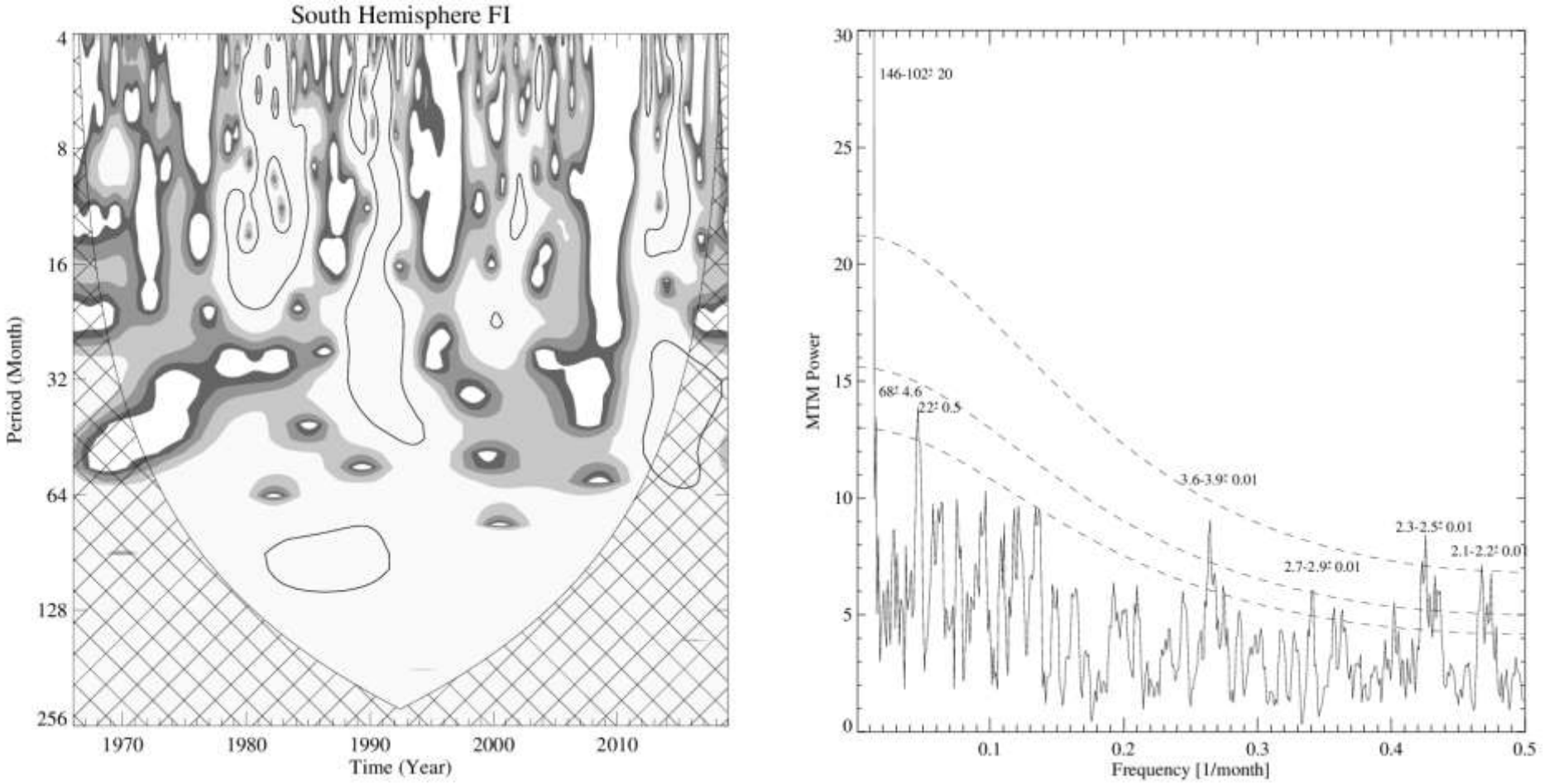


Figure 5. Wavelet (left panel) and MTM (right panel) period analysis results for the South hemisphere FI data during the investigated time period (1966-2018).

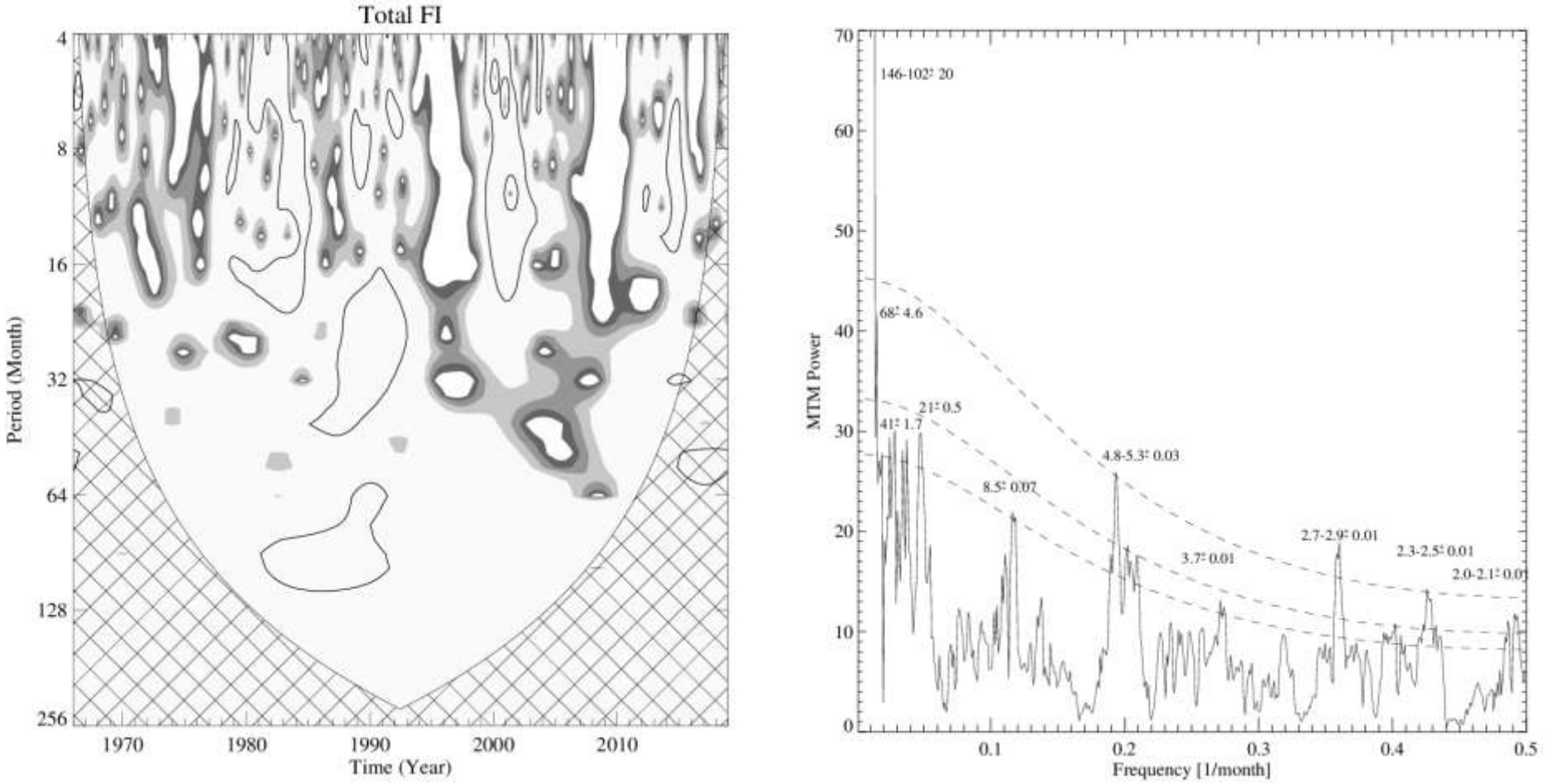


Figure 6. Wavelet (left panel) and MTM (right panel) period analysis results for the full disc FI data during the investigated time period (1966-2018).

| DATA / PERIOD (MONTH) | SSN | NORTH HEMISPHERE | SOUTH HEMISPHERE | FULL DISC |
|---|---|---|---|---|
| 102-146 | + > 99 | + > 99 | + > 99 | + > 99 |
| 68 | + > 99 | - | + > 90 | + > 95 |
| 41-47 | + > 90 (43) | + > 90 (47) | - | +> 90 (41) |
| 35 | + > 95 | - | - | +> 90 |
| 29 | + > 95 | - | - | + > 90 |
| 17-22 | - | + > 99 (18) | + > 90 (22) | + >90 (21) |
| 12 | + > 90 | - | - | - |
| 6.7-8.5 | - | + >95 (6.7) | - | +>90 (8.5) |
| 4.8-5.3 | + >99 | - | - | + >99 |
| 3.6-4.3 | + > 99 (4.3) | - | + > 90 (3.6-3.9) | + >90 (3.7) |
| 2.7-3.2 | + >95 | + > 99 | + > 90 | + > 99 |
| 2.0-2.5 | + > 90 | + > 90 | + > 99 | +> 95 |

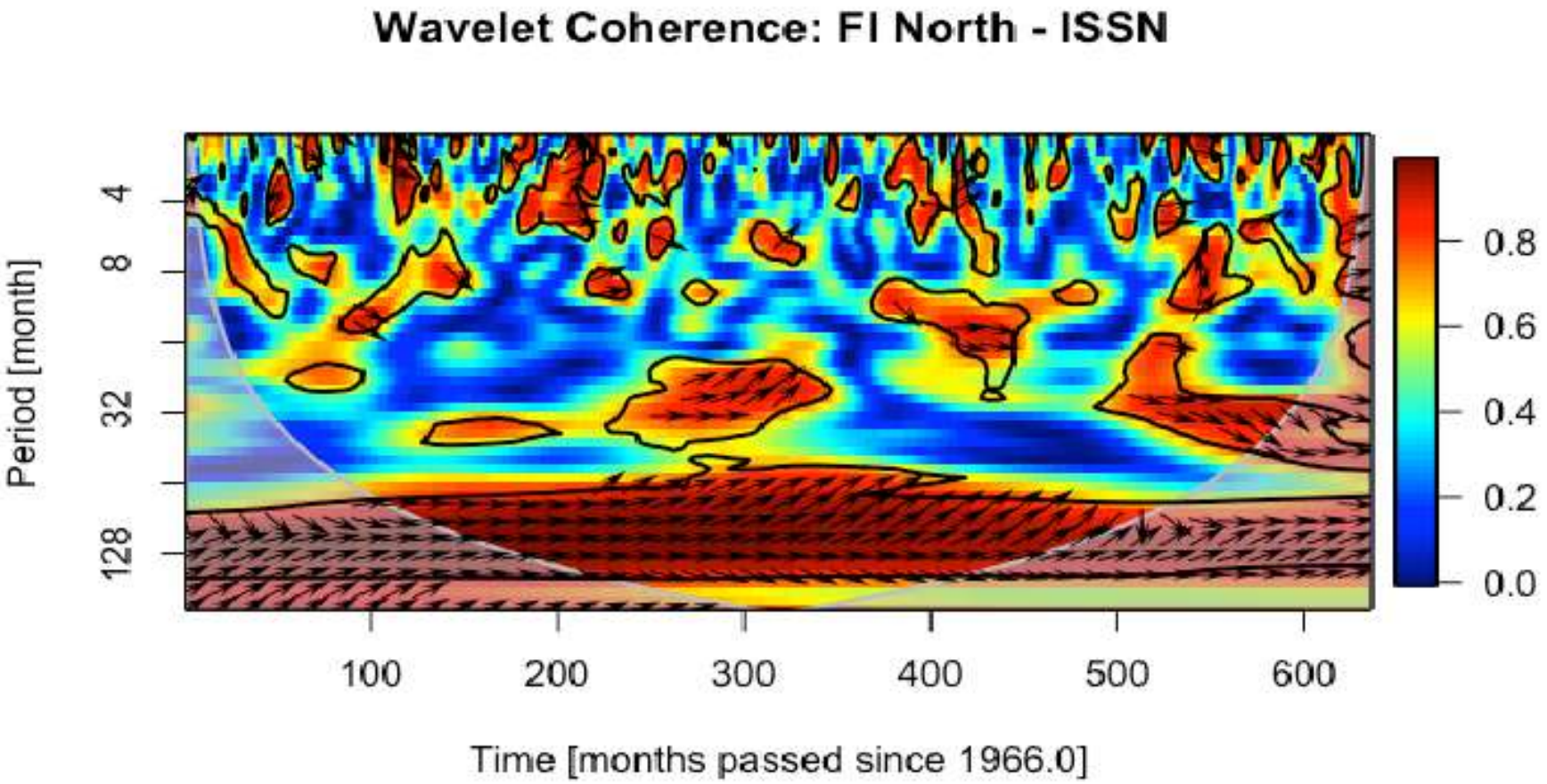


Figure 7. Wavelet coherence of North hemisphere FI versus the ISSN data during the investigated time period (1966-2018).

When the two series are in phase, it indicates that they move in the same direction, and anti-phase means that they move in the opposite direction. Arrows pointing to the right-down or left-up indicate that the first variable is leading, while arrows pointing to the right-up or left-down show that the second variable is leading.

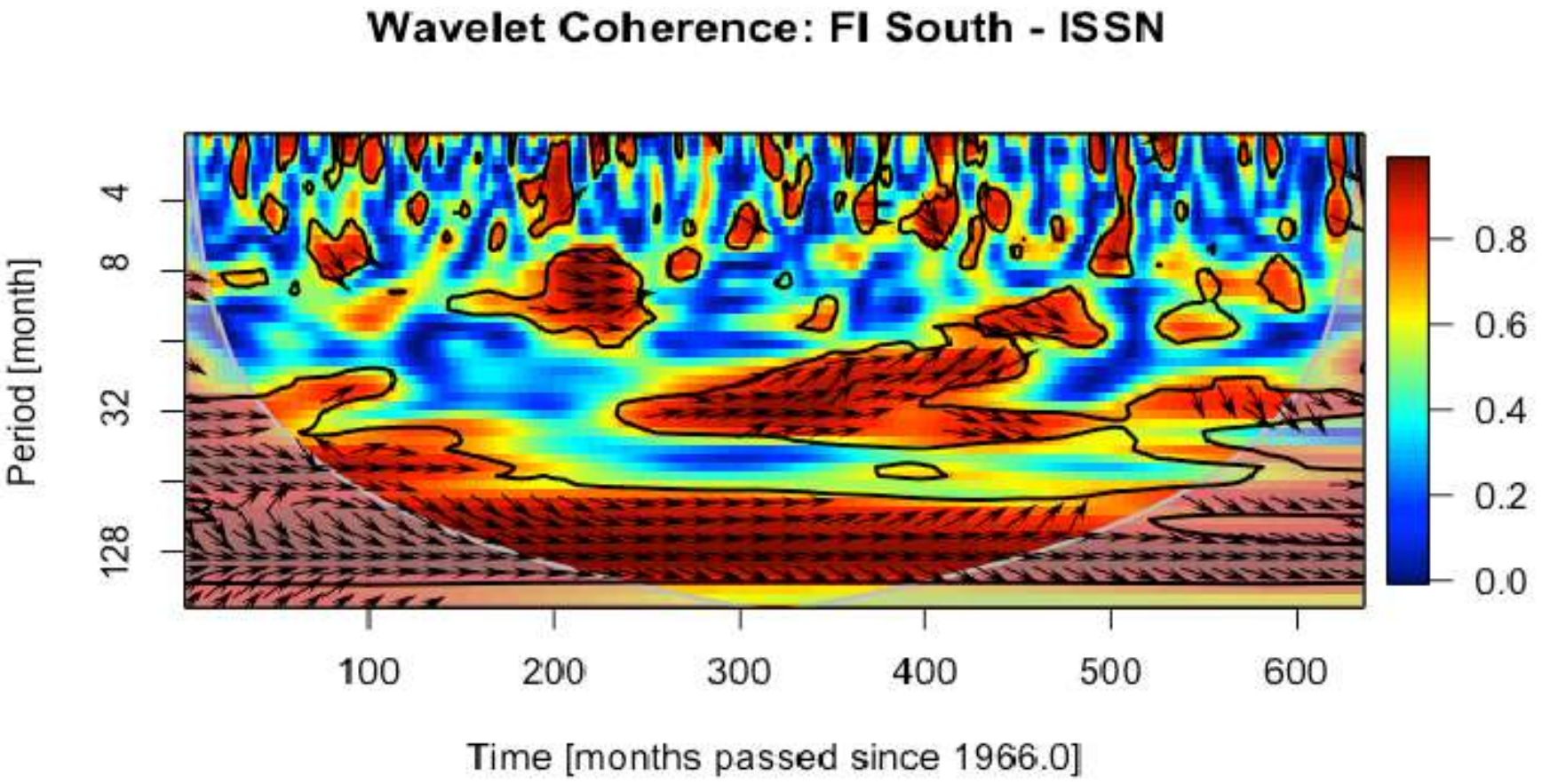


Figure 8. Wavelet coherence of South hemisphere FI versus the ISSN data during the investigated time period (1966-2018).

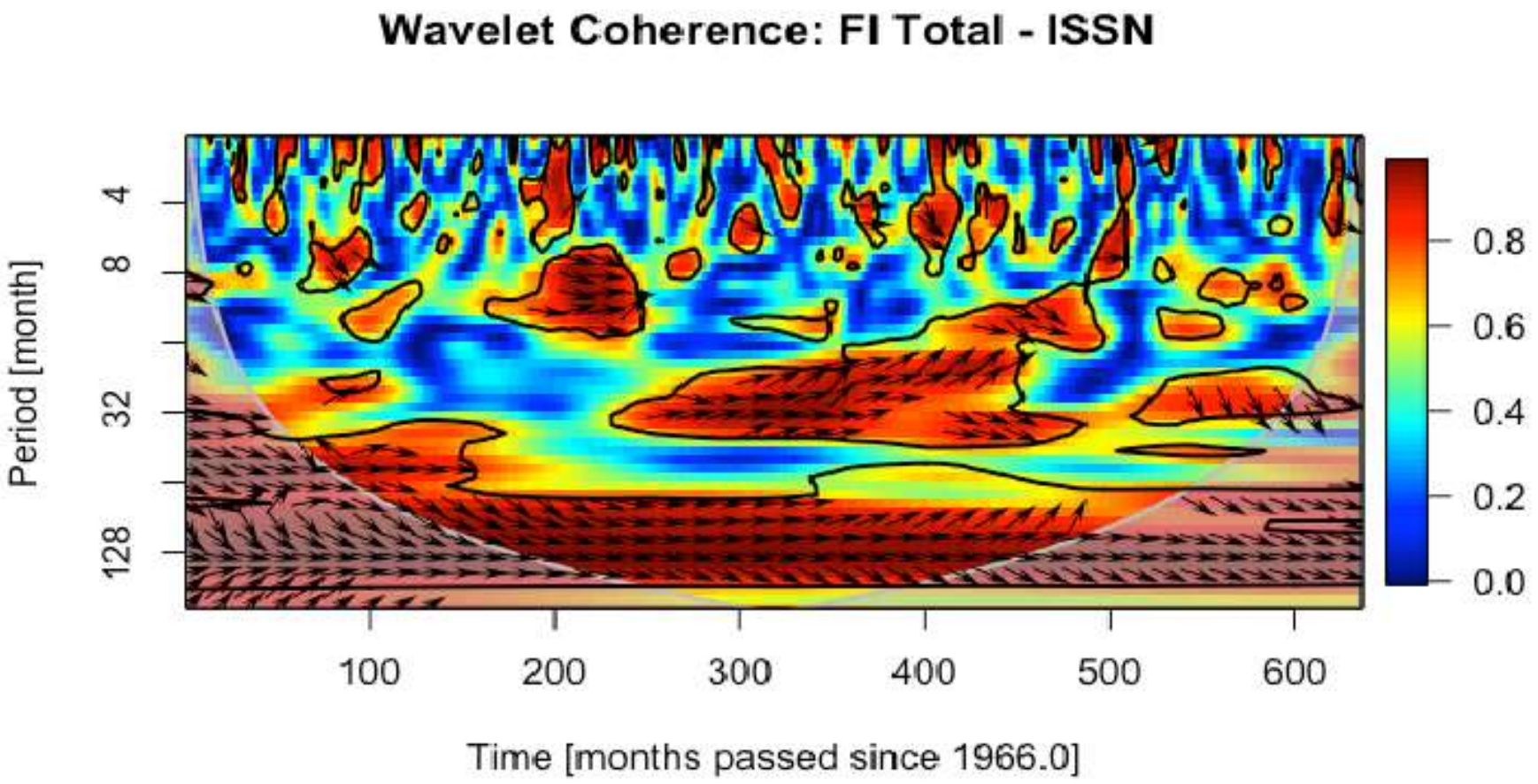


Figure 9. Wavelet coherence of Total FI versus the ISSN data during the investigated time period (1966-2018).

## Conclusions

- The temporal variations of North and South hemisphere FI data show some differences and total FI data behave as a combination of both data sets variations.
- In general, North hemisphere data access its maximum during the first peak of sunspot cycle, while the South hemisphere in the second peak.
- Both north and south hemisphere FI data show the same level of correlation ($r = 0.71$) which is lower than the total FI data ($r = 0.82$), with ISSN
- Hemispheric FI data sets also show some cyclic differences especially in the short period range in both wavelet and MTM periodicity analysis.
- Wavelet coherence analysis also show some differences except 11 year Schwabe cycle in all cases; In case of the Schwabe cycle there are no phase differences between hemispheric and total FI data sets and ISSN. All data sets are in phase.

# THANKS FOR YOUR ATTENTİON

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