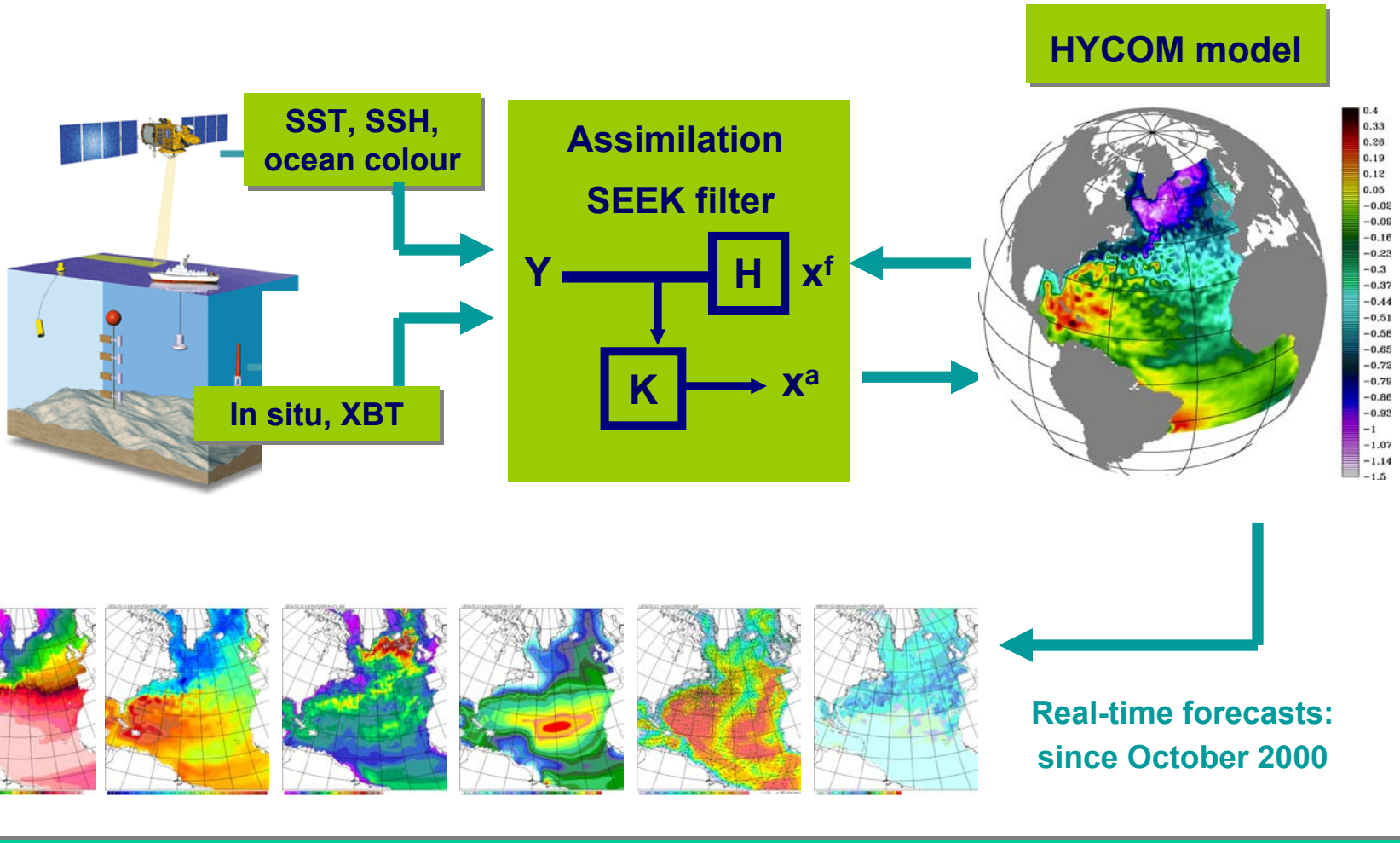
Implementation of the SEEK filter in HYCOM

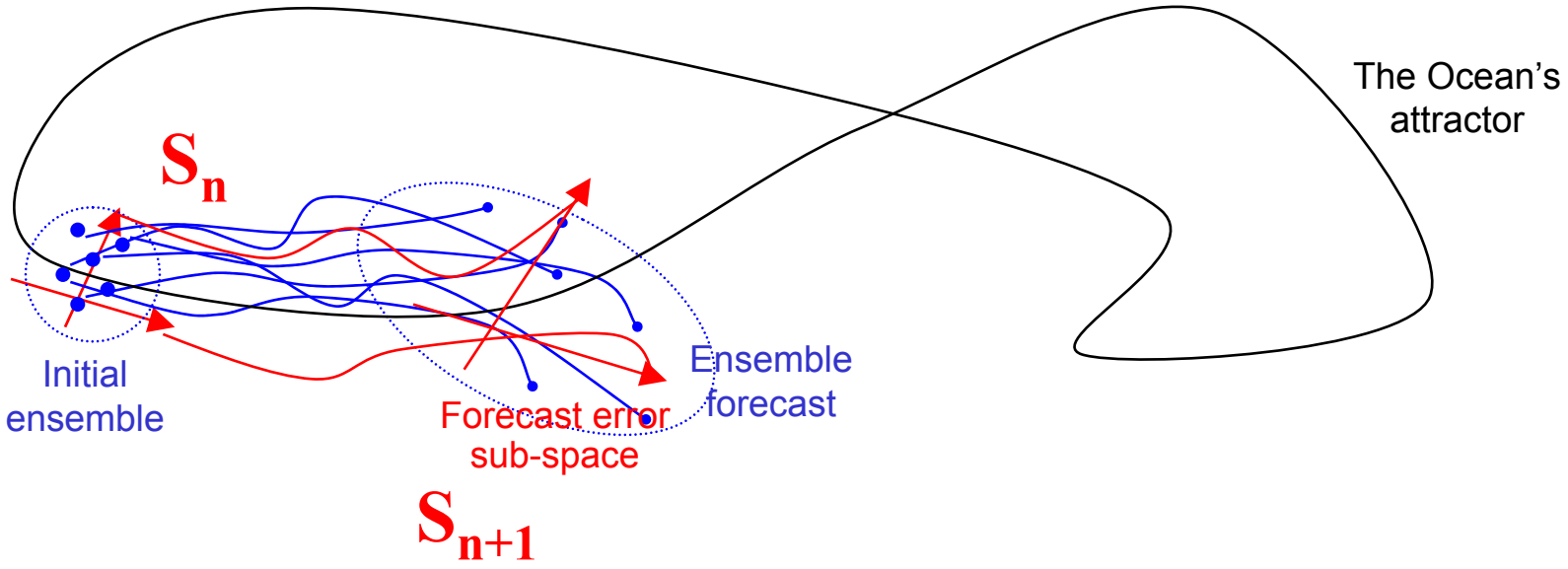
P. Brasseur, J. Verron, J.M. Brankart
LEGI/CNRS, Grenoble, France



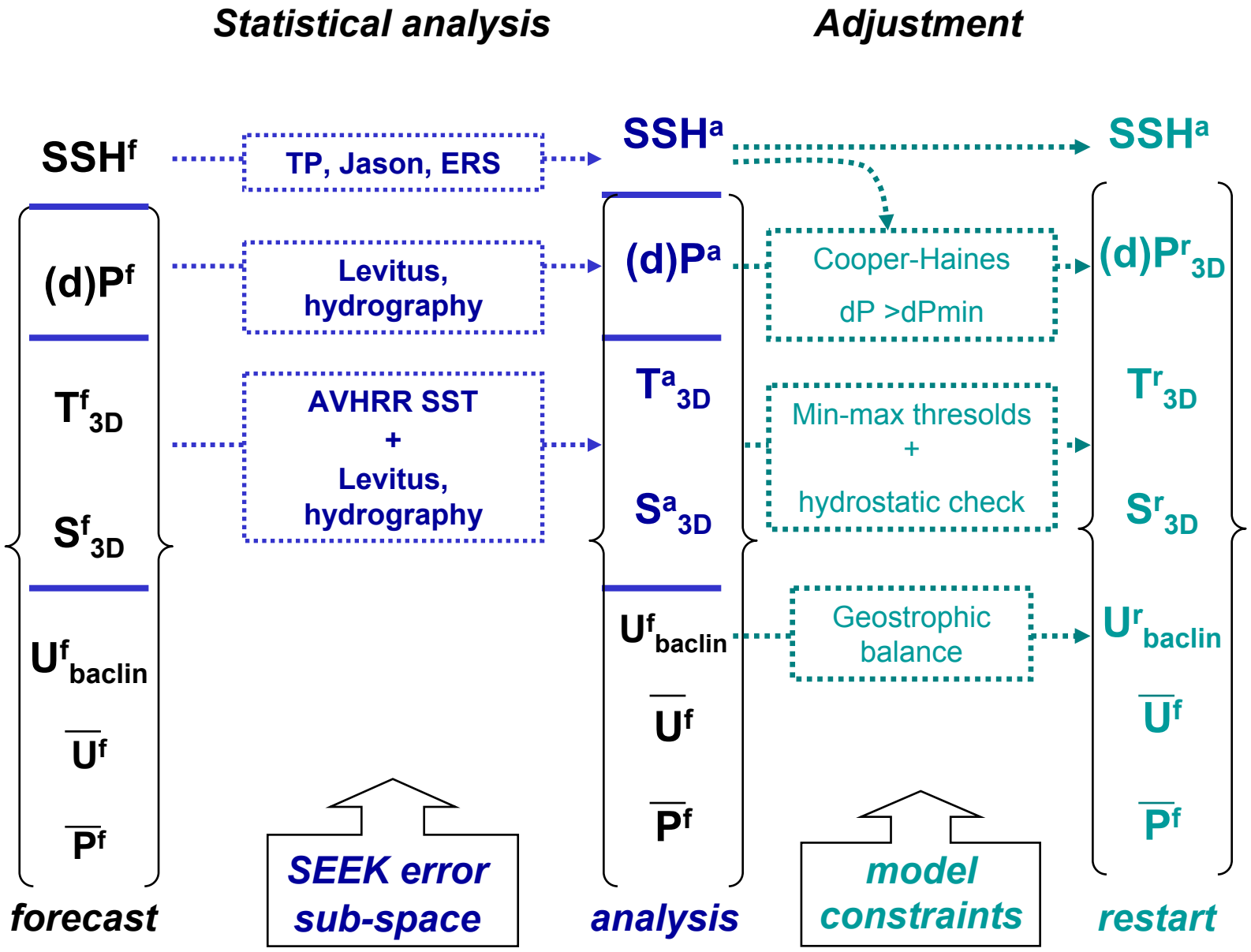
The SEEK filter vs. ensemble methods

Philosophy :

Sequential corrections along
privileged directions of error growth



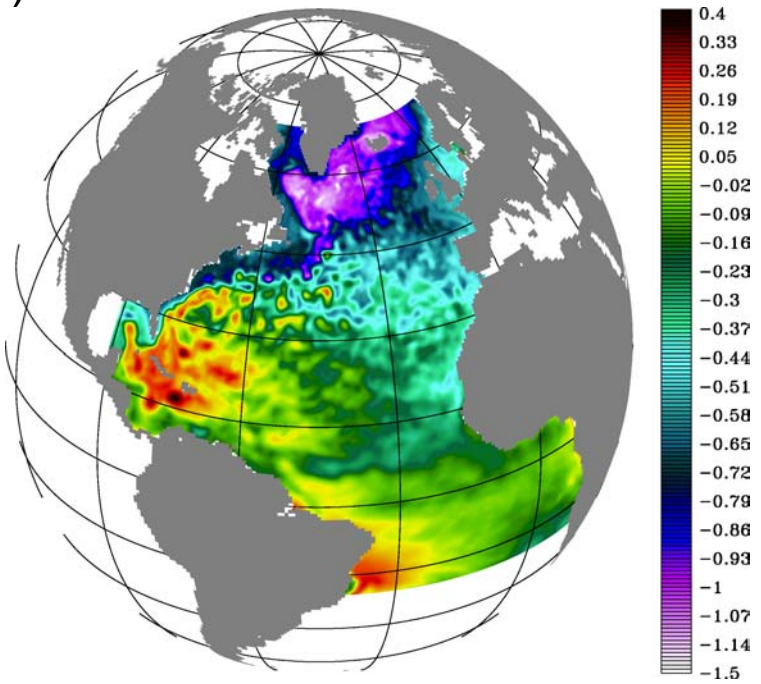
Correction step with a HYCOM state vector



Data assimilation experiments

Configuration

- Horizontal grid: 1/3° (402 x 421 grid points)
- 28°S to 70°N (including the Mediterranean Sea)
- 26 vertical layers, ETOPO5 bathymetry
- Mixed layer: KPP



Assimilation setup

- Assimilation period: Oct. 1992 / Dec.1996
- SEEK algorithm: fixed basis (+ adaptive)
- Assimilation cycle: 3 days
- No assimilation between 8°N / 8°S

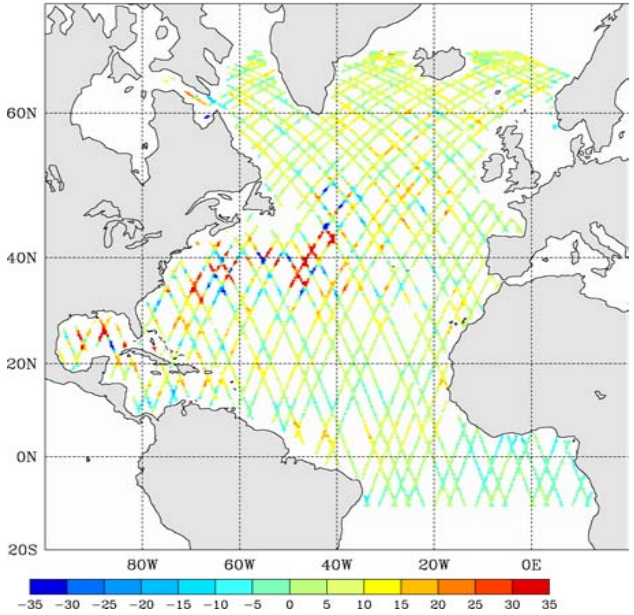
Model spin-up

- ECMWF monthly climatological forcings during 9 years
- ECMWF re-analysis data between 1985 and 1992

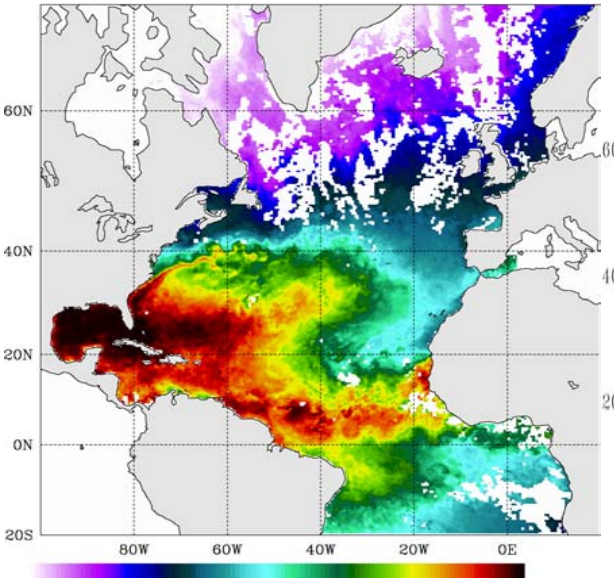
Assimilation experiments

1. ‘Reference’ hindcast experiment (1993 – 1996)
2. Mean SSH : sensitivity experiments (1993)
3. SSS assimilation: sensitivity experiment (1993)
4. In situ data assimilation: ‘profile’ experiments (June 1993)
5. Real-time demonstration (July 2003)

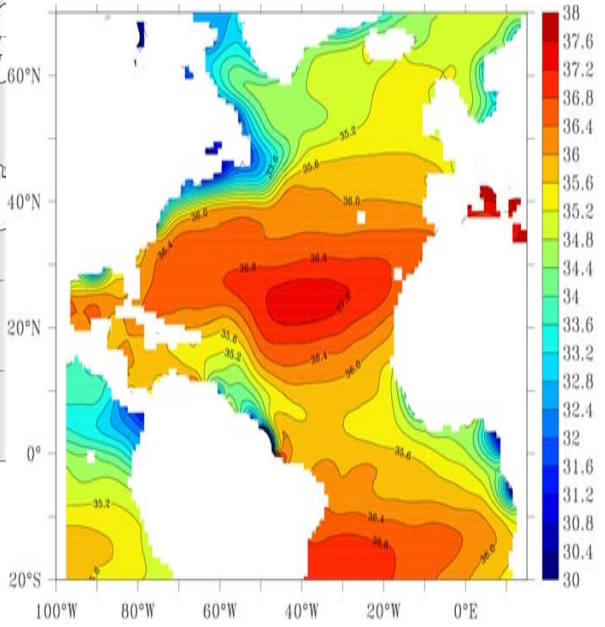
Hindcast experiment: assimilated data



TP/ERS along track data
August 19-26,1993

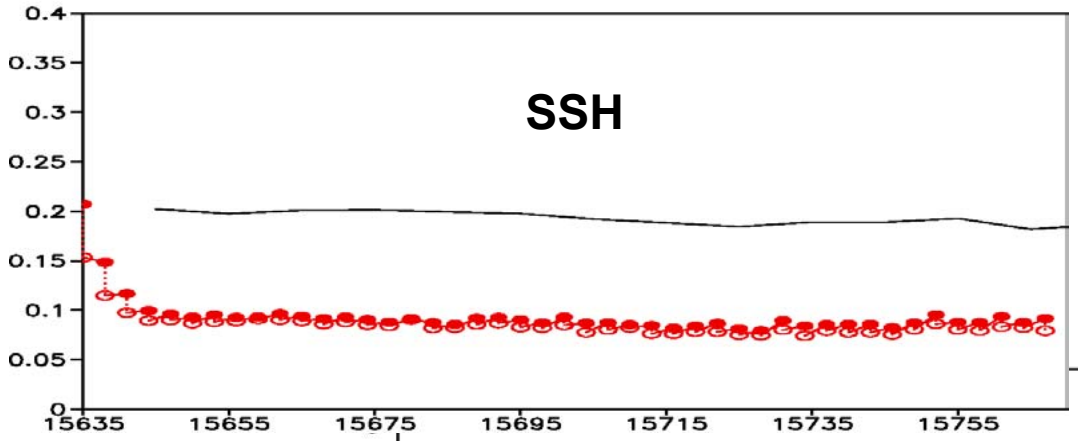


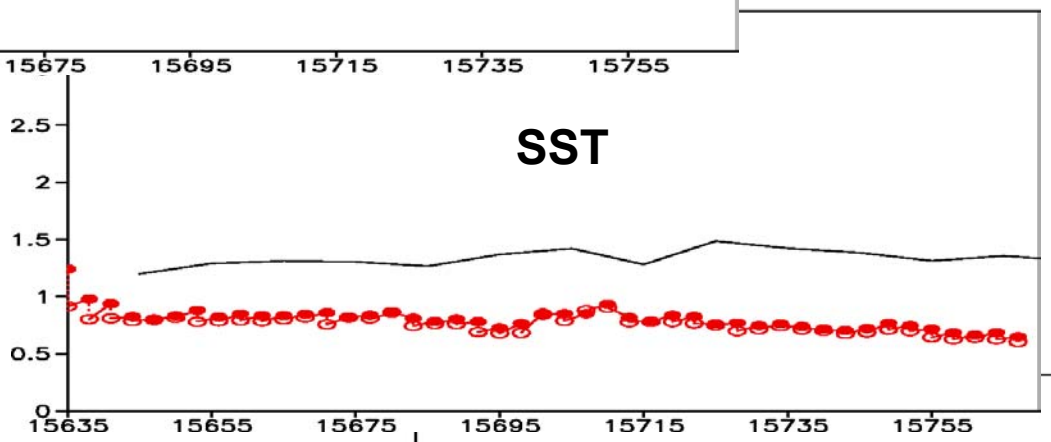
AVHRR SST
August 19-26,1993

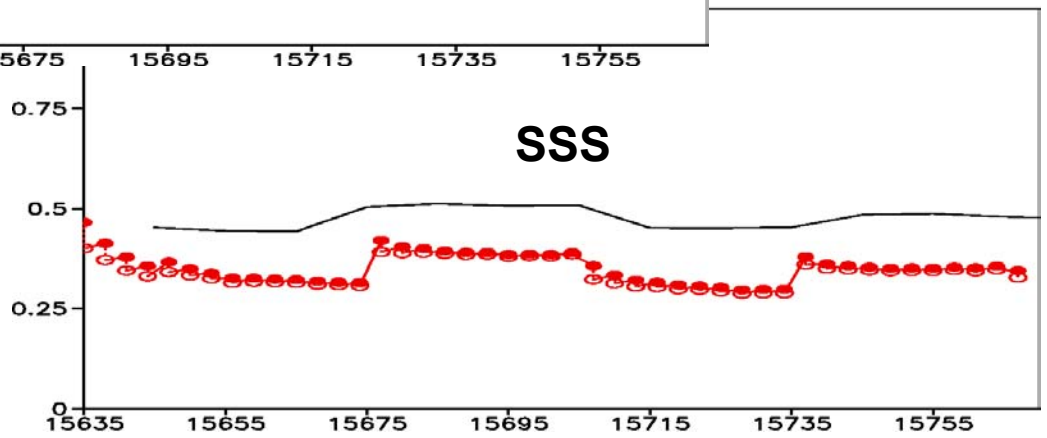


Climatological SSS
Monthly Levitus

RMS misfit to assimilated data





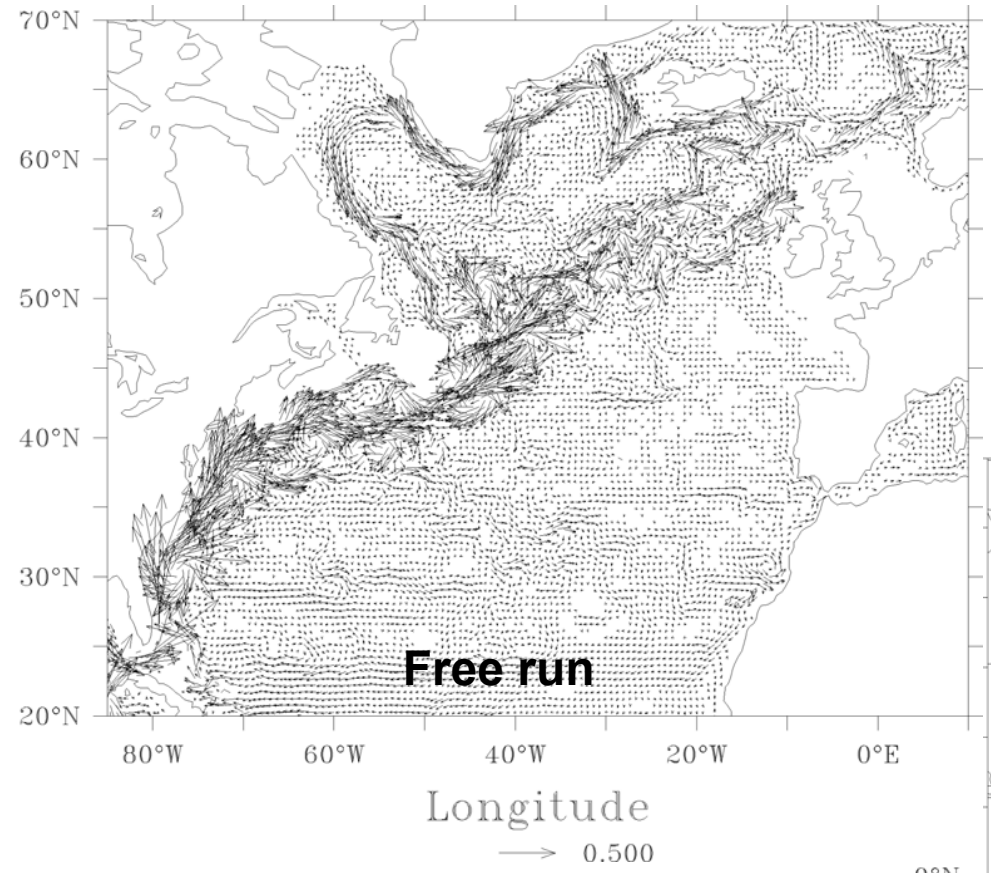


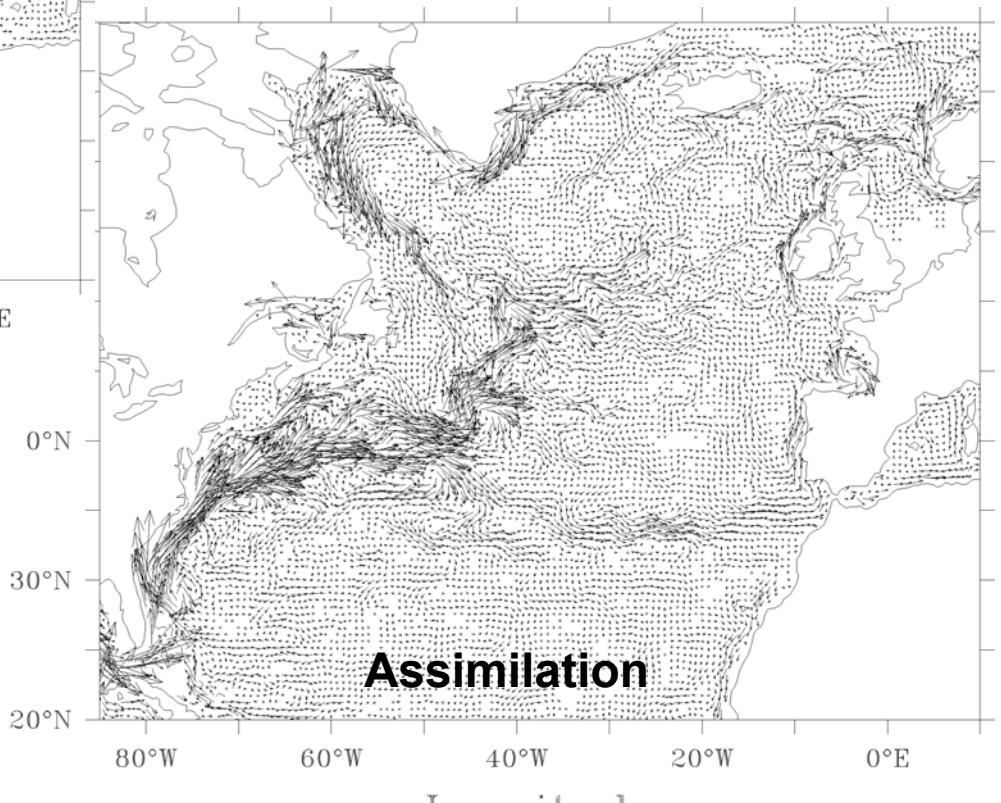
Free run

Analysis

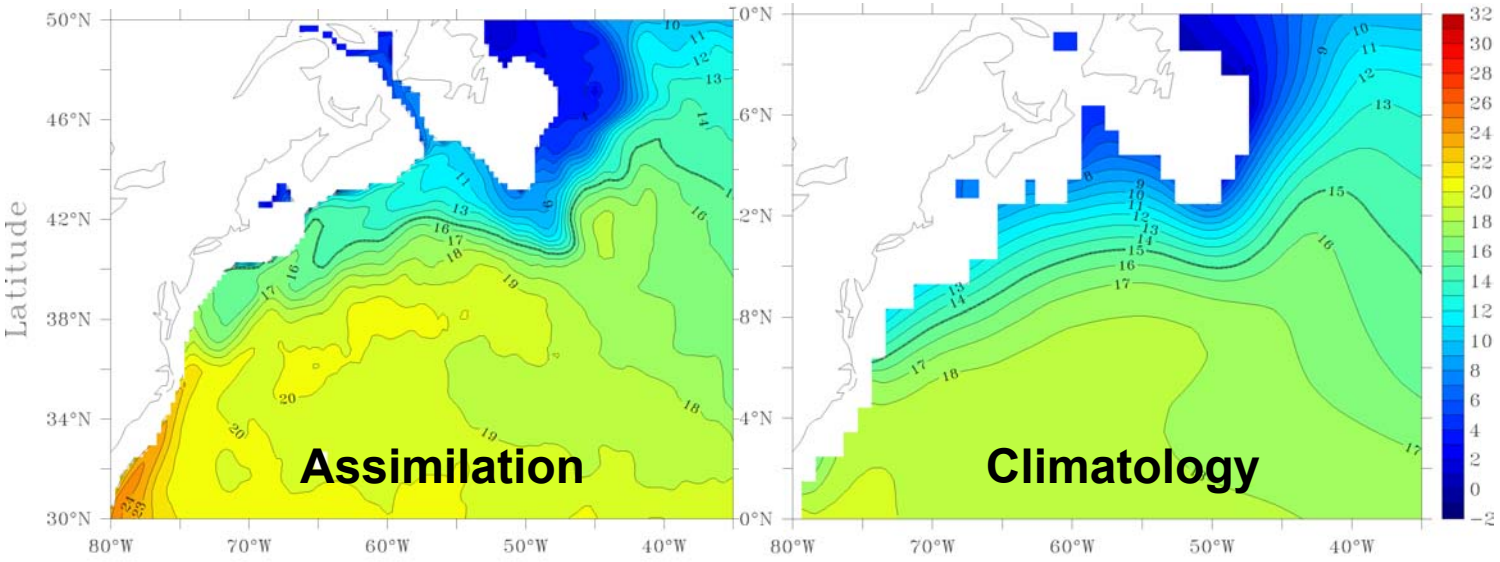
Forecast

Velocity field at 50 m (1993 average)





Verification in the Gulf Stream region



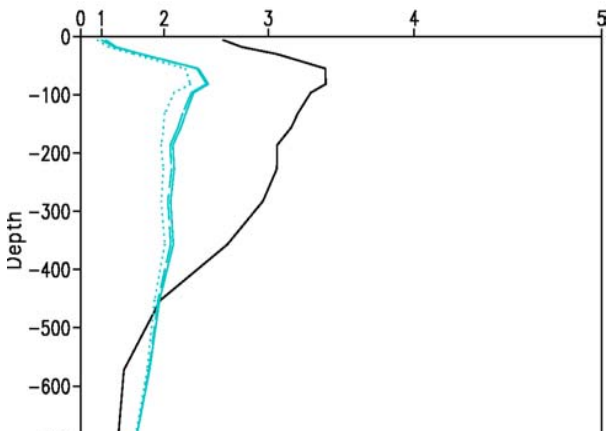
Temperature 200 m depth

Temperature misfit

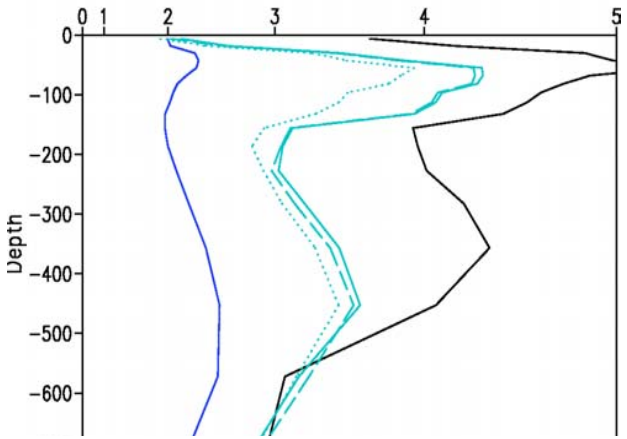
Free run

Analysis

Forecast

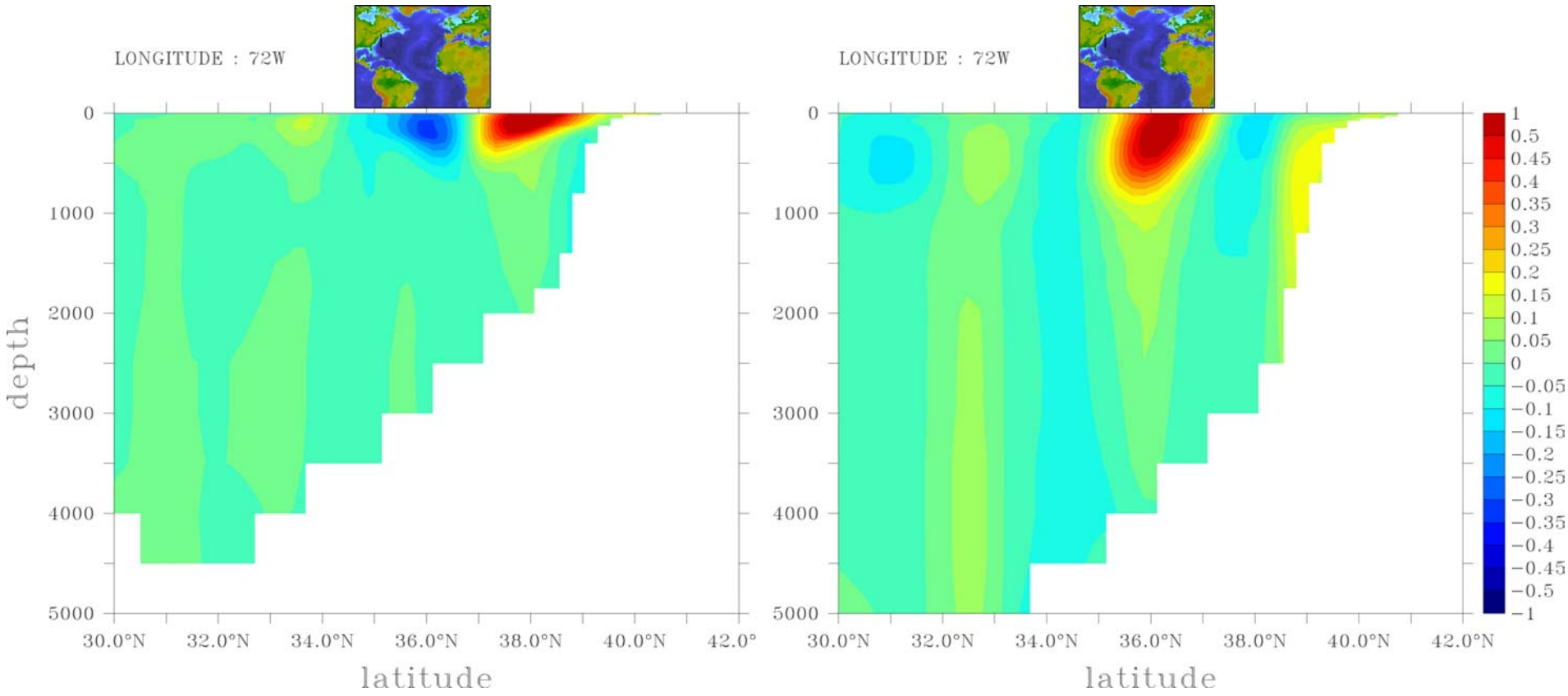


RMS to CLIM



RMS to XBTs

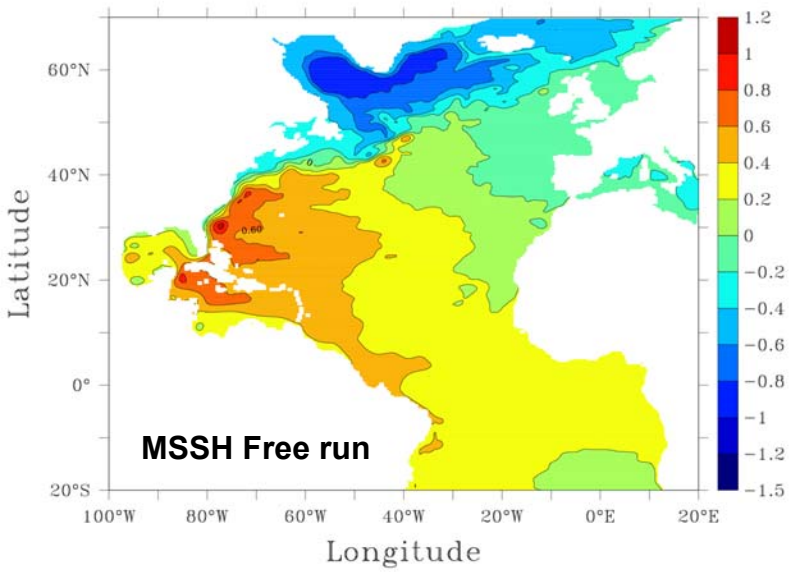
Zonal velocity at 72°W

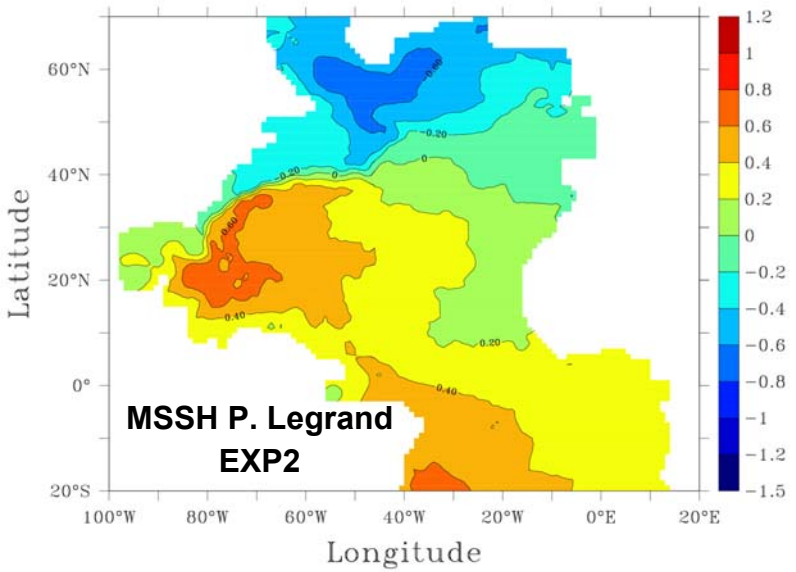


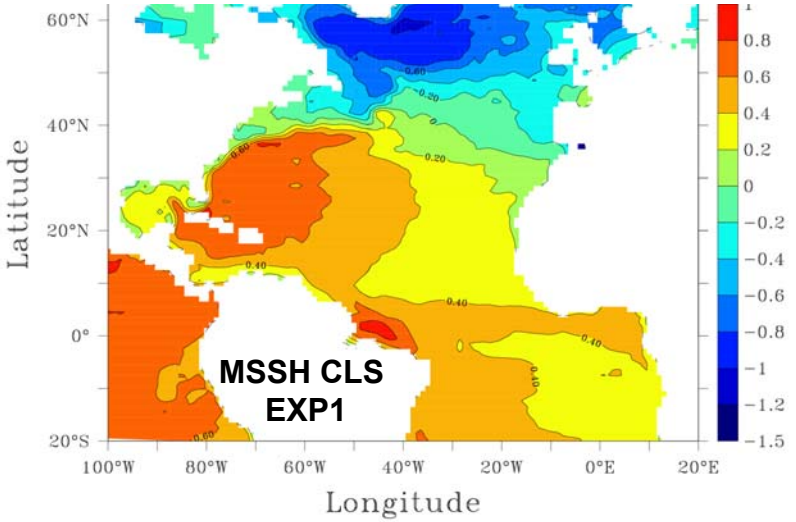
Free run

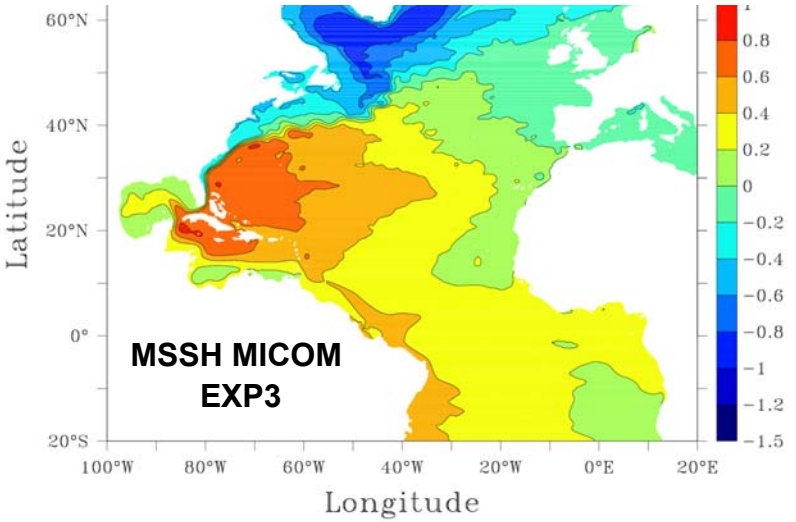
Assimilation

Sensitivity experiments: Impact of the Mean SSH

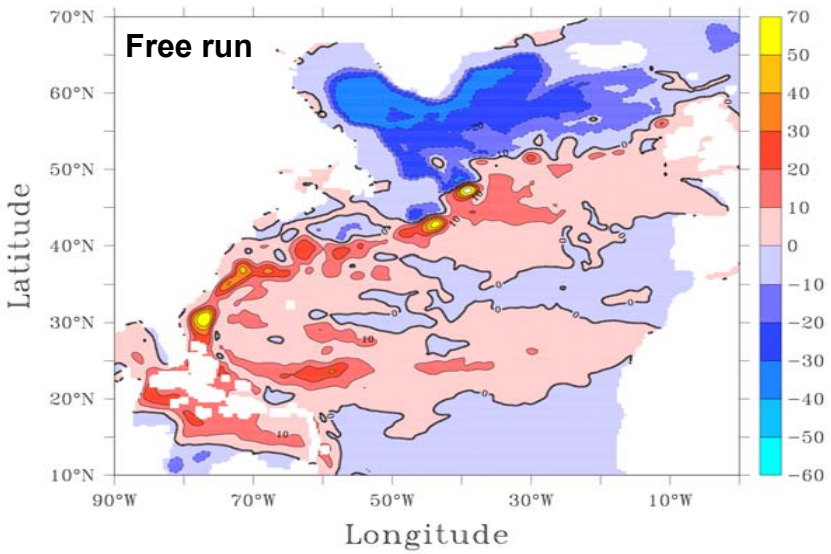


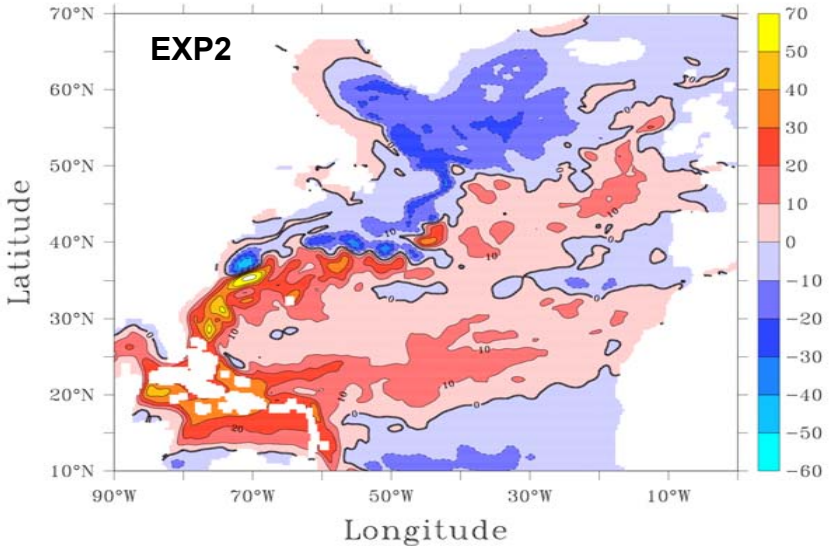


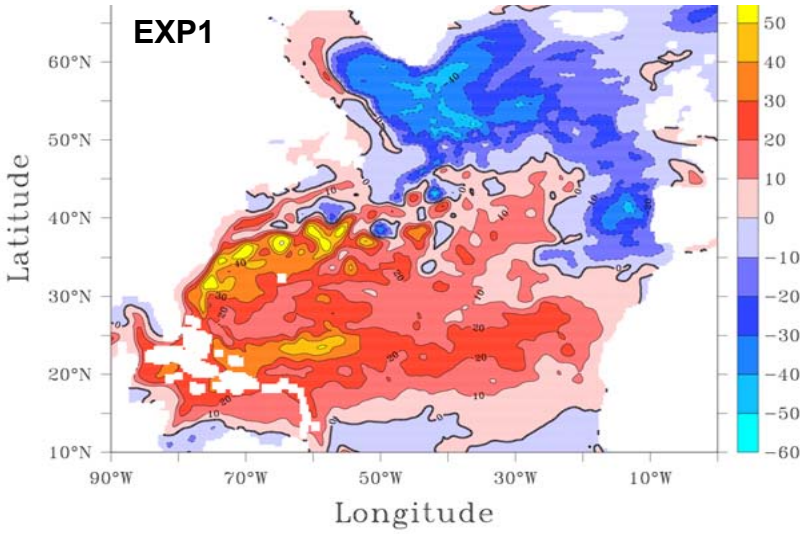


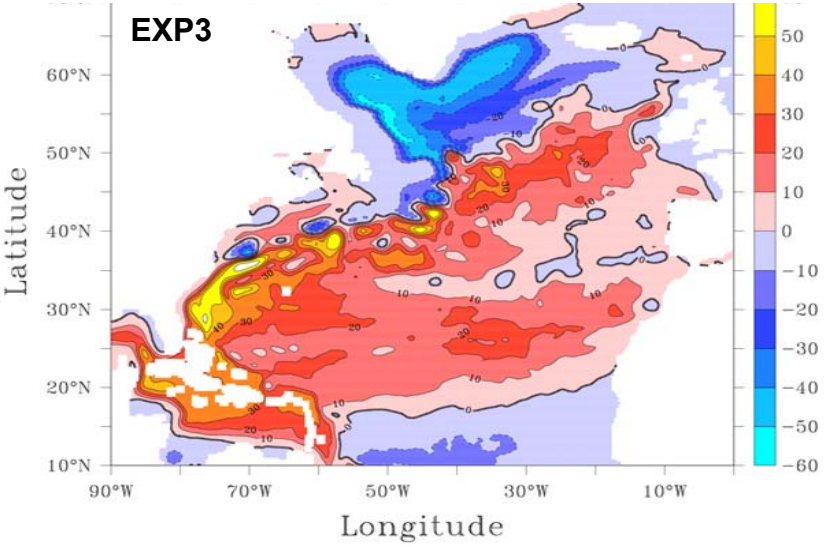


1993 Barotropic Stream Function

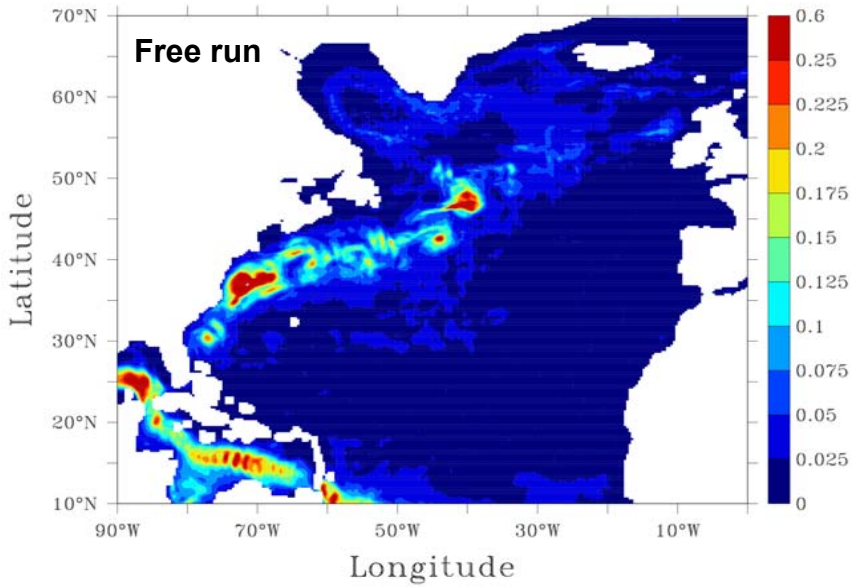


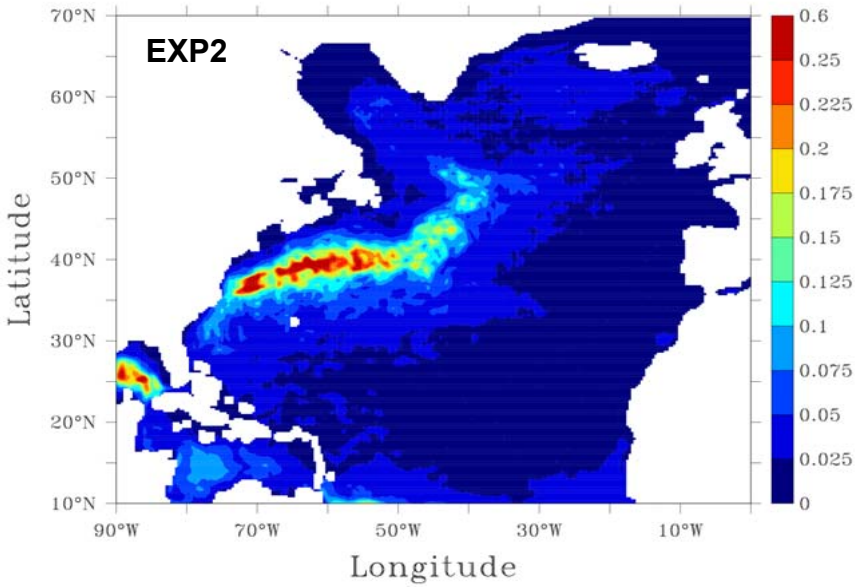


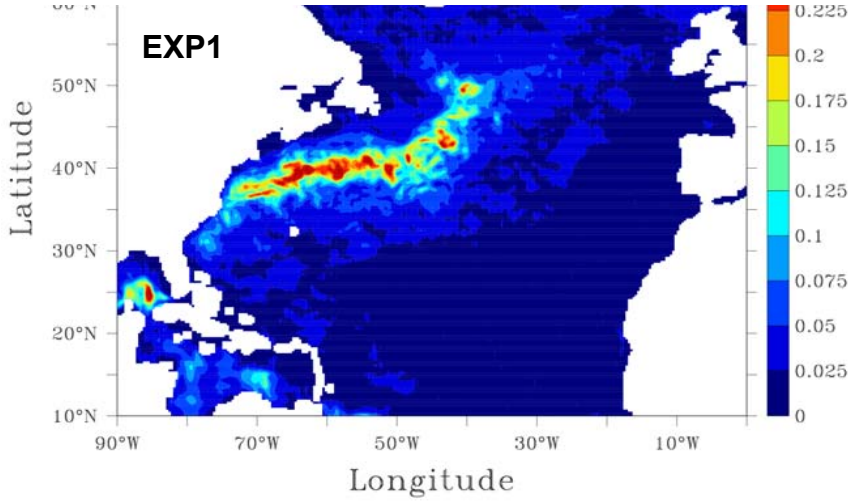


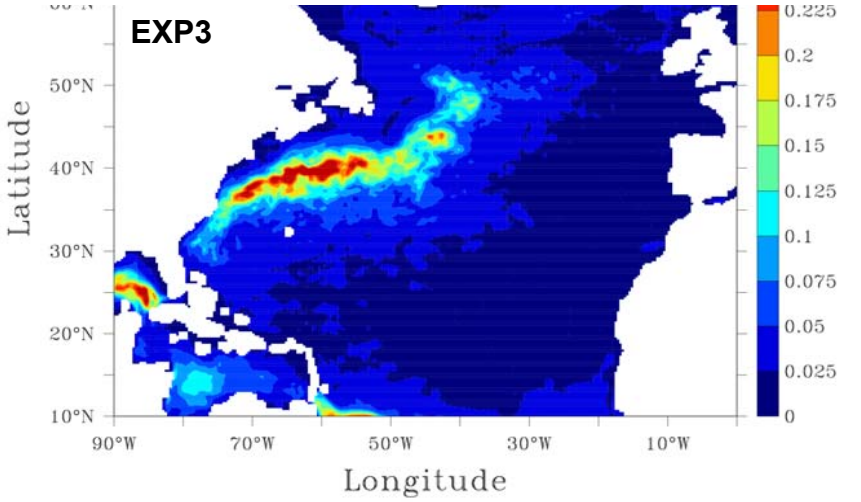


1993 Eddy Kinetic Energy

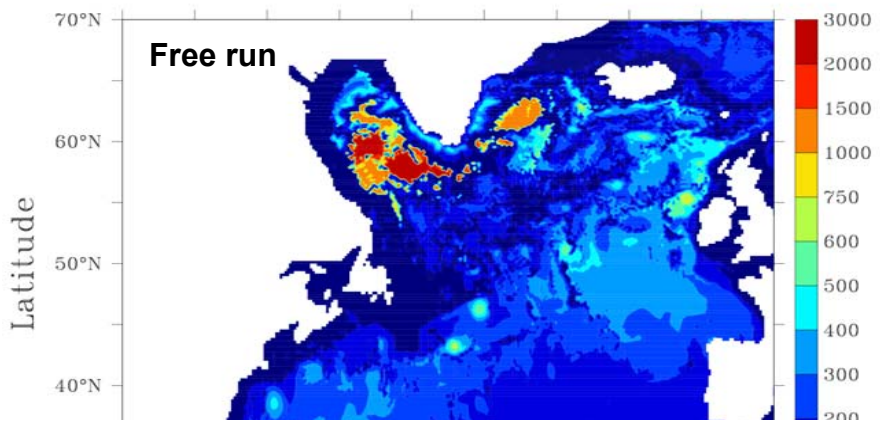


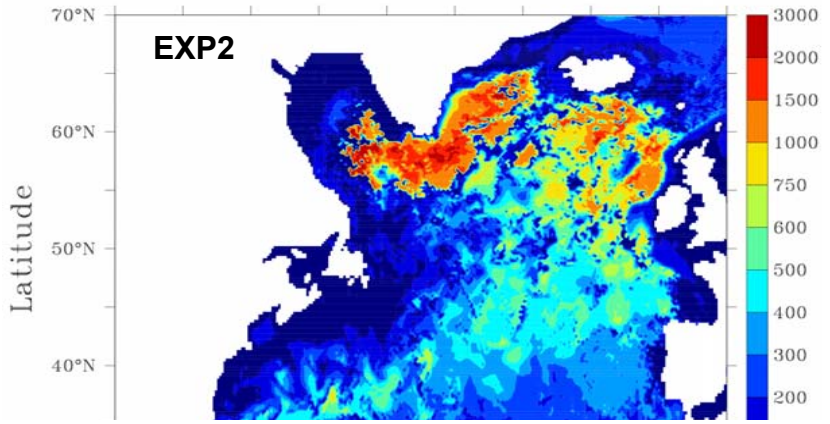


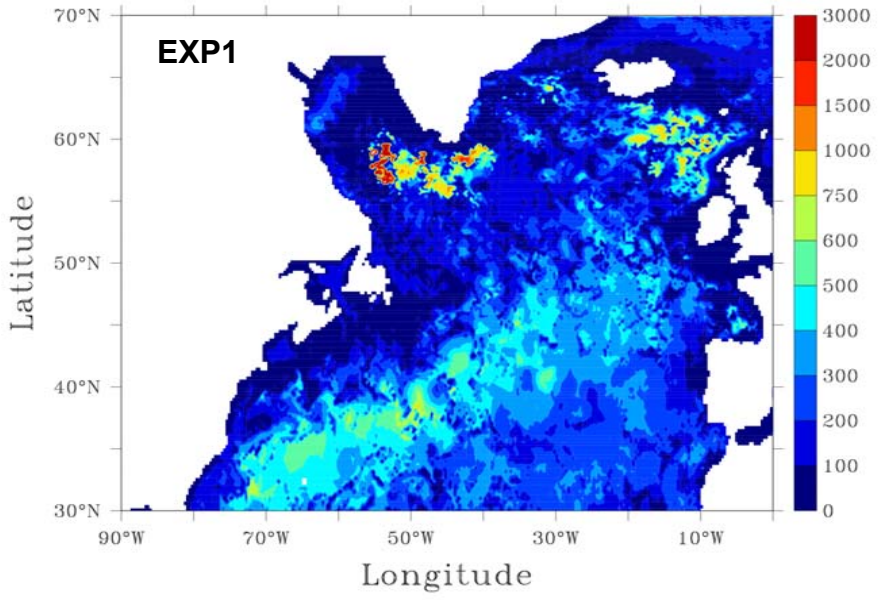


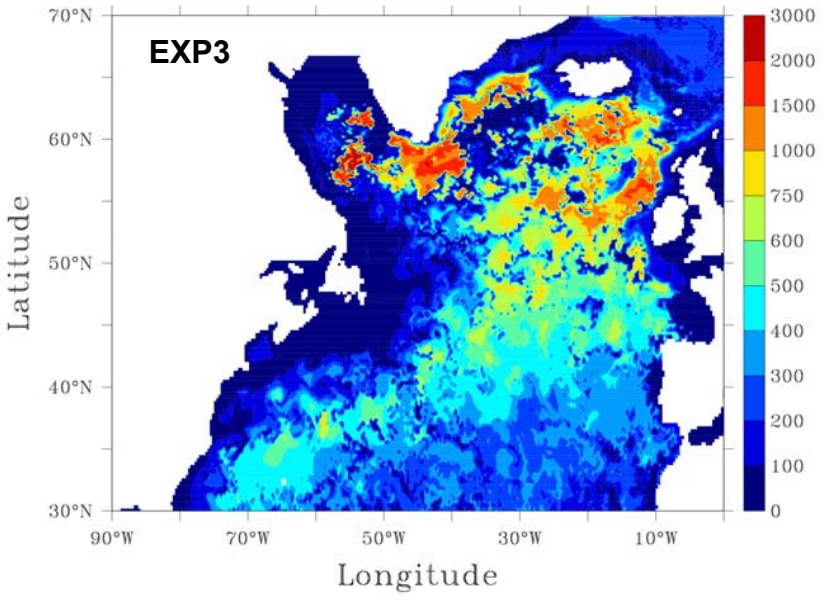


Mixed-Layer Depth forecast : March 15th, 1993



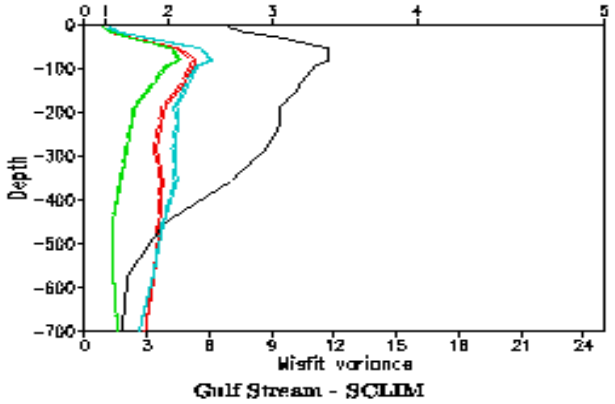




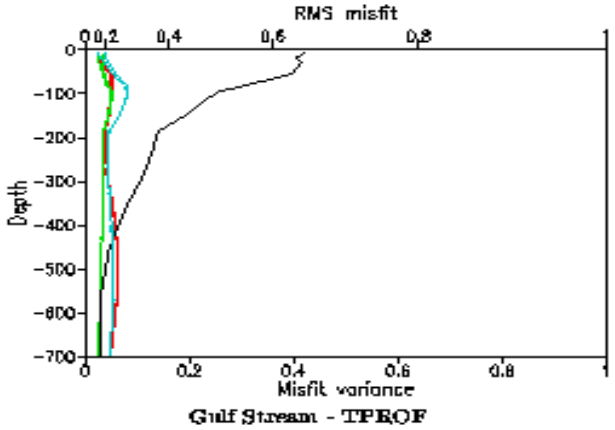


RMS misfit to *in situ* data

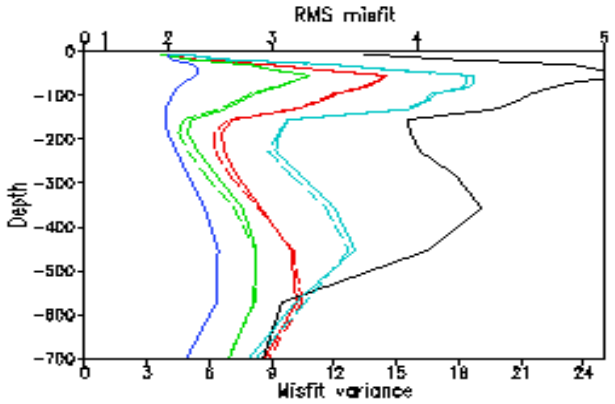
Misfit to Tclim



Misfit to Sclim



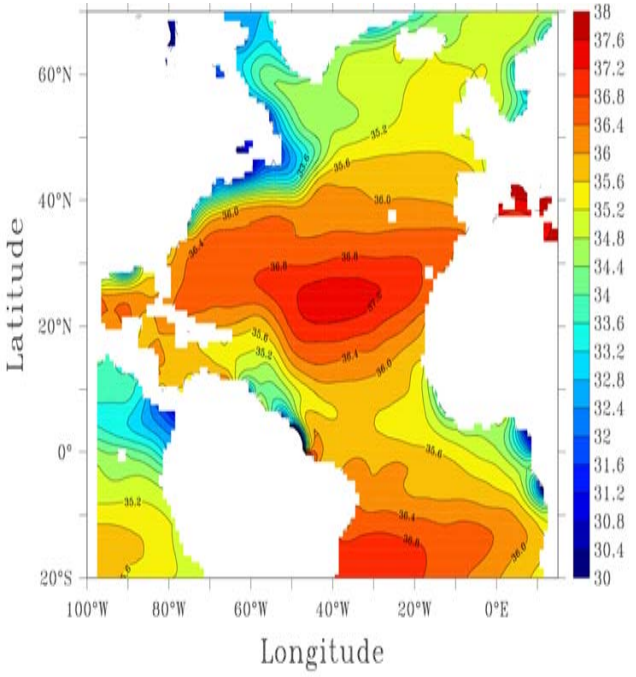
Misfit to XBTs



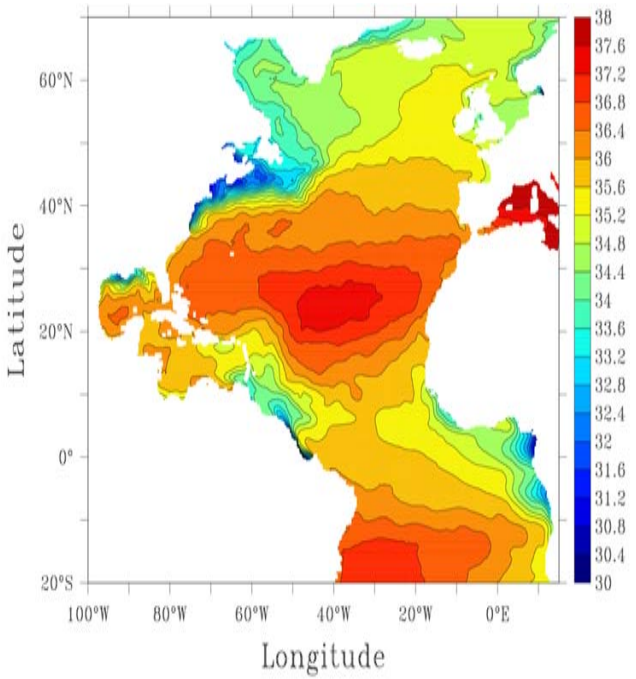
- Free run
- Climatology
- EXP1: CLS
- EXP2: P. Legrand
- EXP3: MICOM

Impact of climatological SSS assimilation (I)

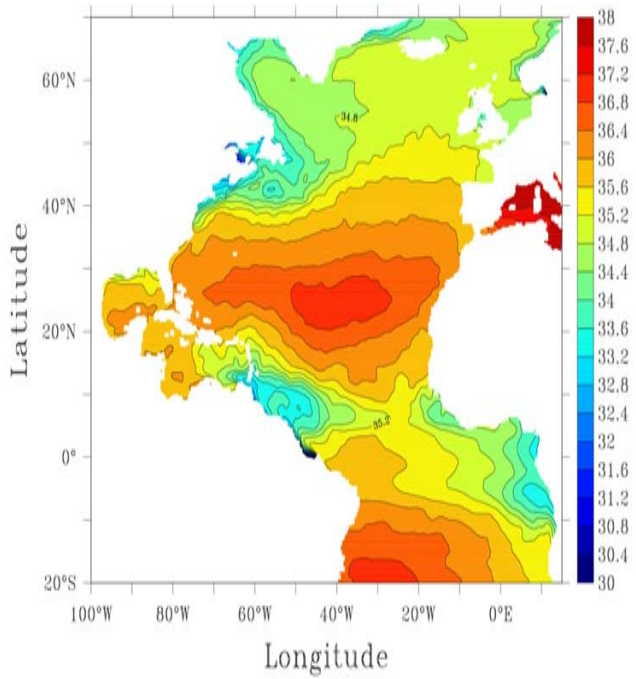
Mean SSS averaged over 1-year (Oct. 92 - Oct. 93)



CLIMATOLOGY

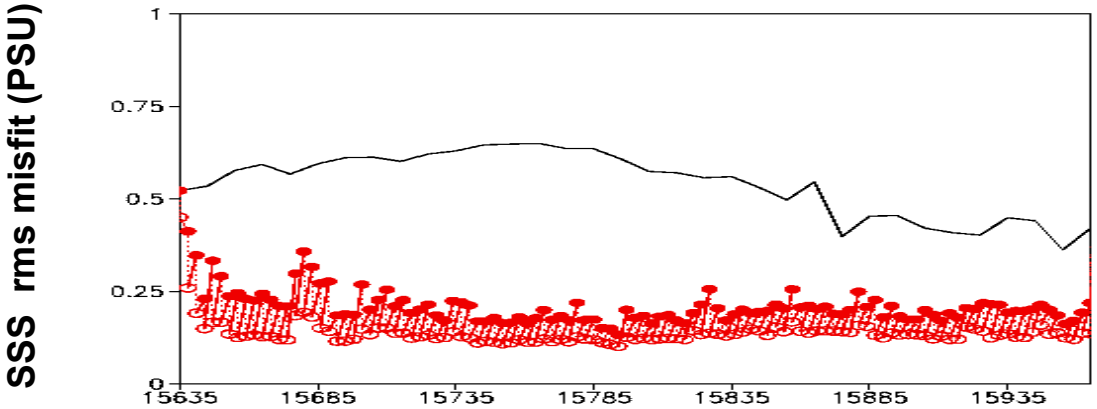


ASSIMILATION OF SSH, SST AND SSS

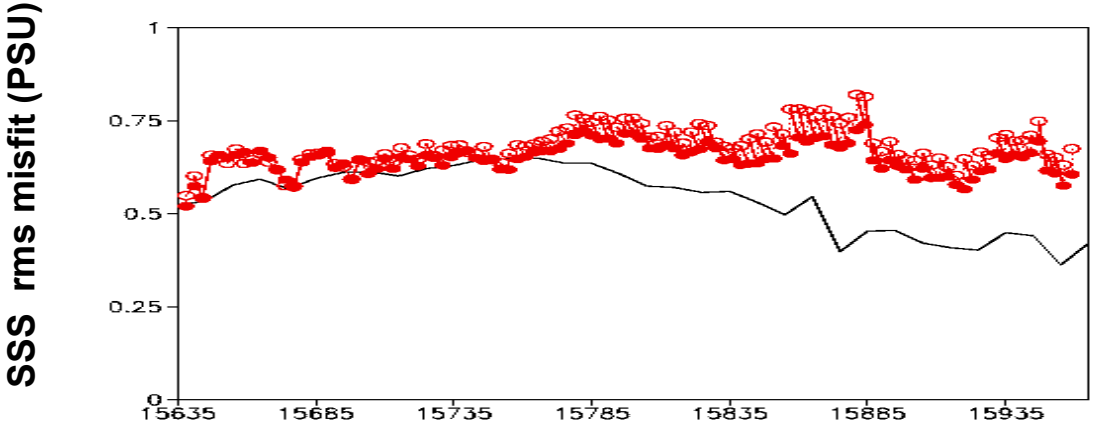


ASSIMILATION OF SSH AND SST

Impact of climatological SSS assimilation (II)

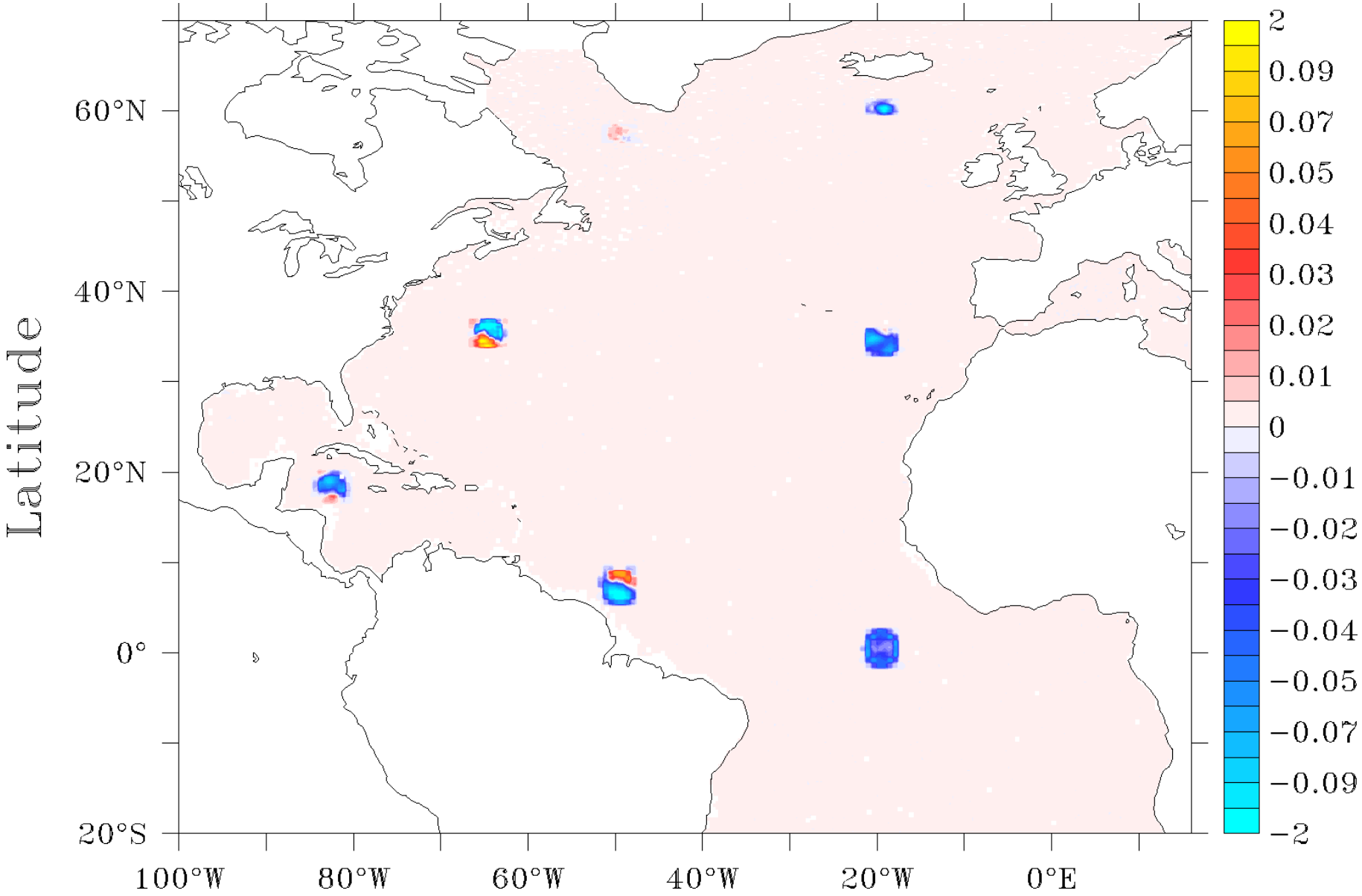


ASSIMILATION OF SSH, SST AND SSS

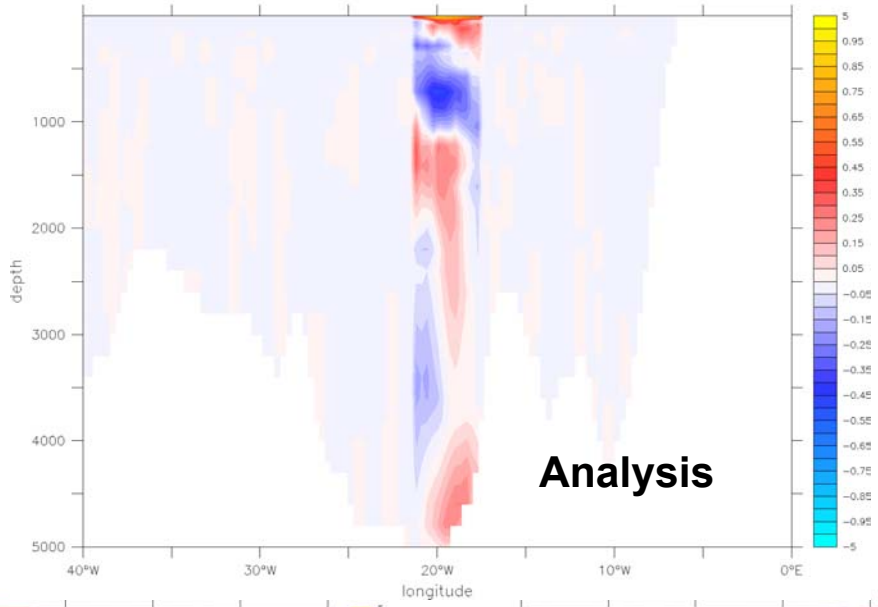


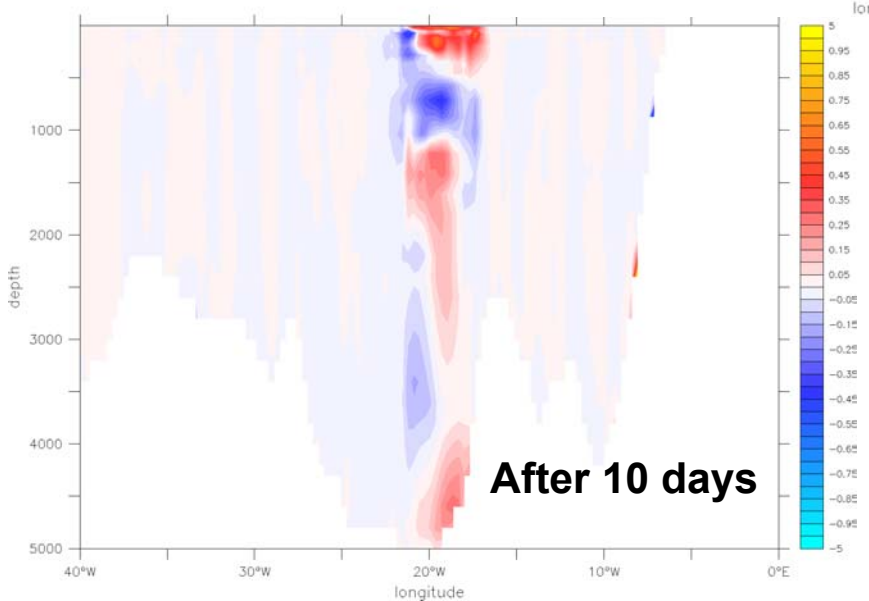
ASSIMILATION OF SSH AND SST

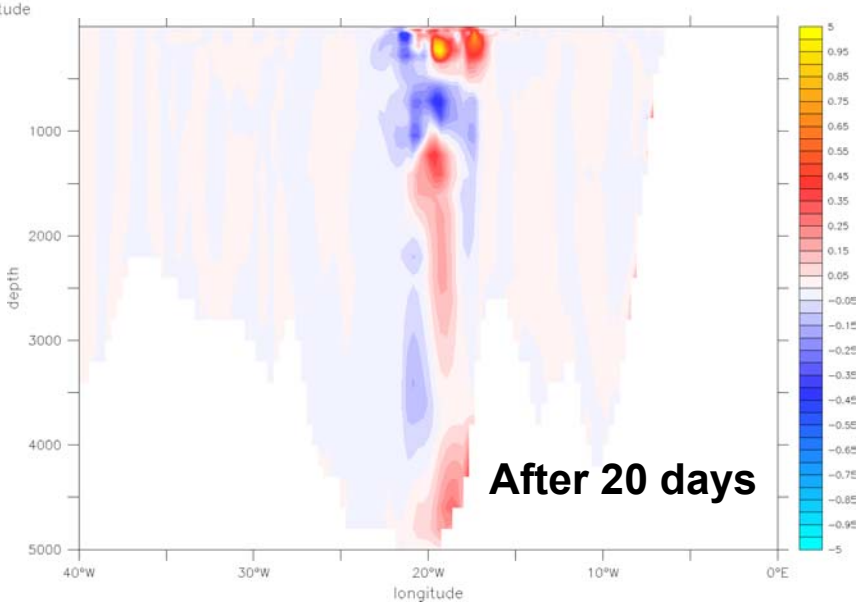
Impact of *in situ* T/S profile analysis on SSH



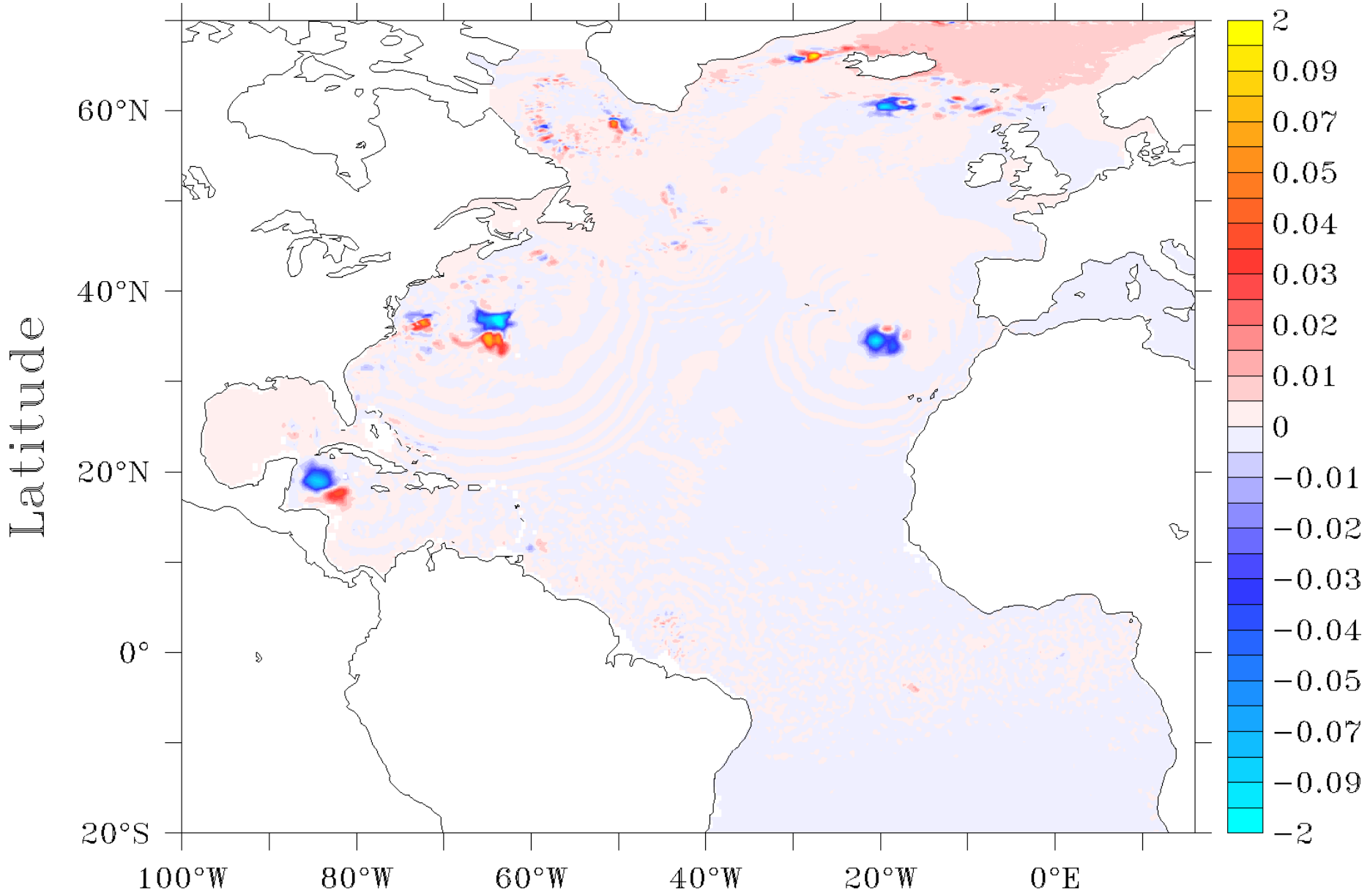
Evolution of Temperature increment:
'Azores' profile (34°N, 20°W)



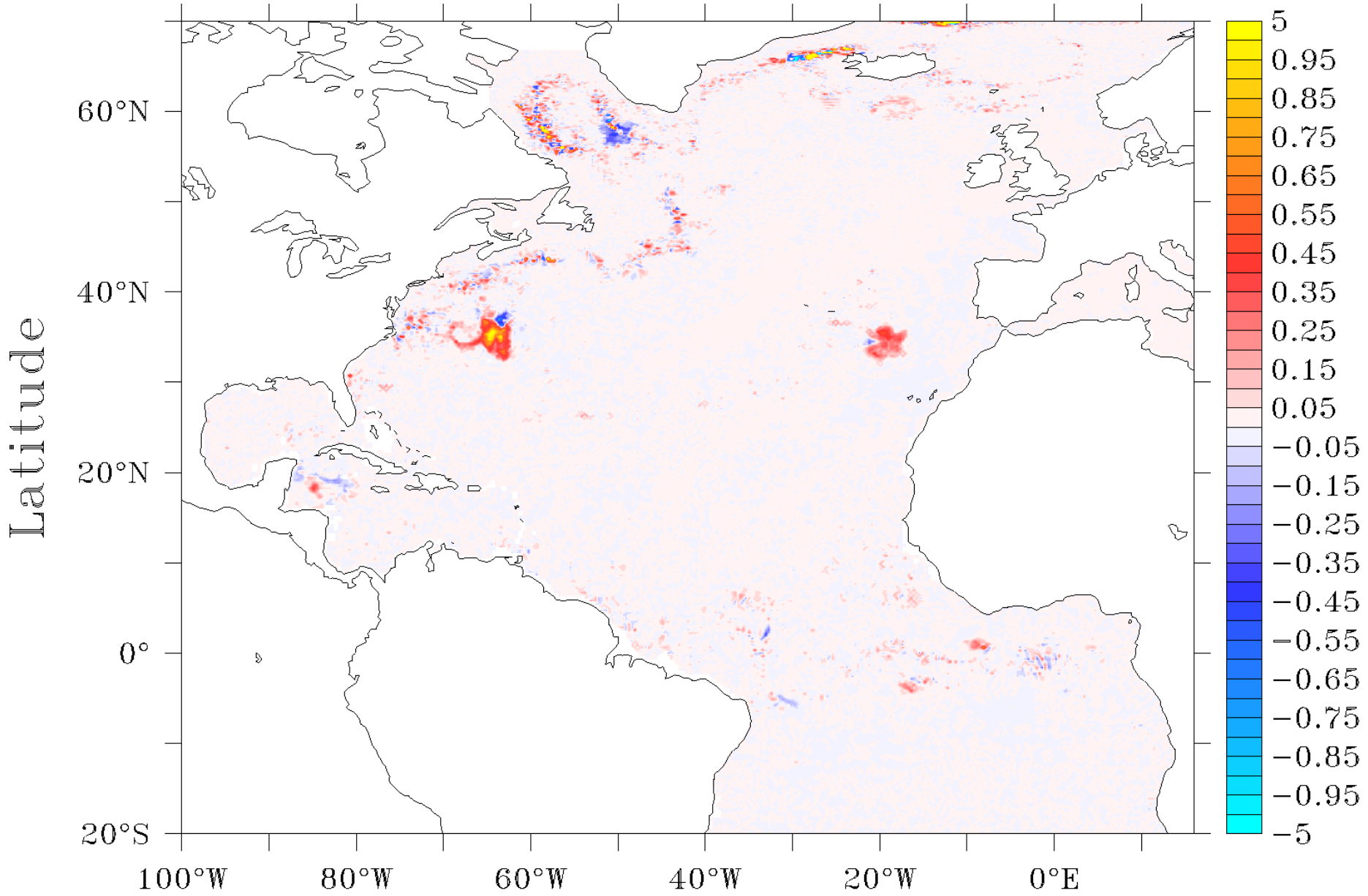




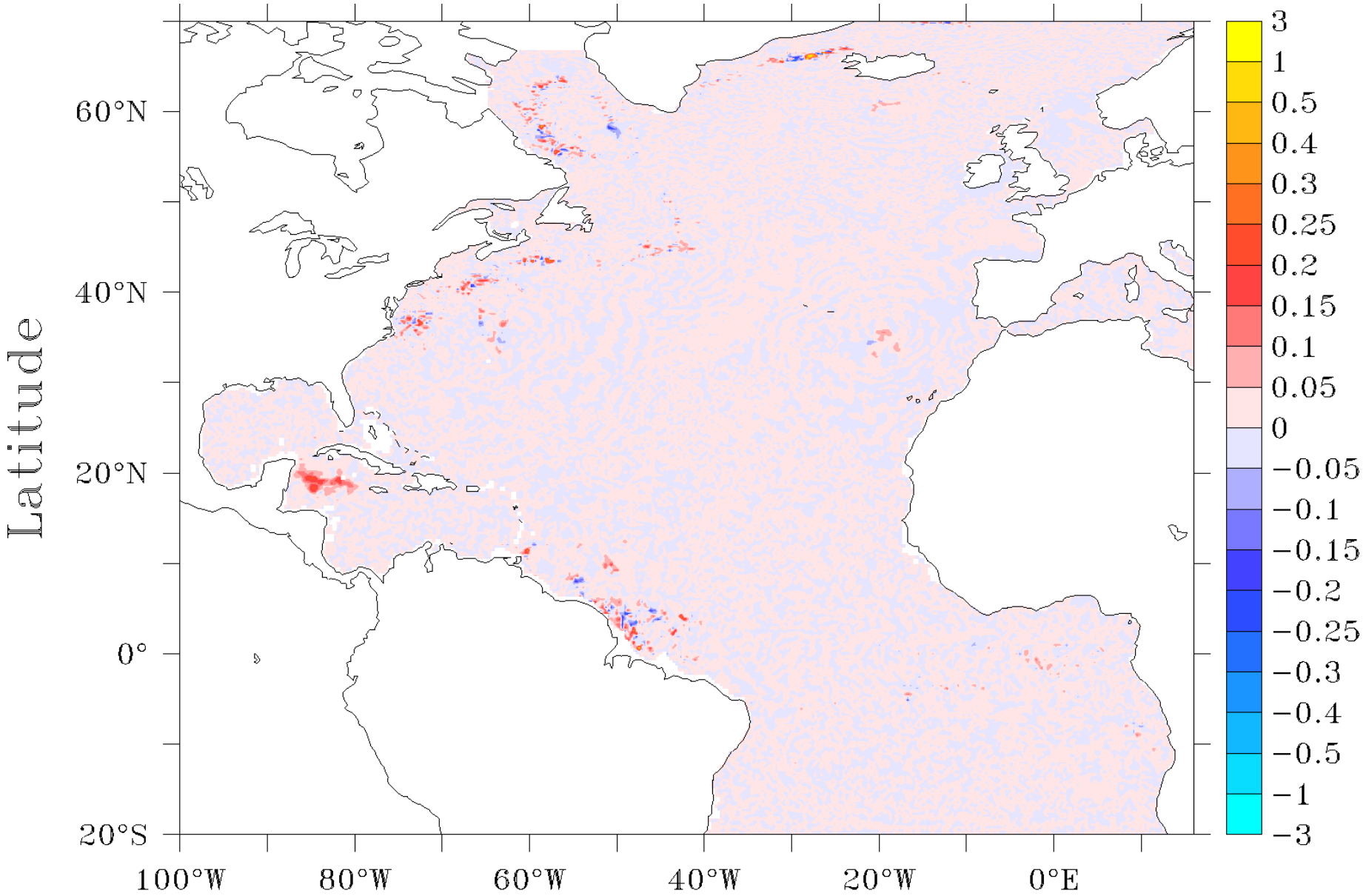
Surface increment of SSH after a 10-day forecast



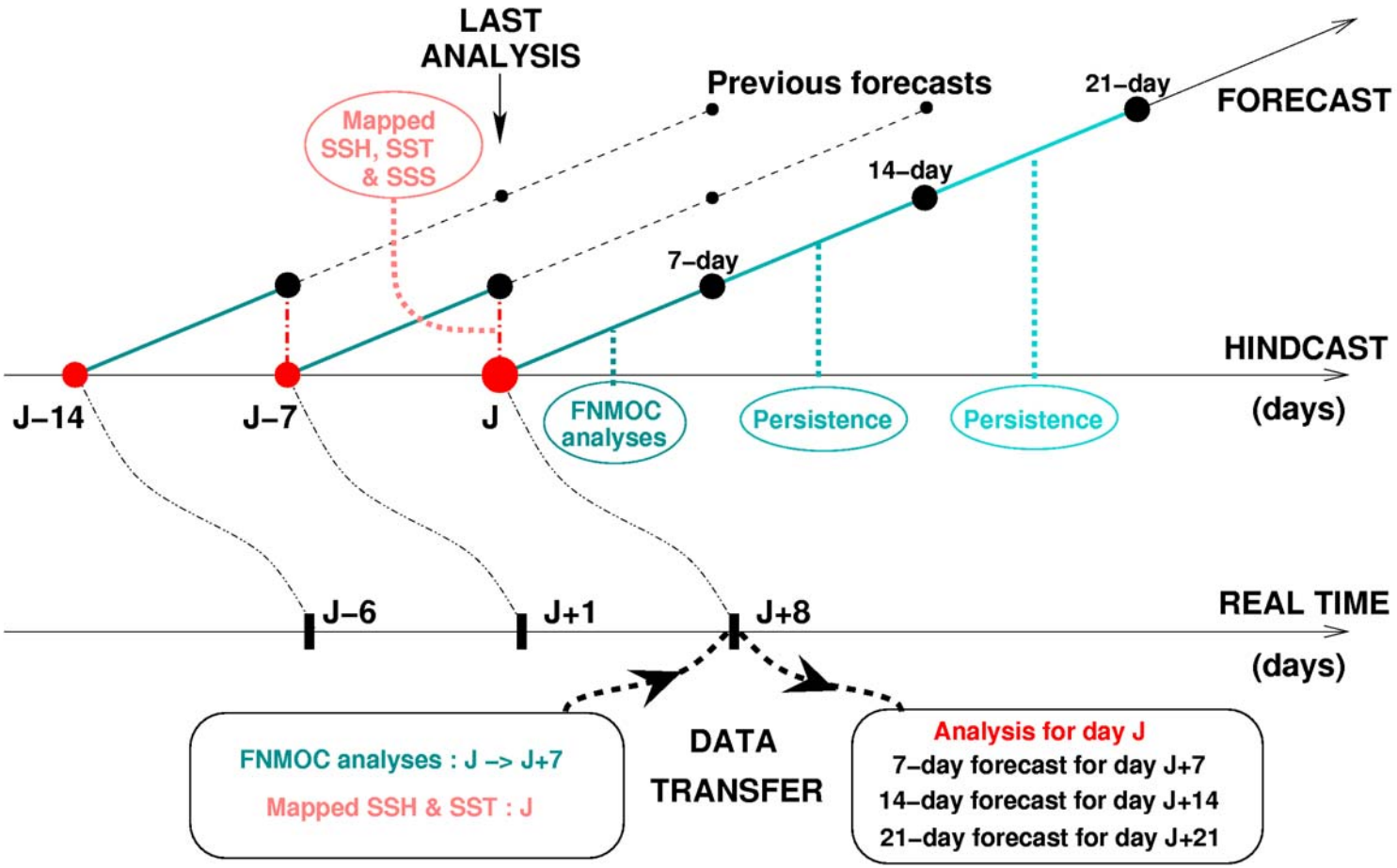
Surface increment of SST after a 10 day-forecast



Surface increment of SSS after a 10 day-forecast



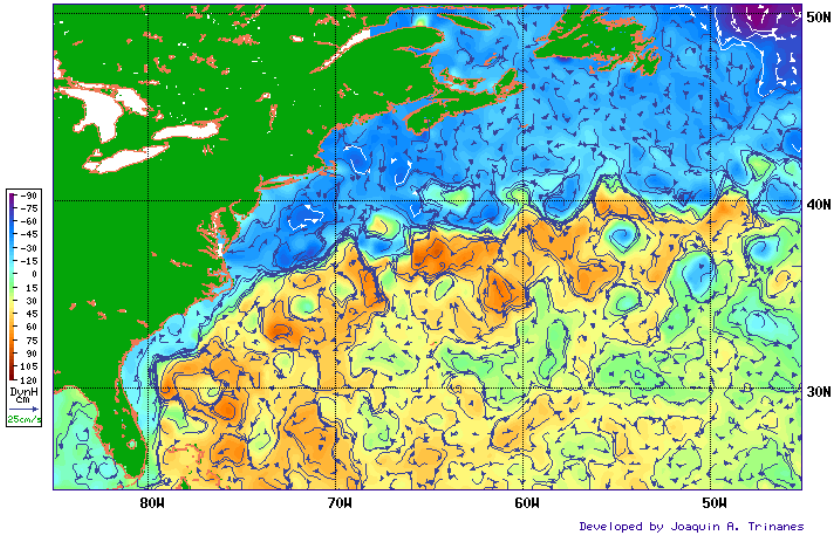
Real-time demonstration experiment: the weekly cycle



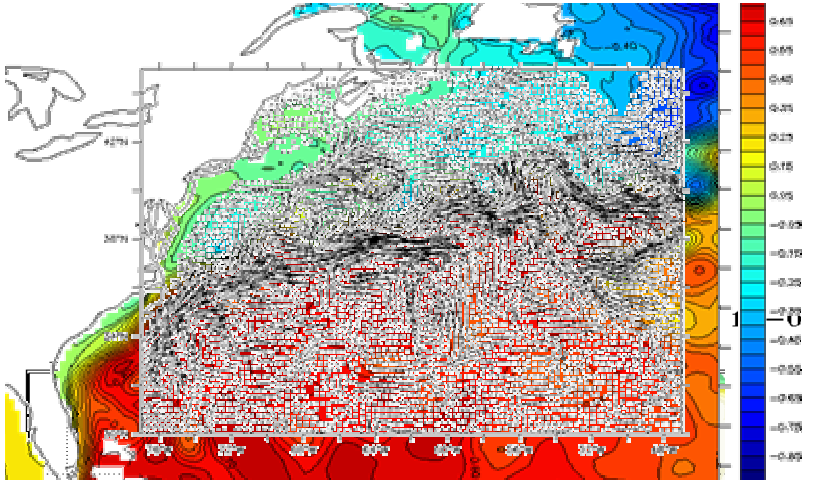
http://www-meom.hmg.inpg.fr/Web/Projets/TOPAZ/

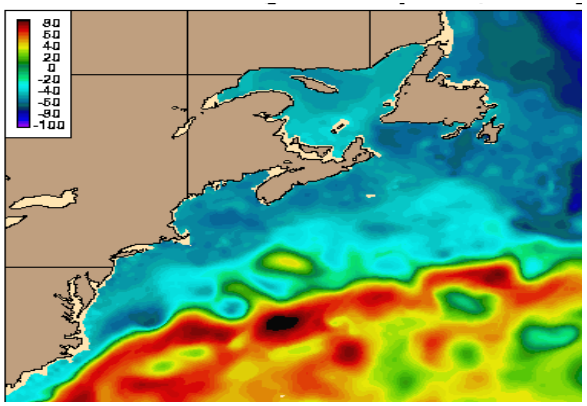
Gulf Stream analyses: Jun-18-2003

GOOS/CoastWatch (J Trinanes, NOAA/AOML)

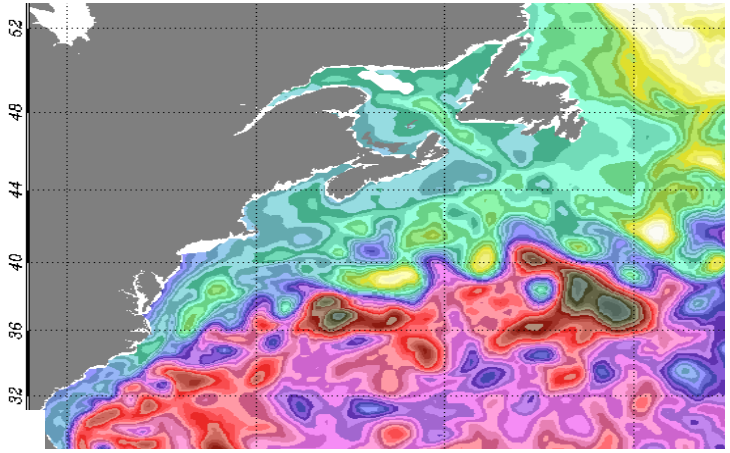


TOPAZ/SEEK (J.M. Brankart, CNRS/LEGI)





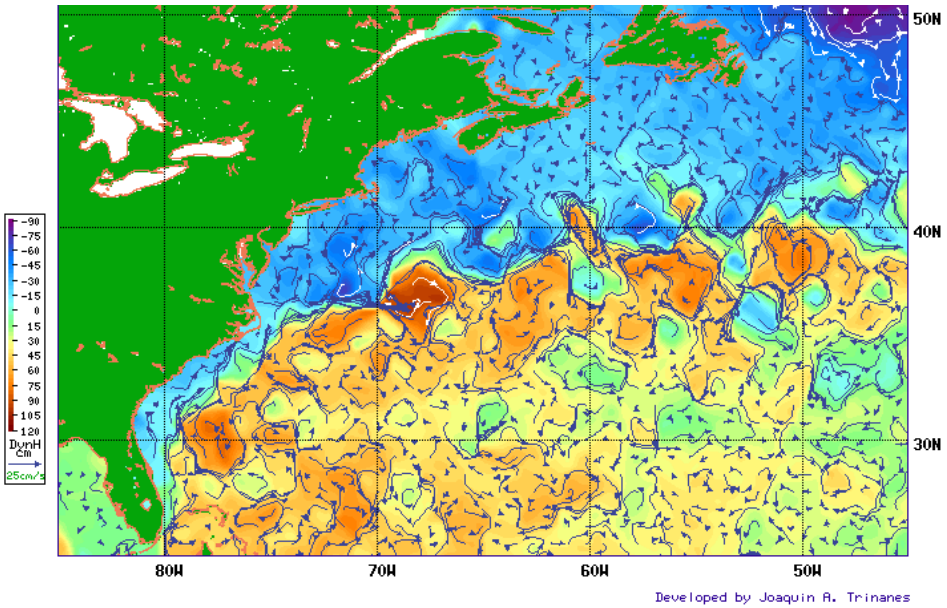
HYCOM/OI (O.M. Smedstad, PSI)

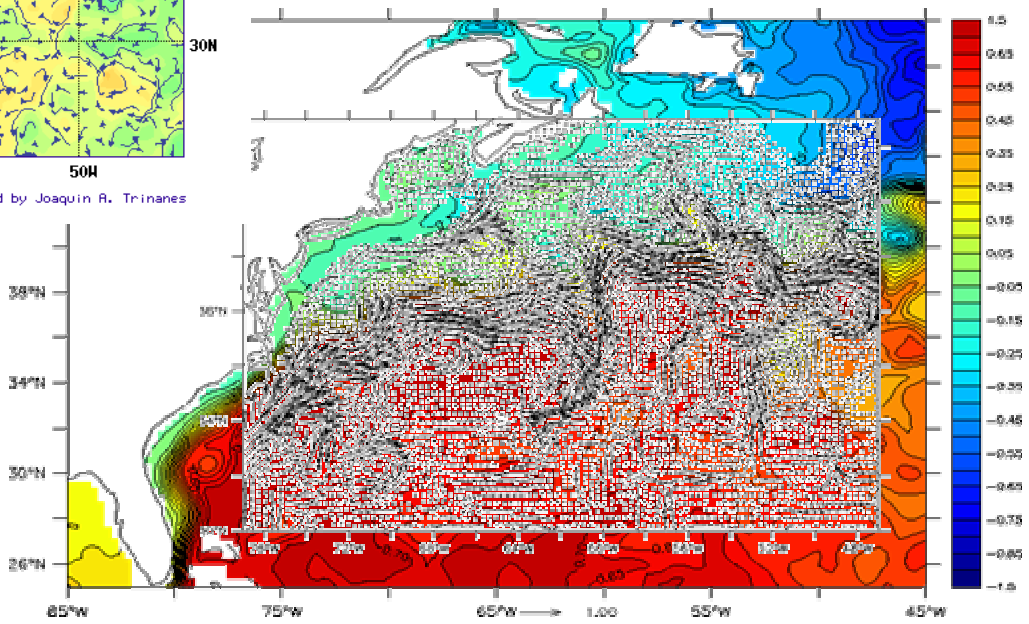


MERCATOR/SOFA (P. DeMey CNRS/LEGOS)

Gulf Stream forecast: Jul-16-2003

GOOS/CoastWatch (J Trinanes, NOAA/AOML)





TOPAZ/SEEK (J.M. Brankart, CNRS/LEGI)

Future plans and research activities

SEEK/HYCOM

1. Nested-grid data assimilation with HYCOM
2. From deep ocean … towards the shelf
3. Transition of a SEEK prototype for intercomparison exp.

SEEK/OPA

1. MERCATOR: implementation in the 1/15° North Atlantic
2. E.U. MERSEA project:
   - further R&D in the perspective of global HR prototypes
   - assimilation into 1/3 NA coupled physical/NPZD model
3. SEEK smoother in the Tropical Pacific

Discussion

Towards operational D.A. implementations : a few guidelines

1. **Theoretical framework: from OI to Ensemble Methods**
2. **Computer cost** (and human resources !)
3. **Assimilation of multivariate data: SLA, SST, clim SSS in situ profiles, …**
4. **Scientific community working on research and development in the long term**