ENSO effects in the North Atlantic-European sector
A paleo-perspective

S. Brönnimann[1], T. Ewen[1], J. Luterbacher[2], C. Casty[2], E. Xoplaki[2]
[1] Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland
[2] Institute of Geography / NCCR Climate, University of Bern, Switzerland

The problem

The effect of ENSO on climate in the North Atlantic-European is debated. We have recently found an effect of a strong El Nino on Europe during World War II (Brönnimann et al. 2004), but it is not clear to what extent this event can be generalised. Here we use reconstructed climate data in order to analyse ENSO effects on Eurpoean climate during the past 275 yrs.

Composites

We use reconstructions of the NINO3 index (October to March, from Mann et al., 2000, until 1879 and ERSSTv2, Smith and Reynolds 2004, thereafter) to address ENSO. For Europan climate we use independently reconstructed fields of SLP (Luterbacher et al. 2002), surface air temperature (Luterbacher et al. 2004), 500 hPa GPH (back to 1765, Casty et al. 2005) and precipitation (Pauling et al. 2005). All fields and series were high-pass filtered prior to the analysis.

Figure 1 shows averaged anomaly fields (Jan-Apr) for strong El Nino minus strong La Nina cases (outside ±1 std. deviation) defined for three periods: 1725-1879, 1880-1939, and 1943-2000. Also shown are the fields for 1940-1942. The main features in the 1940s is a negative NAO, low pressure at 500 hPa over western Europe, cold temperatures over northeastern Europe, and increased (decreased) precipitation over the Mediterranean and eastern Europe (Norway). These features are broadly reproduced in the composites of the different periods. However, individual events may deviate strongly from this picture, and separate composites for El Nino and La Nino are not exactly symmetric.

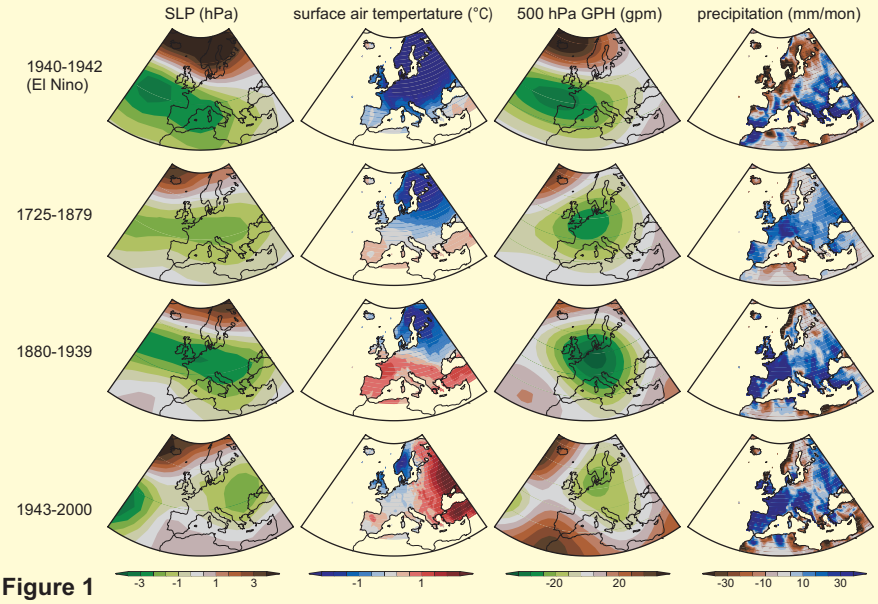

Figure 1

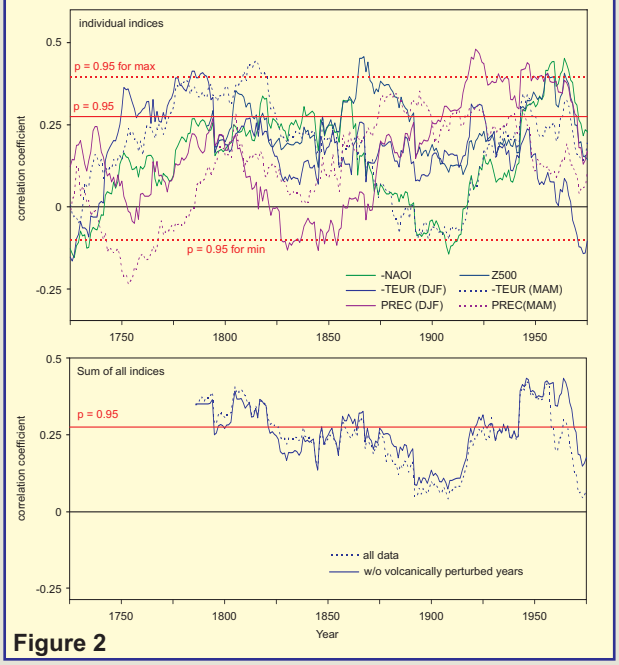

Figure 2

Correlation analysis

For further analysis we assumed that the anomalies in the 1940s were caused by the El Nino event and defined corresponding index series (excluding volcanically perturbed years).

-NAOI: Negative NAO index for January to April from Luterbacher et al. (2002)
-TEUR: Seasonal negative temperature average (20-55E/45-70N)
PREC: Seasonal precipitation difference between 10-30E/40-45N and 5W-30E/55-65 N
Z500: GPH difference at 500 hPa between 15-25W/60-65N and 10-25E/45-50N from January to April.

The correlation between these indices and NINO3 is analysed using a 51-yr moving window (Fig. 2 top). Correlations vary, but they are generally positive and often significant.

Using the mean of all series (Fig. 2 bottom), we find a clear positive correlation throughout the period; there is no evidence for a non-stationarity. However, the over all correlation is not very high (r = 0.25). Volcanic eruptions disturb the signal.

Apart from the large regional climate variability in the North-Atlantic European sector, processes in the Pacific might also modulate the effect. Figure 3 shows the mean index as a function of NINO3, stratified according to whether the Gulf of Alaska spring temperature (Wiles et al. 1998) is in phase with NINO3 or not. If the two are in phase, the correlation is much higher.

Stratification by Gulf of Alaska spring temperature

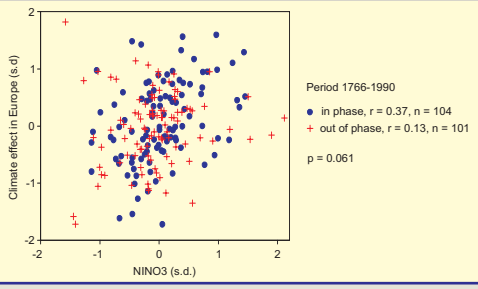

Figure 3

Conclusions

- Weak but consistent and statistically significant relation between ENSO and the North Atlantic-European sector detected in climate reconstructions
- No evidence for a non-stationarity
- Modulation by Tropical/North Pacific effects and volcanic eruptions

References

Brönnimann S et al., Nature **431** (2004), 971-974
Casty C et al., Geophys. Res. Lett. **32** (2005), L13801
Luterbacher J et al., Science **303** (2004), 1499-1503
Luterbacher J et al., Atmos. Sci. Lett. **2** (2002), 114-124
Luterbacher J et al., Clim. Dyn. **18** (2002), 545-561
Mann ME et al., Earth Interactions **4** (2000), paper 4
Pauling A et al., submitted (2005)
Smith TM, Reynolds RW, J. Clim, **17** (2004), 2466-2477
Wiles GC et al., Clim. Change **38**, 289-306

Contact
broennimann@env.ethz.ch