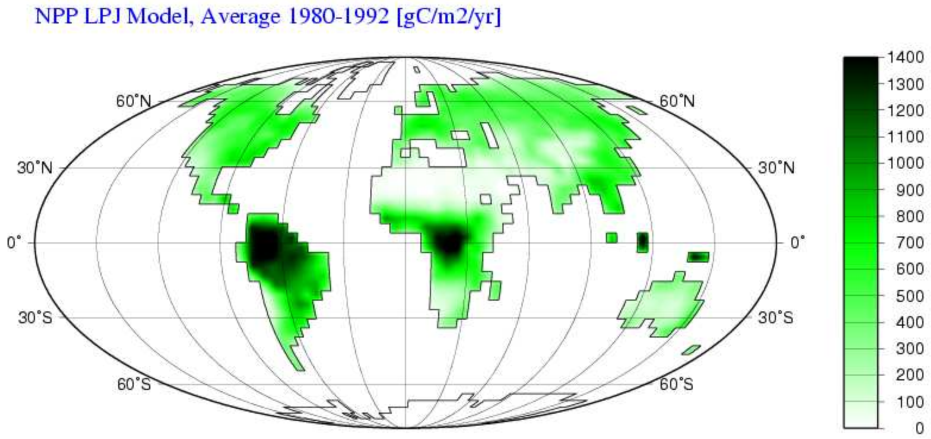

Fig. 3. Spatial pattern of $\boldsymbol{f}_{\text{sh,nee}}$ shaping those flux adjustments of the inversion that refer to the terrestrial biosphere. The exact meaning is explained in Sect. 2.2.4. The chosen pattern is proportional to an estimate of annual NPP.

Table 3. Specification of the different inversion runs. In the text, they are referred to by their respective number of sites

# of sites	Sampling sets used	Target period
11	▲	01/1982–12/2000
16	▲+◆	01/1986–12/2000
19	▲+◆+▪	01/1990–12/2000
26	▲+◆+▪+■	01/1993–12/2000
35	▲+◆+▪+■+★	01/1996–12/2000
42	▲+◆+▪+■+★+●	(inhomogeneous)

2.2.4 A-priori information

A-priori information comprises the flux model ($\boldsymbol{f}_{\text{pri}}$, $\mathbf{F}$) and the covariances of the source strength parameters ($\mathbf{Q}_{\boldsymbol{s}}$). Three processes are taken into account:

– Anthropogenic emissions from fossil fuel burning and cement manufacturing,

– net ecosystem exchange (NEE) of the terrestrial biosphere, and

– ocean-atmosphere carbon exchange.

Correspondingly, the best-guess a-priori flux has three components,

$$\boldsymbol{f}_{\text{pri}} = \boldsymbol{f}_{\text{pri,ff}} + \boldsymbol{f}_{\text{pri,nee}} + \boldsymbol{f}_{\text{pri,oc}} \tag{13}$$

the choices for which are listed in Table 4. Except for the rising fossil fuel component, $\boldsymbol{f}_{\text{pri}}$ has no year-to-year variability, in order that the interannual variability of the resulting flux estimates be dominated by that of the atmospheric concentration signal.

The deviation term of the flux model is split into independent parts referring to NEE and ocean exchange, respectively,

$$\mathbf{F}\delta\boldsymbol{s} = (\mathbf{F}_{\text{nee}}, \mathbf{F}_{\text{oc}}) \begin{pmatrix} \delta\boldsymbol{s}_{\text{nee}} \\ \delta\boldsymbol{s}_{\text{oc}} \end{pmatrix} \tag{14}$$

while any fossil-fuel correction term is omitted (see remark below). All columns of $\mathbf{F}_{\text{nee}}$, describing tracer pulses that are thought to be associated with terrestrial NEE, are set elementwise proportional to a fixed spatio-temporal pattern (shape) $\boldsymbol{f}_{\text{sh,nee}}$,

$$\mathbf{F}_{\text{nee}} = [\boldsymbol{f}_{\text{sh,nee}}]\mathbf{G}_{\text{nee}} \tag{15}$$

(the square brackets denote the diagonal matrix formed out of the argument vector). In this formulation, the spatio-temporal extents of the individual NEE pulses are determined by the columns of $\mathbf{G}_{\text{nee}}$ (values between 0 and 1 to be defined in the next paragraph), while the common fixed factor $\boldsymbol{f}_{\text{sh,nee}}$ sets both the internal structure within the areas/durations of the pulses, as well as a weighting among them (see below). Spatially, this pattern $\boldsymbol{f}_{\text{sh,nee}}$ is taken proportional to annual net primary productivity (NPP) (see Table 4), in order that the inversion preferentially adjusts fluxes in locations with high vegetation activity (as opposed, e.g. to deserts). As seen in Fig. 3, this leads to relatively high per-area uncertainties in the tropics[8]. For the tracer pulses associated with ocean exchange, the corresponding shape $\boldsymbol{f}_{\text{sh,oc}}$ is chosen spatially flat (i.e., proportional to water area in the grid cell). Temporally, both $\boldsymbol{f}_{\text{sh,nee}}$ and $\boldsymbol{f}_{\text{sh,oc}}$ are constant. To avoid errors in the land/ocean partitioning arising at coastal grid cells, NEE and ocean shapes partially overlap, such that mixed land/water pixels are proportionally assigned to both an NEE and an ocean tracer pulse.

[8]In sensitivity set-up (c), a flat NEE shape $\boldsymbol{f}_{\text{sh,nee}}$ (i.e. proportional to land area) is used.