



西北太平洋 热带气旋气候图集

Climatological Atlas of
Tropical Cyclones over the
Western North Pacific

1981 ~ 2010

中国气象局上海台风研究所

Shanghai Typhoon Institute, China Meteorological Administration



科学出版社

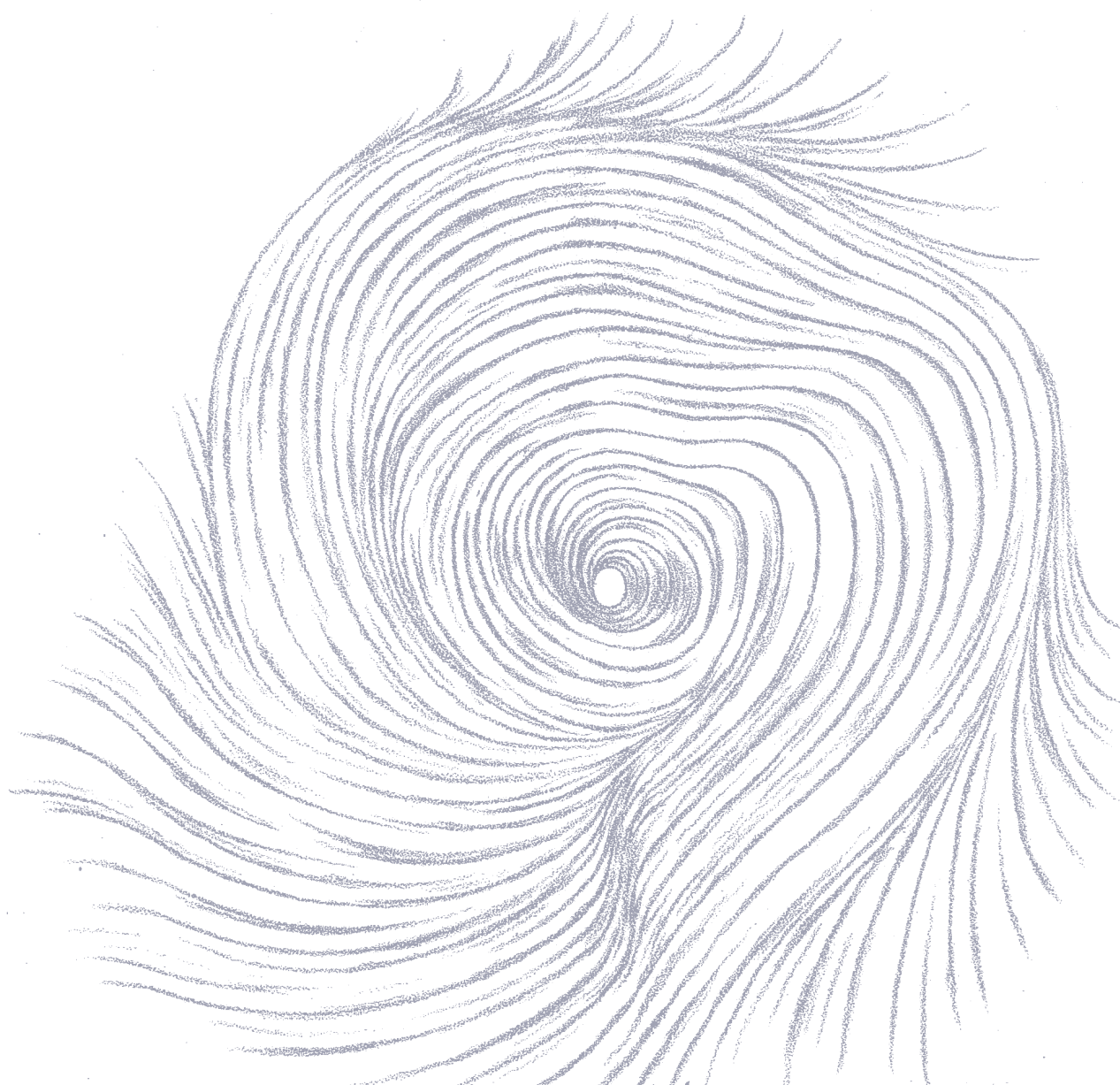
www.sciencep.com

国家科学技术学术著作出版基金资助出版

西北太平洋热带气旋气候图集

Climatological Atlas of Tropical Cyclones
over the Western North Pacific

1981~2010



中国气象局上海台风研究所

Shanghai Typhoon Institute, China Meteorological Administration

科学出版社

北京

《西北太平洋热带气旋气候图集 (1981~2010)》

编纂委员会

主 编：雷小途 应 明

副 主 编：余 晖 鲁小琴 唐 曦 赵兵科 顾建峰

技术总设计：应 明 鲁小琴

地图总设计：唐 曦

审 稿：李永平 曹晓岗 冯泾贤

学术顾问：陈联寿 陈永林 刘 敏 黄余明 李朝颐 陈智强 朱永提 漆梁波
林 毅 林良勋 吴立广 任福民 赵珊珊 陈光华 张 维 曾智华
万日金 邓之瀛

统计计算：陈佩燕 占瑞芬 岳彩军 张 吉 季晓东 王 晓 白莉娜 廖 蜜

地图编绘：孙斐然 宋 歌 徐鹏飞 赵 越 张 玥 朱 峰 陈一凡 蒋俊帆

英文翻译：应 明 余 晖 方志刚

责任编辑：彭胜潮

制印工艺：高晓梅 薛海红 张理学

主编单位：中国气象局上海台风研究所

制图设计单位：华东师范大学地图研究所

协作单位：上海中心气象台
香港天文台
澳门地球物理暨气象局
台湾大学大气科学系
上海气象博物馆
国家卫星气象中心
中煤航测遥感集团有限公司

地图制印：中煤地西安地图制印有限公司

Climatological Atlas of Tropical Cyclones
over the Western North Pacific (1981–2010)

EDITORIAL COMMITTEE

Chief editors :	Lei Xiaotu	Ying Ming			
Associate chief editors :	Yu Hui	Lu Xiaoqin	Tang Xi	Zhao Binke	Gu Jianfeng
Technical designers :	Ying Ming	Lu Xiaoqin			
General cartographic designer :	Tang Xi				
Reviewers:	Li Yongping	Cao Xiaogang	Feng Jingxian		
Scientific advisors :	Chen Lianshou	Chen Yonglin	Liu Min	Huang Yuming	Li Chaoyi
	Chen Zhiqiang	Zhu Yongti	Qi Liangbo	Lin Yi	Lin Liangxun
	Wu Liguang	Ren Fumin	Zhao Shanshan	Chen Guanghua	Zhang Wei
	Zeng Zhihua	Wan Rijin	Deng Zhiying		
Statistical analyzers :	Chen Peiyan	Zhan Ruifen	Yue Caijun	Zhang Ji	Ji Xiaodong
	Wang Xiao	Bai Lina	Liao Mi		
Map and information designers :	Sun Feiran	Song Ge	Xu Pengfei	Zhao Yue	Zhang Yue
	Zhu Feng	Chen Yifan	Jiang Junfan		
Translators :	Ying Ming	Yu Hui	Clarence Fong Chi-Kong		
Responsible editor :	Peng Shengchao				
Map technician :	Gao Xiaomei	Xue Haihong	Zhang Lixue		

Principal editing institution :	Shanghai Typhoon Institute, China Meteorological Administration
Cartographic institution :	Institute of Cartography, East China Normal University
Cooperating institutions :	Shanghai Central Meteorological Observatory
	Hong Kong Observatory
	Macao Meteorological and Geophysical Bureau
	Department of Atmospheric Sciences, Taiwan University
	Shanghai Meteorological Museum
	National Satellite Meteorological Center
	Aerial Photogrammetry and Remote Sensing Co. Ltd. (ARSC)
Mapping and printing :	Xi'an Mapping & Printing Co. Ltd. of China National Administration of Coal Geology

序

中国气象局上海台风研究所 (Shanghai Typhoon Institute, STI/CMA) 自1978年成立以来, 对我国台风研究和业务做出了重要贡献。重要贡献之一是提供了整编后的中国、南海和西北太平洋热带气旋基本资料, 其中两套系列性的出版物最为重要: 一套为《台风年鉴》, 20世纪80年代后期改名《热带气旋年鉴》; 另一套即为西北太平洋热带气旋气候图集。前者为每年出版一册, 后者为每10年整编出版一册; 目前以中英文双语公开出版的气候图集有《西北太平洋热带气旋气候图集》(1951~1980年) 和《中国热带气旋气候图集 (1951~2000)》。这两套系列出版物的整编出版, 对我国台风科研和业务起了重要的推动作用, 并对台风防灾减灾、台风业务管理以及高等院校教学具有重要的应用和参考价值。

这本图集是继《西北太平洋热带气旋气候图集》(1951~1980年) 后第二个30年 (1981~2010年) 的整编资料, 具有如下特点:

(1) 内容丰富完整。该图集显示热带气旋气候特征很全面, 包括发生发展消亡、强度和强度变化、双热带气旋和多热带气旋; 移动路径及其变化、移向移速和转向点分布、异常路径; 影响和登陆中国的热带气旋及其风雨强度和分布。图集内容包括台风气候特征的各个方面, 使它具有较高的业务应用和科研参考价值。

(2) 资料与时俱进。这30年与前30年相比, 大气探测技术有了飞速发展, 气象卫星和雷达等遥感资料广泛深入地应用, 并对一些台风登陆前后作了外场观测试验。在此期间大量的自动站高密度地布设, 这使得图集资料的精细化和正确性有了很大提高。

(3) 具有权威性和不可替代性。该图集和它所依托的热带气旋年鉴一样, 在国内具有权威性和不可替代性; 尤其对影响和登陆中国的热带气旋, 更是依托在中国的业务观测系统上, 它是权威的, 也是不可替代的。对此, 图集和年鉴的编纂人员精心设计和整编, 努力工作, 对图集的出版作出了奉献; 广大读者对图集定会倍加爱护, 帮助改进和提高。

创新和完善是永无止境的, 希望气候图集能一代一代传承下去, 持之以恒, 定将会对台风科研和业务做出持续性的更大的贡献。

中国工程院院士 陈联寿
2017年4月于北京

Great contributions have been made by Shanghai Typhoon Institute, China Meteorological Administration (STI/CMA) for the development of national typhoon research and operation since her establishment in 1978. One of the important contribution is to publish the basic data of tropical cyclones (TCs) in China, South China Sea and western North Pacific after data processing and editing. Among them, the two serial publications are most important. The one is *Typhoon Yearbook*, then replaced the name with *Tropical Cyclone Yearbook* in late 1980s. The other is climatological atlas of tropical cyclones. The former is edited and published once a year and the latter is edited and published one volume every ten years. Two climatological atlases, which were named *Climatological Atlas for Northwest Pacific Tropical Cyclones* (1951–1980) and *Climatological Atlas of Tropical Cyclones Affecting China (1951–2000)*, had been published in Chinese-English bilingual versions. These data publications advance development of TC research and operational work. It is also valuable for the area of disaster prevention and preparedness, operational management as well as the references for college educations.

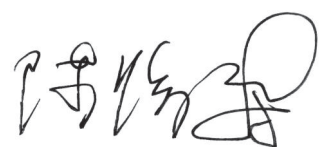
This is the second thirty years (1981–2010) volume of climatological Atlas for TCs over the Western North Pacific basin with the following properties.

(1) Plentiful and integral contents. The Atlas comprises the TC formation and decay, intensity and intensity change, binary and multiple TC frequency and distribution; tracks and motion variation, the distribution of TC motion direction/speed and recurvature point of the tracks, TC unusual movement; the frequency and distribution of TCs which affected China or made landfalling in China and their corresponding winds and rainfall. The contents almost cover all aspects of the TC climatological features. It enables more utility in different areas of tropical cyclone.

(2) Data advanced with time. Atmospheric observational techniques have developed a great deal in the late thirty years. Remote sensing data from satellite and radar have been widely employed in tropical cyclone detection. Field experiments for individual landfalling typhoons had been implemented frequently in this period. On the other hand, dense automatic weather stations had been deployed and developed. The advanced observation systems have promoted the data quality in the Atlas.

(3) Authoritativeness and not substitutable. Data for off shore TC, especially for landfalling typhoons totally depend upon domestic observational system. So the two publications are authoritative and not substitutable. The editorial staff offer their great contributions with meticulous and elaborative work for the publications. The readers will cherish it and help to improve the further publications.

Innovation and perfection are endless. It's hoped that the TC climatological Atlas should be handed down and persevere in. Then the persistent contribution will be made for the tropical cyclone research and operational forecasting.



Prof. **Chen Lianshou**

Academician, Chinese Academy of Engineering

Beijing, April, 2017

热带气旋是世界上发生频率高、危害程度大的灾害性天气系统，它所带来的大风、暴雨、风暴潮以及伴生的其他灾害常造成极大的经济损失和人员伤亡，严重影响公共安全和社会稳定。据瑞士再保险公司统计，造成全球保险损失金额最高的十大灾害事件中有八起与热带气旋有关。

西北太平洋是全球热带气旋发生频率最高的海域，也是全年各季均可能生成热带气旋的海域。中国地处西北太平洋西岸，每年登陆中国的热带气旋90%集中在人口密集、经济发达的东南部沿海。随着经济社会的发展和人口规模的增长，热带气旋造成的经济损失呈日趋加重的态势。因此，做好热带气旋的监测、预报、预警和防御工作越来越重要。作为基础工作，热带气旋资料的整编和统计、热带气旋气候特征的总结和分析，将有助于从历史事实中认识热带气旋活动的一般规律，为热带气旋预报和深入开展热带气旋研究提供基础数据与参考思路。这也是制订合理的防台对策、保障人民生命财产安全、促进经济社会可持续发展的重要基础性工作。

1972年，中央气象台与上海气象局牵头，会同相关省市气象局、气象与海洋院校等单位，整编出版了1949~1971年逐年的热带气旋年鉴。之后，上海市气象局成立了热带气旋年鉴整编小组（上海台风研究所台风气候室前身）负责此项工作。年鉴整编组在中国气象局与有关省（自治区、直辖市）气象局的支持和协助下，每年组织整编热带气旋年鉴。经过多年的努力，上海台风研究所积累了1949~2015年的热带气旋资料。在此基础上，中国气象局先后整编出版了《西北太平洋台风基本资料集（1949~1980年）》《西北太平洋热带气旋气候图集》（1951~1980年）和《中国热带气旋气候图集（1951~2000）》，深受气象工作者和水文、海洋、建筑设计、保险等部门的欢迎。

20世纪80年代以来，气象卫星、天气雷达、自动气象站网、风廓线仪等先进探测装备广泛应用，涵盖了从地面到高空的立体探测。这些观测资料的积累有助于对热带气旋中心准确定位，也有助于对热带气旋移动与强度变化、精细结构、和环境场相互作用等科学问题的探索，促进了热带气旋监测和预报水平的大幅度提升。为了及时总结热带气旋活动的气候规律，增强我国热带气旋基本资料的系统性和完整性，发挥资料的更大价值，中国气象局预报与网络司于2013年委托上海台风研究所整编出版《西北太平洋热带气旋气候图集（1981~2010）》。自该项工作启动以来，图集的主创者以饱满的热情投身其中，集思广益，对图集内容进行了科学的设计，对每一个细节都反复斟酌、论证和修改完善，付出了很多心血和汗水。

我看了这本令人耳目一新的图集样稿，深为作者科学严谨、认真负责的精神所感动，欣然为其写序，并因其具有以下特点而向广大读者推荐。

一是数据翔实可靠，内容与时俱进。图集依托中国气象局整编的热带气旋基本资料，不仅融合了先前出版图集之精髓，而且追踪科研业务发展趋势，更新与增补了大量内容，推陈出新。图集内容全面、完整，既总结了西北太平洋海域热带气旋的活动（发生发展消亡、路径与移动等），又概括了热带气旋对中国的影响（风、雨和登陆等），统计深入精细，实用性强。

二是设计理念新颖，结构脉络明晰，表现手法美观多样。每个专题由一幅主图与若干辅图构成，内容相互关联。除了常用的图示、表格，还有多项目时空结合的立体展示，并对重点内容加以渲染，使图幅包含丰

富的信息量。如生命史图，描述了三十年内所有热带气旋从发生发展至消亡的过程，既有强度等级，又有热带气旋静寂期与频发期、除名热带气旋等信息。用如此直观生动的手法表现丰富综合信息的图表，在该图集中比比皆是，令人耳目一新。

三是主创人员的精与勤。他们都是长期工作在热带气旋领域的佼佼者，目光敏锐，对热带气旋科研业务发展脉搏有准确的把握，工作作风严谨、务实，有力保证了图集的专业性、先进性和实用性。

我相信，该图集的出版将成为各界了解热带气旋的又一重要窗口，必将受到广大气象工作者与各应用部门的欢迎，成为热带气旋预报预警业务、科研和教学工作者不可或缺的参考工具，对提高全社会防御热带气旋灾害的水平和保障经济社会的可持续发展有重要价值。

郑国光

中国气象局局长 郑国光
2016年10月于北京

I am very impressed by the new updated *Climatological Atlas of Tropical Cyclones over the Western North Pacific (1981–2010)* which the Shanghai Typhoon Institute will issue soon. This Atlas gives very detailed and authoritative new information on tropical cyclones in the world's most active cyclone basin.

This long report gives extensive statistical analysis of the large variety of Northwest Pacific tropical cyclone sizes, intensities, movement characteristics, frequency of occurrence, annual-monthly-seasonal differences, long-period variability and many other features. This new updated Atlas should be of help to anyone having to deal with the Northwest Pacific tropical cyclones or anyone who just wants to learn of the characteristics and wide ranging behavior aspects of these unique cyclone systems.

William M. Gray
Professor Emeritus
Colorado State University
July, 2013

前 言

西北太平洋和南海海域是全球热带气旋最活跃的海区。热带气旋给该海域沿海各国造成严重灾害，全球受热带气旋灾害影响最严重的10个国家中有6个毗邻该海区。中国又是其中最为严重的国家之一，受热带气旋影响的地区南起“两广(广东、广西)”和海南，北至“东三省(辽宁、吉林、黑龙江)”，除新疆、西藏和青海等省(自治区)外，均曾遭受过热带气旋的侵害。当然，除了带来灾害，热带气旋也会给人类社会带来益处，例如缓解旱情、在夏季缓解酷暑等。

中国一向十分重视历史资料的积累，中国气象局上海台风研究所整编了自1949年以来的《热带气旋年鉴》，包括热带气旋最佳路径、热带气旋导致的大风和降水以及登陆热带气旋等资料，至今共出版发行60余册。在此基础上，中国气象局上海台风研究所还先后编纂出版了《西北太平洋台风基本资料集(1949~1980年)》《西北太平洋热带气旋气候图集》(1951~1980年)和《中国热带气旋气候图集(1951~2000)》。这些珍贵资料被广泛应用于中国的防台减灾业务和台风科学研究，并参与国际间的资料交换和合作研究。

为了更好地揭示当前气候背景条件下热带气旋的活动特征，中国气象局上海台风研究所对1981~2010年期间的热带气旋气候特征进行了系统的统计分析，在此基础上编纂了本图集。本图集内容分四部分：

1. 热带气旋的发生、发展和消亡。
2. 热带气旋的路径和移动。
3. 影响和登陆中国的热带气旋。
4. 热带气旋气候统计表。

本图集的资料源自中国气象局上海台风研究所整编的《热带气旋年鉴》，并收录了中国香港、澳门和台湾地区气象部门提供的气象资料。本图集的出版不仅为气象工作者提供一本有价值的工具书，也为海洋、航空、防汛、国防、交通等非气象部门提供有益的参考。

本图集的编制和出版由中国气象局(预报与网络司)、国家重点基础研究发展计划(973计划)课题(编号：2013CB430305和2015CB452806)、国家自然科学基金项目(编号：41475082和41675116)、公益性行业(气象)科研专项项目(编号：GYHY201406010和GYHY201506007)、中央级公益性科研院所基本科研业务费专项资金和上海市气象局台风科技创新团队项目等联合资助。

The western North Pacific, including the South China Sea, is the most active basin of tropical cyclone activity in the world. These tropical cyclones cause severe natural disasters in the countries along the coastline of the Pacific Basin. Six of the ten countries that are most strongly affected by tropical cyclone disasters are adjacent to this basin, and China is among the worst affected. With the exception of Xinjiang, Xizang, and Qinghai provinces and autonomous regions, the whole of China, from Guangdong, Guangxi, and Hainan provinces and autonomous regions in southern China, to Liaoning, Jilin, and Heilongjiang provinces in northeast China, has been affected by tropical cyclones. In addition to their associated hazards, tropical cyclones may also be beneficial to human society, such as by easing droughts or relieving heat waves in summer.

China has always attached great importance to collecting historical data. The Shanghai Typhoon Institute of the China Meteorological Administration (STI/CMA) has compiled and published nearly 70 volumes of the *Tropical Cyclone Yearbook*, which contain tropical cyclone best track data, tropical-cyclone-induced wind and precipitation observations, landfall locations, and other data. In addition, STI/CMA has edited and published the *Basic Dataset of Tropical Cyclones over the Western North Pacific (1949–1980)* (in Chinese), the *Climatological Atlas for Northwest Pacific Tropical Cyclones (1951–1980, Chinese-English bilingual edition)*, and the *Climatological Atlas of Tropical Cyclones Affecting China (1951–2000)* (Chinese-English bilingual edition). These publications have been widely used in operational services and in research aimed at reducing the disastrous impacts of tropical cyclones. The tropical cyclone best track data have also been made available for international data exchange programs and other collaborative research.

To accurately define the characteristics of tropical cyclone activity under the current climate, STI/CMA analyzed the comprehensive characteristics of tropical cyclones recorded between 1981 and 2010 and have compiled this climatological atlas, which comprises the following four chapters:

- I. Genesis, development, and decay of tropical cyclones;
- II. Tracks and motion of tropical cyclones;
- III. Tropical cyclones affecting and landfalling in China;
- IV. Tropical cyclone statistics.

This Atlas is based on data obtained from the *Tropical Cyclone Yearbook* edited by STI/CMA, as well as meteorological observations from the Hong Kong Observatory, the Macao Meteorological and Geophysical Bureau, and the meteorological institution of Taiwan. We expect that this Atlas will not only provide a valuable reference work for meteorologists, but also for marine, aviation, flood administration, national defense, transportation, and other non-meteorological institutions.

The Atlas was jointly sponsored by CMA (Department of Forecasting and Networking), the National Basic Research Program of China (Grant Nos. 2013CB430305 and 2015CB452806), the National Natural Science Foundation of China (Grant Nos. 41475082 and 41675116), the National Special Funding Project for Meteorology (Grant Nos. GYHY201406010 and GYHY201506007), the National Public Welfare Scientific Institution Basal Research Fund, and the Typhoon Scientific Technological Innovation Group of the Shanghai Meteorological Service.

1. 本图集所指“热带气旋”指发生在西北太平洋和中国南海 (0°~50°N, 105°E~180°) 上的热带气旋 (tropical cyclone, 缩写TC)。
2. 本图集所取的资料年代为1981~2010年, 内容包括:
 - (1) 中国气象局热带气旋最佳路径数据集 (Ying et al., 2014);
 - (2) 中国气象局热带气旋大风和降水观测资料集 (Ying et al., 2014);
 - (3) 中国香港地区风和降水观测资料, 由香港天文台提供;
 - (4) 中国澳门地区降水观测资料, 由澳门地球物理暨气象局提供;
 - (5) 中国台湾省热带气旋降水观测资料, 取自台湾气象部门网站。
3. 考虑资料的代表性和均一性, 本图集共选取了观测覆盖1981~2010年、且包括主要基准气候站在内的1443个气象观测站 (见210~211页附录), 其中内地1416个, 香港2个, 澳门1个, 台湾24个。具体的选取方法参见鲁小琴等 (2016)。
4. 本图集采用的时间一律为北京时, 即120°E 地方标准时。
5. 本图集按2006年发布的热带气旋等级国家标准 (GB/T 1902—2006) 来划分热带气旋等级:
 - 热带低压 (TD: 10.8 ~ 17.1 米/秒);
 - 热带风暴 (TS: 17.2 ~ 24.4 米/秒);
 - 强热带风暴 (STS: 24.5 ~ 32.6 米/秒);
 - 台风 (TY: 32.7 ~ 41.4 米/秒);
 - 强台风 (STY: 41.5 ~ 50.9 米/秒);
 - 超强台风 (SuperTY: ≥51.0 米/秒)。
6. 本图集中热带气旋的代号写成YYYYNN, 其中YYYY为年份, NN为中国气象局最佳路径数据集中使用的序号; 热带气旋编号依照中国气象局中央气象台编号为准, 以YYMM表示, YY为年份后两位数字, MM为中央气象台编报的序号。与本图集中热带气旋代号相对应的热带气旋名称, 请参阅《热带气旋名录》(第IV章, 180~189页)。
7. 有关热带气旋的位置:
 - 生成点: 指热带气旋首次达到热带风暴等级时的位置;
 - 变性点: 热带气旋完成到温带气旋转变的位置, 即中纬度冷锋侵入热带气旋眼区时的位置;
 - 消亡点: 指热带气旋在消失前的最后可识别环流的中心位置, 不包括合并、停滞、移出和变性为温带气旋等情况。
8. 双热带气旋: 指在西北太平洋及南海海域同时出现2个达到热带风暴强度的热带气旋, 其中心间距不超过20个纬距。
多热带气旋: 指在西北太平洋及南海海域同时出现3个或3个以上达到热带风暴强度的热带气旋, 不论间距大小。按照同时出现热带气旋的个数多少, 分别称为三热带气旋、四热带气旋或五热带气旋。
9. 有关热带气旋的移动:
 - (1) 移向和移速: 指关注点处热带气旋移动矢量的方向和大小, 由前后6小时的位置计算。
 - (2) 转向: 指热带气旋在移动过程中移动矢量的向西分量转变成了向东分量。如果在转变成向东分量前, 经历了一段纬向移动分量为零的阶段, 即“方头路径”, 则纬向分量开始为零的位置定为转向点。跨月的转向热带气旋, 其出现月份按转向时的月份为准。
 - (3) 打转路径: 指热带气旋路径转了一个或一个以上圈。在统计5°×5°经纬网格内的打转频数时, 如涉及两个或两个以上网格时, 只以一次打转计入所涉及的主要网格。

- (4) 路径突变在5°x5°经纬网格内统计，指以下几种现象：
- 突然加速：12小时前后热带气旋移速增加值 ≥ 15 千米/小时，或初速度 ≤ 5 千米/小时 时12小时前后移速增加值 ≥ 10 千米/小时；
- 突然减速：12小时前后热带气旋移速减少值 ≥ 15 千米/小时，或初速度初速度介于10~15千米/小时 (不包括15千米/小时) 时12小时前后移速减少值 ≥ 10 千米/小时；
- 突然左折：12小时前后热带气旋移向沿逆时针方向角度变化 $\geq 30^\circ$ ；
- 突然右折：12小时前后热带气旋移向沿顺时针方向角度变化 $\geq 30^\circ$ 。
10. 强度突变指以下两种现象：
- 迅速加强：任意12小时时段热带气旋近中心最大风速的变化量 $\Delta V_{12} \geq 10$ 米/秒，或任意24小时时段近中心最大风速的变化量 $\Delta V_{24} \geq 20$ 米/秒；
- 迅速减弱：任意12小时时段热带气旋近中心最大风速的变化量 $\Delta V_{12} \leq -10$ 米/秒，或任意24小时时段近中心最大风速的变化量 $\Delta V_{24} \leq -20$ 米/秒。
11. 中国近海海域定义为自中国大陆海岸线到连线 A (34°N, 132°E) – B (15°N, 132°E) – C (0°, 105°E) 之间的海域。A–B–C在2014年之前的数十年间曾作为中国气象局热带气旋影响48小时警戒线。
12. 热带气旋登陆：特指登陆中国。根据中国气象局《台风业务和服务规定》，除舟山群岛、台湾、香港和海南岛外，中国其他沿海岛屿不作为登陆点统计。
- 热带气旋首次登陆中国后，如再次越过海面在中国另一地点登陆，则该地点作为第二次登陆点。依此类推确定第三次登陆点。
- 热带气旋登陆地段自西向东、由南向北划分为：
- | | |
|---------------------------|---------------------------|
| (1) 广西； | (2) 海南； |
| (3) 广东雷州半岛 – 阳江 (含阳江)； | (4) 广东阳江 – 海丰 (含海丰、不含阳江)； |
| (5) 广东海丰 – 饶平 (含饶平、不含海丰)； | (6) 台湾； |
| (7) 福建诏安 – 惠安 (含惠安)； | (8) 福建惠安 – 长乐 (含长乐，不含惠安)； |
| (9) 福建长乐 – 福鼎 (含福鼎，不含长乐)； | (10) 浙江； |
| (11) 上海； | (12) 江苏； |
| (13) 山东； | (14) 河北； |
| (15) 天津； | (16) 辽宁。 |
13. 热带气旋影响：特指影响中国，并在特定区域内满足以下三个条件之一的热带气旋：
- (1) 有一站出现过程降水量 ≥ 50 毫米；
- (2) 有一站出现 ≥ 7 级的平均风，或 ≥ 8 级的阵风；
- (3) 有一站出现过程降水量 ≥ 30 毫米，且出现 ≥ 6 级的平均风或 ≥ 7 级的阵风。

参考文献

鲁小琴, 余晖, 应明, 漆梁波. 2016. 不同站网密度对热带气旋降水气候统计特征分析的影响. 热带气象学报, 32(5): 597-606. doi: 10.16032/j.issn.1004-4965.2016.05.03

Ying M, W Zhang, H Yu, X Lu, J Feng, Y Fan, Y Zhu, and D Chen. 2014. An overview of the China Meteorological Administration tropical cyclone database. J. Atmos. Oceanic Technol., 31, 287-301. doi: 10.1175/JTECH-D-12-00119.1

1. In this Atlas, tropical cyclone (TC) refers specifically to activity over the western North Pacific and South China Sea (0° – 50° N, 105° E – 180°) .
2. The data used in this Atlas cover the period 1981–2010 and were obtained from the following sources:
- (1) the China Meteorological Administration (CMA) TC best track data and TC-induced wind and precipitation data (Ying et al., 2014);
 - (2) wind and precipitation data covering Hong Kong, China obtained from the Hong Kong Observatory;
 - (3) precipitation data covering Macau, China obtained from the Macao Meteorological and Geophysical Bureau; and
 - (4) TC-induced precipitation covering Taiwan, China obtained from the website of meteorological institution of Taiwan.
3. To ensure the representativeness of stations and the homogeneity of the data series, a total of 1443 weather stations were selected from across China, comprising 1416 from the mainland, 2 from Hong Kong, 1 from Macau, and 24 from Taiwan. The observations from these stations covered the period 1981–2010, with the national reference climatological stations included. The distribution of the selected stations is shown in the Appendix on pages 210–211, and the selection criteria can be found in Lu et al. (2016).
4. All times quoted in this Atlas are Beijing Time (i.e., UTC+8 hours).
5. Tropical cyclones were classified into six categories according to the national standard of China issued in 2006 (i.e., GB/T 1902–2006), as follows:
- tropical depression (TD: 10.8 – 17.1 m s⁻¹);
 - tropical storm (TS: 17.2 – 24.4 m s⁻¹);
 - severe tropical storm (STS: 24.5 – 32.6 m s⁻¹);
 - typhoon (TY: 32.7 – 41.4 m s⁻¹);
 - severe typhoon (STY: 41.5 – 50.9 m s⁻¹); and
 - super typhoon (SuperTY: ≥ 51.0 m s⁻¹).
6. Tropical cyclones were numbered using the YYYYNN format, where YYYY denotes the year and NN the annual order in the CMA TC database. The China Serial Number, which is assigned operationally in real time by the National Meteorological Center (NMC) of the CMA, is represented by YYMM, where YY denotes the last two digits of the year and MM denotes the serial number assigned by NMC/CMA. These two serial numbers, together with the names of every tropical cyclone that occurred between 1981 and 2010, can be found in the *List of Tropical Cyclones* (Chapter IV, pages 180–189).
7. Definitions of specific locations of tropical cyclones:
- **genesis location** refers to the location where a tropical cyclone first reaches the tropical storm category;
 - **location of extratropical transition** refers to the location where a tropical cyclone develops into an extratropical cyclone; that is, the midlatitude cold front has merged into the inner core of the tropical cyclone circulation;
 - **location of dissipation** refers to the location of a recognized tropical cyclone circulation just before its final dissipation in the study region (0° – 50° N, 105° E – 180°) rather than merging, standstill, extratropical transition, or moving out of the study region.
8. Definitions of binary and multiple tropical cyclones:
- **binary tropical cyclones** refers to two tropical cyclones with intensities of tropical storm or above, separated by a distance of no more than 20° latitude within the western North Pacific basin;
 - **multiple tropical cyclones** refers to three or more simultaneous tropical cyclones with intensities of tropical storm or above, within the western North Pacific, which are referred to as “three” , “four” or “five” tropical cyclones according to the total number of tropical cyclones in the basin.
9. Definitions related to tropical cyclone propagation:
- (1) **propagation direction and speed** refers to the direction and magnitude of the tropical cyclone propagation vector at any point along the track, as determined using the locations at six hours before and after the point of interest;

- (2) **recurvature** refers to the point when the westward component of the tropical cyclone propagation vector becomes zero and the eastward component develops. Specifically, when a stage of zero zonal component of tropical cyclone propagation has formed before the appearance of the eastward component, which is called “square track” , the location of recurvature is defined as the location at which the zero zonal propagation component first appears. In addition, for a tropical cyclone with a lifespan that extended into the next month, the month of recurvature was determined according to the time of recurvature occurrence.
- (3) **loop** refers to a tropical cyclone track that turns one or more circles. To calculate the frequency of looping on a longitude–latitude grid of $5^{\circ} \times 5^{\circ}$, if the track circles cover more than one grid, only the main grid is considered.
- (4) **abrupt change of track** refers to the following phenomena and the associated frequencies were calculated on a longitude–latitude grid of $5^{\circ} \times 5^{\circ}$:
- **sudden acceleration** is defined as when the propagation speed of a tropical cyclone accelerates either with an increment of $\geq 15 \text{ km h}^{-1}$ in 12 hours, or $\geq 10 \text{ km h}^{-1}$ in 12 hours when the initial speed was $\leq 5 \text{ km h}^{-1}$;
 - **sudden deceleration** is defined as when the propagation speed of a tropical cyclone decelerates either with a decrement of $\geq 15 \text{ km h}^{-1}$ in 12 hours, or $\geq 10 \text{ km h}^{-1}$ in 12 hours when the initial speed is ≥ 10 and $< 15 \text{ km h}^{-1}$;
 - **sudden left turn** is defined as when a tropical cyclone turns anticlockwise with the propagation direction changing by $\geq 30^{\circ}$; and
 - sudden right turn is defined as when a tropical cyclone turns clockwise with the propagation direction changing by $\geq 30^{\circ}$.

10. **Abrupt change of intensity** refers to the following two phenomena:
- **rapid intensification** is defined as either an increase in maximum sustained wind speed $\Delta V_{12} \geq 10 \text{ m s}^{-1}$ within any 12 hours, or $\Delta V_{12} \geq 20 \text{ m s}^{-1}$ within any 24 hours; and
 - **rapid weakening** is defined as either $\Delta V_{12} \leq -10 \text{ m s}^{-1}$ within any 12 hours, or $\Delta V_{24} \leq -20 \text{ m s}^{-1}$ within any 24 hours.
11. The near-coast sea area of China is defined as the sea area between the coastline of mainland China and the line connecting points A (34° N , 132° E), B (15° N , 132° E), and C (0° , 105° E). Line A–B–C has been used as the 48–hour warning line for tropical cyclone hazards by the CMA in the decades leading up to 2014.
12. Tropical cyclone landfall refers specifically to the tropical cyclone making landfall in China rather than any other region. According to the *Tropical Cyclone Operational and Service Manual* of the CMA, only the Zhoushan Islands and the islands of Taiwan, Hong Kong, and Hainan are considered to be landfall locations; smaller islands are not included in the list of possible landfall locations.

A tropical cyclone may make landfall in China multiple times, as it may reenter the marginal seas after landfall. Such multiple landfall locations are defined using the first, second, third, and fourth landfall locations.

The islands and coastline of China are divided into 16 regions for collation of the landfall locations of tropical cyclones:

- (1) coastal area of Guangxi;
- (2) Hainan Island;
- (3) coastal area between Leizhou Peninsula and Yangjiang (including Yangjiang) in Guangdong Province;
- (4) coastal area between Yangjiang and Haifeng (excluding Yangjiang but including Haifeng) in Guangdong Province;
- (5) coastal area between Haifeng and Raoping (excluding Haifeng but including Yangjiang) in Guangdong Province;
- (6) Taiwan;
- (7) coastal area between Zhao'an and Hui'an (including Hui'an) in Fujian Province;
- (8) coastal area between Hui'an and Changle (excluding Hui'an but including Changle) in Fujian Province;
- (9) coastal area between Changle and Fuding (excluding Changle but including Fuding) in Fujian Province;
- (10) coastal area of Zhejiang Province;
- (11) coastal area of Shanghai Municipality;

- (12) coastal area of Jiangsu Province;
- (13) coastal area of Shandong Province;
- (14) coastal area of Hebei Province;
- (15) coastal area of Tianjin Municipality; and
- (16) coastal area of Liaoning Province.

13. The impacts of tropical cyclones refer specifically to the effect of tropical cyclones on China rather than any other regions. A tropical cyclone affecting a specific region (e.g., China, South China, and East China) is defined as being when one of the following three criteria are met:
- (1) total precipitation of $\geq 50 \text{ mm}$ observed at one or more stations in the specified region;
 - (2) either a sustained wind of Beaufort scale (BS) ≥ 7 or wind gusts of BS ≥ 8 observed at one or more stations in the specified region; or
 - (3) total precipitation of $\geq 30 \text{ mm}$ and also either sustained wind of BS ≥ 6 or wind gusts of BS ≥ 7 observed at one or more stations in the specified region.

References

- Lu X, H Yu, M Ying, and L Qi. 2016. Effects of different density station on climate statistical characteristics analysis of tropical cyclone precipitation. *J. Tropical Meteorol.* 32(5), 597–606. doi: 10.16032/j.issn.1004–4965.2016.05.03 (in Chinese)
- Ying M, W Zhang, H Yu, X Lu, J Feng, Y Fan, Y Zhu, and D Chen. 2014. An overview of the China Meteorological Administration tropical cyclone database. *J. Atmos. Oceanic Technol.*, 31, 287–301. doi: 10.1175/JTECH–D–12–00119.1

目 录

Contents

I

热带气旋的发生、发展和消亡

Genesis, Development and Dissipation of Tropical Cyclones

1 热带气旋的生命史	2
Lifespan	
<hr/>	
热带气旋生命史	2
Lifespan of tropical cyclones	
热带气旋的生成、变性和消亡 (1~12月)	4
Locations of tropical cyclone genesis, extratropical transition, and dissipation (Jan.–Dec.)	
西北太平洋和南海海域热带气旋出现的年日数	9
Annual days with tropical cyclones over the western North Pacific and South China Sea	
西北太平洋和南海海域热带气旋的逐月日数	9
Monthly days with tropical cyclones over the western North Pacific and South China Sea	
2 热带气旋的频数	10
Frequency	
<hr/>	
西北太平洋热带气旋年频数	10
Annual counts of tropical cyclones over the western North Pacific	
南海热带气旋年频数	10
Annual counts of tropical cyclones over the South China Sea	
热带气旋月频数和日频数	11
Monthly and daily counts of tropical cyclones (1981–2010)	
3 热带气旋的强度	12
Intensity	
<hr/>	
累积气旋能量指数	12
Accumulated cyclone energy (ACE)	
各等级热带气旋出现的比例分布	16
Distribution of percentage of tropical cyclones in each intensity category	
各等级热带气旋出现的比例	17
Percentage of tropical cyclones in each intensity category	
热带气旋强度的频率分布	18
Probability distribution of tropical cyclone intensity	
4 热带气旋强度的变化	19
Intensity Change	
<hr/>	
热带气旋强度变化的频率分布	19
Probability distribution of tropical cyclone intensity change	
热带气旋强度的变化	20
Tropical cyclone intensity change	

5 双热带气旋和多热带气旋
Binary and Multiple Tropical Cyclones26

双热带气旋和多热带气旋过程的频数 Frequency of binary and multiple tropical cyclones	26
双热带气旋和多热带气旋出现的时段 Duration of binary and multiple tropical cyclones	27
双热带气旋和多热带气旋过程期间的频次 Tropical cyclones occurrence frequency during periods with binary and multiple tropical cyclones	30

II热带气旋的路径和移动
Tracks and Propagation of Tropical Cyclones

1 热带气旋的频次
Occurrence Frequency34

热带气旋的频次 Tropical cyclone occurrence frequency	34
热带气旋的逐月频次 Monthly tropical cyclone occurrence frequency	38

2 热带气旋移向和移速
Direction and Speed of Propagation44

移向的频率分布和各方位平均移速 Probability distribution and mean speeds of different propagation directions	44
逐月移向频率分布和各方位平均移速 Monthly probability distribution and mean speeds of different propagation directions	46
移向的频率分布 Probability distribution of tropical cyclone propagation direction	60
移速的频率分布 Probability distribution of tropical cyclone propagation speed	62

3 热带气旋转向
Recurvature66

热带气旋转向点的分布 Distribution of tropical cyclone recurving locations	66
热带气旋转向前后的平均移速和强度 Mean propagation speed and intensity before and after tropical cyclone recurvature	68

4 热带气旋移动的变化
Changes in Propagation84

热带气旋移动的变化 Changes in propagation	84
-------------------------------------	----

5 热带气旋的异常路径
Abnormal Tracks90

热带气旋异常路径出现的频次 Occurrence frequency of abnormal tracks	90
--	----

III影响和登陆中国的热带气旋
Tropical Cyclones Affecting and Landfalling in China

1 中国近海热带气旋活动
Tropical Cyclones near Coastal China94

中国近海热带气旋活动的频数 Frequency of tropical cyclones near coastal China	94
中国近海热带气旋强度变化的频率分布 Probability distribution of intensity changes for tropical cyclones near coastal China	98
中国近海热带气旋的移动 Tropical cyclone propagation near coastal China	100

2 影响中国的热带气旋
Tropical Cyclones Affecting China102

热带气旋影响中国期间的生命史 Lifespan stages of tropical cyclones affecting China	102
热带气旋影响中国的频数 Frequency of tropical cyclones affecting China	104
热带气旋影响中国的季节 Seasonality of tropical cyclones affecting China	115
热带气旋影响中国的年日数 Annual days of tropical cyclones affecting China	116
热带气旋影响中国的月日数 Monthly days of tropical cyclones affecting China	120
影响中国热带气旋的源地 Genesis locations of tropical cyclones affecting China	124
影响中国热带气旋的路径 Tracks of tropical cyclones affecting China	126
影响中国热带气旋的强度 Intensities of tropical cyclones affecting China	130

3 热带气旋影响中国导致的大风
Severe Winds Generated by Tropical Cyclones in China

132

导致中国陆域出现大风的热带气旋频数 Counts of tropical cyclones generating severe wind over the land area of China	132
热带气旋导致中国出现大风的极值分布 Extreme winds generated by tropical cyclones in China	138

4 热带气旋影响中国导致的降水
Precipitation Generated by Tropical Cyclones in China

140

热带气旋暴雨的频次 Frequency of torrential rain generated by tropical cyclones	140
热带气旋暴雨的月频次 Monthly frequency of torrential rain generated by tropical cyclones	142
热带气旋导致中国陆域出现降水时的位置 Locations of tropical cyclones when generating precipitation over the land area of China	158

5 登陆中国的热带气旋
Tropical Cyclones Landfalling in China

162

登陆中国热带气旋的频数 Counts of tropical cyclones landfalling in China	162
热带气旋登陆中国的季节 Seasonality of tropical cyclones landfalling in China	164
登陆中国热带气旋的源地 Genesis locations of tropical cyclones landfalling in China	166
登陆中国热带气旋的路径和移动 Tracks and propagation of tropical cyclones landfalling in China	168
登陆中国热带气旋的强度 Intensity of tropical cyclones landfalling in China	174

IV

热带气旋统计表
Lists of Tropical Cyclones

1 热带气旋名录
List of Tropical Cyclones

180

2 因灾被除名的热带气旋
Tropical Cyclones with Names Retired Due to Severe Damage

190

3 双热带气旋和多热带气旋名录
List of Binary and Multiple Tropical Cyclones

192

4 影响和登陆中国的热带气旋
Tropical Cyclones Affecting or Landfalling in China

194

影响和登陆中国的热带气旋 Tropical cyclones affecting or landfalling in China	194
对中国影响居前50位的热带气旋 Top 50 tropical cyclones affecting China	197
登陆中国时强度居前 20 位的热带气旋 Top 20 tropical cyclones according to their intensity when landfalling	198
1981~2010 年间最早和最晚登陆中国的热带气旋 Earlist and latest tropical cyclones landfalling in China between 1981 and 2010	198
热带气旋登陆中国时的强度极值 Extreme intensity of tropical cyclones when landfalling	198
热带气旋登陆中国前后的强度和移速 Tropical cyclones intensity and propagation speed before and after landfall in China	198
1981~2010 年期间在中国造成重大灾害的热带气旋 Tropical cyclones causing severe damages in China between 1981 and 2010	204

附录
Appendixes

扩展的蒲福风力等级表
Extended Beaufort Wind Scale

209

观测站分布
Distribution of Weather Stations

210