



# Data Assimilation for Numerical Weather Prediction

Presented by James G. (Jim) Yoe  
Joint Center for Satellite Assimilation  
and NWS/NCEP



# Overview

---

- Background
- Assimilation of Suomi NPP
  - Data Impacts
- Planning for JPSS-1 in NWP
- Summary



## BACKGROUND: NOAA Operational Numerical Guidance Supports the Agency Mission

- Numerical Weather Prediction (NWP) at NOAA

- Required for agency to meet service-based metrics

- National Weather Service GPRA\* Metrics

- Hurricane Track and Intensity

- Winter Storm Warning

- Precipitation Threat

- Flood Warning

- Marine Wind Speed and Wave Height

**Lead Time  
and  
Accuracy!**

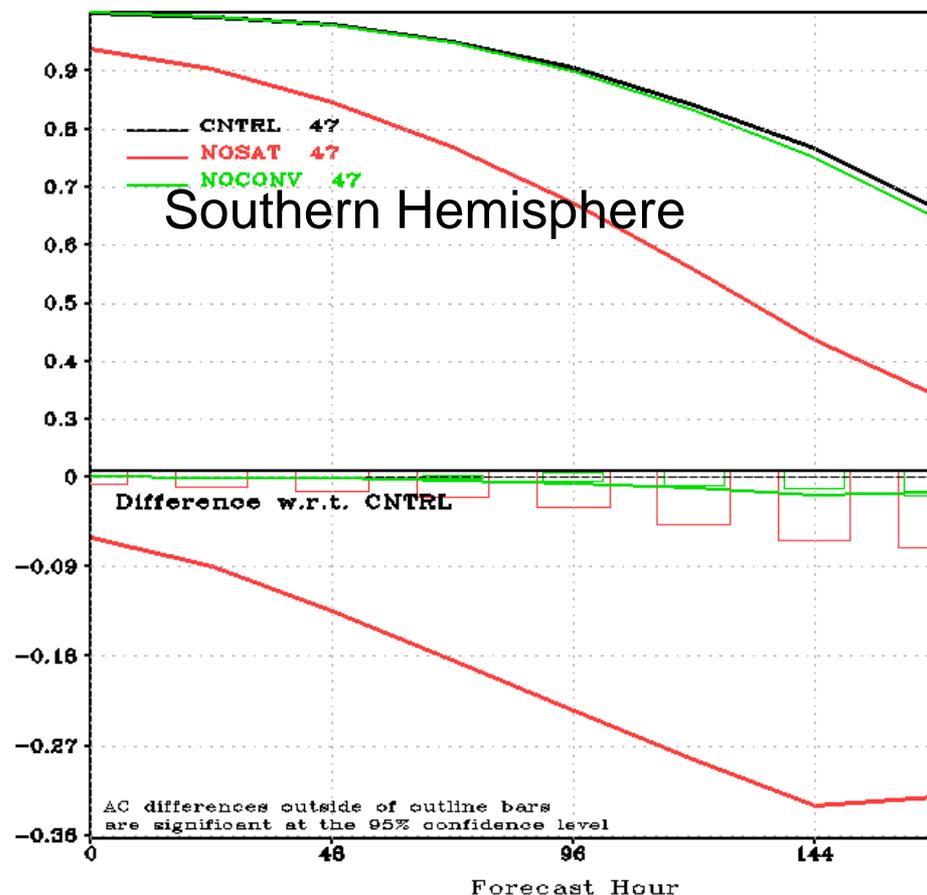
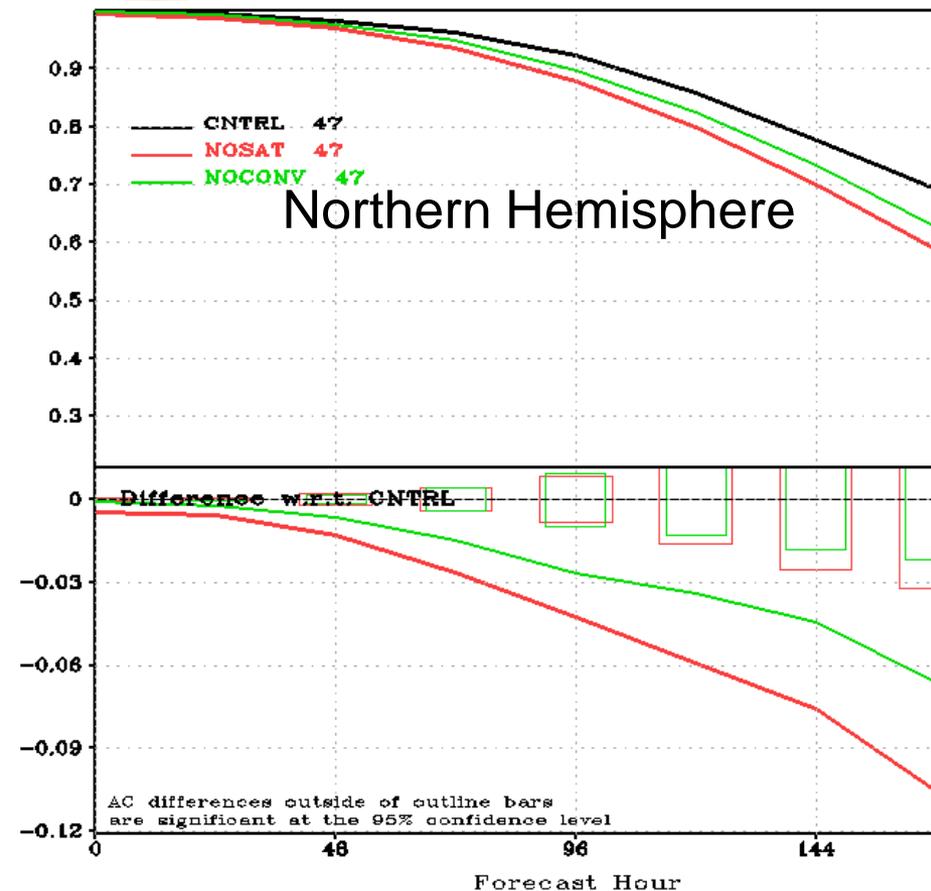
- Operational numerical guidance:

- Foundational tools used by government, public and private industry to improve public safety, quality of life and make business decisions that drive U.S. economic growth



# Background: Satellite Data Crucial in the GFS

No Satellite / No Conventional Data

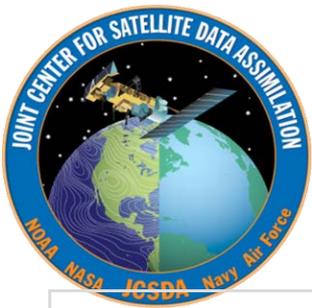


500 hPa Anomaly Correlations  
15 Aug – 30 Sep 2010



# Assimilation of Suomi NPP Data

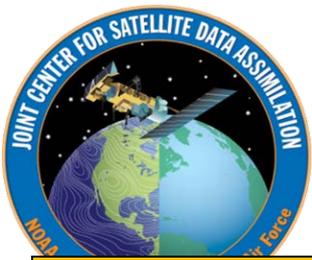
- Pre-Launch
  - Working Group – NDE, EMC, NCO, STAR, JCSDA
    - Prioritized data requirements; generated/shared formatted test data; tested data paths, tanks, and decoders; prepared and adapted DA (channel selection, radiative transfer, etc.)
- Post-Launch
  - Data Monitored, evaluated in global NWP)
    - ATMS SDRs (Operational in GDAS/GFS 5/22/2012)
    - CrIS SDRs (Operational in GDAS/GFS 8/20/2013)
      - 399 channels received of 1305
    - OMPS EDRs used in CPC analysis (10/1/2013), monitoring, ozone hole assessment
    - VIIRS EDRs (SST) development for testing underway



# Data Impact: JPSS (CNTL) Scorecard

	GFS Scorecard Summary							
	August	SON	DJF					
NH-Z500	Blue	Green	Blue	Green	CNTL better (Stat. Sig.)			
NH-MSLP	Blue	Green	Blue	Blue	CNTL better (No Stat. Sig.)			
NH-RMS-T	Blue	Green	Blue	Yellow	Neutral (No Stat. Sig.)			
NH-RMS-W	Blue	Green	Blue	Brown	NOPM better (No Stat. Sig.)			
CONUS Precip 24-48h	Yellow	Blue	Yellow	Red	NOPM better (Stat. Sig.)			
CONUS Precip 60-84h	Blue	Blue	Brown					
Tropics-RMS-W-grid	Yellow	Blue	Blue					
Hurricane Track-ATL	Blue	Blue	N/A					
Hurricane Track-EPAC	Yellow	Blue	N/A					
SH-Z500	Blue	Green	Green					
SH-MSLP	Yellow	Green	Green					
SH-RMS-T	Yellow	Green	Green					
SH-RMS-W	Yellow	Green	Green					
NH-RMS-WvsObs-24-48h	Yellow	Yellow	Yellow					
SH-RMS-WvsObs-24-48h	Green	Green	Green					
Tropics-RMS-WvsObs-24-48h	Yellow	Yellow	Yellow					
NAmer-RMS-WvsObs-24-48h	Yellow	Blue	Yellow					

From G. Gayno  
and S. Lord, 2014



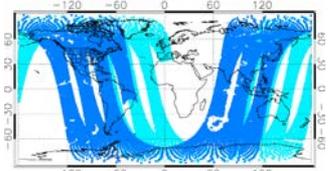
# More Recent Impact Experiment Design

Remove quasi-redundant satellite data.

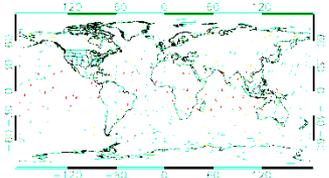
Remove GPSRO data with no future mission or uncertain funding.

Current Operational	Type	Orbit	3polar	2polar (PM Gap)	3pgps (Expected RO)
F16 (SSM/I/S)	MW	Early-AM			
F17 (SSM/I/S)	MW	Early-AM			
F18 (SSM/I/S)	MW	Early-AM			
N15 (AMSU)	MW	Late PM			
N18 (AMSU/MHS)	MW	PM			
N19 (AMSU/MHS)	MW	PM			
SNPP (ATMS/Cris)	MW/IR	PM			
Metop-A (AMSU/MHS/IASI/HIRS)	MW/IR	Mid-AM			
Metop-B (AMSU/MHS/IASI)	MW/IR	Mid-AM			
Aqua MODIS IR Winds	IR	PM			
Aqua AIRS	IR	PM			
Aqua MODIS WV Winds	IR	PM			
Terra MODIS IR/WV Winds	IR	AM			
WindSat		Early-AM			
GOES Sounder, AMVs	IR	GEO			
JMA AMVs	IR	GEO			
METEOSAT AMVs	IR	GEO			
COSMIC	RO	n/a			Polward 24° Latitude
Metop-A (GRAS)	RO	n/a			Polward 24° Latitude
Metop-B (GRAS)	RO	n/a			
TerraSAR-X	RO	n/a			
GRACE	RO	n/a			
C/NOFS	RO	n/a			Polward 24° Latitude
SAC-D	RO	n/a			Polward 24° Latitude

**Polar Coverage**



**GPSRO Coverage**



\*MODIS IR winds are a proxy for SNPP VIIRS

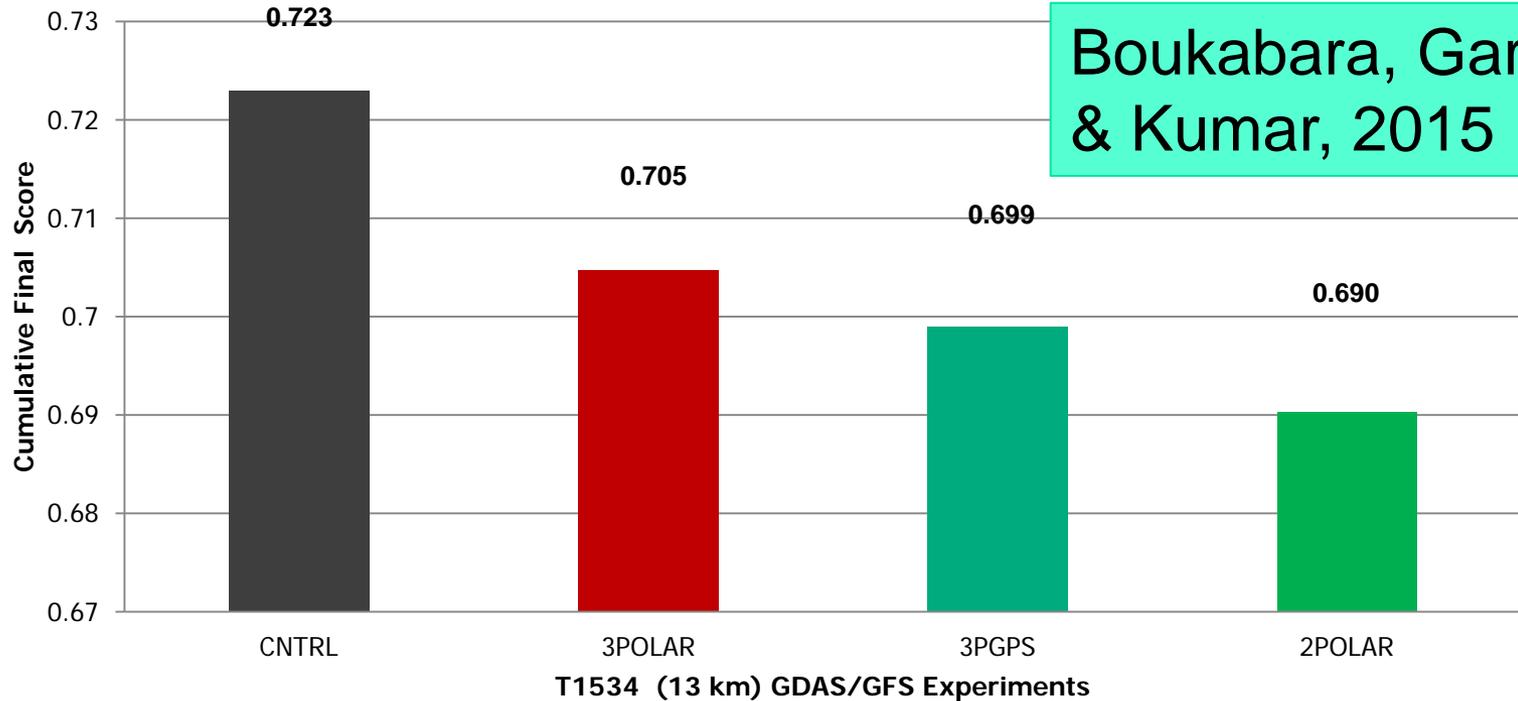
Assimilated

Denied



# More Recent Impact Experiment Results

## Normalized Cumulative Forecast Scores



## Cumulative Forecast Scores

- 1). The loss of a quasi-redundant polar satellite constellation results in a significant degradation of overall forecast quality.
- 2). The further loss of the Primary PM polar data (S-NPP) further degrades forecast quality



# Preparing for JPSS-1 in NWP

- Leverage infrastructure, lessons learned from NPP
  - Plan for rapid readiness for sounder implementation
  - Contingency planning for readiness at commissioning for “gap mitigation”
- VIIRS
  - Incorporate SST EDR, Land Surface Data
- OMPS
  - Assimilate OMPS ozone to adjust CrIS channels for T, moisture
- Improved CrIS assimilation
  - Make use of cloudy radiances
  - Make use of full-spectral resolution radiances
- Synergy with Improved
  - GFS Model Resolution
  - 4D Hybrid Data Assimilation System (DAS)
  - Low-latency JPSS data



## NWP Summary and Path Forward

- NWS assimilates S-NPP in operational NWP
  - Early access to S-NPP ATMS, CrIS contributed to calibration and validation of SDRs
  - JPSS, NESDIS, NWS and JCSDA preparing to extend and transition to use of JPSS-1 observations
- JPSS will be foundational stone for NWS' NWP
  - ATMS and CrIS especially as POES, Aqua retired
- Advancements in Data Assimilation System, Models, will yield significant NWP improvement in the JPSS era in conjunction with the advancement in the observations