WWRP
WORLD WEATHER RESEARCH PROGRAMME

DAOS

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		Bin Wang	*(CMA China)*

DAOS interactions with WGs and Projects

Weather Modification

- 2D and 3D model to describe aerosol and microphysics. DAOS can participate to write a white paper in the subject

AVRDP (**Aviation Research Demonstration Project**)

- data assimilation (reanalysis product) to better understand climate change affecting airport functionality and for verification purposes

S2S (Daryl Kleist)

OSEs can be designed to understand valuable observing system affecting longer range forecast (2weeks 1 month). For example deny all lower tropospheric observations would affect longer range forecast in particular in the tropics?

PPP (Mark Buenher)

- YOPP needs to fund a position to conduct proper diagnostic evaluation on observations performance over the poles. The person can perform different experiments at different institutes

HiW (Nadia Fourier, Sharan Majumdar)

- Collaborate on an DA systems inter-comparison on a 1km scale - DAOS, PDEF and HiW-

NMR (Nowcasting and Mesoscale Research)

- LAFE project with LIDAR in urban areas and mesoscale

FWV (Forecast Weather Verification)

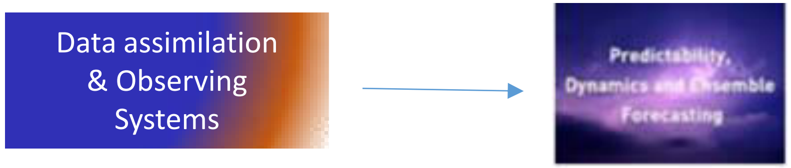
- Common project on verification against observations

TMR (**Tropical Meteorology Research**, FDP) **Bin Wang**

- UPDRAFT

DAOS activities

- OSSE review paper: first draft recently distributed, to be a WMO report by the end of 2017
- Development of coupled data assimilation (Steve Penny paper)
- 2017 WMO DA Symposium organization
- Development of assimilation methods for trace gases
- DA urban area, crowd-sourced and data
- High-resolution DA
- Model uncertainty
- Tropical and Polar DA, observing surface fluxes (especially over the oceans), polar and tropical regions
- PPP: PDEF stronger focus on understanding the dynamics of the coupled land-atmos (ice interaction) system; DAOS more attention to improving observing networks for the coupled system
- Reanalysis



ECMWF/WWRP Workshop: Model Uncertainty 11-15 April 2016

- What are the fundamental **sources of model error**?
- How can we improve the **diagnosis of model error**?
- What are and how do we **measure** existing **approaches** to representing **model uncertainty**?
- How do we **improve** the **physical** basis **for model uncertainty** schemes?

Better link should be established with

a) 5th WGNE workshop on systematic errors in weather and climate models

June 19-23, 2017, Montréal, Québec, Canada

b) WMO DA Symposium Florinapolis Brazil 2017

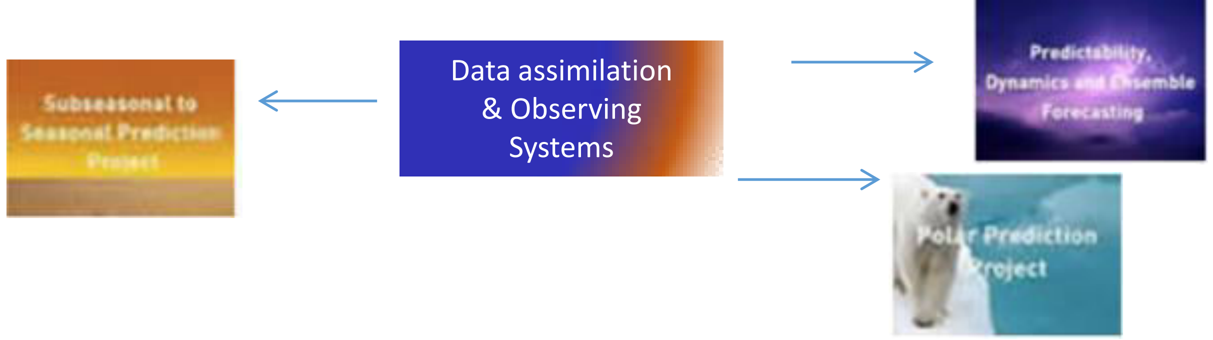
WMO DA Symposium Florinapolis Brazil 2017

http://www.cptec.inpe.br/das2017/

Worldwide established and early career scientists convened in Brazil to address the challenges and trigger innovations on advanced data assimilation methods for a wide spectrum of applications in atmospheric, oceanic and earth system science

- Global and Regional Atmospheric
- Convective Scale
- Atmospheric Constituent
- Coupled
- Global and Regional Ocean
- Assimilation of Observations to Represent the Land Surface Evolution
- Assimilation of Space-Based Remote Sensing, Ground-Based Remote Sensing and in Situ Observations
- Methodology
- Assimilation System Performance Diagnostic

- Scientists participation from more than 20 Countries; 25 financially supported students –WMO, EUMETSAT, ESA and Brazil; 42% women presenters; half presenters were early career scientists



International workshop on coupled data assimilation

http://www.meteo.fr/cic/meetings/2016/CDAW2016

Special thanks to Steve Penny (UMD) and Meteo France staff for a well-run workshop

The output is now published on a **WMO WWRP 2017 - 3**

Coupled Data Assimilation for Integrated Earth System Analysis and Prediction: Goals, Challenges and Recommendations Penny et al. 2017

- **Weakly coupled data assimilation** (e.g., ocean/atmospheric forecast models coupled, state estimation not) **is relatively mature**, with improvements shown at several operational centres
- **Strongly** coupled data assimilation is **still a research frontier**, but with several groups demonstrating promising results.

Research and methodology

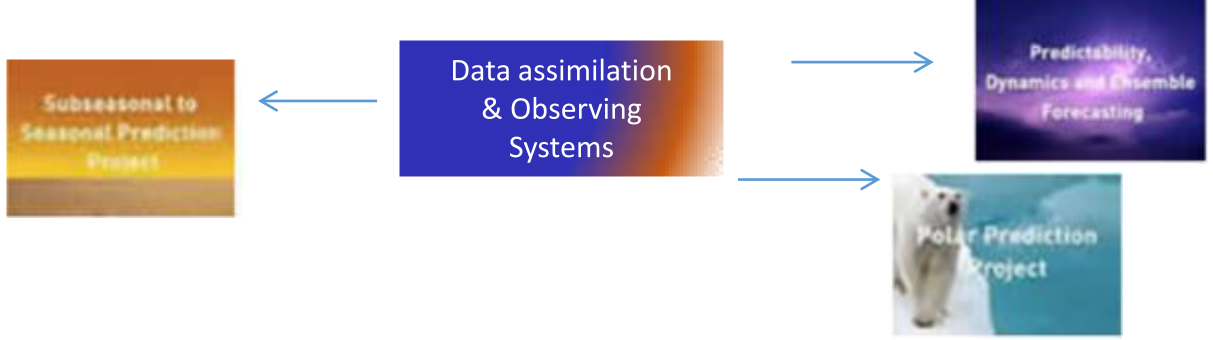
- Evaluate the benefits of (a) **CDA versus independent D**A for stand-alone modelling systems and (b) the **benefits of WCDA versus SCDA** on systems comparable to those used in operations -multiscale DA: updating differ model components at different time scales-
- Evaluate **forecast improvement**
- Demonstrate the benefit of applying **coupled observation operators** within CDA systems, in comparison to current observation operators
- Hybrid DA methods to explore **cross-domain covariances** on multiple spatiotemporal scales
  - International collaboration: assimilating near-interface observations with a focus on the temperature (e.g. SST, LST) at the interface between many model component combinations would serve as a useful coordinated exercise to start evaluating coupled error covariances in the context of different coupled models and resolutions
  - Investigation on time-varying nature of cross-domain error covariances in detail, showing how the cross-domain error covariance structure changes based on diurnal, seasonal, and longer timescales
  - Localizing coupling effects to the boundary layer must be quantified
- It is common for WCDA to generate analyses for each domain that are inconsistent with one another, with the potential to create shocks at the interface when used to initialize the coupled model. **Primary motivation for SCDA is to improve consistency and eliminate these shocks** .
- **Characterize systematic errors** in each of the components and the fluxes between those components. This requires also (a) improved modelling of the **interfaces between domains** and (b) improved **observing of these interfaces**
- Representations of **surface fluxes** must be **improved**, whether through improvements to the bulk formulae or improved resolution and modelling of the near surface boundary layers. A more sophisticated 'surface interface model' should be considered

Observing missions

- Increase the **observing** effort of **the cross-domain interfaces**. This includes measurements of air-sea fluxes, ice-ocean fluxes, air-land fluxes, etc.
- Encourage **field campaigns** that plan for **co-located observations spanning multiple domains**. These are needed to constrain the coupled system, correct biases in observations, and estimate observation errors. As a general guiding principle for planning observing missions, DA typically benefits more from larger quantities of well- distributed data rather than a small quantity of specialized data.
- **Increase collaboration** between **field campaigns, modellers, and the CDA** community for conducting process studies on cross-domain boundaries.
- Regional field campaigns may be valuable for performing focused tests of CDA on a limited scale.
- Increase the **observing** effort for areas of the Earth system that are under-observed and underconstrained. As we shift from forced single-domain models to coupled Earth system models, the predominant impacts from biases in one domain can shift to another. In order to constrain these biases there must be a concerted effort to constrain **long ignored regions, such as the deep ocean, sea ice, and the ocean under sea ice**.
- Establish a mechanism for developing countries to securely contribute local observations to major global NWP operational forecasts. Further, establish a visiting scientist plan for providing expert **training in DA and NWP** to forecasters, researchers, and students from these countries.
- **Dedicated field campaigns** should be identified that can improve earth-system predictability through better formulation of either **model forecast**, **observation**, or **CDA methods** due the insights derived from those campaigns. Examples of successful field campaigns in the past included studies of coupling in tropical cyclones, marginal ice zone, and the Madden-Julian oscillation (MJO).

Organizational planning

- Transmit observational data rapidly to operational centers for use in NWP. A shift is required that will allow **ocean, snow, sea ice, and other data to be used in near real-time NWP applications**
- A research-to-operations pipeline must be established to allow the **academic research** community the ability to (a) **address scientific questions** of interest to the operational centers and (b) facilitate the **transfer** of **new methods and knowledge** from the research community **to the operational centers**
- Sustained working groups and **regular workshops** with significant training and tutorial sessions on coupled Earth system processes relevant to CDA
- Establish common data sets/fields, such as observational innovations and air-sea fluxes, for a common time-period between CDA research groups for **international intercomparisons**
- It is recommended that a specific set of criteria be agreed upon and accepted for a **baseline international 'scorecard'** for NWP using CDA to provide a starting point for comparisons
- **3-5 years is to validate** methodology and software tools, and to establish best practices for CDA. In a 3-**7 years** timeframe, the community can begin to **meaningfully address forecast and observation impact problems**
- **CDA OSSEs** should be a priority application for future observation network design, and to help plan and prioritize future observation campaigns
- General trends in **software design** should be adopted for the development of future CDA tools, including: **modularity of code**, managing code complexity, efficient/optimal use of emerging hardware
- **Databases**/repositories storing observations across all domains with standardized data formats are recommended **standardized forward operators** for the global observing network is encouraged.



DAOS should help on

- Advocacy of and **support for initiatives** like US Joint Center for Satellite Data Assimilation's JEDI (Joint Environmental Data Assimilation Initiative) **to develop a more modular DA infrastructure** that can be shared across labs, centres and countries.
- Facilitate development of **modern observation databases that can be shared**, easily added to
  - add new data, old field program data to GTS, BUFR format