

東亞歷史氣候 學術討論會

2017

2.13⁽⁻⁾ ~ 2.14⁽⁼⁾

主辦單位：中央研究院環境變遷研究中心
協辦單位：中央研究院永續科學中心
中央研究院人文社會科學研究中心



會議議程

2017.02.13 (一)

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歷史氣候研究的新認知

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本報告簡述中國歷史文獻中的古氣候記錄的概況和近三十餘年來進行的歷史氣候資料的系統採集、收藏和《中國三千年氣象記錄總集》的編寫、以及中國歷史氣候基礎資料庫的研製等情形。著重講述這些歷史氣候記錄被用於重建定量的歷史氣候序列（溫度、降水、乾濕、降塵、梅雨等）、復原歷史氣候極端事件實況（乾旱、雨澇、寒冬、炎夏等）和定量推斷歷史極端氣候值的探討（以 1876-78 年乾旱、1892/93 年寒冬、1743 年炎夏為例），以及編制古環境事件年表（降塵、蝗災年表）和用於古氣候代用資料（proxy data）校準等方面的嘗試。

中國夏商周文明發展的氣候背景：

古環境資料的整合與評析

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近年來「古科學」(Paleosciences) 蓬勃發展，能就各種天然古環境檔案（海洋及湖泊岩芯、石筍、樹輪、冰芯等）提取高時間解析度的連續環境變遷時間序列。上世紀末，因「夏商周斷代工程」的成功執行，對於中華古文明起源期的夏商西周的年代有初步斷定。本文結合這兩方面（古環境科學及夏商周斷代）的進步成果，就夏商西周時期（公元前 2070 到公元前 770 年間）的古環境背景做進一步的檢視。

除了夏朝開國與商朝末期，整體夏商時期，都處於相對乾涼少雨的狀態。夏朝初年（公元前 2050 年）的高雨量與大禹治水的傳說相呼應。長江中游雨量最低（夏季西南季風減弱）的時候集中在夏朝末年（公元前 1600 年）、公元前 1400 年，及公元前 1250 年（盤庚遷殷之後）；此雨量低落時期持續的到商朝末年的公元前 1100 年（約商後期之文丁、帝乙時期）後，雨量才明顯升高（夏季季風變強）。而此較高雨量的情況一直延續到周朝末年。

東亞夏季風變化與湖泊優養化

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東亞夏季風變化和異常是學術界和政府部分均感興趣的研究課題。作者總結了不同代用指標記錄的全新世東亞夏季風變化歷史，指出東亞夏季風導致的中國降水在空間上存在差異變化，中國北方降水多少是衡量東亞夏季風強弱的指標。眾多可靠記錄說明，東亞夏季風在全新世中期達到現代間冰期的最強盛階段，而石筍氧同位素變化不能指示這一變化，這一指標不是一個有效的東亞夏季風變化的代用指標。在近 2000 年來，依託高山湖泊記錄，首次揭示在隋唐和中世紀自然暖期下高山湖泊發生了顯著的湖泊優養化，而在現代暖期下亞洲高山湖泊生物快速回應全球變暖但沒有發生優養化。研究發現，在人類活動驅動的現代氣候變暖背景下，亞洲地區快速工業化產生的氣溶膠污染對亞洲夏季風的顯著影響導致高山湖泊生態系統產生不同於自然暖期下的回應過程。研究成果發表在《Nature Climate Change》、《Earth Science Reviews》、《Scientific Reports》等學術刊物。

歷史氣候定量化研究方法與指標的敏感性探討

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歷史氣候定量化研究的主要途徑有兩種，一是借助各種代用資料和歷史文獻記載與現代觀測資料的對比建立統計關係，進而重建歷史氣候要素值；二是利用氣候模式再現過去氣候要素場，得到量化的時空分佈。這兩種方法各有特點，但都存在不確定性，也就是對真實氣候的逼近都存在不同的差距。這種不確定性與使用的方法和模式有關，也就是它們對真實氣候要素變化表現出的敏感性是不同的。透過對代用資料重建歷史氣候的個例分析和強迫條件對氣候模擬再現結果影響的討論，初步探討了歷史氣候定量化中的敏感性問題。結果顯示，代用資料的選取、處理和使用方法，氣候模式強迫條件的改變都會對過去氣候要素的重現結果產生顯著影響。由此初步認為，提出敏感性問題對盡可能真實地定量重現歷史氣候有所幫助。

REACHS 東亞歷史氣候資料庫架構與重建方法探究

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歷史氣候重建是氣候變遷研究最重要的課題之一，當代的歷史氣候重建多仰賴環境的代用指標，例如湖底沉積物、冰芯、樹輪或石筍等，以進行高解析度的時間序列重建，然而此種仰賴環境指標的方法，難以涵蓋連續性的空間向度，以分析氣候在空間上的變異特性與型態。建置高時間與空間解析度的歷史氣候資料，因而扮演非常重要的角色。從歷史文獻中提取氣象紀錄，以製成分析可用的氣候指標，雖然存在文字記錄與解讀上的不確定性(此部分討論將由許世旻先生發表)，卻是寶貴的歷史觀測資料，且涵蓋連續性的時間與空間尺度，有利於進行各種高解析度的歷史氣候分析。

本研究將介紹中研院永續科學計畫從 2015 年開始進行的東亞歷史氣候資料庫(REACHS)建置研究，透過數化整部《中國三千年氣象記錄總集》，及系統化與標準化的資料處理程序，按事件屬性、時間、空間、詞彙釋義與登錄檢校等五大類別，建置關聯式資料管理系統。使五大類別相互獨立又彼此關聯，且每筆紀錄都有可參照的定性化氣象編碼、中西曆轉換時間與空間座標，可進行資料存取，及跨時間與空間尺度的量化研究。目前我們從已經數化校對完成的清代氣象紀錄中，提取相關紀錄，使用不同的分析方法進行各種時間與空間尺度的溫度與降水重建，以討論在時間向度下氣候重建的區域特性與空間變異性，並討論指標與分析方法的敏感性。

歷史氣候重建，不僅有助於了解長期氣候變化型態、速率與大氣循環週期的演化關係，更有助於梳理人類發展與環境的關聯性，本資料庫未來將陸續公開於學界，希冀引發後續更廣泛而深入的跨領域研究。

歷史紀錄文獻與詞彙考證

—以《中國三千年氣象記錄總集》為對象

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本研究團隊在數化《中國三千年氣象記錄總集》的過程中，除了發現許多熟悉的自然辭彙，例如：「大雨」、「大旱」、「大水」，更見到諸如「愆雨」、「苦旱」、「壩水」等當代較不常見的詞彙。詞彙本身存在不同時間與空間背景下的模糊性，也具有時間向度上的延續性與演繹性。如何較為精準的解讀歷史氣象紀錄中所使用的詞彙，以降低因詞意不清而增加的文本不確定性與對立性，是本資料庫建置過程中最重要的基礎研究工作之一。在本資料庫中，每個詞彙除了都具有其獨立的詞彙編碼，以供外部對照檢視外，針對當代不常見或較具爭議性的詞彙，研究人員透過「研究回顧」以及「文獻考證」方法交叉分析現代學者的論著與古代文人的典籍，以試圖從中判知這些較為陌生的自然辭彙在被記錄當時的歷史背景下的意義。目前，本研究團隊已經初步完成《中國三千年氣象記錄總集》第三冊詞彙與文獻考證，並將研究心得書寫成〈歷史氣候辭彙字典（清朝）〉以及〈歷史考證報告書第3冊〉，以供檢視，並提升本資料庫建置過程的整體透明度與可信度。

Reconstruction of Climatic and Weather Characteristics over the Shanghai Area in Qing Dynasty

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This study is aimed to reconstruct the climate of Shanghai area in Qing Dynasty (1644-1911) through analyzing the weather descriptions in the historical documents. The temporal variations of temperature and precipitation, spatio-temporal variations of special weathers such as typhoon, hail, thunderstorm, tornado and flooding, and associations between meteorological parameters are investigated.

The average and extreme dry-wet indexes show a frequently dry or wet change in 1644-1730, but a mostly wet change after 1740. The decadal winter and summer temperature indexes show that the Shanghai area is colder in the first fifty years and last fifty years than the middle period of 150 years. However, there is no warming trend during the study period. Summer temperature has a significantly negative relationship with extreme rainfall from decadal data, implying higher extreme rainfall and then lower summer temperature with a non-synochronous change.

The frequency of typhoon, hail, thunderstorm, tornado and flooding is 2.5, 2.3, 3.6, 1.8 and 3.6 for every ten years, respectively, and thunderstorm and flooding have the highest frequency among the spatial weathers. The spatial distribution of event frequency shows that typhoon occurs more in the southeast and northwest. Hail, thunder and tornado have a similar pattern, more in the middle and northwest. This could be attributed to areas close to the sea and the river, and higher urban development status. Flooding occurs more in the counties along the river and sea or in the isolated island, due to the effect of river and sea levels.

Associations between temperature, precipitation and special weathers show that typhoon contributes to average and extreme precipitation; more thunderstorms in the whole year or in the winter contributes to average precipitation in the whole year or in the winter, then lower summer temperature and more flooding. More typhoons and tornados might cause more flooding. Strong associations between hail, thunderstorm and tornado might be caused by severe convective systems and large-scale unstable atmosphere.

Keywords: temperature, precipitation, severe weather, typhoon, tornado.

東亞古風暴學的研究倡議

Towards Developing a Paleotempestology Research Agenda for East Asia

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Tropical cyclone (TC) or typhoon activity in East Asia is intricately related to ENSO and other components of the climate system. Despite an increasing number of paleo-typhoon proxy records in recent years, the development of paleotempestology, a relatively young scientific field that studies paleo-TC activity, is still in its infancy for the East Asian region. Here I draw upon the inspiration provided by paleotempestology research in North America and elsewhere during the past two decades to highlight some key research questions and possibilities for the development of paleotempestology in East Asia.

Compared with other TC regions in the world, an advantage that East Asia (especially China) offers is its rich resources in documentary history, which can be used to complement and validate proxy data obtained from geological records. Conversely, geological proxy data can also be used to verify the validity of historical storms events contained in the documentary record, and to put their occurrence in a broader paleoclimatic perspective. It has been well established that due to longitudinal shifts in TC genesis locations associated with different ENSO conditions, more recurving TC tracks occurred during El Nino years and more westward straight-moving tracks occurred during La Nina years. Since different predominant track types imply different landfall locations along the coastal zones from north to south, a major research topic for paleotempestology in East Asia would be to reconstruct the spatial and temporal patterns in typhoon activity regimes in different geographical locations in East Asia, and to correlate these changes with indices of ENSO activity during the past centuries to millennia.

Moreover, a recent study based on an annually-resolved stalagmite proxy record from the western Caribbean suggests that during the past five centuries Atlantic TC tracks responded sensitively to latitudinal shifts in the positions of the ITCZ and NH Hadley Cell driven by anthropogenic greenhouse gas and sulphate aerosol emissions. Whether such large-scale atmospheric shifts identified from the Atlantic TC basin also applied to TC activity regimes in the Western North Pacific basin would pose a significant research opportunity for paleotempestology in East Asia. Until reliable proxy records are available, however, centuries-long reconstructions of historical typhoon activities derived from documentary evidence could serve as a starting point for investigating these regional teleconnections and climatic linkages.

歷史、社會與氣候變遷

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人類的生活環境受到氣候的影響十分重大。因此每當氣候有顯著改變時，人類社會會受到很大的衝擊，急劇的氣候變遷造成社會動盪，甚至整個政治系統的崩潰。我們若從歷史文獻中收集有關氣候的記錄，並加以謹慎的分析，便可能獲知歷史時期的氣候概況，甚至個別氣候因子（氣溫、乾濕、降水等等）之時間序列。本研究先對先前已有之一些此類研究結果作一簡單綜論，然後從近來根據《中國三千年氣象記錄總集》中的清代記錄之數值化檔案中提取出來的一些氣候序列作一個初步分析，並討論這些序列的一些特徵，並與前此的一些結果互相比較，以期澄清若干疑點。另外，由於大多數的氣候序列重建工作大多聚焦於冷熱與乾濕因子，較少及於環流型式，本研究也嘗試對利用歷史氣候記錄來重建大氣環流型式之變遷作一個可行性之探討。

近三百年東北亞沿海地帶的颱風活動研究

—基於中日韓三國歷史文獻

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Based on a variety of historical literatures of China Japan and Korea, the annual frequency sequence of typhoons making landfall in coastal regions of East and South China from 1650AD to 1911AD is established through examining the meaning of "Ju" (颶) and "Tai" (颱), analyzing recorded characteristics of storm tide phenomenon, as well as the exclusion of non-typhoon events. In the study period (AD1644-1911), a total of 967 typhoons made landfall in China (average 3.62 times), and the typhoon activity is very active in the second half of the 17th century and at the turn of the 19th and 20th century. Changes in temperature conversion in global / hemispheric scale increased in the late 19th century to the early 20th century with the number of typhoons making landfall in coastal regions of China, and over the last 300 years was the period of the fastest rate of growth, but rapid warming phenomenon at the turn of 17th century and 18th century decreased with the number of typhoons making landfall in coastal regions, so the rapid warming phenomenon in global / hemispheric scale and the number of the typhoon happened in coastal regions of the East and South China are irrelevant. On the inter-decadal scale, typhoons that influence coastal regions of East China and coastal regions of South China have the obvious inverse correlation. "Global warming" that effects on the environment still has a great deal of uncertainty, whether a series of disastrous weather, including typhoon, increase because of "global warming", still needs a lot of study works, and also includes a review of cases in history. The relationship between the factors like typhoon strength, its motion path and its remaining time and "global warming" will be still unclear, so that it needs more works. The spatial variation of typhoon activity in coastal regions of East China and South China that article reveals cannot yet give a better explanation, and it should be provided for academic discussion.

尺度氣候，尺度人類社會響應

Scaling Climate, Scaling Human Social Responses:

**a philosophical analysis on the scale issues of climate/culture, politics
and society relationship**

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Recent years, a great proportion of quantitative and qualitative studies concerning the climate change and society relationships in the past have been published after our pioneering exploration on the quantitative relationship between climate change and wars/population in China and around the world (Zhang et al. 2005 and 2007). Many researchers from different parts of the world found that there is a strong association between climate change and war frequencies in history. Such association exists in history of different civilizations and countries ranging from Middle Holocene to recent history. However, some researches show that there is no correlation between climate change and wars at local and regional levels. After carefully examination on these results, here we identified that the cause of such dissimilarity involves a fundamental issue for time series analysis: the scale.

The long-term political and social process are embedded in a complex system that includes both natural and social components. However, any complex system is determined by different factors at different spatial-temporal scales (O'Neill et al. 1989; Norton & Ulanowicz 1992). In this study, the human consequences of climate change were measured at different levels and along multiple scales. As the climate determined ecological and economic conditions in the pre-industrial era, climate change played a very role in human civilization process at different given spatial-temporal scales in history, especially at macro-scales. For the cases of “no correlation”, most of them mismatched scales or were presented with micro-scales. I believe that some processes are more fundamental than the rest in the complex system at a given temporal or spatial scale. Therefore, human social, economic, ecological and political changes at different scale units might have different causes.

The possible impact of hydroclimate dynamics in northern Mediterranean on ancient cultures

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Instrumental observations show that Mediterranean region, as a hot spot of global hydroclimate realm, currently features an unstable climate structure and increased frequency of drought in the past decade. Collapse of some well-known ancient Mediterranean civilization, for example, the Egyptian Old Kingdom and the Uruk Empire, was also hypothesized to be attributed to abrupt climate shifts. However, few high-resolved and well-dated paleoclimate time series hinders our understanding of Mediterranean climatic dynamics since the mid-Holocene and its impact on regional culture development. Here we present an absolute-dated stalagmite-inferred multiannual-resolved hydroclimatic record from the northern Italy over the past 6500 years. Our record shows good correlation between abrupt drought events, with 50 mm/month precipitation decrease within 30 years, and timing of demise of some ancient civilizations. The severe hydroclimate fluctuations could be governed by North Atlantic Oscillation, teleconnected with El Nino-Southern Oscillation variability. The revealed Mediterranean climate response to internal/external forcings offers better comprehending of climatic change, planning of resource management and making of sustainability policy.

歷史氣候資料庫之網站與時空資訊系統建置規劃

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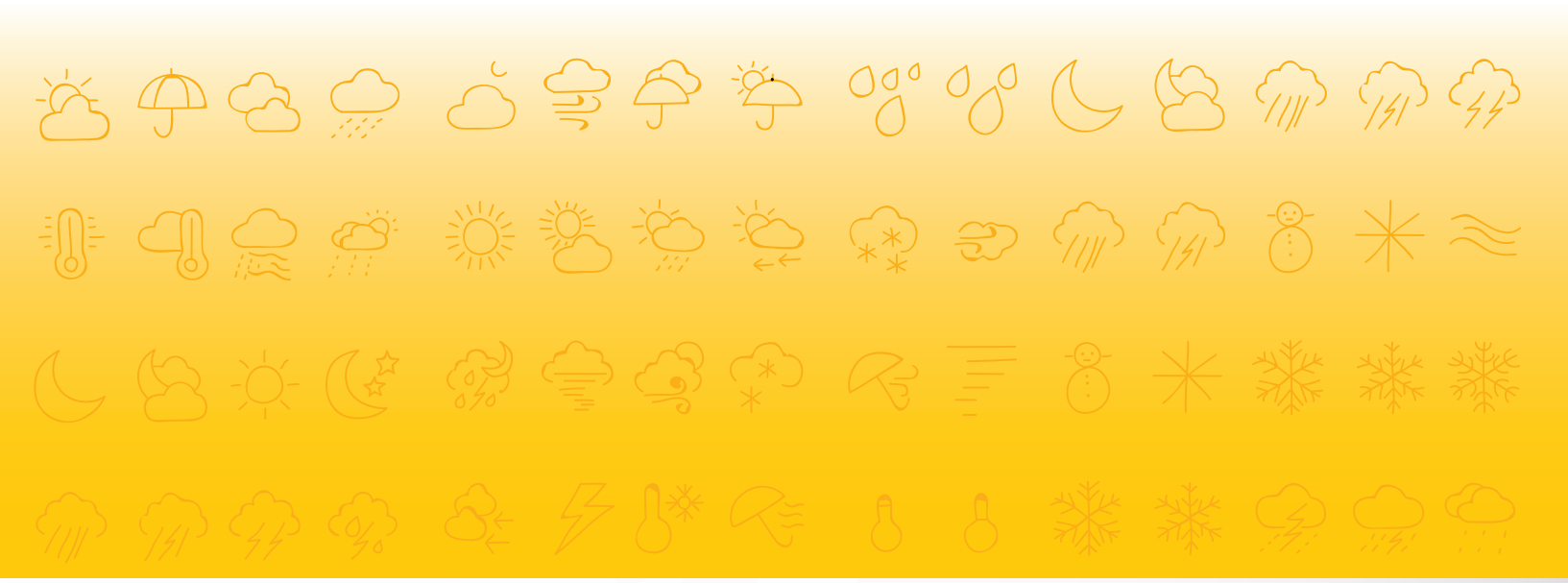
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本研究嘗試建立歷史氣候資料庫之網站及歷史氣候時空資訊平台，網站提供計畫背景資訊（例如：歷史氣候資料進檔、編碼方式、編碼）以及各類型加值處理後的產品或研究成果；平台則是提供歷史氣候資料線上資料探勘分析工作，並結合 GIS 軟體僅行視覺化展示。

目前歷史氣候時空資訊平台完成整合分類詞彙表，設計互動式的資料檢索與地圖瀏覽介面。資料檢索包括全文檢索方式，以及透過分類索引結合時間區間之設定，進行文本內容篩選，以檢視查詢結果所得相關歷史氣候事件詞條，並可下載 CSV 檔。配合分類表的主類別與次類別等分層的類別分析結果，在網頁中進行索引編排，可由主類別進行整批資料檢索，或逐一由次類別來檢索。由於檢索結果之詞條，在資料庫中已藉由地方志來源擷取其所屬地域名稱，與 CCTS 地名資料庫進行比對，賦予空間座標，因此，可同時透過介接地圖瀏覽功能，形成圖文對照的效果。在地圖設計上，可整合 CCTS 歷代地圖的 WMTS 服務及 OpenLayers 等開放式電子地圖，便於套疊多時期圖層進行比對運。為區隔不同使用者的資料使用權限，已開始進一步設計網站的會員權限管理功能；此外，為確保網站功能切合需求，預計增加訪客互動資料收集功能。未來將持續透過討論進行網站各項功能的擴充與改善，使系統充分符合研究需求。

關鍵詞：資料庫、歷史氣候資料、GIS、時空資訊



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