Asia Pacific Advanced Network

Connecting People, Cultures, Research and Education

Masterclass on Disaster Mitigation

Collaborations in Asia

Collaborators

UNESCO Jakarta Office

Disaster Mitigation Competence Centre of EGI-Engage &

APAN Disaster Mitigation Working Group

United Nations
Educational, Scientific and
Cultural Organization

30 & 31 Aug. 2017

Dalian, China

Disaster Mitigation Competence Centre (DMCC) in EGI-Engage

- Partners: TW(AS), PH(ASTI), MY(UPM), ID(ITB), DE(LMU)
- Schedule of EGI-Engage: March 2015 - August 2017
- Goals: Improving strategy of prevention and reduction of disasters
  - By better knowledge of the Earth's physical phenomena, we can mitigate the consequences of similar disasters in the future.
  - Advancement of prediction accuracy on target disasters
- Deliverables
  - D6.9: Web portals for tsunami wave propagation simulations and for WRF-based weather simulation
  - D6.20: Application of the simulation portals for scientific scenario in disaster mitigation
  - D6.22: Design larger scale multi-hazards simulation attempting to reduce uncertainty of climate change assessment

APAN Disaster Mitigation Working Group

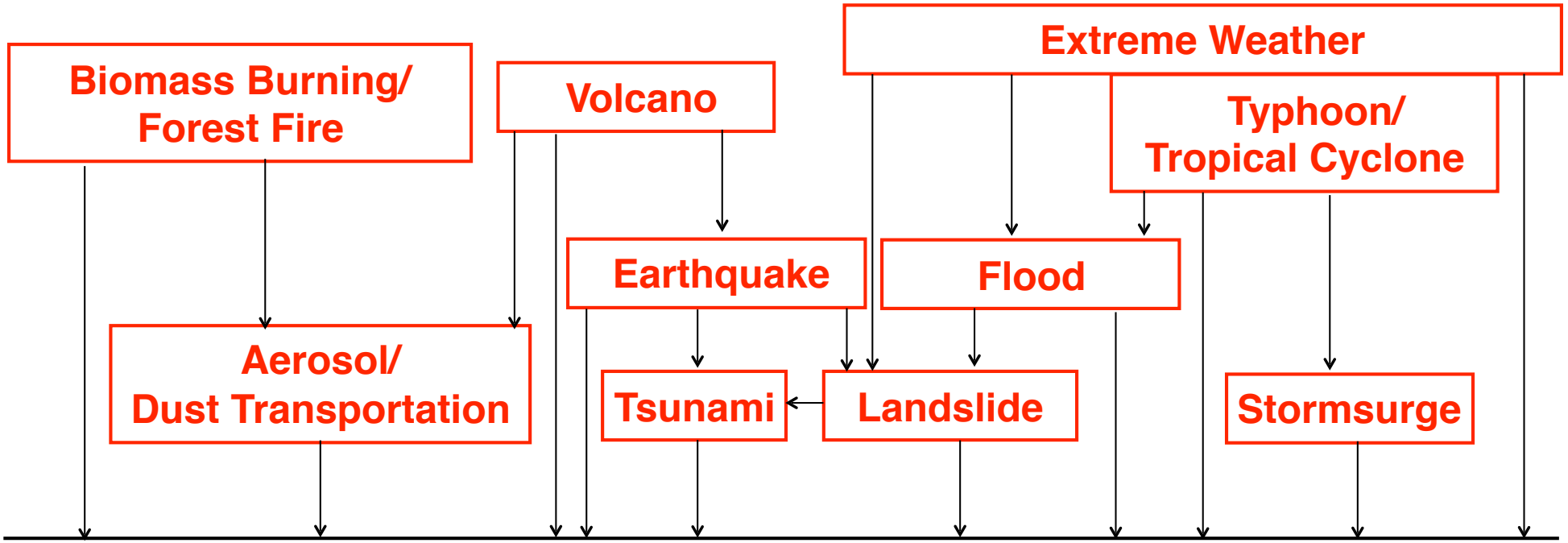
- Chair: Eric Yen (TW); Co-Chair: Peter Banzon (PH)
- Initiated in APAN41 in Jan. 2016
- Case Study: Disaster Case Study and Impact Analysis on Agriculture first
- Service Directory: Welcome all parties provide any service end point
- Data Directory:
  - Weather, geospatial, observation, satellite images/data, earthquake, etc.
  - Public open data sources
- Proof of Concept Experiment
- Review the Progress at least once every year at APAN meeting

Disaster Mitigation in Asia Pacific

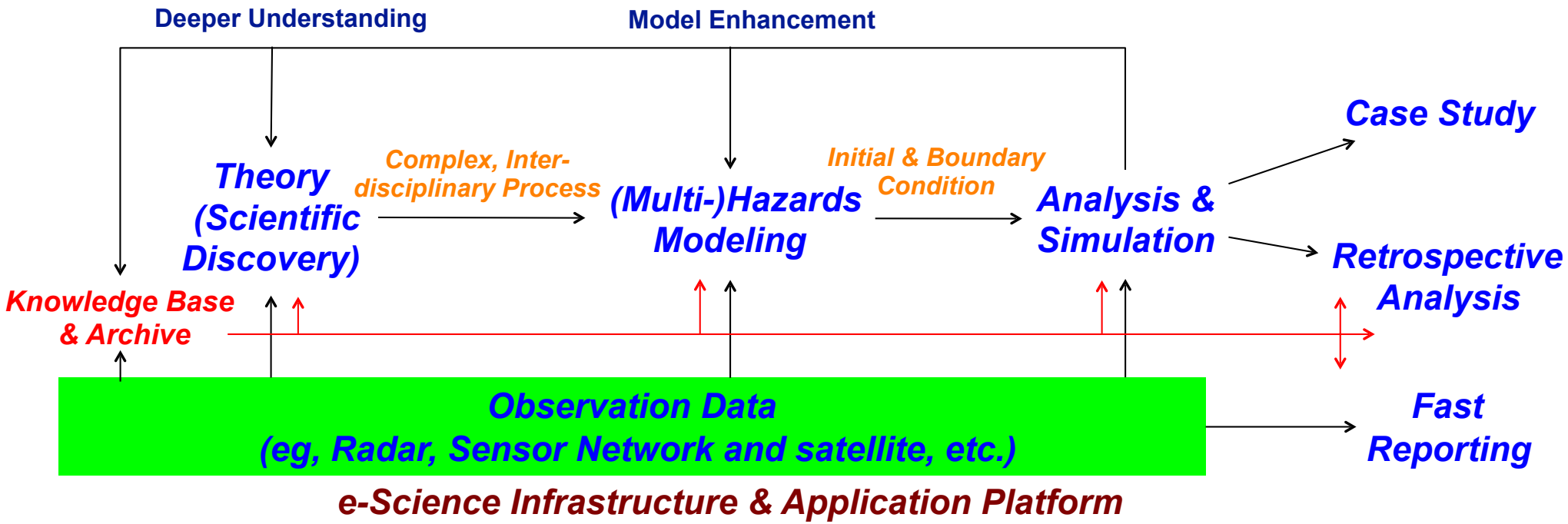
A New Collaboration Paradigm between EGI and APAN

- EGI-APAN Collaboration connects regional resources on disaster mitigation
  - DMCC (EGI) + DM WG (APAN)
  - Making disaster mitigation application as services
  - Extending to social-economic impact analysis
- Availability of local detailed data is crucial for deeper understanding of natural disasters
- This is the best opportunity based on deeper understand of disasters by close collaborations with Scientists and users
  - Different disciplines to work together such as Typhoon Haiyan
  - Global data and local data combined together
  - Worldwide communities and resources working with local scientists
- Deep understanding will lead to more accurate Alert System

Deeper Understanding on Multi-Hazards



Improving Disaster Mitigation by Deeper Understandings

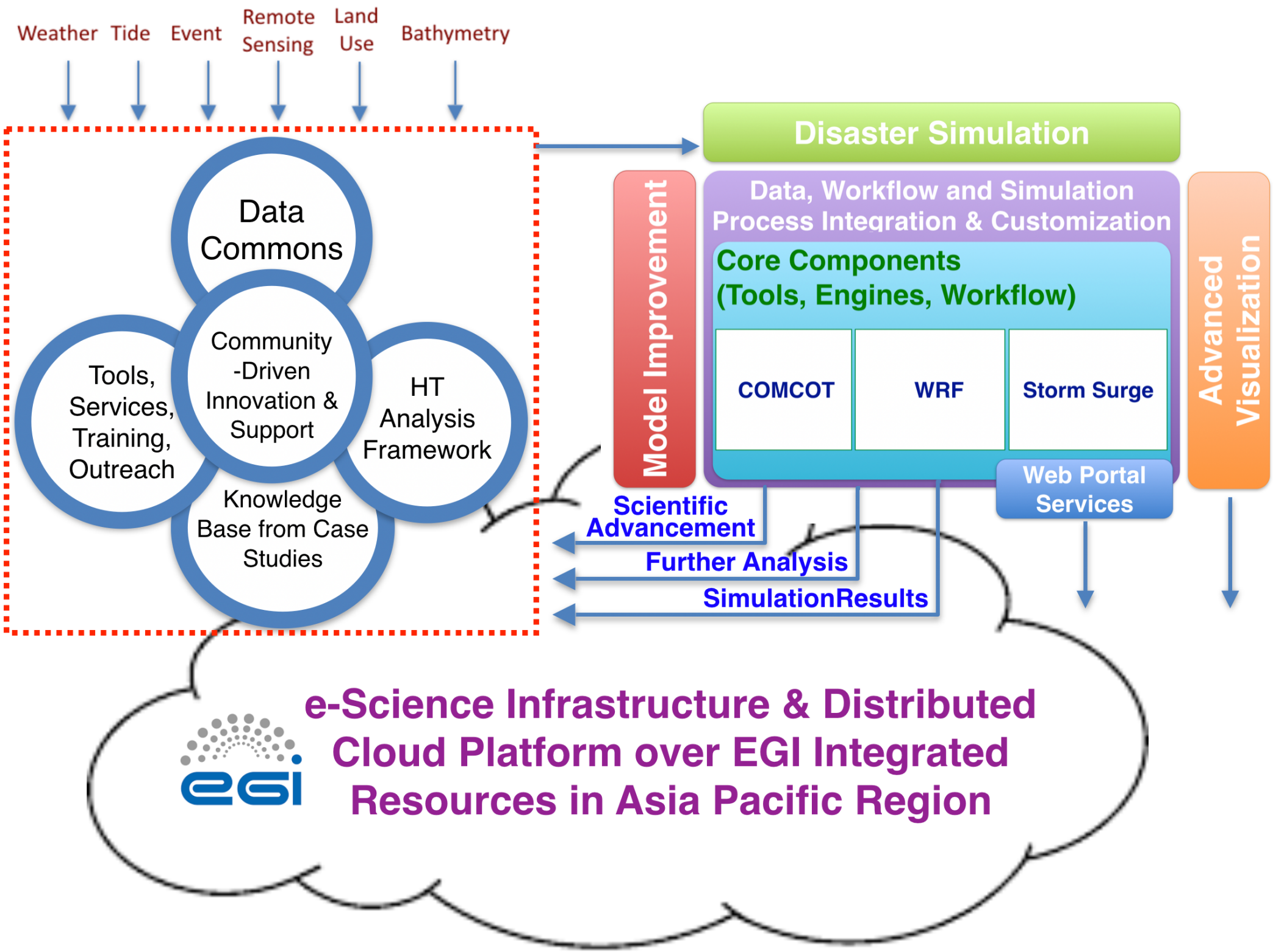


e-Science Infrastructure & Application Platform

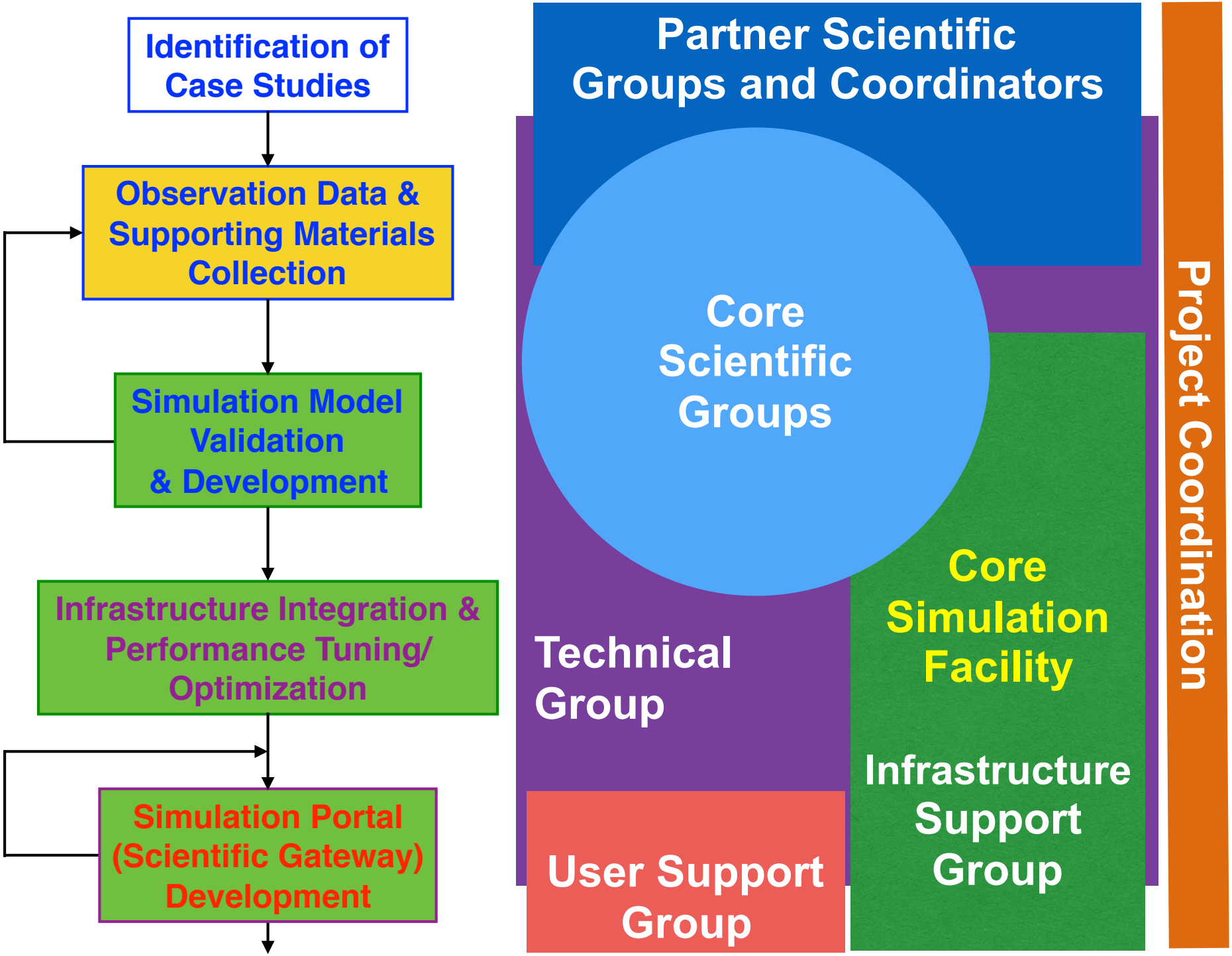
Disaster Mitigation Case Study & Collaboration Model

Partner	Selected Case	Required Data Sets	Status	Check Point	Simulation Framework
PH, TW	**Typhoon Haiyan**	Doppler Radar, Tidal gauge, air pressure, wind speed, typhoon path; hourly resolution	Finish 1st numerical study by combining atmospheric and ocean model	**Demo @ APAN41**	**gWRF, iCOMCOT**
MY, TW	**Flooding 2014-15**		Simulations by AS (global data) and MY have been achieved. Need more observation data to refine and confirm the model.	**Demo @ APAN43**	**gWRF, Scouring**
TH, TW	Flooding 2011 (Comparative Study)		Simulation by NECTEC and AS (global data) were done. Aim to improve the accuracy and EWS.		gWRF, Scouring
ID, TW	**Long-Dist Dust Transportation of Forest Fire**	air pollutants such as, CO, NOx (NO, NO2), SO2, O3, PM10, PM2.5 etc. with high temporal resolution	Simulations have been done. Need more observation data to refine and confirm the model.	**Demo @ APAN43**	**WRF-Chem**
Nepal, TW	Flooding 2014	High altitude and geographical features need to consider	Waiting for more necessary observation data		gWRF, Scouring
TW, PH	Tsunami Impact Analysis in South China Sea	Bathymetry, fault geometry, historical events,	In progress. Depends on high resolution bathymetry data from partners		iCOMCOT

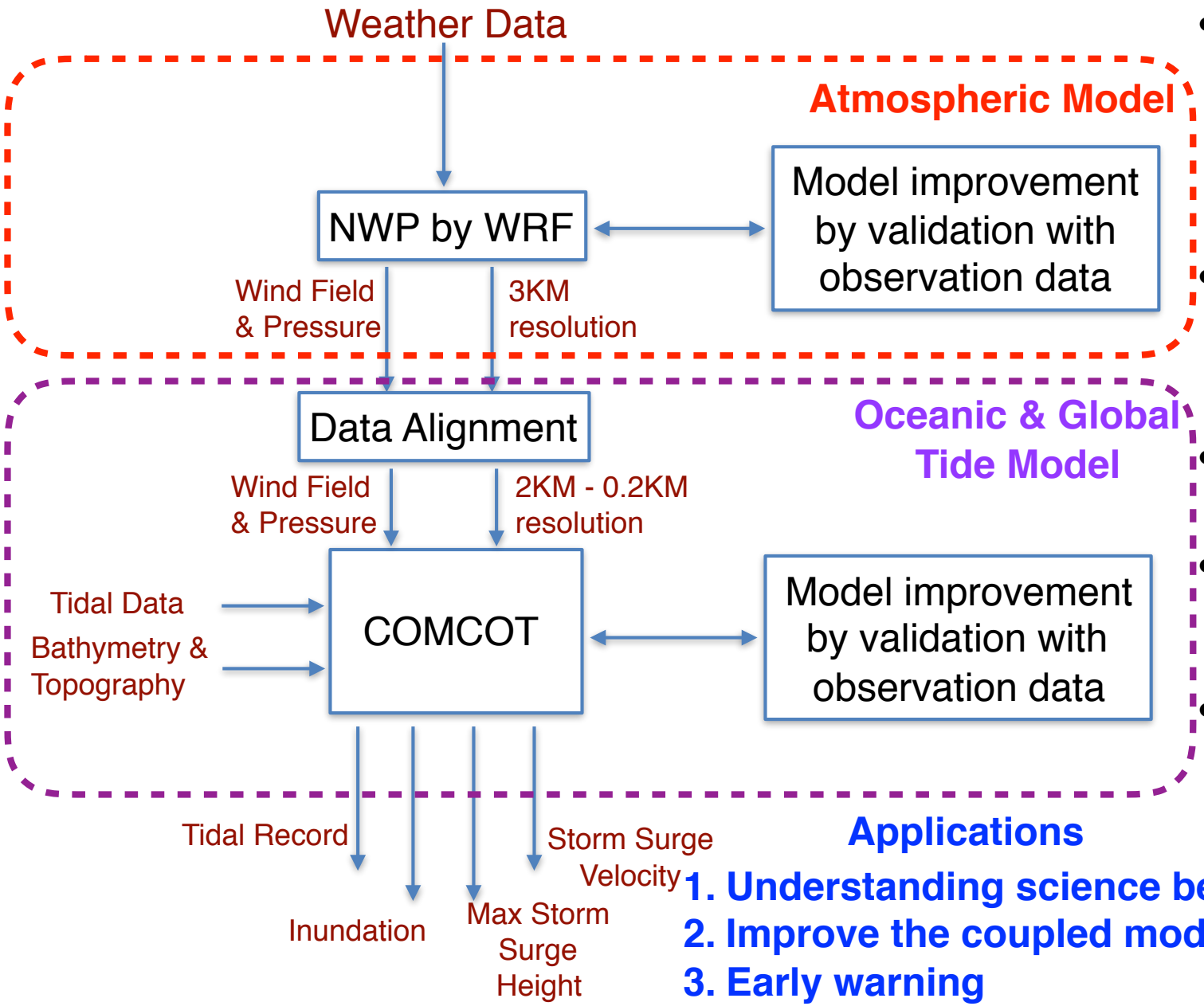
DE provides advanced visualization support whenever it is possible


Weather
Tide
Event
Remote Sensing
Land Use
Bathymetry
Data Commons
Community -Driven Innovation & Support
Tools, Services, Training, Outreach
HT Analysis Framework
Knowledge Base from Case Studies
Disaster Simulation
Model Improvement
Data, Workflow and Simulation Process Integration & Customization
Core Components (Tools, Engines, Workflow)
COMCOT
WRF
Storm Surge
Web Portal Services
Advanced Visualization
Scientific Advancement
Further Analysis
SimulationResults
e-Science Infrastructure & Distributed Cloud Platform over EGI Integrated Resources in Asia Pacific Region

DMCC Collaboration Framework on Case Studies



A New Storm Surge Model for Typhoon Haiyan by Coupling Atmospheric and Oceanic Models



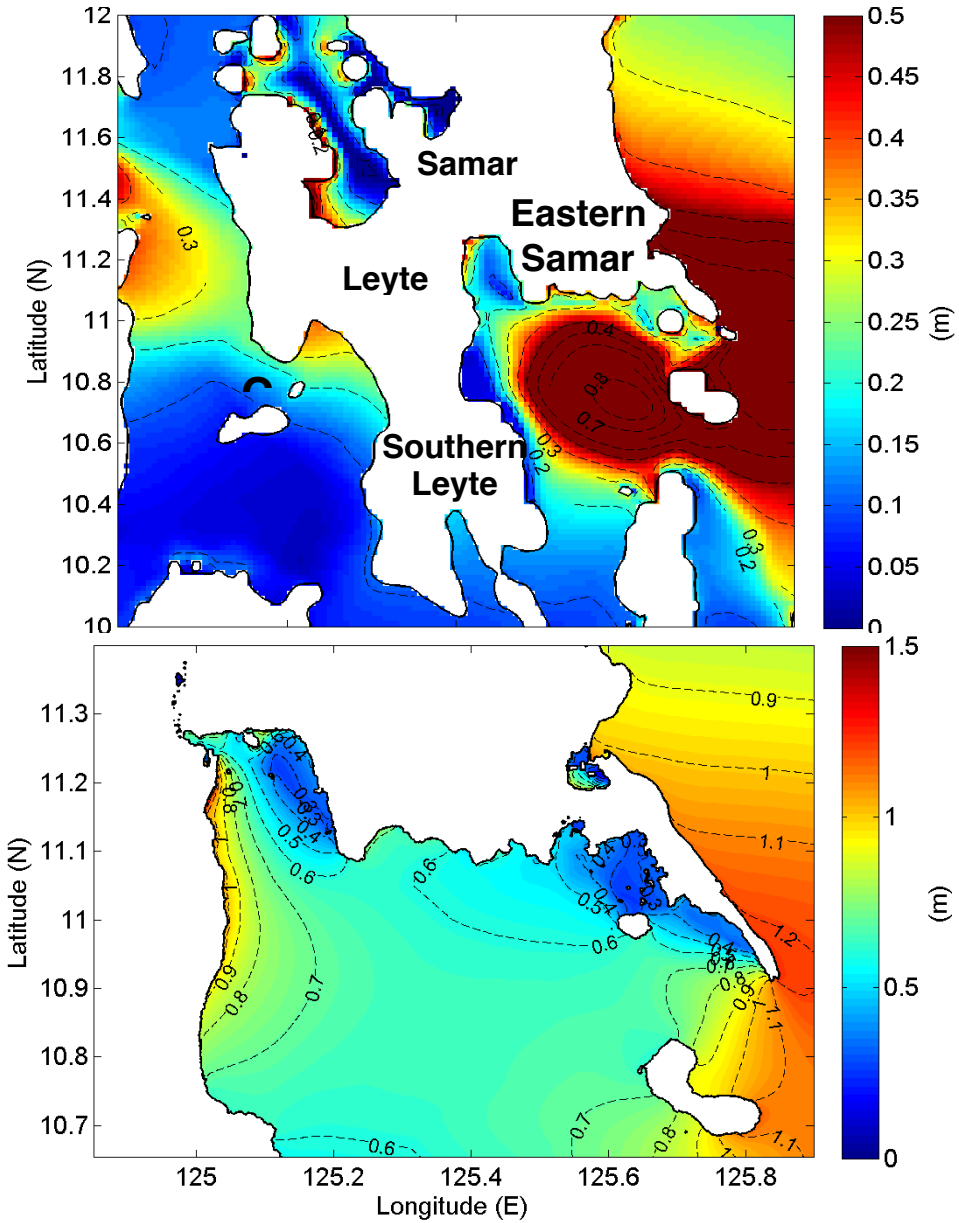
- **Adopt the large computational domain to cover the complete typhoon life cycle and full storm surge propagation.**
- **Couple COMCOT with the dynamic atmospheric WRF model.**
- **Couple with the global TPXO tidal model.**
- **Calculate high-resolution storm surge inundation.**
- **High-speed calculation for the operational system.**

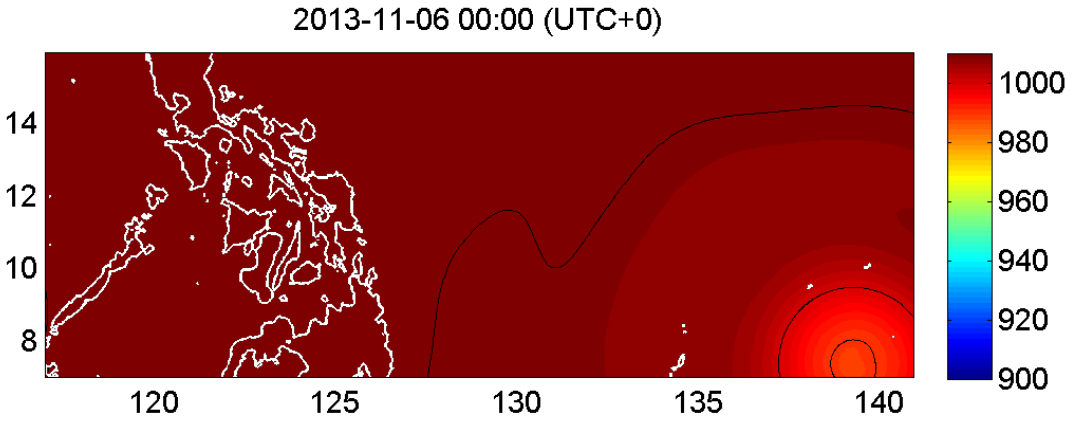
Applications

1. **Understanding science behind the event**
2. **Improve the coupled model**
3. **Early warning**
4. **Providing hazard maps and risk potential analysis**

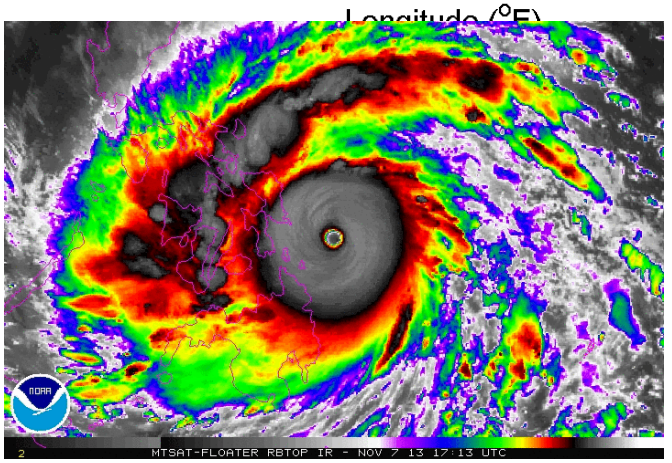
Storm Surge Modeling on 2013 Typhoon Haiyan by Coupling Ocean and Atmospheric WRF Model

Offshore Storm Surge Inundation Induced by Typhoon Haiyan



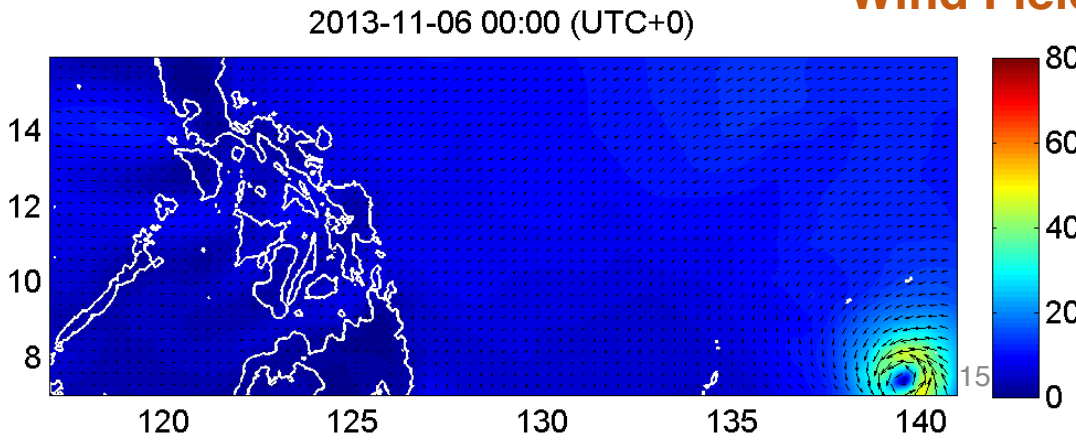


Pressure Field



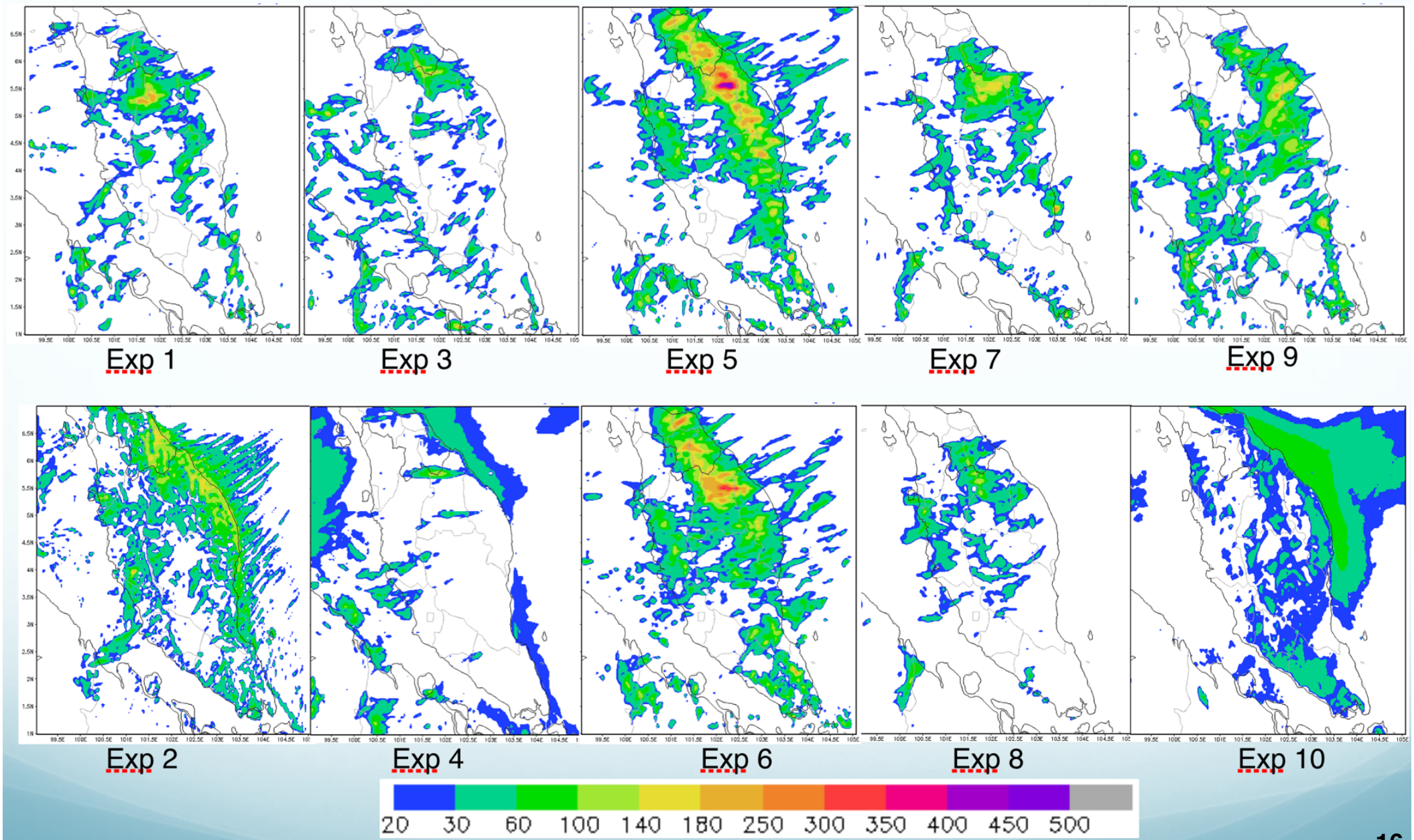
- *Asymmetric effect*
- *Topographic effect*
- *Hydrodynamic Pressure*

Wind Field

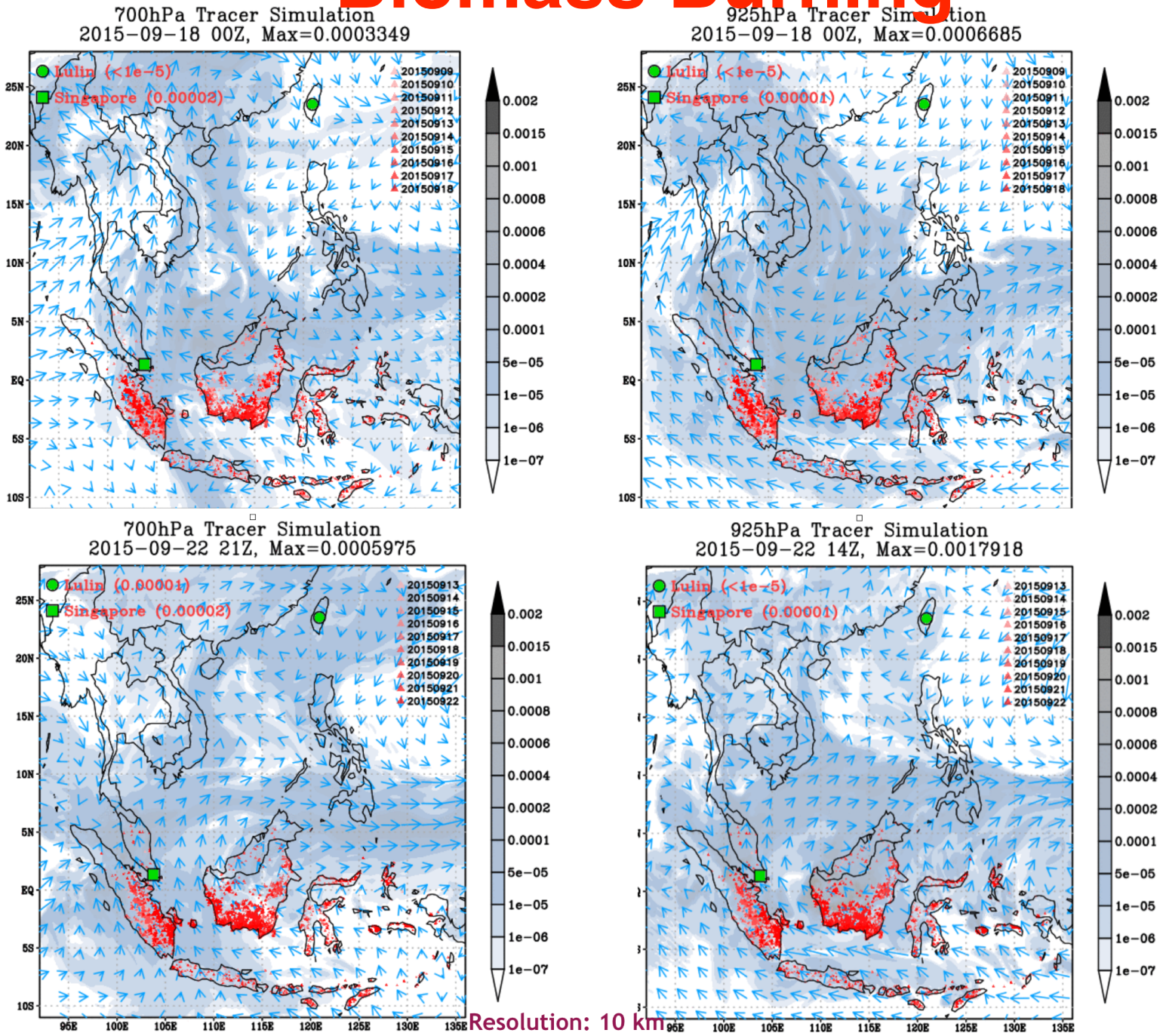


Disaster Mitigation

Studies of Simulation Schemes in Capturing Mechanisms of Rainfall Prediction in WRF on Malaysia Floods



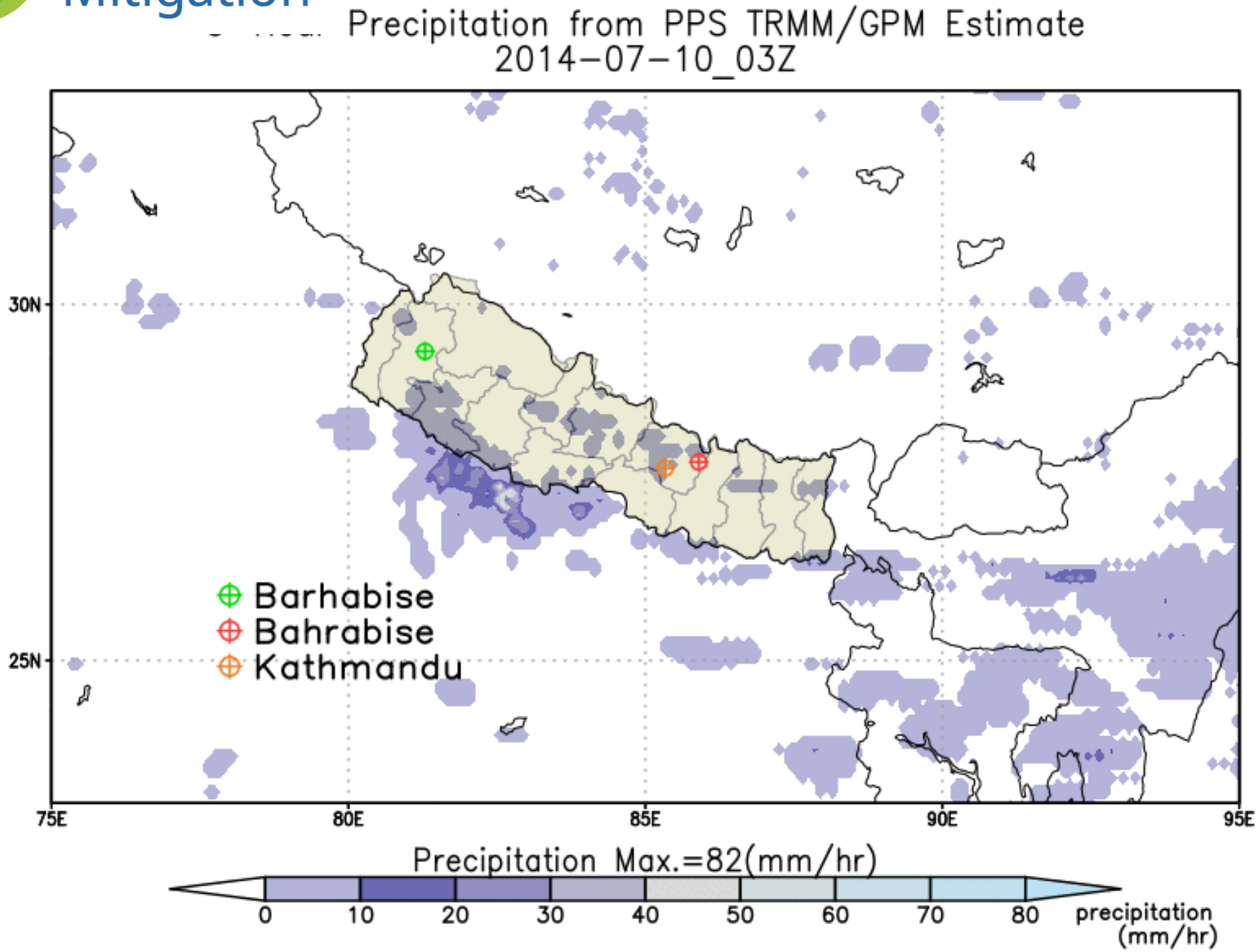
Long-Distance Dust Transportation from Biomass Burning



Resolution: 10 km

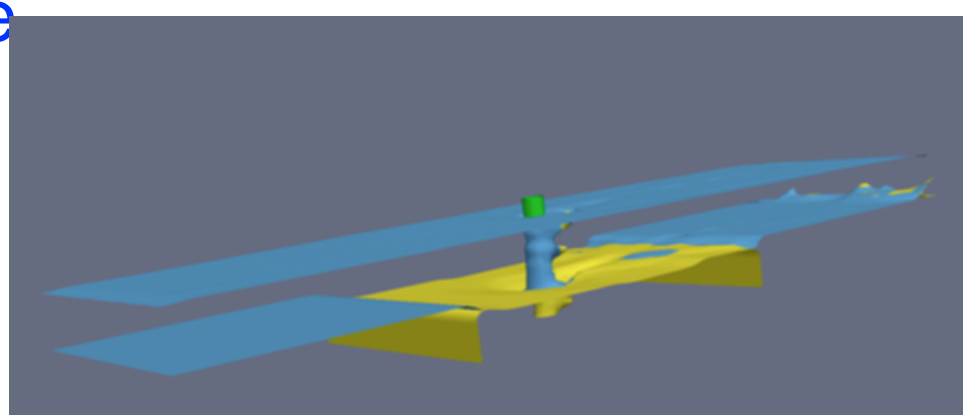
Disaster Mitigation

Flood Case Study in Nepal



Advanced Visualization

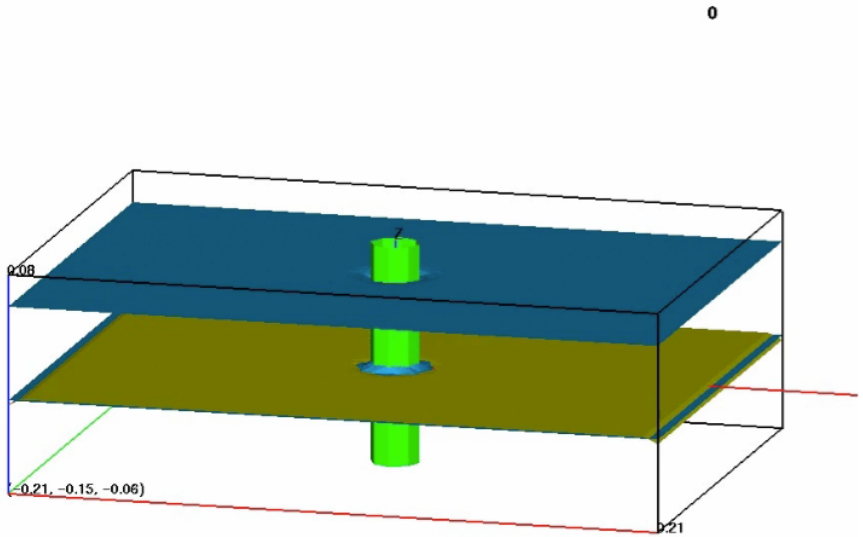
- Local Scouring case study is the first example by collaboration between NCU, ASGC and LRZ
- 3D Typhoon Morakot Visualization is the next case study



Chosen Case Study: Dey and Barbhuiya, 2005

Advance Visualisatio

LRZ: Siew Hoon Leong (12 May 2015)



Compute domain: 1.1m by 0.3m by 0.14m

Abutment model: Circular

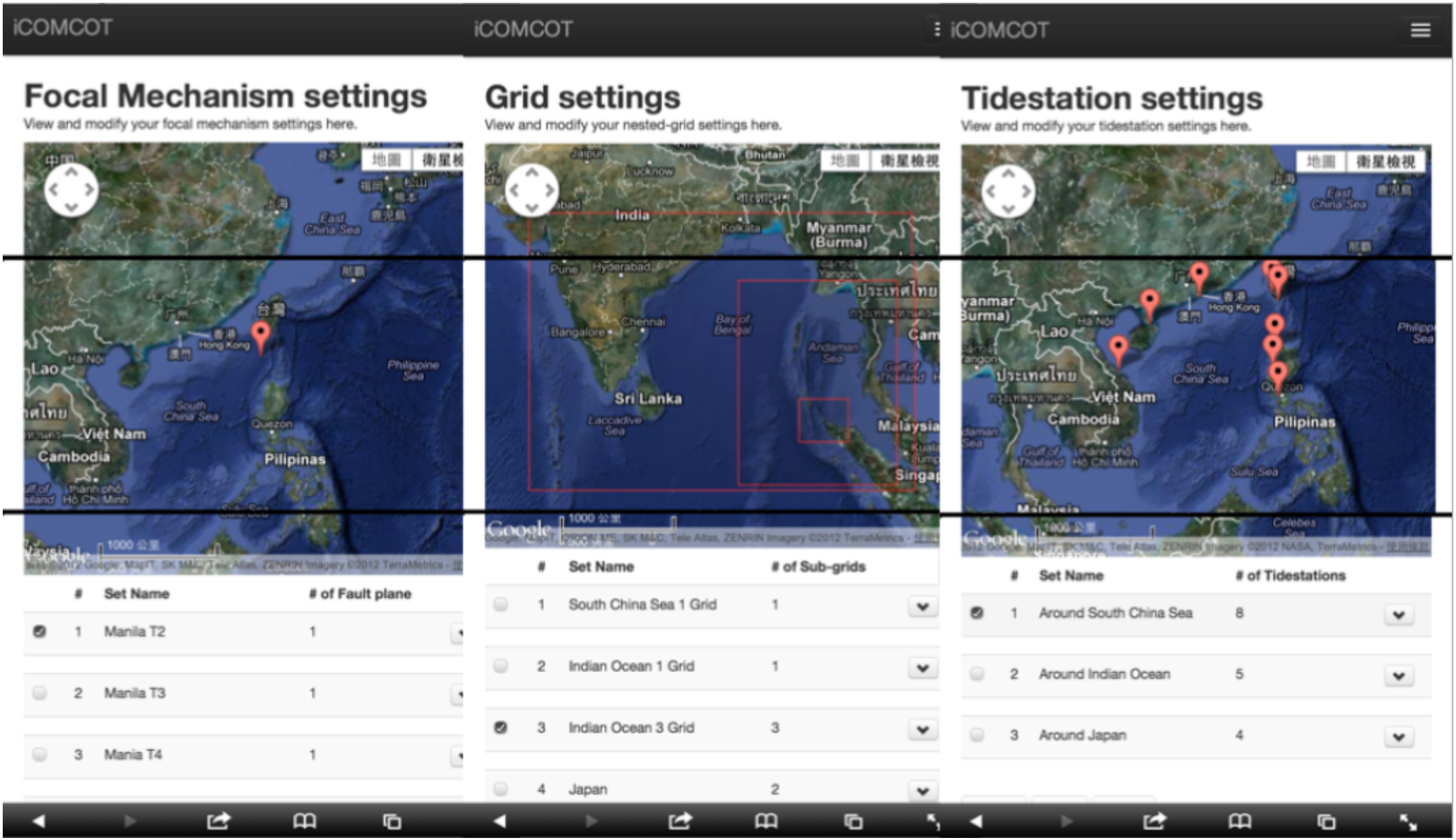
Column radius: 0.015m

Uniform sediments

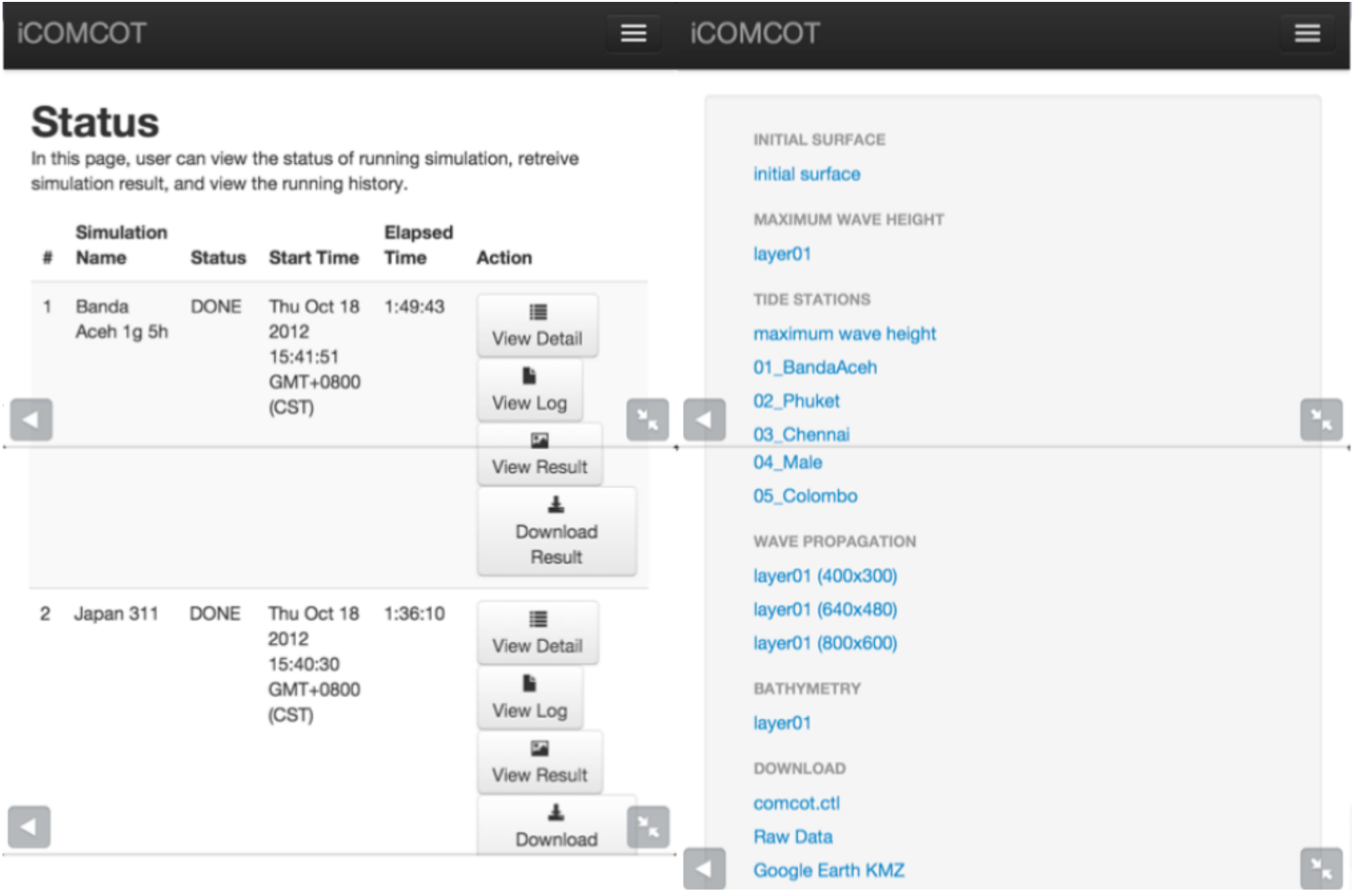
Mud: 6cm thick
Clean water: 6cm thick

Provided by:
Chun-Wei Lin & Tso-Ren Wu (NCU)

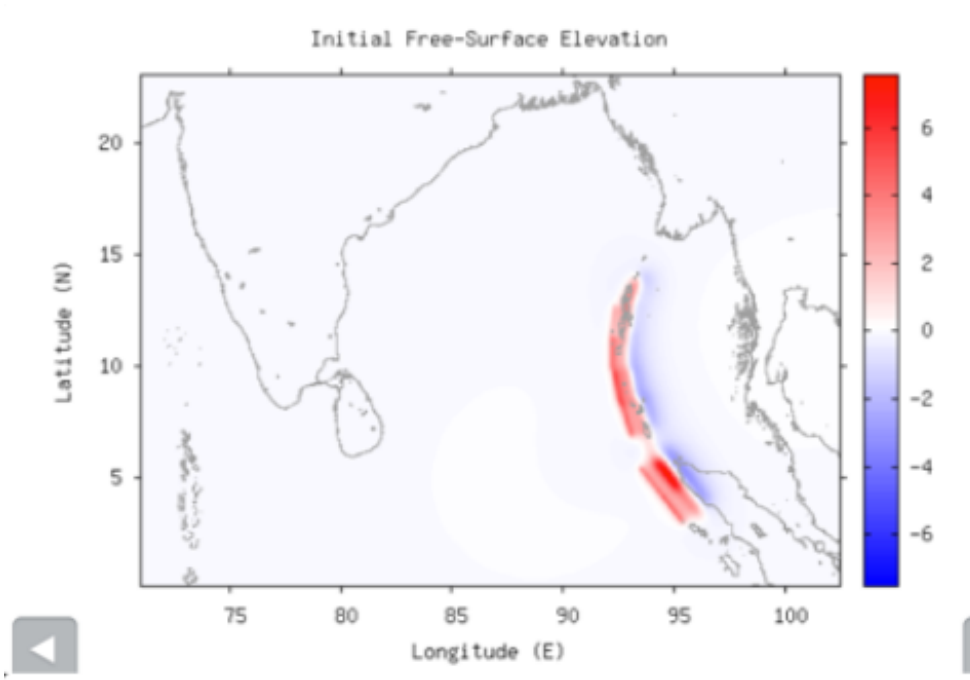
iCOMCOT User Interface (I)

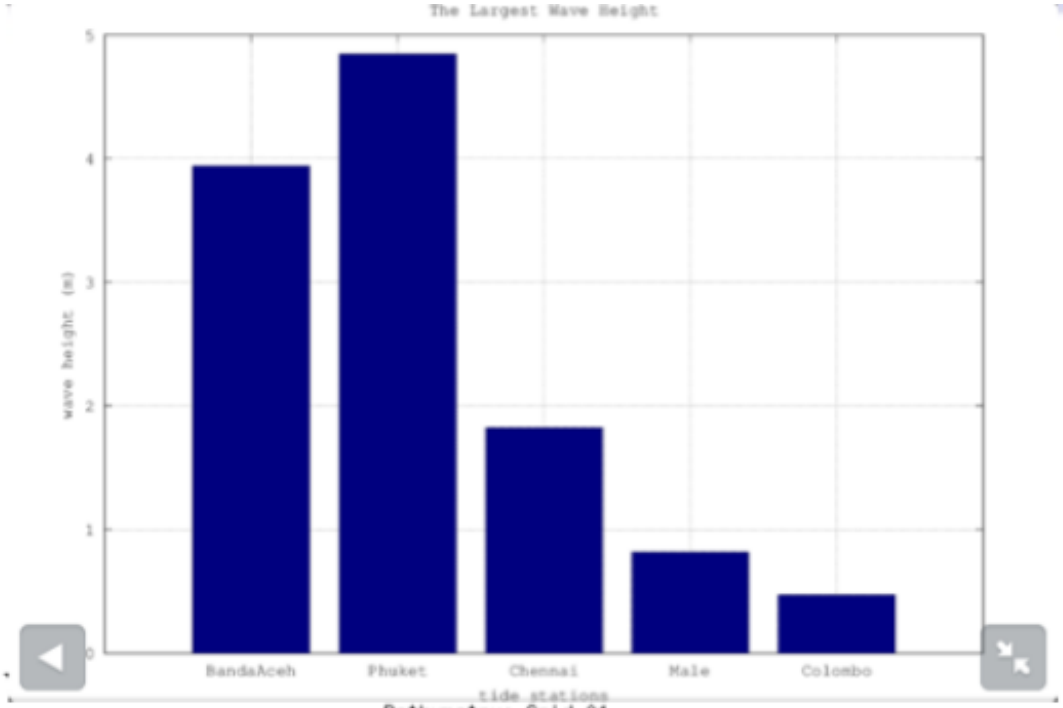


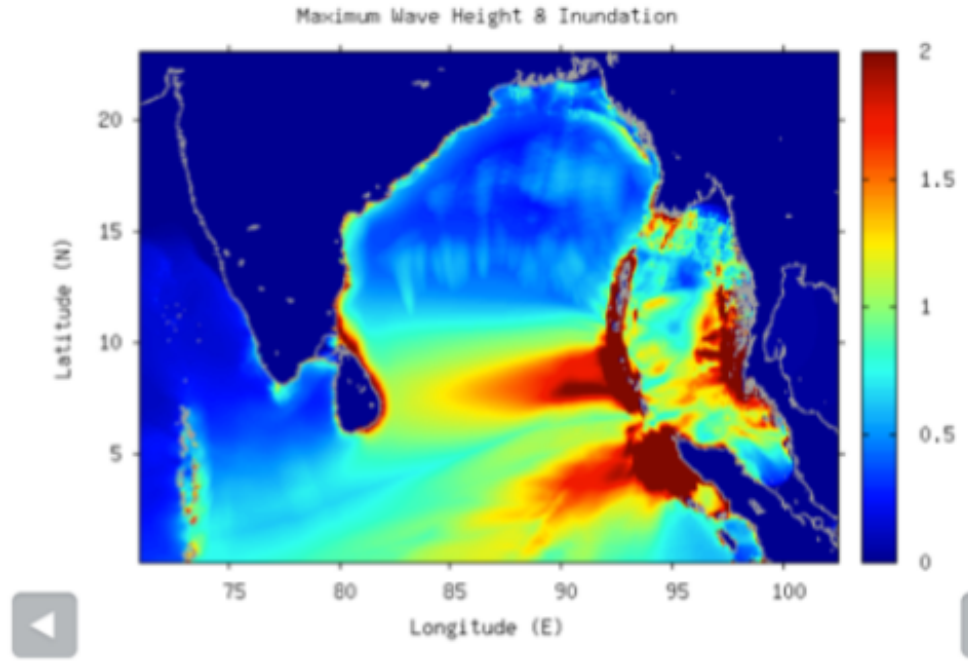
iCOMCOT User Interface (II)

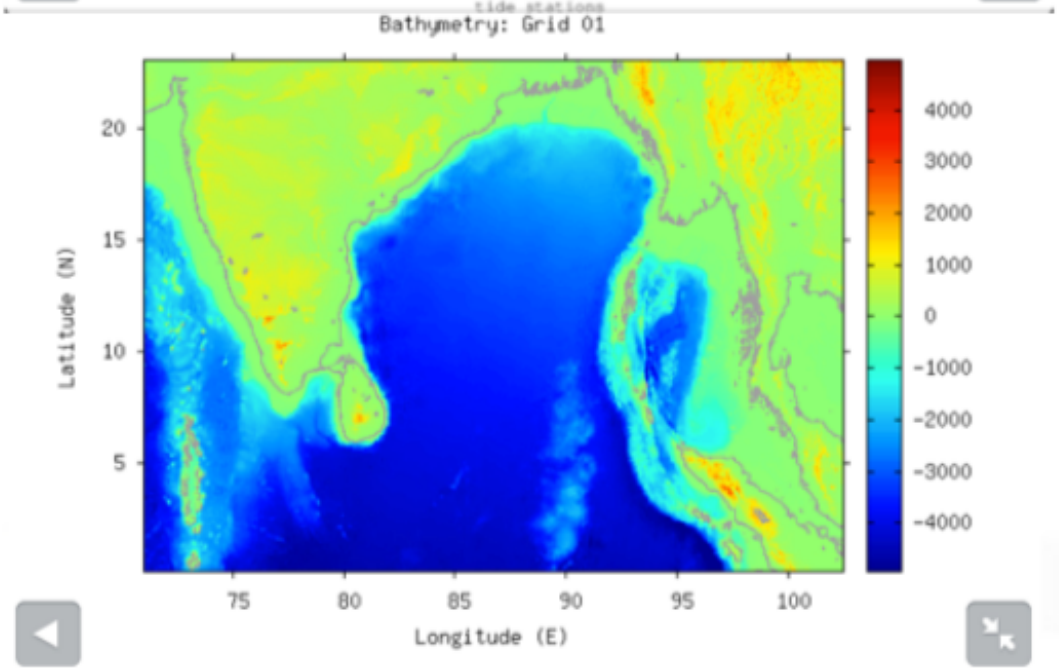


iCOMCOT Result Visualization





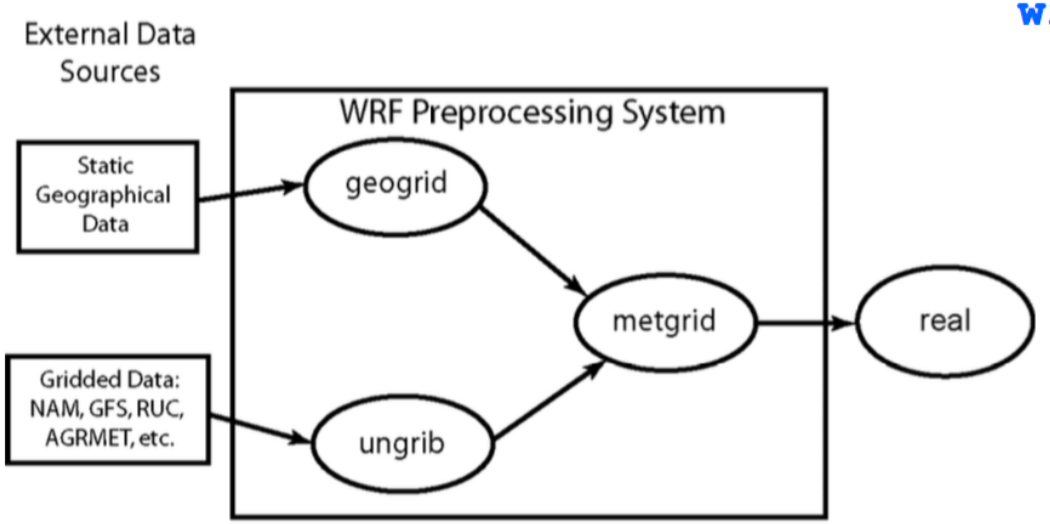




Disaster Mitigation

Running WRF

1. WPS - WRF Preprocessing System

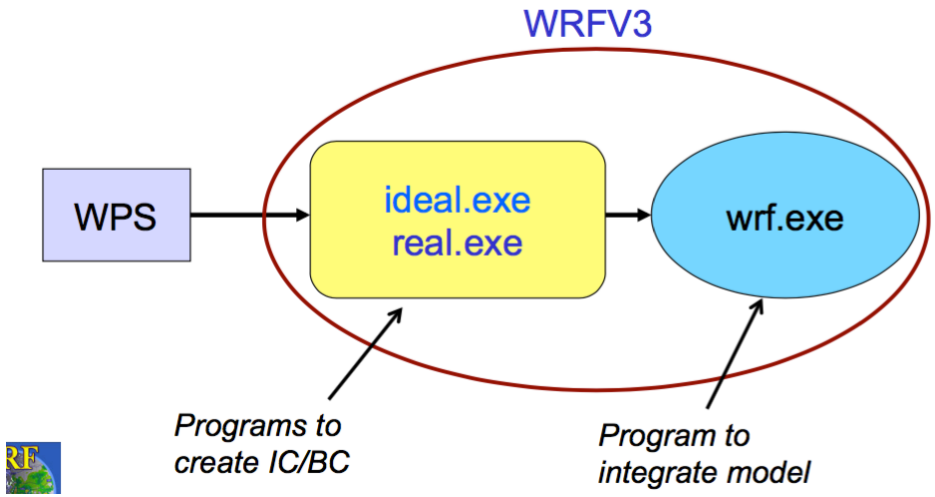


- geogrid: Define size/location of model domains and interpolate static terrestrial fields to simulation grids
- ungrib: Extract meteorological fields from GRIB files
- metgrid: Horizontally interpolate meteorological fields (from ungrib) to simulation grids (defined by geogrid)

2. Running WRF

`ideal.exe` - ideal case initialization program

`wrf.exe` - model executable

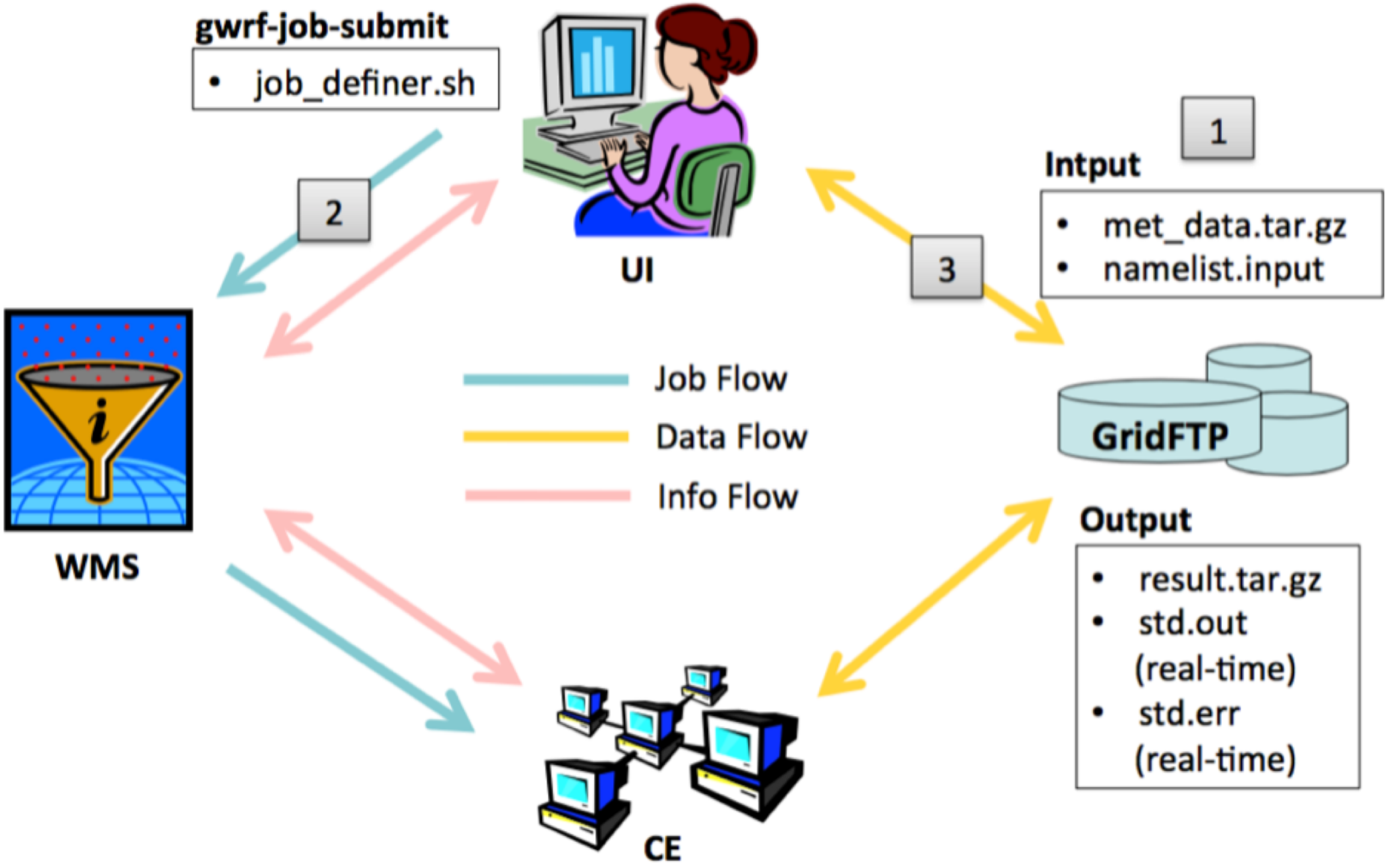


ARWpost

GrADS

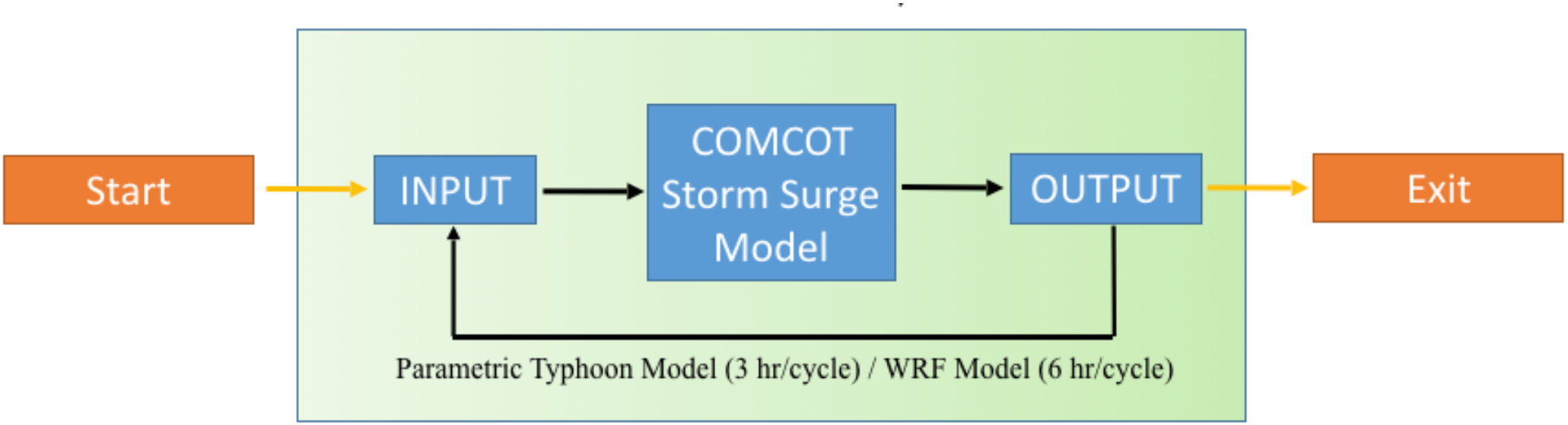
3. ARWpost is a Fortran program that reads WRF-ARW input and output files, then generates GrADS output files.

gWRF Workflow



Taiwan Storm Surge Operational System

Our COMCOT storm surge model has been the official operational system at the Central Weather Bureau of Taiwan in 2016



INPUT

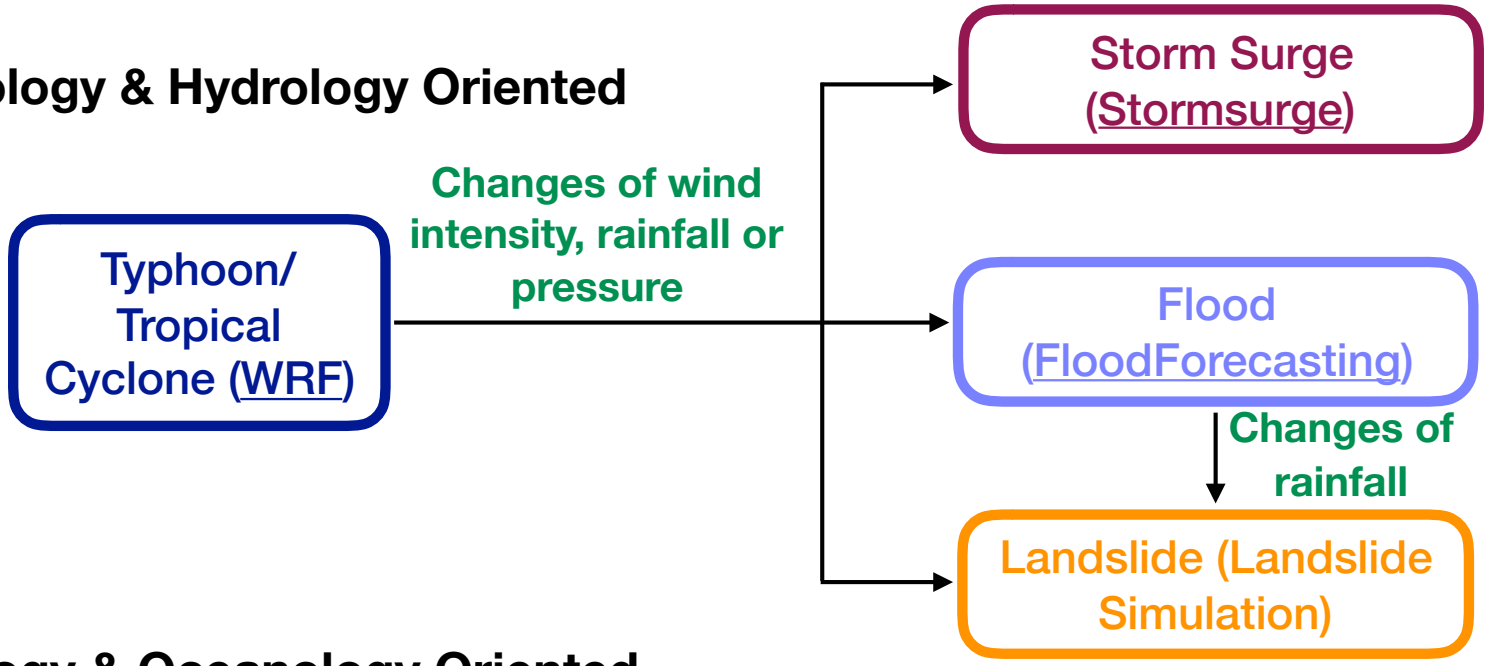
- Meteorological Force: Parametric Typhoon Model or WRF Model.
- Tidal Boundary Condition: TPXO 7.1 model.

OUTPUT

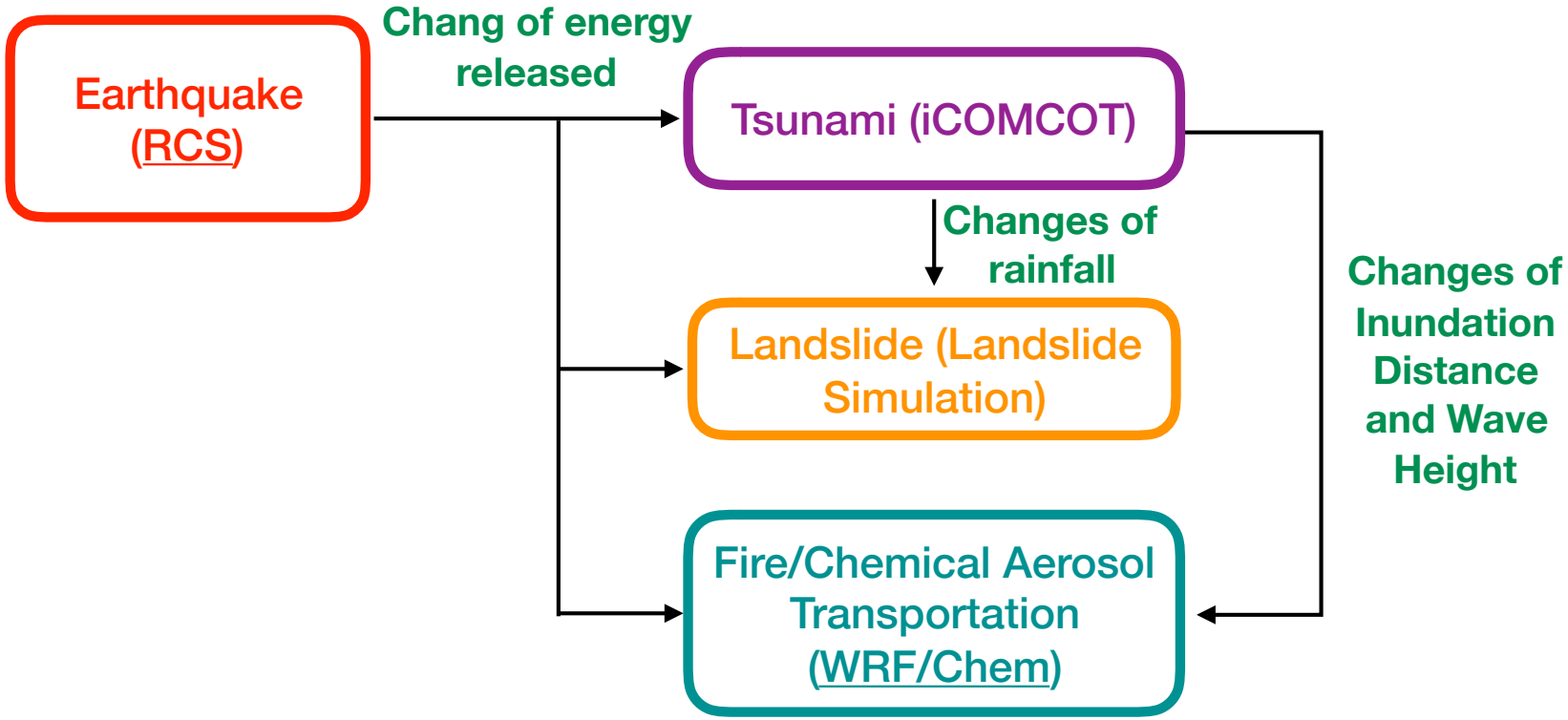
- 48-HR Time Series for Storm Tide and Pure Tide at 34 specified locations.
- 2-dimensional model product.

Multi-Hazards Risk Analysis

A) Meteorology & Hydrology Oriented



B) Seismology & Oceanology Oriented



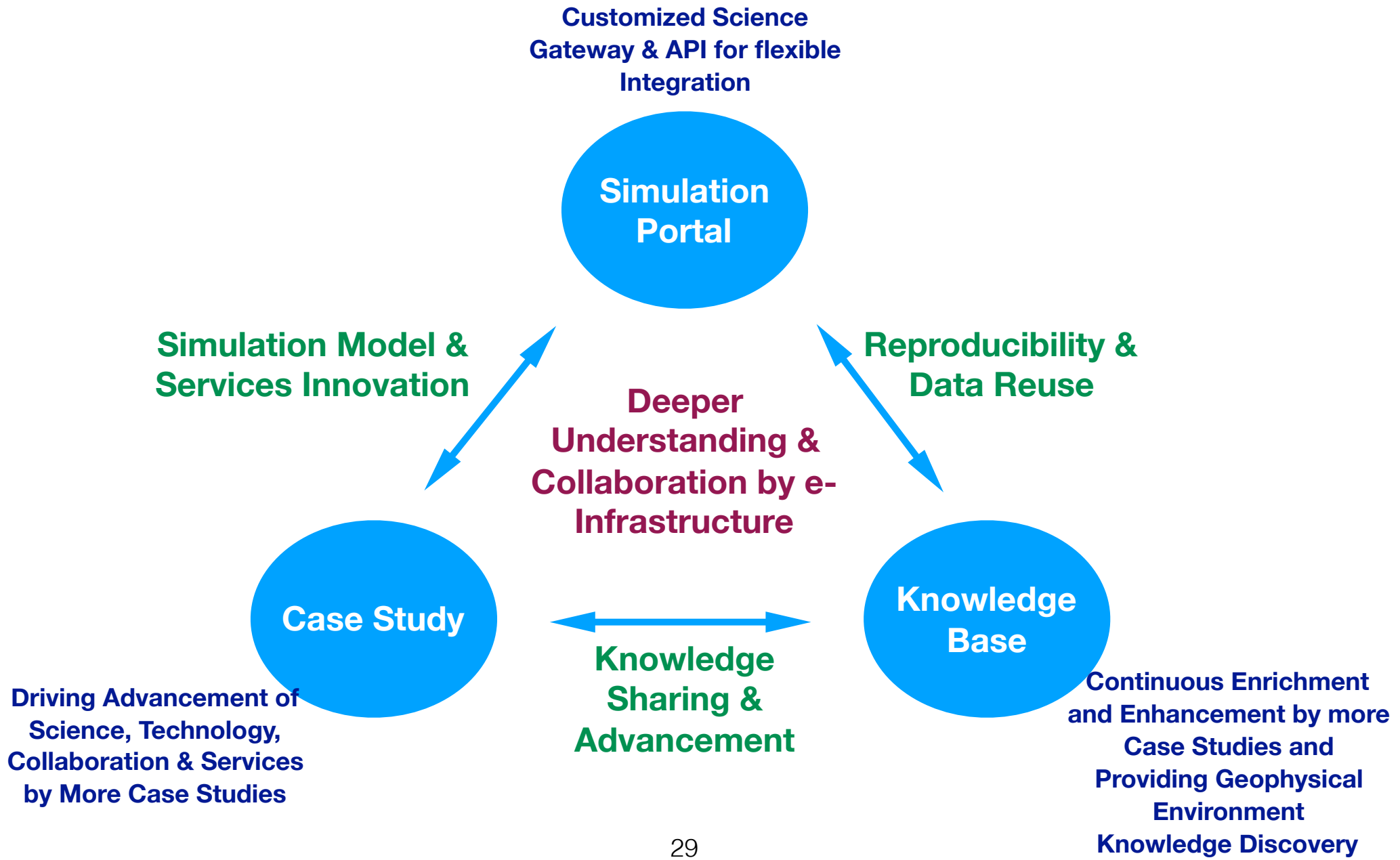
Regional Infrastructure & Technology Requirements

- Observation data is the key for our simulations and model validations
  - Need a systematic approach to integrate data from various sources —> Exception better solutions from Open Science Platform
- Application portal is the right service model for simulation, training and promotion
  - Need to be flexibly support workflows of different needs
  - API should be also provided
- Need to be flexible enough to make use of various types of resources, such as grids, clouds, HPC, local clusters, or even volunteer resources
- Achieving the Open Science Platform for Disaster Mitigation

Challenges & Lessons Learned

- Observation data is the most important and is also hard to acquire
- Insufficient knowledge to the root causes and drivers of disasters leads to invalid and inefficient risk estimation.
- Hard to estimate the risk dynamically before the hazard happens in high level of accuracy
- Every disaster event is unique which needs careful identification of initial condition, boundary condition and right resolution for each simulation in time. Efficient sharing and benefit from expert know-how is still a barrier.
- Duplicate efforts and investments occurred in different countries. Sharing and collaborations across disciplines and across administrative boundaries are demanding.

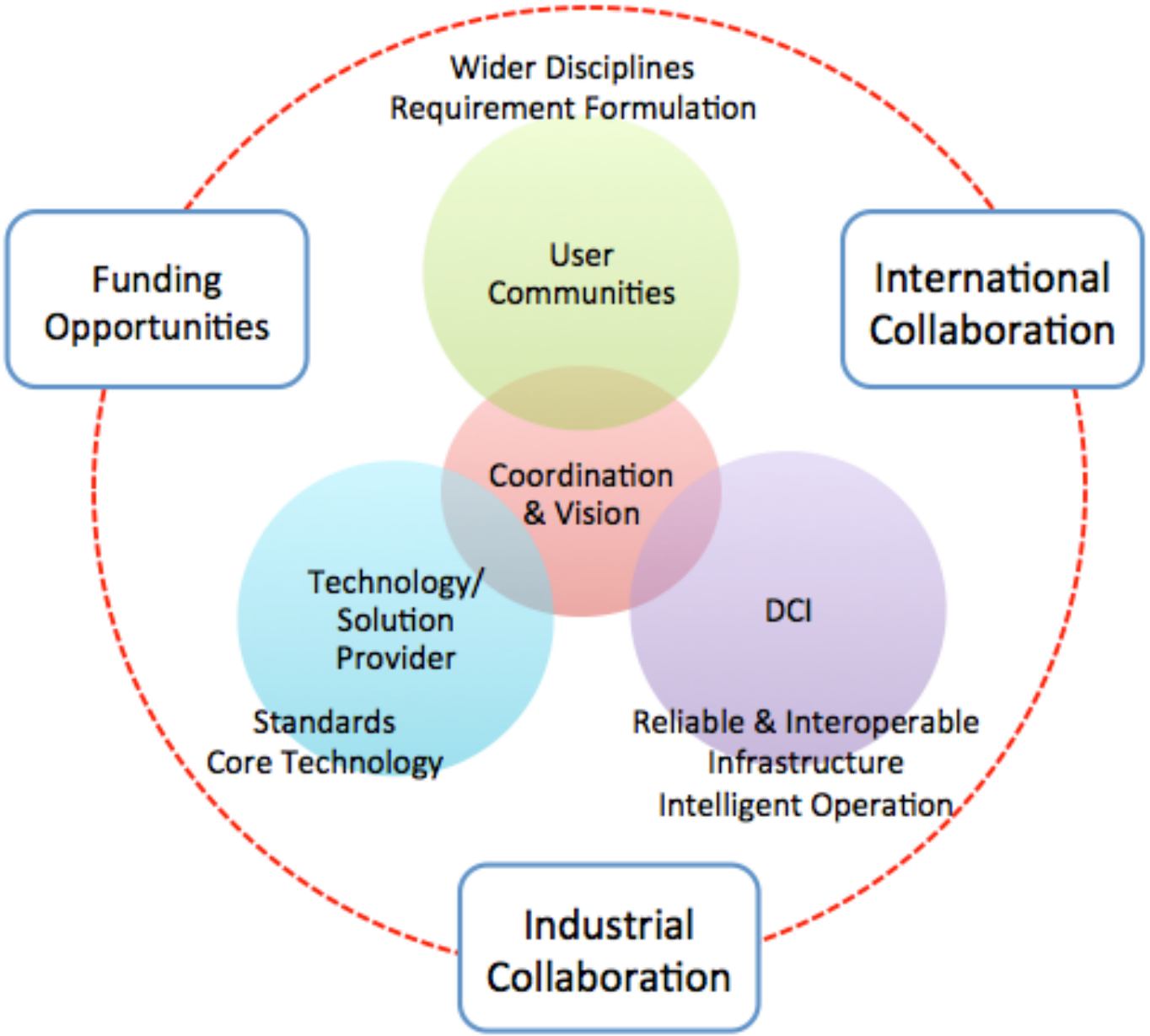
Open Collaboration Model for Disaster Mitigation Based on Deeper Understanding & Moving Towards Open Science



Extending Disaster Mitigation Capacity and Collaboration

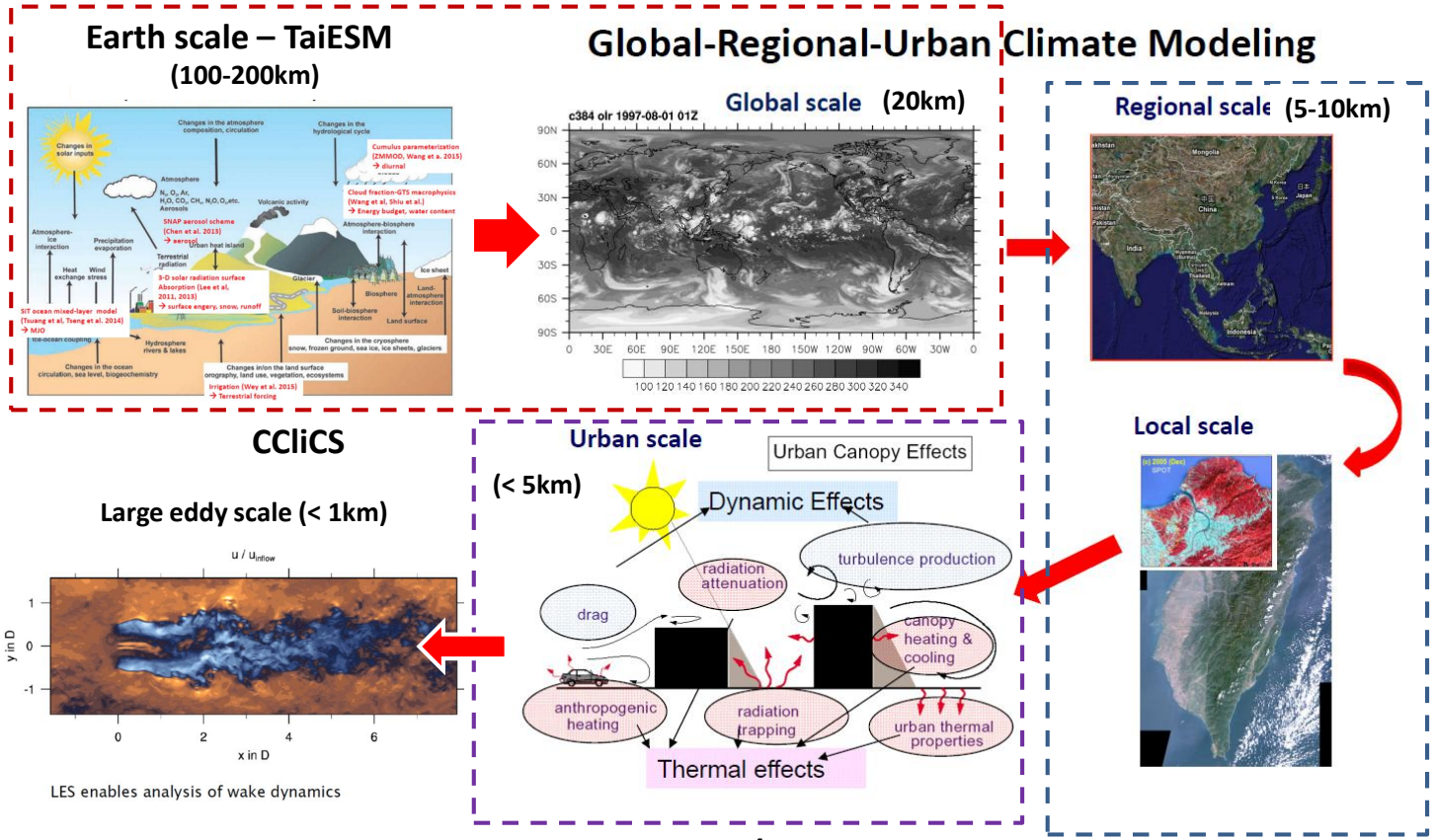
- Partners grows from 4+1 (DMCC) to 8+4 (DMCC+@EOSC-Hub)
- Capacity Building: Develop capacities of natural hazards risk analysis by more accurate and high performance numerical simulations from case studies
- Facilitate Share of Data, Tools, Resource and Knowledge: Buildup the Open Science Platform prototype on Disaster Mitigation to share the data, tools, case studies, services and knowledge
- Extending the Collaboration Network by Training, Dissemination and Support
- Plan for Long-term Collaborations

Sustainability Model



- **Support effective disaster mitigation based on deep understandings**
- **Facilitate scientific advancement on disaster modeling and simulation**
- **Provide e-Services for Scientists, Governments and wider user communities**

Cross-scale Climate Modeling System



Source: Prof. Huang-Hsiang Hsu (RCEC, AS), EnvComp Workshop 2016

DMCC+ in EOSC-Hub (I)

- EOSC-Hub (Call:H2020-EINFRA-2016-2017): Jan 2018 - Dec 2020
- Vision: Reduce the natural disaster risks by numerical simulations based on deeper understandings of the sciences
- Goals: DMCC+ will become the regional open collaboration platform of disaster mitigation by e-Science (EOSC supported high performance numerical simulation services and scientific data sharing) and facilitate the sustainability development of Asia countries.
- Methodology:
  - Develop innovative simulation models and provide scientific gateway services:
    - focusing on meteorological disasters including flood, typhoon, storm surge, landslide, extreme temperature, and long-distance dust transportation as well as tsunami;
    - single hazard and multi-hazards
  - Towards Open Science Platform: Simulation Portal + Case Studies + Knowledge DB

DMCC+ in EOSC-Hub (II)

- **Tasks**
  - Demonstrate the effective collaboration model to engage end users, scientific groups, technical groups, infrastructure support group, user support groups and simulation facility in partner countries to accomplish the planned case studies based on deeper investigation of the underlying causes.
  - Make the existing DMCC regional e-Infrastructure compatible with EOSC framework and support the case studies and shares of data, tools and knowledge to DMCC+ partners and potential collaborators in Asia, Europe and other continents.
  - Open Data: Make data, tools, processes, and derived results from the case studies sharable through EOSC framework and services.
  - Dissemination & Outreach: Collaborate with APAN Disaster Mitigation Working Group, series of master classes on the DMCC+ simulation facilities, web portals and hands-on trainings will take place in various Asia countries. More user communities and cloud resource providers in Asia would be engaged through the EGI-APAN collaboration framework.
- **Deliverables**
  - EOSC Technology assessment and integration plan (milestone in month 6): Goal is to integrate Asia Pacific regional infrastructure with EOSC framework and making use of EOSC services for DMCC+ applications.
  - Online services integrated into a unified e-infra platform (milestone in month 21): Finish planned case studies by simulation portals over EOSC framework and EOSC services.