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CLIMATE SCIENCE EXPERTS NETWORK INAUGURAL MEETING

31 January 2012 (Tuesday), 0830 – 1400hrs
36 Kim Chuan Road, Centre for Climate Research Singapore

ABSTRACTS OF PRESENTATIONS

1. Evaluation of WRF Regional Climate Downscaling Performance for Precipitation Variability over Asia-Pacific

Dr Jeff Lo Chun-Fung, Research Scientist, Meteorological Service Singapore

Abstract

Regional climate downscaling improves the coarse resolution and poor representation of precipitation in global climate models (GCMs), and helps to access regional/local impacts of climate change. This presentation reviews the recent developments of NCAR Weather Research and Forecasting (WRF) model on regional climate modelling application, and to discuss its downscaling capabilities and limitations over the Asia-Pacific region. We used Tropical Rainfall Measuring Mission (TRMM) satellite retrieved precipitation for model verification. We performed several sets of sensitivity runs for different downscaling approaches with different model physics configurations, in separate 5-year runs. We have also examined the regional behaviours of precipitation variability using wavelet analysis. Our findings show that the nudging method is essential for regional climate downscaling, and reveal the distinct frequency characteristics and model performances for different regions over Asia-Pacific.

2. Climate system impacts associated with the sensitivity of black carbon emissions, processing, interactions with other aerosols, and atmospheric feedbacks

Dr Jason Cohen, Postdoctoral Associate,
Singapore-MIT Alliance for Research and Technology (SMART)
Center for Environmental Sensing and Modeling (CENSAM)

Abstract

Black Carbon (BC) impacts the climate system by scattering and absorbing solar radiation, as a function of its mixing state, leading to a cooling effect at the surface and a warming effect in the atmosphere. Other primary and secondary aerosols, such as Organic Carbon (OC), sulfate (SO_4) and various mixtures (such as SO_4 coated OC) scatter solar radiation, leading to a cooling at the surface. Thus, it is important to understand the distribution and processing of these species to better understand atmospheric and climate effects such as: changes in the large-scale dynamics, surface temperature, precipitation, and clouds.

However, present knowledge of BC emissions and mixing state are poorly understood. Large amounts of BC are emitted in urban areas. BC emitted due to biomass burning is a variable in its geographic and temporal distribution. Both effects are overly simplified in present-day global models. Additionally, small amounts of BC in the poorly measured remote atmosphere can have impacts on the radiative budget and hence on the climate system. Furthermore, these issues are compounded by the fact that many present GCMs use simplified aerosol-climate chemistry, physics, and couplings.

To address these issues, this work describes the results of an Ensemble Kalman Filter (EKF) to better quantify the amount and distribution of BC emissions. The EKF has been applied to tens of runs of a state-of-the-art modelling system, calculating the underlying sensitivity. The modelling environment is based on the CAM3 GCM(2), coupled with two-moment core-shell aerosol and interactive radiation models and a fast urban-scale chemical and physical process model. Previous results with this modelling setup have shown that the BC mixing state, and secondary formation of SO_4 both play a large role in the radiative forcing.

The optimized emissions and sensitivities are run in a fully interactive climate mode, coupled to a mixed-layer ocean. This allows the long-term equilibrium climate impacts and their sensitivities to be quantified as a function of BC emissions and associated mixing state, interactions with the other primary and secondary aerosols location of the emissions. Results show that using the optimized emissions lead to significant changes in the surface temperature, precipitation, and cloudiness, both globally and regionally. Additionally, it is demonstrated that these responses differ based on the region from which the baseline aerosol emissions change occur, both due to the short-term changes to the aerosol physics and chemistry, as well induced long-range changes in the dynamics and tele-connection effects.

3. Remote sensing of land cover change and deforestation in Southeast Asia and impacts on climate change

Mr Kwoh Leong Keong, Director,
Centre for Remote Imaging, Sensing and Processing, NUS

Abstract

The Centre for Remote Imaging, Sensing and Processing (CRISP) has initiated a new research area on regional land cover change and its impact on climate change. This talk presents some research work and results of the land cover change group. The highlight includes two whole South East Asia land cover map derived from MODIS (500m resolution) and other supplementary data for year 2000 and 2010. Comparison between these maps showed the amount of deforestation and loss of peat swamp forest over the last decade. At a higher resolution using SPOT satellite data, a more accurate change map showing the loss of peat swamp forest in Sumatra and Kalimantan was derived. The loss of primary forest and peat swamp forest will naturally imply an increase in carbon released into the atmosphere. Some preliminary results of a study of biomass with synthetic aperture radar data will also be presented.

4. Principal Component Analysis of Observed and Modelled Diurnal Rainfall in the Maritime Environment

Asst Prof Koh Tieh-Yong, Principal Investigator, Earth Observatory of Singapore, NTU

Abstract

Principal Component Analysis (PCA) is able to diagnose the diurnal rain cycle in the Maritime Continent into two modes which explain most of the diurnal variability in the region. The first mode results from the differential variation in potential instability forced by surface heat flux, insolation, and long-wave radiative cooling on land and sea. The second mode is associated with intrinsic mesoscale dynamics of convective systems and its interactions with gravity waves, density currents and local circulations in coastal regions or mountainous terrain. The spatial phase relation between the two modes determines whether a diurnal signal is propagating or stationary. Thus, validating model simulations of diurnal rainfall using PCA provides insights on the representation of dynamics and physics. In this paper, the main modes of diurnal rain variability in the Maritime Continent from satellite observations are studied and compared to those from Weather Research and Forecasting (WRF) model simulations. Hovmoeller analyses of the reconstructed rainfall from the first two PCA modes clarify the impact of coastlines and mountains as sources of propagating signals. Wave cavities are identified in the Straits of Malacca, Malay Peninsula and North Sumatra where stationary signals are produced. WRF reproduces the first two modes but each with a phase lead of about 1-2 hours or larger, depending on the satellite rainfall product used for comparison The basic diurnal forcing in the model seems too strong and the model responds too strongly to small islands and small-scale topography. The phase speed of propagating signals over open sea is correctly modelled but that over land is too slow.

5. Use of GRACE gravity data for assessing changes in glacier melting and water storage, and their impacts on sea level

Asst Prof Emma Hill, Principal Investigator, Earth Observatory of Singapore, NTU

Abstract

The GRACE gravity satellites take a monthly snapshot of the Earth's gravity field, and thus show how mass (primarily water) moves around the surface of the Earth, both seasonally and over the long term. The response to this movement of mass is complex: Newton's law of universal gravitation states that all mass attracts other mass. Thus, for example, as the mass of a glacier is reduced through melting, the gravitational attraction of the oceans to this glacier is reduced. This causes a distinct spatial change in sea level. Additionally, the Earth's crust rebounds as the glacier load is reduced, also causing a spatial response in sea level. This leads to the rather counterintuitive result that sea level will fall in the vicinity of a glacier, but rise at higher-than-average levels in the tropics. We thus see how sea-level rise in Singapore is very much connected to the melting of distant glaciers.

6. Internal characteristics of tropical rainfall

Assoc Prof Tan Soon Keat, Student Director, Maritime Research Centre, NTU

Abstract

By looking at the characteristics of a rainfall mass curve during a rainfall event, one could extract information of the distribution of rainfall intensity during the rainfall duration. Typically the rainfall is categorised in 4 quartiles, the first quartile being the situation when more than half of the rainfall depth is discharged within the first quarter of the rainfall duration. This study presented the findings of quartile rainfall distribution observed in Singapore, for rainfall during the northeast monsoon, southwest monsoon and that of convectional rainfall. The study noted that this characteristic appear to be a function of rainfall duration, quantity and type of rainfall (monsoonal or convectional). However, it could be concluded that majority of the rainfall display the typical S-shape distribution, falling into the first and second quartile.

7. Impacts of sea-level rise on salinity intrusion in coastal habitats

Asst Prof Vivien Chua, Department of Civil and Environmental Engineering, NUS

Abstract

Sea-level rise leads to an increase in the salinity of surface water through salt water intrusion. Rising sea levels result in a landward shift of the estuarine salinity field, threatening freshwater supplies upstream. Intrusion of salt water increases the salinity of habitats upstream and may have significant impacts on marine ecosystems that are unable to tolerate high salinity. Wetlands such as salt marshes and mangroves are located close to sea level and particularly susceptible to sea-level rise. Rising sea levels accelerate erosion and new wetlands are formed inland as previously dry areas are flooded. This talk will focus on preliminary efforts to assess the impacts of sea-level rise on salt water intrusion in estuaries by applying models of circulation and transport. The numerical model will subsequently be applied to coastal waters of Singapore to assess the evolution of intertidal wetlands, predict wetland stability and identify sites for wetland restoration in the face of climate change. An enhanced understanding of coastal sensitivity to sea-level rise will enable the management community to prioritize management strategies, improve guidelines for coastal management and assess impacts on water resources and ecosystems.

8. Urban temperature map as a tool for a climatic responsive urban planning for high density city

Dr Steve Kardinal Jusuf, Centre for Sustainable Asian Cities, NUS

Abstract

Urban Heat Island phenomenon has become a common problem in many major cities worldwide. Our study in Singapore concluded the existence of temperature pattern that is closely related to the urban land use. This temperature pattern indicates its relationship with the surrounding distribution of greenery, building and pavement. The *Screening Tool for Estate Environment Evaluation* (STEVE) has been developed to quantify the relationship. The STEVE when used in the GIS platform prove to be very useful for planners to study the air temperature conditions across the estate, either to improve the estate's existing condition or to study the air temperature impact on the future master plan. The generated temperature maps help the planners to point out the hot spots, so that the planners are *able to modify the estates' morphology distributions.*