World Meteorological Organization

Weather • Climate • Water

A global (WMO) perspective on application-oriented R&D activities

EWGLAM meeting, Antalya, 20130930

Jeanette Onvlee, WWRP WG-MWFR

WWRP objectives

- To improve public safety and economic productivity by accelerating research on the prediction of high-impact weather;
- To improve understanding of atmospheric processes of importance to weather forecasting through the organization of focused research programmes (e.g., WWRP Strategic Plan, Research and Development Projects (RDPs));
- To demonstrate improvements in the prediction of weather, with emphasis on high-impact events through the exploitation of advances in scientific understanding, observational network design, data assimilation and modelling techniques and information systems;
- To encourage the utilization of relevant advances in weather prediction systems to the benefit of all WMO Programmes and all Members (e.g., Forecast Demonstration Projects (FDPs))
- To maintain a strong focus on capacity building and training opportunities for young scientists, in particular from developing countries, so that as many countries as possible will be able to contribute to and benefit from the research advances.

Aims, mechanisms and applications of WWRP projects

- Aims of WWRP activities and projects:
  - Enhanced understanding of weather phenomena and forecasting
  - Demonstration and utilization of present state-of-the-art knowledge, with a focus on severe weather
  - Capacity building (young researchers, developing countries
  - Usually a mixture of the above

- Main mechanisms:
  - RDPs for enhanced understanding
  - FDP's for demonstration of present capabilities, assessment of impact of improvements, and support of decision-making
  - Regional provision and enhancement of warning services and capabilities, e.g. SDS project, or through Severe Weather FDP: one regional met service providing operational warnings to other NMS's in the region.

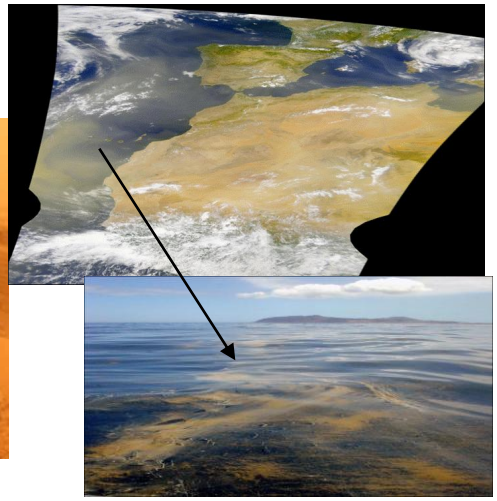
- Applications: high-impact weather warnings (severe convection, typhoons, monsoon, sand and dust storms,urban resilience,…), hydrology, decision-making for major public events

Project	Region	Topic	status
FROST-14 RDP/FDP	Russia	Meteorological decision support for Sochi O.G	ongoing
Typhoon Landfall FDP	Asia, Africa	Ensemble forecasting, warning, typhoons	ongoing
HYMEX	Mediterranean	Hydrology	ongoing
Polar prediction project (PPP) RDP	Polar regions	Understanding polar weather	ongoing
South China Rainfall Monsoon Exp RDP/FDP	S.E. Asia	Warnings severe rainfall, monsoon timing	ongoing
Sand and dust storms warning & assessment system (SDS-WAS)	various	Research, forecasting, impact assessment and real-time services, high impact weather	ongoing
INCA-CE FDP	C. Europe	Nowcasting,high impact weather, communication with public authorities	ongoing
TOMACS RDP	Japan	Severe convective weather in urban environment, enhancing societal resilience	started
Lake Victoria RDP/SWFDP	C. Africa	Prediction of/warning for severe convective storms in the Lake area	started
La Plata basin RDP?	S. America	Prediction of/warning for severe MCS events in the basin	In preparation
High-resolution typhoon forecasting RDP/FDP	S.E. Asia	Typhoon forecasting, LAM models and ensembles, verification	In preparation
High impact weather	global	High impact forecasting, all time scales, incl impact assessment	In preparation
Subseasonal to seasonal prediction	global	Longer-term forecasting	In preparation

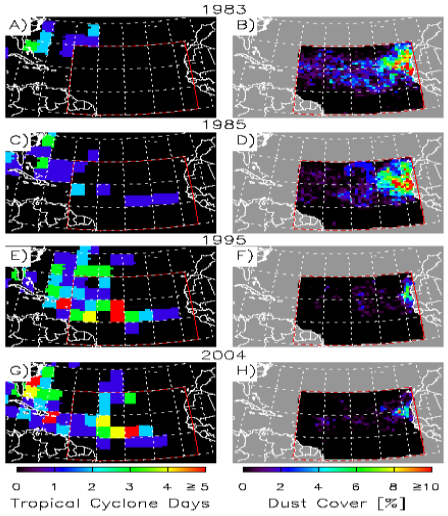
SDS-WAS: Impacts of Sand and Dust

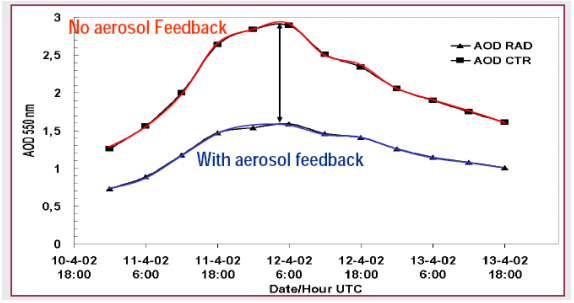
Human Health
(Asthma, infections, Meningitis in Africa, Valley Fever in the America's)

Agriculture (negative & positive impacts)

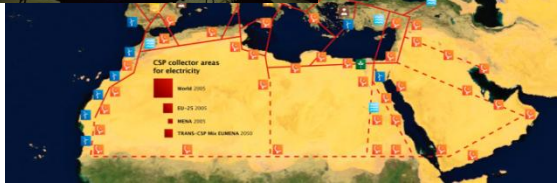


Marine productivity (negative & positive impacts)





Improved **Weather** and **Seasonal Climate prediction**



Industry (Semi-conductor, etc.)
Energy (Thermal solar energy)

Aviation (air disasters)

Ground Transportation (high speed rail)

Elements of SDS-WAS project

- observations: research, validation, exchange, assimilation
- systematic prediction
- scientific assessment
- capacity building
- services

SDS-WAS Node structure

Na-ME-E Regional Centre; http://sds-was.aemet.es

Log in Register

NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER

WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

World Meteorological Organization

WMO SDS WAS | | Asia Regional Center

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Jul 12, 2013

WHO releases 'Review of evidence on health aspects of air pollution'
Jul 04, 2013

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Northern Africa-Middle East-Europe (NA-ME-E) Regional Center

by Francesco Benincasa — last modified May 29, 2012 03:33 PM

Outstanding

Barcelona will host the first WMO Regional Meteorological Center specialized on Atmospheric Sand and Dust Forecast

Forecast evaluation

Training events in Muscat, Oman

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Compared dust forecasts

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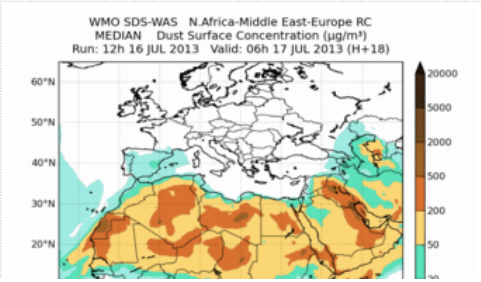
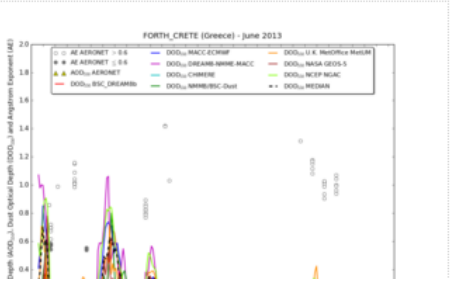
Dust forecasts



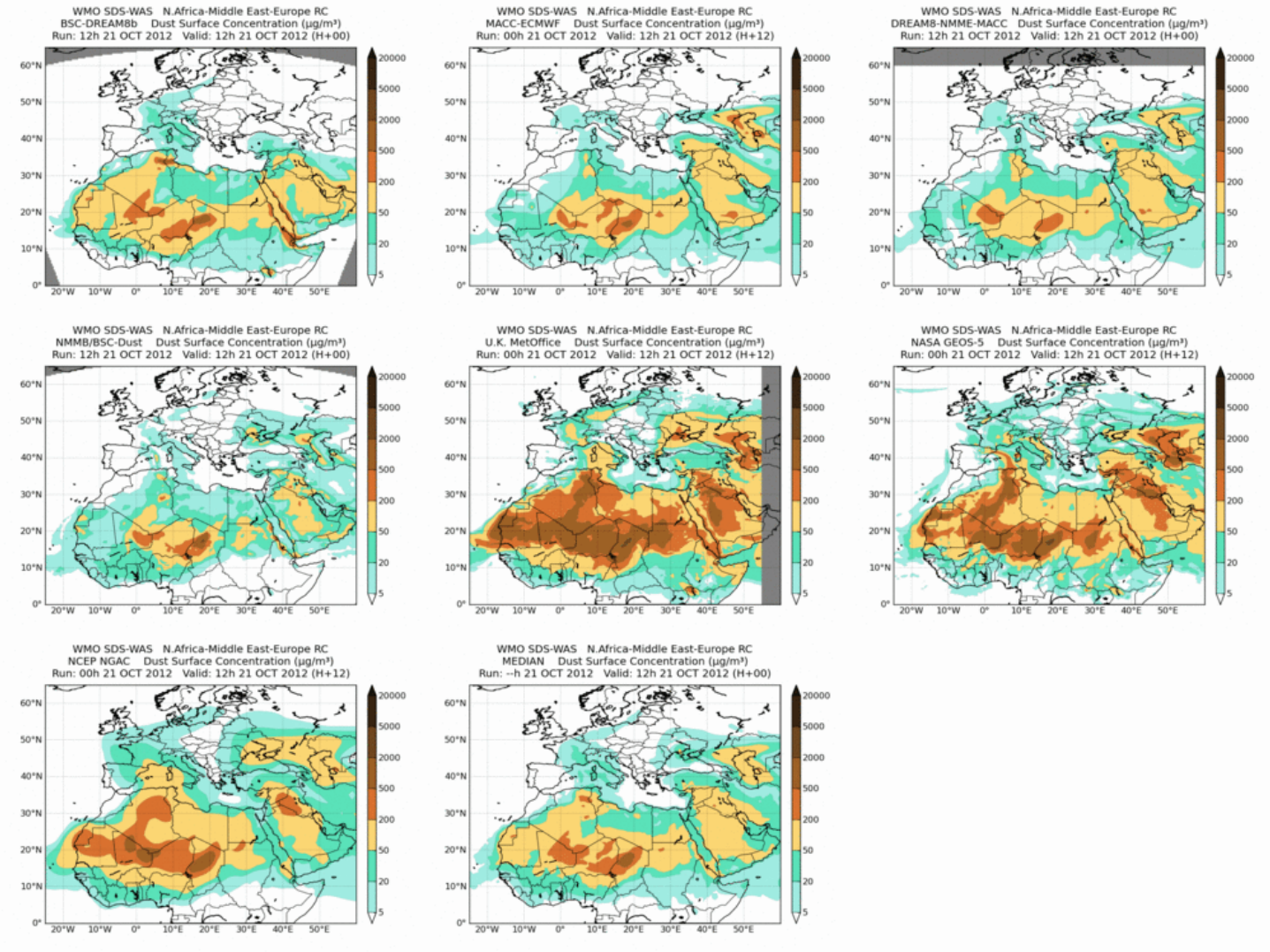


The models

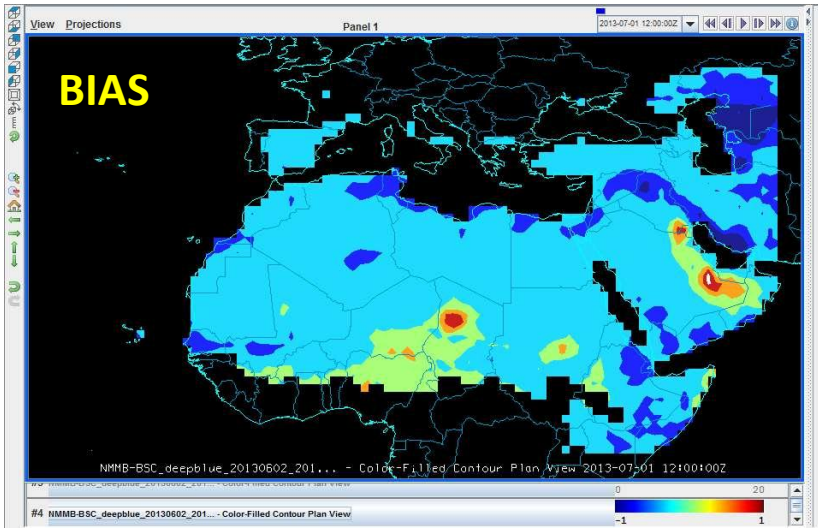
MODEL	INSTITUTION	RUN TIME	DOMAIN	DATA ASSIMILATION
BSC-DREAM8b	BSC-CNS	12	Regional	No
CHIMERE	LMD	00	Regional	No
LMDzT-INCA	LSCE	00	Global	No
MACC	ECMWF	00	Global	MODIS AOD
DREAM-NMME-MACC	SEEVCCC	12	Regional	MACC analysis
NMMB/BSC-Dust	BSC-CNS	12	Regional	No
MetUM	U. K. Met Office	00	Global	No
GEOS-5	NASA	00	Global	MODIS reflectances
NGAC	NCEP	00	Global	No

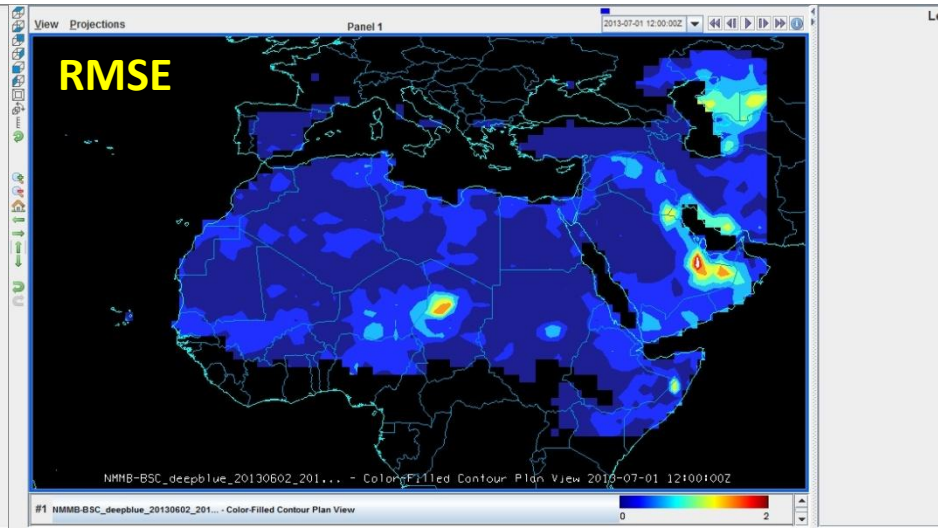
- **VARIABLES**: Dust surface concentration – Dust Optical Depth at 550 nm
- **LEAD TIME**: 0 – 72 hours, every 3 hours
- **GEOGRAPHICAL DOMAIN**: 25ºW – 60ºE, 0 – 65ºN

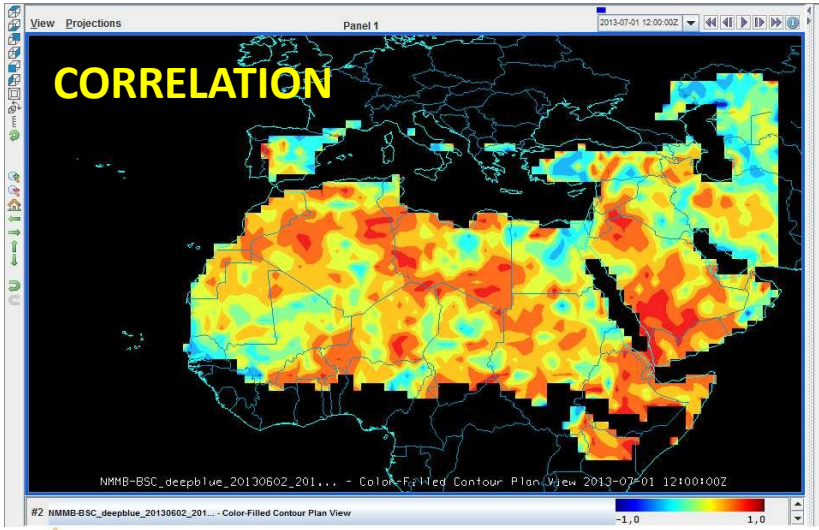
Joint visualization. Surface concentration

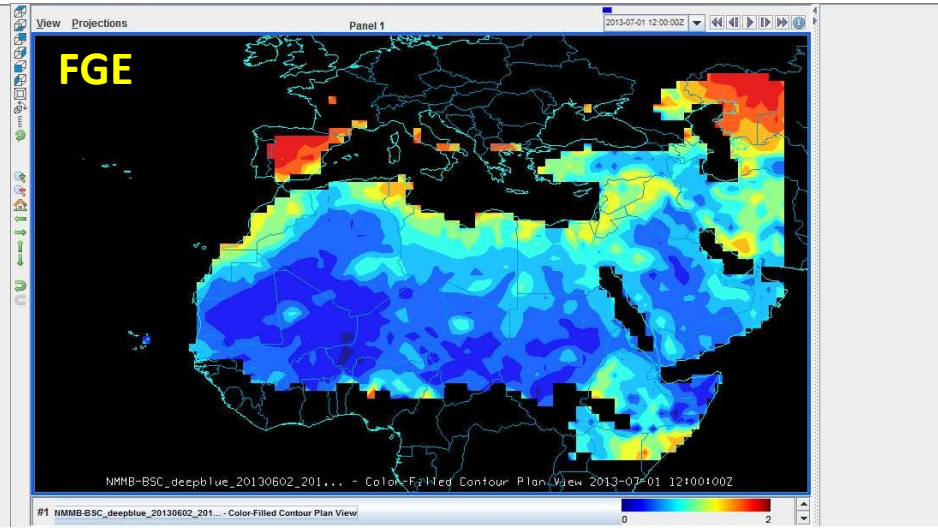


NRT evaluation of dust forecasts with MODIS deepblue: NMMB-BSC/Dust Since June 2013









SDS-WAS research issues

- Sources
- Physical, optical and chemical properties
- Interaction with radiation, clouds and precipitation
- Model validation and intercomparison
- Ensemble forecasting
- Impacts of dust (health, transport, agriculture)
- Improve weather, climate and air quality modelling

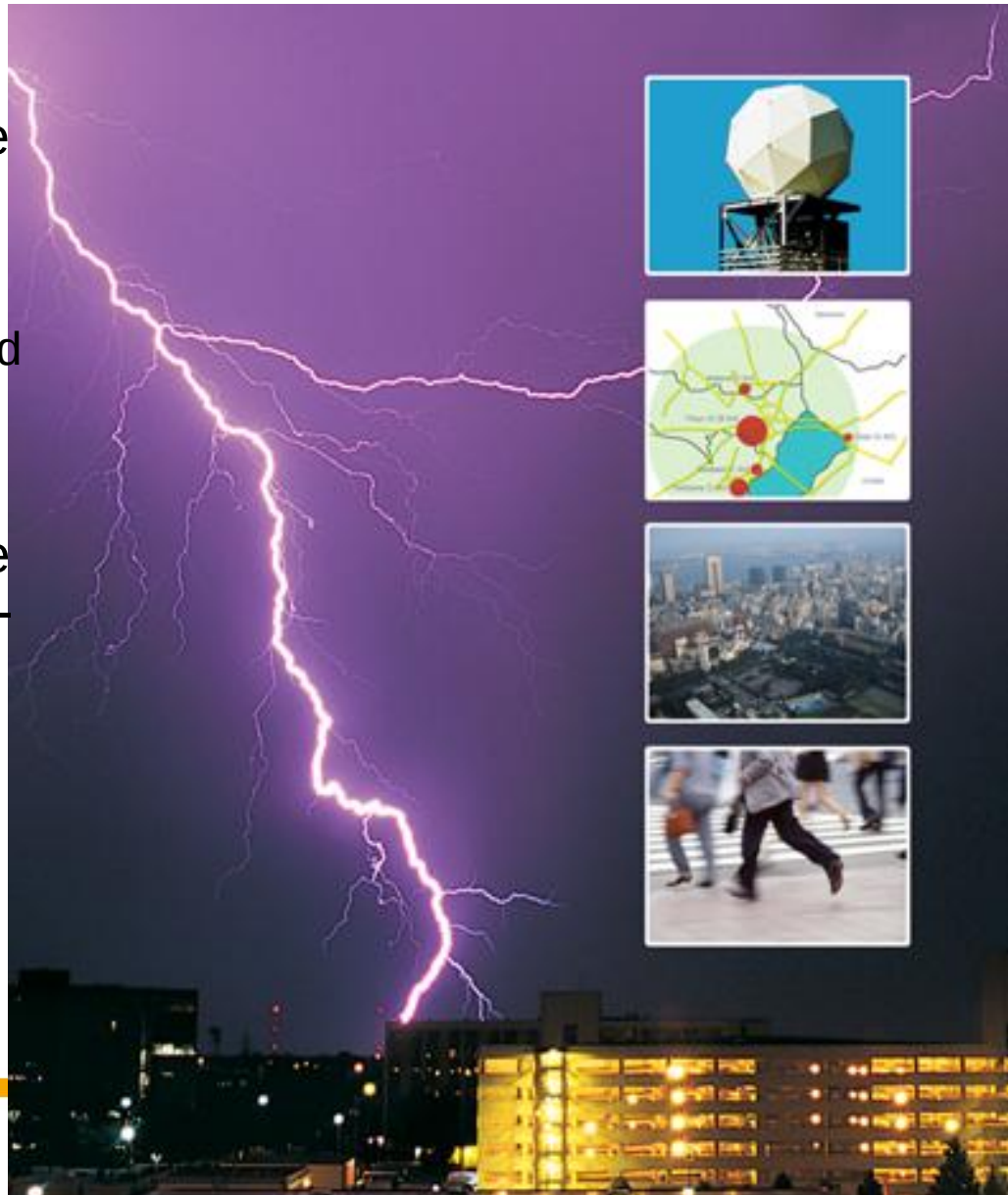
Tokyo Metropolitan Area Convection Study for extreme weather resilient cities (TOMACS)

Project of ~25 Japanese institutes/authorities, aimed at making megacity urban areas more weather-resilient

- Summertime field campaigns (2011-2013)
- Improvement of early detection and warning systems
- Social experiments in rescue services, risk management etc.

Originally purely Japanese initiative RDP started on international follow-up research on the basis of the TOMACS database

- Studies on instrumentation / urban meteorology / very high resolution modelling / improved nowcasting/short-term forecasting and warning systems



Social Experiments on Extreme Weather Resilient Cities

Target: Local Heavy Rainfall in Urban Areas

Subject 1: Field Experiments TOMACS

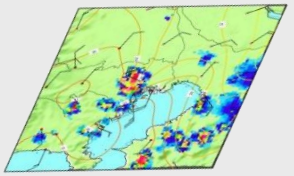
【Meteorology】

To obtain new insight on mechanisms of extreme weather

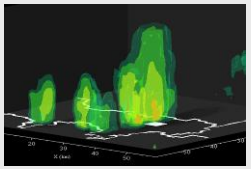
(1) Development of new technologies

(2) Field campaign in the Tokyo area (3) Statistical analysis

New observation facilities



Field campaign in the Tokyo Metropolitan area



Understanding the mechanism

to Issue More Accurate and Adequate Warning

to Evaluate and to Adapt the Nowcasting Systems

Subject 2: Early Detection and Prediction System

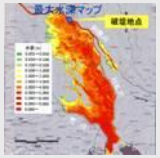
【Engineering】

Developments collaborating with end users

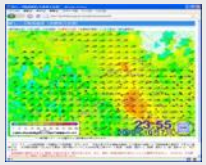
(1) Extreme weather nowcasting/SR forecasting methods

(2) Development of test-beds of nowcasting/SR forecasting systems

(3) Extreme weather database



Hazard Map



Nowcasting

Monitoring/Nowcasting System

Subject 3: Social Experiments

【Sociology】

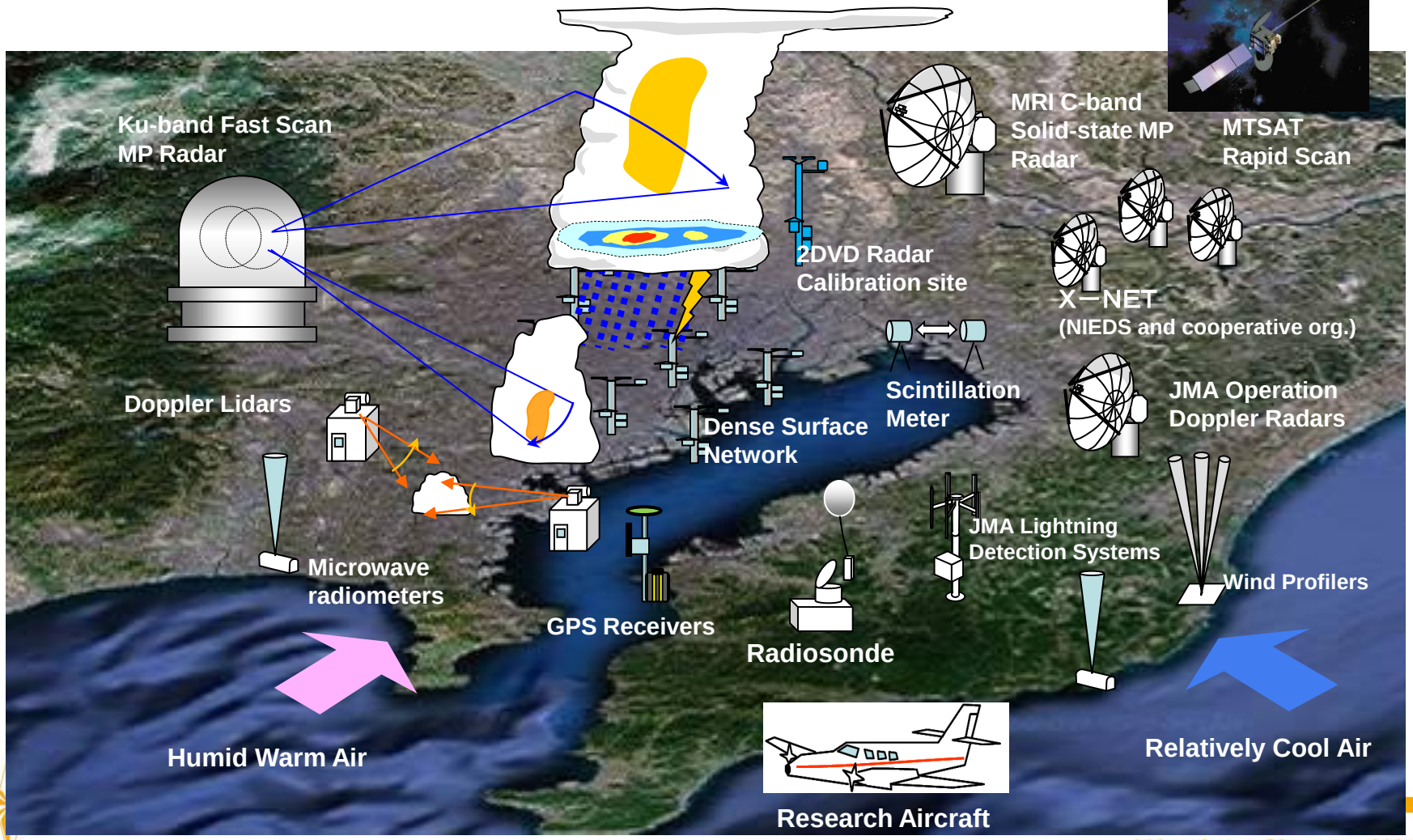
Evaluation and adaption the developed nowcasting/SR forecasting system

(1) Social experiments in rescue services, risk management, infrastructure and education

(2) Recommendations for extreme weather resilient cities

High density field campaign

A field campaign in the Tokyo metropolitan area with a dense observation network is planned by MRI, NIED and 12 research groups in the summers of 2011-2013, as an international testbed for deep convection.



Data archive

Most data available in standard formats, NetCdf or with convertors to NetCdf:

data	archive	format	plan
Satellite Rapid Scan	Archived at MRI	NETCDF	
JMA Doppler radars	Archived at MRI	GRIB2	
JMA Airport lidars	Archived at MRI	SIGMET (convertible to DRAFT)	
MILT MP radars	Archived at MRI	NETCDF	
X-NET radars	Archived at NIED	NETCDF (Level 1-2)	See another table
JMA AWS (AMeDAS)	Accessible from JMA network	Original	to be converted to NETCDF
SYNOP, sonde, Wind profilers, LIDEN	Accessible from JMA network	Original	
GPS TPW	Archived at MRI	Original text file	
JMA Mesoscale analysis	Archived at MRI	Original file (NuSDAS)	4DVAR 5kmL50 3 hourly
JMA hourly analysis	planned	Original file	3DVAR 5 kmL17

International TOMACS RDP

Same aims as national project

Period 3 years: July 2013-June 2016

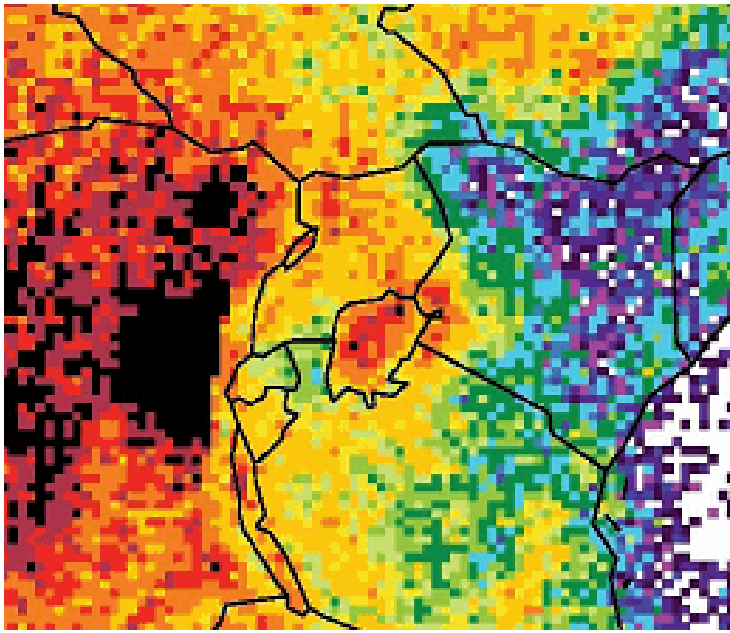
Present partners:

- Korea: Pugyon National Univ. ,Yonsei Univ.,Ewha Womans Univ.
- USA: NCAR, Univ. Georgia, Oklahoma Univ, Colorado State Univ., Univ. Massachusetts
- Brazil: Sao Paulo Univ.
- Australia: BoM
- Canada: EC
- Germany：Univ. Hohenheim
- France: UANPE
- Hong Kong: HKO
- China: Nanjing University

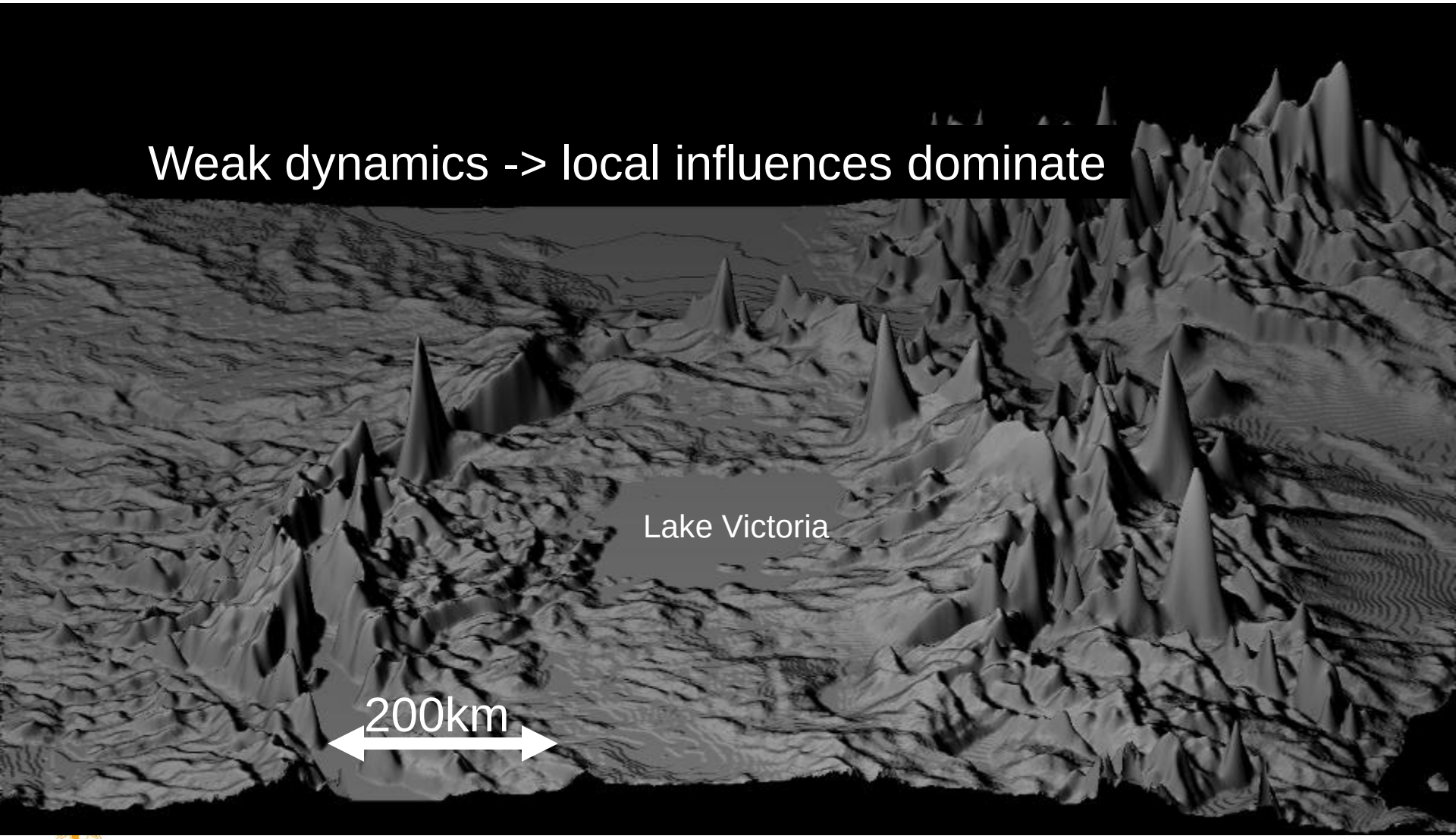
More interest?

Lake Victoria project: The underlying problem

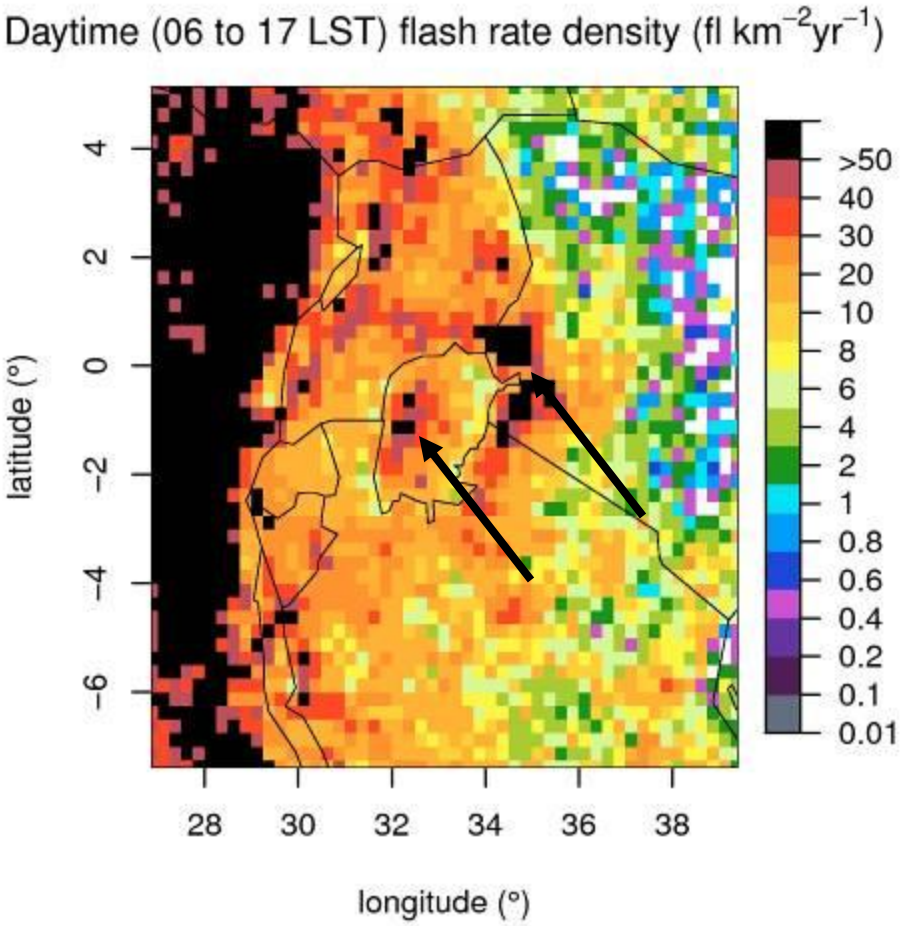
- Frequent severe thunderstorms over the lake, mostly at night
  - 200,000 fishermen active
  - 5000 deaths / year? Many presumed weather-related
  - Local weather/lake conditions poorly known from observations
  - National weather services (NMS) in surrounding countries: little experience with warning services for severe weather
- NMS's requested WMO assistance
- Gaps:
  - Observations/Technology
  - Basic understanding
  - Local knowledge/Capacity
  - Concept of Operations for Warnings
  - Warning services to the lake community

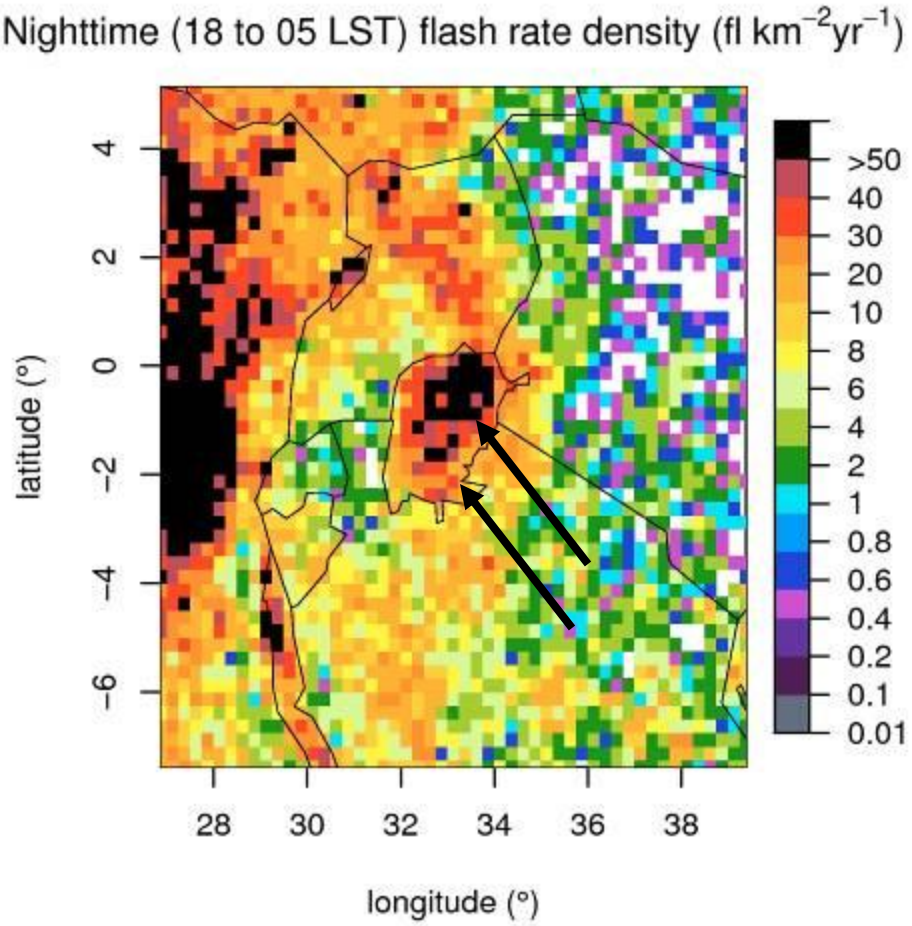


The terrain is complex and near the equator…



Night vs Day


Daytime (06 to 17 LST) flash rate density (fl km^{-2}yr^{-1})
latitude (°)
longitude (°)
>50
40
30
20
10
8
6
4
2
1
0.8
0.6
0.4
0.2
0.1
0.01


Nighttime (18 to 05 LST) flash rate density (fl km^{-2}yr^{-1})
latitude (°)
longitude (°)
>50
40
30
20
10
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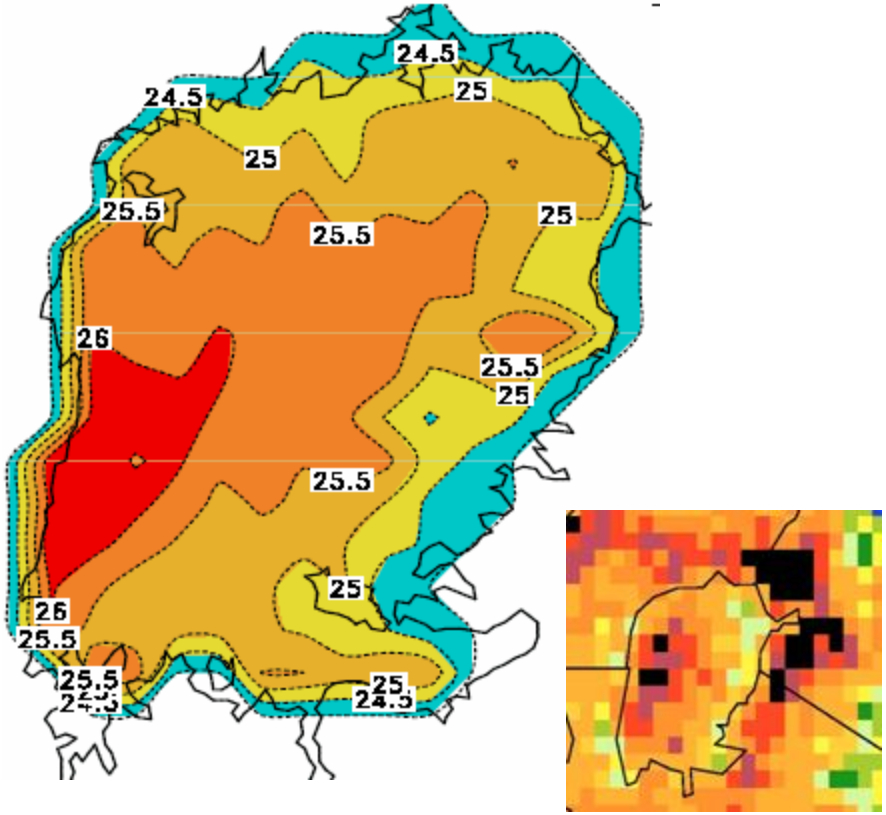
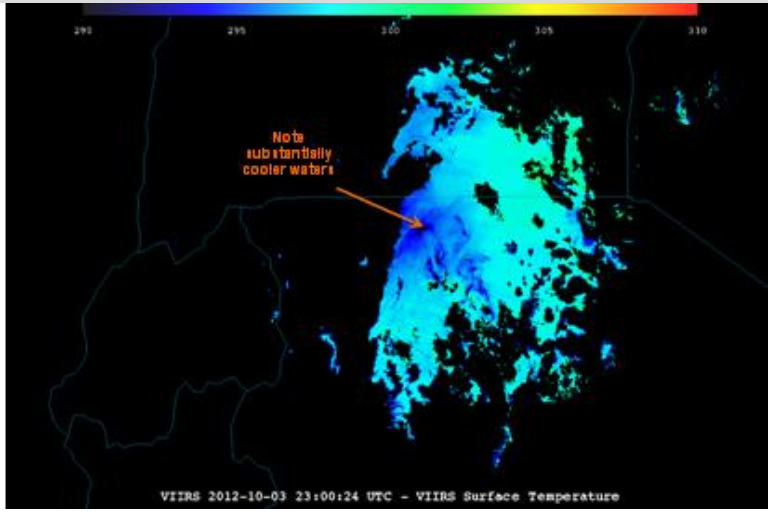
0.6
0.4
0.2
0.1
0.01

The Lake Surface Temperature may play a role in initiation of thunderstorms



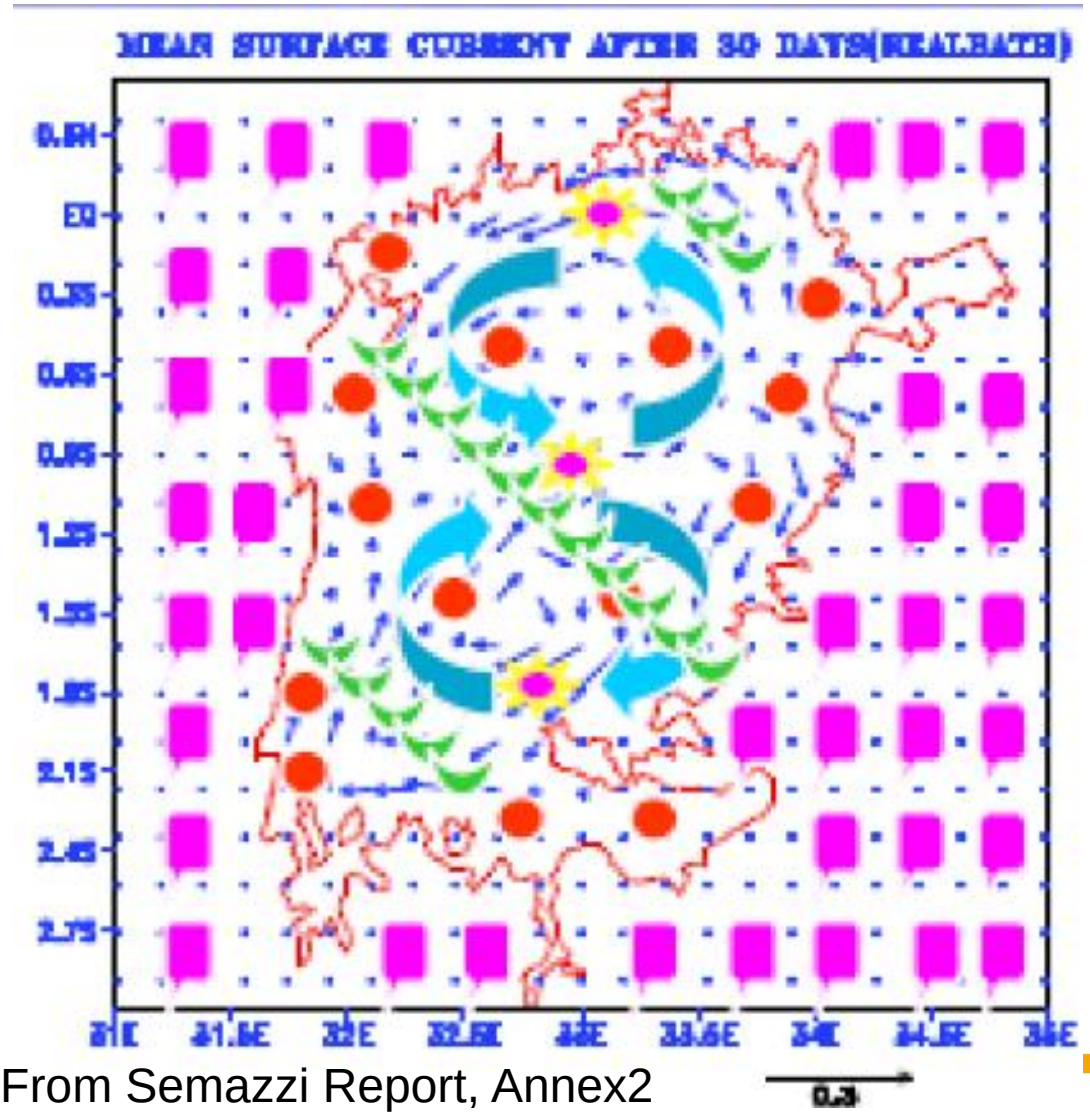
Climate Model, Semazzi

Due to the weak dynamics in the tropics, subtle surface features will have a significant impact on convective initiation. Intra-lake breezes may form.



W. Straka VIIRS

Lake Circulation



From Semazzi Report, Annex2

Climate modeling of the lake currents show a complex pattern of the “mean circulation”.

Thunderstorm downdrafts interact with this circulation to create hazardous waves and lake conditions.

The approach proposed by WMO

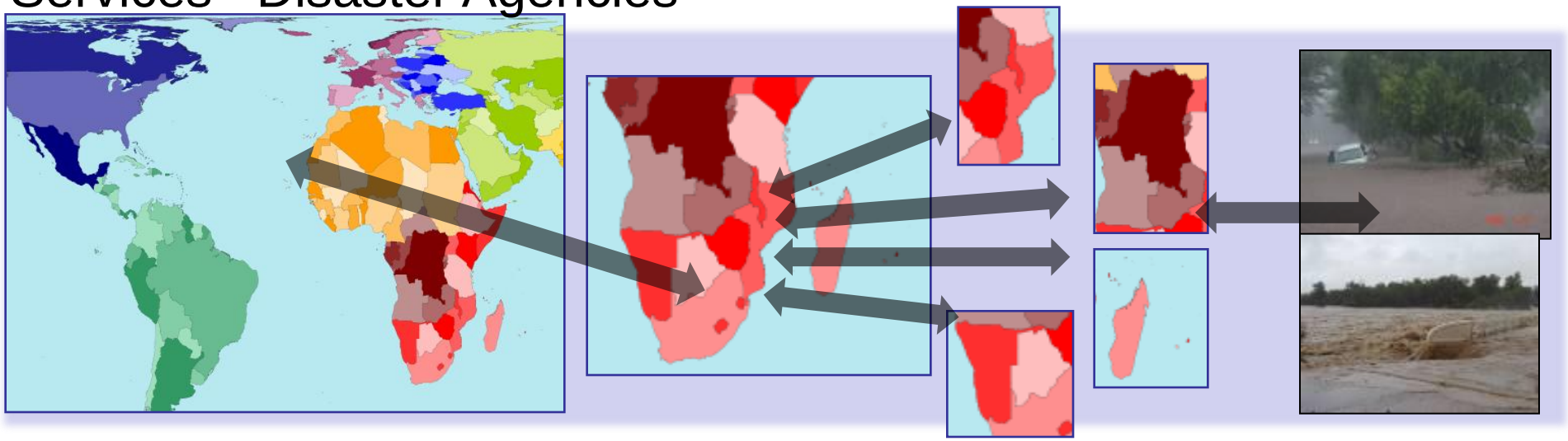
A two-pronged strategy:

1. The SWFDP approach: Do the best you can with what you already have: Set up basic operational warning service in the NMS's involved, using available or easily accessible means and technology
   - In-situ observations, satellite observations, lightning networks
   - UK MetOffice 4km NWP model for Africa
   - Kenya weather service acting as regional center supplying alerts to surrounding NMS's
   - NMS's providing warnings via mobile telephone network

2. Initiate a field campaign + research project to enhance our understanding of the dynamics and thunderstorm evolution over the lake

SWFDP approach: Severe weather warnings and capacity building from Global to Regional to NHMS

Global Centers Regional Centers National Services Disaster Agencies



- Use global observations as much as possible
- Regional model
- Operational warnings via RSMC to NMS's
- Will Need to Evolve

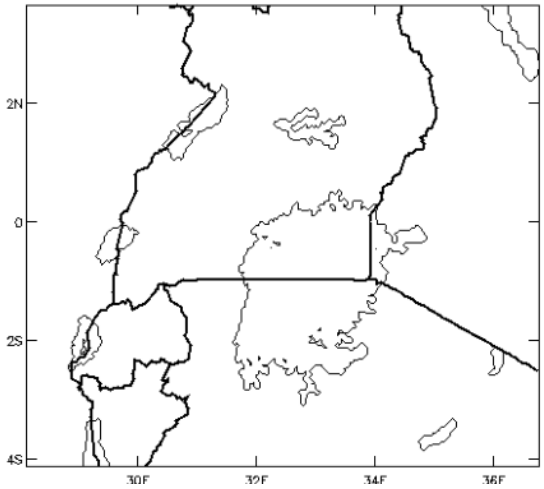
Lake Victoria

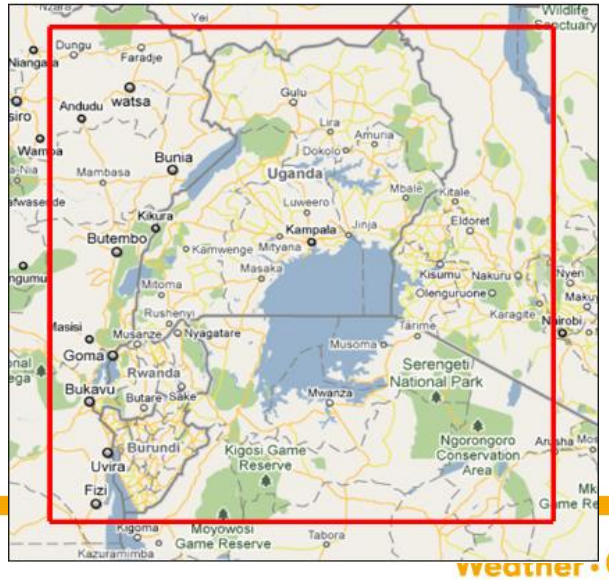
High resolution 4km version of the Met Office UM

Lake Victoria model - 4km L70

Model specification

Model ID:	QK
Grid-points:	240 x 216
Horizontal Resolution:	0.036° x0.036° (4 km x 4 km)
***Unrotated* pole:**	90° N 180° W
1st point (lat, lon):	(-4.1080°,28.1400°)
Vertical Levels:	70 (**details**) 50 BL levels
Model Lid:	40 km
Model Timestep:	100 seconds
Radiation Timestep:	1 hour
Forecast Range:	T+48(51 wrt driver)
Science:	**UK4** setup
Soil moisture and lake temperatures	SMC interpolated from global; SSTs from ARCLake climatology ancil
Main Forecast Times:	00Z, 12Z
Data Assimilation:	None
Driving Model:	Global qg06.T+3 (qk12) and qg18.T+3 (qk00)
LBCs:	3-hourly from T+3 5 point halo 8 point rim (weights, 1,1,1,1,1,0.75,0.5,0.25)
STASH:	As Africa LAM but without dust diagnostics
Dates:	16th August 2011: **PS27 Tech page** **OPCHANGE Operational History**
Orography:	**QK orog**





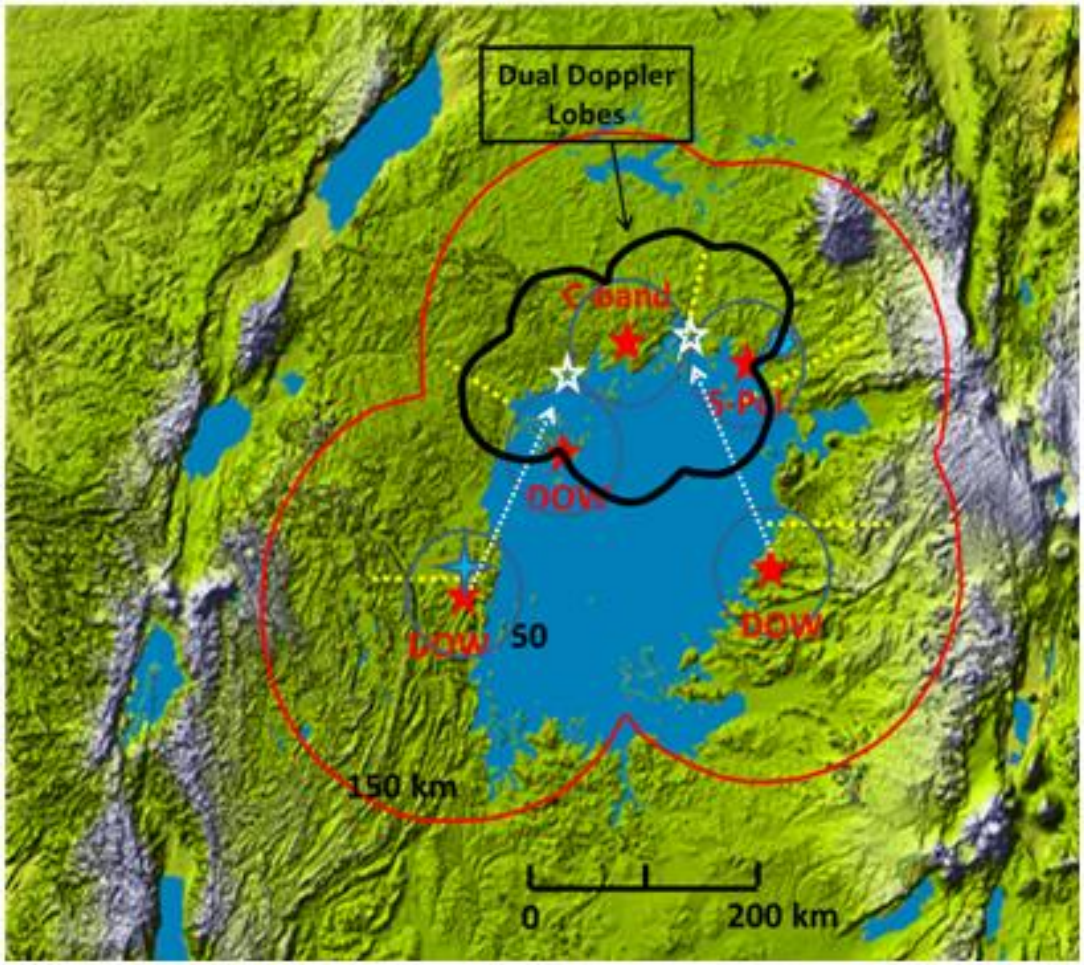
Courtesy of Caroline Bain

What we don't know…

- Which thunderstorms produce hazardous winds
- Relationship of Overshooting Tops and Surface Hazardous winds
- Mechanism of producing strong winds from thunderstorms
- Relationship between wind and waves
- Once we understand, how to identify and predict and "not cry wolf"
- What skill is achievable without radar? Accuracy and precision?

=> Field experiment and "understanding" study

Field Project Proposal to NSF



Red Stars – surveillance radar

White Stars – hi res radar, dual-doppler

Blue Star 6 – IOS

Blue Star 4 – Upper Air Station

Yellow – Met Stns

Facilities have already been requested from NSF instrument pool due to long lead time required. Very positive feedback from NSF for 2016 but need non-NSF funding for operating, capacity building, project office, analysis