Hestia-AKL: An Inventory of Fossil Fuel CO_2 Emissions for Auckland, New Zealand

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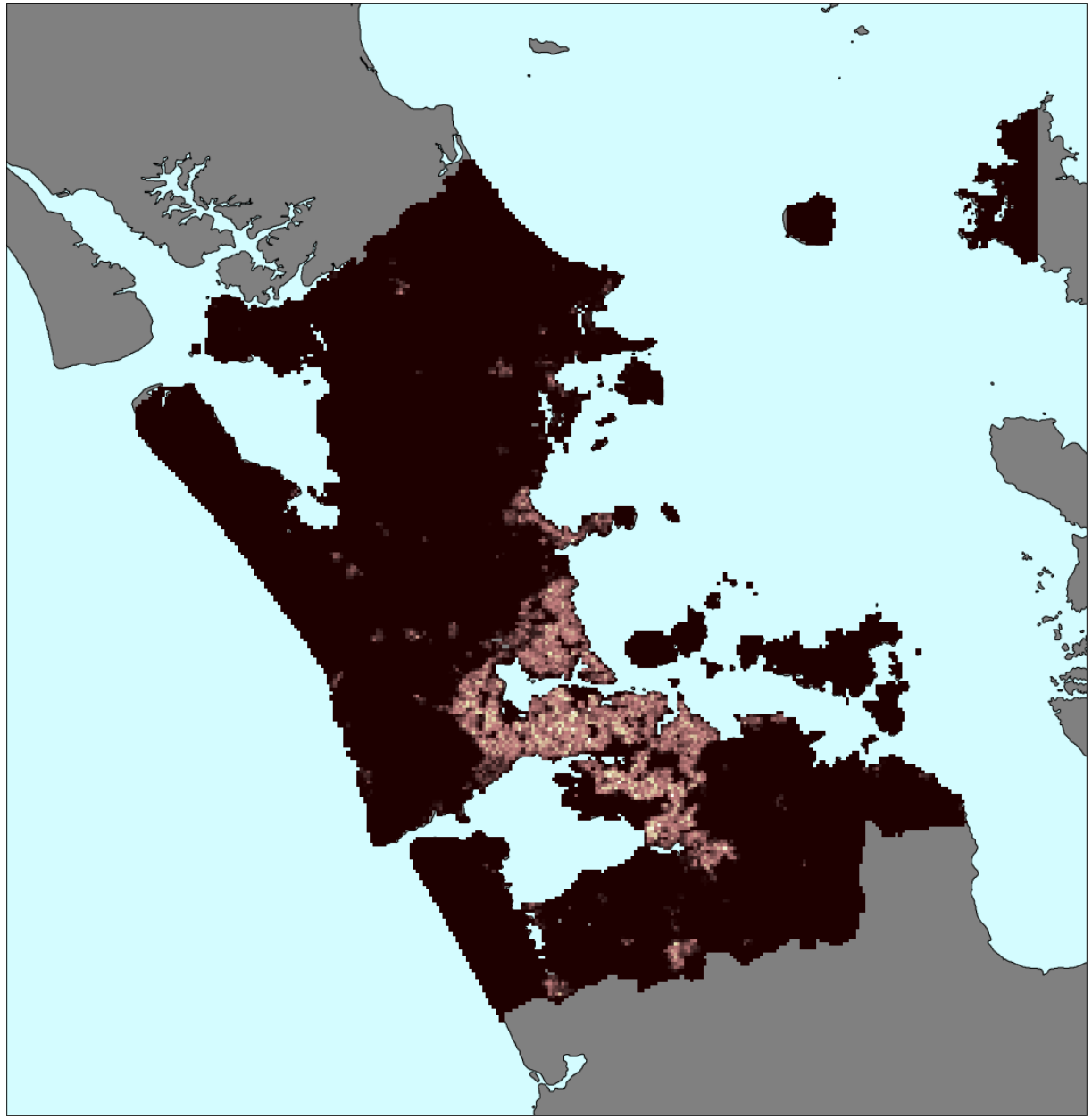
Abstract

The largest city in New Zealand, Auckland is home to roughly 1.5 million people – one third of New Zealand's population. Here we assemble a bottom-up inventory of Auckland's fossil fuel carbon dioxide emissions from a variety of data sources. We use these emissions estimates in combination with the UrbanVPRM land surface model to estimate the net carbon balance of the region. This work is part of the larger CarbonWatch NZ project, which aims to produce estimates of New Zealand's net carbon balance quickly enough to assess and refine ongoing national efforts to reach carbon neutrality.



Mahuika-Auckland

A high-resolution CO_2 emission data product for Auckland, New Zealand

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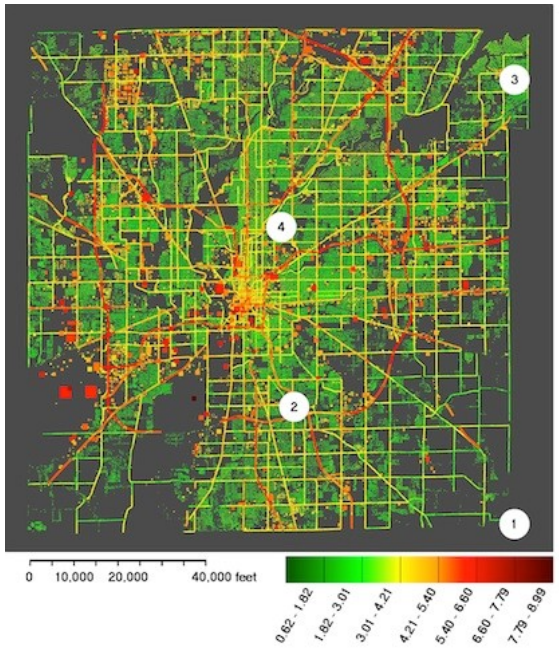
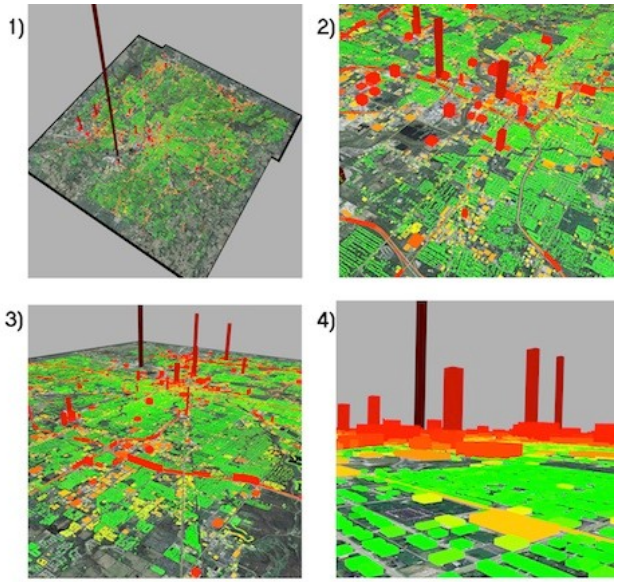
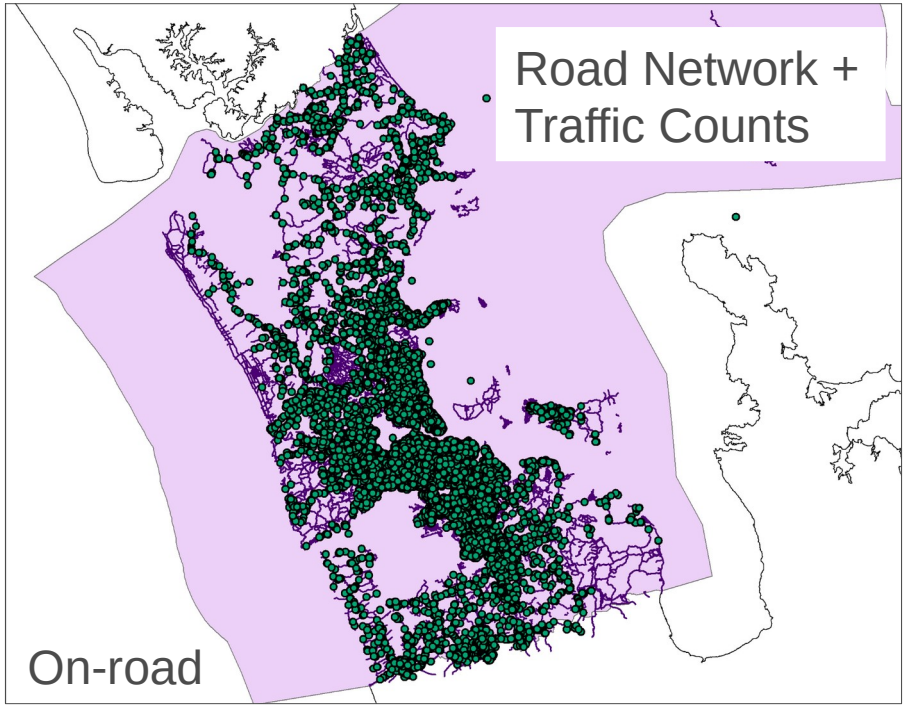
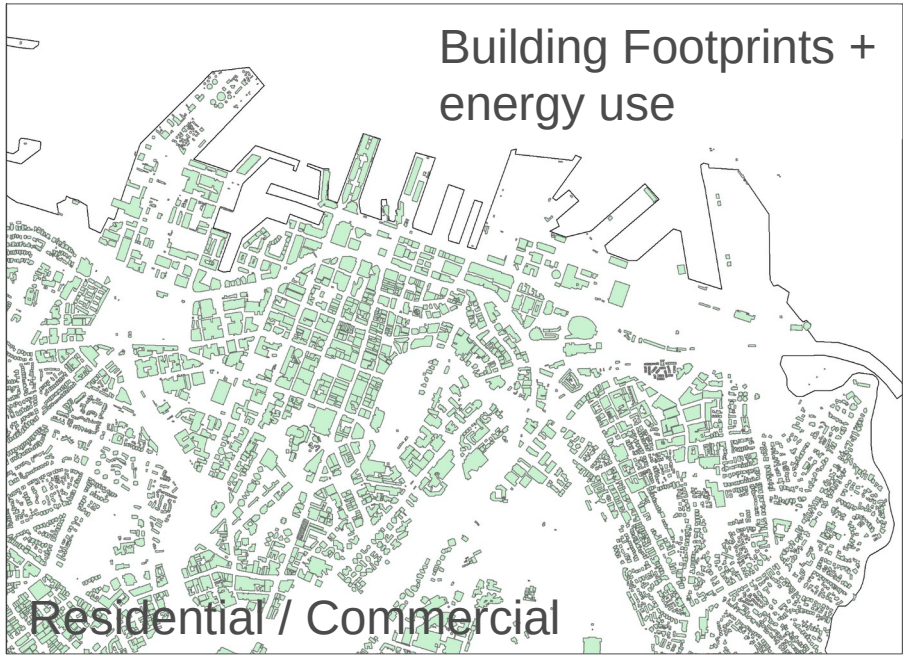
Modelling fossil fuel CO_2: Hestia



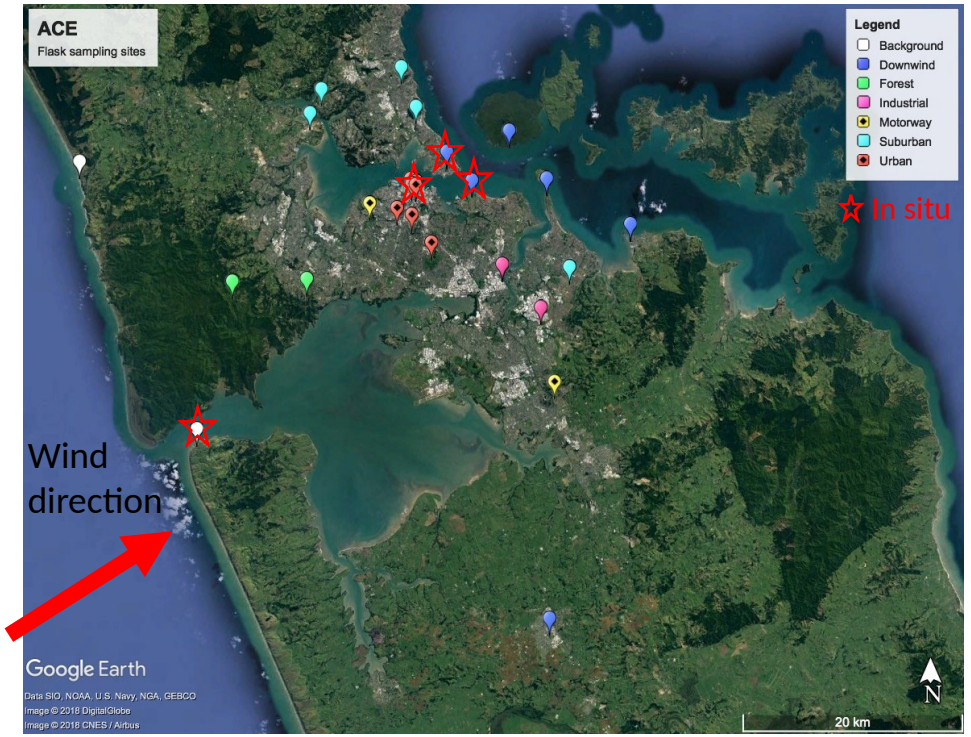


- Data-model system for urban landscape
- Hourly time scale, building / street spatial scale
- Includes residential, commercial, industrial, transportation, electricity generation sector components
- Uses datasets and tools such as building energy simulations, traffic data, power production, local air pollution





CarbonWatch-Auckland integrated network observations



In situ network
In situ CO_2, CO, CH_4
Weekly flasks CO_2, CO, CH_4, $^{14}CO_2$, COS

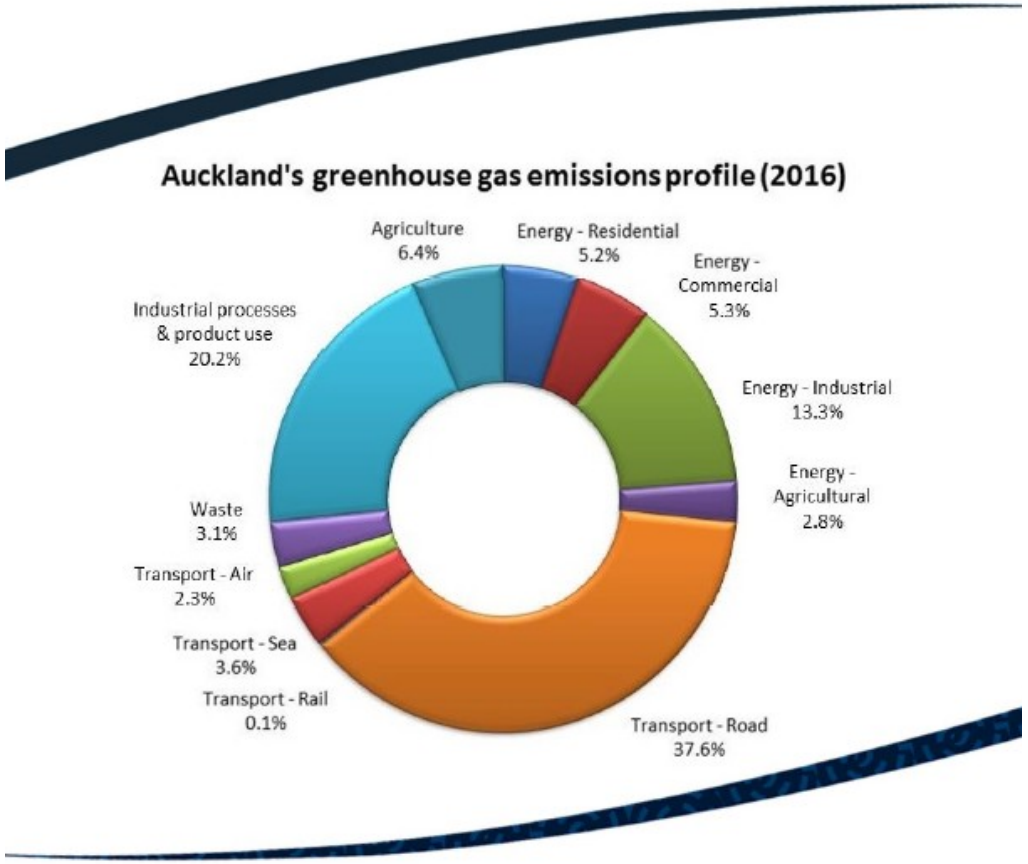
Total emissions: Auckland Council 2016 GHG inventory

- On-road transport ~38%
- Industrial ~33%
- Residential ~5%
- Commercial ~5%

Auckland's Greenhouse Gas Inventory to 2016

Shanju Xie

February 2019 Technical Report 2019/002

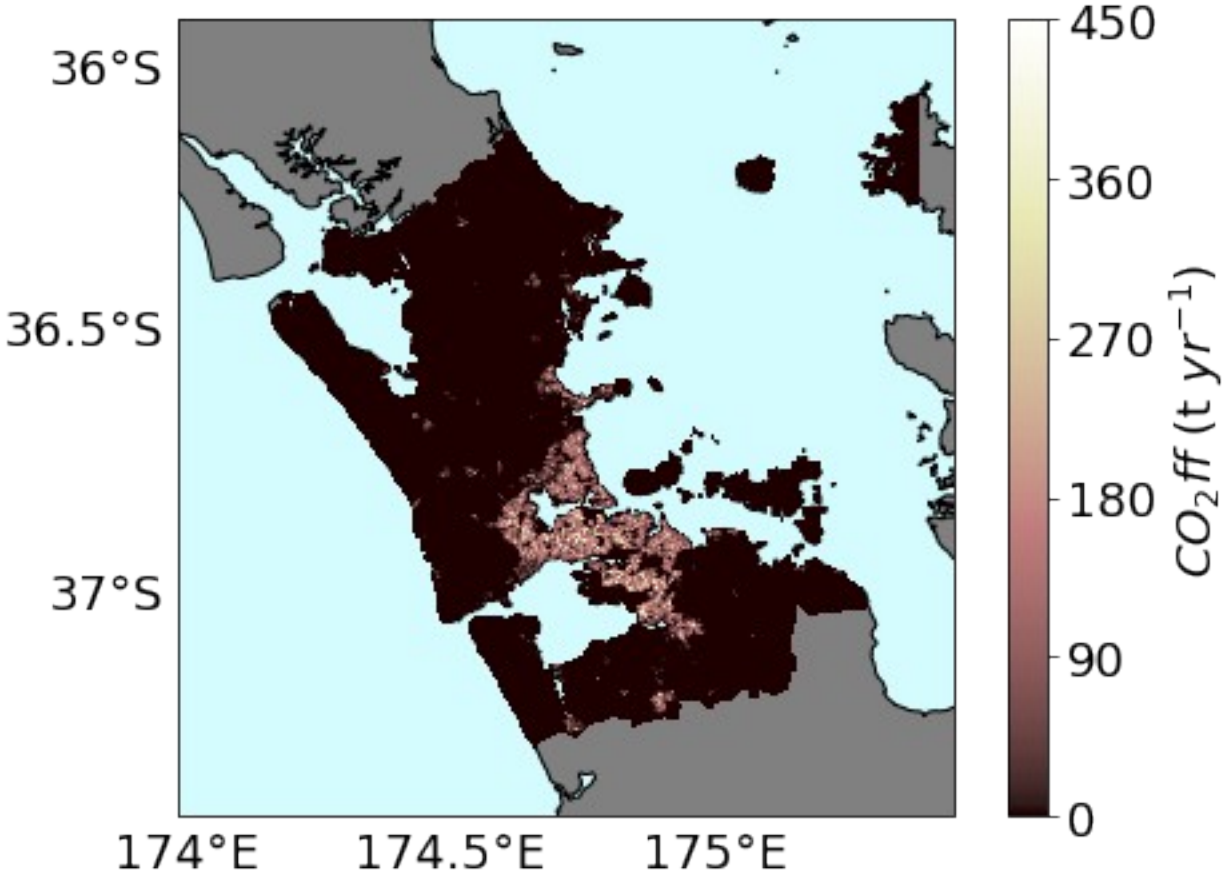


RIMU Research and Evaluation Unit

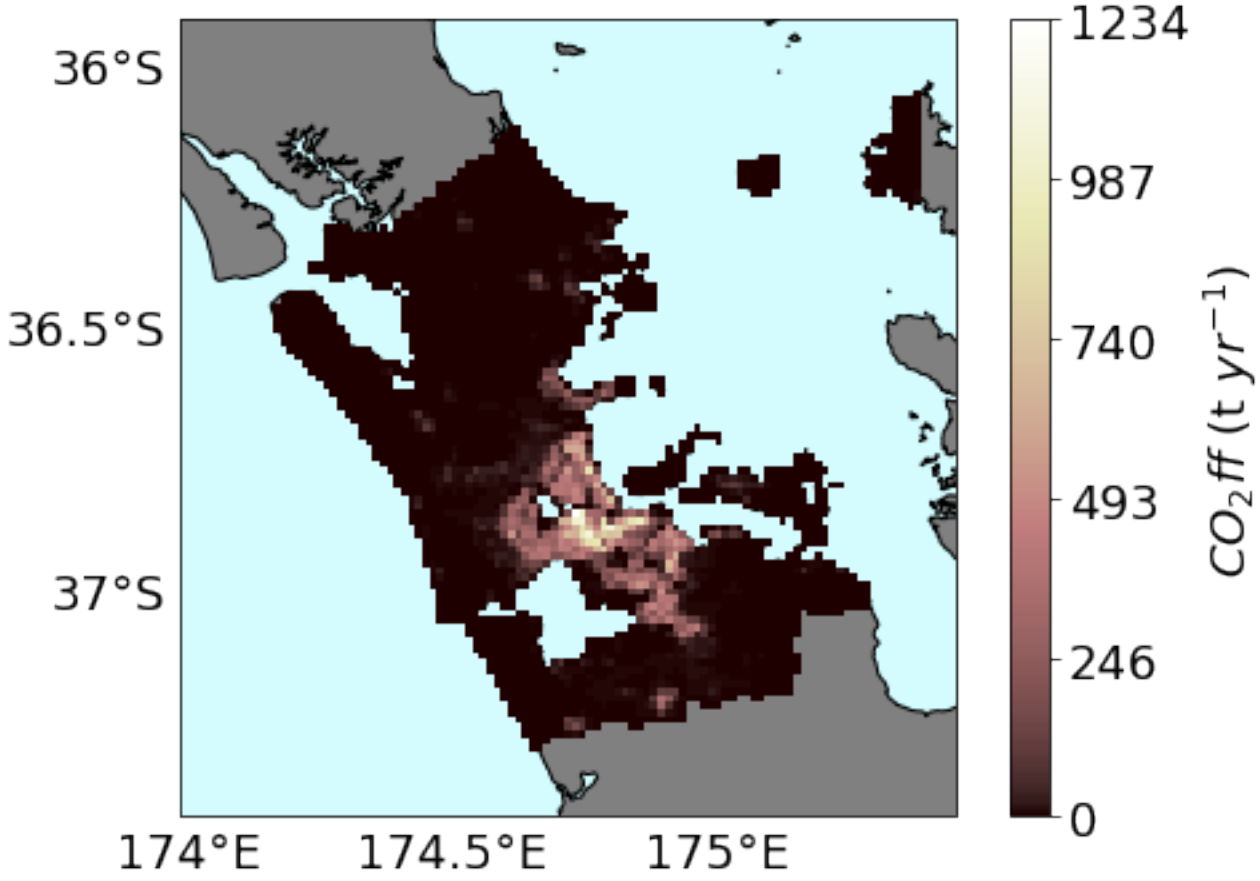
Auckland Council
Te Kaunihera o Tāmaki Makaurau

Residential energy – fossil fuel

Spatial distribution based on NZ census population and fuel used to heat home



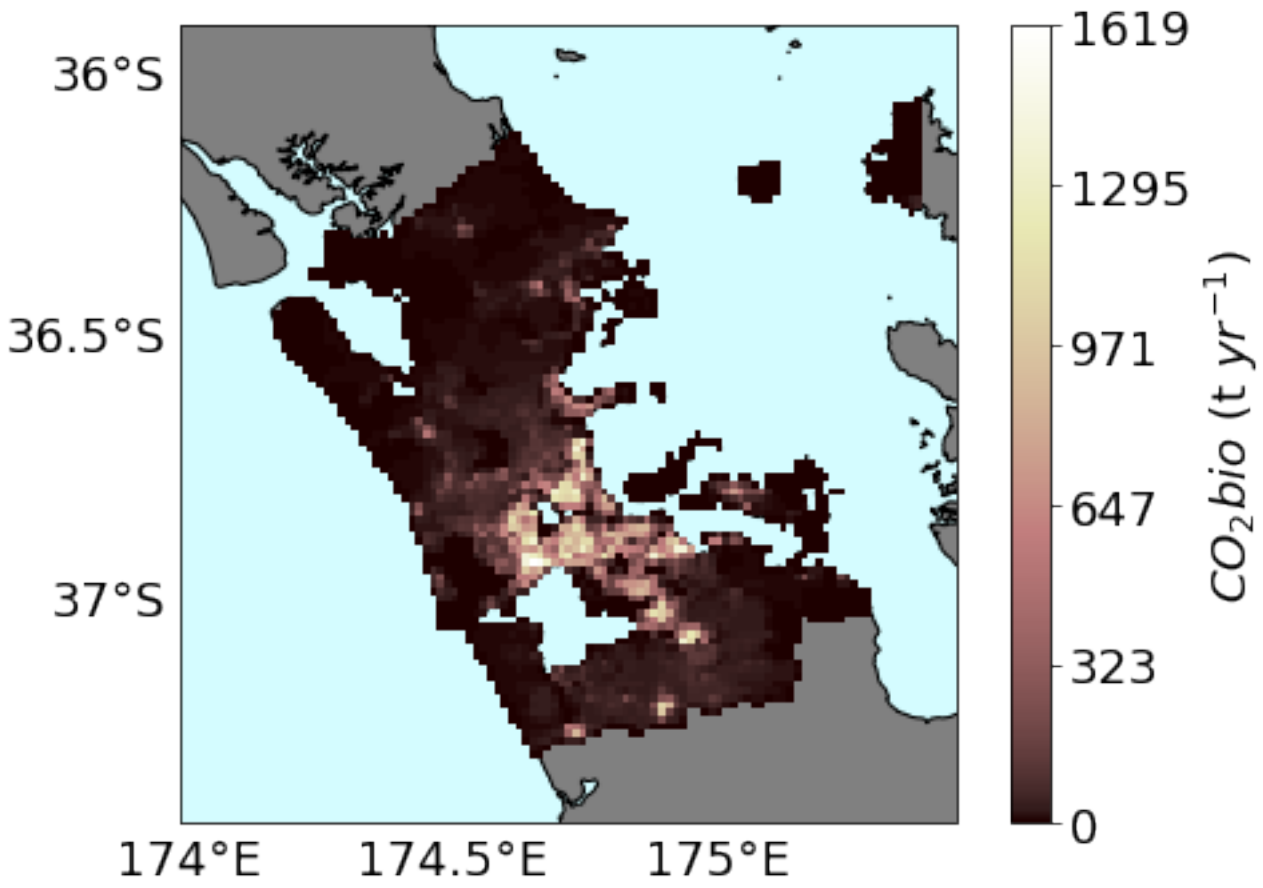
High-resolution based on building footprints



Lower-resolution based on census statistical areas on 1.5 km grid

Residential energy – biogenic (wood burning)

- Time:
  - distributed according to energy use patterns by season
  - Wood burning distributed by month according to Auckland Council report



based on census fuel used to heat home

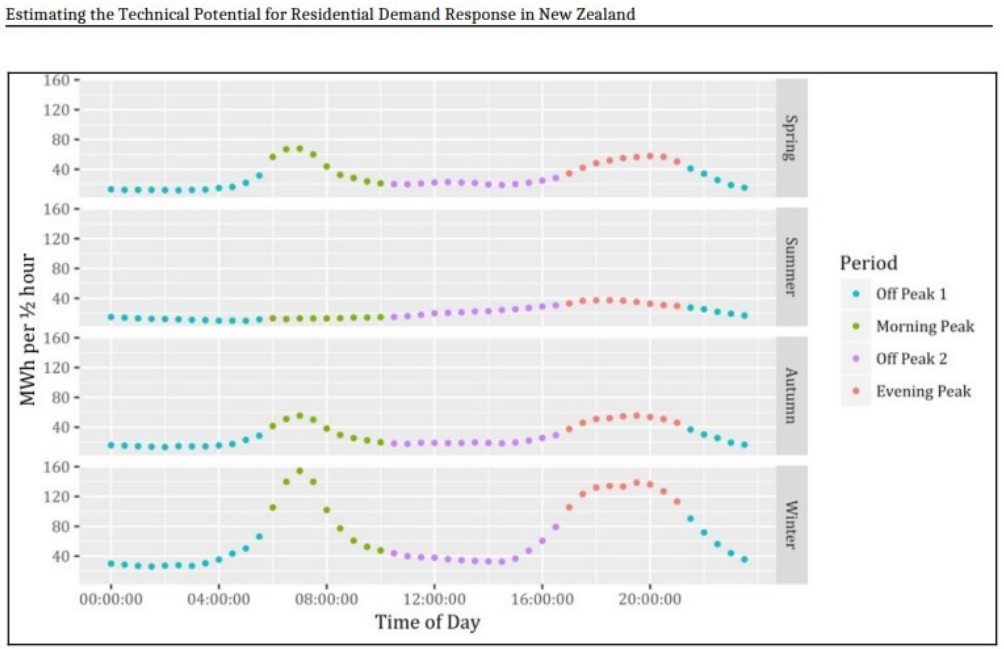


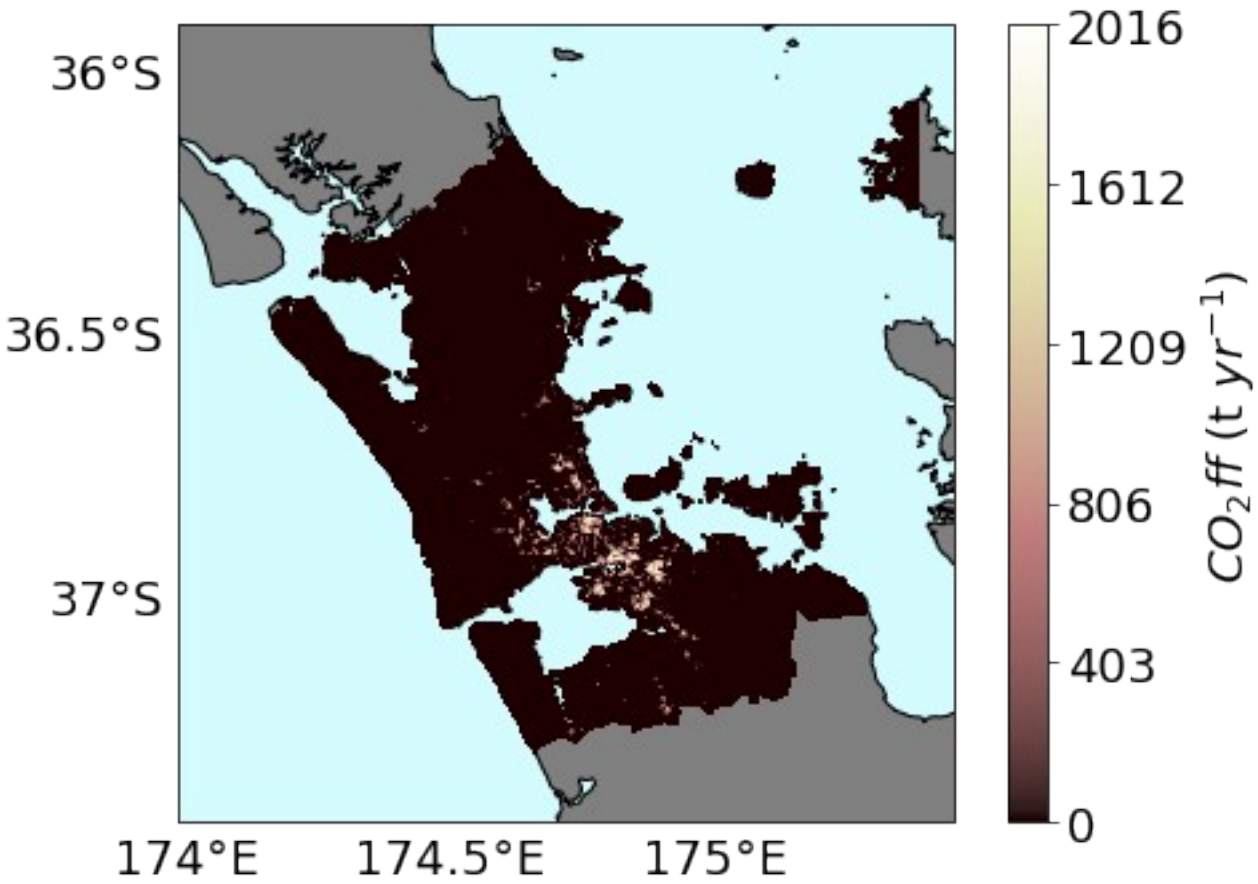
Fig. 19| Estimated daily energy consumption profile for heat pumps

Dortans et al. 2018

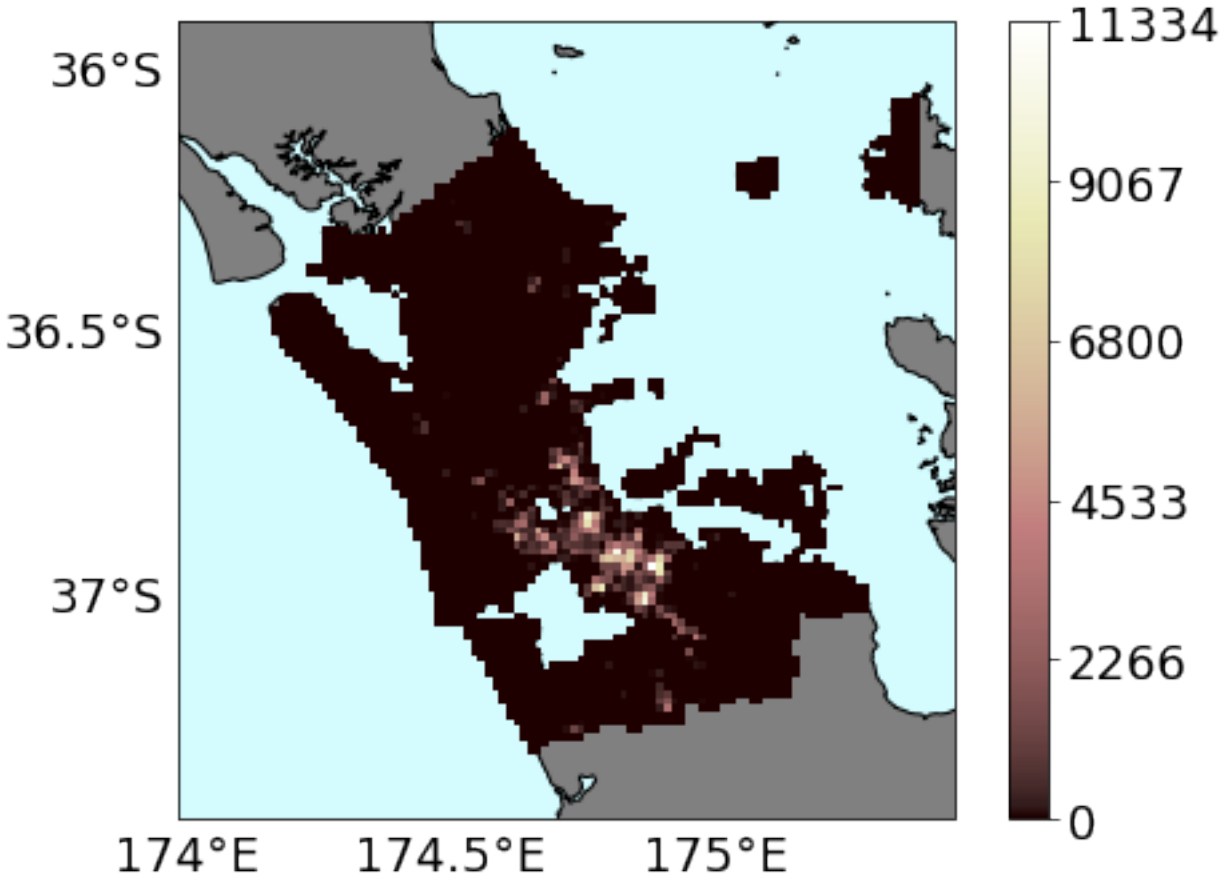
Commercial energy – fossil fuel

Time: distributed evenly over generic operating hours 7:00 am – 9:00 pm

Spatial distribution based on commercial zoning and building footprints



High-resolution

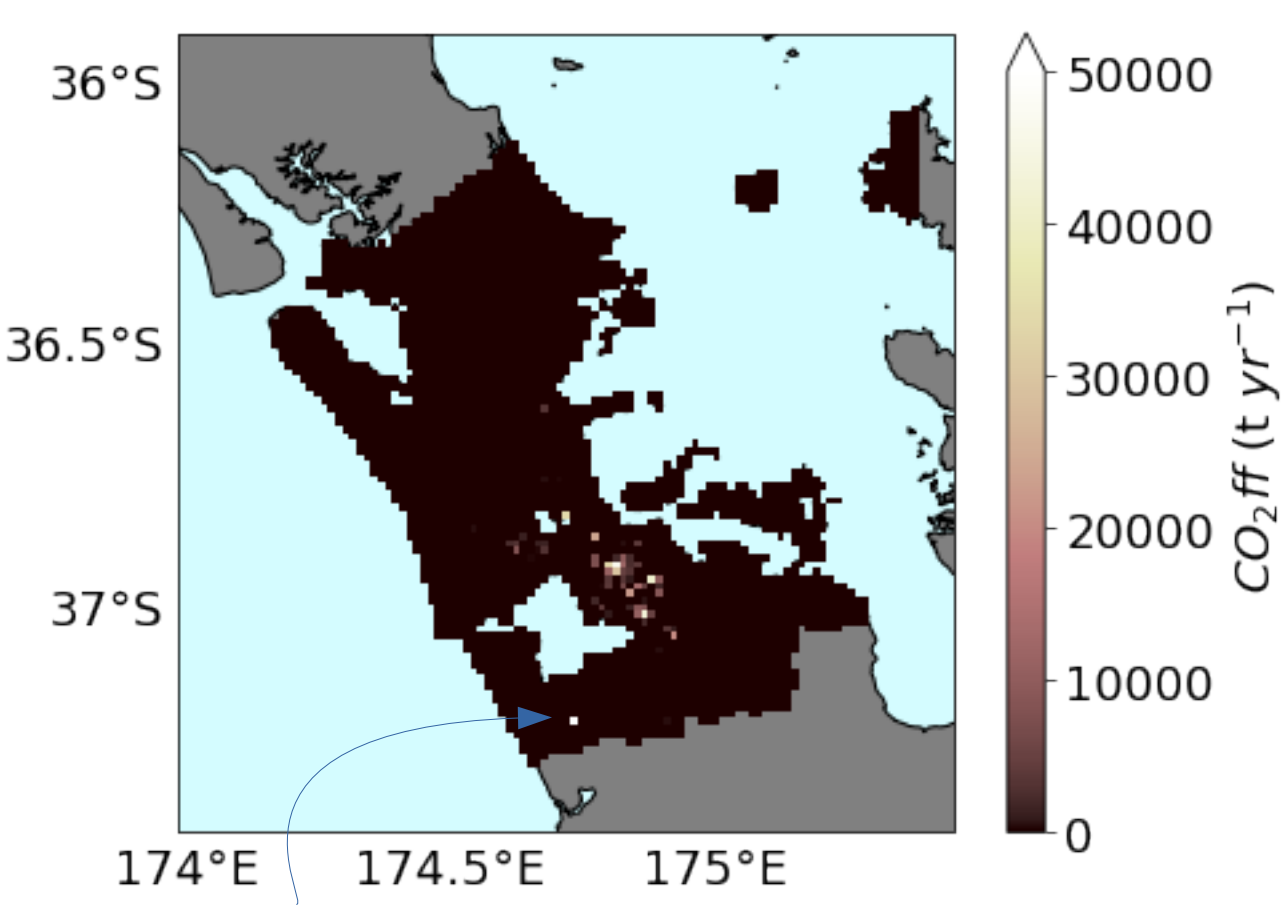


Lower-resolution on 1.5 km grid

Industrial (point sources)

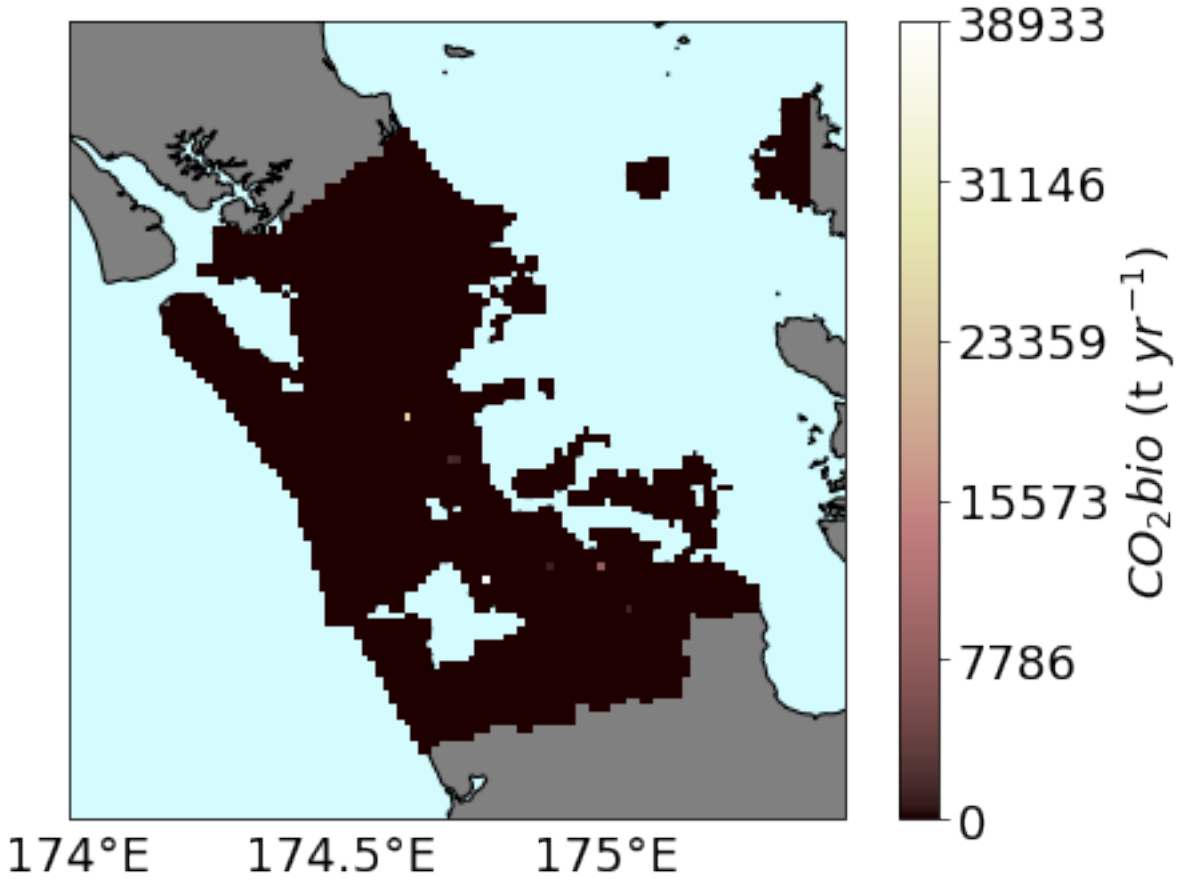
Time: distributed evenly over generic operating hours M-F 7:00 am – 7:00 pm

Fossil fuel



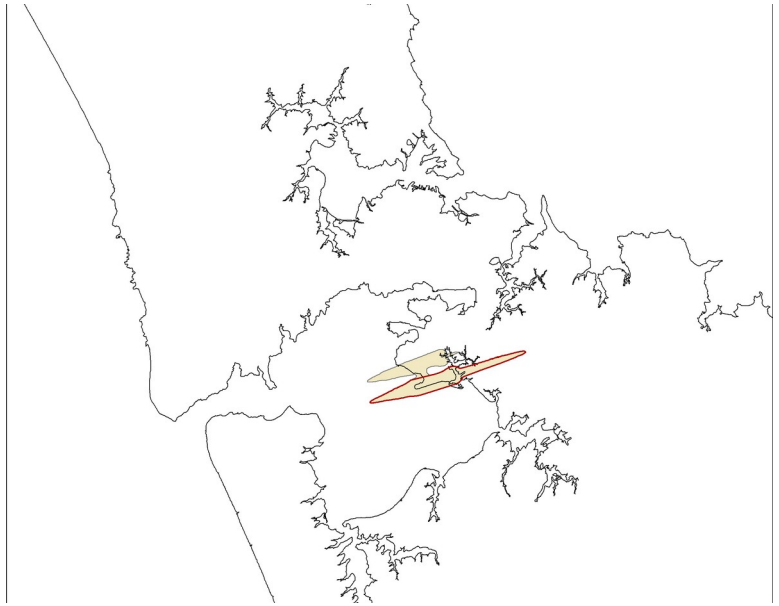
Glenbrook steel mill: ~1.8M t yr^{-1}

Biogenic (waste)

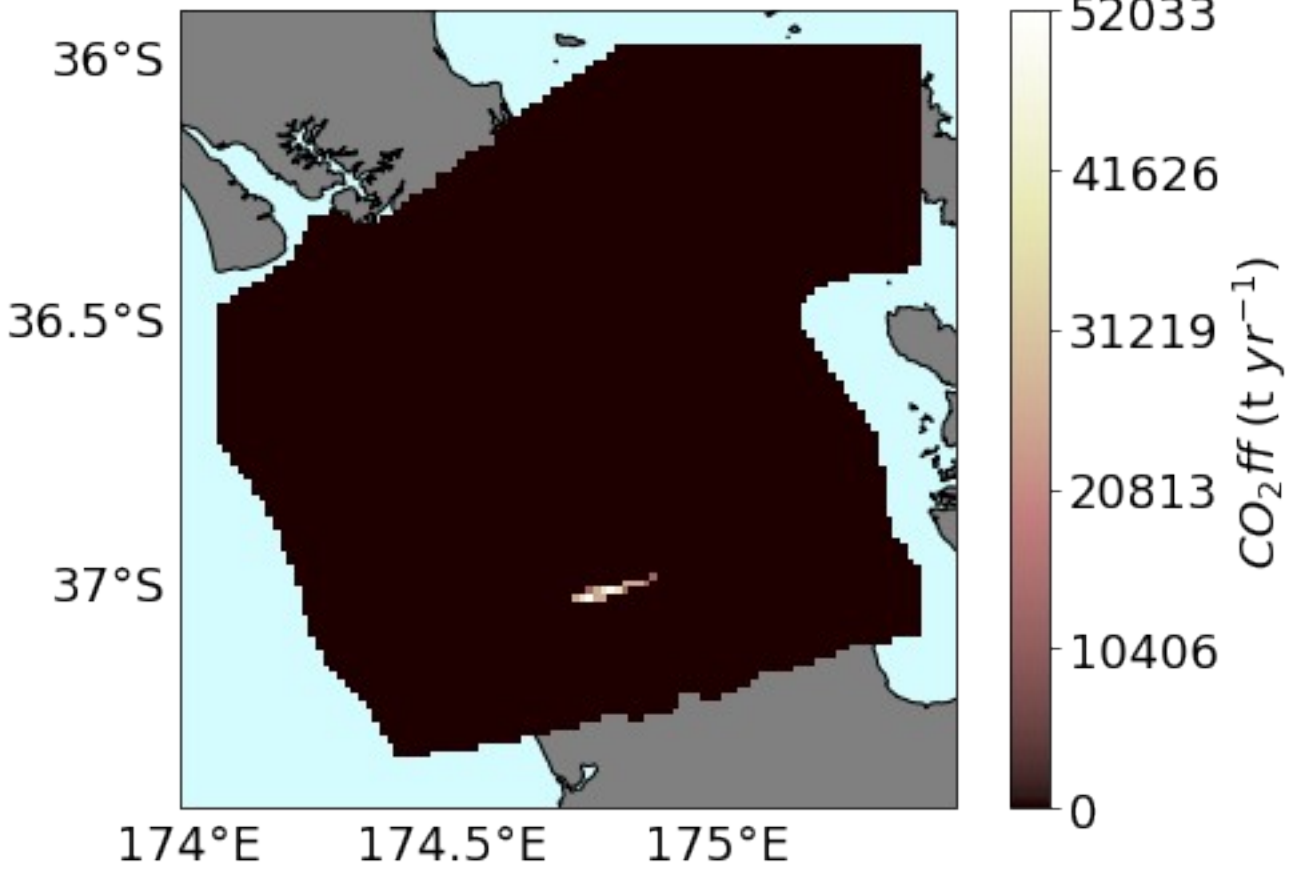


Air transport (Auckland international airport)

- Space:
  - Auckland airport high-noise zone approximates aircraft takeoff / landing path
  - Not restricted to land



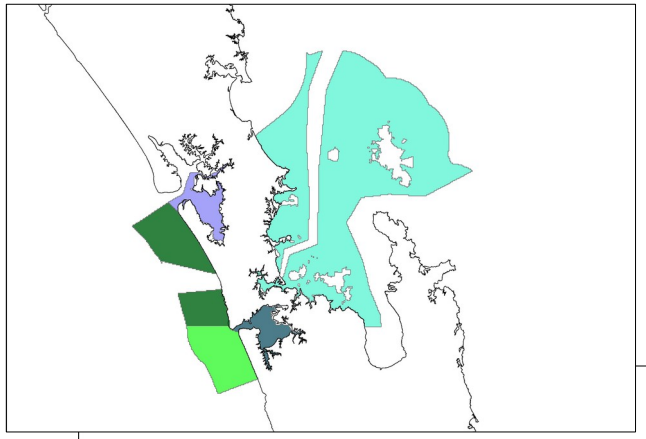
- Time: distributed evenly from 6:00 am - 12:00 am



Sea transport

- Space: automated GIS tracks for ocean going vessels; Auckland port and MPI records for other vessels

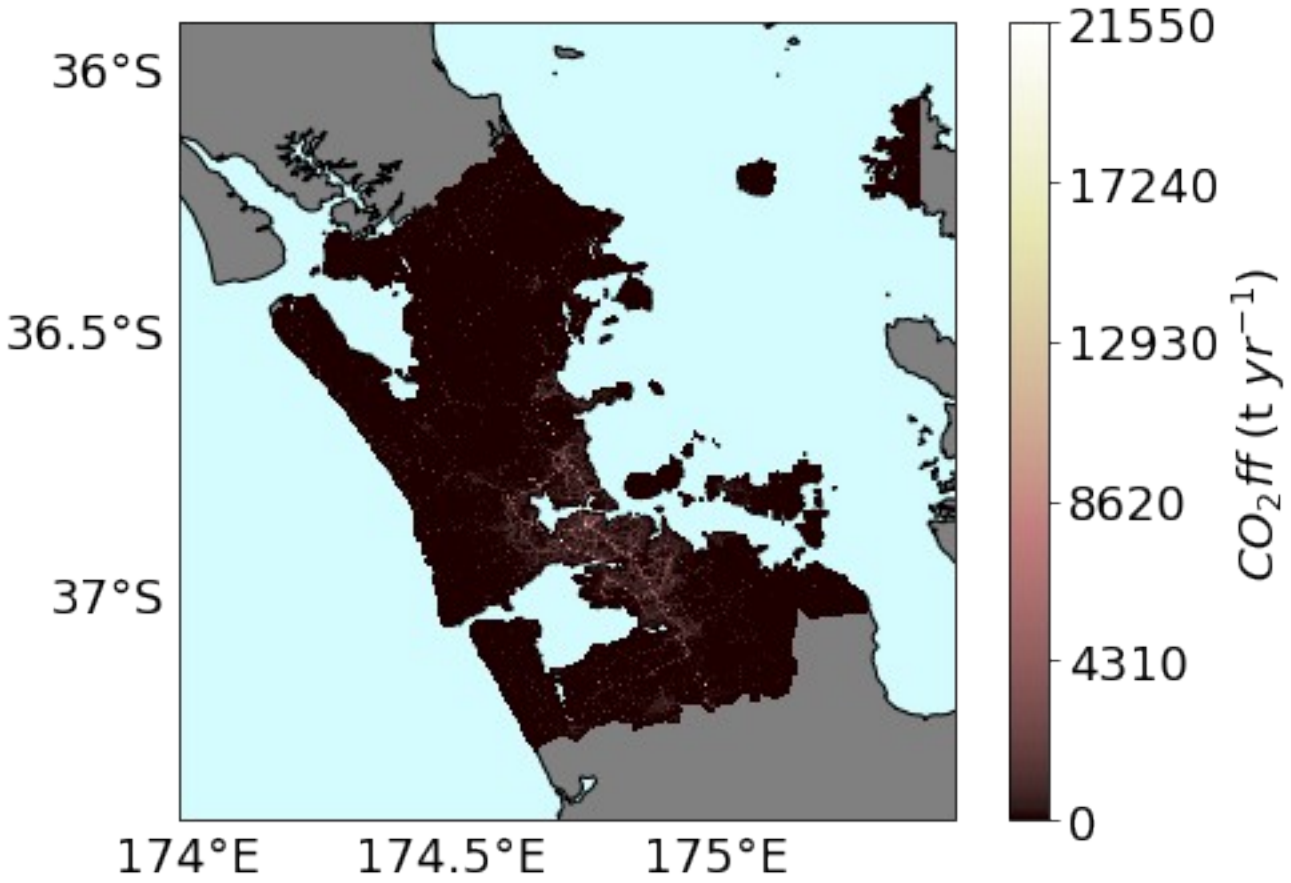
- Time: all data was recorded at specific timestamps for 2016; smoothed out for arbitrary year



On-road transport

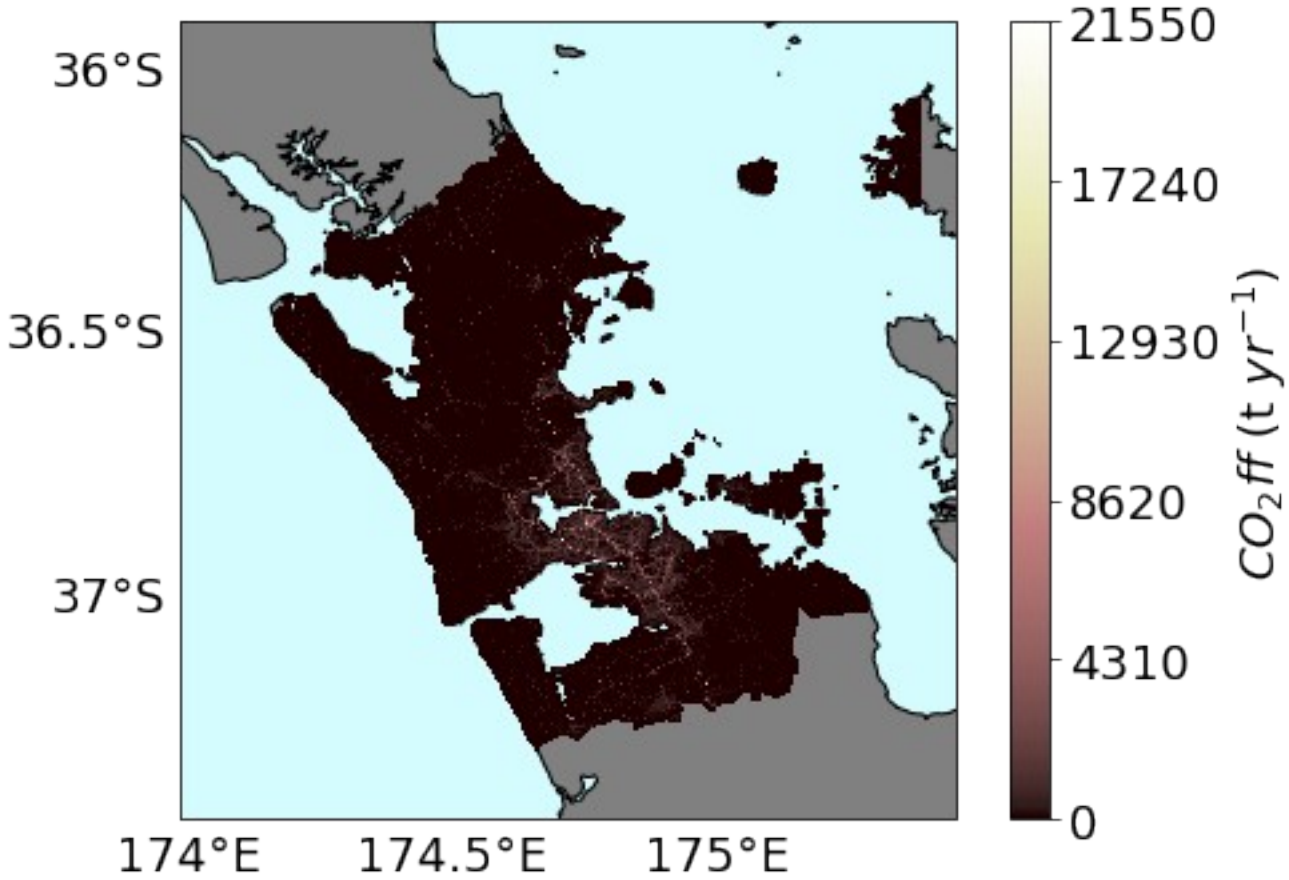
- Space: 13000+ traffic count datasets dating to 2012

- Time: fit linear trends to streets with more than one observation; discard COVID19 period.

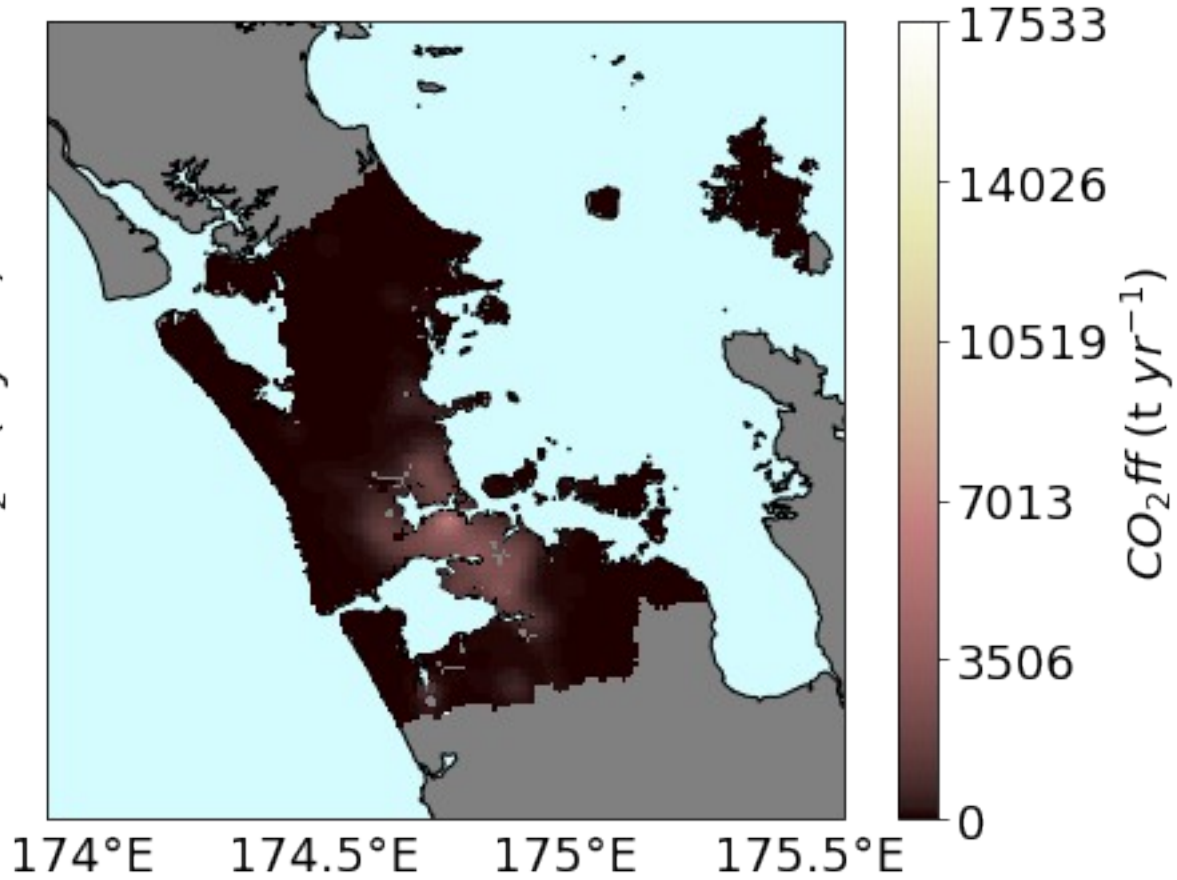


Comparison to global products

Mahuika 500m on-road FF emissions



ODIAC 1km FF emissions



Oda & Maksyutov, 2015. doi:10.17595/20170411.001

Coming soon:

- Put it all together

References

Tomohiro Oda, Shamil Maksyutov (2015), ODIAC Fossil Fuel CO2 Emissions Dataset (ODIAC2020b), Center for Global Environmental Research, National Institute for Environmental Studies, doi:10.17595/20170411.001. (accessed 2 Dec 2021)