



Reservoir coupling

OPM Summit 2024

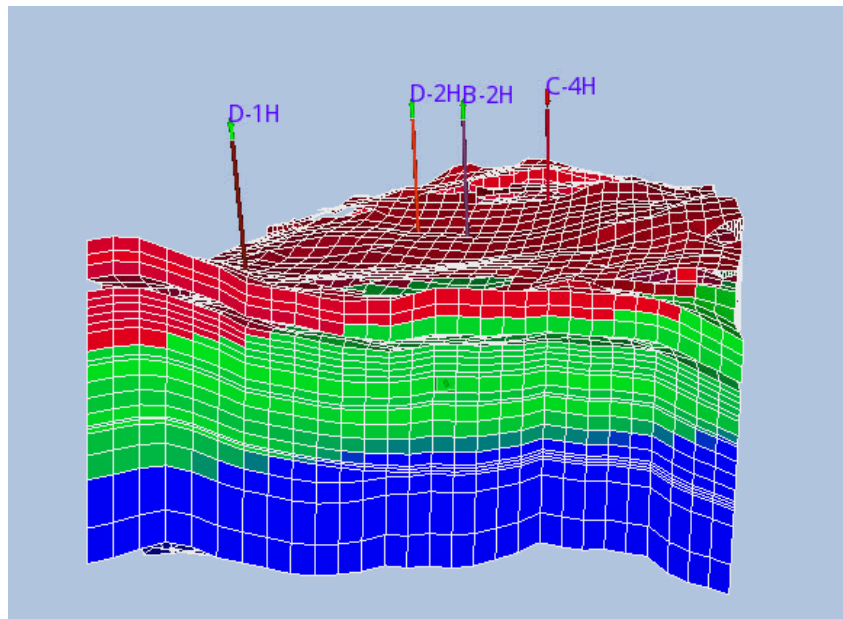
Outline

- Reservoir coupling
 - New functionality not supported in OPM Flow
 - Used by several assets in Equinor
- New test case in opm-test
 - <https://github.com/OPM/opm-tests/pull/1144>
 - 3 master decks
 - RC-01_MAST_PRED.DATA
 - RC-01_MAST_HIST.DATA
 - RC-01_MAST_RST.DATA

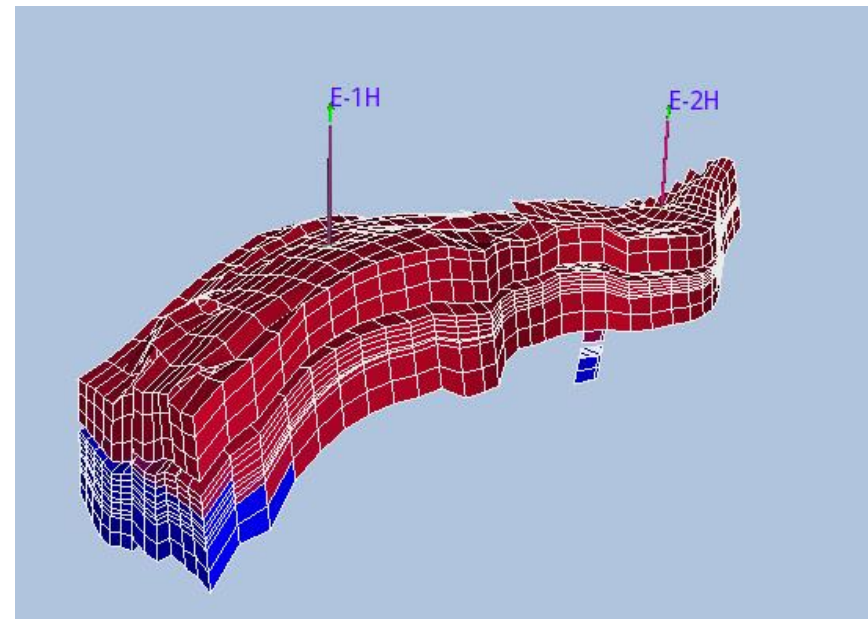
Separate models sharing production constraints



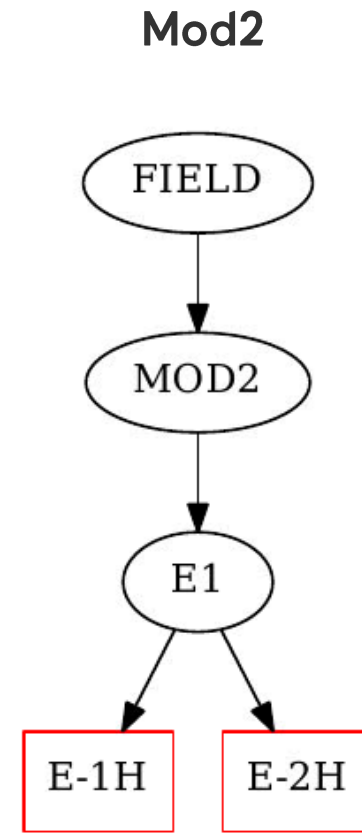
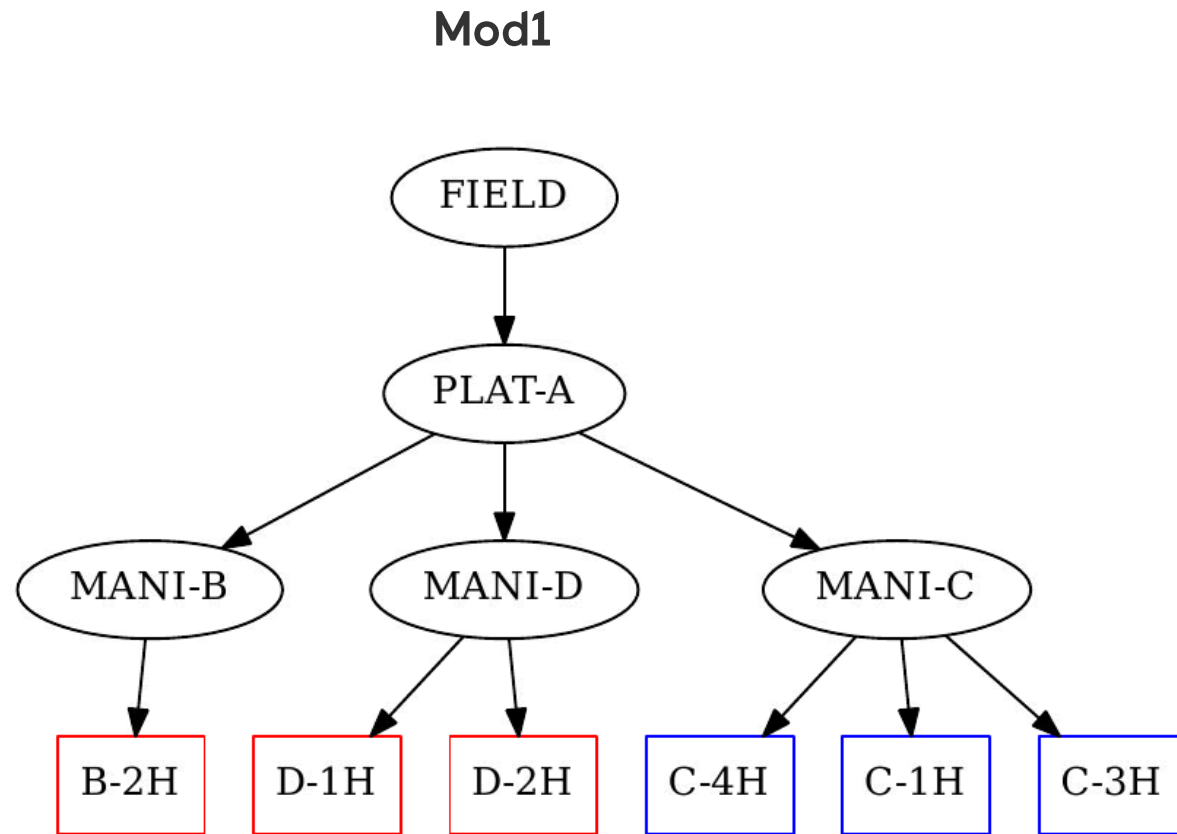
Mod1



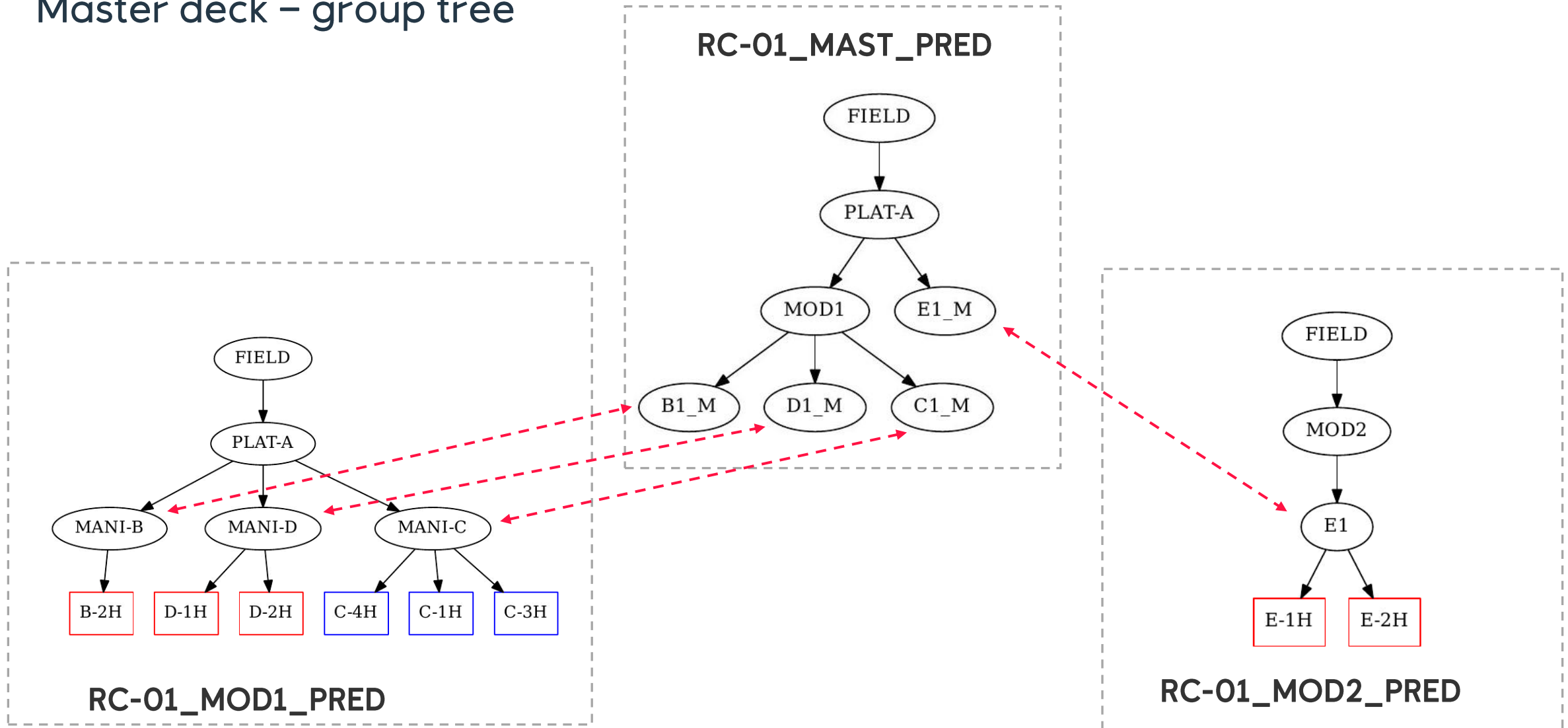
Mod2



Group tree



Master deck – group tree



Master deck – keywords

```
SLAVES  
  'RES-1'  'RC-01_MOD1_PRED'  '*'  './mod1'  4  /  
  'RES-2'  'RC-01_MOD2_PRED'  '*'  './mod2'  1  /  
/
```

```
GRUPMAST  
  'D1_M'  'RES-1'  'MANI-D'  1*  /  
  'B1_M'  'RES-1'  'MANI-B'  1*  /  
  'C1_M'  'RES-1'  'MANI-C'  1*  /  
  'E1_M'  'RES-2'  'E1'    1*  /  
/
```

Slave deck – keywords

```

SCHEDULE

INCLUDE
'./include/B2H.Ecl' /

INCLUDE
'./include/D1CH.Ecl' /

INCLUDE
'./include/D2H.Ecl' /

GRUPTREE
'PLAT-A' 'FIELD' /

'MOD1' 'PLAT-A' /

'B1_M' 'MOD1' /
'D1_M' 'MOD1' /
'C1_M' 'MOD1' /

'E1_M' 'PLAT-A' /
/

GRUPLAV
'MANI-D' 'D1_M' /
'MANI-B' 'B1_M' /
'MANI-C' 'C1_M' /
/
  
```

```

SCHEDULE

GRUPTREE
'MOD2' 'FIELD' /
'E1' 'MOD2' /
/

GRUPLAV
'E1' 'E1_M' /
/

INCLUDE
'include/well_e1h_vfp.inc' /

INCLUDE
'include/well_e2h_vfp.inc' /

WCONPROD
'E-1H' 'OPEN' 'GRAT' 5000.0 1* 4.0E6 2
'E-2H' 'OPEN' 'GRAT' 5000.0 1* 4.0E6 2
/

DATES
1 AUG 2010 /
  
```

Master deck – group controls

GUIDERAT

30.0 OIL 1.0 1.0 1* 1* 1.0 0.2 1* 0.1 /

GCONPROD

'FIELD' 'ORAT' 9200.0 1* 6.9E6 1* 'RATE' /

'D1_M' 'ORAT' 9200.0 1* 6.9E6 1* 'RATE' 1* 1* 'FORM' /

'B1_M' 'ORAT' 9200.0 1* 6.9E6 1* 'RATE' 1* 1* 'FORM' /

'C1_M' 'ORAT' 9200.0 1* 6.9E6 1* 'RATE' 1* 1* 'FORM' /

'E1_M' 'ORAT' 9200.0 1* 6.9E6 1* 'RATE' 1* 1* 'FORM' /

/

GCONSUMP

'FIELD' 200000 /

/

GCONINJE

'FIELD' 'GAS' 'REIN' 4.0E6 1* 1.0 /

'D1_M' 'GAS' 'RATE' 4.0E6 4* 1.0 'RATE' /

'B1_M' 'GAS' 'RATE' 4.0E6 4* 1.0 'RATE' /

'C1_M' 'GAS' 'RATE' 4.0E6 4* 1.0 'RATE' /

'E1_M' 'GAS' 'RATE' 4.0E6 4* 1.0 'RATE' /

'D1_M' 'WATER' 'RATE' 4.0E6 4* 1.0 'RATE' /

'B1_M' 'WATER' 'RATE' 4.0E6 4* 1.0 'RATE' /

'C1_M' 'WATER' 'RATE' 4.0E6 4* 1.0 'RATE' /

'E1_M' 'WATER' 'RATE' 4.0E6 4* 1.0 'RATE' /

/

DATES

1 NOV 2018 /

/

Master deck – group controls

DATES

1 NOV 2018 /
/

GCONINJE

'MOD1' 'WATER' 'VREP' 10000.0 2* 1.0 /
/

DATES

1 DEC 2018 /
1 JAN 2019 /
/

GCONPROD

'FIELD' 'ORAT' 13100.0 1* 6.9E6 1* 'RATE' /
/

DATES

1 FEB 2019 /
/

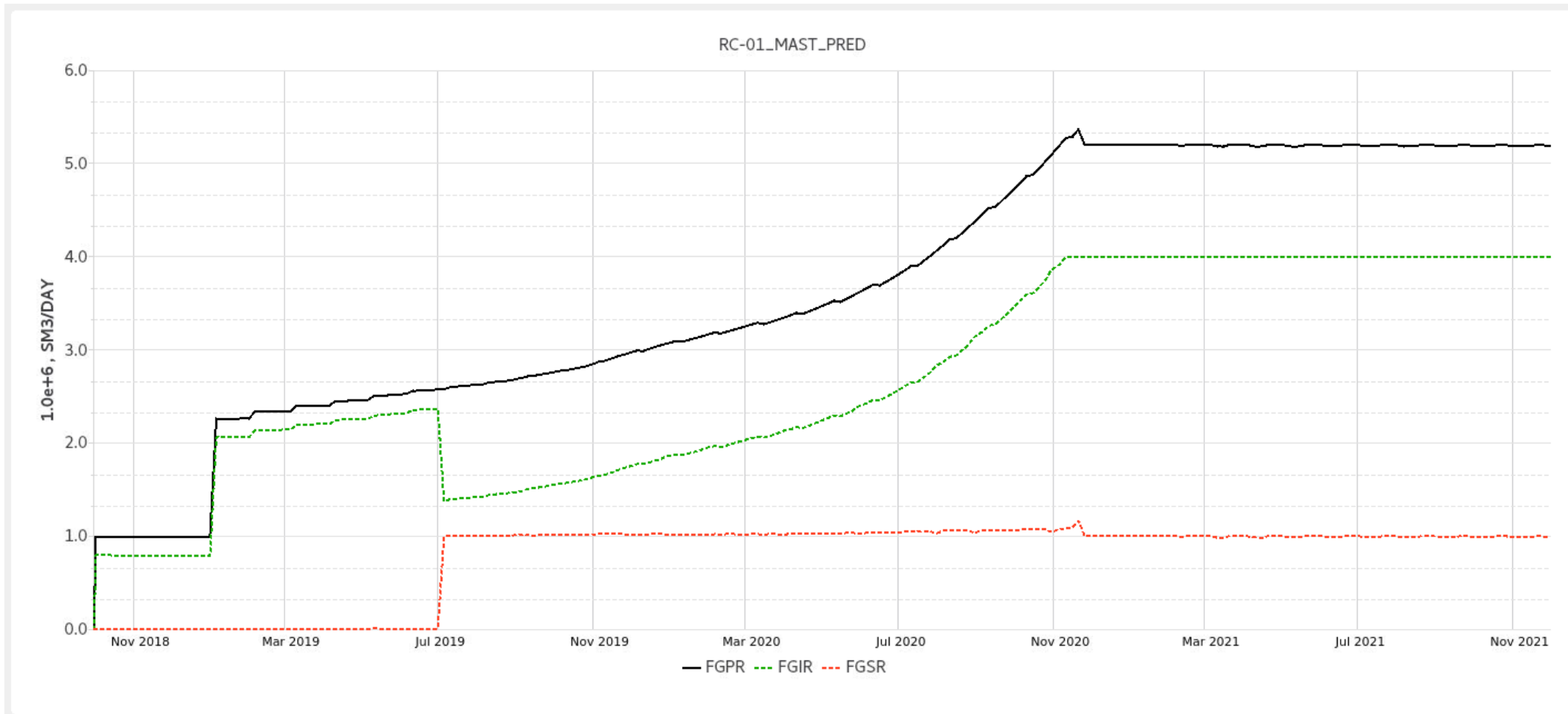
DATES

1 MAR 2019 /
1 APR 2019 /
1 MAY 2019 /
1 JUN 2019 /
1 JUL 2019 /
/

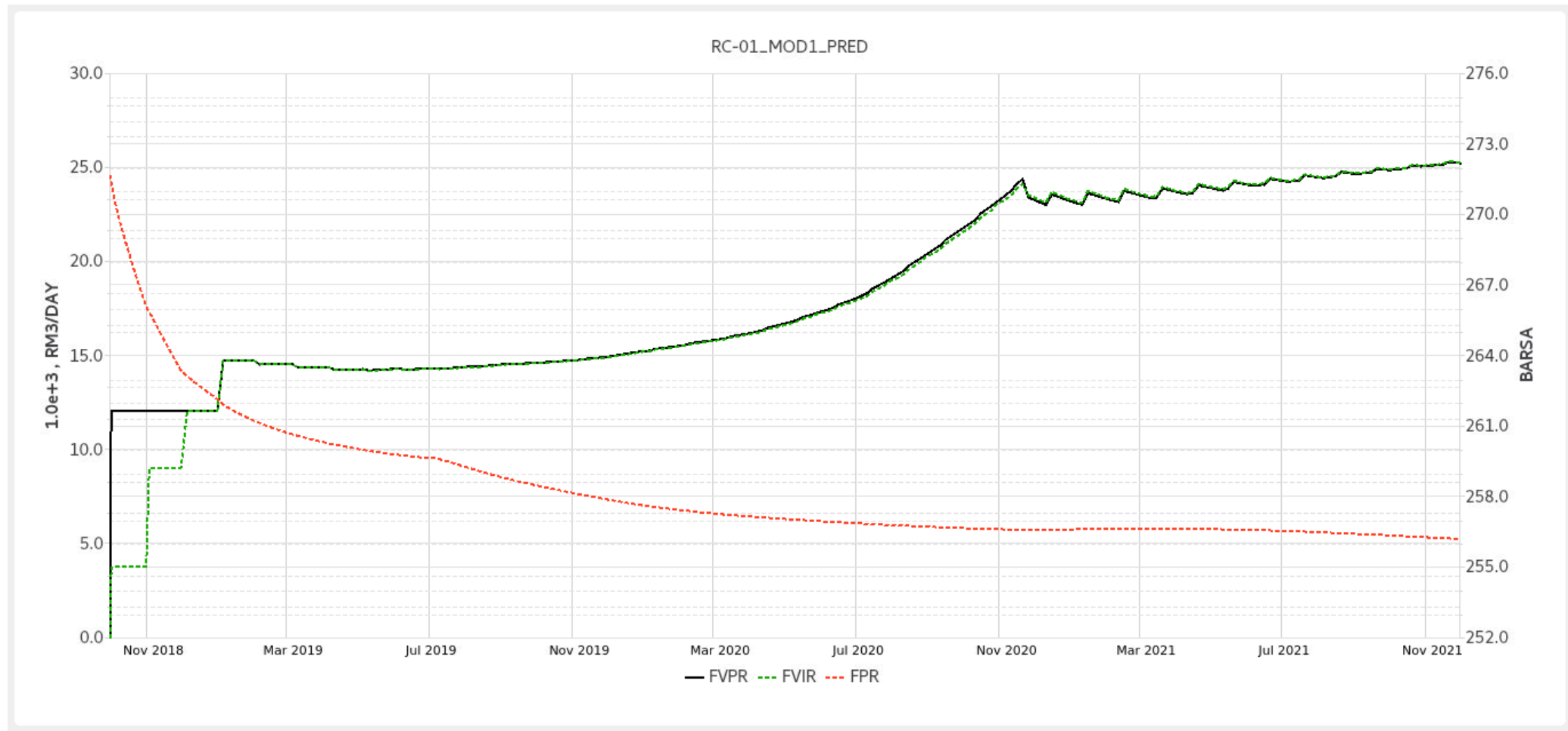
GCONSALE

FIELD 1.0E6 1.05E6 0.99E6 RATE /
/

RC MASTER – Gas handling (production, injection and export)



SLAVE - MOD1 – reservoir volume replacement injection



Master deck – network modelling

```

GRUPTREE
'PLAT-A' 'FIELD' /

'MOD1' 'PLAT-A' /

'B1_M' 'MOD1' /
'D1_M' 'MOD1' /
'C1_M' 'MOD1' /

'E1_M' 'PLAT-A' /
/

BRANPROP
-- Downtree Uptree #VFP ALQ
   B1_M 'PLAT-A' 3 1* /
   D1_M 'PLAT-A' 4 1* /
   E1_M 'PLAT-A' 5 1* /
/

NODEPROP
-- Node_name Press autoChoke? addGasLift? Group_name
   PLAT-A 21.0 NO NO 1* /
   B1_M 1* NO NO 1* /
   D1_M 1* NO NO 1* /
   E1_M 1* NO NO 1* /
/

```

Restart

```

SOLUTION
-----
RESTART
'RC-01_MAST_HIST' 9 /

SUMMARY
-----
INCLUDE
'include/summary.inc' /

SCHEDULE
-----

TUNING
1.0 5.0 /
/
/

INCLUDE
'include/b1_vfp_flowline.inc' /

INCLUDE
'include/d1_vfp_flowline.inc' /

INCLUDE
'./include/flowline_e1_vfp.inc' /

GRUPTREE
'PLAT-A' 'FIELD' /

'MOD1' 'PLAT-A' /

'B1_M' 'MOD1' /
'D1_M' 'MOD1' /
'C1_M' 'MOD1' /

'E1_M' 'PLAT-A' /
/

SLAVES
'RES-1' 'RC-01_MOD1_RST' '*' './mod1' 4 /
'RES-2' 'RC-01_MOD2_RST' '*' './mod2' 1 /
/

```

```

SOLUTION
-----
RESTART
'RC-01_MOD1_HIST' 35 /

SUMMARY
-----
NEWTON
MLINEARS

--
INCLUDE
'include/summary.data' /

--
INCLUDE
'include/gas.inc' /

SCHEDULE
-----

INCLUDE
'./include/B2H.Ecl' /

INCLUDE
'./include/D1CH.Ecl' /

INCLUDE
'./include/D2H.Ecl' /

GRUPTREE
'PLAT-A' 'FIELD' /

'MOD1' 'PLAT-A' /

'B1_M' 'MOD1' /
'D1_M' 'MOD1' /
'C1_M' 'MOD1' /

'E1_M' 'PLAT-A' /
/

GRUPLAV
'MANI-D' 'D1_M' /
'MANI-B' 'B1_M' /
'MANI-C' 'C1_M' /
/

```

```

SOLUTION
-----
RESTART
'RC-01_MOD2_HIST' 23 /

SUMMARY
-----
INCLUDE
'./include/summary.inc' /

GOPGR
/

SCHEDULE
-----

GRUPTREE
'MOD2' 'FIELD' /
'E1' 'MOD2' /
/

GRUPLAV
'E1' 'E1_M' /
/

```

CONCLUSIONS

- Reservoir coupling
 - Functionality that Equinor would like to have in OPM Flow
 - Used by several assets in Equinor
- The Eclipse format has well defined keywords for setting up reservoir couplings
 - SLAVES, GRUPMAST and GRUPLAV
- New test case with reservoir coupling now in opm-test
 - <https://github.com/OPM/opm-tests/pull/1144>