ARRIVAL DATES OF MIGRATING BIRDS IN CENTRAL EUROPE AND CLIMATE VARIABILITY

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Abstract: Recently the study of plant and animal phenological observations has contributed much to understand the sensitivity of biosphere to the variability of its atmospheric environment. This study is based on time series of 3 bird phenological phases ('first barn swallow', 'first cuckoo call' and 'all swallows have left') from the archive of the Central Institute for Meteorology and Geodynamics in Vienna, which have been collected at 65 Austrian stations from 1951 – 1999. In contrast to many European countries the arrival times of barn swallow and the cuckoo have predominantly been moving to later dates in Austria. A preliminary analysis points towards dryer conditions in the sub - saharan winter quarters as possible cause for a later departure from the African winter quarters to Europe. About a third of the year to year variability of both spring bird phases can be explained by temperature and wind conditions on the migration route and local temperature.

Keywords - *bird phenology, global change, climate variability*

1. INTRODUCTION

Plant and animal phenological observations constitute an easily available indicator, which allows to study the sensitivity of the biosphere to the variability of its atmospheric environment (Sparks and Menzel, 2002). In many countries time series of plant and animal phenological observations extending over several decades are readily available and are thus a valuable contribution to a quantitative description of the influence of climate variability on the biosphere. While most national phenological networks concentrate on plant phenology, some also collect animal phenological observations, like the first appearance of insects and the spring arrival and autumn departure of migrating birds. In western Europe migrating birds indicate a trend towards earlier arrival dates coincident with temperature variability along the migration route and the breeding areas (Huin and Sparks, 1998; Sparks, 1999; Cotton, 2003). Similarly earlier arrival dates of lark and wagtail have been reported from Estonia over the last decades (Ahas, 1999) and in Poland 14 out of 16 bird species show a trend towards earlier arrival dates over the time period from 1913 – 1996 (Tryjanowski et al., 2002). From the United States a trend towards earlier arrival dates has also been observed (Bradley et al., 1999). In contrast barn swallows tend arrive at later dates in Slovakia (1961 – 1985), which appears to be linked with a decreasing trend of mean April temperatures there (Sparks and Braslavska, 2001).

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2. RESULTS

Only a rather small fraction of the spatial variability of the long term mean entry dates (minimum time series length 30 years) can be explained by station coordinates and station elevation. In case of both swallow phases the explained spatial variability is about 10% and in case of the 'first cuckoo call' about 33%.

The mean long term entry dates of the 'first cuckoo call' move from east to west with about 100 to 200 km/day, however, the swallow arrival dates are not unequivocally related with the station longitude

The swallows appear to leave first in the eastern part of Austria (70 to 140 km/day from east to west). The relation of the entry dates with station latitude is more clear-cut. The entry dates of the bird phases occur first in the south and move in case of the 'first barn swallow' with 40 to 200 km /day north and in case of 'first cuckoo call' with 20 to 56 km/day north. 'All swallows have left' occurs first in the north and moves with about 70 km/day south. As to be expected, birds arrive first at the low elevation stations. The phase 'first barn swallow' moves with 110 to 230 m/day from low to high elevation stations and the phase 'first cuckoo call' with 100 to 120 m/day. Swallows leave at about the same time at all altitudes in autumn.

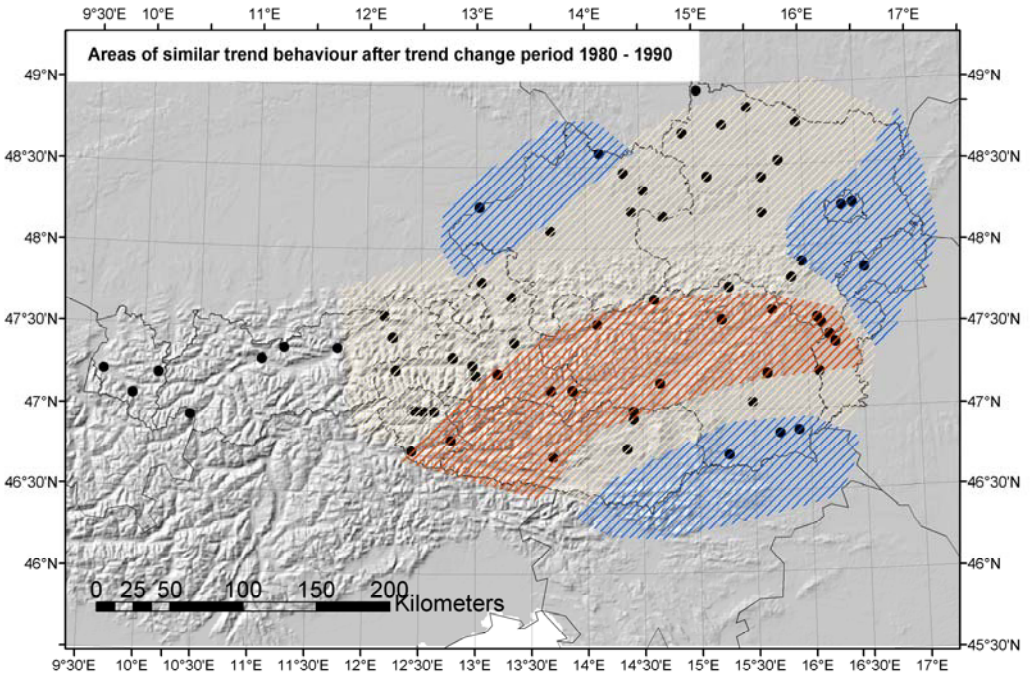

Figure 1. Preliminary spatial distribution of the trends of swallow arrival times during 1980–1999. The red area indicates a trend towrads earlier, the blue towards later arrival dates and the brown area no clear trend.

Because most of the bird phenological time series are incomplete and because of the lack of information on the temporal development of the population density, which influences first sighting dates, the following conclusions about temporal trends have to be taken as tentative. A very first subjective spatial attribution of temporal trends of 'first barn swallow' from 1980 to 1999 shows 3 subregions in Austria, where the swallows in the Alpine area appear to arrive earlier and in the surrounding lowlands trends towards later arrival dates predominate (Fig. 1). The 'first cuckoo call' shows nearly everywhere trends towards later occurrence dates. With few exceptions the swallows seem to leave earlier in autumn.

In order to make it easier to find candidates, which might explain the predominant trend of both bird phases towards later arrival times, all time series involved have been smoothed with a Gaussian filter. Time series of decreasing precipitation sums from an area 0° - 20°E and 5° - 30°N show the best match from all atmospheric variables with the long term trend of the spring bird phases towards later arrival times. The only restriction are the last 15 years of the precipitation time series (1984-1999), where precipitation sums are still low but increasing, whereas the birds continue their trend towards later arrival times. Precipitation in the African overwintering areas governs the food supply of the birds, where dry years with low food availability are connected with late arrival times in Europe. Another atmospheric factor with a good potential to influence the bird arrival time is the air flow situation. The northerly flow component for instance in March between 0° - 23.5° N over the Sahara has been increasing since the sixties of the last century at the surface and at 850 hPa. At the surface the northerly wind speeds have also increased during April between 23.5°–47°N during the last decades. This could mean that headwind situations have become more frequent.

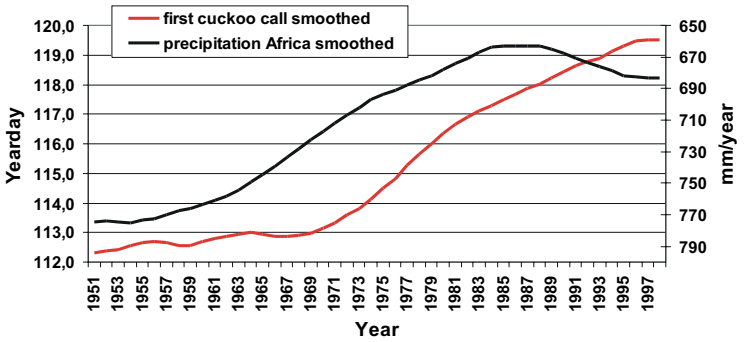

Figure 2. Smoothed time series of ‚first cuckoo call' and yearly precipitation sums (from April of the previous year to March of the year of observation) over an area from 5°-30° N and 0°-20° E.

The correlation analysis between the bird phenological observations and atmospheric variables are based on the NCAR reanalysis data set with a monthly resolution and Austrian homogenised temperature time series from the HISTALP database (Ungersböck et al., 2003). Linear trends have been subtracted from all time series before regression. Among the atmospheric variables temperature and wind show the highest correlations with the bird phenological observations. The mean monthly temperature of April can explain about 25% of the year to year variability of the swallow arrival dates. The year to year variability of the 'first cuckoo call' can be explained by about 35% with the April temperature (Fig. 3) and by 25% by the mean monthly distribution of the meridional geopotential component at 850 hPa along 20°E over a distance from 23.5° to 47°N during April. A multiple regression model combining both atmospheric variables can explain 39% of the year to year variability of the 'first cuckoo call'. Air flow and temperature are strongly related, where southerly air flows are connected with higher temperatures and earlier arrival times of the cuckoo.

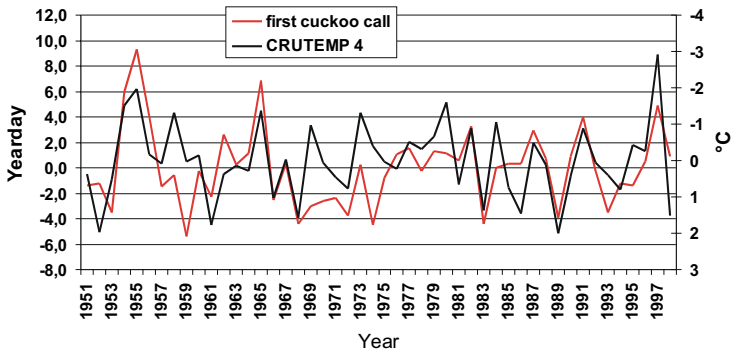

Figure 3. Time series of the mean monthly temperature of April, averaged along 20°E from 23.5°-47° N (black) and the mean dates of the 'first cuckoo call' in Austria (red).

3. CONCLUSIONS

Summarisingly one can conclude that even with a monthly resolution a number of potential relationships between bird phenological entry dates and atmospheric variables can be identified. Future research will have to quantify and strengthen these relationships between the atmosphere and bird arrival dates with time series of atmospheric variables at a higher temporal resolution.

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