Long-term El Niño forecasting

Josef Ludescher
El Niño Southern Oscillation

Figs: NASA, IRI
El Niño Southern Oscillation

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Social and economic consequences

Floodings  Agriculture  Fresh Water & Power  Fisheries

Infrastructure  Wildfires  Public health  Biodiversity

Figs: Ministerio de Defensa del Peru; wikimedia
Impact of El Niño on Kiremt

- Single main rain season (June-September) for central and northwestern Ethiopia
- Accounts for 65% to 95% of all Ethiopian annual rainfall
- Up to 50% of variability due to ENSO [Gleixner et al. (2017)]

El Niño predictions before or during the boreal spring are particularly challenging
Two kinds of El Niño prediction models

Dynamical models

• are initialized by observations

• simulate directly the development of physical quantities

Figs: NOAA; JL et al., PNAS 2013, 2014
Two kinds of El Niño prediction models

**Dynamical models**
- are initialized by observations
- simulate directly the development of physical quantities

**Statistical models**
- use statistical relationships within the observational data
- In our case: regard data as a network

Figs: NOAA; JL et al., PNAS 2013, 2014
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Forecasts before the spring barrier also possible for:

- El Niño magnitude
- El Niño type

Figs: J Meng et al., PNAS 2020; NOAA climate.gov
Very early warning of a moderate-to-strong El Niño in 2023

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Abstract
The El Niño Southern Oscillation (ENSO) is the strongest driver of year-to-year variations of the global climate and can lead to extreme weather conditions and disasters in various regions around the world. Here, we review two different approaches for the early forecast of El Niño that we have developed recently: the climate network-based approach allows forecasting the onset of an El Niño event about 1 year ahead, while the complexity-based approach allows additionally to estimate the magnitude of an upcoming El Niño event in the calendar year before. For 2023, both approaches predict the onset of an El Niño event, with a combined onset probability of about 85%. The complexity-based approach predicts a moderate-to-strong El Niño with a magnitude of $1.49 \pm 0.37^\circ$C. Since El Niño events temporarily increase the global temperature, we expect that the coming El Niño will increase the global temperature by about $+0.2^\circ$C, likely making 2024 the hottest year since the beginning of instrumental observations. It is possible that as a consequence of this El Niño, the $+1.5^\circ$C target (compared to pre-industrial levels) will be temporarily breached already in 2024.

Our forecast, data until Nov 2022:

- El Niño onset with 89% probability
- Moderate-to-strong ($1.49 \pm 0.37^\circ$C)
- Eastern Pacific type 86% prob.
Forecast for 2023:

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Figs: JL et al., arXiv:2301.10763; NOAA
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NOAA Coral Reef Watch Daily SST Anomalies (v3.1) 1 May 2023

WMO, “Prepare for El Niño“, May 2023:

- “80% between July and September”
- ”At this stage there is no indication of the strength”

Figs: JL et al., arXiv:2301.10763; NOAA
Skillful probabilistic El Niño forecasts across the spring barrier are possible:

- The climate network approach can forecast the **onset** of an El Niño event or its absence about 1 year in advance

- Forecasting the **magnitude** and **type** are also possible in the calendar year before onset