Interagency Weather Research Coordination Committee

Meeting 2019-1

22 May 2019

Administrative Info

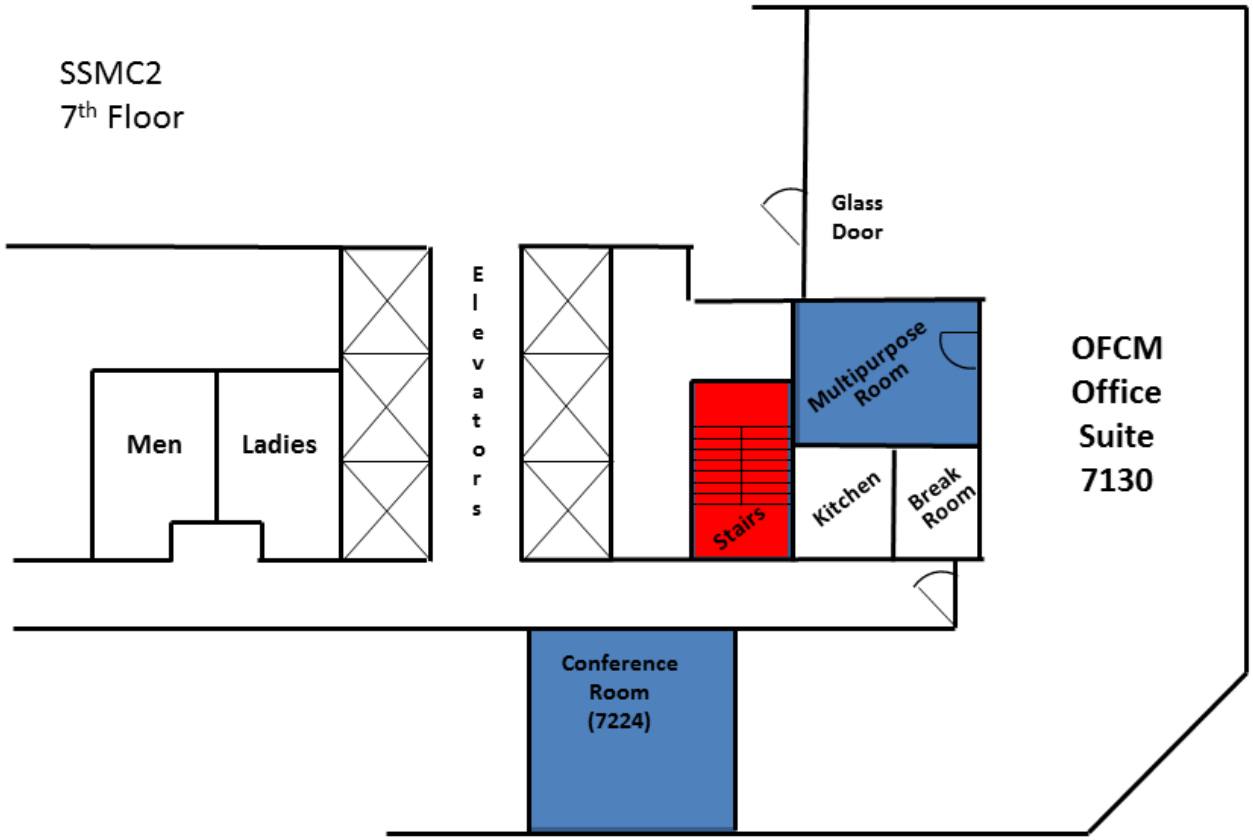
- **Meeting will be recorded in order to produce a Record of Actions**
- **Facilities**

- **Telecon / GoToMeeting**
  - Dial-in 1-888-680-9581, passcode 535430#

- **GoToMeeting:** https://global.gotomeeting.com/join/986746549

- **Slides to be posted at:** https://www.ofcm.gov/groups/IWRCC/meetings/meetings.htm
  - **Please advise us of any sensitivities**

OFCM Floor Plan



Today's Agenda

- **Chair's Opening remarks**
- Administration
  - Review Action Items
  - Membership Changes
  - Working Group Alighnment
- USWRP Report Exploratory Committee
- WG/WR Co-Chairmen Remarks
- WMO Update
- Open Discussion
- Adjourn

Opening Remarks

Interagency Weather Research Coordination Committee (IWRCC)

Dr. John Cortinas (NOAA)
Dr. Tsengdar Lee (NASA)
Co-Chairs, IWRCC

- **Welcome**
- **Roll Call**
- **Approve Agenda**

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  - **Review Action Items**
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  Adjourn

Action Items

Action Items Review

2018-2.2	Assist with next steps in developing and reporting the research implementation plan in response to the Weather Act. (PL 115-25)
2018-2.4	(CLOSED) Assist with determining how and where $50 K can be provided to maintain S2S database identified by ECMWF contact
2018-2.5	Inform ICMSSSR and FCMSSR of priority research topics at next IWRCC ICMSSR Brief in 2020
2018-4.1	Coordinate with National ESPC to look for places existing working groups could be merged or correspond with one another where interests overlap
2018-4.2	Map S2S WG activities to existing NAS report
2018-4.3	Get approval from IWRCC for broader distribution of S2S projects list for comment

Administrative Matters

- Welcome, Randy Bass (FAA)
- New NWS Representative
- Working Group Alignment

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USWRP Congressional Reporting

- Section 109 of the Weather Research and Forecasting innovation Act of 2017 amends Sec. 108 of the Oceanic and Atmospheric Administration Authorization Act of 1992

- Section 108 of Oceanic and Atmospheric Administration Authorization Act of 1992 establishes the USWRP and it's associated reporting requirements

- Sec. 108 also directs the requirement to list and describe research goals and activities as part of the Implementation Plan

USWRP Research Needs Reporting

- Where we are:
  - Dr. Cortinas took the matter to the ICMSSR earlier this year as discussed at last IWRCC.
  - Proposal was to form group of ICMSSR representatives to list priorities and publish in FY 20 BCR
  - ICMSSR directed an exploratory scoping meeting of needs for a one time report

USWRP Research Needs Reporting

- Where we are:
  - Mr. James called for personnel to assist with the scoping meeting. Received nominations from all agencies.
  - Digital copy of the original created by OFCM
  - Initial meeting held before last ICMSSR, made some preliminary decisions about general content of the report.
  - Need to have second, more comprehensive meeting and a new NASA Rep.

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Weather Research Working Group

- Dr. Waliser: S2S Update to OMB
- Dr. Morgan: WMO Hi-Wx update
- Take it away, Gents...

S2S Briefing

for OMB-Grace Hu

NASA Examiner

RECOMMENDATIONS FOR NEAR-TERM ACTIONS

1. Conduct model/OSSE studies to prioritize new Earth observations based on their impacts for improving S2S forecasts **(SLIDES 2-5)**
2. Provide inter-agency R-O support for NCEP/NOAA's community model vehicle to improve S2S forecasts **(SLIDES 6-7)**
3. Increase computation capacity for S2S predictions and determine optimal ensemble forecast strategies. **(SLIDE 8-9)**
4. Increase focus and capacity for applied science research to help bridge gaps between S2S forecast product development and stakeholder needs **(SLIDES 10-12)**

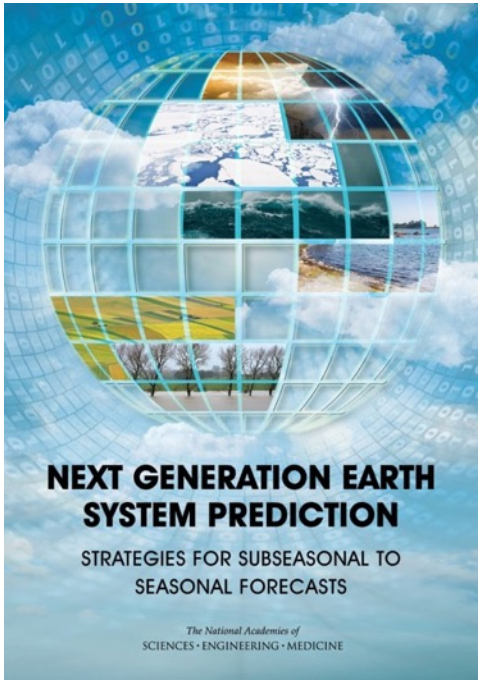
Duane Waliser, JPL/Caltech/NASA

April 23, 2019

#1

Sources of S2S Predictability & New Observations

U.S. National Academy of Sciences Study 2016: Next Generation Earth System Prediction: Strategies for Subseasonal to Seasonal Forecasts



Supported by NASA, ONR and Heising-Simons Foundation

1) **Natural Modes of Variability**
   ENSO,
   MJO,
   QBO
   etc
2) **Slowly Varying Surface Processes**

Need observations to improve process knowledge, modeling and forecast capabilities.

snowpack - only have cover, not snow water amount
sea ice– only have cover, not thickness or snow vs ice
soil moisture – have near surface but not root zone
vegetation & VWC – limited quantitative information
ocean mixed-layer – have SST, but not MLD except ARGO
planetary boundary layer – little information over ocean

#1

U.S. Decadal Survey Recommended Science Priorities and Program

Many of the prioritized observations from 2018 ESAS have relevance to S2S prediction, with the red items being called out in the NAS S2S report (previous slide).

Supported by NASA, NOAA and USGS

Total Water Storage

Vegetation

Sea Ice

Ocean Currents

Snowpack

Vegetation

Planetary boundary layer

Ocean Ecosystem/ Mixed-Layer Depth (MLD)

Soil Moisture

Designated

TARGETED OBSERVABLE	SCIENCE/APPLICATIONS SUMMARY	CANDIDATE MEASUREMENT APPROACH	Designated	Explorer	Incubation
Aerosols	**Aerosol properties, aerosol vertical profiles, and cloud properties** to understand their direct and indirect effects on climate and air quality	Backscatter lidar and multi-channel/multi-angle/polarization imaging radiometer flown together on the same platform	x		
Clouds, Convection, & Precipitation	**Coupled cloud-precipitation state and dynamics** for monitoring global hydrological cycle and understanding contributing processes	Radar(s), with multi-frequency passive microwave and sub-mm radiometer	x		
Mass Change	**Large-scale Earth dynamics** measured by the changing mass distribution within and between the Earth's atmosphere, oceans, ground water, and ice sheets	Spacecraft ranging measurement of gravity anomaly	x		
Surface Biology & Geology	**Earth surface geology and biology,** ground/water temperature, snow reflectivity, active geologic processes, vegetation traits and algal biomass	Hyperspectral imagery in the visible and shortwave infrared, multi- or hyperspectral imagery in the thermal IR	x		
Surface Deformation & Change	**Earth surface dynamics** from earthquakes and landslides to ice sheets and permafrost	Interferometric Synthetic Aperture Radar (InSAR) with ionospheric correction	x		

Explorer

TARGETED OBSERVABLE	SCIENCE/APPLICATIONS SUMMARY	CANDIDATE MEASUREMENT APPROACH	Designated	Explorer	Incubation
Greenhouse Gases	**CO_2 and methane fluxes and trends,** global and regional with quantification of point sources and identification of source types	Multispectral short wave IR and thermal IR sounders; or lidar**		x	
Ice Elevation	**Global ice characterization** including elevation change of land ice to assess sea level contributions and freeboard height of sea ice to assess sea ice/ocean/atmosphere interaction	Lidar**		x	
Ocean Surface Winds & Currents	**Coincident high-accuracy currents and vector winds** to assess air-sea momentum exchange and to infer upwelling, upper ocean mixing, and sea-ice drift.	Radar scatterometer		x	
Ozone & Trace Gases	**Vertical profiles of ozone and trace gases** (including water vapor, CO, NO_2, methane, and N_2O) globally and with high spatial resolution	UV/IR/microwave limb/nadir sounding and UV/IR solar/stellar occultation		x	
Snow Depth & Snow Water Equivalent	**Snow depth and snow water equivalent** including high spatial resolution in mountain areas	Radar (Ka/Ku band) altimeter; or lidar**		x	
Terrestrial Ecosystem Structure	**3D structure of terrestrial ecosystem** including forest canopy and above ground biomass and changes in above ground carbon stock from processes such as deforestation & forest degradation	Lidar**		x	

Incubation

TARGETED OBSERVABLE	SCIENCE/APPLICATIONS SUMMARY	CANDIDATE MEASUREMENT APPROACH	Designated	Explorer	Incubation
Atmospheric Winds	**3D winds in troposphere/PBL** for transport of pollutants/carbon/aerosol and water vapor, wind energy, cloud dynamics and convection, and large-scale circulation	Active sensing (lidar, radar, scatterometer); passive imagery or radiometry-based atmos. motion vectors (AMVs) tracking; or lidar**		x	x
Planetary Boundary Layer	**Diurnal 3D PBL thermodynamic properties and 2D PBL structure** to understand the impact of PBL processes on weather and AQ through high vertical and temporal profiling of PBL temperature, moisture and heights.	Microwave, hyperspectral IR sounder(s) (e.g., in geo or small sat constellation), GPS radio occultation for diurnal PBL temperature and humidity and heights; water vapor profiling DIAL lidar; and lidar** for PBL height			x
Surface Topography & Vegetation	**High-resolution global topography** including bare surface land topography ice topography, vegetation structure, and shallow water bathymetry	Radar; or lidar**			x

** Could potentially be addressed by a multi-function lidar designed to address two or more of the Targeted Observables

Other ESAS 2017 Targeted Observables, not Allocated to a Flight Program Element

Aquatic Biogeochemistry	Radiance Intercalibration
Magnetic Field Changes	Sea Surface Salinity
Ocean Ecosystem Structure	Soil Moisture

#1

Prioritizing New Observing Systems for their Impacts on S2S Forecast Fidelity

- The Earth science modeling community is very adept at, and willing to undertake, systematic model experimentation (e.g. CMIP, GASS-YOTC, S2S, GLACE, etc).
- *Typically, the objective of these community experiments are posed with only a science or forecast evaluation objective(s) in mind.*
- In some limited cases, community experimentation has been done to examine the utility of a specific observation type for these objectives (e.g. GLACE examined soil moisture impacts for subseasonal forecasting).

➢ Little or no experimentation has been done that quantitatively compares the *utility of one observation type over another* for improving S2S prediction, making it difficult to prioritize.

#1

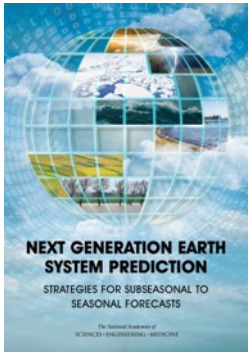
Recommendation #1

Develop model experimentation – namely Observing System Simulation Experiments (OSSEs) - that more overtly and concretely addresses the relative impacts and prioritization of S2S relevant observations as recommended by:

- NAS 2016 Strategies for S2S Prediction Study
- NAS 2018 Earth Science Decadal Survey

with a particular focus on slowly varying boundary conditions (e.g. snowpack, sea-ice, soil moisture, ocean mixed-layer depth, vegetation).

This is something that NASA centers & GMAO, etc could uniquely lead / help with.



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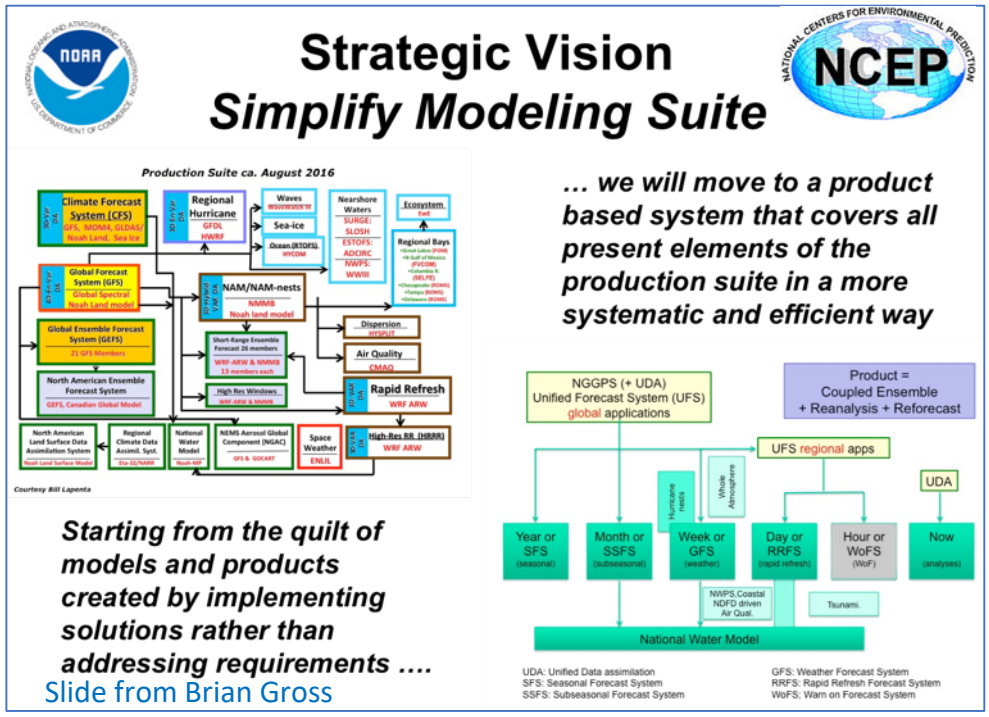
Recommendation	Research Strategies	Basic Research	Applied Research / Opera-tional	Benefits Likely in the Short Term	May Need New Initiative	Inter-national Collab. Criticlal
F: *Determine priorities for observational systems and networks by developing and implementing OSSEs, OSEs, and other sensitivity studies using S2S forecast systems*	2, 3, 4	■	■	■	■	

#2

Improving our Nation's S2S Forecast Model



Slide from Brian Gross

- NCEP/NOAA modeling capabilities represent the core of our nation's operational S2S forecast guidance.
- The better NCEP/NOAA's modeling capabilities are, the more our nation yields benefits from S2S forecast opportunities (not only through "weather" guidance but also for decision support of water availability, air quality, etc.)
- It is challenging, based on available resources and expertise, for NCEP/NOAA to stay at the leading edge for all required science/technical elements that make up S2S prediction.

Creative ways need to be developed to collaboratively enhance our nations S2S forecast model

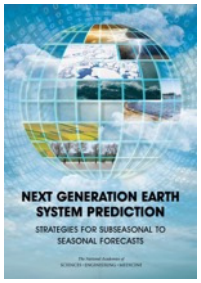
#2

Improving our Nation's S2S Forecast Model

NCEP/NOAA are partnering with NCAR to provide a community version of their model forecast system providing a vehicle to reduce the path (in terms of time, $, effort) between Research and improved Operational prediction (R to O).

Recommendation #2: Provide additional funds (a new program element) focused on exploiting this new community access opportunity and directly target the improvement of NCEP/NOAA S2S forecast model fidelity.

NASA and other federal Earth Science research agencies have the expertise to significantly improve NCEP/NOAA S2S forecast fidelity, given they have the needed/added resources and direction.



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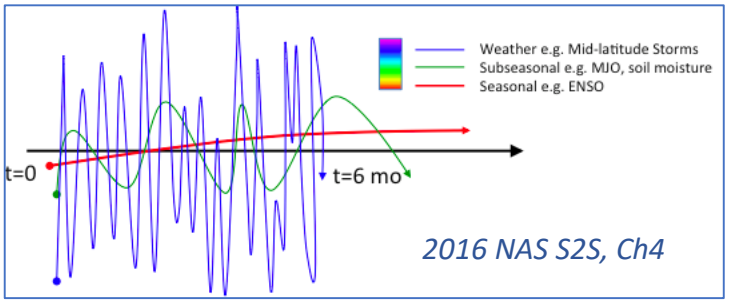
Recommendation	Research Strategies	Basic Research	Applied Research / Operational	Benefits Likely in the Short Term	May Need New Initiative	International Collab. Criticlal
M: *Provide mechanisms for research and operational communities to collaborate, and aid in transitioning components and parameterizations from the research community into operational centers, by increasing researcher access to operational or operational mirror systems.*	2, 1, 3, 4		■	■		■

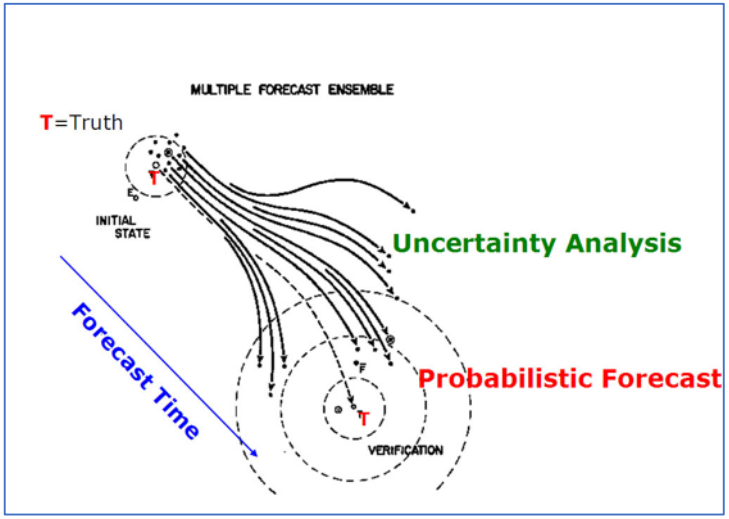
To take advantage of this new opportunity (not present in 2015-16), it will likely need an infusion of resources.

#3

Determining Optimal Ensemble Forecast Strategies



- *S2S forecasting is challenging because it involves a mix of time scales and phenomena, with the latter requiring strongly coupled models i.e. atmosphere, ocean, land, sea-ice, etc.*
- *At lead times of 2 weeks to 2 months, there is a mix of so-called "deterministic" prediction, e.g. state of the slow MJO and ENSO phenomena, as well as the prediction of the statistical characteristics of the weather phenomena and its extremes associated with the states of MJO and ENSO.*



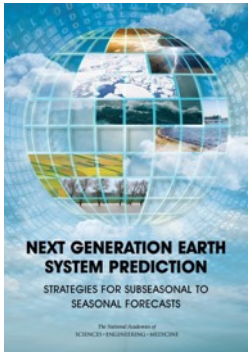
- *Modern day S2S forecasting relies on "ensemble" approaches to forecasting to account for uncertainties in the initial conditions and model physics. Forecast fidelity, strongly relies on the size and comprehensive nature of the forecast ensemble.*
- *There are still many questions concerning what is the best strategy for ensemble characteristics such as: how to use available, yet limited, computer resources across the ensemble trade space: how frequent to initiate a forecast (e.g. every day, every week), how many members in the ensemble, how long to forecast, how many physics schemes to consider in the ensemble, etc.*

#3

Determining Optimal Ensemble Forecast Strategies

In concert with NCEP/NOAA and other S2S forecast centers, NASA and GMAO are in a strong position to help determine optimal S2S forecast strategies.

Recommendation #3: Provide additional funding and computation resources to determine optimal ensemble forecast strategies for S2S.



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Recommendation	Research Strategies	Basic Research	Applied Research / Operational	Benefits Likely in the Short Term	May Need New Initiative	International Collab. Critical
K: *Explore systematically the impact of various S2S forecast system design elements on S2S forecast skill. This includes examining the value of model diversity, as well as the impact of various selections and combinations of model resolution, number of ensemble perturbations, length of lead, averaging period, length of retrospective forecasts, and options for coupled sub-models.*	2, 3, 4	■	■	■	■	■

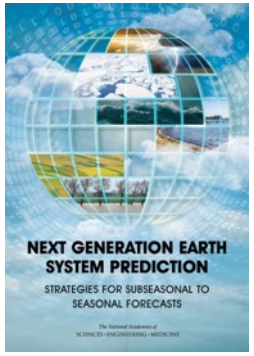
Recommendation	Research Strategies	Basic Research	Applied Research / Operational	Benefits Likely in the Short Term	May Need New Initiative	International Collab. Critical
O: *Develop a national plan and investment strategy for S2S prediction to take better advantage of current hardware and software and to meet the challenges in the evolution of new hardware and software for all stages of the prediction process, including data assimilation, operation of high-resolution coupled Earth system models, and storage and management of results.*	Supporting	■	■	■	■	

#4a

Bridge Gaps Between S2S Forecast Product Development And Stakeholder Needs

NASA's Applied Sciences Program (ASP) is in a position to foster the dialogue between S2S stakeholders and S2S forecast agencies and product developers, and help advance the state of the art of S2S Decision Support. Programmatically, this is challenging as it cross-cuts across several ASP focus areas (Ecological Forecasting, Water Resources, Disasters, Health & Air Quality), albeit through ASP's capacity building programs such as SEVIR, DEVELOP, WWAO, and ARSET, the foundations exist to support a cross-cutting S2S initiative.

Recommendation #4a: Provide additional funding for NASA ASP and related bridge organizations to develop products that meet stakeholder needs.



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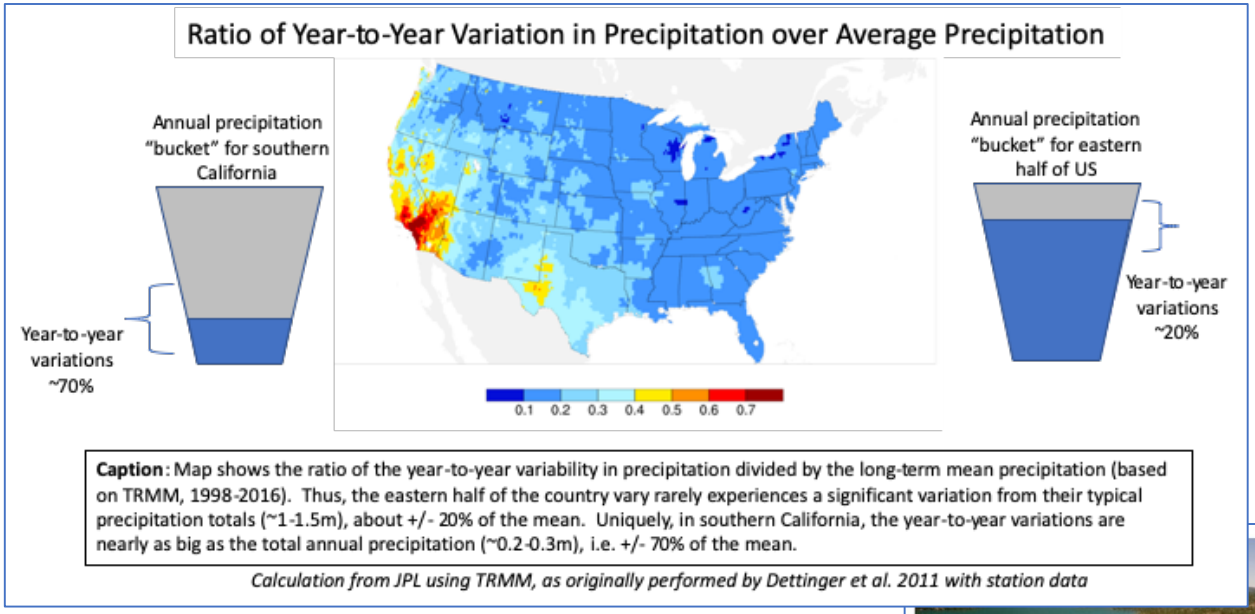
Recommendation	Research Strategies	Basic Research	Applied Research Opera-tional	Benefits Likely in the Short Term	May Need New Initiative	Inter-national Collab. Criticlal
Chapter 3						
A: *Develop a body of social science research that leads to more comprehensive and systematic understanding of the use and barriers to use of seasonal and subseasonal Earth system predictions.*	1, 4	■	■	■	**	
B: *Establish an ongoing and iterative process in which stakeholders, social and behavioral scientists, and physical scientists co-design S2S forecast products, verification metrics, and decision-making tools.*	1, 4	■	■	■	**	

** For NASA ASP to support this, new funds would likely be needed in order to not compromise existing programs/priorities.

#4b

Focused S2S Pilot Program for Water Management

Water management in the west and southwest is unique and challenging, relative to the the eastern and northern parts of the U.S (figs below). *S2S forecast guidance is critical for water availability and drought concerns, as well as flood preparation and response.*



Caption: Map shows the ratio of the year-to-year variability in precipitation divided by the long-term mean precipitation (based on TRMM, 1998-2016). Thus, the eastern half of the country vary rarely experiences a significant variation from their typical precipitation totals (~1-1.5m), about +/- 20% of the mean. Uniquely, in southern California, the year-to-year variations are nearly as big as the total annual precipitation (~0.2-0.3m), i.e. +/- 70% of the mean.

Calculation from JPL using TRMM, as originally performed by Dettinger et al. 2011 with station data

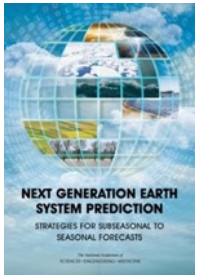
FIGURE 3.3 Recent drought has a severe impact on water availability in California, and water levels are exceedingly low in many CA reservoirs. NOTES: Here, water levels over a section of Lake Oroville near the Bidwell Marina are shown on July 20, 2011 (left) versus on January 16, 2014 (right). Such scarcity has heightened the desire for more skillful and usable S2S forecasts. SOURCE: California Department of Water Resources.

#4b

Focused S2S Pilot Program for Water Management

Recommendation #4b: Provide additional funding for NASA, via its Western Water and Applications Office, and for NOAA to develop a regional pilot project for demonstrating near-term improvement of S2S forecasting skill for water resource management, with the latter represented by the Western States Water Council and its S2S Coalition.

This effort supports the intent of the 2019 reauthorization of the National Integrated Drought Information System (NIDIS) and Weather Research and Forecasting Innovation Acts.



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Recommendation	Research Strategies	Basic Research	Applied Research / Operational	Benefits Likely in the Short Term	May Need New Initiative	International Collab. Critical
B: *Establish an ongoing and iterative process in which stakeholders, social and behavioral scientists, and physical scientists codesign S2S forecast products, verification metrics, and decision-making tools.*	1, 4	■	■	■	**	

Recommendation	Research Strategies	Basic Research	Applied Research Operational	Benefits Likely in the Short Term	May Need New Initiative	International Collab. Critical
D: *Focus predictability studies, process exploration, model development, and forecast skill advancements on high-impact S2S "forecasts of opportunity" that in particular target disruptive and extreme events.*	3, 2	■		■	**	■

** For such a cross-agency consideration, new funds would likely be needed.

High Impact Weather Project (HIWeather)

M. Morgan

http://www.wmo.int/pages/prog/arep/wwrp/new/high_impact_weather_project.html

Mission

To promote cooperative international research to achieve a dramatic increase in resilience to high impact weather, worldwide, through improving forecasts for timescales of minutes to two weeks and enhancing their communication and utility in social, economic and environmental applications

Scope

The scope of the project is defined by the needs of users for better forecast and warning information to enhance the resilience of communities and countries in responding to a carefully selected set of [five] hazards: Urban flood, Wildfire, Localized Extreme Wind (downslope winds, tornadoes, localized wind within TCs and ETCs), Disruptive Winter Weather, Urban Heat Waves and Pollution.

The research required to deliver enhanced resilience to these hazards will be carried out in five themes that cover areas traditionally separated into the

Research themes

- Predictability and Processes
- Multi-scale forecasting of weather-related hazards
- Human impacts, vulnerability and risk
- Communication
- User-oriented evaluation

Predictability and Processes

- Research will be focused on the meteorological processes that influence the predictability of High Impact Weather: control of convective- scale predictability by large scale processes in tropical & extra-tropical latitudes; differences in predictability of hazardous weather relative to “normal” weather; association with forecasts that are very sensitive to initial state; mechanisms that produce quasistationary hazardous weather systems; role of diabatic heating; role of boundary layer and land surface; pre-conditioning of the land surface for hazards.

- lead: Michael Riemer, Germany, mriemer@uni-mainz.de. Members: ***John Knox***, Peter Knippertz, Andreas Schäfler, Juan Fang, Shira Rabeh-Ruvin, Linus Magnusson, ***Deanna Hence***, Yali Luo, Linda Schlemmer, ***Robert Rogers* (NOAA/HRD)***

Multi-Scale [coupled] Forecasting of Weather-Related Hazards

- Research covers the observations, nowcasting, data assimilation, modeling and post-processing required to forecast weather-related hazards using coupled numerical weather, land surface, ocean and chemistry models, including modeling of floods, landslides, bushfires, air pollution etc. Research will focus on advances in the whole prediction chain needed to forecast the hazards, on prediction at convective-scale (<3km), on coupled modeling and on the use of ensembles to quantify probability and uncertainty.

- lead: ***Jenny Sun*** sunj@ucar.edu. Members: Paul Joe, Peter Steinle, ***Sharan Majumdar***, Jianjie Wang, ***Jim Dudhia***, Krushna Chandra Gouda, ***Nusrat Yussout**(NOAA/NSSL)***.

Human impacts, Vulnerability & Risk

- Research will be led by social scientists, with a focus on the interface between the physical hazard and the human impact. It will cover modeling of the role of the built environment in hazards, and of the exposure and vulnerability of individuals, businesses and communities.
- lead: Brian Mills, Canada, bmills@uwaterloo.ca. Members: Joanne Robbins, Michael Kunz, Isabelle Ruin, ***Melanie Gall***

Communication

- Research will focus on the choices of information content, language, format and media channels used, spatial and temporal precision, timeliness and context that together determine whether forecasts & warnings will be received, trusted, understood and acted on.

- co-leads: Andrea Taylor a.l.taylor@leeds.ac.uk & Shannon Panchuk, s.panchuk@bom.gov.au; Members: Abi Beatson, ***Greg Carbin***, Melanie Harrowsmith, ***Amber Silver***, Rutger Dankers, Thomas Kox, Claudia Adamo, ***Jose Galvez***, Kiernan

User-oriented Evaluation

- Research will focus on the profile of accuracy and value through the forecasting, warning & communication chain with an emphasis on the information required by decision makers to build their trust in the information they receive.

- lead: Beth Ebert, Australia, e.ebert@bom.gov.au; Members: ***Amanda Anderson***, ***Barb Brown***, Julia Chasco, Martin Goeber, ***Masa Haraguchi***, Rainer Kaltenberger, Chiara Marsigli, Marion Mittermaier, Anna Scolobig, Helen Titley, Xudong Liang

On-going projects

- The **High Impact Weather Lake System** (**HIGHWAY**) project is a three year project that aims to increase the use of weather information to reduce the loss of life and damage to property in the Lake Victoria Basin region of East Africa. This project will address the lack of much needed in-situ observations and data availability both for research and meteorological operational purposes. Enhanced observations will be used to increase the scientific knowledge of storm initiation, evolution and development of severe weather over the lake and provide additional guidance to operational forecasters in providing regular weather forecasts and severe weather warnings for fishing boats and small transport vessels on Lake Victoria. [2017 – 2020; sponsored by UK's Weather and Climate for Information Services (WISER) for Africa program NSF/NCAR (involvement)]

https://www.youtube.com/watch?v=DAkhxqb6HVg&feature=youtu.be

On-going projects

TIGGE (THORPEX Interactive Grand Global Ensemble) and TIGGE-LAM (-Limited Area Model)

- The TIGGE dataset (https://www.ecmwf.int/en/research/projects/tigge) is one of the major achievements of THORPEX. It now contains over 10 years of global data. On a smaller scale, the TIGGE-LAM dataset provides 5 years of multi-model ensemble data at mesoscale resolution for limited areas. These datasets have been used to investigate a variety of atmospheric processes and there is scope for more use in the context of HIWeather. Opportunities may be driven by analysis of weather phenomena or weather variable thresholds associated with high impact. Within the S2S project, activities related to specific weather phenomena are brought together at http://s2sprediction.net/ under topic wiki pages. *There may be opportunities to do something similar for phenomena relevant to HIWeather. If you are interested, please contact John Methven at Reading University.*

Upcoming relevant activities and events

- **27th IUGG General Assembly**, 8-18 July, Montreal, Canada; Sessions of interest to HIWeather include:
  - High-impact Weather and Climate Extremes
  - Hydrometeorologic and coastal extremes in current and future climates
- **European Meteorological Society Annual Meeting**: Copenhagen, Denmark, 9-13 September
- **Herrenhausen conference** on "**Extreme Events: Building Climate Resilient Societies**", Hanover, Germany, October 9-11, 2019.
- **Cyclone workshop,** 29 September – 4 October 2019, Seeon, Germany
- **WMO High Mountain Summit**, 29-31 October 2019, Geneva, Switzerland

Action items

- Complete inventory of activities
- Re-convene HiWx working group
- Contact John Methven on possible HIWx wiki page to relate activities to phenomena

Today's Agenda

- Chair's Opening remarks
- Administration
  - Review Action Items
  - Membership Changes
  - Working Group Alignment
- USWRP Report Exploratory Committee
- WG/WR Co-Chairmen Remarks
- **WMO Update**
- Open Discussion
- Adjourn

WMO Happenings

- **Over to you, Shanna...**

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Closing

- Review new action items
- Proposed agenda items and time for next meeting