Assimilated Meteorological Data

Eighth Modeling Conference on Air Quality Models

Research Triangle Park, NC

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Outline

- Background
- Gridded Met. Data Project (CALPUFF & AERMOD)
- Gridded Met. Data Workgroup
- New Developments in NOAA/NCEP Products

Background

- ~1998 – John Irwin initiated requests in EPA budget for seed money for incorporating gridded meteorological data into dispersion models
- 2000 – 7th Modeling Conference; panel discussion
- 2004 – Renewed interest in “Irwin’s world” ideas, including gridded meteorological data
- Sept. 2004 – Gridded met. data project initiated

Background

- Why use gridded met. data?

  - NWS surface and upper air sites often not co-located
  - may be more representative than distant NWS site
  - more data parameters to characterize the atmosphere
  - state-of-the-science product (cloud physics, land/air moisture exchange, spatial density)
  - NOAA approved (NCEP); accepted by the modeling community (MM5)

Background

- Advancement of science at EPA

1. CAAAC (Clean Air Act Advisory Committee) – references to using more advanced tools for air quality modeling and pairing national/regional scale with more local scale modeling

   http://www.epa.gov/air/caaac/report1-17-05.pdf

Background

- Advancement of science at EPA

2. National Academy of Science (NAS) – suggests that models in a 4-dimensional data assimilation mode would provide superior air quality forecasts in the future

http://www.nap/edu/openbook.php?record_id=10728&page=239#pagetop

Background

- Which gridded met. product should be used?

  - GFS (Global Forecast System) – used for aviation, 00 06 12 18Z (95km grid)
  - ETA – regional mesoscale model, 00 06 12 18Z (12km grid)
  - NARR (North American Regional Reanalysis) – every 3 hrs (32km grid)
  - RUC (Rapid Update Cycle) – every 3 hrs (20km)
  - MM5 (PSU/NCAR Mesoscale Met. Model) – available 36km, some 12/4 km domains; hourly

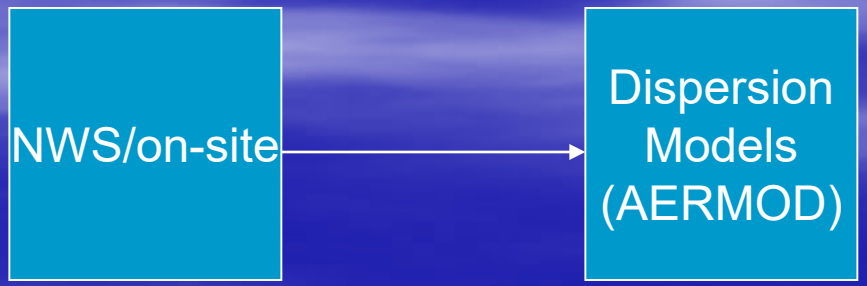
Background

- Which gridded met. product should be used? (cont'd)
  - WRF (Weather and Research Forecasting Model; partnership between NCAR, NCEP, FSL, AFWA, NRL, OU, FAA) – next generation of MM5-type model; 8km (NCEP) , HiRes Window forecasts

Background

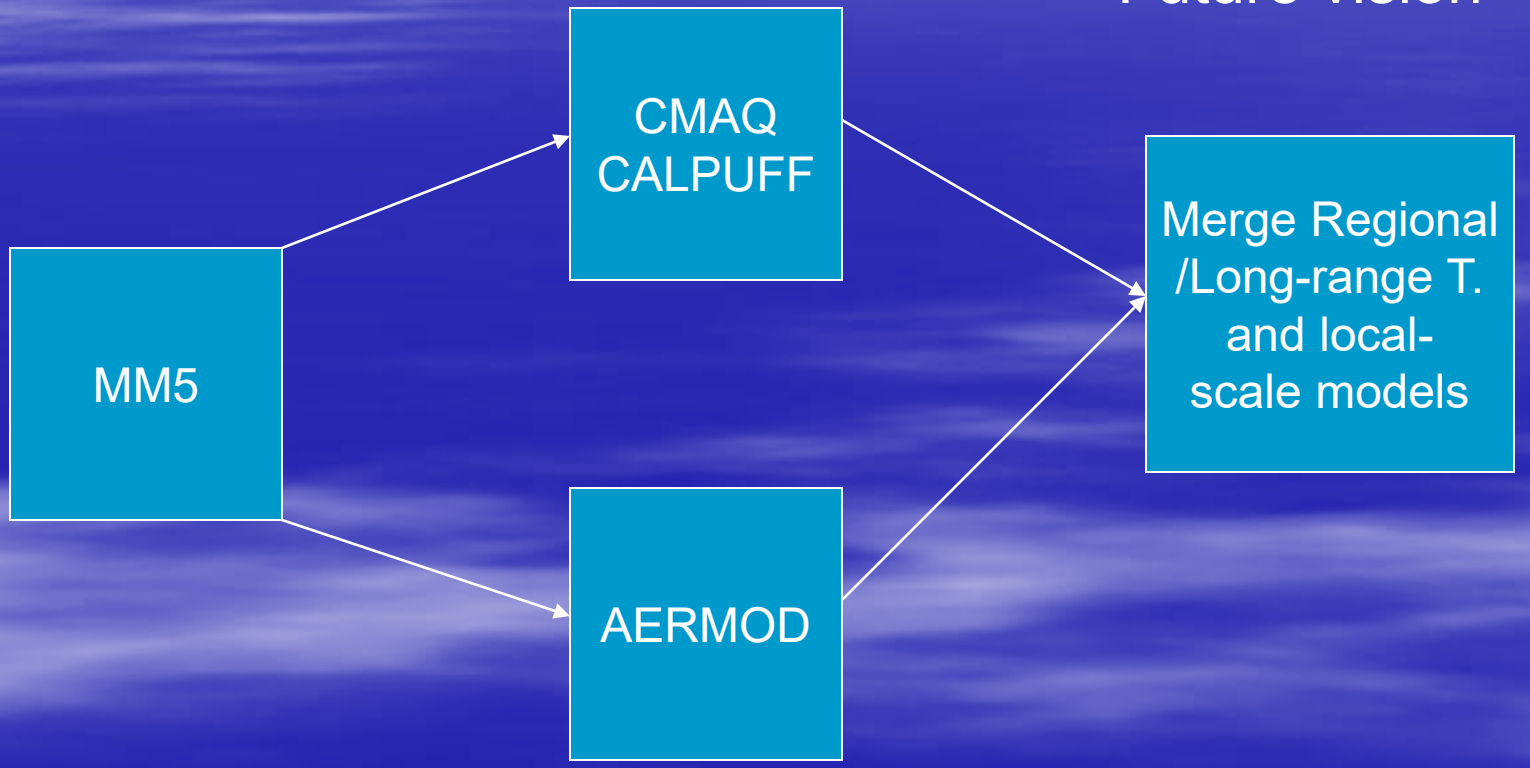
Regional & long-range transport scale models – use MM5 data

Local-scale **models -- use NWS or on-site data**



Background

Future vision



Background

- OAQPS Innovations Project submission --

  "Developing the Capacity to Convert Routinely Available Meteorological Modeling Data into Inputs for Regulatory Air Quality Modeling Applications"….March 25th

  - funding awarded – $50K

Gridded Met. Data Project

GOAL: Incorporate/assess gridded met. data into dispersion modeling world

STEPS:

1. Review…MM5 into CALPUFF
   -- currently accepts MM5 via CALMM5; soon CALRUC, CALETA
   -- educate/learn how MM5 is processed through CALPUFF to apply similar procedures to AERMOD
   -- run MM5 (36 and 12km) and NWS data through CALMET and analyze results
   -- run processed MM5 (36 and 12km) and NWS data through CALPUFF and analyze results

Gridded Met. Data Project

2. MM5 into AERMOD

2-parts:

(1) using current variables needed by AERMET from MM5 to drive AERMOD

(2) utilizing additional variables available from MM5 to improve the physics within AERMOD

Gridded Met. Data Project

- MM5 into AERMOD (Part 1)

-- process MM5 for a single grid cell and NWS data into AERMOD (AERMOD will not be modified to accept more than a single grid of data)

-- run AERMET using MM5 and NWS data and analyze results

-- run AERMOD using MM5 and NWS data and analyze results

Gridded Met. Data Project

- MM5 into AERMOD (Part 2)

-- utilize new variables available within MM5 to enhance current physics by modifying AERMET/AERMOD, as needed

-- run “modified AERMET” using MM5 vs. NWS and analyze results

-- run “modified AERMOD” using MM5 vs. NWS and analyze results

Gridded Met. Data Project

3. RUC,ETA,WRF into AERMOD,CALPUFF

-- software needed to convert RUC, ETA, WRF for input to AERMET and CALMET (CALRUC, CALETA coming soon)

-- run RUC, ETA, and WRF through AERMET and CALMET; analyze results and compare with MM5

-- run AERMOD and CALPUFF using RUC, ETA, and WRF-driven gridded data; analyze results and compare with MM5

Gridded Met. Data Project

- End Product – an IT tool
  - that will accept multiple gridded met. inputs
  - process fields for compatibility (reformat) with the desired air dispersion model
  - compute fields from gridded meteorological data needed by recipient model

Gridded Met. Data Workgroup

Members

- EPA Regional Offices
  - Bret Andersen (R-VII)
  - Herman Wong (R-X)
- Fisheries and Wildlife Service
  - Tim Allen
- States
  - many states
- Canada – British Columbia
  -

Activities

- Formed in late February
- 4 productive workgroup calls; email exchanges
- Primary Focus - 7 issues related to gridded met. data
- Survey – State's experience with gridded met. data

Issue #1

- Identify additional meteorological parameters available from the gridded output that would be useful in AERMOD.

- Turbulent Kinetic Energy (TKE) – AERMOD currently uses similarity theory for CBL

- Vertical velocity – potential replacement for convective velocity scale

Issue #1 (cont'd)

- PBL Height – profiling is current used (for wind speed, wind direction, potential temp. gradient, potential temp., etc.)
- PBL regime (category, 1-4) – w/PBL height
- Surface sensible heat flux – currently used
- Surface latent heat flux – currently used
- Terrain elevation – currently used; important to determine the dividing streamline in complex terrain

Issue #1 (cont'd)

- Land-use category – caution is needed when using MM5 LU information; LU is averaged within a grid cell (and nudged), so local variations will not be captured; smaller grid scales pick up more details

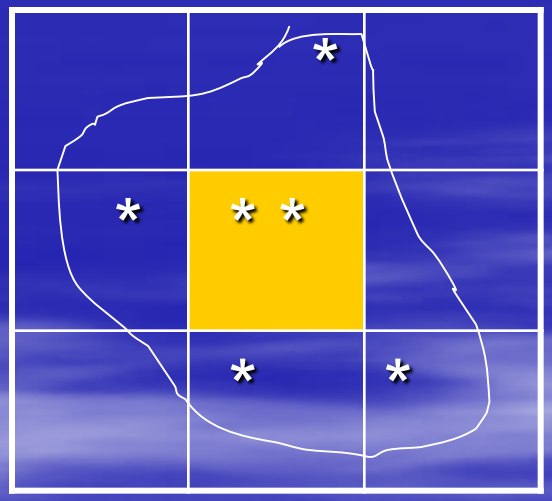
Issue #2

- Multi-grid source fields. How would a single met. source model handle met. data from multiple grid cells?

- Make multiple runs for the sources within each grid cell; add the results together in space and time…labor intensive

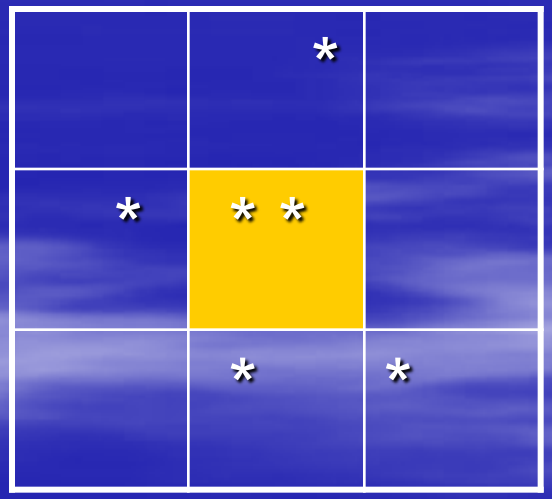
Issue #2 (cont'd)

- Use the center grid cell for the source group.



Issue #2 (cont'd)

- Interpolation of grid cells…a interpolation scheme would be necessary, i.e. requires a weighting calculation for each grid cell



Issue #3

- Is on-site data necessary if grid cell data is used?

- On-site data captures local-scale phenomenon that does not get resolved by even higher resolution gridded met. data, such upslope/downslope winds, sea/land breezes, mountainous terrain areas, etc.

Issue #3 (cont'd)

- Gridded data has been nudged to create a flowing regime.
- When gridded met. data get resolved to 4km or less, then this issue will probably need to be revisited.
- On-site data is useful/necessary for the foreseeable future.

Issue #4

- Issues with “data representativeness”?

- If local (sub-grid scale) effects are important, it may be necessary to incorporate local data (NWS/on-site)
- Studies show the spatial resolution of MM5 is 3 to 5 times the grid spacing (4km grid can resolve features with a wavelength of 20km); WRF has a resolution of ~3X grid

Issue #4 (cont'd)

- Sensitivity tests – necessary to compare gridded met. data with traditional NWS data; done NOT to prove which is better but to explain the differences
- Number of years to be used – currently 3 years has been used (due to data availability) for applications using gridded met. data…5 years should be used when available

Issue #4 (cont'd)

- Grid spacing requirement – lower grid resolution captures more local effects

36km - resolves met. features from 108km (3x) to 180km (5x) km in wavelength; common with current NWS configurations

12km - resolves 36km (3x) to 60km (5x)

(4km - resolves 12km (3x) to 20km (5x))

Issue #4 (cont'd)

- Complex terrain -- western states would likely need resolution of 1km to adequately capture the Rockies, bluffs, gorges, etc.
- Fenceline concentrations – should NWS data, on-site, or gridded met. data be used? …what grid resolution would capture sufficient detail to use for NAAQS, PSD, toxics, urban, etc. modeling?

Issue #5

- Known shortcomings of current gridded modeling input and their impact…precip. inconsistences, lack of calms (very few), etc.
  - Precipitation inconsistences – should be cross-checked when employing wet deposition
  - Fewer calms -- results…steady-state models (AERMOD) will use more hours to calculate concentration estimates; could lead to higher design concentrations

Issue #6

- If given the choice, where would we want the gridded data to reside?

- Data should be readily available, regardless of its physical location; URL(s) available on SCRAM
- Data tools should be provided by EPA
- Data for modeling should be public domain

Issue #7

- Logistical issues, such as computer resources of users, acquisition of data, file sizes, etc.

- Dissemination of large files – use the same technique that NCEP uses…tiling
- Data should be easily accessible

Issue #7

- All data should be public-domain data (not proprietary)
- Data portability is important; data should be usable by multiple models (1 atmosphere)

Gridded Met. Data Survey

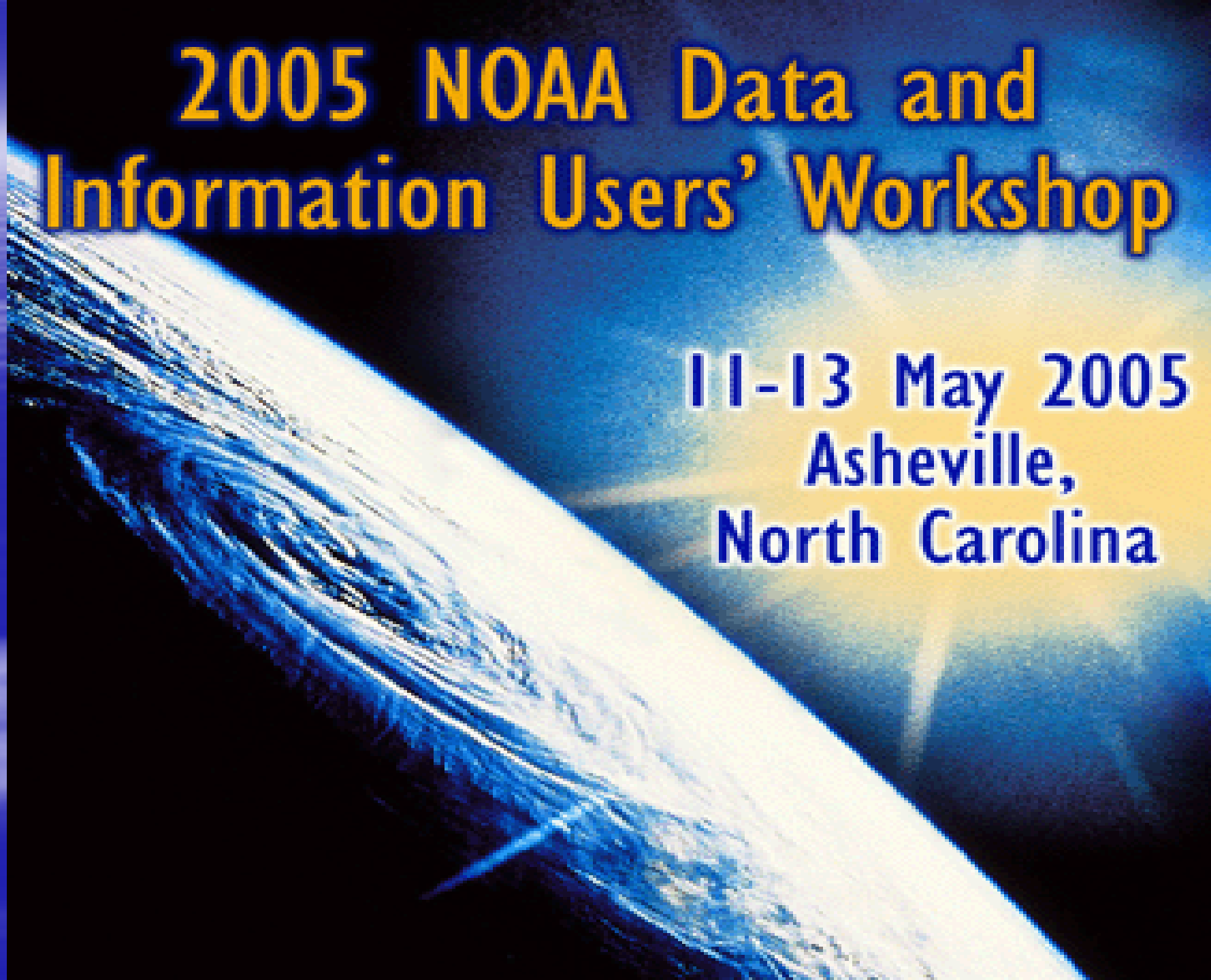
- 20 of 50 States reporting….
- 3 pieces of information:

1. Gridded Met. Data used/dates
2. Source of data
3. Other relevant information

- 12 “Some experience” , as inputs to CALPUFF
- 8 “No experience”
- No response…many with no experience

Other Issues -- Important

- Education -- many States have not used gridded data; assistance in learning needed
- Partnering – on-going dialogue from OAQPS to Regional and State offices, FWS, NPS, and others


2005 NOAA Data and Information Users' Workshop
11-13 May 2005
Asheville,
North Carolina

Availability of NCEP Products

- National Climatic Data Center – archives GFS, ETA (NAM), RUC data starting in 2002
- NOMADS – NOAA Operational Model Archive and Distribution System; collection of portals to data
- http://nomads.ncdc.noaa.gov/data-access.html

Model Data Access
NOMADS Web Interface

Table of Contents

Latest NOAA Developments

- RUC…20km to 13km (June 2005)
- WRF…initial storage by NCDC ~April, 2006
- CLASS (Comprehensive Large Array data Stewardship System) – IT tool for archival and access to NCEP products; volume to 100 Petabytes by 2015
- MM5 storage by NCDC – possibility in the future

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http://www.class.noaa.gov/nsaa/products/welcome;jsessionid=49FBD5FC6A00429E8A95C19E66CD9677

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Comprehensive Large Array-data Stewardship System

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The Comprehensive Large Array-data Stewardship System (CLASS) is an electronic library of NOAA environmental data. This web site provides capabilities for finding and obtaining those data.

CLASS is NOAA's premiere on-line facility for the distribution of NOAA and US Department of Defense (DoD) Polar-orbiting Operational Environmental Satellite (POES) data, NOAA's Geostationary Operational Environmental Satellite (GOES) and derived data.

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Thank You!