SAFARI 2000 ETA Atmospheric Model Data, Wet and Dry Seasons 2000

Abstract

The ETA Model was used to provide operational regional forecast guidance and basic meteorological data for the SAFARI project. The model outputs proved in this data set are ASCII map images (0.5 degree) for each of 51 parameters at 12 hour intervals. Data are available for February-April and August-September 2000.

The National Centers for Environmental Prediction (NCEP) developed this step-mountain eta coordinate model generally known as the ETA Model. This NCEP ETA data assimilation and prediction system (see Mesinger et al., 1988; Black, 1994) has been used by the South African Weather Bureau/Service (SAWS) to provide operational regional forecast guidance since November 1993. The SAWS ETA model is a hydrostatic model with a horizontal grid spacing of approximately 48 km and 38 vertical levels, with layer depths that range from 20 m in the planetary boundary layer to 2 km at 50 mb. There have been several major ETA Model upgrades at SAWS: in March 1996, August 1998, November 1999, and August 2001.

Background Information

Investigators:

South African Weather Service (SAWS)

Project: SAFARI 2000

Data Set Title: SAFARI 2000 ETA Atmospheric Model Data, Wet and Dry Seasons 2000

Site: Southern Africa
Westernmost Longitude: 13 W
Easternmost Longitude: 53 E
Northernmost Latitude: 9 S
Southernmost Latitude: 53 S

Data Set Citation:

South African Weather Service (SAWS). 2004. SAFARI 2000 ETA Atmospheric Model Data, Wet and Dry Seasons 2000. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Data File Information

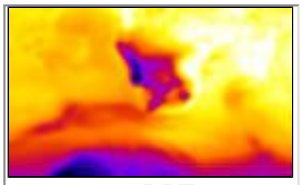
The data files contain a single ASCII map image (133 values per line by 79 lines, single space delimited, 0.5 degree data) for each parameter, every 12 hours. The files are named using the following format:

eta_variable_2000MMDD_HHz.asc

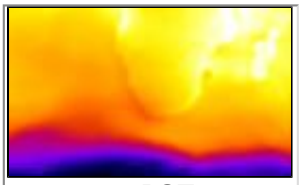
For example, the file "**eta_DPT-1000_20000201_00z.asc**" is an ETA model run ("**eta**") for the variable "**DPT-1000**" (dew point temp at 1000 mb, see the **Parameter Table** just below) on **2000-02-01** (February 1, 2000) at **00z** (hour 0000 Zulu, or GMT).

The files are organized by month (wet season: Feb, Mar, Apr 2000 and dry season: Aug, Sep 2000). Within the month-directory, there are ZIP files for the various parameter groups (see the table below). Thus, an entire month of a parameter group is stored together in a single ZIP file.

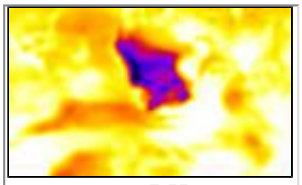
Sample ETA Maps (actual size) from February 1, 2000, 00 Zulu (GMT)



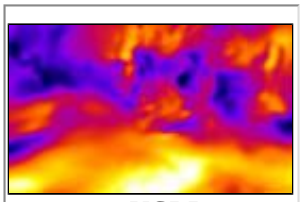
eta_DPT-1000_20000201_00z.asc
Dew point temp. [K] at 1000 mb



eta_POT-1000_20000201_00z.asc
Potential temp. [K] at 1000 mb



eta_RH-1000_20000201_00z.asc
Relative humidity [%] at 1000 mb



eta_UGRD-1000_20000201_00z.asc
u wind [m/s] at 1000 mb

ETA Atmospheric Model Parameters

ZIP File	Parameter	Description
eta_ACPCP-sfc_2000-MM.zip	ACPCP-sfc	Convective precipitation [kg/m^2] at the surface (sfc)
eta_CAPE_2000-MM.zip	CAPE-180	Convective Avail. Pot. Energy [J/kg] at 180-0 mb above the ground
	CAPE-sfc	Convective Avail. Pot. Energy [J/kg] at the surface (sfc)
eta_CIN_2000-MM.zip	CIN-180	Convective inhibition [J/kg] at 180-0 mb above the ground
	CIN-sfc	Convective inhibition [J/kg] at the surface (sfc)
eta_CLOUD_2000-MM.zip	HCDC	High level cloud cover [%]
	LCDC	Low level cloud cover [%]
	MCDC	Mid level cloud cover [%]
eta_DPT_2000-MM.zip	DPT-1000	Dew point temp. [K] at 1000 mb

	DPT-250	Dew point temp. [K] at 250 mb
	DPT-500	Dew point temp. [K] at 500 mb
	DPT-700	Dew point temp. [K] at 700 mb
	DPT-850	Dew point temp. [K] at 850 mb
eta_HGT_2000-MM.zip	HGT-1000	Geopotential height [gpm] at 1000 mb
	HGT-250	Geopotential height [gpm] at 250 mb
	HGT-500	Geopotential height [gpm] at 500 mb
	HGT-700	Geopotential height [gpm] at 700 mb
	HGT-850	Geopotential height [gpm] at 850 mb
	HGT-sfc	Geopotential height [gpm] at the surface (sfc)
eta_POT_2000-MM.zip	POT-1000	Potential temp. [K] at 1000 mb
	POT-250	Potential temp. [K] at 250 mb
	POT-500	Potential temp. [K] at 500 mb
	POT-700	Potential temp. [K] at 700 mb
	POT-850	Potential temp. [K] at 850 mb
eta_PWAT_2000-MM.zip	PWAT	Precipitable water [kg/m^2]
eta_RH_2000-MM.zip	RH-1000	Relative humidity [%] at 1000 mb
	RH-250	Relative humidity [%] at 250 mb
	RH-500	Relative humidity [%] at 500 mb
	RH-700	Relative humidity [%] at 700 mb
	RH-850	Relative humidity [%] at 850 mb
eta_TMP_2000-MM.zip	TMP-1000	Temp. [K] at 1000 mb
	TMP-250	Temp. [K] at 250 mb
	TMP-500	Temp. [K] at 500 mb
	TMP-700	Temp. [K] at 700 mb
	TMP-850	Temp. [K] at 850 mb
	TMP-sfc	Temp. [K] at the surface (sfc)
eta_UGRD_2000-MM.zip	UGRD-1000	u wind [m/s] at 1000 mb
	UGRD-250	u wind [m/s] at 250 mb
	UGRD-500	u wind [m/s] at 500 mb
	UGRD-700	u wind [m/s] at 700 mb
	UGRD-850	u wind [m/s] at 850 mb
eta_VGRD_2000-MM.zip	VGRD-1000	v wind [m/s] at 1000 mb
	VGRD-250	v wind [m/s] at 250 mb
	VGRD-500	v wind [m/s] at 500 mb
	VGRD-700	v wind [m/s] at 700 mb
	VGRD-850	v wind [m/s] at 850 mb
eta_VVEL_2000-MM.zip	VVEL-1000	Pressure vertical velocity [Pa/s] at 1000 mb
	VVEL-250	Pressure vertical velocity [Pa/s] at 250 mb
	VVEL-500	Pressure vertical velocity [Pa/s] at 500 mb
	VVEL-700	Pressure vertical velocity [Pa/s] at 700 mb
	VVEL-850	Pressure vertical velocity [Pa/s] at 850 mb

Data Processing from the Original GRIB Format

The original data files were in GRIdded Binary (GRIB) format, a compressed format used for gridded meteorological data. The files were decoded into ASCII streams (all 51 parameters in a single file) using the WGRIB program [http://wesley.wwb.noaa.gov/wgrib.html]. These ASCII stream files (one file per month per parameter) were then were broken up into single files and reprocessed into maps (133 values per line by 79 lines, single space delimited, one file per 12-hour period per parameter) and flipped right-side up. The files were reorganized to be grouped by parameter (instead of by 12-hour period).

ETA Model Information

Background

The ETA model is a relatively new model, which is very similar to the older synoptic-scale Nested Grid Model (NGM), and forecasts the same atmospheric variables. The ETA model takes its name from the vertical coordinate η (Greek letter êta), defined by Mesinger, 1984. This coordinate is also known as the step-mountain coordinate because the surfaces are represented in the form of steps whose tops coincide with model layer interfaces. The eta vertical coordinate system was used in order to remove the large errors that are known to occur when computing the horizontal pressure gradient force, as well as the advection and horizontal diffusion, along a steeply sloped coordinate surface. The eta coordinate system makes the surfaces quasi-horizontal everywhere as opposed to sigma surfaces which can be steeply sloped. Because the eta coordinate is pressure based and normalized (i.e. quasi-horizontal), it leads to a much simpler solution of the equations of motion.

As a result of using this coordinate system and a higher resolution, the ETA model has a much more accurate picture of the terrain. According to Dr. Ronald McPherson, Director of NCEP, the ETA model has outperformed all the other models in forecasting amounts of precipitation. This noted improvement is very important and useful for many applications such as hydrology and flood forecasts.

The NCEP ETA data assimilation and prediction system (see Mesinger et al., 1988; Black, 1994) has been used by the South African Weather Bureau/Service (SAWS) to provide operational regional forecast guidance since November 1993. SAWS used this model to produce the basic meteorological data for the SAFARI project. The SAWS ETA model is a hydrostatic model with a horizontal grid spacing of approximately 48 km and 38 vertical levels, with layer depths that range from 20 m in the planetary boundary layer to 2 km at 50 mb. There have been several major ETA Model upgrades at SAWS: in March 1996, August 1998, November 1999, and August 2001.

Assimilation

Ingest of observational data takes place via an intermittent data assimilation scheme. After preparation of the initial first guess, four preliminary analysis-initialization-forecast cycles are run, from t-12h to t-9h, t-9h to t-6h, t-6h to t-3h and from t-3h to time t, followed by a final analysis at time t.

Analysis

The analysis system is the NCEP three-dimensional variational (3DVAR) scheme. Preliminary guess fields for the initial analysis at t-12h are provided by an NCEP global analysis from the Global Telecommunication System (GTS), or from the in-house Global Spectral Model (GSM), while guesses for the subsequent analyses are 3-hour forecasts from the ETA model itself. Observations are included from a 3-hour window around each analysis time. The World Meteorological Organization (WMO) GTS network allows a vast amount of global observational data to be exchanged very rapidly.

Model

The prediction model in use is the NCEP regional eta-coordinate model with step-terrain representation.

Basic equations	Primitive equations
Independent variables	Longitude, latitude, eta, time.
Dependent variables	Prognostic variables are temperature, horizontal wind components, surface pressure, specific humidity and turbulent kinetic energy. Prognostic soil and cloud water models are incorporated.
Diagnostic variables	Geopotential height and 'eta vertical velocity'.
Integration domain	Southern Africa and surrounding waters, transformed grid roughly contained in 52 S to 1 N, 28 W to 68 E.
Vertical coordinate	Eta coordinate with step-like terrain representation.
Grid	Arakawa E-grid (106 x 157) on a transformed latitude/longitude grid centred at 20 E, 28 S.
Resolution	48 km horizontally, with 38 eta levels in the vertical (top at 25 hPa).
Time integration	Split explicit adjustment scheme, Euler backward advection scheme, basic time step 120 s.
Orography	Silhouette-mean mountains.
Boundary values	Time-dependent lateral boundary conditions by default from an NCEP global forecast from the GTS (low-resolution, gridded, pressure-level) or, as back-up, from the local GSM model (high-resolution, spectral coefficient, sigma-level), based on t-12h and sampled at 6-hourly intervals.

Physical Parameterization

- Mellor-Yamada level 2.5 turbulence closure model for planetary layer, level 2 for surface layer
- Fourth-order non-linear lateral diffusion
- Modified Betts-Miller-Janjic scheme for deep and shallow convection
- GFDL radiation scheme
- Ground surface processes and surface hydrology
- Large-scale precipitation
- Model-predicted cloud cover
- Cloud water model
- Soil model (four-layer)

Additional Sources of Information

More Information on Numeric Weather Prediction (NWP) Models:

Operational Models Matrix: Characteristics of Operational NWP Models:
http://meted.ucar.edu/nwp/pcu2/index.htm

On vertical resolution and coordinates:
http://www.met.tamu.edu/class/metr452/models/2001/vertres.html

NCEP's ETA Model FAQ Page:
http://www.emc.ncep.noaa.gov/mmb/research/FAQ-eta.html

NCEP Home Page:
http://www.emc.ncep.noaa.gov/

WGRIB: GRIB data processing program:
http://wesley.wwb.noaa.gov/wgrib.html

South African Weather Service (SAWS) Web Site:
http://www.weathersa.co.za/

References

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Rogers, E., T. L. Black, D. G. Deaven, G. J. DiMego, Q. Zhao, M. Baldwin, N. W. Junker, and Y. Lin. 1996. Changes to the operational 'Early' ETA analysis/forecast system at the National Centers for Environmental Prediction. Wea. Forecasting, 11: 391-413.

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Revision Date: Monday, June 14, 2004