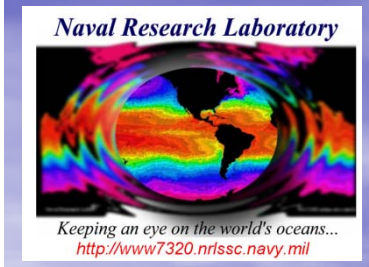

Impact of Assimilating SSH on Dynamics of the Gulf Stream

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Presented at
OSTST Meeting Lisbon
19 October, 2010

Modeling the Gulf Stream, its separation from the coast, open ocean pathway and transport represent a major challenge for Ocean General Circulation Models

- In today's talk, I want to present results from a set of twin experiments using the NRL global HYCOM OGCM looking at the behavior of the Gulf Stream (GS), in particular the separation from the coast and the open ocean pathway to the east
- Based upon idealized studies recently published by Hurlburt and Hogan (DAO,2008), Deep Western Boundary Current (DWBC) and eddy-driven abyssal flows help steer the GS
- The current 1/12 global HYCOM has a weak upper ocean and deep eddy field and lacks to deep mean flows to help steer the GS
- Increasing the resolution of the model increases the upper ocean and deep eddy field and generates a robust deep mean flow
- Lastly, assimilation of altimetric sea surface height (SSH) is as effective as increasing the resolution in driving a robust abyssal circulation to steer the GS and impacts the GS forecasts

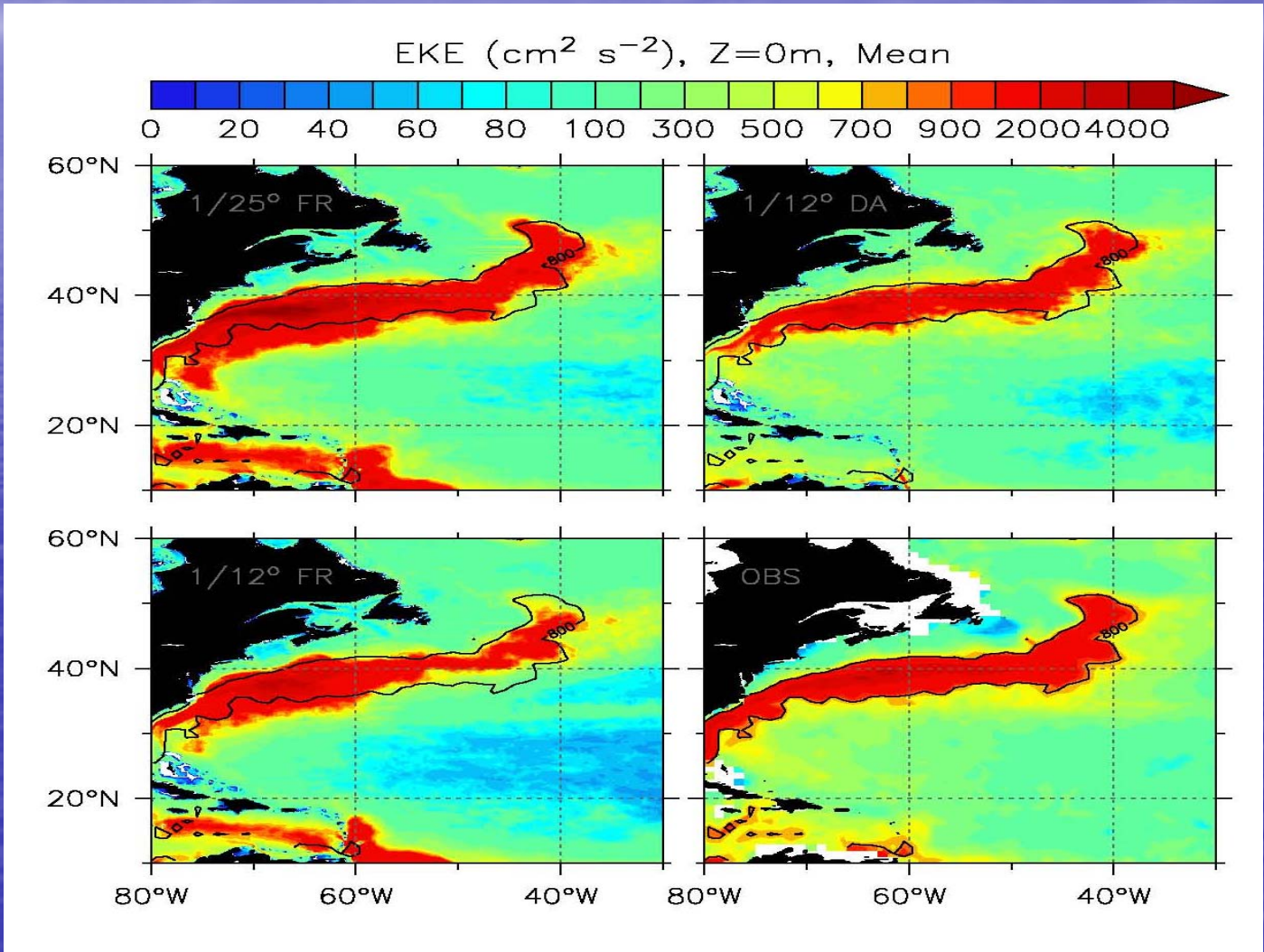
Application of the dynamical evaluation to eddy-resolving ocean general circulation model simulations

- Twin experiments in the global model:
  - Changing resolution 1/12 to 1/25
  - Assimilating data
  - EKE increases in the surface and deep water for both data assimilation and resolution increase
- Twin experiments using different data assimilation techniques
  - Cooper-Haines layer adjustment
  - MODAS synthetic profiles
  - Both techniques show similar improvements with better pathways, greater penetration of the Stream to the east, increased MOC, increased EKE in the upper and deep ocean and presence of key abyssal steering currents

Eddy Kinetic Energy at the Surface in the Gulf Stream

The 1/25 model has the highest EKE with a larger southern recirculation gyre

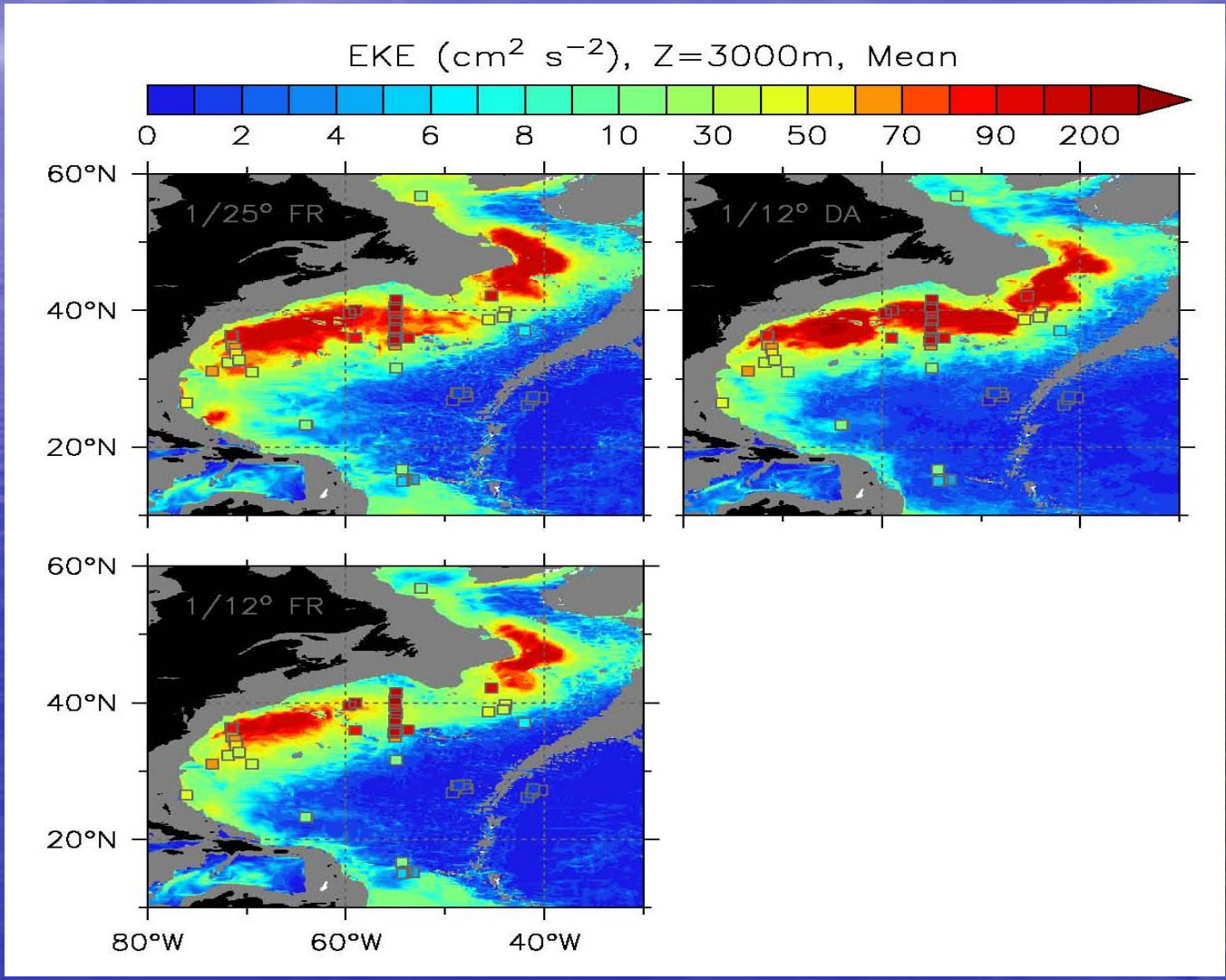
Data assimilation brings the EKE close to the observations from the drifters



Deep Eddy Kinetic Energy in the Gulf Stream Region

The boxes are the EKE from the deep current meter moorings colored with the same scale as the model EKE

The higher resolution and the data assimilative model are much closer to the observations



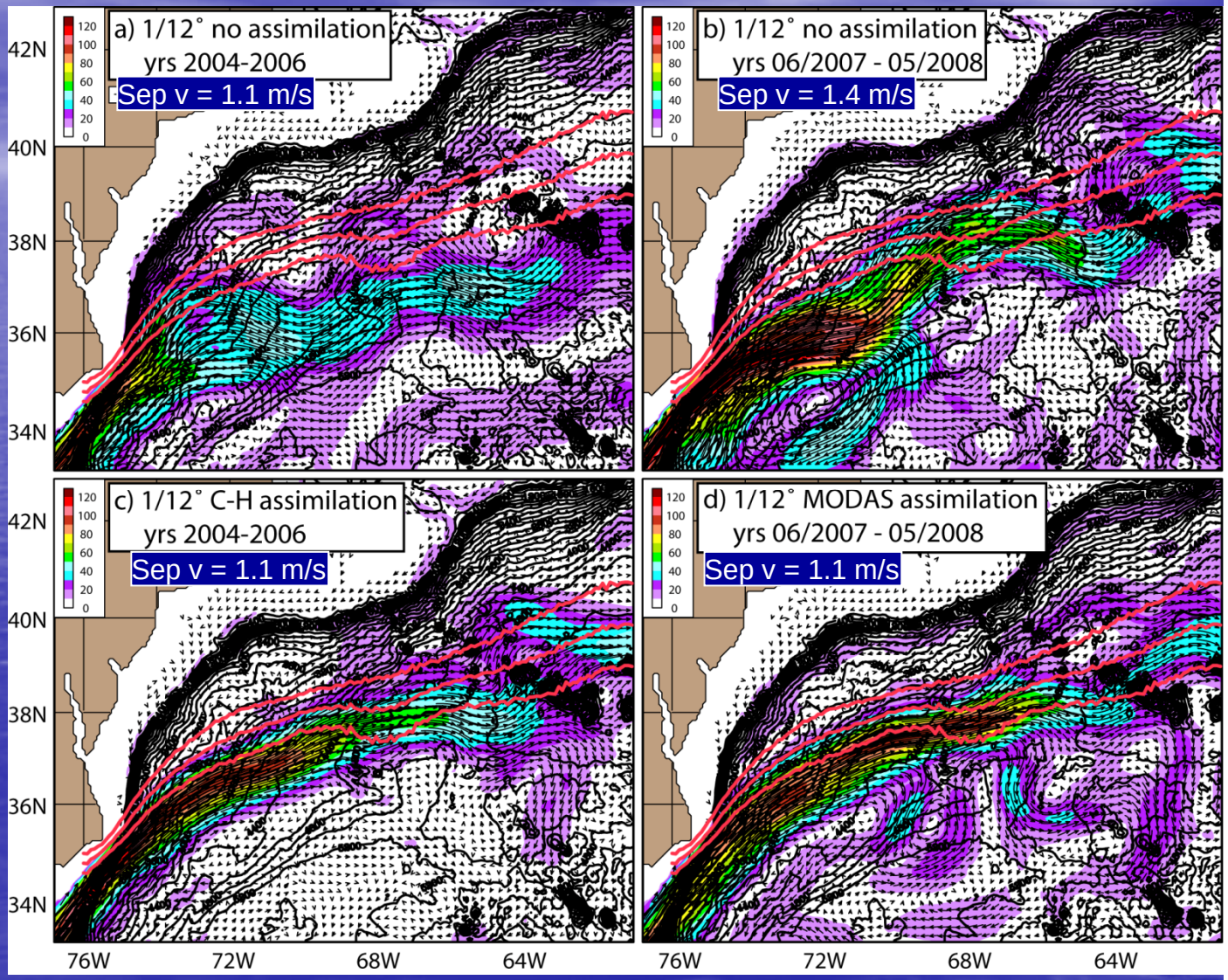
Impact of Assimilating SSH

- **In forecast systems, data assimilation is used to force the model to resemble reality to improve the initial conditions**
- **In the global HYCOM forecast system, assimilation is performed using the Navy Coupled Ocean Data Assimilation (NCODA, Cummings, QJRMS, 2005)**
- **The SSH is not assimilated directly, but extended into the interior using either the layer adjustment technique of Cooper and Haines or synthetic temperature and salinity profiles from the Modular Ocean Data Assimilation System (MODAS, Barron, et al., JGR-Oceans, 2007)**
- **A set of twin experiments are performed with simulations without assimilations and hindcasts with assimilation by either Cooper-Haines or MODAS synthetic profiles**

Impact of Data Assimilation on Mean Near Surface Currents in the Gulf Stream Region Using 2 Techniques for Downward Projection of SSH from Satellite Altimetry: Cooper-Haines (C-H) and Synthetic T and S Profiles (MODAS)

In both simulations (top) the Gulf Stream is too far south and fails to penetrate to the east

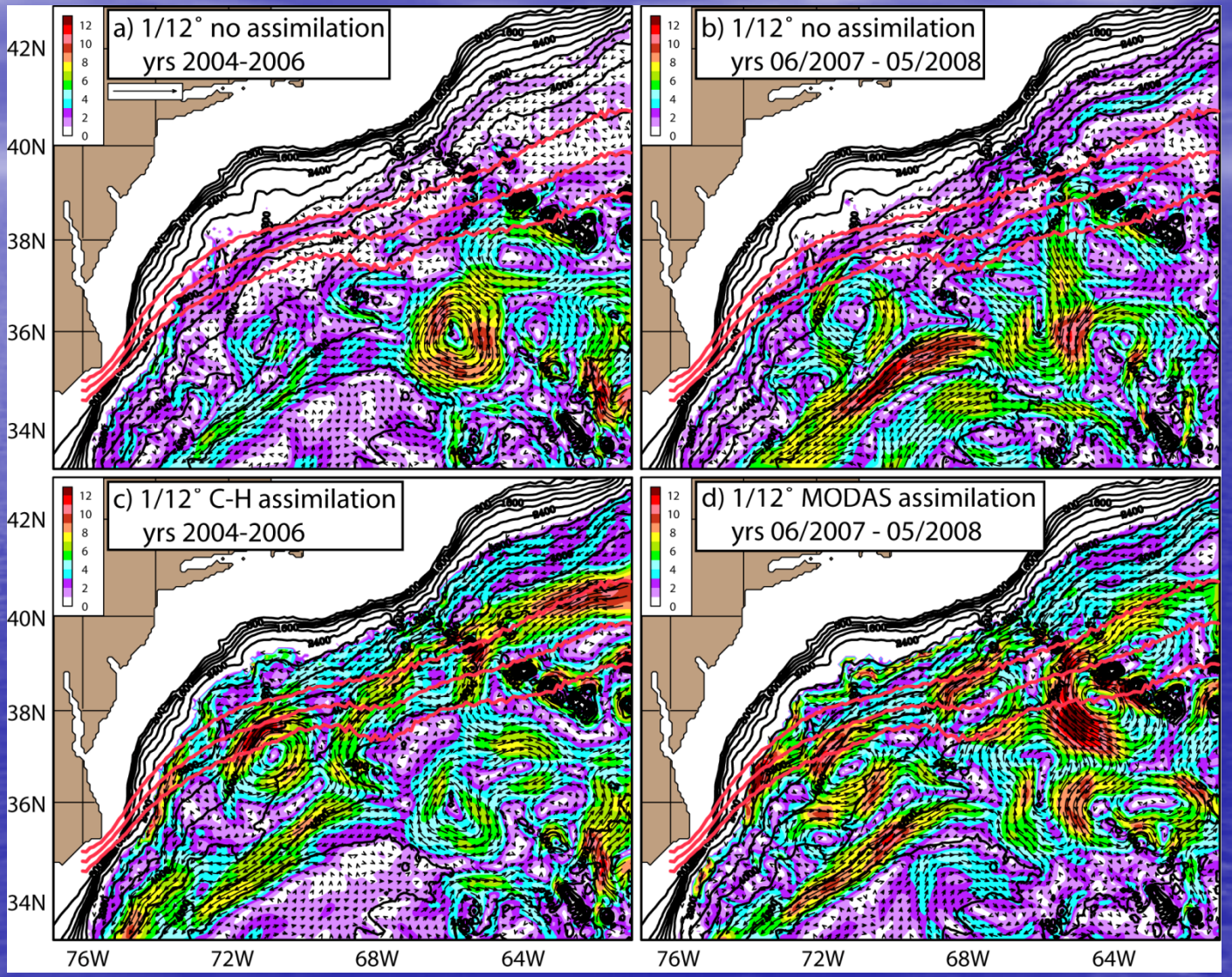
In the hindcasts (bottom) the Gulf Stream pathway is improved with greater penetration to the east, although the mean speed of the Gulf Stream is decreased



Impact of Data Assimilation on Mean Abyssal Currents in the Gulf Stream Region Using 2 Techniques for Downward Projection of SSH from Satellite Altimetry: Cooper-Haines (C-H) and Synthetic T and S Profiles (MODAS)

In the simulations the deep flow is weak and doesn't lie beneath the Gulf Stream and the deep EKE (not shown) is weak

In the hindcasts the deep flow show the key abyssal currents at 72 W and 68.5 W crossing beneath the Gulf Stream and the deep EKE is much larger



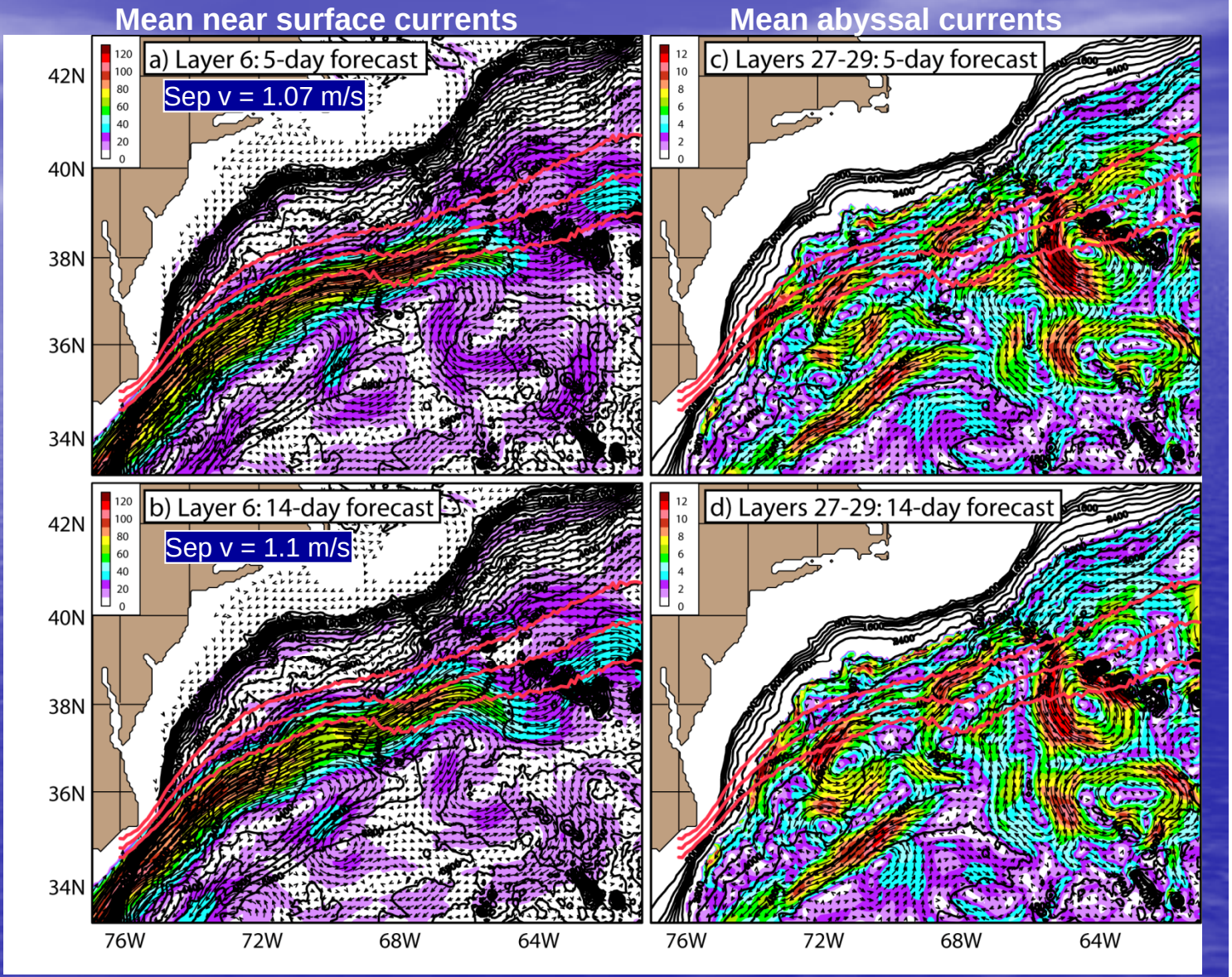
Impact of assimilating SSH

- Assimilation inserts eddy variability into the Gulf Stream system, which may not be generated by the intrinsic instability of the Stream
- The inserted upper ocean variability interacts to transfer eddy energy to the deep ocean and to generate abyssal currents
- The eddy-driven abyssal currents steer the Gulf Stream to maintain the model Stream similar to the observed Stream
- The mean Gulf Stream is weaker than observed at separation, but penetrates to the east farther than the simulations without assimilation

Mean of 48 5-day and 14-day Forecasts in the Gulf Stream Region from MODAS Assimilation Nowcasts

In the 5 day forecast the Gulf Stream pathway is well maintain, but the mean velocity and EKE are slightly reduced

In the 14 day forecast the Gulf Stream pathway is still maintained but the mean velocity and EKE are reduced further



The impact on assimilation of SSH on the Gulf Stream forecasts

- The mean Gulf Stream characteristics are improved by assimilation, but the mean improvement does not lead to improved forecasts
- The mean Gulf Stream with assimilation is much weaker than the observed Stream and is not as unstable as the observed Stream
- Without the instabilities the meanders of the Stream are not generated in the forecasts, but the abyssal currents generated through the assimilation persists to steer the Stream in the forecasts