



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



# Applying Machine Learning to Associate Precipitation Extremes with Synoptic-Scale Weather Events

**Katie Dagon**

*with:* Julie Caron, Jerry Meehl, Maria Molina, and John Truesdale

*Climate and Global Dynamics Lab*

*National Center for Atmospheric Research*



RGMA PI Meeting  
October 13, 2020



# Extreme Precipitation Has Significant Consequences

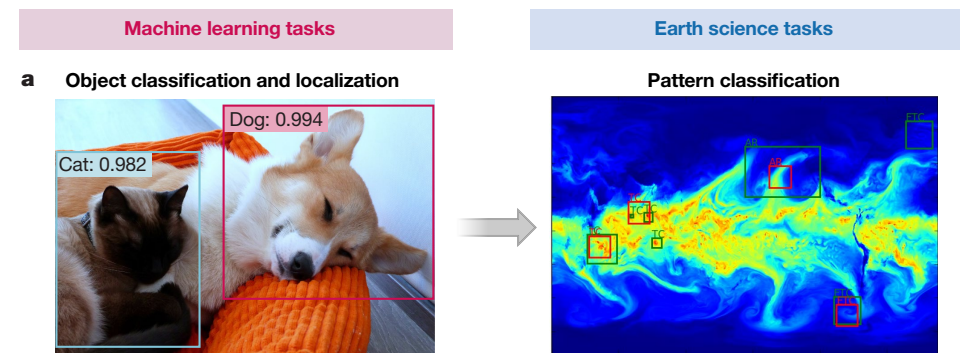


Oroville Dam spillway overflowing in February 2017 following an atmospheric river event in California



Flooding after Hurricane Harvey in August 2017

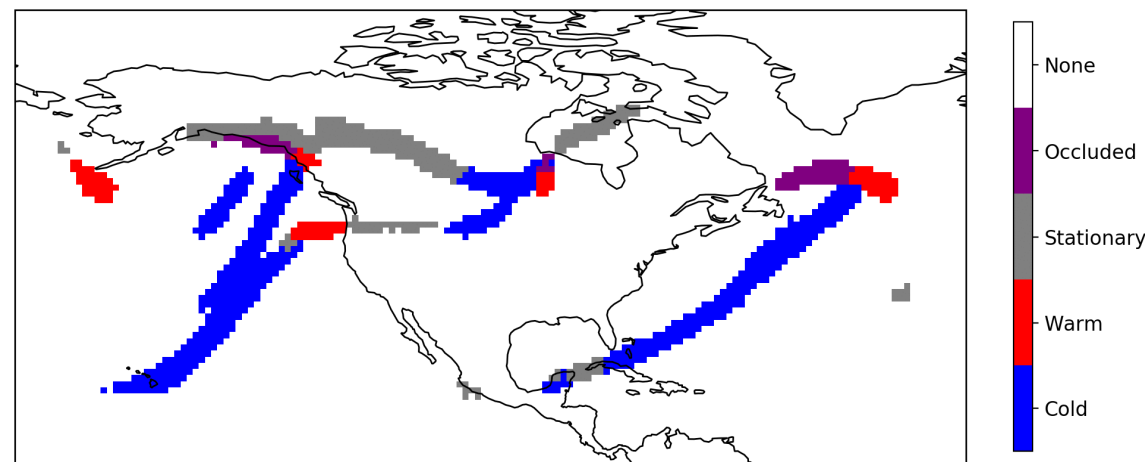
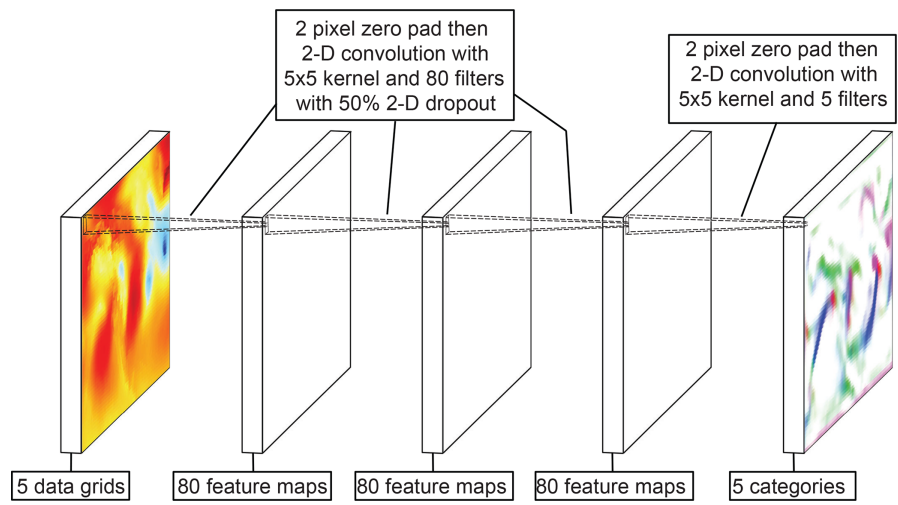
**Can we use machine learning-based detection algorithms to automate the classification of synoptic weather features such as fronts, ARs, TCs, and MCSs?**  
*Using a combination of new and existing ML algorithms applied to observations and climate model output.*



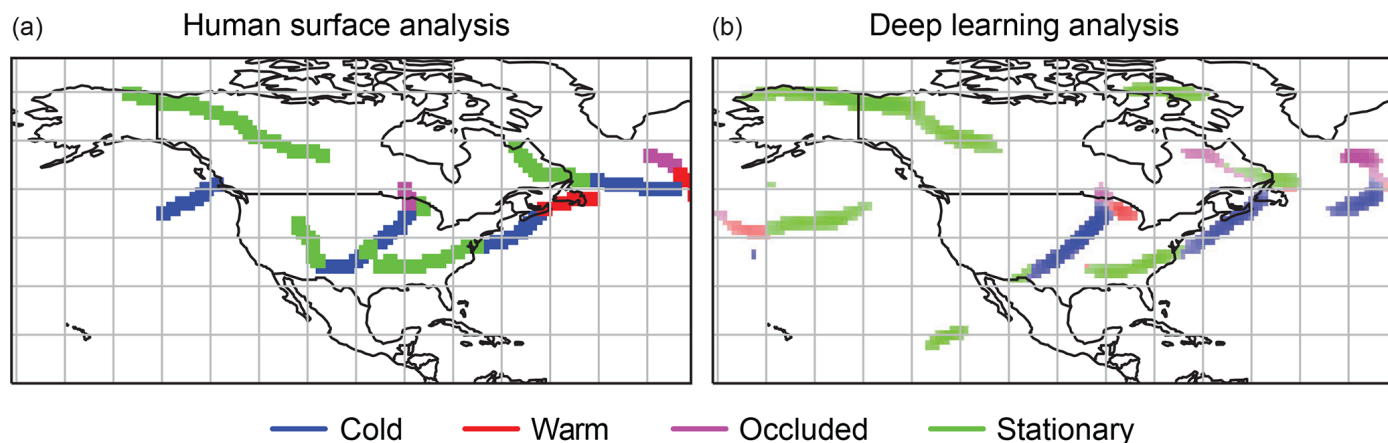
Reichstein et al. (2019)

# Detection of Extreme Precipitation Events: Fronts

**DL-FRONT:**  
Machine learning-based frontal detection algorithm (Biard and Kunkel, 2019)



Front identification comparison: 1 August 2009, 12:00 UTC

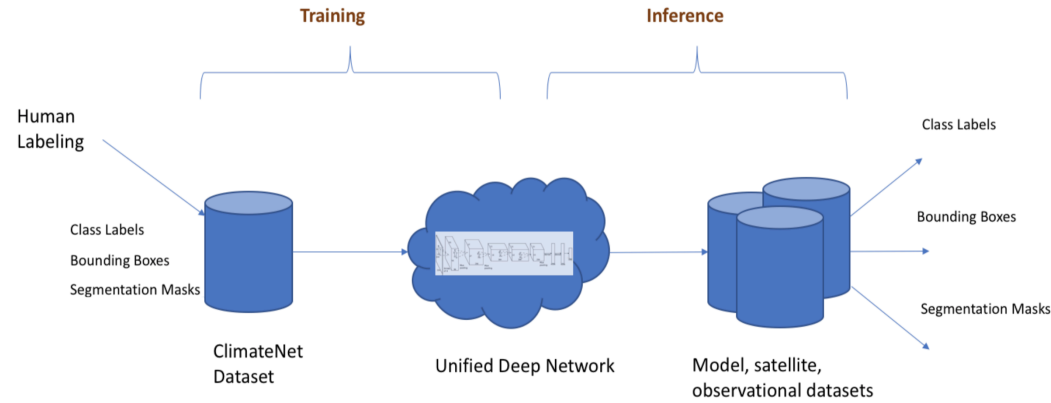


↑  
Applying trained algorithm to 3hrly CESM output to detect fronts

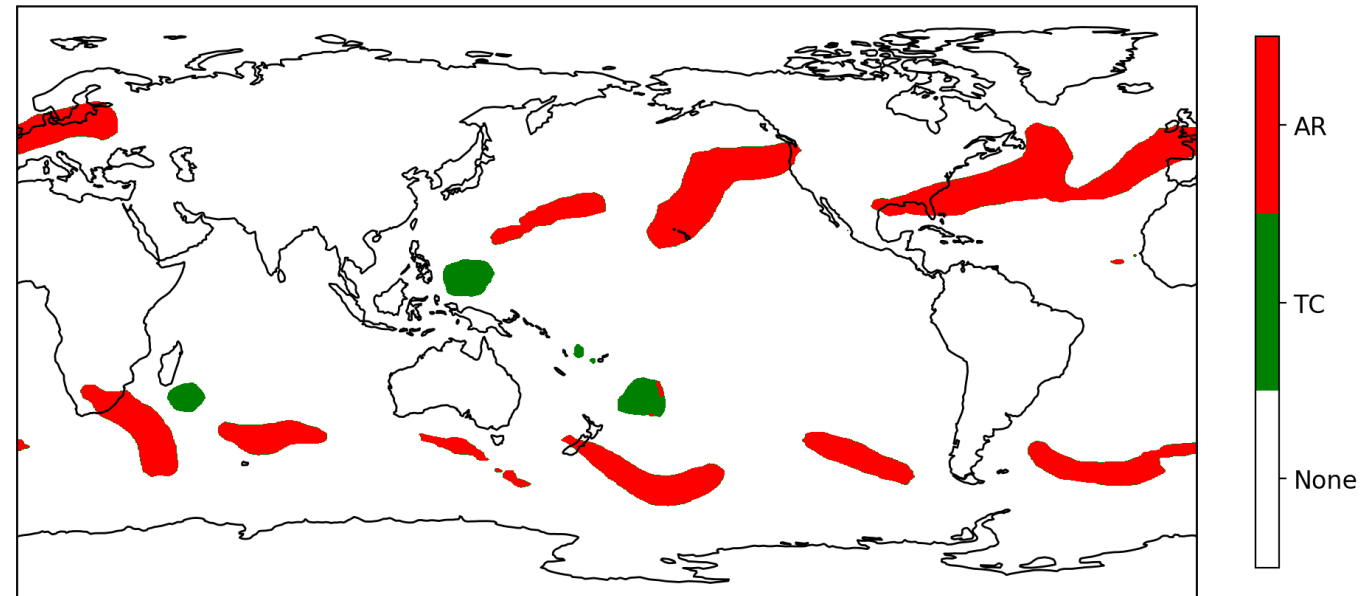
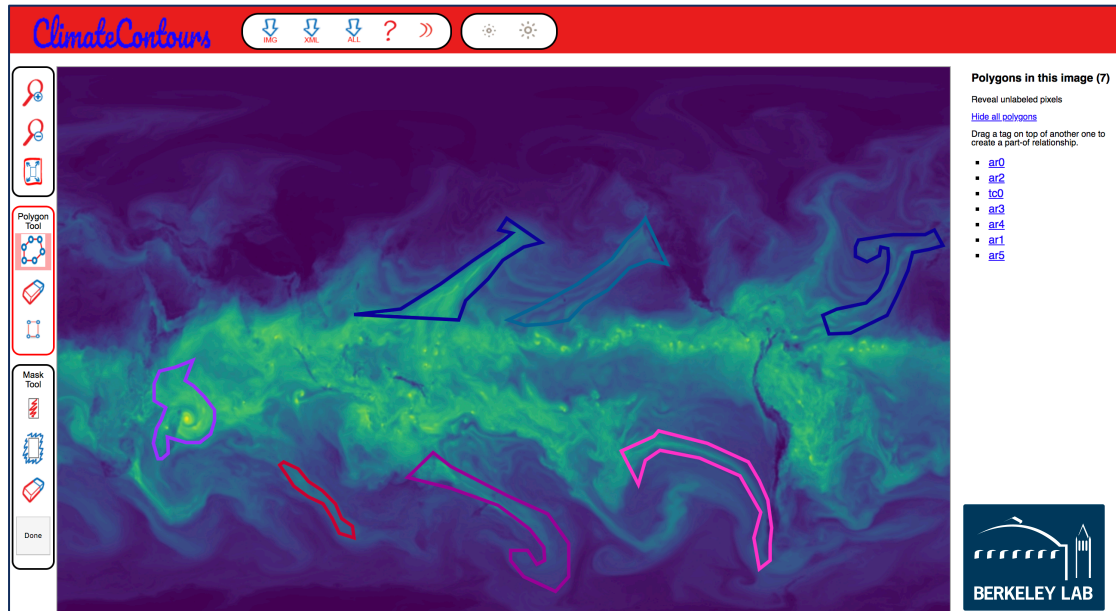
← Training and identifying different front types in reanalysis data

# Detection of Extreme Precipitation Events: ARs and TCs

**ClimateNet:** Machine learning-based detection algorithm for atmospheric rivers and tropical cyclones (Prabhat et al., 2020)



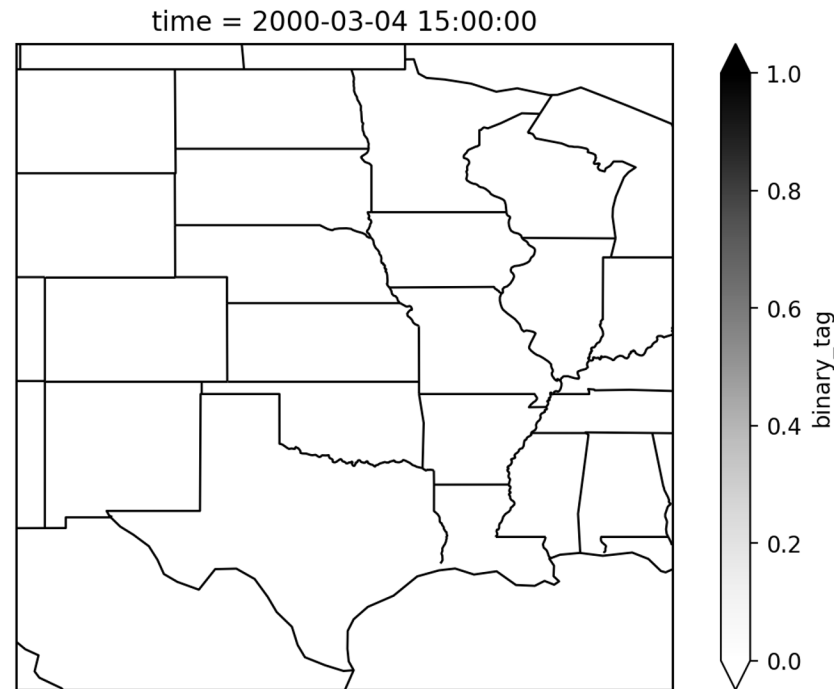
Applying trained algorithm to CESM output to detect ARs and TCs  
*Led by John Truesdale, NCAR*



# Detection of Extreme Precipitation Events: MCSs

Train a deep learning model to detect mesoscale convective systems (MCSs) using similar input fields to frontal detection algorithm.

*Led by Maria Molina, NCAR*



MCS labels using TempestExtremes

# Summary and Next Steps

## Next Steps:

- Validating the output of the machine learning models
- Connecting precipitation extremes with weather events
- Interpretation methods
- Resolution dependence of feature detection
- Inference on future climate states

## White Paper Discussion:

- Causal relationships between synoptic-scale features and extreme events
- Machine learning approaches to understanding Earth system variability
- Application of high resolution modeling
- Development of frameworks for computationally efficient analysis