Climate Service Innovation from WMO/CAgM Perspectives

Implication of APCC as a Hub Center with Potential Global Partners

2016

Byong Lyol LEE

President of CAgM

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

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1. UN Agenda
& Implementation Projects

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Climate Chan?e Paradigm

- ***Global Issues***
- Climate change
- Economic Crisis

❖ ***Implementation Targets***

❖ ***Global Agenda***

1) Sustainable Development Goals
2) Sendai Framework for Disaster Risk Reduction
3) UNFCCC & IPCC (Climate Change)
4) Future Earth (Earth System)

- Food / Feed
- Energy / Environment
- Water / Willingness

– **Farming :** practices
- **productivity** & economy

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UN Agenda – SDG

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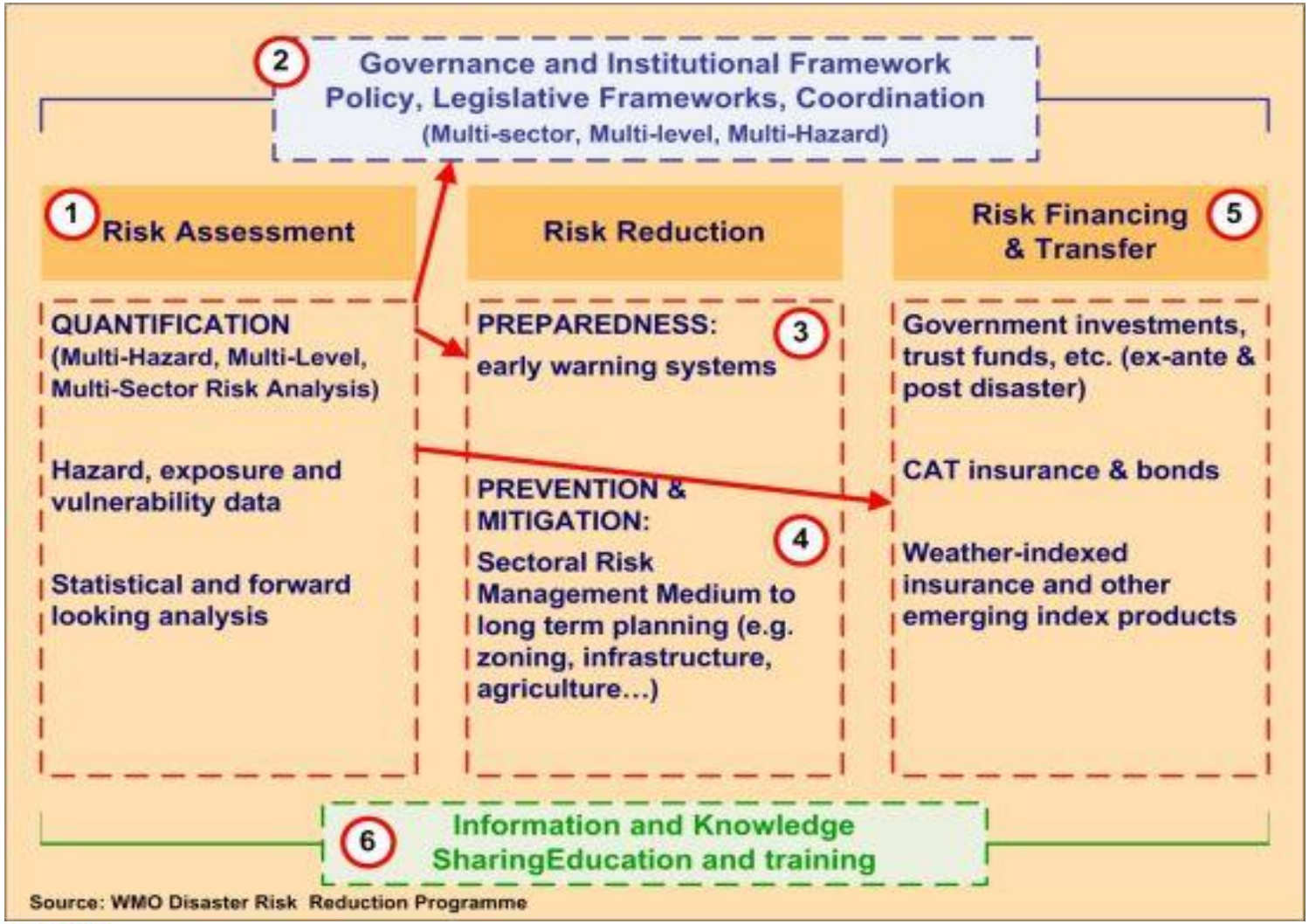
DRR

Disaster Risk Reduction Program



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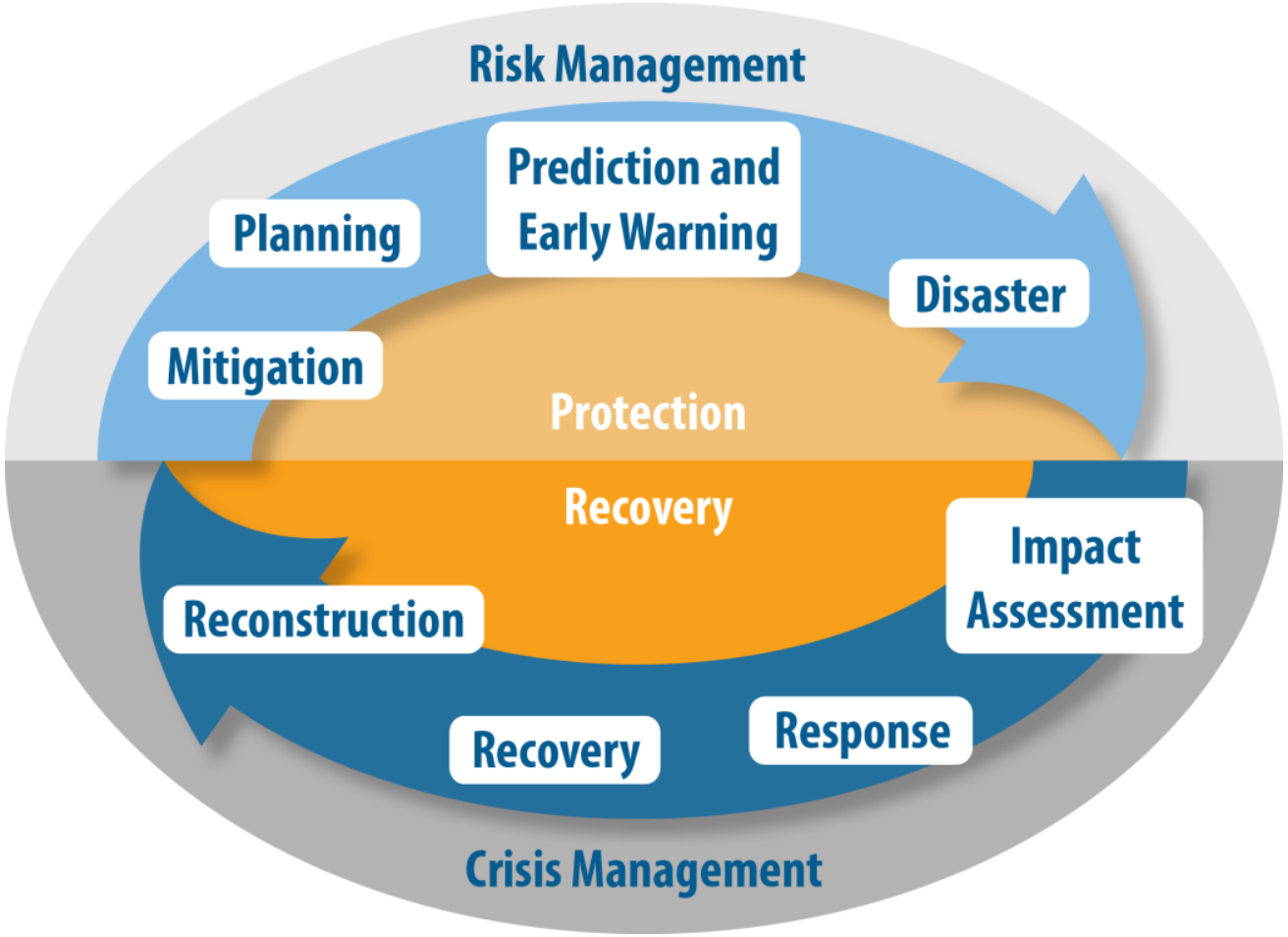
Towards a paradigm shift

From crisis to risk management



Proactive

Reactive

Source: Adapted from National Drought Mitigation Center, http://drought.unl.edu

A need to develop risk-based drought management policies

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International Programs on Climate Change

IPCC
Intergovernmental Panel on Climate Change
DECISION SUPPORT

WCRP
World Climate Research Program
ANALYSIS

&

IGBP
International Geosphere, Biosphere Program
RESEARCH

GEOSS
G ms
OBSERVATION

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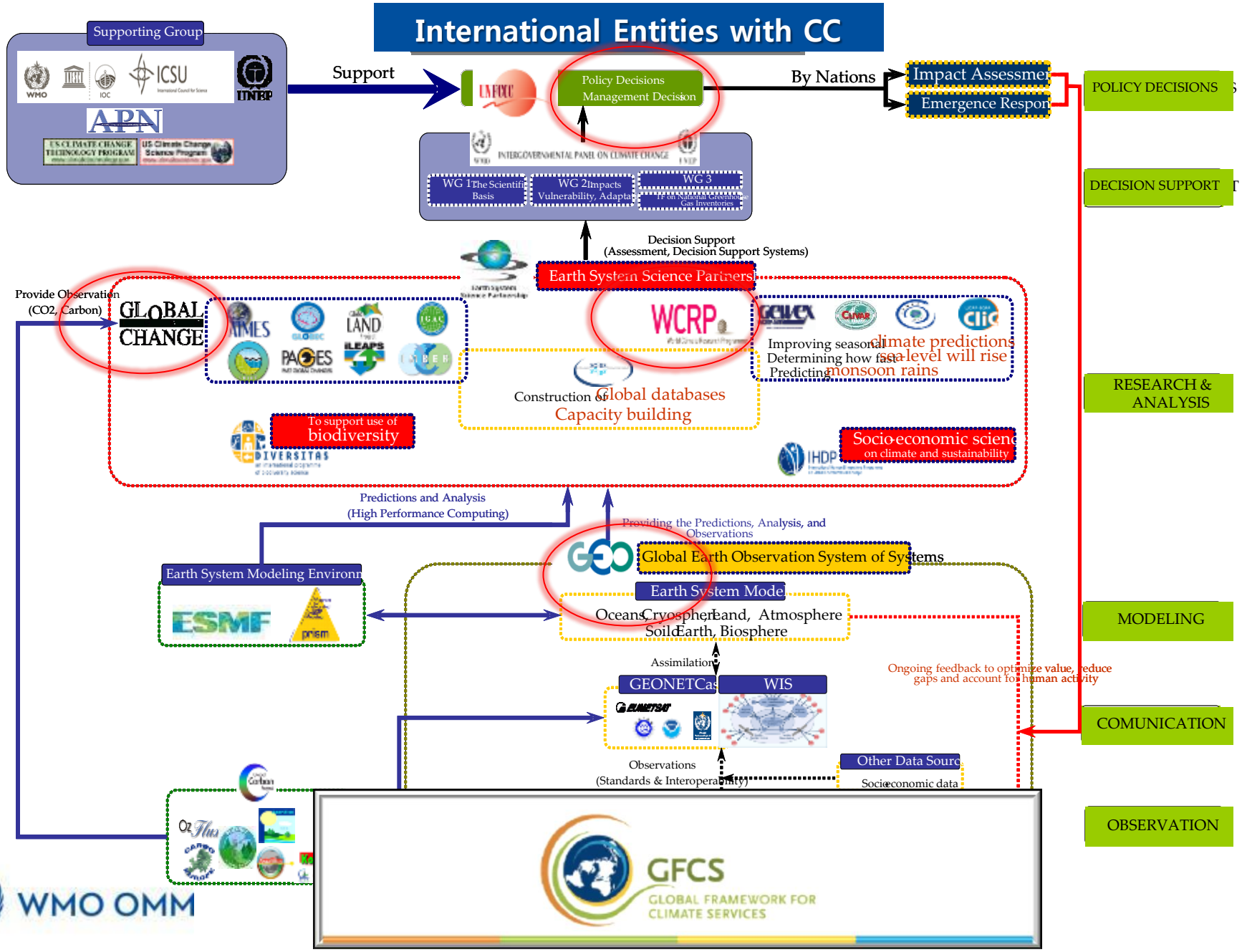
World Climate Conference-3

GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

World Meteorological Organization
Weather • Climate • Water

Emerging GFCS
Better climate information for a better future

UN SYSTEM DELIVERING AS ONE ON CLIMATE KNOWLEDGE


International Entities with CC
Supporting Group
WMO
IOC
ICSU
UNEP
APN
US CLIMATE CHANGE TECHNOLOGY PROGRAM
US Climate Change Science Program
Support
UNFCCC
Policy Decisions
Management Decision
By Nations
Impact Assessmer
Emergence Respor
POLICY DECISIONS
DECISION SUPPORT
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WG 1 The Scientific Basis
WG 2 Impacts Vulnerability, Adapta
WG 3
Gas Inventories
Decision Support
(Assessment, Decision Support Systems)
Earth System Science Partnersh
Provide Observation
(CO2, Carbon)
GLOBAL CHANGE
IMES
LAND
IGAC
PAGES
ILEAPS
WCRP
CLIVAR
CLIC
Improving seasonal
Determining how fast
Predicting
climate predictions
sea-level will rise
monsoon rains
RESEARCH & ANALYSIS
Construction of
Global databases
Capacity building
To support use of
biodiversity
DIVERSITAS
IHDP
Socio-economic scienc
on climate and sustainability
Predictions and Analysis
(High Performance Computing)
Providing the Predictions, Analysis, and Observations
GEO
Global Earth Observation System of Systems
Earth System Modeling Environm
ESMF
prism
Earth System Model
Oceans, Cryosphere, Land, Atmosphere
Soil, Earth, Biosphere
MODELING
Assimilation
GEONETCas
WIS
Ongoing feedback to optimize value, reduce gaps and account for human activity
COMUNICATION
Observations
(Standards & Interoperability)
Other Data Sourc
Socioeconomic data
OBSERVATION
GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES
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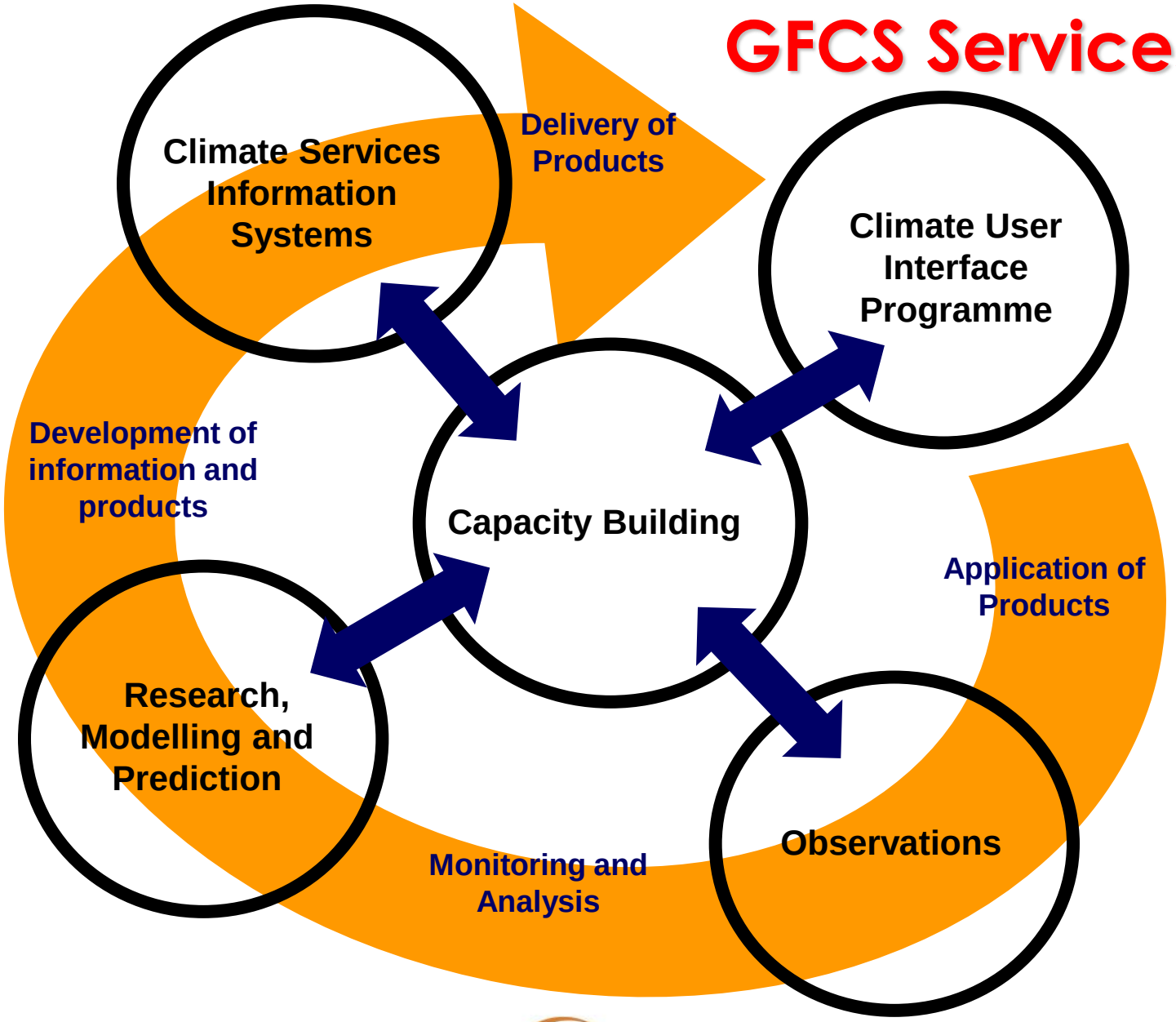
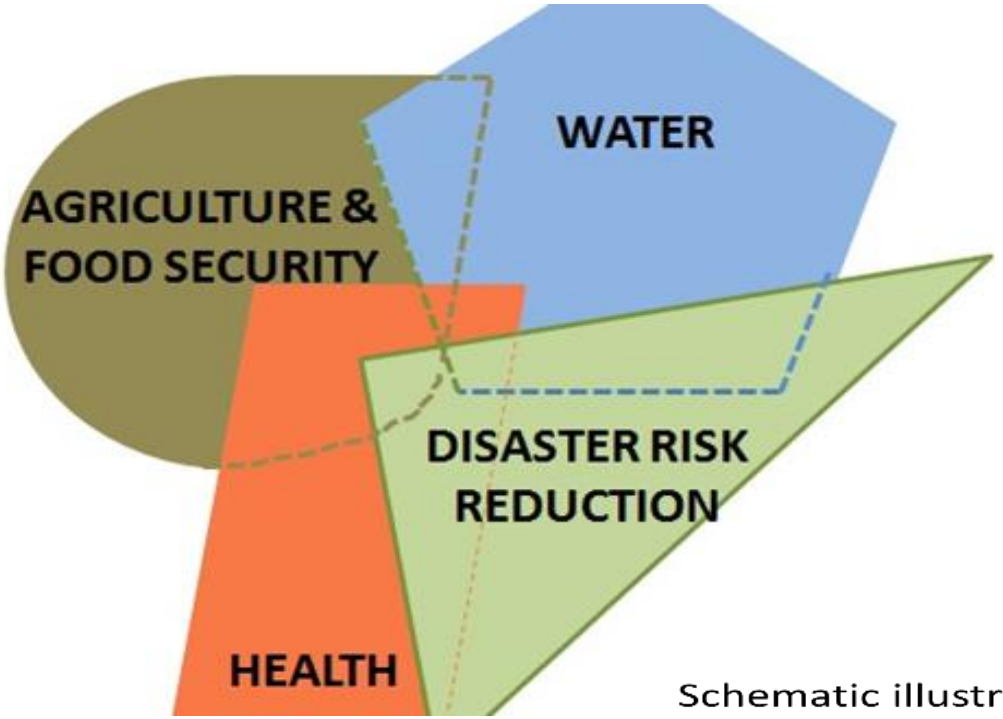
GFCS Services Cycle



GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Global Projects : GFCS

Global Framework for Climate Services



Schematic illustrating that while the Framework's four priority areas are quite different in nature there are nevertheless substantial overlaps which will require addressing as the UIP is implemented.

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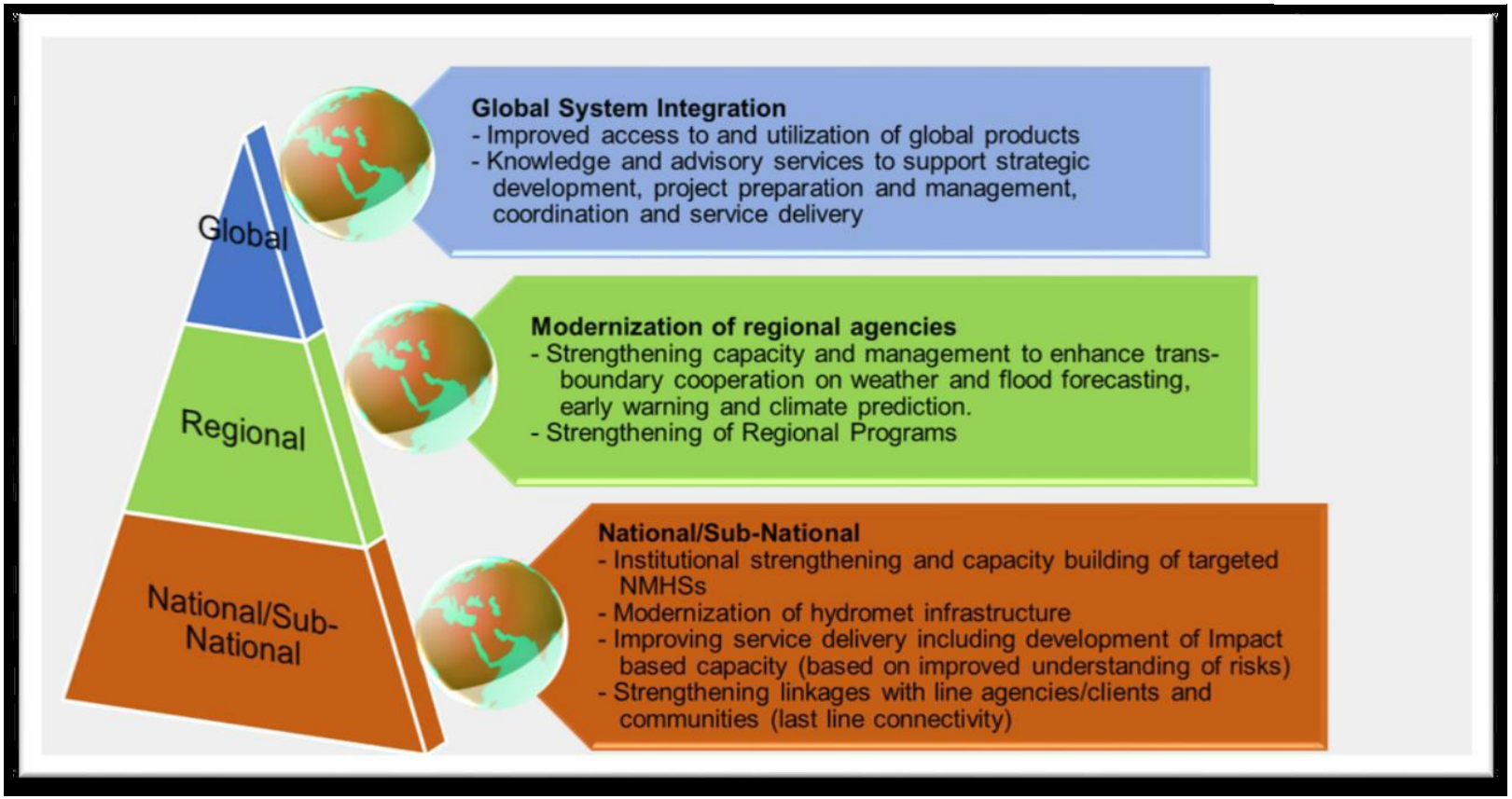
Global Projects : CREWS

Climate Risk Early Warning Service

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11



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Global Project : IKI

International Climate Initiative

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Joint Research Projects (2) – Candidates

Crucial Factor for Sustainable Operation of GRIAM

4. International joint research : 2016~ **CAgM engaged**

1) Global Challenge Research *by WMO(CD/SCI/SD)* ***100 M USD / 10 Years***

(WMO will prepare for project proposal to Green Climate Fund, 2018~2027)

"Operational Framework for AgroEcosystem Sustainability Assessment (OFASA) to support Policy Decision Making for better AgroEcosystem Performance under present and future Climate Change at diverse spatial scales through joint Global Challenge Research Projects"

2) GFCS for AgFS (WMO/GFCS) about **200 M USD in total**

(CAgM will take part in GFCS implementation for 8 priority countries, 2016~2020)

"GFCS Implementation Work Plan for the sector of Agriculture and Food Security in the Countries with high priority (6+2)"

3) CREWS from COP21 (WMO/UNISDR) 300 M USD / 5 Years committed

(WMO & CAgM will take part in CREWS implementation, 2016~2020)

"Climate resilient Early Warning System for LDCs & SIDs"

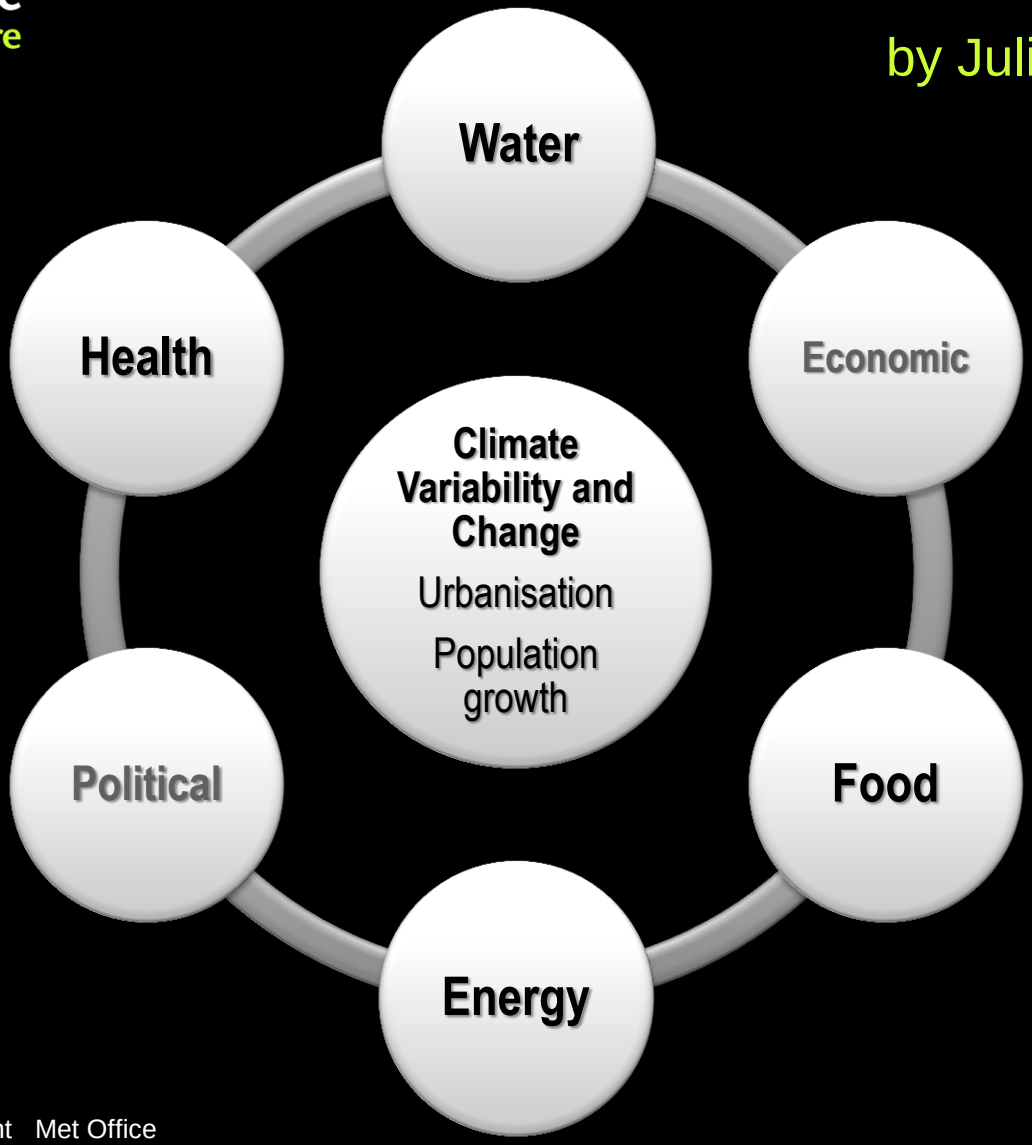
4) IKI project from Germany (USQ/WMO) 20 M USD/5 Years, *approved*

"Applying seasonal climate forecasting and innovative insurance solutions to climate risk management in the agriculture sector in SE Asia"

2. Challenges in Climate Service Innovations

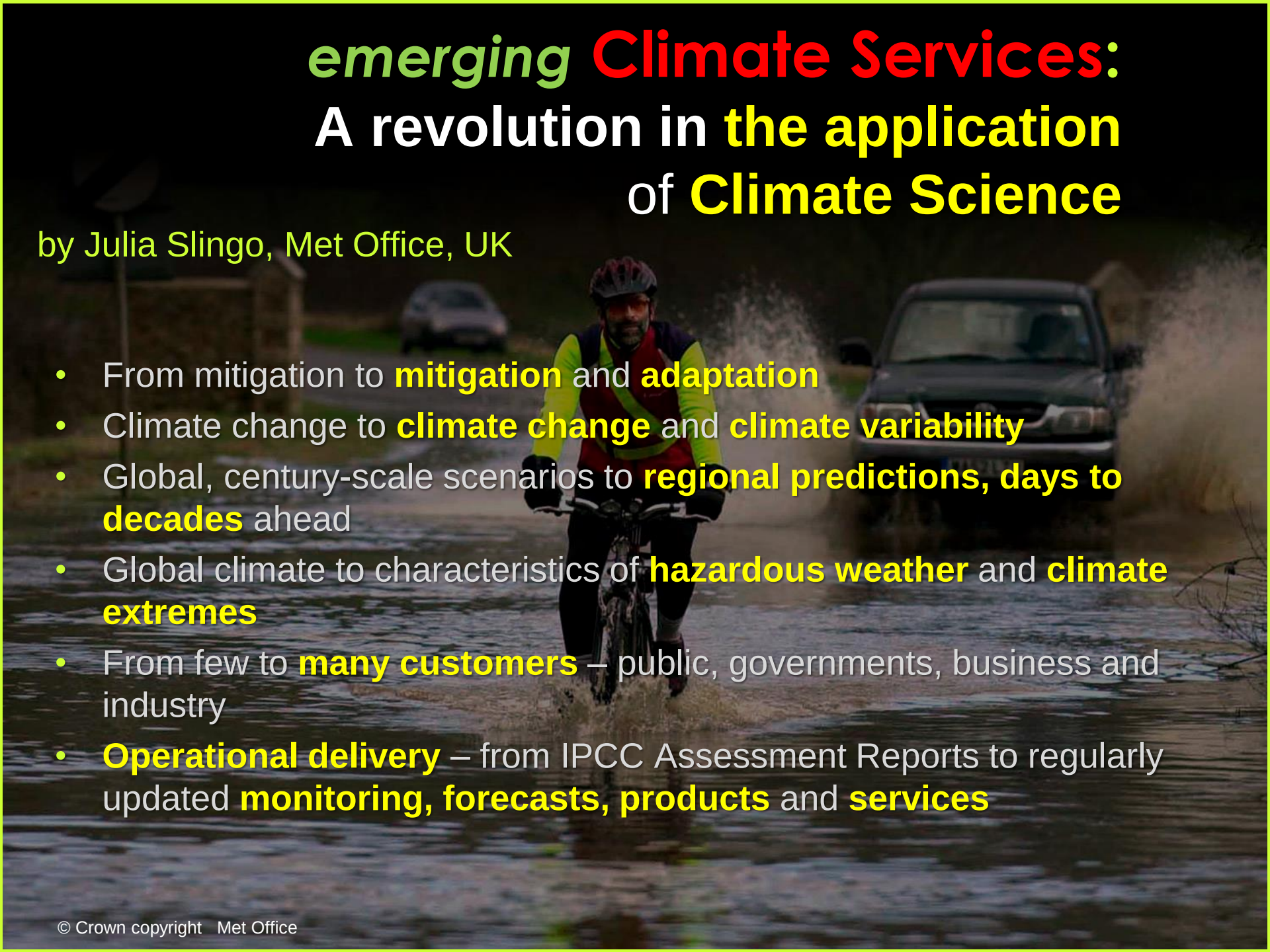
Circle of Securities:
Thinking Across Boundaries

by Julia Slingo, Met Office, UK



emerging Climate Services: A revolution in the application of Climate Science

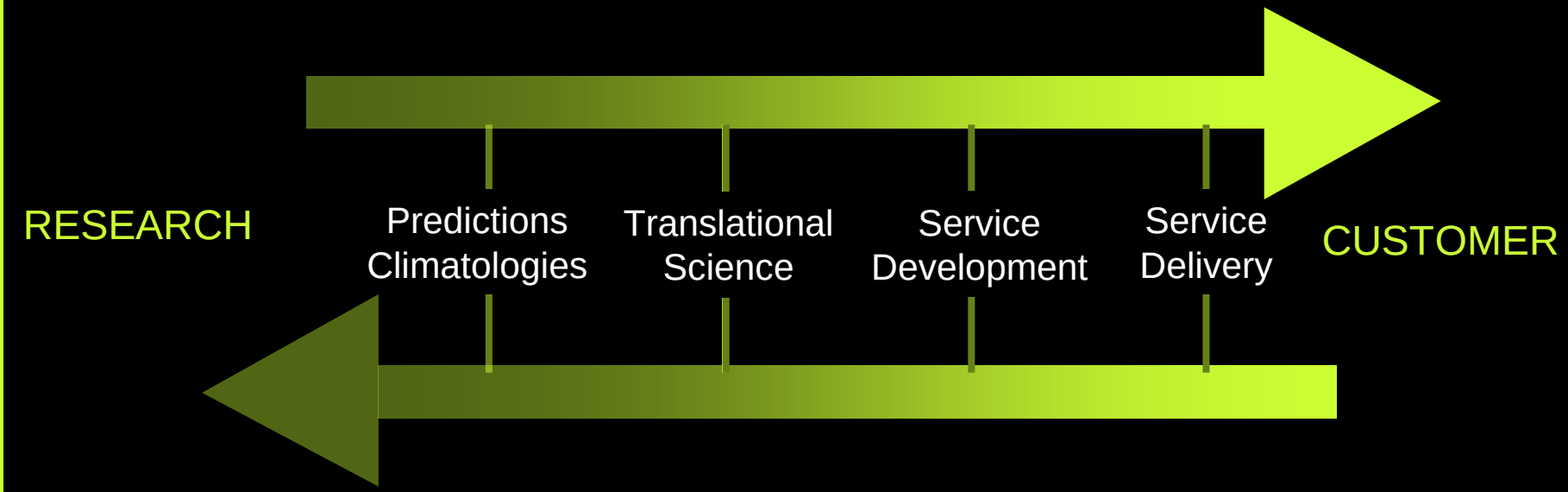
by Julia Slingo, Met Office, UK



- From mitigation to **mitigation** and **adaptation**
- Climate change to **climate change** and **climate variability**
- Global, century-scale scenarios to **regional predictions, days to decades** ahead
- Global climate to characteristics of **hazardous weather** and **climate extremes**
- From few to **many customers** – public, governments, business and industry
- **Operational delivery** – from IPCC Assessment Reports to regularly updated **monitoring, forecasts, products** and **services**

Setting the Right Structures

From Science to Service: The end-to-end delivery chain

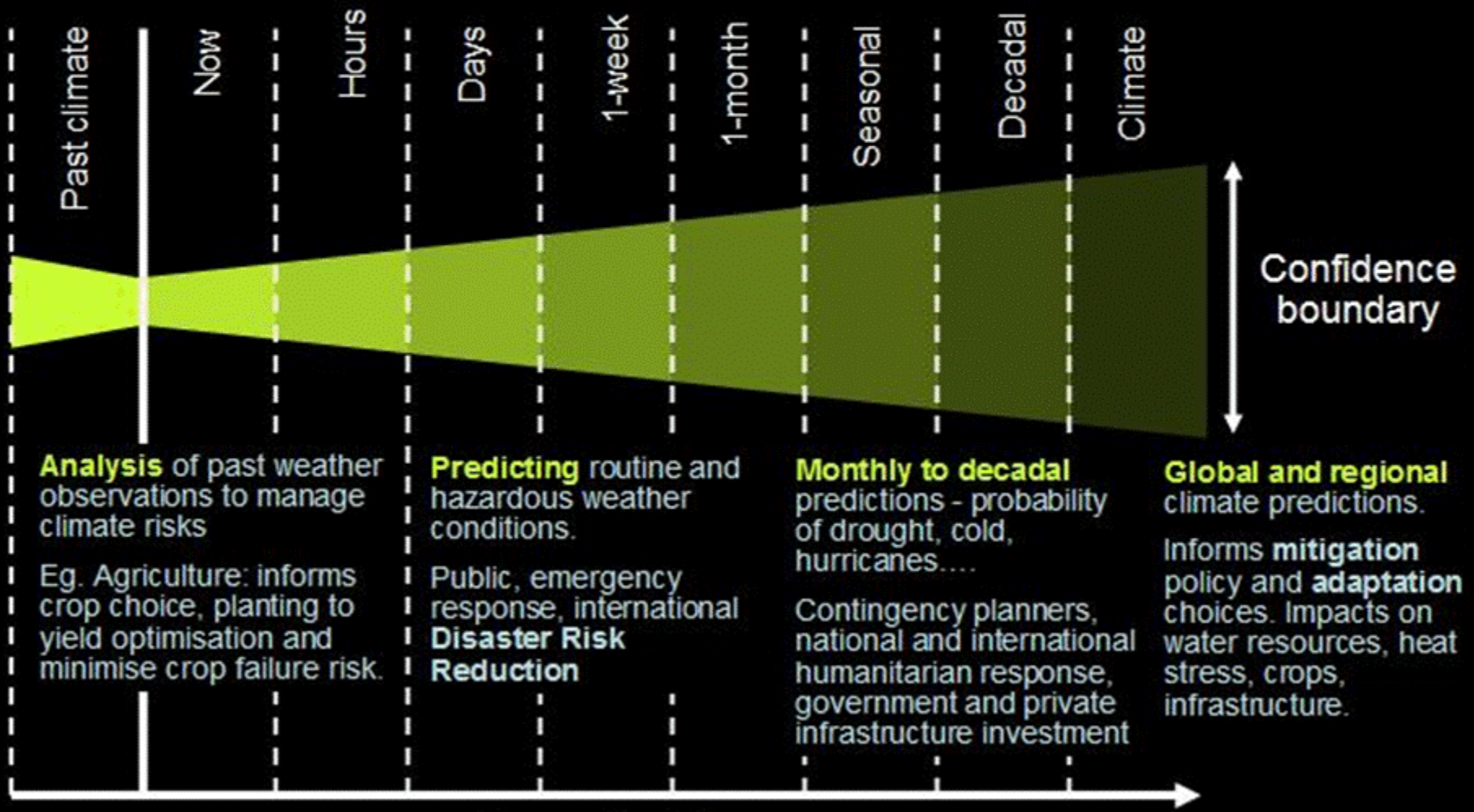


Continuous Dialogue *Beginning* with the Customer

Full Implementation of Seamless Prediction: From Hours to Decades

Met Office

Global coupled modelling on all timescales



Analysis of past weather observations to manage climate risks

Eg. Agriculture: informs crop choice, planting to yield optimisation and minimise crop failure risk.

Predicting routine and hazardous weather conditions.

Public, emergency response, international **Disaster Risk Reduction**

Monthly to decadal predictions - probability of drought, cold, hurricanes....

Contingency planners, national and international humanitarian response, government and private infrastructure investment

Global and regional climate predictions.

Informs **mitigation** policy and **adaptation** choices. Impacts on water resources, heat stress, crops, infrastructure.

Earth System Science &
Sustainable Development
needs a holistic approach

- someone needs to put together the puzzle!

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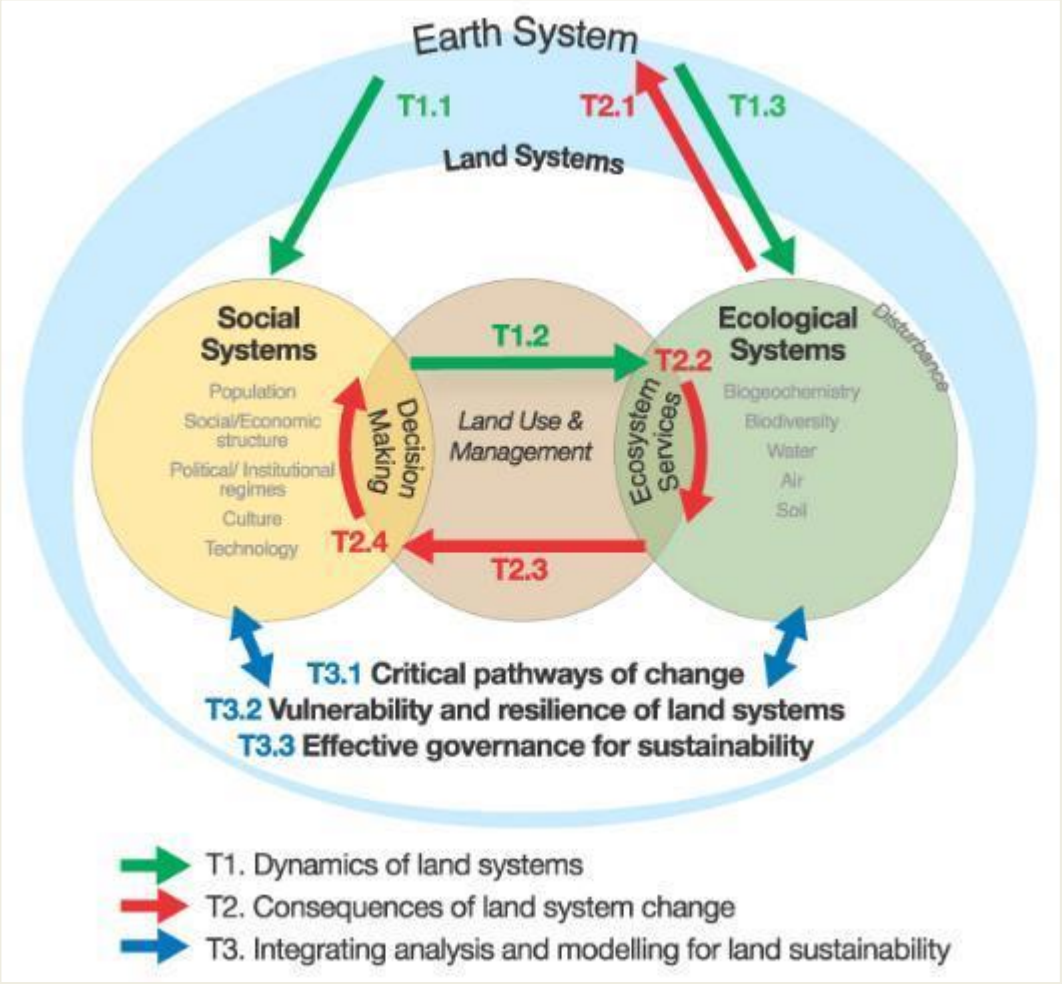
Science Challenges

Land System Change (IGBP)

for Ecosystem Services & Earth System Functioning



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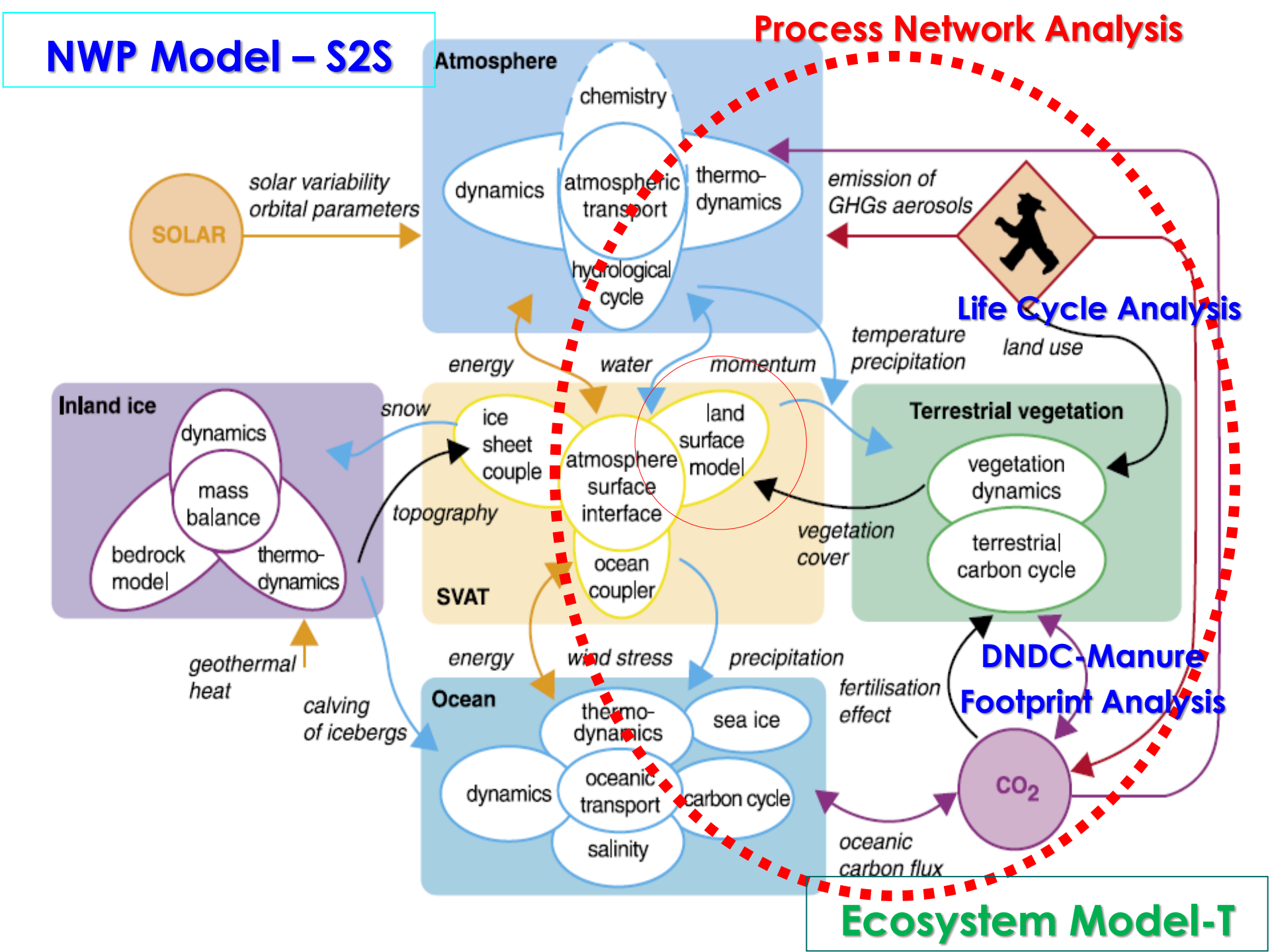
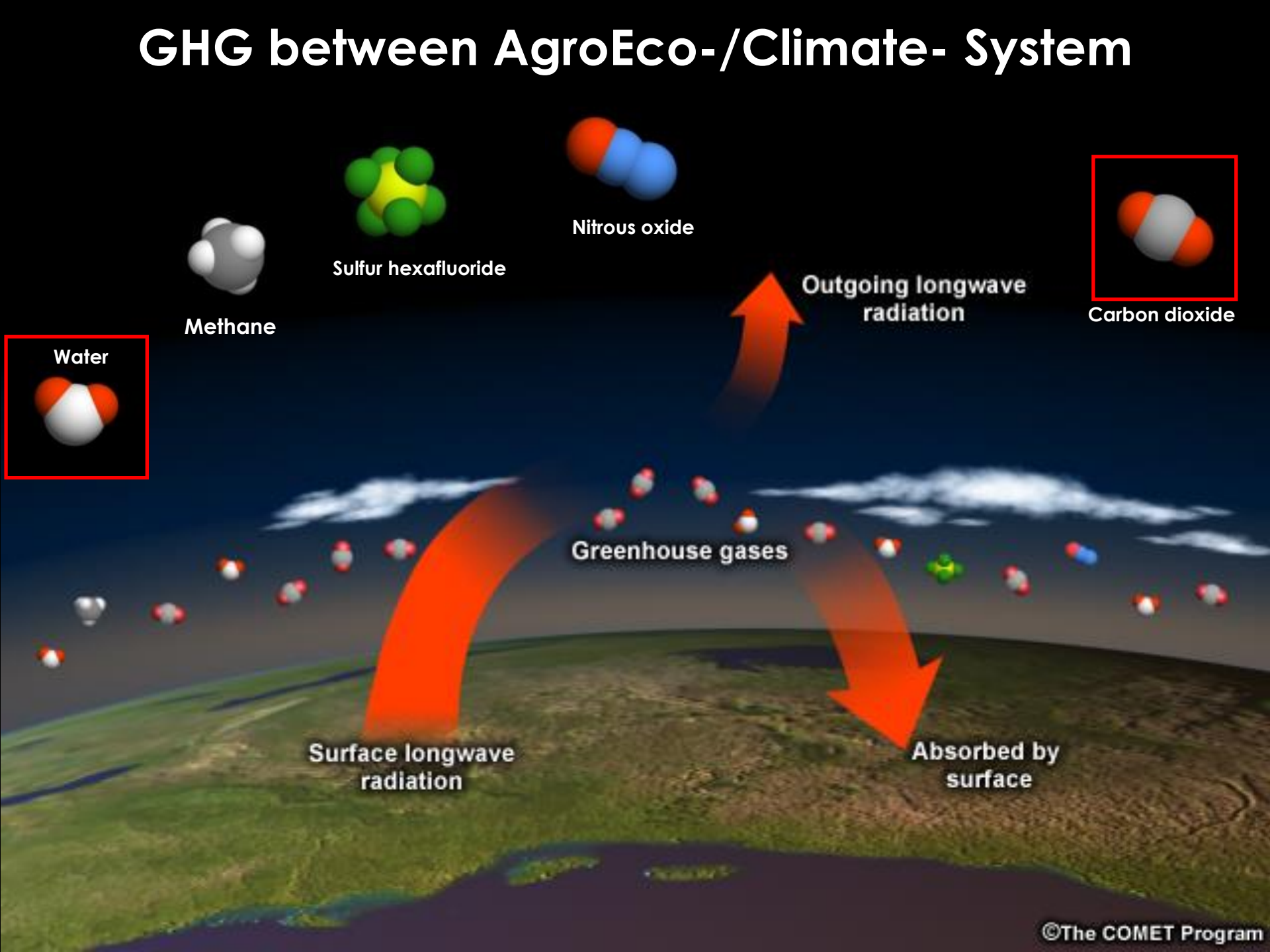
Partnerships with AAFC, Canada


NWP Model – S2S
Process Network Analysis
Atmosphere
chemistry
dynamics
atmospheric transport
thermo-dynamics
hydrological cycle
SOLAR
solar variability
orbital parameters
emission of GHGs aerosols
Life Cycle Analysis
temperature
precipitation
land use
energy
water
momentum
Inland ice
dynamics
mass balance
bedrock model
thermo-dynamics
snow
ice sheet couple
topography
atmosphere surface interface
land surface model
SVAT
ocean coupler
Terrestrial vegetation
vegetation dynamics
terrestrial carbon cycle
vegetation cover
geothermal heat
calving of icebergs
energy
wind stress
precipitation
Ocean
thermo-dynamics
sea ice
dynamics
oceanic transport
carbon cycle
salinity
fertilisation effect
DNDC-Manure
Footprint Analysis
CO2
oceanic carbon flux
Ecosystem Model-T

GHG between AgroEco-/Climate- System



World Modeling Summit

*Revolutionizing **Global Climate Prediction** for Regional Adaptation and Decision-Making in the 21st Century*

Organizations : WMO, IOC, ICSU
Organizing committee
Chairman : J. Shukla
20 members from WCRP, WWRP, IGBP

Hosted by ECMWF for May 6-9, 2008

Participants : World leading scientists and representatives for many countries and various organizations (invitation only)

Nature News

NEWS

They say t… want a rev…

Climate scientists call for m…

Researchers from around the world gathered in Reading, UK, for the summit.

"We need to be breathtakingly bold."
-Leo Donner

"Climate prediction is a national security issue if ever there was one

…ells more than 100 kilometres across.
Increasing computing power 10,000 times
New Jersey. Antonio Navarra, a climate model-
ler at the National Institute of Geophysics and
day, econon
the Earth I

A real solution?

Is the answer to climate prediction sitting in your pocket? Lenny Oliker, John Shalf and Michael Wehner of the Lawrence Berkeley National Laboratory in California think it could be. In a proposal discussed at the Reading climate-modelling summit (see main story) they suggest that the very small processors in mobile phones might be ideal components for very large climate computers — if 20 million of them could be wired together in the right way.

To run at the sort of kilometre-scale resolution that could accurately model cloud processes, they argue, a computer has to be able to run at a sustained speed of around 10 petaflops, and a peak speed of perhaps 20 times that or more. If built with traditional high-performance chips such as AMD's Opteron or Intel's Xeon, such a machine would be extremely expensive and power-hungry — perhaps requiring as much as 100 megawatts. Processors developed for cell phones are small — less than a square millimetre in area — and frugal in their power requirements, needing less than a tenth of a watt each. These advantages, the researchers argue, far outweigh the slower speed at which such processors work and would permit construction of a multi-petaflop computer that was much cheaper both to build and to run.

In some ways this is an extrapolation of the approach that IBM has taken to its successful Blue Gene line of supercomputers, which also rely on many relatively small and slow processors. But it goes further in the sheer number of processors and in an architecture designed specifically for the demands of climate calculations, rather than general-purpose computing.

Per Nyberg of Seattle-based supercomputer makers Cray — which, like rivals IBM and NEC, sent speakers to the summit with an eye to business opportunities

nature
www.nature.com/nature
Vol 453 | Issue no. 7193 | 15 March 2008

The next big climate challenge

Governments should work together to build the supercomputers needed for future predictions that can capture the detail required to inform policy.

Few scientific creations have had greater impact on public opinion and policy than computer models of Earth's climate. These models, which unanimously show a rising tide of red as temperatures climb worldwide, have been key ove… forging the scientific and political consensus th… a grave danger.

Now that that consensus is all but universal… are looking to take the next step, and to convert… harbingers of doom to tools of practical policy.… their simulations good enough to guide hard de… for carbon dioxide emissions on a global scal… required to meet changing rainfall and extrem… regional and local scales.

Today's modelling efforts, though, are not … all agree on the general direction in which th… as greenhouse gases build up, but they do not … the nuances of today's climate, let alone tomorrow's. Moreover, each model differs from reality in different ways.

It was in recognition of this that a cross section of climate modellers gathered for a 'summit' at the European Centre for Medium-Range Weather Forecasts in Reading, UK, last week (see page 268). The meeting called for an ongoing project aimed at understanding and modelling the climate system well enough to provide the sorts of prediction that policy-makers and other stakeholders need — or, at the very least, to show why such prediction might not, in fact, be achievable. Key to this project would be one or more dedicated facilities offering world-class computational resources to the climate-modelling community.

A clear resolution

Those resources are notably lacking at the moment. The world's very fastest computers run at hundreds of teraflops (which is to say, hundreds of trillions of mathematical operations a second), and the first forays into the petaflop range are expected by the end of the year. But today's climate models rarely run on machines that can manage more than a few tens of teraflops. This translates into spatial resolutions of a hundred kilometres or so. There was a general agreement at the summit that more realistic models will require resolutions in the tens of kilometres, at least. And even higher resolutions — a kilometre or less, say — may well be needed to handle such critical issues as cloud formation realistically. Hence the need for computers a couple of generations beyond the current state of the art.

Meeting this need is not just a matter of buying a supercomputer. It means moving climate modelling up the petaflop pecking order for a sustained period of time. One plausible goal might be to assure that the most powerful supercomputer in the public realm should be devoted to climate work by 2012, and that the field's lead should be

all, the fastest computers are nearly always paid for out of the world's public purses, often for use in areas of national security such as communications intelligence or nuclear weapons design. And climate

Living large

Aware of budgetary realities and the history of scientific centralizations, national centres of climate modelling and expertise such as Britain's Hadley Centre or the US National Center for Atmospheric Research might reasonably see the development as a threat. International collaborations such as CERN — the European particle-physics laboratory — and the European Southern Observatory have served the scientific communities of their member states well, yet have undoubtedly taken their toll on national facilities. With the upcoming inauguration of the Large Hadron Collider (LHC) at CERN, Europe will have the world's best particle-physics facility — but it will have very few of its other particle-physics facilities.

This analogy is not, however, fully convincing. Building an LHC does not make it significantly easier to build lesser accelerators. But advances in supercomputing do make it easier to build computers formerly known as super: a petaflop will seem slow in less than a decade. A world facility where teams of researchers try out very high resolutions and new techniques, and where software engineers and programmers learn how to get the most out of bleeding-edge hardware, will require a network of more modest centres around the world from which to draw its problem-list and into which to feed its insights. A range of operational climate-prediction capabilities could help keep modelling close to stakeholders' needs, and lessen the all-eggs-in-one-basket group-think risk of a global facility.

An ambitious climate-modelling facility dedicated to solving problems beyond the capability of today's national programmes carries risks, but they are risks worth taking. The world's governments — and even, conceivably, its high-tech philanthropists — should listen to the modellers. Big science is often, and gloriously, justified on the basis of pure intellectual excitement. This field offers that — and a chance

The Sub-seasonal to Seasonal (S2S) Prediction Project

Co-chairs:
Frédéric Vitart (ECMWF)
Andrew Robertson (IRI)

Bridging the gap between weather and climate

WMO OMM

S2S Project Objectives

- To improve **forecast skill and understanding** on the sub-seasonal to seasonal timescale with special emphasis on high-impact weather events

- To promote the initiative's uptake by operational centres and **exploitation by the applications community**

- To capitalize on the expertise of the weather and climate research communities to address issues of importance to the **Global Framework for Climate Services**

The project will focus on the forecast range between 2 weeks and a season

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Technology Challenges

Establishment of Technology Consortium on Downscaling Skills for Applied Meteorology

- Diverse challenges in developing downscaling technologies for in-situ, monitoring, RS, predictions over the world have been made to meet the user requirements for higher resolutions in time, space and element in the disciplines of Applied Meteorology.

Potential Partners

[First Phase 2015]

GridMET (NUIST, **China**) : Xinfa QIU

Real-time Downscaling : Grid-RD (PKNU, **Korea**), Jaiho OH

Digital Climate Map (SNU/NCAM, **Korea**), Byong LEE

HR-AgMet : KLAPS (KMA/NIMR, **Korea**) Kyurang KIM

[Second Phase 2016]

Uncoupled Surface Model (Nanowx，USA）Matt Haugland

Synthetic Observations (EC, **Canada**) (TBD)

(TBD) (ASU, **USA**) Ben RUDDELL

❖ WMO Demonstration project (AGMP/CAgM, WWRP/S2S)

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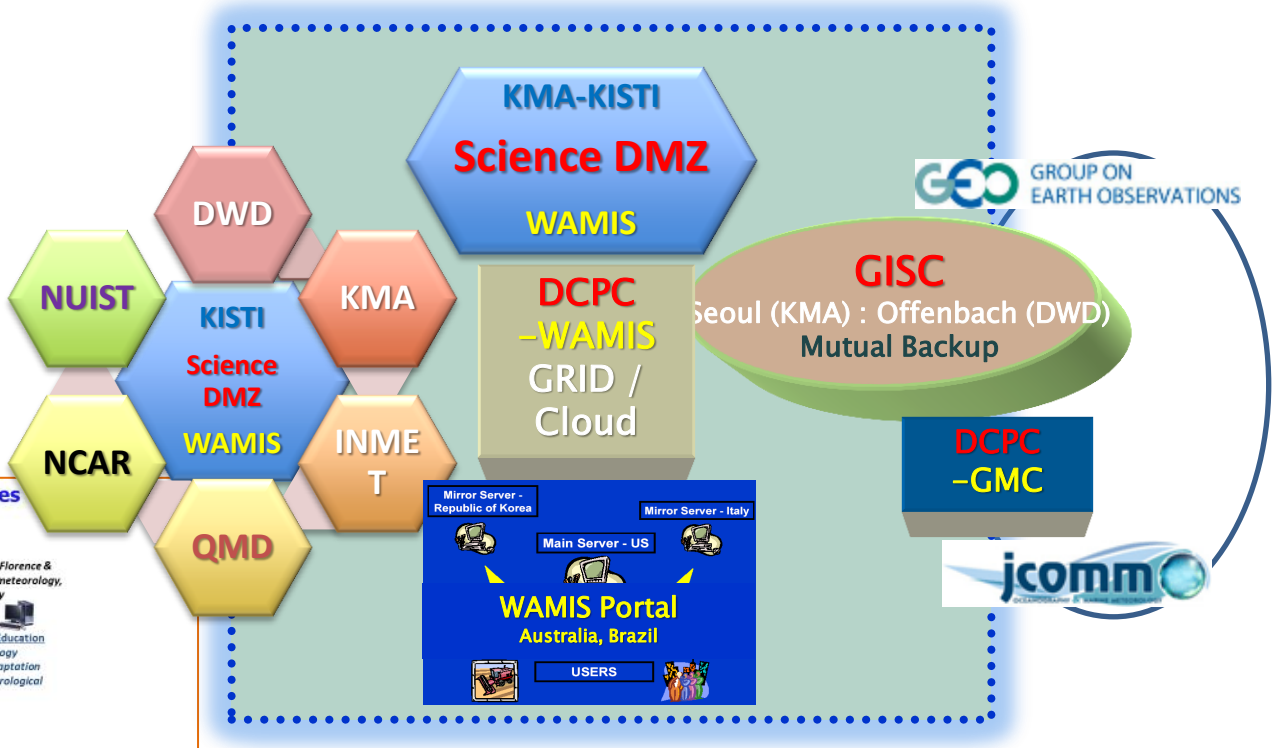
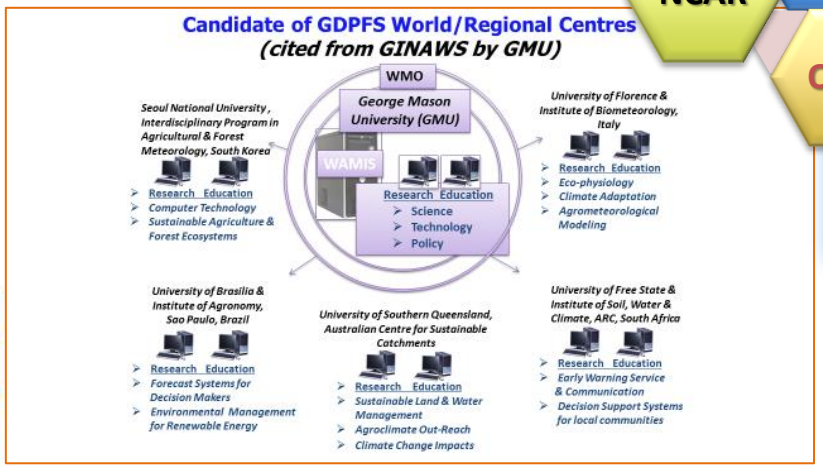
ICT Sharable Platform of WAMIS II





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Global Challenge Research Proposal

- Development of ***Life Cycle Analysis Framework*** (LCAF) on ***GHG/water (resource) footprints*** for national policy decision on best ***Environment performance*** of AgroEcosystem under present and future ***climate conditions***

- ***Focusing on***

- Climate Variability issues: **S2S**
- System integration : **Process Network Analysis**
- **Coupling** of AgroEcosystem to Atmospheric System
- **Synchronization** of Mitigation/Adaptation strategies
- Operation supporting **ICT infrastructures**

GCR KEY SUBJECTS

1) Carbon/Water footprints under present and future climate conditions

Assessment on the effects of AgroEcosystem changes on Carbon/Water footprints under climate projection scenarios

2) Interactions mechanism between AgroEcosystem/Climate system

Modeling agricultural interactions with the environment, especially related to GHG emissions and climate change

3) (Short-/)Long-term feedback of AgroEcosystem to Climate system

Prediction on long-term orientation of AgroEcosystem changes and its impact on Climate system

4) Cross-over impact assessments for Adaptation/Mitigation strategies

Establishing policy decision-making support system with LCAF for adaptation/mitigation strategies under climate change projections

5) ICT platform to support LCA framework

6) Sustainability Evaluation in terms of Socio-Economic-Policy implications

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Partnerships with AAFC, Canada

3. Perspectives of APCC for Climate Service Innovations

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Four Areas of Competencies in Capacity Building

(as articulated by HLT-GFCS)

1. **Human resource capacity (Experts)**
   - equipping individuals with skills, information, knowledge and training to generate, communicate and use decision-relevant information;
2. **Infrastructural capacity (ICTs)**
   - enabling access to the ICT resources that are needed to generate, archive and use data and decision-relevant information;
3. **Procedural capacity (Efficacy)**
   - defining, implementing and advancing best practices for generating and using information;
4. **Institutional capacity (Governance)**
   - elaborating management structures, processes and procedures for effective services, not only within organizations but also between the different organizations and sectors;

Toward Global Climate Service Center

- Vision of APCC under GFCS Umbrella -

❖ GISC-Seoul 의 기후서비스 플랫폼으로 활용
- GFCS의 글로벌 센터화 추진
- 개도국 기후변화 대응 정보 및 전산자원 공유체계

❖ 세계적 기후변화 관련 정보 허브 역할 수행
- 비 기상/기후정보 서비스제공 브릿지로 활용
  WAMIS -DCPC 연계 GEO-PORTAL GATEWAY 기능
- WAMIS DCPC는 전산자원 공유를 위한 클라우드컴,
- GIS Online 등 특수기능을 KISTI 협력을 통해 구현

❖ S2S 농림(응용)기상분야 R&D&S GLOBAL Platform화
- GFCS 농업 식량안보 지원 기후변동 예측정보 제공
- 향후 개도국 기후변화 대응지원 기후서비스센터화

Vision of APCC with GFCS (proposal)

기상청 대기과학기술 보유 자산

- 현재 세계 최고수준 기상자원 보유국

- **기상기후 국가 대형 R&D사업** (현존 세계 최대/최장 유일 사업단)
  한수예(KAIPS),
  차세대 도시농림기상 사업단(WISE),
  기상기후지진사업단(CATER) 등

- **대기과학분야 국제협력 기구/사무국/프로그램 운영/선도**

  GPC-LC-LRFMME, APCC, ICO-S2S, GIAM-TIEGERS
  NIMR : 계절 앙상블 예보 (S2S) KAIPS
  WISE : Megacity, GRUME and
  NCAM : GIAM (GFCS) /WAMIS (DCPC)

- **기상청 소속/산하 관련 조직/제도**

  국가기후자료센터(NCDC) 외 Typhoon/COMS/COMIS
  기상관측표준화 및 공동활용 제도 (보성관측소)
  기상산업진흥원/기상기후아카데미/기상전문인협회

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기상청

National Assets in Atmospheric Science

nimr 국립기상연구소

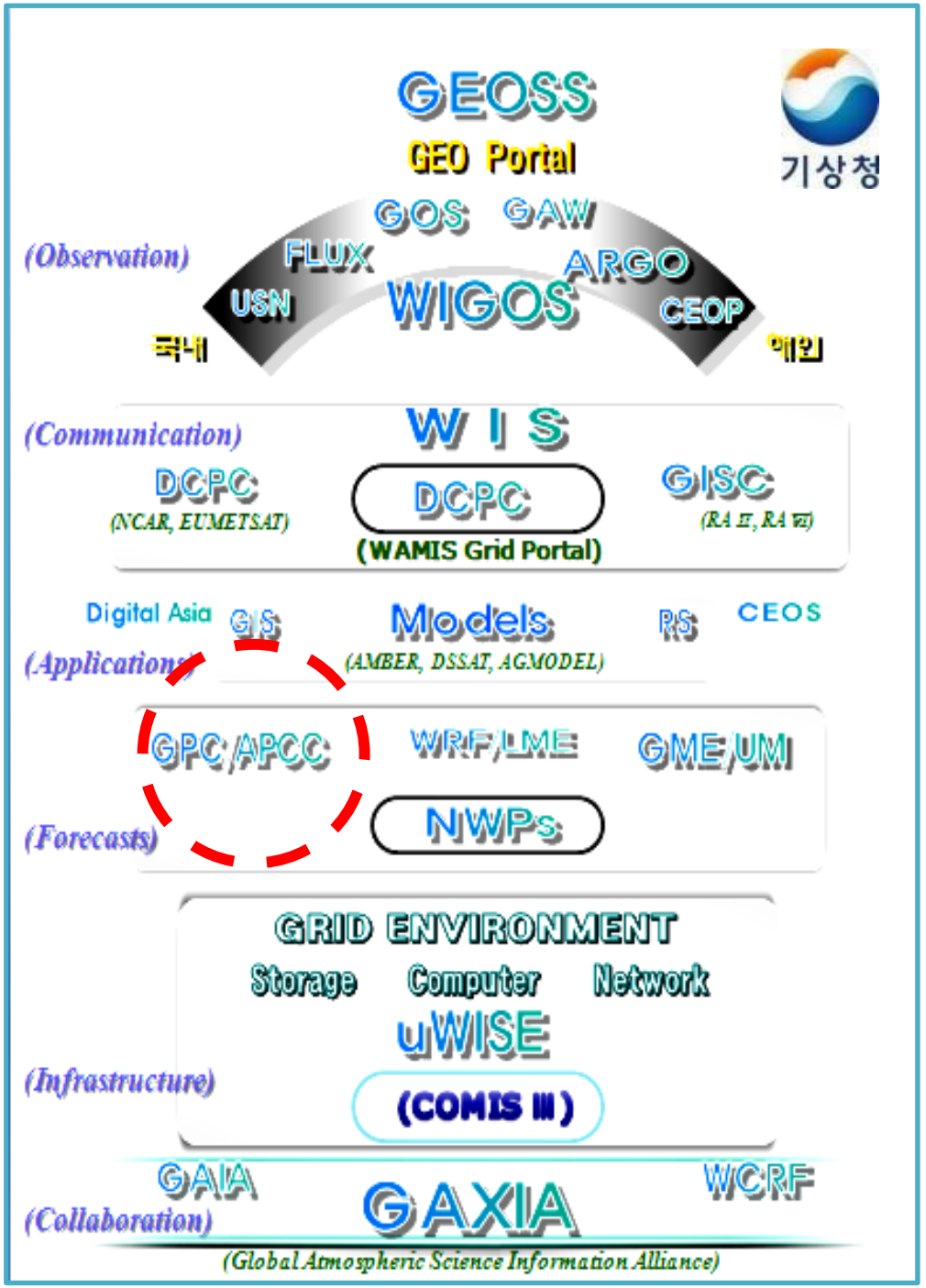
CATER 기상 · 기후 · 지진기술 연구개발사업 전문기관 기상기술개발원

KIAPS KOREA INSTITUTE OF ATMOSPHERIC PREDICTION SYSTEMS

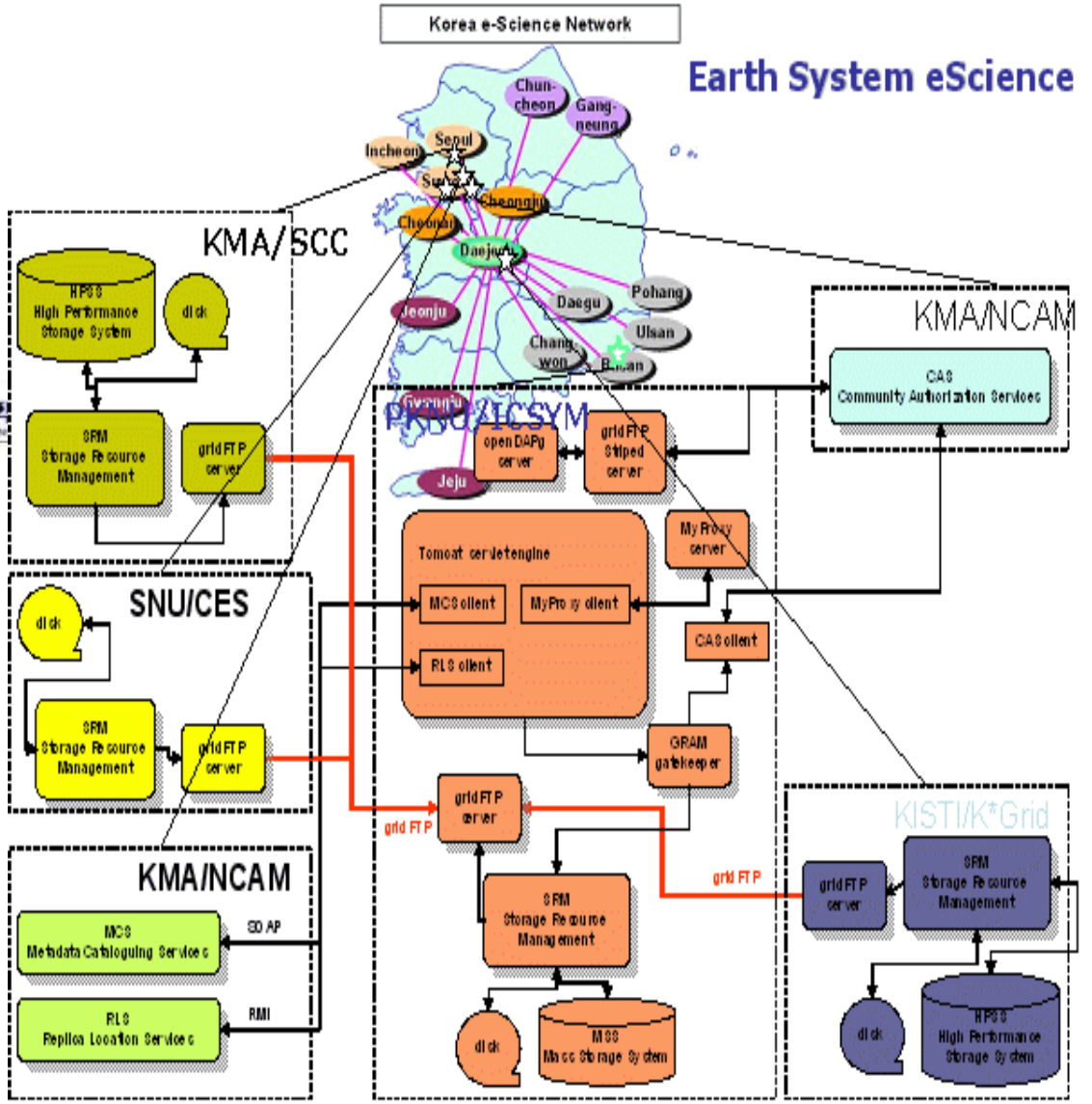
APCC APEC CLIMATE CENTER

SUPERCOMPUTING CENTER

WMO OMM

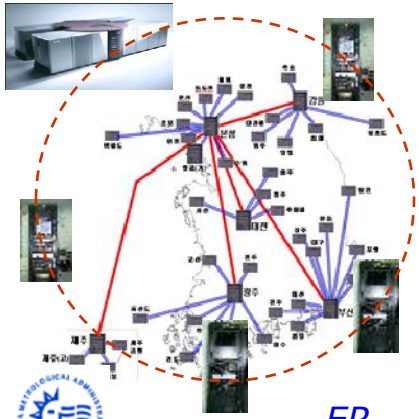


Virtual Earth System eScience Laboratory (VESEL)



WMO OMM

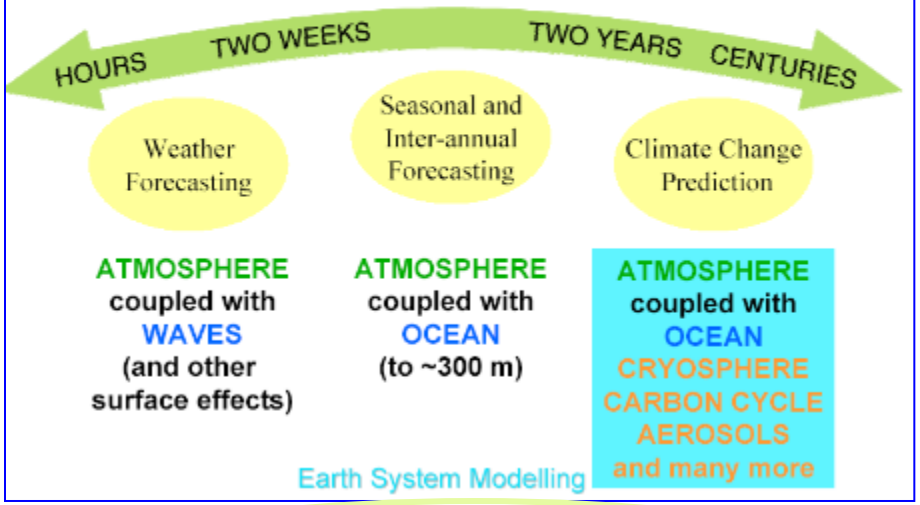
Emergence Response
국가/지역 비상대응체계



ER-IntraGrid

Major model components used

uWISE implementation by KMA

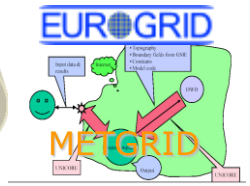


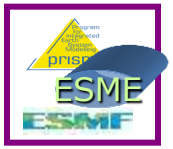
Impact Assessment
기상/기후 환경영향평가

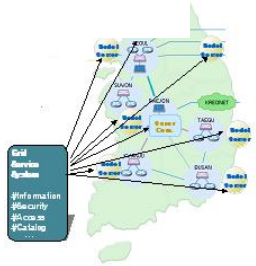
ES-CampusGrid

Implementations

NWP Model

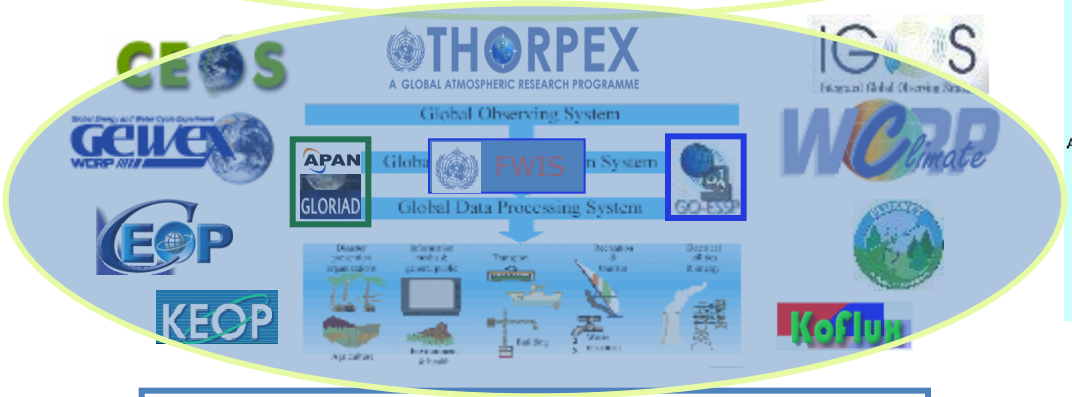


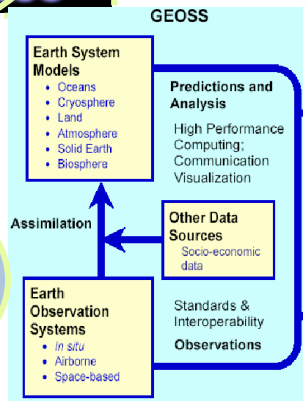




Communication

Observation





IT Framework

Ubiquitous Weather Information System Environment (uWISE)

HPN
HPC
Earth Sys

기상청

Earth System Modeling

Earth Simulator

통합 전지구관측시스템

GEOSS

Earthh System Fremework

Program for integrated Earth System Modelling
prism
유럽
ESME
ESMF
미국

GLORIAD

EURGRID
METGRID
(유럽/독일)

GO-ESSP
지구시스템 자료협의회

GCESD
지구시스템개발컨소시엄

미국/NCAR
ESG

ES²
Earth System eScience
한국/기상청

APAN

APAN
GLORIAD

Earth System Models
- Oceans
- Cryosphere
- Land
- Atmosphere
- Solid Earth
- Biosphere

Predictions and Analysis
High Performance Computing; Communication Visualization

Assimilation

Other Data Sources
Socio-economic data

Earth Observation Systems
- Airborne
- Space-based

Standards & Interoperabilit

Observations

Decision Support
- Assessment
- Decision Support Systems

Policy Decisions
Management Decisions

Impact Assessment
기상/기후 환경영향평가

Emergence Response
국가/지역 비상대응체계

Impact Assessment

CENTURIES
TWO YEARS
TWO WEEKS
HOURS

Climate Change Prediction
Seasonal and Inter-annual Forecasting
Weather Forecasting

Emergence Response

APCN
아태기후센터

GEO Center
국가기상자료센터

Global Observing System
Global Telecommunication System
THORPEX
A GLOBAL ATMOSPHERIC RESEARCH PROGRAMME
전지구관측연구실험시스템

FWIS
차세대기상정보시스템

LEAD
단기악기상예측

GIFS
Global Interactive Forecasting System
중기악기상예측

FWIS Pilot Project
농업기상프로젝트

GISC
METASERVER
RDF/OWL

DCPC
Data/Production
RDF/OWL

NflaAM
국가농업기상센터

G/R-Server
WAMIS
Grid Portal
Web Service

Global Best Partner in Climate Service
We are the Face of Pride-Korea

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Thank you

谢谢

Merci

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

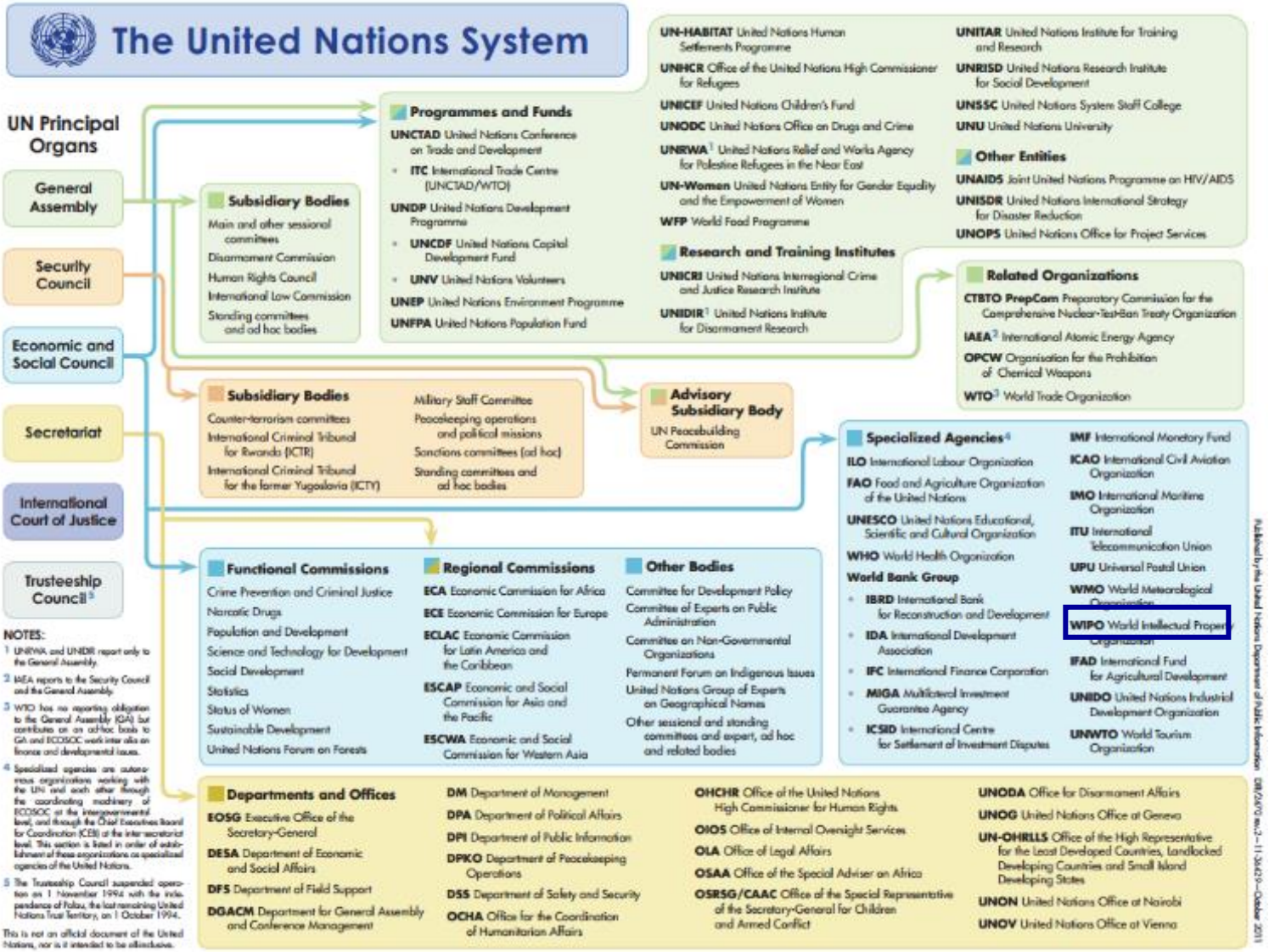
4. References

WMO

UN Special Agency
in Weather, Climate, Water
and relevant Environment

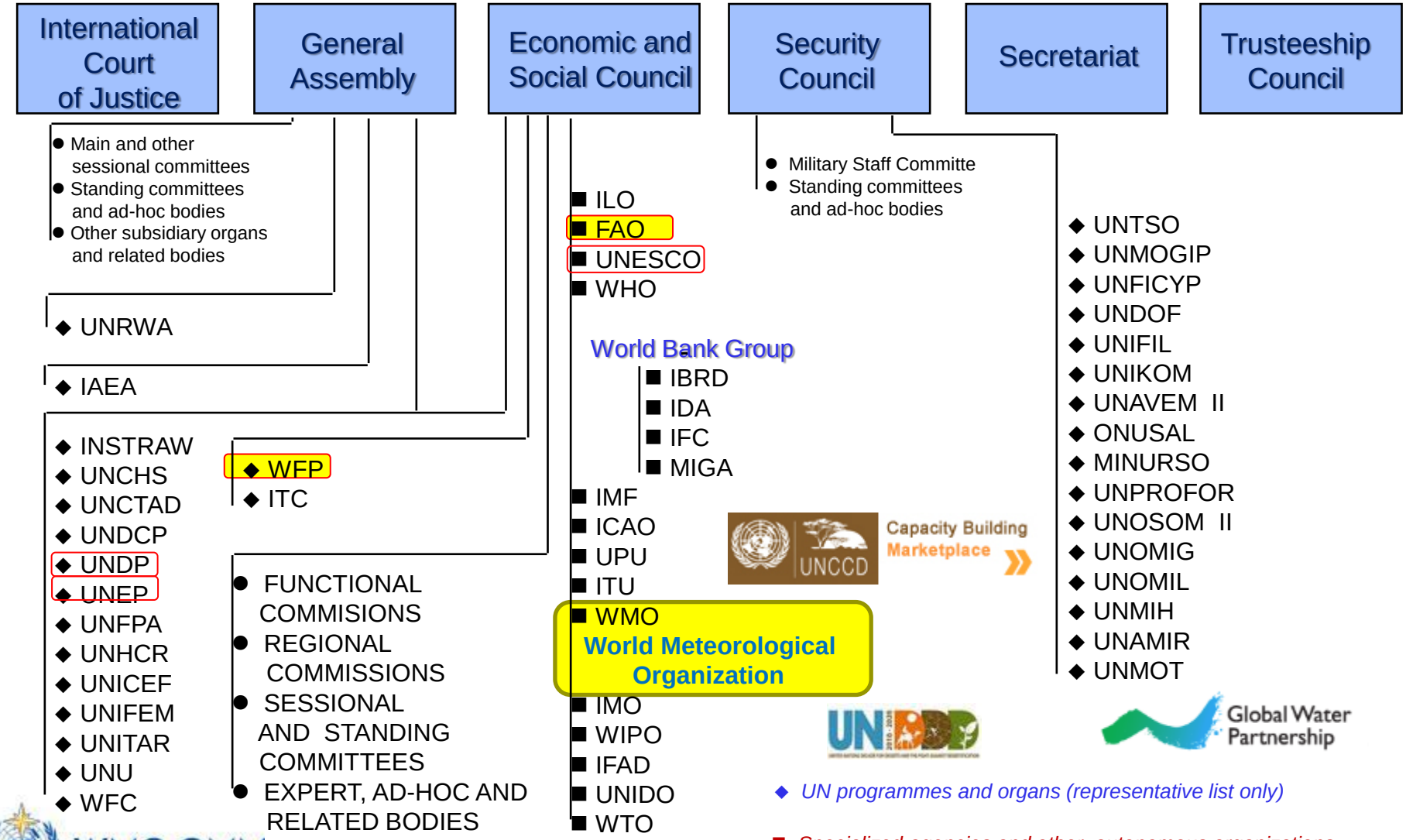
WMO OMM

The United Nations System



WMO OMM

The United Nations System



◆ *UN programmes and organs (representative list only)*

■ *Specialized agencies and other autonomous organizations within the system*

● *Other commissions, committees and ad-hoc related bodies*

WMO in UN inter-agency coordination

- Chief Executives Board for Coordination (CEB)
  - *High-level Committee on Programmes (HLCP)*
  - *High-level Committee on Management (HLCM)*
  - *UN Development Group (UNDG)*
- Mechanisms and networks of HLCP
  - *UN Water* *(Current Chair: Mr. Michel JARRAUD)*
  - *UN Oceans*
  - *UN Energy*
  - *CEB-climate change* *(Current Chair: Ms. Elena MANAENKOVA)*
- Environment Management Group (EMG)
- UN Communications Group (UNCG)
- UN-ISDR (International Strategy for Disaster Reduction)
- Other inter-agency mechanisms and networks

UN Coordination on Climate Change: Areas (conveners)

5 Focus Areas

- Adaptation (HLCP WGCC – All Agencies, Funds and Programmes)
- Technology transfer (UNIDO, UNDESA)
- Reducing Emissions from Deforestation and forest Degradation (FAO, UNDP, UNEP)
- Capacity Building (UNDP, UNEP)
- Financing (WB, UNDP)

---

4 Cross Cutting Areas

- Science, Assessment, Monitoring and Early Warning - Climate Knowledge (WMO, UNESCO)
- Supporting Global, Regional and National Action (UNDP, UNDESA, UN Regional Commissions)
- Public awareness (UN Communication Group, UNEP)
- Climate-neutral UN (UNDP, UNEP)

WMO OMM

WMO in UN inter-agency coordination

- **Chief Executives Board for Coordination (CEB)**
  - ***High-level Committee on Programmes (HLCP)***
  - ***High-level Committee on Management (HLCM)***
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  - ***CEB-climate change*** *(Current Chair: Ms. Elena MANAENKOVA)*
- **Environment Management Group (EMG)**
- **UN Communications Group (UNCG)**
- **UN-ISDR (International Strategy for Disaster Reduction)**
- **Other inter-agency mechanisms and networks**

WMO OMM

UN Coordination on Climate Change: Sectors (conveners)

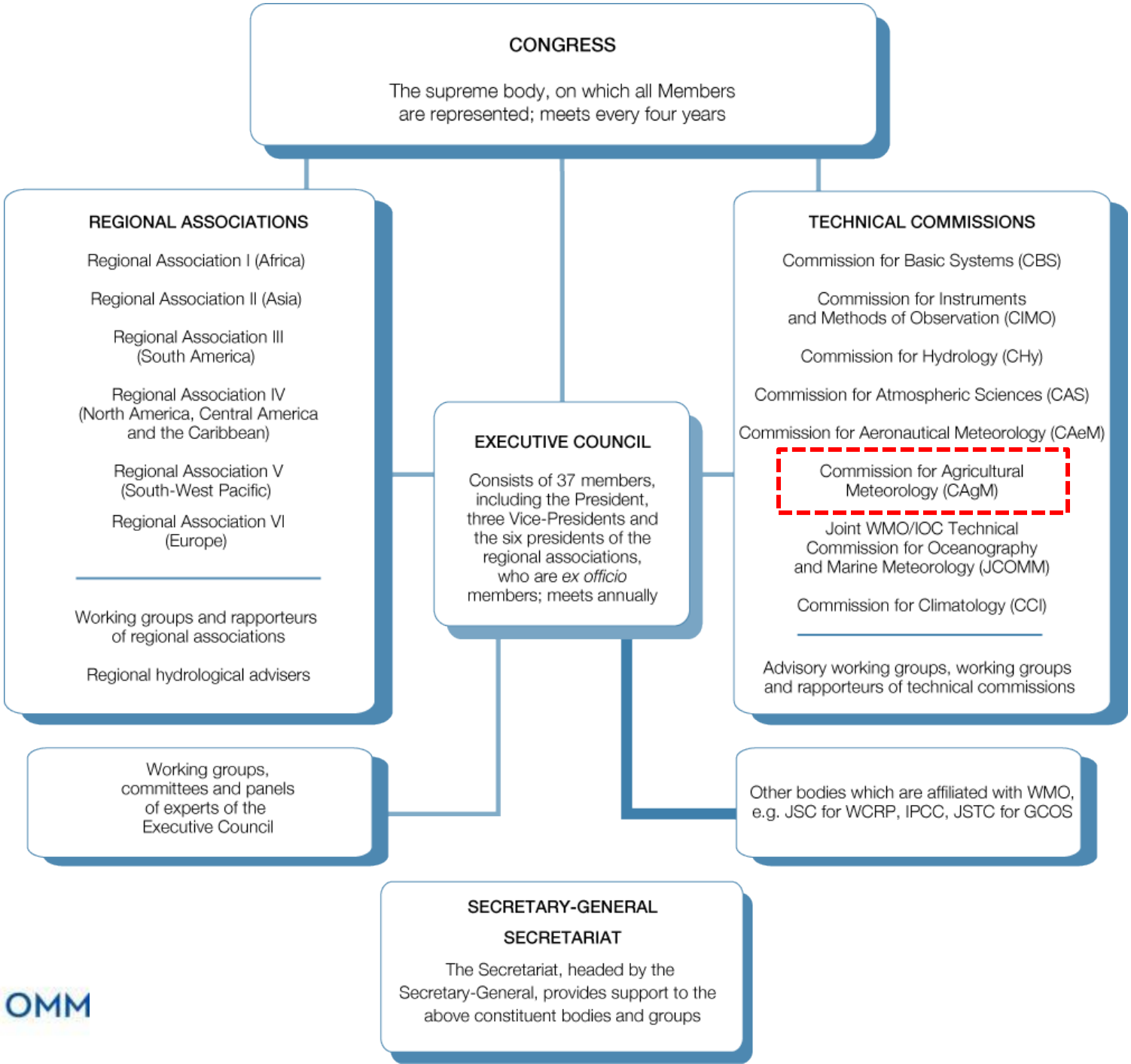
Energy	UN-Energy
Agriculture	FAO, IFAD, WFP
Water	UN-Water
Oceans	UN-Oceans
Forestry& Fishery	FAO
Transport	IMO, ICAO, UPU
Health	WHO
Disaster Risk Reduction	ISDR, WMO
Human Settlements	UN-Habitat
Education	UNESCO
Industry	UNIDO, WIPO

WMO OMM

World Meteorological Organization

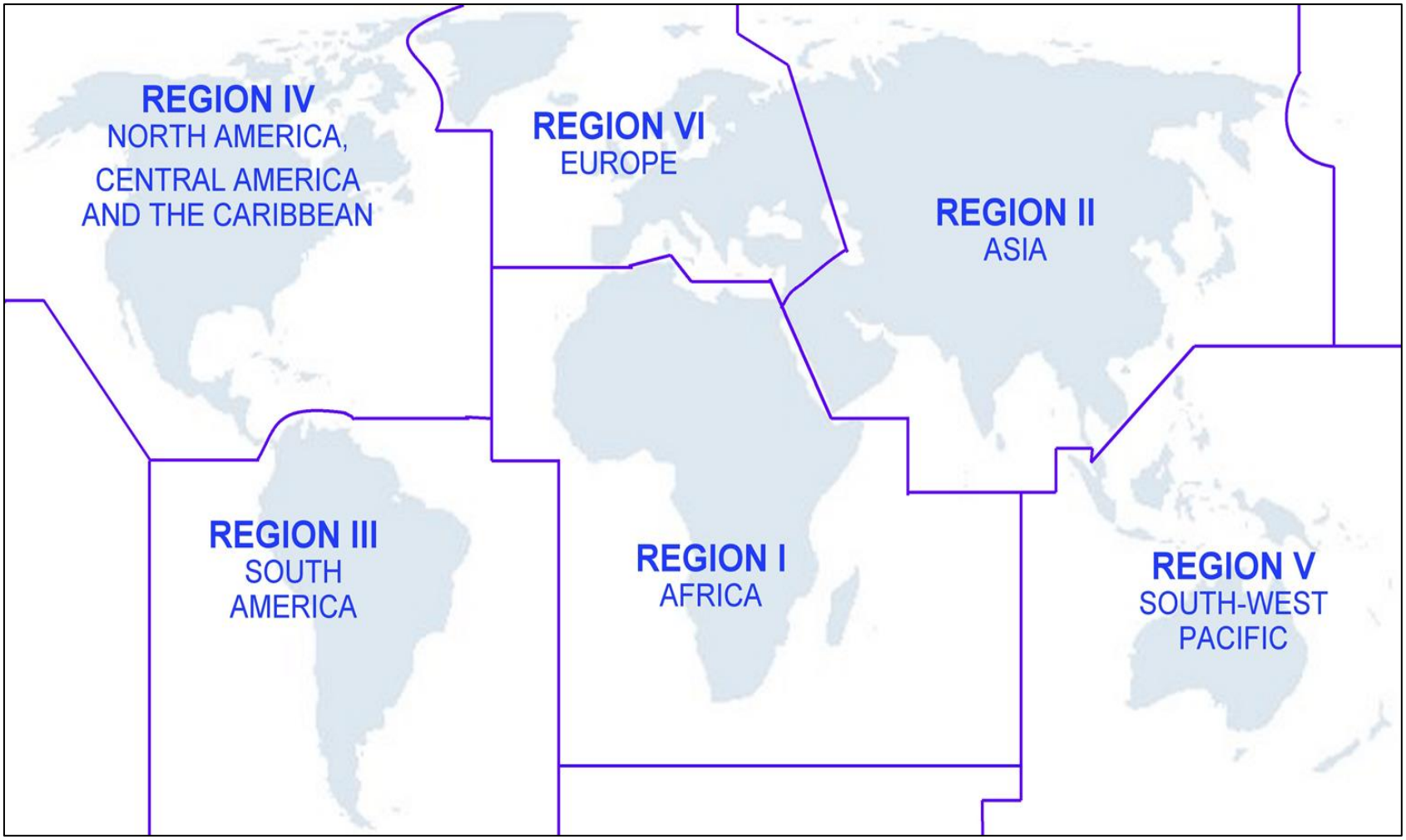
- United Nations agency for weather, climate, hydrology and water resources and related environmental issues.
- 191 Members from National Meteorological and Hydrological Services (NMHS) - New member South Sudan – Dec 2012
- 10 major scientific & technical programmes (Secretariat)
- 8 Technical Commissions advise & guide activities of programmes (Experts)
- 6 Regional Associations involved in implementation

WMO OMM


CONGRESS
The supreme body, on which all Members are represented; meets every four years
REGIONAL ASSOCIATIONS
Regional Association I (Africa)
Regional Association II (Asia)
Regional Association III (South America)
Regional Association IV (North America, Central America and the Caribbean)
Regional Association V (South-West Pacific)
Regional Association VI (Europe)
Working groups and rapporteurs of regional associations
Regional hydrological advisers
EXECUTIVE COUNCIL
Consists of 37 members, including the President, three Vice-Presidents and the six presidents of the regional associations, who are ex officio members; meets annually
TECHNICAL COMMISSIONS
Commission for Basic Systems (CBS)
Commission for Instruments and Methods of Observation (CIMO)
Commission for Hydrology (CHy)
Commission for Atmospheric Sciences (CAS)
Commission for Aeronautical Meteorology (CAeM)
Commission for Agricultural Meteorology (CAgM)
Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)
Commission for Climatology (CCl)
Advisory working groups, working groups and rapporteurs of technical commissions
Working groups, committees and panels of experts of the Executive Council
Other bodies which are affiliated with WMO, e.g. JSC for WCRP, IPCC, JSTC for GCOS
SECRETARY-GENERAL
SECRETARIAT
The Secretariat, headed by the Secretary-General, provides support to the above constituent bodies and groups

WMO OMM

WMO Regional Associations



WMO OMM

WMO Technical Commissions

- Commission for Aeronautical Meteorology (CAeM)
- Commission for Agricultural Meteorology (CAgM)
- Commission for Atmospheric Sciences (CAS)
- Commission for Basic Systems (CBS)
- Commission for Climatology (CCl)
- Commission for Hydrology (CHy)
- Commission for Instruments and Methods of Observation (CIMO)
- Joint WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM)

WMO OMM

WMO Co-Sponsored Programmes

❑ World Climate Research Programme (WCRP)

- Established in 1980 (WMO, ICSU, IOC joined in 1993)
- Focus on operational extended weather, seasonal forecasts and interannual, decadal and longer-term variability
- Evaluating uncertainties in climate-change projections
- Major contributor to IPCC and UNFCCC

❑ Intergovernmental Panel on Climate Change (IPCC)

- Established in 1988 (WMO and UNEP)
- To understand the scientific basis of human-induced climate change, its potential impacts and options for adaptation and mitigation
- No research or monitoring climate-related data/parameters
- Assessment based on peer reviewed and published literatures

❖ Global Climate Observing System (GCOS)

- Established in 1992 (WMO, IOC, UNEP, ICSU)
- Detecting and attributing climate change
- Assessing the impacts of climate variability and change
- Understanding and prediction of the climate system

❖ Global Ocean Observing System (GOOS)

- Sponsored by IOC, UNEP, WMO, ICSU
- Support operational ocean services worldwide
- Provides the basis for forecasts of climate change
- 3000 Argo floats, 1250 drifting buoys, 350 embarked systems, etc.

WIGOS
WMO Integrated Global Observing System

- ***A framework for***
  - ◆Bringing together complementary observing systems from relevant stakeholders
    - **National** – NMHS, Military, Transport, Universities, Agriculture, leisure activity support networks, Emergency Management, etc.
    - **Regional** & thematic – Met Satellite Centres, RSMCs, etc
    - **Global** – WMO, ICSU, IOC, FAO, ISO, OGC, etc
  - ◆Helping national entities meet national mandates and international obligations

WMO OMM

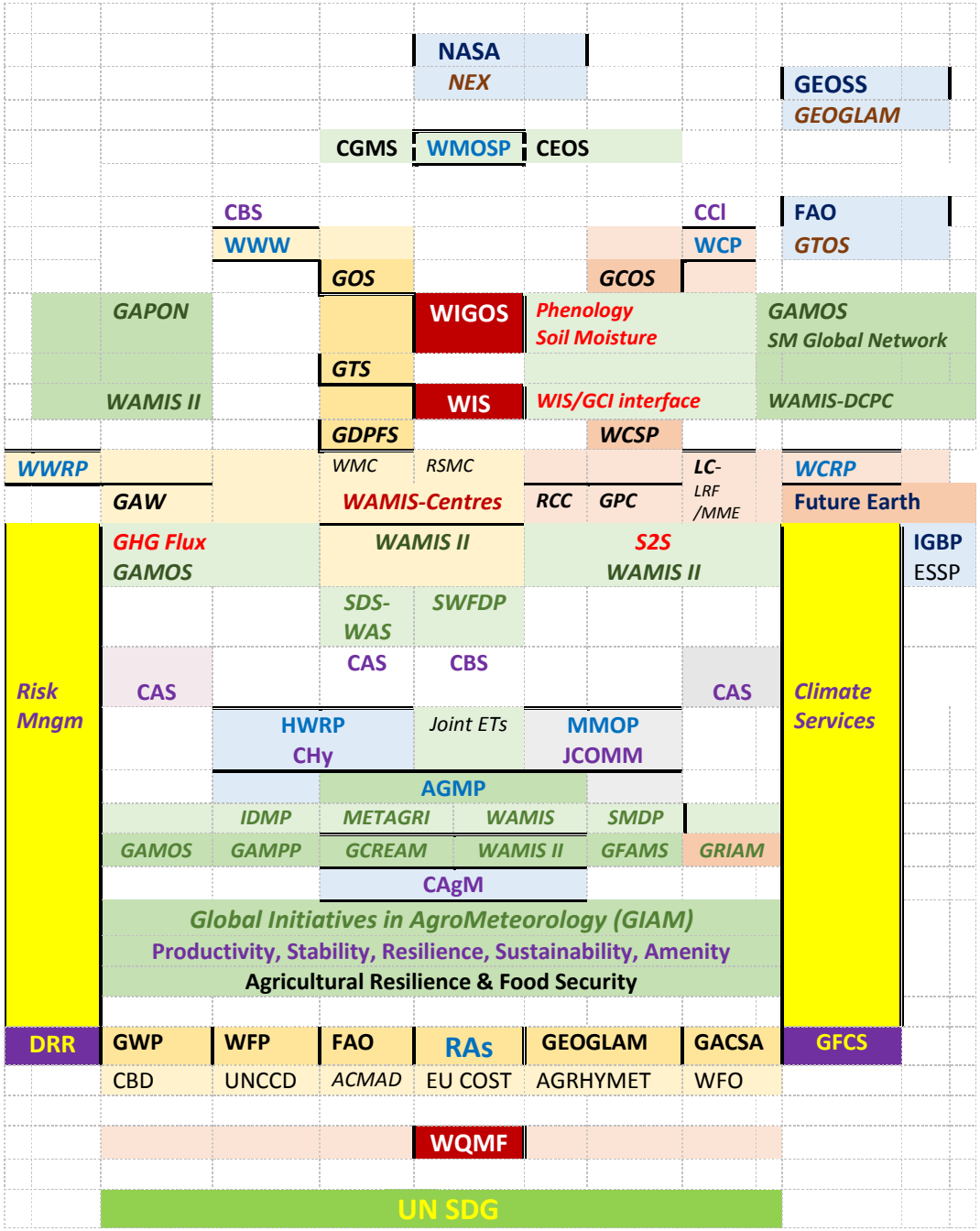
WIS
WMO Information System

Core, cross-cutting component of WMO activities

- **The interoperability layer of WIGOS**
  - ditto GFCS Obs & Monitoring
- **Information Discovery and Exchange for GDPFS**
  - ditto GFCS Research, Modelling & Prediction
- **Core of GFCS Climate Services Information System (CSIS)**
  - Interoperability based on a few agreed standards allows different communities to describe, find and share each others information
  - Work to be done on modelling data representation Systems

WMO Structural Schematic

Partnerships
CAgM Perspective



WMO OMM

WMO CAgM
& GFCS

WMO OMM

CAgM Vision & Missions

Sub-Sectors (4) : Agriculture, Livestock, Forestry, Fishery

To promote **AgroMeteorology** and related **research** & **services** for sustainable **food supply & rural resilience** to adapt to **weather and climate variability** on **all time scales.**

Missions (141 member countries)

***provides* guidance** in the field of **agricultural meteorology** by studying and reviewing the available science and technology;

***proposes* international standards** for methods, procedures;

provides a **forum** for the examination and resolution of relevant **scientific and technical** issues;

promotes the **training** and the **transfer** of **knowledge** and **methodologies**, including the results of research, between WMO Members; and

***promotes* international cooperation** and maintains **close cooperation** in scientific and technical matters with **other international organizations**.

CAgM & Sustainable Agriculture

By definition, CAgM has a focus on sustainable agriculture especially where weather and climate information can reduce production risks and increase production with minimal impact on the environment

WMO OMM

Sustainable Agriculture

- **Sustainable agriculture integrates three main goals--environmental health, economic profitability, and social and economic equity.**
- ***Stewardship of both natural and human resources* is of prime importance**
- ***Systems perspective* is essential to understanding sustainability**
- ***Interdisciplinary efforts in research and education***
- ***Making the transition to sustainable agriculture is a process*.**

WMO Requirements to CAgM

UN SYSTEM
DELIVERING AS ONE ON
CLIMATE KNOWLEDGE

1. **Strategic Plan : Enhanced Capability for Better Service**

   Enhanced Capabilities for **High Quality resources** , **Risk Management**, better **information service**, earth system **monitoring**, **ST developments**, **for emerging members** through **better partnerships and cooperations**

2. **WMO Reform : Application oriented Service**

   a. Improved Documentation & **communication between TCs and Ras**
   b. Orientate the constituent bodies of WMO **to deliver the Strategic Plan**
   c. Reduce the intergovernmental part of constituent body sessions

3. **GFCS Implementation : 5 Components**

   a. Internal working methods, …deciding on **implementation priorities,**
   b. Mechanisms to strengthen the **global cooperative system**
   c. Projects for **the needs of developing countries**
   d. External communications, resource mobilisation and capacity development

4. **WIS Implementation : DCPC, metadata**

   - **Agronomy data sharing beyond WMO**

5. **WIGOS Implementation : Function/Manual/Metadata**

   - **LDAS, NASNET, Carbon Tracker supports, Ground truth, Phenology**

6. **DRR Implementation : Focal point/Hazard risk/Multi hazard etc.**

   - **DRR thematic "user-interface mechanisms"**
   - **associated deliverables during the 2012-2015 Inter-sessional Period**

WMO OMM

Key Questions in AgroMeteorology

- What are the weather / climate events that impact agricultural decision-making?
- How to relate weather / climate information to meaningful agricultural actions / practices?
- How to assess Sustainability under Climate Variability in terms of Mitigation & Adaptation

COMMISSION FOR AGRICULTURAL METEOROLOGY

President: Byong Lee, Vice-President: Federica Rossi

Management Group (MG)

Advisors:
S. Orlandini (Italy-RA VI)
G. Zhou (China-RA II)

FOCUS AREAS (FA)

FA 1
Operational Agricultural Meteorology

Chair: N. Chattophday (India-RA II)
Co-chair: D. Diarra (Mali-RA I)

FA 2
Science and Technology for Agricultural Meteorology

Chair: O. Brunini (Brazil-RA III)
Co-chair: H. Shannon (USA-RA IV)

FA 3
Natural Hazards and Climate Change/Variability In Agriculture

Chair: R. Stone (Australia-RA V)
Co-chair: R. Desjardins (Canada-RA IV)

FA 4
Capacity Development in Agricultural Meteorology

Chair: E. Mateescu (Romania-RA VI)
Co-chair: J. Ukeje (Nigeria-RA I)

WMO OMM

Sustainable Development Goals and CAgM

- **Goal 1.** End poverty in all its forms everywhere
- **Goal 2.** End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- **Goal 13.** Take urgent action to combat climate change and its impacts
- **Goal 15.** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and Halt and reverse land degradation and halt biodiversity loss
- **Goal 17.** Strengthen the means of implementation and revitalize the global partnership for sustainable development

FAO Definition of SARD

(Sustainable Agriculture & Rural Development)

- Maintains and, where possible, **enhances the productive capacity of the natural resource base as a whole**, and the regenerative capacity of renewable resources, without disrupting the functioning of basic **ecological cycles and natural balances**, destroying the socio-cultural attributes of rural communities, or **causing contamination of the environment.**

- **Reduces the vulnerability of the agricultural sector to adverse natural** and socio-economic **factors and other risks**, and strengthens self-reliance.
- (From FAO Trainer's Manual, Vol. 1, "Sustainability issues in agricultural and rural development policies," 1995).

WMO OMM

CAgM Partnerships

- FAO and WFP
- World Farmer's Organization (WFO)
- AGRHYMET and ACMAD
- EUMETSAT and WMO-RTCs
- United Nations Convention to Combat Desertification (UNCCD)
- Convention on Biological Diversity (CBD)
- COST Actions of the European Science Foundation
- Group on Earth Observations (GEO)
- Climate Smart Agriculture Alliance (CSAA)

WMO OMM

CAgM and GFCS

- **CAgM members helped develop the GFCS Agriculture and Food Security Exemplar**

- **CAgM-16 created User Interface Platform for Agriculture and Food Security (UIP-AFS) within the Focus Area 4 - Capacity Development**

- **UIP-AFS meeting in 2016 developed user requirements based on the needs of selected GFCS countries**

3-Tiers Approach for AGMP

for efficient, effective & on-time supports to emerging requirements from UN, WMO, Members, Partners through Synergy build-up by leveraging available resources and legacy systems

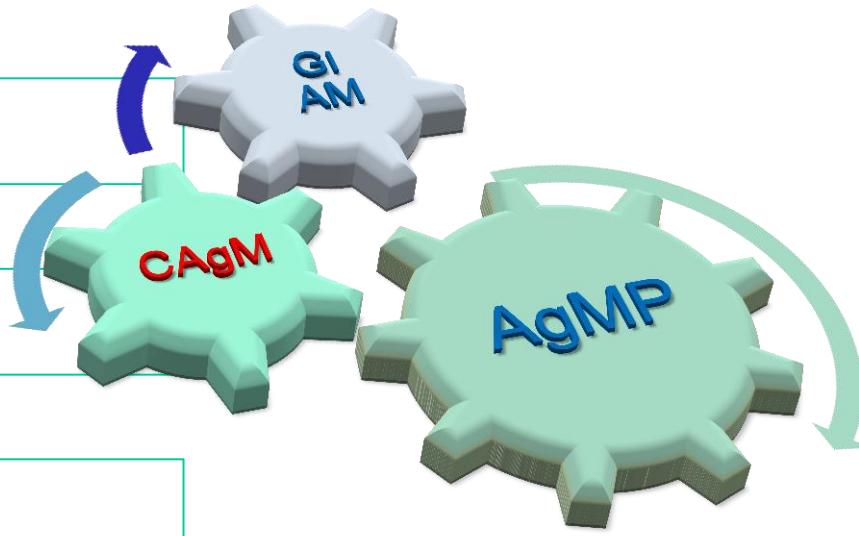
FOCUS AREAS (FA)

FA 1	FA 2	FA 3	FA 4
Operational Agricultural Meteorology	Science and Technology for Agricultural Meteorology	Natural Hazards and Climate Change/Variability In Agriculture	Capacity Development in Agricultural Meteorology
Chair: N. Chattophday (India-RA II) Co-chair: D. Diarra (Mali-RA I)	Chair: O. Brunini (Brazil-RA III) Co-chair: H. Shannon (USA-RA IV)	Chair: R. Stone (Australia-RA V) Co-chair: R. Desjardins (Canada-RA IV)	Chair: E. Mateescu (Romania-RA VI) Co-chair: J. Ukeje (Nigeria-RA I)

Emerging/Future issues, Flexible & Supplementary Scheme

Current issues (ToR), Fixed & Key Strategic plans

Project Implementation & Management for the Members



WMO OMM

Global Initiatives in Agrometeorology (GIAM)

- Global Centres of Research and Excellence in AgroMeteorology (GCREAM)
- Global Federation of AgroMeteorological Societies (GlobalFAMS)
- WAMIS Next Phase (II) with WAMIS-DCPC
- Global AgroMeteorological Outlook System (GAMOS)
  - Global Alliance of Phenology Observation Network (GAPON)
- Global AgroMeteorological Pilot Projects (GAMPP)

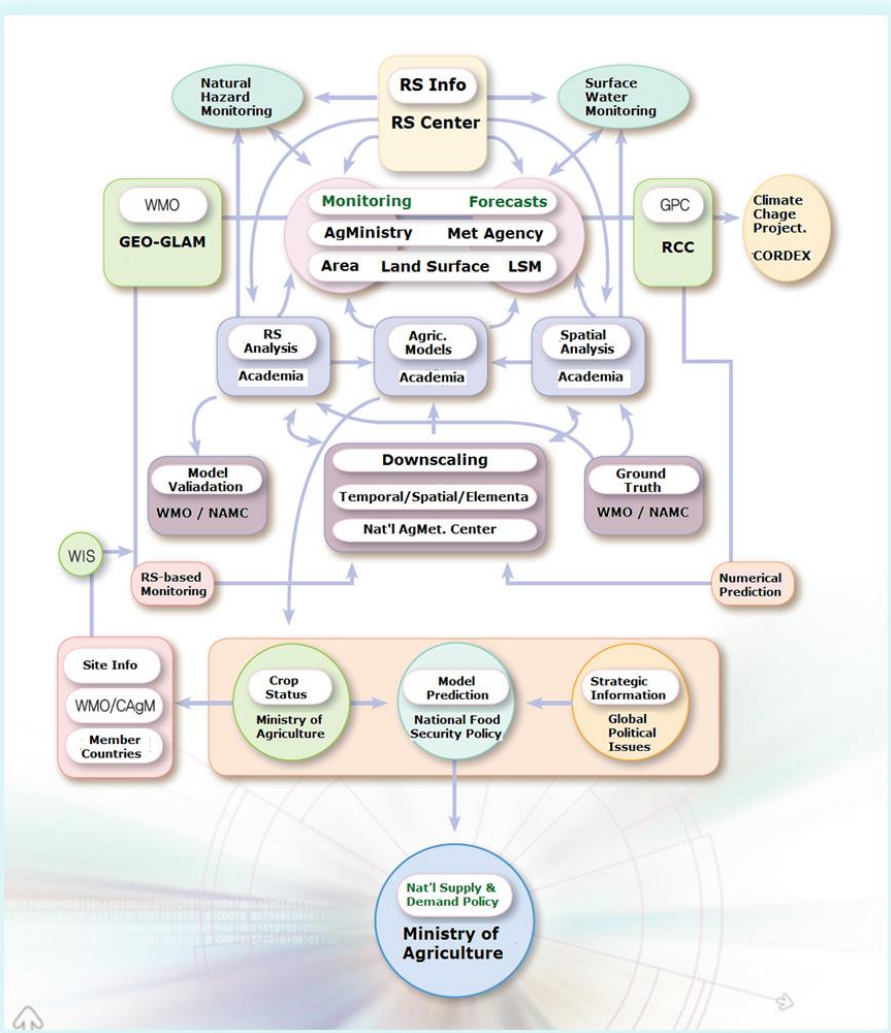
WMO OMM

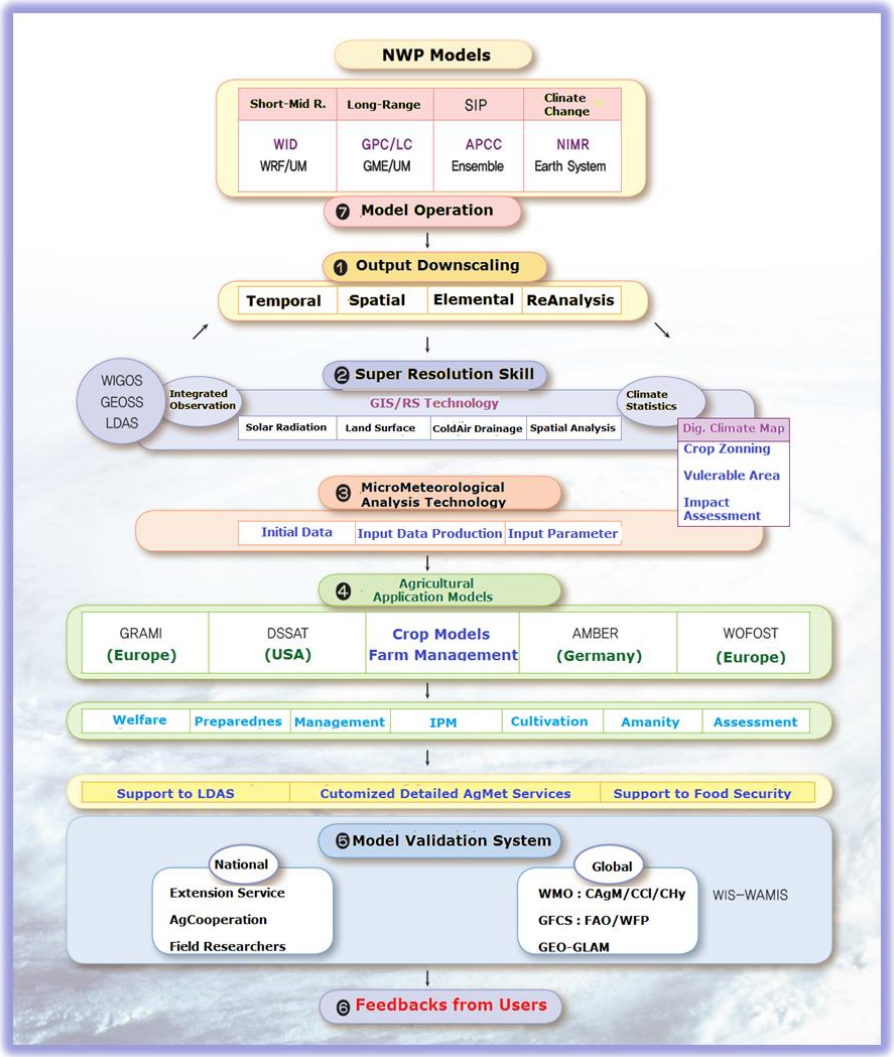
GFCS Pillars vs CAgM GIAM Components

GFCS	CAgM GIAM
User Interface Platform (UIP)	Global Federation of AgroMeteorological Societies (GlobalFAMS) WAMIS Next Phase
Climate Services Information System (CSIS)	WAMIS Next Phase
Research, Modeling and Prediction	WAMIS Next Phase Global AgroMeteorological Outlook System (GAMOS)
Observations and Monitoring	Global Alliance of Phenology Observation Network (GAPON) Global AgroMeteorological Outlook System (GAMOS) Global AgroMeteorological Pilot Projects (GAMPP)
Capacity Building	Global Centres of Research and Excellence in AgroMeteorology (GCREAM)

WMO

Core Climate Services : In-situ/RS/NWPs based



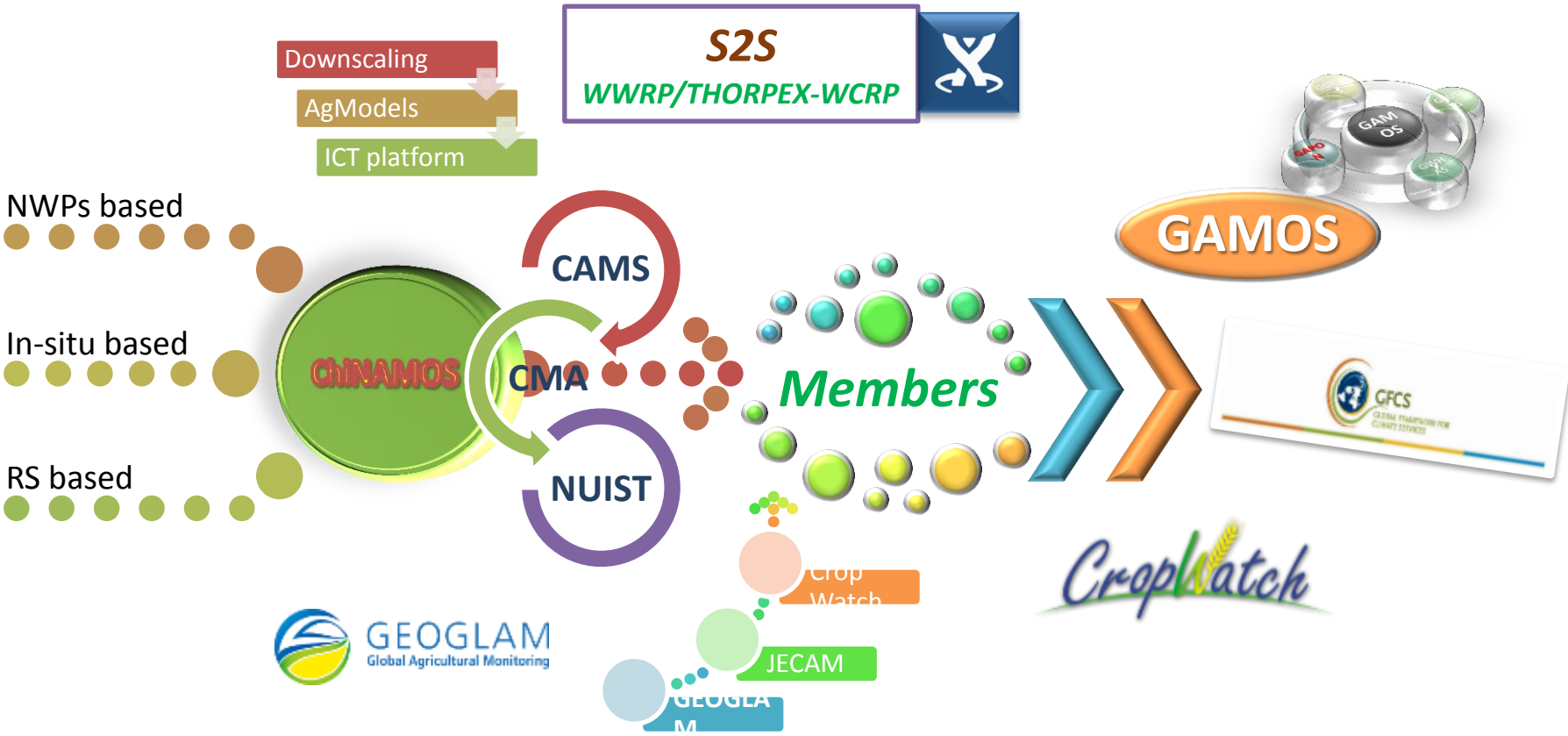


WMO OMM

From now-casting
To climate change projection

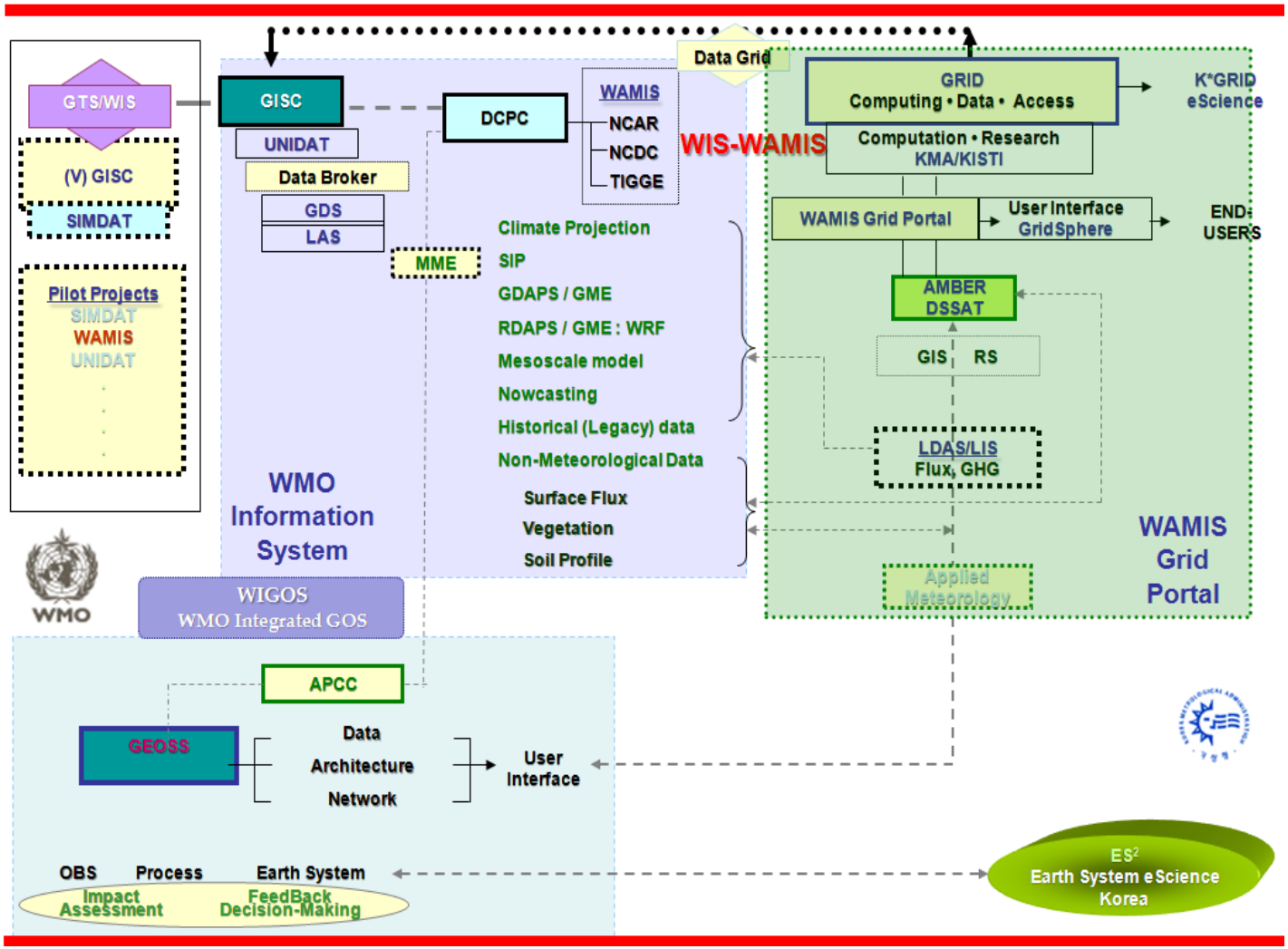
CAgM-GEOGLAM :

Global AgroMet Early-Warning & Outlook System



WMO OMM

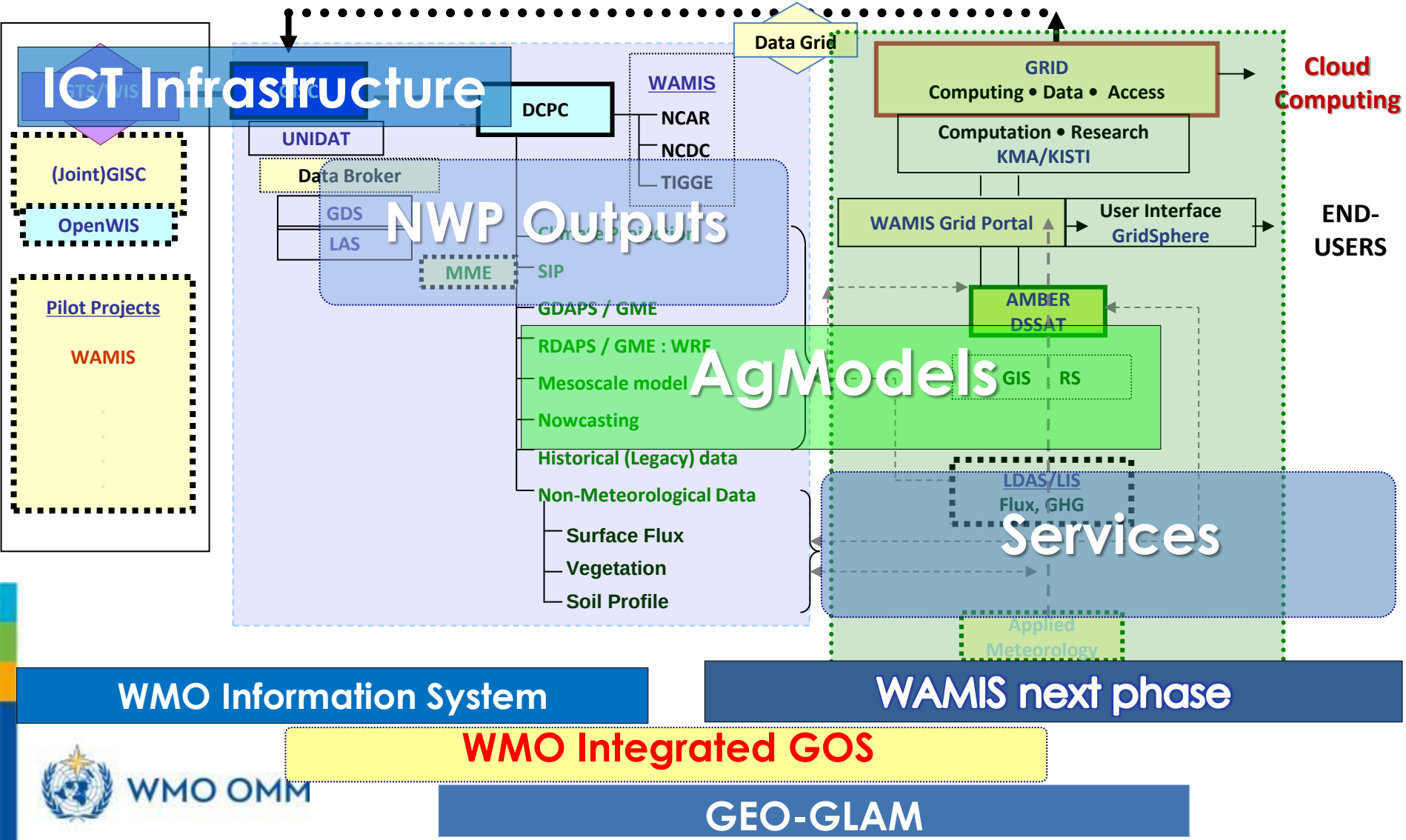
Service Framework of WAMIS I

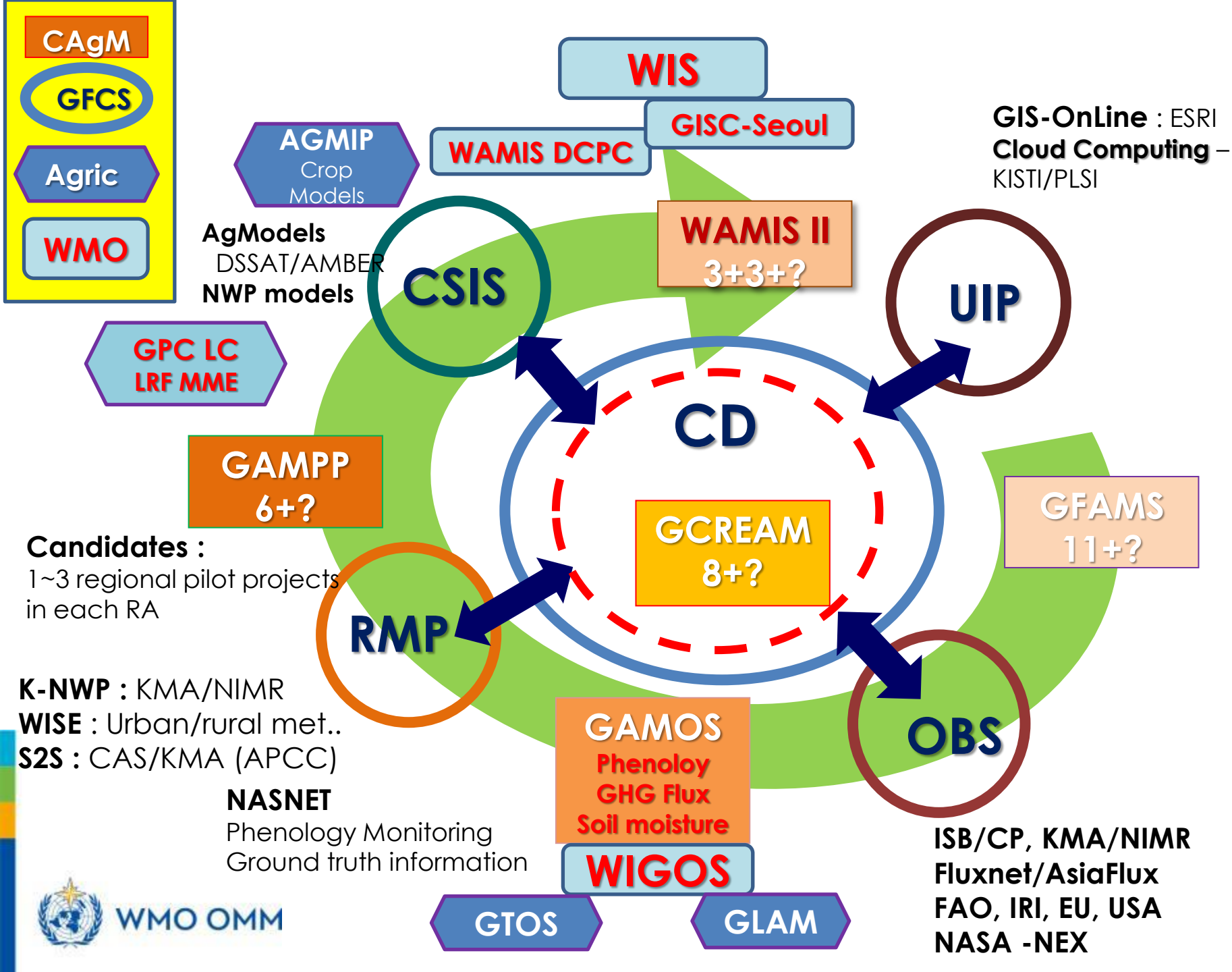


APCC
APEC CLIMATE CENTER

WMO OMM

Service Framework of WAMIS II




CAgM
GFCS
Agric
WMO
WIS
GISC-Seoul
WAMIS DCPC
AGMIP
Crop
Models
AgModels
DSSAT/AMBER
NWP models
GIS-OnLine : ESRI
Cloud Computing – KISTI/PLSI
WAMIS II
3+3+?
CSIS
UIP
GPC LC
LRF MME
CD
GAMPP
6+?
GCREAM
8+?
GFAMS
11+?
Candidates :
1~3 regional pilot projects
in each RA
RMP
OBS
K-NWP : KMA/NIMR
WISE : Urban/rural met..
S2S : CAS/KMA (APCC)
GAMOS
Phenoloy
GHG Flux
Soil moisture
NASNET
Phenology Monitoring
Ground truth information
WIGOS
GTOS
GLAM
ISB/CP, KMA/NIMR
Fluxnet/AsiaFlux
FAO, IRI, EU, USA
NASA -NEX
WMO OMM

GIAM Governance for CD with GRIAM

ICO-GIAM
GRIAM/China

GCREAM
Korea/India+8

GFAMS
Italy/Brazil/India+9

GAMPP
Australia/Korea+

GAMOS
China/Canada+8

WAMIS II
USA/Italy/Korea+2

GAMPP (in preparation for GCF)

-Global Challenge Research : LCA Framework for Sustainability Assessment

-ICT Sharable Platform for Operational S2S applications to AgFS

WMO OMM