Data Assimilation for MPAS

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MPAS DA Objectives

Development integrated with that of model

- DA, especially using ensembles, is strong test of model
- DA as vehicle for improving model, which benefits both DA and prediction

Global and regional

- Satellite observations essential for modern global NWP
- Parameterized physics must work well everywhere on globe

Ensemble and variational

- Distinctions between these branches of DA becoming blurred
- Techniques combining aspects of both are now state of the art for operational DA

MPAS DA Status

EnKF, from MPAS/DART

Variational and EnKF from NOAA GSI

- From Bresch, Liu & Schwartz, ~2016
- Development frozen (though may live on at IBM/TWC?)

Ensemble-variational DA from JEDI

MPAS/DART

Relatively mature, available now

- Deterministic EnKF via Data Assimilation Research Testbed (Anderson et al. 2009)
- Conventional observations only, at present
- Documented in Ha et al. 2017 MWR doi:10.1175/MWR-D-17-0145.1

MPAS additions

- Incremental analysis update (Ha et al. 2017)
- Improved temporal filtering for acoustic waves (Klemp et al. 2018)

MPAS-JEDI

Ensemble-variational DA for MPAS

- Under development through PANDA-C
- Uses JEDI
- Initial phase will provide 3DVar, EnVar (3D & 4D), hybrids

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PANDA-C = *Prediction and Data Assimilation for Cloud*

- USAF funded
- Joint NCAR-JCSDA project
- Partnership with Met Office Next Generation DA

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JEDI = *Joint Effort for Data assimilation Integration*

- JCSDA project to develop DA tools suitable for operational use with many models, many DA techniques
- Joint development with multiple partners (NOAA, NASA, Navy, AF; *NCAR, Met Office*)

Teams

PANDA-C (NCAR/MMM):

- Junmei Ban, JJ Guerrette, BJ Jung, Jake Liu, Chris Snyder, Steve Vahl, Yali Wu

JCSDA: JEDI core team

- Led by Yannick Trémolet

ExaDA (UKMO):

- David Davies, David Rundle, Steve Sandbach, David Simonin, Marek Wlasak

Also B. Ménétrier, BUMP (fast correlation model for general meshes)

MPAS-JEDI Interfaces

Capitalize on native MPAS capabilities:

- data structures for model fields (and copies and subsets)
- domain decomposition and parallelization
- subroutine for time stepping

Initial Experiments

120-km MPAS mesh

EnVar (pure ensemble), localization from BUMP

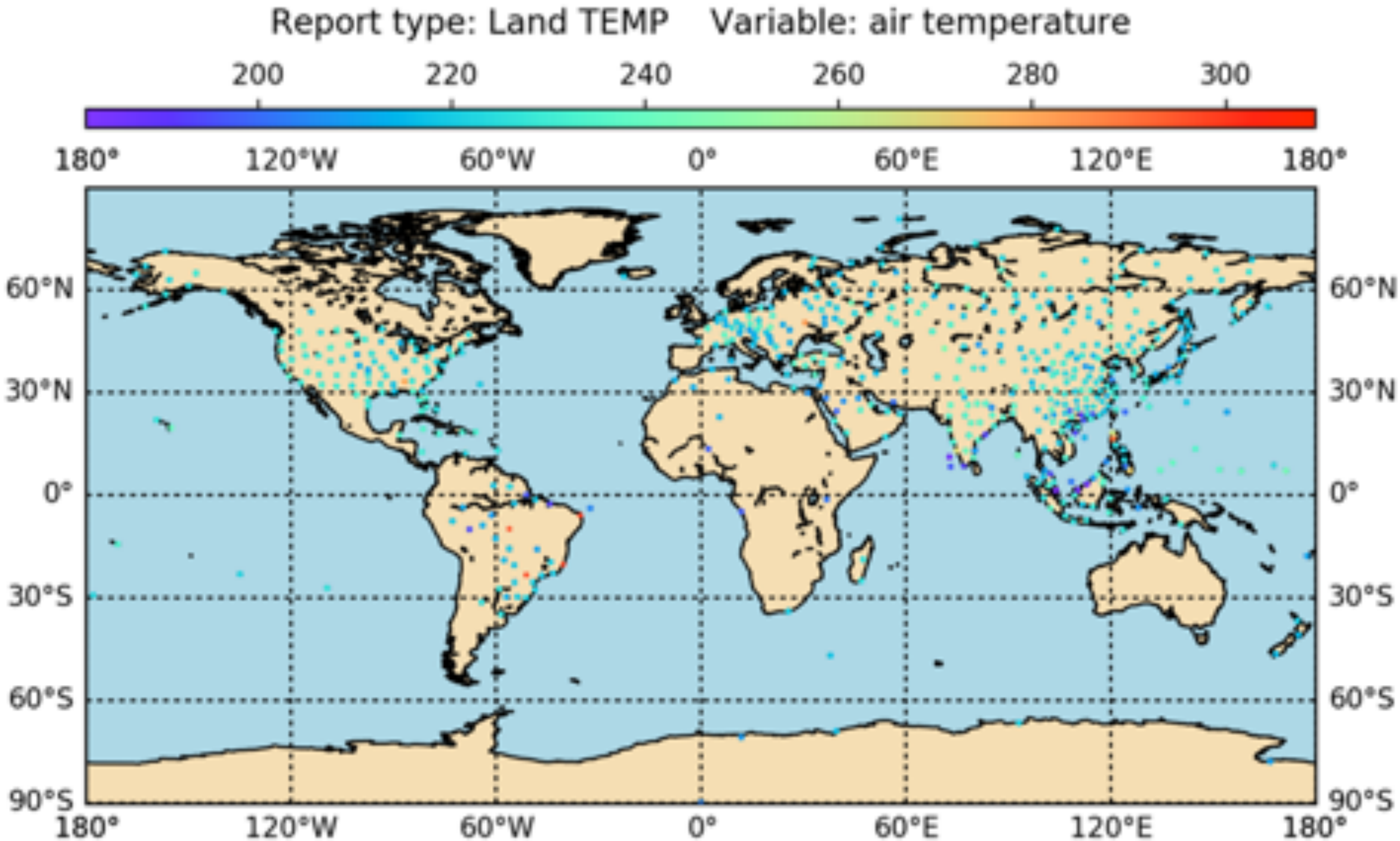
- First background is 6-h forecast from GFS analysis (18Z 14 April 2018)
- 20 ensemble members, 6-h forecasts from GEFS Ics
- Localization: 2000 km, 5 vertical levels
- Running on 36 processors (NCAR cheyenne)

Assimilate u, v, T from radiosondes and aircraft

- Observations from UKMO ODB-API files, 15 April 2018

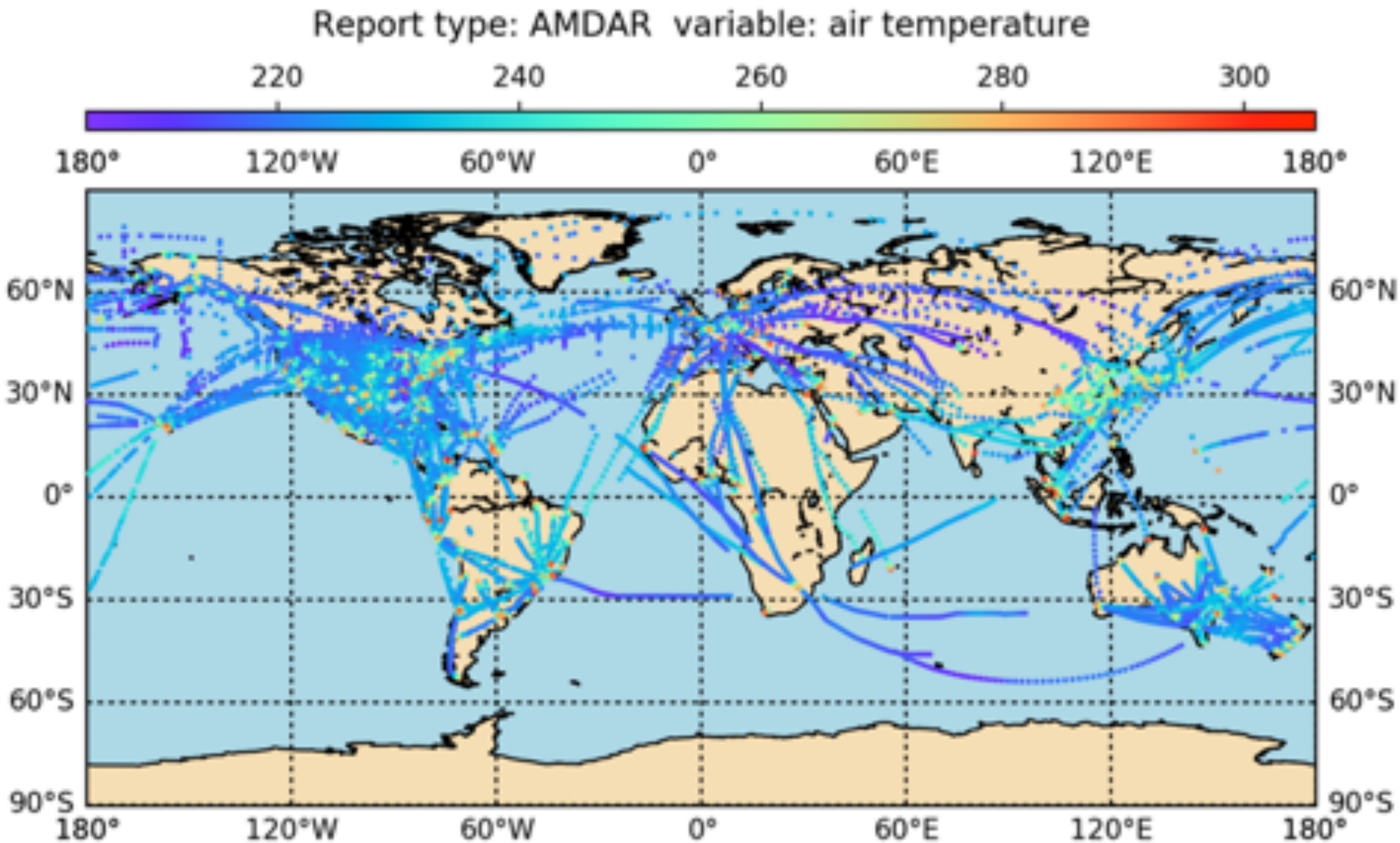
Observations

Radiosondes, 00Z 15 April



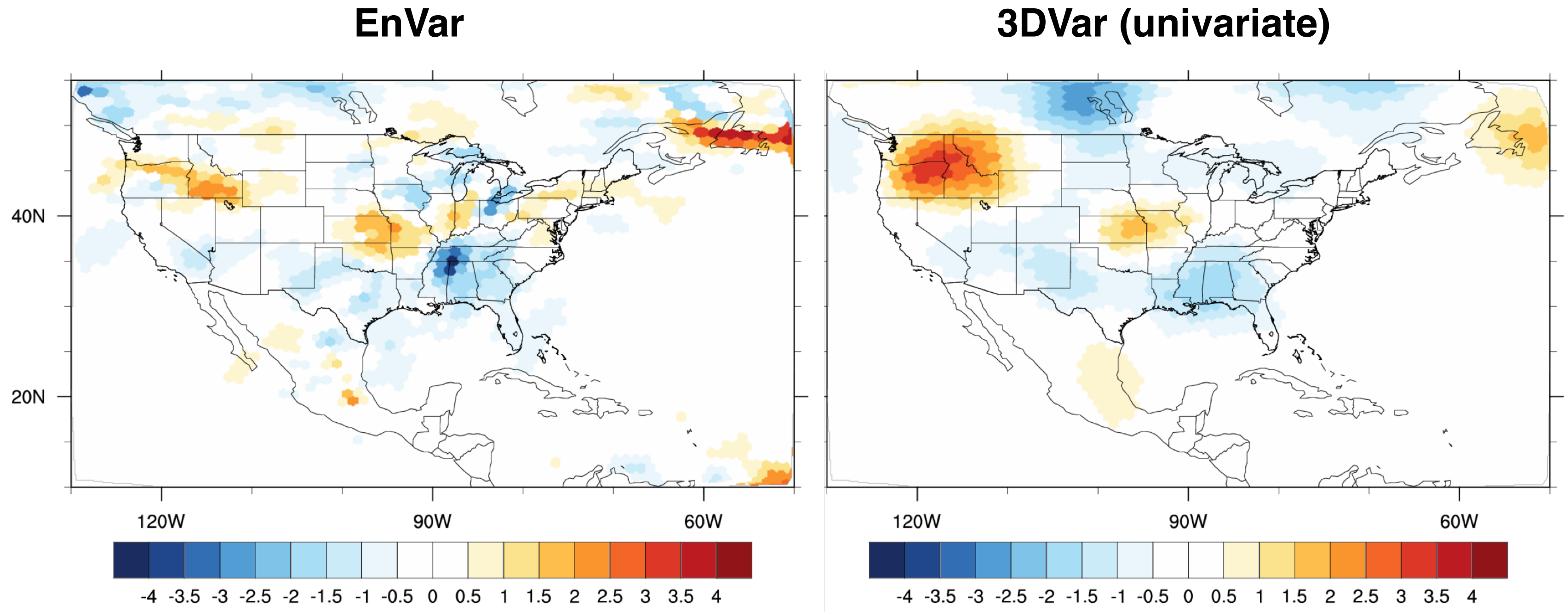
Observations

Aircraft, 00Z 15 April



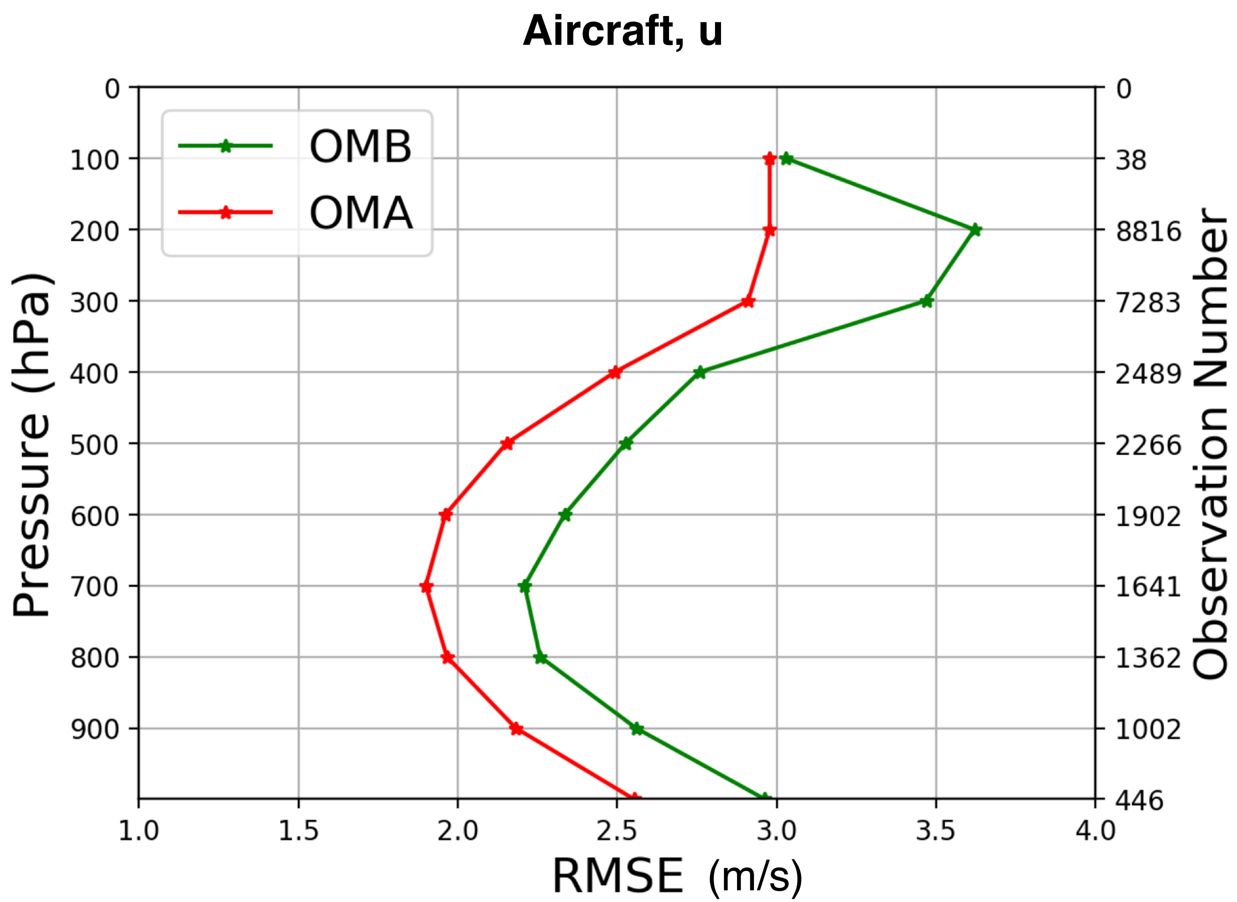
Results

First analysis, 00Z 15 April: analysis increment, *u*, level 17



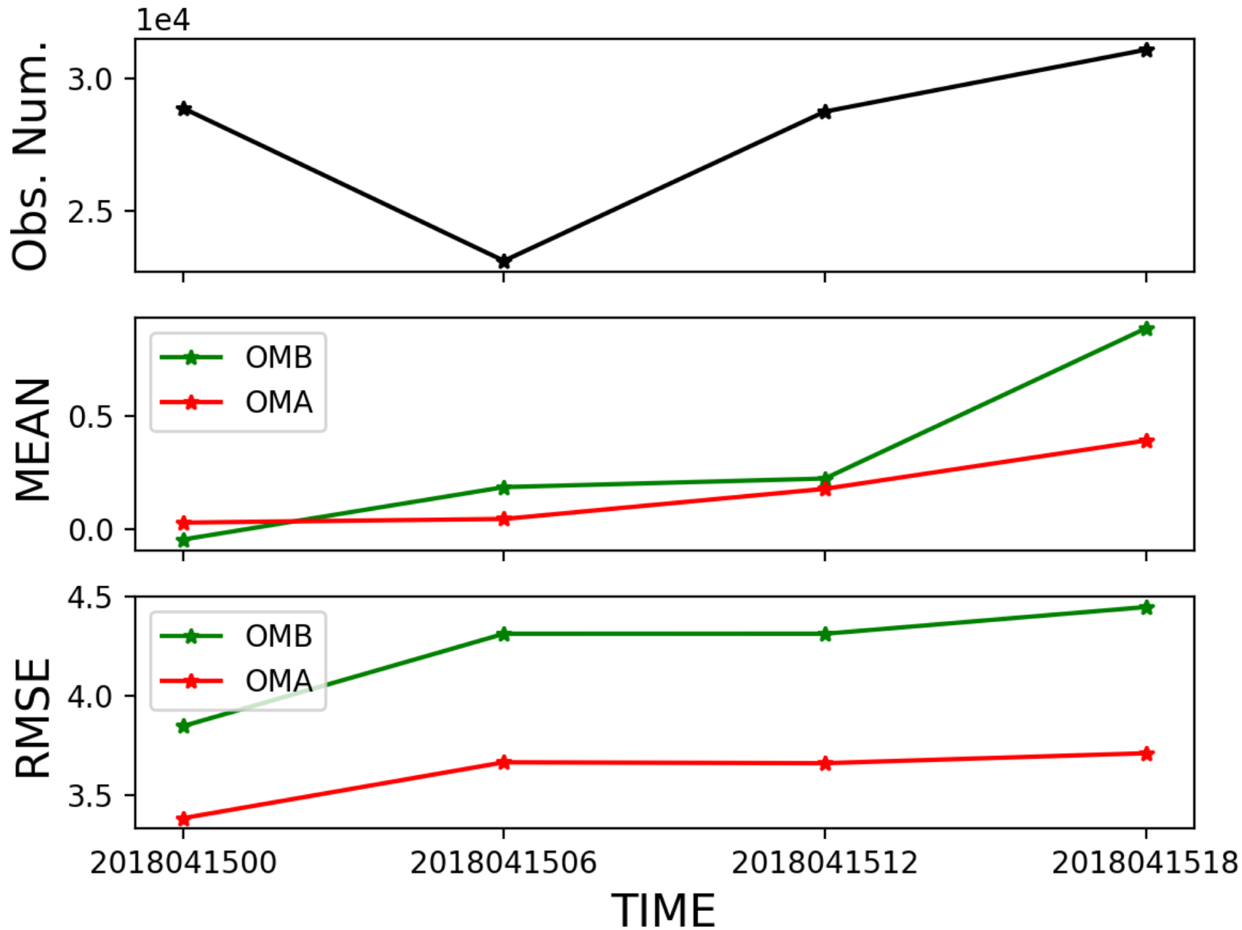
Results

First analysis, 00Z 15 April: forecast and analysis fits to obs



Results

4 6-h cycles, 00Z – 18Z April 15: fits to analyses and forecasts, aircraft *u*



MPAS-JEDI Outlook

Development proceeding well

JEDI greatly facilitates leveraging/sharing

Important next steps

- Multivariate static background covariance
- Explore scaling, both higher-res state and more obs
- Include AMSU-A and begin extended periods of cycling

Why MPAS/JEDI?

Open and collaborative development practices

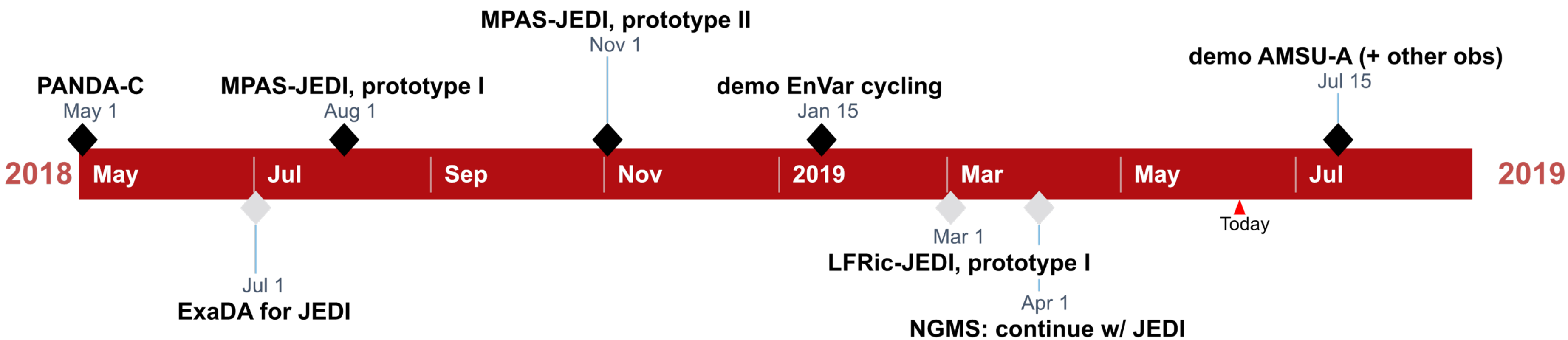
- Leverage and contribute to larger effort
- Facilitate community access to advanced and operationally relevant system(s)

Sustainable path to access and develop MPAS capability for:

- Ensemble-variational DA
- Comprehensive radiance DA

Strong prospects for external funds to augment limited NCAR base funds

PANDA-C Status



PANDA-C Phase II

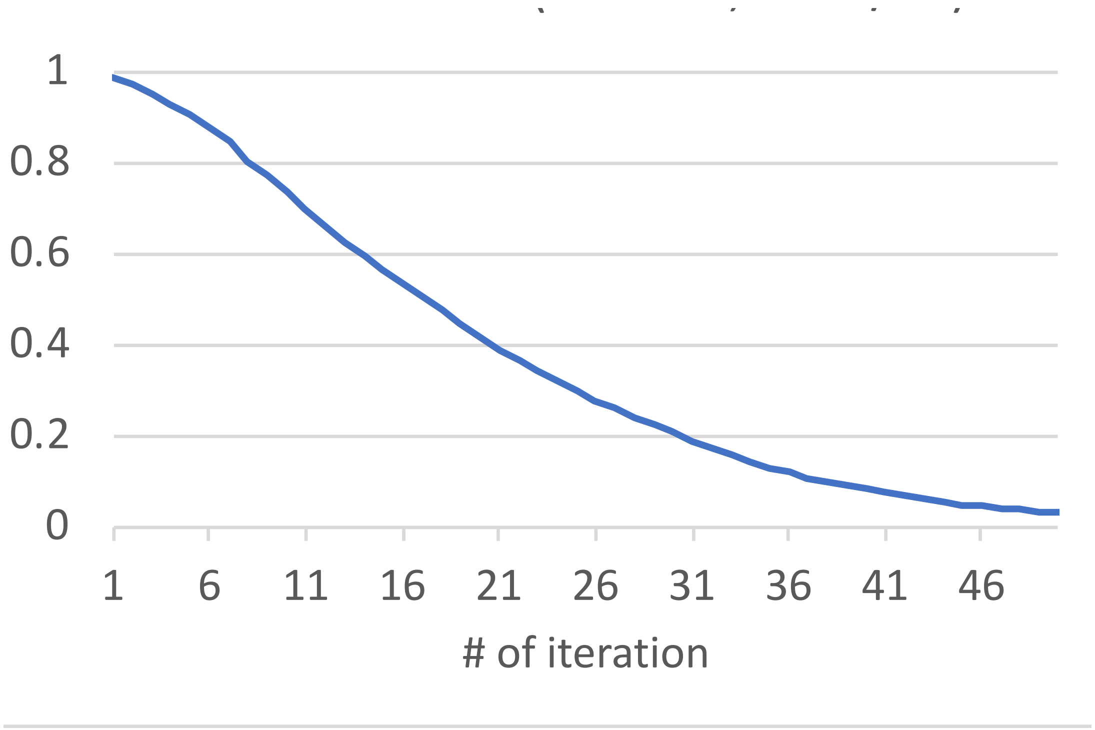
Potential phase II, 2021-2023:

- AF-specific implementation of next-generation system, tailored to cloud analysis and short-range cloud forecasting
- Demonstrate improvements over existing USAF cloud products (non-NWP)

Decision on feasibility in 2020

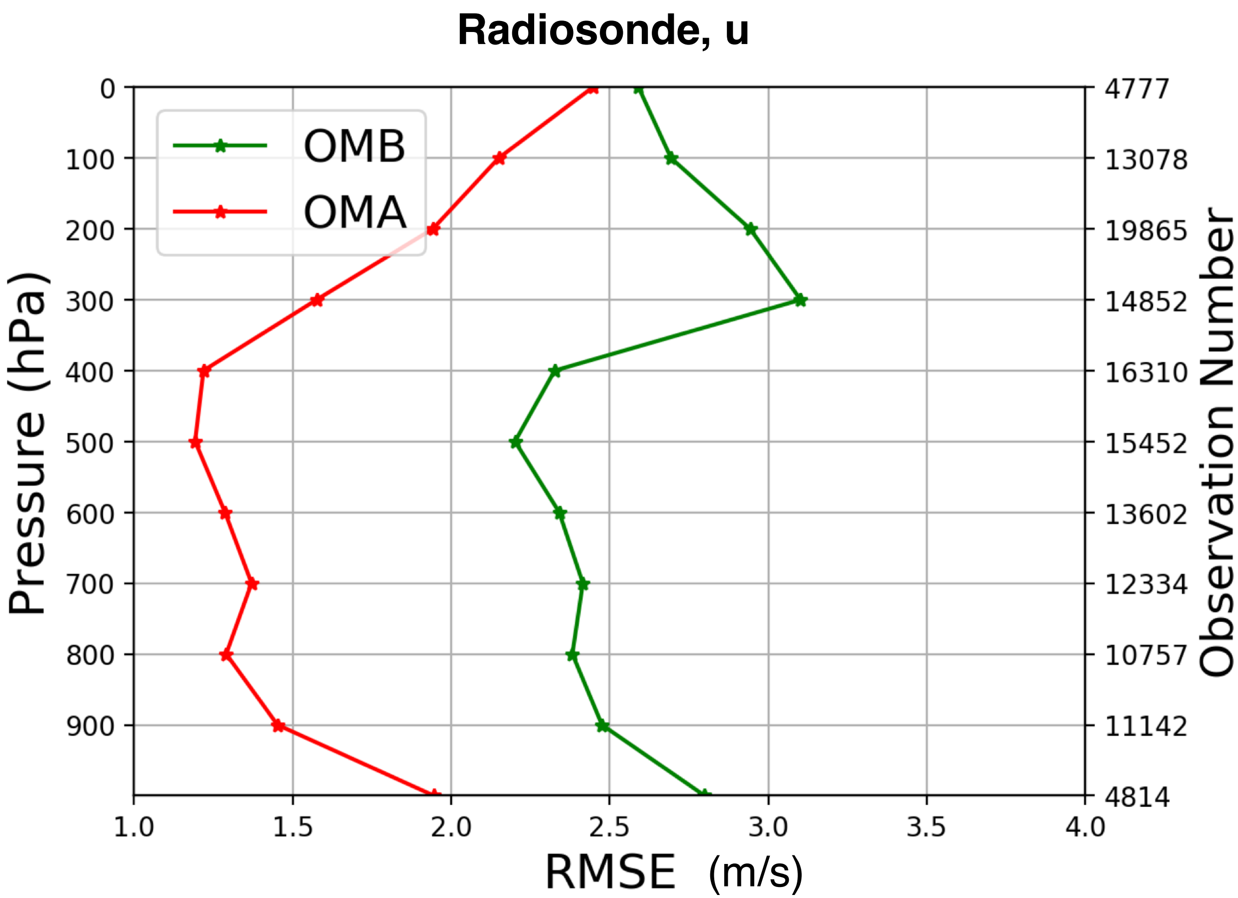
Results

First analysis, 00Z 15 April: norm of cost-function gradient

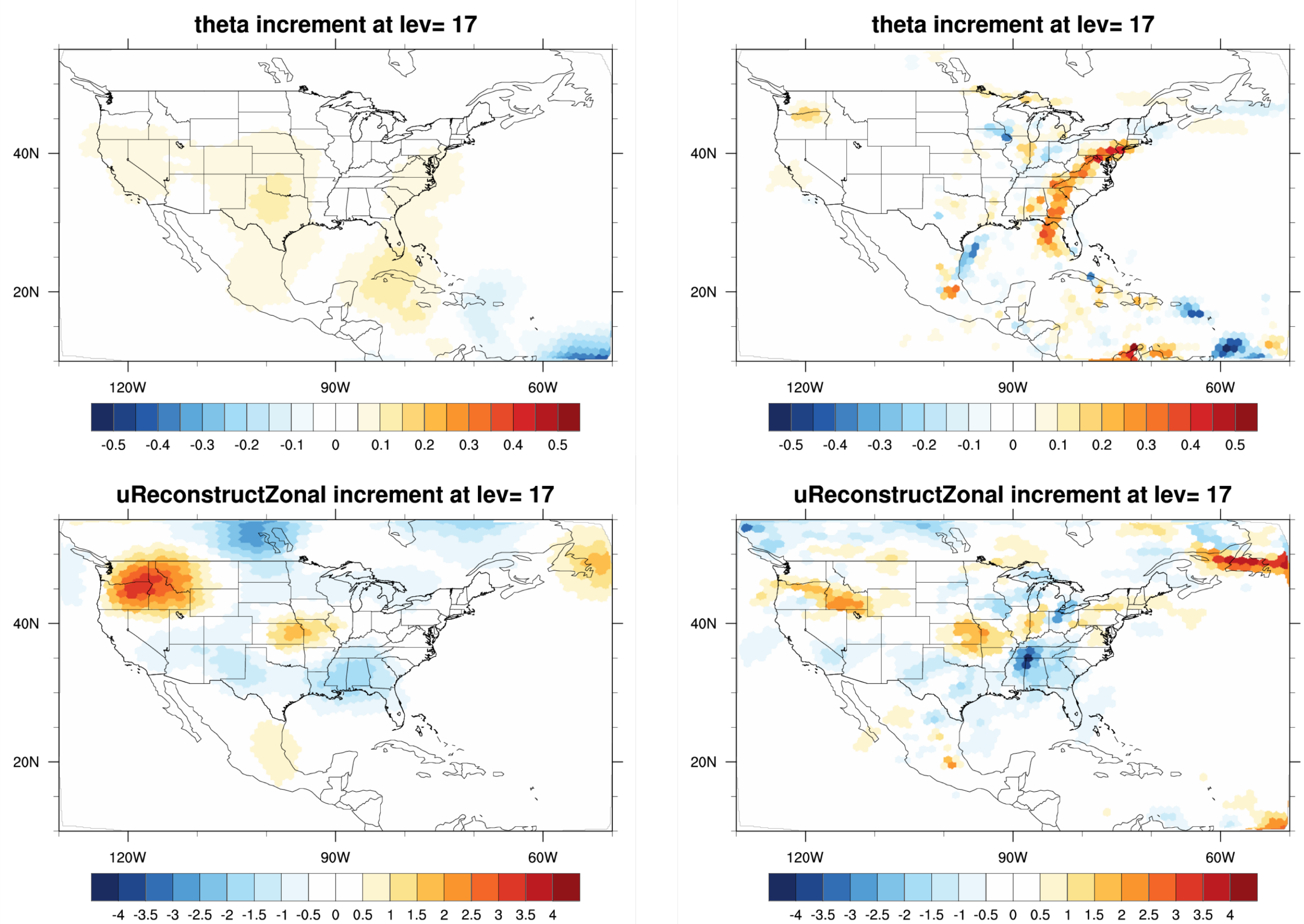


Results

First analysis, 00Z 15 April: forecast and analysis fits to obs



3DVAR **Analysis Increment @ ~500 hPa** **EnVar (2000/5)**



First analysis, 00Z 15 April T