NCEP Regional Reanalysis
NARR

Glenn K. Rutledge
NOMADS PI
NESDIS Data Archive Board Briefing

17 March 2004

Briefing Overview

- NARR Informational Briefing
  - NARR Overview
  - Improvements over Global Reanalysis
  - Domain / Resolution / Frequency
  - NCDC NARR: Ingest/Archive/Access

North American Regional Reanalysis (NARR): Background

- The NARR is an improved long term re-analysis of basic meteorological fields on a high resolution gird, that for the first time on any scale, includes precipitation.
- NCDC has agreed to archive most of these new data.
- This is an informational briefing for the DAB for
  - NARR availability with background information
  - Provide access information

NARR: Purpose

- Create a long-term set of consistent climate data on a regional scale on a North American domain
- Superior to NCEP/NCAR Global Reanalysis (GR) due to:
  - use of a regional model (the Eta model)
  - Advances in modeling and data assimilation since 1995, especially:
    - Precipitation assimilation
    - Direct assimilation of radiances
    - Land-surface model updates

ETA / NOAH LAND-SURFACE MODEL UPGRADES:

- **Assimilation of Hourly Precipitation**
  -- hourly 4-km radar/gage analysis (Stage IV)

- **Cold Season Processes** (*Koren et al 1999*)
  -- patchy snow cover
  -- frozen soil (new state variable)
  -- snow density (new state variable)

- **Bare Soil Evaporation Refinements**
  -- parameterize upper sfc crust cap on evap

- **Soil Heat Flux**
  -- new soil thermal conductivity (*Peters-Lidard et al 1998*)
  -- under snowpack (*Lunardini, 1981*)
  -- vegetation reduction of thermal cond.

- **Surface Characterization**
  -- maximum snow albedo database (*Robinson & Kukla 1985*)
  -- dynamic thermal roughness length refinements

- **Vegetation**
  -- deeper rooting depth in forests
  -- canopy resistance refinements

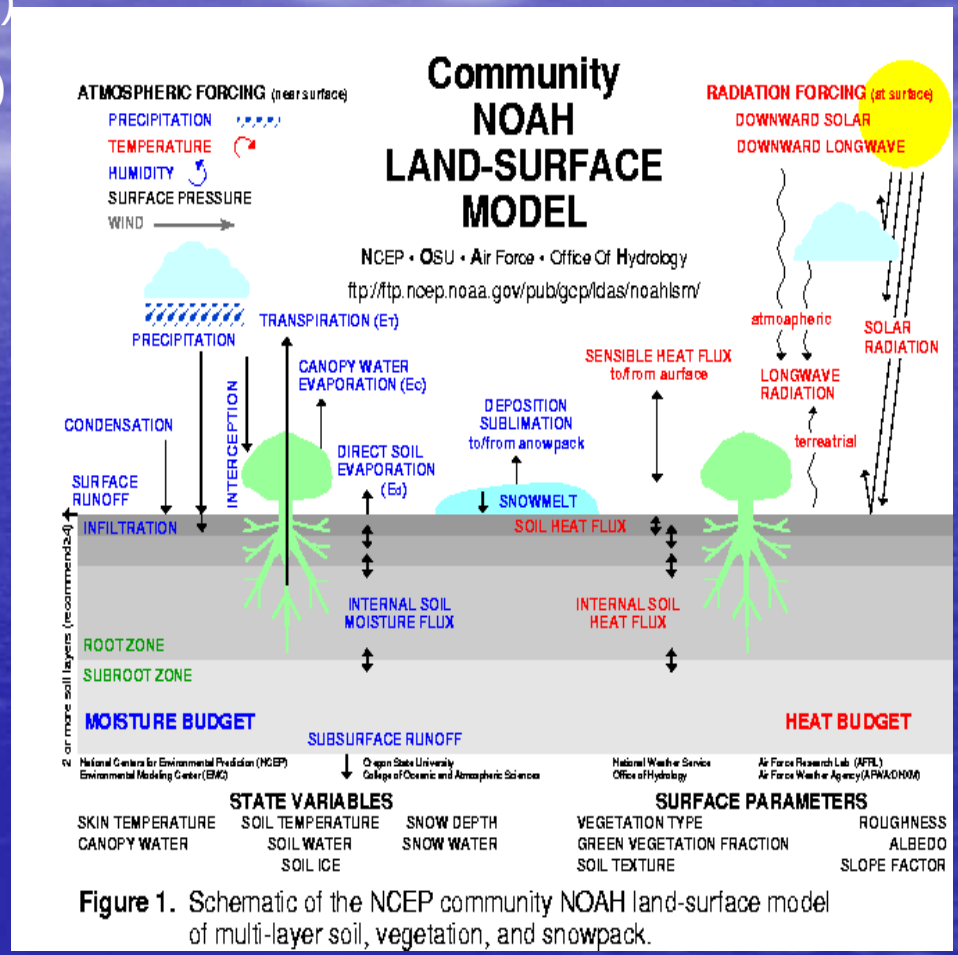
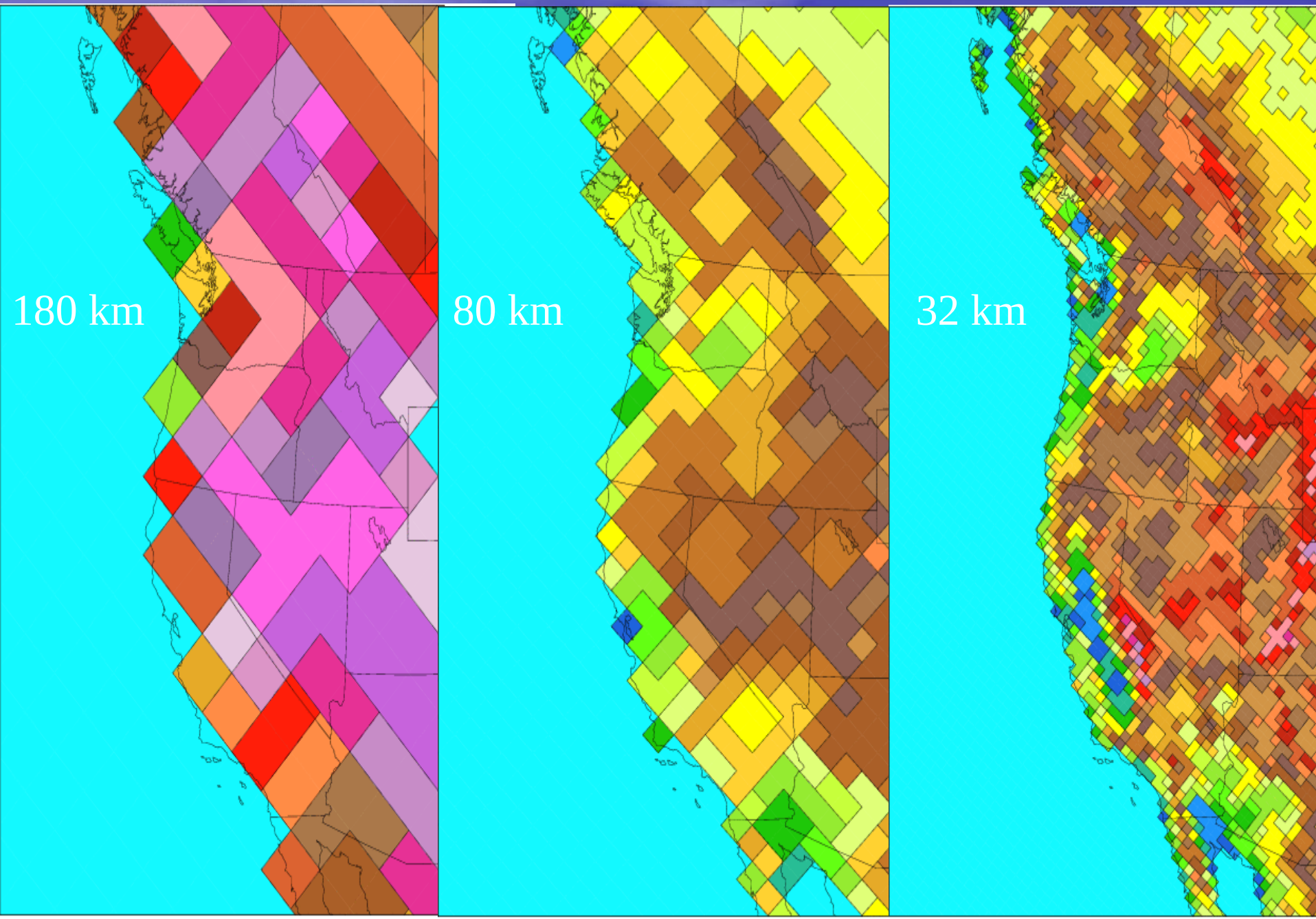
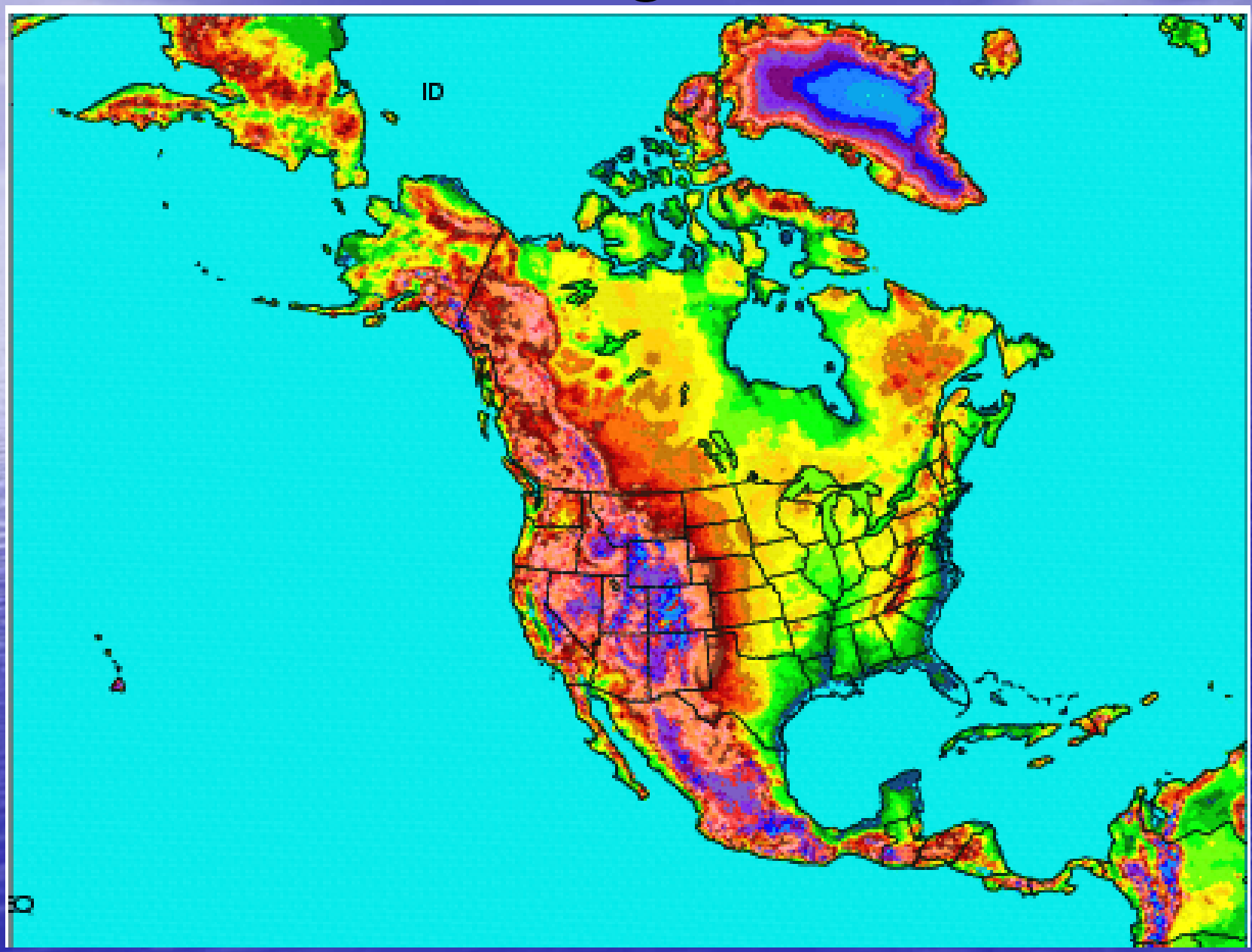


Figure 1. Schematic of the NCEP community NOAH land-surface model of multi-layer soil, vegetation, and snowpack.


180 km
80 km
32 km

Domain Coverage of NARR



NARR: Data for Global

Dataset	Details	Source
Radiosondes	Temperature, winds, moisture	NCEP/NCAR Global Reanalysis (GR)
Dropsondes	Same as above	GR
Pibals	Wind	GR
Aircraft	Temp. and wind	GR
Surface	Pressure	GR
Cloud drift winds	Geostationary satellite	GR

NARR: Data for Regional

Dataset	Details	Source
Precipitation	CONUS (with PRISM), Mexico, Canada, CMAP over oceans	NCEP/CPC
TOVS-1B radiances	Winds, precipitable water over oceans	NESDIS
Surface land	Wind, moisture	GR, TDL
COADS	Ship and buoy data	NCEP/EMC
Air Force Snow	Snow depth	COLA and NCEP/EMC
SST	1-degree Reynolds, with Great Lakes SSTs	NCEP/EMC, GLERL
Sea and lake ice	Contains data on Canadian lakes, Great Lakes	NCEP/EMC, GLERL, Canadian Ice Center
Tropical cyclones	Locations used for blocking of CMAP Precipitation	Lawrence Livermore National Laboratory

NARR Results: Upper-Air

- Compared both GR and RR against fits to raobs
- Root-mean-square (RMS) analysis fits significantly better for temperatures and vector wind speeds
- Wind speed improvement greatest in the upper troposphere, especially in winter
- First guess (3-hr forecast, pre-3DVAR) temperatures not always as favorable for RR compared to GR
- Relative humidity improved for RR for both analysis and first guess

NARR Results: Near Surface

- First guess, 1997: for temperatures, comparison against ship/buoy only. Surface temperature RMS improved both in winter and in summer
- 1998: Surface temperatures RMS favorable for NARR in both winter and summer. RR biases closer to zero and little diurnal variation problem in summer
- 10-m winds: RMS in NARR neither better nor worse compared to GR (remarkably similar!)
- Slow wind biases improved in NARR: just a little in winter, visibly in summer

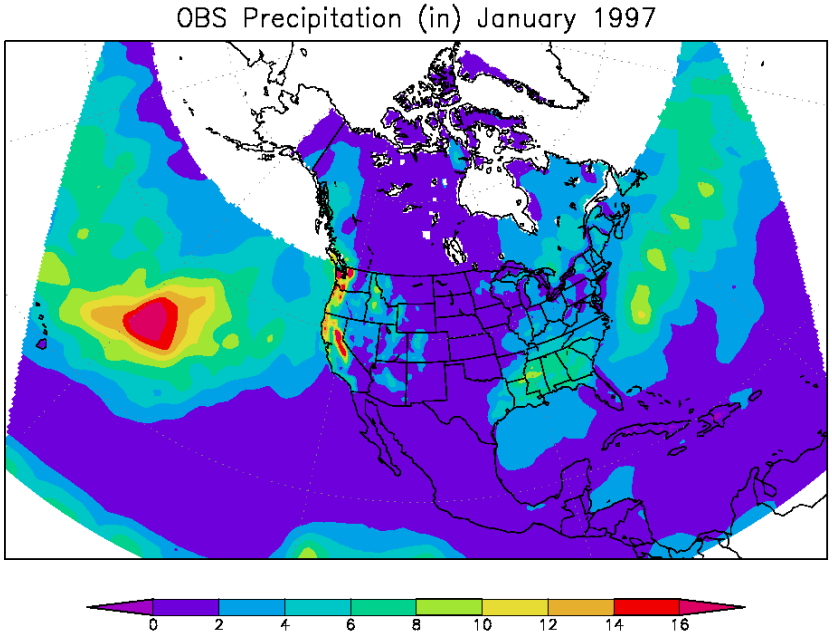
NARR Results: Precipitation

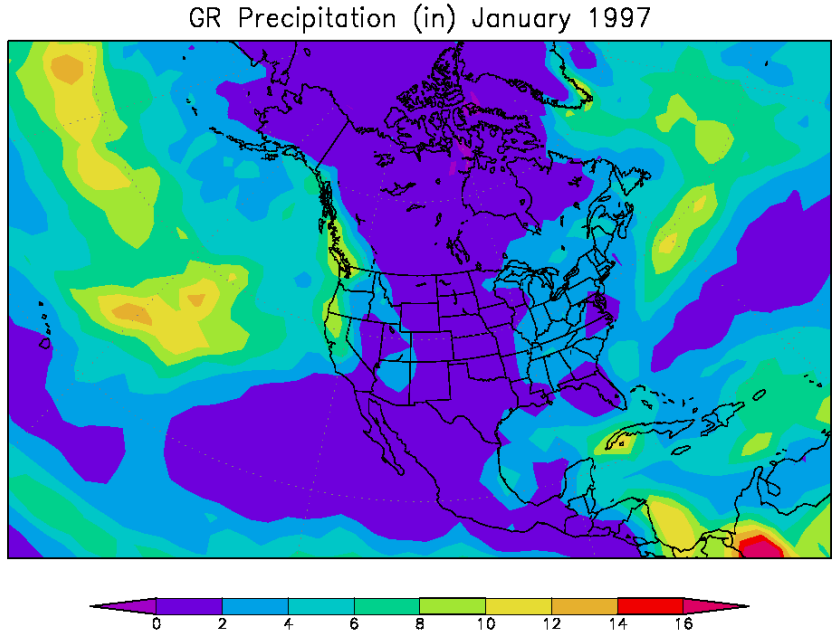
- Several sources of precipitation
  - CONUS data with PRISM (Mountain Mapper) to improve orographic effects
  - Canada
  - Mexico
  - CMAP (combination of satellite and gauge data) over oceans; CMAP is blocked:
    - Near central areas of hurricanes (7.5 by 7.5 deg)
    - Observed precipitation > 100 mm/day
    - A 15-degree “blending belt” between 27.5 and 42.5 N, with no CMAP north of 42.5 N

NARR Results: Precipitation (cont)

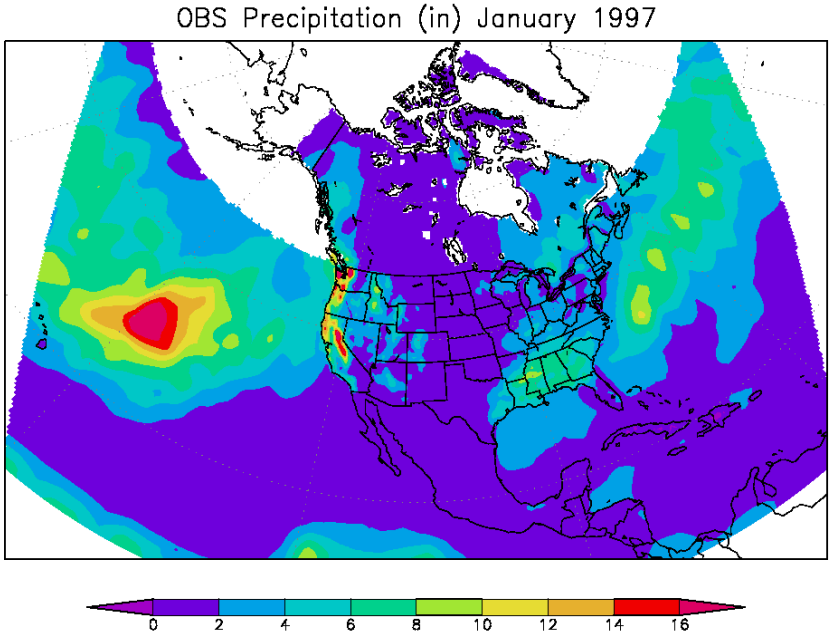
- Precipitation observations used to prescribe the latent heat profile in Eta
- Model uses given latent heat profile to simulate precipitation
- Resulting precipitation pattern looks very much like the observed precipitation pattern in both summer and winter

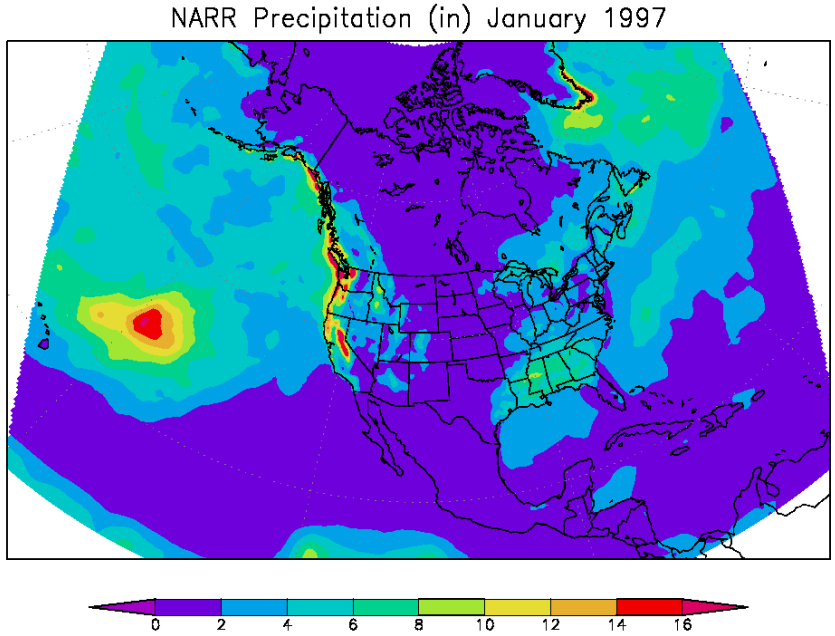
January 1997 Precipitation Results



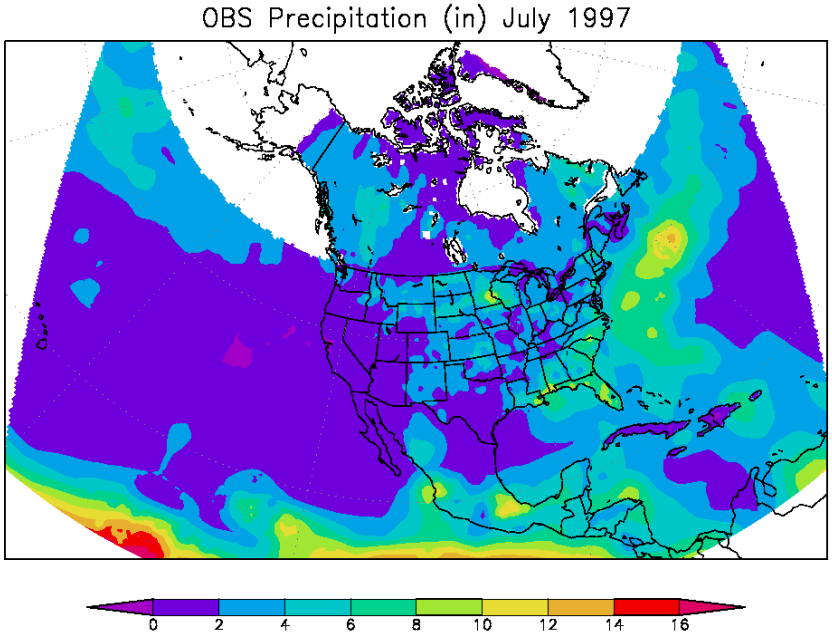


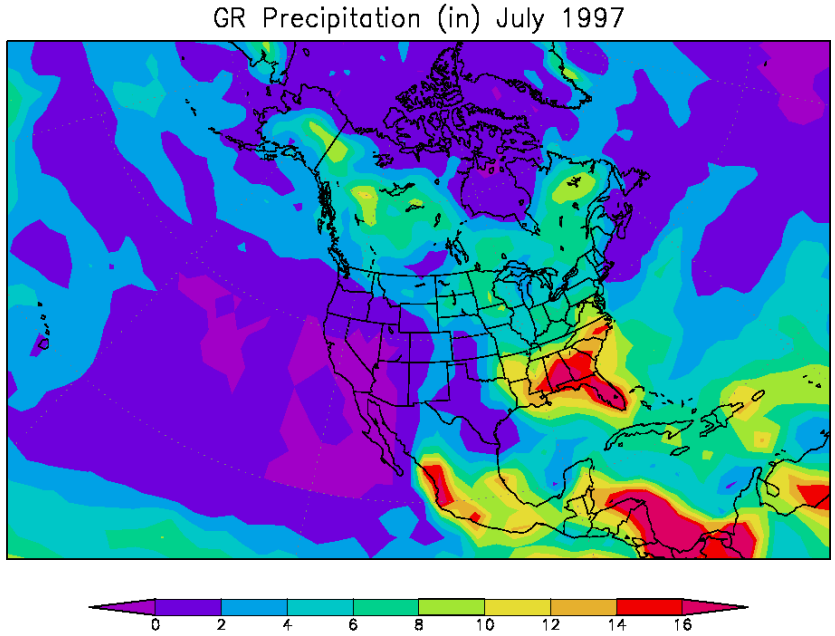
January 1997 Precipitation Results



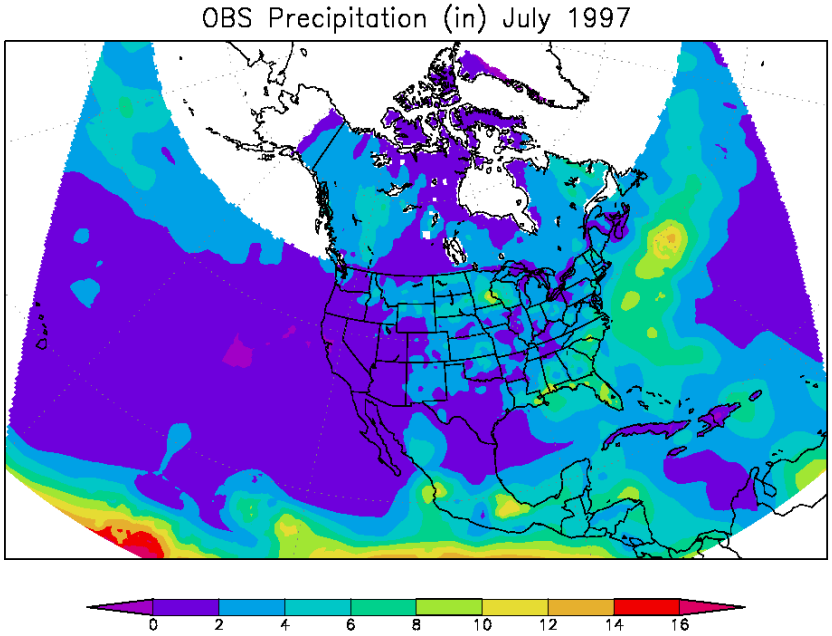


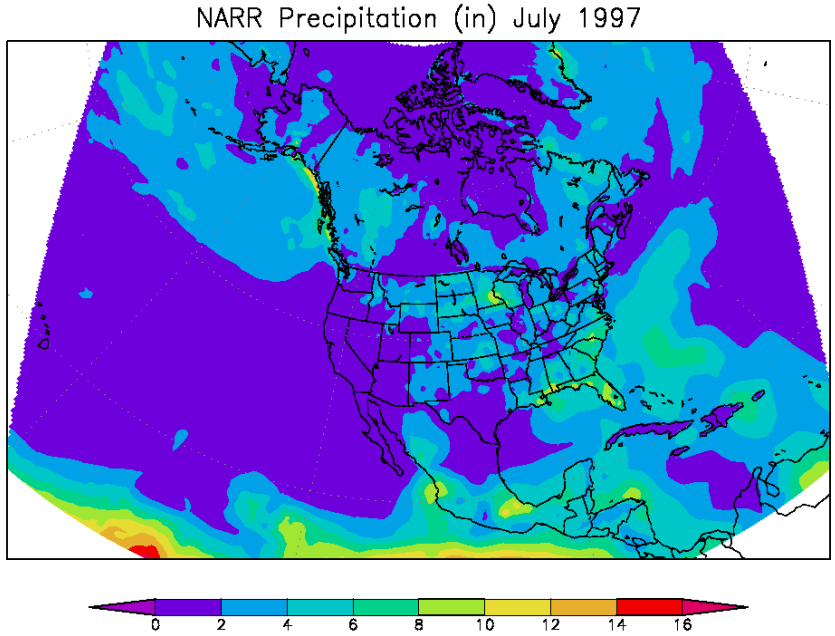
July 1997 Precipitation Results





July 1997 Precipitation Results





NARR: Analysis System

- Precipitation assimilation in EDAS
- Revised 3DVAR to run using the satellite bias corrections for all the satellites
- Updated the RR's land-surface model
- Ported the RR pilot system from the SGI Origin 3000 to the IBM-SP

NARR: System Design

- Fully cycled 3-hr EDAS
- Lateral boundary conditions supplied by GR2
- Forecasts to 72 hr every 2.5 days, using GR2 forecast boundary conditions
- Resolution: 32-km, 45 layers
- NARR time period: 1979-2003 Updated monthly

NARR: Data Acquisition and Processing

- Acquired precipitation dataset with use of PRISM (Mountain Mapper); disaggregated data to hourly
- Acquired TOVS-1B data for 1979-1997 time period
- Acquired Air Force snowdepth dataset
- Created a high-resolution sea-ice field

NARR: Archiving Overview

- Several archiving centers
  - National Climatic Data Center (10TB)
  - National Centers for Atmospheric Research *
  - San Diego Supercomputing Center **
  - Perhaps University of Maryland

* 7TB

** Ambitious amounts

NARR: Archive Data Volumes

Archive a) and b) only: 7.8TB
+ 2.2TB of restart= 10TB

AWIPS Grid 221

a) analysis files
- 52 Mb single file
- 420 Mb daily (8 times per day, every 3 hr)
- 12.6 Gb monthly
- 151 Gb yearly
- 3.7 Tb entire RR period (25 years)

b) 3-hour first-guess forecast files
- 58 Mb single file
- 464 Mb daily (8 times per day, every 3 hr)
- 14 Gb monthly
- 168 Gb yearly
- 4.1 Tb entire RR period (25 years)

c) Restart files
- 265 Mb single file
- 4.1 Gb daily (16 files per day; 8 analysis and 8 first-guess files, every 3 hr)
- 130 Gb monthly
- 1.5 Tb yearly
- 37 Tb entire RR period (25 years)

NCDC: Data Ingest and Archive

- 10TB on HDSS and 7.8TB on NOMADS
  - No off-site backup
- Metadata: FGDC, COARDS, and XML
  - Dynamic XML and GrADs via NOMADS Infrastructure
- Serviced thru NOMADS – NOMADS is “NARR Ready”
  - Traditional ftp or Web browse/plot via NOMADS Web
  - NOMADS Distributed Access Services