

Project Proposal

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Introduction

Shallow boundary layer clouds cover vast amounts of subtropical oceans and have an overall cooling effect on the climate (Hartmann, Ockert-Bell, and Michelsen (1992)) and are thus important topics of research. In this project shallow boundary layer clouds and stratocumulus clouds will be used interchangeably. These clouds have favored development in particular on the eastern side of subtropical oceans. These clouds are also described as “semipermanent” (Wood (2012)) because they exist for large periods of time.

The stratocumulus cloud sheet over the Southeast Atlantic Ocean experiences what have been called “cloud clearing events” which feature large, sharp propagating boundaries which cause irreversible clearing of the low cloud (see Figure 1). These events are important to understand the effect they have on the Earth’s energy balance and the dynamics and feedbacks of the cloud in general. They have been largely unstudied to date. My master’s thesis project will focus on simulating these events with the Weather Research and Forecasting (WRF) Model. For this class project a simple case study will be conducted to look at the environmental conditions associated with a clearing event (Figure 1). These conditions will be compared to another case without a cloud clearing event (Figure 2). The ultimate goal of this project will be to see if the test cases match what we expect of the environmental conditions as discussed in Hader (2016).

Methods

In order to study the environmental conditions of these test cases, several functions and scripts have been written. The first script used downloads European Reanalysis Interim (ERA-Interim) data from the European Centre for Medium-Range Weather Forecasts (ECMWF). This script utilizes API packages created by the ECMWF (documentation for the WebAPI found [here](#)). The data is presented on pressure surfaces. The variables requested include geopotential (z), temperature (t), vertical velocity (w), relative humidity (r), cloud liquid water content (lwc), cloud cover (cc), horizontal velocity (u,v). The data is requested at the following pressure levels (hPa): 300, 500, 600, 700, 800, 850, 900, 950, 1000. Once the selected data is downloaded, a function has been written to select a certain variable at a certain time and level from the downloaded file. After this, another function has been/will be written to plot the data (this step is still a work in progress).

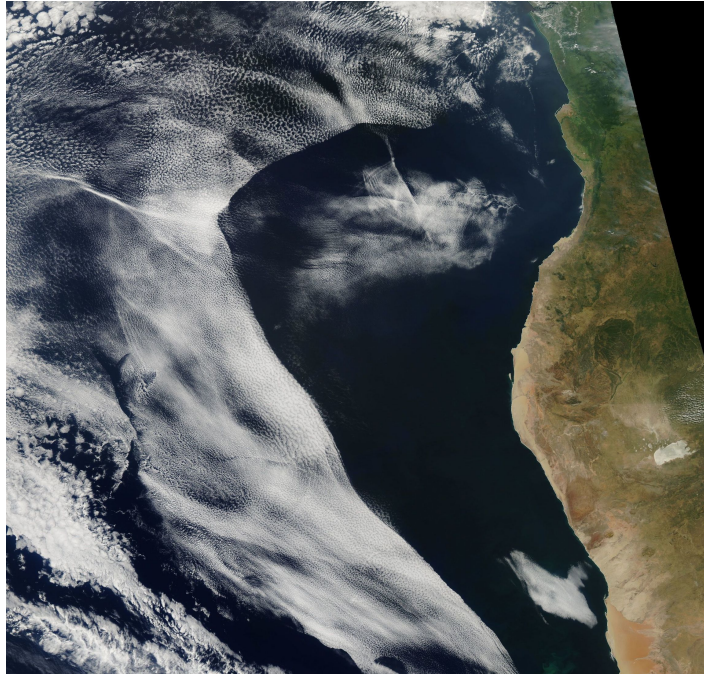


Figure 1: MODIS corrected reflectance true color image from the Aqua satellite on 26 May 2014. Figure shows a propagating clearing boundary as discussed in the paper.

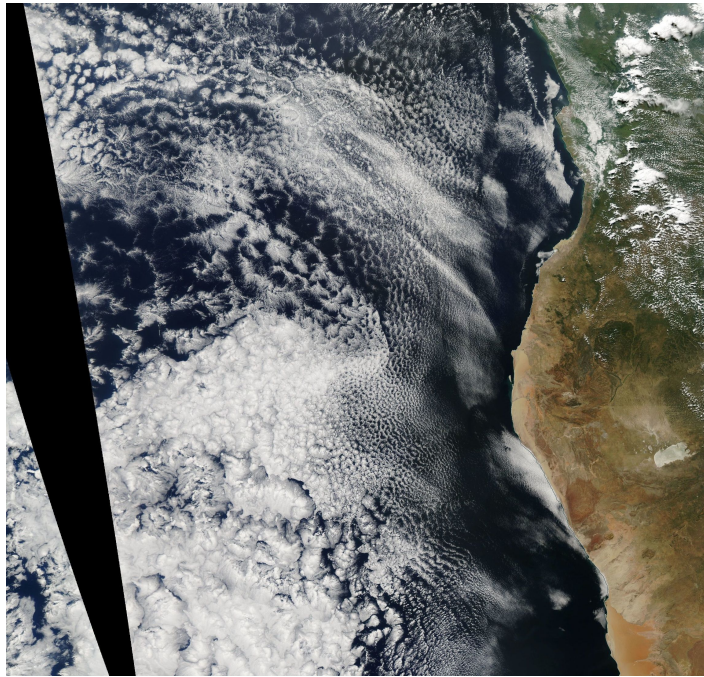


Figure 2: MODIS corrected reflectance true color image from the Aqua satellite on 21 May 2014. Figures shows an example of a case without a boundary.

Preliminary Results

The results presented in this proposal are very minimal as plotting has not been successful (yet). The following are preliminary results which show the data downloaded and a printout of relative humidity as the first time (25 May 2014 00Z) at the lowest level (1000 hPa)

```
import os
import sys
sys.path.insert(0, "C:\\Users\\Laura\\Documents\\EVRN720\\tomkins_dcei\\UnitTesting\\")
startdate = '2014-05-25'
enddate = '2014-05-27'
date_str = startdate+'/to/'+enddate
data_path = 'interim_'+startdate+'to'+enddate+'.nc'
execfile('ei_download.py')
```

```
## 2018-04-09 13:06:14 ECMWF API python library 1.5.0
## 2018-04-09 13:06:14 ECMWF API at https://api.ecmwf.int/v1
## 2018-04-09 13:06:16 Welcome Laura Tomkins
## 2018-04-09 13:06:17 In case of problems, please check https://software.ecmwf.int/wiki
## 2018-04-09 13:06:17 In case of delays, please check service activity page http://app
## 2018-04-09 13:06:18 Request submitted
## 2018-04-09 13:06:18 Request id: 5acbab9ad64e60c506b921a3
## 2018-04-09 13:06:18 Request is queued
## Calling 'nice mars /tmp/tmp-_marsTN8PmN.req'
## mars - WARN -
## mars - WARN - From 9 February 2016 10AM (UTC) MARS uses versions of
## mars - WARN - libemos newer than 4.3.0. For more details, see
## mars - WARN - https://software.ecmwf.int/wiki/display/EMOS/Bug+fix+implemented+in+EMO
## mars - WARN -
## PPDIR is /var/tmp/ppdir/x86_64
## mars - INFO - 20180409.180621 - Welcome to MARS
## mars - INFO - 20180409.180621 - MARS Client build stamp: 20180219222651
## mars - INFO - 20180409.180621 - MARS Client version: 6.20.2
## mars - INFO - 20180409.180621 - EMOSLIB version: 4.5.3
## mars - INFO - 20180409.180621 - Using ecCodes version 2.6.1
## mars - INFO - 20180409.180621 - Using odb_api version: 0.15.6 (file format version:
## mars - INFO - 20180409.180621 - Maximum retrieval size is 30.00 G
## retrieve,levelist=300/500/600/700/800/850/900/950/1000,area=10/-35/-46/25,levtype=pl,
## mars - INFO - 20180409.180621 - Automatic split by date is on
##
## mars - INFO - 20180409.180621 - Processing request 1
## mars - WARN - 20180409.180621 - Area not compatible with grid
## mars - WARN - 20180409.180621 - Area changed from 10/-35/-46/25 to 10.5/-35.25/-46.
##
## RETRIEVE,
```

```

##      CLASS      = EI,
##      TYPE       = AN,
##      STREAM     = OPER,
##      EXPVER     = 0001,
##      REPRES     = SH,
##      LEVTYPE    = PL,
##      LEVELIST   = 300/500/600/700/800/850/900/950/1000,
##      PARAM      = 129/130/131/132/135/157/246/248,
##      TIME       = 0000/1200,
##      STEP       = 12,
##      DOMAIN     = G,
##      RESOL      = AUTO,
##      AREA       = 10.5/-35.25/-46.5/25.5,
##      GRID       = 0.75/0.75,
##      PADDING    = 0,
##      DATE       = 20140525/20140526/20140527
##
## mars - INFO    - 20180409.180621 - Web API request id: 5acb9ad64e60c506b921a3
## mars - INFO    - 20180409.180621 - Requesting 432 fields
## mars - INFO    - 20180409.180621 - Calling mars on 'marser', callback on 45847
## 2018-04-09 13:06:26 Request is active
## mars - INFO    - 20180409.180641 - Server task is 357 [marser]
## mars - INFO    - 20180409.180641 - Request cost: 432 fields, 52.4803 Mbytes online, no
## mars - INFO    - 20180409.180641 - Wind conversion requested by server
## mars - INFO    - 20180409.180641 - Transferring 55029564 bytes
## mars - WARN    - 20180409.180646 - INTFB: Resolution automatically set to 213
## mars - INFO    - 20180409.180646 - Deriving U and V from vorticity and divergence
## mars - WARN    - 20180409.180646 - INTUVU: Resolution automatically set to 213
## mars - INFO    - 20180409.180650 - 432 fields retrieved from 'marser'
## mars - INFO    - 20180409.180650 - 432 fields have been interpolated
## mars - INFO    - 20180409.180650 - Request time: wall: 29 sec cpu: 4 sec
## mars - INFO    - 20180409.180650 - Read from network: 52.48 Mbyte(s) in 5 sec [10.8
## mars - INFO    - 20180409.180650 - Processing in marser: wall: 20 sec
## mars - INFO    - 20180409.180650 - Visiting marser: wall: 29 sec
## mars - INFO    - 20180409.180650 - Post-processing: wall: 3 sec cpu: 3 sec
## mars - INFO    - 20180409.180650 - Writing to target file: 4.76 Mbyte(s) in < 1 sec
## mars - INFO    - 20180409.180650 - Memory used: 51.44 Mbyte(s)
## mars - INFO    - 20180409.180650 - No errors reported
## Process '['nice', 'mars', '/tmp/tmp-_marsTN8PmN.req']' finished
## Calling 'nice grib_to_netcdf /data/data01/scratch/_mars-atls19-a82bacafb5c306db76464b
## grib_to_netcdf: Version 2.7.0
## grib_to_netcdf: Processing input file '/data/data01/scratch/_mars-atls19-a82bacafb5c3
## grib_to_netcdf: Found 432 GRIB fields in 1 file.
## grib_to_netcdf: Ignoring key(s): method, type, stream, refdate, hdate
## grib_to_netcdf: Creating netCDF file '/data/data03/scratch/_grib2netcdf-atls09-98f536

```

```

## grib_to_netcdf: NetCDF library version: 4.3.0 of Jul  3 2017 10:17:54 $
## grib_to_netcdf: Creating large (64 bit) file format.
## grib_to_netcdf: Defining variable 'z'.
## grib_to_netcdf: Defining variable 't'.
## grib_to_netcdf: Defining variable 'w'.
## grib_to_netcdf: Defining variable 'r'.
## grib_to_netcdf: Defining variable 'clwc'.
## grib_to_netcdf: Defining variable 'cc'.
## grib_to_netcdf: Defining variable 'u'.
## grib_to_netcdf: Defining variable 'v'.
## grib_to_netcdf: Done.
## Process '['nice', 'grib_to_netcdf', '/data/data01/scratch/_mars-atls19-a82bacafb5c306
## 2018-04-09 13:06:56 Request is complete
## 2018-04-09 13:06:56 Transferring 5.20625 Mbytes into interim_2014-05-25to2014-05-27.nc
## 2018-04-09 13:06:56 From https://stream.ecmwf.int/data/atls09/data/data03/scratch/_gr
## 2018-04-09 13:07:01 Transfer rate 1.02931 Mbytes/s

dir_path = "C:\\Users\\Laura\\Documents\\EVRN720\\tomkins_dcei\\UnitTesting\\"
filename = "interim_"+startdate+"to"+enddate+".nc"
full_path = dir_path+filename
import get_variable as gv
r = gv.get_variable(full_path, "r")
print r[0,8,.,:]

## [[ 83.4213612  82.85778486  82.33178027 ...,  75.79429473  84.00201561
##    84.4819094 ]
## [ 83.43160804  83.19934627  82.72799152 ...,  84.19499781  89.37648452
##    90.14499771]
## [ 82.23785088  81.88433481  81.16193241 ...,  94.19762394  92.52055738
##    94.56480247]
## ...,
## [ 78.80003521  79.08182338  78.92128951 ...,  91.47025602  90.92375775
##    90.05789955]
## [ 83.09517004  81.27464768  80.68374643 ...,  95.10446951  96.01473069
##    95.23255504]
## [ 84.68855406  82.25322115  81.58376077 ...,  89.84783928  90.73589897
##    90.24917395]]

```

References

Hader, John. 2016. “Propagating, Cloud-Eroding Boundaries in Southeast Atlantic Marine Stratocumulus.” Master’s thesis, North Carolina State University.

Hartmann, Dennis L, Maureen E Ockert-Bell, and Marc L Michelsen. 1992. “The Effect of Cloud Type on Earth’s Energy Balance: Global Analysis.” *Journal of Climate* 5 (11):

1281–1304.

Wood, Robert. 2012. “Stratocumulus Clouds.” *Monthly Weather Review* 140 (8): 2373–2423.