

# The World Weather Research Programme

*WWRP promotes international and interdisciplinary research for more accurate and reliable forecasts from minutes to seasons, expanding the frontiers of weather science to enhance society's resilience to high-impact weather and the value of weather information for users.*

*WWRP aims at Seamless Prediction by increasing convergence between weather, climate and environmental approaches. WWRP strengthens academic – operational partnerships and interdisciplinary collaborations, and enhances the role of Early Career Scientists.*

WEATHER CLIMATE WATER  
TEMPS CLIMAT EAU



**WMO OMM**

World Meteorological Organization  
Organisation météorologique mondiale

Sarah Jones,  
Chair WWRP Scientific  
Steering Committee

Paolo Ruti, Chief World  
Weather Research Division

# A seamless approach

WMO's mechanism to foster and progress cooperative research for improved weather and environmental prediction services from minutes to months

## Seamless Definition

In the context of WMO, seamless prediction considers not only all compartments of the Earth system, but also all disciplines of the weather–climate–water–environment value chain (monitoring and observation, models, forecasting, dissemination and communication, perception and interpretation, decision-making, end-user products) to deliver tailor-made weather, climate, water and environmental information covering minutes to centuries and local to global scales.





WORLD  
METEOROLOGICAL  
ORGANIZATION

# WMO Science Summit

20-22 October 2017 | WMO Headquarters, Geneva, Switzerland



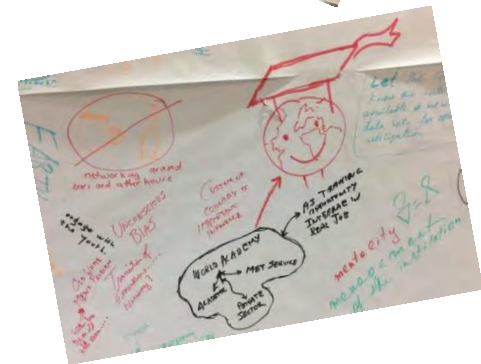
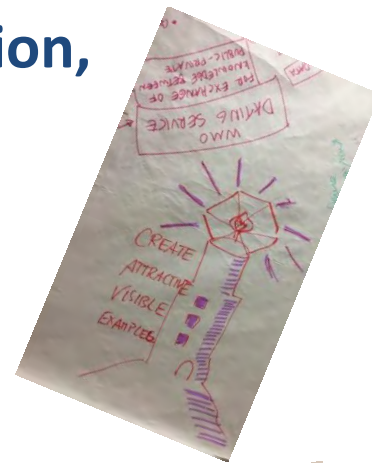
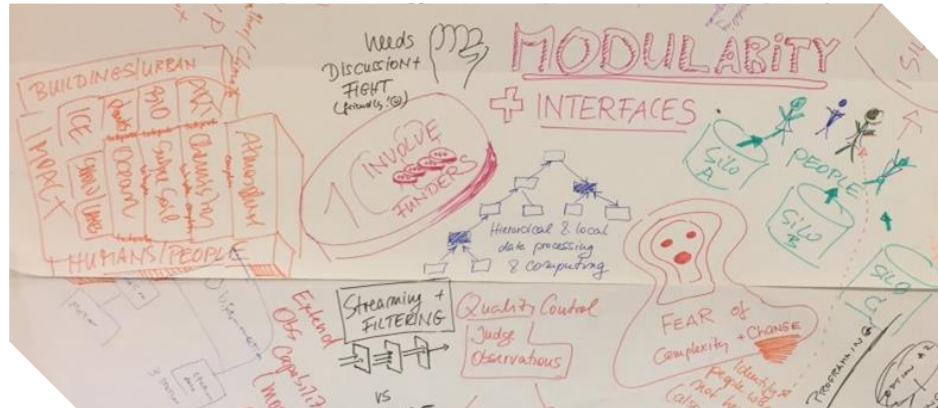
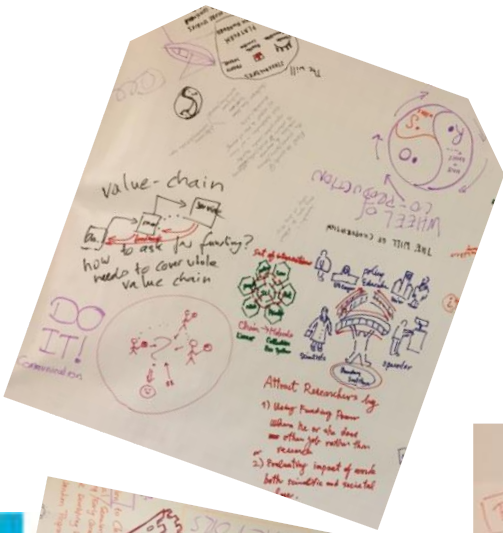


WORLD  
METEOROLOGICAL  
ORGANIZATION

# WMO Science Summit

20-22 October 2017 | WMO Headquarters, Geneva, Switzerland

Science for Services, Seamless prediction,  
Future infrastructures,  
Nurturing scientific talents,  
Innovation & Resources



# Five priorities for weather and climate research

Science Summit key outcomes (Nature, vol 552, Dec 2017)

More than 100 experts and more than 50 countries met in Geneva last October, discussing and agreeing on five priorities:

1. Deliver Science for Services
2. Build Seamless Models
3. Improve Infrastructure
4. Nurture a Diverse Workforce
5. Build New Partnerships

Science Summit gathered together a broad spectrum of expertise, from atmospheric science to hydrology, from social science to science management, from NGOs to private companies, setting a platform for future partnerships.

The Science Summit and CAS session made concrete proposals to the next Congress on Science for Services, Seamless prediction, Future infrastructures, Nurturing scientific talents, Innovation & Resources.

# The Global Data Processing and Forecasting System (GDPFS)



# Vision of future seamless DPFS

The proposed vision for the Future GDPFS is:

The GDPFS will be an effective and adaptable monitoring and prediction system enabling Members and partners to make better-informed decisions;

The GDPFS will facilitate the provision of impact-based forecasts and risk-based warnings through partnership and collaboration;

The GDPFS will do so through the sharing of weather, water, climate and related environmental data, products and services in a cost effective, timely and agile way, with the effect of benefitting all WMO Members, while also reducing the gaps between developed and developing Members.

# Implementation Plan Components

- Overarching challenges -



- Concrete Activities -



# Concrete Activities



**Implementation is a 2 stage process:**

- 1) Conduct Benchmarks, Pilot projects, TestBeds**
- 2) Transfer into operational system**

**Current focus is to identify, prioritise and plan benchmarks and pilot projects to Kick-Start the implementation process**

**Some key criteria for setting priorities:**

- Information needed in decision making**
- Ensuring relevance of WMO and its members**
- Geographical Dimension**
- Building on existing and emerging data platforms**

# WWRP Implementation Plan Action Areas



- are fundamental building blocks for WWRP Implementation
- articulate WWRP aims for each societal challenge
- provide mechanism for different WWRP activities to work together towards common goal
- evolve in response to progress made, needs of stakeholders, .....

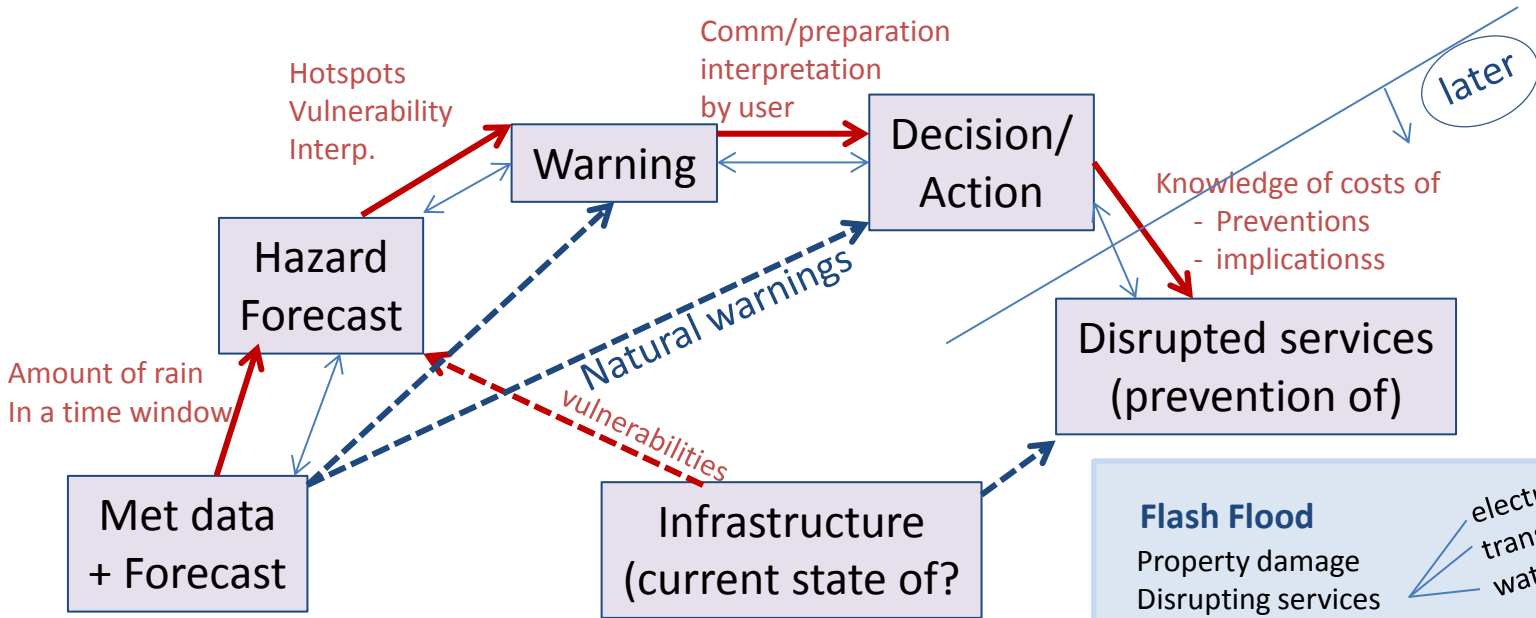
# High-Impact Weather Project

- Increasing resilience to Urban Flood, Wildfire, Urban Heat and Air Pollution in Megacities, Localised extreme wind, Disruptive winter weather through improving forecasts for timescales of minutes to two weeks and enhancing their communication and utility in social, economic and environmental applications
- Links to WCRP through quantifying vulnerability and risk assessment, and for response to High Impact Weather in a changing climate.

Co-Chair: Brian Golding, MetOffice, David Johnston Massey Un International Coordination Office, CMA, China



# Value Chain Workshop Breakout 2 – Floods



## Flash Flood

Property damage  
Disrupting services  
Poor people with little lose everything

electricity  
transport  
water + sewage

## Decision / Action

Move out of of harms way /higher ground  
Suspension of services  
Some action is better than no action (graduated response)

## Warning

Official, informal (soc. Media)  
'natural' warnings + 'natural' cues  
Different levels of warnings (i.t.o. details)  
Sufficient to make decisions

## Forecast

Surface water important -> no model output  
Local knowledge  
Bypassing state sector decision making

## Ideas for RDP

1. Accuracy of precip fcsts (by lead time) – metric at urban scales (sub-hourly)
2. Link between met + hydr response
  - Can weather fcst improve short-term decision making outcomes (<3h)? -> If yes, in what way?
  - What are the optimal actions?
  - Answering the «joint» question? (physical + societal sciences)
  - Asking questions across the entire value chain
  - Look from multiple perspectives and more specifically
  - Value chain purpose to integrate

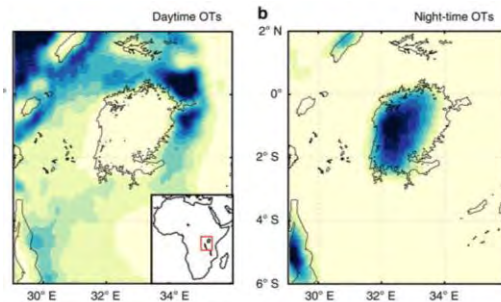
# DFID/WISER Project Highway (HIGH impact Weather lAke sYstem)

**Outcome:** Increased access to and use of co-designed and sustainable early warning systems to inform regional, national, sub-national and community level planning and decision-making in the East African region

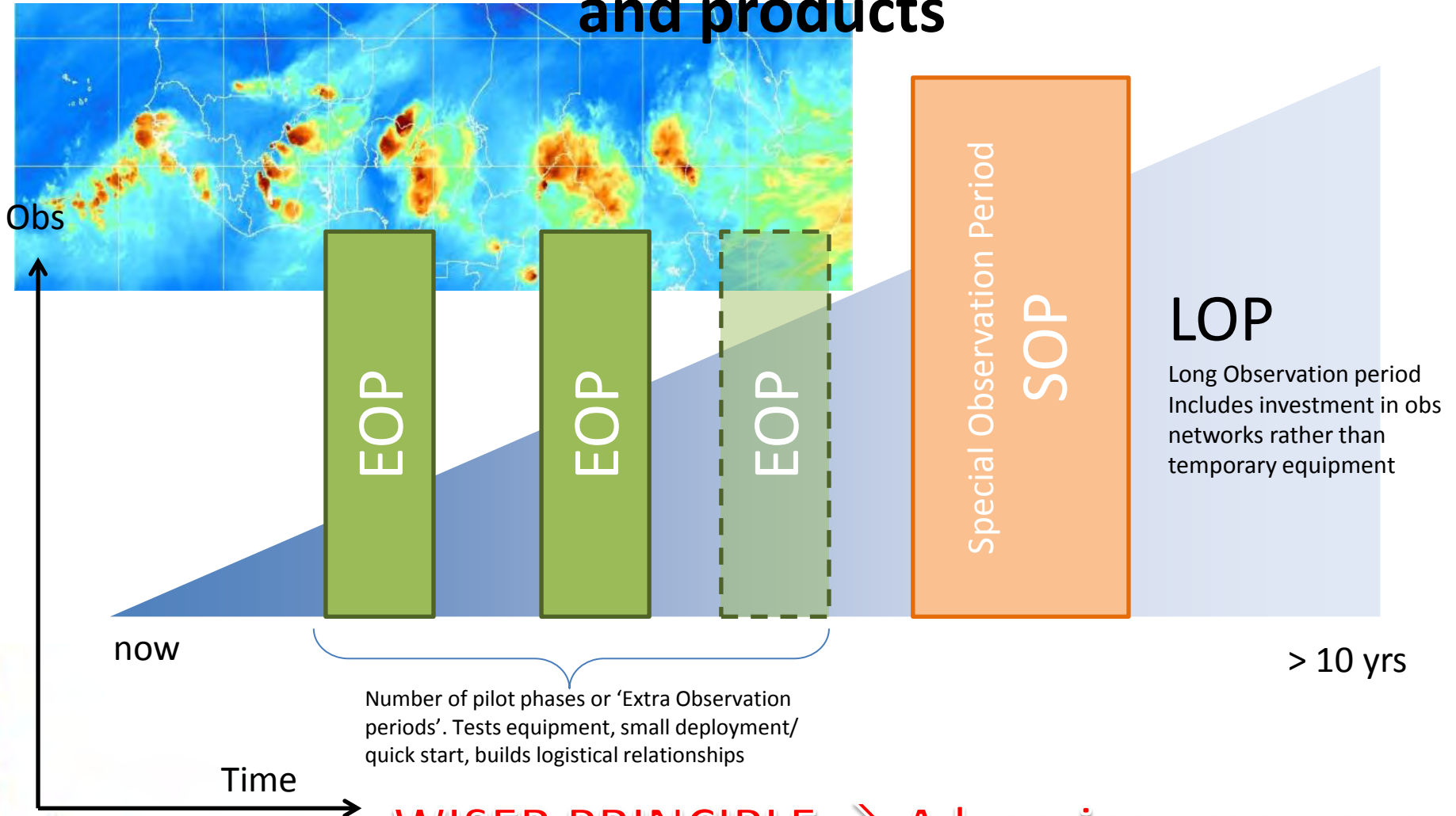
**Output 2:** Improved access to all operational data sources to support the generation and maintenance of Early Warning Services for the East African Region

**Activity 2.3 – Mini field campaign to exploit and improve all existing data sources and products**

**Partners:** NCAR, UK MetOffice, Met services of Kenya Tanzania Uganda Rwanda Burundi East Africa commission



# Mini field campaign planned for Spring 2019 to exploit and improve all existing data sources and products



**WISER PRINCIPLE → A learning programme**

# ClimXtreme

German (BMBF) funded 3 year project, Starting early 2019  
~ 13 PostDocs, 36 Ph.D. positions

*Module A provides understanding of generating processes, identifies similar situations (with no extreme event conditions identified) allowing to reassess relevant weather conditions.*

### Module A: Processes

- Recurring generating processes
- Extreme event related circulation patterns
- Process based analysis of present and

*Module A provides assessment of physical and scale representation of extremes in model data allowing for interpretation of frequency/intensity changes (?)*

**Need to link to  
WWRP HIWeather  
and  
WCRP GC Extremes**

### Module C: Impacts

- Identification of relevant weather conditions for related extreme events
- Impact estimation
- Present and future changes in Impacts

### Module B: Statistics

- Improved probabilistic assessment of extreme weather events
- Statistical methods tool box for extremes incl. compound events
- Changes in frequency/intensity of extremes

*Module B provides statistical methods for improved assessment of frequency of impact related events*

Module D: coordinated strategy for data management, software tools and modelling

# WWRP Structure

## WWRP Working Groups

### Tropical Meteorology

Identify and support research initiatives on tropical cyclones and monsoons

### Predictability, Dynamics and Ensemble Forecasting

Advance the science of dynamical meteorology, predictability ensemble forecasting, promoting the development of ensemble applications

### Weather Modification

Promote scientific practices in weather modification

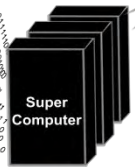
### Data Assimilation and Observing Systems

Obtain and make use of best possible information on the atmospheric state

### Socio-Economic Research Applications

Advance the social and economic application of weather related information and services

$$\frac{\partial}{\partial t} \left( \frac{\partial p}{\partial \eta} \right) + \nabla \cdot \left( \mathbf{v}_{11} \frac{\partial p}{\partial \eta} \right) + \frac{\partial}{\partial \eta} \left( \eta \frac{\partial p}{\partial \eta} \right) = 0$$



WCRP-JSC / CAS Working Group on Numerical Experimentation

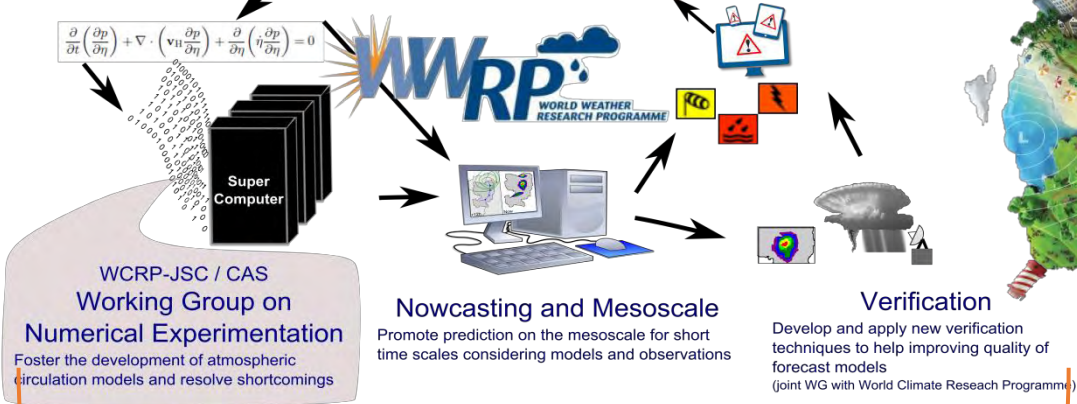
Foster the development of atmospheric circulation models and resolve shortcomings

### Nowcasting and Mesoscale

Promote prediction on the mesoscale for short time scales considering models and observations

### Verification

Develop and apply new verification techniques to help improving quality of forecast models  
(joint WG with World Climate Research Programme)



## WWRP Core Projects

### Polar Prediction

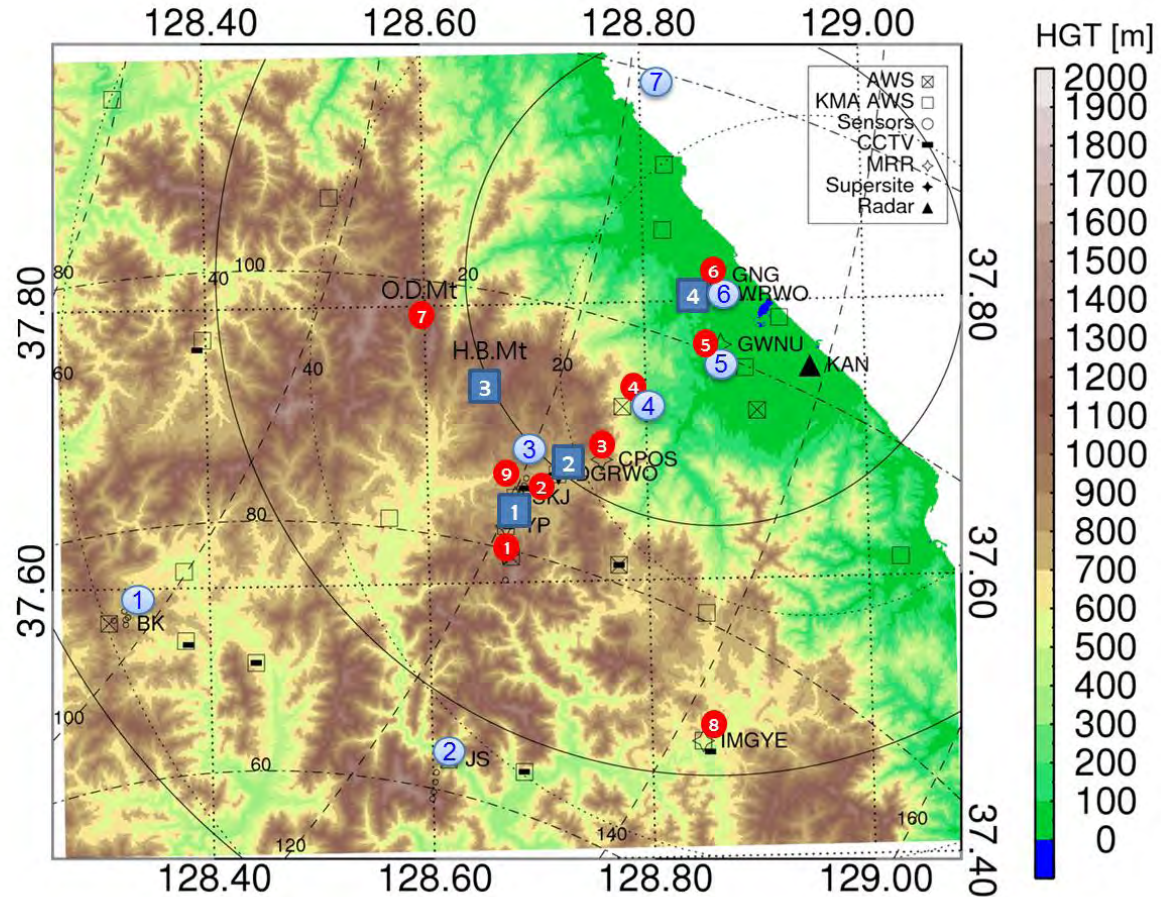




# RDP: Intensive Observation for ICE-POP2018

■ Radar Site(R)    ● Sonde Site(S)    ● Ground Supersite(G)

- 1 APR
- 2 DGW
- 3 HBM
- 4 GWW
- 1 BKR
- 2 JSC
- 3 DGW
- 4 EHC
- 5 GWU
- 6 GWW
- 7 OBS Ship
- 1 YPO
- 2 MHS
- 3 CPO
- 4 EHC
- 5 GWU
- 6 GWW
- 7 ODO
- 8 IGD
- 9 SJO

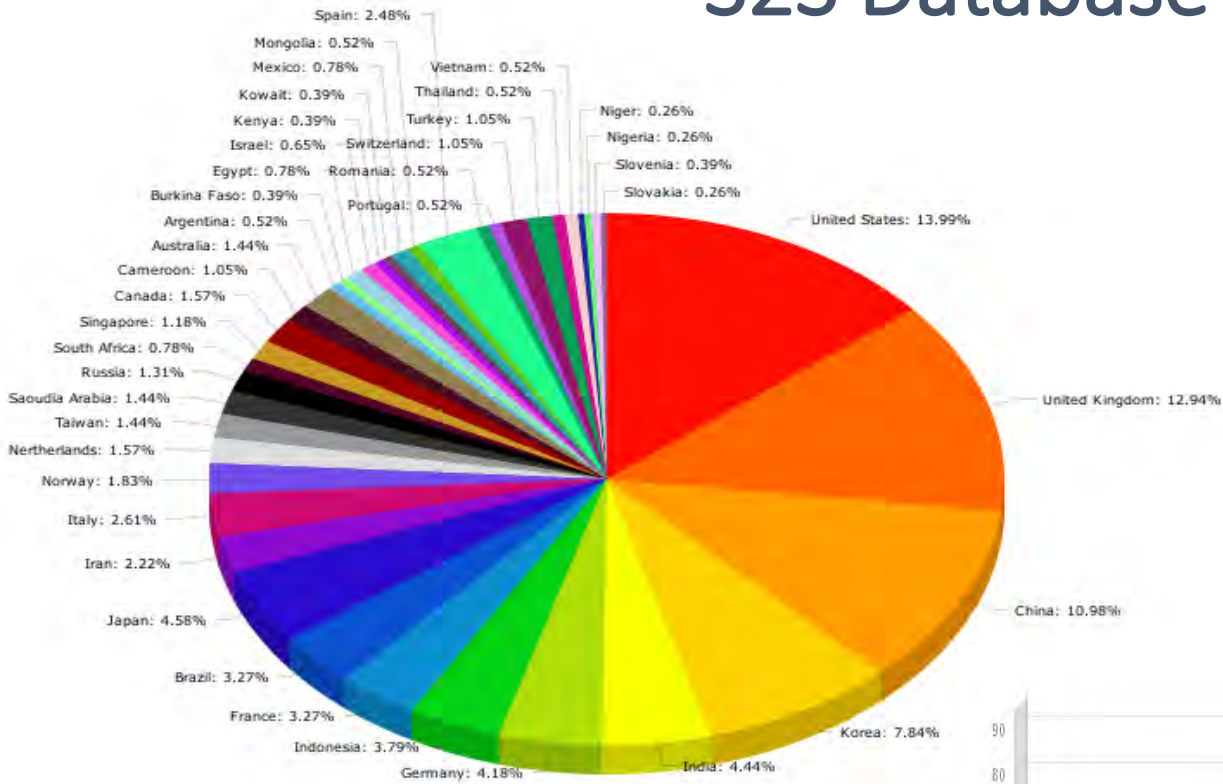


GNG: Gangneung radar(S-band, Operational radar/KMA)

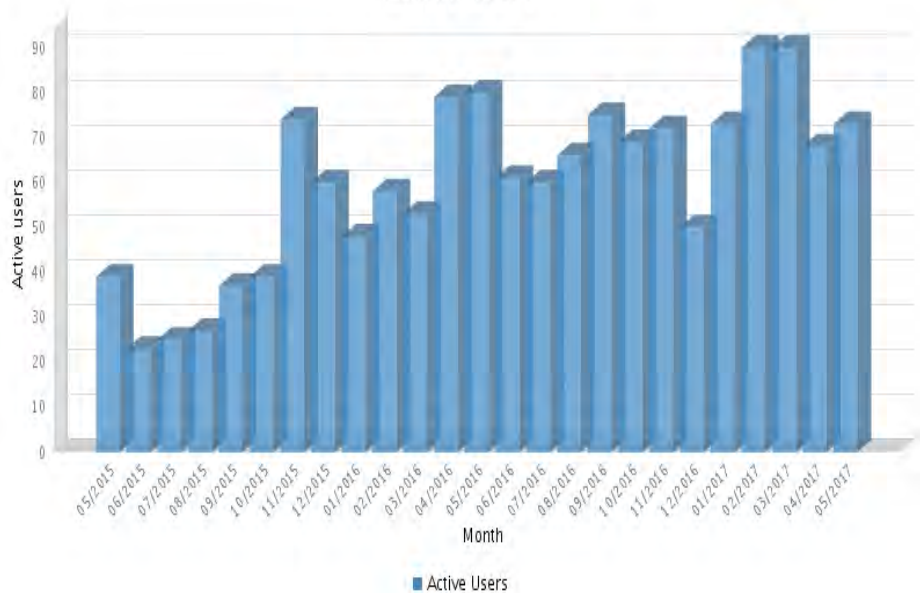
KAN: Airforces Radar(C-band)



# S2S Database




Active users





# Seventh International WMO Symposium on Data Assimilation in Brazil




# Monitoring S2S Products



European Centre for Medium-Range Weather Forecasts

Search Content   
Search People 

Home > ECMWF intranet plot database > User plots > s2s products > Laura Ferranti 

**Other charts**

s2s products


**Chart catalogue**

Page overview

Find charts

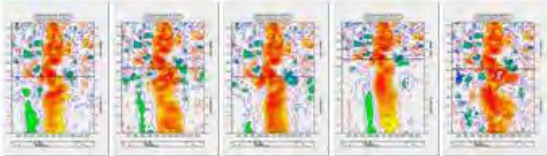
## s2s products

### anomaly



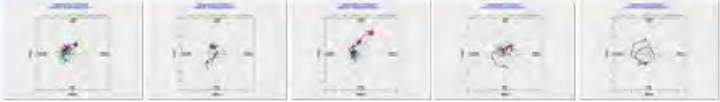
**"ensemble mean anomalies"**  
Product updated 5 hours ago

### hovmoller



**"hovmoller over tropical band"**  
Product updated 5 hours ago

### mjo

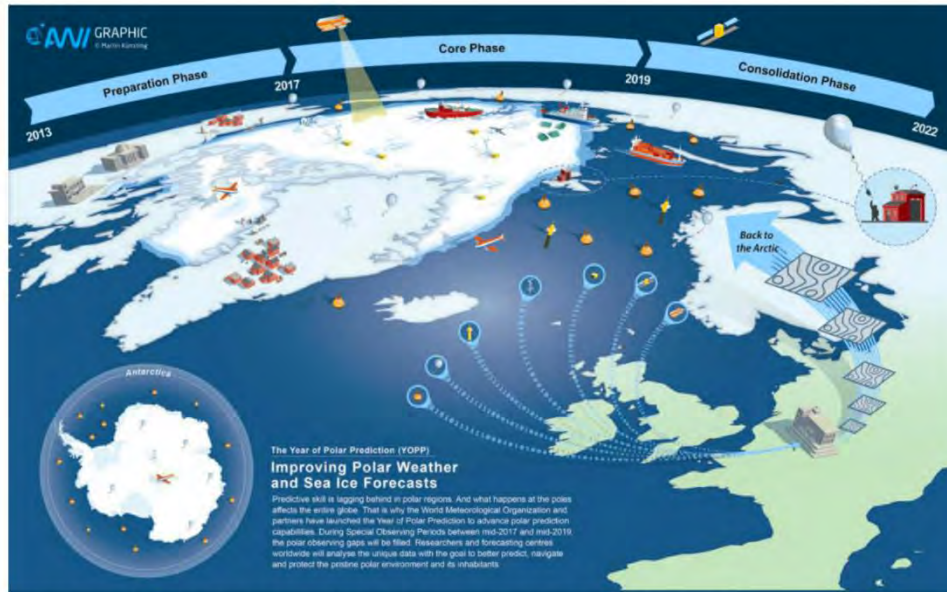


**"mjo index"**  
Product updated 5 hours ago

[Show statistics for the products above](#)

31-10-2015 ©ECMWF 2005

# Year of Polar Prediction - YOPP



YOPP Infographic available at [polarprediction.net](http://polarprediction.net)

Coordinated by the  
World Meteorological  
Organization (WMO)

Period:  
mid 2017– mid 2019  
(Launch: 15th May  
2017)

- **Goal: Improving predictions of weather and environmental conditions in polar regions and beyond**
- International collaboration between academia, operational forecasting centres, and stakeholders
- Improving the polar observing system, as well as weather and climate prediction models in polar regions

# Tropical Meteorology Research WG

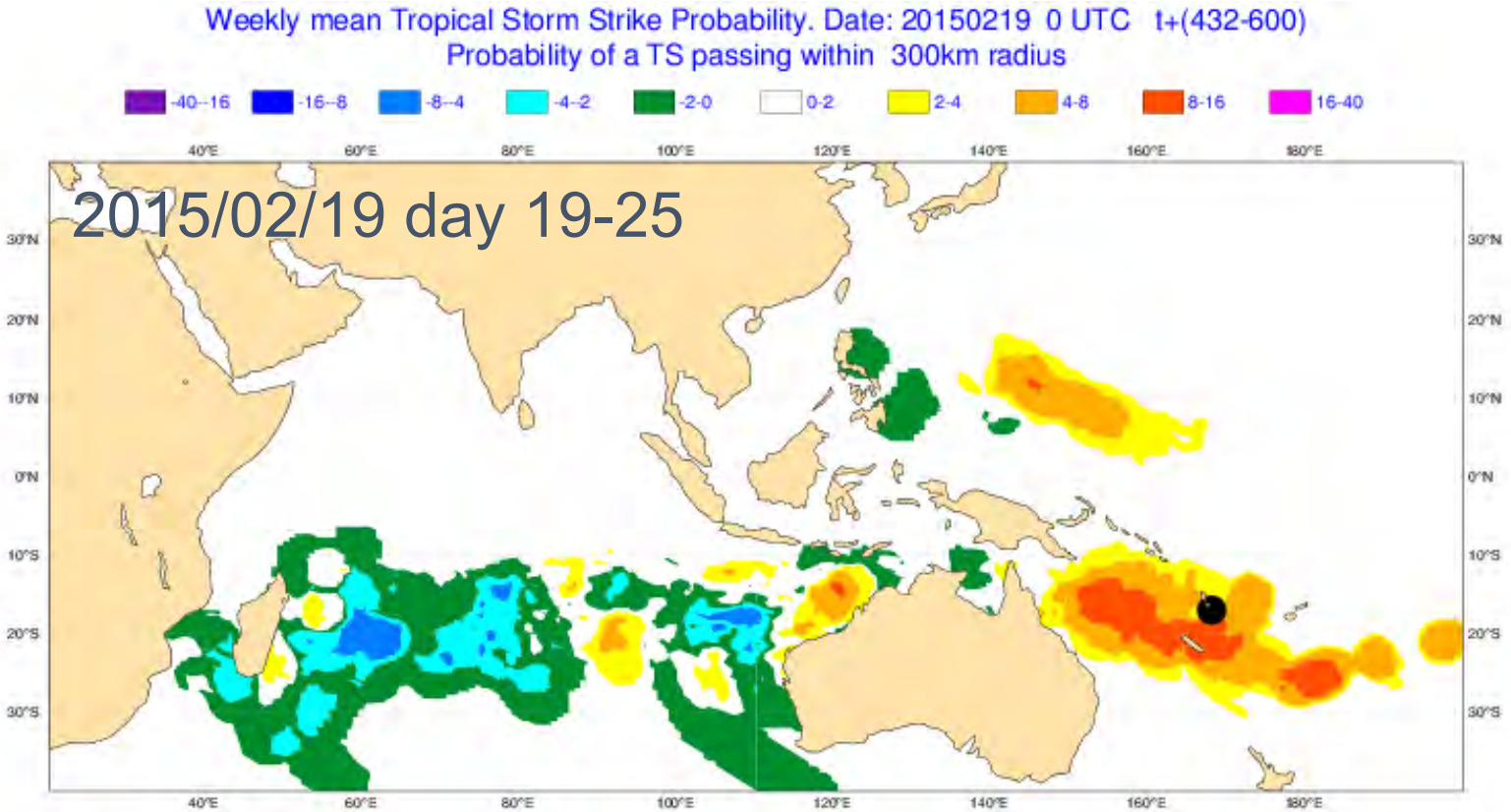


Joint workshop on UPDRAFT, TLFDP  
& EXOTICCA  
(Oct. 2016, Shanghai, China)



Workshop on Frontiers of Tropical Meteorology  
(Sep. 2017, Hong Kong, China)

# S2S Multi-model prediction of TC Pam Strike Probability Anomalies 9-15 March 2015



(NCEP/ECMWF/BoM/JMA/CMA)

# YOPP Launch and YOPP Summit



120 participants

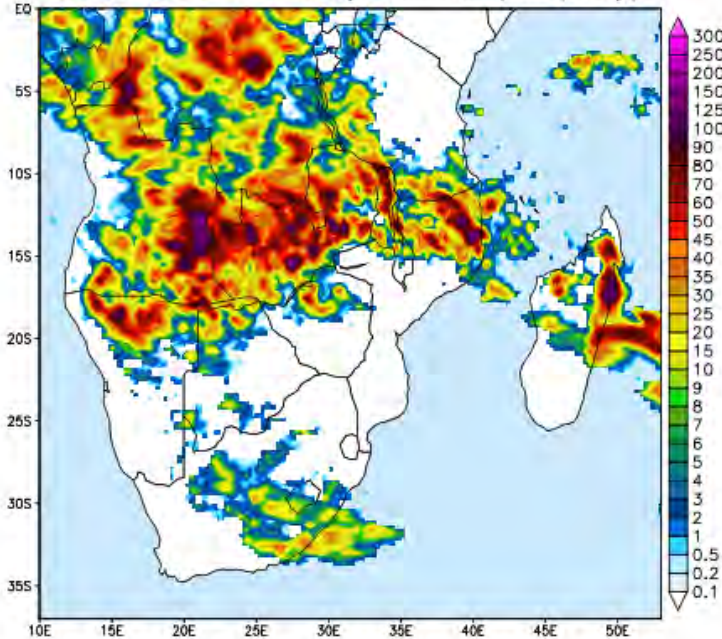




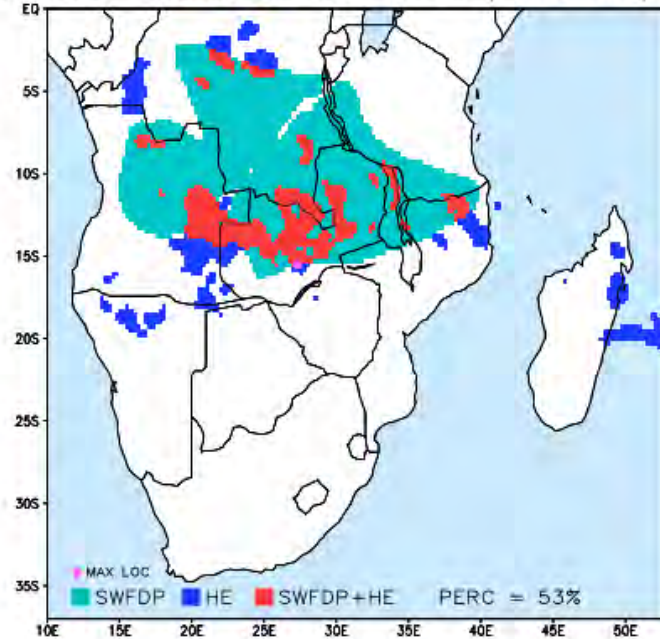


# Verification of regional forecast

20121219 H-E daily rainfall (mm/day)



Guidance and Observation fields (> 50 mm/day)



Verification statistics for 20121219 : Grid Size = 0.25° : Units = mm/day : n = 25777

	Guidance	H-E
Number of gridpoints $\geq 50$ mm	3294	1243
Average Rain over domain	~	19.7012
$\geq 50$ mm Rain Area (km <sup>2</sup> +10 <sup>4</sup> )	2.05875	0.776875
Maximum Rainfall Observed (mm)	~	151.124

	Categorical Forecasts
Frequency Bias	2.65004
Probability of Detection	0.526146
False Alarm Ratio	0.801457
Hansen & Kuipers Score	0.418541
Equitable threat score	0.132959
Spatial Correlation	0.264835

GUIDANCE	OBSERVATION	
	$\geq 50$	$< 50$
$< 50$	654	2640
$\geq 50$	589	21894

Extreme Events Verification	
Extreme Dependency Score	0.650434
Symmetric Extreme Dependency Score	0.385181
Extremal Dependency Index	0.552717
Symmetric Extremal Dependency Index	0.59486

(\*\*Ferro and Stephenson, 2011\*\*)

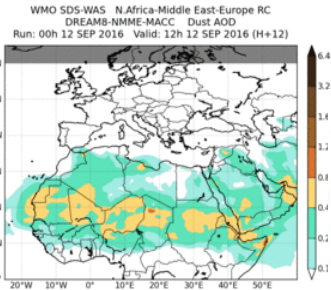
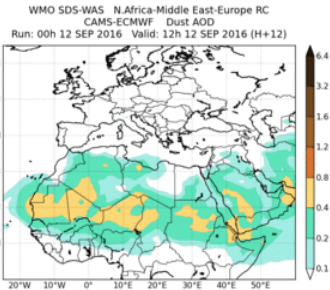
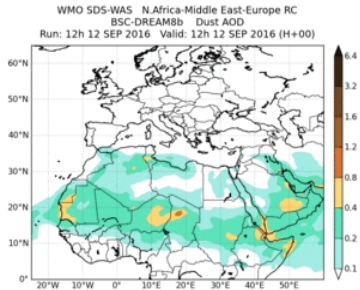
<http://rsmc.weathersa.co.za/RSMC/index.php>  
Format based on IPWG verification output



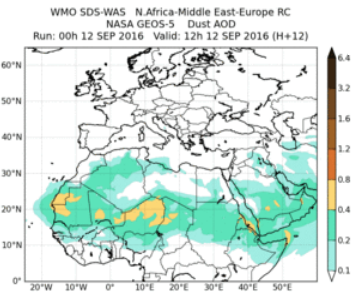
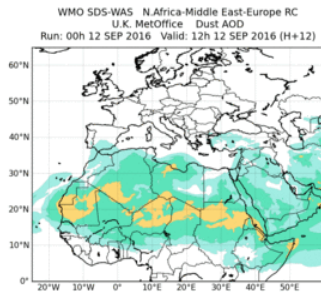
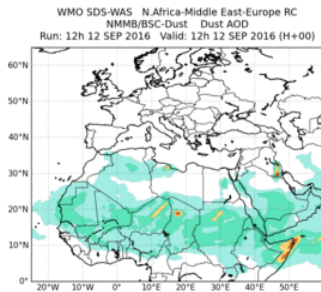
# HIWeather International Coordination Office at CMA



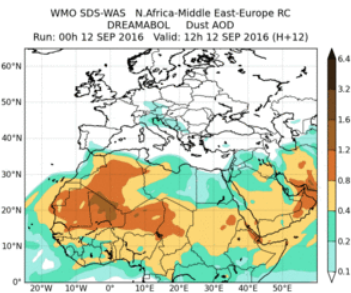
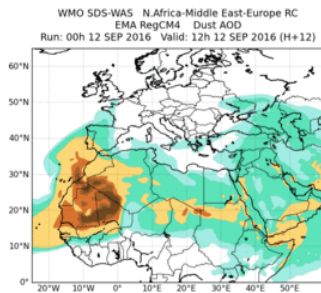
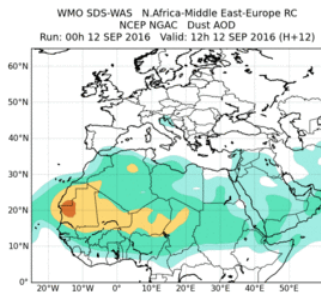
# SDS-WAS Dust forecasts



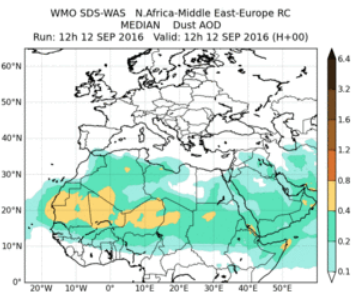
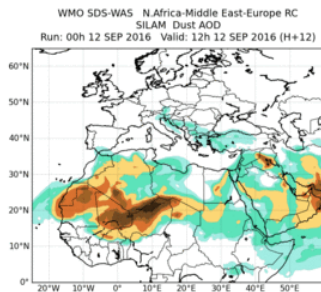
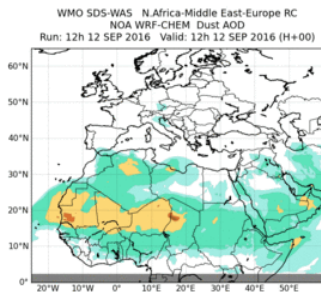
WRF-Chem-NOA  
(Dec 2015)



SILAM-FMI  
(May 2016)



FINNISH METEOROLOGICAL  
INSTITUTE



LOTO/EUROS-TNO  
(Oct 2016)

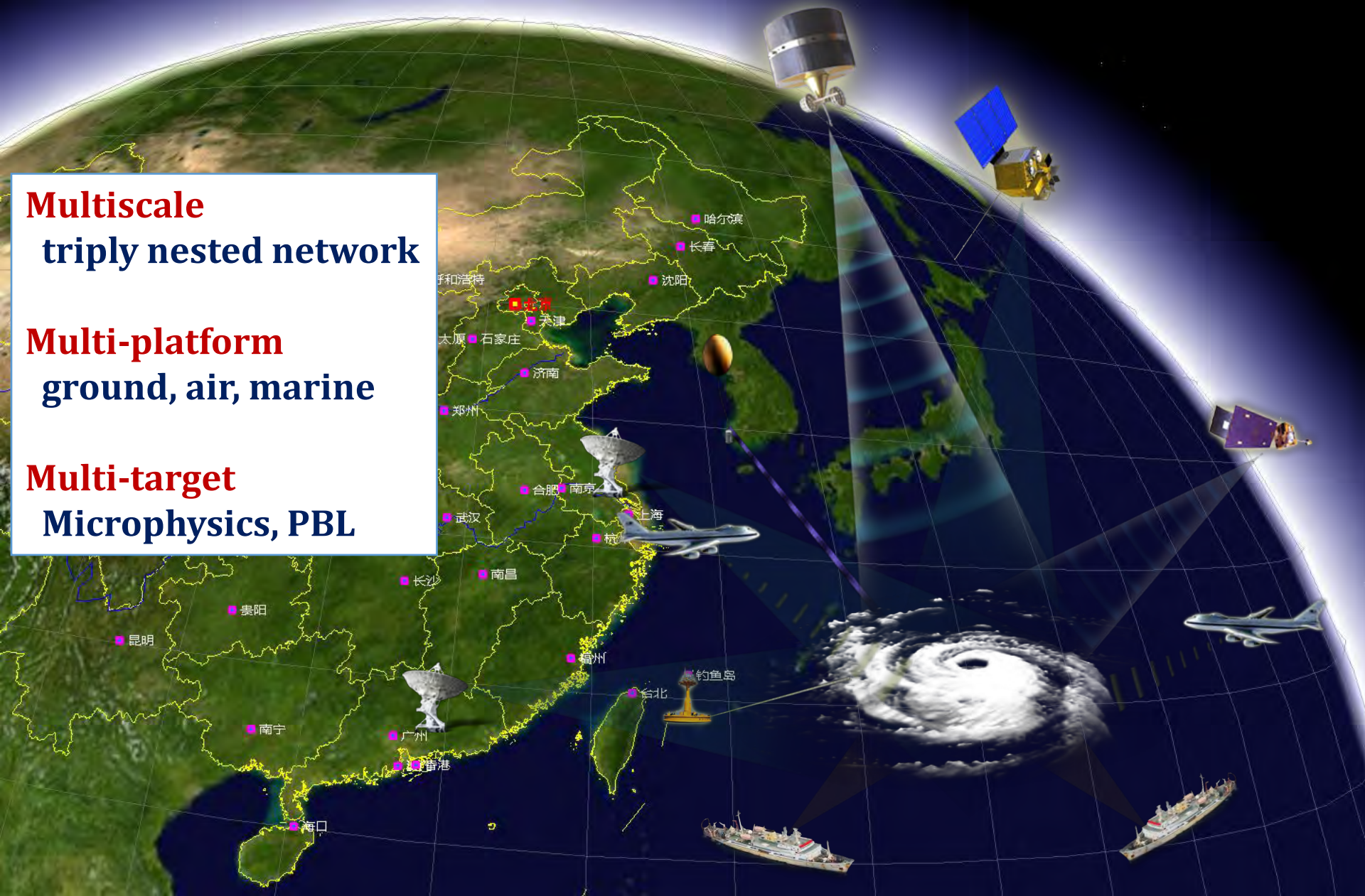
11 models + 1 “ensemble”

# TMR: UPDRAFT Field Observations

**Multiscale**  
triple nested network

**Multi-platform**  
ground, air, marine

**Multi-target**  
Microphysics, PBL



# PDEF: TIGGE and SWFDP

Successful transfer of research outcomes into operations

## Research Phase

TIGGE  
(started 2006)

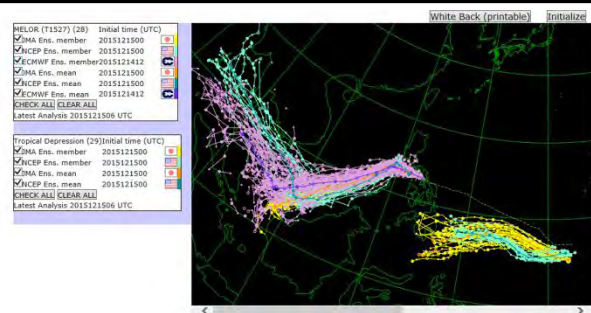
The screenshot shows the TIGGE website interface. At the top, there are navigation links for Home, Data Search, Login, Contact, Feedback, and Site Map. Below this, there are sections for 'About Us', 'Products', 'Services', 'Research', 'Publications', and 'News & Events'. The 'TIGGE Data Retrieval' section is highlighted, containing a note: 'Note: In order to retrieve data from this server, you first have to accept the conditions of use.' Below the note are fields for 'Select date' (Start date: 2006-10-01, End date: 2011-11-27) and 'Select origin' (Select a list of months: Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec). There are also checkboxes for 'Data range' and 'Data range'.

TIGGE CXML  
(started 2008)

The screenshot shows the TIGGE CXML website interface. It features a header with 'TIGGE', 'Cyclone Exchange', and 'THORPEX' logos. Below the header is an 'Introduction' section with a paragraph of text. A 'Data' section follows, containing a table with columns for 'Participating center', 'Center', 'URL', and 'Data'. The table lists various meteorological centers and their respective URLs for data retrieval.

Participating center	Center	URL	Data
European Meteorological Centre (EMC)	EMC	<a href="http://ftp.ecmwf.int/pub/ensemble/tigge/">http://ftp.ecmwf.int/pub/ensemble/tigge/</a>	EMC
China Meteorological Administration (CMA)	CMA	<a href="http://www.cma.gov.cn/eng/ensemble/">http://www.cma.gov.cn/eng/ensemble/</a>	CMA
European Centre for Medium-Range Weather Forecasts (ECMWF)	ECMWF	<a href="http://www.ecmwf.int/en/ensemble/">http://www.ecmwf.int/en/ensemble/</a>	ECMWF
Japan Meteorological Agency (JMA)	JMA	<a href="http://www.jma.go.jp/mof/jma/ensemble/">http://www.jma.go.jp/mof/jma/ensemble/</a>	JMA
Meteo France	Met	<a href="http://www.meteo.fr/ensemble/">http://www.meteo.fr/ensemble/</a>	Met
State of Typhoon Center (SOTC)	SOTC	<a href="http://www.sotc.org/ensemble/">http://www.sotc.org/ensemble/</a>	SOTC
United Kingdom Met Office (UKMO)	UKMO	<a href="http://www.met.rdg.ac.uk/ensemble/">http://www.met.rdg.ac.uk/ensemble/</a>	UKMO
United States Navy (USN)	USN	<a href="http://www.navy.mil/ensemble/">http://www.navy.mil/ensemble/</a>	USN
United States Air Force (USAF)	USAF	<a href="http://www.af.mil/ensemble/">http://www.af.mil/ensemble/</a>	USAF
United States Army (USA)	USA	<a href="http://www.army.mil/ensemble/">http://www.army.mil/ensemble/</a>	USA
United States Marine Corps (USMC)	USMC	<a href="http://www.marines.mil/ensemble/">http://www.marines.mil/ensemble/</a>	USMC
United States Coast Guard (USCG)	USCG	<a href="http://www.uscg.mil/ensemble/">http://www.uscg.mil/ensemble/</a>	USCG
United States Department of Energy (DOE)	DOE	<a href="http://www.doe.gov/ensemble/">http://www.doe.gov/ensemble/</a>	DOE
United States Department of Health and Human Services (HHS)	HHS	<a href="http://www.hhs.gov/ensemble/">http://www.hhs.gov/ensemble/</a>	HHS
United States Department of Justice (DOJ)	DOJ	<a href="http://www.doj.gov/ensemble/">http://www.doj.gov/ensemble/</a>	DOJ
United States Department of Labor (DOL)	DOL	<a href="http://www.dol.gov/ensemble/">http://www.dol.gov/ensemble/</a>	DOL
United States Department of State (DOS)	DOS	<a href="http://www.state.gov/ensemble/">http://www.state.gov/ensemble/</a>	DOS
United States Department of Transportation (DOT)	DOT	<a href="http://www.dot.gov/ensemble/">http://www.dot.gov/ensemble/</a>	DOT
United States Department of the Interior (DOI)	DOI	<a href="http://www.doi.gov/ensemble/">http://www.doi.gov/ensemble/</a>	DOI
United States Department of Education (DOE)	DOE	<a href="http://www.doe.gov/ensemble/">http://www.doe.gov/ensemble/</a>	DOE
United States Department of Agriculture (USDA)	USDA	<a href="http://www.usda.gov/ensemble/">http://www.usda.gov/ensemble/</a>	USDA
United States Department of Defense (DOD)	DOD	<a href="http://www.dod.gov/ensemble/">http://www.dod.gov/ensemble/</a>	DOD

## Operational Phase



RSMC Tokyo – Typhoon Center started providing multi-centre ensemble products of TCs to the Typhoon Committee Members

## WWRP RDP

North Western Pacific Tropical Cyclone (TC) Ensemble Forecast Project (NWP-TCEFP)

# International Workshop on Monsoons IWM-6

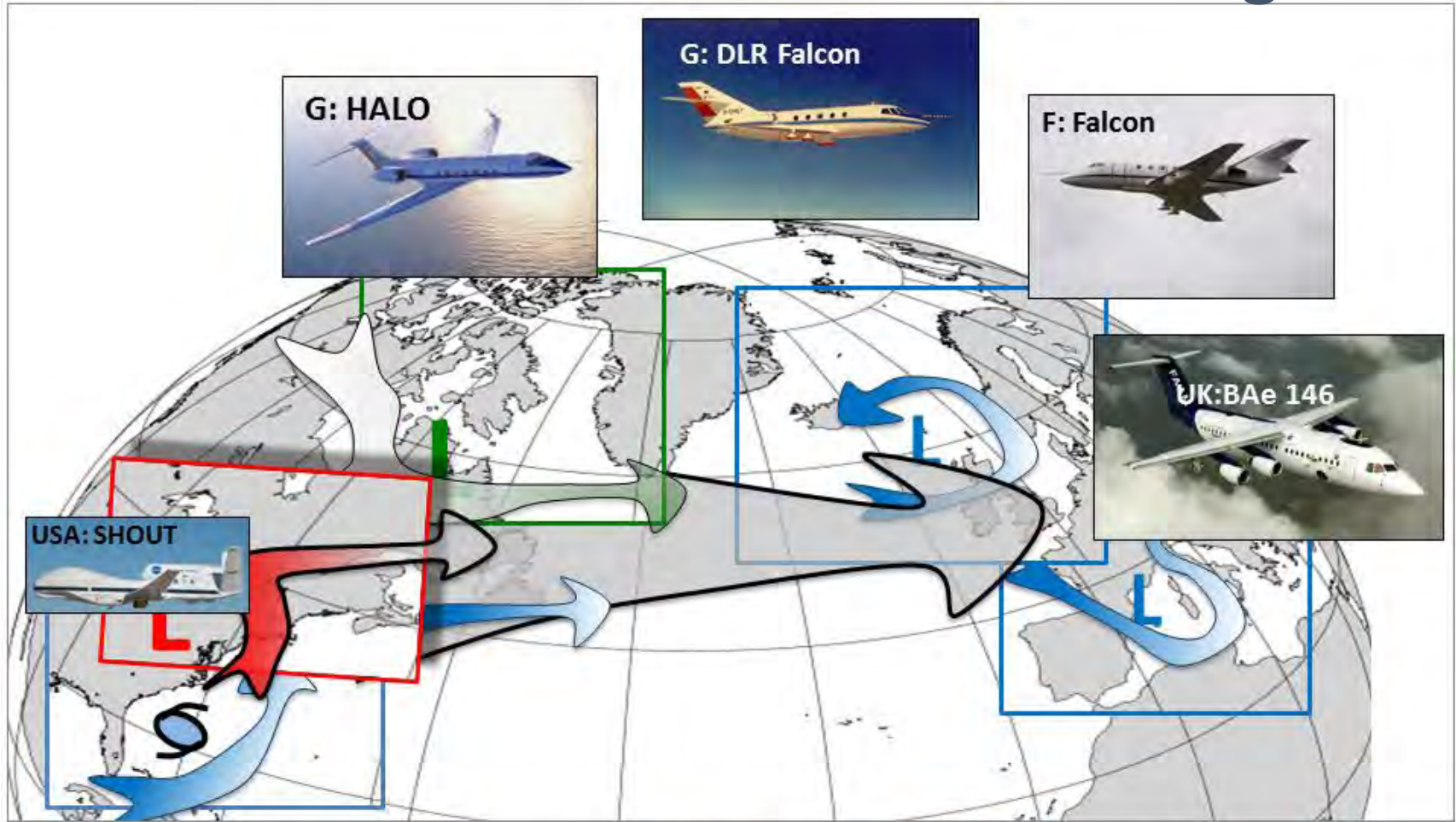


**Singapore, November 2017**

**Researchers and forecasters discuss recent advances and current issues covering all time scales relevant to the forecasts of high-impact weather in the monsoon regions around the world.**



# PDEF: NAWDEX 49 research aircraft flights



# HIWeather / Waves to Weather Conference on Predictability and Multi-Scale Prediction of High Impact Weather





# S2S SST anomaly forecasts

Updated every day with a 21-day delay!  
The latest initial date is 20170129.

- SST
- SST anomaly

Initial time:  
Year:Month    
Day

- Lead time:
- Week1 (+1-7 days)
  - Week2 (+8-14 days)
  - Week3 (+15-21 days)
  - Week4 (+22-28 days)
  - Week5 (+29-35 days)
  - Week6 (+36-42 days)
  - Week7 (+43-49 days)
  - Week8 (+50-56 days)

Initial days of forecasts:

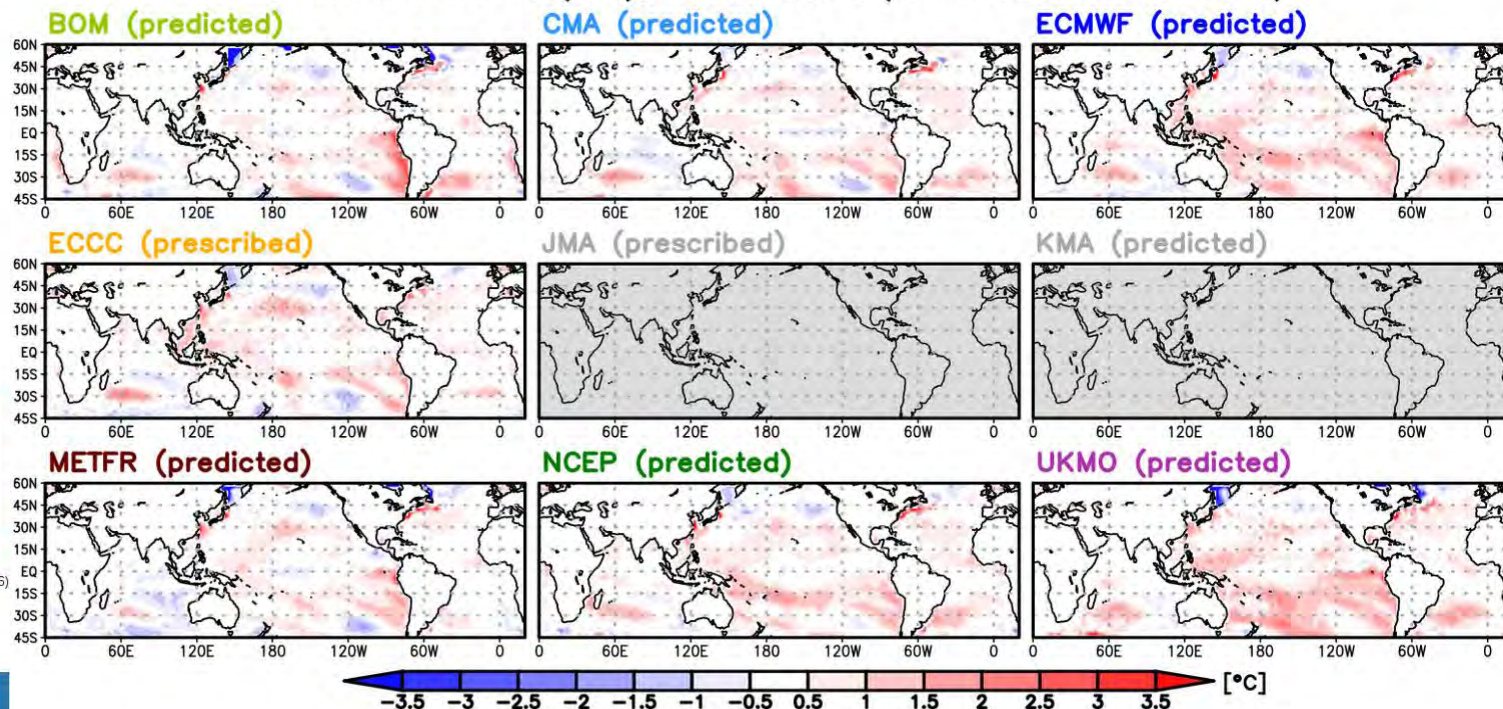
	Sun	Mon	Tue	Wed	Thu	Fri	Sat
BoM							
CMA							
ECMWF							
ECCC							
HMCR							
ISAC-CNR							
JMA							
KMA							
METFR *1							
NCEP							
UKMO							

\*1 METFR: 1st of each month (-Feb 2016)

[Go to the S2S Museum \(top\)](#)



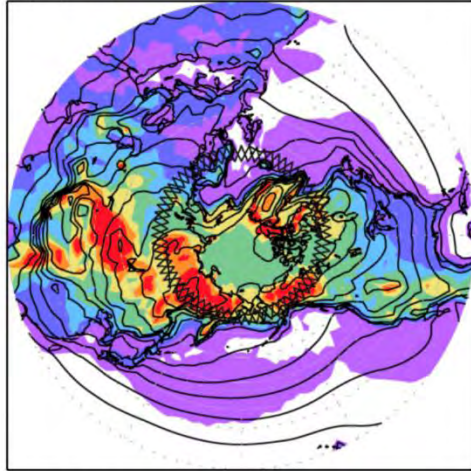
SST anomaly ensemble mean forecasts  
Initial: 2017.01.26(Thu), Valid: Week3(2017.02.10–2017.02.16)



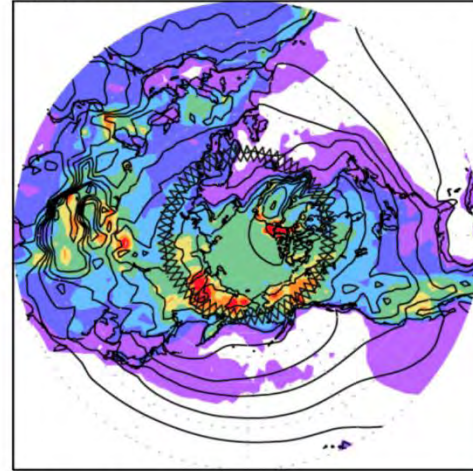
“S2S Museum” at University of Tsukuba, Japan (Mio Matsueda)  
[http://gpvjma.ccs.hpcc.jp/S2S/S2S\\_SICmap.html](http://gpvjma.ccs.hpcc.jp/S2S/S2S_SICmap.html)

# PPP Weather forecast uncertainties

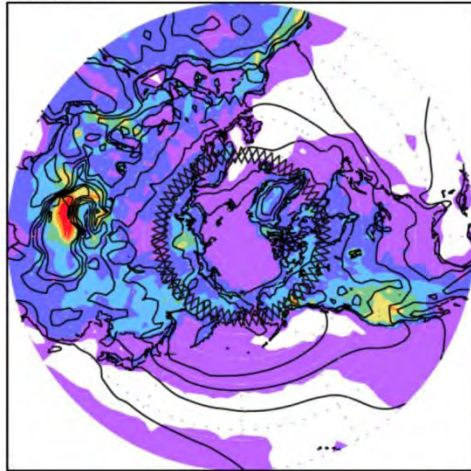
(a)DJF



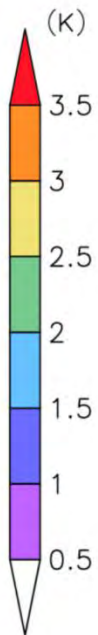
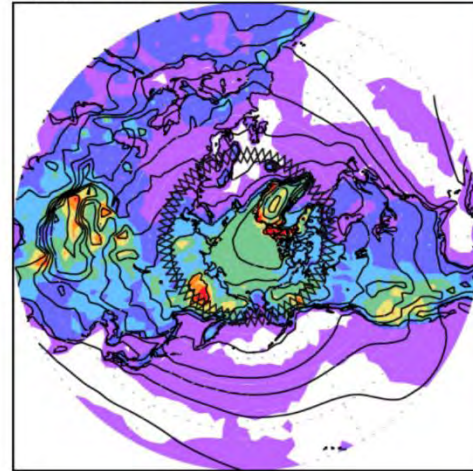
(b)MAM



(c)JJA



(d)SON

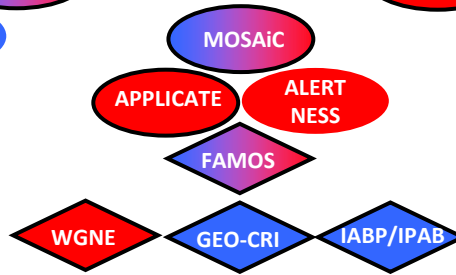
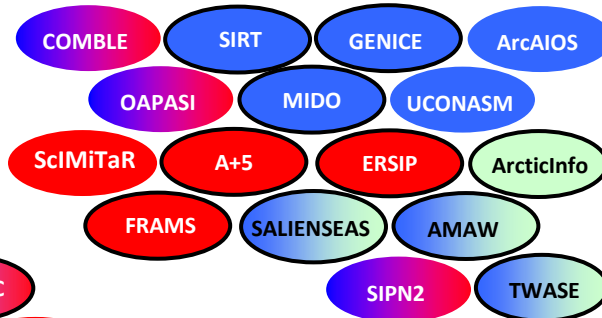
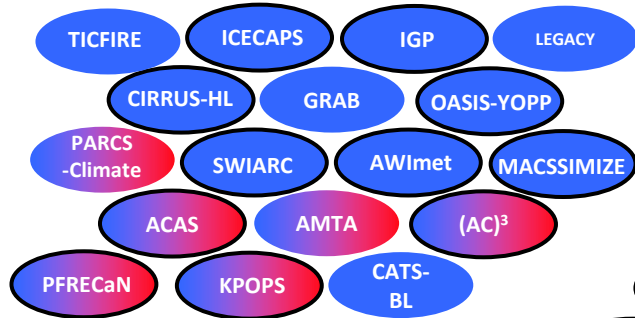


# YOPP Endorsed Projects

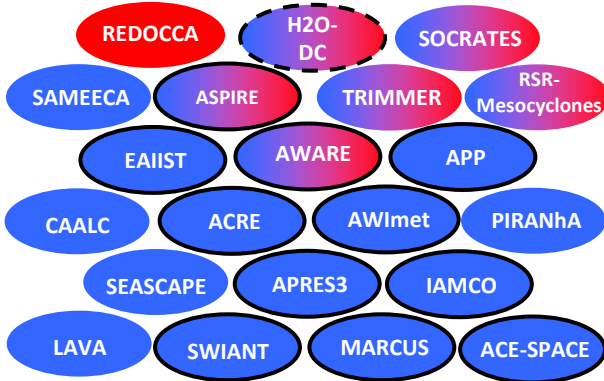
## Atmosphere (incl. Land)

## Ocean (incl. Sea Ice)

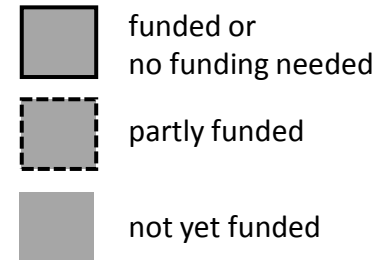
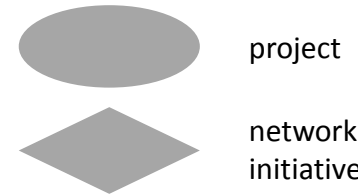
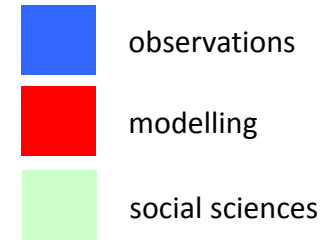
Arctic



Antarctic



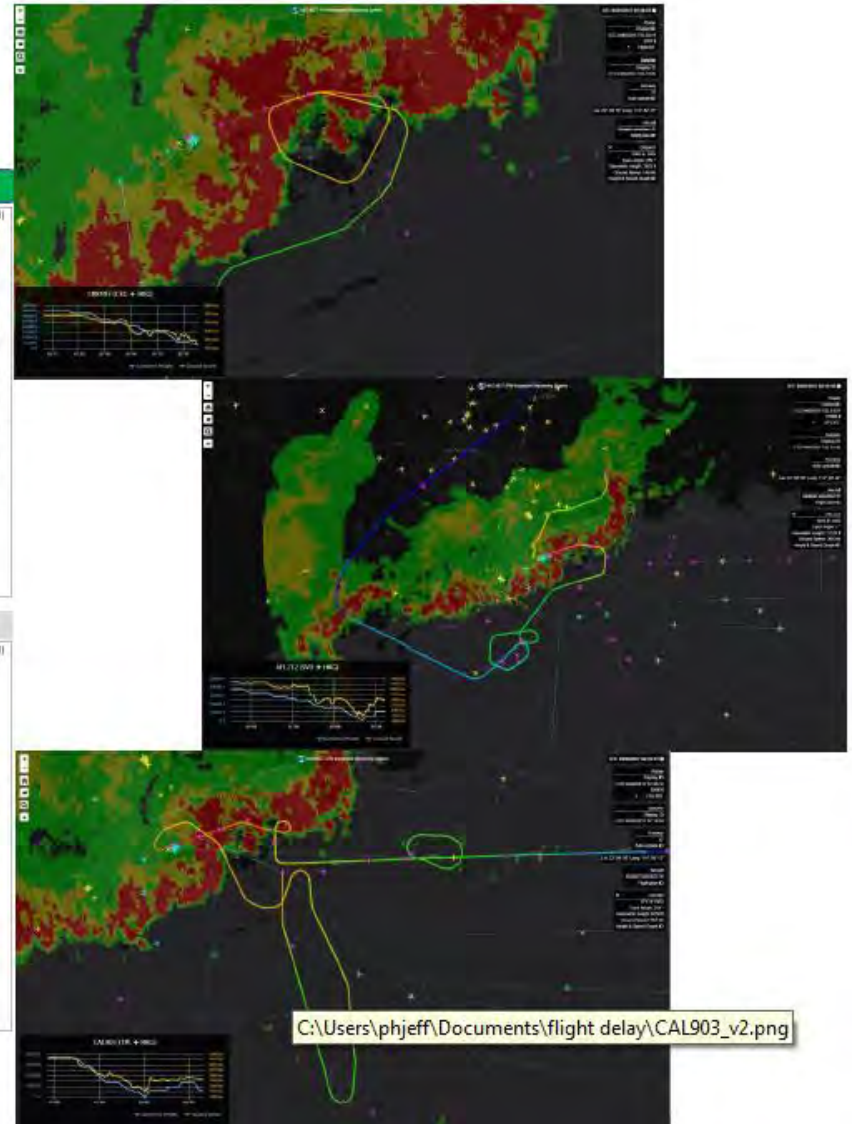
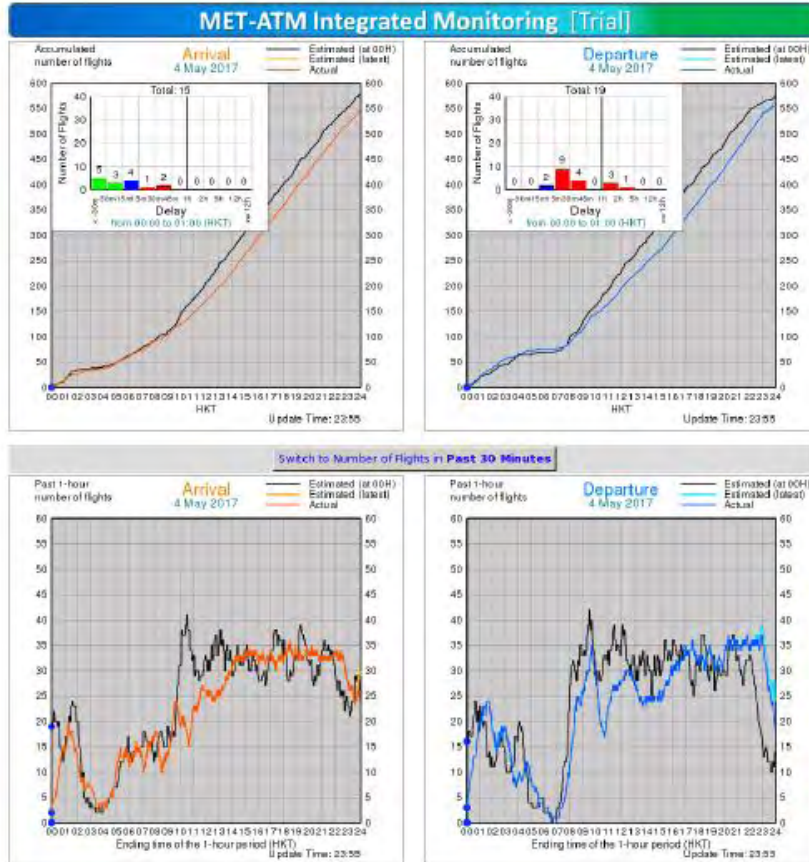
### Legend



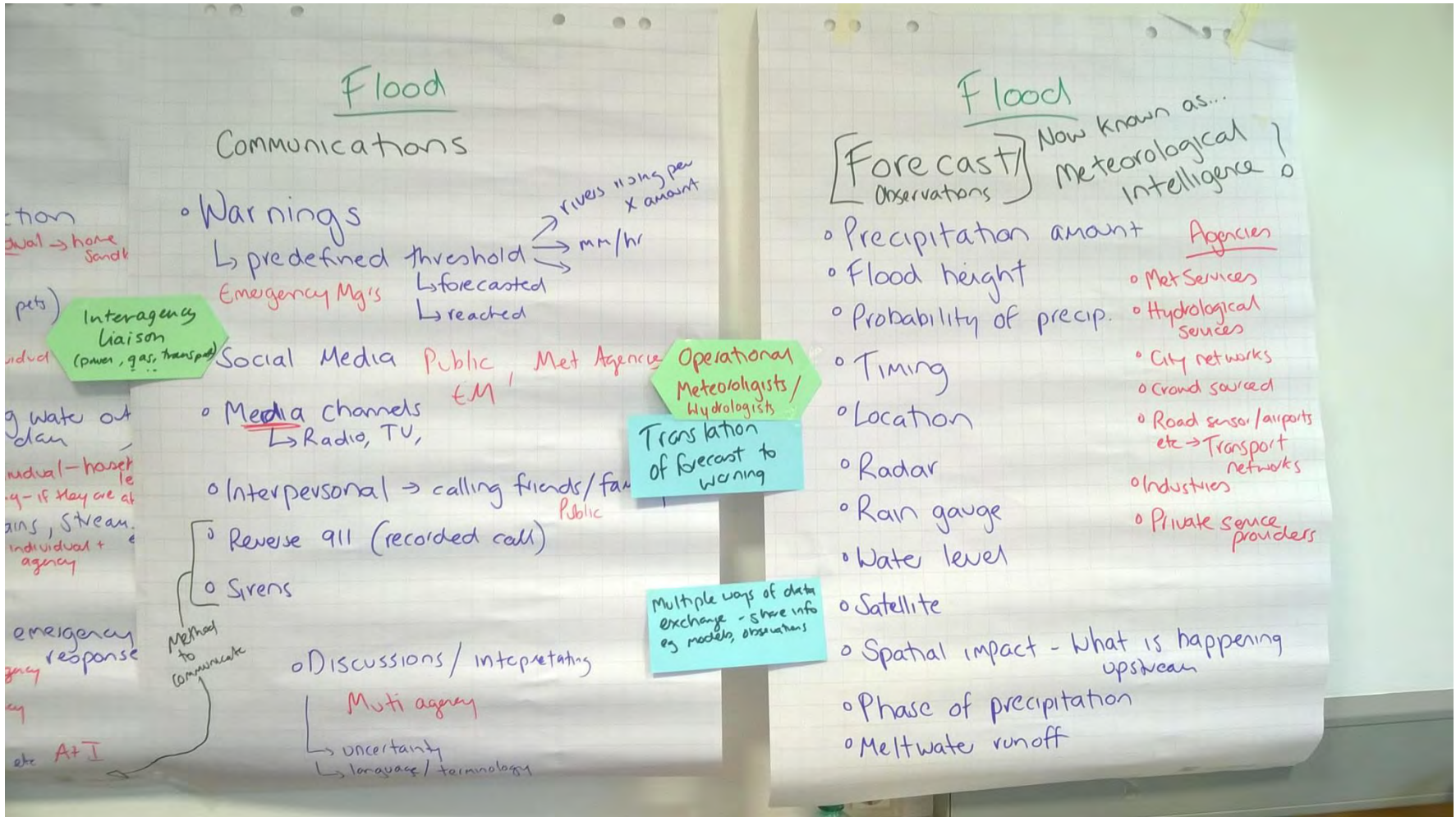
### Institutional Endorsement



# Aviation RDP: flight avoidance study



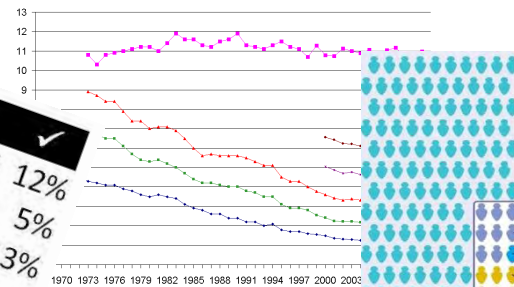
# HIWeather Value Chain Workshop



# HIWeather: enhancing communication and utility of forecasts

$P_{msl}$   
 $H_{500}$

YouTube

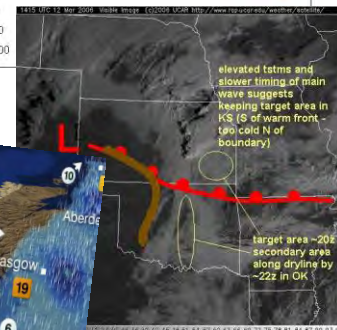
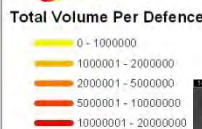
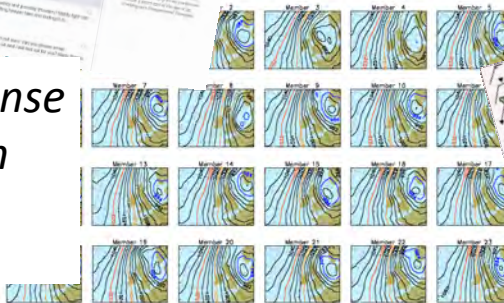


The Gulf coast of Florida

Outlook for days 3-5

A 10% chance of a shower

20% prob of intense rain within 30km between 1-2pm tomorrow



# Resource Mobilization for WWRP

## Global strategy:

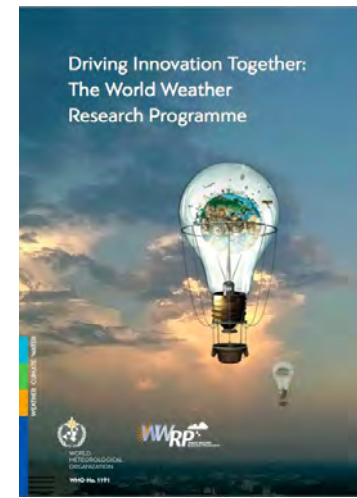
- large international projects have provided research outcomes with the potential for developing new services (THORPEX, AMMA)
- Strengthening the relationship with organizations planning and funding large-scale initiatives with worldwide positive outcomes (EU Research → Polar Prediction Project)

## Regional to local strategy:

- Important players are international funds that are working to improve local developments.
- A co-designed approach could promote innovation and support research activities.
- Example Lake Victoria Project linking together Research and development projects (RDPs) and Severe Weather Forecast Demonstration Projects (FDPs)

## Research infrastructure:

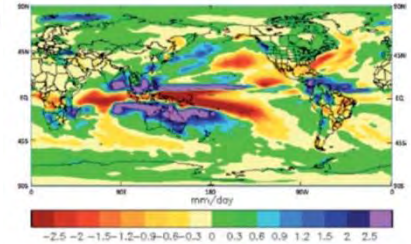
- TIGGE and S2S databases give the research community access to operational predictions, with the potential to develop operational products.
- Securing the long-term maintenance of these databases remains a challenge.



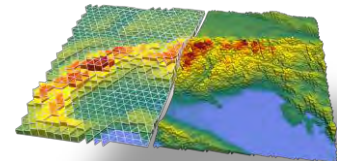
# WWRP working with key partners



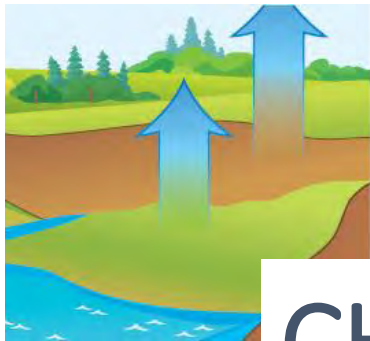
YOUNG  
EARTH SYSTEM  
SCIENTISTS  
community



## WGNE

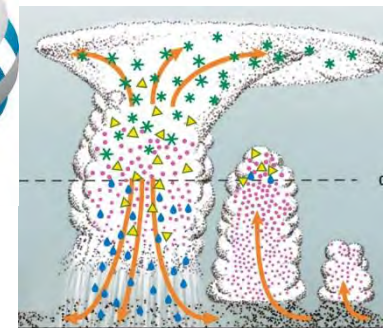


## CAeM



## CHy

## CBS

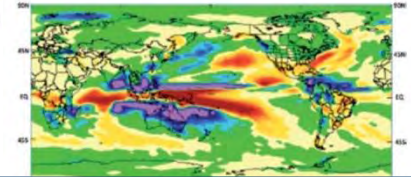




# WWRP working with key partners



YOUNG  
EARTH SYSTEM  
SCIENTISTS  
community

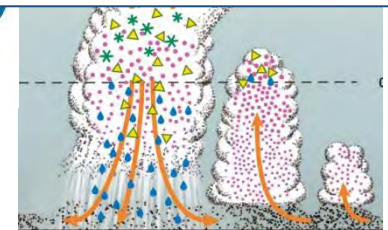


## Enhancing collaboration with WWRP:

- Key science challenges at the intersection of weather and climate
- Advancing modelling and observations
- Strengthening regional activities
- Preparing for the future



CHy



# Thank you Merci



WMO OMM

World Meteorological Organization  
Organisation météorologique mondiale

# CAS Management Group 2017-2020

Øystein Hov, Norway, president

Jae-Cheol Nam, Republic of Korea, vice-president

Gregory Carmichael, United States of America, chairperson of EPAC SSC

Sarah Jones, Germany, chairperson of WWRP SSC

Amanda Lynch, United States of America, invited expert representing the academic research community

Keith Williams, United Kingdom of Great Britain and Northern Ireland, co-chairperson of the Working Group on Numerical Experimentation

Pascal Waniha, United Republic of Tanzania (Regional Association I – Africa)

Yi-Hong Duan, China (Regional Association II – Asia)

Carolina Vera, Argentina (Regional Association III – South America)

John Cortinas, United States of America (Regional Association IV – North America, Central America and the Caribbean)

Peter May, Australia (Regional Association V – South-West Pacific)

Jörg Klausen, Switzerland (Regional Association VI – Europe)

A representative of the European Commission, Directorate General: Research, invited expert