Outcomes of the 8th WMO Workshop on the

Impacts of Various Observing Systems on NWP and Earth System Prediction

Presented to CGMS-52 Plenary session, agenda item *CGMS-52-WMO-WP-04p*

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8th WMO Impact Workshop: Facts

8th in a series of workshops that take place every ~4 years

This time, it took place last week:
27 to 30 May 2024

In the Swedish Meteorological and Hydrological Institute (SMHI)

In Norrköping, Sweden

110 participants (on-site)
(+ about 80 online participants)

- **20 countries represented**

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8th WMO Impact Workshop: What was different this time?

- First time workshop scope expanded beyond NWP to include all Earth System Components:
  - Global NWP & Climate
  - Short-Range/Nowcasting
  - Hydrology and Land Applications
  - Space Weather
  - Ocean Applications
  - Cryospheric applications
- Science organizing Committee was composed of leaders in the different communities above: in an attempt to coalesce the Earth Science community through this SOC.
- Science questions were co-developed between the Science Organizing Committee, their communities, as well as the Observing systems owners: space agencies (including CGMS), ground based observing systems operators (such as EUMETNET)
- Preparation for the workshop started more than 2 years ago. To allow ample time to conduct impact experiments.

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General Comments

- Multiple applications have either demonstrated (or have potential to) benefit from coupling with other applications (e.g. NWP/Ocean, High-Resolution NWP/Hydrology): ESP is encouraged!
- This ESP approach is leading to an increase in the value of some observations that were not necessarily valuable for NWP before (e.g. soil moisture, sea-ice, etc.).
- The landscape of 'Impact of Observing Systems on NWP/ESP' is changing rapidly: increasing diversity of new observing systems, evolving ESP, AI, ML, non-traditional players, etc. Results today could change tomorrow.

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Findings: High-Level Take aways

1. Significant impact from PMW, IR, RO, radiosondes and aircraft data (without specific order).
2. Coupled Earth system approaches emphasize emerging significant impact of ocean, land and snow observations on NWP.
3. There has been an increase in the (quantitative and qualitative) use of many observations in high resolution NWP.
4. New Observations have been tested (i.e. HR radar wind profilers, ground based lightning detection, etc) with demonstrated positive impact for high-resolution NWP.
5. Increased use of satellite data in LAMs. Generally positive and increasing impact, with some exceptions noticed.
6. Increased use of satellite data over land, over complex surfaces, and in all-sky conditions.
7. Positive Impacts from assimilating multiple constellations of smallSats of MW and IR sensors were demonstrated in simulation
8. Positive Impacts from assimilating space-based wind lidar, and its additive impact to MW sensors, were demonstrated in simulation.
9. There are multitude metrics used to assess impacts: OSE/DDE, OSSE, EDA, FSOI, EFSOI, ESA, PAI. These approaches serve both to assess impact but could serve the purpose of optimizing the design and evolution of observing systems.
10. Combining LEO and GEO Sounders have been shown to have complementary positive impacts on global NWP, in simulation
11. Several types of observations (Ocean Obs, UAS, Balloons, etc) have been demonstrated to add value to many applications
12. Synergy between several types of Observation (e.g. in-situ and space) has been highly positive and encouraged.
13. Several needs from science community have been expressed (deep ocean, high density ground based measurements, etc.).

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Findings: New and emerging observing systems and their impacts

- Positive Impact, to various degree, on a variety of applications was demonstrated for:
  - Doppler wind lidar
  - mw-profiler
  - MODE-S
  - Deep ocean Argo,
  - SWOT satellite: SWOT ocean topography data successfully assimilated, added small-scale features that survive in the ocean forecast. Impact first estimated in OSSE, then verified in OSEs
  - Drones (UAS)
- Prospective (in simulation) : EPS-Sterna, EPS-Aeolus, CMIM, TSCV

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Recommendations: Space Agencies (1/3)

- *Recommendation 2.1:*

Recommend sustaining critical observations that are now considered fundamental to maintaining NWP skills, in particular passive microwave (MW), Infrared (IR) and Radio Occultation (RO).

- *Recommendation 2.2:*

Recommend sustaining observations that have been demonstrated to be increasingly important for Coupled NWP and Earth System Prediction (ESP). Such observations include surface sensitive channels of passive MW and IR, scatterometers, SARs and altimeters, for which strong evidence has been presented in this workshop to constrain ocean (e.g. SST, sea ice, sea-level anomaly) and land (e.g., soil moisture, land surface temperature, snow), with positive impact on ESP.

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Recommendations: Space Agencies (2/3)

- *Recommendation 2.3:*

Recommend considering the extension of space-based Observing systems with capabilities with demonstrated positive impact on NWP and Earth System Prediction skills. Such capabilities that were demonstrated in this workshop (based on real data or simulations) to have such characteristics include:

- Lidar Wind profiling from Space
- Increased temporal resolution, coverage of MW/IR observations (both T, Q sounding)
- Increase number of radio occultations

Recommendations: Space Agencies (3/3)

- *Recommendation 2.4:*

When planning new instruments (especially research missions), observations availability timeliness should be considered. At a minimum, the design should allow relatively easy extension of the capability to provide observations at the desired timeliness.

- *Recommendation 2.5:*

Recommend early initiation of the process of considering follow-on options to research missions with significant (and evidenced) potential for being transformative to ESP coupled systems. Such research mission identified in this workshop includes the Surface Water and Ocean Topography (SWOT) mission

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Thank you

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