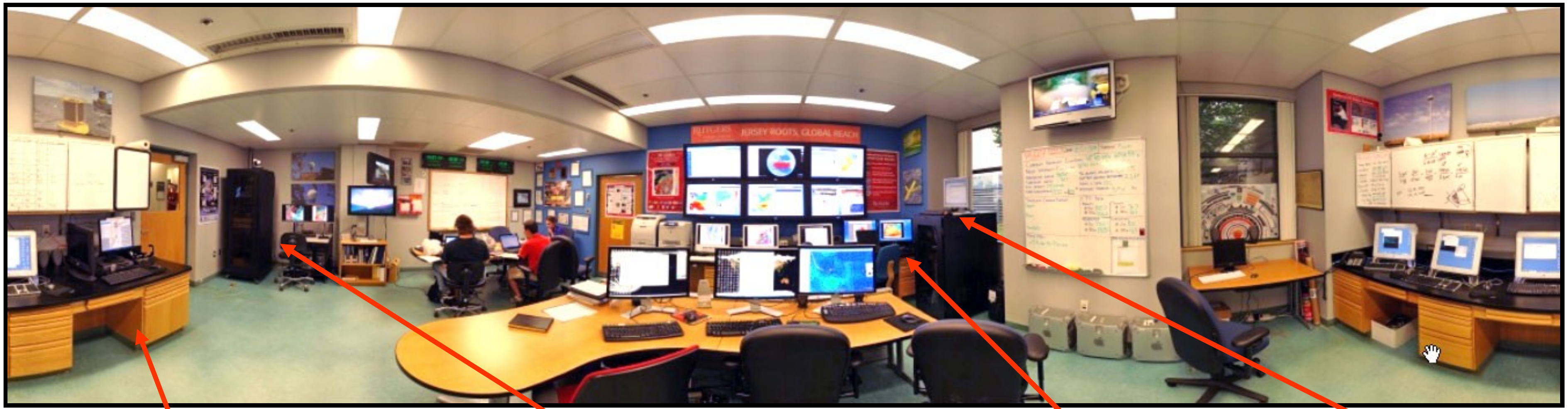
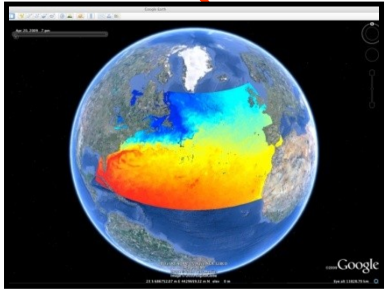
Observatory Simulation Experiment: Rise of the Machines

Rutgers University - Coastal Ocean Observation Lab

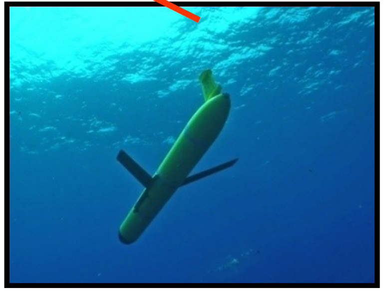


CODAR Network

L-Band & X-Band Satellite Receivers



3-D Nowcasts & Forecasts



Glider Fleet

Whose who in RU COOL?

Faculty


S. Glenn
Physics


O. Schofield
Biology


J. Kohut
Phys/Bio


R. Chant
Physics


R. Dunk
Physics


J. McDonnell
Education


M. Gorbunov
Biology


J. Wilkin
Modeling


U. Kremer
Comp. Sci.


D. Pompili
Engineer

Gliders


C. Haldeman


T. Haskins


D. Aragon


K. Coleman

CODAR


E. Handel


H. Roarty


M. Smith


E. Rivera

Satellites


L. Ojanen


M. Crowley

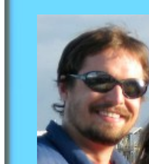
Software


J. Kerfoot


I. Heifetz


E. Hunter

Undergrad & Grad Students



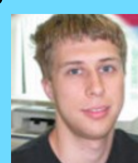
Coordinator


C. Kohut

Modeling

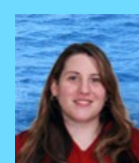

H.Arango


L. Bowers

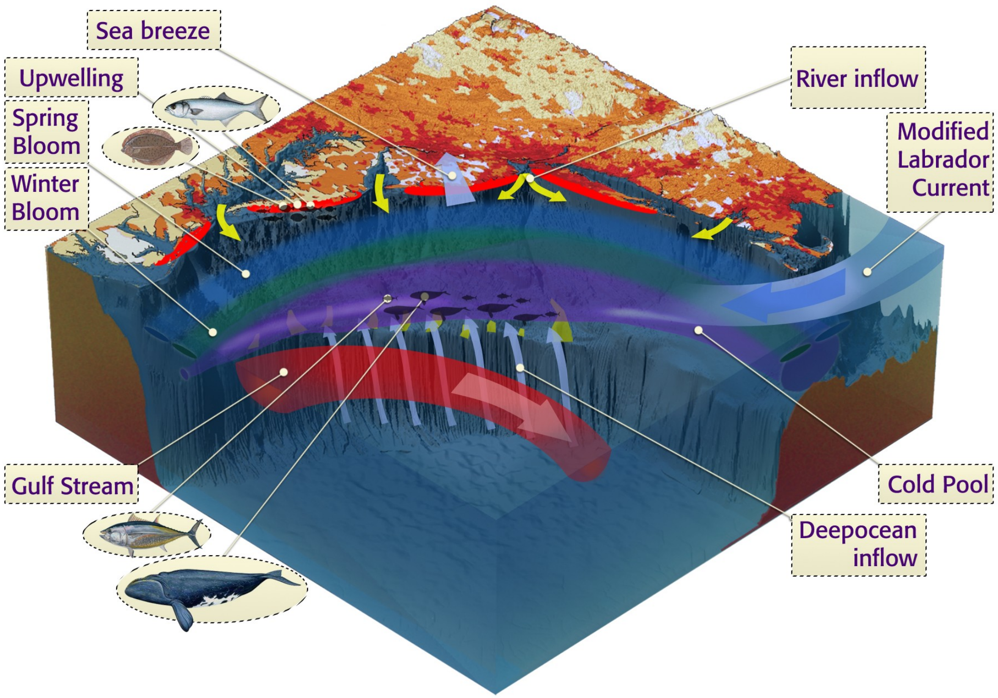

D. Robertson

Education


S. Lichtenwalner


C. Ferraro

Science driven experiments to enables technical developmen



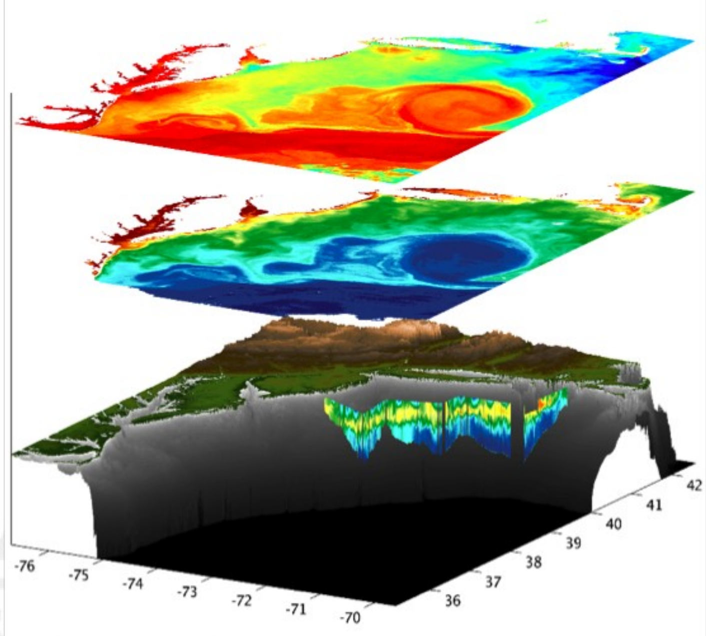
For those using or discussing gliders

27 publications since 2005

Transition in last 3 years from technical engineering manuscripts to science results

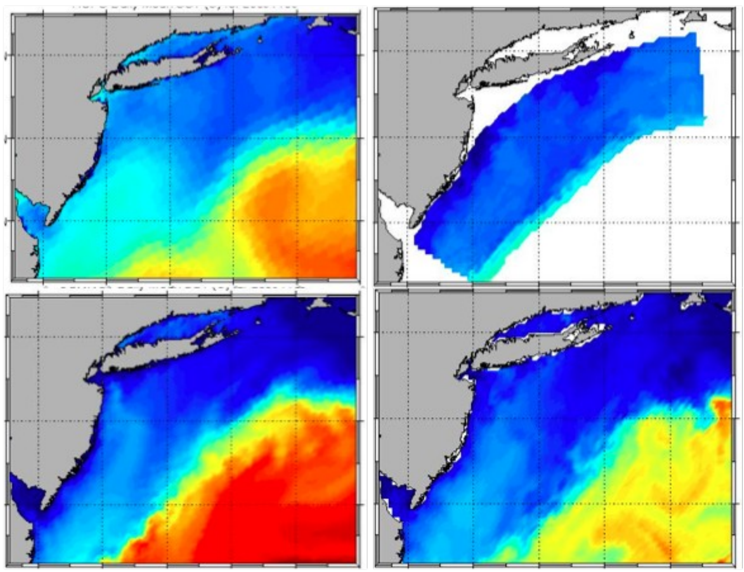
The COOL group provides a rich engineering/science environmental test-bed that allows for technology development locally before being transplanted globally

Data

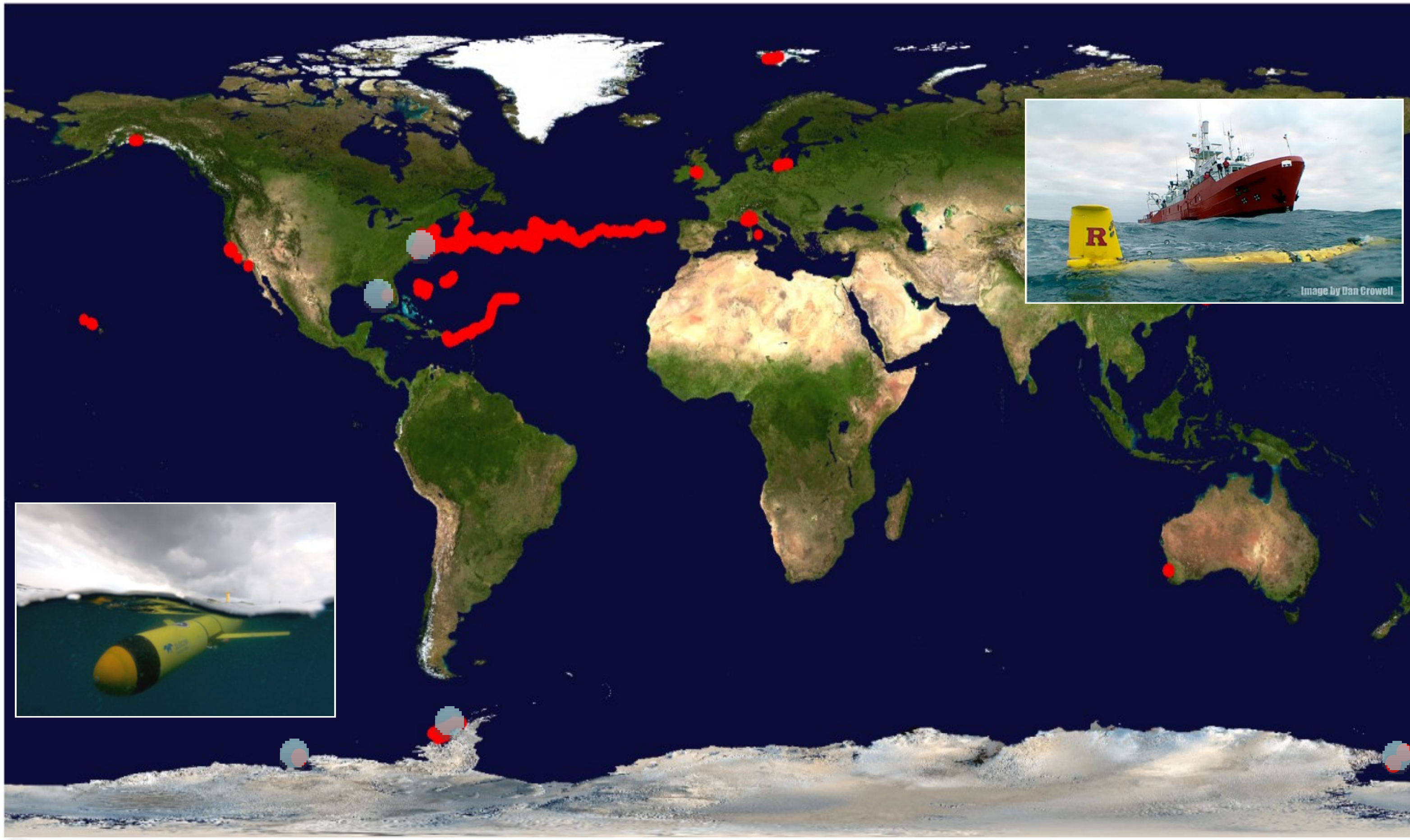


⇄

Ensembles of Numerical Models



RU-COOL Global Slocum Glider Fleet Deployments



Fleet Statistics:

- 259 Deployments
- 3987 In-water days
- 93000km flown (2.3 times around the Earth)

The Ocean Observatory Initiative (OOI) will develop an interactive laboratory integrated by a leading-edge, multi-scalar cyberinfrastructure

Currently in construction phase with 5 implementing organizations leading large consortia of academic partners

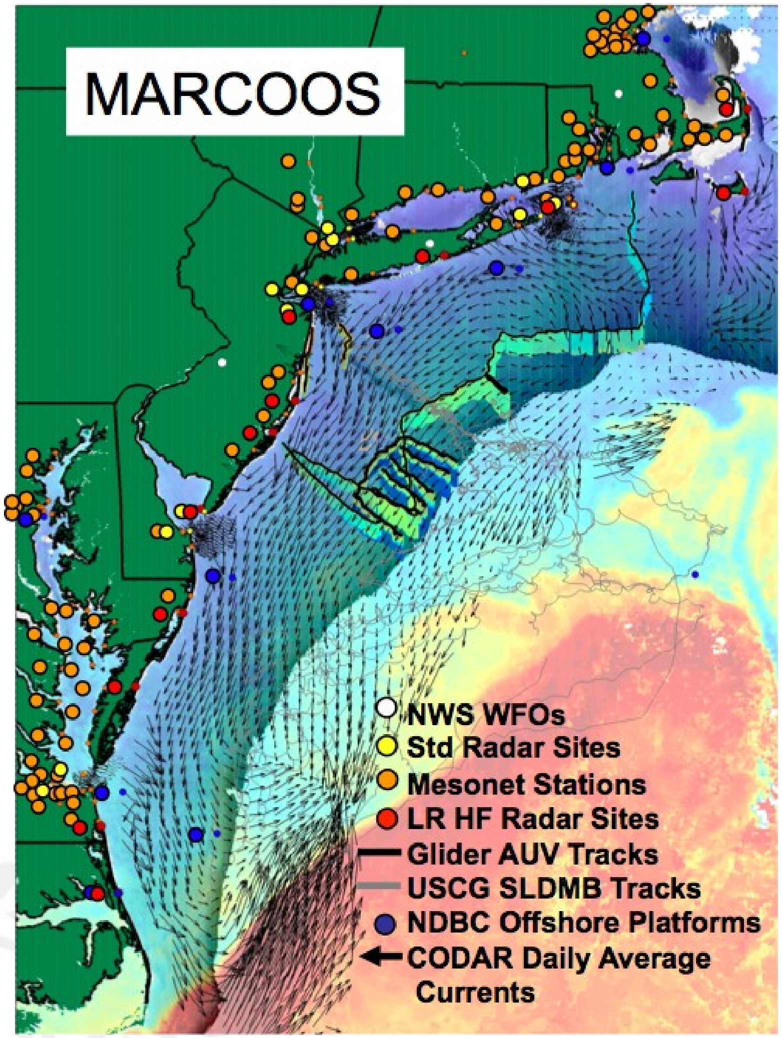
Coastal Global Networks: WHOI & OSU (PI)

Regional Cable Network: U. Washington (PI)

Cyberinfrastructure: Scripps (PI)

Education & Public Engagement: Rutgers (PI)

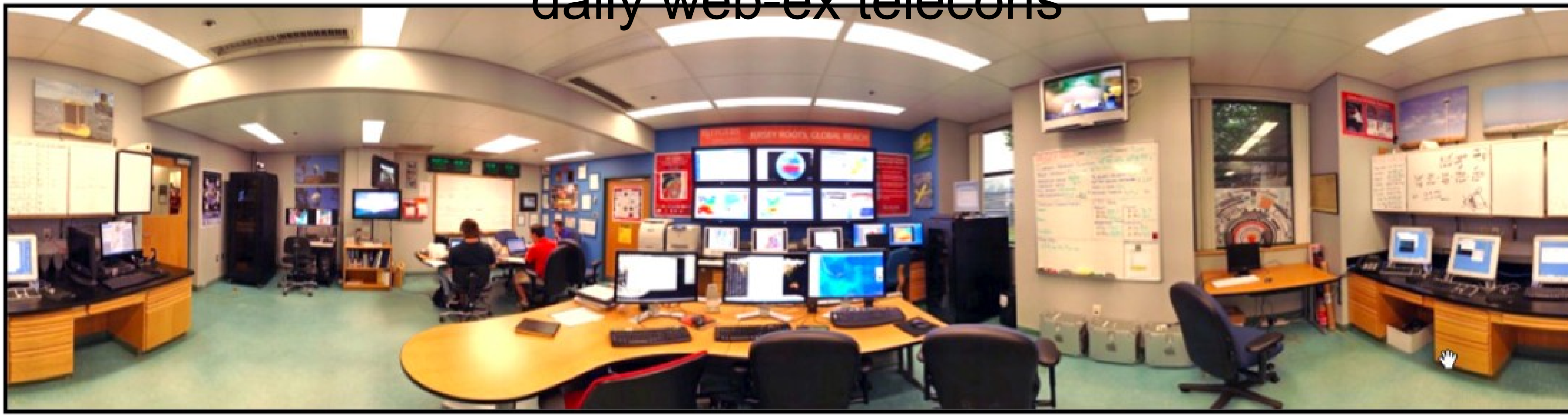
NOAA Integrated Ocean Observing System (IOOS)

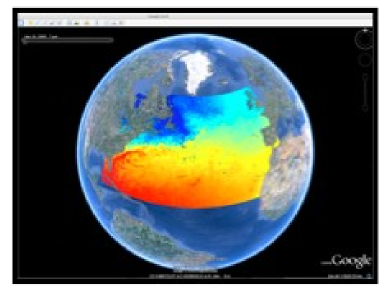


To test the software, OOI used an existing ocean network. The test engaged scientists from across the country who used the software to enable their science. For OOI, the network provided an ideal "real world" test

<u>Participating Institutions</u>: Rutgers, MIT, Scripps, Wood Hole, NRL, U Mass, U Maryland, JPL, WHOI, Cal Poly, U Del, Stevens, OSU, USGS, NOAA, NURC, NWS(~125 scientists & engineers)

OSE (Observatory Simulation Experiment) was coordinated in COOL room, blogging, a social portal, and daily web-ex telecons





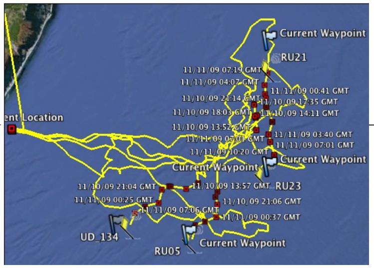
HF Radar

Satellites

3D Now- & Forecasts

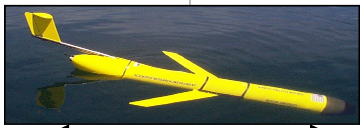
Robots

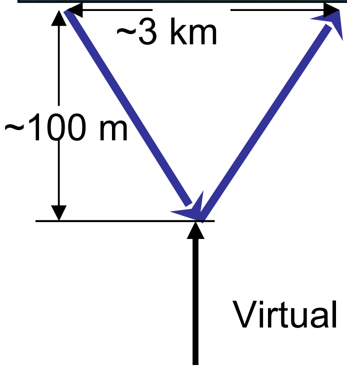
Design, Testing and Deploy



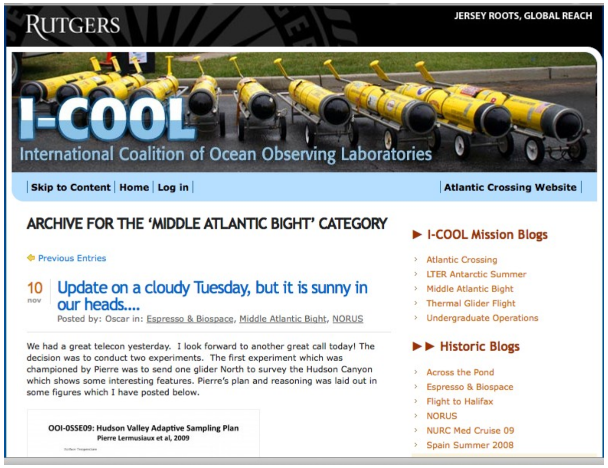
Observatory (simulated) data

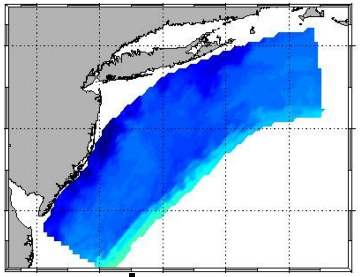
Models



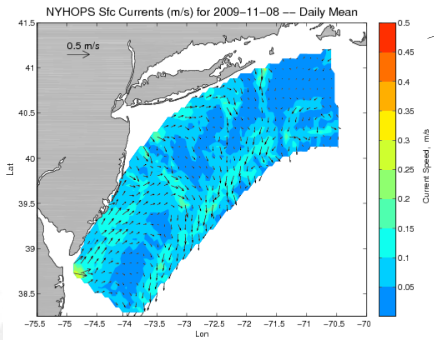


Sensor & Platform

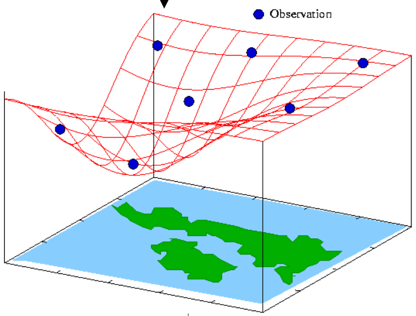


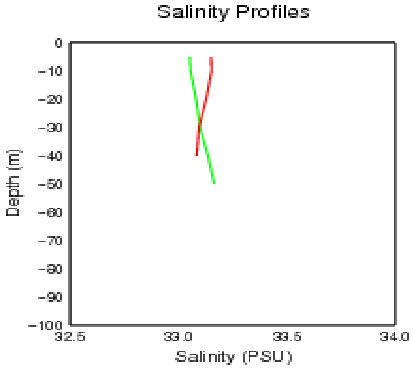


Virtual Ocean



Data Assimilation



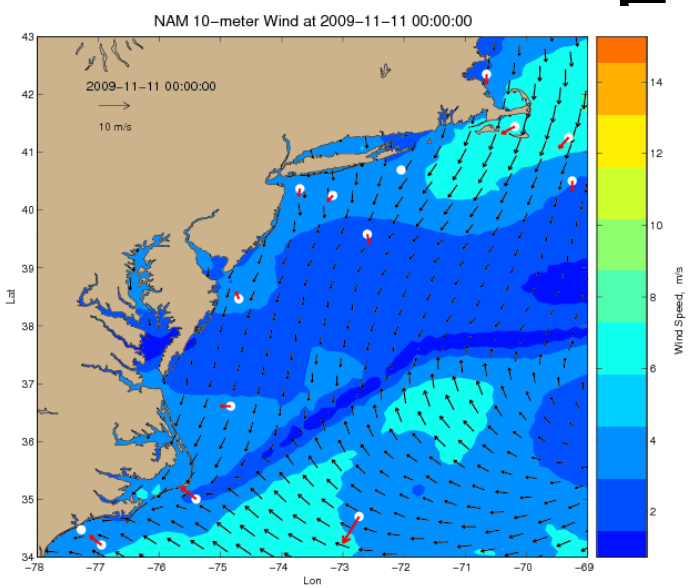


Data Analysis

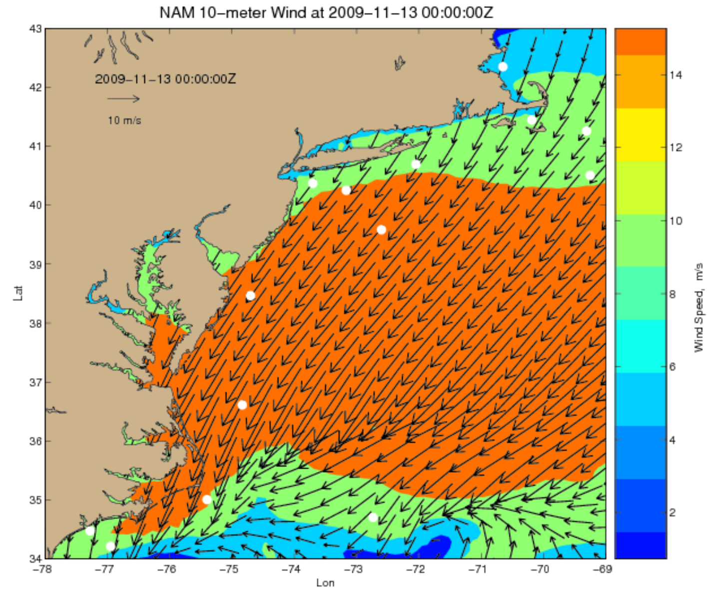
Science Questions & Drivers

Data Synthesis: Nowcast & Data Impact

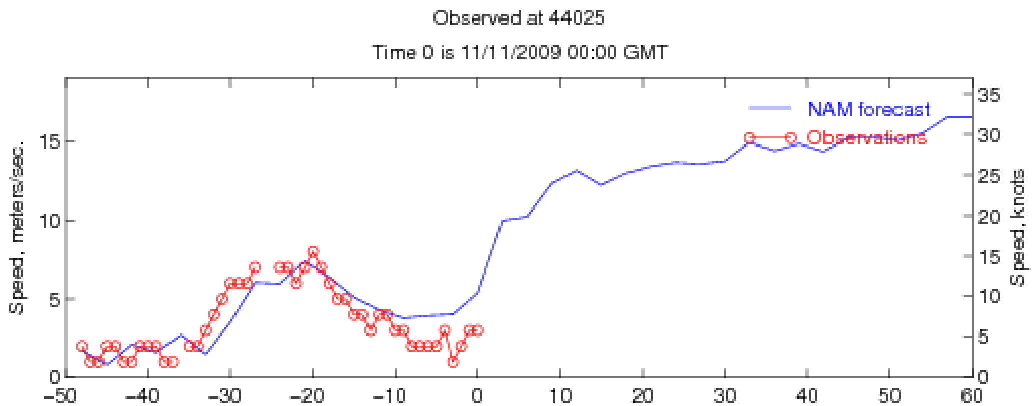
W



NAM 10−meter Wind at 2009−11−11 00:00:00
2009−11−11 00:00:00
10 m/s
Lat
Lon
Wind Speed, m/s

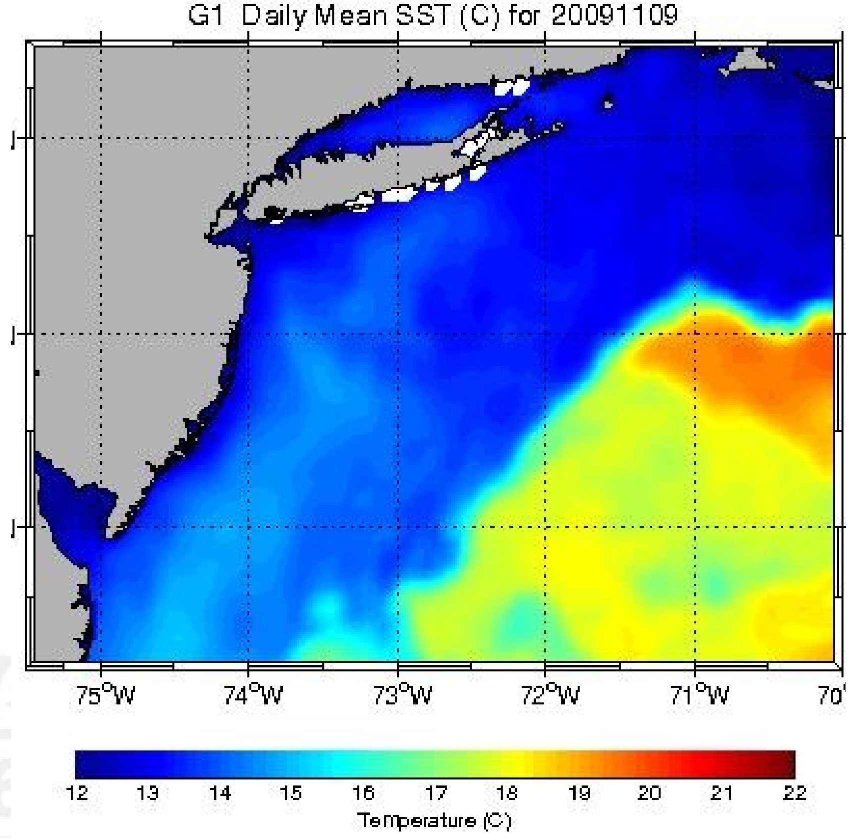


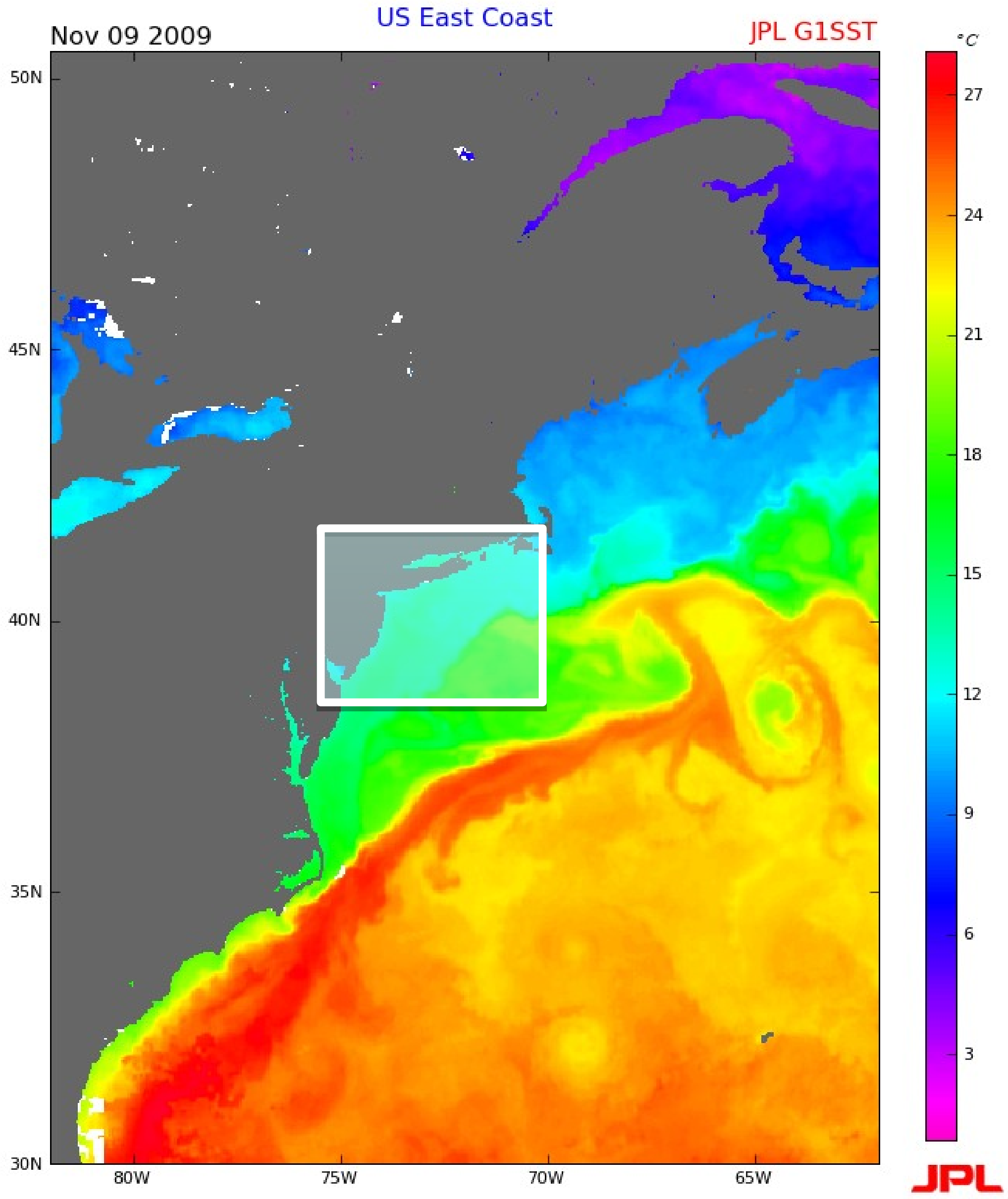
NAM 10−meter Wind at 2009−11−13 00:00:00Z
2009−11−13 00:00:00Z
10 m/s
Lat
Lon
Wind Speed, m/s



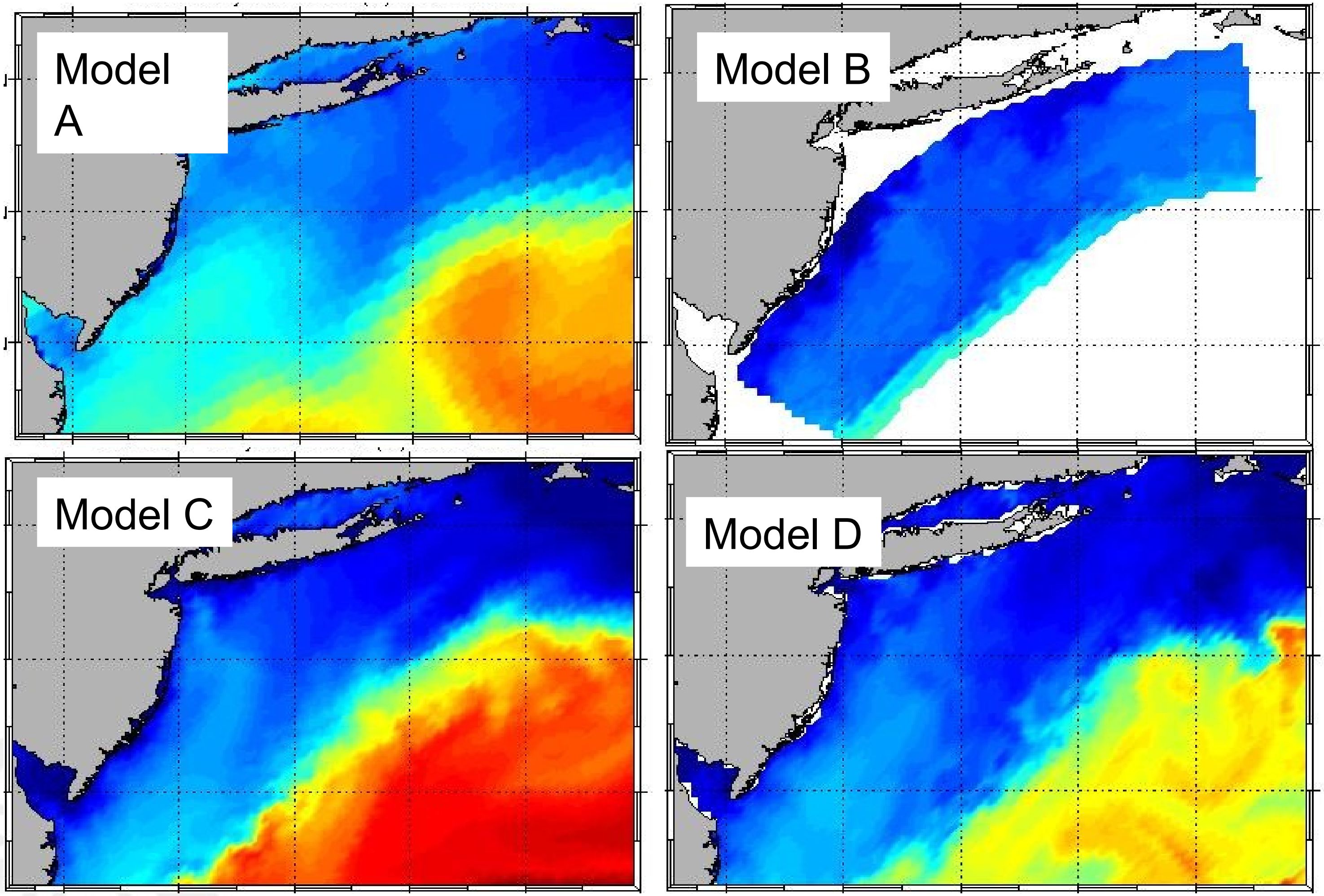
Observed at 44025
Time 0 is 11/11/2009 00:00 GMT
NAM forecast
Observations
Speed, meters/sec.
Speed, knots

Multiple Satellite passes of varying resolution

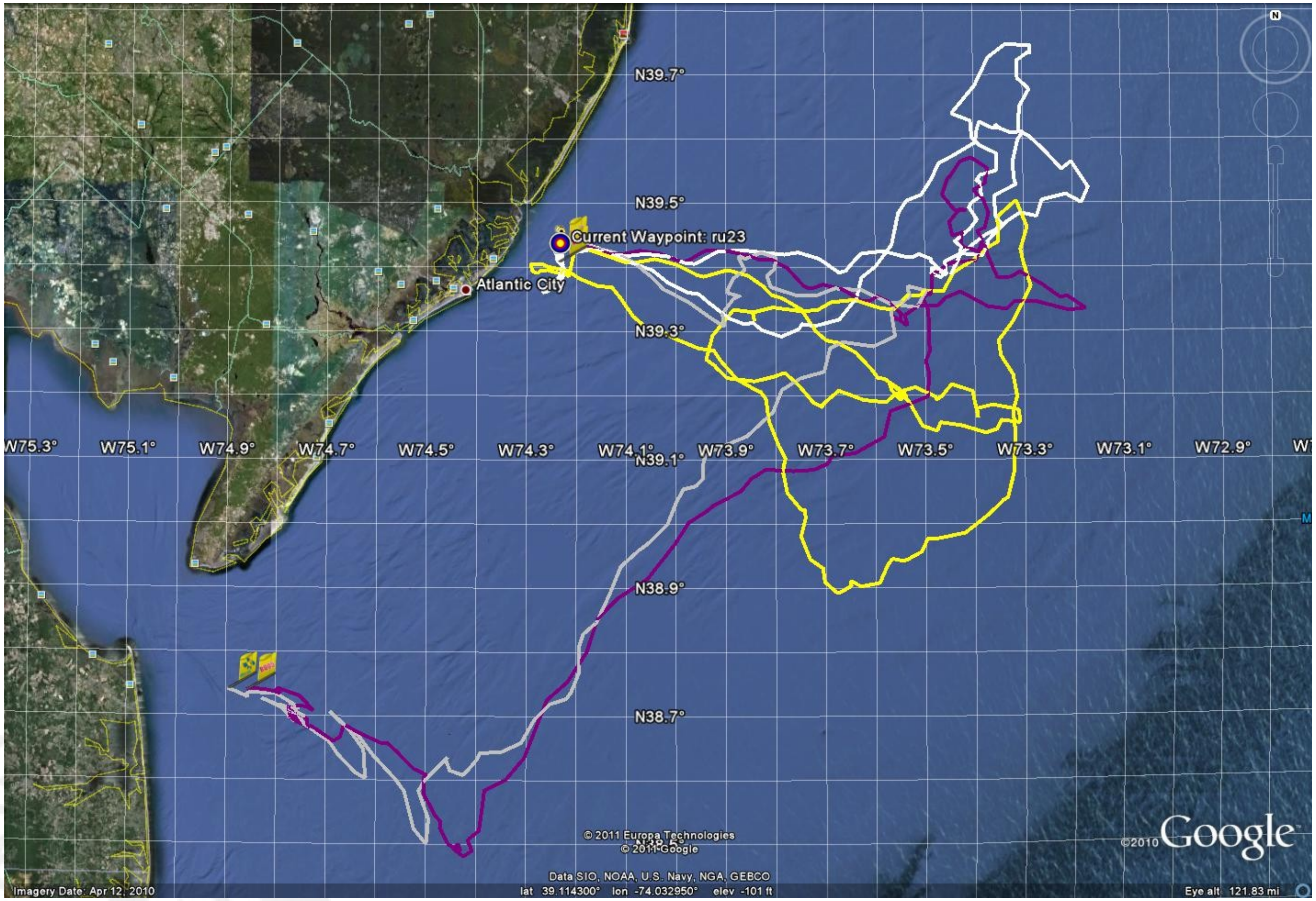




An ensemble of different numerical models run by different laboratorie



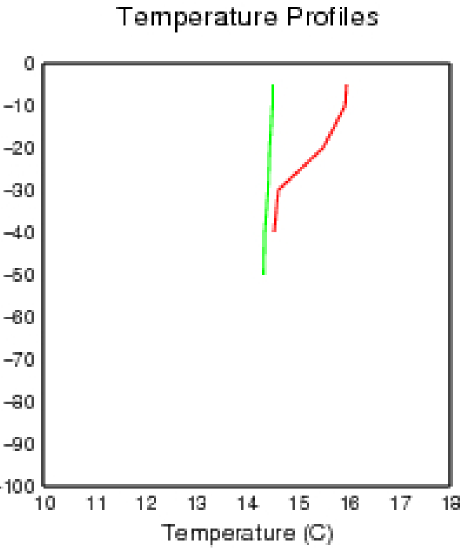
A fleet of four gliders
October 30 – November 20, 2009

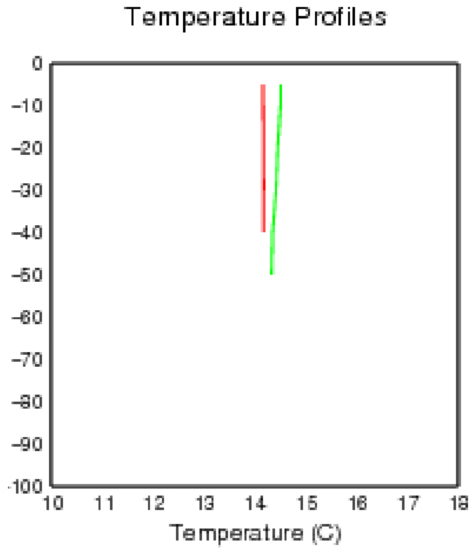


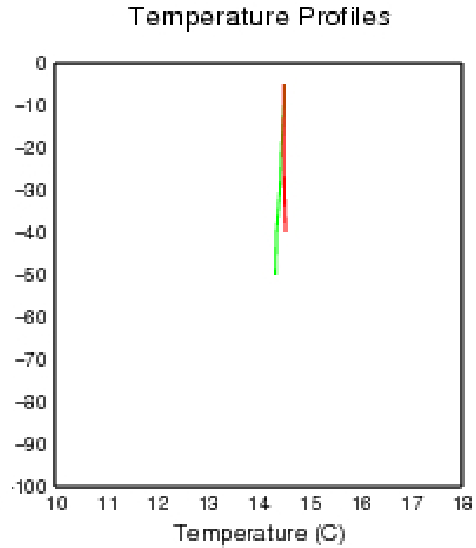
4 Deployments (3 Rutgers, 1 University of Delaware)

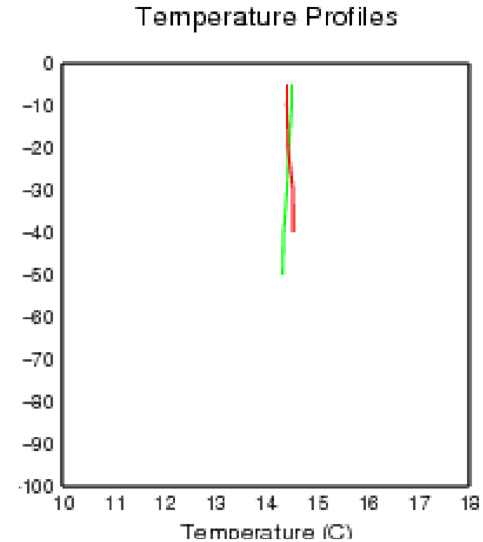
77 in-water days

1608 km flown







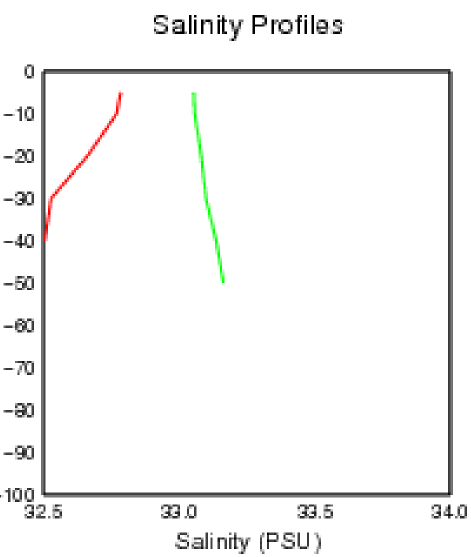


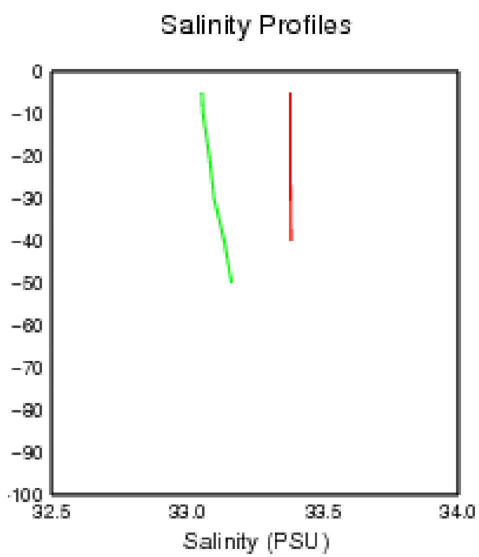
Model A

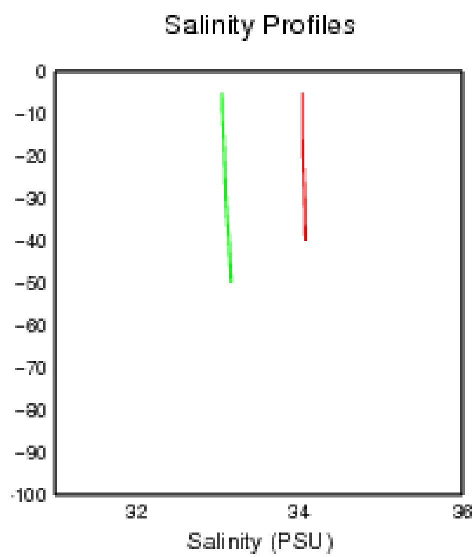
Model B

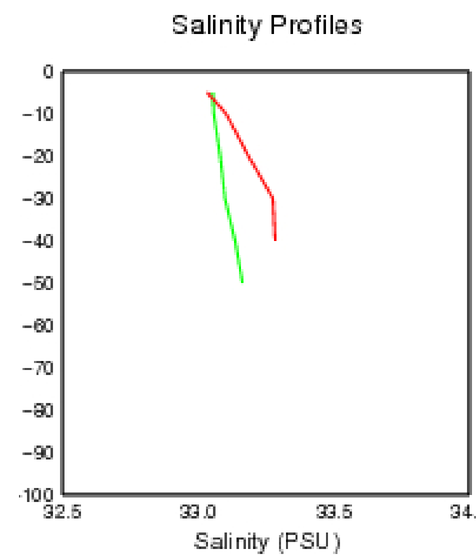
Model C

Model D

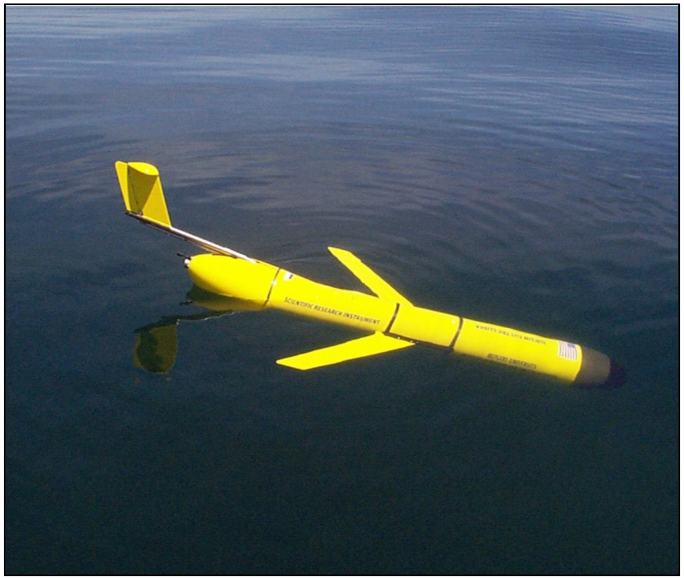




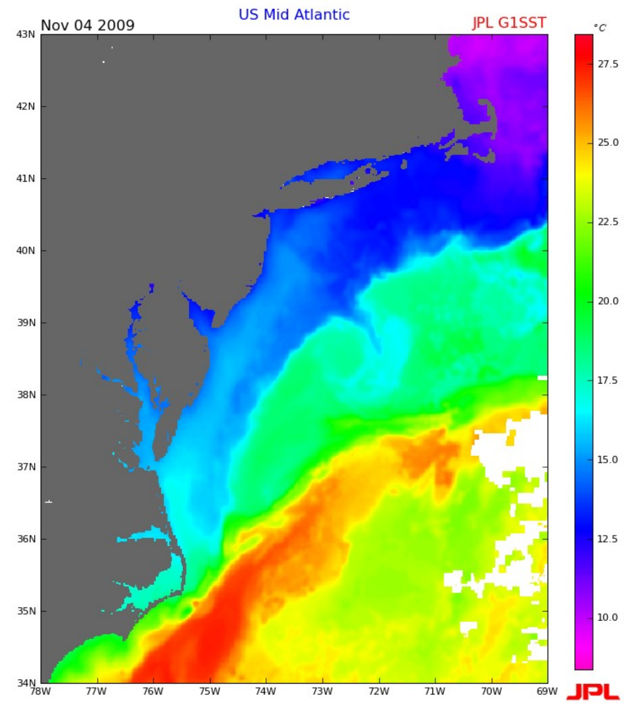




COMBINING THE FIELD ASSETTS WITH OCEAN FORECASTS FOR PLANNING AND PROSECUTION EFFORTS

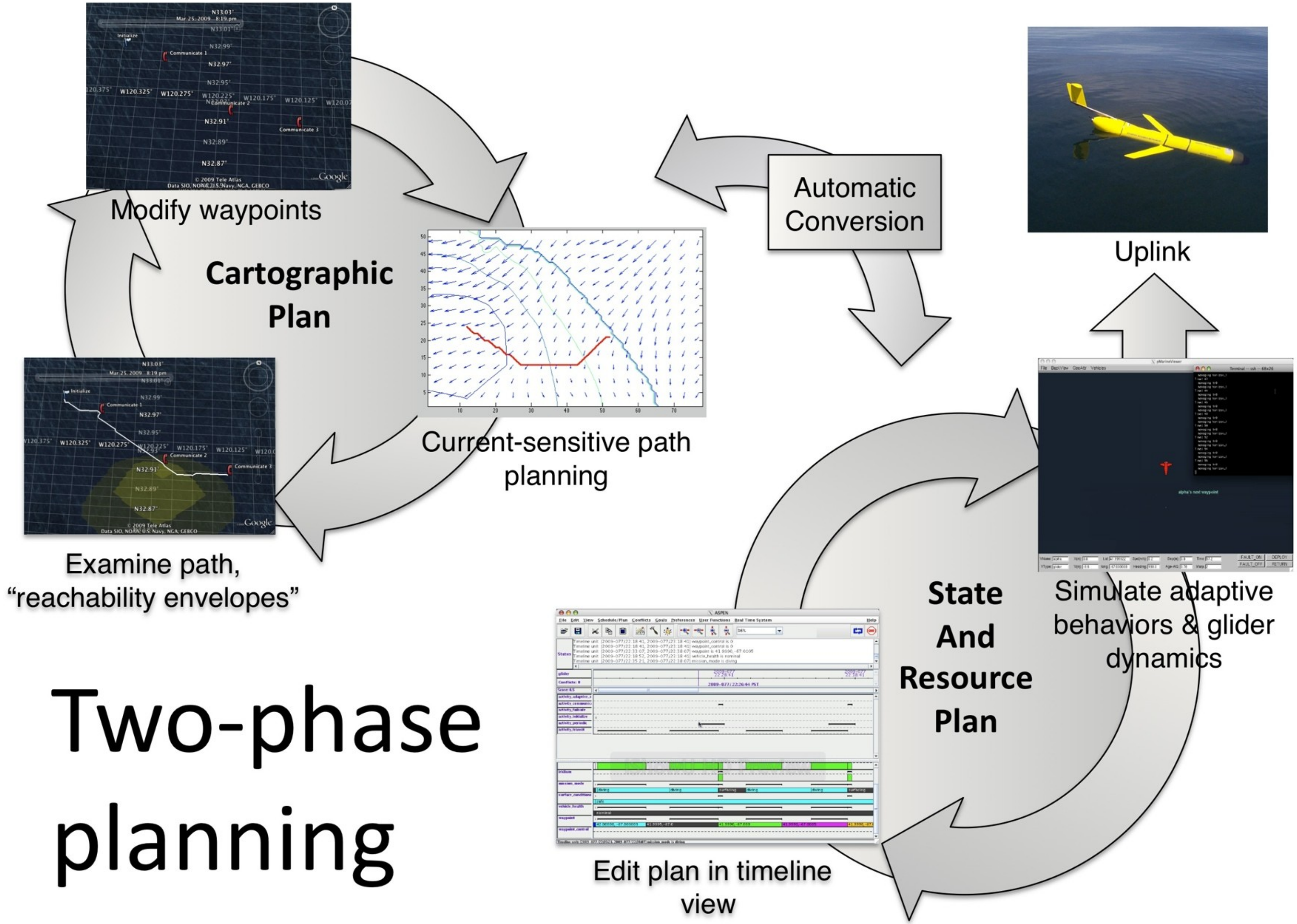


- Known constraints (slow 0.5 knot, Battery, shipping lanes)
- Uncertain constraints (time-varying 3D currents)
- Operate autonomously & re-plan daily

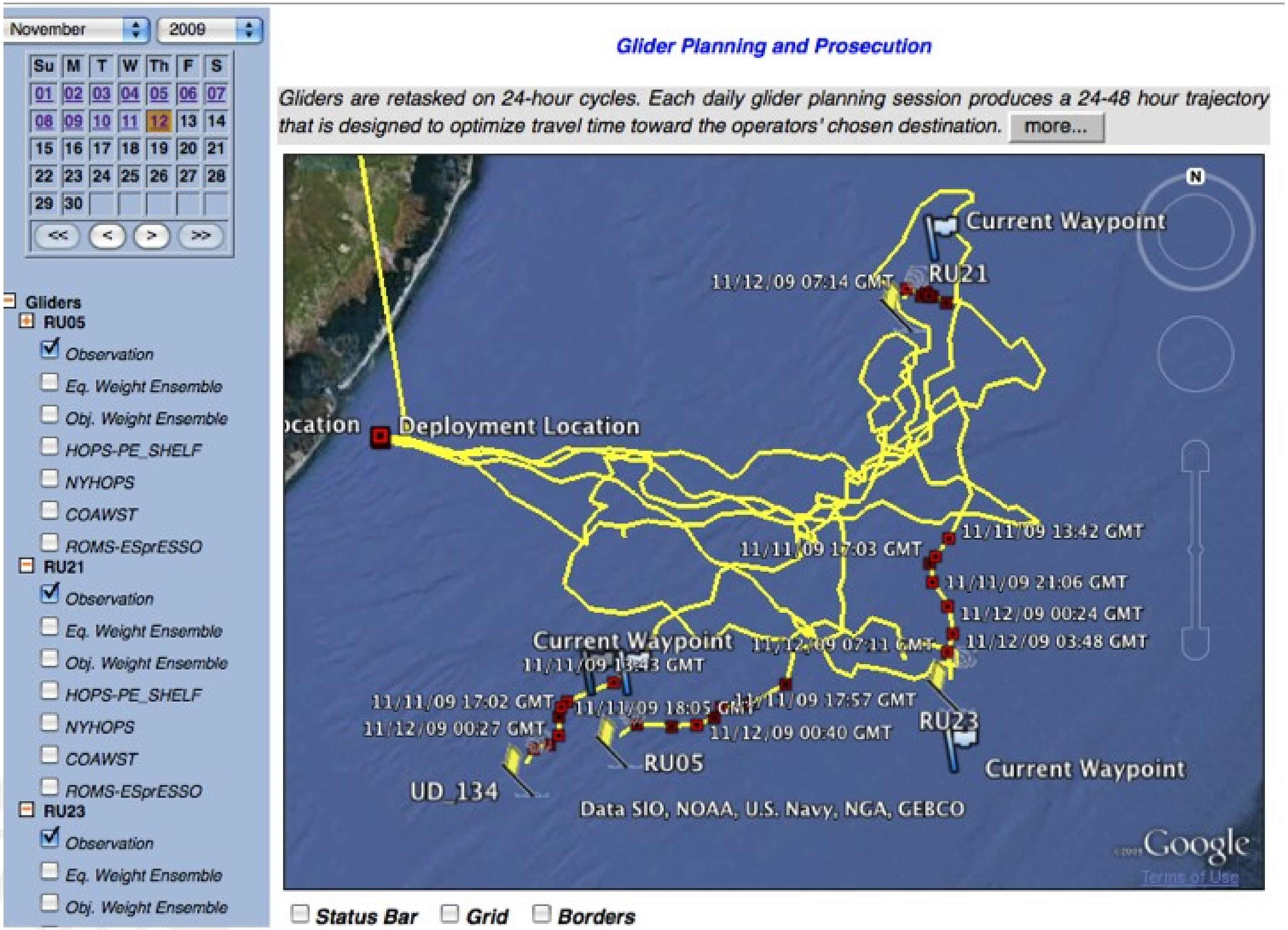


- From A to B in the shortest time
- Follow a time-varying feature (shelf-slope salinity intrusion)

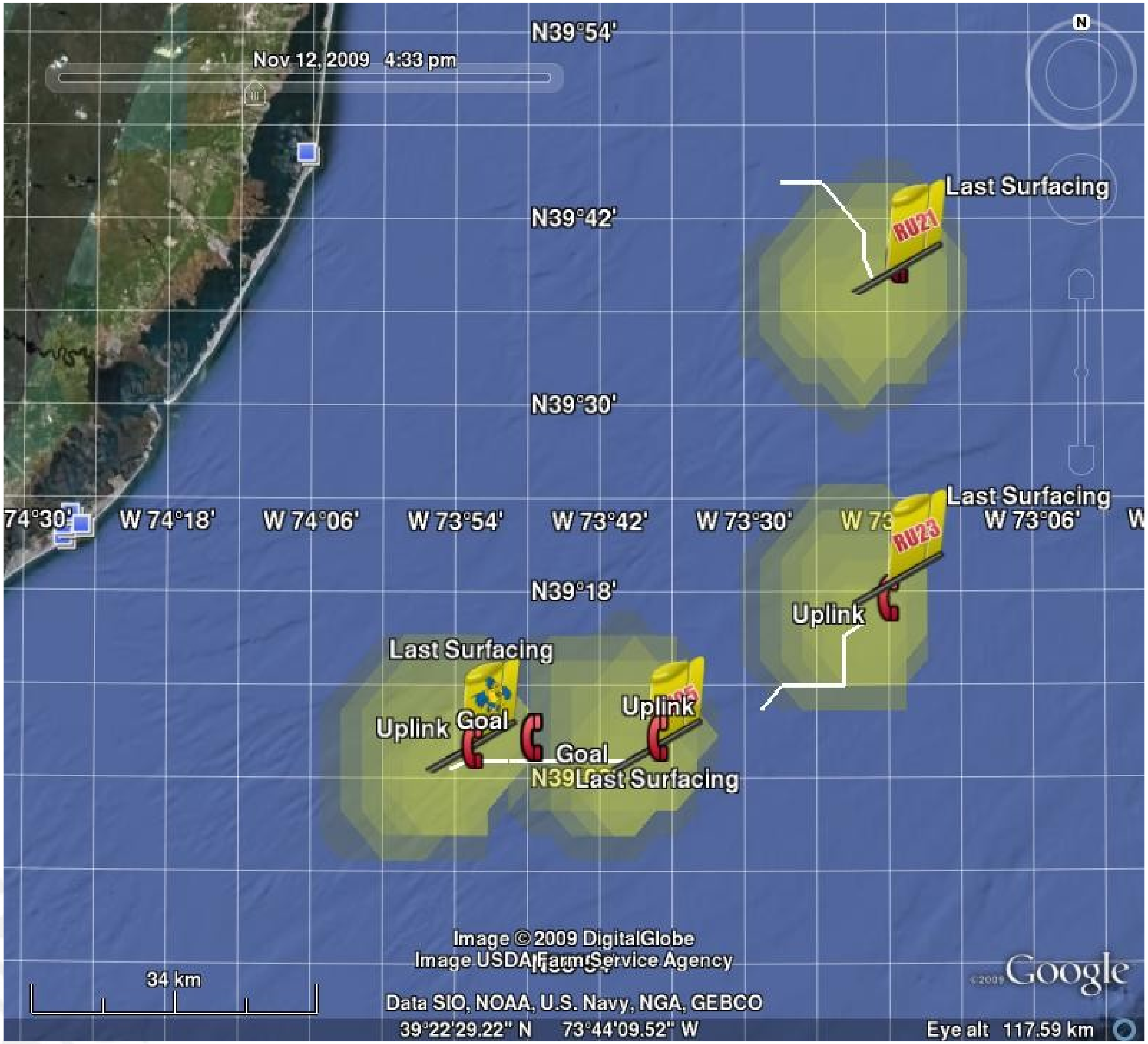
Two-phase planning

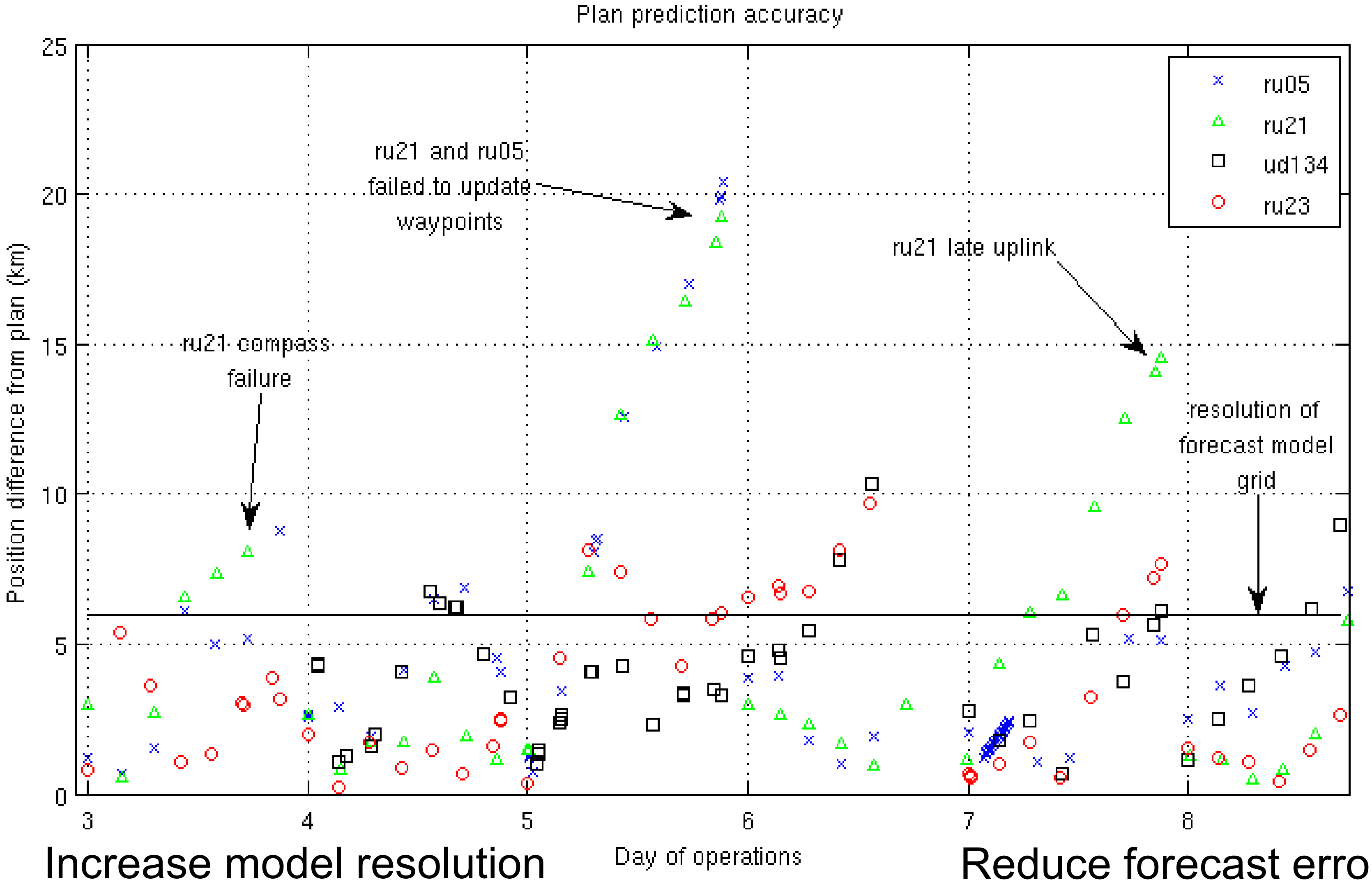


PLANNING FOR THE PRESENT



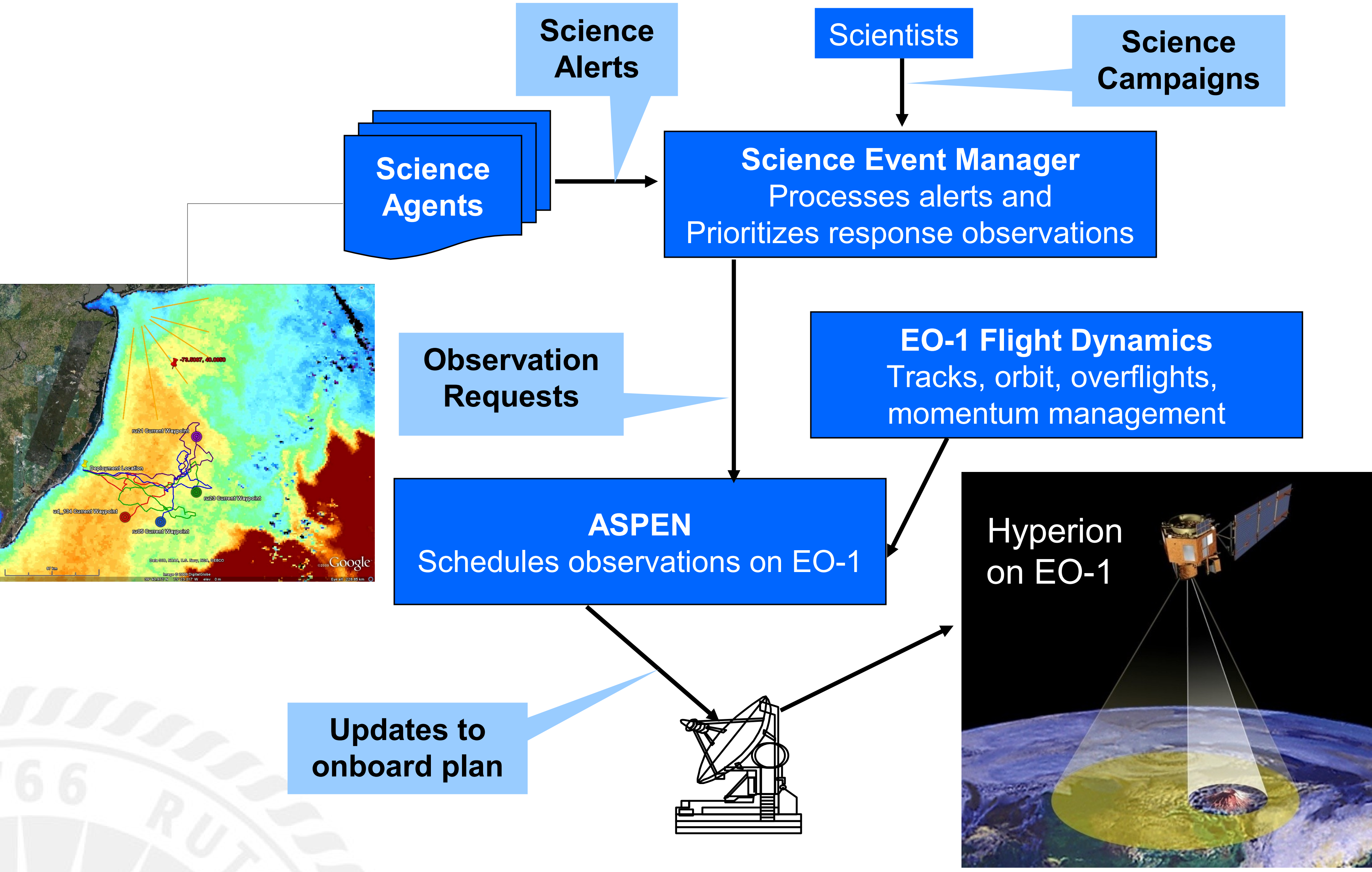
PLANNING IN THE FUTURE



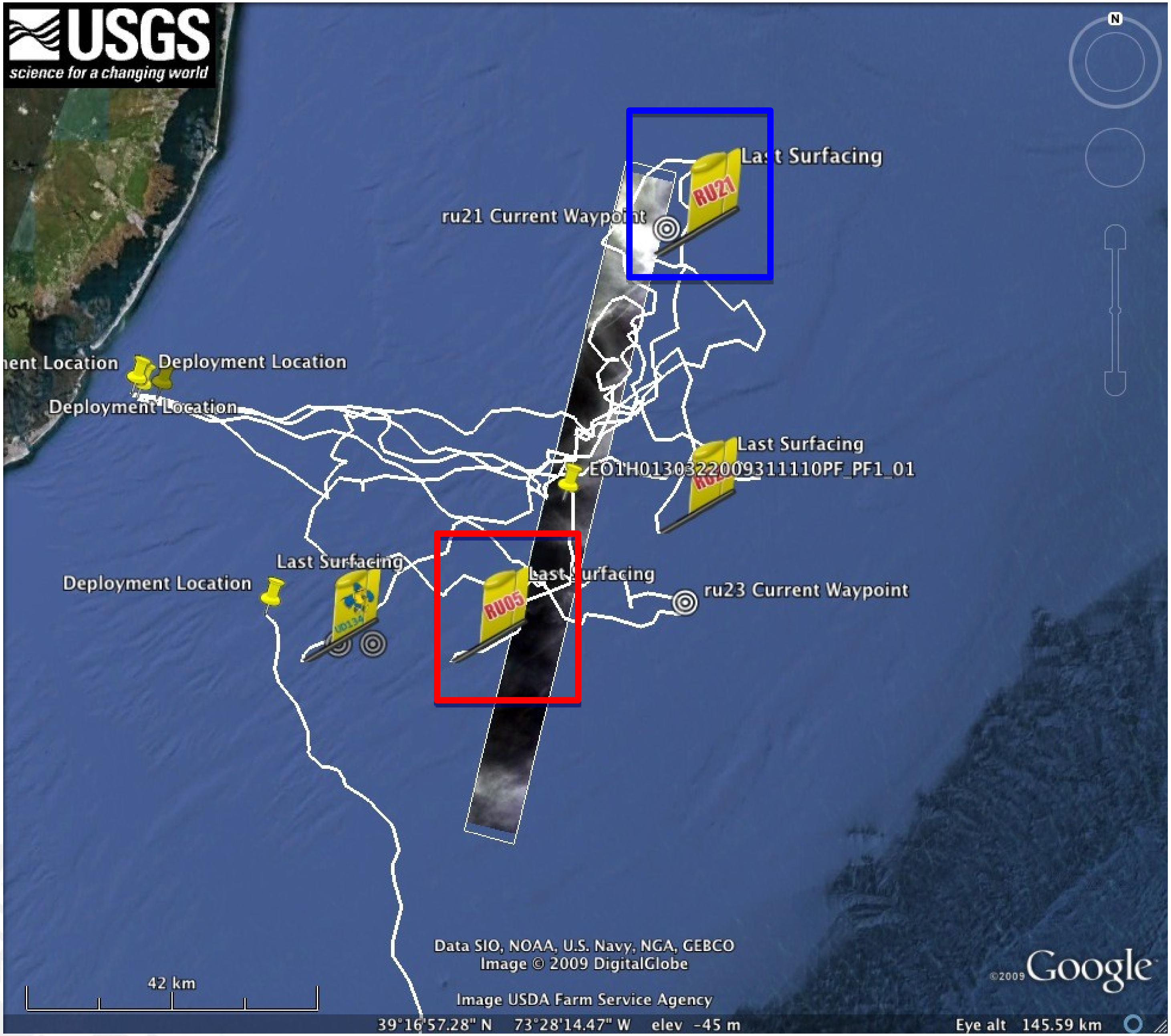


Increase model resolution

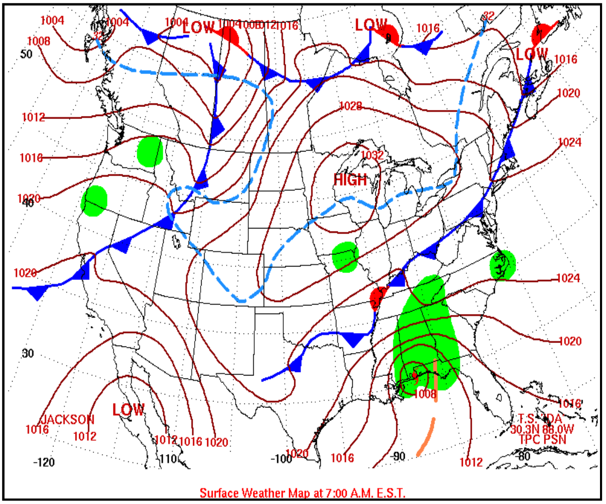
Reduce forecast error



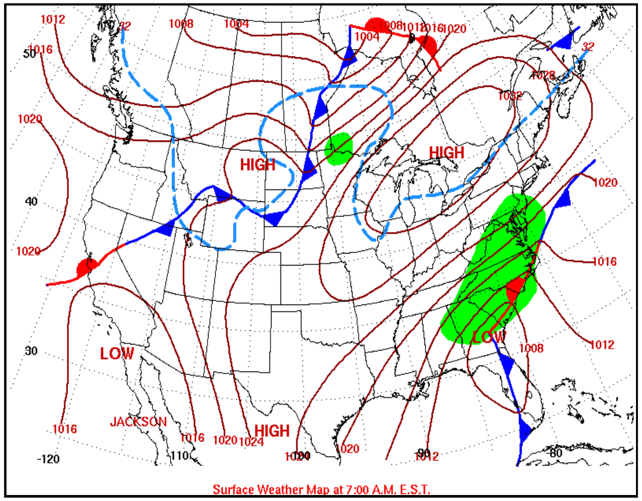
Science Alerts
Scientists
Science Campaigns
Science Agents
Science Event Manager
Processes alerts and
Prioritizes response observations
Observation Requests
EO-1 Flight Dynamics
Tracks, orbit, overflights,
momentum management
ASPEN
Schedules observations on EO-1
Hyperion
on EO-1
Updates to onboard plan


USGS
science for a changing world
Last Surfacing
RU21
ru21 Current Waypoint
ent Location
Deployment Location
Deployment Location
Last Surfacing
E01H0130322009311110PF_PF1_01
Last Surfacing
Deployment Location
Last Surfacing
RU05
ru23 Current Waypoint
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2009 DigitalGlobe
Image USDA Farm Service Agency
42 km
39°16'57.28" N 73°28'14.47" W elev -45 m
Eye alt 145.59 km
©2009 Google

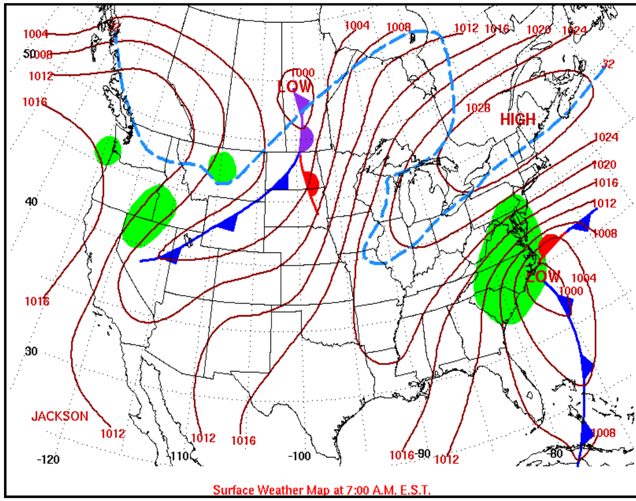
Tropical Storm Ida Transition to Extratropical Northeaster (Nor-Ida Storm)



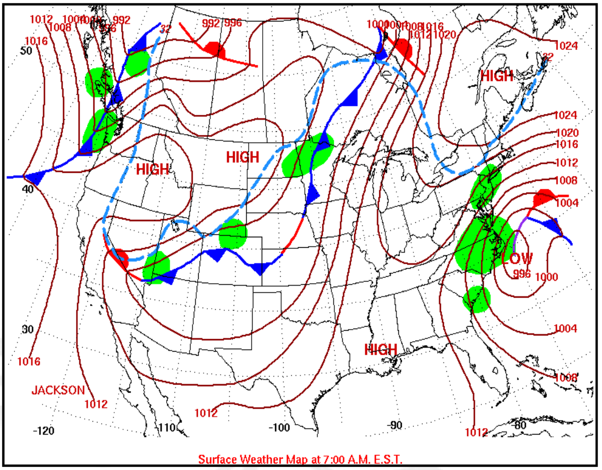
Nov 10, 2009



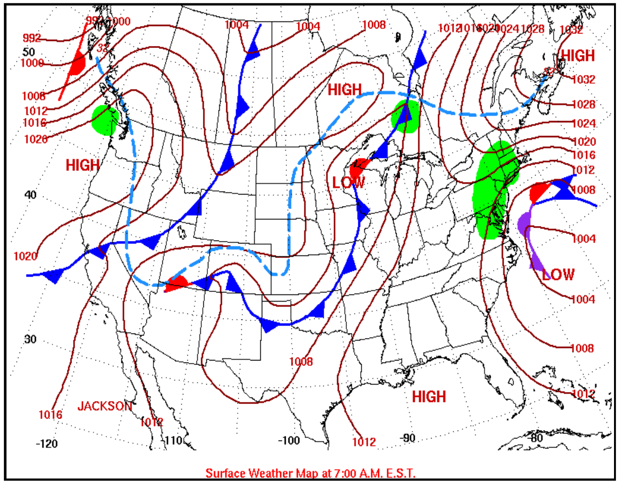
Nov 11, 2009



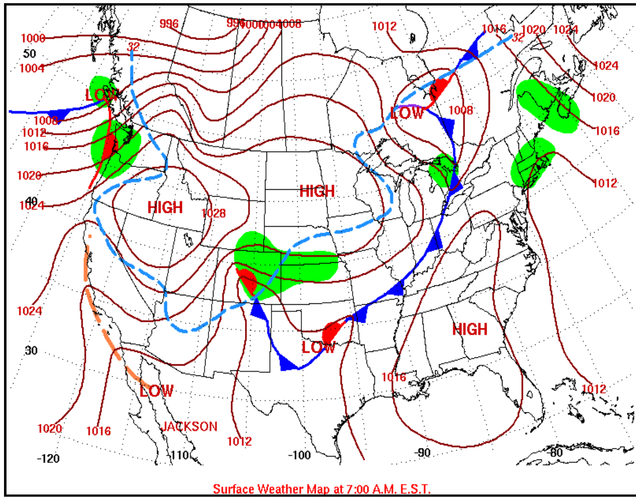
Nov 12, 2009



Nov 13, 2009

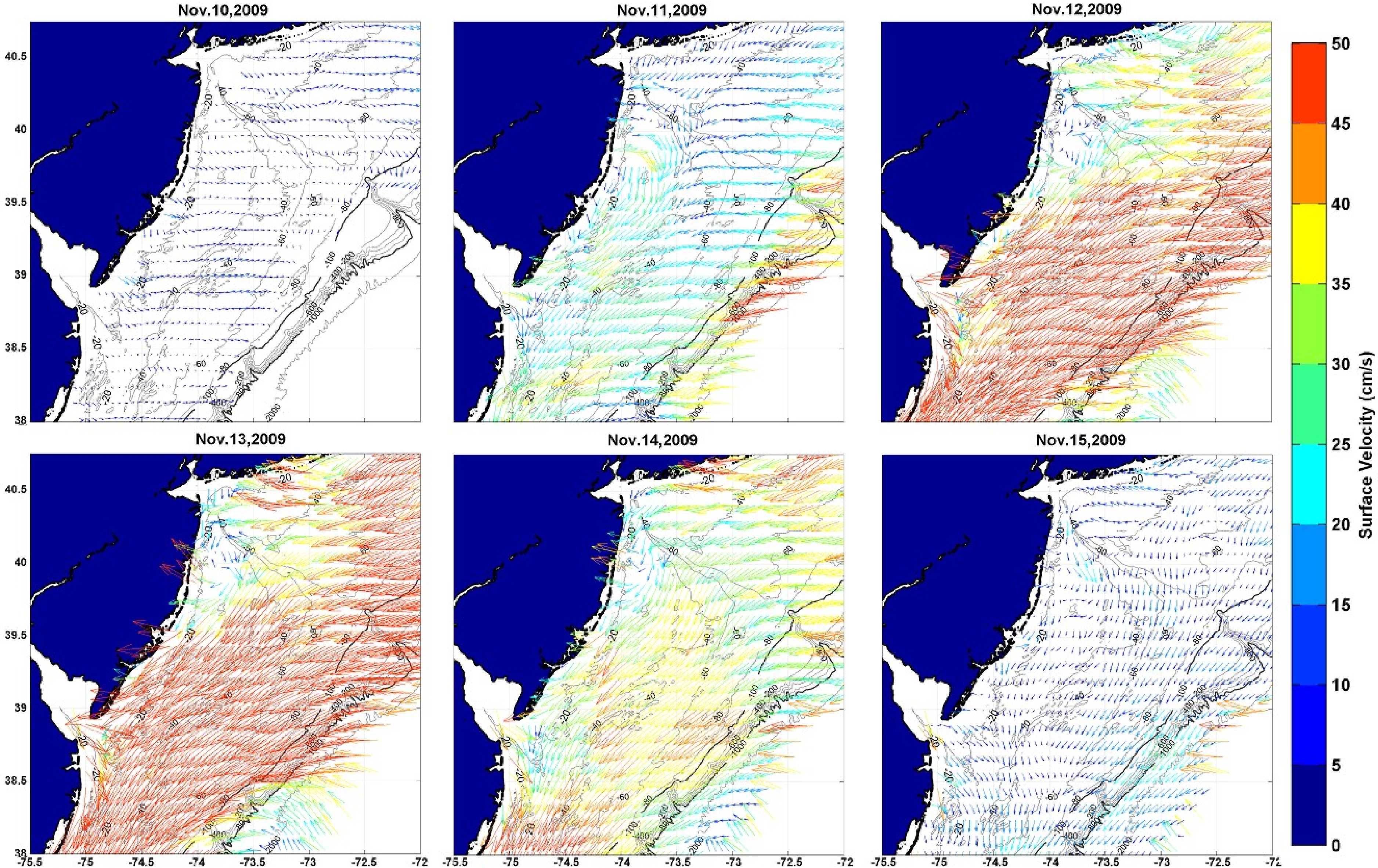


Nov 14, 2009

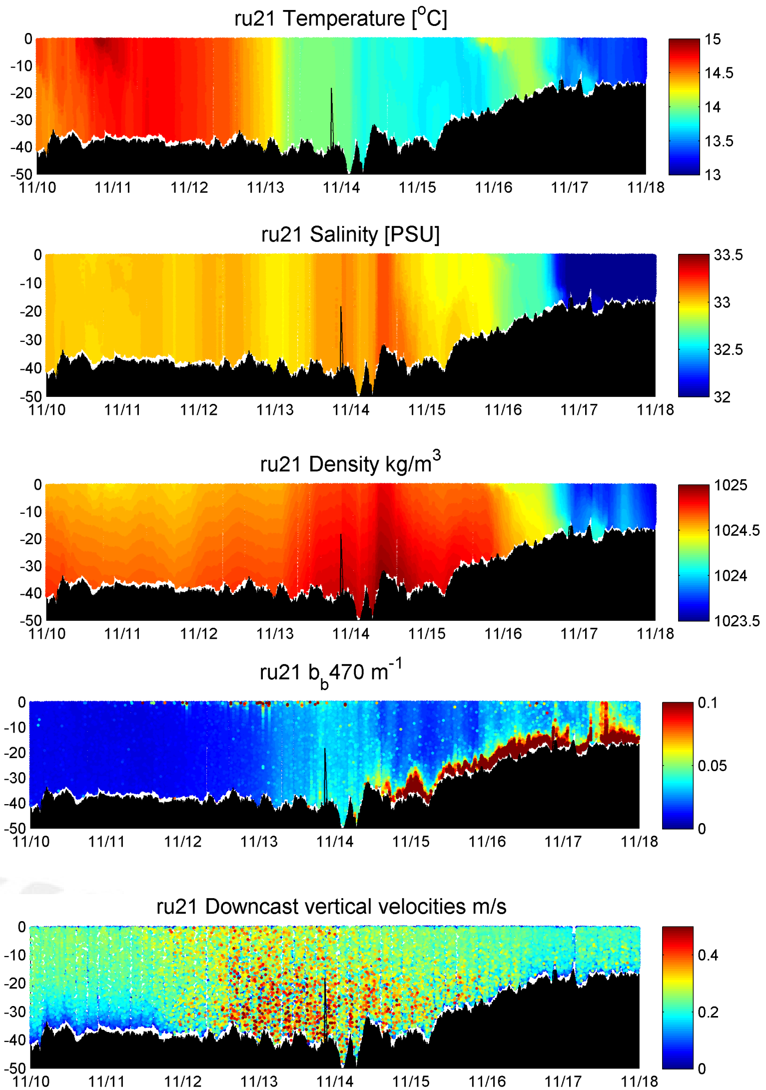


Nov 15, 2009

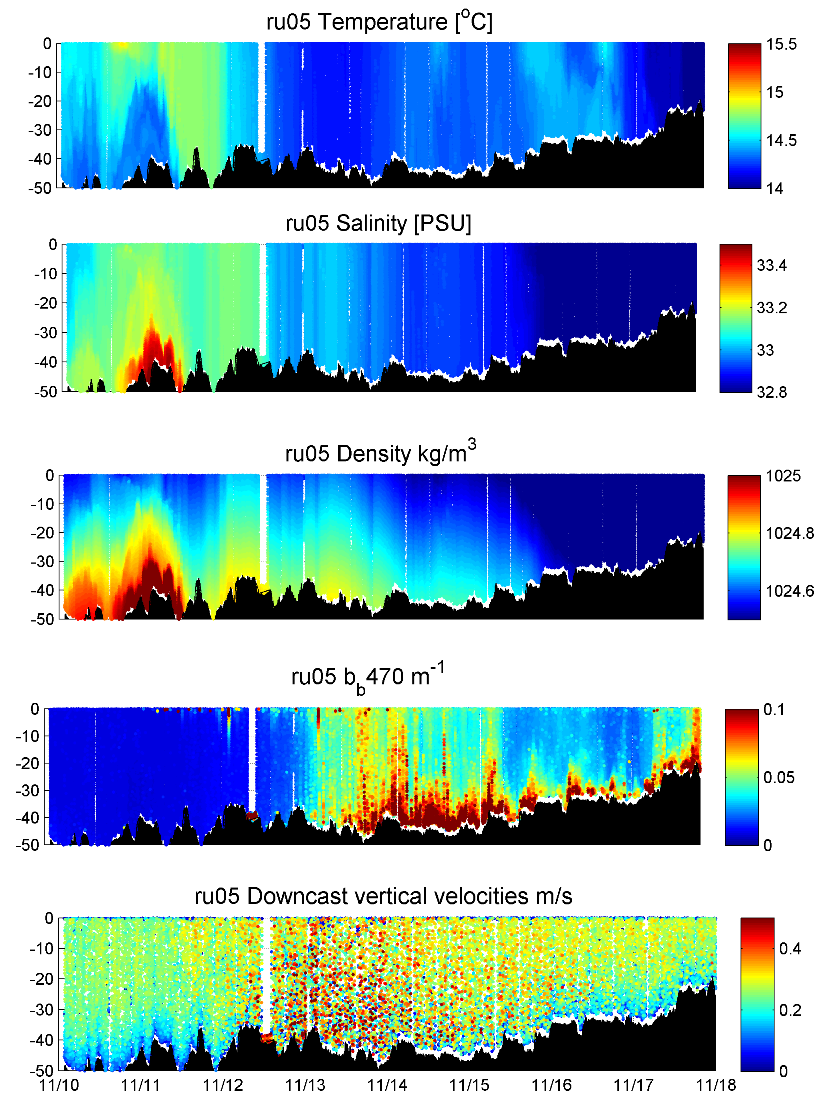
Nor-Ida Storm – High Frequency Radar Surface Current Mapping



Northern Glider

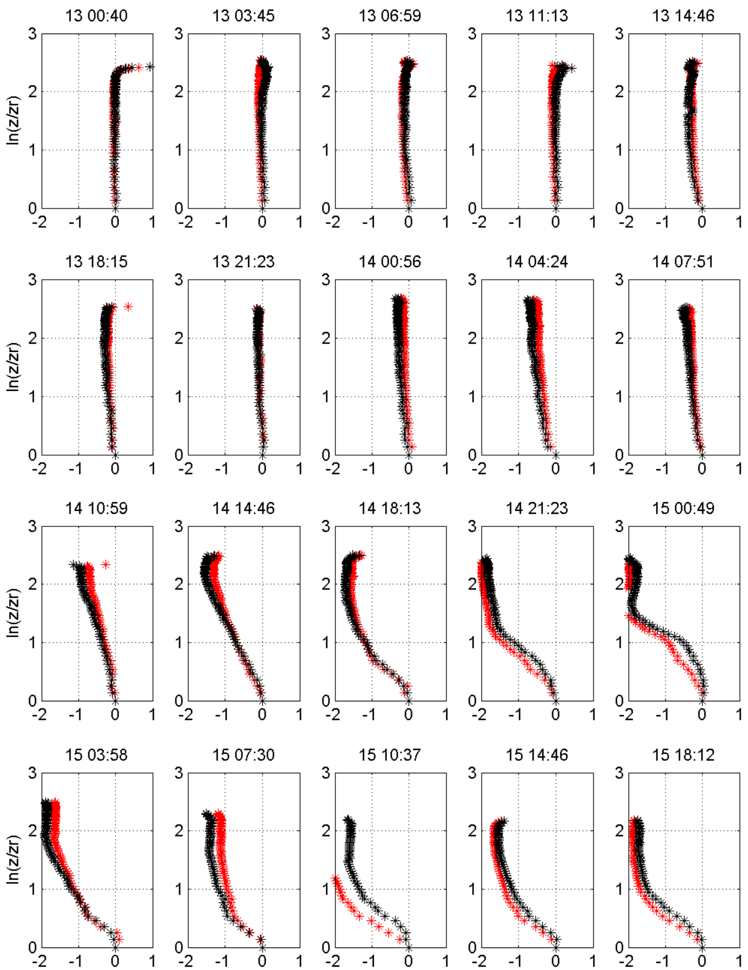


Southern Glider

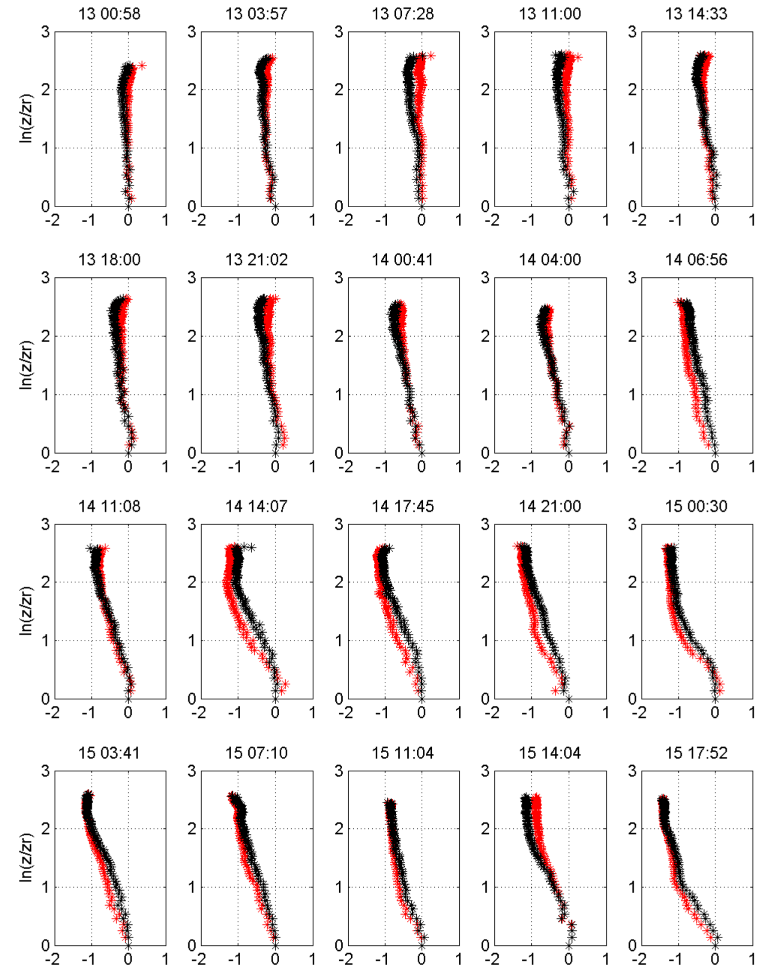


3-hour Average Relative Backscatter Profiles on a Log-Log Scale – "Rouse Profiles"

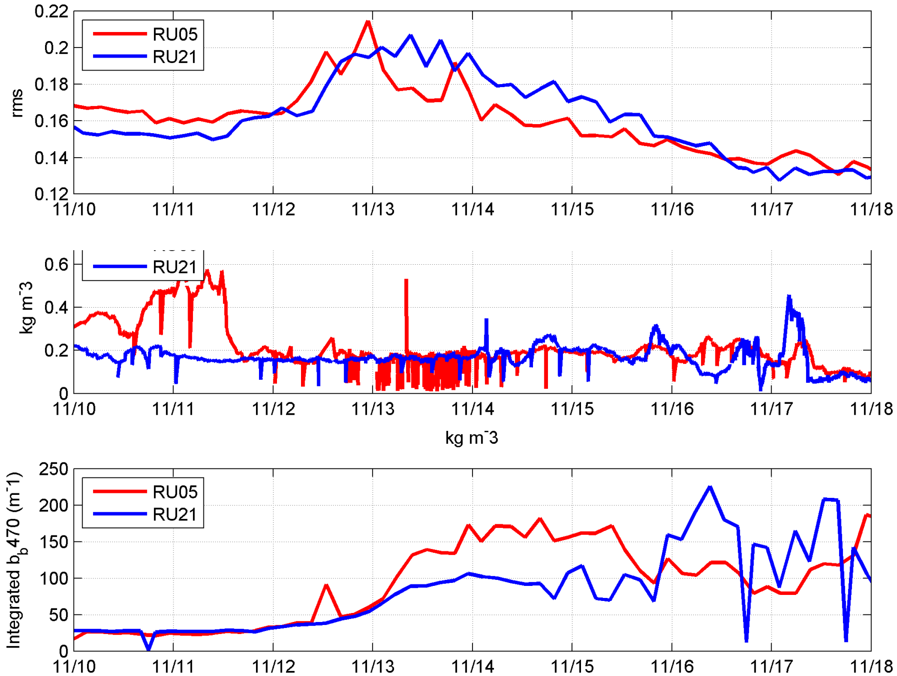
Northern Glider

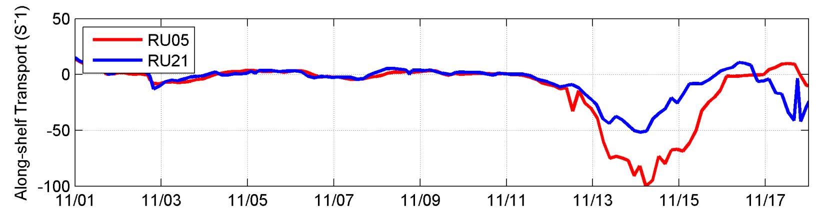


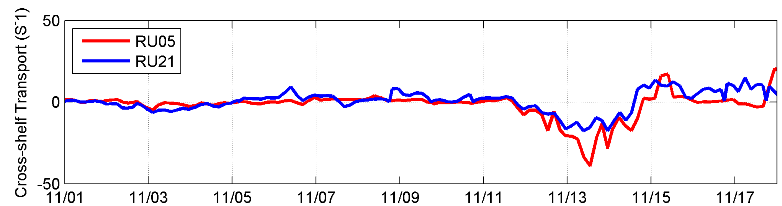
Southern Glider



Depth Integrated Results: Northern Glider RU21; Southern Glider RU05







- Turbulence levels increase rapidly with currents, drop slowly.
- Density stratification mixes away rapidly at Southern Glider – little influence through storm
- Maximum resuspension occurs late in the storm

- Alongshore Transport is downshelf with storm
- Cross-shore Transport is (a) onshore for both gliders during peak, and (b) offshore for the northern glider after the storm.
- Northern glider is consistent with expected downwelling during northeaster

To complement the Mid-Atlantic technology test-bed we are working the human educational test-bed using undergraduate students on campus