

## *NKS NordRisk II*

# Atlas of Long-range Atmospheric Dispersion Model Calculations

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# Risk Atlas



Risks from long-range atmospheric dispersion and deposition of radionuclides from selected nuclear risk sites in the Northern Hemisphere.

Considers climatic effects from different regimes (annual averages for selected years), as well as from geographic regions (coastal and continental).

Risk indicators: annual average time-integrated concentration and total deposition fields.

Atlas to be used for probabilistic risk assessment, e.g. emergency preparedness planning and educational purposes.

# Risk Sites

Geographical positions of the 16 selected risk sites

- Kola
- Novaya Zemlya
- Balakovo
- Belojarask
- Bilibino
- Kanupp
- Sinpo



- Sellafield
- Borssele
- Tricastin
- Dukovany
- Leningrad
- Chernobyl
- Kosloduj

- Davis Besse
- Savannah River

# Source Term

Ground-level non-buoyant unit releases of three forms of radionuclides:

	<sup>137</sup> Cs aerosol	<sup>131</sup> I aerosol	<sup>131</sup> I elementary gas
Half life (days)	1.1 · 10 <sup>4</sup>	8.07	8.07
Particle diameter (µm)	0.3	0.3	0
Dry deposition speed (m s <sup>-1</sup> )	0.0015	0.0015	0.015

Wet deposition parameterized according to Baklanov and Sørensen (2001).

# Meteorological Data

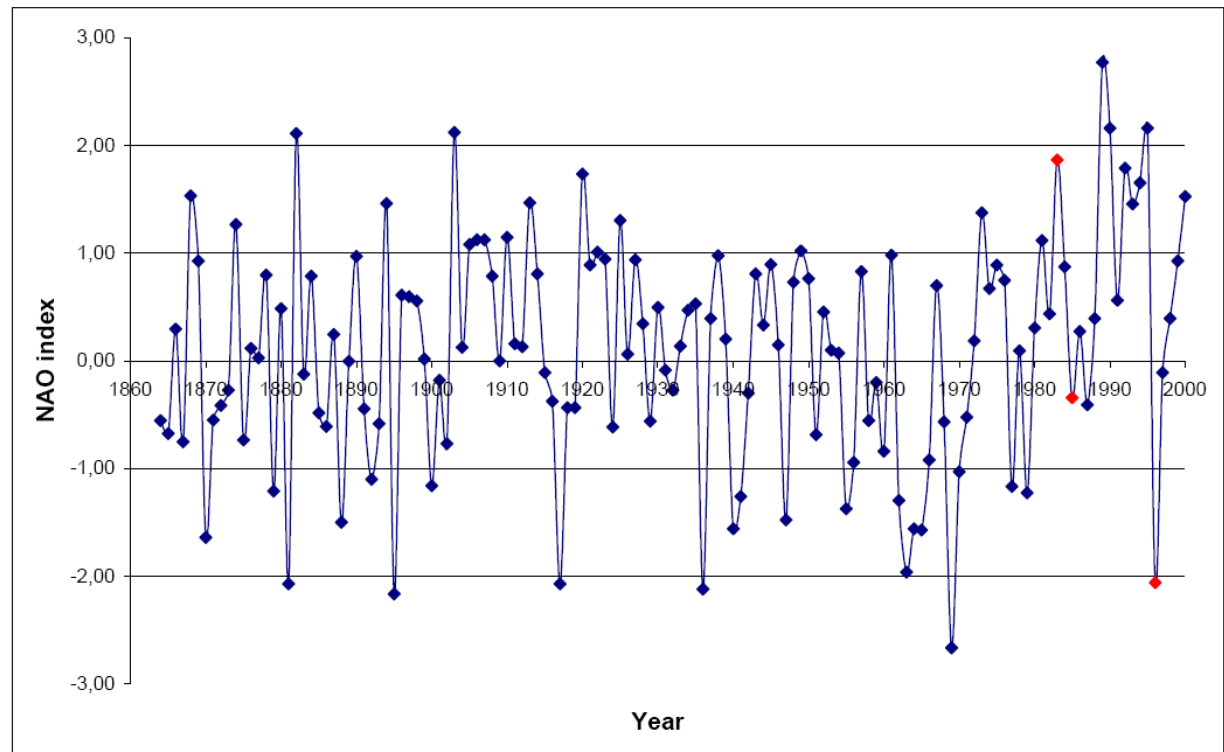
Re-analysed global meteorological data from ECMWF

Resolution:

- Temporal: 3 hourly
- Horizontal: 1.125 regular lat-long
- Vertical: 28 hybrid levels

North Atlantic  
Oscillation (NAO)

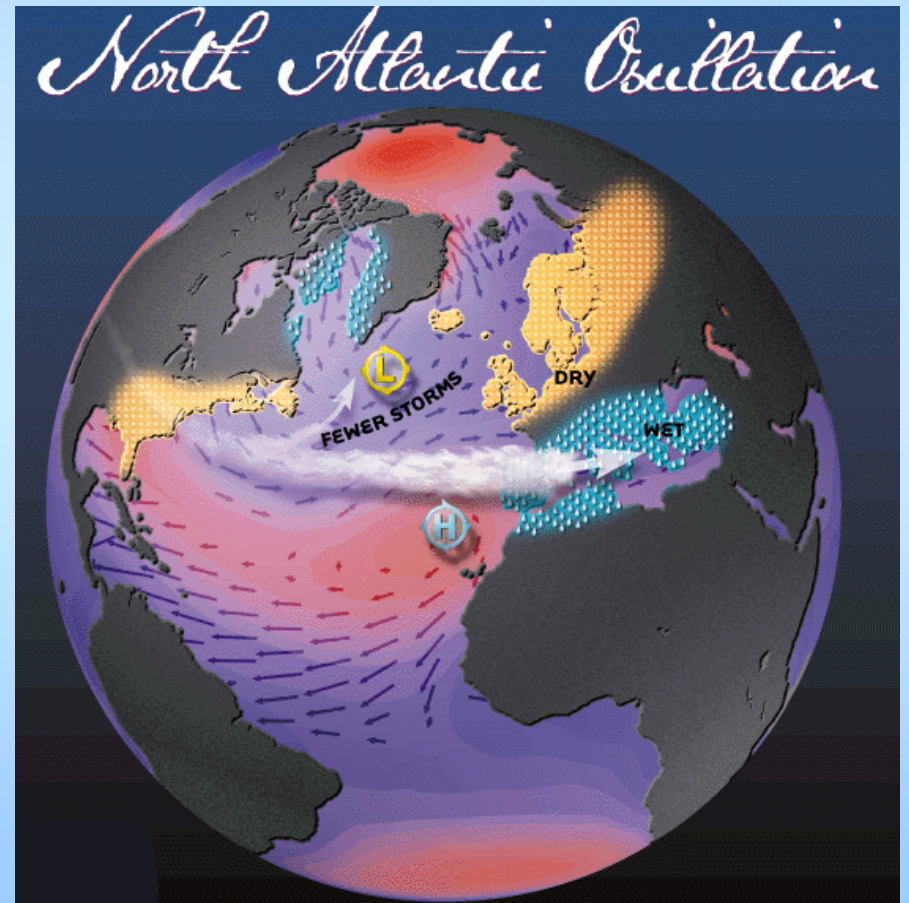
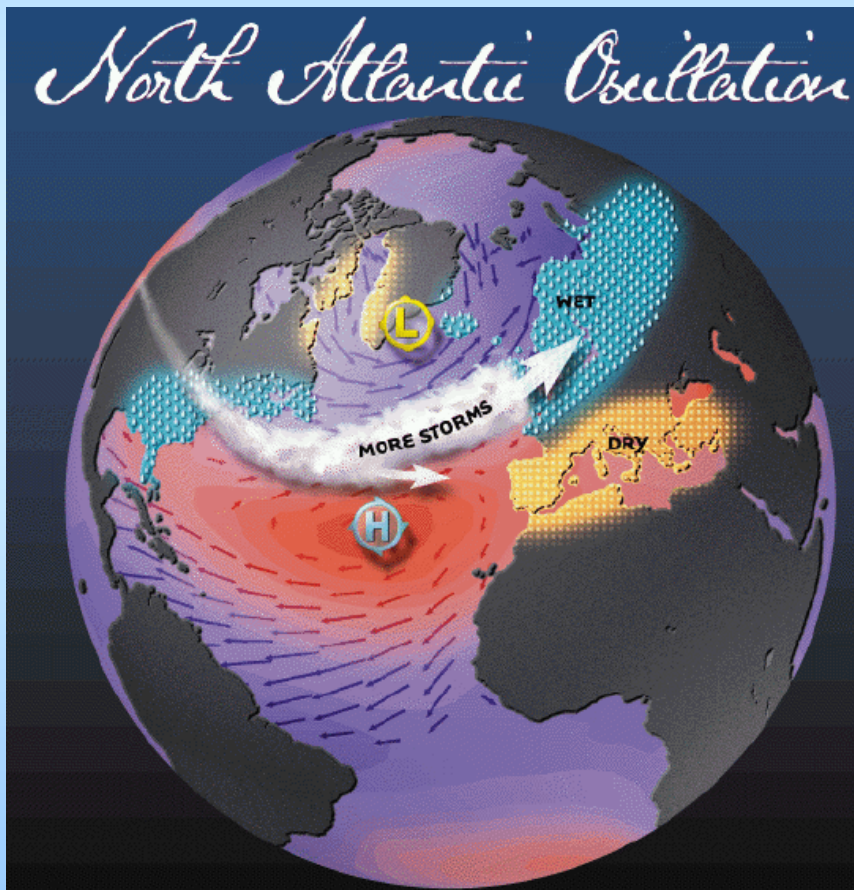
Three full years selected:  
1983, 1985, 1996



# Meteorological Data

Positive NAO index

Negative NAO index



# Atmospheric Dispersion Model

## Danish Emergency Response Model of the Atmosphere (DERMA):

- 3-D atmospheric long-range dispersion model developed at DMI
- Developed mainly for nuclear emergency preparedness
- Stochastic Lagrangian model using a puff diffusion parameterization
- Dry and wet deposition, particle size dependent
- Radioactive decay
- Simultaneous calculation for several pollutants
- Simultaneous calculations for several release points
- Uses data from the DMI-HIRLAM or ECMWF NWP models.

# Super Computer

Cray XT5

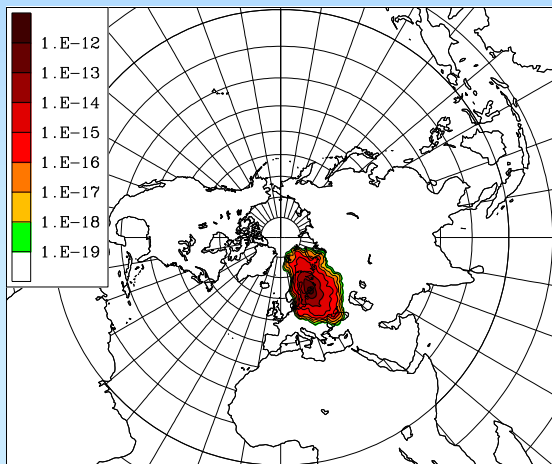


# Time Development

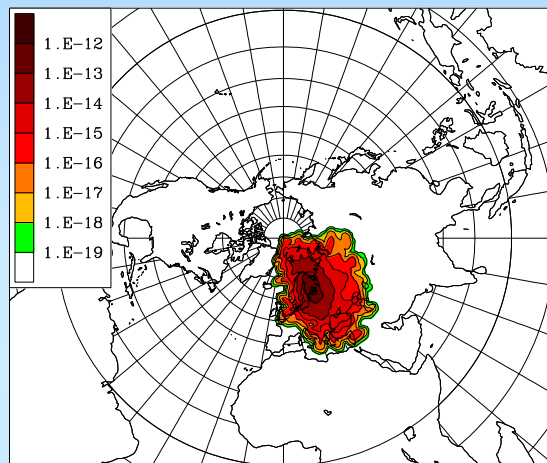


Total deposition of  $^{137}\text{Cs}$  ( $\text{m}^{-2}$ ) (Leningrad, 1983)

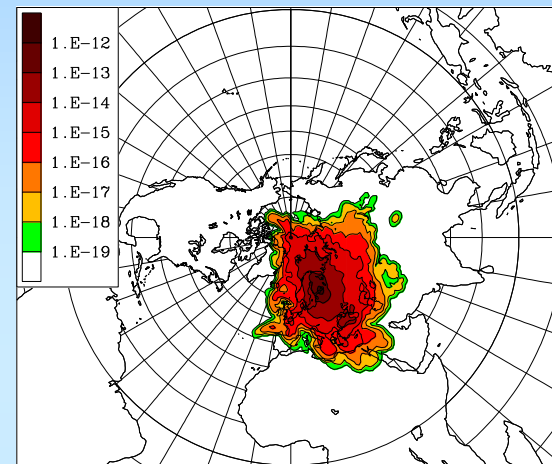
1 day



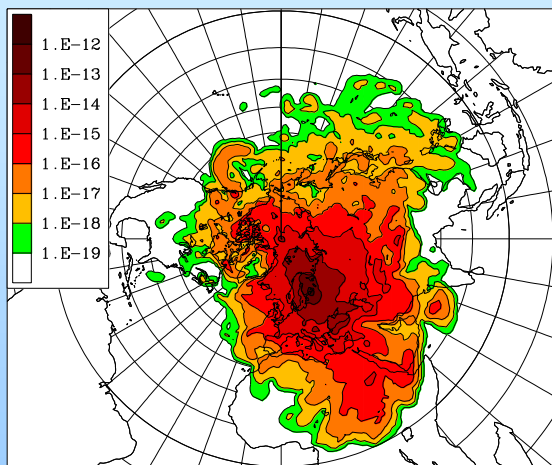
2 days



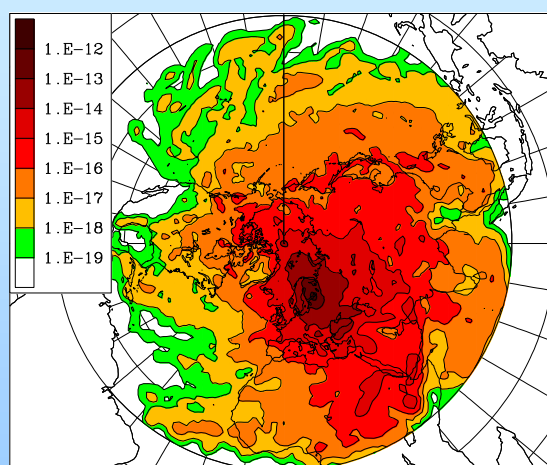
3 days



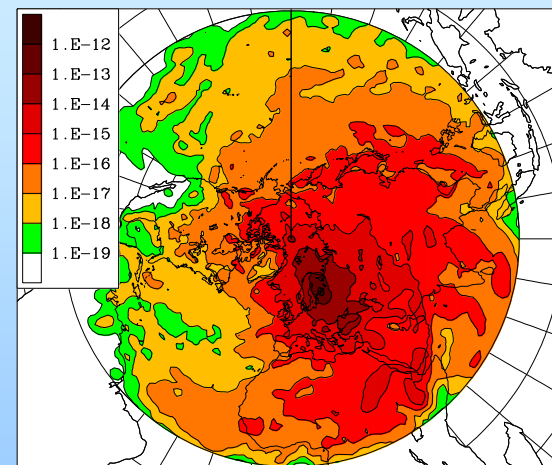
7 days



14 days



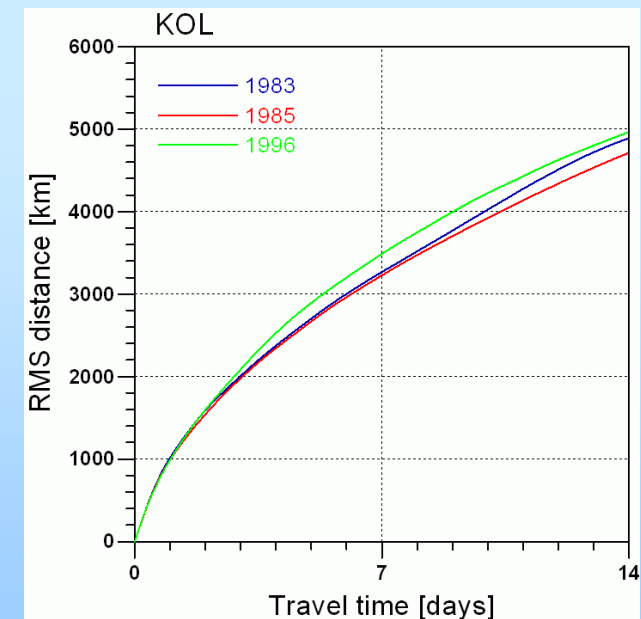
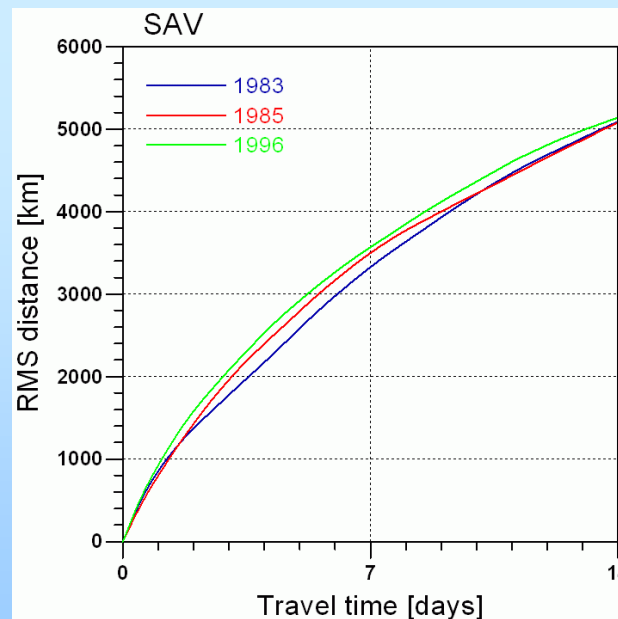
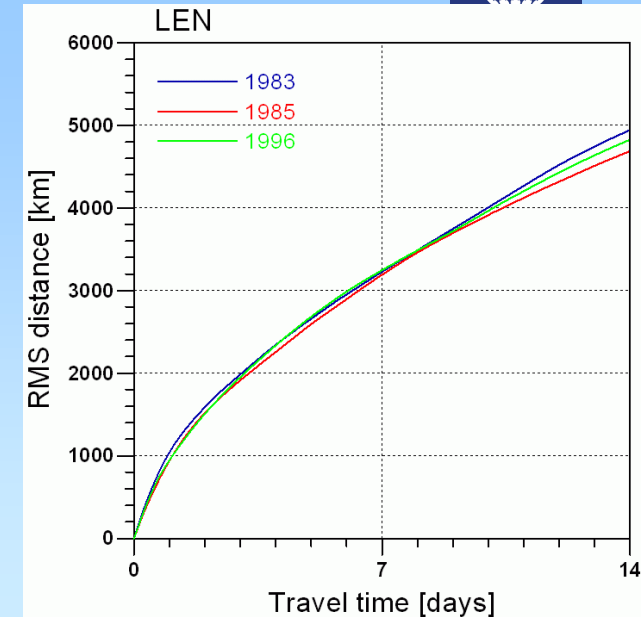
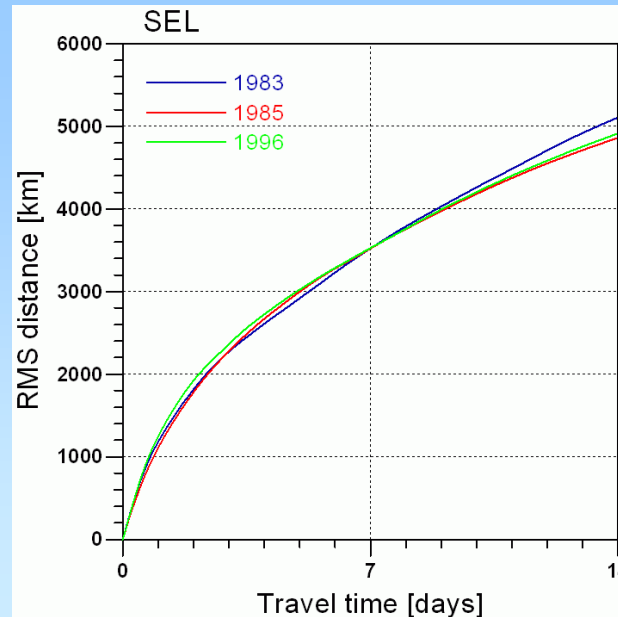
30 days





# Ensemble Mean Dispersion

Root-mean-square distance from release sites to puff centres as function of travel time. Annual averages for 1983, 1985 and 1996.

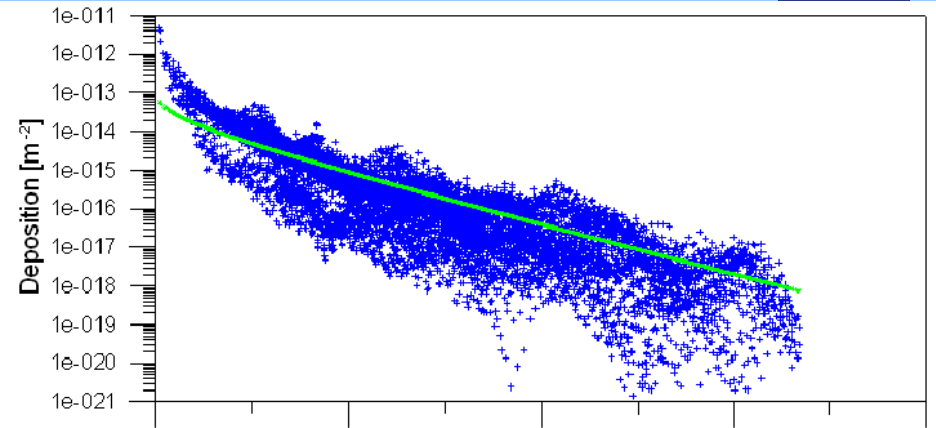


# Ensemble Mean Dispersion

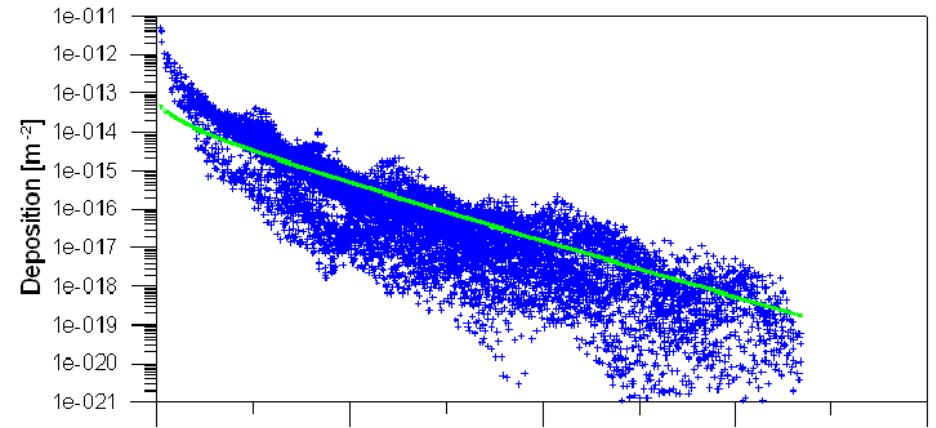
Annual mean deposition as function of the distance from the release site (Leningrad, 1983).

The averages (green curves) result from non-linear regression.

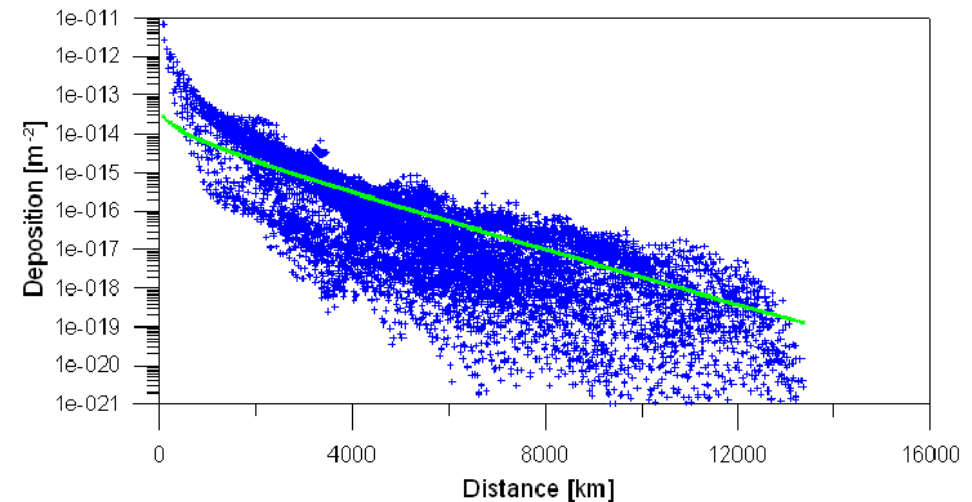
$^{137}\text{Cs}$



$^{131}\text{I}_{\text{aero.}}$



$^{131}\text{I}_{\text{gas}}$

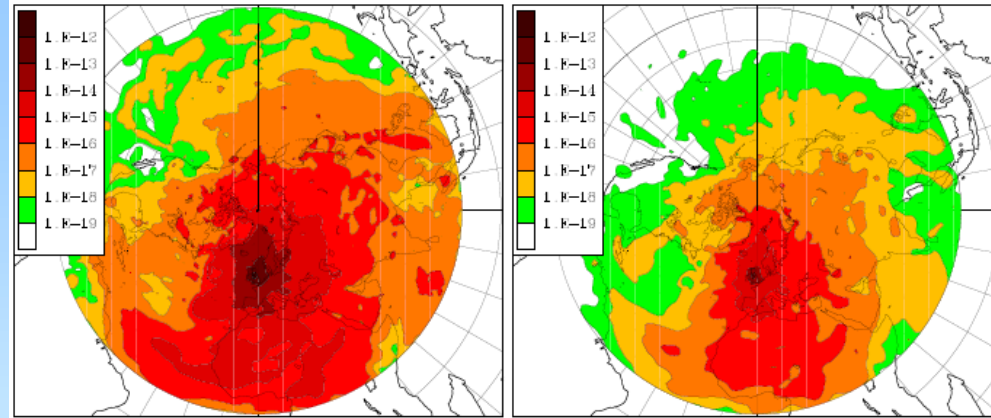


# Ensemble Mean Dispersion

1983

Deposition ( $\text{m}^{-2}$ )

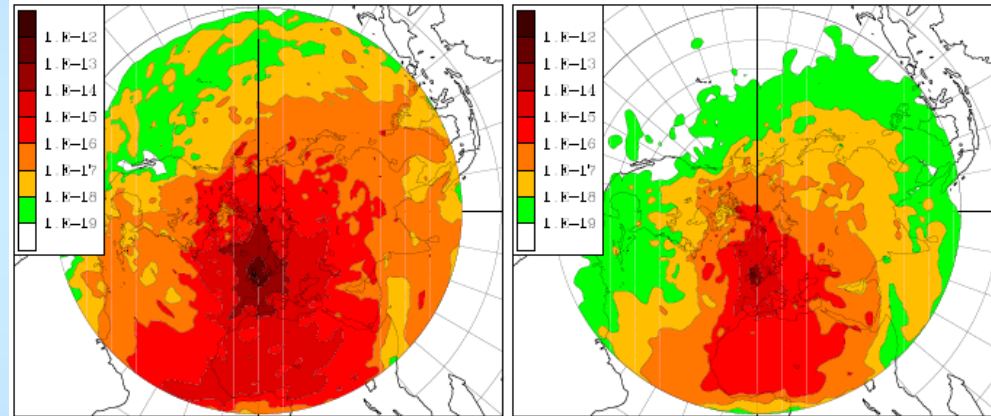
TIC ( $\text{h m}^{-3}$ )



Annual mean

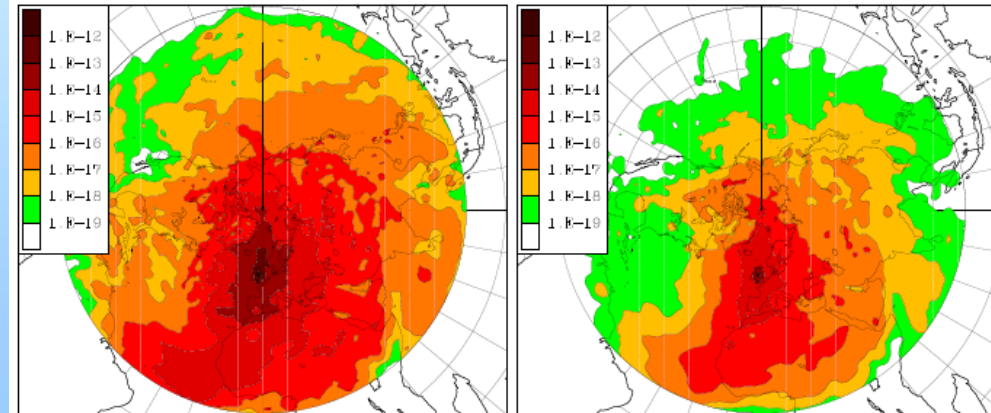
Release site:  
Sellafield

1985



Radionuclide:  
Cs-137 aerosol

1996

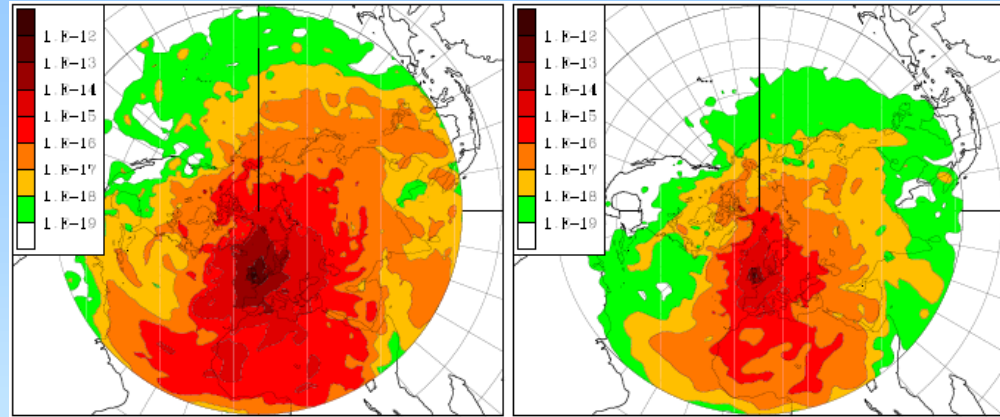


# Ensemble Mean Dispersion

1983

Deposition ( $\text{m}^{-2}$ )

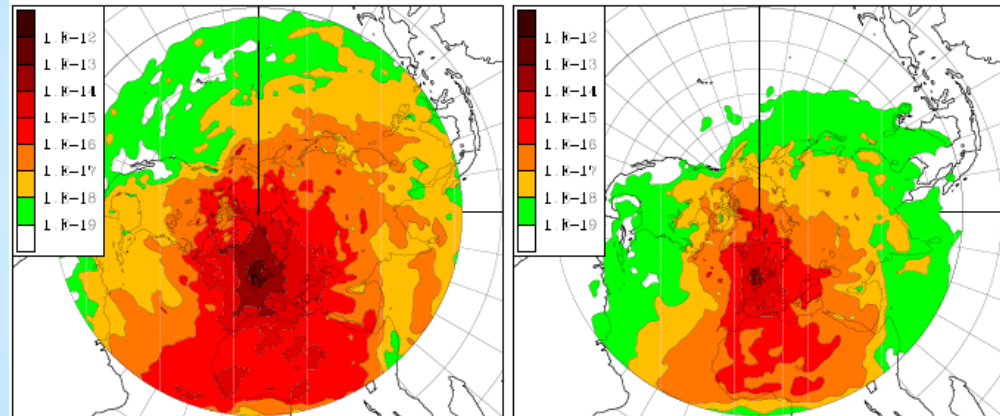
TIC ( $\text{h m}^{-3}$ )



Annual mean

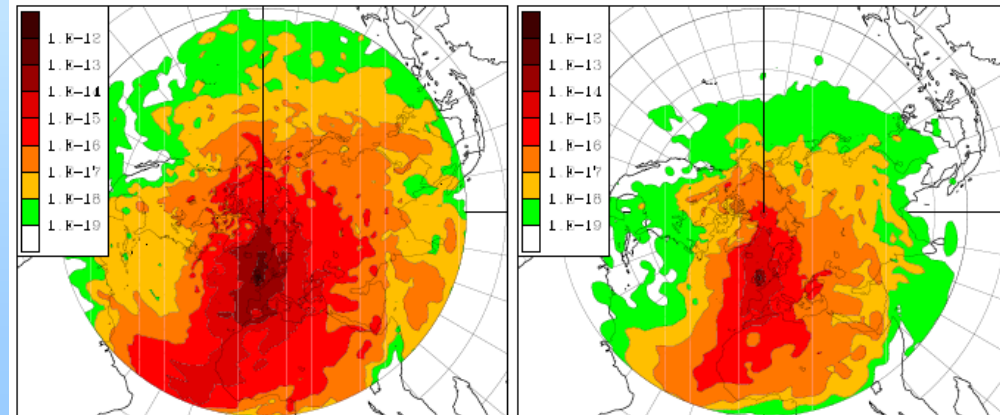
Release site:  
Sellafield

1985



Radionuclide:  
I-131 aerosol

1996

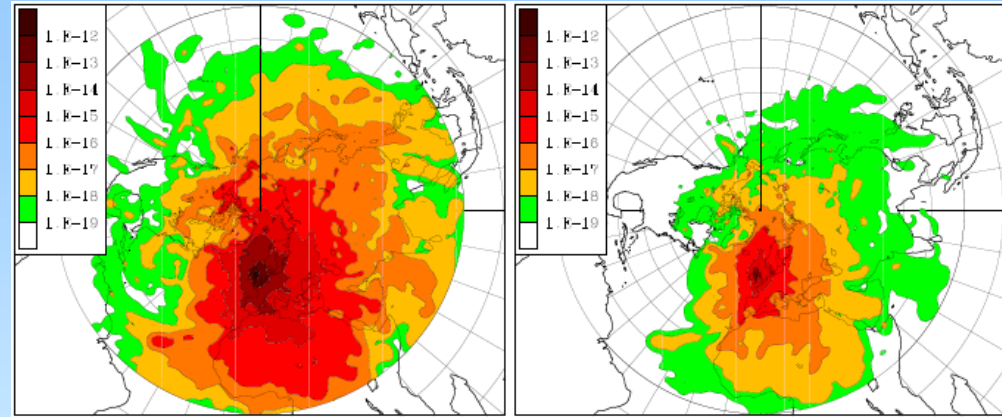


# Ensemble Mean Dispersion

1983

Deposition ( $\text{m}^{-2}$ )

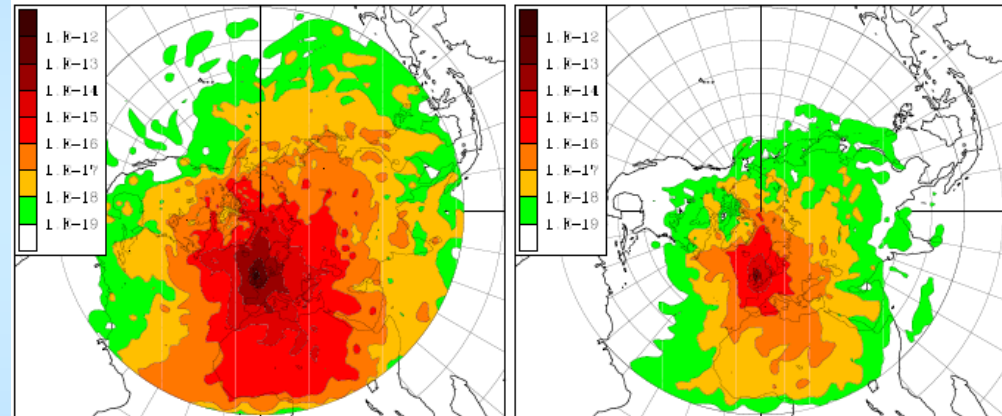
TIC ( $\text{h m}^{-3}$ )



Annual mean

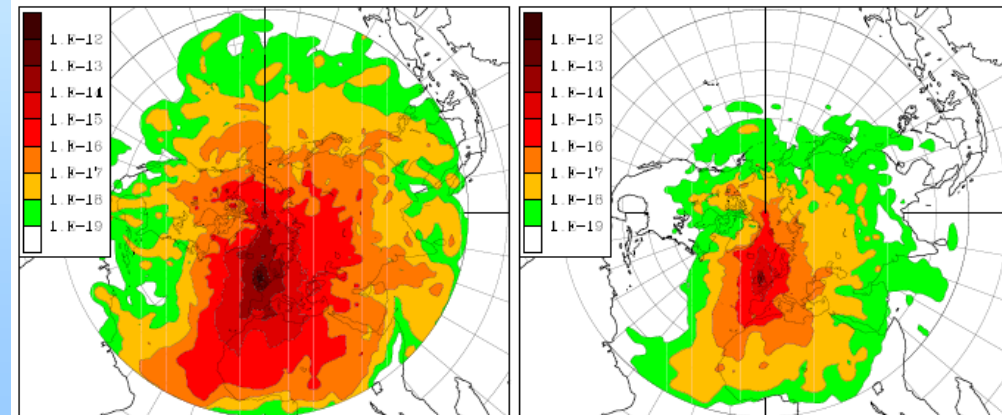
Release site:  
Sellafield

1985



Radionuclide:  
I-131 gas

1996

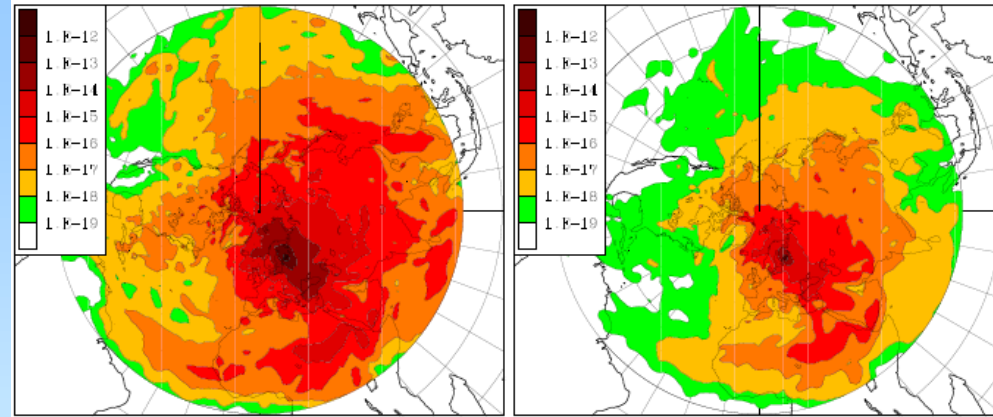


# Ensemble Mean Dispersion

1983

Deposition ( $\text{m}^{-2}$ )

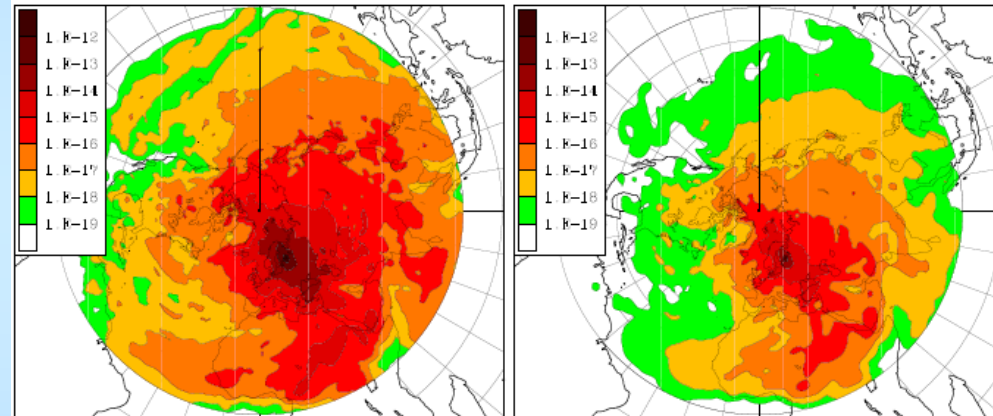
TIC ( $\text{h m}^{-3}$ )



Annual mean

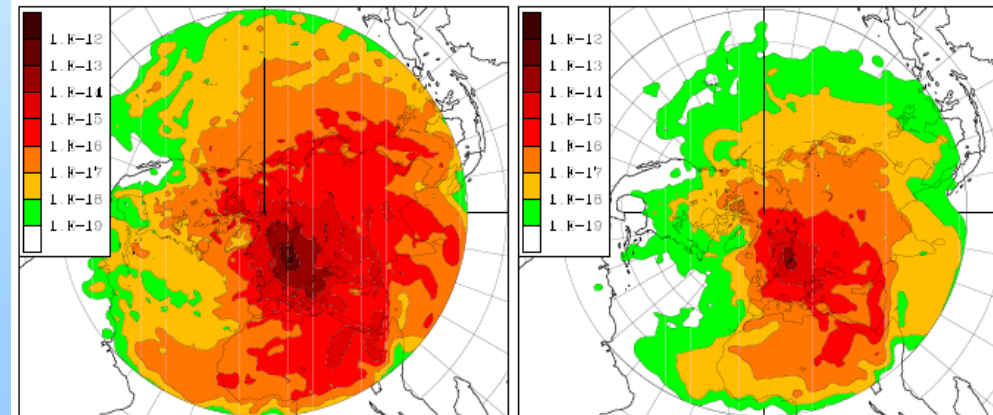
Release site:  
Leningrad

1985



Radionuclide:  
Cs-137 aerosol

1996

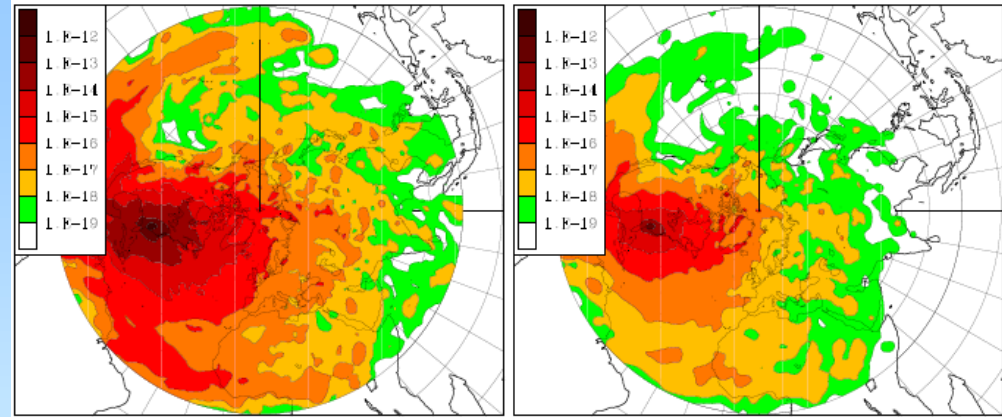


# Ensemble Mean Dispersion

1983

Deposition ( $\text{m}^{-2}$ )

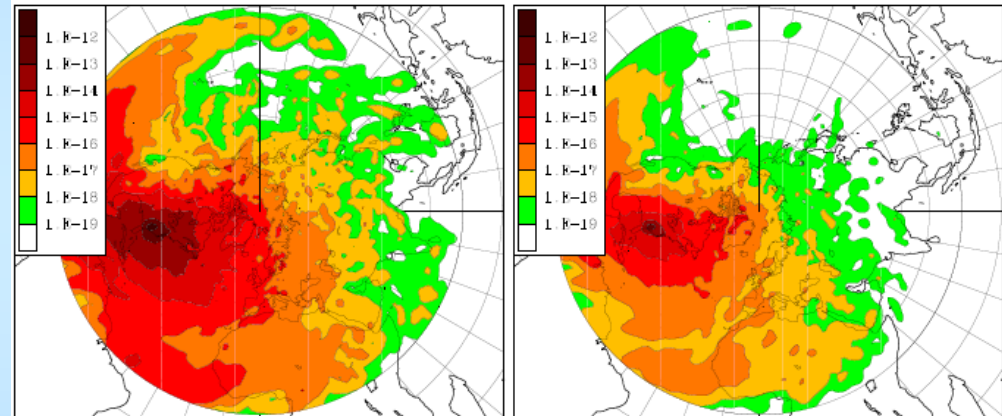
TIC ( $\text{h m}^{-3}$ )



Annual mean

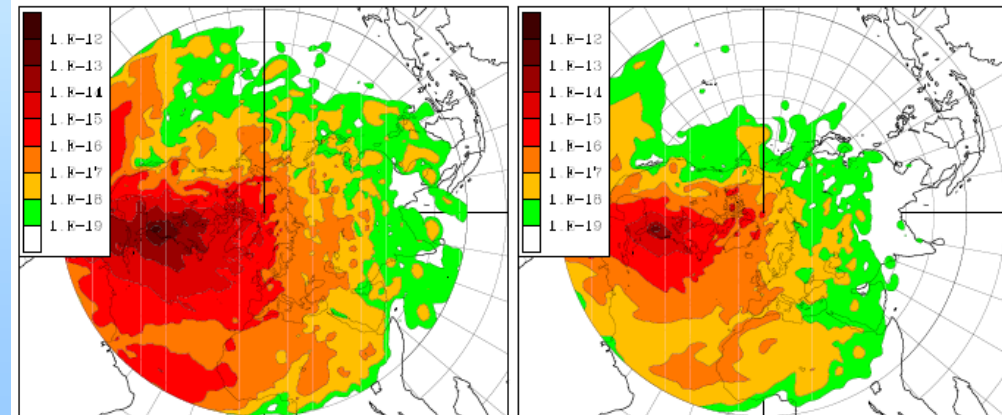
Release site:  
Savannah River

1985



Radionuclide:  
Cs-137 aerosol

1996

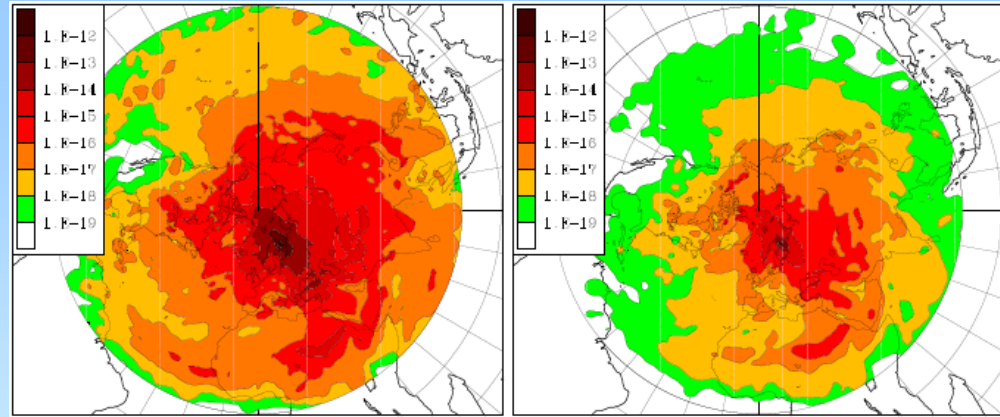


# Ensemble Mean Dispersion

1983

Deposition ( $\text{m}^{-2}$ )

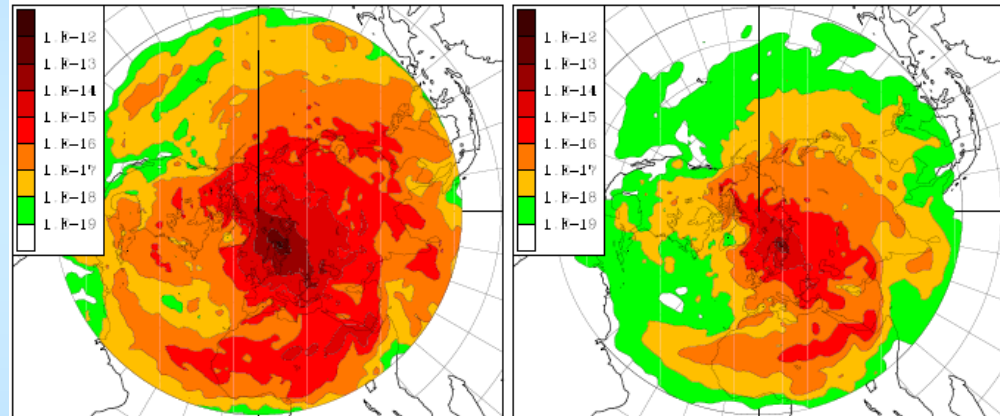
TIC ( $\text{h m}^{-3}$ )



Annual mean

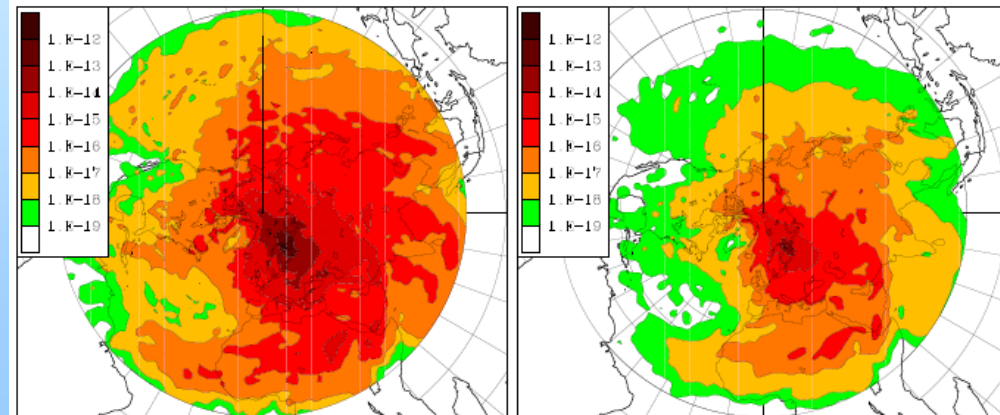
Release site:  
Kola

1985



Radionuclide:  
Cs-137 aerosol

1996



# Atlas



NKS-242 Report available

- in hardcopy from the NKS secretariat, and
- in PDF from <http://www.nks.org>.
- Results can be viewed with the ARGOS decision-support system