FFATURES

GLOBAL warming caused by our consumption of fossil fuels has often been cited as the reason for the increase in frequency and severity of climate-related disasters. However, based on Earth history, natural variability has also resulted in such disasters in the past and will certainly continue into the future irrespective of anthropogenic forcing. For effective mitigation, it is necessary to understand how natural forcing and anthropogenic forcing interact.

This article briefly reports selected severe weather events, within a two-month period after a volcanic eruption, through the impact of the eruption cloud on the stratosphere. Previously satellite observations have shown that such clouds may take two to three weeks to circle the Earth to impact weather.

On May 2 2008 at about 08:00 co-ordinated universal time (UT), the Chaitén volcano, at longitude 42.83°S and latitude 72.65°W in Chile's south-

ern volcanic zone, erupted violently after an estimated time gap of 9,400 years. The explosive eruption lasted six hours lofting ash to an altitude of over 22 kms or 12kms above the troposphere. The ash plumes continued for about a week, punctuated by two stratospheric columns to 20km and 22km in altitude on May 6 and May 8 respectively. Based

mainly on the volume of ash released, the eruption falls into the Volcanic Explosivity Index 4 range which is considered to be large with 0.1 to 1 km3 of ejecta. Because a fleet of NASA's five polar-orbiting spacecrafts, with overpass times separated by about eight minutes, were operating to provide aviation safety warning, a great deal can be learnt from the images col-

Chilean volcano produces trail of destruction

by Professor Wyss Yim

lected on the long-range transport of fine ash following the eruption.

A visible image from the Terra and Aqua MODIS sensors of ash plumes from Chaitén over Chile and Argentina on May 5 2008 at 14:25 UT is shown in Figure I. Based on a study by the Norwegian Institute for Air Research, the fine-ash mass loadings were significant and high enough to cause damage to jet aircraft engines several hundred kilometers downstream from the vol-

This leads to two questions. First, how the spread of the eruption cloud within the stratosphere interferes with the 'normal' circulation pattern and, second, whether the ash and aerosol in the eruption cloud impacts climate by providing condensation nuclei to cause anomalous precipitation as it spread (FIGURE II). The following is a chronological list of severe weather events possibly linked to the

Chaitén eruption. Month of May - Driest on record across Australia; 3 typhoons in the northwestern Pacific for the first time since 1959.

Another space-borne asset is the

Cloud-Aerosol Lidar with Orthogonal

Polarisation (CALIOP) which detected

stratospheric aerosol from Chaitén

drifting over south-eastern Australia.

May 4 - Powerful storm in southern Brazil; 20,000 displaced.

May 8-10 - Typhoon Rammasun (maximum wind speed 250km/hour).

May 10 - 80 tornadoes and hail in central and southeastern USA; 23 deaths.

May 12 - Storm in Bangladesh; 44

May 13-14 - Storms/torrential rainfall/ flooding in Shreveport, LA, USA (51mm in 20 minutes and 164mm in two hours).

May 14 - Strong wind in northern India; several deaths.



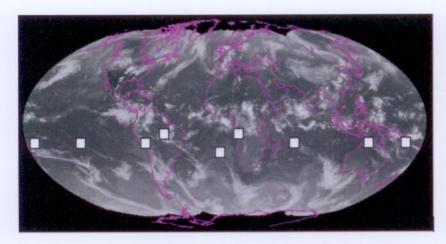
FIGURE I: The eruption cloud of the Chaitén volcano spreading eastwards across the Atlantic coast of Argentina on May 5, 2008 at 14:25 UT. (Courtesy of the MODIS Rapid Response Project at NASA/GSFC http://rapidfire.sci.gsfc.nasa.gov/

cano. At least one aircraft encounter confirmed the eastward spread of the ash as far as South Africa.

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May 17-18 - Typhoon Halong (maximum wind speed 130km/hour); 25 deaths

May 20-25 - Tornadoes including a deadly EF-5 tornado in Parkersberg, USA, 7 deaths.

May 21-26 - Torrential rainfall/flooding/landslides in south central Chile: 15,000 displaced.

May 23-25 - Torrential rainfall/flooding in El Salvador; one death.

May 24-25 - Torrential rainfall/flooding in northwestern Pakistan; 10 deaths

May 27-28 - Torrential rainfall/flooding/landslides in southern China; 0.5 million displaced, 28 deaths; torrential rainfall/flooding in Colombia; 100,000 displaced, nine deaths.

May 27-29 - Typhoon Nakai (maximum wind speed 232km/hour).

May 29 - Torrential rainfall/flooding in Germany, France, Italy and Belgium

Month of June – Wettest month ever in Hong Kong (1364.1mm) including a rainstorm with a return period of 1,100 years and numerous landslides (figure III), Guangzhou (872.7mm); Macau (1200.8mm); anomalously wet June in South Africa and Australia with records broken at various localities

June 1-7 - Torrential rainfall/flooding in northeastern and western India; 25 deaths, 200,000 displaced.

June 1-14 - Torrential rainfall/flooding in Mid-west, 1100 precipitation records broken.

June 4-13 - Torrential rainfall/flooding in southern and central Mexico.

June 7-18 - Torrential rainfall/flooding in southern China; US\$4 billion loss 57 deaths

June 13-16 - Torrential rainfall/flooding in Kenya.

June 19 - Torrential rainfall/flooding in Eastern Province, South Africa; four deaths.

Volcanic eruptions are a natural phenomenon of random occurrence.

FIGURE II Storm systems on May 27 2008 at 00:00 UT. White boxes depict possible locations where ash and aerosols from the Chaitén eruption may be transported into the northern hemisphere to affect precipitation through the provision of condensation nuclei. Courtesy of SSEC, University of Wisconsin-Madison.

Based on available satellite information and instrumental observation record, the severe weather-related events, occurring within two months of the Chaitén eruption, are thought to be linked to the spreading eruption cloud.

Further research is needed to distinguish between the natural forcing and anthropogenic forcing of climaterelated disasters to assist the decision on engineering mitigation.



FIGURE III. Some of the 2400 landslides occurring on Lantau Island near Tai O, Hong Kong triggered by the severe June 7 2008 rainstorm. Total rainfall reached a maximum of 384mm over a 4-hour period. Courtesy of the Civil Engineering Development Department, Hong Kong SAR Government.

...AND MORE RECENT ACTIVITY...

SOUFRIÉRE HILLS, MONSERRAT ON FEBRUARY 11, at 1635 GMT, (latitude 16°43'N longitude 62°11'W), this volcano erupted, sending an ash plume into the stratosphere reaching an altitude of 15.2km. The plume tracked on Meteosat SEVIRI (available from www.sat.dundee.ac.uk) was caught up within the warm sector of a frontal system spreading in a northeasterly direction towards Europe.

On the morning of February 20, torrential downpours occurred in Madeira causing disastrous landslides and flooding with a death toll of at least 48. From February 26-28, violent storms, with winds reaching 175 km/bour, bit western Europe. France was the worst bit with a death toll of 51 out of a total of

at least 63. These disastrous east Atlantic storms were probably exacerbated by the eruption cloud interfering with the stratospheric circulation in addition to providing condensation nuclei to make the rainfall more torrential.

EYJAFJALLAJÖKULL, ICELAND
IN THE eruption on April 14, the
maximum plume beight was only
11km and the amount of ash was
below 250 million m³. Because it is
much smaller than Pinatubo in 1991,
climate impact is considered unlikely.
Nevertheless, weather changes over
much of Europe, including being
cooler, more cloudy and rainy than
normal, can be expected in the next
one or two months.