Rapid Emission Updates With Satellite Observations

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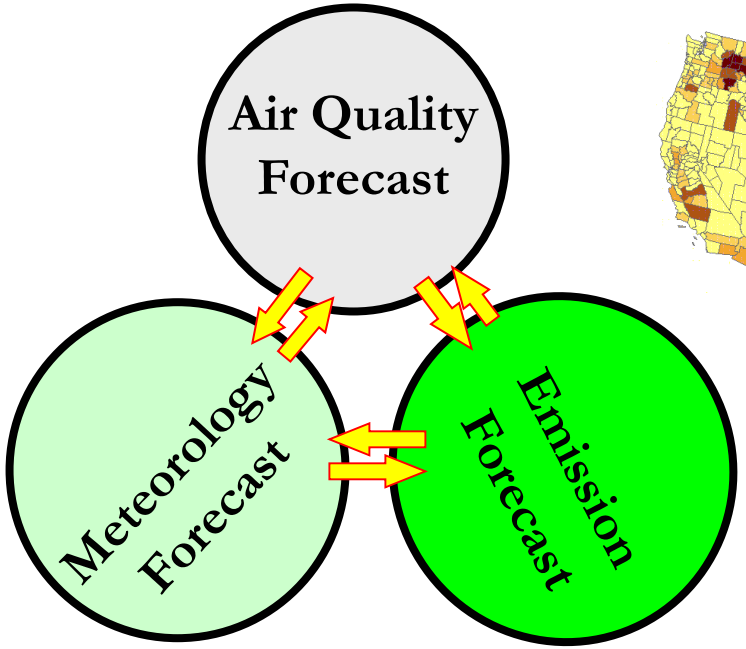
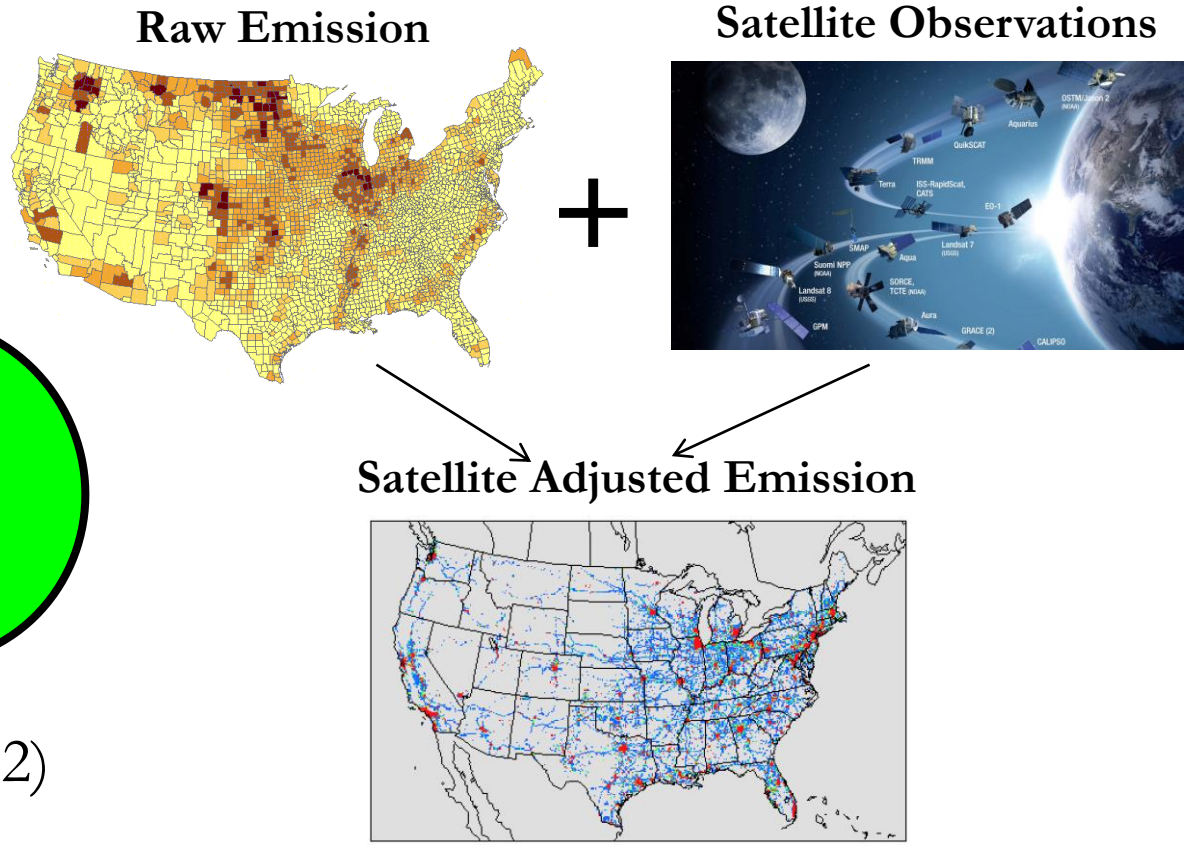
Emission and Chemical Data Assimilation

Chemical Data Assimilation (CDA): Use satellite observations to improve chemical fields, including initial concentrations.

Emission Data Assimilation (EDA): Assimilate satellite observations to reduce emission uncertainties;



(Source: Tong et al., 2012)



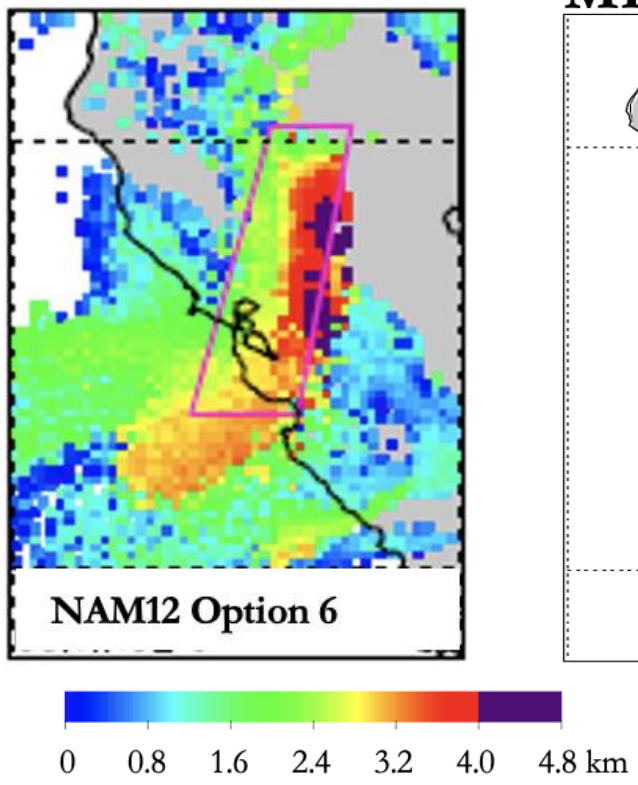
EDA provides rapid emission refresh for air quality forecasting.

Ensemble Wildfire Forecasting: Camp Fire

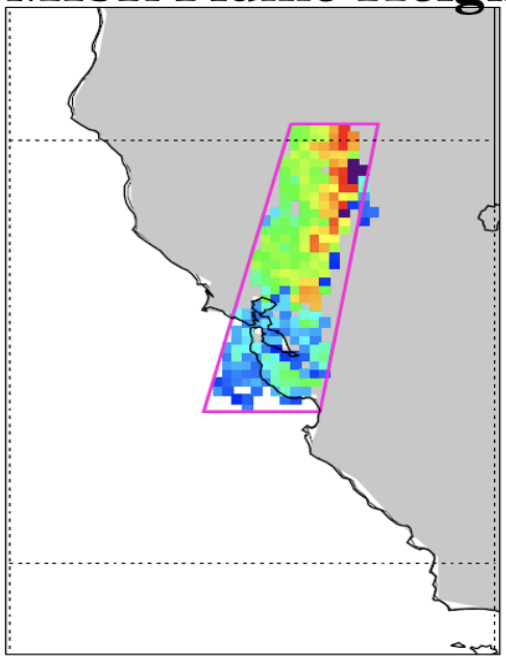
(Li, Tong, et al., 2020)

- FRP (MODIS/VIIRS): wildfire emissions and plume rise modeling;
- MISR plume height, MODIS/VIIRS AOD, TROPOMI CO/NO_2 for model validation;

HYSPLIT Plume Height During Camp Fire

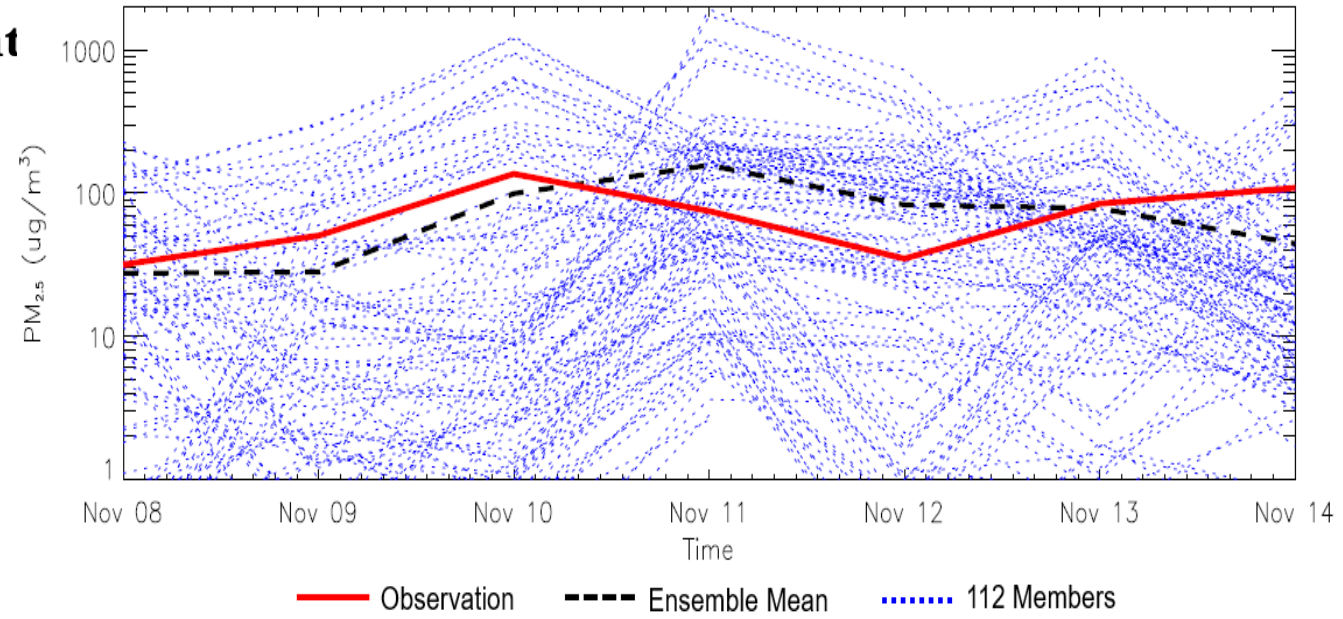


201811091900 UTC MISR Plume Height



(Ralph Kahn, NASA)

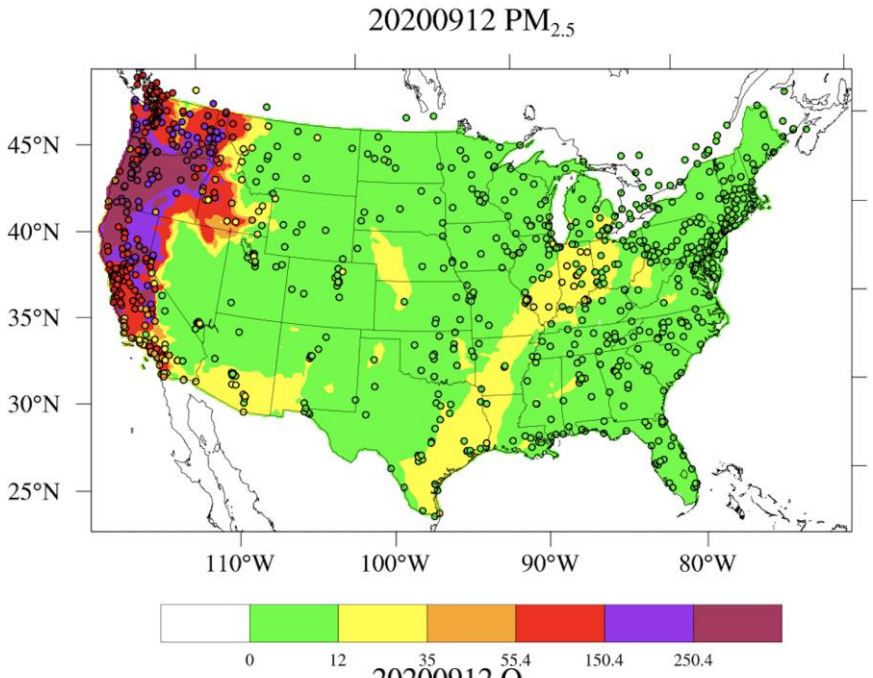
Ensemble $PM_{2.5}$ Forecasts

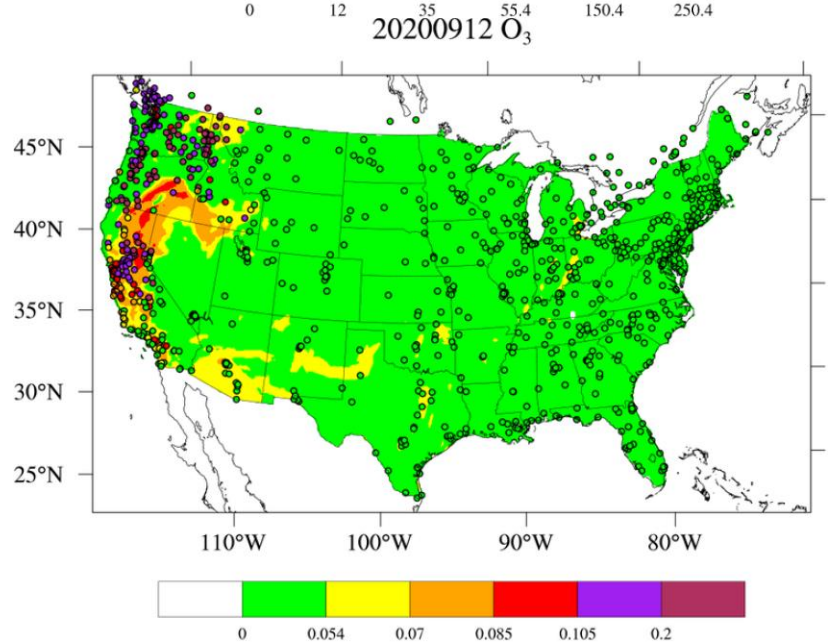


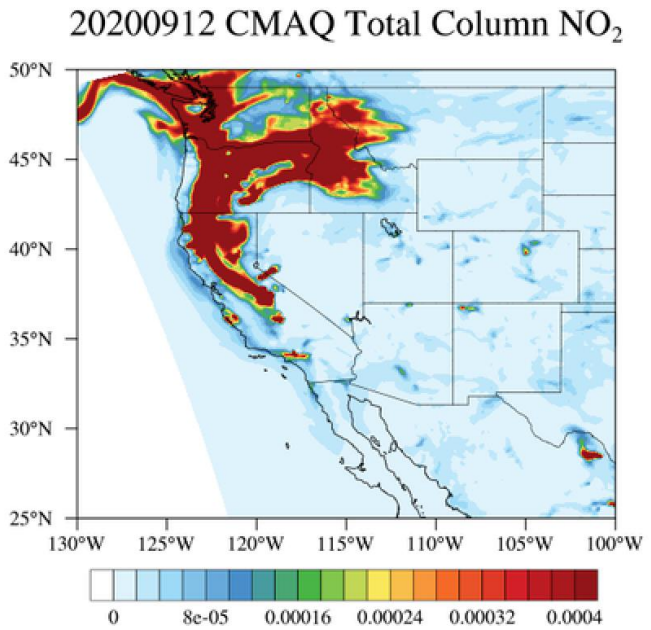
- Emissions differ 10x;
- Predicted surface PM2.5 differ 1000x;
- Thick smoke →biased FRP/emission/plume rise

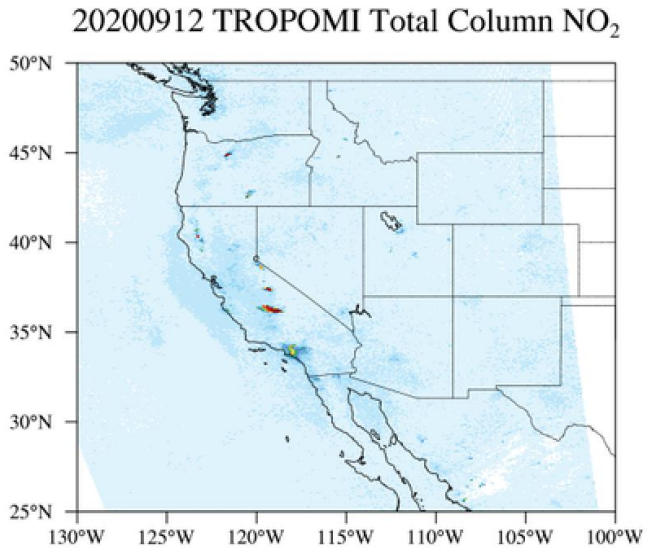
2020 "GigaFire", Ozone and $PM_{2.5}$ Exceedance

(Yunyao Li)





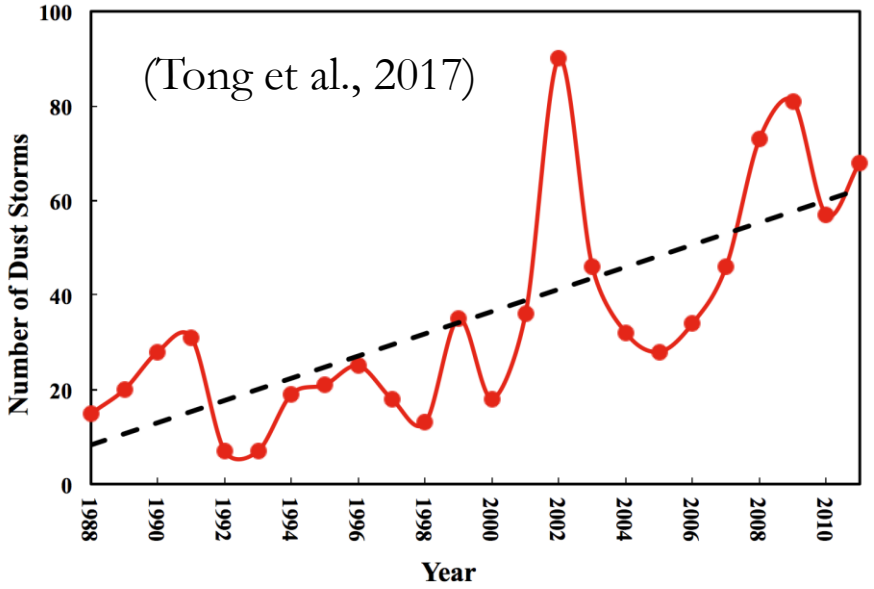




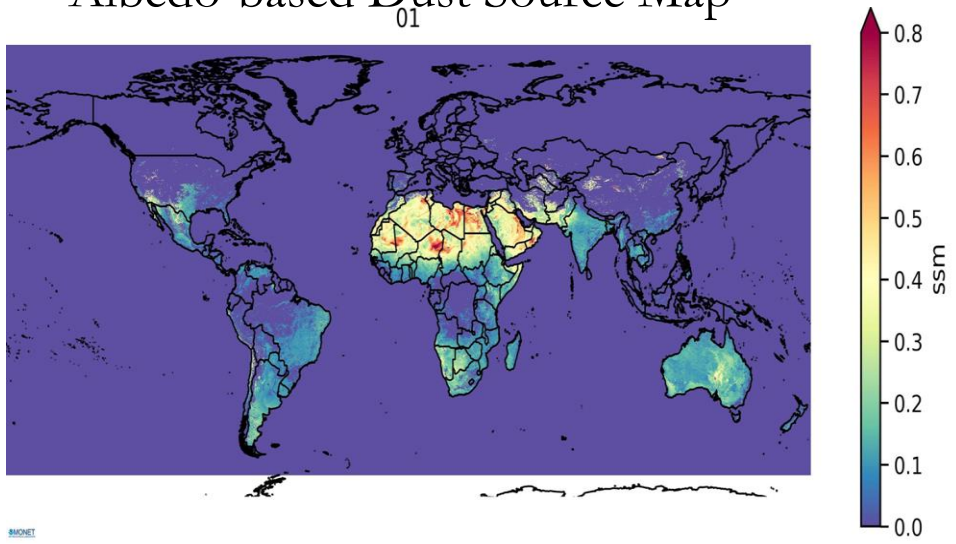
- Wildfire NO_x emissions (and VOCs) are highly uncertain;
- More challenging to predict O_3 exceedance than $PM_{2.5}$;
- When there is a big fire, it rules!

Predicting Dust Storms

Dust Trend

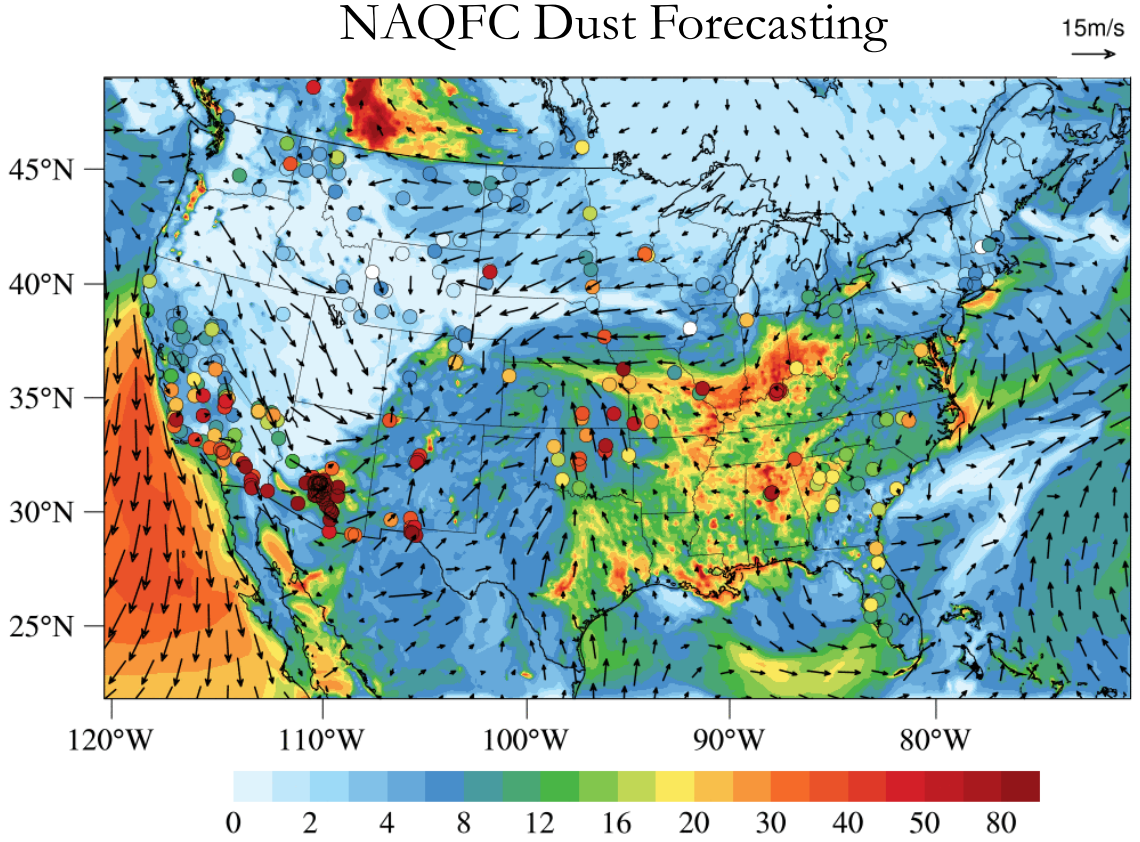


Albedo-based Dust Source Map



(Barry Baker, GMU/NOAA)

NAQFC Dust Forecasting



Satellite products used:

Source: MODIS/VIIRS NDVI, BRDF/Albedo;
Validation: MODIS/VIIRS AOD, Dust Mask

Concluding Thoughts

- Air quality improves, extreme events increase;
- Some pressing needs in forecasting air quality extreme events:

Topics	Challenges
Wildfire Forecasting	**High-opacity retrievals;** **Plume height** (more often, better vertical resolution); **Burning stage** (emission factors; hygroscopicity etc). **Data Latency;**
Dust Forecasting	**Observing time** (NA dust peaks in late afternoon; Fatal dust accidents at 5PM); **Dust source detection**; **Aerosol type** (dust mask); **Better dust retrievals with cloud;**