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Motivation

The decade **1531-1540** was characterized by a high number of dry summer episodes, making it the **driest summer decade** in some areas of Central Europe (Brazdil et al, 2020).

With our novel atmospheric model simulations and paleo-reanalysis (**ModE-Sim** and **ModE-RA**) we can complement established climate reconstructions to in-depth analyse the variability and drivers of such **decadal dry spells over Europe**.

Our previous work already showed that ModE-Sim can be used to analyse the variability of preindustrial extreme events such as heatwaves (Lipfert et al, 2023, submitted).

Datasets

- **ModE-Sim** 36 member ensemble of historical atmospheric simulations based on ECHAM 6.3.05p2 using observed forcings over the period 1420-2009 with a horizontal resolution of 1.8° (Hand et al, 2023, EGU23-14112)
- **ModE-RA** global monthly paleo-reanalysis covering 1421-2008 using offline data assimilation with a horizontal resolution of 1.8° (Valler et al, 2023, EGU23-386)
- Reconstructions of European **summer temperatures** from Luterbacher et al (2004)
- Reconstructions of **seasonal precipitation totals** over Europe from 1500-2000 from Pauling et al (2006)
- **PDSI** indices from the Old World Drought Atlas (OWDA) covering 0-2012 (Cook et al, 2015)
- Reconstructions of **sea level pressure (SLP)** fields from Luterbacher et al (2002)

The 1531-1540 dry summers

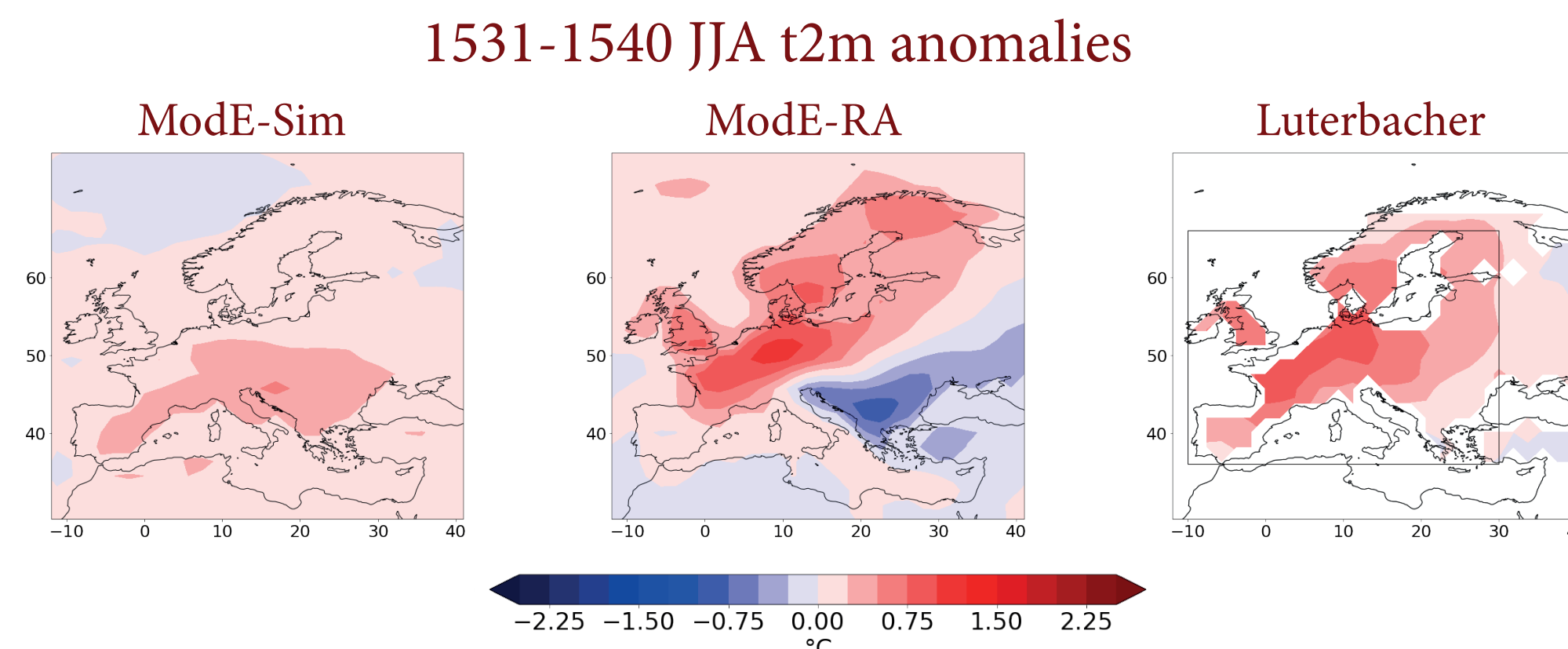


Figure 1: JJA air temperature anomalies for 1531-1540 (climatology 1500-1800) for ModE-Sim ensemble mean, ModE-RA ensemble mean and Luterbacher reconstructions

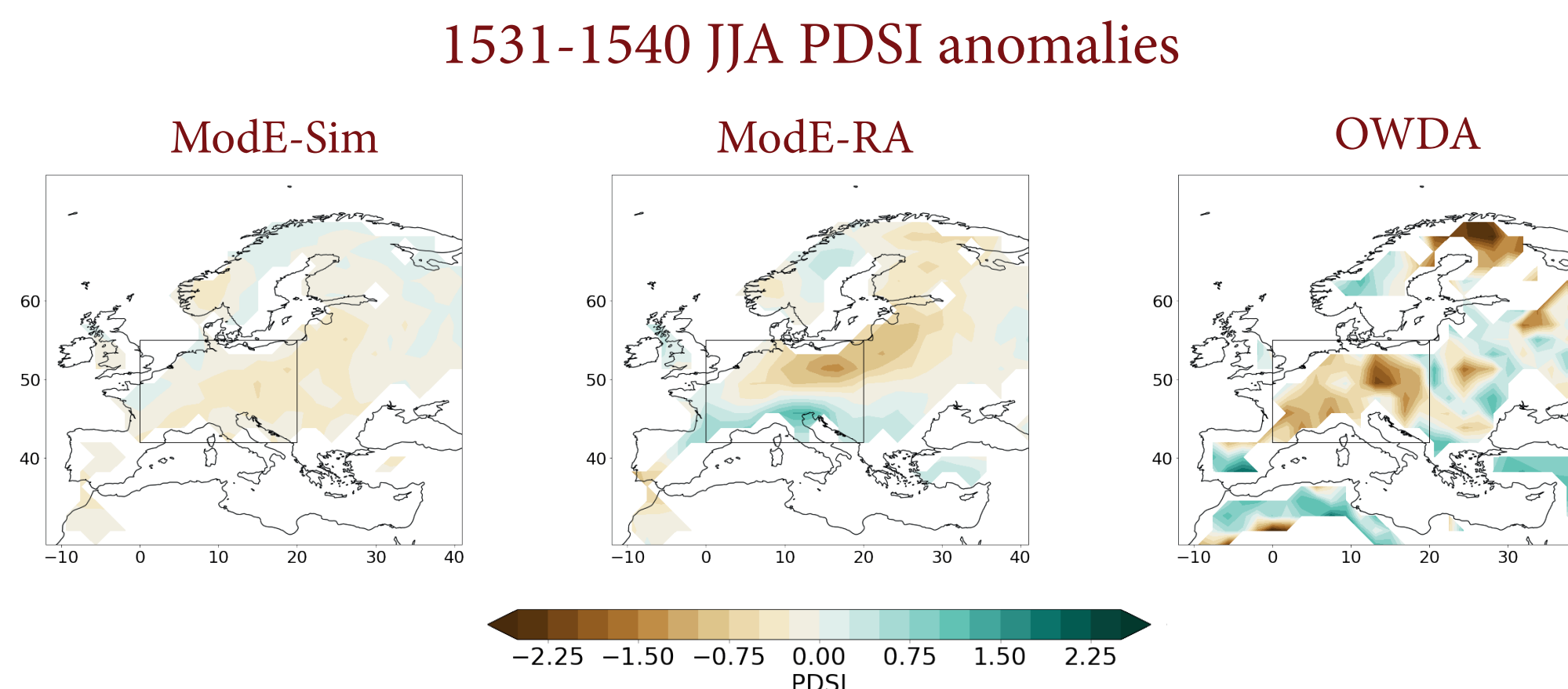


Figure 3: JJA Palmer Drought Severity Index anomalies for 1531-1540 (climatology 1500-1800) for ModE-Sim ensemble mean, ModE-RA ensemble mean and the Old World Drought Atlas

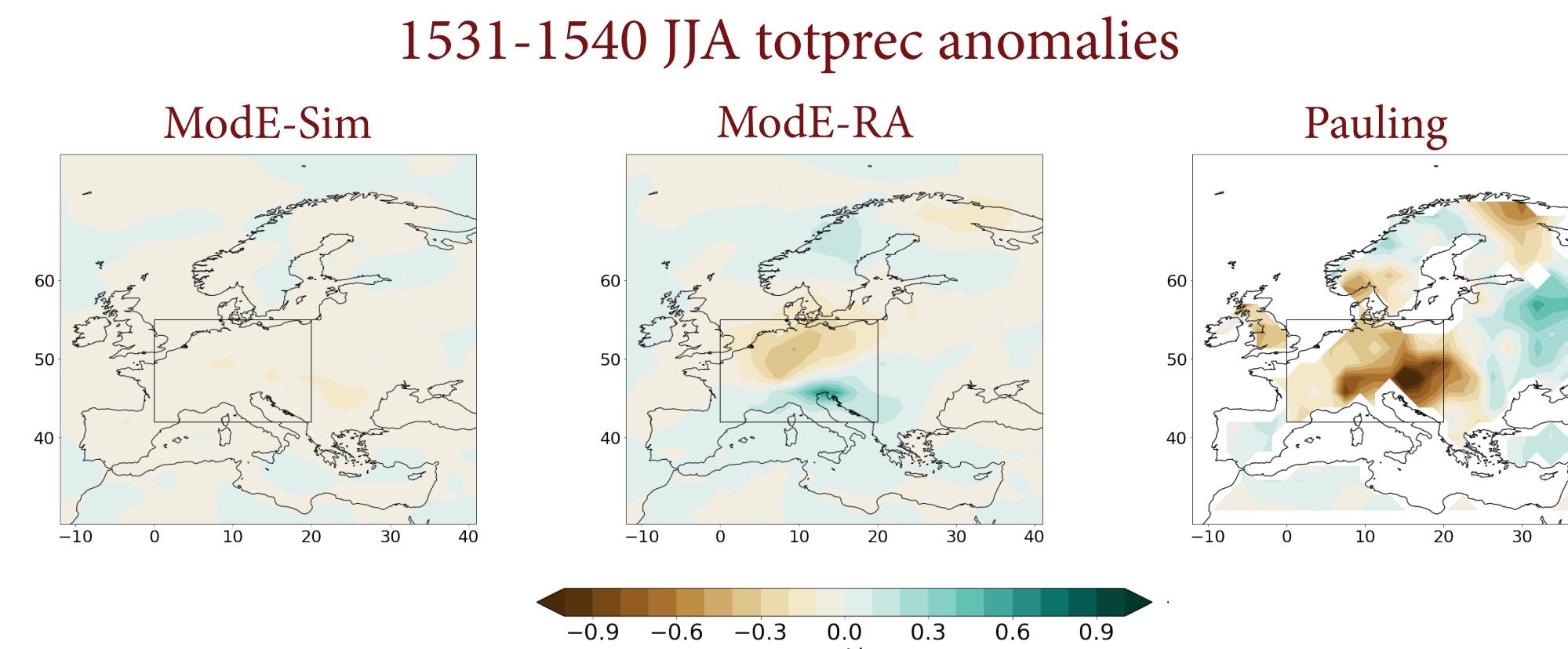


Figure 2: JJA total precipitation anomalies for 1531-1540 (climatology 1500-1800) for ModE-Sim ensemble mean, ModE-RA ensemble mean and Pauling reconstructions

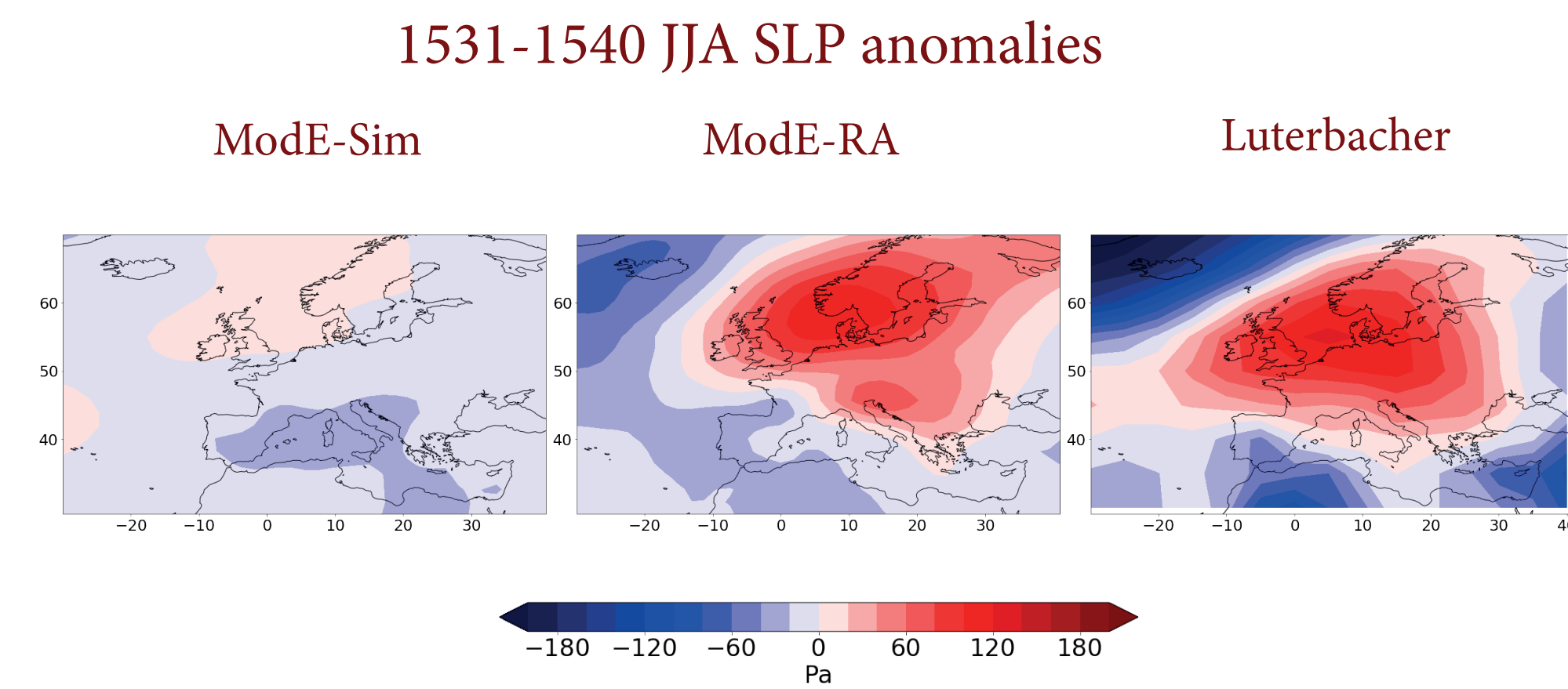
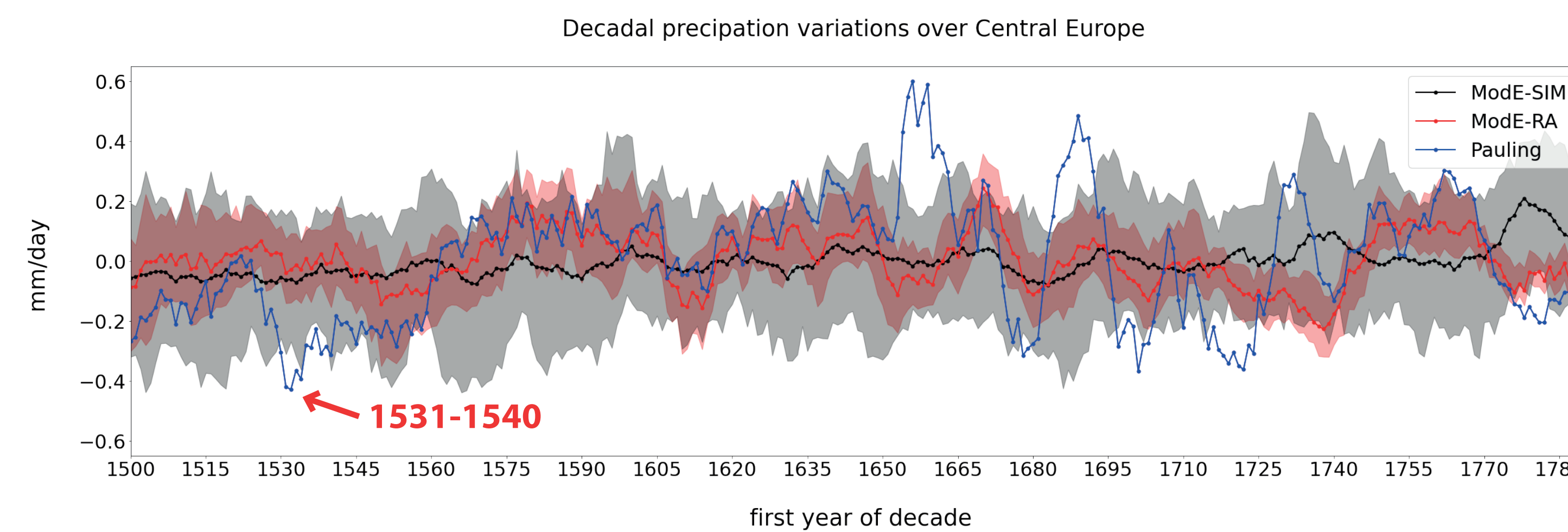


Figure 4: JJA Sea Level Pressure anomalies for 1531-1540 (climatology 1500-1800) for ModE-Sim ensemble mean, ModE-RA ensemble mean and Luterbacher reconstructions

- **ModE-Sim** and **ModE-RA** are able to **simulate parts of the drought signal** from available climate reconstructions which were investigated in previous research on this decade (i.e Brazdil et al., 2020)

Decadal drought variations 1500-1800



ModE-Sim and ModE-RA are able to simulate decadal dry periods over Europe similar (and even stronger) to the 1531-1540 decade.

Both datasets can be used to further investigate decadal dry periods and **identify the drivers of decadal hot and dry periods** in Central Europe as well as other regions.

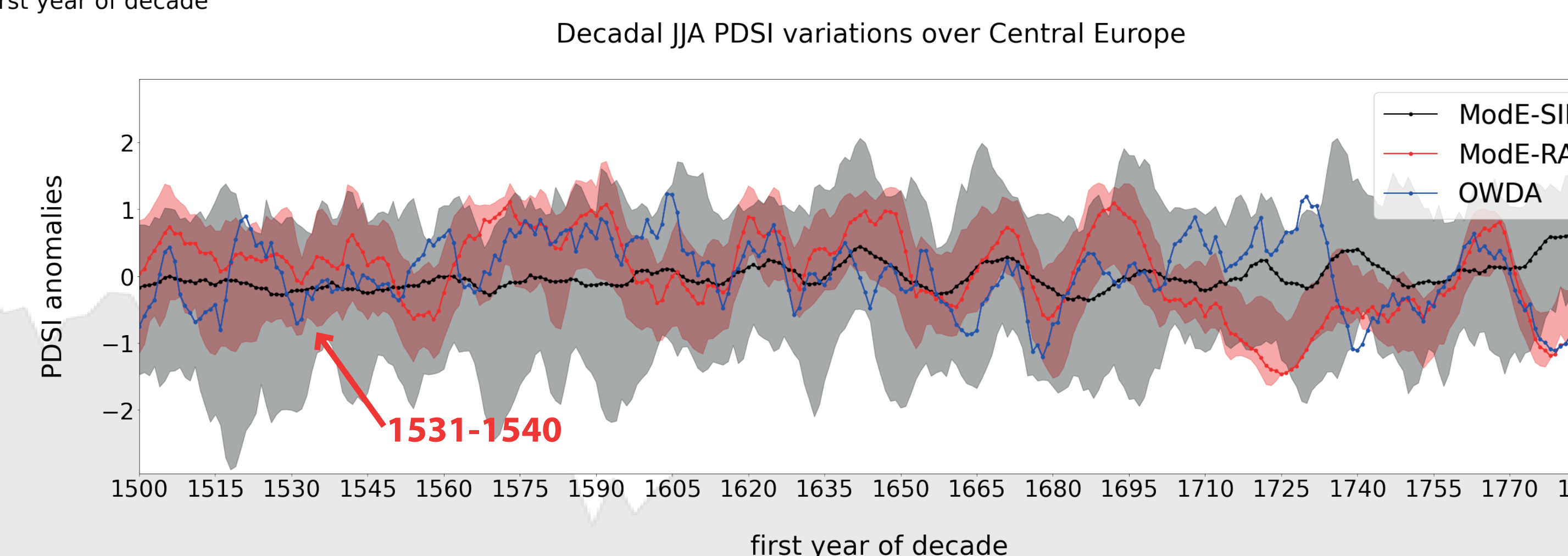
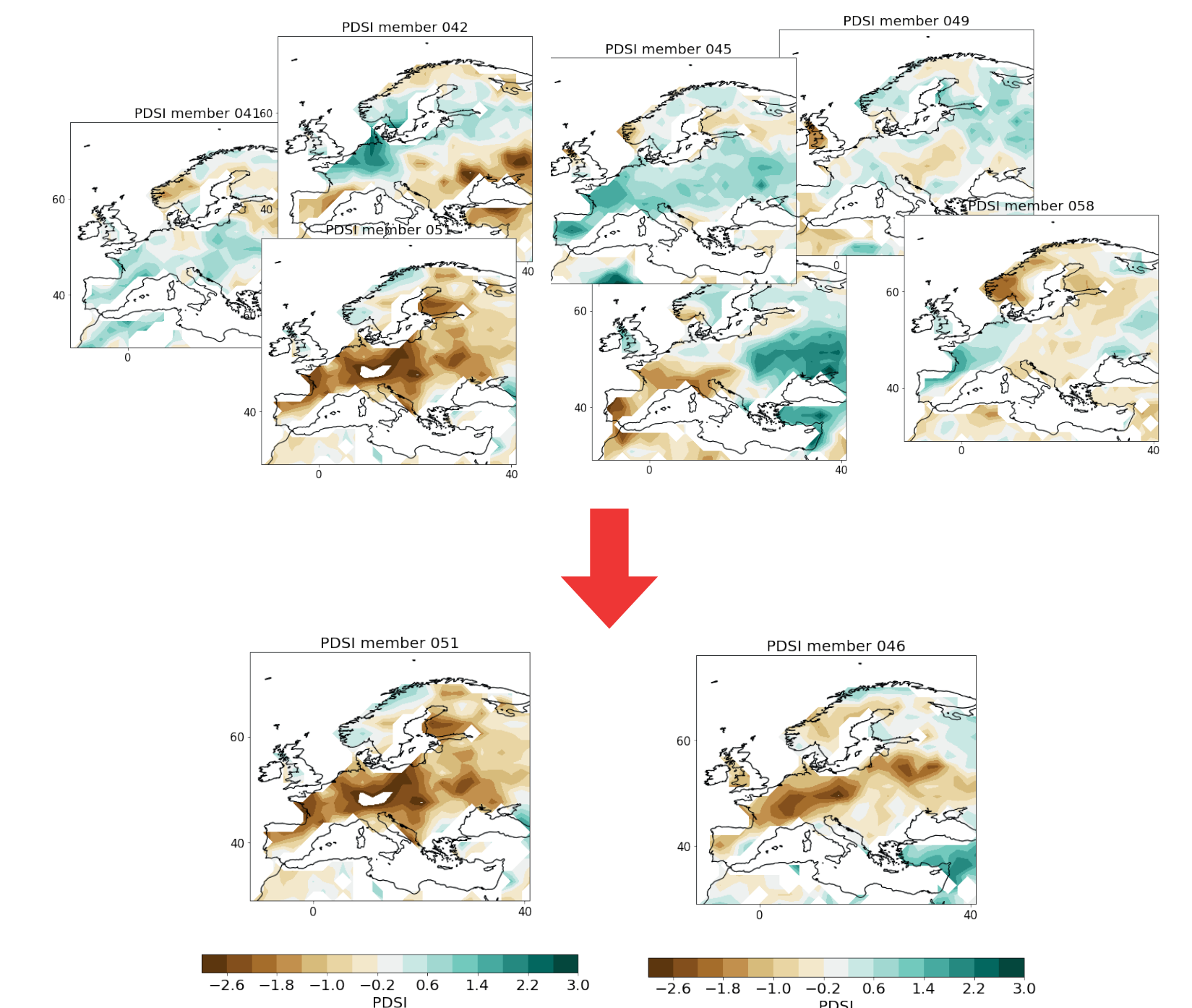


Figure 5: JJA total precipitation (PDSI) anomalies for 1500-1800 over Central Europe (climatology 1500-1800) for ModE-Sim, ModE-RA and the OWDA (Pauling reconstructions)

Concept to identify drivers

- Identify decadal dry spells in **individual members of ModE-Sim** simulations



- Investigate atmospheric and oceanic circulation patterns and calculate blocking indices for composites of decadal dry spells

First Conclusions & Outlook

- Magnitude and distribution of decadal dry spells in ModE-RA and ModE-Sim is realistic and comparable to other climate reconstructions
- We can compare drivers of preindustrial dry spells and heat periods with present day events
- Our analysis will be complemented with high resolution model simulations and reanalysis in the future
- Combination of decadal drought and heatwave analysis (Lipfert et al, 2023) contributes to a better understanding of past climate extremes

References: Lipfert, Laura et al. (submitted): A global assessment of heatwaves since 1850 in different observational and model datasets. Submitted to GRL (2023) Hand, Ralf et al. (submitted): ModE-Sim - A medium size AGCM ensemble to study climate variability during the modern era (1420 to 2009). Submitted to Geoscientific Model Development (2023). Veronika Valler et al. (submitted): ModE-RA - A global monthly paleo-reanalysis of the modern era (1421 to 2008). Submitted to Nature scientific data (2023). Brázdil, Rudolf, et al. „Central Europe, 1531–1540 CE: The driest summer decade of the past five centuries?“. Climate of the Past 16.6 (2020): 2125-2151. Pauling, Andreas, et al. „Five hundred years of gridded high-resolution precipitation reconstructions over Europe and the connection to large-scale circulation.“ Climate dynamics 26 (2006): 387-405. Cook, Edward R., et al. „Old World megadroughts and pluvials during the Common Era.“ Science advances 1.10 (2015): e1500561. Luterbacher, Jörg, et al. „Reconstruction of sea level pressure fields over the Eastern North Atlantic and Europe back to 1500.“ Climate Dynamics 18 (2002): 545-561. Luterbacher, Jörg, et al. „European seasonal and annual temperature variability, trends, and extremes since 1500.“ Science 303.5663 (2004): 1499-1503