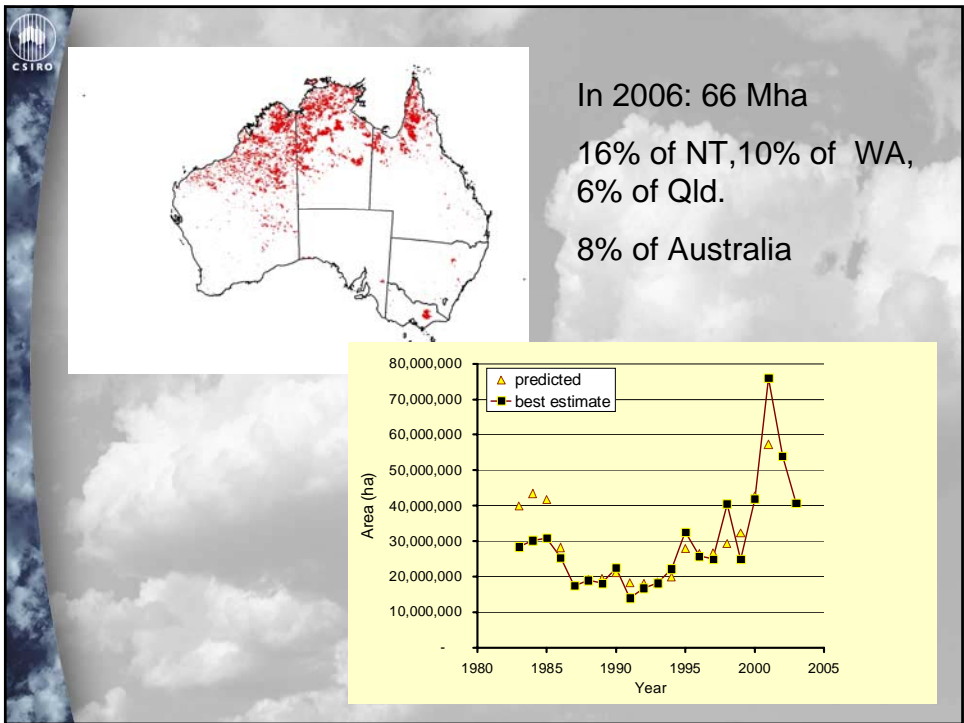




# Inventory Methodology Issues and Developments





## Outline

1. General background on inventories
2. Timeseries of emissions
3. New developments in IPCC methodology
  1. Adds a new dimension: TIME



## Background (1)

### Range of Inventories

- ❖ Total accounting- all sources and sinks (natural and anthropogenic)
- ❖ Anthropogenic emissions inventories
  - Air quality (air pollutants (CO, NO<sub>x</sub>, VOCs, aerosols, air toxics, POPS etc)
    - Corinair
    - National Pollutant Inventory
  - Greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, PFC, CO, NO<sub>x</sub>, VOCs)
    - IPCC
    - Country specific
  - Special purpose: detailed highly resolved activities
    - Mitigation accounting e.g. farm/industry inventories
    - Carbon credits/carbon offsets



## Background (1)

### IPCC/UNFCCC Inventories

- ❖ Anthropogenic
  - Emissions associated with human activity
  - NOT natural emissions
- ❖ Time base - annual
- ❖ Area-base – national
- ❖ Gases
  - Direct i.e. Infra red absorbers ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ , PFC)
  - Indirect -> Ozone ( $\text{CO}$ ,  $\text{NO}_x$ , VOC)
  - Emissions weighted by GWP ( $\text{CH}_4=21$ ;  $\text{N}_2\text{O}=310$ ;  $\text{CO}_2=1$ )




## Background (4)

**Anthropogenic  $\text{CO}_2$**  is  $\text{CO}_2$  that is added to the atmosphere due to human activity

- e.g. release of  $\text{CO}_2$  from geological C
- Fossil fuels

**BIOGENIC  $\text{CO}_2$**  is  $\text{CO}_2$  cycles naturally through the biosphere. Only the human induced change is accounted

- Biogenic  $\text{CO}_2$  a change in the mass of carbon stored in the ecosystem over time
  - forest clearing,
  - land-use change
- NOT  $\text{CO}_2$  from forest fuels which are replaced by forest regeneration



## Rules


- ❖ IPCC Revised 1996 Guidelines
- ❖ Kyoto
  - Apply until 2012

Good Practice Guidance, 2000, 2003

IPCC 2006 Guidelines

**DOCUMENTS;**

- IPCC website - IPCC96, GPG, IPCC2006
- AGO website – NGGI methodology 2005



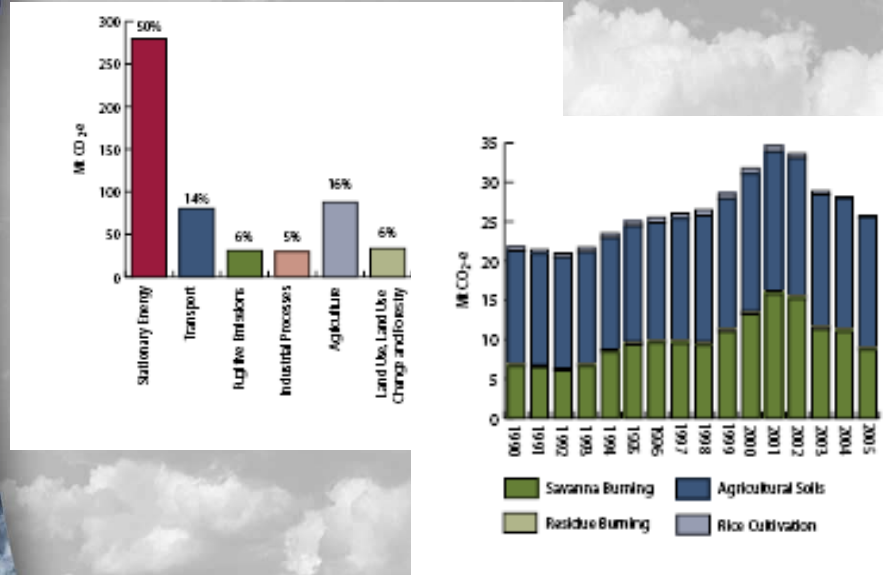
## NGGI

### Inventory facts

- Australia is the only annex 1 party for which fires, particularly Savanna fires, are a major emission source
- Currently reported in two places
  - Sector 4E (Agriculture):  
**Savanna burning**
  - Sector 5D ( Land Use, Land use change and Forestry):  
**Prescribed burning and wildfires**
- ***The methods assume the systems are at equilibrium***



## NGGI -2005 Emissions



## NGGI: Atmospheric Composition issues

Savanna: Major emission source of many constituents

Constituent	Mass (Gg)	% National
CH <sub>4</sub>	477	8%
N <sub>2</sub> O	24	24%
NO <sub>x</sub>	1410	44%
CO	18600	66%
VOC	1085	52%
<b>Total C</b>	<b>102198</b>	<b>85%</b>

- ❖ High inter-annual variability (CV= 45%)
- ❖ Large global contribution (16% total fire area in 2000)
- ❖ Significant proportion of GPP.



$$\text{Emission} = \text{Activity} * \text{Emission factor}$$

$$\text{Emission} = \text{Fuel burned} \times \text{emission factor}$$

$$\text{Fuel}_{\text{burned}} = \text{Area} \times \text{fuel load} \times \text{combustion efficiency}$$

Ideally:

- ❖ Fire areas (time resolved)
- ❖ Fuel loads (regional)
- ❖ Burning efficiencies (seasonal, regional)
  - patchiness, fuel classes
- ❖ Emission factors (seasonal, regional)
  - Fire intensity (i.e oxidation efficiency)

In practice:

annual, state means, global parameters



*Woodland -Central Arnhem Land (Russell-Smith et al.)*

Fuel loads

Forest type	%total area	Fuel load ( $t\ ha^{-1}$ )			
		Fine fuel	Coarse fuel	Heavy fuel	Shrub
Eucalypt open forest	6%	5.9	1.3	18.9	0.6
Eucalypt open woodland	52%	3.9	1.1	4.0	0.9
Sandstone woodland	20%	6.0	1.0	12.9	0.6
Sandstone heath	23%	4.0	0.4	4.0	0.7
<b>Weighted mean</b>		<b>4.4</b>	<b>0.9</b>	<b>6.6</b>	<b>0.8</b>

**Forests:**

- Review by Kevin Tolhurst (~1991) of measured fuel loads from forestry departments, forest research in Universities, CSIRO etc
- Supplemented by newer studies as they become available



## Burning efficiency

Woodland -Central Arnhem Land (Russell-Smith et al.)

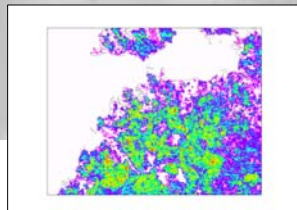
	%	Patchiness	Pyrolysis efficiency			
			Fine fuel	Coarse fuel	Heavy fuel	Shrub
Early season	5%	0.71	0.70	0.03	0.05	0.45
Mid season	20%	0.8	0.70	0.03	0.05	0.45
Late season	75%	0.84	1.00	0.25	0.25	0.75
weighted mean		0.83	<b>0.92</b>	<b>0.19</b>	<b>0.20</b>	<b>0.67</b>

Fine Fuels BE= 0.76, Coarse woody fuels= 0.24

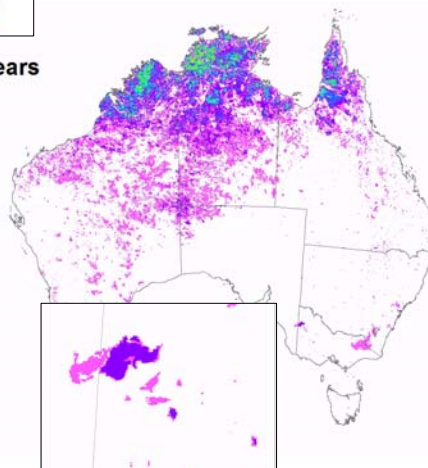
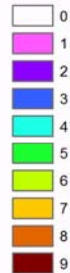
Not much change from 0.72/0.3

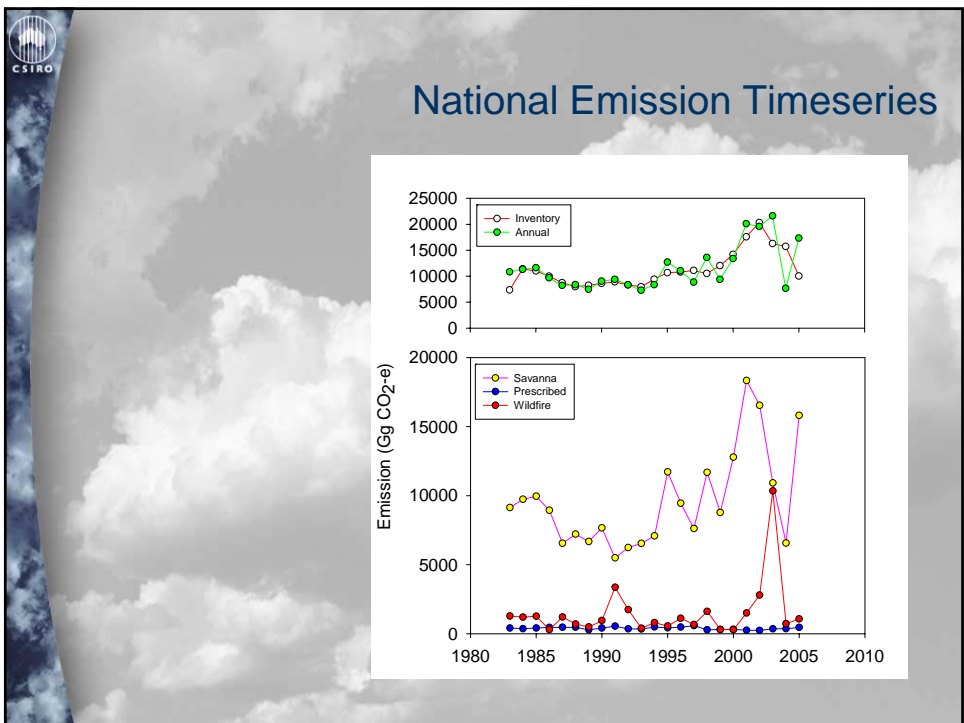
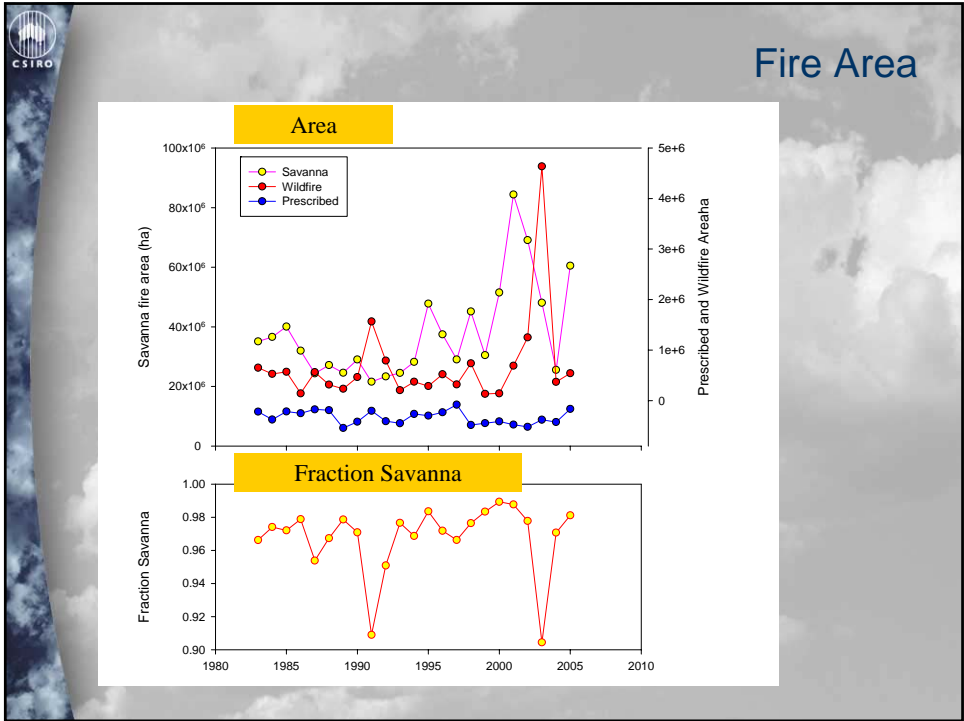


## Fire frequency 1998 to 2006

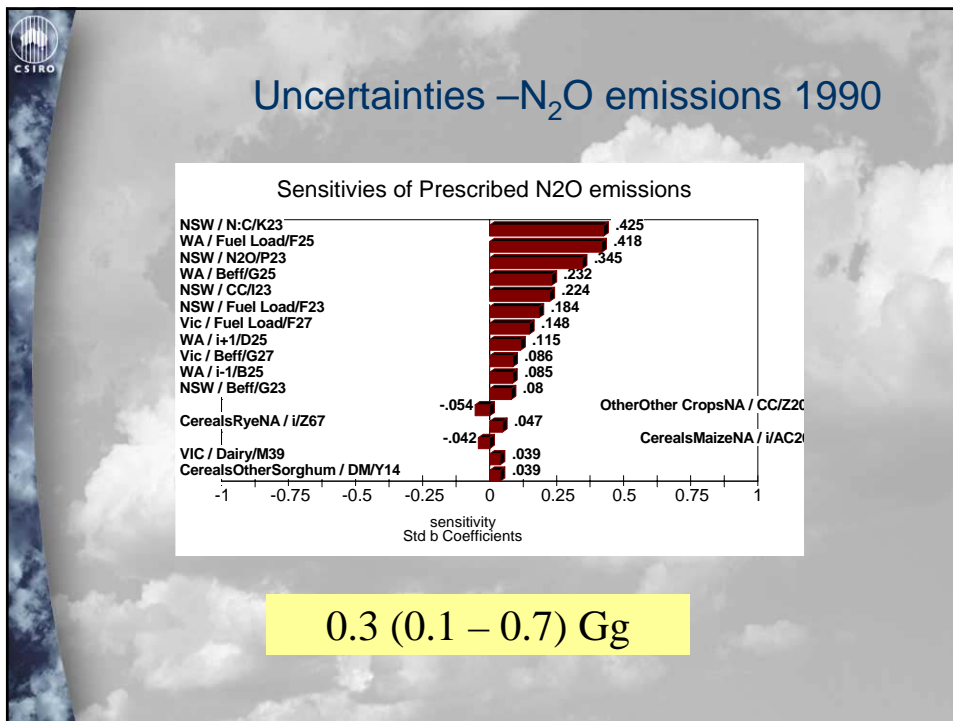
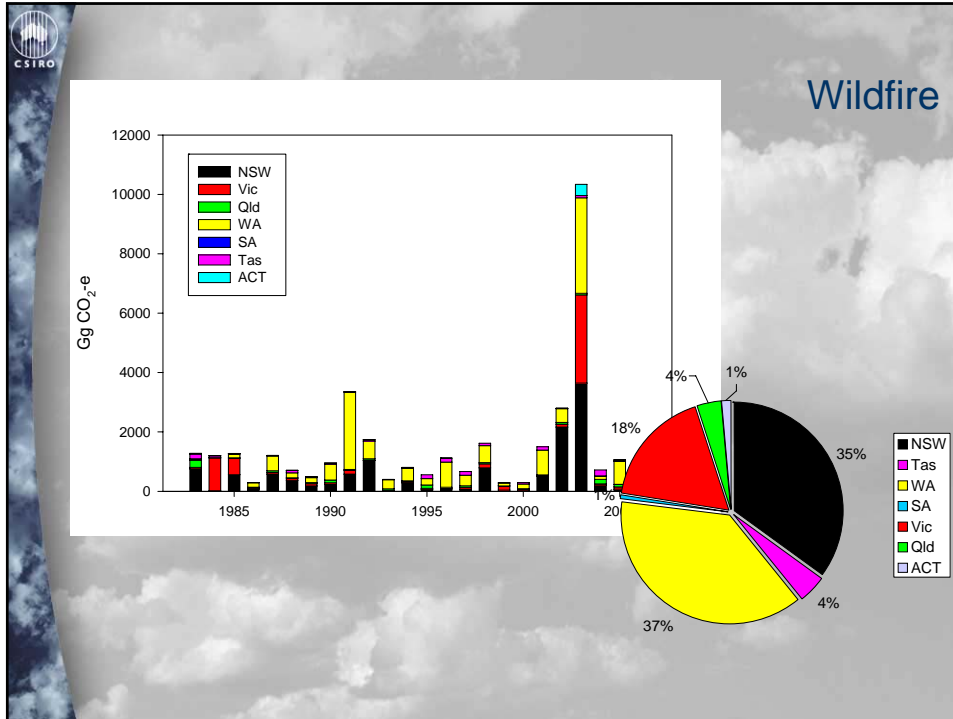


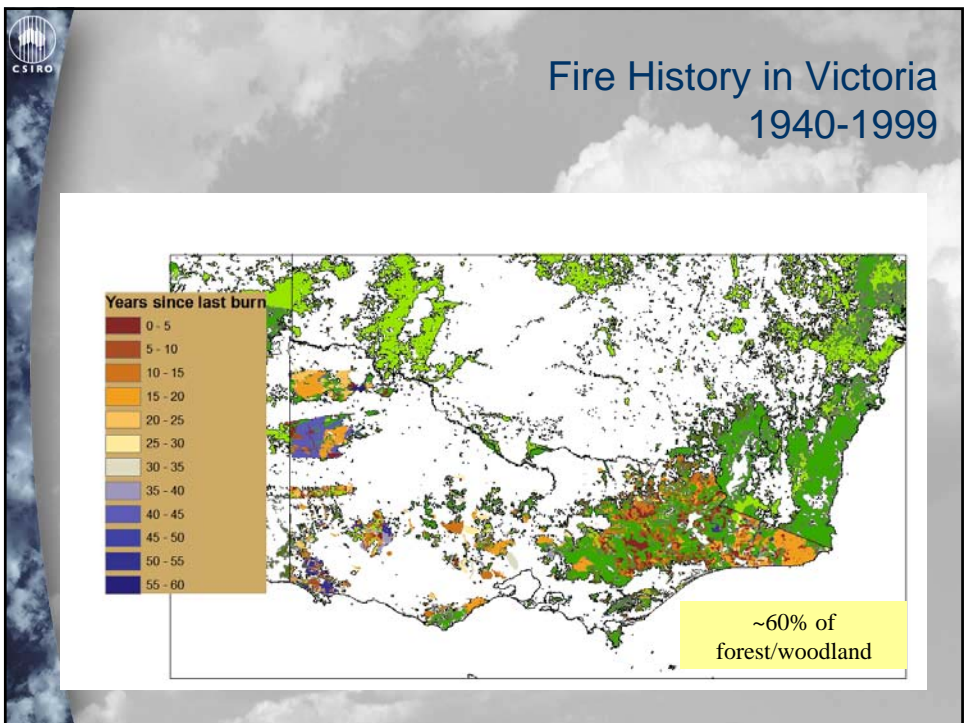
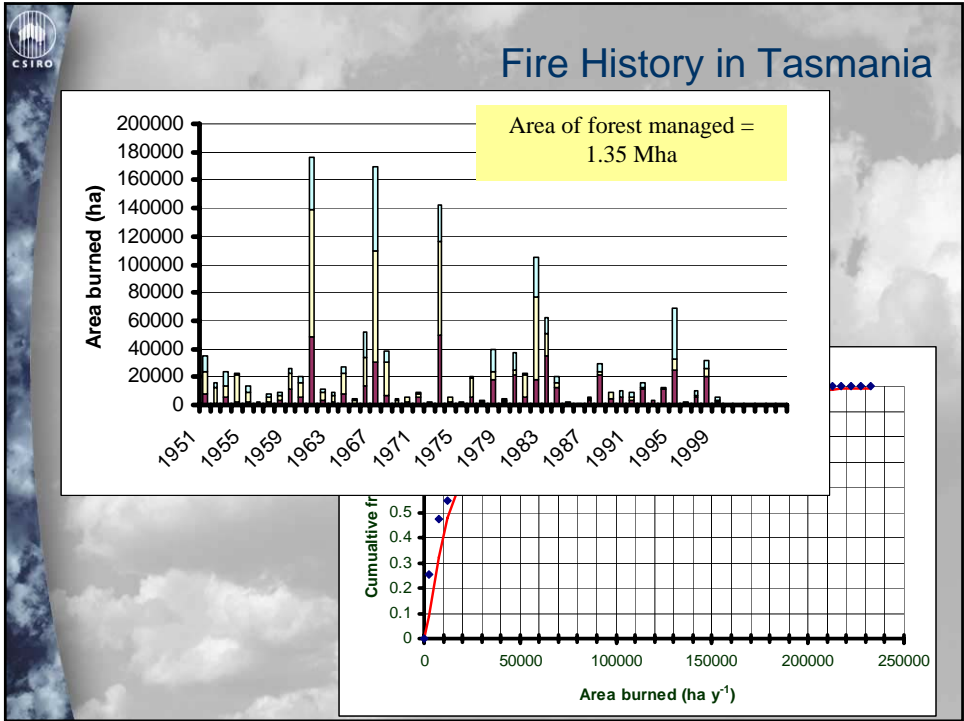
Times burned in 9 years













## Developments

2006

1990 Baseline emissions are declared  
Inventory methodology is frozen until 2012

2006 IPCC Guidelines for GHG Inventories accepted by  
IPCC plenary

IPCC Annual review process for NGGI is formalised with  
independent expert review panels following formal IPCC  
review guidelines:

- Revisions to methodologies that deviate from GPG
- Require adjustments to emission estimates where errors, or deviations from good practice occur



## Implications of 2006 Guideline

- ❖ Very comprehensive revision incorporating:
  - 2000 Good Practice Guidance
  - 2003 GPG for LULUCF
- ❖ Clear guidance (i.e. specification) of most details.
- ❖ For AgForestry&OtherLandUse (AFOLU)-  
a comprehensive C and N cycle philosophy



## Tiers

- ❖ Tier 1 - default emissions factors and other parameters, minimal disaggregation, country specific activities
- ❖ Tier 2- country specific EFs & parameters, disaggregation to regions, industry classes etc., country specific activities
- ❖ Tier 3- high level of disaggregation, country specific data, mostly model based (e.g. NCAS)



### Tier 2 +

- ❖ All parameters and EFs in open, peer- reviewed literature
- ❖ Annual activity data
- ❖ Verification of parameter values and emission estimates encouraged

Key Source Identification leads to pressure to move to a higher- tier methodology

Comprehensive guidance on

Data sources, QA/QC, Uncertainty estimation, Trends and Time series



## For biomass combustion

- ❖ The basic emission algorithms remain
- ❖ But
  - Apply mostly to “managed land”
  - CO<sub>2</sub> is now accounted for by explicitly including dynamics of dead organic matter in Tier 2 and Tier 3 methodologies except where CO<sub>2</sub> emissions are removed within the same year (e.g. grasslands).
  - Tier 3 will account for changes in ecosystem structure, e.g. C pools such as soil C, post fire emissions etc



## Concluding Issues

- ❖ Current emissions require verification. Savanna is looking good. Forest fires are less confident
- ❖ 2006 Guidelines-Improved dynamics
  - The impact of fires will be both emissions and uptake. It will have a long time constant, potentially centuries
  - Fire is a disturbance as complex for accounting as timber harvesting or land clearing
  - Attribution of fluxes will be strongly time dependent