Final Report
HIWPP Task 3.1.2 Parameterization Development
Unified representation of turbulence and clouds
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A novel unified representation of sub-grid scale (SGS) turbulence, cloudiness, and shallow convection has been implemented into the NOAA NCEP Global Forecasting System (GFS) general circulation model. The approach, known as Simplified High Order Closure (SHOC), is based on predicting a joint PDF of SGS thermodynamic variables and vertical velocity and using it to diagnose turbulent diffusion coefficients, SGS fluxes, condensation and cloudiness, Unlike other similar methods, only one new prognostic variable, turbulent kinetic energy (TKE), needs to be introduced, making the technique computationally efficient.
SHOC is now incorporated into a version of operational GFS, as well as into the next generation of the NCEP global model - NOAA Environmental Modeling System (NEMS). Turbulent diffusion coefficients computed by SHOC are now used in place of those produced by the boundary layer turbulence and shallow convection parameterizations. Large scale microphysics scheme is no longer used to calculate cloud fraction or the large-scale condensation/deposition. Instead, SHOC provides these variables. Radiative transfer parameterization uses cloudiness computed by SHOC.

Figure 1 shows sea level pressure and precipitation fields on 0Z of October 24, 2012 (forecast hour 177) from a T2046L64 NEMS/SHOC run that also includes a new Chikira-Sugiyama deep convection scheme. Unlike the operational version of GFS, this run correctly predicts westward track of hurricane Sandy, and its consequent landfall in the NY/NJ area.
Outstanding problems include high level tropical cloud fraction being too high in SHOC runs, possibly related to the interaction of SHOC with condensate detrained from deep convection. We continue to work on improvement of NEMS/SHOC with the goal of having it operational in the 2018 implementation of NEMS.

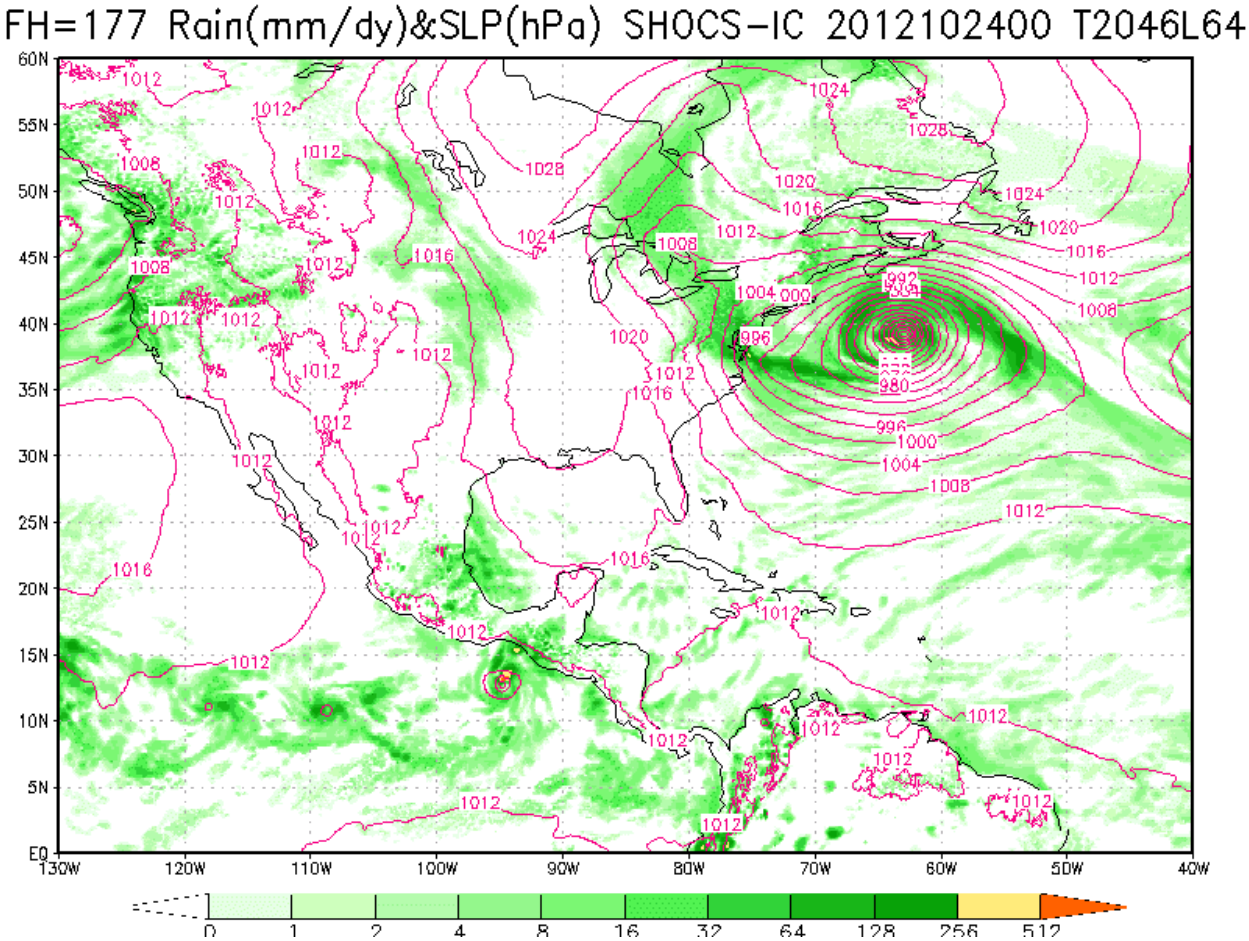
FH=177 Rain(mm/dy)&SLP(hPa) SHOCS-IC 2012102400 T2046L64
60N
55N
50N
45N
40N
35N
30N
25N
20N
15N
10N
5N
EQ
130W
120W
110W
100W
90W
80W
70W
60W
50W
40W
0
1
2
4
8
16
32
64
128
256
512

Figure 1.