Operational implementation of displacement data assimilation

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Introduction

- First guess fields used in data assimilation procedures, typically short-term forecasts, often contain errors caused by position errors of coherent structures or features.
- A prototype implementation (**dWRF**) of a **feature alignment technique (FAT)** has previously been implemented in the **WRFDA** variational data assimilation system (Nehrkorn 2015).
  - *Replace additive increments by increments computed by displacing features in model fields*
  - *Reuse existing 3DVAR infrastructure:*
    - minimization (conjugate gradient in inner loop with linearized displacements; nonlinear adjustments in outer loop)
    - obs operators (H)
- This poster describes an implementation in the operational data assimilation system (**GSI**) and plans for migration to **JEDI** and testing with convective-scale DA

FAT Implementation in Variational DA

- Use standard 3dvar control variable (**v_s**) and pre-conditioning (**U** operator) for additive replacements
- "Unstack" u,v wind increments into horizontal displacements
- Apply displacement vectors (**S** operator)
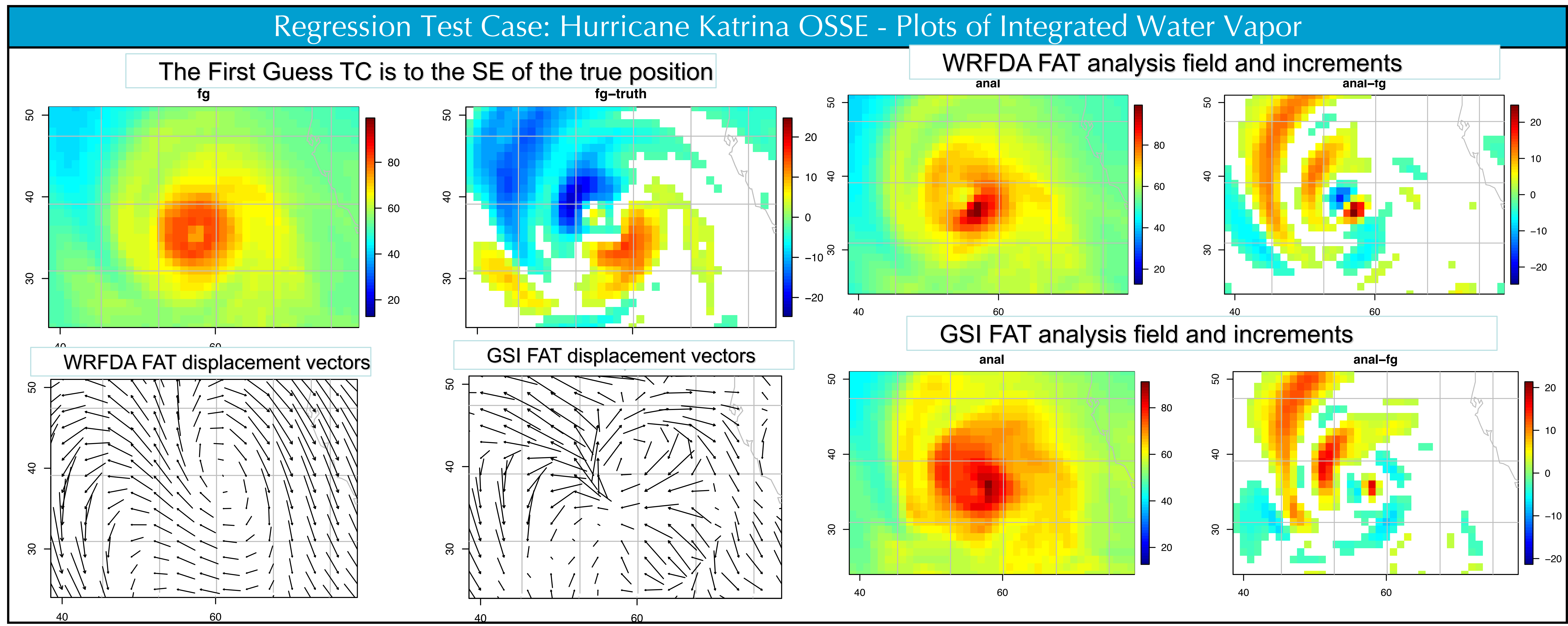- Use resulting differences as additive increments

FAT Software Refactoring for Migration to GSI

- Separate software into independent modules

Core FAT Functionality:
- Apply displacement vectors to horizontal gridded fields
- Handle horizontal domain decomposition for parallel processing

Generic 43%-46%

Horizontal gridded slabs Displacement Vectors

WRF FAT Functionality:
- Apply displacement vectors to 3D quasi-conservative fields
- Variable conversion between diagnostic and quasi-conservative fields

WRF-specific 38%-40%

WRF model states Displacement Vectors

FAT-DA Interface Functions:
- Convert between increments and displacement vectors
- Convert between DA and FAT model states

WRF-specific + DA-specific 11%-15%

DA-specific 3%

Future Extensions

- generic model states

- generic model states
- Generic DA (JEDI) interfaces
- Support multiscale FAT

Regression Test Case: Hurricane Katrina

The First Guess TC is to the SE of the true position

WRFDA FAT displacement vectors

GSI FAT displacement vectors

WRFDA FAT analysis field and increments

GSI FAT analysis field and increments

anal

anal−fg

anal−truth

Conclusions and Future Work

- The feature alignment technique (FAT) was migrated from its WRFDA implementation (Nehrkorn et al. 2015) to the operational EMC DA (GSI)
- FAT software was refactored to allow reuse of most of the code base without changes
- Regression test case results agree for WRFDA and SGI
- Future Work:
  - Extensions for generic model states and DA interfaces
  - Application and testing for convective-scale DA

References and Acknowledgements