



Surface Flux Dust Model Version Description



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1. INTRODUCTION

1.1 Document Overview

Section 1 describes the scope of the Surface Dust Flux Model software system.

Section 2 lists Referenced Documents.

Section 3 provides a detailed description of the contents of Version 1.0 of the Surface Dust Flux Model software system.

1.2 Overview

This document describes the Surface Dust Flux modeling software package. The model uses forecasted surface winds to estimate the rate at which ground level dust is being produced from source areas within a mesoscale theater. Surface dust fluxes vary in desert regions from 10 –100 $\mu\text{gm}/\text{m}^2\text{-s}$ for small to moderate fluxes, and 500 to 2000 $\mu\text{gm}/\text{m}^2\text{-s}$ or more under dust storm conditions.

The model uses MM5 forecasted wind fields, soil moisture and estimated precipitation as input. Surface dust flux is calculated at each MM5 model grid location (~45 km intervals) in the mesoscale theater. The flux is calculated using forecasted 10 meter winds and the dust source database and model developed by Dr.Paul Ginoux at NASA GSFC/GIT.

The dust model can make forecasts for 2 MM5 mesoscale regions covering Northern Africa and the Middle East (T9z) and Southwest Asia (T4y). The surface dust fluxes are displayed as regional maps with color overlays showing dust fluxes in $\mu\text{gm}/\text{m}^2\text{-s}$. The user should note that this model does not forecast the transport of dust in the atmosphere. It only makes a prediction of the rate at which dust is generated at the surface.

1.3 System Overview

The Surface Dust Flux model has been created as a forecasting and analysis tool to predict the rate at which surface dust is produced in desert regions. The model estimates the rate as a dust flux, calculated in $\mu\text{gm}/\text{m}^2\text{-s}$ from the surface. The model estimates surface fluxes for 4 particle sizes groups: 0.1 to 1.0 μm , 1.0-1.8 μm , 1.8-3.0 μm and 3.0 to 6 μm .

Features of the dust flux model are the inclusion of a new dust source model based on research work by Paul Ginoux and Mian Chin (*Ginoux et al. 2000, Chin et al. 2001*). The dust source model is unique in that it uses a global dust database based on terrain elevation data in desert regions to identify topographic depressions that are key dust source areas. The Ginoux dust source model included with this software package is based on the 1°x1° resolution reinterpolated to each MM5 mesoscale theater grid point at roughly 1/2° intervals. The Ginoux source model has been verified and supplemented using satellite and ground observations. It is currently undergoing continuing research to generate a higher resolution 10kmx10km global model.

The surface dust fluxes are driven by the forecasted MM5 windfields at 10 meter heights. The dust flux is calculated based on a calculated wind threshold velocity, u_t for each particle diameter Φ_p . The threshold velocity is calculated using:

$$u_t = A \sqrt{(\rho_p - \rho_a) / \rho_a g \Phi_p} * 1.2 + 0.2 \log_{10} w \text{ if } w < 0.5$$

$$\infty \text{ otherwise}$$

where g is the acceleration of gravity, ρ_p and ρ_a are the dust particle and air density respectively. The model can incorporate precipitation surface soil moisture to derive a soil wetness w , which varies from 0.01 to 1. If soil wetness values are included, dust fluxes are reduced in source areas as the soil wetness approaches 0.5. Above a soil wetness of 0.5, the dust flux is assumed to be zero where the wind threshold velocity becomes infinite. In desert regions under arid conditions, w varies from 0.01 to 0.1. If soil moisture and precipitation are not used in the Surface Dust Flux Model (SDFM), w is set to a default value of 0.1. Note that in the first version of DSFM, w is set to the default value for arid regions. The surface dust flux is calculated for each particle size class using:

$$F_p = C * S * s_p u_{10m}^2 (u_{10m} - u_t) \text{ if } u_{10m} > u_t$$

$$0 \text{ otherwise}$$

F_p is the surface dust flux in $\mu\text{g}/\text{m}^2\text{-s}$, C is a dimensional constant equal to $1 \mu\text{g s}^2\text{m}^{-5}$, and S is the Ginoux dust source value at the MM5 grid point. The surface wind velocity is taken at 10 meters. Future versions of this model will use the surface friction velocity to calculate dust fluxes when available in MM5 data files.

2. Referenced Documents

C. H. Dey. GRIB, Edition 1, NCEP Central Operations, National Weather Service, NOAA, U.S. Dept. of Commerce, Office Note 388, 1998.

3. Version Description

3.1 Inventory of Materials Released

The Surface Dust Flux Model software system is being released on a single 4mm DAT tape labeled SDFM Software.

The documentation that supports this version is listed below and has been delivered with the installation of the system.

- Surface Dust Flux Model Functional Requirements Document, UPOS-A53-20, Version 1.0, L. M. Hasselbarth, Benjamin H. Barnum, Bruce A. Toth, TBD
- Surface Dust Flux Model Design Document, UPOS-A53-23, Version 1.0, L. M. Hasselbarth, Benjamin H. Barnum, Bruce A. Toth, 17 October 2001
- Test Plan for the Surface Dust Flux Model, Version 1.0, L.M.Hasselbarth, Bruce A. Toth, TBD
- Surface Dust Flux Model Test Report, Version 1.0, L. P. Butler, TBD
- Surface Dust Flux Model User's Guide, UPOS-A53-19, Version 1.0, L. M. Hasselbarth, Benjamin H. Barnum, Bruce A. Toth, 17 October 2001
- Surface Dust Flux Model Support Plan, UPOS-A53-22, Version 1.0, L. M. Hasselbarth, Benjamin H. Barnum, Bruce A. Toth, 17 October 2001
- Surface Dust Flux Model Software Version Description, UPOS-A53-21, Version 1.0, L. M. Hasselbarth, Benjamin H. Barnum, Bruce A. Toth, 17 October 2001

3.2 Inventory of Software Components

Appendix B contains the complete list of directories and files being delivered as Version 1.0 of the Surface Dust Flux Model software system.

3.3 Changes Installed

This is the initial delivery of the software system.

3.4 Related Documents

All documents pertinent to Version 1.0 of the Surface Dust Flux Model software system are included in the release.

3.5 Install Instructions

A UNIX system administrator will need to perform the installation and the acceptance testing for the UNIX version of the Surface Dust Flux Model software system. The Surface Dust Flux Model software was backed up using tar (tape file archiver) to a 4mm dat tape.

A. Acronyms and Abbreviations

Acronym	Definition
AACGM	Attitude Adjusted Corrected Geomagnetic
AFCCC	Air Force Combat Climatology Center
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AFSCN	Air Force Satellite Control Network
AFSPACECOM	Air Force Space Command
AFSWC	Air Force Space Weather Center
AFWA	Air Force Weather Agency
AFWIN	Air Force Weather Information Network
AF/XOW	Air Force Director of Weather
APL	Applied Physics Laboratory of Johns Hopkins University
ASCII	American Standard Code for Information Interchange
ASPAM	Atmospheric Slant Path Analysis Model
AVHRR	Advanced Very High Resolution Radiometer
AVN	Aviation Model
AVO	Alaska Volcano Observatory
BATS	Biosphere-Atmosphere Transfer Scheme
CLASS	Canadian Land Surface Scheme
COE	Common Operating Environment
DII	Defense Information Infrastructure
DMSP	Defense Meteorological Satellite Program
ECMWF	European Center for Medium-Range Weather Forecasts
FNMOG	Fleet Numerical Meteorology and Oceanography Center
FSL	Forecast Systems Laboratory
FTP	File Transfer Protocol
GI	Geophysical Institute
GIT	Georgia Institute of Technology
GIF	Graphic Interchange Format
GMT	Generic Mapping Tools
GOLD	Geophysical On-Line Data
GRIB	Gridded Binary
GSFC	Goddard Space Flight Center
HLBL	High Latitude Boundary Layer
IDL	Interactive Data Language
IMF	Interplanetary Magnetic Field
JHU	Johns Hopkins University
LAN	Local Area Network
LAPS	Local Analysis and Prediction System
LSM	Land Surface Model
MM5	Fifth Generation Mesoscale Model

NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
netCDF	Network Common Data Form
NGDC	National Geophysical Data Center
NGM	Nested Grid Forecast Model
NOGAPS	Navy Operational Global Atmospheric Prediction System
NWP	Numerical Weather Prediction
OWS	Operational Weather Squadron
PACE	Polar Anglo-American Conjugate Experiment
PBL	Planetary Boundary Layer
PCA	Polar Cap Absorption
PFRR	Poker Flat Research Range
SABER	Sounding of the Atmosphere using Broadband Emission Radiometry
SD	Space Department of the Applied Physics Laboratory
SDP	Software Development Plan
SEC	Space Environment Center
SEE	Solar EUV Experiment
SEON	Solar Electro-optical Observing Network
SFOC	Spaceflight Operations Center
STP	Solar Terrestrial Physics
SWOC	Space Weather Operations Center (Offutt)
SWXS	Space Weather Squadron
Tcl	Tool Command Language
Tk	Toolkit
Tix	Tk Interface Extension
UAF	University of Alaska, Fairbanks
UCAR	University Corporation for Atmospheric Research
UPOS	University Partnering for Operational Support
WDC	World Data Center
WF	Weather Flight
WMO	World Meteorological Organization
XDR	External Data Representation

A. Inventory of Software Contents of Version 1.0

UNIX SOFTWARE

Directory /project/upos/dust/SURFLUX			
PG1x1InterpIDL.dat	102064	idlusr	13824
PG1x1T4Y.dat	84108	make_movie.pro	905
check_setup.pro	748	mm5_lib	512
dust.pro	20514	seltoAAAa003sn.bin	10378082
dust_common.pro	171	start	248
dust_lib	1024	temporary	512
dust_setup.txt	228	Wgrib-afwa	109180
Total of 14 files, 10712120bytes.			
Directory /project/upos/dust/SURFLUX/dust_lib			
cindex.pro	1983	mergegifs.pro	2566
color_key.pro	8771	mm5_mdfm_surfacextract72.pro	21755
create_elev_map.pro	1885	plot_th_border	657
gif_recolor.pro	1992	plot_theather.pro	11323
imagemap.pro	8782	read_mgrid_mapgui.pro	23308
map_getindex.pro	536	stack_viewer.pro	4954
mag_segments.pro	3602	stdcolor.pro	1456
mergicolors.pro	2846	surface_dustgui.pro	16335
Total of 16 files, 112751 bytes.			
Directory /project/upos/dust/SURFLUX/mm5_lib			
mm5_dat.pro	1430	mm5_map.pro	5248
mm5_dict.pro	759	mm5_map_notes.pro	654
mm5_exvar.pro	5647	mm5_pickfile.pro	2000
mm5_flist.pro	762	wgrib-afwa	109180
mm5_header.pro	2595		
Total of 9 files, 128275bytes.			
Grand total of 4 directories, 39 files, 11 MB.			