# The results of RAMI data inversion

The Results of the RAMI data inversion over all available angels (from $-75^0$ to $75^0$)

In [69]:
```
import numpy as np
import os
import eoldas
%pylab inline
plt.rcParams['figure.dpi'] = 1.5*plt.rcParams['figure.dpi']
plt.rcParams['savefig.dpi'] = 1.5*plt.rcParams['savefig.dpi']
```

```
Welcome to pylab, a matplotlib-based Python environment [backend: module://IPython.zmq.pylab.backend_inline].
For more information, type 'help(pylab)'.
```

In [70]:
```
out_dir = '/media/sf_JRC/RAMI/output_prior/'
```

Read the RAMI *.mes files in order to obtain view zenith angles and other data

In [71]:
```
def read_rami_data(f_red, f_nir):
    f = open(f_red, 'r')
    tmp_str = f.read()
    f.close()
    list1 = tmp_str.split('\n')
    f = open(f_nir, 'r')
    tmp_str = f.read()
    f.close()
    list2 = tmp_str.split('\n')

    N = len(list1)-1

    red = np.zeros(len(list1)-1)
    nir = np.zeros(len(list1)-1)
    sza = np.zeros(len(list1)-1)
    saa = np.zeros(len(list1)-1)
    vza = np.zeros(len(list1)-1)
    vaa = np.zeros(len(list1)-1)

    for i in range( 1,  N):
        red[i] = list1[i].split()[3]
        nir[i] = list2[i].split()[3]
        sza[i] = round(float(list1[i].split()[0]) * 180/pi)
        #saa[i] = list1[i].split()[2]
        saa[i] = 0
        vaa[i] = round(float(list1[i].split()[2]) * 180/pi)
        vza[i] = round(float(list1[i].split()[1]) * 180/pi)
        if (vaa[i] == 90.0) or (vaa[i] == 0.0):
            vza[i] = round(-1 * float(list1[i].split()[1]) * 180/pi)

    return red, nir, sza, saa, vza, vaa, N
```

Plot inversion results - LAI

In [72]:
```
def plot_rami_inv(f_param, f_red_, f_nir, true_lai):
    n = 76
    lai = np.zeros(n-1)
    red, nir, sza, saa, vza, vaa, N = read_rami_data(f_red, f_nir)
    for i in range(1,n):
        f = open(f_param + str(i) + '.params', 'r')
        tmp_str = f.read()
        f.close()
        list_str = tmp_str.split('\n')
        #lai[i-1] = abs( true_lai - (-2*np.log( float(list_str[1].split()[2]) )) )
        lai[i-1] = ( -2*np.log( float(list_str[1].split()[2]) ) )
    #print lai
    #print vza.shape
    #print lai.shape
    #print N
    plt.plot(vza[1:N-1], lai, lw=2, label='EO-LDAS LAI (inversion)')
    plt.xlabel('View Zenith Angle')
    plt.ylabel('LAI')
    plt.axhline(y=true_lai, color='r', label='LAI of the RAMI scene')
    misr = [-70.5, -60.0, -45.6, -26.1, 0, 26.1, 45.6, 60.0, 70.5]
    plt.axvline(x=misr[0], color='g', lw=0.5, ls='--', label='MISR VZA')
    for i in range(1, len(misr)):
        plt.axvline(x=misr[i], color='g', lw=0.5, ls='--')
    plt.legend(loc='best')
    #plt.plot(lai)
```

Read results of the forward modeling (recinstructed spectral data)

In [73]:
```
def read_fwd(f_param):
    n = 76
    red = np.zeros(n-1)
    nir = np.zeros(n-1)
    for i in range(1,n):
        f_in = f_param + str(i) + '.fwd'
        f = open(f_in, 'r')
        tmp_str = f.read()
        f.close()
        list_str = tmp_str.split('\n')
        red[i-1] = float(list_str[1].split()[6])
        nir[i-1] = float(list_str[1].split()[7])
    return red, nir
```

Plot RAMI BRF against view zenith angles

In [74]:
```
def plot_rami_data(f_red, f_nir, fwd_red, fwd_nir):
    red, nir, sza, saa, vza, vaa, N = read_rami_data(f_red, f_nir)
    N=N-2
    plt.subplot(1,2,1)
    plt.title('RED')
    plt.ylabel('BRF')
    plt.xlabel('VZA')
    plt.plot(vza[1:N], red[1:N], c='r', label='RAMI BRF RED')
    plt.plot(vza[1:N], fwd_red[1:N], c='g', label='Reconstructed BRF')
    plt.legend(loc='best')
    plt.subplot(1,2,2)
    plt.title('NIR')
    plt.ylabel('BRF')
    plt.xlabel('VZA')
    plt.plot(vza[1:N], nir[1:N], c='m', label='RAMI BRF NIR')
    plt.plot(vza[1:N], fwd_nir[1:N], c='g', label='Reconstructed BRF')
    plt.legend(loc='best')
```

## Homogeneous discrete cases in the solar domain

PRIOR DATA:
exp. transform: xlai = 0.3, sd = 0.7; inv. transform: xlai = 2.5 - LAI
xhc = 1, sd = 3 - Height
rpl = 0.1, sd = 0.5 - Leaf radius/dimensios (I suppose it is the same as Scatterer Radius in RAMI)
exp. transform: xkab = 0.5, sd = 0.5; inv. tranform: xkab = 70 $[\mu g cm^{-2}]$ - $C_{ab}$ concentration
scen = 0.5, sd = 0.5 - The proportion of senescent material (fractional, between 0 and 1)
exp. transform: xkw = 0.5, sd = 0.5 - equivalent leaf water
exp. transform: xkm = 0.5, sd = 0.5 - Dry matter
xleafn = 1.5, sd = 1.5 - The number of leaf layers
xs1 = 2.0, sd = 2 - Soil PC1 - soil brightness
xs2 = 2.5, sd = 2.5 - Soil wetness
lad = 5, sd = 5 - Leaf angle distribution

### BRF in the cross plane (perperdicular to the principal plane) - brfop

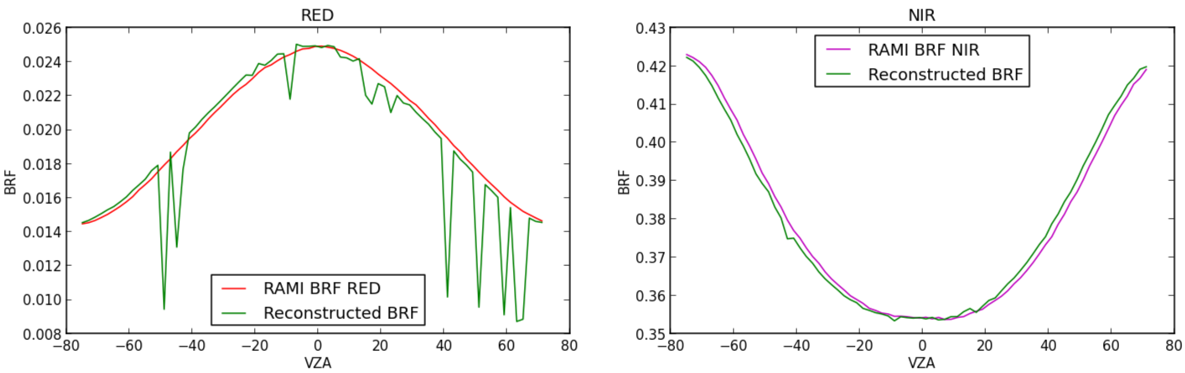
SZA: 20.0, 50.0
SAA: 0.0
LAI: 3.0 $m^2/m^2$
Height: 2.0 m
lad: Erectophile (2)

#### Input

In [96]:
```
true_lai = 3
f_param = out_dir + 'brfop_ROMCREF-hom03_dis_ere_20_'
f_red = '/media/sf_JRC/RAMI/HOM03_DIS_ERE/brfop_ROMCREF-HOM03_DIS_ERE_RED_20.mes'
f_nir = '/media/sf_JRC/RAMI/HOM03_DIS_ERE/brfop_ROMCREF-HOM03_DIS_ERE_NIR_20.mes'
```

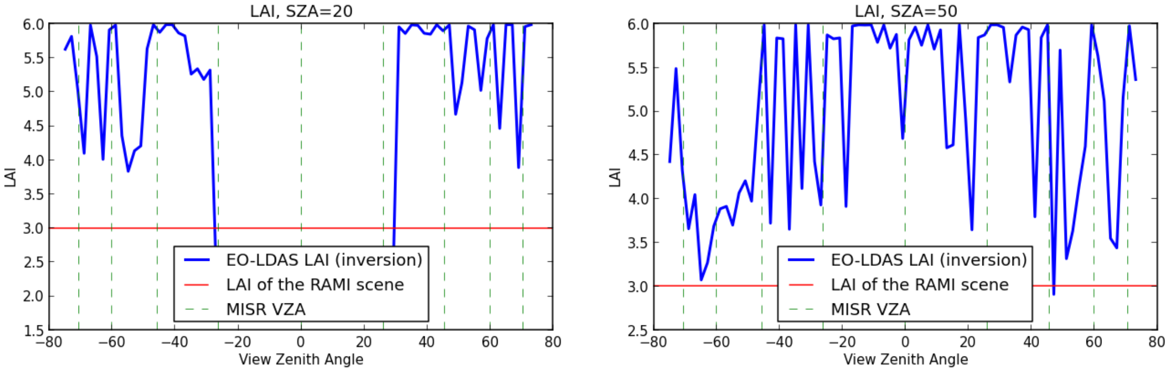
#### RAMI BRF

In [97]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




#### Inversion

In [98]:
```
plt.subplot(1,2,1)
plt.title('LAI, SZA=20')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
f_param = out_dir+'brfop_ROMCREF-hom03_dis_ere_50_'
plt.subplot(1,2,2)
plt.title('LAI, SZA=50')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
subplots_adjust(right=2, wspace=0.2)
```

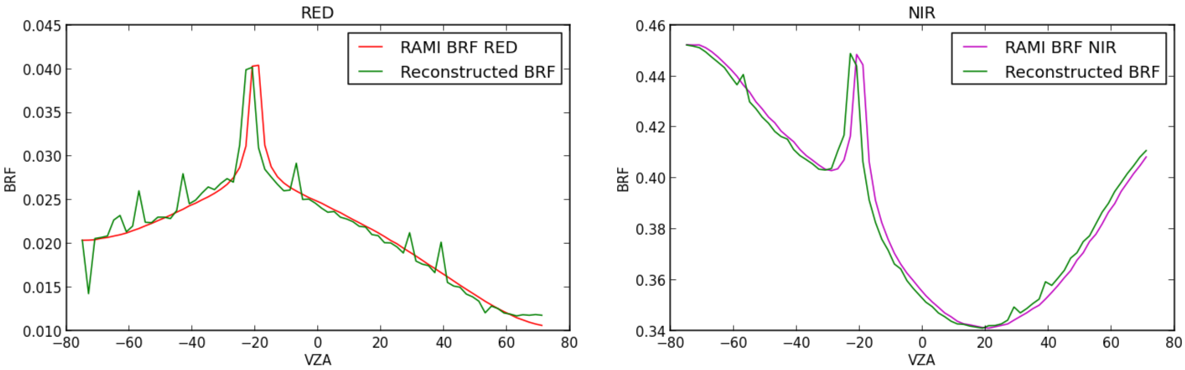



#### BRF in the principal plane - brfpp

In [100]:
```
true_lai = 3
f_param = out_dir+'brfpp_ROMCREF-HOM03_DIS_ERE_20_'
f_red = '/media/sf_JRC/RAMI/HOM03_DIS_ERE/brfpp_ROMCREF-HOM03_DIS_ERE_RED_20.mes'
f_nir = '/media/sf_JRC/RAMI/HOM03_DIS_ERE/brfpp_ROMCREF-HOM03_DIS_ERE_NIR_20.mes'
```

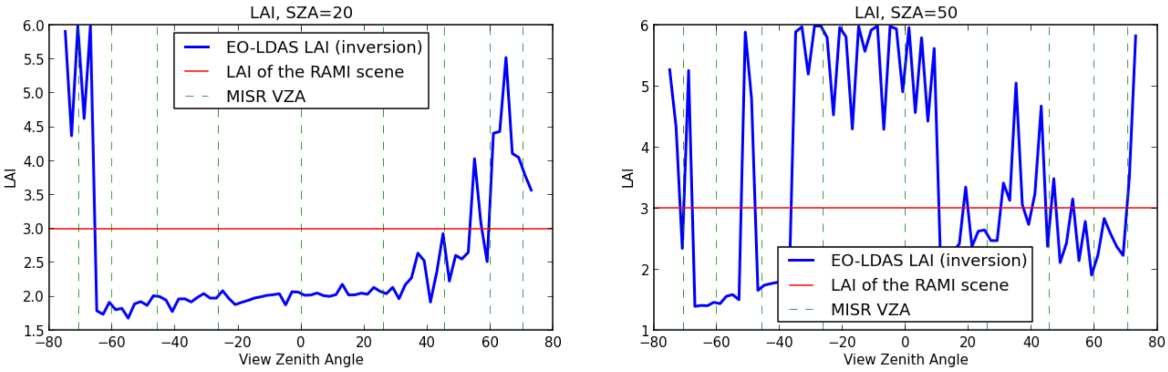
##### RAMI BRF

In [101]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




##### Inversion

In [102]:
```
plt.subplot(1,2,1)
plt.title('LAI, SZA=20')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
f_param = out_dir + 'brfpp_ROMCREF-HOM03_DIS_ERE_50_'
plt.subplot(1,2,2)
plt.title('LAI, SZA=50')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
subplots_adjust(right=2, wspace=0.2)
```



### RAMI Forest

PRIOR DATA:
exp. transform: xlai = 0.45, sd = 0.5; inv. transform: xlai = 1.6 - LAI
xhc = 20, sd = 20 - Height
rpl = 0.05, sd = 0.1 - leaf radius/dimensios (I suppose it is the same as Scatterer Radius in RAMI)
exp. transform: xkab = 0.5, sd = 0.5; inv. tranform: xkab = 70 $[\mu g cm^{-2}]$ - $C_{ab}$ concentration
scen = 0.5, sd = 0.5 - the proportion of senescent material (fractional, between 0 and 1)
exp. transform: xkw = 0.5, sd = 0.5 - equivalent leaf water
exp. transform: xkm = 0.5, sd = 0.5 - dry matter
xleafn = 1.5, sd = 1.5 - the number of leaf layers
xs1 = 2.0, sd = 2 - Soil PC1 - soil brightness
xs2 = 2.5, sd = 2.5 - Soil wetness
lad = 5, sd = 5 - Leaf angle distribution

### Conifer forests: NO TOPOGRAPHY - HET06_STO_UNI

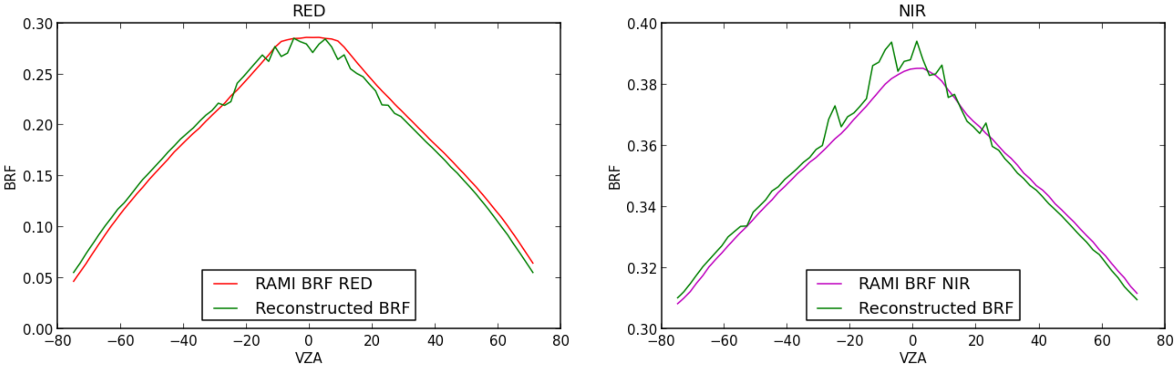
#### BRF in the cross plane - brfop

SZA: 40.0
SAA: 180.0
LAI: 2.0358 $m^2/m^2$
Height: 12.0 m
lad: Uniform (5)

In [78]:
```
true_lai = 2.0358
f_param = out_dir + 'brfop_ROMCREF-HET06_STO_UNI_40_'
f_red = '/media/sf_JRC/RAMI/HET06_STO/brfop_ROMCREF-HET06_STO_UNI_RED_40.mes'
f_nir = '/media/sf_JRC/RAMI/HET06_STO/brfop_ROMCREF-HET06_STO_UNI_NIR_40.mes'
```

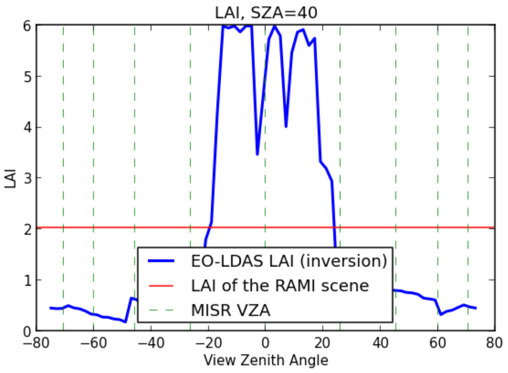
##### RAMI BRF

In [79]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```



##### Results of the Inversion

In [80]:
```
plt.title('LAI, SZA=40')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
```

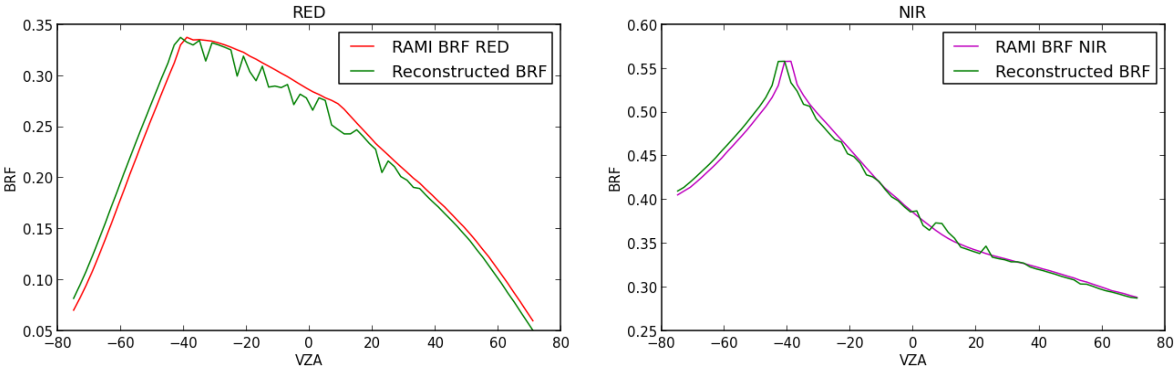


#### BRF in the principal plane - brfpp

In [81]:
```
f_param = out_dir + 'brfpp_ROMCREF-HET06_STO_UNI_40_'
f_red = '/media/sf_JRC/RAMI/HET06_STO/brfpp_ROMCREF-HET06_STO_UNI_RED_40.mes'
f_nir = '/media/sf_JRC/RAMI/HET06_STO/brfpp_ROMCREF-HET06_STO_UNI_NIR_40.mes'
```

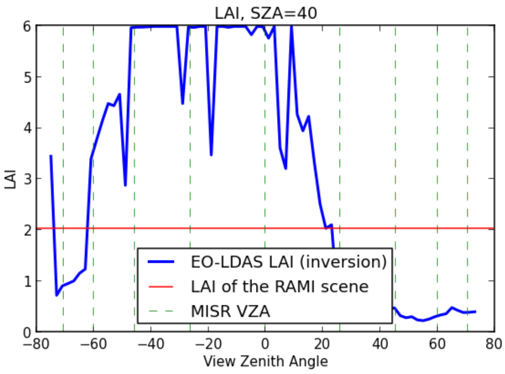
##### RAMI BRF

In [82]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




**Inversion**

In [83]:
```
plt.title('LAI, SZA=40')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
```



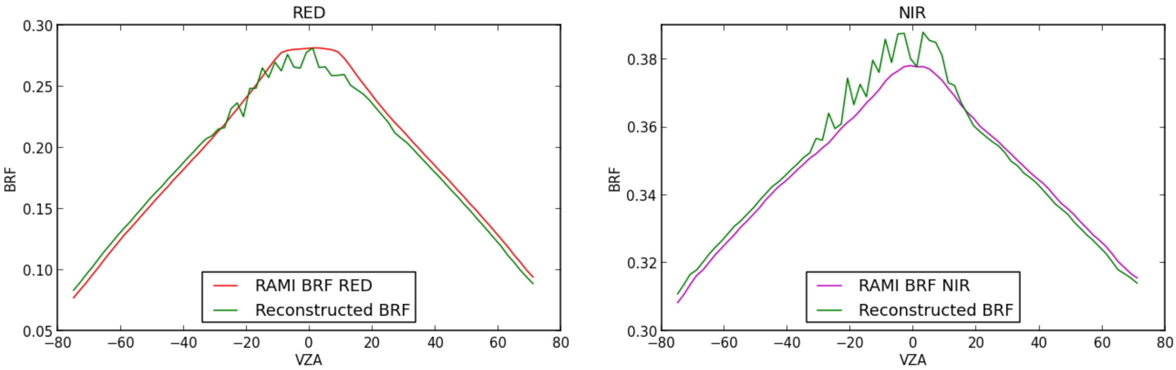

### Conifer forests: TOPOGRAPHY - HET03_STO

**BRF in the cross plane - brfop**

In [84]:
```
true_lai = 2.0358
f_param = out_dir + 'brfop_ROMCREF-HET03_STO_UNI_40_'
f_red = '/media/sf_JRC/RAMI/HET03_STO/brfop_ROMCREF-HET03_STO_UNI_RED_40.mes'
f_nir = '/media/sf_JRC/RAMI/HET03_STO/brfop_ROMCREF-HET03_STO_UNI_NIR_40.mes'
```

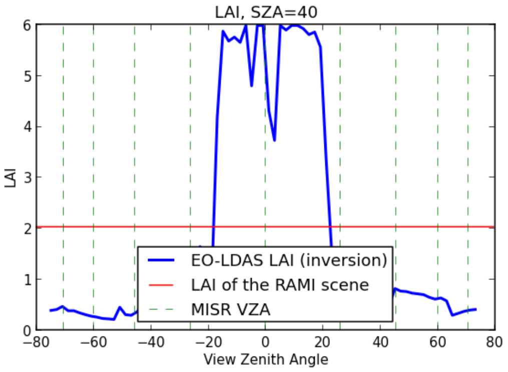
**RAMI BRF**

In [85]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




**Inversion**

In [86]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plt.title('LAI, SZA=40')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
```

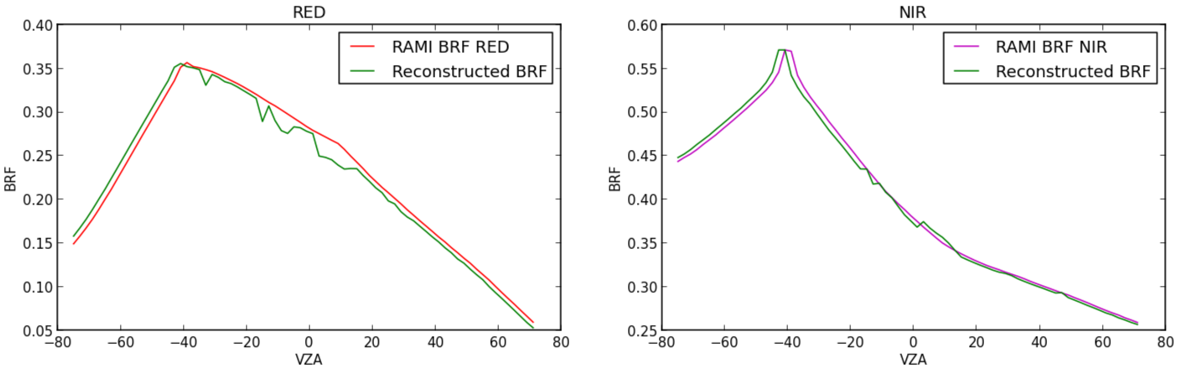



**BRF in the principal plane - brfpp**

In [87]:
```
f_param = out_dir + 'brfpp_ROMCREF-HET03_STO_UNI_40_'
f_red = '/media/sf_JRC/RAMI/HET03_STO/brfpp_ROMCREF-HET03_STO_UNI_RED_40.mes'
f_nir = '/media/sf_JRC/RAMI/HET03_STO/brfpp_ROMCREF-HET03_STO_UNI_NIR_40.mes'
```

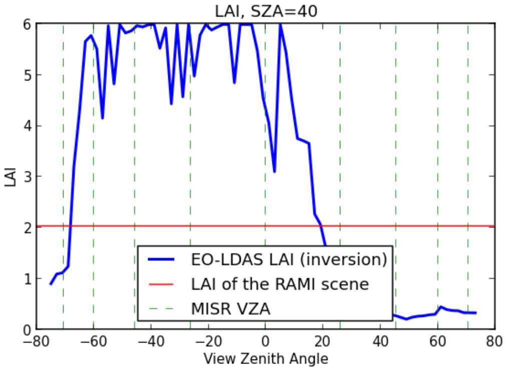
**RAMI BRF**

In [88]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




**Inversion**

In [89]:
```
plt.title('LAI, SZA=40')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
```




## Birch stand - HET05_STO_UNI

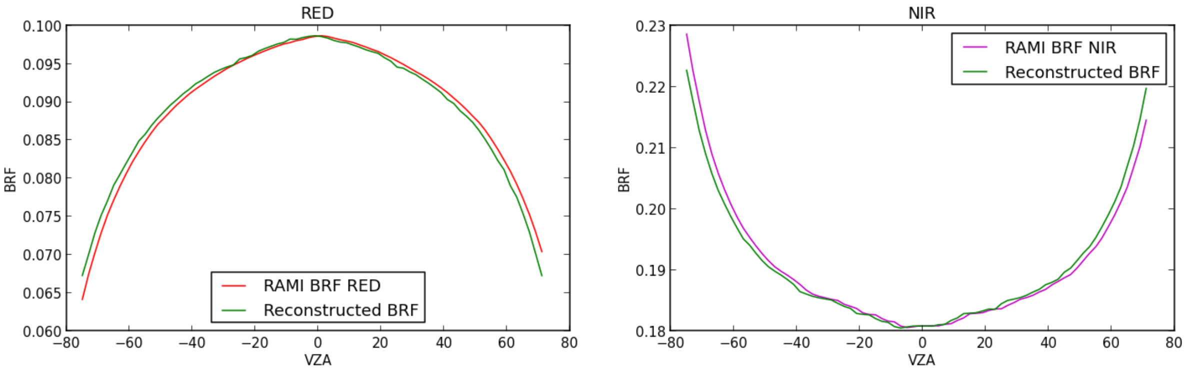
SZA: 20.0, 50.0
SAA: 180.0
LAI: 0.388 $m^2/m^2$
Height: 8.007 m
lad: Uniform (5)

#### Cross plane

In [90]:
```
true_lai = 0.388
f_param = out_dir + 'brfop_ROMCREF-HET05_STO_UNI_20_'
f_red = '/media/sf_JRC/RAMI/HET05_STO_UNI/brfop_ROMCREF-HET05_STO_UNI_RED_20.mes'
f_nir = '/media/sf_JRC/RAMI/HET05_STO_UNI/brfop_ROMCREF-HET05_STO_UNI_NIR_20.mes'
```

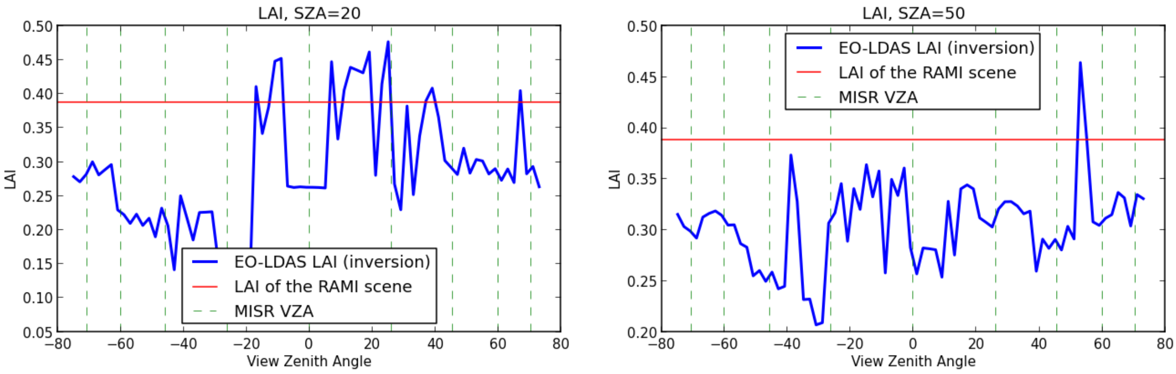
##### RAMI BRF

In [91]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




##### Inversion

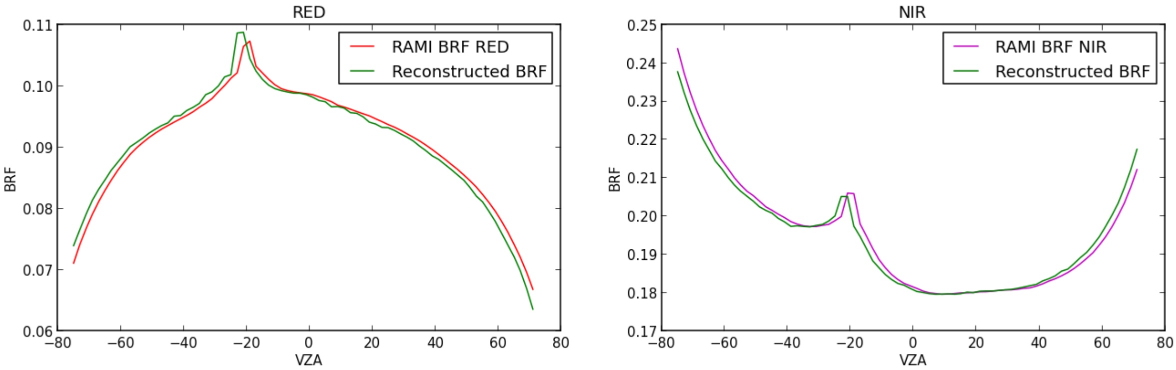
In [92]:
```
plt.subplot(1,2,1)
plt.title('LAI, SZA=20')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
f_param = out_dir + 'brfop_ROMCREF-HET05_STO_UNI_50_.mes'
plt.subplot(1,2,2)
plt.title('LAI, SZA=50')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
subplots_adjust(right=2, wspace=0.2)
```




In [93]:
```
f_param = out_dir + 'brfpp_ROMCREF-HET05_STO_UNI_20_'
f_red = '/media/sf_JRC/RAMI/HET05_STO_UNI/brfpp_ROMCREF-HET05_STO_UNI_RED_20.mes'
f_nir = '/media/sf_JRC/RAMI/HET05_STO_UNI/brfpp_ROMCREF-HET05_STO_UNI_NIR_20.mes'
```

##### RAMI BRF

In [94]:
```
fwd_red,fwd_nir = read_fwd(f_param)
plot_rami_data(f_red, f_nir, fwd_red, fwd_nir)
subplots_adjust(right=2, wspace=0.2)
```




**Inversion**

In [95]:
```
plt.subplot(1,2,1)
plt.title('LAI, SZA=20')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
f_param = out_dir + 'brfpp_ROMCREF-HET05_STO_UNI_50_.mes'
plt.subplot(1,2,2)
plt.title('LAI, SZA=50')
plot_rami_inv(f_param, f_red, f_nir, true_lai)
subplots_adjust(right=2, wspace=0.2)
```