



SOCIO-ECONOMIC BENEFITS OF EPS/METOP-SG

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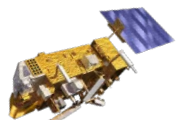


Objective and Scope

- **Objective:** Assessment of benefit/cost ratio for the EPS/Metop-SG programme (observations over 2020-2040)

- **Scope:** Benefit areas wide-ranging, not all currently quantifiable:
 - A. Areas directly benefitting from the improved accuracy of forecast information (e.g. protection of property and infrastructure, transport, energy management, private use by individuals....) – **quantitative assessment possible**

 - B. More specialized or complex areas (e.g. safety of life, security and defence, climate monitoring/projections, forecasts of air quality and the ocean.....) – **quantitative assessment more complex or not feasible**



4-Step Methodology

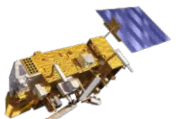
Gather Socio-Economic Benefit Information on Forecasting

Assess Impact of Metop Data on Forecast Accuracy

Estimate the Socio-Economic Benefits Attributable to EPS/Metop-SG

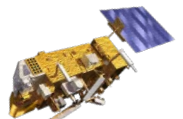
EPS/Metop-SG Programme Costs

Determine the Benefit/Cost Ratio of the EPS/Metop-SG programme



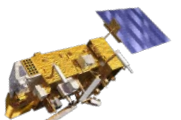
Background

- Collaborative venture:
 - Socio-Economic Benefits of forecasts: World Bank/Météo-France
 - Impact of satellites on forecasts : ECMWF, UKMO, DWD, Météo-France
 - Benefits attributable to satellites : All



Socio-Economic Benefits of Forecast Information

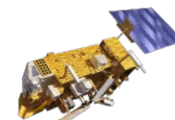
- Focus on benefits which can be assessed quantitatively
- Scope limited to Europe (EU27) and covered **three** areas:
 - Protection of property and infrastructure (avoided costs)
 - Direct added value to the European Economy: 1/3 of EU GDP is “weather sensitive”
 - Value of private Use by European Citizens



Socio-Economic Benefits of Forecast Information - Summary

BENEFIT AREA	MINIMUM	LIKELY
Protection of Property and Infrastructure	€1.32 billion/year	€5.4 billion/year
Added Value to the European Economy	€10.23 billion/year	€41.0 billion/year
Private Use by European Citizens	€4.0 billion/year	€15.0 billion/year
TOTAL	€15.55 billion/year	€61.4 billion/year

ESTIMATED ANNUAL BENEFITS OF FORECAST INFORMATION TO THE EU27 ECONOMY
(Excluding Safety of Life)



Impact of Metop Data on Forecasting

Parallel investigations undertaken to provide 3 different perspectives on impact of EPS/Metop-SG on forecast accuracy:



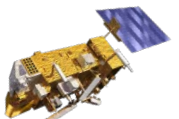
Assessment of the relative contributions of the various observation sources to forecast accuracy (Met Office UK)



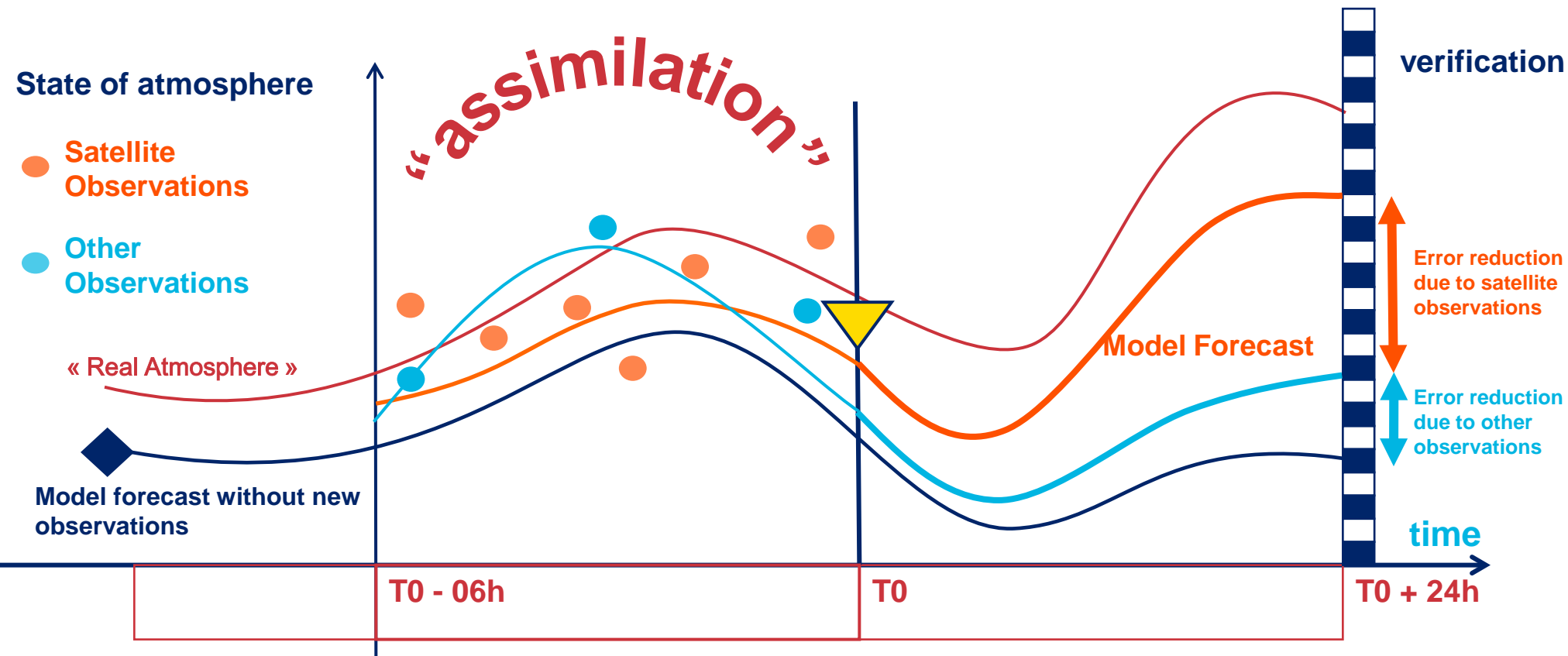
Statistical Impact on Forecast Accuracy using Data Denial Experiments (ECMWF)



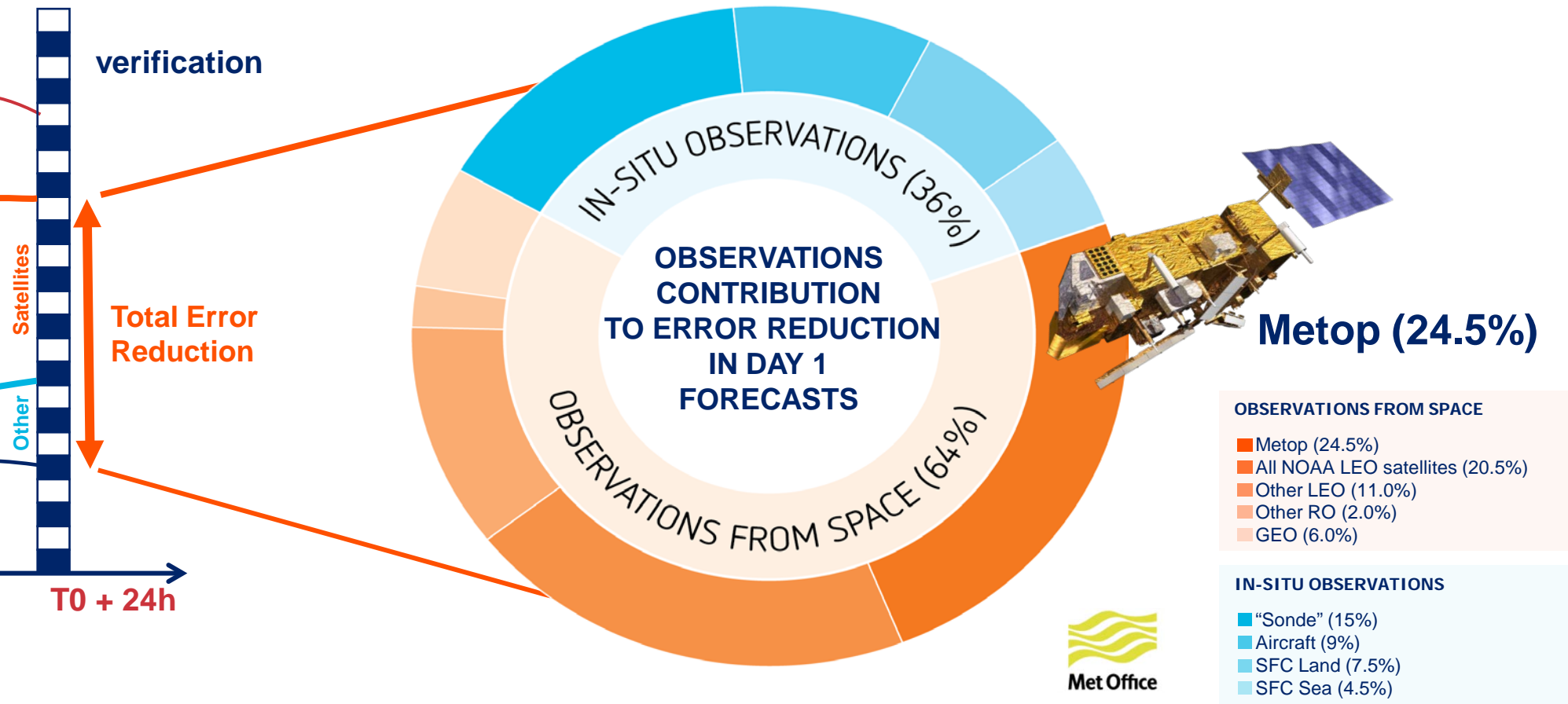
Case Study on the Impact of Polar Data on the Forecasting of Winter Storms over Europe (DWD)



Constrain the “initial trajectory” of the forecast model



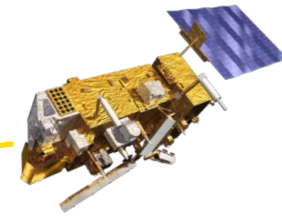
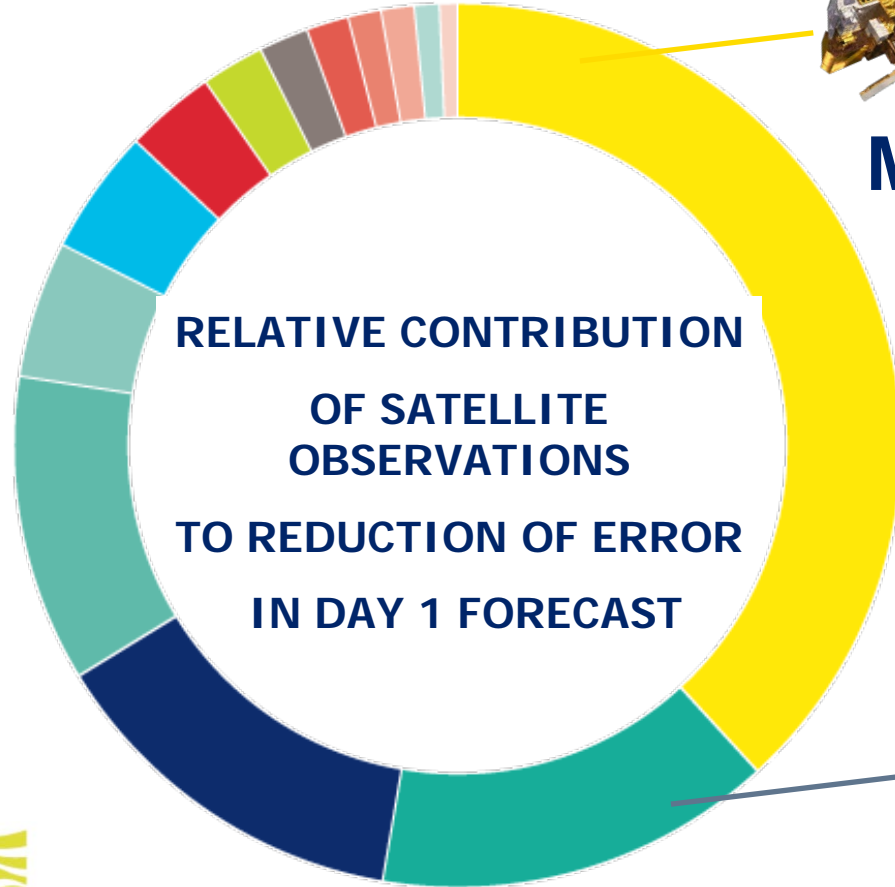
Major impact of Metop-A on Day 1 forecast (average)



NOAA 19 versus Metop-A: Benefits of Investing in a New Generation

OBSERVATION TYPES

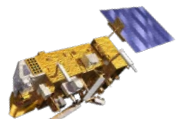
- METOP
- NOAA-19
- AQUA
- NOAA-15
- NOAA-18
- METEOSAT
- COSMIC
- MTSAT
- GOES
- CORIOLIS
- TERRA
- F16
- NOAA-17
- GRACE
- NOAA-16
- ERS



Metop-A (38%)



NOAA-19 (13%)

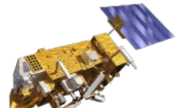
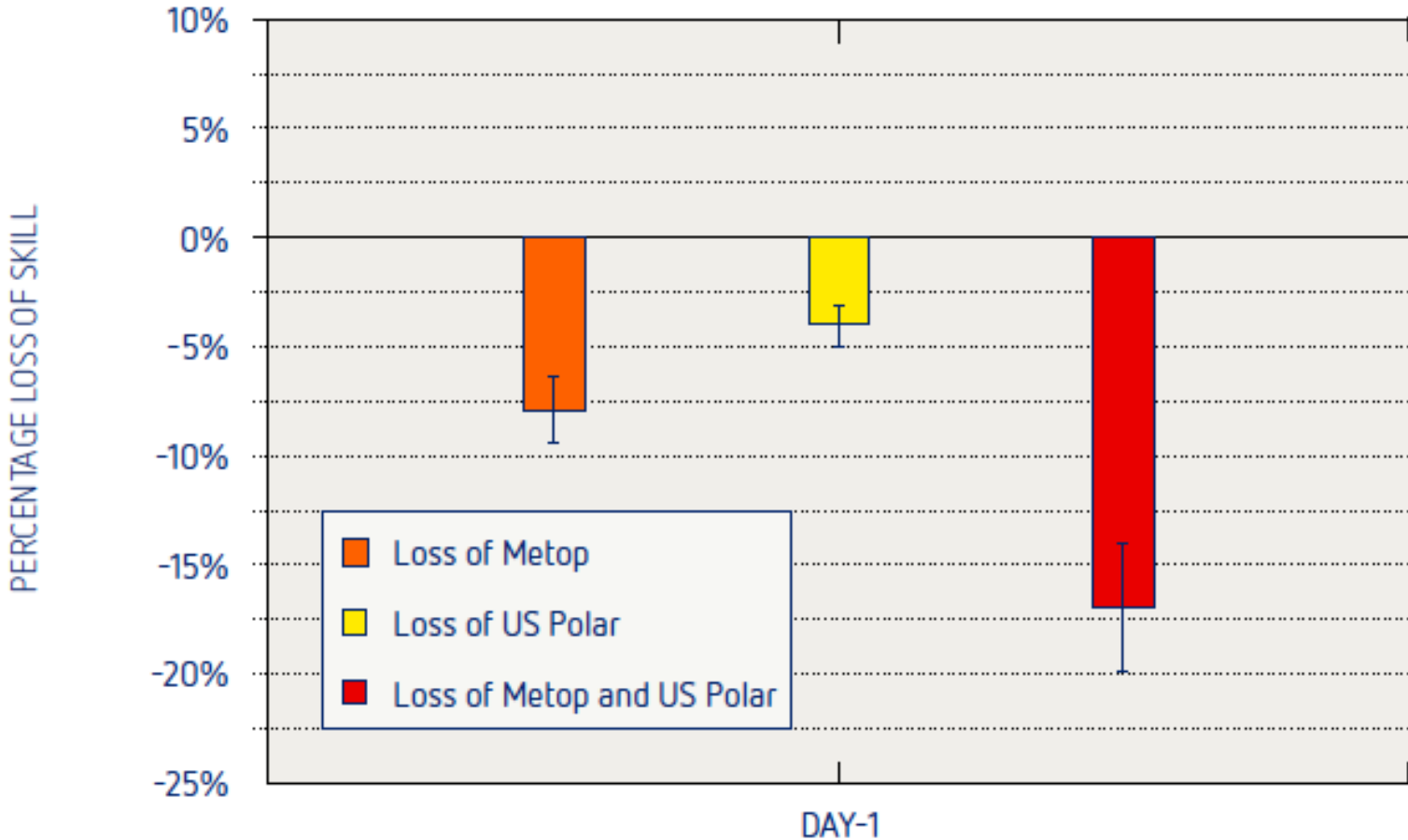


IMPACT OF POLAR OBSERVATIONS ON DAY-1 FORECAST ACCURACY



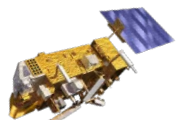
EUROPEAN REGION

(Loss of skill relative to baseline that includes Metop + US Polar)



AVERAGE IMPACT OF METOP DATA ON FORECASTING – MAIN RESULTS

- EUMETSAT and NOAA operational polar orbiting satellites account for more than 45% of the impact of all observations on Day 1 forecast
- Metop-A alone accounts for 24.5% of the reduction of forecast errors by all observations (statistical average)
- This is roughly 2.5 times more than one US spacecraft from a previous generation
- Loss of Metop data would lead to an 8% drop in forecast accuracy over Europe (statistical average), assuming other components of the observing system remain in place
- On a case by case (e.g. major storm), loss of Metop data can ruin the forecast (100% drop) with major negative impact on EU citizens

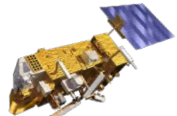


ESTIMATED SOCIO-ECONOMIC BENEFITS OF EPS/METOP-SG

- Most conservative assumption on forecast impact taken : 8%
- Likely benefit of current Metop: 4,9B€ per year
- For 20 years of EPS/Metop-SG:

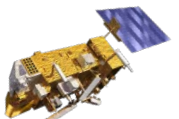
BENEFIT AREAS	SOCIO-ECONOMIC BENEFIT ²⁹ (over 20 years of EPS/Metop-SG)	
	MINIMUM	LIKELY
Protection of Property and Infrastructure	€1.45 billion	€6.0 billion
Added Value to the European Economy	€11.3 billion	€45.2 billion
Private Use by European citizens ³⁰	€3.0 billion	€11.45 billion
TOTAL	€15.7 billion	€62.6 billion

(Present Value (2010), Discount Rate of 4%, Annual GDP growth of 2%)



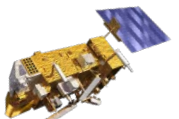
Estimated EPS/Metop-SG Benefit/Cost Ratio

- Benefit/cost ratio likely to exceed 20, based on the most conservative assumptions on impact of forecasts
- Benefit underestimated
 - Not included: safety of life, security and defence, climate monitoring, climate predictions/projections, seasonal forecasting, competitiveness of the European Space Industry...
 - Benefits expected to be significantly larger with enhanced EPS/Metop-SG instruments



Why Benefits will Increase Further in the Future

- The accuracy of forecasts is likely to rise further as a result of improvements in models and observations
- Benefits will increase faster than forecast accuracy, i.e. when performance thresholds are exceeded
- The relevance of warnings and decision-making support delivered by National Meteorological Services of Member States will improve
- Public and private decision making will improve and make better use of forecasts and warnings
- The vulnerability of our society and economy (e.g. with the development of renewable energy) to weather and related hazards will continue to increase
- More frequent high-impact weather events are expected in our changing climate, increasing further the avoided costs



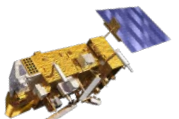
CONCLUSION

□ Economy

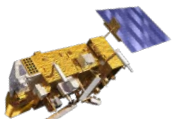
- EPS/Metop-SG is essential for European citizens and the economy....
- Based on the most conservative assumptions the benefit to cost ratio of the programme is likely to exceed 20

□ Value of innovation

- The development of innovative and more capable satellite systems will further increase benefit
- And preserves Europe's position as a world leader in both forecasting and meteorological satellites

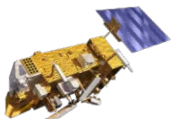


BACKUP SLIDES



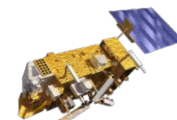
Socio-Economic Benefits of Forecast Information

- **Protection of Property and Infrastructure (avoided costs)**
- Forecast information and warnings combined with prevention and protection/mitigation systems limit economic losses due to severe weather and related events (e.g. floods, storms, snow, heat-waves, cold spells, etc)
 - Floods in Europe cost on average about €4Bn/year
 - Storms in Europe cost on average about €2.6Bn/year
- Based on published information, the annual benefit of forecast information in limiting European losses due to such events is estimated to lie between €0.66Bn (minimum) and €2.7Bn (likely)



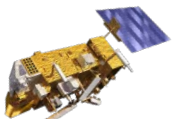
Socio-Economic Benefits of Forecast Information

- **Direct Added Value to the European Economy (Exc. private use)**
- Forecast information widely used to optimize activities and increase productivity
 - Transport Sector
 - air traffic management (weather-induced air traffic delays cost around €700m/year in Europe)
 - route planning/optimisation
 - road and rail network management,
 - Energy Management (demand estimation, renewable supply....)
 - Agriculture (planting, harvesting, use of fertilizers...)
 - Leisure and tourism (demand planning)
 - Construction (planning)
 - Mining



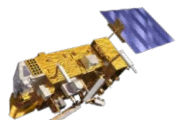
Socio-Economic Benefits of Forecast Information

- **Direct Added Value to the European Economy....Ctd**
- Estimations available for added value of weather forecasts to weather-sensitive sectors of European economy
- About 1/3 of European GDP is weather-sensitive, with some sectors particularly sensitive (e.g. transport and energy)
- Aviation sector alone contributes over €120Bn to European GDP, as well as being a vital infrastructure component for Europe
- If forecast information yields a conservative “added value” of 0.25% to these weather-sensitive sectors the benefit would be about €10Bn/year, a more realistic contribution of 1% would yield a benefit of around €40Bn/year
- Case studies and national studies in developed countries suggest an “added value” much larger than 1%.



Socio-Economic Benefits of Forecast Information

- **Value of Private Use by European Citizens**
- A US study has indicated that private households in the US place a value of about US\$280/year on forecast information
- Assuming each European household would be prepared to pay €20/year (directly or through taxes) then the aggregate benefit would be around €4Bn/year
- Benefit increases to 15Bn/year if a more likely value of €80/year for each European household is assumed



Socio-Economic Benefits of Forecast Information

- **Safety of Life**
- Core Mission of Meteorological Services and Civil protection
- Many weather-related threats to life (floods, storms, heat-waves, cold snaps, avalanches....)
- Difficult to quantify how lives saved by prevention and warning systems but essential for the safety of the population
- Forecast information plays a large role in safety of leisure activities, e.g. sailing, hiking and skiing
- No quantitative benefit assessment included but conservatively assumed many hundreds of lives saved each year by forecast and warning systems
- Invaluable benefit for both society and policy-makers

