

# SABER library basics

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# Outline



Background error modelling

SABER usage

Upcoming extensions

# Background error modelling



Background error modelling

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## Background error: static B



The background error can be parametric (“static”):  $B = B_s$

- It can be model-specific (here the QG model):

```
background error:
  covariance model: QgError
  horizontal_length_scale: 2.2e6
  maximum_condition_number: 1.0e6
  standard_deviation: 1.8e7
  vertical_length_scale: 15000.0
```

- It can also come from SABER, with several blocks:

```
background error:
  covariance model: SABER
  saber blocks:
  - saber block 1
    [...]
  - saber block 2
    [...]
    [...]
```



## Background error: ensemble B

The background error can be sampled directly from an ensemble and localized to damp sampling noise:  $B = L \circ \tilde{B}$

- The localization can be model-specific (here the QG model):

```
background error:
  covariance model: ensemble
  localization:
    localization method: QG
    horizontal_length_scale: 2.0e6
    maximum_condition_number: 1.0e6
    standard_deviation: 1.0
    vertical_length_scale: 3694.0
  members (or members from template):
    [...]
```

- It can also come from SABER, with a single block:

```
background error:
  covariance model: ensemble
  localization:
    localization method: SABER
    saber block:
      [...]
```

```
members (or members from template):
  [...]
```



## Background error: hybrid B

Finally, a hybrid background error is a weighted combination of several components:  $B = \gamma^e L \circ \tilde{B} + \gamma^s B_s$

The number of components and their type is not limited. For each component, a weight must be provided:

```
background error:
  covariance model: hybrid
  components:
  - covariance:
      covariance model: ensemble
      localization:
        [...]
      members (or members from template):
        [...]
      weight:
        [...]
  - covariance:
      covariance model: SABER
      saber blocks:
      - saber block 1
        [...]
      - saber block 2
        [...]
        [...]
      weight:
        [...]
  [...]
```



## Background error: linear variable change

A linear variable change  $T$  can be added around the background error:  $B_{\text{total}} = T B T^T$

```
background error:  
  covariance model: [...]  
  [...]  
  linear variable change:  
    linear variable change name: [...]  
    input variables: [...]  
    output variables: [...]
```

This linear variable change can be model-specific or come from VADER (Steve's presentation).

# SABER usage



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# Static background error with SABER



A typical static B :

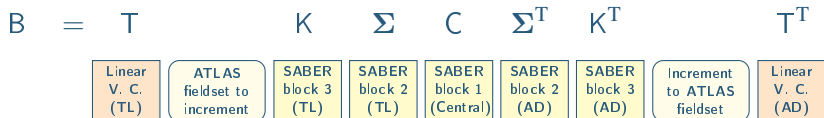
$$B = T K \Sigma C \Sigma^T K^T T^T$$

- T: linear variable change
- K: balance operator
- $\Sigma$ : standard deviations
- C: correlation operator

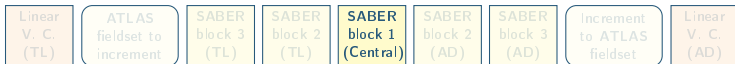
# Static background error with SABER



A typical static B :



# Static background error with SABER



```
background error:
covariance model: SABER
saber blocks:
- saber block name: BUMP_NICAS
  saber central block: true
  iterative inverse: true
  input variables: [psi, chi, t, ps, rh]
  output variables: [psi, chi, t, ps, rh]
  bump:
    [...]
- saber block name: StdDev
  input variables: [psi, chi, t, ps, rh]
  output variables: [psi, chi, t, ps, rh]
  file:
    [...]
- saber block name: BUMP_VerticalBalance
  input variables: [psi, chi, t, ps, rh]
  output variables: [psi, chi, t, ps, rh]
  active variables: [psi, chi, t, ps]
  bump:
    [...]
linear variable change:
- linear variable change name: Control2Analysis
  input variables: [psi, chi, t, ps, rh]
  output variables: [ua, va, t, ps, sphum]
```

# Static background error with SABER



```
background error:
covariance model: SABER
saber blocks:
- saber block name: BUMP_NICAS
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  iterative inverse: true
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  bump:
    [...]
- saber block name: StdDev
  input variables: [psi, chi, t, ps, rh]
  output variables: [psi, chi, t, ps, rh]
  file:
    [...]
- saber block name: BUMP_VerticalBalance
  input variables: [psi, chi, t, ps, rh]
  output variables: [psi, chi, t, ps, rh]
  active variables: [psi, chi, t, ps]
  bump:
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# Static background error with SABER



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# Coming extensions



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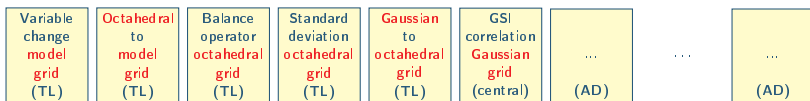
# Block types

All changes of variable or grid should be **explicit SABER blocks**.

Block type	Input/output grids	Input/output variables
Variable change	Same	Different
Interpolation	Different	Same
Classical block	Same	Same

- Variable change block:
  - implementation in SABER now,
  - implementation in VADER when VADER is ready.
- Interpolation block: probably a single generic block
- Classical block examples: vertical balance, std-dev, correlation.

Example (only the TL part is shown):





## Block list



### Blocks currently available in SABER:

- `BUMP_NICAS` : NICAS smoother of BUMP
- `BUMP_PsiChiToUV` : psi-chi to u-v convertor of BUMP
- `BUMP_StdDev` : standard-deviation loaded through BUMP
- `BUMP_VerticalBalance` : vertical balance of BUMP
- `ID` : identity operator
- `StdDev` : standard-deviation directly loaded from a file.

### Blocks available soon (work in progress):

- `GSIBCLIM` : GSI static covariance (GMAO)
- `SPECTRALB` : spectral covariance (UKMO)
- `INTERP` : generic interpolator
- `VADER` : generic linear variable change calling VADER

Any questions?