Monthly mean sea surface temperature (SST) around premier seabird colonies from 1981 to 2024 (Stratification impacts on seabirds project)

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Data Type: Synthesis
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Project
» Global analysis of stratification impacts on seabirds through food resources (Stratification impacts on seabirds)

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Abstract
This dataset provides monthly sea surface temperature (SST) data derived from three satellite-based sources: NASA MUR SST, UK Met Office OSTIA, and NOAA OISST. SST values were averaged within a 200-km radius around major seabird colony sites worldwide. These premier colonies are defined as locations where at least two seabird species have reproductive success records spanning 25 years or more and that are also frequented by other seabirds and marine mammals. The dataset spans varying temporal coverage from 1982 to 2024, depending on the source product. For each site, circular spatial masks were used to extract monthly mean SST, standard deviation, and the proportion of land area contained within each mask.

Table of Contents

Coverage

Location: Global
Spatial Extent: **N**:70.3877 **E**:175.924722 **S**:-66.66667 **W**:-170.283
Temporal Extent: 1981-09-01 - 2024-05-22

Methods & Sampling

Methods Details:

Monthly sea surface temperature (SST) time series were derived from three Level-4, gap-filled global SST products: the Multi-scale Ultra-high Resolution SST (MUR SST; Chin et al., 2017), the Operational SST and Sea

Ice Analysis (OSTIA; Donlon et al., 2012), and the Optimum Interpolation SST (OISST; Huang et al., 2021).

For each seabird colony, a 200-km circular buffer was generated around the nesting site coordinates. SST data within this area were extracted at each monthly time step. To exclude land, a land mask derived from the MUR SST mask variable was applied at the appropriate spatial resolution for each dataset. For colonies located in regions with seasonal sea ice, an additional ice mask was calculated for each time step by assuming that missing ocean data (not flagged as land) represented ice-covered areas. These ice masks were computed separately for each dataset and combined with the circular and land masks.

SST data from ice-free ocean pixels within the masked region were averaged spatially and aggregated to monthly means, producing a continuous SST time series for each colony. For each site and dataset, both mean and standard deviation were calculated. All data acquisition and processing were performed in Python using the xarray library.

Sampling Site Details:

Sea surface temperature data were extracted for 22 premier seabird colony sites worldwide (listed below), each defined as a location with a high density of seabird nests and at least two species with reproductive success time series spanning more than 25 years. For each site, a 200-km circular sampling area was centered on the colony coordinates.

Admiralty; Latitude: -62.1778°; Longitude: -58.4447°
Aiktak; Latitude: 54.1886°; Longitude: -164.8400°
Bird; Latitude: -54.0056°; Longitude: -38.0500°
Buldir; Latitude: 52.3581°; Longitude: 175.9247°
Cape Peirce; Latitude: 58.5528°; Longitude: -161.7690°
Chowiet; Latitude: 56.0342°; Longitude: -156.7012°
Crozet; Latitude: -46.4167°; Longitude: 51.8333°
Foula; Latitude: 60.1385°; Longitude: -2.0793°
Hornøya; Latitude: 70.3877°; Longitude: 31.1553°
Isle of May; Latitude: 56.1858°; Longitude: -2.5575°
Kerguelen; Latitude: -48.4000°; Longitude: 68.3667°
Middleton; Latitude: 59.4382°; Longitude: -146.3266°
Pointe Géologie; Latitude: -66.6667°; Longitude: 140.0167°
Røst; Latitude: 67.5200°; Longitude: 12.0989°
Southeast Farallon; Latitude: 37.7249°; Longitude: -123.0303°
Seal Island NWR; Latitude: 43.8876°; Longitude: -68.7408°
Shetland; Latitude: 60.4100°; Longitude: -1.2600°
Signy; Latitude: -60.7170°; Longitude: -45.6000°
St. George; Latitude: 56.5743°; Longitude: -169.6130°
St. Lazaria; Latitude: 56.9872°; Longitude: -135.7047°
St. Paul; Latitude: 57.2044°; Longitude: -170.2830°
Talan; Latitude: 59.3107°; Longitude: 149.0829°
Teuri; Latitude: 44.4167°; Longitude: 141.3000°

Data Processing Description

Sea surface temperature (SST) data from the MUR SST, OSTIA, and OISST products were processed in Python using 200-km circular masks around each seabird colony, with land and seasonal ice excluded via combined mask layers to compute monthly mean and standard deviation values for ice-free ocean areas.

BCO-DMO Processing Description

- When originally submitted, the dataset was distributed across multiple files, each corresponding to a specific SST data product, site name, and year range. These files have been concatenated into a single dataset, with new columns, "Sourced_SST_Data_Product", "Site_Name", and "Original_File_Name", added to retain source information.
- Site latitude and longitude values were merged into the dataset from a supplemental data file that was originally provided separately.

- The original data file contained a range of dates representing year coverage ("Year_Coverage_Range"), this column has been split into two separate columns, "Year_Coverage_Range_Start" and "Year_Coverage_Range_End."

Problem Description

No dataset problems or issues have been noted by the dataset authors.

[table of contents | back to top]

Data Files

File
986216_v1_seabird_colony_sst.csv (Comma Separated Values (.csv), 78.69 MB) MD5:f0d92fd1a7343040c8f12db231299c1e Primary data file for dataset ID 986216, version 1

[table of contents | back to top]

Related Datasets

IsDerivedFrom

NASA/JPL. (2015). GHRSST Level 4 MUR Global Foundation Sea Surface Temperature Analysis (Version 4.1) [Data set]. NASA Physical Oceanography Distributed Active Archive Center (PO.DAAC). https://doi.org/10.5067/GHGMR-4FJ04

NOAA National Centers for Environmental Information. (2020). NOAA 0.25° Daily Optimum Interpolation Sea Surface Temperature (OISST), Version 2.1 [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/RE9P-PT57

UKMO. (2012). GHRSST Level 4 OSTIA Global Foundation Sea Surface Temperature Analysis (GDS Version 2) [Data set]. NASA Physical Oceanography Distributed Active Archive Center (PO.DAAC). https://doi.org/10.5067/GHOST-4FK02

[table of contents | back to top]

Parameters

Parameter	Description	Units
time	Date when sea surface temperature was measured at the site.	unitless
analysed_sst_mean	Sea surface temperature (SST) averaged within the 200-km radius around the seabird colony for the specific date.	degrees Celsius
analysed_sst_std	Standard deviation of SST calculated within the 200-km radius around the seabird colony for the specific date.	degrees Celsius
mask_clip	Proportion of land/ice data within the 200-km radius 'mask' around a seabird colony. Range: 0-1.	unitless
Sourced_SST_Data_Product	Dataset where the sea surface temperature data originated. OISST: NOAA Optimal Interpolation SST; MURSST: NASA Multi-scale Ultra-high Resolution SST; OSTIA: UK MetOffice Operational SST and Ice Analysis.	unitless
Site_Name	Name of seabird colony around which the SST data were derived.	unitless
site_latitude_degN	Latitude of the seabird colony site location in decimal degrees.	decimal degrees
site_longitude_degE	Longitude of the seabird colony site location in decimal degrees.	decimal degrees
Year_Coverage_Range_Start	The starting year of the dataset’s temporal coverage.	unitless
Year_Coverage_Range_End	The ending year of the dataset’s temporal coverage.	unitless
Original_File_Name	Filename of the originally submitted data file from which this row of data was derived.	unitless

[table of contents | back to top]

Project Information

Global analysis of stratification impacts on seabirds through food resources (Stratification impacts on seabirds)

Coverage: global

NSF Award Abstract:
Global warming is affecting the world’s oceans by altering marine habitats, yet the effects on marine life vary by ocean region. One factor that may explain these observations is that ocean surface waters have warmed faster than deeper waters. Temperature differences may act as a physical barrier to mixing, thereby impeding deeper nutrients from reaching the sunlit surface where they are used by ocean plants in photosynthesis. With less mixing, the upper layers of the ocean may have become less productive, which may in turn impact marine fish, bird, and mammal populations of economic and cultural (ecological) value to society. To conduct this

study, the investigators are examining the effects of ocean warming by depth on the abundance of plankton, small fish, and the breeding success of marine birds across the world using existing long-term data. They are developing mathematical relationships to understand how ocean warming at various depths is linked to plankton, fish, and bird productivity. Results will provide key information for selecting which seabird species may be best suited as ecological indicators of change for different ecosystems across the globe, and therefore has implications for remote-ocean monitoring. The project will contribute new scientific understanding for upcoming United Nation assessment reports and enhance public awareness of ocean health through outreach materials centered on popular seabirds such as puffins and penguins. It will support early career and postdoctoral scientists.

Ocean thermal stratification is an important factor determining primary productivity in epipelagic zones of the world's oceans. A recent global analysis showed declining trends in the breeding productivity of fish-eating seabirds that forage in the epipelagic zone, but increasing stratification has yet to be investigated as an explanatory factor. The primary objective of this project is to test the hypothesis that seabird species groups vary in their responses to increasing thermal stratification through the indirect effects of stratification on epipelagic food resource availability and/or prey use by the birds. The investigators are testing the prediction that thermal stratification has the largest effect on breeding productivity of piscivorous, surface-foraging species. They are integrating a new global database on seabird productivity with high-resolution data on thermal stratification available from the European GLORYS model, as well as satellite-based chlorophyll-a data from NASA. They are using Generalized Linear Mixed Models to test for variation between seabird groups and Structural Equation Models to test direct and indirect pathways of response from stratification through prey availability to seabird productivity, focusing on mid-to-high latitude ecosystems across ocean basins in both the northern and southern hemispheres. Results will improve understanding of how seabirds respond to increasing thermal stratification in relation to fundamental differences in seabird life history traits. The retrospective analysis will advance knowledge of how seabirds that feed on different prey, and in different epipelagic habitats of the world's oceans, have responded to recent increases in stratification. More generally, the study will contribute insight into how physical changes in the upper ocean affect predators through the availability of food resources.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Location Description:
Data to be analyzed are from around the world and contributed from numerous local providers and other groups. The study area is the global ocean. Analysis will be done at the Farallon Institute, located in Petaluma, California.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2142918

[table of contents | back to top]