EPESC-LEADER Joint Workshop, Busan, 15-18 July 2025

# Explaining and Predicting Earth System Change

**Erich Fischer and Kirsten Findell**
On behalf of the EPESC SSG and members

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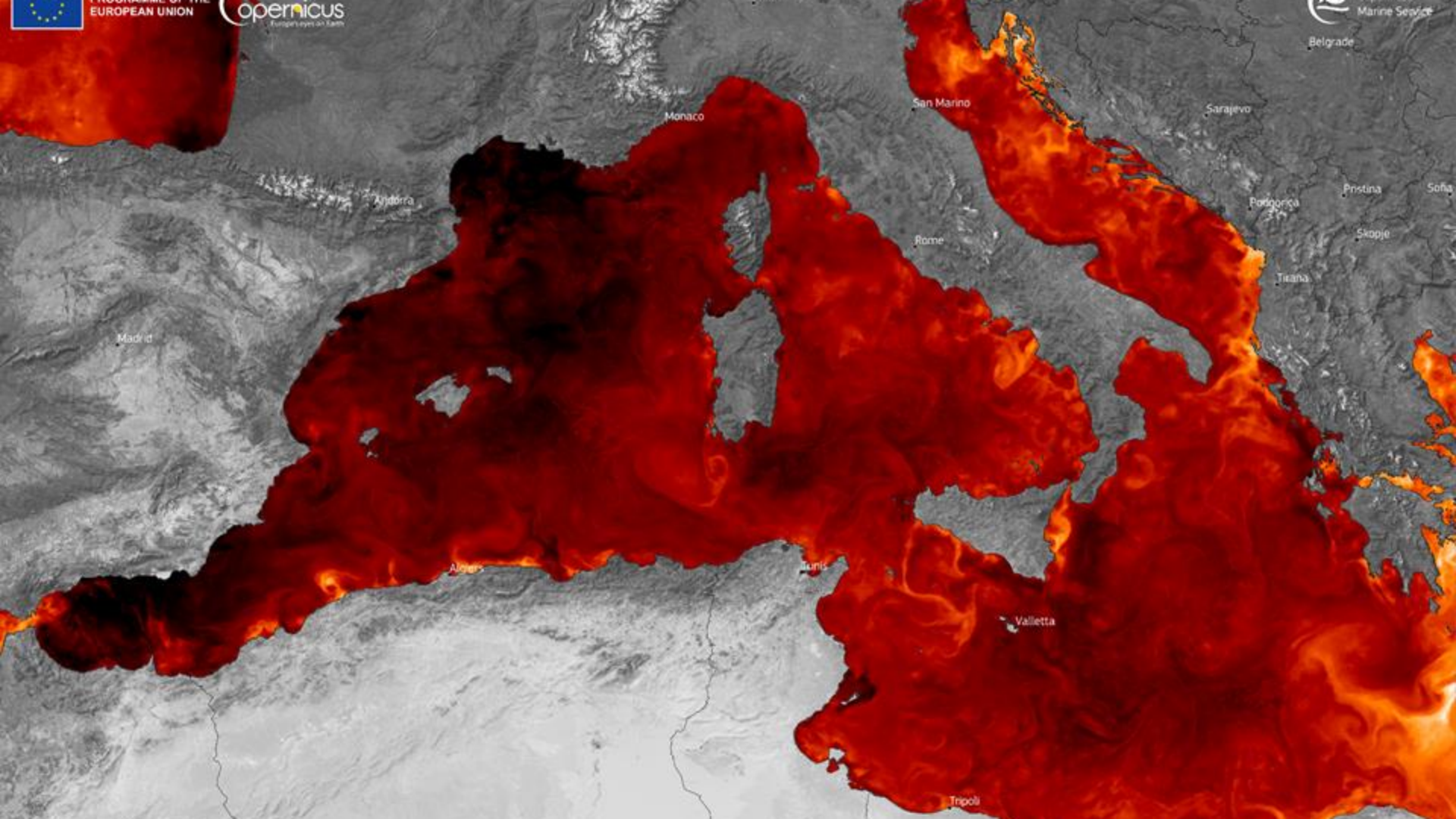
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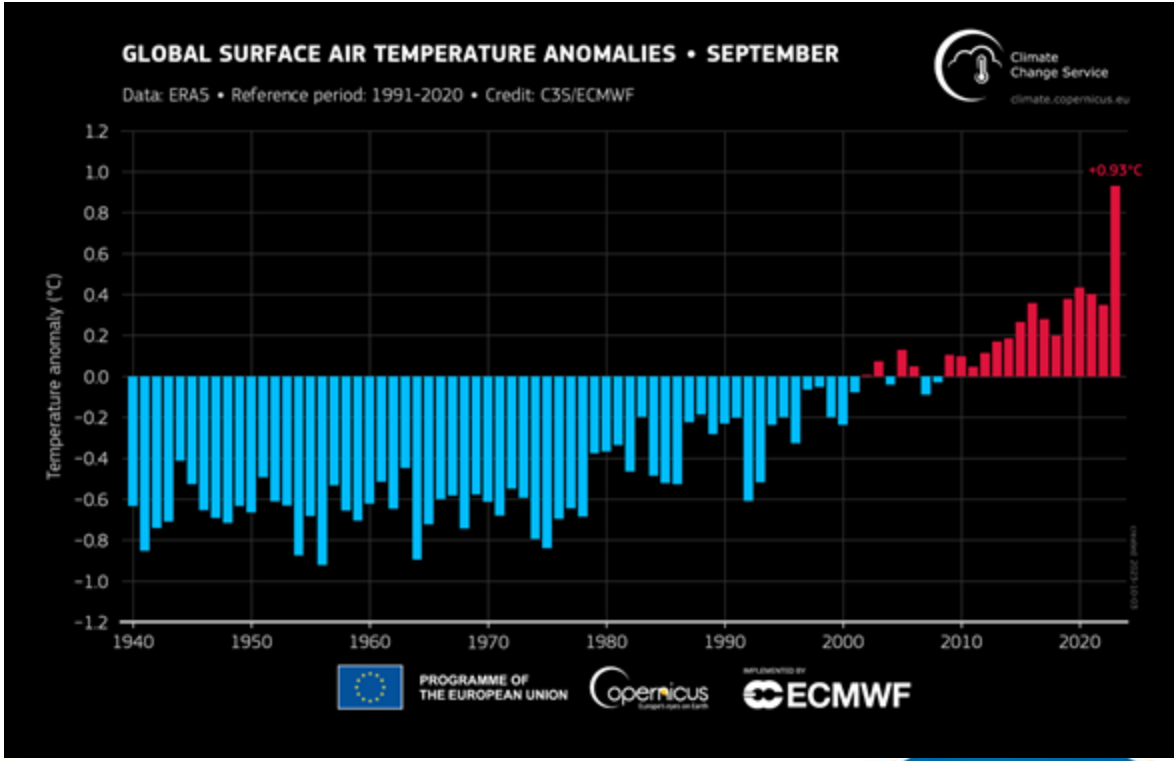
# Why EPESC?

Unprecedented extremes of 2023 and 2024 provided (more) motivation to understand the drivers of large-scale changes in the Earth system

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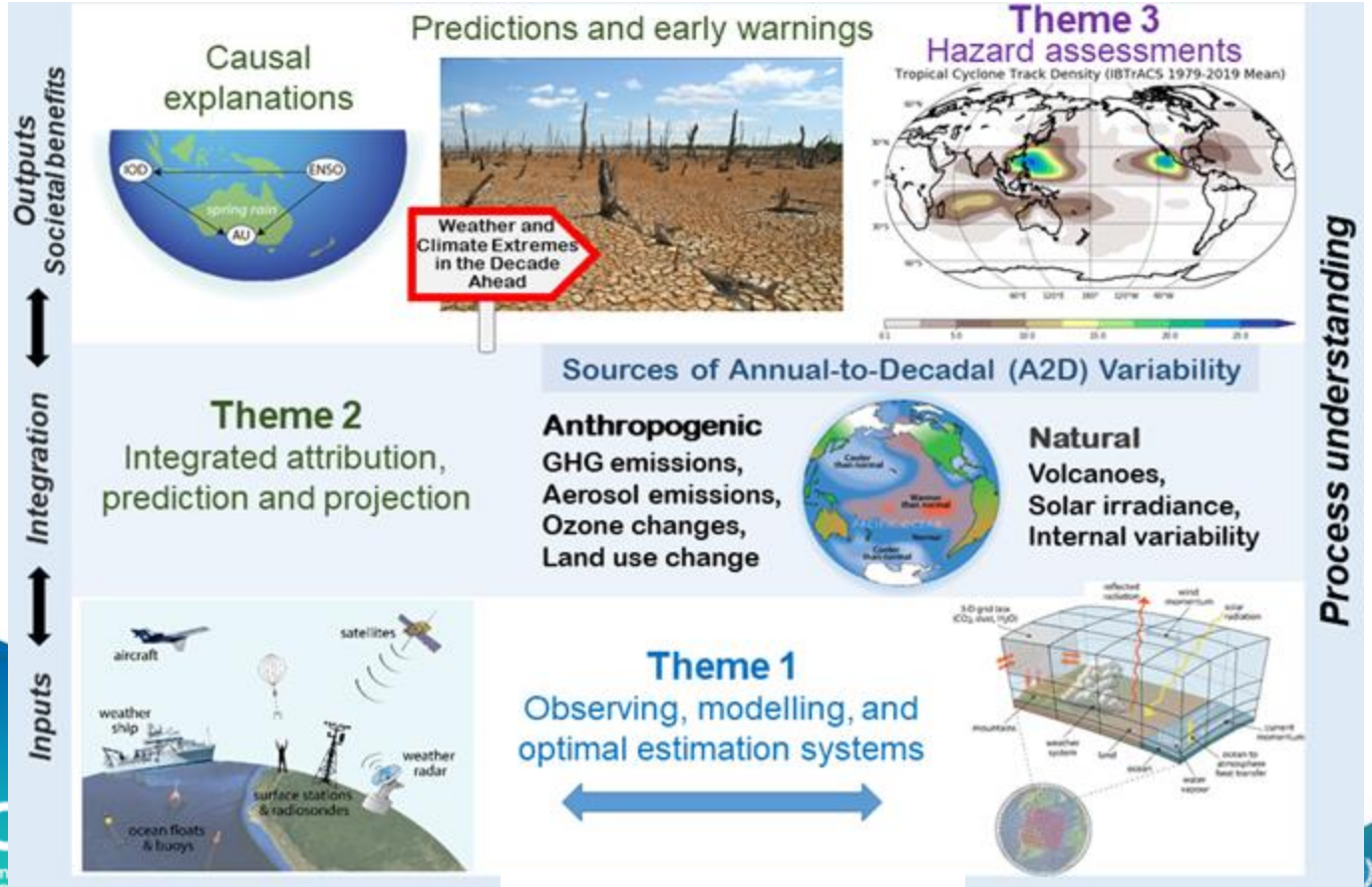
# Attribution of such events is at the core of EPESC




Findell et al. *BAMS*, 2023

WG3 co-chairs:
James Risbey
Zhuo Wang

WG2 co-chairs:
Doug Smith
Scott Osprey

WG1 co-chairs:
Paul Kushner
Anca Brookshaw


# Atmospheric Processes And their Role in Climate

## Large Ensembles for the Attribution of Dynamically Driven ExtRemes

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# APARC STRUCTURE


**18 Activities grouped in 3 core research themes:**

**Processes relating to atmospheric composition**
to improve understanding of fundamental climate processes, including those related to atmospheric chemistry, radiation and dynamics.

**Processes related to variability and trends across timescales**,
including research related to atmospheric and climate prediction, and occurrence and attribution of extreme events.

**Processes related to atmospheric dynamics**
focused on leveraging observations, reanalyses, models, and innovative analysis and attribution methods to demonstrate new understanding of the climate system, its changes and drivers.

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Atmospheric Processes And their Role in Climate

# LEADER

## Large Ensembles for Attribution of Dynamically-driven ExtRemes

LEADER is a limited-term activity from 2024–2026 focused on analyzing the outputs of the Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP), an ongoing extension of the Detection & Attribution MIP (DAMIP) protocol to more forcing agents and larger ensembles:

### Large Ensemble

What are the characteristics of internal variability?

### Single Forcing


What is the response to different forcings?

### MIP

How well are current climate models doing?

To sign up, or for more information, contact:

Chaim Garfinkel (chaim.garfinkel@mail.huji.ac.il)
Scott Osprey (scott.osprey@physics.ox.ac.uk)

**Objectives of the LEADER activity:**

- Provide a **process-based understanding** of recent annual to decadal climate changes
- Quantify the roles of **internal variability** and **external drivers**
- Assess predictability, sources of skill, drivers and mechanisms to increase **confidence in predictions and projections**
- Contribute to **IPCC** and **WMO Climate Update** and **State of Climate** reports

**Chaim I. Garfinkel**

## Eight LEADER working groups:

1) Role of **annual to decadal variability** of the **polar vortex** for surface climate
2) Identifying the forced response of the **Southern Hemispheric atmospheric circulation** to greenhouse gases, aerosols, and ozone, and associated surface impacts on extremes
3) Identifying the forced response of the **Northern Atlantic atmospheric circulation** to greenhouse gases, aerosols, and ozone, and associated surface impacts on extremes
4) Surface response to **solar** variability
5) Surface response to **Pinatubo** and other large **eruptions**
**6) QBO** influences on surface climate (4 models spontaneously simulate a QBO)
7) Identifying the forced response of the **Asian monsoon** to greenhouse gases, aerosols, and ozone, and associated surface impacts on extremes
8) Role of external forcings and internal variability for **atmospheric temperature trends**:

# Eight LEADER working groups:

1) Role of **annual to de** surface climate
2) Identifying the forced **atmospheric circulation**
to greenhouse gases, a ace impacts on extremes
3) Identifying the forced **ospheric circulation** to
greenhouse gases, aer impacts on extremes
4) Surface response to
5) Surface response to
**6) QBO** influences on s simulate a QBO)
7) Identifying the forced enhouse gases, aerosols,
and ozone, and associa
8) Role of external forci **ric temperature trends**:

A key objective is to make the underlying model data as accessible as possible, hence the large focus on populating the JASMIN workspace

Thanks to all those who made it possible! (Jonathon Wright and David Avisar)

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

# APARC STRUCTURE


- Large Ensembles for Attribution of Dynamically-driven ExtRemes (LEADER)
- Hunga Tonga-Hunga Ha'apai stratospheric impacts (HTHH)
- Very short-lived substances – model intercomparison project (VSLS-MIP)



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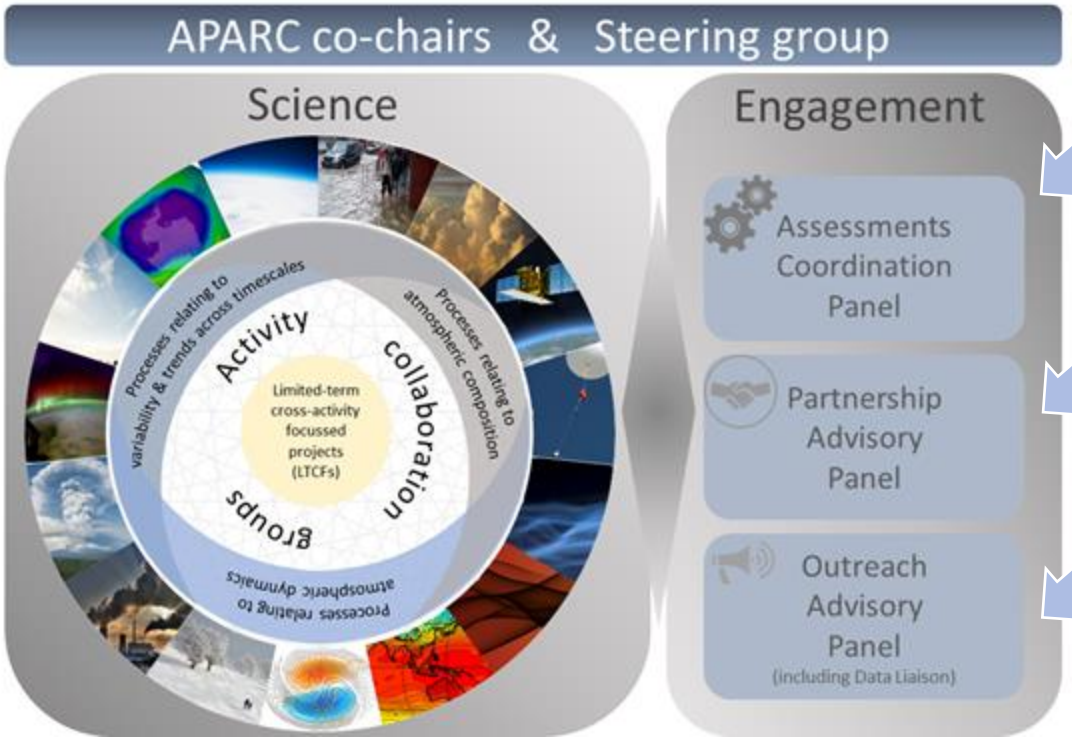
# APARC STRUCTURE




Make sure APARC science stays relevant
Deliver outcomes to be included in larger Assessment reports
Publish our own reports

We can‘t know or do it all – but we want to share our knowledge and work together with other communities!

Make sure APARC science is seen
Share our skills with the next generation of scientists
Share our knowledge and make our science usable for others



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# CURRENT APARC ACTIVITIES

- Atmospheric Composition and the Asian Summer Monsoon (ACAM)
- Assessing predictability (SNAP)
- CCM initiative (CCMI)
- Composition Trends And Variability in the Upper Troposphere and Lower Stratosphere (OCTAV-UTLS)
- Dynamical variability (DynVar)
- Gravity waves
- Fine-scale Processes (FISAPS)
- Ozone Trends (LOTUS)
- Quasi-biennial oscillation (QBOi)
- Reanalysis intercomparison (S-RIP, now A-RIP)
- Solar influence (SOLARIS-HEPPA)
- Stratospheric sulfur (SSiRC)
- Temperature changes (ATC)
- Towards Unified Error Reporting (TUNER)

**Limited-term cross-activity project**

- Hunga Tonga-Hunga Ha'apai stratospheric impacts (HTHH)
- Very short-lived substances – model intercomparison project (VSLS-MIP)
- Large Ensembles for Attribution of Dynamically-driven ExtRemes (LEADER)



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# SOME RECENT OUTPUTS FROM APARC

- Hunga Assessment Report (due late 2025)
- S-RIP Assessment Report on reanalysis intercomparison
- Long standing contributions to WMO/UNEP Ozone Assessment Reports through CCMI and LOTUS (upcoming 2026 Assessment underway)
- IPCC WGI Chapter 2 Observed atmospheric temperature trends
- Perspective papers from DynVar and community papers from SNAPSI (ongoing)
- ACAM Training School on the Asian Summer Monsoon (Bali, June 2025)
- Forcing datasets for CMIP7 (solar forcing, ozone forcing underway)
- And many more…..



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# SAVE THE DATE!



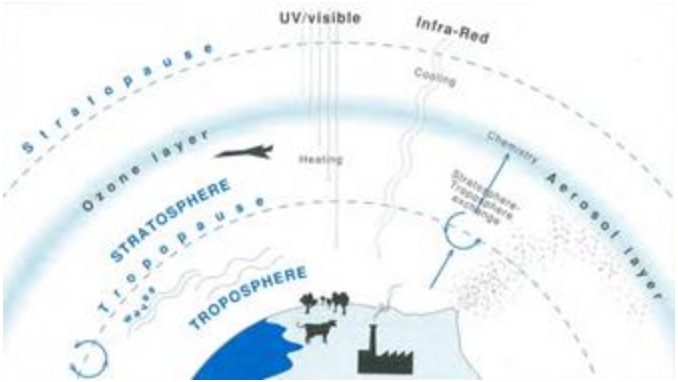

APARC
Atmospheric Processes
And their Role in Climate

# FROM SPARC TO APARC

Founded in 1992, SPARC (Stratosphere-troposphere Processes And their Role in Climate) has coordinated high-level research activities related to understanding atmospheric processes for over three decades.

Original focus was on the stratosphere and interactions with climate, however, what now broadened the range of topics to the whole atmosphere. As such, it was decided by the SPARC Scientific Steering Group to move to a new era of the project now called APARC (Atmosphere Processes And their Role in Climate) starting on 01 January 2024.

APARC is a core project of the
World Climate Research Programme (WCRP).




Cover of the first SPARC newsletter, 1993