Smoke consequences paper
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Outline
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1. **Rationale**
    1.1. Smoke from fires and air quality
        1.1.1. Consequences of local airshed smoke (health, safety, etc.)
        1.1.2. Consequences of regional dispersed smoke (regional haze, PM, and ozone)
    1.2. Concern about air quality under global climate change
        1.2.1. More and larger fires would mean more smoke
        1.2.2. More or more severe exceedances; worst days associated with fire
        1.2.3. Altered fire seasonality, intensity, geographic patterns of occurrence
        1.2.4. Positive feedbacks of air-quality changes to climate change
            1.2.4.1. Emission of GHGs
            1.2.4.2. Changing chemistry affects boundary layer
    1.3. Need forecasting systems, broad and fine scale, short and long term
        1.3.1. Informing global-change research
        1.3.2. Strategic
        1.3.3. Tactical and operational
    1.4. Scope of this paper extends from the "landscape" to CONUS, with implications for the extent and resolution of models
2. **What are the elements of the modeling system?**
    2.1. Appropriately scaled climatology
        2.1.1. At least to CONUS domain, possibly higher-resolution (identify optimal resolution)
        2.1.2. Range of GCMs and RCPs needed
        2.1.3. Need to capture variability and extremes
        2.1.4. Dynamically downscaled to link with other process models?
            2.1.4.1. Fully coupled models, e.g., WRF-CHEM?
            2.1.4.2. Driving finer-scale landscape models?
    2.2. Climate-vegetation modeling
        2.2.1. Need to get fuels from whatever the veg output is, so
        2.2.2. Crosswalk from DGVM-type output is non-trivial
        2.2.3. Making statistical models dynamic?
        2.2.4. Land-use or demographic changes
    2.3. Predicting fire

- 2.3.1. Climate / fire weather / fire
  - 2.3.1.1. Changing climate and fire weather
  - 2.3.1.2. Value of current fire-weather indices?
  - 2.3.1.3. Area burned vs. explicit prediction (e.g., “megafires”)
- 2.3.2. Constraints from dynamic vegetation (“refueling”)
  - 2.3.2.1. Not in NARCCAP simulations, but
  - 2.3.2.2. Fuels are important
- 2.3.3. Land-use or demographic changes
- 2.3.4. Altered human vs. natural causation

2.4. Predicting smoke
- 2.4.1. Emissions models
- 2.4.2. Plume rise and plume chemistry models
- 2.4.3. Dispersion models
  - 2.4.3.1. Local dispersion
  - 2.4.3.2. Regional dispersion/transport
  - 2.4.3.3. Air chemistry & trajectory modeling

2.5. Feedbacks
- 2.5.1. Vegetation and land surface to climate
- 2.5.2. Fire emissions to climate
  - 2.5.2.1. Aerosols and changing radiative forcing
  - 2.5.2.2. Short-term effects, e.g., turbulence and plume dynamics
- 2.5.3. Vegetation to fire
  - 2.5.3.1. Post-fire succession can change fuels and flammability
  - 2.5.3.2. Other disturbances (grazing, insects, windthrow)
- 2.5.4. Land-use or demographic changes

2.6. Scale and complexity issues
- 2.6.1. Linking models of processes that happen at incompatible spatial or temporal scales
  - 2.6.1.1. Regional climate models or reanalysis data
  - 2.6.1.2. Vegetation (fuels)
  - 2.6.1.3. Fire on landscapes
  - 2.6.1.4. Emission, dispersion, air chemistry
- 2.6.2. Are linkages dynamic, with feedbacks?
  - 2.6.2.1. Fully coupled,
  - 2.6.2.2. Two-way interactive
- 2.6.3. Or time-dependent without feedbacks
  - 2.6.3.1. Prescribed values or parameters, e.g., emissions in air chemistry models

2.6.3.2. Other cases: land surface, radiative transfer, etc.

2.6.4. Complexity

2.6.4.1. Computational burden of representing all processes reduces replication or ensemble members

2.6.4.2. Cumulative error propagation from explicit representation of processes

3. What are known ways to construct the system (review, with examples if there are any but we should cover all bases?)?

3.1. Concept-based

3.1.1. Completely coupled model (e.g., DGVM with fire + WRF-CHEM or WRF-CMAQ) that finesses scale mismatches

3.1.2. Optimizing individual components, with cross-scale *ad hoc* linkages or parameter choices (e.g., DGVM -> FireBGC -> CMAQ)

3.1.3. Assumes, and justifies, an intrinsic superiority of one approach

3.2. Outcome-based

3.2.1. Mix and match to optimize accuracy

3.2.2. Mix and match to optimize robustness to future

3.2.3. Mix and match to optimize #replications (with stochastic approach)

3.2.4. Superior approach determined empirically, and may be different for different applications

3.3. Other ways of looking at it?

4. What works best (what is our consensus on the best way(s))?

4.1. Well, this is going to depend partly on the outcome of the lit review, but one way to approach this section would be to assess strengths and weaknesses of the elements of #**3** both conceptually and empirically (from the lit review).

4.2. What are the uncertainties associated with the best way(s)?

4.3. What level of uncertainty can we live with? (depending on application) Tradeoffs between that uncertainty and feasibility of approach.

5. What are the research needs to enable the best way(s)?

5.1. Maybe build on Somers et al. report?

Appendix: maybe tables/lists of DGVMs, RCMs, ESMs, air-quality/ar-chemistry models, RCPs?