UNESCAP/WMO
Typhoon Committee

2nd Organization Committee meeting of

Progress of Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)

Shanghai Typhoon Institute of CMA

2017.9.8 Shanghai, China

UNESCAP/WMO
Typhoon Committee

Outline

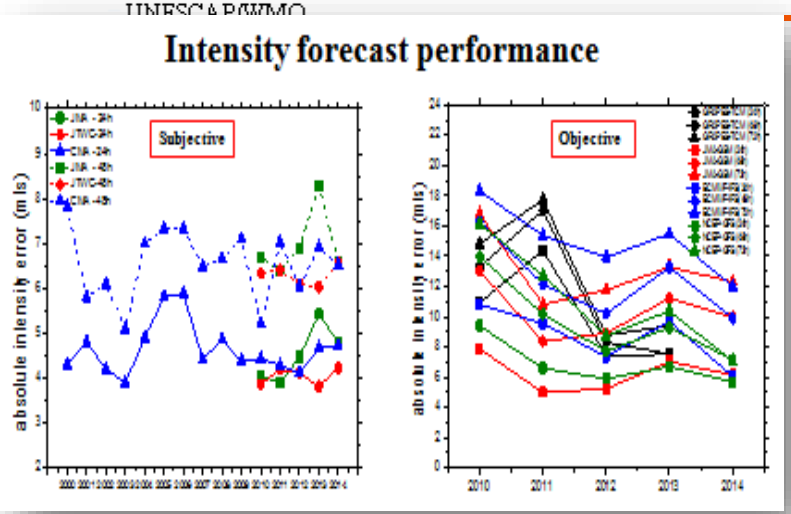
- Background
- Major progress
- Future plan

UNESCAP/WMO
Typhoon Committee

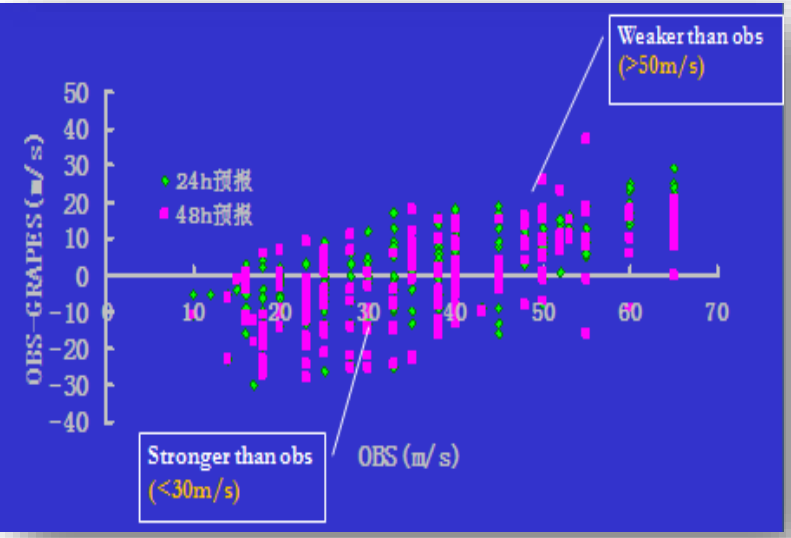
Part I:

Background

Challenges: for Intensity(estimate & forecast)



- Weak stage (TD → TS, TS → TD)
  Strong stage (super Typhoon)
- Rapid change (RI & RW)
- Coastal area & landfalling



Lack of:

Operational direct observation data

Proposal: (2013.1) 45th TC Session

UNESCAP/WMO
Typhoon Committee

45th Session of ESCAP/WM

2012 Annual Re

Chairman: LEI XiaoTu (STI

Vice-chairman: Mr. Nathani
Ms. Che Ga

Mete. Expert of TCS: Kai H

30, January 2013, Ho

UNESCAP/WMO
Typhoon Committee

Recommendation & suggestion (3)

- To prepare a joint field experiment within TC region
  - similar to SPECTRUM90
  - using flights, radar, wind profile, satellite and GPS sounding….
  - coordinate with the demonstration projects (e.g. WMO/WWRP/TMRP)

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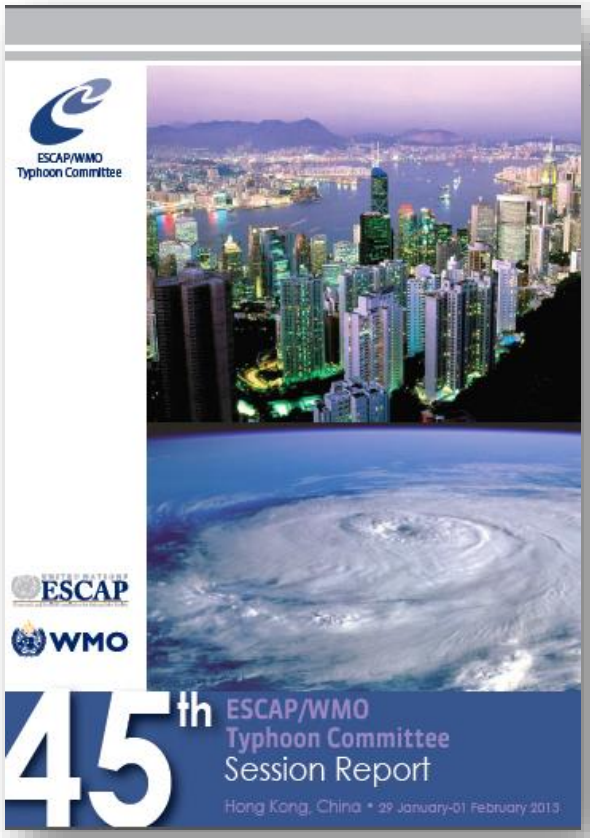
Final Report: (45th TC Session)



- Paragraph 45.t:

*" WGM In conjunction with other WGs and TRCG, to take the lead in **designing and formulating a tropical cyclone field experiment** within the region, in particular by making use of the available opportunity **in collaborating with the Southern China Monsoon Rainfall Experiment (SCMREX)** planned by the WGTMR of WMO for implementation in 2013 (spin-up phase) and 2014 (field phase), and **hold a small expert meeting to draft the proposal if necessary**."*

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Typhoon Committee

Drafting Process: (from 2013)

- 1st Version
  - Draft: March 2013, on behalf of WGM, STI/CMA drafted the 1st version of the plan.
  - Symposium: March 2013, Chaired by Ms. JIAO Meiyan, a coordinated meeting was held in CMA, attended by Dr. LEI Xiaotu (Chairperson of WGM), Prof. LUO Yali (Chief Scientist of SCMREX), Prof. DUAN Yihong (Chair of WMO/WGTMR).
  - Circulate: the 1st draft was circulated among TRCG.

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Typhoon Committee

Drafting Process (con.)

- **2nd Version**
  - Revise: April 2013
  - Present: May 2013, **AWG** small meeting-Bangkok (Jun YU)
    May 2013, 8th **WGDRR** workshop-Seoul (Derek Leong)
    October 2013, 2nd **WGH** workshop-Seoul (Jin ping LIU)
- **3rd Version**
  - Revise: November 2013
  - Present: December 2013, 8th IWS and 2nd TRCG Forum
- **4th Version**
  - Revise: January – February, 2014
  - Submit: February 2014, 46th Session

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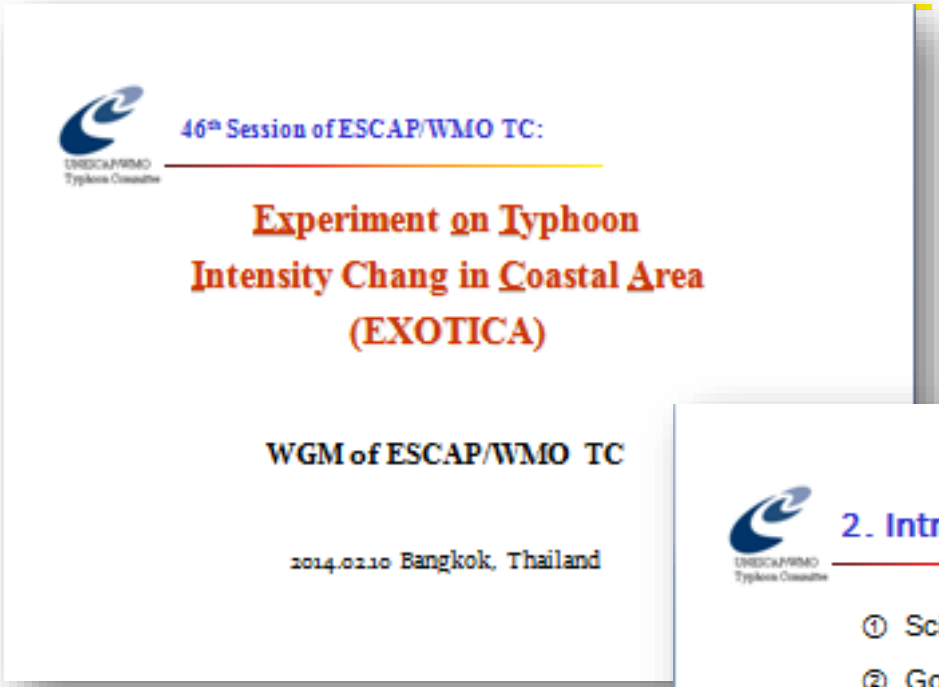
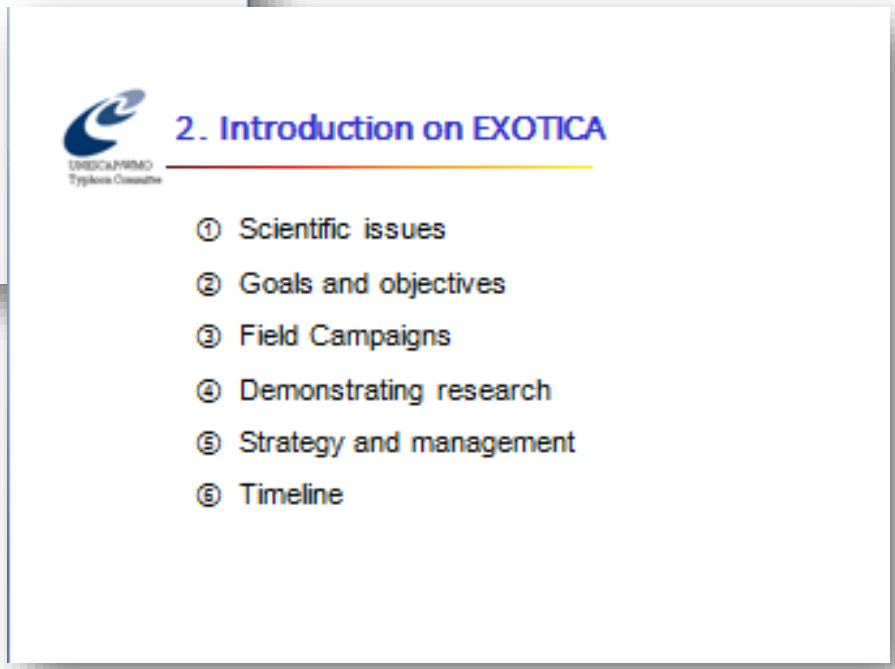
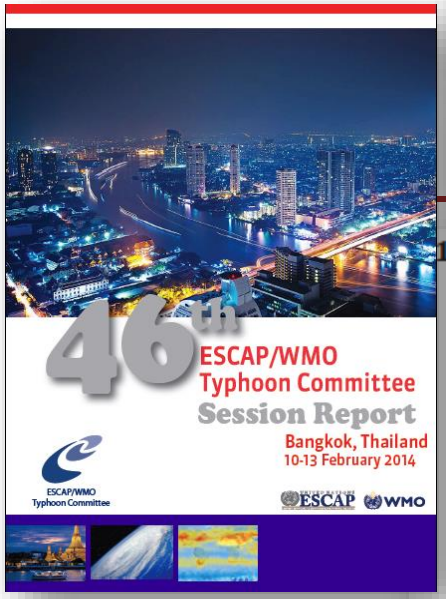
Typhoon Committee

Endorsed: (2014.2) 46th TC Session







a. To endorse the WGM project proposal of EXOTICA as shown in Appendix X (Appendix II – EXOTICA), to encourage the active participation of the Members and WGs, and watch for opportunities to collaborate with other field experiments in the area.

s. Request TCS to send letters to Members requesting the nomination of the Organizing Committee (OC) for Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA).

1.4. Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)

117. The Committee noted with appreciation the submission of the project EXOTICA to the 46th Session by WGM in accordance with the decision on the WGM recommendation at the 45th Session.

118. The Committee noted the organization structure of EXOTICA and recognized that the OC should be at the top of the organization structure.

119. The Committee noted the implementation plan as well and recognized that the OC should be established as soon as possible to start up the implementation of the project.

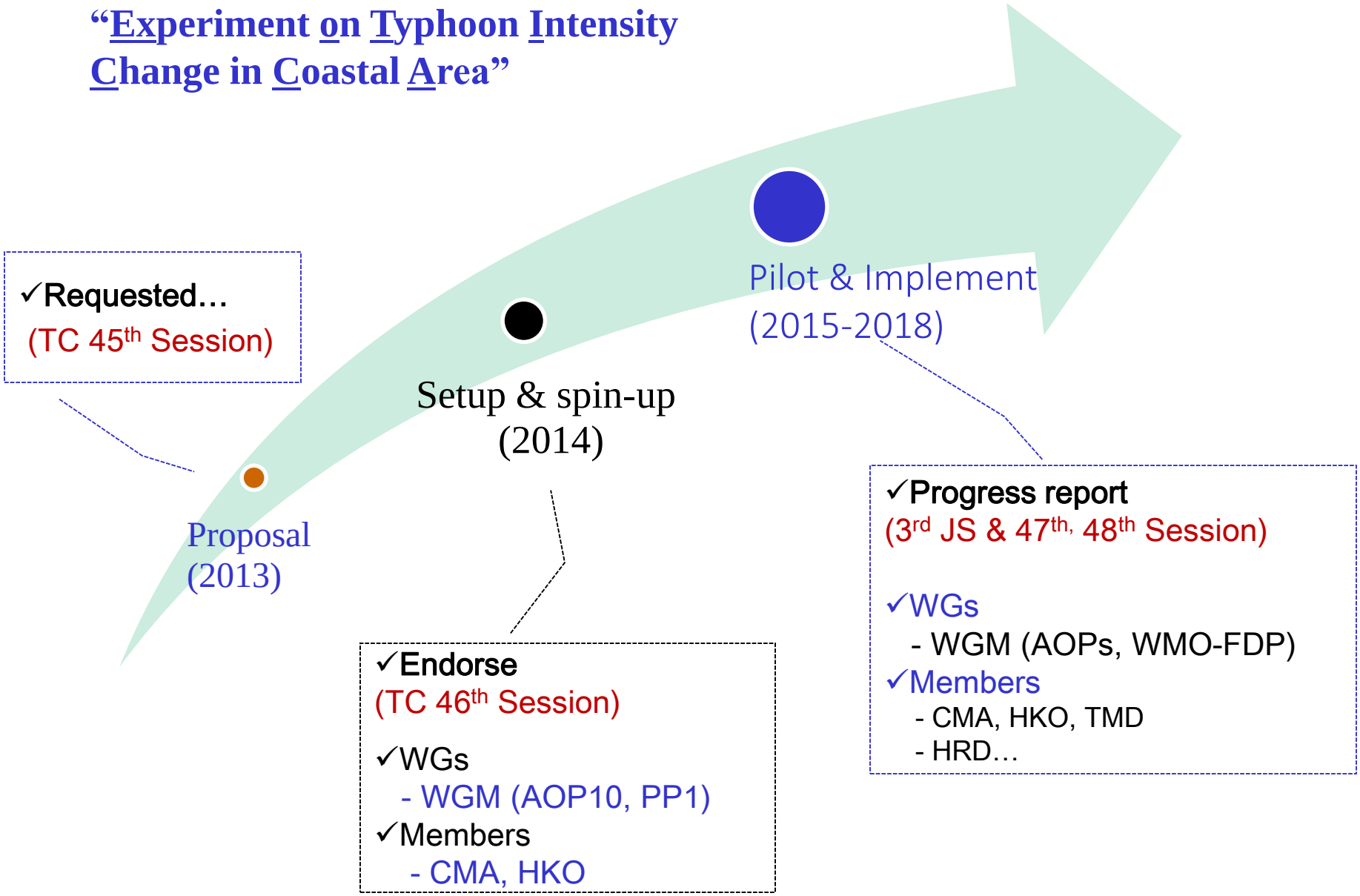
120. The Committee noted that The Scientific Steering Committee (SSC) will be established to provide guidance on the design and implementation of this field experiment. SSC will comprise the renowned typhoon experts. All the members of the SSC will be nominated by the OC.

121. The Committee further noted the following:

- the OC will develop the detailed implementation structure and procedures.
- to complete the nomination of members of SSC, Chief Scientists, and members of Research Group as soon as possible after the establishment of the OC.
- Piloting (spin-up) the field campaign (including the trial target observations for 1-2 tropical cyclones) and testing of instruments, demonstration research in 2014.

Footprints of EXOTICCA :

"Experiment on Typhoon Intensity Change in Coastal Area"



UNESCAP/WMO
Typhoon Committee

Goals and objectives

- Carry out the field campaigns (target typhoon observation)
  - 3-5 target typhoons of coastal area and landfalling per year
  - By using the new monitoring techniques, such as: aircraft (drop-sound), mobile GPS (rise-sound), …. and rocket (drop-sound)
  - gather the comprehensive observation data of the structure and intensity change of target typhoon

UNESCAP/WMO
Typhoon Committee

Goals and objectives (con.)

➢ Demonstration research

- Improve the knowledge of abnormal intensity change (rapid change), in particularly, the genesis (in South China Sea) and disappear (in mid- and high-latitude area and after landfall)
- Improve the performance of typhoon intensity determine and regional numerical modeling
- Develop the storm surge (urban city) , flooding (inland) forecasting and damage risk estimate/forecast system

UNESCAP/WMO
Typhoon Committee

Part II:

Major progress

UNESCAP/WMO
Typhoon Committee

2. Major progress

- Organization
- Instrument (new)
- Experiment (field campaign)
- Demonstration research

AOP10 of WGM:

contribution for the EXOTICCA

(from 2014：46th TC Session)

Pilot (2015.2) :

3rd JS & 47th TC Session

(Bangkok, Thailand)

47th TC Session final report (Paragraph 14**)**

p. To request CMA to host the EXOTICA organization committee (OC) meeting for preparing the implementation of the field campaign and demonstration research, including establishing the Scientific Steering Committee and Research Groups and confirm the tasks of participating Members. To request CMA, HKO and the participating Members to pilot the field campaign by using dropsonde as well as the reconnaissance flight.

1st Organization Committee (OC) meeting:2 015

April.23-June
- plan

Sept. 4
- postpone

Oct. 9 2015
- implementation

Programme:

ESCAP/WMO Typhoon Committee | UNITED NATIONS ESCAP | WMO | WMO ESCAP Panel on Tropical Cyclones

First Organizing Committee Meeting
Experiment of Typhoon Intensity Change in Coastal Area (EXOTICA)

9 October 2015
Shanghai Meteorological service
Shanghai, China

TENTATIVE PROGRAMME

2. Discussion and Approval on the structure and TOR - Scientific Steering Committee - Research Groups - The Agreement of Project EXOTICA	LEI Xiaotu
Coffee break (& Group Photo)	
3. Summary on the progress (up to now) - CMA - HKO - JMA	YU Hui WONG Wai-Kin FUJITA Tsukasa
4. Technical Lectures - The currently progress of the field campaign on hurricane intensity change in USA	Peter BLACK
5. Discussion on the future plans	LEI Xiaotu

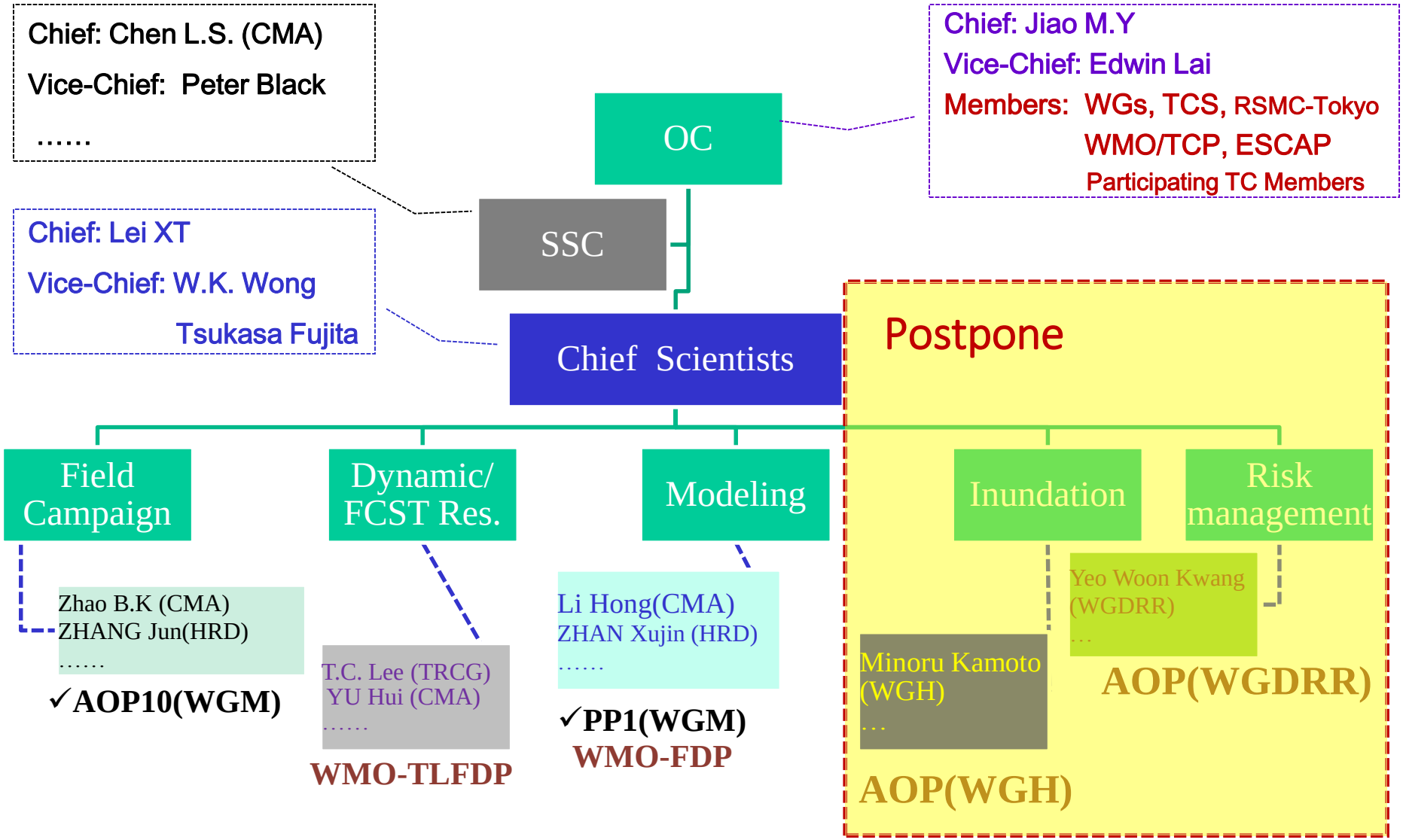
Participants: 15

UNESCAP/WMO Typhoon Committee Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)
(Shanghai, China. 8-9 October, 2015)

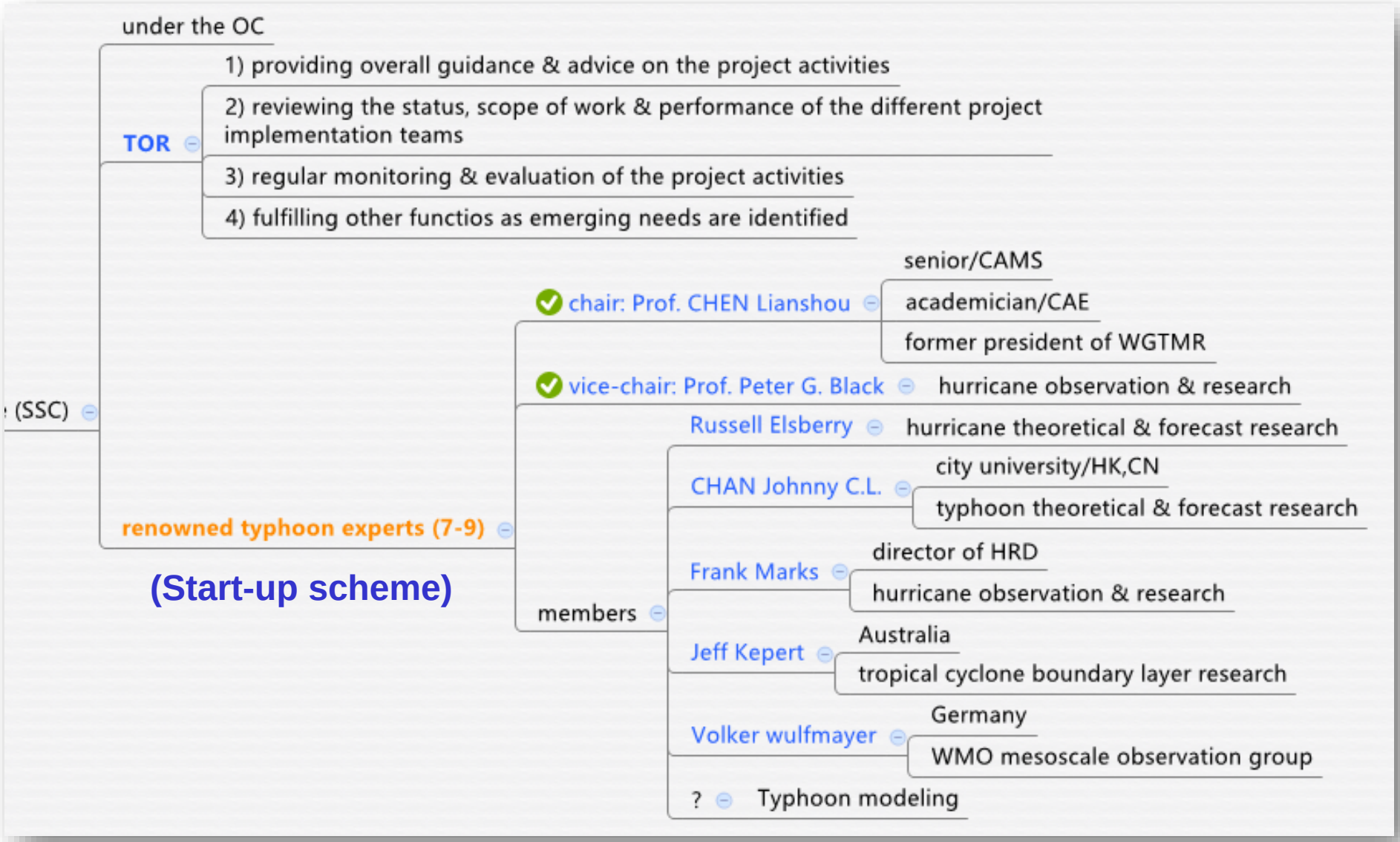
Name List

No.	Name	Gender	Affiliation	title
1	JIAO Meiyan	Female	China Meteorological Administration	chair of OC
2	Edwin LAI	Male	Hong Kong Observatory	vice-chair of OC
3	FUJITA Tsukasa	Male	Tokyo Typhoon Center	member of OC
4	CHEN Zhenlin	Male	Shanghai Meteorological Service	general director of SMS
5	WONG Wai-kin	Male	Hong Kong Observatory	member of OC
6	LEI Xiaotu	Male	Shanghai Typhoon Institute	member of OC
7	Clarence FONG	Male	ESCAP/WMO Typhoon Committee	member of OC
8	Peter BLACK	Male	NRL/Marine Meteorology Division (SAIC CTR)	Meteorologist
9	DUAN Yihong	Male	Chinese Academy of Meteorological Sciences	Meteorologist
10	YU Jun	Male	CMA	
11	YU Hui	Female	Shanghai Typhoon Institute	deputy director of STI
12	CHEN Baode	Male	Shanghai Typhoon Institute	Meteorologist
13	ZHAO Bingke	Male	Shanghai Typhoon Institute	Meteorologist
14	ZENG Zhihua	Male	Shanghai Typhoon Institute	Meteorologist
15	TANG Jie	Male	Shanghai Typhoon Institute	Meteorologist

Organization Structure of EXOTICCA



Scientific Steering Committee (SSC)



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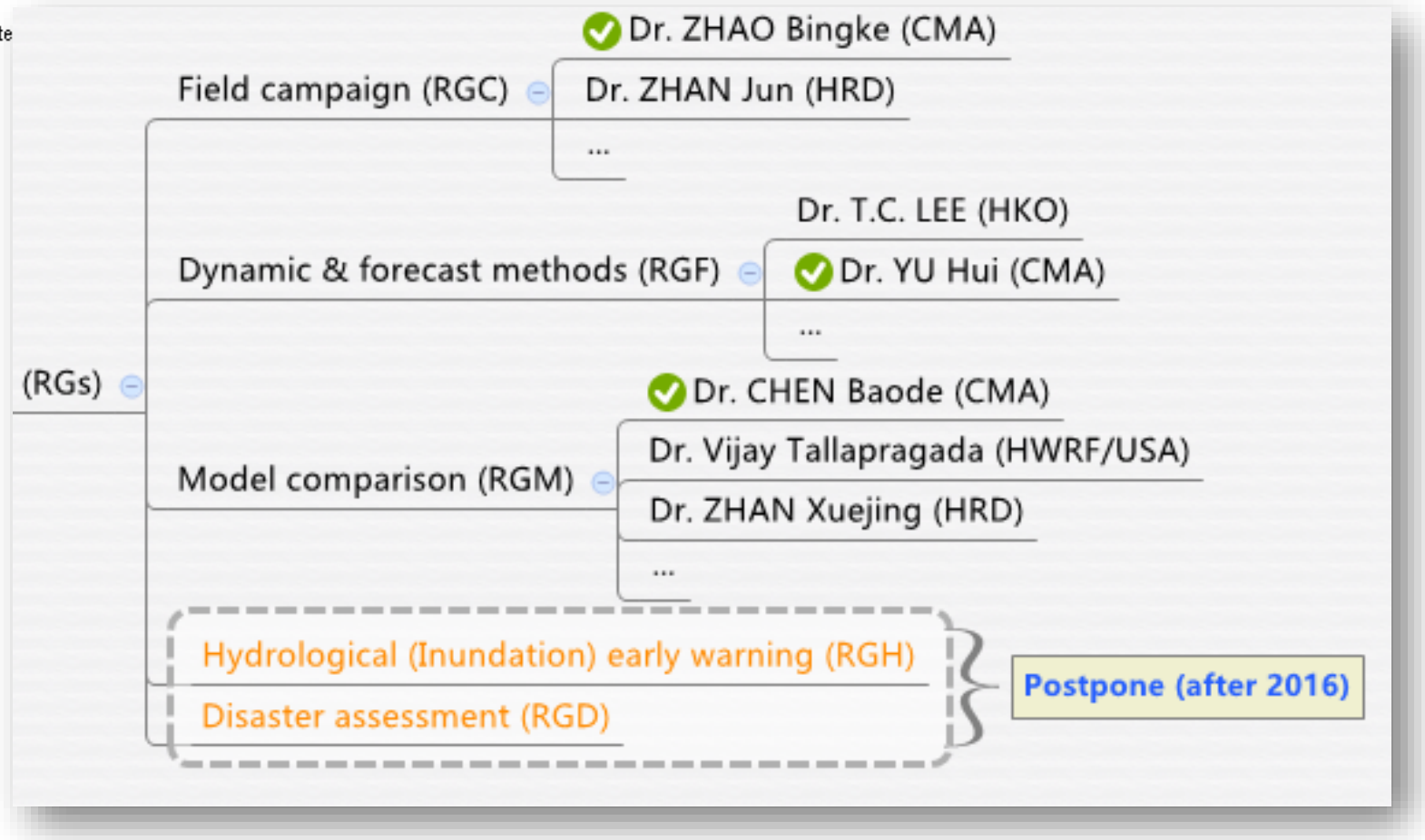
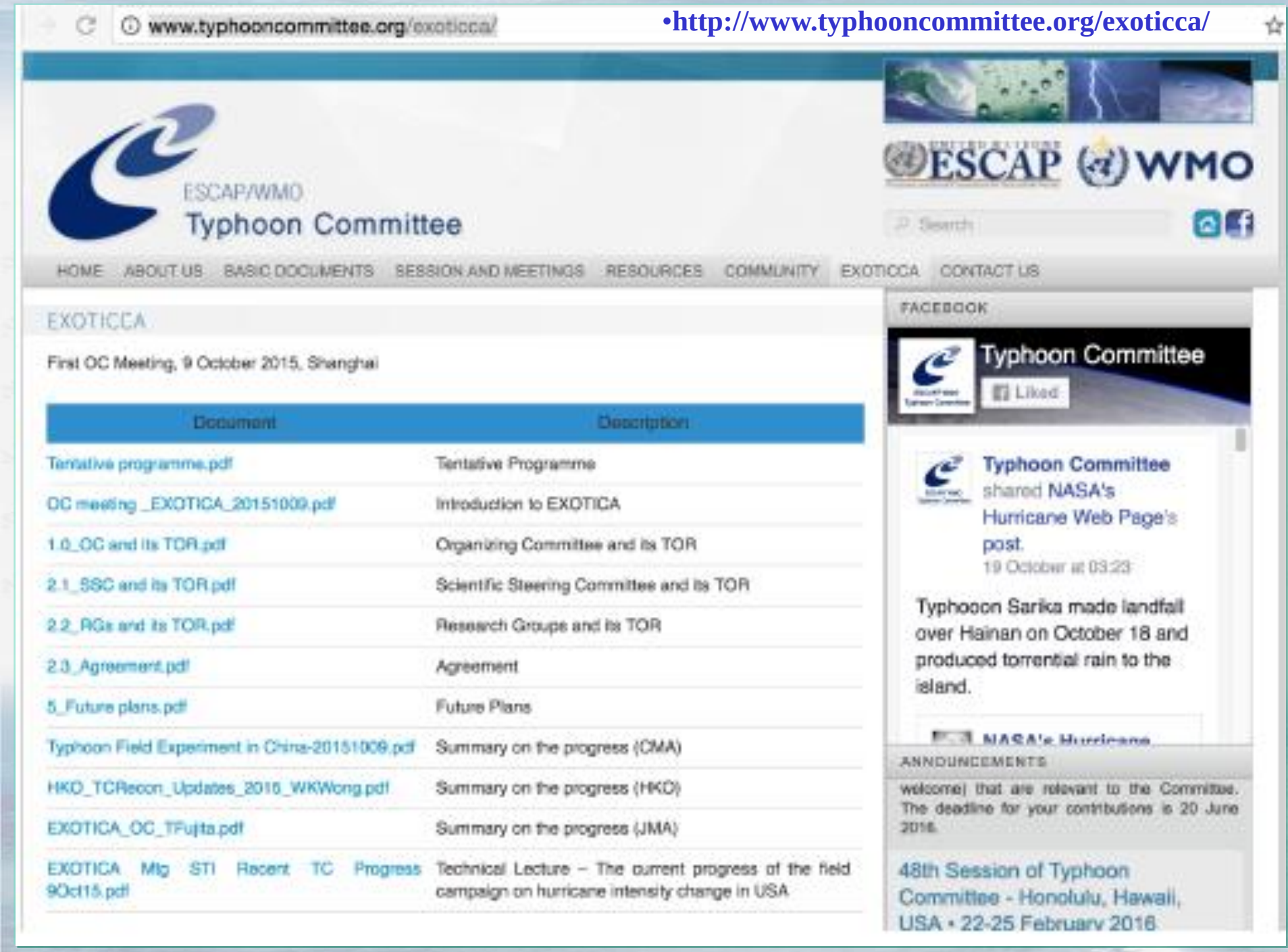
Typhoon Committe

Research Groups (RGs)




www.typhooncommittee.org/exoticca/
•http://www.typhooncommittee.org/exoticca/
ESCAP/WMO
Typhoon Committee
ESCAP
WMO
HOME
ABOUT US
BASIC DOCUMENTS
SESSION AND MEETINGS
RESOURCES
COMMUNITY
EXOTICCA
CONTACT US
EXOTICCA
First OC Meeting, 9 October 2015, Shanghai
Document
Description
Tentative programme.pdf
Tentative Programme
OC meeting _EXOTICA_20151009.pdf
Introduction to EXOTICA
1.0_OC and its TOR.pdf
Organizing Committee and its TOR
2.1_SSC and its TOR.pdf
Scientific Steering Committee and its TOR
2.2_RGs and its TOR.pdf
Research Groups and its TOR
2.3_Agreement.pdf
Agreement
5_Future plans.pdf
Future Plans
Typhoon Field Experiment in China-20151009.pdf
Summary on the progress (CMA)
HKO_TCRecon_Updates_2015_WKWong.pdf
Summary on the progress (HKO)
EXOTICA_OC_TFujita.pdf
Summary on the progress (JMA)
EXOTICA Mtg STI Recent TC Progress 9Oct15.pdf
Technical Lecture – The current progress of the field campaign on hurricane intensity change in USA
FACEBOOK
Typhoon Committee
Liked
Typhoon Committee shared NASA's Hurricane Web Page's post.
19 October at 03:23
Typhoon Sarika made landfall over Hainan on October 18 and produced torrential rain to the island.
ANNOUNCEMENTS
welcome) that are relevant to the Committee. The deadline for your contributions is 20 June 2016.
48th Session of Typhoon Committee - Honolulu, Hawaii, USA • 22-25 February 2016

k. Approve the Terms of Reference (TOR) and composition of the Organizing Committee (OC) of EXOTICCA, as provided in **Appendix XXVI**.

l. Request OC further develop terms and conditions and report back to the next Session.

EXOTICCA - TERMS & CONDITIONS for Participating Members

The TERMS and CONDITIONS of EXOITCCA for Participating Members

(Draft)

(Background text.....)

1. Background

The Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA) was proposed by the C
the 45th
from 29
Thailanc
conduct

2. Term and conditions

Member Country of TC undertakes to take part in the EXOTICCA project (hereafter "the project") by:

1. submitting a formal application to OC with the term and conditions signed by PR;
2. providing a written notice to OC to express interest on field campaign and/or demonstration research, and nominating the expert(s) as a member of OC and/or RGs;

participating in OC activities and meetings, including an annual OC meeting to review and update the project implementation plan;

3. participating in project activities and meetings, including OC meeting to review and update the project implementation plan and Member's action;
4. sharing data, observations and other information relevant to the project under the Member's own data policy with other participating members if no objection from participate Member; and
5. providing one month's written notice to OC should withdrawal from the project become necessary

Terms & Conditions for Participating Members

(2016：Hawaii, USA)

-- Joint workshop with TLFDP & UPDRAFT

Shanghai, China, 17-21 Oct. 2016

The 16th Annual Meeting of the Working Group on Tropical Meteorology Research

The Workshop/Progress Meetings of the WWRP & TCP Projects (TLFDP & UPDRAFT)

Shanghai, China

17-21 October, 2016

Aircraft Reconnaissance of Tropical Cyclone over South China Sea - An Update

WONG Wai Kin

WMO Joint Workshop/Progress Meetings of TCP & WWRP Projects (TLFDP and UPDRAFT)
20-21 October 2016

Hong Kong Observatory

TLFDP Progress Meeting

Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)

Lei Xiaotu
Shanghai Typhoon Institute of CMA

2016.10.21 Shanghai, China

Final report (Paragraph 1)

i. Approve the Terms and Conditions of the EXOTICCA as provided in **Appendix VIII**.

j. Request TCS to invite Members to join based on the Terms and Conditions of EXOTICCA, expressing the benefits on joining the project.

cc. Request TCS to work with WG Chairs on the theme for the 12th IWS and to consider including a session for EXOTICCA. Request TCS to circulate the proposed arrangements to Members.

(2017：Yokohama, Japan)

- **Approve the T&C**
- **2nd OC meeting**
- **EXOTICCA session 12th IWS**

Final report (Paragraph 5.4.1)

5.4.1 Report on the Progress of Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA) and its Annual Implementation Plan

14. The Committee took note with appreciation of the progress report EXOTICCA provided by the WGM Chair, Dr. LEI Xiaotu as provided in **Appendix VIII**.

15. The Committee discussed the update and approved the Terms and Condition of EXOTICCA.

16. The Committee expressed that all the Members should be invited to join the project and request the Organizing Committee (OC) to find a way to accommodate other Members on the project.

17. The Committee made a suggestion to hold an EXOTICCA Workshop to encourage Members to participate.

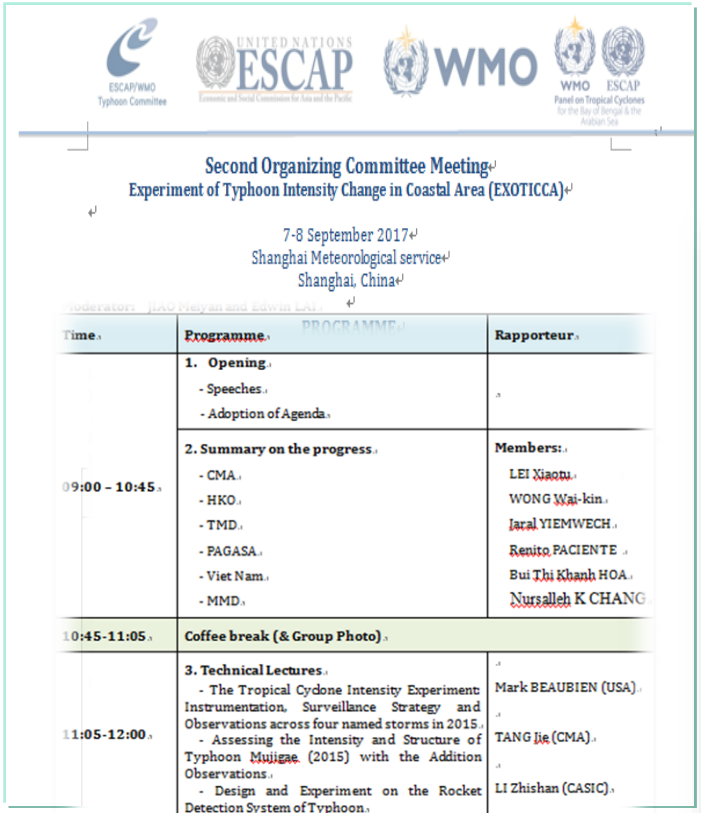
18. The Committee request TCS to invite Members to join this project based on the Terms and Conditions of EXOTICCA expressing the benefits on joining the project.

2nd Organization Committee (OC) meeting:2017

June
- plan

Sept. 8 (2017)
- implement ation

Programme:



Second Organizing Committee Meeting
Experiment of Typhoon Intensity Change in Coastal Area (EXOTICCA)

7-8 September 2017
Shanghai Meteorological service
Shanghai, China

Time	Programme	Rapporteur
09:00 – 10:45	1. Opening - Speeches - Adoption of Agenda	
	2. Summary on the progress - CMA - HKO - TMD - PAGASA - Viet Nam - MMD	Members: LEI Xiaotu WONG Wai-kin Jaral YIEMWECH Renito PACIENTE Bui Thi Khanh HOA Nursalleh K CHANG
10:45-11:05	Coffee break (& Group Photo)	
11:05-12:00	3. Technical Lectures - The Tropical Cyclone Intensity Experiment: Instrumentation, Surveillance Strategy and Observations across four named storms in 2015 - Assessing the Intensity and Structure of Typhoon Mujigae (2015) with the Addition Observations - Design and Experiment on the Rocket Detection System of Typhoon	Mark BEAUBIEN (USA) TANG Jie (CMA) LI Zhishan (CASIC)
12:00-14:00	Working Lunch	
14:00 – 17:00	4. Discussion on the future plans	LEI Xiaotu
	5. Other issues	

Participants: 18

UNESCAP/WMO Typhoon Committee Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)
(Shanghai, China. 8-9 October, 2015)

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15	TANG Jie	Male	Shanghai Typhoon Institute	Meteorologist

UNESCAP/WMO
Typhoon Committee

2. Major progress

- Organization
- Instrument (new)
- Experiment (field campaign)
- Demonstration research

Key instruments (major, new)

(1) mobile monitory system

STI/CMA

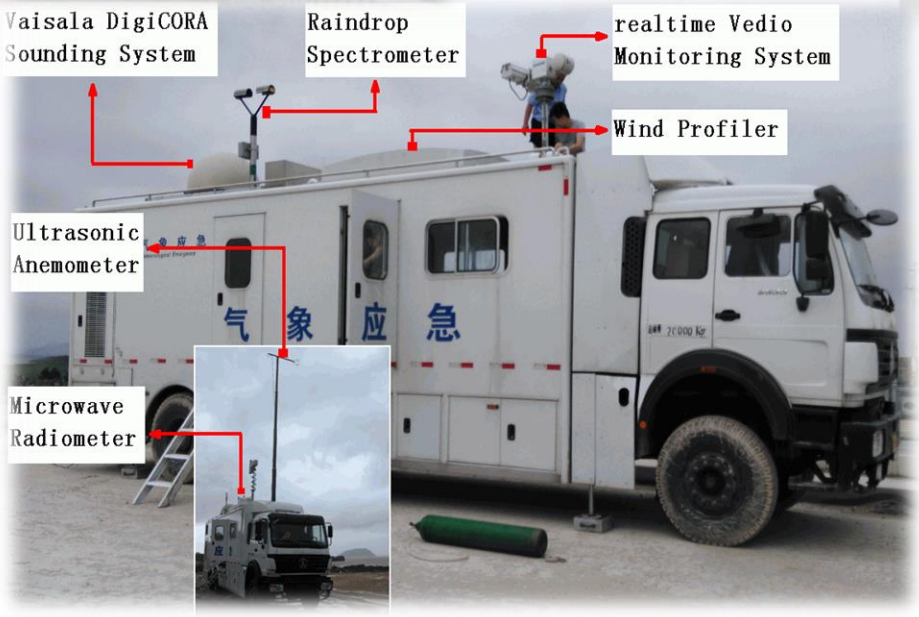
2007:

•Wind profiler

• Camera

• Radio-sonde

< 24.5m/s (9 class)



2014:

•Wind profiler

• Camera

• Radio-sonde

• Microwave radiometer

• raindrop spectrometer

<37m/s (12 class)

Key instruments (major, new)

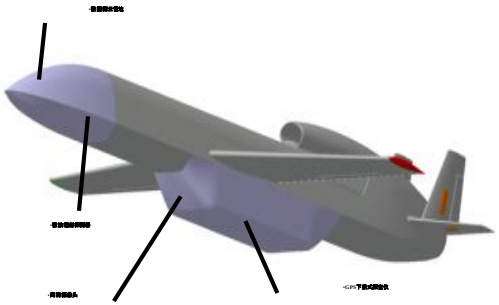
(2) Aircraft (Reconnaissance flight)	HKO

2012: V. T. P. RH

2016

- V. T. P. RH
- Drop-sondes

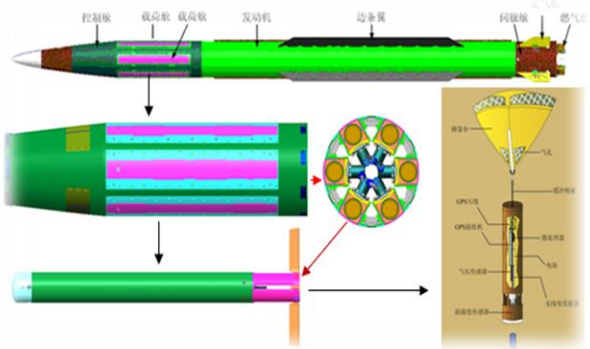
Key instruments (major, new)

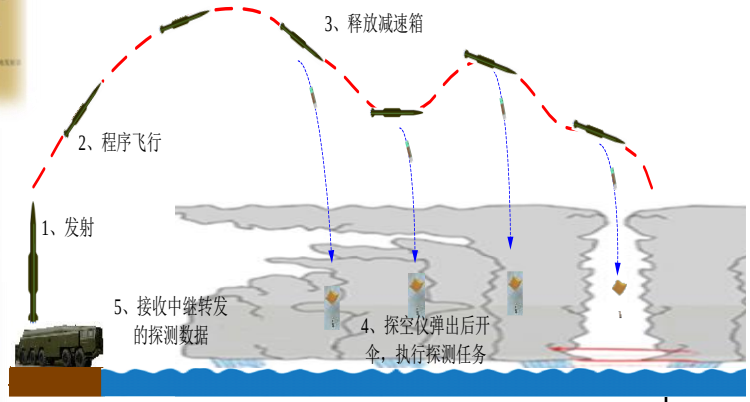
(2) Aircraft (UAV)	STI/CMA
 	**2014:** • V. T. P. RH •altitude < 2km •Wind resistance<17.2m/s (7 class)
 	**2017-2018:** • V. T. P. RH • Drop-sondes

Key instruments (major, new)

(3) Rocket-dropsonde system

STI/CMA





2015:

- V. T. P. RH

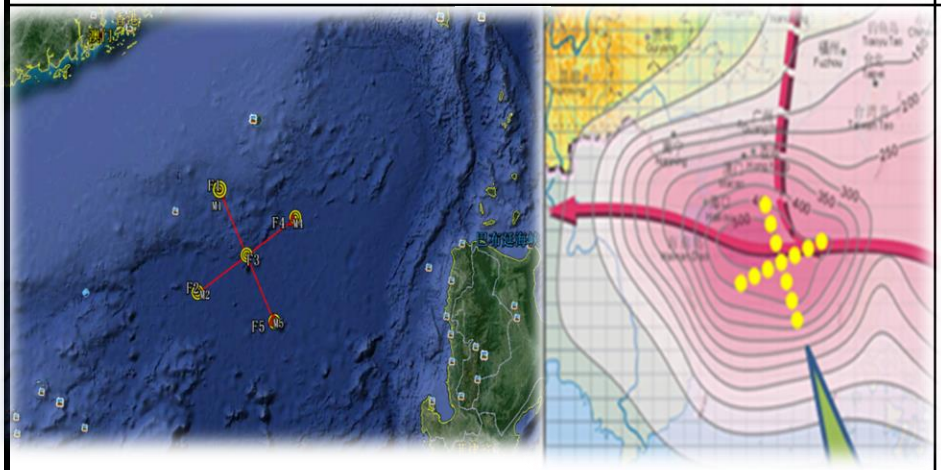
- Max. altitude >20km
- Max. distance > 500km
- Dropsondes > 4

2016 (mini-rocket dropsond):

- V. T. P. RH

- Max.altitude > 10km
- Max. distance < 100km
- Dropsonde =1

Key instruments (major, new)

(4) Others	STI/CMA
 **Buoy array system (2014-)**	**Tower & radar (2014-)** 
 Automatic Radio-sonde system (2017-)	National Typhoon observing station (2017-) 

UNESCAP/WMO
Typhoon Committee

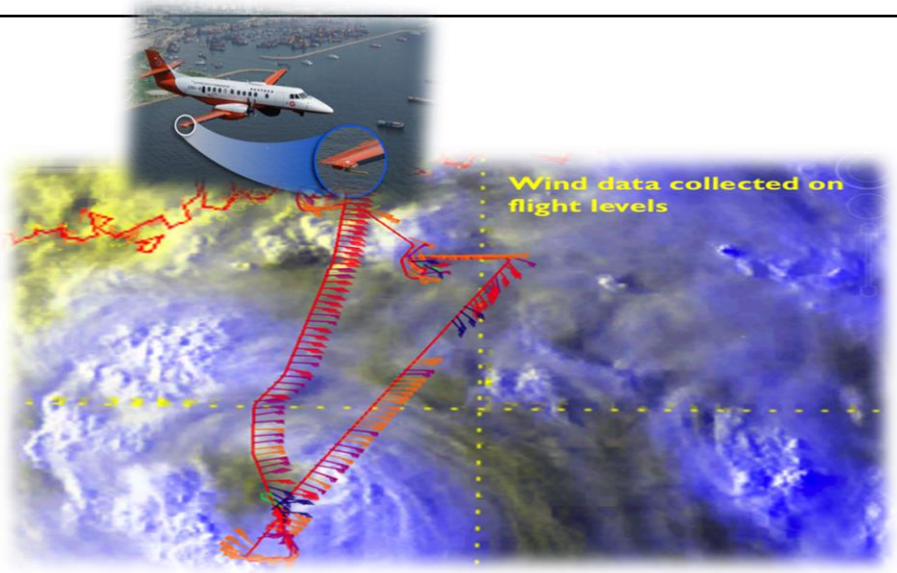
2. Major progress

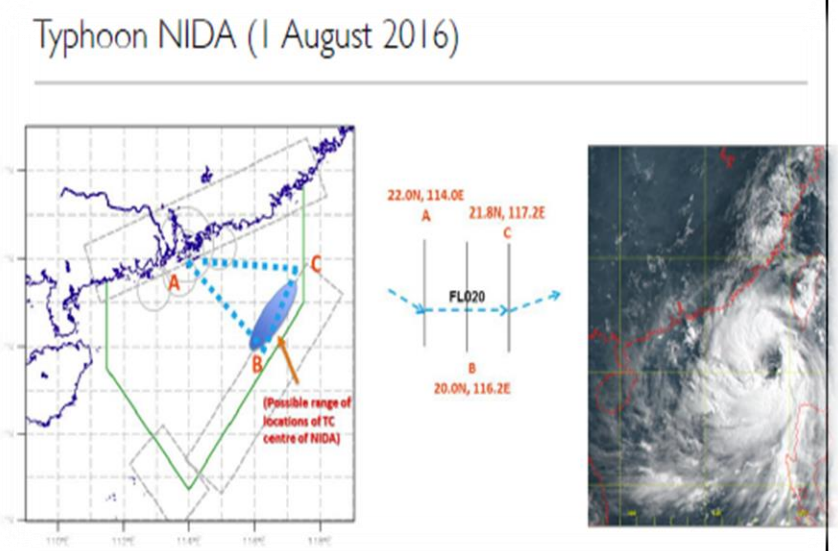
- Organization
- Instrument (new)
- Experiment (field campaign)
- Demonstration research

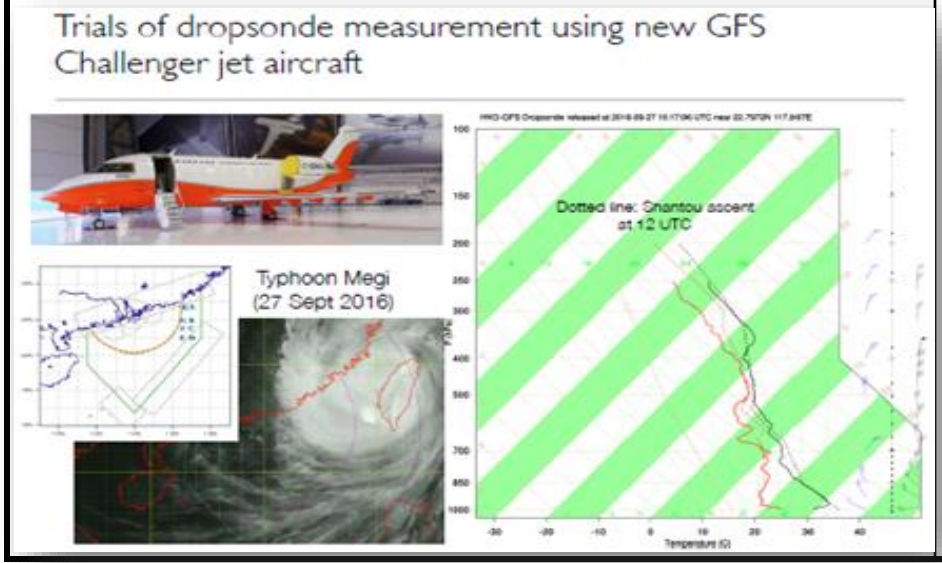
Experiment (field campaign)

(1) Aircraft (surveillance flight & Challenger jet)

HKO (2012-)







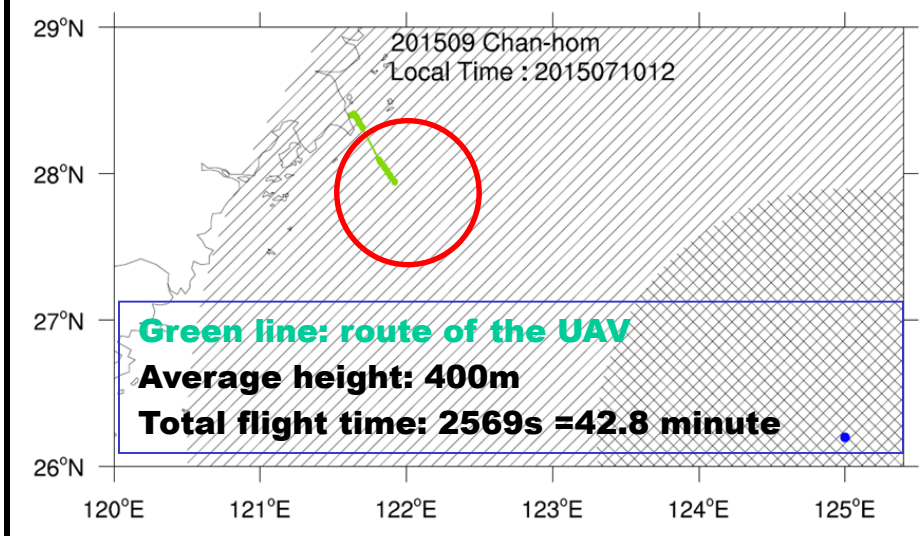
Target tropical cyclones:

-

Experiment (field campaign)

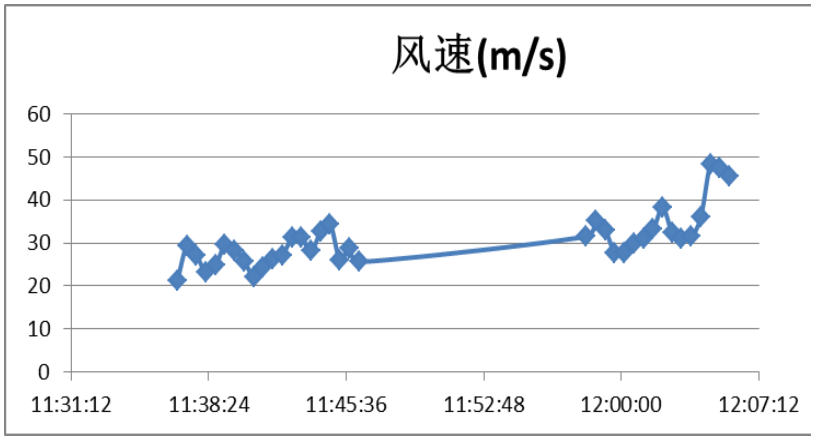
(2) Aircraft (UAV)

STI/CMA (2015)



UAV obs. in Typhoon Chan-hom

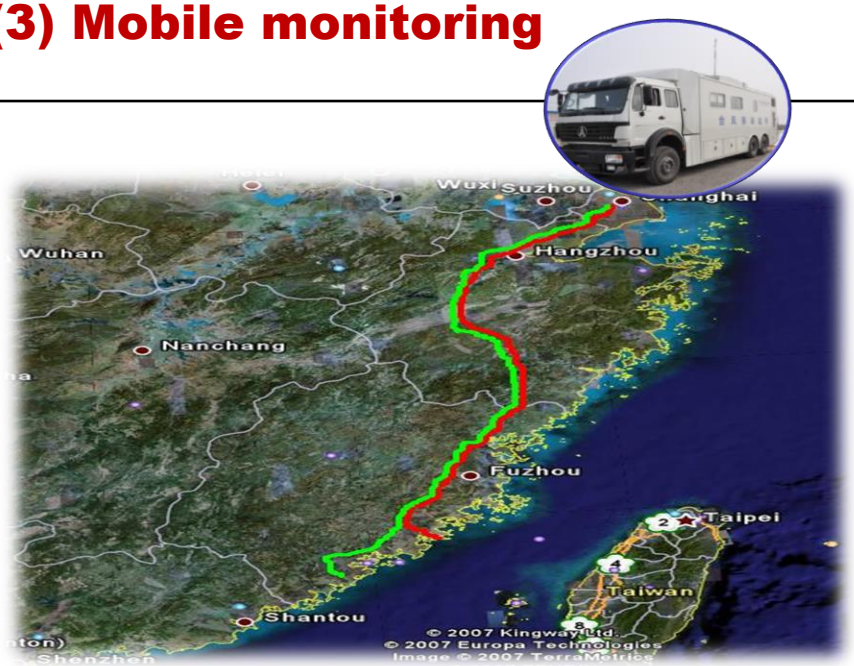
July 10, 2015

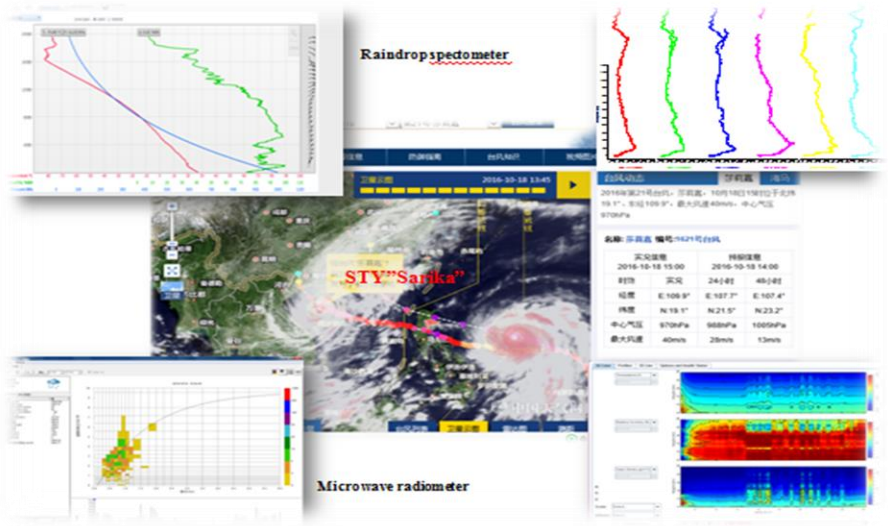


Experiment (field campaign)

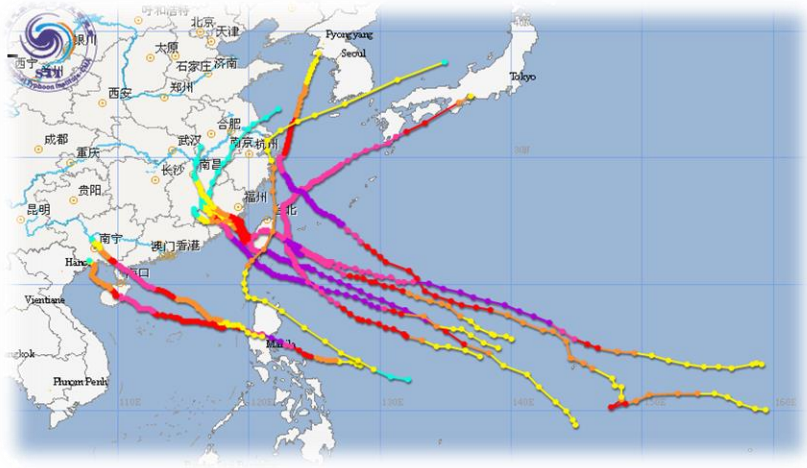
(3) Mobile monitoring

STI/CMA (2007-)





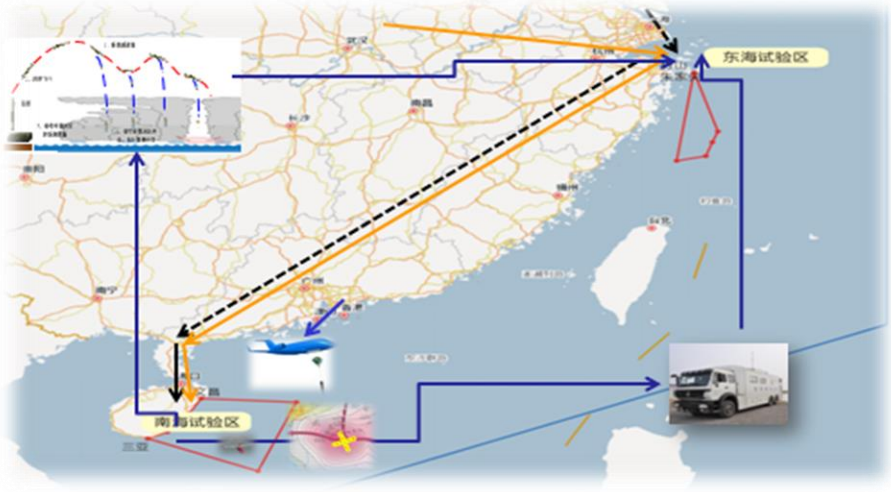
Target tropical cyclones(10): 2014-2016



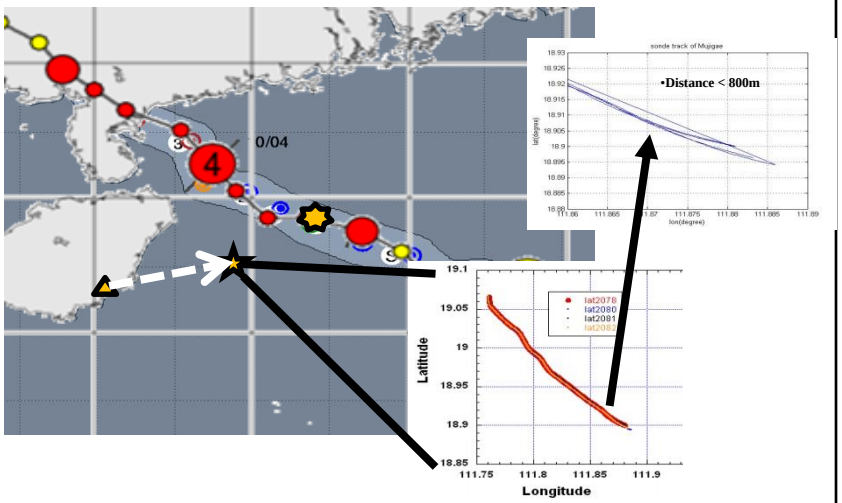
Experiment (field campaign)

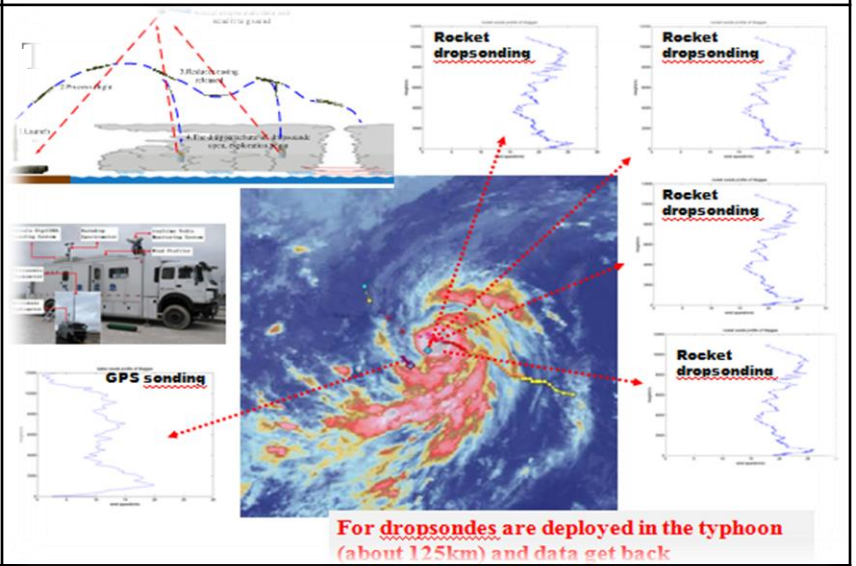
(4) Rocket-dropsonde

STI/CMA (2015)



STY Mujigae (2015) 11pm Oct 3

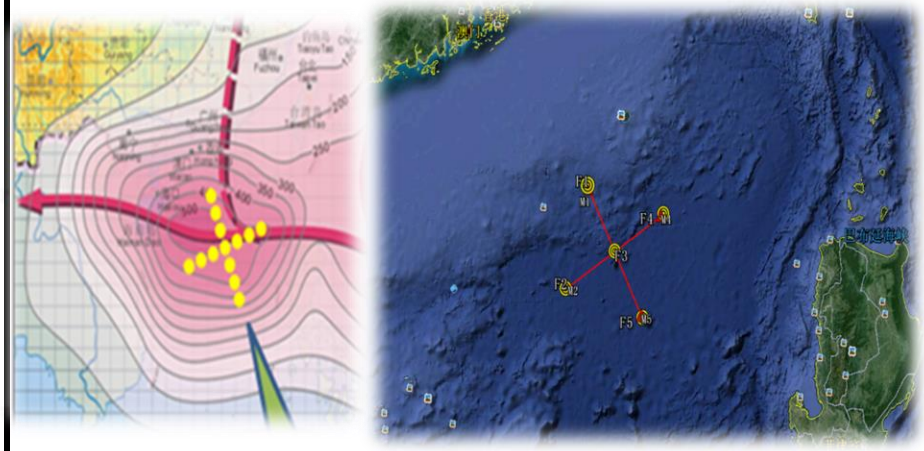




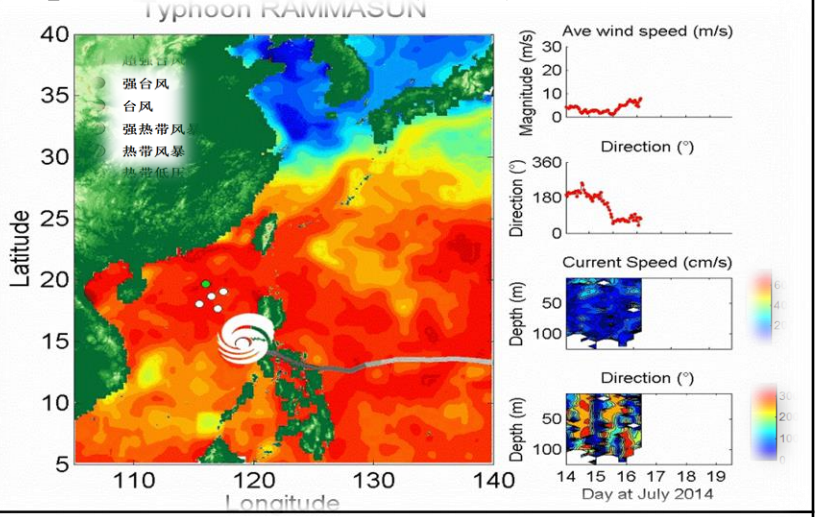
Experiment (field campaign)

(5) Buoy array & others

STI/CMA (2014, 2010)



Super TY Rammasun (2014)



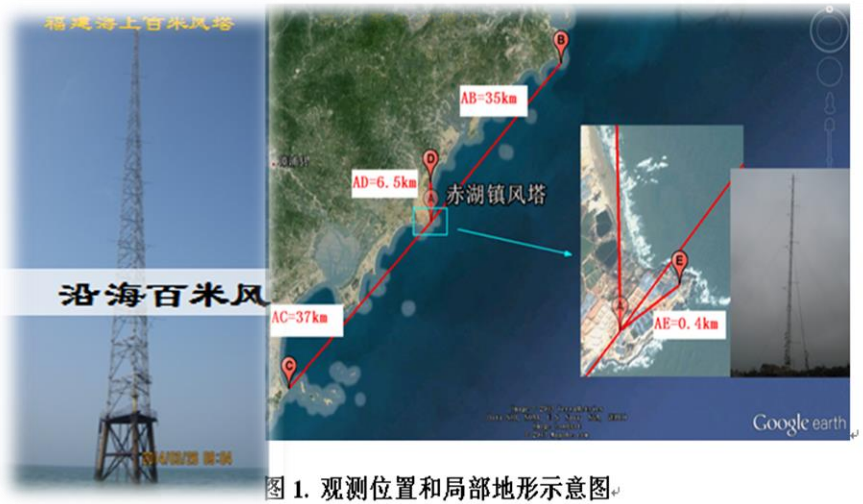
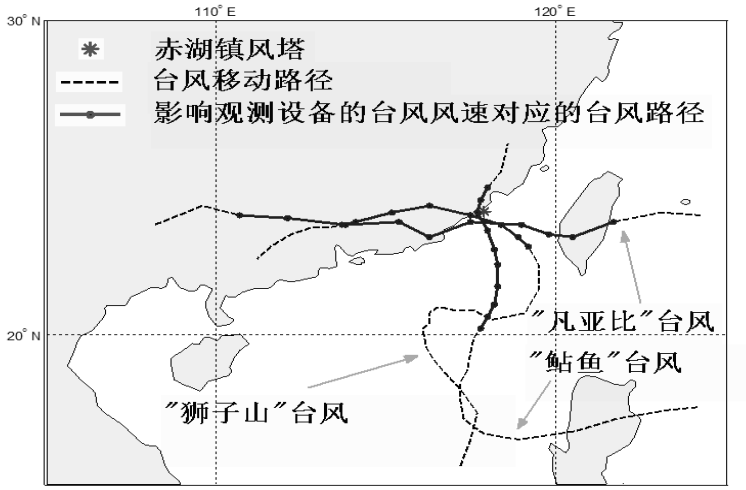


图 1. 观测位置和局部地形示意图

Fig. 1. Skeleton map of the observation site and local topograph



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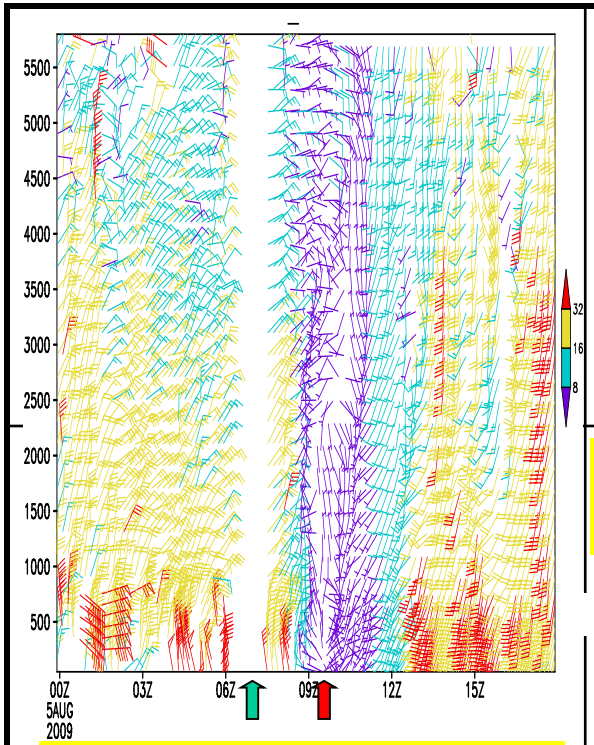
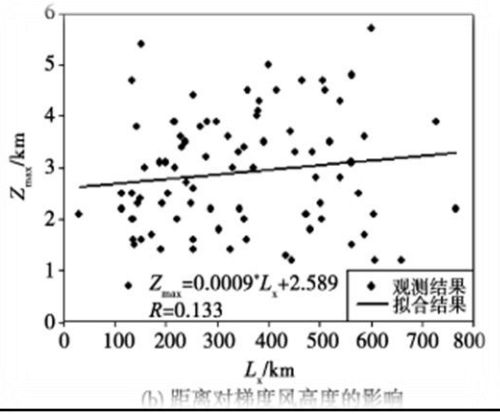
2. Major progress

- Organization
- Development of new instrument
- Experiment (field campaign)
- Demonstration research

Demonstration research (dynamic analysis)



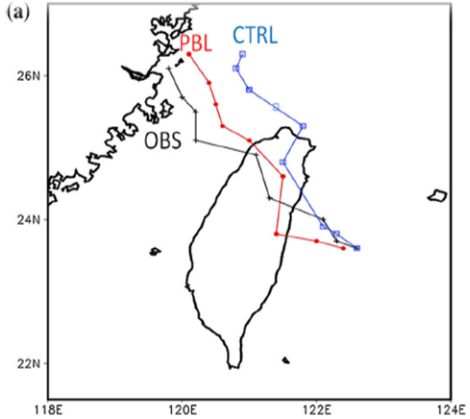
PBL more than 5km (during landfalling)

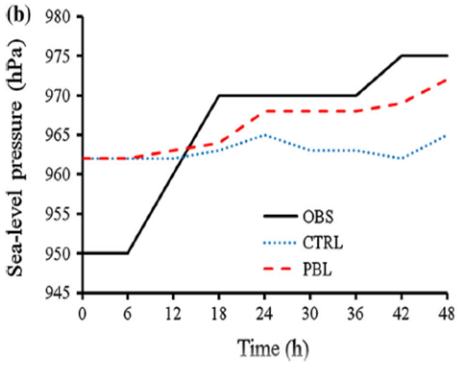


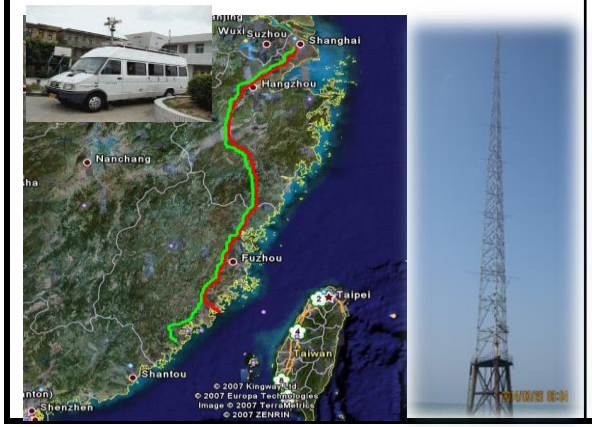
Modify the definition of PBL in HWRFV3.3 (YSU) based on field campaign data

$$h = \max\left(\left|\frac{\partial H_1}{\partial \sigma}\right|\right).$$

Conversion factor of wind speed between 1min, 2min & 10min (WMO recommendation) are small than obs.



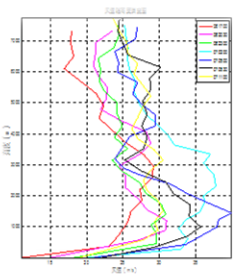




转换系数	距下垫面高度	V_{10m}/V_{1min}	V_{10m}/V_{2min}	V_{2min}/V_{1min}
陆风	10m	0.79	0.88	0.90
	26.6m	0.86	0.91	0.95
	42.4m	0.90	0.93	0.97
	60.4m	0.92	0.94	0.98
	82.9m	0.93	0.95	0.98
混合风	10m	0.91~0.92	0.94	0.97~0.98
	55.6m	0.92	0.94	0.97
	71.4m	0.92	0.94	0.98
	89.4m	0.92	0.94	0.98
	111.9m	0.92	0.94	0.98
海风	10m	0.87	0.90	0.97
	55.6m	0.92	0.94	0.98
	71.4m	0.93	0.95	0.98
	89.4m	0.94	0.95	0.98
	111.9m	0.94	0.96	0.98

•风随高度变化的 α 指数

•	600m	500m
•福州	0.176	0.172
•厦门	0.236	0.229
•龙岩	0.362	0.332
•邵武	0.495	0.475

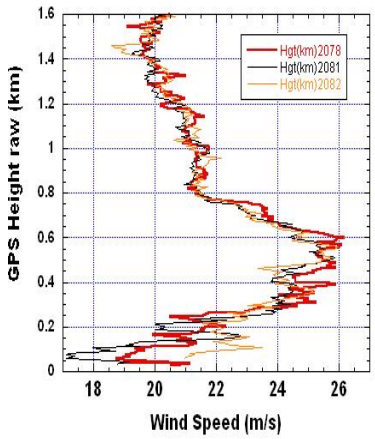


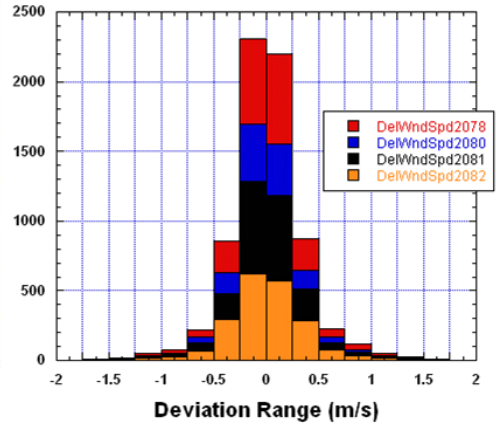
0.408

- Wind ratio (10m .vs. surface) is 0.12-0.9
- Difference with different location

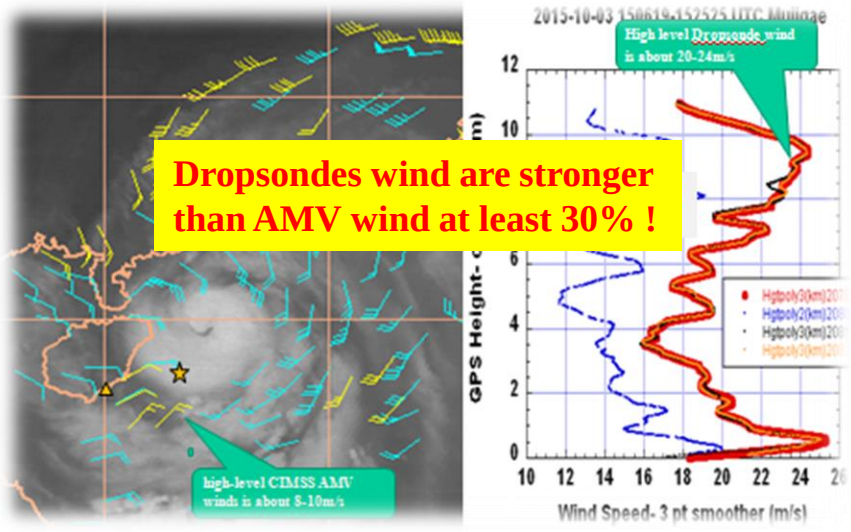
Demonstration research (dynamic analysis)

Rocket drop-sondes



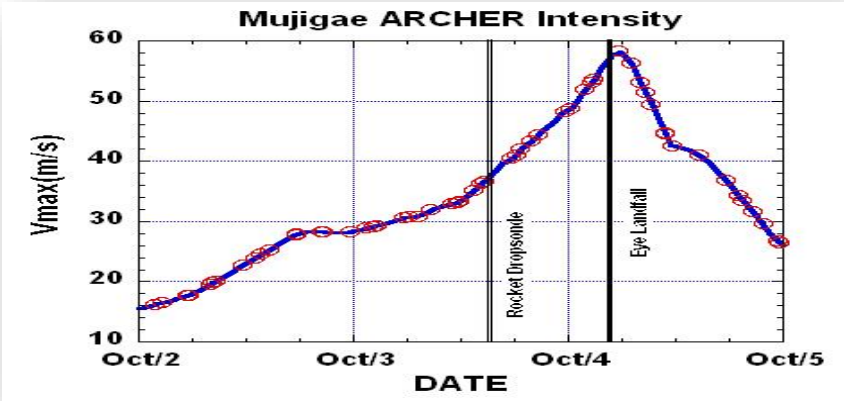


Comparison between CIMSS AMV wind



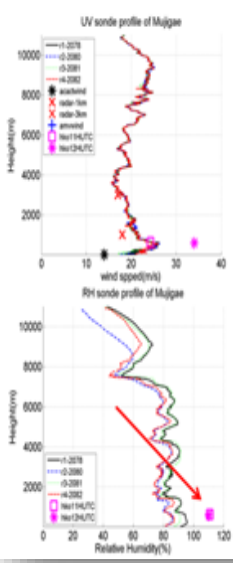
Dropsondes wind are stronger than AMV wind at least 30% !

Intensity analysis



-Intensity: CMA & HKO are better (JMA is weaker)

- radius (30 & 50kt): small (JMA, CMA, HKO, JTWC)

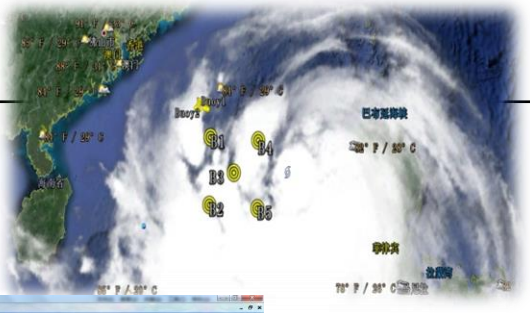


Centers / Variables	CMA	HKO	JMA	JTWC	KMA	WE
WIND	38-45	36-41	33-37	33-41	35-36	41
Pressure	965		970		970	
30kt	260	220	390	160		267
50kt	70	110	110	65	/	155

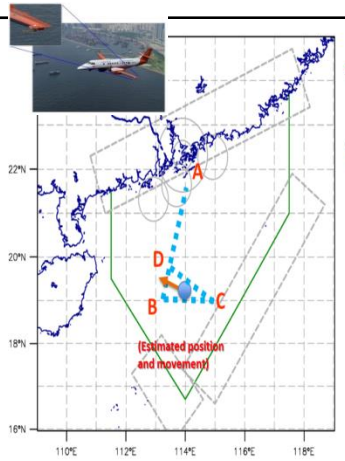
对台风强度的估计更接近于中央台和香港天文台的业务估计结果，而强于日本东京台风中心；而风圈估计结果则与几乎所有业务中心结构多不一致，且明显偏大

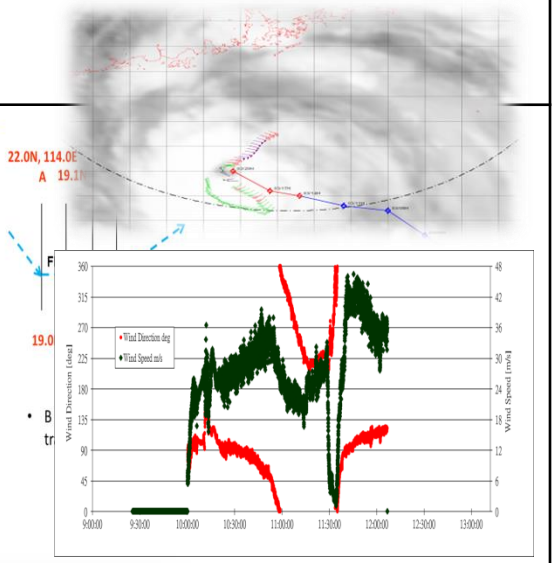
Demonstration research (modeling)

Buoy data

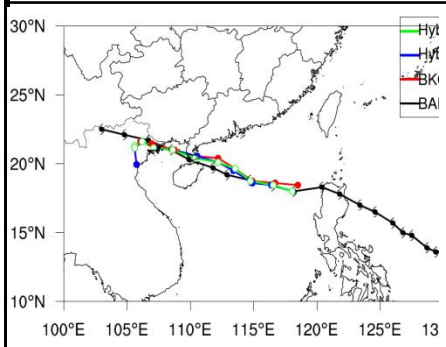


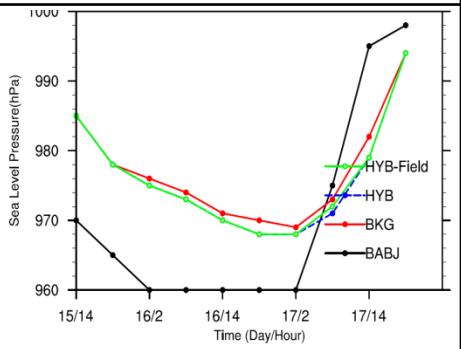
Aircraft data

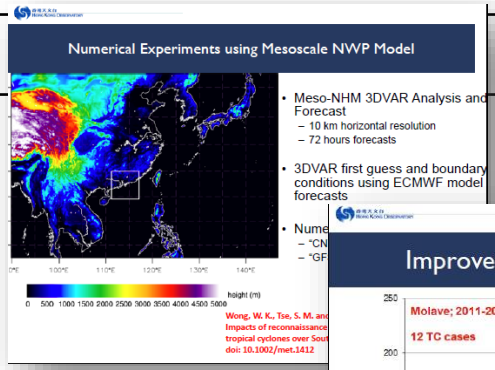


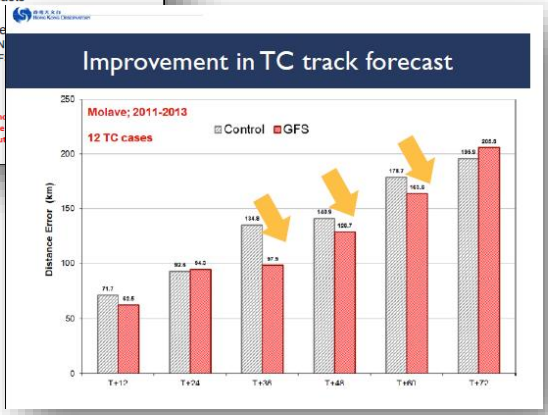


- Assimilation of buoy array data (Rammasun,2014)









- Track : Hyb-Field ~ Hyb
- Intensity: Hyb-Field is a little better than Hyb

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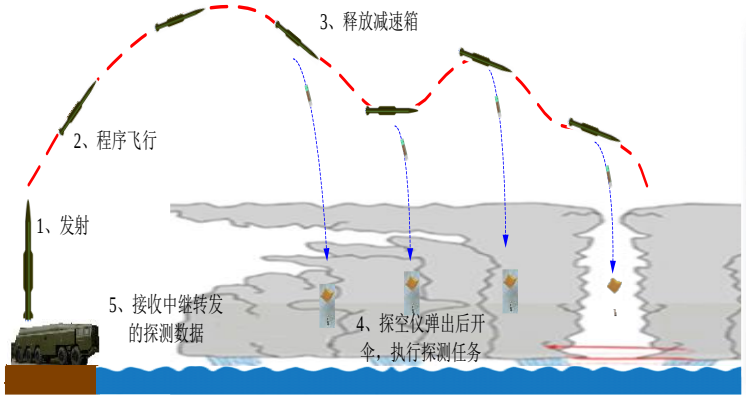
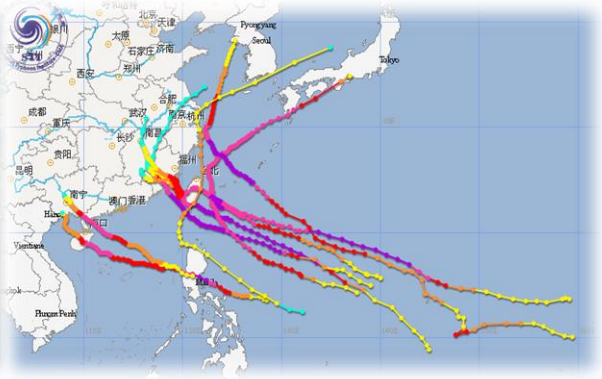
Summary (up to now)

- **New instruments** (developing during EXOTICCA)
  - Rocket-dropsonde, Aircraft (manned & UAV)…
- **Target typhoon** (total: 10+)
  - ECS(6): Phoenix(1416), Namtheun(1509), Soudelor(1513), Nepartak(1601), Meranti(1614), Megi(1617)
  - SCS(4): Rammasun(1409), Kalmaegi(1415), Mujigae(1522), Sarika(1621)





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Summary (up to now)

- **Demonstration research** (STI: articles/publish: 6+)
  - Horizontal Transition of Turbulent Cascade in the Near-Surface Layer of Tropical Cyclones, *JAS,* 2015
  - Progress of unmanned aerial vehicles and their application to detection of tropical cyclone (Chinese), *Adv. Earth Sci*.,2015
  - Estimation of observation impact with an ensemble sensitivity method (Chinese). *J.Trop.Mete*, 2016.
  - Study on the converting coefficients of maximum wind speed with different averaging periods for landfall typhoons (Chinese), *J.Trop.Met.*, 2016
  - Investigation of Turbulent Momentum Flux in the Typhoon Boundary Layer. *Journal of Geophysical Research,Oceans*,2017
  - New technology and experiment of rocket dropsondes for typhoon observation, *Chinese Science Bulletin*, 2017.
  - Intensity and wind radii densifications of typhoon Mujigae(2015) in the pre-landfall stage, *Weather*, 2017.
  - Data evaluation of the first fly of the rocket-deployed dropsonde experiment for STY Mujigae(2015), *Nature*, 2017

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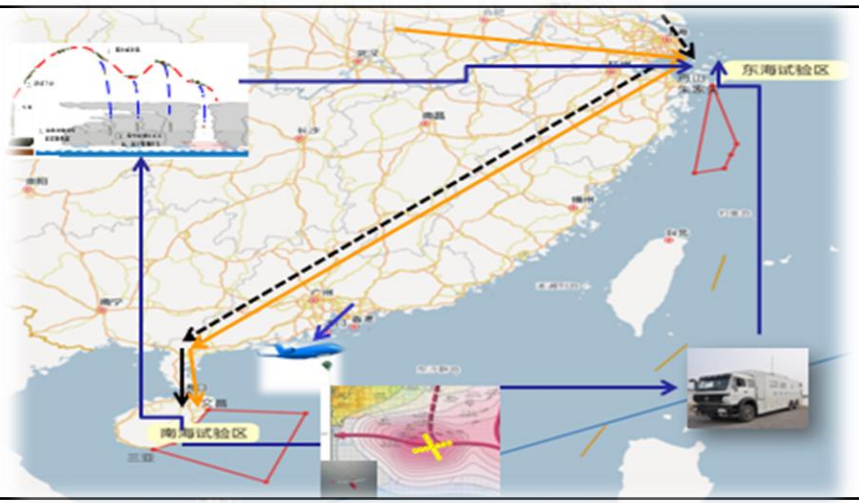
Part III:

Future plan

Actions of 2017

Field campaign



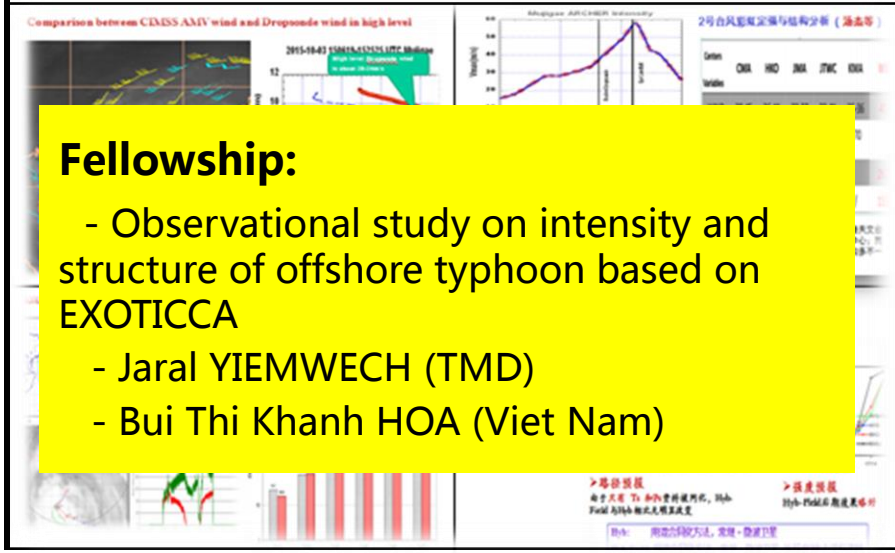
Instruments (new)

Mini rocket drop-sonde

Auto. GPS radio-sonde

Aircraft & UAV

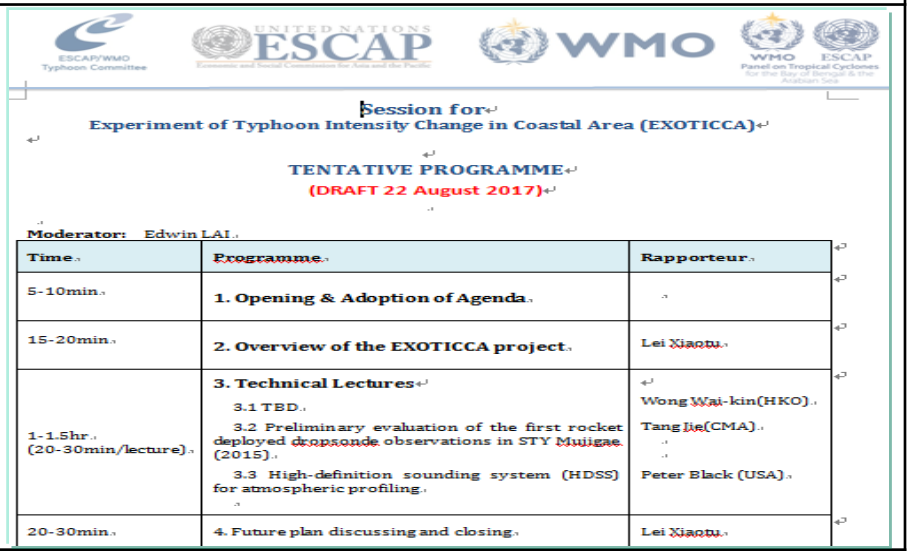
Demonstration research (new data using)



Fellowship:

- Observational study on intensity and structure of offshore typhoon based on EXOTICCA
  - Jaral YIEMWECH (TMD)
  - Bui Thi Khanh HOA (Viet Nam)

Workshop (Session during 12th IWS October)



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UNITED NATIONS ESCAP

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WMO ESCAP Panel on Tropical Cyclones for the Bay of Bengal & the Arabian Sea

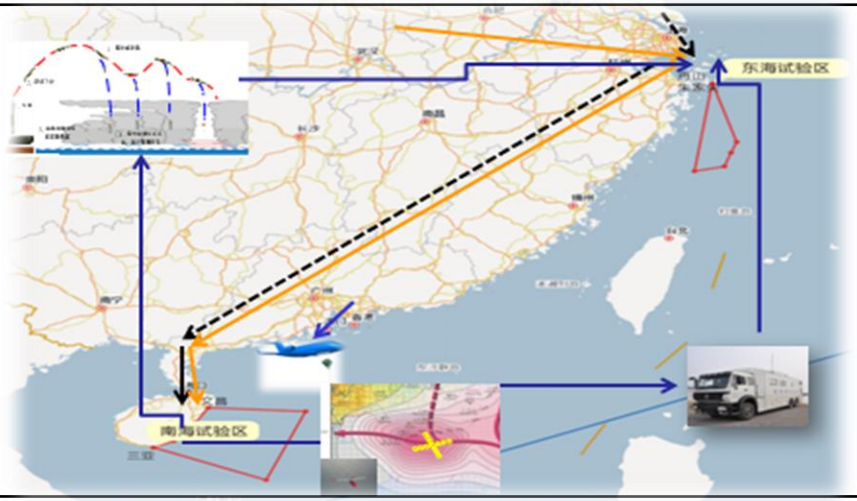
Session for
Experiment of Typhoon Intensity Change in Coastal Area (EXOTICCA)

TENTATIVE PROGRAMME
(DRAFT 22 August 2017)

Moderator: Edwin LAI

Time	Programme	Rapporteur
5-10min	1. Opening & Adoption of Agenda	
15-20min	2. Overview of the EXOTICCA project	Lei Xiaotu
1-1.5hr (20-30min/lecture)	3. Technical Lectures 3.1 TBD 3.2 Preliminary evaluation of the first rocket deployed dropsonde observations in STY Mujigae (2015) 3.3 High-definition sounding system (HDSS) for atmospheric profiling	Wong Wai-kin(HKO) Tang Jie(CMA) Peter Black (USA)
20-30min	4. Future plan discussing and closing	Lei Xiaotu

Plans of 2018 & beyond

Field campaign	Major Instruments
	◻ CMA: ✓ mobile(car) system (GPS radiosonde); ✓ rocket-dropsonde (mini-,); ✓ UAV (low & high level) ◻ HKO: aircraft (manned) dropsonde ◻ ……
Demonstration research (Fellowship)	**Workshop & annual progress**
◻ Analysis/Re-analysis (structure & intensity) techniques ◻ Modeling (High-resolution typhoon model, target typhoon data assimilation) ◻ Dynamic mechanism of target typhoon intensity change (conjunction with TLFDP, and …)	◻ Annual progress will be submitted to IWS & Session of TC ◻ To hold a joint workshop with TLFDP in 2018 (WMO/TCP & WMO/WWRP) → TLFDP-IV(2019-2021)

Thank you for your attention!