Mesoscale Modeling To Characterize Eagle Soaring Habitat

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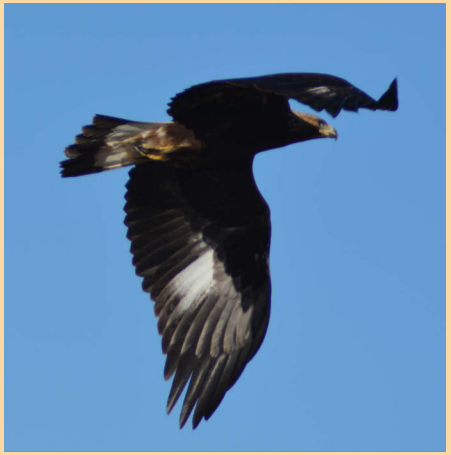
Goal

Atmospheric flow can greatly influence flight patterns of volant species. For obligate soaring birds like golden eagles, updraft velocities can inform where they are likely to travel, at what altitude, and where conditions are not likely sufficient to sustain soaring flight. Of particular concern are areas where near-ground conditions encourage slope soaring on terrain-deflected updrafts (orographic updrafts). Slope soaring eagles are found at altitudes comparable to those occupied by modern wind turbine rotors; thereby creating potential for conflict.

This has been an active area of study in recent years, using relatively coarse atmospheric data generally at the 20-km-by-20-km scale or larger.

Our goal is to:

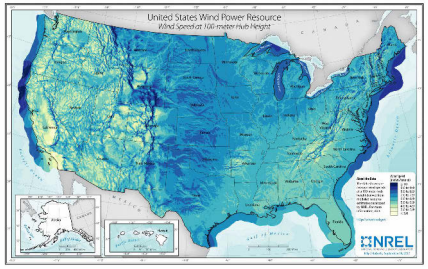
- Understand larger-scale effects that may influence movement patterns of eagles.
- Identify the likelihood that a particular area provides atmospheric conditions that will support eagle soaring and quantify vertical updrafts.
- Perform landscape screening to determine potential eagle risk related to flight heights.
- Identify areas in which slope soaring is unlikely. This will help determine where eagle conflict can be avoided.



Golden eagle. Credit: Chris Farmer, Western EcoSystems Technology Inc.

Method

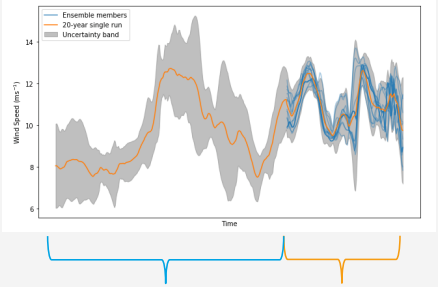
In 2013, NREL created the Wind Integration National Dataset (WIND) Toolkit, which is a time series data set covering 8 years (2007–2014), with model output over the United States every 5 min for every 20 m up to 200 m. It is freely available online. We also created wind power forecasts for selected sites.



100-m averaged wind speeds from the WIND Toolkit (https://www.nrel.gov/grid/wind-toolkit.html)

We will update this data set to

- Cover 20 years
- Create a probabilistic data set and include uncertainty estimates
- Create uncertainty maps together with wind speed maps
- Extract the vertical components of the modeled winds
- Educate users about the benefit of using uncertainties.



Extrapolate uncertainty to 20-year single model run with machine learning techniques

Calculate uncertainty from ensemble spread over subset of data (1 year)

NREL's pathway to creating a 20-year data set including uncertainty estimates. Graph by Mike Optis, NREL

Final Product

Through this work, a mesoscale vertical velocity layer will be produced by calculating the likelihood of orographic updraft and thermal updraft conditions across the continental United States. Specifically, we will use the Weather and Research Forecasting model output combined with digital elevation maps to predict updrafts and then determine if vertical velocities are sufficient to support golden eagle soaring and gliding.

Ultimately, this data layer will be made available as a geographic information system (GIS) layer in the Wind Prospector (maps.nrel.gov/wind-prospector/) tool or a similar framework, so that it is available for use as a siting tool. The data will include:

- Wind speed and direction
- Vertical velocities
- Temperature
- Relative humidity
- Pressure
- Air density
- Turbulence kinetic energy
- Boundary layer height
- Precipitation
- Atmospheric stability
- Sensitive and latent heat fluxes.

Wind speed and direction, vertical velocities, temperature, and turbulence kinetic energy will be available in the vertical every 20 m up to 200 m, every 200 m between 200 m and 1 km, then at 1.5 km, 2 km, and 3 km.

The methods to compute the data will be made public; therefore, the simulations can be reproduced or extended by anyone. These products will advance research on interactions between volant species and wind energy by providing open access to highly resolved data with uncertainty quantification not previously available at this scale.

Atmospheric modeling

- Improved 20-year hindcast of flow across the United States
- 2-km spatial resolution
- 5-min temporal resolution
- Parameterizations of thermals

Eagle flight physics

- Updraft velocity needed to sustain soaring flight
- Understanding of how eagles use terrain and thermal updrafts

Product: GIS layer of soaring habitat

Final GIS layer available through NREL Wind Prospector

Figure credits from left to right include NREL, USGS, NREL.

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