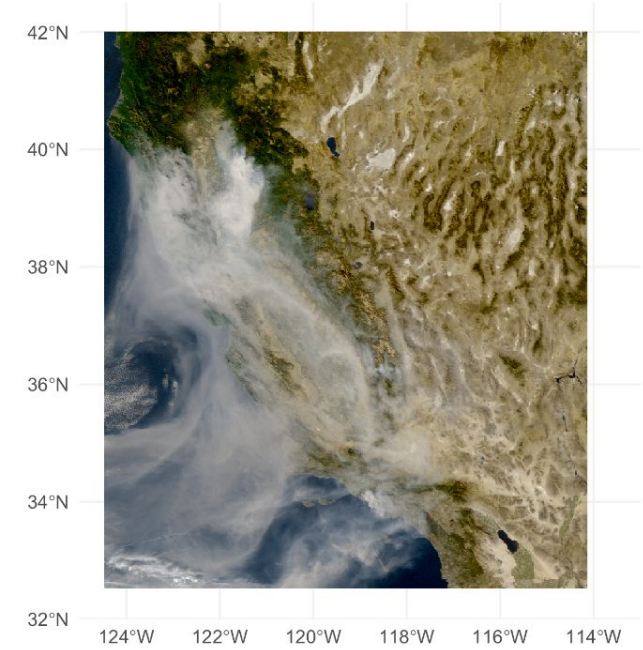
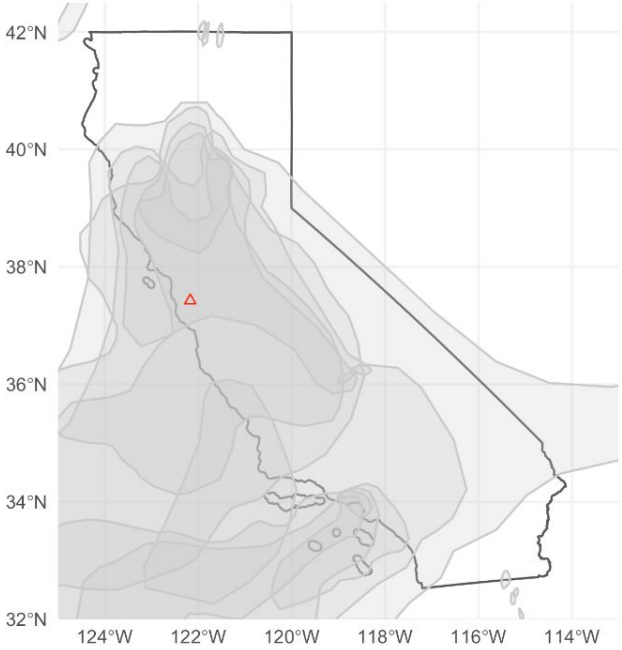
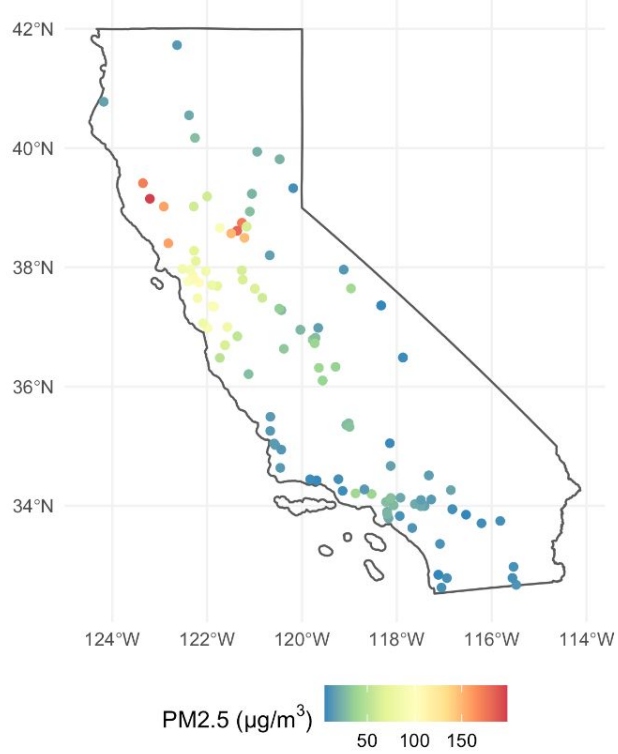
Wildfire smoke plume segmentation using geostationary satellite imagery

Jeff Wen & Marshall Burke | ICML Climate Change AI Workshop

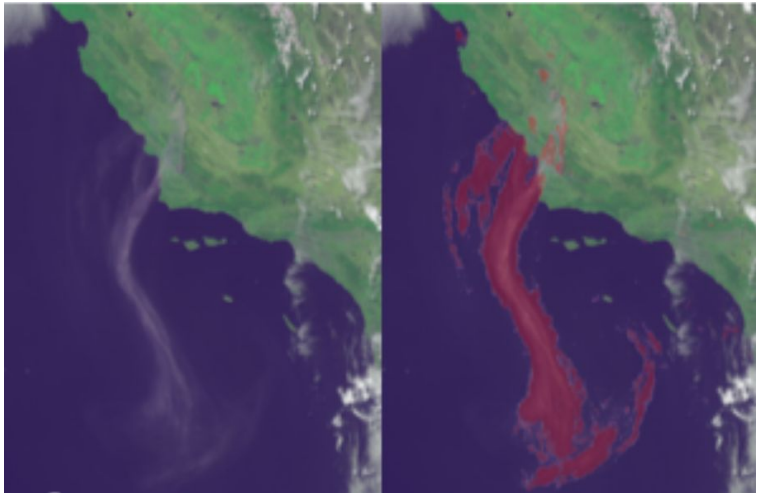
What is the impact of wildfire smoke exposure on society?



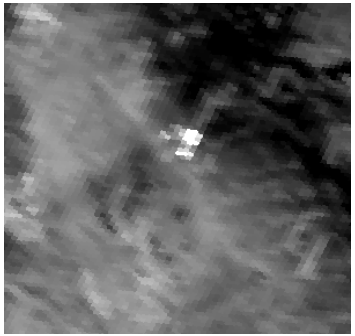
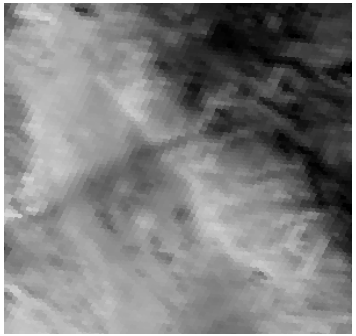




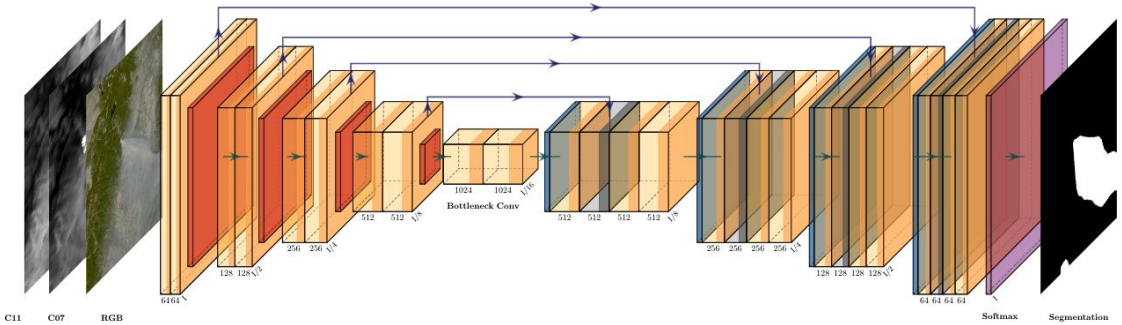
Previous work has leveraged linear models and expert corrected labels



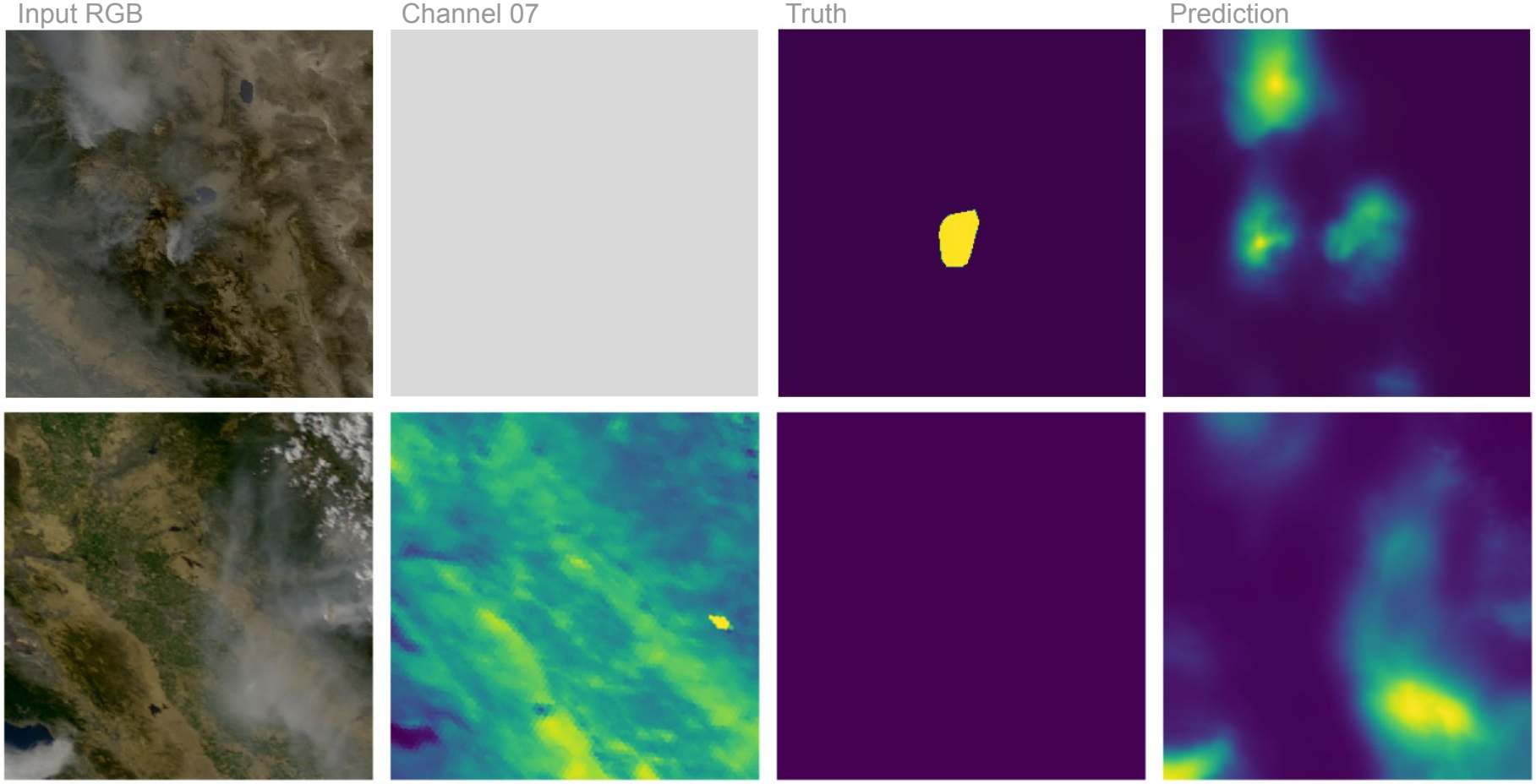
Wolters and Dean 2015
Ramasubramanian et al. 2019


- Pseudo-true color RGB - generated with visible bands red, “green”, blue
- Channel 7 - infrared band used for identifying fog and low clouds at night, fire hot spots, and volcanic ash
- Channel 11 - infrared band used for tracking cloud top phase

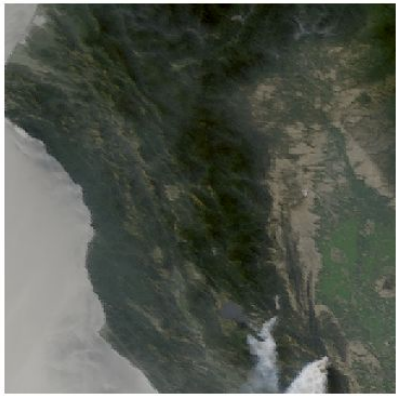


Example results on the validation set

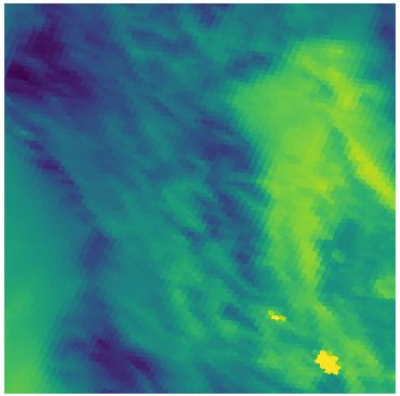


Example with MERRA2 AOT channel

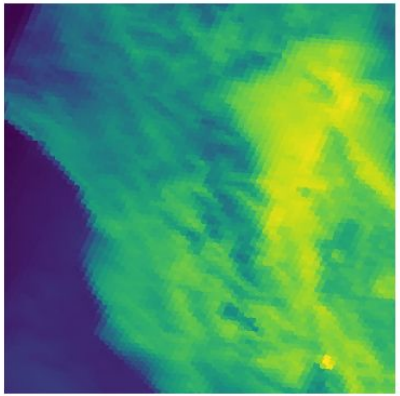
Input RGB



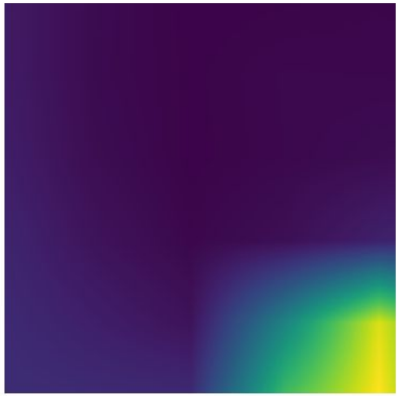
Channel 07



Channel 11

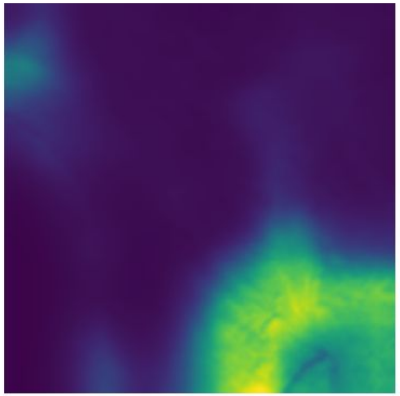


Input MERRA2



Truth

Prediction



- Trained with all bands including MERRA2 as a separate channel
- Prediction appears to anchor onto the MERRA2 input as the segmentation covers the entire bottom right corner even though the visible smoke is only a portion of the image

Example predictions

Input RGB | Truth | Prediction

- Trained with true color, channel 07, and channel 11 bands using binary cross entropy loss
- The model is able to differentiate between smoke and clouds and does not predict smoke when there is no smoke in the input image

Bands	Loss	Avg. Loss	Avg. Dice
1	BCE	0.2535	0.0948
3	**BCE**	**0.2236**	**0.1074**
3*	BCE	0.2313	0.1008
4	BCE	0.1884	0.1028
1	MAE	0.0986	0.2635
3	MAE	0.0986	0.2649
3*	**MAE**	**0.0986**	**0.2655**
4	**MAE**	**0.0986**	**0.2655**

Takeaways and future work

- The trained model is able to segment smoke plumes more precisely than the smoke annotations
- There are still challenges capturing the continuity of the smoke plume, which may be a function of the threshold used to generate the mask
- Future work will focus on improving model performance given noisy truth labels and transferring to geographies outside of the US