2nd CLIMATE SCIENCE EXPERTS NETWORK (CSEN) SYMPOSIUM

27 November 2012 (Tuesday), 1415 – 1730hrs
40 Scotts Road, Environment Building, Theatrette

ABSTRACTS OF PRESENTATIONS

1. Rapid and abrupt climate changes as an inherent behaviour of nonlinear feedback systems

Lim Hock, Professor, Department of Physics, NUS

Abstract

The subsystems of the earth's climate: the atmospheric general circulation, the thermohaline circulation of the oceans, etc., are governed by highly nonlinear equations. The response of these subsystems to forcings and their mutual interactions determine the state of the climate. Nonlinear systems exhibit complex behaviours. The "butterfly effect" of Edward Lorenz is well known, but it is probably more relevant to weather than climate. In this talk, we will use some simple one-dimensional nonlinear systems to illustrate some behaviours of nonlinear feedback systems, such as multiple equilibria, thresholds, abrupt changes, hysteresis, etc. Some modelling studies suggest that past abrupt climate changes could be a manifestation of such behaviours. A natural question that follows is: How can we tell if the climate is approaching an abrupt change?

2. Aerosol, Bruneian Peat, Coral and Dynamics: An Overview of the Physical Climate Research Being Conducted at SMART

Benjamin Grandey, Shao Yi Lee, Eun-Soon Im, Intan Suci Nurhati and Alex Cobb,
Singapore-MIT Alliance for Research and Technology (SMART)
Center for Environmental Sensing and Modeling (CENSAM)

Abstract

Interactions between different components of the atmosphere-ocean-land system occur over a large range of spatial and temporal scales. In order to improve understanding of climate, these different scales must be considered in relation to anthropogenic influences and natural variability. Study of past climatic changes can aid understanding of present and future climate. Analysis of coral skeletal geochemistry provides sub-monthly resolved sea-surface temperature and salinity data over the past century. These data can be used to infer past hydrological and oceanographic circulation changes in South-East Asia, changes which may play a role in the long-term evolution of regional climate variability. To provide further understanding of regional climate change, state of the art computational models can be used to investigate various aspects of the climate system and to provide projections of future climate change. Fully coupled atmosphere-ocean general circulation models are being run for a range of different future scenarios, in order to investigate the contribution of emissions uncertainty to projection uncertainty. These global data can then be downscaled using regional climate models, enabling more detailed investigation of regional impacts. In addition to South-East Asia being affected by climate change, emissions from this region may also have a large effect on global and regional climate. Tropical peat forests are an important component of the carbon cycle. However, pristine tropical peat forests are poorly understood. It is important to improve understanding of these unique biogeochemical ecosystems. When peat forests are drained, and often subsequently burned, a significant amount of carbon dioxide is released. Such fires also release much aerosol pollution, causing problematic regional haze events which may impact regional climate as well as human health.

3. Effect of model resolution on downscaling of atmospheric and ocean parameters in typhoons

Aboobacker V.M., Vinod Kumar K., P. Tkalich,
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Abstract

Model resolution has considerable impact on the prediction of atmospheric and ocean parameters, especially during extreme events. Global climate models and data sets such as NCEP (National Centres for Environmental Prediction, USA) provide coarse resolution (6 hourly, 1.9° x1.85° grid spacing) atmospheric parameters which is insufficient to resolve the typhoons. However, mesoscale weather prediction models are proved to be efficient in hindcasting and downscaling the typhoons, upon consideration of appropriate domain and resolution. In the present study, the mesoscale model WRF (Weather Research and Forecasting) has been used to hindcast the typhoon Vamei occurred during 26-28 December 2001 in the southern South China Sea (SCS) around 1.4°N latitude and closely missed Singapore region. It is one of the rarest typhoon event occurred so close to the equator which is formed due to interaction of weak vortex at Borneo shifting to southern part of SCS, and a strong and persistent cold surge at equator. WRF simulations have been carried out considering two cases - with spatial resolutions 15 km and 9 km, to understand the effect of model resolution in typhoon predictions. The results show that 9 km resolution produces the typhoon track, and wind speed and pressure along the track more closely with JTWC (Joint Typhoon Warning Centre) observations. Further, the wind waves have been simulated using a third generation wave model over two domains: a regional domain considering the SCS and part of Pacific, and a local domain consists of southern SCS and Malacca Strait. The large domain is forced by NCEP winds and thus provides the boundary conditions for the local domain. For downscaling the Vamei, wave model (local domain) is forced by WRF winds with 9 km resolution. Simulated significant wave heights were as high as 9.0 m off the southeast coast of Malaysia and 5.8 m at the area adjacent to the Singapore Strait.

4. Catchment response uncertainty in a tropical urban environment

SK Ooi, Lead Numerical Modeller, Singapore-Delft Water Alliance, NUS

Abstract

Increases in erratic tropical rainfall patterns are beginning to impose serious flood threats on tropical urban megacities worldwide. The demand for flood mitigation infrastructure (i.e. water sensitive urban design) as well as flood early warning systems is accelerating worldwide. However, the accuracy of flood predictions is highly dependent on the accuracy of hydrological models. One of the main drivers for discharge predictions at catchment scale is precipitation. As such, besides model parameter uncertainty related to rainfall-runoff processes, rainfall forecasting contributes towards the uncertainty of flood prediction. Moreover, in coastal tropical cities, where convection storms due to urban heating are common, the spatio-temporal variability of precipitation is increasing, contributing to the existing complexity of rainfall predictions and associated runoff response in urban cities such as Singapore. To understand the uncertainty of discharge simulations a detailed monitored catchment at the National University of Singapore was selected for modeling. High resolution discharge and rainfall time series were used to calibrate and validate the hydrological numerical model. Standard procedures for goodness of fit between observed and measured discharge were performed at the catchment outlet. The storm event of 12 November 2011 with a return period of 100 years was selected to assess the uncertainty of simulated discharge as a function of rainfall uncertainty. As such 32 scenarios representing rainfall variation were created using Weather Research and Forecasting (WRF) model. The different members of the ensemble differ by the parameterization that WRF uses to forecast the event. All rainfall scenarios were simulated using the validated model and the resulting uncertainty in discharge predictions were evaluated using standard statistics. These results entail valuable information with regards to rainfall-runoff uncertainty as influenced by weather predictions and needs to be incorporated when designing appropriate water sensitive urban infrastructure and flood early warning systems in tropical megacities.

5. Human-Induced Combustion and Climate: Looking Beyond CO_2!

Jason Blake Cohen, Assistant Professor, Department of Civil & Environmental Engineering, NUS

Abstract

Black Carbon (BC) and other absorbing aerosols uniquely impact the climate system by both scattering and absorbing solar radiation, leading to simultaneous heating of the atmosphere and cooling of the surface. A critical understanding of its emissions, processing, transport, and removal is necessary to accurately understand the anthropogenic impacts on the climate system.

However, BC is tricky to model: it has a mostly anthropogenic origin that is highly variable in both space and time. Furthermore, its atmospheric chemical and physical processing involves interaction with third-party chemical species. Finally, there is a strong correlation between uncertainty in prediction of the primary removal mechanism, precipitation, and those regions having both a high mean loading as well as large variability in this load. In these regards, Monsoon regions of Asia qualify as one of the toughest, yet most pertinent to study!

Recent work using a coupled climate/radiation/aerosol/urbanization model and data of from more than 100 different globally dispersed sites, has concluded that on annual average scales, emissions of BC are globally underestimated from 200% to 300%, including those emissions currently used by the IPCC RCPs. The differences in modeled and measured concentrations and optical properties will be discussed. Furthermore, differences between model computed radiative, energy, and other relevant climate parameters between the old and updated emissions conditions will be briefly summarized.

Finally, a new method and some results will be displayed to address the regionally and temporally non-uniform loading of BC over the Maritime Continent. This technique, based on remotely sensed data provides a new way to correlate, corroborate, and analyze large scale human induced combustion events.

These new constraints will be further combined with model runs under the different emissions scenarios to test the impacts of both annual average as well as more realistic cases of large-scale, season-to-season, and year-to-year variations. These results will be displayed, compared against measurements, and the influence of the time-varying component quantified both globally as well as over two regions exhibiting such an influence. It is hoped that such quantification can lead to further improvement of both impact that these play on the local atmospheric energy balance and its other properties, as well as the impact that this has on the climate system.