AFFORESTATION FOR IMPROVING VALLEY URBAN AIR-QUALITY

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Topography around Lanzhou, China
Lanzhou – One of the Most Polluted Cities in China

In the past two decades, the air pollution problem (gaseous) has been improved.
Factors Affecting Air Quality

- Meteorological Conditions
  - Stable stratification especially Inversion
  - Low Winds

- Pollution Sources
Mountain-Valley Wind (at Night)
Valley Winds (Night)
Keeping High Concentration
Three Major Tasks in Controlling Air Pollution

- Change Micro-Meteorological Conditions (Weakening the Inversion)
- Create Pollutant-Sinks
- Reduce the Pollutant Source-Level
Model Simulation

- Effect of Mountain Slope Afforestation Using Regional Atmospheric Modeling System (RAMS)
Model Description

- Nonhydrostatic
- Multi-grid System: 9 km, 3 km, 1 km
- 23 vertical levels, to 50 hPa
- 30"- Topography data
- Assimilation of observational data
- Land surface model
- Integration area: 720 km (E-W), 540 km (N-S)
  Centered at 103.8°E, 36.1°N
Multi-Grid System
USGS Vegetation 25-Category

- 1 – Urban
- 4 – Mix. Dry/Irrg. C.P.
- 5 – Crop/Grs. Mosaic
- 6 – Crop./Wood Mosc
- 7 – Grassland
- 8 – Shrubland
- 9 – Mix. Shrb./Grs.
- 10 – Savanna
- ...........
Model Integration – Control Run

- Winter Simulation (Dec 5 – 7, 2000)
- Initial Time: 08 BT, Dec 5, 2000
- Initial Conditions (NCEP Reanalysis)
- Lateral Boundary for the Largest Area (Every Six Hours, NCEP Reanalysis)
- $\Delta t$: 60 s, 30 s, 10 s
Simulated Wind and Temperature Fields at 800 hPa on: (a) 08, (b) 14, (c) 20, (d) 02 BT
Simulated \((v, w)\) and \(T\) in the north-south cross-section across the GaoLanShan Mountain on: (a) 08, (b) 14, (c) 20, (d) 02 BT
Mountain Slope Afforestation

- Weakens the Inversion
- Weaken the Valley Circulation at Night
- Creates Pollutant-Sinks
What type of afforestation should be used?
Three Possible Types of Afforestation

- **Green-A**: All area above 2100 m

- **Green-B**: Northern Mountain (below 1800 m) and Valley

- **Green-C**: Northern and Southern Mountains (below 2200 m) with 40 km (E-W) x 26 km (N-S) and centered in Lanzhou
Green-B

南北方向格点数
Green-C
Reduction of Inversion Strength

Time (BT)

Inversion Strength (unit: °C/m)

Control
Green_A
Green_B
Green_C
Reduction of Stability (Lapse Rate) (°C/m) Green-A minus Control
Reduction of Stability (Lapse Rate) (°C/m)
Green-B minus Control
Reduction of Stability (Lapse Rate) (°C/m)  
Green-C minus Control
Conclusions

- Afforestation type-C is used.
- Afforestation improves the air quality (reduces gaseous pollutants) through destabilizing the atmosphere and providing sinks for pollutants.
- The improvement in TSP, PM$_{10}$ is not evident.