



# North Carolina Statewide Multimodal Freight Plan

*Freight Flow Tool Reference  
Guide*



*prepared for*  
North Carolina  
Department of Transportation

*prepared by*  
Cambridge Systematics, Inc.

*with*  
AECOM  
Volkert Inc.  
IEM  
Baseline Mobility Group

*January 4, 2017*



*report*

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## 1.0 Introduction

The North Carolina Freight Flow tool provides insight into multimodal freight flows into, out of, within, and through North Carolina. The tool is based on Tableau Desktop visualization software.<sup>1</sup> The Tableau platform allows the creation of interactive visualization tools, which have several advantages over their static counterparts. These tools, or “dashboards” allow the depth of analysis and ability to drill down into specific data categories of databases while preserving the legibility and intuitiveness of charts and infographics.

This reference guide contains information on the background and use of the North Carolina Freight Flow Tool. The tool contains summary information on freight activity using North Carolina’s transportation network, including mode of travel, commodity type, and flow direction.

By selecting different chart elements in the interactive tool, users can drill down into freight activity attributes and obtain insights into the state’s freight economy.

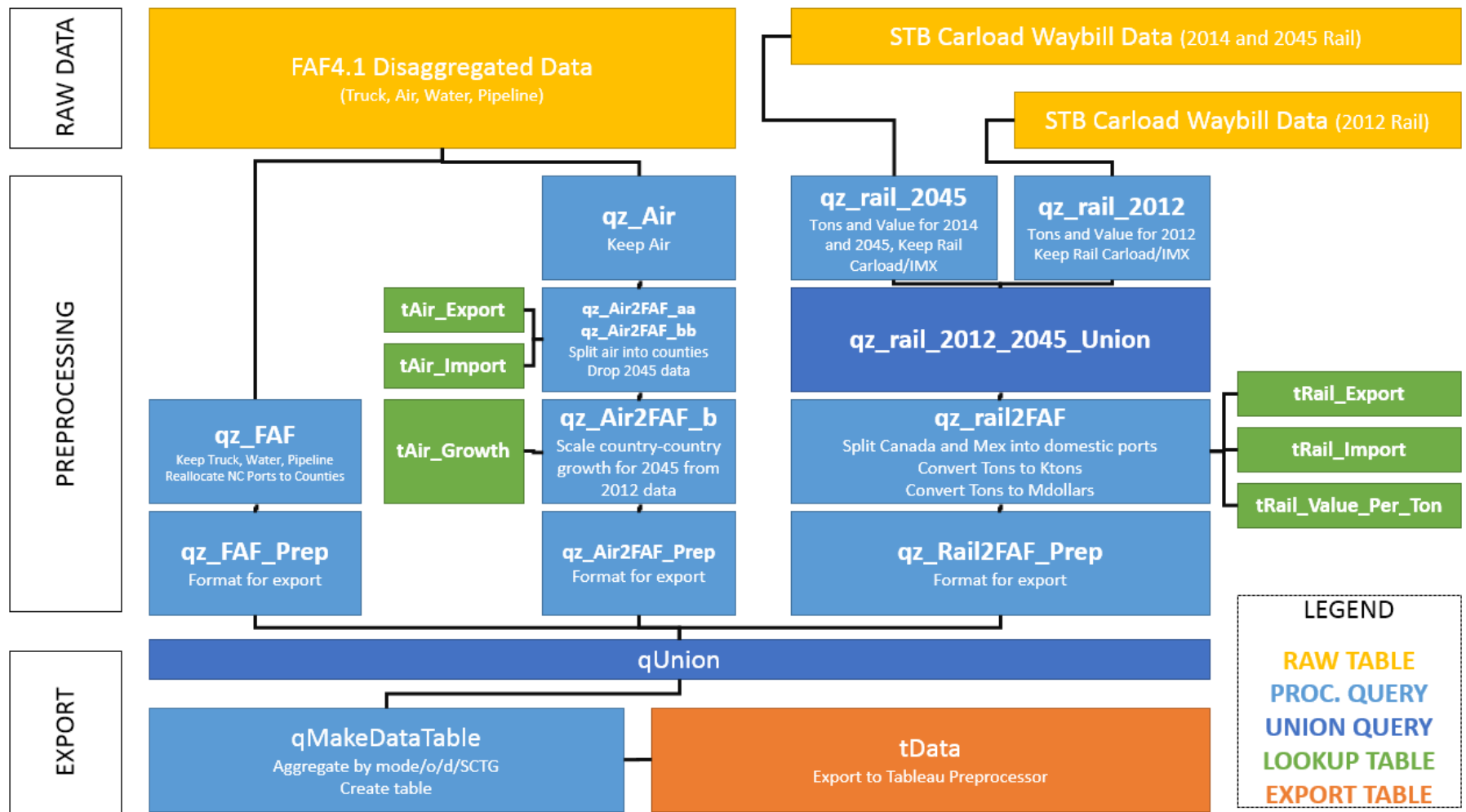
### 1.1 Data

Data for North Carolina’s freight flow visualization tool were collected from two primary sources: the Federal Highway Administration (FHWA)’s Freight Analysis Framework Version 4.1 (FAF4.1) county-level disaggregation processed by Cambridge Systematics for 2012, 2015, and 2045; and Surface Transportation Board (STB) Rail Carload Waybill Sample for North Carolina for both 2012 and 2014 and forecasted to 2045 using FHWA’s FAF4.1 origin-destination and commodity growth rates for rail flows. Data preprocessing for the freight flow tool was performed using a SQL database (Figure 1.1 and Table 1.1).

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<sup>1</sup> <http://www.tableau.com/>

**Figure 1.1 Data Preprocessing Schema**



**Table 1.1 Mode Data Sources**

Mode	Truck	Pipeline	Water	Other	Air	Rail
Source	FAF4 Disaggregation				STB Carload Waybill	
Notes	North Carolina data disaggregated to county level. NC Ports assigned to respective county. Other data remains at original FAF geographic designation.		Includes mail.	North Carolina data for three major airports (RDU, CLT, and GSO) assigned directly to respective county. Other NC airports disaggregated proportionately to remaining NC airports using Bureau of Transportation Statistics (BTS) TranStats data. 2045 data based on scaled 2012 data using annual growth rate from 2015 Boeing World Air Cargo Forecast (WACF).		International (Canada and Mexico) data assigned to domestic port of entry/exit based on proportional flow. Value assigned based on per-ton value by commodity. Commodity details obscured at county level to preserve anonymity of shippers. Separated into carload and intermodal modes.

Commodities are coded using the Standard Classification of Transported Goods (SCTG) schema, then aggregated to reduce the size of the dataset and improve legibility (see Table 1.2).

**Table 1.2 Commodity Code Groups**

SCTG	Commodity Description	Aggregation
1	Animals and Fish	Agriculture and Fish
2	Cereal Grains	Agriculture and Fish
3	Agricultural Products Except for Animal Feed	Agriculture and Fish
4	Animal Feed and Products of Animal Origin	Agriculture and Fish
5	Meat, Fish, and Seafood and Their Preparations	Agriculture and Fish
6	Milled Grain Products and Preparations, and Bakery Products	Food, Alcohol and Tobacco
7	Other Prepared Food Stuffs, and Fats and Oils	Food, Alcohol and Tobacco
8	Alcoholic Beverages and Tobacco Products	Food, Alcohol and Tobacco
9	Alcoholic Beverages and Tobacco Products	Food, Alcohol and Tobacco
10	Stone and Sands	Aggregates
11	Stone and Sands	Aggregates
12	Stone and Sands	Aggregates
13	Other Non-Metallic Minerals	Aggregates
14	Metallic Ores and Concentrates	Aggregates
15	Coal	Energy Products
16	Crude Petroleum, Gasoline, Fuel Oils, and Aviation Turbine Fuel	Energy Products

SCTG	Commodity Description	Aggregation
17	Crude Petroleum, Gasoline, Fuel Oils, and Aviation Turbine Fuel	Energy Products
18	Crude Petroleum, Gasoline, Fuel Oils, and Aviation Turbine Fuel	Energy Products
19	Other Coal and Petroleum Products	Energy Products
20	Basic Chemicals	Chemicals, Pharmaceuticals, Plastics, and Rubber
21	Pharmaceutical Products	Chemicals, Pharmaceuticals, Plastics, and Rubber
22	Fertilizers	Chemicals, Pharmaceuticals, Plastics, and Rubber
23	Other Chemical Products and Preparations	Chemicals, Pharmaceuticals, Plastics, and Rubber
24	Plastics and Rubber	Chemicals, Pharmaceuticals, Plastics, and Rubber
25	Logs and Other Wood in the Rough	Raw and Finished Wood Products
26	Wood Products	Raw and Finished Wood Products
27	Pulp, Newsprint, Paper, and Paperboard	Raw and Finished Wood Products
28	Paper or Paperboard Articles	Raw and Finished Wood Products
29	Printed Products	Raw and Finished Wood Products
30	Textiles, Leather, and Articles of Textiles or Leather	Textiles and Leather
31	Non-Metallic Mineral Products	Nonmetallic Mineral and Base Metal Products
32	Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	Nonmetallic Mineral and Base Metal Products
33	Articles of Base Metal	Nonmetallic Mineral and Base Metal Products
34	Machinery	Machinery, Electric, and Precision Instruments
35	Electronic and Other Electrical Equipment and Components, and Office Equipment	Machinery, Electric, and Precision Instruments
36	Motorized and Other Vehicles	Vehicles and Transportation Equipment
37	Transportation Equipment	Vehicles and Transportation Equipment
38	Precision Instruments and Apparatus	Machinery, Electric, and Precision Instruments
39	Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	Mixed Freight
40	Miscellaneous Manufactured Products	Mixed Freight
41	Waste and Scrap	Waste and Scrap
43	Mixed Freight	Mixed Freight

## 1.2 General Navigation

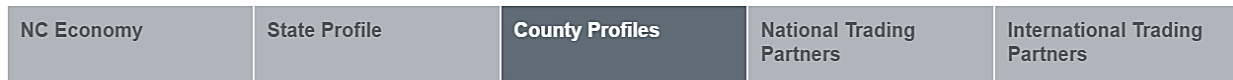
The Tableau tool has five tabs, each giving insight into a particular facet of freight movement in North Carolina. The five tabs, displayed in Figure 1.2, include:

- NC Economy
- State Profile

- County Profiles
- National Trading Partners
- International Trading Partners

To navigate around the tool, the user will click a tab and the title of the current tab will be highlighted.

**Figure 1.2 Five Main Tabs within the NC Freight Flow Tool**



Once a new tab has loaded, the user can click on the various graphics on the page, resulting in new information being displayed. After the display for a tab changes, a rounded arrow will appear as shown in Figure 1.3. The user can click this arrow to restore the current tab to its original state.

**Figure 1.3 Restoring a Tab's Original Layout**



The bottom of the tool contains a few more utilities as shown in Figure 1.4.

**Figure 1.4 Additional Utilities for the NC Freight Flow Tool**



The undo, redo and reset buttons function as one would expect, with the reset button resetting the entire tool (as opposed to just the tab). The share button provides both an internal link to the tool (located on public.tableau.com) as well as HTML code to embed the tool in another web page. The download tab allows the entire tool to be downloaded as an image or workbook, the latter requiring a license for Tableau desktop. Finally, the full screen button enlarges the tool for presentation or distraction-free use.





## 2.0 Content Overview

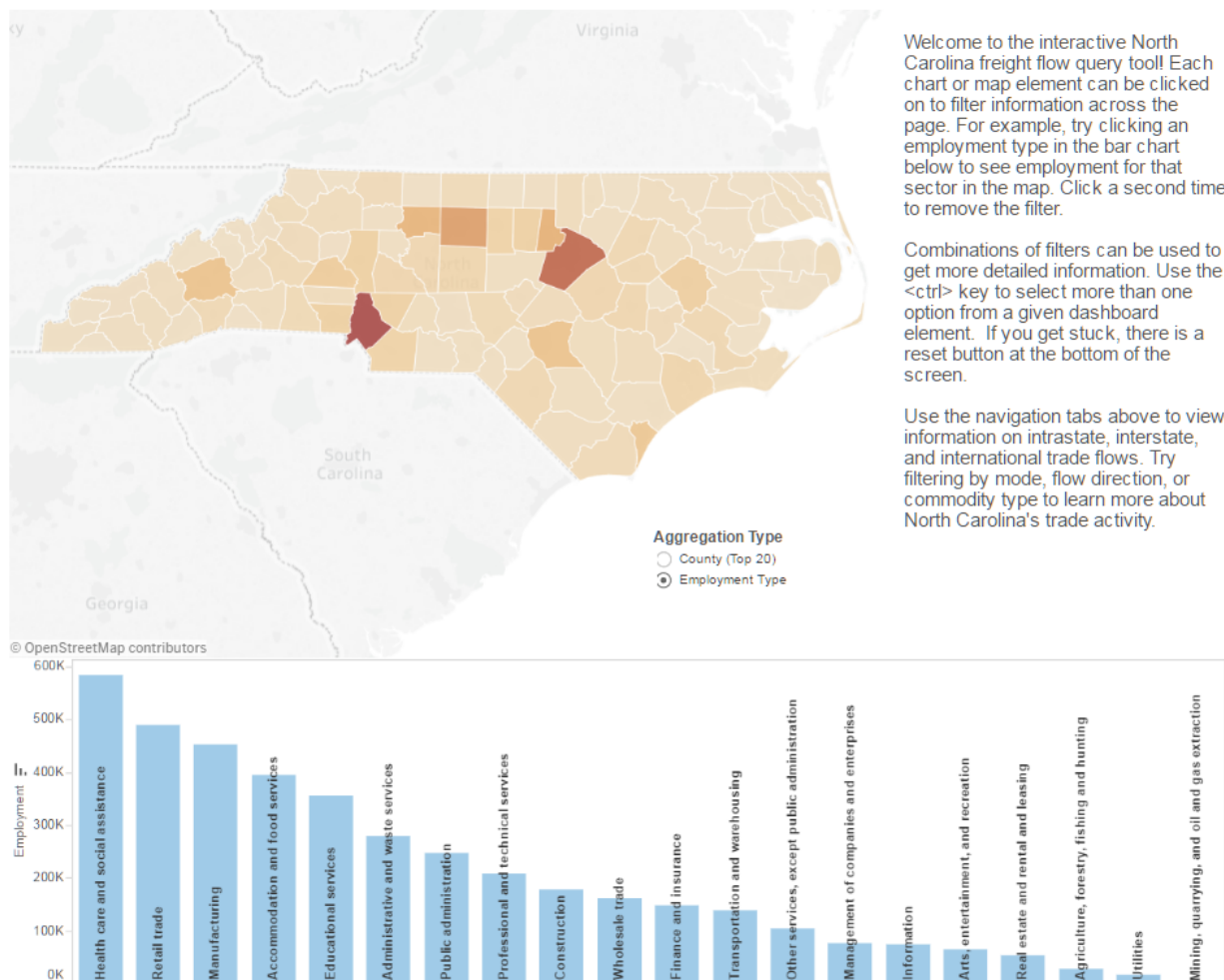
The following sections present an overview of each of the five main tabs.

### 2.1 NC Economy

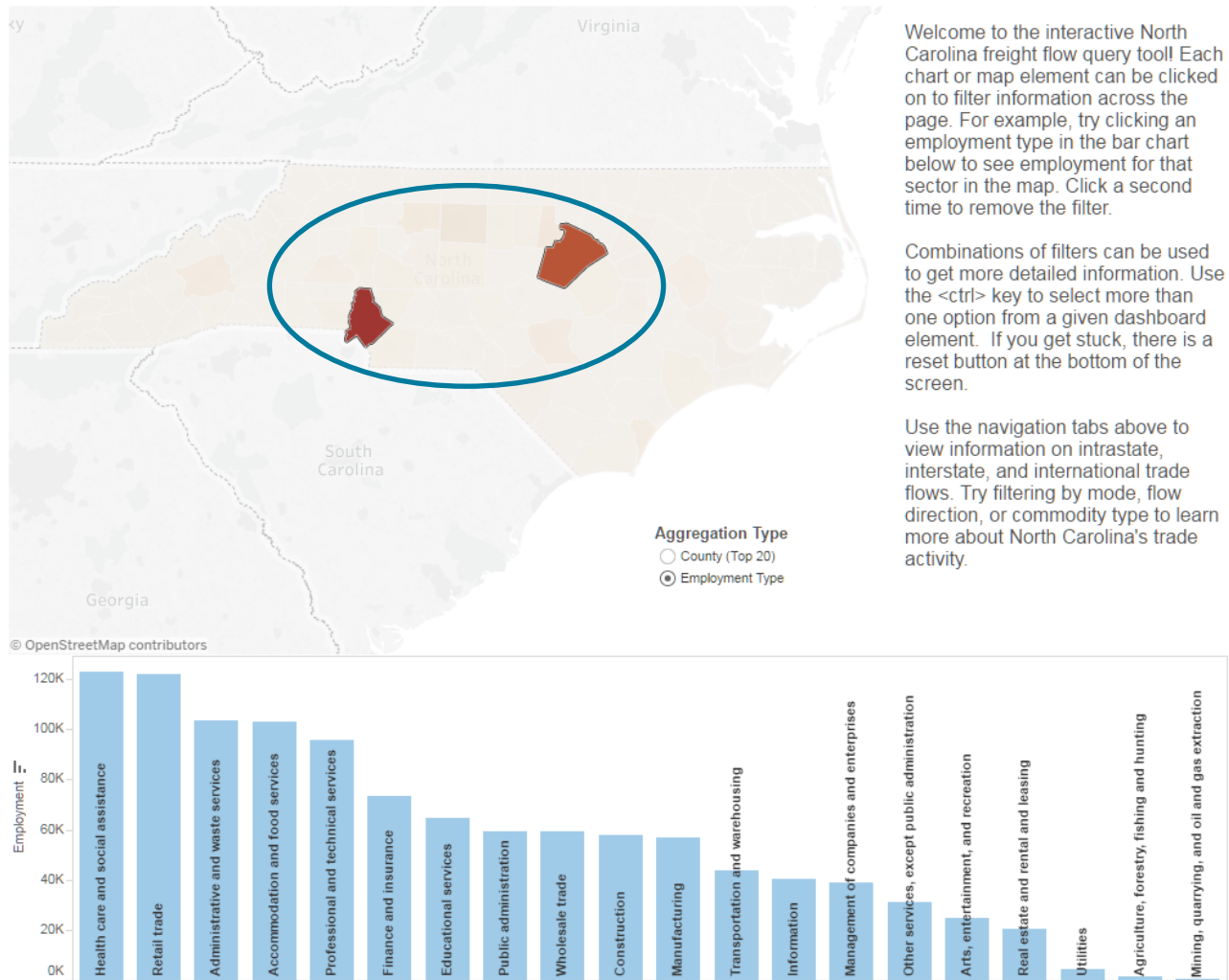
The NC Economy tab, displayed in Figure 2.1, contains an overview of the tool, and an example of *cross filtering*. Cross filtering propagates interactions with one map or graph to other dashboard elements, allowing the user to “drill down” into the data set.

To use this tab, the user will select a county on the map by clicking it and the employment bar chart will update to show that county’s employment mix. The user can also select a type of employment on the bar chart (also via clicking) and the shading of the counties will update to show the geographic distribution of that type of employment. More than one county or employment type can be selected by holding down the <ctrl> key and clicking additional choices (Figure 2.2).

**Figure 2.1 NC Economy Tab**



**Figure 2.2 NC Economy Tab, Filtered by County**



In Figure 2.2, Wake and Mecklenburg Counties have been selected by holding down the <ctrl> key and clicking them in succession. The bar chart has updated to reflect the employment mix of these two counties only.

The user can reset the filters by clicking the selected county or employment type a second time, or click the rounded arrow above the navigation tab (as previously displayed in Figure 1.3).

Changing the aggregation type can be done using the radio buttons below the map as shown in Figure 2.3. This changes the labels on the bar chart from employment type to county name, showing the ranked order of the top 20 counties by employment.

**Figure 2.3 Radio Buttons**

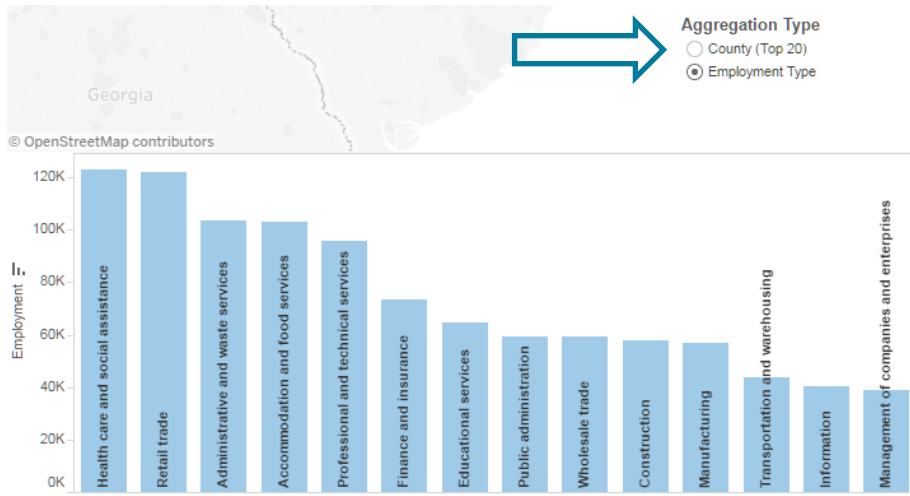
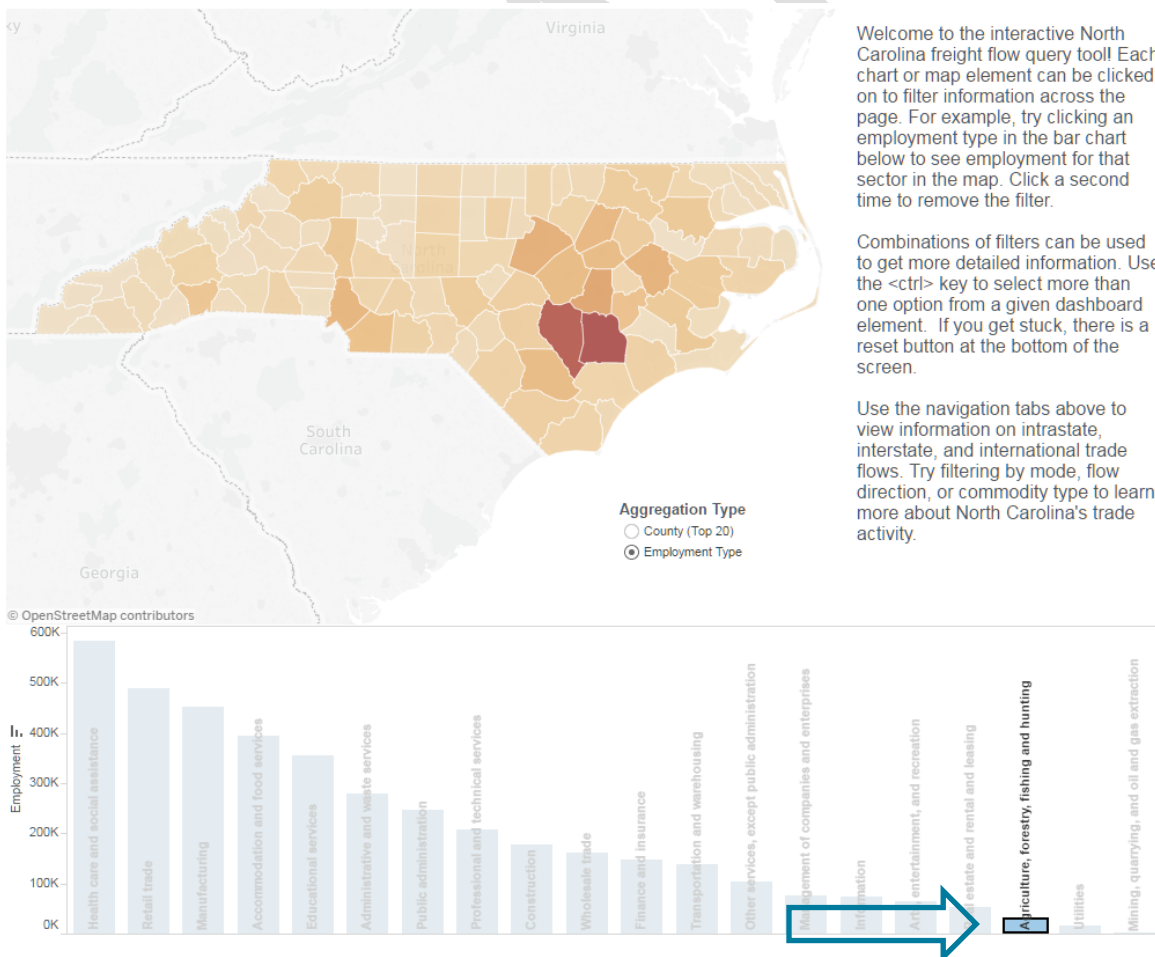


Figure 2.4 displays the ability to view employment by sector. The user can click on the bar for the desired sector and the map will change to reflect the distribution of employment in that sector by county.

**Figure 2.4 NC Economy, Filtered by Sector**



In Figure 2.4, the 'Agriculture, forestry, fishing and hunting' sector has been selected. Note the change in shading on the map, showing strong agricultural employment in Sampson and Duplin Counties.

## 2.2 State Profile

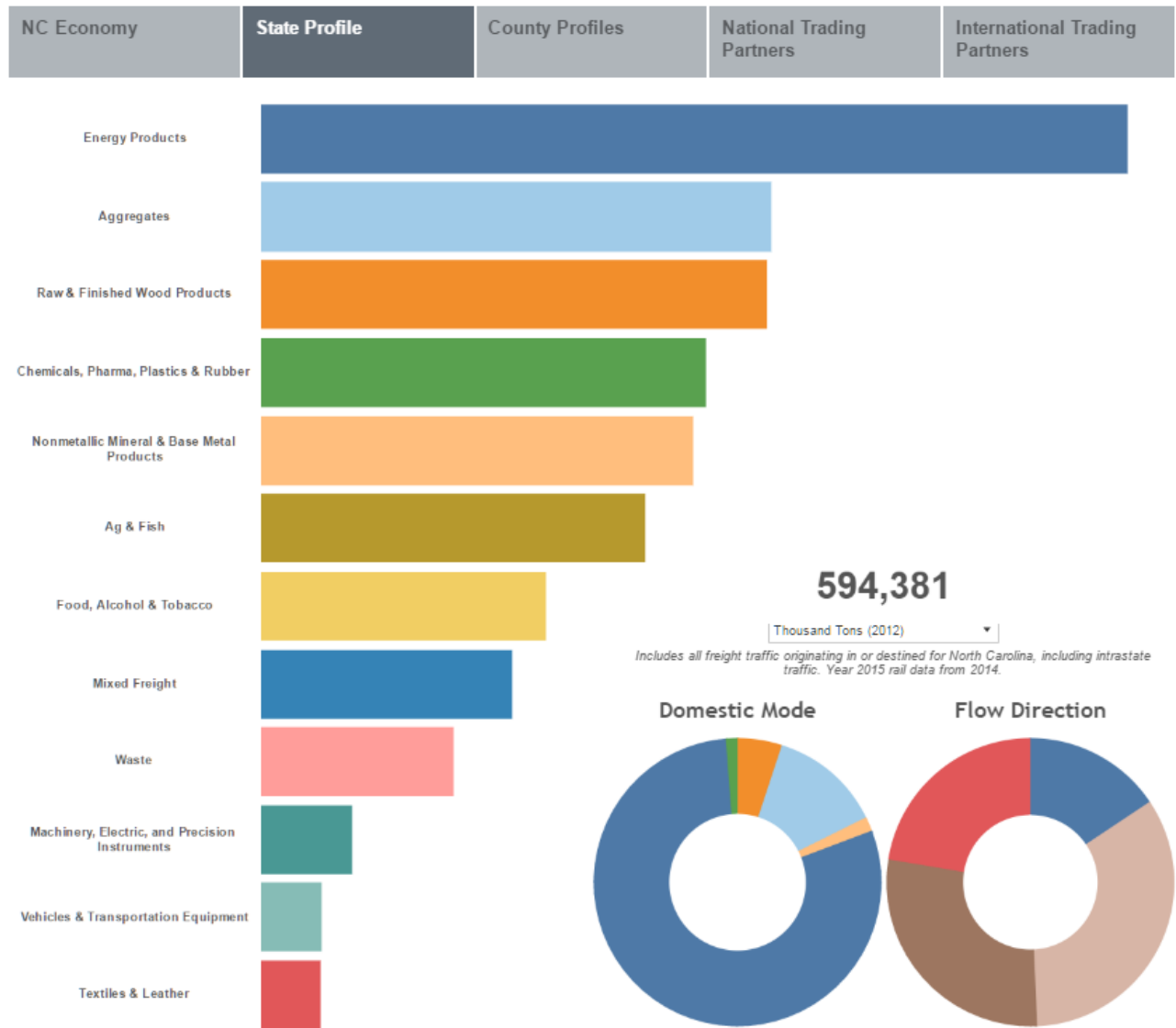
The state profile tab, displayed in Figure 2.5, shows an overview of North Carolina's freight activity. This tab introduces the units and filters that will be used across the rest of the tool:

- **Commodities** are the type of freight carried, ranging from unprocessed raw materials to finished goods. A list of commodity groups can be found in Table 1.2 under the column "Aggregation".
- **Mode** is the transportation mode carrying the freight, i.e., truck, rail, air, water, pipeline, and other.
- **Flow direction** is the way freight moves across borders, i.e., inbound, outbound, intrastate, through the State.

The meanings of these filters change slightly based on the focus of the tab. For the State Profile tab, mode refers to the mode used domestically; for example, freight imported through a seaport then driven by truck to North Carolina would be counted as "truck".

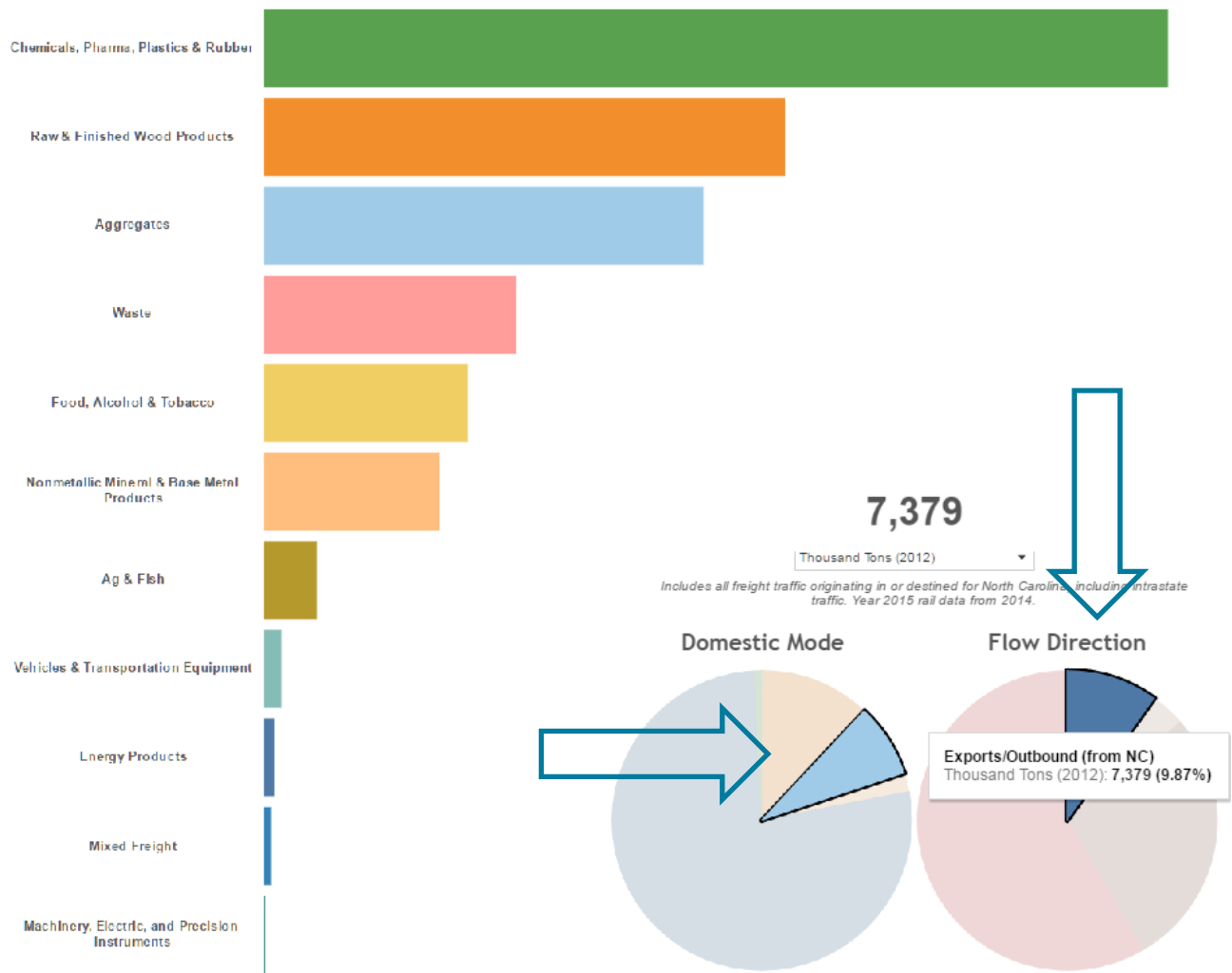
In this tab, direction refers to the movement of freight in, out, within, or through the State of North Carolina. Further, direction refers to domestic origins and destinations only; freight originating in Texas, trucked to North Carolina and then shipped by water to Europe would be counted as a North Carolina Import or inbound flow.

**Figure 2.5 State Profile**



This tab, like all tabs in the tool, is interactive. The user can hover over a bar or doughnut chart segment to see its name and value. Click a segment to filter the entire view by that attribute (Figure 2.6). As with the previous tab, use <ctrl> to select more than one segment from the same graph (e.g. Imports and Exports). To remove a filter, the user simply clicks on that segment again.

**Figure 2.6 State Profile, Filtered**



When a mode and flow direction are selected via click, the total tonnage and commodity figures update to reflect the selection. Click a chart in the same place (e.g. on the same mode) a second time to remove that filter while leaving the others in place. Note the “Exports/Outbound (from NC)” tooltip – this will appear whenever any clickable/filterable chart element is hovered over using the cursor. The commodity bars are also clickable; the rest of the tool will update to show total activity, mode split and flow direction for that commodity (or commodities).

Just below the total volume count for tonnage or value of the freight flows, there is a dropdown menu to select the year and unit of analysis (see Figure 2.7). This menu remains present through the rest of the tool.

**Figure 2.7 Year and Unit Selector**

The following combinations are available:

- Thousand Tons (2012)
- Thousand Tons (2015)
- Thousand Tons (2045)
- Million Dollars (2012)
- Million Dollars (2015)
- Million Dollars (2045)

These choices will persist across the tool, and can be changed at any time. (Selecting a new choice may reset the current view).

### 2.3 County Profiles

The County Profiles tab allows a unique “fact sheet” to be created for each of North Carolina’s 100 counties. The user selects the county in the upper right hand corner of the tool, just below the navigation tabs (see Figure 2.8). The map will re-center to show that county, and the five charts will update to reflect its freight activity.

The doughnut charts for Commodity Type (displayed as a bar chart on the State Overview tab), Mode, and Flow Direction behave similarly as they did in the State Overview. In this view, Flow Direction refers to travel to, from, or within the county itself, as opposed to the entire state. (Through traffic is not shown in this view.) As shown in Figure 2.9, these charts can be clicked to filter by their respective categories.

Two new bar charts appear below the map: the top ten import origins and export destinations for the selected county. These will update dynamically as the filters are chosen from the three doughnut charts. In turn, selecting one of these bars will update the doughnut charts, showing the mix of commodities and modes traveling to (or from, depending on which bar chart is used) the selected county.

Destinations are divided into either counties (for NC origins and destinations) or FAF zones (for domestic origins and destinations outside of NC). International destinations are grouped into their domestic port of entry or exit.

**Figure 2.8 County Profiles**

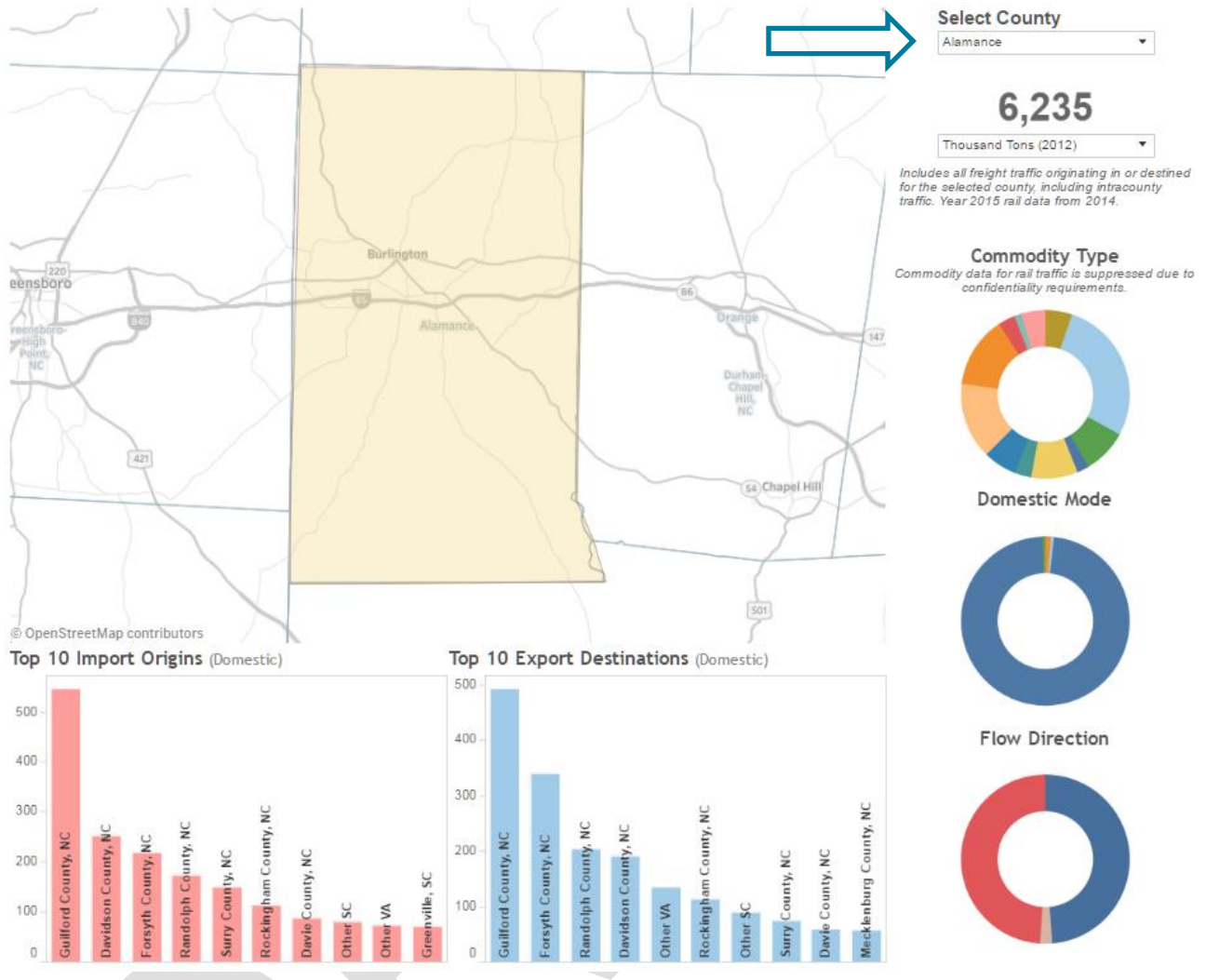
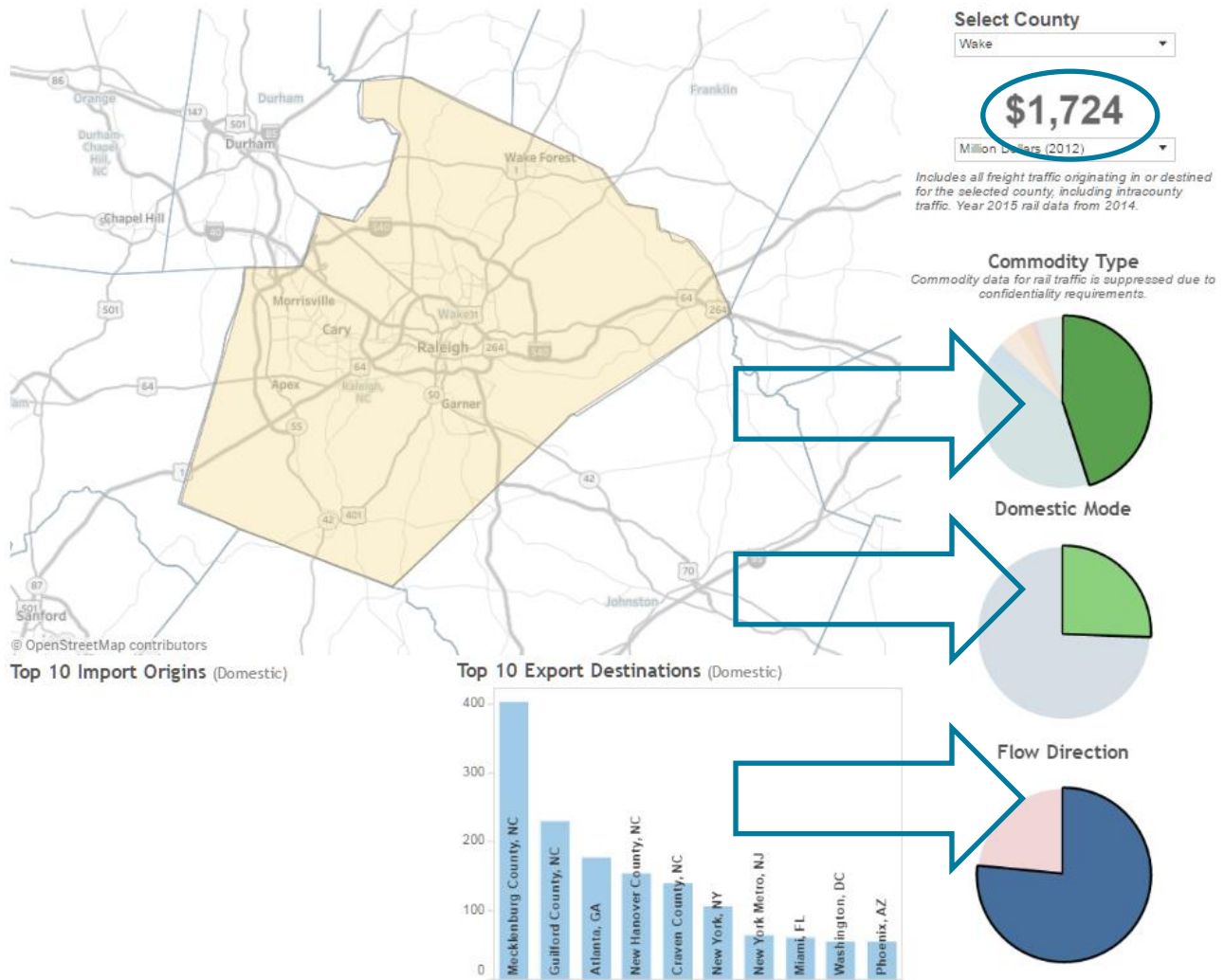




Figure 2.9 County Profiles, Filtered



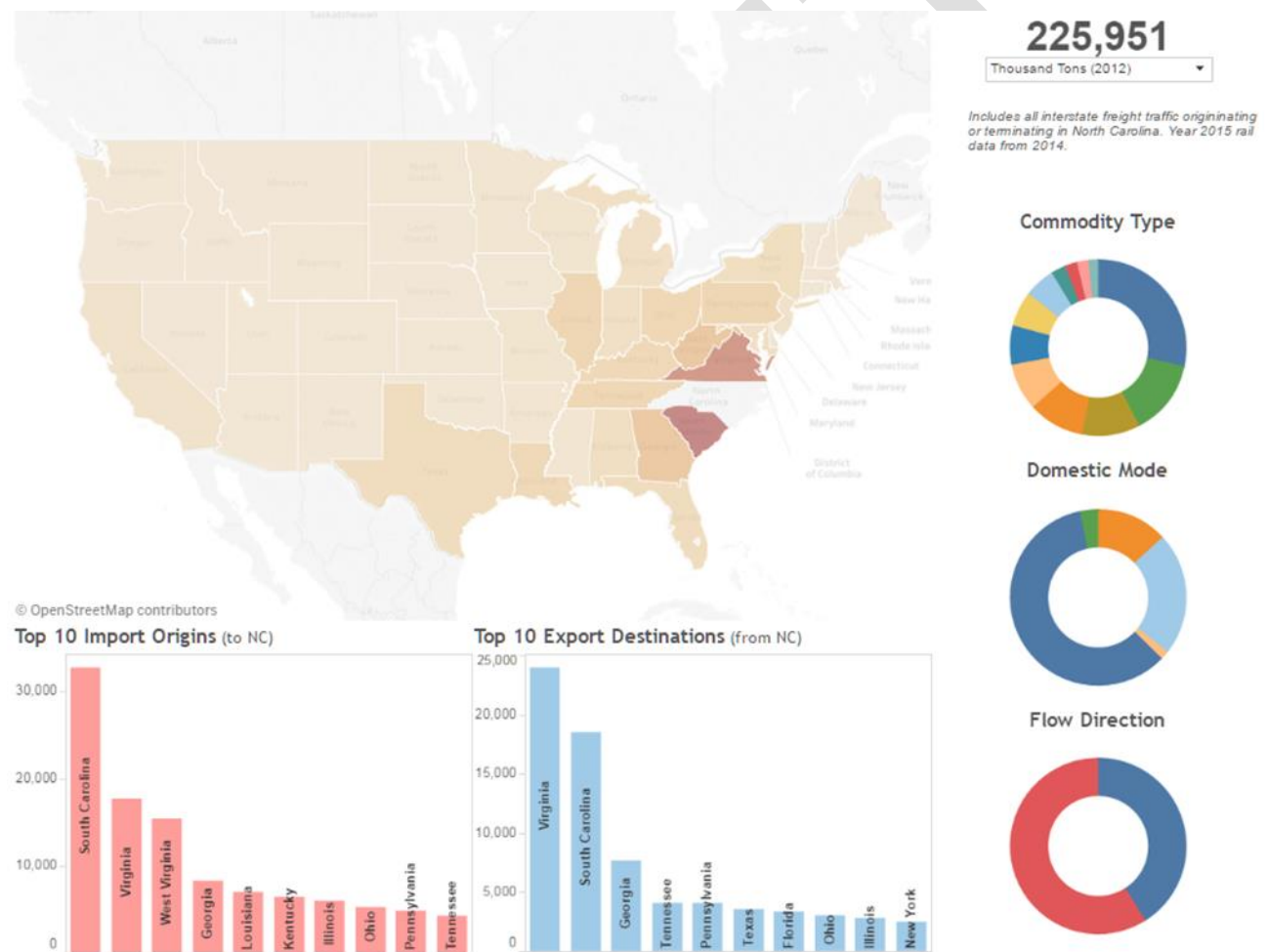
In the example displayed in Figure 2.9, the commodity category 'Chemicals, Pharmaceuticals, Plastics and Rubber' has been selected (one may also hold down the <ctrl> key while clicking to select more than one category from the same chart); the mode 'Air' has been selected; and the flow direction 'Outbound' has been selected. Additionally, the county has been changed to Wake County, and the units updated to Million Dollars. As a result, the total value has been updated at the top of the screen, and each chart has updated to reflect all other filters. For example, the Domestic Mode chart shows that about 25% of outbound shipments of 'Chemicals, Plastics and Rubber' and 'Pharmaceuticals' are shipped by air; the Flow Direction chart shows that a little over 75% of shipments of 'Chemicals, Plastics and Rubber' and 'Pharmaceuticals' shipped by air are outbound. Note the disappearance of the origins bar chart. Since outbound shipments are selected, all trips with an origin outside of Wake County have been filtered out, leaving the chart blank.

## 2.4 National Trading Partners

The fourth tab shows an overview of North Carolina’s interaction with other states in the US (Figure 2.10 ).<sup>2</sup> This tab operates in the same fashion as the County Profiles tab; however, instead of selecting one county at a time using the drop-down box, states can be selected directly by clicking them on the map (Figure 2.11 ). Compare the totals in this tab when no state is selected with the State Profile tab for inbound and outbound flows; they should match, showing the total trade across NC’s borders.

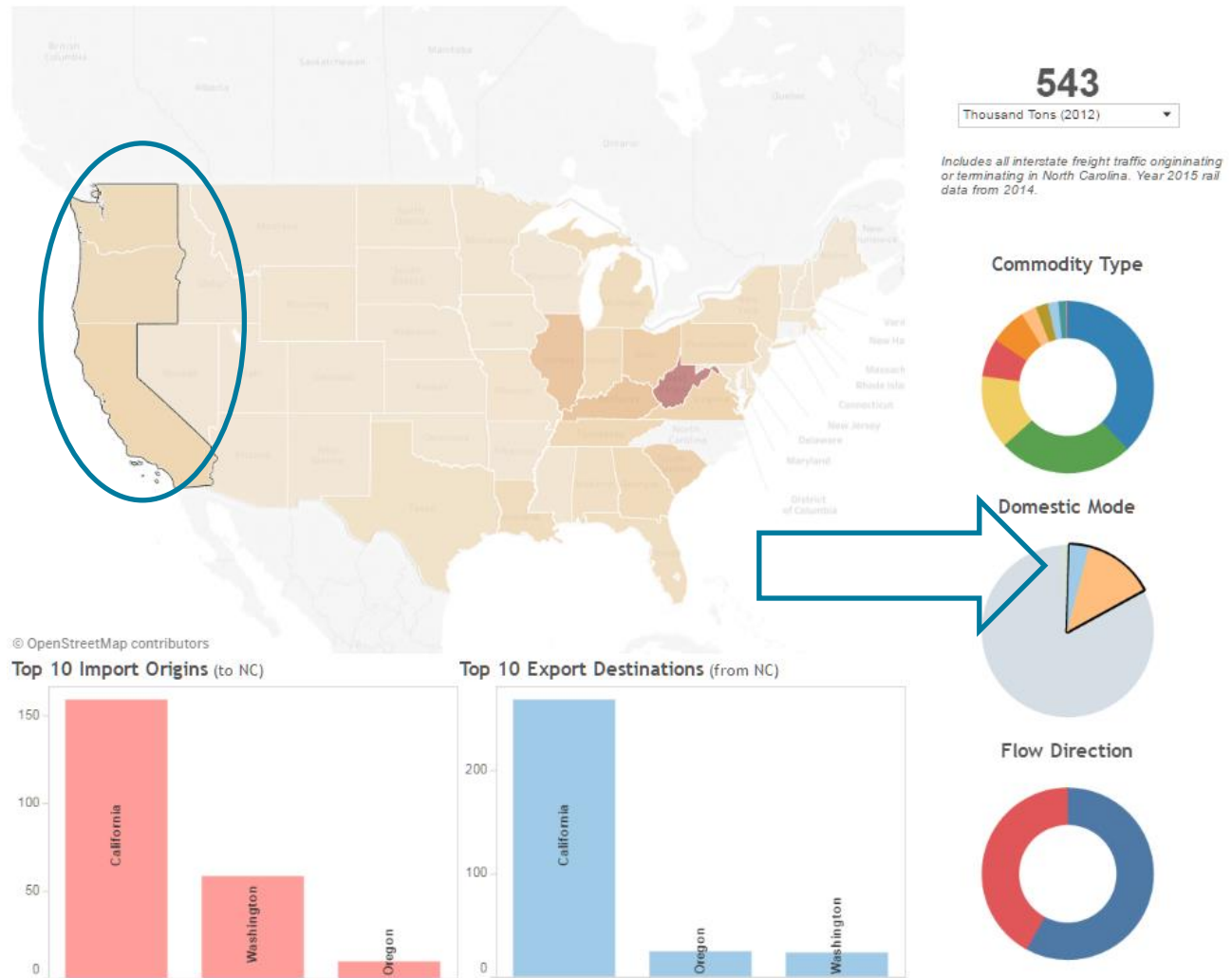
Through traffic (that is, traffic beginning and ending outside of North Carolina, but passing through it) and intrastate traffic (that is traffic beginning and ending in North Carolina) are not shown in this tab. As before, international freight traffic is accounted for at the U.S. port of entry or exit.

**Figure 2.10 National Trading Partners**



<sup>2</sup> This tab behaves slightly differently than the previous county-focused tab. Conceptually, these differences exist because the county focus allowed both the origin and destination to vary, necessitating safeguards against “double-counting” trade between NC counties. In the national focus tab, either origin or destination is required to be North Carolina, removing this risk and therefore changing the way the visualization interacts with the underlying data. For example, the national map can be shown with all states at once, while only a single county could be shown at a time; on the other hand, the bar charts cannot be used as filters in the national and international maps.

**Figure 2.11 National Trading Partners, Filtered**



In the example in Figure 2.11, California, Oregon, and Washington have been selected (using the <ctrl> key), as well as Rail (Carload) and Rail (Intermodal). Note that the bar charts have updated to include just these three states. A slight trade surplus can be seen, indicating that North Carolina sends more goods by rail (measured in weight) to these states than it receives.

## 2.5 International Trading Partners

The final tab shows an international perspective on North Carolina’s freight activity (Figure 2.12 ). Freight flows for this tab include freight moving from, to, or through North Carolina. Trips with no international component are not shown. This tab behaves the same as the National Trading Partners tab, allowing filtering by commodity type, mode, and flow direction.

A circle located approximately in the region of interest indicates the relative intensity of traffic with both size and color. Hovering over the circle will display the name of the region and the value or weight of freight traffic to and from the region. A total of eight regions are shown:

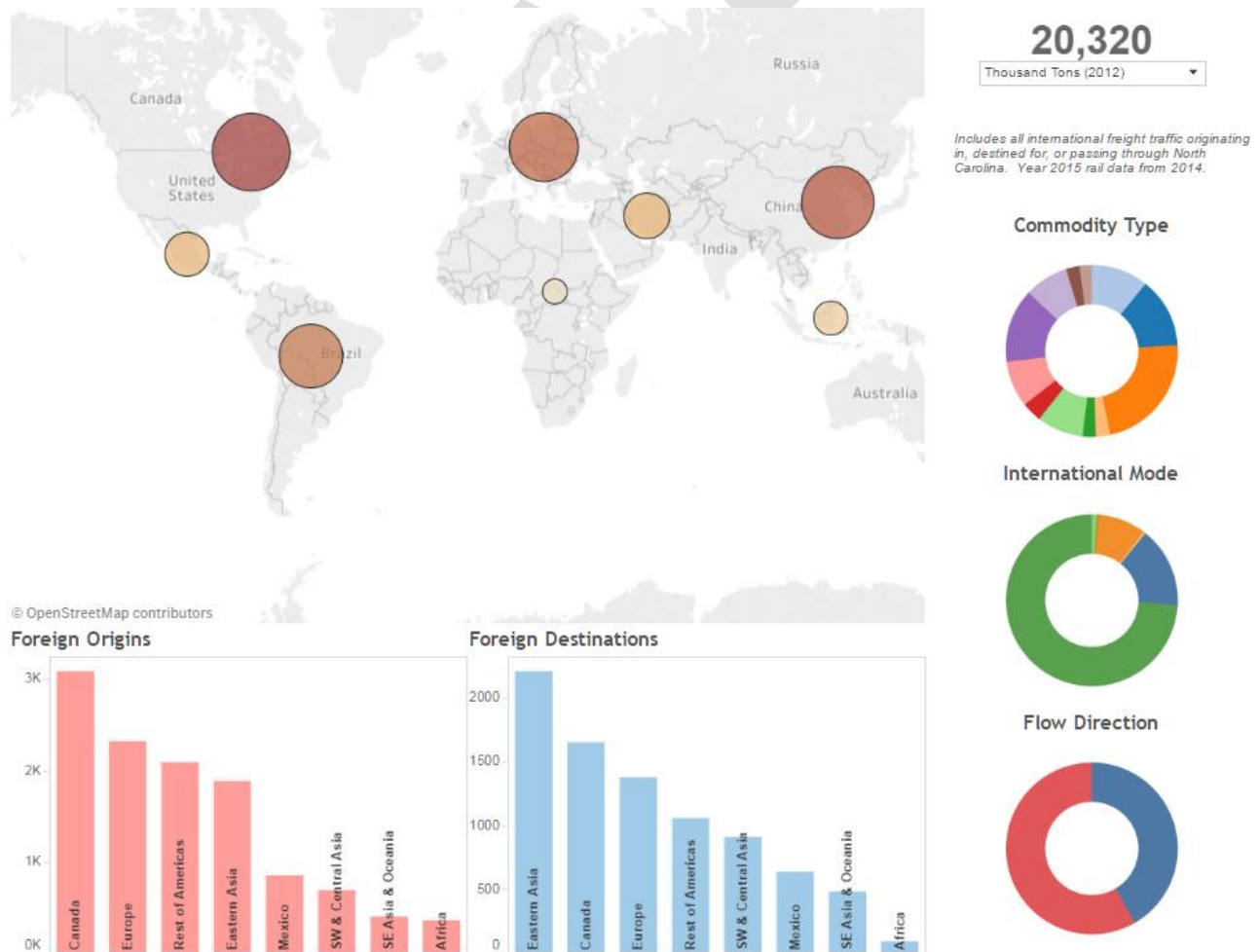
- Canada

- Mexico
- Rest of Americas (South and Central America, including the Caribbean)
- Europe
- Africa
- Southwest and Central Asia
- Eastern Asia
- Southeast Asia and Oceania

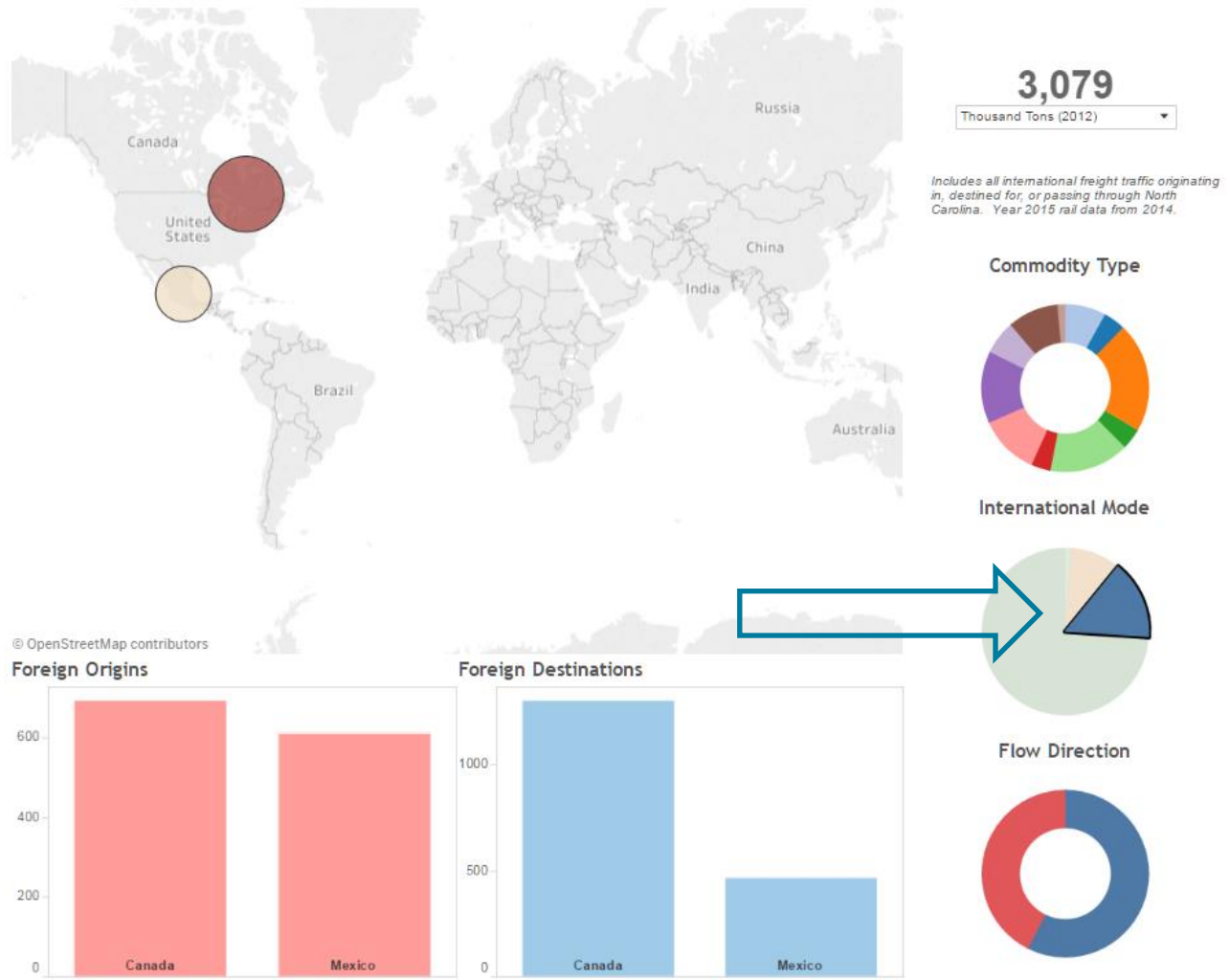
Modes are shown by their international mode type; for example, note that all land-based modes (truck, rail, etc) flow to Canada and Mexico (Figure 2.13 ).

The bar charts cannot be used to filter the dataset.

**Figure 2.12 International Trading Partners**



**Figure 2.13 International Trading Partners, Filtered**



In Figure 2.13, the 'Truck' mode has been selected (note the tooltip that appears in the interactive version!); as a result, only Canada and Mexico are visible on the map, as these are the only destinations reachable by overland vehicle directly from the United States.