

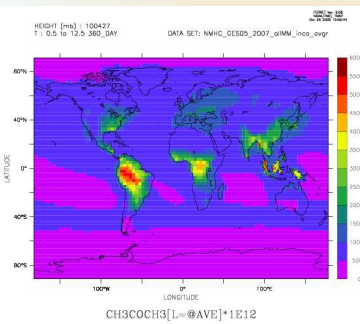
# Modelling acetone with the LMDz-INCA Chemistry-Transport Model: spatial distribution, temporal variability and budget components

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## Spatial distribution and annual cycle of acetone load

**Figure 1.** Annual average of the global distribution of acetone concentration (ppt) at surface level, simulated by LMDz-INCA for 2007.

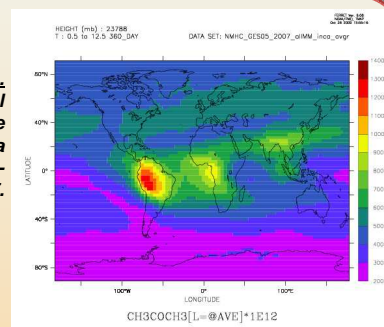


The LMDz-INCA Chemistry-Transport global model is used to simulate the acetone concentration. Annual average for 2007 is plotted in Figures 1 and 2.

Main source of acetone being primary emission from vegetation, highest levels of acetone concentration at surface level (Figure 1), larger than 4000 ppt, are encountered over land and in particular in the tropical band latitude, as over the Amazon forest and the forests of Central Africa, Indonesia and Malaysia. High values larger than 2000 ppt are also encountered where industrial activities and urban pollution are important: Europe, USA, South Asia. Over Ocean, acetone concentration is generally smaller than 1000 ppt.

**Figure 2.**

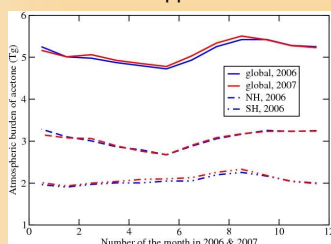
Annual average of the global distribution of acetone concentration (ppt) at 238-hPa altitude, simulated by LMDz-INCA for 2007.



In response to the strong emission sources over tropical land, acetone concentration simulated at the altitude of 238 hPa (Figure 2) is also most abundant over South America, Central Africa and South Asia. The maximum reaches 1300 ppt over South America and minimum occurs at the South Pole and in the Pacific Ocean, at less than 200 ppt. Transport of acetone generates an acetone belt where concentration is larger than 600 ppt: it is simulated from South America to Pacific Ocean offshore Japan. A stripe of acetone concentration smaller than 500 ppt is found northwards of the acetone belt, from Caribbean islands to Central Asia, extending across the Atlantic Ocean, and including Northern Africa and eastern Mediterranean. Continents of the Northern hemisphere seem shrouded in a background of 500-600 ppt in acetone concentration.

**Figure 3.**

Annual cycle of the atmospheric burden of acetone (Tg) in 2006 and 2007: for the globe, and separately for both hemispheres.



Atmospheric burden of acetone (Figure 3) is computed by summing the acetone mass contained in each grid box. Acetone burden is minimum at 4.8 Tg in June and is maximum at 5.5 Tg in September after vegetation is densest in the northern hemisphere. Annual cycle indicates little inter-annual variability. In particular, mean acetone burden is constant at 5.1 Tg in both 2006 and 2007, indicating that sources and sinks in LMDz-INCA are balanced over the globe.

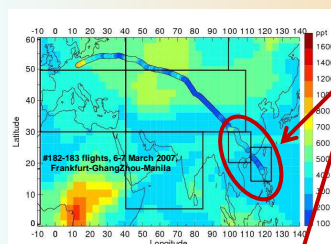
## World budget, and South Asian contribution

	WORLD		South Asia LMDz-INCA
	GEOS-CHEM <sup>1</sup>	LMDz-INCA	
Primary emission (Tg/yr)	67	60	8 (14%)
Chemical production (Tg/yr)	28	34	8.4 (25%)
Chemical (Tg/yr)	73	65	9.1 (14%)
Deposition (Tg/yr)	23	30	4.2 (14%)
Source/sink strength (Tg/yr)	95	94	
Burden (Tg)	3.8	5.1	0.55 (11%)
Residence time (days)	15	20	

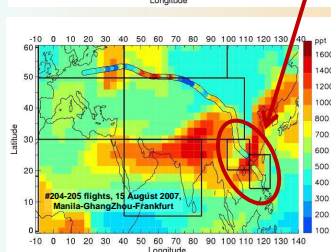
<sup>1</sup> Jacob et al., JGR 2002

Budget components computed by LMDz-INCA confirm that sources and sinks are balanced over the globe, with a global source/sink strength of 94 Tg/yr. Given a mean global atmospheric burden of 5.1 Tg of acetone, the mean residence time is 20 days. Considering extended South Asian region (5-45°N, 45-150°E), computation of the budget components indicates that South Asia is a strong and systematic net source of acetone, in part due to a strong chemical activity, as 25% of global chemical production occurs over South Asia. Indeed, primary emission is equal to secondary emission over South Asia, while on a global scale primary emission is twice more important than secondary. While source exceeds sink over South Asia, acetone does not accumulate over South Asia and is instead redistributed to other regions, as only 11% of global acetone burden remains over South Asia.

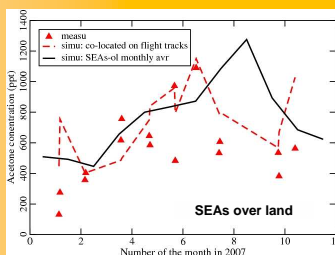
## Validation with CARIBIC data acquired over South East Asia



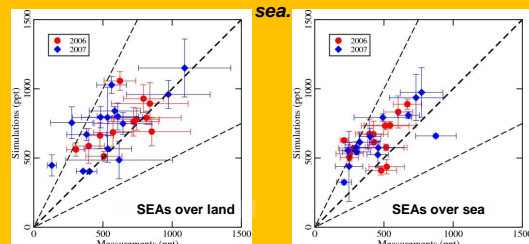
Modelling is able to reproduce the temporal variability of the impact of the South Asian plume over two focused South East Asian zones (Figure 4): correlation is good (Figure 5) between measurements and simulations co-localised on the flight track (time and spatial interpolation). In both 2006 and 2007, acetone concentration over South east Asia varies by a factor 2 to 3 because of annual cycle (Figure 6), day-to-day variability, and diurnal cycle.



**Figure 4.** Airborne measurements (CARIBIC project) of acetone concentration (ppt) superimposed to a map of simulations made by LMDz-INCA (daily average).



**Figure 5.** Comparison of simulations and measurements (CARIBIC) of acetone concentration (ppt) for two years and two zones: South East Asia over land, South East Asia over sea.



**Figure 6.** Annual cycle of acetone concentration (ppt) over South East Asia over land. Modelling provides monthly averages and also averages of co-localised simulation over the flight track.

Acetone concentration in South East Asia over land follows an intense annual cycle (Figure 6) according to simulations averaged for the whole zone, and in agreement with measurements: minimum in winter at 200-400 ppt, maximum in summer (July and September) at 1200 ppt, and increase by around 200 ppt/month from winter to summer. Co-localised simulations improve agreement with measurements (CARIBIC) by considering day-to-day variability as well as diurnal cycle.