

Managing animal tracking data with Movebank

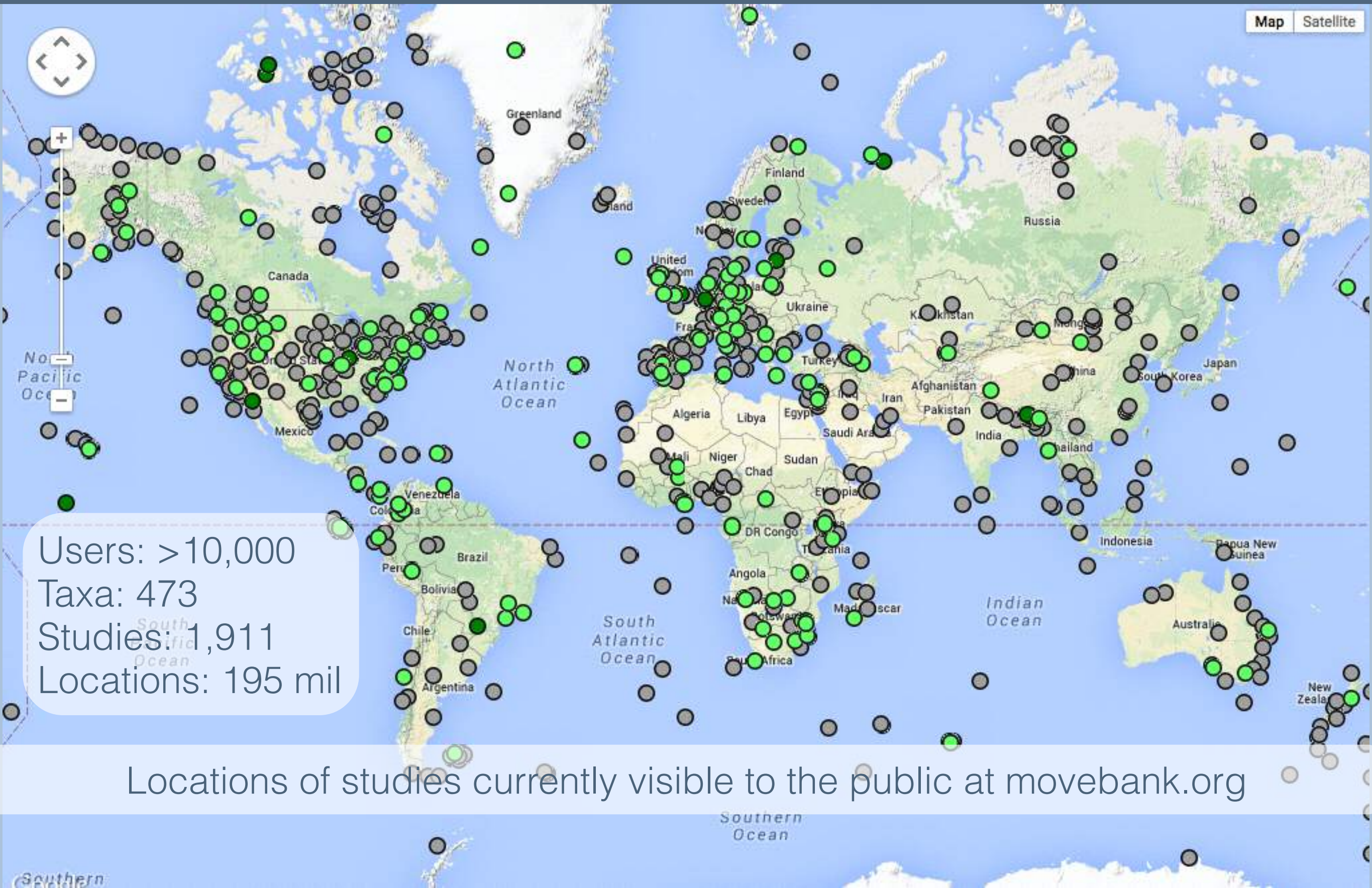


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Max Planck Institute for Ornithology

9 July 2015
Fondazione Edmund Mach
Trento, Italy

MOVEBANK

Manage | Analyze | Share | Archive



Home

About Movebank

Movebank is a free online infrastructure created to help researchers manage, share, analyze, and archive animal movement data. The Movebank project is coordinated by the **Max Planck Institute of Natural Sciences**, and the **University of Konstanz**. Movebank collaborates with the United Nations Food and Agriculture Organization (FAO), the Ohio State University, and the U.S. Geological National Science Foundation, the German Science Foundation, and NASA. Movebank has long-term (>20 years) funding through the Max Planck Society and the University of Konstanz and is dedicated to managing and archiving animal movement data.

Movebank has over 3,500 users including people from universities, government agencies, and other research and conservation groups around the world. Movebank is a resource open to all researchers, regardless of species, study area, or source of funding. **Movebank users retain ownership of their data** and can choose whether or not to make their data available to the public. We encourage collaboration and encourage government to re-use animal tracking data and give it a second life.

The database is designed primarily for datasets that include multiple locations of individual animals, commonly referred to as tracking data. It also allows inclusion of a growing number of additional data types, including data about animals and tags, manufacturer-specific measurements, and data from other bio-logging sensors attached to animals.

In addition to the main database, the **Movebank Data Repository** allows researchers to submit data sets in Movebank for publication. Submitted data sets undergo a review process and if accepted, are licensed, and are archived and made permanently available online by the University of Konstanz.

As of August 2014, Movebank includes

- 1,306 studies
- over 1,296 contributors
- 417 taxa
- 40,615 tracks
- 100 million locations

Background

Information about animal movement is important to addressing environmental challenges such as climate and land use change, biodiversity loss, invasive species, and infectious diseases. Advances in tracking technology are allowing researchers to collect increasingly large amounts of animal movement data. However, working with these large data sets remains a challenge, and a large fraction of these data sets are not professionally catalogued or archived.

FUNDING

Long term

Max Planck Institute for Ornithology
University of Konstanz

Previous grants

German Science Foundation
U.S. National Science Foundation
U.S. National Aeronautics and
Space Administration (NASA)

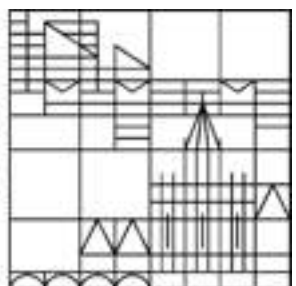


MAX-PLANCK-GESELLSCHAFT

DFG Deutsche
Forschungsgemeinschaft



Universität
Konstanz



GOALS



Enable collaborations

GOALS



Enable collaborations

Help scientists address new questions

GOALS



Enable collaborations

Help scientists address new questions

Promote open access to data

GOALS



Enable collaborations

Help scientists address new questions

Promote open access to data

Allow the public to explore

GOALS



Enable collaborations

Help scientists address new questions

Promote open access to data

Allow the public to explore

Archive animal movement data

SHARING & PRIVACY



Data owners control access

data managers (read and write)

collaborators (read only)

public

Permissions

[?](#)

Visibility of study name and summary Public

Default visibility of tracking data Collaborators Only

It is possible to override the visibility of tracking data at the level of individual animals. Here you can undo all settings done on individual animals:

☐ Reset visibility of tracking data to default

You may allow users to see your tracking data on a map, but restrict their ability to download data, e.g. in Excel, csv or kml format.

☒ Restrict data downloads to Data Managers Only

Users downloading your data for the first time, are prompted to accept the license terms. For some external applications this feature is not desirable and may therefore be disabled.

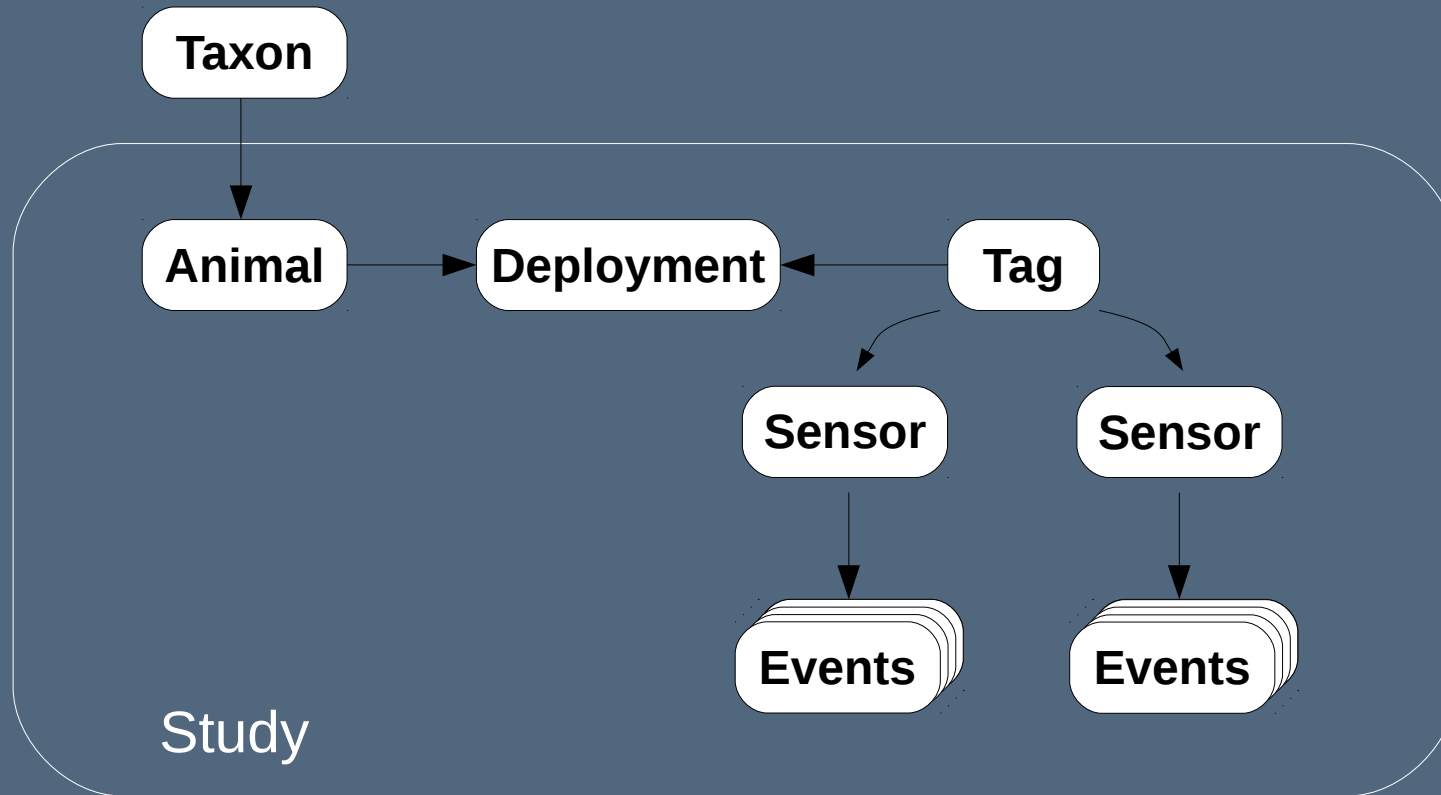
☒ Prompt users to accept license terms?

Save Close

DATA TYPES

Individual animal tracks and related attributes

All data are stored in user-created studies.



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DATA TYPES



Tracking methods

GPS

Argos Doppler Shift

Radio transmitter

Bird ring

Natural mark

Solar geolocator: locations + light levels



DATA TYPES

Movebank provides a common format.

What Movebank sees in your file

date	time	long	lat	species	tag	individual name	speed	heading	height	visible
2008-12-18	12:21:19.001	8.9858828	47.7382944	Aythya ferina	420	Common Pochard F	73	347.34	438.5	TRUE
2008-12-18	12:30:22.999	8.9857864	47.7382972	Aythya ferina	420	Common Pochard F	22	33.42	441	TRUE
2008-12-18	13:01:38.001	8.9859685	47.7378514	Aythya ferina	420	Common Pochard F	97	191.37	441.7	TRUE
2008-12-18	13:30:12.000	8.9855835	47.738281	Aythya ferina	420	Common Pochard F	12	351.93	442.4	TRUE
2008-12-18	14:01:25.998	8.985615	47.7382313	Aythya ferina	420	Common Pochard F	86	348	449.6	TRUE
2008-12-18	14:30:23.999	8.9857624	47.73807	Aythya ferina	420	Common Pochard F	23	336.86	453.1	TRUE

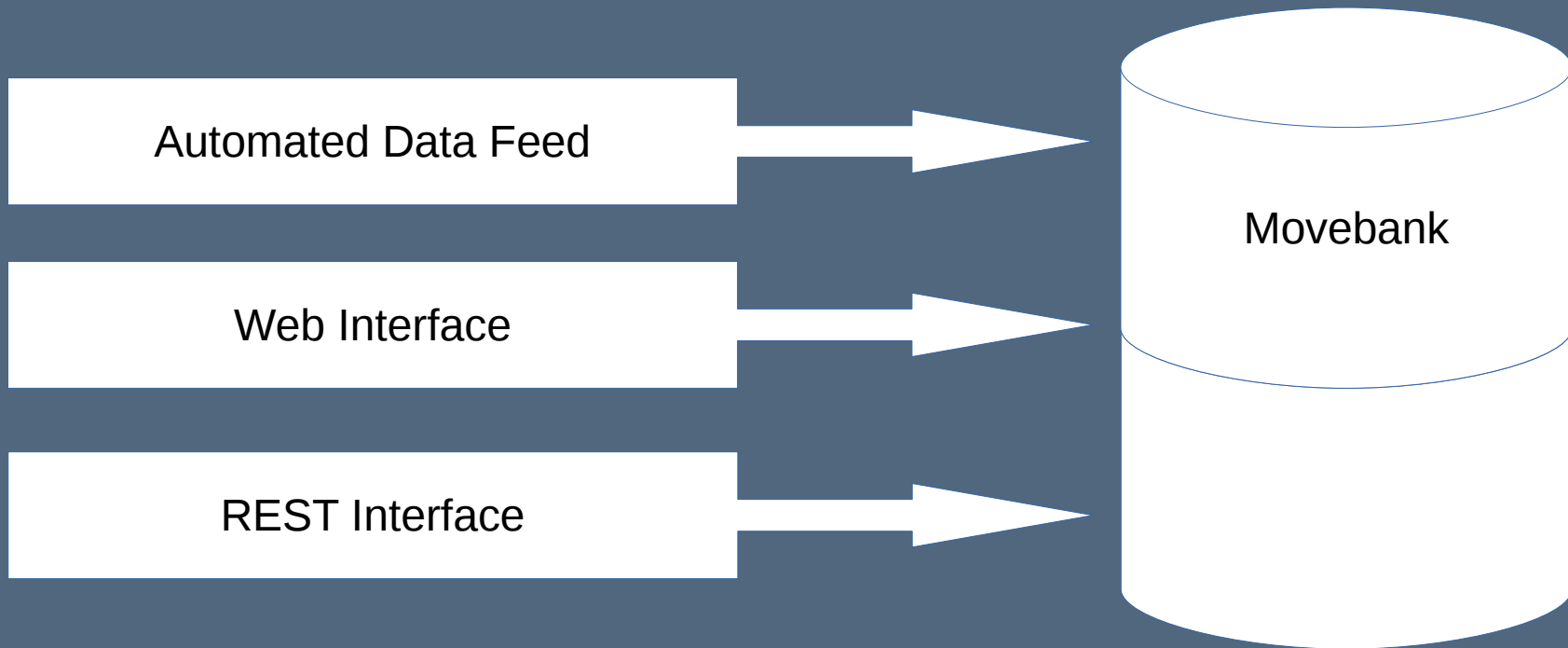
Map other Attributes

How Movebank will save the data

Sensor Type ✕	Timestamp ✕	Location Lat ✕	Location Long ✕	Animal Id ✕	Tag Id ✕
GPS	2008-12-18 12:21:19.001	47.7382944	8.9858828	Common Pochard F	420
GPS	2008-12-18 12:30:22.999	47.7382972	8.9857864	Common Pochard F	420
GPS	2008-12-18 13:01:38.001	47.7378514	8.9859685	Common Pochard F	420
GPS	2008-12-18 13:30:12	47.738281	8.9855835	Common Pochard F	420
GPS	2008-12-18 14:01:25.998	47.7382313	8.985615	Common Pochard F	420
GPS	2008-12-18 14:30:23.999	47.73807	8.9857624	Common Pochard F	420

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DATA IMPORT



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DATA IMPORT



1. Set up an automated data feed to
 - Argos GPS-PTTs: Microwave and NorthStar/GeoTrak
 - Argos DIAG: all PTTs

Live Argos Feed Monitor

Program 983 DIAG GPS

New Edit

DIAG	Last input of raw data:	2011-03-07 03:58:02	OK	
DIAG	Last time locations were imported into Movebank:	2011-03-07 05:22:13	OK	Import OK in 33 of 33 tags.
DS	Last input of raw data:	2011-03-05 22:00:31	OK	
DS	Last time locations were imported into Movebank:	2011-03-05 23:13:32	OK	Import OK in 33 of 33 tags.

Refresh

Close

Argos telnet subscription

Program ID User Password Test connection

☒ Get all data for selected program
☐ Download data only for following PTTs

Known PTTs

☒ Download DIAG data
☒ Import Argos Doppler locations Configure Argos filtering

☒ Download DS data
☒ Import / Decode Microwave GPS data

☒ All data ☐ For following PTTs

Known PTTs

☐ Import / Decode North Star / GeoTrak GPS data

Finish Cancel

DATA IMPORT

I. Set up an automated data feed to

Argos DIAG

Argos GPS-PTTs: Microwave and NorthStar/GeoTrak

GSM-GPS tags: CTT, Ecotone, e-obs, Fleetronic, Microwave

Manage live feed: CTT GSM

Provider: CTT GSM

Feed subscriber: j.schmoe (Joseph Schmoe)

Feed activity: ☒ on ☐ off

Feed elements:

Tag ID	Data points	Last import	Status
89014103256540803045	2184	Thu May 15 10:20:34 GMT-400 2014	OK
89014103256540803078	2964	Thu May 15 10:20:30 GMT-400 2014	OK
89014103256345345796	6484	Wed May 21 08:37:45 GMT-400 2014	OK
89014103256345345804	5313	Wed May 21 08:40:03 GMT-400 2014	OK

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DATA IMPORT



I. Set up an automated data

Argos DIAG

Argos GPS-PTTs: Microway

GSM-GPS tags: CTT, Ecoto

and receive email notifications

Email Configurator

Subscribe here for a daily or weekly email notification containing basic statistics of your recent data. These include information on when data have been last collected and what distances were travelled.

Subscribe for email	<input checked="" type="checkbox"/> (Uncheck to revoke subscription)
Schedule	<input type="radio"/> daily <input checked="" type="radio"/> weekly
Day of week	Monday
Time of day (GMT)	9:00
Send to	support@movebank.org
Email format	<input checked="" type="radio"/> ASCII <input type="radio"/> HTML
Hide undeployed data	<input type="checkbox"/>
Hide outliers	<input checked="" type="checkbox"/>
Include Argos Doppler Shift Statistics	<input checked="" type="checkbox"/>
Attach KMZ file	<input type="checkbox"/>
KMZ data interval	Unlimited
Include GPS Statistics	<input checked="" type="checkbox"/>
Attach KMZ file	<input checked="" type="checkbox"/>
KMZ data interval	Two weeks
Detect mortality	<input type="checkbox"/> Edit criteria

Save

Send mail now

Close



DATA IMPORT

1. Set up an automated data feed.

2. Import a supported standard file.

Argos Doppler Shift raw DIAG files

GPS: e-obs, Lotek, Microwave, NorthStar/GeoTrak, Sirtrack

Solar geolocators: BAS trajectory data

Others can be added by request

DATA IMPORT

1. Set up an automated data feed.
2. Import a supported standard file.
3. Import a custom format .csv file.

What Movebank sees in your file

date	time	long	lat	species	tag	individual name	speed	heading	height	visible
2008-12-18	12:21:19.001	8.9858828	47.7382944	Aythya ferina	420	Common Pochard F	73	347.34	438.5	TRUE
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Map other Attributes

How Movebank will save the data

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GPS	2008-12-18 13:01:38.001	47.7378514	8.9859685	Common Pochard F	420
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GPS	2008-12-18 14:30:23.999	47.73807	8.9857624	Common Pochard F	420

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TOOLS



A shared database allows shared tools.

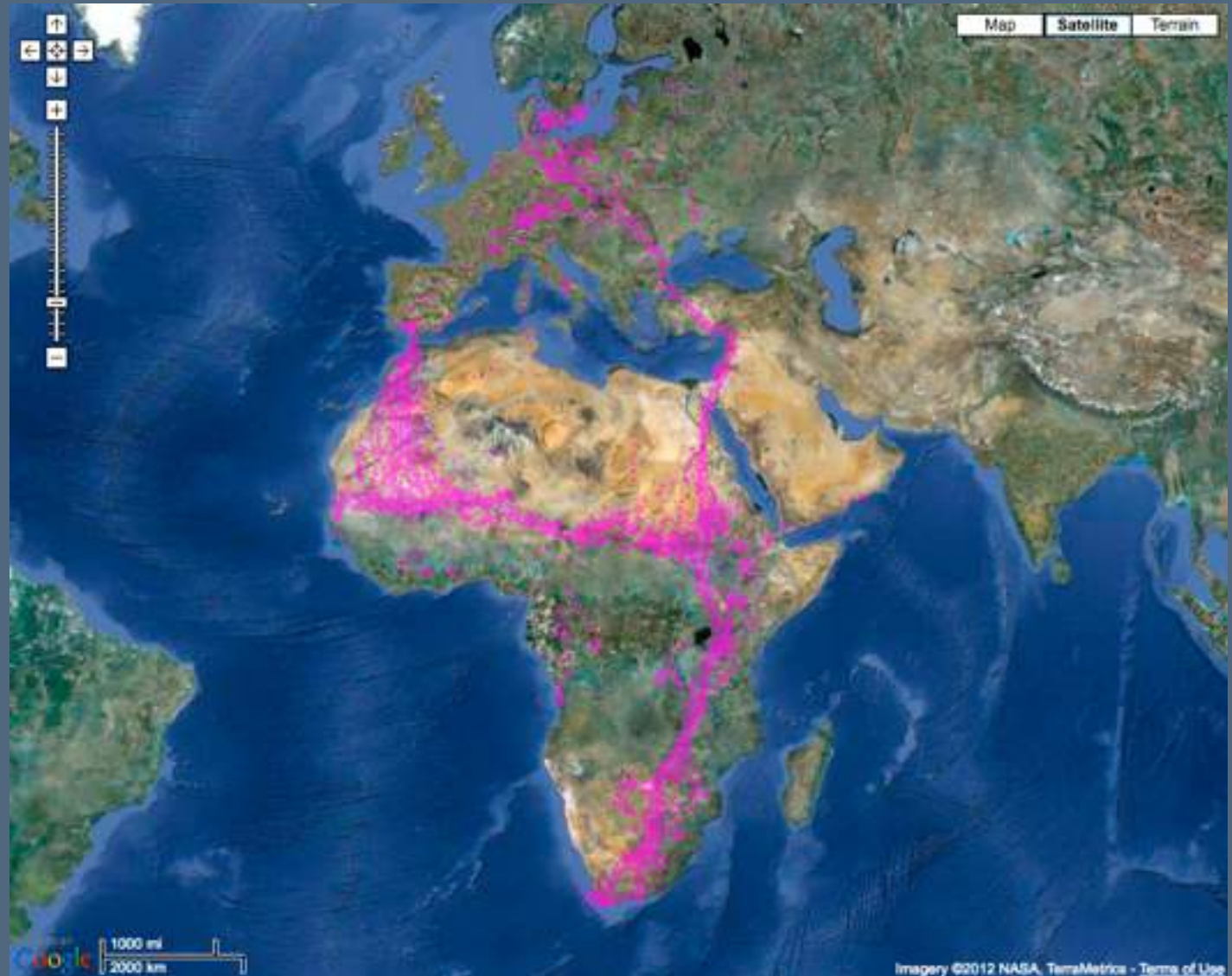
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TOOLS



A shared database allows shared tools.

Mapping



data from Max Planck Institute for Ornithology and collaborators

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TOOLS

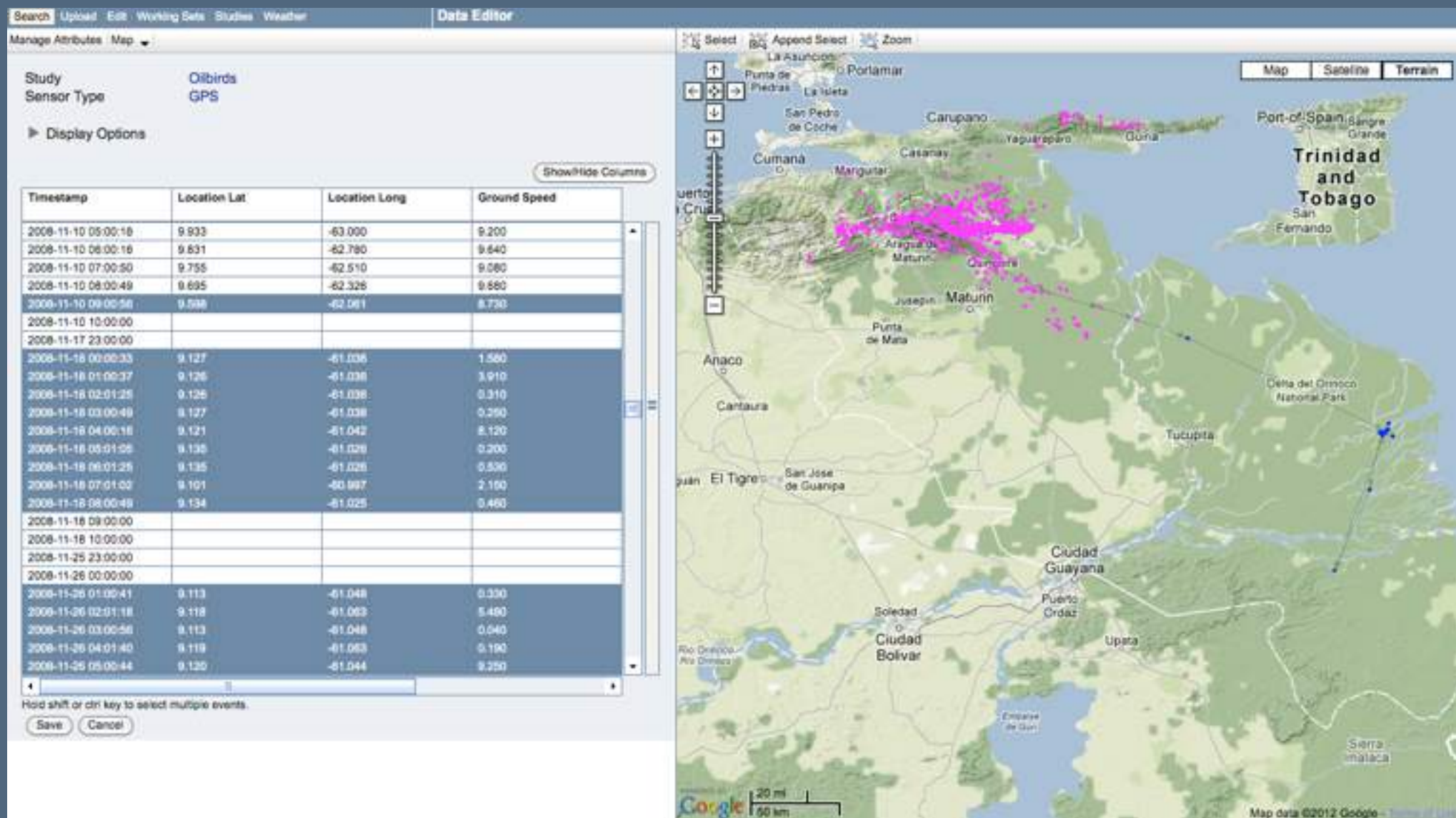


A shared database allows shared tools.

Mapping

Management

Event Editor



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TOOLS

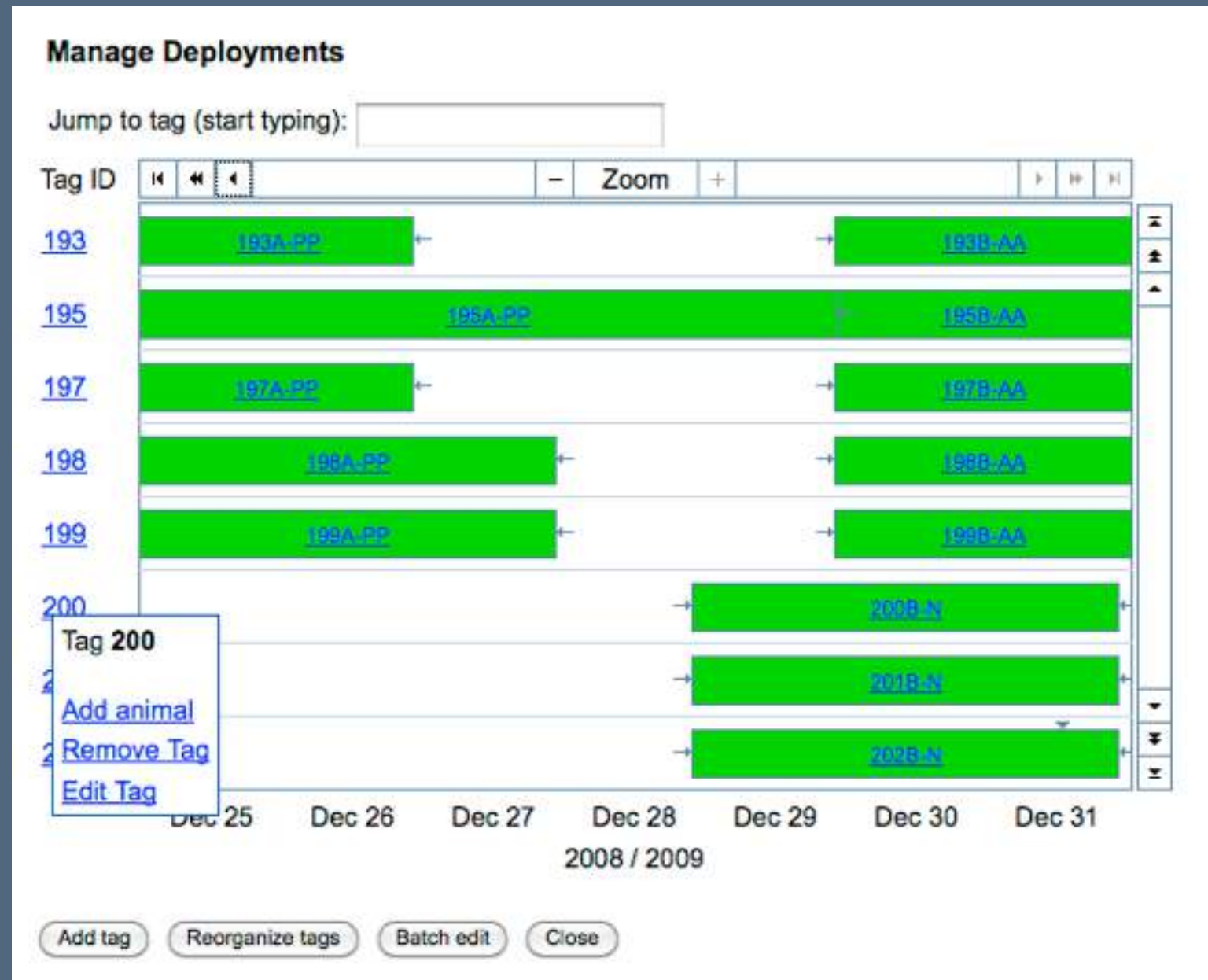


A shared database allows shared tools.

Mapping

Deployment Manager

Management



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TOOLS



A shared database allows shared tools.

Mapping

Management

File conversion

Download tracking data

Available Sensor Types

GPS

☒ Filter by date

From: yyyy-MM-dd select interval

To: yyyy-MM-dd

☒ Csv ☐ ESRI shapefile

☐ Excel 97 ☐ GoogleEarth (Tracks)

☐ Excel 2007 ☐ GoogleEarth (Home Range) ?

☐ Include undeployed locations ?

☐ Include points marked as outliers ?

☐ Add UTM coordinates

☒ Add study local time ?

Download Close

Manage | Analyze | Share | Archive

TOOLS



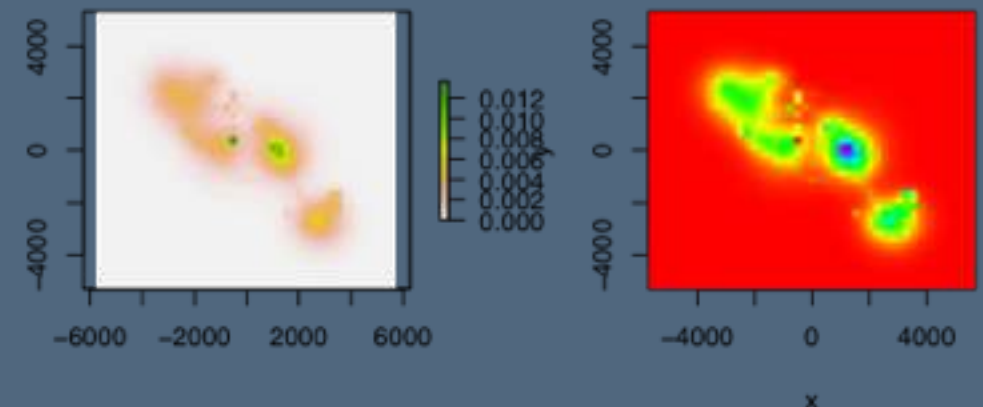
A shared database allows shared tools.

Mapping

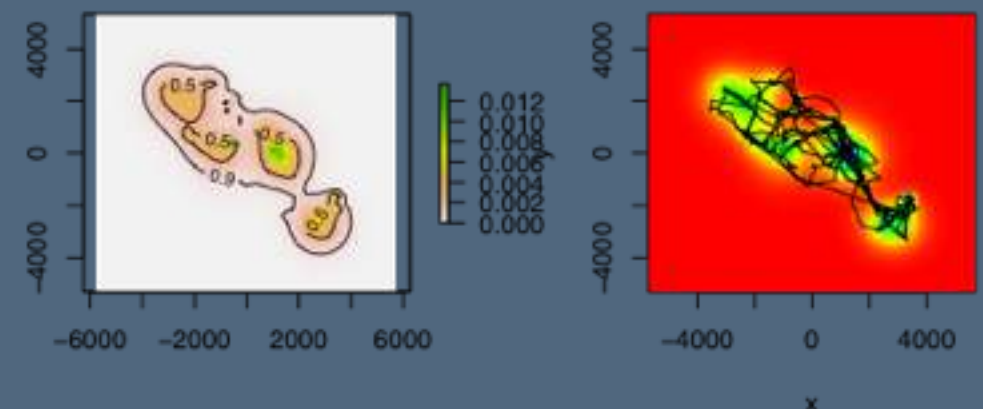
Management

File conversion

Software and analysis packages



R package “move”



DATA FILTERS

Filters flag outliers but do not delete data.

Study: FAO-USGS goose migration (Douglas Argos Filter Tutorial)

Sensor Type: Argos Doppler Shift

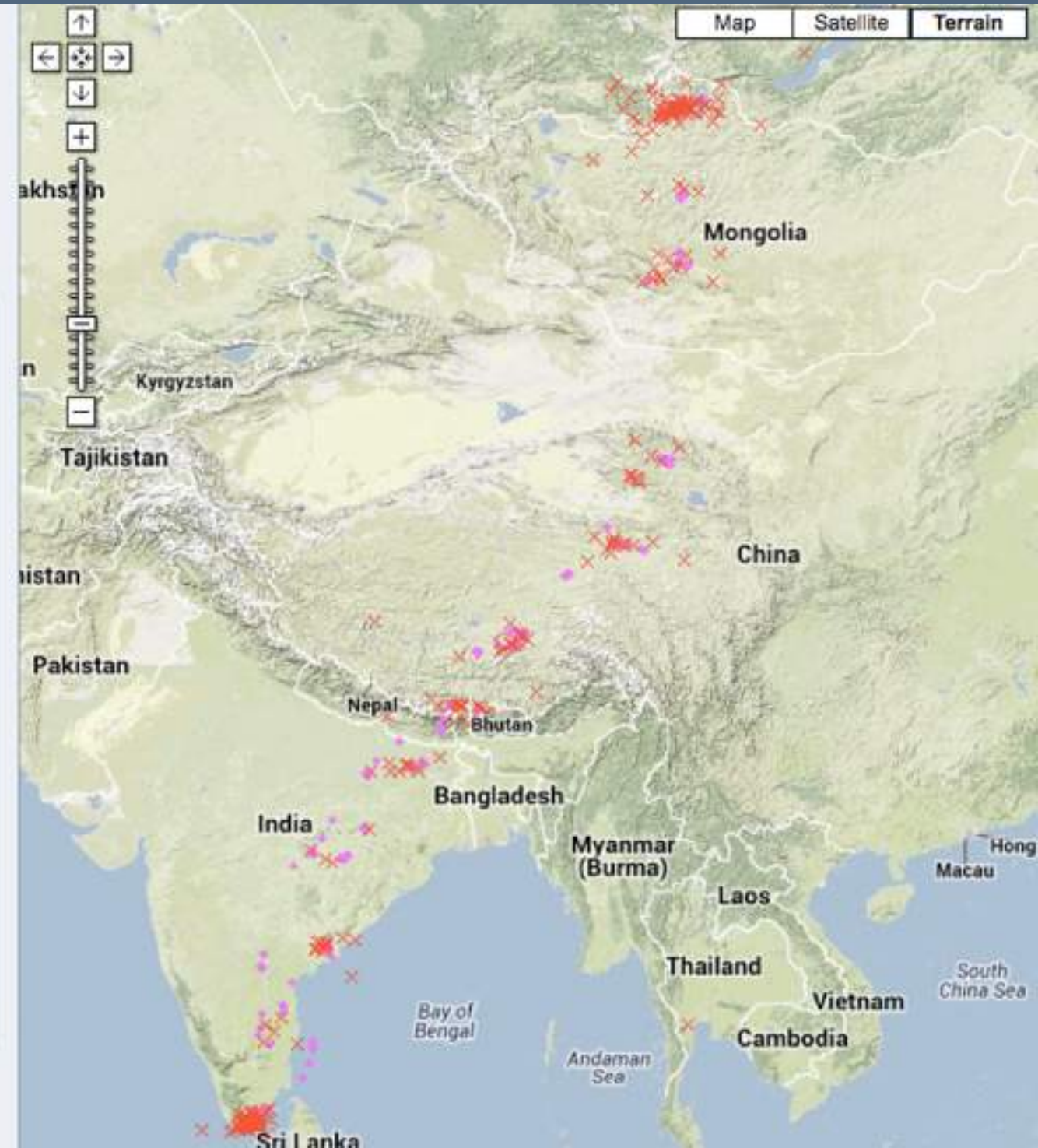
Display Options

Show/Hide Columns

Timestamp	Location Lat	Location Long	Algorithm Marked Outlier
2009-01-27 11:02:10	8.488	77.760	
2009-01-27 11:22:04	8.463	77.757	
2009-01-27 12:40:40	8.505	77.797	
2009-01-27 13:04:24	8.489	77.764	
2009-01-28 09:02:37	8.493	77.771	
2009-01-28 10:35:00	8.515	77.733	
2009-01-28 11:10:50	8.493	77.767	
2009-01-28 12:16:07	8.546	77.818	true
2009-01-28 12:16:07	8.546	77.818	
2009-01-28 12:51:14	8.499	77.747	
2009-01-28 16:08:02	8.509	77.747	
2009-01-28 16:08:32	8.509	77.751	
2009-01-30 12:27:45	8.541	77.756	
2009-01-30 15:22:24	8.329	77.812	
2009-01-30 15:26:24	8.495	77.843	
2009-01-30 17:01:09	8.446	77.829	
2009-01-30 17:07:00	8.449	77.836	
2009-01-30 19:43:54	8.445	77.818	
2009-01-30 21:24:01	8.466	77.856	
2009-01-30 22:25:00	8.441	77.831	
2009-01-30 23:32:46			true
2009-02-01 00:58:42	8.501	77.897	
2009-02-01 03:34:42	8.662	78.249	true
2009-02-01 03:42:37	8.393	77.854	
2009-02-01 05:13:52	8.430	77.849	

Hold shift or ctrl key to select multiple events.

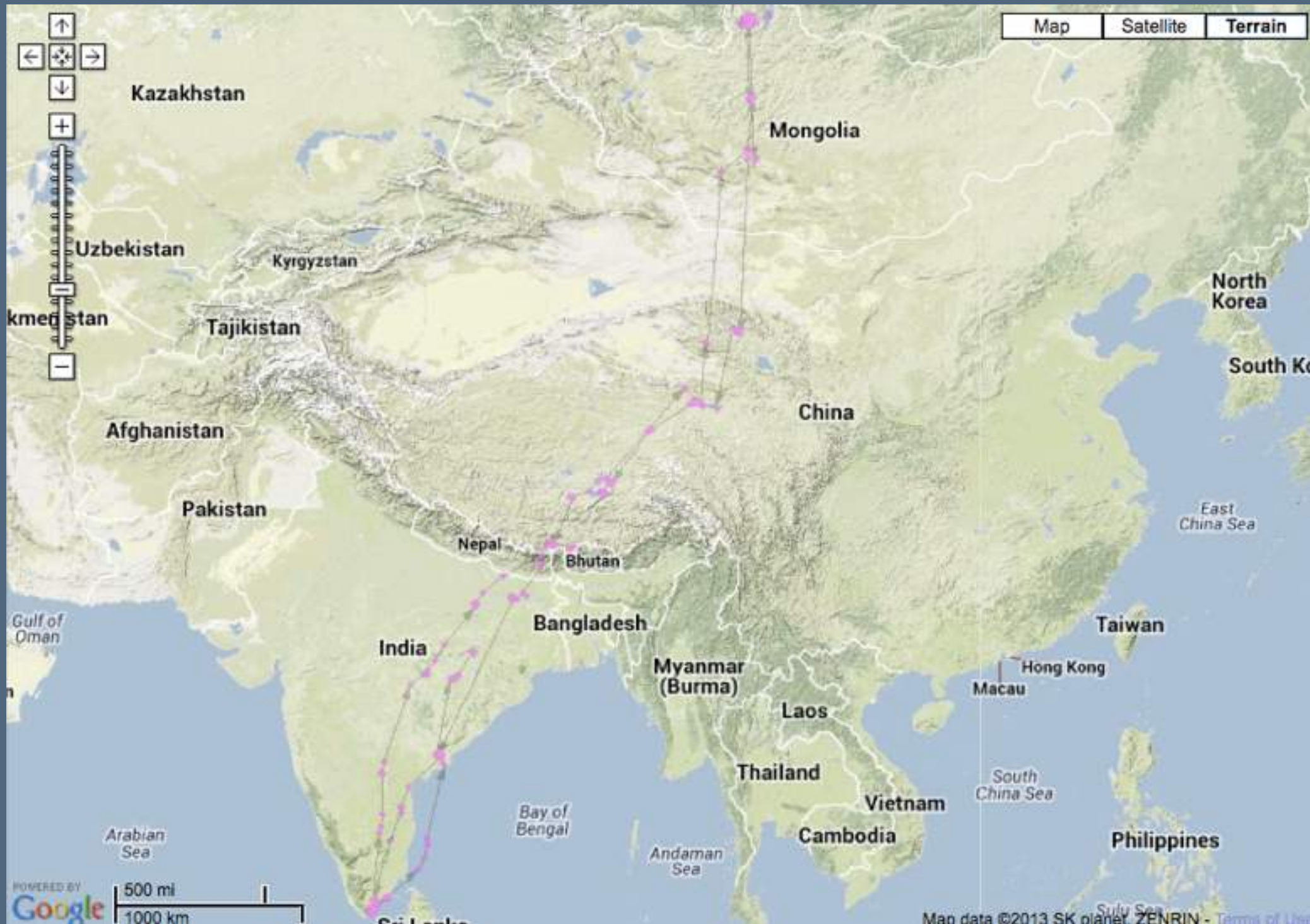
Save Cancel



DATA FILTERS



Filters flag outliers but do not delete data.



DATA FILTERS



Douglas Argos Filter Algorithm

Douglas Filter Parameters

Filter Method: ?

keep_lc: ?

maxredun: ?

MRD filter advanced parameters:

keeplast: ☐ enabled ?

skiploc: ☐ enabled ?

DAR filter parameters:

minrate: ?

r_only: ☐ enabled ?

ratecoef: ?

Best Hybrid filter parameters:

xmigrate: ?

xoverrun: ?

xdirect: ?

xangle: ?

xpercent: ?

testp_0a: ?

testp_bz: ?

Best of Day filter

pickday: ☐ enabled ?

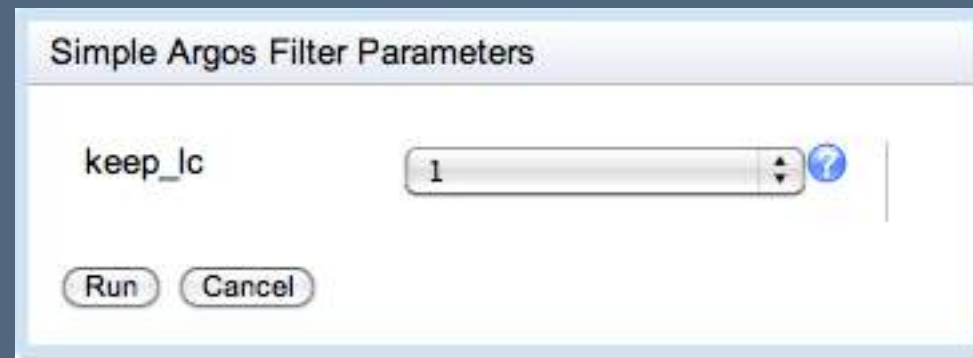
minoffh: ?

rankmeth: ?

☒ Remember Configuration

DATA FILTERS

Argos LC filter

A screenshot of a software dialog box titled "Simple Argos Filter Parameters". It contains a single parameter, "keep_lc", which is set to the value "1" in a numeric input field. To the right of the input field is a small blue circle with a white question mark. At the bottom of the dialog box are two buttons: "Run" and "Cancel".

Simple Argos Filter Parameters

keep_lc 1

Run Cancel

DATA FILTERS

General purpose filters

Duplicate filter

☒ Filter duplicates

The filter will flag records for which all key attributes are duplicated.

Available Attributes		Key Attributes
Location Long	➔	Tag Id
Location Lat	➔	Timestamp
Eobs Battery Voltage	➔	
Heading	➔	

DATA FILTERS

General purpose filters

Duplicate filter

Value range filter

☒ Filter by value range

The filter will retain records that match the ranges provided, and flag records outside the ranges.

☒ Keep null values ☐ Remove null values

☒ Match all of the following ☐ Match any of the following

Location Error Numerical < 30 Add

Remove All Filters

DATA FILTERS

General purpose filters

Duplicate filter

Value range filter

Speed filter

☒ Filter by speed (experimental)

Read about [speed filter algorithms](#)

Max. plausible speed (m/s):

Max. location error (m):

Used algorithm: ☒ Valid anchor ☐ Longest consistent track ☐ Simple outlier

ENV-DATA

Environmental Data Automated Track Annotation System

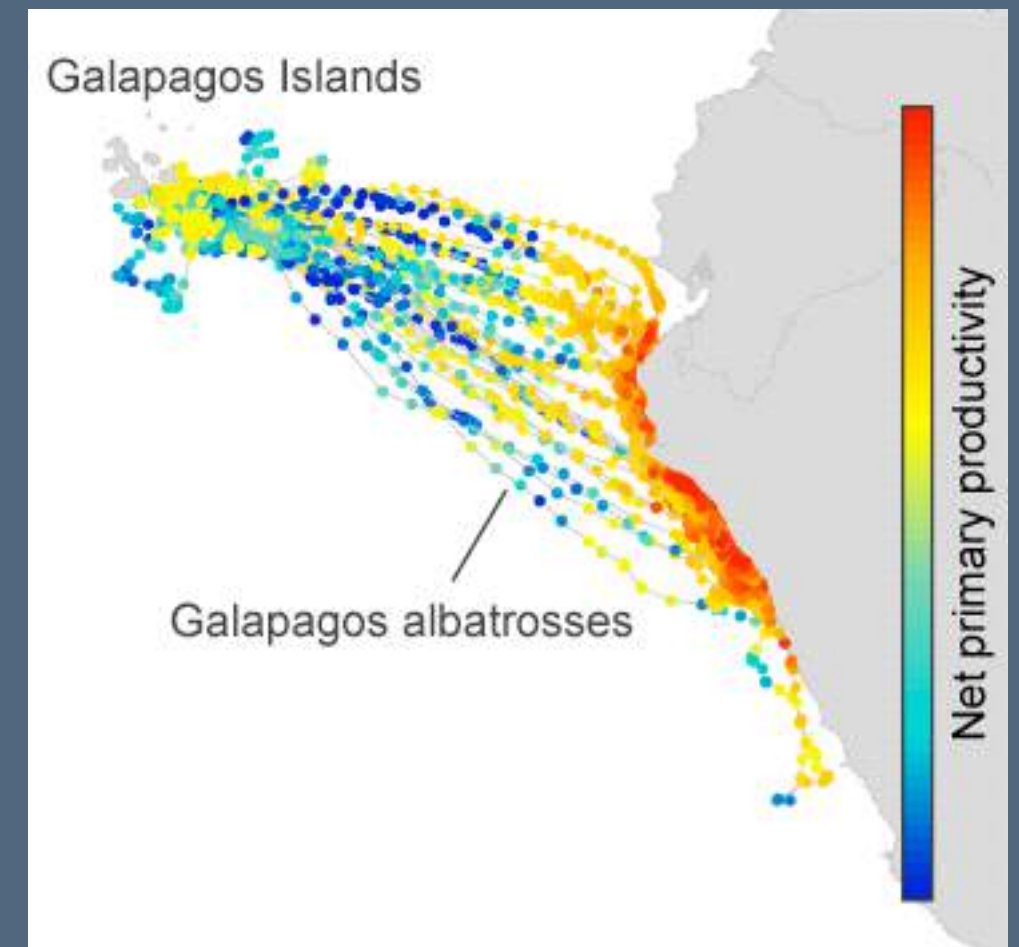
Link animal movement data to global environmental datasets:

- Identify and download data files

- Transform formats/projections

- Interpolate values

- Provide documentation



ENV-DATA: PRODUCTS

Topography: ASTER, ETOPOI, and SRTM digital elevation models



ETOPOI Global Relief Model

ENV-DATA: PRODUCTS

Topography

Weather and climate:

European Centre for Medium-range Weather Forecasts

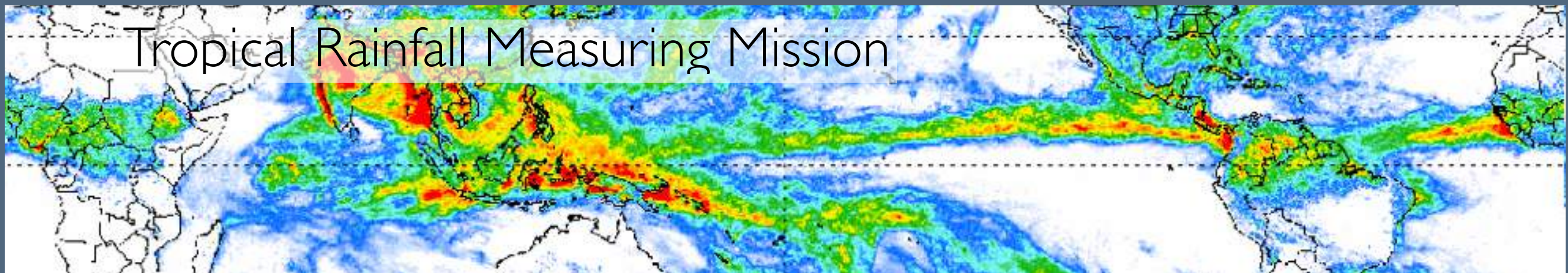
National Oceanic and Atmospheric Administration (NOAA)

NCEP-DOE Reanalysis 2

North American Regional Reanalysis (NARR)

NOAA Global Climate Indices

Tropical Rainfall Measuring Mission



TRMM average rainfall, July 2013

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ENV-DATA: PRODUCTS

Topography

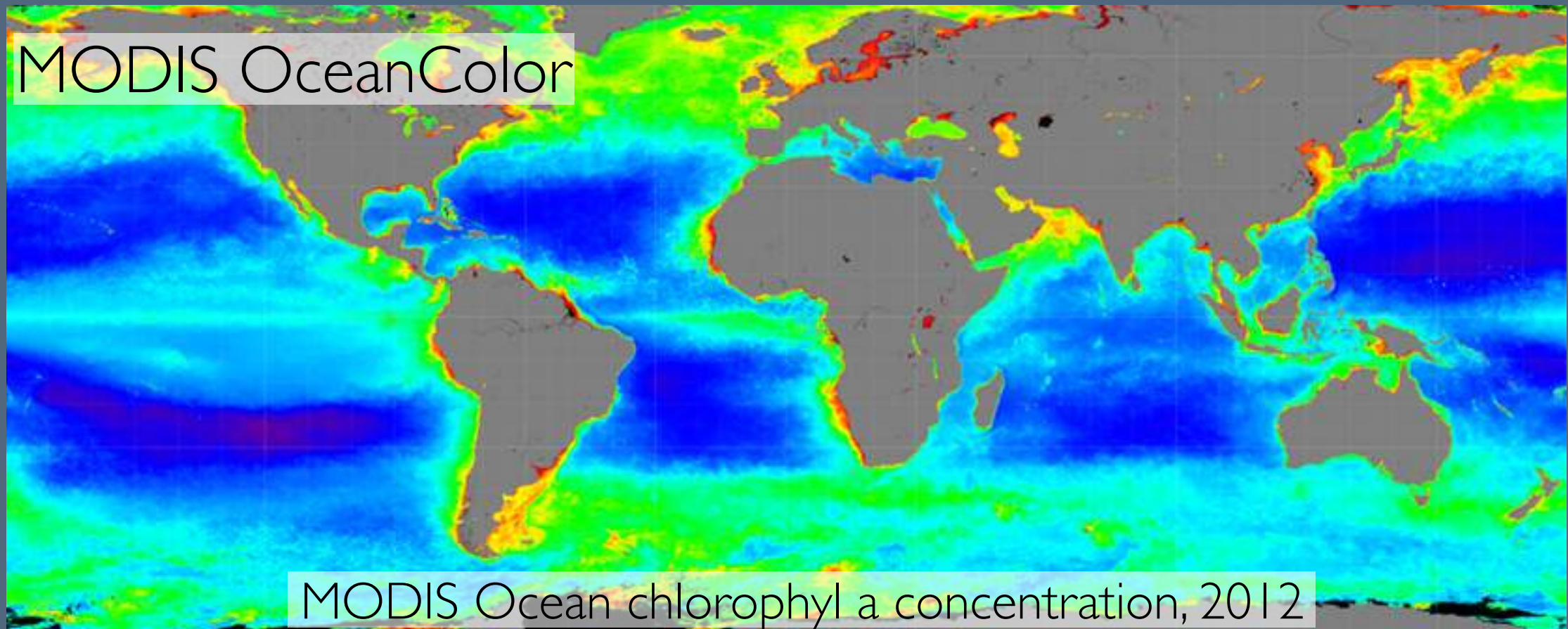
Weather and climate

Ocean conditions:

Oregon State University Ocean Productivity Reanalysis

OSCAR Ocean Surface Currents

MODIS OceanColor



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ENV-DATA: PRODUCTS

Topography

Weather and climate

Ocean conditions

Terrestrial conditions
and demographics:

MODIS Land, Snow & Ice

GlobCover Land Cover

SEDAC Human Population Density

Global Land Cover Facility AVHRR NDVI



GlobCover land cover, 2009

ENV-DATA: PRODUCTS

Topography

Weather and climate

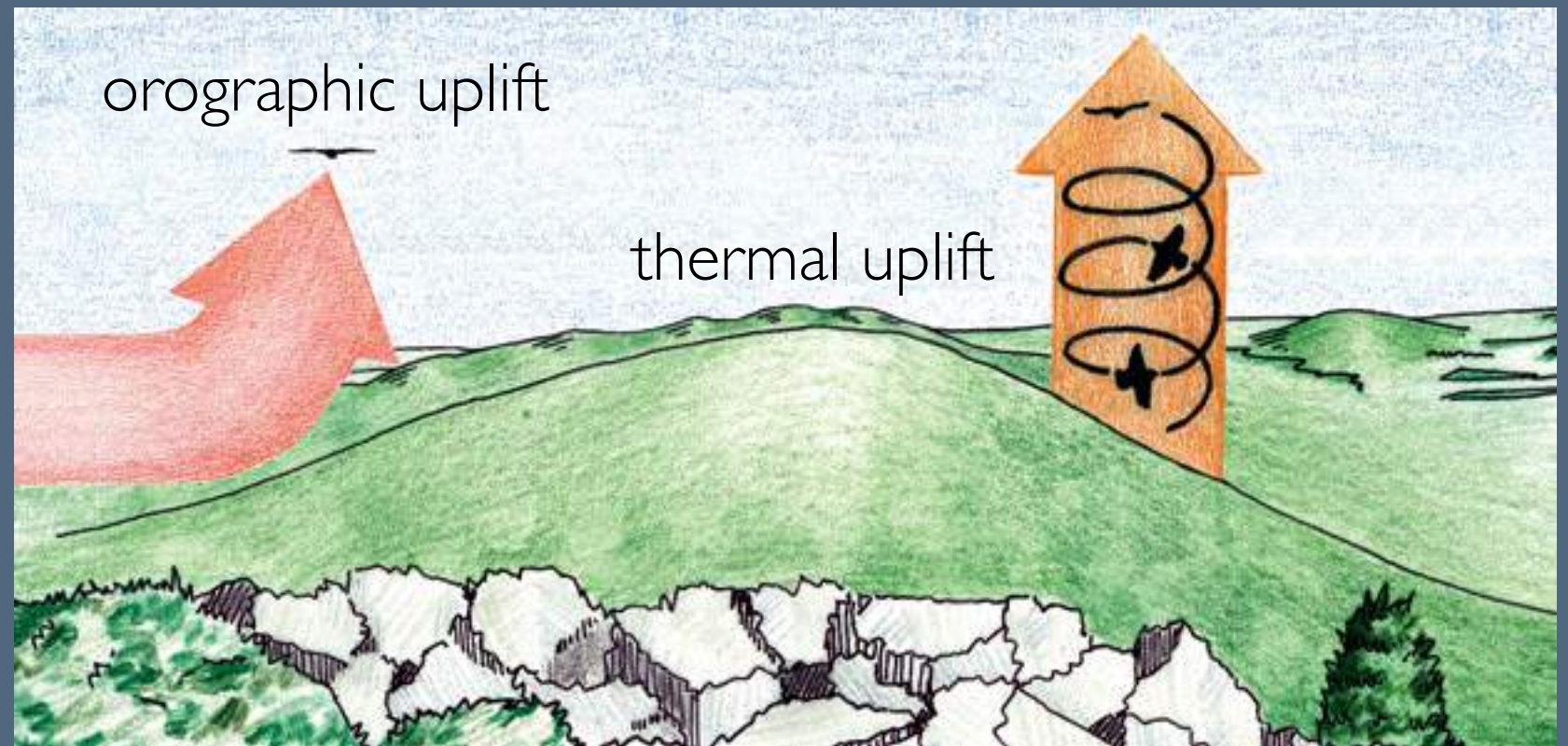
Ocean conditions

Terrestrial conditions

Derived variables

Terrain slope and rugosity

Orographic and thermal uplift velocity



INTERPOLATION

Bilinear

Inverse distance weighted

Nearest neighbor

INTERPOLATION

Bilinear

Inverse distance weighted

Nearest neighbor

In space



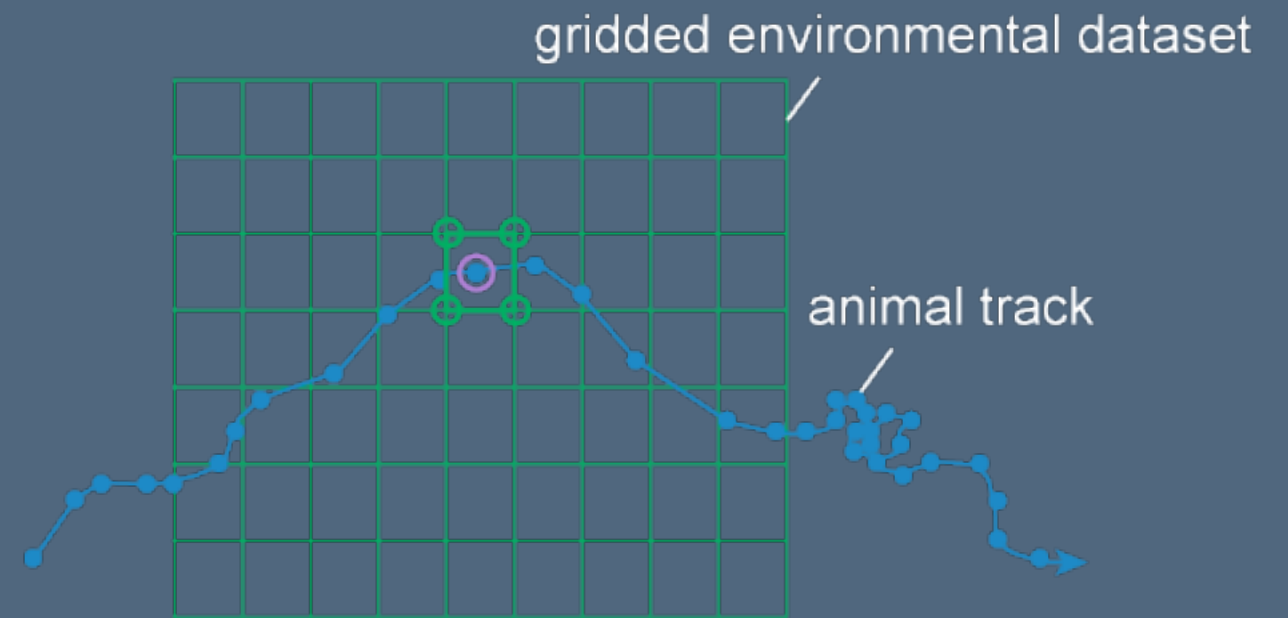
INTERPOLATION

Bilinear

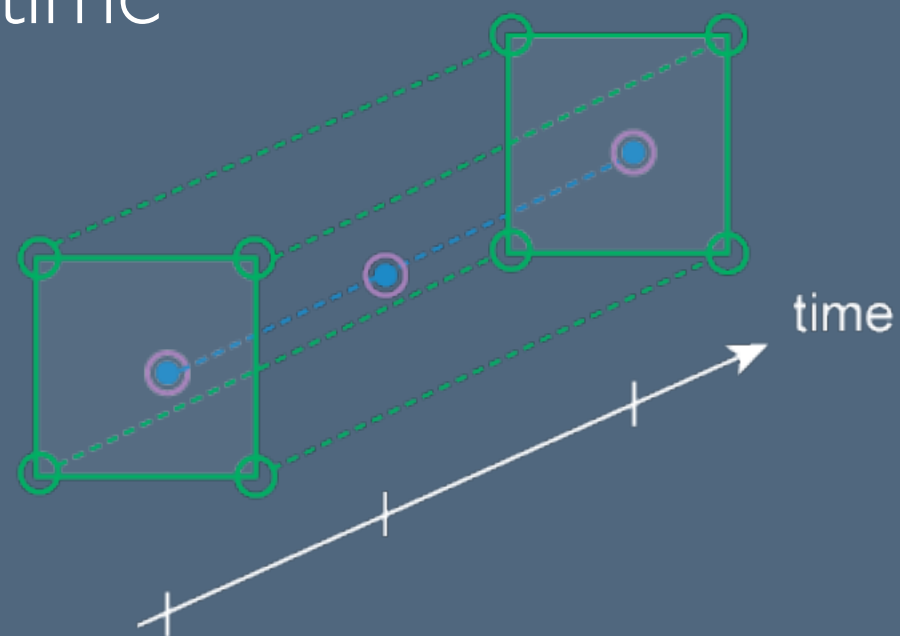
Inverse distance weighted

Nearest neighbor

In space



In time



INTERPOLATION

Bilinear

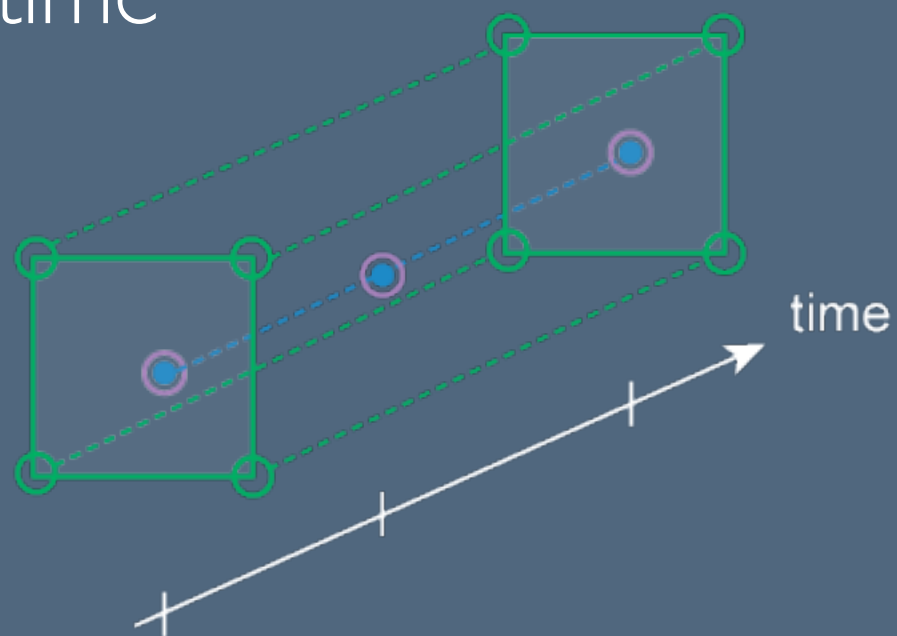
Inverse distance weighted

Nearest neighbor

In space



In time



By height

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ENV-DATA: USER INTERFACE

I. Select data from Movebank.

Choose which data from this study you want to annotate

☒ Select animals
☐ Select tags

Available sensor types
Radio Transmitter

☐ Include outliers

<input checked="" type="checkbox"/>	Grey
<input checked="" type="checkbox"/>	Juliet
<input checked="" type="checkbox"/>	Jupiter
<input checked="" type="checkbox"/>	Laelaps
<input checked="" type="checkbox"/>	Mady
<input checked="" type="checkbox"/>	Mange Pup
<input checked="" type="checkbox"/>	Mangy Mom
<input checked="" type="checkbox"/>	Marathon
<input checked="" type="checkbox"/>	Mars
<input checked="" type="checkbox"/>	Mrs.Z
<input checked="" type="checkbox"/>	Newbie
<input checked="" type="checkbox"/>	Omega
<input checked="" type="checkbox"/>	Quick
<input checked="" type="checkbox"/>	Red
<input checked="" type="checkbox"/>	Roger

Select all Deselect all

Cancel Continue

ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.

Browse available environmental variables and select those you want to annotate

Variables by source
Variables by type

- + ETOPO1 Ice Surface Global Relief Model [i](#)
- + GIMMS AVHRR NDVI [i](#)
- + GlobCover
- + MODIS Land
- + MODIS Ocean
- + MODIS Snow
- + Movebank Derived Variables
- + NASA Ocean Biology Processing Group
- + NCEP North American Regional Reanalysis [i](#)
- + NCEP-DOE Reanalysis 2
- + NOAA Global Climate Indexes
- + OSCAR
- + Oregon State Ocean Productivity Reanalysis
- + SRTM 90-m DEM [i](#)

Variable

ECMWF Interim Full Daily SFC Temperature (2 m above Ground)	Remove
SRTM Elevation	Remove
ASTER ASTGTM2 Elevation	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, U Component)	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, V Component)	Remove

Cancel
Back
Continue

ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.

Browse available environmental variables and select those you want to annotate

Variables by source

Variables by type

+

Earth surface & vegetation

+

Human Population

+

Ocean

+

Topography

-

Weather

+

Albedo

+

Canopy conductance

+

Clouds

+

Derived variables

+

Evaporation

+

Global climate indexes

+

Humidity

+

Kinetic & thermal energy

+

Land surface temperature

Variable

ECMWF Interim Full Daily SFC Temperature (2 m above Ground)	Remove
SRTM Elevation	Remove
ASTER ASTGTM2 Elevation	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, U Component)	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, V Component)	Remove

Cancel

Back

Continue

ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.

Browse available environmental variables and select those you want to annotate

Variables by source
Variables by type

Albedo
ECMWF
Interim Full Daily at Surface Forecast

Albedo
NCEP NARR
Snow albedo
Canopy conductance
Clouds
Derived variables
Evaporation
Global climate indicators
Humidity
Kinetic & thermal energy
Land surface temperature

Name: Albedo

Description: The fraction of solar (shortwave) radiation reflected back into space from the surface of the earth—a measure of the reflecting power of a surface.

Provider: European Centre for Medium-Range Weather Forecasts

Unit: (0-1)

Value range: 0 – 1

Spatial range: E: 180.0 W: -180.0 N: 89.463 S: -89.463

Spatial granularity: 0.75 degrees

Temporal granularity: 3 hourly

Temporal range: 1979-01-01 to present

Source link: [Open](#)

Related websites: [Open](#), [Open](#), [Open](#)

Nodata value local: NaN


Variable

ECMWF Interim Full Daily SFC Temperature (2 m above Ground)	Remove
SRTM Elevation	Remove
ASTER ASTGTM2 Elevation	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, U component)	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, V component)	Remove

ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.
3. Choose interpolation methods.

Choose which interpolation method you want to use for each variable

Variable	Interpolation 	
ASTER ASTGTM2 Elevation	bilinear	Remove
ECMWF Interim Full Daily SFC-FC Albedo	inverse-distance→	Remove
ECMWF Interim Full Daily SFC Temperature (2 m above Ground)	inverse-distance→	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, U Component)	inverse-distance→	Remove
ECMWF Interim Full Daily SFC Wind (10 m above Ground, V Component)	inverse-distance→	Remove
GlobCover 2009 2009 Land-Cover Classification	nearest-neighbou	Remove
GlobCover 2009 2009 Land-Cover Classification Data Source Indication	nearest-neighbou	Remove
SRTM Elevation	bilinear	Remove

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ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.
3. Choose interpolation methods.
4. Submit request.

Review a summary of your order and submit your annotation request

study:

Coyotes, Kays and Bogan, Albany NY

sensor type:

Radio Transmitter

tracking data:

Animal: Juliet, Omega, Grey, Jupiter, Laelaps, Mady, Mange Pup, Mangy Mom, Marathon, Mars, Mrs.Z, Newbie, Quick, Red, Roger

Send download notification to:

Request name:

Variable	Interpolation
ASTER ASTGTM2 Elevation	bilinear
ECMWF Interim Full Daily SFC Albedo	inverse-distance-weighted
ECMWF Interim Full Daily SFC Temperature (2 m above Ground)	inverse-distance-weighted
ECMWF Interim Full Daily SFC Wind (10 m above Ground, U Component)	inverse-distance-weighted
ECMWF Interim Full Daily SFC Wind (10 m above Ground, V Component)	inverse-distance-weighted
GlobCover 2009 2009 Land-Cover Classification	nearest-neighbour
GlobCover 2009 2009 Land-Cover Classification Data Source Indication	nearest-neighbour

ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.
3. Choose interpolation methods.
4. Submit request.
5. Retrieve data and documentation.

My requests

Find a list of your submitted annotation requests below. For information on submitted data sets and annotated environmental variables click on the respective links in the table.

Request	Timestamp	State	Overview	Details
Coyotes Env-DATA annotation	2013-07-23 16:33:21.397	available	view	view download

ENV-DATA: USER INTERFACE

1. Select data from Movebank.
2. Browse and select environmental variables.
3. Choose interpolation methods.
4. Submit request.
5. Retrieve data and documentation.
6. Explore your results!

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DATA REPOSITORY



Have your dataset reviewed and receive a DOI.

Movebank Data Repository

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Submission

Submit Data Now!

Data from: Thieving rodents as substitute dis

When using this dataset, please cite the original article.
Additionally, please cite the Movebank data package:

Jansen PA, Hirsch BT, Emsens W, Zamora-Gutierrez V, Wikelski M, dispersers of megafaunal seeds. Movebank Data Repository. **doi:10.5441/001/1.9t0m888q**

Package Identifier doi:10.5441/001/1.9t0m888q

Keywords seed dispersal, radio telemetry, cocosold pa

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Map Satellite Terrain

1000 ft 500 m

Map data ©2012 Google

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PUBLIC OUTREACH



Show tracks on other websites.

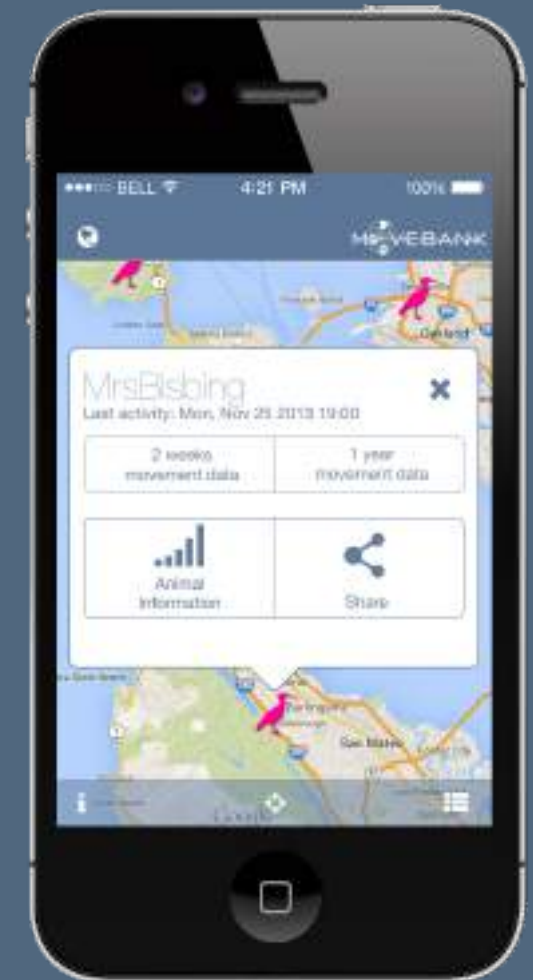


20 September

www.ospreytrax.com

Huge news here. Belle made an amazing 56-hour non-stop flight from Cape Cod to Cuba! She was going over 40

PUBLIC OUTREACH



available on the Apple AppStore and at Google Play

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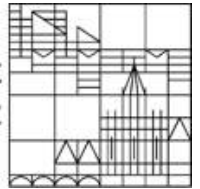
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WILDLIFE AND
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A white egret is captured in mid-flight against a clear, vibrant blue sky. The bird's wings are fully extended, showing the intricate structure of its feathers. Its long, thin legs trail behind it, and its sharp, yellow beak is pointed forward. The lighting suggests a bright, sunny day.

THANK YOU!

Questions, feedback, requests?

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CITATION



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