

SAGE III is designed to measure the concentration of aerosols in the stratosphere, but where do these particles come from?

The figure to the left shows some of the common sources. Scientists are concerned about recent increases in stratospheric aerosols because they have an impact on climate change. In the stratosphere, miles above Earth's surface, aerosols can reflect sunlight back into space, which leads to a cooling influence at the ground. According to recent studies, this cooling effect may explain the changes in the pace of global warming measured since 2000.

According to recent measurements, carbonyl sulfide is produced at the following rates given in terms of millions of tons per year: Marine = 0.33 Mt/yr; Volcanism = 0.05 Mt/yr; Terrestrial = 0.02 Mt/yr; Biomass Burning = 0.07 Mt/yr; Industrial = 0.33 Mt/yr.

Sulfur dioxide is produced at a rate of 10 Mt/yr from volcanos; Industrial = 146 Mt/yr; Biomass burning = 8 Mt/yr.

**Problem 1** – What is the total rate of production of carbonyl sulfide by all sources?

**Problem 2** – What is the percentage of each source of carbonyl sulfide compared to the total production rate?

**Problem 3** – Draw a circle (pie) graph that illustrates the percentages of each carbonyl sulfide source compared to the total rate.

**Problem 4** – Comparing carbonyl sulfide and sulfur dioxide, which of the two has the largest percentage contribution due to human activity?

OCS rates from C. Brühl<sup>1</sup>, J. Lelieveld<sup>1,3</sup>, P. J. Crutzen<sup>1</sup>, and H. Tost<sup>2</sup> 'The role of carbonyl sulphide as a source of stratospheric sulphate aerosol and its impact on climate', *Atmos. Chem. Phys.*, 12, 1239-1253, 2012, <http://www.atmos-chem-phys.net/12/1239/2012/acp-12-1239-2012.html>

According to recent measurements, carbonyl sulfide is produced at the following rates given in terms of millions of tons per year: Marine = 0.33 Mt/yr; Volcanism = 0.05 Mt/yr; Terrestrial = 0.02 Mt/yr; Biomass Burning = 0.07 Mt/yr; Industrial = 0.33 Mt/yr. Sulfur dioxide is produced at a rate of 10 Mt/yr from volcanos; Industrial = 146 Mt/yr; Biomass burning = 8 Mt/yr.

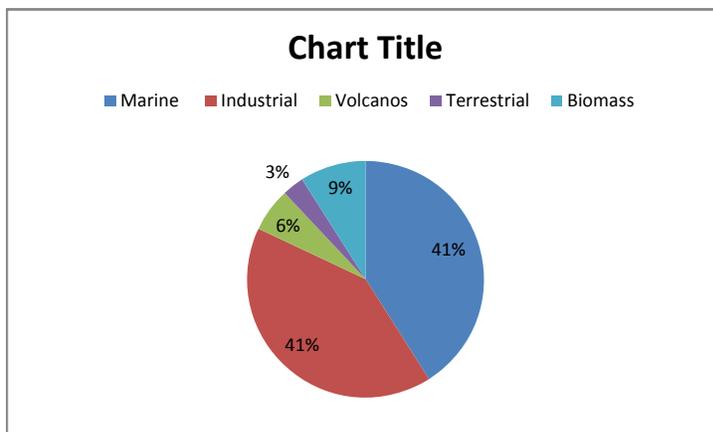
**Problem 1** – What is the total rate of production of carbonyl sulfide by all sources?

Answer:  $0.33 + 0.05 + 0.02 + 0.07 + 0.33 = \mathbf{0.80 \text{ Mt/yr}}$ .

**Problem 2** – What is the percentage of each source of carbonyl sulfide compared to the total production rate?

Answer: **Marine: 41% Volcanism: 6% Terrestrial: 3% Biomass: 9% Industrial: 41%**

**Problem 3** – Draw a circle (pie) graph that illustrates the percentages of each source compared to the total rate. Answer: See below.



**Problem 4** – Comparing carbonyl sulfide and sulfur dioxide, which of the two has the largest percentage contribution due to human activity?

Answer: Total production = 164 Mt/yr. Percentages: Volcanism: 6%, Biomass burning: 5%; Industrial: 89%. **The production of sulfur dioxide by human activity is the highest: 89% vs 41%.**