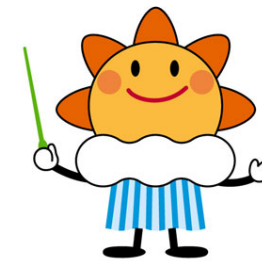
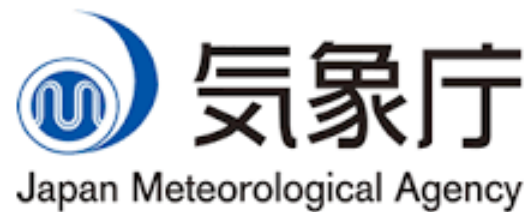


# CERA-20C: Assimilation of TC best track

ERA-CLIM2 4<sup>th</sup> General Assembly

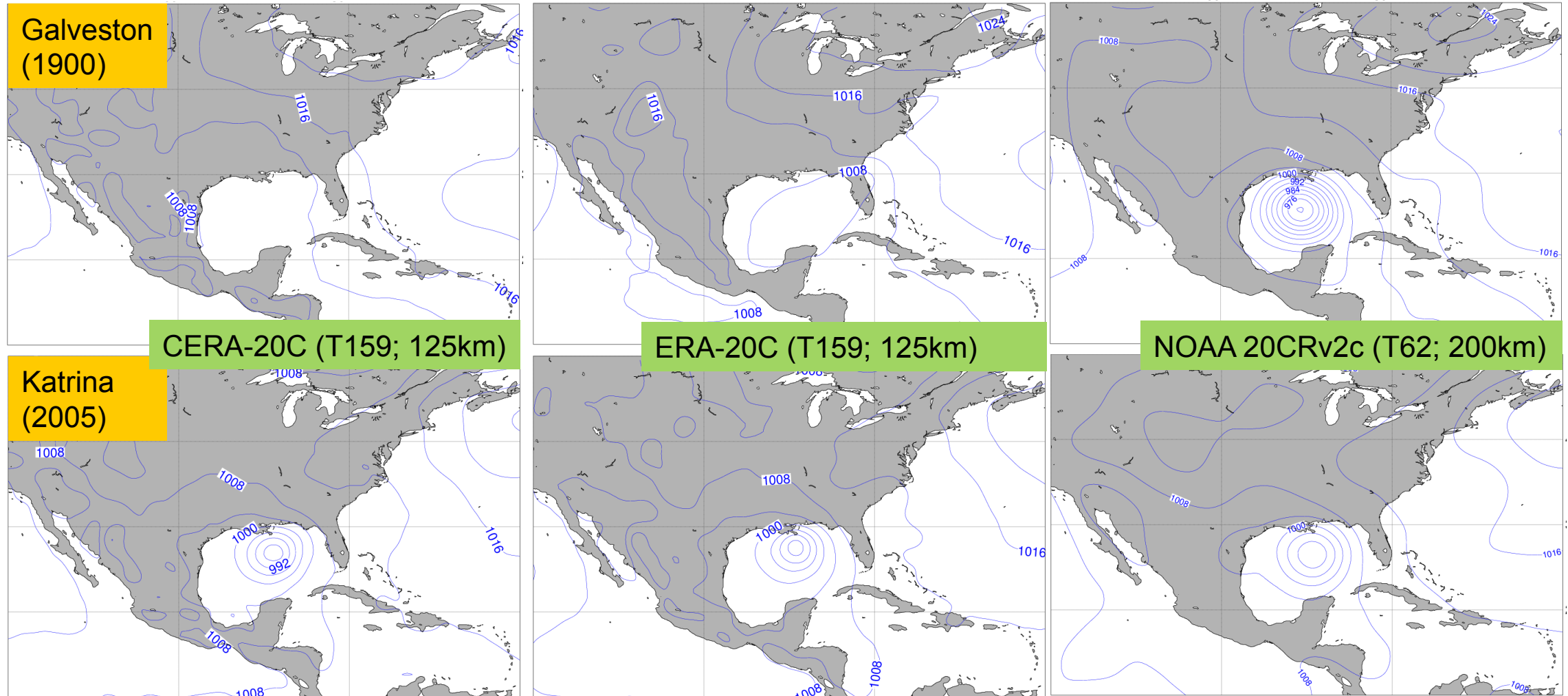
Yuki Kosaka

JMA / ECMWF



# Representation of TCs in the analysis field of CERA-20C

- TC best track pressure observations from IBTrACS are assimilated in CERA-20C
- There is a known problem that **some TCs are not represented** in the analysis fields of CERA-20C

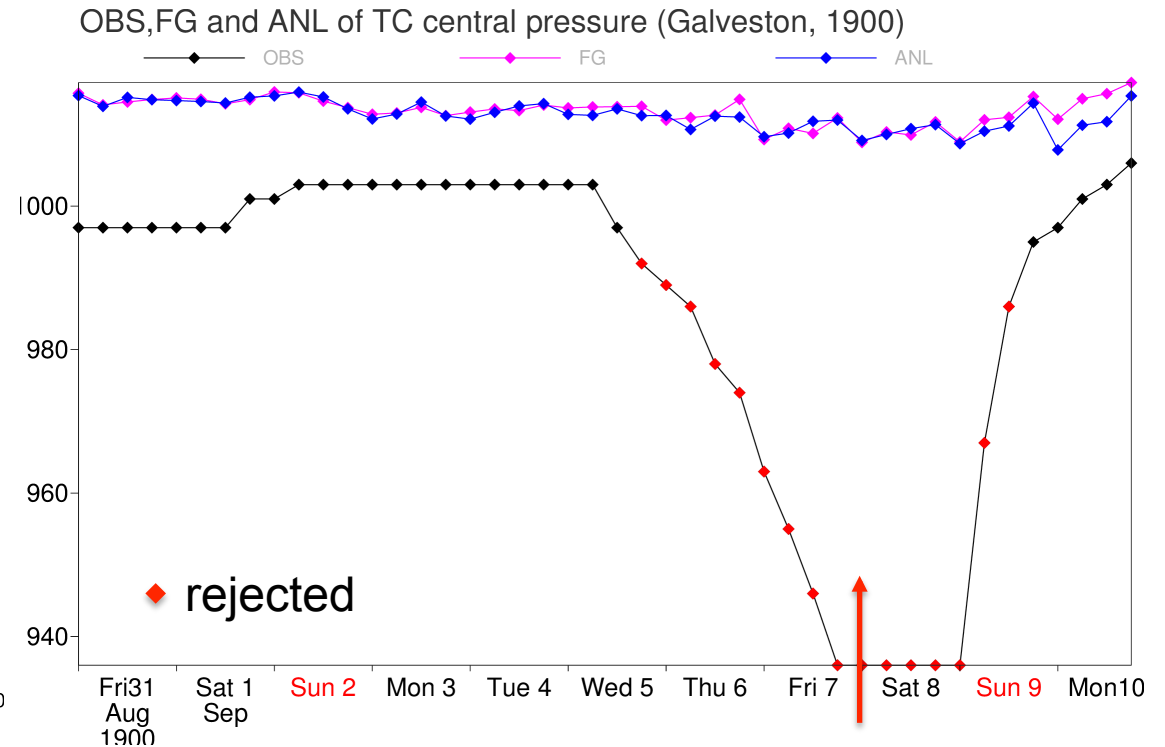
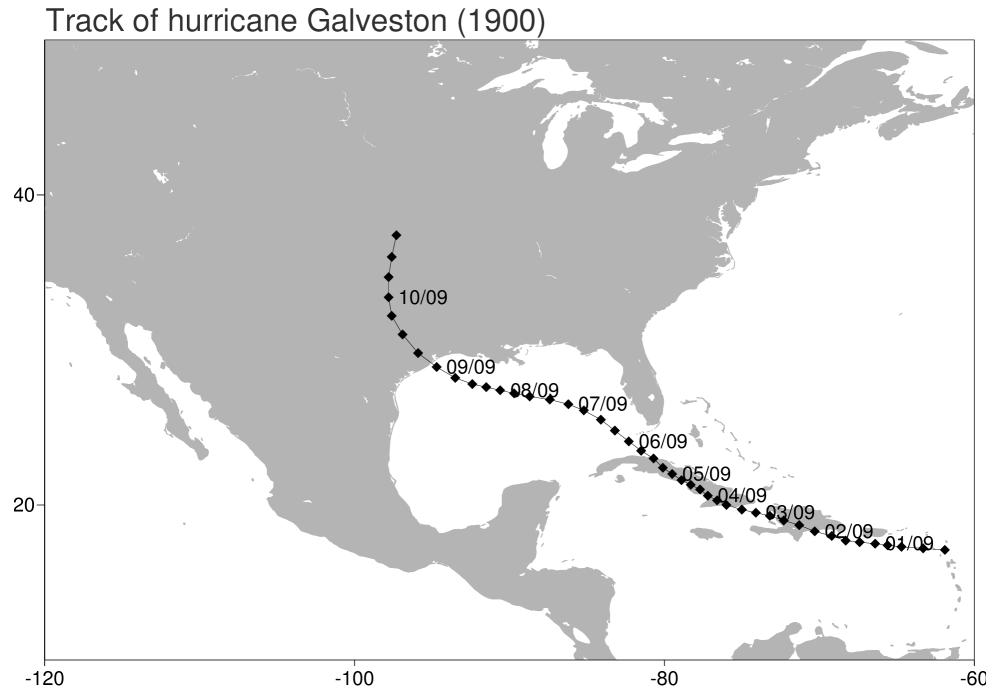


## Outline

- Assimilation performance of TC best track in CERA-20C
- Improvement of TC best track assimilation
- Observation data denial experiment
- Summary

# Assimilation Performance of TC best track (Galveston, 1900)

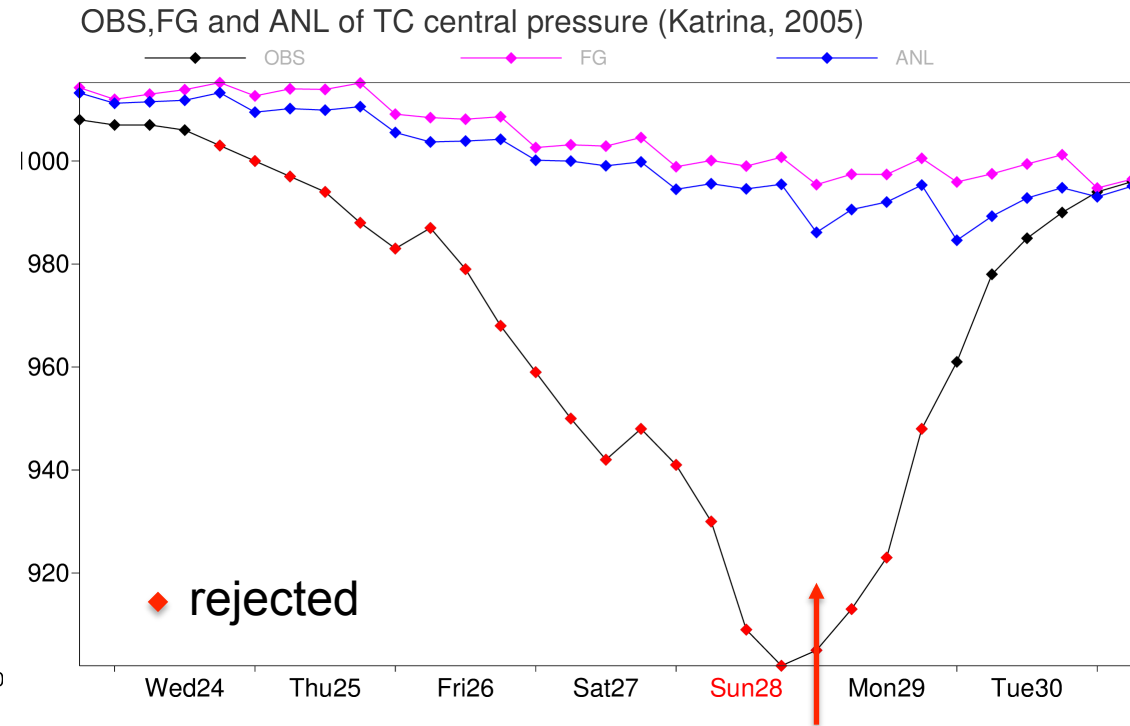
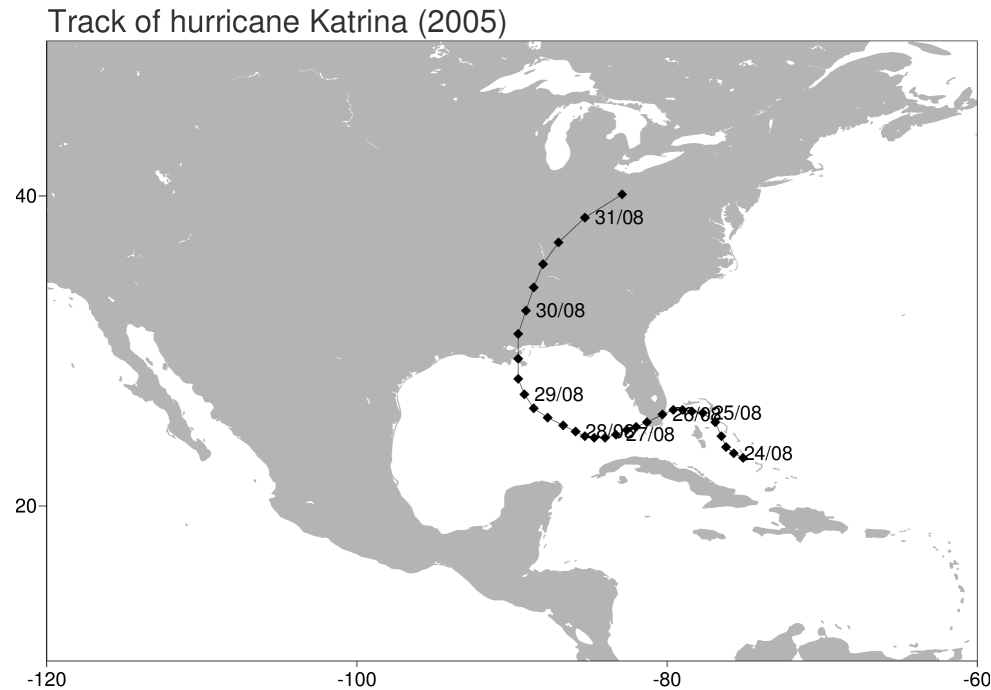
- The hurricane Galveston, known as the Great Storm of 1900, made landfall on 8<sup>th</sup> September, 1900 in Galveston, Texas, in the United States (936 hPa)



- Difference between analysis and first guess is almost 0, meaning that impact of TC best track assimilation is very small
- Investigation was done to identify the causes of this by using observation feedback archive
  - It was found that about **30% of TC best track reports were rejected by quality control** (FG check, VarQC)

# Assimilation performance of TC best track (Katrina, 2005)

- Katrina is the hurricane that struck the south eastern United States and claimed more than 1800 lives in late August 2005



- Although many TC best track data are rejected by quality control, difference between analysis and first guess is larger compared to case of the hurricane Galveston

# Outline

- Assimilation performance of TC best track in CERA-20C
- **Improvement of TC best track assimilation**
- Observation data denial experiment
- Summary

## Experiments for improving TC best track assimilation

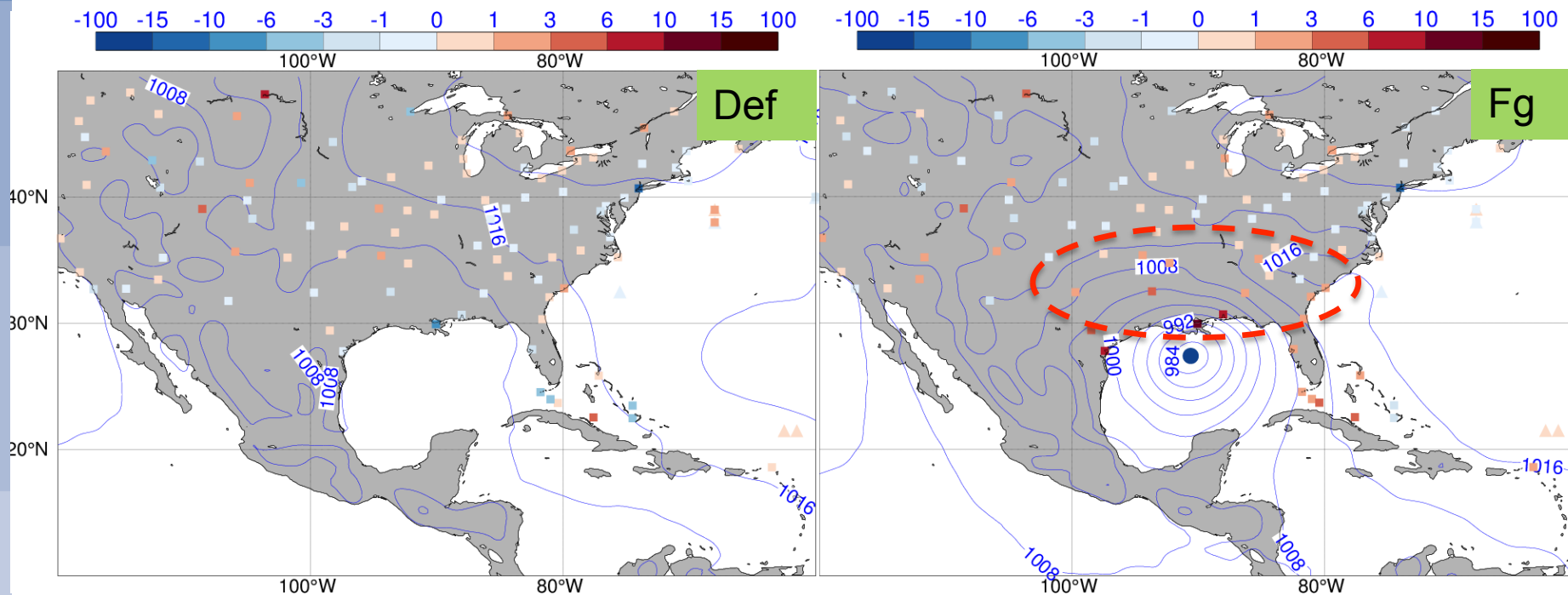
- In order to solve the problem of “missing TCs”, improvement of TC best track assimilation was conducted.

EXP	Preprocessing for TC best track		Weight of hybrid JB	Ensemble members	Resolution (outer / inner)
	FG check and VarQC	Observation error [hPa]			
Def (CERA-20C)	On	2	0.15	9	T159 / T95
Fg	Off	2	0.15	9	T159 / T95

- ‘Def’: Experiment with the default configuration of CERA-20C
- ‘FG’: FG check and VarQC for TC best track were switched off

# Impact of switching off FG check and VarQC (Galveston, 1900)

- Low pressure area of TC came to be represented
- Analysis departure of other observations in the vicinity of the TC got large, meaning that consistency between analysis and other observations was deteriorated.
  - Horizontal length scale of background error covariance is larger than that of the TC



08 Sep 1900

MSLP analysis field (blue line; hPa)  
Analysis departure (symbols)

- circle: TC best track [hPa]
- square: conventional pressure [hPa]
- triangle: conventional wind [m/s]



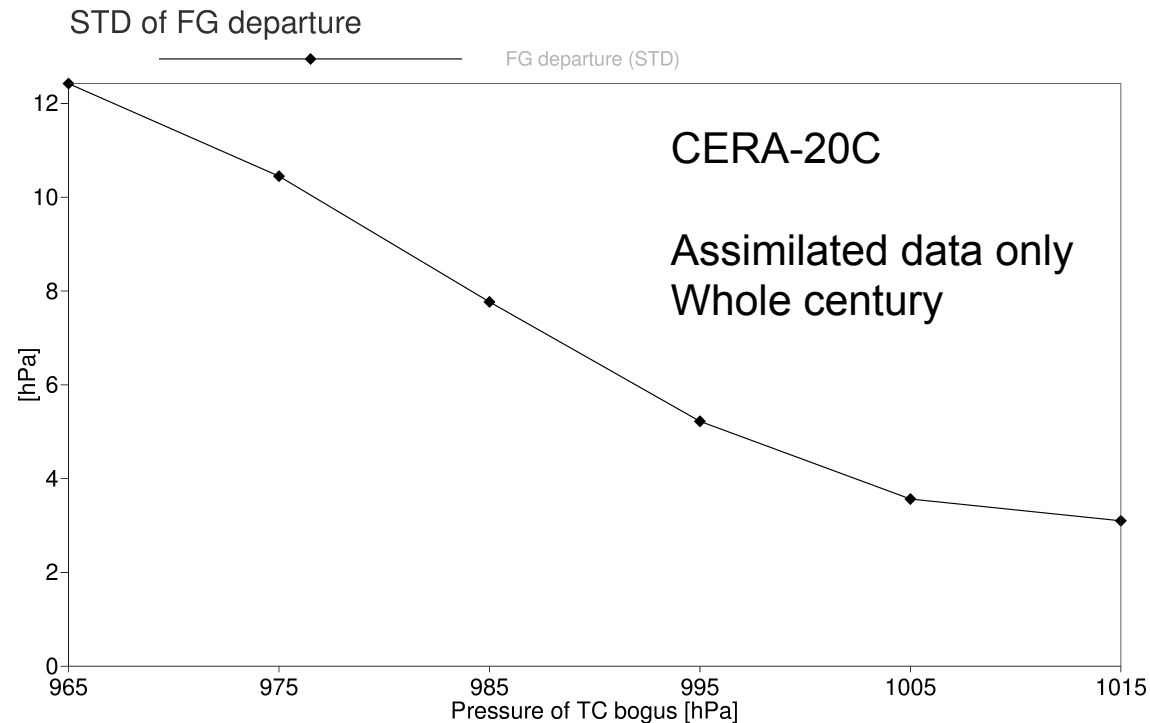
# Experiments for improving TC best track assimilation

EXP	Preprocessing for TC best track		Weight of hybrid JB	Ensemble members	Resolution (outer / inner)
	FG check and VarQC	Observation error [hPa]			
Def (CERA-20C)	On	2	0.15	9	T159 / T95
Fg	Off	2	0.15	9	T159 / T95
Jb	Off	2	0.30	25	T159 / T95
Res	Off	2	0.30	25	T319 / T159
Obse	Off	0.6 (1000hPa) to 5.4 (850hPa)	0.15	9	T159 / T95

- 'Jb' : Flow dependent component of hybrid JB is increased. Number of ensemble members is also increased to try to enhance the error of the day and capture smaller scales in the background error covariance matrix
- 'Res' : In addition to change in 'Jb', outer and inner loop resolution are increased to shorten horizontal scale of the background error covariance matrix
- 'Obse' : Observation error for TC best track varied depending on TC best track pressure

# Situation dependent observation error for TC best track

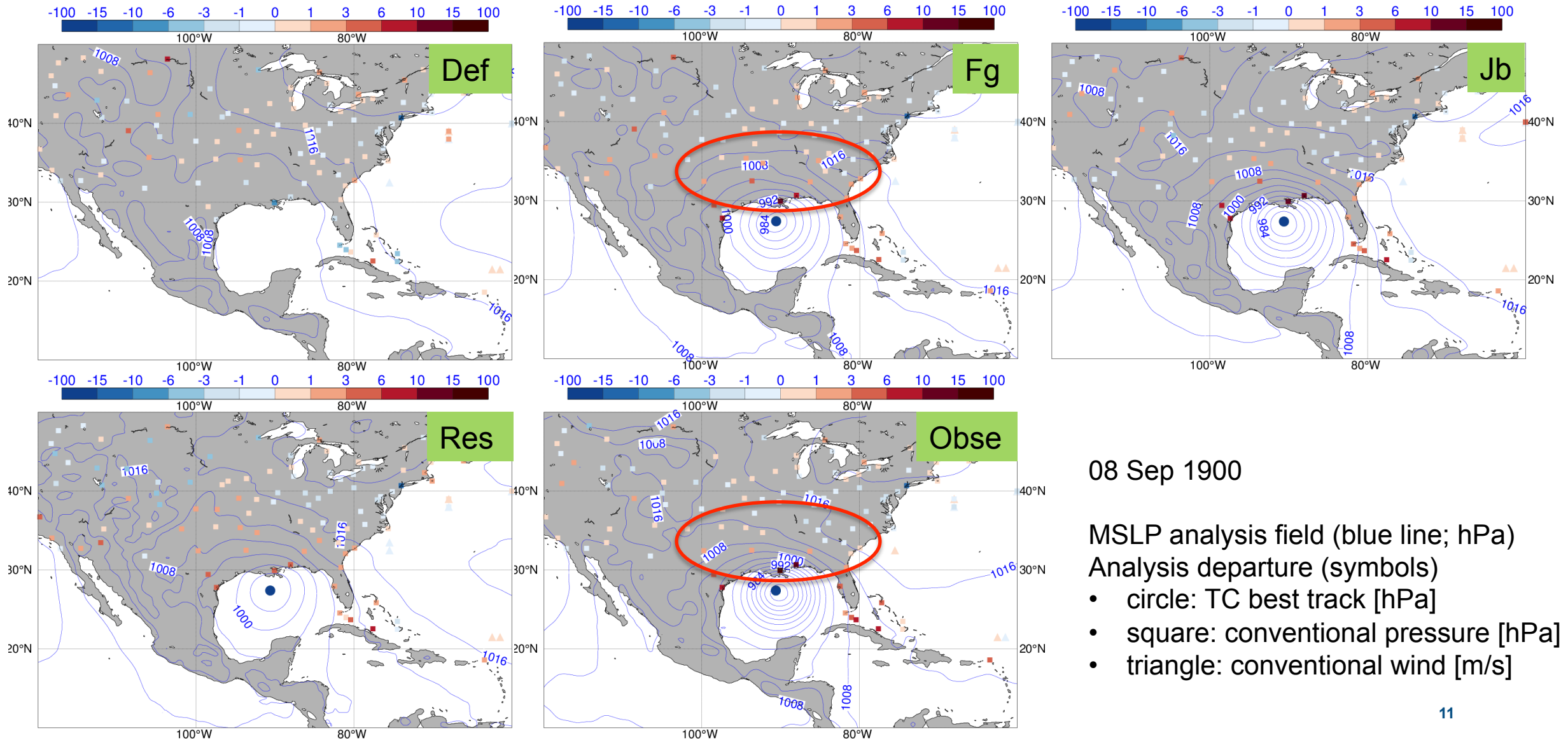
- There is a possibility that observation error varies depending on atmospheric parameter such as horizontal scale of TC or central pressure
- I divided TC best track data into several bins depending on central pressure and took statistics of first guess departure for each bin



- The lower TC best track pressure is, the larger standard deviation of first guess departure becomes

# Impact of improving TC best track assimilation (Galveston, 1900)

- Deterioration in consistency between analysis and other observations was mitigated with experiment 'Obse'.



08 Sep 1900

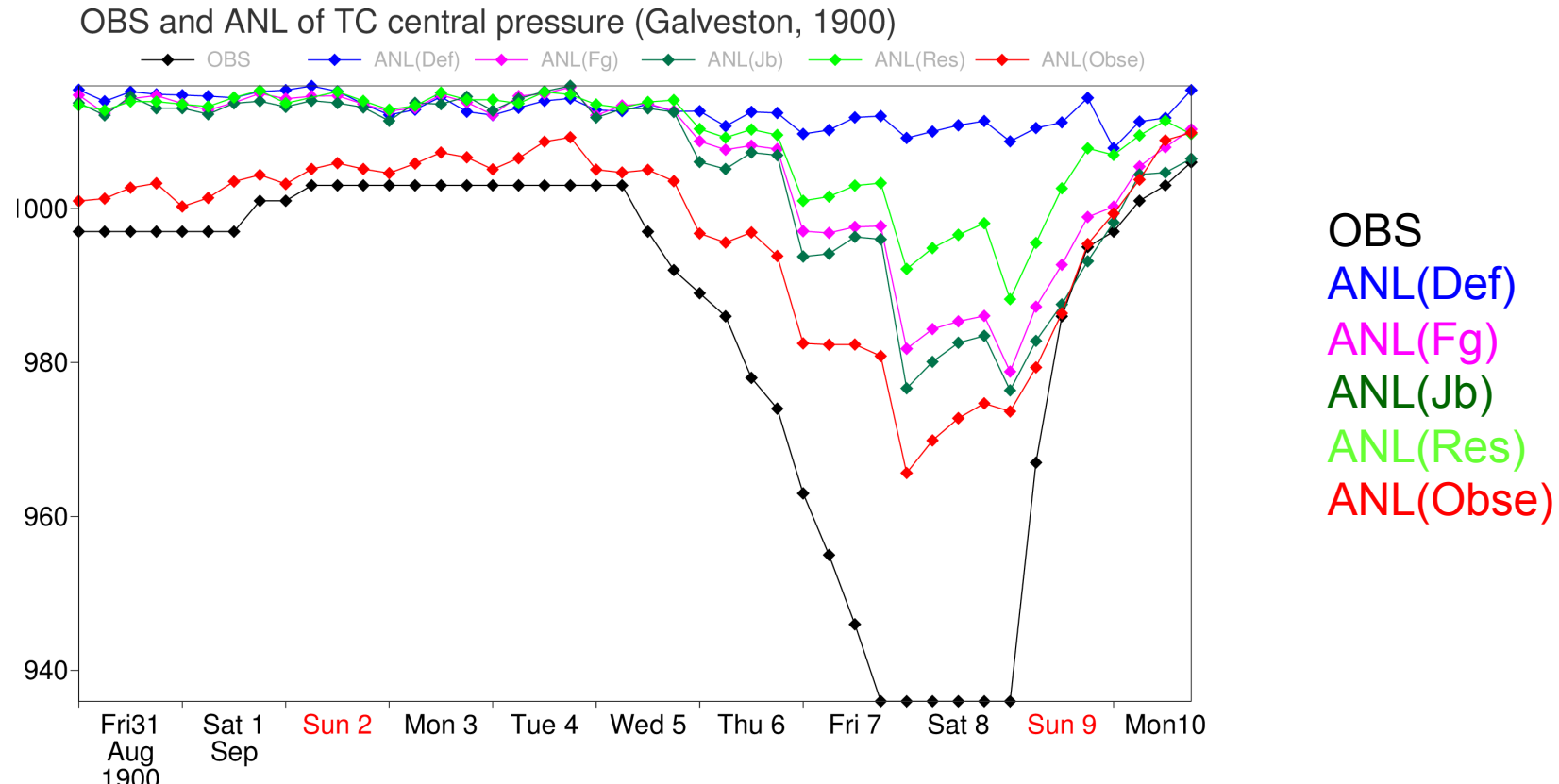
MSLP analysis field (blue line; hPa)

Analysis departure (symbols)

- circle: TC best track [hPa]
- square: conventional pressure [hPa]
- triangle: conventional wind [m/s]

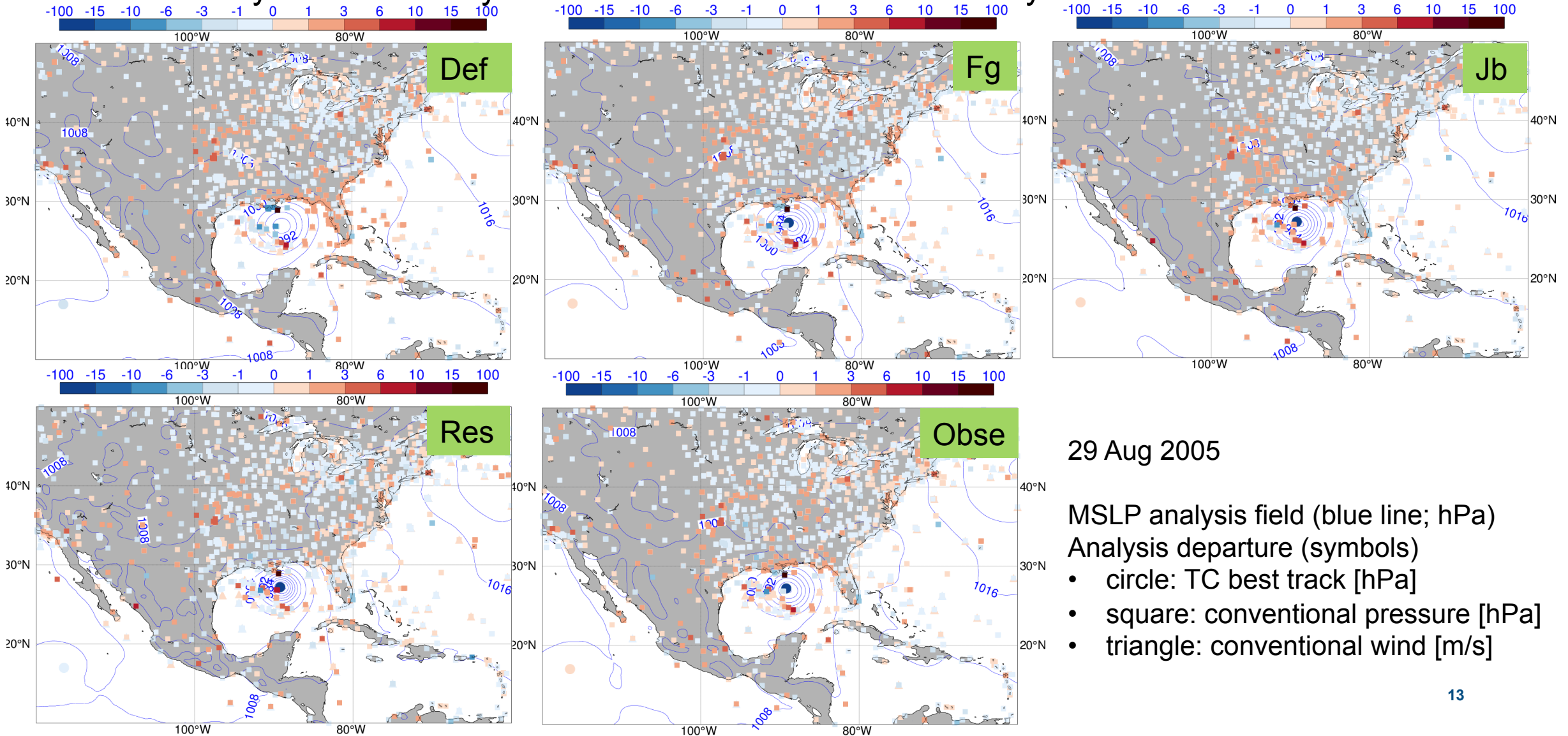
# Timeseries of TC central pressure (Galveston 1900)

- Impact of adopting situation dependent observation error ('Obse') is the largest in this case
  - Central pressure in experiment 'Obse' is about 10 hPa lower compared to that in experiment 'Fg' on average throughout the period
- Increasing flow dependent component of hybrid JB ('Jb') or increasing resolution ('Res') have little impact on deepening central pressure



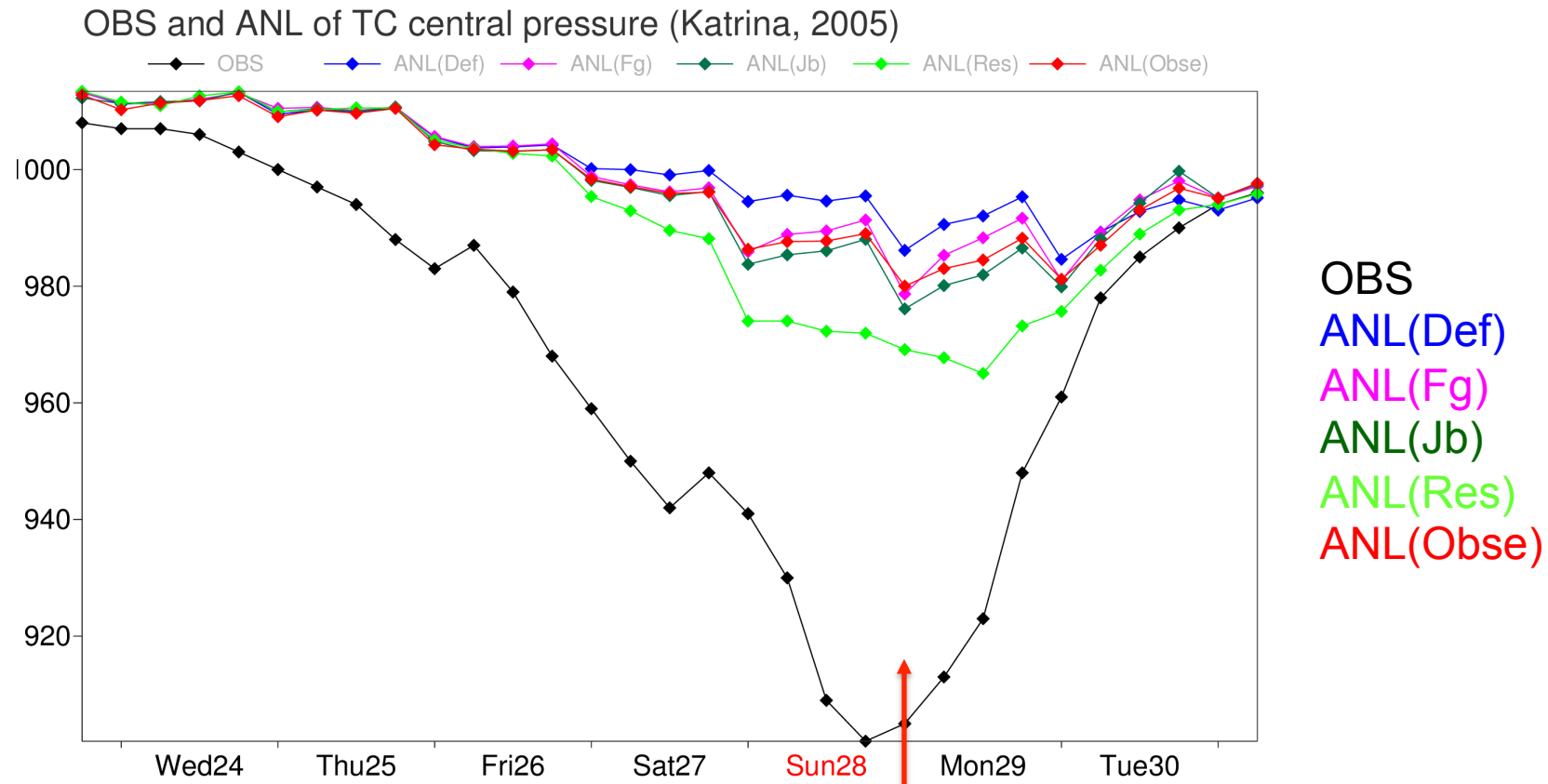
# Impact of improving TC best track assimilation (Katrina, 2005)

- TC is clearly represented in the analysis field of any experiment
- Consistency between analysis and other observations in vicinity of TC is not deteriorated.



# Timeseries of TC central pressure (Katrina 2005)

- Impact of increasing resolution ('Res') is the largest in this case
- Impact of adopting situation dependent observation error ('Obse') is small in this case



# Outline

- Assimilation performance of TC best track in CERA-20C
- Improvement of TC best track assimilation
- **Observation data denial experiment**
- Summary

## Observation data denial experiments

- Impact of adopting situation dependent observation error ('Obse') varied depending on cases of TCs.
- One of the possible causes for this variance is that other conventional observations assimilated in the vicinity of the TC affect representation of TC

Experiments	Observation data assimilation in vicinity of TC*		
	Conventional pressure	Conventional wind	TC best track
Baseline (Fg)	Yes	Yes	Yes
-P	No	Yes	Yes
-W	Yes	No	Yes
-PW	No	No	Yes
Denial	No	No	No

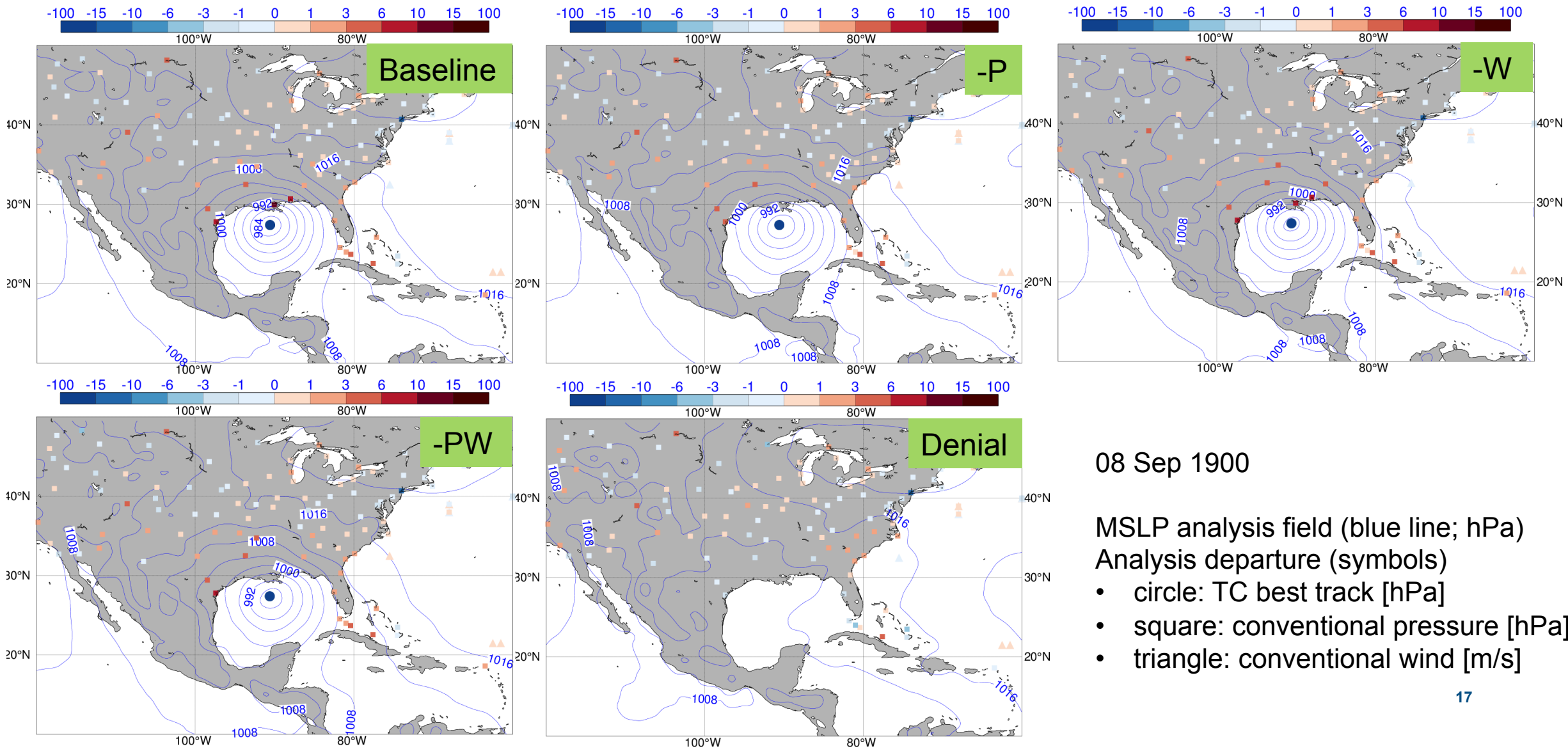
\*"vicinity of TC" = region whose distance from TC central is less than 500km

- Observation data denial experiments were performed to investigate impact of assimilating each observation on representation of TC



# Representation of TC (Galveston, 1900)

- TC is clearly represented in the analysis fields of 'Baseline', '-P', '-W', and '-PW', while TC is missing in the analysis field of 'Denial'



08 Sep 1900

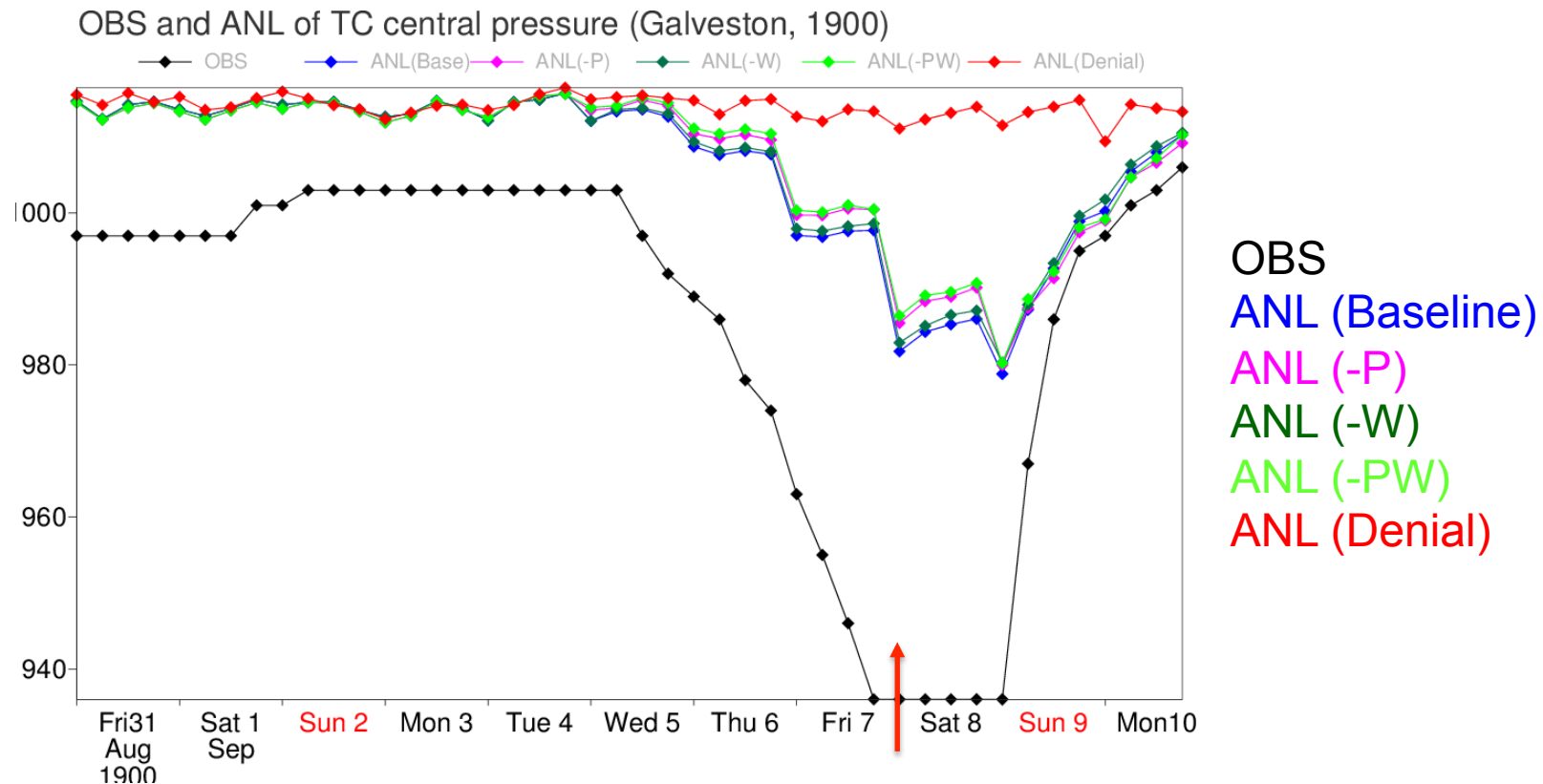
MSLP analysis field (blue line; hPa)

Analysis departure (symbols)

- circle: TC best track [hPa]
- square: conventional pressure [hPa]
- triangle: conventional wind [m/s]

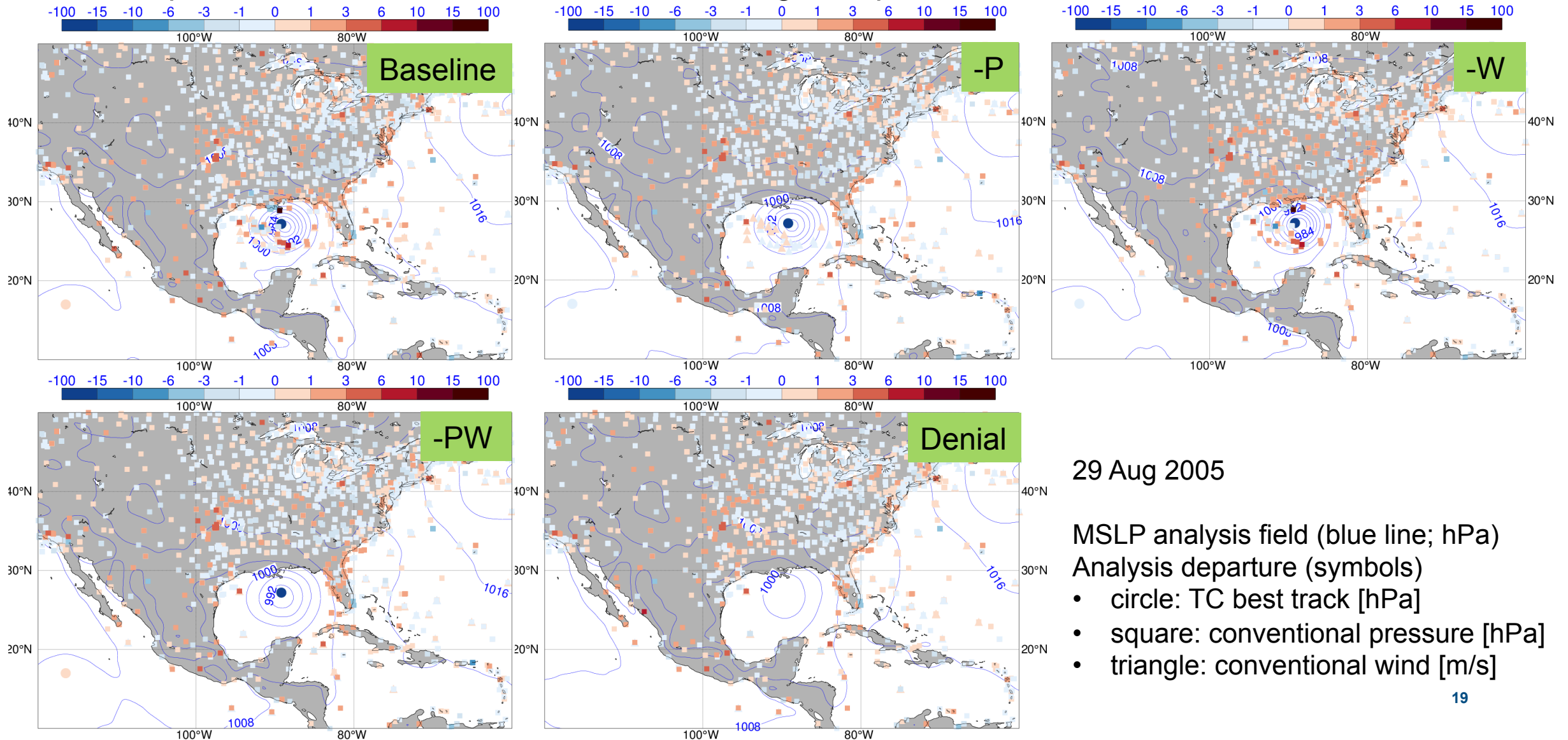
## Timeseries of TC central pressure (Galveston, 1900)

- Difference in analysed central pressure between 'Baseline' and '-PW' is much smaller than that between '-PW' and 'Denial', meaning that **impact of TC best track assimilation is dominant** in terms of representing TC in this case.
- **Conventional pressure assimilation has some impact** on deepening central pressure



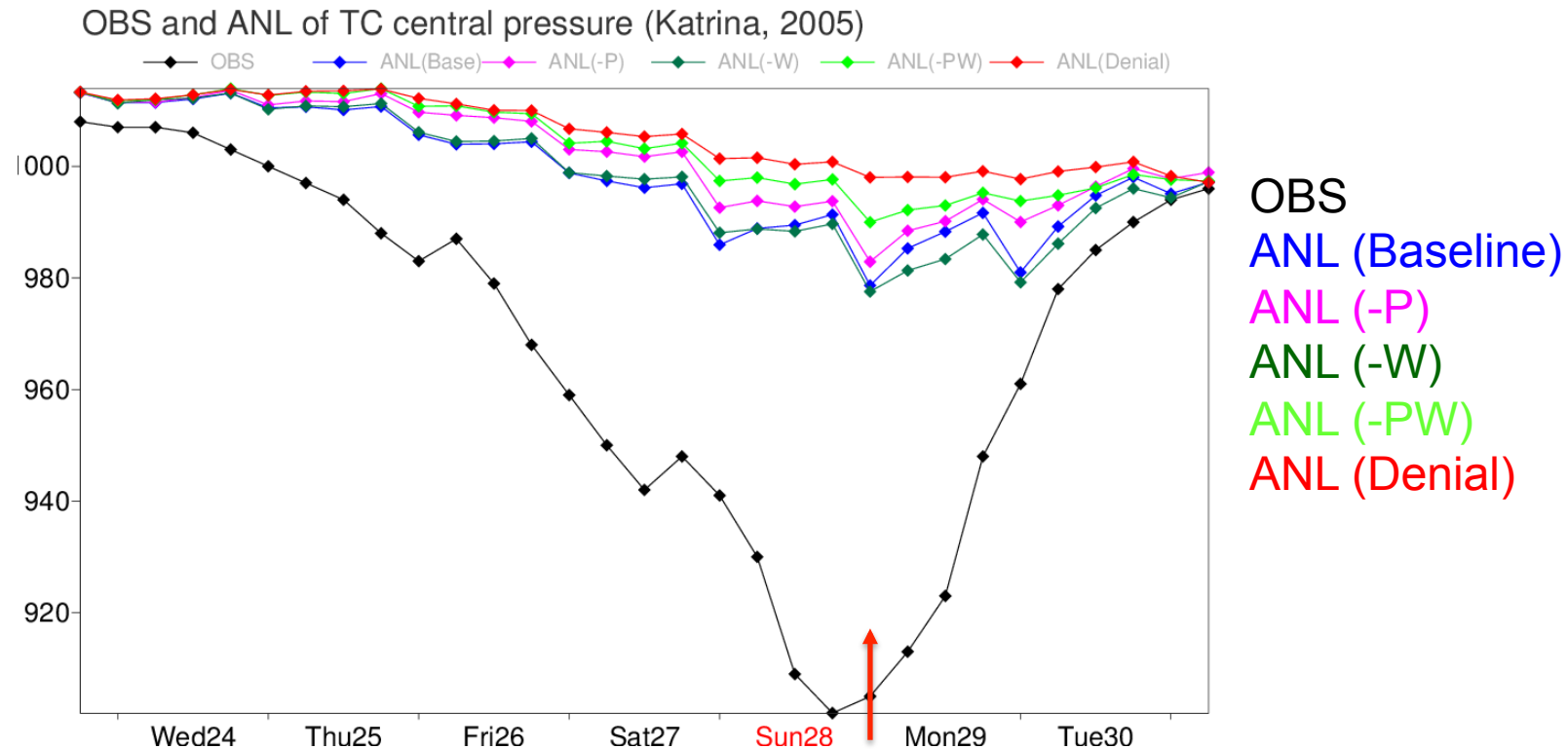
# Representation of TC (Katrina, 2005)

- The more observations around TC are denied, the higher analysed central pressure becomes
- Low pressure area of the TC is almost missing in experiment 'Denial'



# Timeseries of TC central pressure (Katrina, 2005)

- Difference in analysed central pressure between 'Baseline' and '-PW' is larger than that between '-PW' and 'Denial', meaning that **impact of TC best track assimilation is smaller** than that of conventional observation assimilation in this case
- **Conventional pressure assimilation has some impact** on deepening central pressure



# Summary

- Assimilation performance of TC best track in CERA-20C
  - There is a problem that some TCs such as the hurricane Galveston in 1900 are not represented in the analysis field of CERA-20C
  - About 30% of TC best track were rejected by FG check or VarQC
- Improvement of TC best track assimilation
  - Representation of TC was improved by switching off FG check and VarQC and adopting situation dependent observation error
  - Size of Impact of improving TC best track assimilation varied depending on cases of TCs
- Observation data denial experiment
  - Impact of TC best track assimilation is dominant in case of the hurricane Galveston, on the other hand impact of conventional observation assimilation is larger than that of TC best track assimilation in case of the hurricane Katrina

# Backup



# Analysis field of TC Galveston and Katrina

CERA20C

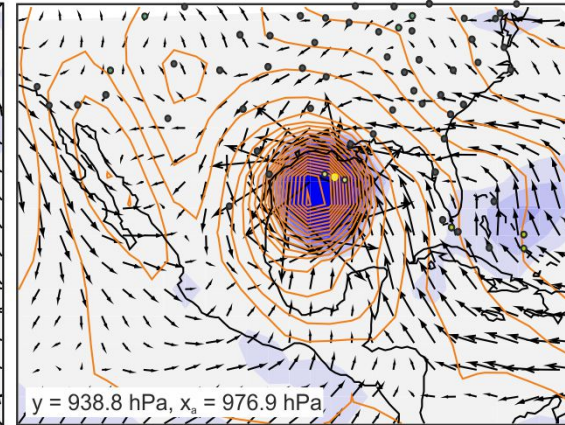
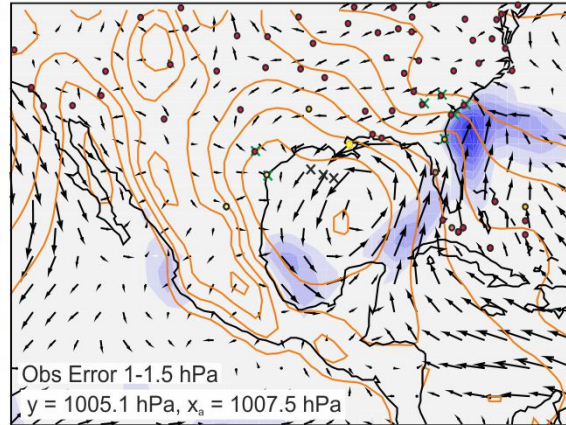
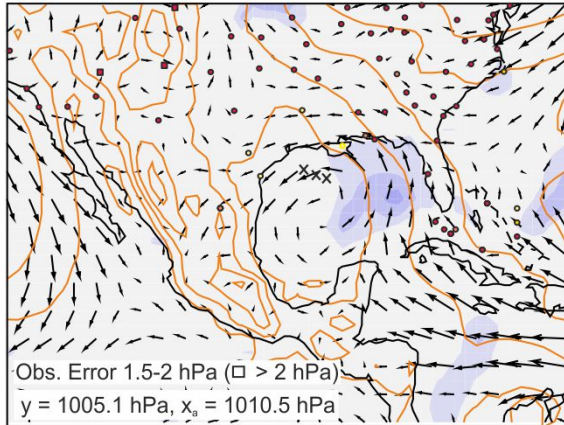
(coupled)

ERA20C (uncoupled)

20CRv2 (NOAA)

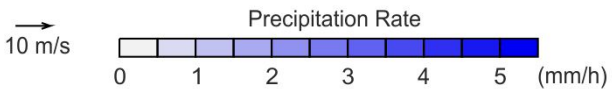
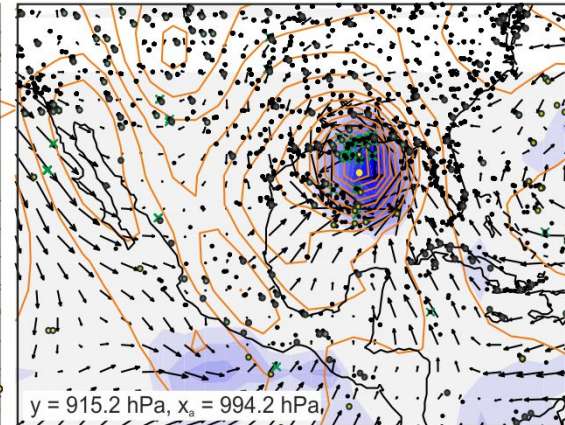
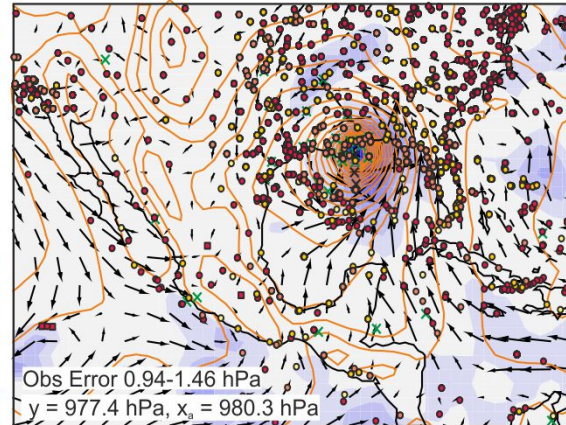
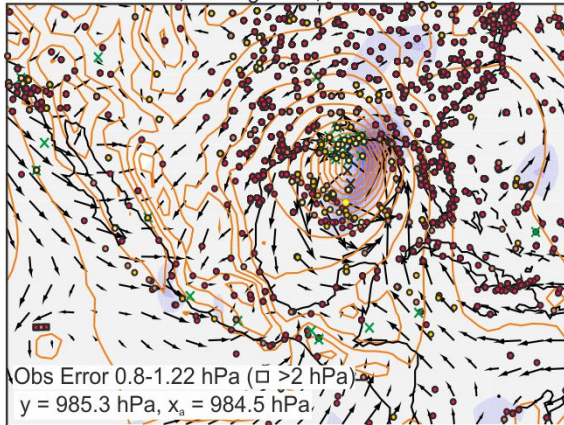
Galveston  
(1900)

Galveston Hurricane, 8 Sep 1908, 18 UTC



Katrina  
(2005)

Hurricane Katrina, 29 Aug 2005, 12 UTC



Rejected by First-Guess Check  
 x Tropical Cyclone Bogus  
 x Other Observation

Weight VarQC  
 ● 1  
 ● 0.75-0.99  
 ● 0.50-0.74  
 ● 0.25-0.49

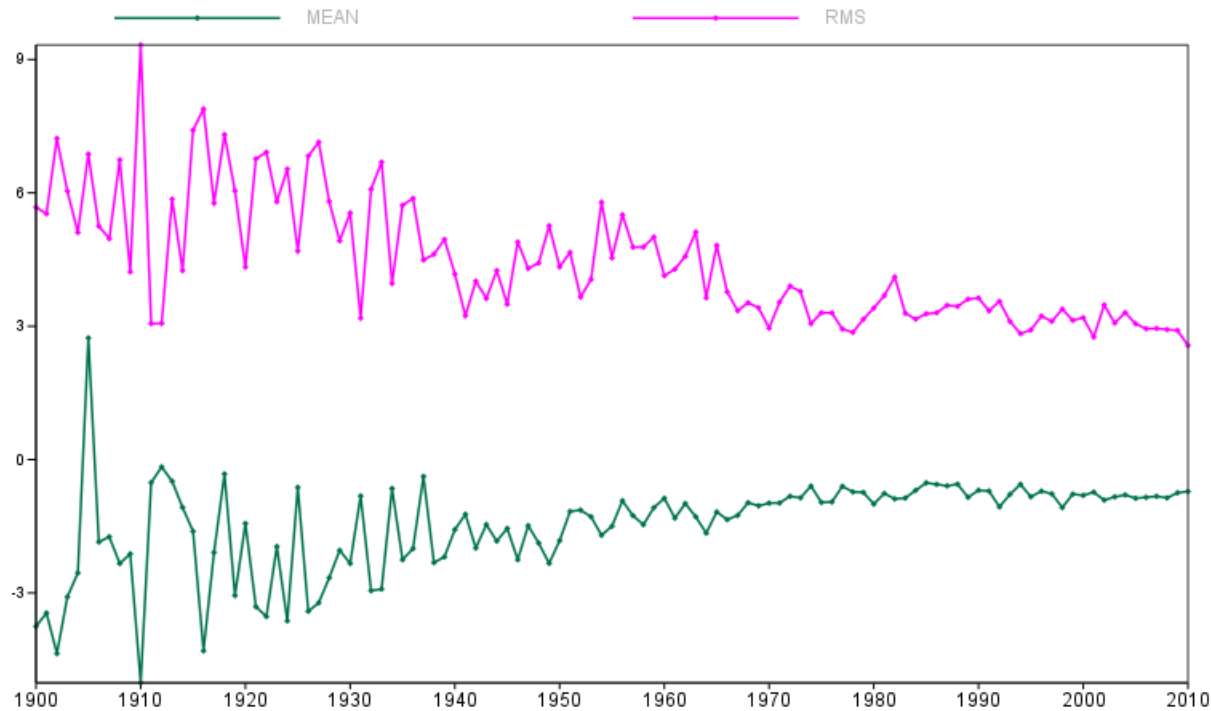
Obs. Error (20CRv2c)  
 ● >2.49 hPa  
 ● 2.00-2.49 hPa  
 ● 1.50-1.99 hPa  
 ● 1.00-1.49 hPa  
 ○ Thinned out observation

- There is a problem that some TCs are not represented in the analysis fields of CERA-20C and ERA-20C

# Statistics of FG departure of SYNOP and SHIP near TC best track

All data except blacklisted data

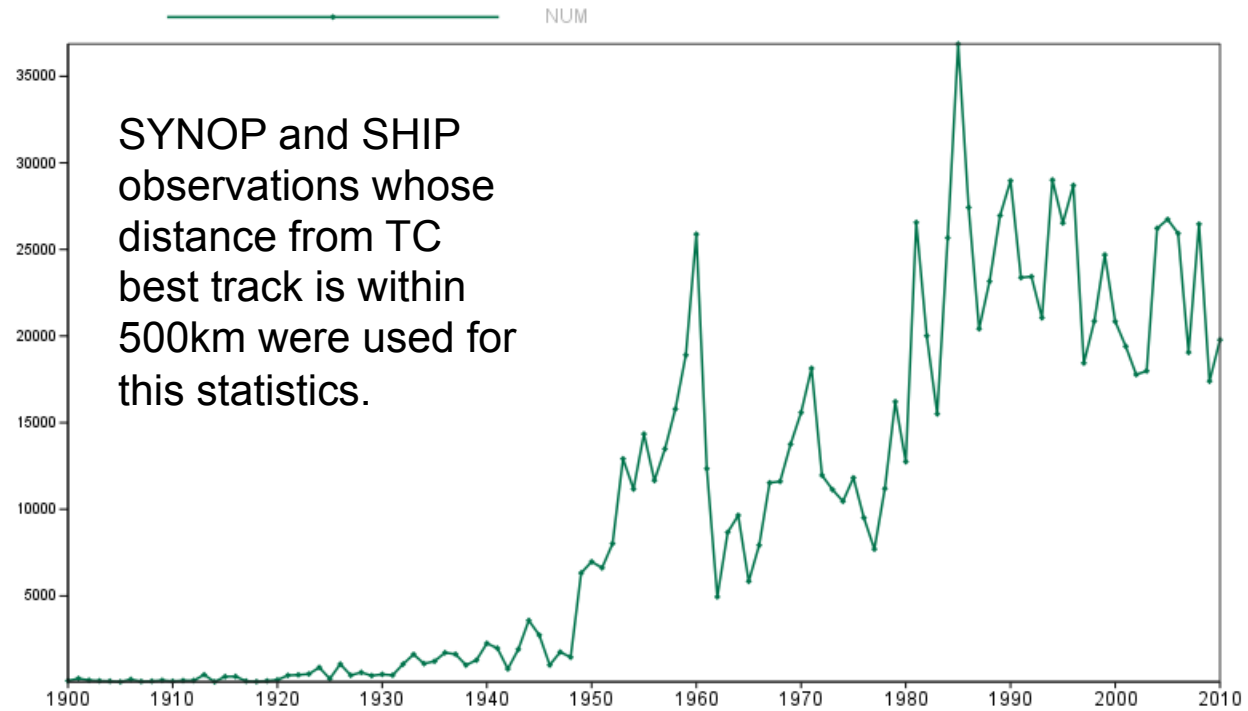
Statistics of FG departure (SYNOP,SHIP near TC bogus)



Magma 2.31.0 (64 bit) - fang - dyk - Thu May 25 16:37:17 2017

ECMWF

Number of observations (SYNOP, SHIP near TC bogus)



SYNOP and SHIP observations whose distance from TC best track is within 500km were used for this statistics.

Magma 2.31.0 (64 bit) - fang - dyk - Tue May 23 16:15:09 2017

ECMWF

- RMS of FG departure decreases with time
  - Number of conventional observations near TC increases with time