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Regional Artic Prediction System

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Award Number: N0001415WX01786
Award Number: N0001415WX00987

LONG-TERM GOALS

Our primary goal of this proposal is to advance Navy's coupled regional Arctic system with a particular emphasis on physical presentations of clouds and land surface. We propose to implement and assess the impact of new cloud microphysics schemes and land surface model in the coupled system. To accomplish the objective, we will employ the latest version of the COAMPS/NCOM/CICE Arctic system to conduct extended simulations of up to a month during the melt/freeze seasons over the Beaufort and Chukchi Seas; both *in-situ* and remote sensing measurements from latest field programs (e.g., ONR DRI Sea State/Boundary Layer 2015) as well as long-term observations (e.g., measurements at North Slope of Alaska Barrow Facility) will also be used.

OBJECTIVES

We propose to focus on the following specific objectives to accomplish the goal of advancing physical representation in the Arctic system.

1. Advance the representation of Arctic mixed-phase clouds;
2. Improve the performance of the WRF land surface prediction, particularly regarding the surface snow and permafrost.
3. Examine in detail to what extent the modeled surface energy balance can represent the observed energy exchange across the air-sea-ice interface.

APPROACH

Our overall approach is to use a combined modeling-observational-analysis method to achieve these objectives; it has following three components: 1) implement and improve two advanced cloud microphysics representations. One is the Morrison (2005, 2011) two-moment scheme; the other is the Thompson and Eidhammer (2014) microphysics representation. Both schemes have special treatment of mixed-phase clouds, which have a large impact on radiative fluxes in the Arctic; 2) Evauate and improve WRF land surface model, which is already availabe in COAMPS, in the Arctic focusing on surface snow and permafrost; and 3) conduct coupled Arctic simulations and analyze the surface energy balance derived from both the prediction and observations and study the impact of major weather events.

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WORK COMPLETED

Because the ONR FY15 funding was received on 4 September 2015, the work has just started. The plan is as follows.

- We will implement the Morrison parameterization and refine the mixed-phase cloud representation. Case studies will be conducted to evaluate the Morison as well Thompson parameterizations. The new cloud formulation will be linked to the radiation representation so that the radiative flux at sea ice surface can be accurately computed.
- Simulations using the improved microphysics will be analyzed with observations from ASCOS (Tjernstrom et al. 2014), many site observations (Shupe et al. 2011), and possibly measureents from the ONR DI Sea State program. The analyses include comparisons with the observations in terms of liquid and ice clouds, radiative fluxes and boundary layer structure.

RESULTS

Figure 1 demonstrates a comparison of the ASCOS cloud simulation with the observation. This simulation was conducted using the baseline cloud microphysics, a single moment parameterization. It shows that two distinctly different cloud systems, a deep frontal cloud system and a shallow boundary layer stratus cloud system, are, in general, reaonsonably simulated in terms of the time period, boundary layer structure, and cloud-top heights. The total cloud condensate is significantly underestimated by the model, as clearly demonstrated by the figure. We will improve this baseline model performance with more advanced cloud microphysics representations and evaluate their capabilities using more observations.

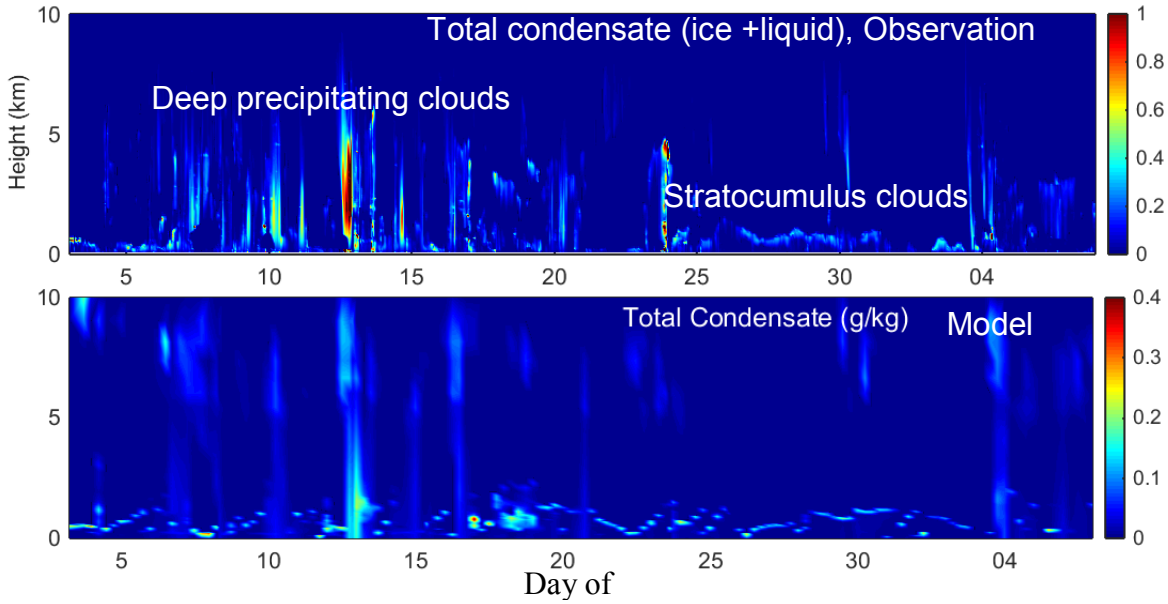

Figure 1. Comparison of the COAMPS simulation during ASCOS 2008 with the Lidar observations. Top: observed total condensate (liquid + ice); Bottom: modeled total condensate (liquid+ice). Note the different color coding for the different plots.

IMPACT/APPLICATIONS

TRANSITIONS

RELATED PROJECTS

ESPC-WU7 COAMPS-Arctic System

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