Region-wide synchrony and traveling waves of dengue across eight countries in Southeast Asia

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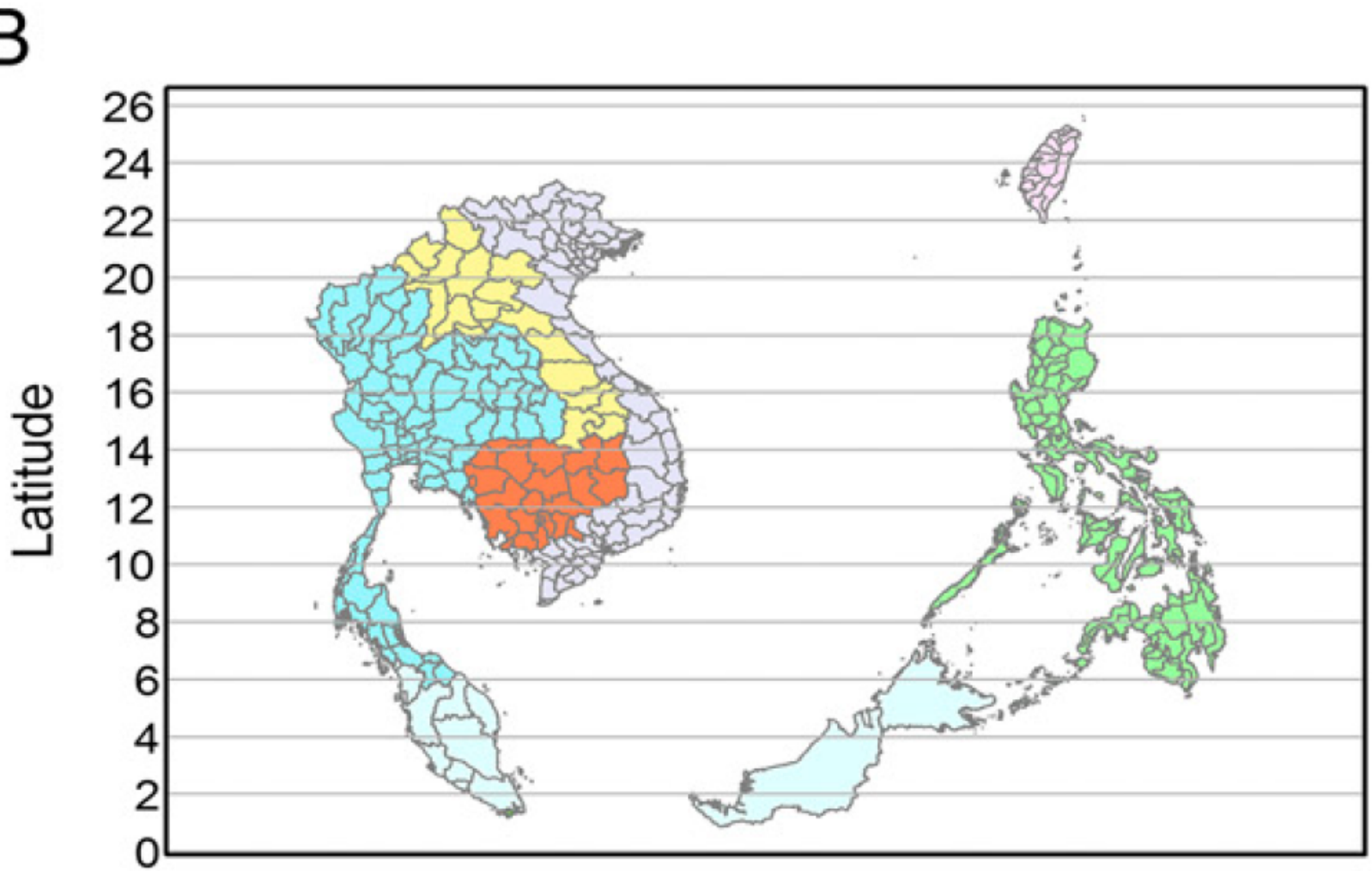
January 22, 2018

Traveling waves background

- This work was a followup to Derek AT Cummings paper on the traveling waves of Thailand (2004)
- That paper used wavelet analysis on Thailand to show that there were was inter-annual synchrony between neighboring provinces and multi-annual trends ("waves") in dengue that pulsed from Bangkok to the rest of the country
  - Used data from 1983-1997
- This paper extends wavelets to the provinces of 8 countries in Southeast Asia and incorporates weather information
  - Using data from 1993-2010

What are we looking at/for?



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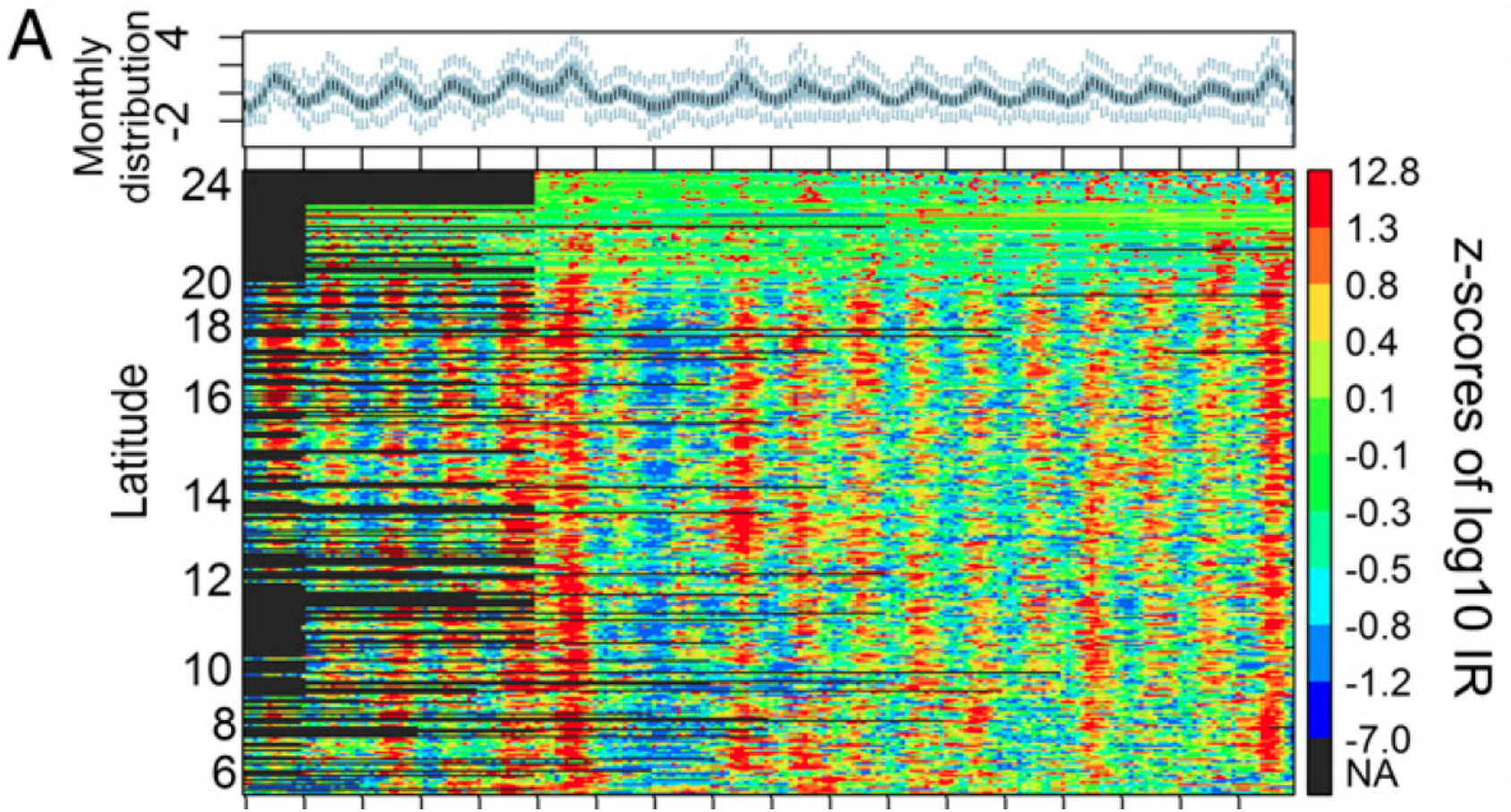


There are clear annual trends, but multi-annual trends and figuring out who is leading or lagging is difficult.

Wavelets, why use them?

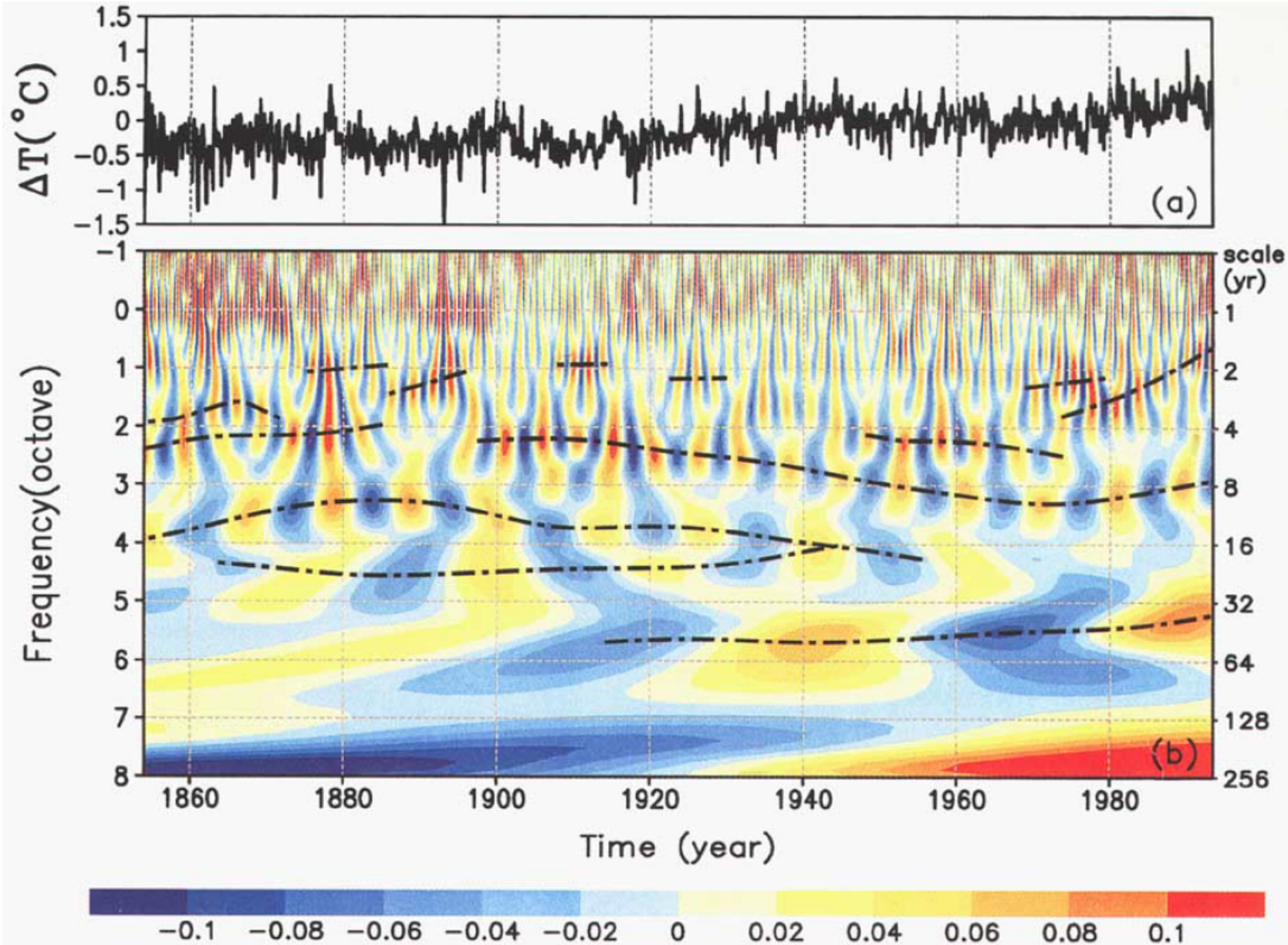
- Consider a time series of dengue incidence
- This has two dimensions, time and cases
- Each observation is affected by "waves" of different frequencies:
  - AR frequency, a 1-step wave
  - Seasonal frequency, a 1-year wave
  - Multi-annual frequency, a multi-year wave
- These waves have different amplitudes relative to each other, and can change over time
- Different locations' waves differ by timing (some leading or lagging others) and duration, as well as amplitude
- Wavelets attempt to preserve all of this information, so that we can determine which waves are responsible for the values we observe

Wavelets, what are they?

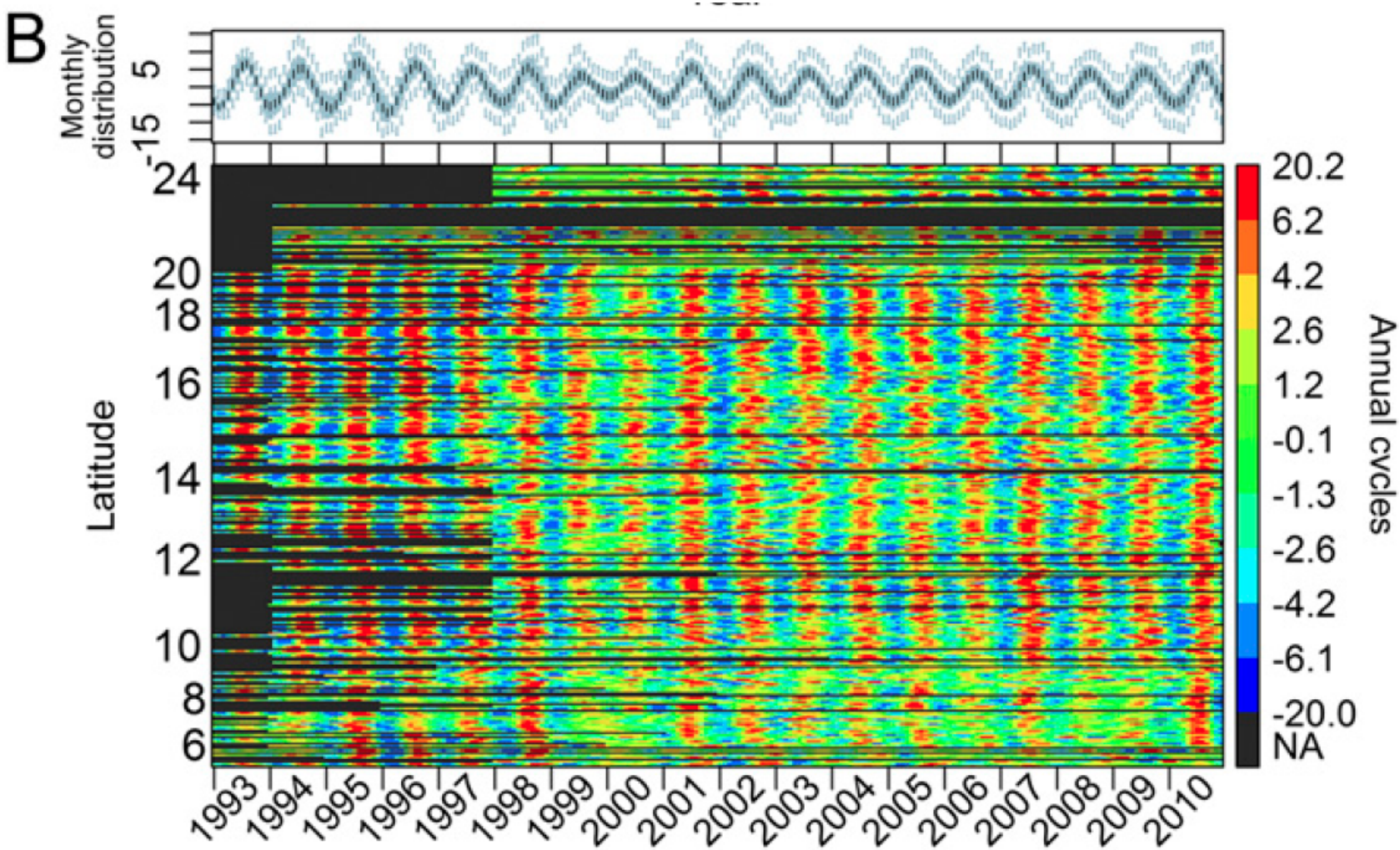
- Sounds like a straightforward concept, but I don't really understand it
- I've watched a few videos and read a couple papers/blog posts and have started to understand the frequency domain, but I get lost in the math
- Seems like people who write and talk about it needed a while to comprehend it, but eventually had an epiphany and started to see the world differently – I'd like to get there but need more time
- This paper specificly uses Morlet wavelets, which have a nondimensional frequency parameter (???), in addition to the usual nondimensional time parameter
  - Uses discrete Fourier transforms, complex numbers, and red noise (?!?)
  - These are mostly another language to me

Wavelet figures

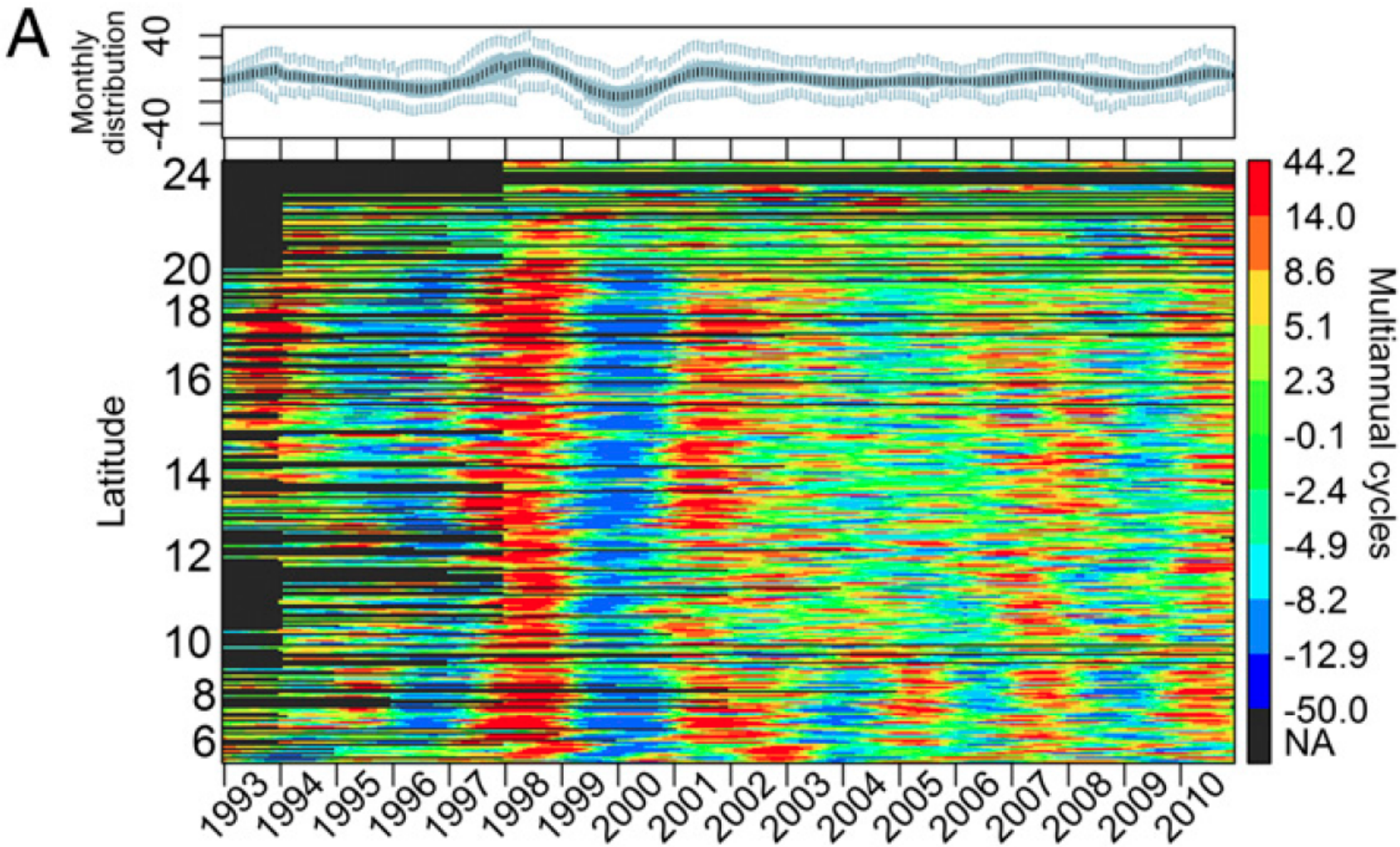
Usually we see a figure like below, but not in this paper.



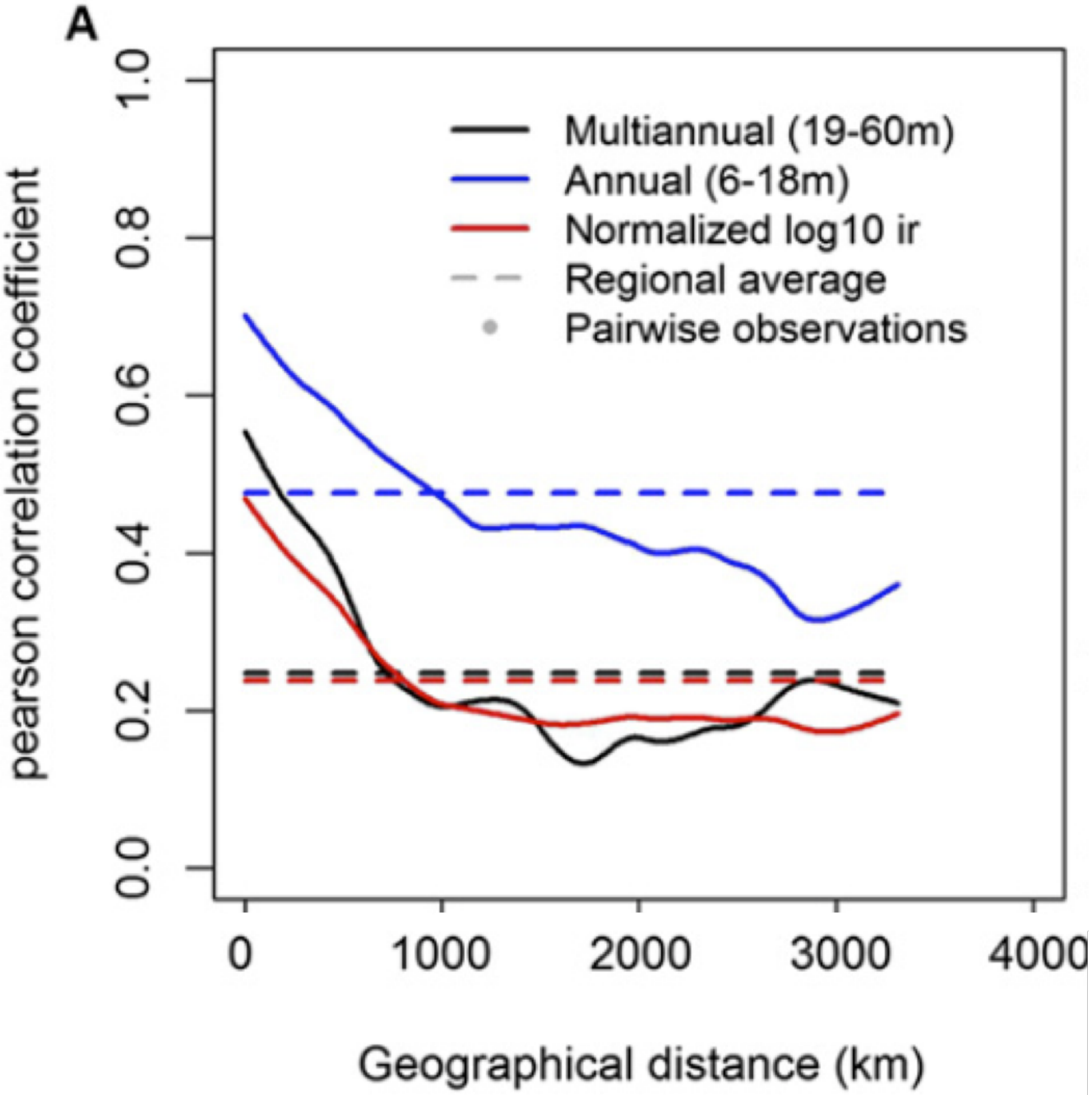
Results: strong region-wide annual synchrony



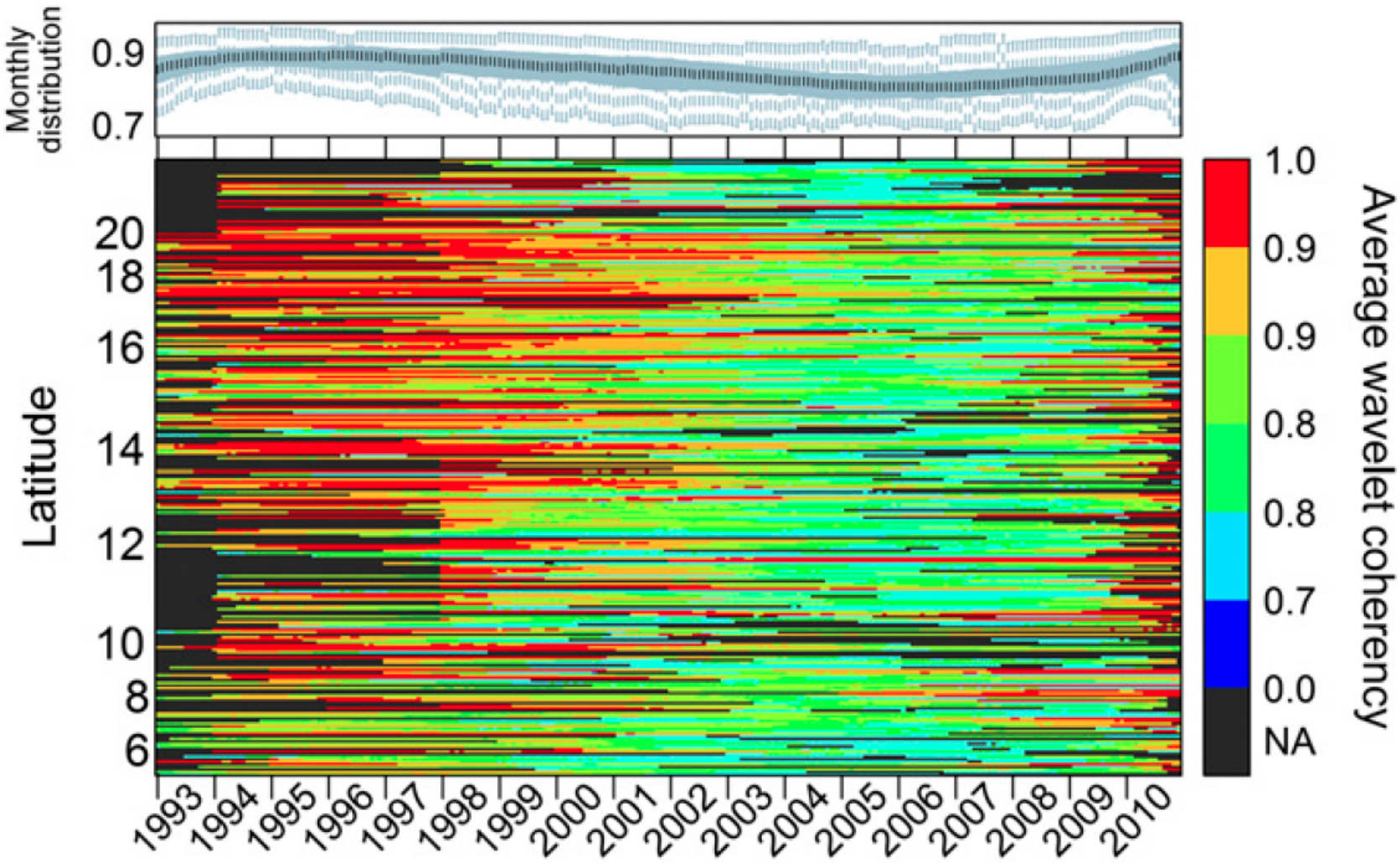
Results: periods of strong region-wide multiannual synchrony



Results: synchrony by distance

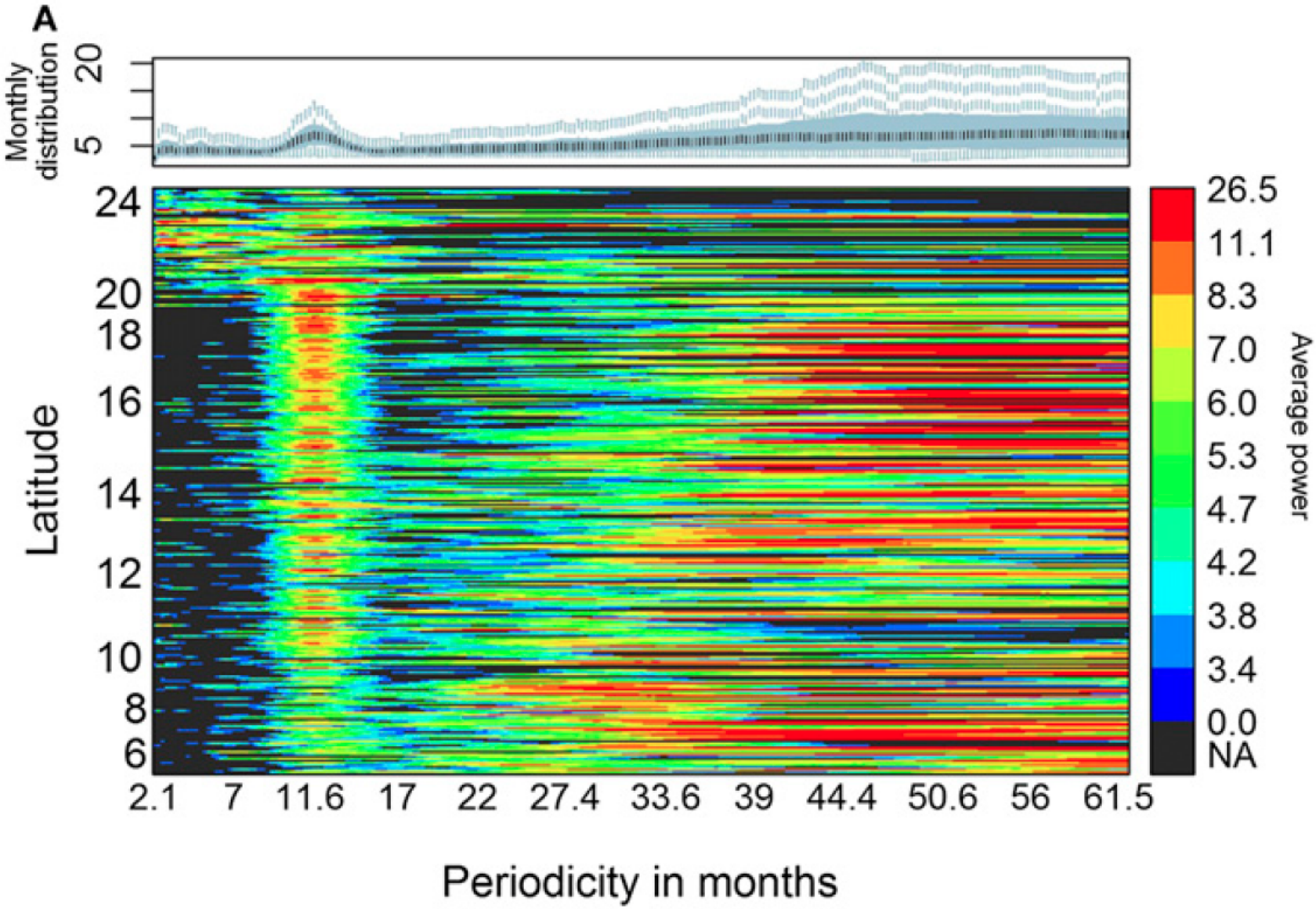


Results: strong synchrony with climate



The strange color scale seems to underestimate the coherence here.

Results: multi-annual frequency may vary by region



Results: synchrony between specific regions

Kinda nifty, see supplement

Discussion

- The actual traveling waves portion of the paper seemed a bit weak. There's no obvious geographical trend, though Bangkok was still listed as a leading province. Perhaps there is a metropolitan center effect, but that isn't mentioned in the paper.
  - I might be underselling this; could just be that I didn't find it as interesting as the rest of the paper.
- Would have liked to have seen some validation, rather than just hypothesis testing, which they rely heavily upon.
  - Perhaps remove some end values and try to predict them using a model based on annual cycles with and without multiannual cycles to see if the multiannual cycles add value to forecasts?
  - Difficult because wavelets can have large edge effects