Physics
Orography maker

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NOAA/NWS/NCEP/EMC/Physics

Global Orography Data Sets - Orog_Maker

Orography elevations for each model resolution are

- Constructed from the United States Geological Survey (USGS) global digital elevation model (DEM) (see image)
- Horizontal grid spacing of 30 arc seconds, approximately 1 km
- Orography statistics including average height, and calculates mountain variance, maximum elevation per grid box, etc on the model physics grid or reduced grid
- Orography, land-sea-lake masks are directly derived from 30-arc second DEM and University of

Global Orography Data Sets - Orog_Maker

- High-resolution Radarsat Antarctic Mapping Project (RAMP) Digital Elevation Model (DEM) combines topographic data from a variety of sources to provide consistent coverage of all of Antarctica.
- For Gravity Wave Drag and Mountain Blocking physics routines, file MTNVAR14 attaches to unit 24, holds moments and other orography information derived from the USGS data.
- Sea-Land Mask (SLM) on the model physics grid
- Mountain std dev on the model physics grid

Global Orography Data Sets - Orog_Maker

- Spectral filtered orography in the spectral domain
- Unfiltered gridded orography on the model physics grid
- Kim's 4^{th} moment
- Orographic Asymmetry (OA 4 directions)

(statistic from counting mtn blocks in a column)

- Orographic Convexity (OC 4 directions)

(asymmetry or mountain grid box balances)

MTNVAR14 Records

1. Variance
2. Var4; Kim's 4th moment
3. OA1: Kim's Orographic Asymmetry
4. OA2: "
5. OA3: "
6. OA4: "
7. OL1: Kim's Orographic convexity
8. OL2: "
9. OL3: "
10. OL4: "
11. THETA : Angle of mountain
12. GAMMA: Asymmetry
13. SIGMA : Slope
14. ELVMAX: Max elevation

Backward compatibility to NAVY 10 minute dataset and lake mask or USGS 30”

NMC OFFICE NOTE 424 (Song-Yu Hong) 1999

Output in grib1, binary or Netcdf tiles ready for input to CHGRES.

Mountain Blocking statistics

In the formulation, the actual orography is replaced by an equivalent elliptic mountain with parameters derived from the topographic gradient correlation tensor, H_{ij}:

$$H_{ij} = \overline{\frac{\partial h}{\partial x_i}} \overline{\frac{\partial h}{\partial x_j}}$$

The model sub-grid scale orography is represented by four parameters, after Baines and Palmer (1990), h', the standard deviation, ?, ?, ?, the anisotropy, slope and geographical orientation of the orography form the principal components of H_{ij}, respectively. These parameters will change with changing model resolution (Orog_maker: USGS 30” elevations).

Global land/water masks from ARC-Lake

The European Space Agency (ESA) using Along Track (dual view) Scanning Radiometers, funded the ARC-Lake (http://www.laketemp.net/home/) project to derive observations of Lake variables from which lake mask cover can be derived

Two types of masks are provided at each resolution: a mask of the maximum water area over a time period, and annual masks of the minimum water area.

Documentation to download and reference the datasets and the details of their composition are at:
http://www.laketemp.net/home/document.php

ARC-Lake v2.0 data products are available for download from the University of Edinburgh DataShare (http://hdl.handle.net/10283/88).

Adding a lake mask to the OROG maker

- The eg., USGS, 30” elevation resolution is used to process needed elevation fields by averaging the 30” fields into user chosen resolution grid boxs.
- 1/120 degree resolution (processing resolution)
- Two types of mask are provided: a mask of the maximum water area and a minimum water area.

Adding a lake mask to the OROG (con't)

- The global sea land mask (SLM) is a wet vs dry mask with lakes added from the UMD vegetative index file.
- The model resolution land masks are made by averaging the high resolution USGS (0.00833 degree) elevations for each model grid box
- This means that to make a SLM land point, representing one model grid box, from the 30” elevations, or a lake point, must have over 50% of the 30” contributing values to become a land or lake point respectively.
- Therefore, the maximum lake water area mask is chosen since the lake edges could be cut off from the SLM global elevation mask calculation, especially for low res models.

The Ocean model specifies an Ocean Sea_Land mask: (See background slides)

Ocean sea land mask following ocean model points as derived by the NEMS (ESMF) Mediator to facilitate the Ocean-Land interaction of fluxes or sea-surface temperature

This ocean mask has the property of not preserving lakes (no lakes).
Also some ocean and land masses are altered as necessary for the ocean model
For example, some islands are connected to near by land bodies, (Indonesia and Australia)

To preserve lakes the global wet-dry SLM is used with UMd lakes added.

GFS sea-land mask is categorical 0=water, 1=land

Lake mask is 1 = Lake, 0 = Not Lake

New Lake Mask for the Orography maker (con't)

A test at t126 384x190 Gaussian Grid

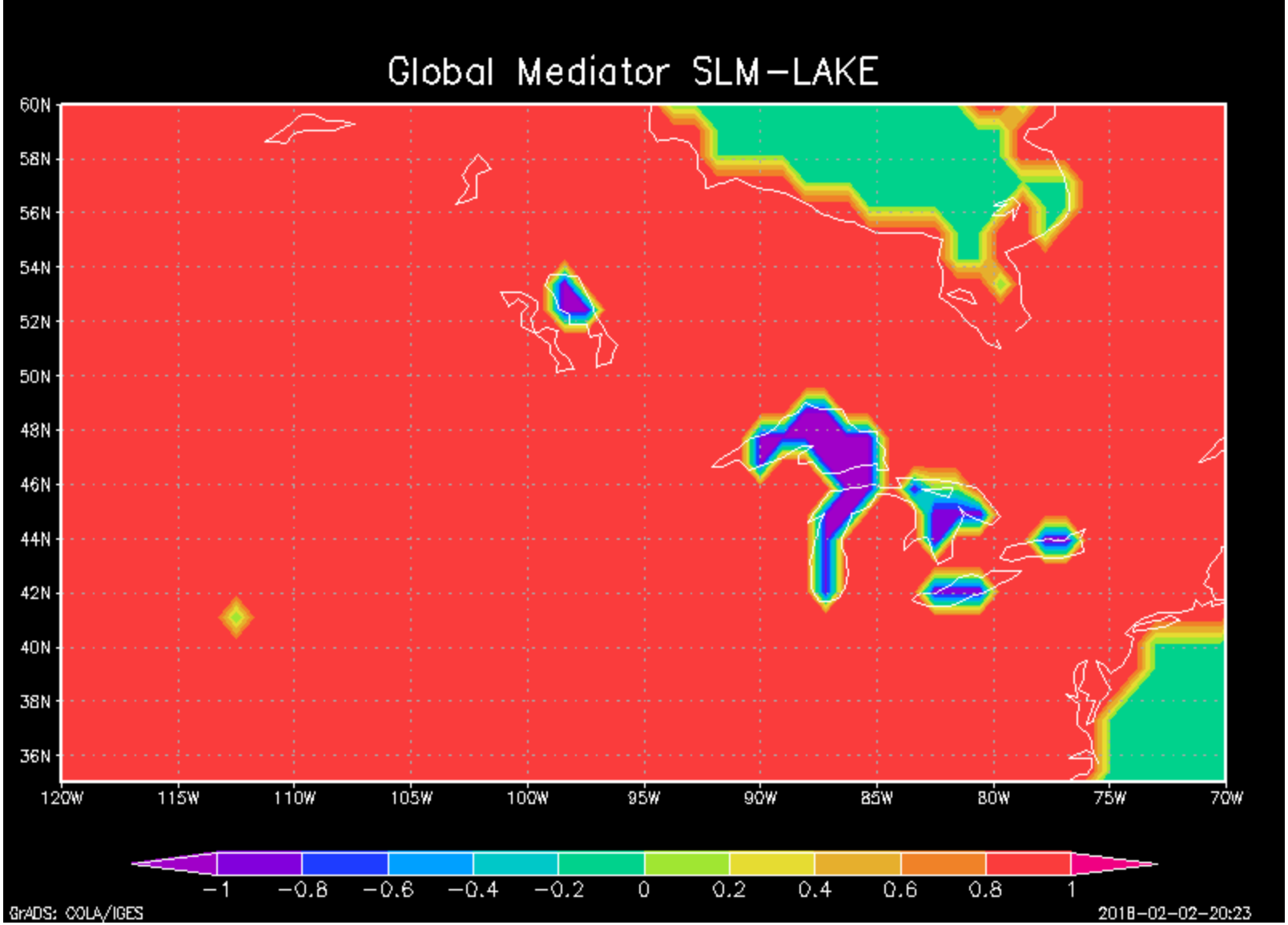
The Orography (Orog) maker has a number of extra script changes when ocean model coupling is present.

1)If there exists an ocean model derived land-sea mask file at the atmospheric model resolution and file type (internal program switch MSKOCN can be set)
2)An exported variable set in a new Orog submitting script "submit_terrain.sh":
OCLSM=_oclsmg is set to use the ocean land/sea Mediator made mask option

Then the Global SLM will be derived with Ocean model points replacing the atmospheric values in the mask

As referenced in the background slides, this will cause the ocean model points to be used by the atmospheric model as prescribed by the ocean model Mediator in the global SLM file.

While if either 1) or 2) above is not satisfied, the Ocean model preference will be ignored and the Global SLM will be written, the independent ARC-lake high resolution Lake mask will be produce (written) if 2).


Global Mediator SLM-LAKE
60N
58N
56N
54N
52N
50N
48N
46N
44N
42N
40N
38N
36N
120W
115W
110W
105W
100W
95W
90W
85W
80W
75W
70W
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
GrADS: COLA/IGES
2018-02-02-20:23

Location on WCOSS phase 2:

Fortran and script and .ctl files for grads to be used in ptmp dir ${pwd}:
/global/save/Jordan.Alpert/gfs2018/terr/test

Lakemask1 and Orog maker input fields
/global/save/Jordan.Alpert/gfs2018/terr/test/fix

Raw lakemask files and some code to read/write them
/global/save/Jordan.Alpert/terr/lake

Submitting script #1
Usage: ./submit_terrain.sh > sub_terr.out 2>&1
In submit_terrain.sh exported source directory variable SCRDIR is set to
export SCRDIR=$(pwd) but changed in subsequent steps.
submit_terrain.sh execs the script submit_orgml7_slm30g.sh
where the locations of SCRDIR and HOMEDIR are changed. Also
export OCLSM=_oclsm uses ocean model Mediator land/sea mask option
Right now this runs different fortran code.

Above will call the script:
submit_orgml7_slm30g.sh
where it also sets
export SCRDIR=${SCRDIR:-/global/save/Jordan.Alpert/gfs2018/terr/test}
export HOMEDIR=${HOMEDIR:-$SCRDIR}
where this script sets the which script and fortran code will be used according to the OCLSM switch and assigns filenames with names like those used in operations. The Ocean model Mediator derived mask is set here as well:
export a_ocean_mask=$SCRDIR/t${jcap}.field_med_atm_a_land_mask.ascii

Script Step 3
ml7_slm30g$OCLSM.sh
Or as in this case, ml7_slm30g_oclsm.sh
under the OCLSM switch (set in step 1),
submit_terrain.sh,
compiles and executes and copies files back to ${pwd}
usually ptmp.

Future work:

- Simplify and unify the scripts and code to a single entry with at most a
- simple starter script for our multi platform environs.

- After Coupled model testing with this, integrate the new hi res ARC-lake mask into the SLM Global mask so there is only one representation for lakes and “wet” over land. This can be done with a test on surrounding points (only) triggered by the presence of the ARC-lake mask Lakes, instead of all coastlines.
- Also test speed up – Orog maker is all I/O and text files have been used slowing things down, since time was short. The Orog maker is a one time only run so this is OK for now, but some I/O changes will make it much faster.

- Make it work with FV3 OROG maker code all of it for FV3

- Test and place it into GIT

- Integrate the FV3 Orog maker version to be automatically called, if necessary in the FV3 model.

Invoice is in the mail.

Background Slides

Ocean and GFS Land Sea Masks

Jordan Alpert

NOAA/NWS/NCEP/GCWMB

20150130

Ocean land_sea_mask

- Test Data (from Zeus): field_med_atm_a_land_mask.nc
- netcdf field_med_atm_a_land_mask {

dimensions:

land_mask_dim001 = 384 ;

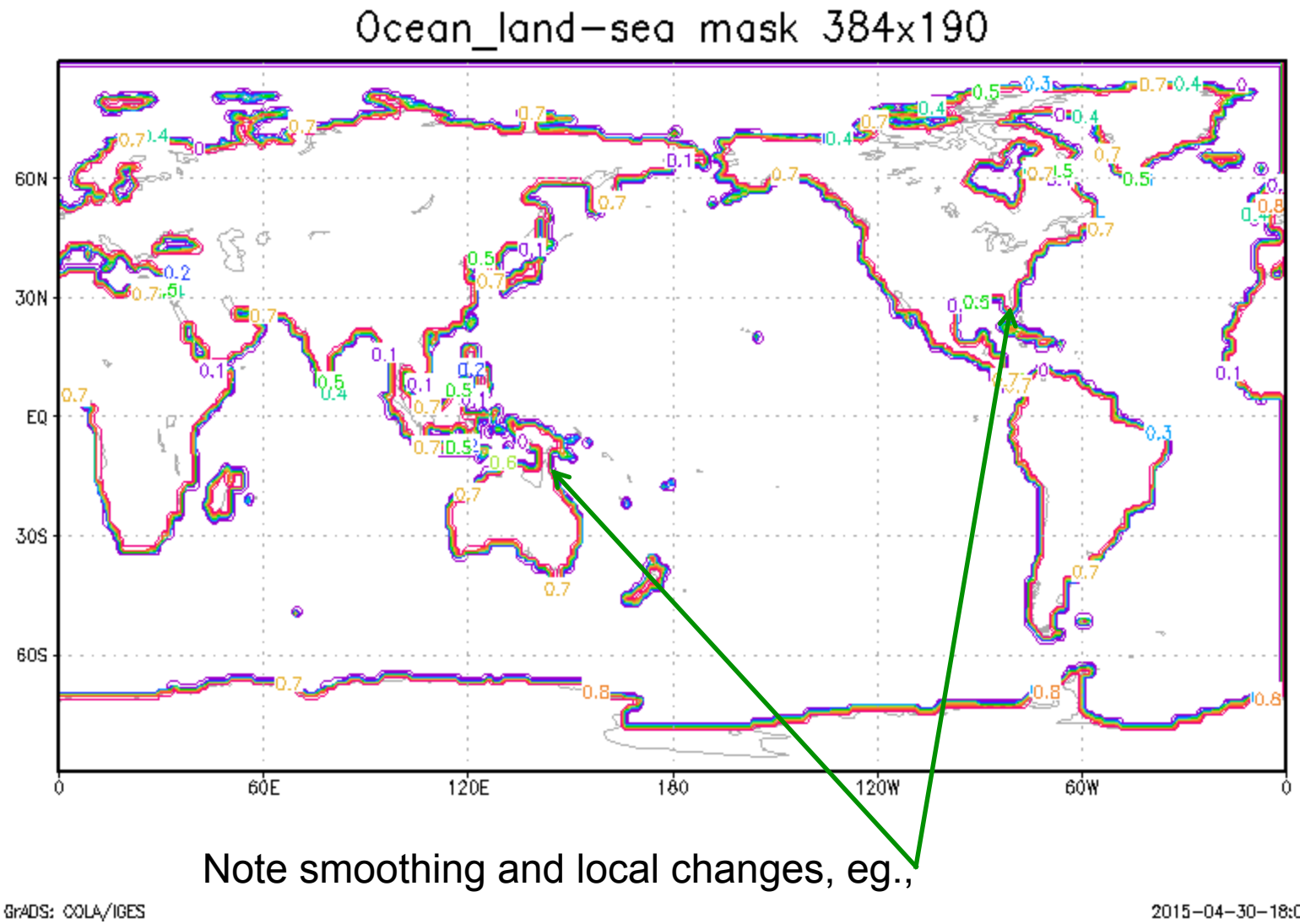
land_mask_dim002 = 190 ;

variables:

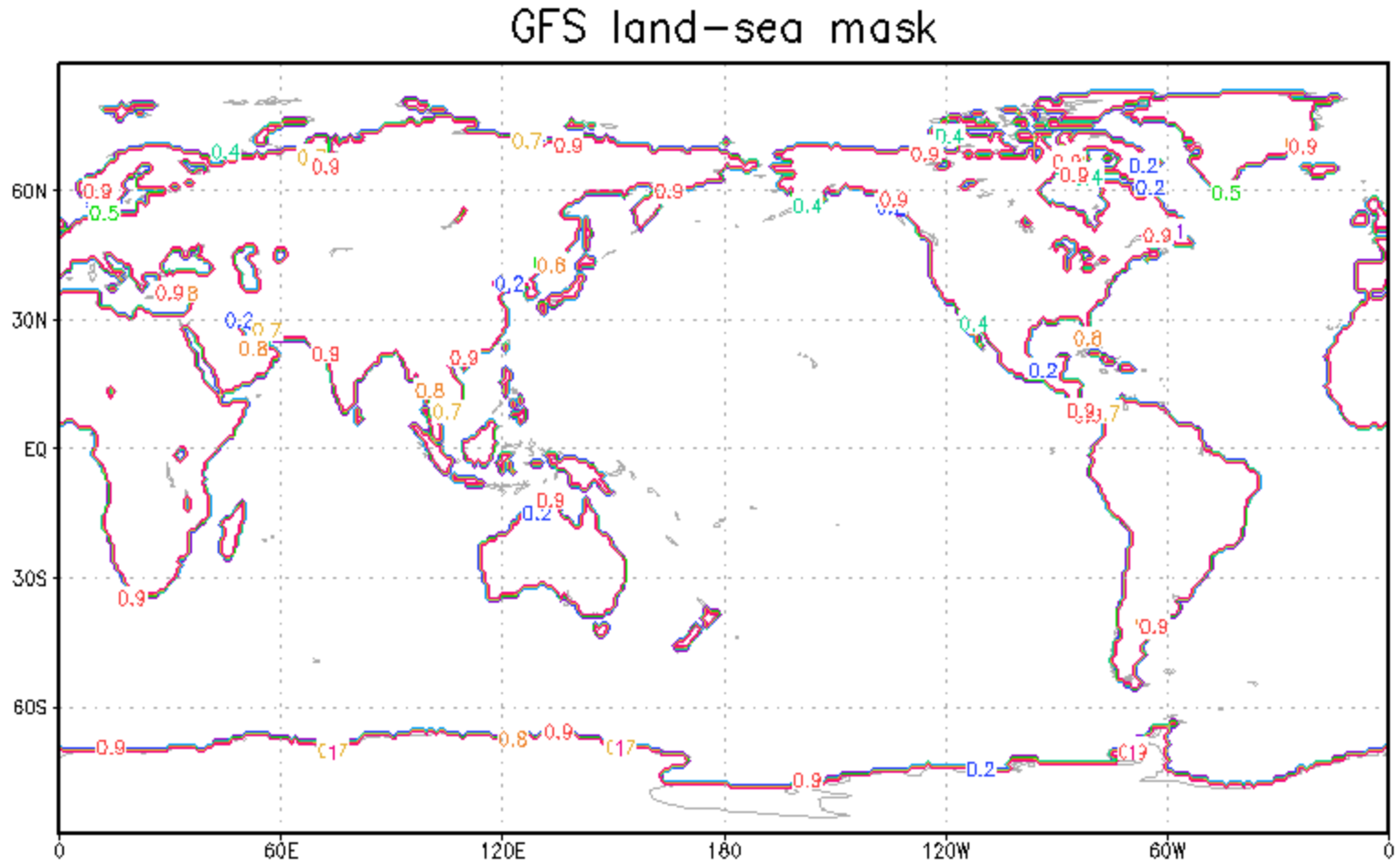
double land_mask(land_mask_dim002, land_mask_dim001)

(comma separated free format Data …… Gaussian Grid

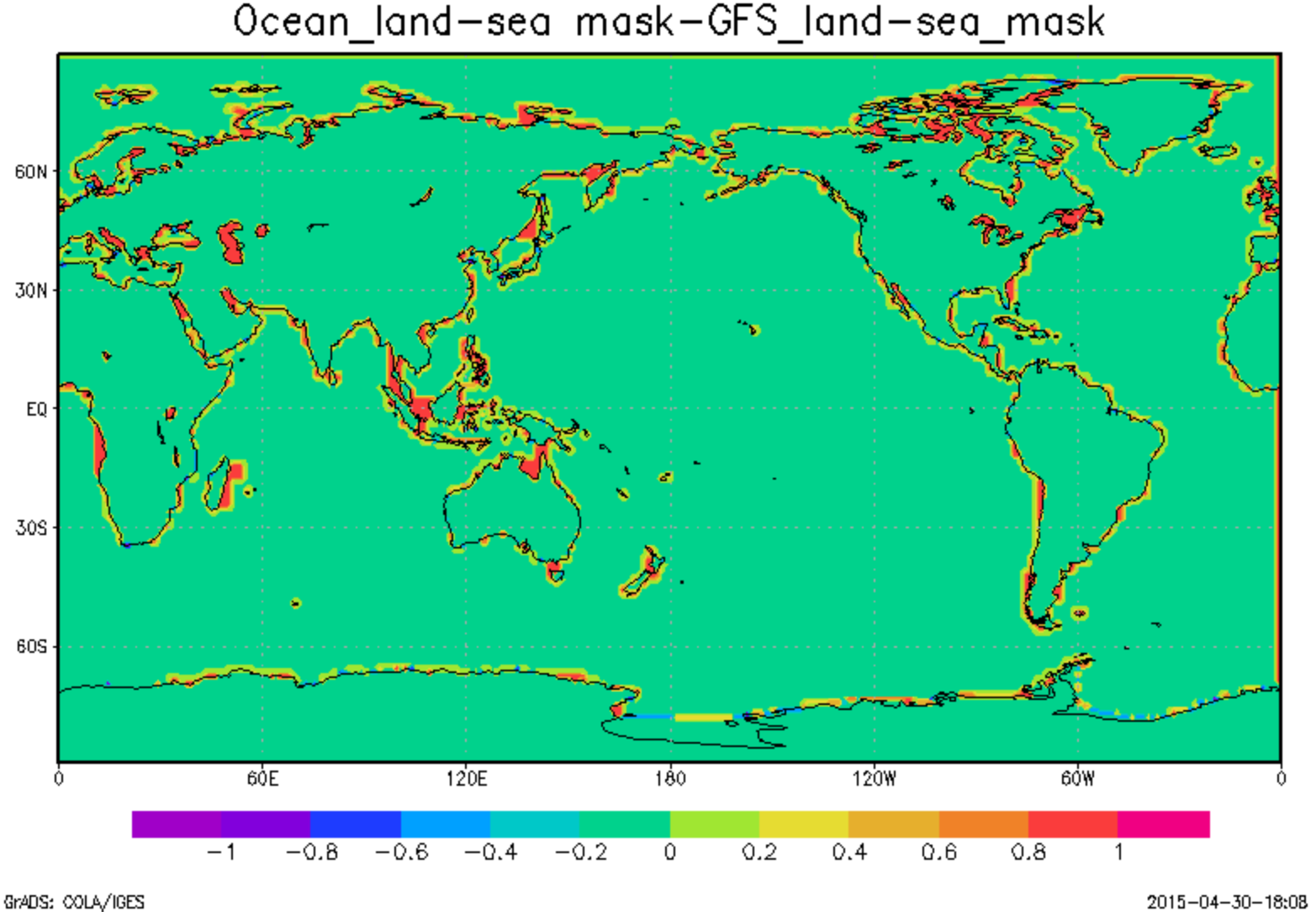
Remove text, commas and other noise ... from landmask.txt and apply wgrib(2) to make binary or grib(1,2) file and compare with GFS land_sea_mask



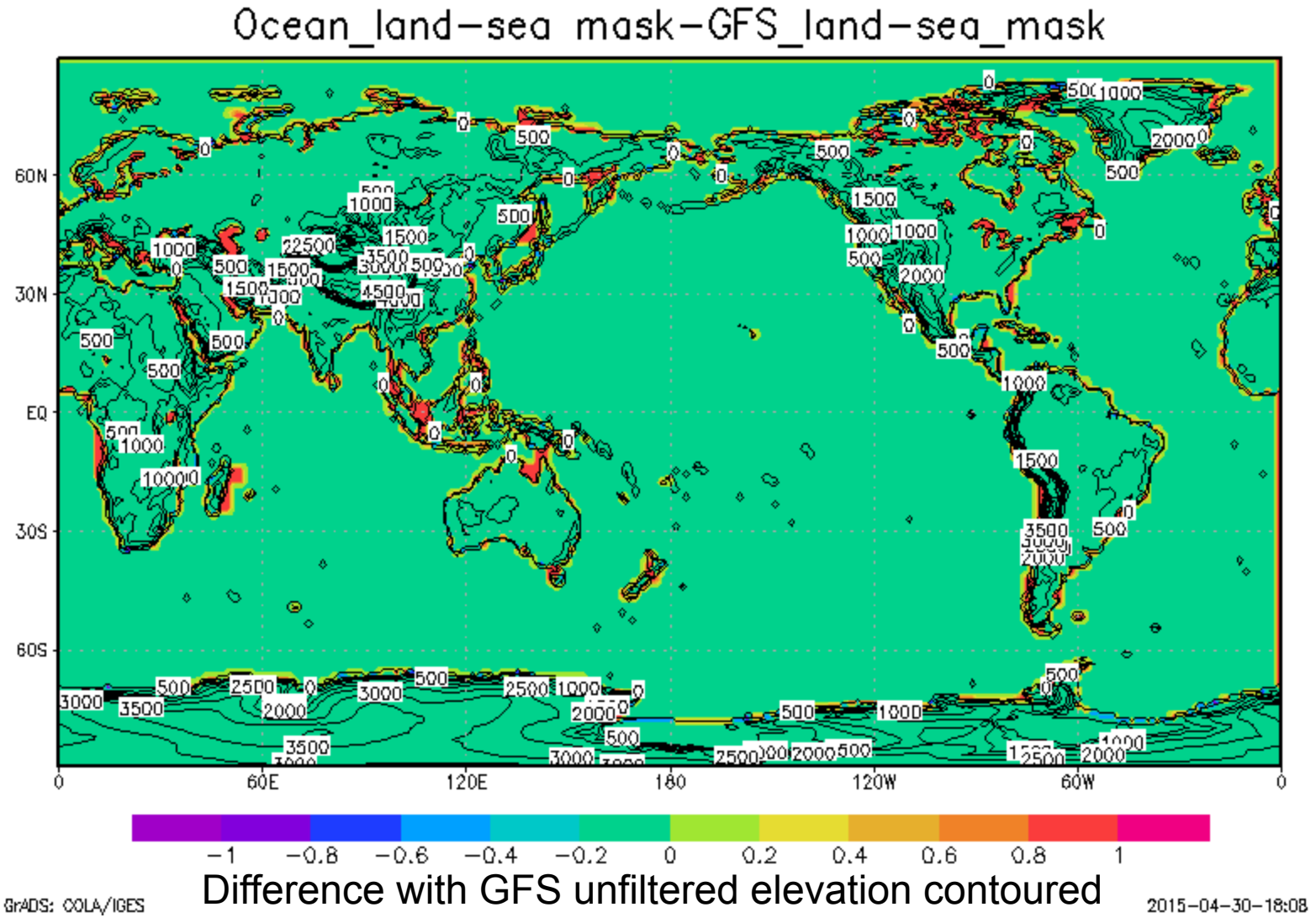
Note smoothing and local changes, eg.,



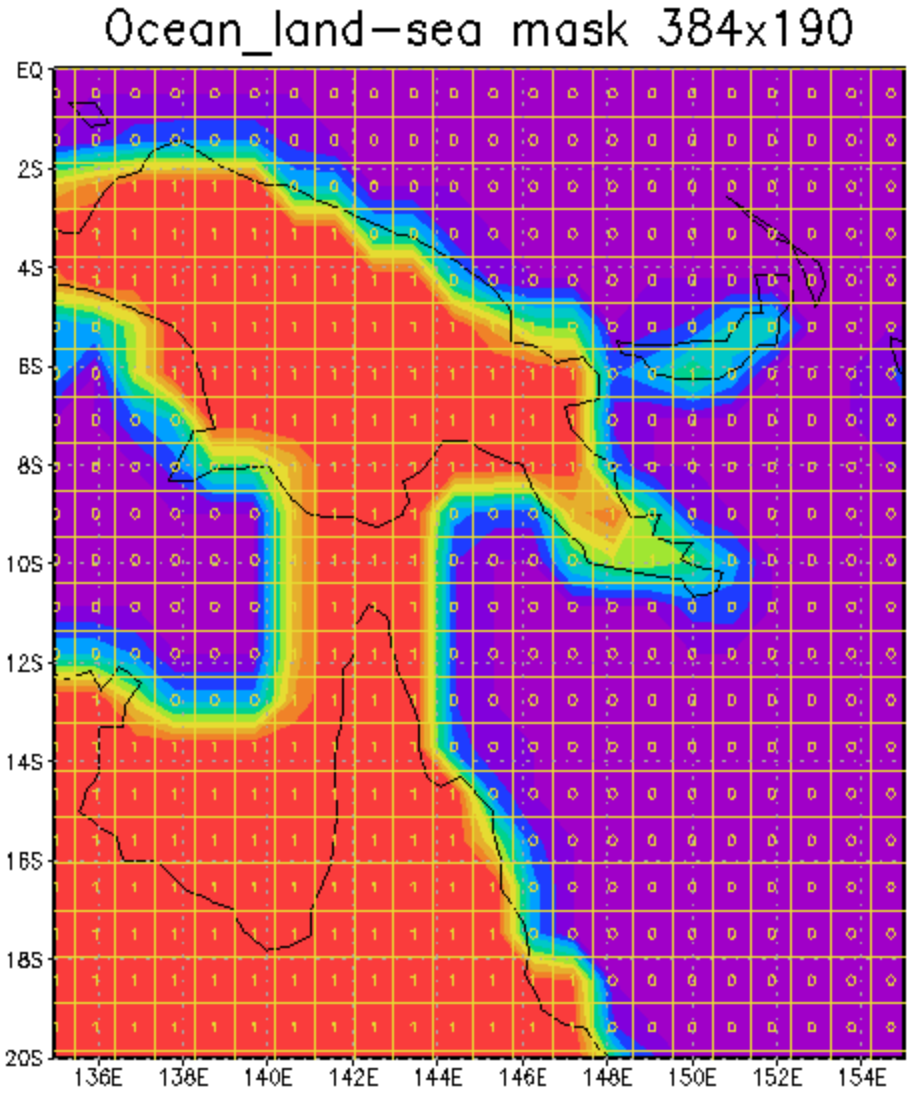
GFS uses 30” USGS but suppresses single point islands



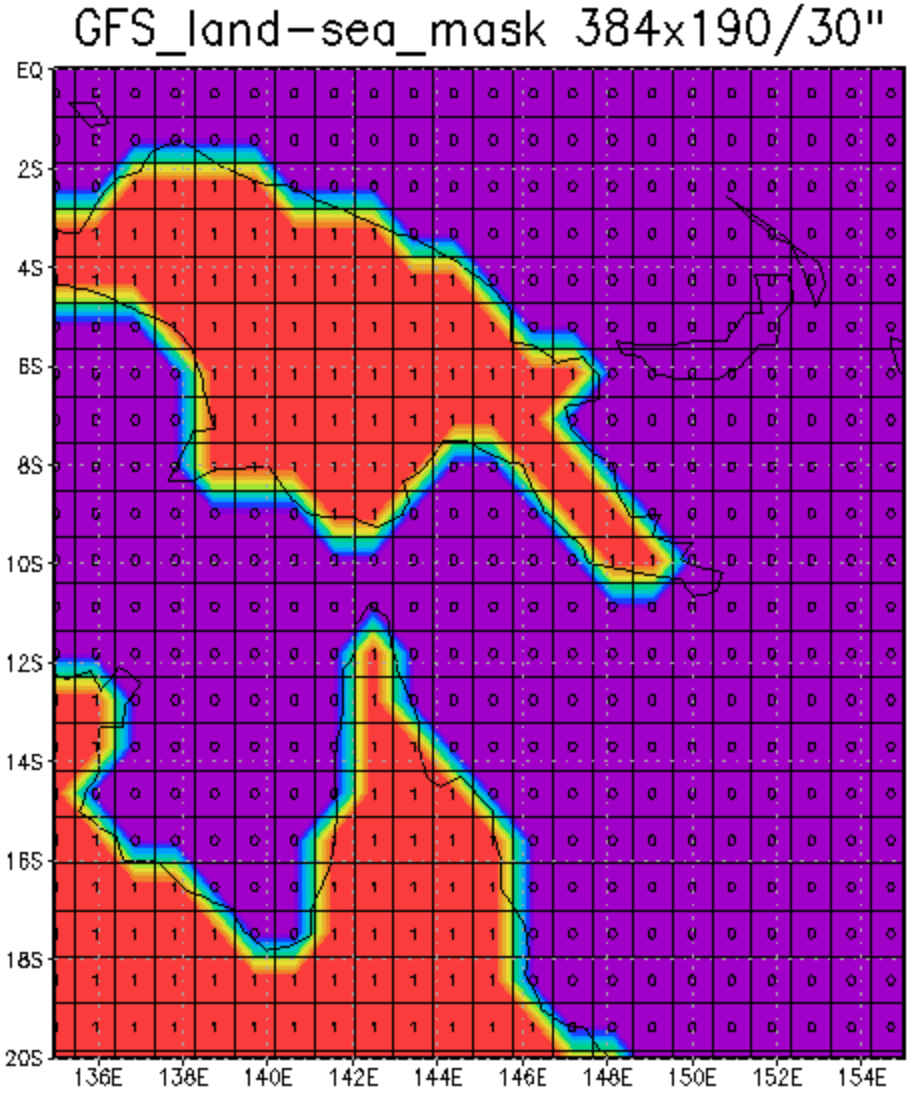
Differences show the smoothing, lake mask and island effects
No lakes or interior points in the Ocean land sea mask



Difference with GFS unfiltered elevation contoured



The 20 degree area from (-20S,135E) and grid values

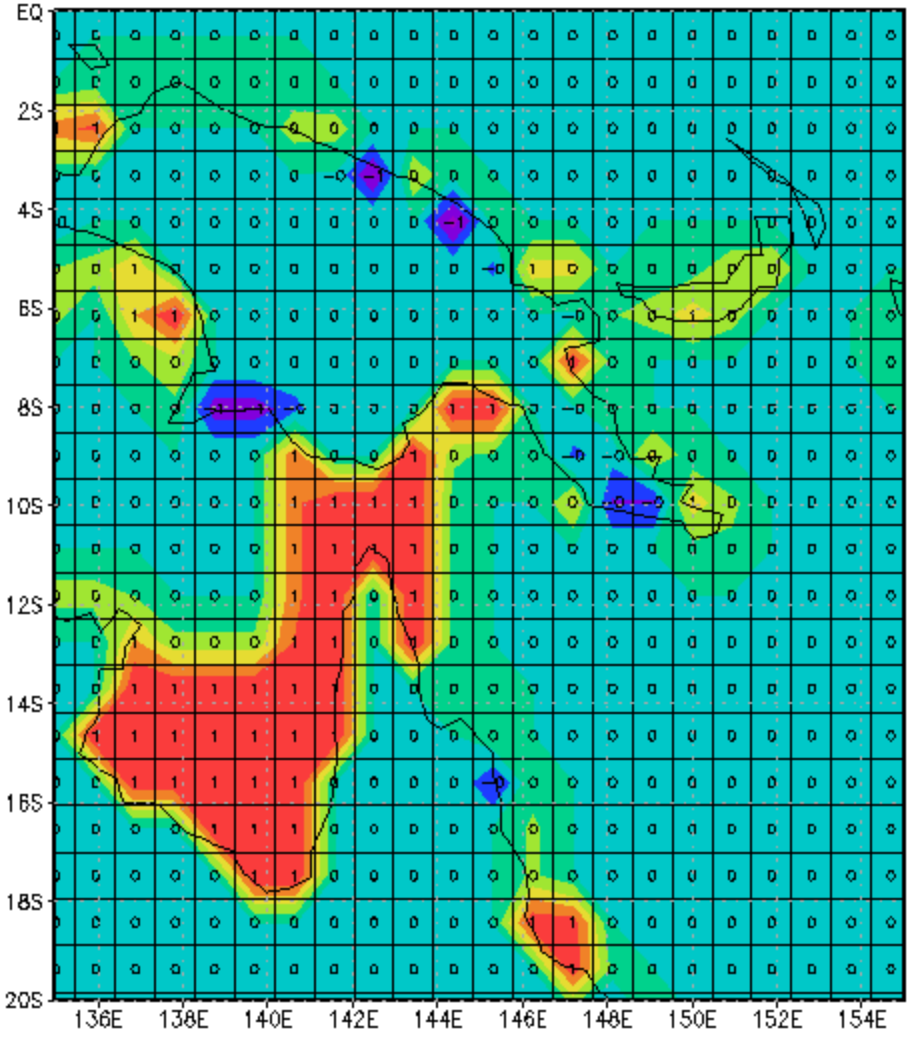


Better definition when 30” base is used

GrADS: COLA/IGES

2015-04-30-20:18

Ocean_land-sea_mask_384x190-GFS_land-sea_mask_384x190/30



GrADS: COLA/IGES

2015-04-30-20:21

The differences near New Guinea. Only coast line differences, No interior differences.

GFS Orog/GWD/MTN and other Moment maker Summary

- Orog code: GFS USGS 30” elevation, variance, mtnvar file higher moments. Mounting blocking files and sea-land mask
- GFS uses UMD Global 30” lake mask from the 17 record vegetative index file first and adjustments for USGS errors and Antarctic RAMP data.

For Ocean sea_land mask:

- Introduce new Gaussian (smooth) ocean sea land mask following to preserve lakes
- GFS sea-land mask is categorical 0=water, 1=land
- Check out

- Future:
- Expand sea-land mask to reflect coast lines with non categorical values
- Allow call from inside GFS on the fly (can do this if linked in and setup call parameters
- Place in GSM trunk.

Given:

- Elevation (orogb) unchanged
- Land-Sea Mask: Ocean mask dictates where ocean model is providing fluxes.
- … but …
- GFS orography fixed fields from 30” (USGS) elevation and (UMD) Lake mask and delivering catagorical land-sea state.
- No unique way to determine final mask.

Use elevation

- When elevation |elev|~≤ small (1 meter)

SLM 1 0 1 0

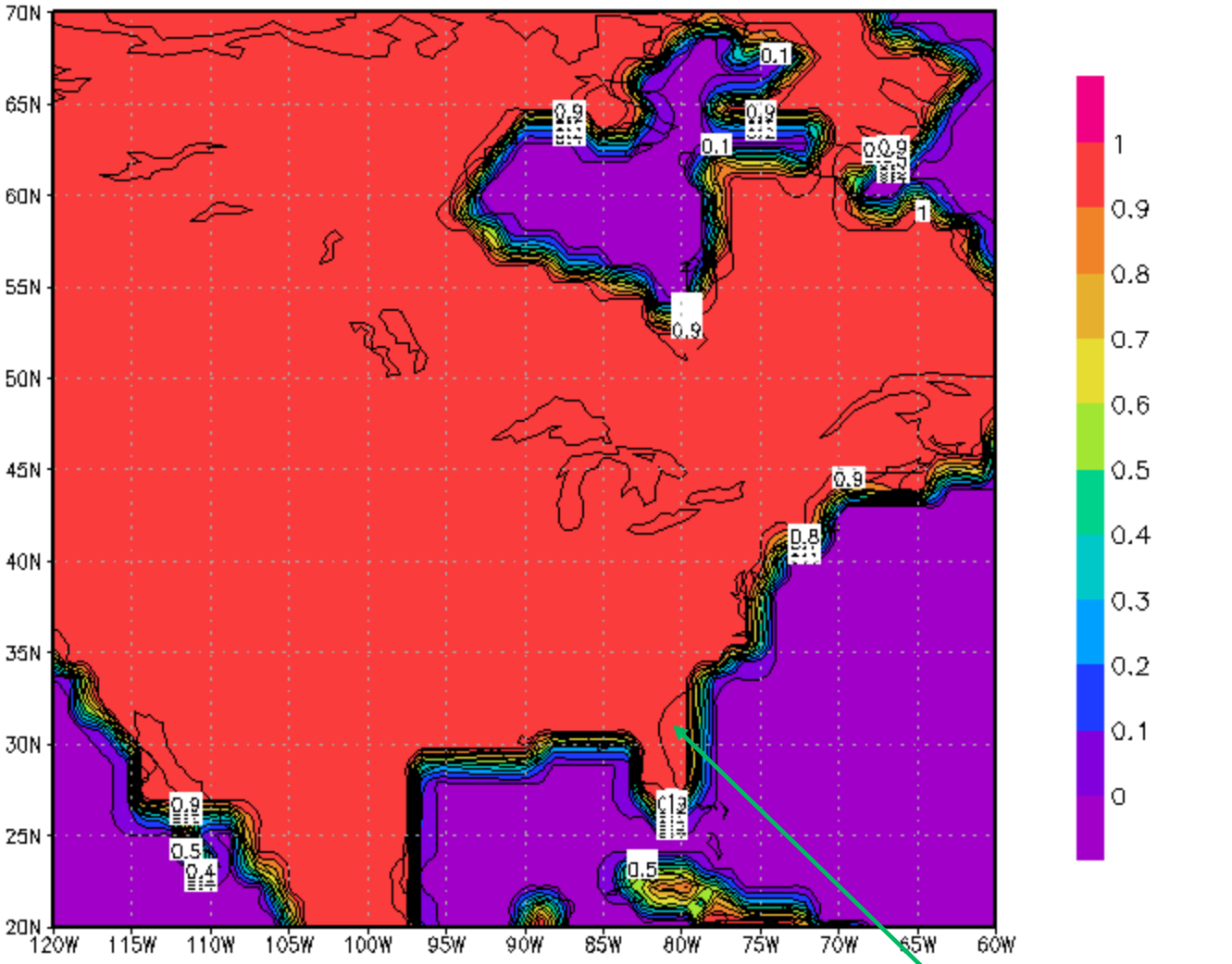
OC 1 0 0 1

Rule 1 0 0 1

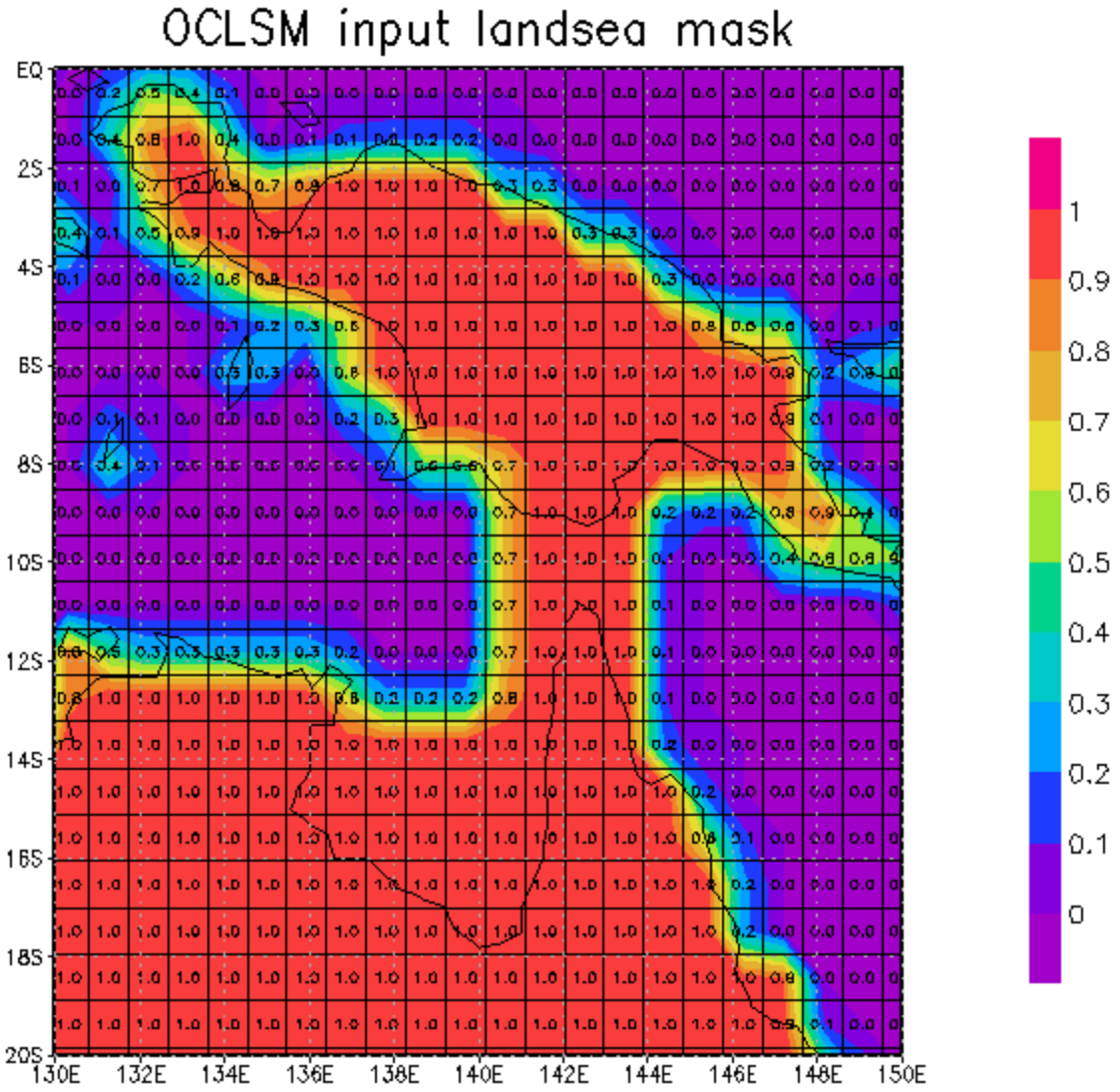
- When elevation |elev|~≥ not small

Rule 1 0 0 0

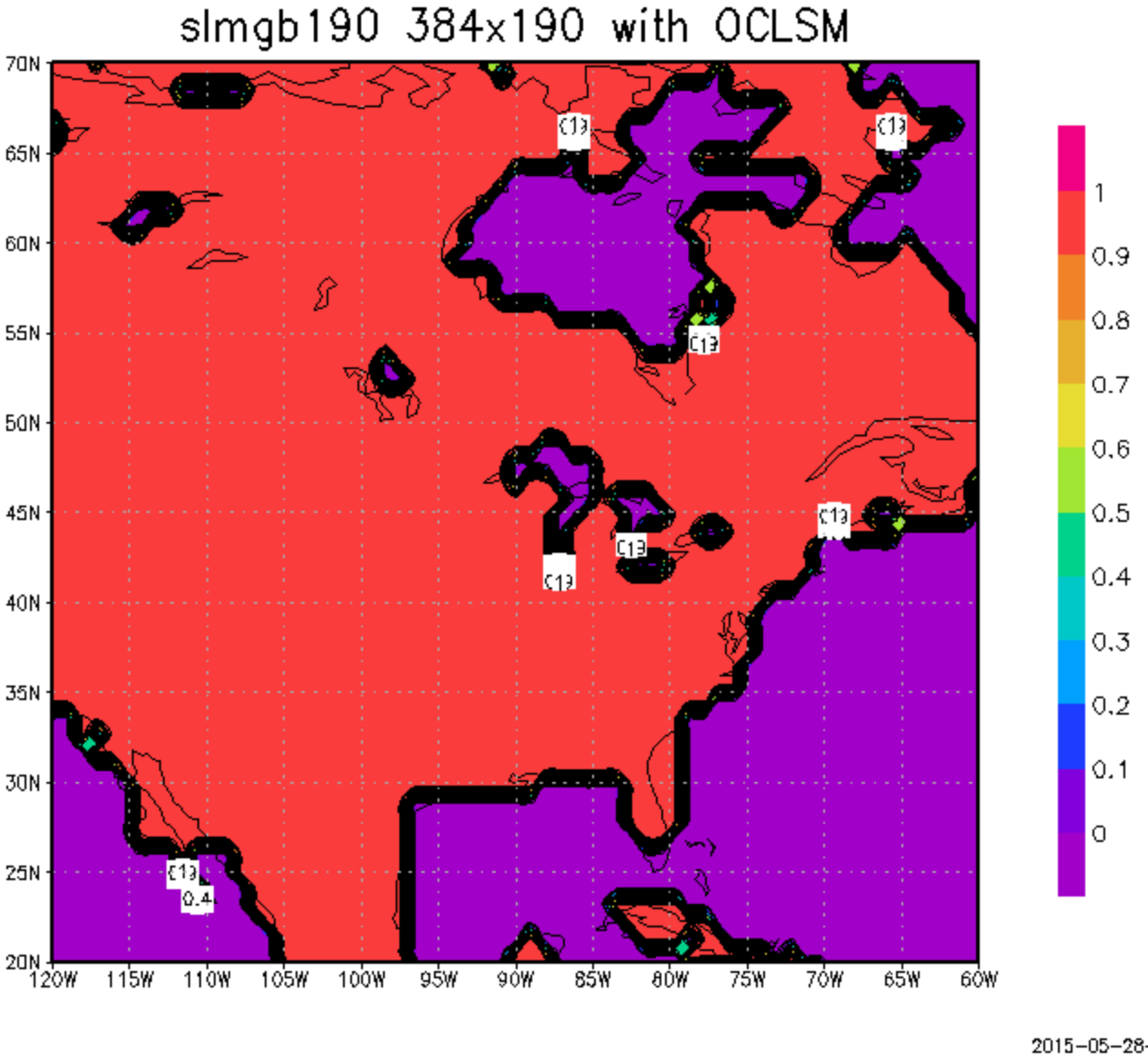
OCLSM original ocean model land-sea mask



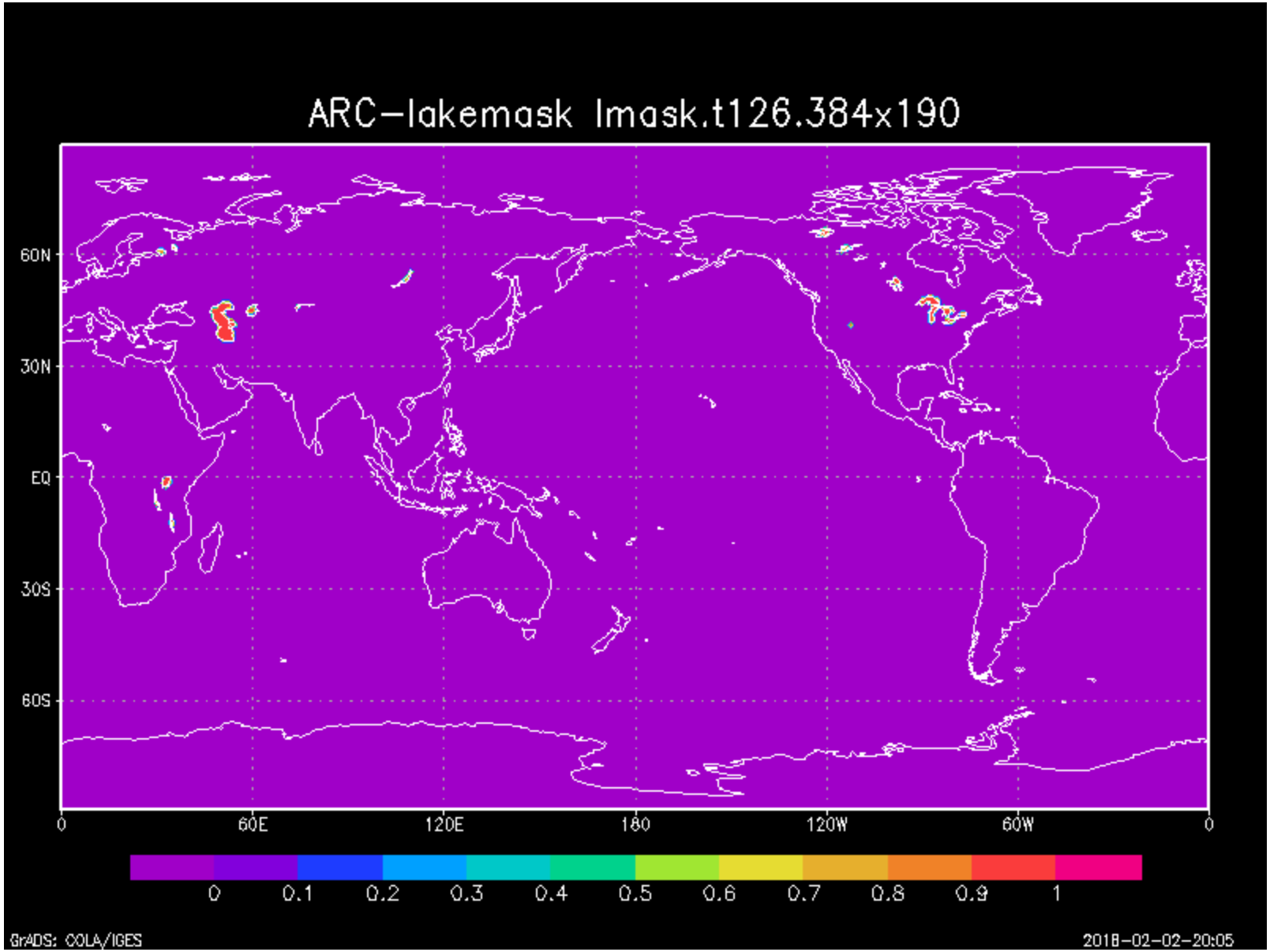
NB: No Lakes in addition to ocean model local changes

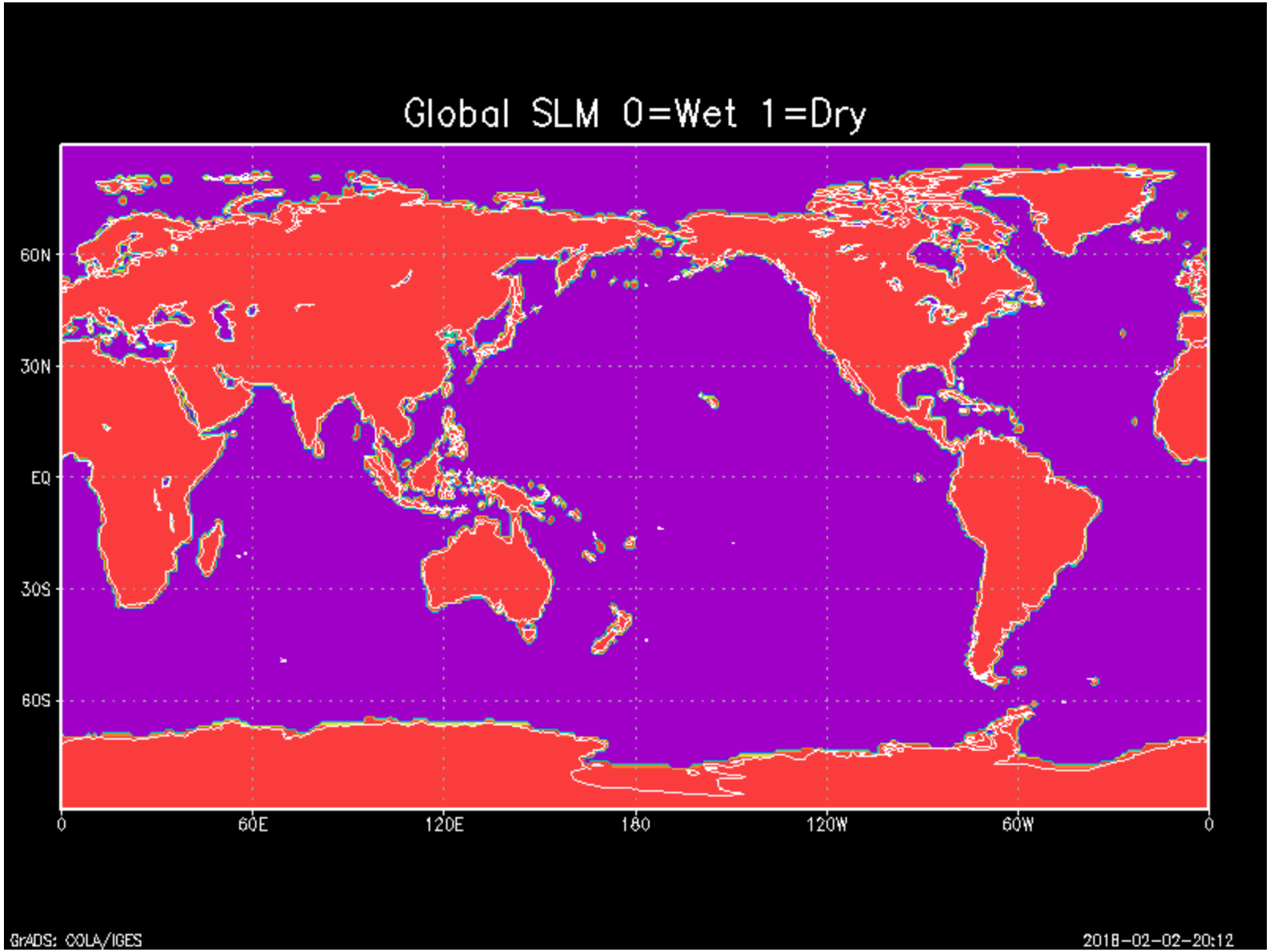


Note fractional values

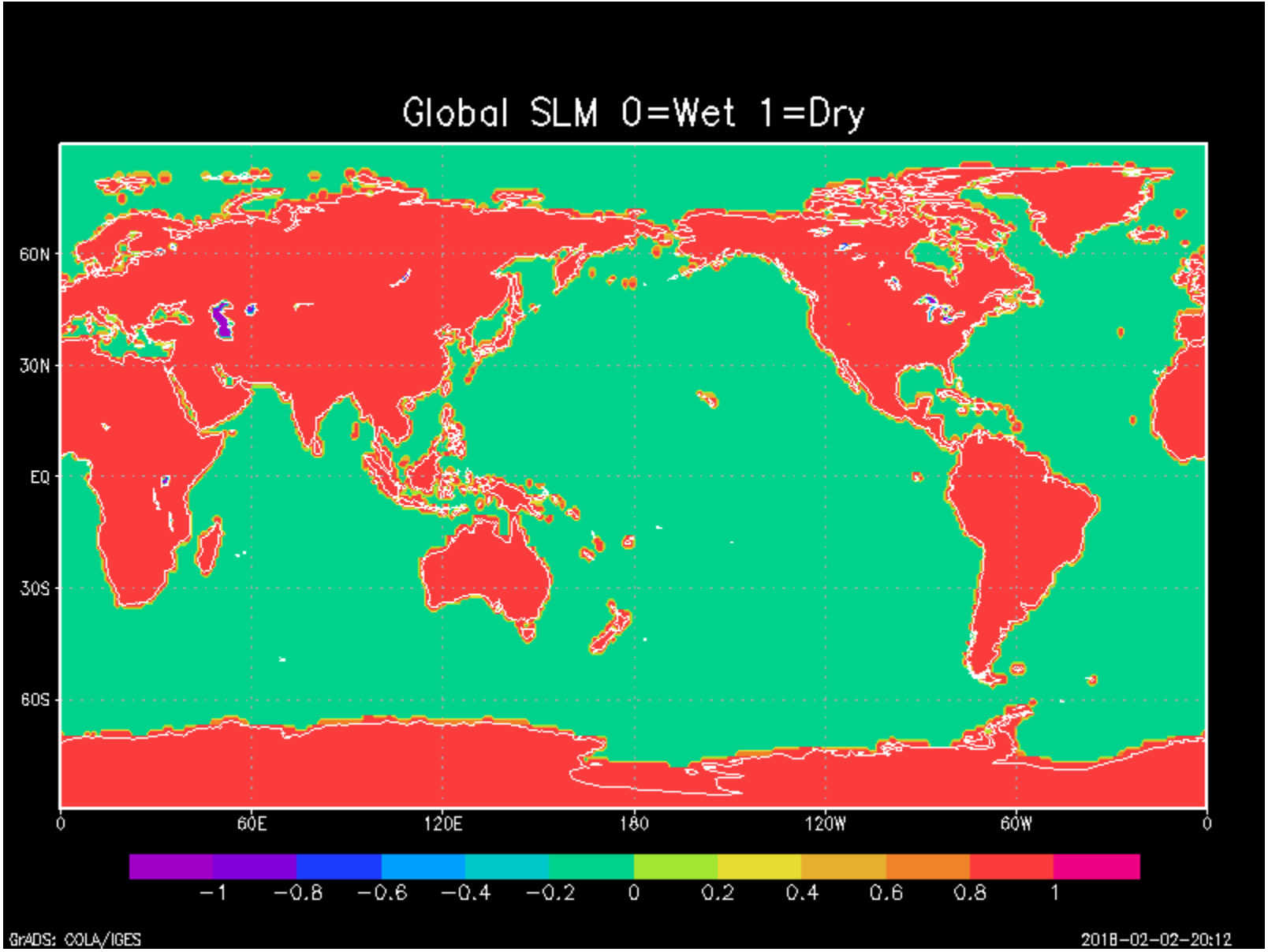


Lake present and ocean model land-sea mask presides over ocean


ARC-lakemask lmask.t126.384x190
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
GrADS: COLA/IGES
2018-02-02-20:05



Global SLM Ocean model Mediator made mask


Global SLM 0=Wet 1=Dry
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
GrADS: COLA/IGES
2018-02-02-20:12