```python
In [1]:  import sys
         print(sys.executable)
```

```
/bin/python3
```

```python
In [2]:  import pandas as pd
         import numpy as np
         import matplotlib.pyplot as plt
         from pathlib import Path

         # On est dans notebooks/, donc on remonte d'un niveau
         base = Path("..")
         data_dir = base / "data" / "part1_seirs_ode"

         files = {
             "python_euler": data_dir / "python_euler.csv",
             "python_rk4":   data_dir / "python_rk4.csv",
             "c_euler":      data_dir / "c_euler.csv",
             "c_rk4":        data_dir / "c_rk4.csv",
         }

         files
```

```
Out[2]:  {'python_euler': PosixPath('../data/part1_seirs_ode/python_euler.csv'),
          'python_rk4': PosixPath('../data/part1_seirs_ode/python_rk4.csv'),
          'c_euler': PosixPath('../data/part1_seirs_ode/c_euler.csv'),
          'c_rk4': PosixPath('../data/part1_seirs_ode/c_rk4.csv')}
```

```python
In [3]:  dfs = {name: pd.read_csv(path) for name, path in files.items()}
         {n: df.shape for n, df in dfs.items()}
```

```
Out[3]:  {'python_euler': (731, 5),
          'python_rk4': (731, 5),
          'c_euler': (731, 5),
          'c_rk4': (731, 5)}
```

```python
In [4]:  t_ref = dfs["python_euler"]["t"].to_numpy()

         for name, df in dfs.items():
             print(name, np.allclose(t_ref, df["t"].to_numpy()))
```

```
python_euler True
python_rk4 True
c_euler True
c_rk4 True
```
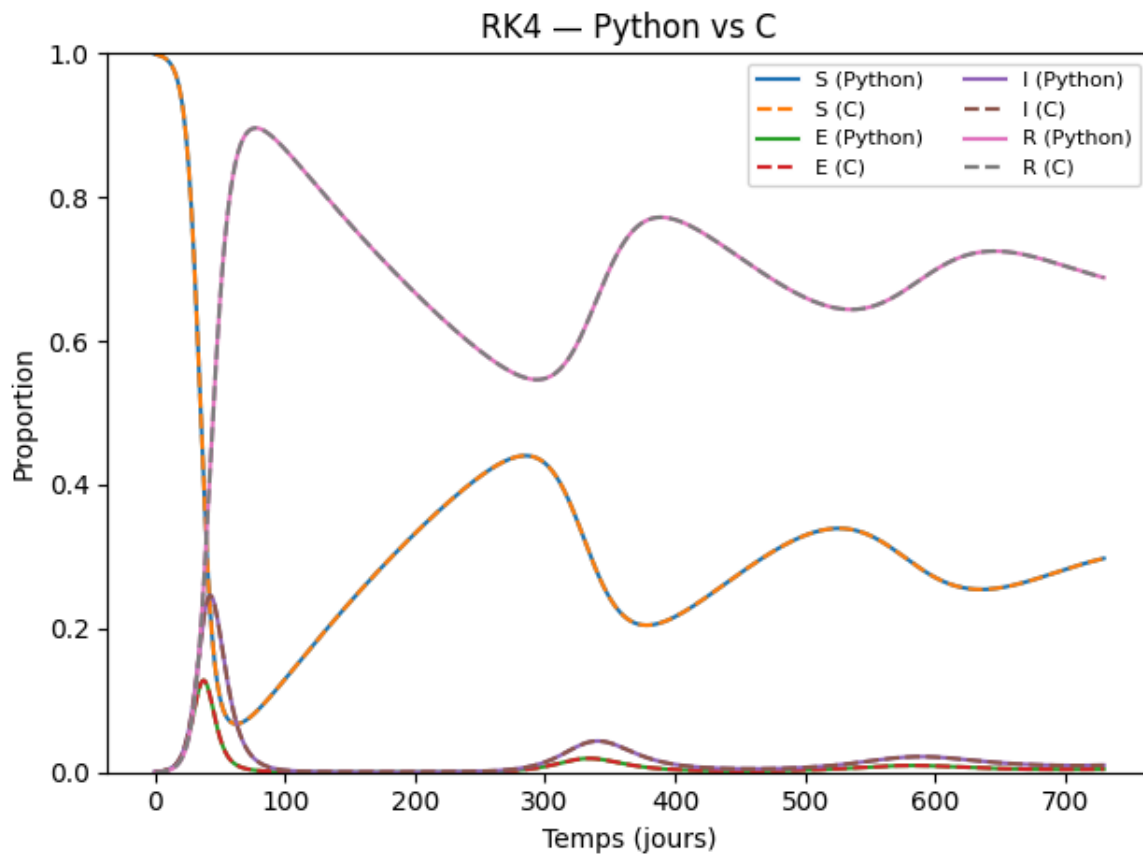
```python
In [6]:  def plot_seirs(df1, df2, title, label1, label2):
             t = df1["t"].to_numpy()

             plt.figure()
             for comp in ["S", "E", "I", "R"]:
                 plt.plot(t, df1[comp], label=f"{comp} ({label1})")
                 plt.plot(t, df2[comp], "--", label=f"{comp} ({label2})")
             plt.xlabel("Temps (jours)")
             plt.ylabel("Proportion")
             plt.ylim(0, 1)
             plt.title(title)
             plt.legend(ncol=2, fontsize=8)
```
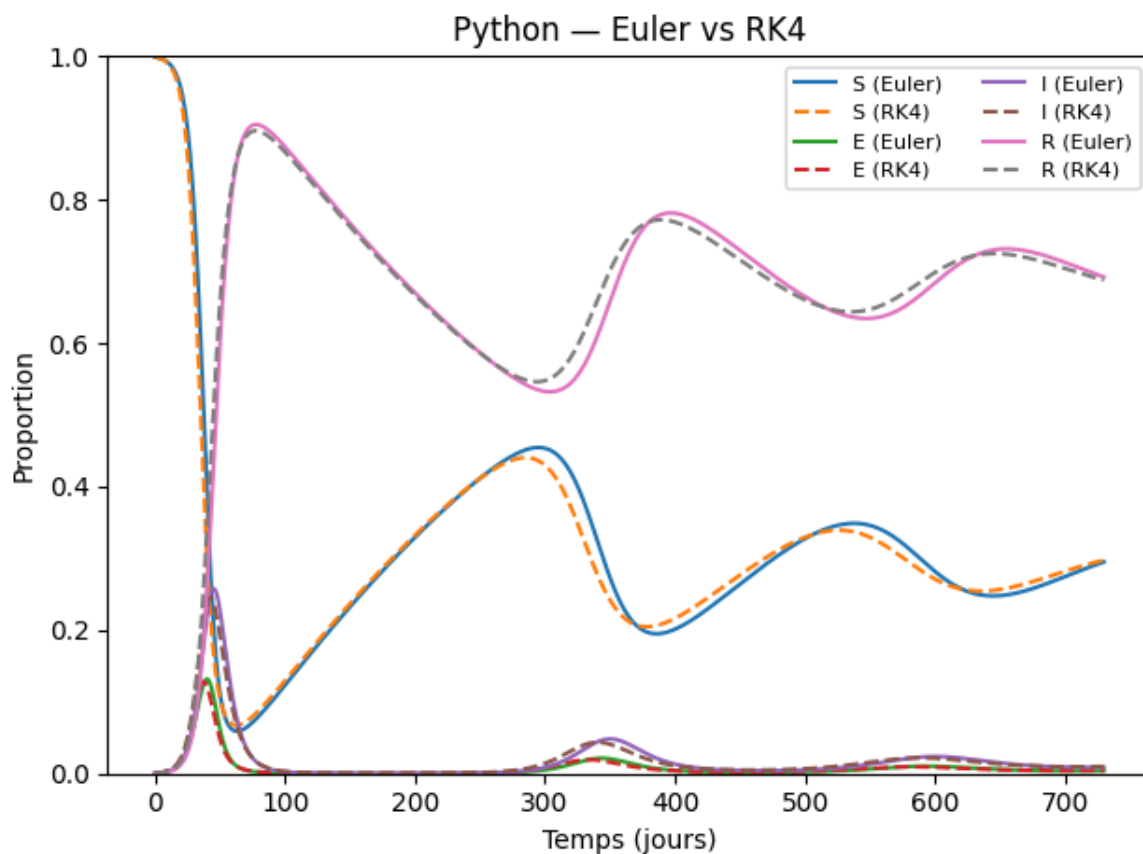
```
        plt.tight_layout()
        plt.show()
```

In [7]:
```
plot_seirs(dfs["python_euler"], dfs["c_euler"],
           "Euler — Python vs C", "Python", "C")

plot_seirs(dfs["python_rk4"], dfs["c_rk4"],
           "RK4 — Python vs C", "Python", "C")
```
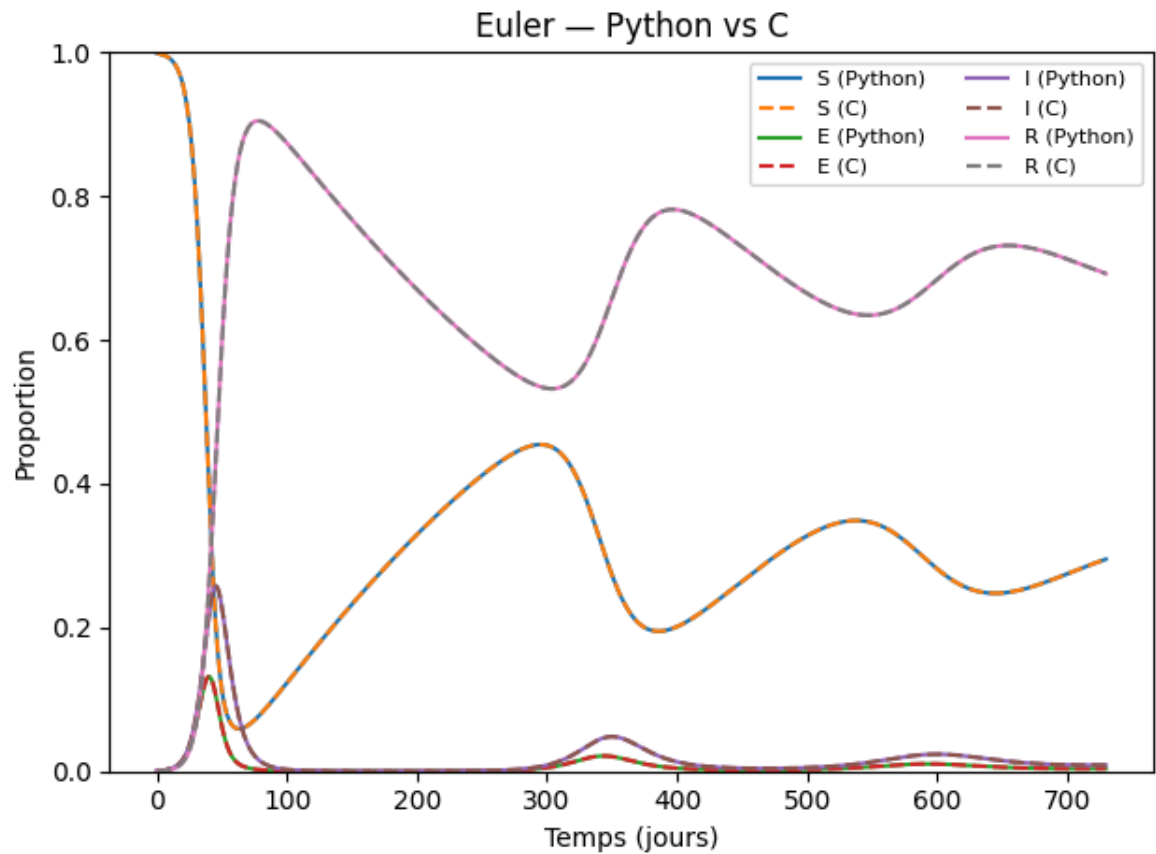
RK4 — Python vs C
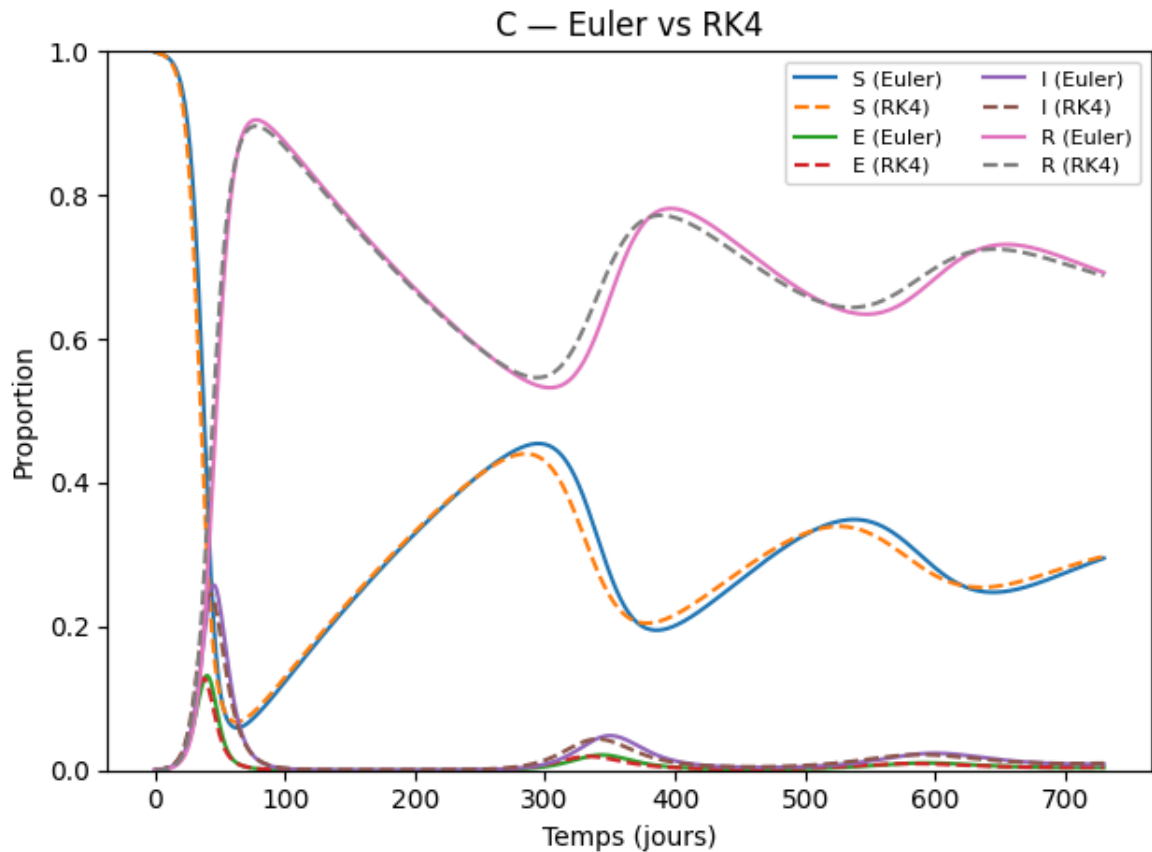


```
In [8]: plot_seirs(dfs["python_euler"], dfs["python_rk4"],
                    "Python — Euler vs RK4", "Euler", "RK4")

        plot_seirs(dfs["c_euler"], dfs["c_rk4"],
                    "C — Euler vs RK4", "Euler", "RK4")
```

Python — Euler vs RK4

C — Euler vs RK4


```python
In [12]:  from pathlib import Path
          import matplotlib.pyplot as plt

          out = Path("..") / "figures" / "part1"
          out.mkdir(parents=True, exist_ok=True)

          def save_compare_methods(df1, df2, title, l1, l2, filename):
              t = df1["t"].to_numpy()
              plt.figure(figsize=(7,5))
              for comp in ["S", "E", "I", "R"]:
                  plt.plot(t, df1[comp], label=f"{comp} ({l1})")
                  plt.plot(t, df2[comp], "--", label=f"{comp} ({l2})")
              plt.xlabel("Temps (jours)")
              plt.ylabel("Proportion")
              plt.ylim(0, 1)
              plt.title(title)
              plt.legend(ncol=2, fontsize=8)
              plt.tight_layout()
              plt.savefig(out / filename, dpi=180)
              plt.close()

          # Python : Euler vs RK4
          save_compare_methods(
              dfs["python_euler"],
              dfs["python_rk4"],
              "Python — Euler vs RK4",
              "Euler",
              "RK4",
              "compare_methods_python.png"
          )

          # C : Euler vs RK4
          save_compare_methods(
```

```
            dfs["c_euler"],
            dfs["c_rk4"],
            "C — Euler vs RK4",
            "Euler",
            "RK4",
            "compare_methods_c.png"
        )

        list(out.iterdir())
```

Out[12]: [PosixPath('../figures/part1/compare_methods_c.png'),
           PosixPath('../figures/part1/python_rk4.png'),
           PosixPath('../figures/part1/compare_methods_python.png'),
           PosixPath('../figures/part1/compare_lang_rk4.png'),
           PosixPath('../figures/part1/python_euler.png'),
           PosixPath('../figures/part1/compare_lang_euler.png')]

In [9]:
```python
def max_abs_diff(a, b, comp):
    return np.max(np.abs(a[comp].to_numpy() - b[comp].to_numpy()))

for method in ["euler", "rk4"]:
    print(f"\nDifférences Python vs C ({method.upper()})")
    for comp in ["S", "E", "I", "R"]:
        d = max_abs_diff(dfs[f"python_{method}"], dfs[f"c_{method}"], com
        print(f"{comp} : {d:.3e}")
```

```
Différences Python vs C (EULER)
S : 4.987e-13
E : 4.995e-13
I : 4.999e-13
R : 4.996e-13

Différences Python vs C (RK4)
S : 4.990e-13
E : 4.998e-13
I : 4.985e-13
R : 4.994e-13
```

In [10]:
```python
def peak_I(df):
    idx = np.argmax(df["I"].to_numpy())
    return df["I"].iloc[idx], df["t"].iloc[idx]

for name, df in dfs.items():
    h, day = peak_I(df)
    print(f"{name:12s} → pic I = {h:.6f} au jour {day:.0f}")
```

```
python_euler → pic I = 0.257911 au jour 45
python_rk4   → pic I = 0.245657 au jour 43
c_euler      → pic I = 0.257911 au jour 45
c_rk4        → pic I = 0.245657 au jour 43
```

In [11]:
```python
out = base / "figures" / "part1"
out.mkdir(exist_ok=True)

def save_plot(df1, df2, title, l1, l2, fname):
    t = df1["t"]
    plt.figure()
    for comp in ["S", "E", "I", "R"]:
        plt.plot(t, df1[comp], label=f"{comp} ({l1})")
        plt.plot(t, df2[comp], "--", label=f"{comp} ({l2})")
    plt.xlabel("Temps (jours)")
```

```python
    plt.ylabel("Proportion")
    plt.ylim(0, 1)
    plt.title(title)
    plt.legend(ncol=2, fontsize=8)
    plt.tight_layout()
    plt.savefig(out / fname, dpi=180)
    plt.close()

save_plot(dfs["python_euler"], dfs["c_euler"],
          "Euler — Python vs C", "Python", "C", "compare_lang_euler.png")

save_plot(dfs["python_rk4"], dfs["c_rk4"],
          "RK4 — Python vs C", "Python", "C", "compare_lang_rk4.png")
```