Southeast Asia Climate Analysis and Modelling Framework

COLLABORATIVE REGIONAL CLIMATE MODELLING FOR SOUTHEAST ASIA

CHALLENGE

Southeast Asia is particularly vulnerable to weather and climate extremes. Differences in economic level, population density, technological capacity, urbanisation and physical geography mean that some regions may experience more severe impacts than others. Within the next century, increased temperatures and, in many regions, extreme rainfall events are expected on a sub-regional scale. This poses increasing challenges to socio-economic and environmental development.

Despite these challenges, there has been a lack of accessible and detailed regional climate information. To help address this the Southeast Asia Climate Analysis and Modelling Framework was set up to develop regional climate modelling capability and capacity across Southeast Asian nations. The project was supported by the Foreign & Commonwealth Office Southeast Asia Prosperity Fund, the Centre for Climate Research Singapore and the Met Office.

A COLLABORATIVE APPROACH

The Southeast Asia Climate Analysis and Modelling Framework has brought together scientists from the Met Office Hadley Centre and the Centre for Climate Research Singapore with representatives from Southeast Asia, including national meteorological and hydrological services, universities and research institutes.

Together we have analysed future changes in climate up to the year 2100, at a national and regional level, to provide new scientific evidence on the implications of climate change for weather events and the overall climate. From the outset, this collaborative approach has been central to the success of the project.

As well as increasing the scientific capacity of those involved, the project also aims to enhance regional scientific partnerships through related workshops and collaborative projects. The new scientific evidence would also enable governments and policymakers in the region to make better-informed decisions around responding to the changing climate.

> (This) is a great example of a successful collaborative project in the Southeast Asia region. Through (the project), I could broaden my working network not only with international colleagues but also with colleagues from Vietnam.

Ngo Duc Thanh,
Lecturer at the Department of Meteorology,
VNU Hanoi University of Science

A PROJECT BUILT FOR PEOPLE'S NEEDS

At the heart of this initiative is a user-centred approach. An initial survey ensured that the project would meet the needs of the policymakers, government departments, researchers and community organisations for regional climate information.

The respondents represent 25 national agencies and research institutes around Southeast Asia, primarily from hydrology (54%), marine (41%) and agricultural sectors (39%), with some respondents representing more than one sector.

Many respondents work to support downstream studies of climate impacts and adaptation, including managing vulnerability areas and extreme events such as flood and drought risks, heavy rainfall and extreme temperatures.

The survey helped to determine what weather and climate information was needed, how this information should be stored and accessed, as well as detail on related challenges faced by respondents. One recurring development area was highlighted: the need for improved capacity to interpret and correctly use climate information. To address this need, training workshops were hosted across the region.

The key areas of interest identified by the survey were:

- Annual cycle of temperature and precipitation
- Mean temperature and precipitation
- Extreme temperature and precipitation
- Monsoons

A range of useful, qualitative responses were also received, such as:

"... The need for greater access to various types of climate information products is immense; however, capacity to interpret and correctly use the information is low."

This user-centred approach, combined with the scientific network and supporting training, ensured that the development of the project was informed by the best scientific information available. Access and use of the model was designed in a user friendly manner and outputs are relevant to, and inform, a wide range of end-users.

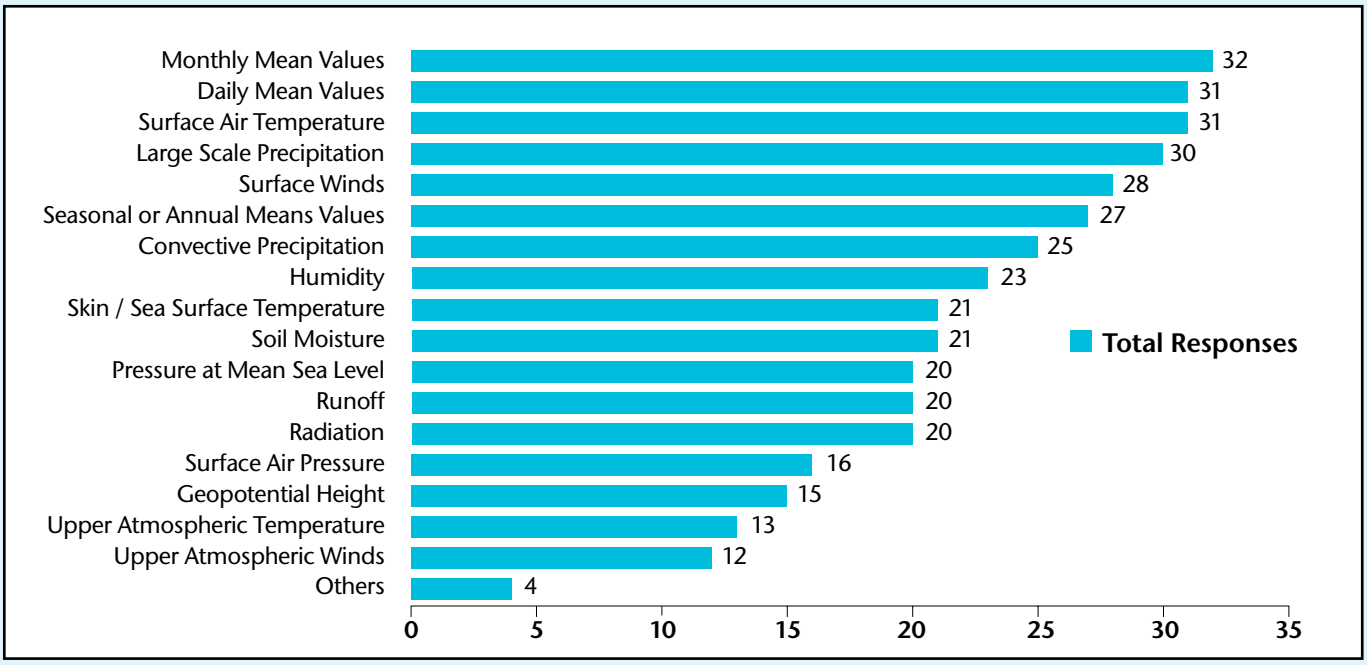


Figure 1. Survey results showing the key interest areas most useful to respondents work.

DESIGNING THE APPROACH

The Met Office Hadley Centre led the planning and analysis training workshops to help improve capacity to interpret and correctly use climate information, as well as encourage and facilitate regional collaboration.

These workshops were attended by representatives from the Association of Southeast Asian Nations (ASEAN) member states. The Met Office Hadley Centre's regional climate model PRECIS (Providing Regional Climates for Impact Studies) was made available to all members, and the workshops explained relevant scientific background and how to make best use of the model.

Figure 2. Map of the 10 Association of Southeast Asian Nations (ASEAN) member states.

Six model experiments were run over a common domain that included all Association of Southeast Asian Nations member states.

Using data from six global climate models, PRECIS was used to generate high resolution (25 km) future climate change projections for Southeast Asia up to the year 2100. This information was analysed by the project team, and a regional climate change tool website was developed so that climate information could be easily viewed.

The PRECIS regional model enables better representation of regional topography. This is beneficial for smaller islands in Southeast Asia, as they can be represented as land masses rather than as ocean points, as occurs on larger scale models. Land responds to climate change differently to the ocean.

Figure 3. Domain used in the model experiments. This area encompasses each of the ASEAN member countries.

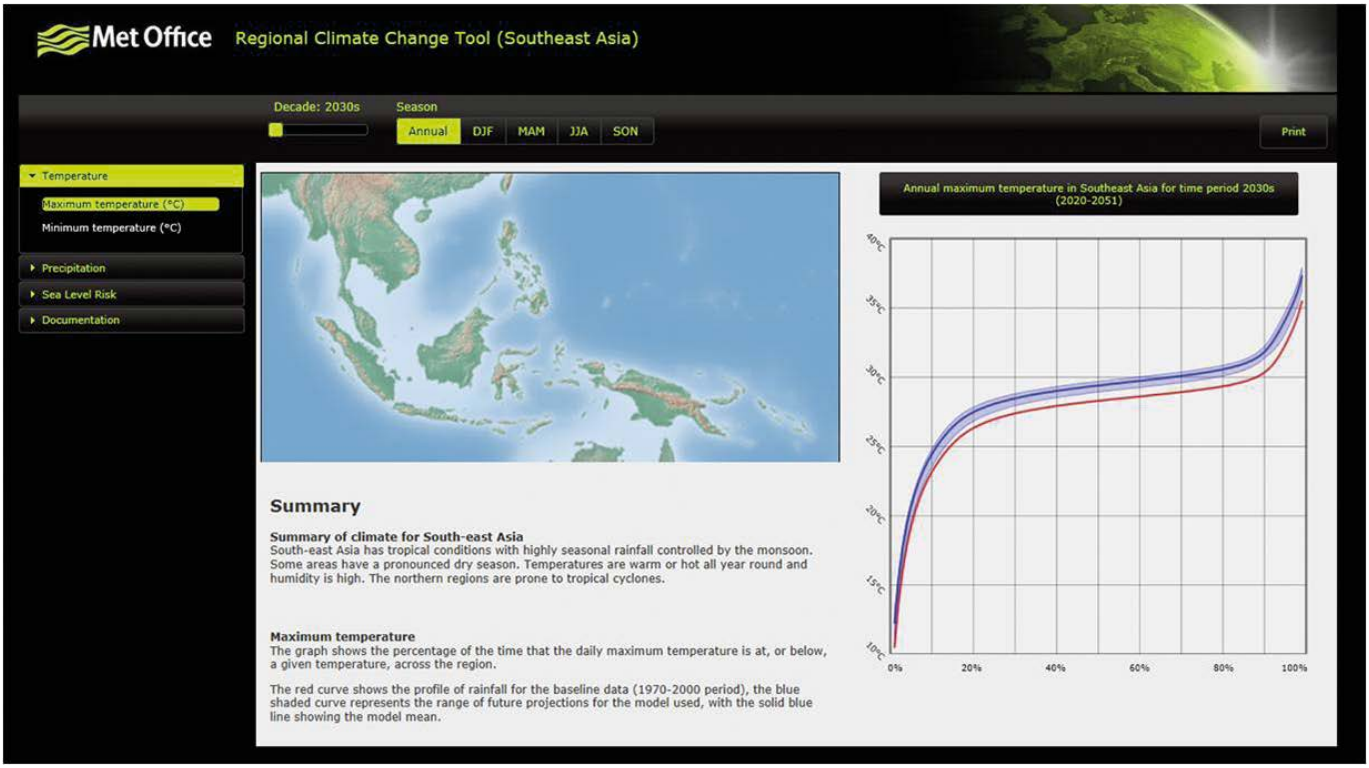


Figure 4. Regional climate change tool website, developed to allow easy access to climate information: www.precisrcm.com/rcct/

WHAT IS A GLOBAL CLIMATE MODEL?

A global climate model is a mathematical model of the general circulation of the Earth's atmosphere or oceans. Mathematical equations from planetary physics are the basis for complex computer programmes used for simulating the atmosphere and ocean. Global climate models are used for many applications including projecting climate change, seasonal and short range weather forecasting and scientific research that helps us better understand the behaviour of the atmosphere and oceans.

WHAT IS A REGIONAL CLIMATE MODEL?

A regional climate model is a climate model run over a limited area of the Earth's surface using global climate model data for input at the lateral boundaries. Because regional climate models run at higher resolutions than global climate models, they have the potential to represent projected changes in climate for localised areas more accurately than global models.

BENEFITS OF THE PROJECT ACHIEVED SO FAR

This collaborative project is already starting to strengthen the ability of the ASEAN member states in developing national adaptation and mitigation plans based on sound science.

Robust climate information produced for the project has been fundamental in raising awareness and understanding of climate change and related impacts in Southeast Asian countries.

All participants have improved their ability to analyse regional climate model data and summarise results, skills which are becoming increasingly important across Southeast Asia as climate change becomes a higher priority.

Collaboration has also helped to improve communication and analysis skills within the region's scientific community.

> "The Southeast Asia Climate Analysis Modelling Framework provides a valuable data source for climate change studies over the Southeast Asia region."
>
> **Ling Leong Kwok,** Malaysian Meteorological Department

FUTURE PLANS

As the focus of the project has been on meeting end users' needs, it has built a strong foundation for future work, ensuring sustainable results.

In future, the new climate information will support countries in the region to integrate climate issues into sector budgets, plans and policies in areas including agriculture, food security, forestry, land use change, disaster risk reduction, health and water resources.

Continued collaboration across Southeast Asia will enhance future research as more scientists engage with and review the work. The success of this project so far has set a precedent for future collaborative research projects, such as the Southeast Asia Coordinated Regional Climate Downscaling Experiment (CORDEX).

The PRECIS model has several potential applications and can be used to inform risk and vulnerability assessments and subsequent adaptation strategies in areas such as agriculture, health, water management, disaster risk reduction and early warning systems, transport etc.

WHAT DID THE CLIMATE PROJECTIONS REVEAL?

The model outputs reflect the needs and key areas of interest of the stakeholders surveyed at the beginning of the project.

REGIONAL TEMPERATURE INCREASE

Average annual temperature is likely to

increase across the whole of Southeast Asia (see figure 5.). The strongest annual warming is likely to occur in mainland Southeast Asia, with fairly uniform warming throughout the seasons. Regional surface air temperature is typically expected to rise by 2 °C by mid-century and by 4 °C by the end of the century, although some countries could experience an increase of up to 5 °C. Table 1 summarises each country's projected changes; all show significant and consistent increases on today's temperatures.

EXTREME TEMPERATURES

Unlike the uniform inter-annual warming of mainland Southeast Asia, projections for equatorial regions depict much stronger seasonal warming. Daily maximum temperatures could increase by as much as 5 °C in boreal throughout June, July and August; higher than their average annual increases shown in table 1

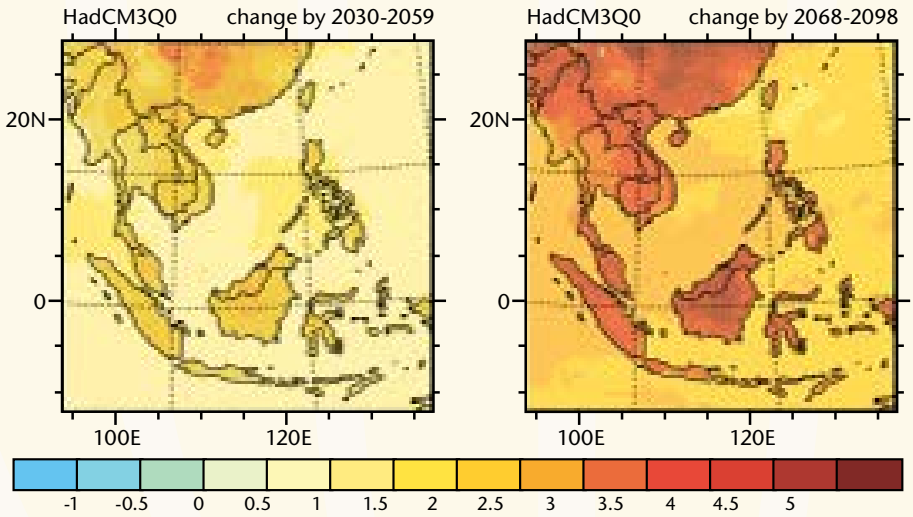


Figure 5. Projected changes in annual mean temperature (annual maximum daytime temperature in °C) from HadCM3Q0 for mid-century (left) and end-century (right). Darker red shades show stronger areas of temperature increase compared to the baseline temperatures; 1970-2000.

COUNTRY	APPROXIMATE PROJECTIONS OF TEMPERATURE CHANGE (°C)		SIGNIFICANT PROJECTIONS
	MID TERM	LONG-TERM	
Cambodia	2.0 – 3.0	4.0 – 5.0	All
Laos	2.0 – 3.0	3.0 – 4.0	
Myanmar	Up to 2.0	Up to 4.0	
Philippines	Up to 1.5	Up to 3.0	
Thailand	2.0 – 3.0	4.0 – 5.0	
Vietnam	2.0 – 3.0	3.0 – 4.0	
Brunei	2.0 – 3.0	3.0 – 4.0	All
Indonesia	2.0 – 3.0	3.0 – 4.0	
Malaysia	2.0 – 3.0	3.0 – 4.0	
Singapore	Up to 1.5	Up to 3.0	
Timor Leste	1.5 – 2.0	3.0 – 4.0	

Table 1. Summary of estimated mid-term (2031-2050) and long-term (2031-2050) projections of annual cycle temperature changes.

CHANGING RAINFALL PATTERNS

End of century projections of average precipitation show large spatial and seasonal variation. Generally, the model projects wetter climates will develop over large land masses.

NORTHERN MONSOON INTENSIFICATION

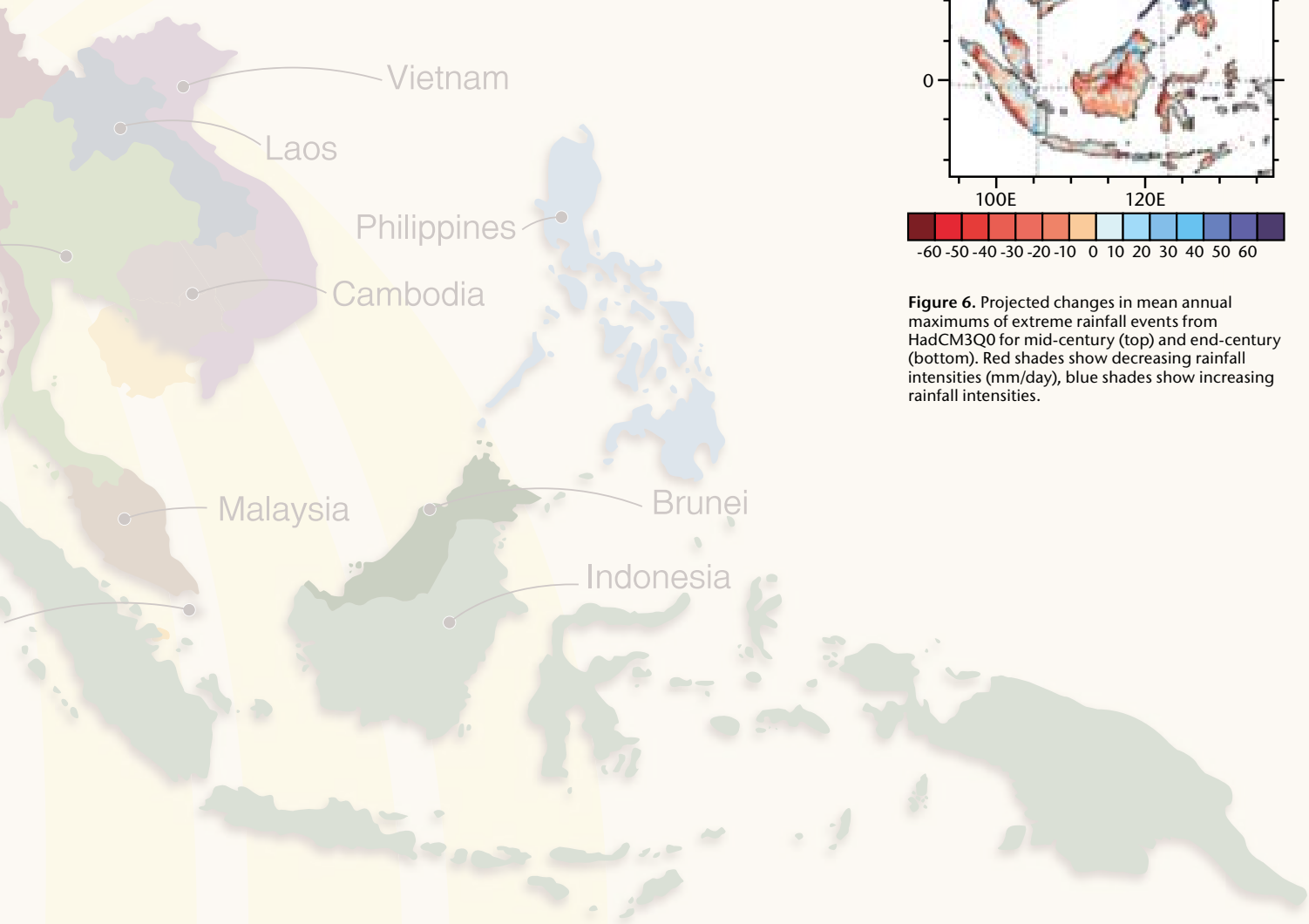
Above 15 degrees north the increasing average precipitation would largely be due to summer monsoon intensification (June to August); in Myanmar, seasonal precipitation increase could reach 4 mm/day by 2100.

Figure 6. illustrates an intensification of extreme rainfall events over mainland Southeast Asia, with increases of up to 40% (20-60 mm/day) predicted across North Vietnam, Laos, parts of Thailand, China and the northern Philippines.

SEASONAL VARIATION NEAR THE EQUATOR

Below 15 degrees north, the maritime continent (Brunei, the Philippines, Singapore, East Malaysia, East Timor and Indonesia) is projected to experience a significant reduction in the frequency and intensity of rainfall from June to August, alongside increasing seasonal rainfall from March to May and September to November. Conversely, the southern Philippines is projected to see drier climate throughout these seasons.

The full scientific report is accessible from the documentation link at **www.precisrcm.com/rcct/**



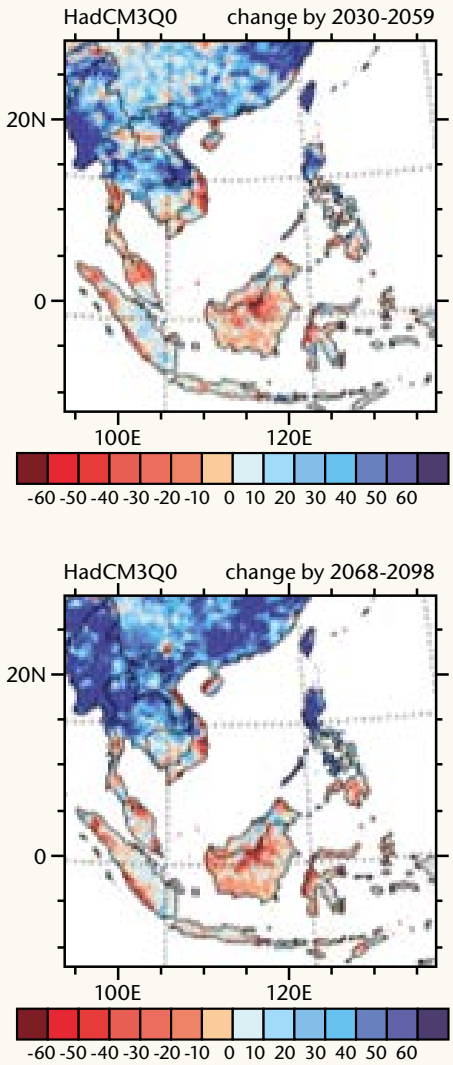


Figure 6. Projected changes in mean annual maximums of extreme rainfall events from HadCM3Q0 for mid-century (top) and end-century (bottom). Red shades show decreasing rainfall intensities (mm/day), blue shades show increasing rainfall intensities.

WHO WE ARE

The Met Office is a global centre of excellence in weather and climate science, and the United Kingdom's national weather service. Founded in 1854, the Met Office pioneered weather forecasting. Ever since then we have been at the forefront of developments in weather and climate science.

WHAT MAKES US DIFFERENT

As an international organisation, we are exposed to many challenges, and have a reputation of meeting and exceeding expectations. Our strong track record includes:

- experience of working in over 65 countries;
- a pool of internationally experienced specialist staff;
- World Meteorological Organization accredited training;
- a thorough understanding of how weather and climate are linked to development goals;
- supercomputing capacity for sophisticated modelling;
- developing one of the most accurate regional meteorological models in the world, now adopted by Australia, Thailand, South Korea, Norway and South Africa.

To find out more, please email us at internationaldevelopment@metoffice.gov.uk or call on +44 1392 885680

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