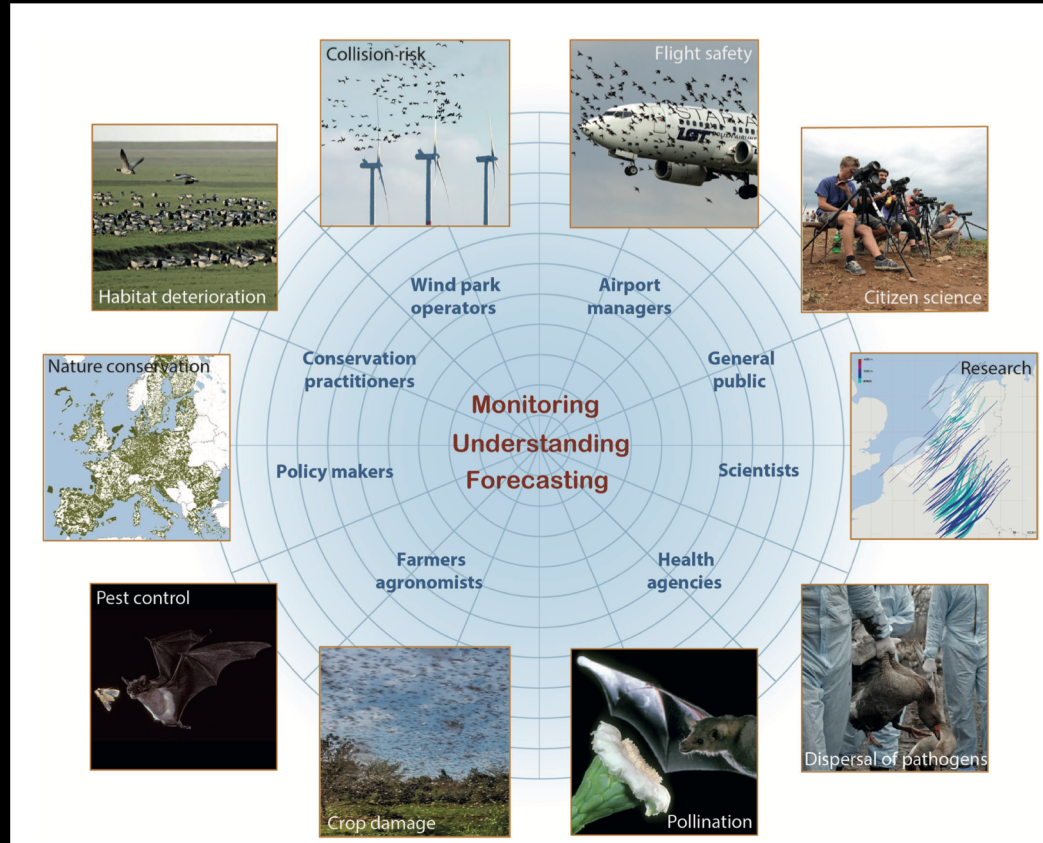


The role of weather surveillance radar in biodiversity monitoring

Andrew Farnsworth, Ph.D.
Center for Avian Population Studies
Cornell University
26 May 2021, EuropaBON



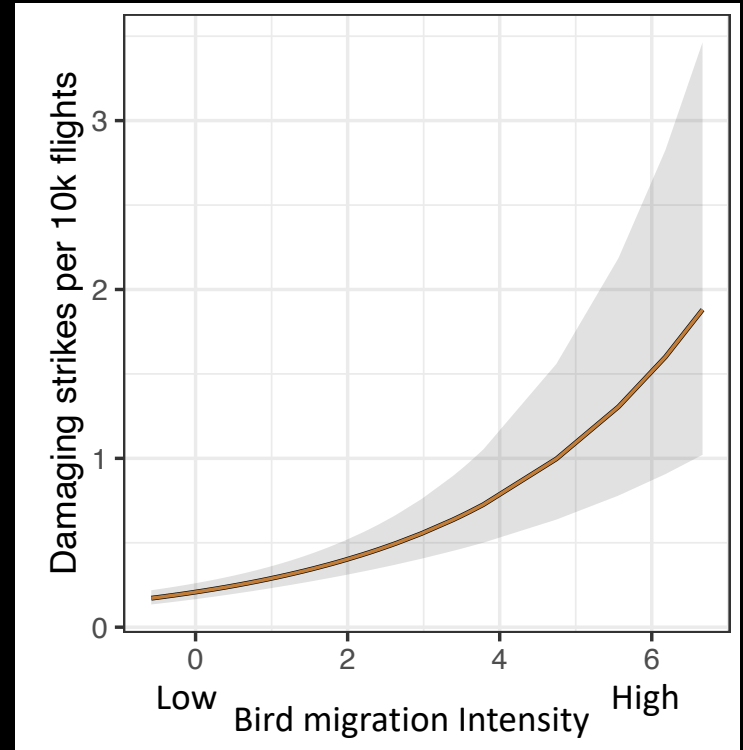
Radar aeroecology for diverse stakeholders



How can bird migration forecasting data enter into major environmental EU policies

- Flight safety – birds and aircraft overlap in airspace usage, creating challenges for aviation safety since the very first human-powered flights and providing opportunities for improving air travel (including siting of airports or aviation activities more broadly).
- Sensory Pollution – air, noise, light, and chemical pollution from anthropogenic activities adversely impacts sensory capabilities of many animals; this is especially true for birds and light pollution

Birds and Aircraft



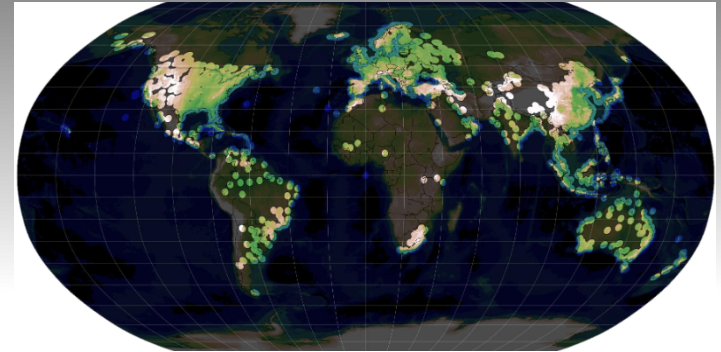
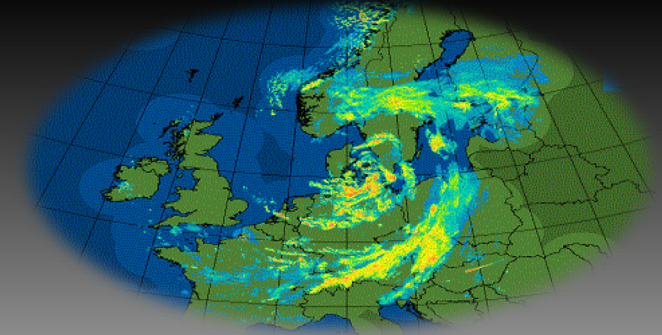
Potential of weather radar networks for flight safety

- Existing hardware organized in networks, upgraded in many countries
- Software tools available for automated extraction of birds
- Ongoing research to improve target detection and data quality
- Online and freely available archive (USA)
- Efforts underway to create European network for monitoring bird movement

<https://globam.science> www.enram.eu



@globam_net



Saltikoff et al 2019 BAMS

Global distribution of operational weather radars indicated with 200km buffer

Sensory (e.g. Light) Pollution is a serious issue for nocturnally migrating birds



Eddystone Lighthouse, 12 October 1901, Marian Clark (in W. E. Clark, Studies in Bird Migration)



1893 – The Columbian Exposition, Chicago: first all electric World's Fair, powered by Tesla!




National 9/11 Museum & Memorial Tribute in Light, Van Doren et al. 2017

Lights Out Alerts: alert.birdcast.info/lightsout

Lights Out Alerts ALPHA BirdCast

Houston, TX Change location

Tonight's migration forecast ⓘ
Night of Friday, April 24
High >21,000 birds/km/night

 **Lights Out Alert**
Turn off your lights tonight to save migrating birds.

A Lights Out Alert has been issued for this region. Large numbers of birds are forecast to migrate over this area overnight. Bright lights attract and disorient nocturnally migrating birds, potentially causing fatal building collisions or exhaustion that leaves birds vulnerable to threats on the ground. Help protect birds as they pass through your region by turning off all non-essential lighting from 7:00PM - 7:00AM tonight.

[Learn more about Lights Out Alerts](#)

3-night migration forecast ⓘ

Fri, Apr 24 High >21,000 birds/km/night	Sat, Apr 25 Low 0-13,000 birds/km/night	Sun, Apr 26 Medium 13,000-21,000 birds/km/night
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The US solution to reducing sensory pollution employs the BirdCast forecast model (Van Doren and Horton 2018)

Three, location specific prediction classes

High intensity prediction produces an "Alert"




How are data integrated through models and data harmonization tools



- Open source analysis tools (bioRad)
- Data standardization (vpts format)
- Van Doren and Horton (2018) - BirdCast
- Indicators – migration metrics, phenology, population declines

bioRad

Biological Analysis and Visualiz ✕

+

← → ↻ adokter.github.io/bioRad/  ⋮

bioRad 0.4.0  Get started Reference Articles ▾ Changelog 

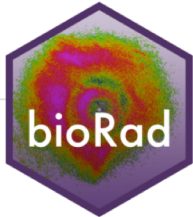
bioRad

bioRad provides standardized methods for extracting and reporting biological signals from weather radars. It includes functionality to inspect low-level radar data, process these data into meaningful biological information on animal speeds and directions at different altitudes in the atmosphere, visualize these biological extractions, and calculate further summary statistics.

To get started, see:

- [Dokter et al. \(2018\)](#): a paper describing the package.
- [bioRad vignette](#): an introduction to bioRad's main functionalities.
- [Function reference](#): an overview of all bioRad functions.
- [Introductory exercises](#): a tutorial with code examples and exercises

Documentation for the latest development version can be found [here](#).



Links

Browse source code at <https://github.com/adokter/bioRad>

Report a bug at <https://github.com/adokter/bioRad/issues>

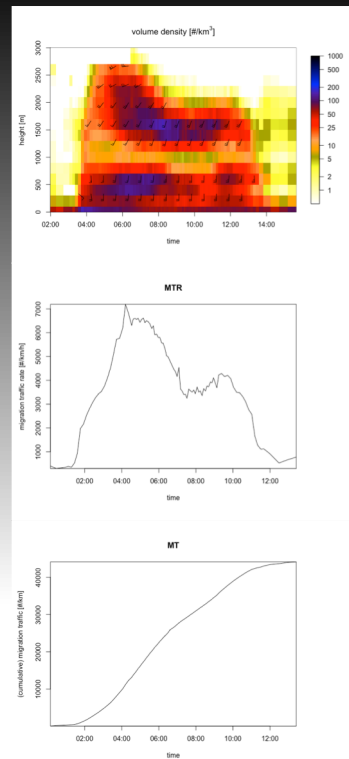
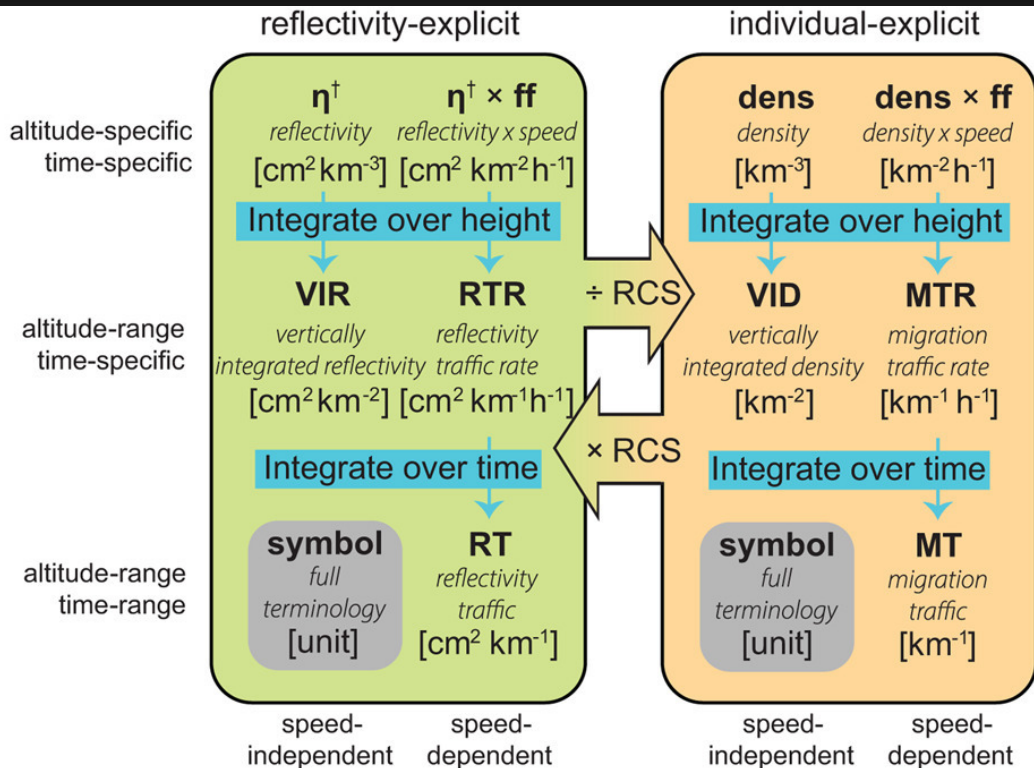
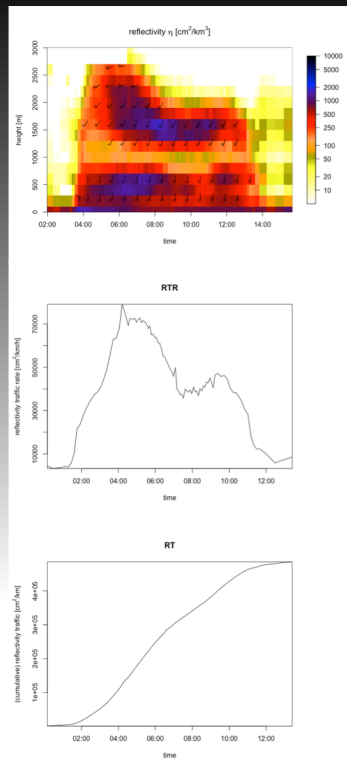
Browse latest development docs at <https://adokter.github.io/bioRad/dev/>

License

[MIT](#) + file [LICENSE](#)

Citation

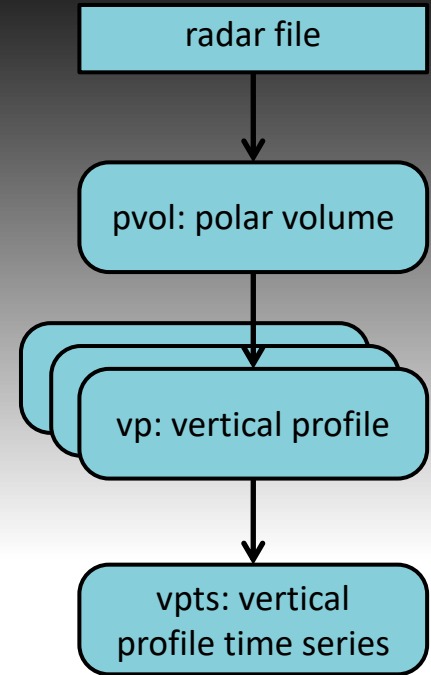
Common measures



RCS = 11 cm² Dokter et al. 2011 *J. R. Soc. Interface*

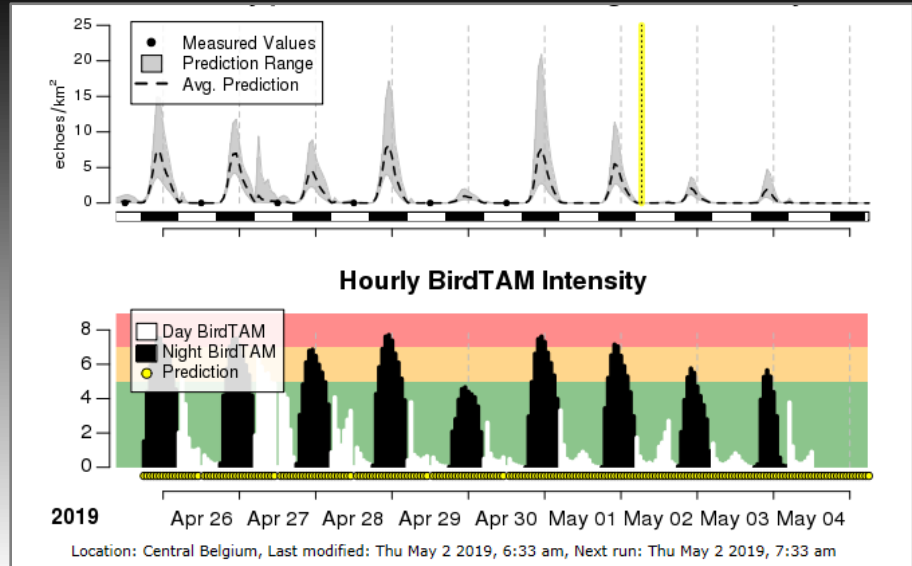
Data standards

- Supported pvol formats:
ODIM (Europe), NEXRAD (US),
Vaisala Iris (e.g. Canada)
- Export vp format of vol2bird:
ODIM bird profile
- Export vpts format:
tabular format under discussion



Predicting migration for flight safety warnings

- Migration abundance, flight altitude, speed and direction from radar as model input
- Atmospheric conditions & seasonal phenology as predictors
- Statistical ensemble models to forecast migration and provide BirdTAMs for military aviation

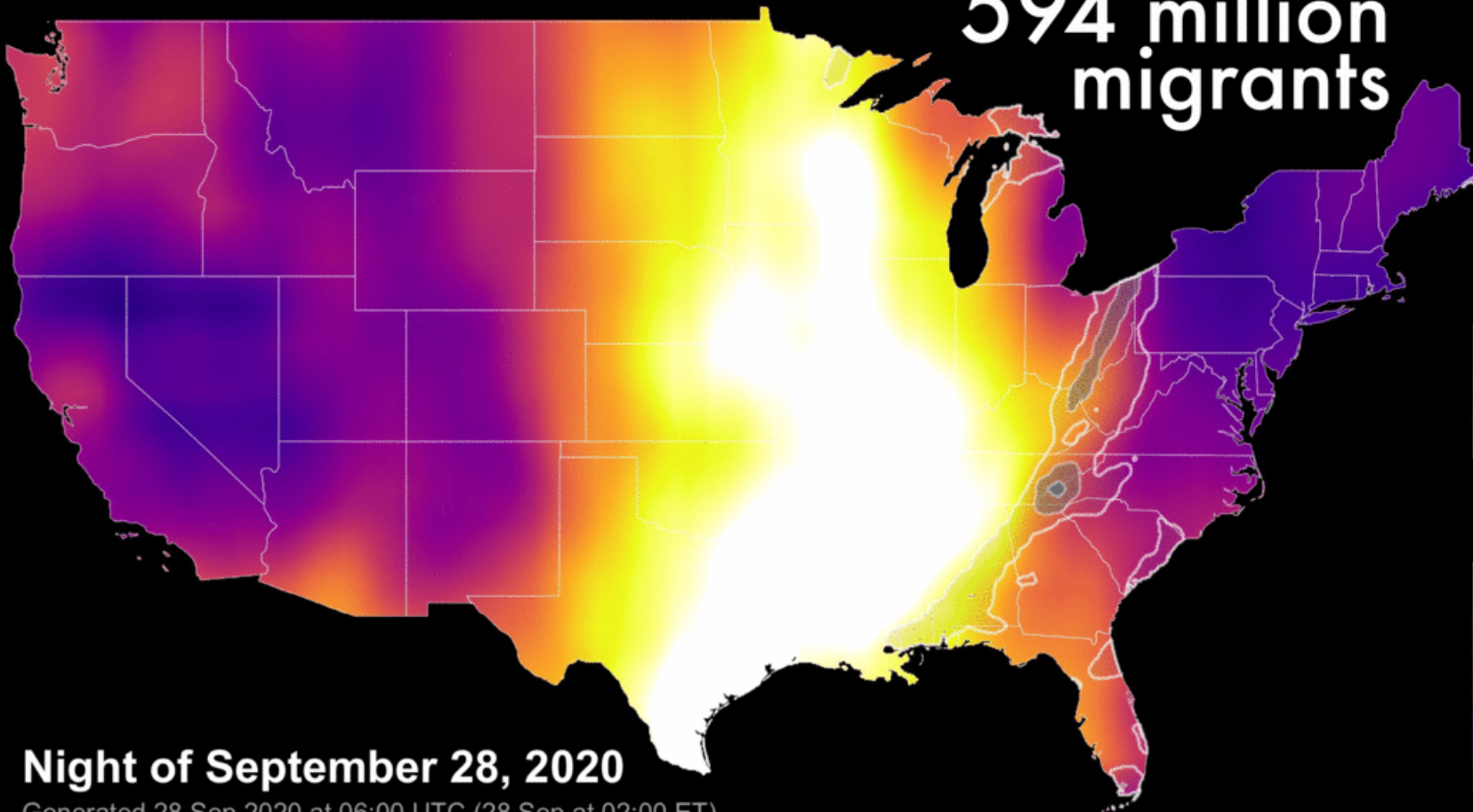


See <http://www.flysafe-birdtam.eu/>
For NL & BE predictions & Western Europe composites

Postdoc Bart Kranstauber, PhD Michael Kemp

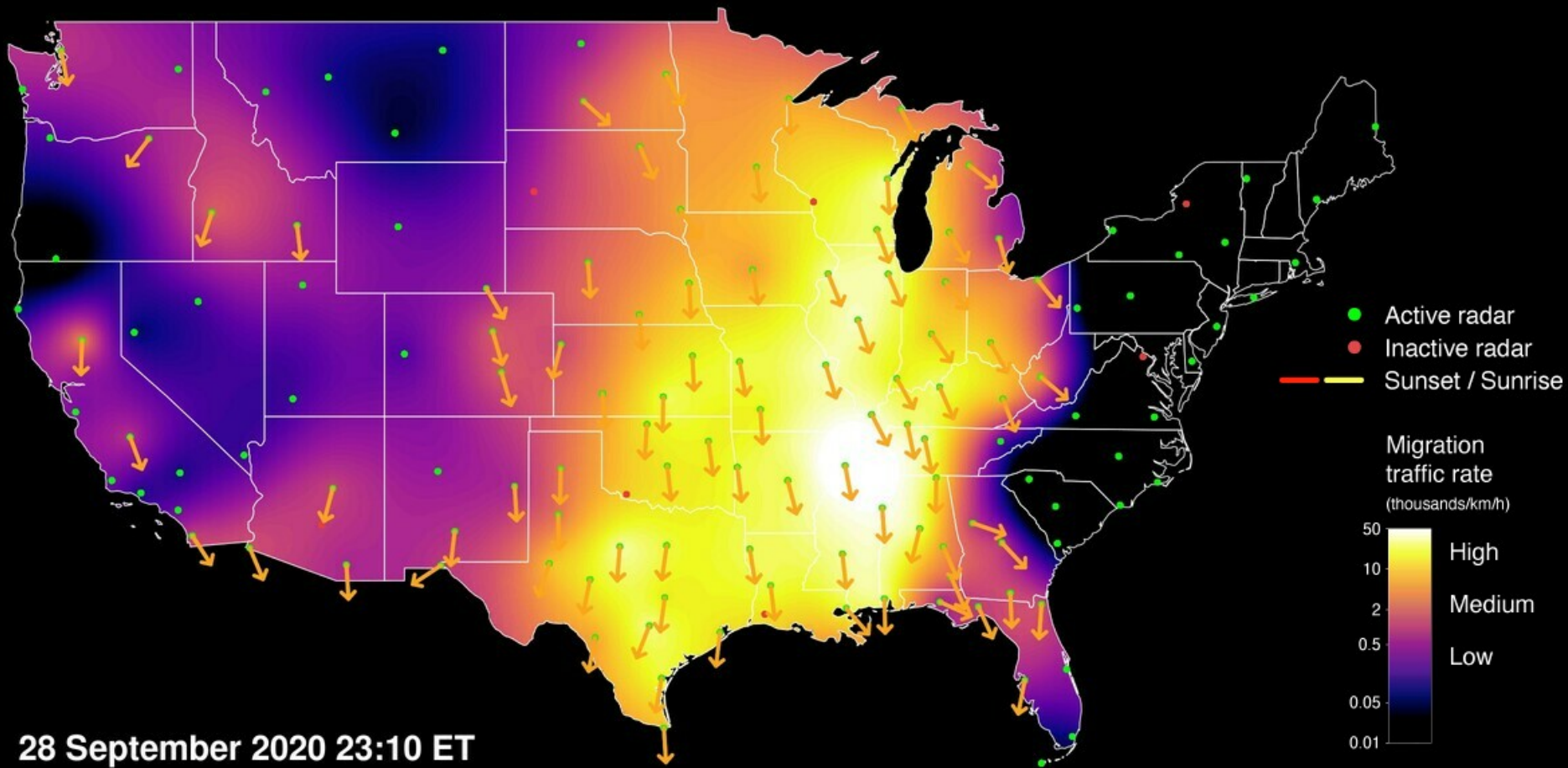
van Gasteren et al 2019, *Ecography*

594 million migrants



Night of September 28, 2020

Generated 28 Sep 2020 at 06:00 UTC (28 Sep at 02:00 ET)



28 September 2020 23:10 ET

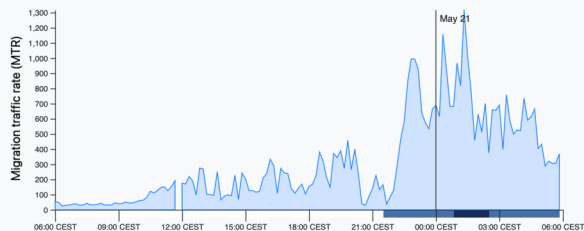
CROW: A new tool to watch bird migration in real time

A GloBAM partner launched an interactive visualization to follow bird migration detected by weather radars across the Benelux.



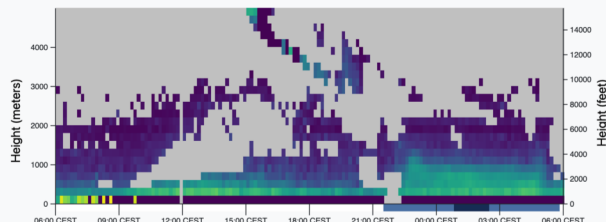
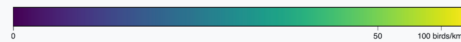
This chart shows the **total number of birds** passing at any given moment over the radar. In total about **7400 birds** flew across a 1 km line during the time shown.

Variable:



This chart shows the measured **bird density** (colour: birds/km²) per height above mean sea level. The BirdTAM colour scale is tailored to aviation.

Colour scale:



This application was jointly developed by the [Royal Meteorological Institute of Belgium \(RMI\)](#) and the [Research Institute for Nature and Forest \(INBO\)](#) in collaboration with the [Royal Belgian Institute for Natural Sciences \(RBINS\)](#), with financial support from the [Belgian Science Policy Office \(BeSPo valorisation project CROW\)](#).

The bird detection is based on the algorithm described in [Dokter et al. \(2011, 2019\)](#). The source data are accessible via the [RMI open data portal](#).

The radar data are provided by:

- [Royal Meteorological Institute of Belgium \(RMI\)](#) (Jabbek & Wideumont)
- [Flemish Environment Agency \(VMM\)](#) (Helchteren)
- [Skeyes](#) (Zaventem)
- [Royal Netherlands Meteorological Institute \(KNMI\)](#) (Herwijnen & Den Helder)
- [Deutscher Wetterdienst \(DWD\)](#) (Essen & Neuheilenbach)
- [Météo-France](#) (Abbeville & Avesnois)

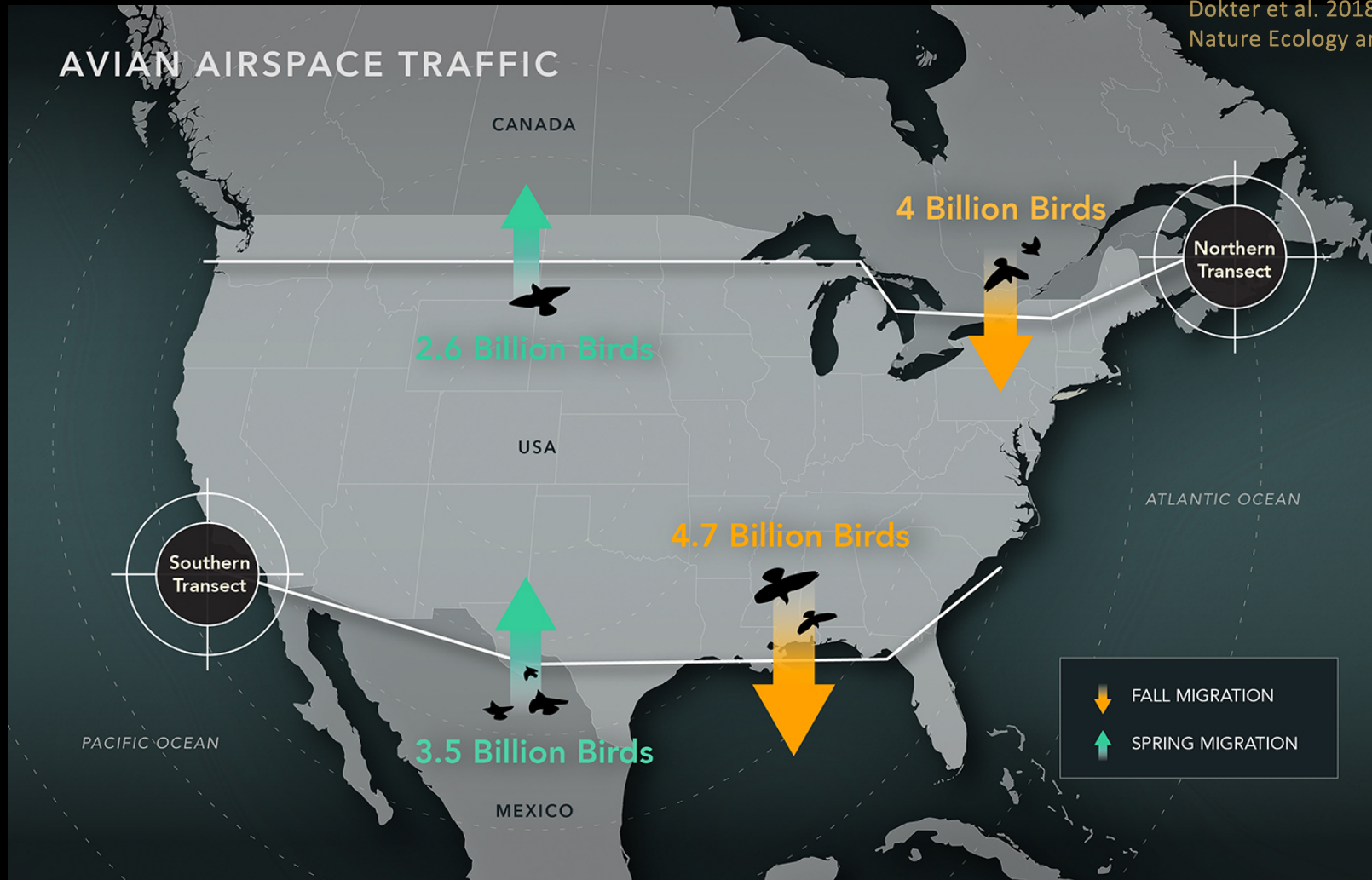
RESEARCH INSTITUTE
NATURE AND FOREST



museum

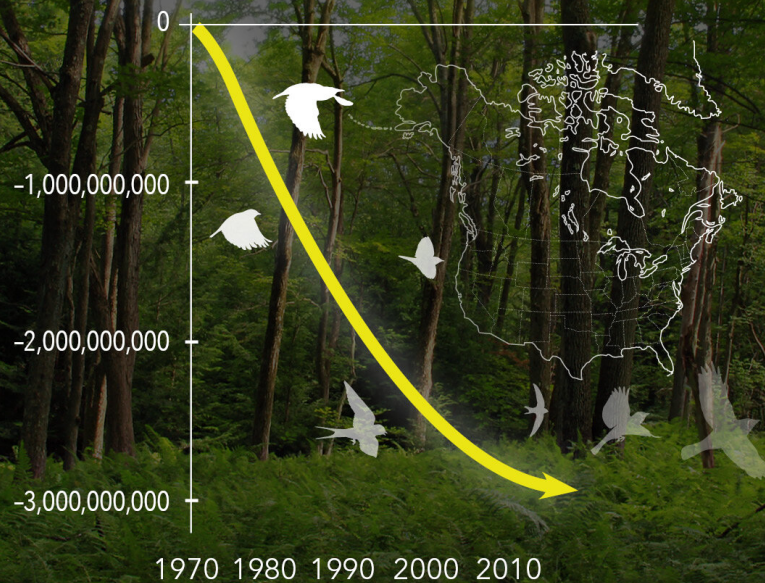


AVIAN AIRSPACE TRAFFIC



2.9 billion

birds gone since 1970



Courtesy of the Cornell Lab of Ornithology. Source: Science, 2019

Forest by Nicholas Tonelli/Creative Commons, Map from Birds of North America birdsna.org

Migratory Birds

2.5

BILLION

MIGRATORY BIRDS

LOST SINCE 1970

-28%

POPULATION LOSS
IN MIGRATORY
BIRD SPECIES
SINCE 1970

2 IN 5

BALTIMORE ORIOLES
LOST SINCE 1970



Courtesy of the Cornell Lab of Ornithology. Source: Science, 2019

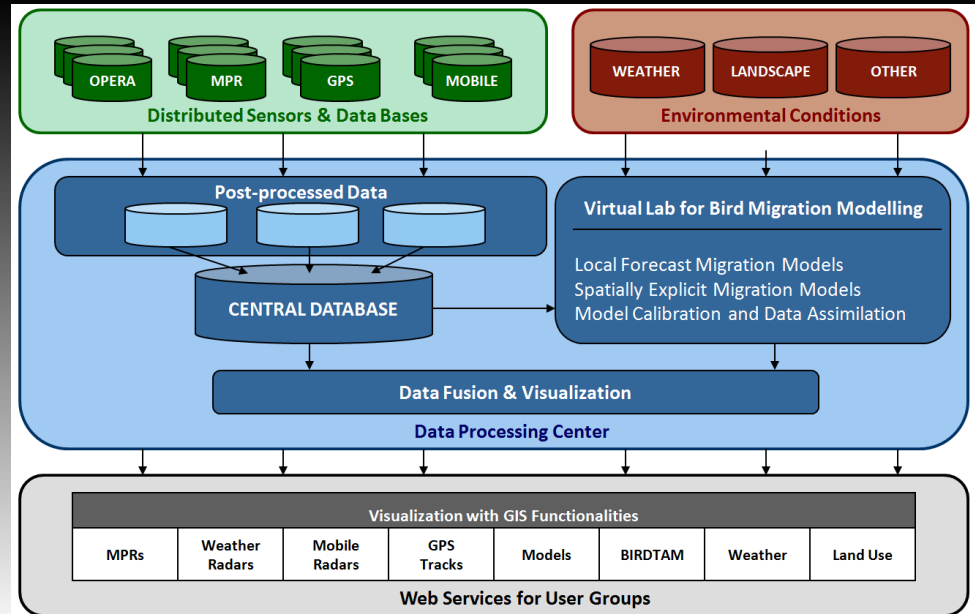
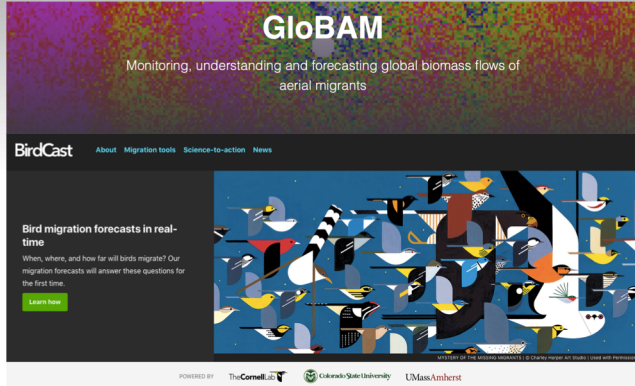
Baltimore Oriole by Gary Mueller/Micra/Getty Library, Forest by Nicholas Tonelli/Creative Commons

Specific opportunities, gaps and challenges to improve data streams and workflows

- Unclean/raw data – Shamoun-Baranes et al. 2021, letter to Science magazine
- Convergence of meteorological and biological research for broad application in aviation, epidemiology, agriculture, climate change studies

EU and International research & development infrastructure and collaboration

- Global infrastructure to support research, development and web services for diverse interest groups
- Include access to diverse radar datasets
- Include post processing & quality control
- Enable integration of data
- Create long term & continuous archive
- Open access for research



System currently under development at University of Amsterdam

The **Cornell** Lab of Ornithology



Colorado State University

