

Particulate Air Pollution in China in Recent Years and Effectiveness of Emission Control

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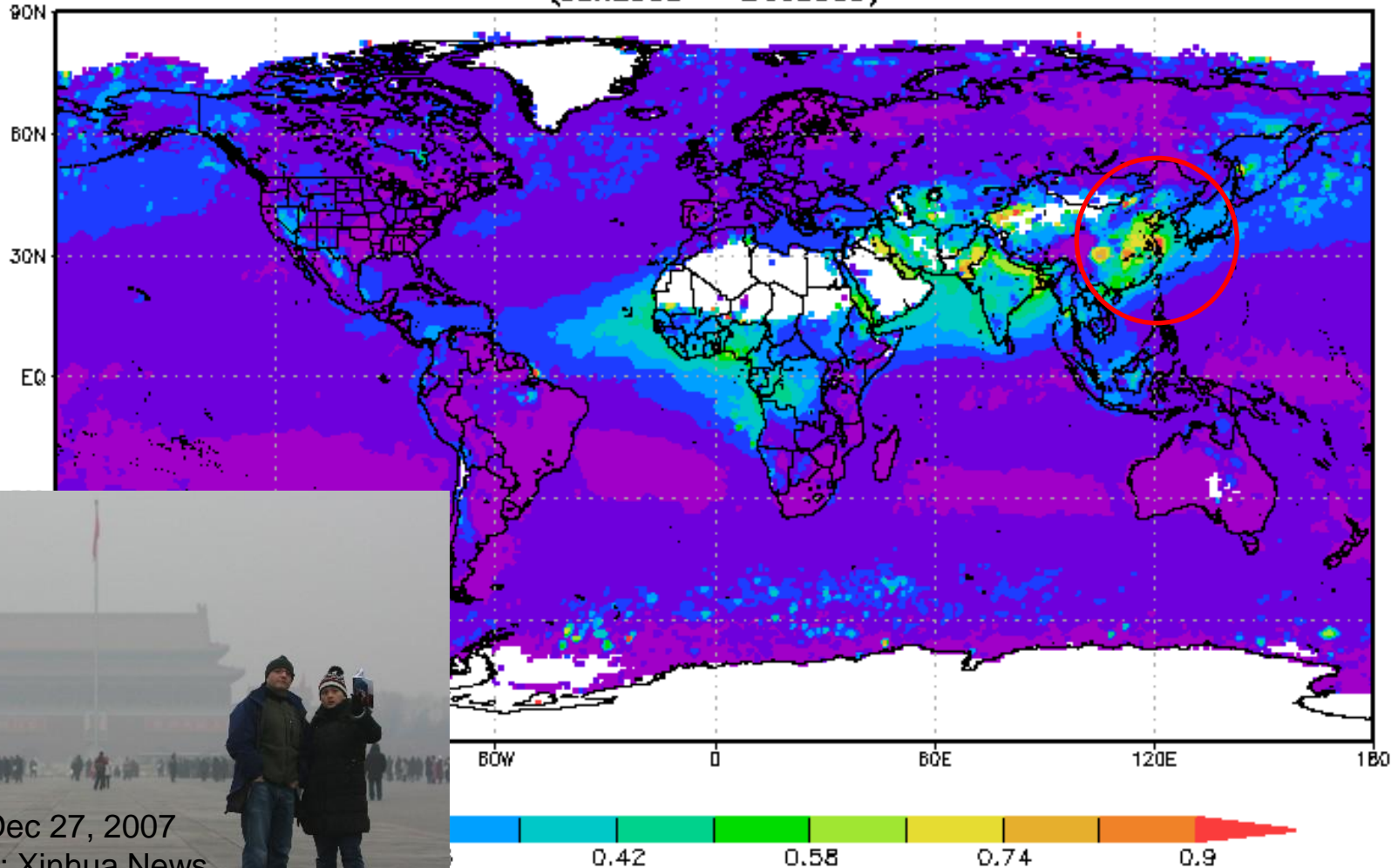
May 04, 2011

Reference: Lin et al., 2010 ES&T; Lin and McElroy, 2011 ACPD

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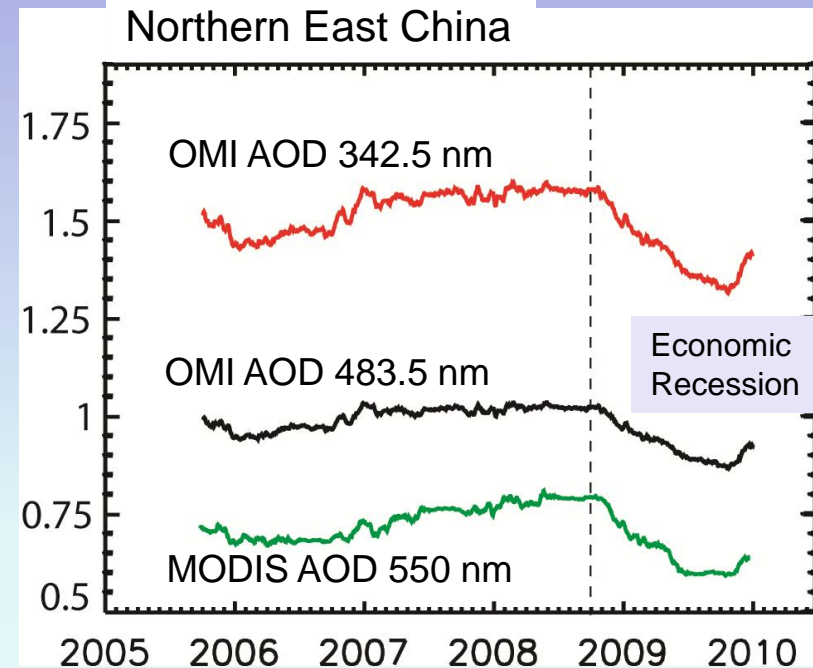
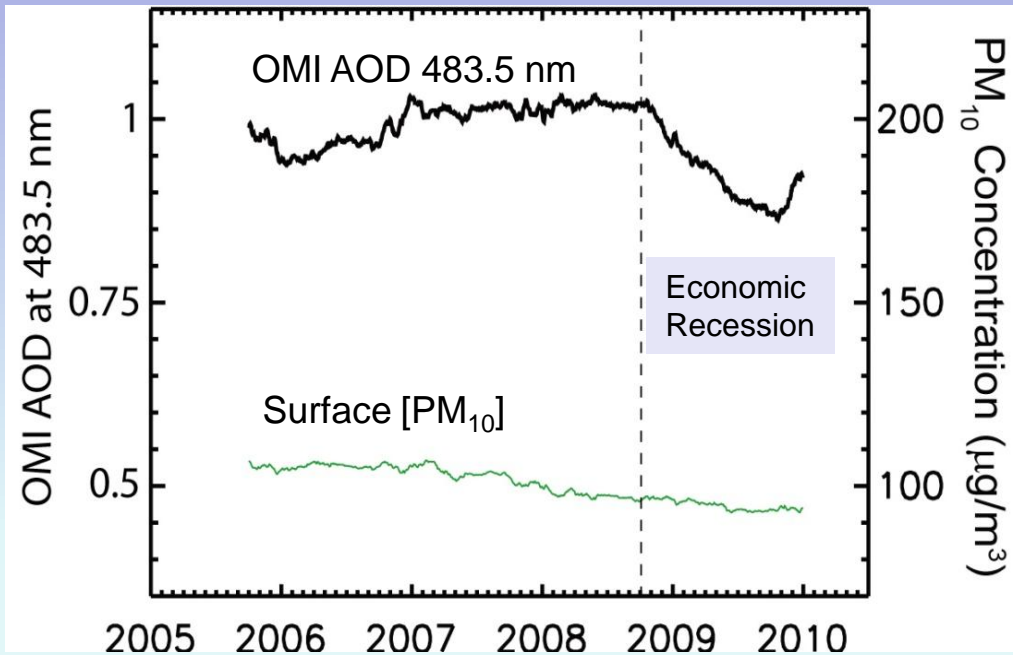
Annual Average AOD from MODIS: 2009

MOD08_M3.051 Aerosol Optical Depth at 550 nm [unitless]
(Jan2009 - Dec2009)



Date: Dec 27, 2007
Source: Xinhua News Agency

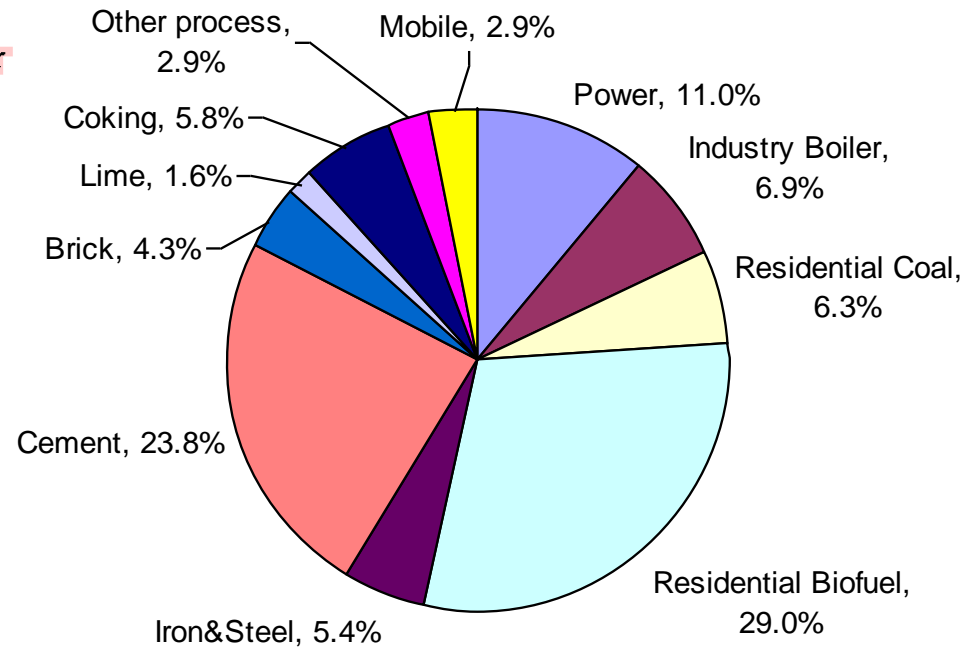
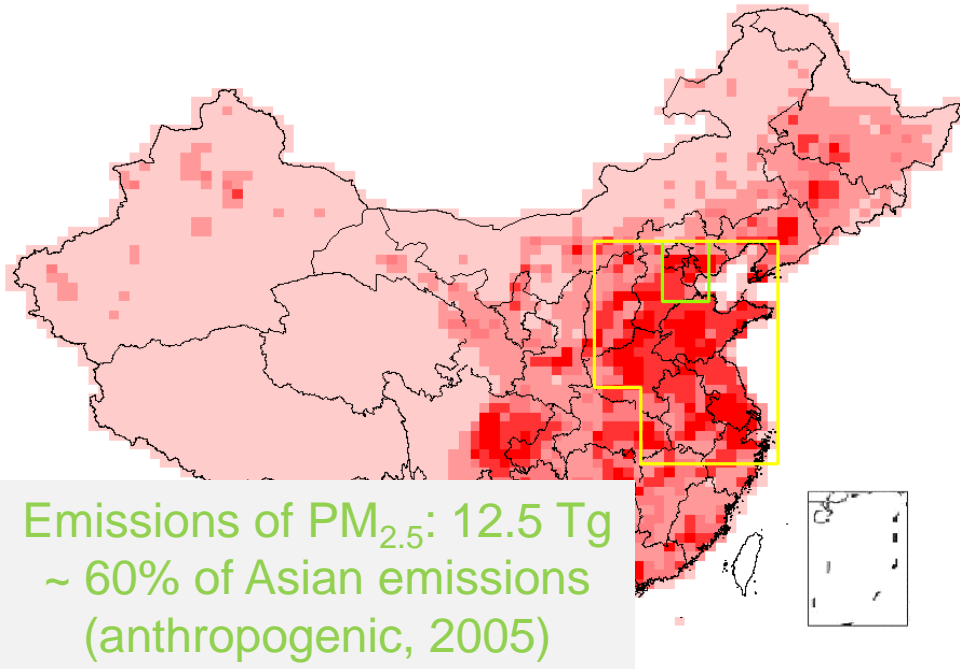
Trends of Surface [PM₁₀] & AOD: 2005 – 2010



Prior to the onset of the economic downturn in late 2008:

- ◆ Increasing AOD versus decreasing [PM₁₀]
- ◆ Likely cause: increases in secondary aerosols (small sized) more than offsetting decreases in primary aerosols (small and large sized)

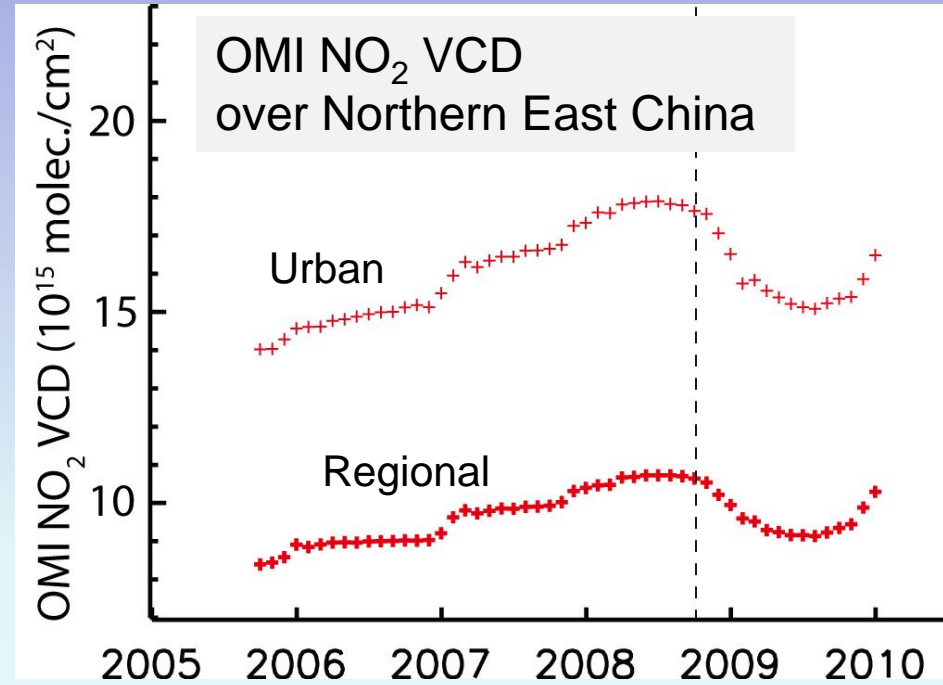
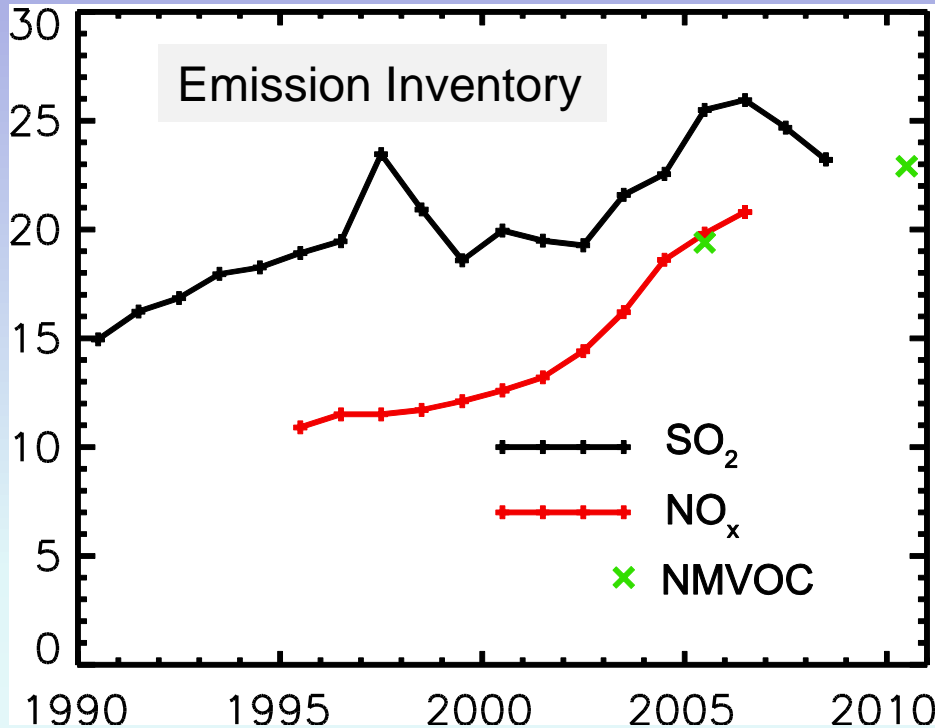
Decreasing Anthropogenic Primary Aerosols



Primary $PM_{2.5}$ and PM_{10} are reduced since 2005 from:

- cement industry (by more than 60%)
- power plants (to some extent due to FGD)
- fugitive dust (significantly)
- residential biofuel (to some extent due to urbanization)

Increasing Anthropogenic 2nd Aerosol Precursors



Controls on sources of secondary aerosols:

- ◆ SO₂: mainly on power plants → 9% **reduction** from 2005 to 2008
- ◆ NO_x: weak regulations → emissions **increase** rapidly (~27%, inversion)
- ◆ NMVOC: weak regulations → emissions **increase** (~11%)
- ◆ NH₃: virtually no regulations → emissions **increase** slightly (~6%)

GEOS-Chem Simulation: Overall increase in secondary inorganic aerosols by ~10%

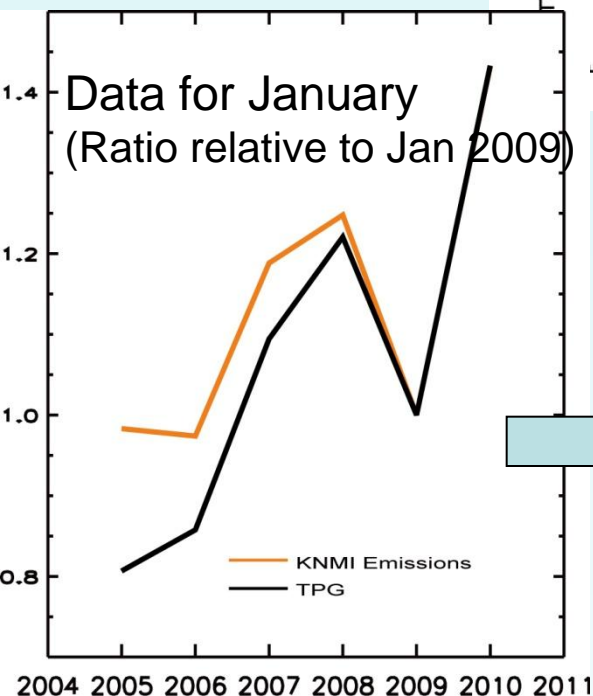
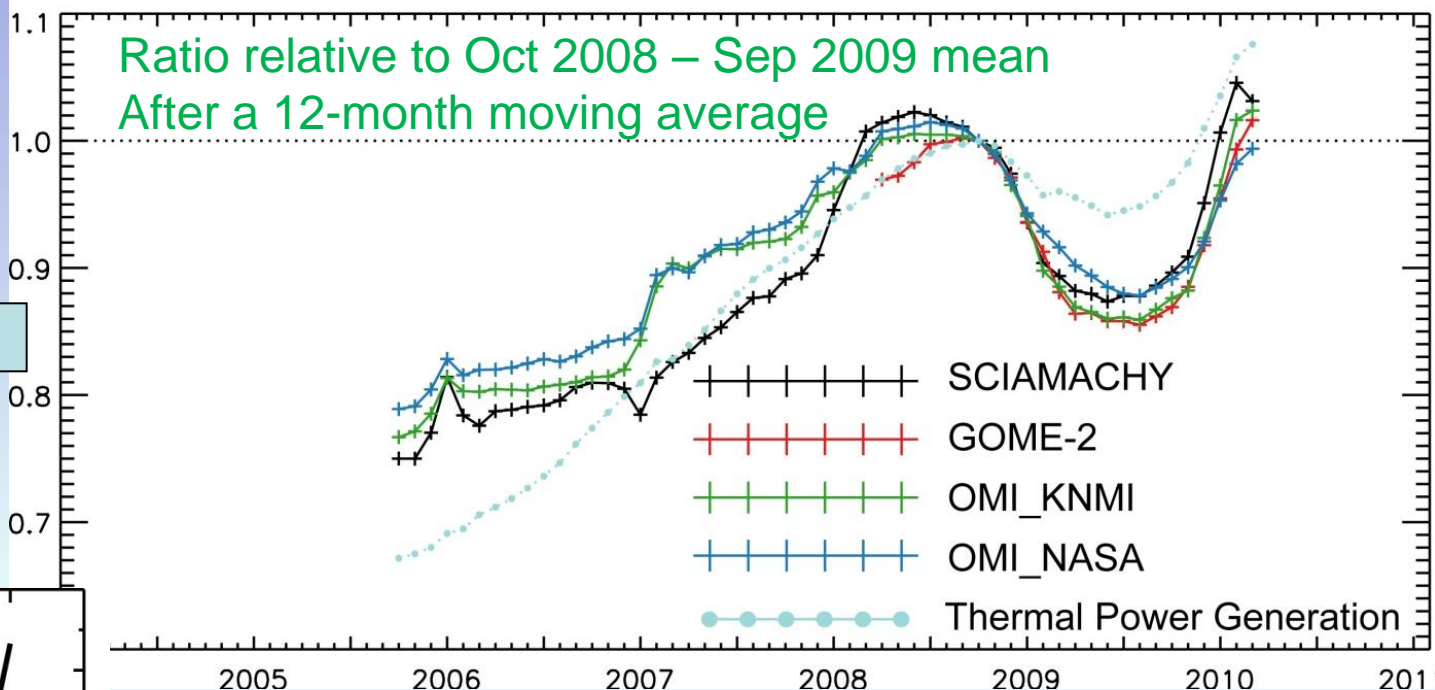
Other Factors Are Not Significant!

Factors affecting trends of aerosols (and AOD):

- ◆ Emissions of aerosols and precursors
- ◆ RH: Hygroscopic growth of aerosols affecting AOD
- ◆ Biogenic SOA formation: Occurring mainly in summer
- ◆ Desert dust: Occurring in spring
- ◆ Air temperature: Biogenic SOA formation
- ◆ Precipitation: Wet deposition of aerosols
- ◆ Winds: Horizontal transport of aerosols
- ◆ PBL mixing: Vertical transport of aerosols

In short, factors other than emissions are found to be highly unlikely the main cause of observed aerosol trends since 2005.

Signal of Growing Economy versus Downturn



- Anthropogenic NO_x emissions decrease **9-11%** in January 2009 due to the recent Chinese economic recession
- (Another **~10%** is due to the Chinese New Year)

Concluding Remarks

1. Recent increases in anthropogenic emissions of precursor chemicals including NO_x, NMVOOC and NH₃ (due to the lack of effective regulations) may have complicated the effort of Chinese government on PM control.
2. Impacts on regional and global climate?
3. Impacts on ozone? NO_x increase → ozone?
4. (Discussion) The newly proposed control in power sector is an important step in NO_x control, but other sources should also be taken into account.
5. Recent economic recession has resulted in 9-11% reduction in anthropogenic NO_x emissions in January 2009.