Use of VIIRS Ocean Products for Operational and Experimental Forecast Systems at NWS/NCEP

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NOAA / NWS / NCEP

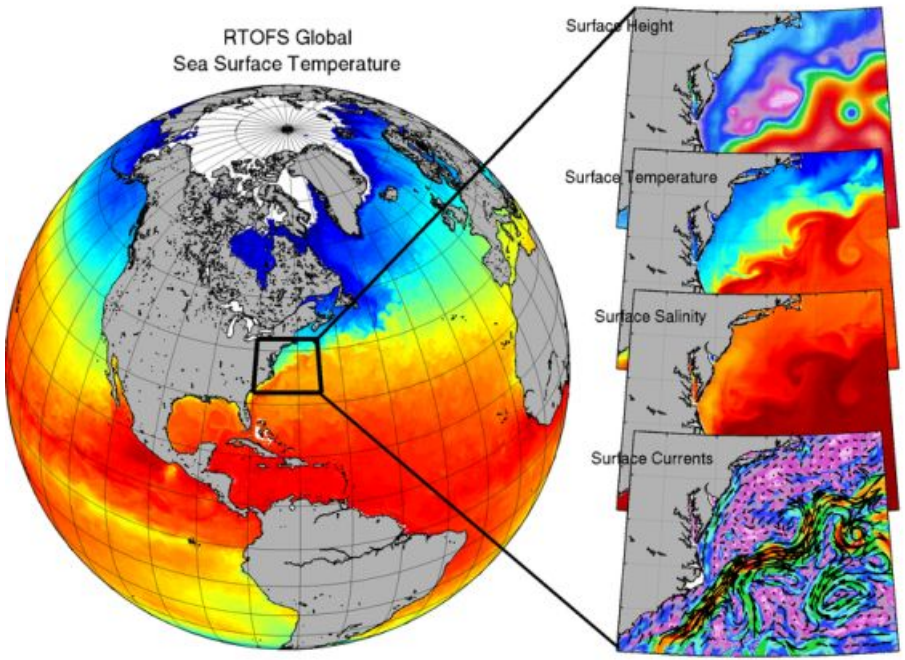
VIIRS User Meeting - Celebrating 10 years of SNPP

29th June, 2022

Outline

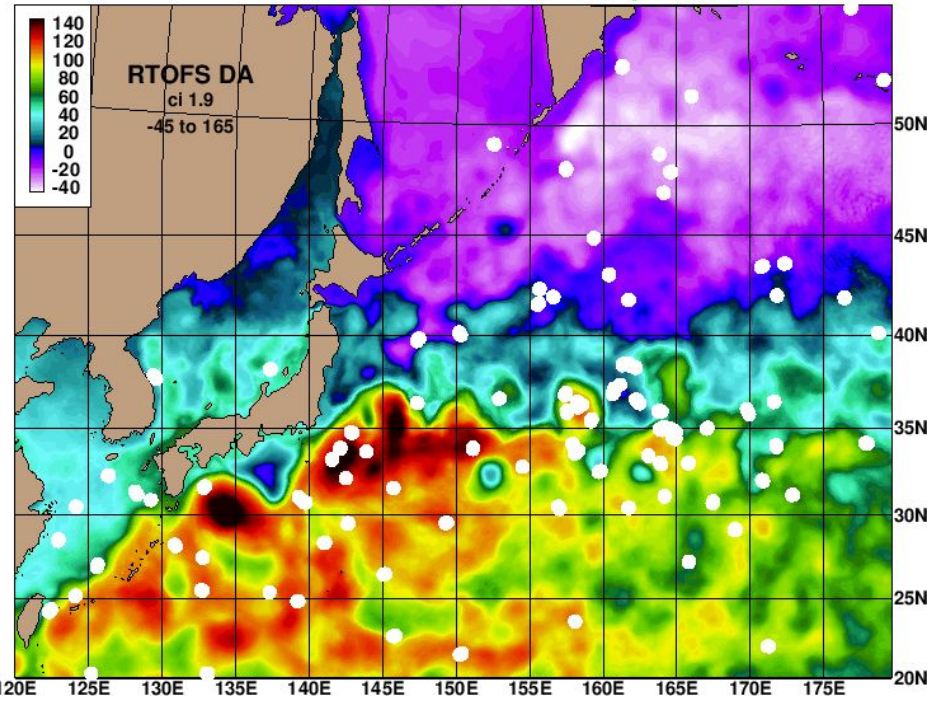
- Operational Real Time Ocean Forecast System
- Operational Hurricane Models (HWRF, HMON)
- Experimental Ocean Data Assimilation Systems
  - JEDI-based GODAS
  - Ocean Color Data Assimilation

Real Time Ocean Forecast System (RTOFS) at NOAA/NWS

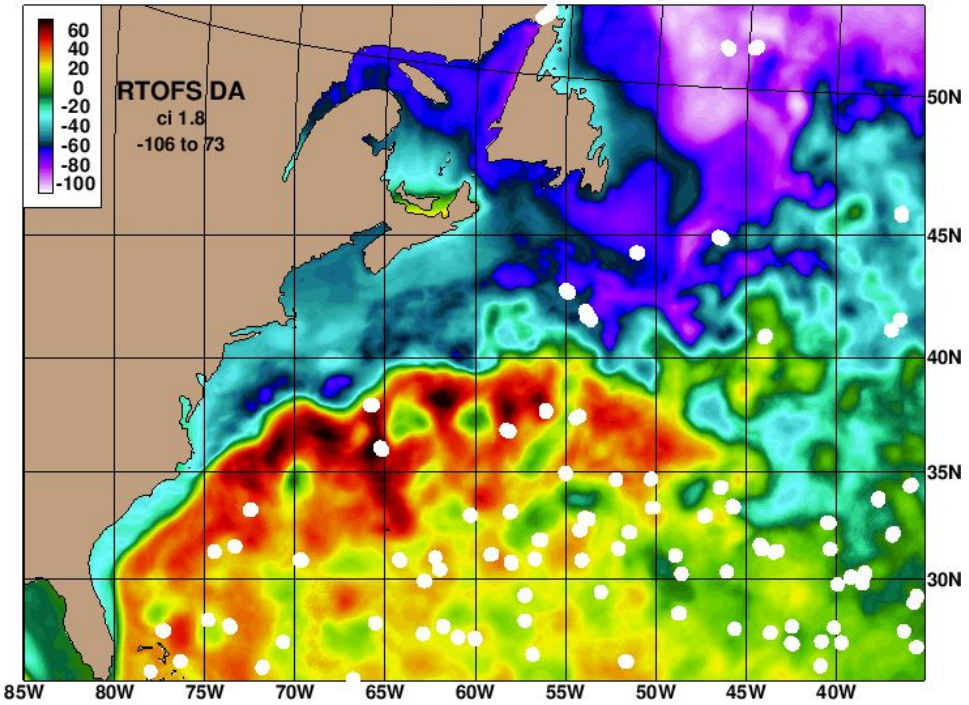


- Flag ship Operational Global Ocean Forecast System at NOAA/NWS
- Provides 3D fields of Temperatures, Salinity and Ocean Currents for the next 8 days
- Inputs to operational Hurricanes Models (Air- Sea- Wave flux interactions)
- Inputs to other operational Global (like GFS) and Coastal (like NWPS) models
- Boundary conditions for multiple NOAA/NOS coastal ocean forecast systems
- **RTOFS-v2: First operational Global Data Assimilation System at NOAA/NWS at 1/12 deg resolution.**

Kuroshio Extension

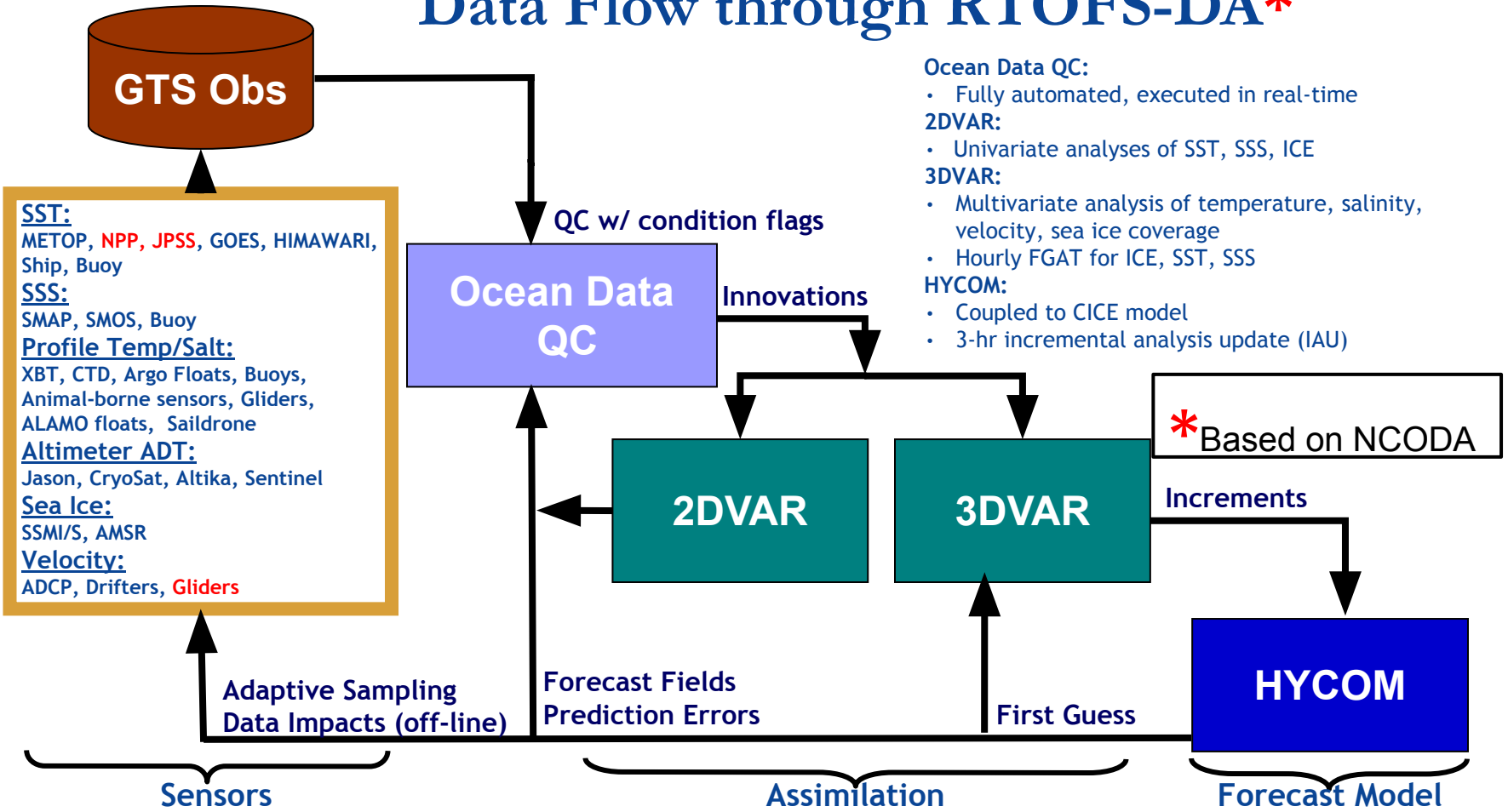


Gulf Stream



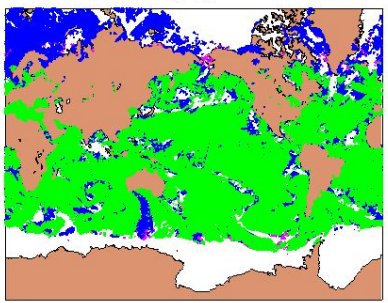
Drifting buoy tracks vs. RTOFS model surface circulation patterns

Data Flow through RTOFS-DA*

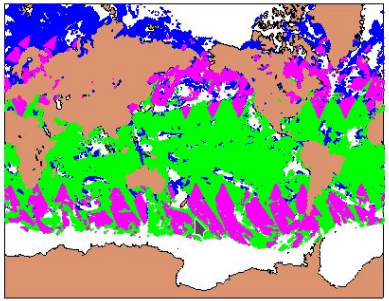


SST Observing Systems in RTOFS: June 2022

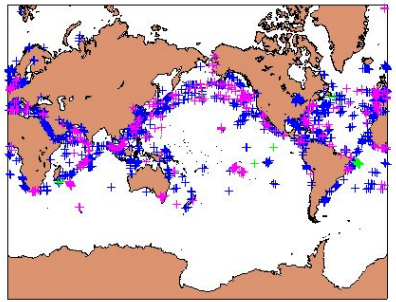
Satellite and In situ SST



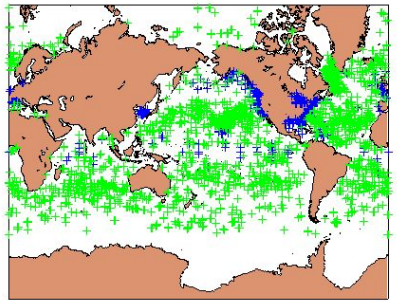
JPSS-VIIRS



METOP-B

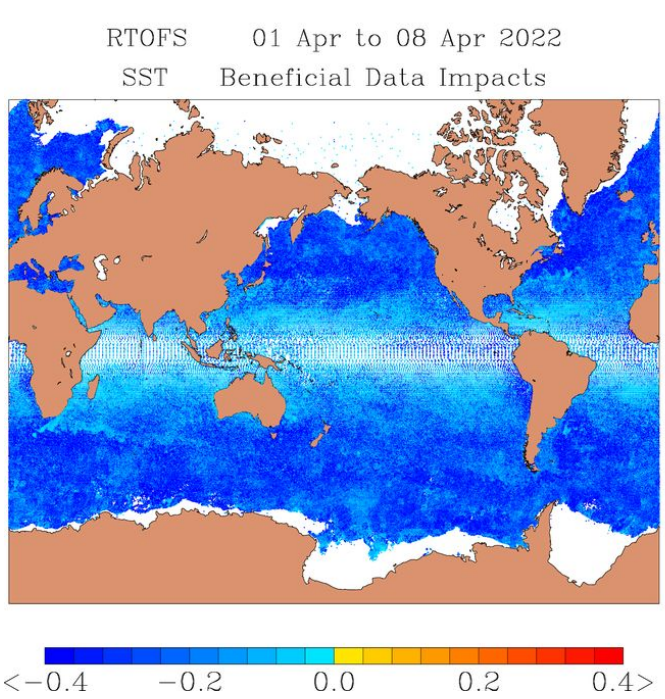


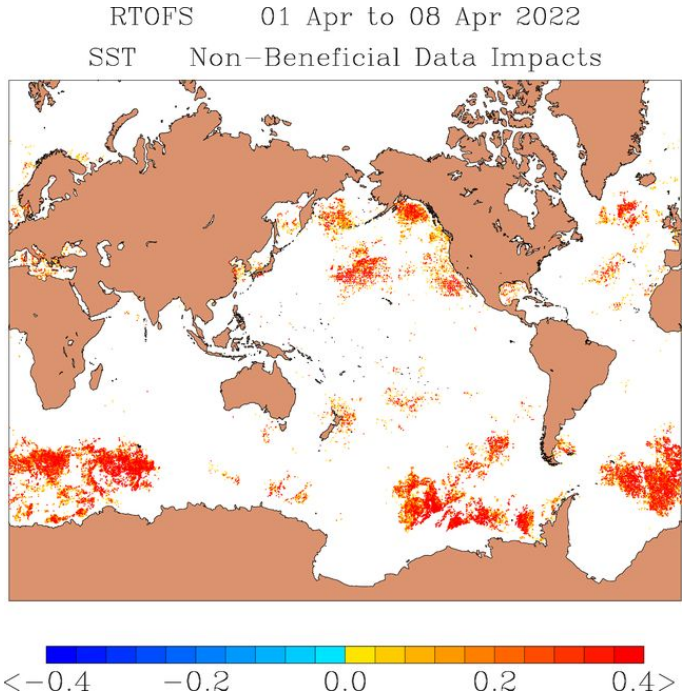
Sfc SHIP



Fixed/Drifting Buoy

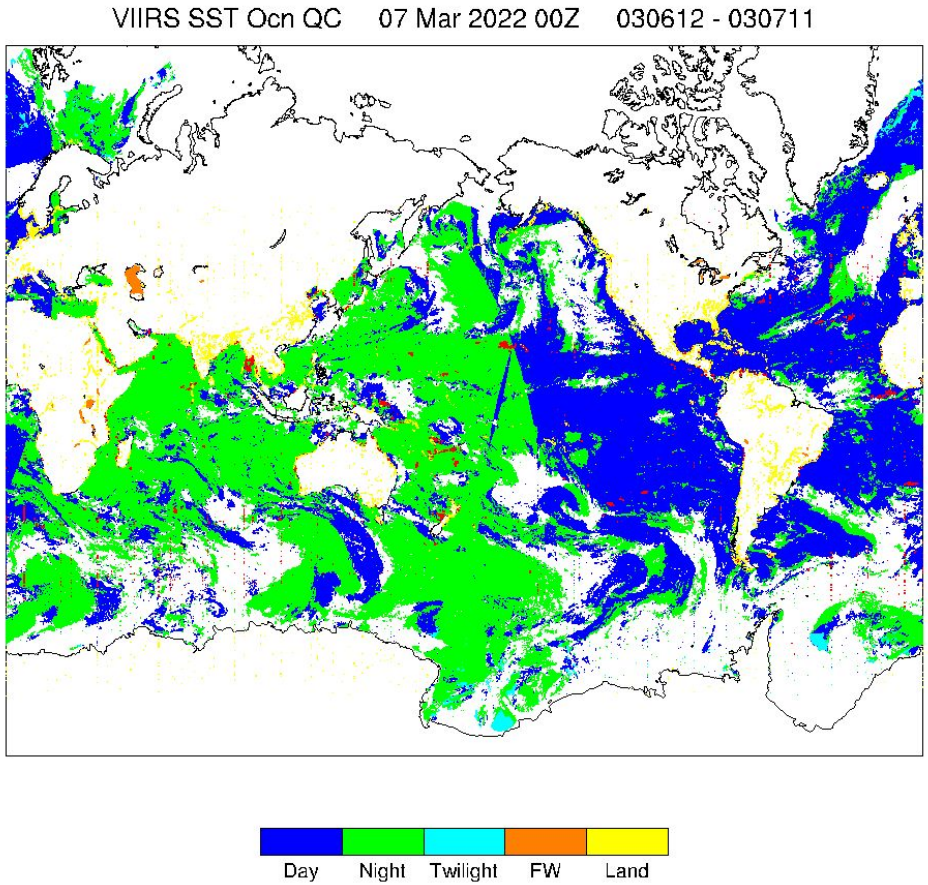
RTOFS: Operational Data Impact





Data impacts of assimilating satellite SST observations on reducing 48 hr forecast error. Impacts are calculated daily and the results have been pooled over a 8 day period from 01 - 08 April 2022.

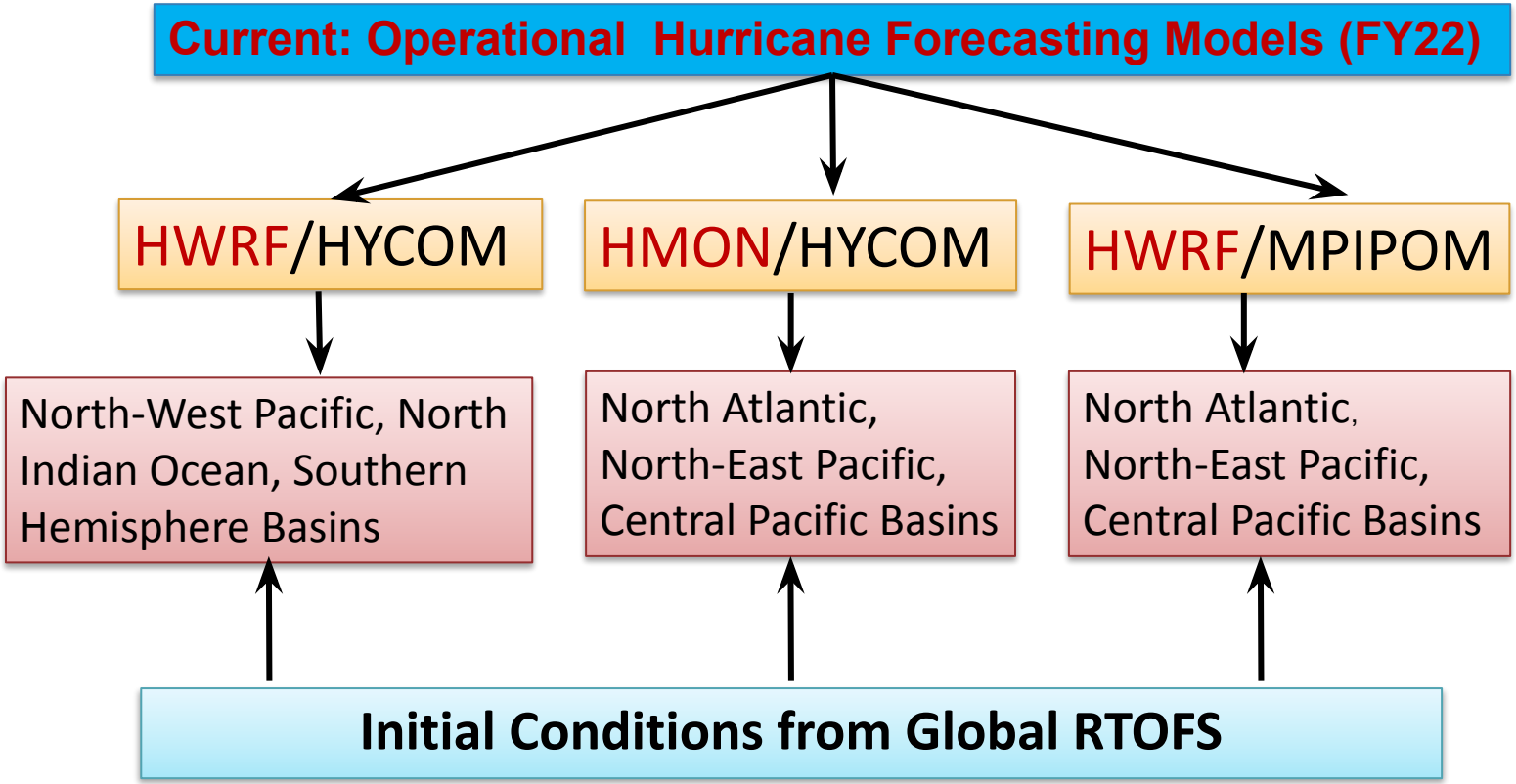
Use of VIIRS SST data for RTOFS at NWS/NCEP



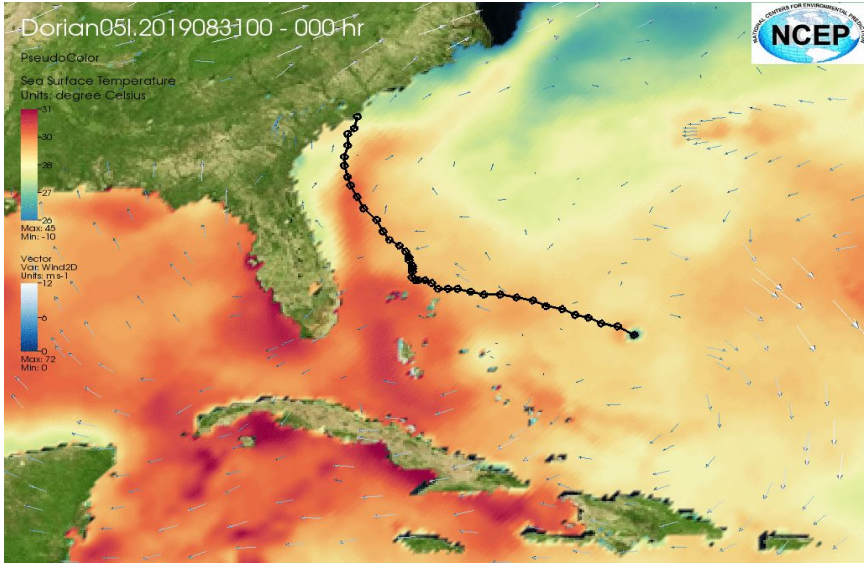
VIIRS L2 SST is a key input for:

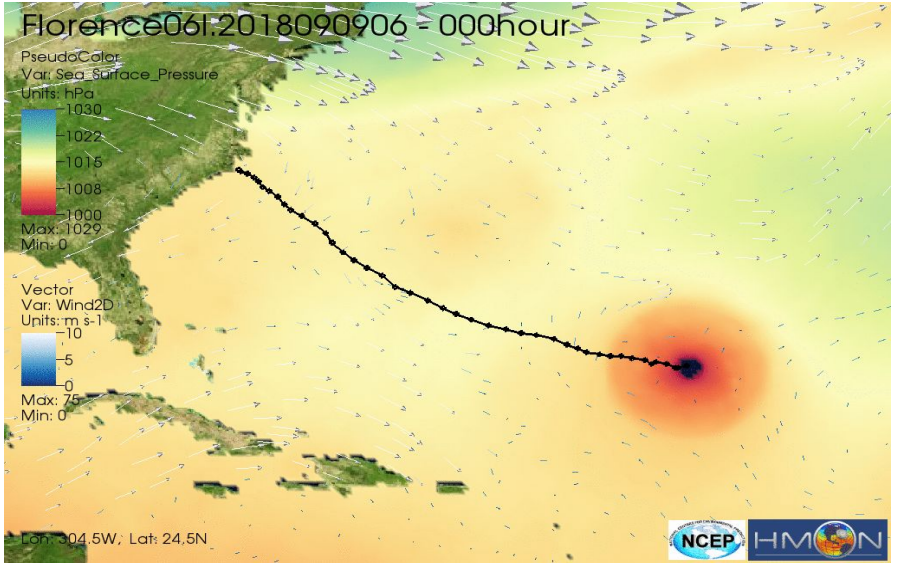
(a) Extensive spatial and temporal coverage; and

(b) QA/QC of other SST inputs (both in situ and satellite)


Current: Operational Hurricane Forecasting Models (FY22)
HWRF/HYCOM
HMON/HYCOM
HWRF/MPIPOM
North-West Pacific, North Indian Ocean, Southern Hemisphere Basins
North Atlantic, North-East Pacific, Central Pacific Basins
North Atlantic, North-East Pacific, Central Pacific Basins
Initial Conditions from Global RTOFS

Current Operational Regional Hurricane Models at NWS/NCEP: HWRF & HMON





HWRF:

- WRF-NMM+MPIPOM/HYCOM+WWIII Coupled System
- Triply nested 13.5/4.5/1.5 km resolution w/91 levels
- 4D Hybrid EnVar DA System with Vortex Initialization, RTOFS for Ocean Initialization
- Advanced Physics
- All Global Basins (NHC and JTWC), max. 7 storms on-demand

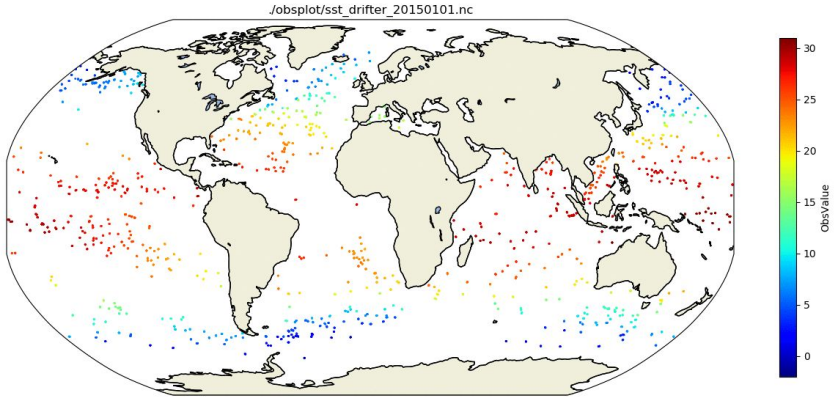
HMON:

- NMMB+HYCOM Coupled System
- 18/6/2 km resolution w/71 vertical levels
- Advanced Vortex Initialization, Advanced Physics
- RTOFS for Ocean Initialization
- NHC Basins, max. 5 storms on-demand

Use of VIIRS in the JEDI based GODAS (EMC-JCSDA)

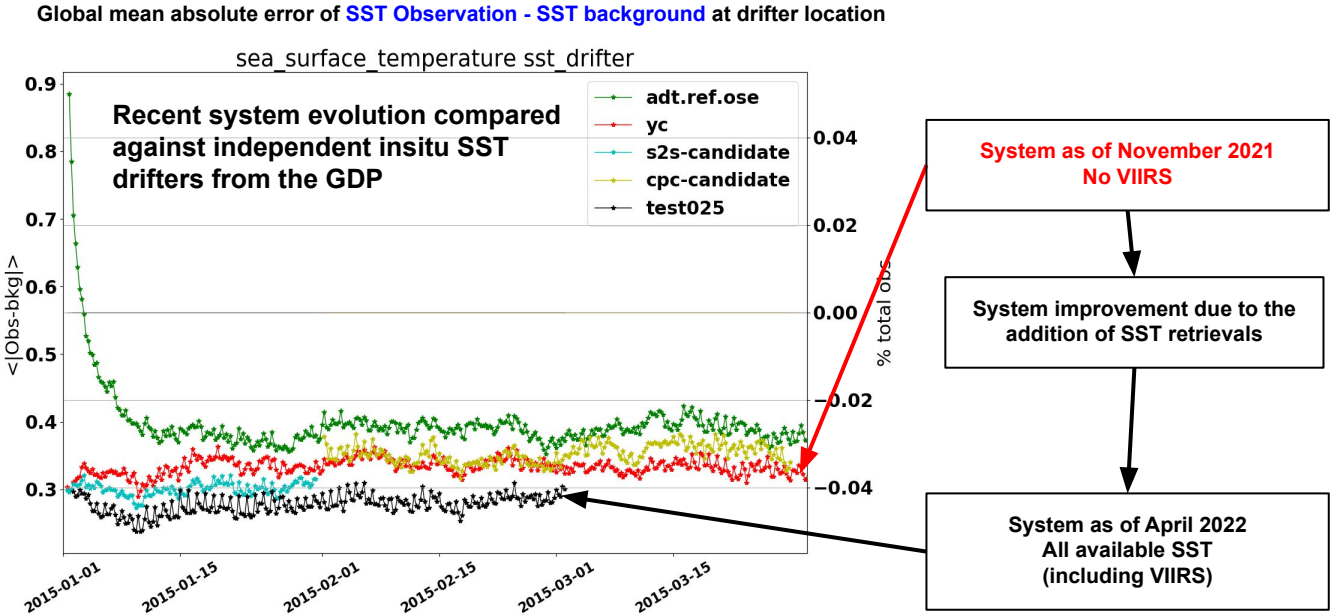
- Model: Data Atmosphere + MOM6-CICE6: from 1 to ¼ degree resolution
- DA infrastructure: JEDI-SOCA
- DA configuration summary: 3DVAR, 6 hour window
- Observing system: All trusted retrievals (VIIRS, AVHRR but NO MW), altimeters, insitu (Argo, CTD, XBT, TAO, RAMA, PIRATA, …)
- Use of VIIRS: Ocean only (no sea-ice yet)
- Use of GDP drifter SST as an independent observing system (Not assimilated)

Passive GDP drifter observing system (Jan-March 2015)



Courtesy: Marine JEDI team at EMC

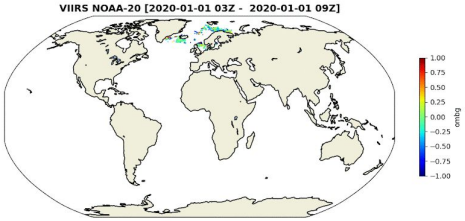
Use of VIIRS in the JEDI based GODAS (EMC-JCSDA)

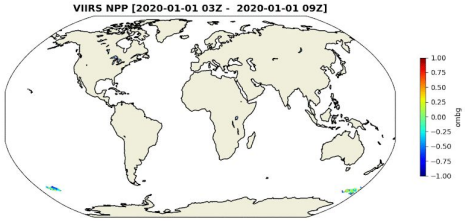


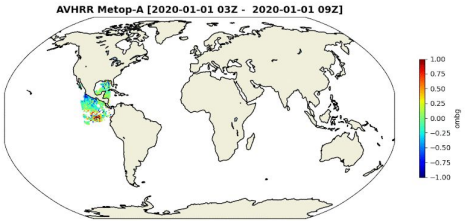
Courtesy: Marine JEDI team at EMC

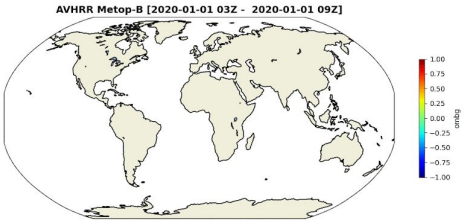
Use of VIIRS in the JEDI based GODAS (EMC-JCSDA)

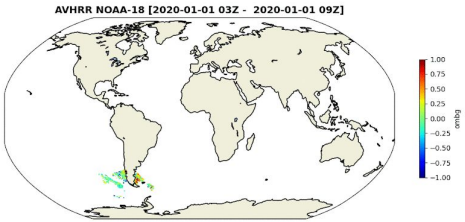
Illustration of the SST observing system coverage for a 6 hour DA window
(not the same time period as the time series on the right)

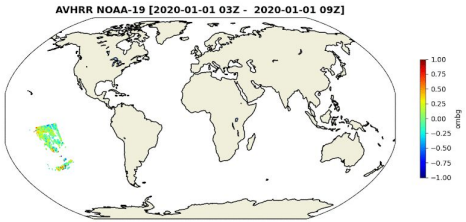


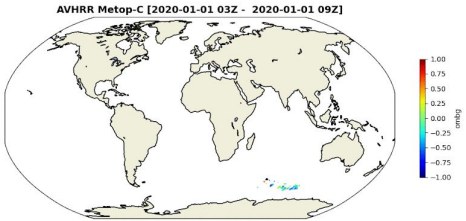


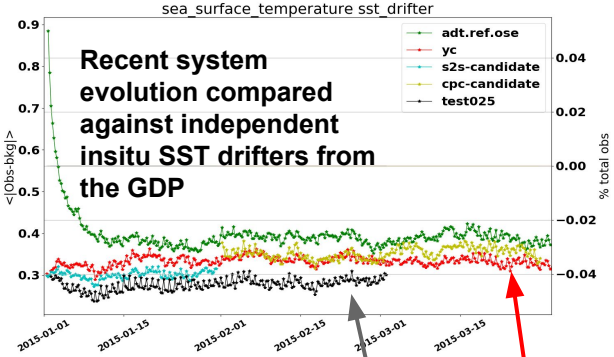












Recent system evolution compared against independent insitu SST drifters from the GDP

Some of the improvement (black vs red) can be explained by the addition of the SST retrievals from VIIRS-NPP

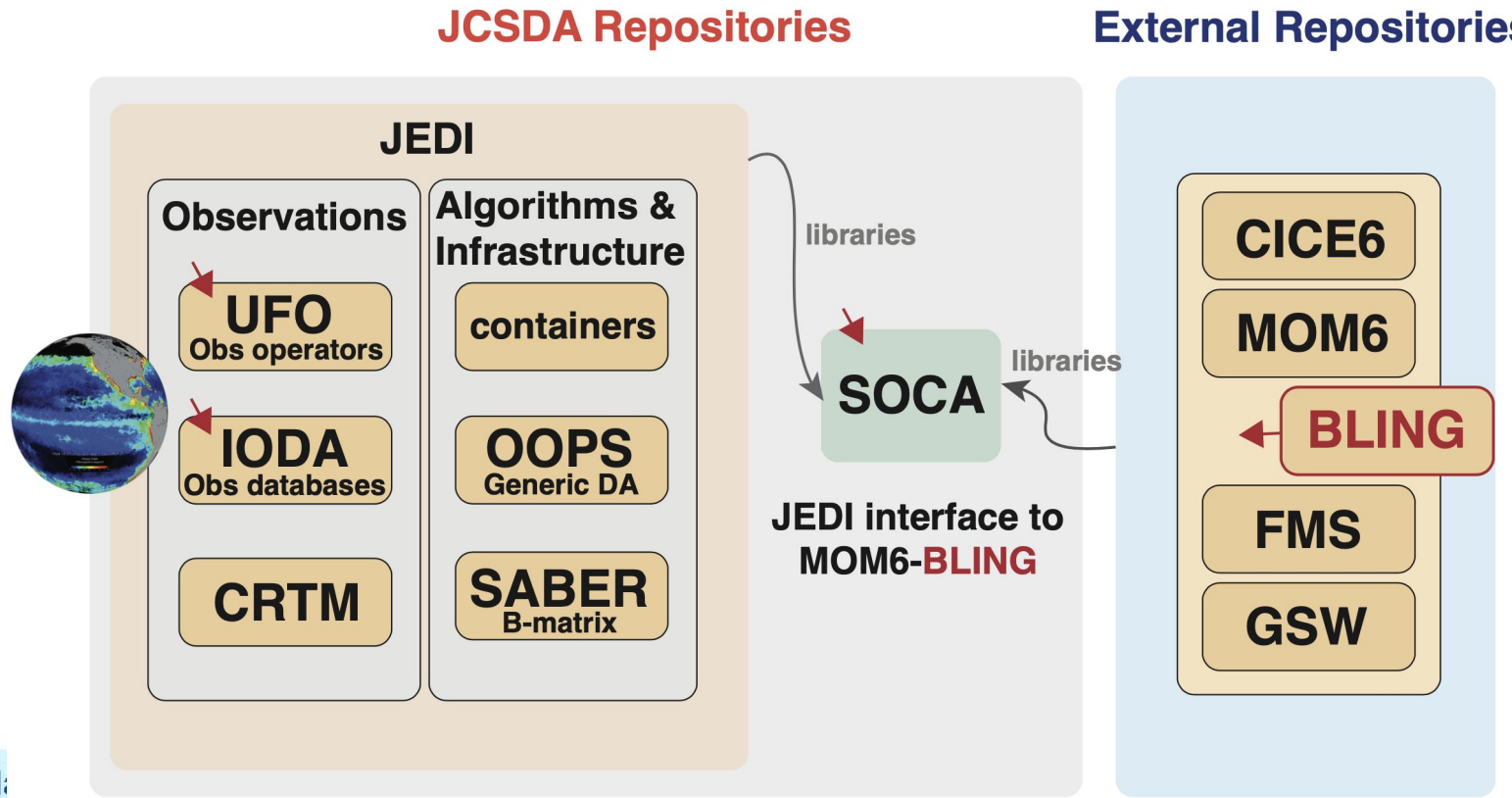
VIIRS Ocean Color Data Assimilation

Actively supported by JPSS-PGRR FY21-23:

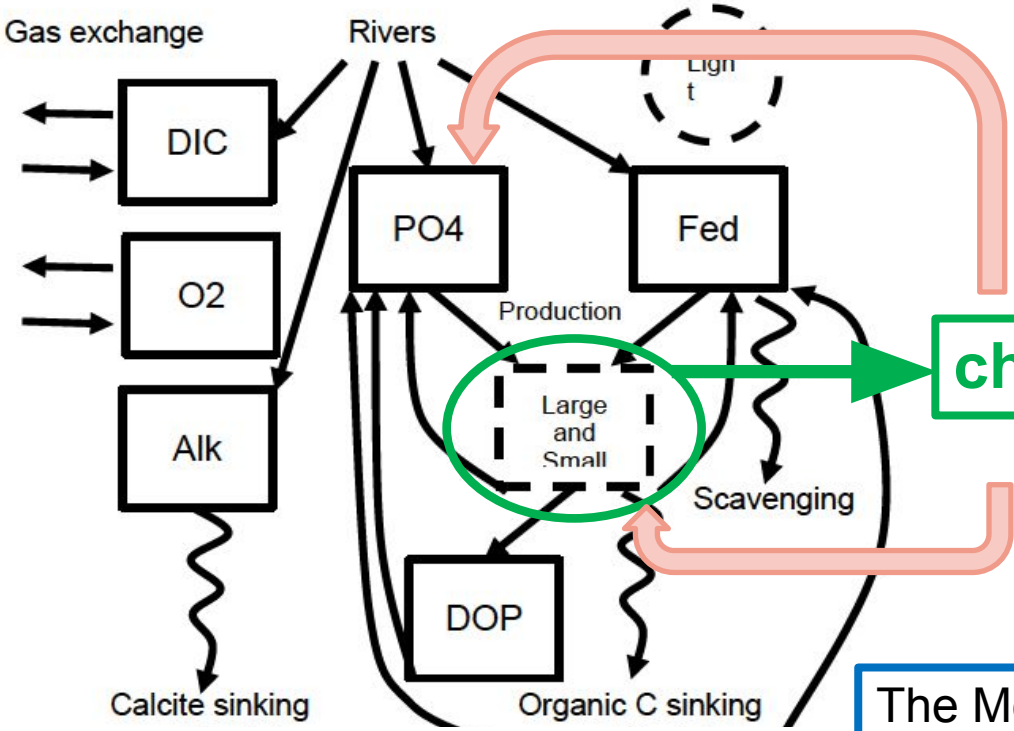
Project: "Implementation of ocean biogeochemical modeling and ocean color data assimilation in the Unified Forecast System in support of NCEP's weather, S2S, and ecological predictions"

Co-PI's: Avichal Mehra, Xiao Liu, Daryl Kleist, André Van der Westhuysen, Hae-Cheol Kim and Eric Bayler

Next-generation Unified Marine DA + Ocean Color



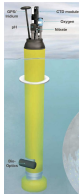
BLING – Biogeochemistry with Light Iron Nutrient and Gas



S-NPP/VIIRS, NOAA20/VIIRS Ocean color, active

chlorophyll

biogeochemical Argo



BGC-Argo, passive

Saildrones (near future)

The Modular Ocean Model v6 (MOM6)

Ongoing/planned ocean analysis experiments

- 0.25° global, DATM-MOM6-BLING-CICE6, JEDI-based DA

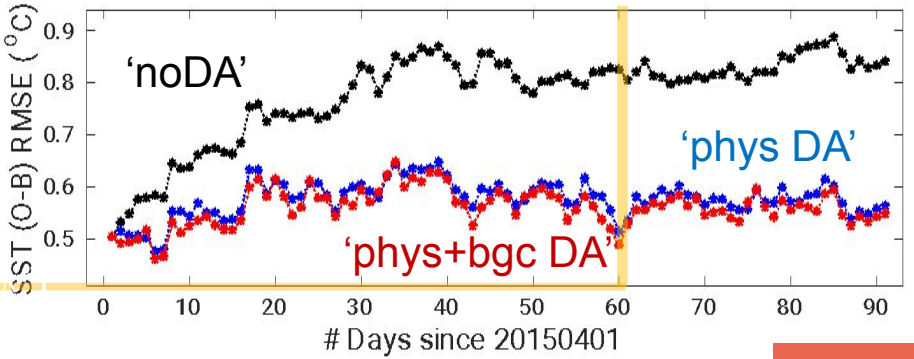
Near real-time data ingestion: SST, SSS, ADT, in situ T/S **profiles**, sea ice conc.,…, **chlorophyll** ([1]VIIRS L2, [2]VIIRS L3, [3]BGC-Argo, [1]VIIRS L4 DINEOF), **particulate organic carbon** ([2]VIIRS L3), **backscattering coeff.** ([3]BGC-Argo)

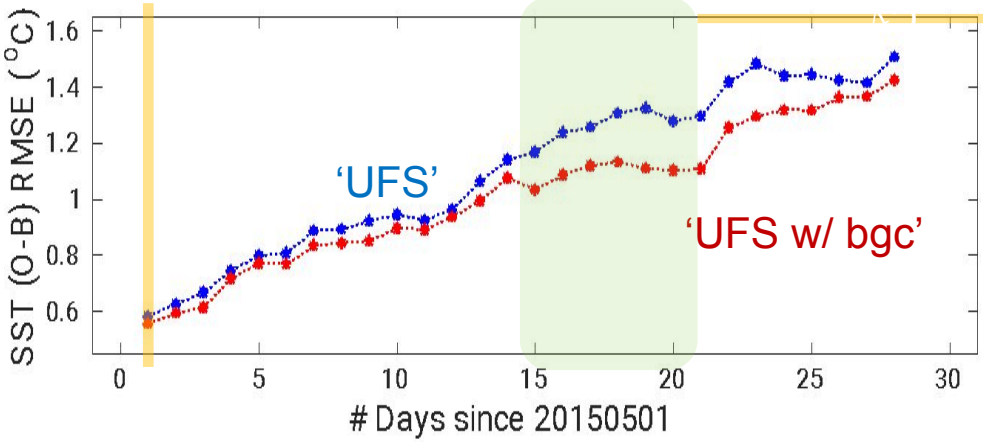
- Goals:
  I. Provide a multi-year ocean biogeochemical reanalysis product
  II. Improve marine initialization for UFS (Unified Forecast System) S2S application
  III. Explore ecosystem prediction capability using UFS w/ BLING

Data source: [1]NOAA CoastWatch, [2]NASA OB.DAAC, [3]US-GODAE

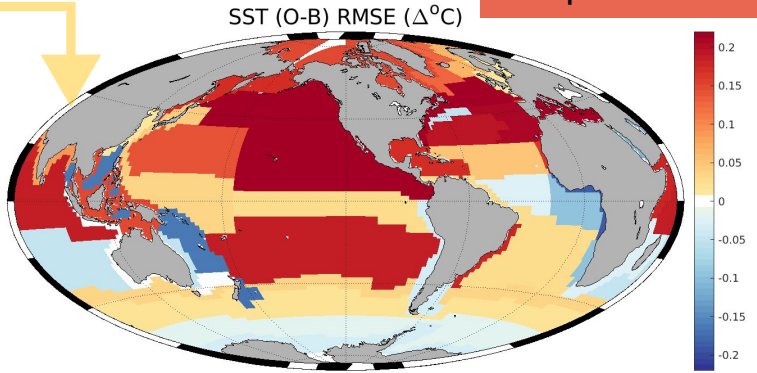
Impact of ocean color DA on SST predictions

Preliminary results
run w/ UFS 7c





Improvement



Degradation

Thank You! Questions?