

An aerial photograph of a large fire, likely a controlled burn or a wildfire, showing thick, billowing white and grey smoke rising from a landscape of dark, charred ground. Bright orange and yellow flames are visible in several areas, particularly in the center and towards the right side of the frame. The smoke is dense and fills much of the upper half of the image.

Cropland Burning in North America: Overview of the United States and Canada

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Objectives

- **Overview of cropland burning in the contiguous U.S. (CONUS) and Canada**
- **State- and provincial-level regulations**
- **Remote sensing-based analysis of cropland burning**
 - CONUS
 - Canada

CONUS Cropland Burning

- Croplands
 - Established crop areas that produce food, fiber, and seeds
 - Fallow fields
- Bluegrass, Corn, Cotton, Rice, Soy, Sugarcane, Wheat, Other/Fallow
- Residue Burning:
 1. Post-harvest burning for removal of ground-level senescent vegetation;
 2. Pre-harvest burning for removal of leaves and other biomass (sugarcane).



Cropland Burning Policies Timeline

1970s: Complaints concerning diminished air quality and visibility (OR, WA, CA).

1980s: Oregon Department of Environmental Quality requires permits for farmers to burn their fields in 1981; Requirements became stricter in 1988 following a multi-car accident in which smoke from field burning near Albany, Oregon blew onto I-5, leading to 23-car accident in which seven people died and 37 were injured. OR HR 3343 created state monitoring and permitting system that can be enforced through fines.

1990s: Federal Clean Air Act (1990) lead to state-level laws which addressed crop residue burning in CA, OR, and WA; Agricultural Air Quality Task Force created in 1996.

2000s: State limits on burning; farmers voluntarily submitting to non-fee-based permitting systems, legal battles between environmental/health organizations and states; states refining their application of 'Freedom to Farm' and/or 'Right to Farm' to crop residue burning.

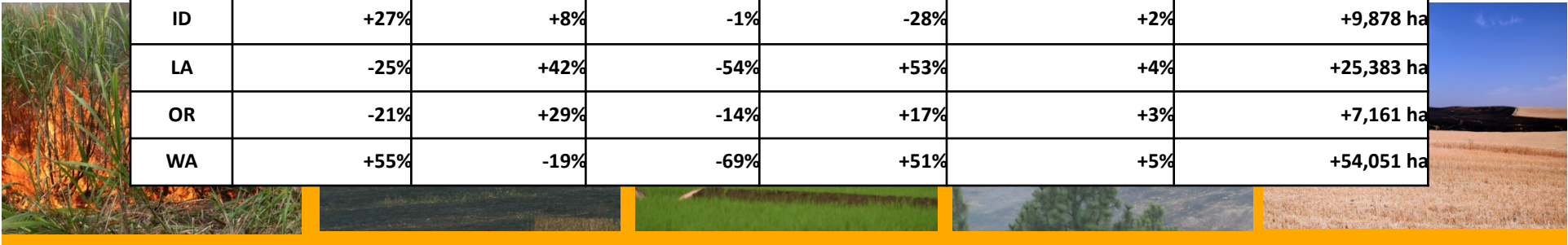
2010s: U.S. Environmental Protection Agency actively pursuing monitoring and control of crop residue burning under the Regional Haze Rule.



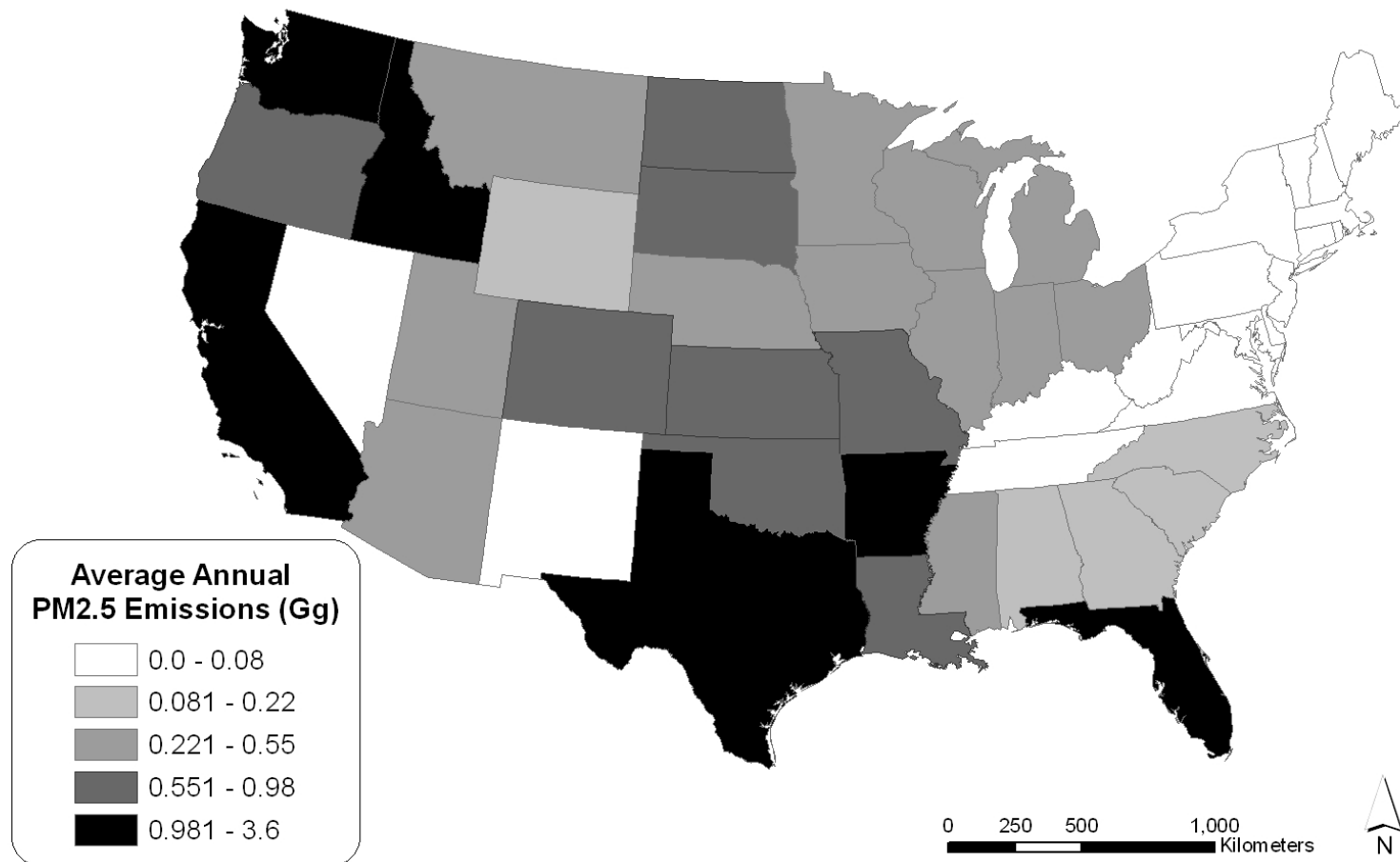
Influence of permitting and education programs on crop residue burning

- Net decrease in burning for California and Florida
 - Permitting systems
 - Restrictions on total burned area (CA)
 - Decrease in Florida could also be related to changing land use
- ID, LA, OR, WA showed net increase in burning
 - Increase in WA also noted in state-level statistics
 - LA decreases occur in years of hurricane landfall

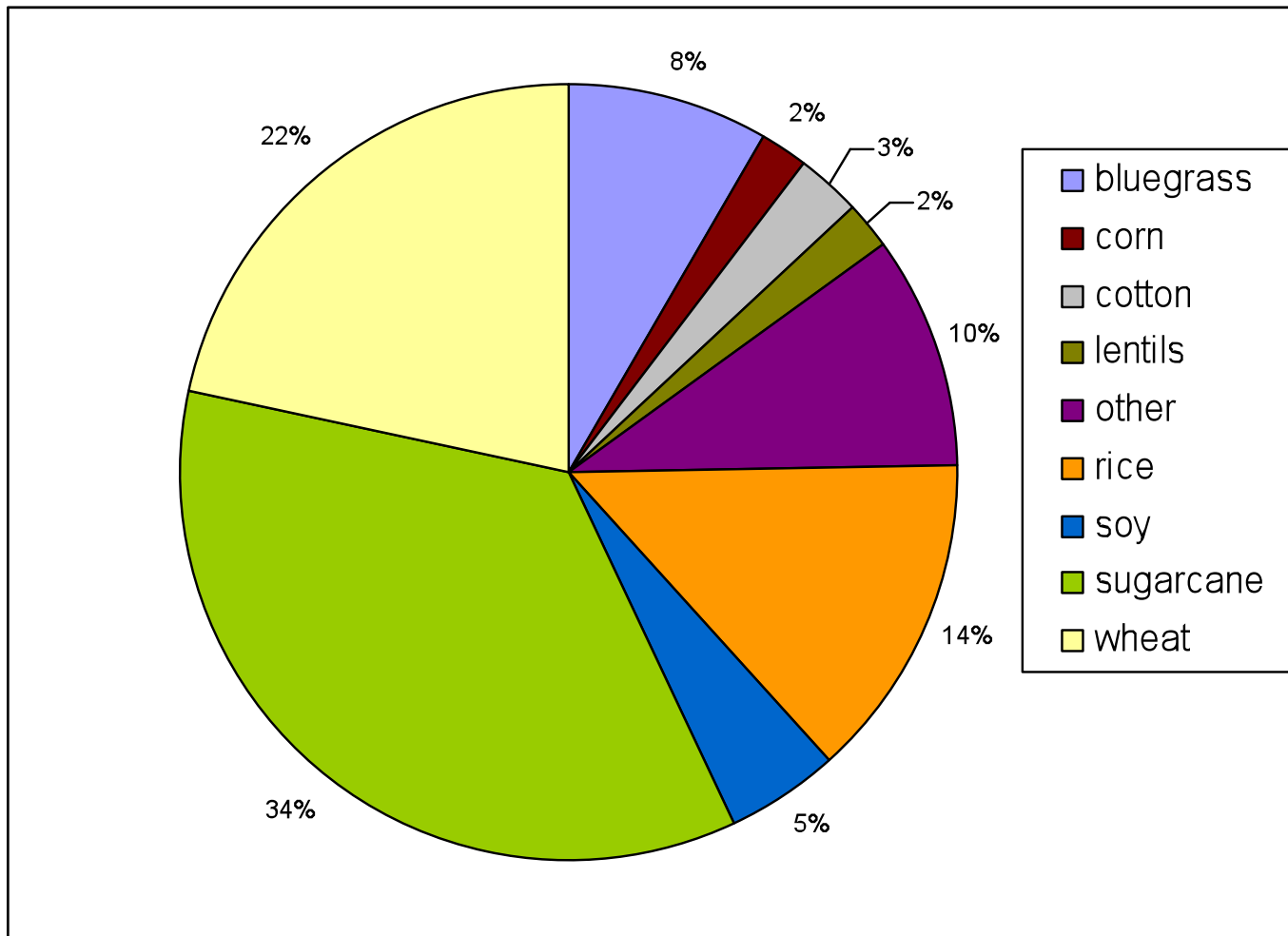
State	Percent change, 2003-2004	Percent change, 2004-2005	Percent change, 2005-2006	Percent change, 2006- 2007	Average percent change, 2003-2007	Net change of burned area, 2003-2007
CA	+19%	-28%	-58%	+13%	-13%	-26,179 ha
FL	-12%	-2%	-14%	+4%	-6%	-73,272 ha
ID	+27%	+8%	-1%	-28%	+2%	+9,878 ha
LA	-25%	+42%	-54%	+53%	+4%	+25,383 ha
OR	-21%	+29%	-14%	+17%	+3%	+7,161 ha
WA	+55%	-19%	-69%	+51%	+5%	+54,051 ha



State-level Emissions from Crop Residue Burning



Emissions by Crop Type



Average contribution of emissions by crop type for years 2003-2007.

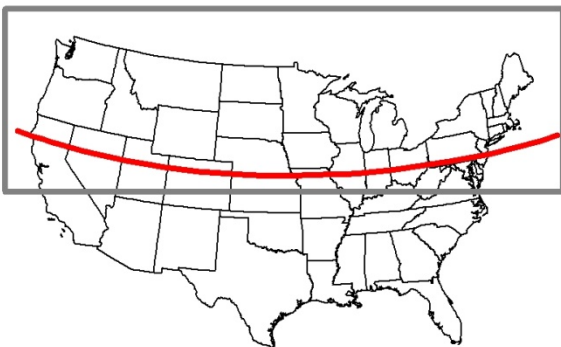
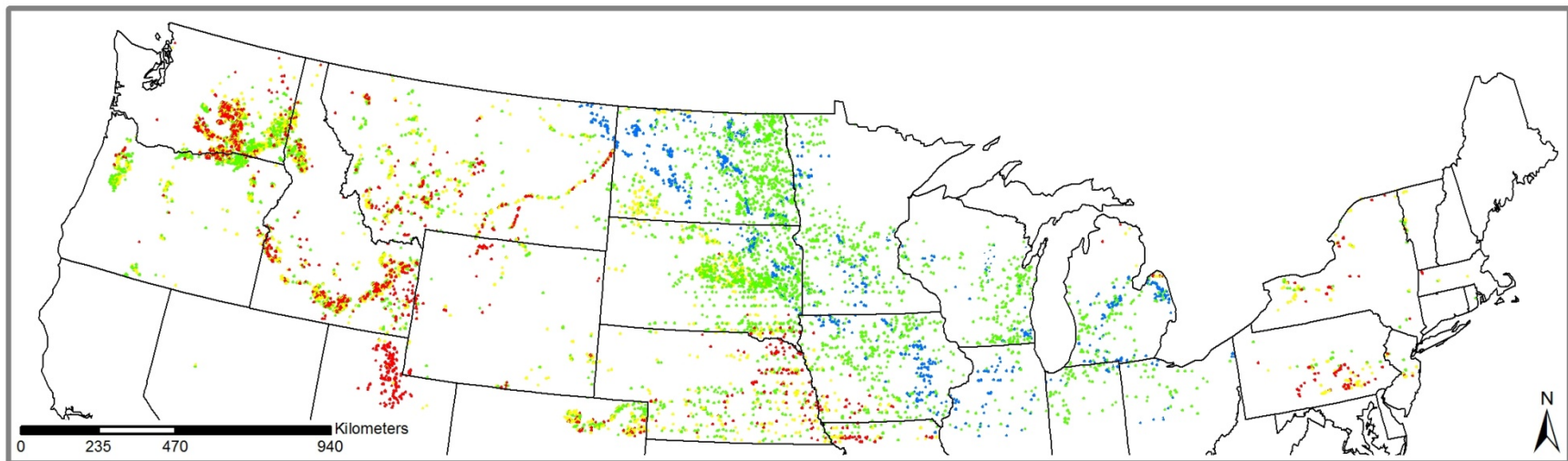
Interannual Variability of Emissions

Years	CO ₂ (Tg)	CH ₄ (Gg)	CO (Gg)	NO ₂ (Gg)	SO ₂ (Gg)	PM _{2.5} (Gg)	PM ₁₀ (Gg)
2003	6.5	9.1	252.1	12.2	5.2	22.3	29.0
2004	6.0	9.2	230.4	11.3	4.3	21.1	28.2
2005	6.1	9.4	234.0	11.1	4.4	21.4	29.1
2006	5.7	8.4	212.3	9.4	4.0	19.2	26.4
2007	6.2	9.3	240.2	11.1	5.1	21.0	29.2
Average	6.1	9.1	233.8	11.0	4.6	21.0	28.4
Average Interannual Variability (%)	5.1%	5.9%	7.8%	9.1%	10%	7.1%	7.1%

- Varied less than $\pm 10\%$ over five years



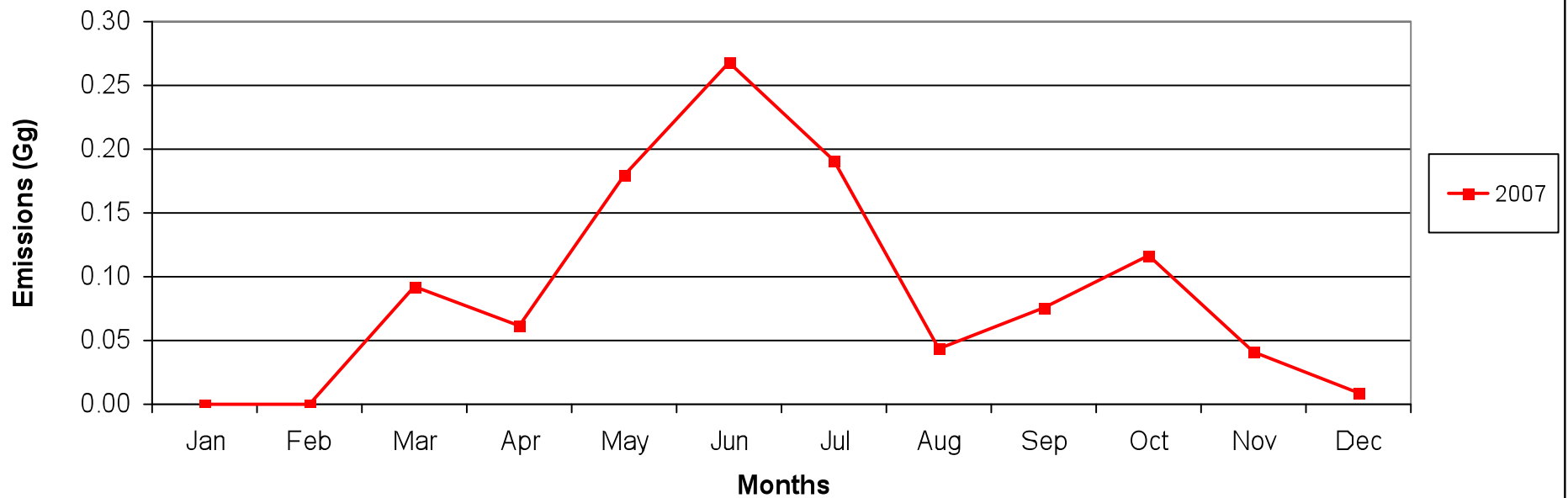
Focus on Arctic: seasonal CONUS cropland burning above 40°N



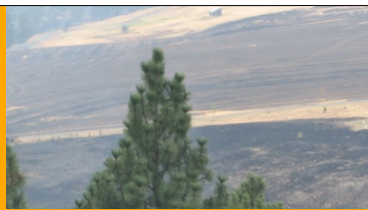
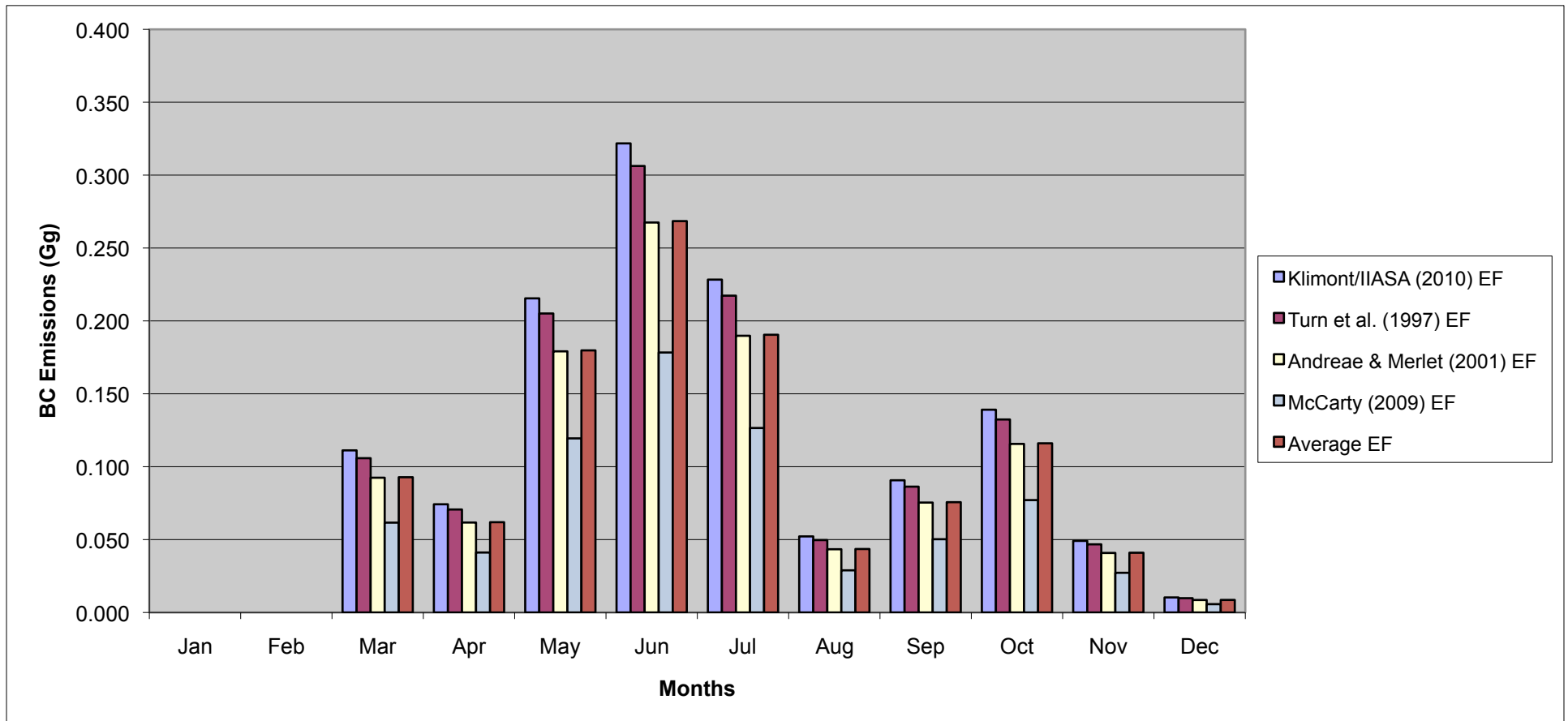
- Winter
- Spring
- Summer
- Fall
- U.S. state boundaries



Monthly BC Emissions from Cropland Burning in Contiguous U.S. North of 40° Latitude



Monthly BC emission from CONUS cropland burning above 40°N



Canada Cropland Burning

- Croplands
 - Established crop areas that produce food, fiber, and seeds
 - Fallow fields
- Wheat, Other Grains, Specialty Crops, Other/Fallow
- Residue Burning:
 1. Post-harvest burning for removal of ground-level senescent vegetation.



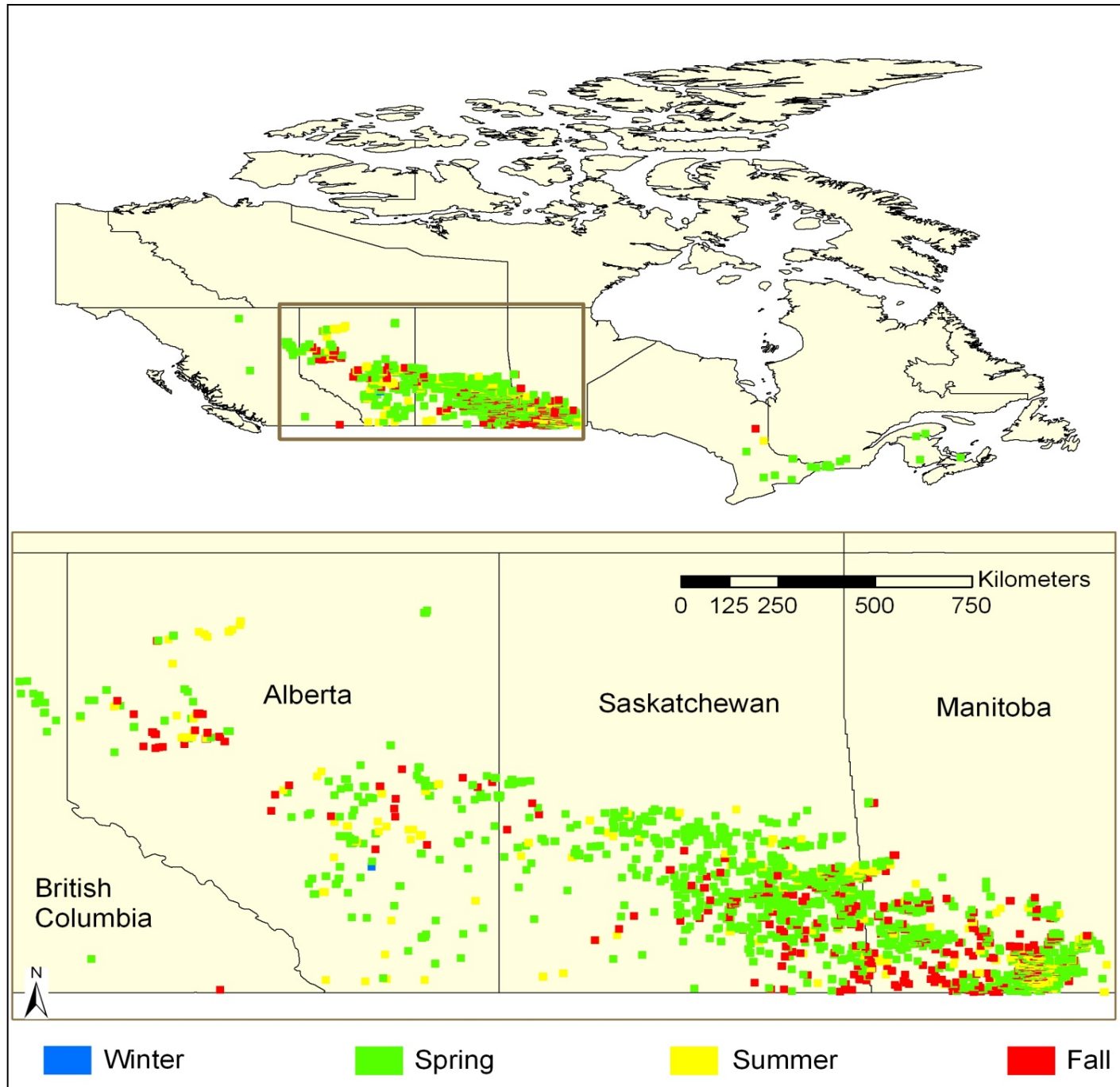
Province	Ministry	Regulation
Ontario	Natural Resources	<ul style="list-style-type: none"> Concern is spread of cropland fires to forests; <ul style="list-style-type: none"> Provincial <i>Forest Fires Prevention Act</i>; Farmers can be held responsible for costs of suppressing fire and property damage; Must meet certain safety and burning conditions.
Manitoba	Agriculture, Food and Rural Initiatives	<ul style="list-style-type: none"> Concerns mainly are health, road safety and environment; Crop residue burning managed under the provincial smoke management plan; <ul style="list-style-type: none"> Certain municipalities are authorized to burn without permits but must follow daily burn authorizations; Municipalities not authorized to burn must apply for permits; Maintains a Crop Knowledge Centre for farmers seeking answers and/or guidance.
Saskatchewan	Agriculture	<ul style="list-style-type: none"> Discourages farmers from burning based on economic loss of straw, potential destruction of soil organic matter, liability for fire and smoke hazards, health risks, and environmental pollution; Advocates other methods of straw management; Maintains an Agriculture Knowledge Centre for farmers seeking answers and/or guidance.



Province	Ministry	Regulation
Alberta	Agriculture and Rural Development	<ul style="list-style-type: none"> • Lists burning straw as last resort; • Avoid burning 2 years in a row; • Check local laws for permit requirements; • Liability associated with fire and smoke hazards may be possible.
British Columbia	Agriculture, Food and Fisheries	<ul style="list-style-type: none"> • Main concern is spread of cropland burning to forests; <ul style="list-style-type: none"> ○ Provincial <i>Forest Fire Prevention and Suppression Regulation</i> regulates open fires within 1 km of forests • Nuisance from smoke leaves farmers open to liability.

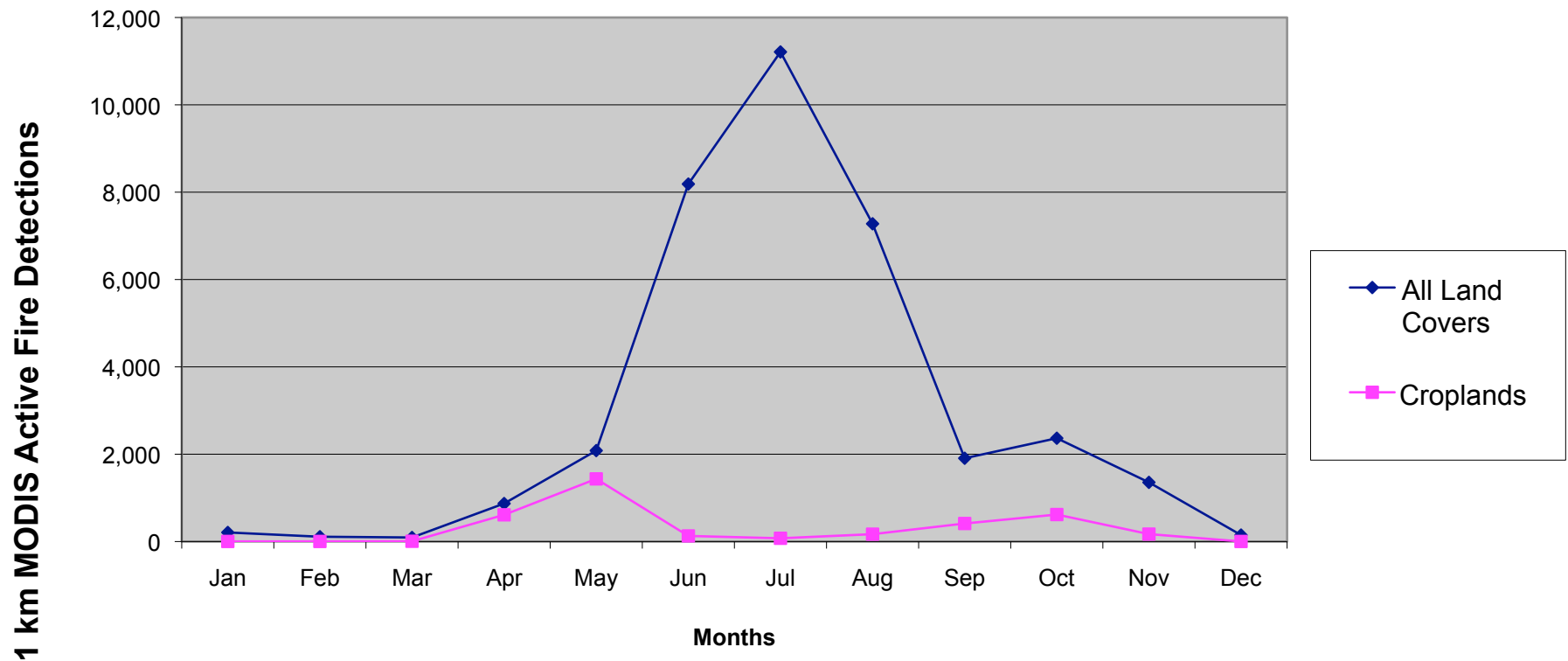
- Like U.S. states, Canadian provinces also have ‘Right to Farm’ laws.



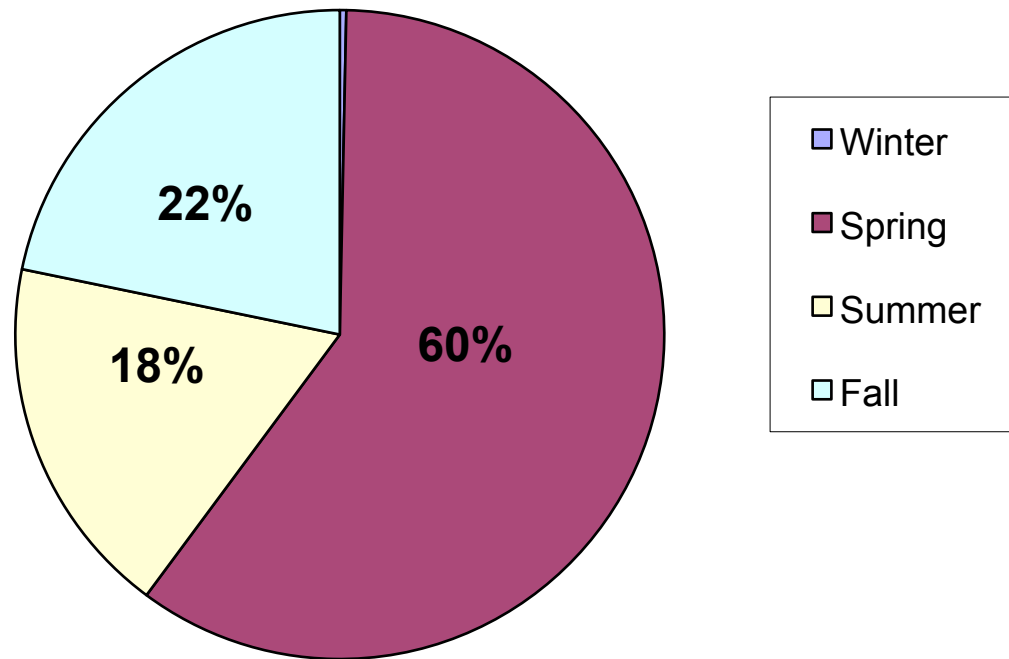


Seasonal cropland burning detected by 1 km MODIS Active Fire detections for 2009

Average Monthly Fire Counts by Land Cover, 2003 - 2009



Average Seasonal Distribution of Fire for Croplands, 2003 - 2009



Questions?

