



WRF-STILT Gridded Footprints for Boston, MA, USA, 2013-2014

Get Data

Documentation Revision Date: 2018-05-18

Data Set Version: 1

Summary

This dataset provides Weather Research and Forecasting (WRF) Stochastic Time-Inverted Lagrangian Transport (STILT) footprint data products for two receptors located in Boston, Massachusetts, USA, for July 2013 - December 2014. The data are gridded footprints on a 1-km grid congruent with the ACES emissions inventory. Meteorological fields from version 3.6.1 of the Weather Research and Forecasting 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. The footprint, with units of mixing ratio (ppm) per surface flux ($\mu\text{mol m}^{-2} \text{s}^{-1}$), quantifies the influence of upwind surface fluxes on CO₂ and CH₄ 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.

The WRF-STILT particle trajectories and footprints were used to compute enhancements (over background values) of CO₂ due to surface fluxes over the Boston metropolitan area.

There are 18 monthly data files with this dataset provided as TAR/GZIP files (*.tar.gz). When uncompressed, each monthly file contains 48 files per day (24 hourly files at 2 receptors) in NetCDF (.nc4) format.

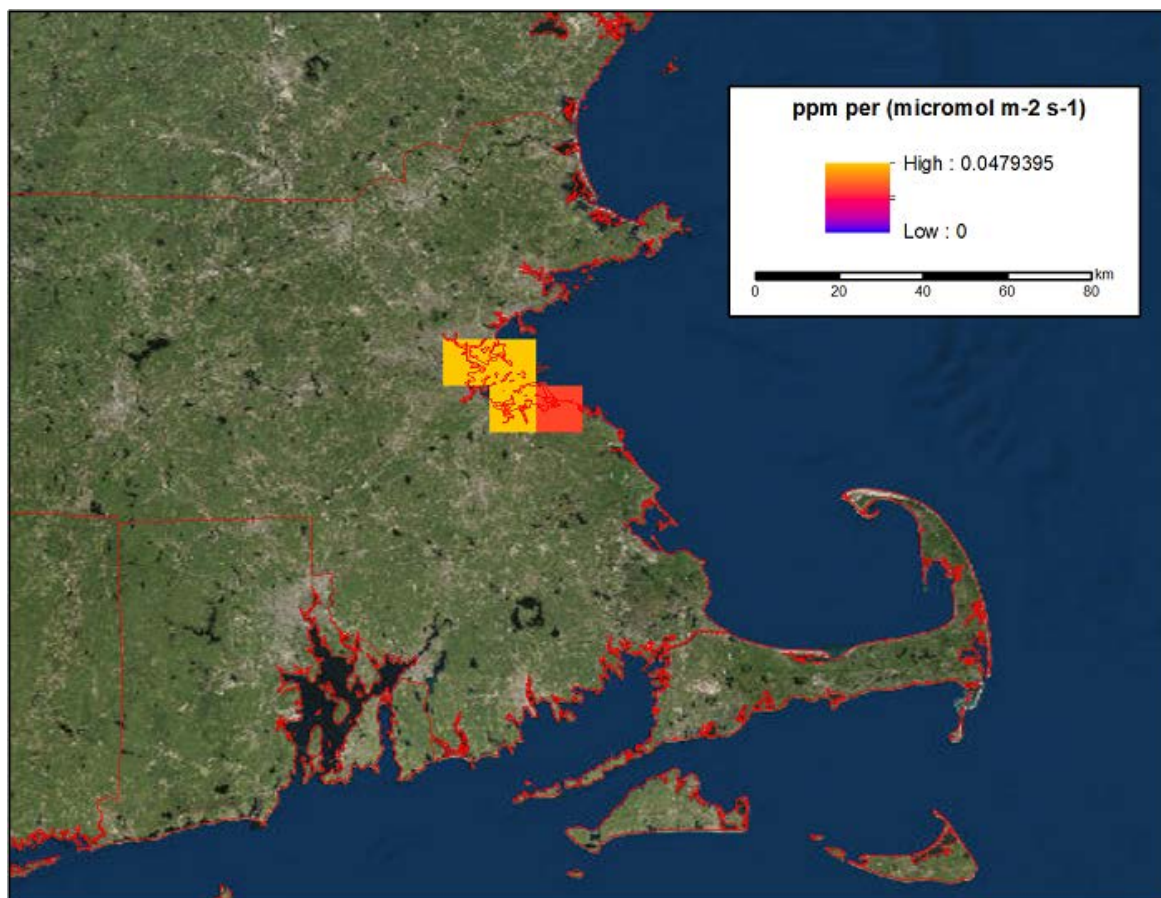


Figure 1. Data from the WRF-STILT model for emissions of CO₂ (ppm/ $\mu\text{mol m}^{-2} \text{s}^{-1}$) in Boston, Massachusetts.

Citation

Nehrkorn, T., M. Sargent, S.C. Wofsy, and M. Mountain. 2018. WRF-STILT Gridded Footprints for Boston, MA, USA, 2013-2014. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1572>

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1. Data Set Overview

This dataset provides Weather Research and Forecasting (WRF) Stochastic Time-Inverted Lagrangian Transport (STILT) footprint data products for two receptors located in Boston, Massachusetts, USA, for July 2013 - December 2014. The data are gridded footprints on a 1-km grid congruent with the ACES emissions inventory. Meteorological fields from version 3.6.1 of the Weather Research and Forecasting 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. The footprint, with units of mixing ratio (ppm) per surface flux ($\mu\text{mol m}^{-2} \text{s}^{-1}$), quantifies the influence of upwind surface fluxes on CO₂ and CH₄ 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.

The WRF-STILT particle trajectories and footprints were used to compute enhancements (over background values) of CO₂ due to surface fluxes over the Boston metropolitan area.

User Notes:

- This dataset contains only the gridded surface influence-function footprints on the 1 km ACES grid.
- The related dataset (Nehrkorn et al., 2018) provides both gridded footprints (on latitude-longitude grids) and the particle trajectory data (the time-

dependent location of each of 500 particles on their backwards-in-time trajectories).

- Users may find these gridded footprint data files more convenient since they are much smaller in size and most end-users are only interested in this final component of the model output.

Project: [North American Carbon Program \(NACP\)](#)

The North American Carbon Program (NACP) is a multidisciplinary research program to obtain scientific understanding of North America's carbon sources and sinks and of changes in carbon stocks needed to meet societal concerns and to provide tools for decision makers. The NACP is supported by a number of different federal agencies. The central objective is to measure and understand the sources and sinks of Carbon Dioxide (CO₂), Methane (CH₄), and Carbon Monoxide (CO) in North America and in adjacent ocean regions.

Related datasets

Nehrkorn, T., M. Sargent, S.C. Wofsy, and M. Mountain. 2018. **WRF-STILT Particle Trajectories for Boston, MA, USA, 2013-2014**. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1596>

Gately, C., and L.R. Hutyla. 2018. **CMS: CO₂ Emissions from Fossil Fuels Combustion, ACES Inventory for Northeastern USA**. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1501>

Acknowledgements

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2. Data Characteristics

Spatial Coverage: Boston, Massachusetts and area congruent with the ACES emissions inventory, Northeastern USA

Spatial Resolution: 1 x 1 km

Temporal Coverage: 2013-07-01 to 2014-12-31

Temporal Resolution: Hourly

Study Area (coordinates in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Boston University (receptor)	-71.1040	-71.1040	42.35	42.35
Copley Square (receptor)	-71.084	-71.084	42.347	42.347
Area congruent with the ACES emissions inventory, Northeastern USA: foot1 and foot1_int10_resmedian variables	-81.7794	-65.9319	49.19362	34.51113

There are 18 monthly data files with this dataset provided as TAR/GZIP files (*.tar.gz). They are named by year and month (for example, **foot1km-201310.tar.gz** and **foot1km-201410.tar.gz**).

When uncompressed, each of the 18 monthly files contains 48 files per day (24 hourly files at 2 receptors), 26,304 files total, provided in NetCDF (.nc4) format.

NetCDF file naming convention:

The files provided in the zipped files above are named according to the following naming convention:

foot **year**, **month**, **day**, **hour**, **minute**, **latitude**, **longitude**, and **height** A.G.L. in meters, separated by an **x**.

Example file name: **foot2014x12x31x23x00x42.3500Nx071.1040Wx00029.nc4**

This file contains the modeled footprints for December 31, 2014 at 23:00 UTC. The observation was taken at 42.3500N, 71.1040W at 29 m above ground level.

Table 1. Description of elements in the data file name

Name element	Example value	Units
Year	2014	YYYY
Month	12	MM
Day	31	DD

Hour	23	hh (UTC)
Minute	00	mm (UTC)
Latitude	42.3500N	decimal degrees
Longitude	71.1040W	decimal degrees
Height A.G.L.	00029	m

Data Dictionary

Table 2. Variables in the data files

Variable name	Units	Description
foot1	ppm per (umol m ⁻² s ⁻¹)	Gridded STILT footprint
foot1date	days	Date of foot1 (days since 2000-01-01 00:00:00 UTC)
foot1hr	hours	Hours back from STILT start time
foot1lat_meters	meters	Latitude of SW corner of grid cell on the projected map coordinate system
foot1lon_meters	meters	Longitude of SW corner of grid cell on the projected map coordinate system
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
origtctime	UTC time	Original receptor time
origtctimeformat		Original receptor time format
foot1_int10_resmedianlon_meters	meters	Latitude of SW corner of grid cell on the projected map coordinate system
foot1_int10_resmedianlat_meters	meters	Longitude of SW corner of grid cell on the projected map coordinate system
foot1_int10_resmediandate	days	Date of foot1_int10_resmedian (days since 2000-01-01 00:00:00 UTC)
foot1_int10_resmedian	ppm per umol m ⁻² s ⁻¹	Resampled version of the raw gridded footprints, in which footprints are time-interpolated during the first [hr] hours of the back trajectories, and are averaged in space after that time, by an averaging length determined by a combination of the particle spread in space and the median distance traveled by particles between footprint times
foot1_int10_resmedianhr	hours	Hours back from STILT start time

3. Application and Derivation

STILT footprints support accurate estimates of CO₂ and CH₄ surface-atmosphere fluxes.

4. Quality Assessment

Extensive evaluation of WRF meteorological fields, PBL height, and WRF-STILT simulated enhancements are included in Sargent et al. (2018).

5. Data Acquisition, Materials, and Methods

WRF-STILT Simulations

The Weather Research and Forecasting (WRF; Powers et al., 2017) Stochastic Time-Inverted Lagrangian Transport (STILT) coupled model was used to

simulate footprint data products for particle receptors located in Boston for July 2013 - December 2014. The receptors were located at Boston University and at Copley Square, Boston.

The related dataset (Nehrkorn et al., 2018) provides [both the gridded footprints and the full particle trajectory data](#) (the time-dependent location of each of 500 particles on their backwards-in-time trajectories).

The WRF-STILT coupled model is described in Nehrkorn et al. (2010). The methods used here are consistent with Henderson et al. (2015). For more information, see Sargent et al. (2018).

6. Data Access

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

[WRF-STILT Gridded Footprints for Boston, MA, USA, 2013-2014](#)

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Gately, C., and L.R. Hutya. 2017. CMS: CO2 Emissions from Fossil Fuels Combustion, ACES Inventory for Northeastern USA. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1501>

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