

Application of the meso-SAS scheme to HWRF model: Preliminary Results

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Outline

- Problems in current HWRF model
- What the meso-SAS scheme can do in HWRF model?
- Preliminary results
- Discussions and future work

Problems in current HWRF model

- **Small weak storms have large negative intensity bias**

The intensification of small weak storms are slow, and may even fall apart in some cases. These small weak storms are mainly confined to the third nest (which uses explicit microphysics), and are dominated by the explicit microphysics. At 3km, the vertical velocity is small in HWRF model, and the boundary layer moisture convergence does not generate enough CAPE to sustain the convection.

- **Strong storms have large positive intensity bias**

This intensity bias is connected to the grid-scale convection. Generally speaking, explicit microphysics is prone to grid-scale convection, and the grid scale convection can produce very strong small size storms. In HWRF model, the grid-scale convection is enhanced due to the moisture convergence from the second nest (where SAS scheme is used, and the storm size is larger compared to the third nest).

What the meso-SAS scheme can do in HWRF model?

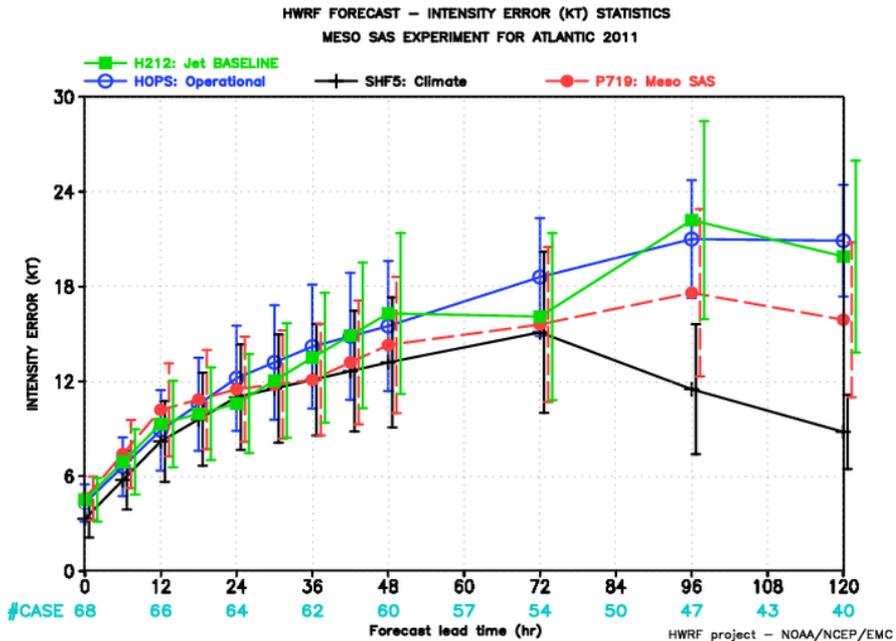
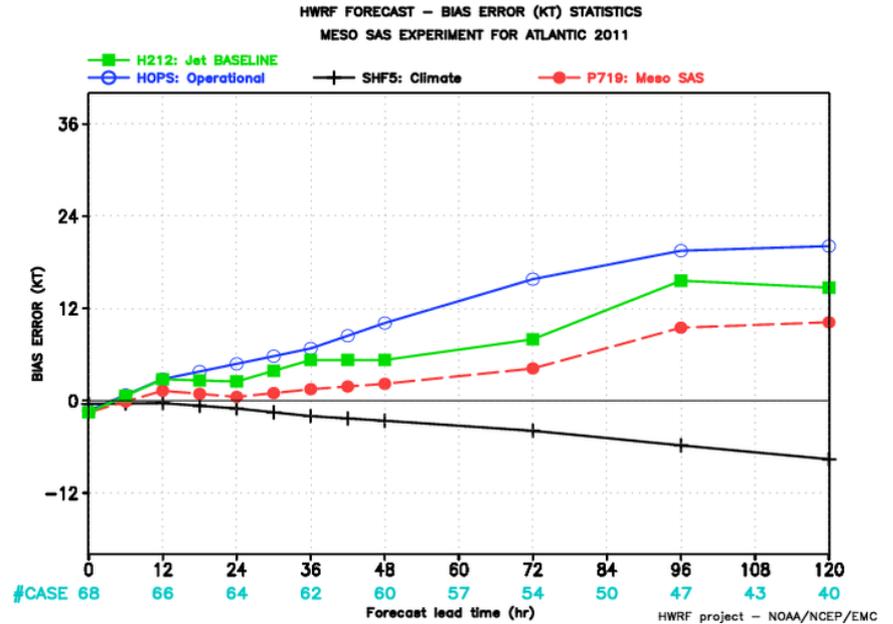
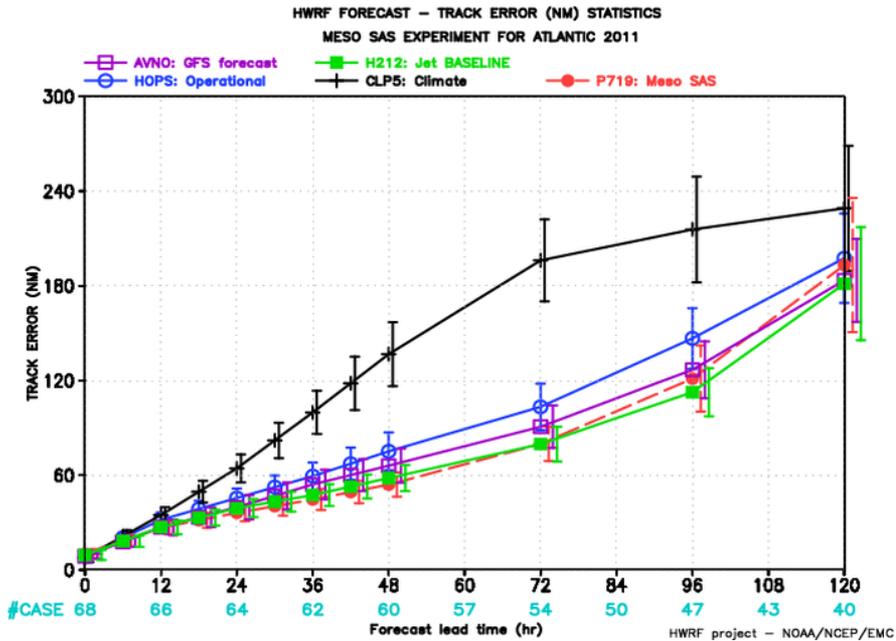
- Increase the intensity of weak storms
- Decrease the intensity of strong storms (reduce the intensity overshoot)

Compare to observation, we have the following problems:

- Explicit microphysics used at 3km model resolution
 - Storm size is small (may be related to grid scale convection)
 - Intensification is slow (the vertical velocity may not be large enough)
 - If intensified, storm tends to have significant overshoot (related to grid scale convection)
- Operational SAS scheme (Not designed to use at high model resolution)
 - Storm size is reasonable (may be too large in HWRF, need further verification)
 - Intensification is too fast for some storms
 - If intensified, some weak storms tend to become too strong
- Meso-SAS (designed to use at all model resolutions)
 - Storm size will fall within the two limits (explicit vs operational SAS)
 - Intensification rate will fall within the two limits
 - Weak storms are easier to intensify. Strong storms have less overshoot

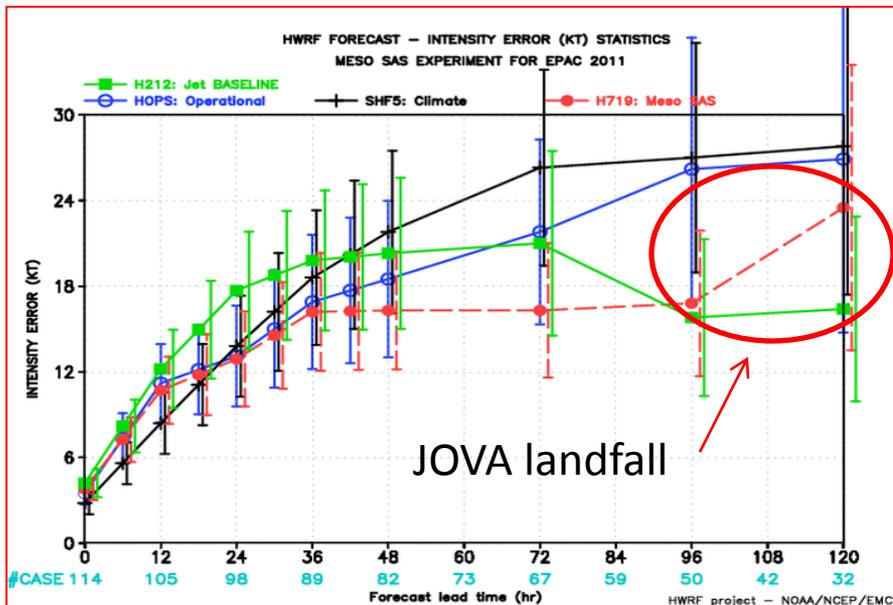
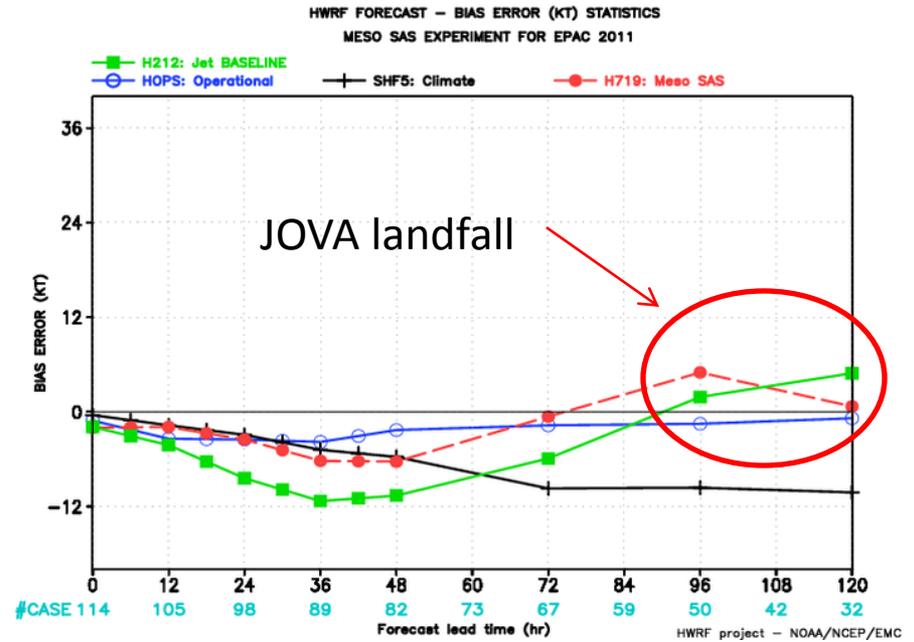
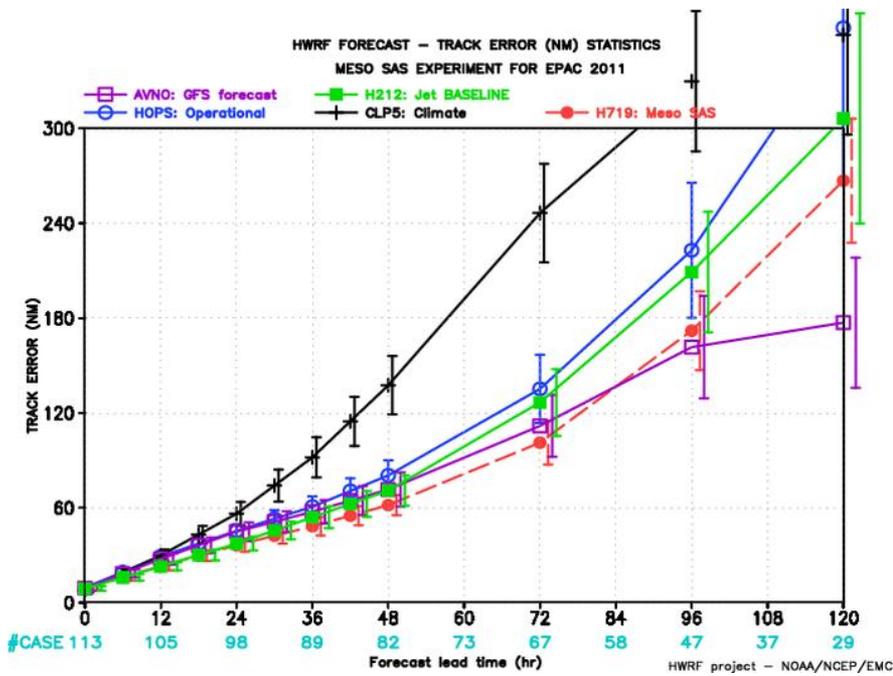
Preliminary results:

- Use 2012 operational HWRF configuration, only replace the SAS scheme with the meso-SAS, and turn on the meso-SAS scheme in the third nest (2012 operational HWRF uses explicit microphysics in third nest)
- Storms tested: 2011 hurricane season
 - Atlantic: IRENE(09L) and KATIA (12L) (strong storms)
 - East Pac: DORA(04E), EUGENE (05E), HILARY (09E) and JOVA (10E)
- Experiments:
 - H719 (or P719): meso-SAS
 - H212: Baseline (2012 operational version)
 - HOPS: 2011 operational HWRF



Atlantic Storms: 09L and 12L

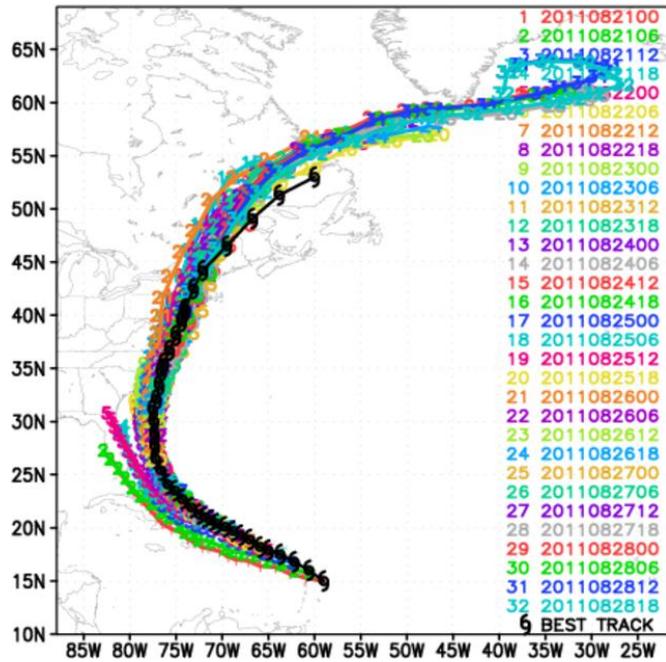
- Track slightly degraded after 72h
- Intensity improved after 30h
- Positive intensity bias reduced



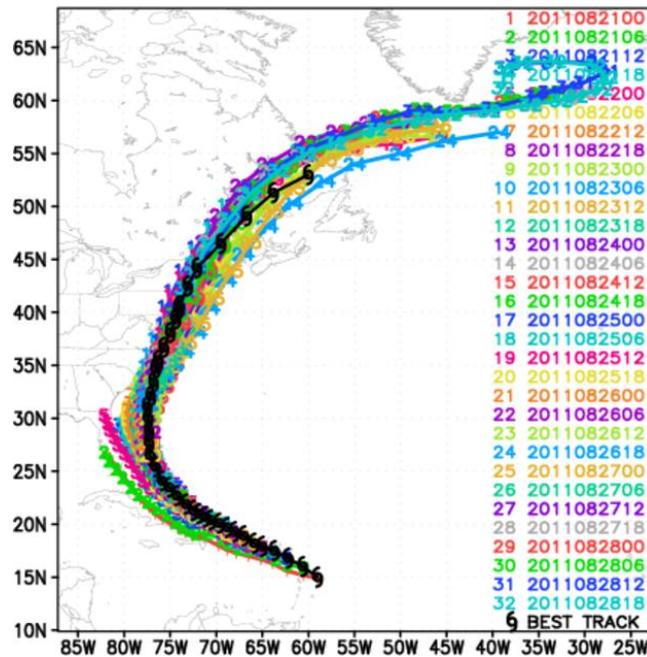
East Pac Storms: 04E, 05E, 09E and 10E

- Track improved
- Intensity improved except at 120h (caused by the wrong timing of hurricane JOVA landfall)
- Storms become stronger

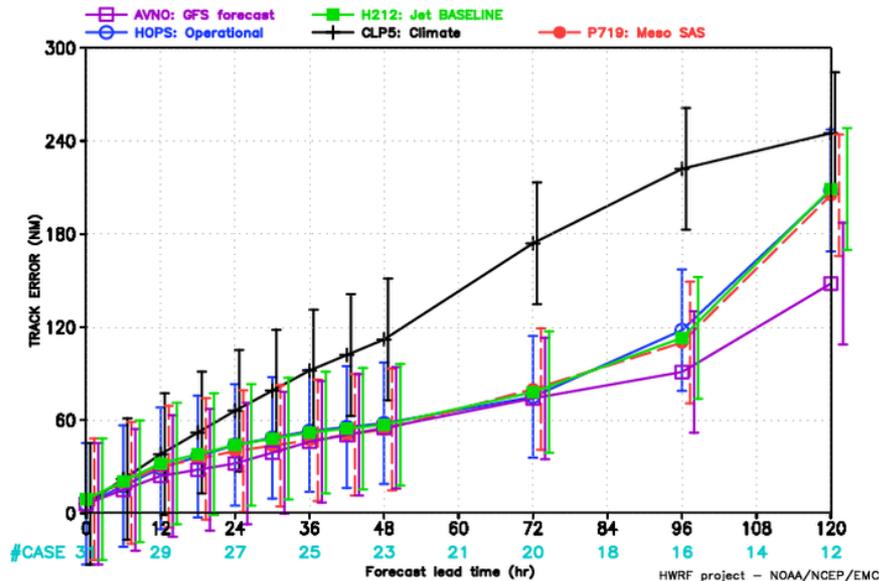
H719 forecast: IRENE (a1092011)



H212 forecast: IRENE (a1092011)



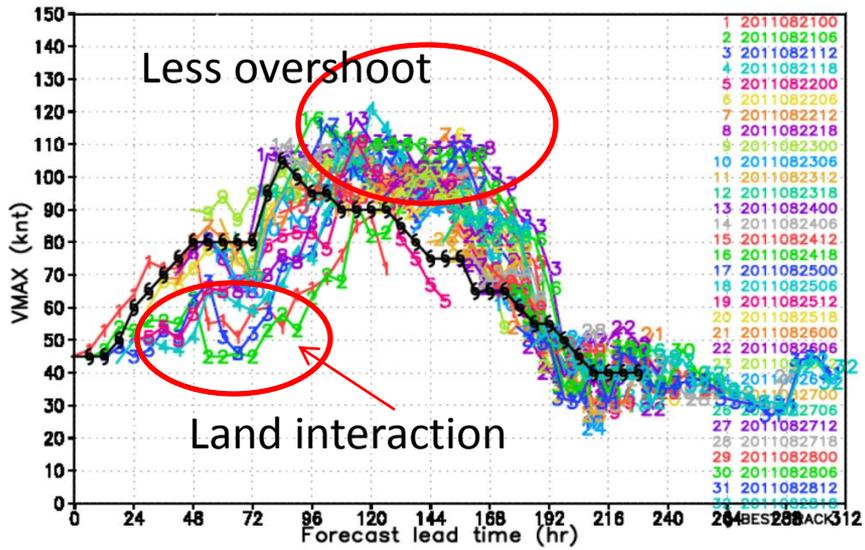
HWRP FORECAST - TRACK ERROR (NM) STATISTICS
STATISTICS FOR A SINGLE CASE - a1092011_IRENE



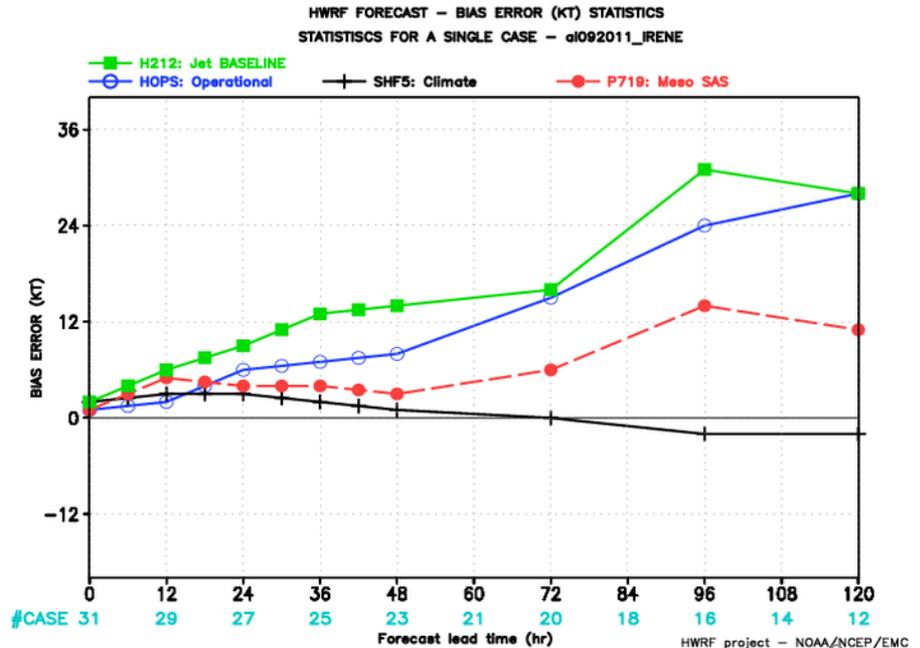
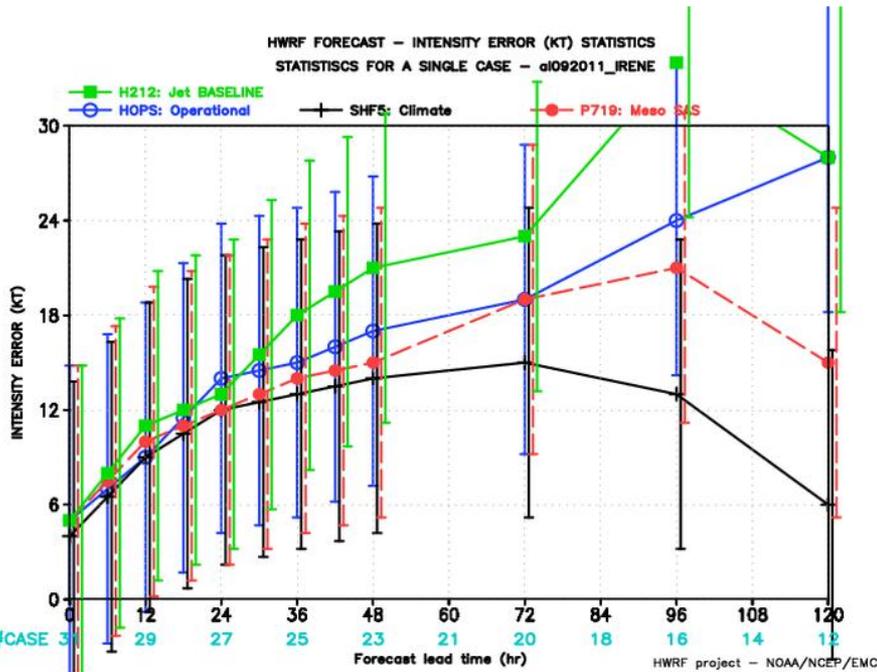
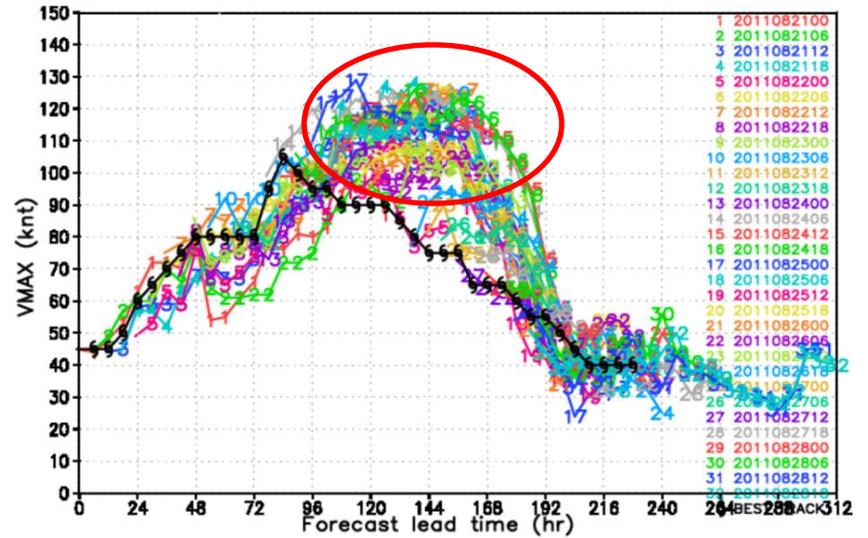
Hurricane IRENE (09L)

- Track basically same
- Intensity improved (page 9)

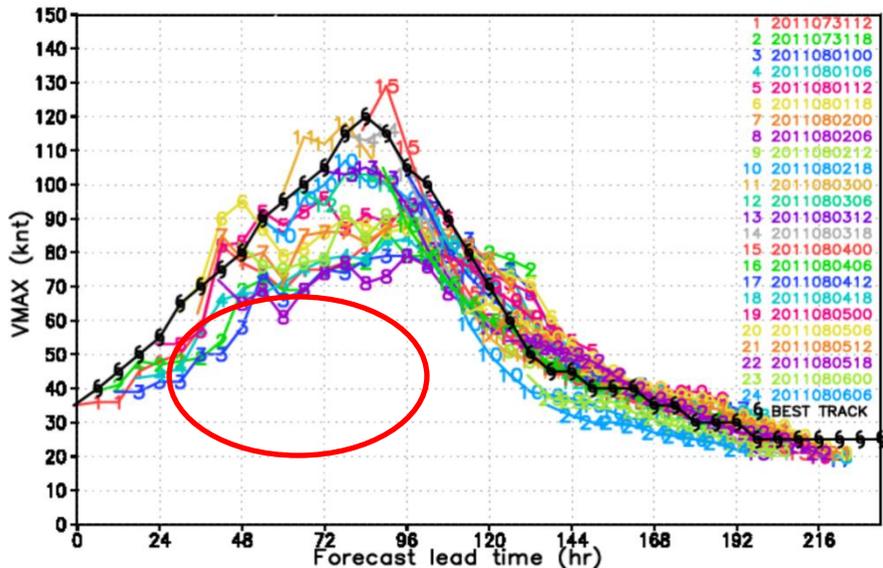
H719 forecast: IRENE (aI092011)
Maximum 10-m wind time series



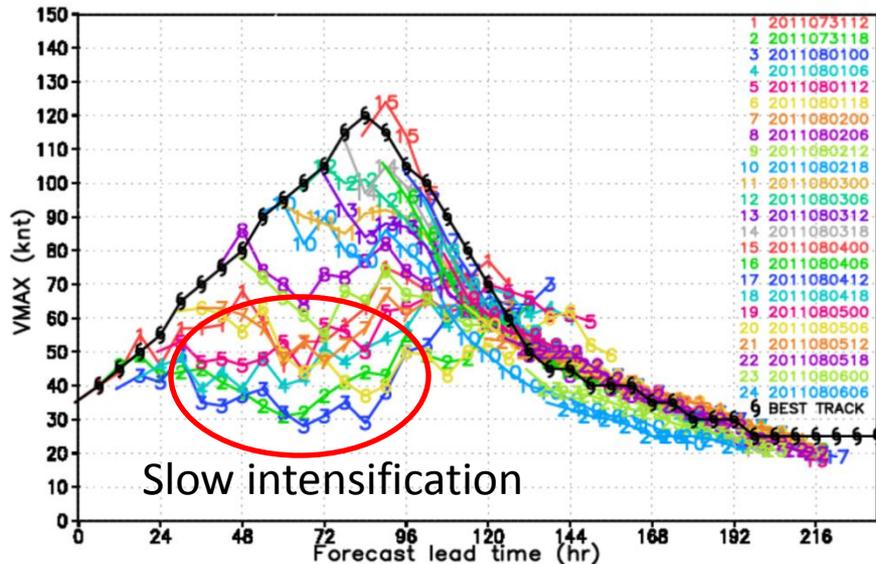
H212 forecast: IRENE (aI092011)
Maximum 10-m wind time series



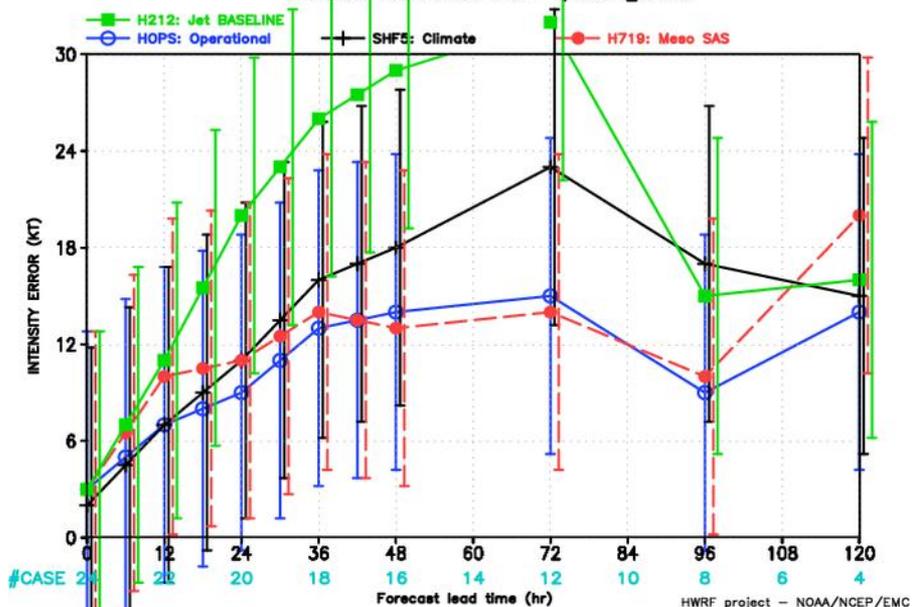
H719 forecast: EUGENE (ep052011)
Maximum 10-m wind time series



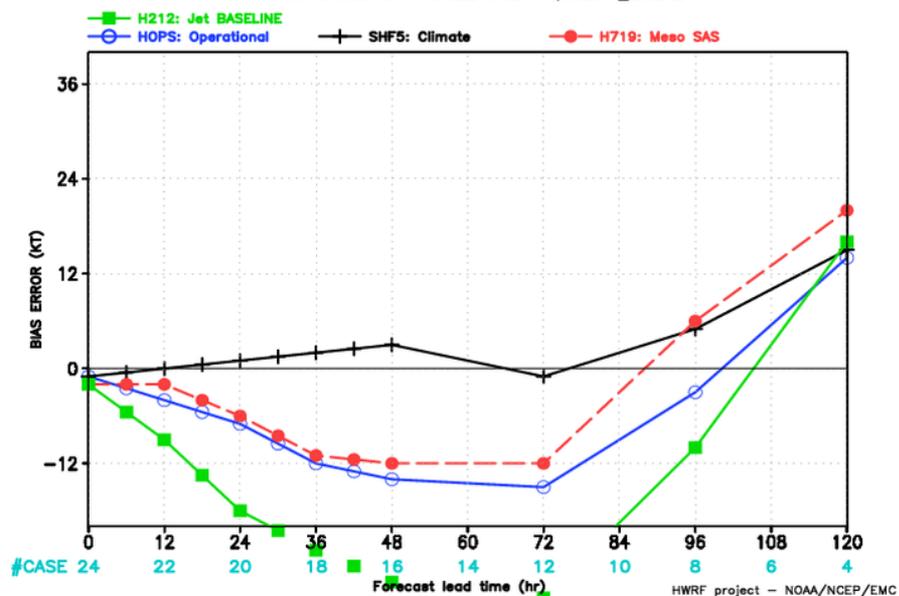
H212 forecast: EUGENE (ep052011)
Maximum 10-m wind time series



HWRP FORECAST - INTENSITY ERROR (KT) STATISTICS
STATISTICS FOR A SINGLE CASE - ep052011_EUGENE

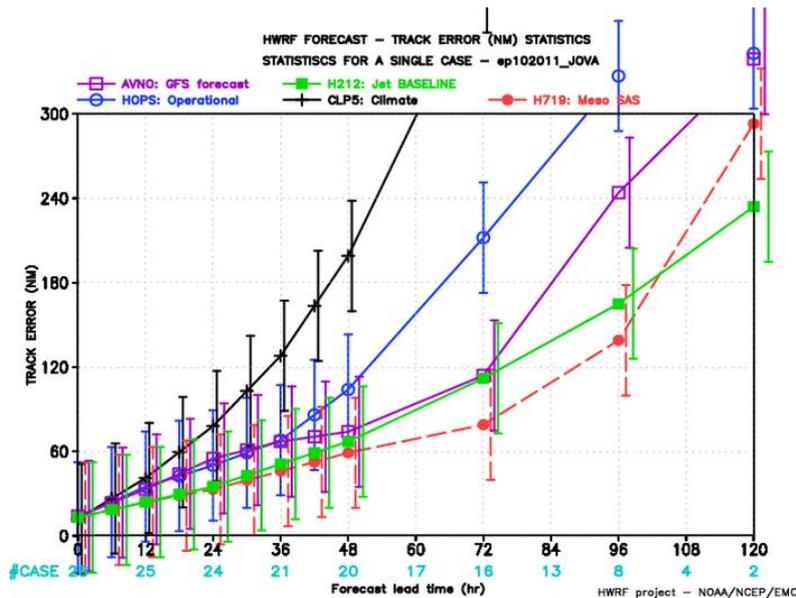
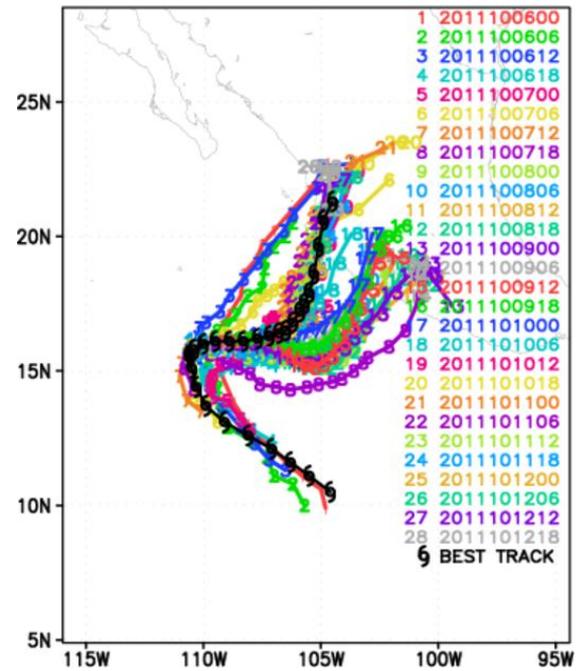
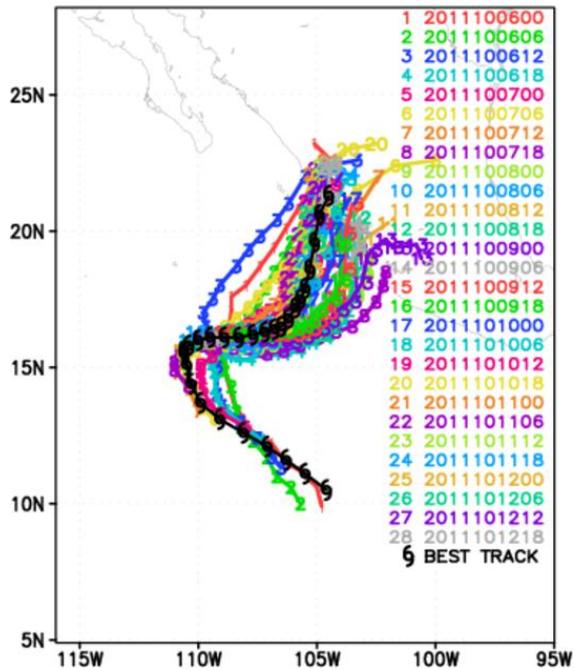


HWRP FORECAST - BIAS ERROR (KT) STATISTICS
STATISTICS FOR A SINGLE CASE - ep052011_EUGENE



H719 forecast: JOVA (ep102011)

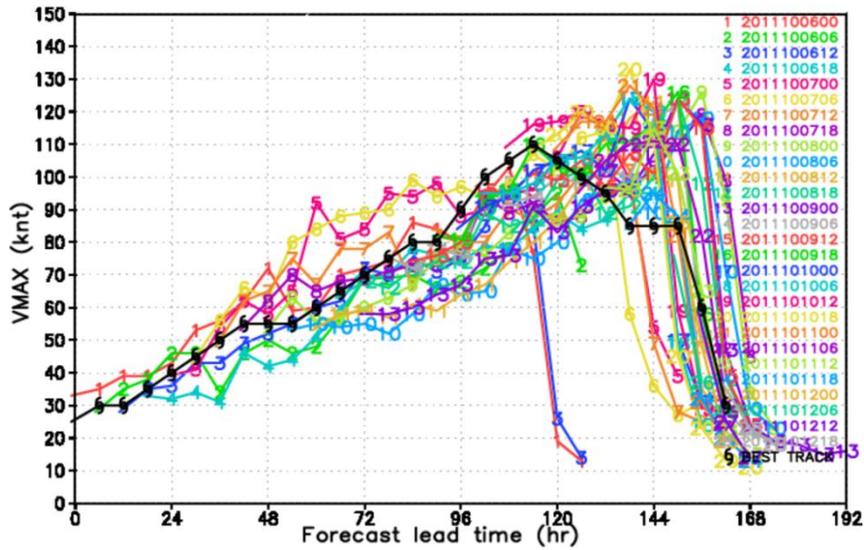
H212 forecast: JOVA (ep102011)



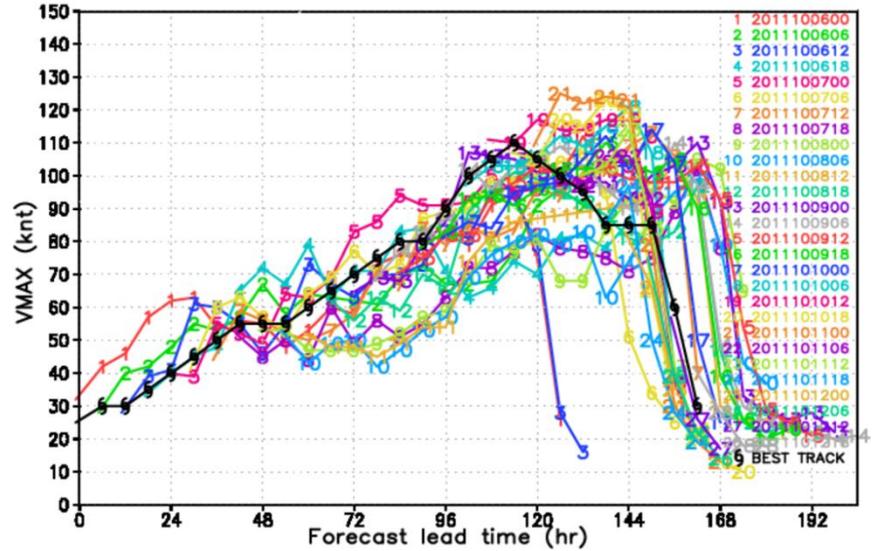
Hurricane JOVA (10E)

- Track improved before 96h and degraded at 120h
- Intensity degraded at 120h due to the wrong timing of landfall (page 13)

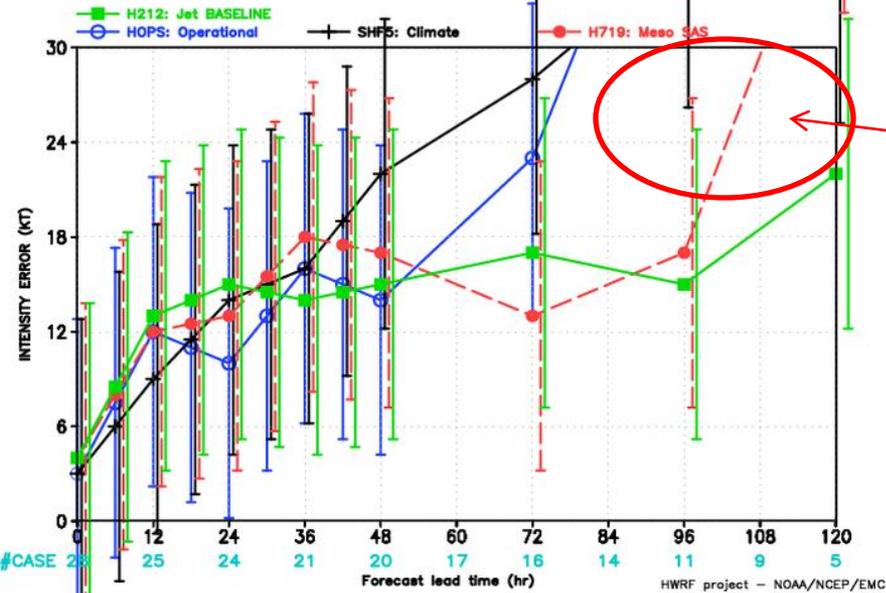
H719 forecast: JOVA (ep102011)
Maximum 10-m wind time series



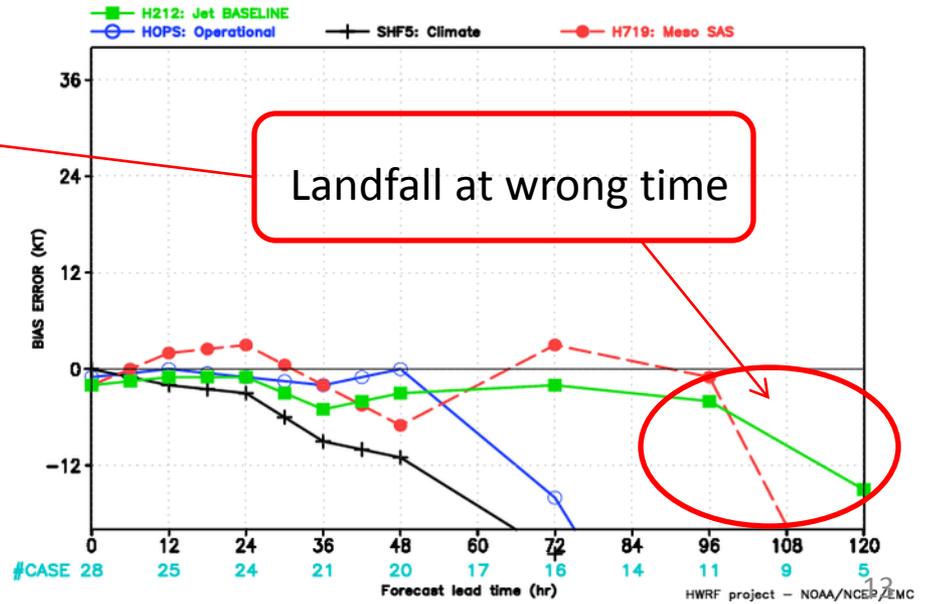
H212 forecast: JOVA (ep102011)
Maximum 10-m wind time series



HWRP FORECAST - INTENSITY ERROR (KT) STATISTICS
STATISTICS FOR A SINGLE CASE - ep102011_JOVA



HWRP FORECAST - BIAS ERROR (KT) STATISTICS
STATISTICS FOR A SINGLE CASE - ep102011_JOVA



Discussions and future work

- The meso-SAS scheme is developed not just for hurricane models, it is for all numerical models.
- The meso-SAS scheme, if used in coarse grid ($>10\text{km}$), produces the same results as the current operational SAS scheme. If it is used in high resolution models, the impact of the subgrid scale convection will be reduced. As sigma (fraction of the updraft area in model grid) approaches 1.0, the meso-SAS scheme will be automatically turned off, and the model will use explicit microphysics
- In current HWRF model, sigma is small (due to small vertical velocity), and the meso-SAS scheme behaves similar to the current operational SAS. Three major problems identified: 1) some of the weak storms become too strong. 2) track and intensity forecasts are degraded for some strong storms. 3) current meso-SAS code may have computational problem when sigma is large
- We need to adjust some parameters and do more tests. There is a potential that the meso-SAS scheme can produce much better intensity forecast (without degrading the track forecast) in HWRF model.