Visualization

In [27]:
```
import pandas as pd
import numpy as np

df_par = pd.read_csv('par_means_new.csv')
df_par.sample(5)
```

Out[27]:

	Lat	Long	Year	par_10	par_11	par_12	par_01	par_02	
28088	85.130000	-150.100000	2009	NaN	NaN	NaN	NaN	NaN	
6107	15.000000	-107.000000	2008	41.386192	42.098250	40.334015	43.171787	47.998158	5
16220	42.241817	-19.196100	2002	21.938272	15.629298	10.025449	12.675606	28.845797	3
27879	74.633333	-137.333333	2005	NaN	NaN	NaN	NaN	NaN	
4502	15.000000	-107.000000	2005	45.956856	40.589333	40.509533	42.376183	51.080853	5

In [28]:
```
month_name = ["01","02","03","04","05","06","07","08","09","10","11","
for month in month_name:
    unique_values = df_par['par_' + month].unique()
    print(f"Unique values in par_{month}: {unique_values}")
df_par['yearly_mean_par'] = df_par[['par_' + month for month in month_
```

```
 51.567062  53.708042  53.327827  54.226574  53.59164   47.511395
 50.093864  51.85216   31.583729  40.90161   37.836063  44.135967
 41.78932   42.518837  52.02734   49.289467  50.392887  49.907856
 32.857433  20.143078  20.034723  27.86753   53.092064  39.044838
 49.939194  19.932821  26.957998  23.605417  30.957998  44.694775
 53.272953  51.128387  39.146996  53.552742  50.299107  55.219322
 45.713627  51.555946  52.89895   51.15687   56.57374   55.42224
 56.432724  51.01598   52.88318   52.839046  55.584694  43.219967
 45.063595  40.09132   36.43166   35.96105   36.107918  45.814014
 38.426754  41.043354  54.217632  51.970367  54.550514  53.397438
 55.760807  55.106144  53.420643  48.13208   51.989414  35.723934
 40.688656  44.89527   49.995285  50.54024   50.662193  53.988903
 51.56267   50.872787  48.80582   34.003     22.67419   22.092127
 26.942642  54.94108   41.73444   51.080032  19.847578  24.246418
 27.55511   29.656206  48.990818  54.474174  54.854824  44.66856
 56.491467  52.247066  55.29024   54.398582  54.932888  48.236774
 48.128807  53.311676  51.188145  54.63058   54.5079    53.21232
 52.26937   55.44821   43.005356  41.134293  42.390804  38.153095
 36.542965  44.629852  43.953903  39.02319   38.3418    55.639786
 54.828354  56.18308   56.03029   56.537354  56.368126  49.990517
```

In [29]:
```
df_par.sample(5)
```

Out[29]:

	Lat	Long	Year	par_10	par_11	par_12	par_01	par_02
12475	45.000000	145.000000	2020	24.651644	11.447199	8.398288	10.375013	14.317164
7501	-14.000000	-99.000000	2010	51.274548	53.683830	54.715740	56.872307	50.366820
25549	-45.700000	153.500000	2010	38.892254	46.032433	50.800804	51.319115	26.229498
12755	-30.000000	165.000000	2020	48.181713	56.220630	59.685577	61.994820	49.104362
609	24.283333	-114.983333	1998	40.360960	33.517483	28.484533	30.729593	44.247433

In [30]:
```
for col in df_par.columns:
    if 'par' in col:
        print(f"Correlation between 'Cr_nmol/kg' and '{col}': {df_par[
```

```
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_10': 0.026160223866698914
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_11': 0.042474854075537985
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_12': 0.07433330514367914
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_01': 0.06194890043641667
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_02': -0.07417956865861323
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_04': -0.1621215179291404
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
```

```
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_05': -0.1770778297501502
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_06': -0.18054341065607285
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_07': -0.17337811856110918
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_08': -0.14208968382267473
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_09': -0.06385273006181
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'par_03': -0.10938615471446997
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2
(Intel(R) SSE4.2) enabled only processors has been deprecated. Intel
oneAPI Math Kernel Library 2025.0 will require Intel(R) Advanced Vect
or Extensions (Intel(R) AVX) instructions.
Correlation between 'Cr_nmol/kg' and 'yearly_mean_par': -0.0774839459
6546491
```

In [31]:
```
import seaborn as sns
import matplotlib.pyplot as plt

par_cols = ['yearly_mean_par']

for col in par_cols:
    plt.figure(figsize=(8, 6))
    sns.scatterplot(data=df_par, x=col, y='Cr_nmol/kg', hue='Ocean')
    plt.title(f'Relationship between Cr_nmol/kg and {col}')
    plt.show()
```