BioSpace25 - Biodiversity insight from Space
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Predicting species distributions in the open ocean

Using satellite-derived environmental data and convolutional neural networks

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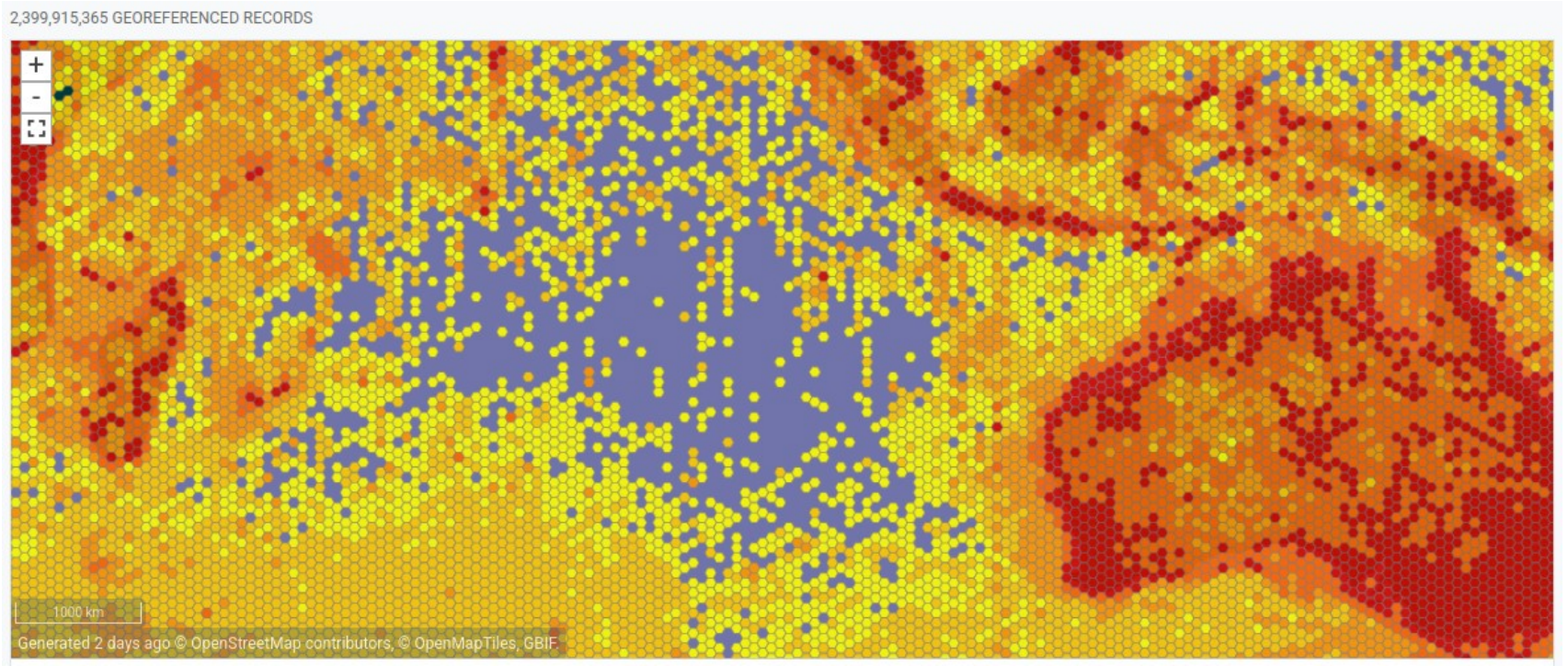
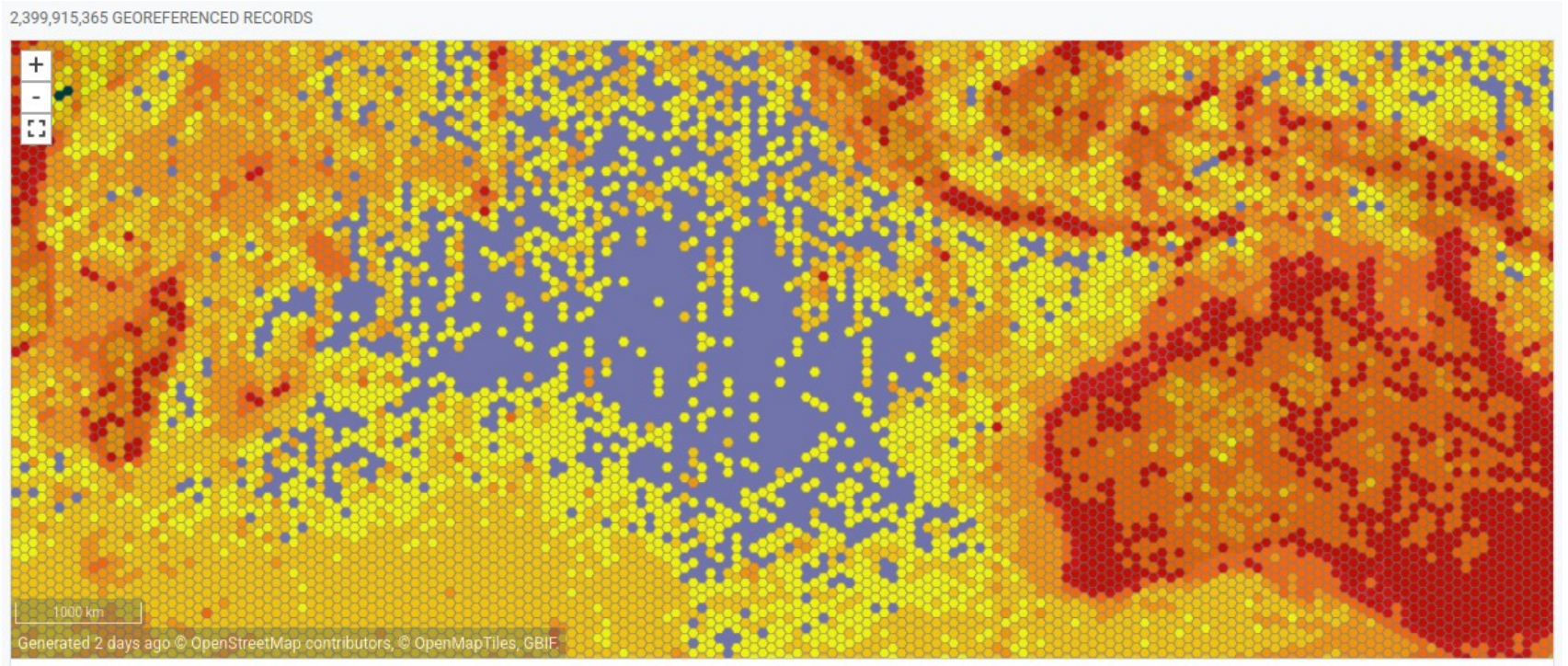
Introduction: what data?



Introduction: what data?



Models cannot use coordinates as predictors

Hypothesis: same environmental conditions = same species

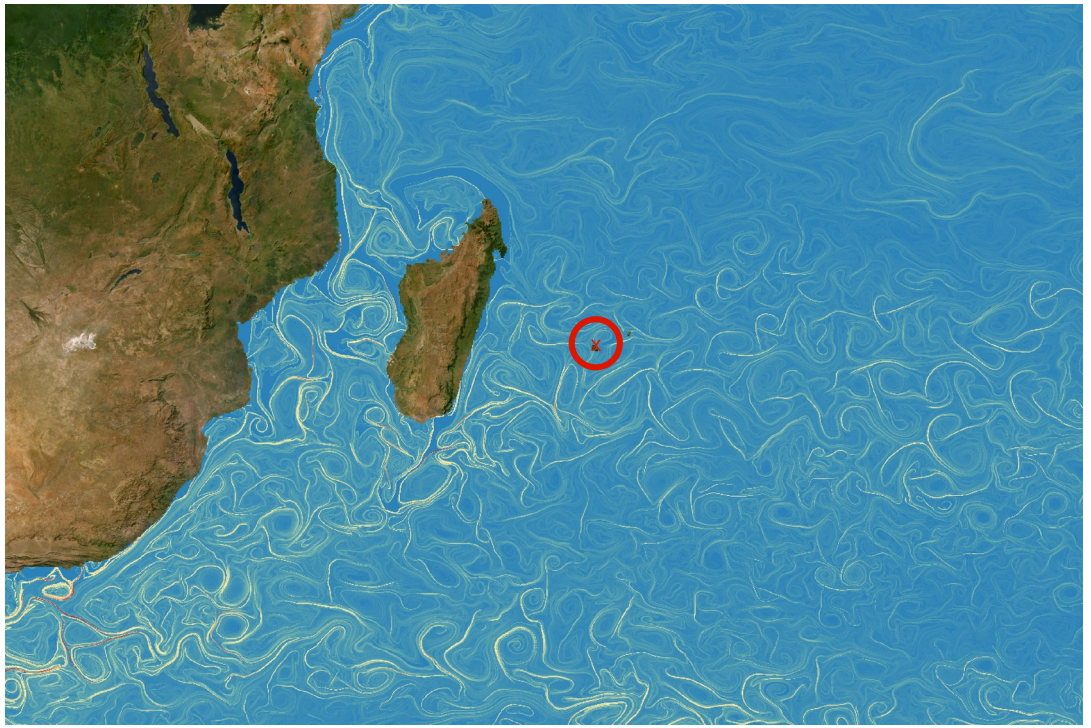
SDMs: Chosing environmental data

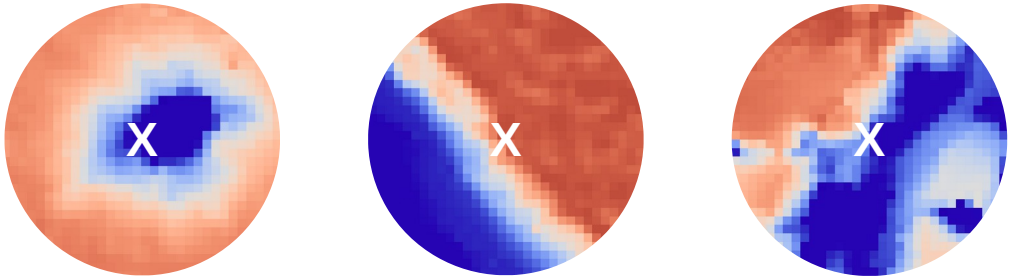
Limitation in usual SDMs: number of predictors

=> Only one value per variable

Point of observation	Buffer around observation
Value	Average (+ STD, min, max)

Environmental landscape



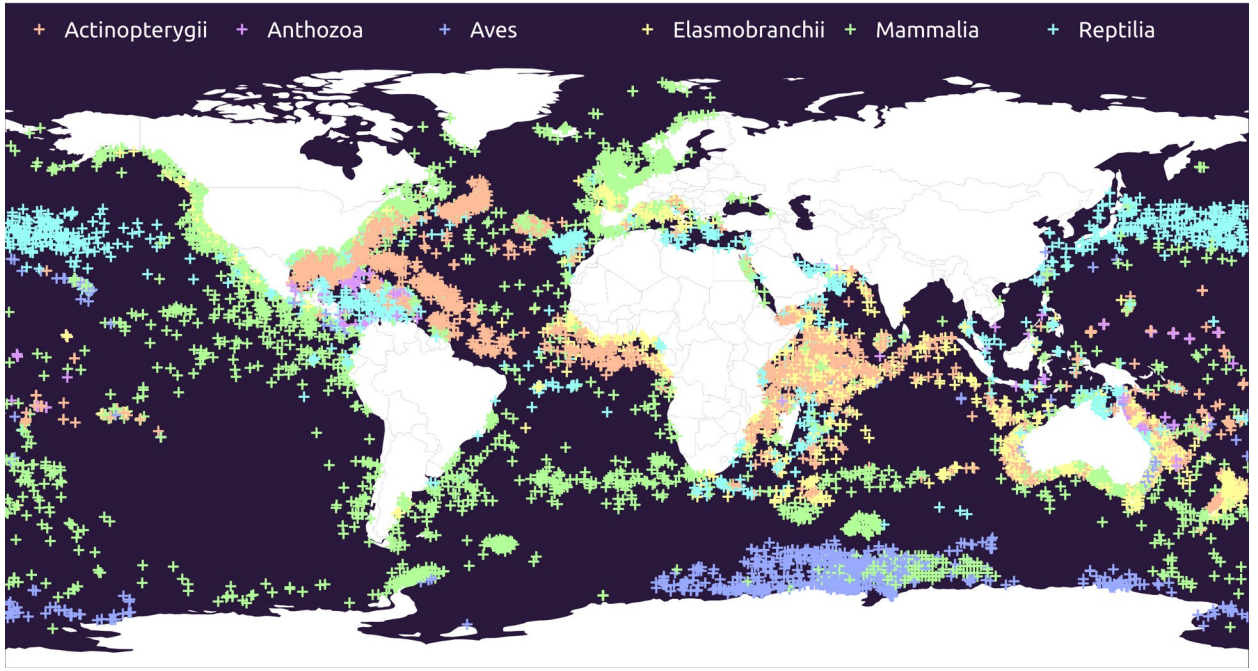


Spatial structure IS important

SDMs: Chosing environmental data

Point of observation	Buffer around observation	Environmental landscape
Value	Average (+ STD, min, max)	**Spatially structured data**

Pilot study

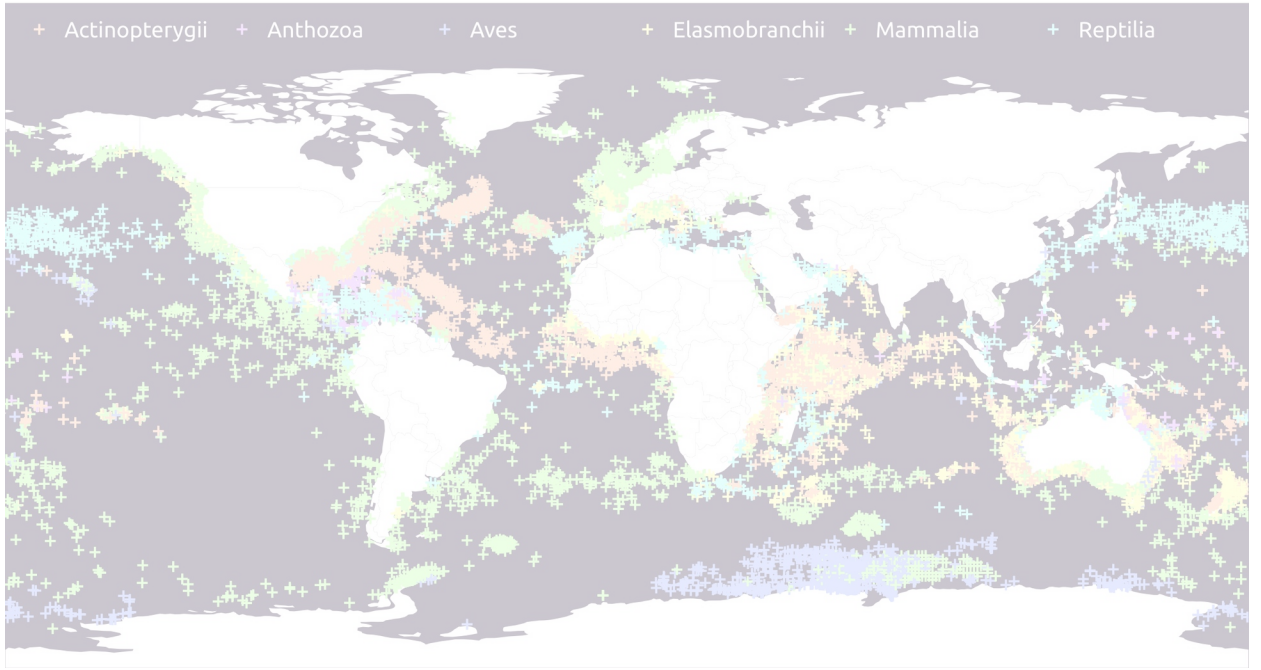


GBIF

38 genera

300,000 occurrences

Pilot study



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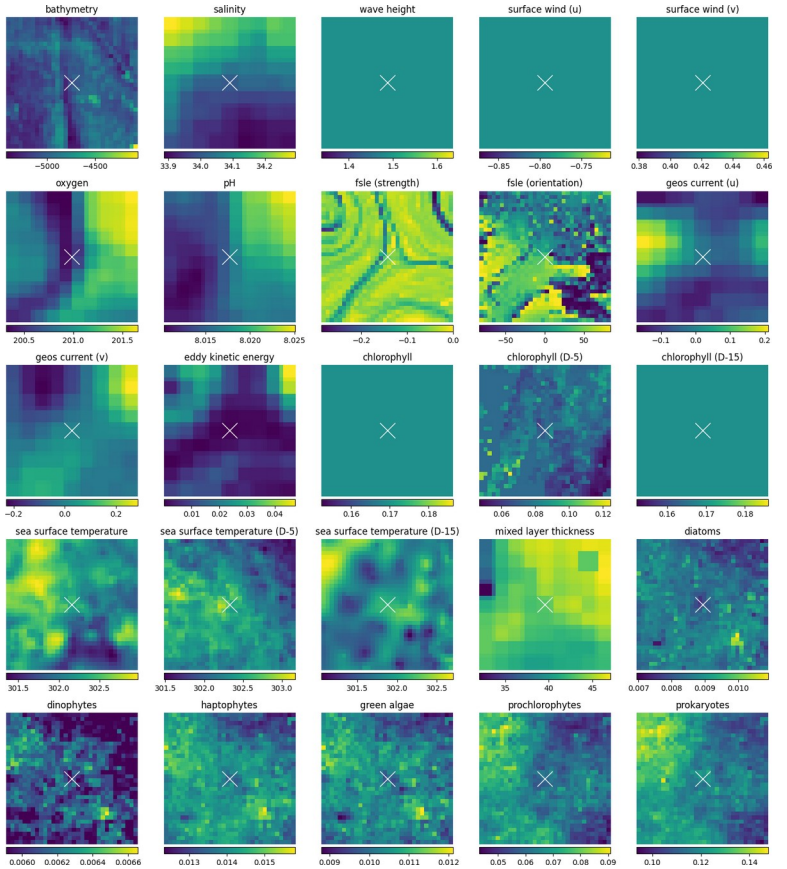
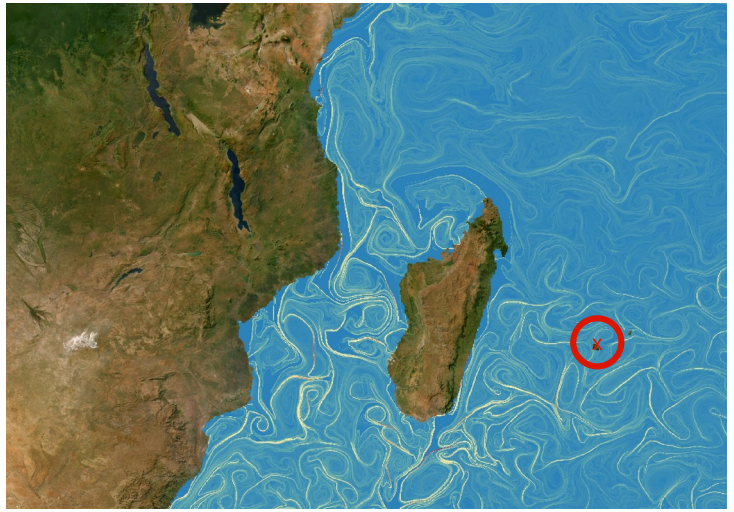


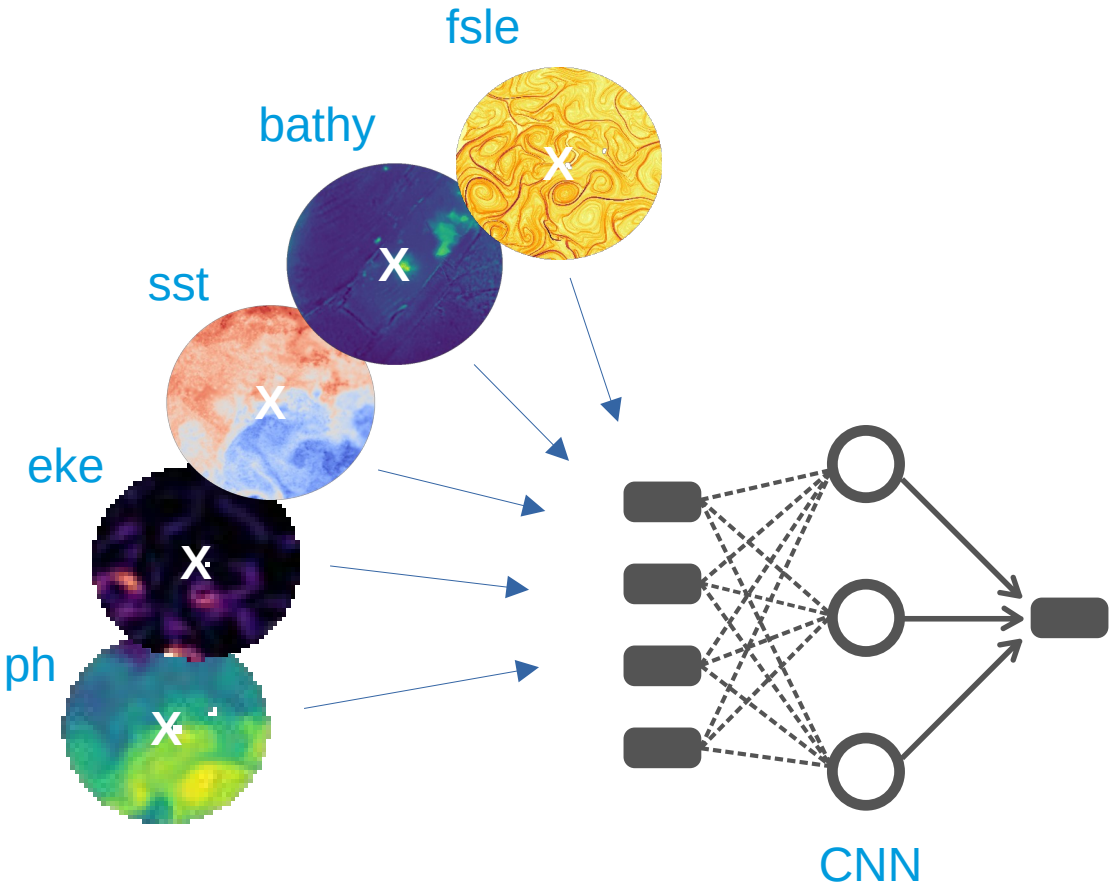
18 variables

geoenrich 0.6.5

```
pip install geoenrich
```

Spatial data processing





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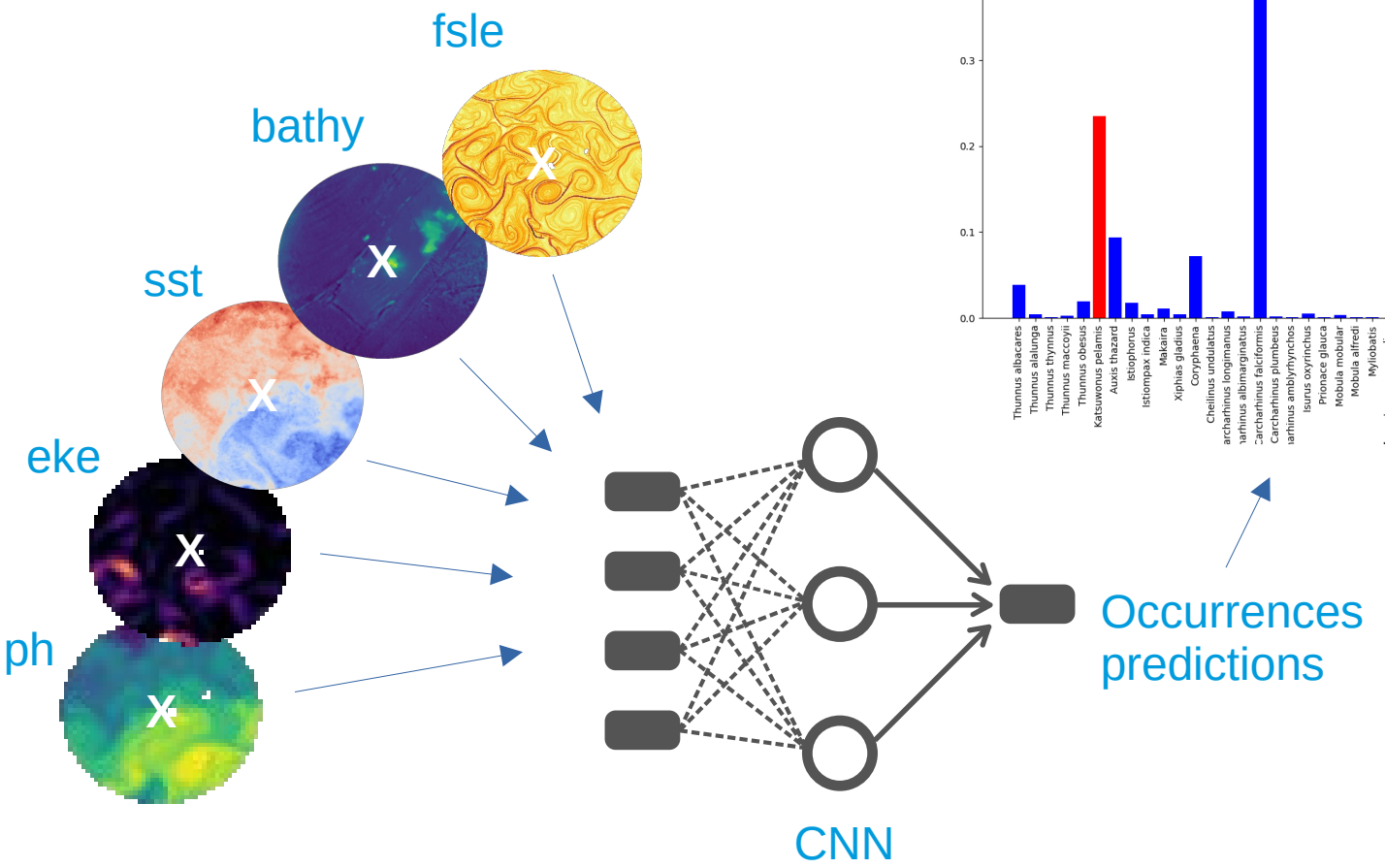


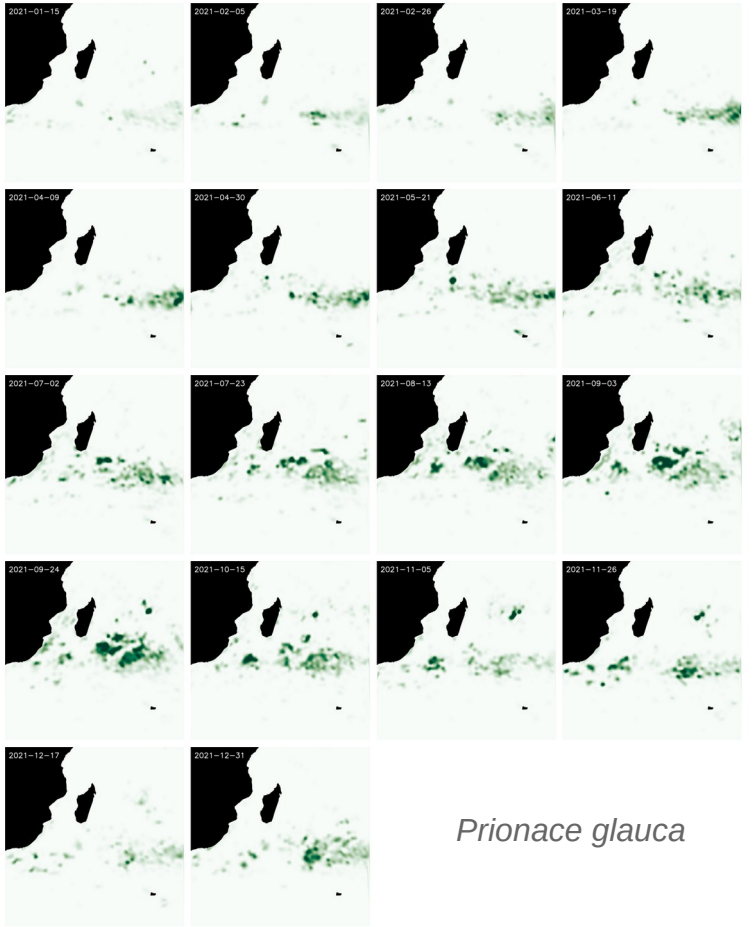
Results

Variation in space

Puffinus pacificus

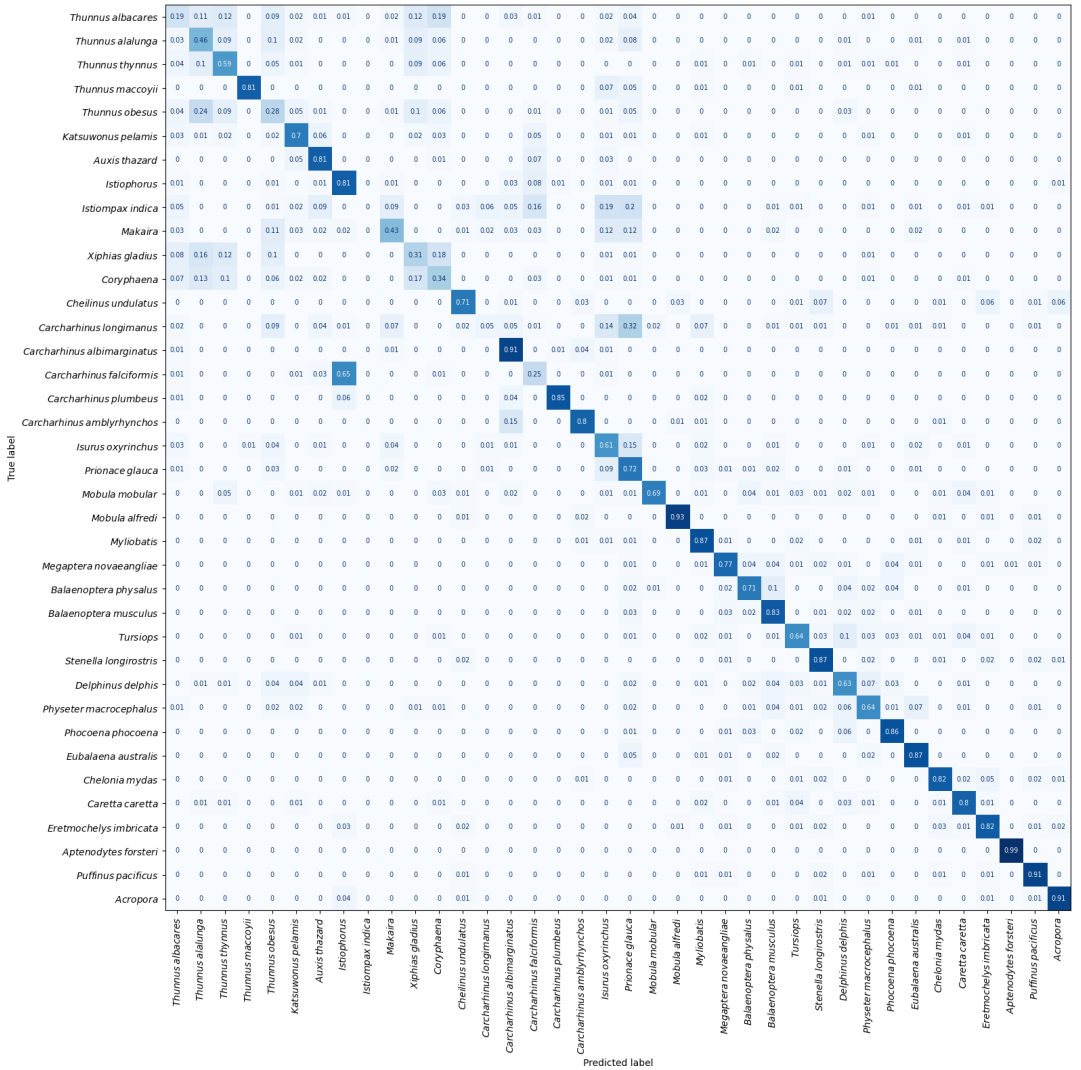
Thunnus thynnus

Variation in time

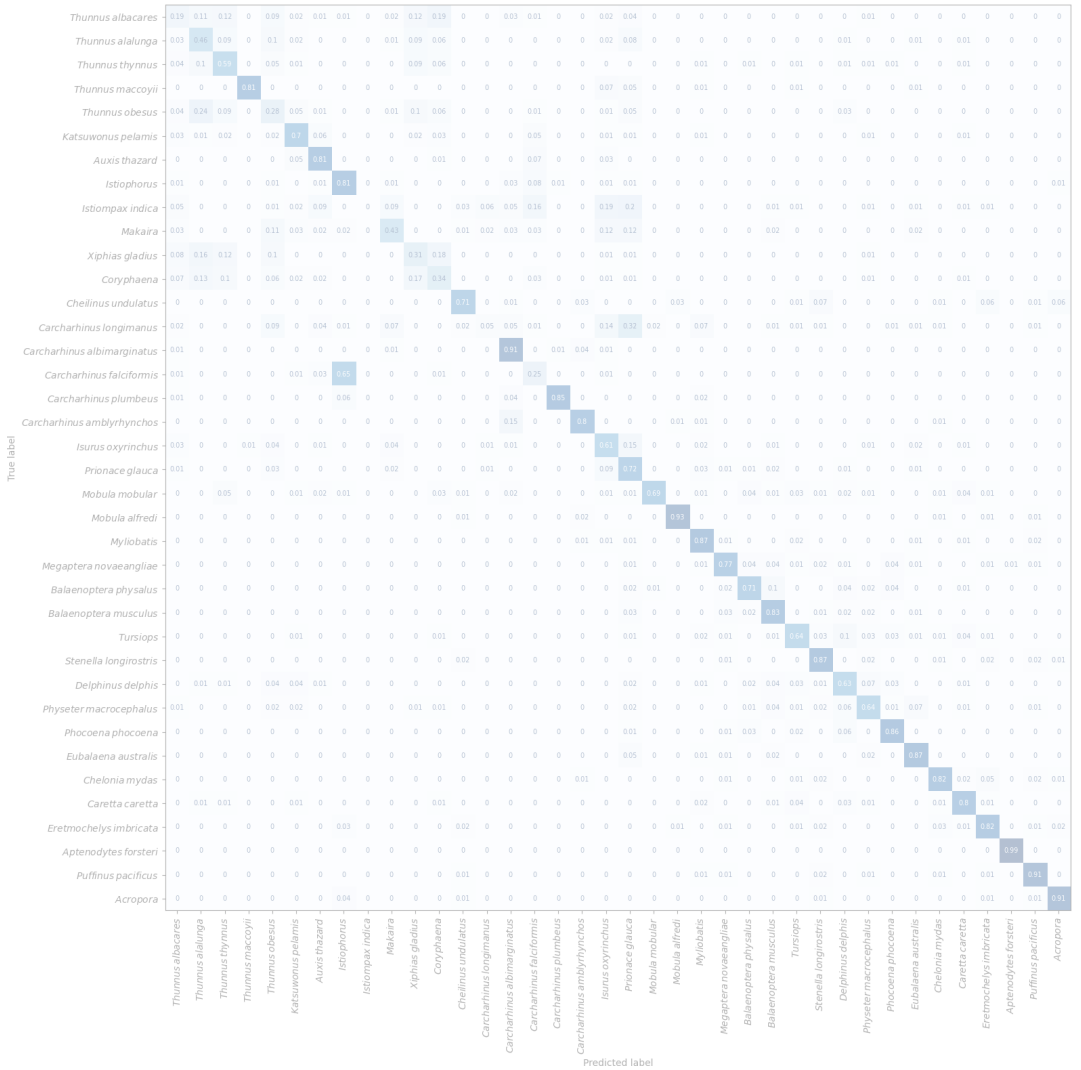


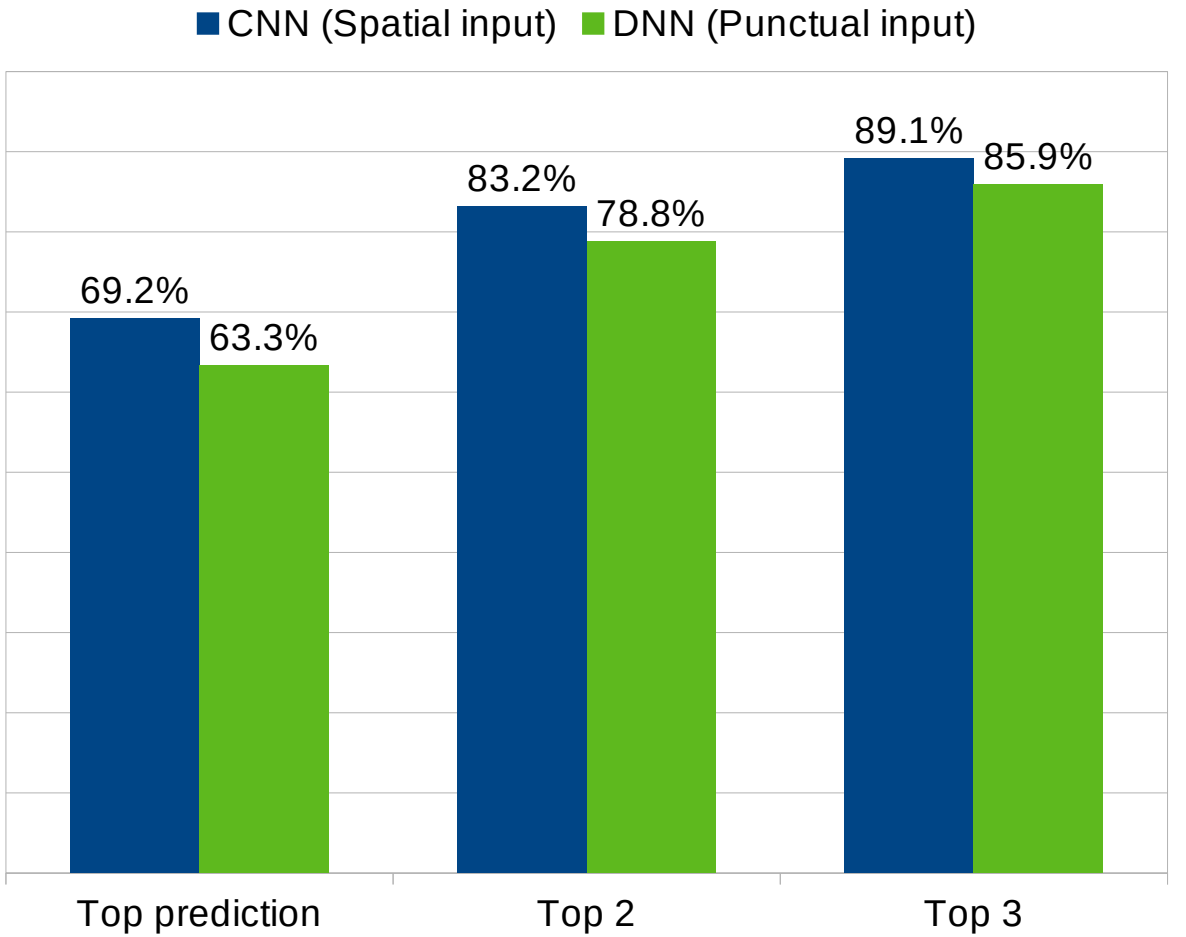
Prionace glauca

Model performance



Model performance





Most important insight

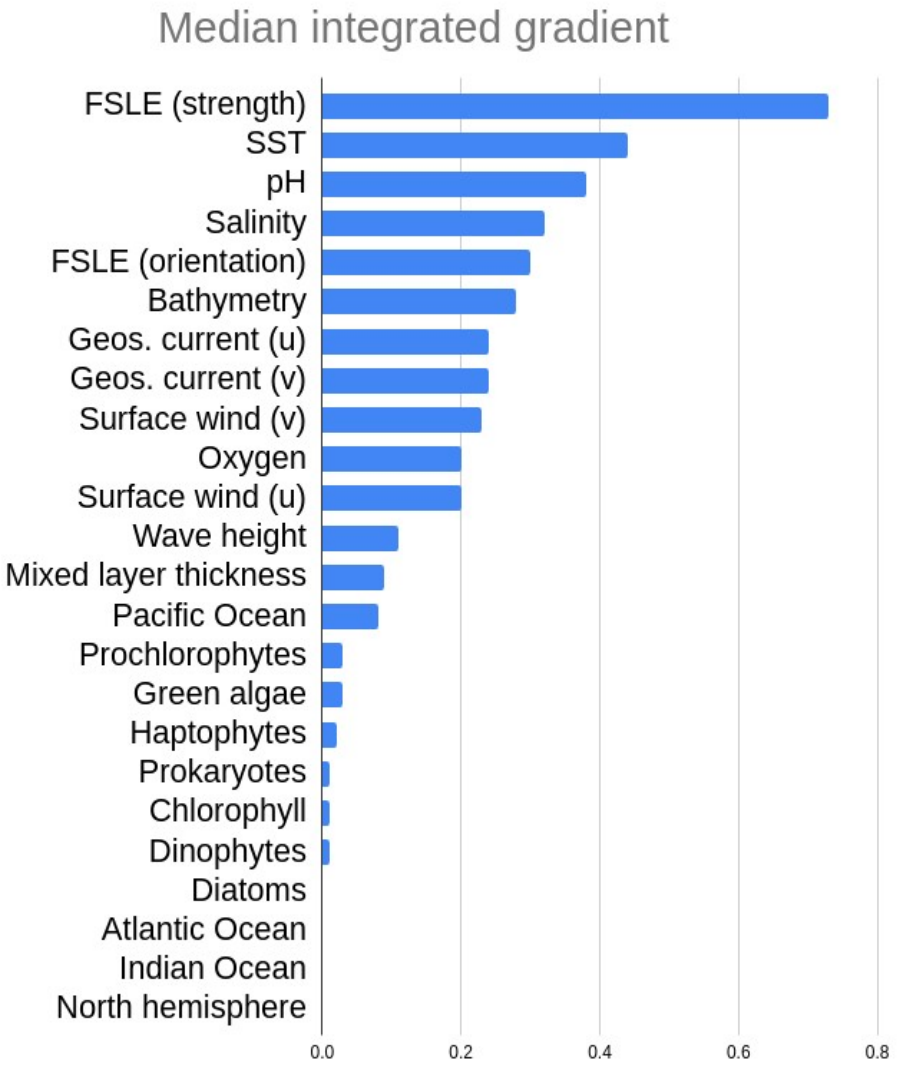
~~Predictive power~~

Influence of variables

Most important insight

~~Predictive power~~

Influence of variables



Thank you

Peer Community Journal

Section: Ecology

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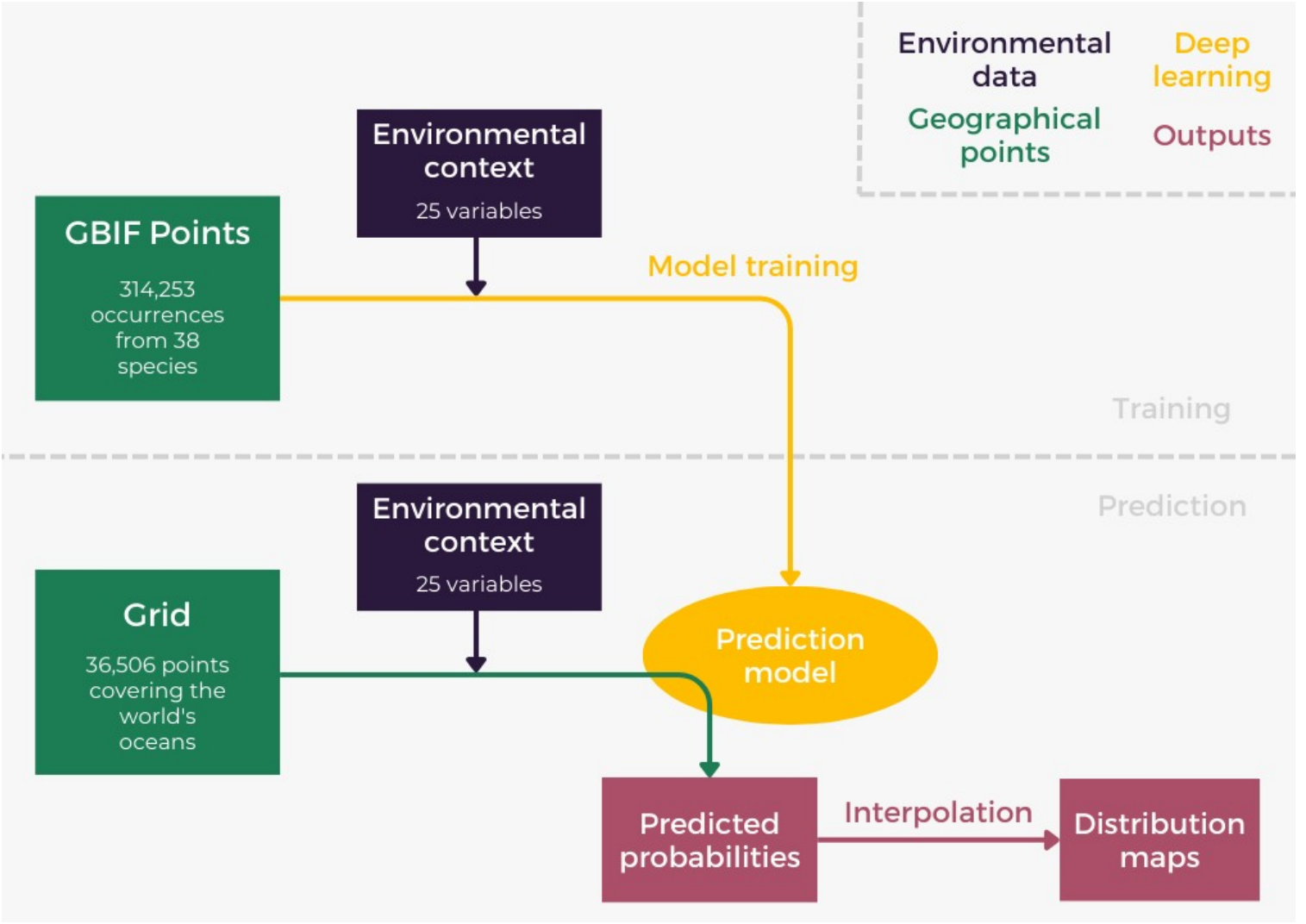
Future work:

Include multiple modalities in the model: satellite imagery and scalar time series.

Recommendations for data producers:

- Maintain data access protocols in the long term
- Maximize duration and geographical coverage

Appendix: Pipeline



Appendix: Genera

English name	Taxonomic name	N samples	DOI
Yellowfin tuna	*Thunnus albacares*	9,998	10.15468/dl.gr2wbb
Longfin tuna	*Thunnus alalunga*	9,991	10.15468/dl.aqjv3y
Atlantic bluefin tuna	*Thunnus thynnus*	8,908	10.15468/dl.nnyeyb
Southern bluefin tuna	*Thunnus maccoyii*	2,022	10.15468/dl.tw97qj
Bigeye tuna	*Thunnus obesus*	9,999	10.15468/dl.c96qpp
Skipjack tuna	*Katsuwonus pelamis*	9,986	10.15468/dl.6y2zzm
Frigate Tuna	*Auxis thazard*	4,855	10.15468/dl.kfm6kq
Sailfish	*Istiophorus*	9,996	10.15468/dl.f48dug
Black marlin	*Istiompax indica*	705	10.15468/dl.b5acky
Blue marlin	*Makaira*	2,767	10.15468/dl.sygtaw
Swordfish	*Xiphias gladius*	9,996	10.15468/dl.hazqd2
Dolphinfish	*Coryphaena*	9,992	10.15468/dl.q67bqt
Humphead wrasse	*Cheilinus undulatus*	2,446	10.15468/dl.9g76hq
Oceanic Whitetip	*Carcharhinus longimanus*	2,160	10.15468/dl.b5ws4q
Whitetip	*Carcharhinus albimarginatus*	9,991	10.15468/dl.vpc772
Silk shark	*Carcharhinus falciformis*	9,998	10.15468/dl.vg4rwh
Sandbar shark	*Carcharhinus plumbeus*	9,993	10.15468/dl.7fczpa
Grey reef shark	*Carcharhinus amblyrhynchos*	10,000	10.15468/dl.ccqyws
Mako shark	*Isurus oxyrinchus*	6,240	10.15468/dl.h5akxk
Blue shark	*Prionace glauca*	9,973	10.15468/dl.zqkssk
Devil ray	*Mobula mobular*	1,064	10.15468/dl.p4e2sx
Reef manta	*Mobula alfredi*	7,928	10.15468/dl.bkjkgu
Eagle ray	*Myliobatis*	9,974	10.15468/dl.3u3v7k
Humpback whale	*Megaptera novaeangliae*	9,980	10.15468/dl.yzg4n3
Fin whale	*Balaenoptera physalus*	9,996	10.15468/dl.r9kaq8
Blue whale	*Balaenoptera musculus*	9,973	10.15468/dl.28f7xd
Bottlenose	*Tursiops*	9,952	10.15468/dl.bec9p4
Spinner dolphin	*Stenella longirostris*	7,394	10.15468/dl.xz5eds
Common dolphin	*Delphinus delphis*	9,974	10.15468/dl.u5be7v
Sperm whale	*Physeter macrocephalus*	9,984	10.15468/dl.7pf4ue
Harbour porpoise	*Phocoena phocoena*	9,937	10.15468/dl.afr2fn
Southern right whale	*Eubalaena australis*	9,963	10.15468/dl.e3hdkj
Green turtle	*Chelonia mydas*	9,835	10.15468/dl.6gs9rp
Loggerhead	*Caretta caretta*	9,941	10.15468/dl.dmb6ds
Hawksbill turtle	*Eretmochelys imbricata*	9,721	10.15468/dl.e6w44w
Emperor penguin	*Aptenodytes forsteri*	9,981	10.15468/dl.s5unhs
Wedge-tailed shearwater	*Puffinus pacificus*	9,964	10.15468/dl.vyztue
Acropora coral	*Acropora*	8,676	10.15468/dl.vg752f

Appendix: Variables

Variable	Source	Source type	Res.	Time Res.	Unit
Bathymetry	GEBCO, 2022	Observations	0.0042°		m
Salinity	European Union-CMS, 2020	Observations	0.25°	weekly	$P.S.U.$
Wave Height	European Union-CMS, 2021b	Observations	2°	daily	m
Surface wind (u)	CCMP (Mears et al., 2022)	Observations	0.25°	6 hours	$m.s^{-1}$
Surface wind (v)	CCMP (Mears et al., 2022)	Observations	0.25°	6 hours	$m.s^{-1}$
Oxygen	European Union-CMS, 2018, 2019	Models	0.25°	daily	$mmol.m^{-3}$
pH	European Union-CMS, 2018, 2019	Models	0.25°	monthly	
FSLEs (strength)	LOCEAN/CLS/CTOH/CNES, 2021	Observations	0.04°	daily	$days^{-1}$
FSLEs (orientation)	LOCEAN/CLS/CTOH/CNES, 2021	Observations	0.04°	daily	$degrees$
Geostrophic Current (u)	European Union-CMS, 2017, 2021a	Observations	0.25°	daily	$m.s^{-1}$
Geostrophic Current (v)	European Union-CMS, 2017, 2021a	Observations	0.25°	daily	$m.s^{-1}$
Eddy kinetic energy	Calculated		0.25°	daily	$m^2.s^{-2}$
Chlorophyll	OCCI (Sathyendranath et al., 2021)	Observations	0.042°	daily	$mg.m^{-3}$
Chlorophyll (D-5)	OCCI (Sathyendranath et al., 2021)	Observations	0.042°	daily	$mg.m^{-3}$
Chlorophyll (D-15)	OCCI (Sathyendranath et al., 2021)	Observations	0.042°	daily	$mg.m^{-3}$
SST	MUR (NASA/JPL, 2019)	Observations	0.25°	daily	$kelvin$
SST (D-5)	MUR (NASA/JPL, 2019)	Observations	0.25°	daily	$kelvin$
SST (D-15)	MUR (NASA/JPL, 2019)	Observations	0.25°	daily	$kelvin$
Mixed layer thickness	European Union-CMS, 2020	Observations	0.25°	weekly	m
Diatoms	European Union-CMS, 2022	Observations	4km	monthly	$mg.m^{-3}$
Dinophytes	European Union-CMS, 2022	Observations	4km	monthly	$mg.m^{-3}$
Haptophytes	European Union-CMS, 2022	Observations	4km	monthly	$mg.m^{-3}$
Green algae	European Union-CMS, 2022	Observations	4km	monthly	$mg.m^{-3}$
Prochlorophytes	European Union-CMS, 2022	Observations	4km	monthly	$mg.m^{-3}$
Prokaryotes	European Union-CMS, 2022	Observations	4km	monthly	$mg.m^{-3}$
Atlantic Ocean	Calculated				
Indian Ocean	Calculated				
Pacific Ocean	Calculated				
North hemisphere	Calculated				

FSLE (Finite Size Lyapunov Exponents) = rate of separation of particle trajectories