Challenges and Limitations of the Long-Term Sunspot Number Record

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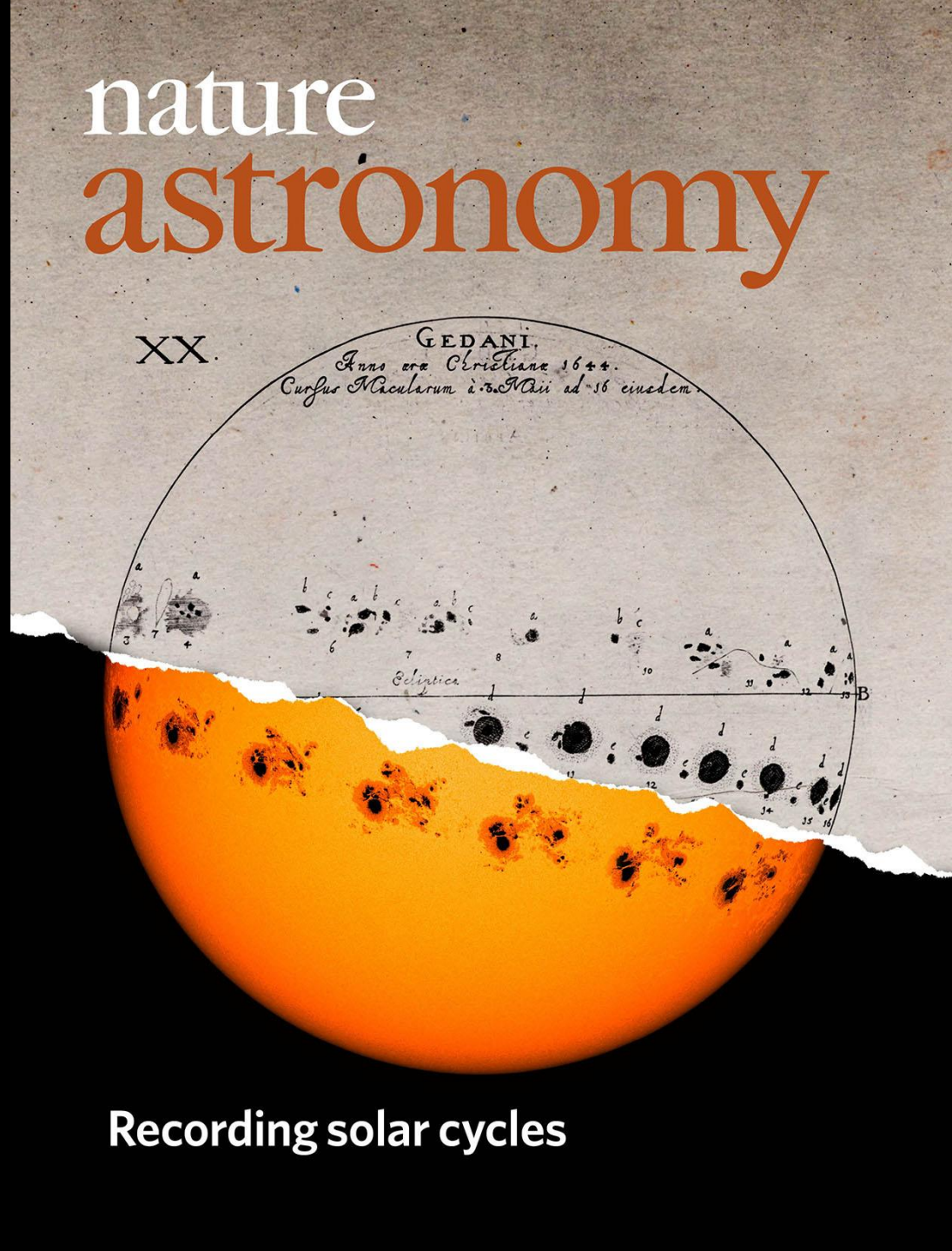
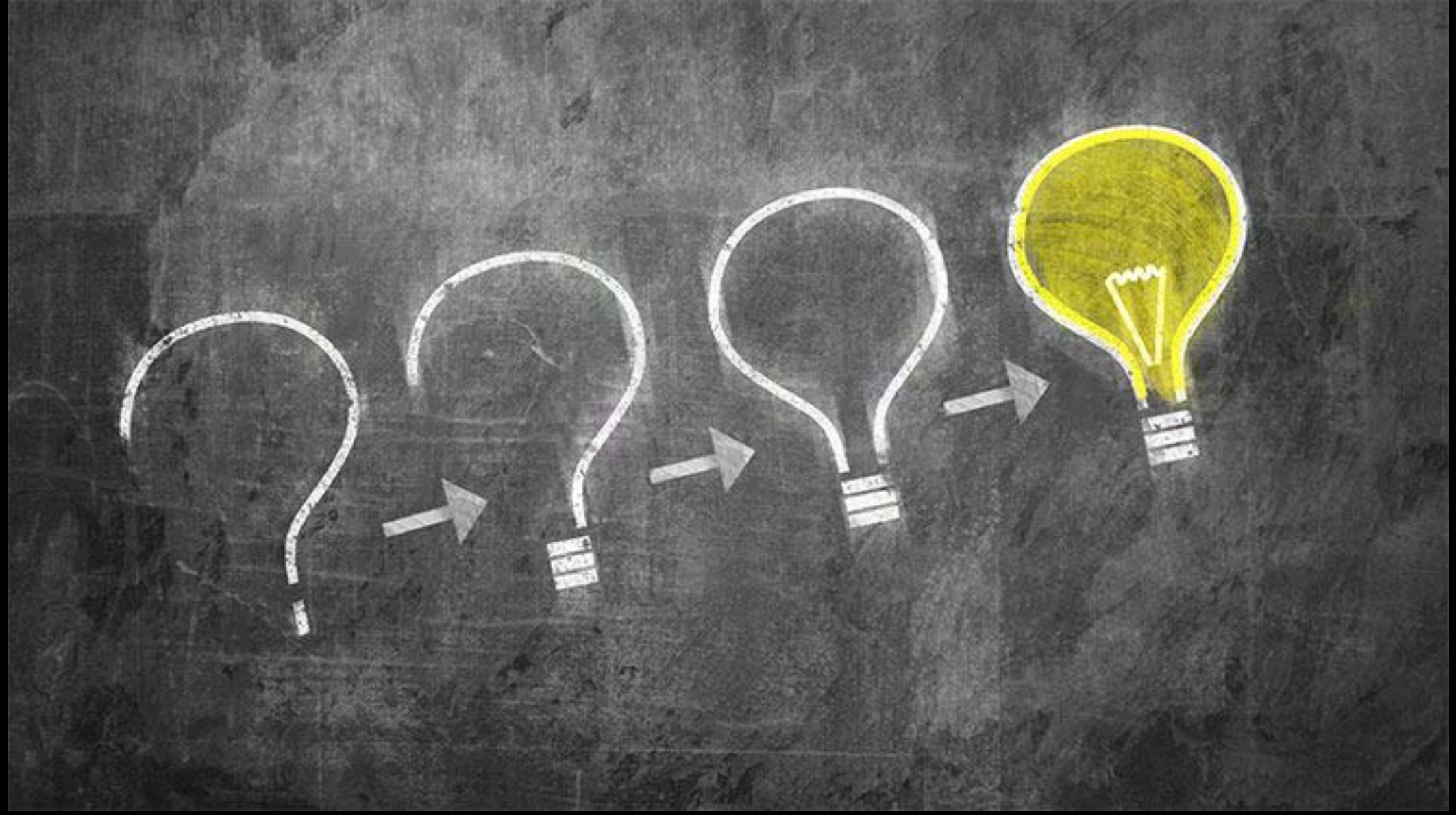
www.solardynamo.org

Jose M. Vaquero, Victor Sanchez-Carrasco,
Ilya Usoskin, Laure Lefevre & the ISSI team





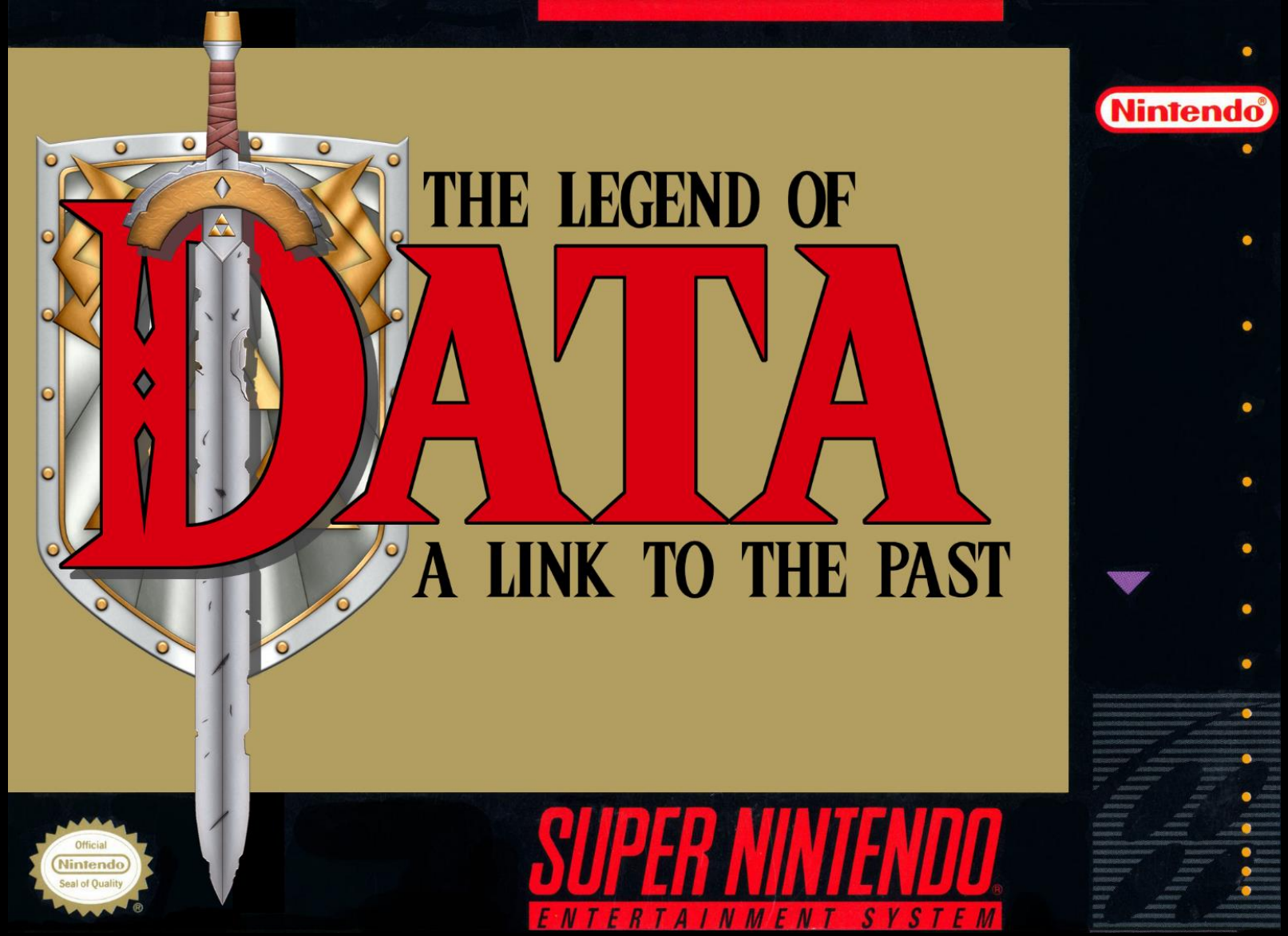
Issue we are trying to address

- The sunspot series is one of the most externally used data products provided by solar physics.

- Users from all backgrounds are not aware of the challenges and limitation of the series:
  1. Our disagreement should be seen as inherent uncertainty.
  2. There is no clear way for users to grasp the level of observational coverage.

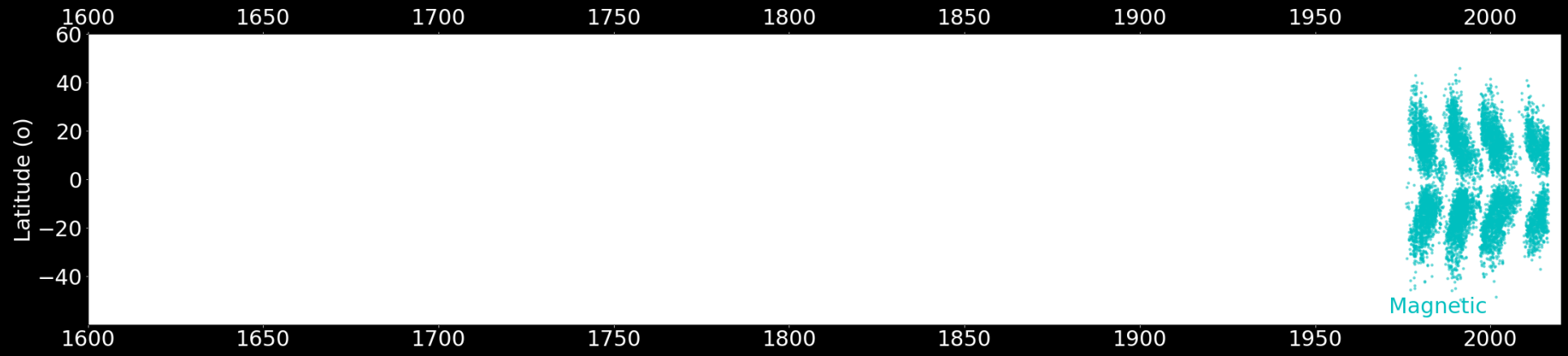
- Subtle shades, areas, and transparencies can go a long way to provide context and valuable information.

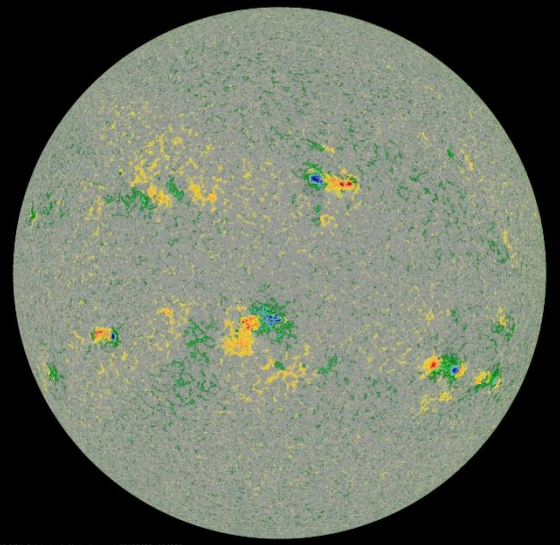
- There is currently a community concerted effort to produce better long-term sunspot number series (coming up in 2020).



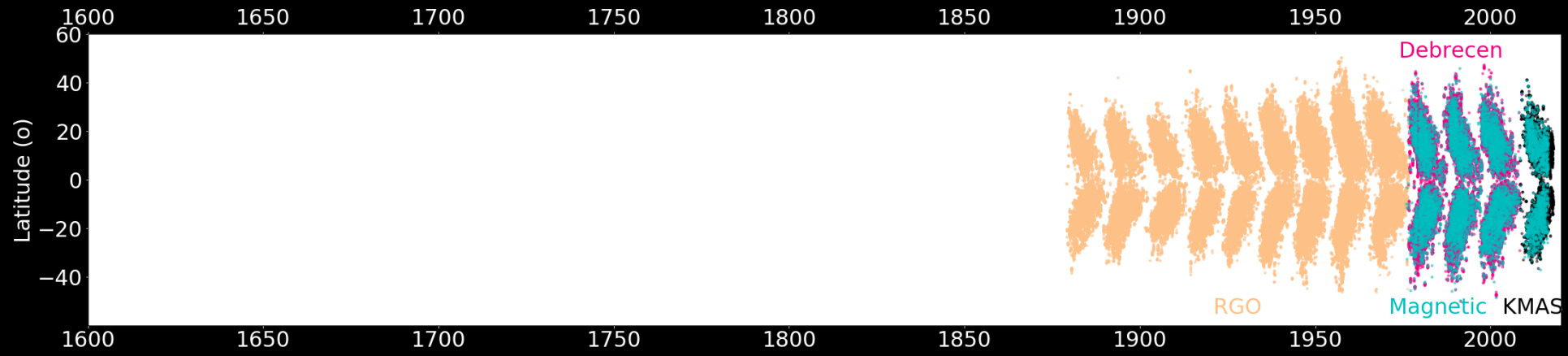
The challenge of studying the solar cycle

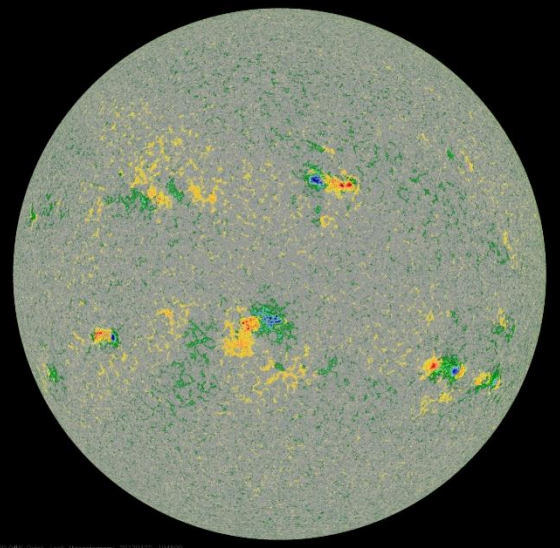
We only have 4 cycles of magnetic observations…



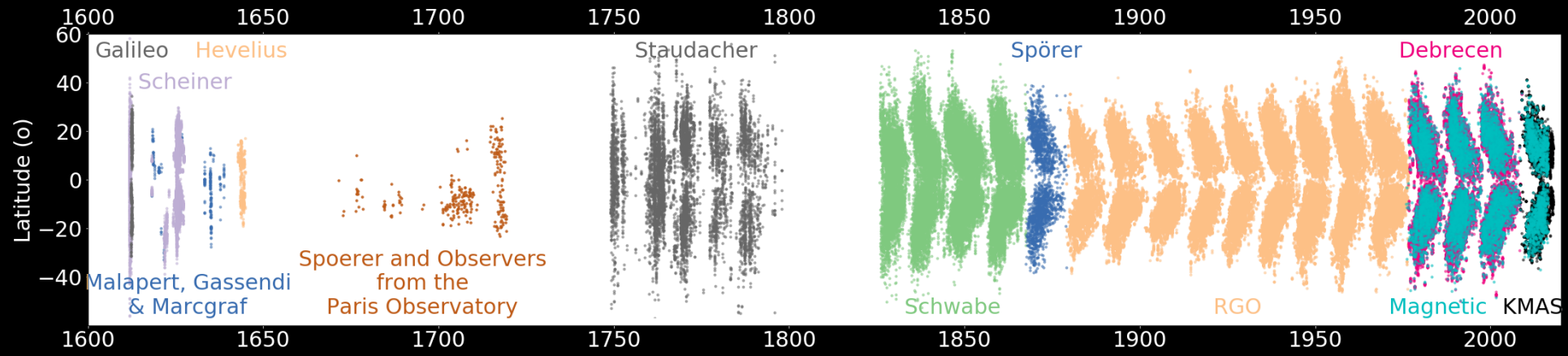


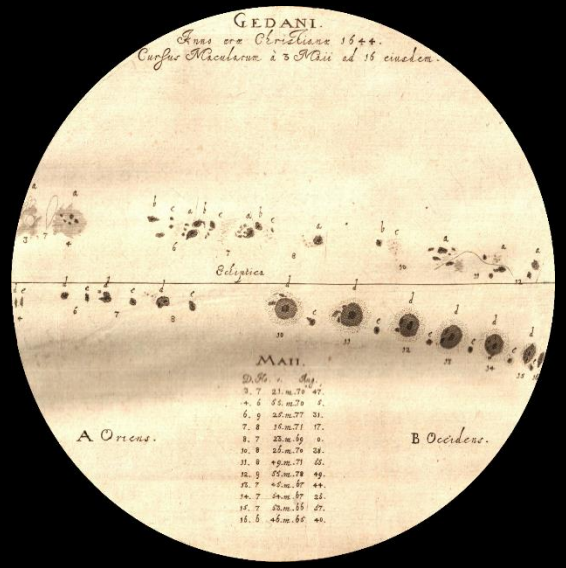
...13 cycles of photographic plates...

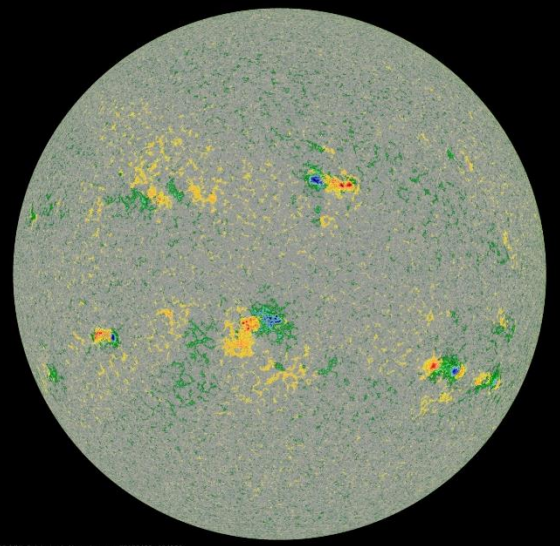




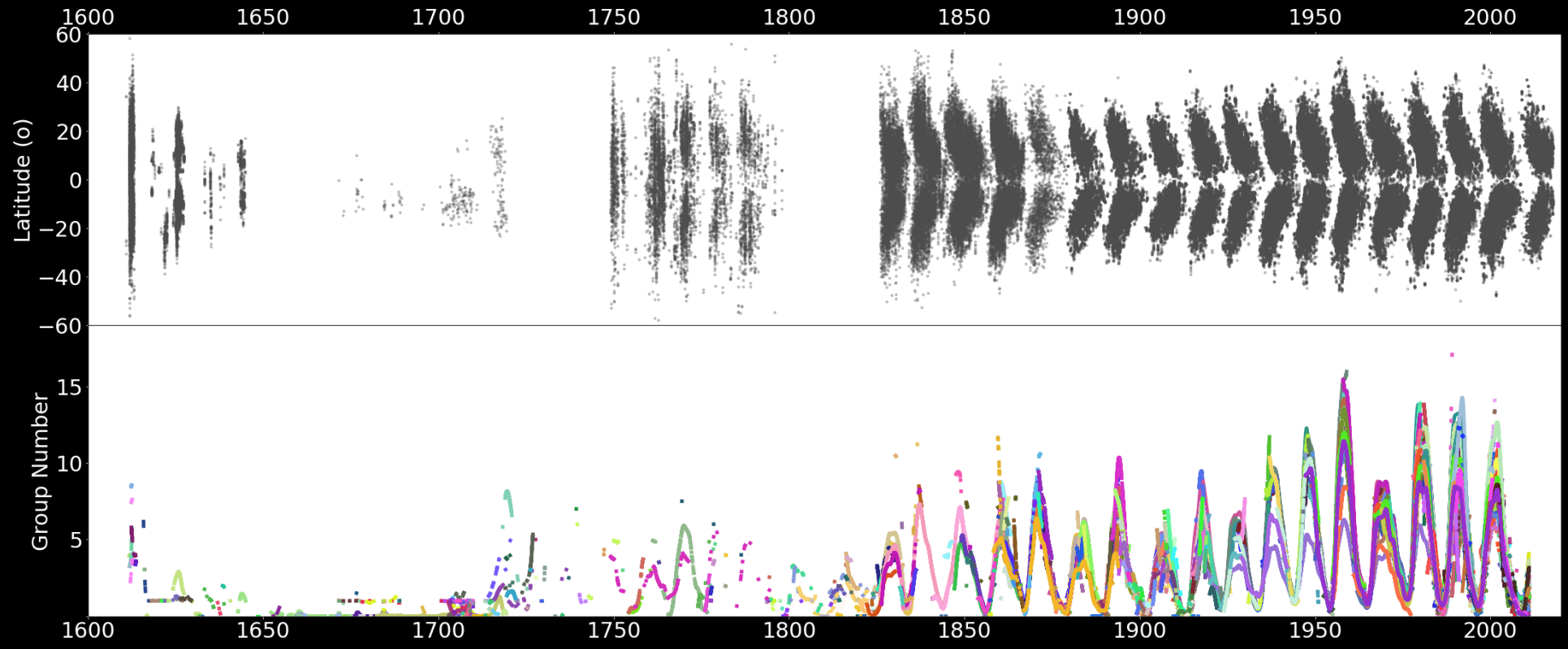
...a smattering of drawings...



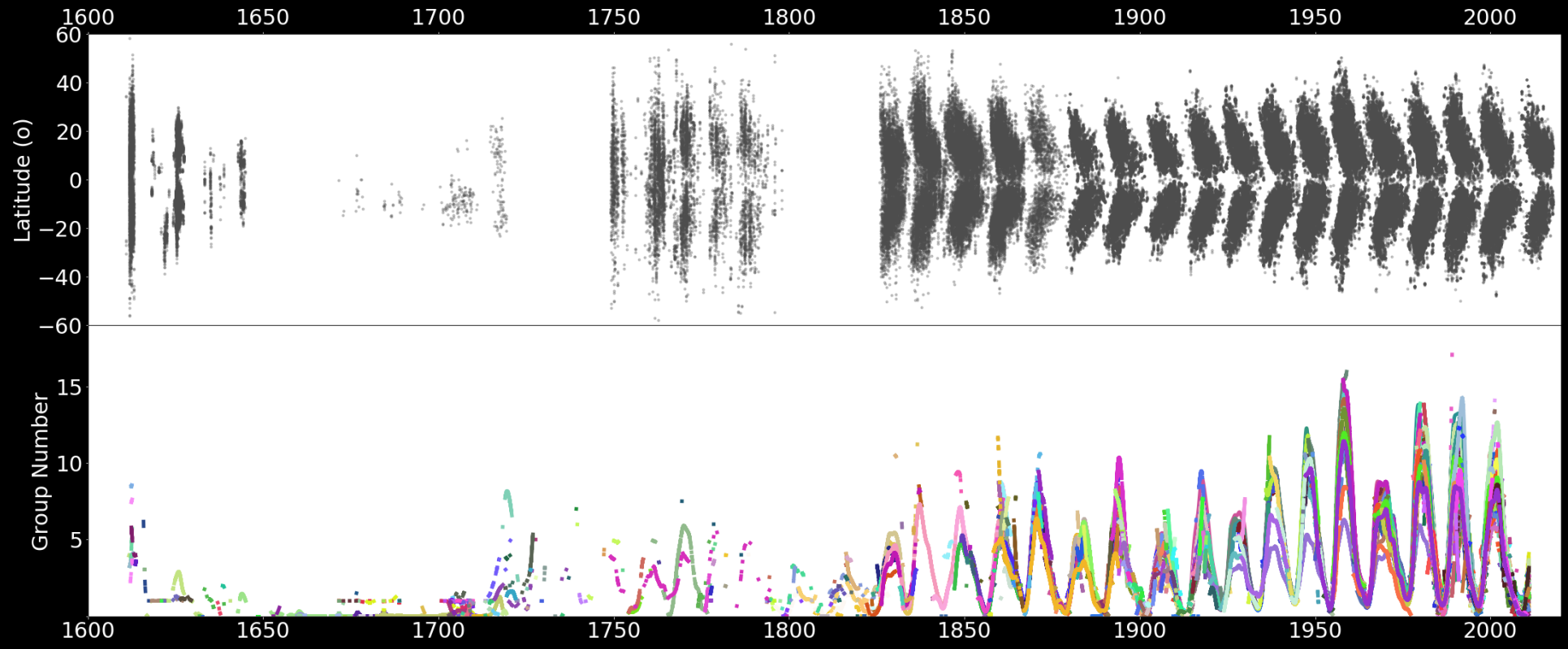




...and sunspot group counts



Calibrating sunspot group counts is difficult



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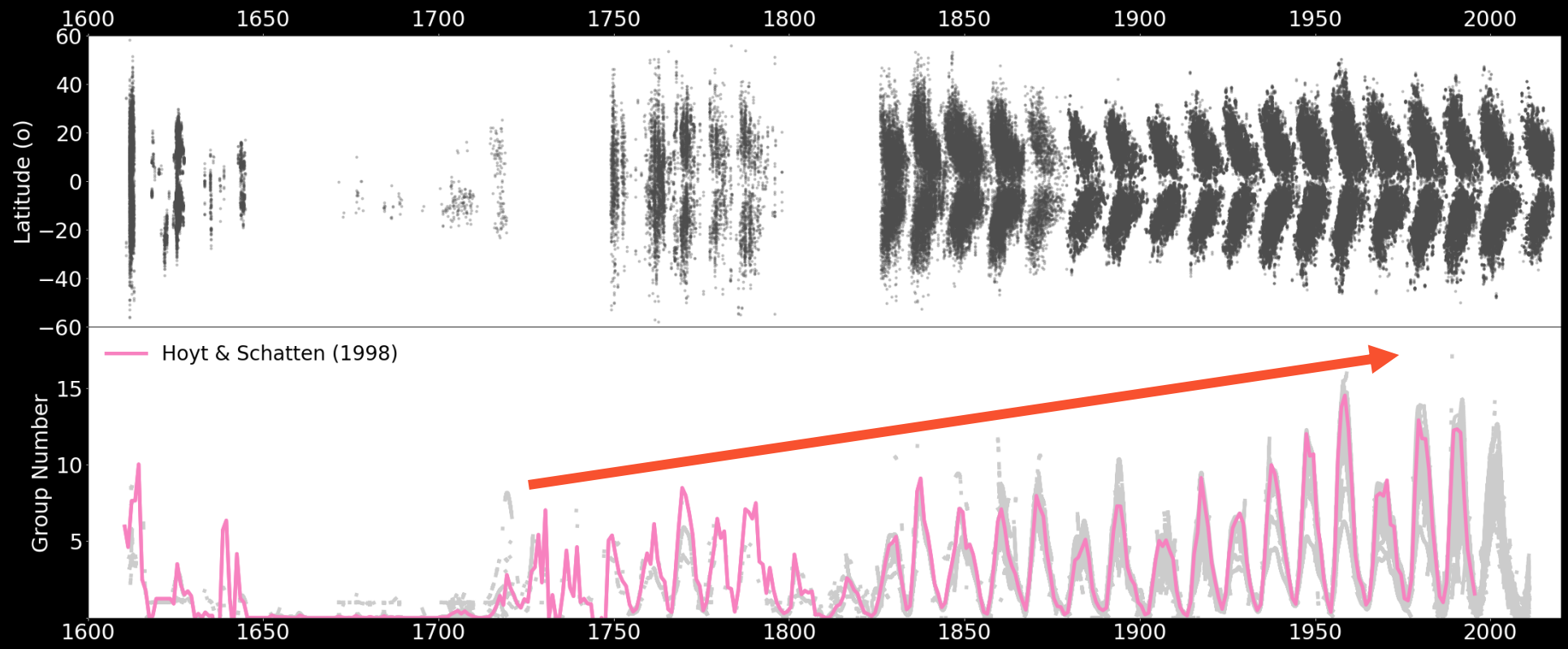

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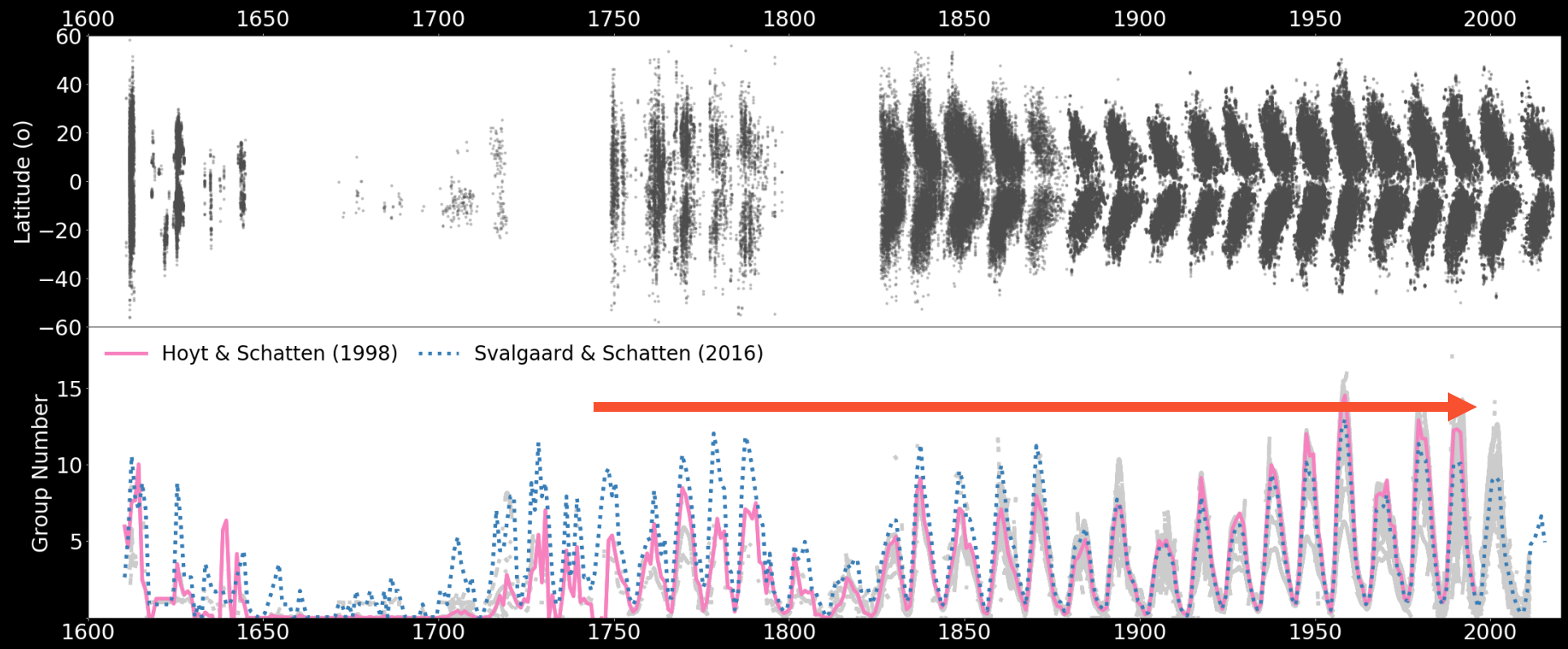

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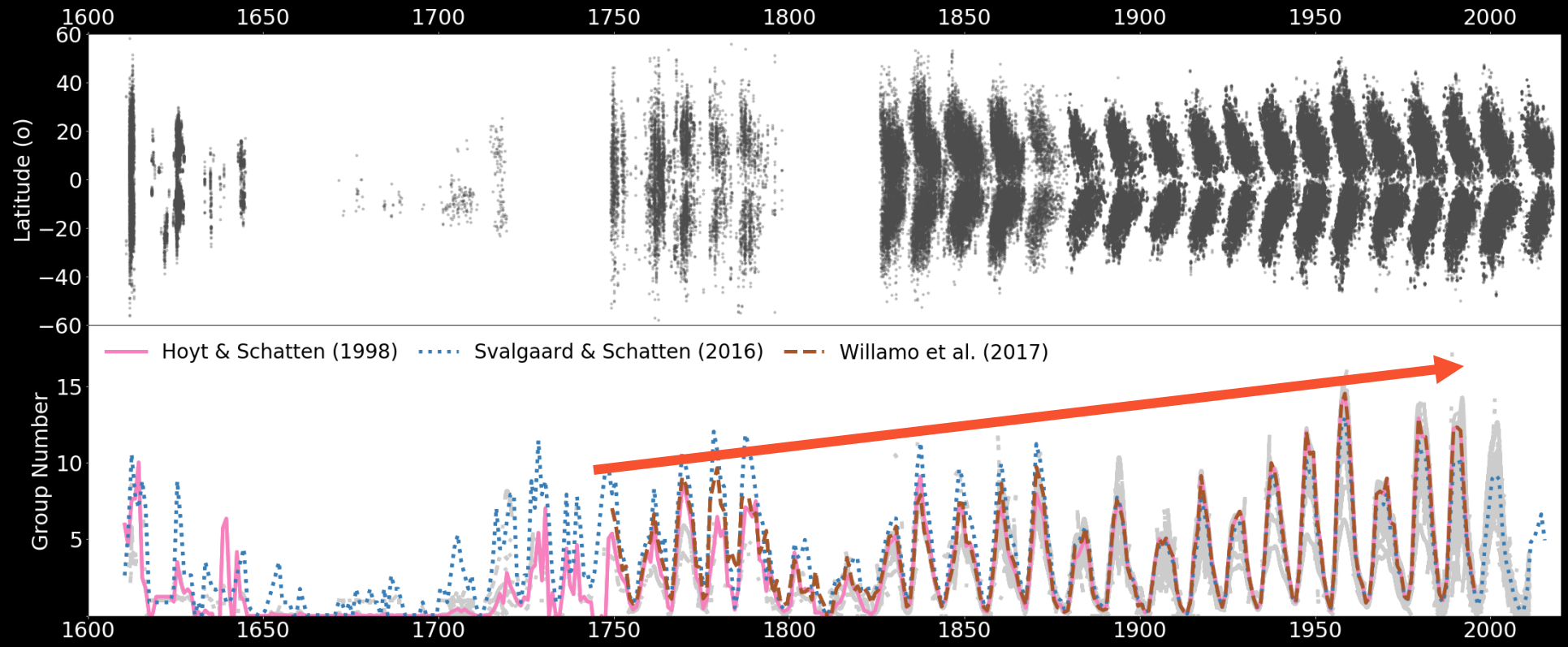

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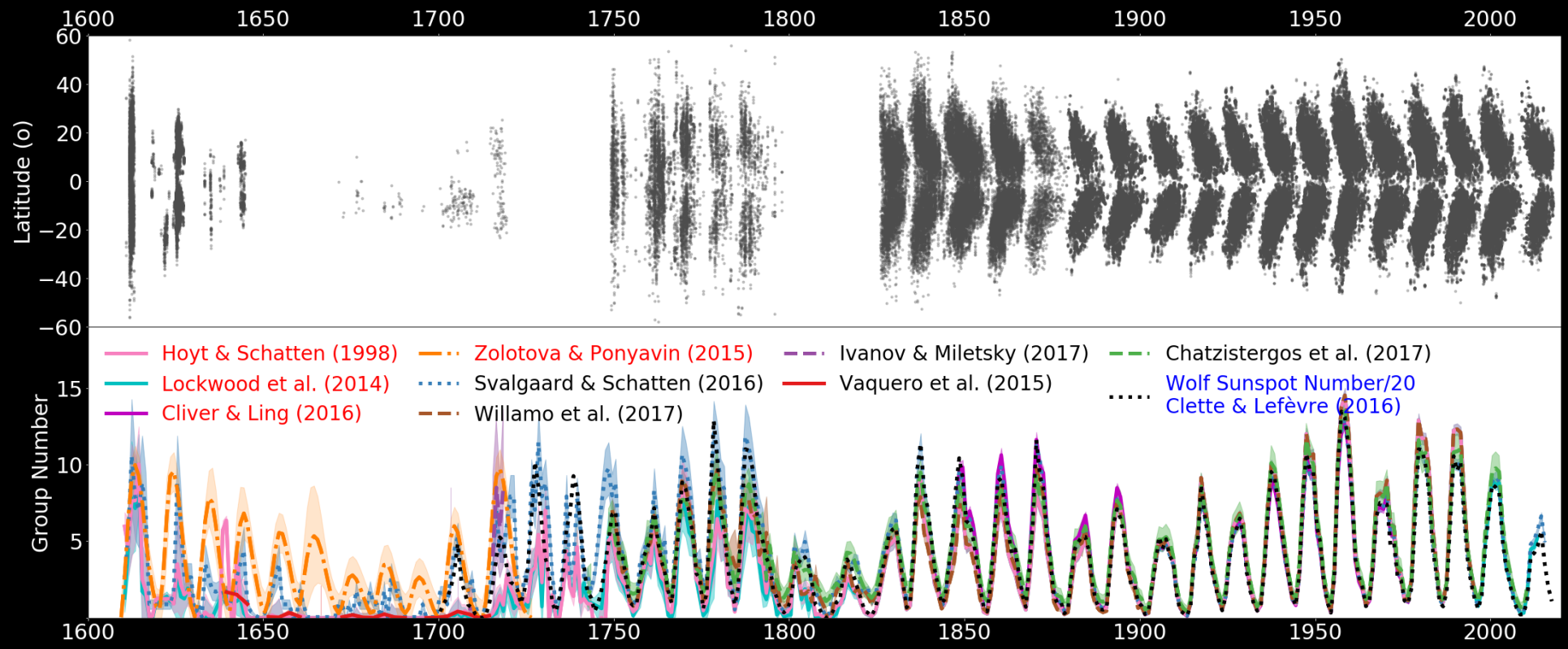

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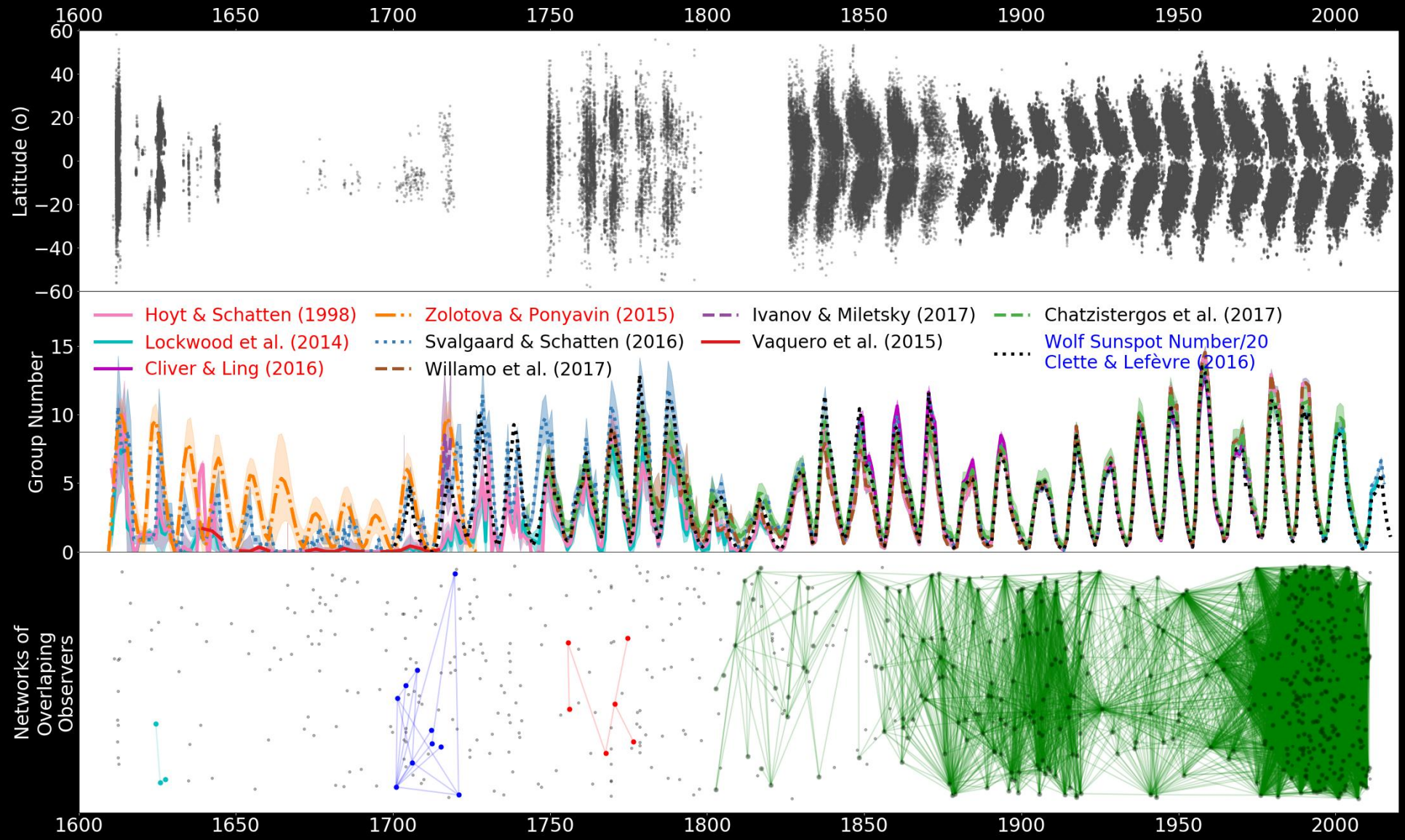
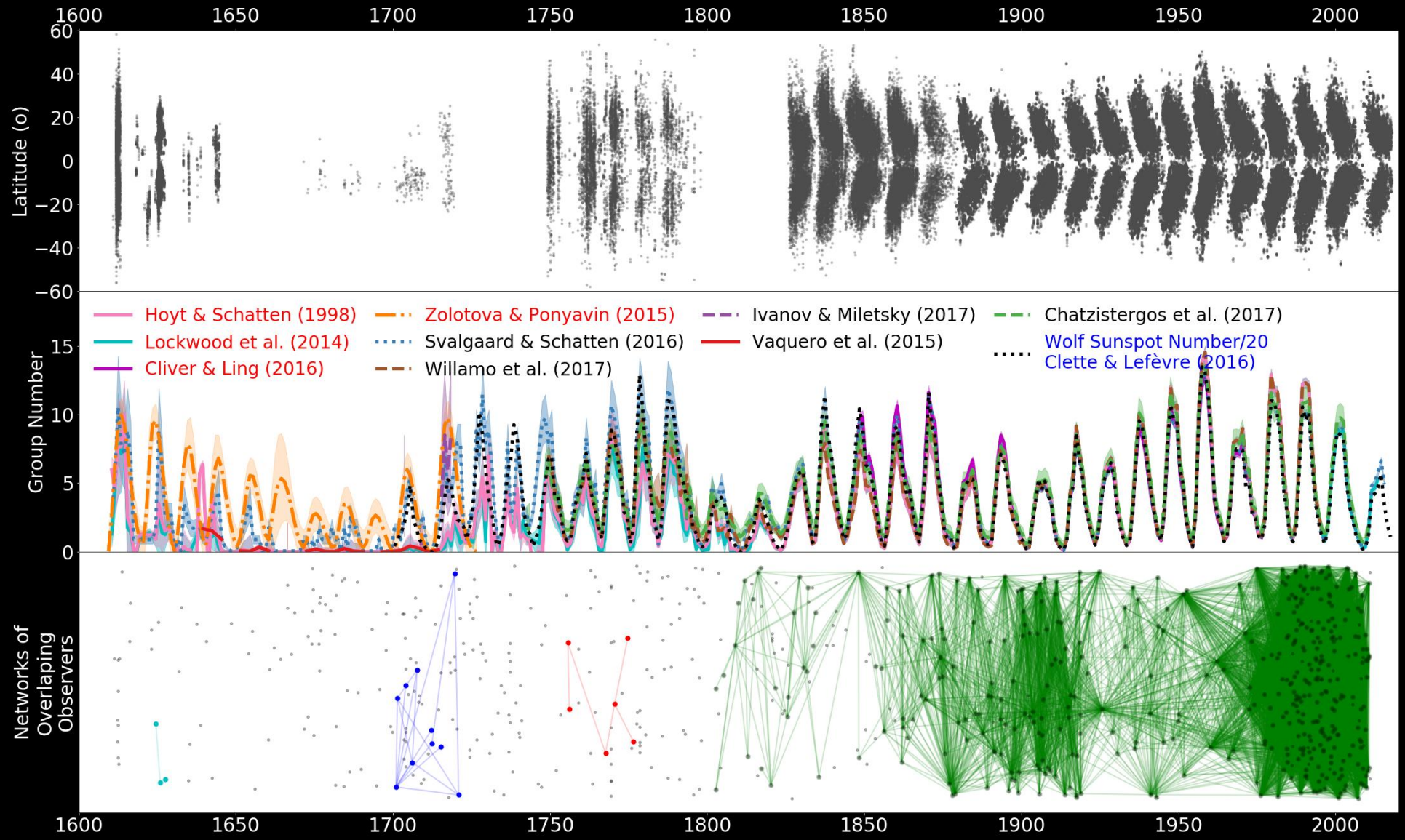
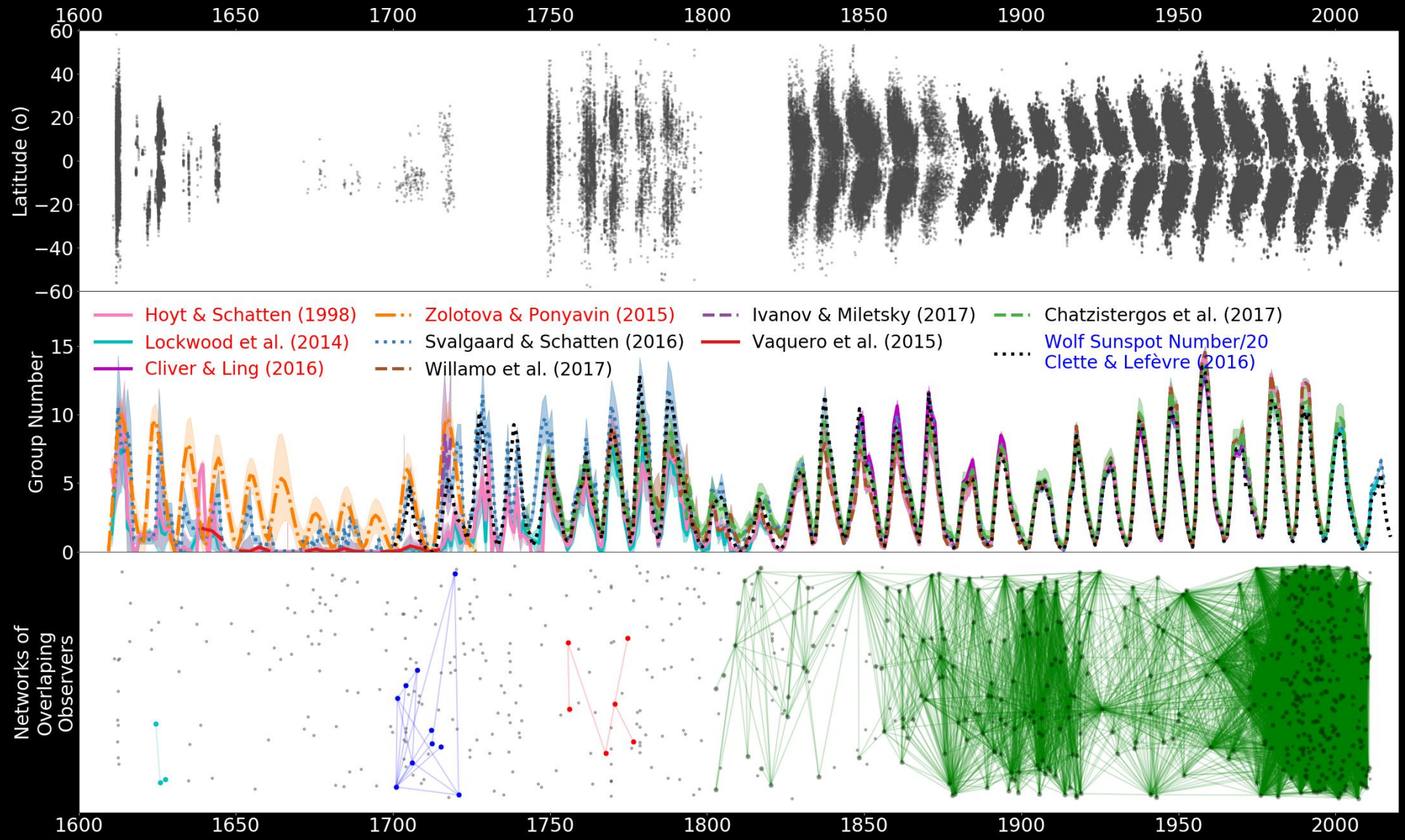


Problems and solutions

Problem 1: Our disagreement should be seen as inherent uncertainty



Solution: Combining competing series visually allows users to understand that



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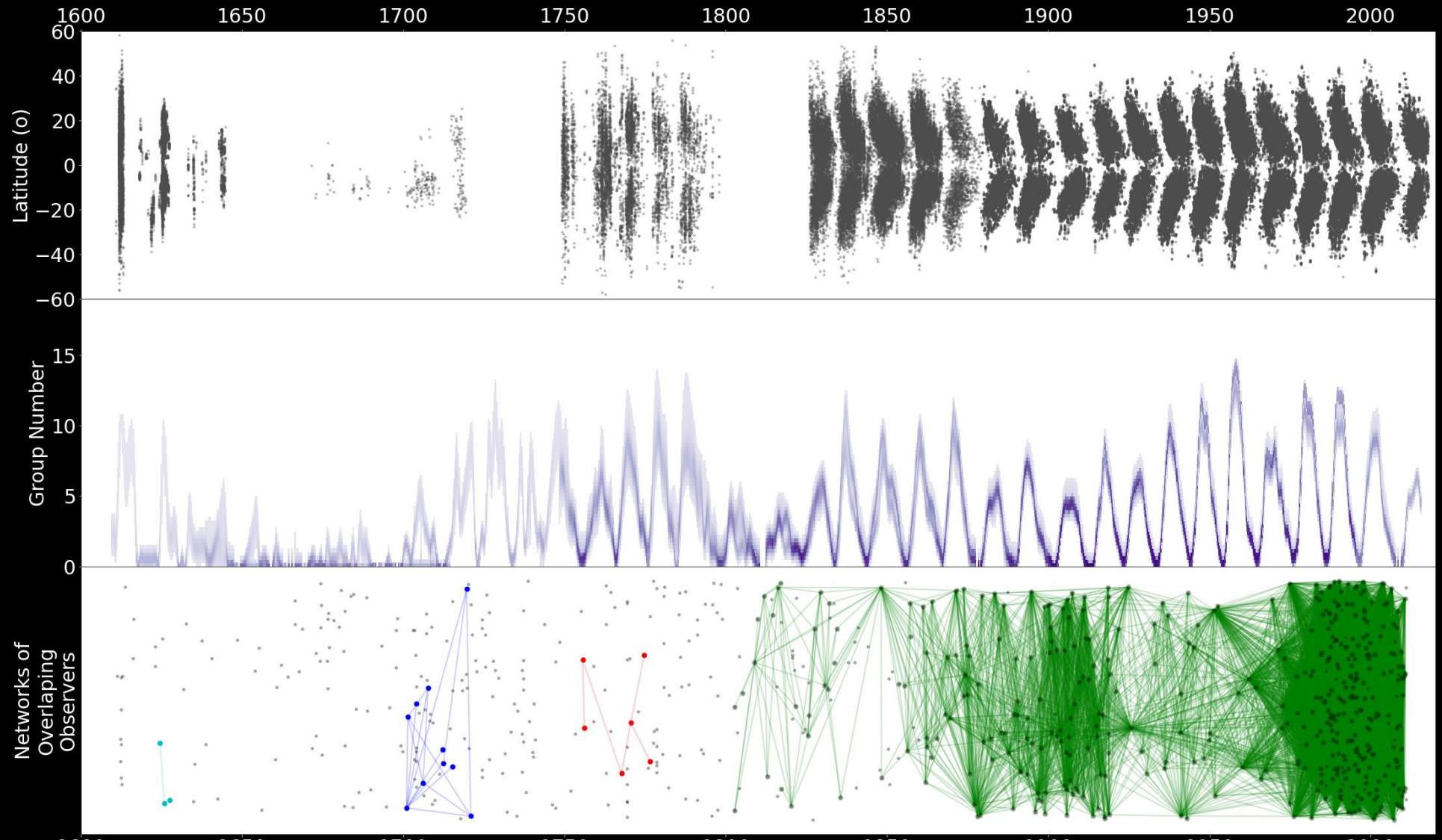
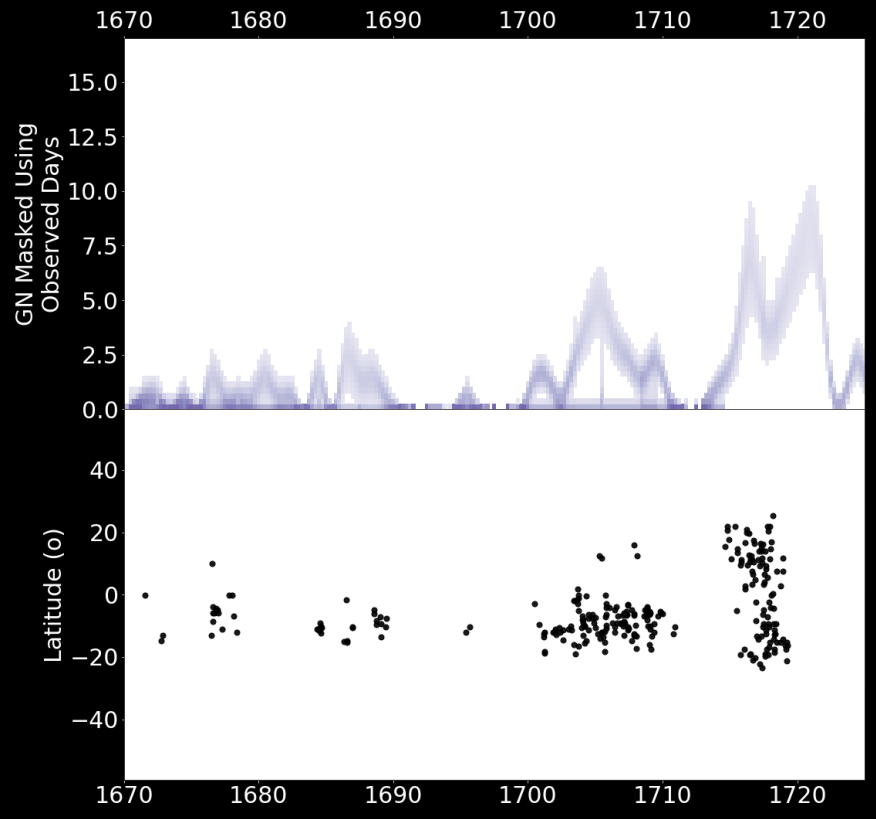
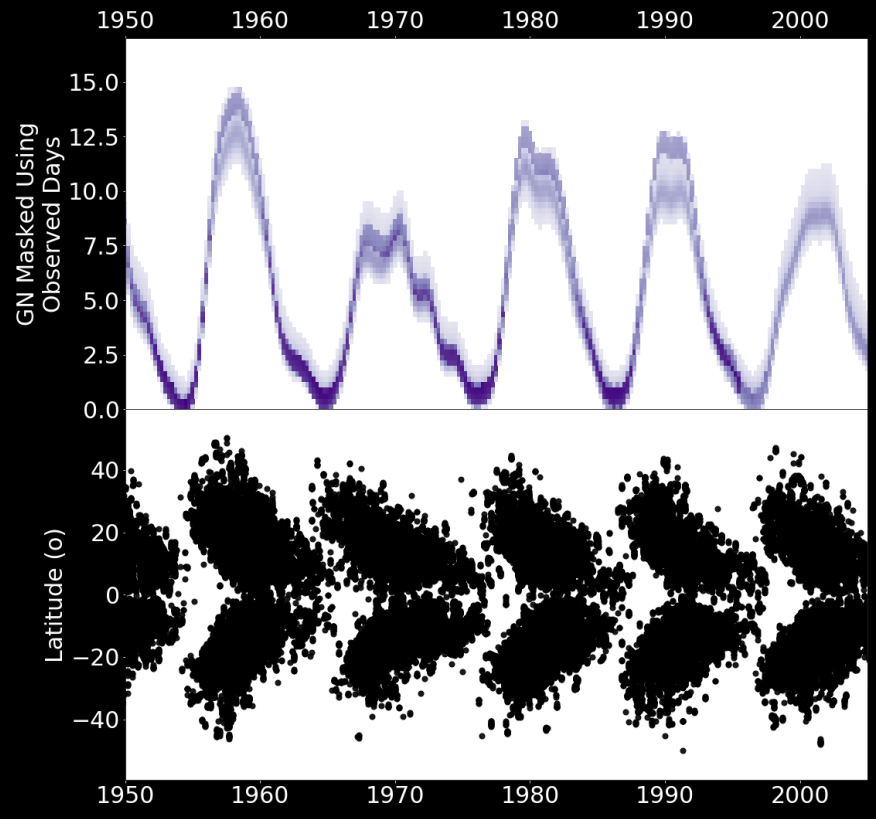
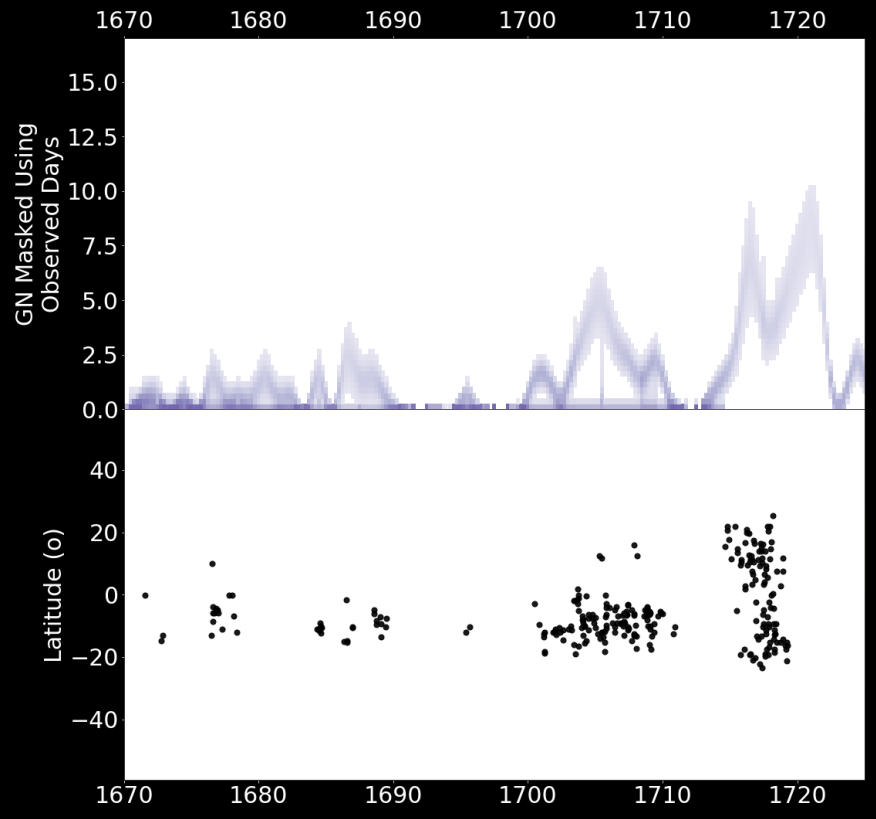


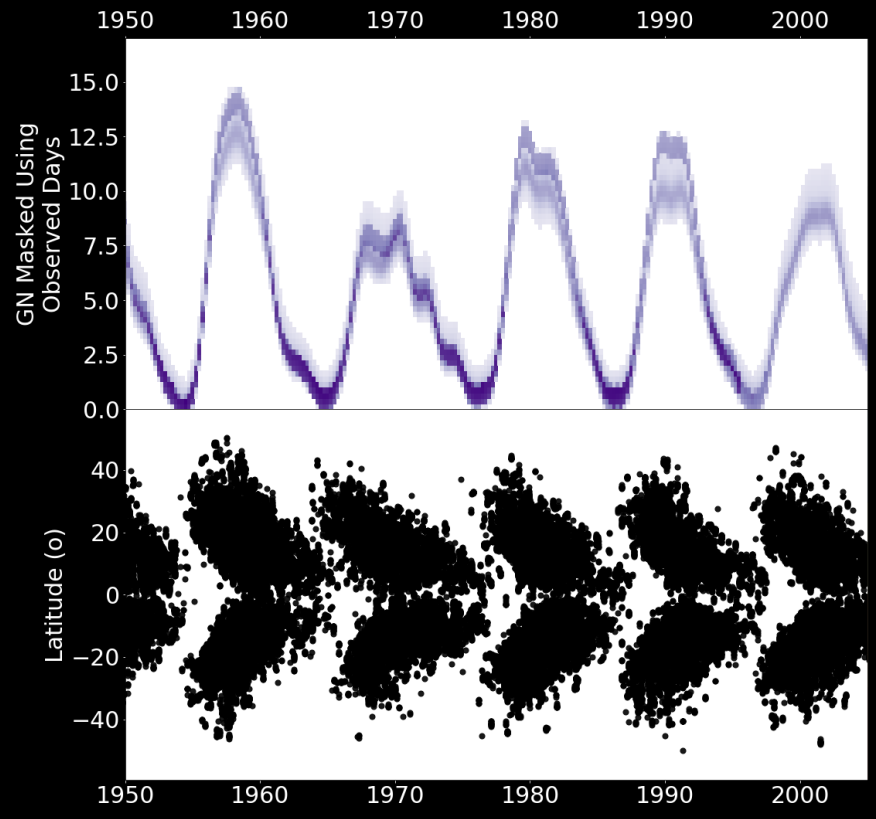
Problem 2: There is no clear way for users to grasp the level of observational coverage





Solution: Use background space to provide context





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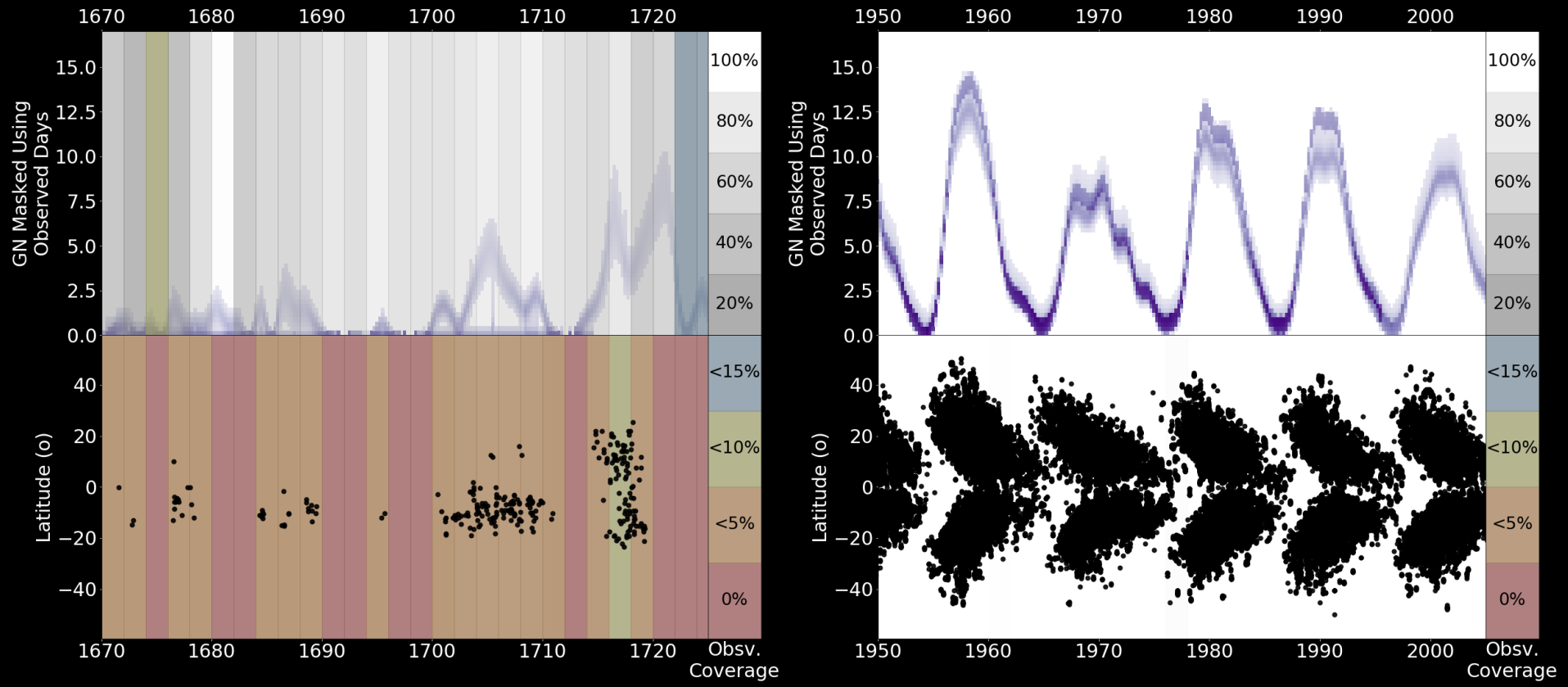

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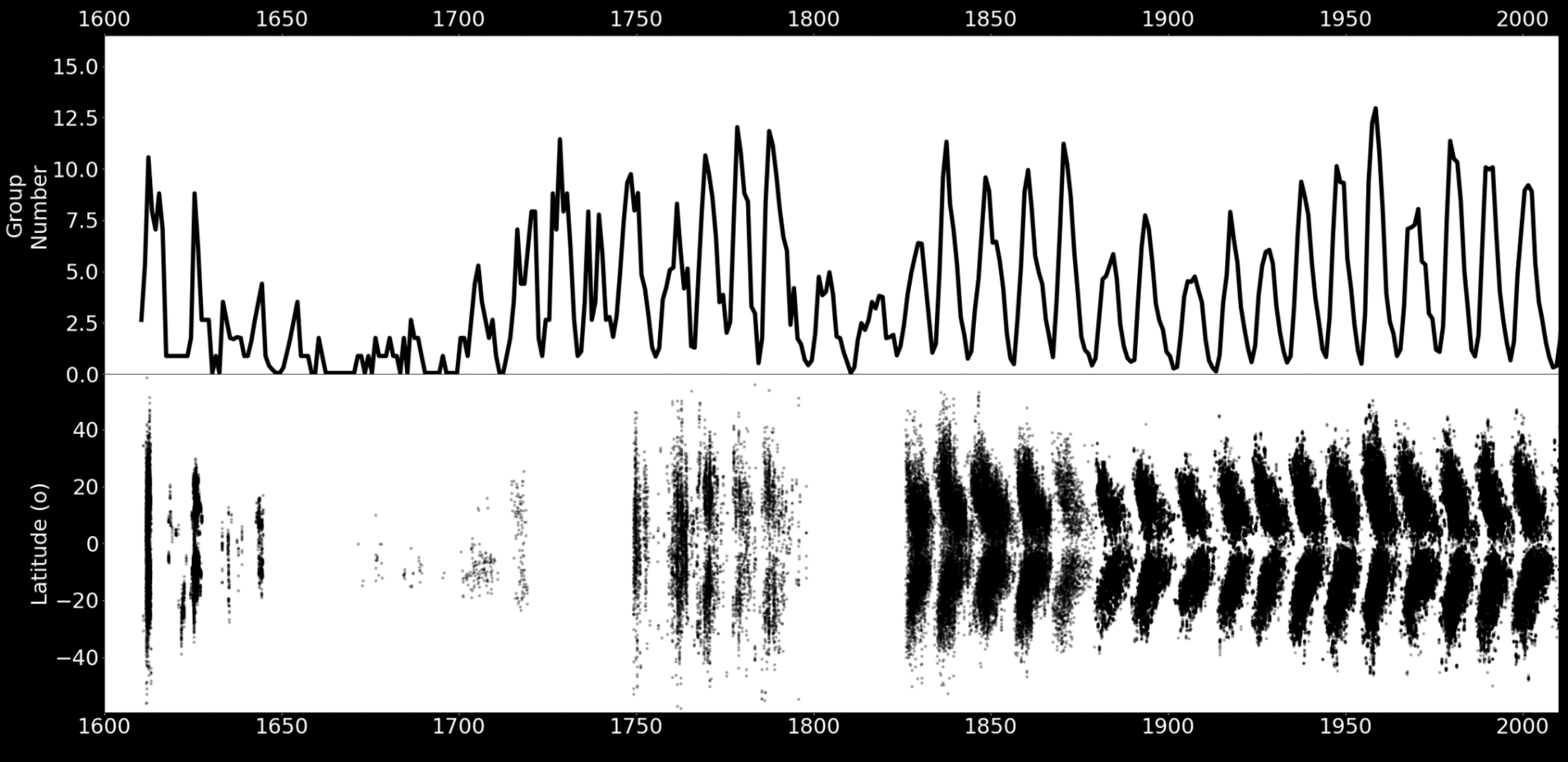

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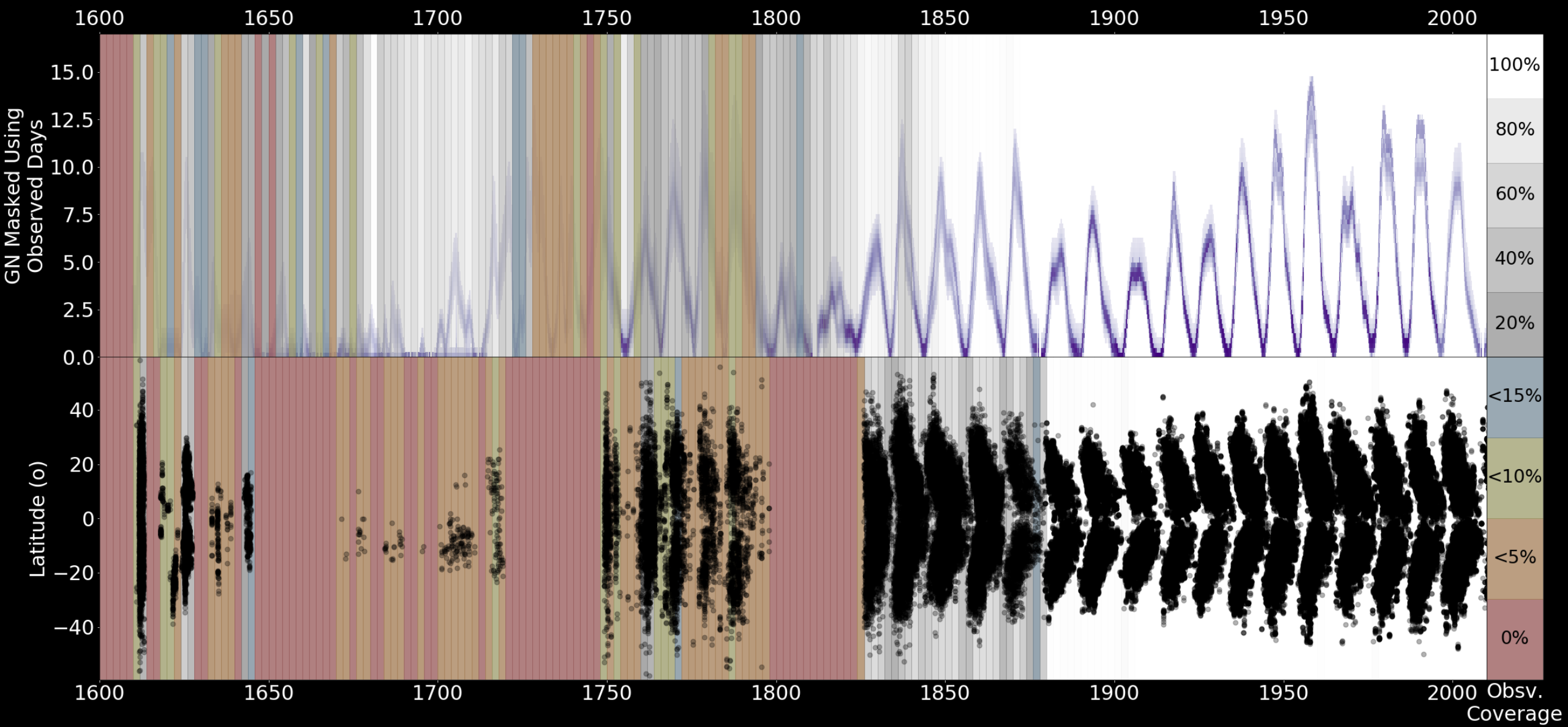
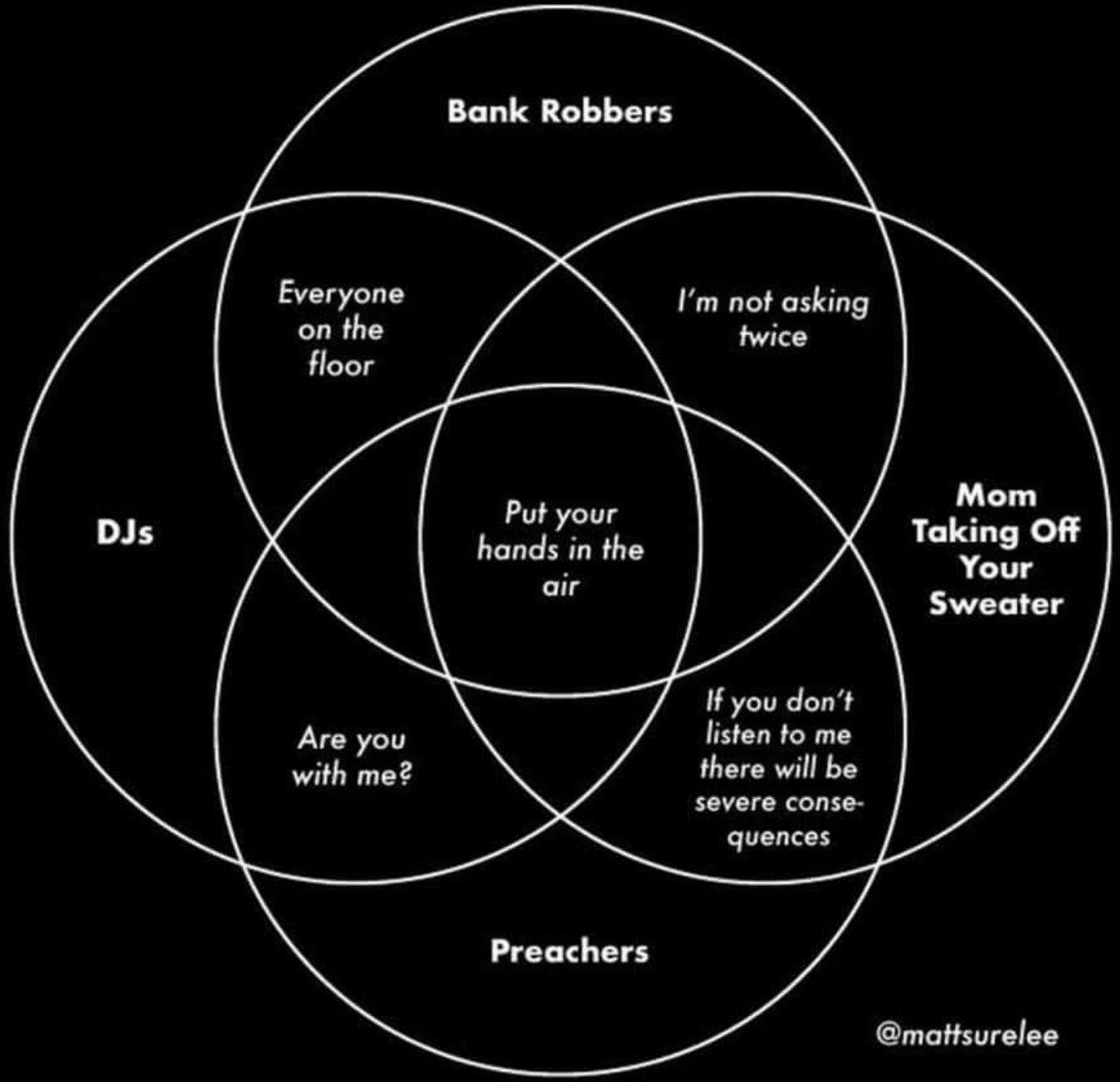


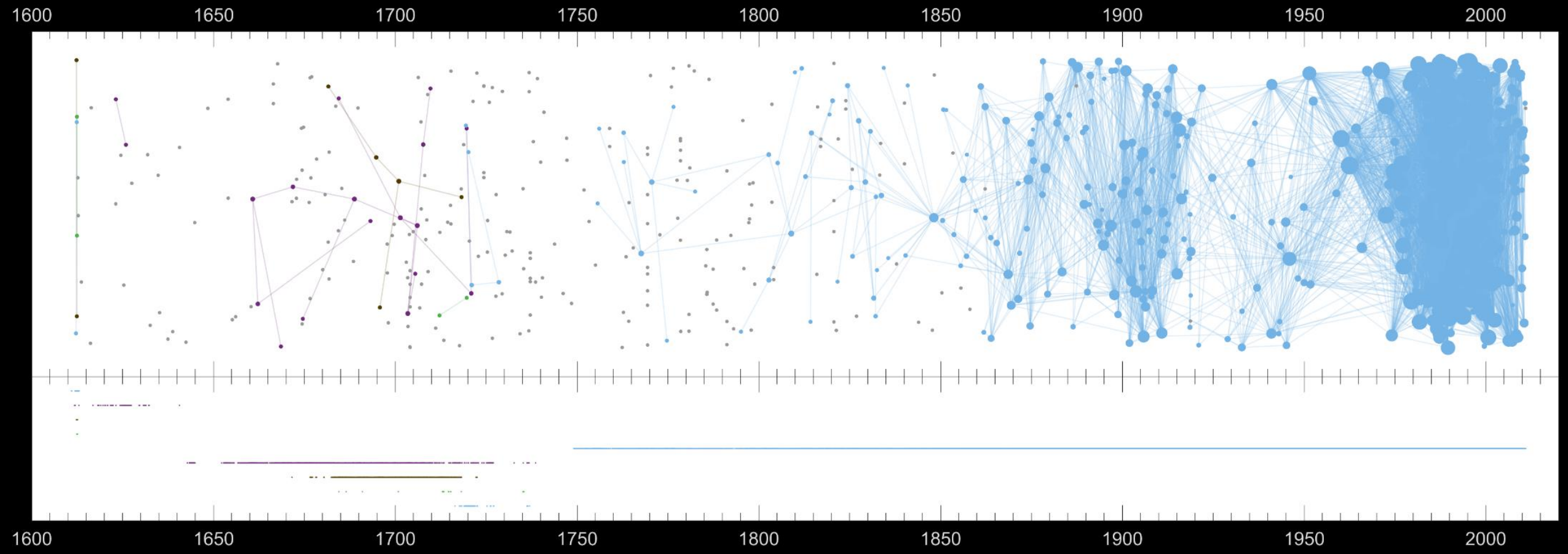


Finding common ground

Finding common ground

Pathfinding chains:

Svalgaard & Schatten (2017), Chatzistergos et al. (2017)



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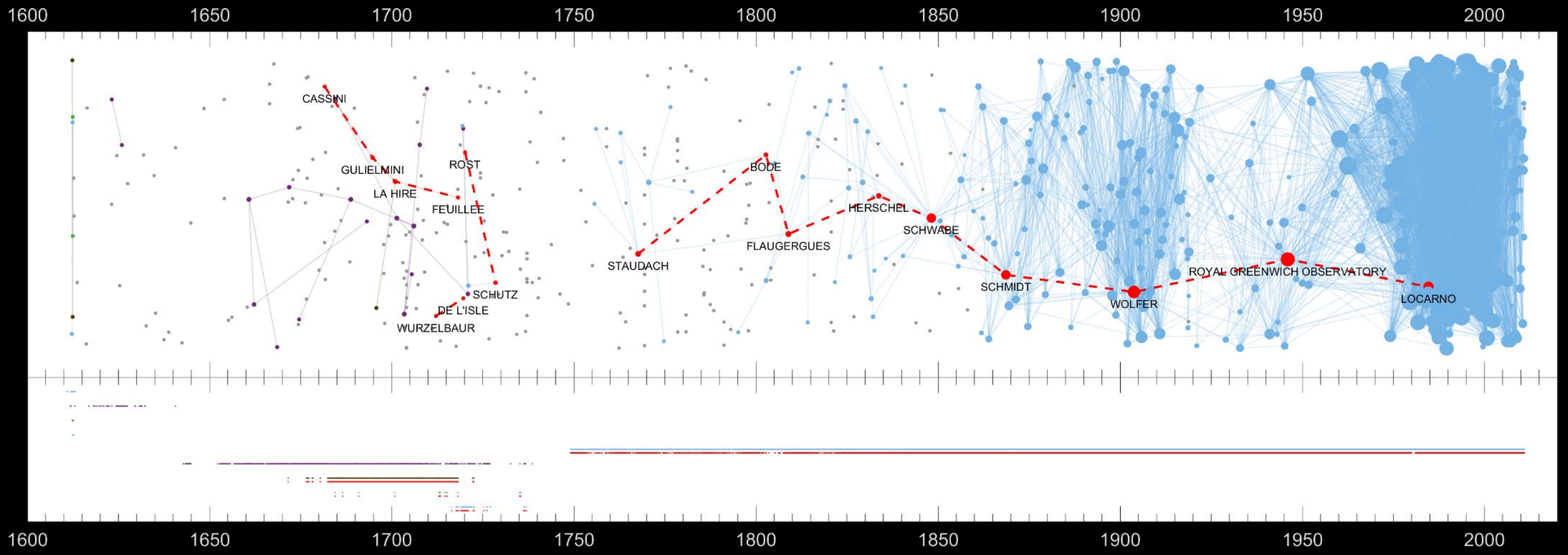
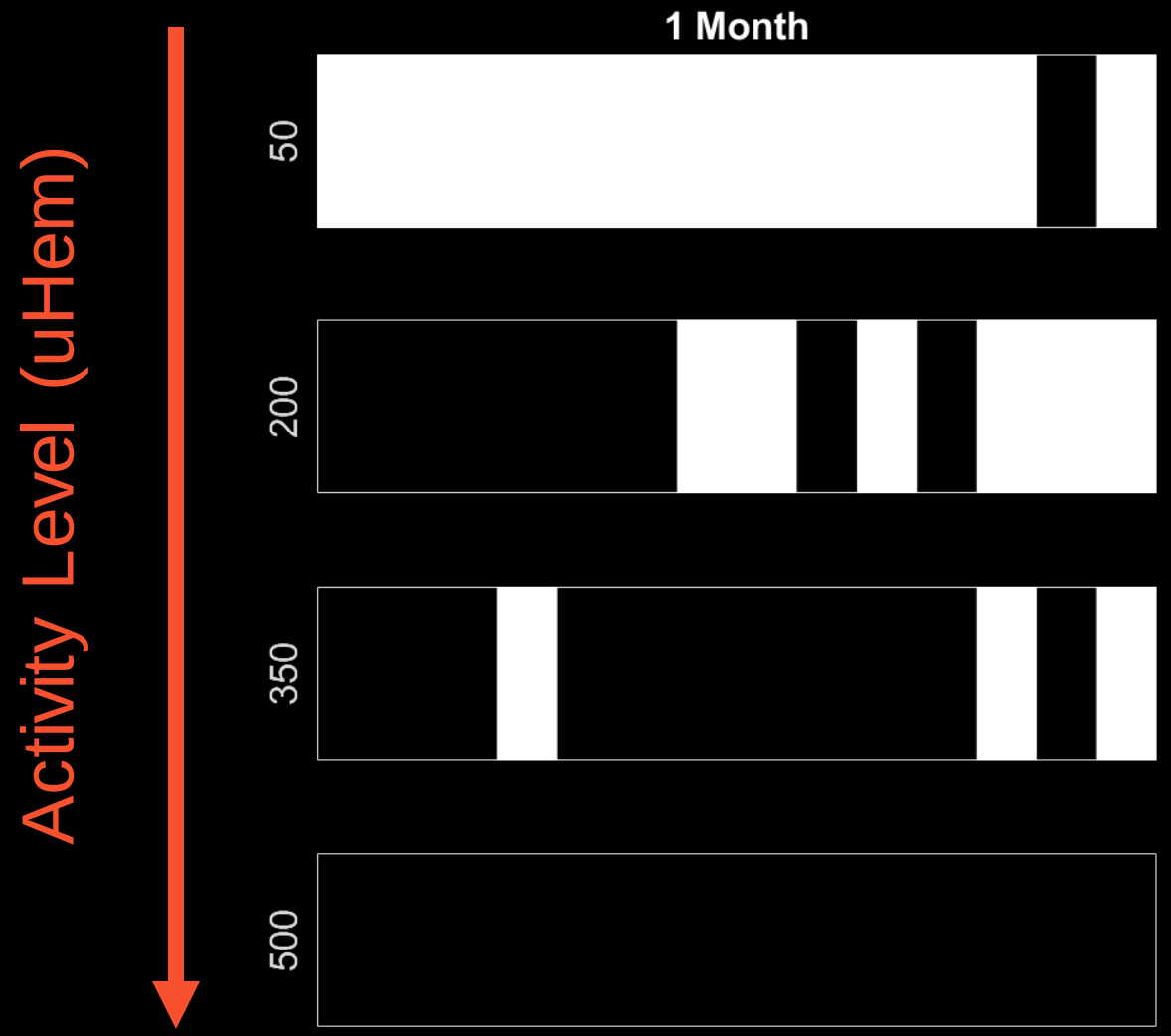
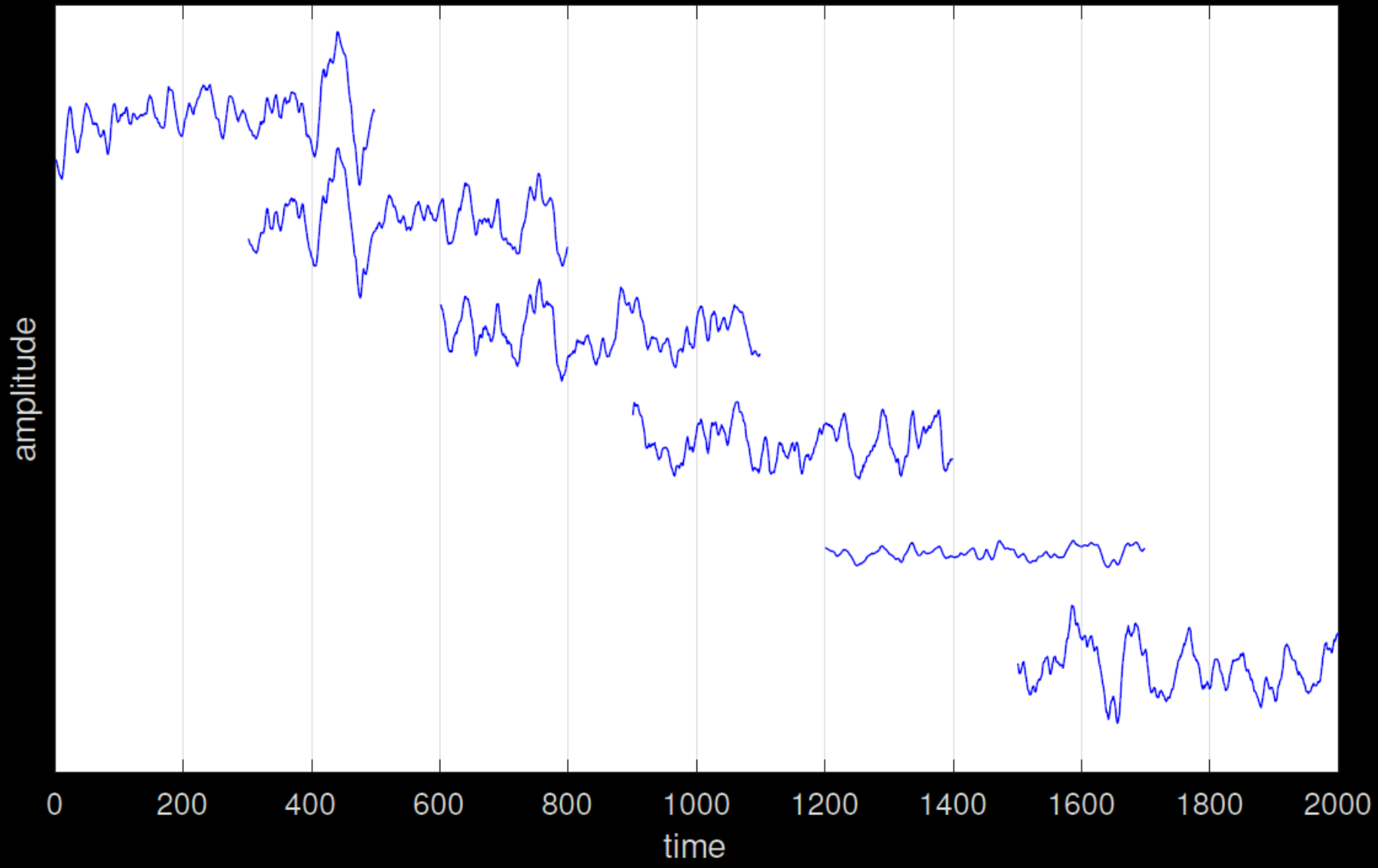


Fingerprinting the solar cycle (active day fraction):

Usoskin et al. (2016), Willamo et al. (2017)



Looking for the underlying signal (expectation maximization): Dudok de Wit et al. (2017)



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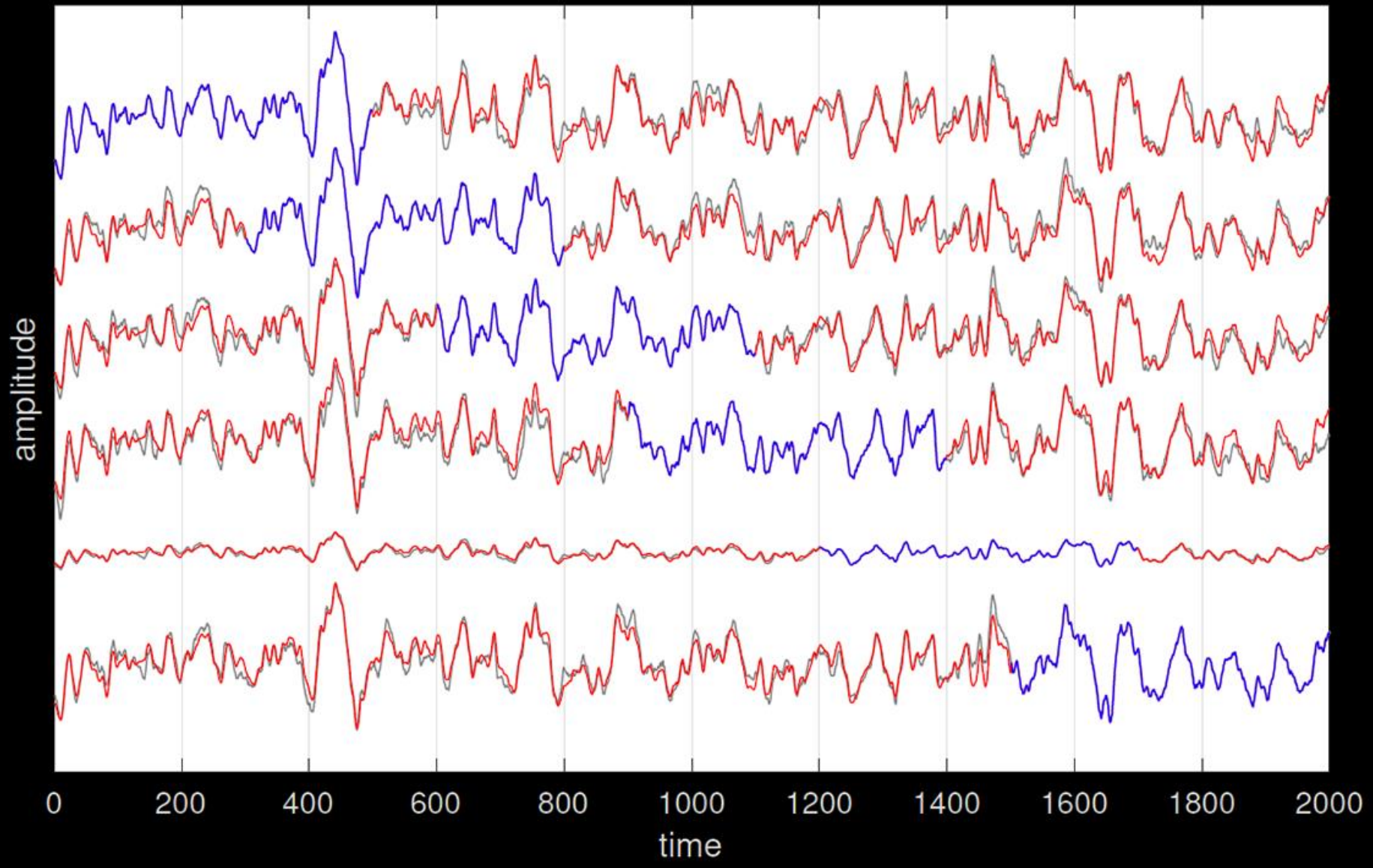
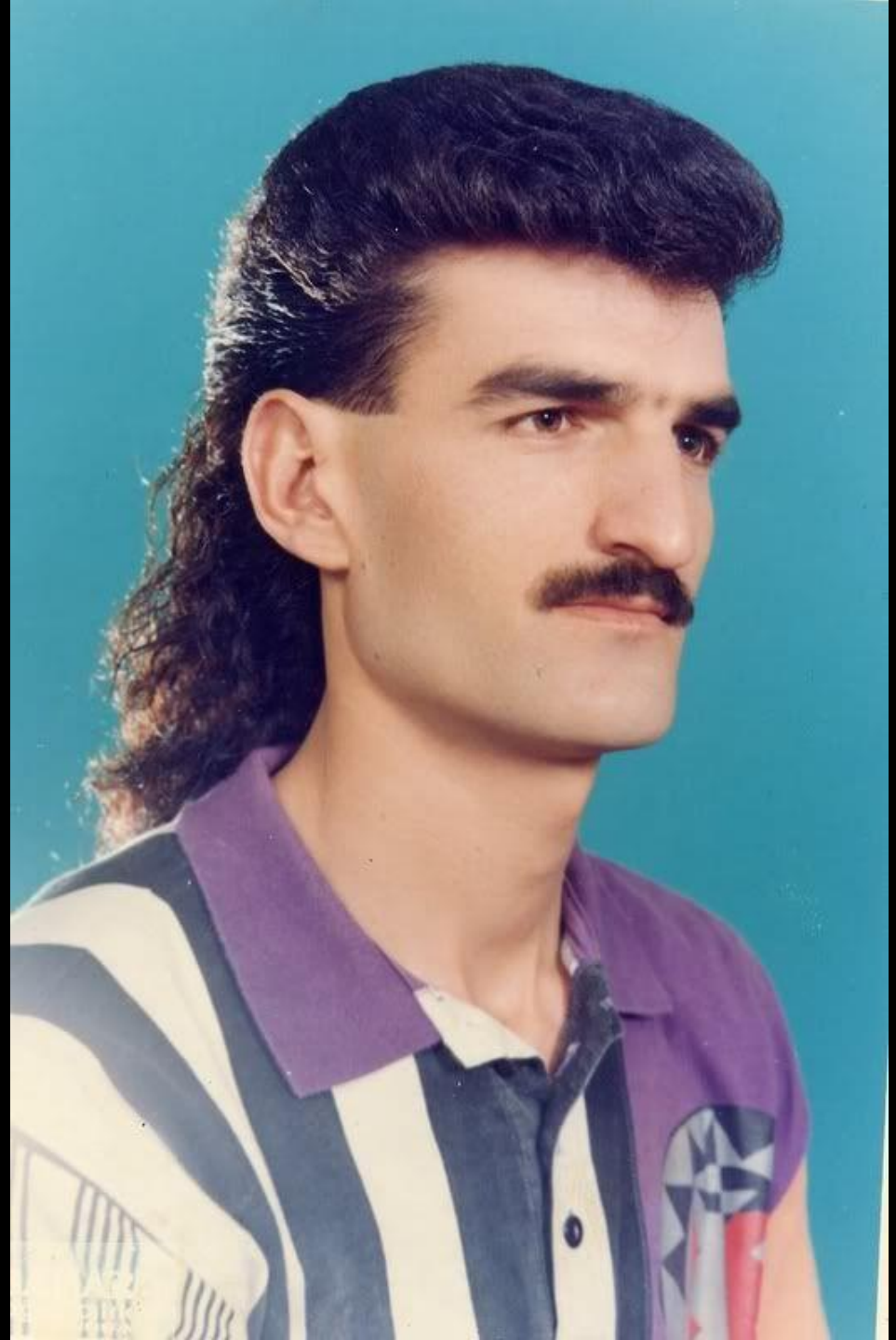


Business or party?



Why not both?

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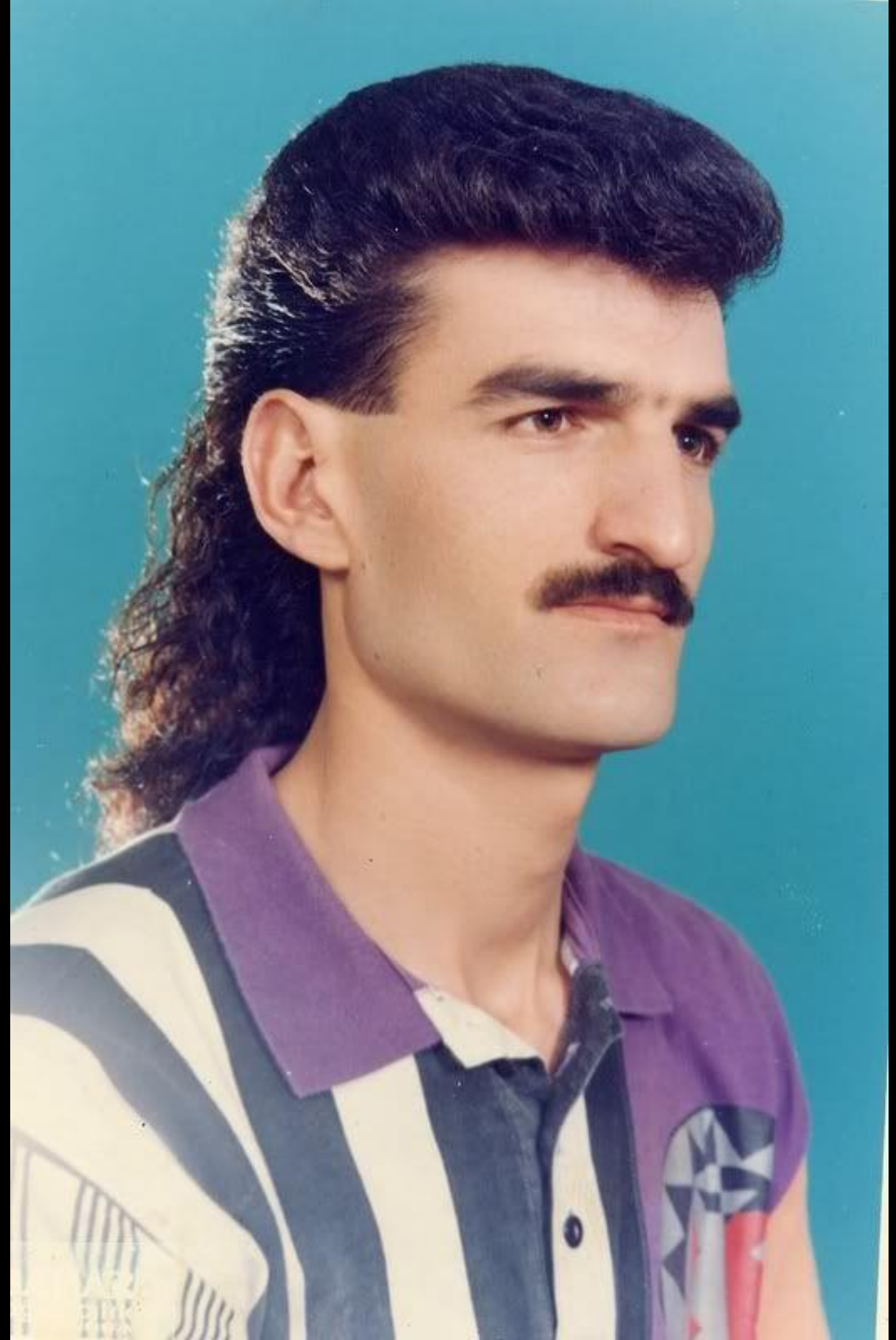

Any resemblance to actual persons, **living** or dead, or actual events is purely coincidental

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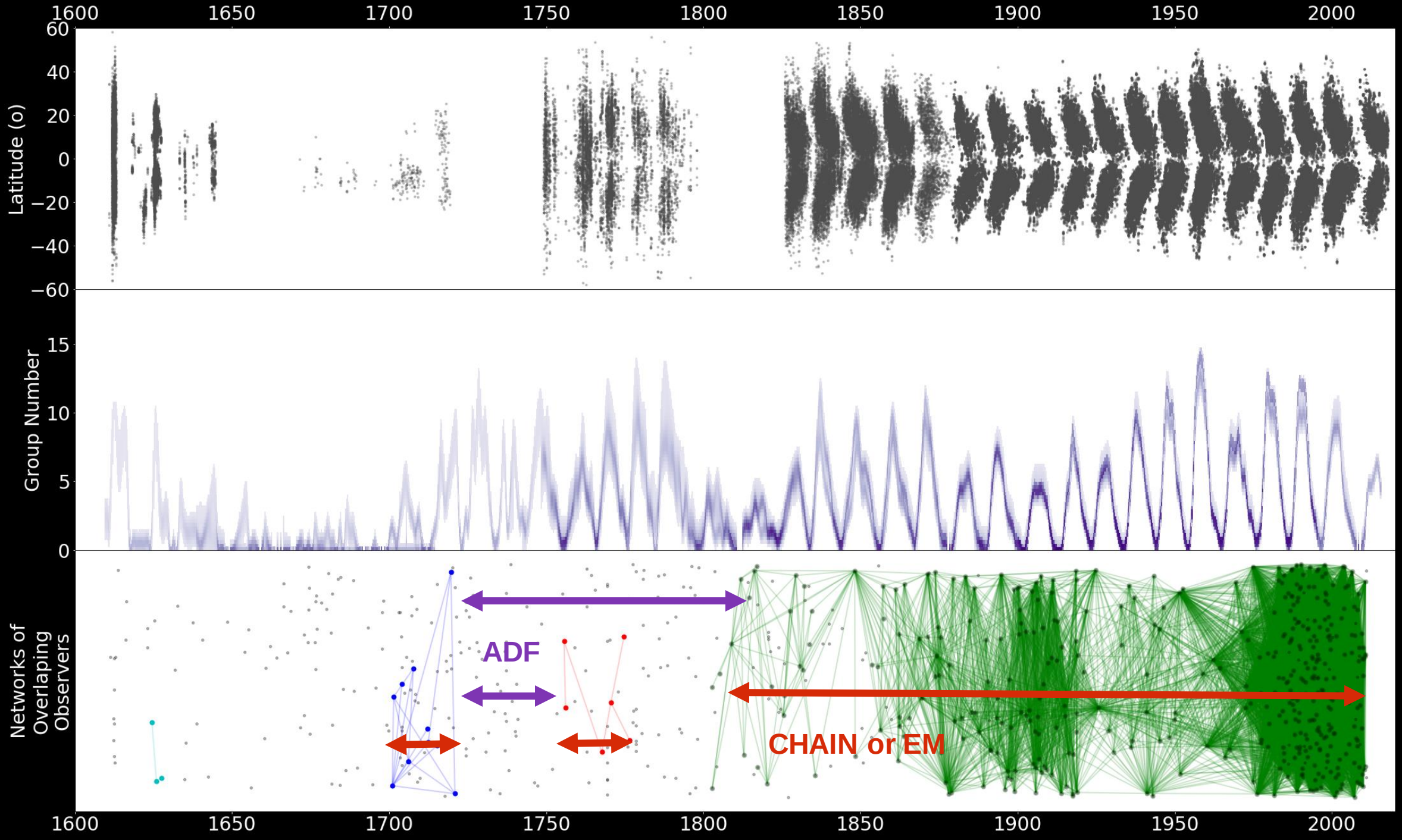
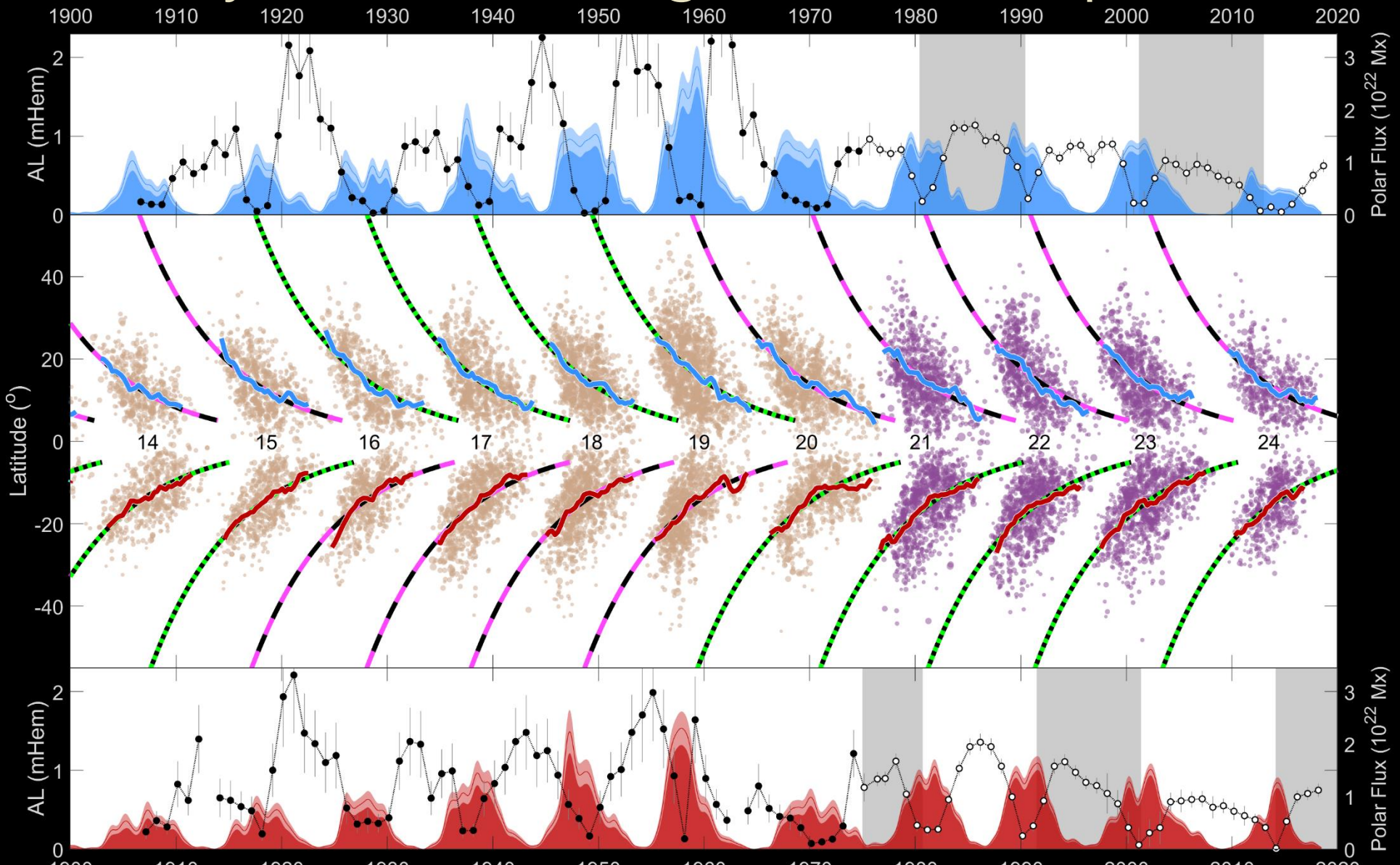

1600
1650
1700
1750
1800
1850
1900
1950
2000
Latitude (o)
60
40
20
0
−20
−40
−60
Group Number
15
10
5
0
Networks of Overlaping Observers
ADF
CHAIN or EM

Polar field reversal seems to determine when the cycle starts tracing the universal path



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merci de m'avoir invité à la gynécologie-périnatalité