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THE GLOBAL CO2 SUPPLY / DEMAND BALANCE

AND

THE STORAGE OF CO2 EQUIVALENTS IN THE WORLD

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CO2 was meant to be a " GROWTH GAS "

and

Nature should be stimulated to use more !

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AND

THE STORAGE OF CO2 EQUIVALENTS IN THE WORLD

This presentation focuses on the storage and flows of CO2.

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CO2 equivalent Storage Areas

CO2 stored in Atmosphere

CO2 equivalent stored in Oceans
CO2 , HCO3- , Bio-mass

CO2 equivalent stored on Land
in Bio-mass

CO2 equivalent stored in Soil as Coal , Oil , Gas , CO2

CO2 equivalent stored in Earth Crust as Limestone

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Chemical CO2 Equivalents

Ratios

	Product	Chemical CO2 equivalent
Starch / Glucose /Cellulose	1	1.63
Vegetable Oil	1	2.81
Carbon	1	3.67
Limestone	1	0.44
Methane	1	2.75

CO2 equivalents will allow calculations to be executed among different products

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CO2 equivalents stored in Gt

CO2 in Atmosphere at 380 ppm **3 400**

CO2 equivalent stored in
Oceans **140 000**
CO2 , HCO3-, Bio-mass

CO2 equivalent stored on **Land**
in Bio-mass
From 2 400 to 5 000 use **3 500**
Human 0.2

CO2 equivalent stored in **Soil** **18 000**

CO2 equivalent stored in Earth Crust as Limestone **330 000 000**

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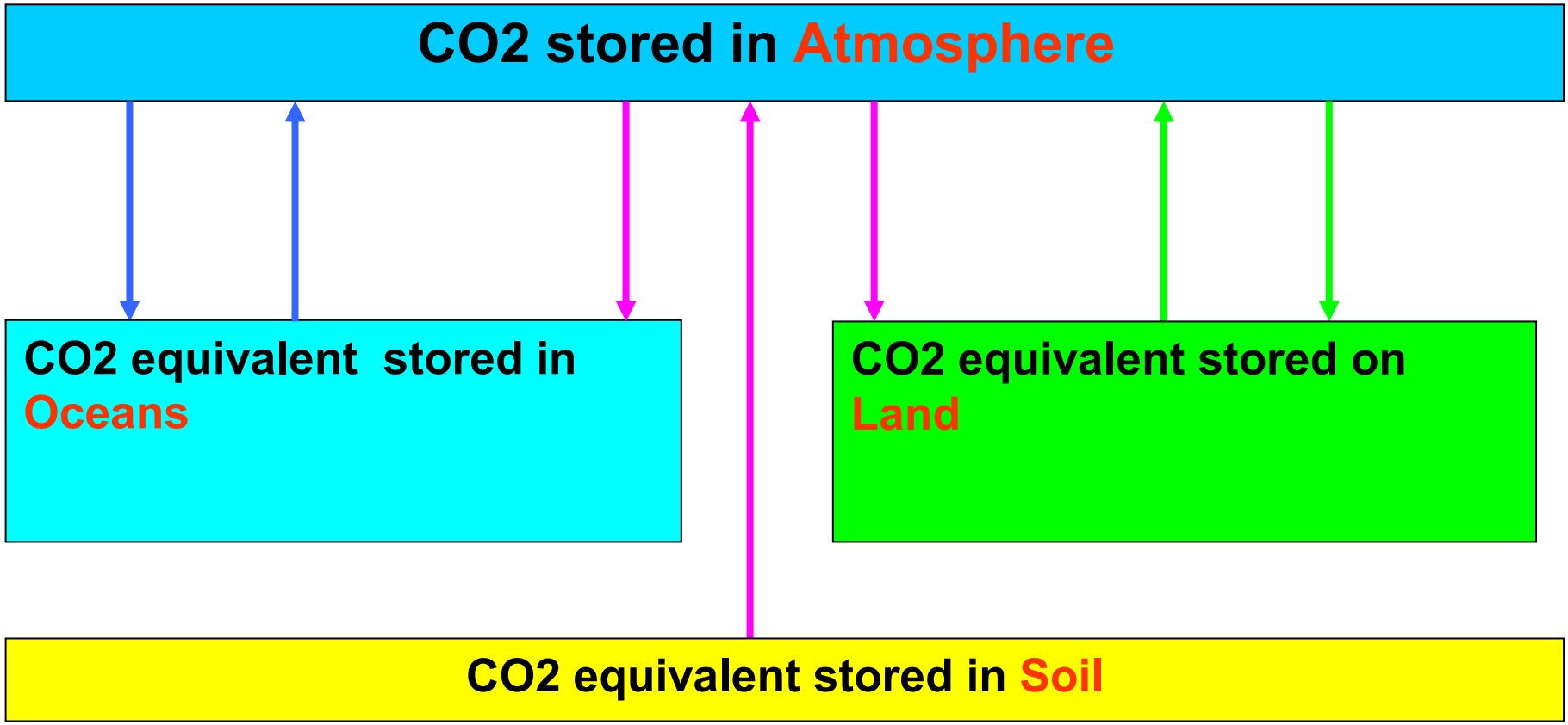
CO2 equivalent Flows between storage areas.



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Can we make some estimates about the flows of CO2 ?

Kyoto Protocol (the IPCC) :
22 Gt CO2 from fossil fuel flows into the atmosphere based on 1990 data

In 2004 CO2 fossil fuel equals 29 Gt (used in this presentation)
In 2007 CO2 fossil fuel equals 32 Gt

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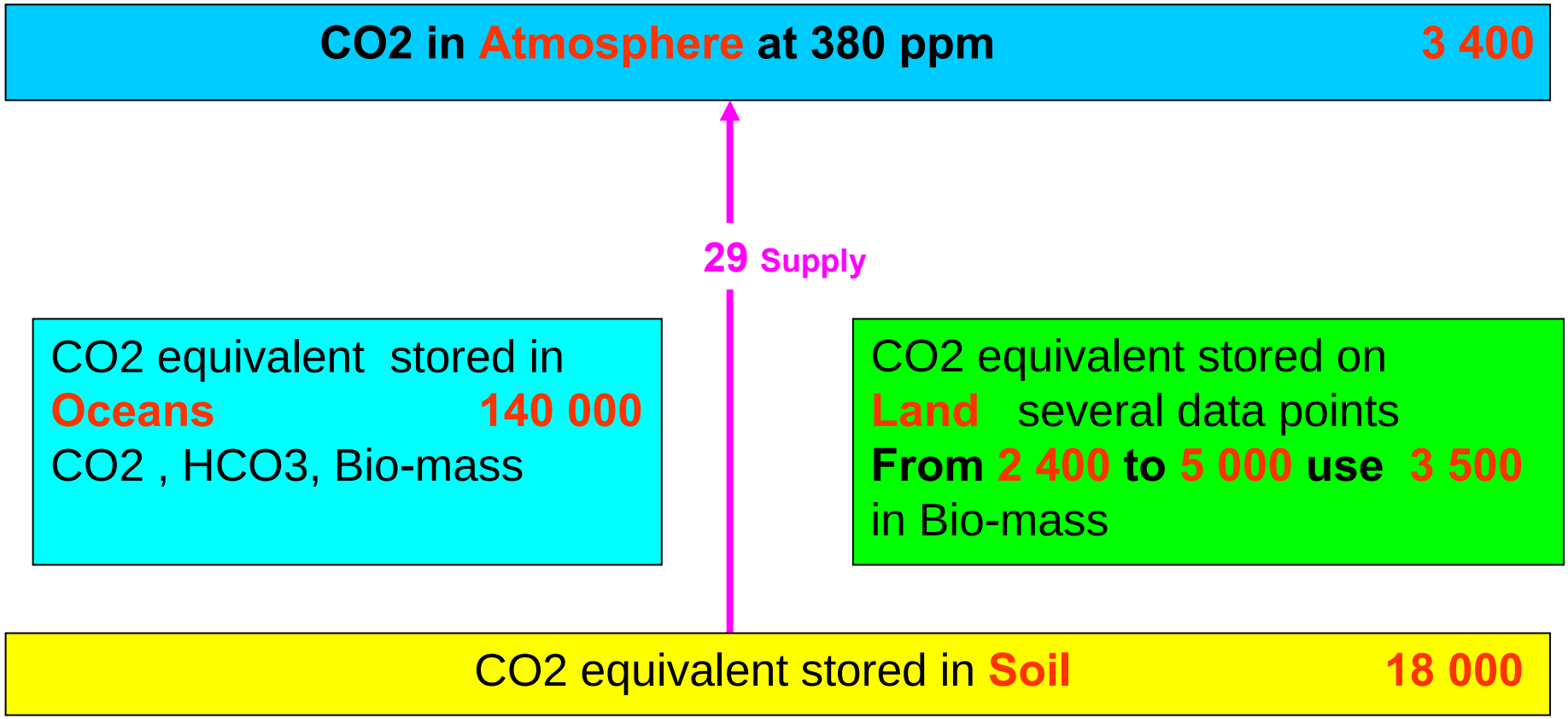
CO2 equivalent flows in Gt /Year and CO2 stored in Gt



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A part of CO2 stays in Atmosphere and a part is returned

CO2 content in the Atmosphere in 1960	**300 PPM**	**=**	**2 690 Gt**
CO2 content in the Atmosphere in 1998	**360 PPM**	**=**	**3 240 Gt**
CO2 content in the Atmosphere in 2008	**380 PPM**	**=**	**3 420 Gt**

The difference between 300 and 380 ppm = 730 Gt

Inventory increase in the Atmosphere = 15 Gt CO2 / Year (1960-2008)

The difference between 360 and 380 ppm = 180 Gt

Inventory increase in the Atmosphere = 18 Gt CO2 / Year (1998-2008)
(used in this presentation)

Return from Atmosphere (Demand by Ocean) = 11 Gt CO2 / Year (1998-2008)
(used in this presentation)

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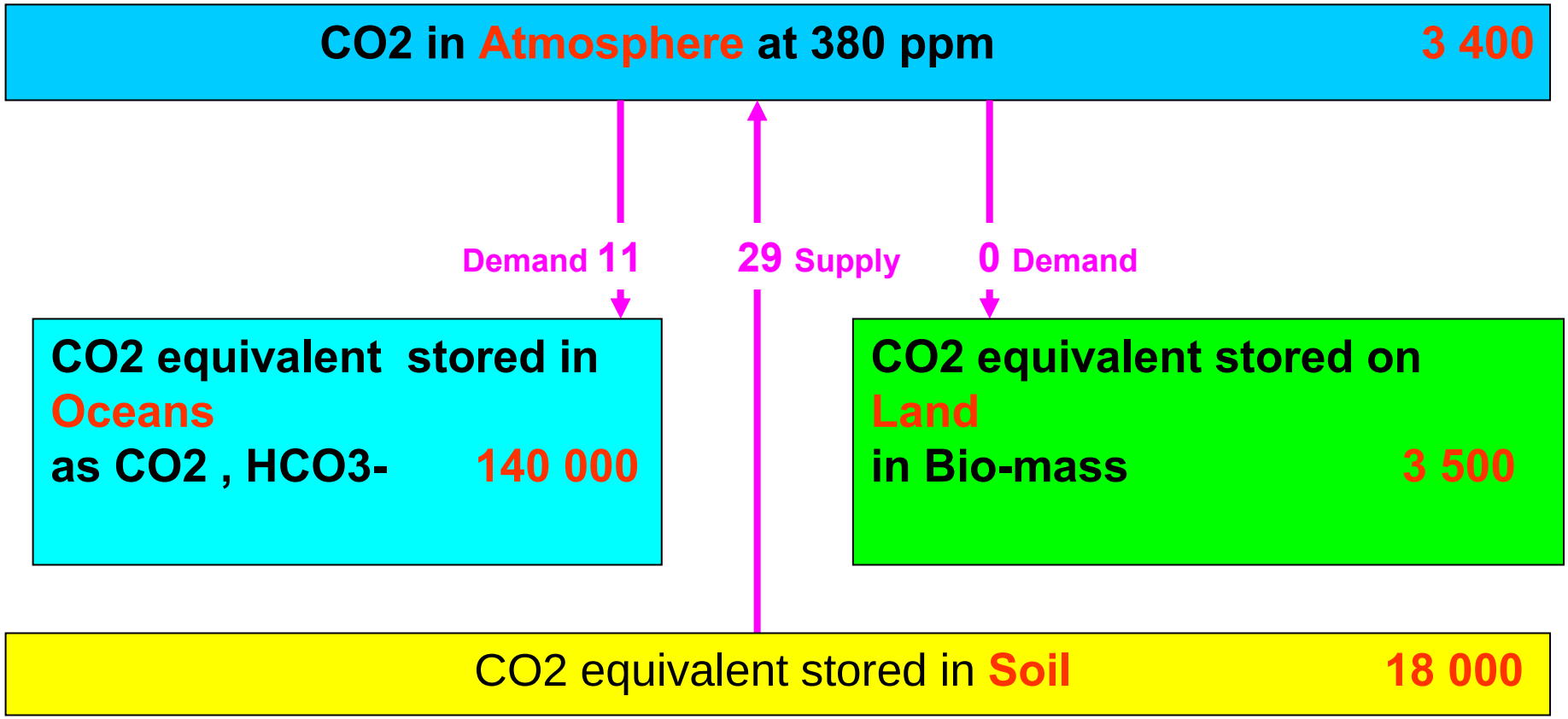
CO2 equivalent flows in Gt /Year and CO2 stored in Gt



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Some agriculture data

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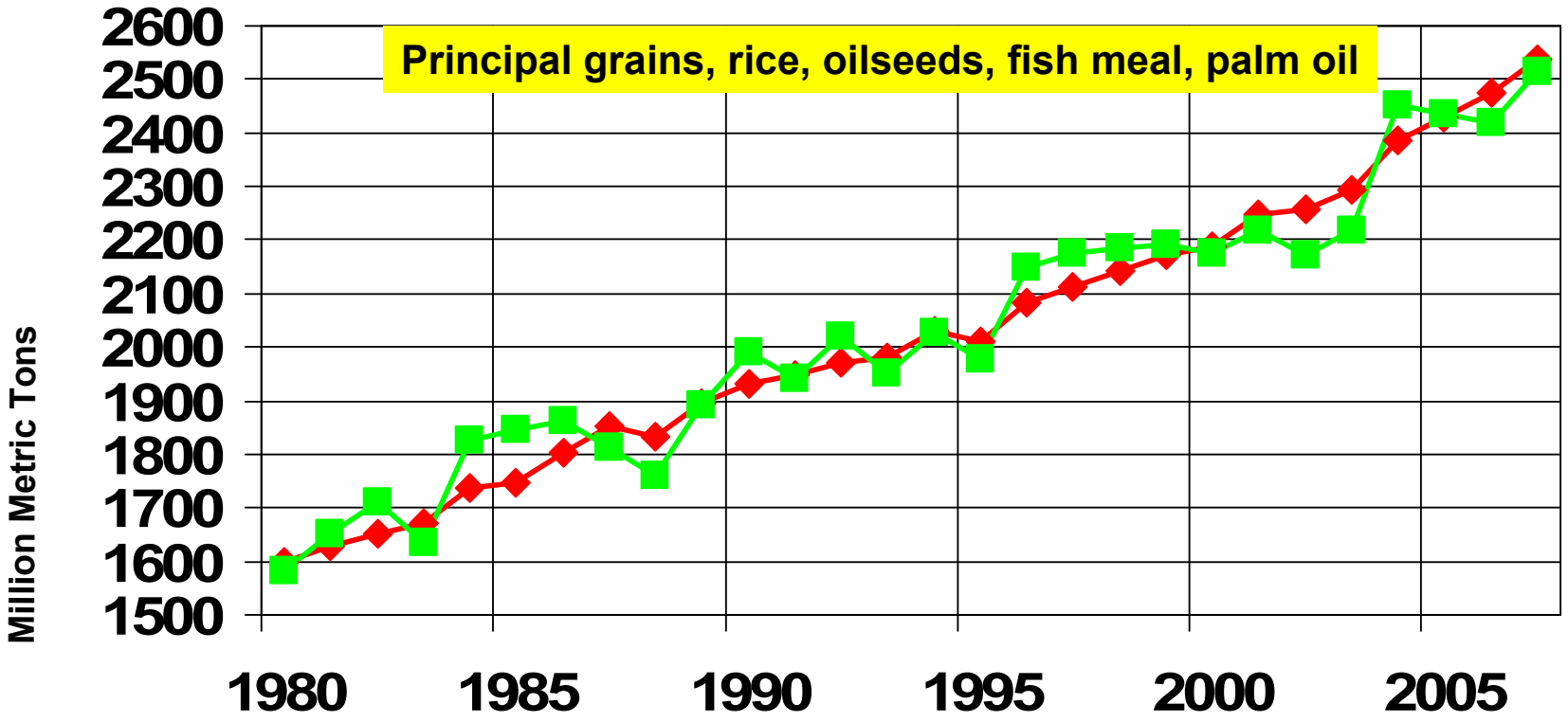
Global supply / demand of raw crop materials



The composition contains 4.8 % vegetable oil, the remainder is considered starch and cellulose. Please note that sugar cane is excluded form this chart.

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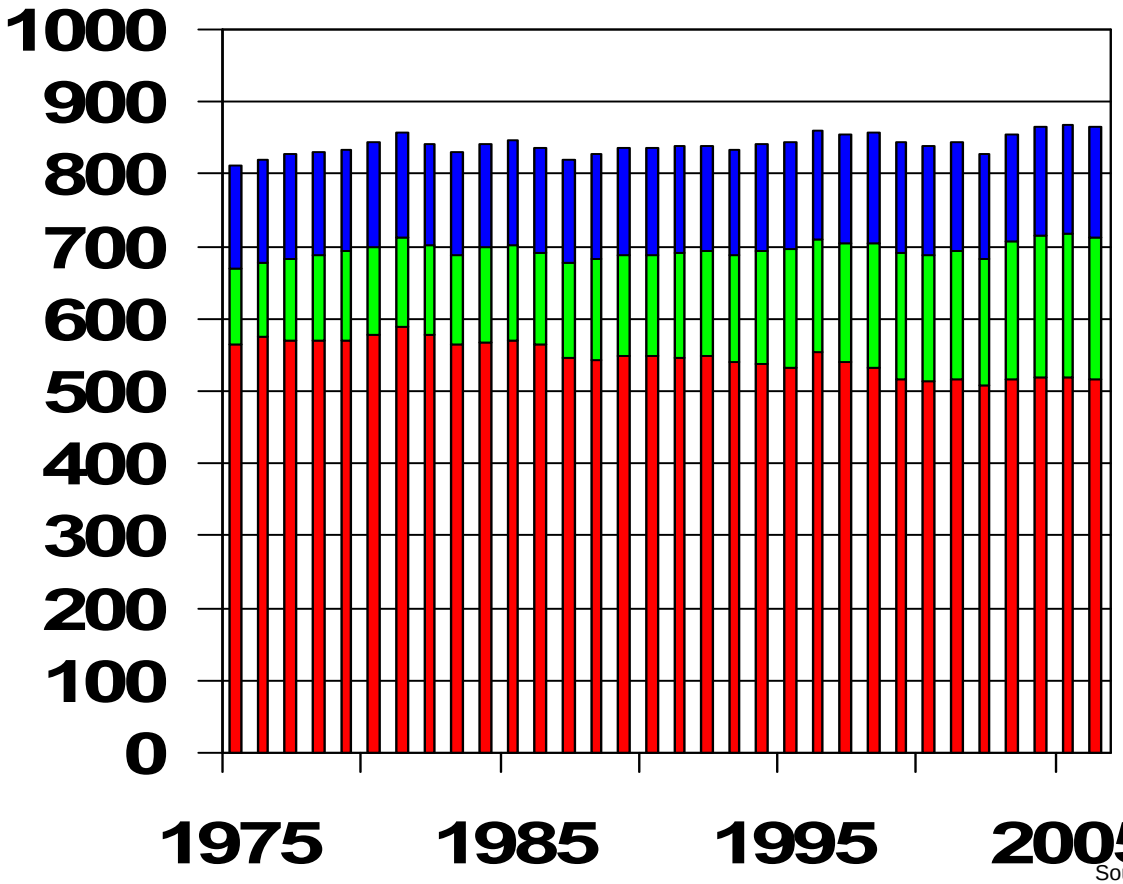
Global Crop Area - Million Hectares

Grain, Oilseeds, Rice



Global croplands holding steady for 30 years

Source: USDA, Foreign Agricultural Service

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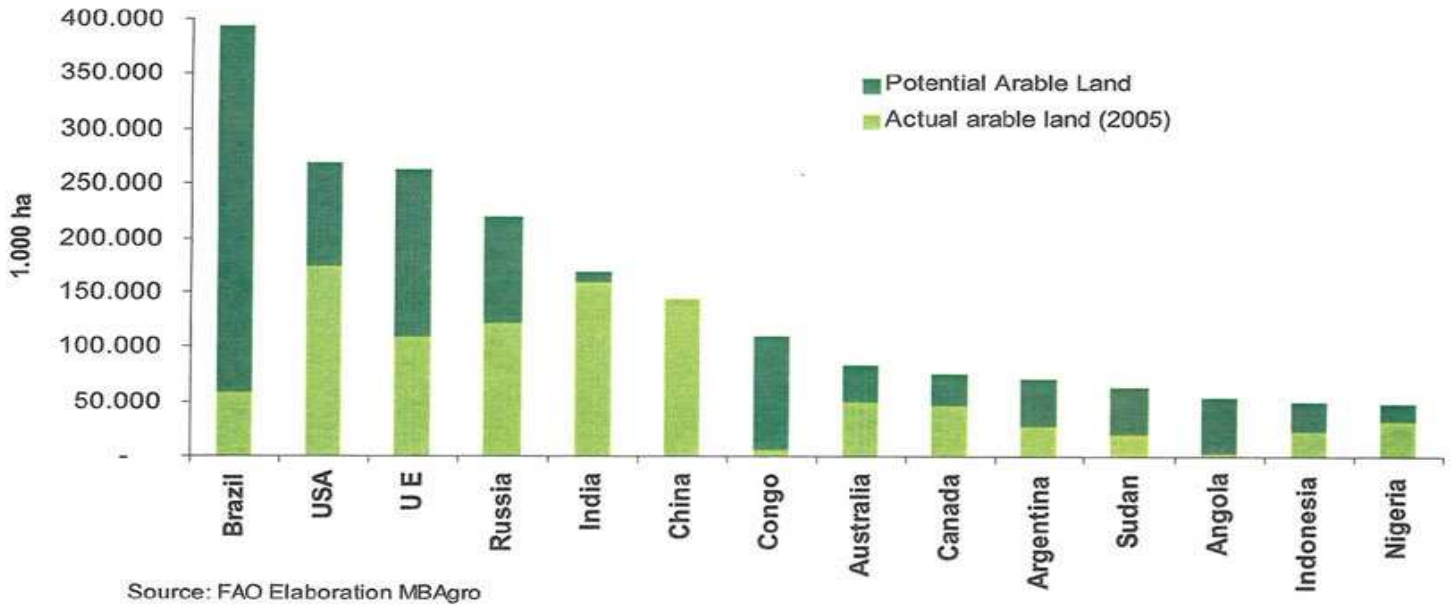
Basically no shortage of Croplands on a global basis

MBAgro

Available Land



Source: FAO Elaboration MBAgro

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CO2 consumption Raw crops

2.5 Gt / Year of Raw crops require:	**4.5 Gt CO2 / Year**
4.9 Gt / Year associated Biomass require:	**8.0 Gt CO2 / Year**
Total	**12.5 Gt CO2 / Year**

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Land Biomass MT/Hectare/Year

Biomass growth on cropland:

3.0 MT/Hectare/Year for the crop itself

5.6 MT/Hectare/Year for associated Biomass

Biomass growth estimate on non-crop land :

3.6 MT/Hectare/Year

Biomass growth estimate for desert land :

0 MT/Hectare/Year

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CO2 consumption on Land

CO2 demand for cropland	**13**	**Gt / Year**
CO2 demand for non-cropland	**88**	**Gt / Year**
CO2 demand from Atmosphere by Land	**101**	**Gt / Year**

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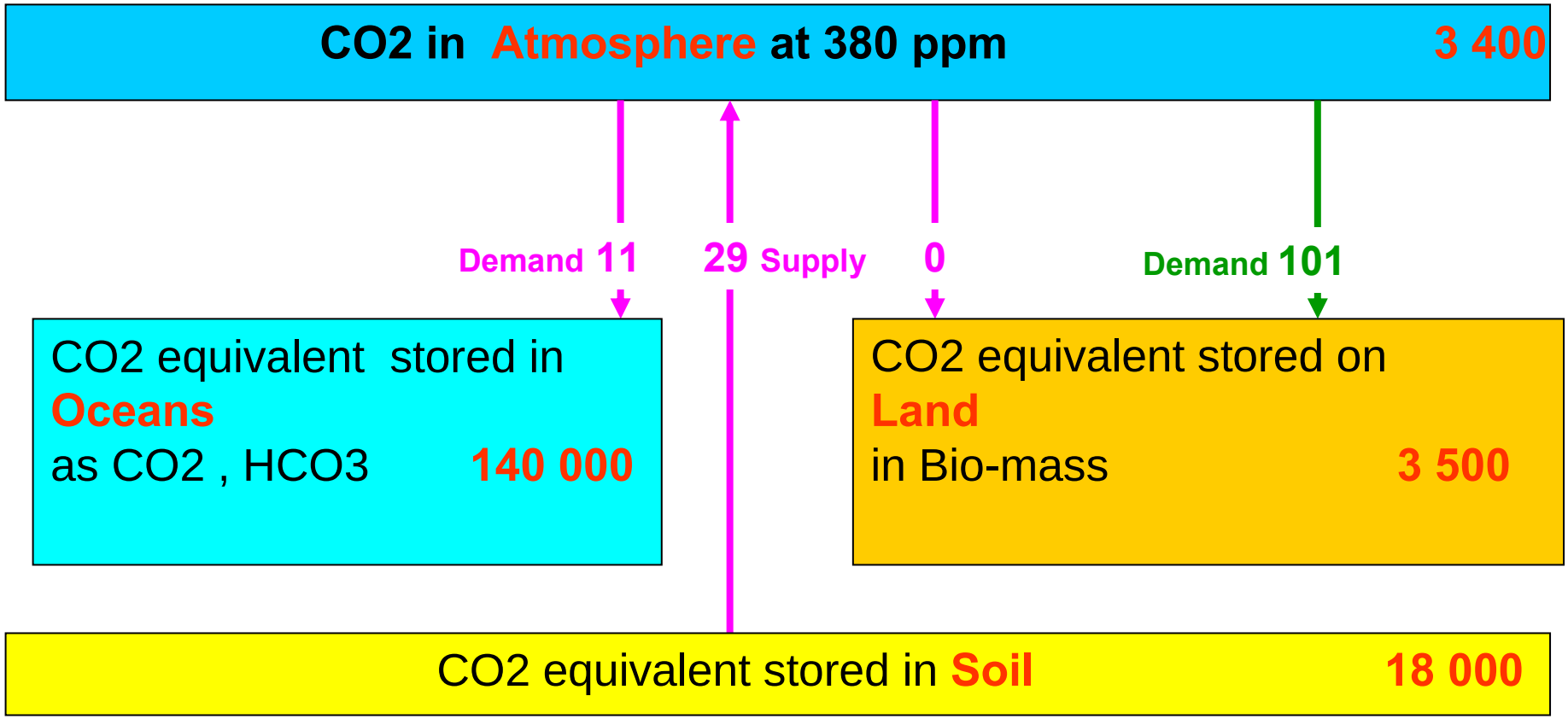
CO2 equivalent flows in Gt /Year and CO2 stored in Gt



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CO2 consumption Oceans

The Oxygen (O2) supply to the Atmosphere comes from Land and Ocean.

Estimated that 55 % of the Oxygen comes from Land and 45 % from Oceans.

O2 is only generated through photosynthesis

Therefore:

45 % of CO2 demand for photosynthesis is created by Oceans .

or

CO2 demand by Oceans for Photosynthesis = 83 Gt CO2 / Year

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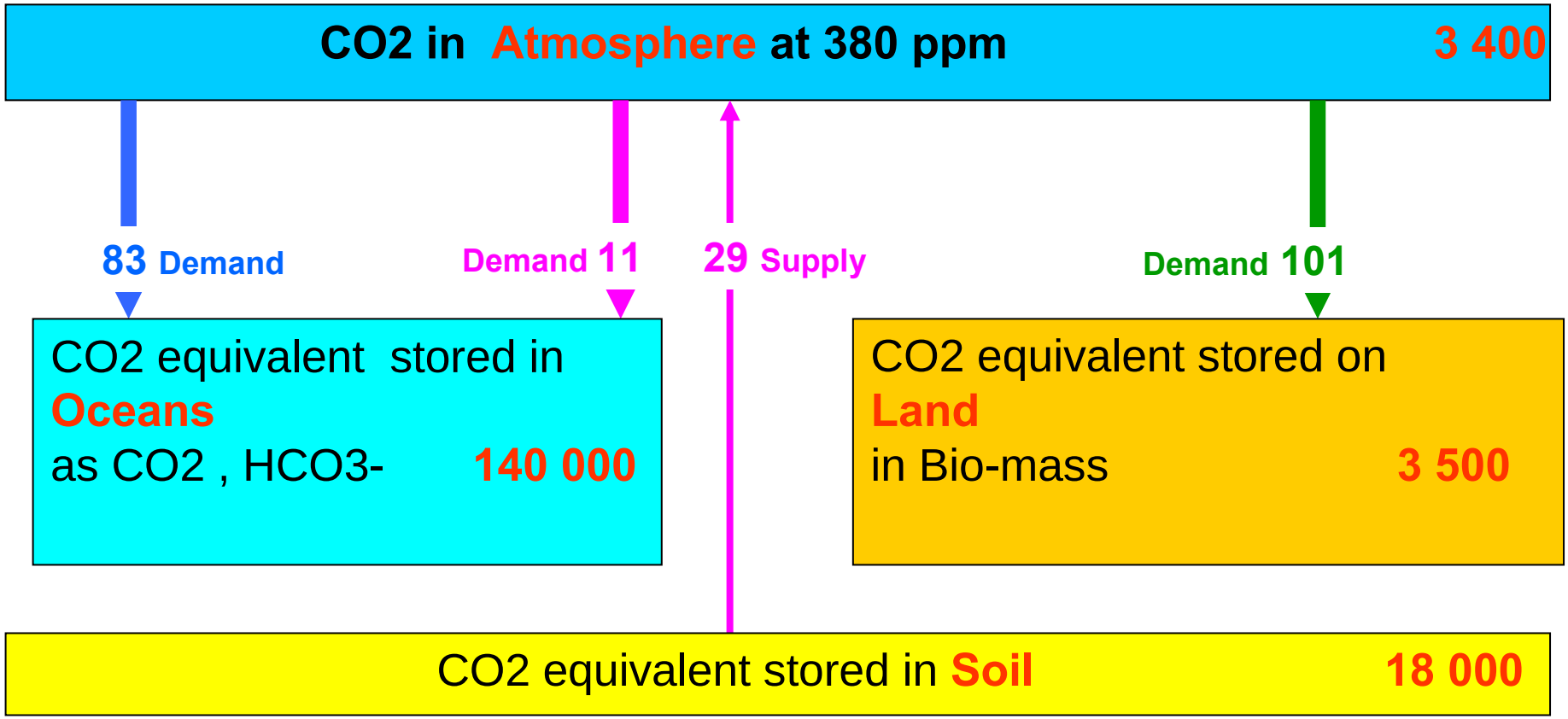
CO2 Demand in Gt /Year and CO2 stored in Gt



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CO2 supply to Atmosphere

CO2 demand from Atmosphere (photosynthesis)	184	Gt / Year
CO2 return as demand back to Ocean	+ 11	Gt / Year
CO2 supply to Atmosphere to cover demand	195	Gt / Year
CO2 supply to cover inventory change	+ 18	Gt / Year
Grand total CO2 supply to Atmosphere	213	Gt / Year
Fossil CO2 supply	− 29	Gt / Year
CO2 supply to Atmosphere other than Fossil	184	Gt / Year

CO2 Supply from decomposed Biomass from Land + Oceans equals CO2 Demand for photosynthesis on Land + Oceans.

The inventory balance of 11 Gt / Year was allocated to Fossil CO2.

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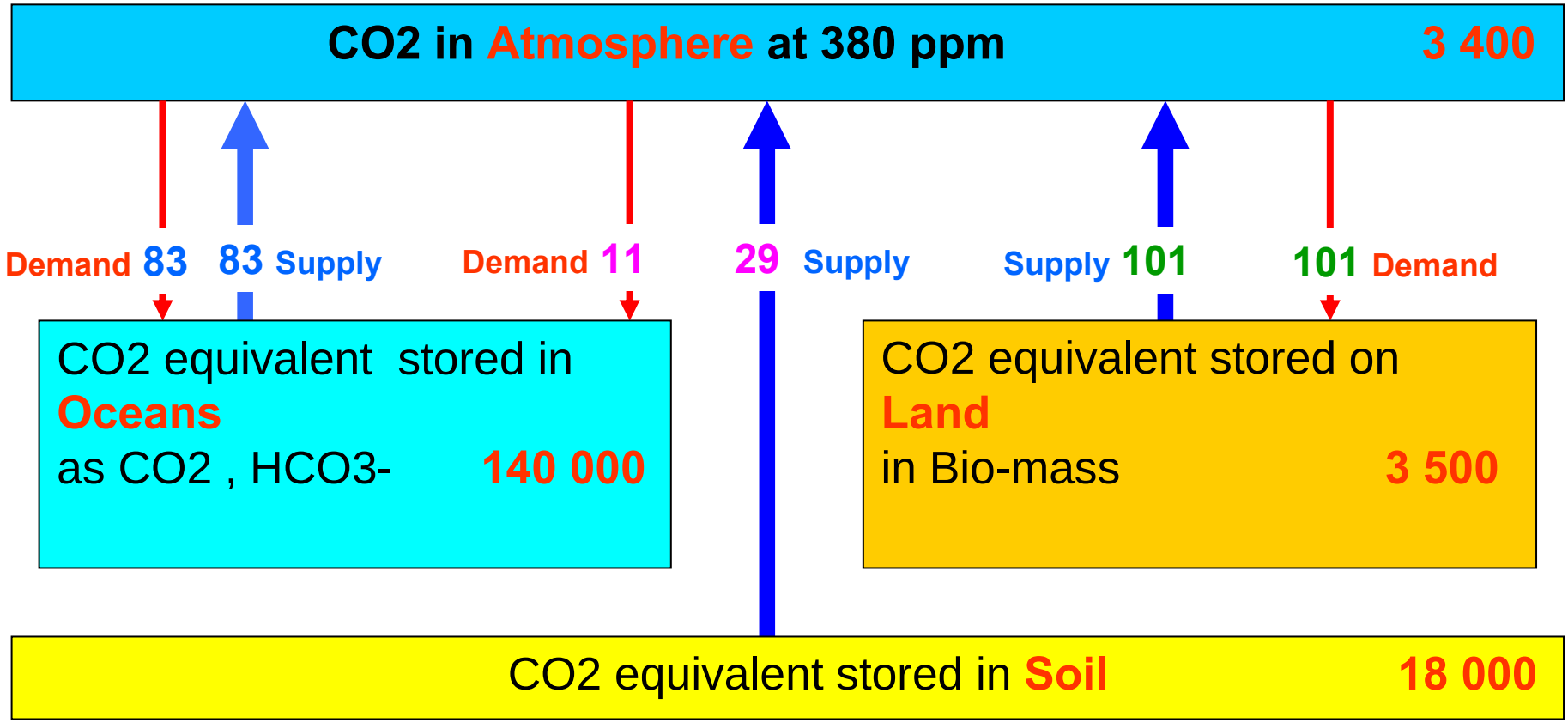
CO2 equivalent flows in Gt /Year and CO2 stored in Gt



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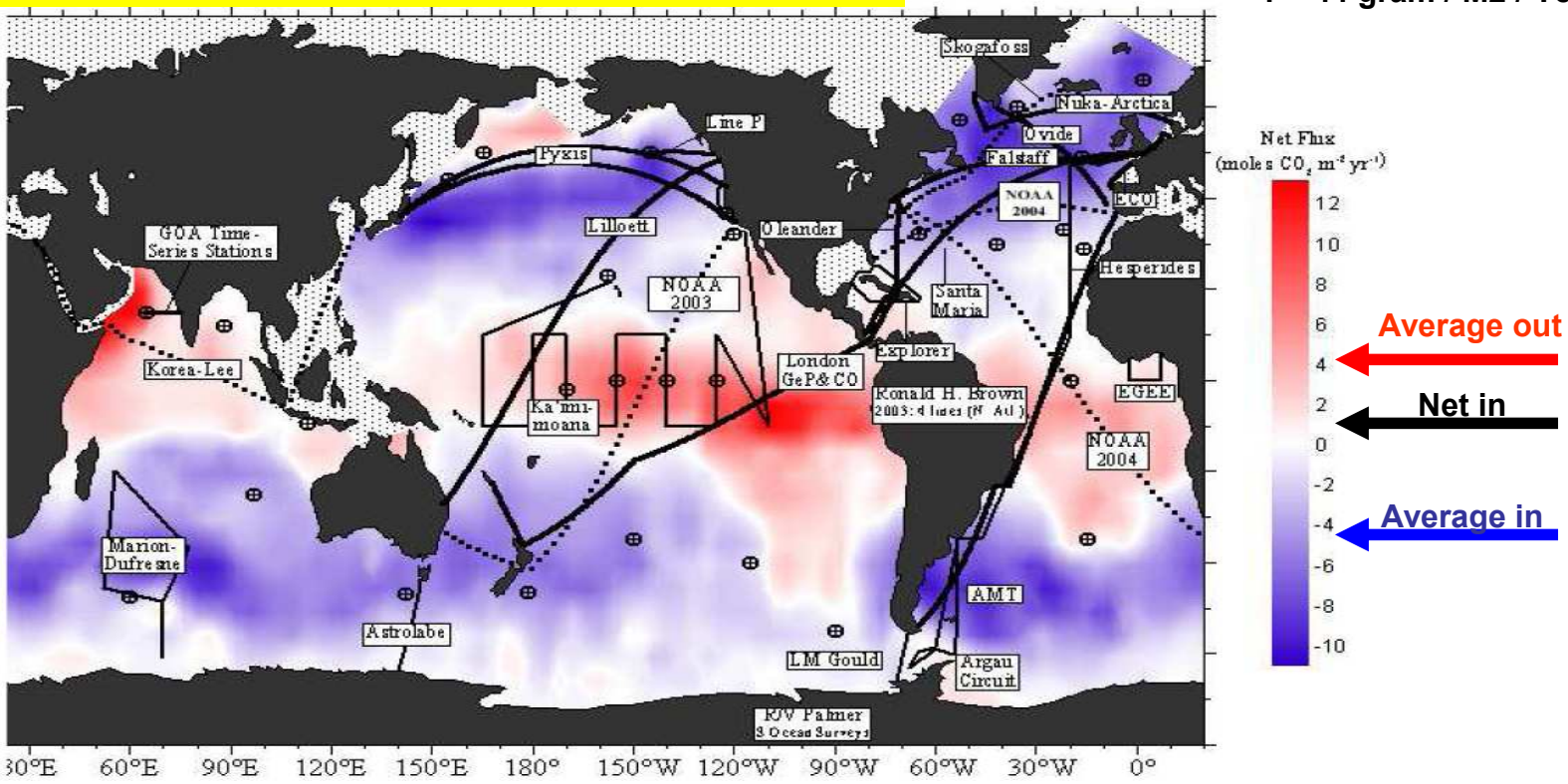
Net CO2 Flux from Ocean to Atmosphere

1 = 44 gram / M2 / Year



The Oceans have a high Net Flux CO2 from Ocean to Atmosphere near the Equator and negative Net Flux away from equator.

Source: Integrated Global Carbon Observation (IGCO)

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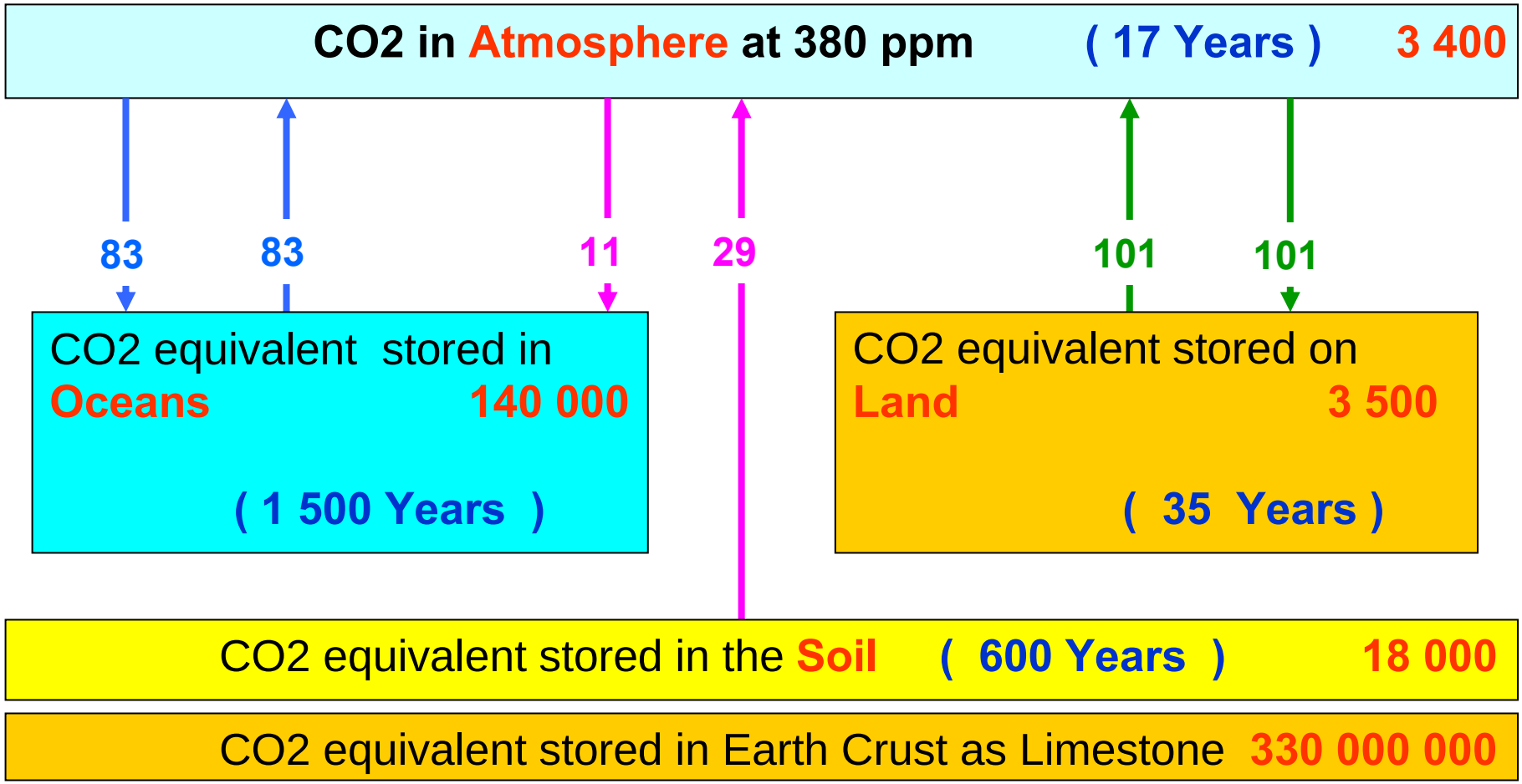
Inventory years = Inventory / Demand



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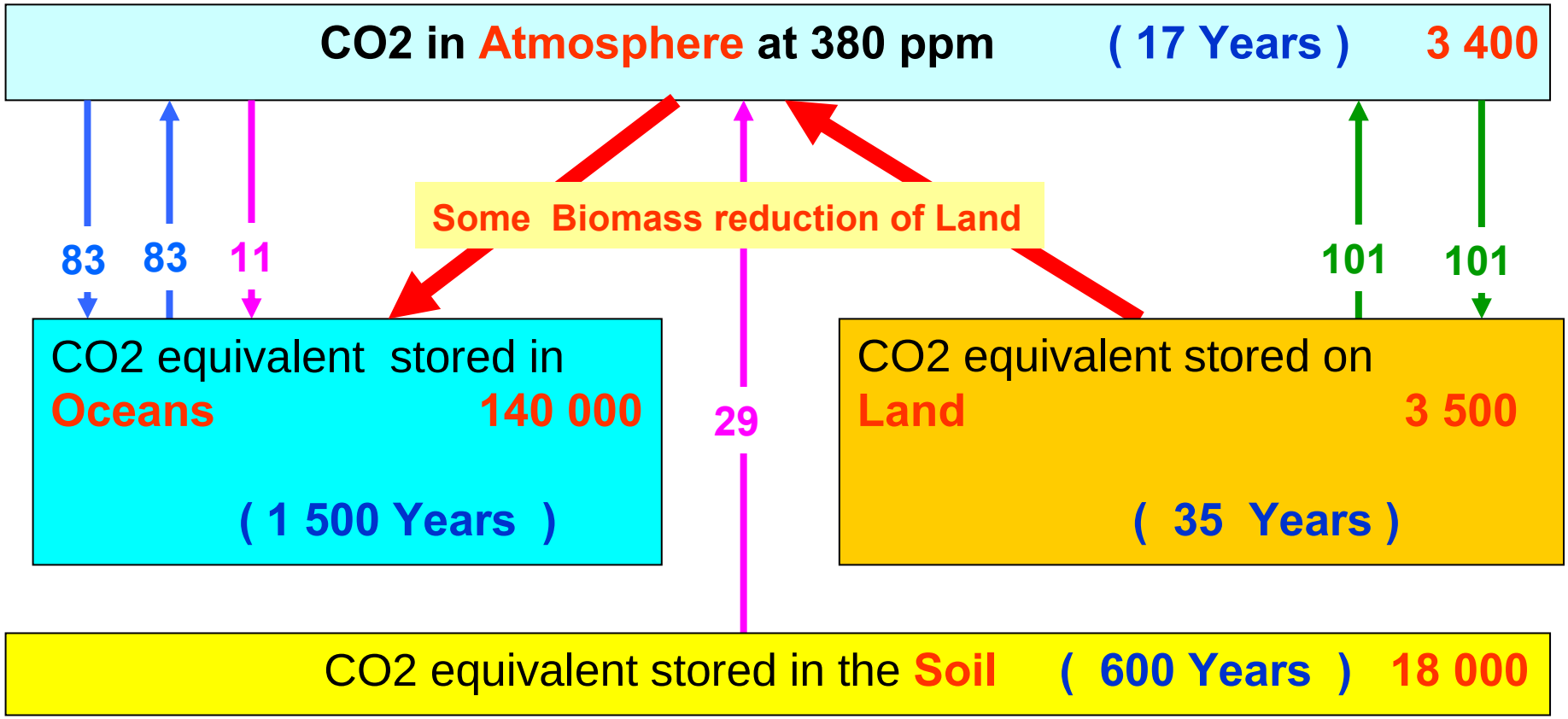
Some Land Biomass reduction



CO2 flow from Land to Atmosphere maybe higher and CO2 flow from Ocean to Atmosphere maybe lower

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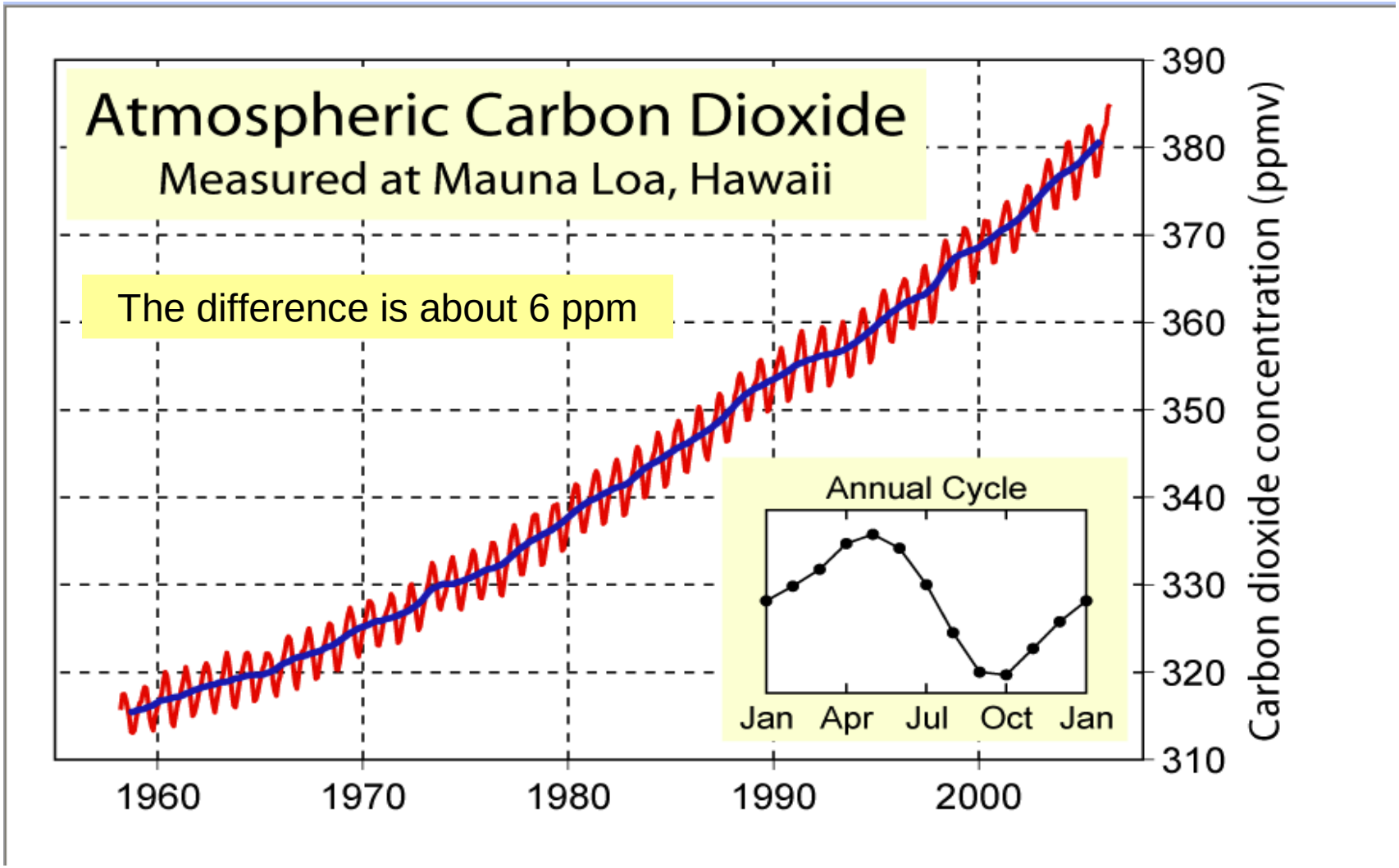

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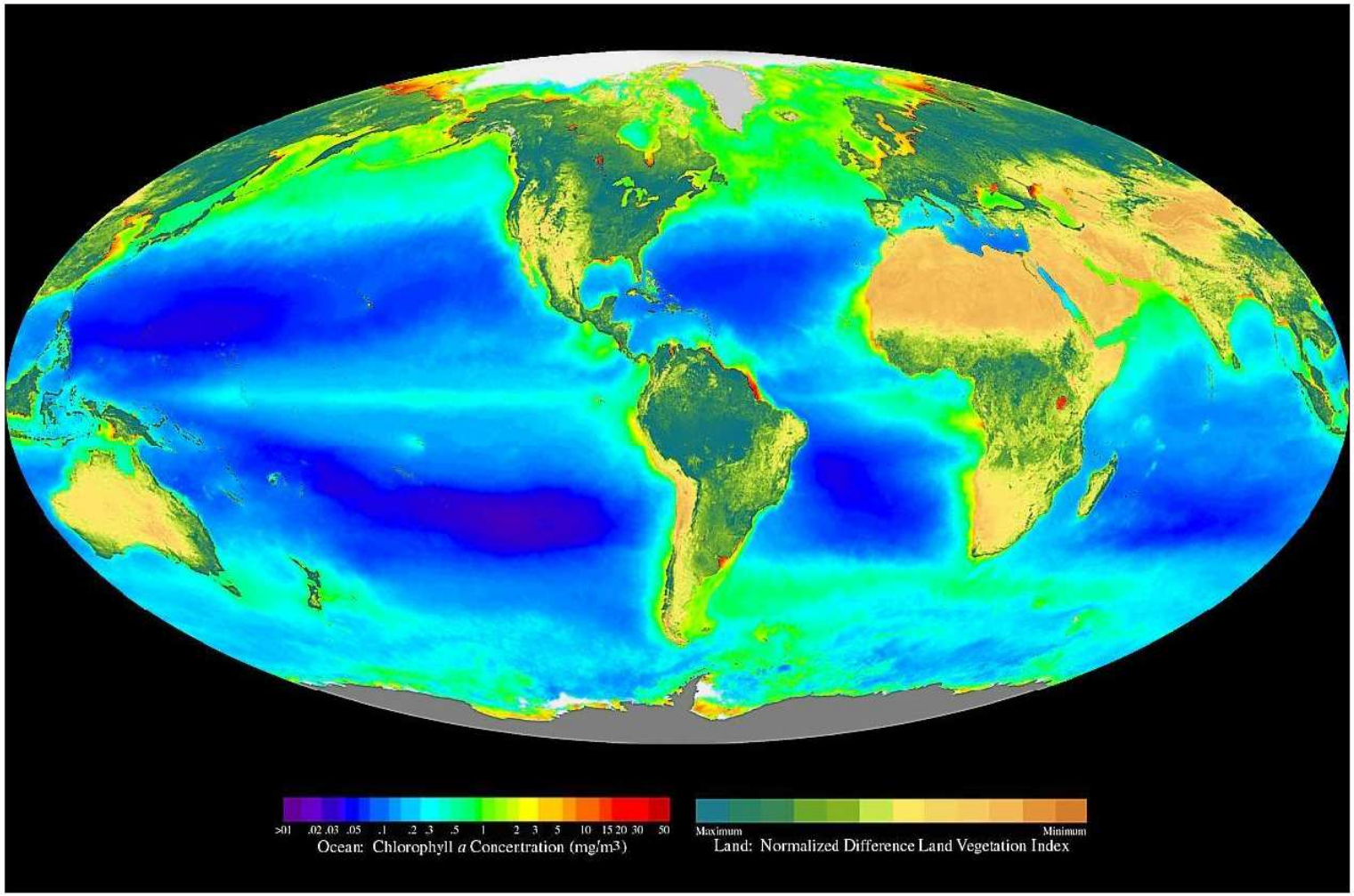

Like Agriculture on Land ……stimulate Photosynthesis where it naturally occurs

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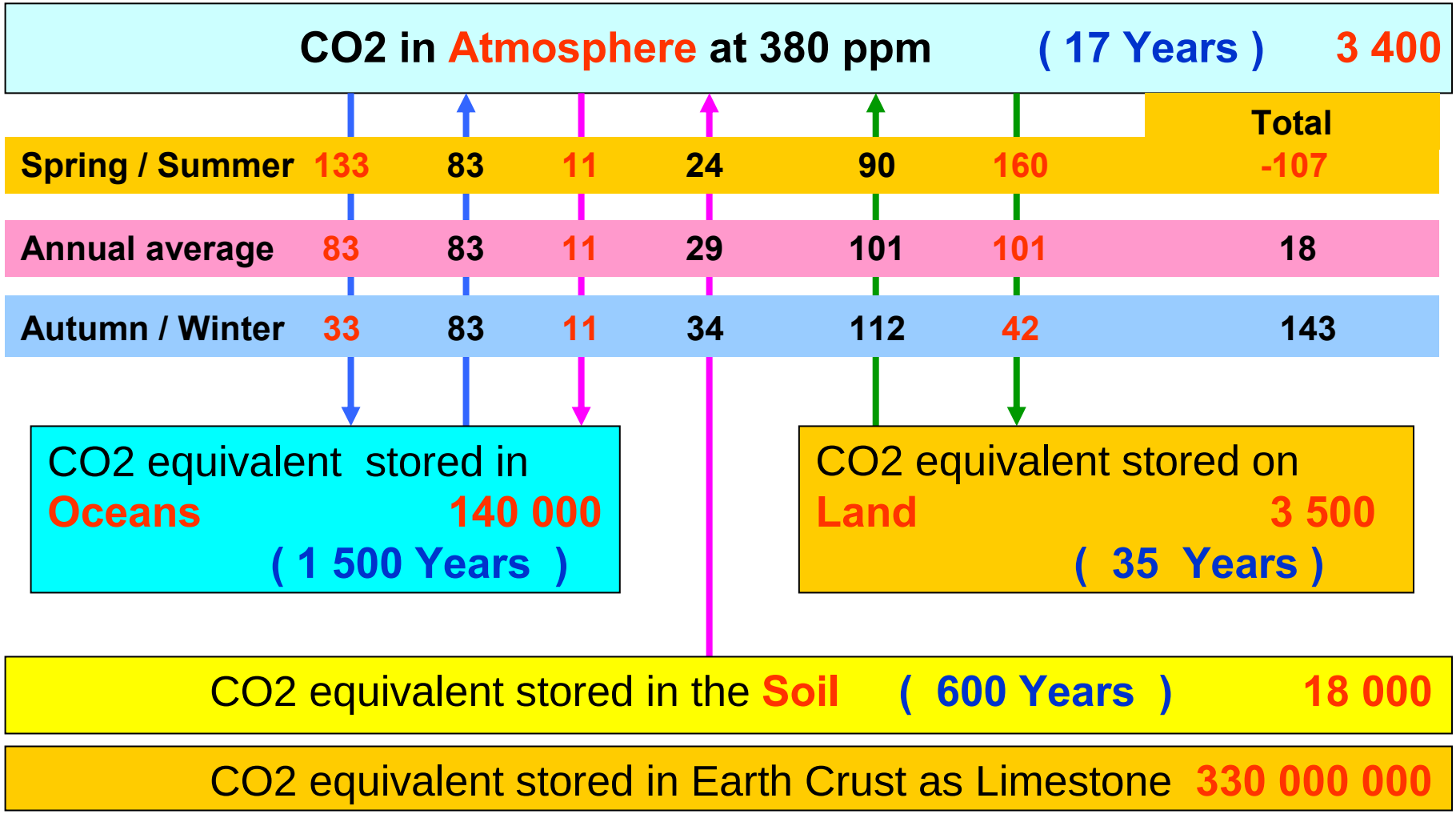
Seasonal Flow rates based on seasonal CO2 concentration changes



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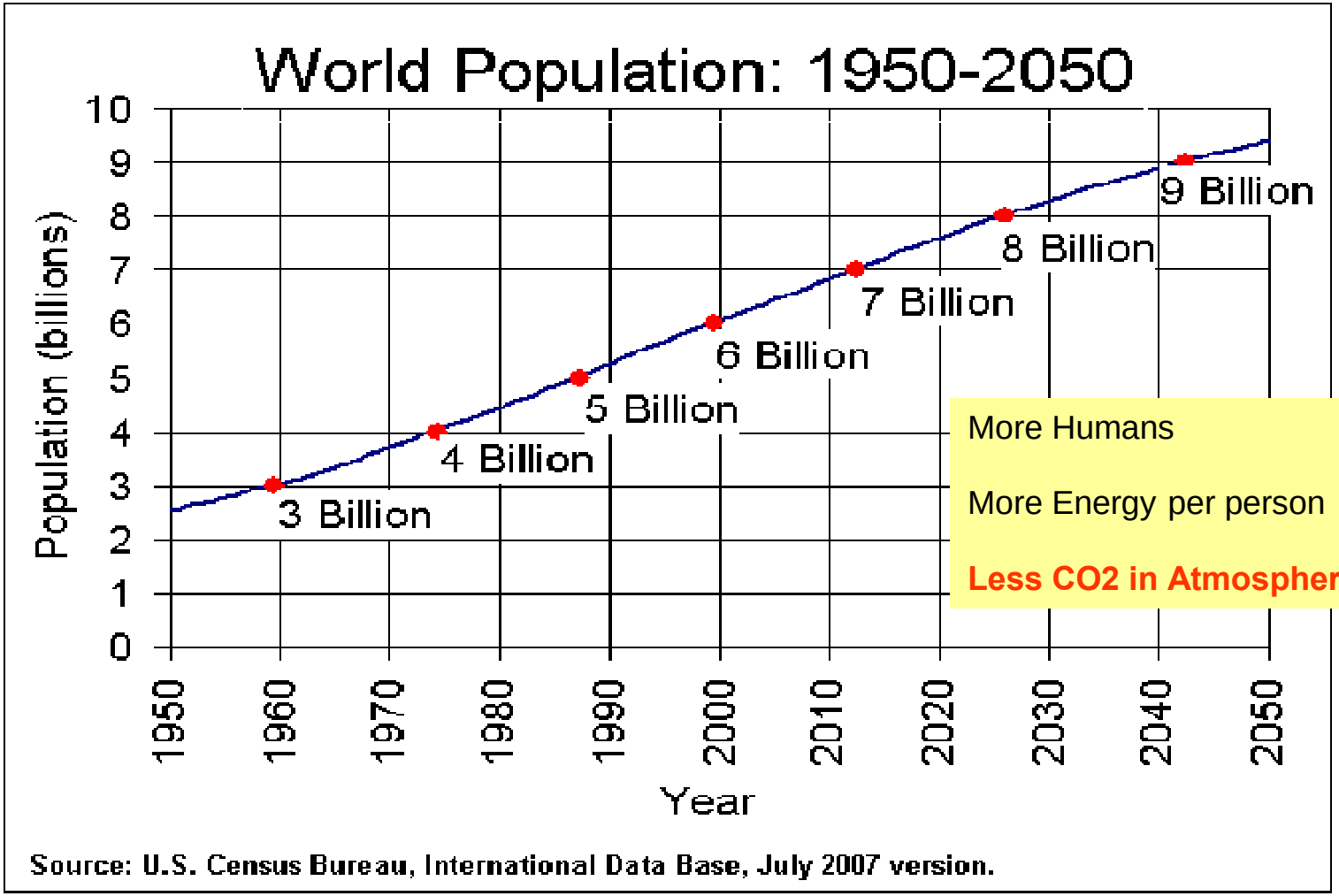

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How to reduce the CO2 inventory in Atmosphere ?

Reduce CO2 supply to Atmosphere !

Increase CO2 demand from Atmosphere !

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Reduce supply of CO2 to Atmosphere

Stable CO2 inventory in Atmosphere requires a reduction or replacement of 60 % of fossil fuel CO2 supply based on 2004 numbers.

Major assumptions:

1. **Oceans will continue to absorb 11 Gt CO2 / Year or more extra**
2. **Land Bio-mass supply / demand stays at 101 Gt CO2 / Year**
3. **Ocean Bio-mass supply / demand stays at 83 Gt CO2 / Year**
4. **Alternative energies satisfy the energy demand increase globally**

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Reduce supply of CO_2 to Atmosphere (switch from Coal to Methane)

On a caloric value basis, One MT Carbon = 0.6 MT methane

One MT Carbon creates = 3.65 MT CO_2 when burned

0.6 MT Methane creates = 1.65 MT CO_2 when burned

Therefore:

Replacing 1 Gt Carbon with 0.6 Gt Methane reduces CO_2 supply to the atmosphere with 2 Gt CO_2

Worldwide 5.4 Gt coal is burned.

About half of all CO_2 from fossil fuel comes from coal.

THIS LOOKS VERY SIGNIFICANT

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Increase demand of CO2 from the Atmosphere

Double Raw crop (+120 %) production balances CO2 in the Atmosphere

Increase Biomass growth on Land by 18 % balances CO2 in the Atmosphere

but

The Biomass should stay on Land …… to reduce the supply back to Atmosphere

and

How do we do that ??

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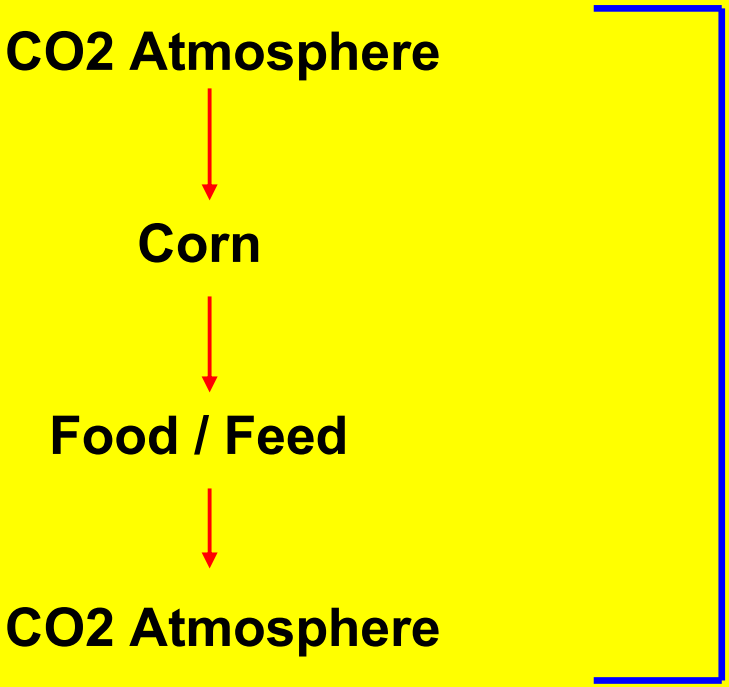
Increase the CO2 Biomass inventory on Land. Focus should be on Biomass with a long lifecycle



The total cycle is about 2-3 years

1 MT / Year cycle stores 2-3 MT

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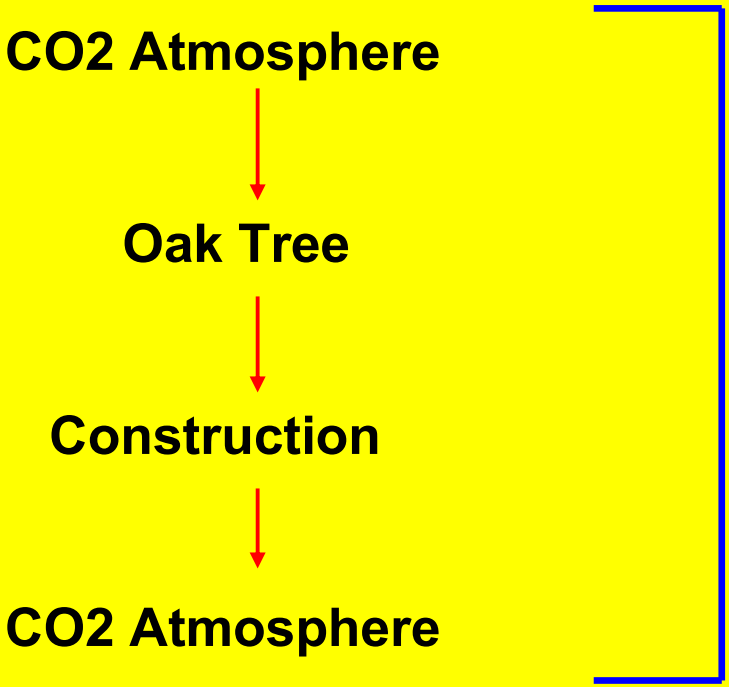
Increase the CO2 Biomass inventory on Land. Focus should be on Biomass with a long lifecycle



The total cycle is about 50 - 100 years

1 MT / Year cycle stores 50 MT

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Increase the CO2 Biomass inventory on land. Focus should be on Biomass with a long lifecycle

CO2 Atmosphere

↓

Vegetable Bio Mass

↓

Coal

↓

CO2 Atmosphere

The total cycle is about 60 million years

1 MT / Year cycle 60 mm MT

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CO2 Atmosphere

↓

Vegetable Biomass

↓

Charcoal

↓

CO2 Atmosphere

Extend short lifecycle Biomass into a long lifecycle through charcoal (terra preta)

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Reduce supply of CO_2 to Atmosphere

Reduce spontaneous and deliberate burning of vegetable Biomass

Fires in the USA release 0.29 Gt CO_2 / Year.

Worldwide > 2.5 Gt CO_2 / Year

Improve technology to prevent and extinguish fires

THIS LOOKS SIGNIFICANT

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On land , farmers have many choices in absorbing CO2

Product	CO2 MT/Hectare/Year
Algae	70 …. 350
Raw Crop	10 …. 50
Palm Oil	5 …. 30
Rape Seed	10 …. 30
Forest // Bamboo	2 …. 30
Raw crop Land	14.5
Worldwide Land average	3.3
Ocean Average	1.8

But they are not financially incentivized to capture CO2

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Increase demand of CO2 from Atmosphere

Lifecycle for Raw crops to stay on land equals 2.5 years

All in Gt MT

Year	2000	2007
Raw Crop growth	2.0	2.5
Associate Biomass growth	4.0	5.0
Total Biomass growth	6.0	7.5
CO2 consumption per year	10.0	12.5
Land inventory of CO2 for Raw crops cycle	25.0	31.3

From 2000 to 2007 a CO2 inventory increase of 6.3 Gt has taken place on Land as a result of increasing Raw crop growth.

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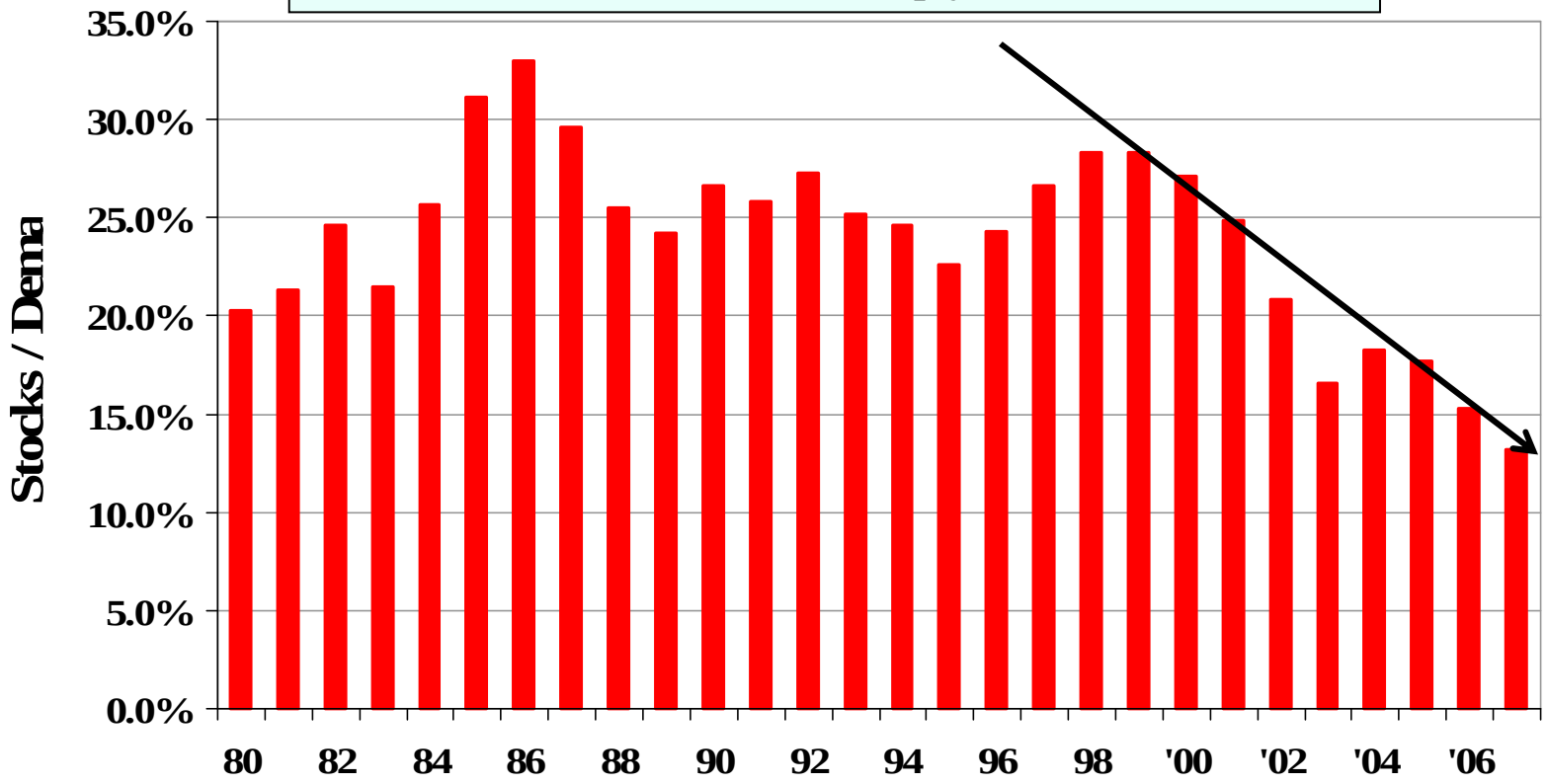
World Grain & Oilseed Stocks as a % of Demand

World Demand Growth has Exceeded World Production
Thus
World Stocks have Declined Sharply!



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Increase demand of CO2 from Atmosphere

Increasing the world grain inventories from 12 % of world demand back 25 % of world demand would store an additional

0.5 Gt CO2 One time effect + associate Biomass in a 2.5 Year cycle

Increase the world grain inventories to ONE YEAR would store an additional

3.7 Gt CO2 One time effect + associate Biomass in a 2.5 Year cycle

THIS IS SIGNIFICANT

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HOWEVER

WE MUST ASSURE THAT ALL CO2 STAYS IN THE OCEANS.

INCREASED EMISSIONS OF CO2 FROM THE OCEANS COULD BE MASSIVE …..

AND

MAY OVERWHELM EVERYTHING …….

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What happens in the Oceans ?

A Temperature increase of the water makes it more difficult to absorb CO_2 from Atmosphere

Moving in that wrong direction ……. due to global warming

A lower pH of the water makes it more difficult to absorb CO_2 from the Atmosphere

Moving in that wrong direction ……. acidity is increasing in Oceans !!

CO_2 absorbed in water makes the water more acid unless the CO_2 is used in photosynthesis or stays as dissolved CO_2 gas.

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Increase demand of “Growth Gas” CO2 by Oceans

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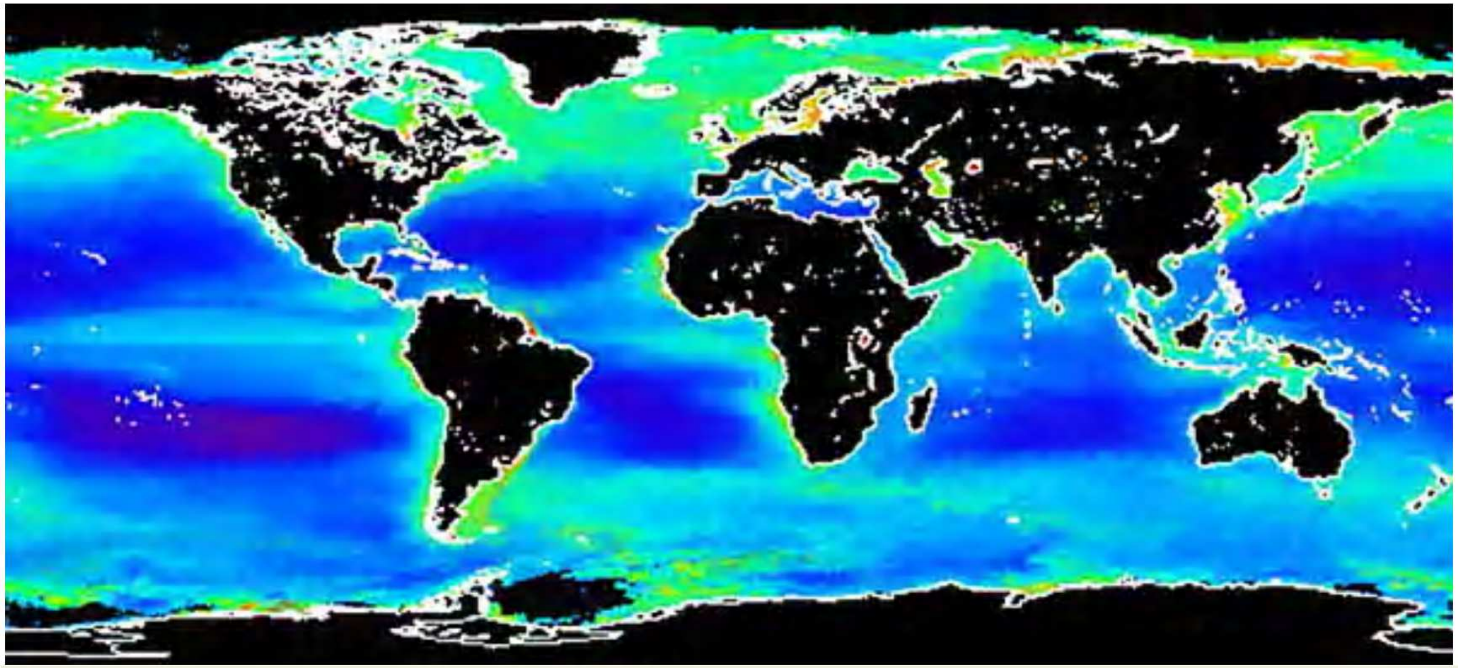
NASA



In this image of the Earth, blue areas indicate low chlorophyll concentrations, with purple regions being very low. Greens and yellows indicate higher concentrations of chlorophyll.

It is reported that in many parts of Oceans photosynthesis is stifled due to a lack of Fe , soluble Si and Nitrogen….etc.

A 20 % increase in CO2 demand for photosynthesis keep balance CO2 in Atmosphere stable.

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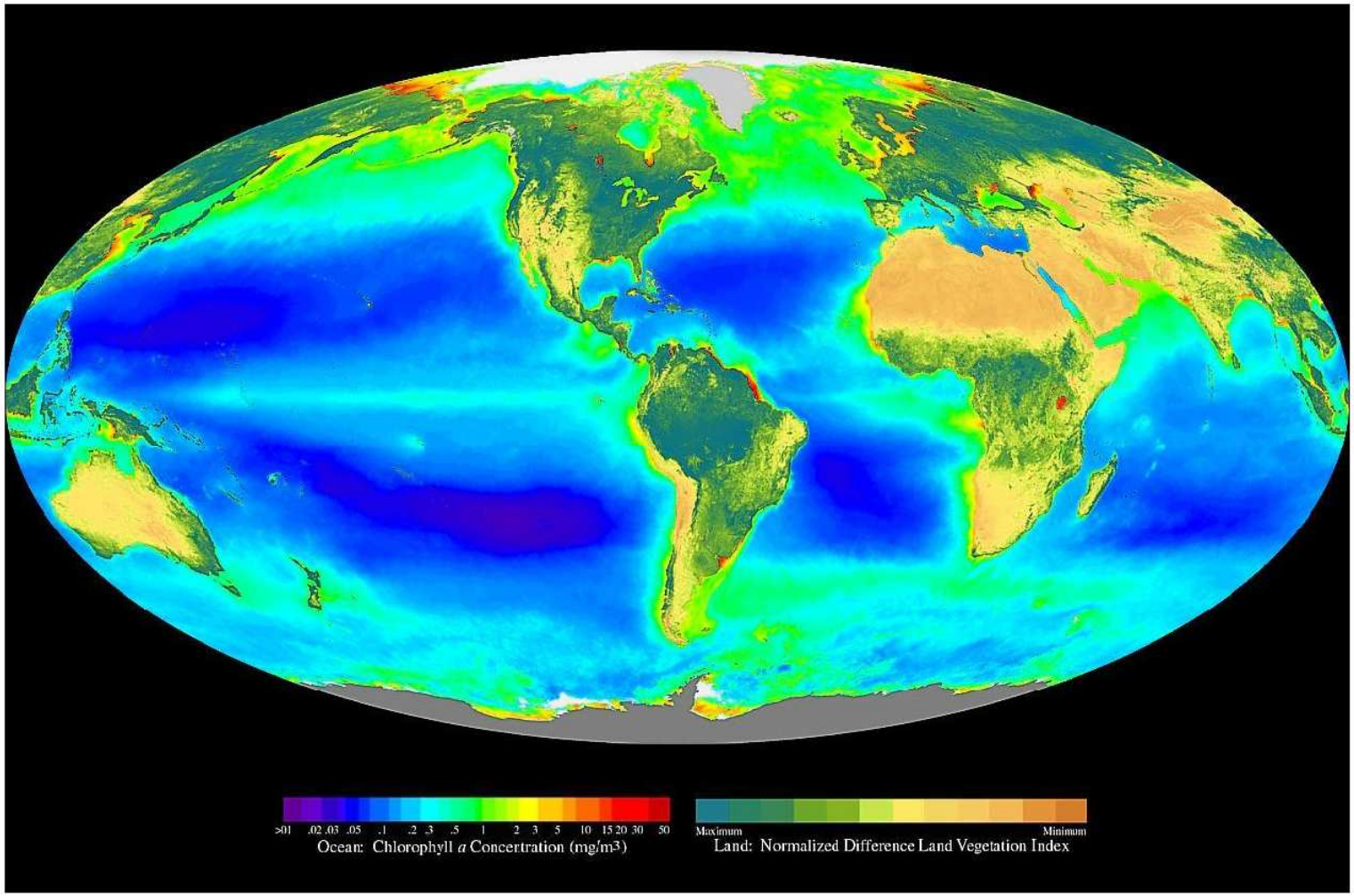

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Option to use CO2 as “Growth Gas”

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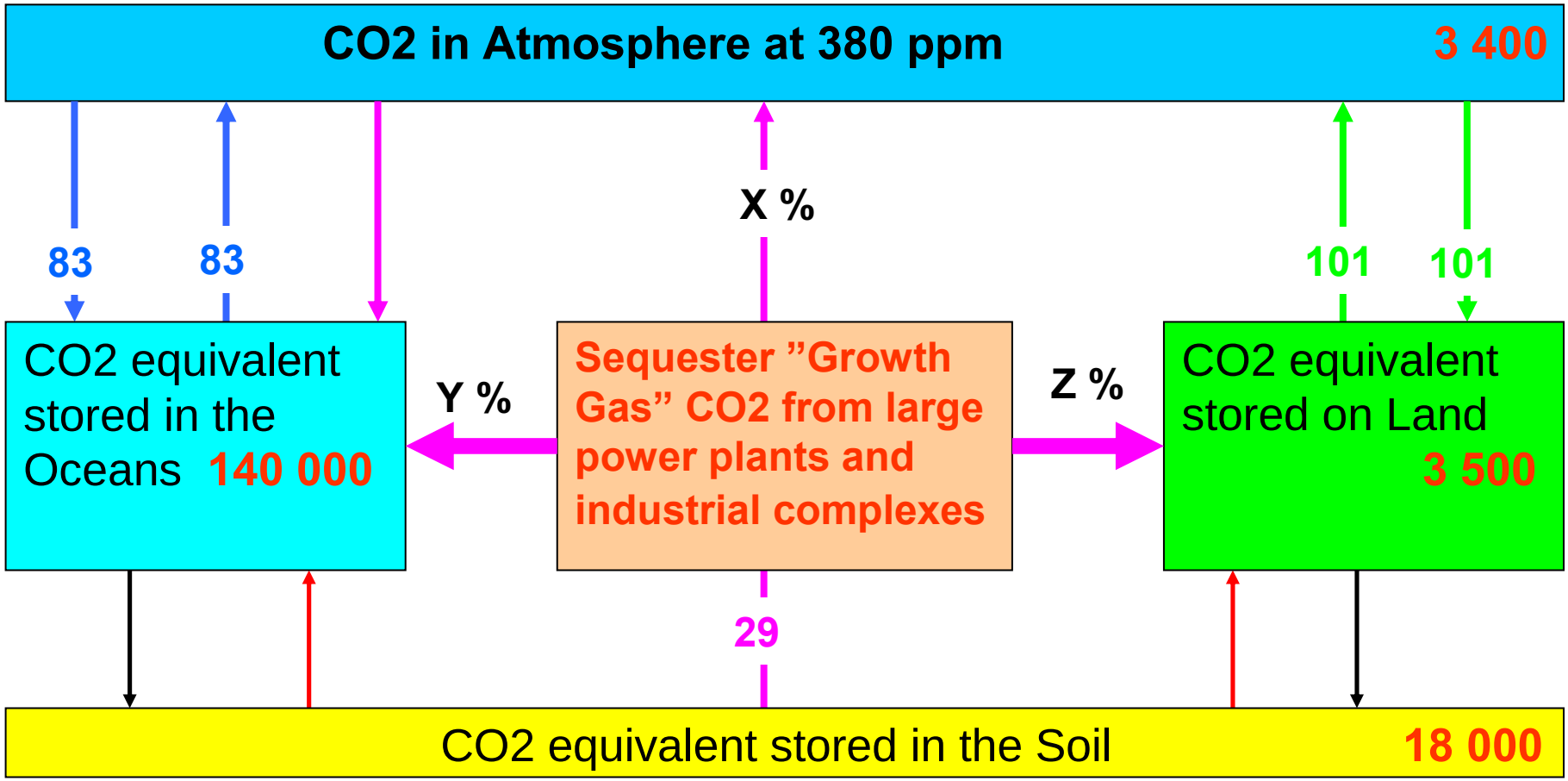
CO2 equivalent flows in Gt /Year and CO2 stored Gt



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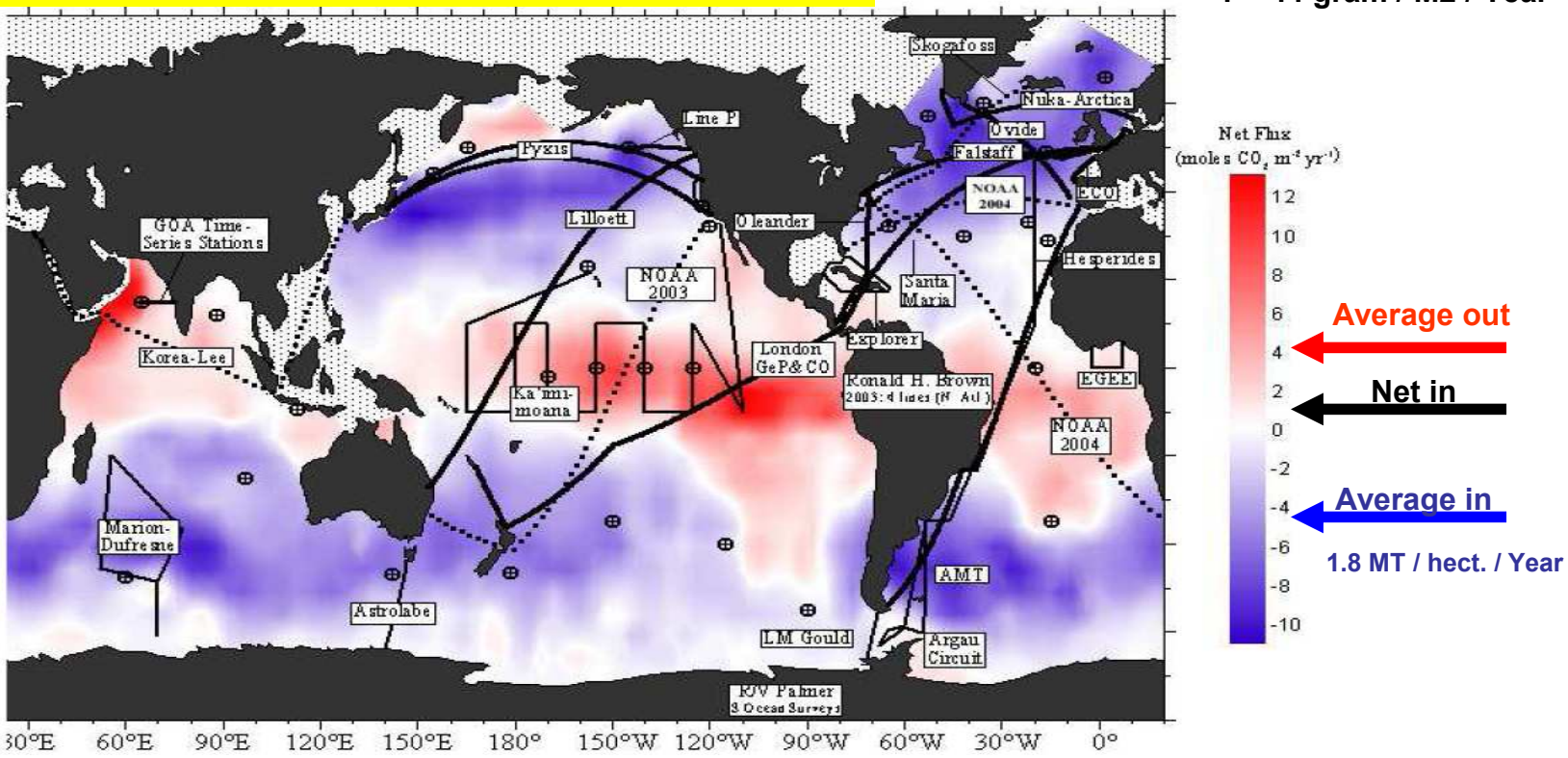
Net CO2 Flux from Ocean to Atmosphere

1 = 44 gram / M2 / Year



The Oceans have a high Net Flux CO2 from Ocean to Atmosphere near the Equator and negative Net Flux away from equator.

Source: Integrated Global Carbon Observation (IGCO)

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Injecting CO2 into Oceans

Wrong Way

$CO_2 + H_2O \rightleftharpoons HCO_3^- + H^+$

The Ocean becomes more acid….

Possible Way

Inject CO2 in the cold under-current where it travels as CO2

Right Way

CO2 in Oceans used as a ”Growth Gas” for photosynthesis in the same way as on Land.

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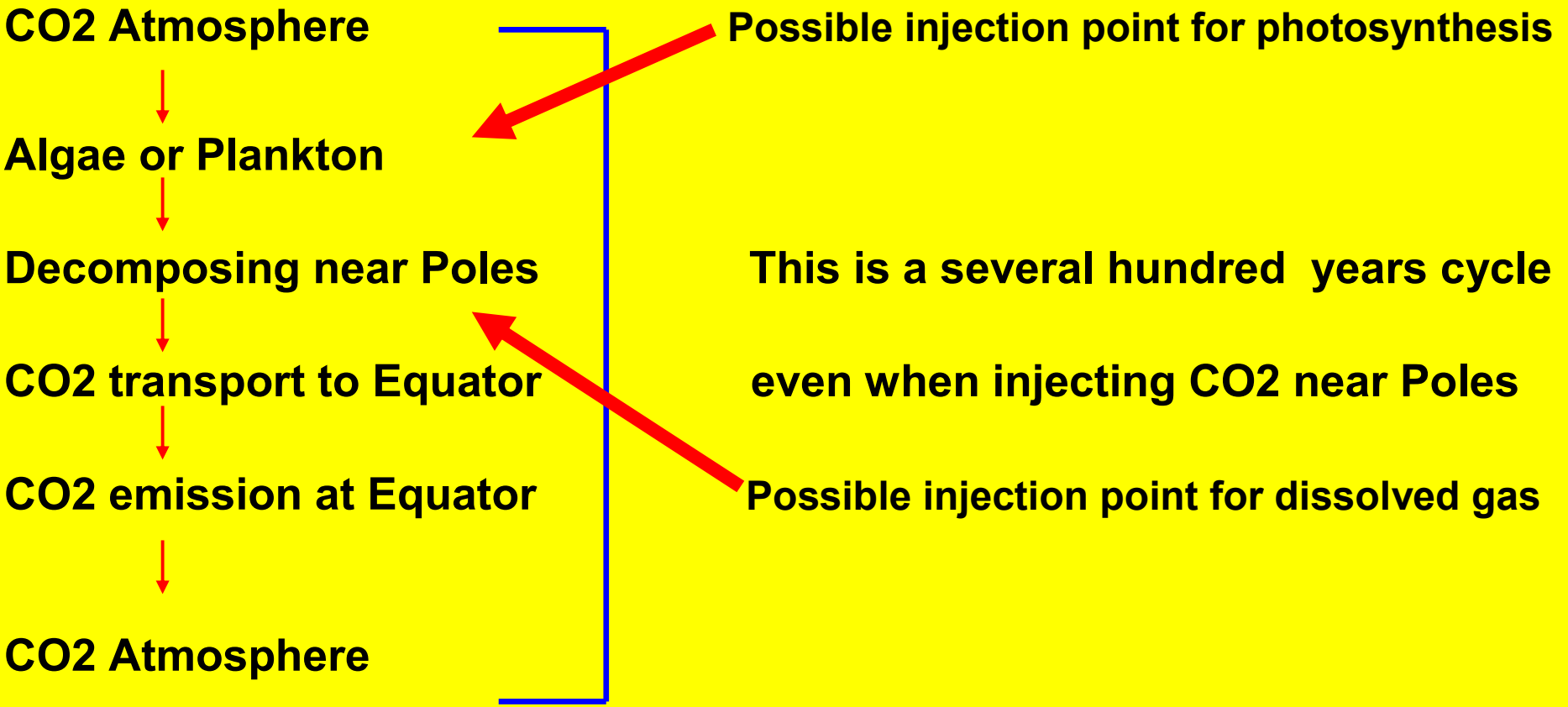
Injecting CO2 in the Oceans increases the CO2 inventory in Oceans.
These are long lifecycles



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Increase demand of CO2 from Atmosphere

Increase growth of Biomass in Oceans

Seems to have a big potential ……

but…..

concepts need to be developed.

Do not be afraid to experiment as no change is the biggest experiment

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Balancing or reducing CO2 in Atmosphere requires that:

CO2 supply and demand on Land + Oceans should become part of the policy makers knowledge. A 10 % increase in demand will balance the CO2 in Atmosphere.

CO2 equivalent inventories on Land + Oceans should be well understood and should become part of the policy makers knowledge.

An increase < 0.5 % in CO2 inventories on Land + Oceans reduces CO2 in Atmosphere from 380 ppm to 300 ppm.

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Summary for policy makers: CO2 = "Growth Gas"

TEIJIN
Human Chemistry, Human Solutions

1. Understand Inventory-and-Flow data + adopt the thinking process.
2. Continue to stimulate all forms of alternative energy and efficiency to replace fossil.
3. Economically discourage use of coal, stimulate switch to methane.
4. Improve fire fighting technology and crop residue burning.
5. Extend the average Bio-mass lifetime on Land with one year. This amounts to 100 Gt CO2 (11 ppm reduction in Atmosphere)
6. Inject CO2 directly into Oceans for photosynthesis, NOT ACID.
7. Increase the food inventory to at least one year.
8. Create long term stable elevated demand for Vegetable oil. Think about replacing part of the strategic Crude Oil reserves with Vegetable oil inventories.

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Industrial approach to set quantitative targets, in CO2 equivalents

CO2 Supply reduction to the atmosphere

Alternative energy	**1– 30 Gt / Year**
Nuclear energy	**1– 10 Gt / Year**
Discouragement of Coal (methane)	**1– 10 Gt / Year**
Reduce wildfires and crop residue burning	**1– 2 Gt / Year**
Inject CO2 directly into Oceans	**5- 10 Gt / Year**

CO2 Demand increase from the atmosphere

Extension of Biomass life cycle on Land (1 Year)	**100 Gt one time + 5 Gt / Year**
Increased photosynthesis Land + Oceans	**5 – 40 Gt / Year**
Strategic Vegetable oil reserves	**0.5 – 1 Gt / Year**
Increase global food inventories	**1 Gt one time + 0.2 Gt / Year**

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Conclusion

The CO_2 inventory in Atmosphere should be controlled by working on :

The Supply side through reducing CO_2 emissions

and

The Demand side through massive increases of photosynthesis that will stay on Land + Oceans.

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THANK YOU FOR YOUR ATTENTION

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Proposing the 'Global CO2 Inventory-and-Flow Project'

-new effort to research the implications for:

….various groups (multilateral, national and city governments; private sector; NGOs)

….in multiple sectors (forestry , agriculture, industry; ocean management ; energy; waste management ; etc)

-provide expertise and coordination when policy initiatives are formulated , before, during and after COP15

Starting today:

www.globalCo2equivalent.com and through www.Econcern.com

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