**Shanghai Integrated Urban Weather and Climate Service Demonstration Project**

**(WMO-Shanghai-IUWCS)**

**Implementation Plan**

East China Regional Meteorological Center / CMA

Shanghai Meteorological Service / CMA

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**1. Background**

Urbanization，as one of the main characteristics of the 21st century，has great impact on sustainable development. The environment of urban areas is so complex and sensitive that little environmental disturbance may bring about unpredictable consequences. Therefore, improving the resilience of a city to weather and climate disasters has become an important issue. Under the background of climate change, improving weather/climate forecast on full time and space scale has become a general agreement. Based on this understanding, WMO set providing seamless weather/climate forecast and integrated services to cities one of its priority development fields, as mentioned in the GFCS. Studying and serving megacities will be one of six new challenges the Commission of Atmospheric Sciences will face in the next few decades.

China is urbanizing rapidly. Urbanization and climate change are increasingly intertwined in dangerous ways, which is likely to cause unprecedented negative impact on people's quality of life, economic and social stability. As a typical megacity, Shanghai has reached the population of more than 24,000,000and the population density of 10,000 people per square kilometer. The increase of population density, infrastructure expansion and rapid development of economic activity would decrease the city’s resilience and increase its vulnerability. Extreme weather/climate events (e.g. urban floods, heat waves, etc.) and environmental hazards (e.g. haze, photochemical pollution, etc.) have become essential crisis to cities and have posed great challenges in crisis and risk management of megacities.

Since 2007, Shanghai Meteorological Service (SMS) has successfully conducted 4 WMO programs including Shanghai MHEWS, Shanghai GURME, and Shanghai TLFDP etc. under the support of China Meteorological Administration (CMA). The researches effectively promoted the development of modern meteorological practice and played a good role in crises and risk management. Meanwhile, SMS, as one of CMA’s pilot program of meteorological modernization, established the goal of achieving comprehensive meteorological modernization in 2016. To better accomplish the task, SMS is in need of utilizing international cooperation resources continuously and learning from new technologies to realize core technology breakthrough, improve the ability of risk and crisis management and show China's achievements in meteorological modernization. Presently, Shanghai is building an influential technology innovation center, which needs better international cooperation and creates more opportunities for SMS.

In August 2013, WMO convened Multi-Hazard Early Warning System (MHEWS) and Megacity Implementation Plan (MIP) Expert Meetings in Shanghai, where WMO experts spoke highly of the achievements of Shanghai MHEWS and strongly recommended establishing an Integrated Urban Weather and Climate Service Demonstration Project in Shanghai to demonstrate how to improve risk and crisis management and push GFCS to be implemented in urban area. In June 2014, WMO sent a formal letter to inquire if SMS is willing to undertake the demonstration project. In May 2015, SMS replied WMO to confirm SMS will undertake the task and a few other typical cities will jointly take part in the program.

Shanghai IUWCS is leaded by SMS, participated by Beijing Meteorological Service, Jiangsu Meteorological Bureau, Zhejiang Meteorological Bureau, Guangdong Meteorological Bureau (Guangzhou Meteorological Bureau), and Shenzhen Meteorological Bureau. Through introducing advanced technology and weather/climate disaster management theories, the project is aimed at developing seamless multi-time-scale weather forecast supported by numerical models, developing impact-based forecasting and warning system, improving urban climate services, interacting with users by information services and helping the city to manage risks caused by climate change. The project is an extension of Shanghai MHEWS as well as a demonstration of how GFCS can be applied to urban areas. At the research frontier of disaster prediction and reduction, IUWCS represents the international community’s joint efforts to adapt climate change.

**2. Objectives**

The objective of the project is realizing “two integrations” through introducing and studying advanced weather/climate risk management experience and core technologies.

1) Develop a seamless forecast system including nowcasting, short-term, mid-term, extended range and Long-term forecast to realize the integration of weather forecast and climate prediction.

* Improve nowcasting technology by combining high-resolution numerical models. Increase the ability of strong convection nowcasting and refined weather forecasting.
* Develop High-resolution regional climate prediction and interpretation technology to improve prediction ability for 10-30 days.
* Observe physical and chemical process in urban boundary layer, collect data, conduct research on inversion method and data fusion to improve the ability of urban integrated meteorological observation and application.
* Improve high resolution regional weather forecasting technology and establish high resolution regional NWP system up to 3 km horizontal resolution.

2) Develop impact-based weather forecasting and risk warning system to realize the integration of weather/climate and risk management.

* Develop a demand-oriented, user-interactive system of impact-based weather forecasting and risk warning system based on high resolution numerical forecasting.
* Establish a user-interactive urban climate service platform to improve the resilience of the city.
* Establish and improve public service quality management system, standardize the process of emergency warning, improve Shanghai meteorological disaster prevention/reduction system and public meteorological service system.

**3. Development Plan**

**3.1 Seamless weather forecast and climate prediction system construction**

Develop a multi-scale seamless forecasting system including nowcasting, short-term, mid-term, extended range and Long-term forecast. Take nowcasting and extended range forecast as two priorities and construct an integrated forecast platform to realize fined weather forecast.

**3.1.1 Fined nowcasting for 0-12h**

Advance strong convection nowcasting technique by combining high resolution numerical models. Build nowcasting system for both forecast analyzing and producing.

(1) Construction tasks

1) Strong convection nowcasting operation for 0-2h

* Develop multi-kind observation merging technique to improve Quantitative Precipitation Evaluation (QPE).
* Develop techniques for a) monitoring and analyzing strong convection and b) recognizing and diagnosing convection system/cell during different phases of development.
* Improve radar extrapolation for strong convection nowcasting. Build nowcasting operation support system which is capable of automatically recognizing, warning and forecasting strong convective systems.
* Build nowcasting operation system for issuing real-time convection forecast and warning. The system is capable of provide basic forecast of convection weather such as heavy rainfall, thunder storm, gale wind and thunder. Besides, the system is going to imply localized visual warning products for 0-2h strong convection with real time update. Techniques and products for gale wind forecast will be developed.

2) Strong convection nowcasting operation for 2-6h

* Improve analysis for mesoscale weather systems and their feature factors. Develop forecast techniques for the moving, developing and dissipating of convection systems based on rapid update NWPs.
* Improve operation work of meso-β scale weather analysis. Provide real time analysis products as daily work.
* Establish Radar-NWP blending QPF service for 0-6h nowcasting. Reaching resolution of 1km/10min.

3) Gridded short-term weather forecast for 1-12h

* Establish gridded forecast service based on the integration of main operation NWP models including models of ECMWF, JMA, GFS, T639 and STI-WARMS. Forecast elements will include precipitation, wind, temperature, disastrous weather location and so on. Reaching resolution of 3km/1h.
* Start station forecast for local stations and customized region of Shanghai based on gridded forecast products above.

(2) Core technologies

1) Strong convection recognition: Downburst and gale wind region recognition based on features such as strong low-level convergence and fast barycenter descending; Thunder and hail recognition based on core reflectivity and temperature; Classified convection potential forecast based on NWP diagnostics and statistics.

2) Objective verification and fuzzy verification of strong convection. Blending QPF of radar extrapolation and regional NWP forecast: COTREC radar extrapolation; NWP calibration based on object recognition of different scales; QPE based on real time Z-R relation.

3) Gridded short-term forecast based on Optimal Consensus Forecast (OCF) technique: Multi-model bias estimation, calibration and integration; Downscaling based on information of topography, surface category and statistics; Station elements diagnostic.

(3) Anticipated achievements

1) Build nowcasting operation system for strong convective weather warnings. Establish basic warning products of short-term rainfall, gale wind and thunder due to user demands. Establish dynamic updating text-image warning products of 0-2h strong convective weather, especially for varied gale winds induced by strong convections.

2) Establish QPF products which blend radar nowcasting and short-term NWP for 0-6h with resolution of 1km, 10min.

3) Establish short-term fined station and grid forecast products of East China with resolution of 3km, 1h.

**3.1.2 Extended range forecast and short-term climate prediction**

The high-quality climate database consisted of multi-source data will be integrated to refine the monitoring of atmospheric circulation anomaly and extreme weather & climate events; High-resolution climate models will be applied as the core technology to develop objective climate prediction based on multi models; Inter-monthly extreme weather & climate events forecast methods and models will be explored to develop extended-range prediction technology on high-impact events; A well-systematic and integrated, responsive, efficient-operated climate prediction comprehensive service system is expected to be established.

(1) Construction tasks

1) Atmospheric anomalies and extreme event monitoring services in subtropical monsoon region

Daily, pentadly, dekadly and monthly monitoring products will be operated automatically in real time to provide information concerning multi-spatial and temporal scales, multi-factors and multi-index monsoon circulation as well as its anomaly diagnosis to client-side users when searching it on the websites, which allows the users to know the onset, evolution and influence of subtropical monsoon in a more comprehensive way. Moreover, in order to realize the real-time automatic monitoring and historical sensitivity queries of Meiyu, high temperature, typhoon, cold wave, rainstorm, thunderstorms, gale, fog and haze, and other high-impact weather, typical cities’ (Shanghai & Guangzhou) extreme events monitoring subsystems will be constructed and the corresponding index for extreme events monitoring will also be established.

2) Climate prediction services based on integrated dynamic statistical method of multi model

High-resolution regional climate models (eg: RegCM3 and WRF, etc.) will be applied to develop high-resolution regional climate model prediction techniques. Regional climate model system revised by boundary forcing field will be further established depending on the global reanalysis data, which aims to realize the monthly and seasonal prediction of basic elements and the seasonal prediction of heat, rainstorm and other extreme events.

Based on the data products from a variety of global seasonal models, the interpretation and application of seasonal climate prediction are to be carried out through a variety of interpretation methods. Different model results and their interpretation results will be further integrated to realize monthly and seasonal prediction of temperature and precipitation as well as the operational applications.

3) Extended range prediction of high-impact events

By using the extended-range forecast output by multi models from domestic and foreign, an objective extended-range forecast system is to be developed. Also, the objective application of low-frequency weather map, low-frequency wave, MJO, comprehensive similarity analysis based on multiple criteria, dynamic regression and other statistics forecast techniques in extended range forecast will be improved. In addition, the predictions of impact periods of meiyu, heavy rainfall, cold air and heat process over 10-30 days are to be output in operational application. Further by the integration of statistical & dynamic prediction products, the development of objective extended range prediction systems are to be realized. The research on extended-range prediction technology of strong haze process and its operation tests in extended-range forecast system is also in processing.

(2) Core technologies

1) The monitoring and diagnostic techniques which comprehensively reflect the onset, process, intensity, weather and climate impact of subtropical monsoon;

2) The dynamic downscaling prediction techniques based on high-resolution regional climate model revised by boundary forcing field and the multi-model statistical downscaling interpretation and prediction techniques;

3) Extended-range statistical prediction techniques based on low-frequency atmospheric signals and extended-range dynamic downscaling prediction techniques based on high-resolution regional climate model.

(3) Anticipated achievements

The results will be remitted in forms of operational systems, technical reports, papers, etc. which including:

1) To establish extreme events monitoring systems in typical cities (Shanghai, Guangzhou).

2) To form high-resolution regional climate model prediction technologies and release monthly/seasonal forecast on basic meteorological elements, seasonal forecasting products of extreme events including high temperature, heavy rain, etc. as well as multi-model interpretation and application monthly/seasonal forecasting products.

3) To form important events/processes prediction technologies in extended range and establish objective extended range forecast systems.

**3.1.3 Design and applications of urban synthetic observation**

The observation, data acquisition, retrieval algorithms and the data fusion of physical and chemical processes in urban boundary layer will be prominently enhanced to understand the feedback and interaction between urban boundary layer (canopy layer) and mesoscale weather systems, pollution processes and to meet the increasing needs from science and users and to increase the ability of urban synthetic observation.

(1) Construction tasks

1) Environment survey of urban site and construction of metadata base.

The formats list for urban site metadata survey will be established. The environment survey and of classical urban site and the quality control of its observation data as well as the metadata base will be conducted. The regulations for formats and requirements of urban site metadata survey will be developed.

2) The retrieval of boundary layer height (structure), vertical profile of wind, temperature, water vapor and atmospheric composition.

The observations and retrievals of boundary layer height (structure), the vertical profile of wind, temperature, water vapor and atmospheric composition using wind profiler, Ceilometer, Lidar, microwave radiometer, meteorological tower and other advanced equipment in chosen megacity (etc. Shanghai, Shenzhen) will be carried out.

3) Studies focused on the impact of urban boundary layer on the formation and dispersal of convective precipitation, fog and haze.

Intensive observation experiments aimed at local convective weather, fog and haze will be conducted in megacity such as Shanghai and Shenzhen to study the features of boundary layer (wind field, temperature stratification characteristic, atmospheric stability, boundary layer height etc.) and the vertical distribution of haze and to understand the mechanism of the impact of complex underlying surface condition and boundary layer structure on the formation and dispersal of local convective precipitation, fog and haze by diagnostic analysis using observations and numerical simulation at the scale of atmospheric boundary layer.

4) Experimental studies on adaptive layout of the synoptic network in Yangtze River Delta.

With the acquisition of observation data from automatic weather station and the wind profile radar in Yangtze River Delta region, according to the metadata information, such as the observation environment and equipment type, the observation sites will be evaluated and the observation data will be quality controlled. And the standard database for typical weather processes will be established. Using WRF four-dimensional variational (4DVAR) assimilation, the Forecast Sensitivity to Observation (FSO) and Observation System Simulation Experiments (OSSEs) for typical weather processes such as strong convections and typhoons will be carried out. Based on the characteristics of different weather systems, evaluation tools including subjective verification, traditional metrics, object-based and fuzzy verification, are introduced into NWP verification and analysis. And so, the layout strategy of the automatic weather station and the wind profile radar which is suitable for numeric weather model will be proposed.

(2) Core technologies

1) The acquisition and analysis of the characteristic of urban boundary layer based on the fusion of multivariate data.

2) The fusion of land surface process with inhomogeneous underlying surface characteristic, urban canopy model and mesoscale model.

3) Forecast Sensitivity to Observation (FSO) and Observation System Simulation Experiments (OSSEs)

(3) Anticipated achievements

1) Establish a formats list for urban site metadata survey.

2) Achieve the retrieval of boundary layer height and the vertical profile of wind, temperature, water vapor and atmospheric composition.

3) Reveal the mechanism of the impact of urban underlying surface environment and boundary layer structure on the formation and dispersal of local convective precipitation and the urban fog, and haze.

4) Build a standard case base of classical weather process; propose the layout strategy of automatic weather station, wind profiler etc.

**3.1.4 High resolution regional weather forecasting systems**

(1) Construction tasks

1) Tropical cyclone modeling system. Through integrating regional NWP data assimilation system and NCEP vortex initialization technology, a new generation of high resolution regional tropical cyclone modeling system will be established based on SMS regional meteorological model (SMS-WARMS),.

2) Air quality forecasting system. Based on SMS regional meteorological model (SMS-WARMS) and the Community Multi-scale Air Quality (CMAQ) modeling system, a new generation of air quality forecasting system will be established. Through integration work, SMS-WARMS will be used as meteorological initial and boundary conditions for CMAQ chemical transport model. Further effort will be focused on improving chemical boundary conditions, anthropogenic and biogenic emission inventory, as well as gas phase and aerosol schemes.

3) Ocean modeling system. Based on non-hydrostatic and wave current interaction, a semi implicit Finite-Volume Coastal Ocean Model (FVCOM) will be developed. The operational model will be configured with nest capability, focusing on high resolution forecasting of ocean circulation, wave, thermocline, sea level, and tide in key regions such as Yangshan, Jinshan, Wusongkou, and Baoshan.

(2) Core technologies

1) Rapid updated cycling analysis and forecasting system will have the capacity to assimilate multi-source observational data, including upper-air (RAOB, PIBAL) reports, AMDAR aircraft reports, surface land (synoptic, METAR) reports, surface marine(ship, buoy) reports, radar reflection, and FY-2E infrared and visible light reports.By adding additional meso-scale and micro-scale weather information in the initial fields, forecast skill will be improved for local and extreme weather events.

2) Tropical cyclone modeling system will have the capacity to assimilate multi-source observational data. TC intensity and its structure in initial background will be improved by applying and optimizing the NCEP vortex initialization technique.

3) By integrating meteorological model and chemical transport model, transport and diffusion process of pollutants will be better represented. Meanwhile, chemical boundary conditions will be improved based on global model results. High resolution anthropogenic and biogenic emission inventories will be established and updated. Chemical transformation process of tropospheric pollutants will also be improved by optimizing gas phase chemistry and aerosol schemes.

4) The ocean model will be developed with nest capability so that high resolution forecasts in key areas can be achieved.

(3) Anticipated achievements

High resolution regional weather prediction systems will be developed and put into operation. The NWP systems will be composed of rapid updated cycling analysis and forecasting system, tropical cyclone forecasting system, air quality forecasting system, and ocean forecasting system.

High resolution regional NWP system up to 3 km horizontal resolution will be established. Based on current system (SMS-WARR1.0), a new generation of regional rapid updated cycling analysis and forecasting system (SMS-WARR2.0) will be developed at 3 km horizontal resolution covering Eastern China and surrounding regions.

**3.2 Construction of weather and climate service system based on risk management**

**3.2.1 Impact-based weather forecasting and warning**

To fully construct the impact-based forecasting and risk warning platform, meteorological disaster risk survey should be carried forward, impact assessment model and risk matrix based on ensemble forecast and probability forecast should be built. Timely and effective impact-based forecasting and warning products will be developed to fulfill the demand in five susceptible areas as urban flooding, healthy meteorology, rail transportation, lightning disaster and aeronautical meteorology.

(1) Construction tasks

1) Flooding in city group and urban area

Research and development of key technologies in small and medium brook flood impact and risk warning in the core region of city group along the Yangtze river in South Jiangsu need to be down, Research and development of key technologies in urban rainstorm flooding simulation, rainstorm flooding impact assessment, rainstorm flooding impact-based forecasting and risk warning and others need to be carried out; professional and comprehensive rainstorm flooding impact-based forecasting and risk warning products need to be developed; business process of collaborative response needs to be built; multi-channel service distribution system needs to be completed while service for communities and others in the city will be improved step by step.

* Risk survey for urban rainstorm flooding needs to be carried forward, corresponding survey data contents need to be clarified and survey technique standard needs to be set up, in order to build an urban flooding underlying database.
* Synthesizing upstream flood of river network and regional drainage capacity, dynamic flood simulations of small and medium brook in the city group in South Jiangsu need to be down by using flood area model. High risk area needs to be found by taking considerations of population, GDP and land use information. Adverse impact on important hazard-affected bodies needs to be analyzed. Rainstorm flooding risk warning of small and medium brook in the city group needs to be carried on.
* Simulations of rainstorm urban flooding need to be carried out, while upstream flood impact in the city group needs to be synthesized. Therefore rainfall intensity and relevant hydrographical and environmental features will be analyzed to further build urban flooding model.
* Research and development of rainstorm flooding impact assessment indexes for communities need to be accomplished, impact assessment model which based on communities’ exposure and vulnerability needs to be built, rainstorm flooding risk matrix for communities needs to be established, corresponding threshold values under different risk levels need to be analyzed, rainstorm flooding impact-based forecasting and risk warning products for communities needs to be developed.
* Community rainstorm flooding impact-based forecasting and risk warning service system needs to be established in shanghai; support functions of weather forecast and weather service in business platform also need to be pushed on; service ability needs to be improved by using new media; effects of urban flooding impact-based forecasting and risk warning service needs to be evaluated.

2) Health-Meteorology

To develop health risk forecasting technology by epidemiological and toxicological methods . To make health risk forecasting and alert service packages on several diseases with professional guidance. To develop meteorology-health platform, to establish health risk forecasting system in Shanghai (Yangtze River Delta), and to deliver service extensively step-by-step to vulnerable population and industries in Shanghai.

* To investigate the effects of weather, climate change and air pollution exposure on related diseases by epidemiological and toxicological methods. To develop health risk forecasting technology, and build forecasting models of heat wave, meteorological living index, respiratory diseases risk (cold, childhood asthma, COPD and so on), and explore the index measuring the impact of heavy pollution in public health.
* To establish health risk forecasting system in Shanghai (Yangtze River Delta). To develop meteorology-health platform and weather sensitive health forecast products. It will be improved in the capacities of forecasting technique and service delivery through new media such as Wechat. The health risk forecasting service is promoted in Shanghai, which could be a pilot and support similar services in the Delta.
* To evaluate the effect and benefit of health risk forecasting service by knowledge, altitude and practice (KAP) study.

3) Traffic meteorology

Based on urban observatory site and fine grid forecast data, to carry out urban traffic meteorological disaster risk census; with urban express road, rail transportation, port as the focus, to develop the risk assessment and early warning platform of urban traffic disaster weather effect.

* Using the observation data of automatic stations, to carry out real-time wind monitoring business of urban rail transportation. According to the analysis of wind impact on track traffic safety, combined with subway company emergency response mechanism, to develop the meteorological element threshold for different levels of risk; based on the fine grid forecast data, to develop the prediction products of risk early warning of wind’s impact on track traffic safety.
* Using the observation data of automatic stations and the fine interpolation technique of wind field, to investigate the influence of weather conditions on the traffic safety of vehicles. Based on the traffic meteorological monitoring platform, to carry out the real-time risk early warning products of traffic safety.
* By carrying out the research of user’s requirements and the meteorological disaster risk census of port terminal, to set up the meteorological element threshold for the safe operation of port terminal for different levels of risk. Based on the fine grid forecast data, to develop the risk early warning products of the safe operation of port terminal.

4) Lightning disaster

Monitoring Service products of direct lightning flash and lightning electromagnetic pulse need to be provided to highly sensitive users in surrounding areas; assessment of lightning disaster impact needs to be carried forward, lightning disaster risk matrix needs to be built；lightning disaster risk warning products need to be developed; business process of collaborative response needs to be built; multi-channel service distribution system needs to be completed; service ability needs to be improved by using new media, service for susceptible areas such as amusement parks in the city needs to be provided.

* Supported by all lightning monitoring system, monitoring service products of direct lightning flash and lightning electromagnetic pulse need to be provided to highly sensitive users in surrounding areas.
* Considering the population density and the defense capacities of outdoor facilities and others of highly sensitive objects comprehensively, impact assessment of lighting disaster needs to be down while lightning disaster risk matrix needs to be established; lightning disaster risk warning products need to be developed on the basis of severe convection weather forecast in the short-term.
* Lightning disaster risk warning service system for highly sensitive users in Shanghai needs to be established, business process of collaborative response needs to be built, multi-channel service distribution system needs to be completed, service ability needs to be improved by using new media, effects of lightning disaster impact-based forecasting and risk warning service need to be evaluated.

5) Aviation Meteorology

Develop aviation high impact weather monitoring and nowcasting technologies, translate numerical weather prediction products into aviation impact. Establish aviation impacting weather index, including severe convection, low visibility, etc. Develop aviation weather nowcasting/forecasting products and risk warning service for Shanghai Hongqiao and Pudong airport, main airways and low-altitude flights. Strengthen cooperation between meteorological department and civil aviation department on information sharing, technical development and linkage guarantee.

* Develop weather related main airways capacity and delay forecast services for high impact weather (eg: severe convection, low visibility, etc ) in Shanghai PuDong Airport and Shanghai HongQiao Airport, based on monitoring and nowcasting technologies on aviation high impact weather and high-resolution numerical weather prediction products.
* Provide monitoring and nowcasting services on high impact weather (eg: severe convection, low visibility, etc ) for Shanghai PuDong Airport and Shanghai HongQiao Airport. Based on the demand of airport security operation, develop airport impact forecast products.
* Develop weather impact forecast services for low-altitude flight, with the demand of general aviation users, focusing on aviation high impact weather, including severe convection, low visibility and gale.
* To meet different requirements of users including civil aviation, airport, general aviation and public, set up aviation weather forecast platform, develop aviation weather impact forecast and risk warning service experiment. With Strengthened cooperation between meteorological department and civil aviation department, jointly establish aviation information sharing, promote technical development and construct linkage guarantee mechanism.

(2) Core technologies

1) Urban flooding: rainstorm flooding survey technology; rainstorm flooding assessment model.

2) Meteorology-health: health risk forecasting technology by epidemiological and toxicological methods.

3) Traffic meteorology: Applying the products which combine forecast and probability forecast in severe weather influence and risk early warning forecasting; fine interpolation technology of wind field.

4) Lightning disaster: Lightning disaster impact assessment model.

5) Aviation Meteorology: Monitoring and nowcasting technologies on aviation high impact weather; translating high-resolution numerical weather prediction products into aviation impact; evaluation model for effects of aviation impact weather on airways, airports and others.

(3) Anticipated achievements

1) To develop urban rainstorm flooding impact-based forecasting and risk warning system.

2) To develop health risk forecasting technology by epidemiological and toxicological methods.

3) To develop the risk assessment and early-warning platform of severe weather focusing on urban transportation in Shanghai.

4) To develop Lightning impact-based forecasting and risk warning for highly sensitive users in Shanghai.

5) Establishment of aviation meteorology impact forecast platform based on high impact weather analysis and forecast system.

**3.2.2 Urban climate services**

Strategies include survey on users’ demand, research on meteorological disaster risk zoning technology, establishment of climate impact assessment model & urban climate service platform and the mechanism improvement of communication & cooperation with climate services users will be taken to enhance the performances of climate service products in economy and society.

(1) Construction tasks

1) Urban climate service demands & platform construction

For the departments and fields such as governmental disaster-preventing and decision-making departments which are closely related to climate and climate change, demand researches in forms of face-to-face communication, questionnaire survey, etc. will be carried out to find the pressing problems existed or the user groups who have urgent needs as well as the ways to provide services. To upgrade the service levels in terms of automation, objectivity and timeliness, a targeted urban climate service platform will be established to provide rolling climate risk prediction for focus areas (such as reservoir basin, flood, geological disasters, etc.) closely associated with urban public safety.

2) Priority areas for climate services & technology research and development

Centering on the areas concerning urban rainstorm & flood disaster, urban planning & ecological environment, urban climatic resources & energy and urban health & environmental quality, the technologies including climate impact assessment, climate resources assessment & prediction, urban ventilation corridor planning & meteorological evaluation and meteorological disaster risk zoning will be developed. The research on the key technologies of climate service concerning meteorological disasters, urban planning, urban economic production, residents health and urban environment will be also carried out.

3) Climate service mechanism construction & products benefit evaluation

The multi-sectoral cooperative and interactive relationships are to be established among climate service users, service provider and technology R&D staff. Therefore, seamless and customized urban weather and climate services products (such as urban heat island index, wind energy, solar energy, etc.) will be provided to the related industries and areas in real time. The service products diversification and service performance evaluation will be also conducted to support urban air pollution control, urban planning, industrial layout, sustainable development and meteorological disaster risk management.

**Table1. The details of construction**

|  |  |  |
| --- | --- | --- |
| Service areas | Examples of climate service products | Users |
| Urban flood prevention | The urban waterlogging risk zoning;  Design criteria update for urban flood and waterlogging control;  Integrated service platform for urban weather and climate | Water Affairs Bureau; Water Planning & Research Institute; Drainage company, etc. |
| Urban planning & urban ecology | Large construction projects (Disney) climate feasibility demonstration;  Design parameters update for urban heating and ventilation, wind and lightning protection;  Impact assessment of large-scale construction projects on local climate environment;  Urban ventilation corridor planning & meteorological evaluation  Environmental benefit evaluation of urban green land planning;  Study on the evolution of urban thermal environment;  Effects of climate change on phenology (flowering period) | Planning Bureau; Greening bureau; Tourism Bureau, Municipal Engineering Institute; Architectural design company, etc. |
| Climate resources & energy | Wind and solar energy resource assessment;  Wind power prediction;  Longer-term urban electricity consumption prediction | NDRC, power company, wind power company, etc. |
| Economic production | Insurance product R&D based on urban green-leaf vegetable meteorological index;  Meteorological disaster risk assessment of large-scale social activities | COA, Tourism Bureau, Insurance companies, event organizers, etc. |
| Health & environment | The advance and retreat of monsoon and air quality;  Climate change and Human health;  Season and health (heating) | Environmental Protection Agency; health departments, hospitals, schools, etc. |

(2) Core technologies

1) Climate impact assessment technology: By using the regional climate model driven by the prediction results from global models, the changes of future extreme weather and climate events are to be estimated; the relationship between wind speed thresholds variation and corridor ventilation performance is to be analyzed based on the observational data; The impacts of climate conditions on green-leaf vegetables and urban power are to be evaluated based on statistical methods.

2) Climate resources assessment technology: Based on high-resolution numerical model, the spatial and temporal distribution of wind energy & solar energy, the ecological environment benefits of green land planning, the performance evaluation of urban ventilation corridor planning and the relationship between monsoon & air quality are to be simulated.

3) Disaster risk zoning technology: Based on remote sensing, GIS as well as combined with climatological statistical diagnosis technology as well as hydrological hydrodynamic model, urban waterlogging risk zoning is to be conducted; Based on the extreme value statistics method, the design criteria and parameters of flood and waterlogging control are to be updated; Based on high-resolution urban geographic information data, surface ventilation potential is to be calculated and classified; Based on the remote sensing and process model, the study of urban thermal environment dynamic is to be conducted.

(3) Anticipated achievements

1) Urban Water-logging Risk Zoning Results and Operation System in Shanghai.

2) Integrated service platform for urban weather and climate.

3) Urban Ventilation Corridor Planning in Beijing.

4) Urban Ventilation Corridor Planning in Beijing.

5) Wind Power Forecast System in Shanghai.

6) Urban Rainstorm Formula in Shanghai.

7) Wind and Solar Energy Service Products in Shenzhen.

**3.2.3 Warning Release and Department Interaction**

Improve the early-warning releases job specification, build early warning releases standardization system, and strengthen the linkage mechanism. Integrate the resources of the whole city emergency warnings to make them published in the first and become the first choice of the public. Develop the new channels of the early-warning release, achieve full coverage of information; upgrade early-warning release system, enhance the one-click publishing capability.

(1) Construction tasks

1) Establish standardization system of emergency early-warning release.

Refer to the existing construction of the standardization system of public weather services and cooperate with Guangzhou and Shenzhen meteorological bureaus, for different types of early-warning rules and publishing processes, make emergency warning release standardized.

2) Establish and improve the mechanism for early-warning release departments interaction.

Form the interaction mechanism of the whole city early-warning release; clear the solutions of early-warning release responsibilities and response time. Complete non-meteorological early warning information release access early-warning center, gradually achieve the releases “ sort management, unified release, full coverage”.

3) Establish an integrated emergency warning issue platform.

Guangzhou emergency warning dissemination system has been built to achieve provincial and municipal accesses to multiple distribution channels. Reference to related work experience, complete the upgrade early-warning system of warning issued through various channels, develop and improve website, client, micro-blogging, we-chat, text messages, cell broadcast and other new media system to achieve early-warning for one-click publishing and systematic and comprehensive monitoring(data flow, external display, and so on)

(2) Core technologies

1) Multi-platform ‘one-click’ publishing technology. Simplify early-warning release processes, optimize existing means, explore other advanced release systems (cell broadcast), make cell broadcast, SMS, radio, TV, fax, mail, we-chat and other multi-channel information released on real time.

2) Interactive audit issue platform. Implement administrative networks, real-time delivery of internet publishing approval process. Improve data link monitoring alert technology from system-level data link for the real-time monitoring, any node fails, and active alarm mechanism to reduce, avoid warning release failures.

(3) Anticipated achievements

1) To establish files of standardized early-warning issue system .

2) To build a platform of “one click” early-warning information issue.

**3.3 Practices of comprehensive urban weather climate services in Shanghai Disney Resort**

Advances and application of ultra-fine and comprehensive meteorological monitoring system in Shanghai Disney Resort (SDR for short)；application of advanced short-term forecast technology and climate prediction products in SDR; establishment of meteorological service processes and demonstration for government decision and public service in SDR.

**3.3.1 Construction tasks**

(1) Application and Practice of the Ultra-fine Comprehensive Meteorological Observation System in the SDR.

1) Construction of the SDR Observation Network

In addition to the current modernized comprehensive meteorological monitoring system over Shanghai and its surrounding areas, x-band radar and special meteorological stations will be equipped to enhance the capability to capture abrupt severe weather in STR region, providing demonstration for metropolitan three-dimensional high-resolution meteorological observation.

2) Application and service based on realtime observation in the SDR

Real-time meteorological observation and analysis will be carried out based on the multi-source observing data obtained inside and outside the SDR region. Services based on analysis of observations will be provided for decision making, SDR operation and public service through LED screen, meteorological website, mobile messages, WeChat and so on.

(2) Application of seamless Weather and Climate Service Products in the SDR

Advanced weather and climate forecast methods will be applied in the forecast service of SDR. The performance of forecast for disastrous weather such as heavy rain, intensive wind, high temperature, fog, etc, will be evaluated, which should be valuable for the weather disasters prevention in the key region of megacities.

(3) Establishment of New Mode for Professional Meteorological Service in the SDR.

New mode of professional meteorological service for SDR region will be established with emphasis on meteorological disaster prevention and reduction, according to the typical features of the SDR management, operation and public tourism meteorological service. Comprehensive and targeted tourism meteorological service will be developed for warning of risk in flood, health and atmospheric environment in SDR.Assessment on degree of satisfaction will be conducted. Finally, SDR may act as a window for demonstration of standard tourism meteorological service.

(4) Establishment of the Integrated Meteorological Operational Platform and the Meteorological Disaster Prevention Mechanism for the SDR.

The SDR meteorological integrated operational platform, which supports the forecast service for SDR, will be built upon the SMB integrated operational platform and SDR observatory. The emergency response plan for meteorological disaster will be drawn up to facilitate the cooperation with other administration units of emergency. This may facilitate effective response to the abrupt meteorological disaster in SDR.

**3.3.2 Core technologies**

1) High-resolution meteorological monitoring techniques based on X-band Radar and multi-observations in the SDR.

2) Short-term weather forecast and warning techniques based on high-resolution real time monitoring and numerical weather prediction in the SDR.

3) Special techniques for tourism weather service in the SDR.

**3.3.3 Anticipated achievements**

1) A composite meteorological station will be built in SDR in which multiple meteorological and atmospheric environmental elements can be simultaneously observed with high reliability.

2) An integrated meteorological operational platform will be established in SDR based on the integrated platform of SMB and advanced technologies, which can provide customer-oriented products and meteorological service for SDR administrative committee, Disney commercial operation and public. The degree of satisfaction on meteorological service in SDR will be evaluated, which should meet the standard of meteorological modernization in Shanghai.

3) A short-term meteorological forecast and warning system will be developed for SDR based on the realtime observation and high-resolution numerical prediction. The performance of this system should meet the standard of meteorological modernization in Shanghai.

**4. Organization Structure**

The organization structure of IUWCS consists of 3 levels:

* Science Steering Group (SSG) is responsible for the overall planning and instruction.
* Project Coordination Group (PCG) is responsible for coordination and pushing the project.
* Working Teams are responsible for implementation and accomplishing the construction tasks.

**4.1 Science Steering Group (SSG)**

Science Steering Group (SSG) provides technology instruction, reviews the work progress, supervises the implementation process and evaluates construction achievements. SSG should report to WWRP to show how the project going.

Team Members:

1) China

Zhenlin Chen, Director General, Shanghai Meteorological Service (SMS)

Mingmei Li, Deputy Director General , Department of Emergency Response, Disaster Mitigation and Public Services, CMA

2) International

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Secretaries: QiqigeWuyun, Liming Fan

**4.2 Project Coordination Group (PCG)**

PCG is responsible for coordination, especially for bridging SSG and Working Teams.

Team Leader: Yinming Yang, Deputy Director General of Shanghai Meteorological Service (SMS)

Team Members:

1) Executive member, Department of International Cooperation, CMA

2) Di Zhang, Deputy Director, Public Weather Service Division, Department of Emergency Response, Disaster Mitigation and Public Services, CMA

3) Hui Zhang, Director, Department of Emergency Response, Disaster Mitigation and Public Services, SMS

4) Liying Tao, Director, Department of Science & Technology Development, SMS

5) Weidong Liu, Director, Department of Science & Technology Development, Beijing Meteorological Service

6) Jun Lv, Director, Department of Science & Technology and Forecasting, Jiangsu Provincial Meteorological Service

7) Zhenming Wang, Deputy Director, Forecast and Scientific Department of Zhejiang Provincial Meteorological Service

8) Cong Zeng, Director, Department of Science & Technology and Forecasting, Guangdong Meteorological Service

9) Beilei Wang, Deputy Director, Department of Observation and Forecasting, Guangzhou Meteorological Service

10) Xiaoli Zhang, Deputy Director, Department of Science & Technology Development, Shenzhen Meteorological Service

11) Coordinators from WMO (2 people)

Secretaries: Liming Fan, QiqigeWuyun

**4.3 Working Teams**

Two Chief Scientists lead 8 working teams to conduct the project. The working teams are built according to their leading units which are responsible for providing support to the working team members.

General Leading Unit:

* Shanghai Public Meteorological Service Centre
* Shanghai Institute of Meteorological Science

Chief Scientists:

* Chunyan Kong
* Jianguo Tan

Secretary: Huijie Feng

Team 1：Fined nowcasting for 0-12h team

Leading unit: Shanghai Central Meteorological Observatory

Director: Hai Chu

Team Members: (Shanghai) Jianhua Dai, Min Sun, Mengjuan Liu, Lei Chen, Lan Tao, Yang Ding; (Zhejiang) Lie Chen, Jun Yang; (Guangzhou) Dongming Hu, Cong Luo, Xinyu Zhou, Yu Zhang; (Shenchen) Yuanzhao Chen, Cheng Li.

Team 2：Extended range forecast and short-term climate prediction team

Leading unit: Shanghai Climate Center (East-China Reginal Climate Center)

Director: Ping Liang

Team Members: (Shanghai) Fei Xin, Jiawei Wang, Guangtao Dong; （Jiangsu）Wei Jiang; (Zhejiang)Hao Ma; (Guangzhou)WeijuanPan, Ting Wang

Team 3：Design and application of urban synthetic observation team

Leading unit: Shanghai Institute of Meteorological Science

Director: Jianguo Tan

Team Members: (Shanghai) Haojun Chen, Juan Sun, Jie Peng; (Shenzhen) Yin Jiang, Honglong Yang

Team 4：High resolution regional weather forecasting team

Leading unit: Shanghai Innovative Center of Regional High Resolution Numerical Weather Prediction

Director: Xiaofeng Wang

Team Members: (Shanghai) Xiaolin Xu, Ying Xie, Yue Yin, Lei Zhang, Jia Li, Yuhua Yang, Tong Xu, Jie Xu, Qin Jiang, Yuncheng Zhang, Ping Wang; (Zhejiang) Feng Chen, Zhenshou Yu.

Team 5：Impact-based weather forecasting and warning team

Leading unit: Shanghai Meteorological Disaster Protection Technology Center

Director: Qiang Wang

Team Members: (Shanghai) Li Peng, Chunyan Kong, Baiping Li, YudanGu, Chen Yang, Ya Wang, Yi Sun, Min Yu, Haihong Li, ZheMou, Xiaofang Ye, Jing Zhang, Beibei Zhu, Yin Zhang, Zhihui Han, Junjing Wu, Lei Chen, Kang Xu; (Jiangsu) Zhiqing Xie.

Team 6：Urban climate services team

Leading unit: Shanghai Climate Center

Director: Jun Shi

Team Members: (Shanghai) Hanwei Yang, Yue Ma; (Beijing) Xiaoyi Fang; (Shenzhen) Lei Li, Shenpeng Chen.

Team 7：Warning release and department interaction team

Leading unit: Shanghai Public Meteorological Service Centre

Director: Xuejun Bao

Team Members: (Shanghai) Ye Shan, Beibei Zhu; (Guangzhou) Weijun Xiao, Jieyi Li, Tingting Gao; (Shenzhen) Yaling Wu.

Team 8：Practices of comprehensive urban weather climate services in Shanghai Disney Resort team

Leading unit: Pudong Meteorological Office of Shanghai

Director: Leiming Ma

Team Members: Songqiang Gu, Wenwei Pan, Guangliang Zhang, Ying Lin, Jingjing Han, Liya Zhang, Lihua Di, Yuya Liu, Jing Xu, Liangwen Yin，Chen Shen

**5. Project Schedule and Milestones**

**5.1 Schedule**

Phase I: Jan. 2015-Dec.2015 Preparation（Build teams and complete project implementation plan）

Phase II: Jan. 2016-Sep. 2017 Project Development

Phase III: Oct.2017-Jan.2018 Evaluation, test and improvement.

Phase IV: Feb.2018-May2018 Summarize and share experiences among WMO member countries (publish papers and conduct trainings)

**5.2 Milestones**

Dec. 2015: Complete project implementation plan (Draft)

May. 2016: Complete project implementation plan

Oct.-Dec. 2016: Mid-term Meeting (review project progress)

Dec. 2017: Evaluation Meeting (evaluate project implementation)

May. 2018: Summary Meeting (Approve project summary report)