

Discovering relationships between climate and animal migration with new tools for linking movement tracks, weather and land-use data

Gil Bohrer¹, Roland Kays, Martin Wikelski, David Brandes, Jiawei Han, David Douglas

bohrer.17@osu.edu ; <http://www.ceegs.ohio-state.edu/~bohrer.17/>

¹The Ohio State University, Dept. of Civil, Env. & Geodetic Engineering, Columbus, OH, USA;

NASA biological response to Climate Change Application Project NNX11AP61G

NY State Museum, Albany, NY

Max Plank Institute for Ornithology, Radolfzell, Germany

Lafayette College, Easton, PA

University of Illinois, Urbana-Champaign, IL

USGS, Juno, AK

Abstract

We will present the development of a widely needed on-line portal that will streamline the co-registration and analysis of animal tracking data with a variety of weather and land surface data. This on-line resource will help discover unique information about weather and land-surface dependencies and vulnerability of migrating birds and other threatened and endangered species. These kinds of information are crucial for planning and management of areas allocated as refuges and for forecasting the population status and habitats needs in future conditions of climate and land use changes. Wildlife biologists from the US Fish and Wildlife Service, the US National Park Service, the USGS, the Smithsonian National Migratory Bird Center, and the Acopian Center for Conservation have partnered with us to contribute to the system development and contribute bird migration tracks data from GPS tags.

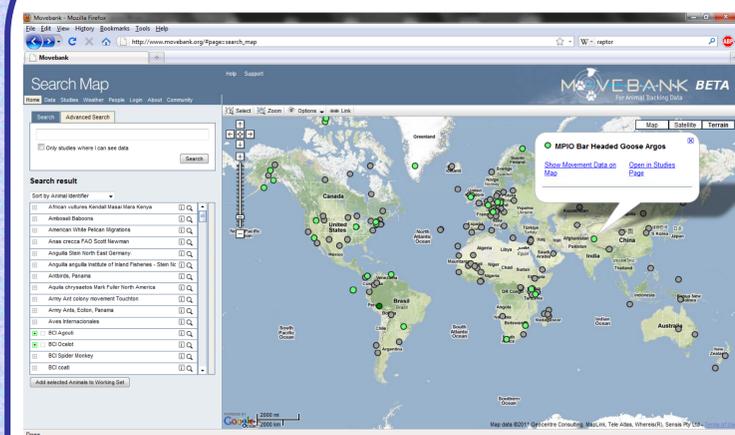
The project is based on extending the capabilities of Movebank (www.Movebank.org). Movebank provides a secure on-line archive to store, process, and share animal movement data. The tools we propose will allow all Movebank users to directly integrate their movement data with remote sensing and weather-reanalysis datasets. This will allow easy, automated access to data about the environmental conditions along migration routes, which influence the physiological condition and the survival of individuals during the migration event.

Data will be obtained from satellite observation products, such as the MODIS ecological, ocean, land and atmospheric level-3 products, as well as from high resolution DEM, Landsat, TRMM, NCEP-NCAR reanalysis models. Derived data variables will be calculated and added to this combined environmental data resource. We will present a test case in which derived variables that indicate the strength up wind uplift sources were calculated using data from DEM and the North American Reanalysis. We used this data to analyze the track preferences of two raptor species and detected contrasting preferences to orographic uplift vs. thermal uplift between the two species.

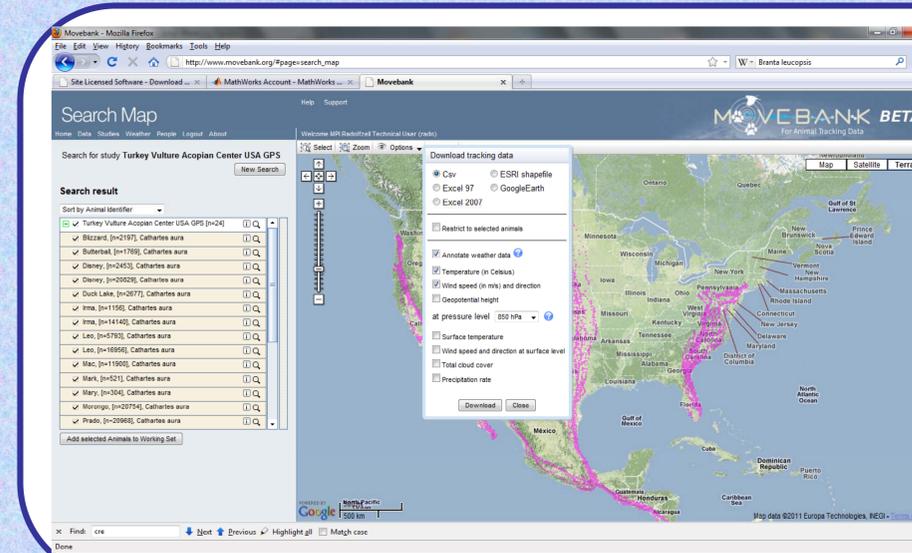
References

- Mandel et al. 2008 *Proc. Nat. Acad. Sci.* 49: 19102-19107
- Mandel et al. 2011 *Ecological Applications* 21: 2258-2268
- Kranstauber et al. *Environ. Modeling & Software* 26: 834-835
- Bohrer et al. (under review) *Ecology letters*

www.movebank.org



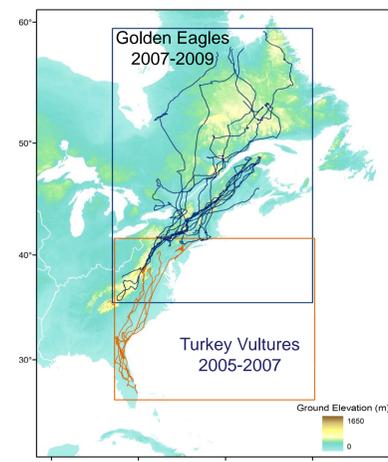
Movebank is an open access international on-line data archive, processing and research system for animal movement tracks. Developed by NSF and European research funding, it is administered by the max Plank Institute of ornithology in Radolfzell Germany, and mirrored at the NY-State Museum. Currently holding more than 10 million track, it rapidly grows with data from satellite, GPS and radio tags, as well as point observations (Kranstauber et al 2011)



Track annotation GUI

GUI assisted menu in movebank will allow researchers and species managers to select the variables with which they want to annotate the data. An off-line process will process the request and provide annotated tracks for download b the data owners. This process, currently working with NCEP reanalysis II global weather data, will use Modis, Landsat, TRMM, DEM and regional climate datasets. This will facilitate access by the stake-holders and biological researchers to previously challenging data resources. Additionally, we will develop datasets that are particularly catered to flight weather and movement, such as uplift availability.

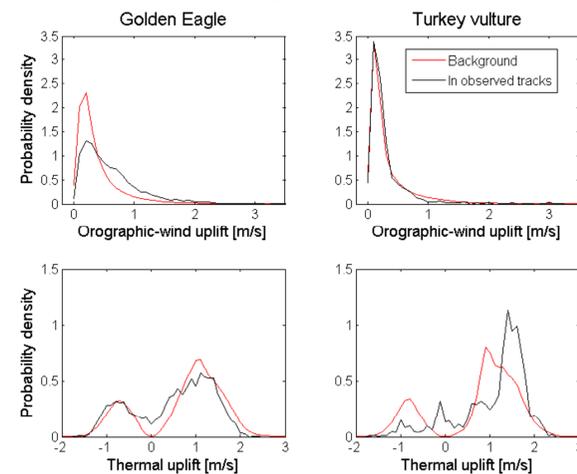
Case study: Comparison of updraft preferences in two large soaring raptor species



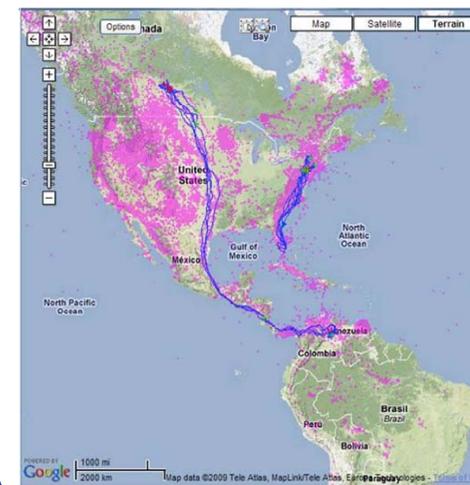
We developed a dataset for uplift strength from orographic deflection and thermals, based on the North American Regional Reanalysis weather data and a DEM.

We compare the observed distribution of uplift to the background distribution in each species.

Eagles prefer Orographic uplift while vultures specialize in utilizing thermals. (Bohrer et al, under review)



Research and visualization tools

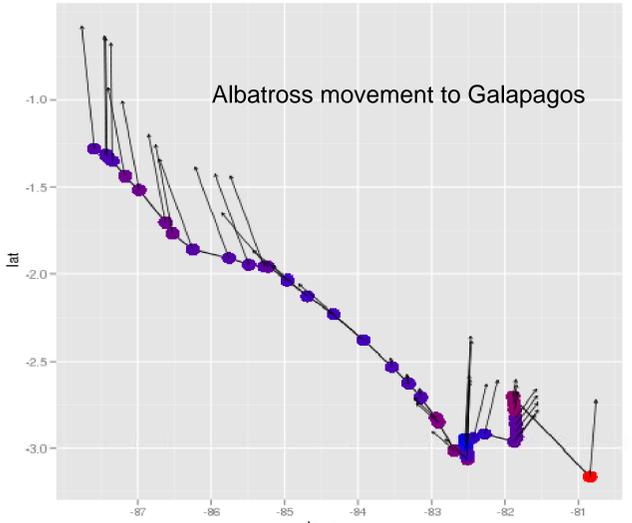


A static visualization tool is producing GoogleEarth KVM files, and can map or overlay satellite image. Dynamic fly-over movie and overlay on wind and temperature will be developed.

Research tools will include GUI assisted hypothesis generation, that will use several methods to generate background "null" domains or virtual movement tracks. The observed distributions of environmental variables along the tracks will be compared with values in the background, or virtual tracks to test hypothesis about response to environmental changes, and environmental drivers of movement

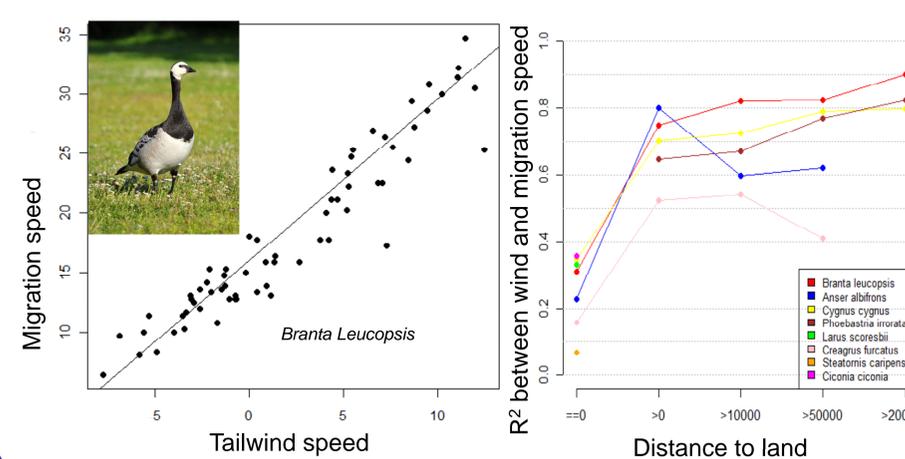
Approach: Track annotation

Interpolating environmental data to observed track points



(Mandel et al. 2008, 2011)

Case study: Importance of wind assistance in long-distance, intercontinental migration



We used data from 8 species of water fowl to test the importance of tailwind assistance in long-distance intercontinental migrations.

We used global wind data from NCEP reanalysis II dataset.

Many species, such as the goose *Branta Leucopsis*, show strong dependence on tailwind.

Tailwind is particularly important out at sea, as evident by the high correlation coefficients between tailwind and migration speed or all species.

However, over land migration speed is less affected by tailwind.