

# WGNE 34

Data Assimilation and Observing Systems (DAOS)

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DWD, Offenbach, Germany



WMO OMM

World Meteorological Organization

Organisation météorologique mondiale

# DAOS Overview

## Membership:

- Co-Chairs
  - Daryl Kleist (NOAA/NWS/NCEP)
  - Ulrich Löhnert (Univ. of Köln)
- Working Group Members
  - Tom Auligne (JCSDA USA)
  - Nadia Fourrie (Météo France)
  - Saroja Polavarapu (ECCC)
  - Juan Ruiz (CIMA-UBA Argentina)
  - ***Sarah Dance (University of Reading)***
  - ***Sean Healy (ECMWF)***
  - ***Lili Lei (Nanjing University)***
  - ***Andy Moore (UC Santa Cruz)***



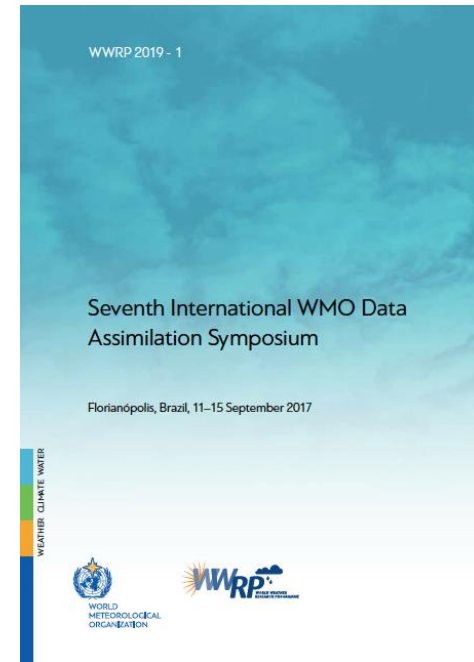
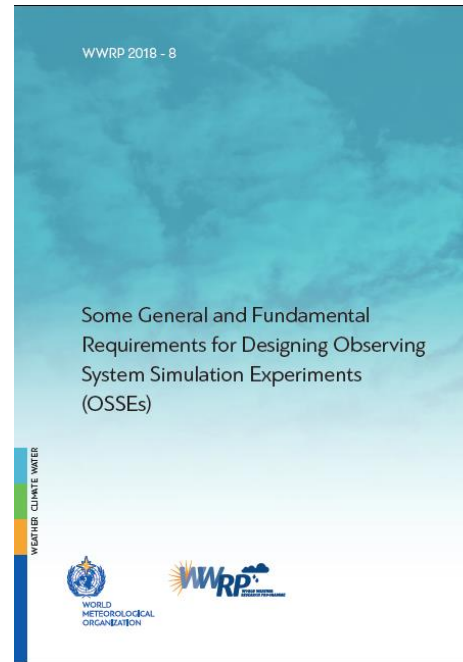
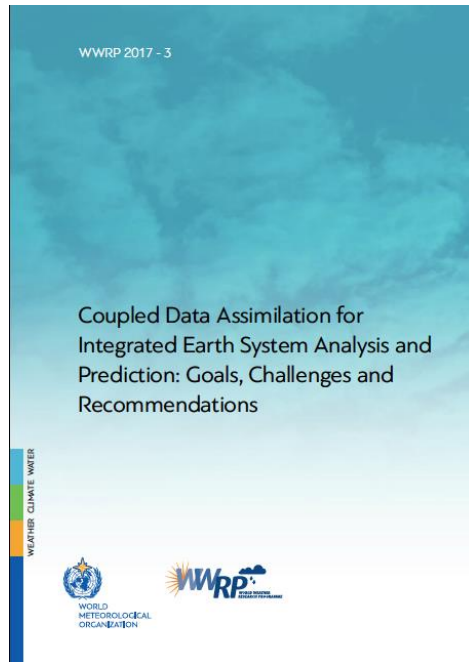
# DAOS Overview

- Founded in 2008 as part of THORPEX, continued on as part of WWRP... Aims to provide guidance to the WWRP to optimise the use of the current WMO Global Observing System (GOS). The DAOS Working Group ***will facilitate the development of data assimilation and observing system methodologies*** from the convective scale to planetary scales and for forecasts with time ranges of hours to weeks.
  - Provide community consensus guidance on data assimilation issues, including the development of advanced methods for data assimilation.
  - Promote research activities that will lead to a better use of existing observations and that will objectively quantify the impact of current and future observation for NWP.
  - ***Assist WWRP projects and other WMO working groups in achieving their scientific objectives by providing expert advice on the use of observations and data assimilation techniques***
  - To organize and provide the scientific steering committee for the WMO Data Assimilation Symposium, which is to be held approximately every 4 years.



# Recent Highlights: Meetings and White Papers

- Quadrennial DA Symposium (2017 meeting summary available online), Coupled DA workshop (summary white paper online)
- Organized white paper on OSSEs. Reviews completed and now published online:
  - [https://www.wmo.int/pages/prog/arep/wwrp/new/documents/Final\\_WWRP\\_2018\\_8.pdf](https://www.wmo.int/pages/prog/arep/wwrp/new/documents/Final_WWRP_2018_8.pdf)
- Former DAOS working group member (Sharan Majumdar) co-leading review paper in BAMS on nowcasting and forecasting High Impact Weather

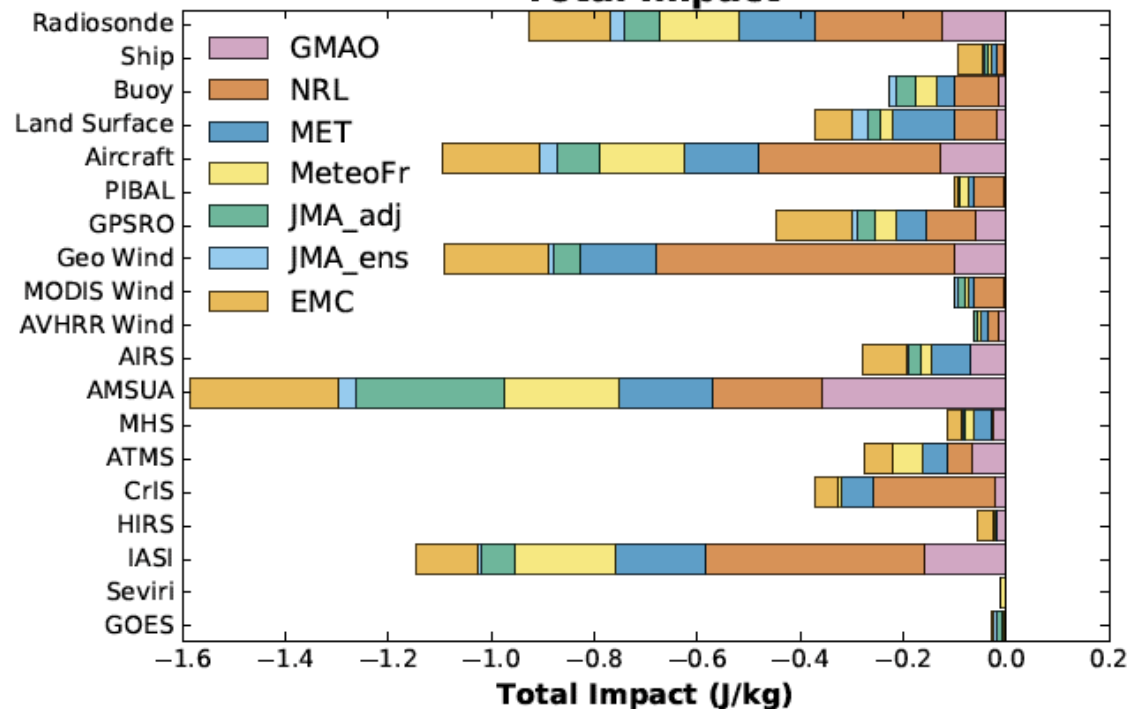


# Recent Activity: FSOI Inter-comparison

- DAOS has a history of facilitating inter-comparison efforts. In the past year, we have begun exploring the formalizing of a Forecast Sensitivity to Observations Impact (FSOI) inter-comparison effort.

- Recent study led by JCSDA in the US

**24-h Observation Impact Summary**  
**Global Domain, 00Z 06Z 12Z 18Z DJF 2014-15**  
**Total Impact**

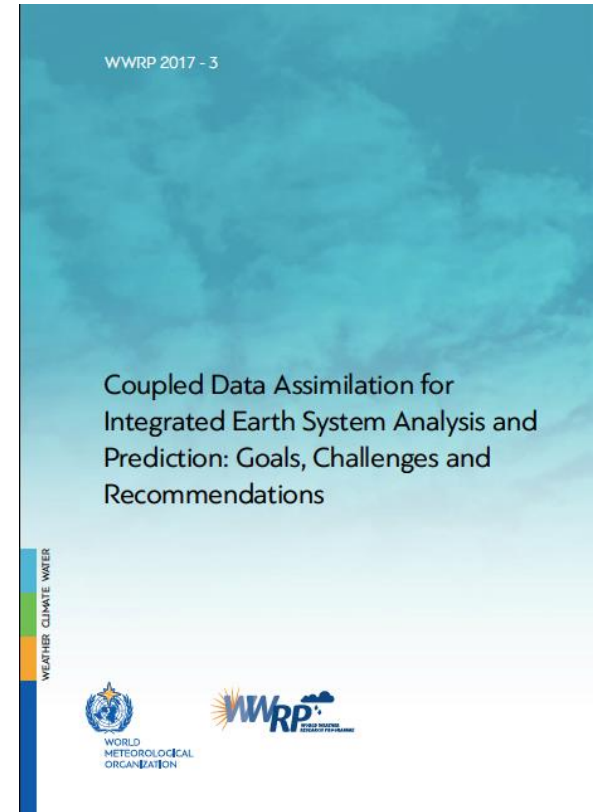


# Expansion of exchange of observation-space Information

- In the next two years, build upon this effort to
  - Bring in additional centers for additional FSOI inter-comparison for periods of interest
  - Standardize database for exchange of FSOI information
  - Establish real-time facility for operational centers to contribute such information to the standardized database
  - Identify a Lead Center for collection of information
  - Expand and generalize database for exchange of additional information
    - Observation space: Assimilation usage, observation errors, quality control, bias correction, O-F, O-A, etc.
    - Analysis increments (extremely useful for diagnosing model bias)

# Coupled Data Assimilation

- DAOS has been involved in exploring, supporting, and making recommendations for coupled data assimilation for the past several years
  - 2016 Coupled DA Workshop and White Paper
    - [https://www.wmo.int/pages/prog/arep/wwrp/new/documents/Final\\_WWRP\\_2017\\_3\\_27\\_July.pdf](https://www.wmo.int/pages/prog/arep/wwrp/new/documents/Final_WWRP_2017_3_27_July.pdf)
  - Coupled DA Session at 2017 WMO DA Symposium
  - One motivation for the OSSE white paper was to provide guidance on new OSSEs for coupled earth system models



Looking for smaller (few components) projects to explore and facilitate coupled DA research. Promotion of additional observations as interfaces (fluxes) and observation timeliness for operations. OSE and OSSEs for coupled models.

# Future GOS

- DAOS has historically played a role in OSEs and FSOI inter-comparison to assess value of assimilation of observations into NWP
  - Including targeted observation recommendations
  - Needs to be expanded to km-scale and coupled modeling
- Identification of other weaknesses, gaps, and grand challenges
  - Land/Hydrology
  - Middle/Upper Atmosphere
  - Constituent/Composition
  - Interfaces & Fluxes
  - Non-traditional, private sector, and crowd-sourced/citizen observations
- Need research on better exploitation of current global observing system
  - All sky radiances for NWP
  - Adaptive selection and thinning
  - AI for extraction of maximal information content
  - Coupled DA



# Major DAOS upcoming activities

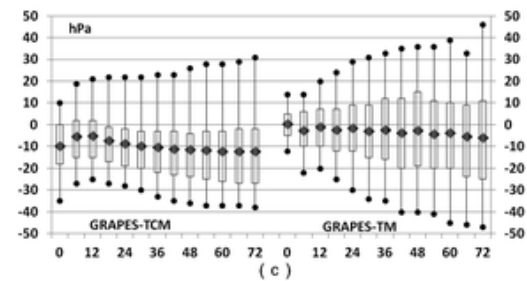
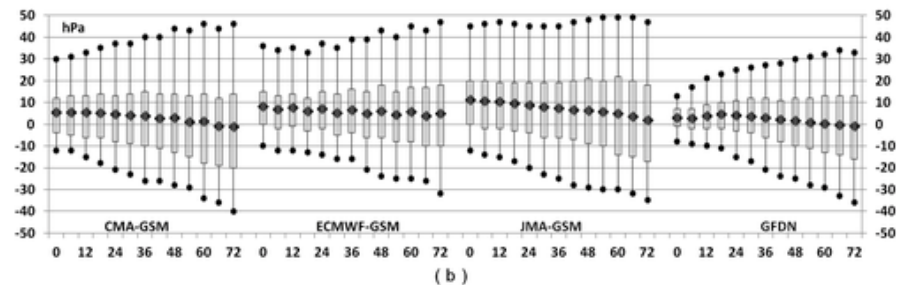
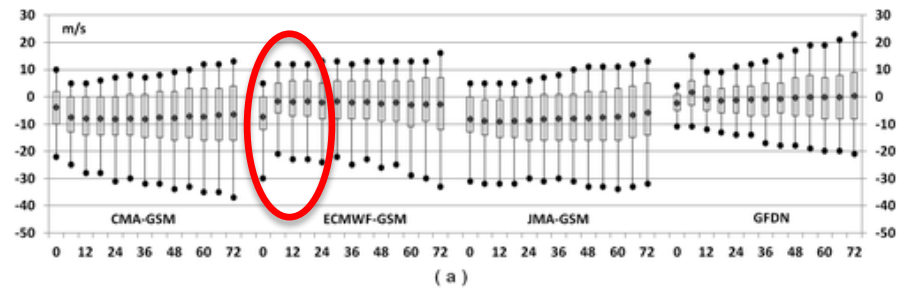
- Meetings
  - WMO DA Symposium (Likely 2021)
  - Workshops to address grand challenges (like coupled DA and subsequent white paper)
    - Joint meeting on “non-conventional”, crowd-sourced, social media type observations
- FSOI inter-comparison and observation-space database
  - Promotion of exchange of assimilation relevant quantities
- Km-scale data assimilation inter-comparison
  - HiWeather request
- Coupled initialization for S2S prediction models



# Tropical Cyclone Initialization

- Question Posed:
  - While many global models are now capable of accurately simulating TC intensity (sometimes unbiased at T+72h), most models suffer from weak intensity bias (particularly for strong storms). What are the underlying issues and what recommendations can be made?

From Yu et al. (2013). One example of initially weak vortices but good predictions thereafter (ECMWF)

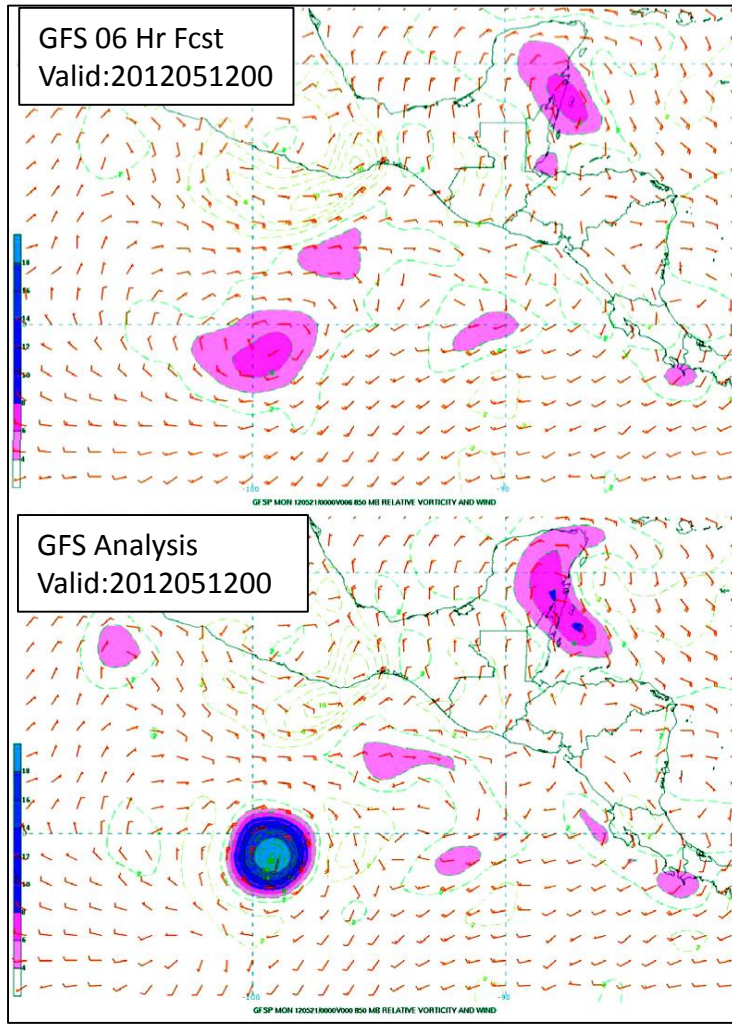


# Tropical Cyclone Initialization

- Mechanical vortex relocation
- Bogus observation assimilation
- Bogus vortex placement
- Assimilation of advisory information (minimum sea level pressure, wind, size information)
- Standard assimilation
  - Including dropsondes / near-storm observations (representativeness)
  - Does methodology matter?
  - Continued advancements in all-sky radiance assimilation
  - Toward field alignment or other methods for accounting for displacement errors



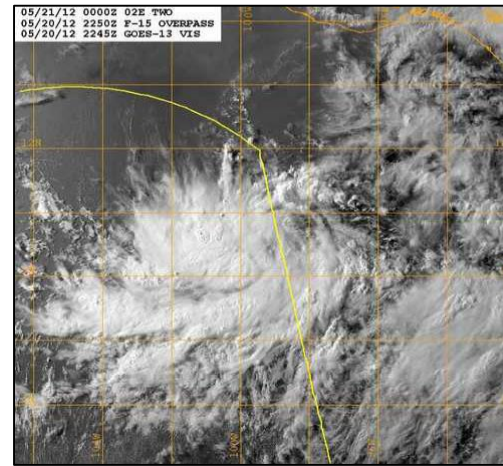
# Example of Bogus Wind Assimilation



Automated tracker “failed” to find coherent vortex to relocate

This can happen because:

- Distance from observation too large
- Too much tilt
- Parameters used to find position misaligned
- Nothing there

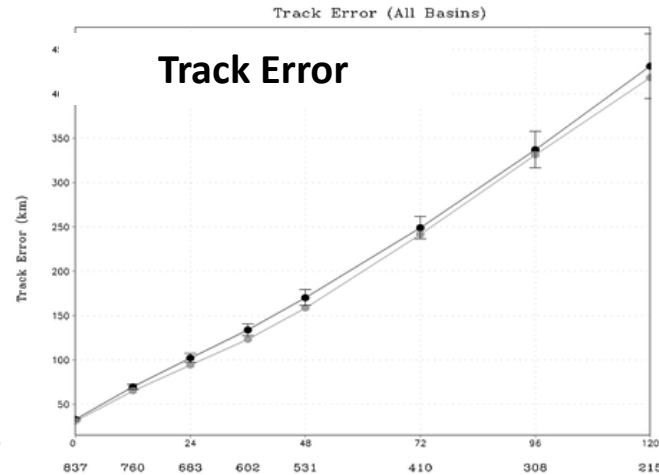
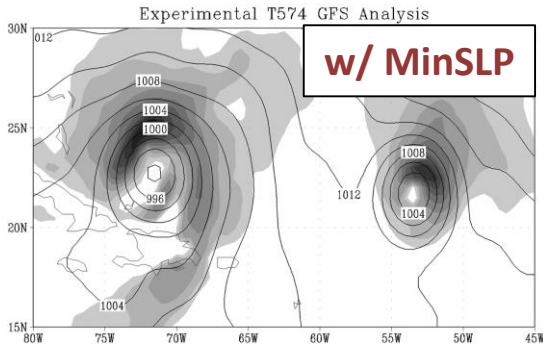
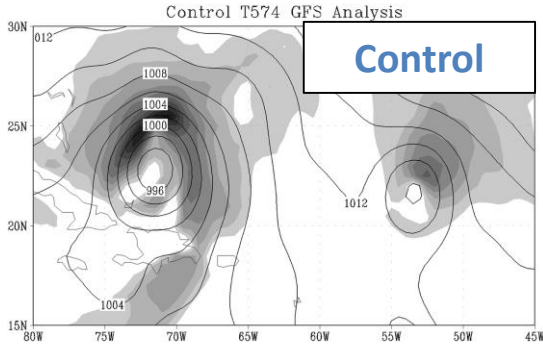
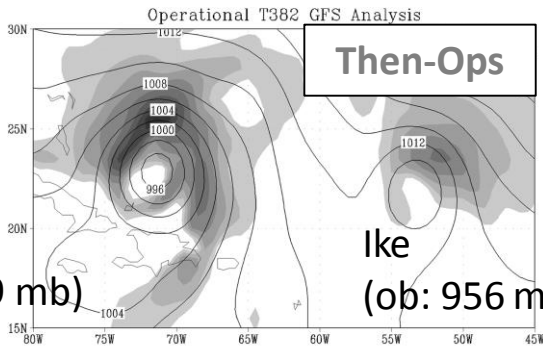


For Bud, tracker “failed” and resultant analysis had radically different vortex due to assimilation of bogus winds (and advisory minSLP)

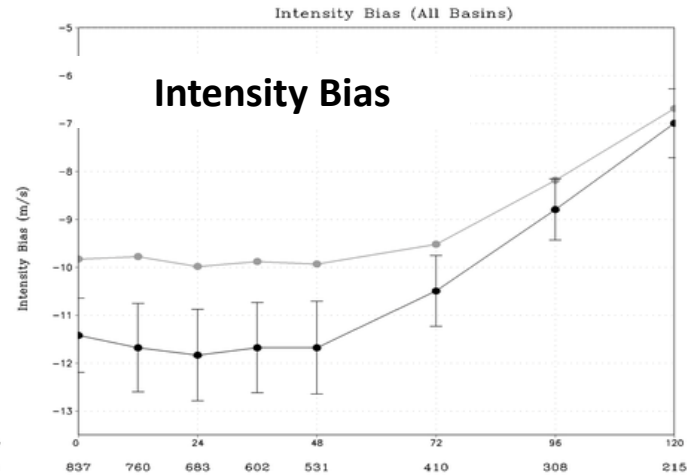
# Advisory MinSLP in GDAS/GFS (Kleist 2011)

Hanna  
(ob: 989 mb)

Ike  
(ob: 956 mb)



Control  
MinSLP

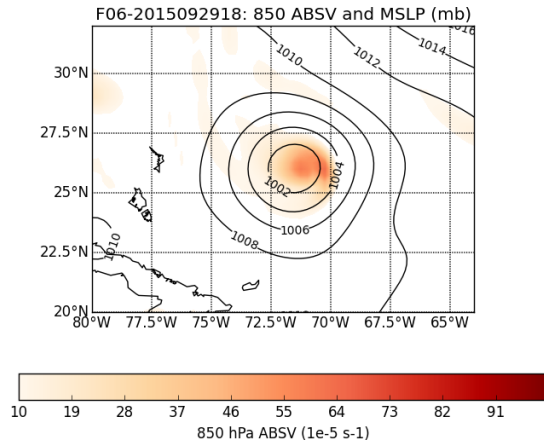


Control  
MinSLP

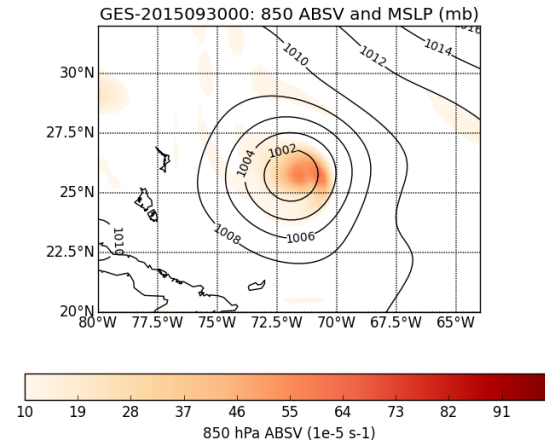
# Impact of Relocation (2015093000)

Move Storm SW by  $\sim 0.5$  degrees

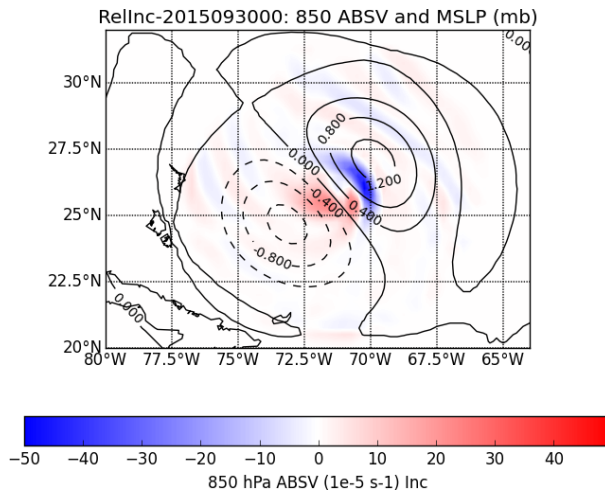
Original  
F06



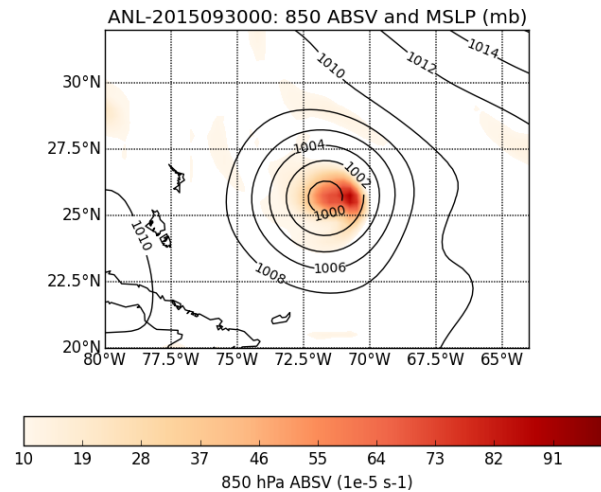
Relocated  
F06  
(Background  
d)



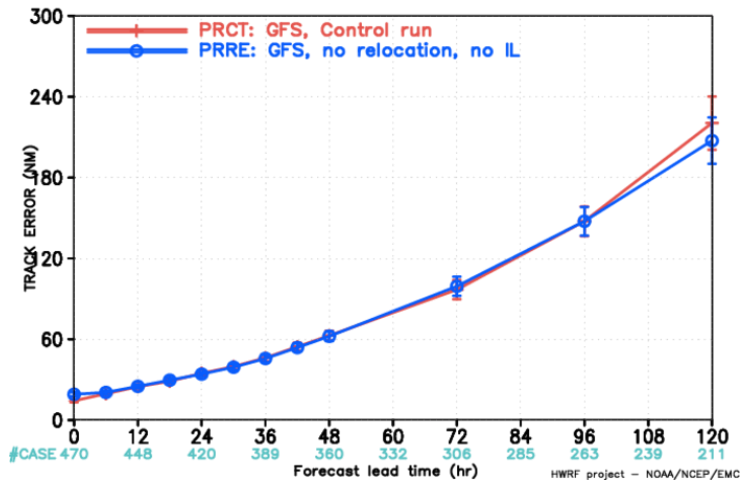
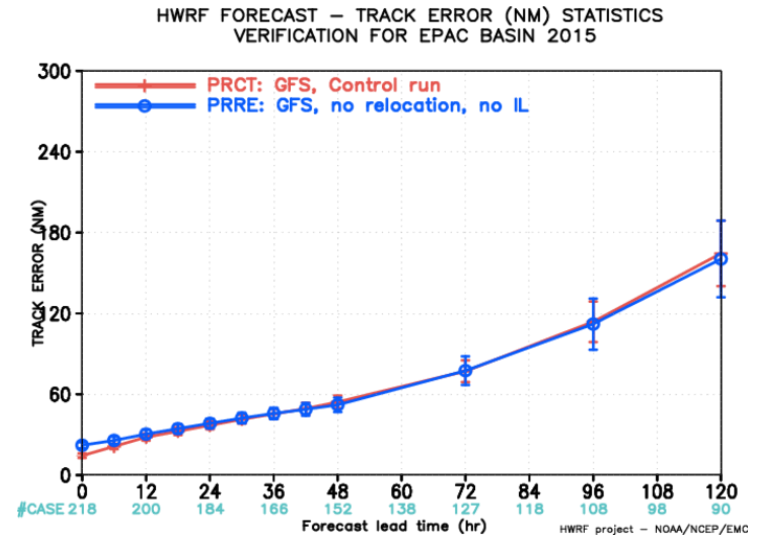
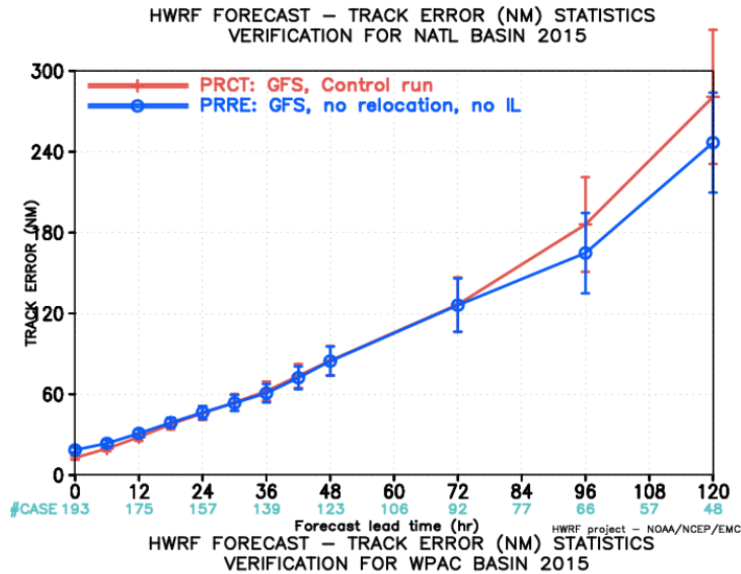
Relocation  
Increment



Final  
Analysis



# Summary of Results: Mean Track Error Control (relox) v. Experiment (no relox)



- Slight degradation < 12h
- Neutral 12h-72h
- Neutral to slight improvement > 72h

# Joint WGNE/DAOS White Paper

- DAOS has three individuals willing to take this on (two current, one former). Identify participation from WGNE.
- Survey the landscape of what is done for global NWP at met centers
  - Description/examples of methodologies
- Explore and summarize relevant, current research
  - Coupled DA
  - All-sky assimilation
  - Nonlinear/non-Gaussianity
  - Field Alignment/Displacement assimilation
- Recommendations





# Thank you Merci



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