Sub-seasonal to Seasonal Prediction Project (S2S)

40th Session of the WCRP Joint Scientific Committee

Andrew W. Robertson, IRI, Columbia University
Frederic Vitart, ECMWF
May 2019
Geneva, Switzerland

S2S Mission [WWRP/WCRP Joint Project]

Subseasonal-to-Seasonal **S2S** Prediction Project

SUB-SEASONAL TO SEASONAL PREDICTION
RESEARCH IMPLEMENTATION PLAN

OBJ 1, 2

OBJ 4

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

- Promote the initiative's uptake by operational centres and exploitation by the applications community

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

Progress and achievements

Community building

International Conferences on Subseasonal to Decadal Prediction
17–21 September 2018 | NCAR, Boulder, CO, USA

Second International Conference on Subseasonal to Seasonal Prediction (S2S) and
Second International Conference on Seasonal to Decadal Prediction (S2D)

Conference by the numbers

- 347 Participants
- 224 Poster Presentations
- 144 Oral Presentations
- 92 Early Career Scientists
- 38 Countries
- 5 Days
- 2 Conferences

S2S and S2D Boulder 2019

AGU 2019 S2S Session - 72 Presentations

Science

MJO Prediction and Teleconnections [WCRP-WWRP/WGNE MJO Task Force]

Forecast Lead Time When MJO Index Skill Reaches 0.6

Z500 anomalies 10 days after an MJO in Phase 3

- Big recent improvements in MJO prediction skill
- MJO Teleconnections still show serious model biases

Vitart (2017)

Stratospheric Impacts on S2S Predictability [SPARC]

Neutral Stratospheric Vortex

Weak Stratospheric Vortex

Prediction skill of the 1000 hPa Northern Annular Mode for week 3 in the S2S models

- For most models, skill is higher following weak vortex conditions.
- Similar results are found following strong vortex conditions.

Research-Operations

Calibrated S2S Forecast Product Development [R2O]

On Feb 13–15 2018, Tropical cyclone Basyang/Sanba hit the Philippines (150,000 affected & 50,000 displaced). Could it be predicted 3–4 weeks ahead?

Week 3–4 Forecast   Observed Percentile   MJO Impacts

Probabilistic Skill

- Probabilistic multi-model calibrated forecasts show skill
- MJO often plays a role analogous to ENSO in seasonal forecasting

N. Vigaud, IRI

Data Infrastructure

S2S Database [Data Infrastructure]

Contributing Centres to S2S database

ECMWF S2S Server

Over 1000 active users of ECMWF archive
With ~500TB retrieved since 2015.

S2S Database Models

CMA S2S Data Server

S2S Database in IRI Data Library

WCRP — World Climate Research Programme
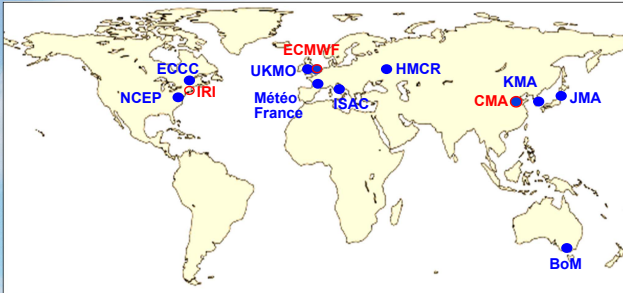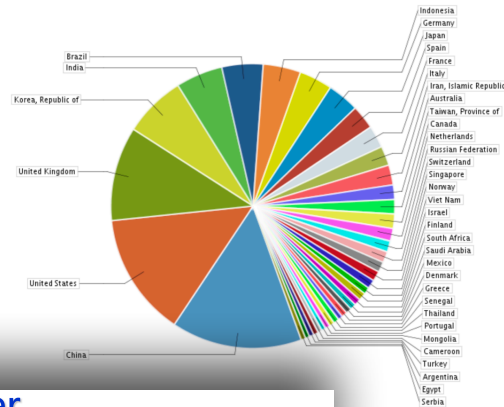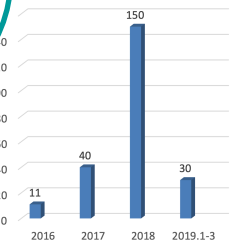
S2S Database [Data Infrastructure]

Contributing Centres to S2S database

● Data provider (11)   O Archiving centre (3)

(World map with labels: ECCC, NCEP, IRI, UKMO, ECMWF, Météo France, ISAC, HMCR, CMA, KMA, JMA, BoM)

ECMWF S2S Server

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■ active users

(Pie chart of user distribution by country: Indonesia, Germany, Japan, Spain, France, Italy, Iran Islamic Republic of, Australia, Taiwan Province of, Canada, Netherlands, Russian Federation, Switzerland, Singapore, Norway, Viet Nam, Israel, Finland, South Africa, Saudi Arabia, Mexico, Denmark, Greece, Senegal, Thailand, Portugal, Mongolia, Cameroon, Turkey, Argentina, Egypt, Serbia, Brazil, India, Korea Republic of, United Kingdom, United States, China)

S2S Database Models

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rf
					Forecasts		**Hindcasts**	
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28						
JMA (rjtd)	d 0-33	TI479/TI319L						
KMA (rksl)	d 0-60	N216L85						
NCEP (kwbc)	d 0-44	T126L64						
UKMO (egrr)	d 0-60	N216L85						

Forecasts available 3 weeks
Currently ~70 Tbytes

S2S Database in IRI Data Library

- Over 2/3 of the S2S database is archived at IRI, including MJO indices
- Kept up to date
- Allows server-side and "lazy" computation to analyze the data according to user requests (eg weekly averaged anomalies of ensemble means, EOFs …)
- Good for low-bandwidth situations
- OpenDAP
- Includes RMM indices

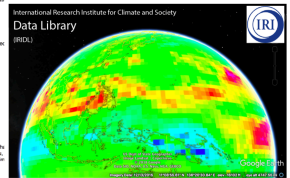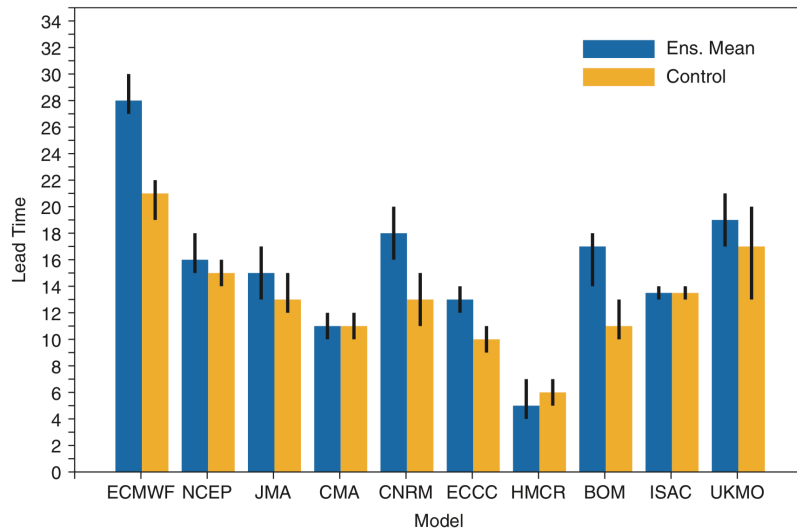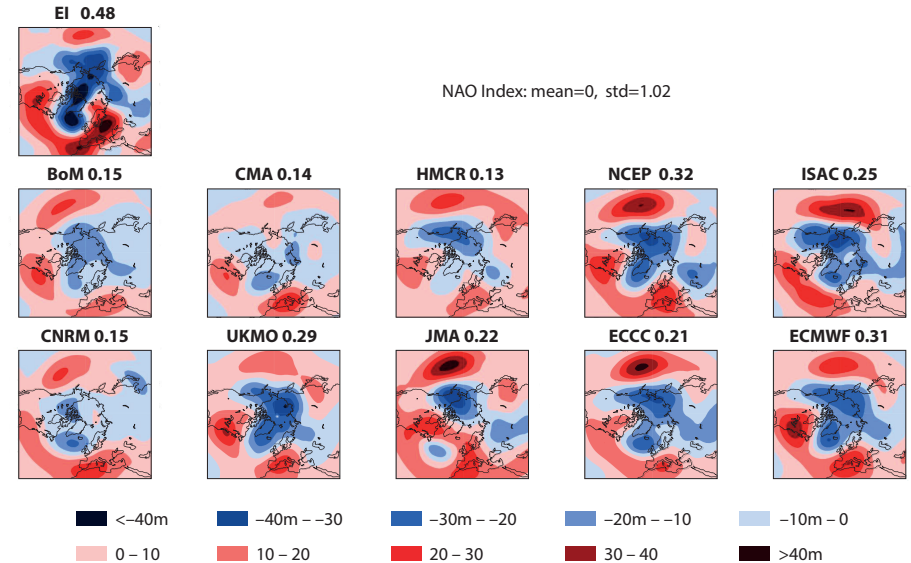*Figure 1. Visualization of an S2S forecast using Google Earth. Data was post-processed and downloaded from the IRI Data Library.*

61 articles using S2S DB

CMA S2S Data Server

Number of Visits (ten thousands)

(Bar chart: 2016: 11, 2017: 40, 2018: 150, 2019.1-3: 30)

Registered user distribution

download top five centers
ECMWF, CMA, BOM, UKMO, NCEP
download top five parameters
t, u, v, mx2t6, gh
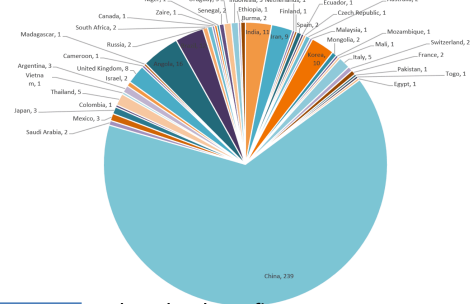
Data download (TB)

year	amount of data
2016	1.9
2017	3.1
2018	3.2
2019.1-3	20.7

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MJO Prediction and Teleconnections
[WCRP-WWRP/WGNE MJO Task Force]

Forecast Lead Time When MJO Index Skill Reaches 0.6

Z500 anomalies 10 days after an MJO in Phase 3
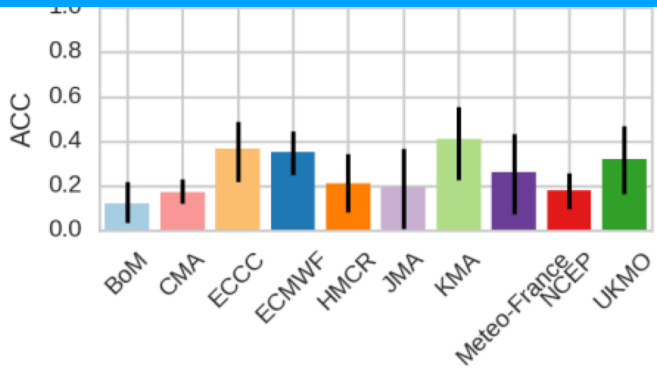

NAO Index: mean=0, std=1.02

- • Big recent improvements in MJO prediction skill
- • MJO Teleconnections still show serious model biases
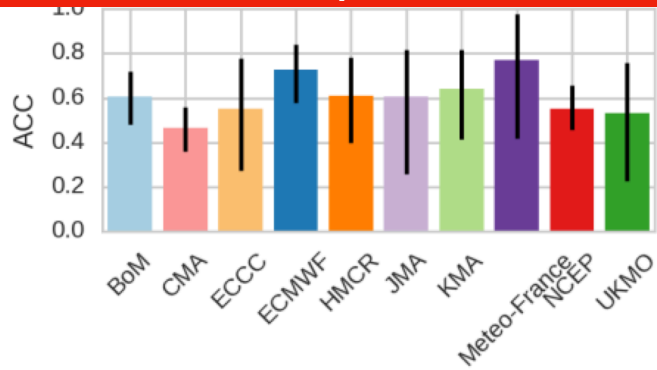
Vitart (2017)

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SPARC-SNAP

Prediction skill of the 1000 hPa Northern Annular Mode for week 3 in the S2S models
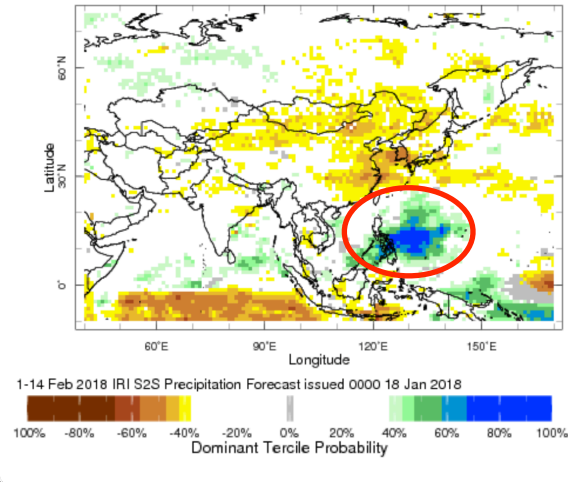
• For most models, skill is higher following weak vortex conditions.

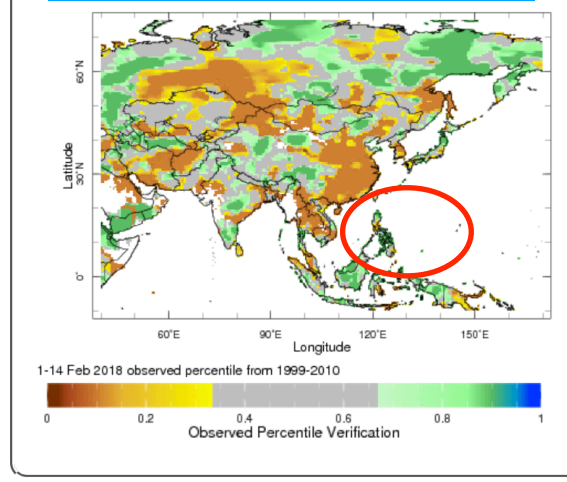• Similar results are found following strong vortex conditions.

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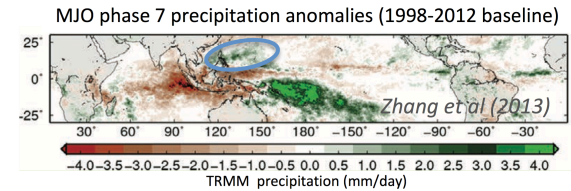
Week 3–4 Forecast

1-14 Feb 2018 IRI S2S Precipitation Forecast issued 0000 18 Jan 2018

Dominant Tercile Probability

Observed Percentile

1-14 Feb 2018 observed percentile from 1999-2010

Observed Percentile Verification

MJO Impacts

MJO phase 7 precipitation anomalies (1998-2012 baseline)

Zhang et al (2013)

TRMM precipitation (mm/day)

Skill relationship to **strong MJO activity in phase 7**

N. Vigaud, IRI

Probabilistic Skill

Ranked Probability Skill Score
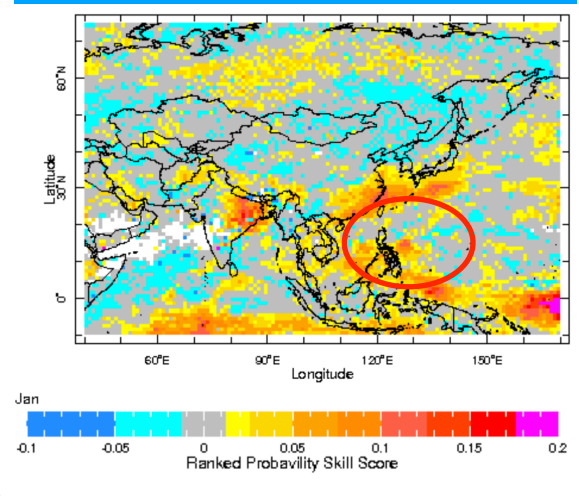
International Research Institute for Climate and Society
EARTH INSTITUTE | COLUMBIA UNIVERSITY

• Probabilistic multi-model calibrated forecasts show skill
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Future plans

Science

New research foci MJO prediction and teleconnections; roles of Ocean and sea ice, Land surface, Stratosphere, Atmospheric composition and Ensemble generation.

Research-Operations Applications Dev.

Enhancing operational infrastructure, user applications & real-time pilot experiment
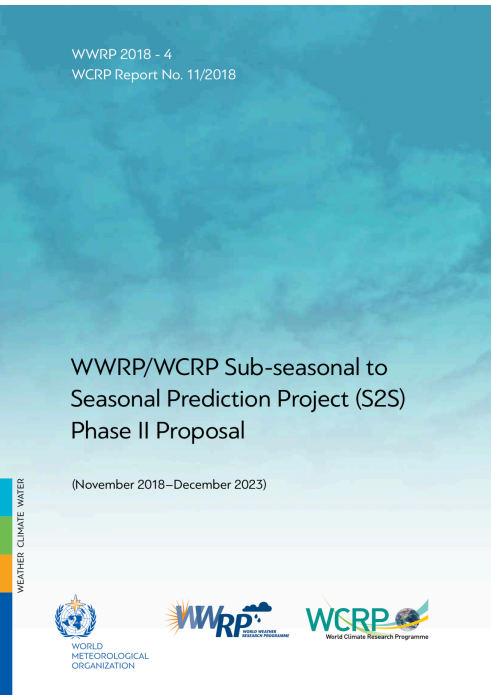
Data Infrastructure

S2S Database enhancement – ocean variables, more surface variables 4xdaily, additional models (eg IMD)

WWRP 2018 - 4
WCRP Report No. 11/2018

WWRP/WCRP Sub-seasonal to Seasonal Prediction Project (S2S) Phase II Proposal

(November 2018–December 2023)

WEATHER CLIMATE WATER

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Future plans: Science Subprojects

Land-atmosphere coupling & initialization
MIPS: LS4P, LFMIP-OBS, GLACE-ESM SnowGLACE.
GEWEX-GASS WGSIP

Ocean
coordinated case studies of ocean extreme events & air-sea interaction. Sea ice prediction assessment.
CliC

Aerosols
S2S/WGNE coord expt with/without interactive aerosols.
4-6 modeling centers
WGNE, GAW

MJO Teleconnections
Systematic errors Relationships w/ extremes
WGSIP, WWRP

Impact of the ocean obs system
on S2S forecasts: data denial expts (eg XBT, ARGO T/S profiles)
ECMWF, JMA

Stratosphere
Nudging expts to better understand impact of SSWs. Also impact of QBO on the MJO.
SPARC

Ensembles
Stochastic physics sensitivity expt.
WGNE, PDEF DAOS

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Research-Operations

- Develop criteria for GPCs.
- Work with WMO Lead Centre for long-range forecasts on real-time MME product
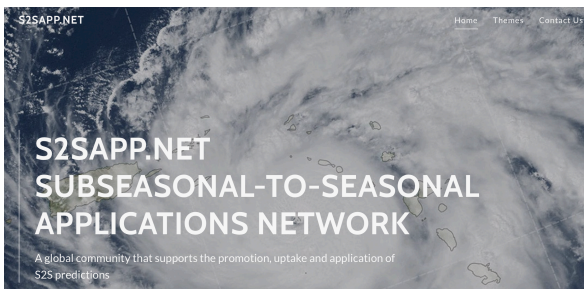- Recommend verification scores, MME methods, calibration, product development research

WMO, JWGFV

Real-Time Forecast Pilot Expt.

Real-time access for applications demonstrations. 2-years, 18 projects under dev:
What? S2S forecasts for agriculture, water resources, energy, health, DRM (Floods, drought, TCs) Sea Ice,
Where? Africa, SE Asia, Amazonia, Western US, Europe, S America

WWRP SERA

S2SAPP.NET   Home   Themes   Contact Us

**S2SAPP.NET
SUBSEASONAL-TO-SEASONAL
APPLICATIONS NETWORK**
A global community that supports the promotion, uptake and application of S2S predictions

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Future plans: Database Enhancement

- S2S Ocean model data fields available in 2019

- Potential new models (IITM, NCMRWF, NASA)

- Possibly additional sub-daily fields

- IRI Data Tools & Server-side analysis for S2S

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Climate Services

S2S Prediction Models

Science

CONCEPTUAL FRAMEWORK FOR IMPLEMENTING WCRP STRATEGY

Climate Services / Information

Key Science Questions

WCRP Strategic Goals / Objectives

WCRP Themes serving Strategic Objectives

1 Understanding Earth System Processes ** ISC **

2 Variability, Predictability & Prediction ** WMO **

3 Climate Change projections, ES feedbacks and long term response ** IPCC **

[Critical Infrastructure] Simulation tools, sustained observations, open access, high-end computing and data management

Earth System Model Development, Observing System Innovation and Evaluation

Model – Data Fusion

[Activities / Engage with the science communities]

Core Climate System Elements:
Water, Energy, Composition, Dynamics, (Biosphere)
Ocean, Atmosphere, Cryosphere, Land

NB: Enduring capability

[Integration] Observation feeding to sustained observing systems (e.g. GCOS)

[Integration] Assessment Coordinated Model Experiments
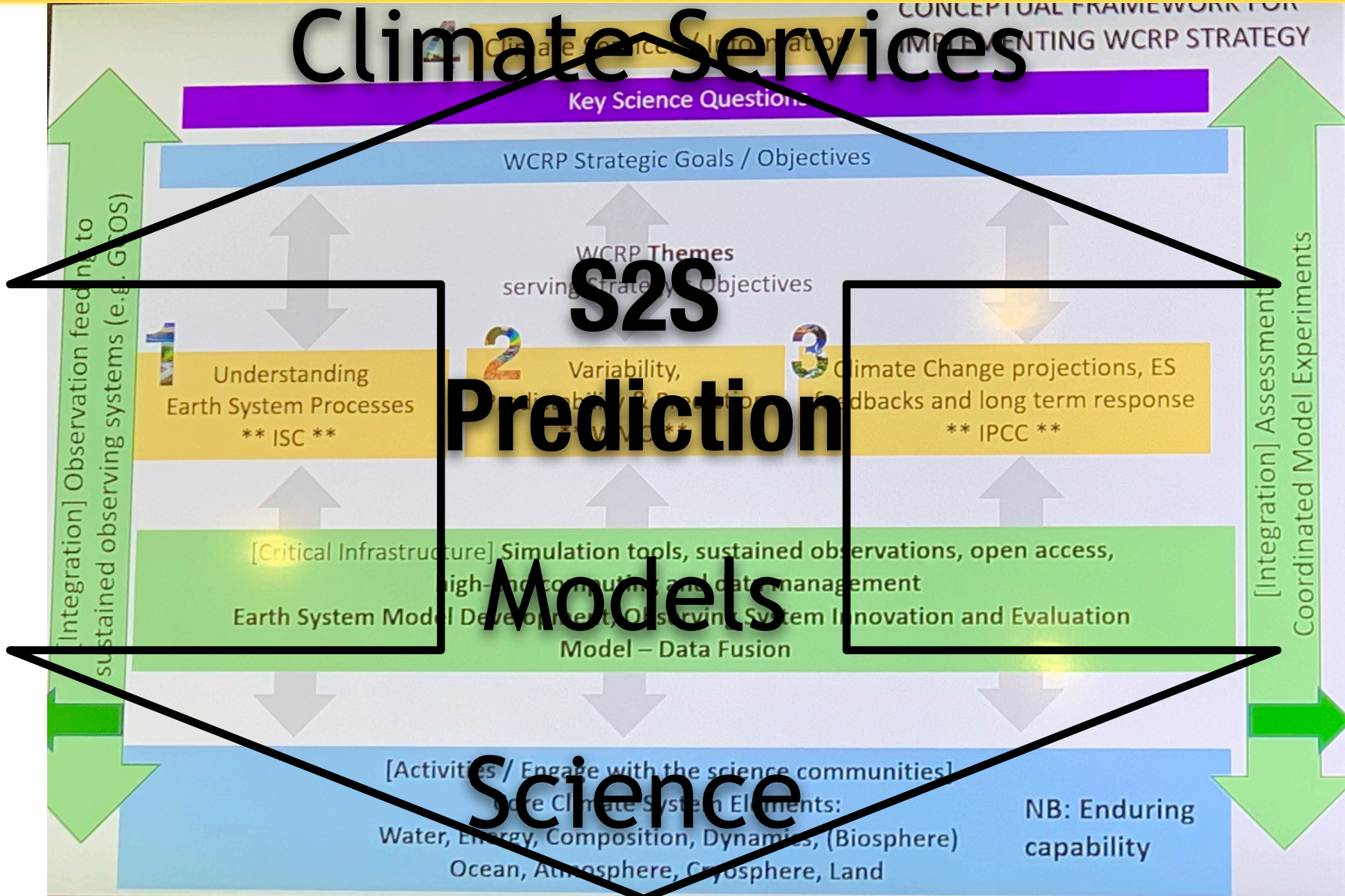
Emerging Opportunities & Issues

- S2S connects WCRP core science (Obj 1) with risk management (Obj 4) through forecasts and early warning system development.
  - Concrete manifestation of Obj 2: PEOPLE! But where are they in latest conceptual diagram?
- Strong S2S relevance to Regional climate (CORA) - connection with Obj 3 through Obj 4 integration
  - WCRP can build on S2S's linkages with WMO NMHSs, RCCs, RCOFs (R-O)
  - Downscaling question: potential to link w/CORDEX
- Data infrastructure: integration needed between S2S database, research S2S datasets (eg NCAR), and with CMIP data.
  - Already integration thru IRI Data Library to NMME, EU-C3S, SubX
  - Weather & Climate data needs integrated Big Data community platform for access/analysis (WDAC?)
- NCAR summer school on S2S proposed for 2020: funding request made to WCRP & WMO jointly from S2S and SPARC. Example of integrated and coordinated research to serve society.

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