Use of fire danger seasonal forecasts and long-term projections to support short and long-term adaptation planning

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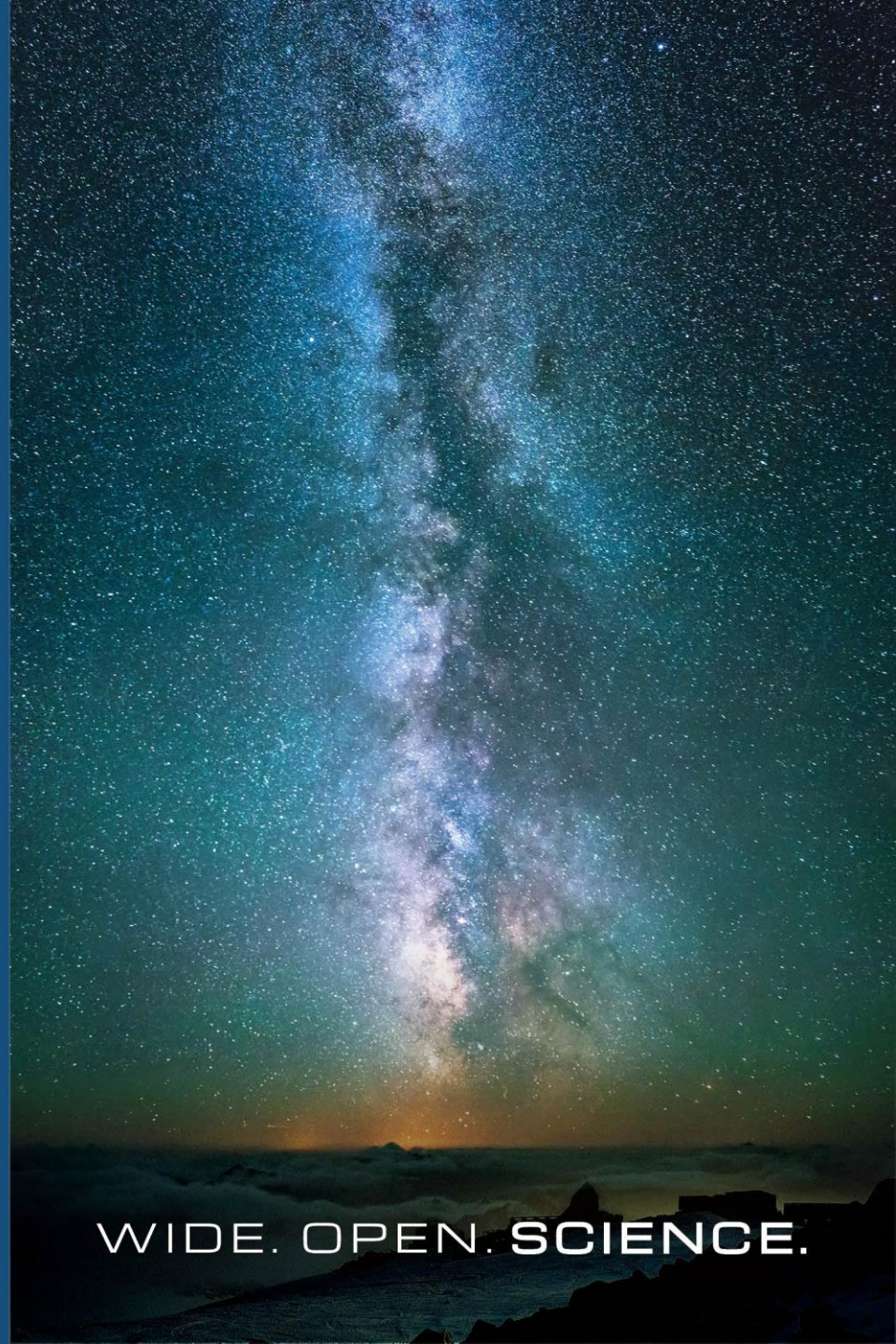

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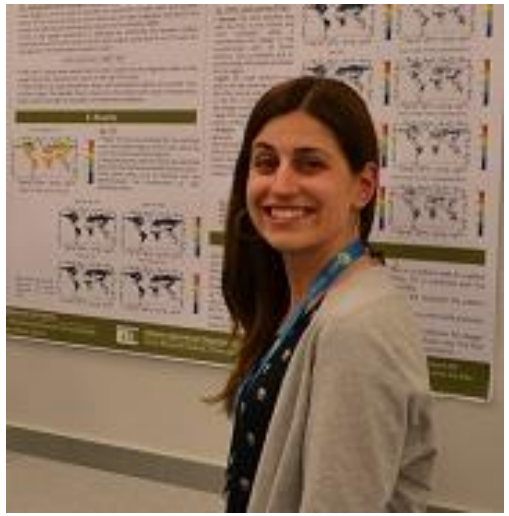

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ΕΘΝΙΚΟΝ ΑΣΤΕΡΟΣΚΟΠΕΙΟΝ ΑΘΗΝΩΝ
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PROBLEM AND SCOPE

High resolution long-term projections of fire related indices

Well informed decision making- Adaptation strategies

Forest fires constitute a major environmental and socio-economic hazard in Mediterranean Europe

Increase of fire danger due to cc

High resolution seasonal forecasts of fire danger

Effective fire prevention policies

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FIRE WEATHER INDEX (FWI)

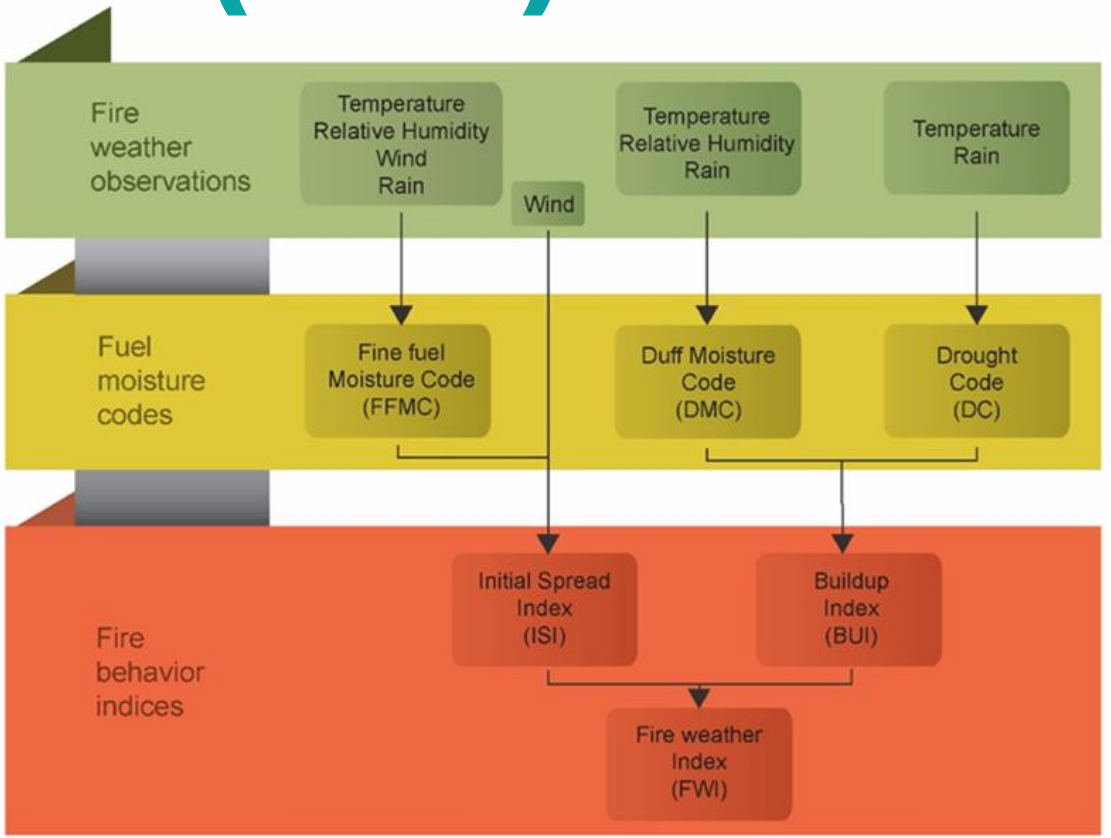
daily meteorologically based index used worldwide to **estimate fire danger in a generalised fuel type** (mature pine stands).

different components for the effects of **fuel moisture** and **wind** on **fire behaviour and spread**.

meteorological inputs

daily noon values of temperature / air relative humidity /
10m wind speed /precipitation during the previous 24 h

adopted at the EU level by the EFFIS of the **Copernicus Emergency Management Service** to assess the **fire danger level** in a **harmonized** way throughout Europe.



FWI structure (adapted from the Canadian Forestry Service, 1984)

LONG-TERM PROJECTIONS: DATA & METHODS

- 8 GCMs from CMIP6 climate projections (hor. res. 1 degree) available at Copernicus CDS
(MIROC6, MPI-ESM1-2-HR, NORESM2-MM, CNRM-ESM2, CNRM-CM6-1-HR, CMCC-ESM2, EC-Earth3-Veg-LR)

- ERA5-Land reanalysis dataset (hor. res. ~9km): reference dataset

- Study periods:
  - Historical: 1995-2014 (Reference period)
  - Near Future: 2041-2060
  - Distant Future: 2081-2100

- Scenarios:
  - SSP1-2.6
  - SSP2-4.5
  - SSP5-8.5

LONG-TERM PROJECTIONS: DATA & METHODS

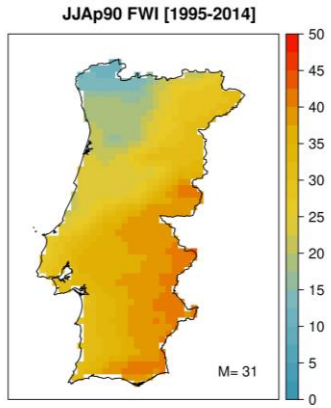
Statistical downscaling

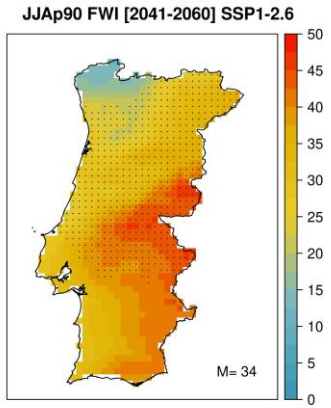
To statistically downscale model simulations at the ERA5-Land horizontal resolution, a two-step approach is followed:

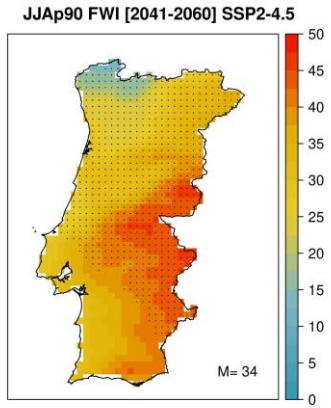
- meteorological variables are initially regridded to the ERA5-Land grid by means of **bilinear interpolation**
- bias correction is applied using **empirical quantile mapping** (EQM) with ERA5-Land FWI values as the reference dataset

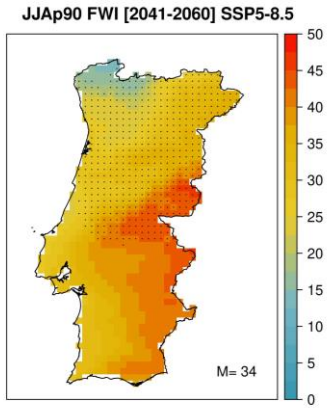
Varotsos KV, Dandou A, Papangelis G, Roukounakis N, Kitsara G, Tombrou M, Giannakopoulos C (2023) Clim Dyn. 60: 2931-2956. https://doi.org/10.1007/s00382-022-06482-z

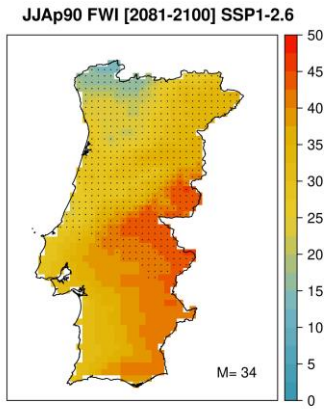
RESULTS-PORTUGAL

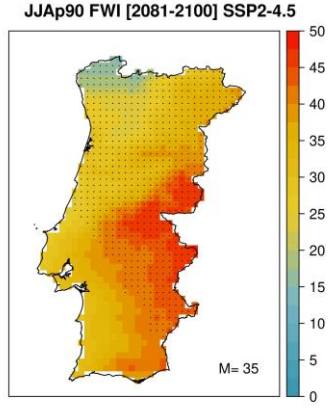


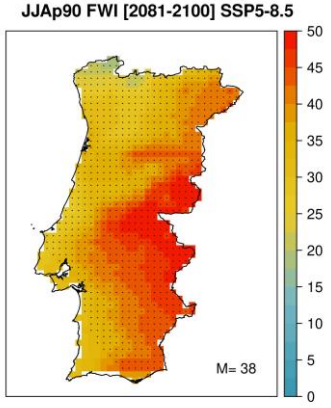












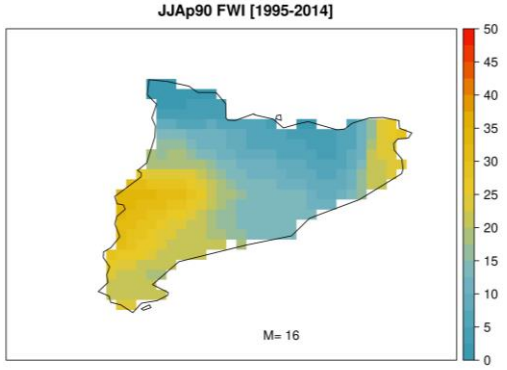
M indicates the average value calculated over all grid points

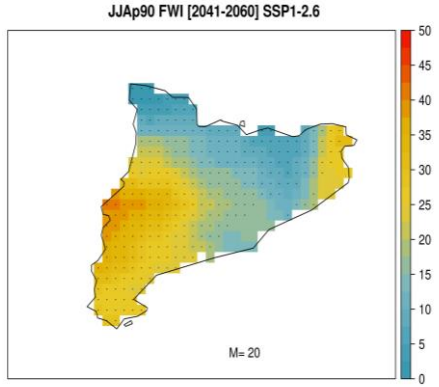
Black dots indicate robust changes at the grid point scale

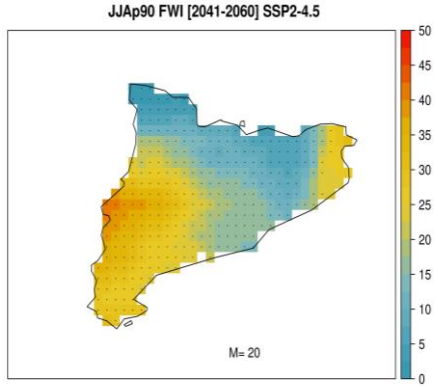
JJA 90th percentile FWI

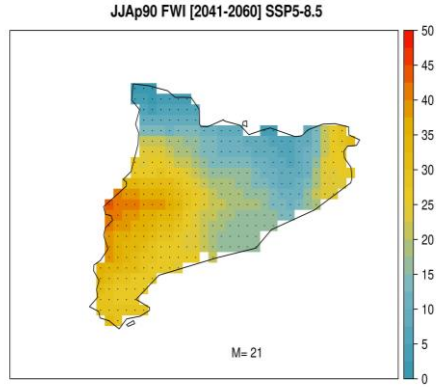
- high danger FWI class (on average over all grid boxes) for the control period with higher values (indicating higher danger FWI class) simulated in the eastern areas
- Higher FWI values for both future periods under all scenarios
- Highest values under SSP5-8.5 and by the end of the century

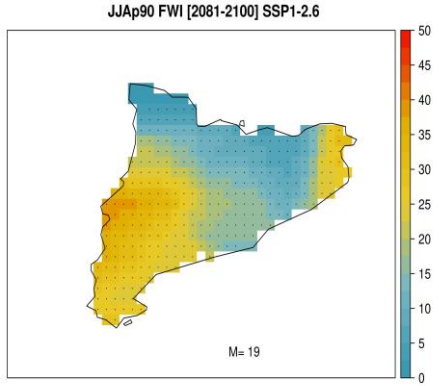
RESULTS-CATALONIA

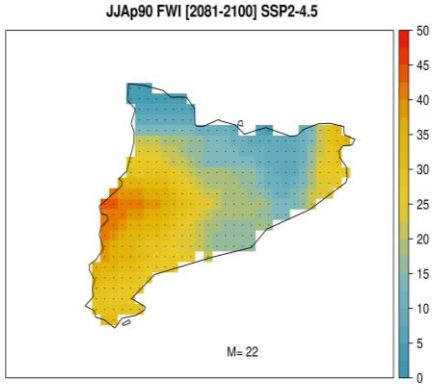


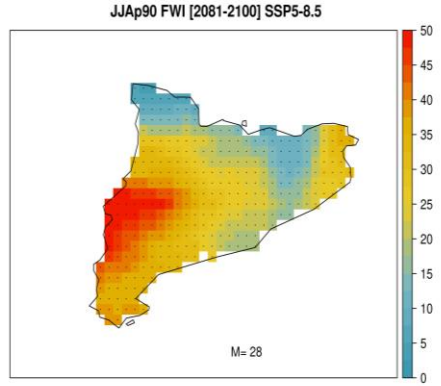












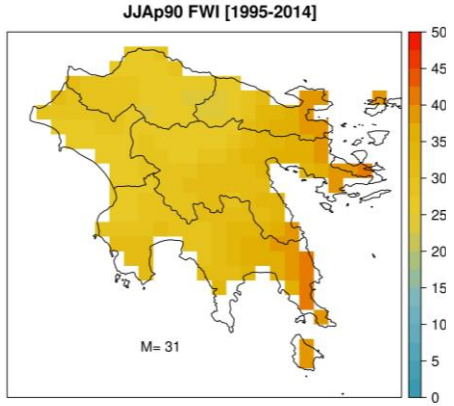
M indicates the average value calculated over all grid points

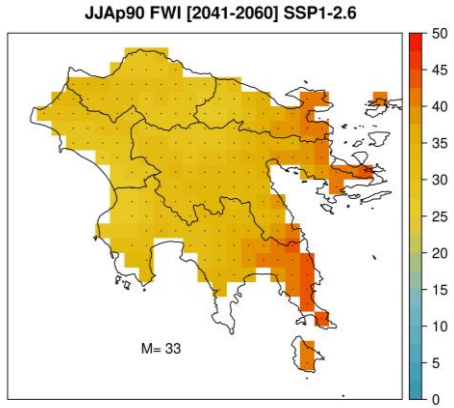
Black dots indicate robust changes at the grid point scale

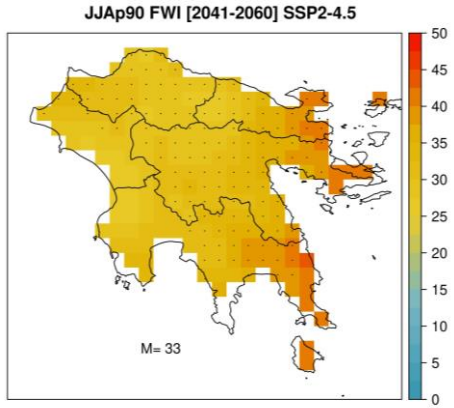
JJA 90th percentile FWI

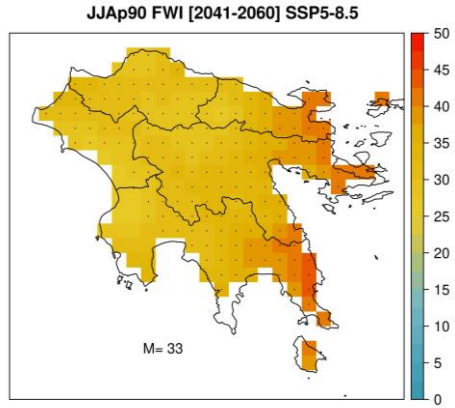
- Moderate danger FWI class (on average over all grid boxes) for the control period with higher values (indicating higher danger FWI class) simulated in the western areas
- Higher FWI values for both future periods under all scenarios (FWI class changes to high danger)
- Highest values under SSP5-8.5 and by the end of the century

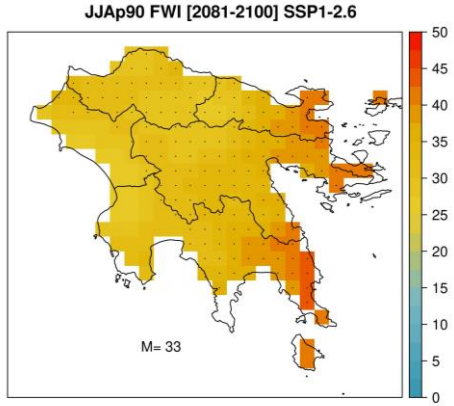
RESULTS-PELOPONNESE

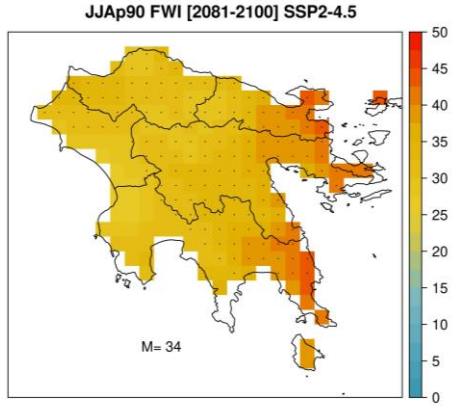


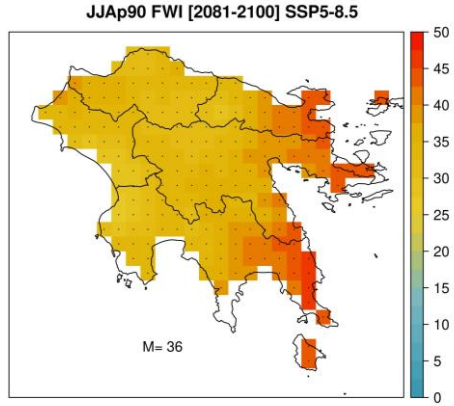












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JJA 90th percentile FWI

- high danger FWI class (on average over all grid boxes) for the control period with higher values (indicating higher danger FWI class) simulated in the eastern areas
- Higher FWI values for both future periods under all scenarios
- Highest values under SSP5-8.5 and by the end of the century

SEASONAL FORECASTS: DATA & METHODS

- **ECMWF SEAS5 v5.1 dataset (hor. res. 1degree):** forecasts initialized in May (one month in advance LM1 of the target season - JJA)

- **ERA5-Land reanalysis dataset (hor. res. ~9km):** reference dataset

- **Study period:** 1981-2016 (reforecasts-25 ensemble members)
- **Fire season:** June-September
- **Variables:** instantaneous outputs at 12 UTC for 2-m air temperature, northward and eastward 10-m wind components, 2-m dewpoint temperature, and daily accumulated precipitation

SEASONAL FORECASTS: DATA & METHODS

Regrid of the seasonal forecast variables to the ERA5 Land grid

Calculation of FWI using the regridded fields and bias correction applying **empirical quantile mapping** (EQM)

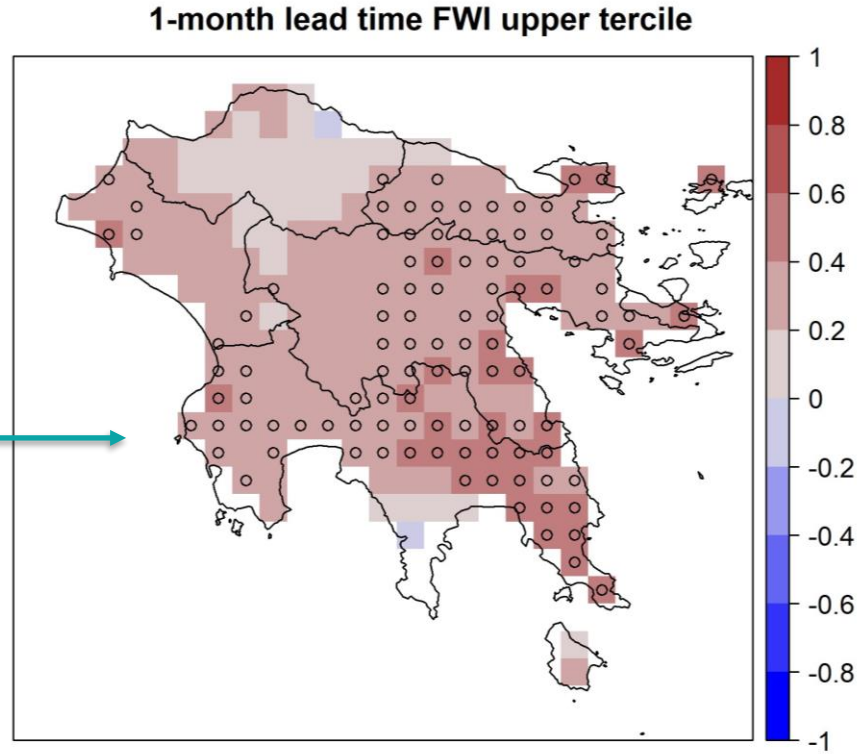
FWI verification using the **probabilistic tercile approach** (metrics: **ROC skill score, reliability diagrams**)

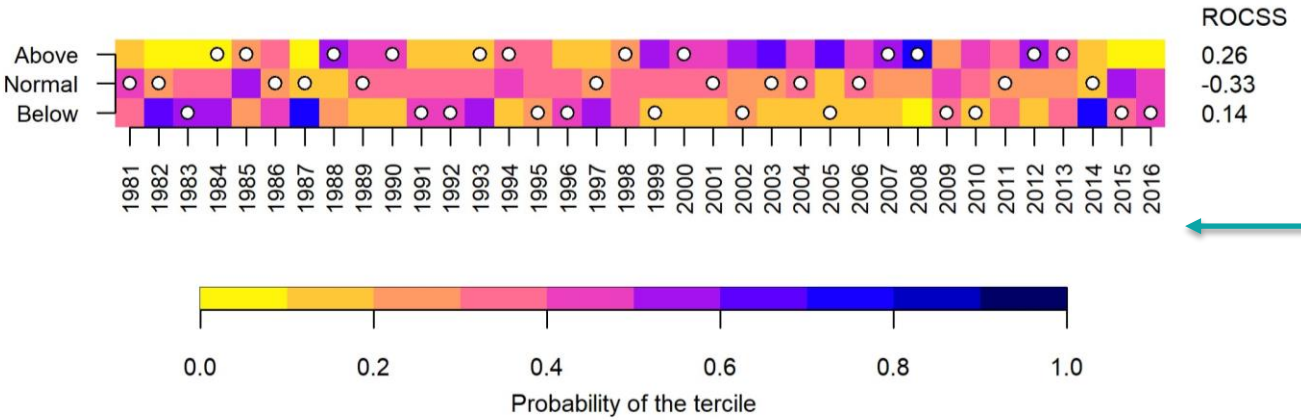
**bias correction is applied for the fire season using a moving window width of 31 d on the calculated FWI*

METRICS FOR FIRE DANGER FORECAST VERIFICATION

ROCSS measures the frequency of occasions when the system correctly distinguished between events occurring and not occurring. It ranges from -1 (perfectly bad discrimination) to 1 (perfectly good discrimination).

The **ROCSSs** are calculated at each grid point for the upper tercile for the FWI, averaged over the verification period.





Tercile plots presenting the performance of the seasonal forecast along the hindcast period.

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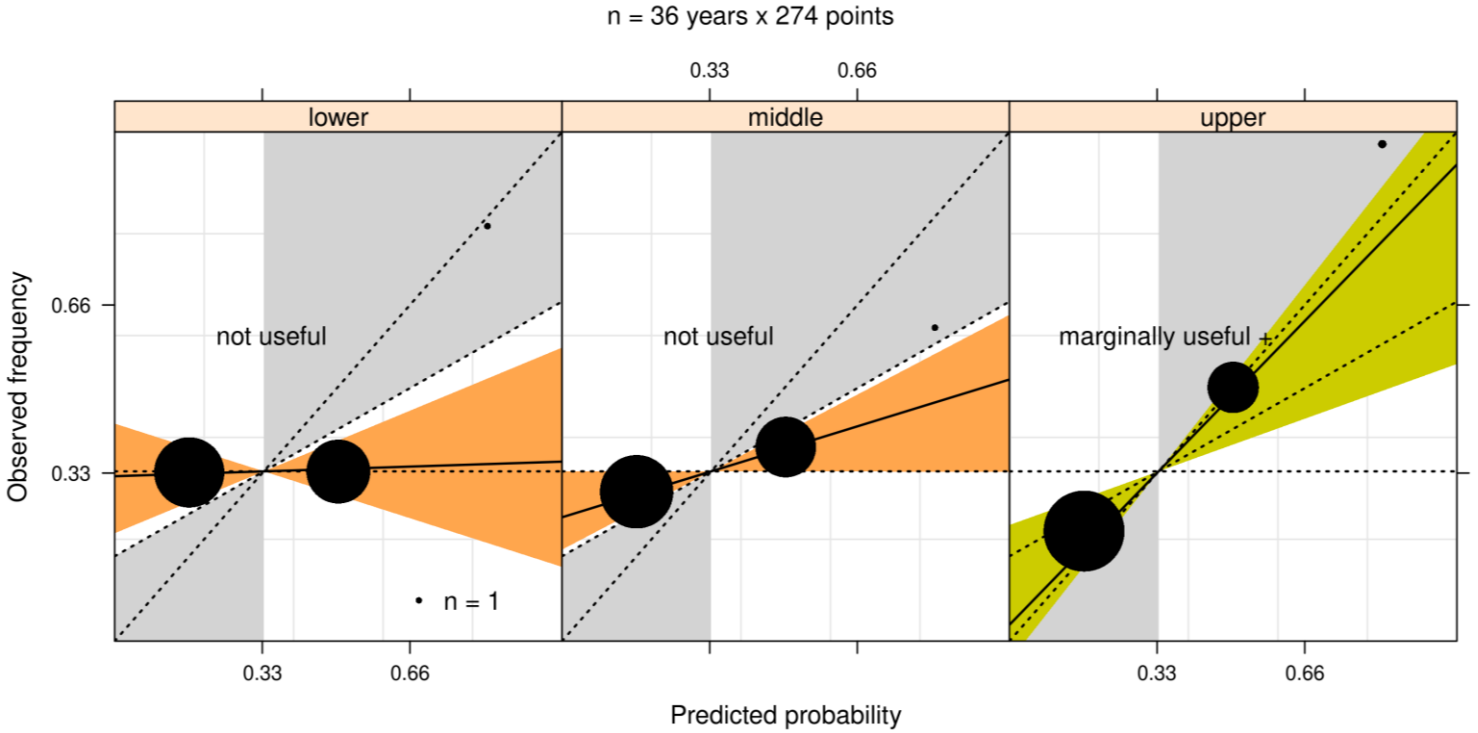
METRICS FOR FIRE DANGER FORECAST VERIFICATION

Reliability diagrams:
Diagnostic tools measuring how closely the forecast probabilities of a specific event (for instance a particular tercile category) correspond to the observed frequency of that event.



* Focus on upper tercile fire danger predictions as high FWI (and its subcomponents) values are related to increased fire danger conditions and, hence, to increased wildfire activity

Karali A, Varotsos KV, Giannakopoulos C, Nastos PP, Hatzaki M (2023) Natural Hazards and Earth System Sciences 23:429–445. https://doi.org/10.5194/nhess-23-429-2023

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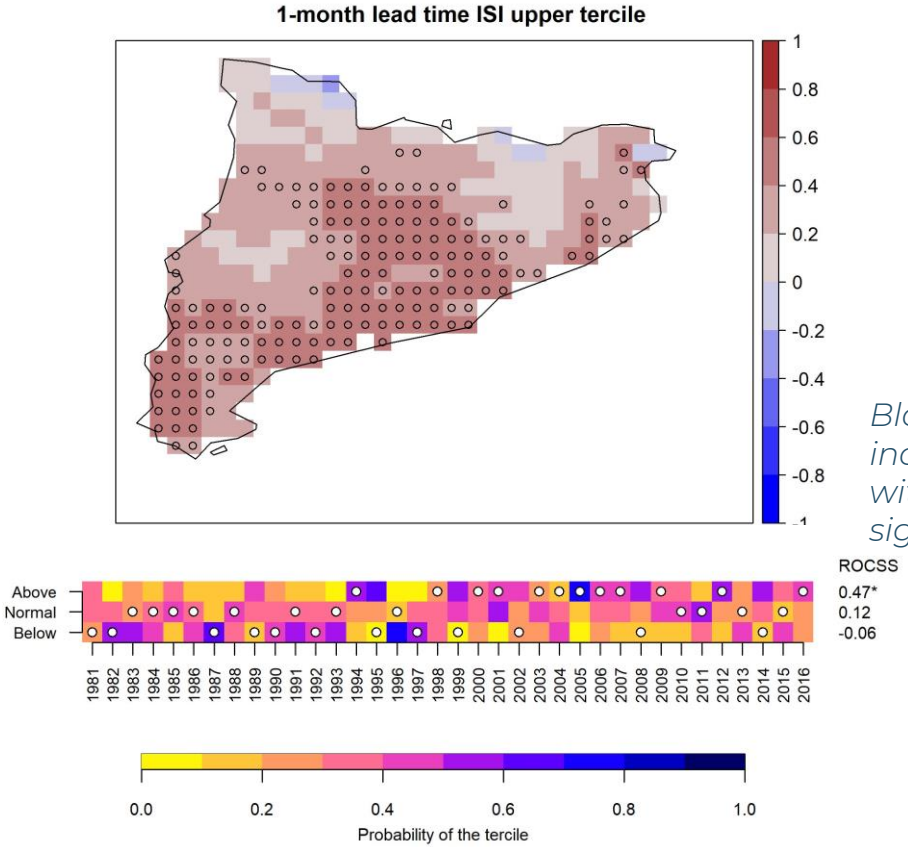
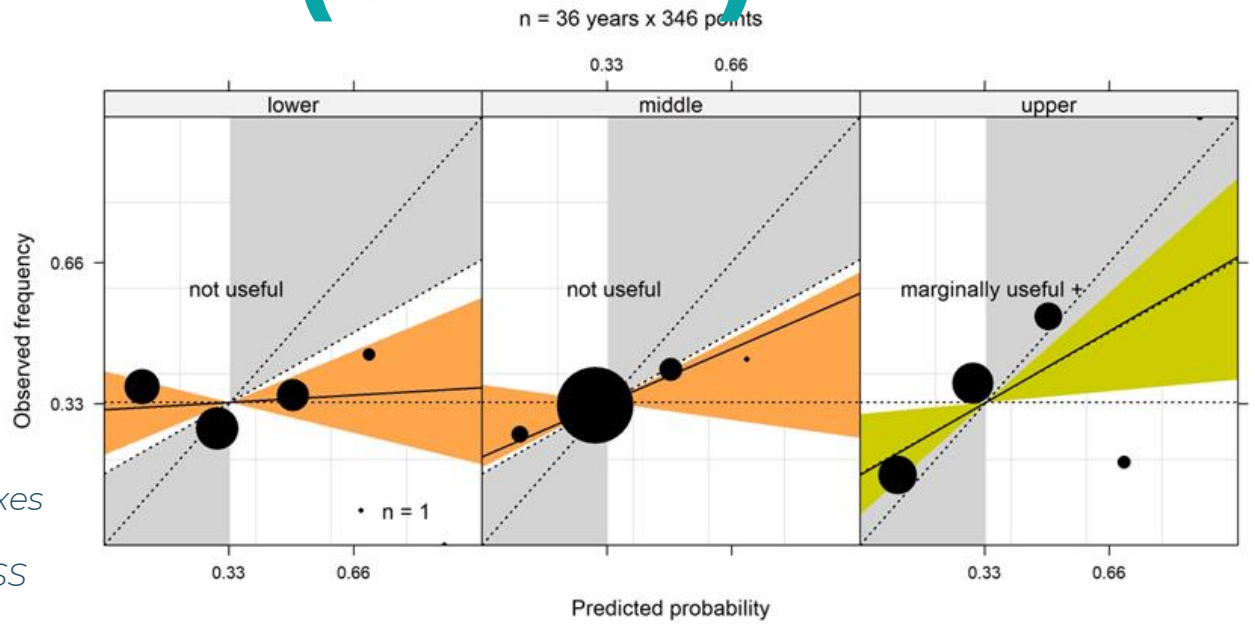
RESULTS - CATALONIA (SPAIN)



Black circles indicate grid boxes with statistically significant ROCSS



- ISI ROCSSs range between 0.4-0.6 for a large part of Catalonia
- 60% of the observed above normal years were predicted by 50%-80% of the members.

The white bullets represent the observed category according to the ERA5-Land dataset. ROCSS values obtained from the hindcast period are shown on the right side of each category and the asterisk indicates significant values

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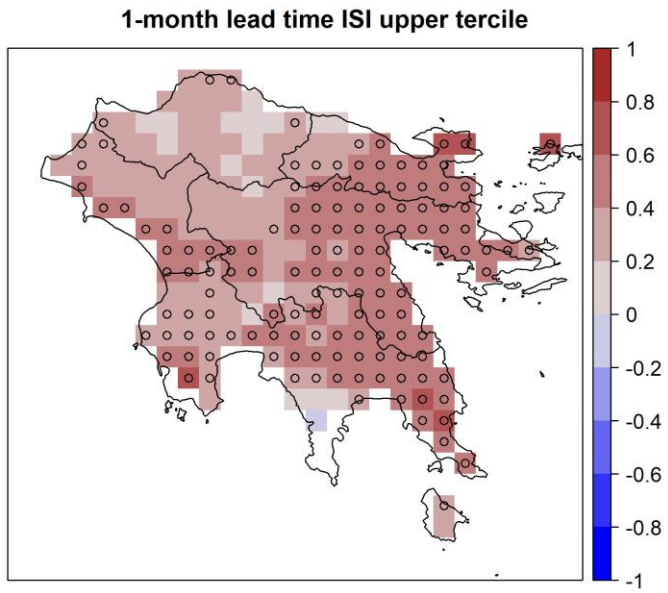
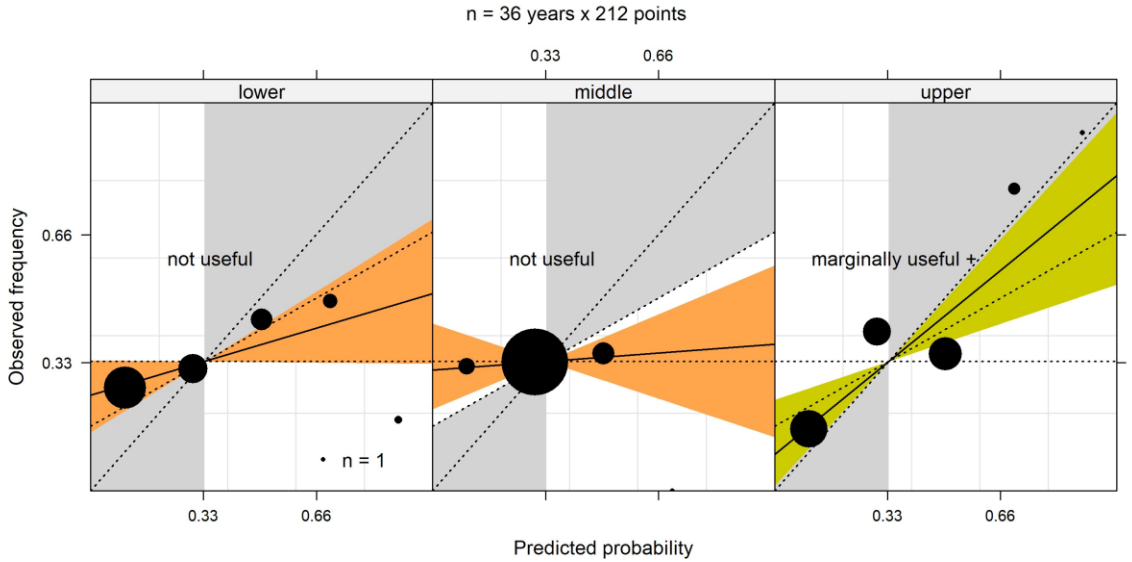
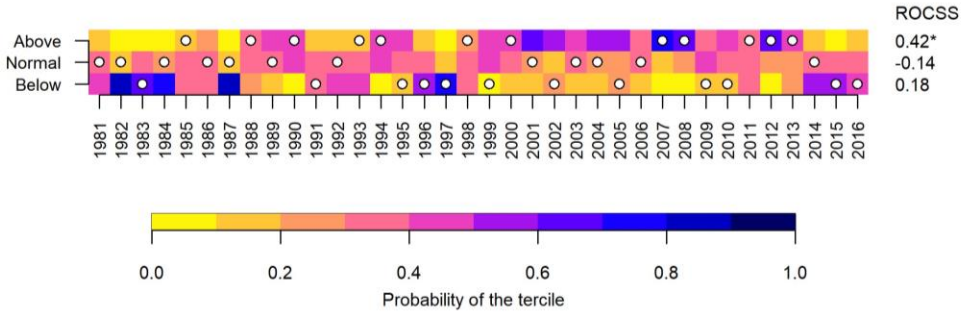
RESULTS - PELOPONNESE (GREECE)







- High ISI ROCSSs (0.6) for a large part of Peloponnese.
- 65% of the observed above normal years are predicted by 50%-80% of the members.

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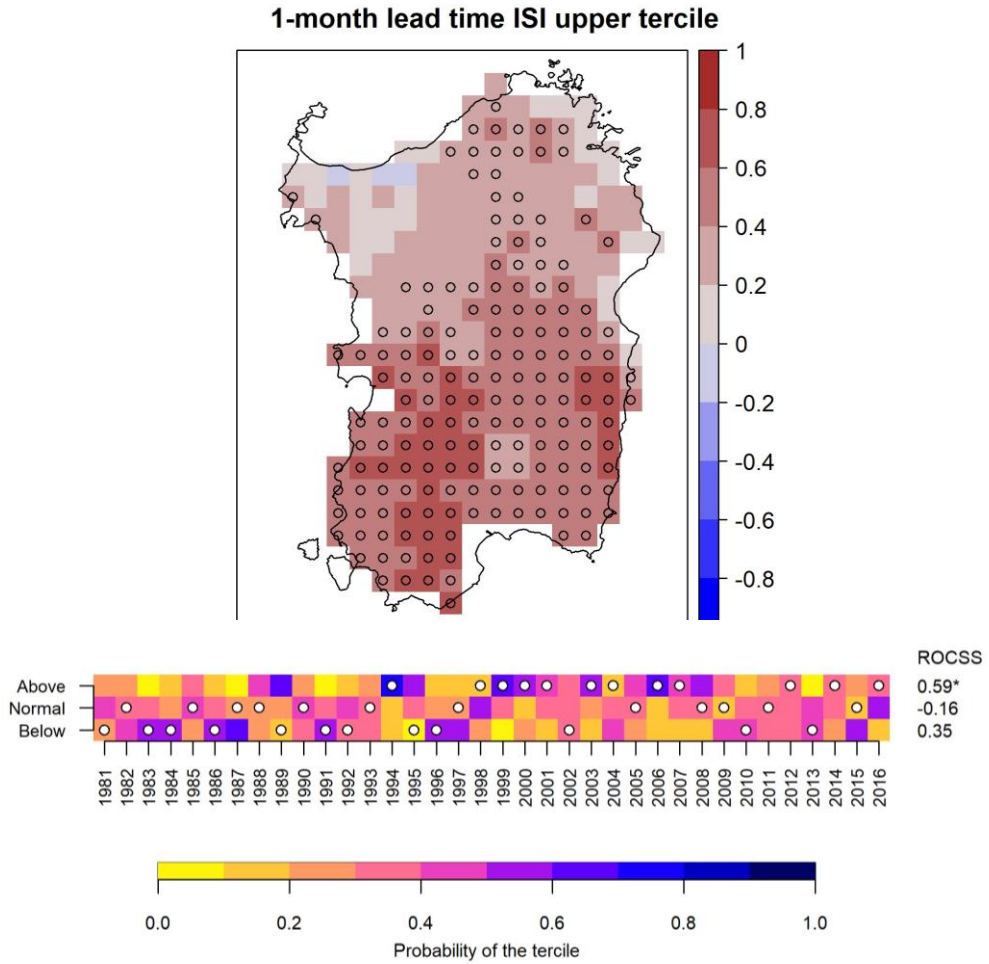
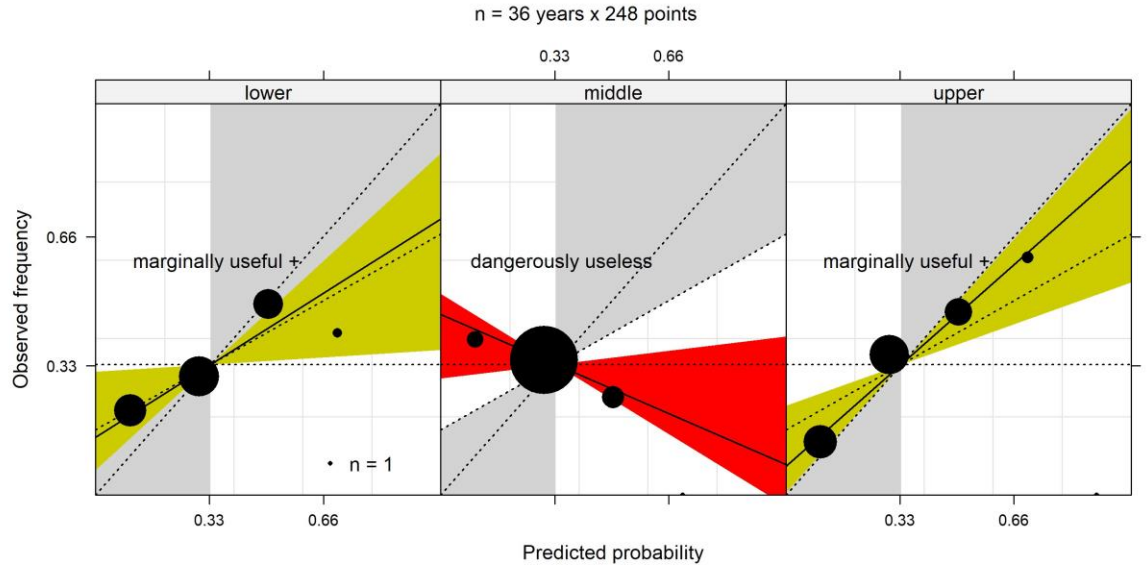
RESULTS – SARDINIA (ITALY)





- Spatially averaged ISI attains a statistically significant positive value (0.59), higher skill scores in the southern part.
- 60% of the observed above normal years are predicted by 50%-80% of the members

TAKE-HOME MESSAGE

Long-term projections

- ✓ Robust FWI changes are projected for all areas under SSP5-8.5 for both periods
- ✓ by the end of the century in the majority of the examined areas and FWI class change to worsening conditions is projected.

Seasonal forecasts

- ✓ Relatively high ROCSS and a partial positive relationship between the Sys5 forecast probability and the observed frequency of occurrence of the above normal conditions are found.
- ✓ the index could be useful in decision making considering.

THANK YOU

TO OUR SPONSORS!

FIRE-RES

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037419.

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