

Professor Wyss Yim (RSM 74) takes a look at

Climatic effects of atmospheric water vapour distribution through volcanic eruptions and human activities

VOLCANIC eruptions and human activities are both important in changing atmospheric water vapour distribution. In comparison with the emission of carbon dioxide released during the consumption of fossil fuel, water vapour's role in climate change has been grossly underestimated. Studies made of volcanic eruptions, including satellite images of cloud cover and meteorological records, have revealed climatic effects in different parts of the globe through the migration of volcanic clouds, depending mainly on their timing, location and Volcanic Explosivity Index (VEI).

The largest eruption in the past 50 years is the June 15 1991 eruption of Pinatubo in the Philippines (VEI = 6), when the maximum cloud height reached 55 km above sea level. This eruption coincided with the passage of Typhoon Yunya over Luzon (see above). Because a large quantity of water vapour transferred from the troposphere and the volcano into the stratosphere, 1991 was a year with global rainfall significantly below normal while temperatures in the northern hemisphere were lowered by ~0.5°C

Particularly noteworthy is the variability in rainfall through the occurrence of extreme environmental events, shown below. Although dry years with below-normal rainfall are more common than wet years during years of major



Satellite image showing the Pinatubo volcanic cloud (blue) and the Typhoon Yunya cloud (white) over the Philippines on June 15, 1991. Typhoon Yunya dissipated into a tropical depression within two days.

eruptions, the regional increase in wetness may be explained by wind shifts and/or wind strengthening.

Climatic effects of volcanic eruptions include:

- * reduction in solar heating because of the particulates discharged;
- * interference with the 'normal' atmospheric circulation and/or oceanic circulation;
- * the ash and aerosols provide condensation nuclei for water;
- * the transfer from the troposphere into the stratosphere of water vapour which act as an important greenhouse gas;
- * variability in regional rainfall including droughts, floods, crop failures.

- * Anomalous regional wind-storms.
- * Acid rain.

Human activities, including water supply schemes, farming, deforestation and the use of groundwater may also change the natural water cycle significantly to contribute to climate change.

A recent example is the Three Gorges Project in China which is a form of 'water pollution' through the introduction of 'unnatural' water to other regions where there otherwise was a supply shortage.

There is an under-estimation of the importance of water vapour as a greenhouse gas in causing climate change. This is shown by the redistribution of water vapour during major volcanic eruptions as well as the overwhelming effect of water vapour in comparison with the current carbon dioxide level of ~390 parts per million. This conclusion is supported by a recent study by Paulo Soares (*Int. J. Geosciences* 2010/1: 102-112). Unlike carbon dioxide, water vapour in the atmosphere rises in tune with temperature changes, even on a monthly scale. Consequently, reducing the current levels of carbon dioxide alone cannot be an effective solution to the problem of climate change.

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CLIMATIC EFFECTS OF SELECTED VOLCANIC ERUPTIONS SINCE 1960

Volcanic eruption	Main eruption date	Climatic effects
Agung, Indonesia	18/2/1963	Worst drought year on record in southern China
El Chichón, Mexico	28/3/1982	Second wettest year on record in Hong Kong
Pinatubo, Philippines	15/6/1991	Year with global rainfall significantly below normal
Chaitén, Chile	2/5/2008	Wettest June in Hong Kong since record began in 1884
Okmok, Alaska, USA	12/7/2008	Severe winter in north America and northern Europe
Kasatochi, Alaska, USA	7/8/2008	Severe winter in north America and northern Europe
Sarychev, Russia	15/6/2009	Severe winter with heavy snowfalls in Manchuria
Soufrière Hills, Montserrat	11/2/2010	East Atlantic frontal activity storms including Xynthia
Eyjafjallajökull, Iceland	14/4/2010	Severe floods in central Europe, Pakistan and China
Shiveluch, Russia	23/10/2010	Worst drought in 200 years in Shandong, China
Kliuchevskoi, Russia	28/10/2010	Worst drought in 200 years in Shandong, China
Shinmoe-dake, Japan	2/2/2011	Worst drought in 200 years in Shandong, China