Progress Report for:

Establishing an OSSE Framework for the THORPEX Program and Mission Planning

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This report covers the six months (January-June) of work due to late arrival of funds.

Progress on the proposed work plan

The proposed research under the Thorpex funding builds upon the significant OSSE capabilities and associated investments at NCEP and GSFC. Given the resources requested to develop an OSSE framework for THORPEX, the efforts under this proposal are primarily ones of upgrading, investigating and evaluating the formal OSSE methodology, and conducting experiments. The degree to which the primary tasks have been fully engaged in or documented has depended upon the level of co-funding through other THORPEX activities and the JCSDA.

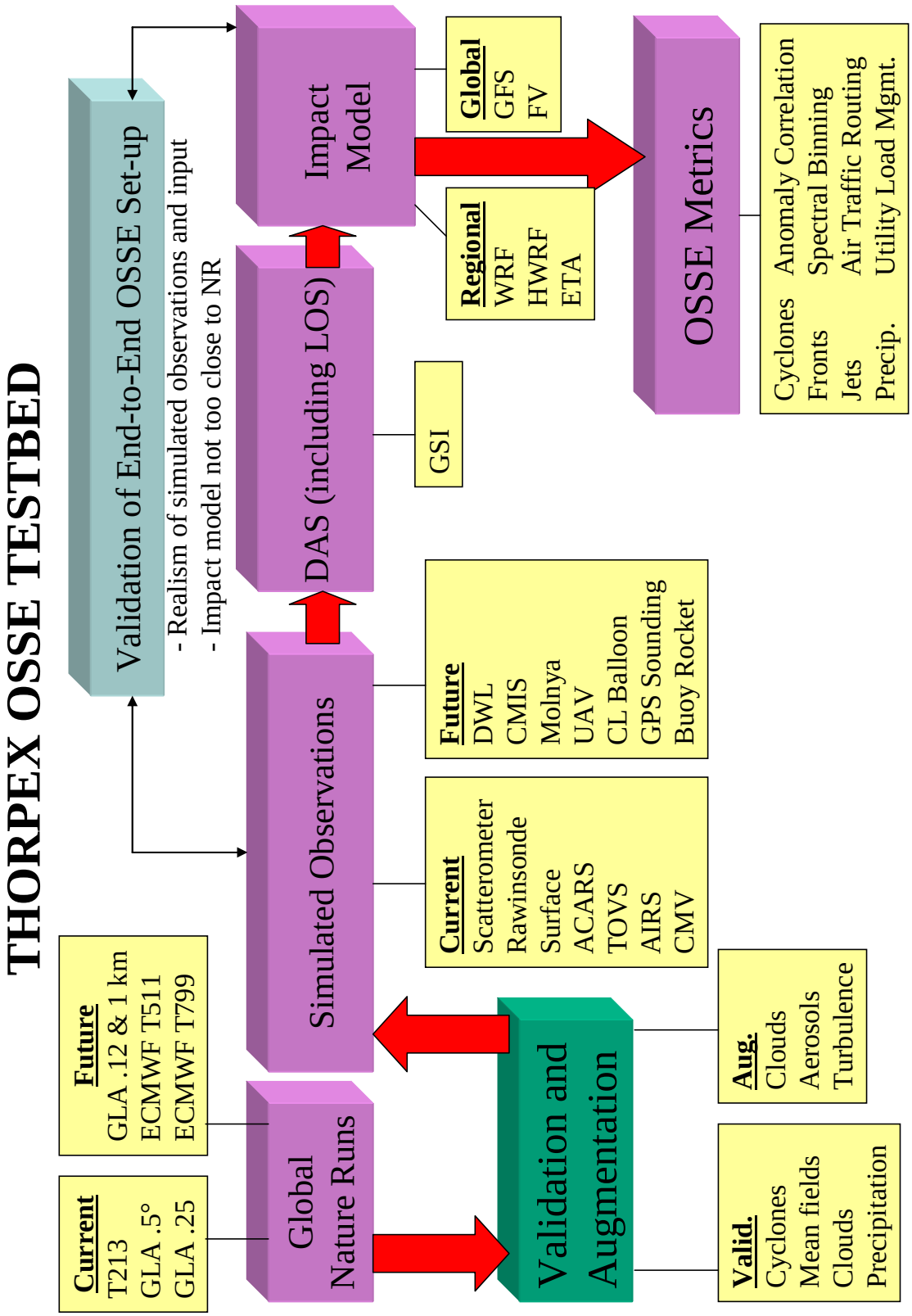
To insure that the OSSEs are understood and usable by other researchers within the THORPEX and JCSDA funded community, an OSSE Working Group is being set up and populated with persons representing the four components of the THORPEX program (Observations, Data Assimilation, Forecast Models and Users).This will address the concern that the OSSEs not be overly directed by the groups interested solely in new observing systems. It is important to have all components of the forecasting process involved in the design and evaluation of the OSSEs. This effort will directly support the THORPEX goal of developing an integrated forecast system with strong interdisciplinary collaboration.

A primary deliverable for this effort will be a documented formal process for conducting OSSEs. Several types of OSSEs are being investigated, including those that use long model integrations (>30 days), multiple short forecasts (<16 days) and analyses for Nature Runs. Depending upon funding levels, new Nature Runs (see reported progress on Task Groups) will be generated to provide more realistic simulated observations and/or longer model integrations. The OSSE framework is modularized to facilitate substitutions of key components in experiments by THORPEX researchers.

The work plan was partitioned into five primary groups of tasks that map to the major components of the THORPEX OSSE Testbed described in Figure 1. Those five areas are:

- Validating and augmenting Nature Runs
- Simulating current observing systems
- Simulating new/proposed observing systems
- Modifying data assimilation schemes
- Conducting adaptive targeting OSSEs

Figure 1


THORPEX OSSE TESTBED
Validation of End-to-End OSSE Set-up
- Realism of simulated observations and input
- Impact model not too close to NR
Impact Model
Global
GFS
FV
Regional
WRF
HWRF
ETA
DAS (including LOS)
GSI
OSSE Metrics
Cyclones
Fronts
Jets
Precip.
Anomaly Correlation
Spectral Binning
Air Traffic Routing
Utility Load Mgmt.
Simulated Observations
Future
DWL
CMIS
Molnya
UAV
CL Balloon
GPS Sounding
Buoy Rocket
Current
Scatterometer
Rawinsonde
Surface
ACARS
TOVS
AIRS
CMV
Validation and Augmentation
Aug.
Clouds
Aerosols
Turbulence
Valid.
Cyclones
Mean fields
Clouds
Precipitation
Global Nature Runs
Future
GLA .12 & 1 km
ECMWF T511
ECMWF T799
Current
T213
GLA .5°
GLA .25

Task group 1: Validating and augmenting Nature Runs

Validation involves comparison of Nature Run features and statistics with those observed in real world data assimilation and forecast applications. Our experience is that the Nature Runs are lacking in realistic cloud coverage, useful estimates of sub-gridscale variability in state parameters, and first order (at least) estimates of aerosol concentrations and their radiative properties.

We have upgraded the representation of clouds in both the existing ECMWF T213 and GSFC's FVCCM (.5 degree) Nature Runs to better match the cloud climatologies being derived from MODIS and other advanced multi-spectral sensors.

We have yet to incorporate first order estimates of sub-grid scale variance in winds, temperature, humidity and clouds to better capture issues of representativeness in the simulated observations. Code for this sub-grid scale representation has been developed for the DWL OSSEs but is part of the DWL simulation code rather than being provided by the Nature Run itself. In order that all observing systems use the same input for the simulations, we will incorporate the subgrid scale variability into the Nature Run data set as we do with the modified cloud coverage and optical depth information.

We have yet to include a background distribution of aerosols based upon recent products derived from MODIS.

We have explored the feasibility of generating new Nature Runs and have now generated several candidates. Under consideration are:

- New high resolution runs with the NASA/GSFC's fvGCM model at .25 and .12 degree resolutions. Three candidate nature runs of 30 days length have been generated at .25 degree resolution, and are in the process of being evaluated for realism. In addition, numerous mini-nature runs have been generated for potential use in "QuickOSSE" experiments.
- High resolution runs with the Japanese Earth Simulator . After meeting with the Japanese, it is not likely that a Nature Run could be generated in the near term.
- ECMWF has offered to generate two new Nature Runs; one at T511 and a regional one at T799.
- NCEP's 16-day GFS forecasts
- NCEP's coupled ocean-atmosphere model using long integrations
- Series of analyses fields

We continue to review these new Nature Run possibilities with special attention paid to costs and benefits since a major investment is needed to validate and augment (e.g. cloud adjustments) the truth set.

Task group 2: Simulating current observing systems

Before new observing systems can be evaluated within OSSEs, all of the data from current observing systems must be properly simulated. Presently, the following systems are being simulated within the OSSE efforts at NCEP and GSFC:

Rawinsondes (code at both NCEP and GSFC)
Land surface stations (code at NCEP and GSFC)
Buoys (code at NCEP and GSFC)
ACARS (code at GSFC)
Scatterometers at GSFC)
ATOVS radiances (at NCEP)
ATOVS retrievals (at GSFC)

The following observing systems have been added to the available set of forward models and instrument models:

CMV and WVMV (code developed at SWA)
AIRS radiances (modifications are needed to TOVS simulation code)
AIRS retrievals (code at GSFC)

In some cases there is a need to revise current simulation code to more directly incorporate the effects of clouds as represented by models. This is particularly true for simulating cloud clearing for the TOVS and AIRS. We will work with the AIRS science team to obtain the most current information on cloud clearing for that instrument.

Of particular interest and challenge is the proper representation of systematic or correlated errors in the simulated observations. We are incorporating systematic instrument errors (e.g. pointing, calibration drift) and correlated sampling errors as appropriate considering the limits of the Nature Runs.

Task group 3: Simulating new/proposed observing systems

While much of the OSSE research to date has been focused upon future space-based systems, the simulation of aircraft, UAV and balloon borne instruments has been investigated as part of DoD funding in the development of the DLSM (Doppler Lidar Simulation Model) at SWA. For THORPEX, we would develop the code (building upon existing code) appropriate for those observing systems that would be involved in targeting during THORPEX field campaigns. It is expected that constant level driftballoons with dropsondes would be one of the first systems to model (personal conversation with Terry Hock (NCAR). Later, UAVs of various capabilities (flight levels, speed, sensors, etc) would be simulated (Personal conversation with Greg Holland and Ted McGeer). Other observing systems of potential interest to THORPEX would be the Smart Balloons (Steve Businger) and Rocketsondes(Roland Stull). The OSSE

Working Group would work with those funded under the THORPEX AO to assure proper representation of the instruments and their platforms.

Task group 4: The choice of NWP model and data assimilation methodology used in the OSSE for data assimilation and forecasting. The OSSE testbed is planned to have multiple models and data assimilation systems (DAS) available for use in OSSEs. Under this proposal, we are evaluating the representation of model error in OSSEs and investigating the realism of different models and DAS in relation to a specific nature run.

Task group 5: Conducting adaptive targeting OSSEs

Throughout the research associated with the task groups above, we have and will continue to conduct OSSEs involving adaptive targeting schemes. In this way we will be able to assess the relative importance of various changes we make to the OSSE formulation to the detection and characterization (metrics) of observing system impacts. This effort is leveraging IPO (NPOESS) funding for simulating adaptive targeting of space-based observing systems such as Doppler Wind Lidars and NASA funding of AIRS OSEs.

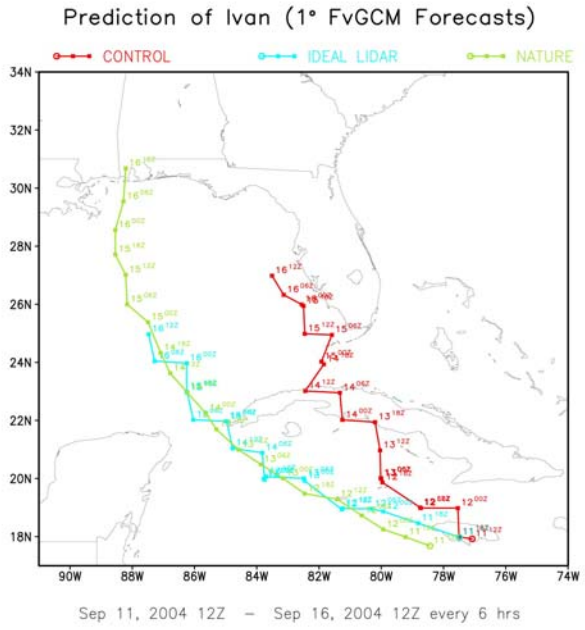
During the first half of this THORPEX effort, Atlas and Emmitt have been exploring the benefits of adaptively targeting Tropical cyclones with a space based DWL or airborne wind sounders (more than just G4). While the term "adaptive targeting" usually is taken to describe a scheme for directing observation systems to limited areas identified as being data sensitive regions for forecasting models, we recognize a second form of adaptive targeting. Given the ever increasing amount of remotely sensed data from space-based instruments and the computational costs of assimilating those data into models, there is an incentive to be more selective in which data are actually used for initial conditions. Currently, most NWP centers employ some form of thinning to reduce the data volumes they assimilate. We envision using the same adaptive targeting schemes developed for data collection to select the data already collected that have the highest impact potential.

Some example adaptive targeting schemes to be considered for THORPEX (and perhaps JCSDA) OSSE evaluation are:

Deployment of constant level balloons over the Pacific Ocean
Deployment of UAVs off coast lines
Selection of high impact data from "over sampled" regions

Under this proposal, a new methodology, termed QuickOSSE was conceived and has been applied to an initial case of hurricane landfall prediction. In essence, QuickOSSEs are conceived to be an adjunct to full OSSEs, that can be performed to address a specific question or forecast scenario in a rapid and inexpensive manner. The QuickOSSE that we performed was designed to test a hypothesis relating the vertical profile of divergence surrounding hurricane Ivan to the predicted track of the storm, and also to test the potential impact of additional wind profile observations to Ivan's forecast track. The

figure below is one of the many results from this QuickOSSE, and shows a significant improvement in the track of Ivan that could have resulted from the assimilation of the additional wind profile observations in this case. In the experiment, the Control contained all of the data currently available, including dropwindsones. The Lidar run added idealized wind profiles sufficient to improve the area averaged divergence profile surrounding the storm. This is only the first such test and should not yet be assumed to have general applicability. Further experiments relevant to this and other storms are currently being performed.



Timeline for OSSE effort

Task	Year 1				Year 2				Year 3			
Group 1												
Group 2												
Group 3												
Group 4												
Group 5												

Status of Deliverables

While a major portion of the proposed work is research aimed at the development of advanced OSSE techniques, we expect to deliver three tangibles:

- Formation of an OSSE Working Group (OWG) that will advise scientists working on the development of an OSSE system ready to be used by the community. Six people have already asked to be on the OWG. A general request for members will be sent out to the funded THORPEX researchers sometime after the 1st of July. A meeting of the OWG will be scheduled to coincide with a more general THORPEX or related meeting.

- Enhanced elements of a modular OSSE software package, along with a document that explains the OSSE methodology and its validation requirements, with sample experimental applications related to THORPEX and the JCSDA interests. This is still in progress. We anticipate NSF help in funding researchers who wish to use the OSSE testbed. A discussion of how academic institutions can participate in OSSE and OSSE-like experiments was held during a recent THOPEX planning meeting in Seattle, Washington. We plan to follow up on the suggestions made by participants in that meeting and anticipate some additional funding from THORPEX (NOAA) to support NCEP and GSFC in collaborating with the academic studies.

- A detailed report (Year 3) on OSSE trade studies designed to reveal the relative role of models, data assimilation schemes and observing system performance in achieving improvements in the 1-14 day forecasts. Particular emphasis will be placed upon the metrics of impact assessment. This study addresses directly the cross-cutting issues of relative merit of individual components within the framework of an end-to-end system approach.