

# Geographical coherence of influenza epidemics in the US, France and Australia: 1972-1998

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# Influenza in temperate areas

- Inter-annual variability in the impact of influenza epidemics, circulating strains, and time of onset.
- Similar patterns in geographically distant areas ⇔ geographical coherence.
- Why study geographical coherence ?
  - The determinants of the spread are unknown\*; global vs local factors that impact or trigger influenza epidemics?
  - Forecasting

# Data

- Weekly number of pneumonia (P) and influenza(I)-coded deaths 1972-1998 \*
  - In the US (National Center for Health Statistics)
  - In France (Inserm = French National Institute for Health and Medical Research)
  - In Australia (Australian Bureau for Statistics)

\* Pneumonia: ICD-8 and 9 codes 480-486; Influenza: ICD-8 codes 470-474, ICD-9 codes 487

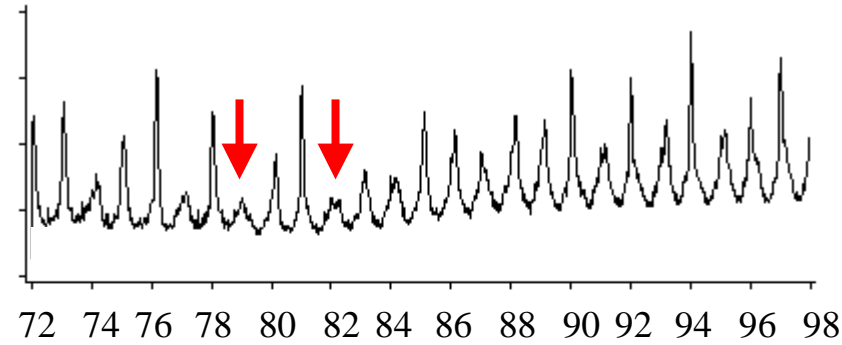
# Methods : measures of geographical coherence

- Epidemic impact:
  - Number of excess deaths (linear seasonal regression)
  - Between countries correlation
- Epidemic onset / date of peak :
  - Distribution of the time lags between dates of epidemic peaks/onsets
  - Phase coherence (synchronization) : wavelets analysis\*

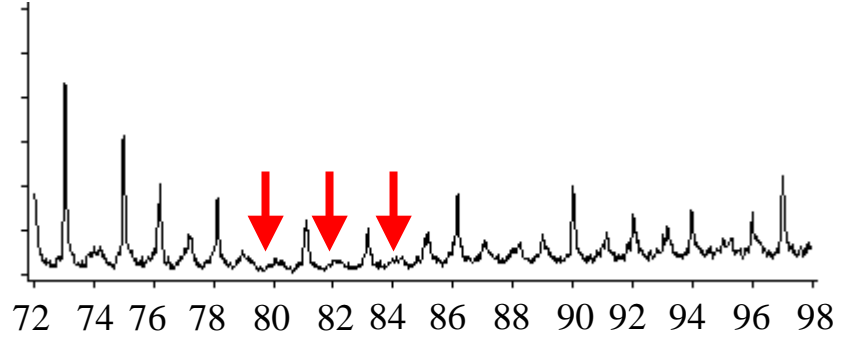
\*<http://paos.colorado.edu/research/wavelets>

# Pneumonia and Influenza, 1972-98

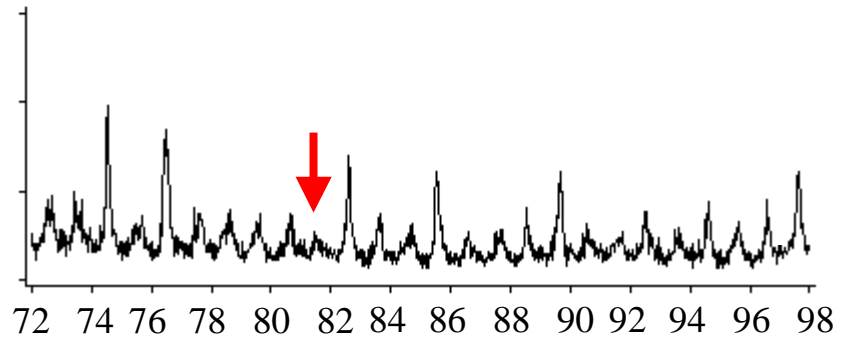
↓ no substantial  
excess mortality



Epidemic  
duration  
  
USA  
11.8 weeks  
(SD=0.8)



France  
11.3 weeks  
(SD=0.8)



Australia  
9.6 weeks  
(SD=1.0;  
P<0.01)

# Pneumonia and influenza excess deaths

<b>Excess deaths</b>	<b>USA</b> (272.7 M pop)	<b>France</b> (58.6 M pop)	<b>Australia</b> (18.9 M pop)
Average	6,200*	2,500*	300
Min	0	0	0
Max	13,600	9,500	1,050

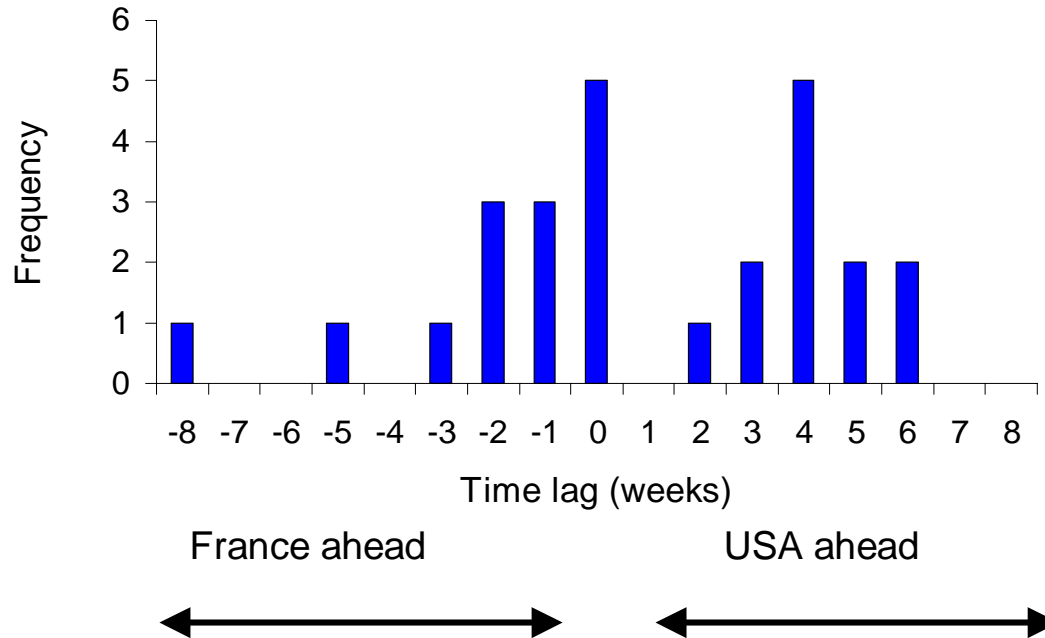
\* In line with Simonsen 1997, Carrat 1995

## Correlation coefficients

	US	France	Australia (preceding summer)
US	1.0	<b>0.76**</b>	<b>0.14</b>
France	-	1.0	<b>0.37**</b>
Australia	-	-	1.0

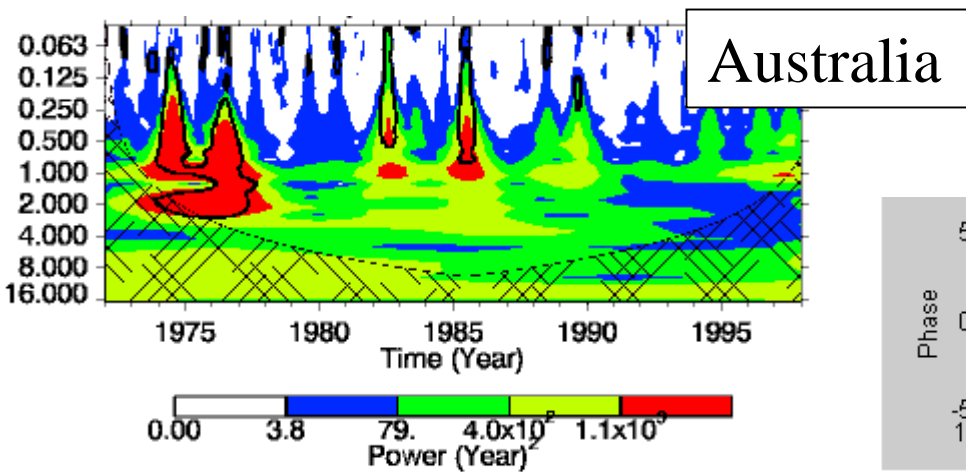
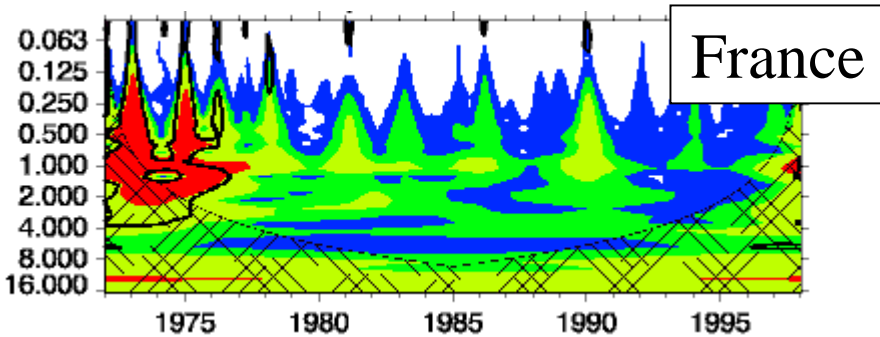
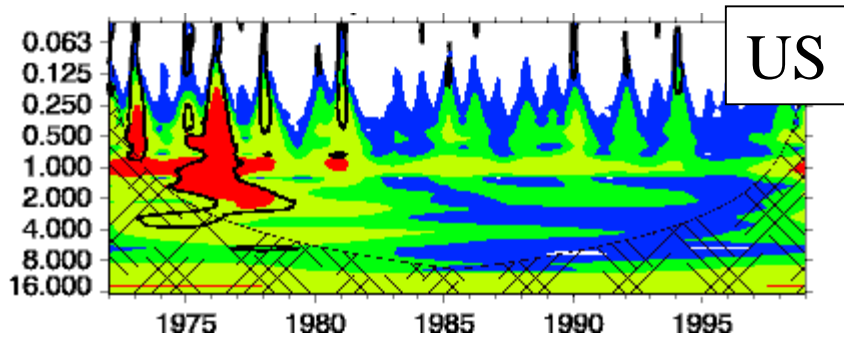
\*\* significant at the 5% level

# USA-France: time lag between epidemic peaks

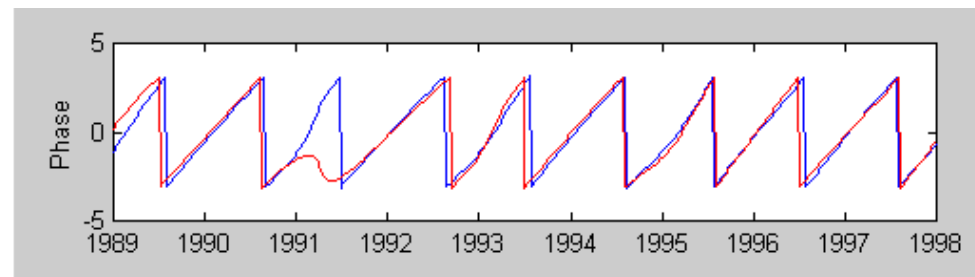


- Mean time lag 0.96 week [-0.40 - 2.32], median : 0.
- No evidence of France or the US peaking in advance (P=0.66)
- Similar results with onsets (median time lag = 0 week [-14; +6])
- Mean time lag Fra / Aus = 26.4 weeks, US /Aus = 27.4

# Wavelet analysis



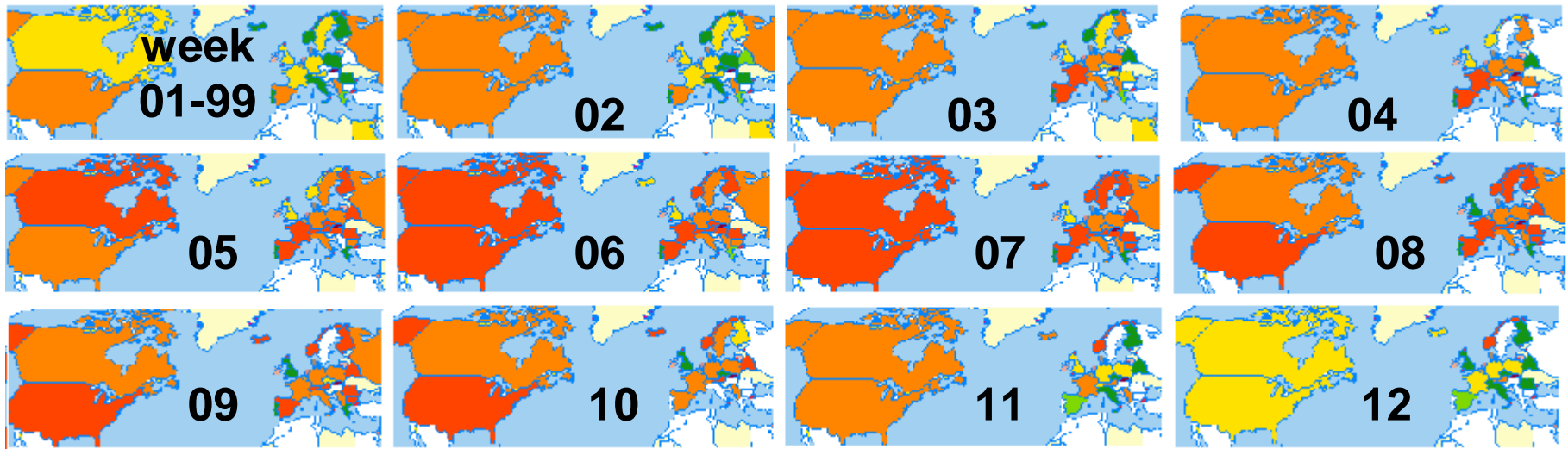
- Analysis in both the time and frequency domains
- Seasonal component (period=1 year)
- Phase analysis : phase coherence between US and France=0.73





# Real time observation: FluNet

<http://oms.u444.jussieu.fr>



- 1998/1999: the epidemic wave lasts 10 weeks in Europe/US
- Similar as in 1999/2000, 2000/2001 (11 weeks, 13 weeks)

# Conclusion

- US-France: fairly good synchronism for influenza related mortality.
  - In term of impact
  - In term of timing
- Australia-[US/France]: not so clear.
  - This lack of coherence may be due to lack of statistical power, or differences in the circulating strains, demography, vaccination.
- This work favors global factor(s) at the hemisphere level to explain the onset and impact of influenza epidemics in inter-pandemic periods: strains (US-France: similar in 15 of 17 winters), transportation fluxes, climate.