

TORONTO WORKSHOP MATERIALS

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An E-Fate Perspective

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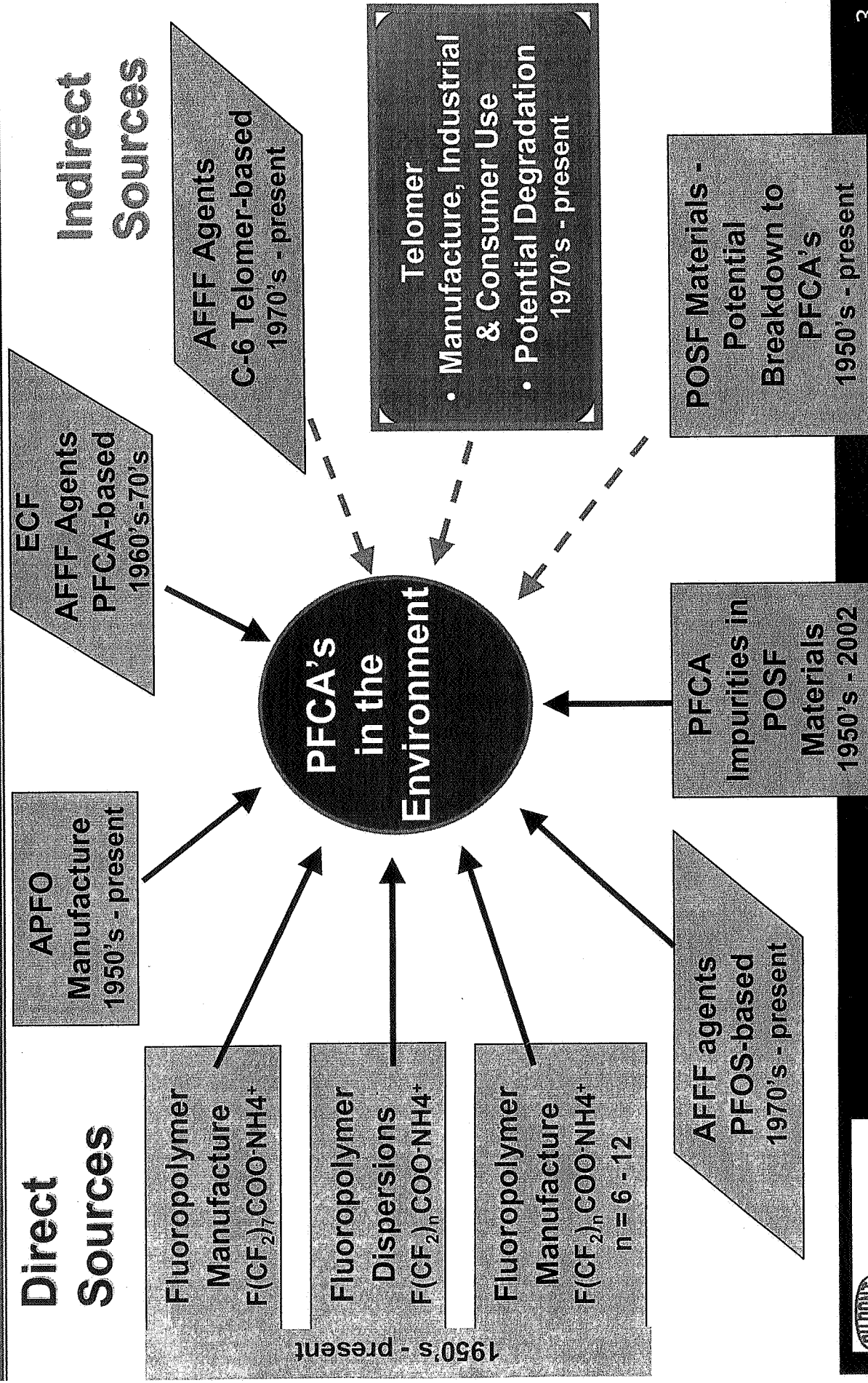
Considerations for Thought

What is the Source of PFCA's in the Environment?

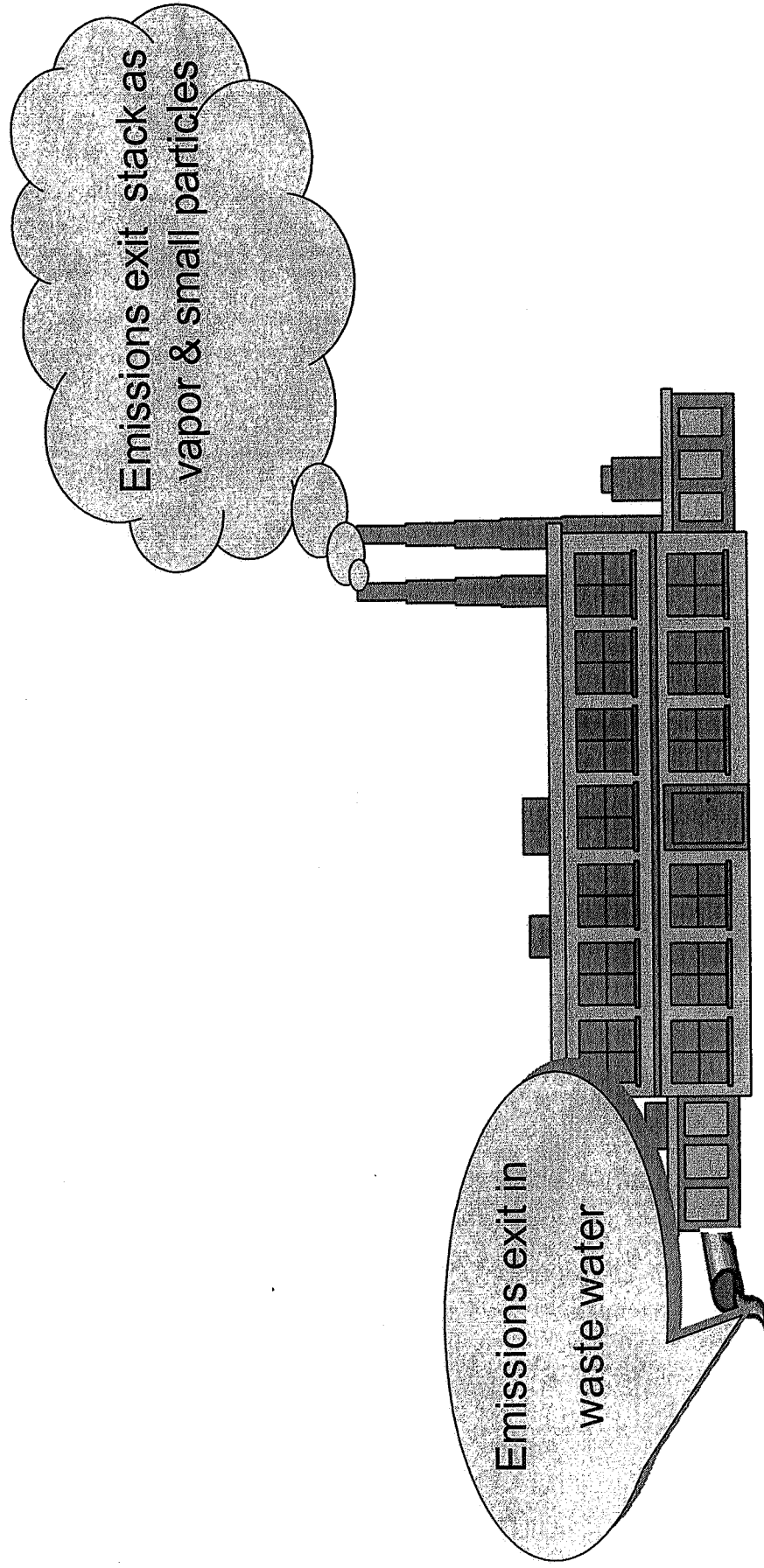
- What is the potential contribution of emissions from direct PFCA Sources?
- What is the potential for degradation of the Fluorotelomer-based polymers as an indirect source?
- What is the potential contribution of Fluorotelomer raw material residuals as an indirect source?



Potential PFCA Sources : $F(CF_2)_n COO^-$

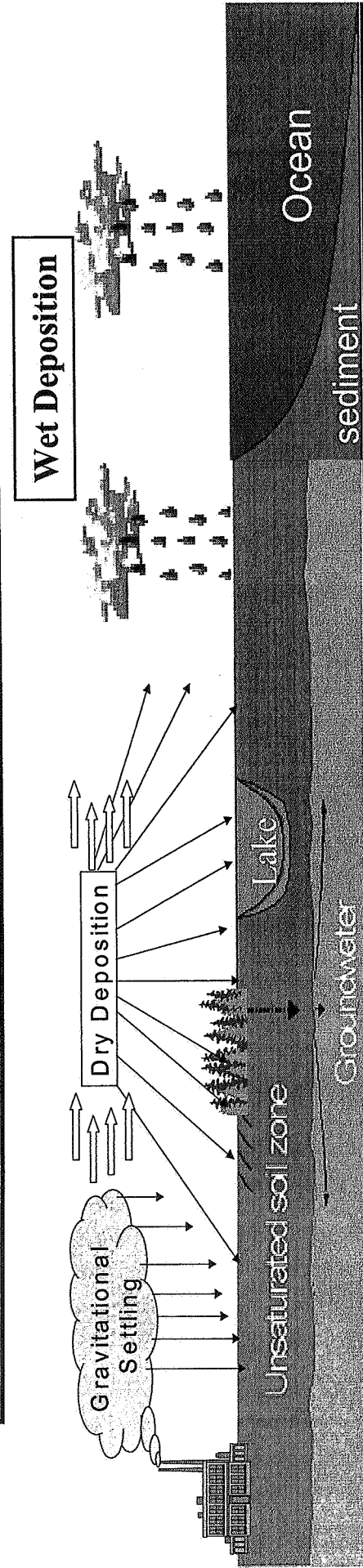


Emissions from Point Sources



Influence of Particle Size Distribution

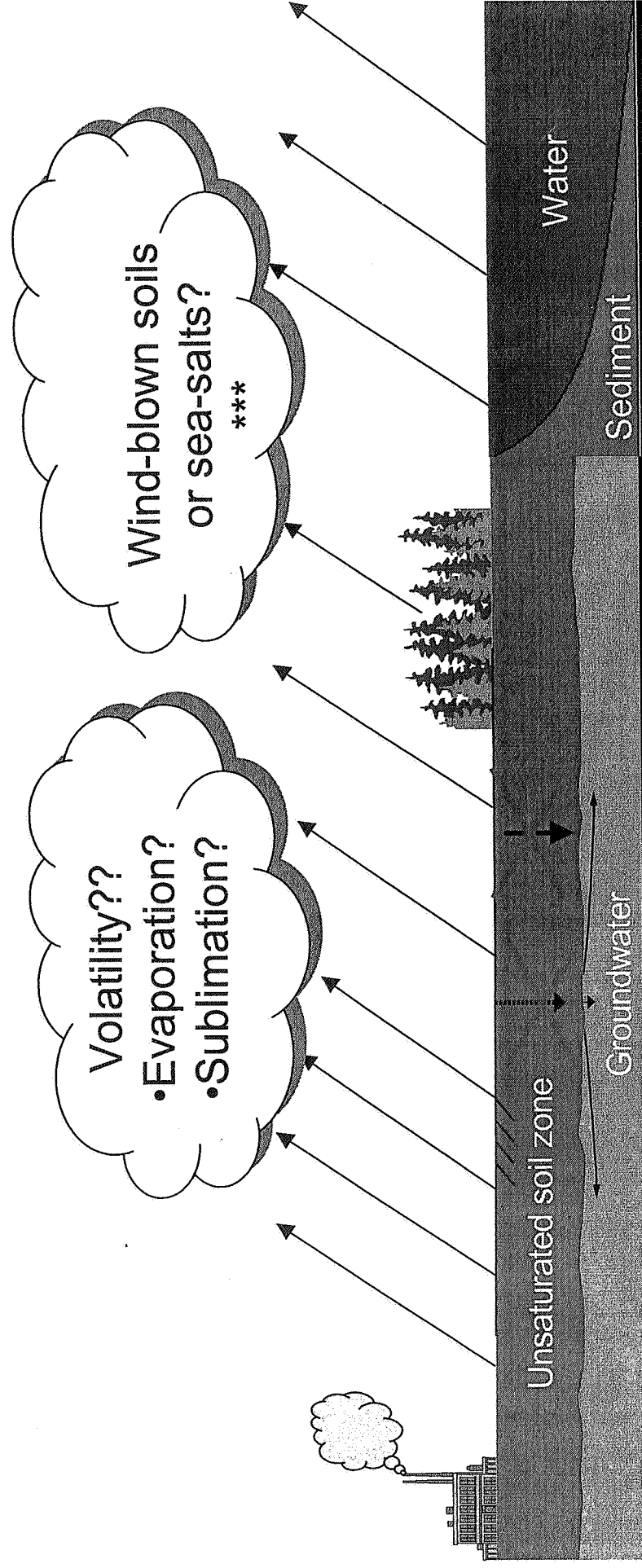
Particle size categories:	Coarse mode	Accumulation mode	Aitkens nuclei mode
Particle diameter (D_p):	$D_p > 2.5 \mu\text{m}$	$< 0.1 \mu\text{m} < D_p < 2.5 \mu\text{m}$	$< 0.1 \mu\text{m}$
Dominant Removal Mechanism:	Gravitational settling	Wet deposition	Dry deposition
Typical residence time:	minutes to days	days to weeks	minutes to days



What Happens Next?: Absence of Rain Event

After material deposited on soil/ in water via gravitational settling / dry deposition:

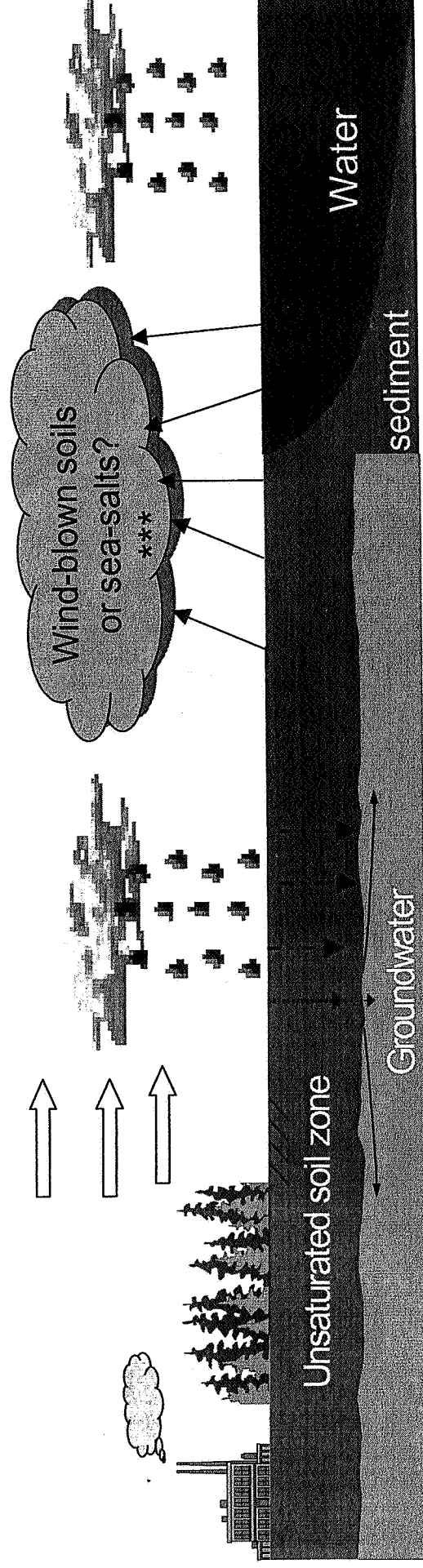
- Materials that are volatile or sublime may evaporate back to atmosphere
- The dominant particle sources (by mass) in air are mineral dust from wind-blown soils and sea-salt particles from wave-breaking.



What Happens Next?: Presence of Rain Event

After Material deposited on soil and in water via wet deposition:

- Water soluble/miscible materials will move with water (e.g., PFCAs)
- Water insoluble materials with high adsorption coefficients may adsorb to soil matrix at or near the surface (e.g., fluorotelomer alcohols (FtOH))
 - Note: TRP soil adsorption studies showed essentially full recovery of FtOH in test soils and soil pore water, but no FtOH in air traps. **Adsorption clearly dominant**
- Questions: Would FtOH adsorbed to wind-blown soils be:
 - reactive in the atmosphere?
 - deposited in remote locations as wind-blown soil with adsorbed FtOH?



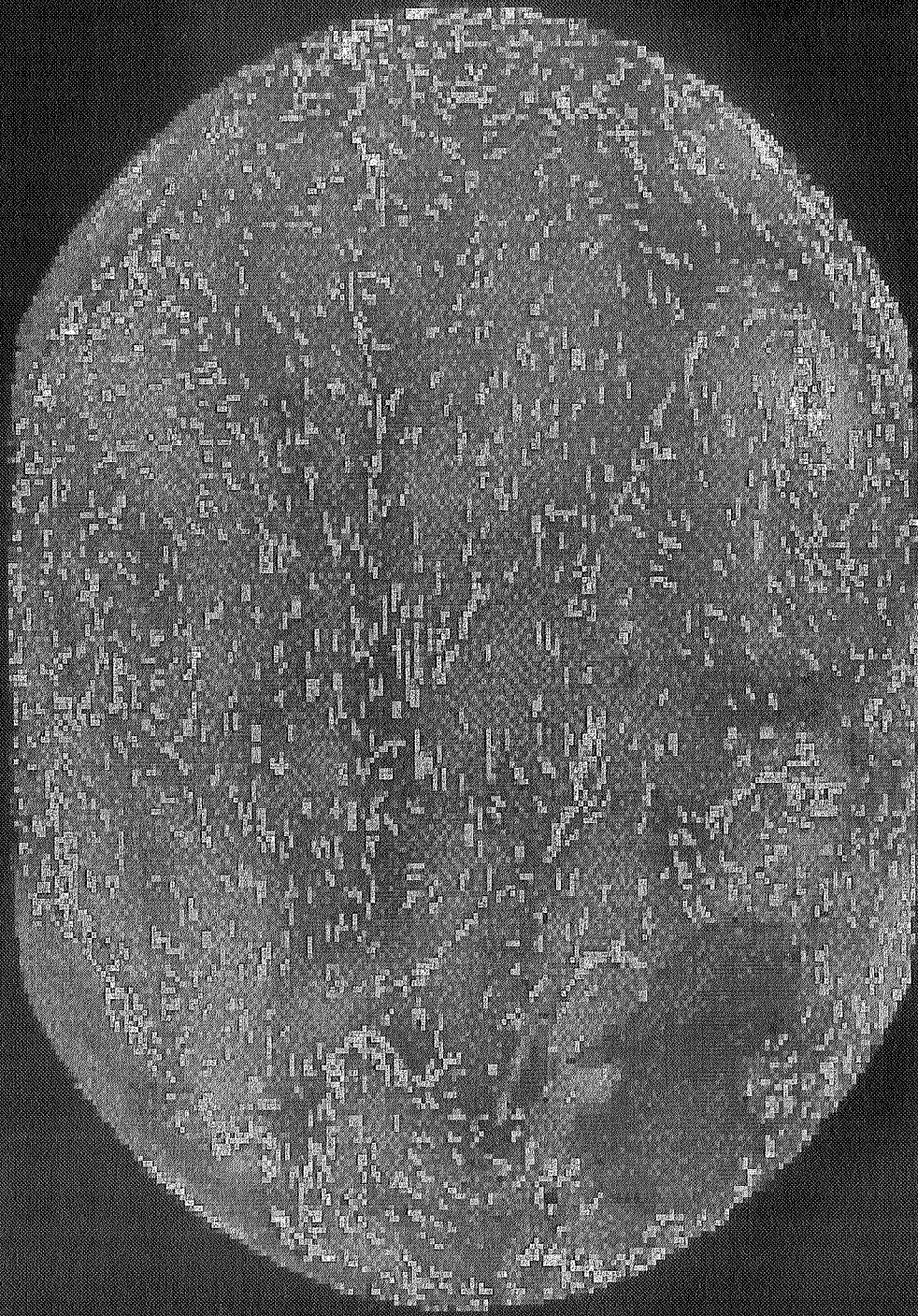
Wind-Blown Soils Hypothesis

- Wind-blown soils may:
 - account for transport of PFCAs and FtOH from surface of soils to the atmosphere.
 - enhance rate of sublimation for PFCAs from soil surfaces.
 - limit potential for FtOH transformation in atmosphere
 - deposit FtOH in remote locations as wind-blown soil with adsorbed FtOH.

Sea-Salts Hypothesis

1. PFCAs and FtOH may be deposited in marine boundary layer of ocean and associated with sea-salts.
2. Wave-breaking and winds move sea-salts into atmosphere.
3. PFCAs may enter atmosphere via transport on sea-salts or perhaps evaporate/sublime from marine boundary layer.
4. FtOH may enter atmosphere via transport on sea-salts or volatility, or perhaps it is transformed in marine boundary layer and/or it may be deposited to sediments.

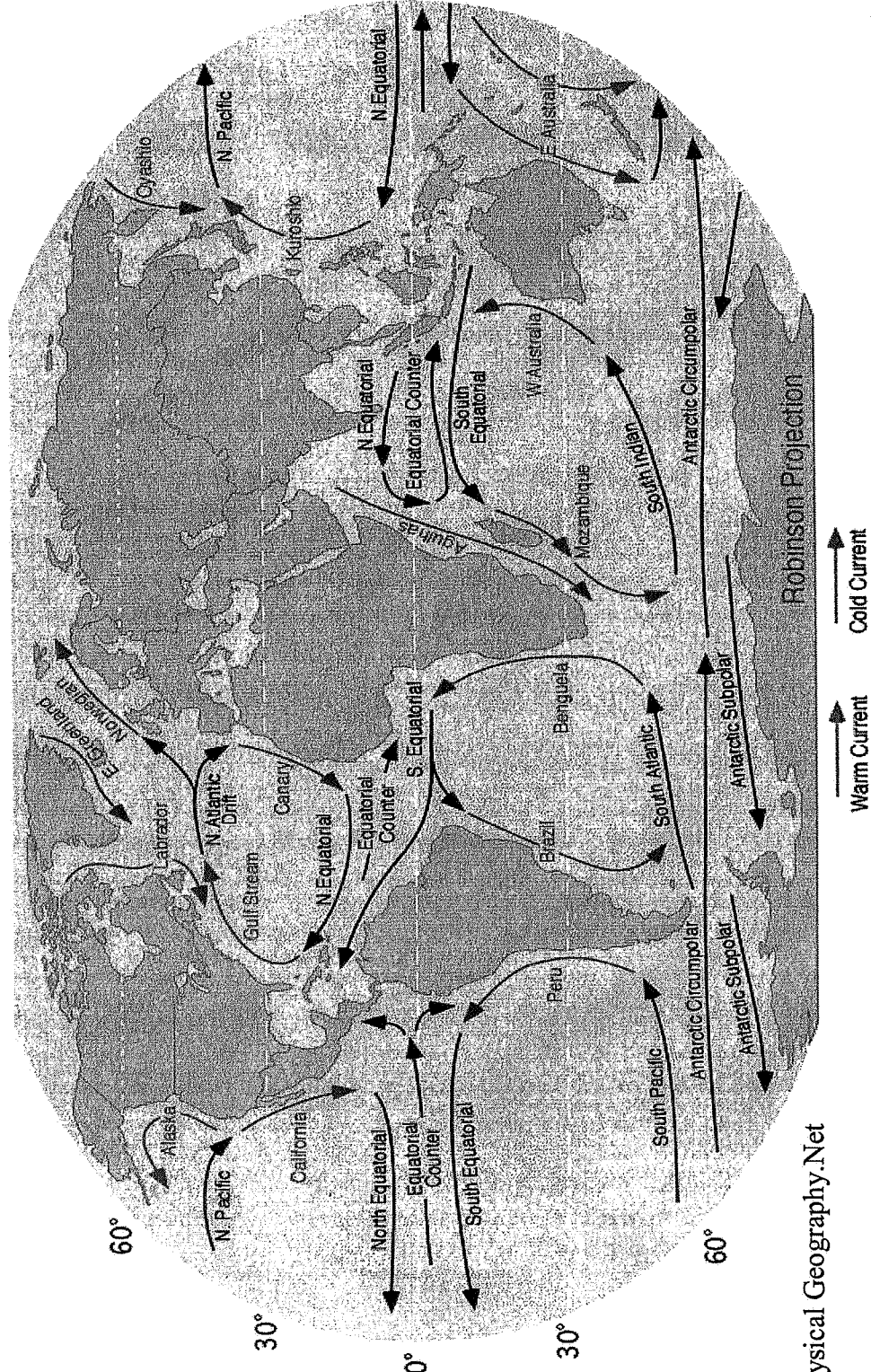
Interpolated Animation of Global Winds as Viewed from the NASA Sea Winds Instrument



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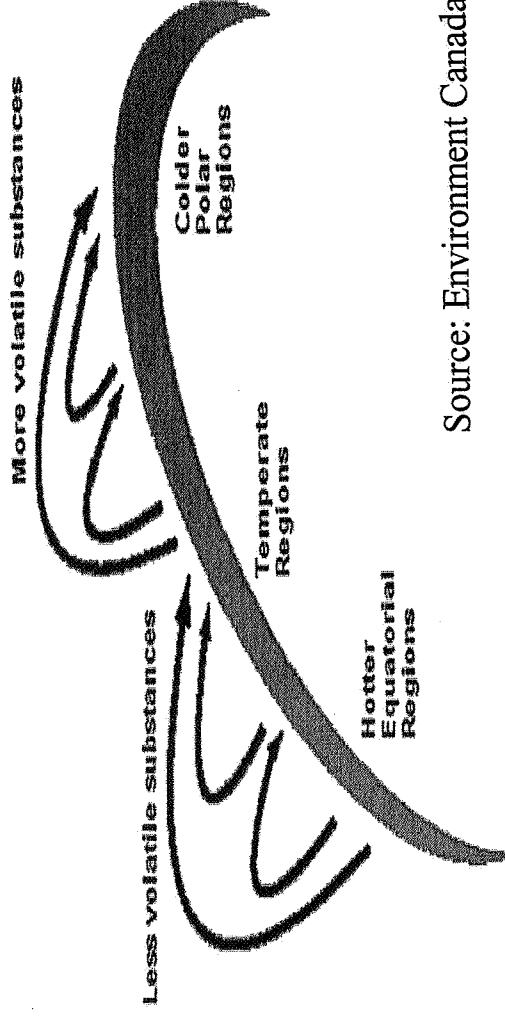
Potential Distribution via Oceanic Surface Currents

Currents flow in complex patterns affected by wind, salinity, heat content, bottom topography, and earth's rotation.



Source: Physical Geography.Net

Grasshopper Effect & Global Fractionation



Source: Environment Canada

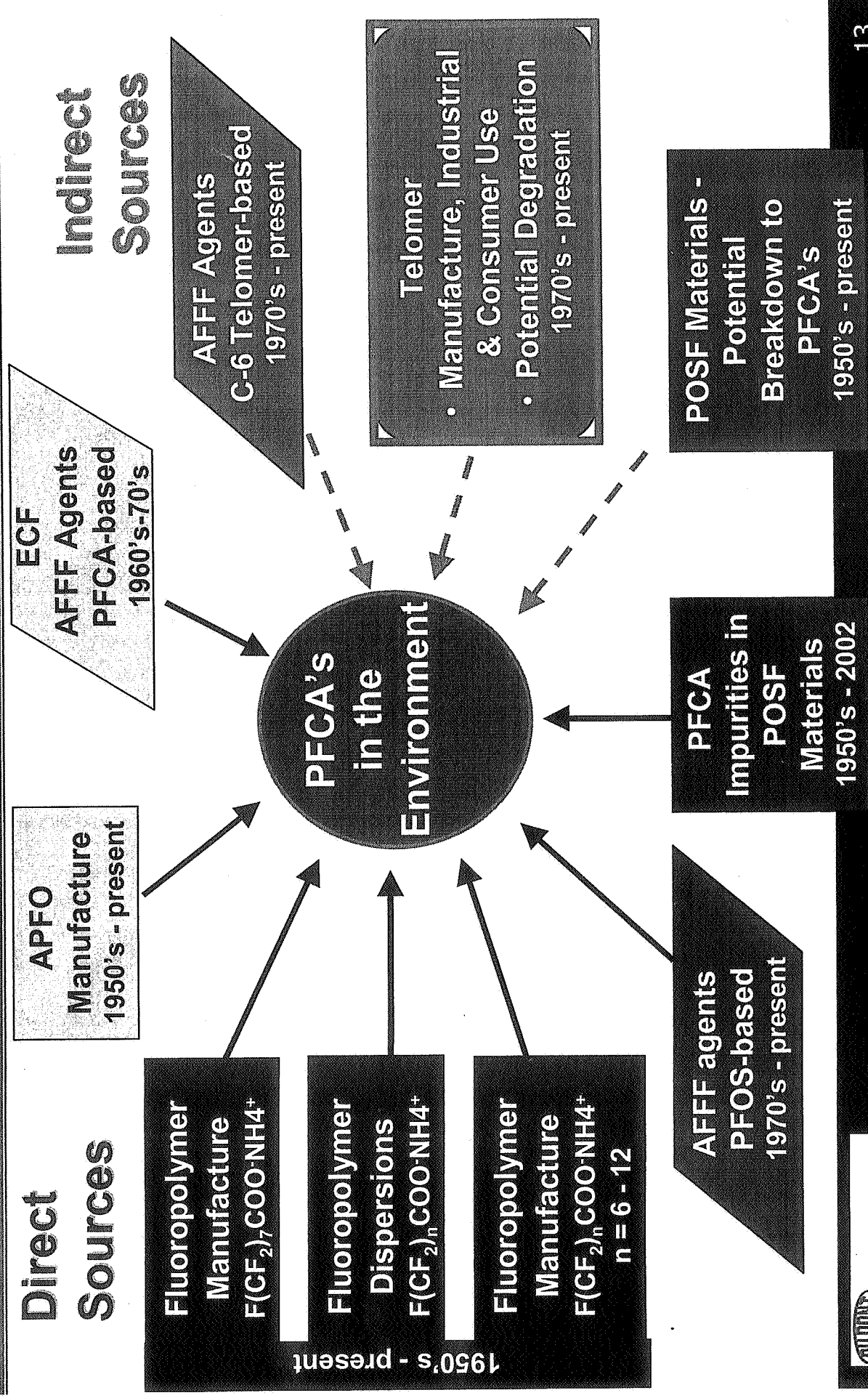
Grasshopper Effect: series of air-surface exchange events following an initial emission–deposition event.

- involves cycles of evaporation/sublimation to the atmosphere, carried by winds for a distance, and then wet deposition (i.e., rain, snow events) to land or water.

Global Fractionation: differing behaviors of chemicals as transported

- phys.-chem. prop. influence residence time and hop probability.

Potential PFCA Sources : $F(CF_2)_n COO^-$



Are Fluorotelomer-Based Polymers a Potential Source of PFCAs?

- To evaluate Fluorotelomer-based Polymers (FTBP) as a potential contributor, we will need to look at the potential for the FTBP to be degraded.

Evaluating Degradation Potential of Fluoro-Telomer-Based Polymers (FTBP)

- **Abiotic Transformation**
 - Hydrolysis
 - Thermal (Incineration Studies)
 - Photochemical Stability under Industrial & Consumer Use conditions
- **Biodegradability: Sewage Treatment Plant**
 - Modified Zahn-Wellens Test per OECD 302B
 - STP Simulation Test per OECD 303A
 - Anaerobic Biodegradability of Organic Compounds in Digested Sludge per OECD 311

Evaluating Degradation Potential of Fluoro-Telomer-Based Polymers (FTBP)

- **Biodegradability: Soils and Sediments**
 - Aerobic and Anaerobic Biodegradation Studies
 - Range of soils and sediments to allow for evaluation of differences in physical-chemical parameters that may influence biodegradability potential.
 - Expected Duration: 1 year
 - Determine Kinetics (if possible)

Summary

- Cannot fully answer questions about PFCA sources in environment and biota without understanding contributions of emissions from all PFCA sources:
 - Need to develop a global distribution model to evaluate relationship of 50 yrs. of PFCA emissions with presence in environment and biota.
- Need to Understand if Fluorotelomer-based Polymers Transform

Potential Distribution Via Air- Global Winds: Circulation Cells and Prevailing Wind Belts

