Potential impacts of assimilating All-Sky Satellite Infrared Radiances on Convention-Permitting Analysis and Prediction of Tropical Convection

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Motivations and Introduction

Difficult to constrain sub-synoptic features over the tropical oceans using the sparse in-situ observation network alone.

Assimilating dense and frequent geostationary infrared satellite radiance observations might improve analyses of sub-synoptic features.

Ultimate goal: improve analysis and prediction of tropical convection by assimilating geostationary satellite IR observations.

Goal of this study: examine impacts of assimilating all-sky water vapor channel (6.4 μm) brightness temperatures (WV-BT) from Meteosat-7 on observed clouds and thermodynamic variables.

Test case: October 2011 Madden-Julian Oscillation (MJO) event. MJO is a frequently occurring planetary-scale tropical disturbance.

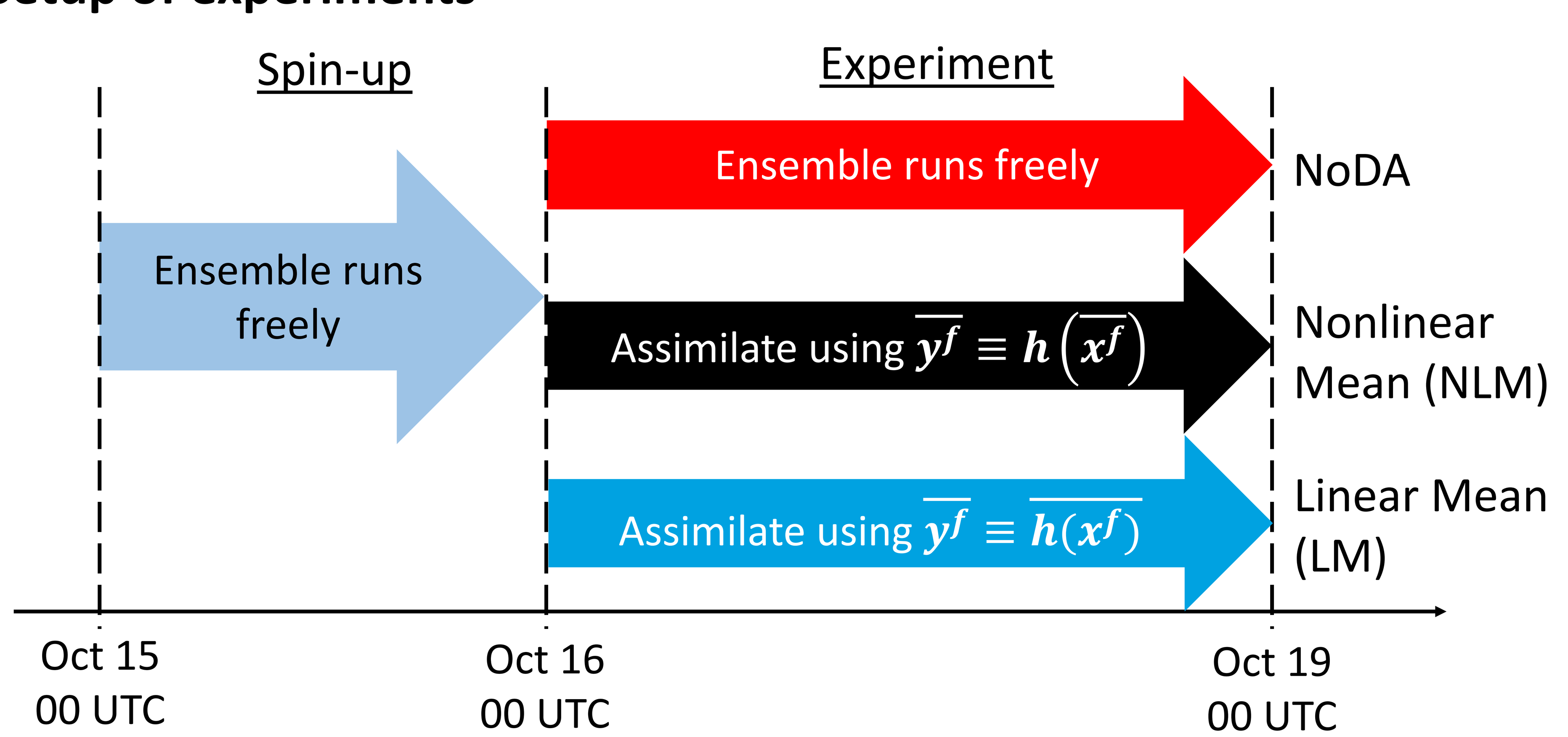
Methods

Ensemble setup

- 50 members drawn from ECMWF perturbed forecasts
- ARW-WRF model version 3.8 [see Ying and Zhang (2018) for setup]
- MJO begins on 16th Oct – ensemble starts running on 15th Oct, 00 UTC.

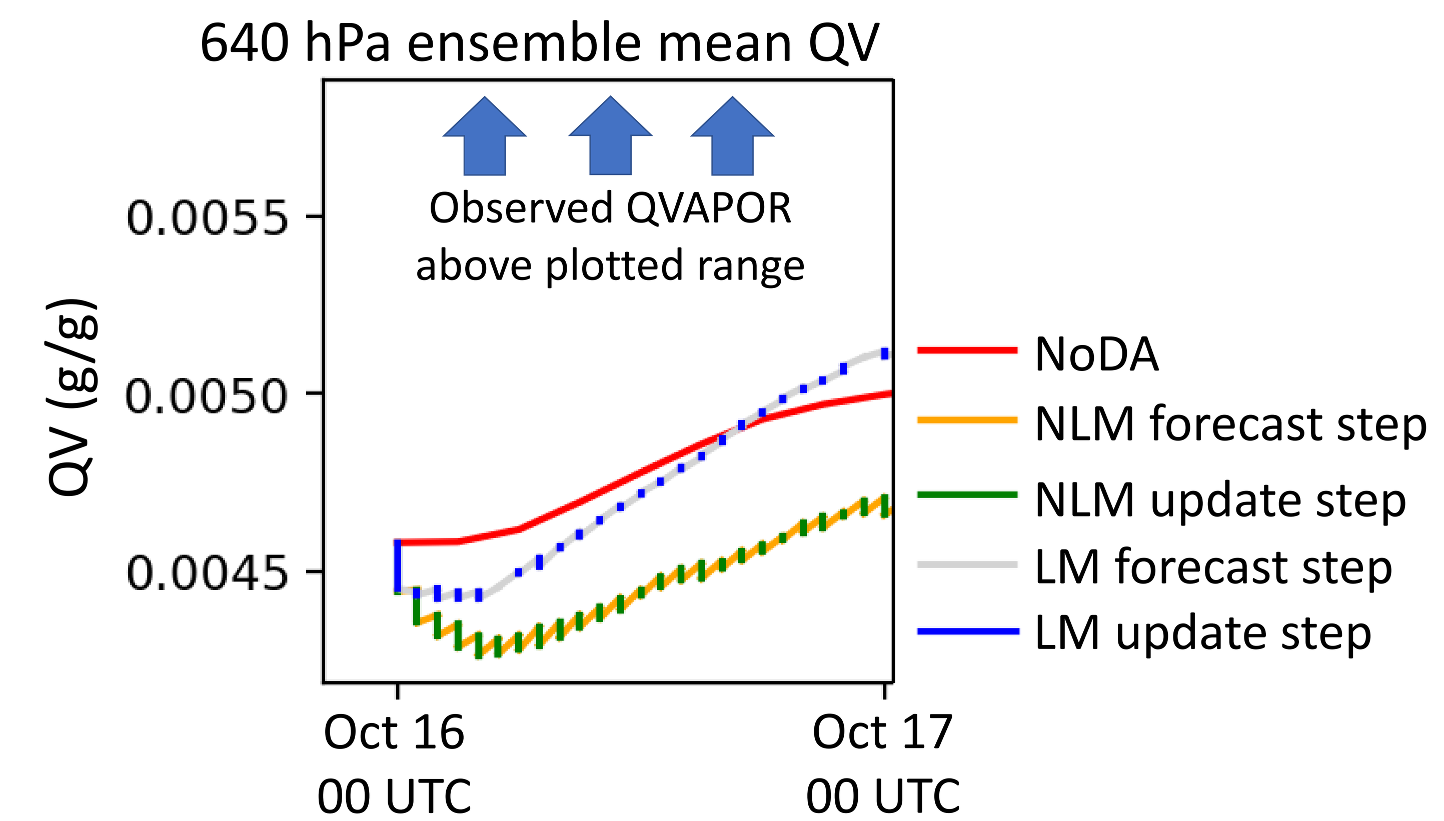
Only WV-BT assimilated. Used PSU-EnKF. Hourly assimilation cycles.

Setup of experiments

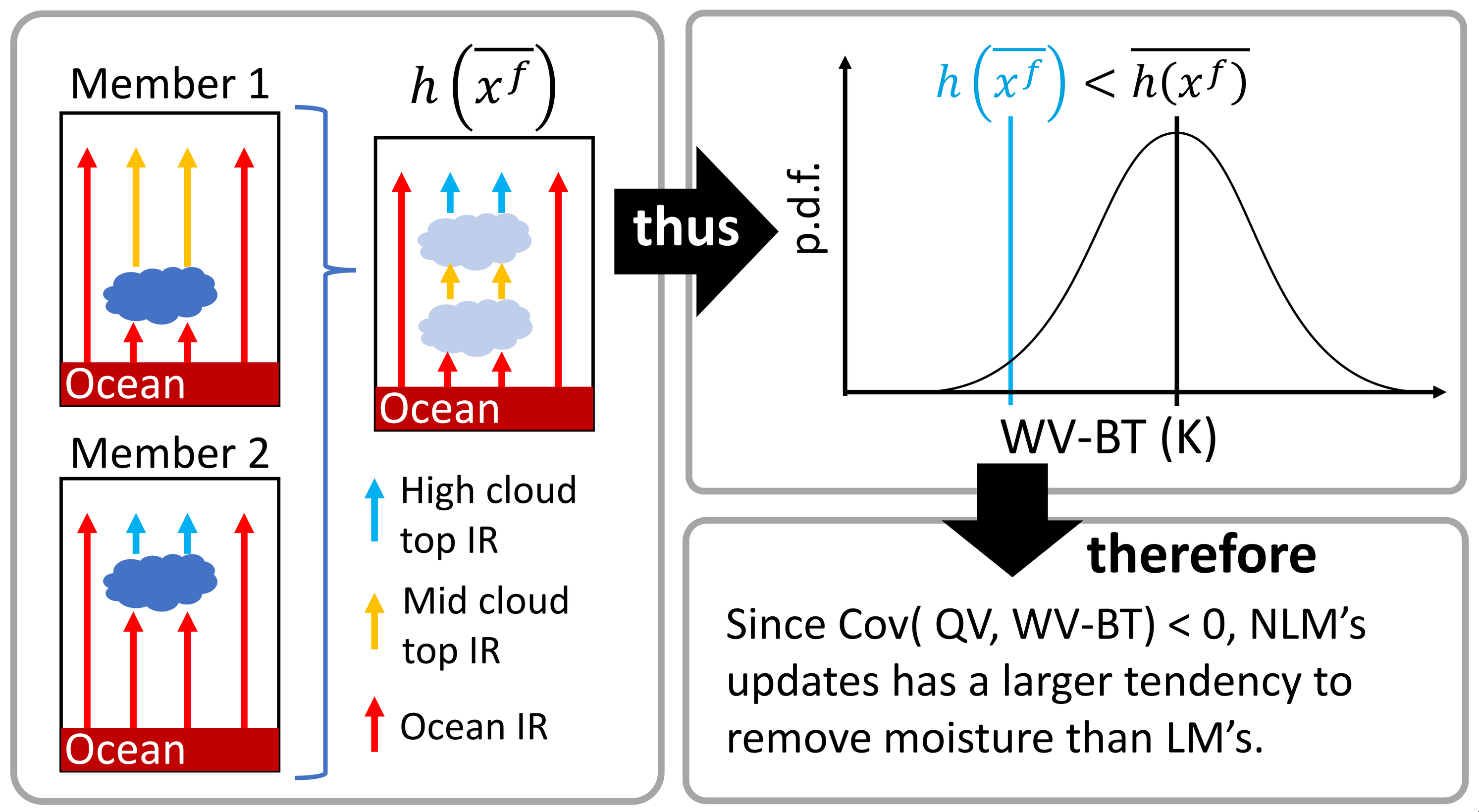


Main finding 1: LM avoided NLM's severely worsened dry bias

Evidence

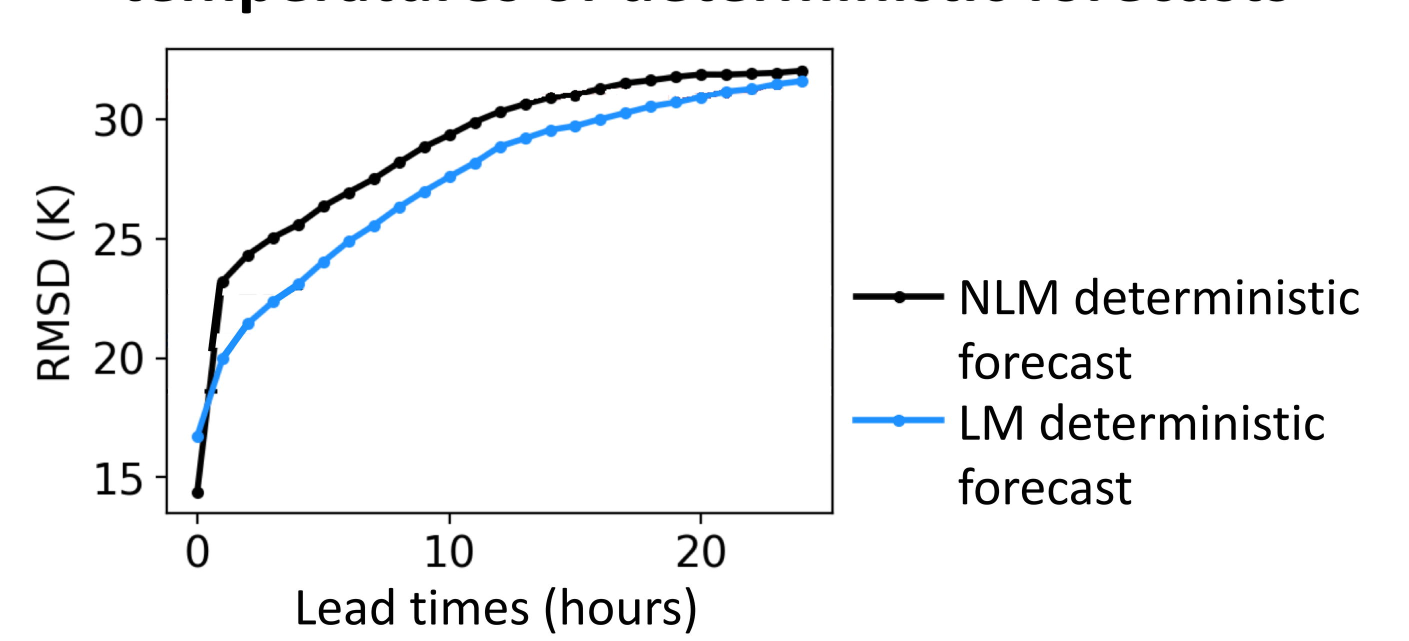


Explanation



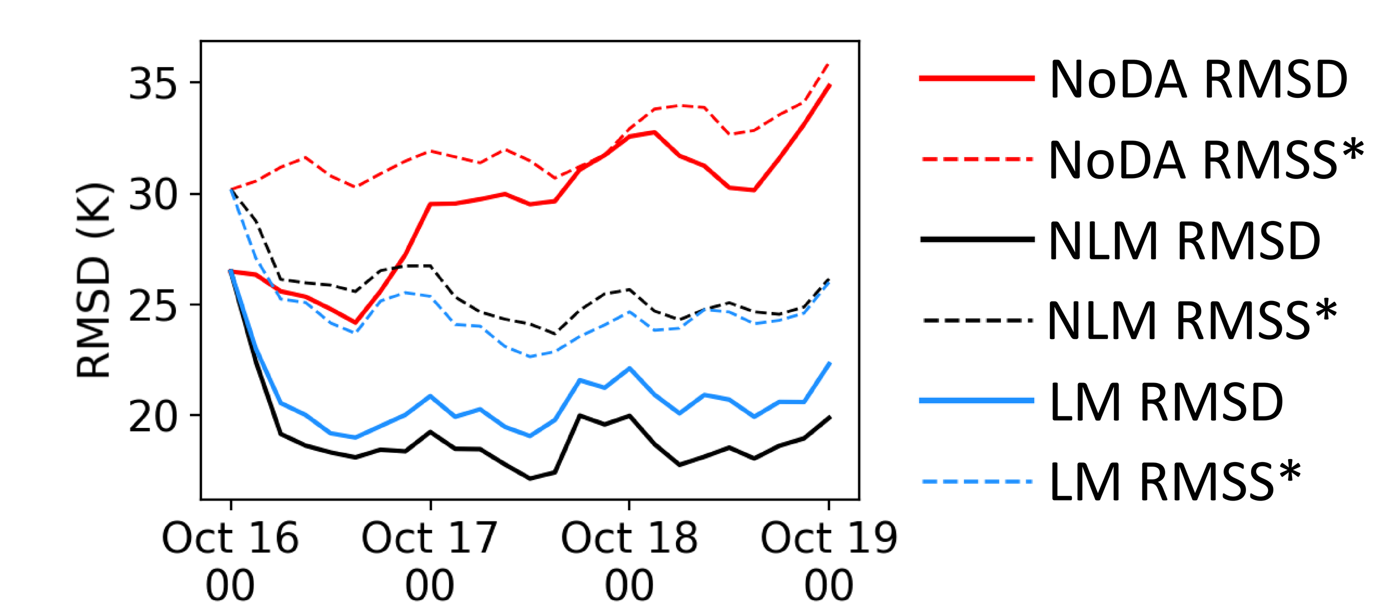
Main finding 2: LM has better deterministic forecasts of cloud patterns

RMSD of simulated window channel brightness temperatures of deterministic forecasts*



*Average RMSD of eight 24-hour deterministic forecasts initiated from the posterior ensemble means on Oct 17 (06, 12, 18 UTC) and Oct 18 (00, 06, 12, 18 UTC).

RMSD of simulated window channel brightness temperatures of prior ensemble means



*RMSS accounts for both the ensemble spread and observation variance.

Conclusions and future work

Using the nonlinear mean to compute the average analysis increment tends to remove moisture dramatically from the domain. Reverting to linear mean avoided this drying effect and improved the deterministic forecasts of cloud patterns seen in the Meteosat-7 window channel.

In the future, we will assimilate conventional observations with WV-BT over a domain with more landmass to quantitatively estimate improvements to tropical convection prediction and analysis from assimilating WV-BT.

Reference:
Ying, Y., & Zhang, F. (2018). Potentials in improving predictability of multiscale tropical weather systems evaluated through ensemble assimilation of simulated satellite-based observations. *Journal of the Atmospheric Sciences*, *75*, 1675–1698. https://doi.org/10.1175/JAS-D-17-0245.1