Application of Sea-Level Pressure and Wind Speeds Climatology in Marine Weather Forecast Operations

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Contents

Rapid/Explosive Cyclogenesis

- ➢ Explosive cyclone development has been traditionally defined by a central pressure fall of 1 hPa/hr over a 24 hour period relative to 60° of latitude.[1]
- ➢ Northern Hemisphere in the winter sees the most frequent rapid/explosive cyclogenesis cases.[2]

Enhanced pressure gradient ➡ Stronger winds ➡ Amplified wave heights ➡ Unsafe sailing conditions

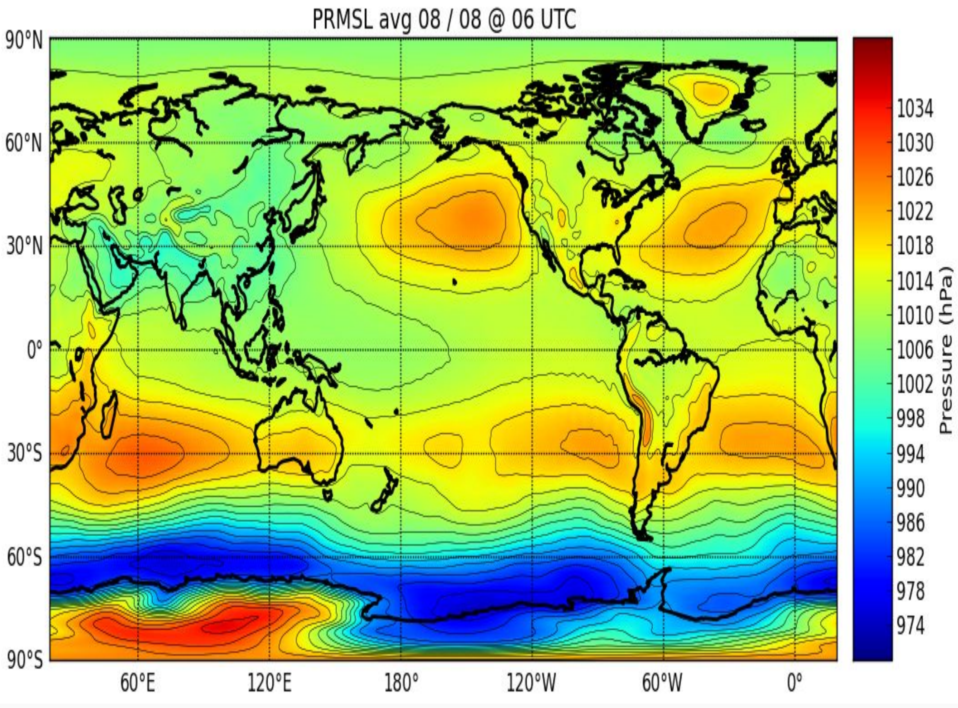
Objective

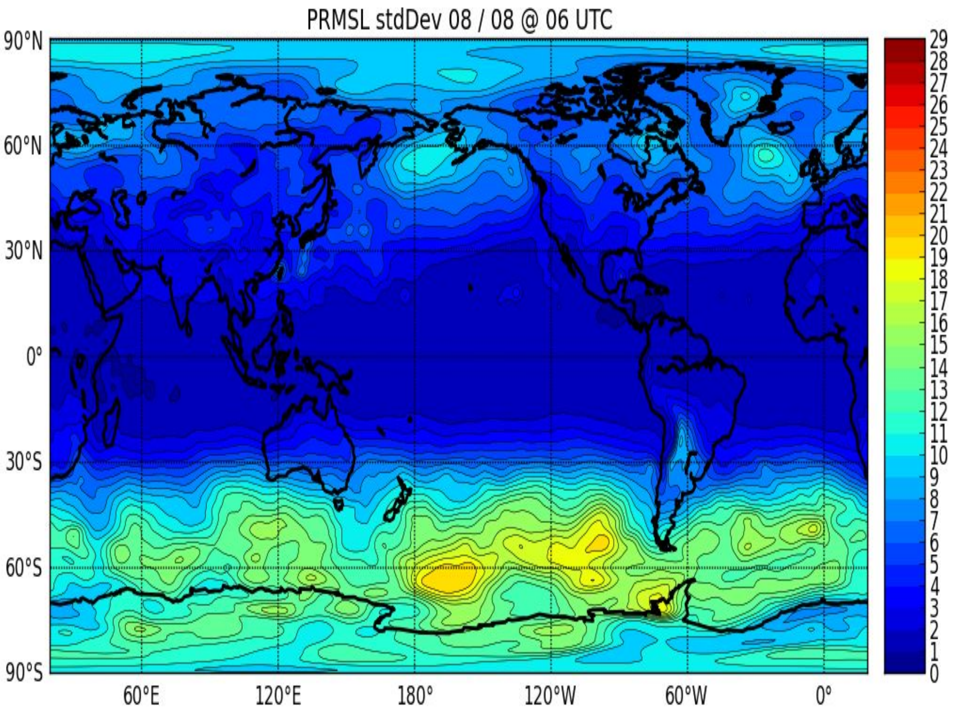
- Create a product to identify an anomalous event
  - Be able to better detect rapid/explosive cyclogenesis to help dictate where forecasters' attention should be.
  - Provide OPC forecasters a clear, convenient and consolidated method to aid in decision making, ultimately to better protect life and property.

Methods

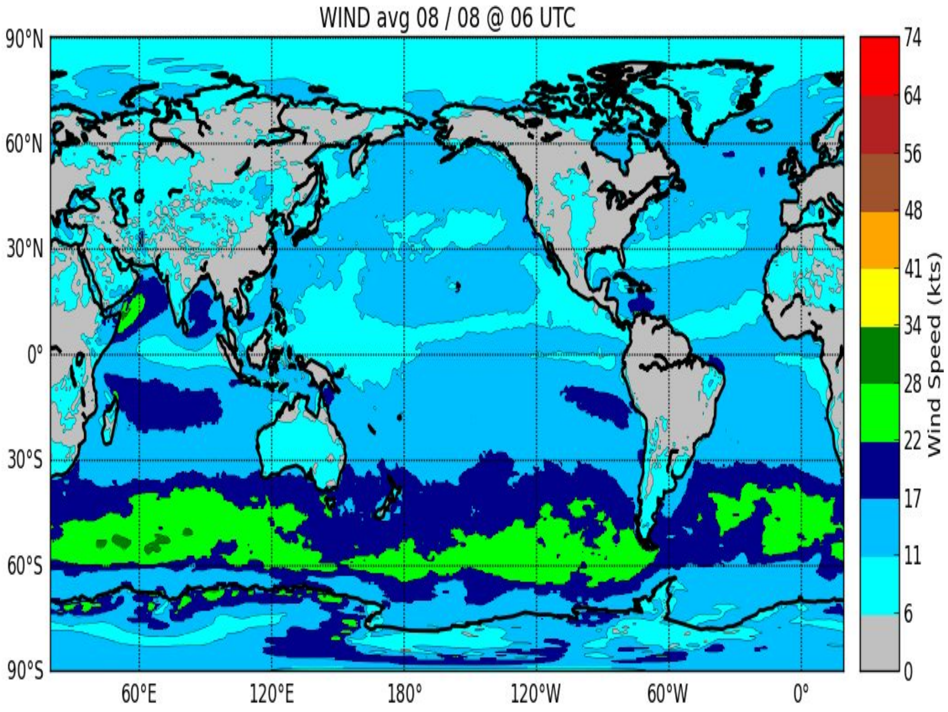
1. Gather CFSR data (PRMSL, WIND) for last 40 years.
2. Use wgrib2 and “ave”/ “ave_var” commands to derive climatological averages, standard deviations, maximums and minimums.
3. Load current GFS run to compare against climate.
4. Create a python script to similarly calculate normalized anomalies, climatological likelihoods, and percentiles.
5. Plot 2-4 in separate figures using matplotlib and python.

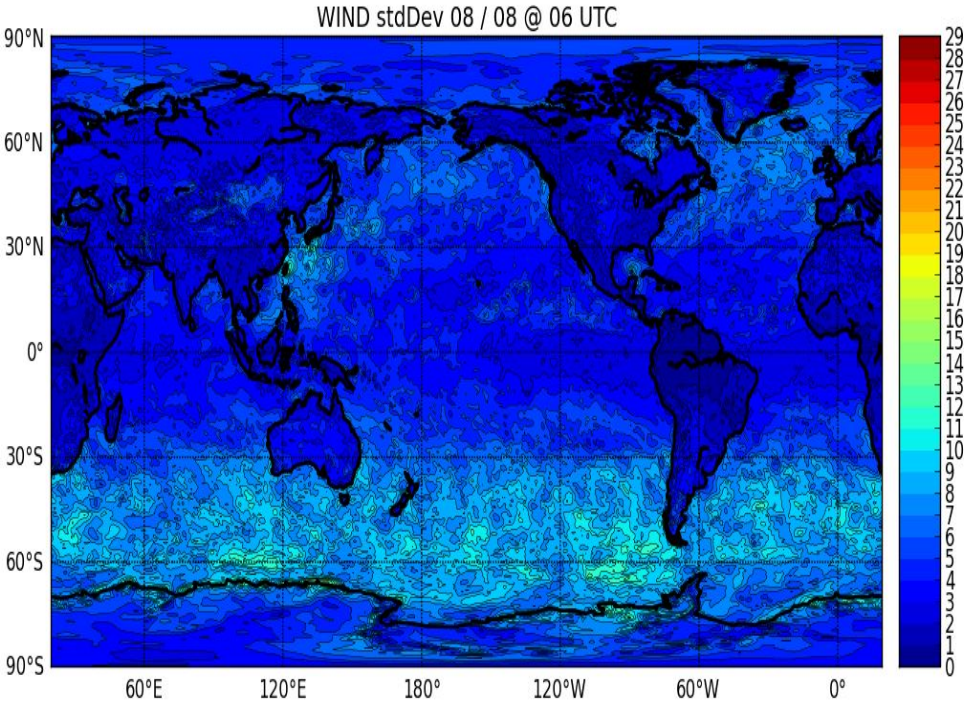
PRMSL - Avg/stdDev



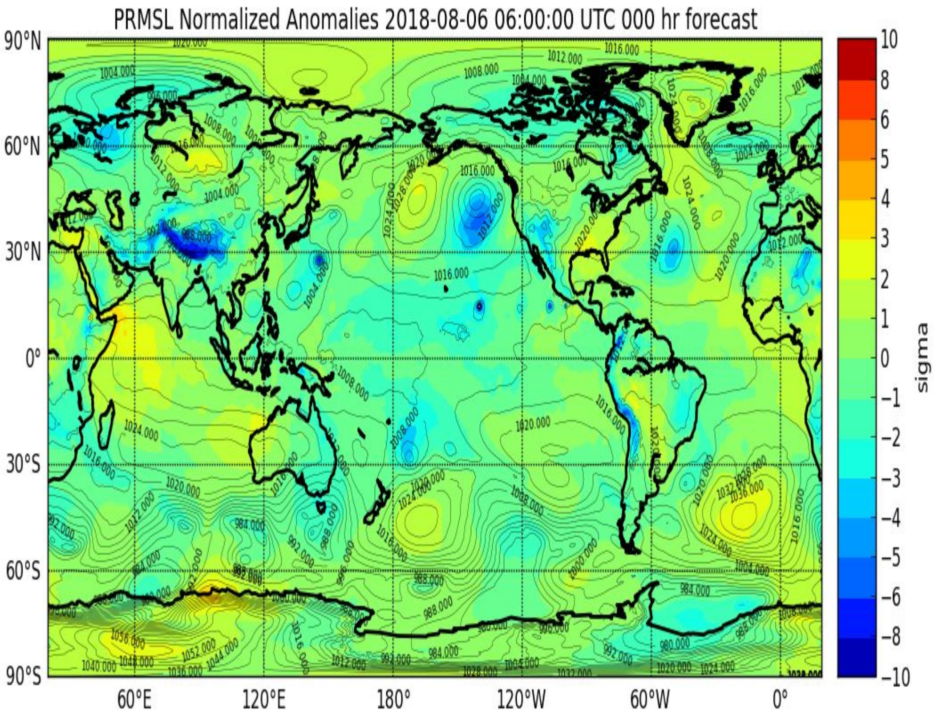


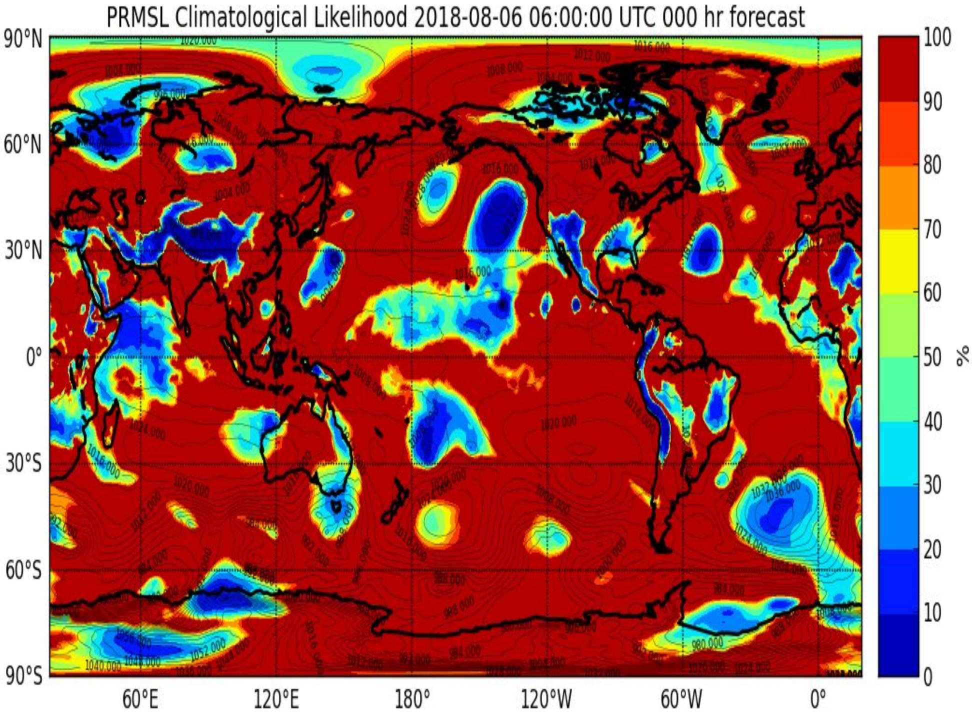
WIND - Avg/stdDev



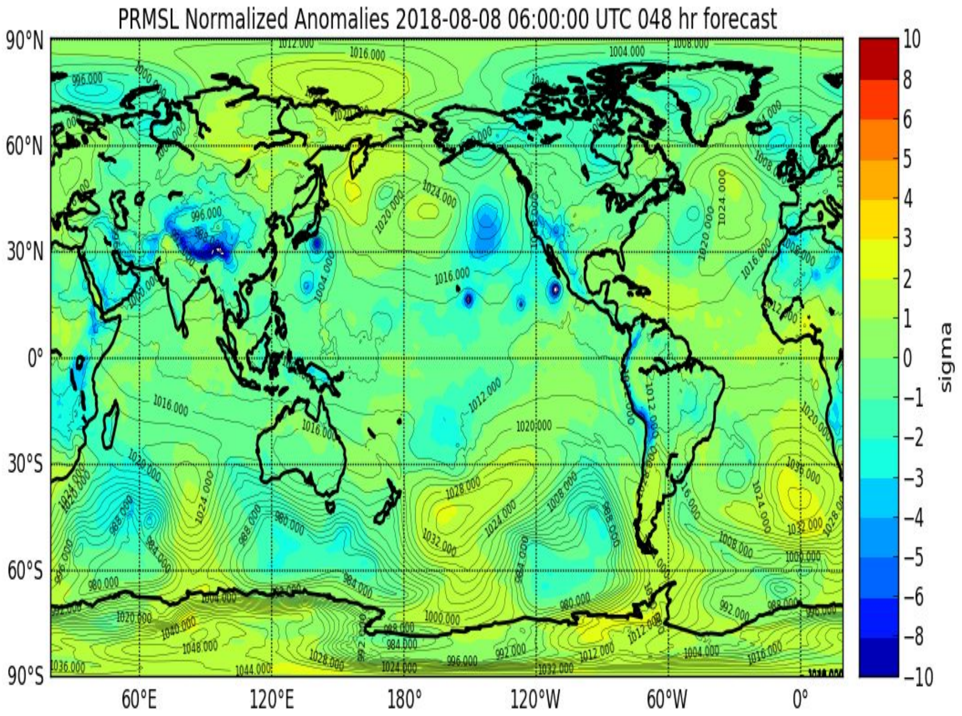


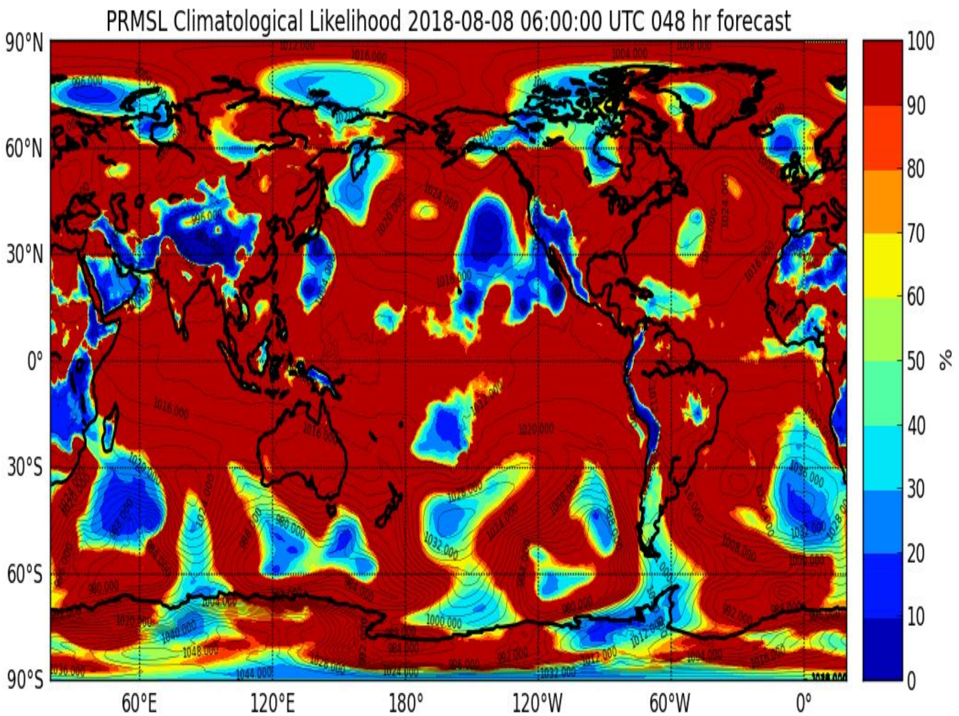
Normalized Anomalies/Climatological Likelihoods
PRMSL: f000



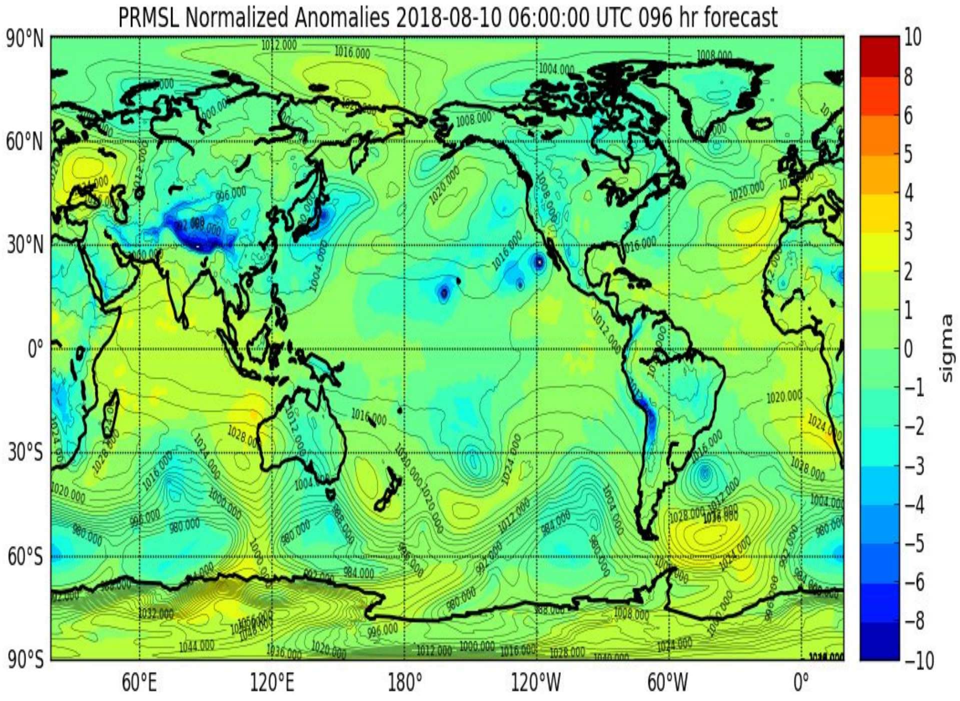


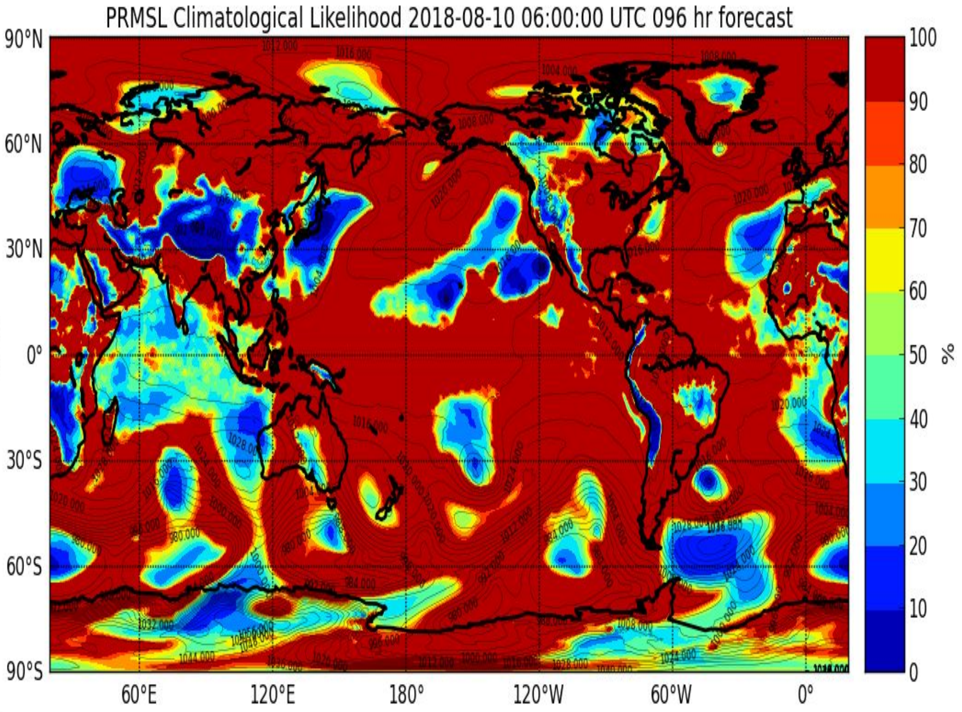
Normalized Anomalies/Climatological Likelihoods PRMSL: f048





Normalized Anomalies/Climatological Likelihoods
PRMSL: f096





Python/Matplotlib

```
        #cs = m.pcolormesh(x,y,spd80m,shading='flat',cmap=plt.cm.RdBu_r)

    m.drawcoastlines(linewidth=2.0)
        #m.fillcontinents(color='tan',lake_color='lightblue')
    m.drawmapboundary()
    m.drawparallels(np.arange(-90.,120.,30.),labels=[1,0,0,0])
    m.drawmeridians(np.arange(-180.,180.,60.),labels=[0,0,0,1])

#To plot Anomalies:
    if parm == "PRMSL":
      cs1 = plt.contourf(x, y, norm_anom, bounds_anom, cmap=plt.cm.jet)
      model_x, model_y = m(model_lons,model_lats)
      CS1 = plt.contour(model_x, model_y, fcst_mslp, pcontours, linewidths=.25, colors='black')
      plt.clabel(CS1, inline=1, fontsize=6)
      cb1 = m.colorbar(cs1, location='right')
      cb1.set_label('sigma')
      cb1.set_ticks(bounds_anom)
      plt.title('%s Normalized Anomalies %s UTC %03d hr forecast' % (parm, valid_date_object, fhour))

    if parm == "WIND":
      cs = plt.contourf(x, y, norm_anom, bounds_anom, cmap=plt.cm.jet)
      cb = m.colorbar(cs, location='right')
      cb.set_label('sigma')
      cb.set_ticks(bounds_anom)
      plt.title('%s Speed Normalized Anomalies %s UTC %03d hr forecast' % (parm, valid_date_object, fhour))
    fhourstr = str(fhour)
    #plt.savefig('/opc_test/home/opc_test/all_opc/python/%s_NormalizedAnom_%s.png' % (parm, fhourstr))
    plt.savefig('/opcnfs/case_studies/cfsr/climo2018_images/%s_NormalizedAnom_%s.png' % (parm, fhourstr))
    plt.show()
    plt.close()

#plot likelihood
    plt.figure(figsize=(12,8))
    m=Basemap(projection='cyl',lat_ts=10,llcrnrlon=lon[0], \
    urcrnrlon=lon[-1],llcrnrlat=lat.min(),urcrnrlat=lat.max(), \
    resolution='c')

    x, y = m(lon,lat)
    m.drawcoastlines(linewidth=2.0)
    m.drawmapboundary()
    m.drawparallels(np.arange(-90.,120.,30.),labels=[1,0,0,0])
    m.drawmeridians(np.arange(-180.,180.,60.),labels=[0,0,0,1])

    if parm == "PRMSL":
      cs1 = plt.contourf(x, y, likelihood, bounds_likely,  cmap=plt.cm.jet)
      model_x, model_y = m(model_lons,model_lats)
      CS1 = plt.contour(model_x, model_y, fcst_mslp, pcontours, linewidths=.25, colors='black')
      plt.clabel(CS1, inline=1, fontsize=6)
      cb1 = m.colorbar(cs1, location='right')
      cb1.set_label('%')
      cb1.set_ticks(bounds_likely)
      plt.title('%s Climatological Likelihood %s UTC %03d hr forecast' % (parm, valid_date_object, fhour))

    if parm == "WIND":
      cs = plt.contourf(x, y, likelihood, bounds_likely, cmap=plt.cm.jet)
#plt.clabel(cs, fontSize=9, inline=1)
      cb = m.colorbar(cs, location='right')
```

Future Work

- Filtering
- Past Events
- More Models
- More Parameters
- AWIPS Integration/Web Application
- Operationalizing Script

Conclusions

- Forecasting for rapid cyclogenesis is a challenge and detection upon onset can be disastrous.
- Normalized anomalies are helpful early on in determining which geographical areas have events out of the ordinary.
- This tool will provide OPC forecasters the capability to better protect life and property.

Acknowledgements

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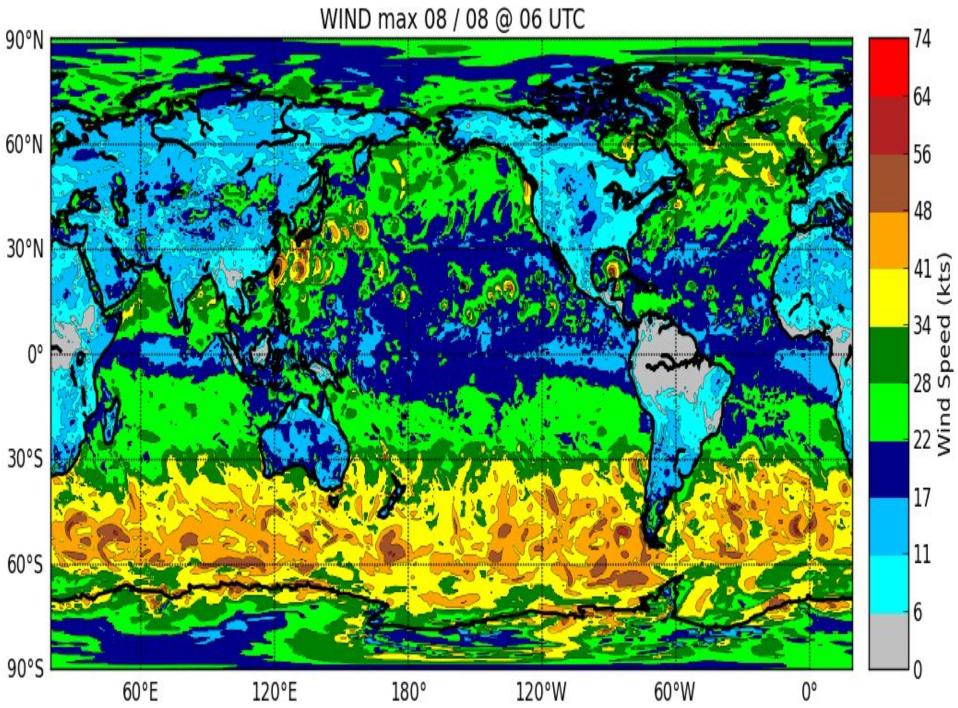
Sources

[1] Sanders, F., Gyakum, J.R. Synoptic-Dynamic Climatology of the “Bomb.” *Monthly Weather Review*. **1980**, 108, 1589-1606.

[2] Allen, J.T., Pezza, A.B., Black, M.T. Explosive Cyclogenesis: A Global Climatology Comparing Multiple Reanalyses. *Journal of Climate*. **2010**, 23, 6468-6484.

Thank you! Questions?



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