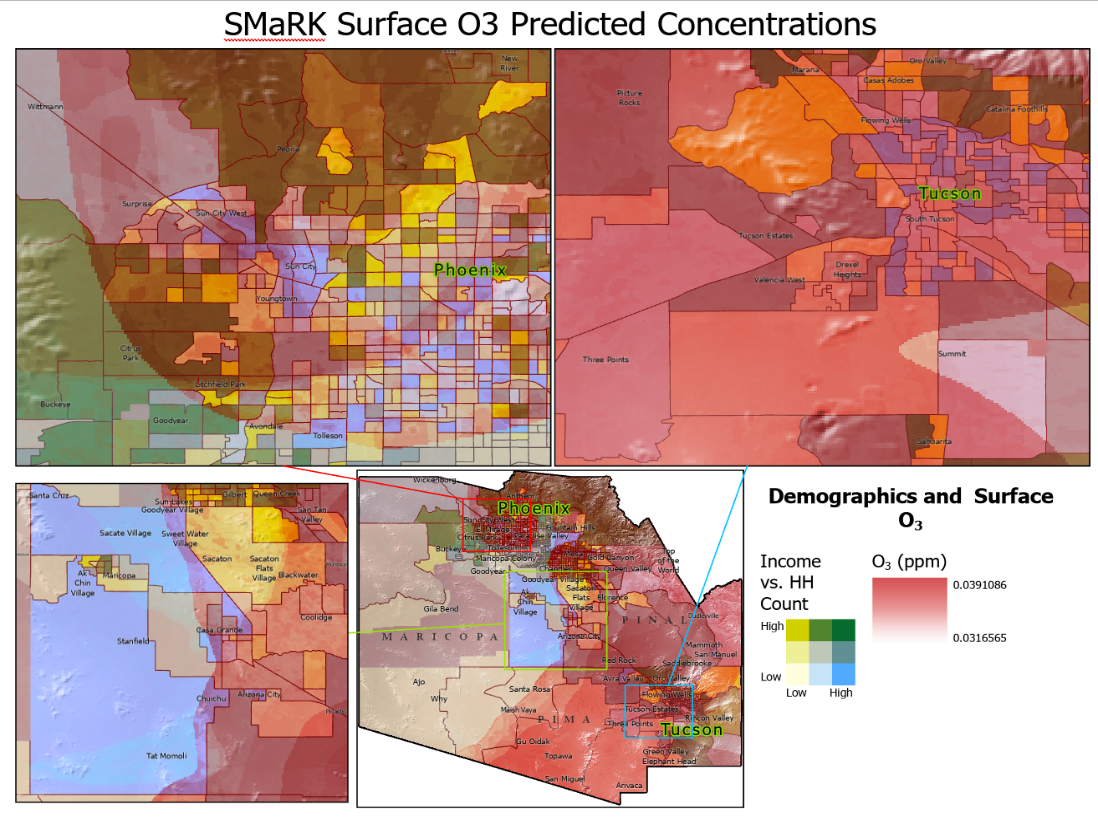
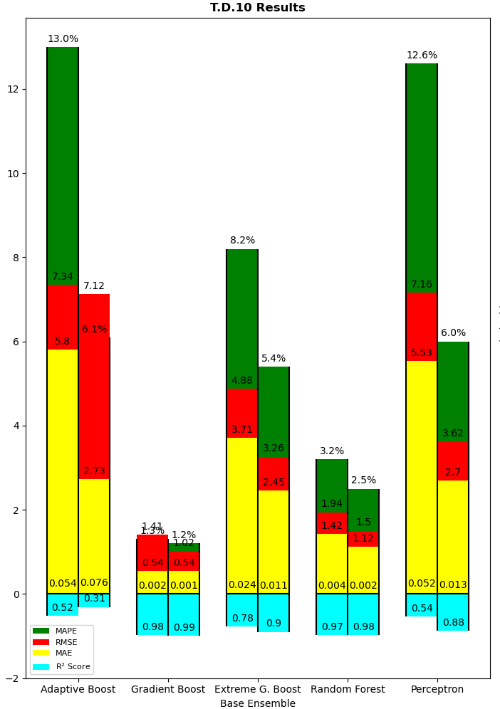
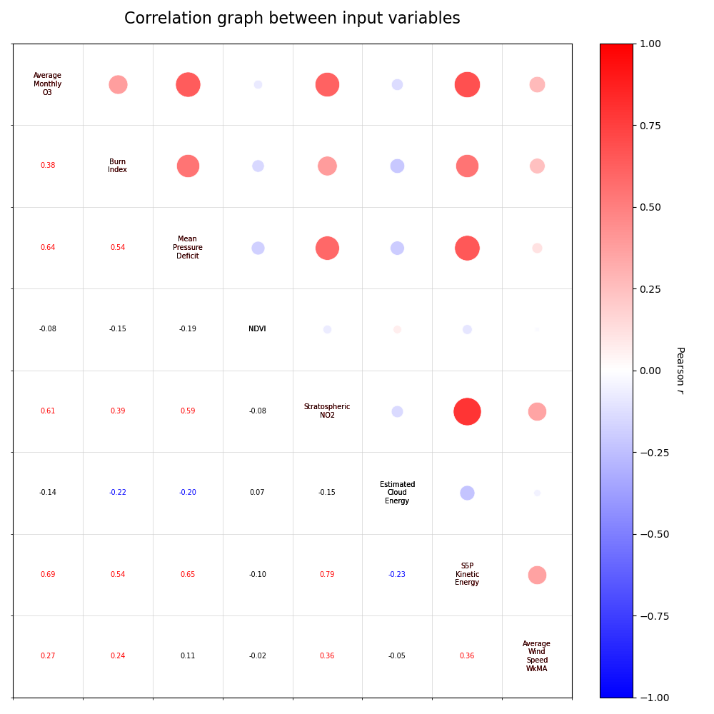
CHAPTER VI

A Brief Case Study Using in Arizona

This section is dedicated to expanding upon the who, when, and where of surface O3 into what potential outcomes can occur in areas exposed to high concentrations. As mentioned in Chapter II.3.4, O3 is an oxidizing agent, participating in redox reactions while simultaneously reducing itself (Marmett et al. 2023; Qiu et al. 2025; Yang et al. 2024). Many of the transformations applied to the models of O3 in the AOI stem from this idea, incorporating air pollutants and high temperatures into thermodynamical equations. Also noted in Chapter II, air pollution and high temperature can be dangerous in their own rights. Features used with TD are included to show that they do not vary with demographic data as much as the estimated surface O3 concentrations. Surface O3 was mentioned to favor high vegetative areas, titrate with its constituents and move towards these sources when exposed to ample heat. Maps XI.3.6-XI.3.11 show clear splits in affected demographics for the randomly selected days to portray concentrations.

VI.1. Trends Over PHOTUC for Five Months

Due to the large nature of this project, depicting 2,125 days would be rather disingenuous to mother nature should a printed copy need exist somewhere. Random months and years were selected to keep the number down to 150. Full applications, processing of the full dataset and project management are further discussed in Chapter VII. It was imperative that all seasons were captured in this section, however due to summer temperatures in the AOI, June 2022 and July 2021 were included as duplicate seasons. January 2019, October 2020, and April 2023 depict the remaining Winter, Fall, and Spring seasons respectively. Given the low variance in terrain except around mountainous areas, many of the urban populations are in basins allowing for cumulation of atmospheric gases. The full daily outputs for each month are depicted starting on Map VIII.MAP.X V.2.2. and on. Only the first of each month was shown in detail. Averages for each county are covered, with the health outcomes of exposures at concentrations greater than the EPA Standard of 70 ppb in mind.



Map 1:

This is a caption for my map!

The overall predicted concentration of O3 for each county was compared to its average monitor value. It’s worth noting that the distribution of monitors per count was even and the distribution of average concentrations was slightly skewed towards Maricopa; in this study, the area saw higher concentrations on average: Studies have shown numerous respiratory and terminal diseases have been exponentially increasing in areas with poor conditions and high exposure to climate change (Abasilim and Friedman 2022; Anbari et al. 2022; Lee, Shin, and Chung 1999; Weschler 2006). In addition, studies find that human expansion tends to also increase exposure as a whole, increasing the amount of populations at risk to air pollution and natural hazards (Di Baldassarre et al. 2018; Abdullah et al. 2019; Iglesias et al. 2021).

In general, exposure to surface O3 has been associated with mortality risk from non-accidental diseases, circulatory disease, respiratory disease, urinary system disease, and nervous system diseases (Chen et al., 2023; Ito et al., 2005; Jerrett et al., 2009; KazemipaRKouhi et al., 2020; Lim et al., 2019; Raza et al., 2018; Reid et al., 2012; Turner et al., 2016). Some of these health outcomes have been related with exposure to mildly toxic environments and harsher living conditions (WHO 2013; Singh, Suresh, and Vellapandian 2023). Health studies which initially implemented ozone exposure as a confounding variable have instead found ozone to be a driver for concerning health outcomes which differ by age, employment, occupation, race/ethnicity, and other socio-economic status (SES) indicators, affecting a wide range of groups (Bell, Zanobetti, and Dominici 2014). Health outcomes due to exacerbated ozone exposure also tend to vary in severity based on duration and frequency of elevated surface O3 reactions (Turner et al. 2016a; Singh, Suresh, and Vellapandian 2023; Y. Wang et al. 2023).

VI.2. Maricopa

Distributions of surface O3 for Maricopa County were the most spread out with values ranging from 8.78 ppm to 107.09 ppm. This county houses Phoenix, the most populous city in Arizona as per census counts and number of households The estimated concentrations ranged from x to y based on gradient boosted fields. The distribution of highly populous areas with smaller amounts of occupied homes can be seen closer to Peoria and Glendale west of Phoenix. The coloring scheme shows many green shaded census tracks near the city center, typically surrounded by counties which have little variations in their mean and median income. Noting the surface O3 maps, the urban setting in Maricopa sees the most diversity in concentration distributions.

A map of a city

AI-generated content may be incorrect.When overlaid with corresponding demographic information, many of the census tracts which have a high population, number of occupied households, and low deviation in their overall mean vs. median income are affected by higher concentrations. In addition, during low concentration months such as January, many of the trends show similar tendencies to weather patterns which tend to wrap around certain communities in the area. These same patterns can be seen during the high concentration months like October as well. The effects of both urban heath island effects and high-quality vegetative areas show the trends mentioned in Chapter II.3 where in O3 tends to settle in dry, undermaintained areas where the reaction is not stemming from.

VI.3. Pima

Distributions of surface O3 for Pima county were the most spread out with values ranging from 8.78 ppm to 107.09 ppm. The estimated concentrations ranged from x to y based on gradient boosted fields.

VI.4. Pinal

Distributions of surface O3 for Pima county were the most spread out with values ranging from 8.78 ppm to 107.09 ppm. This county is situated in between the Northeastern part of Pima and Southeastern part of Maricopa. The estimated concentrations ranged from x to y based on gradient boosted fields.

VI.5. O3 Exposure and Potential Impacts

Nearly all public health studies concerning air pollutants utilize statistical modeling techniques in some shape or form (Knowlton et al. 2004; Ito, De Leon, and Lippmann 2005; Javanmardi et al. 2017; De Marco et al. 2022). Such predictions give people the opportunity to avoid elevated exposure and the related health risks associated with short- and long-term exposure (Abdullah et al. 2019; Ghazali et al. 2010; Ballester et al. 2002; Braik et al. 2024; Duncan et al. 2014; Michael MacCracken 2008). Epidemiological studies have found statistically significant relationships between an increased risk of premature death and exposures to air pollutants. This relationship has been observed in relation to no just surface O3 reactions (Manisalidis et al. 2020; Liang et al. 2018; Nawaz 2023), but also in areas where O3 reactions co-funded with NO2 and temperature are occurring at or above national standards (Sun et al. 2024; Weng 2023; Kumar et al. 2015; X. Liu et al. 2022). A lower exposure of O3 typically relates to a high exposure to nitrogen dioxide (NO2), meaning those who are exposed to the risks of NO2 are equally at risk, if not more so, to illnesses and diseases which stem from both pollutants due to frequent movement between toxic environments (Singh, Suresh, and Vellapandian 2023; Akhter et al. 2015; Alexis et al. 2010; Xue et al. 2023; Turner et al. 2016a; T. Zhao et al. 2018).

Urban studies find interactions with redox states and pulmonary toxicity during long-term exposure episodes (L. Chen et al. 2019; Marmett et al. 2022; Ni et al. 2024) during reaction favored metrological events have been found to be related to mortality, respiratory, and increases in immune system response in numerous countries at urban locations similar to PHOTUC (Geels et al. 2015; Jerrett et al. 2009; Malley et al. 2017a; Turner et al. 2016b; C. Wang et al. 2021; Y. Zhang et al. 2024). Spatial-temporal analytics on monitoring systems combined with individual level data show activity spaces attribute greatly to a variety of health outcomes associated with ozone concentrations (US EPA 2015; Anenberg et al. 2018; H. Liu et al. 2018; Nuvolone, Petri, and Voller 2018; T. Zhao et al. 2018; J. Zhang, Wei, and Fang 2019). In addition, this thesis has found that surface ozone reactions typically follow the patterns mentioned in Chapter 2, occurring in middle-class to middle-low class areas in the study area. Combining the known risks and spatial temporal statistics of the SMaRK model, this section depicts the importance of clear representations of high-resolution surface O3 while doing a small systematic review of the effects of short- and long-term exposures to O3 seen in recent public health studies e.g. (Gao et al. 2022; Marmett et al. 2022; Turner et al. 2016b; Xue et al. 2023; T. Zhao et al. 2018).

VI.5. Environmental Impacts

Epidemiological studies have found statistically significant relationships between an increased risk of premature death and exposures to air pollutants which are common constituents for ozone production (Anenberg et al. 2022; Fuller et al. 2022; Nawaz 2023). Studies such as these tend to utilize the active monitoring of surface O3 reactions combined with statistical models and remote sensing images to create detailed exposure charts assigned to populations of interest (Gao et al. 2022; Jerrett et al. 2009; Turner et al. 2016a). While these are incredibly accurate, the models used can be improved beyond this thesis to allow for larger, more detailed trend analyses of urban environments (US EPA 2015; Balamurugan, Balamurugan, and Chen 2022; Y. Wang et al. 2023).

Current O3 exposure models have been used to support analyses which model the effects of other harmful air pollutants as well (Huang et al. 2017; Liang et al. 2018; N. Zhao et al. 2021). Due to the molecule’s unstable and reaction-ready state, ozone models need to be as accurate as possible to highlight possible health burdens associated with it and subsequent air pollution (Anenberg et al. 2018; Heal et al. 2013; Jahn and Hertig 2022). Policymakers at both local- and national-scales have lead large scale projects dedicated to improving air quality for the public and environmental health of their jurisdictions (Schlink et al. 2006; Honrath et al. 2017; IPCC 2022; WHO 2021; Kobayashi et al. 2015). The studies, data, and resulting policies which stem from these findings rely on consistent and accurate distributions of said pollutant gathered over time (Honrath et al. 2017; Tao 2023; Y. Wang et al. 2023; Weng 2023).

While recent years have added a wealth of information to atmospheric chemistry studies (H. Liu et al. 2018; Gaudel et al. 2018; Bourgeois et al. 2020; Johnson et al. 2024); historical analysis are difficult to create, and their importance for those encased in environmental injustice cycles is invaluable. More data is required for the slight correlations that have been found with the lack of early spatial information (Borja-Aburto et al. 1997; Hoek et al. 1997; Schlink et al. 2006; T. Zhao et al. 2018; J. Zhang, Wei, and Fang 2019; Anbari et al. 2022).

VI.6. Health Outcomes and Indicators

Health indicators such as measurements of lung function, respiratory symptoms, records of hospital admissions for specific diagnoses, and mortality have all been reported as outcomes due to elevated surface ozone exposure over long periods of time. The variation of health outcomes due to socio-economic status (SES) has been discussed in literature during the late 1990s (Hoek et al. 1997; Kelsall et al. 1997; Zmirou et al. 1998; Schwartz 2000). This known connection between predisposed and vulnerable people provides arguments that short-term mortality trends my actually be advanced by several days due to ozone pollution (SAMHSA 2017; Hu et al. 2012; Lopez-Bueno et al. 2020; Padilla et al. 2016). Trends like these have then shown elevated levels are typically followed by reduced mortality after the increased ozone production event. In historical modeling, coarse datasets have found very weak effects (Borja-Aburto et al. 1997; Hoek et al. 1997; Knowlton et al. 2004; Lee, Shin, and Chung 1999) only to be more prominent after adding suitable corrections to ozone models (De Marco et al. 2022; Javanmardi et al. 2017; H. Liu et al. 2018; Nuvolone, Petri, and Voller 2018; J. Zhang, Wei, and Fang 2019). Given such conflicting results in modeling outcomes, the assessment of the health risk due to surface ozone is still an intriguing aspect of air pollution monitoring *that can be further progressed with high spatial resolution data.*

VI.7. Final Exposure Concerns and Mean Aoi Trends

Health outcomes related to short- and long-term surface ozone have been investigated to find worrying evidence that supports O3 tends to disproportionally affect vulnerable populations based on surrounding environments. (Bell, Zanobetti, and Dominici 2014; Turner et al. 2016a; Malley et al. 2017b; Tessum et al. 2021; Hsu et al. 2021; Ermagun, Smith, and Janatabadi 2024). Outcomes such as chronic obstructive pulmonary disease (COPD), elderly cognitive impairment, pro-thrombosis, pediatric asthma, and general inflammation are suspected to stem from exacerbated long-term exposure to surface O3 reactions (Balmes 2019; Gao et al. 2022; Niu et al. 2022). In short-term ozone studies, pre-teen and post-retirement age groups are more at risk while young, healthy populations varying results due to interactions with oxidative systems in the body. (Barath et al. 2013; C. Chen et al. 2023, 2023; Díaz et al. 2018; Goodman et al. 2018; Raza et al. 2018; Roth, Hwang, and Li 2008).

Short-term ambient exposure to surface O3 may also impact the risk of multiple sclerosis (MS) by increasing triglycerides, cholesterol, and blood pressure in predisposed populations. Women and older adults (especially those over 75) seem to be more affected by short-term ozone exposures (C. Chen et al. 2023; Fuller et al. 2022). Many of these outcomes occur at or above the EPA standard of 70ppb. Maricopa county, which houses Phoenix, saw high averages of income, population density, and surface O3 concentrations. In addition, areas with better kept greenspace near both Phoenix and Tucson would see the brunt of high concentrations in the area. While January and October showed averages lover than the EPA standard, these areas spiked, with potential exposures above 70ppb according to both in-situ and modelled measurements. Further improvements to the overall code, pre-processing methods, and applications of RK are needed to better depict harmful substances and exposures at high resolutions in urban areas.

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