Pre-ABoVE: Particle Trajectories for WRF-STILT Model, Barrow, AK, 1982-2011

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Documentation Revision Date: 2018-04-11

Data Set Version: 1

Summary

This dataset provides Weather Research and Forecasting (WRF) Stochastic Time-Inverted Lagrangian Transport (STILT) model inputs for a particle receptor located at the NOAA Barrow Alaska Observatory for the years 1982-2011. The Barrow Alaska Observatory was treated as the receptor in the WRF-STILT model to simulate the land surface influence on observed atmospheric constituents. The measurements included in this dataset are crucial for understanding changes in Arctic carbon cycling and are part of a retrospective analysis to link changes in atmospheric composition at Arctic receptor sites with shifts in ecosystem structure and function. The particle trajectory product consists of multiple NetCDF files packaged as a GZIP file and corresponds to STILT model footprint data provided in a related dataset.

There are 11,904 WRF-STILT Particle files in NetCDF format included in this dataset. The files are provided in one TAR/GZIP file.

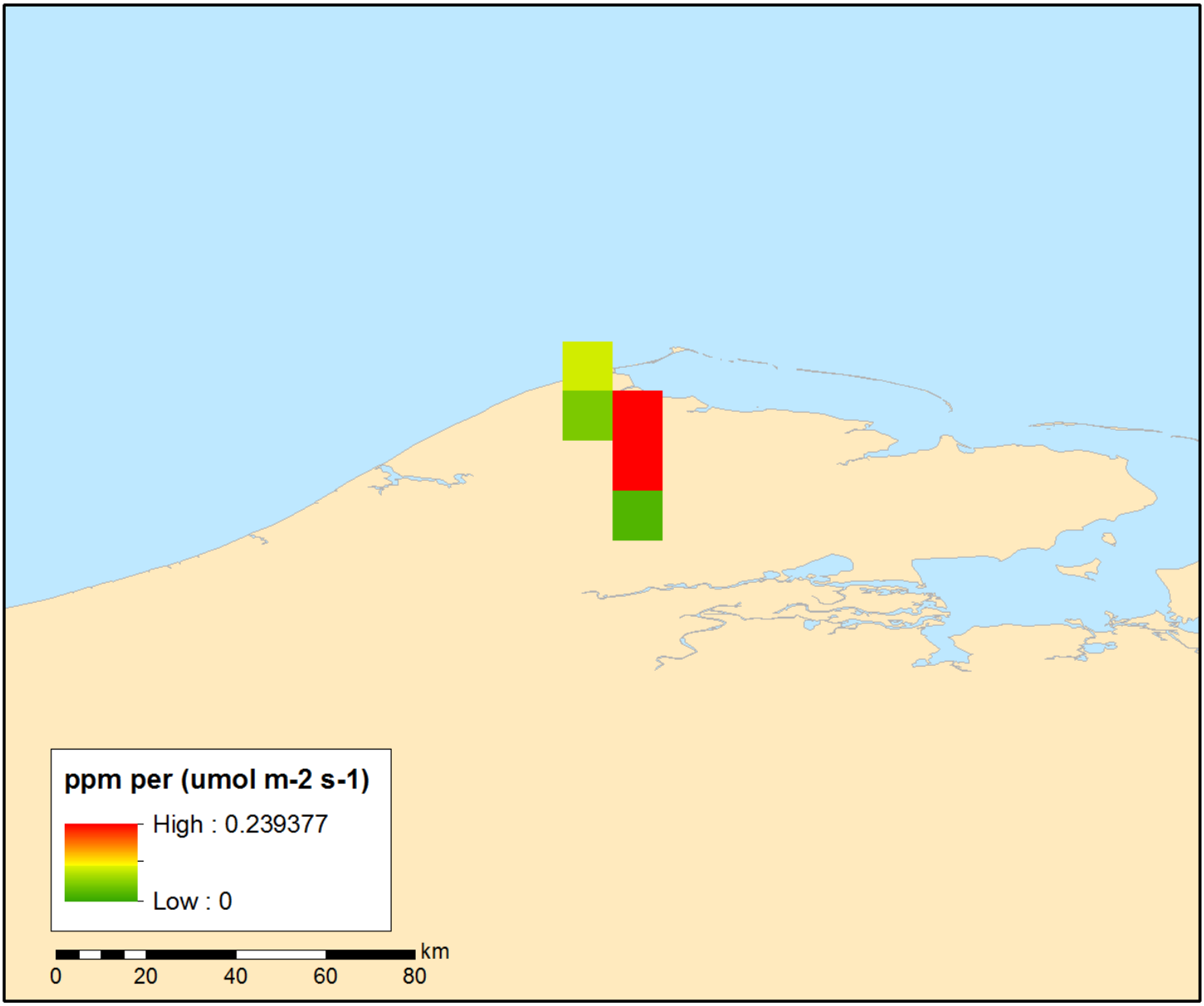

Figure 1. Image of the footnearfield1 variable for 0.1 degree gridded STILT Footprint model output for August 15,1982 near the receptor location at Barrow, Alaska. The footnearfield1 variable provides 24 hours of surface influence representing the response of the receptor to a unit surface emission (ppm/umol m-2 s-1) of CO2 in each 0.1- x 0.1-degree grid cell within a small region close to the measurement location at hourly temporal resolution. From the file foot1982x08x15x06x00x71.3230Nx156.6114Wx00016.nc.

Citation

Henderson, J. 2018. Pre-ABoVE: Particle Trajectories for WRF-STILT Model, Barrow, AK, 1982-2011. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1571

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1. Data Set Overview

This dataset provides Stochastic Time-Inverted Lagrangian Transport (STILT; Nehrkorn et al., 2010) model outputs for receptors located at the NOAA Barrow Alaska Observatory for twelve two-month periods (15 August to 15 October) from 1982 to 2011. Meteorological fields from version 3.5.1 of the Weather Research and Forecasting (WRF; Powers et al., 2017) model are used to drive STILT. STILT applies a Lagrangian particle dispersion model backwards in time from a measurement location (the "receptor" location), to create the adjoint of the transport model in the form of a "footprint" field (Nehrkorn et al., 2010; Henderson et al., 2015). The footprint, with units of mixing ratio (ppm --- CO2; ppb --- CH4) per (umol m-2 s-1 --- CO2; nmol m-2 s-1 --- CH4), quantifies the influence of upwind surface fluxes on concentrations measured at the receptor and is computed by counting the number of particles in a surface-influenced volume and the time spent in that volume. Receptors are hourly from the hours 15-03 UTC and 3-hourly otherwise (6, 9 and 12 UTC).

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign based in Alaska and western Canada between 2016 and 2021. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis and modeling capabilities needed to understand and predict ecosystem responses and societal implications.

Related Datasets:

Henderson, J. 2018. Pre-ABoVE: Gridded Footprints from WRF-STILT Model, Barrow, Alaska, 1982-2011. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1544

Note that the two Pre-ABoVE WRF-STILT model products were created following the same methods as for the CARVE WRF-STILT model products below.

CARVE Science Team. 2017. CARVE: L4 Gridded Particle Trajectories for WRF-STILT model, 2012-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1430

Henderson, J., J.B. Miller, T. Nehrkorn, R.Y-W. Chang, C. Sweeney, N. Steiner, S.C. Wofsy, and C.E. Miller. 2017. CARVE: L4 Gridded Footprints from WRF-STILT model, 2012-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1431

Acknowledgements:

This study was funded by NASA's Arctic-Boreal Vulnerability Experiment (grant number: NNX13AK83G).

2. Data Characteristics

Spatial Coverage: Station observations at the NOAA Barrow Alaska Observatory

Spatial Resolution: 0.5-degree fixed circumpolar; 0.1-degree for near field receptor centered

Temporal Coverage: 1982-08-10 to 2011-10-15

Temporal Resolution: Hourly

Study Area (coordinates in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Barrow Alaska Observatory (receptor)	-156.6114	-156.6114	71.3230	71.3230
Circumpolar (*foot1* variable)	-180.0	180.0	90.0	30.0
Alaska (*footnearfield1* variable)	-169.5135142654	-133.8299205154	71.355322323408	58.352767730653

Data File Information

The TAR/GZIP file (*.tar.gz) contains 11,904 NetCDF files representing gridded particle trajectories from WRF-STILT simulations for one particle receptor location. Each file aggregates particle footprints on a lat/lon/time grid starting at the STILT simulation start time.

The first surface influence field, represented by the *foot1* variable in the NetCDF files, provides 10 days of surface influence representing the response of the receptor to a unit surface emission (ppm/umol m-2 s-1) of CO2 in each 0.25- x 0.25-degree grid cell within the whole area of coverage (30N to 90N, 180E to 180W) at hourly temporal resolution.

The second surface influence field, represented by the *footnearfield1* variable in the NetCDF files, provides 24 hours of surface influence representing the response of the receptor to a unit surface emission (ppm/umol m-2 s-1) of CO2 in each 0.1- x 0.1-degree grid cell within a small region close to the measurement location at hourly temporal resolution.

Data file naming convention: The files are named by **year, month, day, hour, minute, latitude, longitude,** and **height** A.G.L. in meters, separated by an **x.**

Example file name: **stilt1982x08x15x02x00x71.3230Nx156.6114Wx00016.nc.** For a description of the naming elements in the example file name, refer to Table 1.

Table 1. Description of elements in the example file name

Name element	Example value	Units
Year	1982	YYYY
Month	08	MM
Day	15	DD
Hour	02	hh (UTC)
Minute	00	mm (UTC)
Latitude	71.3230N	decimal degrees
Longitude	156.6114W	decimal degrees
Height A.G.L.	00016	m

Table 2. Variables in the data files

Variable name	Units	Description
checkbasic		Basic output from Trajeccheck()
checkbasicnames		Names for checkbasic 1D array
checksum		Checksum array
checksumdate	days since 2000-01-01 00:00:00 UTC	Checksum date
checksumnames		Column names for checksum array
endpts		Stilt particle location array thinned to retain rows containing trajectory endpts
endptsdate	days since 2000-01-01 00:00:00 UTC	End points date
endptsnames		Column names for particle array ‘endpts’
foot1	ppm per (umol m-2 s-1)	Gridded STILT footprint
foot1date	days since 2000-01-01 00:00:00 UTC	Date of foot1
foot1hr	hours	Hours back from STILT start time
foot1lat	degrees_north	Degrees latitude of center of grid cells
foot1lon	degrees_east	Degrees longitude of center of grid cells
footnearfield1	ppm per (umol m-2 s-1)	Gridded STILT footprint
footnearfield1date	days since 2000-01-01 00:00:00 UTC	Date for 'footnearfield1'
footnearfield1hr	hours	Hours back from STILT start time for 'footnearfield1'
footnearfield1lat	degrees_north	Degrees latitude of center of grid cells
footnearfield1lon	degrees_east	Degrees longitude of center of grid cells
ident		Identifier string
nchar		Numeric identifier
origagl	meters	Original receptor height above ground before rounding for STILT
origlat	degrees_north	Original receptor latitude
origlon	degrees_east	Original receptor longitude
origutctime	UTC time	Original receptor time
origutctimeformat		Original receptor time format

part3d		Stilt particle location array thinned to retain rows approximately every so many hours
part3ddate	days since 2000-01-01 00:00:00 UTC	Date of part3d
part3dnames		Column names for particle array ‘part3d’
partfoot		Stilt particle location array thinned to retain rows where foot > 0
partfootdate	days since 2000-01-01 00:00:00 UTC	Date of partfoot
partfootnames		Column names for particle array ‘partfoot’

3. Application and Derivation

The NOAA Barrow Alaska Observatory was treated as receptor in the WRF-STILT model in order to simulate the land surface influence on observed atmospheric constituents. The measurements included in this dataset are crucial for understanding changes in Arctic carbon cycling and are part of a retrospective analysis to link changes in atmospheric composition at Arctic receptor sites with shifts in ecosystem structure and function.

4. Quality Assessment

The Stochastic Time-Inverted Lagrangian Transport model inherently provides uncertainty in atmospheric transport path by following multiple tracer particles from a single point and defining the source area by the ensemble's spread. However, the sensitivity/uncertainty associated with changes in the meteorology or configuration of STILT (e.g., depth of the surface-influencing region) is not quantified.

5. Data Acquisition, Materials, and Methods

The NOAA Barrow Alaska Observatory (https://www.esrl.noaa.gov/gmd/obop/brw/) was treated as receptor in a Stochastic Time-Inverted Lagrangian Transport (STILT) model coupled with meteorology fields from the polar variant of the Weather and Research Forecasting (WRF; Skamarock et al., 2008) model, in order to model the land surface influence on observed atmospheric constituents. The atmospheric model was configured to generate high-quality, high-resolution meteorological fields over Arctic and boreal Alaska.

STILT applies a Lagrangian particle dispersion model backwards in time from a measurement location (the "receptor" location), to create the adjoint of the transport model in the form of a "footprint" field (Nehrkorn et al., 2010; Henderson et al., 2015). The footprint, with units of mixing ratio (ppm --- CO2; ppb --- CH4) per (umol m-2 s-1), quantifies the influence of upwind surface fluxes on concentrations measured at the receptor and is computed by counting the number of particles in a surface-influenced volume and the time spent in that volume. This data product includes the particle files only as NetCDF files.

The WRF-STILT coupled model is described in Nehrkorn et al. (2010). Note that the two Pre-ABoVE WRF-STILT model products were created following the same methods as for the following CARVE WRF-STILT model products.

CARVE Science Team. 2017. CARVE: L4 Gridded Particle Trajectories for WRF-STILT model, 2012-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1430

Henderson, J., J.B. Miller, T. Nehrkorn, R.Y-W. Chang, C. Sweeney, N. Steiner, S.C. Wofsy, and C.E. Miller. 2017. CARVE: L4 Gridded Footprints from WRF-STILT model, 2012-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1431

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

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Contact for Data Center Access Information:

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