‘LENS’ing through Internal Variability in the Heat waves

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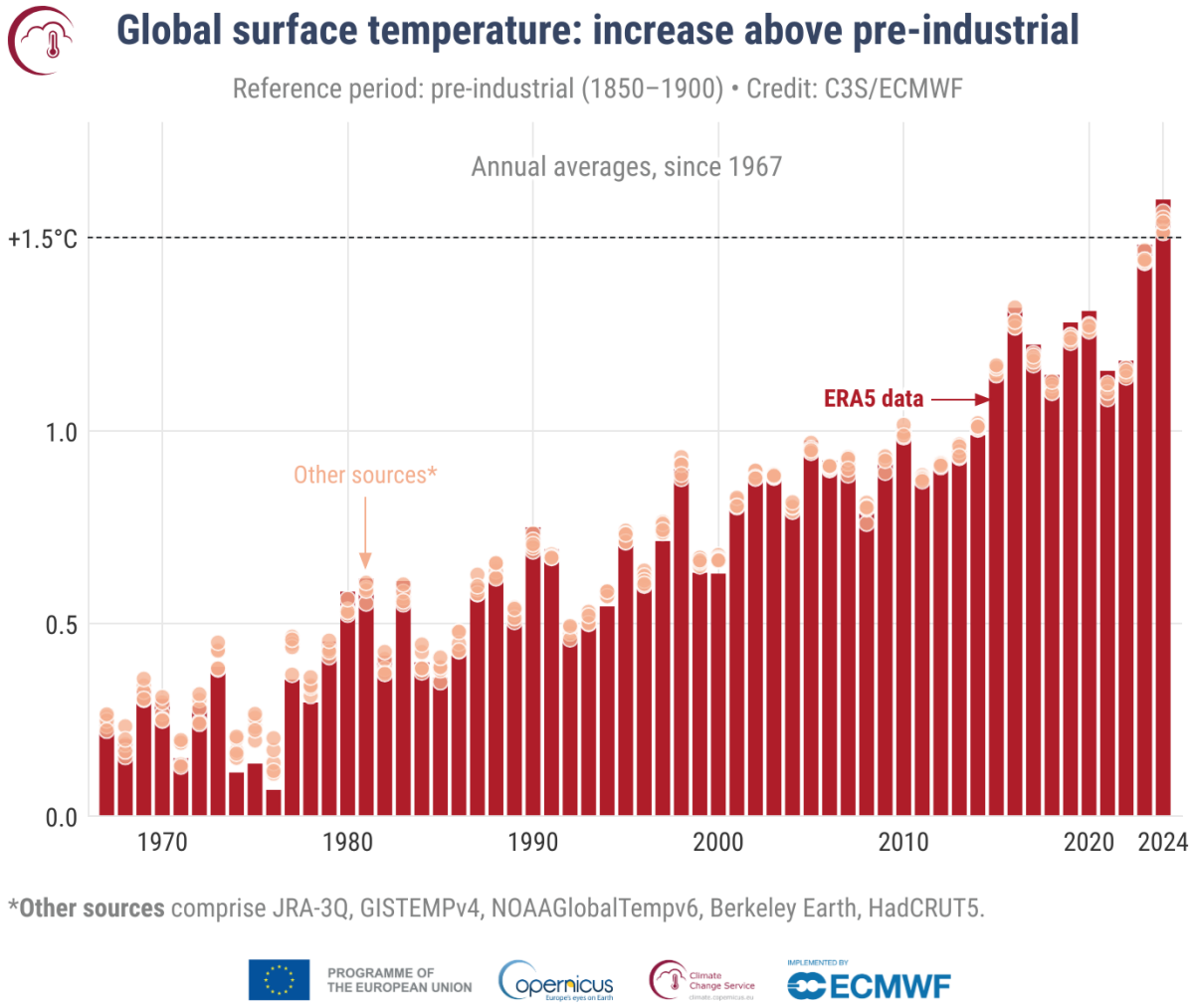
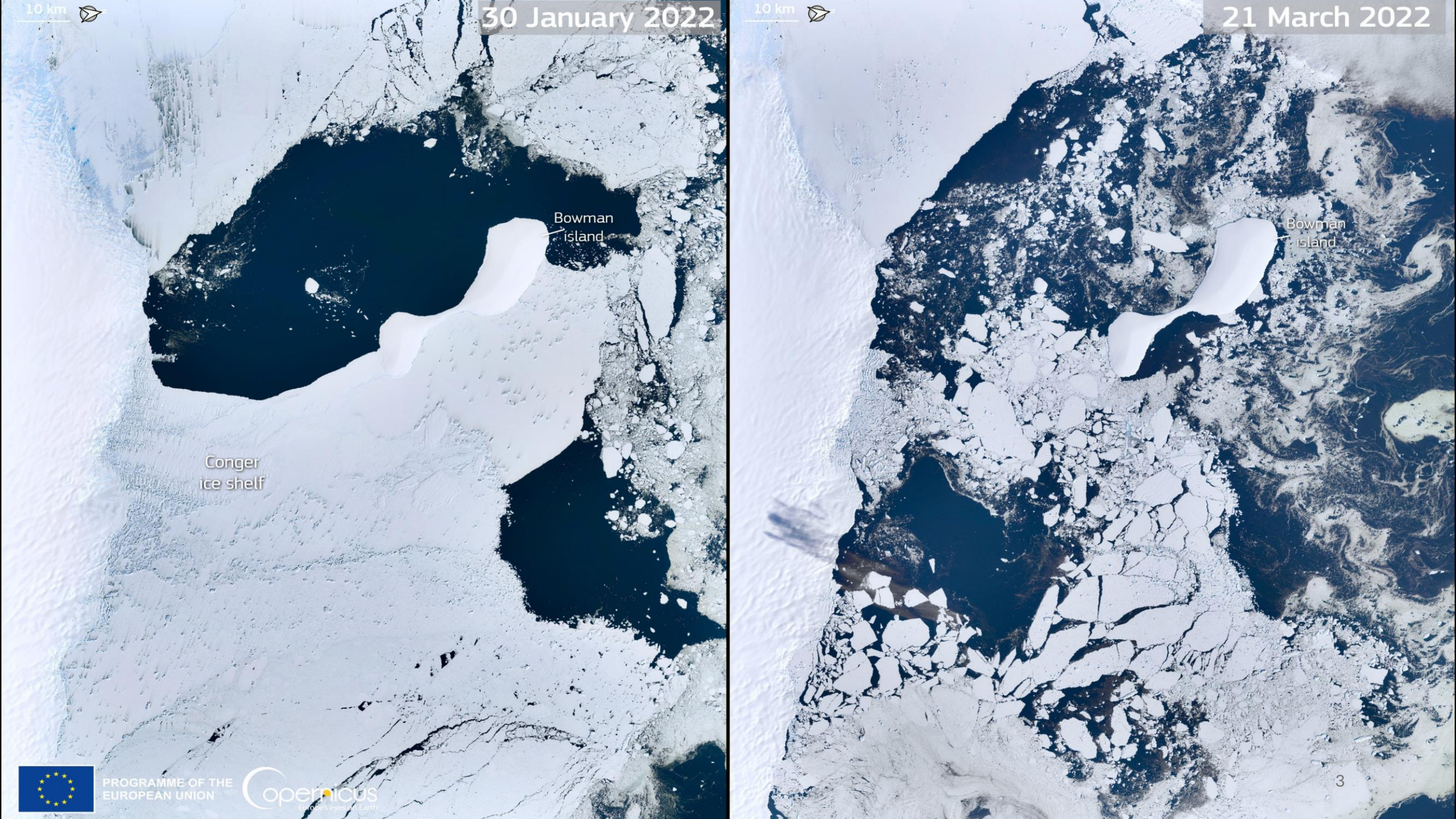
2024 – warmest year on record





PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

Approach

Community Earth System Model 2 Large Ensemble (LENS2)[1]

NCEP-DOE Reanalysis II (NCEP2)[2]

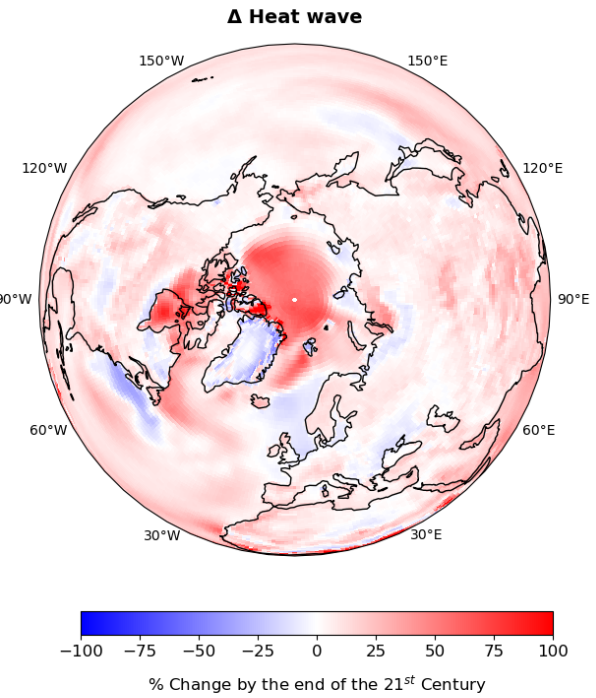
Heat wave[3]

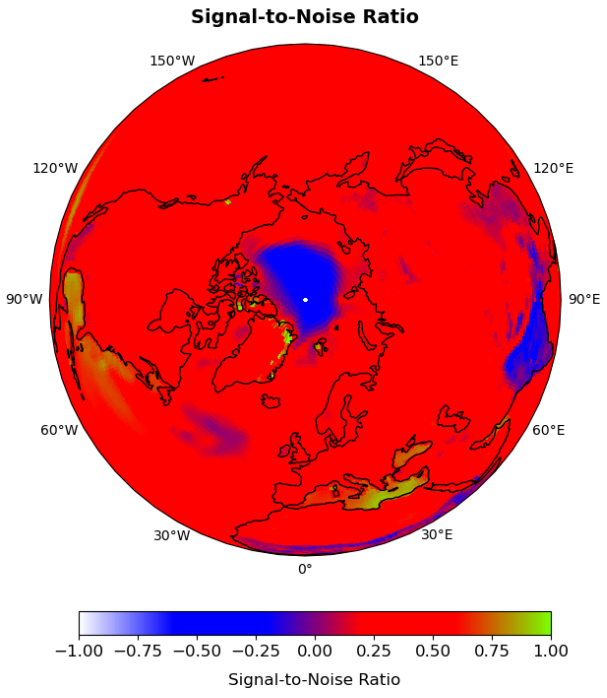
- If $\boldsymbol{TMAX}(\emptyset, \boldsymbol{\lambda}) > \boldsymbol{TMAX\_CLIM}(\emptyset, \boldsymbol{\lambda})$ for 3 or more days → considered as a heat wave.
- $TMAX\_CLIM(\emptyset, \lambda)$ considered as a 90th percentile threshold (15 days window) for a calendar day.

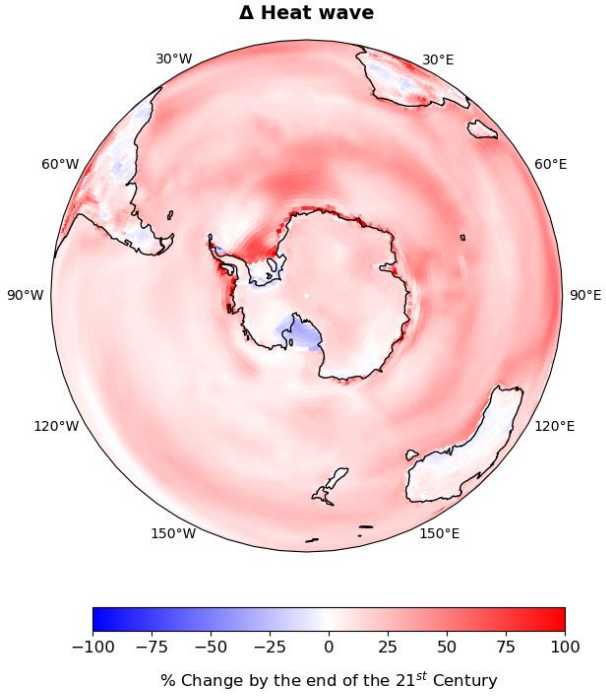
$\emptyset = Latitude, \lambda$ = *Longitude*

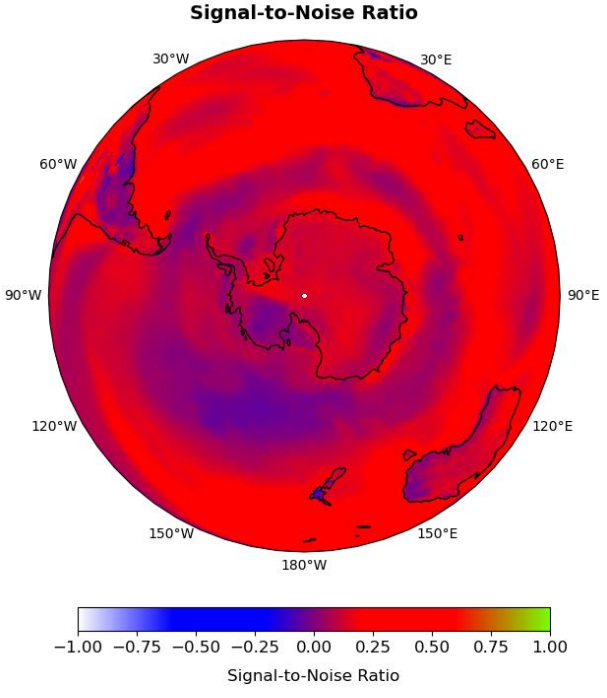
Signal-Noise Ratio (SNR) =

Forced trend / Standard deviation









Mean **Increase in Heat waves** by **+18%** in the NH

Higher Internal Variability and **trend mismatch** over Arctic, Indian subcontinent

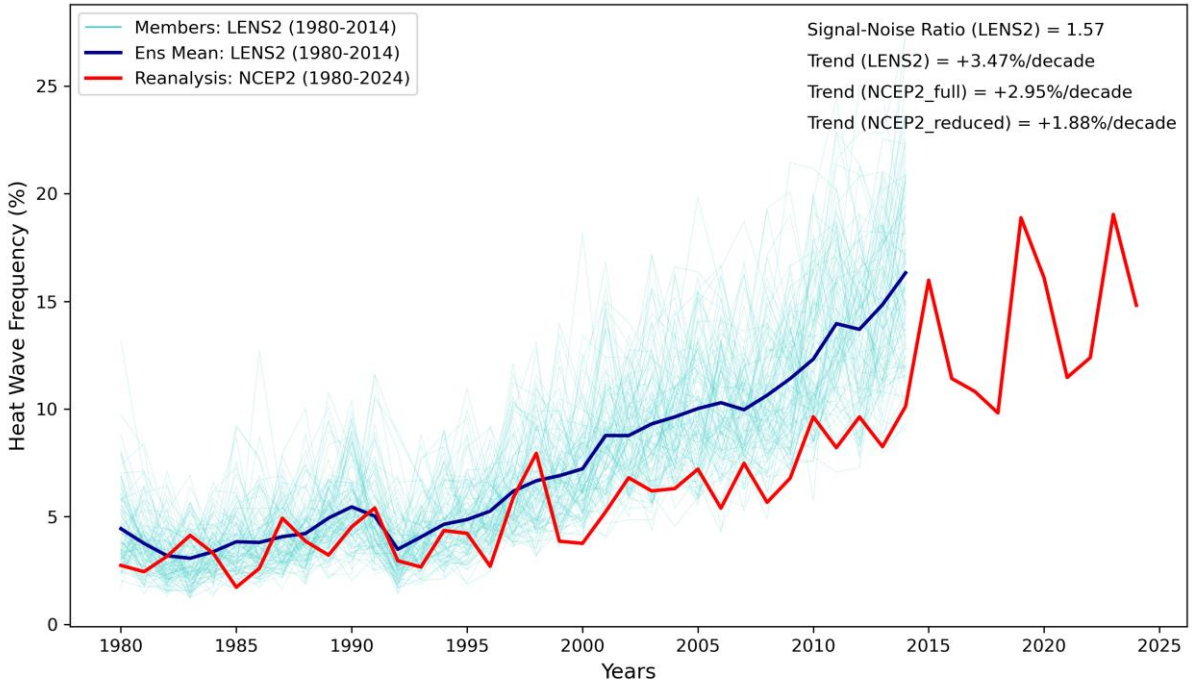
Mean **Increase in Heat waves** by **+18%** in the SH

Higher Internal Variability in Southern Hemisphere

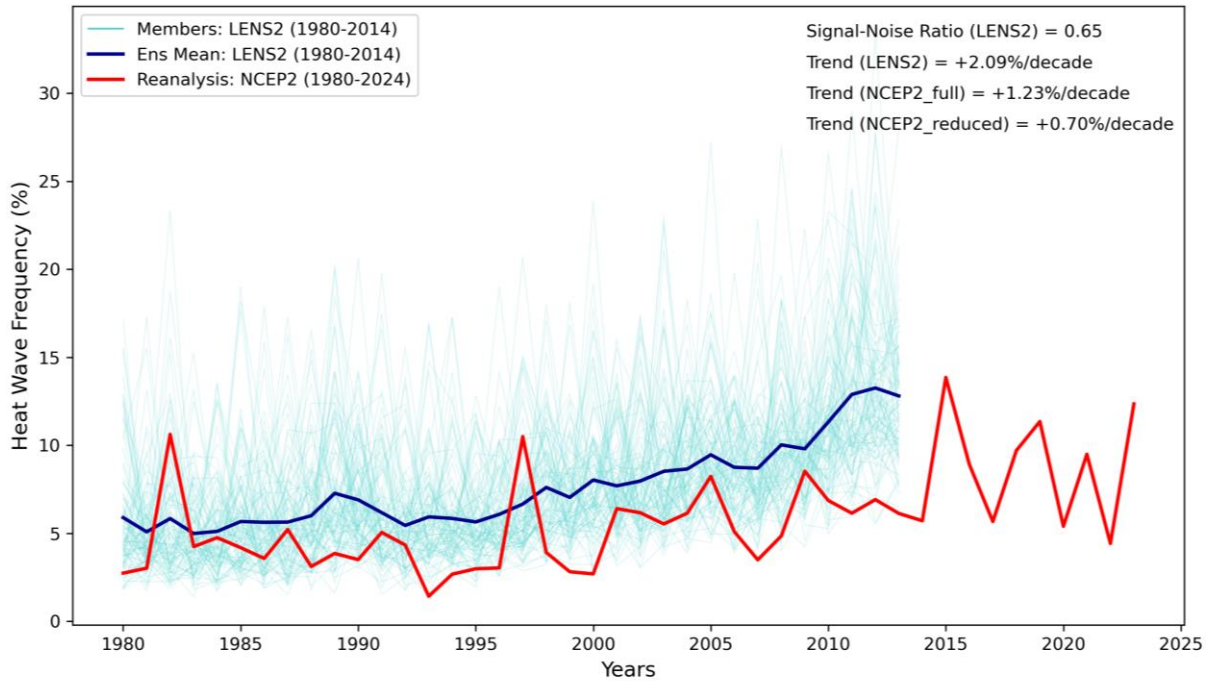
Changes in Global Heat Extremes (Summer) by the end of the 21st century

Summer Heat Wave frequency in CESM-LENS2

Northern Hemisphere



Southern Hemisphere



Stronger trends than observed

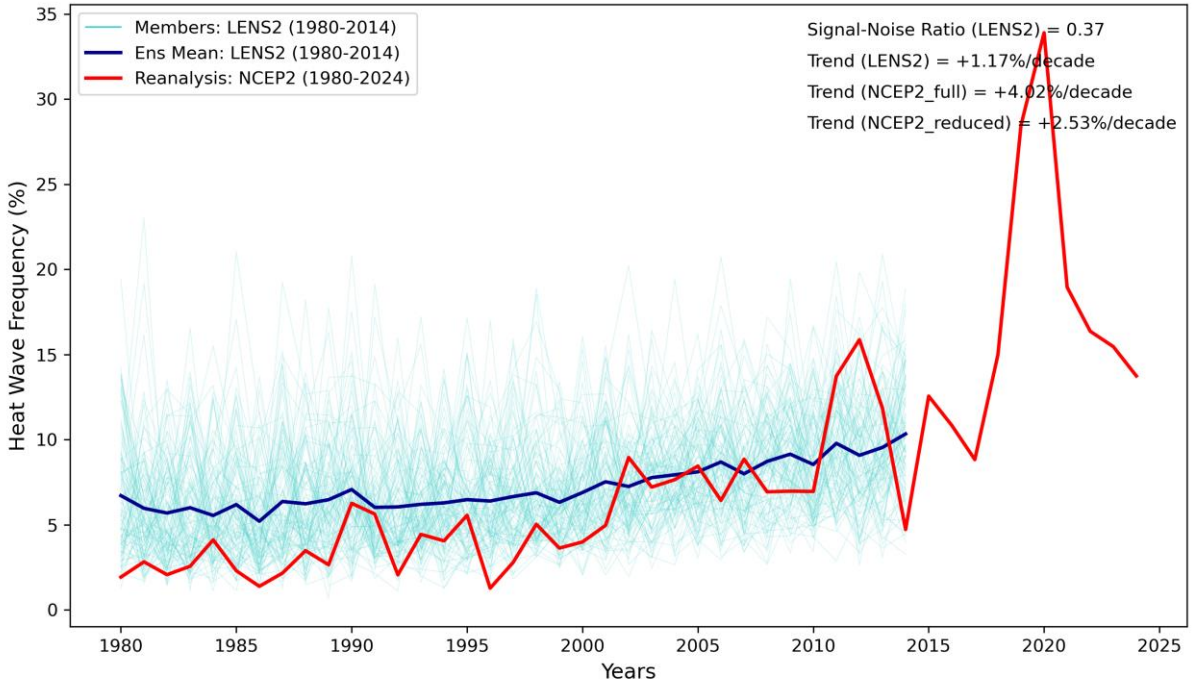
LENS2 simulated More heat waves in the early 21st century

Stronger trends, Higher Internal Variability

Consistent overestimation of the heat waves

Summer Heat Wave frequency in CESM-LENS2

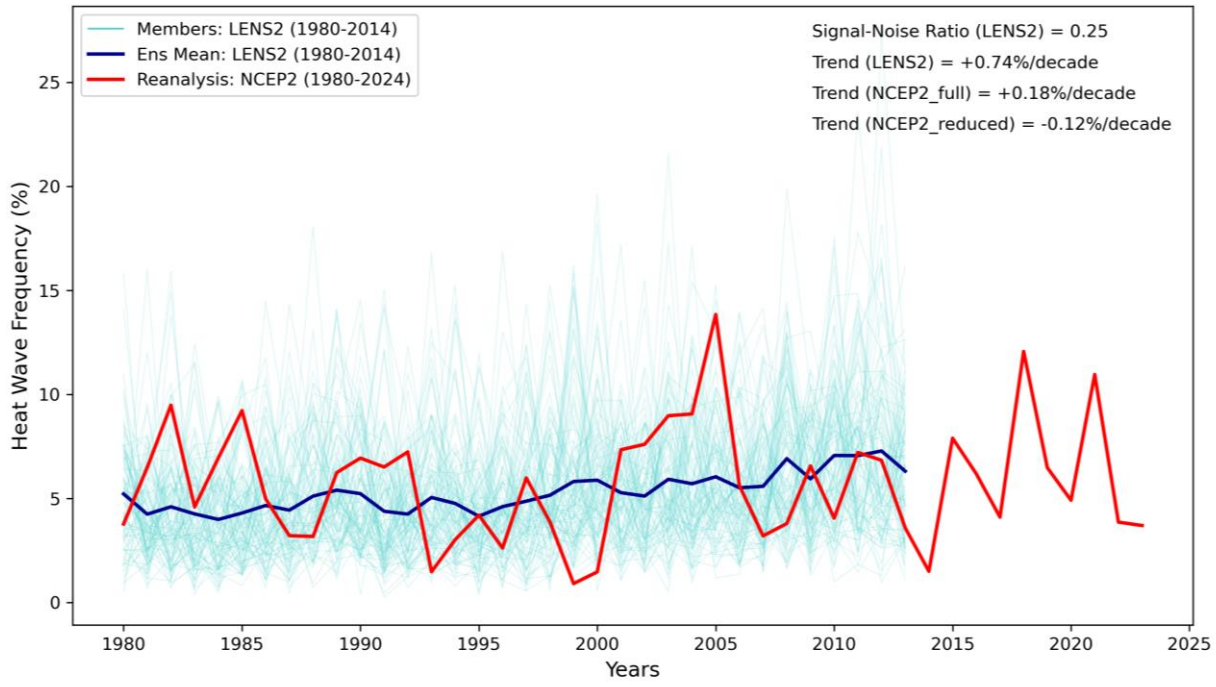
Arctic



Weaker trends than observed

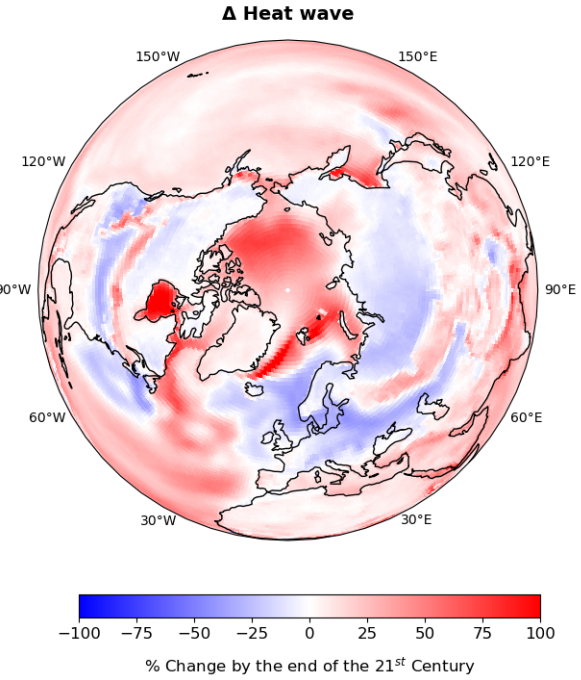
Higher Internal Variability

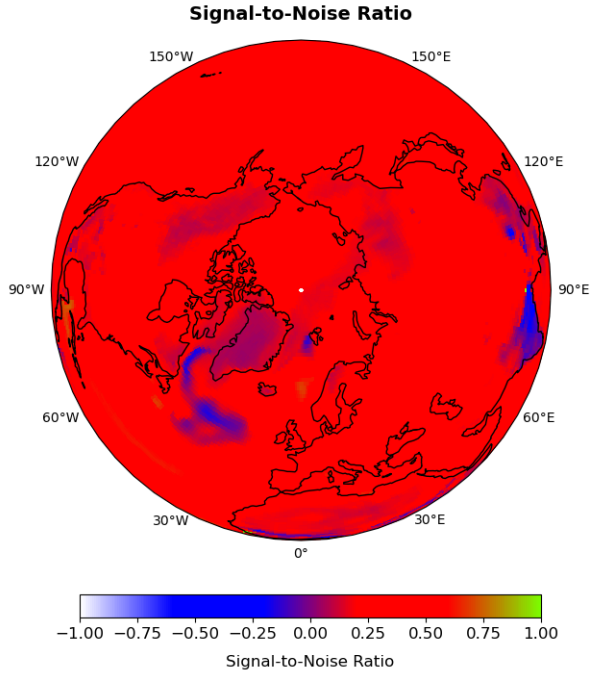
Antarctica

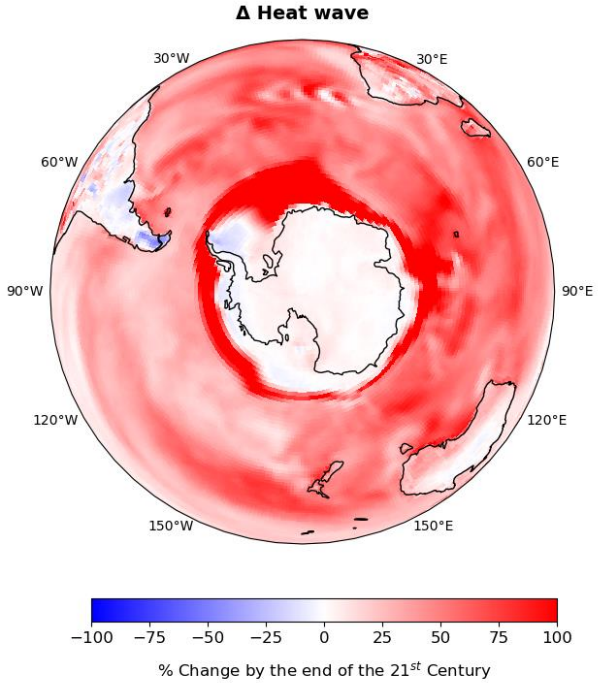


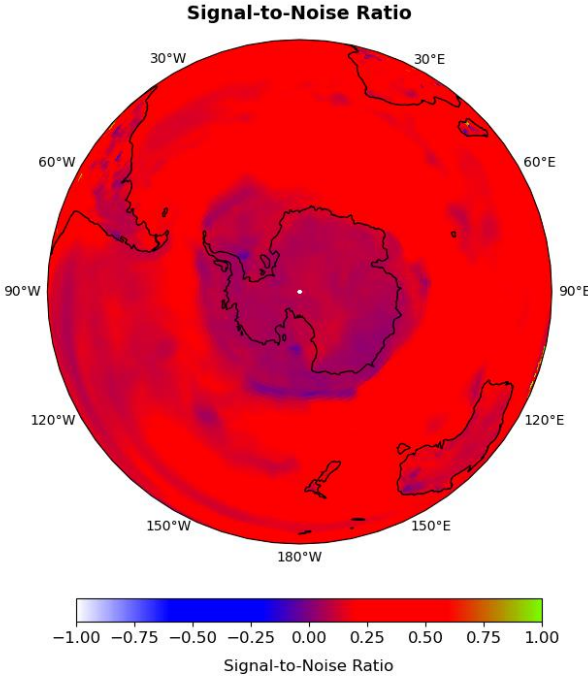
Stronger trends, Higher Internal Variability

Opposite Trend shown by LENS2 and NCEP2









Mean **Increase in Heat waves** by **+14%** in the NH

Higher Internal Variability and **trend mismatch** over North Atlantic, Indian subcontinent

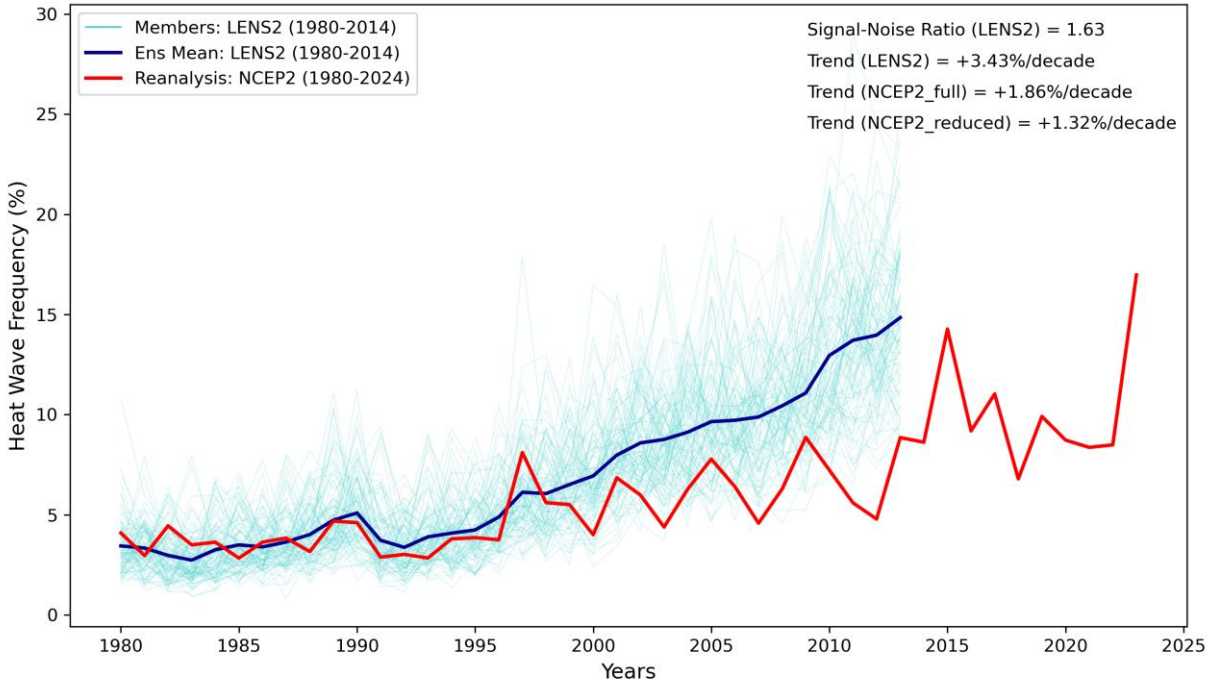
Mean **Increase in Heat waves** by **+34%** in the SH

Higher Internal Variability in Southern Hemisphere

Changes in Global Heat Extremes (Winter) by the end of the 21st century

Winter Heat Wave frequency in CESM-LENS2

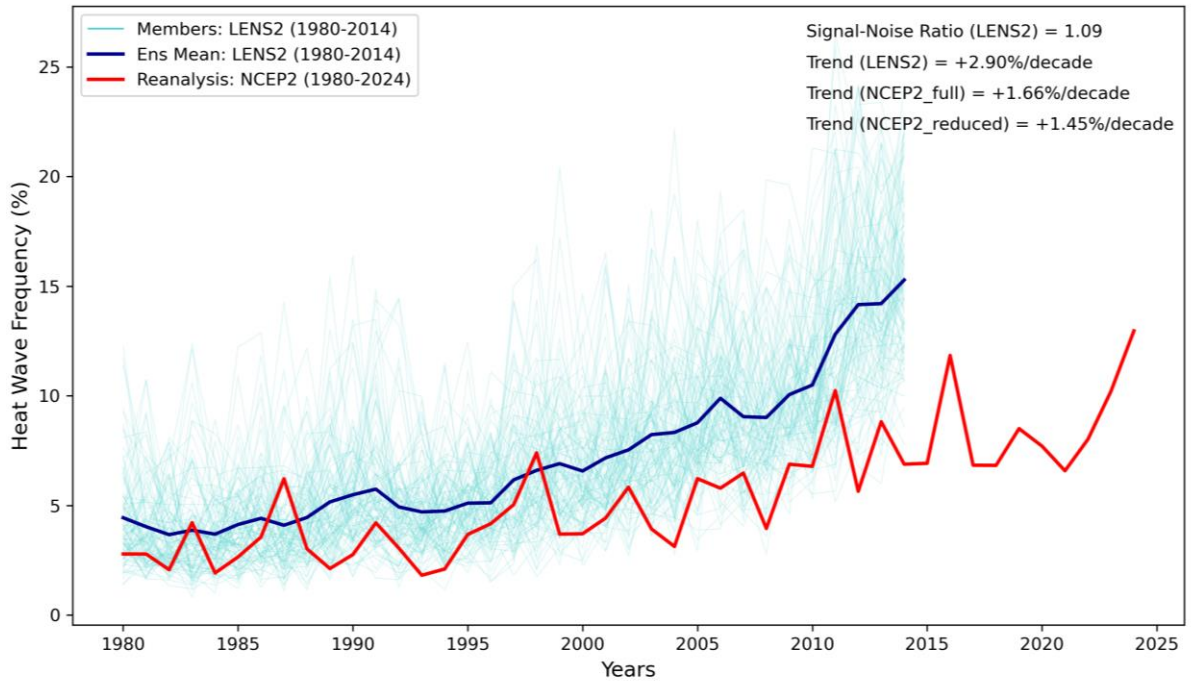
Northern Hemisphere



Stronger trends than observed

LENS2 simulated More heat waves in the early 21st century

Southern Hemisphere

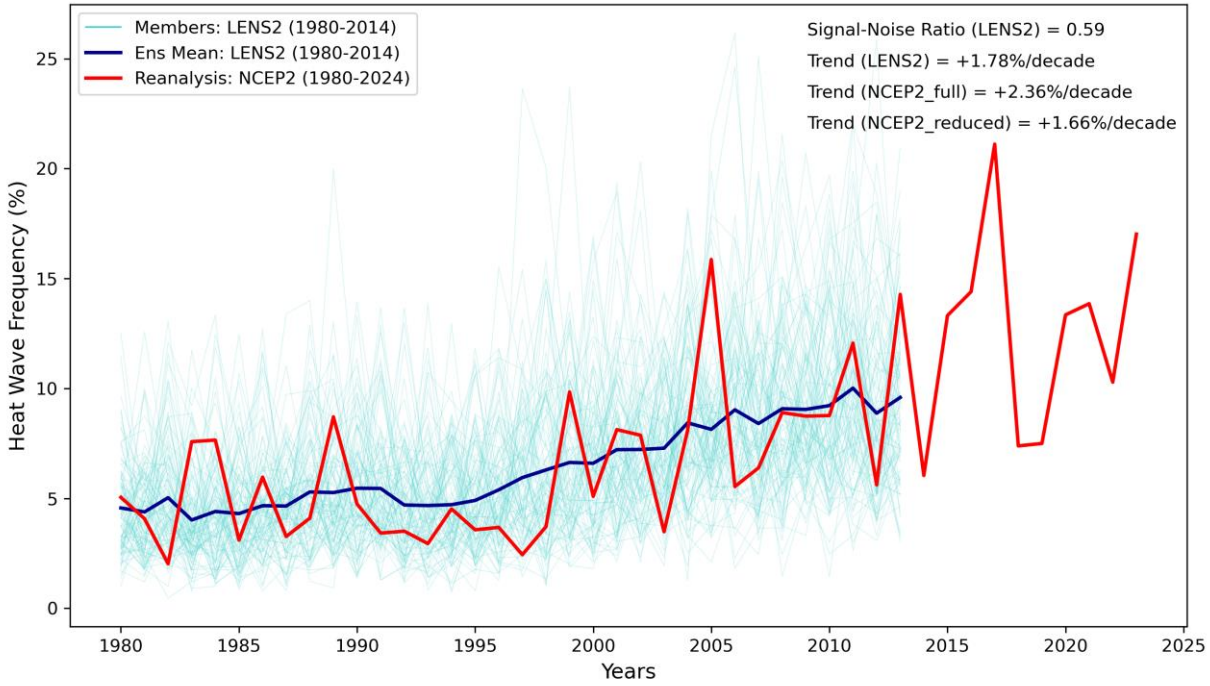


Stronger trends than NCEP2

LENS2 simulated More heat waves in the early 21st century

Winter Heat Wave frequency in CESM-LENS2

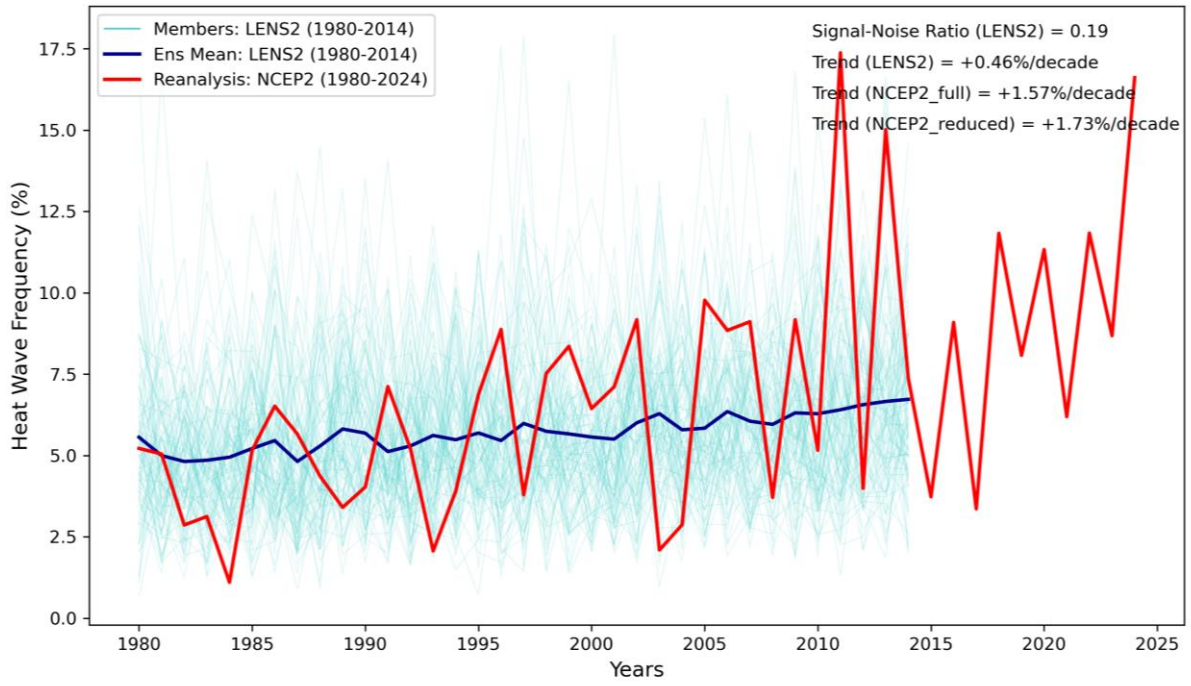
Arctic



Trend closer to NCEP2

Higher Internal Variability

Antarctica



Weaker trends, Higher Internal Variability

Consistent underestimation of the heat waves

Perspectives

- LENS2 suggests **18% increase** in NH summer heat wave frequency but **trends are overestimated** compared to NCEP2.
- High internal variability in LENS2 leads to **inconsistent Arctic summer and Antarctic winter heat wave trends** (weaker than observed).
- LENS2 shows positive trend over Antarctic summer heat waves opposite to NCEP2.
- LENS2 suggest overall **increase in SH winter heat waves by 34%** (forced response dominates).
- LENS2 shows consistently **higher internal variability in the SH and Antarctica** across seasons.

"Behind every groundbreaking invention lies a team of brilliant minds working tirelessly. A special shout-out to all NCAR scientists for their collaborative efforts in building CESM awesome!"

References

1. Rodgers, K. B., Lee, S.-S., Rosenbloom, N., Timmermann, A., Danabasoglu, G., Deser, C., et al. (2021). Ubiquity of human-induced changes in climate variability. *Earth System Dynamics*, *12*(4), 1393–1411. https://doi.org/10.5194/esd-12-1393-2021
2. Kanamitsu, M., Ebisuzaki, W., Yang, S.-K., Hnilo, J. J., Fiorino, M., & Potter, G. L. (2002). NCEP-DOE AMIP-II REANALYSIS (R-2).
3. Perkins, S. E., and Alexander, L. V. (2013). On the measurement of heat waves. *Journal of Climate*, 26(13), 4500–4517. https://doi.org/10.1175/JCLI-D-12-00383.1

Personal Webpage

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NeSI New Zealand eScience Infrastructure

The Meteorological Society of New Zealand

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