Sensitivity of air-sea exchange coefficients (Cd and Ch) on hurricane size and intensity of HWRF

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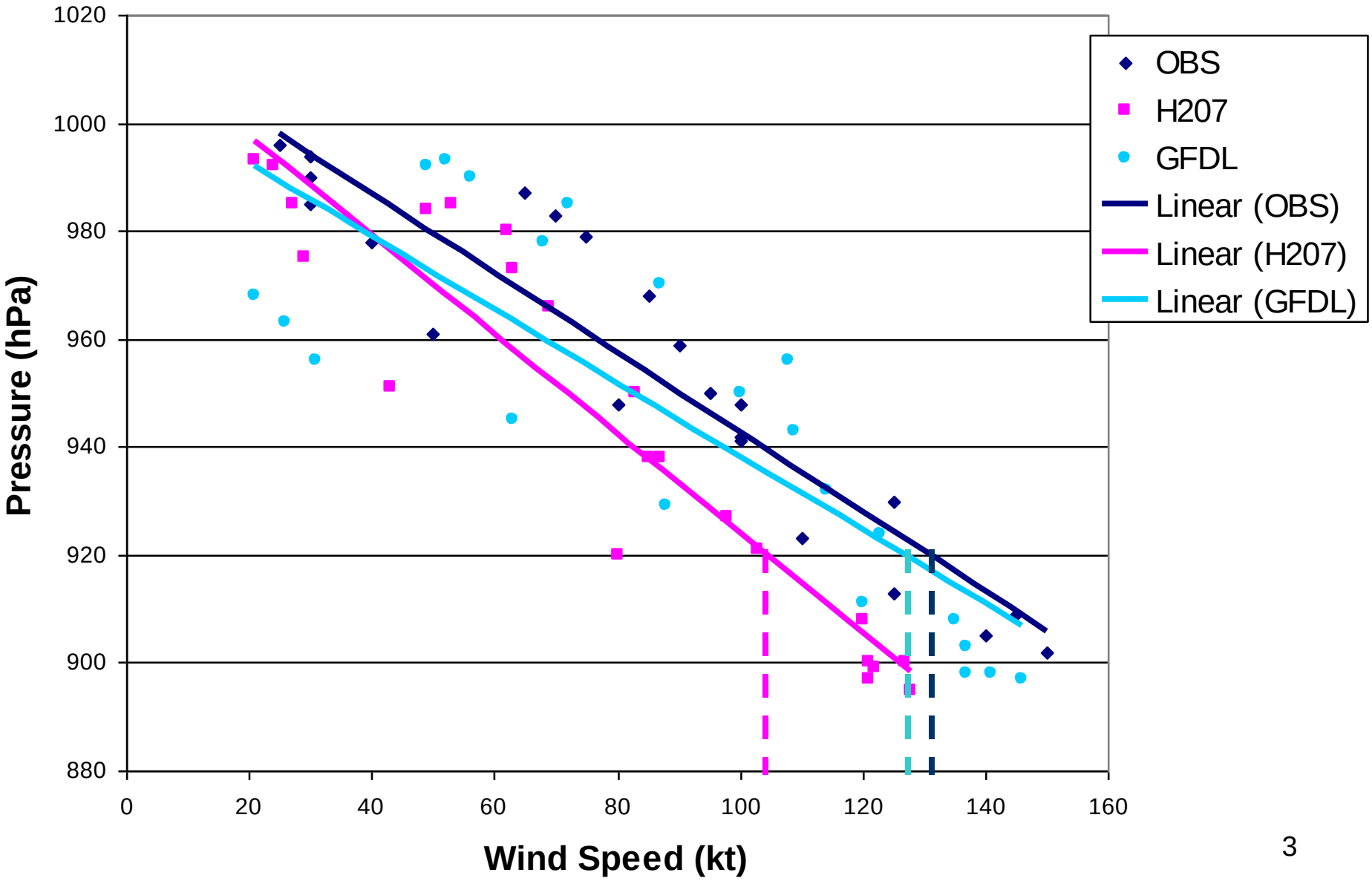
Motivations

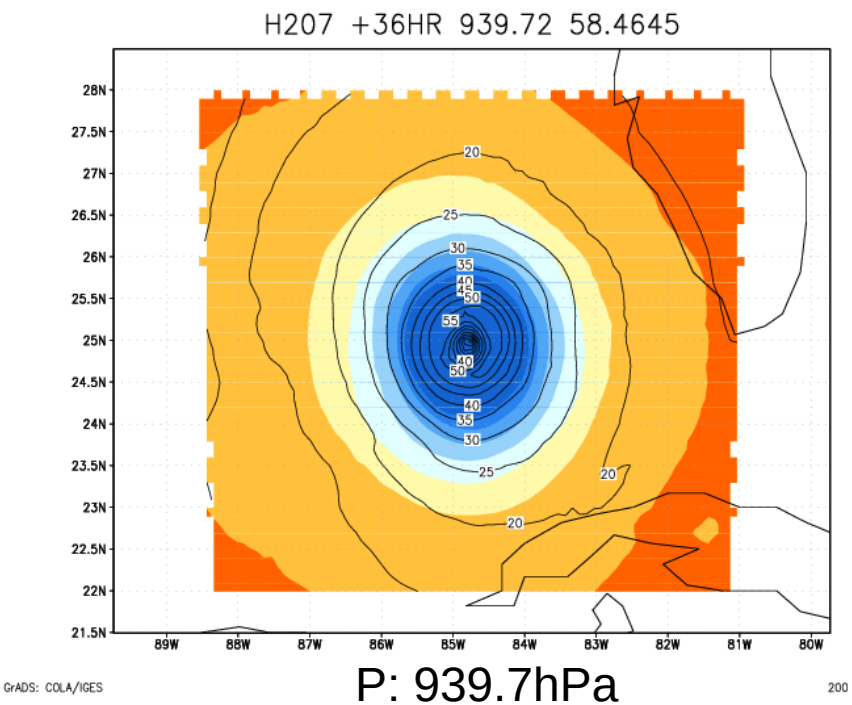
1. **Intensity skill of HWRF is not as good as track forecast skill (sometimes worse than statistical models).**
2. **Part of the poor intensity forecast skill might result from incorrect wind-pressure relationship of HWRF.**
3. **Subjective verification indicates that HWRF has the tendency of producing a larger storm with time, and this tendency seems to cause the wrong wind-pressure relationship. (wind speed is proportional to dp not p).**
4. **The goal of this work is to improve the intensity forecast skill of HWRF by correcting storm size and pressure-wind relationship with tuning Cd and Ch.**

Wind Pressure Relationship (Katrina 2005082600)



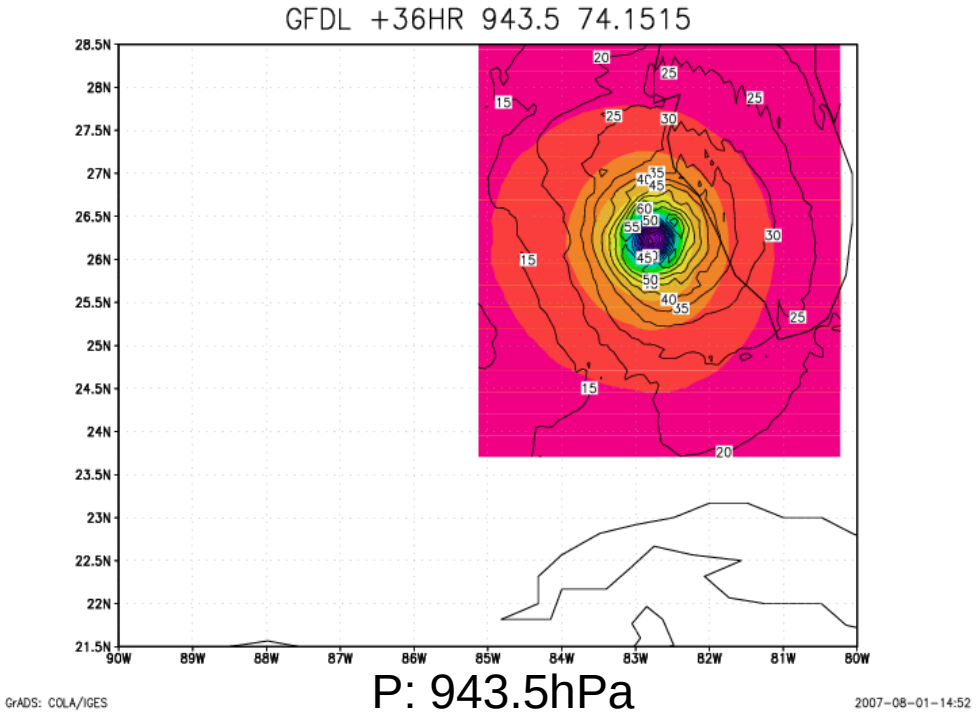
Hurricane Katrina (2005082600) Simulation Result

(HWRF and GFDL)



P: 939.7hPa

W: 58.4 m/s



P: 943.5hPa

W: 74.1 m/s

Motivations

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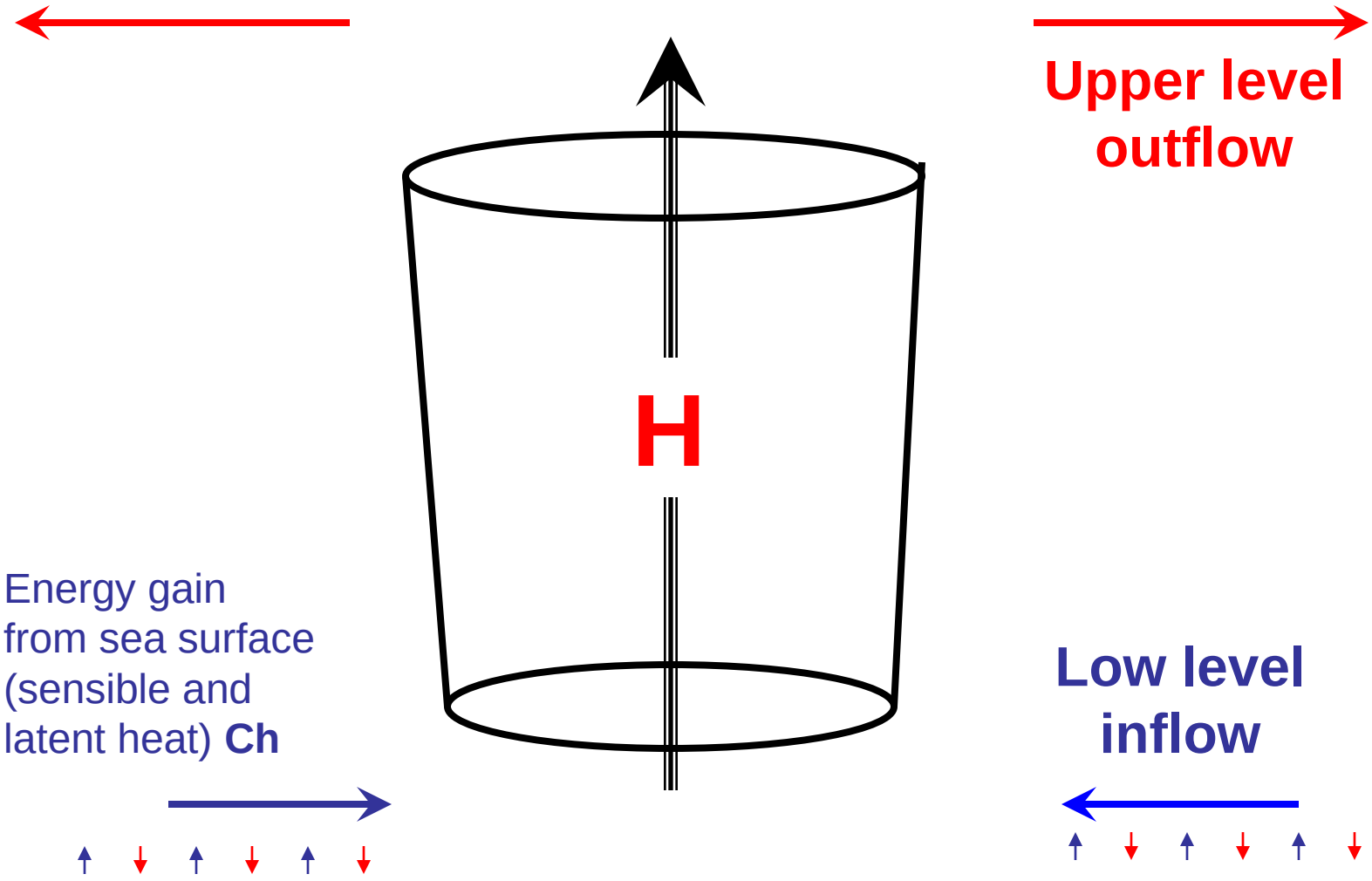
Background

Hurricane intensity is proportional to $\left(\frac{C_h}{C_d}\right)^{1/2}$

Emanuel (1995)

Besides intensity, the size of storm might also depends on surface exchange coefficients (espeially Cd)


Upper level
outflow
H
Energy gain
from sea surface
(sensible and
latent heat) Ch
Low level
inflow
Energy loss by
surface friction Cd
OCEAN

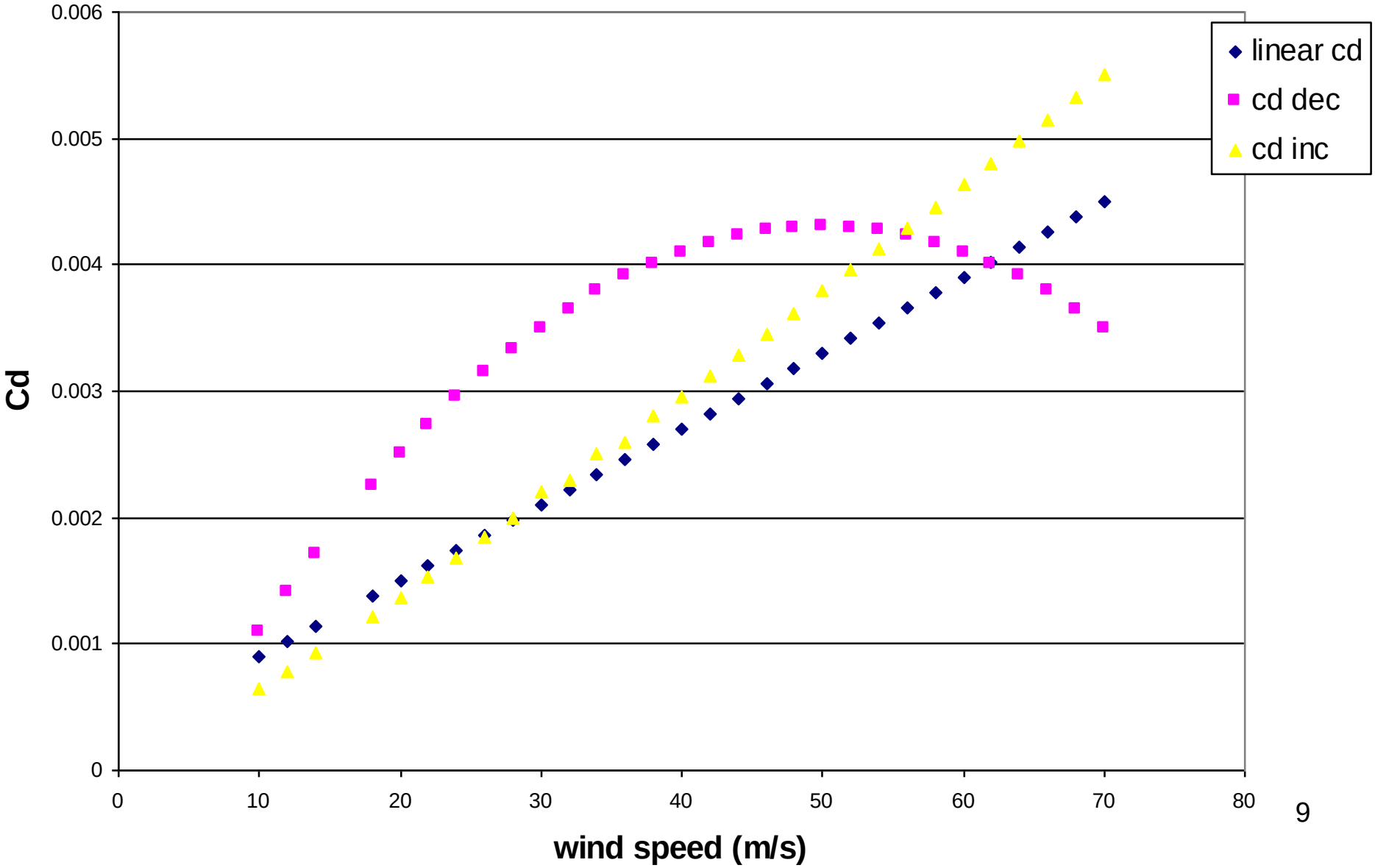
Method and Case

1. **Change HWRF surface physics code in order to use prescribed Cd and Ch separately over the ocean.**
2. **Conduct experiments using fixed Ch/various Cd in order to examine the sensitivity of Cd on storm size and intensity forecast skill.**
3. **Conduct experiment as in 3. except fixing Cd but varying Ch.**
4. **Case for this study:**

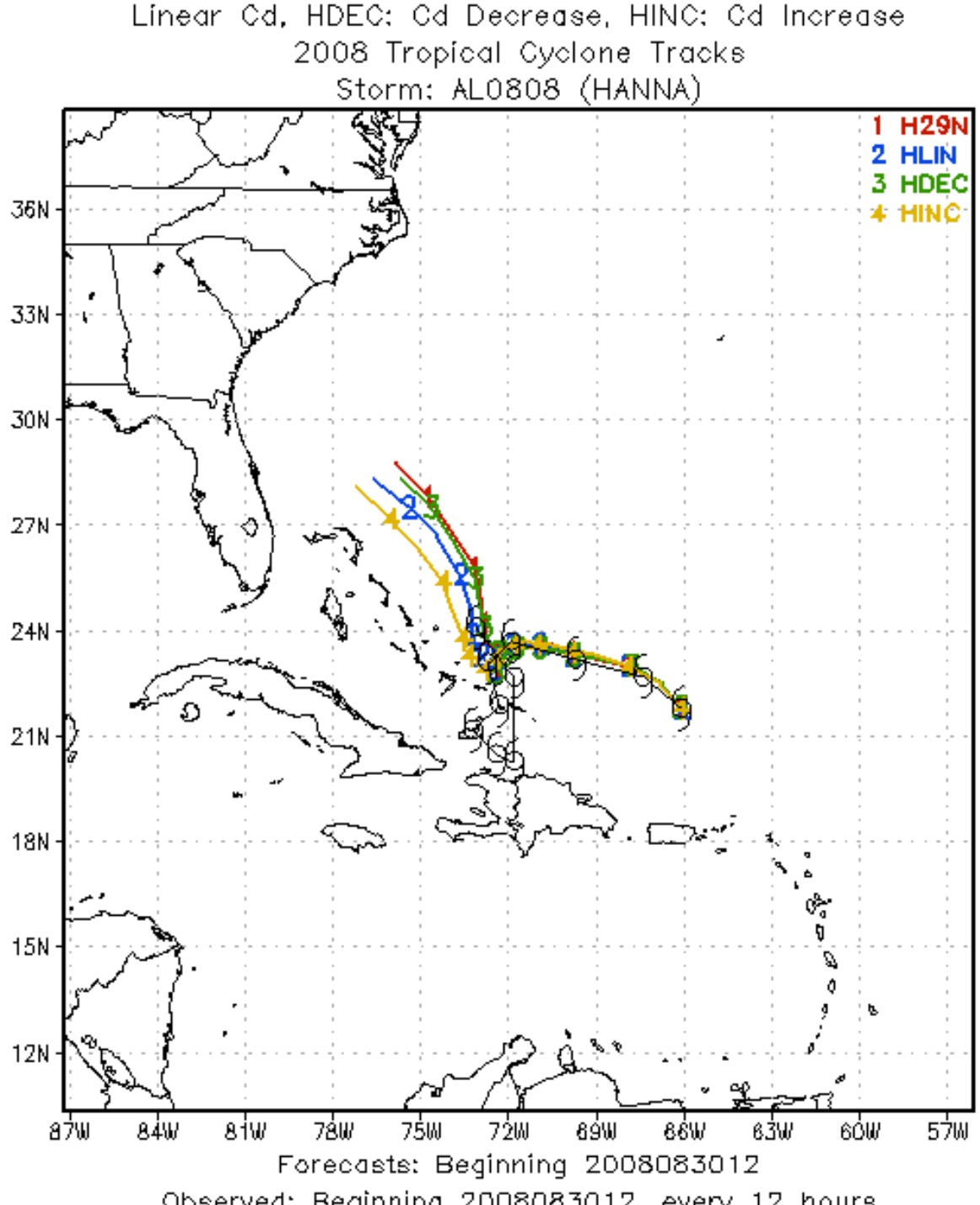
   Hurricane Hanna(2009.08.30.12 UTC)

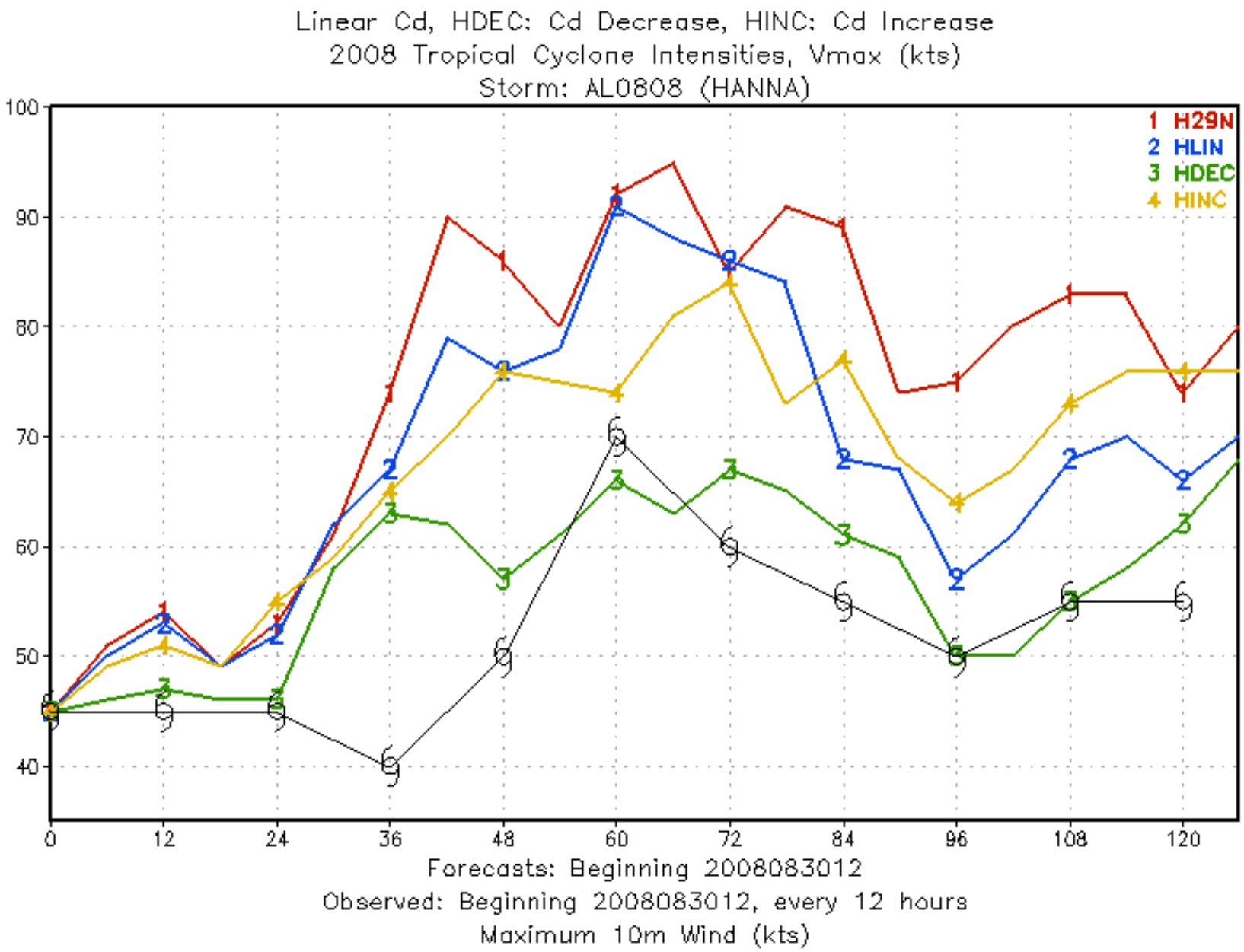
   Stays in the Ocean most of time, positive intensity bias

cd / wind speed profiles



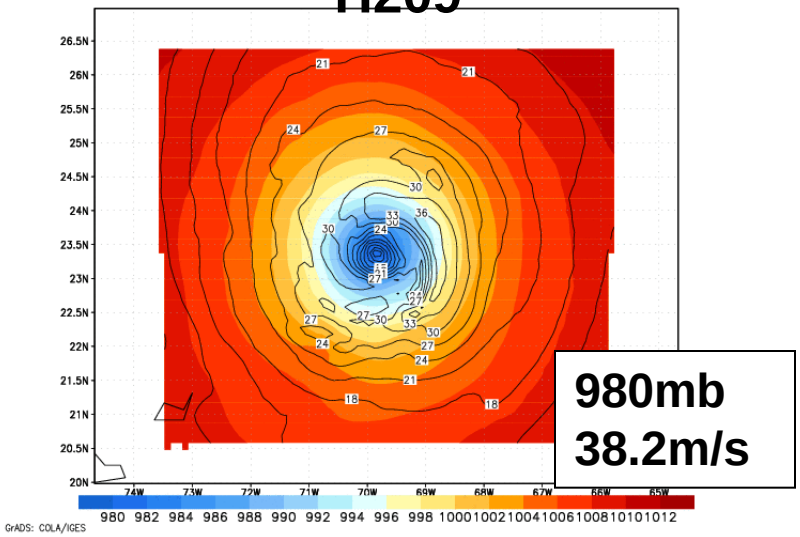
Preliminary Results


Linear Cd, HDEC: Cd Decrease, HINC: Cd Increase
2008 Tropical Cyclone Tracks
Storm: AL0808 (HANNA)
1 H29N
2 HLIN
3 HDEC
4 HINC
36N
33N
30N
27N
24N
21N
18N
15N
12N
87W
84W
81W
78W
75W
72W
69W
66W
63W
60W
57W
Forecasts: Beginning 2008083012
Observed: Beginning 2008083012 every 12 hours

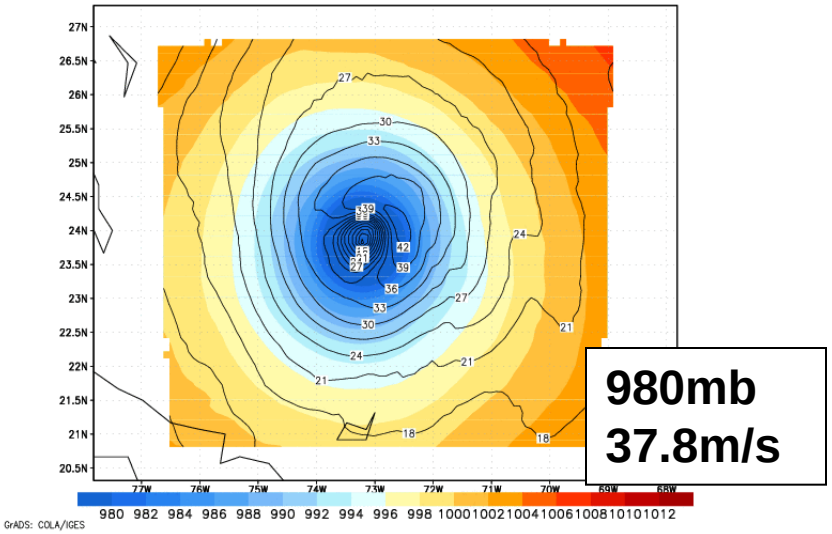

Linear Cd, HDEC: Cd Decrease, HINC: Cd Increase
2008 Tropical Cyclone Intensities, Vmax (kts)
Storm: AL0808 (HANNA)
1 H29N
2 HLIN
3 HDEC
4 HINC
100
90
80
70
60
50
40
0
12
24
36
48
60
72
84
96
108
120
Forecasts: Beginning 2008083012
Observed: Beginning 2008083012, every 12 hours
Maximum 10m Wind (kts)

24hr Forecast (MSLP and 850mb wind speed)

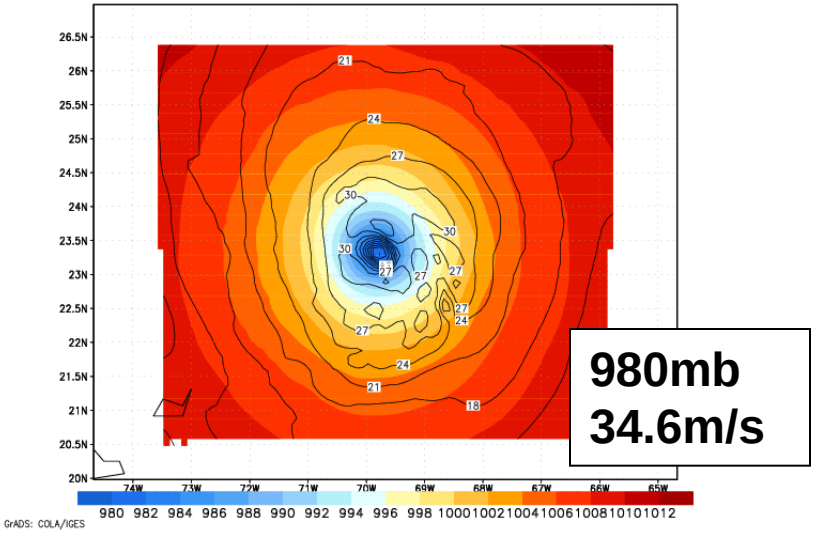
H209



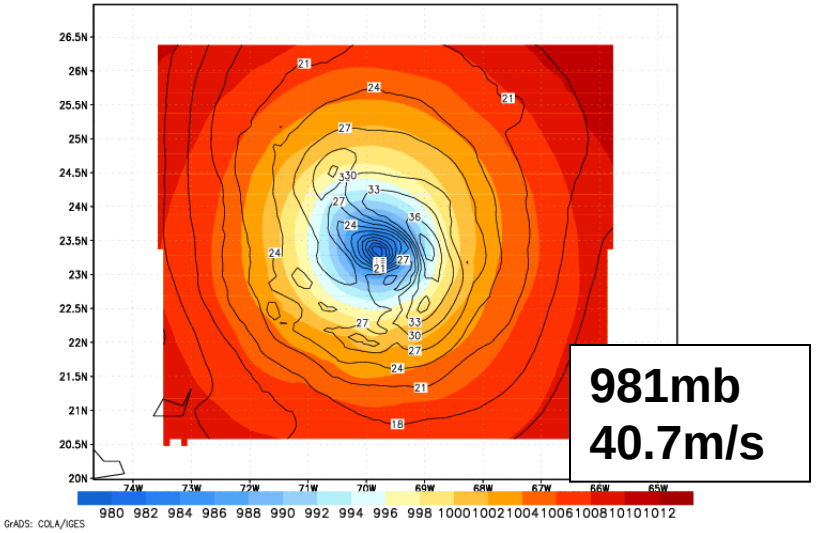
Lin cd



Dec cd

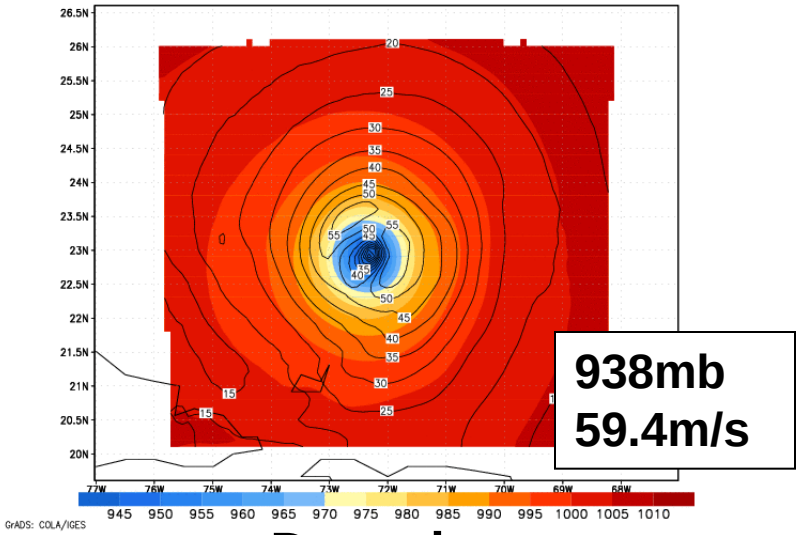


Inc cd

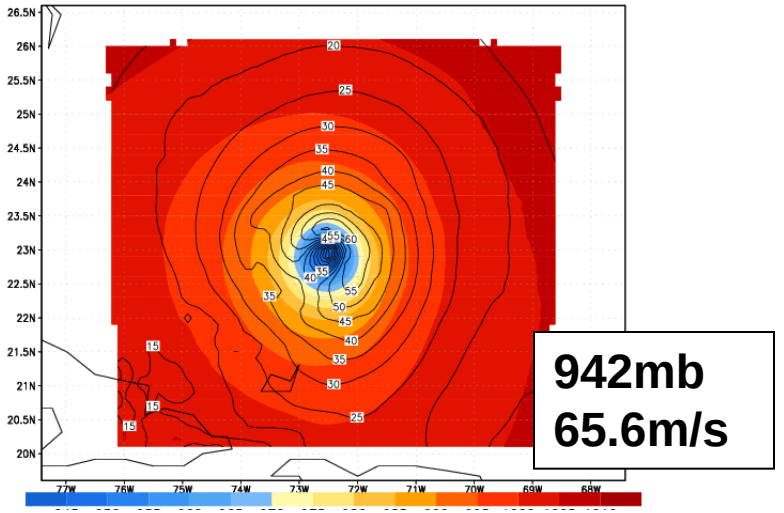


72hr Forecast (MSLP and 850mb wind speed)

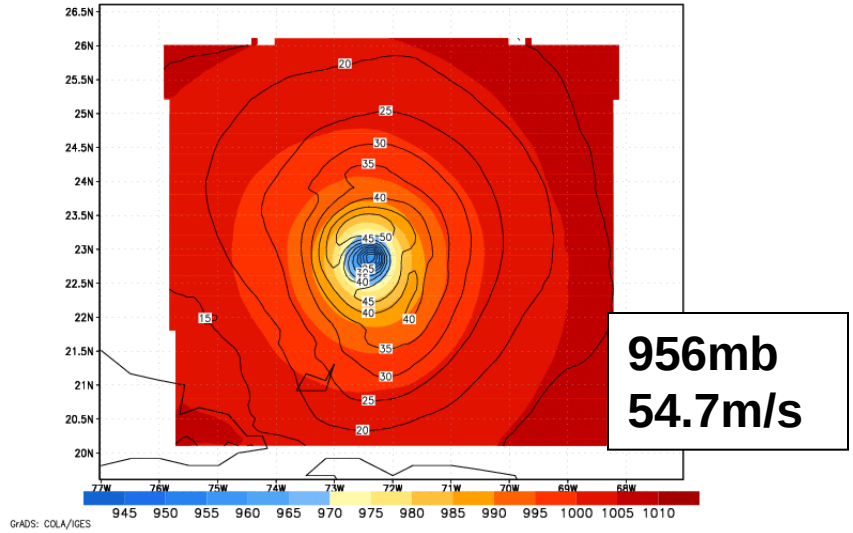
H209



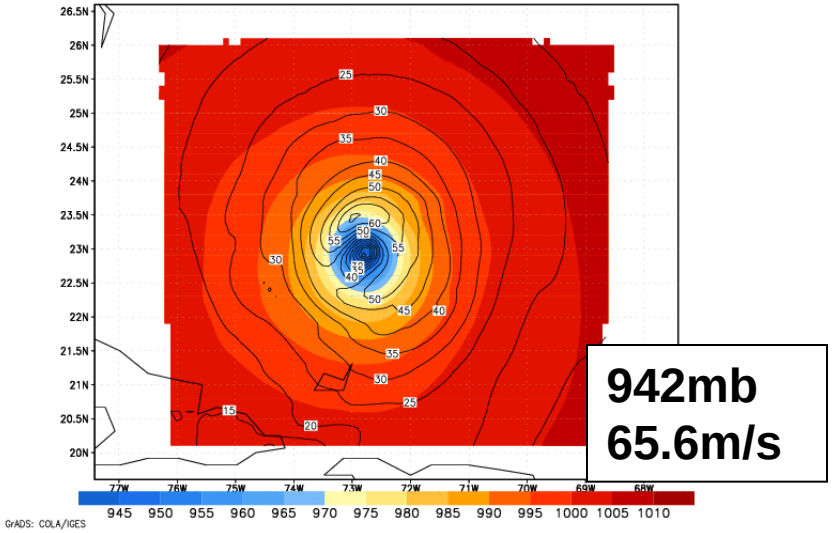
Lin cd



Dec cd



Inc cd



Future plan

1. **Conduct experiments using more Cd profiles with cycled simulation**
2. **After investigating the sensitivity of Cd to hurricane, examine the Ch sensitivity to hurricane forecast skill with Cd value fixed**
3. **Find the optimum combination of Cd/Ch values in order to produce most accurate HWRF's intensity and track forecast**
4. **Tune the surface exchange coefficients with inclusion of sea spray parameterization**

Spray effects on Cd and Ch