Wildfires in GEMS

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Overview of Presentation

- Introduction
- GEMS Requirements
- Available Fire Earth Observations
- Existing Models of Fire Emissions
- Strategy Proposal
- Conclusions

Introduction

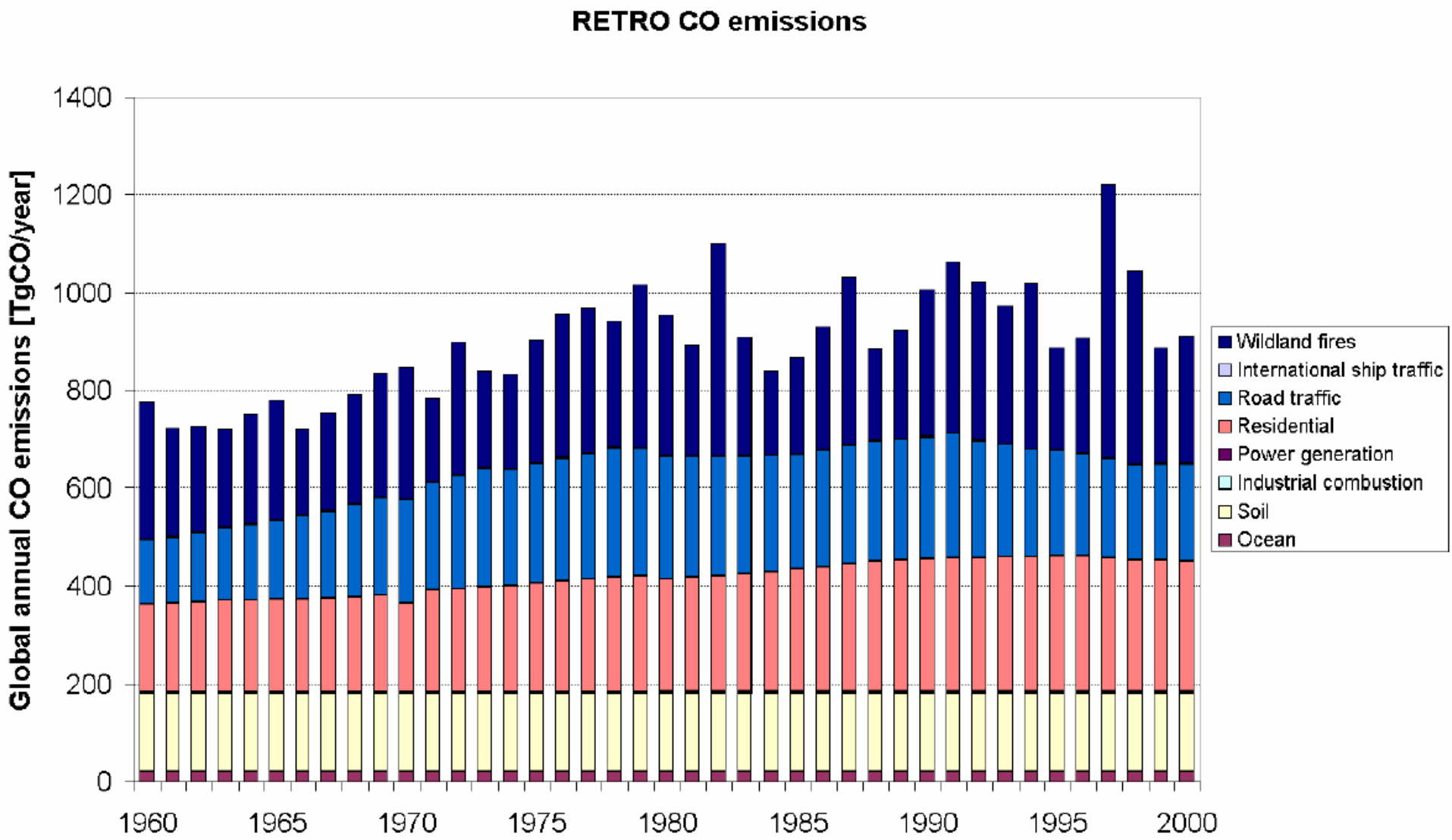
Fire Emissions …

- … may dominate regional air quality in "severe air pollution" events
- … may elevate background after long range transport (Stohl et al. 2001)
- … significantly contributes to emission budgets of several gases (Kyoto, CLRTAP, …)
- … may influence weather by heat production and absorbing smoke.
- … provide essential a priori information for remote sensing
- … are variable on all time scales from hours to decades

near London-Luton, 2005-12-11 <news.bbc.co.uk>

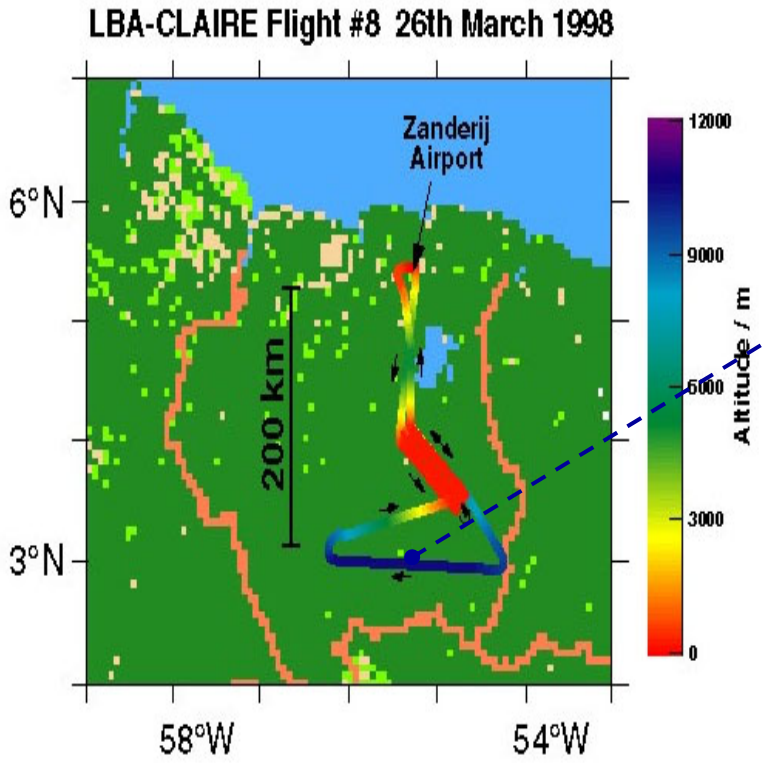
NOAA, 2005-12-12

Interannual Variability

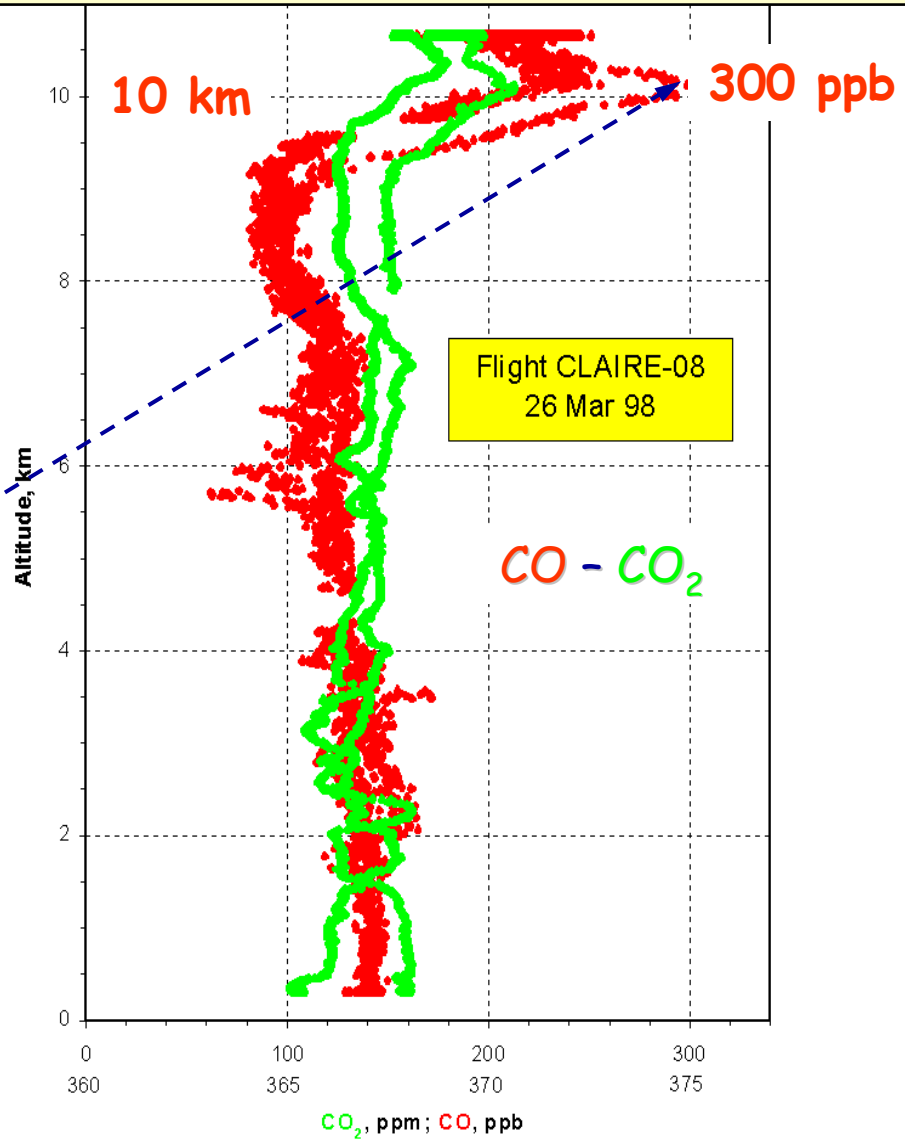


Short-term Variability: CO, CO2

CLAIRE 1998 – vôo sobre o Suriname e Guian

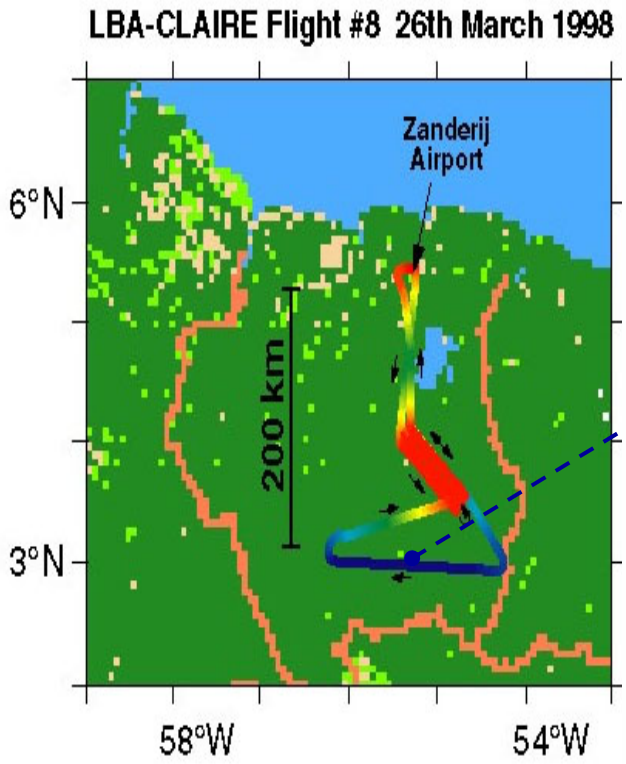


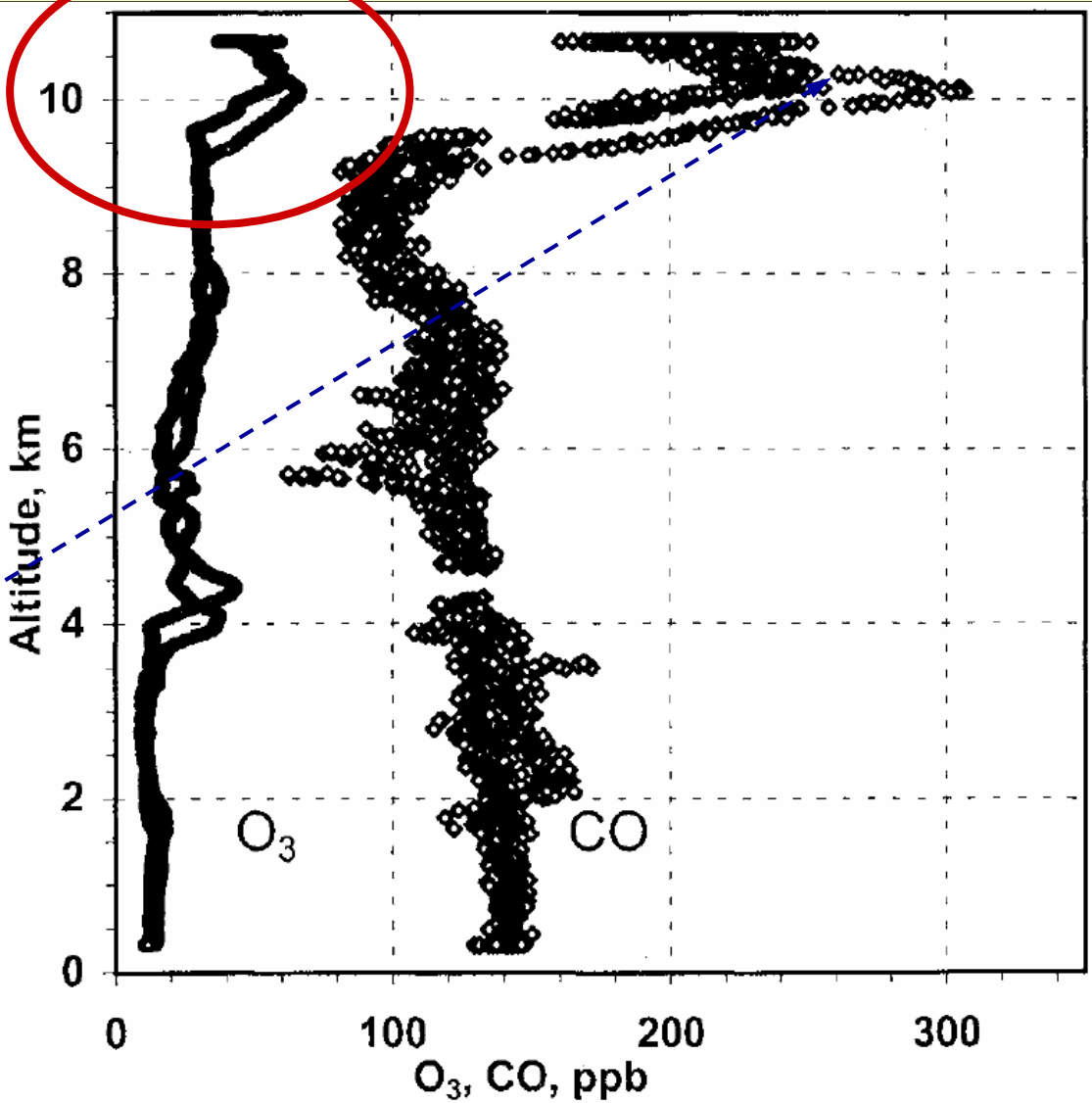
(courtesy M. Andreae, MPI Mainz)



Short-term Variability: O3

CLAIRE 1998 – vôo sobre o Suriname





(Andreae et al. 2001)

GEMS Requirements

GEMS Required Fire Products

- **Products**
  - amount emitted: aerosol, trace gases
  - location, time
  - injection height
- **Availability**
  - global
  - near-real time and retrospectively
  - time resolution of several hours to one day

Schedule of GEMS Work at Central Site

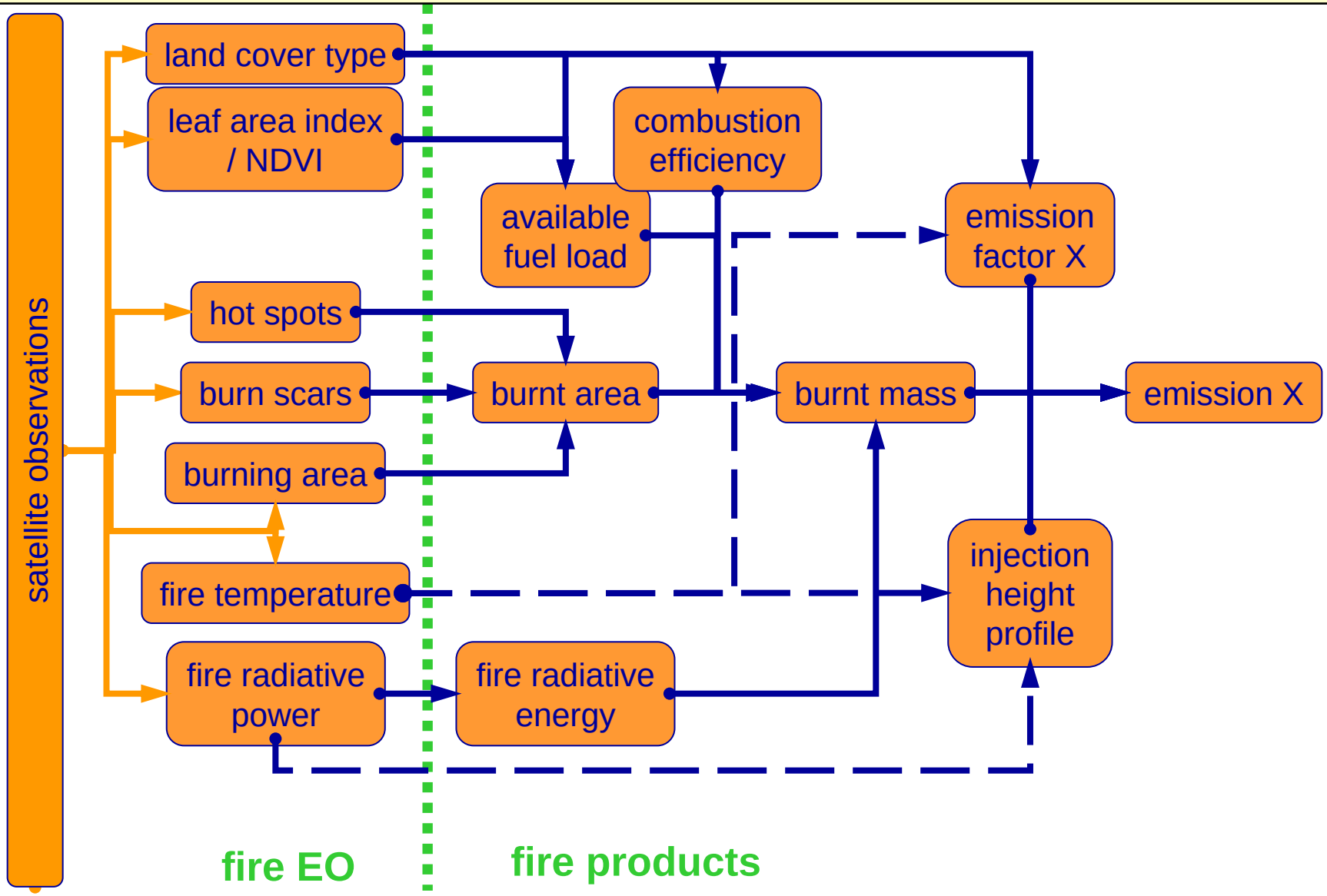
Year 1 May 2005+12 mo	• Build and validate 3 separate assimilation systems for Greenhouse gases, Reactive gases, Aerosol. • Acquire data; build web-site
Year 2 May 2006+12 mo	• Produce 3 different reanalyses for GHG, GRG, Aerosol • Make reanalyses available for validation by all partners • Provide feedback to data providers
Year 2-2.5 May 2007 + 6 mo	• Merge the 3 assimilation systems into a unified system; • Upgrade the models and algorithms based on experience
Year 2.5-3.5 Nov 2007+ 12 mo	• Produce unified reanalyses for GHG, GRG, Aerosol • Build operational system, & interfaces to partners
Year 3.5 - 4 Nov 2008+ 6 mo	• Final pre-operational trials • Documentation & Scientific papers

Schedule of GEMS Wildfire Requirements

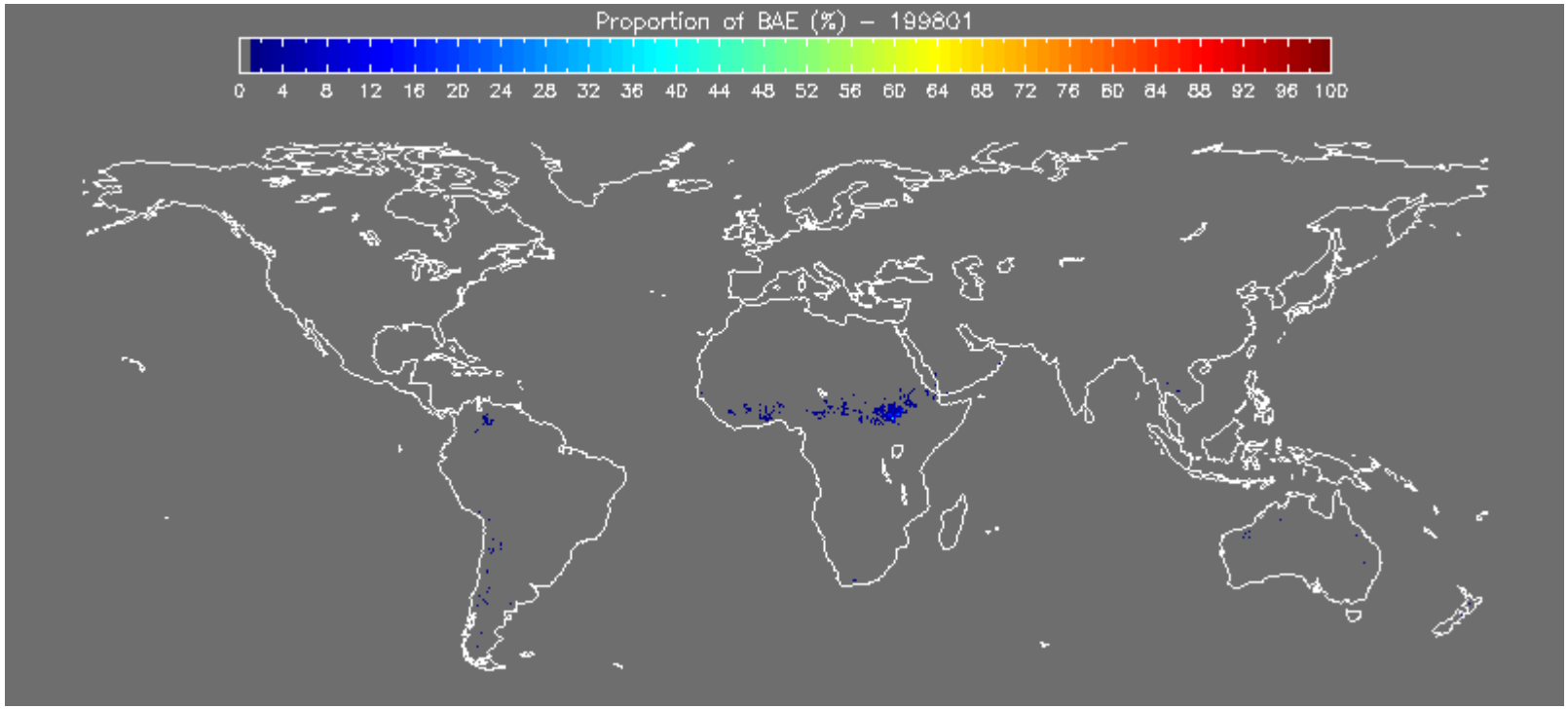
Year 2 May 2006+12 mo	• Produce 3 different reanalyses for GHG, GRG, Aerosol • global emissions for 2003 of correct order of magnitude
Year 2.5-3.5 Nov 2007+ 12 mo	• Produce unified reanalyses for trace gases and aerosol • high-resolution (temporal & spatial) global fire products for 2000–2007
Year 3.5 - 4 Nov 2008+ 6 mo	• Final pre-operational trials • high-resolution (t&s) global fire products in NRT

Available Observations

Products from Fire EO



GLOBCARBON Global Burnt Area Estimate



(courtesy of Olivier Arino)

Some Conclusions on EO Fire Products

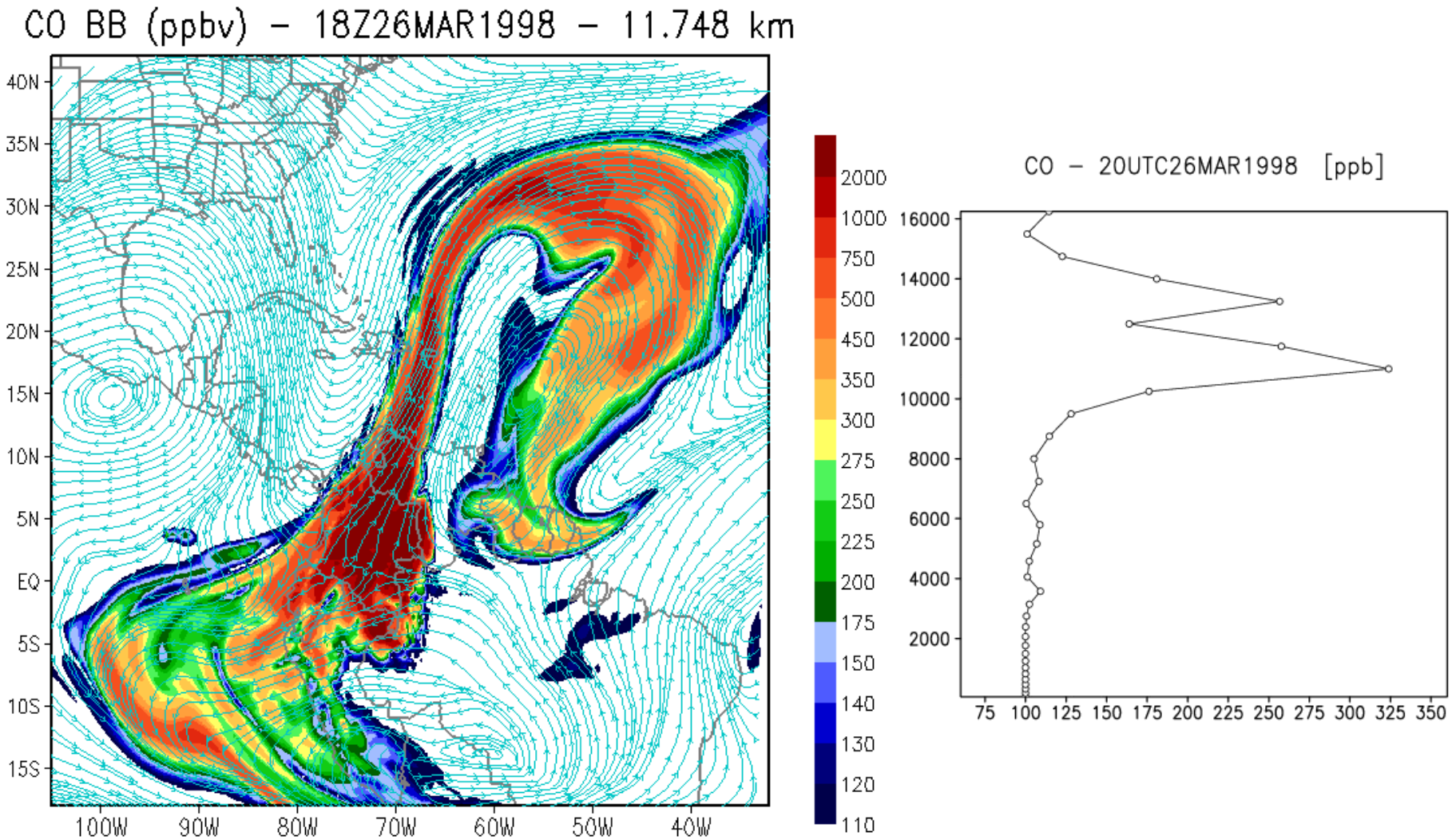
- No current product satisfies all GEMS requirements.
- Many existing products are inconsistent. (Boschetti et al. 2004)
- very active area of research: Several new operational products are anticipated.
  - Burnt Area from MODIS (D. Roy)
  - Fire Radiative Power from SEVIRI (M. Wooster)
  - WF_ABBA from global GEO system (E. Prins)
  - …
- Collaboration with geoland community is needed.

Existing Models of Fire Emission

Existing Emission Models

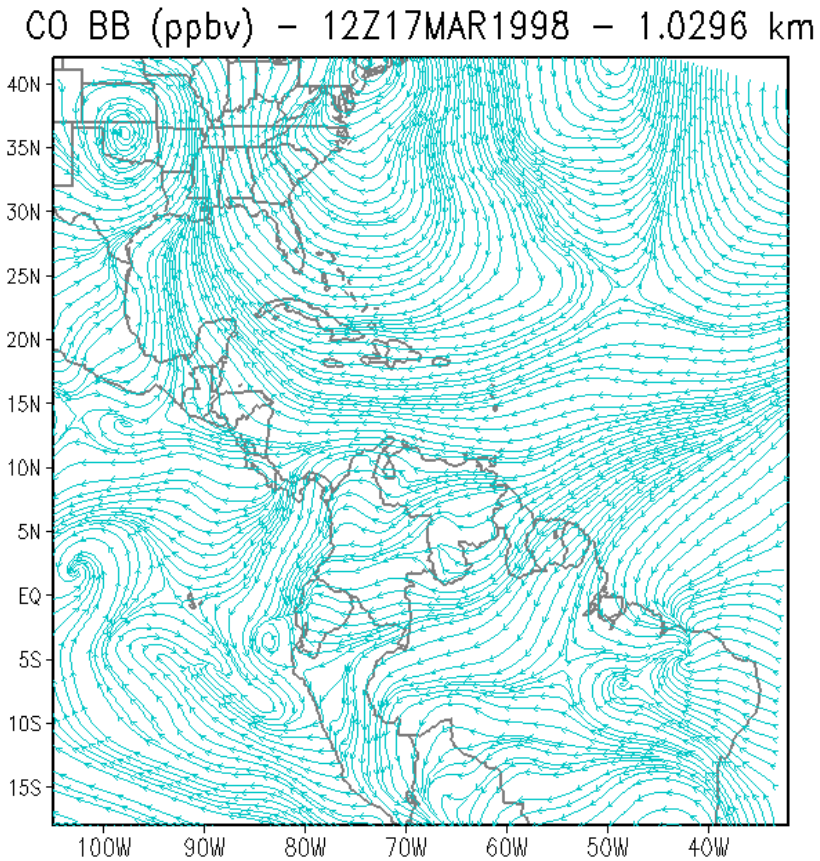
	GWEM Hoelzemann et al. [2004]	GFED van der Werf et al. [2003]	FLAMBE Reid et al. [2004]	INPE/CPTEC Freitas et al. [2005]
target species	AER, GHG, GRG	carbon	AER	PM2.5, CO
timescale	months–years	months–years	hours–days	hours
operational	no	no	yes	yes
fire observations	ATSR-2/AVHRR	TRMM-VIRS	GOES	GOES
fire product	GLOBSCAR/GBA2000		WF_ABBA	WF_ABBA
	Simon et al. [2004]/???	Giglio et al. [2003]	Prins et al. [2001a]	Prins et al. [2001a]
fire product type	burnt area	hot spots	burning area	burning area
land cover	AVHRR (IGBP), MODIS	TRMM, SeaWiFS	AVHRR	AVHRR (IGBP 2.0) [Belward, 1996]
vegetation model	LPJ-DGVM Sitch et al. [2003]	CASA, modified Potter et al. [1993]	—	—

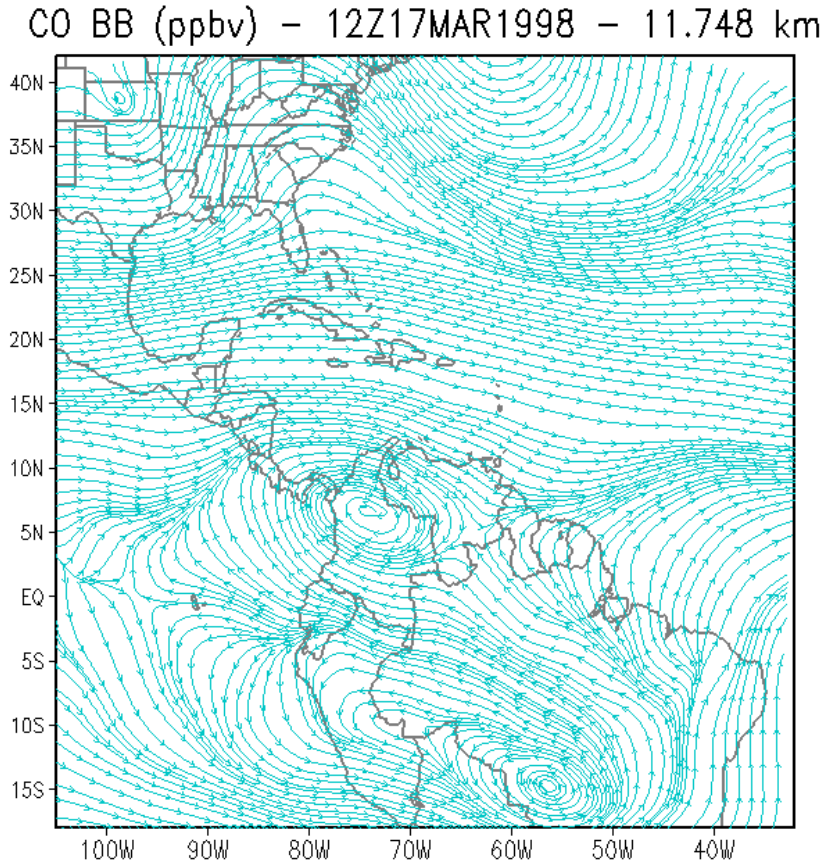
CLAIRE 1998 – Roraima Fires
Simulation using CATT-BRAMS



(courtesy INPE/CPTEC, M. Andreae, MPI Mainz)

CLAIRE 1998 – Roraima Fires
Simulation using CATT-BRAMS Eulerian Transport Model
1000 m ---------- 11700 m





(produced by INPE/CPTEC, courtesy of M. Andreae, MPI Mainz)

Some Conclusions on Existing Fire Emission Models

- No global operational system exists.
- (Some) severe events of pollution with aerosol and CO can be monitored and forecast with observations of fires only.
  - It is possible.
  - Fire EO input is essential.
- High temporal frequency of fire observations is important.

Strategy Proposal

GEMS Baseline Approach (AER)

- GWEM for amount [Hoelzemann et al. 2004]
- BUOYANT for injection height [Nikmo et al. 1999]

Extended Treatment of Wildfire in GEMS

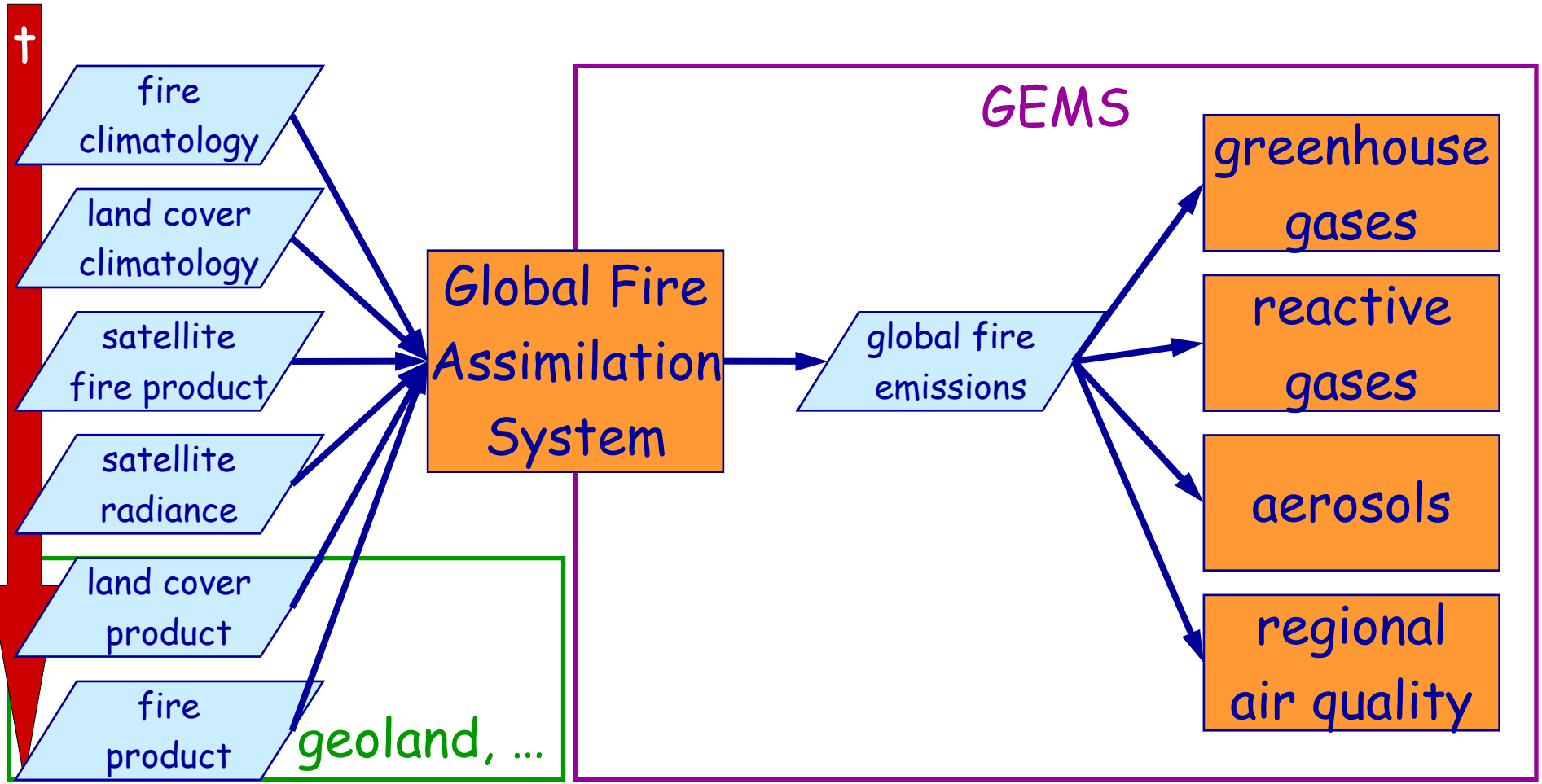
Year 2 May 2006+12 mo	• Produce 3 different reanalyses for GHG, GRG, Aerosol • global emissions for 2003 of correct order of magnitude • climatology: RETRO, AEROCOMM-B & MOPITT2003
Year 2.5-3.5 Nov 2007+ 12 mo	• Produce unified reanalyses for GHG, GRG, Aerosol • high-resolution (t&s) global fire products for 2000-2007 • burnt area, hot spots from MODIS, GLOBCARBON…
Year 3.5 - 4 Nov 2008+ 6 mo	• Final pre-operational trials • high-resolution (t&s) global fire products in NRT • hot spots and/or FRP from MODIS, …
Year 5 - 2009 -	• operational phase • high-resolution global (t&s) fire products in NRT • hot spots and/or FRP from MODIS, … • WF_ABBA and/or FRP from GEO satellites

Partial Funding

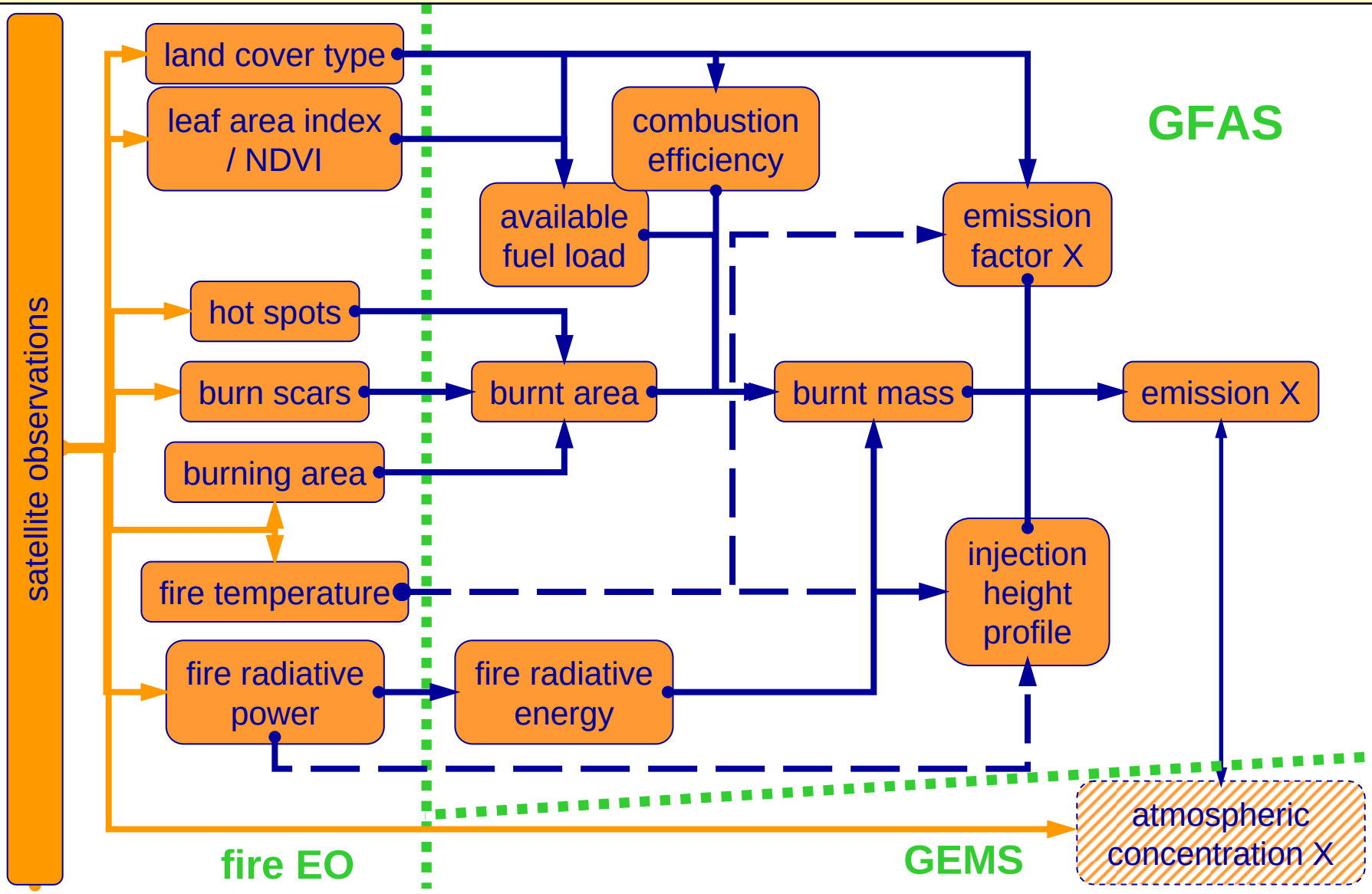
No Funding

Global Fire Assimilation System (GFAS)

- Single, consistent processing for all GEMS subprojects
- Evolution from climatology to existing products to radiance assimilation hidden behind constant interface



GFAS 4 GEMS


satellite observations
land cover type
leaf area index / NDVI
combustion efficiency
GFAS
available fuel load
emission factor X
hot spots
burn scars
burnt area
burnt mass
emission X
burning area
fire temperature
injection height profile
fire radiative power
fire radiative energy
atmospheric concentration X
fire EO
GEMS

Conclusions

Conclusions

- The emission by wildfires of is one of several important cross-cutting issues in GEMS.
- The emission by wildfires is ultimately needed globally in near-real time as well as with a time lag.
- No suitable wildfire emission product is available.
- Several promising developments are visible.

- We propose phased development strategy for wildfire emission modelling for GEMS:

  Global Fire Assimilation System serving the GEMS subprojects, ultimately in near-real time.

- (Feedback through inverse modelling is ultimately expected.)

- We need a collaboration with land monitoring community.
- We need additional funding.

More Info

- www.ecmwf.int/research/EU_projects/GEMS
- www.ecmwf.int/research/EU_projects/HALO
- j.kaiser@ecmwf.int