SAB Work Plan Topic 2: Review the Use of Observing System Simulation Experiments (OSSEs)

OSSE Task Force
23 April 2019
Presented to the NOAA SAB

OSSE Task Force Membership

- EISWG Members: Bill Hooke, Ron Birk, Bob Weller, **Xubin Zeng** (Chair)
- SAB members: Eugenia Kalnay and Susan Avery
- Climate Working Group members: Joellen Russell, Fuqing Zhang, Raghu Murtugudde
- NOAA liaison: Lidia Cucurull and Bob Atlas, NOAA AOML
- Domain experts: Fred Carr (note that other people mentioned here, such as Bob Atlas and Eugenia Kalnay, are also domain experts)
- External Agency Partners: Derek Posselt (NASA JPL)
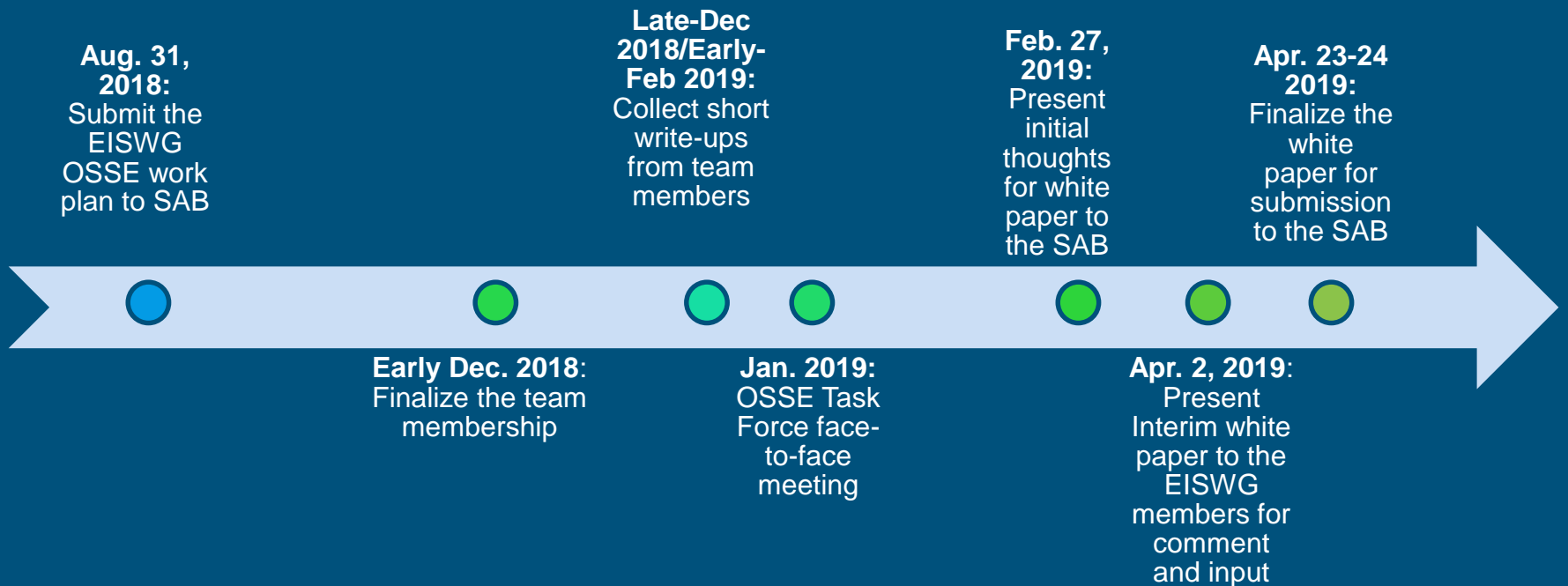
Topic 2 Guiding Statement:

An OSSE is a modeling experiment used to evaluate the impact of new observing systems on operational forecasts when actual observational data are not available. OSSEs are done: 1) to find out if a new observing system will add value to NWP analyses and forecasts; 2) to make design decisions for a new observing system; and 3) to investigate the behavior of data assimilation systems in an environment where the system's behavior is known (paraphrased from Prive & Errico PPT, 2015).

NOAA has a Quantitative Observing System Assessment Program that uses OSSEs for a number of purposes related to NOAA's observing and modeling activities for both the atmosphere and ocean. These OSSEs are mandated by Section 107 of the Weather Act and follow the rigorous methodology for performing OSSEs that was established by (Atlas et al., 1984) and described in detail by Hoffman and Atlas (2016) in the Supplement to their article on future OSSEs in the Bulletin of the American Meteorological Society.

OSSE Work Plan

- Objective:
    - Review the use of OSSEs in NOAA, Navy, NASA, and elsewhere
    - Develop options for NOAA to consider current and future R&D work in this area, such as the combination of OSSEs with EFSO (which is being carried out at AOML with UMD collaboration, and is expected to strongly enhance and accelerate the current abilities of OSSEs).

- Deliverables:
    - A short white paper that will review the use of OSSEs in NOAA, Navy, NASA, and elsewhere; and develop recommendations for NOAA to consider and provide rationales for each recommendation made.

Timeline

Aug. 31, 2018:
Submit the EISWG OSSE work plan to SAB

Late-Dec 2018/Early-Feb 2019:
Collect short write-ups from team members

Feb. 27, 2019:
Present initial thoughts for white paper to the SAB

Apr. 23-24 2019:
Finalize the white paper for submission to the SAB

Early Dec. 2018:
Finalize the team membership

Jan. 2019:
OSSE Task Force face-to-face meeting

Apr. 2, 2019:
Present Interim white paper to the EISWG members for comment and input

Activities since Nov 2018 Update on OSSE - 1

- EISWG OSSE Task Force Meeting in early January 2019 (during the AMS Annual Meeting in Phoenix)
  - Meeting Participants:
    - Xubin Zeng, Lead, NOAA EISWG
    - John Snow, EISWG Chair
    - Bill Hooke, EISWG Member
    - Ron Birk, EISWG Member
    - Joellen Russell, CWG Member
    - Fred Carr, University of Oklahoma
    - Derek Posselt, NASA

- Main outcome of the meeting is the establishment of the organizational structure for the OSSE White Paper
  - **Section 1,** Findings: OSSE Capability/Practice
  - **Section 2,** Discussions: When, on what decision, and with what approach are OSSEs useful? When and on what decision is the value of OSSEs limited
  - **Section 3,** Recommendations: what NOAA might do in the near future with respect to OSSEs.

Activities since Nov 2018 Update on OSSE - 2

- Nine team members have provided written contributions by 2/5/2019: R. Birk, R. Weller, E. Kalnay, B. Hooke, D. Posselt, F. Zhang, F. Carr, R. Atlas and L. Cucurull

- While we don't have a member from Naval Research Laboratory (NRL), Dan Tyndall and his colleagues (N. Baker, D. Flagg, C. Barron, M. Carrier, S. Smith, D. Allen, and K. Hoppel) there helped us by providing the summary of OSSEs at NRL

- A preliminary report was finished in early February and presented to the SAB telecon in late February

- The near-final report was finished in late March based on iterations among the OSSE Task Force members

- The report was finalized on 4/9/2019 after the EISWG telecon and discussions in early April.
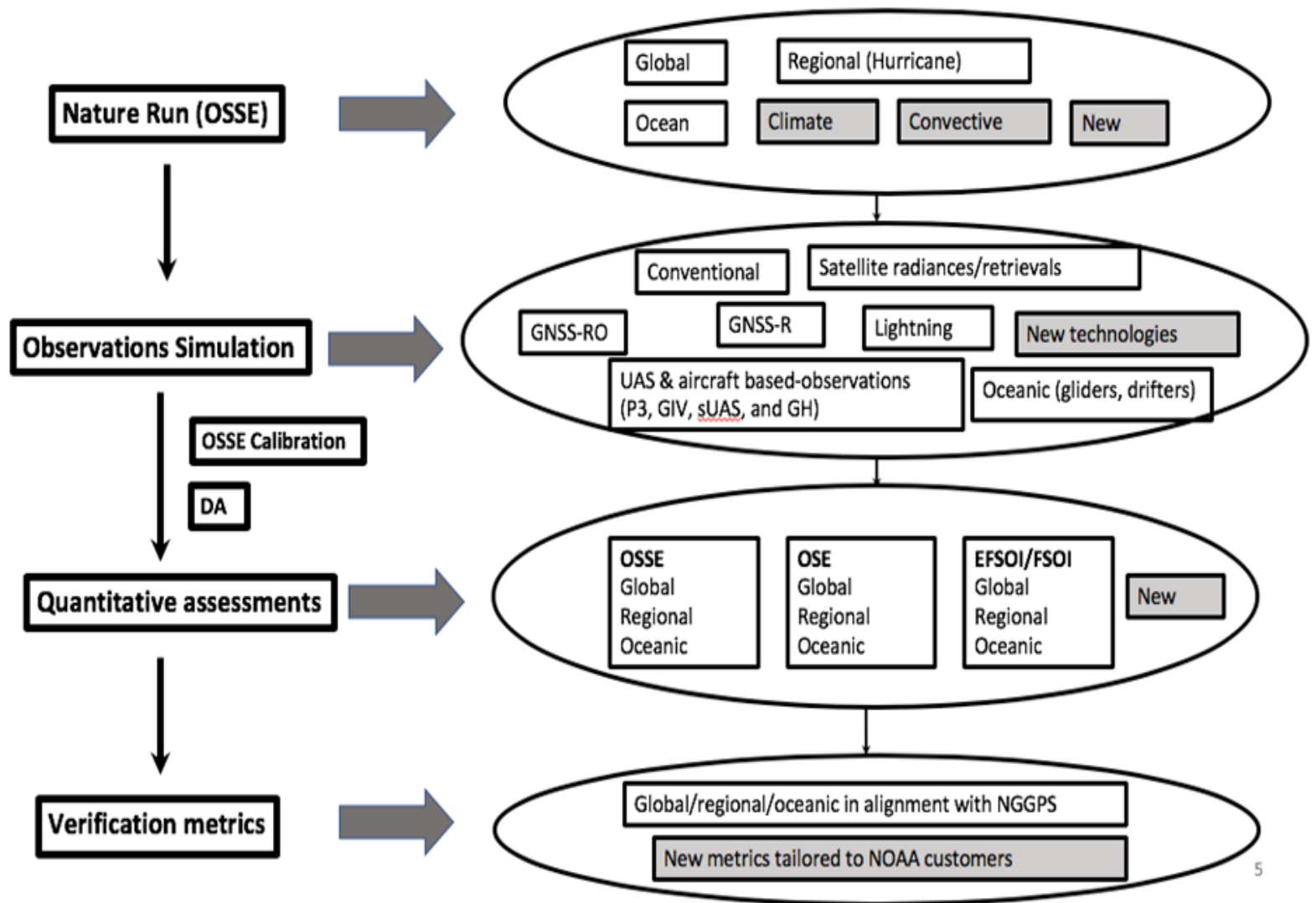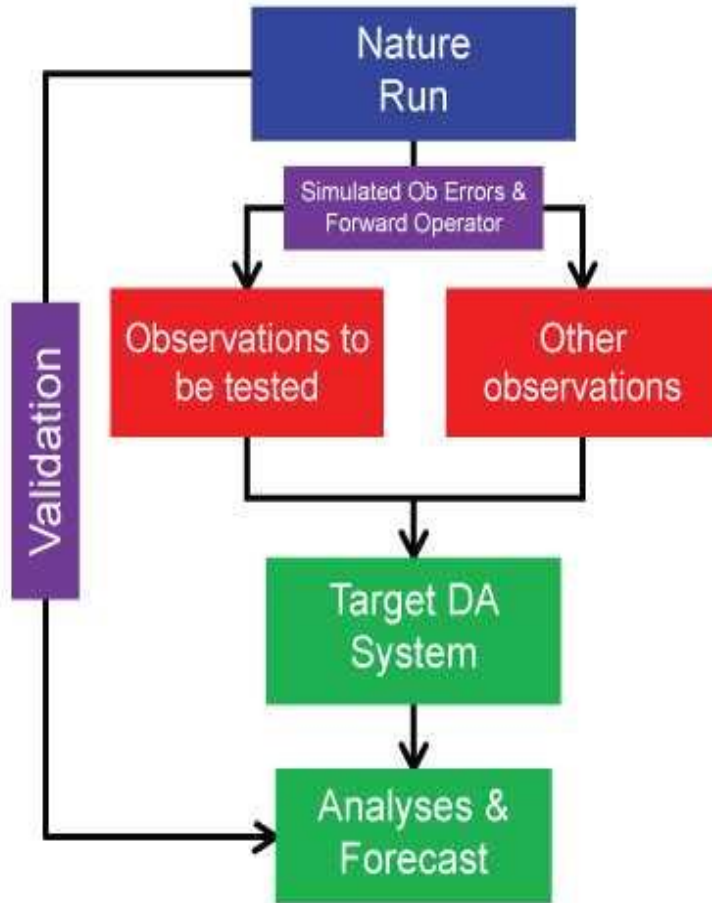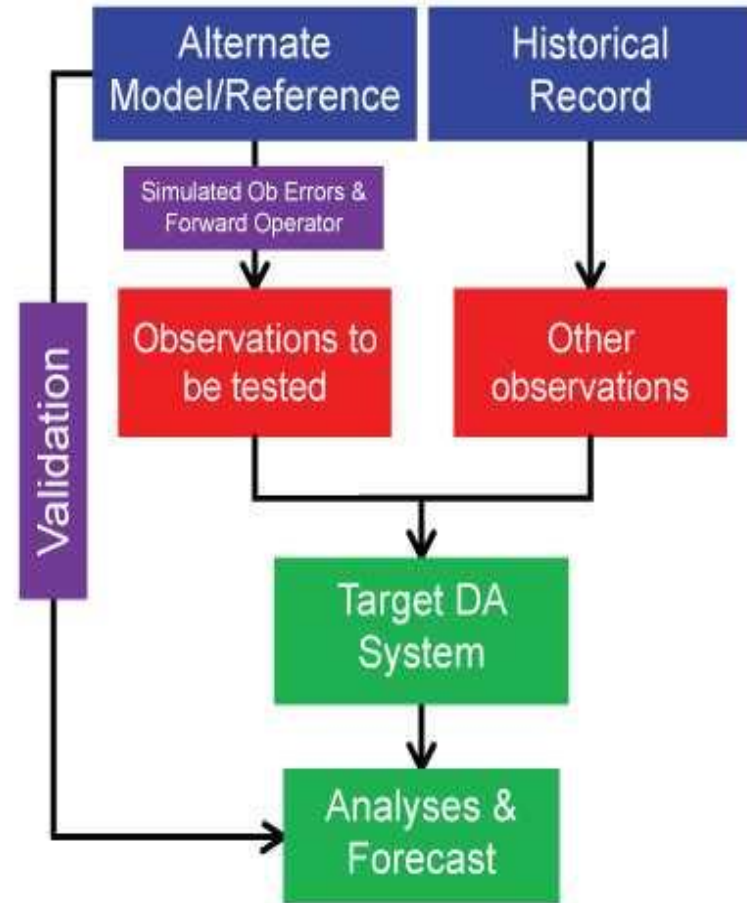
Diagram showing the different components of the OSSE system at NOAA /AOML

Schematic depiction of traditional OSSE methodology (left) and the historical OSSE methodology (right) used at Naval Research Lab

Recommendations on potential NOAA actions related to OSSEs - 1

Recommendation 1 (R1): Use OSSE, OSE, FSO, EFSO synergistically – sometimes even simple experiments could be very powerful (e.g., for sampling strategies)

R2: Accelerate the development of OSSEs for earth system models (ESMs) – this requires ESM nature runs of 3-5 km, and this in turn may request the purchase of new high-performance computers or the partnership with other agencies

R3: Explicitly consider the potential impact of deficiencies in current data assimilation and prediction system when using OSSEs to evaluate observational network likely decades ahead

Recommendations on potential NOAA actions related to OSSEs - 2

R4: Expand the use of OSSEs:

1. Assess the value of NOAA partnership in satellite remote sensing with foreign agencies and the private sector

2. Find the optimal way to address forecast questions (e.g., sea ice prediction)

3. Compare the value of (polar, geostationary, small/cube) satellite network strategy for weather and climate prediction

4. Perform the gap analysis (e.g., what are the greatest new observational needs?)

R5: Extend OSSEs to societal impacts by seeking synergy with the existing NOAA Observing System Integrated Analysis (NOSIA-II)