DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

COAMPS User Support

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LONG-TERM GOALS

The long-term goal of this project is to provide support (e.g., consultation, code updates, training, data transfer, etc.) for those users of COAMPS®[1] who obtain the system through the release of the code as determined by release guidelines. The active distribution of COAMPS to the general scientific community cannot be accomplished without support from NRL-Monterey. NRL is well aware of the requirements of such a code support system. Meanwhile, in order to fully realize the development potential of the COAMPS system, the Navy needs to leverage research being performed in the community at large. This reasoning led to the formation of a COAMPS Process Action Team (PAT) that set the guidelines for the release of the COAMPS code to the general scientific community. The code release practice enhances Navy's capacity to advance the state-of-the-science COAMPS model in the coming years. As a result of this initiative, with the increased usage of COAMPS by the broader community, NRL has been able to leverage discoveries and developments from the scientific community at large, which has led to advancements in the overall COAMPS capabilities including aerosol microphysics, numerical methods, and coupled modeling.

OBJECTIVES

One of the primary objectives of this project is to establish a more comprehensive technical support capability for the COAMPS users, particularly those who have projects supported by ONR. Other functions in the support structure include, but are not limited to: making incremental improvements to the web site, updating versions of the code as necessary, updating the COAMPS documentation, providing user feedback to COAMPS developers, providing NOGAPS data for COAMPS IC and BC for historical cases, providing atmospheric and ocean observations data for the data assimilation systems, and maintaining/updating all of the supporting databases.

APPROACH

The COAMPS code will be released through a two-tier system, with Navy funded collaborators having access to a relatively recent version of the COAMPS model and data assimilation system (tier 1 access), and researchers and users with no existing Navy funding eligible for tier 2 access to the

[1] COAMPS® is a registered trademark of the Naval Research Laboratory.

COAMPS software, which includes an older version of the COAMPS system and a more generic version of the data assimilation software. Our planned work consists of updating and maintaining the COAMPS web site according to the recommended release of COAMPS, and providing support and consultation services to the users. This project will also leverage recent research conducted under the COAMPS-TC for code updating. In addition, we will leverage work performed over the past 2 years to integrate COAMPS with other physical parameterization schemes in the Weather Research and Forecast (WRF) repository.

WORK COMPLETED

The following work was completed in FY10:

1. Develop, improve, and maintain the COAMPS web pages

A new COAMPS web page has been created for the COAMPS Version 4 (V4) release. The links listed on this page provide COAMPS users with information on updates in the model code and also enable COAMPS users to download both the V4 source code and the data for a new benchmark case.

2. Provide available pre-processors to ingest other model output for use as initial and boundary conditions (IC & BC) for COAMPS

We have leveraged the effort ongoing within the COAMPS-TC project (also ONR funded), and have implemented the capability in the newly release COAMPS V4 code of utilizing NCEP Global Forecast System output as IC & BC for COAMPS.

3. Develop and provide a capability of interpolating high-resolution global sea surface temperature (SST) analyses

We have developed a new capability in COAMPS V4 to acquire SST analysis from the FNMOC Global Ocean Data Assimilation Experiment (GODAE) High-Resolution SST (GHRSST) Pilot Project. The global SST analysis data can then be interpolated to user specified domains. This capability, automated in the COAMPS run script and transparent to the user, has been thoroughly tested on different computer platforms for various cases.

4. Implement and distribute a version of the NRL Atmospheric Variational Data Assimilation System (NAVDAS) that does not contain any classified or sensitive observation processing code

In collaboration with colleagues in the data assimilation group (Keith Sashegyi), we now have a version of NAVDAS from which we have removed the code that handles sensitive or classified observations. The code can be made available based on user's request.

5. Functional interoperability with the WRF physical parameterization suite

We have implemented the WRF Thompson microphysical scheme in COAMPS and performed extensive COAMPS simulation with this scheme for both tropical cyclone cases and cases over the continental US and the east Pacific in coordination with the COAPMS-TC efforts and in

collaboration with Jason Nachamkin. Systematic comparisons were made between the Thompson microphysical parameterization and the COAMPS microphysics. This effort eventually led to the implementation of an updated microphysical scheme from Jerry Schmidt. We have also contributed to the effort (by Tracy Haack and Teddy Holt) to implement WRF planetary boundary layer schemes in COAMPS under the PMW-120 sponsored Small Scale Atmospheric Models project.

6. Provide consultation to COAMPS users. Provide user feedback to the COAMPS development team.

We continue to provide support service and consultation to COAMPS users on a routine basis. We have also been actively providing key advice to other research groups on their scientific endeavors using COAMPS.

RESULTS

Figure 1 shows the newly created web page for COAMPS V4 release. Listed under the "Release notes" are new features and updated that have been added to the COAMPS system: analysis, forecasting, and output routines. The source code can be downloaded directly under "source code". The NOGAPS, ADP, and SST data for a new benchmark case of Hurricane Gustav of 2008 are provided under the "New Benchmark".

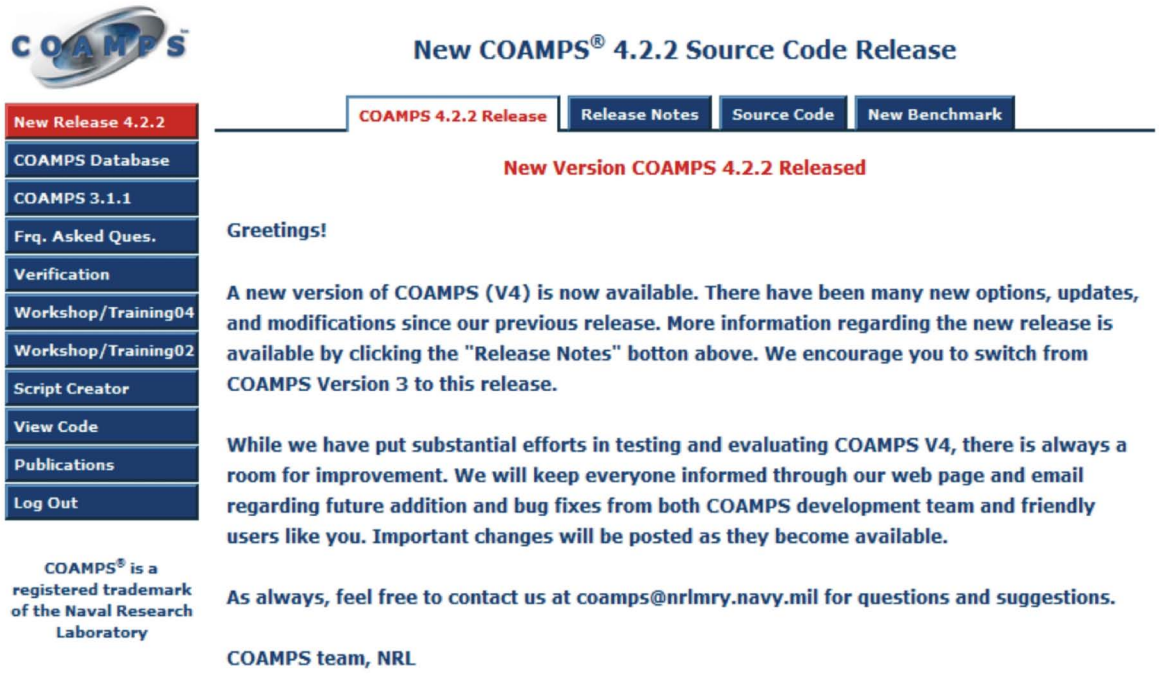

Figure 1. New web page created for COAMPS V4 code release

To facilitate both tier-1 and tier-2 users to run COAMPS, we developed software to extract SST analysis from the GODAE server and then interpolate the SST to the user specified COAMPS grid. These SST products are necessary since the COAMPS ocean analysis code is not released to external users. A newly built-in capability in COAMPS V4 scripts enables the user to download from the GODAE server real time high resolution (~10 km) SST analysis that incorporates various satellite SST observations (e.g., MCSST). We have also developed programs to create a mesoscale sub-domain with different map projections based on the user input as namelist variables in the run script. For example, the user can first download the global SST analysis data for 0000 UTC 26 October 2010 (Figure 2a) and then interpolate the data to two regional domains, one over the Atlantic (Fig. 2b) and the other over the Northwest Pacific (Fig. 2c).

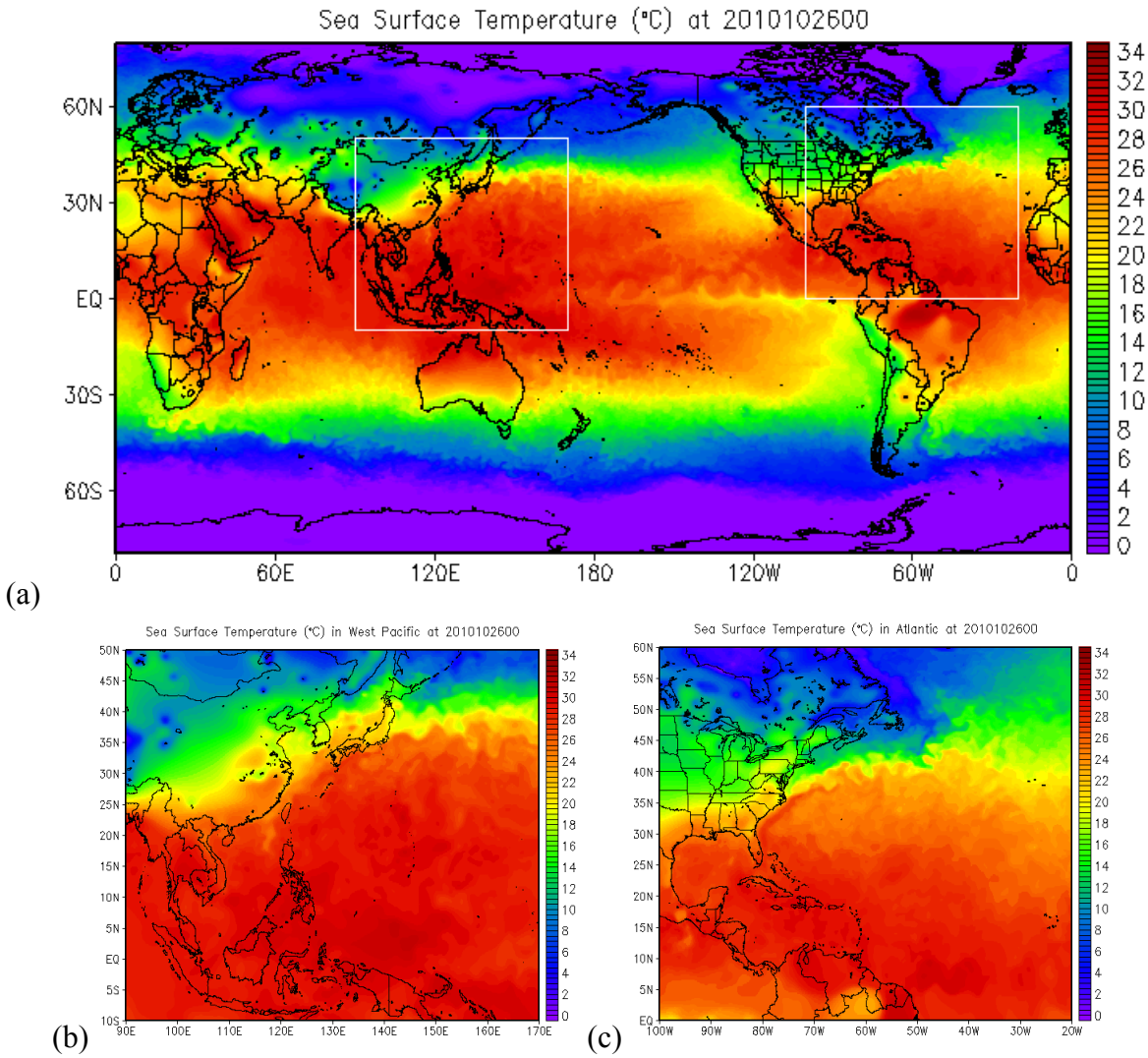

Figure 2. Real time high resolution global SST analysis valid at 0000 UTC 26 October 2010 (a) obtained from the GODAE server using the newly built program in COAMPS V4; SST analysis over Atlantic (b) and Northwest Pacific (c).

As the first step to build a functional interoperability with the WRF physical parameterization suite, we implemented the Thompson microphysical scheme in COAMPS. It had been evident that COAMPS has a tendency to over-predict upper-level clouds for both tropical cyclone cases and continent weather systems. Changes were made to the ice nucleation scheme in the model in attempt to reduce the cloud ice at upper levels. While these efforts have resulted in some improvement in tropical cyclone intensity forecasts, the issue of over-estimating upper tropospheric clouds remained. Simulations using the Thompson scheme (Thompson et al. 2004) provided an opportunity to evaluate the sensitivity of upper-level cloud ice forecasts to representation of microphysical processes in the model. In general, the Thompson scheme is similar to the current microphysics scheme in COAMPS-TC in that both schemes are bulk, mixed-phase microphysical parameterizations evolved from earlier methods such as Reisner et al. (1998). Key differences, however, exist between these two schemes, including primary ice initiation schemes, computation of saturation vapor pressure for the mixed phase, and sedimentation schemes for hydrometeors.

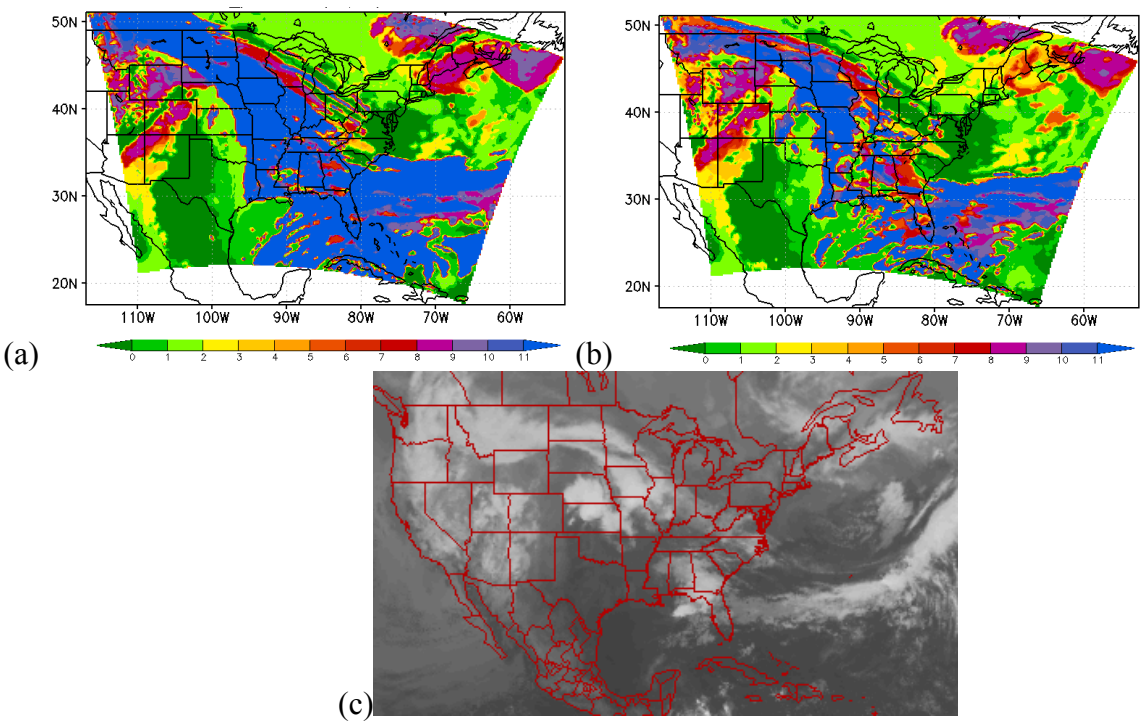

Figure 3. COAMPS simulated cloud top height (km) at 48 h (valid at 1200 UTC 23 May 2008) using the current version of microphysical scheme (a) and the Thompson scheme (b) compared to the infrared satellite imagery (c).

An example of cloud top height forecasts initialized at 1200 UTC 21 May 2008 is shown in Fig. 3. The control run using the current microphysical scheme predicts wide-spread high cloud tops (>11 km) after a 48 h simulation. The areal coverage of the high cloud top height is reduced significantly by the Thompson scheme and cloud top height from this run compares better with the satellite observation (Fig. 3c). More quantitative comparisons are performed for two-week COAMPS simulations of east Pacific where GOES retrievals of clouds are available. The Thompson scheme increased the correlation between the model forecast fields and satellite retrievals for both liquid

water path (Fig. 4a) and the cloud top height (Fig. 4b) at all verification times over the entire 48-h forecast period. The remarkable reduction of upper-level clouds is evident in Fig. 4c that displays the coverage of clouds with different cloud top heights. The control run has the maximum cloud coverage (~50%) for clouds with tops near 14 km whereas the satellite observations suggest that there were very few clouds at this height over the two week period. The Thompson scheme effectively removes the high cloud coverage bias at the upper levels seen in the control run, although it still over-estimates the cloud coverage slightly (by less than 10%) for clouds with tops between 8 and 14 km high. For low-level stratus clouds the Thompson scheme increases the cloud coverage compared to the control forecasts (by 20% at 2 km) and move the forecast values closer to the observed.

It should be noted that the Thompson scheme tends to overestimate the precipitation at the high precipitation threshold. Efforts are underway to address this issue. For this implementation of WRF microphysical schemes, a simplified driver routine was constructed to incorporate the Thompson scheme in COAMPS. This driver routine can be easily adapted to incorporate other microphysical schemes available in the WRF repository. Further tests are planned with more WRF schemes.

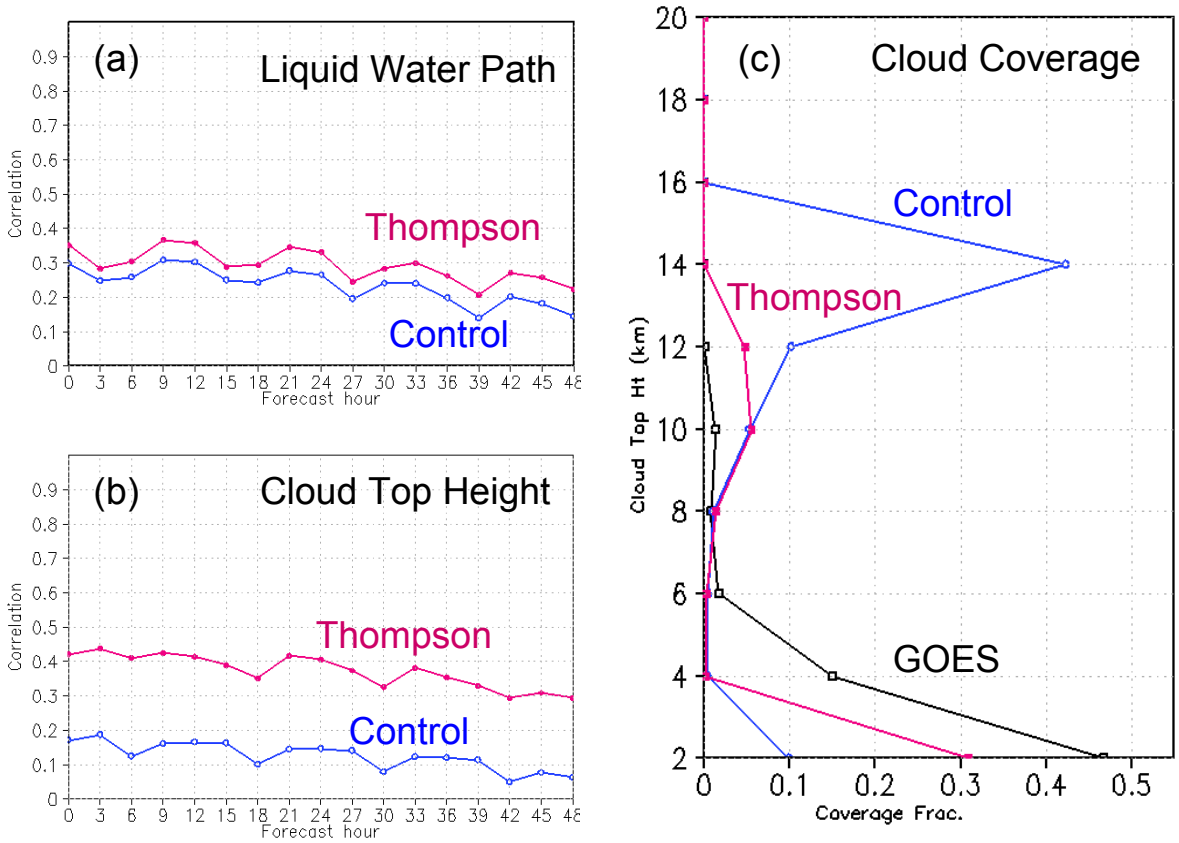

Figure 4. (a) Correlation coefficients between two-week COAMPS forecast of liquid water path (LWP) and GOES retrieved LWP; (b) as in (a), except for cloud top height; (c) cloud coverage as a function of height.

TRANSITIONS

The COAMPS V4 code has been released to the public.

RELATED PROJECTS

This project is closely coordinated with the COAMPS-TC RTP jointly supported by ONR, SPAWAR PMW-120 and HFIP project.

REFERENCES

Thompson, G, R. M. Rasmussen, K. Manning, 2004: Explicit Forecasts of winter precipitation using an improved bulk Microphysics scheme. Part I: Description and Sensitivity Analysis. *Mon. Wea. Rev.*, **132**, 519–542.

Reisner, J., R. M. Rasmussen, and R. T. Bruintjes, 1998: Explicit forecasting of supercooled liquid water in winter storms using the MM5 mesoscale model. *Quart. J. Roy. Meteor. Soc.,* **124,** 1071–1107.

PUBLICATIONS

None.