Developing Storylines for Unprecedented Extreme Events using Ensemble Boosting

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1. How can storylines and boosting help assess extremes?

**Storylines?**
“A physically self-consistent unfolding of past events, or of plausible future events or pathways”[1]
Likelihood of event → impact of event

**Ensemble Boosting?**
1. Select a model event (highest temperature)
2. Re-initialize before peak: initial condition perturbation
3. Run until past peak

Quantitative analysis of tail events

2. Storyline: the Pacific Northwest Heatwave

**PNW, a record-shattering extreme**
End of June 2021
49.6 °C (Lytton), 5 °C warmer than previous record
Extensive ecosystem damage, excess mortality [2]
Multi-day Omega Block and solar irradiation

**T_{2m}:** 4.99 σ above seasonal average
**Z_{500}:** 4.66 σ above seasonal average
**EF:** -1.83 σ above seasonal average

The boosted heatwave shows similar anomaly patterns to observations

3. Ensemble Boosting: Analogues

**Models and variables**
1) Identify real-life extreme or plausible climate change risk:
   **ERA5** for original event (reanalysis)
2) Select analogues from climate model
   **CESM2** for model analogues
• 30-member ensemble
• 2005-2035 (future years warmed w.r.t. SSP-3.70)

**Selection criteria:**

- \( T_{\text{max}}(i) - T_{\text{avg}}(i) \) [σ]

**With ensemble boosting, CESM2 simulates heatwaves that exceed PNW 2021**

4. Extreme boosted analogues

**Humid heatwaves**
Heat stress indicator: \( T_w \) (wet-bulb temperature)
Mortality threshold of 35 °C [3]
Identify unprecedented extremes (jumps) w.r.t model records
Probability of jump (over all years)

**Droughts in Switzerland**
Megadroughts (1-5 years), impact of heavy rainfall aftermath
Seasonal droughts

Selection Criteria:

- \( H = \text{BYA} - \text{WR} \)
- Baseline Yearly Average (BYA) [mm/yr], Wanted Reduction (WR), Time Period (TP)

5. What to boost and storyline-analyze next?

References