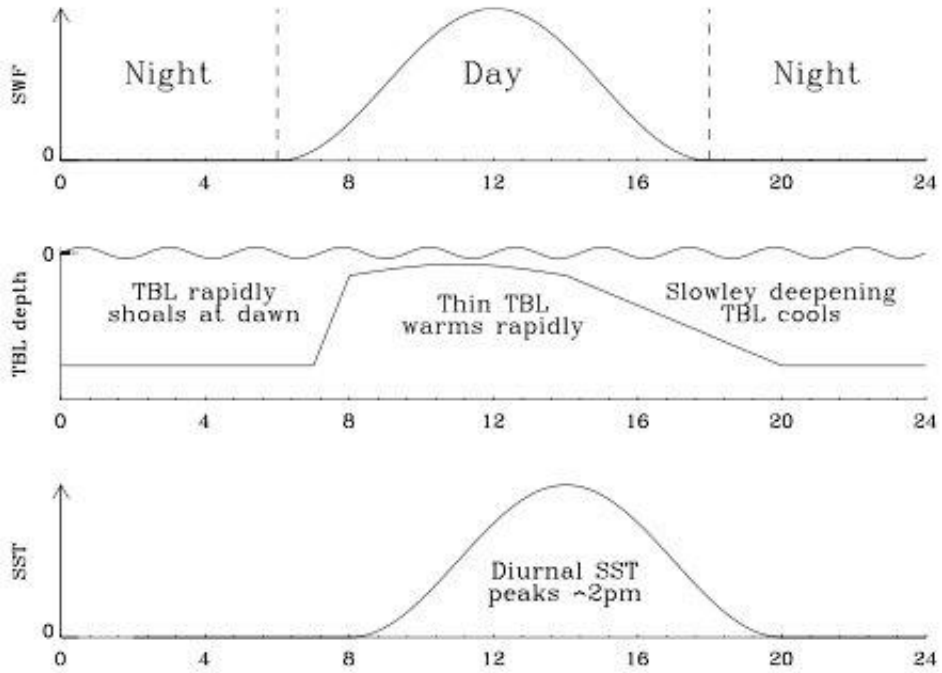
Influence of diurnal forcing on operational forecasts of surface conditions in the northwest Atlantic Ocean

Nathalie Toque, David Straub : McGill University, Atmospheric and Oceanic sciences Dept
Greg Smith, Fraser Davidson : Fisheries and Oceans Canada, NAFC

Response of the ocean to diurnal forcing

Bernie, D.J. et al. 2005 and 2007



The boundary layer is the set of a competition between the vertical turbulent mixing which weakens stable density stratification and processes which lead to an increase in density stratification.

Positive contribution

Short Wave Radiation

Negative contributions

Cooling

Shearing turbulence (wind)

Convection

The balance determines the depth of the turbulent boundary layer and its temperature.

Numerical model and analysis strategy

Numerical model (cnoofs_v1)

Ocean model: NEMO/OPA 2.3
Ice model: LIM2
Resolution: ¼ deg global (20 km)
Initialization: Model restarted from MERCATOR analyses
Forcing: GEM global (33km), using core bulk formula
Our output frequency: 3D fields, 3hrs and 24hrs

Analysis strategy

Simulations done with two resolutions

- Radiative forcing, 3 hrs and 24 hrs
- Output frequencies, 3 hrs and 24 hrs

Comparison between the SST and the depth of the TBL as Bernie et al. 2005

- To select relevant locations, map of the variation *(maxT-minT)/day* averaged over 43 days
- Plots of the SST and the depth of the TBL at chosen coordinates

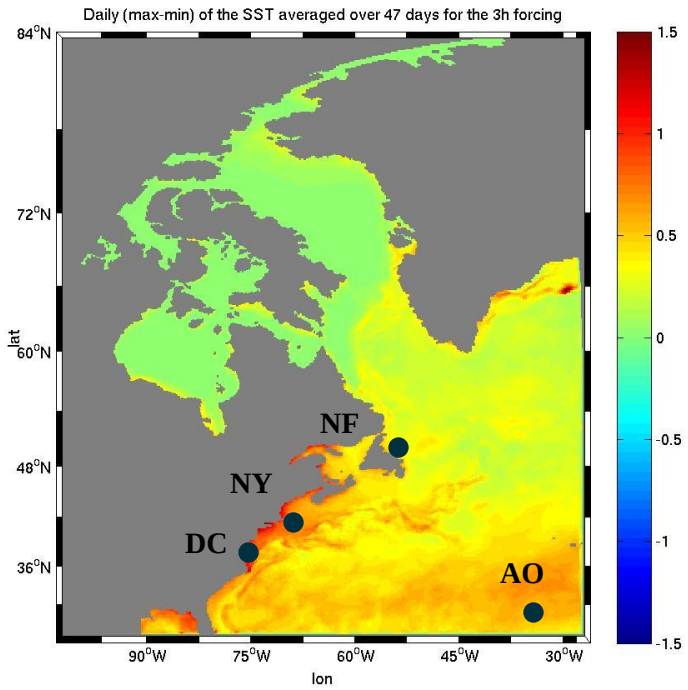
Comparison between the variability of the SST and of the modulus of the SC at chosen coordinates

- *Variability = 3hrs forcing run - 24 hrs radiatively forced run*

Interpretation at two specific locations from NCEP data

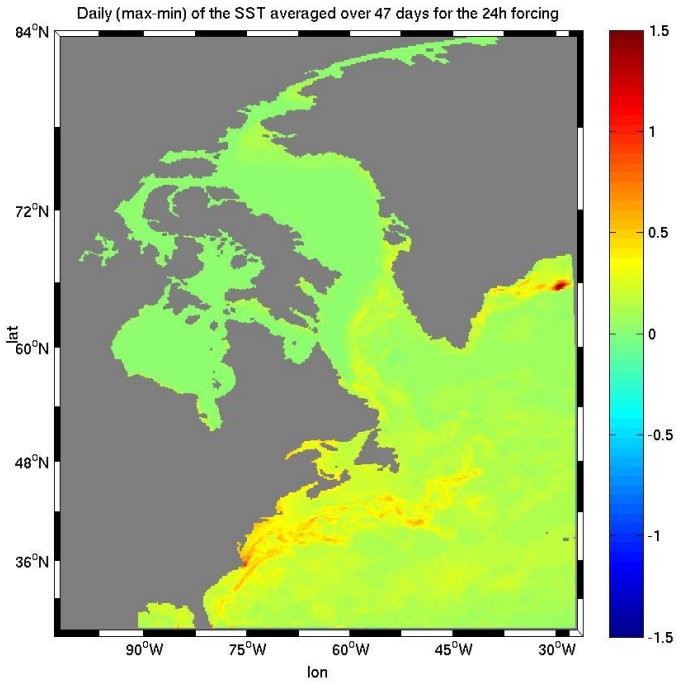
Map of the variation (maxT-minT)/day averaged over 43 days

Radiative forcing with 3 hrs resolution



AO: 38W33N, NF: 56W50N
DC: 75W38N, NY: 68W42N

Radiative forcing with 24 hrs resolution



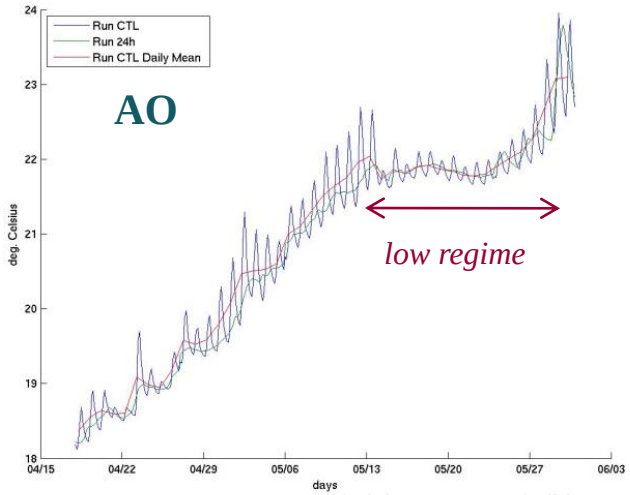
The removal of the short wave component of the radiative forcing eliminates spots in the middle of Atlantic ocean and along the cost

Comparison between the SST and the depth of the TBL as Bernie et al. 2005

38W33N and 56W50N

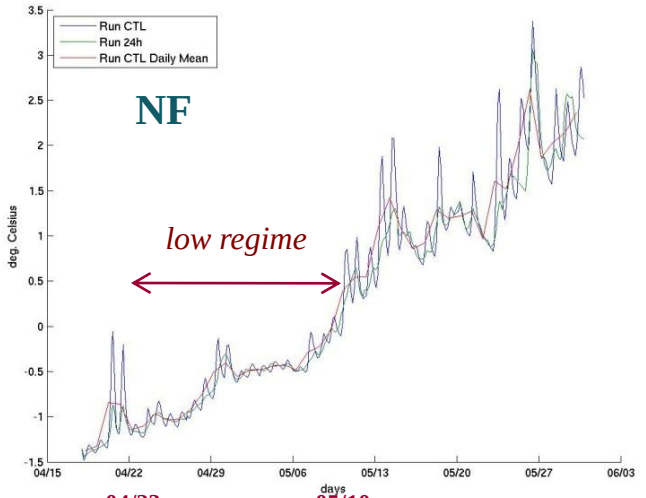
Run CTL, 3 hrs forcing resolution
Run 24hrs forcing resolution
Run CTL, daily mean

SST versus time at coordinates **38W33N**



05/13 **05/28**

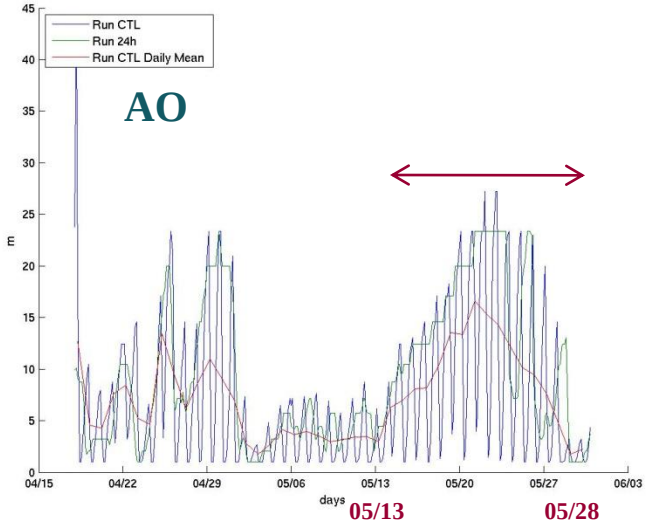
SST versus time at coordinates **56W50N**



04/22 **05/10**

TBL versus time at coordinates **38W33N**

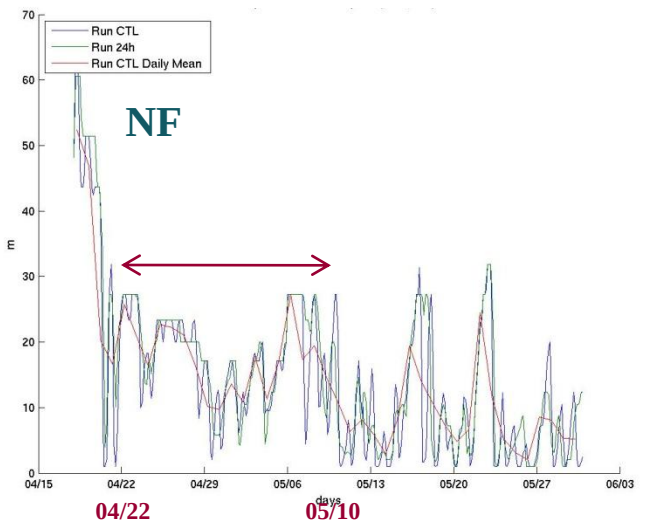
25 m



05/13 **05/28**

TBL versus time at coordinates **56W50N**

30 m



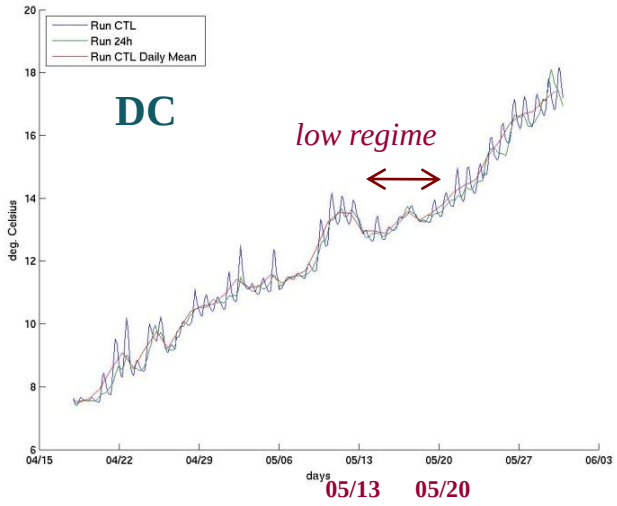
04/22 **05/10**

Comparison between the SST and the depth of the TBL as Bernie et al. 2005

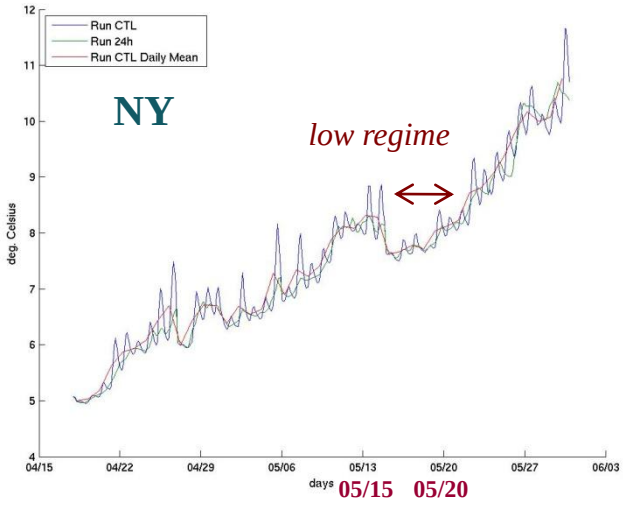
75W38N and 68W42N

Run CTL, 3 hrs forcing resolution
Run 24hrs forcing resolution
Run CTL, daily mean

SST versus time at coordinates **75W38N**

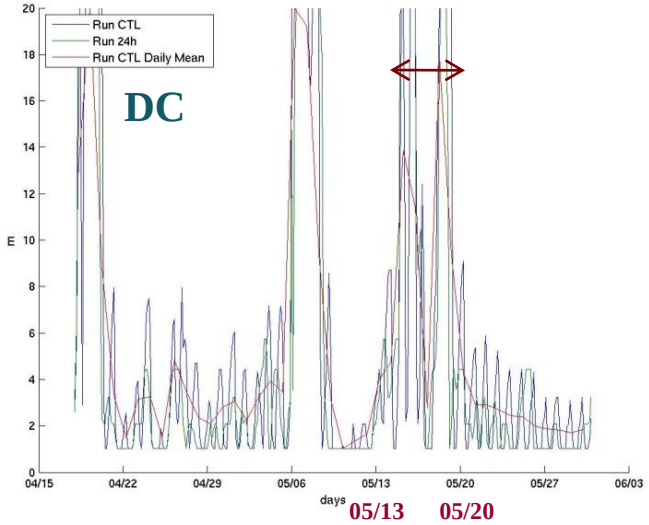


SST versus time at coordinates **68W42N**



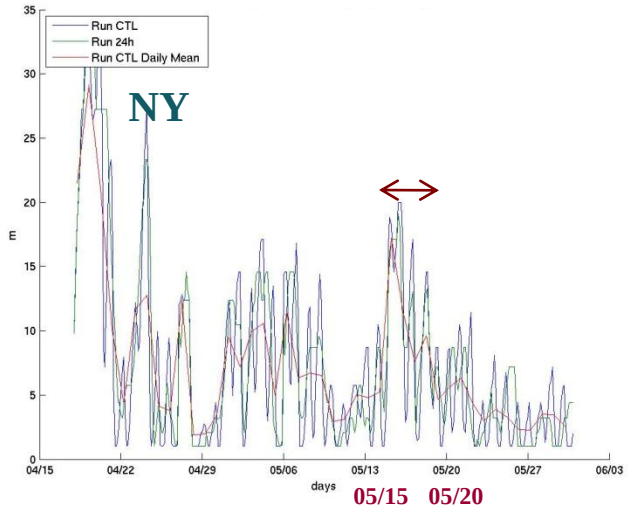
TBL versus time at coordinates **75W38N**

20 m



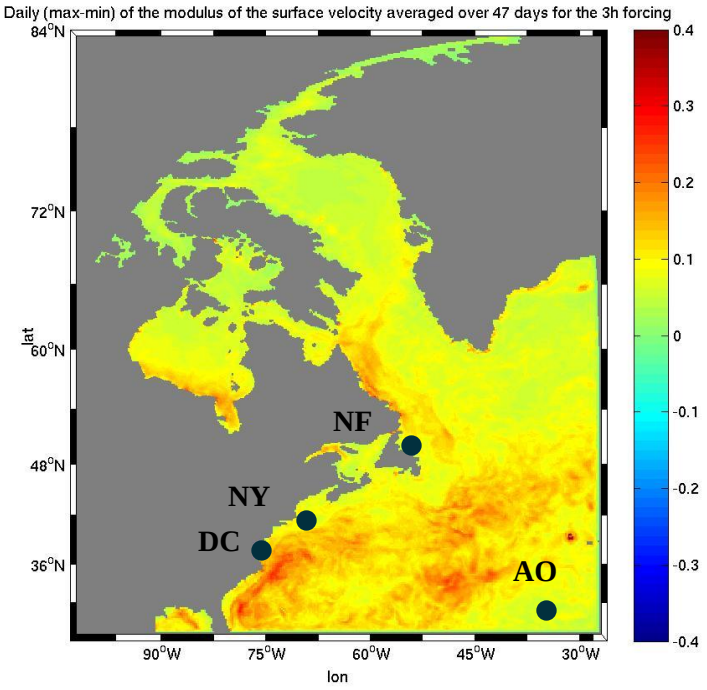
TBL versus time at coordinates **68W42N**

20 m



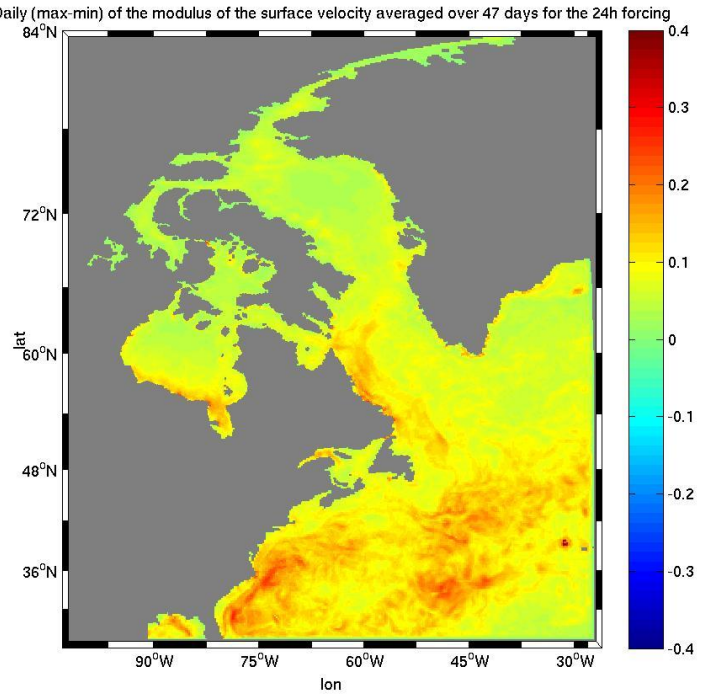
Map of the variation (max$\|u_h\|$-min$\|u_h\|$)/day averaged over 43 days

Radiative forcing with 3 hrs resolution



AO: 38W33N, NF: 56W50N
DC: 75W38N, NY: 68W42N

Radiative forcing with 24 hrs resolution

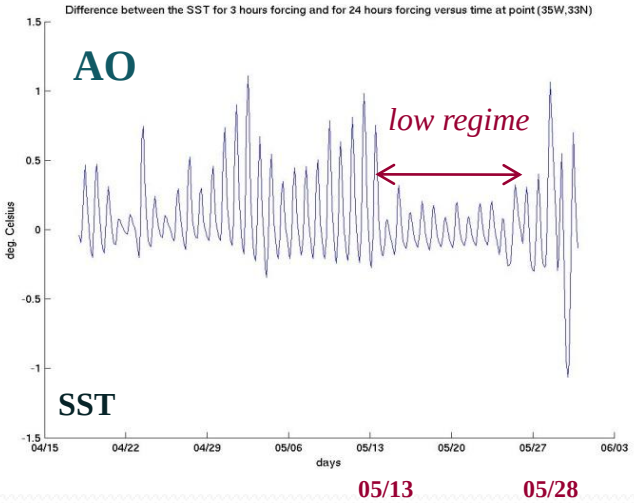


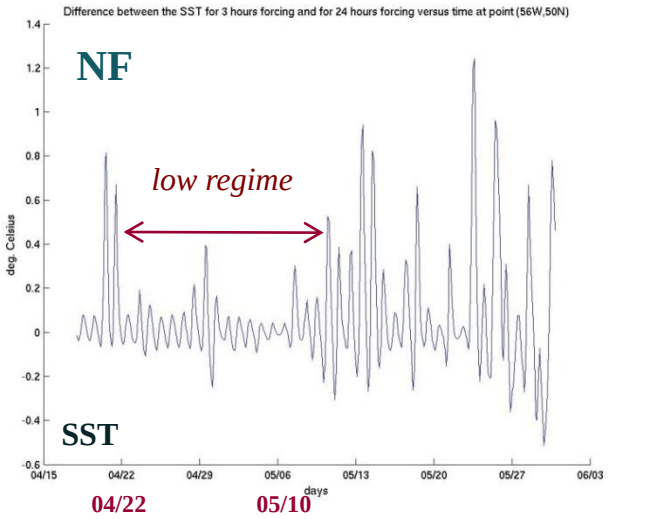
Overview of the response of the momentum equations to the elimination of the short wave radiative component.

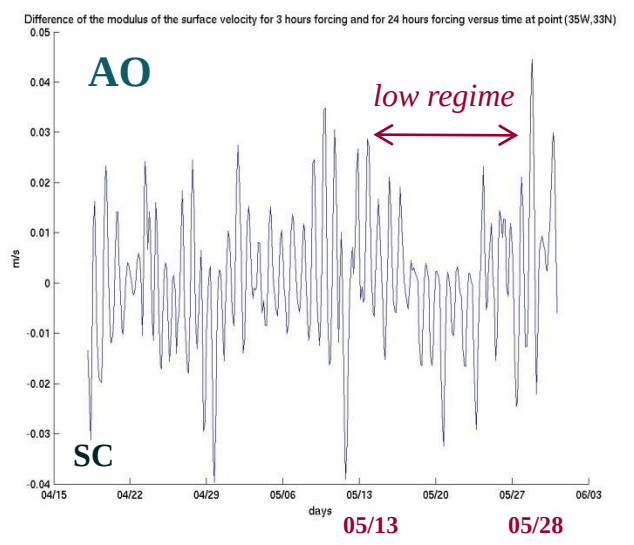
On average not much difference between the two maps

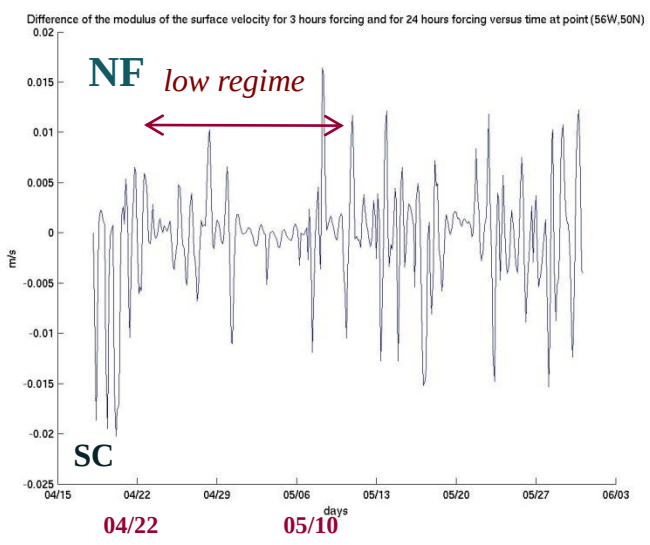
Comparison between the variability of the SST and of the modulus of the SC

variability **=3hrs forcing run - 24 hrs radiatively forced run**





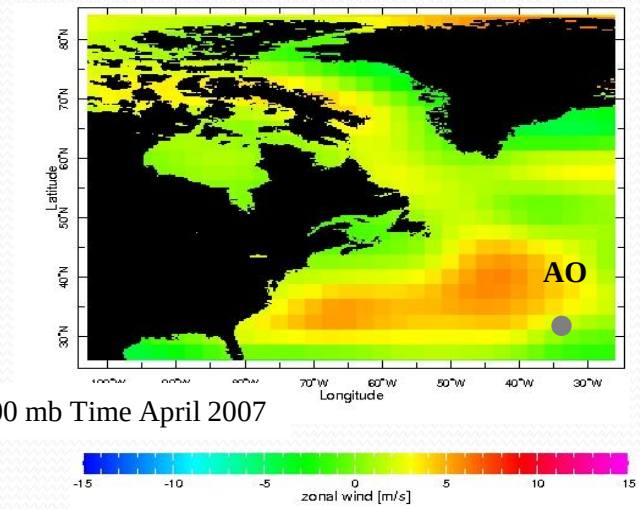




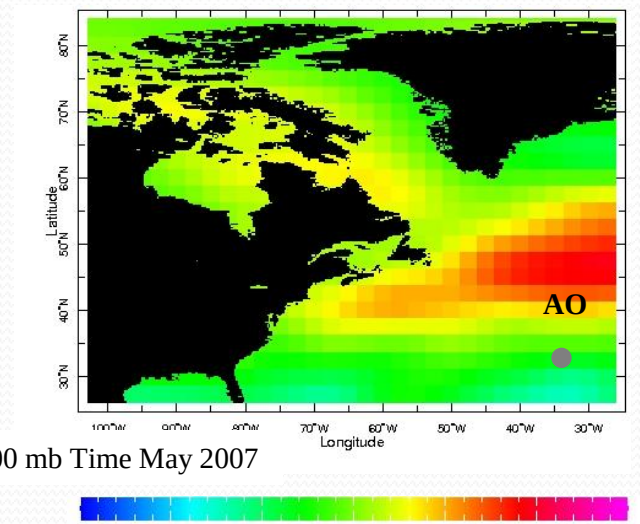
Interpretation at coordinates 38W33N and 56W50N from monthly NCEP data

Courtesy of Prof.Tremblay

Zonal wind (m/s)

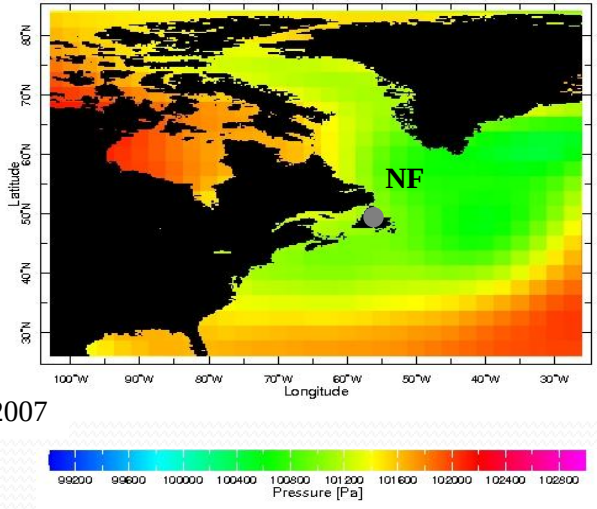


Pressure 1000 mb Time April 2007

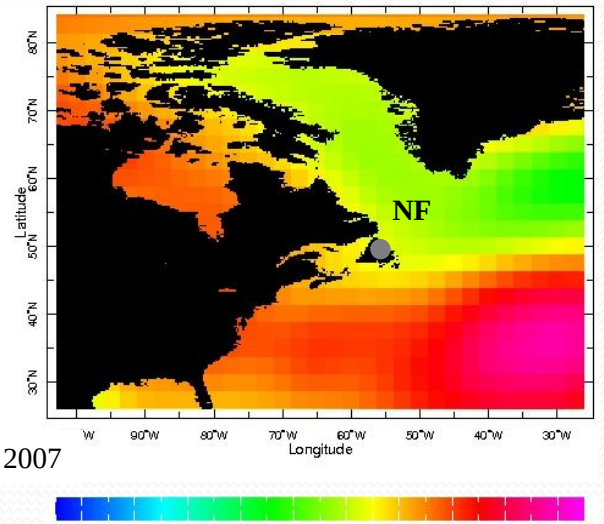


Pressure 1000 mb Time May 2007

Pressure (Pa)



April 2007

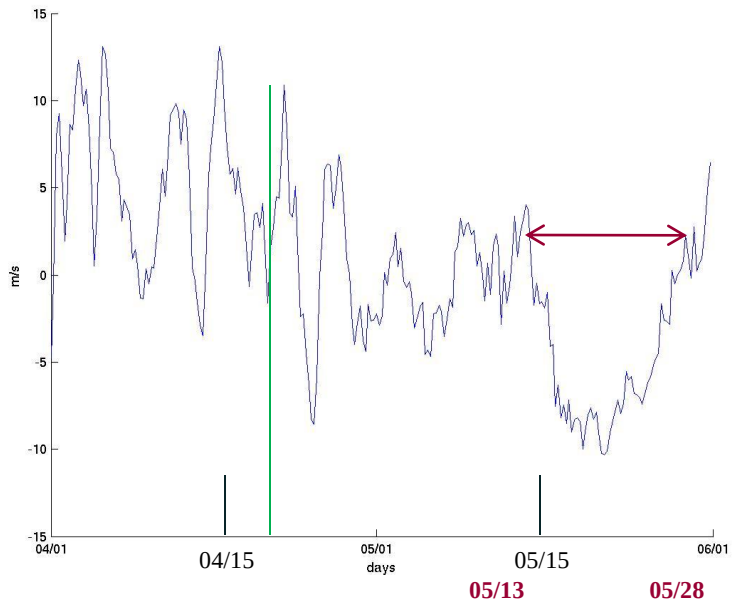


May 2007

Interpretation at coordinates 38W33N and 56W50N from daily NCEP data

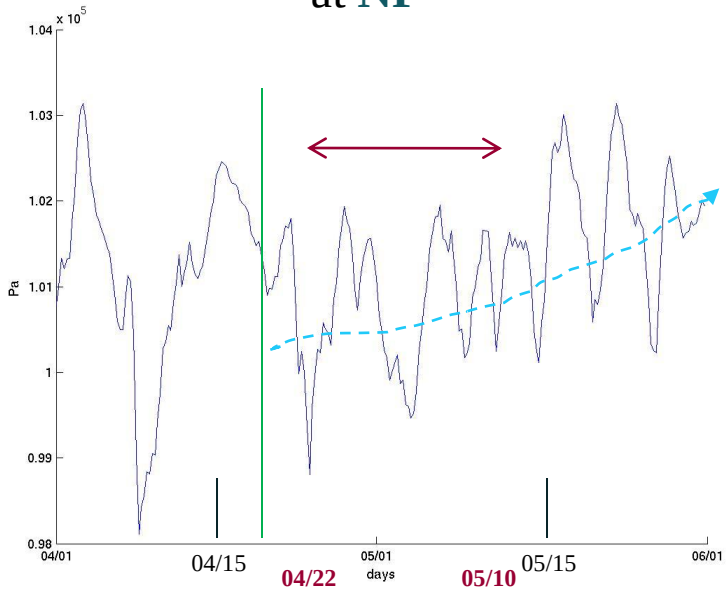
Courtesy of Dr.Atallah

Zonal wind (m/s) at **AO**



Recast 2007: 43 days

Pressure (Pa) at **NF**



Recast 2007: 43 days

Conclusion

For the 3 hrs forcing resolution, the response of the numerical code cnoofs_v1 to the diurnal cycle shows pretty well the predicted correlations between the SST, the depth of the TBL and the surface current, not only at low latitude but also at middle latitude.

Perspective

This work is an encouraging preliminary to the project of analysis of big samples like the one year sample of François Roy from CDC Dorval in order to estimate, *qualitatively and quantitatively*, on long time scales the impact of diurnal forcing over northwest Atlantic Ocean.