Plan and Curriculum for Job-readiness Training of Weather Forecasters

Training Center, China Meteorological Administration

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Plan for Job-readiness Training of Weather Forecasters

Targets:

The trainees need to understand the basic processes, methods and skills of short- and medium-range forecasting. They should be able to analyze and forecast disastrous weather such as typhoon, heavy rain, strong convection, cold front, high winds and fog and meet the requirements for ordinary forecasters.

Trainees:

Newly-recruited staff of weather stations of provinces (autonomous regions or municipalities) who are prepared to work as short- or medium-range/ nowcasting forecasters and who graduated as a major in atmospheric science (with bachelor's degree (4 years), master’s degree (7 years) or PHD (10 years) or as other majors but have received training in basic knowledge for non-meteorological majors (training for forecasting and prediction).

Overall requirements:

1. Using data from surface, upper-air, NWP, satellite images and radar to analyze the basic conditions of the atmosphere and understand the spatial structure of the weather system;
2. Understanding the basic methods of short-range forecasting and nowcasting; Using data and diagnosis tools of different kinds to analyze and produce short-range and mid-range forecasting of impact areas and parameters; having basic capability to forecast typhoon, rainstorm, strong convection, cold front, strong wind, fog and other severe weather phenomena; having the basic capability to identify the features of the thunderstorm and strong

convective weather;

3. Being sophisticated in using MICAPS3; gaining basic knowledge in using Doppler Weather Radar Terminal PUP;
4. Being familiar with the basic management rules on weather forecasting and having the awareness of professional responsibility.

Cycle:

15 weeks.

Curriculum:

1. Weather of China 28 hours

Main contents: the characteristics of the major weather systems and processes which impact China.

2. Weather analysis 100 hours

Main contents: specifications and requirements for weather analysis, analysis of surface and upper-air weather systems, analysis of common auxiliary images such as TLOGP; meso-scale weather analysis; hands-on operations.

3. MICAPS 3 36 hours

Main contents: MICAPS3 and its data structure, retrieving, displaying and property setting, interactive editing, application of radar elements, production and storage of images; hands-on operations.

4. Application of satellite images 40 hours

Main contents: The main parameters of identifying clouds and the application of infrared, water vapor, visible light images to the analysis, diagnosis and forecast of fronts, rainstorms, hails and thunderstorms.

5. Nowcasting and the application of Doppler radars 44 hours

Main contents:

The basics of nowcasting and Doppler radar; the basic features of radar echoes (such as super cell); initially identifying radial velocity; application of Doppler

weather radar products and PUP; nowcasting system.

6. Weather diagnosis and short-range forecasting 140 hours

Main contents: analysis, diagnosis and forecast of main surface weather parameters (temperature and wind); main weather processes (strong precipitation, typhoon, strong convection, cold wave and fog); hands-on operations;

7．Mid-range forecasting 20 hours

Main contents: main points of mid-range forecasting; the basic methods of the forecasting; hands-on operations.

8．NWP and Application of NWP Products 16 hours

Main contents: Operational NWP model and the characteristics of its products; the techniques, features and limitations of statistically interpreting NWP products.

9． Real-time Short-range forecasting 160 hours

Main contents: simulating the duty for making short-range forecasts in groups with forecasting real-time impact areas and the parameters of stations; comments.

10．The rules on forecast operations 4 hours

Main contents: the basic process of producing forecasts; the specifications on releasing forecasts, the rules on shifting, the evaluation of forecast quality and operational specifications.

11．Lectures 24 hours

(1) Operations of CMA: now and future 4 hours

(2) Progress in weather forecast techniques 4 hours

(3) Forecast process in National Meteorological Center (visit included) 4 hours

(4) Comprehensive meteorological observations in CMA 4 hours

(5) Short-range climate prediction 4 hours

(6) How to make weather summary 4 hours

12．Sports 24 hours

13．Self-learning 84 hours

Total： 720 hours，including 636 hours of teaching and tuition, hands-on operations and exams and 84 hours of self-learning.

(calculation method: six days (48 hours) a week, including 4 hours self-teaching on Saturday and 15 weeks in total.)

Materials and textbooks:

1．Zhu Qiangen, et al, Principles and Methods of Synoptic Meteorology (Fourth Edition), Meteorological Press, 2004

2．Xiong Qiufen, et al, Weather Analysis, Training Center, CMA, 2009

3．Xiong Qiufen, et al, Training Handbook on Strong Weather Phenomena for Forecasters, Training Center, CMA, 2009

4．Yu Xiaoding, et al, Principles on and Operations of Doppler Weather Radar, Meteorological Press, 2006

5．Yu Xiaoding, et al, Nowcasting of Strong Convective Weather, Training Center, CMA, 2009

6．Xiong Tingnan, et al, Explanation and Interpretation of Meteorological Satellite Images, Training Center, CMA, 2010

7．Wu Hong, MICAPS (Version 3) Textbook, Meteorological Press, 2010

8. Zhang Lina, Instability and Convections in Atmospheric Stratification, Training Center, CMA, 2010

9. Wu Hong, Thoughts and Methods of Forecasting Fog, Training Center, CMA, 2009

10. Wu Hong, Nowcasting System SWAN, Training Center, CMA, 2011

11.Xiong Qiufen, Analysis and Forecast of Clouds, Training Center, CMA, 2011

12.Wu Hong, On the Principles of the Formation of Clouds, Fogs and Precipitation, Training Center, CMA, 2011

References:

1．Shou Shaowen, Meso-scale Meteorology, Meteorological Press, 2006

2．Zhang Guocai, et al, Modern Weather Forecasting Techniques and Methods, Meteorological Press, 2008

3．Wu Hong, Consolidated Specifications on Weather Forecasting, Training

Center, CMA, 2009

4. CMA: Guidance on the Progress of Modern Weather Operations, 2010

Teachers

1. Teachers of CMA Training Center;
2. Teachers of the Department of Atmospheric Science of Related Universities;
3. Experts and forecasters from CMA

Ways of evaluation:

Homework, performance in hands-on operations and forecasting simulation, exams and operation on platform.

Teaching Program on Weather of China

I. Targets

Reviewing helps trainees better understand the basic principles of synoptics, be familiar with the features of the main weather systems impacting China, the conditions of related atmospheric circulations and the typical weather processes in China.

II. Time arrangement

28 hours, including 24 hours of teaching and 4 hours of exam.

III. Courses trainees should have learned

Meteorology, principle of synoptic meteorology, processes of weather in China, dynamic meteorology and weather analysis.

IV. Basic requirements

1. Knowledge of the basic features of atmospheric circulations, especially those in East Asia;
2. Knowledge of the Westerly weather system impacting China and its features and evolution;
3. Knowledge of the tropical and subtropical regional weather systems impacting China and their features and evolution;
4. Knowledge of the main weather processes impacting China and their evolution;
5. Knowledge of the concept of monsoon and the features, causes and weather characteristics of summer monsoons in East Asia.

V. Contents and requirements of training

Chapter I. Atmospheric Circulation 3 hours

Contents:

Atmospheric circulation and thermodynamic circulation; Three cell

circulation; features of major weather systems in upper, middle and lower layers of troposphere; jet stream

Requirements:

Understanding the concepts of atmospheric circulation, the principles of thermodynamic circulation, the forming principles and scientific hypothesis of three-cell circulation; knowing the conditions of polar circulations and the relations between such circulations and cold waves in China; understanding the distribution of winter/summer global mean zonal wind component and meridional wind component; understanding the concept of atmospheric activity center; being familiar with atmospheric circulations at different levels in troposphere and stratosphere; understanding the concept of high-altitude jet stream, the forming principle of jet stream and the impact of high-altitude jet on precipitation.

Chapter II. Fronts 3 hours

Contents:

Air masses and fronts; Frontogenesis; China's major frontogenesis band.

Requirements:

Understanding the concept and classification of air mass; knowing the concepts of front, frontal zone and frontal line and the thermodynamic classification of fronts, the characteristics of air pressure fields, temperature fields and wind fields around the fronts; knowing the characteristics of weather phenomena, especially precipitation, resulting from different fronts; knowing the concept of frontogenesis and the meaning of frontogenesis formula; understanding the interconnections between air mass, front, frontal cyclone and jet stream; knowing China's major frontogenesis bands.

Chapter III. Westerly disturbances 3 hours

Contents:

Cyclones and anticyclones; frontal cyclone occurrence，development and weather characteristics; long wave, blocking high and cut-off low.

Requirements:

Understanding the concepts and classifications of extratropical cyclone and anticyclone; the dynamic and thermal factors of extratropical cyclone and anti-cyclone; the three-dimensional structure of extratropical cyclone / anticyclone; the process characteristics in the development of extratropical cyclone / anticyclone; the moving paths which impact frontal cyclones in China; the concept of long wave and its change, the concept of blocking high and cut-off low and the circulation features of establishing the blocking high and cut-off low.

Chapter IV. Cold wave 2 hours

Contents:

Cold wave and its strength; the source of cold air and its southward path; basic conditions for the cold wave outbreak; main cold weather systems in China.

Requirements:

Understand the concept of cold wave, the intensity division and weather characteristics; cold wave outbreak path, the main outbreak conditions and weather processes for the cold waves impacting China; the evolution characteristics of cold wave systems and the role of the major outbreak zones.

Chapter V. Rainfall 4 hours

Contents:

The basic conditions of rainstorm formation and the basic principles of precipitation; water vapor equation and precipitation rate; the circulation features of large-scale precipitation; precipitation weather processes in China; weather systems of various scales and their role in precipitation; China’s typical rainstorm processes.

Requirements:

Understanding precipitation formation conditions; upper air and lower air circulation features of large-scale precipitation; the formation and strengthening conditions of heavy rain; low-level jet, shear line, southwest

vortex systems and their role in rainstorm; China's major rainstorm types and their characteristics.

Chapter VI. Convective weather 3 hours

Contents:

General structure of thunderstorms and strong storms; thunderstorm; basic characteristics of mesoscale and small-scale weather systems.

Requirements:

Understanding the concept of mesoscale and the characteristics and classification of mesoscale systems; the life history characteristics of cell storms and the environmental conditions of the formation of convective weather and the development of storms; the concept and features of mesoscale convective complex; dynamic features of supercell storms; the forming conditions, structure and derived weather phenomena of common convective systems and strong convection systems; the differences between the forming conditions of persistent heavy rain and strong convection weather.

Chapter VII. Tropical and subtropical weather system **4 hours**

Contents:

Horizontal distribution features of tropical meteorological factors; western Pacific subtropical high; tropical cyclones and typhoons; ITCZ; South Asia high; easterly waves.

Requirements:

Understanding the patterns of the activities of western Pacific subtropical high and their impact on China; the differences between the South Asian high and the western Pacific subtropical high; the concept of ITCZ and easterly waves; the classification criteria of tropical cyclone; the structure of tropical cyclones and their weather features; the mechanism of the occurrence and development of typhoons; the rules and paths of typhoon movements in China; the features of typhoon paths in various situations.

Chapter VIII. East Asian monsoon 2 hours

Contents:

East Asian monsoon circulations and their characteristics; the causes and weather features of East Asian summer monsoons.

Requirements:

Understand the concept of monsoon, its formation mechanism, the differences between East Asian summer monsoon and South Asian summer monsoon, the characteristics of the tropical and sub-tropical components of East Asian summer monsoons and the main constituent members of the East Asian summer monsoons.

VI. Assessment methods

Quizzes and closed-book exams.

VII. Textbooks and materials

Textbooks:

Zhu Qiangen, Lin Jinrui, Shou Shaowen, Tang Dongsheng, Synoptic Principles and Methods, Beijing: China Meteorological Press, 2000.

References:

1. Wu Rongsheng et al, Modern Synoptic Principle, Beijing: Higher Education Press, 2002.

2. Zhang Yuanzhen, Synoptic Course, Beijing: China Meteorological Press, 1992.

3. Qian Weihong, Synoptics, Beijing: Peking University Press, 2004.

4. Tao Shiyan, “Nowcasting and Very Short-range Forecasting Methods”, New Progress in Weather Science, Beijing: China Meteorological Press, 1986.

Teaching Program on Weather Analysis

I. Targets

Through participating in this course and drawing other charts, be familiar with the analysis methods of commonly-used surface and upper-air weather images for short-range forecasting or nowcasting; understand the analysis and application of the auxiliary analysis charts and the analysis of the potential of a strong convective weather; be able to accurately analyze circulation patterns, weather impact systems and weather processes; understand the causes of weather phenomena; deepen the knowledge of synoptic principle and its application to weather analysis.

II. Time arrangement

A total of 100 hours, including 36 hours of lectures, 56 hours of hands-on operations and 8 hours of assessment.

III. Courses trainees should have learned

Meteorology; dynamic meteorology; atmospheric sounding.

IV. Basic requirements

1. Being familiar with all the basic weather charts and weather symbols;

2. Knowing the principles and methods of analyzing upper-air, ground and auxiliary charts

3. Being familiar with frontal analysis methods

4. Being familiar with the methods of analyzing strong convections

V. Training contents and requirements

Chapter I. Analysis of basic weather charts 8 hours

Contents:

Basemap of weather charts; analysis of surface weather charts; analysis of high-altitude weather charts; comprehensive analysis of the structure of the pressure system.

Requirements:

Being familiar with the projection and the scale of the basemap of weather charts and commonly used weather charts; knowing the filling format of surface weather charts; knowing the analysis items and technical requirements of surface weather charts and the positioning analysis of the surface high / low pressure centers; knowing the concept of isobaric chart and the filling formats of isobaric charts; knowing the analysis items and technical requirements of isobaric chart analysis; knowing the analysis of troughs, shear lines, and high-altitude jet streams; being familiar with the identification of shortwave and long wave systems; understanding the spatial allocation of a pressure system, including the static and dynamic structures of the pressure systems.

Chapter II. Auxiliary weather chart analysis 8 hours

Contents:

Profile image analysis; TLOGP analysis; single station upper-air wind chart analysis.

Requirements:

Being familiar with the main analysis contents of spatially vertical or temporally vertical profile maps (temperature, temperature dew point difference, pseudo-equivalent temperature, wind, etc.); being familiar with the analysis items of tephigram and single station upper-air wind chart; understanding the analysis of clouds and unstable layers of different types, the analysis of thermal inversion layer and the positioning analysis of tropopause;

Chapter III Frontal analysis 8 hours

Contents:

Front types; distribution of meteorological elements around all kinds of

fronts, clouds and weather; frontogenesis (enhancement) and frontolysis (disappearance); characteristics of frontal activities in China; basic principles of a frontal analysis; fronts with special features in China and their analysis; the impact of terrain on fronts and temperature-pressure wind fields.

Requirements:

Understanding the following: the features of meteorological element distribution around fronts and the corresponding weather; the principles and methods of a frontal analysis, the basis for determining fronts and matters needing attention; the characteristics of frontal activities in China; fronts with special features in China and their analysis.

Chapter IV. Mesoscale analysis 8 hours

Contents:

The methods for the analysis of strong convections;

Requirements:

Knowing the basic norms, principles and methods of strong convection analysis; understanding the meteorological principles of contents under analysis.

Chapter V. Analysis of low latitude tropical weather 2 hours

Contents:

Characteristics of the methods of tropical weather analysis; data for a tropical weather analysis; operation and methods of a tropical weather analysis; tropical weather analysis; analysis of streamlines and isotachs.

Requirements:

Being familiar with the following: the sources and identification of tropical weather data, and representation of the basic data; understanding the operation and methods of a tropical weather analysis; the basic forms of the flow fields and the methods of a flow line analysis; the concepts and analysis methods of isotach lines.

Chapter VI. Plateau weather analysis 2 hours

Contents:

Analysis of plateau surface weather charts; analysis of plateau upper-air weather charts; fronts on the Tibetan Plateau.

Requirements:

Being familiar with: analysis of plateau surface and upper-air weather charts; analysis of cold fronts, warm fronts and quasi-stationary fronts in the east side of the plateau.

Chapter VII. Weather analysis hands-on operations 56 hours

Contents:

Basic analysis of weather charts and auxiliary weather charts; analysis of the following: cold waves, typhoon weather processes, sandstorm processes, rainstorm processes in Southern China, plum rain processes in Yangtze-Huaihe basins, rainstorm processes in Northeast China, freezing rain and snow processes, mesoscale analysis.

Requirements:

Accurately analyzing the circulation conditions and impact systems of all kinds of weather processes; understanding the causes, occurrence and development of weather processes.

Chapter VI. Assessment methods

Manual analysis of weather charts, TLOGP analysis and mesoscale analysis.

Chapter VII. Textbooks and materials

Textbooks:

1. Xiong Qiufen, et al, Handouts on Weather Analysis and Frontal Analysis, Training Center, CMA, 2009;

2. Xiong Qiufen, et al, Training Manual for Weather Forecasters of Severe Weather, Training Center, CMA, 2010;

3. Zhang Lina, Atmospheric Instability and Convection, Training Center, CMA, 2010.

References:

Shou Shaowen, "Weather Analysis", Meteorological Press, 2006.

Training Program on MICAPS3

I. Targets

Through systematic learning of the features, functions, operations etc. of MICAPS3, trainees fully understand, master and use MICAPS3.

II. Time arrangement

A total of 36 hours, including 24 hours of lectures and 12 hours of hands-on operations (or quizzes).

III. Courses trainees should have learned

Meteorology; principles of synoptics; weather analysis; windows operating system.

IV. Basic requirements

1. Understanding the main functions of MICAPS3 system;

2. Knowing how to use MICAPS3 system.

V. Contents and requirements of training

Chapter I. Data structure and system installation of MICAPS3 4 hours

Contents:

Data structure of MICAPS3; structure and characteristics of MICAPS3; installation of MICAPS3; installation steps of MICAPS V3.0 comprehensive charts; directory structure of MICAPS3.

Requirements:

Being familiar with the following: main data used in short-range forecast; structure of MICAPS3; installation of MICAPS3 system; directory of MICAPS3.

Chapter II. Main window and configuration of MICAPS3 2 hours

Contents:

Components and functions of the main window; menu and its features;

toolbar and its features; system configuration; contour display configuration of gridded data; display configuration of integrated surface observation mapping; display configuration of discrete point data.

Requirements:

Knowing the components and functions of MICAPS3 main window; understanding the basic setting methods of MICAPS3 system.

Chapter III. Data Retrieval 3 hours

Contents:

Filename retrieval; integrated map retrieval; menu retrieval; parameter retrieval; flip retrieval; animation; knowing data retrieval from Internet and FTP server.

Requirements:

knowing data retrieval from Internet and FTP server; knowing other retrieval methods and settings.

Chapter IV. Image display settings 6 hours

Contents:

Properties and settings of layers; display and setting of surface observations; display and settings of upper-air observation mapping; display and settings of TLOGP charts; display and settings of spatial and temporal profile map of sounding data; display and settings of satellite data; display and settings of radar data; display and settings of numerical prediction products; display and settings of other data; display and settings of basic geographic data.

Requirements:

Being familiar with the display and settings of surface observations, upper-air observation mapping, TLOGP figures, spatial and temporal profile map of sounding data, satellite data, radar data and numerical prediction products; being familiar with the display and settings of additional data and basic geographic data.

Chapter V. Basemap operation and edition of layers 4 hours

Contents:

Operation of display window; scaling, roaming, reduction, positioning and other operations with basemap; editing and correction tools for contour and their operations; analysis tools and operations for weather systems, symbols and areas; editing and correction tools and operations for urban forecast and their operations; saving of the edited results.

Requirements:

Operation of basemaps; fine forecast editing; other editing functions; save edition results.

Chapter VI. Saving images 2 hours

Contents:

Saving images; background image generation; batch image generation and settings.

Requirements:

Background image generation; saving image; batch image generation and batch file editing.

Chapter VII. Producing materials for consultation 1 hour

Contents:

Starting consultation component; producing and editing slides.

Requirements:

Setting path for images for consultation; producing, editing and correcting slides.

Chapter VIII. Other features of MICAPS3 2 hours

Contents:

Data monitoring and its configuration; calculating cumulative rainfall; producing animation; warning signal production; calculating the distance between two points; calculating the area of a partial sphere.

Requirements:

Data monitoring and its configuration; calculating cumulative rainfall; producing animation; producing warning signal; calculating the distance between two points; calculating the area of a partial sphere.

VI. Assessment methods

Hands-on operations and simulation forecasting.

VII. Textbooks and materials

Textbooks:

1. Wu Hong, MICAPS (third edition) training materials, Meteorological Press, 2010;

2. Wu Hong, Manual on MICAPS3 Training for Hands-on Operations, Training Center, CMA, 2008;

3. Wu Hong, Data Structure of MICAPS3, Training Center, CMA, 2008.

Training Program on Application of Satellite Images

I. Targets

Students are to understand the sounding principles of meteorological satellites and have basic knowledge of the application of meteorological satellite images to weather analysis, short-range forecast and nowcasting.

II. Time arrangement

A total of 40 hours, including 24 hours of lectures, 12 hours of hands-on operations and 4 hours of examination.

III. Courses trainees should have learned

Analysis of weather; meteorology; weather principles; Weather processes in China; dynamic meteorology.

IV. Basic requirements

1. Understand the basic principles of the images of the five common channels of geostationary satellites;

2. Understand the fundamental basis for the identification and interpretation of images.

V. Training content and requirements

Chapter 1 Global observing system of meteorological satellites 2 hours

Contents:

Near-polar sun-synchronous orbiting satellites; geosynchronous orbiting satellites; global meteorological satellite observation network.

Requirements:

Understand the main characteristics of geosynchronous orbiting satellites; understand the main features of near-polar sun-synchronous orbiting satellites; understand the composition of global meteorological observation network and the history and future directions of meteorological satellites.

Chapter 2. Satellite remote sensing principle 2 hours

Contents:

Electromagnetic spectrum; basic fundamental radiation volume and basic radiation law; radiation spectrum of the solar and Earth atmosphere system; absorption bands and the atmospheric window.

Requirements:

Understand the following: the main distribution of the electromagnetic spectrum; the fundamental law of radiation; the distribution of the solar and the Earth atmospheric systems; the concepts of "absorption bands" and "atmospheric window", and their application.

Chapter 3 The basic characteristics of meteorological satellite images 4 hours

Contents:

Visible image; standard infrared images I.2 in window; vapor image; short infrared images in window (identification of fog, sand and fire).

Requirements:

Understand the main features of: visible images, standard infrared I.2 images in window, water vapor images; short infrared image in window.

Chapter 4 Identification of clouds on meteorological satellite images 8 hours

Contents:

The main criteria for the identification of clouds; identification of high clouds, middle clouds and low clouds; identification of main cloud systems; the major features of the surface on meteorological satellite images.

Requirements:

Understand the following: the six major criteria for cloud identification; the main features of meteorological satellite images of various types; the main features of the cloud systems; cloud type and three-dimensional air flow for the identification of the stages of the extratropical cyclones; the main characteristics of the surface.

Chapter 5 Meteorological satellite image based analysis of weather systems and processes 8 hours

Contents:

Cloud systems of frontal cyclones; Meiyu front cloud systems; cold vortex cloud systems; typhoon cloud systems; tropical cyclone clouds and ITCZ cloud systems; storm cloud systems; strong convective cloud systems.

Requirements:

Understand the analysis methods for cloud systems of various weather systems and processes; understand the features of cloud systems of various weather systems and weather processes;

Chapter 6 Hands-on operations for meteorological satellite image recognition and analysis 12 hours

Contents of hands-on operations:

Basic identification of various types of clouds; cloud system based identification of weather systems and processes.

hands-on operation requirements:

Understand the basic methods for identifying clouds; learn more about cloud system features of various weather systems and weather processes.

VI. Assessment methods

Quizzes; closed book written examinations.

VII. Major textbooks and references

Textbooks:

Xiong Tingnan, et al, "Interpretation of Meteorological Satellite Images ", Training Center, CMA, 2009

References:

1. Chen Weimin, "Satellite Meteorology", Meteorological Press, 2005

2. M.J. Bud et al, "Application of Satellite and Radar Images to Weather Analysis and Repercussions", Science Press, 1998

Training Program on the Application of Nowcasting and Doppler Weather Radars

I. **Targets**

Students are to understand the basic principles of Doppler weather radar observation and have basic knowledge of the basic application of Doppler weather radars to the nowcasting of thunderstorms and severe convective weather conditions.

II. Time arrangement

A total of 44 hours, including 40 hours of lectures and 4 hours of examination.

III. Courses trainees should have learned

Meteorology; weather principles; Weather processes in China; dynamic meteorology; weather analysis;

IV. Basic requirements

1. Understand the principles of weather radar observation;

2. Have basic knowledge on identification of basic radar reflectivity factors and radial velocity images;

3. Have basic knowledge of the main features of the radar echoes of the convective weather systems;

4. Understand the nowcasting system SWAN.

V. Training content and requirements

Chapter 1 Observation Principles of Doppler Weather Radars 8 hours

Contents:

Components and functions of Doppler weather radar; scattering of meteorological targets to electromagnetic waves; transmission of electromagnetic waves (attenuation and refraction) in the atmosphere; radar meteorology equation; Doppler radar effect and radial velocity method for radar measurement and processing; distance folding and speed blurring; radar data quality control (ground clutter suppression, distance unfolding and the speed back blurring).

Requirements:

Understand the following: structure and function of Doppler weather radar; the relationship between scattering and particle size, phase and wavelength of the incident electromagnetic wave; the scattering features of Rayleigh scattering and Mie scattering; Rayleigh scattering formula; relationship between attenuation features of electromagnetic waves and wavelengths; relationship between electromagnetic wave refraction and atmospheric stratification; radar meteorology equation and Doppler effect; the main technical methods for measuring reflectivity factor, mean radial velocity and velocity spectral width by using Doppler weather radar; concepts of distance folding and speed blurring; basic methods for radar data quality control.

Chapter II Basic reflectivity and Doppler weather radar image recognition 8 hours

Contents:

Reflectivity image features of stratiform cloud precipitation echo, cumulus

cloud precipitation echo and cumulus-stratiform mixed cloud precipitation echo; reflectivity image features of boundary layer convergence line; the main features of radial velocity images where wind direction and speed change with heights; features of radial velocity images of fronts; features of radial velocity images of middle γ scale flow field.

Requirements:

Understanding the following: main reflectivity image features of stratiform cloud precipitation, cumulus cloud precipitation and cumulus-stratiform mixed cloud precipitation; identification of boundary layer convergence line; the main features of radial velocity images where wind direction and speed change with heights; features of radial velocity images of fronts; convergence and divergence, cyclone rotation, anticyclonic rotation of middle γ scale and radial velocity characteristics of their combinations.

Chapter 3 Radar echo characteristics of convective storms 8 hours

Contents:

Concept and classification of convective storms; wind vector image and storm relative helicity; radar echo characteristics of pulse storms; radar echo characteristics of non-supercell storms; reflectivity echo characteristics of supercell storms; concepts of middle cyclone and radial velocity echo characteristics of supercell storms; radar echo structural features of squall lines.

Requirements:

Understanding the following: concept of convective cells; concept and physical meaning of storm relative helicity; radar echo characteristics of pulse storms; concept of middle cyclones; concept and the radar echo characteristics of supercell storms. Concept of squall lines and the radar echo characteristics of squall lines.

Chapter IV Main products of NEXRAD 8 hours

Contents:

Basic reflectivity; average radial velocity; spectral width of average radial

velocity; composite reflectivity factor; height of echo top; vertical accumulated liquid water content; relative radial velocity of storms; storm tracking data; hail index; middle cyclones; vortex signature of tornadoes; one hour accumulated precipitation; three hour accumulated precipitation; total storm precipitation.

Requirements:

Main application of basic reflectivity and mean radial velocity; features of other products.

Chapter V. Nowcasting system SWAN 8 hours

Contents:

The structure and function of nowcasting system; product nowcasting system; products of nowcasting system; structure and function of the terminals of nowcasting system and basic configuration of the user terminals; three-dimensional radar mosaic and its application; forecast volume product of 1 hour accumulated precipitation; storm tracking and forecasting; forecast verification; severe weather monitoring; warning text production of severe weather.

Requirements:

Understanding the following: the structure and function of nowcasting systems; data directory structure and files of products; three-dimensional mosaic and main applications of one hour accumulated precipitation forecast products; features of the products of the nowcasting system.

VI. Assessment methods

Quizzes; closed book written examination.

VII. Major textbooks and references

Textbooks:

1. Yu Xiaoding et al, Strong Convective Weather Nowcasting, Training Center, CMA, 2009

2. Yu Xiaoding, Yao Xiuping, Xiong Tingnan et al, "Principles and Operational Applications of Doppler Weather Radars", Meteorological Press,

2006

3. Wu Hong, Nowcasting System SWAN, Training Center, CMA, 2011

References:

Zhang Peichang et al, "Radar Meteorology", Meteorological Press, 2001

Training Program on Weather Diagnosis and Short-range Forecast

I. Targets

Students are to understand the application of basic meteorological theories to the short-range forecast.

II. Time arrangement

A total of 140 hours, including 60 hours of lectures, 80 hours of hands-on operations.

III. Courses trainees should have learned

Meteorology; weather principles; weather processes in China; dynamic meteorology; weather analysis; weather forecasting platform; meteorological satellite applications; Doppler weather radar applications; numerical forecast product applications.

IV. Basic requirements

1. Understanding short-range weather forecasting methods;

2. Having basic knowledge of how to assess the performance of real-time numerical prediction products;

3. Further understanding the application of the basic meteorological principles.

V. Content and requirements

Chapter 1. Forecast of cloud, fog and precipitation 24 hours

Contents:

Microphysical processes of cloud and precipitation; Diagnostic forecast of non-convective clouds and precipitation; diagnostic forecast of convective precipitation; diagnostic forecast of fog.

Requirements:

Understanding the following: microphysical processes of cloud and precipitation of different phases; impact factors of the formation of non-convective (synoptic) clouds and precipitation, large-scale thermodynamic processes and the impact system; impact factor of convective cloud and precipitation formation, thermodynamic processes and synoptic scale systems; instability parameters and their meanings. The reason of the evolving synoptic system in middle and high latitudes (trough, ridges, low / high pressure and front); basic knowledge of the considerations for short-range forecast of the moving and changing weather system in the middle and high latitudes; basic methods to assess the performance of operational numerical model products in short-range forecast; preliminary knowledge of how to conduct nowcasting extrapolation of the phase, change and drop zone of nonconvective (synoptic scale) clouds and precipitation by using observation data (satellite, radar, etc.); preliminary knowledge of how to conduct nowcasting of the phase, change and drop zone of nonconvective (synoptic scale) clouds and precipitation by using observation data (satellite, radar, etc.) and NWP products (direct results and interpretational products); preliminary knowledge of how to conduct nowcasting extrapolation of convective clouds and weather phenomena by using observation data (satellite, radar, etc.); preliminary knowledge of how to conduct short-range forecast of the potential of convective clouds and weather phenomena by using observation data (satellite, radar, etc.) and NWP products (direct results and interpretational products). Impact factors of the formation of fog, thermodynamic processes and weather systems; preliminary knowledge of the features and forecast methods of precipitation in South China, Jianghuai, North China, Northeast and Northwest China; preliminary knowledge of the

short-range forecast methods for the drop zone of heavy fogs by using observation data (satellite, radar, etc.) and numerical forecast products (direct results or interpretational product, etc.).

Chapter 2 Forecast of meteorological elements 8 hours

Contents:

Diagnostic forecast of ground temperature; diagnostic forecast of surface winds.

Requirements:

Understanding the relationship between the current surface temperature distribution and weather systems; understanding the factors and physical processes influencing ground temperatures; preliminary knowledge of how to conduct nowcasting based extrapolation of the changing surface temperatures by using observation data; preliminary knowledge of how to conduct short-range forecast of the maximum or minimum temperatures on surface by using observation data and NWP products (direct results, interpretational products, etc.); understanding the relationship between the current surface wind and weather systems; understanding the boundary layer wind factors impacting surface layers; understanding the impact of local thermodynamic circulation (land and sea winds, mountain valley winds) on surface wind; understanding the impact of surface friction on surface winds; understanding the impact of topography on surface winds.; having preliminary knowledge of how to conduct nowcasting based extrapolation of the changing surface winds by using observation data and NWP products (direct results, interpretational products, etc.); having preliminary knowledge of how to conduct short-range forecast of the surface wind temperatures by using observation data and NWP products (direct results, interpretational products, etc.).

Chapter 3 Forecasts of main weather processes 20 hours

Contents:

Storm (South China, Jianghuai, North China) forecast; cold wave forecast; sandstorm forecast.

Requirements:

Understanding the following: environmental conditions of rainstorm formation and basics for rainstorm forecasts; reasons for the changing circulation background; cold wave forecast methods; and ambient conditions and forecast methods of sandstorms.

Chapter 4. Short-range forecast of tropical cyclones 8 hours

Contents:

Movement of Western Pacific tropical cyclones; tropical cyclone weather in Western Pacific.

Requirements:

Preliminary knowledge of short-range forecast method for the movement of tropical cyclones by using observational data and NWP products (direct results and interpretational products, etc.); having basic knowledge of the short-range forecast methods for the main weather phenomena (rainstorms, strong wind, etc.) of tropical cyclones by using observational data and NWP products (direct results, interpretational products, etc.) of tropical cyclones.

Chapter V. hands-on operations for short-range weather forecast 80 hours

Contents:

Cloud and precipitation forecast; meteorological element forecast; short-range forecast of convective weather; main severe weather forecasts; short-range forecast of Western Pacific tropical cyclones.

Requirements:

Preliminary knowledge of the basic methods for nowcasting/short-range forecasting of clouds and precipitation of synoptic scale; preliminary knowledge of the basic methods for nowcasting/short-range forecasting of meteorological elements; preliminary knowledge of the basic methods for nowcasting/short-range forecasting of convective clouds and synoptic

precipitation; understanding the methods for severe weather forecast; basic knowledge of the basic method for short-range forecast of the moving Western Pacific tropical cyclones and the weather phenomena they bring about.

VI. Assessment methods

Quizzes.

VII. Major textbooks and references

Textbooks:

1. Wu Hong "Thoughts on and Methods of Fog Forecasting", Training Center, CMA, 2010

2. Xiong Qiufen, "Cloud Analysis and Forecasting", Training Center, CMA, 2011

3. Zhang Lina, "Atmospheric Instability and Convection", Training Center, CMA, 2010

4. Wu Hong, "Introduction to the Principles of the Formation of Clouds, Fogs and Precipitation", Training Center, CMA, 2011

Reference materials:

1. Zhu Qiangen, Lin Jinrui, Shou Shaowen, Tang Dongsheng, Principles and Methods of Synoptics, Beijing: China Meteorological Press, 2000.

2. Tao Shiyan, "Methods of Nowcasting and Very Short-range Forecasting", "New Progress in Synoptics", Beijing: China Meteorological Press, 1986.

3. Shou Shaowen, et al, "Mesoscale Meteorology", Meteorological Press, 2003.

Training Program on Mid-range Weather Forecast

I. Targets

Students are to understand the basic methods for and applications of

mid-range weather forecast.

II. Time arrangement

A total of 20 hours, including 8 hours of lectures and 12 hours of hands-on operations.

III. Courses trainees should have learned

Synoptics; synoptic principles; weather processes in China; dynamic meteorology; weather analysis; weather forecasting platform; NWP.

IV. Basic requirements

1. Understanding the methods for mid-range forecast;

2. Understanding the application of the mid-range weather forecasting methods.

V. Content and requirements

Chapter 1. Outlines of the mid-range weather forecast 4 hours

Contents:

The main tasks and contents of the mid-range weather forecasting; brief history of the mid-range weather forecast.

Requirements:

Understanding the main tasks and timing of forecast and the content of services; understanding the development history.

Chapter II. Mid-range weather forecasting operations 4 hours

Contents:

operational norms of mid-range weather forecast; methods of mid-range weather forecast; application of mid-range numerical prediction model products; application of ensemble forecast; auxiliary chart application.

Requirements:

Preliminary knowledge of the data used for mid-range forecast, basic thoughts on and application of such forecast.

Chapter III. Hands-on operations for mid-range forecast 12 hours

Contents:

Hands-on operations for the historical cases of mid-range forecast;

consultation on and discussion of mid-range weather forecast nationwide.

Requirements:

Basic knowledge of the methods for mid-range forecast; understanding the data used for such forecast.

VI. Assessment methods

Quizzes.

VII. Major textbooks and references

Reference materials:

1. Zhang Jijia, et al, "Mid- and Long-range Weather Forecasting", Meteorological Press, 1983

Training Program on Numerical Weather Prediction and the Application of its Products

I. Training purposes

Understanding the characteristics of operational numerical models and the main methods of verifying numerical prediction; having basic knowledge of major operational products of numerical prediction.

II. Time arrangement

A total of 16 hours of lectures

III. Courses trainees should have learned

Synoptics; dynamic meteorology; hydrodynamics; computational mathematics.

IV. Basic requirements

Understanding the following:

1. the equations of numerical prediction and their properties;
2. the dynamical framework and NWP models and their physical parameters;
3. data assimilation techniques;
4. operational products of NWP Models and their performance;
5. main verification methods of NWP;

6. statistical interpretation techniques of numerical forecast products;

V. Content and requirements

Chapter 1. NWP models 8 hours

Contents:

The equation sets of models; features of vertical coordinate systems and their limitations; horizontal resolution and vertical resolution; spatially differential scheme; temporal integration scheme; formation of initial values; radiation process parameterization; parameterization of cloud and precipitation processes; parameterization of land surface processes; parameterization of turbulence processes; predictability and ensemble forecast of atmospheric processes.

Requirements:

Understanding the following: equation set of primitive equation models; the impact of static approximation on models and the features of NWP model coordinates; the impact of spatial resolution; characteristics and limitations of spatial difference; the characteristics and limitations of the temporal integration; calculation errors; characteristics and limitations of various parameterization programs; the concept and application of data assimilation; the principles and role of ensemble forecasting.

Chapter II. On NWP products of mid- and short-range forecast 4 hours

Contents:

Operational NWP model products; facsimile of Japan’s numerical model products.

Requirements:

basic knowledge of the products of the main models used by short- and mid-range forecasting; understanding the methods for the naming of Japanese fax images and basic knowledge of fax images; basic methods for product testing; preliminary understanding of the performance of different models in forecasting.

Chapter III Statistical interpretation of numerical forecast products

4 hours

Contents:

Techniques and methods for the statistical interpretation of numerical forecast products.

Requirements:

Understanding the techniques, methods for the statistical interpretation of numerical forecast products and their features and limitations.

VI. Assessment methods

Closed book exam of basic theories; hands-on operations and simulation of product application to the forecasting.

VII. Major textbooks and references

Reference materials:

Liao Dongxian, "Principles and Applications of Numerical Weather Prediction", Meteorological Press, 1986

Training Program on Real-time Short-range Weather Forecast

I. Targets

Basic knowledge of the basic processes of short-range weather forecasting operation, forecasting methods and their application.

II. Time arrangement

A total of 160 hours.

III. Courses trainees should have learned

synoptics; synoptic principles; weather processes in China; dynamic meteorology; weather analysis; weather forecasting platform; NWP.

IV. Basic requirements

1. Further understanding weather analysis methods;

2. Understanding the basic comprehensive application of short-range weather forecast methods.

V. Content and requirements

Short-range real-time weather forecast 160 hours

Contents:

Simulating the basic operational processes of on-duty short-range weather forecasts; real-time production of short-range weather forecasts; forecasts commenting.

Requirements:

strengthening weather analysis abilities; understanding the basic operational processes of forecast; having basic knowledge of diagnosis and forecast methods and techniques for short-range weather forecast; understanding the basic methods of nowcasting.

VI. Assessment methods

Panel Q&A Quizzes and hands-on operations.

VII. Major textbooks and references

Reference materials:

1. Zhang Guocai, et al, "Modern Weather Forecast Techniques and Methods", Meteorological Press, 2007;

2. Wu Hong, "Consolidated Management Practices of forecast operations", Training Center, CMA, 2010.