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A hybrid RTFDDA and WRF-3DVAR modeling system for mesoscale weather data assimilation and prediction

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National Security Applications Program
Research Applications Laboratory

Overview

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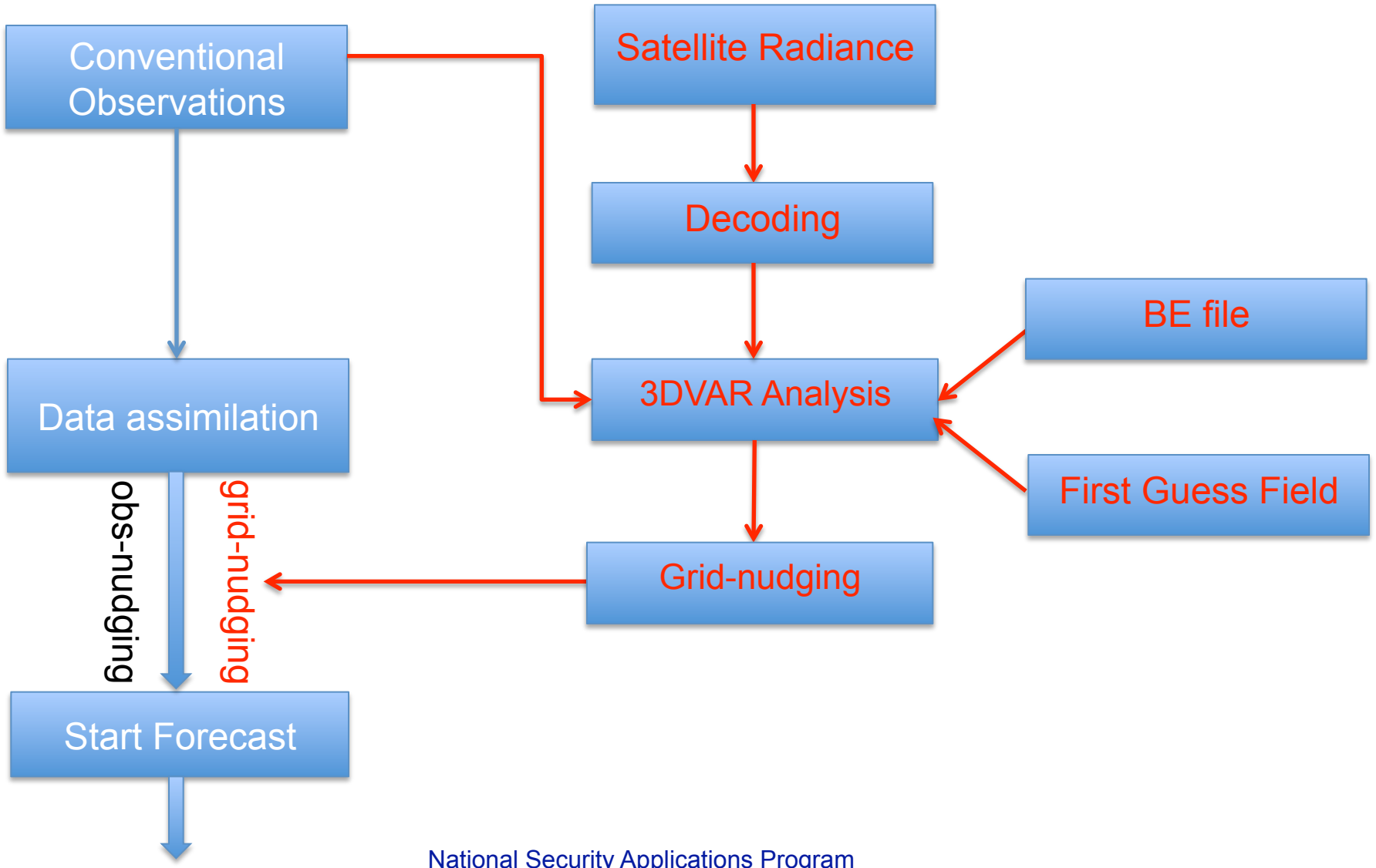
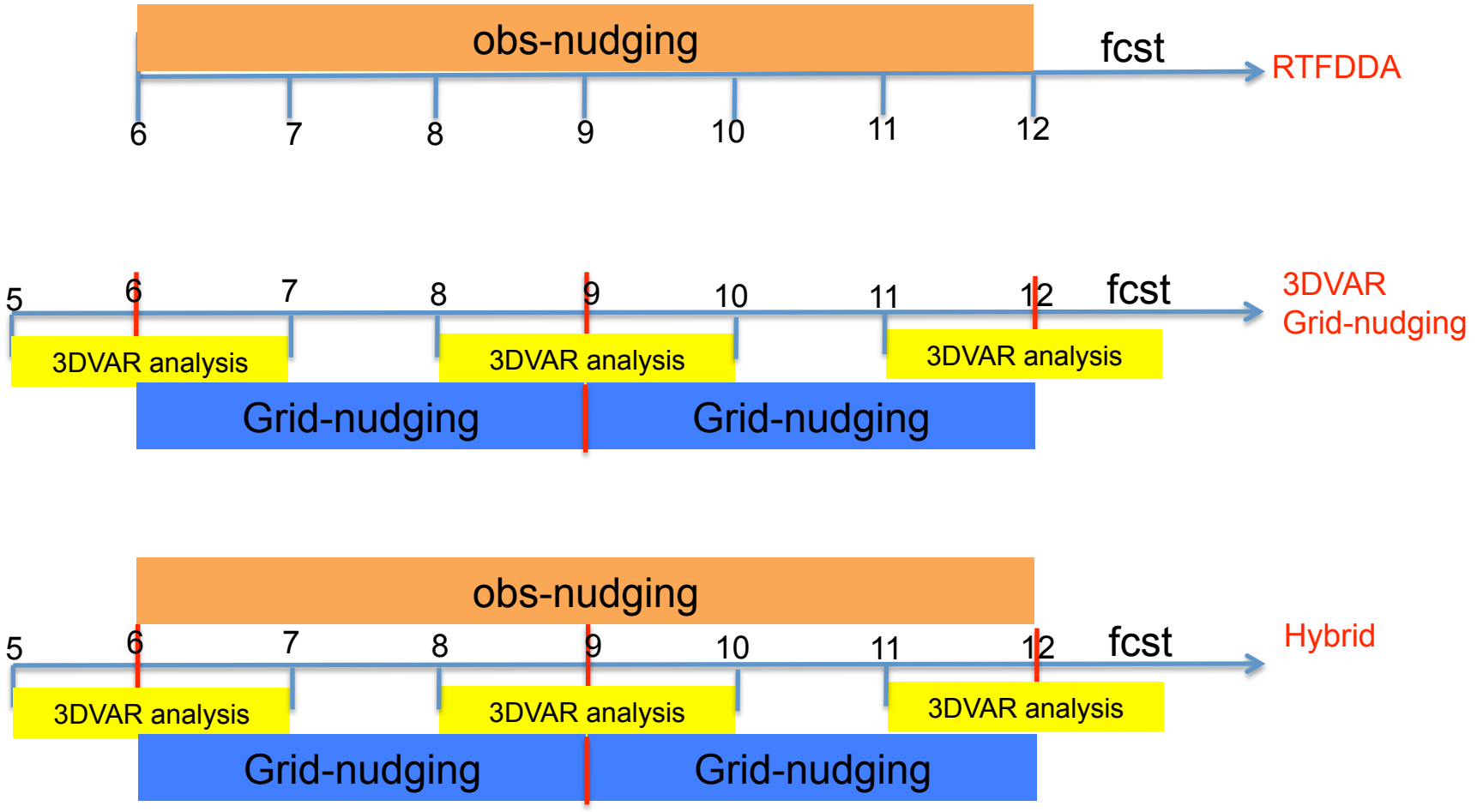
- Description of the hybrid system
- Validation with a case study
- Performance evaluation for semi-operational analysis and forecasting
- Summary

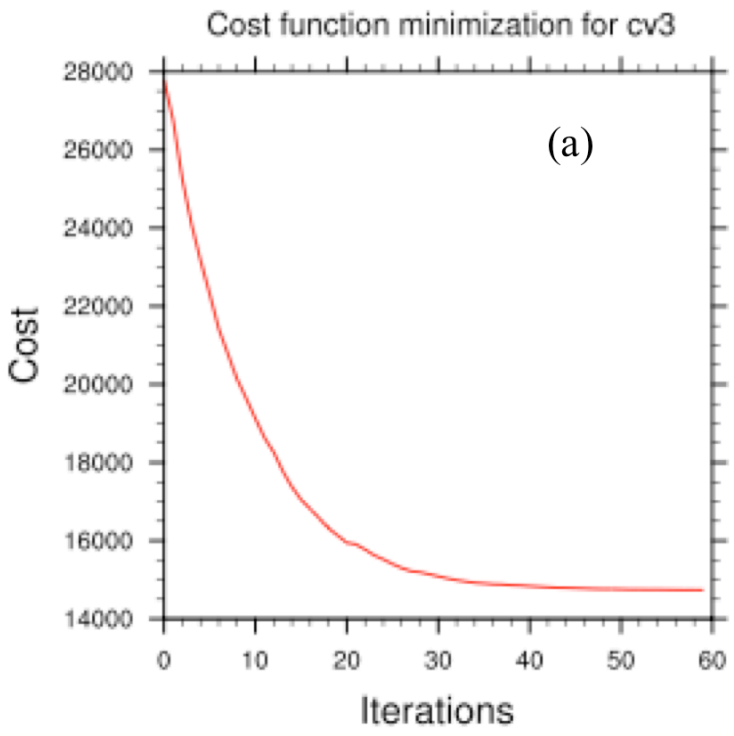
Flow Chart of the Hybrid System

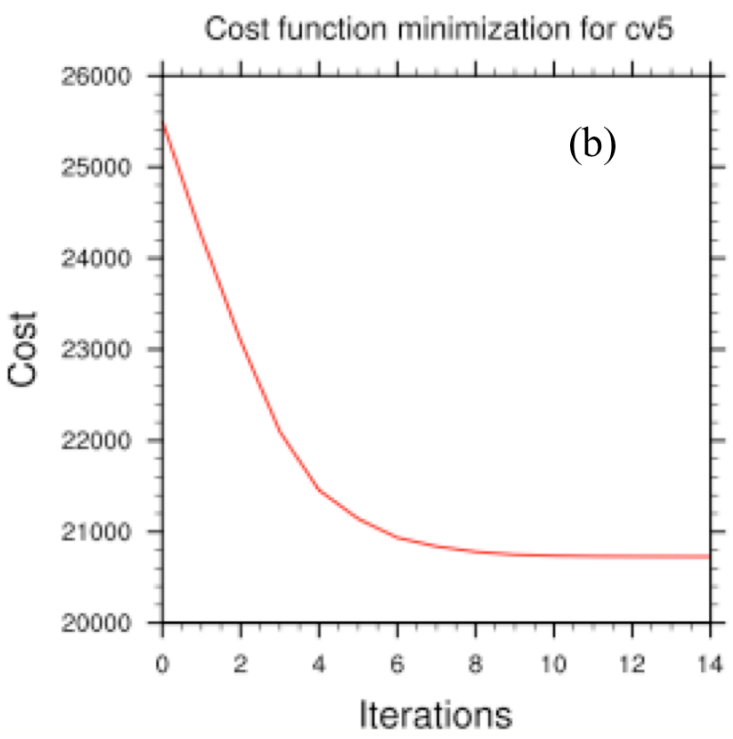


Hybrid System Implementation



BE for WRF-3DVAR: CV5 vs. CV3





CV5 & CV3 Analysis at 2009102900

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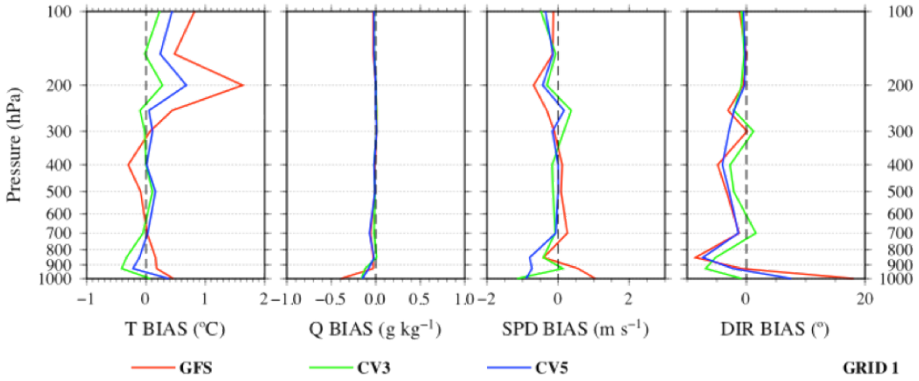
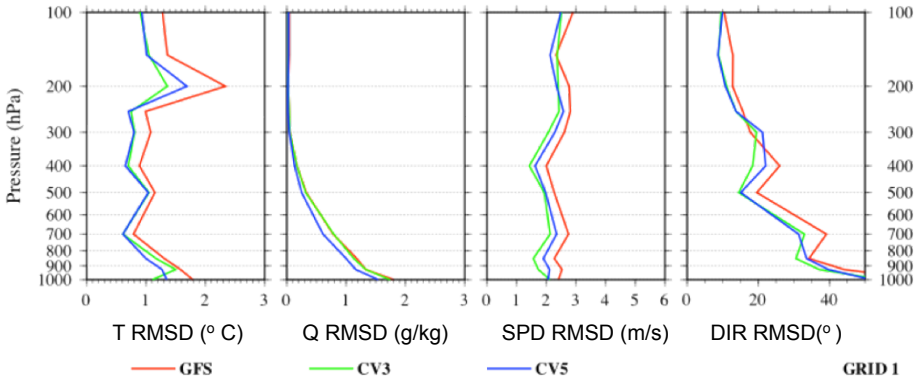
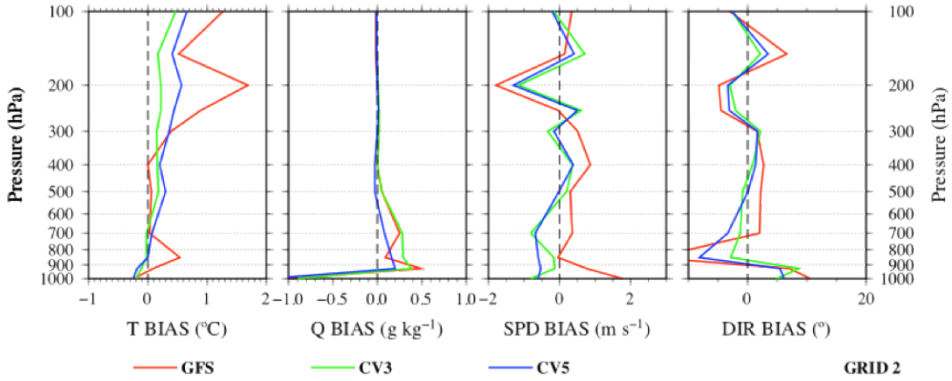
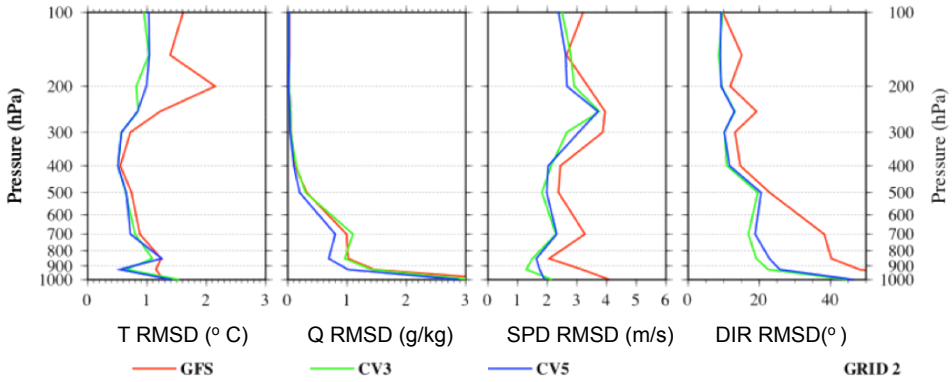
Domain1





Domain2



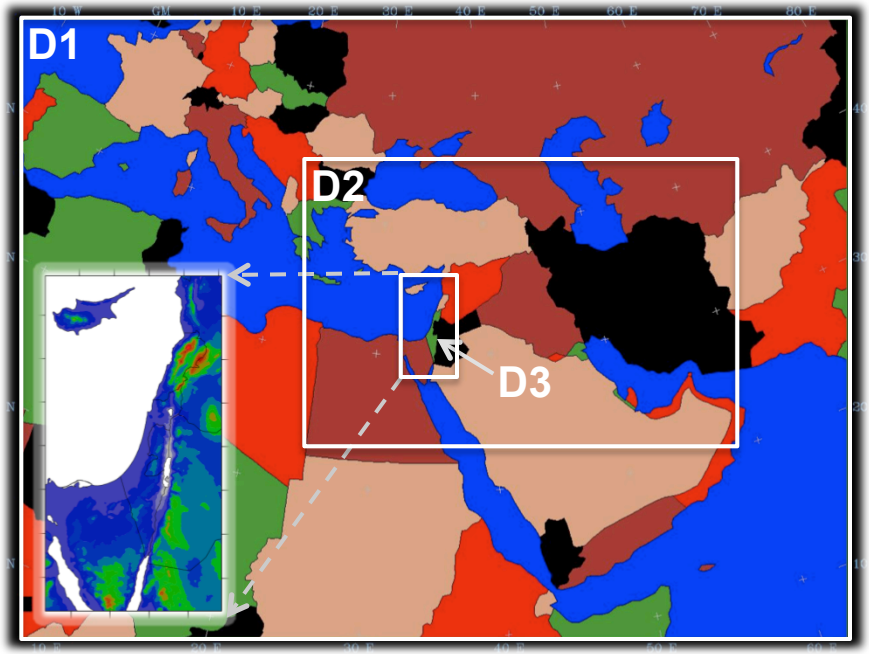


Experiments Design

- Four experiments are designed to make the forecast from 2009102900 to 2009103018:
  - COLDSTART: model starts from GFS field.
  - RTFDDA: obs-nudging based system
  - HY_NORAD: hybrid system without radiance data
  - HY_RAD: hybrid system, including radiance data

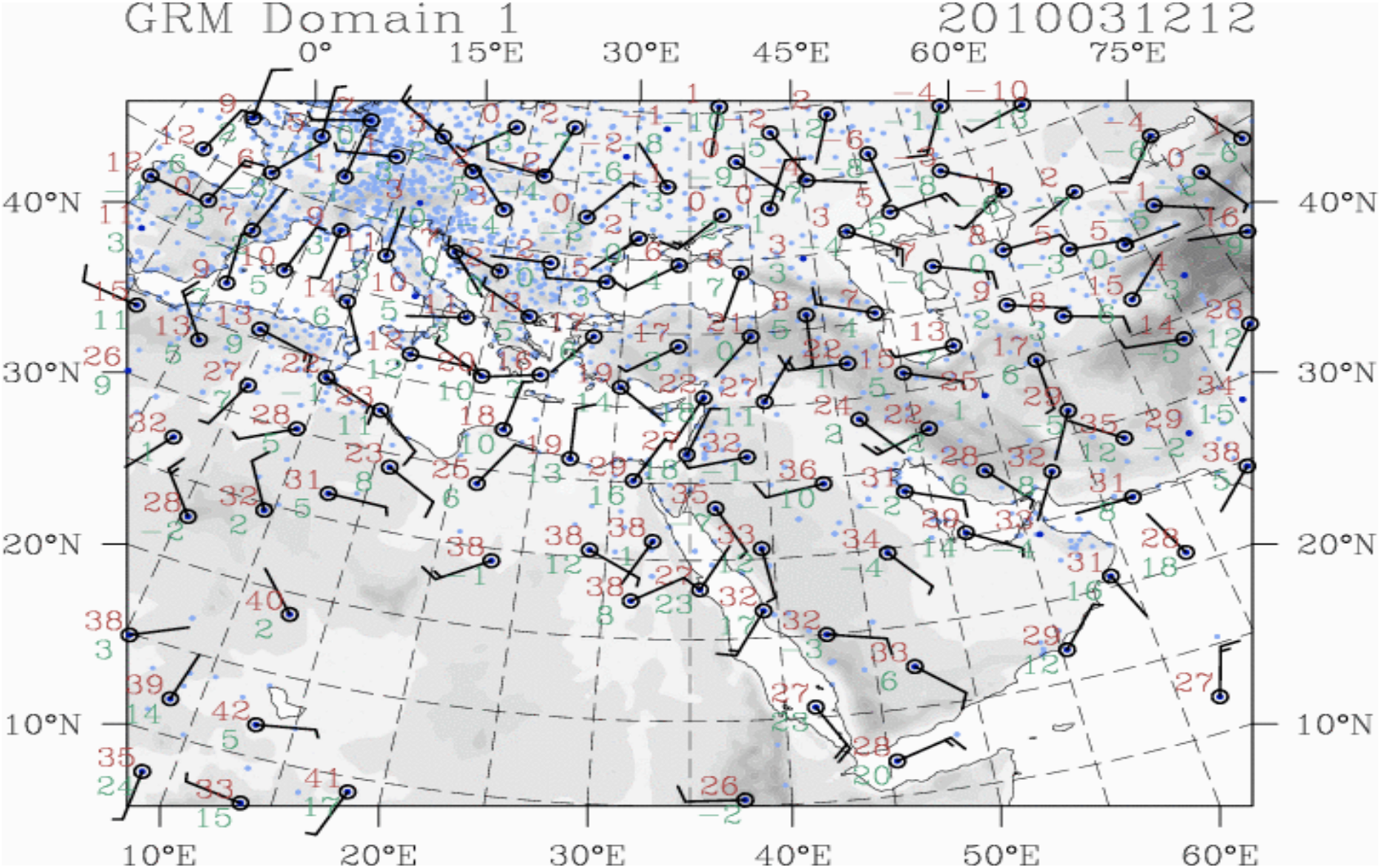
- Calculated BE files for domain 1 and 2 (cv_options = 5)
- GFS Forecast as first guess field for 3DVAR analysis
- Grid-nudging is applied for both D1 and D2

Domain Information



D1: 30km
D2: 10km
D3: 3.3km

Conventional Observation Data Coverage



Radiance Data Coverage

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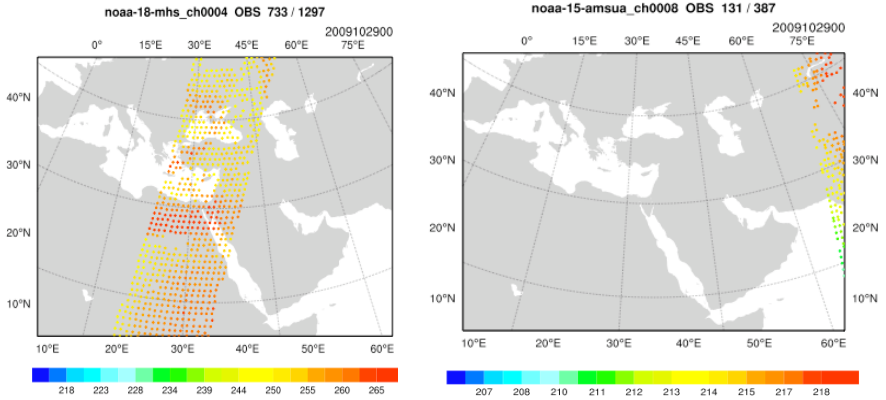
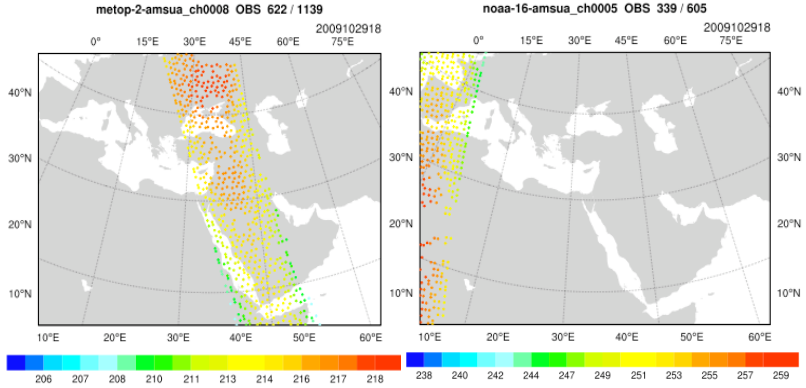
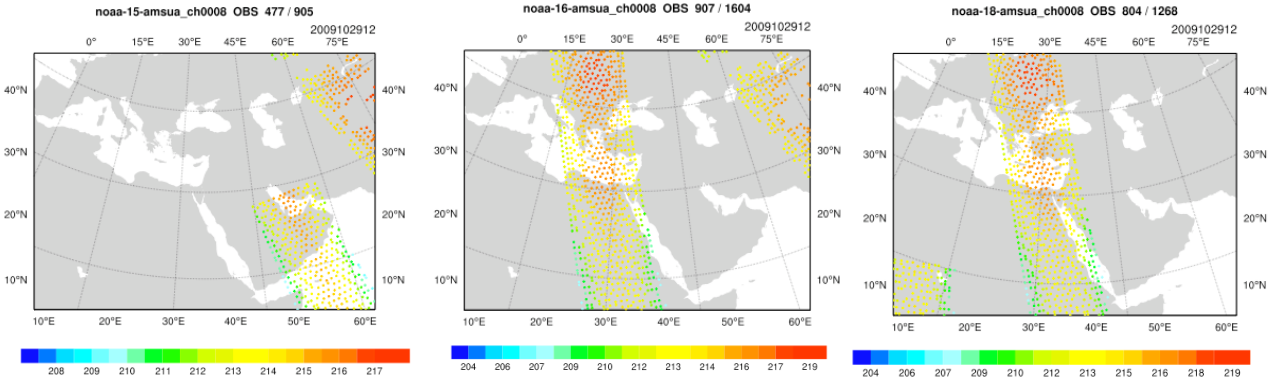
2009102900



2009102918



2009102912



Analysis Validated at 00Z Oct. 29, 2009

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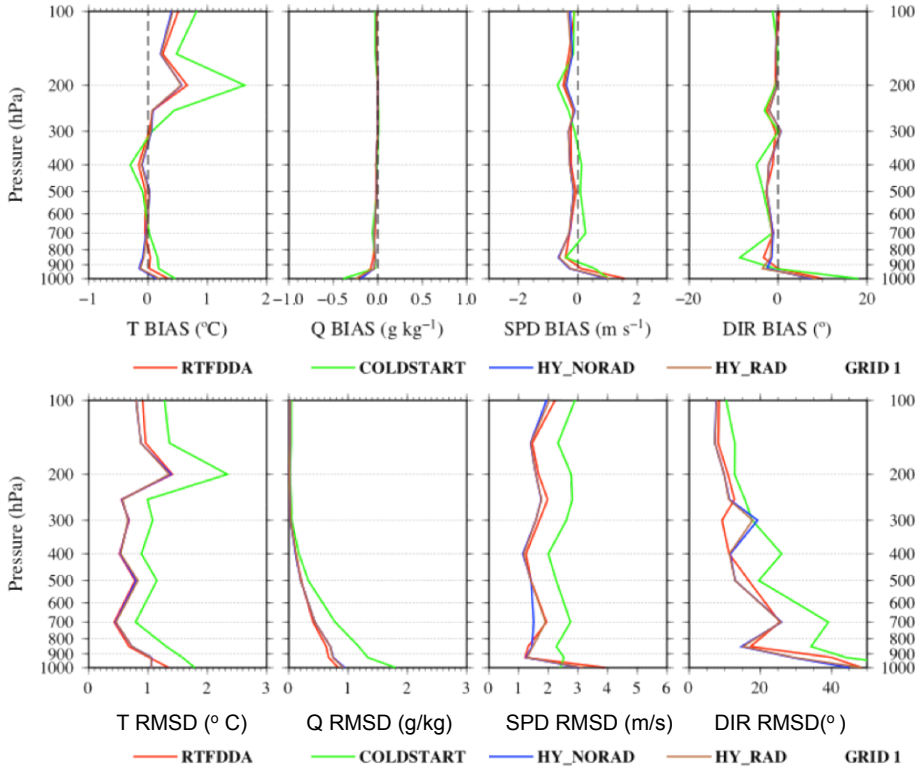
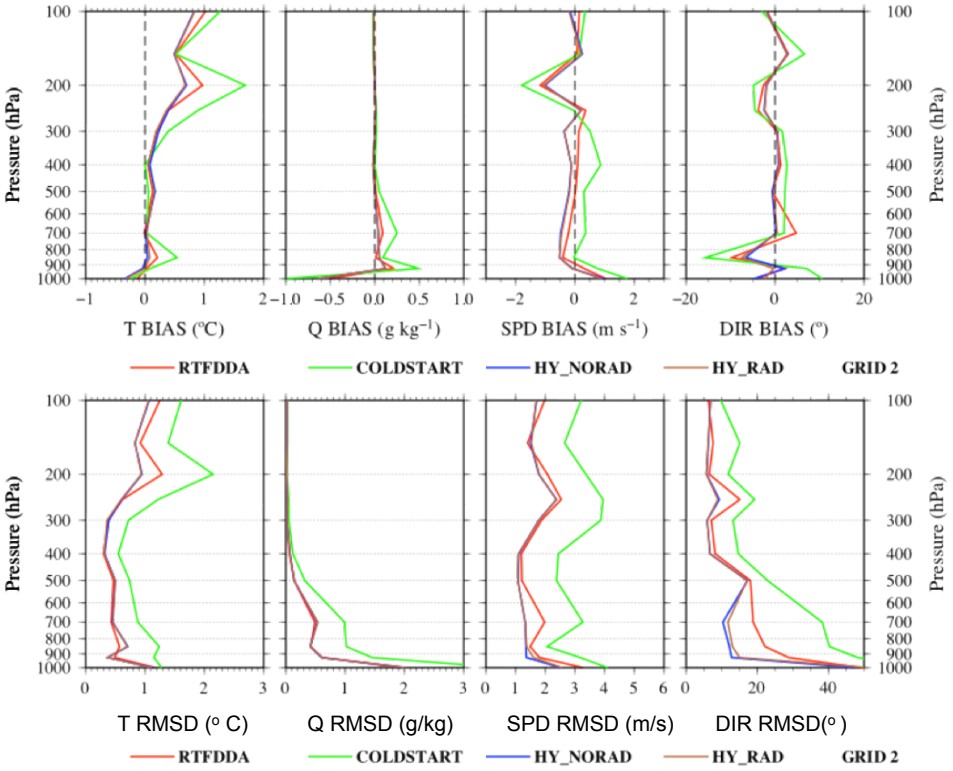
Domain1



Domain2



RTFDDA: data assimilation of RTFDDA from 2009102818 to 2009102900.
COLDSTART: Cold start at 2009102900
HY_NORAD: data assimilation of hybrid method without radiance data from 2009102818 to 2009102900
HY_RAD: data assimilation of hybrid method with radiance data from 2009102818 to 2009102900

24-hr Forecast Validated at 00Z Oct. 30, 2009

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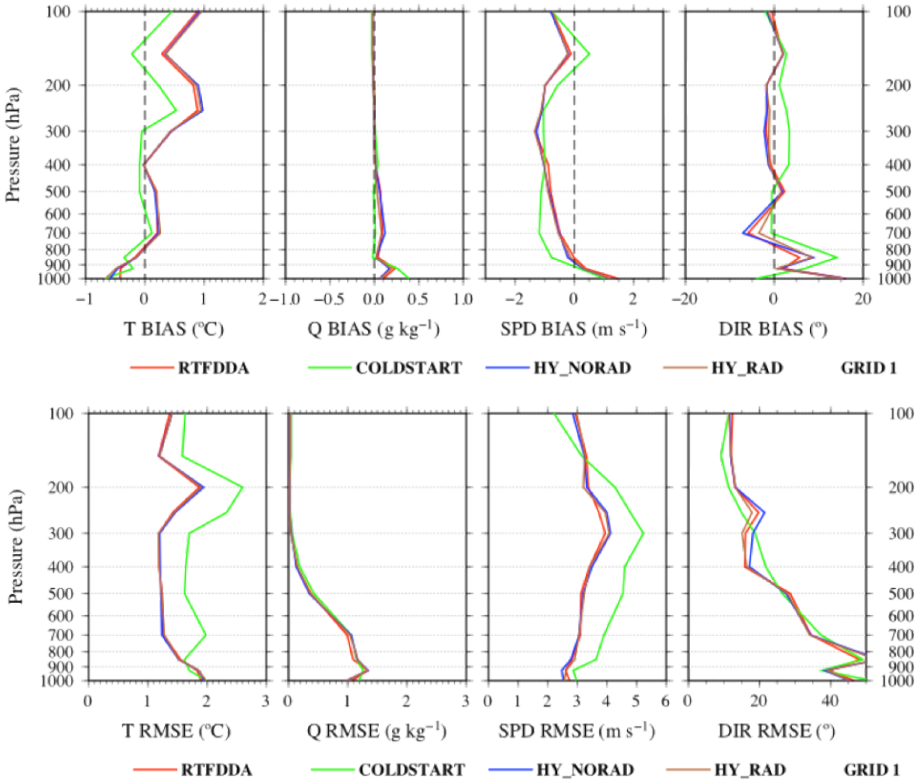
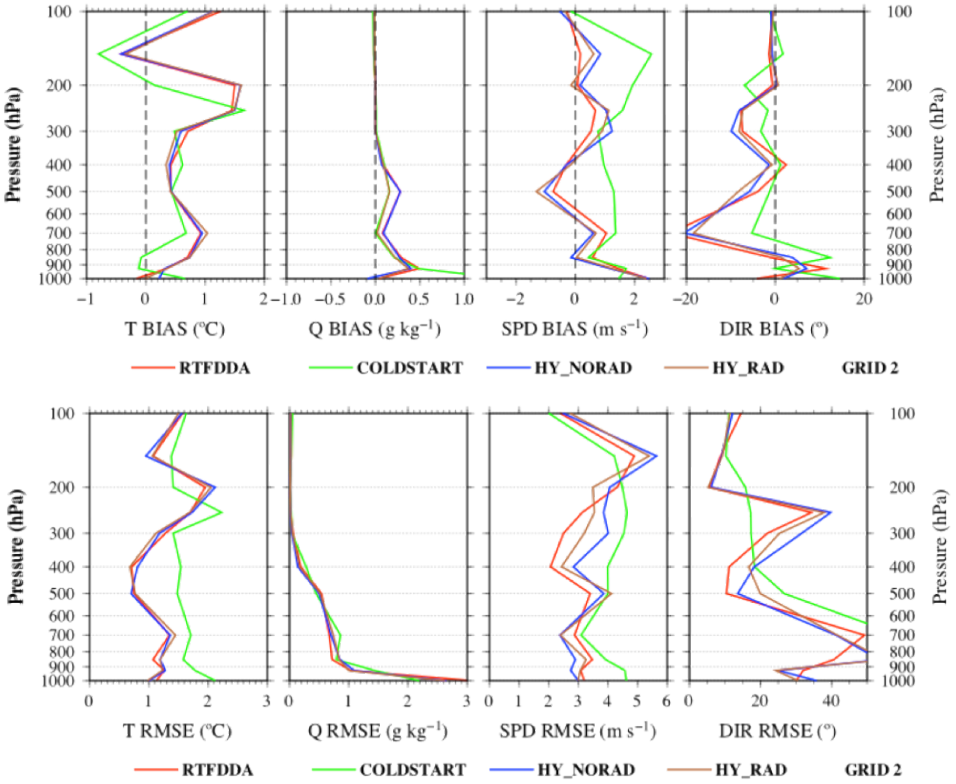
Domain1



Domain2



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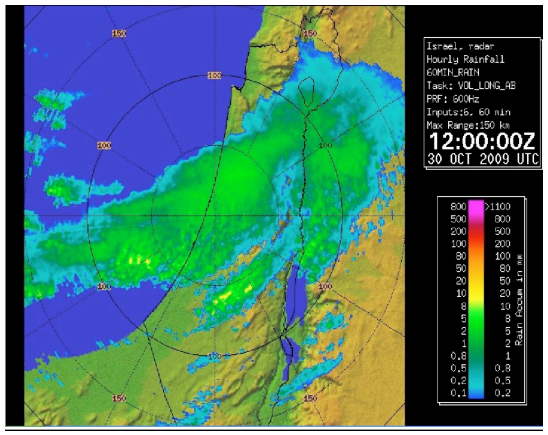
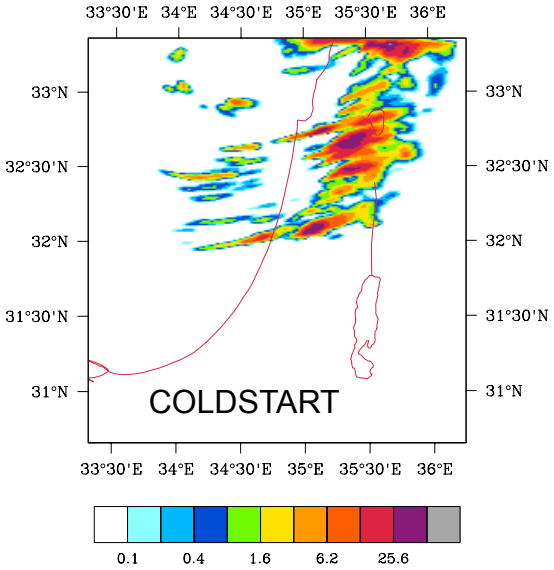
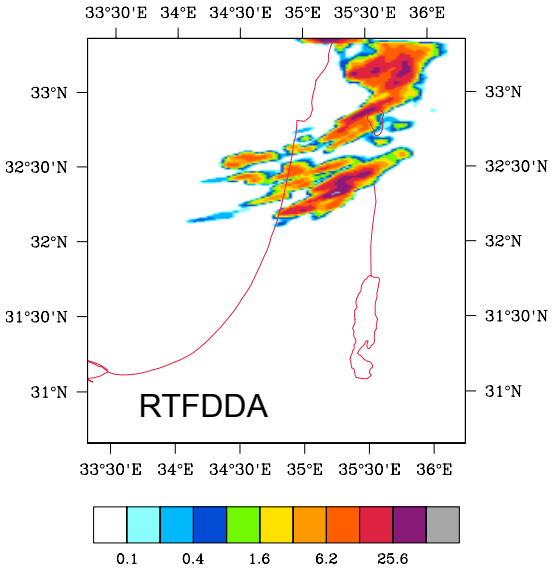
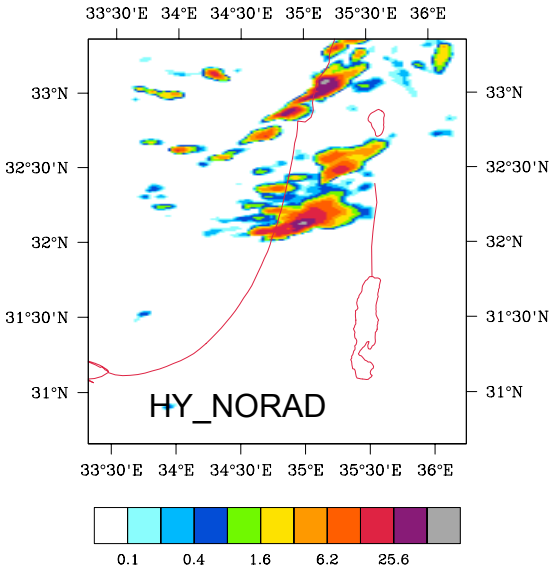
HY_RAD: data assimilation of hybrid method with radiance data from 2009102818 to 2009102900

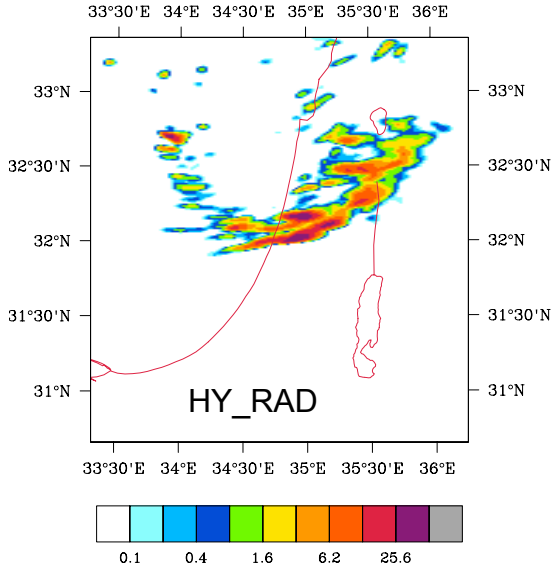
36-hr Forecast of 1-hr Precipitation











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Semi-Operational Systems

- Three systems ran in parallel for 10 days. (4 cycles/day and cold-start every 3 days.)
  - RTFDDA: obs-nudging based system
  - HY_NORAD: hybrid system without radiance data
  - HY_RAD: hybrid system, including radiance data
- Use CV5 BE files for D1 and D2
- GFS Forecast as first guess field for 3DVAR analysis
- Grid-nudging is applied for both D1 and D2

10-day Statistics: Analysis

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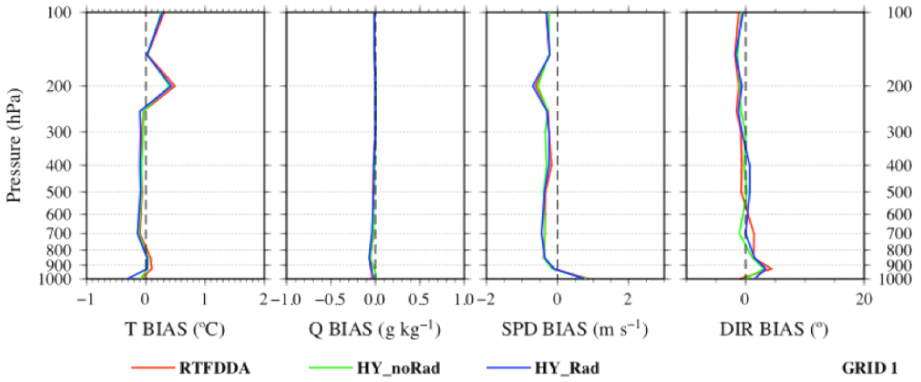
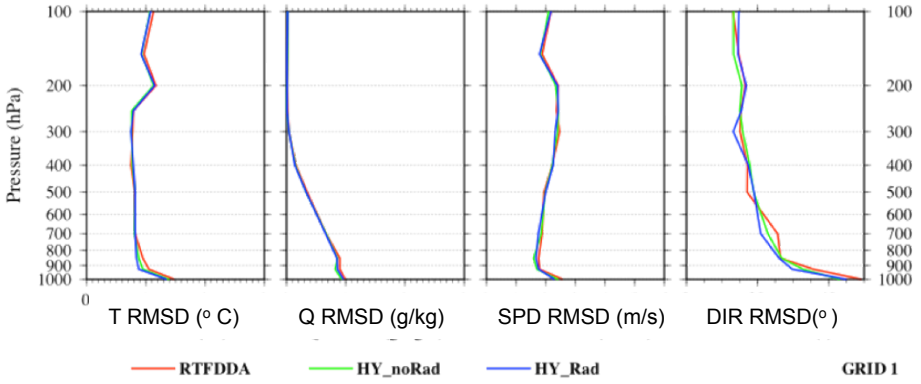
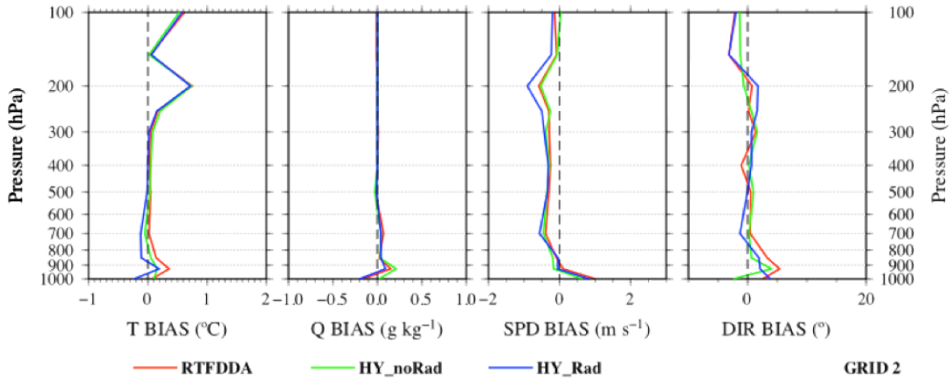
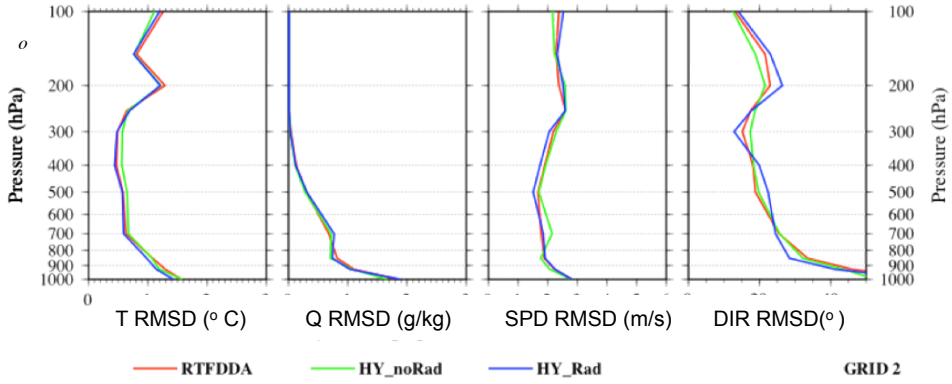
Domain1





Domain2





RTFDDA: data assimilation of RTFDDA
HY_noRAD: data assimilation of hybrid method without radiance data
HY_Rad: data assimilation of hybrid method with radiance data

10-day Statistics: 18-hr fcst

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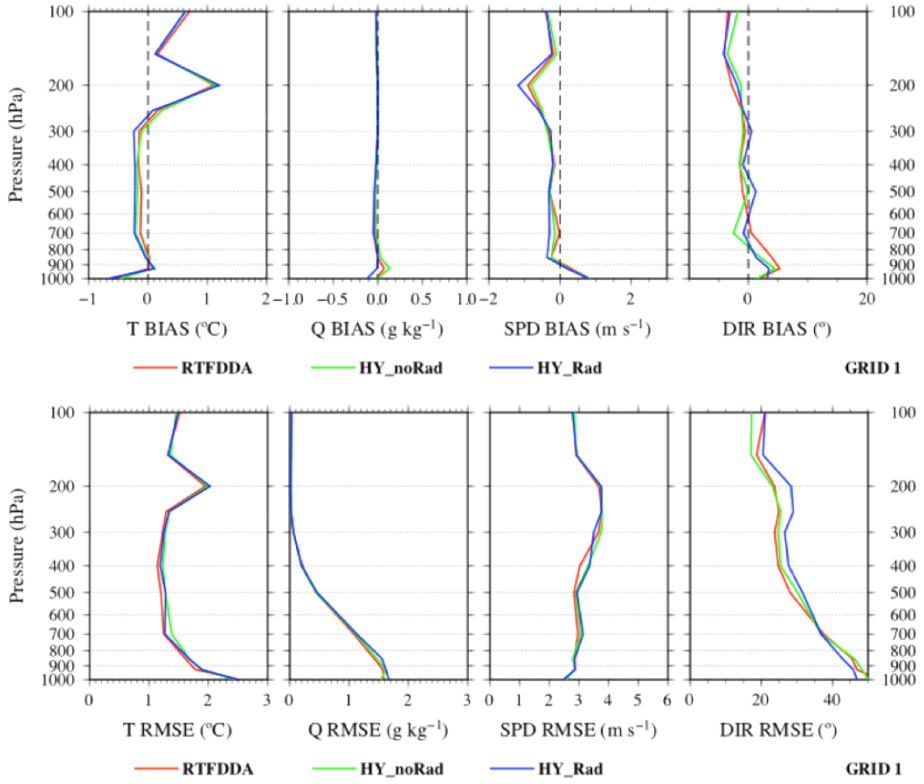
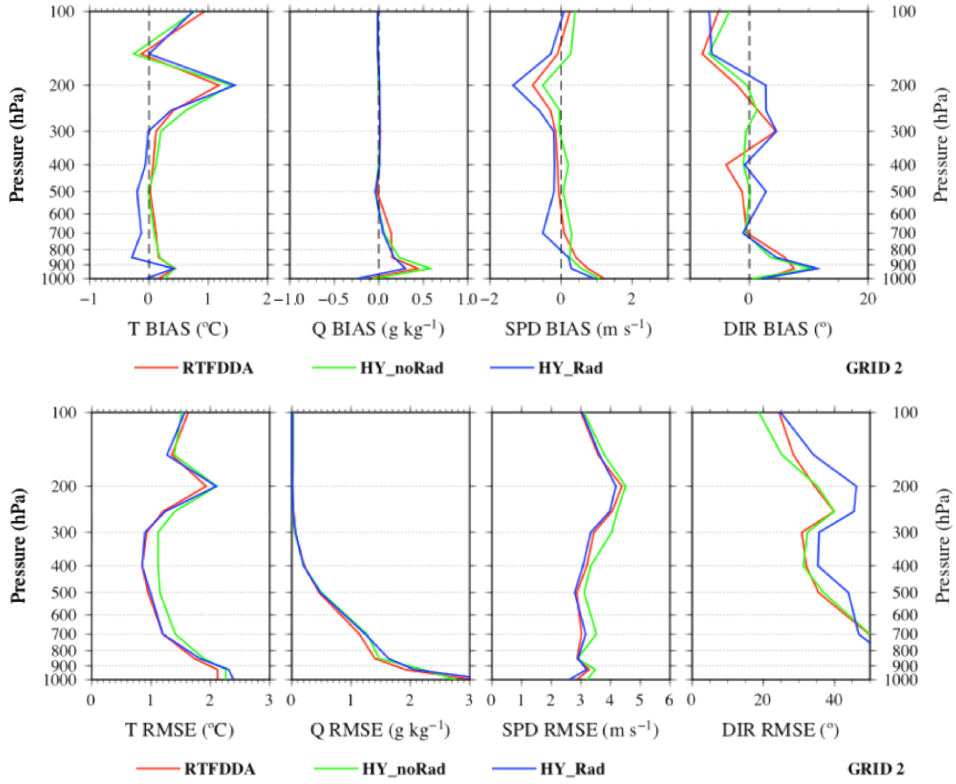
Domain1



Domain2



RTFDDA: data assimilation of RTFDDA
HY_noRAD: data assimilation of hybrid method without radiance data
HY_Rad: data assimilation of hybrid method with radiance data

Remarks and On-going Work

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- A hybrid RTFDDA-3DVAR modeling system has been developed, which allows to assimilate non-conventional observation such as satellite radiance.
- Case study and semi-operational runs indicate an encouraging performance of the hybrid DA algorithm.
- The RTFDDA-3DVAR hybrid system retains the advantages of RTFDDA for creating dynamically consistent and adiabatically “spun-up” initial conditions for continuous-update forecasting cycles.
- More work is needed to understand processes of the hybrid system and tune-up the impact of radiance data assimilation.