JEDI-SABER Experiment

DARC/NCEO Data Assimilation Training Course 2025

In this practical, we explore how observation information is spread by the background error covariance matrix (commonly referred to as the B matrix) in data assimilation systems. Specifically, we apply the B matrix to a Kronecker delta function, which has a value of 1 at a chosen grid point and 0 elsewhere. This allows us to observe

- How an impulse propagates spatially within the same variable field
- How it influences other variables through dynamical constraints, such as geostrophic balance

We use the System Agnostic Background Error Representation (SABER) repository within the Joint Effort for Data assimilation Integration (JEDI) framework. We use a static background error covariance matrix similar to that employed in the Met Office system. Step-by-step instructions for running the experiments are given below.

Experiment 1: Geostrophic Balance

We examine how pressure at a single grid point can influence the pressure field as well as the eastward and northward wind fields.

Step 1: Set up the experiment by running the following commands (after logging into RACC)

```
cp /storage/research/nceo/DA-training-course/docs/setup_saber_exps.sh .

bash setup_saber_exps.sh

cd saber_exps
```

Step 2: Run the SABER experiment

```
bash run_saber.sh
```

This generates a NetCDF file named “output.nc”. The runtime is roughly 54 seconds. For much faster execution (less than 2 seconds), run

```
sbatch run_saber.sh
```

Note that in this case, the screen out is saved to “myout.txt”.

Step 3: Load the Anaconda environment for Python

```
module load anaconda/2023.09-0/met-env
```

Step 4: Plot the result

python plot_saber.py output.nc <variable> 1

Replace <variable> with

- dimensionless_exner_function_levels_minus_one
- eastward_wind
- northward_wind

This shows how information of pressure at a given grid point spreads in the pressure, eastward wind or northward wind fields.

The generated file "figure_ <variable>.png" can be viewed with

display figure_ <variable>.png

Alternatively, the reader can use *ncview* to visualize the contents of the "output.nc" file.

Questions to Discuss:

- *How do the wind fields respond to an observation in the pressure field? And why?*
- *If the observation location is changed (e.g., moved closer to the equator), how do you expect the wind response to change?*

Hint: To change the latitude of the observation, open the file "dirac_spectralb_gauss_vader_1.yaml" and locate the line with "lat:". Set the desired latitude on the line directly below it.

Important:

- YAML files have strict indenting rules.
- Do not set both latitude and longitude to 0, as this will cause an error. If you need a near-zero latitude, use a small non-zero value like 0.01 instead.

Then repeat Steps 2 and 4.

Experiment 2: Non-Divergent Wind

We now investigate how eastward wind at a given grid point influences the northward wind field. This helps us understand the dynamic relationships in a non-divergent flow.

Question to Discuss:

How are the eastward and northward wind components related in a non-divergent wind field?

Hint: To run the experiment, open the file "dirac_spectralb_gauss_vader_1.yaml" and locate the line with "variable:". Change the line below to "- eastward_wind".

Then repeat Steps 2 and 4.