Broader View on Carbon Cycle/Terrestrial Data Assimilation

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Conclusions

- Attribution is required for atmospheric measurements to be useful for policy
- Carbon-cycle Data Assimilation represents one approach to process attribution
- Separation of natural and anthropogenic signals in complex landscapes nearly impossible without strong anciliary information

Defining Terms

Attribution Assigning a process (not just a location) to a flux. Processes are often industrial sectors.

CCDAS (Carbon Cycle Data assimilation) Constraining process parameters in underlying models of fluxes. Includes choosing among candidate models

Combinations May run both in the same problem e.g. CCDAS for biosphere and sectoral attribution for fossil.

From Kyoto to Paris: Carbon Police and Decision Support

- Kyoto featured mutually agreed emissions reductions with international verification and implied possibility of sanctions
- Atmospheric MRV had potential role though attribution difficult
- Could we ever produce information that would be legally defensible?
- Paris and NDCs allow much more flexible decision support
- Also many more actors
- Removes potential role as arbiter

Similarities and differences

- CCDAS usually reduces dimensionality, Attribution usually increases it
- Both need underlying ancillary information
- Both probabilistic
- Attribution more demanding on spatial characteristics, CCDAS on temporal
- CCDAS *far* more dependent on flux model quality

How they Currently Work

Attribution

- Creates underlying map of processes (roads, residential etc)
- Conventional flux inversion
- Projects posterior fluxes onto process map
- Usually does *not* solve for pattern scaling factors

CCDAS

- Forcing strongest driver of spatial structure of fluxes (e.g. precipitation)
- Parameters modulate temporal structure via model
- Parameters apply to large areas so propagate information

How they use Ancillary Observations

- Ancillary information may be other species, proxies for human or vegetation activity, carbon stocks (biomass etc), related flows (water or money)
- Attribution very difficult without it since spatial information rarely enough and uncertainty dominated by small unobserved areas
- CCDAS uses it best as test of models
- Most ancillary information carries nuisance variables (e.g. emission factors which aren't perfectly known)
- Rigorous analysis of their uncertainty is imperative, difficult and rare

Recommendations for Modellers

- Choose combination carefully
- Explore the trade-off of uncertainty vs resolution (sectoral, spatial or parametric)
- Talk to policy experts (*not* just policy-makers) to understand their needs
- Do methane, it's easier :-)

Recommendations for Observers

- Ancillary data *probably* the greatest enabler of improved attribution
- Keep modellers engaged when designing observing systems (this has improved greatly since 2000)
- Talk to policy experts (*not* just policy-makers) to understand their needs

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