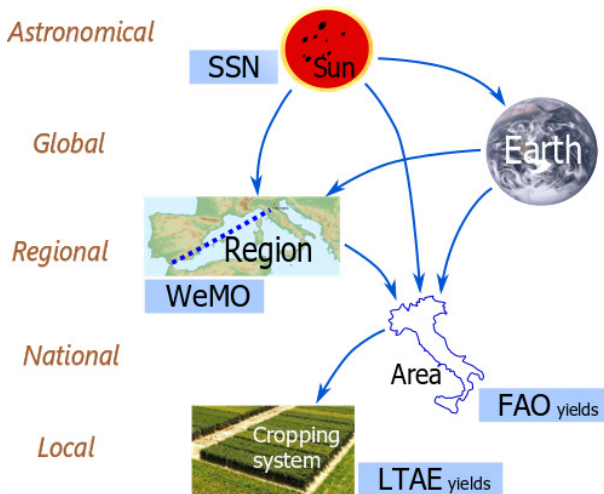# Climate Change in SSN, WeMO and Grain Production Fluctuations

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Causality & scale

Time Series

Parametric analysis

- **Continuous Transform** $F(\omega) = \int_{\tau=0}^{t} K(\tau, \omega) \cdot f(\tau) \, d\tau$

  - **Discrete** $F_k = \sum_{i=1}^{N} K_{k,i} \cdot f_i \Longrightarrow F = K \cdot f$

- **Fourier Analysis** (FA) : kernel = simple harmonic $K(t, \omega) = e^{i\omega t}$

  - **Discrete FA** -> DFT, FFT $F_k = \sum_{i=1}^{N} e^{i2\pi k t_i} \cdot x_i$

NON Parametric Analysis

- Empirical Mode Decomposition (EMD)
- Singular Spectrum Analysis (SSA)

NON-Stationarity

Stationarity Tests

- Kwiatkowski–Phillips–Schmidt–Shin (KPSS)
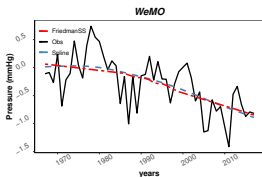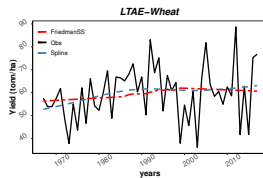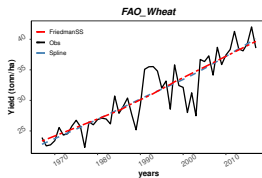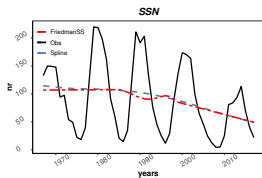- Augmented Dickey Fuller (ADF)

NON Parametric Analysis .. LOCAL operators

- Circulant SSA (CSSA)
- Sliding SSA (SSSA)

Parametric Analysis

- **Windowed FT**
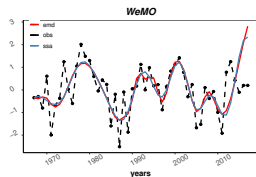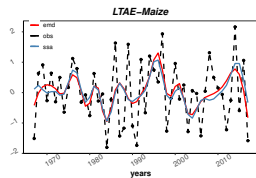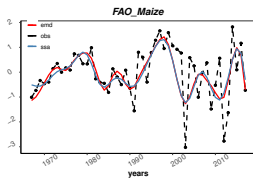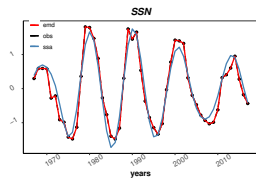   - **Wavelet Transform WT**
        - **Discrete Wavelet DWT**
    - **Cross Wavelet Transform - CWT**

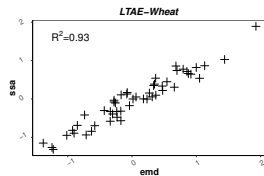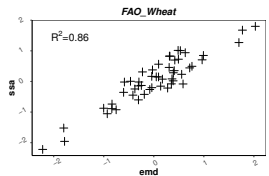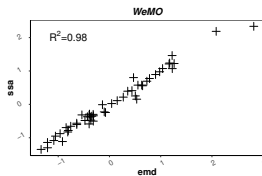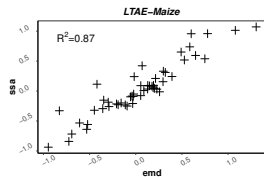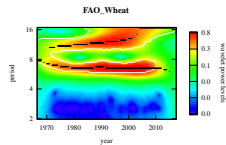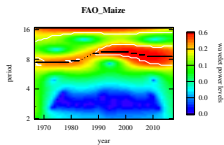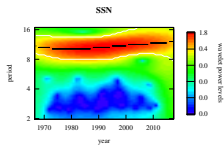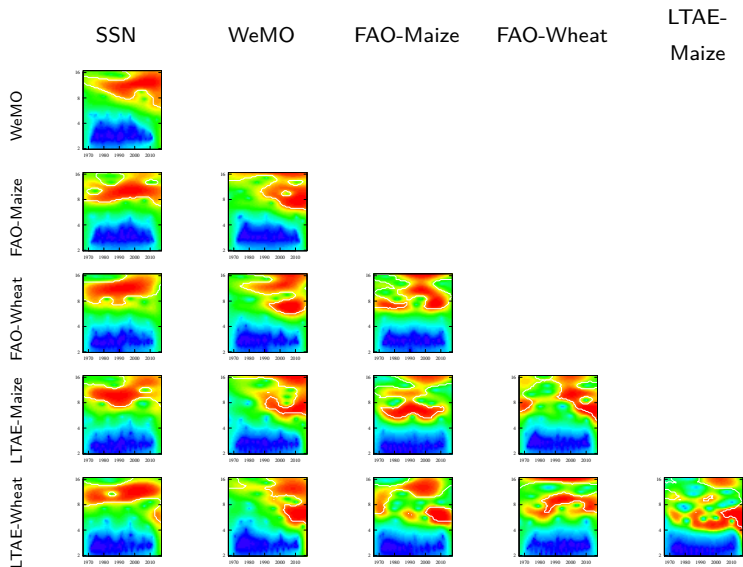# Trends
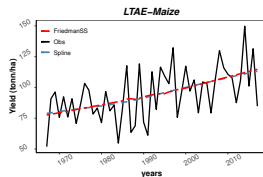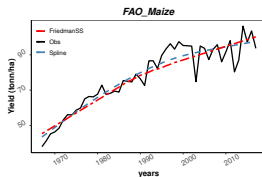
Denoising 1/2
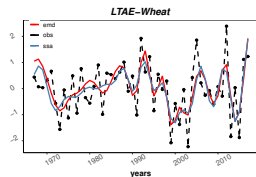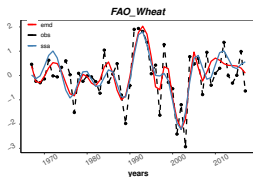
Denoising 2/2
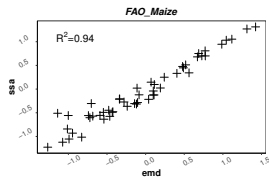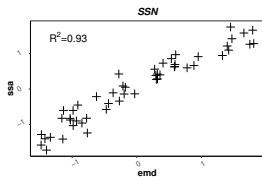
Wavelet Analysis
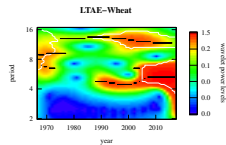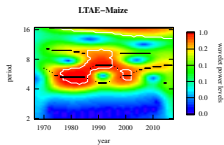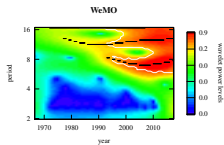
Cross Wavelet Analysis

Many thanks for your attention

further details on `https://arxiv.org/pdf/2002.07039.pdf`