Teaching syllabus on Basic Meteorological Training Course

（For Science and engineering）

CMA Training Centre

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Table of Contents

Syllabus on Introduction to atmospheric science (60 hours)

I. Purpose

This course helps the learners understand the basic concepts and knowledge of atmospheric sciences to lay a foundation for further studying the various branches.

II. The main teaching materials and reference books

1. 《普通气象学》，组织编写；

2. 盛裴轩，毛节泰等，《大气物理学》，北京大学出版社，2003；

3. 尹宏，《大气辐射学基础》，气象出版社，1993；

4. R B 斯塔尔著，徐静琦，杨殿荣译，《边界层气象学导论》，青岛海洋大学出版社，1991；

5. 蒋维楣等，《空气污染气象学教程》，气象出版社，1993年。

III. Basic requirements

1. Master the basic composition of the atmosphere, with a basic understanding of greenhouse gases. Understand the importance of atmospheric water vapor, the representations of atmospheric humidity, as well as the role of aerosol particles in the atmospheric process.

2. Understand the following aspects: atmospheric stratification; the basic characteristics of the ocean and the troposphere; concepts of front and air mass; concepts of main meteorological elements.

3. Master the following definitions: gravity and earth gravity; gravitational potential and geopotential meter; the significance of statics equations; homogeneous atmosphere; the differences in barometric height formulas for homogeneous, isothermal and multiple atmosphere;

Isobaric surface and isohypsic surface; the changes in pressure gradient and pressure system with height.

4. Master the following definitions: dry-adiabatic process, adiabatic process of moist air, potential temperature and pseudo-equivalent potential temperature, and inversion layer. Understand the following aspects: the expression of the first law of thermodynamics in the atmosphere; static stability of atmosphere; individual and local changes in air temperature; factors affecting local change in air temperature. Be familiar with T-LNP map.

5. Master the following definitions: geostrophic wind, wind gradient, changes of wind in free atmosphere with height, and thermal wind. Understand the following aspects: geostrophic deviation, influence of friction on the horizontal movement of air, local wind.

6. Master the following definitions: solar constant, atmospheric counter radiation, and surface effective radiation. Understand the following aspects: the basic principles and laws of radiation; solar radiation absorption and reflection by Earth-atmosphere system; radiation exchange between land and atmosphere.

7. Master the following definitions: the atmospheric boundary layer. Understand the following aspects: the basic theory on and research methods for atmospheric boundary layer; the knowledge of turbulence, the basic structure of atmospheric boundary layer; the role of boundary layer in the modern climate science; the formation mechanism of land and sea breezes.

8. Master the definitions of air pollution and photochemical smog. Understand the following aspects: the theoretical basis of pollution meteorology; addressing atmospheric diffusion based air pollution by

use of the meteorological principles and methods; the major pollutants present in the atmosphere; the main factors affecting the spread of air pollutants; the role of precipitation in atmospheric pollution; the principle of puff diffusion. The purpose of the discipline is to effectively control and prevent the occurrence and development of air pollution, thereby improving air quality.

IV. Teaching contents and teaching requirements

Introduction - Brief History of Atmospheric Sciences

Teaching contents: Overview of the development and research of atmospheric science.

Teaching requirements: Understanding of the development and research of atmospheric science.

Chapter 1 Composition and Distribution of the Earth's Atmosphere

Teaching contents: the evolution of planetary atmosphere and Earth's atmosphere, dry and clean atmosphere, atmospheric water vapor, atmospheric aerosols.

Teaching requirements: Understand the following aspects: the basic components of the atmosphere plus greenhouse gases; the importance of atmospheric water vapor; the representation of atmospheric humidity; the role of aerosol particles in the atmospheric process.

Chapter 2 Atmospheric Stratification and Structure

Teaching contents: Atmospheric stratification, atmospheric level of non-uniformity - fronts and air masses, meteorological factors, main lower boundary of the atmosphere - ocean.

Teaching requirements: Understand the following aspects: atmospheric stratification; the basic characteristics of the ocean and the troposphere; the concepts of fronts and air masses; the concept of major meteorological elements.

Chapter 3 Atmospheric Statics

Teaching contents: The atmospheric statics equations and pressure - height formula, atmospheric models, pressure - potential height formula, standard atmosphere, temporal and spatial distribution of pressure.

Teaching requirements: Understand the following definitions: gravity and earth gravity; gravitational potential and geopotential meter; the significance of statics equations; homogeneous atmosphere; the differences in barometric height formulas for homogeneous, isothermal and multiple atmosphere; Isobaric surface and isohypsic surface; the changes in pressure gradient and pressure system with height.

Chapter 4 Atmospheric Thermodynamic Process

Teaching contents: the application of the first law of thermodynamics to the atmosphere, temperature - pressure diagram and its application, atmospheric static stability, local change in air temperature, temperature change with time.

Teaching requirements: Master the following definitions: dry-adiabatic process, adiabatic process of moist air, potential temperature and pseudo-equivalent potential temperature, and inversion layer. Understand the following aspects: the expression of the first law of thermodynamics in the atmosphere; static stability of atmosphere; individual and local changes in air temperature; factors affecting local change in air temperature. Be familiar with T-LNP map.

Chapter 5 Horizontal Movement of Air

Teaching contents: Atmospheric motion equations, wind in free atmosphere, wind in the planetary boundary layer, atmospheric circulation and local wind.

Teaching requirements: Master the following definitions: geostrophic wind, wind gradient, changes of wind in free atmosphere with height, and thermal wind. Understand the following aspects: geostrophic deviation, influence of friction on the horizontal movement of air, local wind.

Chapter 6 Radiation Processes of Land and Atmosphere

Teaching contents: the basic concept of radiation, the physical laws of radiation, the interaction between atmosphere and radiation, solar radiation transfer in the Earth's atmosphere, the longwave radiation in the Earth - atmosphere system, the radiation balance among the ground, the atmosphere and the earth-atmosphere system.

Teaching requirements: Master the following definitions: atmospheric radiation, solar constant, atmospheric counter radiation, and surface effective radiation. Understand the following aspects: the basic principles and laws of radiation; solar radiation absorption and reflection by Earth-atmosphere system; radiation exchange between land and atmosphere.

Chapter 7 Atmospheric Boundary Layer

Teaching contents: the basic concept of the boundary layer, wind and air flow, turbulent transport, boundary layer thickness and structure, micro-meteorology, the significance of the boundary layer, boundary conditions and surface compulsion, land and sea breeze circulation

Teaching requirements: Master the following definitions: the atmospheric boundary layer. Understand the following aspects: the basic

theory on and research methods for atmospheric boundary layer; the knowledge of turbulence, the basic structure of atmospheric boundary layer; the role of boundary layer in the modern climate science; the formation mechanism of land and sea breezes.

Chapter 8 Meteorology in Air Pollution

Teaching contents: atmospheric composition and the definition of air pollution, precipitation, the major pollutants present in the atmosphere; the main factors affecting the spread of air pollutants, and air pollution forecasts.

Teaching requirements: Master the definitions of air pollution and photochemical smog. Understand the following aspects: five major patterns for puff diffusion, the main factors affecting the spread of air pollutants, and the role of atmospheric precipitation in air pollution. Understand the importance of the discipline to the atmospheric environment in terms of research and application, and its usefulness to the simulation and forecasting of concentration and distribution of air pollutants or, in general, to air quality.

V. Arrangements on class hours (60 h)

Chapter 1 Composition and Distribution of the Earth's Atmosphere	6
Chapter 2 Atmospheric Stratification and Structure	6
Chapter 3 Atmospheric Statics	8
Chapter 4 Atmospheric Thermodynamic Process	10
Chapter 5 Horizontal Movement of Air	8
Chapter 6 Radiation Processes of Land and Atmosphere	8
Chapter 7 Atmospheric Boundary Layer	6
Chapter 8 Meteorology in Air Pollution	6
Examination	2

Syllabus on Atmospheric Sounding (70 hours)

I. Purpose

Through this course, the trainees are trained to learn the quantitative measurement of basic meteorological elements, the principles and methods of remote sensing, the basic concepts and principles of atmospheric sounding, the basic characteristics of remote sensing images, and the development of modern technology in atmospheric sounding to be more aware of the importance of atmospheric sounding.

II. The main teaching materials and reference books

1．《大气探测基础》，组织编写；

2．张蔼琛著，《现代气象观测》，北京大学出版社，2006 年；

3．中国气象局，《地面气象观测规范》，气象出版社，2003 年

4．《雷达气象学》，培训中心组织编写；

5．俞小鼎等，《多普勒天气雷达原理与业务应用》，气象出版社，2006 年。

6．陈谓民编著，《卫星气象学》，气象出版社，2003 年。

III. Basic Requirements

1．Understand the basic concepts and fundamental principles of atmospheric sounding;

2．Understand the quantitative measurement of basic meteorological elements;

3．Understand the basic characteristics of remote sensing images;

4．Learn the basic technical methods currently used in meteorological operational observation;

5．Learn modern atmospheric detection technology and integrated

meteorological observation system.

IV. Teaching contents and teaching requirements

Chapter 1 Introduction

Teaching contents: Overview of atmospheric sounding, detection theory, detection equipment, meteorological observation.

Teaching requirements: Understand the development of atmospheric sounding, the basic principles of atmospheric detection, the key performance indicators of detection instruments, and the main sources of measurement errors.

Chapter 2 Conventional Ground Meteorological Observation

Teaching contents: temperature, barometric pressure, humidity, wind measurements, radiation, precipitation, evaporation measurement, visibility, cloud, observation of weather phenomena, practical instruments in conventional ground meteorological observation, and the main factors affecting the quality of measurements.

Teaching requirements: Understand the following knowledge: the meaning and measuring principle of temperature; the usage of temperature measurers; the structure and installation specifications of thermometer screen; the meaning and measuring principle of humidity; the measuring method of humidity; the working mechanism of barometer; the installation method of barometer; the observation method of pressure; the basic principles of wind; the methods for wind direction and speed measurement; the methods for radiation, precipitation, and evaporation measurement; the methods for visibility, clouds, weather phenomenon observation; the methods of observation for sunshine, snow depth, permafrost and wire icing; the working mechanism of the lightning location system; the main factors affecting

the quality of observations; the composition of automatic weather station system.

Chapter 3 Conventional Upper Air Meteorological Observation

Teaching contents: the observation method for upper wind, the measuring principles of weather balloons, L-band radar and upper wind, upper-air meteorological element detection, and GPS upper-air detection.

Teaching requirements: Understand the observation method for upper wind; the working principle of weather balloon measurements for upper wind; the measuring principles of L-band radar and upper wind; the radiosonde detection methods for upper-air temperature, humidity, and pressure; GPS navigation wind measurement method.

Chapter 4 Introduction to Modern Integrated Meteorological Observation System

Teaching contents: brief introduction to integrated meteorological observation system, airborne atmospheric sounding, space-based atmospheric sounding, ground-based remote sensing atmospheric sounding.

Teaching requirements: understand the composition of integrated meteorological observation system, especially airborne atmospheric sounding system, space-based atmospheric sounding system, ground-based remote sensing atmospheric sounding system.

Chapter 5 Satellite Remote Sensing Principle

Teaching contents: the basic characteristics of near-polar sun-synchronous orbiting satellites and geostationary orbiting satellites, the electromagnetic spectrum, the basic amount and laws of radiation,

solar and Earth-atmosphere system radiation spectrum, absorption bands and the atmospheric window, TBB, OLR, and TOVS.

Teaching requirements: understand the following knowledge: the basic characteristics of near-polar sun-synchronous orbiting satellites and geostationary orbiting satellites, the electromagnetic spectrum, the basic laws of radiation, solar and Earth-atmosphere system radiation spectrum, absorption bands and the atmospheric window, as well as TBB, OLR, and TOVS products.

Chapter 6 Basic Recognition of Meteorological Satellite Images

Teaching contents: basic visible images and their principles, standard infrared images 1 and 2 in window area - their principles and basic images, water vapor image principles and basic images, short infrared images in window area – their principles and basic images.

Teaching requirements: understand the following knowledge: visible images; principles of infrared images 1 and 2, water vapor images, and short infrared images; their respective basic image recognition methods and image features.

Chapter 7 Principle of Doppler Weather Radar

Teaching contents: Three components and functions of the new generation weather radar; the scattering, attenuation, and refraction of electromagnetic waves; radar meteorological equation; distance folding; principles of radar speed measurement, and three basic products.

Teaching requirements: understand the following knowledge: three components and functions of the new generation weather radar; the scattering, attenuation, and refraction of electromagnetic waves; radar meteorological equation; distance folding; and principles of radar speed measurement.

Chapter 8 Basic Recognition of Doppler radar Images

Teaching contents: the basic characteristics of the reflectance factor graph and radial velocity map.

Teaching requirements: identification of the reflectance factor graph and radial velocity map.

V. Arrangements on class hours (70 h)

Chapter 1 Introduction	4
Chapter 2 Conventional Ground Meteorological Observation	16
Chapter 3 Conventional Upper Air Meteorological Observation	12
Chapter 4 Introduction to Modern Integrated Meteorological Observation System	4
Chapter 5 Satellite Remote Sensing Principle	10
Chapter 6 Principle of Doppler Weather Radar	12
Operational facilities tour	10
Examination	2

Syllabus on Synoptic Meteorology (108 hours)

I. Purpose

Through this course, the trainees are trained to learn the following knowledge: the basic knowledge of atmospheric circulation; basic weather systems in high-latitude and tropical regions; monsoons and sandstorms in China; evolution pattern and forecasting method of meso-and micro-scale weather systems; forecasting methods for rainstorm circulation pattern and severe weather; basic analysis and methods of weather map; the weather forecast methods and ideas; MICAPS system. The purpose is to provide basic knowledge of synoptic meteorology to those who will participate in any meteorological operation, services and management.

II. The main teaching materials and reference books

1．宋燕，姚秀萍，熊秋芬，《天气学和天气分析》，北京：气象出版社 2008.

2．朱乾根,林锦瑞,寿绍文,唐东昇，《天气学原理与方法》，北京：气象出版社 2000.

3. 伍荣生等，《现代天气学原理》, 北京：高等教育出版社 2002.

4．张元箴，《天气学教程》，北京：气象出版社 1992.

5．钱维宏，《天气学》，北京：北京大学出版社 2004.

6. 陶诗言,“临近预报和超短时预报方法”，《天气学的新进展》，北京：气象出版社 1986.

7．秦大河等，“沙尘暴”，北京：气象出版社 2003.

8．方宗义,朱福康,江吉喜等，“中国沙尘暴研究”，北京：气象出版社 1996.

9．寿绍文，励申申，王善华，等，《天气学分析》，北京：气象出版社，2006。

III. Basic Requirements

1. Strengthen the understanding of importance of synoptic meteorology and of its current development trend.
2. Master the basic concepts and principles of synoptic meteorology.
3. Understand the basic concepts of synoptic systems and major weather circulation processes to underlie the idea of forecasting.
4. Be familiarized with the concepts of severe weather and rainstorm in China.
5. Be familiarized with basic synoptic charts and a variety of weather symbols.
6. Understand the basic principles and methods of analyzing the westerlies, the Tibetan Plateau and tropical weather.
7. Grasp the three-dimensional structure of the pressure system.
8. Be familiarized with the general method of frontal identification.
9. Understand the types and analysis methods of auxiliary weather charts.
10. Learn commonly used methods, ideas and processes of weather forecasting.
11. Learn the basic operation of MICAPS 3.0 system.
12. Understand the actual weather discussions.

IV. Teaching contents and teaching requirements

Chapter 1 Basic Synoptic Meteorology

Teaching contents: the research elements and methods of synoptic meteorology and its development history and outlook, the formation of seasons and their classification criteria.

Teaching requirements: understand the following general knowledge: the concept and research elements of synoptic meteorology; weather forecasting methods; the development history of synoptic meteorology; the formation of four seasons; the classification of four seasons in atmospheric science.

Chapter 2 Atmospheric Circulation

Teaching contents: Introduction to atmospheric circulation (concept and scale of atmospheric circulation, the fundamental power control factors, and heat circulation principles driving atmospheric circulation); meridional circulation (meridional circulation between the pole and the equator - one-cell circulation, meridional circulation between the pole and the equator - three-cell circulation); polar circulation (monthly polar circulation features, the polar cyclone activity path, vertical distribution characteristics of polar near-surface temperature, abnormal polar circulation); average atmospheric flow field characteristics and seasonal conversion (the meridional distribution of average zonal wind component and average meridional wind component, average horizontal circulation, atmospheric radiation budget, atmospheric temperature field); jet stream (the concept, classification, scale and structural features of jet stream); characteristics of East Asian Circulation (characteristics of East Asian monsoon, and the impact of Tibetan Plateau on East Asian Circulation); profiles of major

atmospheric circulation and weather processes in China (winter, spring, summer and autumn).

Teaching requirements: understand the following general knowledge: concept of atmospheric circulation; the driving force of atmospheric circulation; the concept and principles of thermodynamic circulation; the formation mechanism and scientific assumptions of three-cell circulation; polar circulation; the relationship between the polar vortex and cold wave; global average zonal wind component and average meridional wind component in winter and summer; the concept of atmospheric activity center; various atmospheric circulation in troposphere and stratosphere; the concept of upper-air jet stream; names and formation of the jet stream; the role of upper-air jet stream in precipitation; topographic and thermal characteristics of the East Asian region; and circulation characteristics of East Asian monsoon.

Chapter 3 Air Mass and Front

Teaching contents: Air mass (the concept, classification and birthplace of air masses); front (the concept, scale and structure, as well as classification of a front, characteristics of the meteorological fields near a front; the concept of frontal cyclone; weather features accompanied by various fronts; frontogenesis and frontolysis); the interconnection of air mass, front, frontal cyclone and jet stream (upper and low air flow pattern changes and systems' mutual configuration, changes in low-pressure axis with altitude, analysis of jet axis, frontal zone and warm and cold air advection, the interconnection of the global and China's major frontogenesis areas, air masses, front, frontal cyclone and jet stream).

Teaching requirements: understand the following general knowledge: the concept, variability and classification of air masses; the concepts of frontal edge, frontal zone and frontline; the thermal classification of fronts; the types of frontal edge frequently encountered in weather forecasting; the characteristics of pressure field, temperature field and wind field near fronts; the concept of occluded front; all kinds of weather possibly resulting from fronts, especially frontal precipitation characteristics; the concept of frontogenesis and frontogenesis formula; the interconnection of air masses, front, frontal cyclone and jet stream; the major frontogenesis areas and the corresponding frontal cyclones.

Chapter 4 Large Scale Disturbances and Weather Processes over Westerly

Teaching contents: Overview (the concept of scale, the motion of various types of spatial scales and corresponding weather systems); extratropical cyclones and anticyclones (concept and classification of cyclones and anticyclones, the occurrence frequency, classic model, and life history of extratropical cyclone, and frontal cyclone weather); blocking high and cut-off low (the definitions and building processes of blocking high and cut-off low, the formation of cut-off low); the West Pacific subtropical high (the concept, formation, structure, changes in location and intensity, activities of the West Pacific subtropical high and its relation with weather in China); other weather systems and other phenomena over westerlies (thermal low, the quasi-biennial oscillation-QBO.

Teaching requirements: understand the following general knowledge: the concepts of spatial and temporal scales of weather systems; the scale classification for weather systems; the concepts and

classification methods of extratropical cyclone and anticyclone; the formation and development processes of extratropical cyclone; frontal cyclone weather; the definitions and building processes of blocking high and cut-off low; the weather resulting from blocking high and cut-off low; the concept and causes of West Pacific subtropical high and its impact on weather in China; the concepts of thermal low pressure, quasi-biennial oscillation and orographic depression.

Chapter 5 Overview of Severe Weather

Teaching contents: Local weather, severe weather, precipitation.

Teaching requirements: understand the following general knowledge: the concepts of land and sea breeze, valley wind and heat islands; the concepts, classification, causes and characteristics of convective cells, thunderstorms, tornadoes, meso-scale convective and rainstorm; the concepts of local wind, foehn, bora scura, orographic wave and urban climate; the concepts, causes and characteristics of Benard convection and blizzard; the formation processes of cloud and fog; the classification of cloud; warm rain precipitation; characteristics of cold cloud precipitation.

Chapter 6 Rainstorm Weather Process in China

Teaching contents: Precipitation formation process in general, major rainstorm weather systems in China, weather patterns which can produce a large-scale rainstorm.

Teaching requirements: understand the following general knowledge: the forming conditions of rainstorm and conditions for storm enhancement; the concept of low jet stream and its role in rainstorm; two typical weather patterns for torrential rain; the concepts and characteristics of shear lines in Yangze River and Huai River regions

and southwest vortex; and the main types of rainstorms and characteristics of each type in China.

Chapter 7 Meso-and Micro-scale Convective Systems and Convective Weather

Teaching contents: Introduction to meso-and micro-scale convective systems, formation conditions of convective weather, and meso-and micro-scale weather systems.

Teaching requirements: understand the following general knowledge: the concept, characteristics and classification of mesoscale systems; the concept and characteristics of mesoscale convective complexes; the concept and life cycle of storm cell; the environment conducive to the development of storm conditions; dynamic and thermodynamic conditions for the formation of convective weather；the dynamics of super storm cell; conditions and structures of general convective systems and strong convection systems and their differences in weather phenomena; the differences in formation conditions between persistent rainstorm and strong convective weather.

Chapter 8 Weather Systems in Tropical and Sub-tropical Regions

Teaching contents: Introduction to Tropical Atmosphere (division of geographical scope, horizontal distribution features of tropical meteorological elements); general tropospheric circulation in a tropical region (circulation features of lower troposphere in a tropical region in winter and summer, circulation features of upper troposphere in a tropical region in winter and summer); Walker circulation (definition and formation of Walker circulation phenomena, the linkage of Walker circulation phenomena and El Niño); typhoon (definition of tropical cyclones and typhoons, criteria for intensity, weather resulting from

tropical cyclones); equatorial convergence zone (the concept and classification of equatorial convergence zone, its latitudinal position and seasonal movement, seasonal changes of equatorial convergence zone over Western Pacific, ITCZ formation mechanism); South Asia High (structure and activity characteristics of South Asia High and its impact on weather in China and Asia).

Teaching requirements: understand the following general knowledge: horizontal distribution features of tropical meteorological elements; the characteristics of atmospheric circulation over tropical upper and lower troposphere in winter and summer; the concept of the Walker circulation; formation mechanism of Walker circulation; the El Nino and La Nina; the concepts of tropical cyclones and typhoons; the classification of tropical cyclones. Learn the following aspects: weather resulting from tropical cyclones; large-scale circulation systems affecting tropical cyclone movement paths; the concept, classification and formation mechanism of equatorial convergence zone and its seasonal variation; the concept, classification and formation mechanism of the South Asia High and its impact on the weather in China.

Chapter 9 Monsoon

Teaching contents: the concept of monsoon (the concept, definition and characteristics of monsoon and its changes with time); the East Asian summer monsoon (the key components and characteristics of the East Asian summer monsoon, the main difference with the South Asian summer monsoon, the formation mechanism of monsoon); East Asian winter monsoon and cold wave (the concept of cold wave, the definition of cold wave strength, the characteristics of cold high pressure affecting the strength and outbreak of cold wave, cold air source and its

path towards South, weather accompanied by cold wave activities, cold wave outbreak process, cold wave weather system, and cold wave process).

Teaching requirements: understand the following general knowledge: the concept and formation mechanism of monsoon; the differences between the East Asian summer monsoon and the South Asian summer monsoon; the characteristics of two components (tropical monsoon and subtropical monsoon) of the East Asian summer monsoon; the key components of the East Asian summer monsoon; the concept of cold wave; the definition of cold wave strength and weather features; the outbreak path, process and conditions of cold wave; cold wave weather system and process; the position and role of cold wave outbreak key regions.

Chapter 10 Sandstorm

Teaching contents: the concept, strength division, geographical distribution, the frequency, sources, moving path, hazardousness, analysis and forecasting of sandstorm; the condition and weather pattern resulting in sandstorm.

Teaching requirements: understand the following knowledge: the concept and subdivision of sandstorm; originating sources and moving path of sandstorm; synoptic conditions resulting in sandstorm; the main hazardousness of sandstorm.

Chapter 11 Analysis of Synoptic Chart

Teaching contents: the basemap of synoptic chart; surface synoptic chart; upper-air synoptic chart; analysis of pressure system structure; the generation and analysis of cross-sectional view, single station upper wind map and isentropic surface; the basic processes and principles of

frontal analysis; the analysis methods for tropical weather and surface synoptic chart in Plateau region.

Teaching requirements: understand the following general knowledge: the basemap of synoptic chart; map projection and scale; commonly used synoptic basemap; format, analysis items and technical requirements of surface synoptic chart; the concept and format of isobaric charts; space allocation, static structure and dynamic structure of pressure system; the definition of cross-sectional view; the generation and analysis of spatial and temporal vertical cross-sectional view; the fill-in and analysis of single station upper wind map; the basic processes and principles of frontal analysis; the analysis methods for tropical flow field and Plateau weather.

Chapter 12 Overview of Numerical Weather Prediction

Teaching contents: the statistical interpretation of Numerical Weather Prediction (NWP) products.

Teaching requirements: Be familiarized with the operational NWP models currently used (T213, ECMWF, NWP models run by Japan and NCEP and a new generation CMA NWP model (GRAPES)).

Chapter 13 Introduction to MICAPS 3.0

Teaching contents: System introduction, system interface and basic operations, information retrieval, map and geographic information, surface observations display, upper-air observation display, satellite data display, model product display, other data display, editing and interoperability, and other features.

Teaching requirements: learn the following knowledge: the system function and the system core module structure; the system interface, menu, toolbar, status bar, layer control, basemap display and operation;

retrieval of the file name, menu, parameters, comprehensive map, paging and level changes, animation, Internet and FTP servers and other data; maps and geographic information, including display of map, geographic information, terrain height and status bar; display of common meteorological data; lines and symbols editing, urban forecasting generation, refined forecasting correction and other editing and interoperability; one-dimensional chart display, consultation component, graphics saving and printing, forecasting process management, data monitoring, cumulative rainfall, distance and area calculations, help system and other functions.

Chapter 14 Satellite Radar Image Recognition

Teaching contents: the basic recognition of five-channel images on FY-C and FY-D; recognition of weather system and cloud on satellite images; recognition of three basic products of the new generation weather radar (reflectivity, radial velocity and velocity spectrum width); recognition of products derived from the new generation weather radar.

Teaching requirements: learn the following knowledge: the basic recognition of five-channel images on FY-C and FY-D; recognition of weather system and cloud on satellite images; recognition of three basic products of the new generation weather radar (reflectivity, radial velocity and velocity spectrum width); recognition of products derived from the new generation weather radar.

V. Arrangements on class hours (108 h)

Chapter 1 Basic Synoptic Meteorology	4
Chapter 2 Atmospheric Circulation	10
Chapter 3 Air Mass and Front	8
Chapter 4 Large Scale Disturbances and Weather Processes over Westerly	10
Chapter 5 Overview of Severe Weather	6

Chapter 6 Rainstorm Weather Processes in China	8
Chapter 7 Meso-and Micro-scale Convective System and Convective Weather	10
Chapter 8 Weather Systems in Tropical and Sub-tropical Regions	10
Chapter 9 Monsoon	8
Chapter 10 Sandstorm	4
Chapter 11 Analysis of Synoptic Chart	6
Chapter 12 Overview of Numerical Weather Prediction	2
Chapter 13 Introduction to MICAPS 3.0	4
Chapter 14 Satellite and Radar Image Recognition	14
Examination	4

Syllabus on Climatology (40 hours)

I. Purpose

Through this course, it is possible to understand a series of aspects: the history and current situation of climate science; the basic concept of climate; various types of climate and its distribution in different regions around the world and in different seasons; the impact of atmospheric circulation, ocean, cryosphere and human activities on the climate; the formation and characteristics of monsoon climate in China. This will provide the basics of climate science for those who will engage in a variety of meteorological operations, service and management.

II. The main reference books

1．气候学概论，组织编写；

2．现代气候学进展，王绍武，气象出版社；

3．现代气候学原理，潘绍文等；

4．气象学与气候学基础，李爱贞、刘厚凤编著，气象出版社；

5．现代天气学原理，伍荣生，气象出版社；

6．天气学原理和方法，朱乾根等，气象出版社；

7．宋燕，姚秀萍，熊秋芬，《天气学和天气分析》，气象出版社，2008。

III. Basic Requirements

Through this course, it is possible to understand the history and status of development of climate science, learn a certain level of basic climate knowledge, and be familiarized with various climatic characteristics in different seasons and factors affecting climate.

IV. Teaching contents and teaching requirements

Chapter 1 Climate and Climate System

Teaching contents: the significance of climate research, the basic concept of the climate, the climate system, climate research data, and the World Climate Research Programme.

Teaching requirements: be familiarized with the following knowledge: the concepts of climate, climate variability, climate anomalies and climate system; the similarities and differences between climate and weather; internal factors and external factors affecting the climate system; the significance of climate research; the World Climate Research Programme (WCRP); the definition and branches of climatology; several subsystems and their observation contents of the Global Climate Observing System; five China-sponsored climatic experiments and research programs; the main stages of the development of climatology.

Chapter 2 Influence of Atmospheric Circulation on Climate

Teaching contents: the basic concept, forming factors, average zonal and meridional characteristics, and the basic characteristics of atmospheric circulation and its seasonal transformation, the influence of atmospheric circulation anomalies on the climate.

Teaching requirements: the formation of three-cell circulation; "three wind and four belts"; the conversion of atmospheric activity centers between winter and summer; the role of terrain factor in atmospheric circulation; the distribution characteristics of zonal mean westerly in January and July; the circulation features of upper and lower troposphere; the big and small cycles of water.

Chapter 3 Influence of Ocean on the Climate

Teaching contents: the basic differences in the nature of land and sea and the corresponding climate distribution (the differences in the thermodynamic properties of land and sea surface, the characteristics of maritime and continental climates and their distribution, land and sea breezes and monsoons); marine abnormal impact on the climate (regulatory role of ocean on climate, Walker circulation, El Niño and La Niña, the Southern Oscillation (SO)).

Teaching requirements: be familiarized with the following knowledge: the differences in the thermodynamic properties of land and sea surface; Walker circulation; the Southern Oscillation; effect of EL Nino and La Nina on climate, especially on climate in China; the formation mechanism of sea and land breezes; the characteristics of maritime and continental climates and their distribution; regulatory role of ocean on climate.

Chapter 4 Impact of Cryosphere, Volcanic Activity and Solar Activity on Climate

Teaching contents: Cryosphere and its impact on climate; volcanic activities and their impact on climate; solar activity and its influence on climate.

Teaching requirements: be familiarized with the following knowledge: the impact of cryosphere on climate; an overview of global cryosphere and its long-term changes; the response of volcanic activities to climate; the impact of solar activity on the climate.

Chapter 5 Effect of Human Activities on Climate

Teaching contents: the basic concepts and formation processes of greenhouse gases and the greenhouse effect, the current situation of greenhouse gases; the impact of greenhouse gases on the climate.

Teaching requirements: be familiarized with the following knowledge: the basic concepts of greenhouse gases and the greenhouse effect; the greenhouse gases on Earth; the effect of increased greenhouse gases on climate; the sources of greenhouse gases; the distribution characteristics of greenhouse gas content; the growth of carbon dioxide.

Chapter 6 Distribution and Classification of Climatic Zones

Teaching contents: the geographical distribution of the temperature and precipitation; the basic principle of climate classification; the world climate classification.

Teaching requirements: be familiarized with the following knowledge: geographical distribution of temperature and its influencing factors; names for four global precipitation zones and their geographical distribution; factors influencing precipitation distribution; the concept of climate classification and the world climate classification (name one representative climate classification for each); precipitation characteristics of four global precipitation zones; pattern of climate zones; basic climate types in various climate classification.

Chapter 7 Overview of Climate Change

Teaching contents: the concept and historical fact of climate change; the current study of climate change; possible future change in climate change; the possible causes of climate change.

Teaching requirements: be familiarized with the following knowledge: the concept of climate change; the current study of climate change; the causes of climate change; historical fact of climate change; possible future trends in climate change.

Chapter 8 Overview of Climate in China

Teaching contents: the basic characteristics of the climate in China; the concept and definition of the monsoon; East Asian monsoon circulation background; the establishment, maintenance and retreat of the East Asian summer monsoon; the impact of the East Asian monsoon on climate in China; climatic subdivision and climatic characteristics in China.

Teaching requirements: be familiarized with the following knowledge: the basic characteristics of the climate in China; the concept and definition of the monsoon; the components of East Asian monsoon system; climatological dates for the establishment, maintenance and retreat of the East Asian monsoon; the impact of the East Asian monsoon on climate in China; circulation background of the East Asian monsoon; the corresponding circulation features for the establishment, maintenance and retreat of the East Asian summer monsoon; the study of the East Asian monsoon in recent years; climatic subdivision and climatic characteristics in China.

Chapter 9 Introduction to Climate Simulation

Teaching contents: introduction to climate model; climate predictability; circulation simulated by atmospheric general circulation model; ocean model and ENSO and ocean forecasting and simulation resulting from it; the role of cryosphere in climate models; the impact of human activities on climate and climate change in climate models; future climate trends simulated by climate models.

Teaching requirements: be familiarized with the following knowledge: dynamical framework of climate models; climate predictability; circulation stimulated by atmospheric general circulation model; the simulation and prediction of ocean models; the role of

cryosphere in climate models; the impact of human activities on climate and climate change in climate models; future climate trends simulated by climate models.

V. Arrangements on class hours (40 h)

Chapter 1 Climate and Climate System	4
Chapter 2 Influence of Atmospheric Circulation on Climate	4
Chapter 3 Influence of Ocean on the Climate	6
Chapter 4 Impact of Cryosphere, Volcanic Activity and Solar Activity on Climate	4
Chapter 5 Effect of Human Activities on Climate	4
Chapter 6 Distribution and Classification of Climatic Zones	4
Chapter 7 Overview of Climate Change	4
Chapter 8 Overview of Climate in China	4
Chapter 9 Introduction to Climate Stimulation	**4**
Examination	2

Syllabus on Dynamic Meteorology (52 hours)

I. Purpose

Through this course, the trainees are able to understand causes and laws of the atmospheric motion, change and development.

II. The main teaching materials and reference books

1．《动力气象学》，组织编写；

2．缪锦海、王永中、刘桂芬，《动力气象学》，气象出版社，1992；

3．杨大升、刘余滨、刘式适，《动力气象学》，气象出版社，1983；

4．J.R.霍尔顿，《动力气象学引论》，科学出版社，1972；

5．吕美仲等，《动力气象学》，气象出版社，2004。

III. Basic Requirements

Understand causes and laws of the atmospheric motion, change and development.

IV. Teaching contents and teaching requirements

Chapter 1 The Basic Equations of Atmospheric Motion

Teaching contents: The forces acting on the air micelles; the motion equations of inertial coordinate system; the motion equations, continuity equation and thermodynamic equation of rotating coordinate system; the motion equations of spherical coordinate system; Atmospheric Motion Equations of local Cartesian coordinate system; coordinate transformation; atmospheric motion equations of p coordinate system.

Teaching requirements: be familiarized with the following knowledge: the forces acting on the air micelles and their physical

significance; the equation set of atmospheric motion in rotating coordinate system, i.e. motion equation (Newton's second law), the continuity equation (conservation of mass), equation of state (gaseous state equation), thermodynamic equation (first law of thermodynamics), and their physical significance; the physical significance of the equation set of atmospheric motion in spherical coordinate system; coordinate conversion formula; the equation set of atmospheric motion in local Cartesian coordinate system and P coordinates system.

Chapter 2 Simplified Scale Analysis of Atmospheric Motion and the Basic Equation Set

Teaching contents: Scale concepts, classification of atmospheric movement, scale analysis and simplification of atmospheric motion equation set, the main characteristic non-dimensional parameters.

Teaching requirements: be familiarized with the following knowledge: scale concepts; classification of atmospheric movement; scale analysis of atmospheric motion; simplified atmospheric motion equation set; the basic characteristics of large-scale atmospheric motions; the main characteristic non-dimensional parameters.

Chapter 3 Balanced Motion in Free Atmosphere

Teaching contents: geostrophic balance and geostrophic wind, thermal wind, gradient balance and gradient wind, geostrophic deviation and vertical movement.

Teaching requirements: be familiarized with the following knowledge: the concepts of geostrophic balance and geostrophic wind; the principle and application of thermal wind; the principle of gradient wind; the relationship between geostrophic deviation and vertical movement.

Chapter 4 Circulation and Vorticity

Teaching contents: Circulation theory, vorticity equation and its simplified form, potential vorticity, principle of conservation of potential vorticity, divergence equation and its simplified form.

Teaching requirements: understand the following aspects: the definition of circulation and its changes, the significance of vorticity, vorticity equation and its application, the potential vorticity and its changes, divergence equation and its simplified form.

Chapter 5 Atmospheric Energetics

Teaching contents: The main form of energy in the atmosphere, energy conversion and conservation in conservative system, available potential energy, energy conversion fact in the atmosphere, energy cycling process in large-scale atmospheric movement.

Teaching requirements: understand the following aspects: the form and significance of main energy in the atmosphere; energy conservation in conservative system; the concept of available potential energy; the qualitative results of average energy equation and qualitative conclusions of average atmospheric energy cycle.

Chapter 6 Basic Fluctuations in the Atmosphere

Teaching contents: the basic concept of fluctuation, group velocity, dispersion effect of waves, perturbation method and linearization of equation set, atmospheric sound waves, external gravity wave and internal gravity wave, inertial oscillation and inertial wave, atmospheric longwave (horizontal non-divergent Rossby waves).

Teaching requirements: understand the following aspects: the basic concept of wave number, wave group, and group velocity; linearization technique of equation set; the physical causes and

characteristics of sound wave, external gravity wave, internal gravity wave and inertial waves in the atmosphere; and the significance of atmospheric long wave (horizontal non-divergent Rossby waves).

Chapter 7 Atmospheric Boundary Layer

Teaching contents: the dynamic stratification of atmospheric boundary layer, wind speed distribution near the ground, Ekman layer, secondary circulation and rotation weakening.

Teaching requirements: understand the following aspects: the dynamic stratification of atmospheric boundary layer; wind speed distribution near the ground; the conclusion of Ekman spiral equation; the relationship between vorticity on top of friction layer and vertical velocity; the formation and significance of secondary circulation and rotation weakening.

V. Arrangements on class hours (52 h)

Chapter 1 The Basic Equations of Atmospheric Motion	8
Chapter 2 Simplified Scale Analysis of Atmospheric Motion and the Basic Equation Set	6
Chapter 3 Balanced Motion in Free Atmosphere	8
Chapter 4 Circulation and Vorticity	8
Chapter 5 Atmospheric Energetics	8
Chapter 6 Basic Fluctuations in the Atmosphere	8
Chapter 7 Atmospheric Boundary Layer	4
Examination	2