Wildfires increase in size and frequency in Alaska (Chapin et al., 2008, Woo et al., 2020). Smoke from the wildfires endangers public’s health (Hahn et al., 2021). Lack of surface PM2.5 measurement data is a major challenge.

**Goal:** We want to build good historical daily surface PM2.5 dataset for summer Alaska.

### Introduction

Smoke concentration has been closely monitored using a low-cost air quality sensor network provided by PurpleAir. A new dataset was generated using HRRR forecasts calibrated with PurpleAir PM2.5 measurements collected with the PurpleAir sensor, Atmospheric Meas. Tech., 14, 4617–4637, 2021.

### Develop Machine Learning Methods

#### HRRR-Smoke Hourly Forecasts

**Step 1:** Use machine learning to build relationship/model between collocated HRRR and PurpleAir PM2.5.

#### HRRR-Met Hourly Forecasts

**Step 2:** Apply the trained Machine Learning model to the entire domain to generate the PM2.5 map.

#### Step 3: Post-process with Satellite Daily AOD

- **Step 3:** Apply CNN1D to the Entire Alaska Domain

**CNN1D PM2.5 Map vs HRRR-Smoke PM2.5 Map**

#### Results

**Step 1 Machine Learning Model Build-up**

- **CNN1D and Random Forest improved the original HRRR-Smoke PM2.5.**
- **CNN1D did not improve possibly due to redundant information from finer resolution.**
- **CNN1D is much quicker to train a model than Random Forest.**

**Step 2 Apply CNN1D to the Entire Alaska Domain**

- **CNN1D PM2.5 map shows that wildfire smoke can transport much further than HRRR-Smoke demonstrates.**
- **CNN1D PM2.5 map has much more details than HRRR-Smoke PM2.5, such as the blockade effect of Alaska Range.**

**Step 3 Satellite AOD Post-Process**

- **Using Tianlang Zhao’s AOD-PM2.5 deriving functions, we can get the AOD-derided PM2.5 (Zhao et al., 2024).**
- **At certain mismatching areas, where CNN1D PM2.5 underestimates but AOD is relatively high, or CNN1D PM2.5 overestimates but AOD is relatively low, the AOD-derided PM2.5 agrees better with PurpleAir PM2.5.**
- **We replace CNN1D PM2.5 in these mismatching areas with AOD-derided PM2.5 to generate the combined PM2.5 and it further improved the results.**

**CNN1D Performances Analysis**

- **Satellite True Color Image agrees with the Vertically Integrated Smoke, confirming the long-distance transportation of smoke from wildfires spots. (Seen in the Northern Alaska)**
- **CNN1D PM2.5 combines Surface Smoke and Vertically Integrated Smoke and gives better surface PM2.5 results.**
- **Satellite images also show that there are misdetections in Fire Radiative Power (FRP) due to heavy smoke and clouds, which HRRR data underestimates.**

### Conclusions

- **CNN1D can help to reconstruct high resolution historical surface PM2.5 data in Alaska using HRRR forecasts and PurpleAir PM2.5 measurements.**
- **HRRR-Smoke underestimates surface PM2.5 in Alaska due to missing FRP detection and misdistributions of Surface and Vertical Smoke.**
- **CNN1D can help improving the Surface/Vertical Smoke issue but can not cope with missing FRP.**

### References:


