Ozone transport from Africa to South Asia :

IASI observations and Méso-NH simulations

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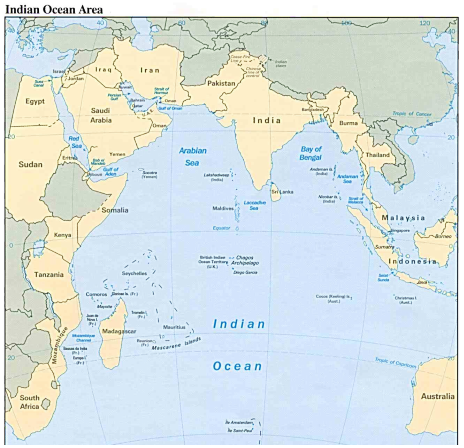
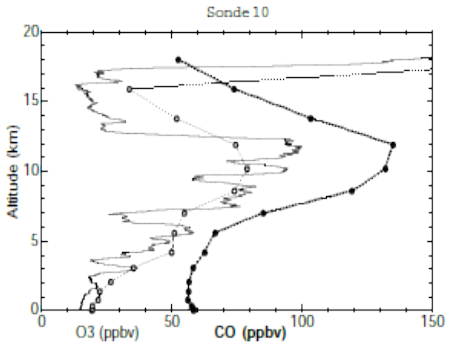
(Laboratoire d'Aérologie)

Context :

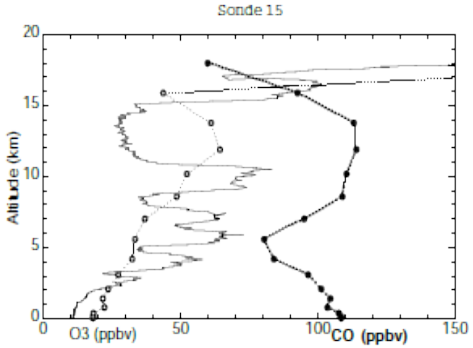
INDOEX
INDIAN OCEAN EXPERIMENT



→ O_3 mid-upper tropospheric peaks and laminae

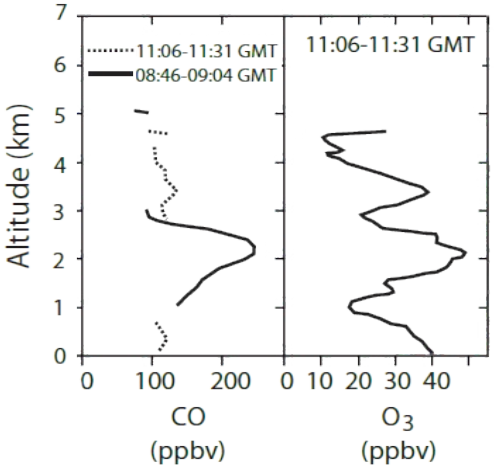


INDOEX O_3 profile 1995



INDOEX O_3 profile 1998

de Laat et al., ACP, 2002



INDOEX O_3 profile 1999

Lawrence and Lelieveld, ACP, 2010

→ Hypothesis on the origin of the ozone?

STE along the Subtropical Jet
(Zachariasse et al., 2000)

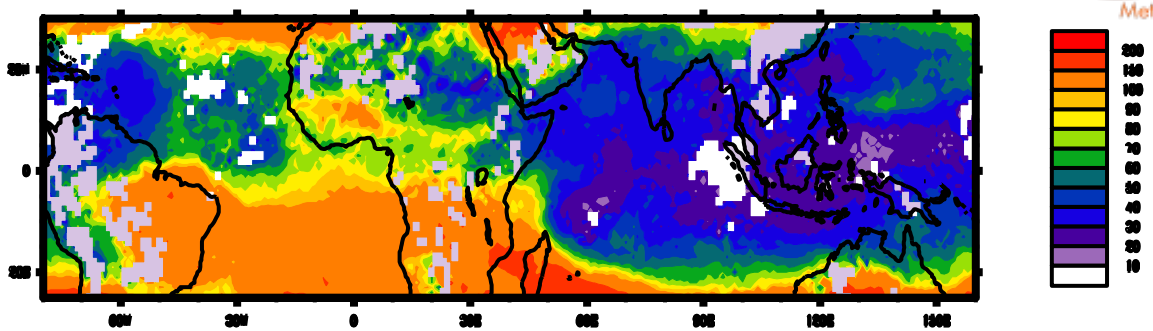
Uplift/westward transport of **Asian pollution** to south Atlantic
(Chatfield et al., 2007)

Eastward advection of air masses impacted by **African BB**
(de Laat et al., 2002)

Context :

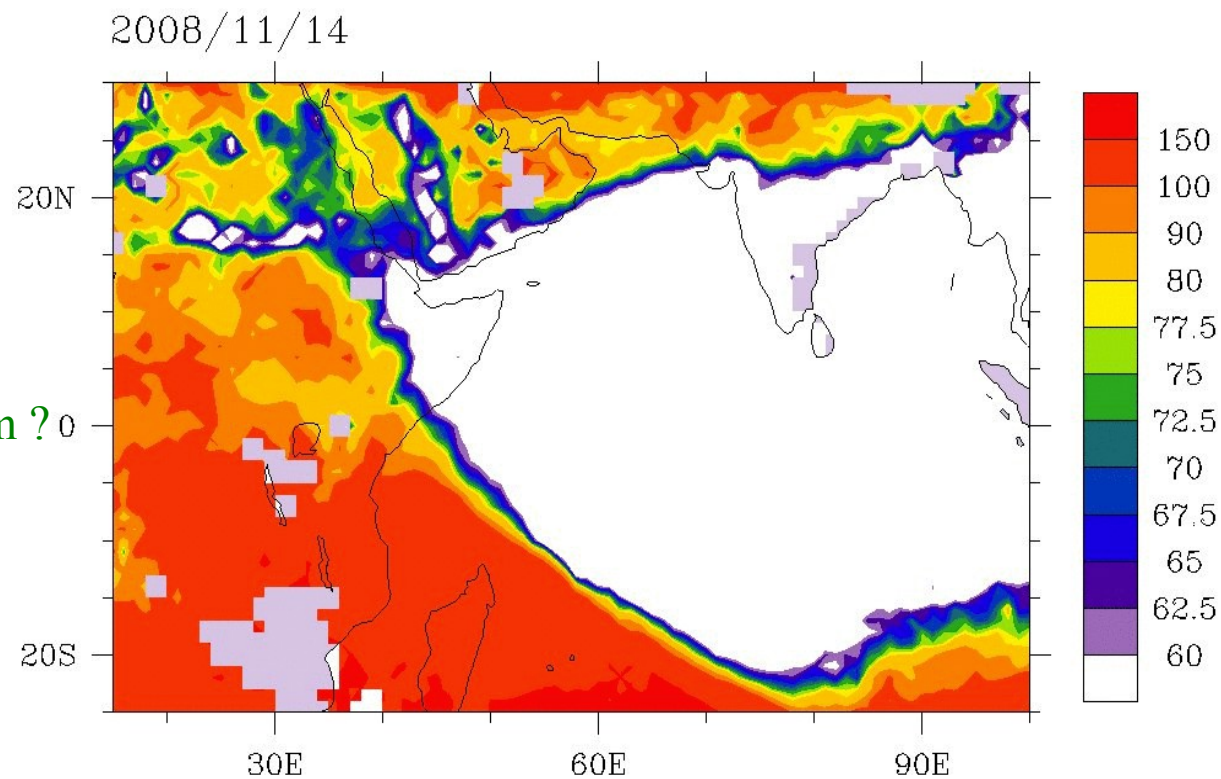
Post-monsoon = low UT O_3 over the Indian Ocean

IASI O_3 at 210 hPa 1 - 3 Nov 2008



IASI O_3 at 210 hPa 14 Nov. - 9 Dec. 2008

O_3 channel = high level transport of O_3 from Africa (26 Nov.) to NE India (4 Dec.)



Where does the O_3 channel come from ?

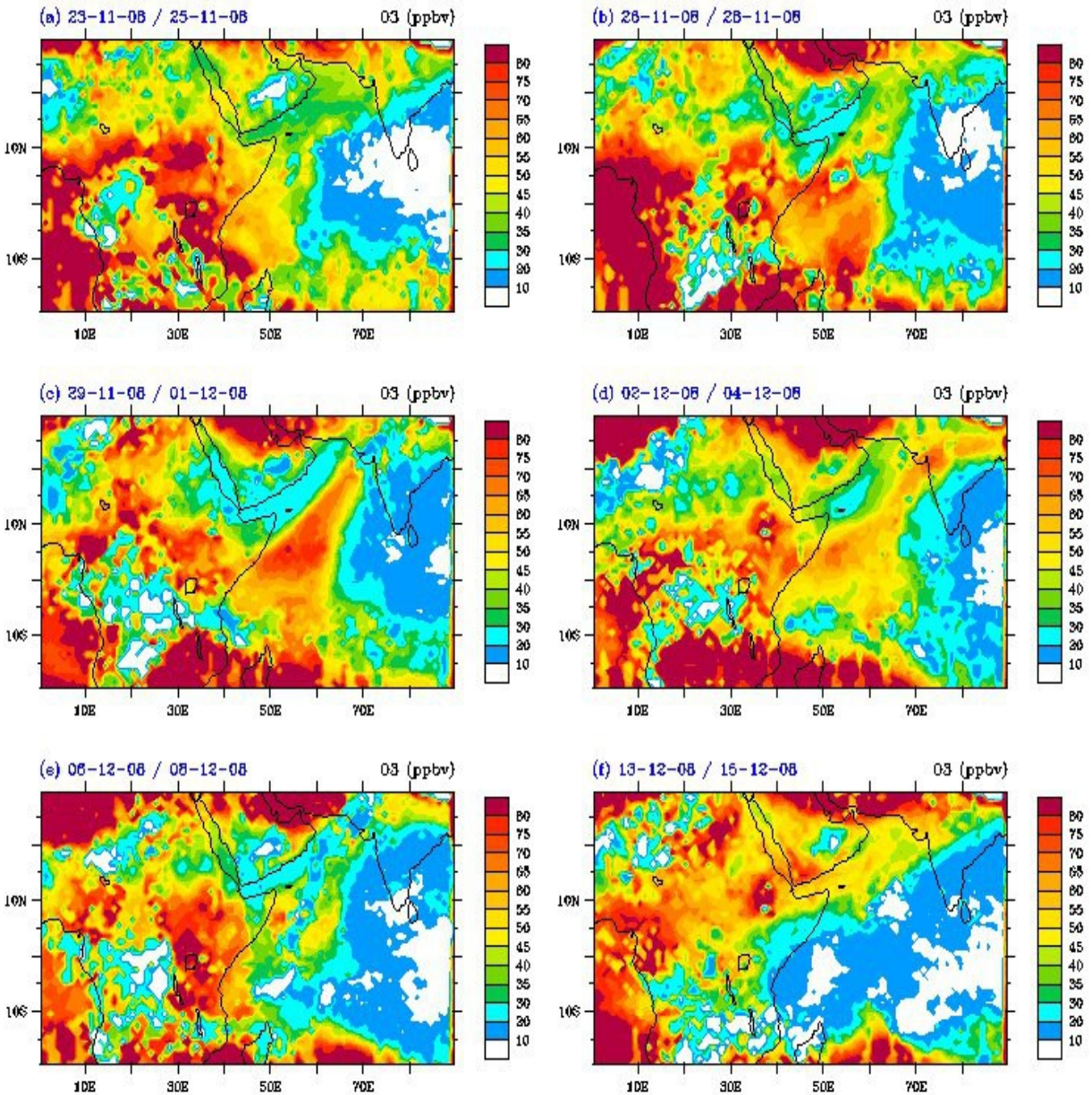
- South SWJ / **UTLS** ?
- **Africa** / BB?, LiNOx ?

Context :

IASI SOFRID O_3 at 210 hPa

UT O_3 variations
14 Nov. - 9 Dec. 2008 :

O_3 channel = high level transport of O_3 from Africa (26 Nov.) to NE India (4 Dec.)



Where does the O_3 channel come from?

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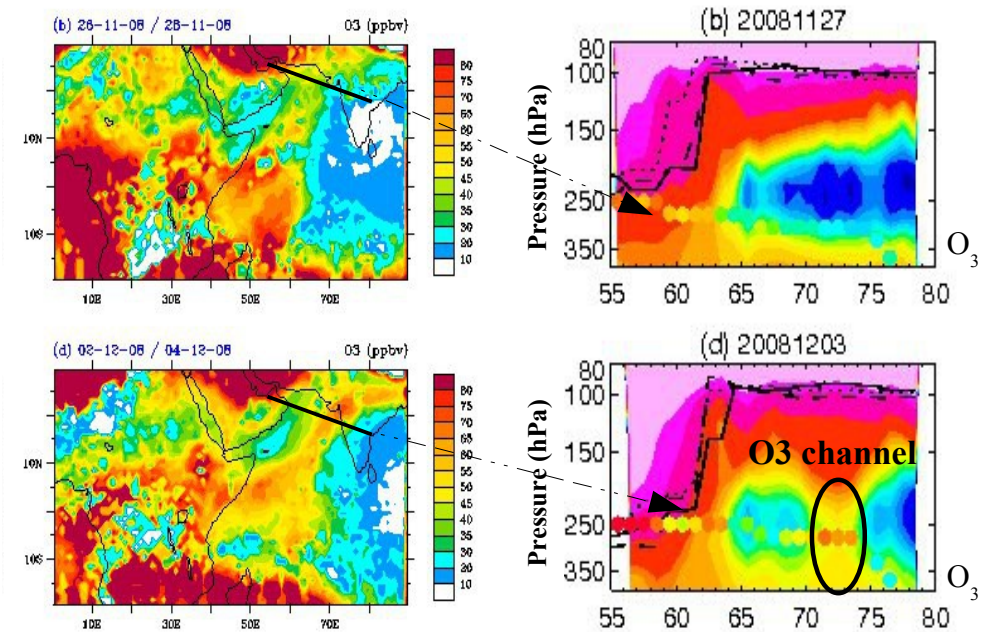
- **Africa** / BB?, LiNOx ?

Context :

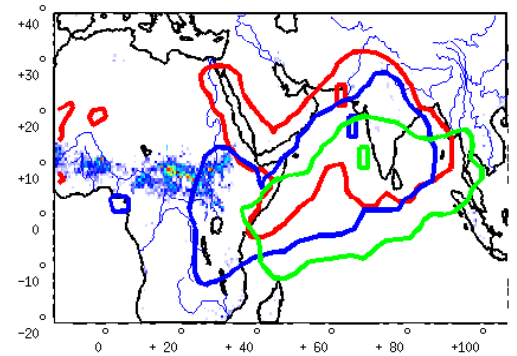
IASI O_3 data

MOZAIC airborne data from Hyderabad-Frankfurt flights



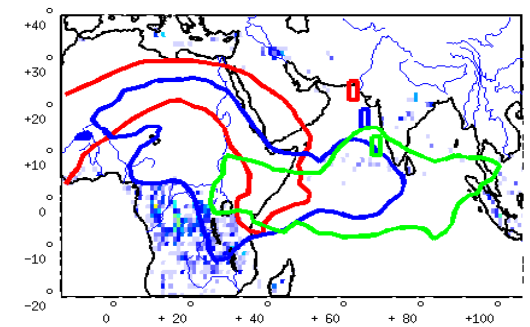
→ Air-mass origin

Contours of integrated residence times
(10 days backtrajectories) - FLEXPART



Lower Troposphere

Biomass burning
(Modis)



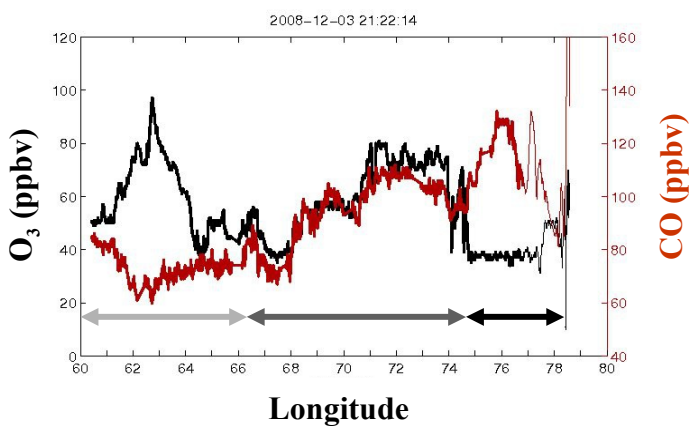
Upper Troposphere

Lightning
(LIS)

Particles released between Nov. 30-Dec. 2 from:

→ Air-mass chemical characterization

MOZAIC flight 2008/12/03 in Arabian sea



→ Hypothesis :

Origin O_3 channel = Africa BB and LiNOx

Méso-NH modelisation

→ Méso-NH is a mesoscale model coupling meteo and chemistry

Objective :

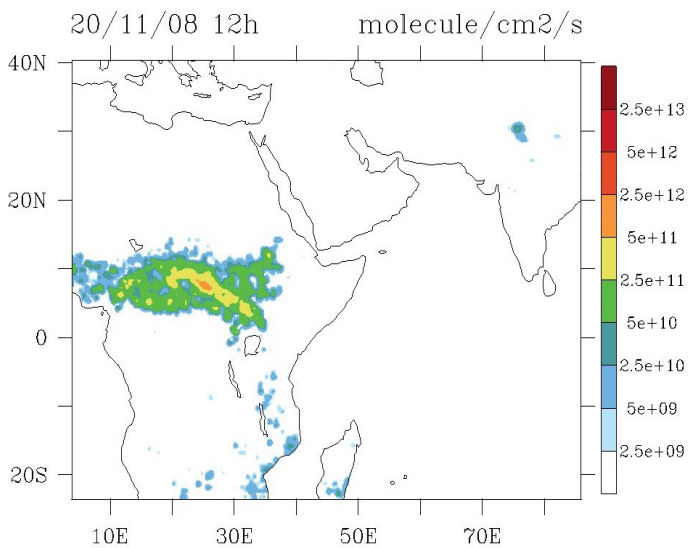
→ Model the transport of two passive tracers : NOx biomass burning and NOx lightning.

→ Determine whether or not mixture of tracers

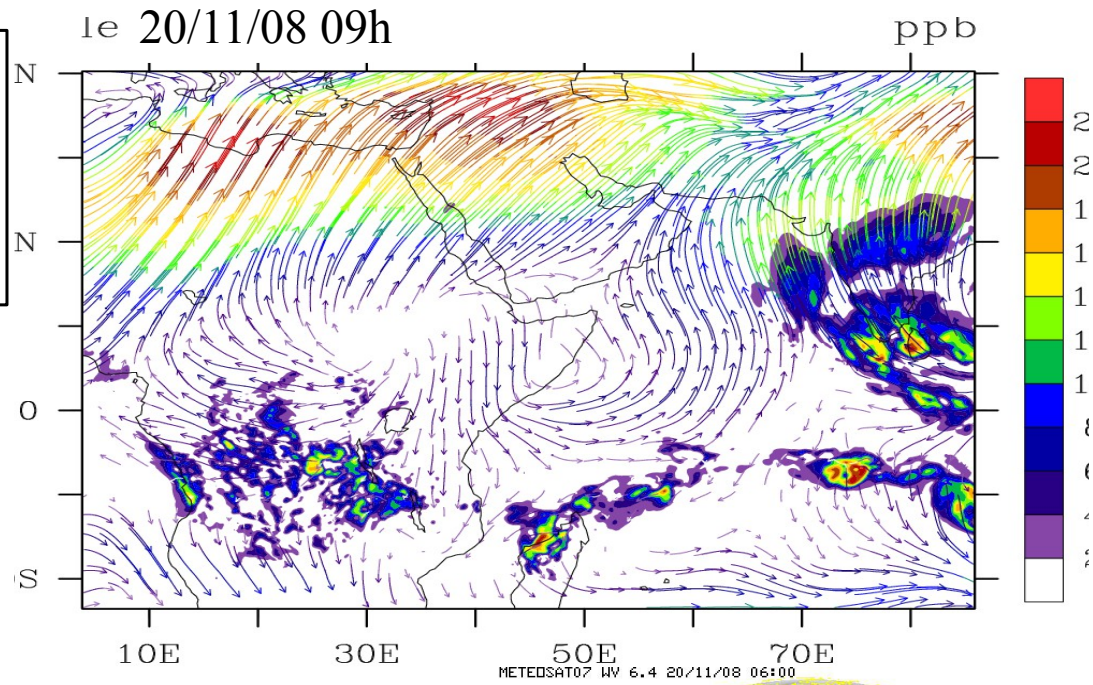
Domain size :

6700 km ~ 500 pts * 9300 km ~ 600 pts

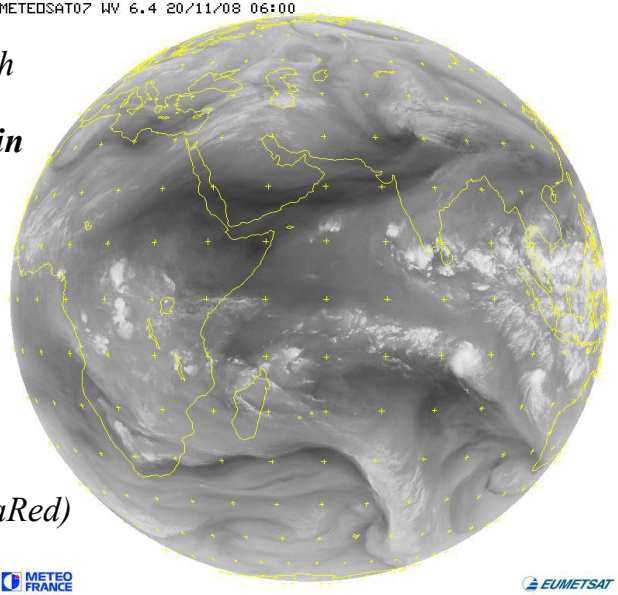
Resolution : 20 km



NOx Biomass Burning emissions
→ GFEDv3 inventory



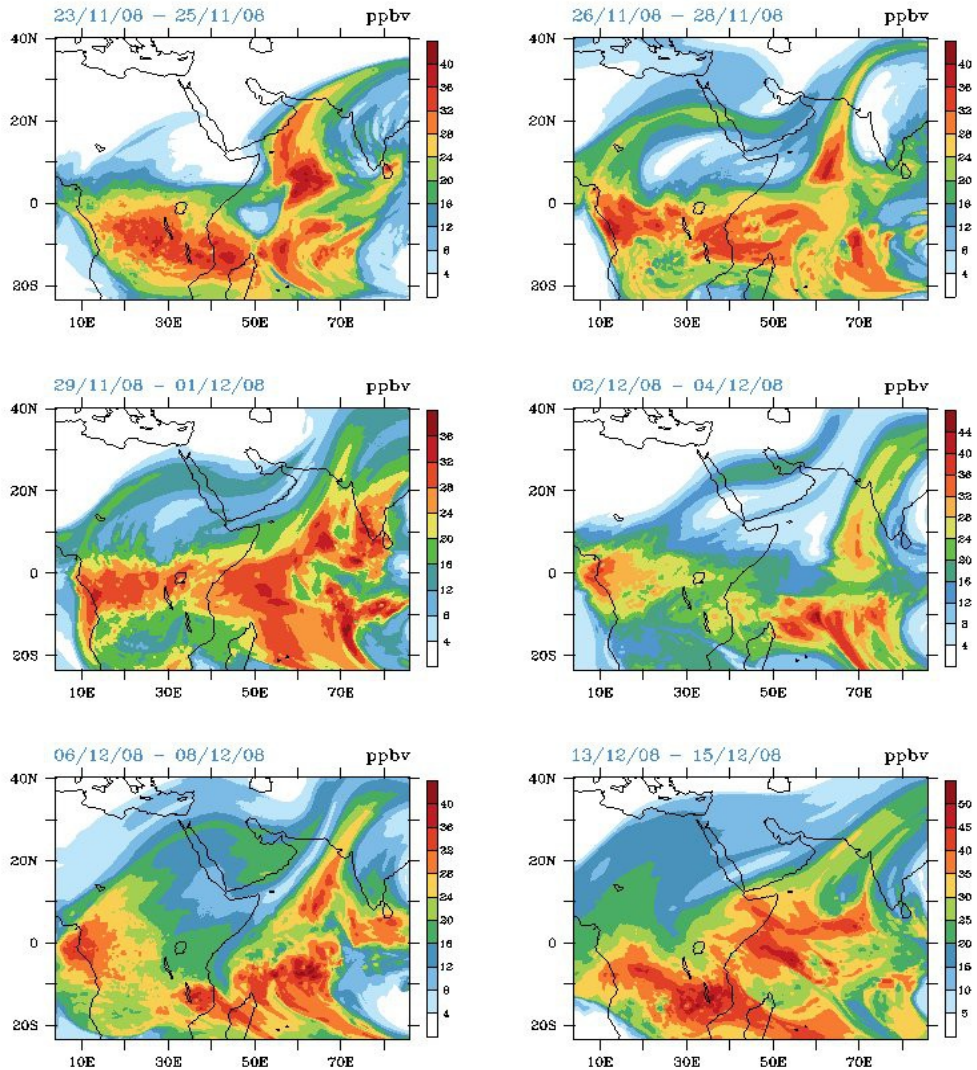
NOx distribution at 180 hPa with horizontal winds
→ lightning sources integrated in the convection scheme



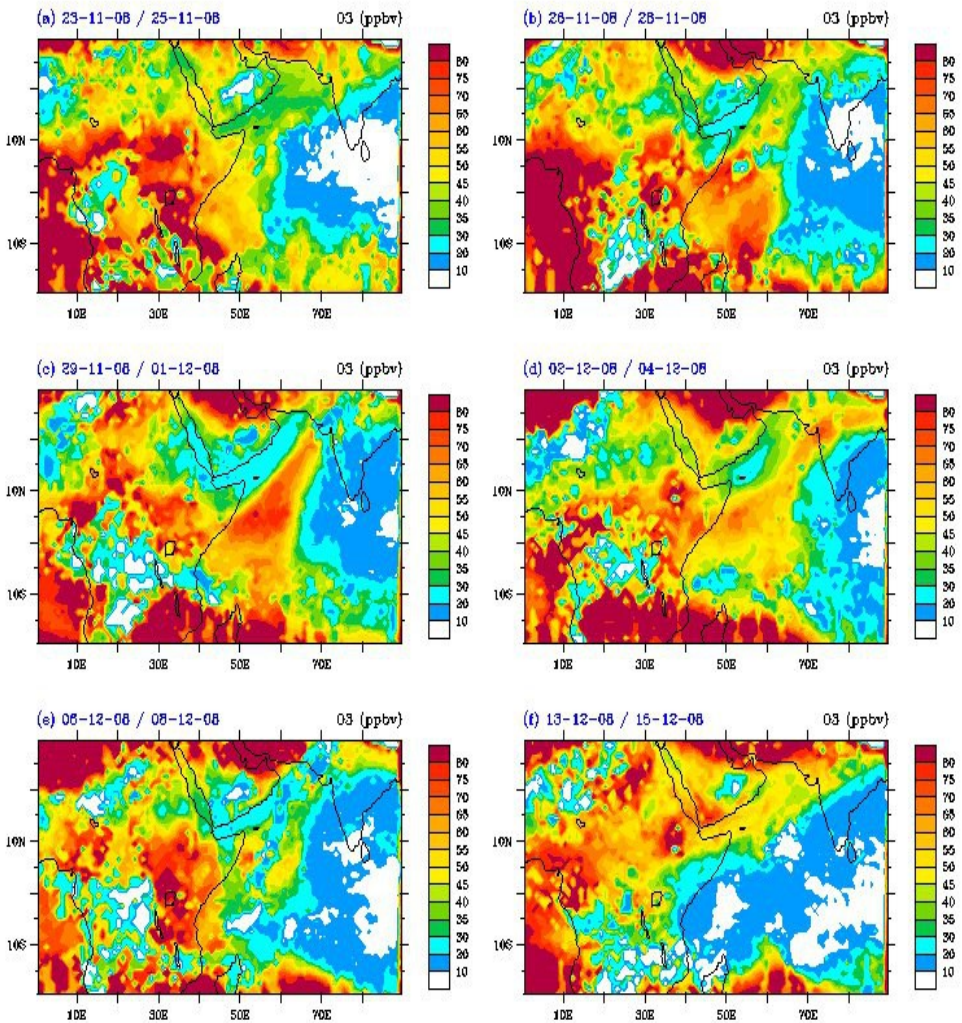
MeteoSat 07 (InfraRed)
20/11/08

Méso-NH modelisation

BB NOx + Lightning NOx distributions _ 210 hPa
23/11/08 – 15/12/08



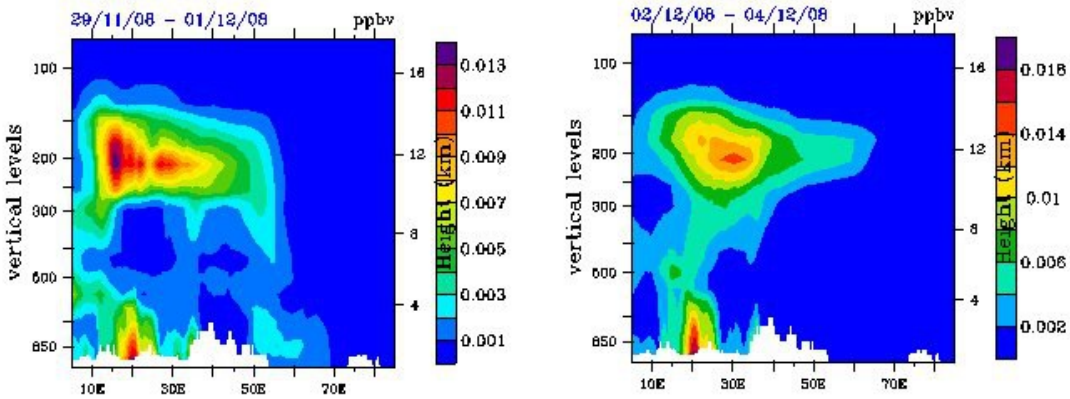
IASI SOFRID O_3 distributions at 210 hPa
23/11/08 – 15/12/08



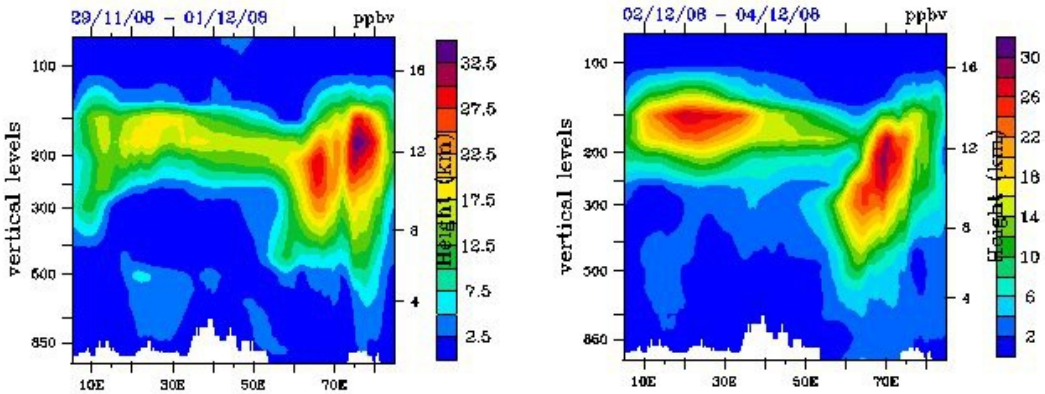
Méso-NH modelisation

→ Vertical transport processes

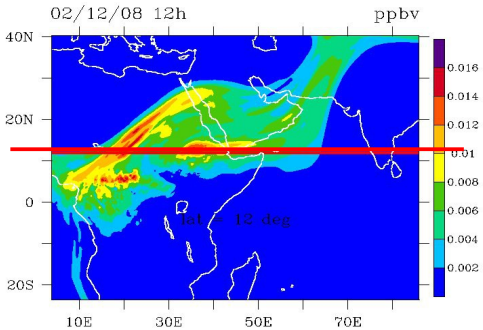
Vertical Cross Section at 12°N _NOx Biomass Burning



Vertical Cross Section at 12°N _NOx Lightning

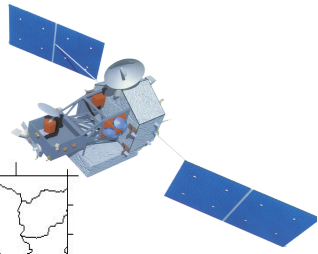


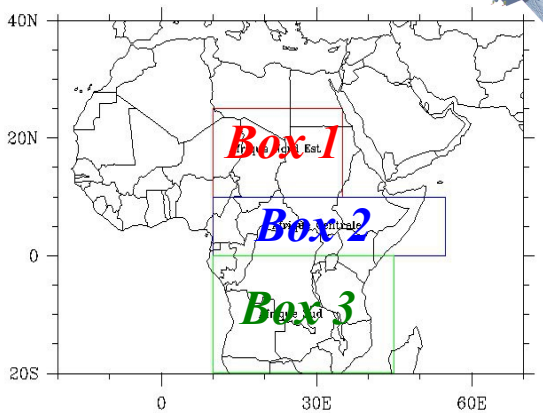
12°N

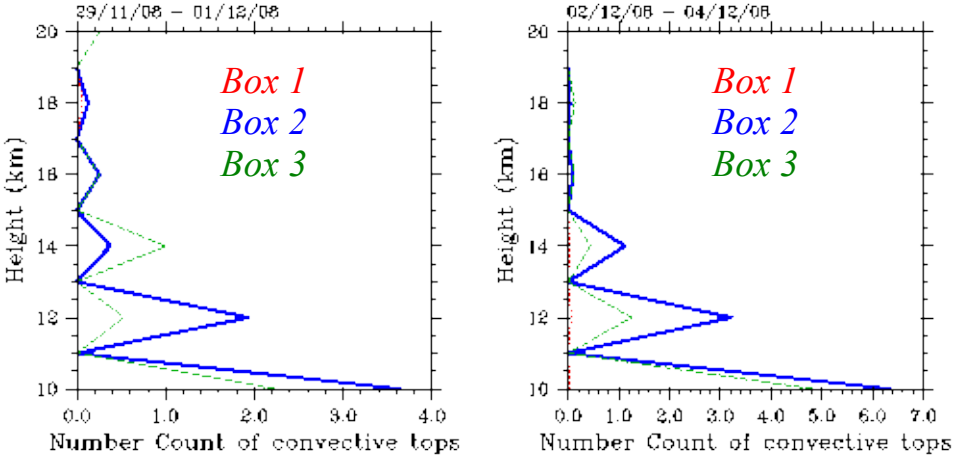


NOx BB at 180 hPa

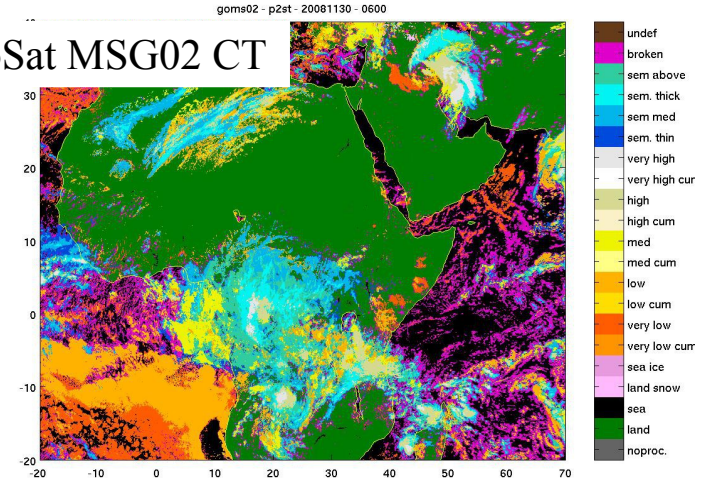
→ TRMM PR data





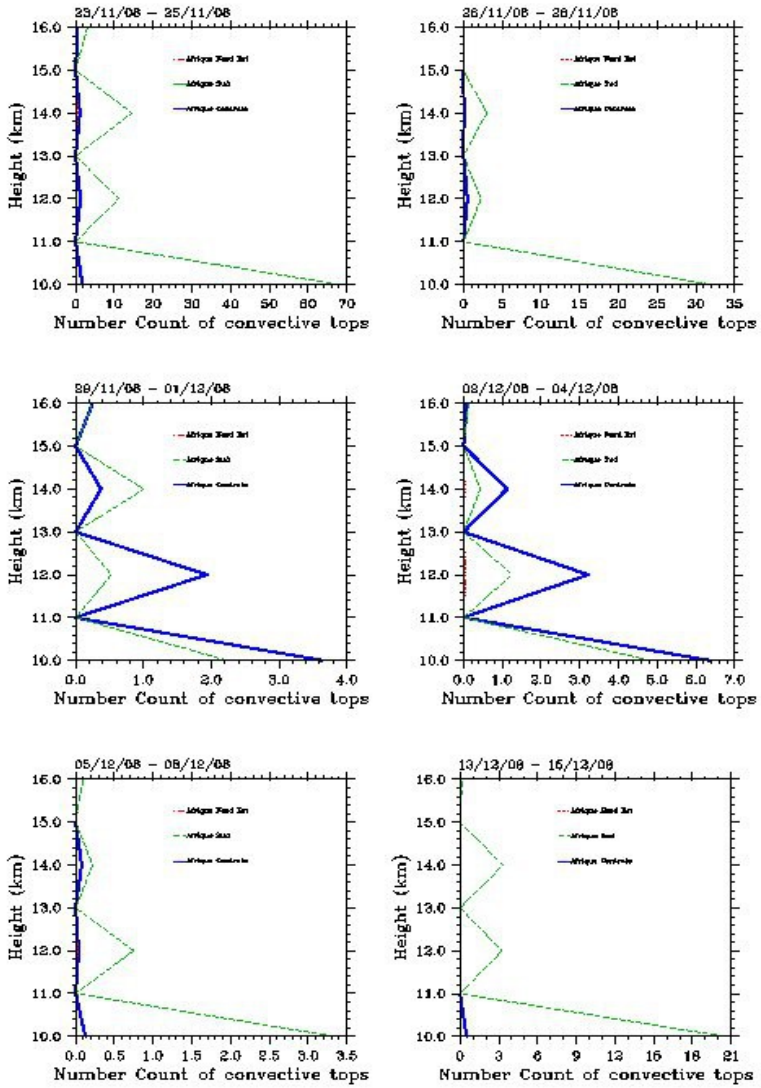


MétéoSat MSG02 CT

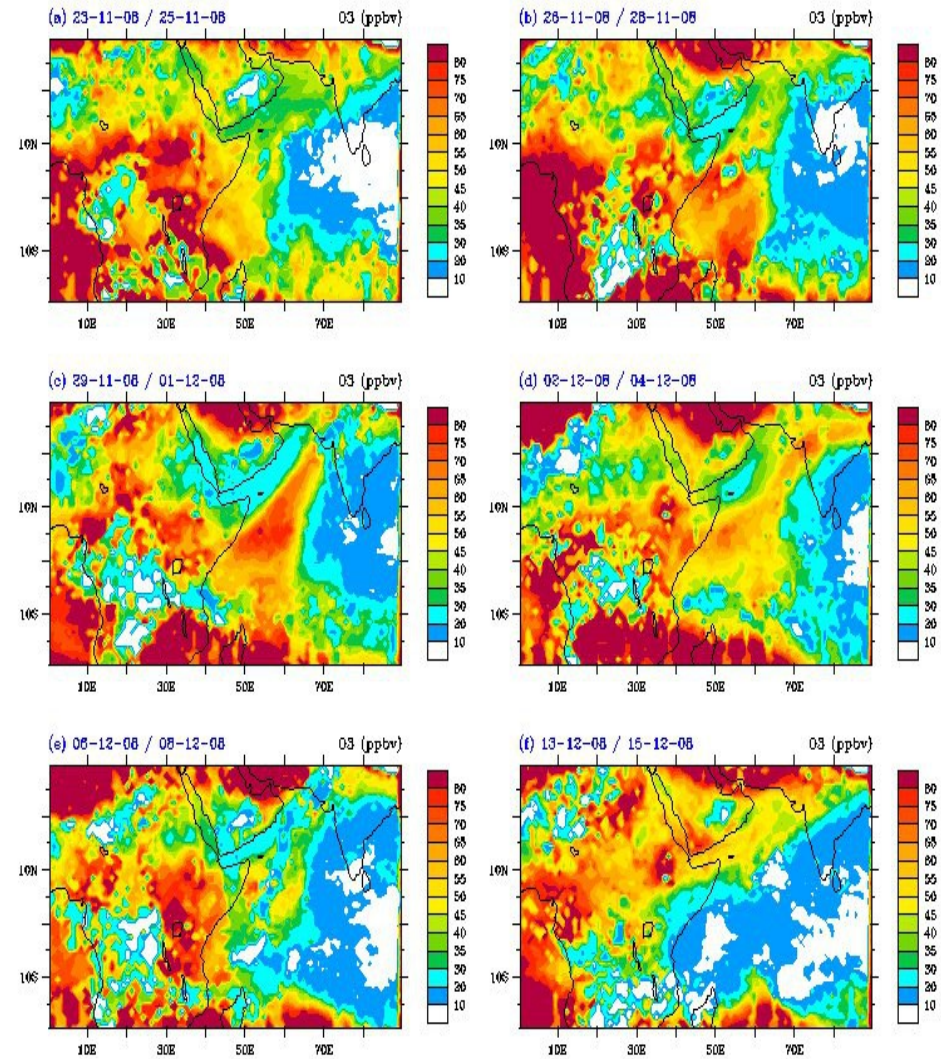


Méso-NH modelisation

Number count of convective tops _ TRMM PR data
23/11/08 – 15/12/08

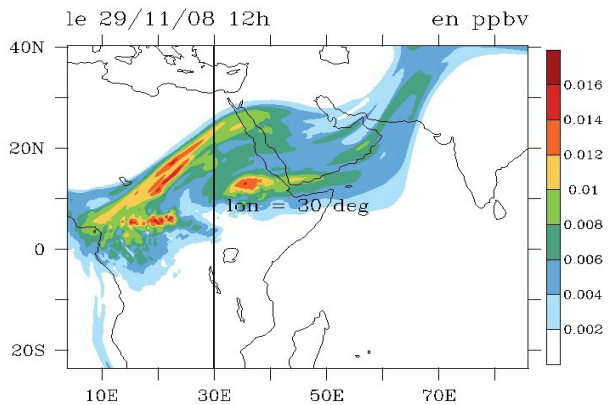


IASI SOFRID O_3 distribution at 210 hPa
23/11/08 – 15/12/08

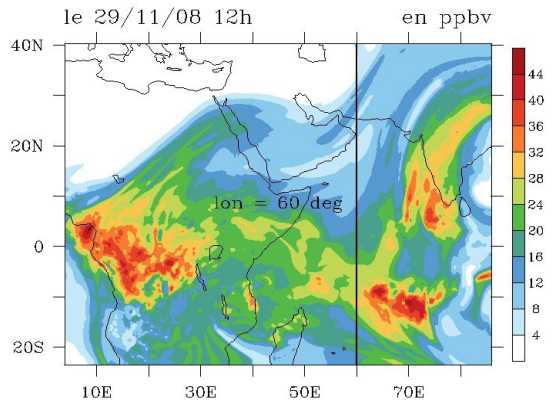


Méso-NH modelisation

BB NOx distribution at 180 hPa



LiNOx distribution at 180 hPa



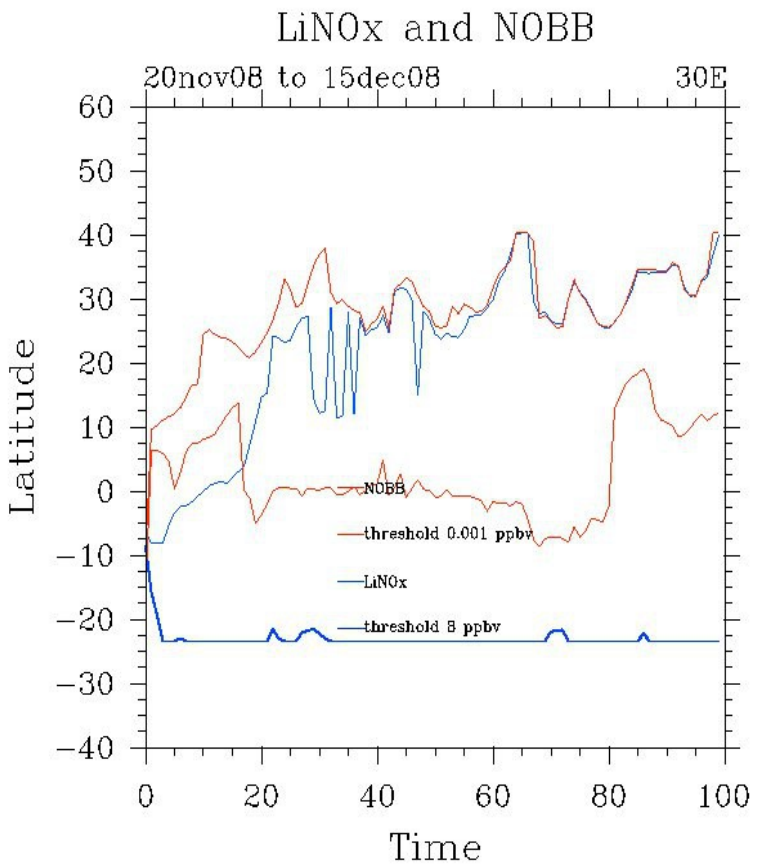
BB Nox in UT :

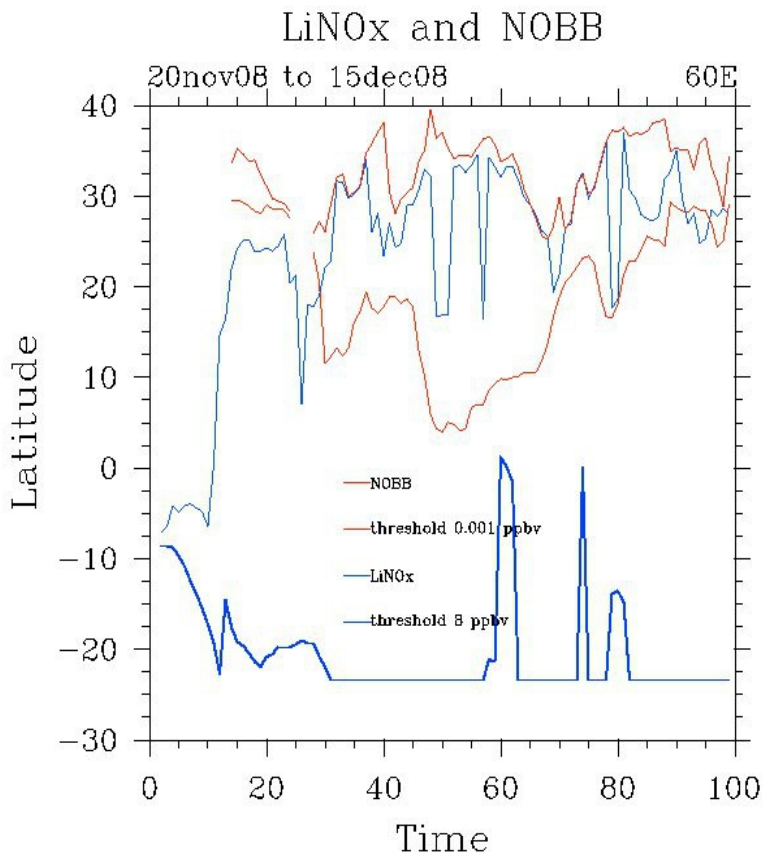
✔ Transport to Asia

✗ Much too far north

LiNOx in UT :

✔ Transport along the Arabian Sea



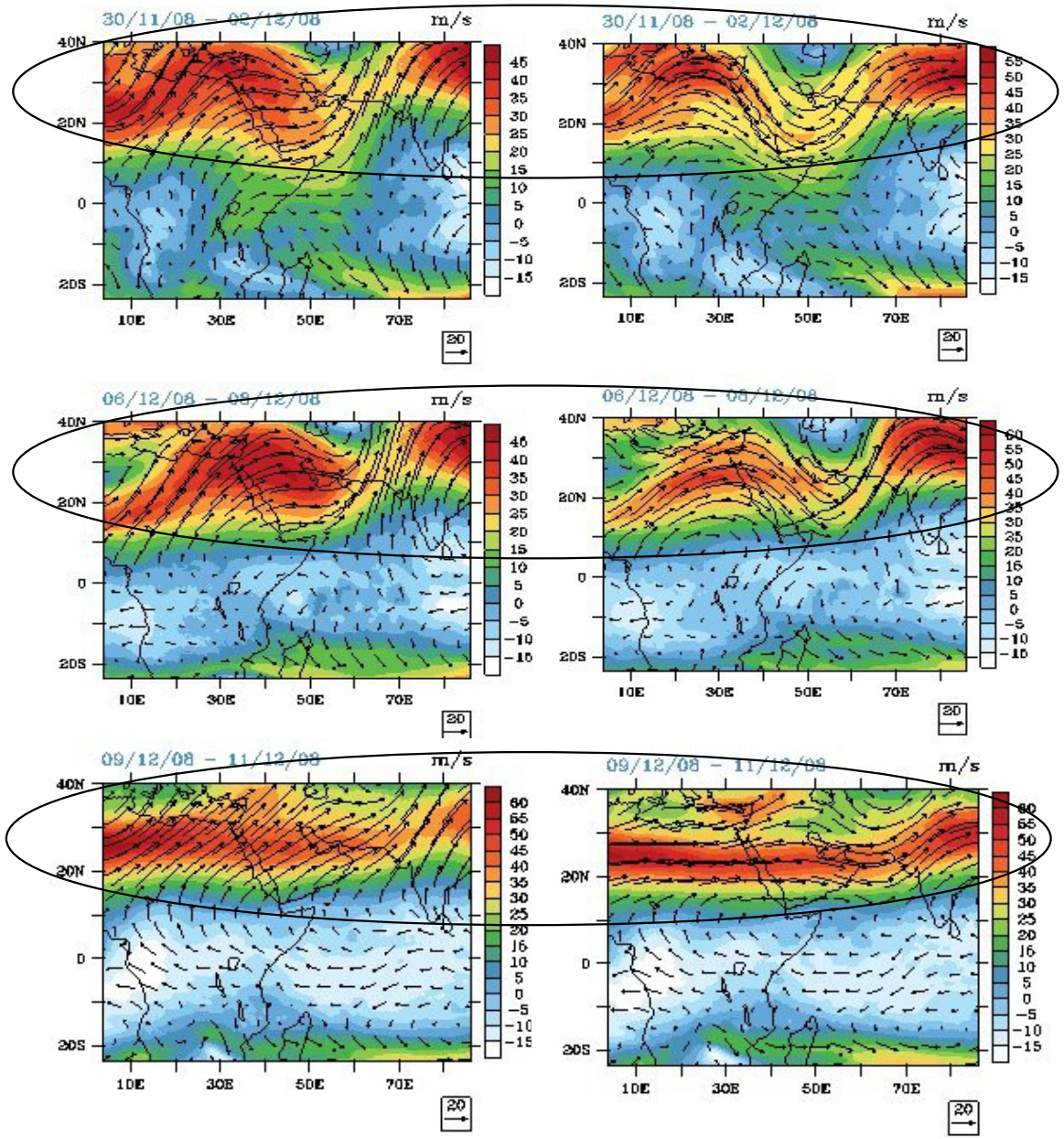


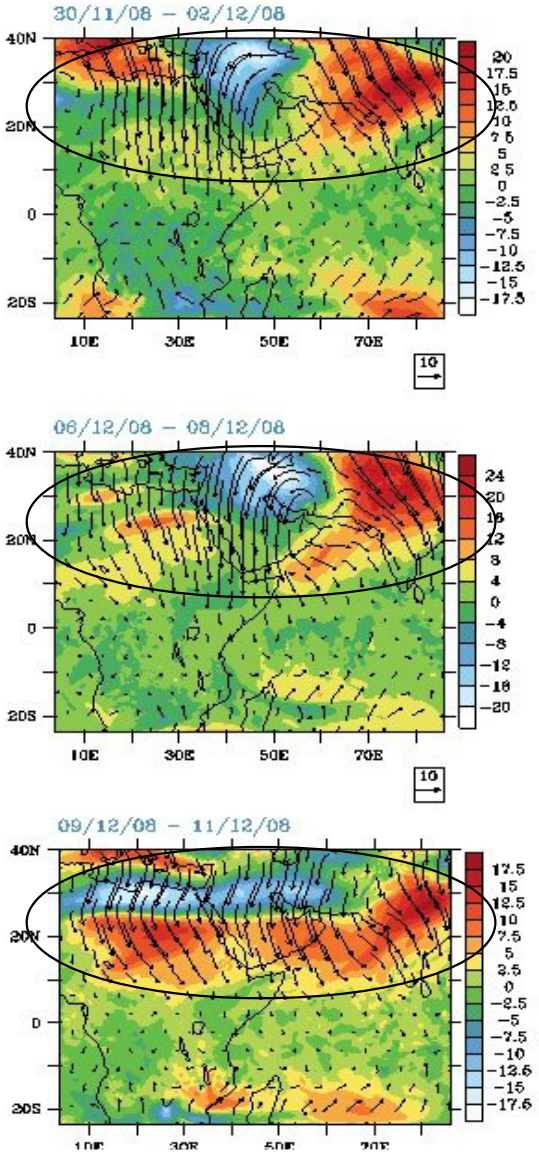
Méso-NH modelisation

Winds Méso-NH 210 hPa

Winds ECMWF 210 hPa

Difference ECMWF-Meso-nh





Conclusion & Prospect

Conclusion :

IASI: Global view of ozone transport from Africa to India, 26 Nov. to 4 Dec.

HYPOTHESIS : Origin of the O3 Channel : Africa BB + LiNOx *(de Laat ; FLEXPART)*

MESO-NH : High resolution and meso-scale
Using passive tracers of NOx BB and NOx lightning
→ Observation : LiNOx and NOx BB transport
→ But the model has a bias in the wind fields

TRMM : Convection in BB emissions region

Perspectives :

→ Finish simulations Meso-nh
Determine transport path of passive tracers
Determine whether or not mixture of tracers

→ Is the O3 River a frequent phenomenon?
Processing and analyses of 4 years of IASI data

→ Continue with my PhD simulations on Indian region during the Asian summer monsoon

Thank you for your attention

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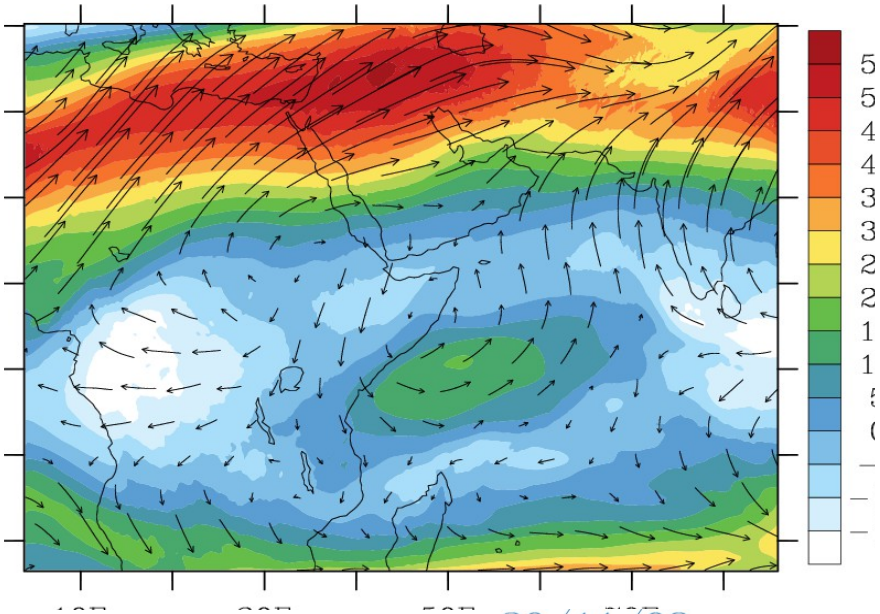
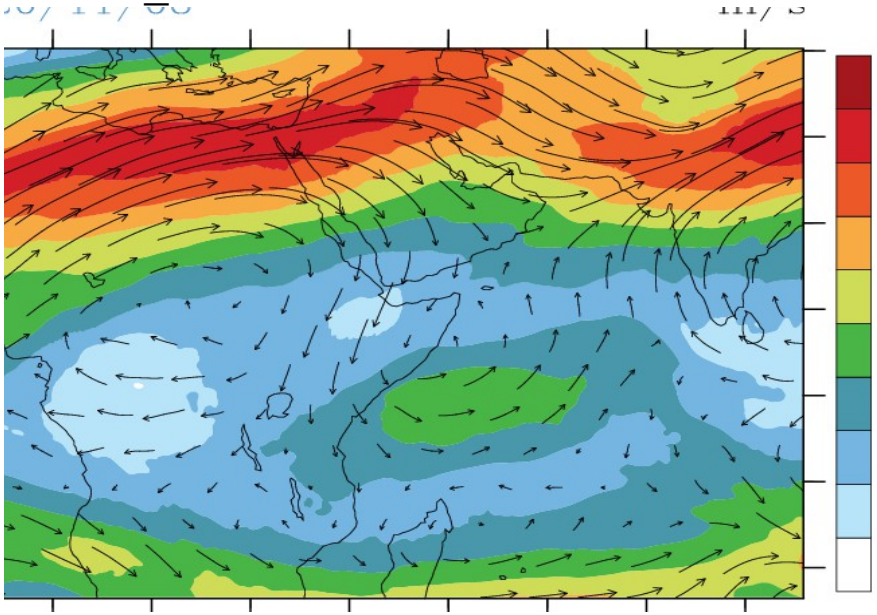
Méso-NH modelisation

→ Preliminary results

Méso-NH _ relax = 6h



Méso-NH _ ECMWF



Méso-NH _ relax = 2h